

environmental experts, they can accompany the interested party if needed.

#### **(5) Penalties and Measures**

Authorities having jurisdiction can take such measures as warning, suspension, fine etc. against a violator, based on Ley 99/93 X II, after proper investigation.

##### **1) Type of Penalties:**

The Ministry of the Environment and CAR will order the infringer of the laws on the protection of the environment and management and exploitation of the renewable natural resources, pursuant to the relevant resolution and in accordance with the seriousness of the infringement to comply with one or more of the following penalties and preventive measures:

- a) Fines to be determined at the time of enacting the corresponding resolution;
- b) The suspension of the registration or license, concession, permit or authorization;
- c) The temporary or definitive closing of the establishment, building or corresponding service, and the revocation or lapse of the permit or concession;
- d) The demolition of the work, at the expense of the infringer, if it was started without a permit or license and was not suspended, when causing clear damage to the environment or the renewable natural resources;
- e) The definitive seizure of individuals or specimens of flora or fauna or of the products or accessories used to commit the infringement;

##### **2) Preventive Measures:**

- a) Oral or written warning;
- b) Preventive seizure of individuals or specimen of flora or fauna or the products or accessories used to commit the infringement;
- c) The suspension of the work or activity, when its continuation could cause damage or danger to the renewable natural resources or human health, or when the work or activity has been initiated without the corresponding permit, concession, license or authorization;
- d) The performance within a non-extendible period of time, of the required studies and characteristics of the damage, the effects and consequences caused by the infringement, as well as the required measures to mitigate or compensate for them.

#### **7.2.2 Environmental Standards**

Standards for the atmosphere, water, noise etc., were established by the Ministry of Health before the Ministry of the Environment was created. The Ministry of the Environment is now amending these environmental standards, but, the norms of the Ministry of Health will remain valid as the formal environmental standards until new standards are established. Environmental quality standards are as follows:

##### **(1) Air Quality (Decreto 0002/82)**

Standard values of basic pollutants in ambient air are summarized in Table 7.2-1. The methods by which they were estimated are as follows:

##### **1) Suspended Particulate Matter (SPM):**

The geometrical average concentration of all the daily samples gathered continuously for 24 hours during 12 months should not exceed  $0.1\text{mg}/\text{cm}^3$ . The maximum

concentration of a samples gathered continuously during 24 hours in a period of 12 months should not exceed  $0.4\text{mg}/\text{m}^3$ .

2) Sulfur Monoxide( $\text{SO}_2$ ):

The arithmetical average concentration of all the daily samples gathered continuously for 24 hours during an interval of 12 months should not exceed  $0.1\text{mg}/\text{m}^3$ . The maximum concentration of a sample gathered continuously during 24 hours once only time in a period of 12 months should not exceed  $0.4\text{mg}/\text{m}^3$ . The maximum concentration of a sample gathered continuously for 3 hours once only in a period of 12 months should not exceed  $1.5\text{mg}/\text{m}^3$ .

3) Carbon Monoxide( $\text{CO}$ ):

The maximum concentration of a sample gathered continuously for 8 hours should not exceed  $15\text{mg}/\text{m}^3$ . The maximum concentration of a sample gathered continuously for 1 hour should not exceed  $50\text{mg}/\text{m}^3$ .

4) Photochemical Oxidant - Ozone ( $\text{O}_3$ ):

The maximum concentration of a sample taken continuously for 1 hour once only in a period of 12 months should not exceed  $0.17\text{mg}/\text{m}^3$ .

5) Nitrogen Dioxide( $\text{NO}_2$ ):

The arithmetical average concentration of all the daily samples gathered continuously for 24-hour periods during 12 months should not exceed  $0.1\text{mg}/\text{m}^3$ .

Table 7.2-1 Environmental Quality Standard for Air Pollution

Substance	Environmental Conditions
Suspended Particulate Matter(SPM)	Annual average : $100\mu\text{g}/\text{m}^3$ or less Daily average : $400\mu\text{g}/\text{m}^3$ or less
Sulfur Dioxide( $\text{SO}_2$ )	Annual average : $100\mu\text{g}/\text{m}^3$ or less Daily average : $400\mu\text{g}/\text{m}^3$ or less Max. for 3 hours : $1,500\mu\text{g}/\text{m}^3$ or less
Carbon Monoxide( $\text{CO}$ )	Mean for 8 hours : $15\text{mg}/\text{m}^3$ or less Max. for one-hour: $50\text{mg}/\text{m}^3$ or less
Ozone( $\text{O}_3$ )	Max. for one-hour: $170\mu\text{g}/\text{m}^3$ or less
Nitrogen Dioxide( $\text{NO}_2$ )	Annual average : $100\mu\text{g}/\text{m}^3$ or less

(2) Water Quality (Decreto 1594/84)

1) Environmental Items for Conservation of the Living Environment

For the establishment of the simulation model of water quality, the following items are listed.

Table 7.2-2 Items for Water Quality

Biochemical Oxygen Demand(BOD)
Chemical Oxygen Demand(COD)
Suspended Solids(SS)
Hydrogen Ion Concentration(pH)
Temperature
Dissolved Oxygen(DO)
Aquatic Organism Data
Coliform Groups

2) Environmental Quality Standards for the Protection of Human Health

The criterion of acceptable quality for human consumption for which conventional treatment is required are as follows;

Table 7.2-3 Environmental Quality Standards for the Protection of Human Health

Substance	Chemical Symbol	Value
Ammonia	N	1.0mg/l or less
Arsenic	As	0.05mg/l or less
Barium	Ba	1.0mg/l or less
Cadmium	Cd	0.01mg/l or less
Cyanide	CN	0.2mg/l or less
Zinc	Zn	15mg/l or less
Chloride	Cl	250.0mg/l or less
Copper	Cu	1.0mg/l or less
Color	Color real	75 unit
Chromium	Cr <sup>6</sup>	0.05mg/l or less
Mercury, etc.	Hg	0.002mg/l or less

(3) Noise

Concerning the environment, the Law of Natural Resources establishes that: "the construction of highways and railways should be done with caution in order not to cause environmental deterioration including alterations in the topography and in order to minimize control vehicle noise"(article 193).

In addition, Resolution No.08321/83 of the Ministry of Health prescribes the aspects related to the protection and conservation of the auditory sense. These norms are as follows;

- a) Permissible maximum sound levels depend on whether it is day or night, and whether it is a residential, commercial, industrial or required silence zone
- b) General norms of sources of noise
- c) Permissible maximum noise level for vehicles
- d) Protection and conservation of the hearing sense from noise in working places (for continuous, intermittent or impulse noise)
- e) Programs of conservation of the auditory sense

Regulations on noise contained in Resolution No.08321/93 of the Ministry of Health establishes that : "In order to prevent and control the nuisance and the hearing loss of residents caused by noise, permissible maximum noise levels are regulated as shown in Table 7.2-4 (Article 17 of the Resolution).

Table 7.2-4 Permitted Noise Levels for Several City Zones

ZONE	Sound Pressure Level (dBA)	
	Daytime(7-21H)	Nighttime(21-7H)
Residential	65	45
Commercial	70	60
Industrial	75	75
Places requiring quiet	45	45

In addition, Article 36 provides that: "No persons should operate motor vehicles, motorcycles or any other similar form of transport, at any time, if the sound pressure level emitted by vehicle exceeds the permissible maximum levels in Table 7.2-5.

**Table 7.2-5 Permissible Maximum Levels for Vehicles**

Type of vehicles	Sound Pressure Level (dBA)
Less than 2 tons	83
From 2 to 5 tons	85
More than 5 tons	92
Motorcycles	86

**7.2.3 International Conventions on Environmental Conservation**

- 1) **Convention on International Trade in Endangered Species of Wild Fauna and Flora (Washington Convention)** : participated (1981)  
 authority Instituto Nacional de los Recursos Naturales Renovables del Ambiente (INDERENA)
- 2) **Convention on Wetlands of International Importance, especially as Waterfowl Habitat (Ramsar Convention)** : non-participatory
- 3) **Convention Concerning the Protection of the World Cultural and Natural Heritage** : participated(1983)  
 a site proposed Sierra Nevada de Santa Marta NP, 2, 3  
 Sierra de la MacAR ena NP,
- 4) **United Nations Convention on the Law of the Sea** : non-participatory
- 5) **Basel Convention** : participated
- 6) **Valuable species**  
 There is no formal published list after establishment of the Ministry of the Environment. However a staff member of MOE suggested that such species as "Saguinus leucopus, Penelope perspicax, Rallus semiplumbeus" may exist.

### 7.3 Present Situation of the Proposed Project Site

Bogota is a cultural city with abundant natural environmental and historical relics.

The Environmental Authority of this area is the DAMA, whose functions are specified in Decreto No.673/95. For more details on the present environmental conditions of Bogota, it is necessary to obtain "Diagnostico Ambiental de Bogota", which is to be published by the DAMA before long. "Plan de Gestion Ambiental del D.C.", published in 1994, also shows conditions of environment in Bogota, although it has not been approved by the Assembly.

The budget of the DAPD for environmental projects is the sum of 447.636 millions pesos for the period from 1995 to 1998.

#### 7.3.1 Socioeconomic Environment

##### (1) Resettlement and compensation

Resettlement with compensation has been implemented for public projects, in some cases by compulsory execution. One problem is that the inhabitants concerned tend to insist on large amounts of compensation.

For illegal occupation of abandoned railway sites order to restore them for use of a metro bus system, the STT is regulating the compensation for evacuation and resettlement.

##### (2) Cultural Property

As an important aspect of cultural traditions, there are many important historical monuments designated by the National Government and Bogota. In Bogota, there are almost 1,000 cultural monuments designated by the National Government and over 4,000 by the City. Patrimonio Cultural and the DAPD promote conservation, protection and maintenance, and undertake investigation of the degree of deterioration as well as repair. These relics are of great importance, so they cannot be easily cleared away. However Congress will need to discuss plans to do this in case problems occur for public works such as road construction. A partial list of sites which should be preserved was established by Decree No.677 in Bogota, as shown in Table 7.3-1.

##### (3) Solid Waste

Santa Fe de Bogota produces approximately 5,200 tons/day of solid waste. The majority of solid waste is transported by contractors to a final landfill site at Dona Juna located in the southern part of the city. This site is expected to be usable for a period of 20 years. Table 7.3-2 shows the composition of waste in Bogota.

There is no system for the management of dangerous waste in Santafe de Bogota. One hundred tons of dangerous industrial waste and 18 tons of dangerous hospital waste are produced daily, and these wastes are not sorted. To cope with this problem, the EDIS (Empresa Distrital de Servicios Públicos) and the DAMA will need to promote proper waste management such as sorted collection of dangerous objects and other waste.

Construction residue and waste are at present transported to Santa Cecilia Bajo and used to fill the old quarry. The authorities in charge of waste management should share the responsibility of waste treatment.

Table 7.3-1 Location of Sites to be Preserved

Neighborhoods	Area
Cabera	Calles 87/88 Cras 10/11; Calles 85/86 Cras 10/11; Calles 87/88 Cras 9/10; Calles 86/87 Cras 9/10; Calles 87/88 Cras 8/9; Calles 86/87 Cras 8/9; Calles 86/87 Cras 8/9; Calles 86/87 Cras 8/9; Calles 85/86 Cras 7/8;
Retiro	Av. 82/Calle 85 Cras 10/11; Av. 82/Calle 84 Cras 10/9; Av. 82/Calle 84 Cras 8/9;
Nogal	Av. 82/Calle 82 Cras 9/10; Calles 77/78 Cras 9/11; Calles 76/77 Cras 9/11; Calles 79/80 Cras 7/9;
Espartillal	Cras. 11/12A Calles 77A/78;
Porciuncila	Cras. 13/14 Calles 75/76; Calles 75/76 Cras 11/13; Cras. 11/13 Calles 74/75; Cras. 11/13 Calles 74/73; Calles 74/76 Cras 9/11; Calles 75/76 Cras 8/9; Calles 73/75 Cras 7/9; Calles 75/76 Cras 7/9;
Bellavista	Cras. 5/7 Calles 77/75; Calles 75/76 Cras 4 Y 3; Cra. 5/ Calles 77/78 Y Parque Rosales;
Rosales	Cras. 4/7 Calles 78/80; Av. Circunvalar/Cra. 4/ Calles 77/78; Calles 78/Cra. 3 Embasada U.S.A Calle 77;
El Refugio	Cras. 5/7 Y Calle 86/ Trasn. 4;
Granada	Calles 67/68 Cras 5/6; Calles 66/67 Cras 5/6; Calles 67/68 Cras 4A/5; Calles 66/67 Cras 4/5; Calles 66/67 Cras 6/7;
Emaus	Calles 69A/70 Cras 6/7;
Quinta Caniacho	Cras. 12/ Av. Caracas Calles 71/72; Cras. 12/ Av. Caracas Calles 70A/71; Cras. 12/14 Y Calles 70A/70; Cras. 11/ Av. Caracas Y Calles 69/70; Cras. 11A/ Av. Caracas Y Diags. 68/69; Cras. 12/ Av. Caracas Calles 68/ Diags. 68; Cras. 11/12 Y Calles 72/73; Cras. 11/12 Y Calles 70A/71; Cras. 11A/12 Y Calles 70/70A; Cras. 11/11A Y Calles 69/70; Cras. 11/11A Y Calles 68/69; Cras. 10A/11 Y Calles 70/70A; Cras. 10A/11 Y Calles 69/70; Cras. 10A/11 Y Calles 67/69; Cras. 10/10A Y Calles 67/69; Cras. 9/11 Y Calles 71/72; Cras. 9/11 Y Calles 70A/71; Cras. 9/10A Y Calles 70/70A; Cras. 9/10 Y Calles 69A/70; Cras. 9/10A Y Calles 69/69A; Cras. 7/9 Y Calles 70A/72; Cras. 7/9 Y Calles 70/70A; Cras. 8/9 Y Calles 69/70; Cras. 7A/8 Y Calles 69/70; Cras. 7/7A Y Calles 69/70; Cras. 7/9 Y Calles 67/69;

Table 7.3-2 Composition of Waste in Bogota

Garbage Item	ton/day	%
Putrescible organic material	2,918	62.8
Paper and Cartons	1,175	25.3
Glass and Stone	223	4.8
Cloth	192	4.1
Metals	95	2.0
Plastic	40	0.9
TOTAL	4,643	100.0

Source: Chamber of Commerce of Santa Fe de Bogota, 1994

### 7.3.2 Natural Environment

#### (1) Topography, Geography and Meteorology

Bogota is located in the southeastern part of the basin on a vast plateau to the east of the Andes Mountains, and is at an elevation 2,600m above sea level. It is adjacent to 3,000m - 3,500m high mountains to the east and south.

The high plain of Bogota, or so-called *Sabana de Bogota*, is situated at an elevation of about 2,600m in the Colombian Eastern Cordillera, between approximately 4° 30' - 5° 15' N latitude, and 73° 45' - 74° 30' W longitude. It presents a large tectonic-sedimentary basin that is surrounded by mountains up to almost 4,000m, and drained by the Rio Bogota and its tributaries. The only fluvial outlet is situated in the southwestern corner. The capitol, Bogota, is located on the southeastern part of the high plain. There are many lakes and marshes, so the surface topography is alluvial soil that has been formed by sedimentation of sand and silt.

Geography and elevation of the high plain area dictates an isothermal temperature

regime with a mean annual temperature of about 13-15° C, which is typical of the climate of tropical mountain areas, though it is located at a low altitude near the equator. Generally there are two wet and two dry seasons, the two dry seasons being December-February and July-August; and the annual mean wind speed is a low 1.9m/s.

## (2) Vegetation

There is no vegetation map presently available. DAMA undertakes investigations where the proportion of greenery is low and implements a variety of greening projects. The vegetation in Bogota belongs to savanna. There are various high trees such as Palm, Cedar, Walnut, Oak, Pine, Willow, etc., in Bogota. The recent condition of green areas is shown in Table 7.3-3.

**Table 7.3-3 Abstract of Green Zone in Bogota**

Description	Area (ha)	Retention Area (m <sup>2</sup> /habitant.)	%
Public domain	1,678.2	3.5	19.1
Private domain	7,094.4	14.6	80.9
Inside the urban area	8,516.7	17.6	97.1
Outside the urban area	255.9	0.5	2.9
TOTAL	8,772.6	18.1	100.0

Source: EPAM LTDA, 1992

Regarding parks in the metropolitan area, the condition of plants and trees are as follows:

- a) Parque Nacional, El Salitre, La Independencia and Ciudad Montes present a good condition of conservation. El Parque Simon Boliver shows signs of abandon in the vegetation due to lack of maintenance.
- b) Parque El Tunal, Timiza, Kennedy, Santa Maria del Lago and District of Sur have deteriorated. These parks need to be rehabilitated.
- c) Parque El Lago and Primero de Mayo are moderately deteriorated.

In general, the deterioration of roadside green zones is similar to that of the park areas. Avenida Eldorado and la Autopista Norte present a good condition of conservation. On Avenida Caracas, many trees were removed and transplanted for construction of Toncal, so survival of trees is approximately 70-80%.

## (3) Natural Disaster

Natural disasters occurred in the past, including slips on the fringes of Cerros Orientales to the northeast of the city, and flooding of Rio Bogota, Tunjuelito and Juan Amarillo.

Geographically, potentially dangerous zones are as follows: firstly between Calles 130 and 190 on the fringes of Cerros Orientales in the northeast of the city; secondly approximately between Rio San Francisco and la Quenta El Zuque in San Cristbal district; thirdly the slopes of hills surrounding southwestern Ciudad Boliver and southern hills of Alcaldias de Rafael Uribe y Usme. Although a large earthquake was recorded in 1785, it is at present estimated as a phenomenon that earthquakes will occur at intervals of 200-500 years.

## (4) Protected Natural Areas

### 1) Location of Environmentally Valuable Areas

An ecosystem which still can be conserved is located in the marsh area in Bogota. Areas to be protected are as follows;

Chucua de la Conejera, Laguna de Juan Amarillo o Tibabuyes, Torca, Guaymaral, El Jaboque, Techo, El Burro, La Vaca, Cordoba, Santa Maria del Lago, Laguna de Tibanica, La Cofradia o Capellania, El Meandro del Say.

## 2) Location of Specific Areas which are officially protected

Though Parque Nacional Natural Sumapaz is situated in the southeast of the city, projects to be proposed in this Master Plan Study will not affect the park, directly.

### (5) Flora and fauna

Outstandingly valuable fauna and flora seem not to exist in Bogota. In the whole Sabana de Bogota, the followings are estimated to exist:

- a) Rivers "pato" and mountains "tigrillo" found upper reaches of Rio San Cristobal
- b) Woodland "pavas" in the Norte of Bogota
- c) Marshes "cucarachero", "tinguas", "patos" and "monjas"
- d) "oso de Antejos", "condor"

These are endemic, vulnerable and endangered species.

### (6) Landscape

It is important to recover and protect areas of interesting archeology in Bogota, especially in areas such as the mountains in the north, the hills of Suba, Conejera, and in the south.

The deterioration of urban landscape is caused by the expansion of socioeconomic activities in the city. Extractive industries destroy vegetation, and soil and leave scars, so the urban landscape has deteriorated seriously. In Bogota, the following areas have been affected: Cerros Orientales al norte de Usaquén, sur del barrio Egipto, Cerro de Juan Rey, Cerros Suroccidentales (Ciudad Bolívar and Bosa), zona gravillera del Tunjuelo(sector de la Escuela de Artillería).

Moreover, urbanization has a deteriorating effect on the urban landscape and public spaces. Cerros Orientales, which is important as a part of Bogota because of its natural beauty, los cerros de suroccidente (Ciudad Bolívar) and el suroriente(alcaldías de San Cristóbal, Usme and Rafael Uribe), are areas in the city have been adversely affected to an especially high degree.

## 7.3.3 Environmental Pollution

The DAMA will study measures to estimate environmental pollution and regulatory norms of Bogota after Environmental Standards have been established by the Ministry of the Environment.

### (1) Air pollution

Factories with old processing equipment emit large volumes of NO<sub>x</sub> and SO<sub>x</sub>. It is important to develop industrial plants which are productive, effective and promote proper consideration of the environment using clean technology. A lot of old buses and 10- to 20-year cars exhaust many pollutants such as NO<sub>x</sub>, CO, HC etc., as a result of poor combustion and idling in traffic jams.

Resolution 003002/91 establishes control and monitoring of automotive exhaust gas.



One of the improvements is to raise the height of the exhaust pipe for better dispersion of the gases.

The JICA study team investigated the actual state of air pollution in Bogota from July, 1990 to February, 1992. The monitoring results are summarized as follows:

1) Sulfur Dioxide(SO<sub>2</sub>):

Ranged from 0.18mg/m<sup>3</sup>-0.66mg/m<sup>3</sup> on average: Proved satisfactory in terms of three-hour average, daily average and annual average criteria. Emissions are mainly from fuel combustion in factories and other establishments, with the high concentration area located to the southwest of the city.

2) Nitrogen Dioxide(NO<sub>2</sub>):

Ranged from 0.31mg/m<sup>3</sup>-0.63mg/m<sup>3</sup> on average: Satisfactory at all stations: Emissions were mostly from motor vehicles, with the effect particularly noticeable along the roadsides.

3) Suspended Particulate Matter(spm):

Ranged from 0.433mg/m<sup>3</sup>-0.702mg/m<sup>3</sup> on average: Comparison of the measured value (SPM) with the standard value (SP) proved satisfactory both in terms of daily and annual average criteria, but the concentration level was not low. Relatively high concentration appeared in industrial areas and in the vicinity of roads.

Table 7.3-4 Amount of Air Pollutants Emitted from Sources (ton/year)

Pollution sources	Substances				
	SOx	NOx	Dust	CO	HC
Industries and establishments	6,504 (82%)	1,688 (15%)	2,198 (95%)		
Vehicles	1,269 (16%)	9,250 (82%)		288,433	19,845
Aircraft	29 (0.4%)	144 (1%)			
Residences	84 (1%)	254 (2%)	105 (5%)		
Total	7,886 (100%)	11,306 (100%)	2,303 (100%)	288,433	19,845

4) Carbon Monoxide(CO):

Ranged from 1.7mg/m<sup>3</sup>-9.7mg/m<sup>3</sup> on average: Two stations proved unsatisfactory in terms of eight-hour average criteria, but satisfactory in terms of one-hour criteria. The other three stations proved satisfactory both with respect to eight-hour and one-hour average criteria. As large quantities of CO are emitted from motor vehicles, a high concentration of CO along the roadside, presents a problem for the air quality standards.

