Expressway and Rapid Transit Authority of Thailand

Royal State Railway of Thailand

The Comprehensive Study for Bangkok Suburban Transportation Project

Summary Report

August 1979

JAPAN INTERNATIONAL COOPERATION AGENCY

Expressway and Rapid Transit Authority of Thailand

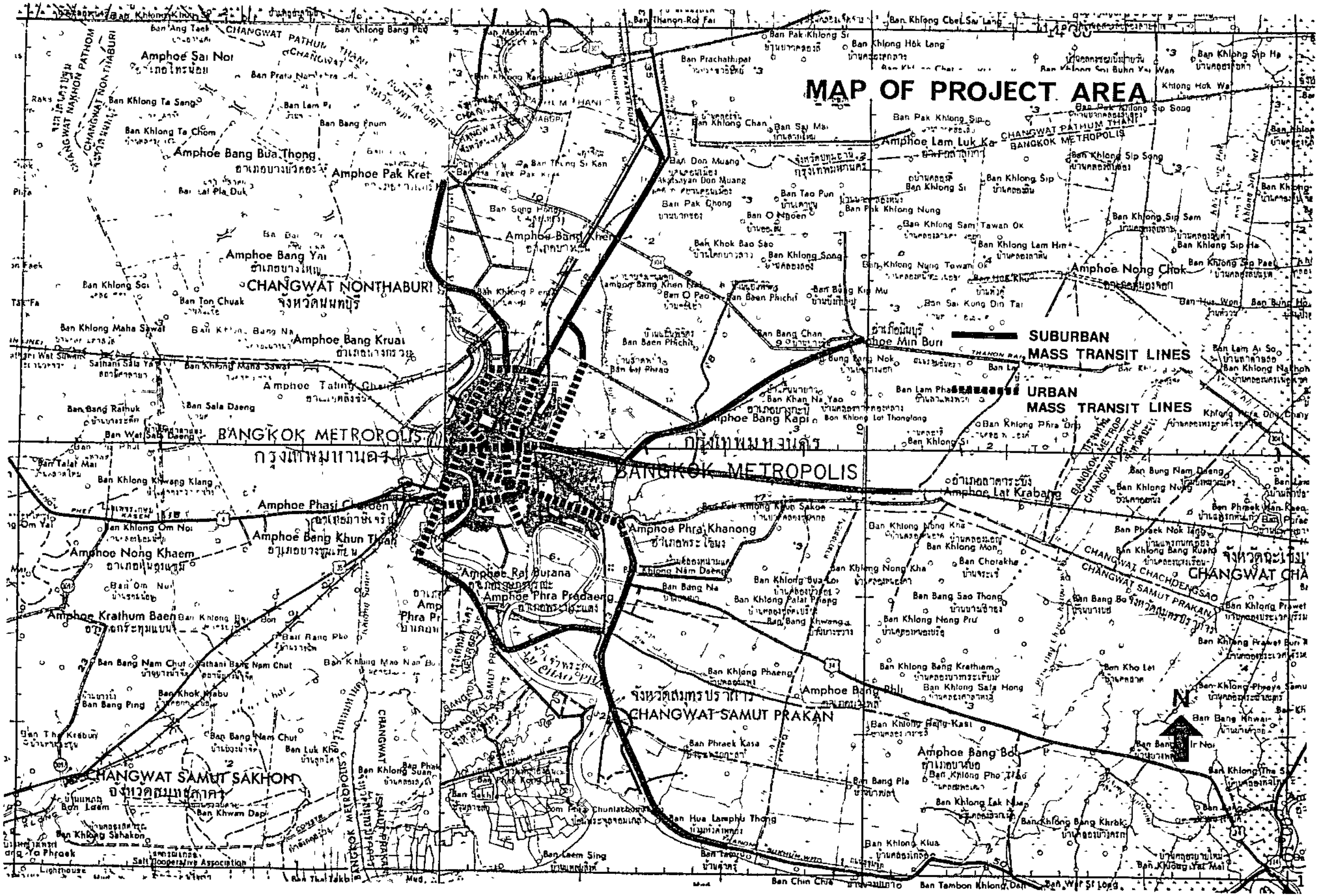
Royal State Railway of Thailand

The Comprehensive Study for Bangkok Suburban Transportation Project

Summary Report

August 1979

JAPAN INTERNATIONAL COOPERATION AGENCY


MAP OF PROJECT AREA
SUBURBAN
MASS TRANSIT LINES
URBAN
MASS TRANSIT LINES
N
BANGKOK METROPOLIS
CHANGWAT NONTHABURI
CHANGWAT SAMUT PRAKAN
CHANGWAT SAMUT SAKHON
CHANGWAT PATHUM THANI
CHANGWAT CHACHOENGSAO
Amphoe Sai Noi
Amphoe Bang Bua Thong
Amphoe Pak Kret
Amphoe Bang Yai
Amphoe Bang Kruai
Amphoe Taling Chan
Amphoe Phasi Charoen
Amphoe Bang Khun Thian
Amphoe Nong Khaem
Amphoe Krathum Baen
Amphoe Bang Khen
Amphoe Lam Luk Ka
Amphoe Nong Chok
Amphoe Min Buri
Amphoe Bang Kapi
Amphoe Lat Krabang
Amphoe Phra Khanong
Amphoe Rat Burana
Amphoe Phra Pradaeng
Amphoe Bang Phli
Amphoe Bang Bo

SUMMARY AND CONCLUSIONS

SUMMARY AND CONCLUSIONS

I. Introduction

A comprehensive master plan on the most efficient and economical mode of mass transportation system (MTS) covering the suburban area of the Bangkok Metropolis together with the best utilization of existing the Royal State Railways of Thailand (SRT) to provide commuter services, has been carried out by the Japanese Study Team organized by the Japan International Cooperation Agency (JICA) during November, 1978 and August, 1979.

