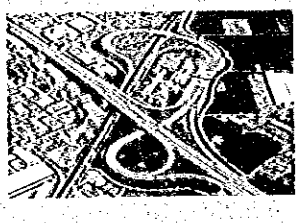
社会開発調査部報告書
No. 64

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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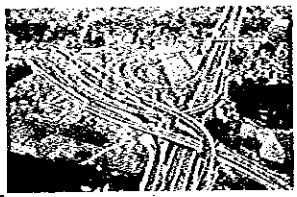

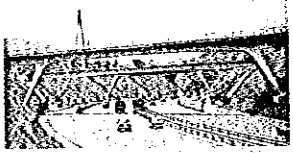

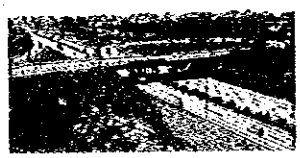

MAIN TEXT I

FEBRUARY 2000

ORIENTAL CONSULTANTS COMPANY LIMITED

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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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VOLUME 2 OF 5

MAIN TEXT I

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).

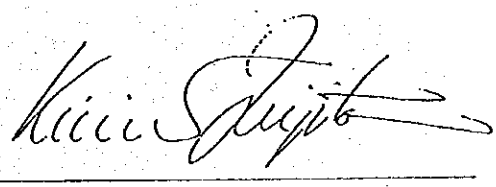
JICA sent to the Democratic Socialist Republic of Sri Lanka a study team headed by YANAGIDA Kazuro, Oriental Consultants Co., Ltd., four times between November 1998 to January 2000.

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

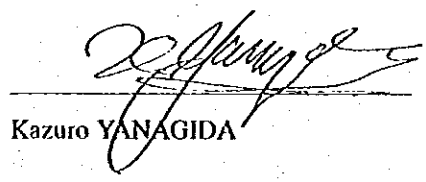
We are pleased to submit to you the report on the Study on the Outer Circular Highway to the City of Colombo in Democratic Socialist Republic of Sri Lanka.

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.

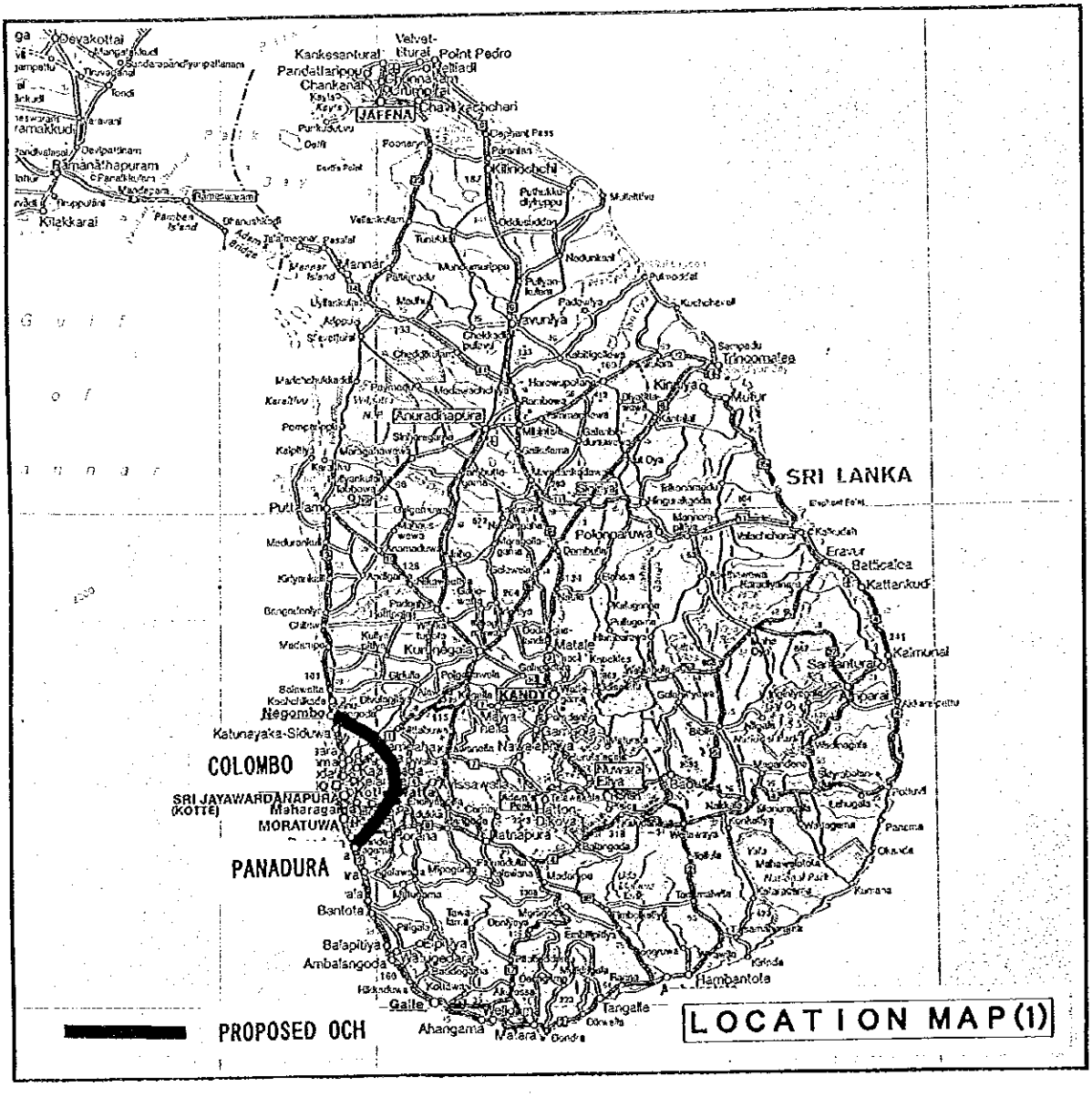
Finally, we hope that this report will contribute to further promotion of the project.