5) Ozone(O<sub>3</sub>):

The maximum one-hour value was 0.224mg/m<sup>3</sup> and 0.241mg/m<sup>3</sup>, but proved unsatisfactory.

Both CO and NOx showed high concentration in the vicinity of roads, and also revealed that the influence of the exhaust gas from motor vehicles reached places as far as about 40m from the road.

Both CO and NO<sub>x</sub> showed high concentration in the vicinity of roads, and also revealed that the influence of the exhaust gas from motor vehicles reached places as far as about 40m from the road.

In addition, the JICA team made a trial calculation of the amount of each air pollutant from various sources, and the result shows that the pollutants originating from vehicles are NO<sub>x</sub>, CO and HC as follows:

#### (2) Water pollution

As the basin of the Rio Bogota is heavily industrialized, the Rio Bogota receives wastewater not only from households but also factories, and is contaminated by as much as 900 t/day of BOD (Biochemical Oxygen Demand). The project for rehabilitation of the Rio Bogota is one of the large-scale projects.

There are three main rivers contributing to the drainage of wastewater in Bogota. The Rio Salitre and Fucha receives all the discharged water from households and factories located in the basin, and the Rio Tunjuelo receives wastewater from the extraction of gravel and the industrial zone. These rivers flow into the Rio Bogota, so that the contaminated water affects the health of inhabitants in the river basin. The concentration of BOD is extremely high; Rio Salitre has 199mg/l; Rio Fucha, 353mg/l; and Rio Tunjuelo, 212mg/l. A little Dissolved Oxygen (DO) creates anoxia condition and contamination by heavy metals also occurs. The total loads of Suspended Solids (SS) is estimated as follows; Rio Salitre at 123ton/day, Rio Fucha, at 263ton/day, and Rio Tunjelo at 362ton/day.

#### (3) Soil Contamination

Concerning the environs of Dona Juana, wastewater permeated from the site and contaminates the Yebuena valley, a branch of the Rio Tunjuelito. According to investigations made by CAR from August 1989 to April 1990, changes of concentration are as follows: BOD is from 5mg/l to 6169mg/l, DQO is from 40mg/l to 9732mg/l, total chromium is from 0.02mg/l to 0.24mg/l, lead is from 0.04mg/l to 0.16mg/l, and zinc is 0.09mg/l to 5.51mg/l.

#### (4) Noise and Vibration

Santa Fe de Bogota has high noise levels caused by automobiles on the main roads, commercial activities, construction works and industrial plants. Especially in the industrial area of Puente Aranda, Autopiasta del Sur and Cundinamarca, the noise level is more than 75dB, the legal level, mainly due to the large volume of heavy vehicles and the poor conditions of the roads.

The National University (Ubaque y Romero, 1990) investigated the actual noise level at 45 locations in Bogota. The observed average noise level at daytime and nighttime are shown in Table 7.3-5. Values of residential and commercial zones are in daytime 3-6dBA over the Standard, but those of the industrial zones are 5 dBA below. In addition, noise levels at intersections in the city are shown in Table 7.3-6. They indicate that these areas are exposed to noise pollution caused by traffic congestion in the city.

Regarding the present state of vibration, the condition of the road surface that causes traffic vibration is conspicuously bad. However, the slow speed-traffic caused by chronic traffic jams does not produce high-vibration levels to the extent that damages nor complaints occur.

**Table 7.3-5 Average Noise Level in Bogota (EN dBA)**

Zone	Daytime	Nighttime
Residential	68	38
Commercial	76	42
Industrial	70	45

**Table 7.3-6 Intersection Noise**

Intersection	Noise Level
Av. Caracas con Calle 53	79dBA
Av. Caracas con Calle 72	78dBA
Carrera 15 con Calle 100	78dBA
Carrera 10 con Calle 13	78dBA
Carrera 30 con Calle 45	78dBA
Av. Boyacá con Calle 26	78dBA
Av. Boyacá con Calle 80	80dBA
Autopista Sur con Av. Boyacá	81dBA

**(5) Ground Subsidence**

The cause of the poor road conditions is not only lack of construction skills, but also the essentially weak ground. With the construction of bridges and buildings, ground surrounding the basic structures subsides and soil erosion occur occasionally. Though these phenomena are caused by ground subsidence, proper technical measures should be implemented to secure the safety of construction and reliability of execution.

**7.3.4 Others**

**(1) Conservation Areas**

Clause 4 of General Principles in the Environmental Law (Ley 99) provides that the paramo (high barren plain), subparamo, water spring areas and the water recharge areas will be the subject of special protection.

**1) Ecological corridors**

The Cerros Orientales form the zones of preservation of the natural topography system and constitute an element of the public space of Santa Fe de Bogota. The system includes the Cerros Conejera, Juan Rey, Guacamayas and the cerro Doña Juana. Though the process of rapid urban increase contributed to deterioration in the last decade, the Cerros Orientales inherits an ecological patrimony of environmental importance, also for landscaping and recreation of the city's residents. Pilgrimages to the sanctuaries of Monserrate and Guadalupe have constituted a major attraction, and visual enjoyment of the city since colonial times.

The principal aspects related to the current problem of the Cerros Orientales and topographical system is incorrect use of the ground for extractive industries (quarries) and housing lots.

The Park Ecological Corridor was created by Decreto 320/92, which adopted el Plan Corredor Ecológico Ffisco del Sistema Orogaráfico, with the aim of preserving the environment surrounding the urban areas such as Cerros Orientales, Surorientales.

**2) Marshes**

The wetlands are swamps, lakes, marshes, deltas, lagoons, reservoirs and other hydrological systems that regulate the volume and flow of the water. They have self-

purification capabilities and are natural reservoirs for absorbing rainwater and regulating growth. In addition, of great ecological value is a wealth of biodiversity in flora and migratory, natatorial birds.

In high plateaus, huge marshes disappeared or were reduced due to agricultural activities, contamination and unrestricted urbanization. In the territory where Santa Fe de Bogota is located, numerous marshes existed at the beginning of the century, but only a few remain. Almost all of them are confronted with grave problems of reclamation for construction of housing and of contamination from residual and liquid waste.

It is important to rehabilitate those public spaces to achieve the environmental benefits, scientific progress and satisfying recreation. Acuerdo 14/94 declared the following: "Reservation of Natural Environment, the public interest and ecological heritage of Santa Fe de Bogota D.C.", the marshes of : Chucua de la Conejera, Laguna de Juan Amarillo o Tibabuyes, Torca, Guaymaral, El Jaboque, Techo, El Burro, La Vaca, Cordoba, Santa Maria del Lago, Laguna de Tibanica, La Cofradia o Capellanfa, El Meandro del Say.

## (2) Others

The DAMA noted to pay special attention to the ecosystem in such areas as marshes, hills, rivers and valleys. In addition, the DAMA requested that JICA send specialists on each item, i.e., air pollution, water contamination, waste disposal etc., independently from this project.

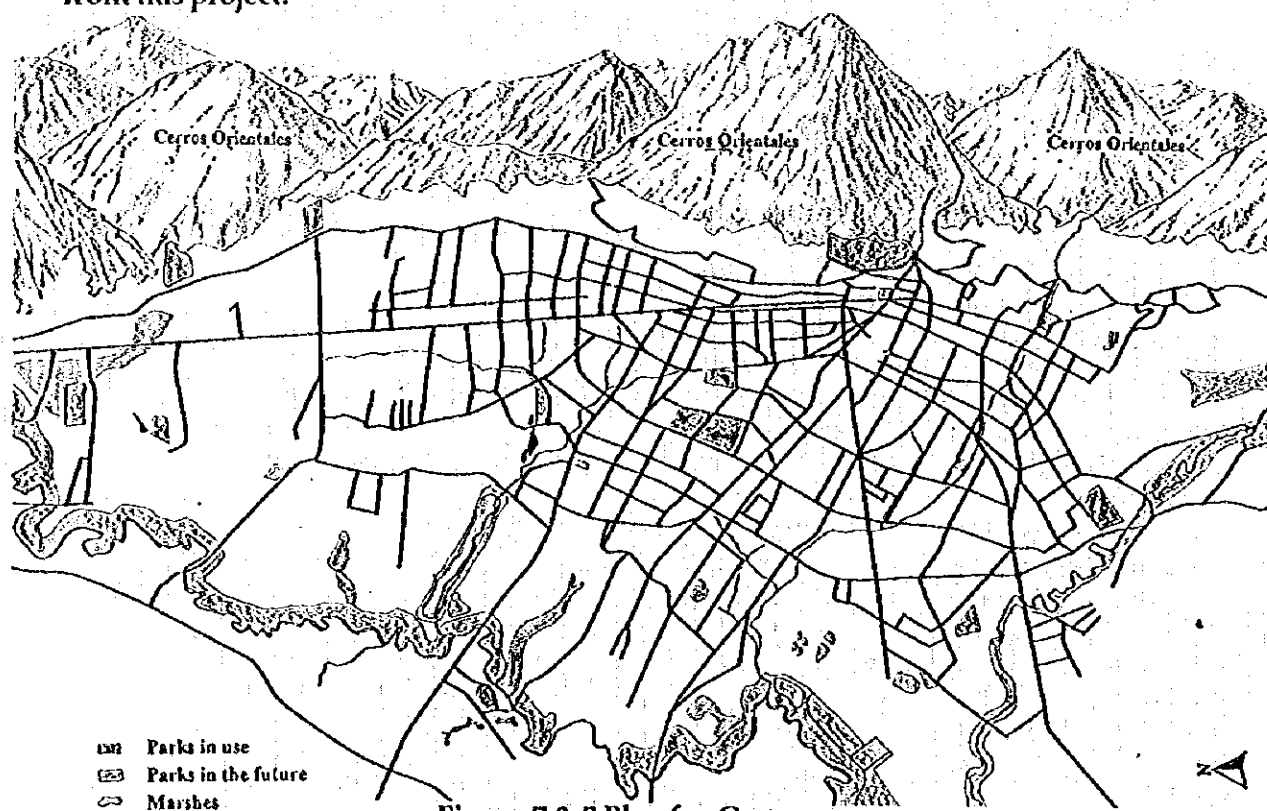


Figure 7.3-5 Plan for Greenery

7.4 Screening/Scoping

7.4.1 Screening

Table 7.4-1 Screening

UN: unknown

Environmental items		Content	Evaluations	Remarks(Basis)	
Socioeconomic Environment	1	Resettlement	Resettlement by occupancy of proposed land (removal of rights of residence and land ownership)	YES/NO/UN	Residences exist in projective area.
	2	Economic activities	Loss of a productive opportunity such as land, and change of economic structure	YES/NO/UN	Change of economic activities will not occur.
	3	Traffic and public facilities	Influence of existing traffic such as congestion, accidents on schools and hospitals	YES/NO/UN	Schools, hospitals, churches, graveyards and parks exist in project area.
	4	Split of communities	Split of communities by obstruction of traffic	YES/NO/UN	Project with split of communities will not planned.
	5	Cultural property	Loss of cultural property and falling of value	YES/NO/UN	Lots of important cultural properties exist in the city.
	6	Water right and right of common	Obstruction of fishing rights, water rights, common rights of forest	YES/NO/UN	Water right and right of common are not established.
	7	Health and sanitation	Deterioration of a hygienic environment by production of refuse and noxious insect	YES/NO/UN	Lots of refuse will not be produced.
	8	Waste	Occurrences of waste dumps and solid waste	YES/NO/UN	A little waste dumps will be produced by construction.
	9	Hazards	Increase of possibility of danger of landslide and accident	YES/NO/UN	Sections of project are mainly plain.
Natural Environment	10	Topography and geology	Change of valuable topography and geology by digging or fill	YES/NO/UN	Valuable topography and geography do not exist.
	11	Soil erosion	Flow of surface soil by rainwater after land development and forest felling	YES/NO/UN	Forest and slanting surface do not exist in project.
	12	Groundwater	Pollution by drainage or leach water by digging construction	YES/NO/UN	Groundwater will not be pumped.
	13	Hydrological situation	Change of flux and riverbed by reclamation and inflow of drainage	YES/NO/UN	Constructions in rivers will not be planned.
	14	Coast and sea area	Change of beach erosion and vegetation by a change of reclamation or sea condition	YES/NO/UN	There are not sea areas.
	15	Flora and fauna	Breeding obstruction and extinction of species by a change of an inhabitable condition	YES/NO/UN	Habitat of valuable flora and fauna do not exist, but marsh is important to ecosystem.
	16	Climate	Change of temperature and wind conditions by the large-scale land development and architectures	YES/NO/UN	Large-scale felling and construction of high building will not be planned.
Environmental Pollution	17	Landscape	Change of topography by land development and harmonious obstruction by structural objects	YES/NO/UN	Landscape of important area with cultural properties exist.
	18	Air pollution	Pollution by emission gas and dust from vehicles	YES/NO/UN	Impact by emission gas from increasing motor car will occur.
	19	Water pollution	Pollution by inflow of earth and sand and industrial water waste	YES/NO/UN	Impact by contamination will not occur.
	20	Soil contamination	Pollution by dust and asphalt emulsion	YES/NO/UN	There will be no action which causes soil contamination.
	21	Noise and vibration	Occurrence of noise and vibration by vehicles	YES/NO/UN	Impact by noise and vibration during and after construction will occur.
	22	Ground subsidence	Subsidence by change of ground and fall of groundwater level	YES/NO/UN	There is weak ground, but groundwater won't be pumped.
	23	Offensive odors	Occurrence of exhaust gas and offensive odors	YES/NO/UN	There is no factors of producing offensive odors.

7.4.2 Scoping

Table 7.4-2 Scoping

Environmental items		Evaluation	Grounds	
Socioeconomic Environment	1	Resettlement	B	Resettlement will occur due to construction of new roads, improvement of roads.
	2	Economic activities	D	Large change of economic activities will not occur.
	3	Traffic and public facilities	B	There is a necessity of consideration for schools and hospitals in urban city.
	4	Split of communities	D	Split of community will not occur.
	5	Cultural property	B	There is a necessity of consideration for cultural property in urban city.
	6	Water right and right of common	D	Water rights and rights of common do not exist.
	7	Health and sanitation	D	Large amounts of refuse will not occur.
	8	Waste	B	A little waste dump will be produced by construction.
	9	Hazards	D	Development on a slanting surface will not be planned.
Natural Environment	10	Topography and geology	D	Valuable topography and geology do not exist.
	11	Soil erosion	D	Large-scale changes of lands such as land development and forest felling will not be planned.
	12	Groundwater	D	Construction caused contamination of groundwater will not planned.
	13	Hydrological situation	D	Construction along the river will not planned.
	14	Coast and sea area	D	There is not sea area.
	15	Flora and fauna	B	Valuable flora and fauna do not exist in project area. However there is a necessity of consideration for marshes as ecosystem.
	16	Climate	D	Large-scale felling and construction of high buildings will not be planned.
Environmental Pollution	17	Landscape	B	There is a necessity of harmony with conservation areas such as Cerros Orientales.
	18	Air pollution	B	There is a necessity of traffic control for jam.
	19	Water pollution	D	Construction along the river will not planned.
	20	Soil contamination	D	There will be no action which causes soil contamination.
	21	Noise and vibration	B	There is a necessity of traffic control and countermeasures of control for traffic noise from overbridges.
	22	Ground subsidence	B	There is a necessity of consideration for construction due to weak ground.
	23	Offensive odors	D	There is no factors of producing offensive odors.

Classification of evaluation:

- A- Serious impact will be anticipated.
- B- Impact will be more or less anticipated.
- C- Unknown ( it is necessity of investigation )
- D- No Impact will be anticipated.

## 7.5 Remarks for the Master Plan

According to a viewpoint of the environmental consideration based on the above-mentioned Screening/Scoping, remarks for projects are as follows;

### 1) Resettlement

Resettlement will occur owing to the construction of new roads, the improvement of roads and the construction of terminals. It is important to compensate for them by providing new housing, new employment, etc.

### 2) Public facilities

There are many schools and hospitals in Bogota. The city suffers from air pollution and noise generated by automobile traffic, so there will be a need for countermeasures for preserving the environment in the vicinity of roads in the future.

### 3) Cultural property

There are many cultural monuments in Bogota. There will be a need for careful planning to preserve these national treasures.

### 4) Solid waste

Construction residues are at present transported to Sanita Cecilia Bajo and used to fill old quarries. The authorities in charge of waste management have not yet been decided, so it is necessary to make a decision in this regards.

### 5) Flora and fauna

Valuable flora and fauna seem not to exist in Bogota, but marshes which are the habitats of flora and natatorial birds are important to the ecosystem. Therefore designated marshes should be protected.

### 6) Landscape

Hills such as Cerros Orientales, etc., are important to the landscape, since they create harmony between the city and the surrounding mountains. Therefore, when considering developments in these hills, it will be necessary to find means to preserve the landscape.

### 7) Air pollution

In the relation between automobile exhaust gas and speed, automobiles emit a large volume of gas at low speeds. Therefore, there will be a need for measures to improve the present condition of air pollution: by enabling traffic to flow more smoothly; exhaust gas regulations etc.

### 8) Noise and vibration

The present noise environment has deteriorated owing to traffic and the noise of daily life. However, countermeasures against increasing traffic noise created by increasing numbers of automobiles and rising of speeds must be taken in the future.

As for the present state of traffic vibration, there is no vibration problem due to slow-speed although the condition of the road surface is poor. However, complaints about excessive vibration will occur in the future due to a combination of higher speeds and the poor condition of the road surfaces.



**PART II**

**TRANSPORT DEMAND FORECAST**

**CHAPTER 8**  
**Urban Development Plan**

## 8. URBAN DEVELOPMENT PLAN

### 8.1 Socioeconomic Framework

#### 8.1.1 Long-Term Future Perspective of Colombia

The Colombian economy has been growing at an annual average rate of 4.5% during the 25-year period of 1970-95. For the future, the government insists on a continuation of high growth of more than 5%, based on the discovery of new oil fields in the Departamento de Casanare. According to British Petroleum, in an area of 500 km<sup>2</sup>, there is crude oil sufficient for 15-year-long production and export, and natural gas sufficient for consumption until 2050. The government expects foreign investment for the oil fields and refinery plants, and export of crude oil and derivatives. But the private sector (FEDESARROLLO) is not so optimistic (especially in the near future) and does not expect a 5% growth until 2000.

For this Study, it is determined to adopt an annual average rate of 5% as the target for future long-term economic growth of Colombia, considering that 6% economic growth is said to be required in order for Colombia to catch up with the Asian tigers, and that it is not impossible to maintain a high growth if the social and political struggles are settled and education becomes widespread.

Tables 8.1-1 to 3 show the projected results. According to Table 8.1-3, the scale of the Colombian economy will be expanded to 3.4 times the present one, and the GDP per capita will rise to 2.5 times the present level; that is, from about US\$2,000 to US\$5,000, in the succeeding 25 years.

Table 8.1-1 Future GDP Growth by Sector, 1995-2020

	Value (million pesos)			
	GDP	Primary	Secondary	Tertiary
1995	915,801	179,411	251,379	485,011
2000	1,169,000	208,000	313,000	648,000
2005	1,492,000	241,000	390,000	861,000
2010	1,904,000	279,000	486,000	1,139,000
2015	2,430,000	323,000	606,000	1,501,000
2020	3,101,000	374,000	755,000	1,972,000
	Assumed annual growth rate (%)			
	GDP	Primary	Secondary	Tertiary
1995-00	5.0	3.0	4.5	6.0
2000-05	5.0	3.0	4.5	5.8
2005-10	5.0	3.0	4.5	5.8
2010-15	5.0	3.0	4.5	5.7
2015-20	5.0	3.0	4.5	5.6

Table 8.1-2 Future Growth Rates of Socioeconomic Indicators

	Population		Per capita GDP	Employment (EAP)	Labor productivity
	New estimate	Old estimate			
1995-	1.50	1.72	3.45	2.02	2.92
2000-	1.35	1.55	3.60	1.75	3.19
2005-	1.23	1.41	3.72	1.54	3.41
2010-	1.12	1.28	3.84	1.40	3.55
2015-	1.00	1.15	3.96	1.20	3.75

Table 8.1-3 Growth Ratios of Colombian Economy

	GDP total	GDP/capita
1995	100	100
2000	128	118
2005	163	141
2010	208	170
2015	265	205
2020	339	249

## 8.1.2 Future Socioeconomic Conditions of Bogota Metropolitan Area

### (1) Population

Based on the changing trend of demographic indicators (fertility rate and survival rate) and net migration into the Bogota Metropolitan Area, future population by sex and age is projected until 2020.

According to Table 8.1-4, the population of the Bogota Metropolitan Area will reach 11 million in 2020.

The net migration into the Area will continue at the level of 400,000 persons per 5 years (80,000 persons per year) until 2010, but the number will gradually decrease along the declining tendency of the national population growth (see Table 8.1-5).

