No.

ROAD DEVELOPMENT AUTHORITY
MINISTRY OF HIGHWAYS AND ROAD DEVELOPMENT
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

# THE DETAILED DESIGN STUDY ON THE OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO

# FINAL REPORT
## (FOR NORTHERN SECTION 1)
# EXECUTIVE SUMMARY
## 1 of 10

February 2008

JAPAN INTERNATIONAL COOPERATION AGENCY

Oriental Consultants Company Limited

Pacific Consultants International

SD
CR(3)
08–016

The following foreign exchange rate is applied in the study:

SLR 1.00 = JPY 1.099 (as of April 2007)

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# 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 Detailed Design Study on the Outer Circular Highway to City of Colombo in the Democratic Socialist Republic of Sri Lanka (Northern Section 1) and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a Study Team headed by Dr. Masaaki TATSUMI of Oriental Consultants Co., LTD. and Pacific Consultants International to Sri Lanka, four times between October 2006 and December 2007.

The Study Team held discussions with the concerned officials of the Government of Sri Lanka and conducted the field surveys in the study area. Upon returning to Japan, the Study Team conducted further studies and prepared this final report.

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

Finally, I wish to express my sincere appreciation to the concerned officials of the Government of Sri Lanka for their close cooperation extended to the Study.

February 2008

Eiji HASHIMOTO
Vice President
Japan International Cooperation Agency

# LETTER OF TRANSMITTAL

February 2008

Mr. Eiji HASHIMOTO,
Vice President
Japan International Cooperation Agency (JICA)
Tokyo, JAPAN

We are pleased to submit to you the Final Report of the Detailed Design Study on the Outer Circular Highway to the City of Colombo (Northern Section 1).

This study was conducted by Oriental Consultants Co., Ltd. in association with Pacific Consultants International under a contract to JICA, during the period from October 2006 to February 2008. In conducting the study, we have completed the Detailed Design of the project.

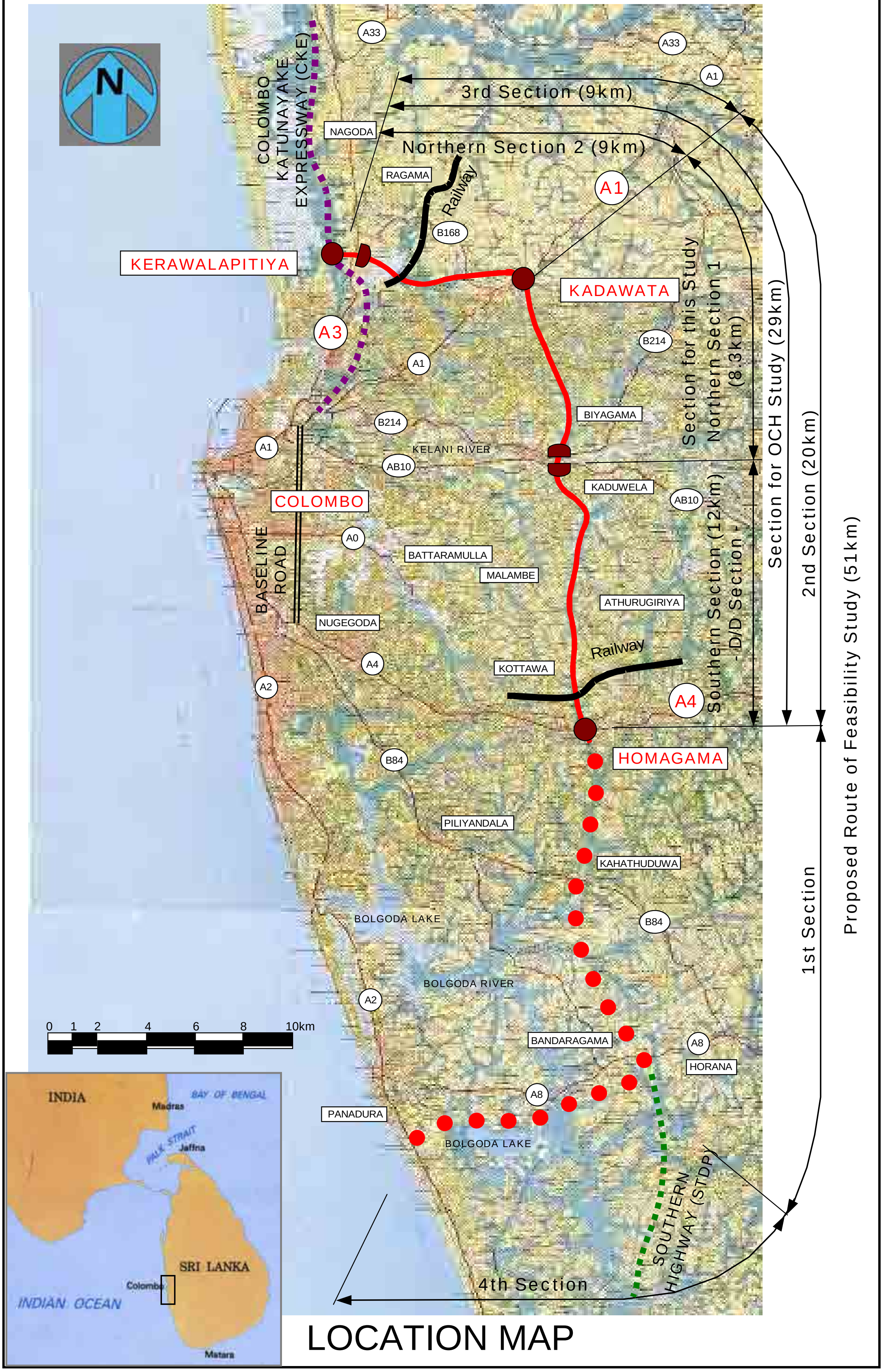
We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, Ministry of Foreign Affairs of Japan, Japan Bank for International Cooperation, Infrastructure Development Institute, Ministry of Highways and Road Development of Sri Lanka, Road Development Authority, Embassy of Japan in Sri Lanka, JICA Sri Lanka Office and JBIC Representative Office in Colombo for their cooperation assistance throughout the Study.

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

Very truly yours,

Masaaki TATSUMI
Team Leader,
Study Team of the Detailed Design Study
on the Outer Circular Highway to the City of Colombo

# OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO (OCH)




LOCATION MAP

# PROJECT SUMMARY

## ◆ Project objectives

The Outer Circular Highway to the City of Colombo (OCH) Project was aimed to relieve traffic congestion in the Gampaha, Colombo and Kalutara districts. From 1998 to 2000, a feasibility study (F/S) was carried out by the JICA Study Team to and it was proposed that the Government construct a 51.26-km circular highway. Consequently, the scale of the OCH Project was reduced to approx. 29km length, consisting of the 2nd and 3rd sections of the F/S. The study was suspended after preparing draft basic design report in 2002 Subsequently, the study was resumed partially from the section that confirmed that it is possible to carry out site survey and Basic design for entire OCH and detailed design for OCH Southern Section was completed. The detailed design in this stage of the study was for an 8.3-kilometer from A1 road to the south bank of the Kelani River (i.e., the Northern Section 1).

## ◆ Study methodology

<u>2001-2002</u>

1) Preparatory work in Japan (analysis of related documents, examination of basic study policies, preparation of inception report)
2) First field study (review of FS report, execution of topographical surveys and surveys on natural and other conditions, basic design)
3) First work in Japan (preparation of draft basic design report)
4) Second field study (submission of draft basic design report)

<u>2004-2005</u>

5) Preparatory work in Japan (preparation of progress report)
6) Third field study (supplementary surveys, execution of surveys on natural conditions, environmental surveys, and surveys of traffic volumes, basic design)
7) Second work in Japan (detailed review of FS, examination of soft ground countermeasures)
8) Third work in Japan (preparation of basic design report)
9) Fourth field study (definitive plan, detailed design, construction plan, cost estimation, etc.)
10) Fourth work in Japan (preparation of interim report)
11) Fifth field study (preparation of PQ documents, tender documents, project implementation & and road operation plans)
12) Fifth work in Japan (preparation of draft final report)
13) Sixth field study (explanation and submission of the draft final report)
14) Sixth work in Japan (preparation of final report)

<u>2006-2007</u>

15) Preparatory work in Japan (preparation of progress report)
16) Seventh field study (supplementary surveys, execution of surveys on natural conditions, environmental surveys, definitive plan, detailed design, construction plan, etc.)
17) Seventh work in Japan (study for design and construction concepts, preparation of interim report)
18) Eighth field study (detailed design, construction plan, cost estimate, preparation of PQ documents, tender documents, project implementation & and road operation plans)
19) Eighth work in Japan (preparation of draft final report)
20) Ninth field study (modification of detailed design, modification of bridge design, modification of project cost estimation, modification of P/Q documents
21) Ninth work in Japan (preparation of draft final report 2, modification of bridge design, modification of construction plan)
22) Tenth field study (explanation and submission of the draft final report 2)

<u>2008</u>

23) Tenth work in Japan (preparation of final report)

## ◆ Project outline

The entire Project is divided into two sections with three construction packages as follows:

- ☐ Northern Section 2: STA.0-600 to STA.8+200 (CKE - A1)
  *Basic Design – completed, Detailed Design – not covered in this study
- ☐ Northern Section 1: STA.8+200 to STA.16+560 (A1 - AB10)
  *Basic Design – completed, Detailed Design – conducted in the present study
- ☐ Southern Section: STA.16+560 to STA.28+500 (AB10 - A4)
  *Basic Design and Detailed Design - completed

## ◆ Project evaluation

The social and environmental problems has been mitigated due to reduction of hauling volume by the application of the Gravel Compaction Pile (GCP) method as soft soil countermeasure, and the adoption of viaducts on sections with deep layers of soft ground or high embankments

## ◆ Conclusion and recommendations

The Southern Highway is now on the peak of construction process and the construction of the OCH Southern Section is to commence shortly. Furthermore, it is expected that the CKE will also be taken up sometime in the near future. In order for these highways to function as intended, the realization of the OCH Northern Section 2 is extremely important. It is therefore hoped that the Sri Lankan Government will continue with its sincere efforts to obtain the understanding of local residents regarding the implementation of this project.

# OUTLINE OF THE STUDY

- Study Term: July 2001 – February 2008 (suspended from February 2002 to May 2004)
- Counterpart Agency: The Road Development Authority of the Ministry of Highways & Road Development of Sri Lanka (hereinafter referred to as the "RDA")

## 1. Objectives

The Outer Circular Highway to the City of Colombo (OCH) Project was aimed to relieve traffic congestion in the Gampaha, Colombo and Kalutara districts. From 1998 to 2000, a feasibility study (F/S) was carried out by the JICA Study Team to and it was proposed that the Government construct a 51.26-km circular highway, which would consist of four sections and connect seven high-priority trunk roads radiating from Colombo as well as a number of intercity expressways.

This study is to carry out detailed design and prepare draft tender documents for two sections (2 and 3), which are about 29 km in length, of the four sections originally proposed in the F/S. It was also decided that basic and detailed designs for a provisional four-lane road be prepared keeping in mind that the OCH will be widened to a six-lane highway in the future.

The basic and detailed design study of OCH would be conducted in accordance with the Scope of Work (S/W) and Minutes of Meeting (M/M) signed and exchanged between the Sri Lankan Government and JICA on 20$^{th}$ February 2001, however, the study was suspended after preparing draft basic design report in January 2002 because the protest of residents made implementation of the field survey impossible.

After That, the study was resumed partially from the section that confirmed that it is possible to carry out site survey and following study was completed. (refer to LOCATION MAP and 1.3. OCH Project Chronology)

- Basic design for entire OCH and detailed design for OCH Southern Section (12-km section south of the Kelani River -June 2004 - July 2005)
- detailed design study for OCH Northern Section 1 (8.3-km section from A1 to Kelani River - October 2006 – February 2008)

The detailed design for the OCH Northern Section 1 was prepared, and includes establishment of design requirements, construction work plans, cost estimates, and bidding documents.

## 2. Design and Construction Concept

OCH's Northern Section 1 extends from Kandy Road (A1) in Kadawatha to AB10 on the left bank of the Kelani River in length of 8.3km, connecting with the Southern Section of the OCH. The A1 Interchange (A1IC) is located in paddy area and the main carriageway around the A1IC is designed with a high embankment in order to cross over the existing A1 Road. In the Biyagama area, the ground is low-lying and soft, resulting in the height of the embankment of the OCH being high here as well.
In the case where the replacement method is applied as a soft soil countermeasure, which is the original concept proposed in the basic design stage of the OCH, all soft soil including peat is removed and replaced with gravel. The estimated total haulage from carrying and dumping material would reach about 4.7 million cu.m. and a large number of trucks would be required for this operation.

It was planned to apply the replacement method against soft ground in the OCHNS1 and the OCHSS, however, in order to reduce the impact on the social environment during construction, the RDA strongly requested to consider other methods which could reduce the amount of earthwork volume much more. The JICA study team compared some alternatives including the application of viaduct instead of embankment structures, and selected the most suitable alternative which make the construction cost increase 20% but reduce haulage 60% as compared with the original method.

In addition, the Sri Lanka side requested the application of a JBIC STEP (Special Term for Economic Partnership) loan, as Japanese technology will provide advantages regarding soft soil countermeasures and rapid construction in congested and/or narrow areas. According to the request the above, some proposals that satisfy their requests were studied by the JICA Study Team and the optimal proposal was determined through discussions with Sri Lanka side again.

## 3. Outline of Detailed Design

The detailed design for the Northern Section 1 covers the following:

(1) Roads

Geometric structural design for the OCH and its interchanges/ramps, embankments, cut soil structures, soft soil coutermeasures, and traffic safety facilities.

(2) Bridges

Design of five highway bridges, six ramp bridges, and five overpasses. Note that the design of bridges except the Kelani River Bridge and overpass bridge were conducted at the basic design level. The basic design for both a concrete structure and a steel structure were carried out for A1 IC bridge including the main carriageway and ramps.

(3) Structures

Design of underpass culverts, drainage culverts, ditchs, retaining walls, and other structures.

## 4. Construction Work Plan

The construction process of OCHNS1, which is influenced by viaducts and Kelani River Bridge construction, is planned to require three years thanks to reducing the total amount of haulage drastically.

## 5. Environmental Study

The Supplementary Environmental Impact Assessment (SEIA) Report for deviation in Biyagama area was reviewed and confirmed the consistancy with the JICA guideline. The Draft Environment Management Plan (EMP) and Environmental Monitoring Action Plan (EMAP) for the OCH were prepared and the Resettlement Implementation Plan (RIP) was also reviewed to reflect present conditions and future plans.

## 6. Project Cost Estimates

The project costs was estimated referring to the unit prices in Sri Lanka and the Japanese standards for cost estimate.

## 7. Road Maintenance & Operation

In view of a previous study of the present operating and maintenance (O&M) conditions for existing roads, the Study team conducted the preliminary examinataion regarding a road operation plan for the OCH.