The main report presents the finding of the study, the reason why the suburban mass transit system is necessary, how the study has been carried out and how it was concluded. This report summarizies the conclusions in the following sections:

II. Necessity for the Suburban MTS
III. Main features of the Suburban MTS and the Railway Commuter Service (RCS)
IV. Cost Summaries
V. Technical Evaluation
VI. Benefits Produced
VII. Conclusions and Recommendations

II. Necessity for the Suburban MTS

In order to meet future traffic demand in Bangkok, the basic strategy is to improve the transportation facilities in its urban area. The First Stage Expressway System and Outer Ring Road in Bangkok will distribute vehicle traffic along trunk routes and the First Stage Mass Transit System and bus system will distribute passengers within the urban area.

Nonetheless, the suburbs will prevent a full solution to the central problem of overconcentration in the Central Business District in the foreseeable future since the residential area (mixed-use low density area) of the Greater Bangkok Area (GBA) in the year 2000 will expand about 2.23 times that of the area in 1977 and hence cause the suburban generated traffic to the central area to increase. Construction of new roads or expanding the width of the existing roads to meet the increase in the urban area has clear limitations.

Even after completion of the first stage MTS in the central area, generated commuter trips will be concentrated in the short peak period, and cause congestion not only on the roads in the urban area, but also in the suburban area. Especially on the trunk radial roads, the road congestion will become as serious as on existing roads in the central area. Already this tendency is conspicuous especially in the morning peak period when almost all the radial roads, from suburban area to central area within 10 kms from the central area are fully occupied by vehicles.

The increasing trend of congestion is expected to continue since trip demand increases with population growth. Based on projections of growth for traffic relevant groups in the Greater Bangkok Area (which covers the urban center and the suburbs of Bangkok), future growth rates will be more rapid in the suburbs than in the central area as shown in Table-1 below.

Table 1 SUMMARY OF TRAFFIC GROWTH INDICES FOR GBA (2000/1977)
(Ref: Table 5-26 in the main text)

Traffic Relevant Group	*Central Area	Suburban Area	GBA Average
Residential Population	1.43	2.60	1.82
Economically Active Population	1.80	2.58	2.11
Workers at Work Places	1.68	3.82	2.11
Traffic-Relevent Student	4.53	8.41	5.81

Note: * The Central Area consists of the zone nos. 1-9, 21, 30-36, and 41-43, as which are shown in the zone map in Fig. 4-6 in the main text.

At the present time, the main mass transportation system from the suburban area to the central area of Bangkok is bus, but buses present an inadequate alternative since they use roads and add to their congestion. The lack of a rapid mass transit system alternative from the suburban area to the central area permits traffic congestion.

According to the results of estimated traffic volume in the year 2000, without a suburban Mass Transit System the average congestion ratio in the peak hour for the total road network including the completion of all planned roads and the first stage MTS shows near-congestion or over-congestion in the total road network and especially on radial roads used by suburban traffic as shown in the following table and figure.

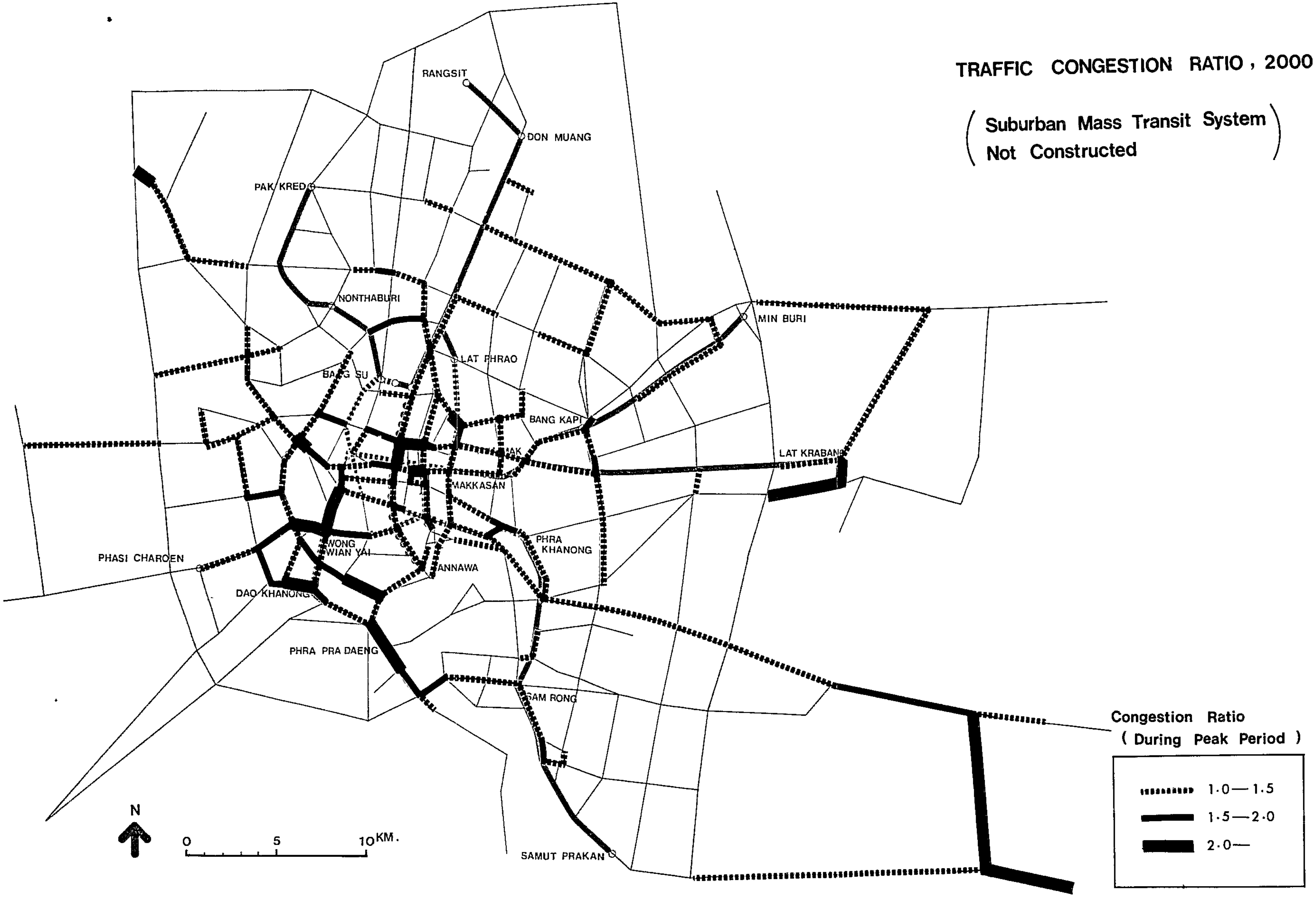
Table 2 AVERAGE CONGESTION RATIO IN THE PEAK HOUR, 2000

