社会開発調査部報告書

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

OFFICE OF THE NATIONAL ECONOMIC AND SOCIAL DEVELOPMENT BOARD
STATE RAILWAY OF THAILAND
THE KINGDOM OF THAILAND

THE STUDY
ON
AN IMPROVEMENT PLAN
FOR RAILWAY TRANSPORT
IN AND AROUND THE BANGKOK METROPOLIS
IN CONSIDERATION OF URBAN DEVELOPMENT
I N
THE KINGDOM OF THAILAND

FINAL REPORT

VOLUME I

PART I INTRODUCTION
PART II INTEGRATED URBAN AND RAILWAY DEVELOPMENT

OCTOBER 1995

JAPAN RAILWAY TECHNICAL SERVICE
YACHIYO ENGINEERING
ALMEC

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PREFACE

In response to a request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct the Study on an Improvement Plan for Railway Transport in and around the Bangkok Metropolis in Consideration of Urban Development in the Kingdom of Thailand and entrusted the study to the Japan International Cooperation Agency (JICA).

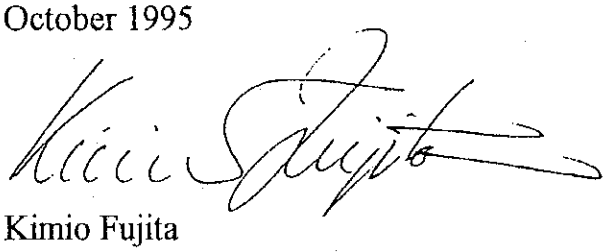
JICA sent to Thailand a study team headed by Dr. Misao Sugawara, a Board Member of Japan Railway Technical Service (JARTS), consisting of JARTS, Yachiyo Engineering Co., Ltd. and ALMEC Corporation, 6 times between August 1993 and August 1995.

The team held discussions with the officials concerned of the Government of Thailand, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the team.

October 1995



Kimio Fujita
President
Japan International Cooperation Agency

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Abbreviations / Acronyms

AAT : Airport Authority of Thailand
ATC : Area Traffic Control
BCR : Bangkok Capital Region
BMA : Bangkok Metropolitan Administration
BMA : Bangkok Metropolitan Area
BMR : Bangkok Metropolitan Region
BMTA : Bangkok Mass Transit Authority
BOI : Broad of Investment
BOT : Built - Operate - Transfer
BTS : Bangkok Transport System in 1975
CCTV : Companion Closed Circuit Television
DCTP : Department of Town and Country Planning
DEPP : Office of Environmental Policy and Planning
DOH : Department of Highways
ESB : Eastern Seaboard of Bangkok
ETA : Expressway Rapid Transit Authority
FCT : Inter-Urban Fast/Comfortable Train
HOV : High Occupancy Vehicle
HSR : High Speed Railway
ICD : Inland Container Depot
IEAT : Industrial Estate Authority of Thailand
IURP : International Urban and Railway Development
JARTS : Japan Railway Technical Service
JICA : Japan International Cooperation Agency
MMG : Modernized Metro Gauge
MOI : Ministry of Interior
MOTC : Ministry of Transport and Communications
MRSP Study : Metropolitan Regional Structure Planning Study
MRT : Mass Rapid Transit
MRTA : Metropolitan Rapid Transit Authority
MWA : Metropolitan Waterworks Authority

NESDB : Thai National Economic and Social Development Board

NHA : National Housing Authority

NIC : New Industrial Country

OCMRT : Office of the committee for the Management for Road Traffic

OESD : Office of Eastern Seaboard

ONEB : Office of National Environmental Board

SBIA :Second Bangkok International Airport

SCOOT : Split, Cycle, Offset Optimization Technique

SPURT : Seventh Plan Urban And Region; Transport

SRT : State Railway of Thailand

PART I

INTRODUCTION

PART I INTRODUCTION

1. Background and Circumstances of the Study

Bangkok, the capital of Thailand, has a population of 6 million in the BMA and a population of 13 million in the BMR including the periphery (in 1990). By 2010, the city's population is expected to grow by an additional 5 million. It is an important policy of the Thai government to decentralize city functions into regional core cities in order to improve the extreme over-concentration in Bangkok.

While Bangkok Metropolis is one of the greatest city areas in the world, it has no mass rapid transit systems to support the activities of the city and the only existing railway in the Bangkok urban area is not provided with a system suitable for urban transport of a large volume of passengers (especially because of the many at-grade crossings with roads within the city center). Furthermore, the urban development in the periphery of Bangkok has been mainly carried out along trunk roads, forcing passengers of both commuting and business to utilize road transport. The road traffic in the center of the city is extremely congested by the demands of both intra-area and flow-in traffic.

The traffic congestion on roads, coupled with lack of alternative means of transport has grown to such an extent that it hinders the further economic growth of Thailand.

Under these circumstances, the Thai government selected urban traffic infrastructure improvement and build-up of railway transport capability and requested Japan to cooperate in a comprehensive urban traffic infrastructure improvement plan integrated with urban development by utilizing the right-of-way of the SRT in October, 1989 as well as railway transport capability build-up projects in the 200 km radius area (approx. 200 km from the center of Bangkok) in December, 1989.

The Thai government formulated the Bangkok urban area comprehensive traffic plan in April, 1991 with assistance from the World Bank, and also decided to carry out the Hopewell Project in November, 1991 to improve traffic infrastructure in the urban area (10 - 30 km from the center) by utilizing the right-of-way of the SRT.

In response, the Japanese Government sent a preliminary study mission from the Japan International Cooperation Agency (JICA), headed by Prof. Yoshitsugu Hayashi of Nagoya University, to Thailand in December, 1992. The preliminary study mission consulted on the contents of the study with the National Economic and Social Development Board (NESDB) and the State Railway of Thailand (SRT) and reached agreement on the Scope of Work and Minutes of Meeting on December 16, 1992.

With this agreement, on August 29, 1993, JICA sent a full-scale study team headed by Dr. Misao Sugawara and composed of the Japan Railway Technical Service, Yachiyo Engineering, and ALMEC to Thailand to carry out the Study.

The JICA Study Team explained the Inception Report to the Thai Government immediately after arrival in Bangkok. As a result, both the Japanese Side and the Thai Side agreed on the contents of the Inception Report at the first Steering Committee meeting held on October 4, 1993.

The Study includes a master plan covering the whole Study Area (the 200 km radius area) and a feasibility study on the selected priority project, Integrated Urban and Railway Development along the Eastern Line. The selection was made at the third Steering Committee meeting held on August 10, 1994.

While the Study was being carried out, the Study Team made six study visits to Thailand to hold discussions with Thai Members and to survey sites, and six sessions of the Steering Committee were held for explanation and discussion of the Study.

The results of the entire Study are compiled in the Draft Final Report. Explanation of the Report and discussion was carried out at the sixth Steering Committee meeting (Seminar) held on August 21, 1995.

Taking into consideration of the discussion at the 6th Steering Committee and comments from the Thai Side received on September 19, the Final Report was drawn up and completed on October 31, 1995.

2. Purpose of the Study

The purpose of this Study is to formulate a master plan for the railway transport capability build-up project incorporated with the urban development project along the railway lines in and around the Bangkok Metropolis (within a radius of 200 km from the center) as well as to carry out a feasibility study on the Eastern Line (a length of approx. 100 km of a railway line) as a project of high priority selected in the Master Plan.

The Study includes establishment of the Master Plan and the Feasibility Study on the Eastern Line selected in the Master Plan for the purpose mentioned above. The Hopewell Project, in which the right-of-way of the SRT in a range of 10 to 30 km from the center of Bangkok is utilized, has already been approved and been carried out. Therefore, the section covered by the Hopewell Project is excluded from the target area of this Study (Fig. 1).

3. Scope of the Study

(1) Objective of the work

The objective of the work is to supply housing with good environmental conditions in the 50 km radius area of Bangkok Metropolis for those who concentrate in Bangkok and its environs in the future and to divert car users flowing into the center of the city to railway users as much as possible by improving the railways, as well as to improve traffic conditions improved in order to alleviate traffic congestion in the center of the city and to prevent environmental disruption.

Furthermore, in the 200 km radius area of Bangkok Metropolis, provision of limited express trains connecting among Bangkok and regional core cities with fairly high frequency will be proposed, and proposals will be made concerning connection with access modes of transport and development of station periphery in regional cities, so as to contribute to the growth of key regional cities.

When this project is completed, it is expected that residential areas will be efficiently connected with business areas, commercial areas, the airport, etc. and a modal shift from automobiles and buses to railways will be made so that the loss caused by traffic congestion

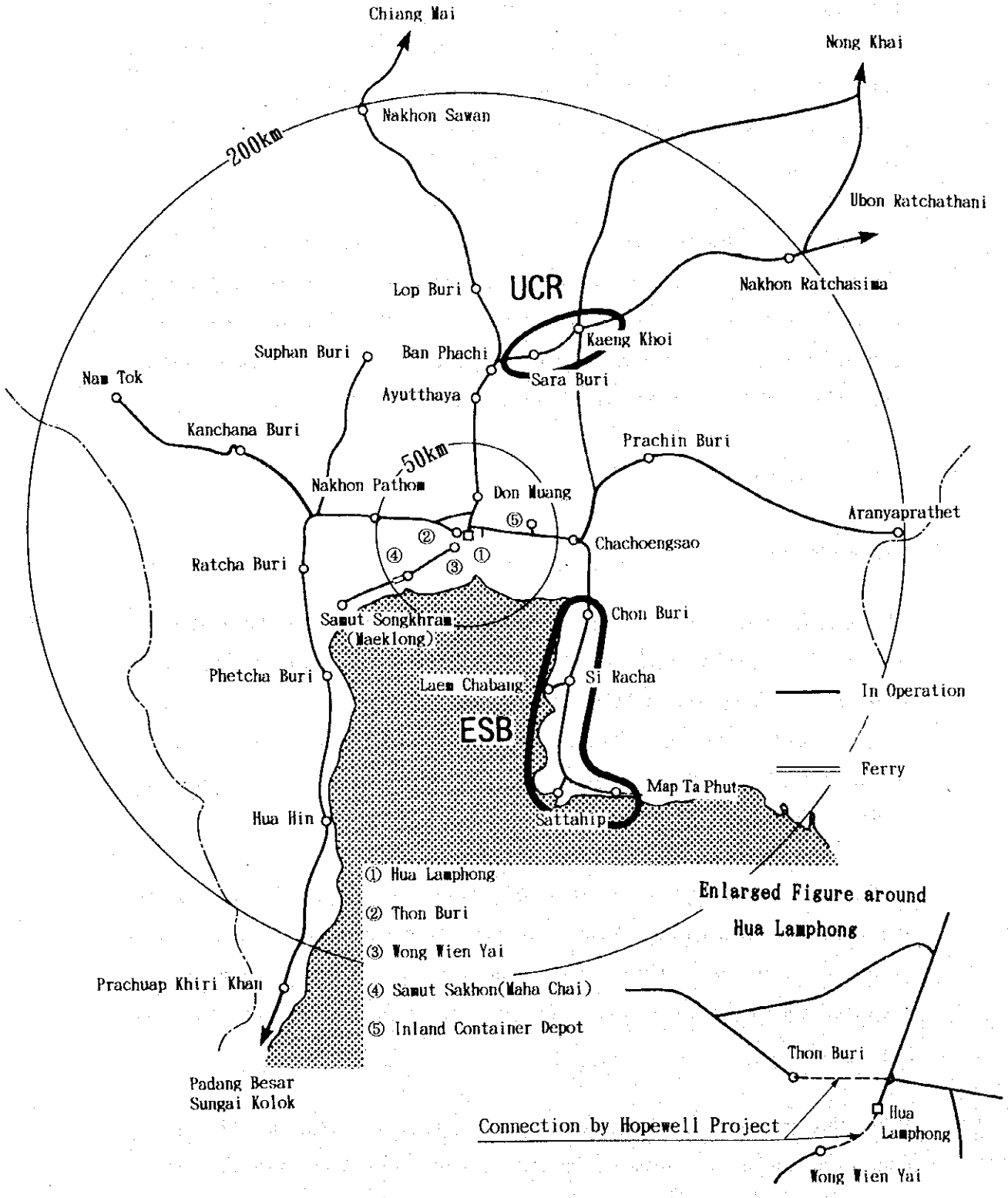


Fig.1 Railway Network in the Study Area

and environmental disruption can be reduced, economic development in Thailand will be promoted and improved conditions for society will be formed.

When planning this project, good use must be made of the SRT's right-of-way along the railway line as well as SRT's idle land even if pieces of this land lie scattered in various places.

In addition, land around the railway stations (including private land) must be developed by applying a land readjustment technique and a plan must be made to meet the above-mentioned purposes.

(2) Target year

The target year of the master plan is 2010. Accordingly, work for the allocation of population to areas along the railway route and improvement of transport services to the residents will be started from 1996.

(3) Coordination with related projects

There are some on-going large-scale projects within the area of this Study and this Study must be harmonized with these projects. The major national projects are as follows:

i) Strategic Planning for Metropolitan Bangkok
ii) Metropolitan Region Structure Plan Development
iii) Infrastructure Surrounding the Second Bangkok International Airport
iv) High Speed Train

The following plan has not yet been determined by the Thai Government, but is also taken into account in this Study.

SRT Master Development Plan

Furthermore, this Study is conducted on condition that the following mass rapid transit projects in the center of the city under consideration (some of them already have been determined and started) are completed and functioning by the target year of each project .

i) Hopewell Project
ii) BMA Mass Transit Project (Tanayon)
iii) MRTA Metropolitan Area Rapid Transit Project (Sky Train)

Since this Study will be most affected by whether these related projects succeed or not and their schedule, it is necessary to fully monitor their progress at all times.