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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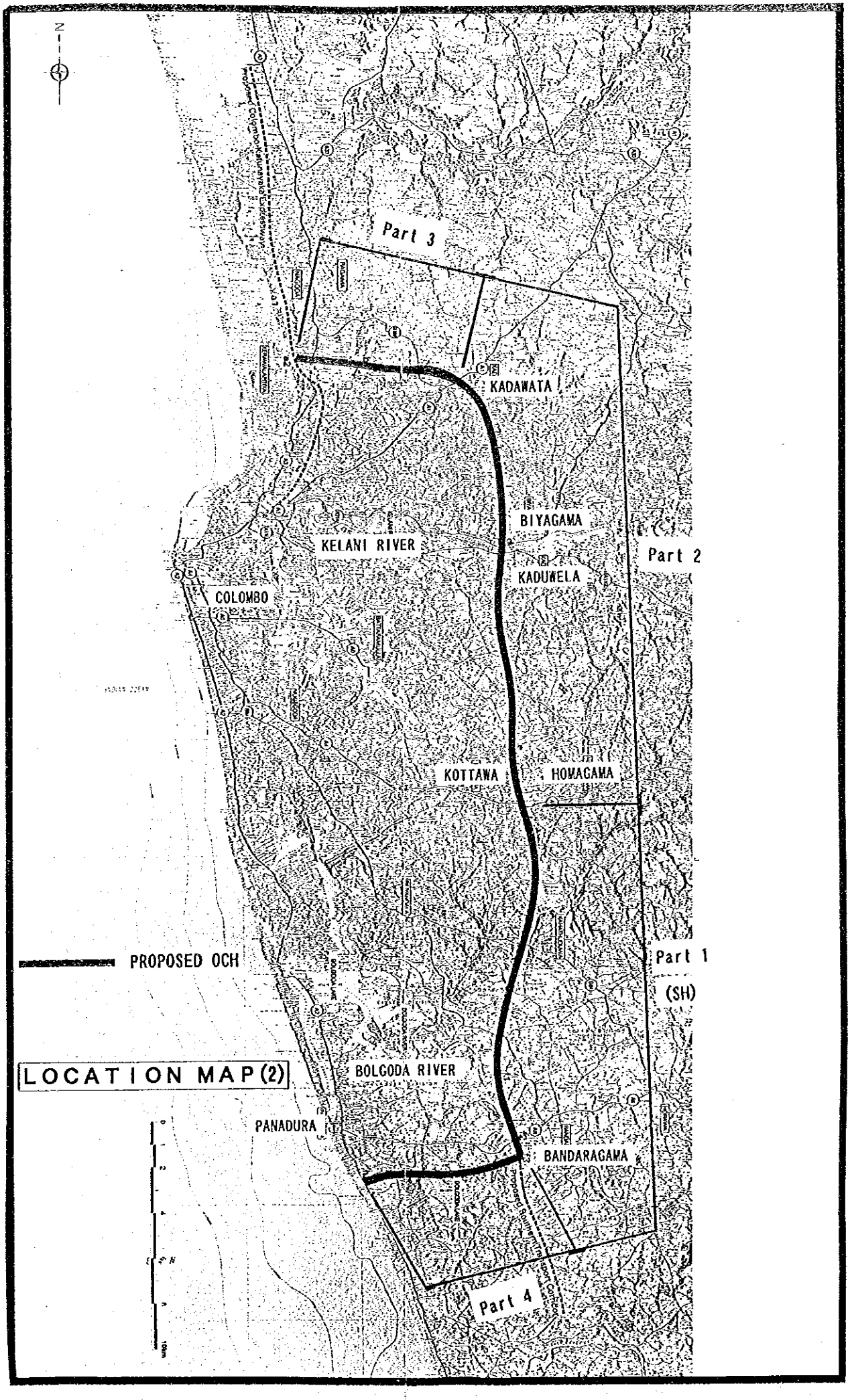
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SUMMARY