## 8. Draft Tender Documents

Tender documents were prepared by referring to other similar projects and to various standards and are as listed below.

| | |
|---|---|
| Volume I: | Instructions to Bidders etc. |
| Volume II: | Conditions of Contract |
| Volume III: | Technical Specifications |
| Volume IV: | Bills of Quantities |
| Volume V: | Data Provided by the Employer<br>(survey data, geological data, climate data, etc.) |
| Volume VI: | Drawings<br>(incl. ROW, soil profile, and utilities) |

## 9. Implementation Program

The Study team proposed a project implementation plan that will require one year of pre-construction preparation (including the signing of the loan agreement) and three years of actual construction work.

## 10. Conclusion and Recommendations

In this study, social and environmental problems has been mitigated due to reduction of hauling volume by the application of the Gravel Compaction Pile (GCP) method as soft soil countermeasure, and the adoption of viaducts on sections with deep layers of soft ground or high embankments.

On the other hand, the Southern Highway is now on the peak of construction process and the construction of the OCH Southern Section is to commence shortly. Furthermore, it is expected that the CKE will also be taken up sometime in the near future. In order for these highways to function as intended, the realization of the OCH Northern Section 2 is extremely important. It is therefore hoped that the Sri Lankan Government will continue with its sincere efforts to obtain the understanding of local residents regarding the implementation of this project.

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# Abbreviations

(In alphabetical order)

| | | |
|---|---|---|
| 1 | ADB: | Asian Development Bank |
| 2 | B/D: | Basic Design |
| 3 | BOI: | Board of Investment (of Sri Lanka) |
| 4 | BS: | British Standards |
| 5 | CBR: | California Bearing Ratio |
| 6 | CEA: | Central Environmental Authority (of Sri Lanka) |
| 7 | CKE: | Colombo-Katunayake Expressway |
| 8 | CKdE: | Colombo-Kandy Expressway |
| 9 | CMC: | Colombo Metropolitan Council |
| 10 | CMR: | Colombo Metropolitan Region |
| 11 | DS | Divisional Secretariat |
| 12 | EIA: | Environmental Impact Assessment |
| 13 | EIRR: | Economic Internal Rate of Return |
| 14 | EMAP: | Environmental Management Action Plan |
| 15 | EMP: | Environmental Management Plan |
| 16 | ESD: | Environmental and Social Division |
| 17 | ERD: | Department of External Resources, Ministry of Finance and Planning (of Sri Lanka) |
| 18 | F/S: | Feasibility Study |
| 19 | GCP: | Gravel Compaction Pile (Method) |
| 20 | GOSL: | Government of Sri Lanka |
| 21 | GPS: | Global Positioning System |
| 22 | HFL: | High Flood Level |
| 23 | HSR: | Sri Lanka Highway Schedule of Rate |
| 24 | IC: | Interchange |
| 25 | ITI: | Industrial Technology Institute (of Sri Lanka) |
| 26 | JBIC: | Japan Bank for International Cooperation |
| 27 | JICA: | Japan International Cooperation Agency |
| 28 | MOF: | Ministry of Finance and Planning (of Sri Lanka) |

29 MOH: Ministry of Highways and Road Development (of Sri Lanka)

30 MSL: Mean Sea Level

31 NEA: National Environmental Act

32 OCH: Outer Circular Highway

33 OCHNS: Outer Circular Highway Northern Section

34 OCHSS: Outer Circular Highway Northern Section

35 ODA: Official Development Assistance

36 OP: Overpass

37 O&M: Operation and Maintenance

38 PBC: Performance-Based Contracting

39 PBM: Performance-Based Maintenance

40 PC: Prestressed Concrete

41 PCU: Passenger-Car Unit

42 PMU: Project Management Unit

43 PQ: Prequalification

44 PSP: Private Sector Participation

45 RDA: Road Development Authority (of Sri Lanka)

46 RIP: Resettlement Implementation Plan

47 ROW: Right of Way

48 SD: Survey Department (of Sri Lanka)

49 SEIA: Supplemental Environmental Impact Assessment

50 SH: Southern Highway (same as STDP)

51 SLEA: Sri Lanka Expressway Authority

52 SLLRDC: Sri Lanka Land Reclamation and Development Corporation

53 SLR: Sri Lanka Rupees

54 STDP: Southern Transport Development Project

55 STEP: Special Term for Economic Partnership

56 UP: Underpass

57 VPD: Vehicle per Day

# CHAPTER 1 GENERAL

## 1.1. Introduction

The Outer Circular Highway to the City of Colombo (OCH) Project was aimed to relieve traffic congestion in the Gampaha, Colombo and Kalutara districts. From 1998 to 2000, a feasibility study (F/S) was carried out by the JICA Study Team to and it was proposed that the Government construct a 51.26-km circular highway, which would consist of four sections and connect seven high-priority trunk roads radiating from Colombo as well as a number of intercity expressways.

This study was conducted to carry out detailed design and prepare draft tender documents for two sections (2 and 3), which are about 29 km in length, of the four sections originally proposed in the F/S. It was also decided that basic and detailed designs for a provisional four-lane road be prepared keeping in mind that the OCH will be widened to a six-lane highway in the future.

The basic and detailed design study of OCH was conducted in accordance with the Scope of Work (S/W) and Minutes of Meeting (M/M) signed and exchanged between the Sri Lankan Government and JICA on 20$^{th}$ February 2001, however, the study was suspended after preparing draft basic design report in January 2002 because the protest of residents made implementation of the field survey impossible.

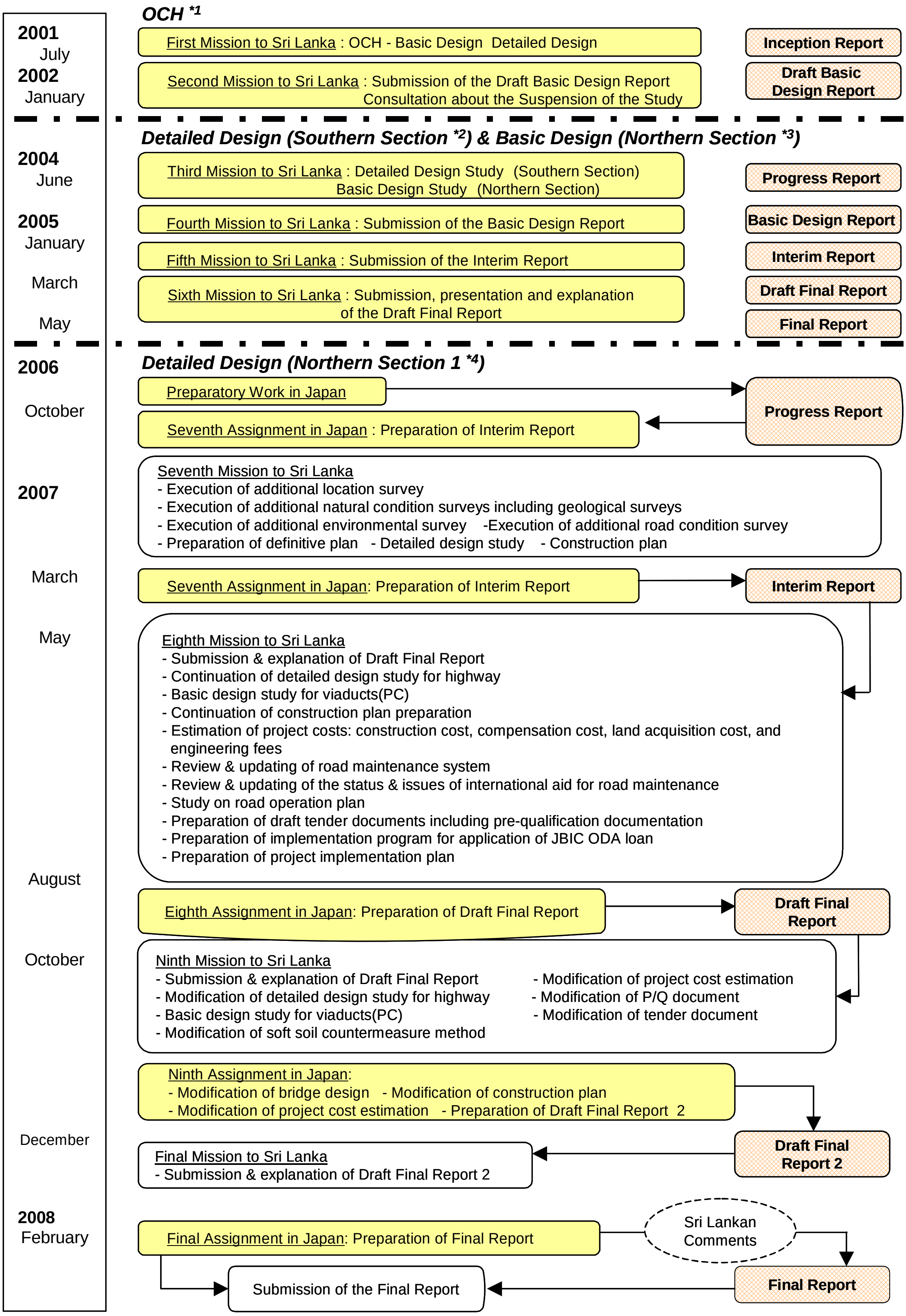
Subsequently, the study was resumed partially from the section that confirmed that it is possible to carry out site survey and Basic design for entire OCH and detailed design for OCH Southern Section was completed. (12-km section south of the Kelani River -June 2004 - July 2005)

The detailed design study for OCH Northern Section 1 (8.3-km section from A1 to Kelani River -October 2006 – February 2008) was commenced on October 2006. In this design, the Sri Lanka side requested the application of a JBIC STEP (Special Term for Economic Partnership) loan, as Japanese technology will provide advantages regarding soft soil countermeasures and rapid construction in congested and/or confined areas. According to the request the above, some proposals that satisfy their expectations were studied by the JICA Study Team.

The detailed design for the OCH Northern Section 1 was prepared and included establishment of design requirements, construction work plans, cost estimates, and bidding documents. This final report therefore put together the following documents and drawings:

- Executive Summary
- Main Text
- Design Standards
- Draft Prequalification Document for Construction Contractors -Northern Section 1-
- Draft Tender Documents -Northern Section 1- Volume I: Instruction to Bidders
- Draft Tender Documents -Northern Section 1- Volume II: Conditions of Contract
- Draft Tender Documents -Northern Section 1- Volume III: Technical Specification
- Draft Tender Documents -Northern Section 1- Volume IV: Bill of Quantities
- Draft Tender Documents -Northern Section 1- Volume V: Data Provided By Employer
- Draft Tender Documents -Northern Section 1- Volume VI: Drawings

The study flow is shown on the next page.




*1 OCH (STA.0-600 - STA.28+300)
*2 Southern Section (STA.16+560 - STA.28+300)
*3 Northern Section (STA.0-600 - STA.16+560)
*4 Northern Section 1 (STA.8+200 - STA.16+560)

Fig. 1.1 Study Flow

## 1.2. Study Organization

The detailed design of the Study was carried out jointly by the RDA and the JICA Study Team within the framework of cooperation indicated in **Fig. 1.2**. Below, a description of the functioning of said framework is given.

The JICA Advisory Committee, which consists of members from the Infrastructure Development Institute of Japan, was responsible for providing technical supervision to JICA Headquarters. From an engineering point of view, the Advisory Committee advised the JICA Study Team in order to expedite the resolution of technical issues that may arise in the course of the Study.

The MOH of Sri Lanka organized a Steering Committee, which is to be composed of the relevant organizations so that the interests of stakeholders are represented, and to provide the necessary information and cooperation for the smooth implementation of the Study. The Steering Committee, exclusive of JICA, shall assist the MOH in making the necessary arrangements for land acquisition and resettlement of affected residents so that the OCH can be constructed properly and smoothly.

Finally, in addition to the Steering Committee, a Technical Committee, consisting of engineers and the relevant expert directors, was established in the RDA.

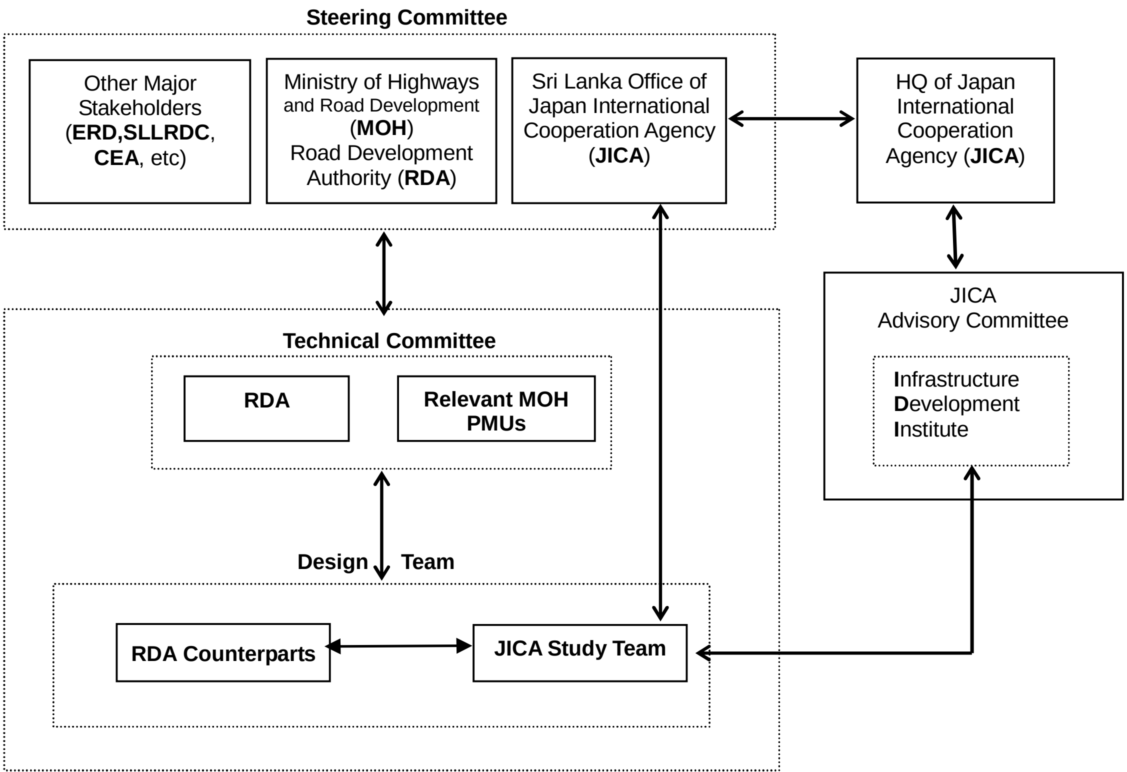



Fig. 1.2 Framework of Cooperation

## 1.3. OCH Project Chronology

A brief chronology of important events of the OCH Project in its execution up to the present time is given below.

- 1998 - 2000

A Feasibility Study (FS) for the OCH was carried out by a JICA Study Team, and the proposed OCH alignment was to cover approximately 51km length (Kerawalapitiya – Kadawatha – Kaduwela – Kottawa – Bandaragama – Panadura).

After completion of the F/S, the 1st Section was incorporated into the Southern Transport Development Project, which is being funded by JBIC, and the 4th section was rejected due to the upgrading of the parallel Rt. A8 and because it was not considered to have sufficient merit for the foreseeable future.