**Table 8.1-4 Future Population by Sex and Age in Bogota Metropolitan Area**

Age	1995			2000			2005		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
0-4	282,914	241,623	524,537	425,087	408,209	833,296	430,545	413,192	843,737
5-9	332,806	286,388	619,194	296,878	253,963	550,841	443,885	426,920	870,805
10-14	326,829	311,454	638,283	349,136	300,812	649,948	309,975	265,463	575,439
15-19	341,791	385,302	727,093	343,961	328,575	672,535	365,546	315,659	681,205
20-24	359,903	379,366	739,269	359,893	407,778	767,671	360,258	345,777	706,035
25-29	320,836	350,734	671,570	376,523	400,969	777,491	374,722	428,609	803,331
30-34	287,014	305,496	592,510	334,300	368,454	702,754	390,583	419,112	809,695
35-39	229,105	267,039	496,144	297,807	317,641	615,449	345,444	381,516	726,960
40-44	183,585	219,193	402,778	236,571	276,366	512,937	306,302	327,473	633,775
45-49	158,685	187,619	346,304	188,460	226,351	414,811	241,924	284,283	526,207
50-54	145,737	170,347	316,084	161,230	191,856	353,086	190,811	230,688	421,499
55-59	104,480	114,243	218,723	145,266	171,526	316,792	160,252	192,690	352,942
60-64	92,471	106,492	198,963	100,327	112,399	212,726	139,314	168,526	307,840
65-69	67,517	66,642	134,159	83,881	100,596	184,478	91,088	106,248	197,336
70-74	41,163	43,269	84,432	56,321	59,319	115,639	69,936	89,832	159,768
75+	44,739	56,218	100,957	57,176	69,615	126,791	76,003	91,206	167,209
<b>Total</b>	<b>3,319,575</b>	<b>3,491,425</b>	<b>6,811,000</b>	<b>3,812,817</b>	<b>3,994,428</b>	<b>7,807,245</b>	<b>4,296,590</b>	<b>4,487,195</b>	<b>8,783,784</b>

Age	2010			2015			2020		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
0-4	407,953	391,269	799,222	380,118	364,349	744,467	376,194	360,370	736,564
5-9	447,602	430,194	877,796	421,502	404,836	826,338	389,953	374,286	764,239
10-14	461,501	444,309	905,809	462,646	445,044	907,691	432,754	415,951	848,705
15-19	323,036	277,224	600,260	477,870	460,937	938,807	475,544	458,218	933,762
20-24	381,036	330,490	711,526	334,491	288,214	622,705	491,040	475,355	966,395
25-29	373,497	361,623	735,120	392,670	343,251	735,921	342,319	296,973	639,292
30-34	387,163	445,974	833,137	383,727	373,914	757,641	400,804	352,357	753,161
35-39	402,115	432,351	834,466	396,508	457,663	854,171	390,606	381,407	772,013
40-44	354,044	391,969	746,012	410,040	442,023	852,064	401,941	465,249	867,190
45-49	312,160	335,684	647,844	359,013	399,775	758,788	413,365	448,177	861,542
50-54	244,179	288,872	533,051	313,595	339,552	653,147	358,668	402,194	760,862
55-59	189,183	231,174	420,358	241,113	288,373	529,486	308,132	337,367	645,500
60-64	153,532	189,110	342,642	180,776	226,255	407,031	229,585	281,197	510,781
65-69	126,615	159,433	286,048	139,442	178,740	318,182	163,910	213,430	377,340
70-74	75,866	95,184	171,051	105,123	143,024	248,146	115,258	160,376	275,634
75+	97,479	129,896	227,375	114,490	158,267	272,757	146,516	215,310	361,826
<b>Total</b>	<b>4,736,960</b>	<b>4,934,757</b>	<b>9,671,716</b>	<b>5,113,126</b>	<b>5,314,218</b>	<b>10,427,344</b>	<b>5,436,591</b>	<b>5,638,217</b>	<b>11,074,808</b>

**Table 8.1-5 Future Net Migration into Bogota Metropolitan Area**

Age	1995/2000			2000/2005			2005/2010		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
0-4	23,067	22,192	45,259	21,090	20,291	41,381	18,032	17,349	35,381
5-9	15,876	13,598	29,474	21,469	20,675	42,144	19,570	18,835	38,405
10-14	17,347	15,065	32,412	13,927	12,023	25,950	18,741	18,190	36,932
15-19	18,481	17,953	36,434	17,768	15,606	33,374	14,198	12,395	26,592
20-24	20,444	23,943	44,387	18,516	18,376	36,893	17,710	15,889	33,599
25-29	19,752	23,350	43,102	17,776	22,589	40,365	16,015	17,239	33,254
30-34	16,593	19,730	36,323	17,526	20,301	37,826	15,698	19,530	35,228
35-39	14,095	14,424	28,519	14,775	15,657	30,432	15,536	16,029	31,565
40-44	11,009	12,155	23,165	12,880	13,013	25,893	13,446	14,067	27,513
45-49	8,900	10,660	19,561	10,322	12,097	22,419	12,028	12,900	24,929
50-54	7,570	9,073	16,643	8,091	9,852	17,943	9,348	11,136	20,484
55-59	6,738	7,965	14,703	6,709	8,074	14,783	7,146	8,737	15,883
60-64	4,581	5,182	9,762	5,732	7,002	12,734	5,691	7,079	12,770
65-69	3,768	4,618	8,386	3,679	4,387	8,066	4,598	5,920	10,518
70-74	2,509	2,692	5,201	2,805	3,657	6,463	2,742	3,476	6,218
75+	2,562	3,158	5,720	3,056	3,706	6,762	3,525	4,724	8,250
<b>Total</b>	<b>193,292</b>	<b>205,760</b>	<b>399,052</b>	<b>196,123</b>	<b>207,305</b>	<b>403,428</b>	<b>194,025</b>	<b>203,495</b>	<b>397,520</b>

Age	2010/2015			2015/2020		
	Male	Female	Total	Male	Female	Total
0-4	14,346	13,802	28,148	11,421	10,988	22,409
5-9	15,762	15,160	30,922	11,749	11,294	23,043
10-14	16,064	15,580	31,644	12,101	11,730	23,831
15-19	17,967	17,633	35,601	14,410	14,130	28,539
20-24	13,303	11,861	25,164	15,744	15,777	31,520
25-29	14,398	14,005	28,403	10,111	9,771	19,882
30-34	13,300	14,006	27,306	11,186	10,636	21,821
35-39	13,090	14,498	27,588	10,379	9,724	20,104
40-44	13,304	13,550	26,854	10,495	11,475	21,969
45-49	11,818	13,125	24,943	10,950	11,841	22,790
50-54	10,253	11,177	21,430	9,433	10,649	20,082
55-59	7,773	9,300	17,073	7,986	8,745	16,731
60-64	5,711	7,219	12,930	5,822	7,204	13,027
65-69	4,307	5,647	9,954	4,057	5,405	9,462
70-74	3,239	4,434	7,674	2,854	3,977	6,831
75+	3,532	4,903	8,438	3,607	5,319	8,926
<b>Total</b>	<b>178,166</b>	<b>185,902</b>	<b>364,068</b>	<b>152,305</b>	<b>158,662</b>	<b>310,968</b>

**(2) Employment**

Table 8.1-6 shows the projected results of the number of employees in the Study Area and in the surrounding municipalities. It is assumed that the labor force participation rates of the Study Area and the surrounding municipalities will gradually rise from 54.8% and 57.5% in 1995, to 59.0% and 60.0% in 2020, respectively. And the unemployment rates are expected to decline from 10.2% and 7.5% in 1995, to 5.0% and 4.0% in 2020, respectively.

**Table 8.1-6 Future Labor Force Supply and Number of Employees**

Study Area							
	Total population	Population 12 years +	Labor force part rate(%)	Economically active pop.	Unemployment rate (%)	No. employed persons	
1995	5,995,000	4,812,700	54.8	2,635,000	10.2	2,365,700	
2000	6,820,400	5,421,100	56.0	3,035,800	9.8	2,738,300	
2005	7,545,600	5,891,100	57.0	3,357,900	8.0	3,089,300	
2010	8,070,600	6,385,100	58.0	3,703,400	7.0	3,444,200	
2015	8,404,900	6,882,800	58.5	4,026,400	6.0	3,784,800	
2020	8,646,200	7,257,700	59.0	4,282,000	5.0	4,067,900	
Surrounding Municipalities							
	Total population	Population 12 years +	Labor force part rate(%)	Economically active pop.	Unemployment rate (%)	No. employed persons	
1995	816,000	599,300	57.5	344,600	7.5	318,800	
2000	986,800	742,000	58.0	430,400	6.8	401,100	
2005	1,238,200	948,000	58.5	554,600	6.1	520,800	
2010	1,601,100	1,247,300	59.0	735,900	5.4	696,200	
2015	2,022,400	1,610,700	59.5	958,400	4.7	913,400	
2020	2,428,600	1,976,800	60.0	1,186,100	4.0	1,138,700	

### 8.1.3 Socioeconomic Framework of the Study Area

#### (1) Population

The future population of the Study Area will reach 8.6 million in 2020 (see Table 8.1-7). The net migration into the Study Area will decrease from 300,000 persons per 5 years (60,000 persons per year) to almost the balanced level, because of the lack of urbanizable land (see Table 8.1-8).

Table 8.1-7 Future Population by Sex and Age in the Study Area

Age	1995			2000			2005		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
0-4	232,762	192,605	425,367	372,980	358,166	731,146	367,615	352,783	720,398
5-9	292,454	247,156	539,610	242,357	200,870	443,226	383,164	368,506	751,670
10-14	279,975	265,873	545,848	304,594	257,719	562,313	249,240	206,780	456,020
15-19	301,695	345,289	646,984	292,355	278,266	570,621	313,717	265,960	579,677
20-24	315,872	336,509	652,381	315,057	362,319	677,376	300,935	287,621	588,556
25-29	277,127	309,338	586,465	327,945	352,668	680,613	322,826	374,105	696,930
30-34	248,651	272,831	521,482	286,678	322,444	609,122	335,077	362,645	697,722
35-39	204,814	242,641	447,455	236,231	281,810	538,041	291,991	329,284	621,275
40-44	163,574	196,165	359,739	210,061	249,514	459,575	259,828	286,665	546,493
45-49	141,868	168,718	310,586	166,768	201,188	367,956	211,744	253,004	464,748
50-54	131,824	155,847	287,671	143,162	171,345	314,507	166,450	202,109	368,559
55-59	95,803	103,554	199,357	130,515	155,869	286,383	140,298	169,674	309,973
60-64	85,909	97,460	183,369	91,386	101,201	192,587	123,442	151,011	274,453
65-69	62,717	60,799	123,516	77,421	91,451	168,873	81,847	94,340	176,187
70-74	37,496	38,641	76,137	51,979	53,762	105,740	63,683	80,552	144,235
75+	39,693	49,340	89,033	51,126	61,234	112,360	68,252	80,413	148,665
Total	2,912,234	3,082,766	5,995,000	3,320,615	3,499,825	6,820,440	3,680,107	3,865,452	7,545,558

Age	2010			2015			2020		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
0-4	332,813	319,173	651,986	294,914	282,644	577,559	282,299	270,389	552,688
5-9	371,642	357,160	728,802	332,685	319,486	652,171	293,578	281,734	575,313
10-14	388,169	373,615	761,783	372,535	358,240	730,775	332,170	319,152	651,322
15-19	252,543	209,854	462,397	388,795	374,703	763,499	371,507	357,656	729,163
20-24	317,427	270,015	587,441	252,455	210,365	462,820	386,910	373,808	760,718
25-29	303,558	291,760	595,318	316,689	270,490	587,179	250,856	209,742	460,598
30-34	325,016	378,513	703,529	302,474	291,849	594,323	314,375	269,421	583,796
35-39	336,566	365,354	701,921	323,305	377,733	701,038	299,847	290,232	590,079
40-44	292,093	330,650	622,743	333,516	363,571	697,087	319,317	374,678	693,995
45-49	258,363	286,732	545,094	287,714	327,607	615,321	327,460	359,052	686,512
50-54	208,558	230,838	439,397	252,171	281,734	533,905	280,001	321,006	601,007
55-59	161,099	197,708	358,807	200,167	243,383	443,550	241,461	272,784	514,245
60-64	131,273	162,591	293,865	149,711	188,132	337,843	185,841	231,345	417,186
65-69	109,620	139,518	249,138	116,023	149,454	265,477	132,438	173,047	305,486
70-74	66,617	82,570	149,187	88,574	121,784	210,358	93,565	130,827	224,392
75+	86,194	112,985	199,179	98,173	133,723	231,946	121,424	178,289	299,714
Total	3,941,551	4,129,037	8,070,588	4,109,901	4,294,950	8,404,851	4,233,049	4,413,163	8,646,212

Table 8.1-8 Future Net Migration into the Study Area

Age	1995/2000			2000/2005			2005/2010		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
0-4	17,442	16,781	34,223	12,175	11,713	23,888	5,591	5,379	10,970
5-9	11,168	9,267	20,435	12,527	12,063	24,590	6,173	5,941	12,114
10-14	13,034	11,316	24,350	7,561	6,324	13,885	5,977	5,801	11,778
15-19	13,536	13,103	26,639	10,308	8,891	19,199	4,218	3,567	7,784
20-24	15,429	18,346	33,774	10,466	10,349	20,815	5,615	4,946	10,561
25-29	14,822	17,709	32,530	10,348	13,347	23,695	4,942	5,298	10,240
30-34	12,254	14,878	27,133	10,151	11,874	22,025	4,996	6,298	11,294
35-39	10,440	11,014	21,454	8,426	9,112	17,538	4,924	5,124	10,048
40-44	8,415	9,443	17,858	7,369	7,677	15,047	4,199	4,485	8,684
45-49	6,780	8,157	14,937	6,095	7,263	13,358	3,770	4,172	7,942
50-54	5,786	6,976	12,763	4,761	5,823	10,584	3,023	3,661	6,684
55-59	5,211	6,230	11,442	3,962	4,795	8,757	2,303	2,828	5,131
60-64	3,591	4,016	7,607	3,425	4,231	7,656	1,841	2,303	4,144
65-69	2,993	3,614	6,607	2,229	2,627	4,855	1,505	1,960	3,465
70-74	1,993	2,100	4,093	1,722	2,211	3,933	910	1,140	2,051
75+	1,971	2,391	4,361	1,849	2,202	4,051	1,178	1,553	2,732
Total	144,865	155,141	300,006	113,373	120,503	233,876	61,165	64,456	125,621

Age	2010/2015			2015/2020		
	Male	Female	Total	Male	Female	Total
0-4	1,501	1,444	2,944	144	139	283
5-9	1,677	1,613	3,289	149	143	291
10-14	1,739	1,687	3,426	156	151	307
15-19	1,971	1,933	3,904	189	185	375
20-24	1,356	1,171	2,527	209	209	418
25-29	1,564	1,492	3,056	124	116	241
30-34	1,409	1,473	2,883	147	137	284
35-39	1,433	1,604	3,037	133	124	257
40-44	1,452	1,493	2,945	139	154	294
45-49	1,271	1,444	2,715	143	159	304
50-54	1,106	1,245	2,351	123	142	265
55-59	866	1,053	1,919	105	118	223
60-64	634	805	1,439	79	99	178
65-69	480	633	1,113	55	73	128
70-74	366	506	872	39	54	93
75+	406	556	962	50	74	124
Total	19,230	20,151	39,381	1,986	2,077	4,063

(2) GRDP

The future economic growth rate of the Study Area is determined to be 5.2% as the target for the improvement of the total urban environment of the Capital City. The share of the national GDP will go up to 22%.

The primary sector is assumed to decrease to 10% of its present level in 2020. As for the secondary and tertiary sectors, it is assumed that the tertiary sector will grow a little more rapidly than the secondary one (see Table 8.1-9).

Table 8.1-9 Future Economic Growth of the Study Area

	Value (million pesos)			
	GRDP	Primary	Secondary	Tertiary
1995	192,750	100	53,100	139,550
2000	248,360	80	66,810	181,470
2005	320,010	60	84,060	235,890
2010	412,330	50	105,760	306,520
2015	531,280	30	133,060	398,190
2020	684,550	10	167,410	517,130
	Assumed annual growth rate (%)			
	GRDP	Primary	Secondary	Tertiary
1995-00	5.2	-4.4	4.7	5.4
2000-05	5.2	-5.6	4.7	5.4
2005-10	5.2	-3.6	4.7	5.4
2010-15	5.2	-9.7	4.7	5.4
2015-20	5.2	-19.7	4.7	5.4

**(3) Employment**

When the GRDP is determined, the number of employees is obtained by dividing the GRDP by labor productivity. Comparing the number of employees obtained from the Person Trip Survey with the estimated GRDP in 1995, the present labor productivity of the Study Area is estimated at 81,300 pesos per person. The labor productivity by sector is 5,700 pesos per person for the primary sector, 92,700 pesos per person for the secondary sector, and 78,300 pesos per person for the tertiary sector.

In Colombia, the annual increase rate of economically active population is low and declining more, reflecting the tendency of the total population. On the other hand, the Colombian economy has been growing at 4-5% per annum. In a situation like this, labor productivity should have been rising steadily. According to a study by the Camara de Comercio de Bogota, the average annual rising rate of labor productivity of the manufacturing industry was 3.30% at the national level and 2.36% in Bogota between 1970 and 1987.

In the future this trend will continue. Table 8.1-10 shows the projected rising rates of labor productivity in the future. In the Study Area the rising pace is slower than in the nation as a whole because there are many small-scale industries, construction works, and various commercial/service activities which absorb in-migrating job seekers. In the future, however, the rising rate will gradually become close to the national level, reflecting the declining tendency of in-migration.

**Table 8.1-10 Future Rising Rates of Labor Productivity (%)**

	Colombia(A)	Bogota(B)	Ratio B/A 1)
1995-00	2.92	2.19	0.75
2000-05	3.19	2.56	0.80
2005-10	3.41	2.90	0.85
2010-15	3.55	3.20	0.90
2015-20	3.75	3.57	0.95

Note: 1) The annual rate of labor productivity of the manufacturing industry in Bogota, 1970-87, was 2.63%, i.e., 0.715 of 3.30% at the national level

Table 8.1-11 shows the future labor productivity by sector and the future number of employees by sector. For the primary sector, it is assumed that the number of employees in 2020 will be 10% of the present one. The labor productivity of the secondary sector is assumed to rise at a slightly higher rate than the tertiary sector.

**Table 8.1-11 Future Labor Productivity and Employment by Sector**

	No. of employees			
	Total	Primary	Secondary	Tertiary
1995	2,372,100	17,500	572,600	1,782,000
2000	2,741,300	14,400	636,900	2,090,000
2005	3,112,900	11,300	699,900	2,401,700
2010	3,476,600	8,100	759,800	2,708,700
2015	3,827,700	4,900	805,000	3,017,800
2020	4,138,800	1,700	832,500	3,304,600
	Labor productivity (pesos/person)			
	Total	Primary	Secondary	Tertiary
1995	81,300	5,700	92,700	78,300
2000	90,600	-	104,900	86,800
2005	102,800	-	120,100	98,200
2010	118,600	-	139,200	113,200
2015	138,800	-	165,300	131,900
2020	165,400	-	201,100	156,500
	Labor productivity rising rate (%)			
	Total	Primary	Secondary	Tertiary
1995-00	2.19	-	2.50	2.08
2000-05	2.56	-	2.75	2.50
2005-10	2.90	-	3.00	2.88
2010-15	3.20	-	3.50	3.10
2015-20	3.57	-	4.00	3.48



The job opportunity in the Study Area is for the residents of the Bogota Metropolitan Area as a whole, that is, for the residents of Study Area and the residents of the surrounding municipalities. Table 8.1-12 shows the future number of employees commuting to the Study Area. It is assumed that the percentage of commuters to Bogota will increase from 30.6% in 1995 to 31.5% in 2005, but will then decrease to 30.0% in 2020. This is because at first residential zones will be developed in these municipalities, and later some job centers like industrial estates or multipurpose-use zones will be developed, and the economically active population will be absorbed there.

**Table 8.1-12 Future Number of Commuters to the Study Area**

Year	Employed persons living in surrounding cities	Percentage of commuters to Study Area	Employed persons working in Study Area
1995	318,800	30.6	97,600
2000	401,100	31.0	124,300
2005	520,800	31.5	164,100
2010	696,200	31.0	215,800
2015	913,400	30.5	278,600
2020	1,138,700	30.0	341,600

Table 8.1-13 shows the future change of the number of employees and the percentage of outgoing and incoming. The number of employees who go out to work outside the Study Area will increase from 91,200 persons, 3.9% of the total, in 1995, to 270,700, 6.7% of the total, in 2020. On the other hand, the number of employees who come into the Study Area will also increase from 97,600 persons, 4.1% of the total, in 1995, to 341,600 persons, 8.3% of the total, in 2020.

**Table 8.1-13 Future Number of Commuters and Percentage to and from the Study Area**

Year	Employed persons living in Study Area				Employed persons working in Study Area			
	Working in Study Area	Working outside	Total	% of outgoing	Living in Study Area	Living outside	Total	% of incoming
1995	2,274,500	91,200	2,365,700	3.9	2,274,500	97,600	2,372,100	4.1
2000	2,617,000	121,300	2,738,300	4.4	2,617,000	124,300	2,741,300	4.5
2005	2,948,800	140,500	3,089,300	4.5	2,948,800	164,100	3,112,900	5.3
2010	3,260,800	183,400	3,444,200	5.3	3,260,800	215,800	3,476,600	6.2
2015	3,549,100	235,700	3,784,800	6.2	3,549,100	278,600	3,827,700	7.3
2020	3,797,200	270,700	4,067,900	6.7	3,797,200	341,600	4,138,800	8.3

## 8.2 Urban Development Pattern and Land Use Plan

### 8.2.1 Conceptual Urban Structure of Bogota Metropolitan Area

The present urban structure of the Bogota Metropolitan Area (BMA) can be called a mono-nucleated pattern, although the business/commercial district is extending to the north through Chapinero towards Usaquen.

For the future urban pattern of BMA, the following three could be considered.

- a) Mono-nucleated Pattern
- b) New Town Pattern
- c) Poly-nucleated Network Pattern

#### (1) Mono-nucleated Pattern

A greater part of economic activities in BMA are concentrated in the present Central Business District (CBD). Residential areas are conurbated to the surrounding cities as bed towns. Suburban cores are not sufficiently developed, so many people are forced to go to the CBD for working, shopping and cultural activities.

The transport network is characterized by strong radial corridors with congested traffic of long trips all day.

#### (2) New Town Pattern

This pattern intends to create several "New Towns" around Bogota, which are self-sufficient in socioeconomic activities. They are created by developing existing surrounding urban areas and new ones. For the assurance of self-sufficiency, it is necessary to develop large-scale and high-quality commercial/business districts in addition to industrial zones

The transport network of this pattern is an interconnection of independent networks (mainly radial/ring road system) of "New Towns" and Bogota. Generally trip length is short and traffic on each network of "New Town" and Bogota is balanced with the capacity. The number of Long trips on inter-city routes is comparatively small.

#### (3) Poly-nucleated Network Pattern

This pattern is a connection of various employment cores within and outside Bogota with a strengthened network of transport and communications. Employment cores are developed by incubating existing small cores and by creating new industrial zones and multipurpose-use zones.

The transport network is a lattice pattern locating employment cores on the nodes. Compared with the two patterns mentioned above, trip length is medium.

The mono-nucleated pattern will worsen the existing problems. On the other hand, the New Town pattern is very difficult to realize, and it is feared that the economic activity of BMA will lose its vitality if mobility of the area will decline too much.

It is considered that the poly-nucleated network pattern is the most realistic and can be created by making efforts to strengthen the present policies for planning and development.

