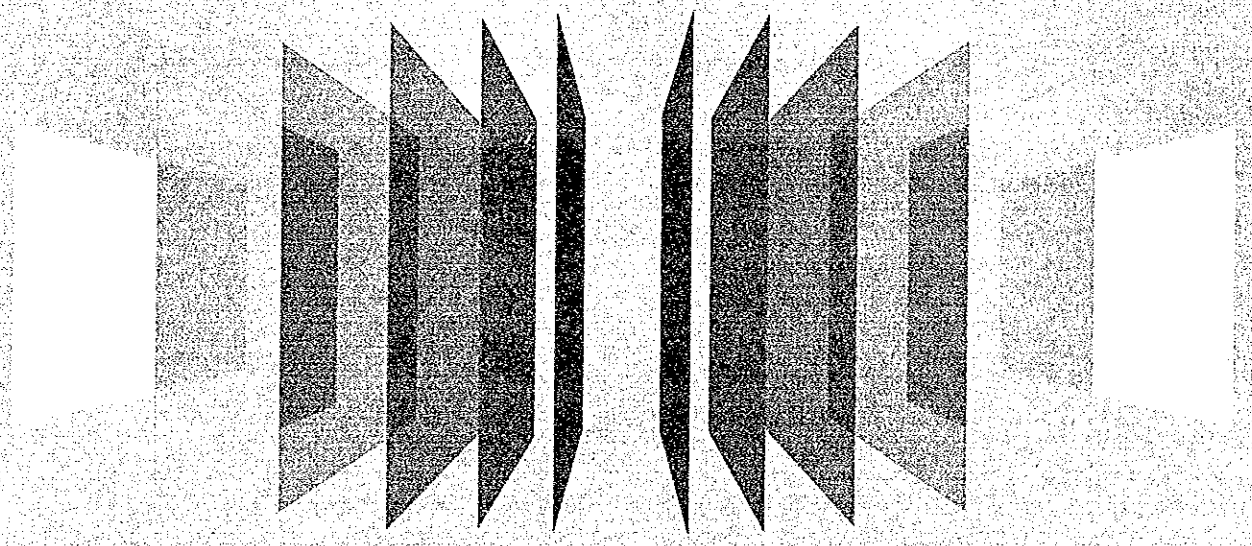
社会開発協力部報告書

No. 7

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



FINAL REPORT

MAJOR FINDINGS AND RECOMMENDATION

DECEMBER 1986

JAPAN INTERNATIONAL COOPERATION AGENCY

THE FEASIBILITY STUDY
ON
GUAYAQUIL CITY
URBAN TRANSPORTATION PLAN
IN
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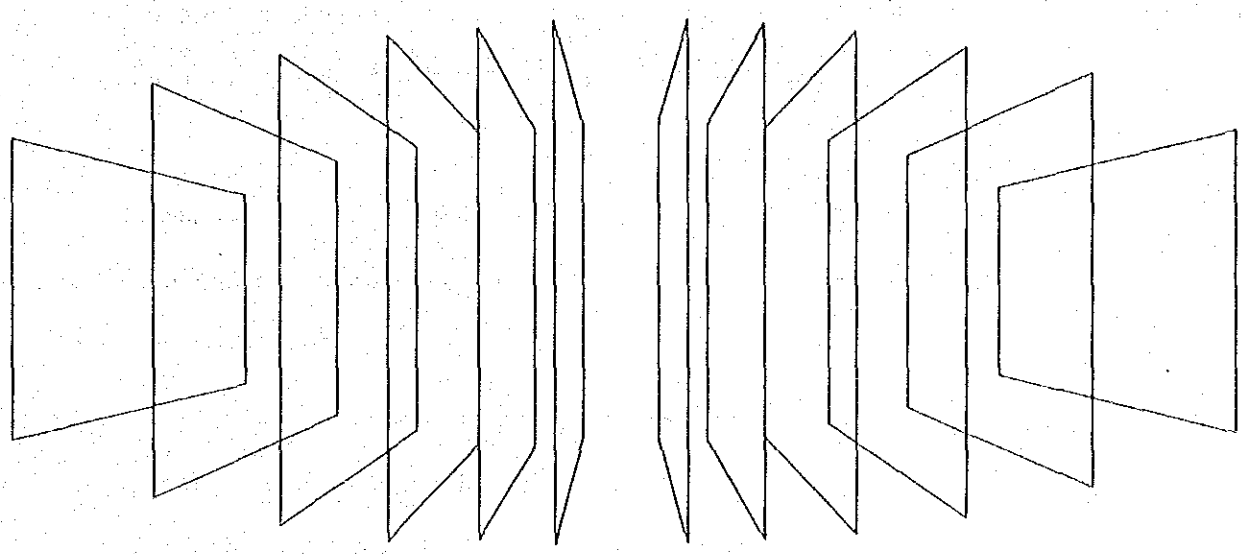

FINAL REPORT

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PREFACE

In response to the request of the Government of the Republic of Ecuador, the Japanese Government has decided to conduct a feasibility study on the Guayaquil City Urban Transportation Plan and entrusted the study to the Japan International Cooperation Agency. JICA sent to Ecuador a survey team headed by Mr. Etsutaro Iimuro, Tonichi Engineering Consultants Inc. from October to November, 1985.

The team had discussions with the officials concerned of the Government of Ecuador and conducted a field survey. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Ecuador for their close cooperation extended to the team.

December, 1986

Keisuke Arita
President
Japan International Cooperation Agency

December, 1986

Mr. Keisuke Arita
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir,

LETTER OF TRANSMITTAL

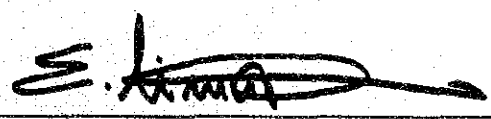
I have the honor of submitting to you herewith the Final Report of the Guayaquil City Urban Transportation Plan in the Republic of Ecuador.

The Study has been conducted by 15 Japanese experts on transportation, composed of Tonichi Engineering Consultants, Inc. and other consulting engineering companies, to examine the technical, economic and financial feasibility of the urban mass rapid transportation system (MRT) of 15 kilometers long in Guayaquil city. The Study has shown that this MRT project would be a drastic measure solving the serious traffic problems, producing considerable benefits well above the cost and promising the further development of Guayaquil, the biggest and very important city in Ecuador. I hope that the project will be carried out immediately and our study will serve as an aid to rid every citizen of the great inconvenience of commuting.

The study Team is greatly indebted to the Government of Ecuador, the Traffic Commission of Guayas, many other authorites, institutes, and persons concerned. On behalf of the Study Team, I would like to express my sincere gratitude for their cooperation and every convenience rendered to the Team.

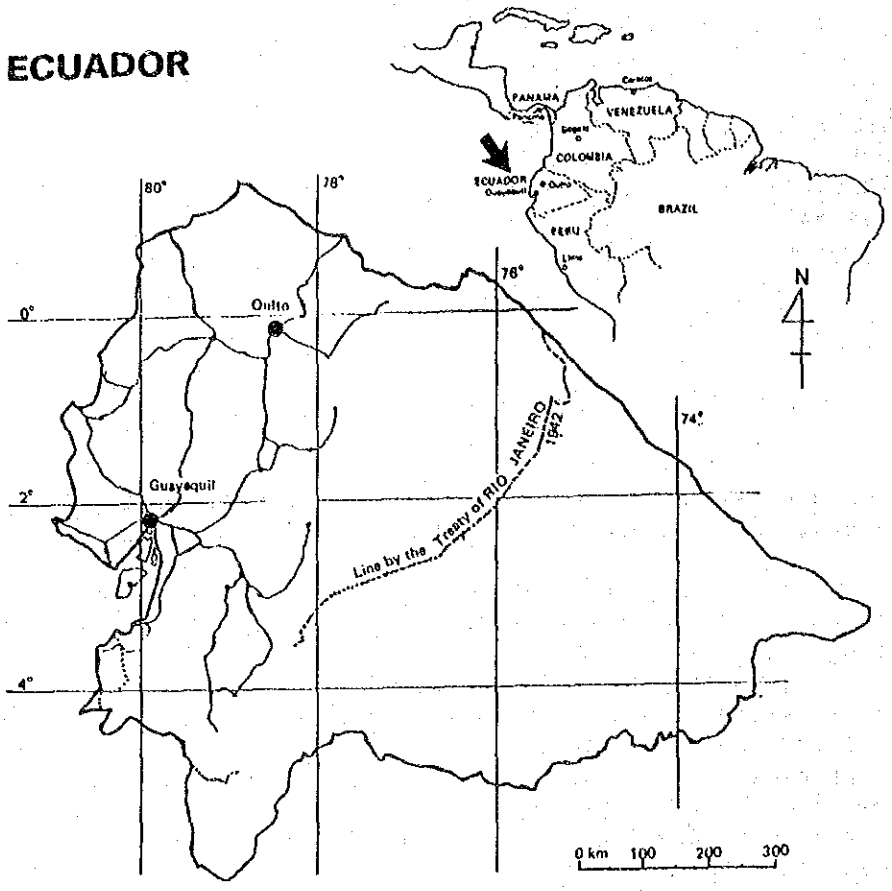
I also would like to express our deepest appreciation to the Japanese Advisory Committee, the Japan International Cooperation Agency, the Ministry of Transport, the Ministry of Construction, the Ministry of Foreign Affairs and the Japanese Embassy in Quito for giving us important suggestions and assistance throughout the Study.