Congested Road Section		Average Congestion Ratio*
The total road network in GBA		0.82
On radial roads in the Greater Bangkok Area	Total	0.95
	Inside CBD**	1.38
	Outside CBD	0.84
At the boundary of the CBD outside the Middle Ring Road	Total	1.14
	East Side	1.30

* Congestion Ratio = Forecast Traffic Volume/Maximum Road Capacity
** Central Business District
Note: This table refers that in page 5-38.

TRAFFIC CONGESTION RATIO, 2000

(Suburban Mass Transit System Not Constructed)



All the above considerations point to the necessity for the establishment of a suburban Mass Transit System. Although there is currently no suburban mass transit system in Bangkok, commuter demand for one can already be seen in the statistics of the State Railway of Thailand. Since 1968, the number of commuters has increased 4.67 times as against a marginal increase for non-commuters so that commuters now form an estimated 80% of the volume during peak rush-hours.

III. Main Features of the Suburban MTS and Railway Commuter Service (RCS)

In this section, the results of the study which include mode selection, route alignments, construction priority and facilities for the new system are summarized.

(1) The Mode of the System

Basically the Suburban Mass Transit System is aimed at providing service covering an area of about 10 to 50 kilometers from the CBD, and the existing railway is expected to serve commuters travelling to the CBD from less than 120 kilometers.

The study proved that the same mass transit railway as will be used in the central urban district would meet the requirement of travel distance between 10 and 50 kilometers, and the express or limited express trains would meet the requirement for more extensive commuting distances of up to 130 kilometers.

The rapid railway transit is considered the most adequate of the alternative modes for the purpose of the project in terms of its transport capacity which would meet the traffic demand arising from the project area with a range of between 6,000 and 30,000 passengers per hour forecast for the year 2000.

Since traffic demand varies depending on the section, several modes of transport such as light rail, monorail, new guideway system, etc. could be selected. However, taking into consideration that these other systems generally serve the short or medium travel distance and are a supplement to a trunk line transport system, and further, that the transition from one mode to another is time consuming due to passenger congestion at transfer stations, it was concluded generally that the same system as being used in the urban area (heavy rail system) is the most recommendable mode for the suburban mass transit. Thus, in this study, the same mode as planned in the urban area was adopted.

(2) Route Alignments

In the study for establishing the project alignment, various related elements were taken into consideration.

The main urban transportation projects which are in the process of being implemented, such as the First Stage Expressway System, the First Stage Mass TRansit System and the Outer Ring Road were assumed to have been completed. The Expressway system has been planned on the premise that the system should be incorporated into the future road network. The First Stage MTS was also assumed to be extended further out, although the timing and extent of the length might depend on the growth of traffic demand. The Outer Ring Road was planned to by-pass the through traffic as well as to carry intra-suburban traffic.

These systems and network compose whole integrated transportation system of the Greater Bangkok Area. The network of the suburban MTS, therefore, was studied to achieve the most efficient and economical route alignment to lead the traffic generated from the growing outside of Bangkok to the Central Business District and vice versa to contribute to the total Bangkok transportation network.

From the viewpoints mentioned above the study concentrated on determining, in a limited time, the right direction for the future planning and the extent of investment which would be appropriate and could be justified during this first planning stage.

Thus, the project alignments were examined based on the results of traffic assignment originating from an O-D study, connecting the new routes selected along the planned road network to the ends of the First Stage Urban Mass Transit System.

The proposed system has six radiating lines: two in the north from Bang Su to Nonthaburi and to Don Muang, one in the east from Makkasan to Hua Mak along the existing Eastern Line of the SRT and then diverging to Min Buri, two in the south extending from Phra Khanong to Samut Prakan via Sam Rong and from Dao Khanong to Sam Rong via Phra Pra Daeng, and the last one in the west aligned from Wong Wian Yai up to Phasi Charoen. All terminal points are major traffic potential areas.

For intrasuburban transportation, neither a new mass transit system nor new construction of SRT Line has been considered since no signs were seen for either traffic growing or being generated outside Bangkok to require an additional mass transit system within the suburbs for the time being. The Planned Outer Ring Road was presumed to be able to meet traffic demand for it provided that the missing link from east to west at the northern end is constructed.

The study recommended the construction of the suburban MTS at an early time in order to insure usage as soon as possible.

The related transport networks in Bangkok are shown in the main text in Figs. 5-6, 5-7, 5-8, 5-9 and 5-10.

The location and length of the recommended system route is shown in the following figure and table.