Consequently, the scale of the OCH Project was reduced from approx. 51km to approx. 29km length, consisting of the 2nd and 3rd sections of the F/S.

- May 2001

The EIA Report for the OCH from Kerawelapitya to Kottawa was approved by the Central Environmental Authority (CEA) of Sri Lanka and had a three-year period of validity. In its conditional letter of approval, the CEA recommended a deviation of the trace from station 17+000 to station 21+800, in order to reduce resettlement impacts by shifting the OCH alignment from an existing residential area to marshland.

- 2001 - 2002

The Detailed Design Study for the OCH Project commenced in June 2001, with the scope of the Study to include Basic and Detailed Design for a 29km section from Kerawalapitiya to Kottawa of the original 51km route. Note that the Study included in its scope the deviation at Kaduwela section in accordance with the conditions of approval by the CEA together with a Supplemental Environmental Impact Assessment (SEIA).

On the other hand ground surveys, including topographic and geological surveys necessary for proceeding with the detailed design, could not be carried out at most sections due to protests from residents. As a result, after the completion of the Basic Design, the Study was suspended in an Agreement concluded between the Sri Lankan side (ERD, MOH, RDA) and Japanese side (Embassy of Japan, JICA) at the end of January 2002, pending a situation that would allow for the smooth implementation of the necessary site surveys.

- 2002 - 2004

In accordance with the above-mentioned Agreement, the RDA carried out public consultations in view of convincing residents of the need and importance for an expressway in Sri Lanka. With these consultations, other controversial subjects also arose, particularly regarding possible alternative alignments. In regards to this, the JICA Study Team supported the activities of the RDA by preparing relevant technical papers in a timely manner to deal with each of the subjects deliberated on.

- May 2004

The validity of approval for the OCH EIA Report for entire section, which was initially May 2004 was extended until May 2007.

It was determined that site surveys could be carried out smoothly after the successful completion of a topographic survey by the Survey Department of the Sri Lankan

Government on the OCH Southern Section (OCHSS), which is approx. 12km long and south of the Kelani river. The RDA and JICA therefore agreed to resume the Study and that it could consist of a Supplemental Basic Design for alignment and condition variations, Detailed Design for the OCHSS, and technical cooperation for the OCH Northern Section (OCHNS), witch is approx. 17km long and north of the Kelani River.

- June 2004

The Detailed Design for the OCHSS and the Supplemental Basic Design for the OCHNS were recommenced.

- November 2004

The SEIA Report for the deviating section at Kaduwela was submitted to the CEA.

- May 2005

In spite of consultations, which included the active cooperation of the JICA Study Team, understanding towards the Project by residents did not increase significantly. For example, the ratio of completion regarding the topographic survey by the Survey Department for the entire OCHNS was 75% in terms of route length and 55% in terms of the number of houses affected. On the other hand, the ratios of completion for these two factors on the section between the interchanges for A1 to AB10 were 88% and 79%, respectively. As a result, JICA concluded that it is not yet possible to execute the Detailed Design for the OCHNS.

From the direction of the President, the RDA is now to examine the feasibility of shifting the OCH alignment in the Kadawatha area, and consigned this task to the University of Moratuwa.

- July 2005

The SEIA Report for the deviating section at Kaduwela was approved by the CEA.

The Detailed Design for the OCHSS was completed.

- December 2005

The feasibility study of the OCH deviating section at Kadawatha area by a Moratuwa university concluded that the OCH deviation plan by JICA study is the most appropriate and the argument about the deviation was settled.

- September 2006

RDA and JICA agreed to recommence the study of the OCH Northern Section 1 (OCHNS1) from the middle of October. The scope of works included A1 interchange, A1 Bypass, B214 interchange in addition with OCH main lane, the detailed design of Kelani bridge, construction plan/cost estimation and draft tender documents.

- October 2006

The JICA study resumed in conformity with the above-mentioned plan. At the study start time, a survey and field survey of geology could not be carried out at about six points (about 4% of object area).

- February 2007

The SEIA Report for the deviating section at Biyagama was approved by the CEA.

- April 2007

The plan undertaking STDP soft ground countermeasure construction, it caused many problems for residents by disposal and haulage of borrow pit.

It was planned to apply replacement method against soft ground in the OCHNS1 and the OCHSS. However, in order to reduce the impact on the social environment during construction, the RDA strongly requested to consider other methods which could reduce the amount of earthwork volume much more.

The JICA study team compared some methods including the application of viaduct instead of embankment structures, and selected the most suitable method that make the construction cost increase 20% but reduce haulage 60% as compared with the replacement method.

- August 2007

Based on the alternative selected in April, the detailed design of embankment, Kelani River Bridge and the basic design of viaducts was carried out. The Draft Final Report including the drawings, construction plan, cost estimate and draft tender documents was submitted to RDA.

After that, RDA requested the Japanese Government to apply a STEP Loan for OCHNS1 expecting to apply Japanese technology which is superior for soft soil countermeasures and rapid construction in congested or narrow area.

- November 2007

The SEIA Report for the deviating section at Katawatha (A1IC) was approved by the CEA. In addition, the EIA Report for entire OCH project, which expired in May 2007 was expanded with 3 years.

- December 2007

The low-noise and low-vibration type of GCP method were applied as soft soil countermeasure, and the steel viaducts were applied to diminish the site work and shorten the construction period in congested and/or narrow areas. Based on that, JICA Study Team carried out the detailed design of earthworks & Kelani River Bridge and basic design of steel viaducts and submitted the DF/R2 with drawings, construction planning, cost estimates and draft tender documents. In addition, it was decided to remove the section between A1 and A1 Bypass (460m) from this project in order to reduce the hauling volume.

- February 2008

The detailed design of the OCH Northern Section 1 was completed.

## 1.4. Present Status of Other Expressway Projects

The present status of other expressway projects, which would interface with the OCH, is described below.

- CKE (Colombo-Katunayake Expressway)

Construction work has been suspended and RDA is looking for funding to restart the construction as a public-private partnership venture or via donor assistance.

- CKdE (Colombo-Kandy Expressway)

Malaysian firm is studying with RDA to carry out as a BOT project.

- STDP (Southern Transport Development Project)

The STDP is being funded by both the ADB and JBIC. Both portions of ADB and JBIC are currently under construction.

# CHAPTER 2 INVESTIGATION

## 2.1. Supplemental Topographic Survey

A supplemental topographic survey was implemented to enhance the survey data on the section between Station 9+300 and 16+500, which the Survey Department (hereafter referred to as the "SD") surveyed in 2006, and the section between Station 8+200 and 9+300, which the National Peoples' Forum surveyed between 2006 and 2007. The main work of this Study is as follow:

(1) Verification Survey
 1) Verification of the SD GPS control points and traverse points and the reference points via a traverse survey.
 2) Verification of the GPS control points and leveling observed by the SD.
(2) Route survey for deviating section and additional plan survey for local roads
(3) Route survey for interchange site
(4) Cross section survey of river
(5) Revision work for survey data carried out by SD
(6) Compilation of existing drawings using photogrammetric map data

Table 2.1 Contents of Supplemental Topographic Survey

| Work Items | Contract Volume | Progress Volume | Remarks |
|---|---|---|---|
| 1. Verification Survey | | | |
| 1.1 Positioning Survey of Control Points | 98 points | 113points | (Coordinate) |
| 1.2 Leveling Confirmation | 10 km | 12.6 km | (Altitude) |
| 2. Route Survey for Deviation Section and Additional Plan Survey | | | |
| 2.1 Positioning Survey of Center Line | 141 stations | 165stations | For main carriageway |
| 2.2 Profile Leveling | 2.76 km | 3.30 km | Ditto |
| 2.3 Cross-section Survey | 141 sections | 165sections | Ditto |
| 2.4 Plan Survey | 6.98 ha | 7.98 ha | Ditto |
| 2.5 Additional Plan Survey | 2.22 ha | 4.85 ha | For approach roads |
| 3. Interchange Survey | | | |
| 3.1 Positioning Survey of Center Line | 165 stations | 155stations | |
| 3.2 Profile Leveling | 2.50 km | 2.4 km | |
| 3.3 Cross-section Survey | 165 sections | 129sections | |
| 4. River Survey | | | |
| 4.1 Cross-section Survey of Kelani River | 10 sections | 7 sections | |
| 4.2 Cross-section Survey of Tributaries | 41 sections | 38 sections | |
| 5. Route Survey Revision Work | | | |
| 5.1 Profiles | 0.98 km | 0.80 km | |
| 5.2 Cross-sections | 4,900 m | 4000 m | |
| 5.3 Plans | 9.8 ha | 8.0 ha | |
| 6. Compilation of Existing Drawings Using Photogrammetric Maps | 6.23 ha | 6.80 ha | |

## 2.2. Geotechnical & Materials Survey

### 2.2.1. General Geology

**Table 2.2** provides an overview of the general geology of the area along the OCHNS1. The geological profile of the OCHNS1 (refer to **Fig. 5.1** to **Fig. 5.4**) and indicates that the area along the section consists mainly of soft ground.

Table 2.2 Geological Conditions of OCHNS1

| STA. | Length (km) | Filling or Cutting | Geological Condition |
|---|---|---|---|
| 8+200 I 9+000 | 0.80 | Filling/ Viaduct | Soft alluvial clay and sandy clay is distributed and is about 3m thick. The bearing layer for the viaduct is around G.L.-5 to -10m. |
| 9+000 I 12+660 | 3.66 | Cutting/ Filling | This section is mainly hilly with small valleys and the cutting and filling volume is approximately the same. In the small valleys, there are soft soil deposits 2 to 5m thick. Hills consist of residual soil 2 to 15m thick and weathered rock 4 to 20m thick. |
| 12+660 I 14+500 | 1.84 | Filling/ Viaduct | This section is located mainly in a marshy area, ground level of which is about 1 to 2m above sea level. The alluvial formation consists of peat, organic clay, and sandy clay is 3 to 7m thick. Over the whole section, there are organic clay and peat formations about 1 to 3m thick on the surface. The thickness of these layers is over 6m on a particular 300m section between Sta. No. 13+750 and Sta. No. 14+050. In the rainy season most of this section is inundated. |
| 14+500 I 15+700 | 1.20 | Cutting/ Viaduct | This section consists of hilly and plain area. In the plain area between Sta. No. 14+080 and Sta. No. 15+540, there is very soft alluvial clay, organic clay and peat 4 to 6m thick. In the rainy season this section is inundated. |
| 15+700 I 16+500 | 0.80 | Filling/ Viaduct | This section is located in hilly and plain area beside the Kelani River. The hilly area is near Sta. No. 15+700 and consists of residual soil and fresh rock. The left section between Sta. No. 15+900 and Sta. No. 16+500 consists of soft organic clay, peat and alluvial clay and is 5 to 10m thick, while on the right bank of the Kelani River there is alluvial sand and a gravel layer 6 to 17m thick. |

### 2.2.2. Materials Survey

The purpose of the embankment material surveys was to confirm residual soil at existing borrow pits and natural hills. The depth of residual soil was confirmed via drilling work and the quantity of residual soil estimated (exclusive of topsoil and clayish soil). Note that surveys of rock material were carried out mainly in existing quarries. The quantity of soil & rock and the location map for them are as shown in the **Table 2.3** and **Fig. 2.1** respectively.

Table 2.3 Borrow & Quarry Materials Survey Results

(×1, 000m$^3$)

| Item | Position No. | Estimated Quantities (near OCHNS1, northern side of Kelani river) | Required Quantities for OCHNS1 |
|---|---|---|---|
| Borrow Material | B6, B7, B10, B19, B31, B32 | 1,800 | 880 |
| Quarry Material | Q15, Q18, Q19, Q21, Q24 | 3,500 | 456 |

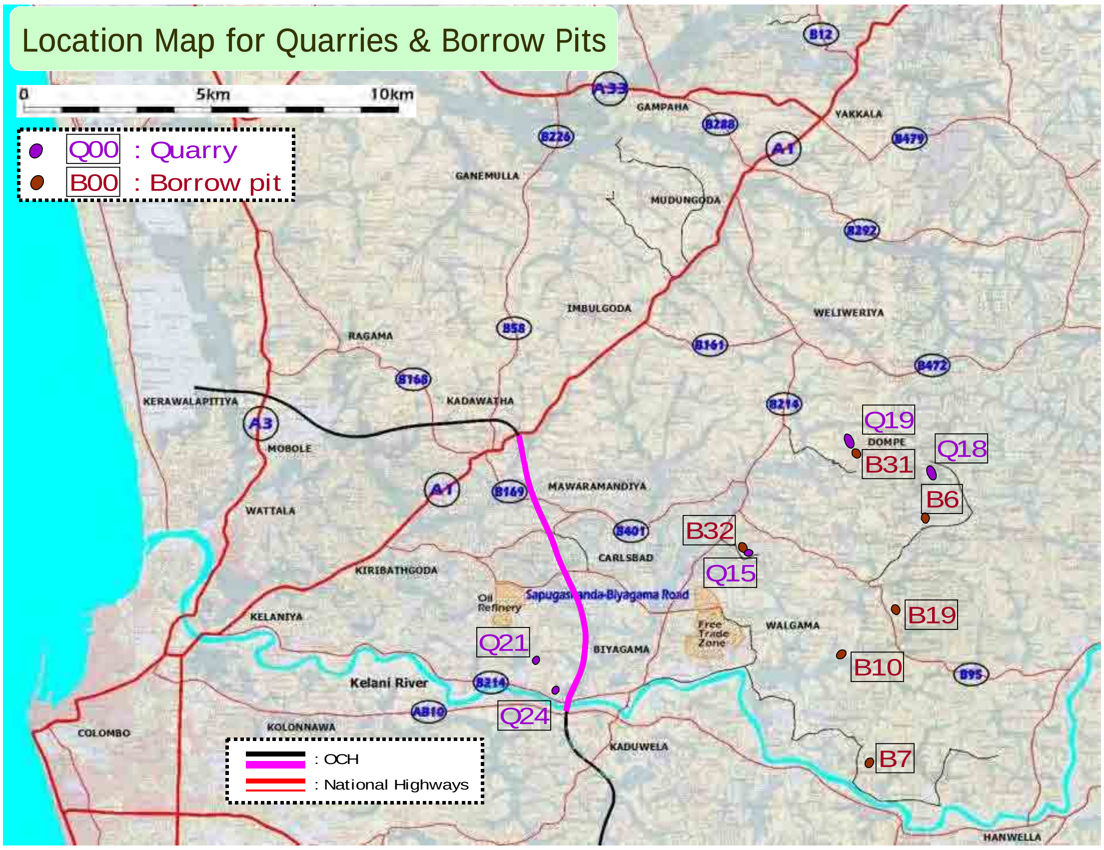



Fig. 2.1 Location Map for Borrow & Quarry Materials

# CHAPTER 3 DESIGN & CONSTRUCTION CONCEPTS

## 3.1. General

OCH's Northern Section 1 extends from Kandy Road (A1) in Kadawatha to AB10 on the left bank of the Kelani River, connecting with the Southern Section of the OCH. The A1 Interchange (A1IC) is located in paddy area and the main carriageway around the A1IC is designed with a high embankment in order to cross over the existing A1 Road. In the Biyagama area, the ground is low-lying and soft, resulting in the height of the embankment of the OCH being high here as well.