SUMMARY

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 are being carried out with the aim of executing appropriate projects.

The Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of the technical co-operation programs of Japan, decided to undertake one of these studies in close co-operation with the authorities concerned in Sri Lanka.

The objective of the JICA Study, which commenced in November 1998, is to examine the feasibility of constructing the Outer Circular Highway (OCH) for the City of Colombo for the target years of 2010 and 2020.

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 Colombo Metropolitan Region (CMR) would be to encourage the development of current or future growth centers, to connect radial routes, to divert through traffic from the center of the city, and lastly to shift some of the city's core urban functions and population to the outer suburbs in order to reduce congestion and control urban sprawl.

Based on the needs of the CMR described above, 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 its intended functions. It is suggested, therefore, that the OCH be constructed to a standard somewhere between an arterial

road and an expressway.

Given the above suggestions, it is realistically unfeasible for the OCH to be a toll road, since a toll road must be a fully-controlled facility in order to collect tolls from users. On the other hand, a partially-controlled facility with levels of service between an arterial road and an expressway (e.g., a toll way) would have the functions needed to provide the access required together with sufficient travel speeds for the people of the CMR. Based on this, it is recommended that the physical structures of the OCH have the 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.

Highway Alignment

The OCH which will be located approximately 20km away from 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 at Panadura (A2), Colombo-Ratnapura-Wellawaya-Batticaloa in between Kottawa and Homagama (A4), Colombo-Hanwella Low Level Road at Kaduwela (A110), Colombo-Kandy Road at Kadawata (A1), Peliyagoda-Puttalam Road at Welisara (A3), and the proposed Colombo-Katunayake Expressway and Southern Transport Corridor.

Traffic Forecast

In the following tables , the traffic indices of vehicle-kilometers, vehicle-hours, average area congestion, and average area speed are used to assess the impact of the OCH on the CMR.

Comparison of Traffic Impacts with and without the OCH for 1999

	Daily Veh-km For CMR (mil)	Daily Veh-hrs for CMR (mil)	Daily Average VCR	Daily Average Speed
Without OCH	8.99	0.26	0.47	32.7
With OCH	8.92	0.26	0.41	34.7
Ratio of with/without	0.99	1.00	0.87	1.06

Comparison of Traffic Impacts with and without the OCH for 2010

	Daily Veh-km for CMR (mil)	Daily Veh-hrs for CMR (mil)	Daily Average VCR	Daily Average Speed
Without OCH	19.69	0.71	0.83	27.7
With OCH	19.57	0.65	0.73	30.3
Ratio of with/without	0.99	0.92	0.88	1.09