Very truly yours,

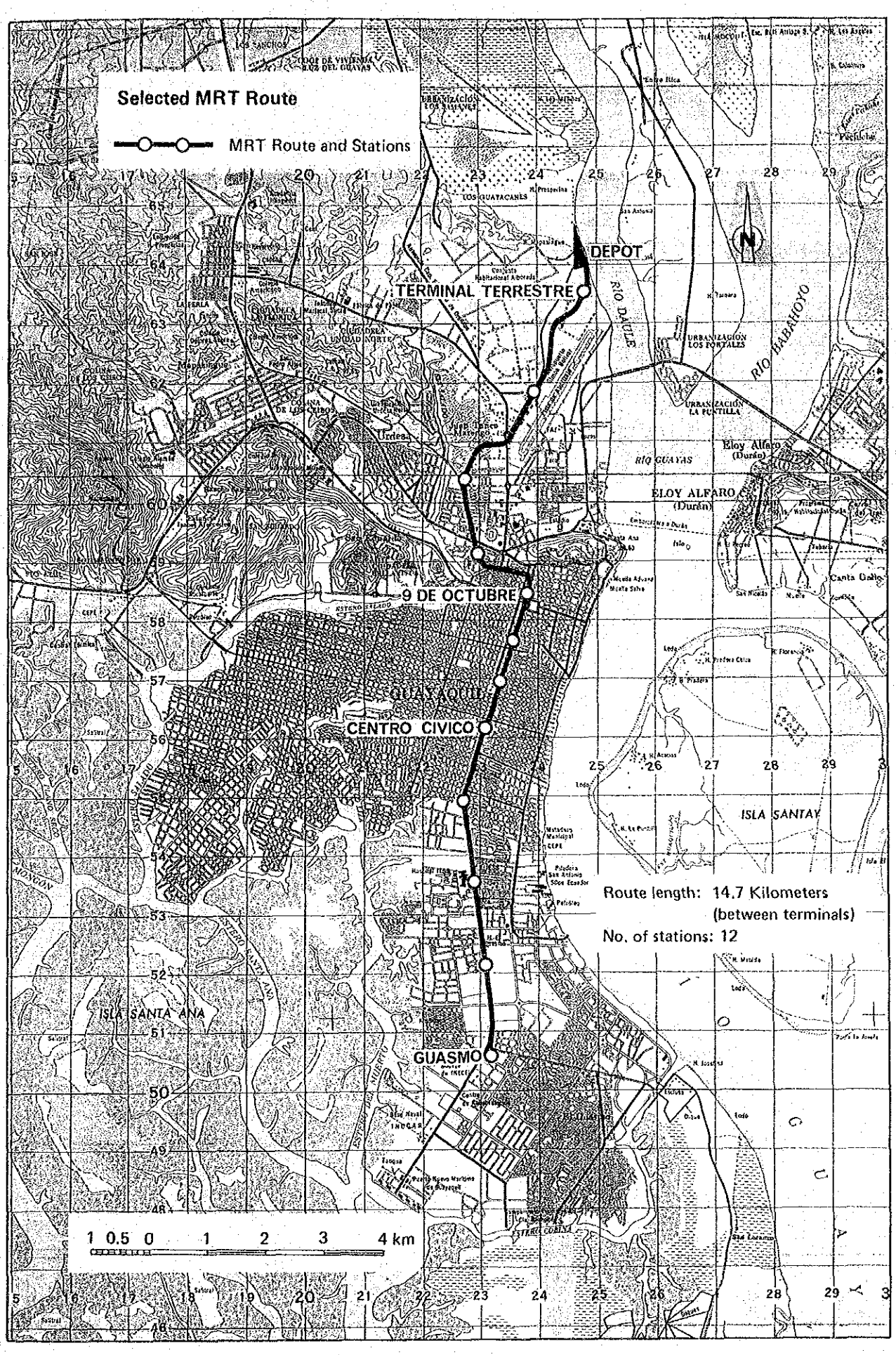


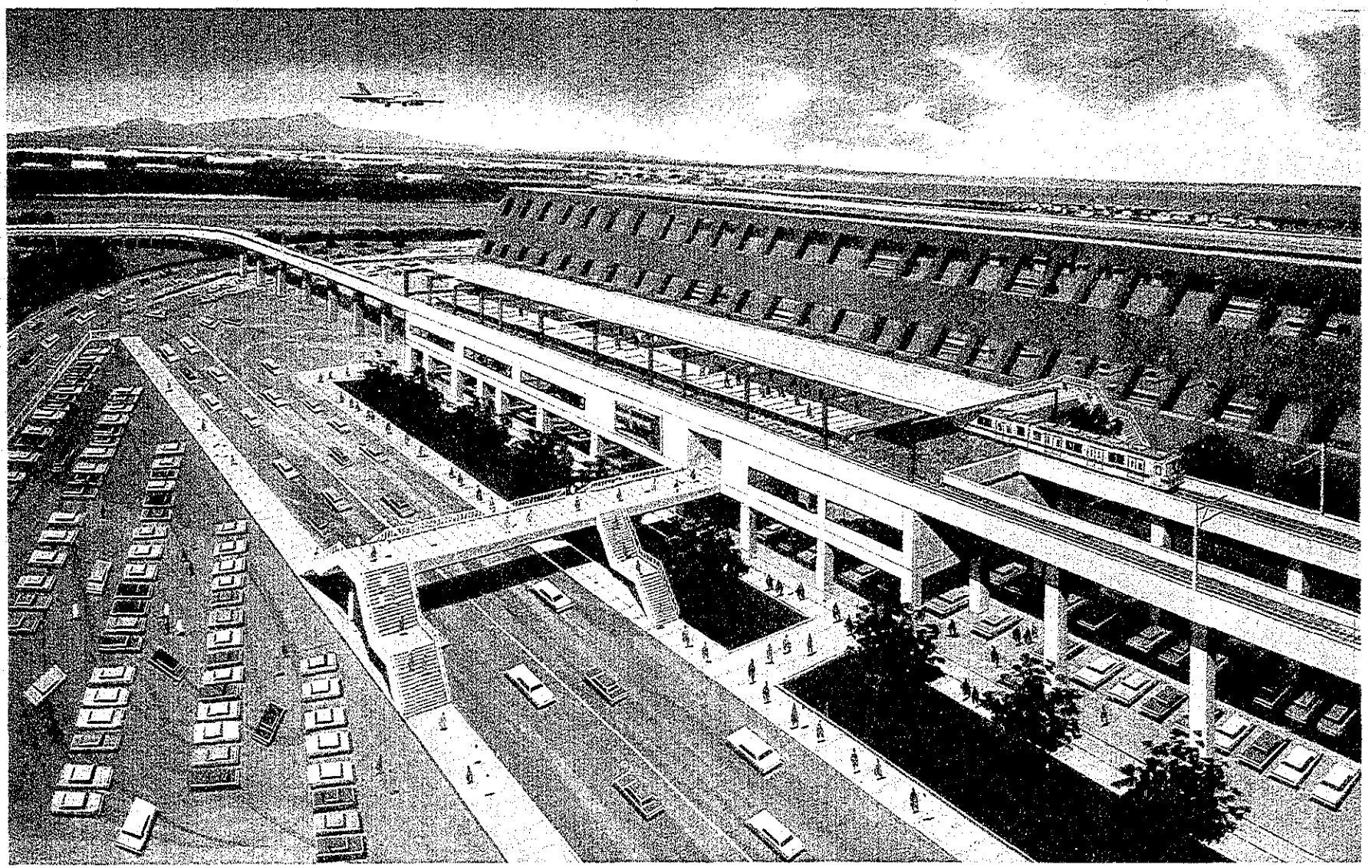
Etsutaro Iimuro
Project Manager
Japanese Study Team for
the Guayaquil Urban Transportation Plan

ECUADOR

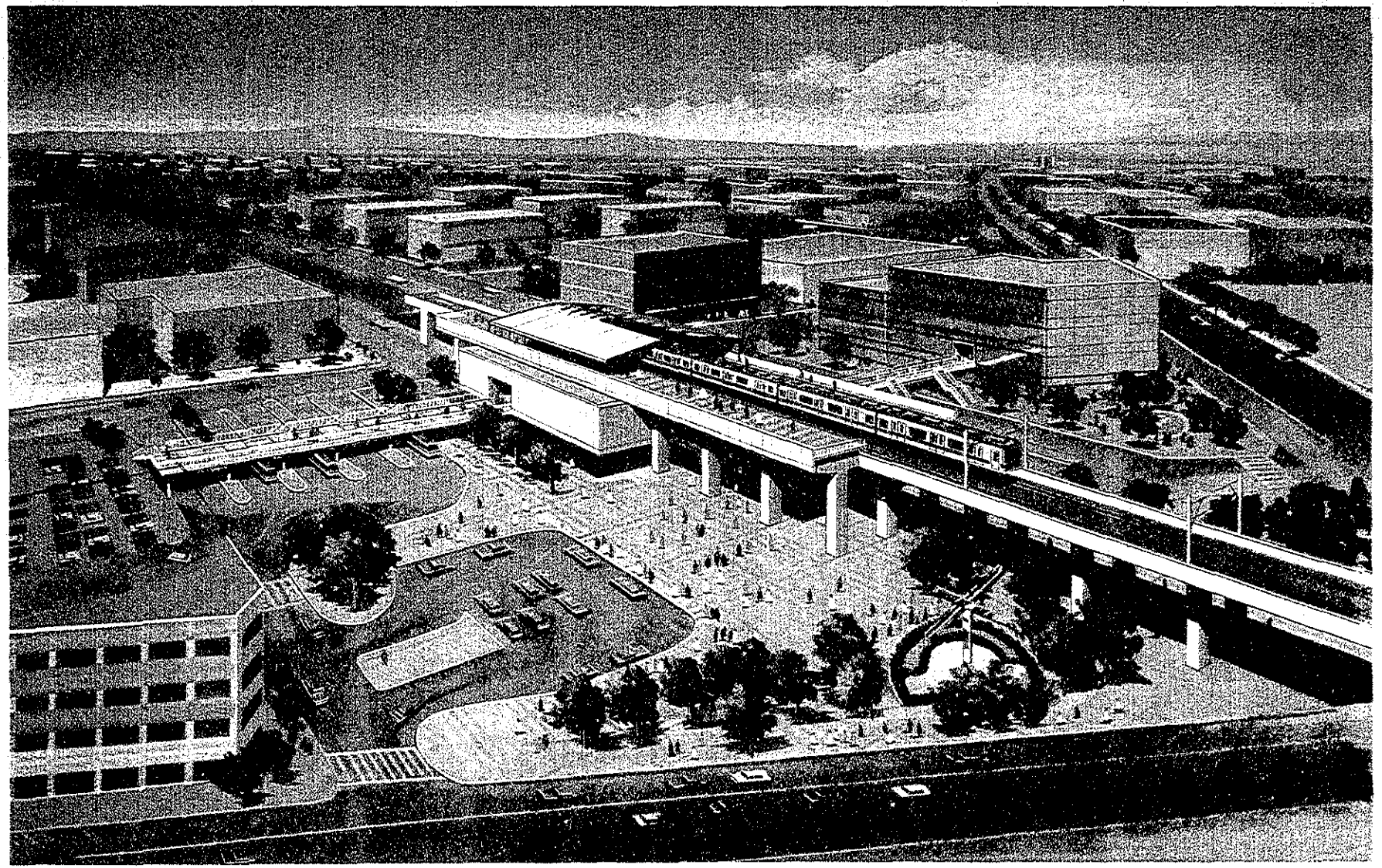


Area	;	270,670 Km^2 (after 1942)
Population & Growth Rate	;	9,378,000 (1985),2.91%/year (80-85)
Foreign Money Exchange rate	;	US 1$ = 95 Sucres in free market of the Central Bank (A) =120 Sucres in free market (Nov.1985)
Gross Domestic Products	;	6,503 mil.US $ (1983, 87 S./ $ by (A))
GDP Per Capita	;	734 US $ (1983, 8.857 mil. Population)
Productive Structure	;	Agriculture 13.5%, Mine & Manifacture 39.7%, Services,etc. 46.8% (1983)
International Trade	;	Export 2,583 mil. US $/ Import 1.458 , Balance 1,125 mil. US $ (1984)
National Budget of Govern - ment	;	953 mil.US $ (1983, 87 S. / $ by (A))
Index of Consumer's Prices	;	48.1%/year (1983), 30.4 (84)