In the case where the replacement method is applied as a soft soil countermeasure, which is the original concept proposed in the basic design stage of the OCH, all soft soil including peat is removed and replaced with gravel. The estimated total haulage from carrying and dumping material would reach about 4.7 million cu.m. and a large number of trucks would be required for this operation.

In this chapter, the issues surrounding the replacement method, which is the most conventional and economical way to deal with soft soil, are examined. Next, alternative options are proposed to reduce negative social and environmental impacts and compared with the Original Design (or replacement method) in order to determine the most suitable option. Finally, the design and construction concept for Northern Section 1 is finalized based on discussions with the RDA. The selected construction method is the proposal that adopted GCP (Gravel Compaction Pile) method as soft soil countermeasure which is possible to reduce a volume of disposal and borrow material and adopted the viaduct at the place where is deep soft ground layer and high embankment due to the same reason.

At the stage carried out the detailed design (viaducts: basic design) based on the selected construction method, the Sri Lanka side requested the application of a JBIC STEP (Special Term for Economic Partnership) loan, as Japanese technology will provide advantages regarding soft soil countermeasures and rapid construction in congested and/or confined areas. According to the request the above, some proposals that satisfy their expectations were studied by the JICA Study Team and the optimal proposal was determined through discussions with Sri Lanka side again.

## 3.2. Examination of Original Design

### 3.2.1. Outline of Northern Section 1 and Division into Sections for Examinations

The horizontal and vertical alignments of Northern Section 1 are as shown in Fig. 3.1 and Fig. 3.2, respectively, together with the existing road crossings and 50-year return period flood level. As the figures show, the vertical alignment is determined based on the clearance needed for the existing A1 Road and A1 Bypass around Sta.8+500, with the flood level of the Kelani River affecting the vertical alignment in the Biyagama area south of Sta.12+500. These factors are the cause for the embankments on these sections of the OCH being high.

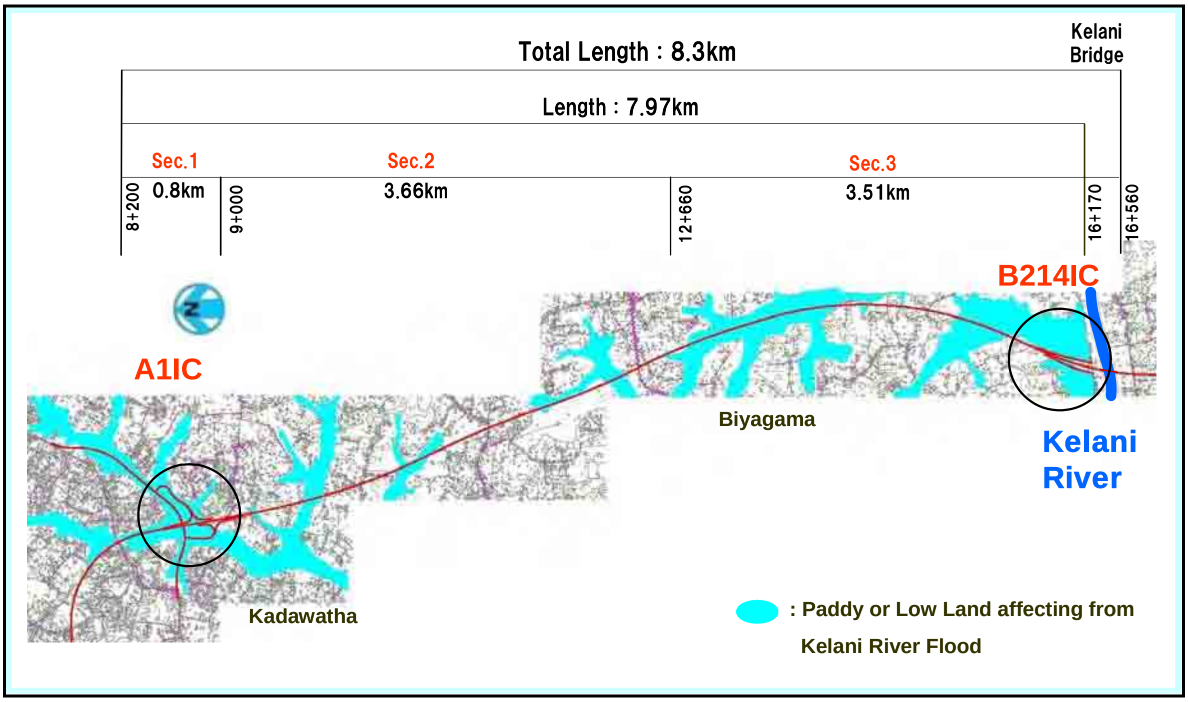



Fig. 3.1 Horizontal Alignment

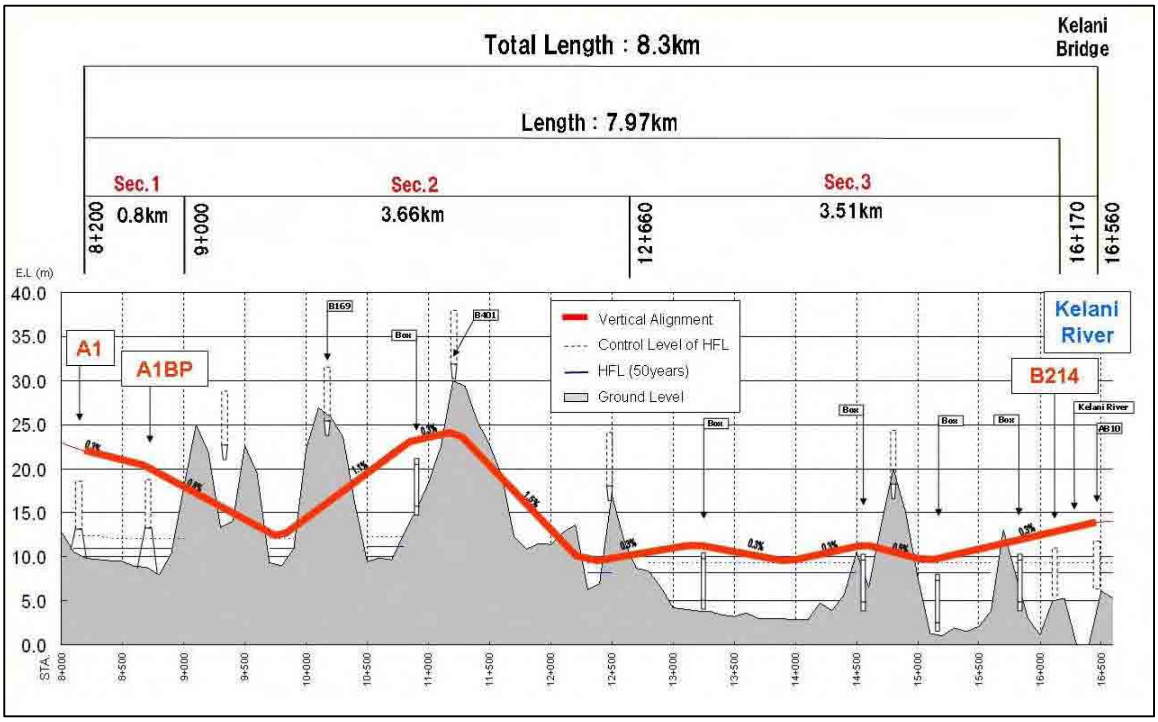



Fig. 3.2 Vertical Alignment & Control Factors

OCH Northern Section 1 is divided into 3 sections as shown in the above figures in order to examine the Original Design and alternatives. Note that much earth work will be required for Section 1 and Section 3 because of soft soil countermeasures and the road embankment, while the haulage volume of earth work material will be less for Section 2 owing to a balance between the cut and fill sections and to the existence of small amounts of soft soil.

### 3.2.2. Outline of Original Design (Embanked Structure)

Earthwork includes disposal, quarry and borrow material for the construction of each the sections and has been estimated as shown in **Table 3.1**. According to the results, it is necessary to transport 2.3 million and 2.0 million cu.m. of material for Section 1 and Section 3, respectively, while only 0.3 million cu.m. need to be hauled for Section 2. This means that it is important to consider the haulage for Section 1 and Section 2.

Table 3.1 Earthwork Volume for Northern Section 1

| Item | | Section 1 | Section 2 | Section 3 | Total |
|---|---|---|---|---|---|
| Earthwork (x1000m$^3$) | Embankment | 898 | 461 | 1,028 | 2,387 |
| | Cutting | 8 | 407 | 99 | 514 |
| | Disposal | 642 | 85 | 471 | 1,198 |
| | Quarry | 807 | 156 | 637 | 1,600 |
| | Borrow pit | 890 | 54 | 929 | 1,873 |
| Volume of Transportation | | 2,339 | 295 | 2,037 | 4,671 |

The candidate locations for dumping, quarry and borrow sites are as shown in **Fig. 3.3**. Based on this and current road conditions, it is expected that A1 will be used for Section 1 and the Sapugaskanda – Biyagama Road and B214 for Section 2 and 3 for the hauling of materials. The distance to the dumping and materials sites from Section 2 and 3 is generally less than 10 km, but from Section 1 it is longer at approximately 22 km. The required volume and available capacity for each type of material and section are as shown in Table 3.2, indicating that the capacity of quarries is quite sufficient.

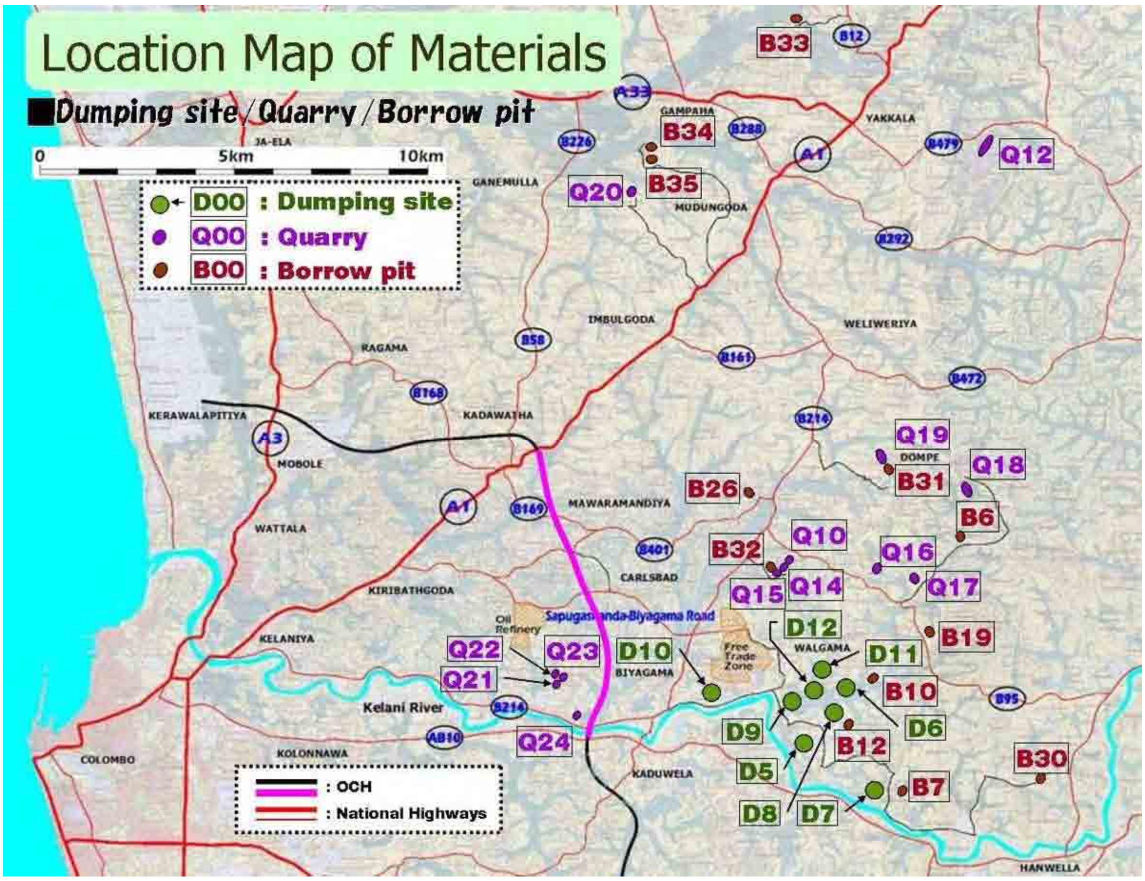



Fig 3.3 Location Map of Sites for Materials & Disposal

Table 3.2 Required Volume & Available Capacity

(Unit: 1,000 $m^3$)

| | Required Volume | | | Available Capacity |
|---|---|---|---|---|
| | Section 1 | Section 2, 3 | Total | |
| Disposal | 642 | 556 | 1,198 | 1,380 |
| Quarry | 807 | 793 | 1,600 | 4,800 |
| Borrow pit | 890 | 983 | 1,873 | 2,220 |

The total period scheduled for construction for the Original Design is almost 4 years (see **Fig. 3.4**), with the transportation of materials to and from Section 1 and 3 being on the critical path. The traffic volumes for transporting Section 1 material are 70 trucks/hr for spoilage, 80 trucks/hr for quarry material, and 90 trucks/hr for borrow material, with total traffic being 240 trucks/hr (round-trip). In the case of Section 3, the total number of daily round-trips by construction trucks is 210, while it is 190 vehicles for Section 2. Because of the large volume of materials that need to be transported, as well as the congestion that on existing roads, the construction period is long (i.e., 4 years).

