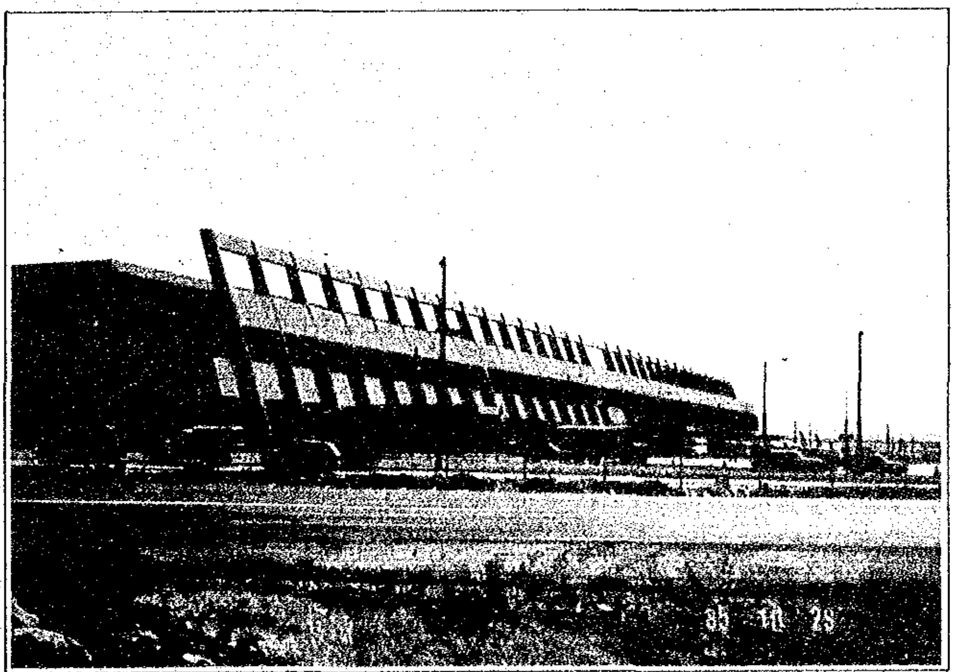
4) Urban Bus Transport

The urban bus transport covers the city in a fairly high service level, such as high density of routes and enough frequency, and is quite convenient transportation means. Total number of buses is estimated about 2000, total number of operations is about 11,000 times a day, and total number of routes is about 80.

Three kinds of bus fares are applied according to their level of services such as the air conditioning or reservation of seat. Figure 2-1.4 shows the bus route network.

5) Inter-City Bus Terminal

The Terminal Terrestre for the inter-city bus transport commenced its operation on October 11, 1985. The number of passengers using inter-city bus terminal is about 80,000 a day and the number of vehicles visiting Terminal Terrestre is about 7,500 a day.



General View of the Terminal Terrestre

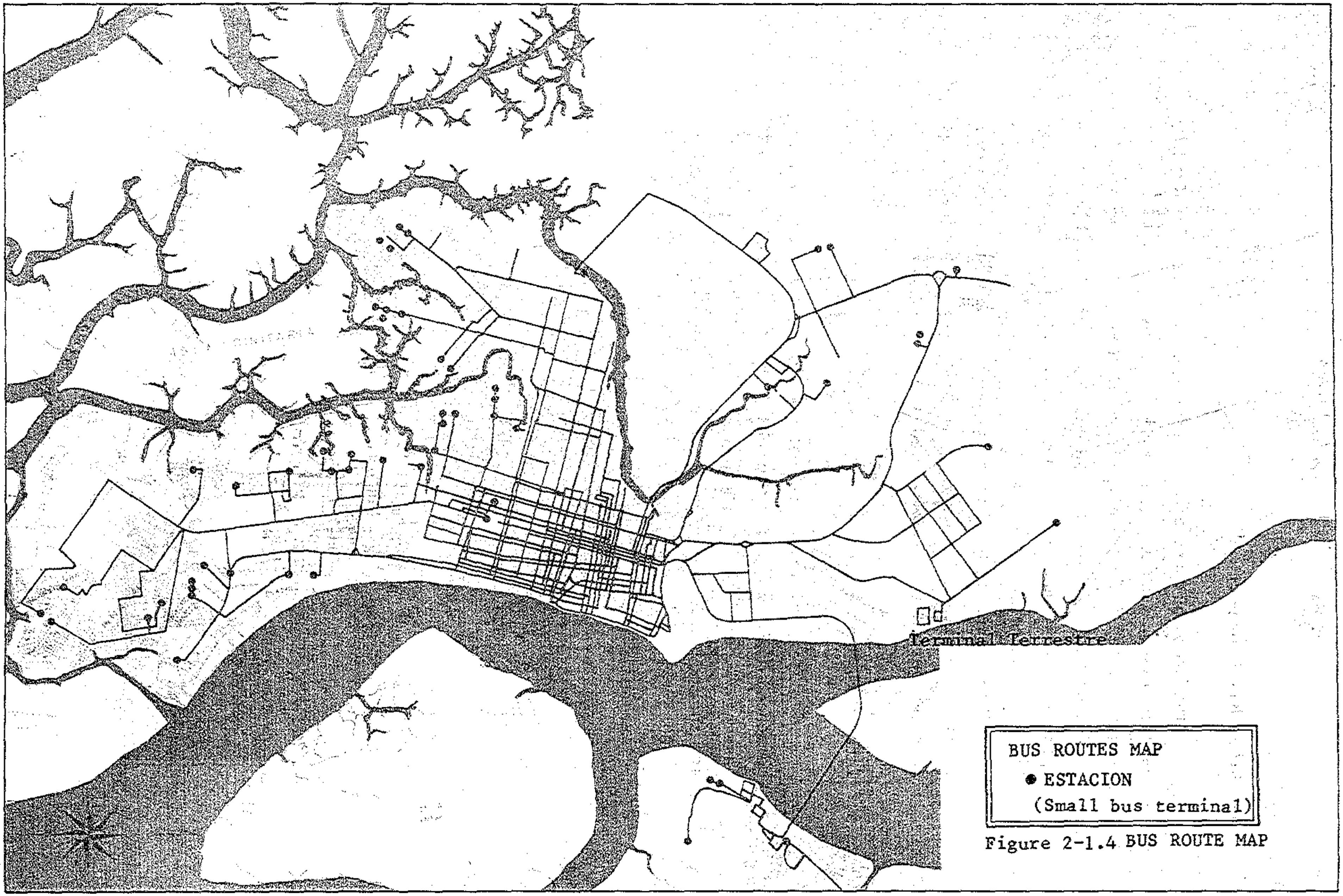


Figure 2-1.4 BUS ROUTE MAP

Urban Bus Passengers at a Small Bus Terminal

Inter-City Bus Passengers at the Terminal Terrestre

2-2 Existing Condition of Road

1) Road Network

The road network of the city is of a classic grid pattern and consists of quite a lot of number, extending to Av. Centenario Sur in the south, to Cerro el Carmen in the north and having the CBD in the center. Urban and suburban areas are connected by radial arterial roads. The streets within the city have almost uniform width, in general 15-20m, but in the suburbs the arterial roads have big width of 30 meters or more.

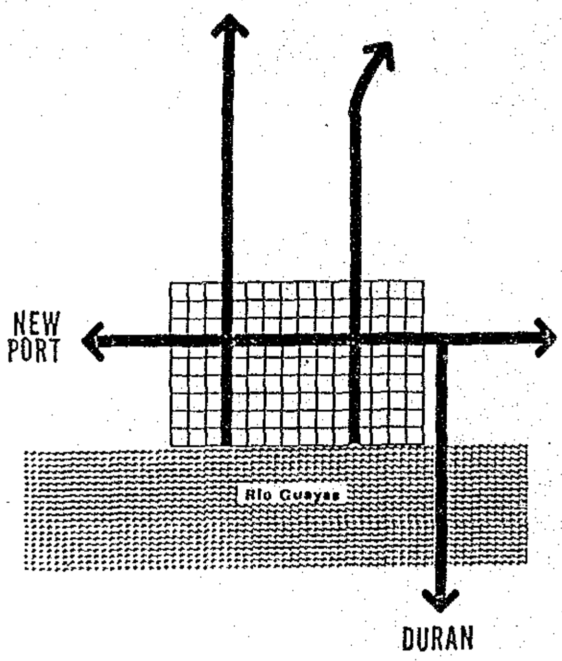


Figure 2-2.1 ROAD NETWORK PATTERN

2) Object Roads used for Alternative Routes of MRT

Several streets are selected for alternatives of MRT route (see Figure 2-2.2) and their present typical sections are shown in Figure 2-2.3.

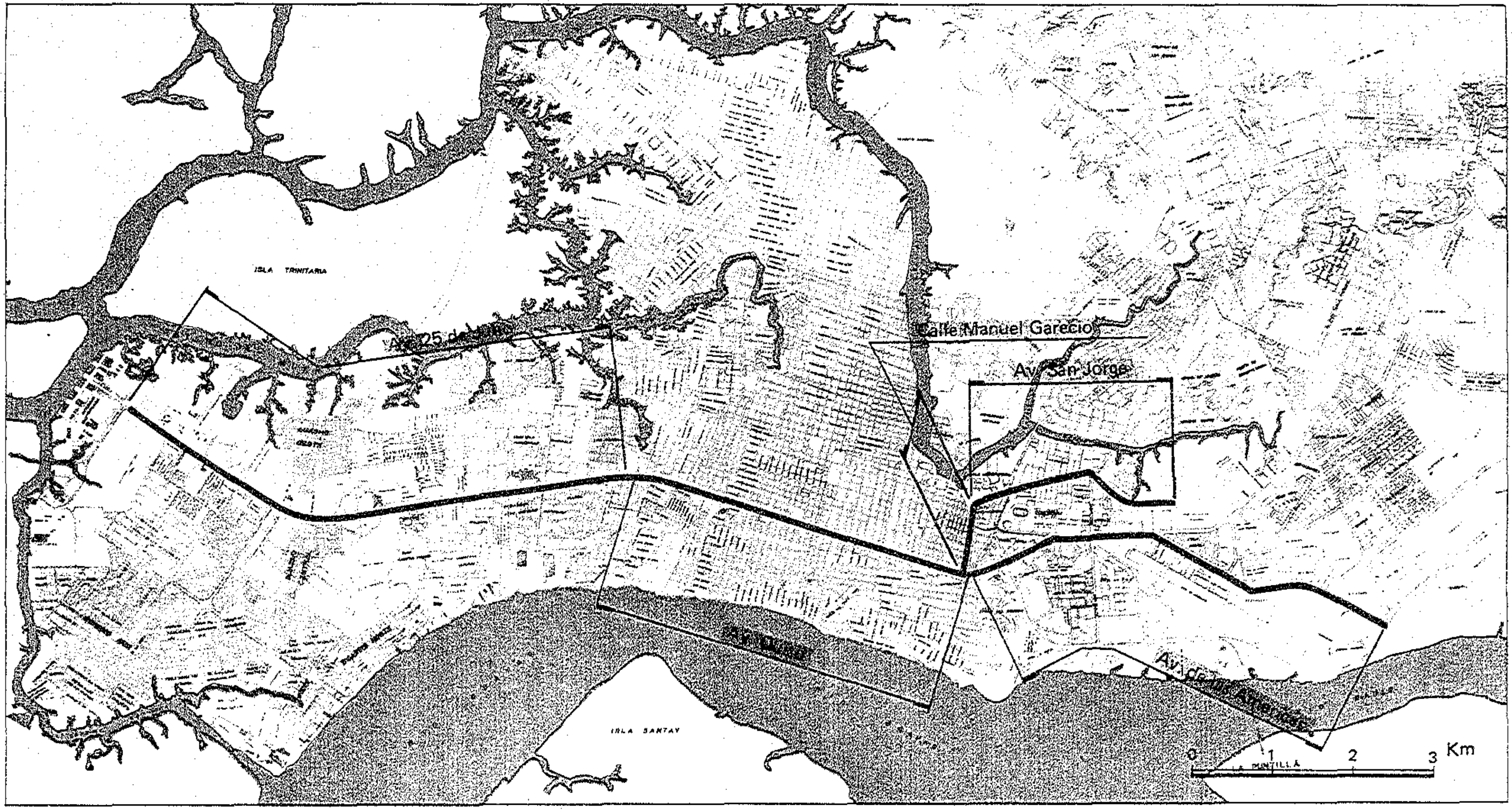


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Figure 2-2.2 ROAD NAME

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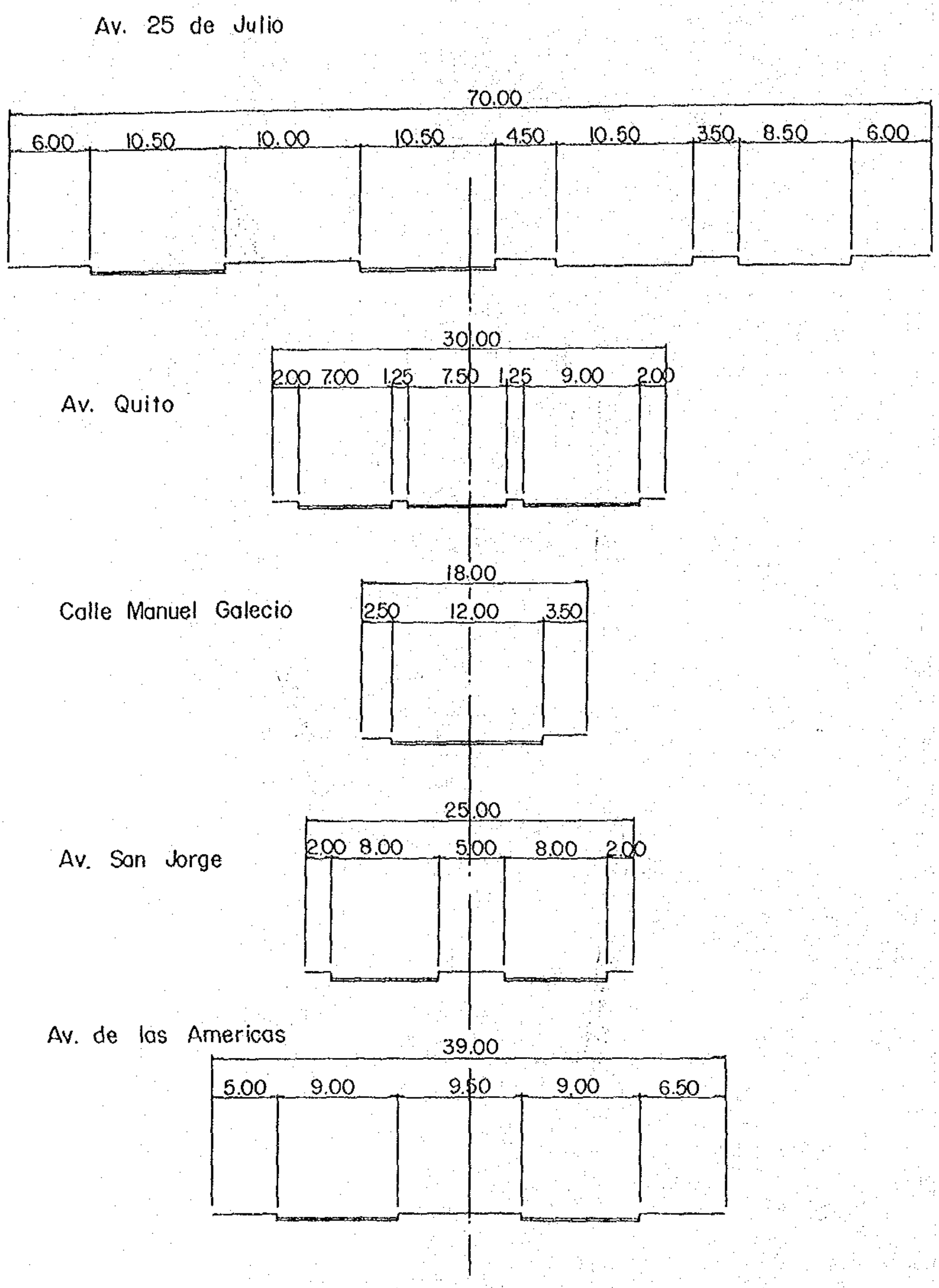
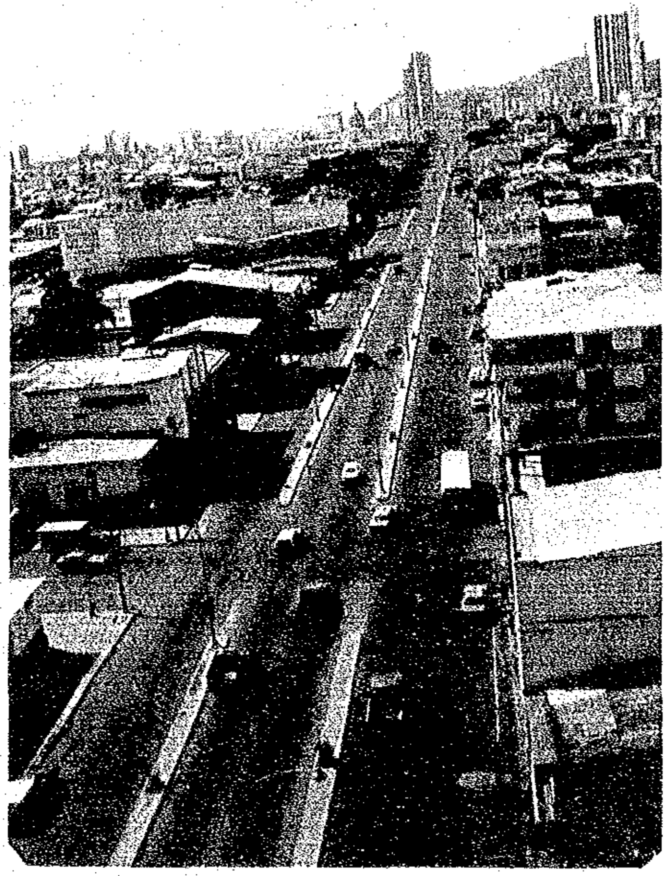


Figure 2-2.3 TYPICAL PRESENT CROSS - SECTION

Av. Quito



Av. San Jorge

2-3 Natural Condition and Obstacles along MRT Route

1) Topographical Feature

Guayaquil is located in the basin surrounded by the Salado estuary (Estero Salado) and developing toward the suburbs of both the north and south filling with the many branch of the Salado estuary.