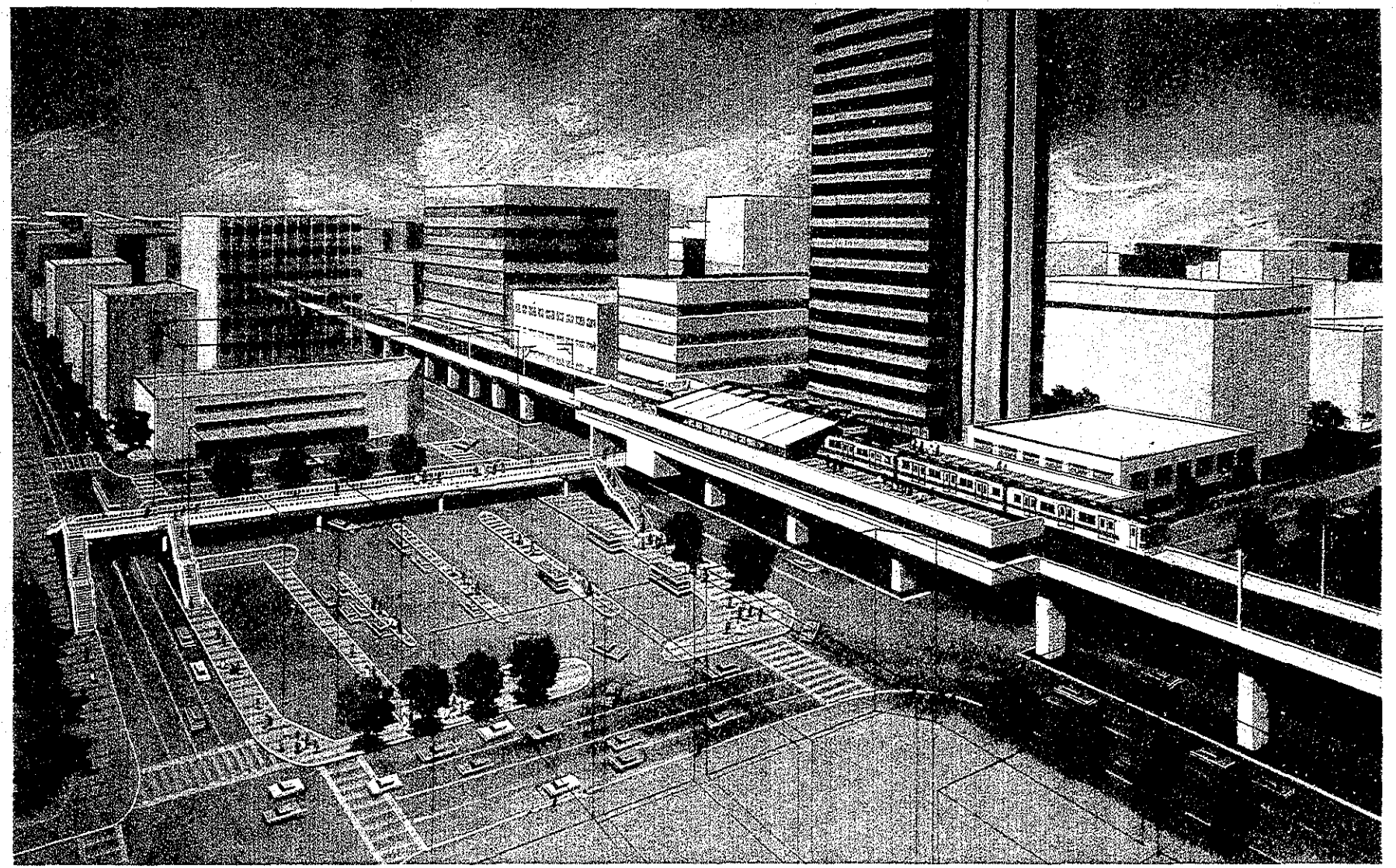

Selected MRT Route
MRT Route and Stations
DEPOT
TERMINAL TERRESTRE
9 DE OCTUBRE
GUAYAQUIL
CENTRO CIVICO
GUASMO
ISLA SANTA ANA
ISLA SANTAY
ELOY ALFARO (Durán)
Eloy Alfaro (Durán)
RIO DAULE
RIO BABAHOYO
RIO GUAYAS
URBANIZACION LOS FORTALES
URBANIZACION LA PUNTILLA
Route length: 14.7 Kilometers (between terminals)
No. of stations: 12
1 0.5 0 1 2 3 4 km



OVERLOOK VIEW OF TERMINAL TERRESTRE STATION



OVERLOOK VIEW OF GUASMO STATION



OVERLOOK VIEW OF 9 DE OCTUBRE STATION

MAJOR FINDINGS AND RECOMMENDATION

CONTENTS

ABBREVIATION AND DEFINITION IN THIS REPORT

CBD	----------	Central Business District (the area surrounded by Rio Guayas, Av. Quito and Av. Olmedo)
CONADE	----------	Consejo Nacional de Desarrollo
CTG	----------	Comisión de Tránsito del Guayas
EMELEC	----------	Empresa Eléctrica del Ecuador
ENFE	----------	Empresa Nacional de Ferrocarriles del Estado
FODUR	----------	Unidad Ejecutora del Fondo de Desarrollo Urbano de Guayaquil
INECEL	----------	Instituto Ecuatoriano de Electrficación
IETEL	----------	Instituto Ecuatoriano de Telecomunicaciones
INEC	----------	Instituto Nacional de Estadística y Censos
JICA	----------	Japan International Cooperation Agency
MRT	----------	Mass Rapid Transportation
the M/P Study	----------	the master plan study in 1983 by JICA
the Study, the F/S	----------	this feasibility study
the Team	----------	Japanese Study Team

MAJOR FINDINGS AND RECOMMENDATION

1. INTRODUCTION

1-1 BACKGROUND OF STUDY

In compliance with the request of the Ecuadorian Government, the Japanese Government decided to conduct a master plan study on the urban transportation plan for Guayaquil city which targeted the year 2000, and its final report which recommended the two MRT (Mass Rapid Transportation) routes with total 50 kilometers long in the year 2000, was submitted to the Ecuadorian Government in August 1983.

As a result, the Ecuadorian Government requested the Japanese Government to conduct the feasibility study on the north-south line (about 15 kilometers between Terminal Terrestre and Guasmo) of the MRT which had been recommended as the most urgently implemented in the final report, and then this feasibility study was started from October 1985.

The relationship between the MRT network to be completed in 2000 proposed in the master plan study and the route section of this feasibility study is shown in Figure S-1 at the next page.

1-2 OBJECTIVES OF STUDY

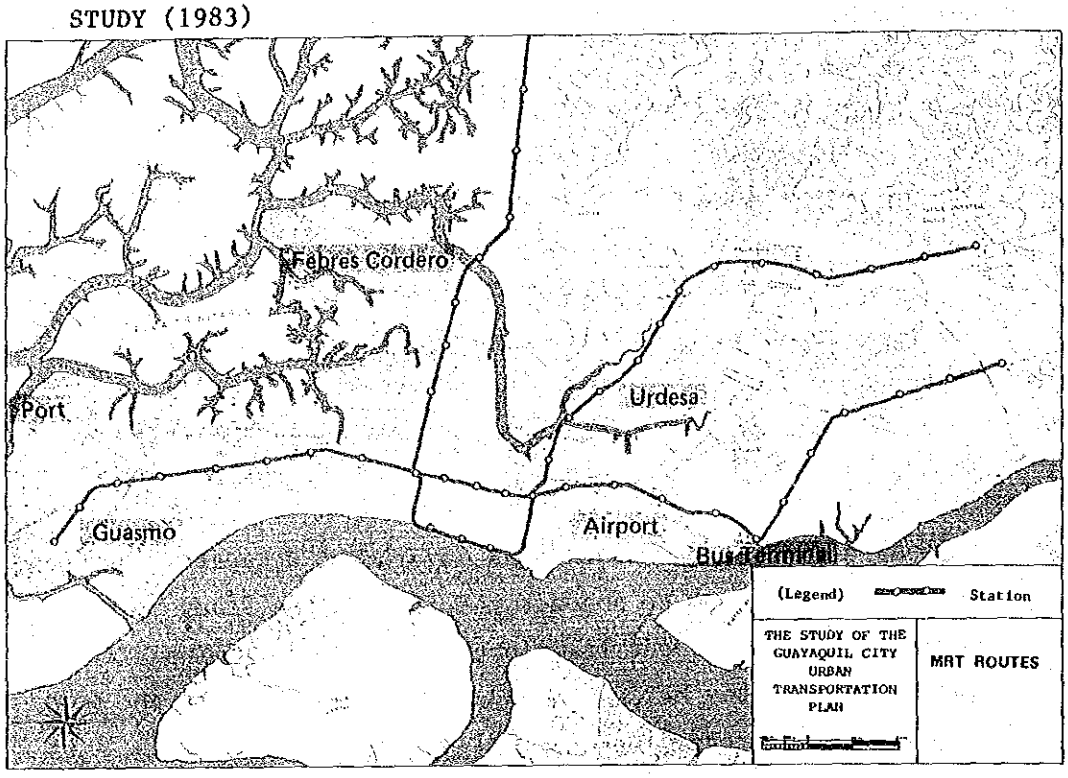
The objectives of the Study are;

to examine the technical, economic and financial feasibility of the north-south line of the MRT with about 15 kilometers long, starting from the Terminal Terrestre in the north and passing Av. de la Américas and Av. Quito toward the southern part of the city, Guasmo.