(4) Subject area for the Study

The subject area is within a radius of 200 km from the center of Bangkok and is divided into 3 or 4 zones.

i) Within a range of 10-30 km

This is a zone corresponding to the BMA which is already a crowded city area. Its major portion is covered by the Hopewell Project.

ii) Range of 10-30 km to 50 km

This is a zone corresponding to the BMR where urbanization will possibly advance rapidly as the suburbs of Bangkok grow. There are many pieces of land suitable for urban development such as housing in combination with a build-up of the railway functions and establishment of new stations.

iii) Range of 50 km to 200 km

This is a zone which has a direct and indirect influence on the center of Bangkok. The Thai Government intends to decentralize urban functions and develop this zone as an independent city. Therefore, a modal shift to railways is encouraged by enhancing railway functions, shortening a time required for arriving at one's destination, providing comfortable coaches, improving access means to stations, providing convenient transfer facilities, setting attractive fare policies for railway users, etc.

(5) Evaluation of projects and execution of the Feasibility Study of priority projects.

In this Study, urban development is planned for areas suitable for development in each direction along the East Line, North Line, South Line and Maeklong Line of the SRT, and railway improvement incorporated with urban development is also planned.

Benefits or an increase of profits against the additional investment/operating cost in this case are calculated and a synthetic judgement is made in view of other local characteristics, urbanization plan, environmental protection, financing issues, etc. to evaluate the project. Based on the results of this evaluation, the Bangkok-ESB Corridor is selected as of high priority and the Feasibility Study on it is conducted.

4. Organization of the Study

The Study has been carried out under the study structure shown in Fig.2, which involves many concerned sectors and organizations in Thailand.

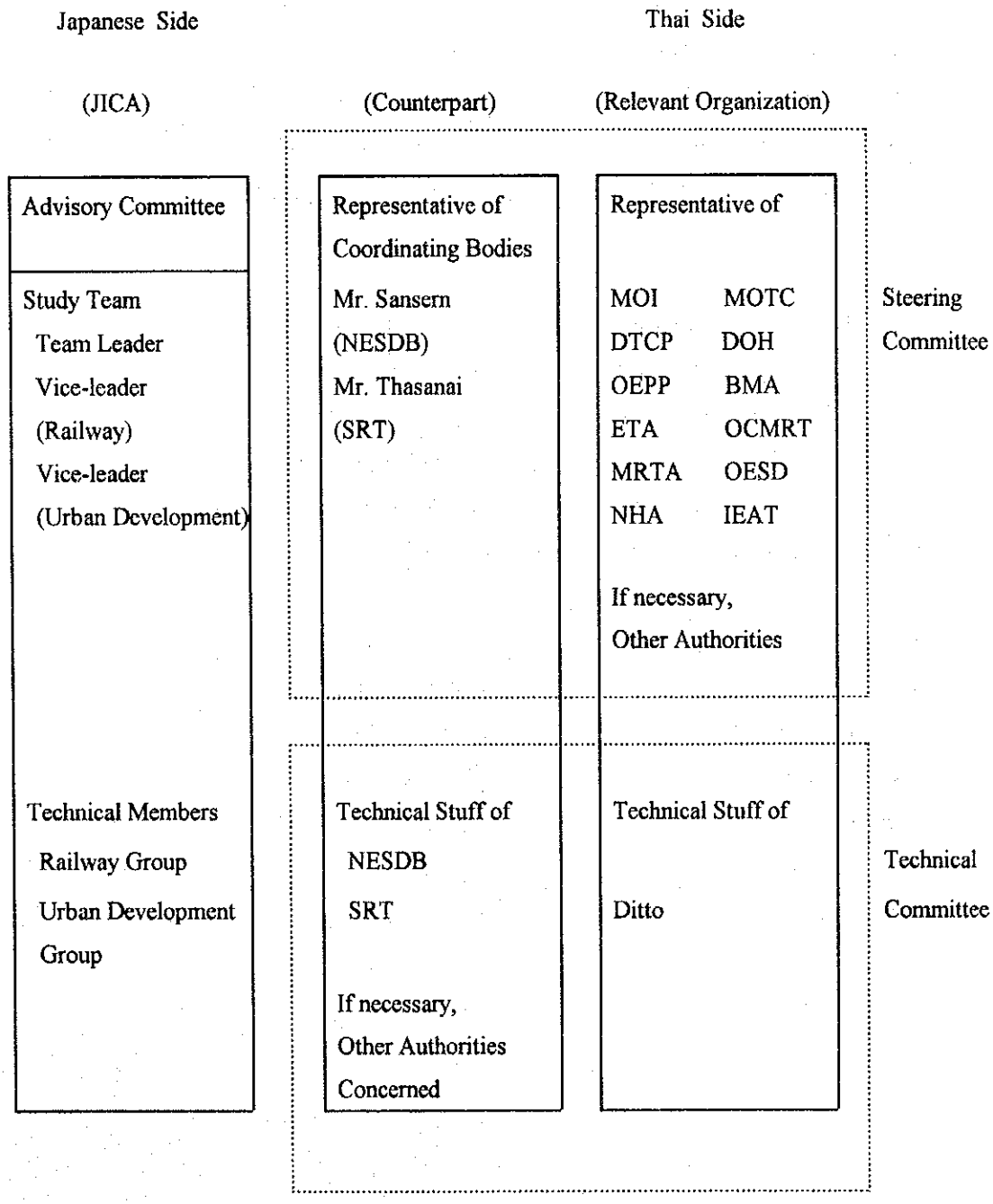


Fig.2 Organization Chart for the Study Implementation

5. Progress of the Study

The progress of the Study are as follows.

(1) Work in Thailand

The 1st work in Thailand	August 29 - November 6, 1993
The 2nd work in Thailand	January 17 - January 26, 1994
The 3rd work in Thailand	August 3 - August 13, 1994
The 4th work in Thailand	October 6 - December 28, 1994
The 5th work in Thailand	May 30 - June 8, 1995
The 6th work in Thailand	August 16 - August 25, 1995

(2) Steering Committee

The 1st Steering Committee	October 4, 1993
The 2nd Steering Committee	January 24, 1994
The 3rd Steering Committee	August 10, 1994
The 4th Steering Committee	November 29 1994
The 5th Steering Committee	June 5, 1995
The 6th Steering Committee (Seminar)	August 21, 1995

(3) Submission of the Reports

Inception Report	September, 1993
Interim Report (I)	January, 1994
Interim Report (II)	July, 1994
Interim Report (III)	May, 1995
Draft Final Report	August, 1995
Final Report	October, 1995

6. Members Concerned

The members of the Japanese Advisory Committee and Study Team, and the members of the Steering Committee and Counterpart of Thailand are as follows.

(Japanese Side)

(1) Members of the Advisory Committee

Prof. Yoshitsugu Hayashi, Chairman
Mr. Hiroyuki Yamamoto, Transportation Plan
Mr. Syun'iti Iwasaki, Transportation Plan
Mr. Yasushi Kamata, Railway Facility Plan
Mr. Tosio Nagasawa, Regional Development / Land Use
Mr. Toshiaki Fukumoto, Road Transportation / Access Plan

(2) JICA Staff

Mr. Fumio Ishikawa, Coordinator
Mr. Kazufumi Shiii, Coordinator
Mr. Shouichi Tsugane, Coordinator

(3) Members of the Study Team

Dr. Misao Sugawara, Team Leader
Mr. Osami Matsumoto, Vice Leader / Railway Plan
Mr. Kenji Tanaka, Vice Leader / City Plan / Regional Development
Mr. Tei Kojin, Railway Transport Plan
Mr. Tsuneo Hashimoto, Railway Construction Plan
Mr. Yoshio Sasaki, Station Plan
Mr. Tetsuhiko Matsumuro, Station Plan
Mr. Katsuro Munezawa, Route and Station Design / Construction
Mr. Michiya Hashimoto, Signalling, Telecommunication and Electrification Plan
Mr. Takashi Nishida, Signalling, Telecommunication and Electrification Plan

Mr. Akio Watanabe, Signalling, Telecommunication and Electrification Design

Mr. Shoichi Inuzuka, Rolling Stock Plan

Mr. Yukio Murakami, Rolling Stock Plan

Mr. Mistumasa Uchihori, Financial Analysis

Mr. Norio Mochizuki, Financial Analysis

Mr. Eiji Nishita, Regional Promotion

Dr. Samart Ratchapolsitte, Environmental Analysis / Marketing

Mr. Masato Kotoh, Transportation and Access Plan

Mr. Shigeki Takashima, Transportation and Access Plan

Dr. Ryuji Nakamura, Demand Forecast / Economic Analysis

Mr. Tetsuo Horie, System Design

Mr. Naoshi Okamura, System Design

Mr. Akitoshi Iio, Urban Design / Land Use Plan

Mr. Hidemi Kuwazawa, Urban Design / Land Use Plan

Mr. Osamu Ohtsu, Urban Policy / Development System

(Thai Side)

(1) Members of the Steering Committee

Mr. Sansern Wongcha-Um, Chairman

Mr. Thasanai Chantarangkul, SRT, Assistant General Manager

Mr. Pree Buranasiri, NHA, Governor

Prof. Kumropluk Suruswadi, OCMRT, Deputy Director of the Office of Megaproject

Mr. Teerasak Mongkolpod, MOF, Senior Specialist for Loan, Loan Policy and Management Division

Mr. Kamrob Warachat, MOTC, Director of Planning Division

Mr. Sarin Skulratana, MOTC, Director of Planning Division

Mr. Chaisit Cururatana, MRTA, Director of Planing Division

Mr. Pallop Onkcharoen, DTCP, Deputy Director General

Mr. Bancha Vathanasindhu, DOH, Chief of Programming Section Planning Division

Mr. Sonthi Vannasaeng, OEPP, Director of Environmental Impact Evaluation Division

Mr. Prapon Vongvichien, BMA, Director of Design Division

Mr. Chukiat Photayanuvat, MRTA, Engineer, Development and Planning Division

Dr. Utis Kaothien, NESDB, Director of Urban Development Coordination Division

Dr. Pornchai Rujiprapha, NESDB, Director, Center for Integrated Plan of Operations

Mr. Piromsakdi Laparojkit, NESDB, Acting Assistant Secretary

Mr. Pornchai Jaruprapha, NESDB, Acting Director Integrated Plan Operation Center

Mr. Amnuay Tonmukayakul, SRT, Superintending Engineer, Project Development Center

Mr. Kriangkrai Boonyayothin, NESDB, Acting Specialist Development Coordination

Mr. Prasert Attanandana, SRT, Divisional Engineer, Project and Planning, Project development Center

(2) Members of the Counterpart

Mr. Thasanai Chantarangkul, Project Manager

Mr. Amunuay Tonmukayakul, SRT, Leader, Superintending Engineer, Project Development Center

Mr. Kriangkrai Boonyayothin, NESDB, Vice Leader, Acting Specialist Development Coordination

Mr. Prachoom Tanticharoen, SRT, Superintending Engineer, Technical Division

Mr. Suri Khuanmon, SRT, Superintending Engineer, Technical Division

Mr. Jakkit Choosaksilp, SRT, Mechanical Engineer, Mechanical Engineer, Mechanical Engineering Department

Mr. Chookiat Leelakajonjit, SRT, Mechanical Engineer, Mechanical Engineering Department

Mr. Pramuan Wongsaroj, SRT, Engineer I/C Structure Design Section, Civil Engineering Department

Ms. Yawamal Chuthathong, SRT, Chief of Foreign Affairs Division, General Manager Bureau

Mr. Sayan Rohitrattana, SRT, Chief of Transportation Division

Mr. Panthop Malakul Na Ayutthya, SRT, Chief of Passenger Division, Traffic Department

Mr. Sujit Chaosirikul, SRT, Engineer I/C Project and Planning Division Signalling Telecommunication Department

Ms. Patama Sridaranop, SRT, Chief of System Section, Signalling and Telecommunication Department

Mr. Supachai Dechakhum, SRT, Chief of Information Section Marketing Department

Mr. Suthee Ploysook, SRT, Chief of Policy and Planning Coordination Division

Mr. Thira Ratanavit, SRT, Assistant Chief of Property Management and Development Bureau

Mr. Yolchai Kemungkorn, SRT, Chief of Technical Service Division Property Management and Development Bureau

Mr. Saittavut Buddasuwan, SRT, Chief of Technical Service Division, Property Management and Development Bureau

Mr. Krit Anurakamonkul, SRT, Chief of Project Management section Project Development Bureau

Dr. Yiemchai Chatkeo, SRT, Assistant Chief of Projetc Development Bueau

Mr. Chatchawal Kanitayon, SRT, Mechanical Engineer, Mechanical Division, Mechanical Engineering Development

Mr. Prasert Attanandana, SRT, Divisional Engineer, Project and Planning Project Development Center, Civil Engineering Department

Mr. Prasert Kamonwatananisa, NESDB, Policy and Planning Analyst

Mr. Chaiwat Srisantiratana, NESDB, Policy and Planning Analyst

Ms. Laksana Limpakanjanarat, NESDB, Policy and Planning Analyst

Mr. Worapong Nipakornpun, NESDB, Policy and Planning Analyst

PART II

INTEGRATED URBAN AND RAILWAY DEVELOPMENT

1. INTRODUCTION

In this part II of Volume I presents the integrated urban and railway development planning (IURD) and implementation system.

Chapter 2 discusses the necessity of railway improvement itself in Thailand, especially Bangkok centrered region as well as the integration of the urban and railway development, highlighting the dynamic relationship between them.

Chapter 3 presents the integrated urban and railway development plan in Bangkok Metropolitan Region (200Km radius area from the center of Bangkok), Bangkok Capital City Area (50Km radius area) and Eastern Corridor (SRT Eastern Line). Urban development plan around the station of the Eastern Line is examined with the application of land readjustment implementation system in Chapter 4.

Chapter 5 proposes the institutional system for the implementation of the integrated urban and railway development.