This study area is flat with an altitude of 3 to 4 m, except for some hillocks.

2) Geological Condition

Geologically, the Guayaquil city has developed on the thick alluvium accumulated by the Guayas river.

The structure of the stratum is calssified into two kinds of strata, soft clay and hard sand.

The clay strata is 15-40 meter deep in the area between the Guayas river and the Salado estuary.

The strata of 3 to 10 meter deep under the ground surface is very soft. (The N value is less than 1). The sand stratum of dilluvium is extremely hard, and then it can support the structural foundation. (The N value is more than 50)

Physical properties and strength of soil are studied for the planning of MRT, but any of difficulties are not found. (see Figure 2-3.1)

3) Ground Water Level

The ground water level is 1 to 2 meter deep under the ground surface.

4) Seism

Small seism have occasionally occured in Guayaquil city and its vicinity while disasterous damages were not recorded.

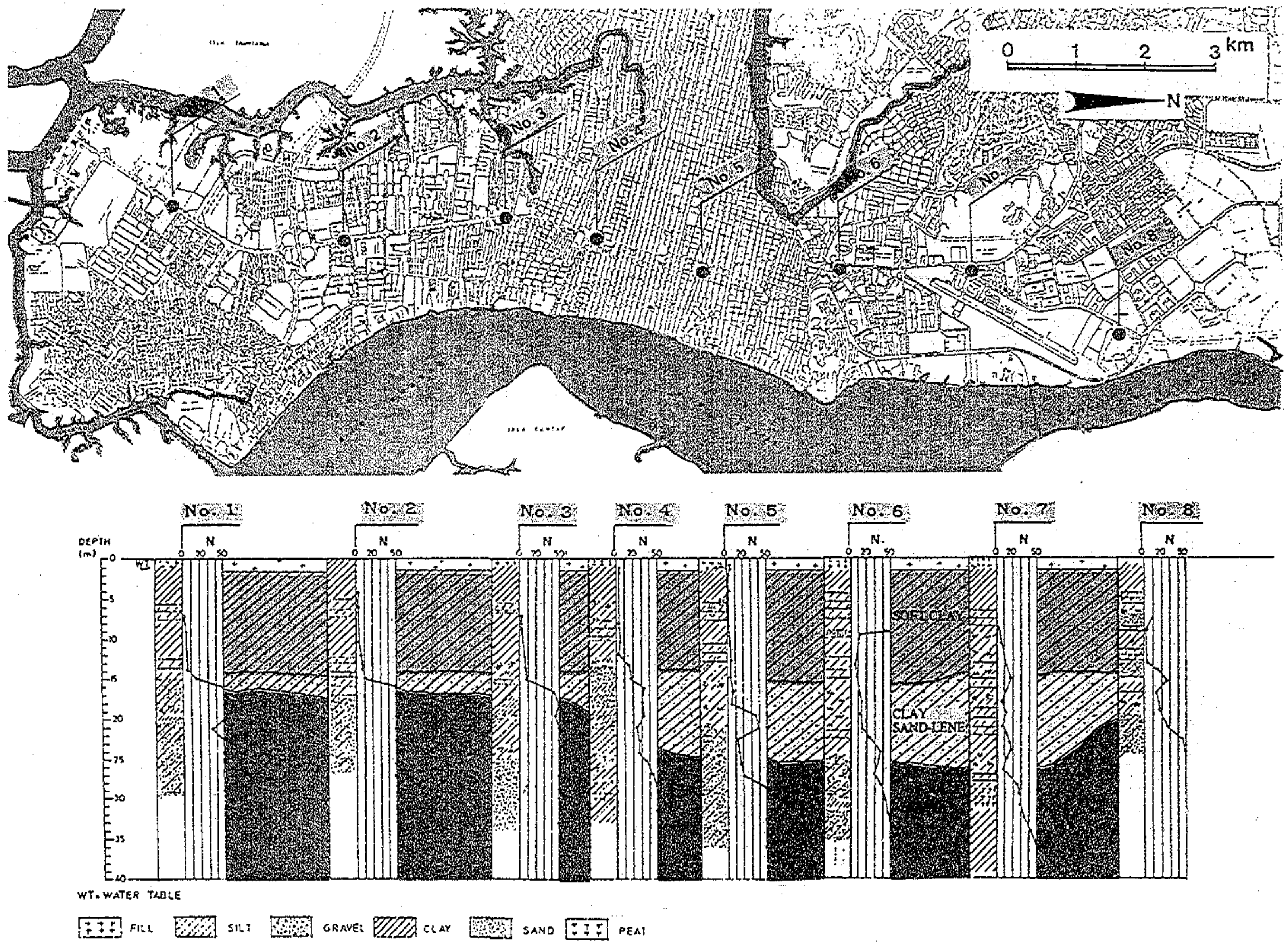


Figure 2-3.1 LOCATION OF DRILLING HOLES AND SOIL PROFILE IN M/P STUDY

5) Meteorology

Major findings of meteorological data for past 24 years are as follows:

Temperature	Maximum	38°C
	Minimum	17°C
Rainfall	Average annual rainfall is about 700 mm	
	90% of annual rainfall is concentrated in rainy season (December - April)	
Wind Velocity	Maximum	13 m/sec.

6) Obstacles along MRT route

a. Aerial Obstacles

There are many kinds of obstacles such as electric power cables, telecommunication calbes, street lamps. Big one is high voltage (69 Kv) electric power cable crossing Av. Quito.

b. Under Ground Obstacles

The water supply pipes, sewerage pipes, power cables, and telecommunication cables have been laid under ground. Especially the water supply pipe and sewerage pipe with large diameters are in Av. 25 de Julio and Av. San Jorge.

CHAPTER 3 REVIEW AND UPDATE OF BASIC FRAMEWORK AFTER M/P STUDY

The frameworks that form the basis for the demand forecast consist mainly of economic development, size of the population and EAP (Economically Active Population), land development pattern, etc. They were reviewed and updated as below.

3-1 General Economic Situation of Ecuador after M/P Study

Although Ecuador confronted the big economic crisis in 1983, the government worked out mighty measures in 1984, which included stabilization and income programs to control the inflation, recover the productivity and improve the monetary situation both in domestic and international. These measures immediately brought an effective result on every economic sector. Inflation of 48% in year rate as of January, 1984 decreased rapidly, especially in August when the new government started, down to 21% in year rate.

Nowadays, in Ecuador there are many signs of economic recovery in agriculture, fishery, manufacturing, and international trade, etc. in the difficult circumstances where all other South American countries are still facing to deficits in the revenue and high inflation. And at present, the national economy is going well under the National Development Plan (1985 - 88) which gave the target shown below.

INCREASE OF GROSS DOMESTIC PRODUCTS (%/year)

Items	1985	1986	1987	1988
Total Ecuador	3.0	3.7	3.9	4.4
Per Càpita	0.1	0.8	1.0	1.5

Source: Plan Nacional Desarrollo (1985 - 1988)

3-2 Population and EAP Growth in Study Area

The fourth national census in 1982 by INEC (Instituto Nacional de Estadistica y Censos), not only defined the population increase after the third census (1974 on which base the M/P Study was) but also made very clear the drastic decrease in the future population growth rate of the whole Ecuador. However, the INEC estimates that a large volume will concentrate more and more to the urban area in a few provinces: the largest is Guayas with 2,156 thousands in 1982 to 3,331 thousands in 1995 (3.40%/year), second is Pichincha with 1,460 to 2,368 thousands (3.79%), and third is Manabi with 960 to 1,241 thousands (2.00%).

The result of the population update in the Study area is given below.

FORECAST OF POPULATION IN THE STUDY AREA

Item	1982	1985	1990	1995	2000
Population (1000 Persons)	1,337	1,521	1,850	2,222	2,630
Growth rate %/year	5.35	4.40	3.99	3.74	3.43
	3.83 for 1982 - 2000				

As for the EAP rate to the total population, its percentage was supposed to remain around 30% until 2000, almost equal to the present figure, due to the high population growth rate mentioned above.

3-3 Family Income and Vehicle Ownership

On analysing the results of the Supplementary Traffic Survey, the present family income and the vehicle ownership in the several typical zones along the MRT route were estimated.

The average family income showed similar growth rate in each zone between 1982 and '85, and the present vehicle ownership was calculated to be 55 cars/1,000 inhabitants, compared with 48 cars in 1982.

The both growth is dotted on almost same curves projected in the M/P (excluding the consumer price inflation in the income), then no correction was made to the assumptions of their growth curves.

3-4 Land Use Framework and Allotment of Population to Zones

The frameworks of the population and EAP in 1990, 1995 and 2000 were broken down and alloted to the small traffic zones for the MRT demand forecast, taking into account the housing development, characteristics and capacity in each zone, foreseeable changes in the land use, etc.

CHAPTER 4 MRT DEMAND FORECAST

4-1 Approach

The MRT demand was forecasted according to the general flow shown in Figure 4-1.1, and the forecasting was made for the cases shown in Table 4-1.1.

These forecasting cases were prepared to concern the test cases in the economic and financial analysis as explained in Table 4-1.2.

The section patterns of the forecasting cases are illustrated in Figure 4-1.2.

4-2 Trip Volume in Future

The total trip volumes in target years were calculated by transport mode 1) from the future O-D tables in the M/P Study, before the MRT trip estimation. Its result was shown in Figure 4-2.1.

Note) 1. It means existing transport mode, bus, taxi and car.

4-3 Diversion Model Formulation

An analysis concerning the existing modal choice was conducted, based on the data collected by the supplementary traffic survey. As its result, car ownership, vehicle running cost, transport fare and time spent between zones were selected as the explanatory variables of the MRT diversion model, and the model was formulated in mathematical function combining these variables. The service level is assumed by each transport mode to forecast MRT demand as shown in Table 4-3.1.

4-4 Demand Forecast by Section Pattern

MRT demands were forecasted by case, i.e each route alternative, section and target years, supposing the bus route reorganization, etc. The result is shown in Table 4-4.1. it shows that 401,000 passengers are estimated for the entire route

(Basic Pattern) between the bus terminal (Terminal Terrestre) and Guasmo entrance in 1990. The demand of Pattern B, from the bus terminal to Centro Civico, is seemed to be largest of section patterns.

The case of MRT fare level changes shows that 5 Sucres up of MRT fare makes the demand decrease by about 50,000 passengers a day. In comparison with the case without bus route reorganization, it was found that about 89,000 passengers would be produced more in the case with bus route reorganization.

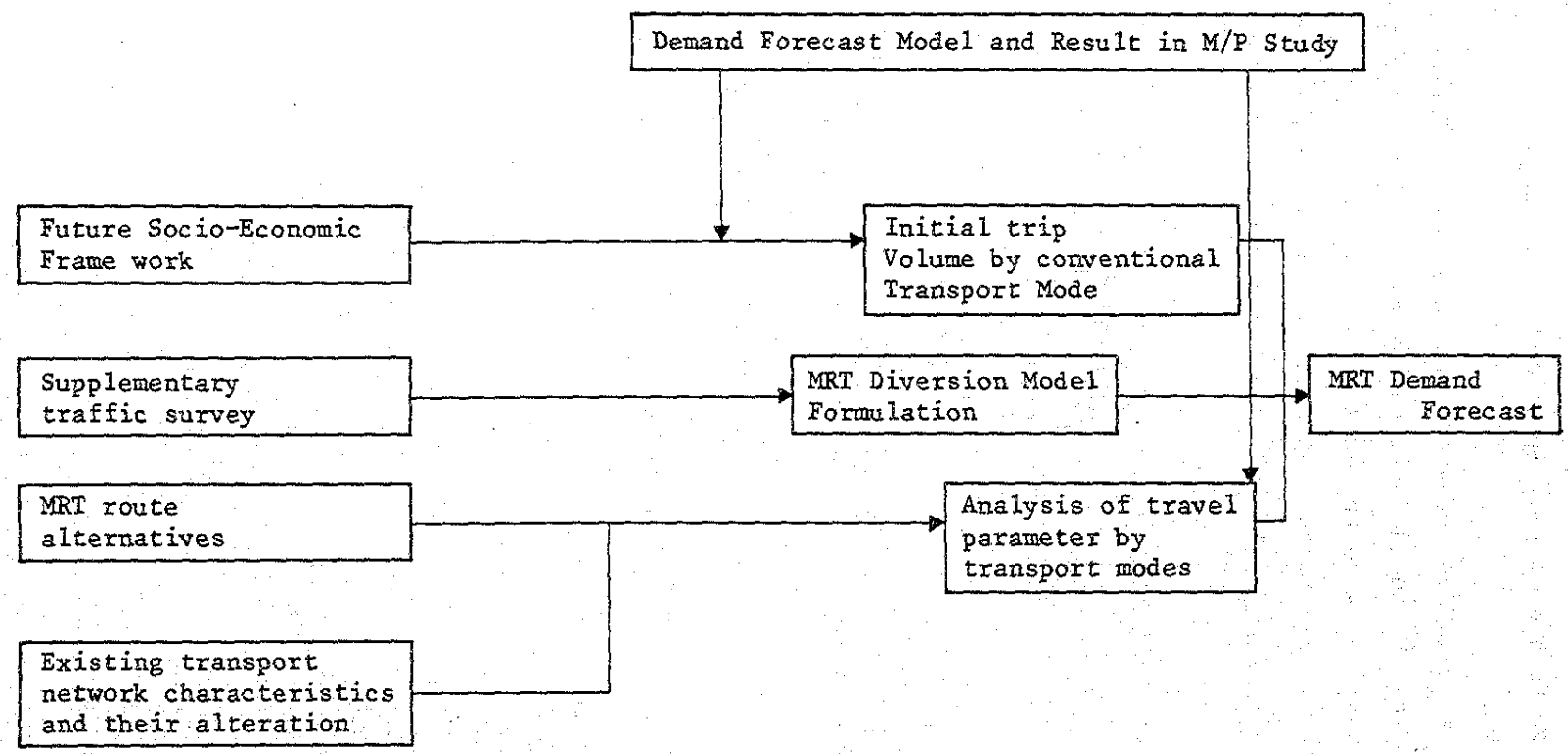


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Figure 4-1.1 DEMAND FORECAST METHOD

Table 4-1.1 CASES FOR DEMAND FORECAST

Route Alternative	Section Pattern	Bus Route Reorganization	Forecasting Year			
			1990	1993	1996	2000
I	Basic Pattern	With	o			
II	Basic Pattern	With	o	o	o	o
II	Pattern A	With	o	o	o	o
II	Pattern B	With	o	o	o	o
II	Pattern C	With	o	o	o	o
II	Pattern D	With	o	o	o	o
II	Basic Pattern	Without	o			

Note) 1. Symbol (o) shows case to be tested.