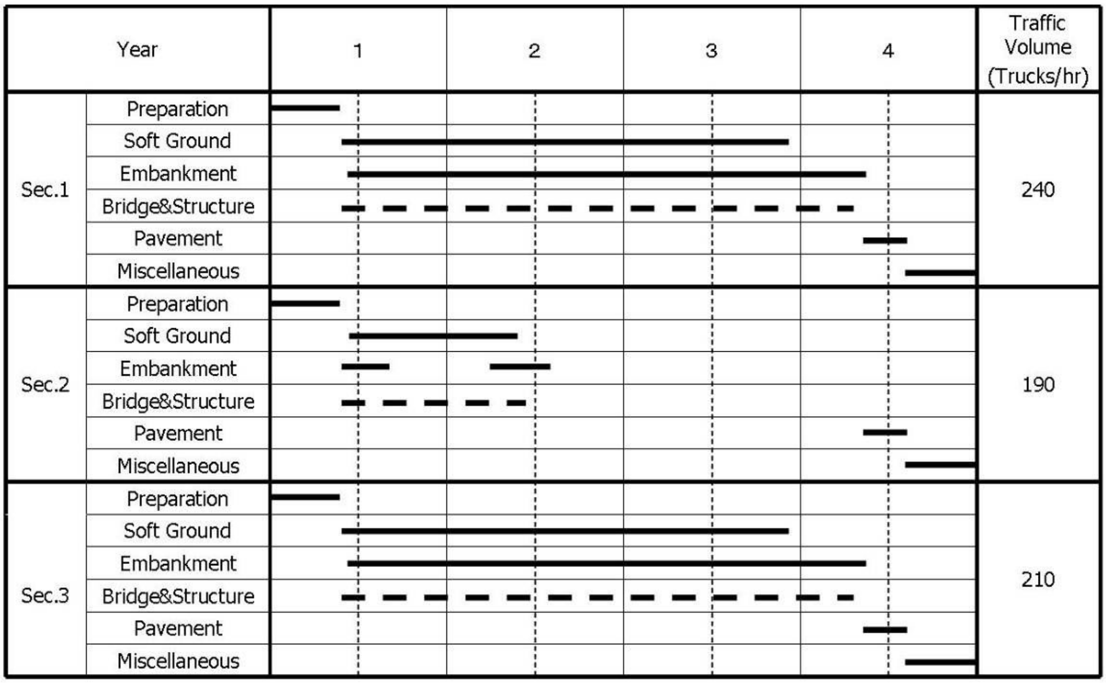



Fig. 3.4 Construction Schedule for Northern Section 1

### 3.2.3. Summary of Issues

The results of the examination of the Original Design are summarized in **Table 3.3**. As the table indicates, it will be necessary to transport materials for Section 1 during the night as congestion on A1 is too severe during the day. This, of course, will still cause undesirable social impacts. As for B214, which will be used for the haulage of Section 2 and 3, although there is sufficient capacity for daytime operation there will be undesirable social impacts due to the large number of construction vehicles. Moreover, there will be negative impacts on the social and natural environment along the OCH due to the large amount of materials to be mined or removed. Therefore, reducing the amount of material or spoilage, together with the number of trucks, will be most effective way to reduce undesirable social and environmental impacts and should be done without sacrificing cost-effetciveness.

Table 3.3 Summary of Issues

| Design & Issue | | Sec.1( incl. IC•Bypass) | | Sec.2 | | Sec.3 | |
|---|---|---|---|---|---|---|---|
| Original Design | Disposal (x1000m³) | 642 | | 85 | | 471 | |
| | Quarry (x1000m³ ) | 807 | | 156 | | 637 | |
| | Borrow pit (x1000m³) | 890 | | 54 | | 929 | |
| Issue | Dumping site | Share with Sec.2,3 | Av.Dist. 25km | Sufficient | Av.Dist. 10km | Sufficient | Av.Dist. 8km |
| | Quarry | Sufficient | Av.Dist. 16km | Sufficient | Av.Dist. 7km | Sufficient | Av.Dist. 5km |
| | Borrow pit | Share with Sec.2,3 (partial) | Av.Dist. 17km | Sufficient | Av.Dist. 12km | Sufficient | Av.Dist. 9.5km |
| | Main transport route | A1 , B214 | | Sapugaskanda – Biyagama Road , B214 | | | |
| | Traffic volume (2008) | A1 : 36,600 cars/day | | B214 : 21,800 cars/day | | | |
| | Operation of construction trucks | A1: Daytime use not possible due to lack of road capacity | | Daytime use possible | | | |
| | | Disposal : 70<br>Quarry : 80<br>Borrow pit : 90<br>(trucks/hr)<br>After completion Sec.2, will be used as access road | | Disposal : 50<br>Quarry : 100<br>Borrow pit : 40<br>(trucks/hr)<br>Timing for transport of borrow pit materials different | | Disposal : 50<br>Quarry : 65<br>Borrow pit : 95<br>(trucks/hr) | |
| | Quantity | Desirable to reduce quantity | | No problem | | Desirable to reduce quantity | |

## 3.3. Examination of Alternatives

### 3.3.1. Selection of Alternatives

To reduce the impacts described above, alternative construction designs and concepts are examined. First, the gravel compaction pile method (hereafter referred to as GCP or Alt. 0) is proposed to be the basic soft soil countermeasure instead of the replacement method, and aims to reduce disposal volume to zero. In addition to the adoption of GCP, the utilization of viaducts on Section 1 and 3 instead of embankments is proposed to reduce the amount of quarry and borrow materials, with Alt.1, 2, and 3 representing minimum, medium, and maximum viaduct application. Note that high priority viaduct application consists of the high embankment of Section 1, which has no peat or organic clay (refer to Fig. 3.5), and Section 2 because of its large amounts of peat or organic clay (refer to Fig. 3.5). The type of viaduct to be used will be pre-stressed concrete in this examination.

A total of four alternatives, in addition to the Original Design, are prepared with the objective of reducing the volume of materials and spoilage, and are described below and summarized in Table 3.4.

**Alt.0:** Same as the Original Design except it applies the GCP method instead of the replacement method as a soft soil countermeasure so as to reduce spoilage to zero.

**Alt.1:** This alternative, which is a plan for minimum viaduct application, will reduce the borrow material of Section1 via the use of 928m of viaduct (323m of main carriageway & 605m of ramp: refer to ②, ③ in **Fig 3.5**). Moreover, the section from A1IC to the A1 Bypass is to be constructed simultaneously.

**Alt.2:** This alternative, which is a plan for medium viaduct application, will reduce the borrow material of Section 3 via the use of 877m of viaduct (refer to ⓑ, ⓒ, ⓓ in **Fig.3.6**), as well as incorporate the viaduct of Alt.1. On the other hand, the section from A1IC to the

A1 Bypass will be completed after the remainder of Northern Section 1 in order to mitigate negative impacts from the transportation of borrow and spoilage.

**Alt.3:** This alternative, which is a plan for maximum viaduct application, will reduce the borrow material from Section1 via the use of 1807m of viaduct (792m of main carriageway, 605m of ramp, 410m of bypass: refer to ①, ②, ③, ④ in **Fig.3.5**) and from Section 3 via the use of 1407m of viaduct (refer to ⓐ, ⓑ, ⓒ, ⓓ in **Fig.3.6**). In addition, the entire Northern Section 1 will be completed in 3 years.

Table 3.4 List of Alternatives

| | Summary | Soft Ground Counter-measures | Viaduct Section | | | ①A1-A1BP Construction timing |
|---|---|---|---|---|---|---|
| | | | Sec.1 | Sec.2 | Sec.3 | |
| Original Design | Embanked Structure | Replacement | 40m (A1BP) | None | 50m (River) | Simultaneous |
| Alt.0 | Review the Soft Ground Countermeasure | GCP | 40m (A1BP) | None | 50m (River) | Simultaneous |
| Alt.1 | Viaduct Construction Minimum Case | GCP | ②A1BP-9+000:323m<br>③IC Ramp :605m | None | 50m (River) | Simultaneous |
| Alt.2 | Viaduct Construction Medium Case | GCP | ②A1BP-9+000:323m<br>③IC Ramp :605m | None | 877m (A) | Later |
| Alt.3 | Viaduct Construction Maximum Case | GCP | ①A1 – A1BP :469m<br>②A1BP-9+000:323m<br>③IC Ramp :605m<br>④A 1 B P :410m | None | 1,407m (B) | Simultaneous |

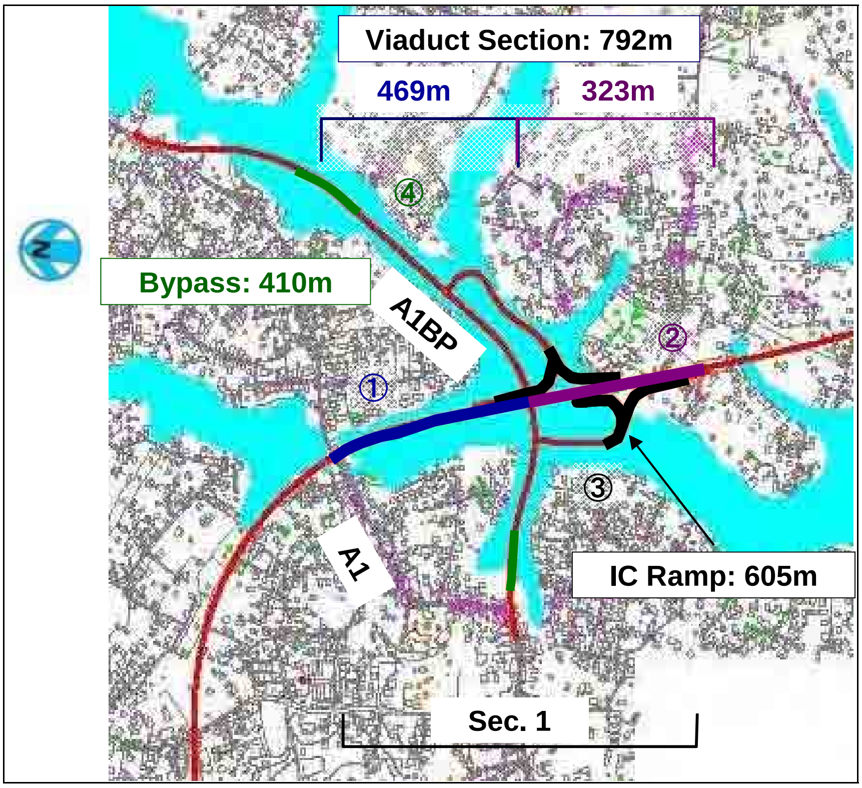
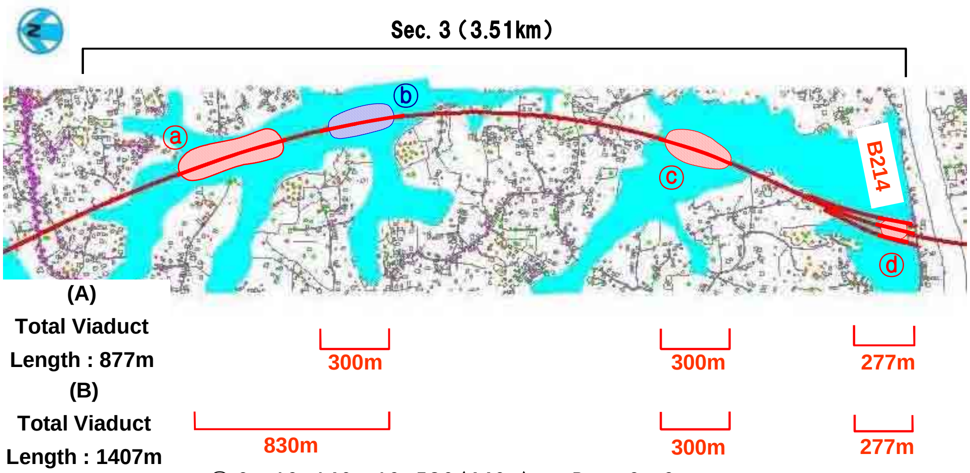



Fig. 3.5 Layout for Section 1




ⓐ Sta.13+140～13+580 (440m) : Peat 2～3 m
ⓑ Sta.13+750～14+050 (300m) : Organic Clay 7 m
ⓒ Sta.15+150～15+450 (300m) : Peat 4～5 m
ⓓ Sta.16+050～16+170 (120m) : Peat 2～8 m

Fig. 3.6 Layout for Section 3

### 3.3.2. Comparison of Alternatives

The earthwork volumes for each alternative are as shown in **Table 3.5**. Note that quarry material consists of material for a 0.5m thick gravel mat for embankments, replacement material is for the Original Design only, and gravel mats and gravel is for the GCP of the alternatives. Note that the amount of borrow material is the same for the Original Design and Alt.0 and decreases in Alt.1 to Alt.3 with the increase in viaduct length.

Table 3.5 Earthwork Volume of Alternatives

| Alter-native | Comparison Item | Sec.1 (Including IC･Bypass) | | | | | Sec.2 | Sec.3 | Total (x1000m³) |
|---|---|---|---|---|---|---|---|---|---|
| | | ① A1 – A1BP | ② A1BP – 9+000 | ③ IC Ramp | ④ A1BP | Total | | | |
| Original Design | Disposal | 138 | 108 | 198 | 198 | 642 | 85 | 471 | 1,198 |
| | Quarry | 170 | 134 | 246 | 257 | 807 | 156 | 637 | 1,600 |
| | Borrow pit | 288 | 144 | 230 | 228 | 890 | 54 | 929 | 1,873 |
| Alt.0 | Disposal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Quarry | 67 | 53 | 103 | 103 | 326 | 101 | 319 | 746 |
| | Borrow Pit | 288 | 144 | 230 | 228 | 890 | 54 | 929 | 1,873 |
| Alt.1 | Disposal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Quarry | 67 | 0 | 62 | 103 | 232 | 101 | 319 | 652 |
| | Borrow Pit | 288 | 3 | 91 | 228 | 610 | 54 | 929 | 1,593 |
| | Viaduct Ext. | – | 323m | 605m | – | – | – | 50m | – |
| Alt.2 | Disposal | 0 | 0 | 0 | 0 | 0 | 0 | 57 | 57 |
| | Quarry | (67) | 0 | 62 | 103 | 165 (67) | 101 | 239 | 505 (67) |
| | Borrow Pit | (288) | 3 | 91 | 228 | 322 (288) | 54 | 551 | 927 (288) |
| | Viaduct Ext. | – | 323m | 605m | – | – | – | 877m (A) | – |
| Alt.3 | Disposal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Quarry | 0 | 0 | 62 | 70 | 132 | 101 | 117 | 350 |
| | Borrow Pit | 0 | 3 | 91 | 113 | 207 | 54 | 337 | 598 |
| | Viaduct Ext. | 469m | 323m | 605m | 410m | – | – | 1,407m (B) | – |

Note 1 : ( ) Volume for A1 – A1BP Construction Work
Note 2 : Replacement method used for some of the soft soil in Alt.2 due to trafficability for bridge construction

The estimated construction cost of each alternative is as shown in **Table 3.6**. These costs include the expenditure necessary for maintaining roads to be used by the construction trucks (such as pavement patching and spraying water), together with a 10% contingency, but exclude engineering fees and land acquisition and long-term RDA maintenance costs. As compared to the Original Design, the construction cost of Alt.0 and Alt.1 will result in approximately a 14% and 15% increase, respectively, while the construction costs of Alt. 2 and Alt.3 will increase by about 20% and 31%, respectively.

Table 3.6 Construction Cost of Alternatives

| | Sec.1 | Sec.2 | Sec.3 (Incl. Kelani Bridge) | Total | Rate |
|---|---|---|---|---|---|
| Original Design | 49.8 | 29.5 | 70.2 | 149.5 | - |
| Alt.0 | 58.3 | 32.3 | 80.3 | 170.9 | 114.3% |
| Alt.1 | 59.5 | 32.3 | 80.3 | 172.1 | 115.1% |
| Alt.2 | 59.5 | 32.3 | 86.9 | 178.7 | 119.5% |
| Alt.3 | 71.2 | 32.3 | 91.8 | 195.3 | 130.6% |

The construction schedule and number of construction trucks per hour for each alternative are as shown in **Fig. 3.7**. The period of construction will be shortened with the utilization of GCP and viaducts. However, even in the case of Alt.3, which has the largest amount of viaduct, a three year construction period will still be necessary due to the time required to build the Kelani River Bridge. Note that the construction period of Alt.2 will also be 3 years, as the section between the A1 Road and A1 Bypass will be constructed at a later time (or, 1 year after the completion of the remaining sections of Northern Section 1). As for Alt.0 and Alt.1, they will require 3 years 9 months and 3 years 6 months, respectively, to be completed and their longer schedules are due to the shorter lengths of viaduct.