Finally, the conclusion and recommendation are set forth including best utilization of the existing railway, Establishment of IURD implementation system, necessary measures in city planning system of Thailand and revision of the general plan in force.

2. IMPORTANCE OF AN INTEGRATED URBAN AND RAILWAY DEVELOPMENT

2.1 Necessity of Railway Improvement

In the midst of worsening traffic congestion on the road network of Bangkok, it has become undeniable that road construction alone can not solve urban transport problems. The road problems have far reaching effects on urban and housing development. It is becoming almost impossible to develop housing sites accessible to the workplaces, especially in the CBD. That is, accessibility of one-hour travel time. In this situation, urban and housing development will no longer be manageable should they keep depending on the road transport system. In this respect, it must be stressed that Bangkok road problems are not only urban transport problems but urban development problems.

The NESDB estimated that the total population of BMR will increase by 40% up to the year 2010. This roughly means that an additional urban area as large as 40% of the existing built-up area will be needed by 2010. This poses the challenge of expanding the urban area within an affordable commuting time (at present 2 hours is not exceptional at the morning peak hour), without adding to the car traffic volume on the existing congested road network.

In order not only to solve the current serious urban transport problems, but more importantly, to secure sustainable urban growth of the Bangkok Capital City through the 21st century, the modal shift of urban transport to public transport (including railway system) or in other words the transformation of the existing road transport based city to a public transport based city has became inevitable.

The currently proposed mass rapid transport systems (partially under construction), such as Tanayong System, MRTA, Hopewell and others seem to be in line with this development policy for the transport system of Bangkok. However, it must be stated that by nature they are quite limited in terms of service area, transport capacity and service (function) to properly establish the public transport based city of Bangkok

Capital. Since the currently proposed systems are mostly designed to serve a limited area including the existing CBD and the nearby commercial and built-up areas, they are not sufficient for establishing an integrated public transport system for the following reasons:

1) They are to run through mainly the business/commercial areas, not connecting the major residential areas in the suburbs, and will not fully respond to the current road traffic problems, especially worsened by the commuter traffic in the morning/evening peak hours.

2) Due to the limited capacity, length of service line and speed, they do not effectively provide for the outward expansion of urbanization.

3) Since the areas they go through have already been built up to a considerably high density, they are not effective for creating new urban areas which are needed by 2010.

4) While they are defined as an intra-urban transport systems, there is a lack in the suburban and inter-urban transport systems in order to establish an integrated public transport system for the Bangkok Capital Region.

In this light, SRT railway system is taking into consideration the following advantages for establishing the public-transport based City of Bangkok with the railway forming the backbone of the transport system:

1) Locational Advantages: The existing right-of-way and rail lines either run through or close to the pivotal parts of Bangkok Capital Region (CBD — built-up area — suburban — regional centers), being best located so as to be the backbone of regional/urban mass transport system of Bangkok Capital Region. It must also be noted that the existing SRT rail lines happen to be in a good location for connecting the proposed MRT systems with one another and with the SRT itself.

2) Functional Advantages: One of the great advantages of a railway system is that it can perform multi-transport functions such as those of intra-urban, suburban and inter-urban transport by providing different train service systems on one and the same line, with less limitation in transport capacity, travel length, and can best function as a main corridor of the mass transport system.

3) Urban Development Advantages: As stated above, the currently proposed Mass Rapid Transit Systems are not designed to respond to the needs of urban development expansion. Fortunately, the areas along the SRT line, especially in the suburbs of Bangkok, are still undeveloped and are large to an extent sufficient to accommodate the huge amount of urban land demands for further growth of the Bangkok Capital Region.

Based on the above explanations, the improvement of the SRT railway will significantly contribute to solving not only the urban transport problems but urban development problems of Bangkok.

2.2 Necessity of an Integrated Urban and Railway Development

(1) Low Regard for the Railway in the Past

In the past, urban development was not a great concern to the railway operator and, likewise, due attention was not given to the railway in the Thai city planning and development activities. As such, city planning and development missed the opportunity to establish a reliable urban public transport system and instead relied heavily on road transport.

It is apparent that this situation must be changed to gear toward railway improvement, which is crucial to the solution of urban transport problems and urban development problems in Bangkok.

(2) Joint Effort Needed

It must be emphasized that one-sided efforts directed to either railway or urban

development cannot reverse the situation toward a maximized railway operation. In this regard, the necessity for integration of railway and urban development requires joint efforts.

(3) Correspondence —Static Relationship between Urban and Railway Development—

The necessity for integrating urban development and railway development is quite understandable when one imagines what would happen if these are separately developed in an uncoordinated manner. For instance, in an extreme case, a railway built in a sparsely populated area could result in wasteful capital investment. In another case, urban development may take place in an area which is out of reach of the railway, thus resulting in failure to avail themselves of the improved rail services.

Based on the above, it is clear that urban and railway development should not be separated, but rather must be coordinated. One of the basic purposes of the integration is to keep consistency and correspondence between land use plan (urban development) and railway development plan.

It is not unusual for railway development to correspond with urban development and vice-versa, in terms of the following:

a) Space : The urban area to be developed should correspond to the service area of the railway.

b) Timing : Construction/improvement schedule of railway should correspond with that of urban development.

c) Characteristics : The characteristics of the railway service to be provided should correspond to that of land use and communities (to cite an example, commuter train service to the residential/commercial area; freight train service to industrial areas and so on).

d) Development Size : There should be a good balance between urban and railway developments in size and scale, otherwise, either over-investment or under-investment would result.

(4) Dynamic Relationship between Urban and Railway Development

The greater importance of integration can be found in the dynamic relationship between the urban and railway development than in the correspondence to be achieved between them.

Full-scale railway development can be made possible only through applying and working the dynamic mechanism, in which urban and railway development help promote each other. This is more important in countries like Thailand where the railway has been disregarded and as a result failed to earn popularity as a main transport mode.

The cycle of demand and supply

It is commonly known that the demand and supply of public transport services like buses and railways are mutually interdependent. The supply of a higher level of service must be financed through increased fare revenues accrued from the larger demand of passengers. Thus, the supply is dependent upon the demand. On the other hand, the larger volume of passengers can be attracted by a higher level service being supplied. Thus, the demand is dependent upon the service. This mutual interdependence can lead to either a vicious or favorable cycle, to wit:

a) Vicious Cycle of Demand and Supply.
Along with the declining tendency of demand (railway passengers) due to the poor transport service, less investment for improving the service due to worsening financial conditions of operators is likely to deteriorate the service level of supply, thus resulting in a further decrease of demand to the railway.

b) Favorable Cycle of Demand and Supply.
On the contrary, improved transport service can increase passenger demand, consequently creating the financial capability, through the increased fare revenue, to further improve the service level of supply.

It appears that the recent stagnant operation of the SRT may be partially attributed to the vicious cycle as stated above. Hence, the ultimate goal of an integrated urban and

railway development is to put the SRT operation in a favorable cycle through the mutual interdependence of demand and supply.

Urban developments along the railway lines are less intensive at present due to the unpopularity and low service level of the existing railway operation including access services. On the other hand, capital investment for improving the existing railway service does not seem feasible due to the low potential demand of passengers resulting from the less intensive urban development.

It is apparent that if things are allowed to continue as they are, the condition of railway operation will further deteriorate and the railway will lose the opportunity to play an important role in urban transportation as well as urban development. The basic idea of this project, is to put an end to this situation and accelerate a favorable cycle where the railway improvement/development goes hand in hand with the urban development along the improved railway lines.

Once this favorable cycle starts working, urban and railway development will automatically make progress, each depending on the other. However, more aggressive promotional measures for either urban or railway development are needed so as to put them on the right track before the favorable cycle starts working. More specifically, vigorous promotional measures for urban development along the railway must be taken before and in parallel with the railway improvement since the important effect of the railway in attracting passengers cannot be expected at the early stages of development where/when the railway is not popular.

The Circulation of Fund

The other cycle that must be established is the funds to maintain the momentum of developing the railway and supplying a high level of railway services. Railway development and supplying the railway services can yield many kinds of development benefits. They are classified as follows:

1) Direct benefits
   - Savings in travel time and cost to the users of the railway.

2) Indirect benefits

- Relieving the traffic congestion for the users of competing transportation system.
- Increased utilization and benefits to businesses around the stations.
- Increased utilization and value of lands and buildings.

Some part of the benefits listed above are collected through railway fares and taxation (ex. property tax, income tax and the like). However, it is obvious that the revenues collected are far below the cost of railway development and operation with the deficits being subsidized by the government.

If the deficits are allowed to grow, railway development and operation are destined to come to a standstill.
On these premises, new systems of cost recovery or the cycle of costs and benefits must be urgently established.

The basis of the discussion of the cost recovery from the development benefits are summarized as follows:

a) While the railway operation can collect the direct benefits through the fare system, whether high or low, indirect benefits are elusive so that the cost sharing by the developers and property owners is generally quite small as compared to the benefits they earn from the high return of the real estate businesses and high land values accruing from the railway development.

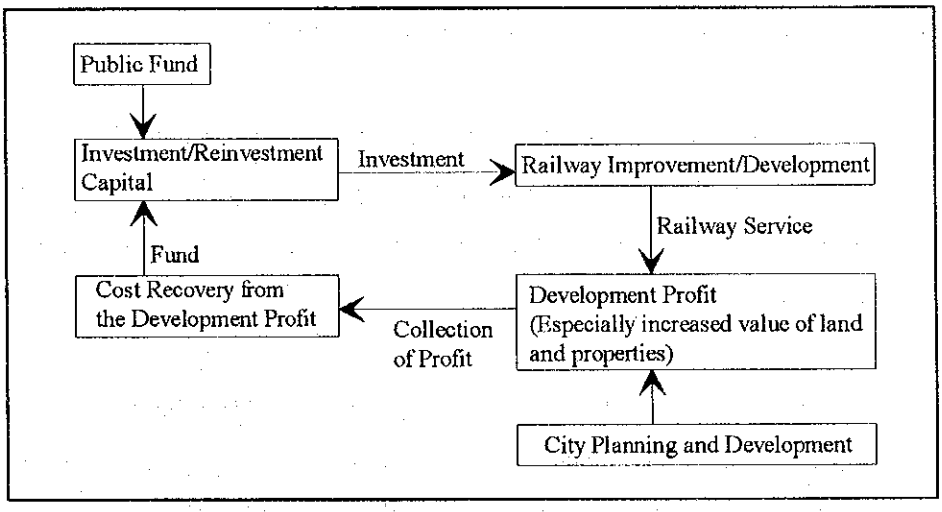
One of the major reasons for cost recovery is based on the necessity of attaining social fairness in the cost sharing for public utilities.

b) It is known that railway developments yield tremendous benefits. However, only a very small amount can be collected to recover the development cost. This is the main reason that there is a large gap between the socially desirable level of railway service and the practical level of services provided by the existing railway operator, leading to the shortage or insufficiency of public transport service.

Eventually without any measures, the social unfairness in public transport service will become blatant on one hand and the government's financial conditions will lead to a crisis or the railway operation will fail on the other hand.

The integrated urban and railway system aims at the establishment of a circulation funds for railway development in such a manner that investment/reinvestment capital is funded through cost recovery from the development projects especially the increased value of land and property due to the railway development, simultaneously arresting the possible social unfairness stated above.

Fig. 2.2.1 Circulation of Funds for Railway Development



(5) Large Scale Urban Restructuring along with Railway Development

The last reason for emphasizing the necessity of "integration" in this study is that it intends to especially stress the necessity of urban development in order to improve and develop the railway system, and gives special attention to the great effects of the urban and railway development, which consequently cannot help drastically changing the existing Bangkok urban area, leading to large scale urban restructuring of Bangkok.

In short, railway development is to be coupled with the change of the urban structure due to the dimension and magnitude of the great effects of railway development as

follows; (In other words the railway development will be feasible only along with changes in the urban structure. It must be noted that the railway cannot be made feasible without such a large, change of population/employment distribution that the existing urban structure changes.

1) Great dimension and magnitude of urban development along with railway development

It is well known that urban developments depend on the capacity of the access system to them, in terms of development size, such as land area, population, employment and others. The size of urban development along the railway is incomparably larger than those along the highway, taking into consideration the large difference in transport capacity between them.

To cite an example, the existing CBD of Bangkok is quite limited in size since depended on the relatively small access transport capacity of road traffic including buses. It will no longer be limited if/when the improved railway provides large capacity access to the CBD.

The large scale new towns — say 300,000 to 500,000 population — will no longer be developed totally depending on the road network, because of the small capacity of road transport to Bangkok. They will be possible only if they rely on the large capacity of the improved railway.

As stated above, the population of BMR is estimated to increase by 40% by 2010. It is anticipated that the greater part of this additional 40% increased population must be served by the railway because of the road traffic problems. To do this, a greater part of the increasing population must be lead to locate along the railway lines. It seems certain that the population distribution pattern forged along with the railway development will be quite different from that which emerged on the existing road based transport system. This will eventually necessitate a change in the urban structure, or urban restructuring.

2) Social/economic influence on people's urban lives and activities

At present the main transport mode for people is road vehicle transport — individual transport system featuring door to door, anytime travel, less punctuality — long delays and unpredictability of arrival time and so on. In addition to these features of road transport, the road traffic congestion has created another feature of road transport in Bangkok, that is "short distance travel". People tend to find their destinations (either for shopping, commuting or others) close to their origins, avoiding the long travel time on the road network, thus resulting in the short distance travel.

The people's travel behaviour and activities based on road transport features which prevail in Bangkok will change with the increasing popularity of railway transport.

Railway transport with characteristics such as high speed, punctuality, scheduled travel and others is likely to bring about a more orderly travel pattern, eventually requiring change in the transport infrastructure system and the urban structure. To cite an example, people who live in the suburbs are likely to go shopping in the nearby commercial center due to traffic congestion in/around the CBD. However, easy and rapid access by railway to the CBD from the suburbs may enhance the shopping in the CBD, thus, leading to a change in the shopping behaviour of the people.