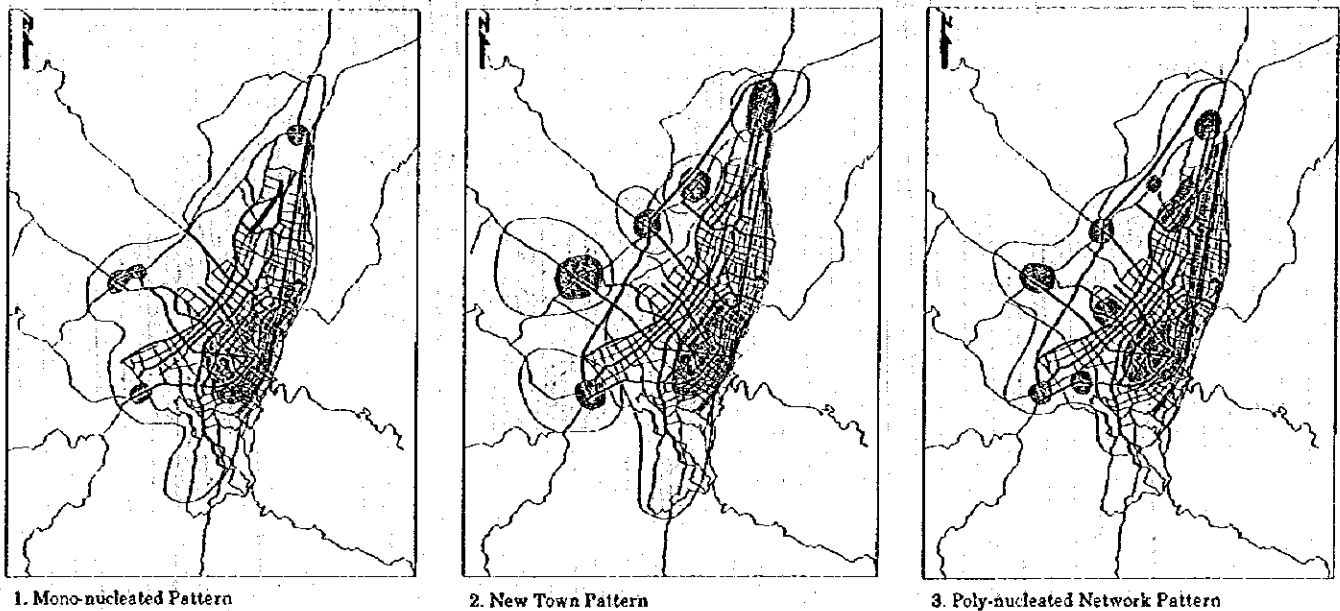


Figure 8.2-1 Urban Development Patterns

### 8.2.2 Basic Policies for Making Land Use Plan

DAPD has an authorized land use regulation plan for the existing urban areas and a development guideline for the transition areas. The surrounding municipalities also have land use regulation plans for the urban areas and rural areas, but in some municipalities the planned urban areas are too small to accommodate the future population projected for 2020.

Considering this fact, the land use plan for the year 2020 is prepared by adding new urban areas by use zoning category to the existing land use regulation plan.

The basic policies for making the land use plan are as follows:

- a) To locate as many job centers such as industrial zones and multipurpose-use zones as possible in new urban areas.
- b) To create the riverside green zone with a width of 300 meters on both sides of rivers
- c) To create the preservation zone with a planned maximum population density of 15 persons per hectare for the hilly area
- d) To locate residential zones for 2.4 million people by considering the size of developed land and transport network in the surrounding municipalities
- e) To prepare a map showing an outline of land use and size of urban area with a population density of 150 persons/ha for the surrounding municipalities
- f) To prepare a map showing use zoning by traffic zone and to make a table showing the area of each use category by zone for the Study Area

### 8.2.3 Land Use Plan for the Study Area

Table 8.2-1 shows the area of newly designated use categories by traffic zone for 20,821.1 ha of "Others" in the 1995 use zoning. Rural areas of 7,242.2 ha will still remain in Zones 26-31 (from San Cristobal to Usme) and in Zones 106-108 (Ciudad Bolivar).

Figure 8.2-2 shows the land use plan for the Study Area and the outline of land use and urban scale for the surrounding municipalities. The area of use zoning for the Study Area in 2020 is shown in Table 8.2-2.

Table 8.2-1 (1) Newly Designated Use Zoning (Traffic Zone)

Ward No.	Zone No.	Special residential	General residential	Institutional	Industrial	Multipurpose use	Metropolitan	Metropolitan green	Preservation	Riverside green	Rural	Total
1	1					784.0	66.3		261.3			1,111.6
	2	121.5										121.5
	3	24.6										24.6
	7								3.0			3.0
	8								15.8			15.8
2	9		253.9									253.9
	10								21.8			21.8
	11	38.0										38.0
	12	6.9										6.9
3	13	44.4										44.4
	14		84.7			46.2		41.3				87.5
	15					81.8						166.5
	16					132.0						132.0
17	17					66.2						66.2
	18	101.5										101.5
	19	57.7										57.7
4	21		36.0									36.0
	23		81.3									81.3
	26									41.5		41.5
5	27											425.0
	28										62.6	62.6
	29										513.3	513.3
	30										1,663.3	1,663.3
	31										586.6	586.6
7	36								13.2			13.2
	37		114.5			60.0		215.0	49.3			163.8
	38	275.0	315.5						510.0			1,325.5
8	42	200.0	393.6		200.0	20.0			127.5			941.1
	44								2.8			2.8
	45		261.0		25.0	12.0			15.0			313.0
	46								18.4			18.4
9	49				130.9	50.0	71.0			96.0		190.9
	51				301.0					26.5		518.0
	52									180.0		26.5
	53				68.5							248.5
10	58		71.6									71.6
	60		86.0									86.0
	61		441						75.0			119.1
	62		308.7						210.0			518.7
11	63								35.6			35.6
	64								48.7			48.7
	65	1,955.0			280.0	445.0	130.0		261.0	360.0		3,431.0
	67								0.5			0.5
	68		26.2						62.0	45.0		133.2
	69		858.2		150.0	45.0			150.0	300.0		1,513.2
	70		69.4							180.0		249.4
	71											180.0
14	83					45.4	12.5					57.9
	84					51.1						51.1
19	106		574.2			55.0					3,682.3	4,311.5
	107		255.6			27.5					62.8	345.9
	108		162.3			35.0					204.8	402.1
Study Area		2,909.3	3,922.1	0.0	1,155.4	1,956.2	279.8	256.3	855.0	2,244.8	7,242.2	20,821.1

Table 8.2-1 (2) Newly Designated Use Zoning (Ward)

No & name of Ward	Special Residential	General Residential	Institutional	Industrial	Mult-purpose Use	Metropolitan Service	Metropolitan Green	Preservation	Riverside Green	Rural	Total
1 Usaquea	146.1	0.0	0.0	0.0	784.0	66.3	0.0	311.5	0.0	0.0	1,307.9
2 Chapinero	89.3	253.9	0.0	0.0	0.0	0.0	0.0	21.8	0.0	0.0	365.0
3 Santafé	185.2	0.0	0.0	0.0	326.2	0.0	41.3	0.0	0.0	0.0	553.7
4 San Cristóbal	0.0	117.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	41.5	158.8
5 Ume	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3,250.8	3,250.8
7 Bosa	275.0	430.0	0.0	0.0	60.0	0.0	215.0	0.0	572.5	0.0	1,552.5
8 Kennedy	200.0	654.6	0.0	225.0	32.0	0.0	0.0	0.0	163.7	0.0	1,275.3
9 Fontibón	0.0	0.0	0.0	500.4	50.0	71.0	0.0	0.0	302.5	0.0	923.9
10 Engañá	0.0	510.4	0.0	0.0	0.0	0.0	0.0	0.0	285.0	0.0	795.4
11 Suba	1,955.0	963.8	0.0	430.0	490.0	130.0	0.0	521.7	921.1	0.0	5,411.6
14 Los Muriles	0.0	0.0	0.0	0.0	96.5	12.5	0.0	0.0	0.0	0.0	109.0
17 La	51.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	51.7
19 Ciudad Bolívar	0.0	992.1	0.0	0.0	117.5	0.0	0.0	0.0	0.0	3,949.9	5,059.5
S.A. Total	2,909.3	3,922.1	0.0	1,155.4	1,956.2	279.8	256.3	855.0	2,244.8	7,242.2	20,821.1

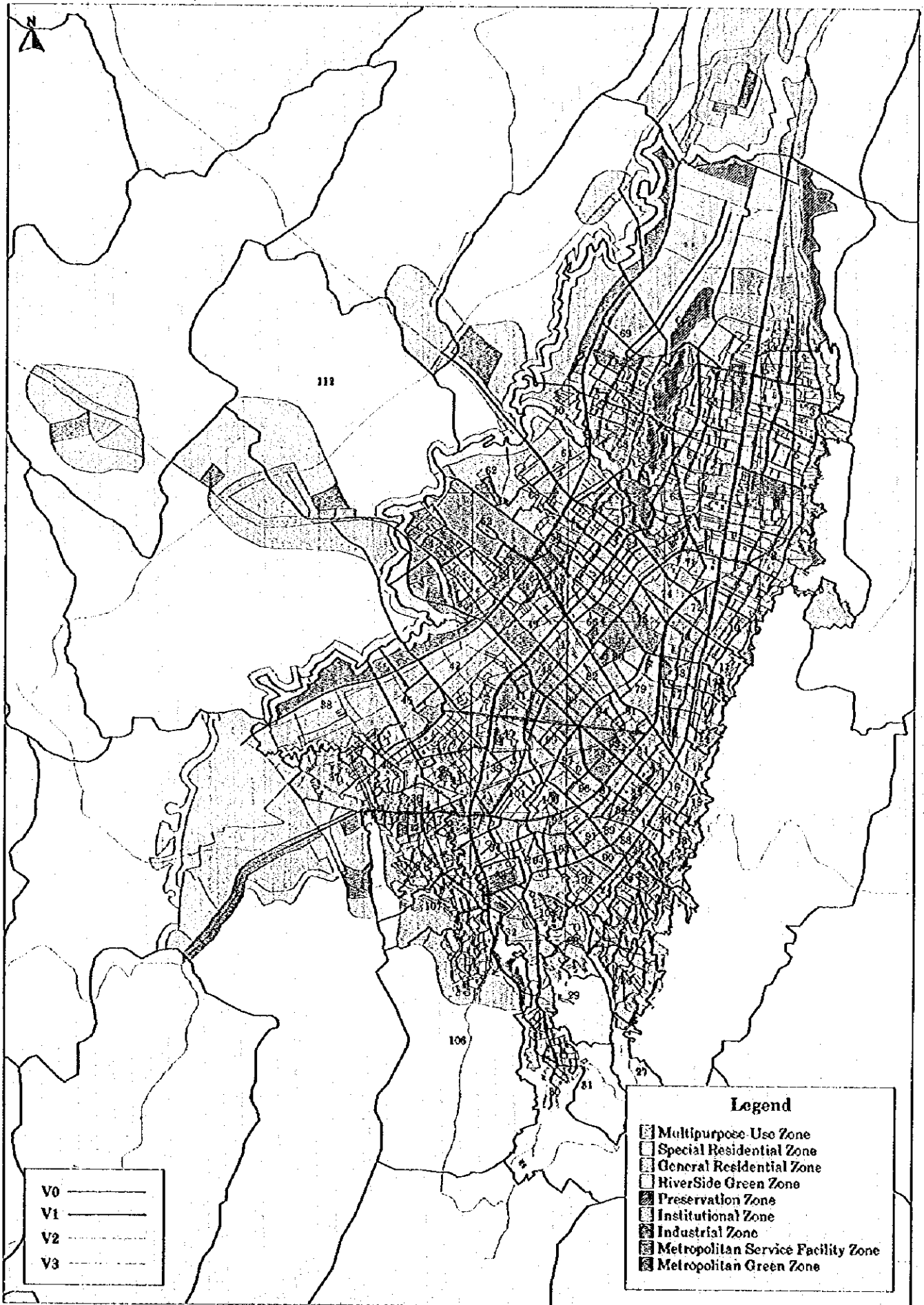


Figure 8.2-2 Land Use Plan for 2020

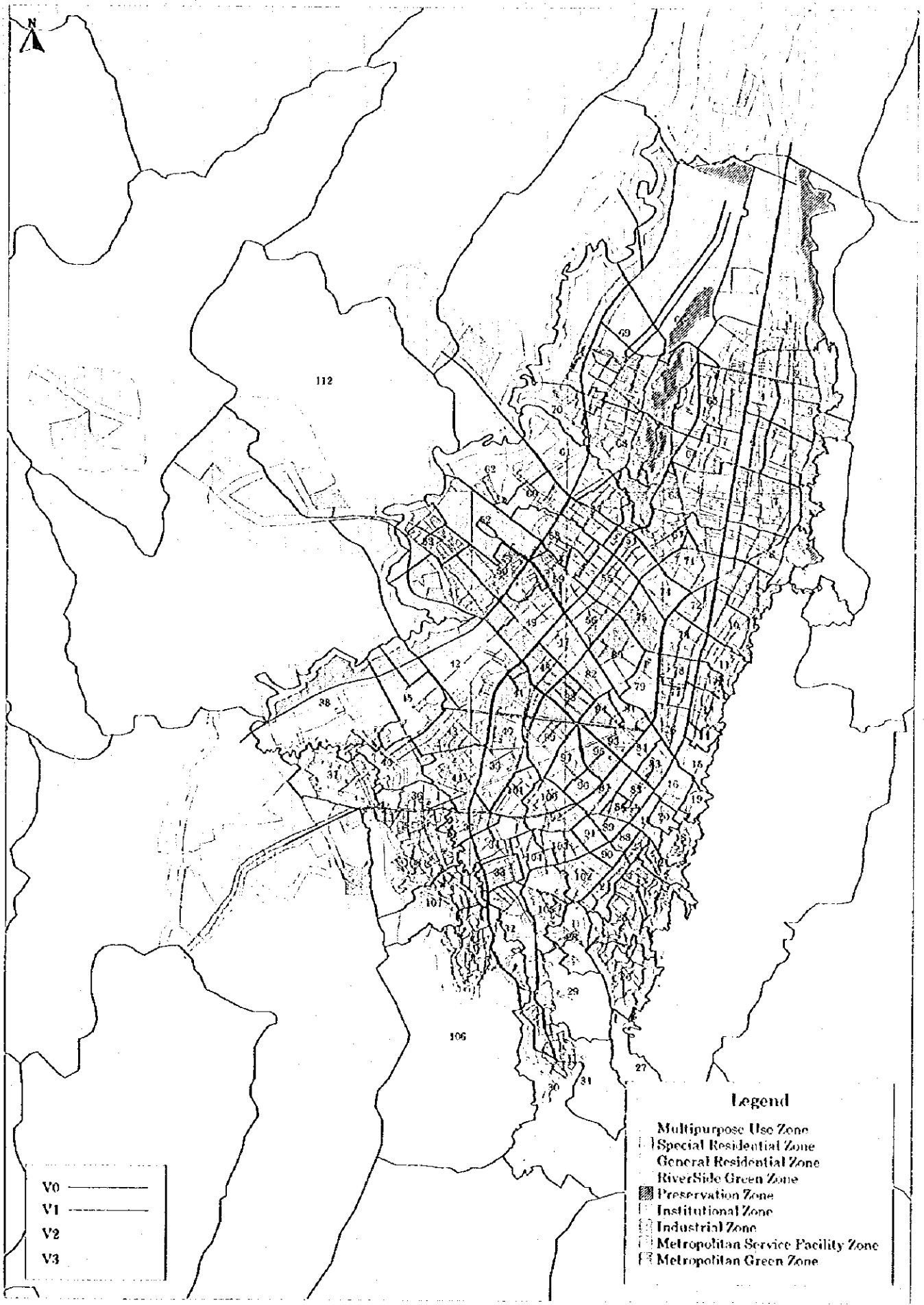


Figure 8.2-2 Land Use Plan for 2020

Table 8.2-2 (1) Use Zoning in 2020 (Traffic Zone)

Ward No.	Zone No.	Special residential	General residential	Institutional	Industrial	Multipurpose use	Metropolitan service	Metropolitan green	Preservation	Riverside green	Rural	Total
1	1	55.9	215.1			784.0	66.3		261.3			1,382.6
	2	173.1	314.9	76.3								564.5
	3	90.3	174.4	6.4		87.6						358.7
	4	25.5	149.7									175.2
	5	398.8	12.8									414.6
	6	198.3	23.2									221.5
	7	445.5	49.4			41.0		108.3	15.8			660.0
	8	380.0	41.6	85.4		23.3		0.0	31.4			561.9
2	9	245.3	375.0			10.7		4.1				635.1
	10	144.7	10.2			122.4			21.8			299.1
	11	129.2	5.0			75.1						209.3
	12	26.5				47.1						103.6
	13	111.9	11.7			56.5						180.1
3	14	0.8				47.1		41.3				89.2
	15	84.7				81.8						166.5
	16	6.6				163.5						170.1
	17	23.7				91.7						114.4
	18	122.4	89.3	4.9								216.6
17	19	71.7		27.3		2.8						102.0
	20	40.7				52.7						93.4
4	21		156.9			1.7						158.6
	22		317.9			5.5		17.8				341.2
	23		0.0			59.2						59.2
	24		119.3			58.0						177.3
	25		392.6			24.1		4.6				411.3
	26		465.8			12.7				41.5		521.0
5	27		65.3								425.0	490.3
	28		245.3								62.6	308.9
	29		203.8	3.7		5.2					513.3	726.0
	30		303.1			28.3					1,663.3	1,994.7
	31		116.2			5.4					585.6	708.2
6	32		181.0	153.4	21.2	6.3		3.9				365.8
	33		94.8					82.7				177.5
	34		174.9	103.2	30.0	7.9						316.0
	35		84.0		42.9	63.0						189.9
7	36		104.5		77.5		54.9			13.2		250.1
	37		539.7			52.2				49.3		641.2
	38	275.0	433.2			61.1		215.0		510.0		1,494.3
8	39		256.6		38.1	6.6						301.3
	40		165.7					21.2				186.9
	41		87.4		165.5							252.9
	42	200.0	713.8		200.0	20.0				127.5		1,261.3
	43		373.2			9.4						382.6
	44		359.9		32.3	8.2		28.9		2.8		432.1
	45		449.9		25.0	15.0	46.5	12.2		15.0		563.6
	46		356.4			15.0	14.3			18.4		384.1
9	47		158.4			30.9	34.8					224.9
	48				189.1							189.1
	49		252.2		156.7	4.9						413.8
	50		246.0		160.7	9.3	23.9	4.4				444.3
	51		135.9		306.1	176.4	71.0			96.0		785.4
	52				39.5		626.0			26.5		692.0
	53				315.2	4.0	17.5			180.0		516.7
10	54	1.7	253.9			4.3		11.6				271.5
	55		196.3	26.0		133.0						355.3
	56	47.2	13.3	65.7				91.2				218.4
	57	7.1	257.0			95.3		8.2				367.6
	58	2.2	216.9		64.9	97.7						381.7
	59	51.8	117.7		111.9	1.0						282.4
	60	4.4	248.8			6.5						259.7
	61		526.2			6.9				75.0		608.1
	62		400.0		70.7	17.6				210.0		699.3
11	63	408.1	47.2			100.7		150.9		35.6		742.5
	64	281.5	147.6	14.4		38.8		4.7	48.7			535.7
	65	155.9	389.0	48.4				53.3				646.6
	66	2,367.0	17.6		280.0	445.0	130.0	11.4	261.0	360.0		3,872.0
	67	213.4	119.3		31.3	20.8		22.9		0.5		408.2
	68	35.4	326.6			147.5		15.9		62.0	45.0	632.4
	69	168.8	1,357.9		293.2	81.6			150.0	300.0		2,346.5
	70		249.0			1.3				180.0		431.3
12	71	77.5	149.5	55.7		10.6						293.3
	72	59.7	108.5			11.3						173.5
	73		37.3			201.6						238.9
	74	6.3	144.5			57.6						208.4
	75	92.6	44.4			2.9		144.4				284.3
13	76		42.5			147.5						190.0
	77	28.0	13.9			73.7						115.6
	78	26.6	11.1			93.7		24.6				156.0
	79	87.5	19.7	135.8								243.0
	80	127.9	3.7	74.6				156.0				362.2
	81	17.7	85.2			17.7						120.6
	82		87.4	28.5		48.3						164.3
14	83					133.4	12.5	7.3				153.2
	84					121.1						121.1
	85					112.9		12.2				125.1
	86					87.7						87.7
	87	42.1	15.7			107.4						165.2
15	88					69.5						69.5
	89					82.5						82.5
	90					63.6						63.6
	91					105.8						105.8
	92					151.4	10.2					161.6
16	93				124.7	37.1						161.8
	94	23.4	17.6		86.6	5.5						133.1
	95				171.9	5.9						177.8
	96		106.1									106.1
	97		206.2									206.2
	98				181.4							181.4
	99		232.1		142.3							374.4

The Master Plan for Urban Transport of Santa Fe de Bogota

Table 8.2-2(1) Contd.