RECOMMENDED SUBURBAN MASS TRANSIT SECTIONS

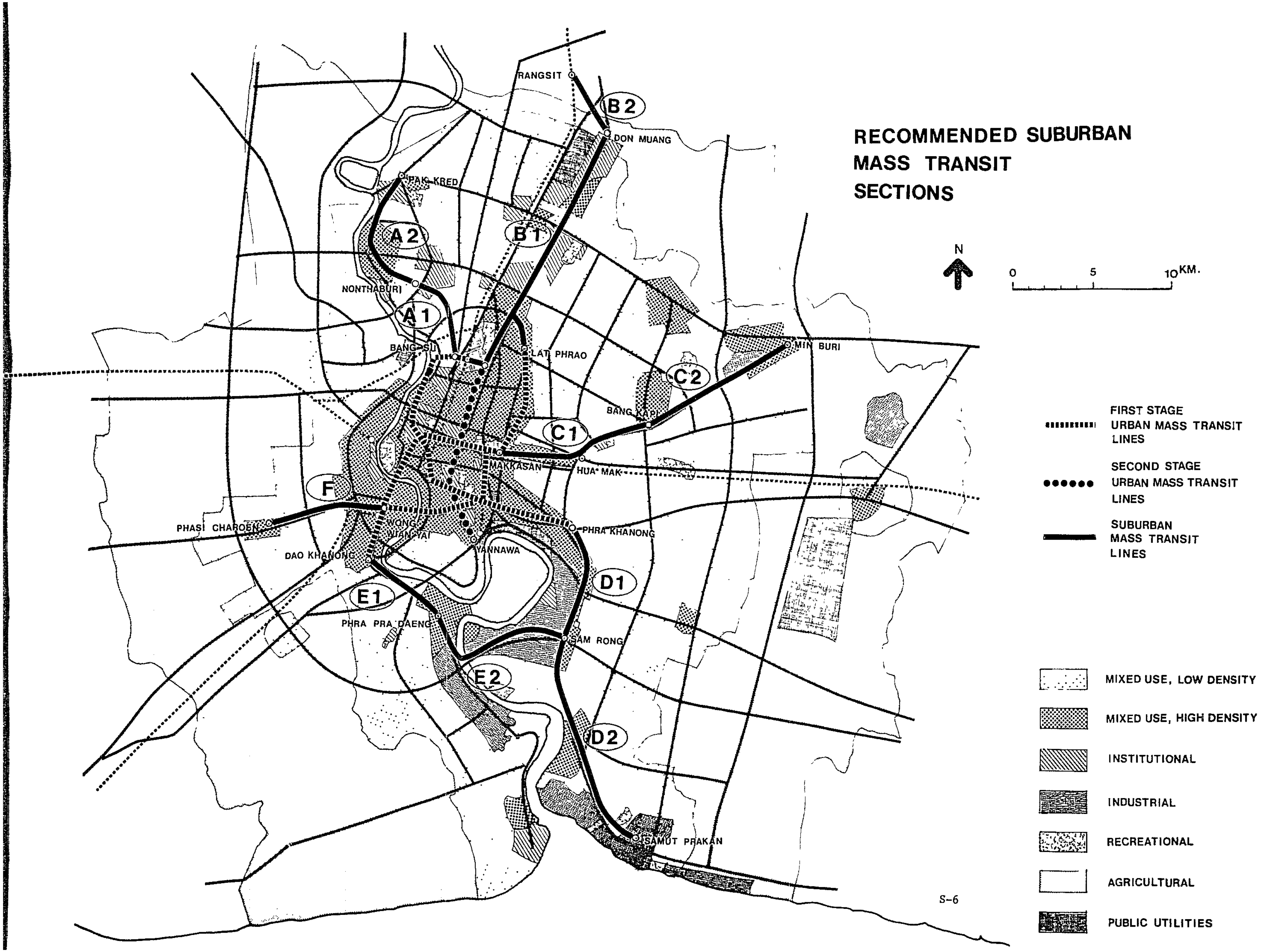


Table 3 SUBURBAN MASS TRANSIT SYSTEM ROUTE LENGTHS

Route		Location	Length (km)	Alternatives Considered
North	Route A1	Ban Khlong Pram	5.0	Alternative-1
	Route A2	Bang Khan	9.4	Elevated Heavy Rail System
	Route B1	Tambon Bang Khen	17.8	
	Route B2	Ban Khlong Chan	3.8	
Sub Total			36.0	
East	Route C1	Bang Kapi	10.1	Alternative-2
	Route C2	Bang Kapi	11.0	At-Grade Heavy Rail System
Sub Total			21.1	
South	Route D1	Phra Khanong	7.3	
	Route D2	Samut Prakan	15.0	Alternative-3
	Route E1	Bang Khun Than	5.0	
	Route E2	Samut Prakan	10.1	System of Alt.-1 and Alt.-2 combined
Sub Total			27.4	
West	Route F	Phasi Choroen	8.3	
Total Length			102.8	

Note: This table refers to that in Page 6-2.

(3) Construction Priorities for the Suburban MTS Sections

The priority for construction of each section of the Suburban MTS alignment was determined by ranking each route to correspond with the future traffic demand and the tentative expectation of revenue. For this purpose a study of traffic assignment was made i.e. the differences between alternatives of construction of the total alighnment minus the section were examined taking into consideration the elements listed below.

a) The volume of future traffic demand on the section.

b) The amount of reduction in total traffic volume on the road network produced by the section.

c) The contribution to total revenue of the mass transit system from the section.

d) The service to high potential development areas based on future land use patterns of housing estates and industrial complexes in the section.

e) The service to traffic congested areas and areas with low road densities.

The results are presented in the following table with the construction schedule outlined further in Fig. 6-7 of the main text.