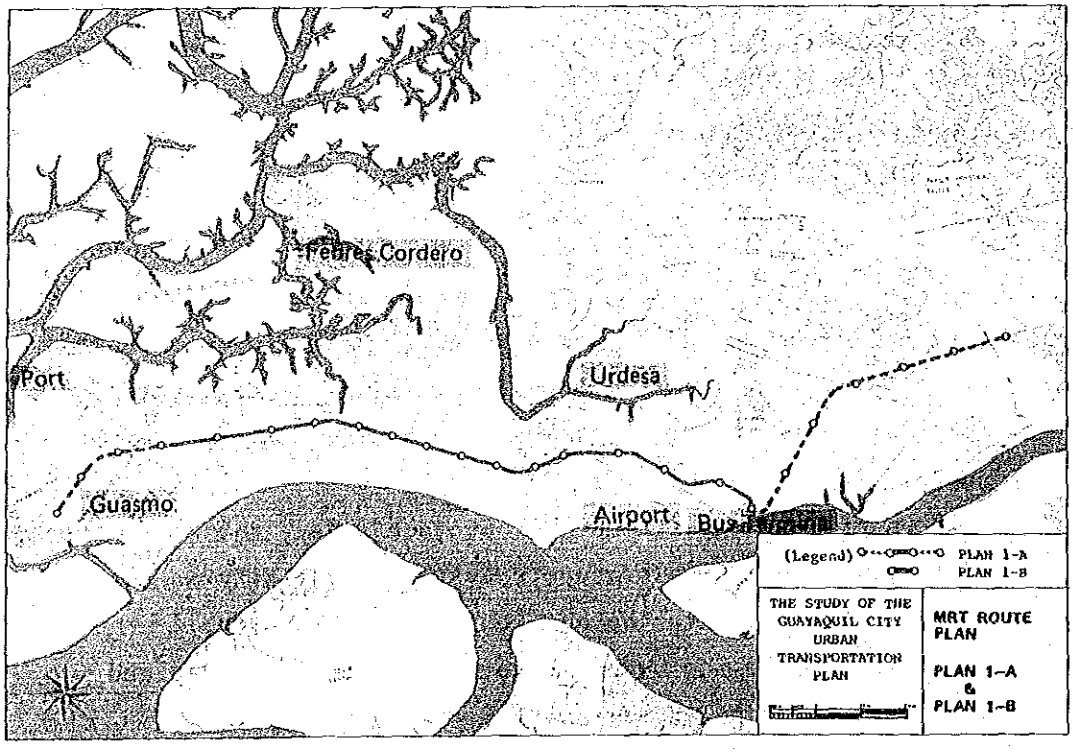
On proceeding with the MRT project study, the basic concept to improve the public transport system in the city is also worked out. They are the bus route reorganization, accessibility to the Guayas river side from Av. Quito and development around main stations, etc.

Figure S-1 WHOLE MRT ROUTE IN 2000 AND OBJECT ROUTE IN THIS STUDY

1) THE WHOLE MRT ROUTE IN 2000 YEAR RECOMMENDED IN THE MASTER PLAN STUDY (1983)

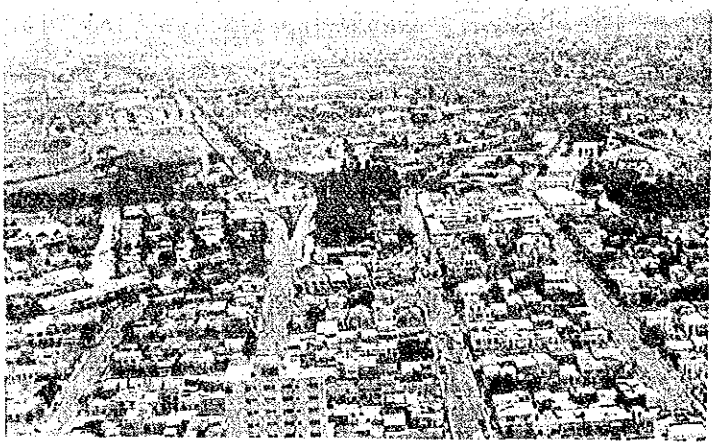


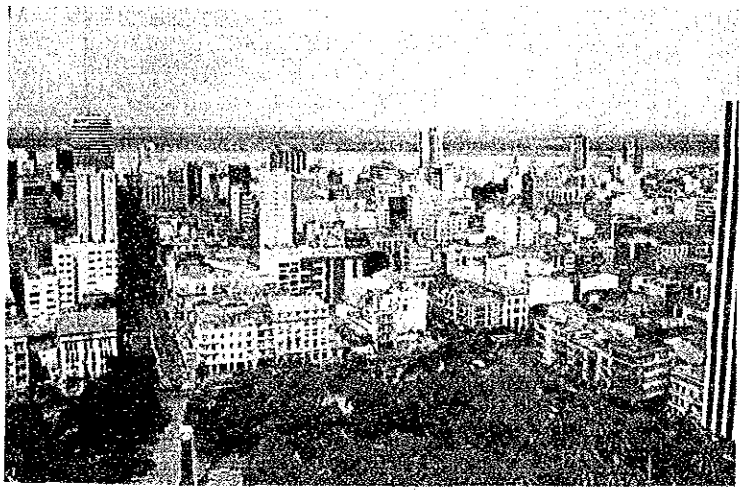
2) THE OBJECT ROUTE OF THIS FEASIBILITY STUDY (PLAN 1-B IN THE MASTER PLAN STUDY)



Present Outlook of the area along the MRT route

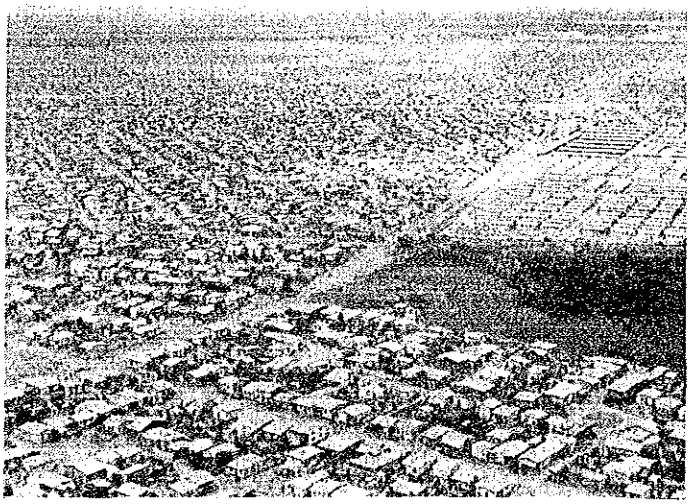
Northern part





Central part

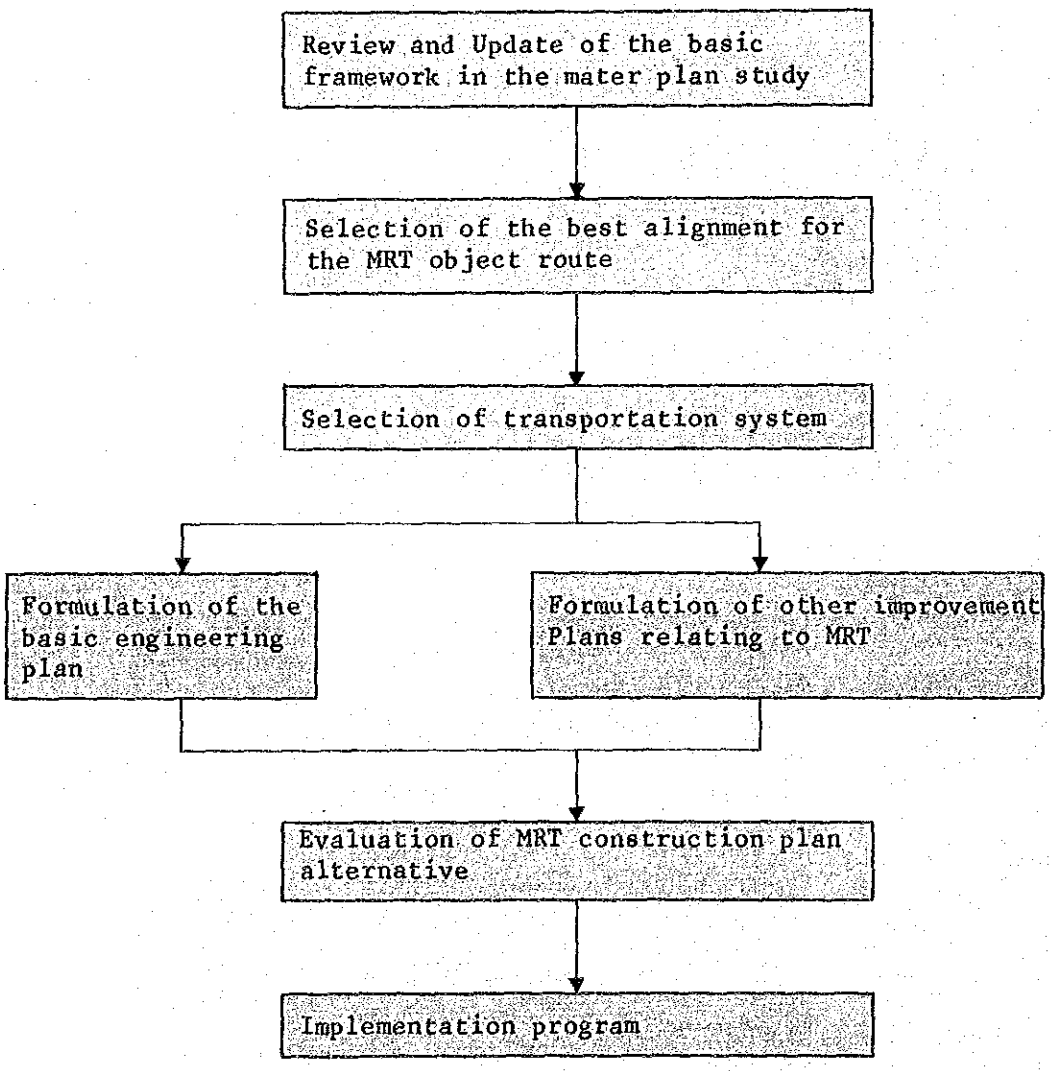
Southern part



1-3 STUDY APPROACH

In the master plan study, all the basic items; selection of the routes, comparison of transportation systems, priority of the construction work in each section of the whole route, etc. have already been examined and evaluated both technically and economically.

Since the object route of this feasibility study was given the top priority to be implemented in the master plan study, this study will be carried out substantially based on the results of the master plan.



The major subjects of the study are as follows;

(1) Review and setting of social and economic indexes as the preconditions of demand forecast, and the demand forecast based on the change in the traffic condition after the master plan study.

(2) Selection of the best alignment for the object route of the feasibility study

The route and the pattern are basically in conformity with those specified in the master plan, but there are some alternatives in the northern and southern part of the route, so that the optimum alignment will be evaluated and selected in consideration of the demand, pattern of route, construction cost and relative difficulty of the execution of work, etc.

(3) Selection of transportation system

Of the five transportation systems compared in the master plan study, the three alternative systems; Urban Railway, Light Urban Railway and Monorail are further examined and evaluated comprehensively as to the transportation capacity, operating cost, relative difficulty of maintenance, project cost and the future extension of the line, etc. Finally the optimum transportation system will be decided.