Comparison of Traffic Impacts with and without the OCH for 2020

	Daily Veh-km for CMR (mil)	Daily Veh-hrs for CMR (mil)	Daily Average VCR	Daily Average Speed
Without OCH	30.11	1.20	1.06	25.2
With OCH	29.40	1.04	0.92	28.4
Ratio of with/without	0.98	0.87	0.87	1.13

The conclusions that can be drawn from the construction of the OCH based on the above tables are as follows:

1) The impact of the OCH becomes larger as time passes by. In the year 2020, the construction of the OCH would result in daily area speeds being 1.13 times faster as compared to only 1.06 times faster if the OCH was in existence today. In the year 2010, the construction of the OCH would result in average area travel speeds being 1.09 times faster.
2) The reduction in distance traveled on the road network with the introduction of the OCH is slight. In the year 2010 it is a small 1% and would reach 2.4% in the year 2020, indicating an increase in the number of orbital trips. On the other hand, vehicle-hours would be 11% and 13% less in the years 2010 and 2020, respectively, as compared to the case of there being no OCH.
3) The difference in actual area travel speeds with and without the OCH is 2.7 km/h in 2010 and 3.2 km/h in 2020. These are substantial differences in speed for an urban area.
4) Area wide congestion with the OCH would be about 12% less as compared to without.

The above clearly indicates that the OCH would be a feasible proposition from the perspective of the impact that it would have on area-wide traffic. As for the traffic demand on the OCH itself, estimates by this study indicate that 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. Given these traffic volumes, it is suggested that the OCH be constructed initially as a 4-lane facility. The most congested parts of the OCH would be located in the middle of this ring road and the least congested parts at the tail ends. However, the northern tail end would have a much higher traffic volume (34,500 pcus) as compared to the southern tail end (19,200 pcus).

In the year 2020, pcus flows indicate that the entire middle portion of the OCH is over capacity. Although a 4-lane OCH facility is sufficient to handle the required traffic flows in the year 2010, improvements to the OCH will be necessary to handle the traffic generated in the year 2020. 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. Although traffic on the northern tail end and on the section between A8 and the Southern Highway can be handled by a 4-lane structure, it would be better from a network point of view to make these 2 sections into 6-lane structures as well. That is, because the northern tail end would connect the important CKE with the 6-lane portion of the OCH, which intersects the busy Kadawata area, it would be in the long run strategically better for the northern tail end to become a 6-lane facility. In the case of the OCH portion between A8 and the Southern Highway, it is quite short in length (less than 1 km) and it would be rather pointless to only retain this section of the OCH straightaway as a 4-lane structure. As for the southern tail end of the OCH, its traffic demand of 28,200 pcus requires that it remain as a 4-lane structure.

Preliminary Design for Highway and Structure

A typical highway cross section of the OCH would be as follows:

- Lane width: 3.5m
- Center Median: 3.0m
- Shoulder (including stopping lane): 0.75m
- Frontage Road: 5.5m
- Green Area: on slope

The OCH carriageway would be a dual 4-lane structure initially. Based on the future traffic demand for the year 2020, it is recommended that this be made into a 6-lane carriageway (excluding the section running from SH junction to A2 road). Traffic lanes would be 3.5

meters wide and be geometrically designed to handle maximum vehicle speeds of 80km/h. Since it is anticipated that there will be relatively large numbers of heavy vehicles that will use the OCH, this has also been taken into account in the drawing up of its geometric design. A frontage road is provided to play two major functional roles, which are as follows:

- To provide access along the OCH route from the proposed interchanges to the residential, commercial, industrial, and planned development areas (such as a free-trade zone or other growth center).
- To provide access to residents whose previous travel route or area has been severed by the proposed highway.

Further design conditions are described below.

1) Pavement
Design CBR: 6% (subgrade)
Design Method: AASHTO
Design Period: 10 years
Heavy Vehicle Traffic: Percentage of Heavy Vehicle Traffic
Pavement Type: Asphalt Concrete Pavement or Concrete Pavement

2) General Structure
The design of bridges and other related structures is carried out in accordance with the 1997 RDA Bridge Design Manual and the British Standard (BS) 5400 with certain modifications for the local conditions of Sri Lanka. However, details on design method, conditions, prescriptions and rules are not described in the manual. Therefore, BS 5400 has been basically adopted for bridge design, together with other standards such as AASHTO and the Japan Road Association Standard (JRAS) for the design of the OCH.