2. The route alternatives and section patterns are illustrated in Figure 4-1.2.

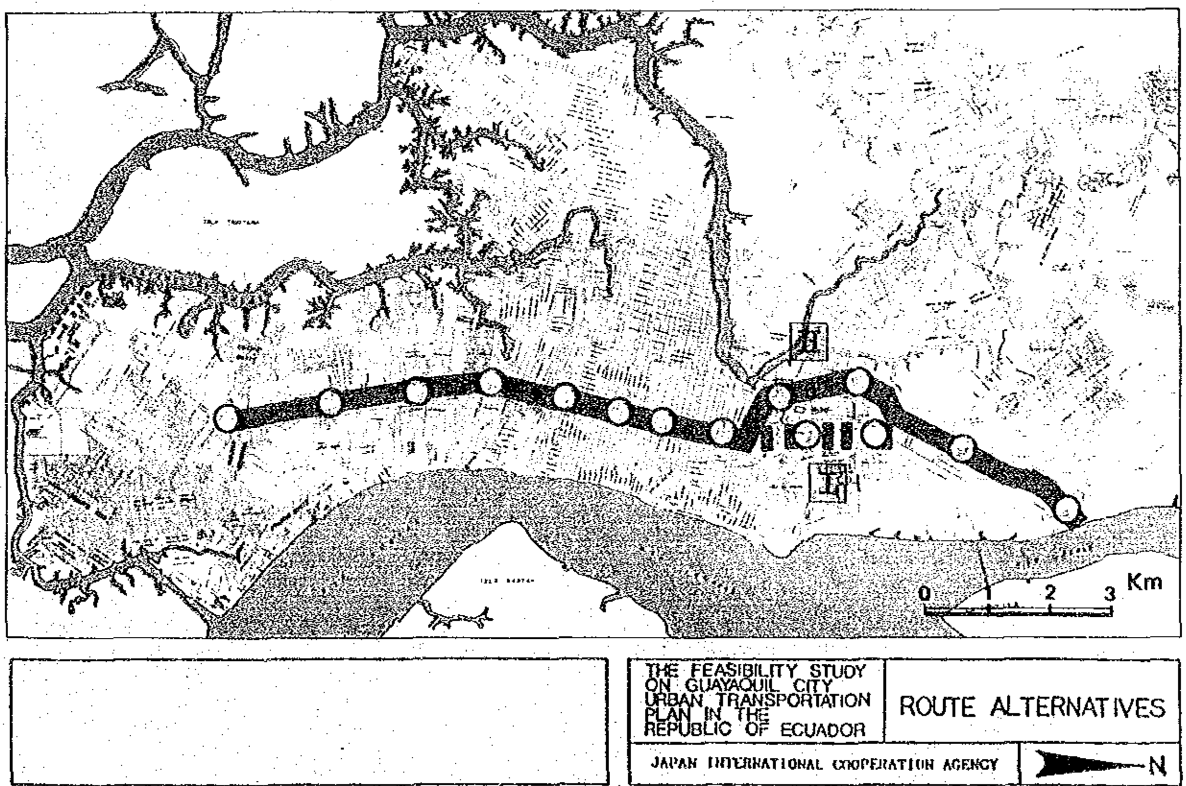

Figure 4-1.2 ROUTE ALTERNATIVES AND SECTION PATTERNS
(Continued in the next page)

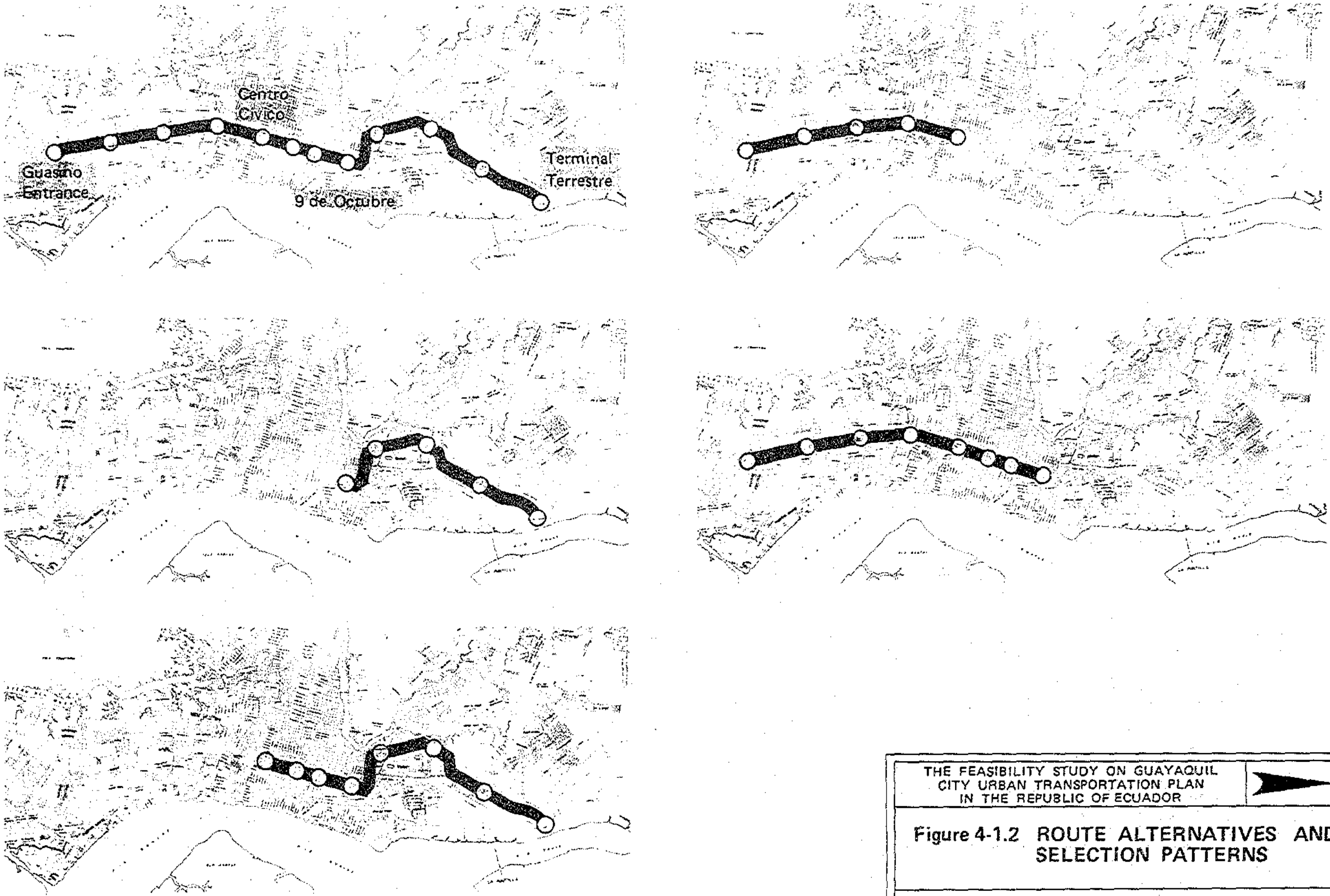

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Figure 4-1.2 ROUTE ALTERNATIVES AND SELECTION PATTERNS

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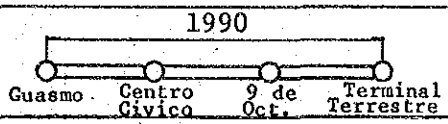
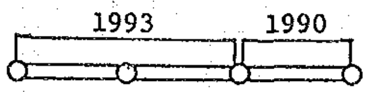
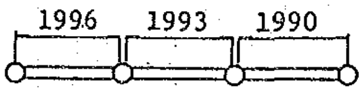
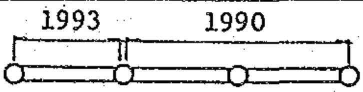
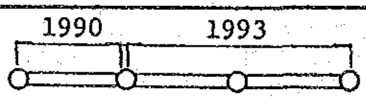
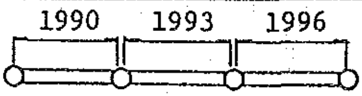
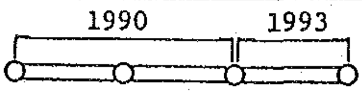
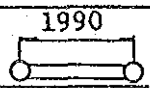
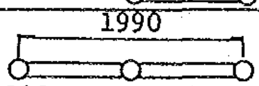
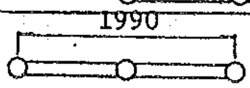
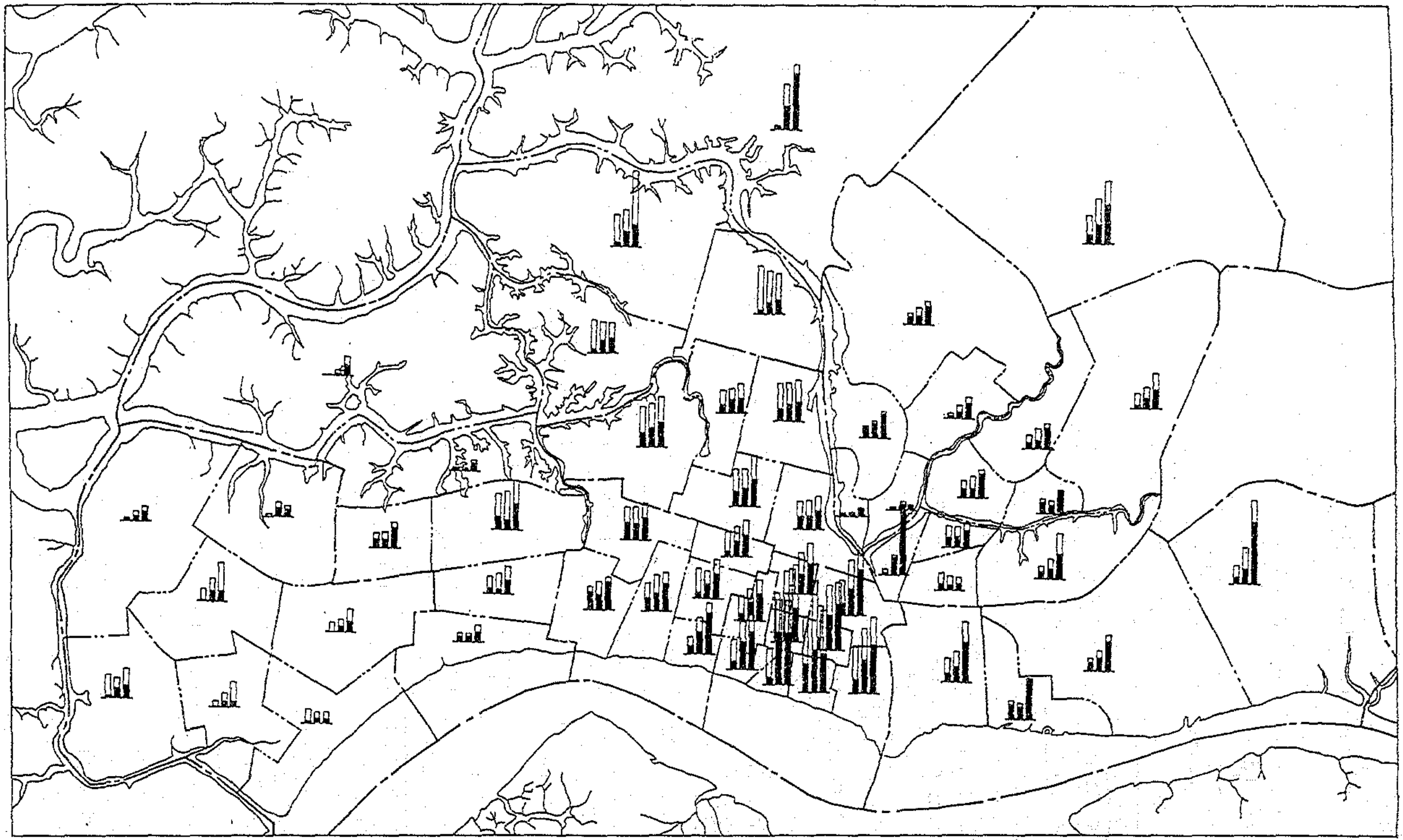
Table 4-1.2 RELATIONSHIP BETWEEN THE SECTION IN SERVICE AND TEST CASES

Test Case		Section in Service by Year			
Case	Schematic Layout	1990	1993	1996	2000
Basic Case		Basic Pattern			
Case A-1		Pattern A	Basic Pattern		
Case A-2		Pattern A	Pattern B	Basic Pattern	
Case B-1		Pattern B	Basic Pattern		
Case C-1		Pattern C	Basic Pattern		
Case C-2		Pattern C	Pattern D	Basic Pattern	
Case D-1		Pattern D	Basic Pattern		
Case E		Pattern A			
Case F		Pattern B			
Case G		Pattern D			



Note)
Figures show the total of the trip generation and attraction in each zone.

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Figure 4-2.1
FUTURE TRIP GENERATION AND ATTRACTION BY ZONE

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Table 4-3.1 ASSUMPTION OF SERVICE LEVEL BY MODE FOR DEMAND FORECAST

Mode	Running Speed (km/h)	Fare level (Sucres)	Others
Bus	15: Suburbs 10: Central area	8	Bus route reorganization
Car	10 - 30	-	
Taxi	10 - 30	60	
MRT	30	25	

Table 4-4.1 MRT DEMANDS BY SECTION PATTERN

Item	Section Pattern	Basic Pattern	Pattern A	Pattern B	Pattern C	Pattern D
Dimen-sion	No. of Stations	12	5	8	5	8
	Section Length (km)	14.7	6.7	9.1	5	8.0
Demands (Persons/day)	1990	401,000	170,000	275,000	92,000	223,000
	1993	447,000	191,000	304,000	99,000	239,000
	1996	482,000	206,000	327,000	105,000	251,000
	2000	530,000	228,000	358,000	112,000	268,000

4-5 Passenger Flow between Stations

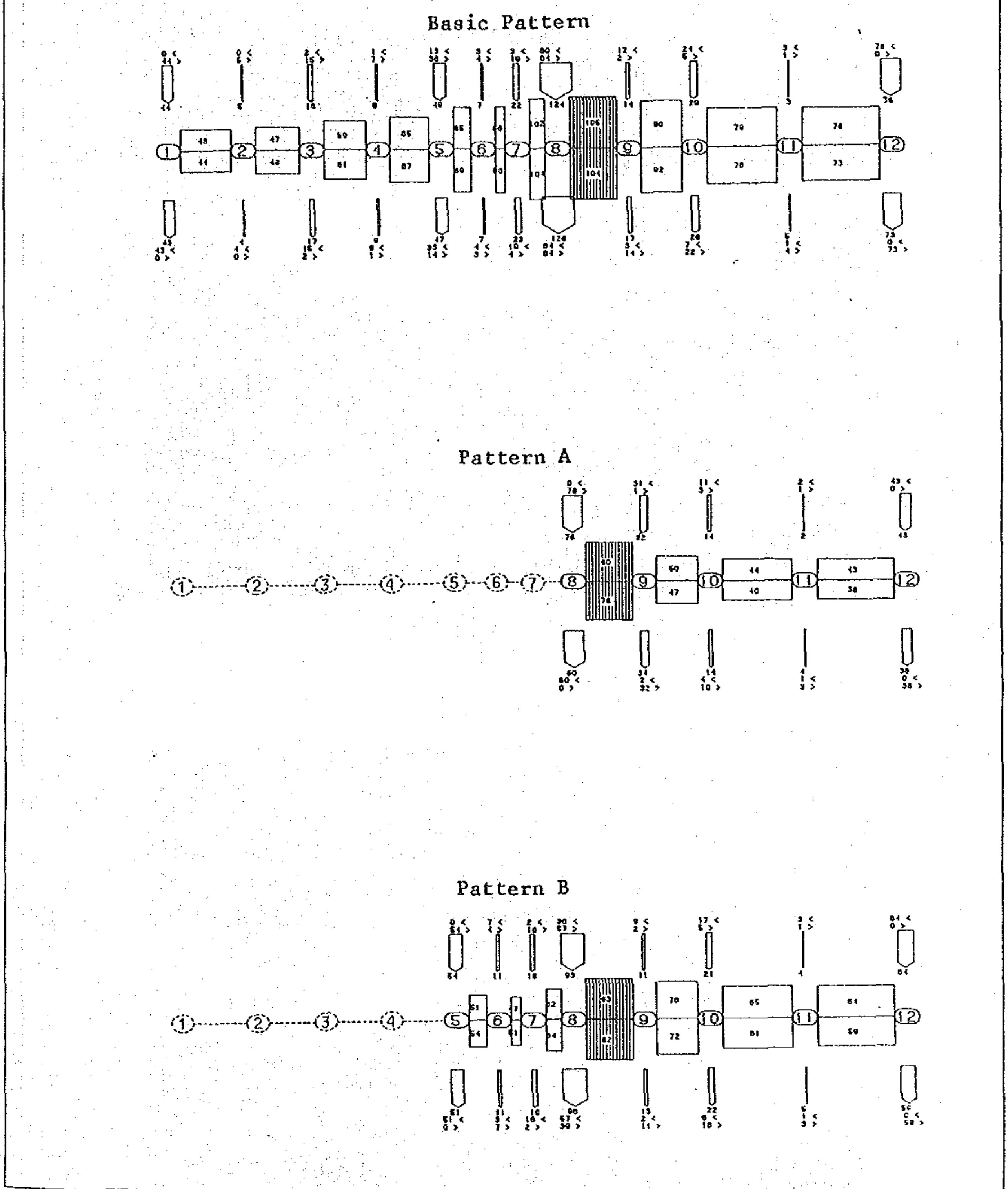
The daily passenger flow was estimated by distributing total MRT demands among MRT stations. Figure 4-5.1 shows the daily passenger flow in 1990 by each section pattern.

The maximum peak hour passengers flow was also estimated as shown in Table 4-5.1, using the average hourly peak rate.