3) Change of location of urban activities and consequent change of traffic flow

Road network tends to disperse urban activities broadly throughout the urban areas while the railway network tends to attract them into the CBD and areas around stations. Thus, high density large commercial centers are to be developed on the railway network, while a large number of small shopping centers are scattered along the road network. These locational differences will be reflected in the traffic flow with random flow on the road network and regular (uniform) flow on the railway network. Moreover the railway is likely to accelerate concentric traffic flow converging on the city center for the purposes of shopping, commuting and

business.

The changes discussed above will inevitably require a new urban structure for the railway transport oriented city.

In conclusion, "Integration" stresses the necessity of city planning and development in response to railway transport.

2.3 Establishment of Integrated Urban and Railway Development System in the Thai City Planning and Development System

As stated in section 2-1, in the past due attention has not been given to the railway system in Thai city planning and development. The necessity for integration suggests simply that the railway system should be properly taken into consideration in the city planning development procedures and systems. This study is to show the methodology of formulating a railway development plan in city planning, in consideration of the railway system, leading to the integration of urban and railway development.

Finally, this study aims at the establishment of an integrated urban and railway development system in Thai city planning and its implementation.

3. INTEGRATED URBAN AND RAILWAY DEVELOPMENT PLANNING

3.1 Outline of Relevant Planning Studies

Excerpts of the ongoing important studies which this study must coordinate with are presented as follows:

3.1.1 Metropolitan Regional Structure Planning Study

The Metropolitan Regional Structure Planning Study conducted under the National Economic and Social Development Board (NESDB) has great significance (especially on this ongoing JICA study) since its recommendations will form the basis of future government policies on development in the central region. The JICA study, therefore, is proceeding in line with the development concepts set forth in the NESDB study. Both studies, however, emphasize the necessity of restructuring the metropolitan region.

The important aspects of the NESDB study and plans shown in the Fig. 3.1.1 are summarized as follows.

(1) Restructuring of Chao Phraya Multipolis

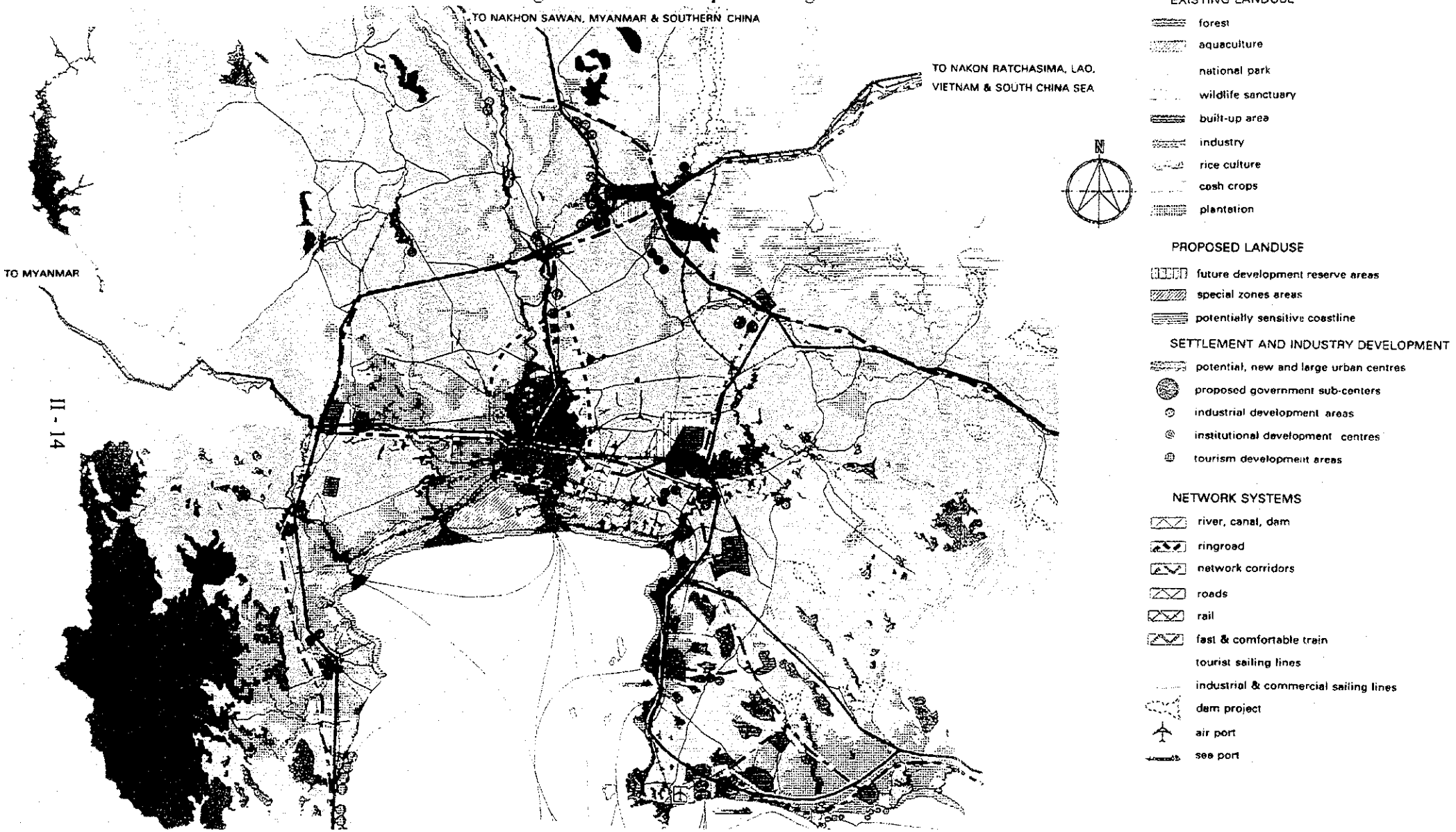
The necessity to restructure Chao Phraya Multipolis is derived from the following:

- To cope with the serious and worsening urban problems in Bangkok arising from the relentless concentration of traffic, air and water problems reaching dangerous levels in the built-up area and urban sprawl, deterioration of agriculture in the suburbs, etc.

- To respond to "quantum changes", it is acknowledged that the Kingdom of Thailand, especially its central region, is presently undergoing drastic changes brought about by changes in the entire country.

- The solution to Bangkok's problems no longer lies within Bangkok Metropolitan's system, but must include a broader area, that is, the Chao Phraya Multipolis and its future. The malfunctioning "primate city" should be transformed into a well-functioning metropolis within a dynamic "multipolis" to share in the vision of Thailand as a well-functioning, financial, communications, research and information center of Southeast Asia.

Fig. 3.1.1 Metropolitan Regional Structure Plan



(2) Multipolitan Structure

A multipolitan system, such as the Chao Phraya Multipolis, is not simply one large settlement. It is a complex, multinodal, poly-centric system of settlements. Most importantly, the settlements differ in function or operation. A well-functioning multipolis generates a type of comparative advantage among the settlements, allowing each center to build on its own strengths (resources, skilled labour, location, institutional base, etc.) and they are developed through the complex inter-relationships (linkage) of the various settlements within the hierarchy.

The emerging multipolis comprises four district sub-systems:

- Greater Bangkok, which includes Bangkok and those areas directly dominated by Bangkok - Thailand has become the gateway to Southeast Asia and its capital city, a force within "Pacific Asia's string of world cities". Bangkok is fast emerging as a financial and developmental hub of Southeast Asia, thereby stressing its important role in the development of the fastest growing region in the world. Therefore, the re-urbanization of Bangkok metropolis is imperative to prepare it in its future role as one of the key financial centers of the Pacific Rim.

- Eastern Seaboard, the Chachoengsao to Rayong (and beyond) Multipolitan System - Thailand's and Indochina's gateway to the world - The Eastern Seaboard within Chao Phraya Multipolis will be a different Eastern Seaboard under the original plan. In addition to the coastal development, this region has great potential for further settlement development in the interior, which in turn is the principal area of further population growth (as many as five million additional people). The region has two principal nodes as follows:

  Chachoengsao: Aside from being a major agricultural/industrial center, Chachoengsao will also assume the role as Thailand's administrative subcentre and be the technical, management, and industrial support center for the Nong Ngu Hao International Airport. Through Chachoengsao, government services can be brought much closer to the rapidly-growing Eastern Seaboard and Saraburi industrial

complexes.

Rayong - Mab Ta Phut - U Taphao: This closely-related, high-tech industrial and global trading complex will not only be Thailand's gateway to the world, but will also play a similar role for Indochina and Yunnan Province in South China.

- The Western Region/Western Seaboard - The Sing Buri to Hua Hin Multipolitan System - Agriculture, natural resources and tourism are the backbones of economic activity in this region. The new steel mill and port development at Bang Saphan and destination tourism complexes between Cha-Am, Hua Hin and beyond will also play major roles in economic development.

  Samut Songkhram - Petchaburi - Hua Hin - Controlled, agri/seafood and tourism development and conservation region.

  Nakhon Pathom - Future Government administrative sub-center, with particular focus on industrial and regional administrative services.

- Upper Central Region - Upper Central Region Multipolitan Sub-system - Anchored by the City of Saraburi, this is a resource-rich region with great potential for further industrial development.

  Saraburi - A metropolis at the crossroads of Indochina and future governmental construction technology and research center with particular focus on industrial and international export administrative services.

(3) Regional Infrastructure Networks

In the study, emphasis is placed on the Inter-Urban Transport System as a key factor to develop the Chao Phraya Multipolis, wherein the transport system would connect and serve the four urban sub-systems. The Inter Urban Transport System would be composed of a motorway and a railway running parallel in such a manner as to effectively serve traffic needs and demand.

- Inter-Urban Roadway System (A Strategic Road Network):

  The study identified an extensive regional and multipolitan scale network of inter-urban roadways. These are to be high-speed, controlled-access routes, offering efficient point-to-point inter-urban transportation links.

- Inter-Urban Fast/Comfortable Train (FCT):

  The proposed system is radically different from the present railway network in the study area, which appears to be a significant deterrent to the choice of rail as an alternative to the automobile. This system will have a speed of 150-175 km/h along modern lines, and travel time from Chachoengsao to Bangkok would be approximately 30 minutes. It should be noted that this proposed system is not high speed rail; HSR systems run at 250-300 km/h. However, Chao Phraya Multipolis has neither the distances nor the population levels to necessitate nor even sustainably support a true HSR. Thus, the proposed system is simply defined as a "Fast, Comfortable Train".

(4) Multipolitan Land Use Plan

< Management and Coordination of Land Use and Land Development >

The development of Thailand, particularly within the study area, has reached the end of an era — an era of informal, unplanned, uncoordinated, and unregulated land use and development.

At this point in time, the mere preparation of land use plans, or even the promulgation of certain legislative or regulatory steps would not suffice.

Thailand's famous and widely admired cultural characteristic of decision-making "by consensus" would probably need to be reconciled with the changing circumstances for land use control and land development process. All that is left is for the government to introduce and fairly and equitably to enforce and to maintain land use and land development rules and regulations.

The next phase of Thailand's development would include the planning, development, and construction of large, extremely important, highly capital intensive projects and programs which are absolutely dependent on good, reliable, publicly-stated and widely

disseminated, comprehensive, well managed and rigorously enforced land use and land development rules and regulations.

< Land Use Plan >

Extensive, legislative, institutional and human resources training efforts would be required for effective implementation of the plan. Every effort was made to keep the range of land uses as close to the existing uses as possible. Additional classes of land use were proposed only where it is felt essential to do so.

There are two major classes of land use:

a) Natural Environment Conservation Areas
   - Controlled Access Area
     - Natural Parks Area
     - Wildlife Sanctuaries
     - Water Reservoirs
     - Coastline Sanctuaries
   - Open Access Areas, not requiring access control
     - Forest Protection Area
     - Coastal Zones
     - Open Countryside

b) Modified and Built Environment Areas
   - Agriculture Land Use
     - Rice Paddy Culture
     - Cash Crops
   - Aquaculture Land/Sea Use
   - Tourism Area
   - Natural Habitat
   - Heritage Protection Area

c) Human Settlement Areas

- Existing Human Settlements
- Urban Fringe Areas
- Future Development Reserve Areas

d) Special Industrial Areas

- Resource-related
- Dangerous/High Risk Industries
- Environmental Risk Industries

e) National Inter-Urban Transportation and Utilities Networks Areas

- Motorways
- Rail
- Energy
- Communications

f) Special Zones

- Airports
- Industrial & Container Ports
- Military & Security Use Areas

3.1.2 Strategic Planning for Metropolitan Bangkok

Phase III

This study covers the impending urban problems of Bangkok, represented by the following five sectors.

- Structuring Suburban Development
- The New Towns Problem
- Wastewater and Drainage Issue
- Urban Congestion in Bangkok
- Unconventional Approaches to Urban Transportation in Bangkok

1) Conclusion

The study concluded that actions in each sector have achievements of their own toward preparing a workable physical design for the future of Bangkok. The combined effort leads to a city twenty years from now with its central cultural and governmental functions as a capital still in place.

