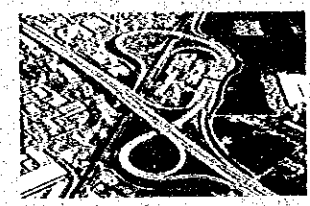
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF TRANSPORT AND HIGHWAYS
ROAD DEVELOPMENT AUTHORITY (RDA)

THE STUDY ON THE OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO

FINAL REPORT



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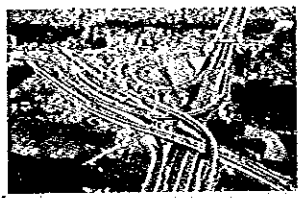
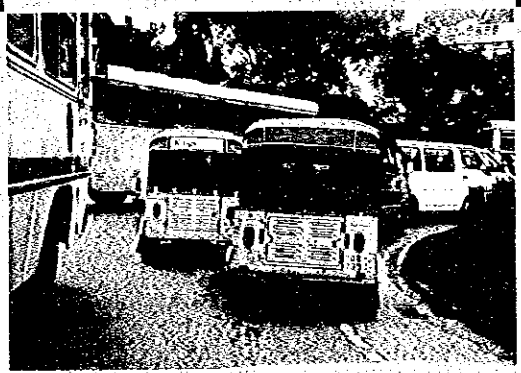
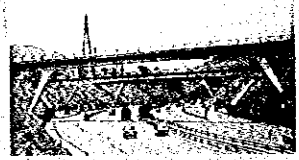






EXECUTIVE SUMMARY

FEBRUARY 2000

ORIENTAL CONSULTANTS COMPANY LIMITED

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF TRANSPORT AND HIGHWAYS
ROAD DEVELOPMENT AUTHORITY (RDA)

THE STUDY ON THE OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO

FINAL REPORT

VOLUME 1 OF 5

EXECUTIVE SUMMARY

FEBRUARY 2000

ORIENTAL CONSULTANTS COMPANY LIMITED

The following foreign exchange rate is applied in the study :

Sri Lankan Rs.= 1.6 YEN (as of December 1999)

PREFACE

In response to the request from the Government of the Democratic Socialist Republic of Sri Lanka, the Government of Japan decided to conduct the Feasibility Study on the Outer Circular Highway to the City of Colombo in the Democratic Socialist Republic of Sri Lanka and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Democratic Socialist Republic of Sri Lanka a study team headed by YANAGIDA Kazuro, Oriental Consultants Co., Ltd., four times between November 1998 to January 2000.

The team held discussions with the officials concerned of the Government of the Democratic Socialist Republic of Sri Lanka, 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 Democratic Socialist Republic of Sri Lanka for their close cooperation extended to the team.

February 2000

Kimio Fujita
President
Japan International Cooperation Agency

Letter of Transmittal

February 2000

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

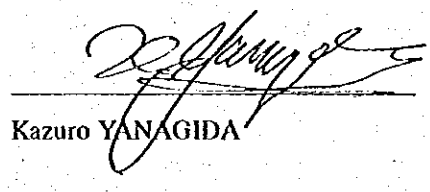
We are pleased to submit to you the report on the Study on the Outer Circular Highway to the City of Colombo in Democratic Socialist Republic of Sri Lanka.

This study was conducted by Oriental Consultants Company Limited, under a contract to JICA, during the period November 1998 to February 2000. In conducting the study, we have examined the feasibility and rationale of the study with due consideration to the present situation of Sri Lanka and formulated the most appropriate project.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, the Ministry of Foreign Affairs, the Ministry of Construction, Japan Highway Public Cooperation, and Japan Bank for International Cooperation. The Ministry of Transport and Highways Road Development Authority, the JICA Sri Lanka office and the Embassy of Japan in Sri Lanka for their cooperation and assistance throughout field survey.

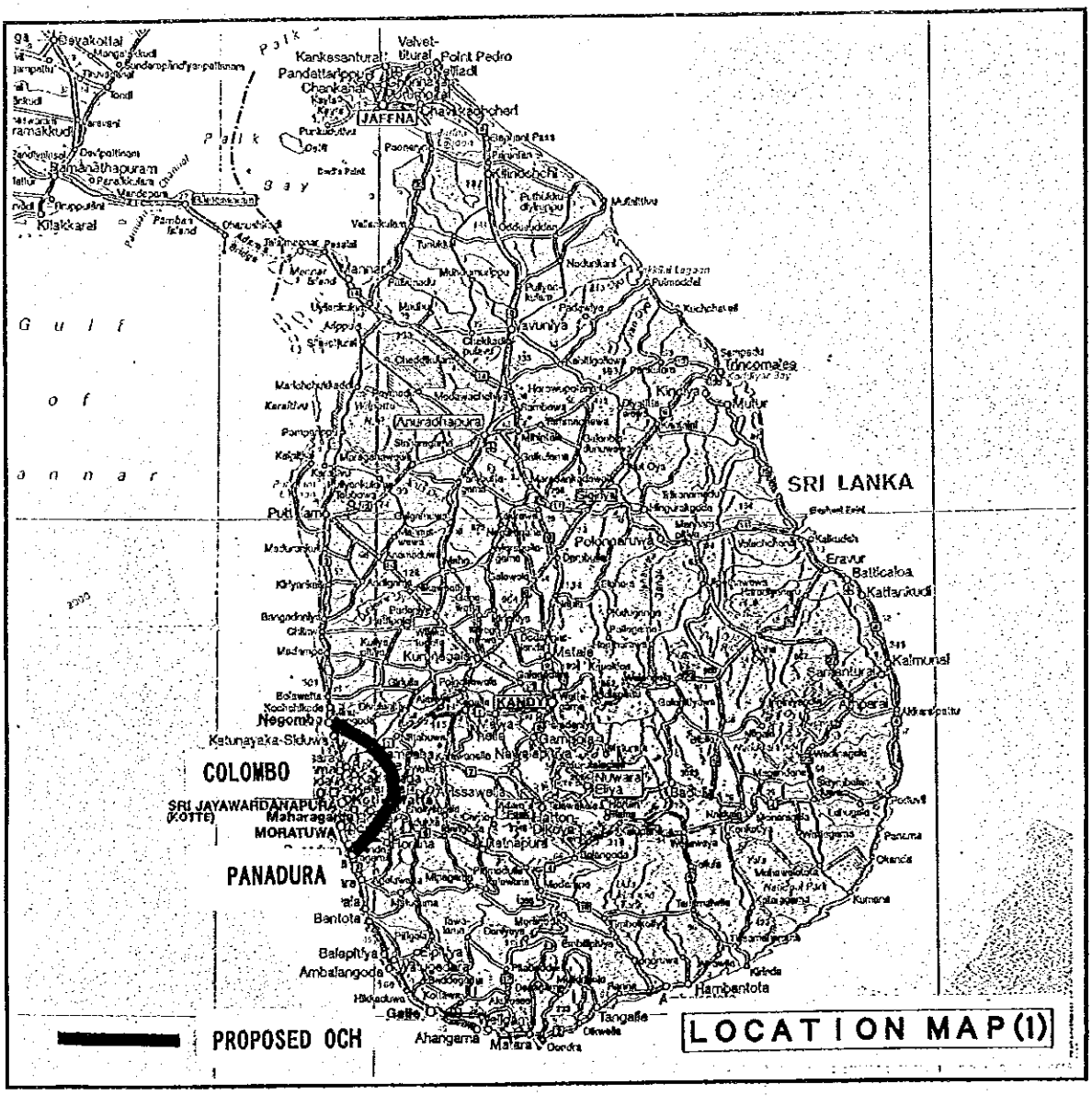
Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,