Table 4-5.1 MAXIMUM HOURLY PEAK PASSENGERS FLOW

(Passengers/hour)

Section Pattern / Year	Basic Pattern	Pattern A	Pattern B	Pattern C	Pattern D
1990	12,600	9,600	9,900	5,400	10,600
1993	14,500	10,500	11,300	5,800	11,100
1996	15,700	11,200	12,300	6,200	11,500
2000	17,400	12,000	13,500	6,600	11,900



LEGEND

UNIT : 1000 Passengers/day

South bound Trip flow — Boarding passengers

< South bound related

> North bound related

North bound Trip flow — Alighting passengers

(Note) Volume as of 1990

THE FEASIBILITY STUDY ON GUAYAQUIL CITY URBAN TRANSPORTATION PLAN IN THE REPUBLIC OF ECUADOR

Figure 4-5.1

MRT PASSENGERS VOLUME BETWEEN STATIONS (SECTIONS)

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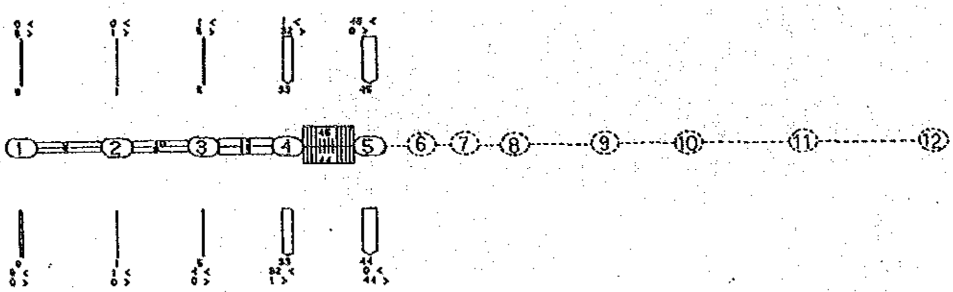
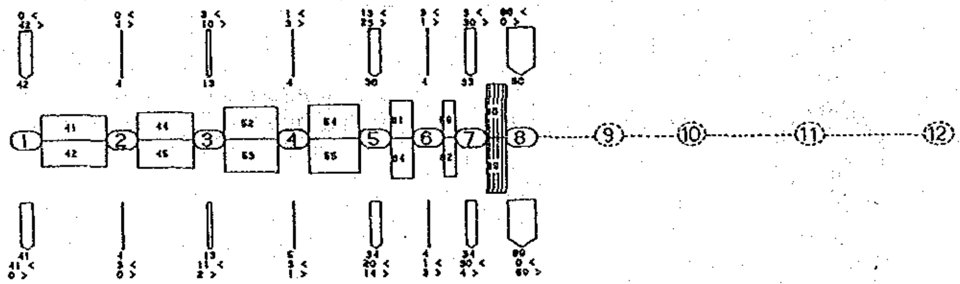
Pattern C



Pattern D



LEGEND

UNIT : 1000 Passengers/day

South bound Trip flow — Boarding passengers

< South bound related

> North bound related

North bound Trip flow — Alighting passengers

(Note) Volume as of 1990

THE FEASIBILITY STUDY ON GUAYAQUIL CITY URBAN TRANSPORTATION PLAN IN THE REPUBLIC OF ECUADOR

Figure 4-5.1 (Cont'd)
MRT PASSENGERS VOLUME BETWEEN STATIONS (SECTIONS)

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Inter-City Bus Terminal (Terminal Terrestre) opened in 1985

Front of the Terminal Terrestre

Inside of the Terminal Terrestre
Ticketting Office and Concourse

CHAPTER 5 ALTERNATIVES OF MRT ROUTE AND SYSTEM, AND THEIR SELECTION

Considering various changes after the M/P Study in 1983, some alternatives of the MRT route were examined both in the northern and in the southern part. Three alternatives of the MRT system out of 5 in the M/P shown also examined again and evaluated.

5-1 Route Alternatives

Alternative cases are: 2 in the southern part and 3 in the northern part, while there are no alternatives between these parts because of no wide roads suitable for the MRT except Av. Quito. They are shown in Figure 5-1.1.

As to the nothern part, small modifications of the alignment were examined in detail from various aspects such as land acquisition/reservation, technical matters, construction cost, etc. (See Table 5-1.1 and 5-1.2).

5-2 System Alternatives

The 3 MRT systems: Urban Railway, Light Urban Railway, and Monorail were picked up as the alternatives, and compared each other based on the many aspects such as project cost, transport capacity, operation cost, easy maintenance, etc., as shown in Table 5-1.3.

5-3 Selection of Route and System

The project cost by route and system which is the most important item for the evaluation were estimated as bellow:

Approximate Project Cost by Alternative Route and System

(Unit: Million sucres in 1985 prices)

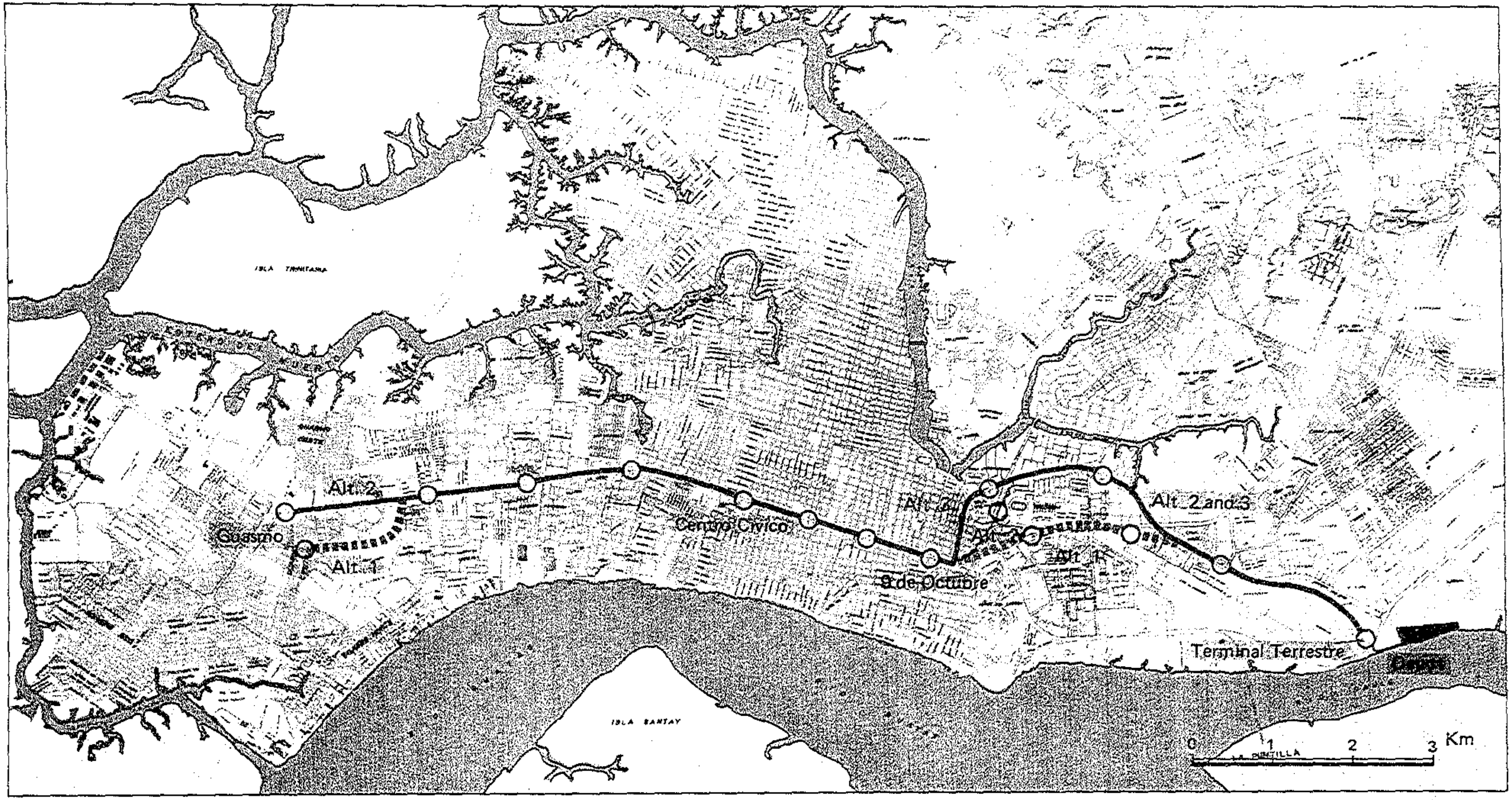
Alternative Route / Alternative System	Alt 1	Alt 2	Alt 3
Urban Railway	29,206 (1.00)	31,133 (1.07)	30,604 (1.05)
Light Urban Railway	27,223 (1.00)	28,876 (1.06)	28,446 (1.04)
Monorail	34,475 (1.00)	35,677 (1.03)	35,280 (1.02)

Note: Figures in ( ) mean ratio to Alt. 1
1 US dollar = 120 Sucres as of October, 1985
(on the free market base)

The final selections were;

For the route; Alt. 2 in the south and Alt. 3 in the north were selected. Although the selected route is a little longer (14.7 km) than Alt. 1 (13.7 km), its construction cost is almost same, and in addition, expected to have the biggest demand and to be easily constructed with less obstacles.

For the system; Light Urban Railway was selected to be the most promising of the three in less project cost, adaptability to the route alignment, less maintenance and operation cost, more advantage for the route extension in future.



Alt 1 in Southern and Northern part	Finally selected route
Alt 2 in Northern part	Station
Alt 2 in Southern part, Alt 3 in Northern part and sections without route alternatives	Depot and maintenance shop

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Figure 5-1.1 ROUTE ALTERNATIVES AND LOCATION OF STATIONS AND DEPOT

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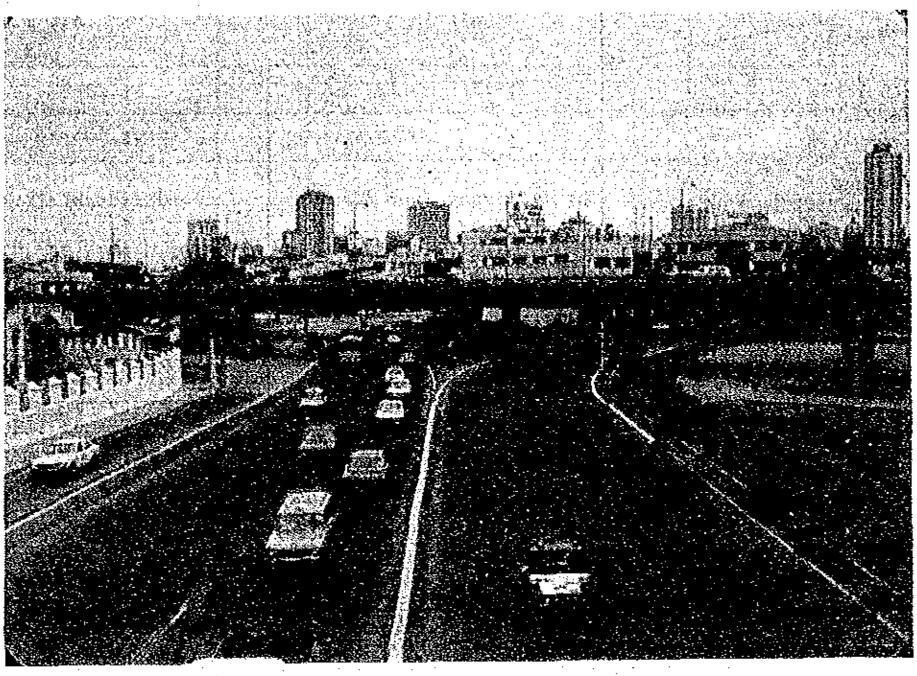
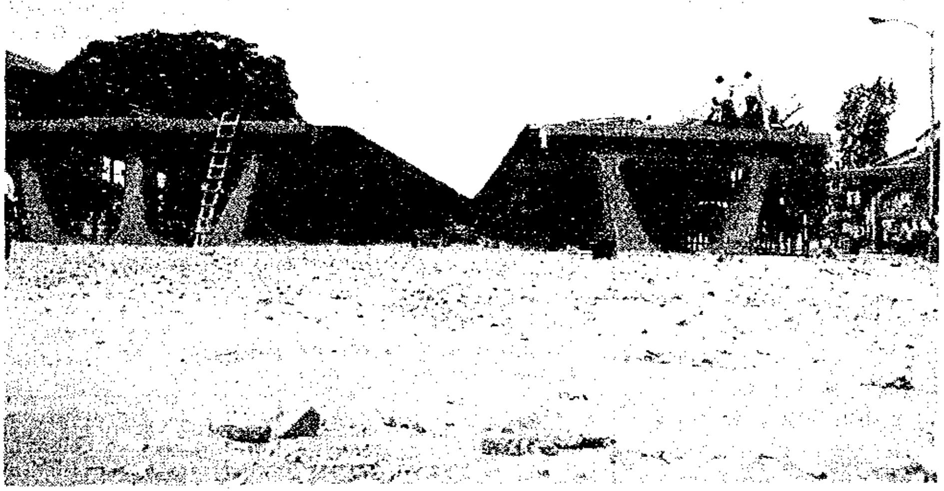
Overpass Related to Route Alternatives
(Alt 1 and 2 have to cross over overpasses shown below.)



Existing overpass (Calle J. Coronel)



Overpass under Construction in 1985 (Av. de las Americas)

Table 5-1.1 COMPARISON OF ALTERNATIVE ROUTES IN SOUTHERN PART OF THE ROUTE

Comparison Item \ Alternative Routes		Alt 1		Alt 2	
1. Route length (km)		1.7	-	1.7	-
2. Number of stations		1	-	1	-
3. Transport demand (passengers per day in 1990)		no different from Alt 2	-	no different from Alt 1	-
4. Appropriateness to connection with bus routes		• disadvantageous to connection with the route from Guasmo Oeste • difficult to acquire land for bus terminal	C	• Alt 2 is more advantageous to both points than Alt 1.	A
5. Accessibility to major urban establishments (major establishments and approx. number of their users)		There are no major urban establishments near the objective section.	-	Same as left	-
6. Alignment of the line and profile (incl. track maintenance, operating efficiency)	Alignment	• sharp curves at 2 places • disadvantageous to track maintenance and operating speed	C	• almost straight	B
	Profile	• almost level		• steep gradient (up and down): 1 place	
7. Characteristics of structure of way		• No high elevated structures are required but long-span beams with sharp curve are required to overpass the existing roads.	B	• High elevated structures are required to overpass the planned interchange. (L = 0.4 km Hmax = 12.7 m Hmean = 9.5 m)	C
8. Difficulty and/or easiness for land acquisition and compensation	Land acquisition	• difficult, because of many proprietors (11,000 m^2)	C	• easier than Alt 1, because of few proprietors (5,200 m^2)	A
	Compensation	ditto (10,000 m^2)		ditto (3,000 m^2)	
	Approx. Cost	122 million sucres		40 million sucres	
9. Adaptability to road improvement plans, and/or interference with road traffic		• unnecessary to coordinate with the planned interchange but necessory to coordinate with distributor roads.	A	• necessary to coordinate with the planned interchange	B
10. Impacts to wayside		• necessary to take countermeasures, protecting the environment from turning for the worse, because most of the route passes through residential area	C	Environmental impacts to wayside are little.	A
11. Difficulty and/or easiness for construction work		easy	A	• comparatively difficult to construct the intersection (overpass) of the planned interchange	B

(continue)

Table 5-1.1 COMPARISON OF ALTERNATIVE ROUTES IN SOUTHERN PART OF THE ROUTE (Cont'd)

Comparison Item \ Alternative Routes	Alt 1		Alt 2	
12. Project Cost (for 1.7 km of the route) (Unit: million sucres)	Civil work cost 1,439 Land cost 122 Total 1,561	A	Civil work cost 1,515 Land cost 40 Total 1,555	A
Ranking from synthetic judgement	2		1	

(Note) Project cost is estimated in 1985 prices and exchange rate "1US dollar = 120 sucres = 210 Yens"

Table 5-1.2 COMPARISON OF ALTERNATIVE ROUTES IN NORTHERN PART OF THE ROUTE

Comparison Item \ Alternative Routes		Alt 1		Alt 2		Alt 3	
1. Route length (km) (as for whole route length)		3.5 (13.7)		4.5 (14.7)		4.5 (14.7)	
2. Number of stations (as for whole route)		2 (12)		2 (12)		2 (12)	
3. Transport demand (passengers per day in 1990)		365,000	B	401,000	A	401,000	A
4. Appropriate places to connection with bus routes		None	C	1 place near Policentro	A	Same as left	A
5. Accessibility to major urban establishments (major establishments and approx. number of their users)		Laica University, Aquirre Highschool, National Police Station, Stadium (Approx. 30,000 persons excl. stadium)	C	Guayaquil University Stadium Policentro (Approx. 60,000 persons excl. stadium)	A	Same as left	A
6. Alignment of the line and profile (incl. track maintenance, operating, efficiency	Alignment	· Sharp curves ($R \leq 160m$): 3 places · Complex of curves and gradient: many places	C	· Sharp curves ($R \leq 160m$): 4 places · Same as left	B	· Sharp curves ($R \leq 160m$): 4 places · Complex of curves and gradient: few places	A
	Profile	Ups and downs are many.		Ups and downs are less than Alt 1 and more than Alt 3.		Ups and downs are few.	
7. Structure Types (Advantages from structural aspects)	Elevated	2.3 km (high elevated: 0.7 km) (maximum beam span: 40 m)	C	4.5 km (high elevated: 1.0 km) (maximum beam span: 60 m)	B	4.5 km (high elevated: none) (maximum beam span: 35 m)	A
	Underground	0.6 km		None		None	
	On-the-ground	0.6 km		ditto		ditto	
8. Difficulty and/or easiness for land acquisition and compensation	Land acquisition	Difficult, because of many proprietors (15,000 m^2)	C	easier than Alt 1, because of few proprietors (14,300 m^2)	A	Same as left (13,200 m^2)	A
	Compensation	ditto (6,000 m^2)		ditto (2,100 m^2)		ditto (2,760 m^2)	
	Approx. cost	205 million sucres		137 million sucres		136 million sucres	

(Continue)

Table 5-1.2 COMPARISON OF ALTERNATIVE ROUTES IN NORTHERN PART OF THE ROUTE (Cont'd)

Comparison Item \ Alternative Routes	Alt 1		Alt 2		Alt 3	
9. Adaptability to road improvement plans, and/or interference with road traffic	• Necessary to Coordinate with the intersection plan (underpass) of Av. Quito and Av. Pedro Menendez	B	no problem	A	Necessary to restrict road traffic flow on Calle M. Galecio	B
10. Impacts on land use of wayside	• Effects on development of wayside is not expected too much. • Exit/entrance to buildings along the route is inconvenient.	C	• Effects on development of wayside are expected.	A	Same as left	A
11. Difficulty and/or easiness for construction work	• difficult to construct the high elevated overpass and underpass heavy traffic road.	C	• difficult to construct the high elevated overpasses	B	Easy	A
12. Project Cost (as for the whole route in case of Light Urban Railway) (unit: million sucres)	27,223 (1.00)	A	28,876 (1.06)	C	28,446 (1.04)	B
Ranking from synthetic judgement	2		3		1	

(Note) 1. Project cost is estimated in 1985 prices and exchange rate: "1US dollar = 120 sucres = 210 Yens."