Ward No.	Zone No.	Special residential	General residential	Institutional	Industrial	Multipurpose use	Metropolitan service	Metropolitan green	Preservation	Riverside green	Rural	Total
	100		154.8			18.7		8.4				181.9
	101		194.7			12.4						207.1
19	102		152.9			70.5						223.4
	103					164.8		7.1				171.9
	104		47.4			135.6						183.0
	105		288.6	43.6	60.5	7.7						400.4
19	106		1,100.0	39.1	66.1	55.0					3,632.3	4,932.5
	107		550.0	13.2		27.5					62.8	653.5
	108		700.0		148.6	35.0					204.8	1,088.4
Study Area Total		7,608.2	18,391.1	1,007.0	3,633.9	5,852.7	1,107.9	1,274.5	855.0	2,244.8	7,242.2	49,217.3

Table 8.2-2 (2) Use Zoning in 2020 (Ward)

No. & name of Ward	Special Residential	General Residential	Institutional	Industrial	Multi-purpose Use	Metropolitan Service	Metropolitan Green	Preservation	Riverside Green	Rural	Total
1 Usaquen	1,767.4	981.1	168.3		936.1	66.3	103.3	311.5			4,339.0
2 Chapinero	687.6	401.9			311.8		4.1	21.8			1,427.2
3 Santa Fe	237.2	89.3	4.9		384.1		41.3				756.8
4 San Cristobal		1,443.5			161.2		22.4			41.5	1,668.6
5 Ume		934.7	3.7		38.9					3,250.8	4,228.1
6 Tunjuelito		534.7	256.6	94.1	77.2		86.6				1,049.2
7 Bosa	275.0	1,077.4		77.5	113.3	54.9	215.0		572.5		2,385.6
8 Kennedy	200.0	2,742.9		460.9	74.2	60.8	62.3		163.7		3,764.8
9 Fontibon	0.8	792.5		1,167.3	225.5	773.2	4.4		302.5		3,266.2
10 Engativa	114.4	2,230.1	92.7	247.5	362.3		111.0		285.0		3,443.0
11 Suba	3,630.1	2,649.2	62.8	604.5	836.7	130.0	259.1	521.7	921.1		9,615.2
12 Barrios Unidos	230.1	484.2	55.7		284.0		144.4				1,198.4
13 Teusaquillo	287.7	263.5	238.9		380.9		180.6				1,351.6
14 Los Martires	42.1	15.7			562.5	12.5	19.5				652.3
15 Antonio Narino					472.8	10.2					483.0
16 Puente Aranda	23.4	911.5		706.9	79.6		8.4				1,729.8
17 La Candelaria	112.4		27.5		55.5						195.4
18 Rafael Uribe		488.9	43.6	60.5	378.6		7.1				978.7
19 Ciudad Bolivar		2,350.0	52.3	214.7	117.5					3,949.9	6,684.4
S.A. Total	7,608.2	18,391.1	1,007.0	3,633.9	5,852.7	1,107.9	1,274.5	855.0	2,244.8	7,242.2	49,217.3



### 8.3 Population and Employment Distribution Plan

#### 8.3.1 Principles for Population and Employment Distribution

Population distribution plan and employment distribution plan should conform to land use plan. For the distribution of projected population in 2020 to traffic zones, the following principles are established:

- a) To determine planned population density for the newly designated Special Residential Zone, General Residential Zone, Multipurpose-Use Zone and Preservation Zone
- b) To consider the density guidelines established by DAPD for the north and northwest areas in Suba
- c) To assume population density a little higher than the present one for traffic zones in the existing urbanized area

For the distribution of employment, the following principles are established:

- a) To distribute employment in the primary sector only to some suburban zones proportionally to the distribution pattern in 1995
- b) To assign the employment increase between 1995 and 2020 to zones for the secondary and tertiary sectors
- c) To determine planned employment density for the newly designated Industrial Zone and Multipurpose-Use Zone
- d) To distribute the employment in the secondary sector by dividing it into three categories, that is, industry, construction and others
- e) To assign employment in industry to the new Industrial Zones according to the planned density, and to distribute employment outside the Industrial Zone proportionally to the future number of employees in industry on living place basis
- f) To distribute employment in construction proportionally to the population increase between 1995 and 2020
- g) To distribute employment in the other secondary sector proportionally to the distribution pattern in 1995
- h) To assign employment in the tertiary sector to the new Multipurpose-Use Zones according to the planned density
- i) To distribute a half of employment in the tertiary sector outside the Multipurpose-Use Zone proportionally to the population distribution in 1995 and to distribute the other half proportionally to the population increase between 1995 and 2020

#### 8.3.2 Population Distribution Plan

Table 8.3-1 shows the assumed population density by category and planned population by traffic zone. For Zones 1, 2, 3, 4, 6, and 7 in Usaquen, population densities of the special residential zone, general residential zone, multipurpose-use zone, and preservation zone were assumed to be 200 persons/ha, 250 persons/ha, 250 persons/ha, and 15 persons/ha, respectively. Zone 38 in Bosa (DAPD's project, "Tintal Sur", is located in this zone) and Zone 42 in Kennedy (Also DAPD's project, "Tintal Norte", is located in this zone) were assumed to have a little higher population density than zones in Usaquen. A high density apartment house development such as Ciudadela Colsubsidio is expected to cover Zones 61 and 62 in Engativa. The population density of 257.5 persons/ha for the special residential zone of Zone 66 in Suba is an average of planned densities ranging from 80 persons/ha to 400 persons/ha. Zone 82 in Teusaquillo is expected to have a population of about 100,000 persons, with a high density of more than 700 persons/ha.

Table 8.3-1 Planned Population and Population Density in Newly Developed Zones

Ward no.	Zone no.	Planned population	Area by zone for residential use (ha)				Preservation	Population density (person/ha)			
			Special residen.	General residen.	Multi-purpose use	Preservation		Special residen.	General residen.	Multi-purpose	Preservation
1	1	264,875	55.9	215.1	784.0	261.3	200.0	250.0	250.0	15.0	
	2	113,345	173.1	314.9			200.0	250.0			
	3	83,560	90.3	174.4	87.6		200.0	250.0	250.0		
	4	42,525	25.5	149.7			200.0	250.0			
	6	45,460	198.3	23.2			200.0	250.0			
	7	111,937	445.5	49.4	41.0		15.8	200.0	250.0		250.0
	7	38	217,040	275.0	433.2		61.1		250.0		300.0
8	42	270,140	200.0	713.8	20.0		250.0	300.0	300.0		
9	47	47,525	0.8	158.4	30.9		250.0	250.0	250.0		
10	61	213,240		526.2	6.9			400.0	400.0		
	62	162,040		400.0	17.6			400.0	400.0		
11	65	128,430	155.9	389.0		261.0	200.0	250.0			
	66	729,162	2,367.0	17.6	445.0		257.5	250.0	250.0		
	67	60,030	213.4	119.3	20.8		150.0	200.0	200.0		
	69	430,498	168.8	1,352.9	81.6		150.0	200.0	275.0		
	70	75,390		249.0	2.3			300.0	300.0		
13	80	32,900	127.9	3.7			250.0	250.0			
	82	101,775	87.4	48.3			750.0	750.0			
19	106	288,750		1,100.0	55.0			250.0	250.0		
	107	144,375		550.0	27.5			250.0	250.0		
	108	183,750		700.0	35.0			250.0	250.0		
	Total	3,751,746									

Table 8.3-2 shows the results of 2020 population distribution plan for the Study Area, compared with the population distribution in 1995. The population of the Study Area will increase by 2,651 thousand persons during the 25-year period from 1995 to 2020, nearly half of which, 1,206 thousand persons, will increase in Suba, especially in Zones 66 and 69. Other zones where great increases in population are expected are Zone 1 in Usaquen, Zone 38 in Bosa, Zone 42 in Kennedy, Zone 62 in Engativa, Zone 82 in Teusaquillo, and Zone 106 in Ciudad Bolivar. Future trend of population increase by zone is shown in Figure 8.3-1.

Projected 2020 populations for the surrounding municipalities are shown in Table 8.3-3. The north area composed of Chia, Cajica and Zipaquira will have a population of about 750 thousand in 2020. The west area (Funza, Mosquera, Madrid, Facatativa, and Bojaca) and the east area (Soacha, Sibate and Sunapaz) will also have a similar size of populations, respectively. Figure 8.3-2 shows these future population increases in the surrounding areas.

Table 8.3-2 (1) Future Population Distribution in the Study Area (Traffic Zone)

Ward No.	Zone No.	Area of Zone (ha)	1995		2020		Population Increase
			Population	Dens (p/ha)	Population	Dens (p/ha)	
1	1	1382.62	41,961	30.3	264,875	*	222,914
	2	564.49	21,985	38.9	113,345	*	91,360
	3	358.72	69,223	193.0	83,560	*	14,337
	4	175.16	34,115	194.8	42,525	*	8,410
	5	414.58	83,647	201.8	87,062	210	3,415
	6	221.49	33,413	150.9	45,460	*	12,047
	7	659.99	84,628	128.2	111,937	*	27,309
	8	561.94	46,034	81.9	56,194	100	10,160
2	9	635.07	47,797	75.3	63,507	100	15,710
	10	259.12	43,073	144.0	44,868	150	1,795
	11	209.28	34,356	164.2	35,578	170	1,222
	12	103.60	20,370	198.6	20,720	200	150
	13	180.05	27,641	153.5	28,808	160	1,167
3	14	89.20	4,520	50.7	5,352	60	832
	15	166.48	21,927	131.7	23,307	140	1,385
	16	170.13	29,717	174.7	30,623	180	906
	17	114.38	30,230	264.3	30,883	270	653
	18	216.64	61,570	284.2	62,826	290	1,256
	19	102.03	11,402	111.8	12,244	120	842
4	20	93.43	17,919	191.8	18,686	200	767
	21	158.56	18,291	115.4	19,027	120	736
	22	341.19	50,309	147.5	51,179	150	870
	23	59.23	13,935	235.3	14,215	240	280
	24	177.31	59,315	334.5	60,285	340	970
	25	411.33	149,564	363.6	152,192	370	2,628
	26	520.95	114,419	219.6	114,609	220	190
	27	490.28	10,748	21.9	12,257	25	1,509
5	28	308.90	50,857	164.7	52,513	170	1,646
	29	725.96	29,929	41.2	36,298	50	6,369
	30	1994.68	74,730	37.5	79,787	40	5,057
	31	708.18	45,806	64.7	49,573	70	3,767
	32	365.81	60,268	164.8	62,188	170	1,920
6	33	177.49	25,137	141.8	26,618	150	1,481

Chapter 8: Urban Development Plan

Table 8.3-2(1) Contd.

Ward No	Zone No	Area of Zone(ha)	1995		2020		Population Increase
			Population	Dens.(p/ha)	Population	Dens.(p/ha)	
7	34	315.99	83,648	264.7	85,317	270	1,669
	35	189.91	50,312	266.0	51,276	270	764
	36	250.13	38,498	153.9	40,021	160	1,523
	37	641.20	158,990	248.0	160,300	250	1,310
8	38	1494.33	68,218	45.7	217,040	*	148,822
	39	301.30	73,378	243.5	75,323	250	1,947
	40	186.85	32,143	172.0	33,633	180	1,490
	41	252.91	14,777	58.4	15,175	60	398
	42	1261.27	64,720	51.3	270,140	*	205,420
	43	382.62	118,291	309.2	118,612	310	321
	44	432.11	93,304	215.9	95,064	220	1,760
	45	563.57	116,372	206.5	118,350	210	1,978
9	46	384.12	147,707	384.5	149,807	390	2,100
	47	224.89	16,551	73.6	47,525	*	30,974
	48	189.14	0	0.0	0	0	0
	49	413.76	58,105	140.4	62,064	150	3,959
	50	444.32	104,253	234.6	111,080	250	6,827
	51	785.41	104,230	132.7	109,957	140	5,727
	52	692.03	0	0.0	0	0	0
10	53	516.73	33,961	65.7	36,171	70	2,210
	54	271.51	87,474	322.2	89,598	330	2,124
	55	355.31	139,439	392.4	142,124	400	2,685
	56	218.41	11,055	50.6	12,013	55	958
	57	367.55	142,641	388.1	143,345	390	704
	58	381.69	106,584	279.2	110,690	290	4,106
	59	282.36	56,073	198.6	56,472	200	399
	60	259.73	88,490	340.7	90,906	350	2,416
	61	608.06	152,169	250.3	213,240	*	61,071
	62	698.27	50,638	72.5	167,040	*	116,402
11	63	742.46	84,780	114.2	89,095	120	4,315
	64	535.65	65,749	122.7	80,348	150	14,599
	65	646.62	43,492	67.3	128,430	*	84,938
	66	3872.00	27,218	7.0	729,162	*	701,944
	67	408.22	41,758	102.3	60,030	*	18,272
	68	632.38	139,970	221.3	158,095	250	18,125
	69	2346.55	75,062	32.0	430,498	*	355,436
	70	431.27	66,608	154.4	75,390	*	8,782
12	71	293.32	50,660	172.7	52,798	180	2,138
	72	173.53	38,302	220.7	39,912	230	1,610
	73	238.87	50,741	212.4	52,551	220	1,810
	74	208.44	73,218	351.3	75,038	360	1,820
	75	284.32	23,777	83.6	25,589	90	1,812
13	76	189.98	32,578	171.5	34,196	180	1,618
	77	115.63	30,501	263.8	31,220	270	719
	78	156.03	26,291	168.5	26,525	170	234
	79	243.01	26,327	108.3	26,731	110	404
	80	362.22	26,666	73.6	32,900	*	6,234
	81	120.64	23,953	198.5	24,128	200	175
14	82	164.24	72	0.4	101,775	*	101,703
	83	153.20	30,139	196.7	30,640	200	501
	84	121.07	16,805	138.8	16,950	140	145
	85	125.10	20,318	162.4	21,267	170	949
	86	87.69	25,673	292.8	26,307	300	634
	87	165.23	36,865	223.1	38,003	230	1,138
	15	88	69.48	25,912	372.9	26,402	380
89		82.54	31,433	380.8	32,191	390	758
90		63.65	18,797	295.3	19,095	300	298
91		105.84	34,194	323.1	34,398	325	204
92		161.63	47,680	295.0	48,489	300	809
16	93	161.79	3,197	19.8	3,236	20	39
	94	133.12	10,274	77.2	10,650	80	376
	95	177.84	3,513	19.8	3,557	20	44
	96	106.14	39,099	368.4	39,272	370	173
	97	206.25	68,564	332.4	70,125	340	1,561
	98	181.38	6,988	38.5	7,255	40	267
	99	374.39	110,911	296.2	112,317	300	1,406
	100	181.85	64,456	354.4	65,466	360	1,010
	101	207.05	78,186	377.6	78,679	380	493
	18	102	223.36	65,461	293.1	65,891	295
103		171.91	61,564	358.1	61,888	360	324
104		182.96	69,834	381.7	71,354	390	1,520
105		400.43	133,708	333.9	136,146	340	2,438
19	106	4942.45	155,938	31.6	288,750	*	132,812
	107	653.46	74,136	113.5	144,375	*	70,239
	108	1088.39	132,350	121.6	183,750	*	51,400
Total		49217.25	5,995,000	121.8	8,646,247	175.7	2,651,247

Table 8.3-2 (2) Future Population Distribution in the Study Area (Ward)

No. & name of Ward	Area of Ward (ha)	1995		2020		Population Increase
		Population	Dens. (p/ha)	Population	Dens. (p/ha)	
1 Usaquen	4,339.0	415,006	95.6	804,958	185.3	389,952
2 Chapinero	1,427.1	173,437	121.5	193,481	135.6	20,044
3 Santa Fe	756.8	147,959	195.5	152,991	202.1	5,032
4 San Cristobal	1,668.6	405,833	243.2	411,507	246.6	5,674
5 Usme	4,228.0	212,080	50.2	230,428	54.5	18,348
6 Tunjuelito	1,049.2	219,585	209.3	225,398	214.8	5,813
7 Bosa	2,385.7	265,706	111.4	417,361	174.9	151,655
8 Kennedy	3,764.8	660,692	175.5	876,106	232.7	215,414
9 Fontibon	3,266.3	317,100	97.1	366,798	112.3	49,698
10 Engativá	3,442.9	834,563	242.4	1,025,427	297.8	190,864
11 Suba	9,615.2	544,637	56.6	1,751,048	182.1	1,206,411
12 Barrios Unidos	1,198.5	236,698	197.5	245,888	205.2	9,190
13 Teusaquillo	1,351.8	166,388	123.1	277,476	205.3	111,088
14 Los Martires	652.3	129,800	199.0	133,167	204.2	3,367
15 Antonio Narino	483.1	158,016	327.1	160,575	332.4	2,559
16 Puente Aranda	1,729.8	385,188	222.7	390,556	225.8	5,368
17 La Candelaria	195.5	29,321	150.0	30,930	158.2	1,609
18 Rafael Uribe	978.7	330,567	337.8	335,279	342.6	4,712
19 Ciudad Bolívar	6,684.3	362,424	54.2	616,875	92.3	254,451
Study Area total	49,217.3	3,923,000	121.8	8,646,247	175.7	2,651,247

Table 8.3-3 Future Population Distribution in the Surrounding Municipalities

Municipality	Projected population for 2020		
	Total	Urban	Rural
North	750,000	723,000	27,000
Chía	500,000	495,000	5,000
Cajicá	100,000	88,000	12,000
Zipacná	150,000	140,000	10,000
Northeast	70,000	49,000	21,000
Sopó	20,000	12,000	8,000
Tocancipá	35,000	26,000	9,000
Gachancipá	15,000	11,000	4,000
Northwest	150,000	120,000	30,000
Cota	90,000	84,000	6,000
Tenjo	35,000	20,000	15,000
Tibío	25,000	16,000	9,000
West	650,000	624,000	26,000
Fuzca	300,000	293,000	7,000
Mosquera	180,000	179,000	1,000
Madrid	70,000	62,000	8,000
Facatativa	90,000	83,000	7,000
Bojacá	10,000	7,000	3,000
Southwest	700,000	681,000	39,000
Soacha	600,000	598,000	2,000
Sibaté	70,000	63,000	7,000
Sumapaz	30,000	0	30,000
East	80,000	65,000	15,000
La Calera	80,000	65,000	15,000
Total	2,400,000	2,242,000	158,000

### 8.3.3 Employment Distribution Plan

Table 8.3-4 and Table 8.3-5 show the assumed employment densities for newly designated industrial zones and multipurpose-use zones and the number of employees there, as well as the assumed employment densities for the old multipurpose-use zones (sometimes industrial zones or metropolitan service facility zones). These tables also show the assignment of the increased employment in the secondary and tertiary sectors other than the industrial or multipurpose-use zones mentioned above.

The employment density of a newly planned industrial zone is assumed to be 50 persons/ha, considering the densities of existing industrial zones. The employment densities of newly designated multipurpose-use zones are assumed to be 300 persons/ha, with the exception of Zone 1 where some non high density activities such as clubs, outdoor recreational facilities or restaurants are already located. As for the old multipurpose-use zones and other selected zones, a variety of employment densities were assumed, taking into consideration their existing densities.

Zones where employment in the secondary sector will increase remarkably (more than 10,000 persons) are Zone 1 in Usaquen, Zone 38 in Bosa, Zone 42 in Kennedy, Zone 51 in Fontibon, and Zones 66 and 69 in Suba. No industrial zones are planned for Zones 1

and 38. However, considerable employment increases in the construction sector are expected on account of proceeding urban development. For the other 4 zones, new industrial zones are planned, and a great number of employment are expected to be created there.

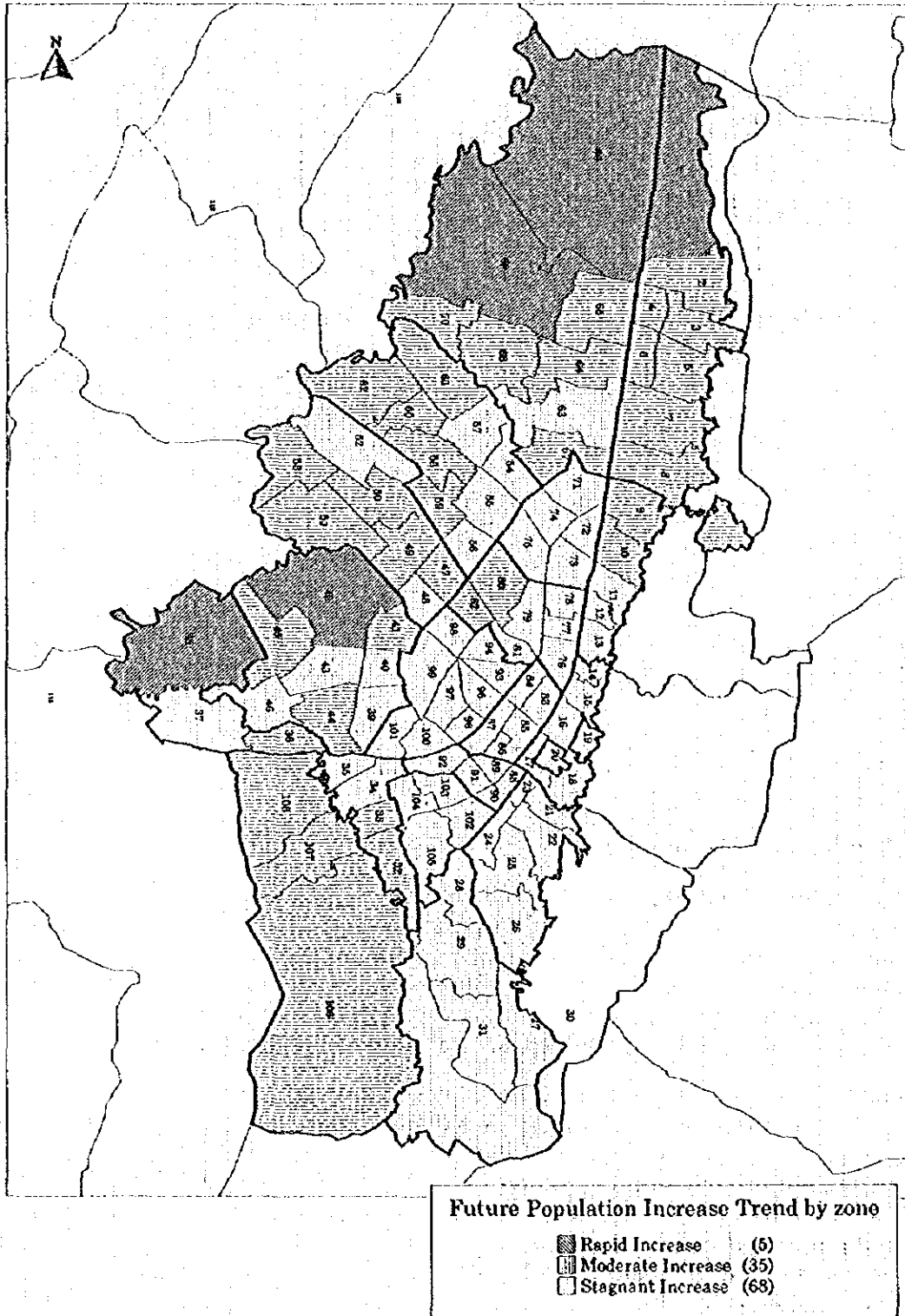
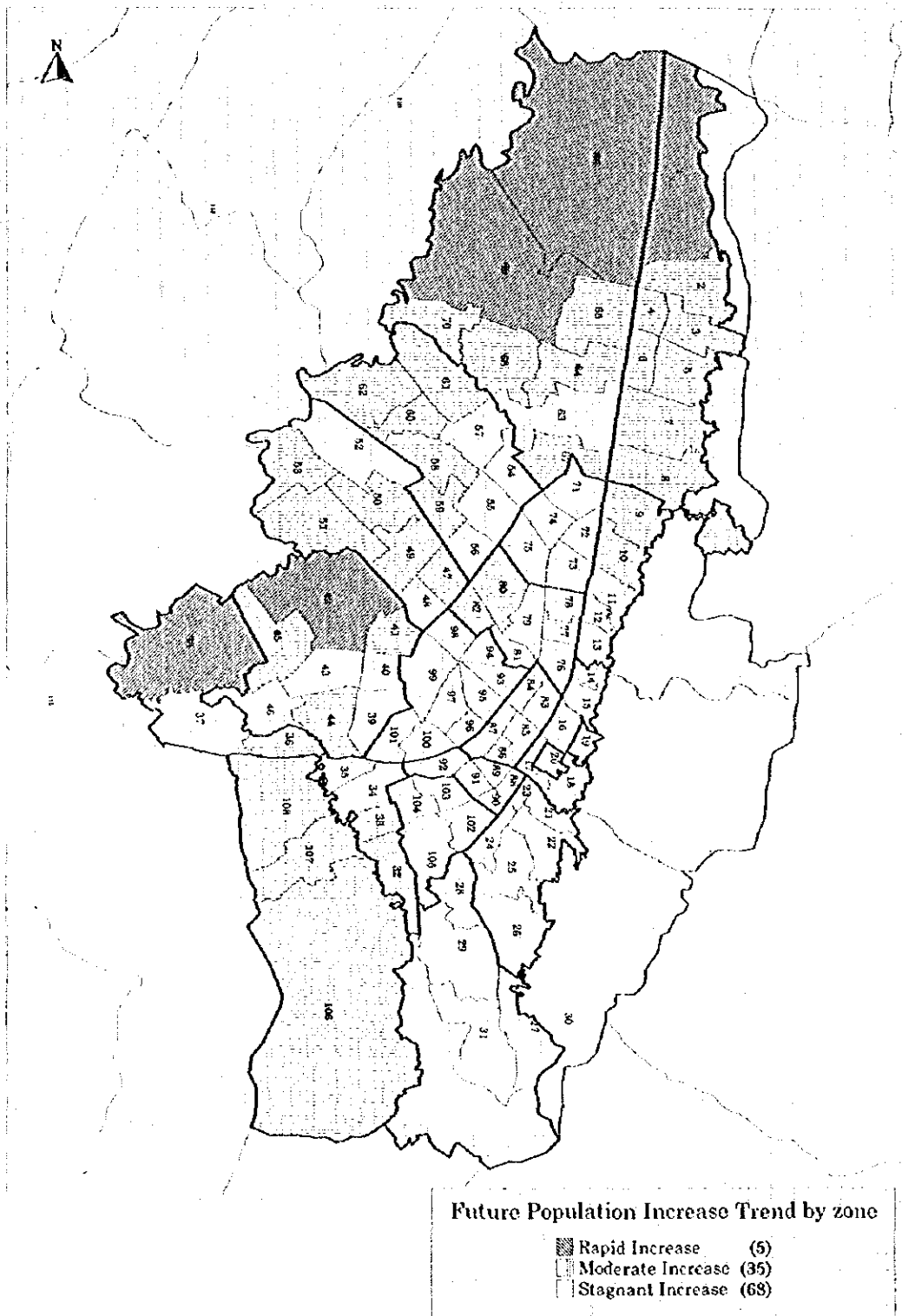


Figure 8.3-1 Future Trend of Population Increase

and 38. However, considerable employment increases in the construction sector are expected on account of proceeding urban development. For the other 4 zones, new industrial zones are planned, and a great number of employment are expected to be created there.