Table 4 SUBURBAN MTS SECTION CONSTRUCTION PRIORITY
(Ref: Table 8-16)

Priority	1	2	3	4	5	6	7	8	9	10	11
Suburban Mass Transit Section	C1	D1	C2	E1	A2	A1	F	E2	D2	B1	B2
Construction Commencement Year	1983	1984	1985			1986	1987		1988	1989	1991

(4) Railway Commuter Service Sections

For SRT Line, new Line construction was not considered based on the original project concept. Instead, it was planned to utilize the existing lines to maximize efficiency and to only improve the existing facilities. The following shows the list of improvements planned for the existing conventional railway lines.

Table 5 RAILWAY COMMUTER SERVICE SECTIONS
(Ref: Table 6-19)

Name of Line	Route	Length (km)	Construction	Improvement
Southern Line	Alt.-1 Bang Su - Sala Ya Alt.-2 Thonburi - Sala Ya	56 48	Double-Truck	Signalling, Telecommunication
North & North-eastern Lines	Bangkok - Ayuthaya	72	New Stations	Signalling, Telecommunication
Eastern Line	Bangkok - Hua Ta Khe	31	Double-Truck, New Stations	Signalling, Telecommunication
Total Length		Alt.-1 151 Alt.-2 159		

(5) Suburban MTS: Number of Rail Cars Required as of the Year 2000

The number of cars required for the operation was calculated taking into consideration running time, turning time and headway, for each system.

In this calculation two alternative tariff rates were assumed, one is the almost same rate as used in the existing SRT (0.078 Baht/km), the other is almost twice the tariff of the city bus (i.e., 0.296 Baht/km). (Ref. Main text 5.3.3)

The second alternative was adopted on a trial and error basis taking into consideration the permissible limit for passengers for the purpose of an economic analysis for the project. Both rates were used to compare various results for the analysis.

The following table indicates the required car numbers for the Suburban MTS as of the year 2000. The total car numbers needed are 756 and 478 corresponding to the tariff rates of 0.078 Baht/km and 0.296 Baht/km respectively.

Table 6 SUBURBAN MTS: NUMBER OF RAIL CARS REQUIRED AS OF THE YEAR 2000 (Ref: Tables 6-4 & 6-5)

Route	Tariff (Baht/Km)	Route length (Km)	Running time (min)	Maximum traffic flow (pass/h)	Number of required trains per hour	Headway (min)	Operation Requirement		Number of cars including reserve
							Train sets	Cars	
A1	0.078	14.4	21.6	21,312	19	3.0	17	102	118
A2	0.296	14.4	21.6	14,370	13	4.5	11	66	76
B1	0.078	21.6	32.4	11,330	9	7.0	10	60	70
B2	0.296	21.6	32.4	3,277	3	24.0	3	18	22
C1	0.078	21.1	31.7	22,465	20	3.0	23	138	160
C2	0.296	21.1	31.7	15,303	14	4.0	18	108	124
D1	0.078	22.3	33.5	25,474	22	2.5	30	180	208
D2	0.296	22.3	33.5	16,995	15	4.0	19	114	132
E1	0.078	15.1	22.7	20,544	18	3.0	18	108	124
E2	0.296	15.1	22.7	12,829	11	5.0	11	66	76
F	0.078	8.3	12.5	21,696	19	3.0	11	66	76
	0.296	8.3	12.5	12,266	11	5.0	7	42	48
Total	0.078	102.8	-	-	107	-	109	654	756
	0.296				67		69	414	478

(6) Railway Commuter Service in GBA: Number of Railcars Required as of the Year 2000

In the same way, the required number of railcars was calculated as shown in the following table. The number of cars needed is 318 for the both tariff rates.

Table 7 RAILWAY COMMUTER SERVICE IN GBA: NUMBER OF RAILCARS REQUIRED AS OF THE YEAR 2000
(Ref: Table 6-7)

Route	Tariff (Baht/Km)	Route length (Km)	Running time (min)	Maximum traffic flow (pass/h)	Number required trains per hour	Headway (min)	Operation Requirement		Number of cars including reserve
							Train Sets	Cars	
E	0.078	30.94	41.3	12,692	10.2	5.5	16	96	108
	0.296	30.94	41.3	7,476	6.0	10.0	9	54	60
N & NE	0.078	28.53	38.0	*9,907	7.8	7.5	11	66	78
	0.296	28.53	38.0	15,300	12.2	4.5	18	108	126
S	0.078	27.19	36.3	18,708	15.0	4.0	20	120	132
	0.296	27.19	36.3	16,980	13.6	4.0	20	120	132
Total	0.078	86.66	-	-	33.0	-	47	282	318
	0.296				31.8		47	282	318

Note: E = Eastern Line (Bangkok - Hua Ta Khe)
N & NE = Northern & Northeastern Lines (Bangkok - Khlong Rangsit)
S = Southern Line (Bangkok - Sala Ya)
* According to the traffic assignment result, the figures are reversed in this case.

IV. Cost Summaries

(1) Project Cost Summary by Item

The project costs were estimated for both the Suburban MTS and SRT Railway Service based on unit price values existing at the end of 1978.

The costs for the Suburban MTS consist of four major items: civil engineering, electrical/mechanical engineering, land acquisition and operations.

For SRT Railway service, the costs are composed of the same basic major items. Since the improvement of the SRT would be made within the existing right of way, the land acquisition cost was excluded from the cost estimate. The project costs are summarized as follows:

Table 8 SUMMARY OF PROJECT COST

(in million Baht)

	Item	Cost	%
a) Suburban MTS (SMTS)	Civil Engineering*1 (Elevated)*2	7,971.24	36.1
	Rolling Stock	8,607.4	39.1
	Power Supply	1,267.6	5.7
	Signalling & Telecommunication	882.7	4.0
	Land Acquisition	348.6	1.6
	Workshop Equipment	34.9	0.2
	Sub-Total	19,112.44	86.7
b) Railway Commuter Service (RCS)	Construction*3	601.96	2.7
	Rolling Stock*4	1,872.00	8.5
	Signalling & Telecommunication*4	442.10	2.0
	Expansion of Workshop	22.20	0.1
	Sub-Total	2,938.26	13.3
c) Total	Total Project Cost	22,050.70	100.0

Note: This table refers Tables 6-13, 6-15 & 6-20.