2. Project costs of other MRT systems are shown in the Table at page 45.

Table 5-1.3 COMPARISON AND EVALUATION OF ALTERNATIVE SYSTEMS

Item \ Alternative System	Urban Railway	Light Urban Railway	Monorail
1. Transport capacity and correspondence to transport demand increase in future	A	B	A
· Maximum capacity for transport plan (Person/hour/one way) (Headway = 3 minutes)	34,000	26,000	30,000
cf.			
· Headway required for demand in 1990. (12,600 persons/hour/one way)	6 minutes	4.7 minutes	5 minutes
· Headway required for demand in 2000. (17,400 persons/hour/one way)	4.2 minutes	3.4 minutes	3.6 minutes
2. Adaptability to route conditions. (judging from minimum curvature and maximum gradient)	C	B	A
3. Operating efficiency and cost. (judging from acceleration deceleration and power cost)	B	A	B
4. Easiness of maintenance (including maintenance cost)	B	A	C
5. Environmental impacts	C	B	A
· Noise and vibration	(C)	(B)	(A)
· Influence to radio wave	(C)	(B)	(A)
· Landscape	(C)	(B)	(A)
6. Safety (in case of emergency)	A	A	B
7. Comfortability to passengers	B	B	A
8. Advantages on route extension in future (judging from possibility of level crossing with roads in suburbs, flexibility of route selection, etc.)	B	A	C (Level crossing with roads is impossible.)
9. Project cost (million sucres) (in case of the selected route) (refer to section 5-3)	B	A	C
	30,604 (1.08)	28,446 (1.00)	35,280 (1.24)
Ranking from synthetic judgement	2	1	3

CHAPTER 6 CONSTRUCTION AND MANAGEMENT PLAN

6-1 Planning Policy

1) Premises

Principal premises for making plan are shown below:

(1) Route : The route selected in the previous chapter 5 which is the whole object route of this study (14.7 km) from Terminal Terrestre to Guasmo (the Basic Case).

(2) MRT system : The Light Urban Railway selected in the previous chapter 5.

(3) Opening year: 1990 (the Basic Case)

(Note) Other staged construction cases are summarized in the later section 6-7.

2) Demand Assigned to the Whole Route

Item \ Year	1990	1993	1996	2000	2010 -
Number of passengers per day	401,000	447,000	482,000	530,000	646,000
Maximum number of passengers per day in one direction	105,000	121,000	131,000	145,000	177,000
Maximum number of passengers per hour in one direction	12,600	14,500	15,700	17,400	21,200

Note) No passenger increase after 2010.

3) Basic Policies for Making Plan

Basic policies and other main items to be considered for making the plan are as follows:

(1) To make construction cost lower

(2) To make maintenance and management easy

(3) To cope with to the demand increase in future

(4) To make the plan adaptable to the route extension in future and connectable to the East-West Line proposed by the M/P

(5) To operate the Light Urban Railway efficiently matching the local circumstances

(6) To make the plan coordinate with other improvement plans related to the MRT construction

6-2 Transport Plan

Based on the planning conditions, principal figures are shown below:

(1) Route length and Number of stations: 14.7 km, 12 stations

(2) Transport demand : 12,600 persons/hour/one direction (in 1990)
21,200 persons/hour/one direction (in 2010)

(3) Train formation and transport capacity: 5 cars, 80 meters long
1008 persons/train

(4) Schedule speed and time required in one direction : 30 km/hr, 29 minutes

(5) Headway : 4.6 minutes in 1990
2.7 minutes in 2010

(6) Required number of train formation : 14 sets in 1990
24 sets in 2010

(7) Required number of cars (incl. reserved cars) : 70 cars in 1990
135 cars in 2010

(8) Number of trains per day : 360 trains in 1990
580 trains in 2010

6-3 Construction Plan

A complete construction plan of the Light Urban Railway system for the Basic Case (14.7 km, from Terminal Terrestre to Guasmo) was worked out to cover the whole system: trackway structures, stations, rolling stock, electrification, signalling and communication system, depot and maintenance shop, etc.

It is outlined as follows:

1) Construction Standards

Construction standards for structures' planning are specified in Table 6-3.1.

2) Route Plan and profile

Based on the above standards, the route plan and profile were designed to match the topographical features of the streets, not to interfere the road traffic and to minimize hindrance to private-owned lands and buildings, etc. Outline of them is summarized in Figure 6-3.1.
(Details of them are referred to the Preliminary Engineering Drawings in another volume.)

3) Trackway structures and stations

According to the route plan and profile, trackway structures and stations were designed not only to match urban landscape but also to be economical, etc. Typical structures of trackway and stations are shown in Figure 6-3.2.

4) Rolling Stock

Rolling stock plan has been laid out to perform mass rapid transport of passengers effectively.

Its principal features and performance are shown in Table 6-3.2 and external appearance of car is shown in Figure 6-3.3.

5) Electrical Facilities

Electrical facilities consisting of the power supply system, signalling system and communication system, were designed to meet operation plan, rolling stock plan, etc. Their basic specifications are as follows:

a. Power Supply System

•	Electric System from Power Supplier	: 60 Hz. 3-phase, 69 kv
•	Electric System of Traction power	: DC 1500 v
•	Type of trolley wire suspention	: Simple Catenary
•	Max. Interval of contact line suspention	: 60 m
•	Electric System of Power Distribution	: 3-phase, 13.2 kV; 3-phase, 208/120 V; a single-phase 240/120 V

b. Signalling System

•	Signals	: Color Light Type
•	Interlocking Device	: Relay Type
•	Train Control	: ATS and CTC
•	Block System	: Automatic Type

c. Telecommunication System

•	Telephone System	:	EPABX Automatic Telephones Selective Type Dispatching Telephone
•	Radio System	:	400 MHz Band Train Radio
		:	150 MHz Band Portable Radio

Schematic diagrams of the above three systems are shown in Figure 6-3.4 to 6-3.6.

6) Depot and Maintenance Shop

Car depot has responsibilities for daily check, inspection, repair and stabling of electric railcars. The headquarers of the MRT and the CTC (Centralized Traffic Control) will be located in this depot. And this depot will be a base for control and administration of the whole MRT system and of train drivers for line services.

Layout of the depot and maintenance shop are shown in Figure 6-3.7 and outline of inspection system is summarized in Table 6-3.3.

7) Construction Schedule

Construction schedule setting a target date for opening of service on 1 January, 1990, is planned as shown in Figure 6-3.8.

Table 6-3.1 DESIGN STANDARDS FOR CONSTRUCTION

Item	Standard	Remarks
Gauge	1,435 mm	
Maximum design speed	80 km/h	
Minimum curve radius	120 m	for main track
	100 m	for depot
	300 m	for station section
Maximum grade	35 ‰	for main track
	10 ‰	for station
Vertical curve	2,000 m	in horizontal curve R ≤ 800 m
	3,000 m	in horizontal curve R > 800 m
Track-center distance	3.1 m	for main track
	4.0 m	for depot
Rail	50 kg/m	
Sleeper	wooden	
Ballast thickness of track	200 mm	under the sleeper
Turnout	No.8(1:8)	for main track
	No.6(1:6)	for depot
Live load	12 ton/1 axle	train moving load
Over head clearance	4.7 m	clearance between the bottom of structures and the road surface

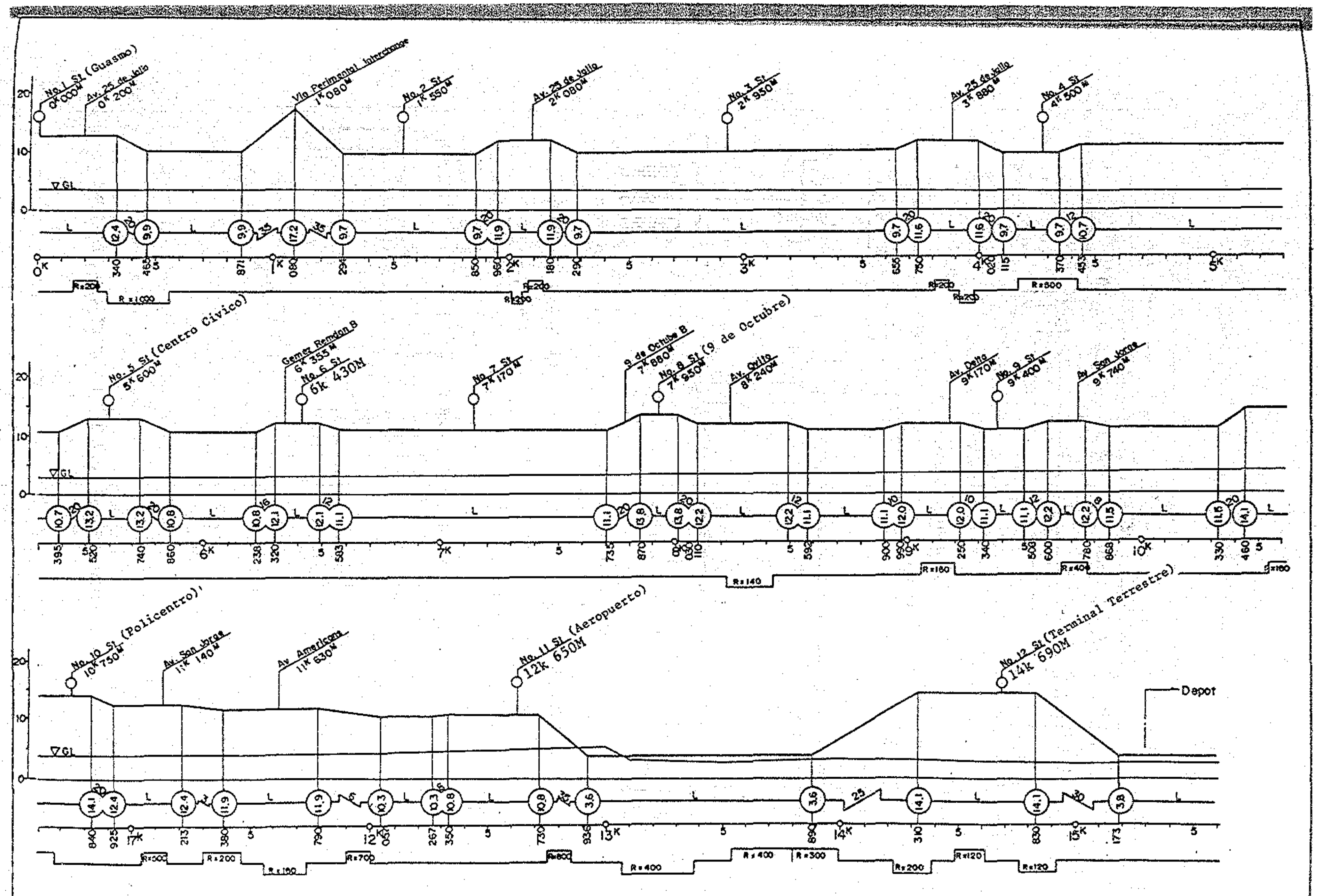
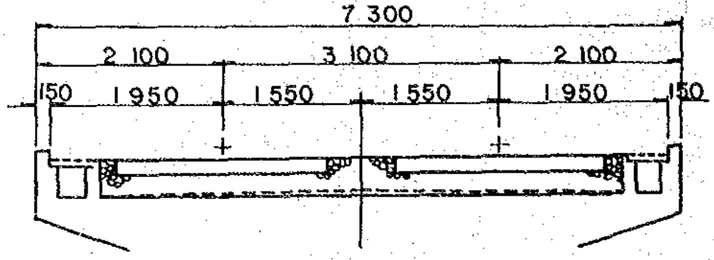
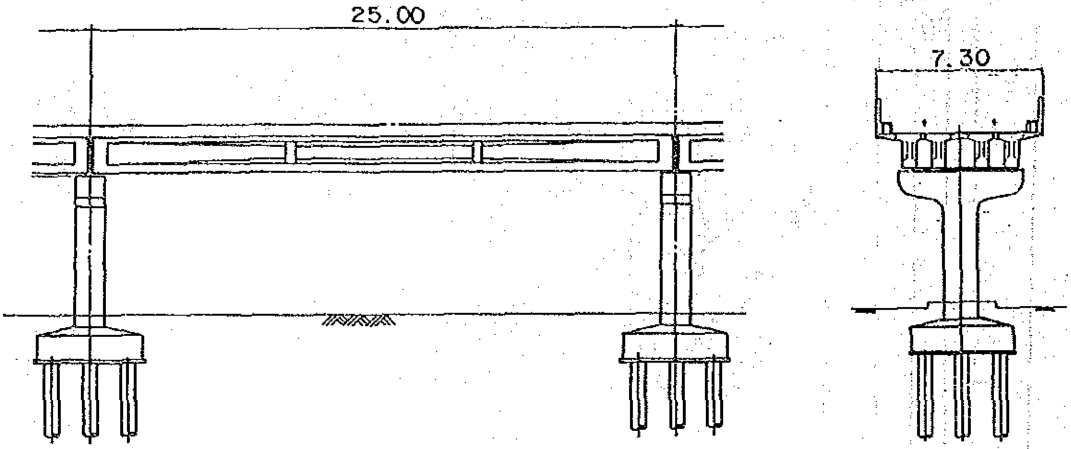


Figure 6-3.1 PROFILE (incl. alignment of the line)