**Figure 8.3-1 Future Trend of Population Increase**

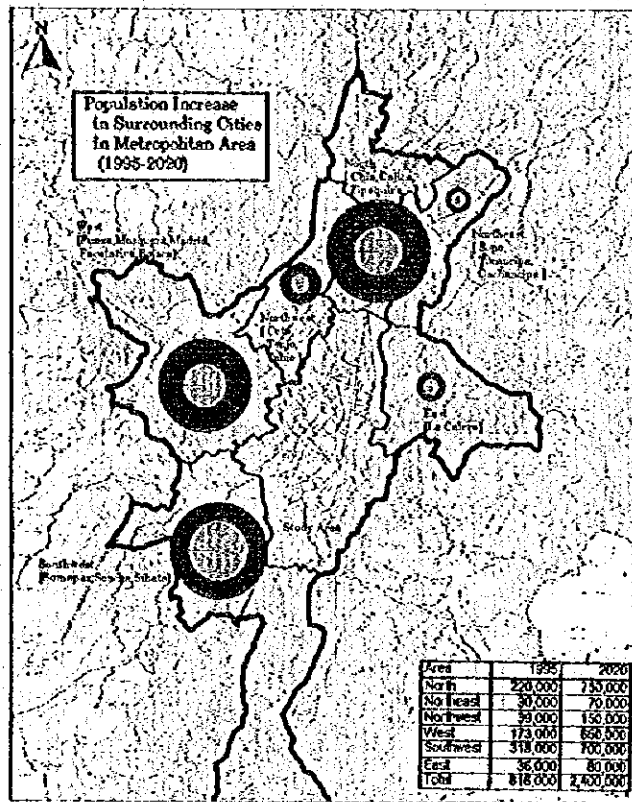


Figure 8.3-2 Population Increase in the Surrounding Cities

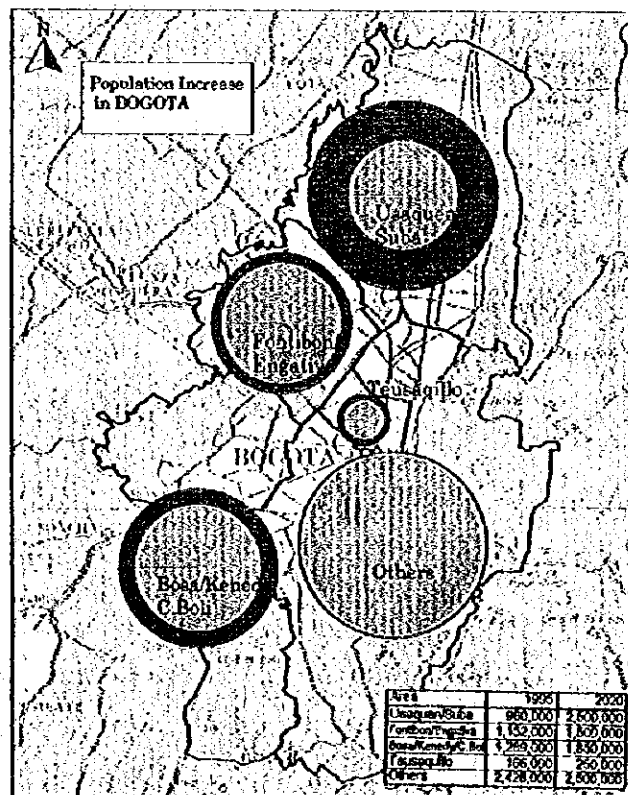


Figure 8.3-3 Population Increase in the City

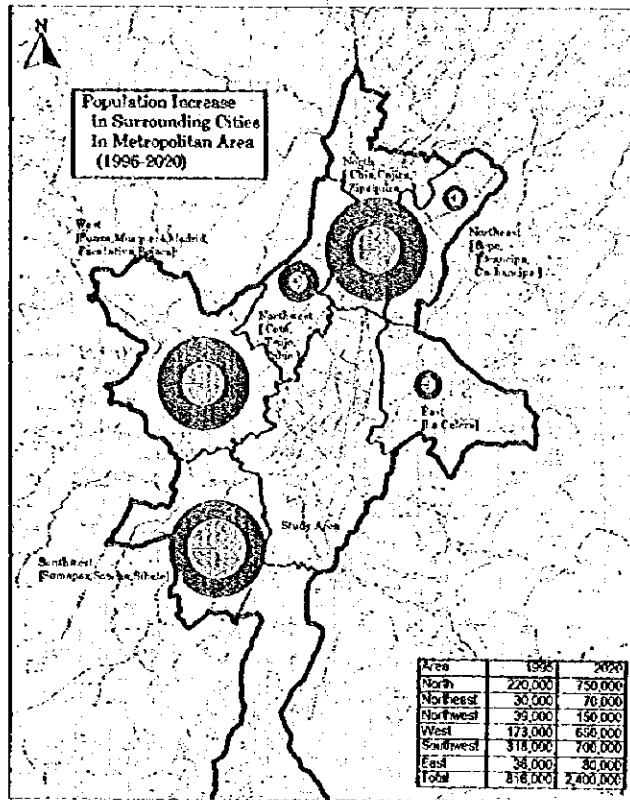


Figure 8.3-2 Population Increase in the Surrounding Cities

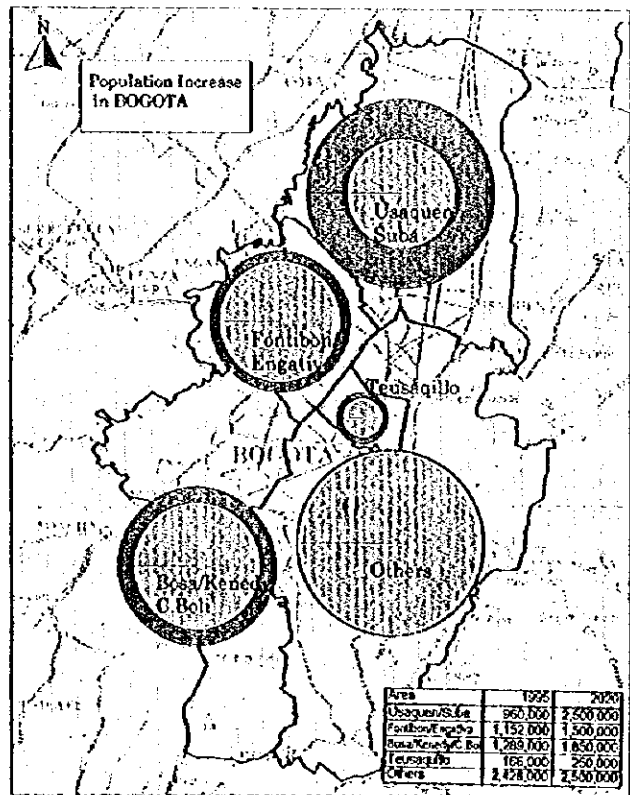


Figure 8.3-3 Population Increase in the City



As for the tertiary sector, Zone 1 in Usaquen, Zone 16 in Santa Fe, Zones 66 and 69 in Suba, and Zone 82 in Teusaquillo will have great employment increases (more than 50,000 persons). Zone 16 is the present Central Business District (CBD) and is attracting nearly 200,000 persons for working there. However, it is expected that this zone will grow into a more sophisticated metropolitan center with a nearly 1.5 times the existing scale of employment. In order to realize this, intensified efforts on improvement of transport conditions and urban renewal. Zone 82 is Ciudad Salitre which aims to be an employment core for the tertiary sector.

The distribution results of employment by sector for 2020 are shown in Table 8.3-6. Zone 16 in Santa Fe will attract about 270,000 persons, with a W/L ratio of 17.28. Zone 66 in Suba is expected to exceed Zone 16 in employment, providing about 300,000 opportunities. However, the W/L ratio will remain under 1.00 because of its large number of resident employees. Zone 1 in Usaquen will become an employment core along Autopista Norte, attracting about 180,000 persons for working there. Other prominent new job centers are Zone 51 in Fontibón (about 76,000 working persons, with a W/L ratio of 1.59) and Zone 82 in Teusaquillo (about 99,000 working persons, with a W/L ratio of 1.89). The former includes Zona Franca, while the latter includes Ciudad Salitre.

Table 8.3-7 shows numbers of employees commuting to outside the Study Area in 2020. Chia, Soacha, Funza, Mosquera and Cota will attract people of 3-4 times the present scale.

Table 8.3-4 Employment Increase by Zone in Secondary Sector (Working Place, 1995-2020)

Ward no.	Zone no.	Industry			Const- ruction	Mining & electri- city	Total	New industrial zone	
		New indus- trial zone	Others	Total				Area (ha)	Emp. dens. (p/ha)
1	1		4,187	4,187	5,878	376	10,441		
	2		1,270	1,270	2,409	267	3,946		
	3		422	422	378	189	990		
	4		346	346	222	363	930		
	5		170	170	90	307	567		
	6		235	235	318	188	740		
	7		619	619	720	822	2,161		
	8		369	369	268	706	1,343		
2	9		473	473	414	785	1,673		
	10		43	43	47	646	736		
	11		90	90	32	102	224		
	12		27	27	4	356	387		
	13		47	47	31	332	410		
3	14		50	50	22	676	748		
	15		84	84	37	494	615		
	16		108	108	24	1,848	1,980		
	17		88	88	17	216	322		
	18		276	276	33	0	310		
17	19		52	52	22	63	137		
	20		36	36	20	137	194		
4	21		98	98	19	48	165		
	22		249	249	23	0	272		
	23		64	64	7	0	71		
	24		156	156	26	171	353		
	25		655	655	69	79	804		
	26		322	322	5	147	475		
5	27		74	74	40	0	114		
	28		129	129	43	90	262		
	29		399	399	168	0	567		
	30		391	391	133	57	581		
	31		322	322	99	32	453		
6	32		369	369	51	42	461		
	33		61	61	39	0	100		
	34		351	351	44	92	487		
	35		254	254	20	228	502		
7	36		143	143	40	116	299		
	37		483	483	35	319	836		
	38		7,722	7,722	3,924	33	11,679		
8	39		422	422	51	292	765		
	40		193	193	39	73	305		
	41		62	62	10	0	73		
	42	10,000	3,083	13,083	5,417	177	18,677	200.0	50
	43		356	356	8	293	657		
	44		349	349	46	119	514		
	45	1,250	550	1,800	52	217	2,069	25.0	50
	46		309	309	55	178	543		
9	47		961	961	817	0	1,778		
	48		0	0	0	173	173		
	49	6,545	339	6,884	104	0	6,988	130.9	50
	50		860	860	180	426	1,466		
	51	15,050	727	15,777	151	342	16,271	301.0	50
	52		0	0	0	87	87		
	53	3,425	240	3,665	58	149	3,872	68.5	50

Table 8.3-4 Continued

Ward no.	Zone no.	Industry			Const- ruction	Mining & Electri- city	Total	New industrial zone	
		New indus- trial zone	Others	Total				Area (ha)	Emp. dens. (p/ha)
10	54		325	325	56	592	972		
	55		539	539	71	493	1,103		
	56		60	60	25	151	237		
	57		373	373	19	480	872		
	58		406	406	108	251	765		
	59		217	217	11	236	464		
	60		311	311	64	33	408		
	61		2,641	2,641	1,610	291	4,542		
	62		5,786	5,786	3,070	33	8,889		
11	63		242	242	114	493	848		
	64		470	470	385	214	1,070		
	65		4,076	4,076	2,240	72	6,388		
	66	14,000	15,566	29,566	18,510	197	48,274	280.0	50
	67		636	636	482	234	1,352		
	68		1,103	1,103	478	69	1,650		
	69	7,500	19,661	27,161	9,373	190	36,724	150.0	50
70		570	570	232	63	865			
12	71		131	131	56	420	607		
	72		123	123	42	271	437		
	73		191	191	48	541	779		
	74		240	240	48	556	844		
	75		173	173	48	41	262		
13	76		101	101	43	305	448		
	77		81	81	19	254	354		
	78		54	54	6	322	383		
	79		62	62	11	129	202		
	80		234	234	164	520	918		
	81		40	40	5	408	453		
	82		4,757	4,757	2,682	167	7,606		
14	83		78	78	13	307	398		
	84		81	81	4	414	500		
	85		38	38	25	123	185		
	86		161	161	17	96	273		
	87		119	119	30	349	498		
15	88		9	9	13	44	66		
	89		97	97	20	88	205		
	90		13	13	8	34	55		
	91		124	124	5	19	148		
	92		187	187	21	139	347		
16	93		15	15	1	550	566		
	94		36	36	10	296	342		
	95		8	8	1	443	452		
	96		93	93	5	24	121		
	97		269	269	41	93	403		
	98		39	39	7	348	393		
	99		443	443	37	619	1,099		
	100		232	232	27	85	343		
	101		484	484	13	439	936		
18	102		183	183	11	204	398		
	103		134	134	9	38	181		
	104		313	313	40	266	619		
	105		576	576	64	119	759		
19	106		6,079	6,079	3,502	154	9,736		
	107		4,128	4,128	1,852	56	6,037		
	108		2,914	2,914	1,355	282	4,551		
	Total	57,770	105,707	163,477	69,913	26,510	259,900	1155.4	

Table 8.3-5 Employment Increase by Zone in Tertiary Sector (Working Place, 1995-2020)

Ward no.	Zone no.	New multi-purpose-use zone	Old multi-purpose-use zone	New community service	Old community service	Total	New m.p.-use zone		Old m.p.-use zone	
							Area (ha)	Emp.dens. (p/ha)	Area (ha)	Emp.dens. (p/ha)
1	1	117,600		35,734	3,058	157,392	784.0	150.0	87.6	300.0
	2	0		15,055	1,602	16,657				
	3	0	12,791	2,363	5,045	20,198				
	4	0		1,386	2,486	3,872				
	5	0		563	6,096	6,659				
	6	0		1,985	2,435	4,420				
	7	0		4,500	6,167	10,668				
	8	0		1,674	3,355	5,029				
2	9	0		2,589	3,483	6,072				
	10	0		296	3,139	3,435				
	11	0		201	2,504	2,705				
	12	0		25	1,499	1,524				
	13	0		192	2,014	2,207				
3	14	0	5,866	137	329	6,333			47.1	500.0
	15	0		228	1,598	1,826				
	16	0	78,431	149	2,166	80,746			163.5	1,500.0
	17	0	9,300	108	2,203	11,611			91.7	350.0
	18	0		207	4,487	4,694				
17	19	0		139	831	970				
	20	0		126	1,306	1,432				
4	21	0		121	1,333	1,454				
	22	0		143	3,666	3,810				
	23	0	2,765	46	1,016	3,827			59.2	100.0
	24	0		160	4,323	4,483				
	25	0		433	10,900	11,333				
	26	0		31	8,338	8,370				
5	27	0		249	783	1,032				
	28	0		271	3,707	3,978				
	29	0		1,050	2,181	3,231				
	30	0		833	5,446	6,279				
	31	0		621	3,338	3,959				
6	32	0		316	4,392	4,708				
	33	0		241	1,833	2,074				
	34	0		275	6,096	6,371				
	35	0		126	3,681	3,807				
7	36	0		251	2,806	3,057				
	37	0		216	11,587	11,803				
	38	18,000		24,524	4,972	47,496	60.0	300.0		
8	39	0		321	5,348	5,668				
	40	0		246	2,342	2,588				
	41	0		66	1,077	1,142				
	42	6,000		33,851	4,717	44,568	20.0	300.0		
	43	0		53	8,621	8,674				
	44	0		290	6,800	7,090				
	45	3,600		326	8,481	12,407	12.0	300.0		
46	0		346	10,764	11,110					
9	47	0		5,104	1,206	6,310				
	48	0	2,233	0	0	2,233			1189.1	40.0
	49	0		652	4,235	4,887				
	50	0		1,125	7,598	8,723				
	51	15,000		944	7,596	23,540	50.0	300.0		
	52	0	12,108	0	0	12,108			MS 626.0	50.0
	53	0		364	2,475	2,839				

Table 8.3-5 Continued

Ward no.	Zone no.	New multi-purpose-use zone	Old multi-purpose-use zone	New community service	Old community service	Total	New m.p.-use zone		Old m.p.-use zone	
							Area (ha)	Emp.dens. (p/ha)	Area (ha)	Emp.dens. (p/ha)
10	54	0		350	6,375	6,725				
	55	0		442	10,162	10,604				
	56	0		158	806	963				
	57	0		116	10,395	10,511				
	58	0		677	7,767	8,444				
	59	0		66	4,086	4,152				
	60	0		398	6,449	6,847				
	61	0		10,064	11,090	21,153				
	62	0		19,182	3,690	22,872				
11	63	0		711	6,178	6,890				
	64	0		2,406	4,792	7,197				
	65	0		13,997	3,170	17,166				
	66	133,500		115,673	1,984	251,156	445.0	300.0		
	67	0		3,011	3,043	6,054				
	68	0		2,987	10,201	13,187				
	69	13,500		58,572	5,470	77,542	45.0	300.0		
	70	0		1,447	4,854	6,301				
12	71	0		352	3,692	4,044				
	72	0		265	2,791	3,057				
	73	0	33,491	298	3,698	37,487			201.6	300.0
	74	0		300	5,336	5,636				
	75	0		299	1,733	2,031				
13	76	0	25,386	267	2,374	28,027			147.5	400.0
	77	0	7,914	118	2,223	10,255			73.7	400.0
	78	0	17,761	39	1,916	19,716			93.7	400.0
	79	0		67	1,919	1,985				
	80	0		1,027	1,943	2,971				
	81	0		29	1,746	1,774				
	82	0	68,620	16,760	5	85,385			48.3	1,500.0
14	83	0		83	2,196	2,279				
	84	0		24	1,225	1,249				
	85	0		156	1,481	1,637				
	86	0	3,232	104	1,871	5,207			87.7	100.0
	87	0		188	2,687	2,874				
15	88	0	1,230	81	1,888	3,199			69.5	100.0
	89	0	3,647	125	2,291	6,063			82.5	100.0
	90	0	1,978	49	1,370	3,397			63.6	100.0
	91	0	2,751	34	2,492	5,276			105.8	150.0
	92	0		133	3,475	3,608				
16	93	0	1,809	6	233	2,048			I,M 161.8	100.0
	94	0	3,218	62	749	4,029			I 92.1	100.0
	95	0	2,045	7	256	2,308			I,M 177.8	130.0
	96	0		28	2,849	2,878				
	97	0		257	4,997	5,254				
	98	0	2,732	44	509	3,285			I 181.4	130.0
	99	0		232	8,083	8,315				
	100	0		166	4,697	4,864				
	101	0		81	5,698	5,779				
18	102	0		71	4,771	4,841				
	103	0	7,050	53	4,487	11,589			164.8	100.0
	104	0		251	5,089	5,340				
	105	0		402	9,744	10,146				
19	106	16,500		21,886	11,364	49,750	55.0	300.0		
	107	8,250		11,575	5,403	25,227	27.5	300.0		
	108	10,500		8,470	9,645	28,615	35.0	300.0		
	Total	342,450	306,358	436,896	436,896	1,522,600				

Table 8.3-6 (1) Future Employment Distribution in the Study Area (Traffic Zone)