To design bridge crossings over rivers, the following items are required for design :

a) Width and cross section of river
b) Highest water level (1.0m clearance from highest flood level)
c) Maximum velocity of water current and maximum volume of flood discharge
d) Location or plan for shore protection - font different

There are two major bridge crossings for the OCH which are at the Kelani and Bolgoda rivers.

Kelani River Crossing:
Superstructure : Bridge length 150 m (river section), span 25 m, six-span PSC continuous girder.
Substructure : Reversed T-type abutment with ø1.0 m cast-in-place concrete pile foundation. The pier is an elliptical column with either an open caisson or cast-in-place concrete pile foundation (determined in detailed design).

However, the type of structure shall be carefully reviewed and determined at the detailed design stage.

Bolgoda River Crossing:
Superstructure : Bridge length 102 m (river section),span 17 m, six-span PSC continuous girder
Substructure : Reversed T-type abutment with ø1.0 m cast-in-place concrete pile foundation, the pier is a Pile bent pier with ø1.0 m cast-in-place concrete pile foundation
However, the type of structure shall be carefully reviewed and determined at the detailed design stage.

To design bridge crossings over highways, the following items are required for design

a) Minimum vertical clearance: 5.25 m (Bridge Design Manual)
b) Road width : Existing road width or planning width
c) Construction conditions: Construction method, diversion

There are two railway crossings on the proposed OCH route. One is the Colombo-Kandy line with a triple-track at Horape near the Halanduruwa marsh and the other is the Colombo - Avissawella line with a single track at Malapalla near the A4 road crossing. To design bridge crossings over a railway, the following items are required for design:

a) Minimum vertical clearance: 18' = 5.50 m (for electrified rail)
b) Structure gauge

3) Interchanges

Since the connecting road and ramp intersection are of a level crossing type, the configuration below has been finalized by checking traffic capacity at the respective locations.

(1)	CKE	:	Double trumpet type JCT
(2)	A3	:	Half trumpet
(3)	A1	:	Diamond type IC
(4)	B214Road	:	Half diamond type IC
(5)	A110Road	:	Half diamond type IC
(6)	A4 Road	:	Basic: Half clover type IC
		:	Alternative: Double trumpet type IC
(7)	B84 Road	:	Diamond type IC
(8)	A8 Road	:	Diamond type IC
(9)	STC	:	Y type JCT
(10)	A2 Road		Composite diamond (Level Crossing)

Construction Execution Strategy and Project Cost Estimate

1) Staged Construction

The construction of the OCH is to be implemented in stages:

Initial Stage	:	Initial construction of a four-lane dual carriageway highway for the entire length
Final Stage	:	Widening from a four-lane to a six-lane structure for sections requiring greater capacity to deal with increases in traffic demand.

2) Framework for Construction Execution

The framework for the construction schedule, which comprises an OCH construction execution strategy, has four parts and is as follows:

Part No.	Section
1	SH (Bandaragama) – (Kottawa)
2	Kottawa – Kadawata
3	Kadawata – CKE (Kelawarapitiya)
4	Bandaragawa - Panadura

3) Construction Time Schedule

Detailed design will commence in the beginning of 2002 and construction will be executed over a period of 2.0 - 2.5 years from the beginning of 2004.

4) Cost Estimate

Project cost was estimated based on the results of the preliminary engineering design.

- **Project Cost Components**
  - Construction
  - Engineering Services (detailed design/ tender assist/ supervision services)
  - Land Acquisition and Resettlement
  - Tax and Duty
- **Operation and Maintenance Cost Components**
  - Utilities (electricity, water supply)
  - Overlay

Summary of Estimated Total Project Costs for OCH Alignment (million Rs.)

		Part 1 (Southern Highway Project Portion)	Part 2.3.4 (OCH Project)
Initial Investment	Construction	3,814.2	8,579.4
	Engineering Services	381.4	857.9
	Land Acquisition etc.	572.0	1,161.6
	Tax and Duty	1,133.2	2,521.5
	Total	5,900.8	13,120.5
Operation and Maintenance (30years)		699	2,016

* : Total project costs to be actually borne by the OCH project.