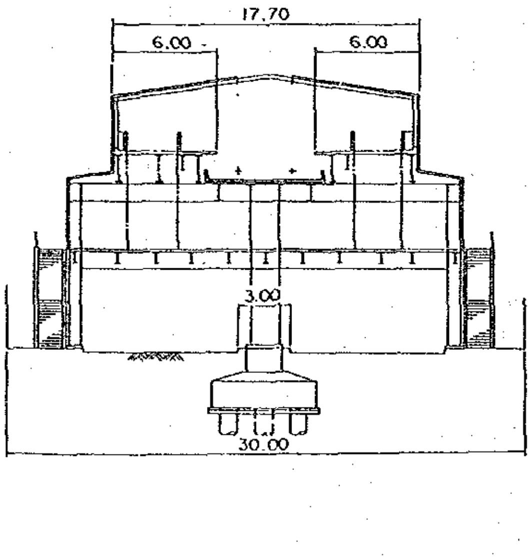
Track



Trackway structure



Main Station



Standard Station

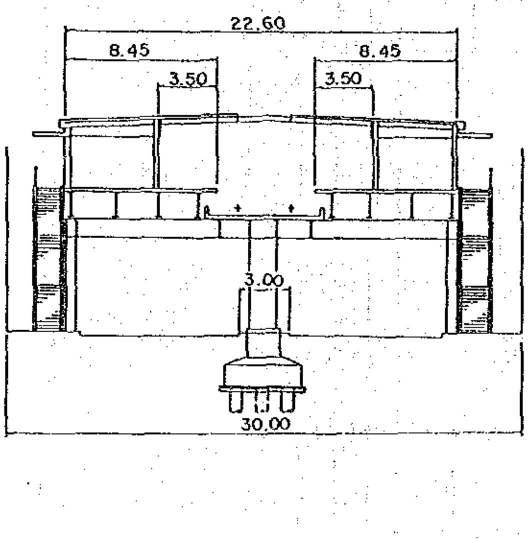


Figure 6-3.2 TYPICAL STRUCTURES OF TRACKWAY AND STATIONS

Table 6-3.2 PRINCIPAL FEATURES OF ROLLING STOCK

Item		Description
1. Train Formation		MC·M·T·M·MC (4M1T)
2. Transport capacity	Nominal capacity	474 person/train
	Projected maximum capacity	1,008 person/train
3. Basic Performance	• Maximum running speed	80 km/hr
	• Acceleration	3.5 km/hr/sec
	• Deceleration (in case of emergency)	4.0 (4.5) km/hr/sec
	• Schedule speed	30km/hr
4. Tare weight (Approximately)		Mc: 32t, M: 32t, T: 25t
5. Passenger load (when filled to its maximum)		Mc: 14.8t, M: 15.8t, T: 15.8t
6. Car body (see Figure 6-3.3)		All-aluminum light alloy and welded structure
7. Truck and power transmission device (System)		Steel plate welded structure, air spring truck
Rigid wheel base & Wheel diameter		2,000 mm, 860 mm
8. Current collector system		Pantograph
9. Main motor system		D.C. series motor with self draft, mounted on frame
One hour rated output, Voltage & Electric current		120 kW, 375V, 350A
10. Controlling system and device		Series parallel, field weakening dynamic brake, multiple unit control
11. Motor generator		Approx. 180 kVA
12. Motor driven air compressor		12 KW (30 min. rated)
13. Braking system		Electro magnetic straight air brake with dynamic brake and hand brake
14. Coupling device		Tight lock coupler with straight air pipe. Semi-permanent bar type coupler
15. Air-conditioning		Unit cooler individually mounted on roof

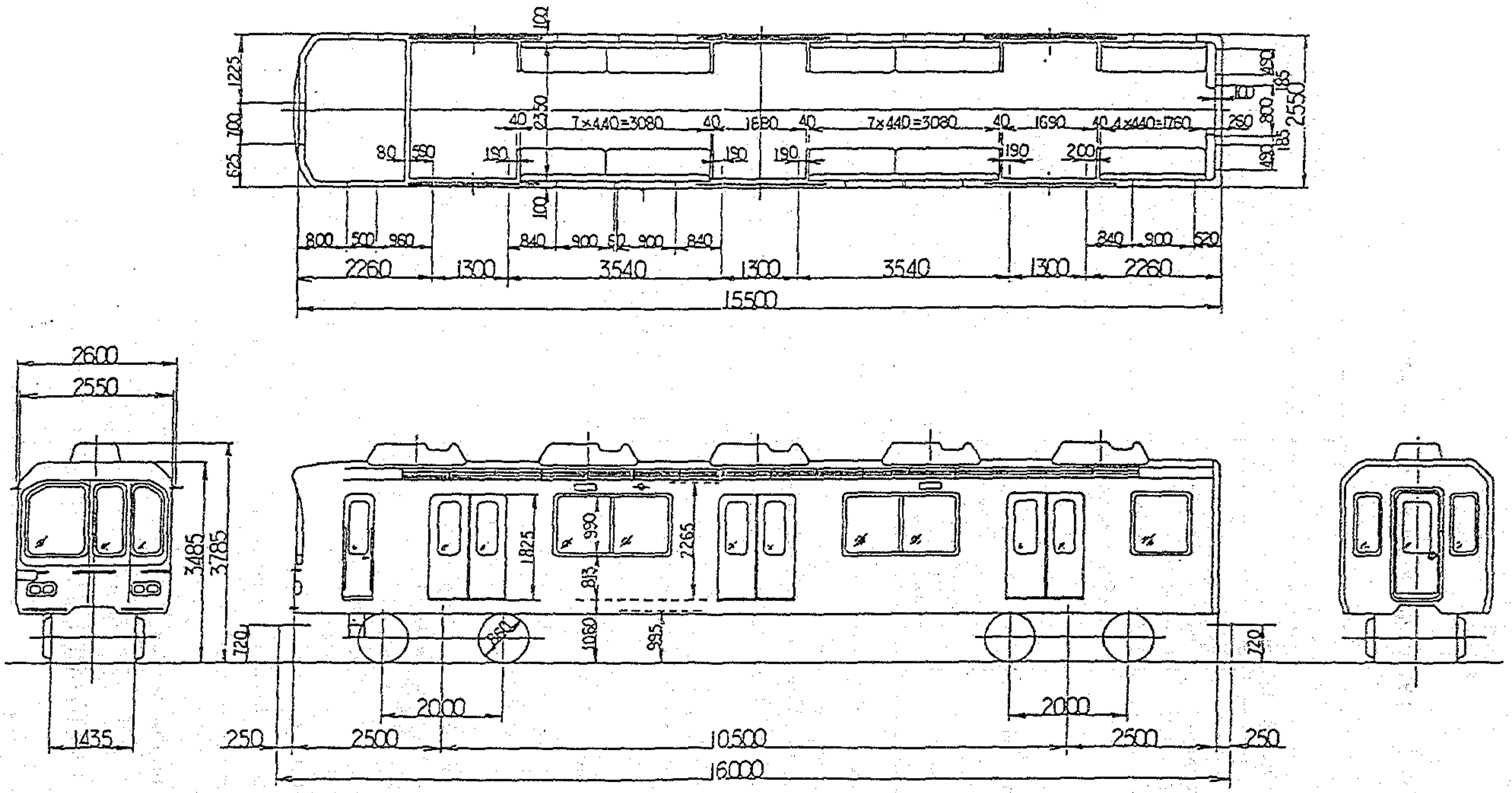
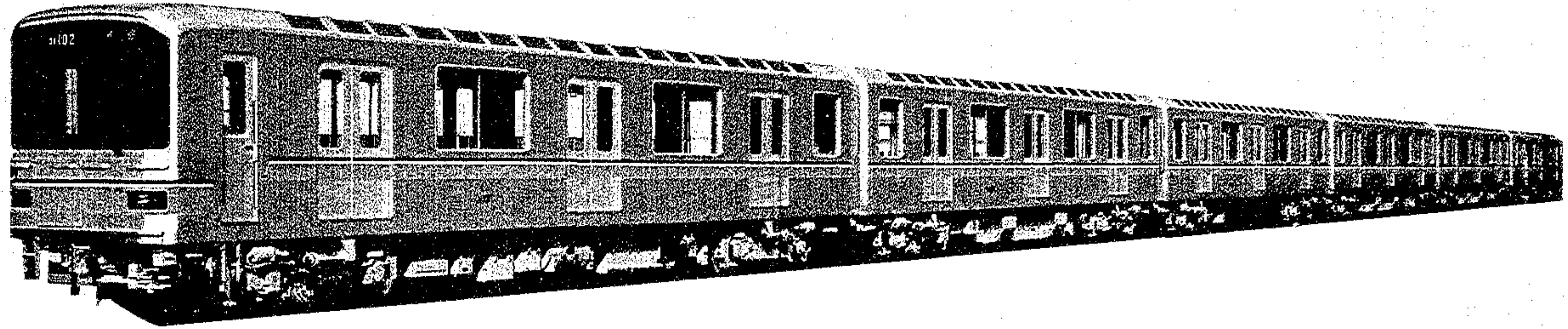
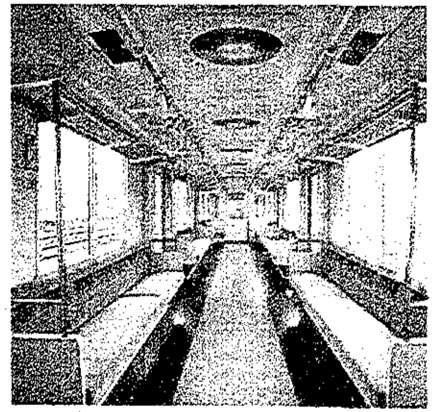


Figure 6-3.3 EXTERNAL APPEARANCE OF CAR
(Head Motored Car (Mc))

Example of Rolling Stock

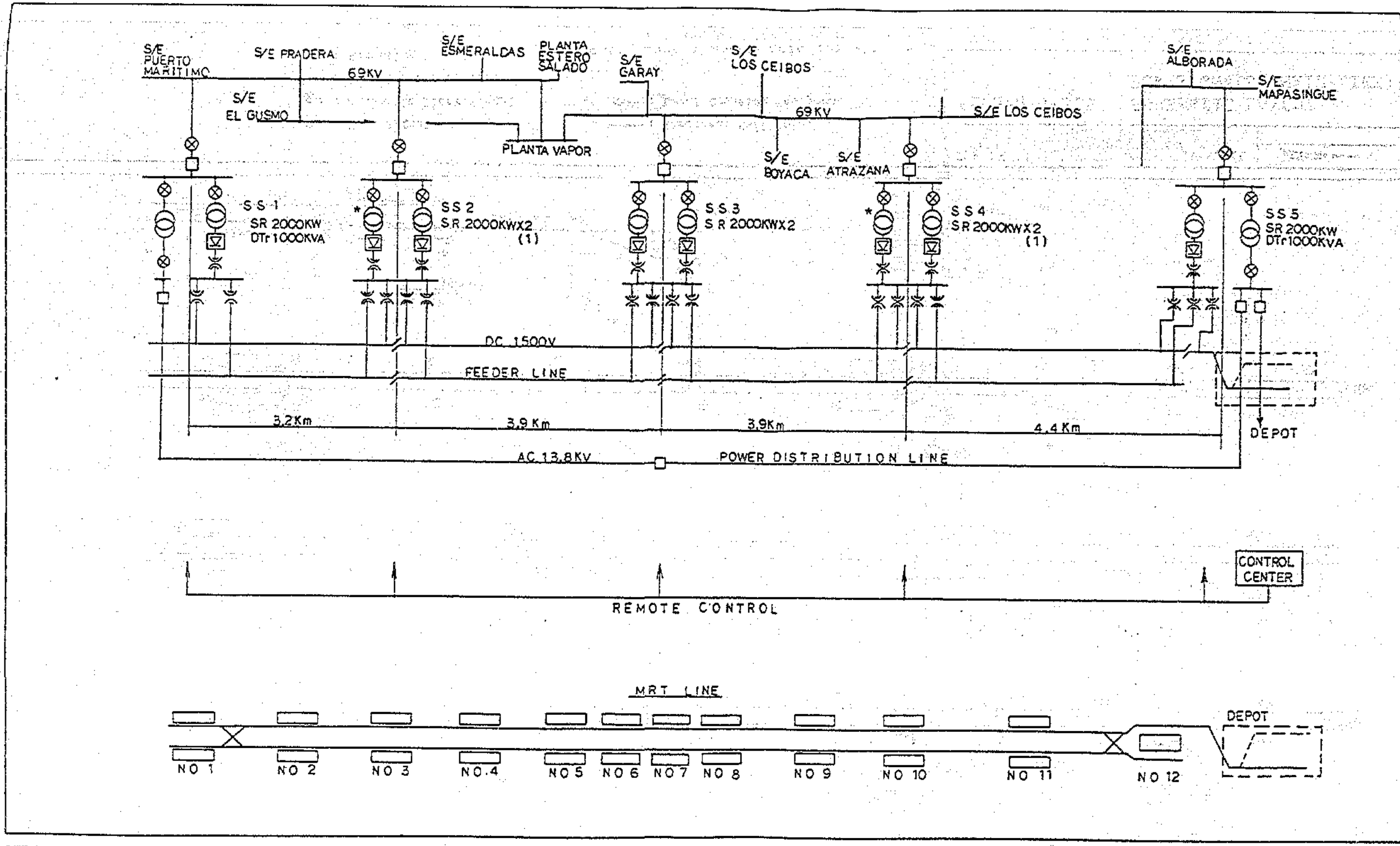


Motorman's cab



Passenger room

Note : This example is used for Ginza Line in Tokyo.



S/E : SUBSTATION OF EMELEC
SS : MRT SUBSTATION & NUMBER
SR : SILICON RECTIFIRE & TRANSFORMER
DTr : POWER TRANSFORMER FOR DISTRIBUTION
Note: Rectifire banks indicated with '*' will not be installed in 1990

: TRANSFORMER
: SILICON RECTIFIRE
: DISCONNECTING SWITCH
: CIRCUIT BREAKER
: HIGH SPEED CIRCUIT BREAKER
: SECTION INSULATOR

THE FEASIBILITY STUDY ON GUAYAQUIL CITY URBAN TRANSPORTATION PLAN IN THE REPUBLIC OF ECUADOR

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Figure 6-3.4 SCHEMATIC FEEDING DIAGRAM

JAPAN INTERNATIONAL COOPERATION AGENCY

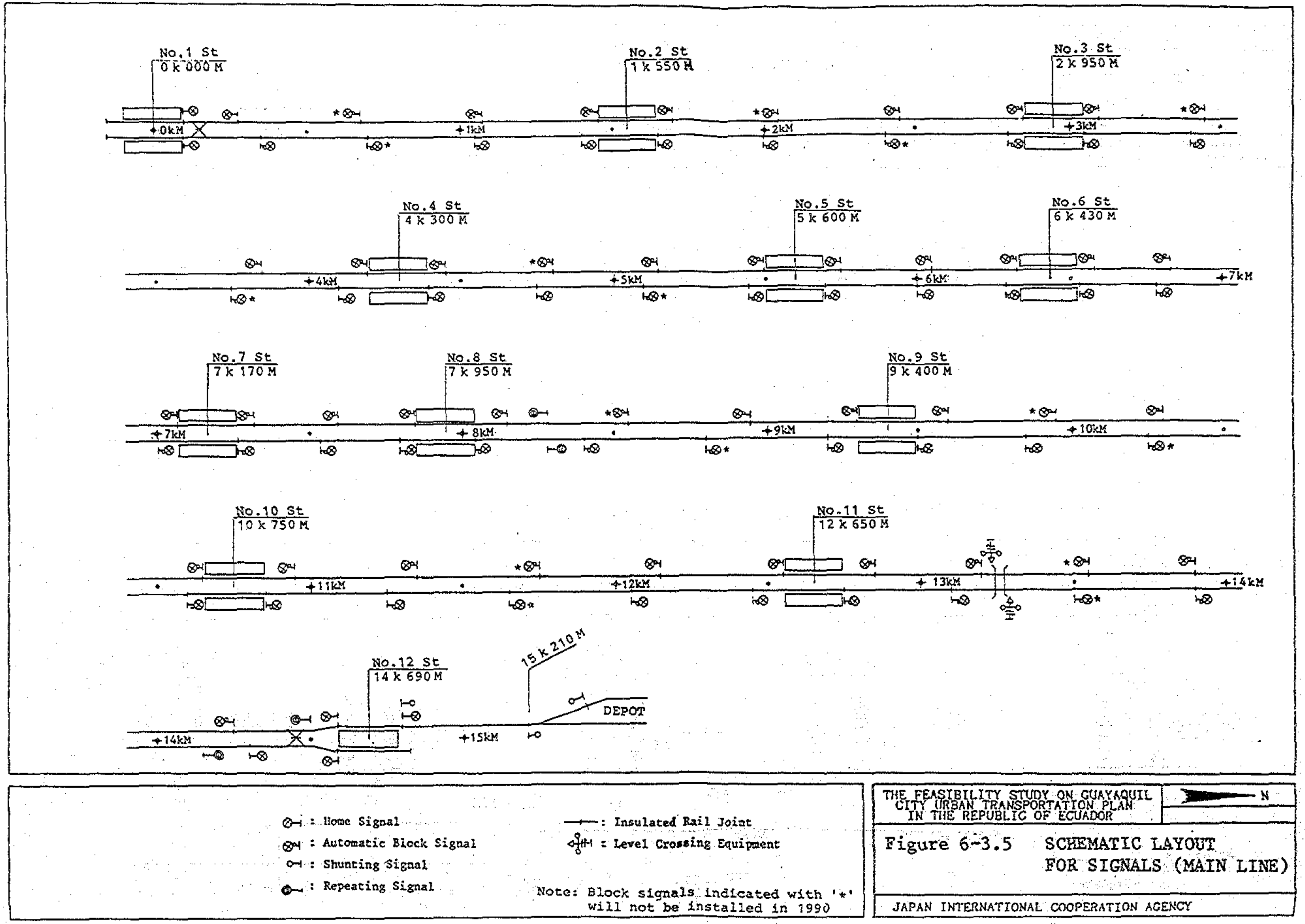

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Figure 6-3.5 SCHEMATIC LAYOUT FOR SIGNALS (MAIN LINE)