Kazuro YANAGIDA

Team Leader,
Study Team for the Study on the
Outer Circular Highway to the City
of Colombo
Oriental Consultants Company Limited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Kankesanturai
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Pandattarippu
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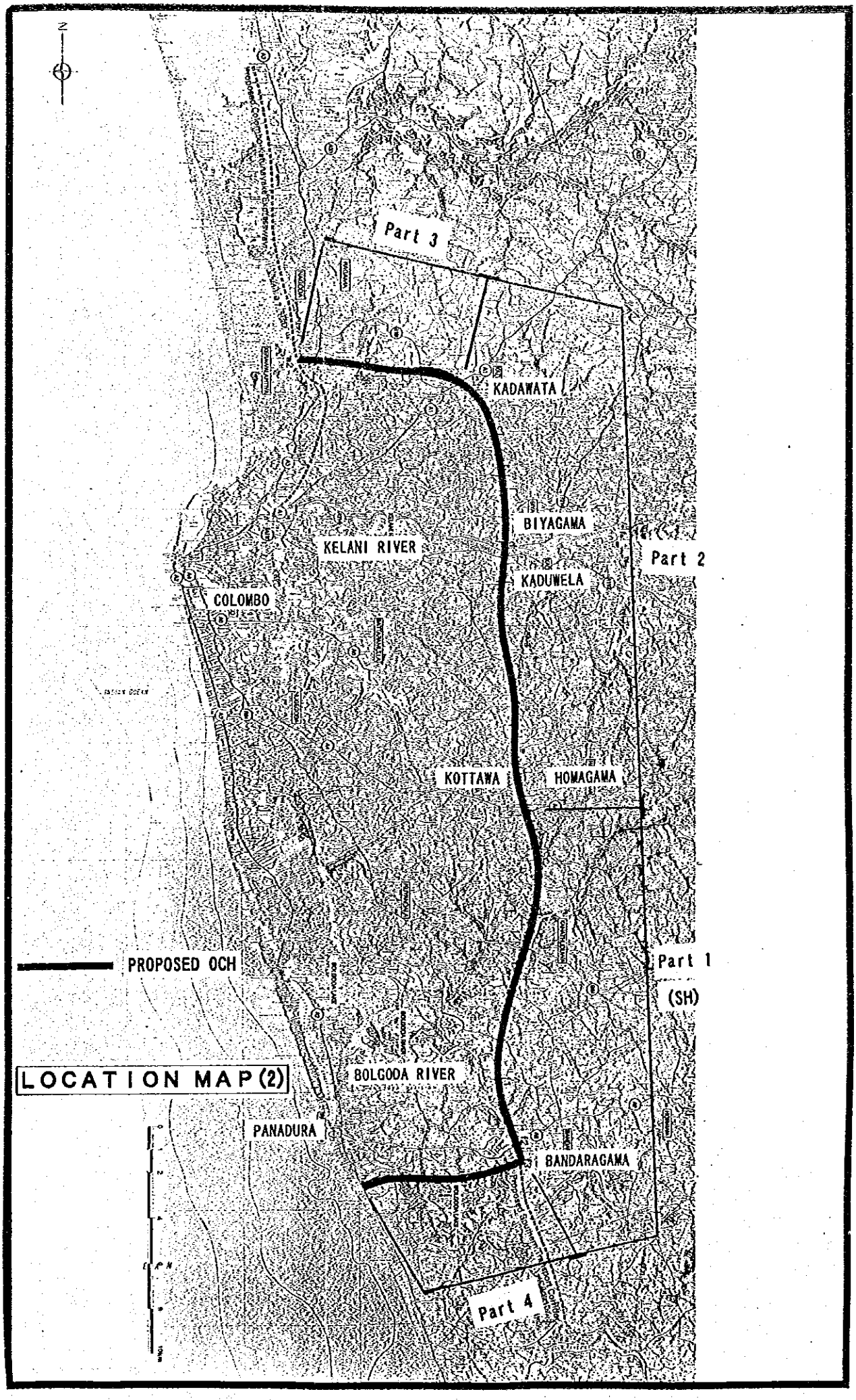
Mandapam
Pamban Island
Adam's Bridge
Talaimannar
Mannar
Vavuniya
Trincomalee
Kinniya
Mutur
Anuradhapura
Puttalam
SRI LANKA
Polonnaruwa
Batticaloa
Eravur
Kattankudi
Kalmunai
Sainthamaruthu
Kurunegala
Matale
KANDY
Negombo
Katunayaka-Siduwa
COLOMBO
SRI JAYAWARDANAPURA (KOTTE)
Maharagama
MORATUWA
PANADURA
Nuwara Eliya
Badulla
Ratnapura
Bantota
Balapitiya
Ambalangoda
Hambantota
Galle
Tangalle
Ahangama
Matara
Dondra
PROPOSED OCH
LOCATION MAP (1)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Part 3
KADAWATA
BIYAGAMA
KELANI RIVER
Part 2
KADUWELA
COLOMBO
KOTTAWA
HOMAGAMA
PROPOSED OCH
Part 1
(SH)
LOCATION MAP (2)
BOLGODA RIVER
PANADURA
BANDARAGAMA
Part 4

PROJECT SUMMARY

1. COUNTRY	Democratic Socialist Republic of Sri Lanka
2. NAME OF STUDY	The Study on The Outer Circular Highway(OCH) to The City of Colombo
3. COUNTERPART AGENCY	Ministry of Transport and Highways Road Development Authority(RDA)
4. OBJECTIVE OF STUDY	To carry out The Study on The Outer Circular Highway to The City of Colombo

1. STUDY AREA: Colombo Metropolitan Region(CMR), in the Western Province.

2. The OCH Concept

① Be partially-controlled: To allow for OCH access only at pre-established interchanges, with fences and bus bays at the appropriate locations.

② Be separated by a median or green area: To secure the safety of OCH users.

③ Be grade-separated: To ensure high levels of operation and the smooth flow of traffic.

④ Be equipped with a frontage road: To ensure sufficient access to the OCH as well as maintain current road and community integrity.

3. Project Cost Estimation

Summary of Project Cost of Foreign and Local Currency in 1999 Prices (million Rs.)

	Part	Stage	Foreign	Local	Total
Southern Highway	1	Initial Stage	2,969.4	2,931.5	5,900.8
		Final Stage	3,156.6	3,087.3	6,243.9
Project Cost	2	Initial Stage	3,277.6	3,240.4	6,518.0
		Final Stage	3,495.0	3,418.3	6,913.3
	3	Initial Stage	1,932.3	2,061.2	3,993.5
		Final Stage	2,037.6	2,150.0	4,187.6
	4	Initial Stage	1,244.3	1,364.7	2,609.0
		Final Stage	1,244.3	1,364.7	2,609.0
	Total	Initial Stage	6,454.2	6,666.3	13,120.5
		Final Stage	6,776.9	6,933.0	13,709.9

4. Project Cost and Benefits of the OCH project (unit: millions of Rs at 1998 economic prices)

	2006	2010	2020
Vehicle running reduction benefit	751.6	328.7	2,521.7
Running time reduction benefit	1,850.0	2,512.3	5,288.9
Air pollution reduction benefit	78.5	29.1	0
Traffic accident reduction benefit	75.9	39.5	240.0
Total	2,756.0	2,909.6	8,050.6

5. Implementation Plan and Recommendation

1.Initial construction is proposed for a 4-lane dual carriageway with grade separated interchanges, with the provision for subsequent widening to 6 lanes. The widening should be executed when traffic volumes reach critical thresholds. It is anticipated that traffic volumes of the OCH on some sections will reach about 55,000 PCUs by about 2020 (i.e.10 years after opening) and that at this time widening may therefore be warranted.

2.Optional staging of the project should be considered as follows:

Part 1 Bandaragama - Kottawa

This section will be implemented as a part of the on-going Southern Transport Corridor Project to Kottawa on the Rt. A4, which is to be funded by the JBIC.