(4) Formulation of the basic engineering plan for transport, construction and management for the Basic Case

Based on the route alignment and the transportation system selected in above (2) and (3), a basic engineering plan for the transport, construction, project cost, operation and management will be worked out in detail for the Basic Case which is supposed to commence its operation in 1990 over the whole object

route from the Terminal Terrestre to Guasmo.

(5) Formulation of Other improvement plans relating to introduction of the MRT

To improve the existing public transportation system in Guayaquil city, several measures in coordination with introduction of the MRT should be adopted. They are basic plans on the reorganization of the bus routes, the improvement of the access to the Guayas river side from Av. Quito and the development of the areas around the MRT stations and the wayside.

(6) Economic and financial analyses and general evaluation of the project

The final goal of this feasibility study is to make the best decisions on the first operation section and its year, and the extension plan to the whole 15 kilometers between the Terminal Terrestre and Guasmo.

For this purpose, various test cases including the Basic Case which opens the whole route in 1990 at a time will be examined and evaluated from economic and financial aspects.

(7) Implementation program

The implementation program comprises a fund raising plan by fund sources, preparatory process in the MRT management and construction schedule for the best solution selected in the above (6).

2. MAJOR FINDINGS

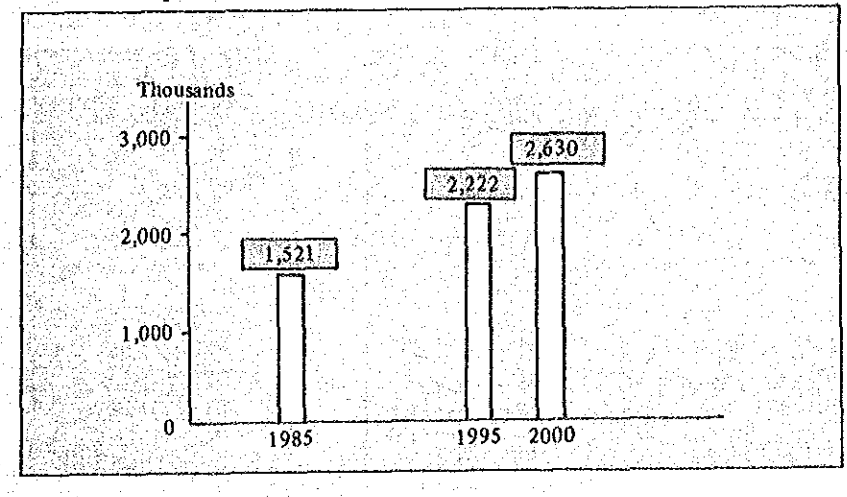
2-1 FINDINGS ON BASIC PLAN FORMULATION

The conclusions obtained in formulating the basic plan are as follows, which include the review of the basic frame following the master plan study, demand forecast based on this review, selection of the route and the transportation system and formulation of the construction plan for the Basic Case which is supposed to commence its operation in 1990 over the whole route.

(1) Growth of Population and EAP (Economically Active Population) in the Study Area

As results of review and update of the population and EAP growth in the Study area, they were set as under, taking into account the various changes after the master plan study.

a. Population in Study Area



b. EAP rate to the population

30% of the above population for 1985 - 1994

31% of the above population for 1995 - 2000

(2) MRT Demand Forecast

The MRT demand for the Basic Case which is for the whole route from Terminal Terrestre to Guasmo (14.7 km) and opens in 1990, was forecasted below, on condition that the MRT fare is 25 Sucres and the existing bus routes related to the MRT are reorganized.

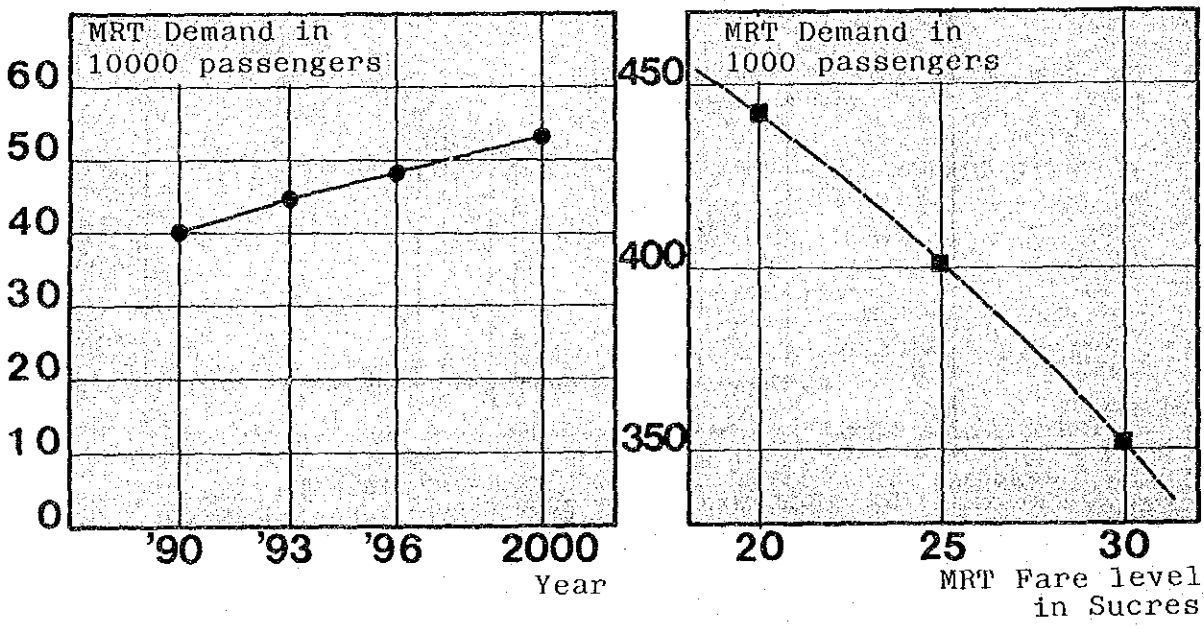
Number of passengers a day for 14.7 km

401,000 in 1990

530,000 in 2000

Average increase rate 2.8%/year

If the MRT fare rises by 5 Sucres from 25 to 30, it will decrease by about 50,000 passengers a day, whereas if the fare lowers by 5 Sucres from 25 to 20, it will increase by 41,000 passengers, and if the present bus routes are left competitive with the MRT, it will decrease by about 89,000 passengers in 1990.

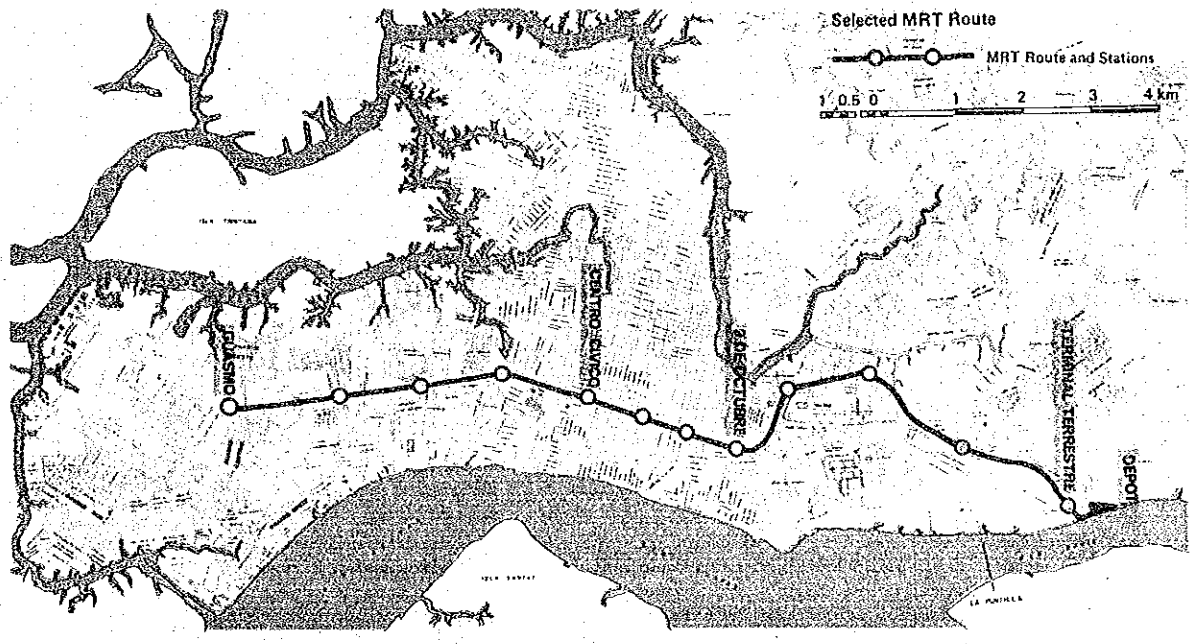


(3) Route Selection

The route alternatives were set for 2 cases in the southern part and 3 in the northern part, and based on the careful examination of them the final route was selected as Figure S-2, which starts from the Terminal Terrestre, passing in the airport site and in front of Policentro, along Av. San Jorge, Av. Delta, Calle Manuel Galecio, Av. Quito, and then straight to Guasmo.

Although the selected route (14.7 km) is a little longer than others, its construction cost is almost same, and in addition, expected to have the biggest demand and to be easily constructed with less obstacles.