JAPAN INTERNATIONAL COOPERATION AGENCY

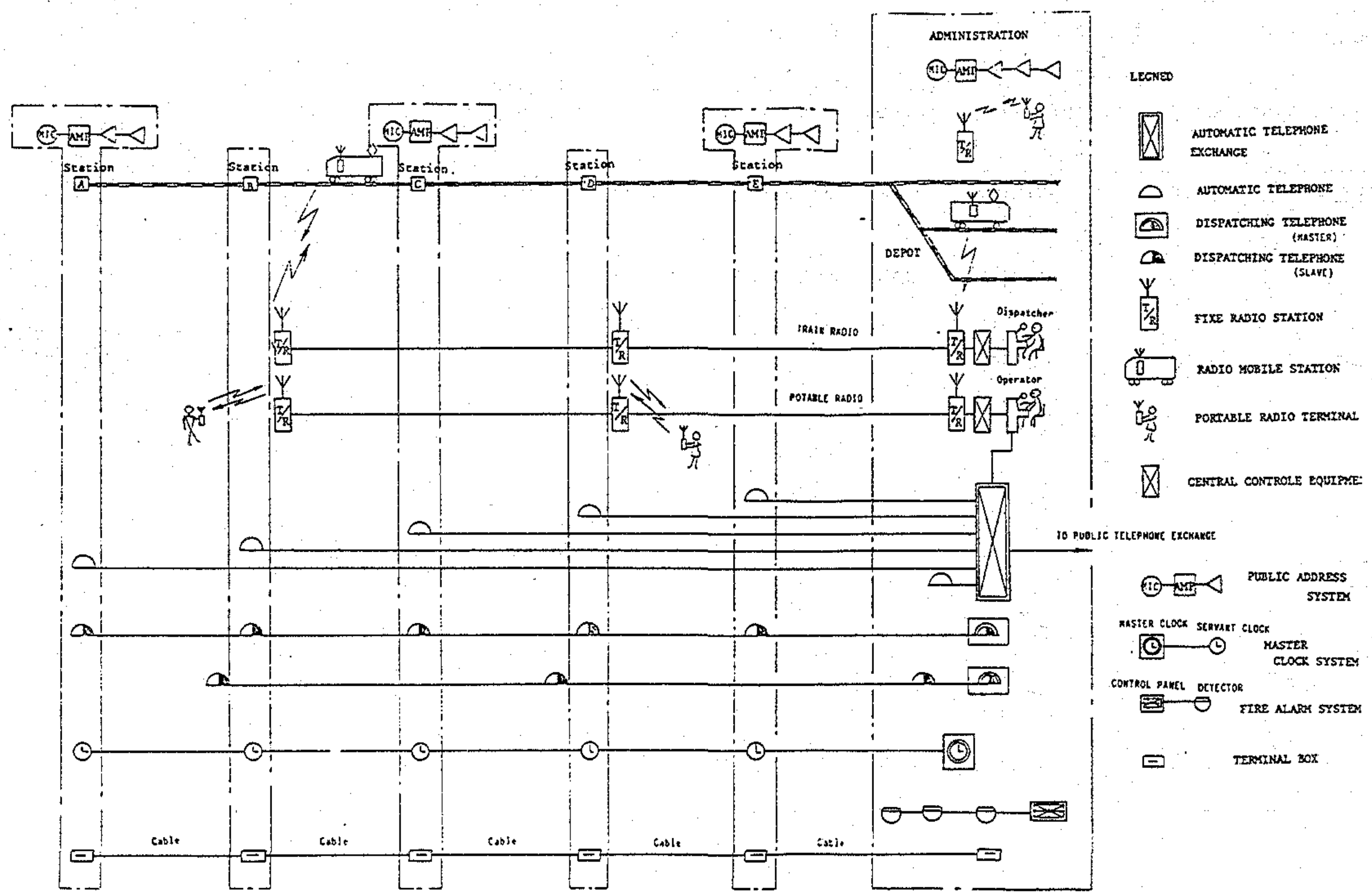

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Figure 6-3.6 SCHEMATIC DIAGRAM FOR TELECOMMUNICATION SYSTEM

JAPAN INTERNATIONAL COOPERATION AGENCY

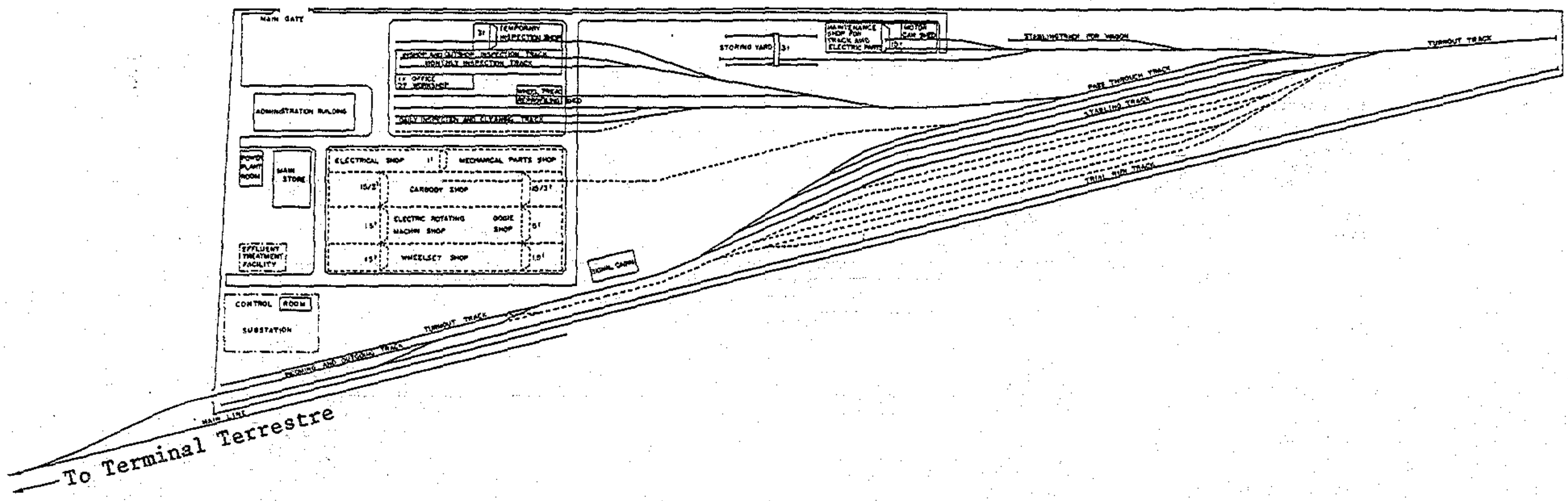


Figure 6-3.7 LAYOUT OF CAR DEPOT

Note: 1. Workshop is constructed in the second stage and opens its operation in 1993.

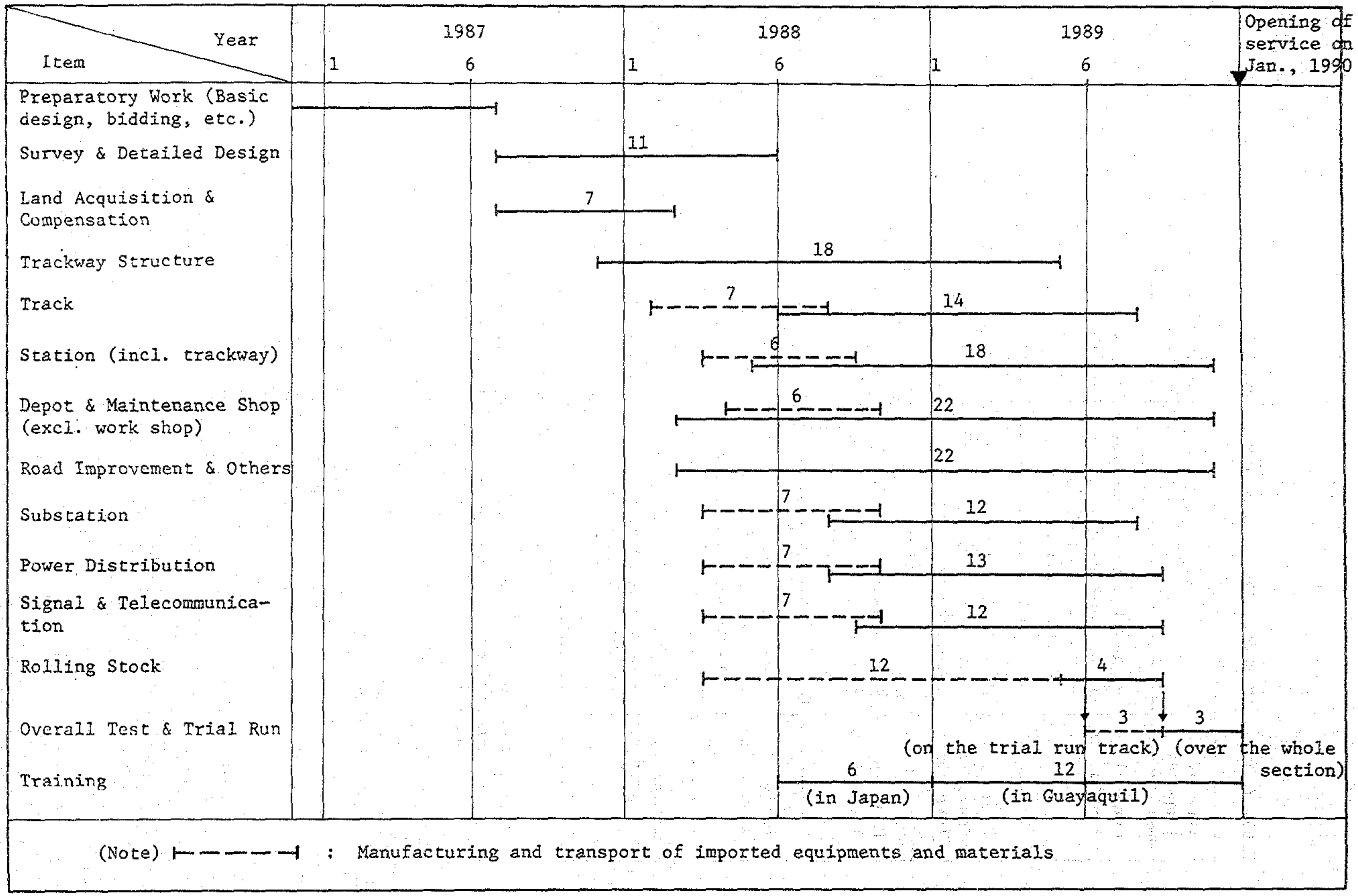
2. Stabling tracks shown in dotted line are constructed in conformity with the increase of rolling stock.

Table 6-3.3 INTERVALS AND PLACES FOR INSPECTIONS

Type of Inspection	Procedure	Inspection Interval	Running Kilometerage	Inspection Place
General Inspection	Parts of car are completely dismantled and all parts are completely inspected and repaired.	4 years or less	600,000km or less	Workshop
Principal Equipment Inspection	Principal equipment are dismantled, disassembled, inspected and repaired.	2 years or less	300,000km	Workshop
Monthly Inspection	Car equipment are inspected in the working order on its functions.	60 days or less	-	Inspection Shed
Daily Inspection	Cars are inspected in the working order in the intervals of train operation.	48 hours or less	-	Inspection Shed
Temporary Inspection	Inspection is conducted whenever need arises from trouble of cars.	Inshop rate 0.1/year	-	Workshop or Inspection Shed

Note: When an inspection of upper grade on the table is executed, the inspections of lower grade are deemed to have been executed at the same time.

Figure 6-3.8 CONSTRUCTION SCHEDULE



6-4 Management Plan

1) Aim of Management Plan

Aim of management plan is to establish the most efficient body of controlling and maintaining the Guayaquil MRT system proposed in this Report. Items considered for the purpose is;

a) What type of the management body will be thought good?

b) What kind of measures will be required for reducing the number of total staff of the MRT system?

c) What kind of education and training will be required for raising necessary staff?

2) Management Body

Four cases of management body are compared with their advantages as shown in Table 6-4.1. Among them, the Study Team proposes to establish a new body because it is thought best to implement independent management to some extent.

3) Office Organization

Office building is built in the premises of the Railcar Depot and commonly used by some field workers for reducing the area of land acquisition and for better communication among MRT staff working in the same building.

Four departments are planned in the office organization as follows:

Organ	Number of Staff
General Manager and his Directly-attached Members	7
Administration Dept.	24
Transportation Dept.	20
Rolling Stock Dept.	12
Civil & Electrical Dept.	15
Total	78

Table 6-4.1 COMPARISON OF MANAGEMENT BODY

Item	Management Body of MRT System			
	Guayaquil Municipal Authority	ENFE	CTG	New Body
1) Necessity of establishing a joint committee to promote MRT project	Necessary	Depending on needs	Necessary	Necessary
2) Employment of staff/their education and training	Newly required	Partly required	Newly required	Newly required
3) Convenience in receiving governmental subsidy	Good	Good	Good	New law required
4) Restraint by total budget	Probably	Probably	Probably	None
5) Efficient management	——	——	——	Good
6) Fare control	——	——	Good	——
7) Coordination with city development plan	Good	——	——	——
8) Coordination with bus service	——	——	Good	——

4) Field Organization

Location of all field organs other than stations is assumed to be concentrated in the Railcar Depot.

Among twelve stations, four are main ones and remaining eight are small ones. Stationmasters are assigned to main statios only and they control small stations in the designated area.

Train movements are controlled centrally under CTC system but their operating time is checked by stationmasters. Small stations don't check train operation but work for passenger services only.

The Railcar Depot has functions of a workshop and a running depot. Car cleaning is entrusted to contractors.

Routine maintenance work of tracks, civil structures and electrical facilities is planned during night hours after the last train. A diesel-powered motorcar is assigned to the Railcar Depot and its drivers to the Civil Maintenance Depot. However, this motorcar is used commonly for all needs of MRT system.

Manager of Rolling Stock Dept. takes the post of the Master of Railcar Depot concurrently and Manager of Civil & Electrical Dept. takes the post of the Master of Civil Maintenance Depot and Electrical Maintenance Depot as well.

Field organization is summarized as follows:

Organ	Number of Staff
Station	292
Railcar Depot	179
Civil Maintenance Depot	22
Electrical Maintenance Depot	22
Total	515

5) Education and Training of Staff

MRT system proposed by the Study Team is an electric railroad and this requires for newly-employed staff of the Guayaquil MRT to receive education and training of railroad technologies.

Some designated staff have to go abroad to receive this education and have to work later as the instructors to give their knowledge and experience to other MRT staff. This preparatory education is thought very important to lead this project in final success.

After commencement of MRT service in Guayaquil, occasional on-the-job training is also required for the staff to become more accustomed to the system for offering better service of mass transportation for the development of the area.

6) Establishment of Maintenance System

As railroad is completely different from road, the management body has a responsibility of maintaining train operation. If some failure arises and causes delay or suspension of train operation, instant response is required for recovery. For this requirement, maintenance system have to be carefully established with preparation of necessary rules and regulations.

6-5 Project Cost

Project cost is estimated as shown in Table 6-5.1. This estimation is carried out based on the prices on commercial base as of October, 1985 giving no consideration to inflation. The cost does not include the import tax but includes the commodity tax for the local materials. The exchange rate applied to the estimation is "1 US dollar = 120 Sucres = 210 Japanese Yens, as of October, 1985 by free market rate".

In Table 6-5.1, the cost in 1990 is the initial cost for opening of service and the costs in other 4 staged years are the additional costs to increase transport capacity (mainly cost for purchasing rolling stock). The cost of the workshop in the depot is added in 1993.