Part 2 Kottawa - Kadawata

The section extending from the north end of the Southern Transport Corridor at Kottawa to the Rt. A1 (Colombo – Kandy Road) should be constructed in parallel with Part 1.

Part 3 Kadawata – CKE (Colombo – Katunayake Expressway)

This section also should be constructed immediately after Part 1. However, the construction schedule should be determined based on progress of the CKE Project.

Part 4 Bandaragama - Panadura

This section can be deferred until the economic situation of the country has improved and until traffic demand requires its construction.

OUTLINE OF THE STUDY

・Democratic Socialist Republic of Sri Lanka
・The Study on the Outer Circular Highway to the City of Colombo
・Study Period: November,1998～February,2000
・Counterpart agency: Ministry of Transport and Highways Road Development Authority(RDA)

1.Background

Over the past two decades, the sectorial development policy of the Government of Sri Lanka has been to rehabilitate its existing road and rail infrastructure. During this period, only rehabilitation work was undertaken to improve the transportation system. However, traffic demand has been increasing very rapidly during the past decade and there is a shortage of road capacity to meet the rising demand and proposed development plan. Hence, the Government of Sri Lanka has decided to implement a policy to develop a system of new highways to supplement existing road capacity. These new highways have been identified by the Road Development Authority (RDA) and pre-feasibility and feasibility studies have been carried out with the aim of executing some appropriate projects.

In response to a request from the Government of Sri Lanka, the Government of Japan has decided to implement one of these projects, i.e., "The Feasibility Study on Outer Circular Highway(OCH) to the City of Colombo" (hereinafter referred to as the Study).

2.Objective

The study will be executed to disperse traffic congestion and encourage development away from the highly densely populated urban areas in the Western Province (hereon referred to as the Colombo Metropolitan Region or CMR); thereby, achieving a better balance for growth.

3.Study Area

The Study area consists of the Colombo Metropolitan Region(CMR), which is representative of the Western Province and is made up of the three administrative districts of Gampaha, Colombo, and Kalutara. In respect to the Outer Circular Highway itself, road trace alternatives has been confined to a belt 10 km in width and approximately 50 km in length.

4.The OCH Concept

One of the biggest transportation issues facing Colombo is the lack of an orbital or outer ring road. The purpose of such a road in the CMR would be to encourage the development of current or future growth centers, to connect radial routes, and lastly to divert through traffic from the center of the city.

Therefore, one of the major functions of the OCH will be the servicing of relatively short-distance trips between existing and future growth centers and existing radial routes. Given this, it does not seem advisable for the OCH to be a fully-controlled facility like the Katunayake Expressway. On the other hand, it is crucial for the OCH to maintain relatively high speeds if it is to properly fulfill the functions mentioned above. It is suggested, therefore, that the OCH be constructed to a standard somewhere between an arterial road and an expressway. Based on this, it is recommended that the physical structures of the OCH has the basic characteristics listed below:

① Be partially-controlled: To allow for OCH access only at pre-established interchanges, with fences and bus bays at the appropriate locations.

② Be separated by a median or green area: To secure the safety of OCH users.

③ Be grade-separated: To ensure high levels of operation and the smooth flow of traffic.

④ Be equipped with a frontage road: To ensure sufficient access to the OCH as well as maintain current road and community integrity.

5.Highway Alignment and Design

Alternative Highway Alignments Methods for Selecting

A flow chart illustrating the steps used to select the method for determining the most appropriate highway alignment is shown Fig.1.

Highway Design

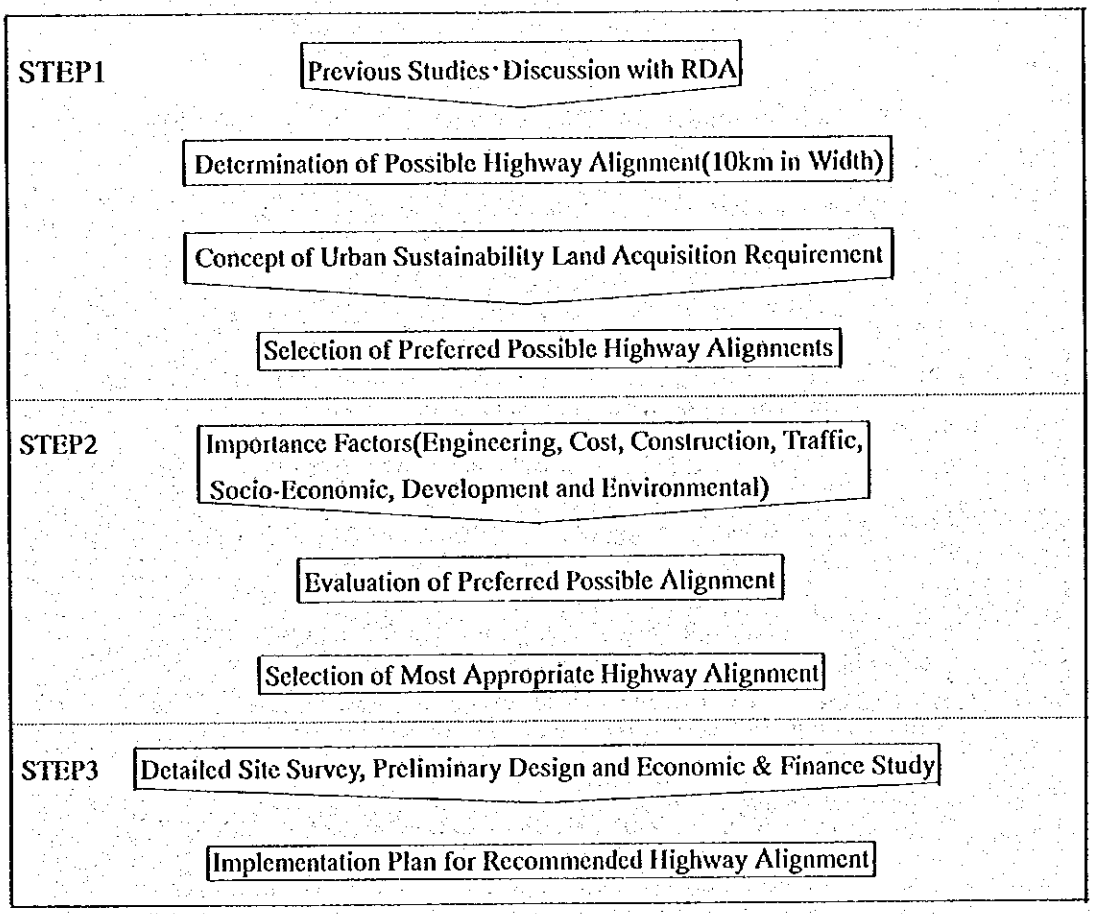
The highway cross section on OCH would be composed the following elements:

- Carriage way
- Center Median
- Shoulder (including Stopping Lane)
- Frontage Road
- Green Belt

The cross section elements for the OCH apply the 4 lanes dual carriageway as an initial stage of construction. The future traffic demand in the year 2020 indicates the necessity of 6 lanes dual carriageway.The 3.5 meters wide of traffic lanes would be applied for the

OCH. The OCH is categorized for limited access controlled road but it is ascertained not to demand expressway characteristic and vehicle design speed is 80km/h.

Fig.1 Flow Chart for Alignment Selection Method



6.Traffic Demand Forecasts for 2010 & 2020

By applying the calibrated traffic alignment model, forecasts for 2010 and 2020 are carried out after inputting the future road network for the target years of 2010 and 2020. The OCH would be a highly traveled facility. For example, in the year 2010, a daily total of about 91,000 vehicles would use the OCH, while in 2020 this total would be about 142,000 vehicles per day. The average traffic flow for a section of road on the OCH would be about 37,000 pcus in 2010 and 45,100 pcus in 2020.