2) Structuring Suburban Development

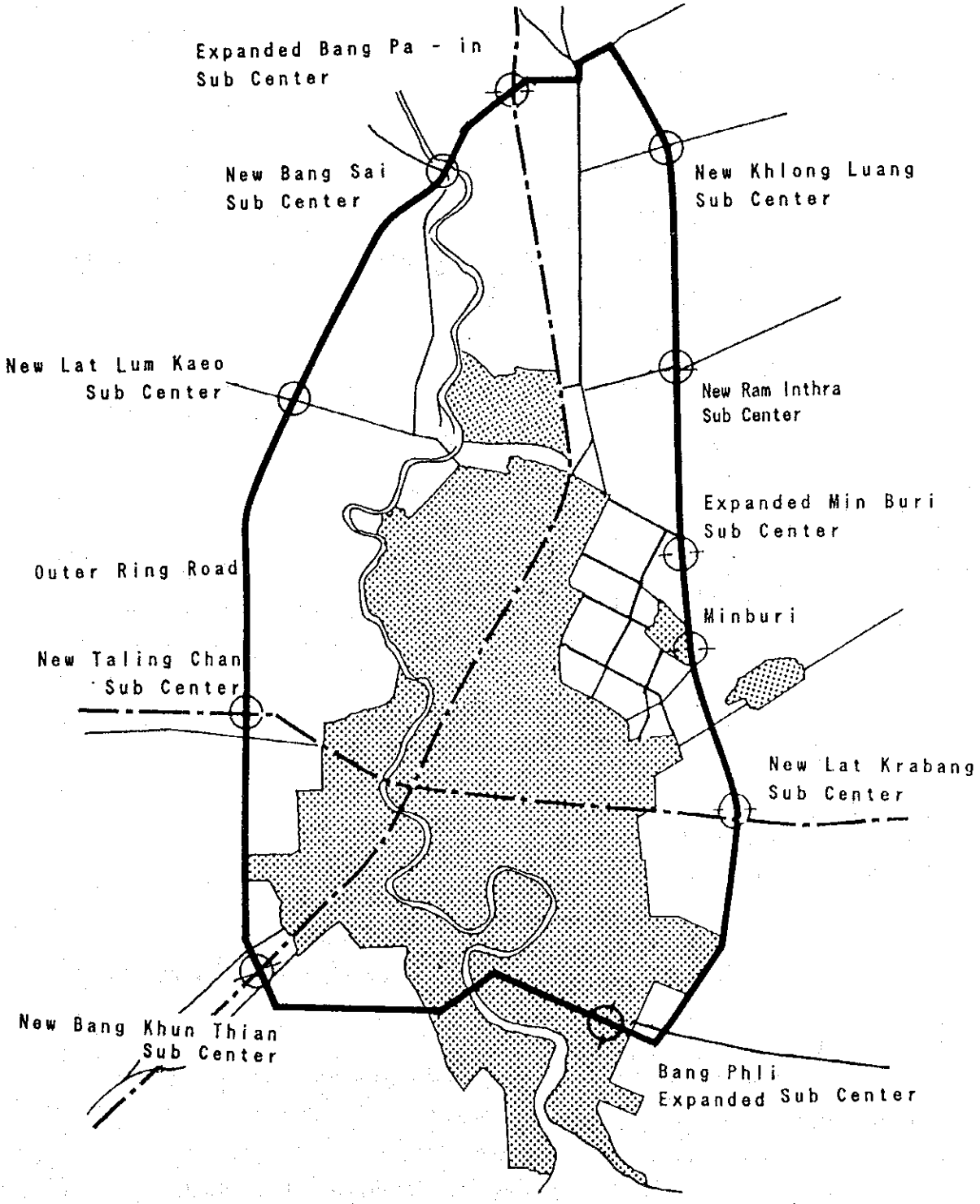
With a view to structuring future metropolitan growth the series of suburban centers, metropolitan subcenters are proposed to be developed in a ring 20 to 30 km from the city center as shown in Fig. 3.1.2, coordinated with the construction of the King's dike, the outer ring road, the new airport and other development stimuli. The significant concepts underlying the suburban development proposed in the study are outlined as follows:

- The subcenters are designed to provide concentrated housing development for families escaping the congestion and high land costs of central Bangkok with the government offices decentralized from central Bangkok serving as catalysts to encourage metropolitan subcenter development.

- The outer ring road, which serves as a spine through the metropolitan subcenters, should be developed as an "intelligent highway/transit corridor, incorporating electronic traffic control methods, among others, the express buses, eventually converting to rail transit.

- The government actions will be needed to assure that concentrated centers emerge, rather than sprawling, uncoordinated development. Adequate land planning controls are concomitant to this program.

Fig. 3.1.2 Proposed Pattern of Metropolitan Centers



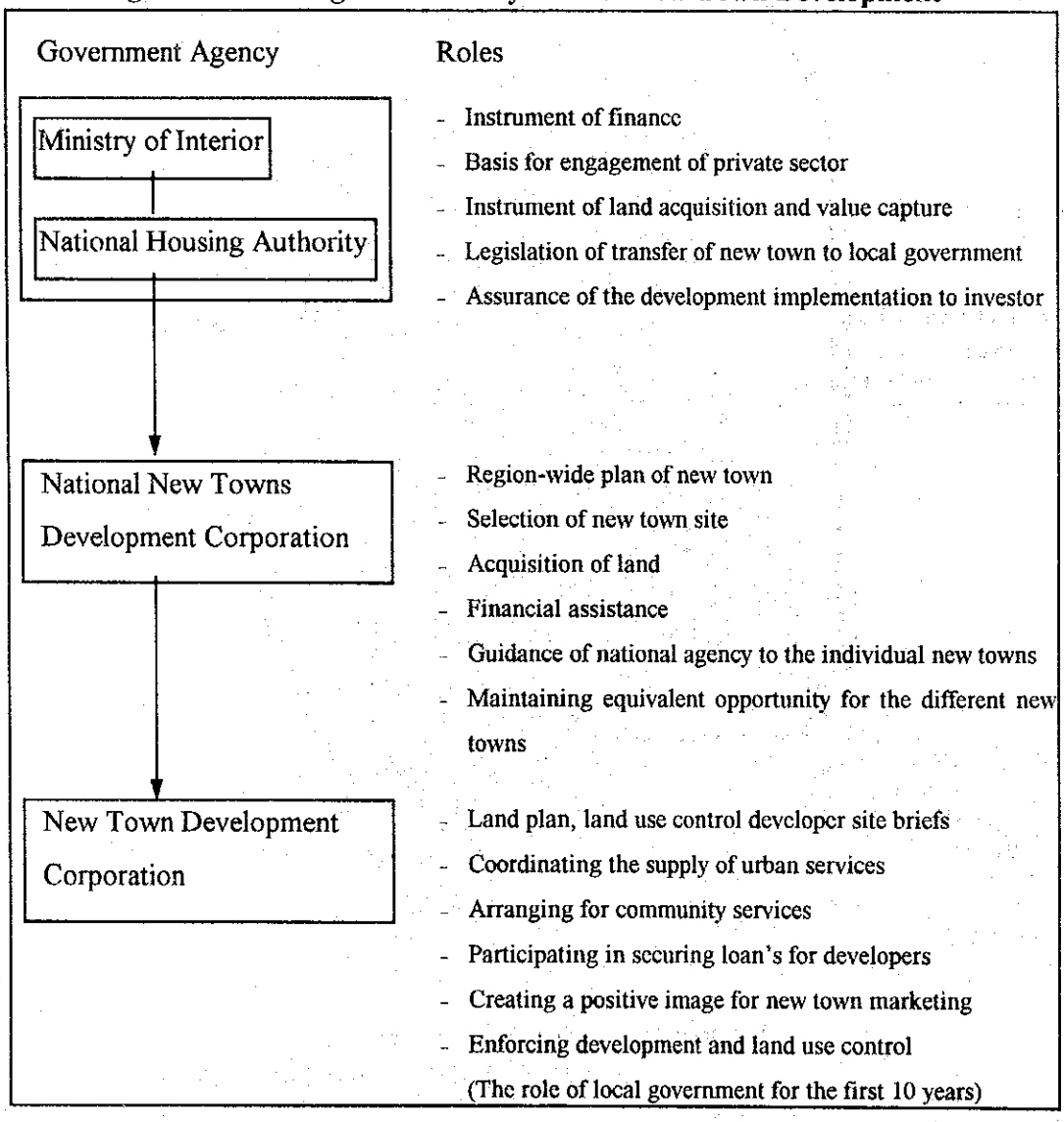
Source = Strategic Planning for Metropolitan
for Metropolitan Bangkok, 1994

3) The New Towns Program

The issues which may impede the implementation of the suburban development proposed in the study are discussed and the countermeasures are proposed as follows:

- Governmental organization of the new town effort: Establishment of the organizational system as shown in Fig 3.1.3 is proposed in order to ensure both a programmatic approach to the development of all new towns and stable approach to the implementation of the plan.

Fig. 3.1.3 Organizational System for New Town Development



- Land acquisition and value capture: There is an important need to streamline land acquisition and control techniques in order to build new towns. Among the available instruments of land acquisition are:

  - Bargaining and voluntary sale
  - Land readjustment
  - Land contribution by land owners (l)in exchange for areas in the project (2) in exchange for land within the project or (3) for cash payment

However, it must be stressed that it is difficult to acquire land by any means unless supported by the public right of eminent domain for purposes including housing.

It is pointed out that techniques of land acquisition and value capture seem to be most threatening issues to the viability of the new town program. It is concluded that the French new town practice of freezing land value is the best option. It enables the increased value of land to be collected by the new town authority itself, rather than permit it to be a windfall profit to a previous owner.

4) Balanced social composition

The study pin-points a potential risk of unbalanced social composition (homogenous area either low income or middle-high income group). In order to achieve a social balance in new towns the following measures are proposed:

- Establish social balance as a priority for new towns.
- Use financial assistance to influence location and type of housing production.
- Adopt a flexible housing policy.
- Development growth and land management strategies to keep housing and commercial rents affordable.
- Encourage a mix of land use
- Develop employment attraction programs.
- Establish a mechanism to monitor the social composition of new town.

5) Wastewater and Drainage Issues

A water and wastewater pricing system for new town: Due to the low lying land in the vicinity of several new towns, the hydraulic works are an important aspect of the development dynamics. However, the public expenditure in these works is a more than usually persuasive justification for expenditure on this work.
In this regard the study prepared scheme for making the water and sewerage system of the new towns self financing.

Financial savings in BMA's wastewater treatment plans from water conservation Programs: Cost-effectiveness of a water conservation investment for reducing flows to the wastewater treatment system is examined. Although the replacement of the toilet with low-flow version (saving 54% of water) shows a marginal effect, it is concluded that it would be more cost-effective to use it as a tool to achieve targeted saving in sectors of the city where it would be more valuable.

6) Urban Congestion in Bangkok-Toward Effective Implementation of Area Traffic Control/Companion closed Circuit Television (ATC/CCTV)

Based on the review of the proposed Area Traffic Control (ATC) implementation for Bangkok and its underlying Split, Cycle, Offset Optimization Technique (SCOOT) logic, the following major points for implementing ATC are raised as follows:

- An early and effective implementation of ATC is critical;
  - to improve congestion
  - to demonstrate cooperation toward a better transportation system
- Implementation is a first step, followed by effective operations and maintenance, guaranteed by a stable funding system.
- The idea of ATC/CCTV systems work as triggering mechanism for the "unconventional" method.
- ATC system should be considered as a catalyst to enable further transportation improvements.

7) Unconventional approach to urban transportation in Bangkok

The study examines cases of extreme congestion and the methods chosen for solving them.

The solutions include:

- Alternative uses of expressways to raise their through-put, for example by bus-only lanes.
- Restrictions on the use of automobiles in favor of more use of transit on certain streets at certain times.
- Bus priorities, ranging from special treatment for buses at traffic signals to the concept of "rush hour" during which private auto traffic would be cleared from key radial corridors to enable buses to rush commuters to the outer areas of the city.
- Large-scale traffic management to deal with severe problems of particular streams of traffic in various parts of the system by enabling congested streams to unload while others wait.

Phase IV

1) The Metropolitan Center Program

The metropolitan centers gain real clarity in this phase of work as a means by which to manage the explosive expansion of the Bangkok metropolitan area in a manner that can include jobs-housing balance, a significant tripmaking share for public transit, mixed use development, a much higher level of amenity than in unplanned parts of the city, the decentralization of some governmental employment, the more timely installation of basic infrastructure, and the mobilization of private development expertise and capital.

These objectives are embodied in a prototype design the metropolitan center near the new airport site at Lat Krabang. This new center design shows how the expanding future of Bangkok can offer much more livable local environments and can provide for much more efficient work setting than unplanned growth. It is

worthwhile to put one's self into this design to appreciate the merits of its micro environment and also the superior linkages it provides with the rest of the metropolitan area.

The program for development of Lat Krabang is proposed in detail by ingenious use of several well-known land development techniques. The techniques impose a real minimum of public control and limited public infrastructure expenditure as a basis for launching private sector initiative toward the rapid achievement of its objectives.

More specifically the development objectives, site and location and transit access are presented as follows:

< Objectives >

- To promote a job-housing balance in suburban sectors of the metropolitan area
- To promote the use of transit
- To encourage mixed use development
- To improve amenities
- To allow for the decentralization of government employment
- To assure the installation of infrastructure in advance of development
- To mobilize private development expertise and capital

< Site and Location >

The Lat Krabang Metropolitan Center should be located on approximately 740 ha of land between the Outer Ring Road on the east, Ramklao Road (Kings Dyke) on the west, the Krung Thep Kritha extension on the north and the Chonburi Highway on the south. Of this area, approximately 215 ha closest to the intersection of the Outer Ring Road and the Chonburi Highway should be planned as the core of the new metropolitan center and reserved for the highest density development (Fig. 3.1.4). This land is largely undeveloped at present, although several subdivisions into individual lots have been approved recently.