*1 SMTS Civil Eng. included:
- Open Line Section (69%)
- New Stations (3%)
- Permanent Way (9%)
- Diversion and Relocation of Public Utilities (1%)
- Civil Engineering Work Shop (2%)
- Engineering Supervision (7%)
- Insurance Claim (1%)
- Contingency (8%)

*2 The At.-Grade Alt. Work reduces the figure to 5,732.44 million Baht.

*3 RCS Construction includes:
- New Stations (2%)
- Double - Track (77%)
- Improvement of Bangkok Station Yard (5%)
- Engineering Fee (7%)
- Insurance Claim (1%)
- Contingencies (8%)

*4 Case of highest demand.

(2) Project Cost Summary by Route

The project cost was calculated per route as follows:

Table 9 PROJECT COST SUMMARY BY ROUTE

(in million Baht)

Route and Section			Cost	%
a) Suburban MTS	Northern Route	A1 = 5.0 km	965.97	4.4
		A2 = 9.4	1,805.97	8.2
		B1 = 17.8	2,418.07	10.9
		B2 = 3.8	653.37	3.0
		Sub-Total 36.0	5,843.38	26.5
	Eastern Route	C1 = 10.1	1,873.23	8.5
		C2 = 11.0	2,033.65	9.2
		Sub-Total 21.1	3,906.88	17.7
	Southern Route	D1 = 7.3	1,622.02	7.4
		D2 = 15.0	3,021.06	13.7
		E1 = 5.0	975.09	4.4
		E2 = 10.1	2,052.00	9.3
		Sub-Total 37.4	7,670.17	34.8
	Western Route	F = 8.3	1,692.01	7.7
	Grand Total L = 102.8 km		19,112.44	86.7
b) Railway Commuter Service	Southern *(Alt. 1) = 56 km		1,505.65	6.8
	North & Northeastern = 72		889.24	4.0
	Eastern = 31		474.85	2.2
	Workshop Expansion		68.52	0.3
	Grand Total L = 159 km		2,938.26	13.3
c) Total	Total Project Cost		22,050.70	100.0

Note: This table summarizes Table 6-13 and 6-15 for the MTS and Table 6-20 for the RCS with operation costs deducted for both systems.

V. Technical Evaluation

In order to determine whether the future transport facilities for a mass transit system in the suburban area would be adequate to meet the future demand, the future traffic volume was forecast and evaluated using the "All-or-nothing Method". The items listed below were calculated by the computer and the main results are summarized in the following Table-10.

i) O-D matrices for each type of transportation mode

ii) Required travel time for each link both MTS and road network

iii) Travel speed for each link of road network

iv) The assigned traffic volumes for each link

v) The accumulated assigned traffic volume both MTS and road network

vi) Degree of congestion for each link of road network

vii) Vehicle-kilometers, vehicle times, passenger kilometers and passenger-hours for each link

viii) Total vehicle-kilometer, vehicle time, passenger kilometers and passenger-hours for all trips

ix) Mass transit passenger volume between each station

x) Average passenger volume on the Mass Transit System

xi) Revenue by the passenger volumes between each station and the amount of the revenue, both for SRT and Suburban Mass Transit System

Table 10 SUMMARY OF TRAFFIC ASSIGNMENT RESULTS, 2000
(Ref: Tables 5-39A & 5-39B)

Item	Unit	Tariff (Baht/Km)	Total System Constructed	Not Constructed	Difference	
					Actual	%
Number of Passengers on the MTS	Trips/Hr.	0.078	353,245	260,957	92,288	135.4
		0.296	253,566	206,958	46,608	122.5
Generated & Attracted Vehicle Trips	Trip Ends/Hr.	0.078	314,394	393,056	-78,622	80.0
		0.296	318,864	395,452	-76,588	80.6
Revenue from MTS	Million Baht/Year	0.078	3,356	1,038	2,318	323.3
		0.296	6,465	2,104	4,361	307.3
Vehicle-Kms on the Road Network	Vehicle-Kms	0.078	3,941,591	4,620,328	-678,737	85.3
		0.296	3,986,995	4,642,845	-655,850	85.9
Vehicle-Hours on the Road Network	Vehicle-Hrs.	0.078	92,053	110,748	-18,695	83.1
		0.296	93,248	111,378	-18,130	83.7

From the table, the following conclusions can be drawn:

1) Since the percentage difference for each item is almost the same in both tariff cases, the benefits of constructing the suburban MTS is deemed to be independent of the tariff rate.

2) The increase in the tariff ratio will have a significant influence on the number of passengers and revenues of the suburban MTS. As the tariff increases from 0.078 to 0.296 Baht/km, decrease of the number of passengers will become about 50 percent, but revenues will double.

3) In every case, construction of the suburban MTS will reduce the vehicle trips, vehicle-hours and vehicle-kms on the road network by about 20 percent each.

4) The construction of the suburban MTS will produce increased

revenue to the first stage urban MTS, about three-fold, although a slight variation is seen due to the rate of tariff (0.078 and 0.296 Baht/km respectively).

The study reveals that the construction of the new suburban MTS system will bring about valuable benefits in terms of the capability of passenger handling, contribution to alleviation of congestion, increase of revenue and reduction of vehicle trips, vehicle-kms and vehicle-hrs compared with the case if the system were not constructed.

VI. Benefits Produced

The construction of the mass transit system will primarily benefit passenger car users who will change their mode of transport from cars to mass transit. The direct benefits calculated and enumerated below consist of savings in vehicle operating costs, travel time costs and vehicle congestion cost. Indirect benefits such as impact on city development, increasing the flow of economic life, etc., were not quantitied as benefits in this study. The benefits from both the Suburban MTS and the Railway Commuter Services were calculated by comparing two alternative cases: the urban MTS with suburban MTS links and urban MTS without the suburban MTS links.