Especially, the most congested parts of the OCH would be in the middle and the least congested parts at the tail ends. However, the northern tail end has much higher traffic volumes (34,500 pcus) as compared to the southern tail end (19,200 pcus).

Given these traffic volumes, it is suggested that the OCH be constructed as a 4-lane

facility. And except for the southern tail end of the OCH, it is suggested that the OCH be made into a 6-lane facility for the year 2020.

7.Engineering Study and Project Cost Estimation

7.1Engineering Study

(1)Design Speed

Route name	Road standard applied	Design speed
Outer Circular Highway	Class 1, type3 for Japanese roads	80 km/ h
OCH Interchange	Class 1 Japanese interchange	40 km/ h

(3)Structure Design

The following structures shall be proposed through construction of the Outer Circular Highway.

(a) Bridges for crossing river
(b) Bridges for crossing the existing major roads
(c) Bridges for crossing the existing miner roads
(d) Bridges for crossing the railways
(e) Viaducts for crossing railway
(f) Overpasses for cross over the OCH
(g) Culverts for cross under the OCH

Project cost Estimation

The basic premises in estimating the project cost are as follows:

1) All the construction work will be executed by contractor(s) to be employed for the highway improvement.
2) The unit cost of each cost component was determined based on the economic conditions prevailing in 1999 (Rs 1.0 = 1.6 Yen).
3) The engineering service which consists of both detailed engineering design and construction supervision has estimated as 8% of construction cost. The tendering assist work will be obviously required at the time of tender. It estimates that 2% of construction cost normally adopted.
4) Land acquisition and resettlement cost were worked out in EIA on the basis of market price estimated by land assessor.
5) Physical contingency is estimated to be 10% of the total of construction cost, land acquisition and resettlement cost, engineering services cost including supervisory services cost.

6) Currency

Exchange Rate: In December 1999 prices (exchange rate used: RS. 1= 1.6 YEN)

7) Taxation

(a) Civil Works:

- GST	12.50%
- Defense levy on imports	6.00%
- Tax on civil works (GST/ CD/ DL)	18.90%

(b) Consulting Services GST only 12.50%

Summary of Project Cost of Foreign and Local Currency in 1999 Prices (million Rs.)

	Part	Stage	Foreign	Local	Total
Southern Highway	1	Initial Stage	2,969.4	2,931.5	5,900.8
		Final Stage	3,156.6	3,087.3	6,243.9
Project Cost	2	Initial Stage	3,277.6	3,240.4	6,518.0
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	4	Initial Stage	1,244.3	1,364.7	2,609.0
		Final Stage	1,244.3	1,364.7	2,609.0
	Total	Initial Stage	6,454.2	6,666.3	13,120.5
		Final Stage	6,776.9	6,933.0	13,709.9

8.Environmental and Social Impact Assesment

Objective

The purpose of the EIA is to ensure that the potential environmental consequences of the proposed OCH are recognized early for required mitigatory action, which will be taken into consideration in project planning and designs.

Conclusion and Recommendation

In conclusion, the project is environmentally acceptable provided that the environmentally acceptable road trace recommended in the EIA is considered and the mitigatory action implemented. Moreover, the detailed design should include environmental safeguards and recommended Project Monitoring Committee should closely monitor the implementation of the mitigatory measures. In addition, a resettlement plan including potential resettlement sites, compensation for different categories of people to be relocated and a time schedule should be formulated immediately after the determination of the final road alignment.

9.Project Cost and Economic and Financial Evaluation

The Economic Internal Rate of Return (EIRR) of the OCH Project, which represents the investment efficiency of the project, is estimated to be 18.87% per annum. According to the sensitivity analysis discussed in more detail below, the EIRR for the entire construction of the OCH could vary anywhere from 16.14% to 21.98% per annum. The sensitivity analysis consists of nine cases where OCH project costs and benefits increase or decrease by 10% from those of the Base Case (i.e., when there are no changes in costs or benefits). The EIRR exceeds the social discount rate or opportunity cost of capital of 12% per annum in Sri Lanka by a fair amount.

Project Costs and Benefits of the OCH Project

Excluding operation and maintenance costs and taxes, the project costs for Part 1, Part 2, Part3 and Part 4 at current prices for 1999 is estimated to be 15,367 millions Rs. As for the benefits of the project, a breakdown for the years of 2006, 2010, and 2020 are shown as follows:

Project Cost and Benefits of the OCH Project

(unit: millions of Rs at 1998 economic prices)

	2006	2010	2020
Vehicle running reduction benefit	751.6	328.7	2,521.7
Running time reduction benefit	1,850.0	2,512.3	5,288.9
Air pollution reduction benefit	78.5	29.1	0
Traffic accident reduction benefit	75.9	39.5	240.0
Total	2,756.0	2,909.6	8,050.6

As the above table shows, the benefits from the OCH project are large. For example, the benefits from the reduction in total running time for the first four years from the beginning of operation can pay for the project's cost.

Evaluation of OCH Project Options

There are four possible OCH project options: (1) completion of Part 1 (Bandaragama – Rt. A4) only; (2) completion of Part 1 and Part 2 (Bandaragama – Rt. A1) only; (3) completion of Part 1, 2, and 3 (Bandaragama – CKE) only; (4) completion of the entire OCH (i.e., Part 1 to 4). The evaluation of these is carried out below in order to determine the feasibility of constructing the entire OCH as well as its separate components.

In following Tab., the benefit/cost (B/C) ratio and the net present worth (or benefits

minus costs) were estimated for each of the four options of the OCH and are as indicated in the said table. A discount rate of 12%, which is a common threshold for developing countries, was applied in the calculation of these estimates.

B/C and Net Present Worth for the 4 Options of the OCH

Option	B/C	B-C
Option 1 (Bandargame – Rt. A4)	2.17	Rs.4,767 million
Option 2 (Banadargame – Rt. A1)	3.23	Rs.13,869 million
Option 3 (Bandaragame – CKE)	1.93	Rs.8,826 million
Option 4 (entire OCH) (Panadora – CKE)	1.74	Rs.7,713 million

As the above table indicates, from the perspective of the B/C ratio and net worth, all of the OCH options can be said to be feasible. That is, anything over 1 for the B/C ratio, or a positive net worth, is theoretically worth constructing.

However, Option 2 is by far the most attractive or feasible portion of the OCH, with a net worth of Rs.13,869 million, or approximately 1.81 times that of Option 3, which is the next most attractive scenario. In addition, the return on per rupee spent for option 2 is 3.23 times.

Therefore, the issue here is whether or not to construct anything beyond Part 2, i.e., whether or not to implement Option 3 or 4. For this purpose, the economic internal rate of return is calculated for Option 2,3, and 4 below.

EIRR for the OCH Project (Option 2 (unit : % / annum))

		Cost		
		10% increase	Unchanged	10% decrease
Benefit	10% increase	26.35	27.92	29.75
	Unchanged	24.86	26.35	28.10
	10% decrease	23.29	24.70	28.46

Note: Colored box is base case for this option

EIRR for the OCH Project (Option 3 (unit : % / annum))

		Cost		
		10% increase	Unchanged	10% decrease
Benefit	10% increase	20.07	21.50	23.19
	Unchanged	18.71	20.06	21.66
	10% decrease	17.29	18.57	21.23

Note: Colored box is base case for this option.