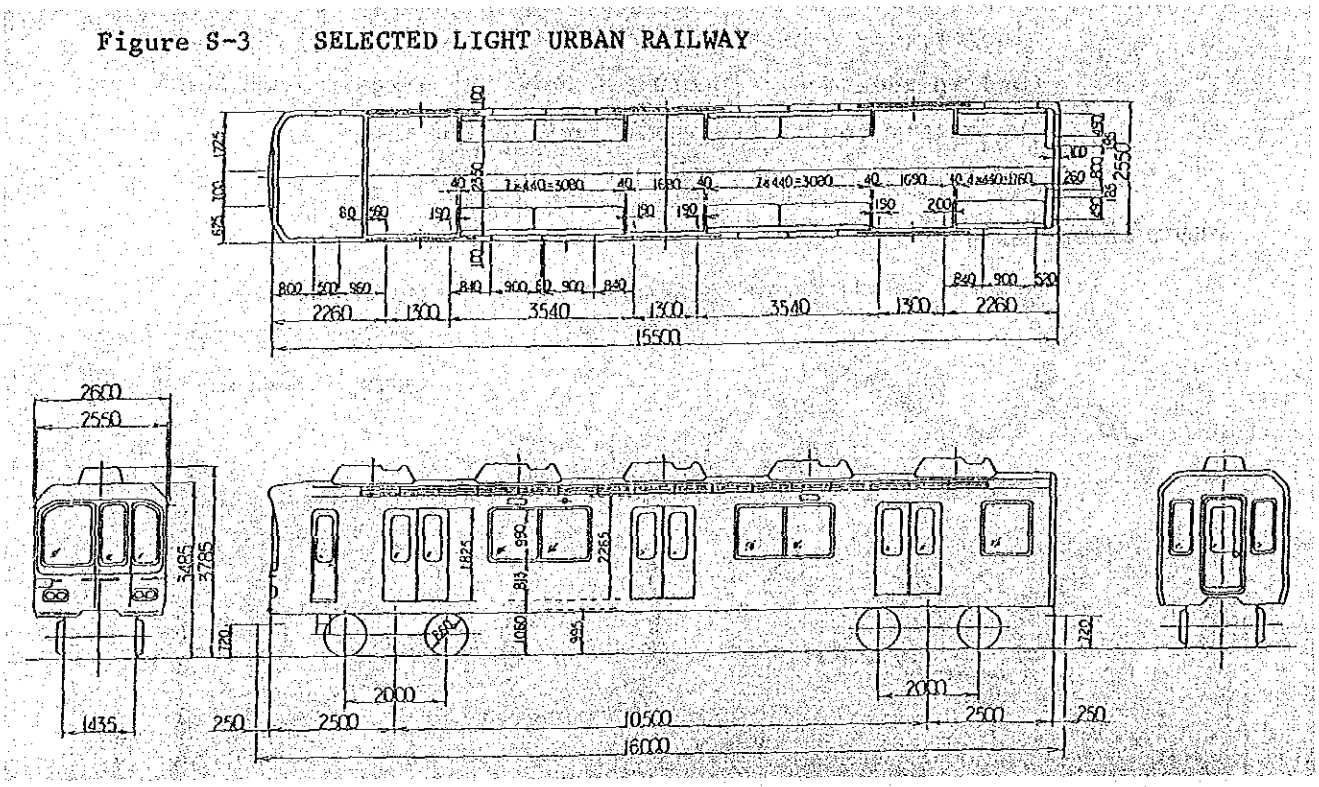
Figure S-2 SELECTED MRT ROUTE



(4) MRT System Selection

The three alternative systems: Urban Railway, Light Urban Railway and Monorail out of 5 examined in the master plan study were picked up again and compared each other from the various aspects, and the 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, advantage for the route extension in future, etc.

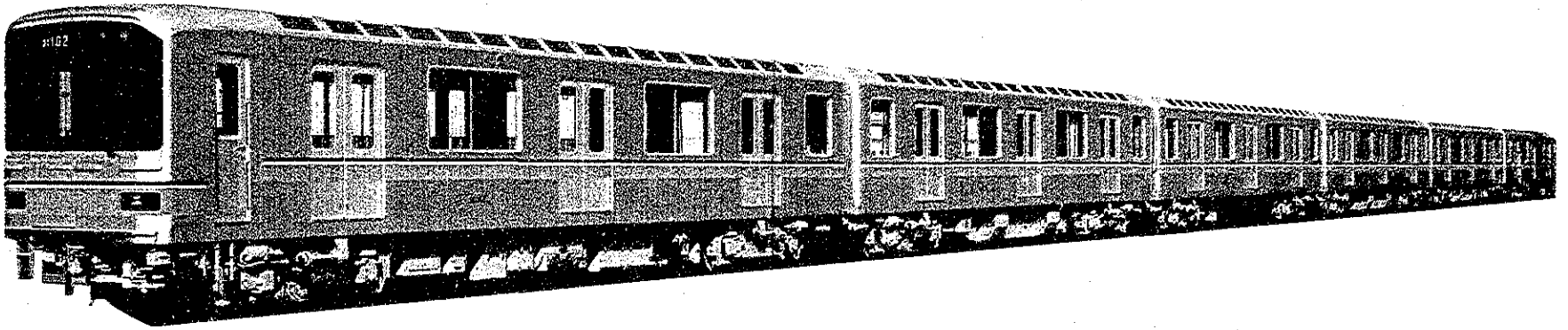
Figure S-3 SELECTED LIGHT URBAN RAILWAY



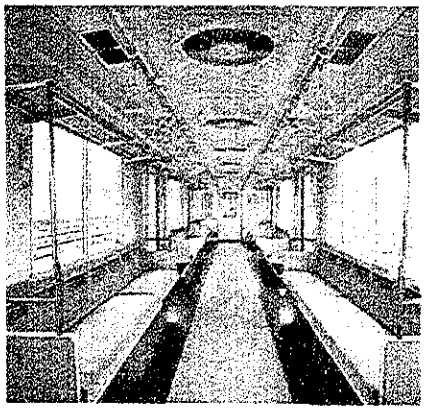
PRINCIPAL FEATURES OF ROLLING STOCK

Item		Description
1. Train Formation		5 cars(80 m)/train, 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

Example of Rolling Stock



Motorman's cab



Passenger room

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

(5) Transport, Construction and Management Plan for Basic Case

The engineering plan for the Basic Case which is supposed to commence operation in 1990 for the whole 14.7 km between the Terminal Terrestre and Guasmo was worked out as under.

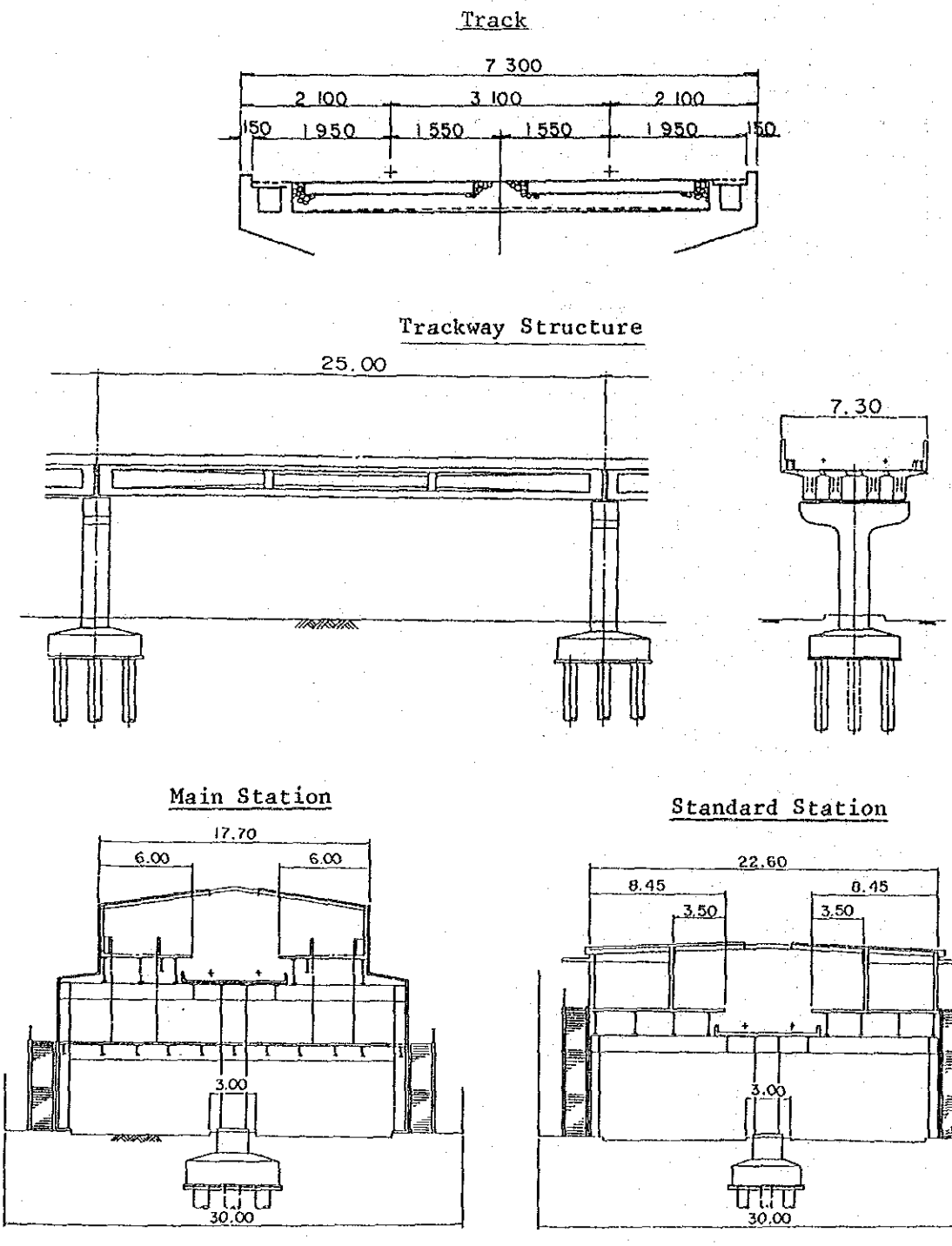
a. Transport Plan

Route Length (km), opening year		14.7 km , 1990			
Number of Stations		12			
		1990	1993	2000	2010-
Transport Demand	Number of Passengers per day	401,000	447,000	530,000	646,000
	Maximum flow of Passengers per day in one direction	105,000	121,000	145,000	177,000
	Maximum Passengers per hour in one direction	12,600	14,500	17,400	21,100
Transport Plan	Train formation	5 cars/train (80 m)			
	Maximum transport capacity	1,008 persons/train			
	Schedule speed	30/km/hr.			
	Schedule time for one direction (minutes	29	29	29	29
	Headway in peak hour (minutes)	4.6	4.0	3.3	2.7
	Number of train sets required	13	15	19	24
	Number of cars required (inc. reserved cars)	70	85	105	135

b. Construction plan

The structures for the tracks and the stations will be constructed mainly above the separator of the streets.

Figure S-4 TYPICAL STRUCTURES OF TRACKWAY AND STATIONS



c. Electrical facilities

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
	Electric System of Power Distribution	3-phase, 13.2 kv; 3-phase, 208/120 v; a single-phase 240/120 v
Signalling System	Signals	Color Light Type
	Interlocking Device	Relay Type
	Train Control	ATS and CTC
	Block System	Automatic Type
Telecommunication System	Telephone System	EPABX Automatic Telephones Selective Type Dispatching Telephone
	Radio System	400 MHz Band Train Radio 150 MHz Band Portable Radio

d. Depot and maintenance shop

The train depot should be provided with the facilities for daily maintenance and inspection and repair works, the head office of the MRT and the CTC (Centralized Traffic Control) center. This depot is recommended to be located in the north of the Terminal Terrestre, and it should have an area of at least 100,000 m^2.

e. Project cost for Basic Case (the whole route opens in 1990)

L.C = Local Currency Portion
F.C = Foreign Currency Portion

(Unit: Million Sucres in 1985 prices)

	L.C.	F.C.	Total
Track, structure, stations & depot	7,024	8,135	15,159
Electric facilities	446	1,686	2,132
Rolling stock	28	5,327	5,355
Land acquisition & & compensation	262	-	262
Engineering services	367	718	1,085
Contingency	452	456	908
Total	8,579	16,322	24,901

1 US dollar = 120 Sucres = 210 Yens in free market exchange rate as of October, 1985.

f. Management plan

f-1 Management body of the MRT

The four authorities: Guayaquil Municipality, ENFE (National Railway), CTG (Comisión de Tránsito del Guayas) and a new body proposed as the management body of the MRT were compared as to their respective advantages. As a result, it is concluded that a semi-governmental new body should be established, because it is expected to be managed with the efficiency comparable to that of the private business under the indirect control of authorities concerned and to be able to introduce the financial aid from the government.

f-2 Office organization

The number of staffs needed for enabling the commencement of the service in 1990 for the whole line is as follows. The new management body should be responsible for the employment of the personnel, their education and training according to their respective job functions.