Taking into account the increase in cost and the required construction time, the EIRR for each alternative was calculated. As **Fig. 3.7** indicates, Alt.2 maximizes economic return. That is, although there is an increase in construction cost, Alt.2 has a higher EIRR than the Original Design due to this cost being offset by a greater increase in benefits (such as time and vehicle operating cost savings) being realized at an earlier date.

The other alternatives have a lower EIRR because of a poorer balance between costs and benefits. For example, Alt.0 has the lowest EIRR as costs will go up significantly but the construction schedule is only shortened by a mere 3 months to 3 years 9 months. On the other hand, Alt.1 has a better EIRR because it will result in the construction schedule being shortened by 6 months and its costs are almost the same (0.8% greater) as that of Alt.0. Alt.2 costs again are only slightly larger (5.2%) than that of Alt.0, but the construction schedule is reduced by a full year, while Alt.3 is about 10% costlier than Atl.2 but does not result in any savings in construction time.

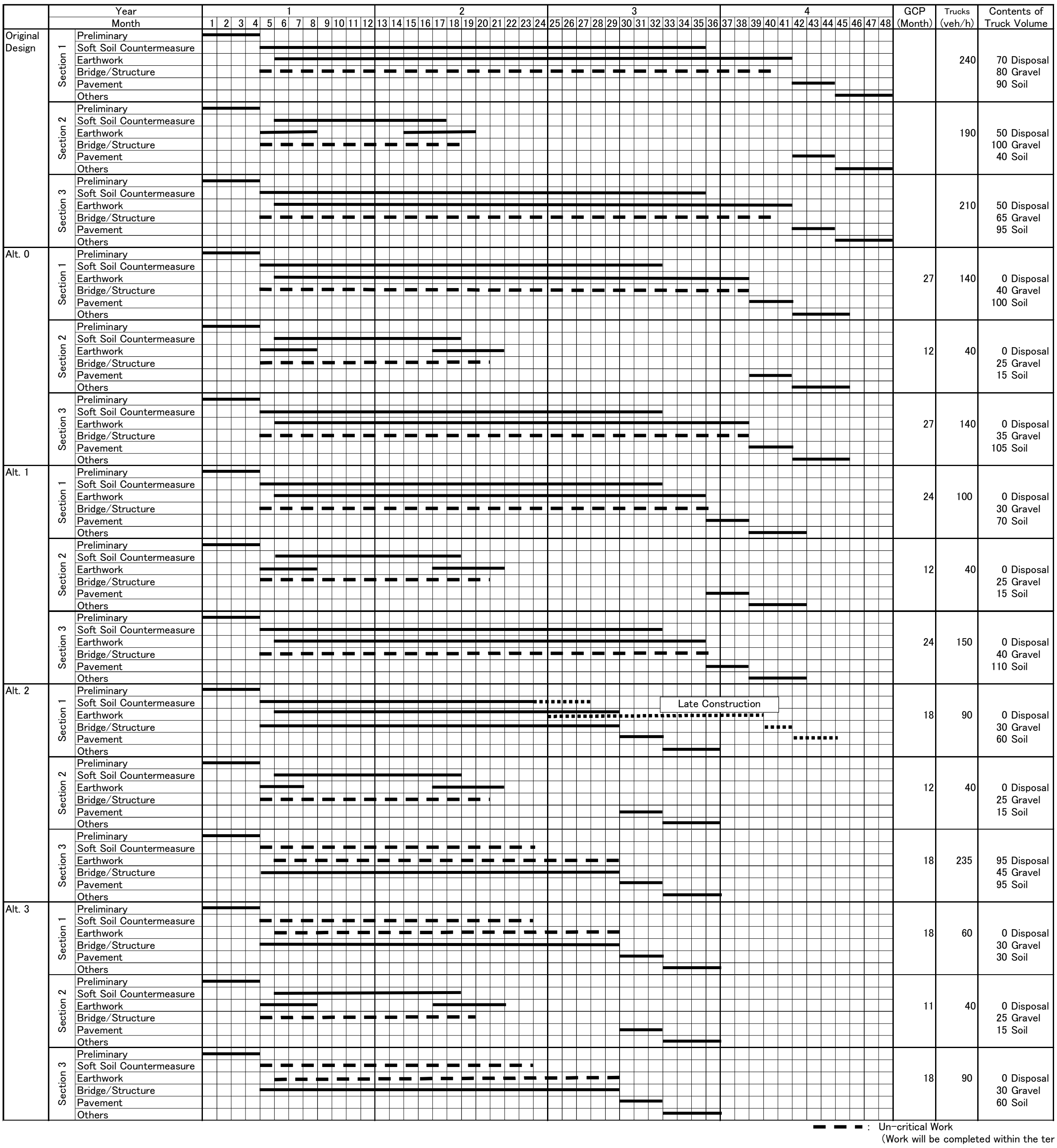



Fig. 3.7 Construction Schedule of Alternatives

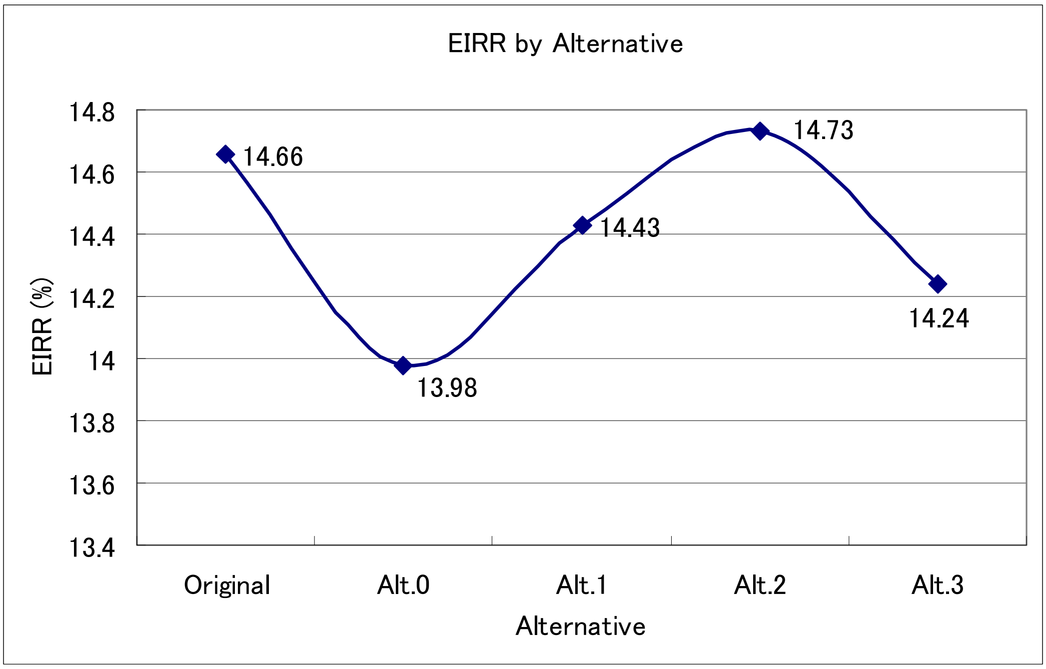
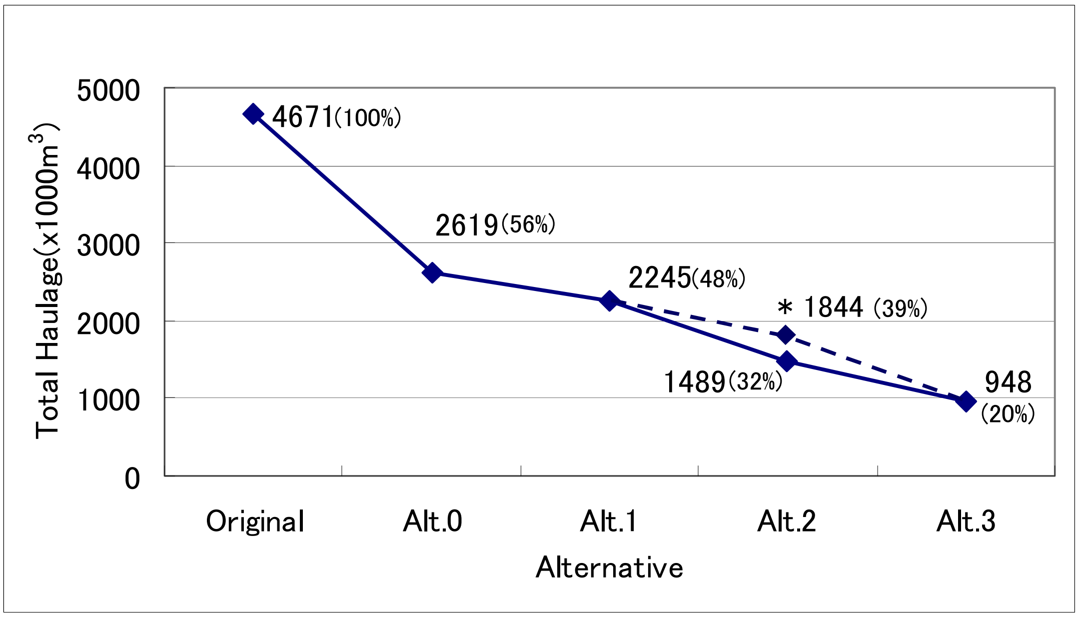



Fig. 3.8 EIRR by Alternative

The variation in total haulage for each alternative is as shown in **Fig. 3.9**. Note that total haulage can be reduced by up to 80% as compared to the Original Design by adopting Alt.3. In the case of Alt.2 61% of haulage can be eliminated, while for Alt.1 and Alt.0 the total reduction is 52% and 44%, respectively. As stated previously, the greater the amount of viaduct the lesser the amount to be hauled.




( ):% rate as compared to Original Alternative
＊: Cost if section to connect Kadawatha Interchange with A1 included

Fig. 3.9 Haulage by Alternative

### 3.3.3. Selection of Most Suitable Alternative

**Table 3.7** shows the overall results of the comparison of the alternatives and the conclusions derived from that are listed below.

Table 3.7 Overall Comparison of Alternatives

| Name of Alternative | Soft Soil Counter-measures | Viaduct Section | | | Haulage | Social Environmental Aspect | Constr. Period (yrs) | Cost | | EIRR (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Sec.1 | Sec.2 | Sec.3 | Total (x1000m$^3$) | | | Total (Bn. Rs.) | Rate (%) | |
| Original | Replace-ment | 40m (A1BP) | None | 50m (River) | 4671 | - | 4 | 14.95 | 100.0 | 14.66 |
| Alt.0 | GCP | 40m (A1BP) | None | 50m (River) | 2619 | - | 3.75 | 17.09 | 114.3 | 13.98 |
| Alt.1 | GCP | OCH: 323m<br>I C: 605m<br>B P: 0m | None | 50m (River) | 2245 | - | 3.5 | 17.21 | 115.1 | 14.43 |
| Alt.2 | GCP | OCH: 323m<br>I C: 605m<br>B P: 0m | None | OCH : 877m<br>I C : 278m | 1489 (1844) | GOOD | 3+(1) | 17.87 | 119.5 | 14.73 |
| Alt.3 | GCP | OCH: 792m<br>I C: 605m<br>B P: 410m | None | OCH : 1407m<br>I C : 278m | 948 | GOOD | 3 | 19.53 | 130.6 | 14.24 |
| Alt.2' | GCP | OCH: 323m<br>I C: 605m<br>B P: 0m | None | OCH : 2057m<br>IC : 278m | 499 (809) | GOOD | 3+(1) | 19.48 | 130.3 | - |
| Alt.3' | GCP | OCH: 792m<br>I C: 605m<br>B P: 410m | None | OCH : 2057m<br>IC : 278m | 488 | GOOD | 3 | 20.83 | 139.3 | - |

Note 1 : Shaded row indicates selected alternative for design concept
Note 2 : GCP - Gravel Compaction Pile Method
Note 3 : Cost excludes expenditures for contingency, land acquisition & consultancy fees

1. Although the replacement method is the most conventional soft soil countermeasure, there will be substantial negative social and environmental impacts during construction due to the great number of construction trucks and large-scale mining and disposal, which requires the hauling of materials in the Original Design 1.8 to 4.9 times that of the alternatives under consideration.
2. Taking into consideration the availability of material, reliability, popularity, and cost, the GCP method is proposed to be the best soft soil countermeasure for reducing spoilage and quarry material and should be used instead of the replacement method. Note that GCP is applied across all of the alternatives.
3. In addition to reducing spoilage and quarry material with the GCP method, borrow material is reduced by adopting viaducts, which vary in amount from alternative to alternative. Alt.2 is recommended by the JICA Study Team for the design and construction of Northern Section 1 for the following reasons:

   - It optimizes the economic viability of the project via the maximization of the EIRR, which is slightly higher than that of the Original Design due to a shorter construction schedule and greater benefits that outweigh the additional costs of viaducts (resulting in an increase of cost of about 20% over the Original Design).
   - The construction period is the same as Alt.3 if the section from A1 to A1 Bypass is constructed later, and construction cost is about 10% less.
   - Total materials for haulage will be cut by 68% as compared to the Original Design and will thereby significantly reduce negative social and environmental impacts. Although this reduction is lower than that of Alt.3, the cost of Alt.3 results in the EIRR being

lower than that of Alt.2 and thereby produces a lower return on investment.

- The resulting decrease in materials to be hauled will result in the number of construction vehicles to be operated to be one-third of that for the Original Design, meaning that daytime operation will be acceptable on all transport routes (including A1).

Based on the above reasons and discussions with the Sri Lanka side, Alt.2 was proposed to be adopted with the A1-A1 Bypass section to be constructed at a later date. Note that an additional geological survey was also carried out for the viaducts of Alt.2.

## 3.4. Preparation of Optimal Proposal

Based on the foregoing, the detailed design (added PC viaduct: basic design) for Alt.2 (hereafter referred to as Alt.2 D/D) has been carried out. Subsequent to that, the following 3 items were taken up regarding Alt.2 D/D and the results incorporated and renamed as Original Design 2:

- Whether the A1-A1 Bypass is to be included in the project scope of work.
- The re-examination of viaduct sections based on updated geological survey data.
- Re-examination of soft soil countermeasures.

In addition, the Sri Lanka side requested the application of a JBIC STEP (Special Term for Economic Partnership) loan, as Japanese technology will provide advantages regarding soft soil countermeasures and rapid construction in congested and/or confined areas. In accordance with this request, proposals that apply Japanese Technology based on the Original Design 2 were examined by the JICA Study Team. After comparing these proposals, an optimal proposal was prepared and finalized in discussions with the Sri Lanka side.