EIRR for the OCH Project (Option 4 (unit : % / annum))

		Cost		
		10% increase	Unchanged	10% decrease
Benefit	10% increase	18.88	20.30	21.98
	Unchanged	17.53	18.87	20.46
	10% decrease	16.14	17.4	19.91

Note: Colored box is base case for this option

The EIRR for all of the scenarios of the above three options is greater than the social discount rate of 12%, indicating that construction of the entire OCH can be deemed feasible (i.e., the implementation of Option 4). Construction of the entire OCH would produce an EIRR of 18.87, which is in itself sufficient justification for its completion. However, the Base Case (i.e., no change in benefits or costs) for each of the above options illustrates a significant difference in EIRR levels. For Option 2 it is 26.35%, for Option 3 20.06%, and for Option 4 18.87%. The high EIRR for Option 2,which was shown to be robust in the above sensitivity analysis, indicates a need for this portion of the project to be implemented as soon as possible. The EIRR for Option 3 is also robust and remains well above 16% (a figure that usually signifies the borderline for a desirable project). As for Option 4, it declined to the 16% level during the sensitivity analysis, indicating that some consideration should be given prior to its implementation. It should also be mentioned here that although the total net worth of the project declines with the implementation of options beyond Option 2, they still produce benefits that are significant in absolute terms. In addition, Option 2's high EIRR does not negate the justification for Option 3 or 4, but indicates the urgency in which it should be addressed. Finally, from a road network viewpoint, it is crucial that the CKE be connected with the Southern Highway via the OCH.

10.Implementation Plan and Recommendation

The implementation plan and related recommendations for the construction of the OCH are briefly described.

1.Initial construction is proposed for a 4-lane dual carriageway with grade separated interchanges, with the provision for subsequent widening to 6 lanes. The widening should be executed when traffic volumes reach critical thresholds. It is anticipated that traffic volumes of the OCH on some sections will reach about 55,000 PCUs by about 2020 (i.e.10 years after opening) and that at this time widening may therefore be warranted.

2.Optional staging of the project should be considered as follows:

Part 1 Bandaragama - Kottawa

This section will be implemented as a part of the on-going Southern Transport Corridor Project to Kottawa on the Rt. A4, which is to be funded by the JBIC.

Part 2 Kottawa - Kadawata

The section extending from the north end of the Southern Transport Corridor at Kottawa to the Rt. A1 (Colombo – Kandy Road) should be constructed in parallel with Part 1.

Part 3 Kadawata – CKE (Colombo – Katunayake Expressway)

This section also should be constructed immediately after Part 1. However, the construction schedule should be determined based on progress of the CKE Project.

Part 4 Bandaragama - Panadura

This section can be deferred until the economic situation of the country has improved and until traffic demand requires its construction.

TABLE OF CONTENTS

LIST OF FIGURES & TABLES

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Tables

ABBREVIATIONS

(In alphabetical order)

1. AASHTO: American Association of State Highway and Transportation Officials
2. ADB: Asian Development Bank
3. B/C: Benefit / Cost Ratio
4. BOI: Board of Investment (of Sri Lanka)
5. BS: British Standards
6. CBR: California Boring Ratio
7. CEA: Central Environment Agency (of Sri Lanka)
8. CKE: Colombo-Katunayake Expressway
9. CMR: Colombo Metropolitan Region
10. CMRSP: Colombo Metropolitan Regional Structure Plan
11. CPU: Computer Processing Unit
12. CUTS: Colombo Urban Transport Study
13. dpi: dots per inch
14. DS Divisional Secretaries
15. EIA: Environmental Impact Assessment
16. EIRR: Economic Internal Rate of Return
17. ERD: Department of External Resources, Ministry of Finance and Planning (of Sri Lanka)
18. FIRR: Financial Internal Rate of Return
19. GB: Gigabyte
20. IEE: Initial Environmental Evaluation
21. ISE: Initial Social Examination
22. JBIC: Japan Bank for International Cooperation
23. JICA: Japan International Cooperation Agency
24. JRSO: Japan Road Structure Ordinance
25. MOTH: Ministry of Transport and Highways (of Sri Lanka)
26. MFE: Ministry of Forest and Environment (of Sri Lanka)
27. NAASRA: National Association of Australian State Road Authorities
28. NEA: National Environmental Act
29. NPV: Net Present Value
30. OCH: Outer Circular Highway
31. OD: Origin-Destination (matrix)
32. OECF: Overseas Economic Cooperation Fund, Japan
33. PCU: Passenger-Car Unit
34. PCU-km: Passenger-Car-Unit Kilometers (car-usage output from traffic assignment

model)

35. QV func.: Quantity-Velocity function (input used in traffic assignment model)
36. RAM: Random Access Memory
37. RDA: Road Development Authority (of Sri Lanka)
38. R^2: Coefficient of Determination
39. SIDA: Swedish International Development Cooperation
40. STRADA: System for Traffic Demand Analysis (transportation demand model from JICA)
41. UDA: Urban Development Authority
42. VCR: Volume-Capacity Ratio (road link congestion index in traffic assignment model)
43. Vmax: Velocity Maximum (max. velocity for road links in traffic assignment model)

CHAPTER 1 GENERAL

1.1 Introduction

Over the past two decades, the sectorial development policy of the Government of Sri Lanka has been to rehabilitate its existing road and rail infrastructure. During this period, only rehabilitation work was undertaken to improve the transportation system, via the execution of a number of road rehabilitation and improvement projects. However, traffic demand has been increasing very rapidly during the past decade and there is a shortage of road capacity to meet this rising demand and proposed development plans. Hence, the Government of Sri Lanka has decided to implement a policy to develop a system of new highways to supplement existing road capacity. These new highways have been identified by the Road Development Authority (RDA) and pre-feasibility and feasibility studies have been carried out with the aim of executing appropriate projects.

In response to a request from the Government of Sri Lanka, the Government of Japan has decided to implement one of these projects, i.e., "The Feasibility Study on Outer Circular Highway to the City of Colombo" (hereinafter referred to as the Study). The provision of an outer circular road for the City of Colombo is a long felt need and its realization an earnest wish of the Government of Sri Lanka.

Accordingly, the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of the technical cooperation programs of Japan, decided to undertake this Study, in close cooperation with the authorities concerned in Sri Lanka, from November 1998 till April 2000.

1.2 Background

The present supply of transportation facilities and services is inadequate to meet the continuing increases in traffic demand, especially in the Western Province (hereon referred to as the Colombo Metropolitan Region or CMR). Hence, there is an urgent need to increase this supply. That is, as a result of an inadequate road network and road capacity, traffic congestion and low travel speeds are becoming common place.

One of the problems facing the CMR is the lack of an orbital or outer ring road. Many of the current radial roads are already congested and are operating at capacity. Therefore, the present road network is incapable of dealing with any future increase in travel demand. The purpose

of such a road in the CMR is to encourage the development of current or future growth centers, to connect radial routes, and lastly to divert through traffic from the center of the city. That is , the eastern part of the Colombo is already saturated and the Urban Development Authority (UDA) wishes to shift some of the city's core urban functions and population to the outer suburbs in order to reduce congestion and to control urban sprawl.

Although ongoing improvement of the Baseline Road will divert intra-regional trips from going through the center of Colombo, all the other road improvement schemes would funnel more traffic into the already congested core of the CMR.

Moreover, none of these schemes would connect the radial routes or connect the present and future growth centers that the RDA envisions in the CMR. These two points are crucial if CMR is to solve its problem of congestion, sprawl, increasing transportation cost, raising automobile emissions, etc, that occur with a uni-core city.

Given this background, an outer ring road (hereinafter referred to as the Outer Circular Highway or OCH) has been identified and proposed as one solution for coping with the above-mentioned problems. That is, the OCH would reduce traffic congestion by providing an effective bypass for north-south bound traffic, as well as by reducing the amount of through traffic that occurs from inter-corridor travel via the improvement of the interconnectivity between the present system of radial trunk roads. Moreover, the OCH would disperse and encourage development away from the highly densely populated urban areas of the City of Colombo; thereby, achieving a better balance for growth.

1.3 Objective

The objective of the Study is to examine the feasibility of constructing the OCH for the City of Colombo with the target years of 2010 and 2020.