Organ		Number of Staff	
Office Organization	General Manager and his Directly - attached Members	7	78
	Administration Dept.	24	
	Transportation Dept.	20	
	Rolling Stock Dept.	12	
	Civil & Electrical Dept.	15	
Field Organization	Station	282	515
	Railcar Depot	179	
	Civil Maintenance Depot	22	
	Electrical Maintenance Depot	22	
	Total		593

(6) Other Improvement Plans Related to Introduction of MRT

Introduction of the MRT will not only improve the present public urban transportation system in Guayaquil dramatically, but also produce various effects on the wayside of the route. Several measures in coordination with MRT should be adopted to maximize the MRT advantages.

Basic plans for such improvement will be recommendable concerning the following items;

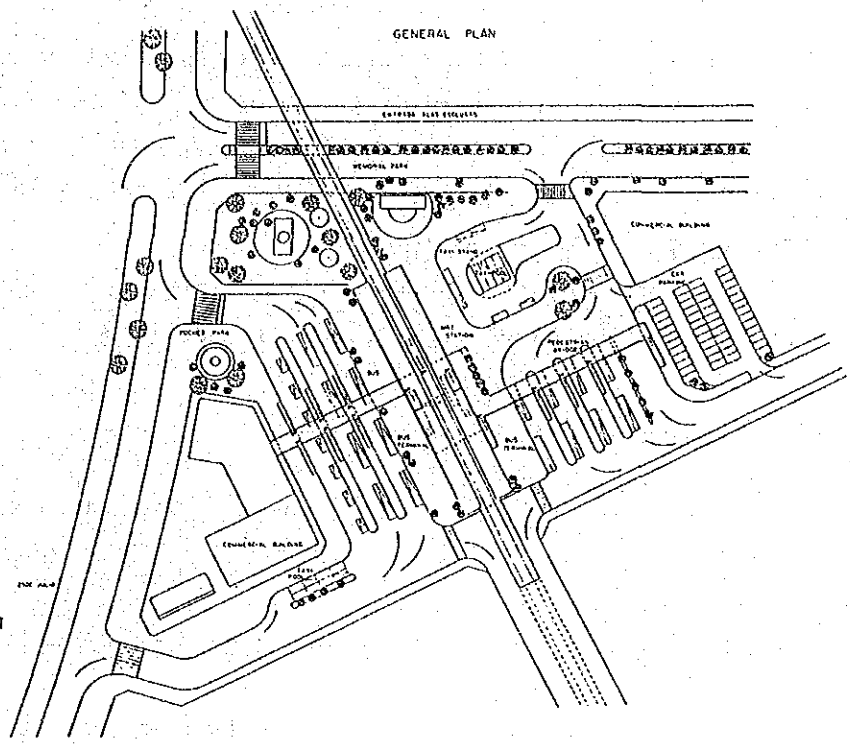
a. Bus route reorganization, and coordination between the MRT and the bus in the main stations

b. Easy accessibility to the Guayas river side from the stations on Av. Quito both on foot and by exclusive bus system in the CBD (Central Business District)

c. Measures not to give any hindrance on the road traffic on the streets used for the MRT

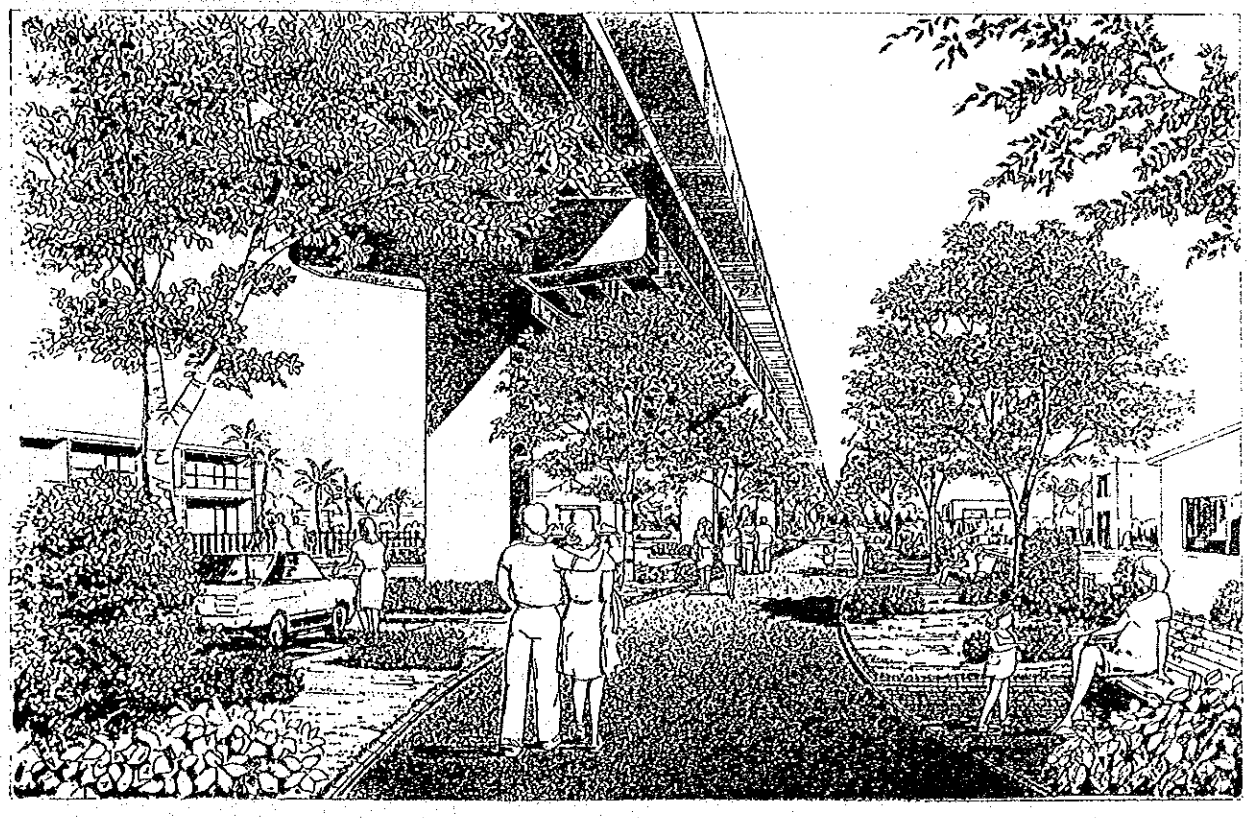
d. Promotion of the development/re-development around the stations, and preservation of the present situation in good residential areas

An example of the coordination between MRT and Bus



CONCEPTIONAL PLAN
OF STATION PLAZA
AT GUASMO

Image sketch of preservation of environment along MRT route



2-2 FINDINGS ON ECONOMIC AND FINANCIAL EVALUATION

The objective of the economic and financial evaluation is to make the best decisions on the selection of the first operation section and its year, and the extension plan to the whole line based on analysis among many cases set for this purpose.

The implementation program for the best solution (the finally selected case) is also formulated.

(1) Setting of Cases for Analysis

Figure S-5 shows the staged construction cases for the test.

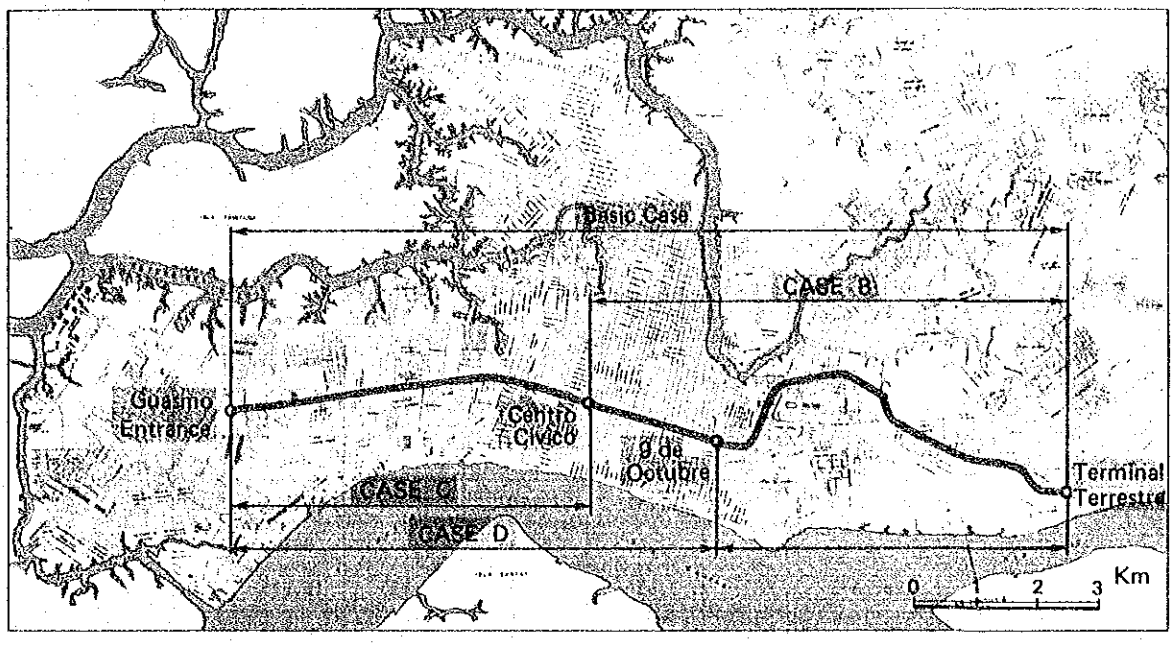
The characteristics of these cases are as follows:

. Basic Case	Scheduled to commence the operation throughout the whole 14.7 km line in 1990.
. Cases A and B	Scheduled to start the construction work from the Terminal Terrestre in the north and extend the line gradually towards the south.
. Case C and D	Scheduled to start the construction work in 1990 from Guasmo in the south and extend the line towards the north.
. Case E,F and G	Scheduled to execute the work only for the first stage in 1990 and no further extension.