Fig. 3.1.4 Lat Krabang Center and Core Area

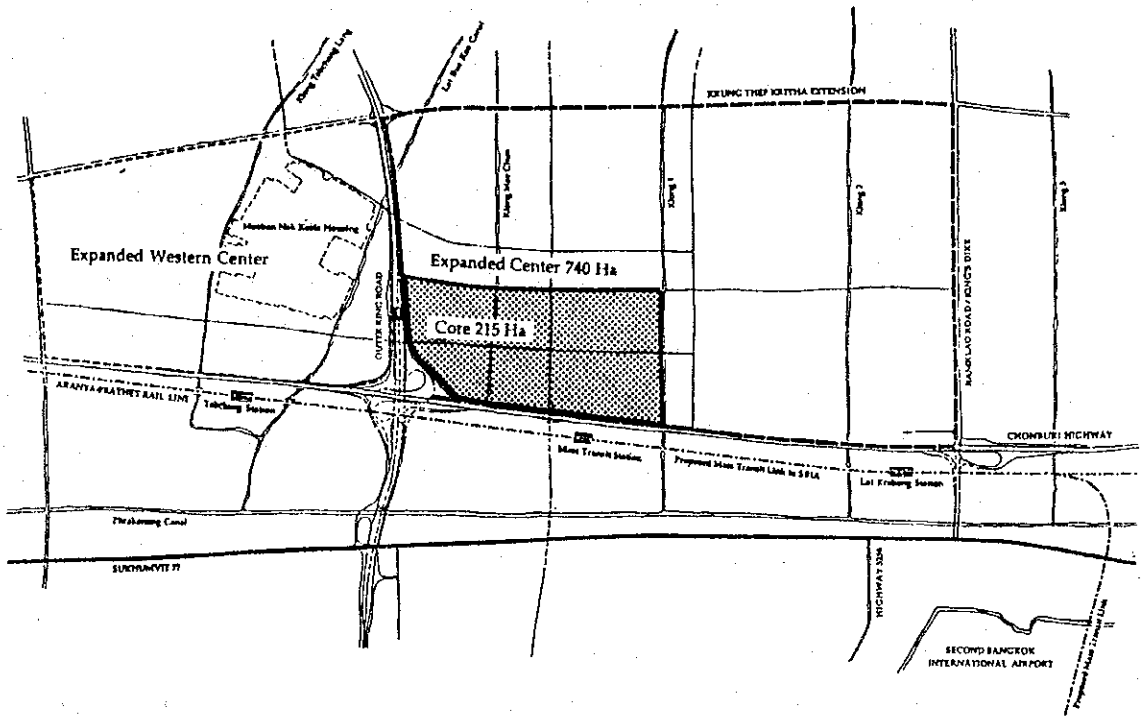
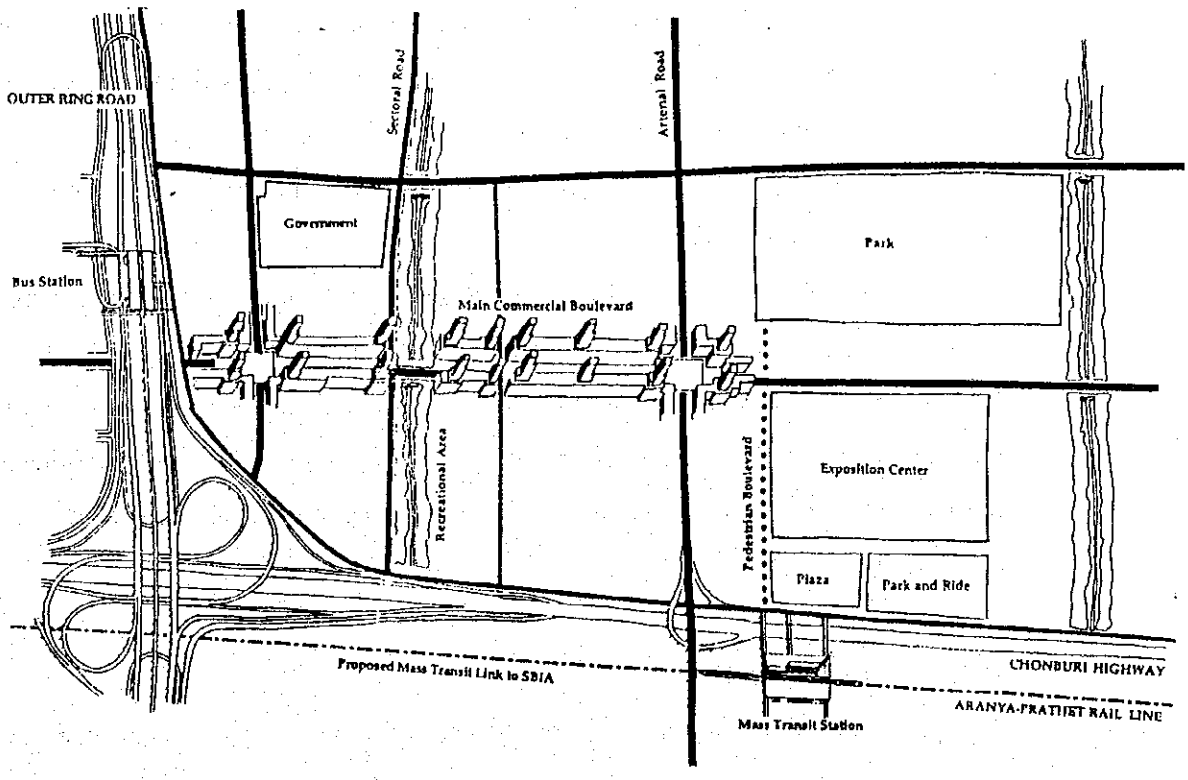


Fig. 3.1.5 Lat Krabang Transit Access



<Transit Access>

Three transit stops are possible to serve the Lat Krabang Metropolitan Center (Fig. 3.1.5). Two of these will be located on the transit system on the Eastern Railway alignment; one on the west end of the center to serve the core area, and a second on the east end to serve the large industrial area and higher density housing located nearby. Park and ride facilities should be located at each of these stations, as well as transfer facilities for local feeder bus lines. Along the Outer Ring Road there is adequate width dimension in the median to install a transit system. This system may be buses on exclusive lanes, or might ultimately be light rail. In the short run, HOV lanes might be provided on the inner lanes of the expressway, to be used by express buses.

2) Environmental Studies

< Air Pollution in Bangkok >

There have been many studies of pollution in Bangkok, many frightening extrapolations of the contamination problem for the coming years, and many policies have been proposed. From this environment of concern and effort two issues seem particularly important as BMA focuses on concerted action. One is that there needs to be careful vertical integration between policy and enforcement of effort in air contamination. We, therefore, would like to stimulate discussion on how integration between the ONEB and the implementation of actions against air contamination can be achieved.

The second problem is the choice of actual action. It is clear that action on this subject is most promising when taken at the national level, and very difficult to implement at the local level. We are therefore, attracted to policies that deal with the composition of fuels, devices required for sale of automobiles, perhaps pricing of fuels and other actions that can be enacted at the national level. We feel this too is worth discussion.

< Open Space for Bangkok >

This report introduces a really assertive structure for green space planning in the entire metropolitan area. It takes the new park at Bang Krachao as the eye of a

system that spans outward, dealing with the needs of different districts of the metropolitan area in terms of their capacities and needs. We are particularly looking forward to the review of BMA colleagues of this concept to retrieve green space for Bangkok. The plan includes a treatment of Lat Krabang as a prototype green area design for the metropolitan centers.

< A Pricing System for Wastewater Management and Strategies to Reduce Groundwater Consumption >

Concluding from studies that began in the early stages of these studies for BMA, we propose a special formulation for financial responsibility in support of wastewater treatment and disposal that charges users on the basis of the volume of use imposed by each user, plus the option of a treatment charge based on the average pollution load imposed by each industrial subclass. This begins to spread the burden of paying for all wastewater disposal is a responsibility of the national government, while still leaving a good deal of the responsibility at that level. It does not yet make individual polluters responsible for the full expense they impose on the system, but works towards that direction.

Proposals for reducing groundwater consumption are based on three basic options: (a) reducing public water rates to compete with the cost of groundwater, (b) compulsory connection with public water, and (c) the use of rates that presume charges to industries, based on their type and size, for public water consumption.

3) Zonal Traffic Management in Bangkok

Further studies show additional possibilities for important congestion reduction in Bangkok based on non-conventional action. In this phase we propose a plan. The basics of the proposed plan are: (a) an auto free central area, (b) the "rush hour" approach to rapid bus transport to the periphery at the end of the day in selected corridors, (c) improved pedestrian access, (d)improved water transit, (e) free bicycles, (f) improved truck access, and (g) firm enforcement. This too is an assertive plan that needs strong BMA commitment if it, or anything similar, is to deal successfully with Bangkok traffic.

One question has been whether congestion management promises any significant impact on the problem. This too will be opened for discussion. We suppose certain highly localized congestion pricing might be effective, while wider spread applications of congestion pricing are likely to be less so.

4) Toward a Strategic Transportation Plan for Bangkok

The IVHS team has documented the current very rapid advance of work in this area all over the world. Capability to assess this technology is building rapidly. This team makes preliminary suggestions for the kinds of electronically based traffic control and advice that would be appropriate on the circumferential corridor that links the Bangkok metropolitan centers. Detailed analyses of the cases of the Hanshin expressway system in Japan and the new INFORM system for a series of expressways on Long Island, New York provide good bases for comparison with the Bangkok case to select features that suit the situation.

3.1.3 Master Plan and Feasibility Studies for Area around SBIA

(1) Objectives and issues

The main objective is to create a master plan for the area around the future second airport to ensure the successful and timely implementation of all associated projects and to produce land use plan taking into account all potential environmental and development impact of the SBIA.

Important issues that have been highlighted for the land use planning around the second airport are:

- Investment in the airport will attract new business;
- Development mix to maximize benefits;
- Flood control and drainage as a tool for high quality development;
- Sufficient infrastructure and utilities;
- Visual impression created by the airport environs, which gives air passengers a lasting impression of the country;
- Quality of life in eastern Bangkok and the region for the next 100 years.

(2) Planning concept

The development potential of the Master Plan Area will be greatly increased as a result of locating the new airport at Nong Ngu Hao (SBIA) as an important piece in the development chain in the western region of Bangkok Metropolis - SBIA - Chachoengsao - Eastern Seaboard.

The area around SBIA can be divided into three major zones. They are:

- Primary zone within 5 km around the airport.
  This zone is designated for the location of national and international office headquarters and warehouses for direct airport related businesses.

- Secondary zone, 5 to 15 km
  This zones is subjected to direct airport influenced businesses and residential area for employees of the airport and airport related businesses.

- Tertiary zone, 15-30 km
  This zone will be allocated for businesses indirectly influenced by the airport and additional residential area for airport employees and others.

(3) Land use and development plan

The Strategic Land Use Plan 2010 is proposed as shown in the Fig. 3.1.6, with the following locational criteria and proposals:

< Commercial and Industrial Development >

- Develop the main infrastructure corridor between Bangkok Metropolitan Center and SBIA along the railway and the new Chon Buri Highway;
- Stimulate high quality business parks related to SBIA in the primary zone;
- Expand and improve existing industrial development in the secondary and tertiary zones, namely; Lat Krabang, Bang Pakong and Chachoengsao;
- Avoid commercial and industrial developments in the main water retention areas around SBIA.

< Residential >

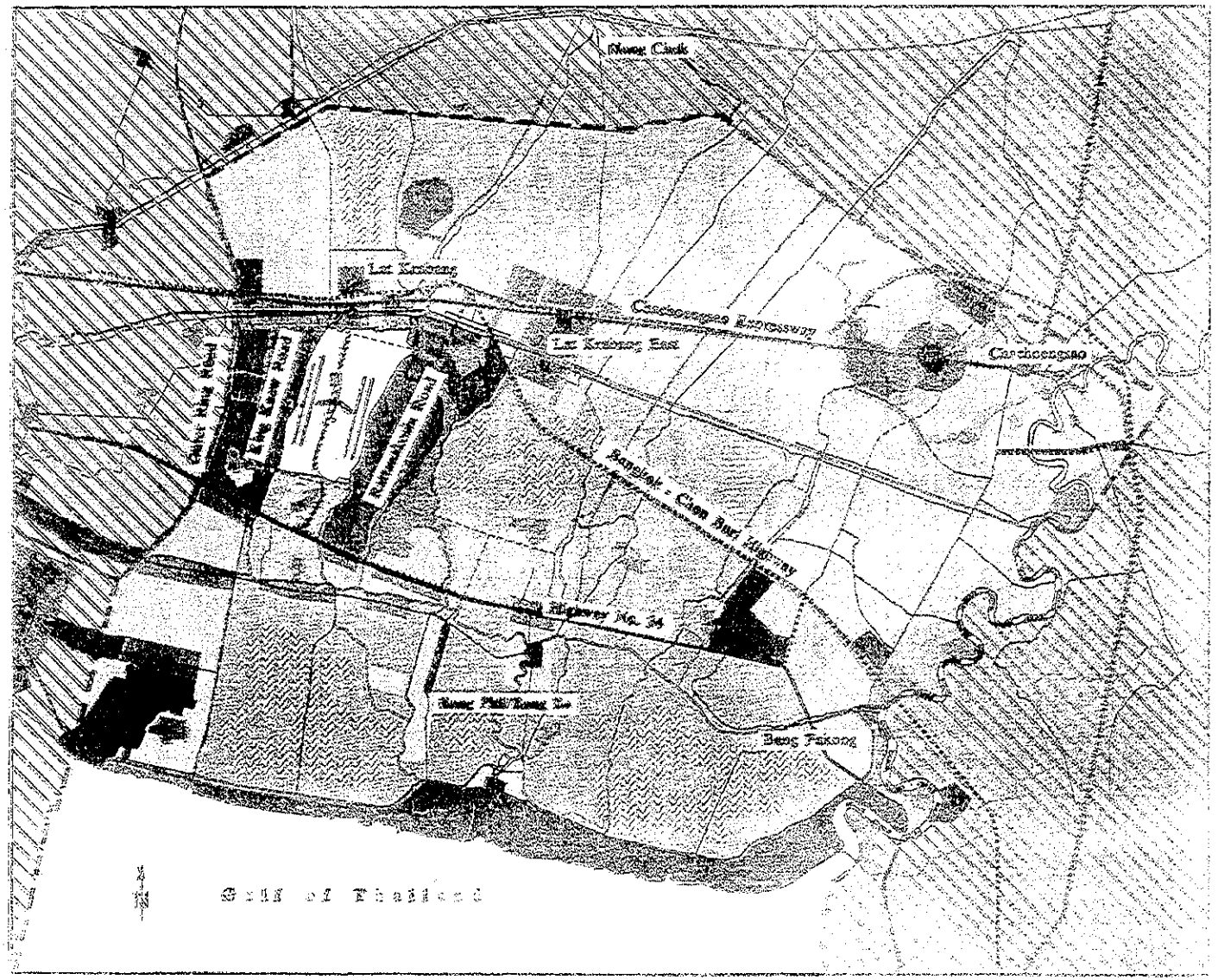
- Use the existing Bangkok - Chachoengsao railway as the main corridor for residential development in order to maximize the use of public transport;
- Plan new residential developments as subcentres near existing, established communities as Chachoengsao City, Bang Pakong area, Bang Bo/Bang Phil development area, Lat Krabang and eastern Bangkok;
- Avoid residential development in the noise zones and obstacle paths north and south of the airport runways;
- Avoid residential development in the main water retention areas.