The OCH which will be located approximately 20km away the City of Colombo, has been selected in order to efficiently cater to increasing traffic demand, to minimize traffic congestion on existing trunk roads radiating from the city, and to encourage regional development and a better balance in urban growth. The OCH will connect the trunk routes of Colombo-Galle-Hambantota-Wellawaya (A2) at Panadura, Colombo-Ratnapura-Wellawaya-Batticaloa (A4) in between Kottawa and Homagama, Colombo-Hanwella Low Level Road (A110) at Kaduwela, Colombo-Kandy Road (A1) at Kadawata, Peliyagoda-Puttalam Road (A3) at Welisara and the proposed new highways of Colombo-Katunayake Expressway and Southern Transport Corridor.

1.4 Study Area

The Study area consists of the Colombo Metropolitan Region(CMR), which is representative of the Western Province and is made up of the three administrative districts of Gampaha, Colombo, and Kalutara. In respect to the OCH itself, road trace alternatives has been confined to a belt 10 km in width and approximately 50 km in length.

1.5 Scope of the Study and Study Approach

The Study has been executed in the area described in the previous clause. The major focus of the Study is to select the most feasible alignment for the OCH within this area for the City of Colombo taking into account socioeconomic, environmental, and technical impacts. The basic approach of the Study is as follows:

1) To select the most suitable road trace and scenario for the OCH based on analyses of existing data/information and data/information gathered from surveys concerning social, transportation, environmental, and technical activities in the CMR.
2) To maximize the feasibility of the selected road trace and scenario via a more detailed analyses and design regimen, taking all of the above activities into account.
3) To provide a realistic implementation plan that adequately takes into account the local construction market, lifecycle costing, maintenance, and appropriate construction phasing and work packaging.

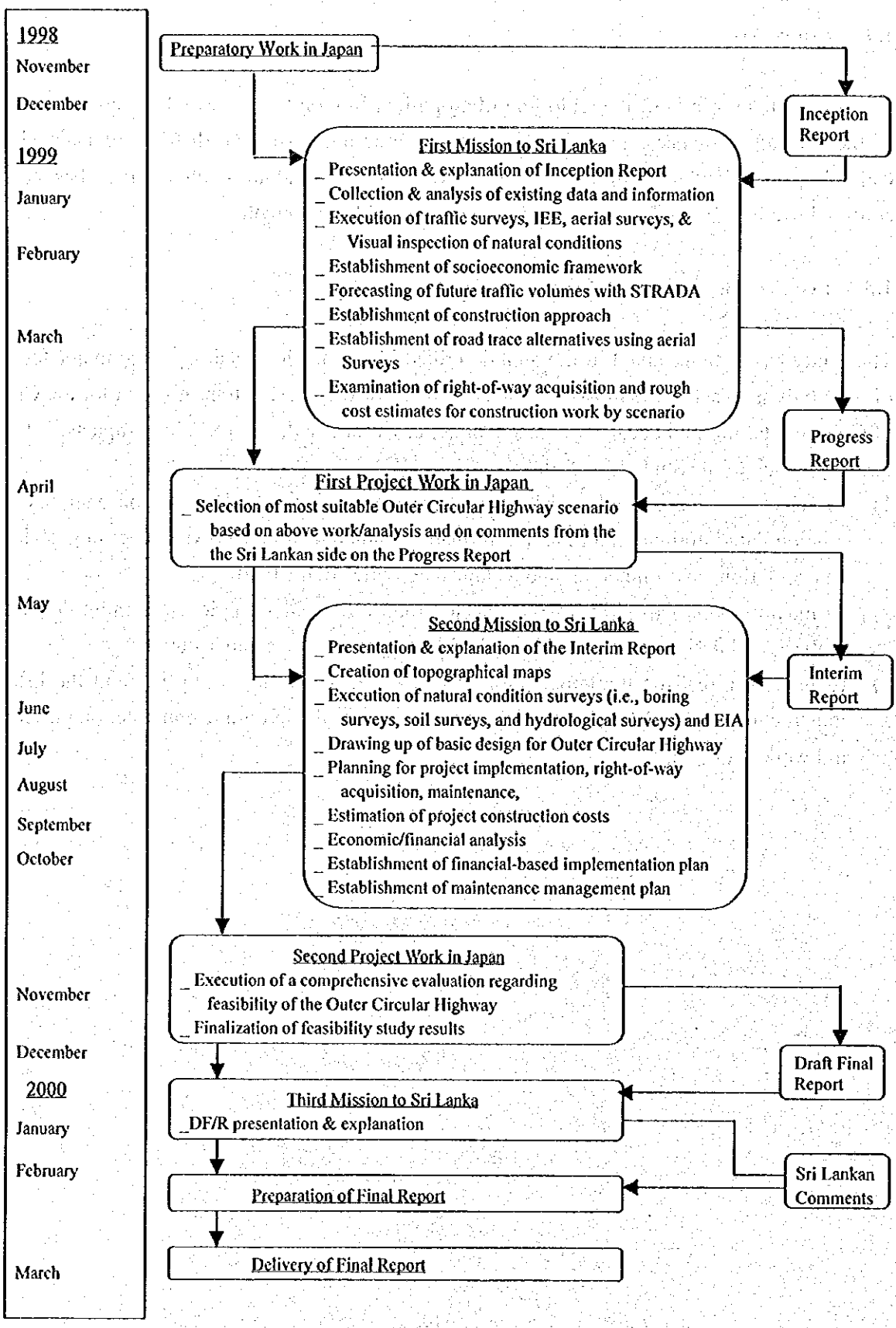

Fig.1.1 Study Flow

CHAPTER 2 PRESENT SITUATION

2.1 Natural Conditions

2.1 1 Topography

The main island of Sri Lanka has a maximum length of 435 kilometers in the north-south direction and a maximum width of 240 kilometers in the east-west direction. The land area is 65,525 square kilometers. From sea level, the relief appears to ascend more or less in steps of three peneplains to a maximum elevation of over 2500 meters at Pidurutalagala.

The project area traverses across different types of land topography, which consists of flood plains, hilly terrain, wetlands and flat areas of raised beaches.

Along the proposal route undulating hilly terrain or isolated round hill, consisting of precambrian rocks and its residual soil, rise to about 10 to 50m above the mean sea level (MSL). Intermittently, the valleys are situated between the hills. The valleys are filled with alluvial materials originating from the flood plains of adjacent rivers. Therefore, the low lands between hills are generally flat. Paddy has been cultivated in some of the valleys, particularly those at a higher elevation (more than about 2 to 3m above the mean sea level (MSL). Low-lying valleys (less than 2 to 3m above the MSL) in Welisara, Weliwita and around Bolgoda river consists of marshes.

2.1.2 Climate and Hydrology

The climate of Sri Lanka is characterized by tropical - monsoon with a marked seasonal rhythm of rainfall. The tropical condition is due to her location between latitudes 6° and 10° north of the equator. The monsoonal conditions refer to two seasonal wind regimes separated by two periods of light and variable winds. The two monsoon periods, Southwest Monsoon (SW, May - September) and Northeast Monsoon (NE, December - February) and the two intermonsoon periods, First Intermonsoon(1st IM, March - April) and Second Intermonsoon(2nd IM, October - November), control the rainfall rhythm. The project (Colombo) area receives an annual rain fall of 2,400 mm, consisting of 350 mm during the 1st IM period, 1050 mm during SW period, 700 mm during 2nd IM period and 300mm during NE period

The project area has a mean temperature of 26℃ during October to February and 28℃ during the warmer months of March to September. The daily temperature rises to a

maximum (30 - 32℃) on the average early in the afternoon and falls to a minimum (22 - 26℃) shortly before dawn. The relative humidity varies from 70% during day to 90% at night. During IM period, the hottest season of the year, the relative humidity remains high.