### 3.4.1. STEP Loan Conditions

The purpose of a STEP loan is to utilize and transfer advanced Japanese technologies and know-how under the following conditions:

(1) Interest/Repayment Period

- Interest Rate: 0.2%/year
- Repayment Period: 40 years (10 years grace)

(2) Procurement of Contractor: Prime contractor must be Japanese firm

(3) Country of Origin of Goods and Services to be procured under STEP:

- No less than 30% of the total amount of the contract must be for goods and/or services from Japan

### 3.4.2. Setting of Original Design 2 for examination of Optimal Proposal

Original Design 2 is examined in **Table 3.8** by comparing it to the Original Design, Alt.2, and Alt.2 D/D. In The result of the Alt.2 D/D, the disposal volume has increased slightly due to the application of the replacement for the soft ground under the box culvert. Total construction cost is estimated 17.7 billion Rs.

Table 3.8 Comparison of Original Design 2

| | | Original Design (B/D) | Alt.2 (26th April 2007) | Alt.2 D/D (30th Sep. 2007) | Original Design 2 (11th Oct. 2007) |
|---|---|---|---|---|---|
| Haulage ($x1000m^3$) | Disposal | 1,198 | 57 | 96 | 6 |
| | Quarry | 1,600 | 505 (67) | 338 (39) | 266 |
| | Borrow pit | 1,873 | 927 (288) | 1027 (235) | 987 |
| | Total<br>% | 4,671<br>100.0% | - | - | 1,259<br>27.0% |
| Bridges/ Viaducts/ Ramps | No. | 4 | 11 | 11 | 11 |
| | Length (m) | 349 | 2,438 | 2,496 | 2,601 |
| Overpass | No. | 6 | 5 | 5 | 5 |
| | Length (m) | 286 | 226 | 226 | 226 |
| Main Method of Soft Soil Countermeasure | | Replacement | GCP | GCP | GCP |
| Construction Period (Yrs) | | 4 | 3 + (1) | 3 + (0.5) | 3 |
| Project Cost (Million Rs.) | | 14,950 | 17,870 | 17,698 | 17,194 |

Note : ( ) Volume for A1 – A1BP Construction Work

Considering the plenty of earthwork volume between A1 and A1 Bypass and the social impact by hauling during construction period, it will take three and half years to complete the construction for Northern Section 1 as mentioned above. On the other hand, the section between A1 and A1 Bypass will not be utilized for operation of the Northern Section 1.

Considering for above regards, it is decided to remove A1-A1 Bypass section from this project in deliberation between the Sri Lanka side and a JBIC Appraisal Mission in September 2007.

In addition, owing to an additional geological survey carried out in August 2007, it emerged that the peat and organic clay layers were wider than thought. Therefore, the Second Biyagama Viaduct was extended from 315m in Alt.2 D/D to 420m in Original Design 2. Note that the vertical alignment of the main carriageway around the bridge was also amended to account for a change in beam clearance due to the extension, and that the soft soil countermeasure was revised slightly to reflect the results of the additional geological survey.

Finally, the soft soil countermeasure for box culverts has been changed from replacement in Alt.2 D/D to GCP in Original Design 2 in order to further reduce spoilage due to the difficulty in securing dumping sites. Note, however, that a little spoilage will still remain as replacement is applied to the narrow valley area at Sta.9+250 of Section 2 because of the difficulty of applying GCP. As the result of this, the total earthwork volume of Original Design 2 is a little less than 1.3 million $m^3$ and is only 27% of that of the Original Design.

Original Design 2 which the construction period is three years and the cost of construction is about 17.2 billion Rs. is considered as the base for the following study.

### 3.4.3. Comparison & Selection of Optimal Proposal

In this section, the content of Original Design 2 is optimized in order to present a final design proposal for the project. In accordance with the request from the Sri Lanka side to apply Japanese technology, which will provide advantages regarding soft soil countermeasures and rapid construction in congested and/or confined areas., the following technologies are recommended by the JICA Study Team.

1. The adoption of low-noise and low-vibration type of GCP method as a soft soil countermeasure because the Project is facing to residential area.
2. The adoption of steel viaducts which is able to save site work and to reduce construction period and then it is possible to facilitate rapid construction in congested and/or confined areas.

Concerning Item 2, the Study Team has proposed three possibilities for steel viaducts and they are compared in Table 3.9, with their locations indicated in Fig.3.10.

**Case-1:** Steel structure for main carriageway and ramp viaducts in A1IC area.

**Case-2:** Steel structure for First and Second Biyagama Viaduct.

**Case-3:** Steel structure for Kelani River Bridge and Kelani River Access Viaduct.

Table 3.9 Cases for Rapid Construction in Congested or Confined Areas

| No. | Category | | | Length (m) | Case-1 (Steel at A1IC) | Case-2 (Steel at Biyagama) | Case-3 (Steel at Kelani River Area) |
|---|---|---|---|---|---|---|---|
| 1 | A1IC | Main Carriageway | | 322 | Steel | PC | PC |
| 2 | | Ramp | | 506 | Steel | PC | PC |
| 3 | Biyagama | Main Carriageway | 1 | 315 | PC | Steel | PC |
| 5 | | | 2 | 420 | PC | Steel | PC |
| 6 | B214IC | Ramp | | 408 | PC | PC | PC |
| 7 | Kelani River Access | | | 275 | PC | PC | Steel |
| 8 | Kelani River | | | 355 | PC | PC | Steel |
| 9 | Overpass | | | 226 | PC | PC | PC |
| Construction Cost (Million Rs.) | | | | | 18,538 | 18,690 | 20,038 |

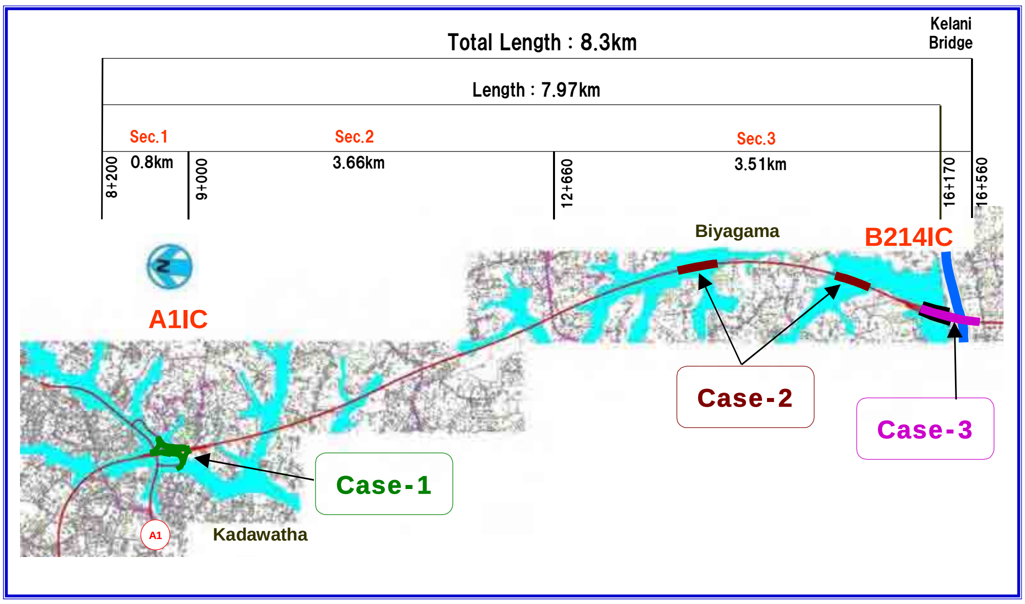



Fig. 3.10 Locations of Steel Viaducts

After deliberation with the Sri Lanka side regarding the above comparison of the different cases for steel viaduct construction, Case-1 was selected as the optimal proposal for the following reasons:

- The increase in project cost for Case-1 is the smallest of all the cases
- The difficulty of transporting material to site is expected to be similar for the A1IC area of Case-1 and the Biyagama Area of Case-2 and 3.
- There will be a big advantage regarding the reduction of the amount and weight of material to be transported to site and thereby will provide some leeway for an already tight schedule at the A1IC area of Case-1.
- It is aesthetically preferable to apply curved steel ramp viaducts in the A1IC area of Case-1 rather than in the Biyagama area of Case-2 and 3.

Furthermore, it was confirmed that Case-1 will satisfy the requirements for a STEP loan roughly when the following items are considered as part of the Japanese portion:

- The purchasing and transportation of low-noise, low-vibration GCP equipment with the operating cost to be borne by the Japanese side on site.
- The material, fabrication, transportation, erection and painting costs for steel girders.
- The cost of Japanese engineers and technicians in connection with the overall project (assumed to be 2-5% of total construction cost).
- Overhead (assumed to be 7% of total construction cost).

### 3.4.4. Detailed Design Result

The summary of final result based on the Case-1 above shows in **Table 3.10**. Basic design is carried out for the viaducts of the A1IC area, Biyagama area, and the approach bridge of the Kelani River Bridge. On the other hand, detailed design is executed for the earthworks, the Kelani River Bridge, and other structures. Based on the design, the construction cost and project cost are estimated and the draft tender document is prepared.

Note that, it specifies in the draft tender document that the proposal of alternatives be accepted for the only following item at a construction bid.

- The viaduct carried out in basic design level

Table 3.10 Final Result

| | | | Bridge Type | Total Length (m) (Number of Bridges) | Design Level |
|---|---|---|---|---|---|
| Earth Work | A1 ～ A1BP | | - | 469 | (Removed) |
| | A1BP ～ AB10 | | - | 6122 | D/D |
| Bridge | A1IC | Main Carriageway | Steel-I Girder | 322 (1) | B/D |
| | | Ramp | Steel-Box Girder | 506 (4) | B/D |
| | Biyagama | Main Carriageway | PC-I Girder | 735 (2) | B/D |
| | B214 IC | Ramp | PC-I Girder | 408 (2) | B/D |
| | Kelani River Access | | PC-I Girder | 275 (1) | B/D |
| | Kelani River | | PC-I Girder | 355 (1) | D/D |
| | Overpass | | PC-I Girder | 226 (5) | D/D |

Detailed design result based on case-1 is as shown in **Table 3.11**. In addition, it is confirmed that the result will satisfy the requirements for a STEP loan.

Table 3.11 Detailed Design Result

| No. | Category | | | Length (m) | Original Design 2 (Adjusted D/D) (exclude A1-A1BP) | Case-1 (Steel at A1IC) | Detailed Design Result (Based on Case-1) 20.Dec.2007 |
|---|---|---|---|---|---|---|---|
| 1 | A1IC | Main Carriageway | | 322 | PC | Steel | Steel |
| 2 | | Ramp | | 506 | PC | Steel | Steel |
| 3 | Biyagama | Main Carriageway | 1 | 315 | PC | PC | PC |
| 5 | | | 2 | 420 | PC | PC | PC |
| 6 | B214IC | Ramp | | 408 | PC | PC | PC |
| 7 | Kelani River Access | | | 275 | PC | PC | PC |
| 8 | Kelani River | | | 355 | PC | PC | PC |
| 9 | Overpass | | | 226 | PC | PC | PC |
| (A) Total Construction (Million Rs.) | | | | | 17,194 | 18,538 | 18,680 |
| (B) Japan Portion of Steel and GCP | | | | | | | 4,005 |
| (C) Japanese Engineer & Technician : (A) x (2～5%) | | | | | | | 374～935 |
| (D) Overhead : (A) x 7% | | | | | | | 1,309 |
| (E) (B) + (C) + (D) | | | | | | | 5,689～6,249 |
| (F) (E) / (A) (%) | | | | | | | 30.4～33.5 |

# CHAPTER 4 HIGHWAY & INTERCHANGE DESIGN

Based on its basic design, the detailed design for the OCH main carriageway, interchanges, bypass, ancillary roads, and highway facilities has been carried out. Note that it has been decided to remove the A1-A1 Bypass section from this project in deliberations between the Sri Lanka side and JBIC Appraisal Mission in September 2007

## 4.1. Summary of the Design

- Main Carriageway : Total Length - 8.3km (A1～AB10 (connecting point to Southern Section))

  A1 - A1 Bypass removed from project
- Interchange : A1IC、B214IC
- A1 bypass : Total Length - 2.1km
- Affected Local Roads : Approach Road (12)、Frontage Road (11)

## 4.2. Design Standard

The main geometric design criteria and values adopted, as well as the standard width for the OCH main carriageway and interchanges, are as shown in **Table 4.1** and **4.2**. For the A1 Bypass and other approach roads, RDA's Geometric Design Standards were used for the detailed design.

Table 4.1 Geometric Design Criteria for the OCH Northern Section 1

| Item | | Main Carriageway | | | Ramp/Interchange | | |
|---|---|---|---|---|---|---|---|
| | | Criteria | Absolute Value | Adopted Value | Criteria | Absolute Value | Adoption Northern Section 1 |
| Design Speed | | 80km/h | | | 40km/h | | |
| Min. Radius of Horizontal Curve | | 280m | 230m | 700m | 50m | 40m | 50m |
| Max. Grade | | 4% | 5 – 7%* | 2.551% | 6% | 7%(down) | 5.366% |
| Min."K" value of Vertical Curves | Crest | 45 | - | 109 | 7 | 5 | 12 |
| | Sag | 31 | - | 70 | 10 | 7 | 11 |
| Crossfall of Carriageway | | 2.5% | | | 2.5% | | |
| Max. Superelevation | | 6% | - | 6% | 6% | - | 6% |
| Max. Composite Gradient | | 10.5% | - | 6.014% | 11% | - | 7.616% |
| Stopping Sight Distance | | 140m | - | 142m** | 45m | - | 45m |

Table 4.2 Standard Width for Cross Sectional Elements

| Item | | Main Carriageway | Ramp/Interchange |
|---|---|---|---|
| Traffic Lane Width | | 3.5m | 3.5m |
| Outer Shoulder Width | Earth Work / Minor Bridge | 3.0m | 2.5m |
| | Major Bridge (L>=100m) | 2.5m | 2.5m |
| Center Median Width | | 4.5m | 2.5m |

## 4.3. Highway Design

### 4.3.1. Typical Cross Section

The typical cross section for the OCH main carriageway is as shown in **Fig.4.1**. The number of traffic lanes will be 6 in the final stage, with 4 lanes to be provided in the initial stage. Note that the outer shoulder for major bridges, which is defined as not being less than 100m (all viaducts fall into the category of a major bridge), is reduced to 0.5m in order to reduce costs.

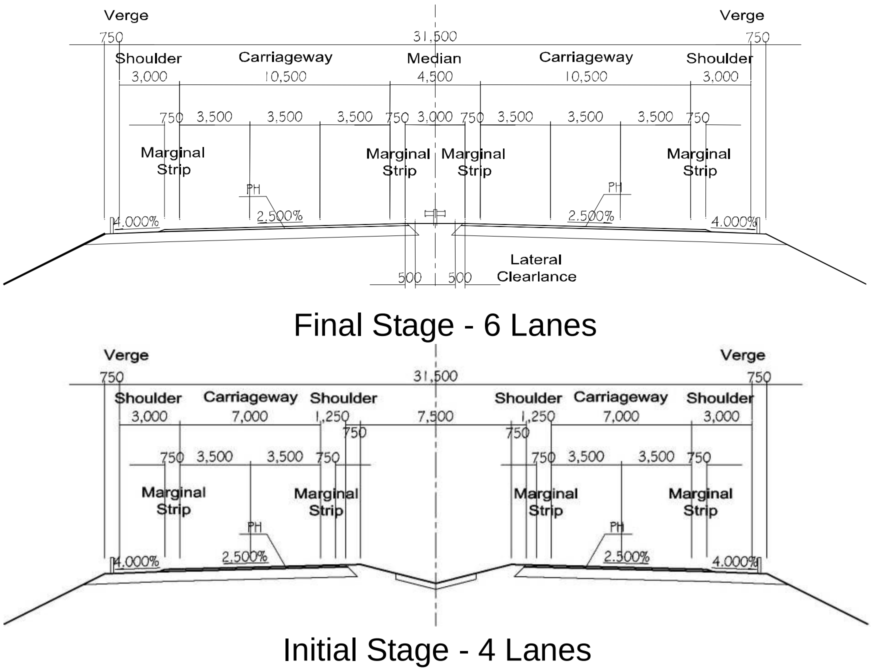



Fig.4.1 Typical Cross Section of the OCH

### 4.3.2. Horizontal Alignment

The alignment for OCH Northern Section 1 passes through low land, such as paddy field or marsh, in order to minimize social impacts and was decided in discussions with the RDA at the basic design stage and is as shown in **Fig.4.2**.