(4) Transport development

High priority of public transport are placed on the following items:

- Provide public transport from Bangkok to the airport terminal station by urban heavy rail and regional rail systems;
- Improved train service (double track) to Chachoengsao;
- Provide high quality bus service on separate bus ways to and within the primary business zone;
- Reserve rights of way for other possible future urban transport lines.

Fig. 3.1.6 Strategic Land Use Plan 2010



Legend

- Residential - Low Density
- Residential - Medium Density
- Residential - High Density
- Mixed Land Use
- Commercial
- Special Business Area Around SBIA
- Industry
- Education
- Government
- Agriculture
- Recreation/Green Area/Parkway
- Water Retention Area
- Mangrove Forest
- Rail
- Rail (Right of Way)
- Highway - Existing
- Highway - Planned
- Road - Existing
- Road - Planned
- River/Khlong
- Provincial Boundary
- Landuse Area Boundary

Km

Date: June 1994

Kingdom of Thailand

Office of the Second Bangkok International Airport Development Committee (OSBAC)
National Economic and Social Development Board (NESDB)

3.1.4 High Speed Train Study

(1) The potential Long-Term Role of High Speed Rail (HSR) in Thailand

< High Speed Rail (HSR) Technology Options Evaluated >

The HSR technology/speed options which are examined in the study are listed in the Table 3.1.1.

Table 3.1.1 HSR Options Evaluated in the National Study

		Typical Speeds (km/h)	
		Maximum	Average
Current Service		110	50
Modernized Metre Gauge	(MMG)	150	100
High Speed 200	(HSR 200)	200	140
High Speed 300	(HSR 300)	300	190

- Current Service

  Current SRT service consists of an infrequent service of long distance trains traveling at a maximum speed of 110 km/h on a predominantly single-track network, together with stopping passenger services, freight trains and some combined freight and passenger trains. It is characterized by many constraints for higher speed operation such as the heavily used grade crossings, lack of continuous signaling, poor acceleration of rolling stock, high probability of delays, no fencing, etc. In the main line, trains are patronized by passengers from lower income groups. Average speed is only 50 km/ h.

- Modernized Metre Gauge (MMG)

  The first higher speed option considered in this study is the modernization of the present system, retaining the metre gauge but removing all the impediments to higher speed operation. It is judged that speeds up to 150 km/h maximum could be achieved, with an average speed of 100 km/h (including stops/delays) on the level straight routes of Thailand's plains. A maximum speed of 100 km/h could be achieved in hilly terrain after the realignment of the sharp curves.

- High Speed Standard Gauge (200 km and 300 km Option)

  The second higher speed option evaluated in this HSR study is the new alignments of standard gauge allowing speeds of 200 km/h and 300 km/h. Basically they are the same except that the higher speed option incurs higher costs in every aspect: High speed 200 could have diesel-electric or electric traction, depending on utilization, whereas High Speed 300 would be electric traction because of the higher power requirement and the need to keep axle loading reasonable.

< Rail Corridor Evaluated >

Because of the size and trip making power of Bangkok, the SRT system is radial from Bangkok and the HSR system would necessarily be so. The rail lines which have been studied for HSR purpose, together with their existing endpoint distances from Bangkok, area shown on Table 3.1.2

Table 3.1.2 Six HSR Corridors Evaluated in the National Study

No.	Corridor	From Bangkok to:	Distance (km)
1.	Southern	Malaysia	990/1,158
2.	Northern	Chiang Mai	751
3.	North Eastern	Nong Kai	624
4.	North Eastern	Ubon Ratchathani	575
5.	Eastern	Aranyaprathet	255
6.	Eastern Seaboard	Map Ta Phut	205

< HSR Analysis Assumption >

- Transportation Mode Assumption
  - Second Bangkok International Airport (SBIA)
  - Metropolitan Bangkok Transit System
  - Intercity Highways (without the imposition of additional tolls)
  - Airport and Air Service

- Bangkok Area Assumptions
  - Radial nature of HSR

- HSR penetration of Bangkok
- HSR Dependence on Transit Feeder Services
- HSR is not an Urban Bangkok Solution

- Railroad Assumptions
  - Other Rail Services
  - HSR Fares and Tariffs
  - SRT Investment

- Thailand Development Assumptions
  - Need for Decentralization
  - Development Zones
  - Creation of New Cities
  - International Potential with Neighboring Countries

< The result of the National Study >

It is clear that investment in improved rail passenger services in Thailand, moving towards higher speeds, may well be worthwhile at some future stage.

- A higher speed rail passenger system connecting Bangkok to the Eastern Seaboard might be financially and economically viable. This supports the requirement in the terms of reference for a more detailed study of this corridor.

- The financial cases for early large-scale investment in the Northern (both the Northeastern corridors and the Eastern) corridor are marginal. The Southern corridor cannot be considered financially viable at this stage. The scene is clearly dominated by three most important factors: the overwhelming dominance of Bangkok, the corresponding limited urban population elsewhere in the country, and the general low levels of income.

- Financial prospects improve for the four marginal corridors if investment is deferred to a later date.

- HSR may well only show financial viability with considerably higher average rail fares than those currently being charged.

- The financial case improves if part-corridors, running from Bangkok to nearer provincial centers, are considered. This indicates that railway development, when it does take place, should commence in Bangkok and proceed outwards, radially.

- Rail patronage falls by about one-third if it is assumed that a comprehensive and effective rail public transport system does not exist in Bangkok.

- The financial case is better for the two lower-speed technologies (MMG and HSR 200) than it is for HSR 300. Metre gauge, with a maximum speed of 150 km/h, exhibits a better return on the investment than HSR 200 standard gauge at 200 km/h which, in turn, shows a better return than standard gauge at 300 km/h.

- All corridors, except the Eastern, show economic first year rates of return for certain options that are above the 100 % goal. The lower the fare, the higher the ridership and the higher the economics benefits. Higher speeds also results in higher ridership and higher economic benefits.

- It is concluded from the technology and cost assessments that the construction of new rail tracks alongside the existing line is both the cheapest and simplest option. The width and straightness of the present rights-of-way would enable a high capacity, higher speed rail network to be built in Thailand with a per-kilometer cost just over half that of the lowest cost for new rail infrastructure identified from other countries where HSR systems have been studied or built.

< Recommendations >

- The case for investment in higher speed railway passenger services should be kept under continuous review. As already noted, the ESB corridor does exhibit some financial and economic promise and is, of course, the subject of the second part of this study (**Report Volume III**)

- The ESB (**Report Volume III**) study should concentrate on a maximum speed capability in the range of 150 km/h to 200 km/h. It should not evaluate HSR 300.

- Investment projects for improving passenger services should be developed as a part of a step-by-step program. Project priorities should be identified through rigorous analysis but are likely to be concentrated initially on those routes radiating from Bangkok to the nearer provincial centers. It is unlikely, however, that worthwhile HSR projects can be developed unless a comprehensive rail mass transit network in Bangkok is in place.

- Any program for HSR development should await the results of the parallel JICA rail study. At that time, a decision can then be made as to whether or not to take the opportunity of undertaking all new construction in standard gauge.

- The restructuring of the SRT along the lines placed forth by the TDRI SRT Master Development Plan Study (February 1993) should be undertaken. Amongst other things, it should enable a program of railway modernization, based on continuous marketing research and business analysis, to be developed using Thai expertise.

(2) The Eastern Seaboard Corridor

The study concluded that Bangkok to ESB corridor offers the greatest potential for HSR and that the ESB analysis should focus on higher speeds than presently offered by SRT trains, but slower speeds than the TGV of France or the Bullet Train of Japan.

< HSR Technology Options Evaluated for the Bangkok ESB Corridor >

In summary, the HSR technology / speed options which are examined for application in the Bangkok-ESB corridor are listed in Table 3.1.3.

Table 3.1.3 HSR Technology Options Evaluated in the Bangkok-ESB Corridor

		Typical Speeds (km/h)	
		Maximum	Minimum
Modernized Metre Gauge	(MMG)	150	100
High Speed Rail 200	(HSR 200)	200	140

< ESB Rail Corridors Evaluated >

Three alternative HSR routes between Bangkok and the ESB are evaluated in this study. These three candidate routes are shown as follows (All three would connect Rayong with Bangkok, via alternative routes):

- **Route A** : Bangkok to Rayong via Chachoengsao, Chon Buri, Phatthaya and Map Ta Phut.

- **Route B** : Bangkok to Rayong via Route A, except that Route B would bypass Chachoengsao by being in the median of the new Bangkok-Chon Buri Expressway.

- **Route C** : Would be on Route A from Bangkok to Chachoengsao, but would then be on a new inland alignment going more directly to Rayong.

< Gauge and routes in Bangkok Area >

- **Metre Gauge Use of Hopewell** : The Analysis assumes that the ESB metre gauge HSR option will be able to operate on tracks provided by the Hopewell scheme, without changing the characteristics or performance of the Hopewell scheme.

- **Standard Gauge Terminus at Huai Khwang** : Unlike the MMG option, the HSR 200 is assumed to terminate at Huai Khwang, where the HSR passengers will transfer to one or more of the Bangkok urban rail systems. It is assumed that the standard gauge HSR will not be able to operate on Hopewell tracks.

< Results of Evaluation >

- Financial Analysis
  - The financial estimates suggest that government will not be able to simply turn HSR construction and operation over to the private sectors. It appears that the private sector will need some types of financial incentive or assistance.
  - The lower cost MMG option appears to be slightly more attractive than the HSR 200.
  - HSR Routes A and B are quite similar, and government could choose between them without significant financial implications. Route C is considerably less promising from the financial perspective.
  - It appears that the financial success of an ESB HSR project is very much dependent on the ability of HSR to serve SBIA.

- Economic Analysis
  - It appears that some form of HSR may in fact be feasible from the perspective of Thai economy, depending on the study's estimated cost and revenues being relatively on target.
  - The MMG option is ever so slightly more feasible than the HSR 200. Government could choose either the metre gauge MMG, or the standard gauge HSR 200.
  - Route B and A appears to be economically justified as long as the HSR serves not only the ESB but also SBIA.

< Conclusion and Recommendation >

- The Technology Option - HSR 200 or MMG

  In spite of the study results that the options are very close to each other in performance, it is concluded that the Eastern Seaboard Corridor would be best served by the lower speed option.

  - The entire route of only 191 km from Huai Khwang to Rayong seems relatively short for HSR.

- Instead of there being a major city at each end, the Seaboard consist of a string of relatively smaller centers.
- Lower speed option is advantageous in giving the opportunity for the use of electric multiple unit trains.

- Gauge

  The standard gauge is recommended for an Eastern Seaboard HSR.

  - The capacity of the "bottleneck" section of Metre Gauge route on the Hopewell line will be insufficient.
  - By choosing standard gauge for Thailand Railway System speeds of up to 300 km/h becomes a possibility in future.
  - Rolling stock fitted with standard gauge bogies gives a wider choice in procurement of rolling stock than those fitted with metre gauge bogies.

- Route Option

  Given a railway where the basic assumption is that it is a for-profit operation, the choice must be Route B. HSR is best suited for longer distance travelers, and Route B more quickly accesses Chan Buri, Phatthaya and Rayong than does Route A.

- Recommendation - S160 - A New Technology Choice

  Combining the lower speed option with standard gauge enables the choice of rolling stock to be freed from the metre gauge limitation of 150 km/h, whilst retaining the arguments against the higher speed HSR 200 and those in favor of electric multiple unit operation. A new choice-electric multiple units running on standard gauge tracks at the highest speed for which such trains are designed (160 km/h) emerges. This is the choice of the Consultant.

3.1.5 NHA New Town Development Study

Recommendations for new town development are made in the study report on NEW TOWN DEVELOPMENT PROJECT. It essentially contains the following:

(1) Justification of New Town Development

One of the appropriate solutions to handle the problems is "New Town Development" by work programming and urban planning to serve such fantastic growth. New Town development can minimize the housing shortage problem, alleviate traffic congestion in terms of job sources and housing locating in the same area, create favorable employment opportunities to be an economic base of a new industrializing country and provide proper urban utilities and facilities which will be more economical for investment than unplanned urban expansion.

(2) Roles and Activities of Bangkok Metropolis' Satellite Towns

The new towns should be Bangkok Metropolis' Satellite Town with the following various roles:

- Civic Center Town

  It will consist of civic center, residential area, commercial and business center, and other components. Moreover, it will be a hi-tech town with convenient and rapid mass transit connecting it to the Bangkok Metropolitan Area.

- Commercial and Business, and Financial Town of S.E.Asia

  New town development can serve the roles of a regional center, where various financial institutions, international hotels, international commercial and business center, hospital and international health center, educational institutions, embassy offices, international organizations, S.E. Asian Promotion Center and so on, are located.