If any of these cases, the commencement of the service in the first stage is assumed to be in 1990 in conformity with the execution plan of the master plan study.

Figure S-5 STAGED CONSTRUCTION CASES FOR TEST

(SECTION CASES)



TEST CASE

Test Case	Opening Year and its Section
Basic Case	1990 (14.7 km)
Case A-1	1993 (8.0 km) — 1990 (6.7 km)
Case A-2	1996 (5.6 km) — 1993 (2.4 km) — 1990 (6.7 km)
Case B-1	1993 (5.6 km) — 1990 (9.1 km)
Case C-1	1990 (5.6 km) — 1993 (9.1 km)
Case C-2	1990 (5.6 km) — 1993 (2.4 km) — 1996 (6.7 km)
Case D-1	1990 (8.0 km) — 1993 (6.7 km)
Case E	(No further construction) — 1990 (6.7 km)
Case F	(No further construction) — 1990 (9.1 km)
Case G	1990 (8.0 km) — (No further construction)

(2) Project Cost by Year (Financial Cost)

L.C = Local Currency Portion

F.C = Foreign Currency Portion

(Unit: Million Sucres in 1985 prices

Case \ Opening year		1990	1993	1996	Total (%)
Basic Case	LC	8,579	348	46	8,973 (31.6)
	FC	16,322	1,528*	1,570*	19,420 (68.4)
	Total	24,901	1,876	1,616	28,393 (100)
Case A-1	LC	4,247	4,794	46	9,087 (31.7)
	FC	7,634	10,413	1,570*	19,617 (68.3)
	Total	11,881	15,207	1,616	28,704 (100)
Case A-2	LC	4,247	1,824	3,052	9,123 (31.7)
	FC	7,634	3,726	8,315	19,675 (68.3)
	Total	11,881	5,550	11,367	28,798 (100)
Case B-1	LC	5,681	3,357	46	9,084 (31.7)
	FC	10,193	7,844	1,570*	19,607 (68.3)
	Total	15,874	11,201	1,616	28,691 (100)
Case C-1	LC	5,143	5,260	46	10,449 (34.8)
	FC	6,759	11,273	1,570*	19,602 (65.2)
	Total	11,902	16,533	1,616	30,051 (100)
Case C-2	LC	5,143	1,849	3,496	10,488 (34.8)
	FC	6,759	4,260	8,647	19,666 (65.2)
	Total	11,902	6,109	12,143	30,154 (100)
Case D-1	LC	6,616	3,791	46	10,453 (34.8)
	FC	10,259	7,782	1,570*	19,611 (65.2)
	Total	16,875	11,573	1,616	30,064 (100)
Case E	LC	4,246	345	-	4,591 (34.4)
	FC	7,650	1,098*	-	8,748 (65.6)
	Total	11,896	1,443	-	13,339 (100)
Case F	LC	5,680	344	2	6,026 (34.0)
	FC	10,206	1,096*	381*	11,683 (66.0)
	Total	15,886	1,440	383	17,709 (100)
Case G	LC	6,615	333	-	6,948 (38.8)
	FC	10,270	697*	-	10,967 (61.2)
	Total	16,885	1,030	-	17,915 (100)

1) 1 US dollar = 120 Sucres = 210 Japanese yens (Free market exchange rate as of October, 1985).
2) * shows the cost for increase of rolling stocks.

(3) Economic Analysis and its Result

a. Method

The benefits measured in this B/C analysis (Benefit and Cost) consists of reduction of the running costs of vehicles, saving of purchase cost of vehicles and reduction of travel time when the MRT project is realized, and while the cost in the analysis consist of the project cost and the running cost of the MRT which are converted into the economic prices. Each case is evaluated by the following three indexes.

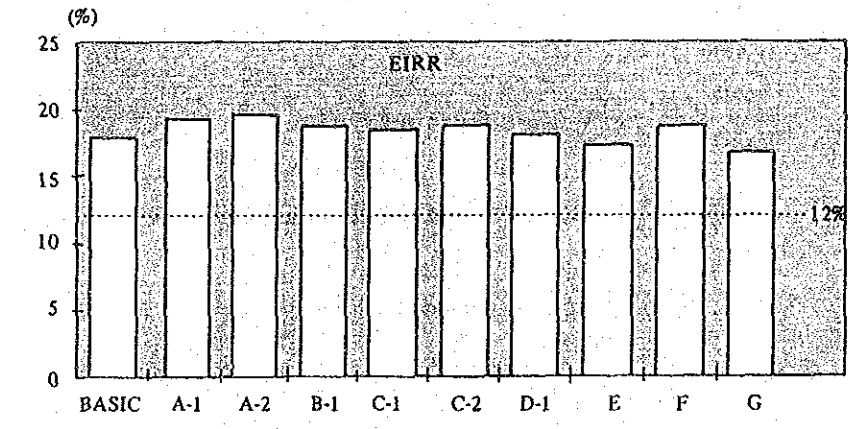
1. NPV (Net Present Value)
2. B/C (Benefit Cost Ratio)
3. EIRR (Economic Internal Rate of Return)

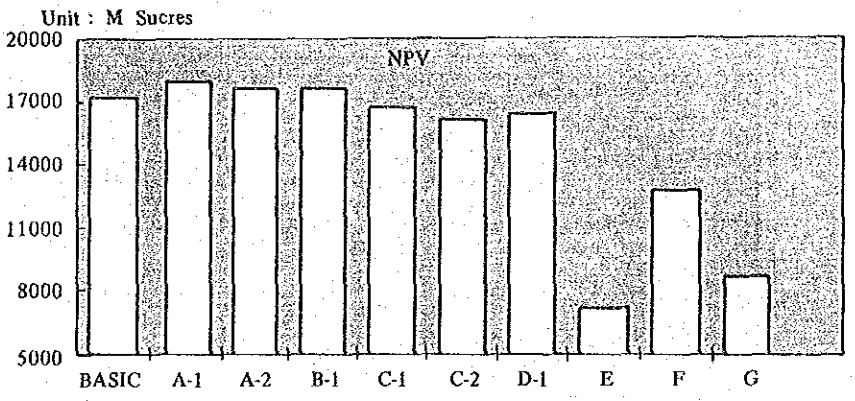
b. Result of cost benefit analysis

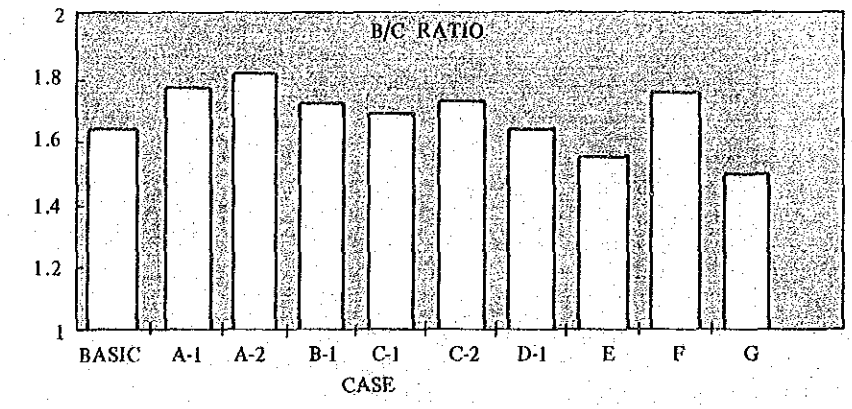
	NPV (Million Sucres in 1985 prices)	B/C Ratio	EIRR %
Basic Case	17,229	1.64	17.8
Case A-1	17,980	1.77	19.1
Case A-2	17,596	1.82	19.5
Case B-1	17,649	1.72	18.6
Case C-1	16,774	1.69	18.4
Case C-2	16,144	1.73	18.6
Case D-1	16,332	1.64	17.8
Case E	7,096	1.56	17.0
Case F	12,753	1.76	18.4
Case G	8,540	1.50	16.5

Judging from the evaluation based on the economic analysis and the levels of the three indexes (NPV, B/C ratio and EIRR), all the cases are acceptable.

When all the cases are compared with each other, however, they differ to some extent in the value of index or in the merit, so that the study team considers it necessary to analyze the causes of such difference and to reflect the result of the analysis on the final evaluation of each case as follows;



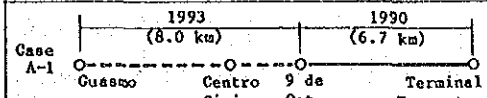
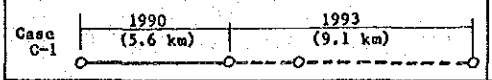




c. Observation among cases

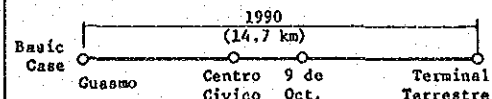
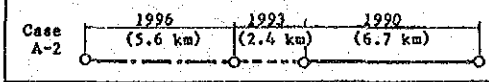
c-1 Order for start of work

When the two contrastive cases: one for starting the construction from the south (Guasmo) and the other for starting from the north (Terminal Terrestre) are compared, then the result of the comparison indicates that the Case A-1 for starting the construction from the north is advantageous over the Case C-1 with respect to all the indexes, since, in the Case A-1, the demand of the passengers transferred from the Terminal Terrestre can be expected earlier.

Case	NPV (mil.Sucres)	B/C Ratio	EIRR (%)
	18,000	1.77	19.1
	16,800	1.69	18.4
Comparison	A-1	A-1	A-1

c-2 Staged opening

In the case of the staged opening, the construction work is supposed to be started from the section for which the largest demand can be expected, and the line is extended according to the increase in the demand, so that this system can be considered to be an extremely practical system. In other words, with the staged opening system, the investment while the generatin of the benefit is too small can be refrained, and this has been proved by the following result of calculation.

Case	NPV (mil.Sucres)	B/C Ratio	EIRR (%)
	17,200	1.64	17.8
	17,600	1.82	19.5
Comparison	A-2	A-2	A-2

c-3 Cases of no further extension

For reference, the calculation was made as to the three cases where the project is terminated only with the completion of the first-stage work. The result of calculation indicates that those cases are disadvantageous compared with the others for completing the whole line at a time. This indicates that the benefit in the extended section increases at a higher rate than the expense, and thus it is advantageous to complete the whole line at a time if the financial condition permits.

c-4 Year for commencement of operation

The two additional cases; the operation commencements of the whole line at a time in 1993 and in 1996 which are equivalent to the Basic Case at a time in 1990 were compared each other to examine the optimum opening year.
The result indicates that these two cases in 1990 and in 1993 are almost equal in their respective advantages while the further delay of the completion of the construction will reduce their advantages. Thus, the commencement of the service in 1990 can be considered to be reasonable enough.