(1) Type of Benefit

Two types of direct benefits were considered for the calculation of total benefit:

a) Time Benefit

i) Benefit for passengers diverted to the suburban MTS:

The total number of passenger-hours on the total MTS network including the time on the approach road to the station.

ii) Benefit for passengers not diverted to the suburban MTS:

The total number of vehicle-hours on the total road network calculated by the type of vehicle and the benefit resulting from reduced traffic congestion.

b) Running Benefit

Benefit for car, bus and truck owners based on the vehicle kilometers spent on the total road network including benefits resulting from reduced traffic congestion. The total benefits are summarized in Table 11.

Table 11 TOTAL BENEFITS
(Ref: Table 8-11)

(Unit: Baht/Hr.)

Tariff of MTS (B/km)	Time Benefit	Running Benefit	Total Benefit
0.296	88,203	1,069,363	1,157,566
0.078	914,186	1,191,031	2,105,217

(2) Economic Viability of the Project

The initial economic investment, operation and maintenance costs have been analysed using 1978 discounted values.

The total economic costs for the construction of the suburban MTS, according to the priority described in Summary Section III (3), and the improvement of railway commuter services were discounted against the total economic benefits created by the project to derive the benefit-cost ratio and the internal rate of return for each alternative case considered. Of the many alternative cases which might be considered for project development, the following three cases were chosen for the purpose of comparative evaluation:

1. Construction of all sections as an elevated type structure.

2. Construction of all sections as an at-grade.

3. Combination of approximately 50% of the total proposed network to be an elevated structure and the rest at-grade.

In each case of above, improvement of the existing SRT facilities was assumed to take place in parallel development.

The results of the economic analysis for the three alternative cases are summarized in Table 12. The results show that this project is economically very viable and will yield a high rate of return (over 20%) and that the tariff rate for the suburban MTS should be kept as low as possible or on per with the existing railway (0.078 Baht/km). Even if the tariff rate were to be increased to twice existing bus tariff rate (i.e. 0.296 Baht/km), the economic feasibility of the project is still viable.

Table 12 PROJECT ECONOMIC INTERNAL RATES OF RETURN
(Ref: Table 8-17)

Case No.	Construction Alternatives		Tariff of MTS (Baht/km)	Internal Rate of Return (%)
	M T S	S R T		
1	Elevated	At-Grade	0.078	31.3
			0.296	22.6
2	At-Grade	At-Grade	0.078	37.1
			0.296	26.7
3	Elevated & At-Grade	At-Grade	0.078	33.5
			0.296	24.2

The results of the sensitivity analysis summarized in table 13 below indicate that from the economic viewpoint, the project will not be particularly sensitive to price escalation since a 20% variation in project benefits and costs will only produce a 4.4% loss of return. Since the suburban MTS is economically feasible, project implementation is recommended in order to alleviate traffic congestion and realize the many associated benefits for the nation.

Table 13 ECONOMIC INTERNAL RATE OF RETURN
(Tariff rate 0.296 Baht/km, all sections constructed)
(Ref: Table 8-18)

		Cost Sensitivity Range		
		-10%	0	+10%
Benefit Sensitivity Range	-10%	—	19.9 (-2.7)	18.2 (-4.4)
	0	24.3 (+1.7)	22.6 (Base)	20.0 (-2.6)
	+10%	26.5 (+3.9)	24.1 (+1.5)	—

(3) Financial Viability of the Project

The effects of different tariff rates on revenues were examined not only for guidance regarding tariff increase, but also to demonstrate the effects on the benefits of price escalation. The results of both an escalating tariff rate at 0.4% p.a. which corresponds to the average tariff raise in the SRT over the past ten years and a fixed tariff rate are summarized in Table 14 below.

Table 14 COMPARISON OF ALTERNATIVE REVENUE BASES
(Ref: Table 8-22)

(Unit: Baht/Hr.)

Base Tariff of MTS (Baht/Km)	Type of Tariff	Suburban MTS	Suburban SRT	Total	Difference (%)
0.078	Fixed	277,783	175,139	452,922	9.18
	Escalating at 0.4% p.a.	303,282	191,297	494,499	
0.296	Fixed	522,711	220,813	743,524	9.18
	Escalating at 0.4% p.a.	570,694	241,083	811,777	

In both cases, whether the base tariff rate is the same as the SRT tariff (0.078 Baht/km) or double the bus rate (i.e. 0.296 Baht/km), the result of a 0.4% tariff escalation is a 9% increase in the total project revenues compared with the fixed tariff rate.

The financial internal rates of return as shown in Table 15 are not as attractive as the economic IRR as shown in Table 12; however, the rate of return still shows more than 10 percent in the case of an MTS tariff rate of 0.296 Baht/km. If the tariff rate were to increase at the rate of about 0.4% p.a., the financial rate of return should increase to more than 15 percent which should be sufficient to cover the opportunity cost of capital of around 12 percent which seems to prevail in the country.

Table 15 PROJECT FINANCIAL INTERNAL RATES OF RETURN

Case No.	Construction Alternatives	Tariff of MTS (Baht/km)	Internal Rate of Return (%)	
			Fixed Tariff	Escalating Tariff (0.4% p.a.)
1	Elevated	0.078	3.8	4.7
		0.296	13.7	15.1
2	At-Grade	0.078	4.9	6.1
		0.296	16.6	18.4
3	Elevated & At-Grade	0.078	4.2	5.3
		0.296	14.7	16.4

Note: This table is the summary of Table 8-23.

The results of the financial sensitivity analysis, summarized in Table 16, indicate that the project will not be particularly sensitive to price escalation since a 20% variation in benefits and cost only produce a 3% loss of return.