Ward no.	Zone no.	Employed persons by living place				Employed persons by working place				Ratio W/L
		Primary	Secondary	Tertiary	Total	Primary	Secondary	Tertiary	Total	
1	1	19	28,795	96,132	124,946	468	14,317	167,926	182,711	1.46
	2	54	11,462	32,353	43,868		9,411	27,548	36,959	0.84
	3	56	7,787	34,612	42,455		4,008	33,687	37,695	0.89
	4	25	3,358	20,794	24,177		4,672	12,497	17,169	0.71
	5	189	3,940	41,123	45,252		6,854	26,681	33,535	0.74
	6	24	1,840	21,113	22,977		5,886	15,995	21,881	0.93
	7	230	10,519	50,359	61,109		17,763	63,293	81,055	1.33
	8	103	5,267	26,212	31,582		13,878	39,869	53,746	1.70
2	9	154	5,874	36,735	42,764	17,741	64,178	81,919	1.92	
	10	154	2,873	22,471	25,498	15,490	70,342	85,832	3.37	
	11	53	2,850	15,977	18,880	11,647	53,199	64,847	3.43	
	12	26	1,490	7,700	9,216	7,416	35,546	42,962	4.66	
	13	0	1,367	12,062	13,429	6,334	37,104	43,438	3.23	
3	14	0	625	3,152	3,778	5,545	24,017	29,562	7.83	
	15	0	1,563	8,798	10,362	5,902	38,940	44,842	4.33	
	16	69	2,039	13,781	15,889	26,993	247,565	274,558	17.28	
	17	0	2,011	11,301	13,312	4,498	34,406	38,904	2.92	
	18	30	11,379	15,787	27,196	1,905	7,864	9,769	0.36	
	19	0	1,004	4,932	5,936	1,075	6,371	7,447	1.23	
4	20	23	1,567	7,219	8,810	3,297	25,277	28,574	3.24	
	21	54	2,234	6,482	8,769	1,058	3,126	4,185	0.48	
	22	148	7,123	15,254	22,526	1,932	8,133	10,064	0.45	
	23	24	1,650	6,618	8,292	1,187	6,982	8,169	0.99	
	24	27	4,446	23,378	27,851	3,270	18,118	21,387	0.77	
	25	100	21,881	41,965	63,946	4,134	17,513	21,646	0.34	
	26	23	15,093	32,762	47,878	4,245	13,685	17,929	0.37	
5	27	5	1,637	2,497	4,138	400	1,623	2,023	0.49	
	28	15	3,734	19,877	23,627	1,068	7,404	8,472	0.36	
	29	9	5,219	8,364	13,592	1,176	4,756	5,932	0.44	
	30	47	7,560	24,223	31,831	3,120	12,048	15,299	0.48	
	31	10	6,153	14,300	20,463	2,153	7,197	9,350	0.46	
6	32	78	8,447	20,403	28,928	4,852	12,455	17,316	0.60	
	33	0	1,791	12,031	13,822	691	7,598	8,289	0.60	
	34	25	10,215	27,925	38,164	2,785	14,180	16,964	0.44	
	35	113	5,640	20,421	26,174	8,262	20,383	28,645	1.09	
7	36	48	2,818	14,255	17,121	3,349	8,070	11,419	0.67	
	37	147	17,401	48,496	66,045	9,911	30,266	40,177	0.61	
	38	102	29,003	47,899	77,003	13,955	50,026	64,043	0.83	
8	39	51	10,063	26,705	36,819	9,229	19,111	28,340	0.77	
	40	0	3,827	10,767	14,594	3,879	9,285	13,164	0.90	
	41	19	1,393	5,968	7,381	3,470	5,934	9,404	1.27	
	42	65	10,429	112,260	122,753	22,210	55,177	77,426	0.63	
	43	69	9,720	46,582	56,371	6,015	37,097	43,112	0.76	
	44	46	9,376	36,575	45,998	5,187	18,557	23,743	0.52	
	45	198	15,376	34,944	50,518	8,051	29,386	37,602	0.74	
	46	112	10,221	55,249	65,582	2,970	22,349	25,320	0.39	
9	47	0	4,053	20,901	24,954	5,345	18,689	24,034	0.96	
	48	0	0	0	0	5,593	7,564	13,157		
	49	211	5,333	25,620	31,164	11,682	18,774	30,456	0.98	
	50	231	13,647	39,650	53,527	8,309	25,626	33,935	0.63	
	51	273	12,726	34,840	47,839	28,941	46,737	75,898	1.59	
	52	0	0	0	0	1,687	31,300	32,987		
	53	0	3,856	12,749	16,605	5,735	6,173	11,908	0.72	

Table 8.3-6 (1) Continued

Ward no.	Zone no.	Employed persons by living place				Employed persons by working place				Ratio W/L
		Primary	Secondary	Tertiary	Total	Primary	Secondary	Tertiary	Total	
10	54	281	9,419	33,777	43,476		8,997	23,238	32,235	0.74
	55	194	14,014	36,866	71,073		11,338	31,321	42,659	0.60
	56	27	941	5,371	6,339		2,624	10,228	12,852	2.03
	57	142	12,015	38,405	70,562		7,487	29,520	37,007	0.52
	58	60	10,758	42,494	53,311		8,897	25,582	34,478	0.65
	59	89	5,863	19,883	25,840		4,327	14,061	18,388	0.71
	60	121	7,663	33,188	40,972		3,396	14,499	17,895	0.44
	61	214	16,171	90,058	106,443	85	9,641	36,104	45,830	0.43
62	57	18,372	58,315	76,744		10,184	28,148	38,333	0.50	
11	63	333	6,810	40,512	47,655		7,898	29,892	37,790	0.79
	64	116	7,539	35,156	42,811		3,753	17,322	21,077	0.49
	65	68	12,436	47,784	60,288		8,979	24,252	33,231	0.55
	66	35	43,707	320,482	364,225	101	50,294	257,266	307,661	0.84
	67	172	4,082	29,189	33,443		6,079	22,211	28,290	0.85
	68	176	19,755	51,902	71,833		9,293	27,949	37,243	0.52
	69	239	61,549	135,409	197,198	238	41,352	86,633	128,223	0.65
	70	91	10,082	24,422	34,594		3,683	12,193	15,875	0.46
12	71	53	3,454	23,294	26,802		6,203	21,918	28,121	1.05
	72	33	3,311	15,900	19,245		4,959	17,259	22,218	1.15
	73	0	4,833	18,287	23,120		13,160	64,476	77,636	3.36
	74	60	6,942	29,940	36,942		7,526	23,321	30,847	0.84
	75	0	2,413	11,960	14,373		4,246	10,708	14,954	1.04
13	76	284	2,114	14,799	17,197		6,752	61,641	68,393	3.98
	77	134	2,623	10,706	13,462		4,553	34,821	36,375	2.70
	78	29	1,955	13,210	15,194		4,798	39,435	44,232	2.91
	79	0	1,676	11,261	12,937		1,429	13,246	14,675	1.13
	80	54	2,401	13,489	15,944		6,077	34,097	40,174	2.52
	81	26	1,604	10,336	11,967		3,859	11,019	14,878	1.24
	82	0	7,277	45,084	52,361		9,526	89,215	98,741	1.89
14	83	0	2,095	11,919	14,014		6,673	23,967	32,640	2.33
	84	58	1,596	5,939	7,594		12,601	41,347	53,947	7.10
	85	0	1,237	8,816	10,053		4,483	22,301	26,784	2.66
	86	0	3,441	11,761	15,201		3,705	10,745	14,451	0.95
	87	0	2,747	16,897	19,643		8,022	28,251	36,273	1.85
15	88	136	633	11,113	11,882		1,436	8,919	10,355	0.87
	89	0	3,249	12,288	15,536		2,136	10,666	12,801	0.82
	90	0	663	8,277	8,940		1,424	7,779	9,203	1.03
	91	35	3,404	11,810	15,249		5,319	18,396	23,714	1.56
	92	35	4,853	19,265	24,153		6,420	12,537	18,957	0.78
16	93	0	434	1,054	1,488		11,010	16,419	27,429	18.44
	94	0	697	5,086	5,783		3,307	10,021	13,327	2.30
	95	0	257	1,774	2,031		9,249	23,377	32,626	16.06
	96	0	3,064	15,815	18,879		2,220	10,765	12,984	0.69
	97	129	6,463	32,672	39,264		2,470	16,719	19,189	0.49
	98	0	907	3,305	4,212		14,506	24,135	38,641	9.17
	99	122	11,528	43,681	55,331		22,211	43,274	65,485	1.18
	100	101	5,100	25,476	30,676		1,791	11,466	13,256	0.43
	101	357	10,706	30,632	41,695		9,050	18,751	27,801	0.67
	18	102	55	5,636	25,229	30,921		3,704	17,222	20,926
103		150	4,107	25,742	29,999		3,859	21,020	24,879	0.83
104		67	7,156	23,108	30,330		3,835	13,730	17,565	0.58
105		32	17,652	42,741	60,424		5,272	19,591	24,863	0.41
19	106	151	35,141	84,280	119,572	55	14,966	60,908	75,930	0.64
	107	0	18,525	48,874	67,400		7,629	30,384	38,212	0.57
	108	126	19,450	55,996	75,571	135	13,409	43,508	57,052	0.75
	Total	8,100	842,200	3,217,600	4,067,900	1,700	832,500	3,304,600	4,138,800	1.02

Table 8.3-6 (2) Future Employment Distribution in the Study Area (Ward)

No. & name of Ward	Employed persons by living place				Employed persons by working place				Ratio W/L
	Primary	Secondary	Tertiary	Total	Primary	Secondary	Tertiary	Total	
1 Usaquen	700	72,967	322,699	396,366	468	76,787	387,496	464,751	1.17
2 Chapinero	387	14,455	94,944	109,786	0	58,629	260,368	318,997	2.91
3 Santa Fe	99	17,618	52,819	70,536	0	44,843	352,791	397,634	5.64
4 San Cristobal	375	52,428	126,459	179,263	0	15,825	67,556	83,381	0.47
5 Usme	87	24,304	69,261	93,651	131	7,918	33,028	41,076	0.44
6 Tunjuelito	216	26,092	80,780	107,088	0	16,589	54,625	71,214	0.67
7 Bosa	297	49,222	110,650	160,169	62	27,215	88,361	115,639	0.72
8 Kennedy	560	70,405	329,050	400,015	204	61,011	196,895	258,110	0.65
9 Fontibon	715	39,614	133,760	174,089	220	67,292	154,863	222,375	1.28
10 Engativa	1,184	95,221	398,356	494,760	85	66,893	212,700	279,678	0.57
11 Suba	1,230	165,960	684,857	852,048	339	131,333	477,717	609,389	0.72
12 Barrios Unidos	147	20,953	99,381	120,482	0	36,094	137,682	173,776	1.44
13 Teusaquillo	528	19,650	118,884	139,062	0	36,994	280,474	317,468	2.28
14 Los Martires	58	11,116	35,331	66,506	0	35,484	128,610	164,094	2.47
15 Antonio Narino	205	12,802	62,733	75,760	0	16,735	58,296	75,031	0.99
16 Puente Aranda	708	39,155	159,495	199,359	0	75,813	174,927	250,739	1.26
17 La Candelaria	23	2,571	12,151	14,745	0	4,372	31,649	36,021	2.44
18 Rafael Uribe	304	34,551	116,819	151,673	0	16,670	71,563	88,233	0.58
19 Ciudad Bolivar	276	73,116	189,151	268,543	190	36,004	135,000	171,194	0.65
Study Area total	8,100	842,200	3,217,600	4,067,900	1,700	832,500	3,304,600	4,138,800	1.02

Table 8.3-7 Employees Commuting to Outside the Study Area in 2020

Zone no. & name	Primary	Secondary	Tertiary	Total
109 Sumapaz	0	0	0	0
110 Cota	345	2,350	12,152	14,847
111 Chia	297	15,176	51,442	66,915
112 Funza	529	7,510	16,205	24,244
113 Mosquera	283	12,165	11,620	24,068
114 Sibate	110	2,400	4,343	6,853
115 Soacha	268	14,511	23,970	38,749
116 Bojaca	51	82	247	380
117 Cajica	0	1,965	4,224	6,189
118 Facatativa	437	1,868	5,340	7,645
119 Gachancipa	0	930	795	1,725
120 Calera	111	1,588	9,009	10,708
121 Madrid	1,138	2,460	8,470	12,068
122 Sopo	340	1,040	4,335	5,715
123 Tabio	87	410	190	687
124 Tenjo	219	144	1,563	1,926
125 Tocancipa	78	1,995	1,944	4,017
126 Zipaquirá	173	1,442	8,447	10,062
Municip. in BMA	4,466	68,036	164,296	236,798
127 North	258	566	4,828	5,652
128 Rionegro	0	0	162	162
129 Subachoque	495	896	1,710	3,101
130 Villeta	62	1,024	3,066	4,152
131 Tequendama	490	3,078	5,460	9,028
132 Fusagasuga	0	394	390	784
133 Caqueza	564	1,452	6,860	8,876
134 Fomeque	0	578	250	828
135 Guasca	65	276	978	1,319
Outside BMA	1,934	8,264	23,704	33,902
Total	6,400	76,300	188,000	270,700



1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for transparency and accountability, particularly in financial matters. This section outlines the various methods and tools used to collect and store data, ensuring that all information is readily accessible and secure.

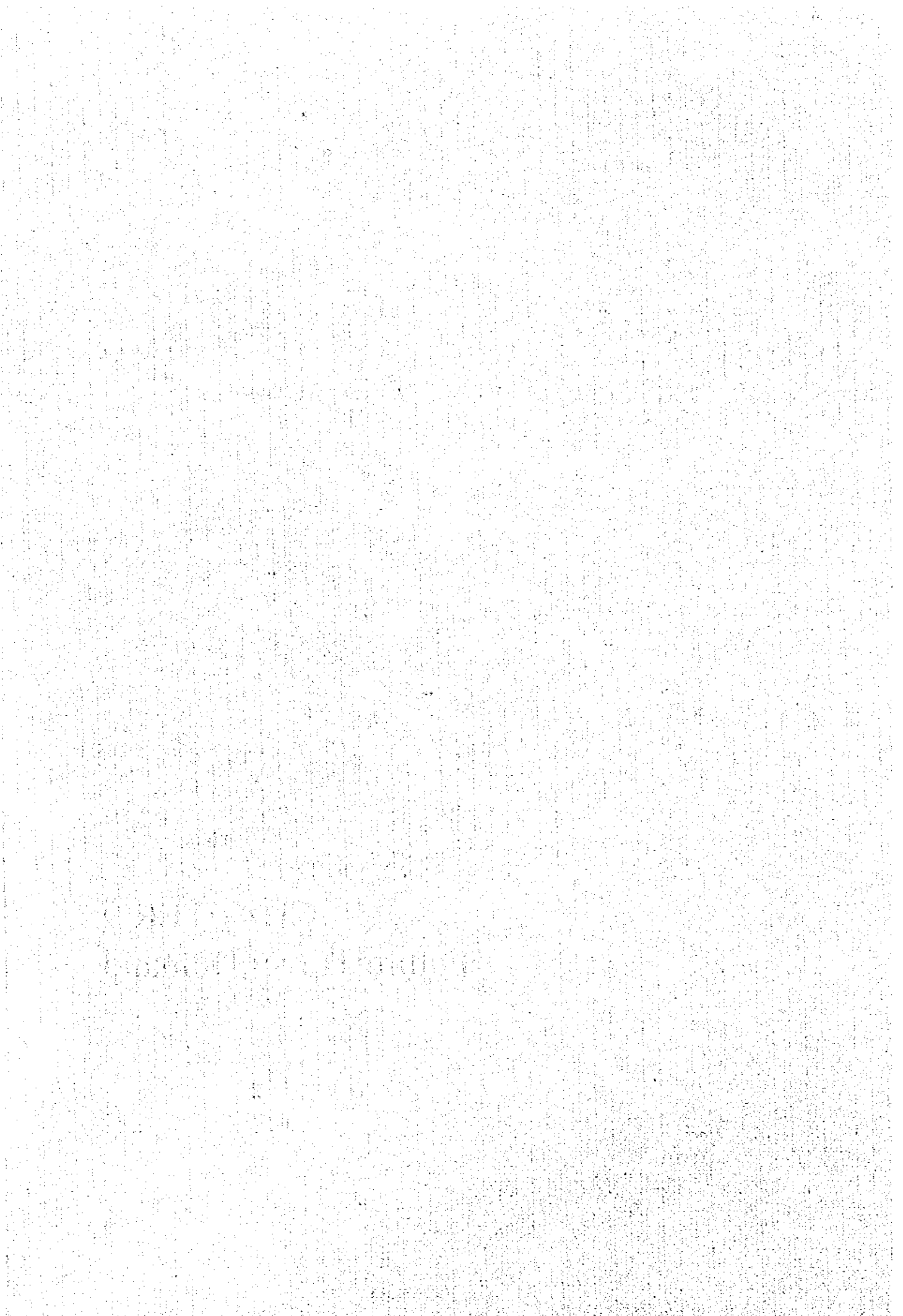
2. The second part of the document focuses on the analysis and interpretation of the collected data. It describes the process of identifying trends, patterns, and anomalies within the dataset. This involves the use of statistical techniques and data visualization tools to present the information in a clear and understandable manner. The goal is to derive meaningful insights from the data that can inform decision-making and strategic planning.

3. The third part of the document addresses the challenges and limitations of data analysis. It acknowledges that while data provides valuable information, it is not always perfect. Issues such as data quality, completeness, and bias can affect the accuracy of the results. The document provides guidance on how to identify and mitigate these risks, ensuring that the analysis remains robust and reliable.

4. The final part of the document discusses the ethical considerations surrounding data collection and analysis. It highlights the importance of protecting individual privacy and ensuring that data is used responsibly. This includes obtaining informed consent from participants and implementing strict security measures to prevent unauthorized access to the data. The document also touches on the broader implications of data analysis in society and the need for ongoing monitoring and evaluation.

## **CHAPTER 9**

# **Future Travel Demand**



## 9. FUTURE TRAVEL DEMAND

### 9.1 General

#### 9.1.1 Model Structure

For estimating travelers' demand for transport facilities and services, the urban travel demand model commonly known as the "Four-Step Method" was employed in the Study. The four-step method is used to predict (1) the number of trips made within the Study Area by purpose, (2) zonal origin-destination (OD) pair, (3) the mode of travel used to make these trips, and (4) the routes taken through the transport network by these trips.

In Bogota, it was disclosed from the data analysis that car ownership influences the determination of modal choice between private car and public bus. The modal choice is less frequently made on the basis of the travel time or travel cost on the route to destination.

In this Study, the urban travel demand model was made taking into consideration the survey method and the trip characteristics such as demand structure and modal choice.

The modal split model employed was a model known as the "trip-end" model. This model assumes that modal choice is primarily explained by socioeconomic characteristics on generated or attracted zone. The variables used in this model are car ownership and income, etc. This model, however, can not utilize the service characteristics (travel times, costs, etc.) of the alternative modes to determine the modal splits. In Bogota, as mentioned above, the modal choice between private car and public bus is primarily determined by whether a car is owned or not, and not by the travel time or cost.

The flowchart of forecasting model is shown in Figure 9.1-1. The model was composed of motorized or non-motorized households, by trip purpose and by mode corresponding to each step, as shown in Table 9.1-1. This is because the number of daily trips for motorized household members is considerably higher than the non-motorized, and the analysis of travel demand structure by person trip showed that zonal OD pair is different by trip purpose and by transport mode from.

For estimating traveler's demand for non-residents who live outside the Study Area, the four-step method for the residents within the Study Area was also applied. In the future, population growth outside Bogota is forecasted at about 2.4 million, in contrast to 800 thousand at present. The travel demand in the future between Bogota and surrounding areas is expected to increase dramatically, and also, the travel pattern of zonal OD will be different. Trip information for non-residents, however, is not available but the ratio of trips made by them to the total is as low as 2.5 % at present. Even when the simple method is employed for non-residents, the influence on accuracy to whole trips estimated is little. Therefore, travel demand for non-residents was estimated by a simplified four-step method.

The classifications of motorized households, trip purposes and transport modes are shown below.

#### 1) Classification of Motorized Households

- a) Motorized household : car owned
- b) Non-Motorized Household : motorcycle or bicycle owned

2) Trip Purposes

- a) To work
- b) To school
- c) Business
- d) Private/Shopping
- e) To home

3) Classification of Modes

- a) Private Mode : Car, Taxi and Truck
- b) Public Mode : Bus

Table 9.1-1 Model Structure

Step	Motorized/ Non-Motorized	By Purpose	By Mode
1) Trip Production	O	-	-
2) Trip Generation/ Attraction	O	O	-
3) Modal Split	O	O	O
4) Trip Distribution	O	O	O
5) Traffic Assignment	-	-	O

9.1.2 Trip Generation and Attraction Model

This model has two steps: the first is to estimate the total trip production for an entire zone, and the second is to estimate zonal generated and attracted trips which are adjusted into agreement with the total trip production, i.e., control total. At the same time, modal choice is made by zone based on the trip-end model.

Future total trip production in the Study Area was estimated by using trip production rate (number of trips per person) on the assumption that the rate will be an unchangeable factor in the future. The total trip production was estimated by motorized and non-motorized household members due to the fact that the production rate between car owning and non-car is considerably different. The production rate as shown below excludes walking and bicycle;

- 1) Motorized household : 1- car owning household : 2.43 trips/person/day
- Multi-car owning : 2.75
- 2) Non-motorized : 1.79

$$P = PR \times Pop$$

- P : Total Trip Production by Motorized/ Non-Motorized Households
- PR : Trip Production Rate by Motorized/ Non-Motorized Households
- Pop : Population of Motorized/ Non-Motorized Household (5 years or above)

Trip generation and attraction by zone are forecasted by motorized and non-motorized households and by trip purpose (exclusive of "to home") as before-mentioned. As for "to home" purpose, the trip generation is reflected as the total sum of attracted trips of other purposes exclusive of "business" purpose. On the other hand, the trip attraction is as the total sum of generated trips in the same manner.