Environmental and Social Impact Assessment

The largest mitigatory action that can be taken for environmental conservation is to design the OCH road trace so as to minimize the negative impacts on adjacent communities, properties, and wetlands. For example, impacts on drainage patterns can be avoided or minimized to an acceptable level by providing bridges, culverts, and other drainage structures where necessary. Again, impacts on the Bolgoda wetlands for example can be avoided by shifting the road trace away from the wetland system when necessary. In the eventuality that a community is affected, proper compensation should be promptly offered. Adequacy, timeliness and reliability are the main criteria to be fulfilled in the implementation of the compensation program.

The institutional requirement for environmental monitoring has been identified as the establishment of a project monitoring committee (PMC), which will be responsible for the implementation of a monitoring plan. The required monitoring activities of the PMC in regards to flood levels, air and water quality, noise levels, biological aspects, and relocation and resettlement have been detailed in this study.

This project has been determined to be environmentally acceptable provided that the environmentally acceptable road trace recommended in the environmental impact assessment (EIA) is taken into consideration and the proper mitigatory actions implemented. Moreover, the detailed design should include environmental safeguards and the recommended PMC 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.

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, 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. Therefore, it can be said that the OCH would contribute greatly to the socioeconomic improvement of Colombo via the alleviation of traffic congestion and better spatial distribution.

As for any negative impacts on the social and natural environment along the OCH route, these would be mitigated via the timely application of appropriate countermeasures, which would include the design aspects of the OCH as well. These countermeasures would deal with the 11 negative impacts mentioned in the EIA of this study. Given this, any negative impacts should not be a reason for rejecting the implementation of the OCH.

Conclusion : Implementation Plan and Recommendations

As indicated above, the OCH will be a highly traveled facility that will contribute significantly to the socioeconomic betterment of Colombo, as shown by the EIRR of 18.87%. In addition, the EIA has determined that the OCH is environmentally acceptable if the proper precautions are taken, which would be finalized in the detailed design stage of this Study. Below, the implementation plan and related recommendations for the construction of the OCH are briefly described.

Part 1 of the OCH, which would extend from the north end of the Southern Transport Corridor at Kottawa at A4 (High Level Road), has already been launched and the RDA has called for tenders for the design as a part of the Southern Transport Corridor, which is being funded by the Japan Bank for International Cooperation (JBIC). However, as shown in the table below, the OCH project would produce the greatest returns and have the largest net worth with the implementation of Part 1 and Part2, which would extend from Rt. A4 to the crossing with the Colombo – Kandy Road (A1). It therefore goes without saying that the construction of the OCH should extend to Rt. A1 at a minimum.

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

Option	B/C	B-C
Option 1 (Construction of Part 1 only)	2.17	Rs.4,767 million
Option 2 (Construction of Part 1 & 2)	3.23	Rs.13,869 million
Option 3 (Construction of Part 1,2,3)	1.93	Rs.8,826 million
Option 4 (Construction of entire OCH)	1.74	Rs.7,713 million

On the other hand, the EIRR with the construction of Part 3 in addition to Parts 1 and 2 (or Option 3) would still be a very attractive 20.06% in comparison to the 26.35% for Option 2. In addition, from a road network viewpoint, it is crucial in the Study Team's opinion that the CKE and the Southern Highway be connected to each other via the OCH. Therefore, the portion between A1 and the proposed Colombo – Katunayake Expressway at Kerawalapitiya will be built at the same time as Part 2. The construction schedule for this portion should be determined based on the progress of the CKE Project.

As for the section between the proposed Southern Transport Corridor junction and the Colombo – Galle Road (Road A2), this would be built last. However, according to the sensitivity analysis in Chapter 13, the EIRR of including Part 4 drops to around 16% with a 10% decline in benefits and a 10% increase in costs. Given this, a reexamination of the benefits and costs of this portion might be necessary prior to actual implementation.

It is recommended also that initial construction be 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 on many sections of the OCH will be more than 50,000 PCUs per day by about 2020 (i.e.10 years after opening). At this time, widening work may therefore be warranted.

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ABBREVIATIONS

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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)