Table 6-5.1 PROJECT COST (SUMMARY)

CASE: Basic Case

(Unit: Million Sucres in 1985 Prices)

	Item / Year / Currency		1990			1993			1996			2000			2010			TOTAL		
			L.C	F.C	Total	L.C	F.C	Total	L.C	F.C	Total	L.C	F.C	Total	L.C	F.C	Total	L.C	F.C	Total
Civil Work	Track	(A.1)	687	484	1,181	-	-	-	-	-	-	-	-	-	-	-	-	687	494	1,181
	Structure of Way	(A.2)	4,502	5,167	9,669	-	-	-	-	-	-	-	-	-	-	-	-	4,502	5,167	9,669
	Station	(A.3)	792	1,435	2,227	-	-	-	-	-	-	-	-	-	-	-	-	792	1,435	2,227
	Depot & Maintenance Shop	(A.4)	588	838	1,436	324	678	1,002	36	46	82	-	-	-	23	42	65	971	1,604	2,575
	Miscellaneous	(A.5)	455	201	656	-	-	-	-	-	-	-	-	-	-	-	-	455	201	656
	Sub-total	(A)	7,024	8,135	15,159	324	678	1,002	36	46	82	-	-	-	23	42	65	7,407	8,901	16,308
Electrical Facilities	Substation	(B.1)	175	963	1,138	4	55	59	-	-	-	8	110	118	-	-	-	187	1,128	1,315
	Power Distribution	(B.2)	180	385	565	-	-	-	-	-	-	1	0	1	-	-	-	181	385	566
	Signal & Telecommunication	(B.3)	60	338	398	-	-	-	-	-	-	2	15	17	-	-	-	62	353	415
	Others	(B.4)	31	0	31	-	-	-	-	-	-	-	-	-	-	-	-	31	0	31
	Sub-total	(B)	446	1,686	2,132	4	55	59	-	-	-	11	125	136	-	-	-	461	1,866	2,327
Rolling Stock (Number of rolling stocks)		(C)	28	5,327	5,355 (70)	4	761	765 (10)	8	1,522	1,530 (20)	2	381	383 (5)	12	2,283	2,295 (30)	54	10,274	10,328 (135)
Land	Land Acquisition	(D.1)	145	0	145	-	-	-	-	-	-	-	-	-	-	-	-	145	0	145
	Compensation	(D.2)	117	0	117	-	-	-	-	-	-	-	-	-	-	-	-	117	0	117
	Sub-total	(D)	262	0	262	-	-	-	-	-	-	-	-	-	-	-	-	262	0	262
Engineering Services (Survey, Design, Supervision)		(E)	367	718	1,085	-	-	-	-	-	-	-	-	-	-	-	-	367	718	1,085
Contingency		(F)	452	456	908	16	34	50	2	2	4	0	0	0	1	2	3	471	494	965
Project Cost		(G)	8,579	16,322	24,901	348	1,528	1,876	46	1,570	1,616	13	506	519	36	2,327	2,363	9,022	22,253	31,275

(Note) 1. L.C = Local Currency Portion
F.C = Foreign Currency Portion

2. Exchange Rate
1 US$ = 120 Sucres = 210 Yens
(as of October, 1985 by free market rate)

3. A.3 incl. structure of way
A.4 incl. track, mechanical and electrical facilities
A.5 incl. road improvement, obstacles elimination, etc.
B.4 = costs for EMELEC and IETEL

4. F = 5% of (Σ(A.1 ~ A.4) + B.2) + 20% of (A.5 + D.2)

5. G = Σ (A ~ F)

6. Opening year and operating kilometerage: in 1990, 14.7 km

6-6 Operation and Maintenance Cost

For the 'Basic Case' of this project, the operation and maintenance cost (Running cost) is estimated as shown in Table 6-6.1. This running cost does not include the tax and other obligation levied by Ecuadorian Government, the repayment of foreign loans and the depreciation cost. Power cost is for train operations and for air conditioning of railcars. Other electrical charge is counted in the management overhead.

Table 6-6.1 RUNNING COST OF MRT SYSTEM

Basic case (1000 Sucre)

Item \ Year	1990	1993	1996	2000	2010-
Personnel expense	188,280	191,160	194,040	196,920	206,136
Management overhead	43,304	43,967	44,629	45,292	47,411
Maintenance cost	187,984	211,410	243,384	261,081	328,869
Power expense	112,788	126,984	134,400	153,072	180,456
Total	532,356	573,521	616,453	656,365	762,872

6-7 Figures for Staged Construction Cases

Staged construction cases are outlined as shown in Figure 1-3.1 in the chapter 1, and their figures of their principal planning items are summarized in Table 6-7.1. Project cost by case and investment year, and running cost by case more in detail are shown in Tables 6-7.2 to 6-7.4.

Table 6-7.1(1) FIGURES FOR STAGED CONSTRUCTION CASES (1)

Item	Tested Case / Year	Basic Case 1990	Basic Case 1993	Basic Case 1996	Basic Case 2000	Basic Case 2010-	Case A-1 1990	Case A-1 1993
Operating Kilometerage (km)		14.7					6.7	14.7
Number of Stations		12					5	12
Transport Demand	Number of passengers per day	401,000	447,000	482,000	530,000	646,000	170,000	447,000
	Maximum passengers per day in one direction	105,000	121,000	131,000	145,000	177,000	80,000	121,000
	Maximum passengers per hour in one direction	12,600	14,500	15,700	17,400	21,200	9,600	14,500
Transport Plan	Schedule time for one direction (minutes)	29	29	29	29	29	13	29
	Headway in a peak hour (minutes)	4.6	4.0	3.8	3.3	2.7	6.0	4.0
	Number of trains required	13	15	18	19	24	5	15
	Number of cars required (incl. reserved cars)	70	80	100	105	135	30	80
Project Cost by Staged Year (million Sucres)		24,901	1,876	1,616	519	2,363	11,881	15,207
Total Project Cost (up to 2010) (million Sucres)		31,300					31,600	
Number of Staff		593	603	613	623	655	367	603
Running Cost (million Sucres/year)		532	574	616	656	763	272	574

(Note)
1. Figures after 1996 expect project cost in 1996 are same as Basic Case.
   Project cost in 1996 is as bellow:
   Case A-1: 1,616 million Sucres
2. Transport capacity: 1,008 person/train
3. Schedule Speed: 30 Km/hr
4. Prices in 1985 and exchange rate: 1US$ = 120 Sucres = 210 Japanese Yens

Table 6-7.1(2) FIGURES FOR STAGED CONSTRUCTION CASES (2)

Item / Tested Case / Year		Case A-2		Case B-1		Case C-1		Case C-2		Case D-1	
		1990	1993	1990	1993	1990	1993	1990	1993	1990	1993
Operating Kilometerage (km)		6.7	9.1	9.1	14.7	5.6	14.7	5.6	8.0	8.0	14.7
Number of Stations		5	8	8	12	5	12	5	8	8	12
Transport Demand	Number of passengers per day	170,000	304,000	275,000	447,000	92,000	447,000	92,000	239,000	223,000	447,000
	Maximum passengers per day in one direction	80,000	94,000	83,000	121,000	45,000	121,000	45,000	93,000	88,000	121,000
	Maximum passengers per hour in one direction	9,600	11,300	9,900	14,500	5,400	14,500	5,400	11,100	10,600	14,500
Transport Plan	Schedule time for one direction (minutes)	13	18	18	29	11	29	11	16	16	29
	Headway in a peak hour (minutes)	6.0	5.0	6.0	4.0	10.0	4.0	10.0	5.0	5.5	4.0
	Number of trains required	5	8	7	15	3	15	3	7	7	15
	Number of cars required (incl. reserved cars)	30	45	40	80	20	80	20	40	40	80
Project Cost by Staged Year (million Sucres)		11,881	5,550	15,874	11,201	11,902	16,533	11,902	6,109	16,875	11,573
Total Project Cost (up to 2010) (million Sucres)		31,700		31,600		32,900		33,000		32,900	
Number of Staff		367	460	450	603	341	603	341	452	450	603
Running Cost (million Sucres/year)		272	339	341	574	218	574	218	345	338	574

(Note)
1. Figures after 1996 expect project cost in 1996 are same as Basic Case . Project cost in 1996 is as bellow: Case A-2: 11,367 million Sucres; Case C-2: 12,143 million Sucres; Other cases: same as Basic Case
2. Transport capacity: 1,008 person/train
3. Schedule Speed: 30 Km/hr
4. Prices in 1985 and exchange rate: 1US$ = 120 Sucres = 210 Japanese Yens

Table 6-7.1(3) FIGURES FOR STAGED CONSTRUCTION CASES (3)

Item \ Tested Case / Year		Case E					Case F					Case G				
		1990	1993	1996	2000	2010-	1990	1993	1996	2000	2010-	1990	1993	1996	2000	2010-
Operating Kilometerage (km)		6.7					9.1					8.0				
Number of Stations		5					8					8				
Transport Demand	Number of passengers per day	170,000	191,000	206,000	228,000	278,000	275,000	304,000	327,000	358,000	436,000	223,000	239,000	251,000	268,000	327,000
	Maximum passengers per day in one direction	80,000	87,500	93,000	100,000	122,000	83,000	94,000	103,000	113,000	138,000	88,000	93,000	96,000	99,000	107,000
	Maximum passengers per hour in one direction	9,600	10,500	11,200	12,000	14,600	9,900	11,300	12,300	13,500	16,500	10,600	11,100	11,500	11,900	12,800
Transport Plan	Schedule time for one direction (minutes)	13	13	13	13	13	18	18	18	18	18	16	16	16	16	16
	Headway in a peak hour (minutes)	6.0	5.5	5.0	5.0	4.0	6.0	5.0	4.6	4.3	3.5	5.5	5.0	5.0	5.0	4.6
	Number of trains required	5	6	6	6	7	7	8	9	9	13	7	7	7	7	8
	Number of cars required (incl. reserved cars)	30	35	35	35	40	40	45	50	50	75	40	40	40	40	45
Project Cost by Staged Year (million Sucres)		11,896	1,443	0	0	442	15,886	1,440	383	0	1,995	16,885	1,030	0	0	469
Total Project Cost (up to 2010) (million Sucres)		13,800					19,700					18,400				
Number of Staff		367	373	377	377	383	450	460	462	466	482	450	452	452	452	462
Running Cost (million Sucres/year)		272	287	294	294	314	341	367	377	385	448	338	345	345	345	379

(Note) 1. Transport capacity: 1,008 person/train

2. Schedule Speed: 30 Km/hr

3. Prices in 1985 and exchange rate: 1US$ = 120 Sucres = 210 Japanese Yens

Table 6-7.2 PROJECT COST BY CASE

(Unit: Million Sucres in 1985 prices)

Tested Case \ Staged Year / Currency	1990 LC	1990 FC	1993 LC	1993 FC	1996 LC	1996 FC	2000 LC	2000 FC	2010 LC	2010 FC	Total LC	Total FC	Opening year and operating kilometerage
	Total		Total		Total		Total		Total		Total		
Basic Case	8,579	16,322	348	1,528	46	1,570	13	506	36	2,327	9,022	22,253	1990: 14.7 km
	24,901		1,876		1,616		519		2,363		31,275		
Case A-1	4,247	7,634	4,794	10,413	46	1,570	ditto		ditto		9,136	22,450	1990: 6.7 km
	11,881		15,207		1,616						31,586		1993: 14.7 km
Case A-2	4,247	7,634	1,824	3,726	3,052	8,315	"		"		9,172	22,508	1990: 6.7 km 1993: 9.1 km
	11,881		5,550		11,367						31,680		1996: 14.7 km
Case B-1	5,681	10,193	3,357	7,844	46	1,570	"		"		9,133	22,440	1990: 9.1 km
	15,874		11,201		1,616						31,573		1993: 14.7 km
Case C-1	5,143	6,759	5,260	11,273	46	1,570	"		"		10,498	22,435	1990: 5.6 km
	11,902		16,533		1,616						32,933		1993: 14.7 km
Case C-2	5,143	6,759	1,849	4,260	3,496	8,647	"		"		10,537	22,499	1990: 5.6 km 1993: 8.0 km
	11,902		6,109		12,143						33,036		1996: 14.7 km
Case D-1	6,616	10,259	3,791	7,782	46	1,570	"		"		10,502	22,444	1990: 8.0 km
	16,875		11,573		1,616						32,946		1993: 14.7 km
Case E	4,246	7,650	345	1,098	-	-	-	-	6	436	4,597	9,184	1990: 6.7 km
	11,896		1,443		-		-		442		13,781		
Case F	5,680	10,206	344	1,096	2	381	-	-	21	1,974	6,047	13,657	1990: 9.1 km
	15,886		1,440		383		-		1,995		19,704		
Case G	6,615	10,270	333	697	-	-	-	-	15	454	6,963	11,421	1990: 8.0 km
	16,885		1,030		-		-		469		18,384		

(Note) 1. Cases E, F and G are for partial opening and no further construction of the system.

2. Project cost in 1985 prices on commercial base (not economic price)

1 US Dollar = 120 Sucres = 210 Japanese Yens as of October, 1985 by free market rate.

Table 6-7.3 PROJECT COST BY INVESTMENT YEAR

(Unit: Million Sucres in 1985 prices)

Case \ Year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996 -1998	1999	2000 -2008	2009	2010 -2015	Total
Basic Case	217	12,342	12,342	0	563	1,313	0	0	1,616	0	519	0	2,363	0	31,275
Case A-1	133	5,874	5,874	213	7,497	7,497	0	0	1,616	0	ditto	0	ditto	0	31,586
Case A-2	133	5,874	5,874	72	2,739	2,739	167	5,600	5,600	0	"	0	"	0	31,680
Case B-1	162	7,856	7,856	167	5,517	5,517	0	0	1,616	0	"	0	"	0	31,573
Case C-1	112	5,895	5,895	241	8,146	8,146	0	0	1,616	0	"	0	"	0	32,933
Case C-2	112	5,895	5,895	71	3,019	3,019	199	5,972	5,972	0	"	0	"	0	33,036
Case D-1	141	8,367	8,367	199	5,687	5,687	0	0	1,616	0	"	0	"	0	32,946
Case E	134	5,881	5,881	0	433	1,010	0	0	0	0	0	0	442	0	13,781
Case F	162	7,862	7,862	0	432	1,008	0	0	383	0	0	0	1,995	0	19,704
Case G	141	8,372	8,372	0	309	721	0	0	0	0	0	0	469	0	18,384

(Note) Project cost by investment year is calculated by (Distribution ratio to each investment year) x (cost in each staged year shown in Table 8-2.2)

Distribution ratio to each staged year is as bellow:

1) For 1990

- All cases: 1987 (20% of engineering services); 1988, 1989 (50% of the remind)

2) For 1993

- Basic Case , Case E, F, G: 1991 (30%); 1992 (70%)
- Other cases : 1990 (30% of engineering services); 1991, 1992 (50% of the remind)

3) For 1996

- Case A-2, Case C-2: 1993 (30% of engineering services); 1994, 1995 (50% of the remind)
- Other cases : 1995 (100%)

4) For 2000 and 2010 -

- All cases : 1999 (100%); 2009 (100%)

Table 6-7.4 RUNNING COST OF MRT SYSTEM BY CASE
(1000 Sucre)

Case & year		Personnel expense	Management overhead	Maintenance cost	Power cost	TOTAL	
A-1	1990	120,540	27,724	75,333	48,492	272,089	1990
	1993	191,160	43,967	211,410	126,984	573,521	1993
	1996	194,040	44,629	243,384	134,400	616,453	1996
	2000	196,920	45,292	261,081	153,072	656,365	2000
	2010-	206,136	47,411	328,869	180,456	762,872	2010-
A-2	1990	120,540	27,724	75,333	48,492	272,089	1990
	1993	148,500	34,155	116,449	68,328	339,472	1993
	1996	194,040	44,629	243,384	134,400	616,453	1996
	2000	196,920	45,292	261,081	153,072	656,365	2000
	2010-	206,136	47,411	328,869	180,456	762,872	2010-
B-1	1990	145,620	33,493	101,107	60,696	340,916	1990
	1993	191,160	43,967	211,410	126,984	573,521	1993
	1996	194,040	44,629	243,384	134,400	616,453	1996
	2000	196,920	45,292	261,081	153,072	656,365	2000
	2010-	206,136	47,411	328,869	180,456	762,872	2010-
C-1	1990	113,052	26,002	43,482	35,496	218,032	1990
	1993	191,160	43,967	211,410	126,984	573,521	1993
	1996	194,040	44,629	243,384	134,400	616,453	1996
	2000	196,920	45,292	261,081	153,072	656,365	2000
	2010-	206,136	47,411	328,869	180,456	762,872	2010-
C-2	1990	113,052	26,002	43,482	35,496	218,032	1990
	1993	146,196	33,625	102,867	61,896	344,584	1993
	1996	194,040	44,629	243,384	134,400	616,453	1996
	2000	196,920	45,292	261,081	153,072	656,365	2000
	2010-	206,136	47,411	328,869	180,456	762,872	2010-
D-1	1990	145,620	33,493	99,630	59,244	337,987	1990
	1993	191,160	43,967	211,410	126,984	573,521	1993
	1996	194,040	44,629	243,384	134,400	616,453	1996
	2000	196,920	45,292	261,081	153,072	656,365	2000
	2010-	206,136	47,411	328,869	180,456	762,872	2010-
E	1990	120,540	27,724	75,333	48,600	272,197	1990
	1993	122,268	28,122	85,157	51,924	287,471	1993
	1996	123,420	28,387	87,879	54,276	293,962	1996
	2000	123,420	28,387	87,879	54,276	293,962	2000
	2010-	125,148	28,784	100,427	59,904	314,263	2010-
F	1990	145,620	33,493	101,461	60,696	341,270	1990
	1993	148,500	34,155	116,448	68,328	367,431	1993
	1996	149,076	34,287	124,044	69,876	377,283	1996
	2000	150,228	34,552	127,726	72,984	385,490	2000
	2010-	154,836	35,612	169,445	88,200	448,093	2010-
G	1990	145,620	33,493	99,630	59,244	337,987	1990
	1993	146,196	33,625	102,867	61,932	344,620	1993
	1996	146,196	33,625	102,867	61,932	344,620	1996
	2000	146,196	33,625	102,867	61,932	344,620	2000
	2010-	149,076	34,287	122,495	73,140	378,998	2010-