Excessive rainfall with bursts of intense rain within short intervals is the main cause of floods. Such events are generally associated with cyclone wind circulation in the low and mid troposphere and also with areas of low pressure, depressions and cyclones. Of the 103 river basins, Kelani, Kalu, Gin, Nilwala and Mahaweli experience floods almost annually and about 200,000 people are affected each year. In June 1989 Kalu, Kelani and Gin rivers over flowed their banks by high rainfall, and the lower catchment areas suffered flash floods. Several earth slips occurred in the Kegalle distinct. It was reported that 300 people died and 15,000 houses were damaged. The major floods of May and December of 1982 and June and July of 1984 were disastrous to many areas. The number of families affected in 1982 was 129,469 and the expenditure for relief measures was Rs 14 million while in 1984 Rs 49 million was spent on 297,237 families.

Flooding of Kelani Ganga is important as it affects the city of Colombo. Major floods have occurred in October 1913, May 1927, May 1939, May 1940, August 1947, October 1966, October 1967, July 1989 and June 1992. Minor floods occur almost every year. Many parts of the City of Colombo were submerged on June 5th 1992 when 494 mm of rain full occurred in 24 hours.

Frequent blockages in the drainage canals that carry away rainy water worsen the flood situation in Colombo. Flood protection works in the Kelani Ganga go back to the Dutch period in the 18th century when a small protection bund on the left bank was constructed. A canal system was also constructed for the dual purpose of transport of goods and for drainage of water from the flood plains. The existing flood protection bund was constructed in 1930 by the British. Recently steps have been taken to control floods in Gin Ganga and Nilwala Ganga with protection schemes. The Department of Irrigation with the co-operation of the World Meteorological Organization installed a realtime flood forecasting system for Kelani Ganga as a pilot project. The maximum flood peaks in some river are shown in Tab.2.1.

Tab.2.1 Maximum Recorded Flood Peaks in Some Rivers

Name of River	Catchment Area (sq. km)	Flood Peak (cu.m/sec)	Date of Floods	Observation Period	Station
Kelani Ganga	1463	6808	1989-6-4	1948/96	Glencourse
Kalu Ganga	2597	2829	1942-8-16	1944/96	Putupaula
Gin Ganga	681	1387	1940-5-18	1928/96	Agaliya
Nilwala Ganga	411	2500	1940-5-16	1940/96	Bopagoda

Source: Dep. of Irrigation, Hydrology Division

2.2 Socio-Economic Characteristics

2.2.1 Administrative Structure of Colombo Metropolitan Region (CMR)

Sri Lanka consists of nine Provinces, which are Western, Central, Southern, Northern, Eastern, North Eastern, North Central, UVA and Sabaragamuwa. Western Province, which consists of Colombo, Gampaha and Kalutara Districts, is regarded as Colombo Metropolitan Region (CMR).Each District, in turn, consists of some Divisional Secretariat Division (DS Division).

2.2.2 Socio-Economic Characteristics in the Study Area

1) Population of the Study Area

The Study Area consists of 14 DS Divisions and, in general, there is at least one township in each DS Division, which falls within the road corridor. The total population and the population density in each Division are shown in Tab.2.2.

Tab. 2.2 Population in the Study Area

DS Division	Extent in (km ^{2})	Population	Population density (persons/km ^{2})
Ja-Ela	65.3	198835	3044
Maharagama*	39.40	201389	5111
Kelaniya	23.1	128258	5552
Biyagama	61.6	115911	1881
Kaduwela	87	145525	1672
Kesbawe	35.75	128307	3589
Mahara	49.4	87327	1767
Wattala	54.6	153477	2810
Kollonnawe	13	103405	7954
Bandaragma	58	66227	1141
Homagama	67	100803	1504
Panadura	59	178652	3028
Gampaha	14.6	25747	1763
Nugegoda	1.8	13411	7450
Total	**629.43**	**1647276**	**2610**

The family size of the population would be an important feature in the demography with regard to the proposed project. Tab.2.3 shows the details of family size in each DS division.

Tab. 2.3 Family Size in the Study Area

DS Division	Total population	Family size
Ja-Ela	198835	6.1
Maharagama	201389	6.8
Kaleniya	128258	5.2
Biyagama	115911	4.6
Kaduwela	145525	4.2
Kesbawe	128307	4.6
Mahara	87327	4.9
Wattala	153477	5.1
Kollonawe	103405	5.8
Bandaragama	66227	4.3
Homagama	100803	4.3
Panadura	178652	5.2
Gampaha	25747	3.3
Nugegoda	13411	6.3
Total	**1647276**	**5.1 (average)**

a) Ethnic Groups

People belonging to all the major ethnic groups in Sri-Lanka live in this area. The ethnic categories include, Sinhalese (about 90%), Tamil (3%), Muslim (5%), Burger (.4%), others (2%).The life styles of these categories have clear differences. The majority of Sinhalese people have been living in these areas for centuries. The Tamils have migrated from outside areas, mainly from northern or the central parts of the country.

b) Economic Activities

When compared with other parts of rural Sri-Lanka, the majority of families in the Study Area has assured and regular income sources. These economic activities are shown in Tab. 2.4.

Tab. 2.4 Composition of Economic Activities

Category	Number of Persons	%
Govt. employment	106597	28.2
Private sector employment	126269	33.4
Labor work (daily paid)	35388	9.3
Agriculture	13268	3.5
Business	10213	2.7
Foreign employment	13883	3.6
Self employment	71716	19.0
Total	**377334**	**100**

2.3 Transportation

2.3.1 Road Network Structure

The road network structure of the CMR is mainly radial and runs in an east-to-west direction (see Fig. 2.1). Most of these roads are two- or three-lane undivided highways with optimum capacities of approximately 1200 pcus per hour per lane. Except for Galle Road, there are very few major north-south routes (i.e., cross-town connections). Moreover, except for the Baseline Road (which is under construction and will serve essentially as an inner ring road), there are no orbital routes in existence. This means a large proportion of trips in the CMR are generated in the eastern suburbs and rural areas and have their destinations concentrated at the core of the CMR in the west, i.e., the Colombo Division. There are eight major east-west routes that serve as the main radial routes for CMR and they are as follows:

1) Route A3 (Peliyagoda-Puttalam Road),
2) Route A1 (Colombo-Kandy Road),
3) Route A110 (Colombo-Hanwella Road),
4) Route A1Sp (Kollupitiya-Sri Jayawardena Pura Road),
5) Route A4 (Colombo-Ratnapura-Wellawaya-Batticaloa Road),
6) Route B84 (Colombo-Horana Road),
7) Route A8 (Pandura-Nambapana-Ratnapura Road), and
8) Route A2 (Colombo-Galle-Hambantota-Wellawaya Road).

Another important characteristic of the road network is that it provides few inter-modal transfer opportunities with the railway, which runs parallel with significant portions of A2, A1, A3, and A4. In fact, the only good inter-modal transfer location is in Fort[5].

2.3.2 Rail Transport

As mentioned previously, rail transport accounts for only a small number of the total trips made in the CMR, despite its routes running parallel to highly congested road corridors. This is due in great part to poor levels of service. Of these trips, about 51% have both their origin and destination within the CMR and another 29% have a trip end outside of the CMR boundary. Over the past decade, the growth of intra-CMR trips has grown much faster than that of inter-regional trips, meaning that the railway is becoming an increasingly important urban and/or commuter service[7]. In fact, during peak hours, many trains carry passenger loads well in excess of design capacity (see Tab.2.5). However, on all of the four railway lines in Colombo (see Fig. 2.2), the busiest sections are away from the city center, indicating that rail is also used as public transport in local areas[8].