Table 16 FINANCIAL INTERNAL RATE OF RETURN
(Tariff rate 0.296 Baht/km, all sections constructed)
(Ref: Table 8-24)

		Cost Sensitivity Range		
		-10%	0	+10%
Revenue Sensitivity Range	-10%	—	12.0 (-1.7)	10.7 (-3.0)
	0	15.4 (+1.7)	13.7 (Base)	12.2 (-1.5)
	+10%	17.1 (+3.4)	15.2 (+1.5)	—

VII. Conclusions and Recommendations

1) Since the construction of suburban mass transit system will produce beneficial results for reducing the traffic congestion, not only in the suburban area, but also in the central urban area, the conclusion that the mode (heavy rail) of the suburban MTS should be the same at the first stage urban MTS can be said to be clearly justified.

2) The tariff system for both the first stage MTS and the suburban MTS should be considered as a single system and be established as high as possible. Even if the tariff system of MTS is almost the same as the existing SRT, the traffic volume on the suburban alignment will still allow for a reasonably profitable operation of the suburban links.

3) The northern sections (Sections B1 and B2) of the suburban MTS will require further scrutiny in the next study phase in the light of the currently implemented widening of the super highway and the more efficient utilization of SRT facilities.

4) In order to meet the future traffic demand from the growth in the Thonburi area, the suburban MTS and the existing southern line of SRT should cooperate closely to provide supplementary services.

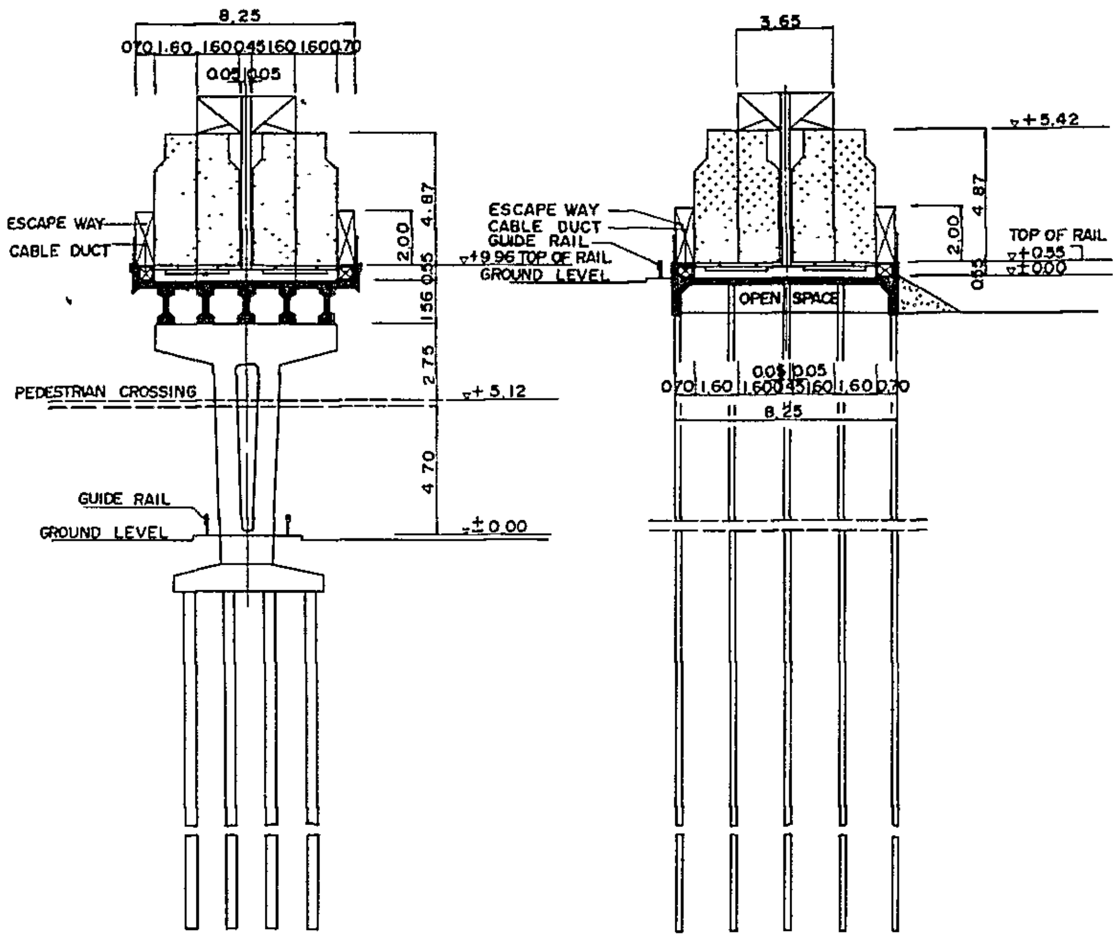
5) Since the bus system will function as the future mass transit feeder system, the fact that the tariff system of the suburban MTS will exert a tremendous influence on bus passenger volume should be considered. In addition, the results in this report indicate the necessity for establishing bus-lanes, even if the suburban MTS is constructed.

6) The 5.8 km missing northern link in the planned Outer Ring Road should be constructed to the same standard as rapidly as possible to cater to suburban transport within the central region.

7) Because of the short study period, it was not possible to either coordinate with the First Stage Mass Transit System or to pursue further comparison of alternatives for more accurate results. It is recommended therefore that after obtaining more data, the coordination and modification of the network, if necessary, should be made and more detailed features of the plan and analysis should be worked out in the next stage.

TYPICAL CROSS SECTION OF SUBURBAN MTS SYSTEM

ELEVATED SECTION　　　　　　　　AT GRADE SECTION



Reference: Report of First Stage Mass Transit
　　　　　System in Bangkok

JICA