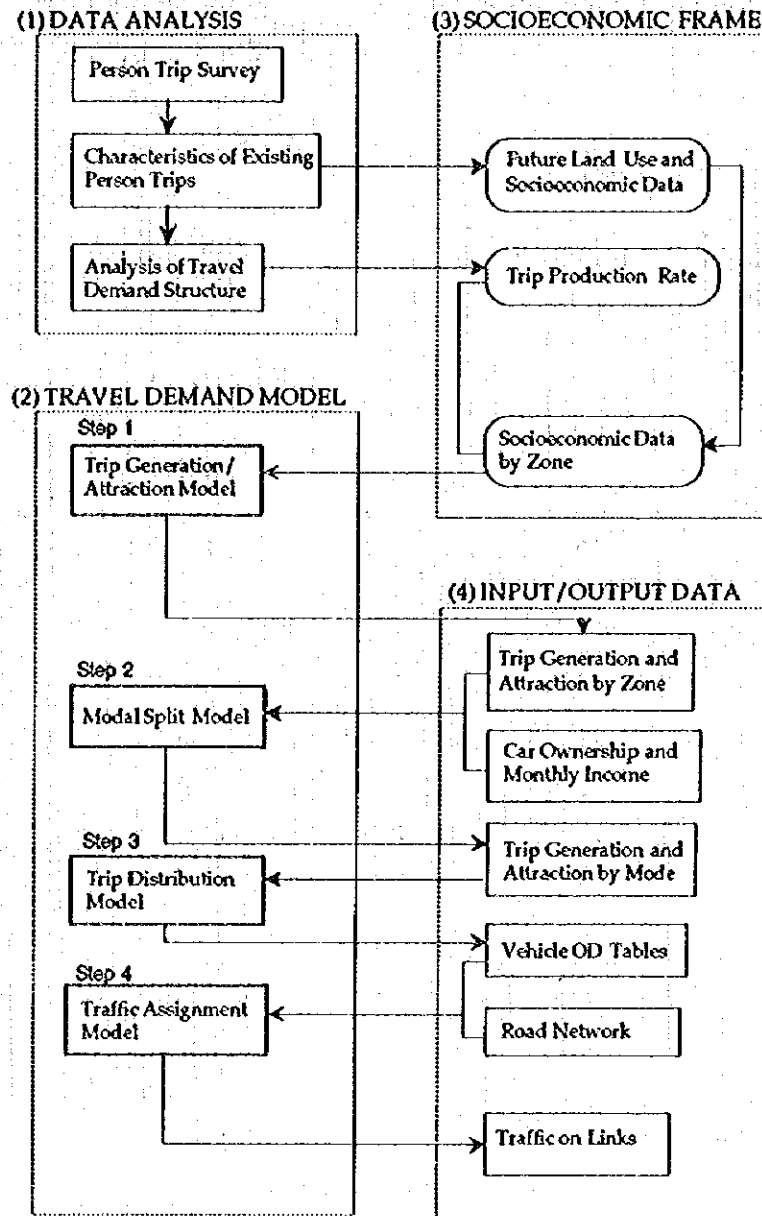


Figure 9.1-1 Flowchart of Forecasting Model

Linear type regression models were developed to estimate trip generation and attraction. The equation is shown below;

$$G_i = a + b_1 \cdot X_{i1} + b_2 \cdot X_{i2}$$

$$A_j = a + b_1 \cdot X_{j1} + b_2 \cdot X_{j2}$$

where;

- $G_i$  : Generation trip from zone i
- $A_j$  : Attraction trip to zone j
- $X_{in}, X_{jn}$  : Socioeconomic data in zone i or j
- $a, b_1, b_2$  : model parameters

Parameters of variables and zone with dummy variable are shown in Table 9.1-2.

Table 9.1-2 Parameter of Trip Generation and Attraction Model

Y Purpose	Y=a+b1*X1+b2*X2+b3*X1*X2						
	a	b1	b2	b3	X1	X2	r
<b>1) Non-Motorized</b>							
<b>(1) Generation</b>							
To work	-847.654	1.169			Employee		0.990
To school	2555.253	0.443			Student-Home		0.848
Business	456.503	0.134	2422.675	0.074	Ind-Tertiary	Dummy=1	0.919
Private	945.576	0.243	0.168		Employee	Student-School	0.865
<b>(2) Attraction</b>							
To work	-631.425	1.055			Ind-Tertiary		0.979
To school	1138.708	0.202	-5769.45	0.731	Student-School	Dummy=1	0.950
Business	-717.852	0.267			Ind-Tertiary		0.942
Private	-870.891	0.508			Ind-Tertiary		0.915
<b>2) Motorized household</b>							
<b>(1) Generation</b>							
To work	513.969	0.964			Employee		0.971
To school	-343.141	1.204			Student-Home		0.950
Business	426.337	0.103	1804.757	0.073	Ind-Tertiary	Dummy=1	0.921
Private	161.182	0.677	7069.032	0.016	Employee	Dummy=1	0.944
<b>(2) Attraction</b>							
To work	-1930.922	0.576			Ind-Tertiary		0.982
To school	908.976	0.079	-2199.677	0.699	Student-School	Dummy=1	0.959
Business	143.591	0.167			Ind-Tertiary		0.924
Private	-379.046	0.408			Ind-Tertiary		0.915

### 9.1.3 Modal Split Model

#### (1) Modal Split Ratio of Private and Public Transport

The modal choice between private and public bus is forecasted after estimating the zonal trip generation by all modes.

In the modal split model, the transport modes were classified into 2 modes: private transport (car, taxi and truck) and public transport (bus). The estimation of each transport mode was made by the trip-end model. In this classification, taxi is classified into private mode since it serves as private as passenger cars.

The model was made for the motorized and non-motorized households. The model variable for motorized households used the average zonal car ownership (veh/1000 pop), while the non-motorized took the average zonal income from the Person Trip data analysis. The future zonal modal choice is estimated by the equations and parameters shown in Table 9.1-3.

**Table 9.1-3 Equations and Parameters of Modal Choice Model**

$$Y = a * e^{bX}$$

Motorized Household	a	b
To Work	0.767	0.00496
To School	0.310	0.00078
Business	3.670	0.00280
Private	1.439	0.00440

$$Y = a + b^x$$

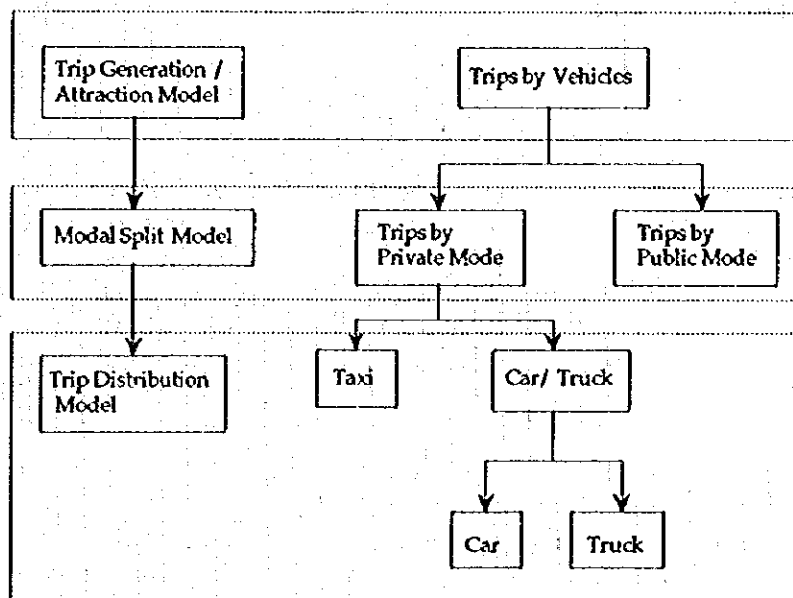
Non-Motorized Household	a	b
To Work	0.128	8.455e-9
To School	0.065	7.789e-9
Business	0.599	7.048e-9
Private	0.225	2.461e-7

**(2) Other Split Ratios**

The split ratio of taxi and car (including truck) applied the present ratio of trips used taxi by each zone from the Person Trip Survey data. As for the ratio of car and truck, future split ratio for an entire zone was estimated based on future trip ratio of truck to car, which was estimated from future car and truck ownership.

The truck demand was estimated by a simple estimation method based on trend analysis. The method has two steps; the first is to estimate the traffic demand corresponding to the future growth of truck volume, and the second is to estimate the generated and attracted volumes from/to zone in the future. A trip OD table of truck was estimated by the present pattern method.

These steps were conducted after forecasting the trip OD table for the private and public transport. The estimation of each transport mode was made using the binary choice method shown in Figure 9.1-2.



**Figure 9.1-2 Procedure of Modal Split Model**



### 9.1.4 Trip Distribution Model

Voorhees-type gravity models were developed to estimate interzonal trips by motorized/non-motorized household and by purpose. The "to home" trip was estimated in the same manner as generated and attracted "to home" trip.

#### (1) Interzonal Trips

$$T_{ij} = G_i \frac{A_j * D_{ij}^a}{\sum_{j=1}^n (A_j * D_{ij}^a)} K_{ij}$$

where;

- $T_{ij}$  : OD trips between zone i and j
- $G_i$  : Generated trips from zone i
- $A_j$  : Attracted trips to zone j
- $D_{ij}$  : Road distance between zone i and zone j (km)
- $a$  : Parameter

The model parameters show in Table 9.1-4.

#### (2) Intrazonal Trip Model

$$T_{ii} = K * G_i^a * A_i^b * L_i^c * D_i^d$$

where;

- $T_{ii}$  : OD trips inside zone i
- $G_i$  : Generated trips from zone i
- $A_i$  : Attracted trips to zone i
- $L_i$  : Area of zone i (km<sup>2</sup>)
- $D_i$  : Dummy variable
- $K, a, b, c, d$  : Parameters

The model parameters show in Table 9.1-5.

### 9.1.5 Traffic Assignment

The last step in the four-step method is the assignment of the predicted modal flows between each origin-destination pair to actual routes through the given mode's network. In this study, the traffic assignment model has two systems. One is for private vehicle such as cars and trucks inclusive of taxis on roads. The private vehicle passes on minimum distance/time route chosen in this model. The other is for public transport (bus) on fixed routes. The buses are assigned on fixed routes prepared in the model. Both assigned traffic volumes were combined together on the same road network after conducting traffic assignment separately.

#### (1) Average Occupancy and Passenger Car Unit (PCU)

The person base trip OD tables (trip/person) by mode have to be modified into passenger car unit (trip/PCU). These OD tables were firstly modified into vehicle base unit divided by average number of passengers (occupancy) and then, multiplied by PCU factor. The average occupancy and PCU factor used for the conversion are shown in Table 9.1-6.

**Table 9.1-4 Parameters of Trip Distribution Model**

	Purpose	Car		Bus	
		Parameter	R	Parameter	R
Motorized	To Work	-0.414	0.807	-0.374	0.877
	To School	-0.730	0.907	-0.429	0.837
	Business	-0.574	0.775	-0.281	0.927
	Private	-0.471	0.828	-0.558	0.869
Non-Motorized	To Work	-0.247	0.860	-0.568	0.888
	To School	-0.837	0.957	-0.864	0.804
	Business	-0.535	0.792	-0.491	0.861
	Private	-0.581	0.764	-0.678	0.838

**Table 9.1-5 Parameters of Intrazonal Model**

$T_{ij} = K * G_i^{\alpha} * A_j^{\beta} * L_i^{\gamma} * D_j^{\delta}$						
	k	$\alpha$	$\beta$	$\gamma$	$\delta$	R
Motorized household						
Mode:Car						
To work	5.1810099	0.429	0.155	-0.135	1.441	0.841
To school	93.316785	0.067	0.026	0.039	0.791	0.814
Business	103.54435	0.259	-0.051	-0.157	1.412	0.803
Private	0.2039256	0.889	-0.046	0.111	0.676	0.811
Mode:Bus						
To work	14.296289	0.316	0.100	-0.122	0.862	0.806
To school	9.2998661	0.225	0.020	0.227	0.860	0.805
Business	2206.1407	-0.376	0.039	-0.057	1.565	0.831
Private	25.380978	0.412	0.035	-0.209	0.920	0.806
Non-motorized household						
Mode:Car						
To work	70.105412	0.079	0.073	-0.035	1.144	0.912
To school	0.4936147	0.560	0.324	0.135		0.905
Business	38.744934	0.331	-0.026	-0.116	1.288	0.838
Private	54.217298	0.314	0.022	-0.173	1.201	0.815
Mode:Bus						
To work	0.001399	0.885	0.387	0.178		0.874
To school	0.0287821	0.759	0.194	0.241	0.957	0.800
Business	19.511421	0.310	0.014	-0.037	1.041	0.896
Private	0.0750951	0.747	0.185	0.108	0.667	0.821

**Table 9.1-6 Average Occupancy and PCU**

Vehicle Type	Average Occupancy	PCU Factor
Car	1.66	1.0
Taxi	1.40	1.0
Truck	1.73	2.5
Bus	21.46	2.0

## **(2) Traffic Assignment Model for Private Mode**

Traffic assignment is to predict traffic volume on roads chosen by minimum distance/time route. The speed of vehicle to select minimum-time route is governed by the relation of traffic volume to the capacity. Hence, the speed of vehicle is determined according to the speed-flow curves which are governed according to number of lanes, one-way and dual-way traffic flows, and land-use conditions along roads classified into urban area, rural area and unpaved roads.

The traffic assignment model for private mode is "capacity restraint" method as shown below:

- a) OD matrices are divided into following 5 lots to make the phased assignment of the traffic: 1st 30%, 2nd 20%, 3rd 20%, 4th 20% and 5th 10%.
- b) Minimum time-route is selected on roads.
- c) The 1st lot of trips is assigned to the selected route, and the number of trips passing over each link of network is counted.
- d) Travel speed on each road is modified according to speed-flow curves.
- e) The above four steps are iterated.

As mentioned before, cars, taxis and trucks are assigned in this model. On the other hand, buses are assigned under the bus assignment models. Finally, after assigned on roads separately, both modes, public and private transport, are combined together to estimate transport facilities.

## **(3) Traffic Assignment Model for Public Mode (Bus Transport)**

Minimum bus route from among several alternative routes by OD pair is chosen taking into account the waiting time at bus stops when passengers transfer buses and bus passengers are assigned on this route. This assignment system introduced the concept of private traffic assignment model. In this model, the assigned bus route is determined by each lot according to frequency of service instead of the speed-flow curve. When the frequency is exceeded by the assigned number of buses, this bus is not chosen in next lot.

Method of the model is outlined as follows:

- a) OD matrices are divided into the following 5 lots to make the phased assignment of the traffic: 1st 30%, 2nd 20%, 3rd 20%, 4th 20% and 10%.
- b) Minimum-distance route is selected on the assumption that minimum-time bus route was selected from among the alternative routes. When the minimum pass is selected, waiting time or transfer time at bus stops is taken into account.
- c) The 1st lot of trips is assigned to the selected bus route, and the number of trips incrementally loaded onto bus network is counted.
- d) Frequency of service by each bus route (input data) is compared to assigned number of buses derived from the assigned number of passengers. When the number of buses exceeds the frequency, this bus route is not chosen in the next lot.
- e) The above 4 steps are iterated.

## 9.2 Estimation of Future Motorized Households

Since the travel demand model is structured by motorized and non-motorized households as mentioned before, the number of motorized households in future must be estimated. The procedure of estimation is shown below.

- 1) Estimation of total number of motorized households
- 2) Estimation of motorized households by zone

The first step is to estimate the total number of motorized households in the Study Area and then, it is broken down into traffic zones in the second step.

### 9.2.1 Total Number of Motorized Households

There is a close relationship between car ownership and household income according to the analysis of the Person Trip Survey data (see Figure 3.3-25). This relationship was used for the estimation of the total number of motorized households, i.e., car-owning households, by inputting both the future income distribution estimated and number of households. In this process, forecasting of two or more vehicle-owning households is indispensable in the estimation of motorized households because they are sizable in number. The multi-car owning was also estimated in the same manner as one-car owning by using the relationship shown in Figure 3.3-25. These estimated motorized households were controlled by the future total number of cars.

The future number of cars was estimated based on the relation between car ownership and GRDP per capita as shown in Table 9.3-1 together with other forecasted figures. The estimated number of cars in 2020 is approximately 1.35 million, thus, car ownership will be 156 cars per 1000 persons. The growth ratio of cars will be approximately 2.7 for 25 years from 1995.

The estimated figures are shown in Table 9.3-1. The number of motorized households is approximately 870 thousand, equivalent to 0.48 per whole household, in 2020, in contrast to 379 thousand (0.30 of the total) in 1995. This is a rise of 2.3. Non-motorized households have a somewhat lower (1.1) growth rate.

### 9.2.2 Motorized Households by Zone

Both average income and car ownership by zone have a close relation with each other in the analysis of the Person Trip Survey data. There is a high car-ownership rate in high-income zones and a low car-ownership rate in low-income zones. This relationship was used to estimate the motorized households by each zone, i.e., the zonal average household income was employed as an explanatory variable. This was adjusted so that the total sum of motorized households of all zones was equivalent to the total number of motorized households.

The estimated zonal motorized households are shown in Figure 9.2-1, which shows the comparison between figures in 1995 and 2020. As seen, the number of motorized households sharply increases in the northern areas of Bogota between 1995 and 2020, while the figures in southern areas increase slightly.

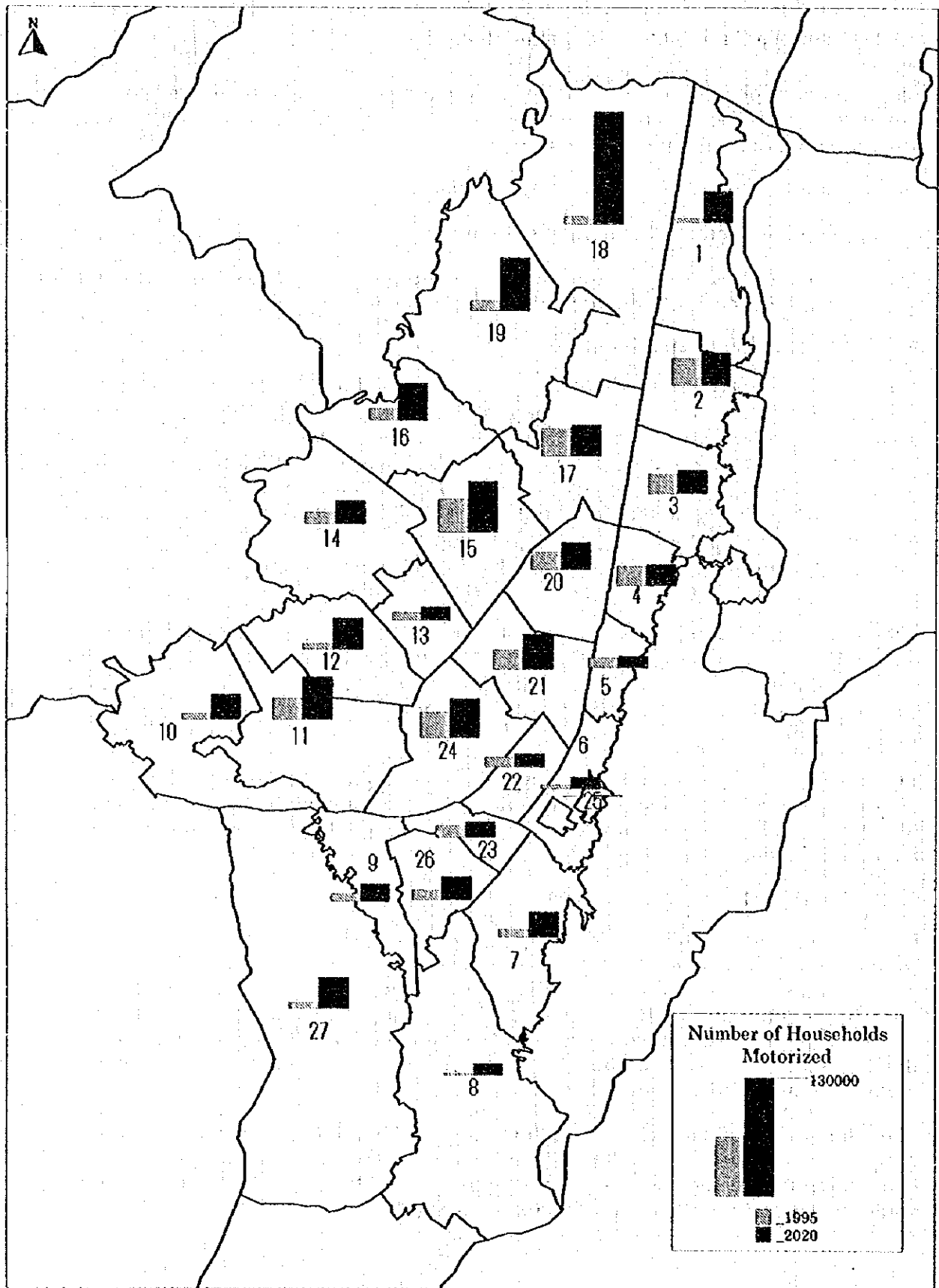


Figure 9.2-1 Estimated Motorized Households by Zone

### 9.3 Projection of Travel Demand

#### 9.3.1 Total Number of Trips

The total number of trips per day in the Study Area in 2020 is approximately 17.41 million. The trip increase ratio from the year 1995 to 2020 is approximately 1.55, in contrast to 1.45 of the population growth ratio. The trip production rate in terms of number of trips per person aging 5 years or above rises from 2.01 to 2.15. This indicates that in 2020, the share of the motorized household ratio to the total contributes to the increase of the production rate. Summary of socioeconomic and travel demand is shown in Table 9.3-1.

Table 9.3-1 Summary of Socioeconomics and Travel Demand

Indicators	1995 Year		2020 Year		2020/1995
1 Population (5 years or more)	5,569,633		8,093,524		1.45
2 Number of Cars	497,747		1,350,000		2.71
3 Car Ownership (veh/1000)	83.0		156.1		1.88
4 Number of Households	1,280,292	1.000	1,830,038	1.000	1.43
1) Non-Motorized	901,232	0.704	959,915	0.525	1.07
2) Motorized Households	379,060	0.296	870,123	0.475	2.30
5 Daily Trips for Residents in Bogota					
1) Number of Trips per Person	2.01		2.15		1.07
2) Total Daily Trips	11,196,830		17,410,563		1.55

#### 9.3.2 Trips by Mode

Numbers of trips by mode (private and public) and by motorized and non-motorized households in the years 1995 and 2020 are shown in Table 9.3-2. The increase ratios of trips by mode are 2.19 for the private mode and 1.31 for the public. As for the private mode, the figure for motorized households in 2020 show a rise of 2.50, while that for non-motorized rises only 1.33 times. The future growth of public transport for the non-motorized households is as low as 1.03.

Table 9.3-2 Trip Comparison by Mode in 1995 and 2020

	1995			2020			2020/1995		
	Private	Public	Total	Private	Public	Total	Private	Public	Total
1) Non-Motorized Households	828,412	6,094,477	6,922,889	1,105,252	6,299,600	7,404,852	1.33	1.03	1.07
2) Motorized Households	2,285,982	1,987,959	4,273,941	5,711,661	4,294,050	10,005,711	2.50	2.16	2.34
3) Total	3,114,394	8,082,436	11,196,830	6,816,913	10,593,650	17,410,563	2.19	1.31	1.55