Tab. 2.5 Maximum Train Load Factors

Line	Rolling stock	Design capacity	Maximum load	Load factor
Main	Loco+14	2,160	3,083	137%
	S8 unit	1,331	2,114	159%
Coast	S8 unit	1,331	1,695	127%
Kelani V.	S7unit	687	1,194	174%

Source : SLR load survey

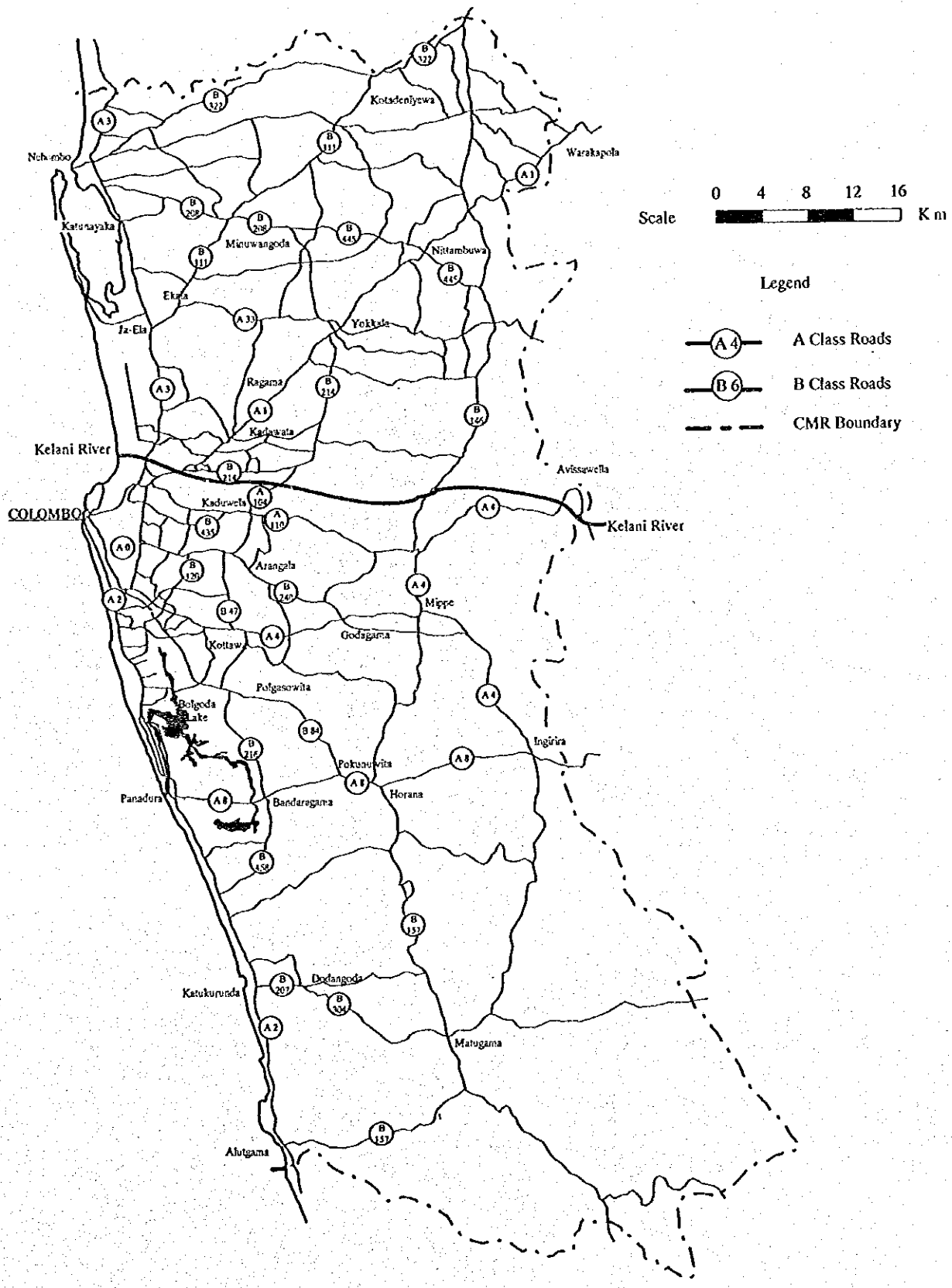

Fig. 2.1 Outline of Road Network Structure

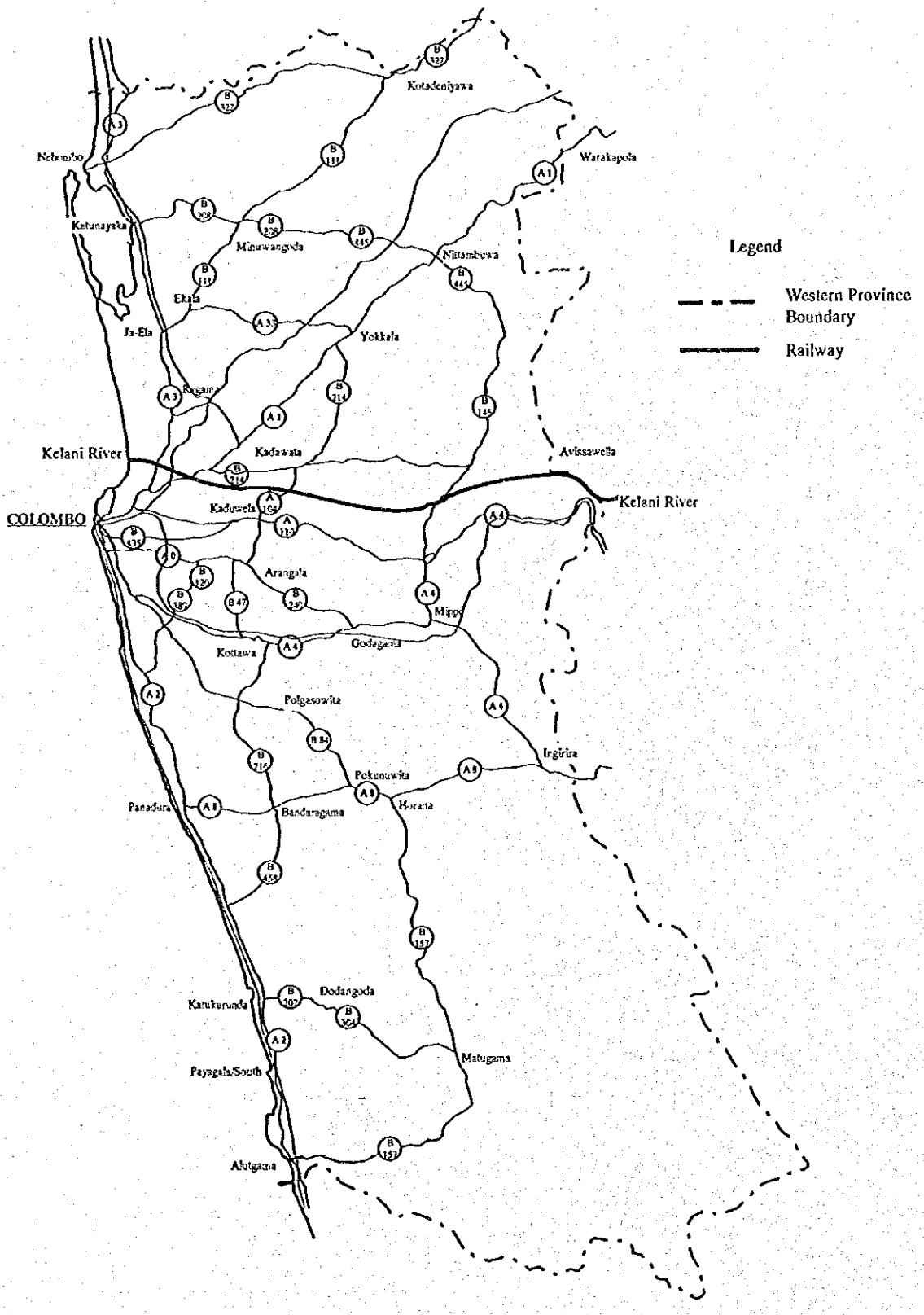

Fig. 2.2 Existing Railway Network in CMR