- Asian Games Town or Olympic Town

  "Sports town" will be advantageous in various ways, for example, convenience in commuting and lower increase of development cost for communications system.

Furthermore, the sports complex can complement the recreation areas in Bangkok Metropolis.

(3) Site Selection

< Criteria >

Site selection was made based on location, land price, landownership, land improvement, urban utilities and facilities.

The key factors in this study are as follows:

a) Plot size must not be less than 700 Rai (112 ha) with land available for spatial expansion for future uses.

b) NHA purchases the land according to the following criteria.
   - Small number of right holders in the site
   - Land concerned or not-concerned with mortgage or rent
   - Conditions of land seller (i.e. period of payment)

These criteria are applied because NHA tries to avoid land expropriation and will introduce it as a last resort or when it needs access.

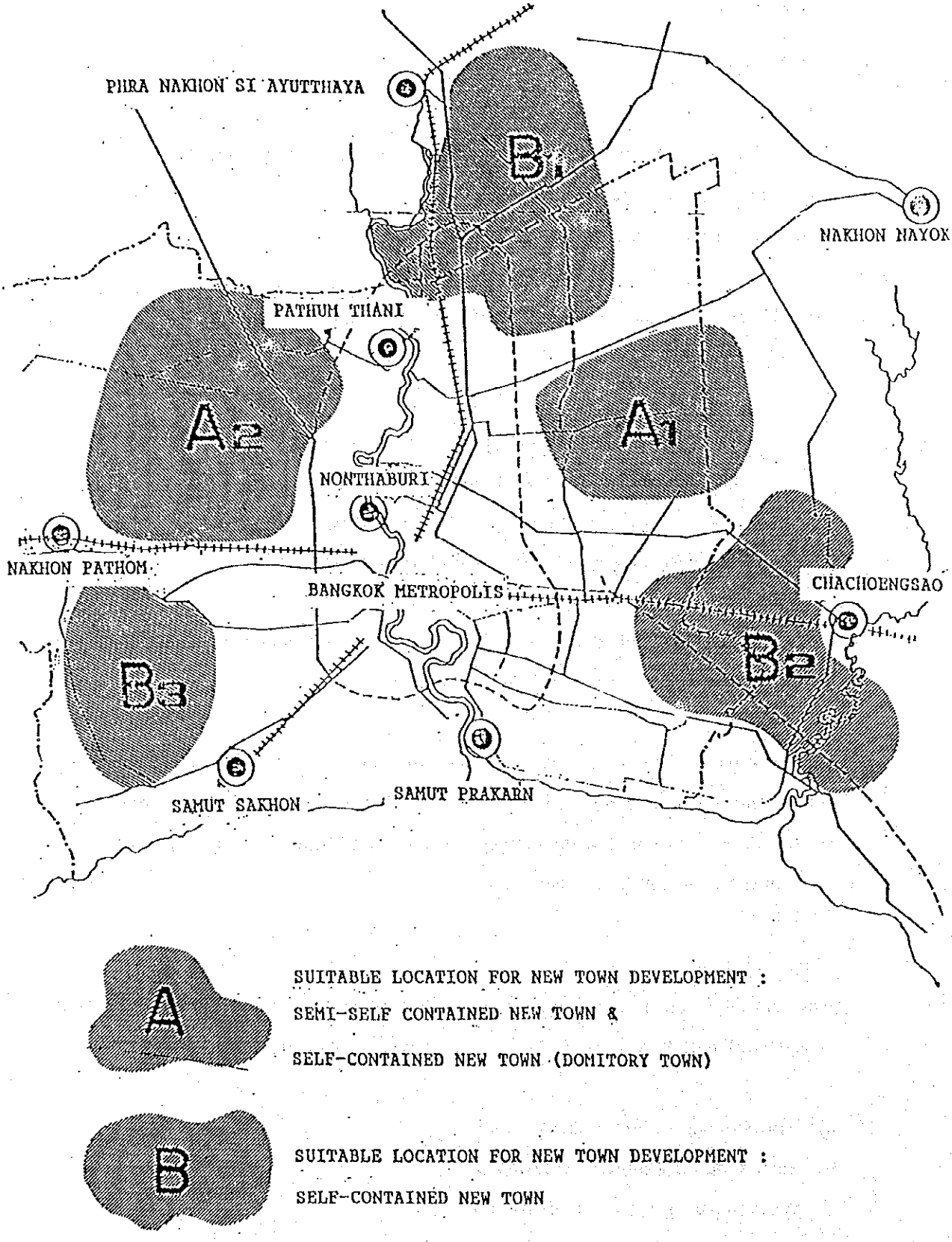
c) There must be an efficient transport system, that is, roads, railways, waterways and the site should be connected to the airport. Moreover, the area should be located in the project area of the government developed transportation network with mass transit system linkage to major cities.

<Site selection>

Analyzing the suitable location for the Satellite towns in 5 areas within 50 km radius area from Bangkok as shown in Fig. 3.1.7, the selected new town sites are as follows.

a) Northern part of Bangkok Metropolis
b) Eastern part of Bangkok Metropolis
c) Western part of Bangkok Metropolis

Fig. 3.1.7 **Suitable Location for New Town Development around Bangkok Metropolis**



(4) Case Study

The case study on new town development is the eastern part of Bangkok Metropolis.

Location and Land Area - The selected area is located in Tambon Klong Luang Paeng, Amphoe Muang, Changwat Chachoengsao, covering 9.500 Rai (1,520 ha).

Objectives and Development Concept - This area will be developed to be Self-Contained Satellite town of Bangkok Metropolis and will be completed in 10 years. It is planned to accommodate a population of 54,000 families or 270,000 in accordance with the Bangkok Metropolitan Region Development Plan.

The development concept consists of:

Item 1. Well-planned communication and transportation system;

Item 2. Beautiful Environment;

Item 3. High technology.

Attention must be paid to item 1, requiring the provision of an inter-town transport network as given below:

- Connecting the arterial road to Bangkok-Chonburi New Highway.
- Commuter train linking between towns.
- Road and railway improvements to connect to Hopewell Project.
- Connecting High Speed Rail System to New Town and Nong Ngu Hua International Airport.

3.2 Principal Goals and Policies of Development

(1) Public Transport Based City through Maximum Utilization of Railway

First of all, it must be stated that the principal policy of this study is to maximize utilization of the existing SRT rail lines for developing the transport system, urban areas and improving the living environment of the Bangkok capital region. The principal goal which shall be achieved through the implementation of this policy is the establishment of public transport based city of Bangkok capital city (Fig. 3.2.1). In order that Bangkok can be defined as a public transport based city, a larger share of the transport modal split must be of the public transport including railways. To attain this, a correspondingly larger size of development will be needed in railway and urban development. This implies the following:

a) This study is not merely the feasibility study for certain lines or sections of railway improvement. Rather, it aims at network development of railways covering the 200 km and 50 km radius area of Bangkok.

b) Urban development planning is not limited to a particular real estate or land development or subdivision along the railway to be improved. Rather, it aims at a broader area development large enough to be effective in changing the urban structure toward the establishment of a public transport based city.

With the view of establishing a public transport based city, the following development goals must be achieved. (In other words, this is the only way to make best use of the existing railway system.):

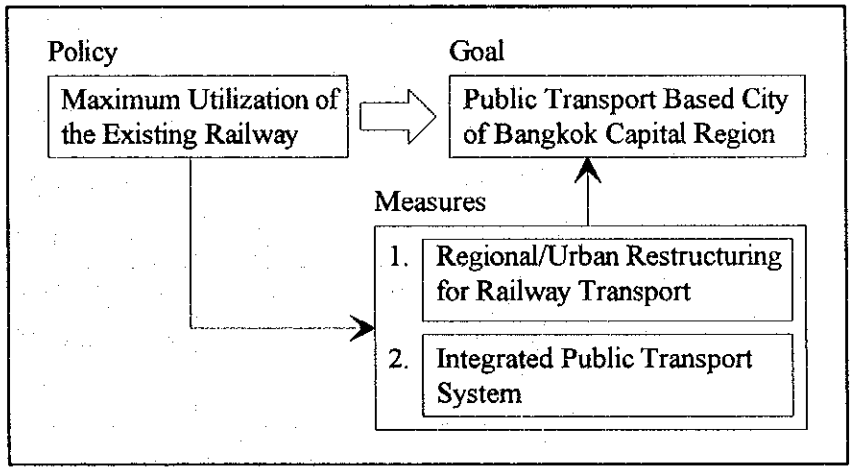
a) Regional and Urban Restructuring for Railway Transport: In order to maximize the utilization of the existing SRT for regional/urban transport of Bangkok, the existing regional/urban structure must be changed and adjusted so as to best suit the railway transport system.

b) Integrated Public Transport System: In order to increase the modal share of public transport to the extent that Bangkok becomes a public transport based city, the

railway needs to play a significant role, not independently, but integrated with other public transport systems such as buses, the currently planned mass rapid transit system and others.

Since each public transport mode is designed to fulfill its own specified transport function/service (speed, frequency, service length, capacity and so on), they must be combined into an integrated public transport system where each can maximize its own transport services. The railway system will be qualified to become the backbone of the integrated public transport system taking into consideration its locational advantages, performance and others.

Fig. 3.2.1 Policies and Goals



(2) Complete Hierarchical System/Structure of Urban and Railway Development

The complete hierarchical structure of urban and railway development must be established as explained below and shown in Fig. 3.2.2

Hierarchical Railway System

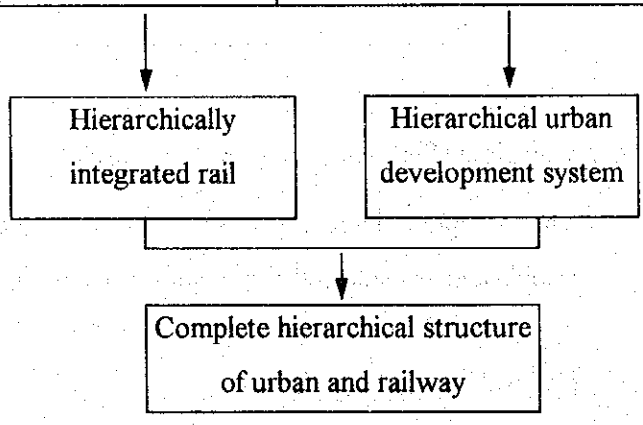
It must be noted that the important factor determining the types and systems of rail transport that should be provided is the dimension (size) of areas which the railway must serve. Usually railways provide 3 types of train service (i.e., National/Regional, Suburban and Urban) with different transport characteristics such as speed, frequency, capacity, travel length and so on. They are likely to be separately operated on different

lines or on the same line insofar as the transport capacity of the line can afford.

The railway is to work as a multi-functional transport system in such a manner as to provide different train services in order to respond to the transport demands for different transport service.

Fig. 3.2.2 Hierarchical Structure of Urban and Railway Development

Region and Area	Railway Development	Urban Development
Bangkok Metropolitan Region (Bangkok centered 200 km radius area)	National/Regional Railway Network and System	Regional Urban Development
Bangkok Capital City Area (Bangkok centered 50 km radius area)	Urban and Suburban Railway Network and System	Bangkok Capital Urban Area Development
Area by Direction	Arterial Rail Line System by Direction	Urban Corridor Development by Direction (Urban development along the railway)
Area centered around the Rail Stations (service area of rail stations)	Suburban-Commuter Railway System	Towns and Cities Development centered around the Rail Stations



One person's trip from an origin to a destination can be conveniently performed through the public transport system alone, not making use of other transport systems such as passenger cars even for part of the trip, because suburban and urban lines

provide a feeder transport system for the national/regional train service, and urban lines do the same for suburban train service, while buses also act as their feeder system.

It is certain that the maximum utilization of railways will be realized only when the hierarchical transport system as stated above is established. The important aspects of this hierarchical system are summarized as follows:

a) Development of the most effective operation system for each train service in accordance with the size of service areas ranging from regional to district level. The different types of train service must maximize their own specific function so as to best meet the demand assigned to them. This indicates the necessity of working out railway development plans which focus on different aspects of train operation in accordance with the size of area which the railway must serve as shown in Fig. 3.2.2

b) Integrated Train Services. The 3 types of train service which differ in the size of service area must be connected with one another so as to establish an integrated train service system.

Hierarchical Urban Development System

It is not uncommon that the socio-economic effects of railway on urban development varies depending on the types of the train services ranging from the regional to district level. In this regard the national/regional rail lines are more concerned with regional development covering wider areas, with the urban and suburban railway network shaping the Bangkok urban area and the commuter lines affecting new towns along the lines and so on. This hierarchical regional/urban development system in response to the hierarchical railway operation system is quite needed so as to make the most of the effects of railway improvement on the socio-economic development of the region as well as make the maximum use of the existing railways.

In conclusion, the public transport based city of Bangkok will emerge along with the completion of the hierarchical structure of urban and railway development.

(3) Railway Transport-Oriented Development Plan at each Regional Level in the Hierarchy

It is well known that the development effects of railway and road transport in the regions and urban areas are quite different. As a result of these different effects, different land uses and urban areas take shape. This study is to seek ways of utilizing the favorable effects of the railway, apart from road transport, to effectively and efficiently improve Thai city planning and development, and also to present a development plan, making maximum use of railway development effects, which are quite different from road transport-based urban development.

In this study rail transport-based urban developments are shown in accordance with the following hierarchical regional area-wise sequences:

1) Bangkok Metropolitan Region (Bangkok Centered 200 km Radius Area)
↓
2) Bangkok Capital City (Bangkok Centered 50 km Radius Area)
↓
3) Urban Area Along the Rail line (Urban Corridor Area)
↓
4) Urban Area Centered Around Rail Stations (New Town Area)

The study intends to show how to formulate urban development plans based on railway improvement at each level of the hierarchical regional system. It must be emphasized that the existing SRT railway system will be best utilized only when rail-transport based urban developments at all levels of the region are realized.