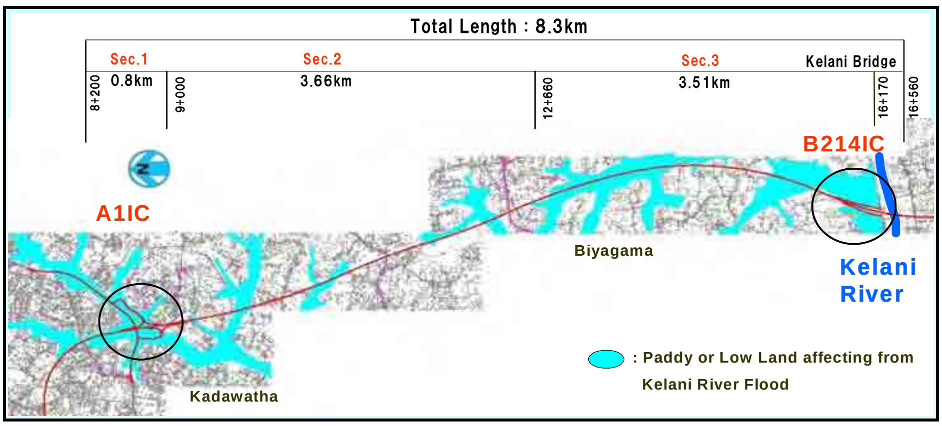



Fig. 4.2 Horizontal Alignment of OCH

### 4.3.3. Vertical Alignment

The vertical alignment for OCH Northern Section 1 was designed during the basic design stage and has been modified based on topographic survey data, changes in the classes of some of the approach roads, and the addition of viaducts. The concept for the setting of the vertical alignment is described below and as shown in **Fig.4.3**

【Concept for Vertical Alignment Setting】

- Minimum embankment height in order to reduce construction costs as much as possible.
  - To be free from 50-year return period flooding (100-year return period for Kelani River).
  - Embankment: keep 30cm from H.F.L. to the bottom of the subbase course
  - Viaduct: keep the free board, which is 120cm for Kelani River and 30 cm for the tributary, from H.F.L. to the bottom of the slab
- Secure minimum vertical clearance for underpasses.
  - A&B Class Roads : 5.1m
  - C&D Class Roads : 4.8m (5.1m when not affect to Vertical Alignment)
  - E Class Roads : 4.5m
  - Select appropriate overpasses and underpasses to lower OCH embankment height. (detours for minor roads could be up to 500m if necessary)
- Minimum vertical gradient of 0.3% for road surface drainage.

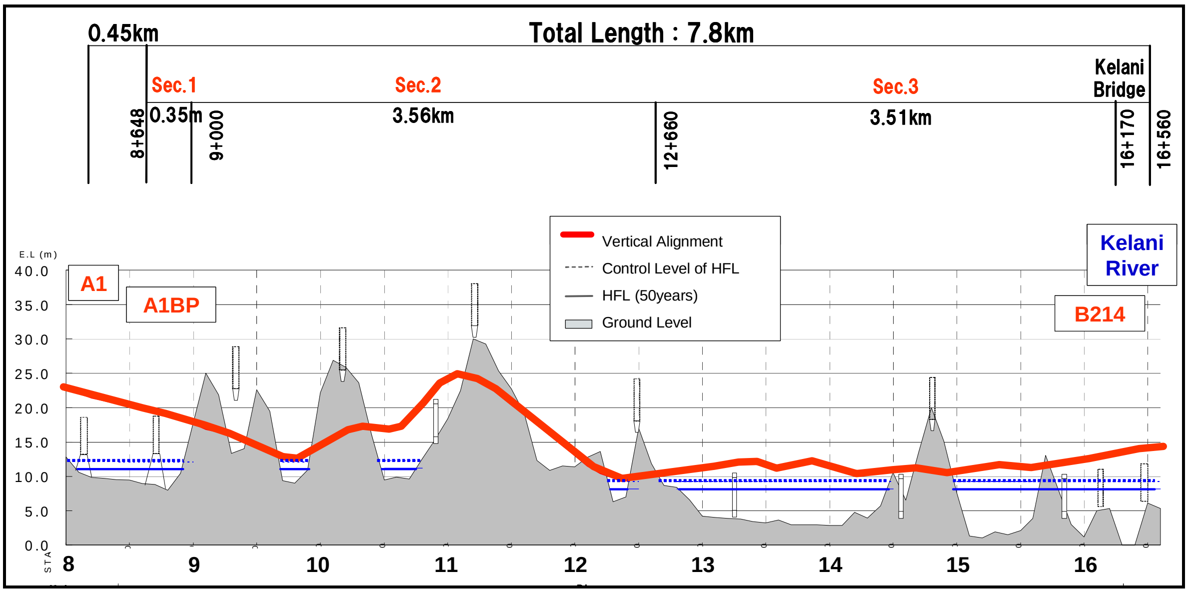
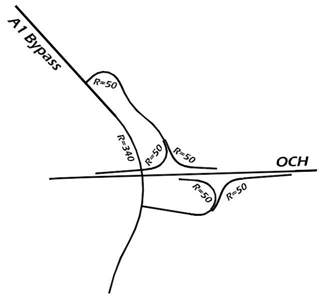
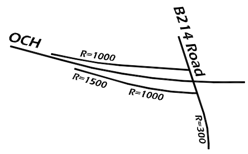



Fig.4.3 Vertical Alignment of OCH

## 4.4. Interchange Design

The detailed design for two interchanges at A1 Bypass and B214 has been carried out and the vertical alignment of the OCH modified. Note that each ramp has been designed so there is sufficient space for a future tollgate if the RDA decides to introduce tolling for the OCH and STDP.

Table 4.3 Summary of Interchanges

| | A1 | | B214 | |
|---|---|---|---|---|
| Alignment |  | |  | |
| Type of Intersection | Two Quadrant Cloverleaf | | Half Diamond | |
| Location | Kadawatha, Gampaha District | | Biyagama, Gampaha District | |
| Connecting Road | A1 Bypass Road | | B214 Road | |
| Ramp | Ramp Class | A | Ramp Class | A |
| | Design Speed | 40km/h | Design Speed | 40km/h |
| | Min. Radiate of Horizontal Curve | R=50m | Min. Radiate of Horizontal Curve | R=1000m |
| | Max. Gradient | 4.69% | Max. Gradient | 5.37% |
| | Land Area | Approx. 221,000m$^2$ | Land Area | Approx. 52,000m$^2$ |

### 4.4.1. Toll Collection Facilities

RDA is planning that the OCH and STDP be toll roads and will adopt an interchange collection (closed toll) system with tolls to vary with distance traveled. In accordance with this scheme, it is required that a toll plaza be installed on both the on and off ramps of the OCH. In order to standardize toll facilities, it is expected that RDA will establish the necessary design standards. In the Study, the JICA Study Team has only designed the earthworks and structures for toll plazas calculating the number of lanes by applying Japanese Standards (see Table 4.4). Note that the design for pavement and toll collection facilities will be carried out by other parties after RDA establishes its design standards.

Table 4.4 Number of Lanes at Toll Gates

| IC | Direction | | Traffic Volume (pc/h) | Number of Lanes |
|---|---|---|---|---|
| A1 IC | Entry (ON) | To North | 574 | 2 |
| | | To South | 952 | 3 |
| | Exit (OFF) | From North | 476 | 3 |
| | | From South | 1,008 | 5 |
| B214 IC | Entry (ON) | | 308 | 2 |
| | Exit (OFF) | | 259 | 2 |

## 4.5. A1 Bypass Design

The A1 Interchange, which will be newly constructed and mainly go through paddy fields in order to avoid land acquisition, will be connected to the A1 Bypass. Note that connecting the A1 Interchange directly to the existing A1 Road would result in land acquisition problems. The A1 Bypass is to run for 2.0km and will have 2 at-grade intersections that connect with the A1 Road at either end, together with 2 at-grade intersections to access interchange ramps. The cross sections for the A1 Bypass at each intersection have also been planned with sufficient secure capacity for traffic.

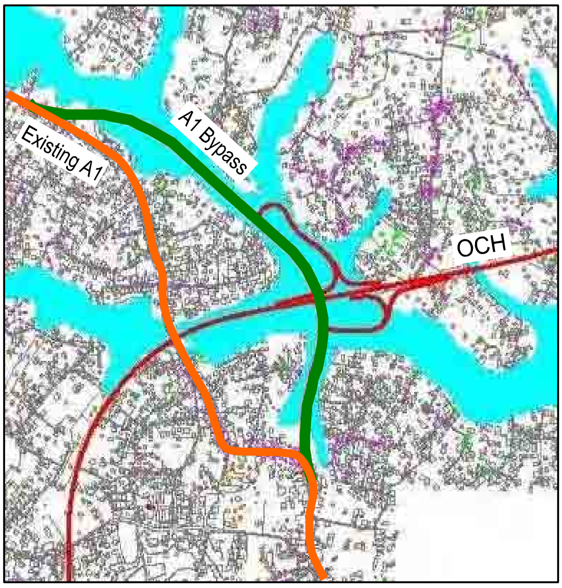



Fig.4.4 Alignment of A1 Bypass

## 4.6. Approach & Frontage Roads

The diversion plan and road design for approach and frontage roads affected by the OCH have been carried out by trying to maintain present accessibility. There will be 14 locations where local roads cross over/under the main carriageway, including the A1 Bypass and ramps, and consist of 7 box culverts, 5 overpass bridges and 2 underpass viaducts. There will also be 11 frontage roads (L = 2,200m) located along the A1 Bypass or ramps.

## 4.7. Design of Other Facilities

The designs of other facilities accompanying roads have been carried out and are described below.

■ Earthworks & Slopes

The slope ratio is to be 1:1.8 in the case of embankments and 1:1.2 in the case of cuts based on the results of the materials and geotechnical surveys. Where embankment height is 10m or higher the berm is to be 7m from the edge of the main line.

■ Pavement Design

Pavement design has been implemented based on the materials survey and forecasted traffic demand. For local roads with no traffic data, pavement design follows either the existing reconstruction design or existing pavement design.

The pavement structure of the OCH main carriageway is composed of a 40mm asphalt concrete wearing course, 85mm asphalt concrete binder course, 225mm dense graded aggregate base course, 175mm granular subbase course, and 200mm of selected material for the upper subgrade.

## ■ Landscaping Plan

The greenery plan for OCH main carriageway, Interchanges and approach roads has been carried out as following point of views.

- Slope protection against storm and/ or flood
- Landscaping plan includes consideration to the facing residential area

## ■ Miscellaneous Work

Design of miscellaneous facilities required for OCH operation were carried out and details are shown in Table 4.6.

Table 4.5 Summary of Miscellaneous Work

| Classification | Item | Application |
|---|---|---|
| Electric Facilities | Highway Lighting Facilities | Main Carriageway at Interchange, Interchange Ramp, Kelani River Bridge, A1 Bypass |
| | Emergency Telephone System | Outer Shoulder of Main Carriageway (1km interval) |
| | Traffic Signals | At Grade Intersections (IC connections, A1 Bypass) |
| Traffic Safety Facilities | Guardrails | Shoulders of Main Carriageway, Approach Road and Frontage Road |
| | Security Fence | Right of Way, Under the Bridges |
| | Curb | Outer Shoulder of Main Carriageway, Median for IC Ramp and A1 Bypass |
| | Delineators | Shoulder of Main Carriageway & IC Ramp |
| Signage & Marking | Traffic Signs | Shoulder of Main Carriageway, IC Ramp & Approach Road |
| | Road Marking | Pavement Surface of Main Carriageway & A1 Bypass |

# CHAPTER 5 SOFT SOIL COUNTERMEASURES

## 5.1. General

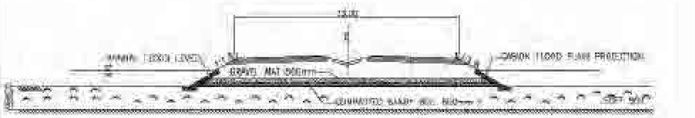
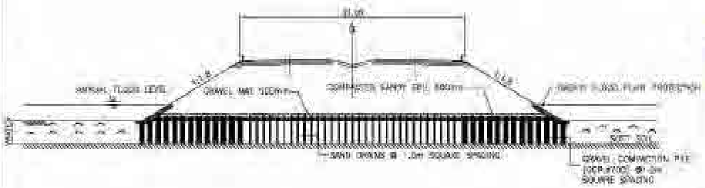
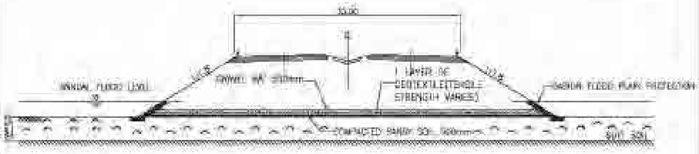
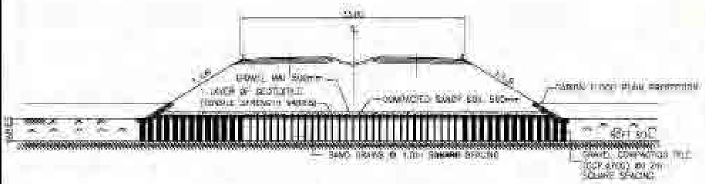
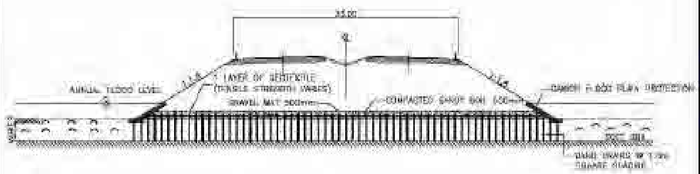
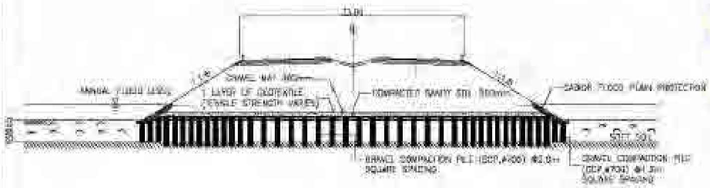
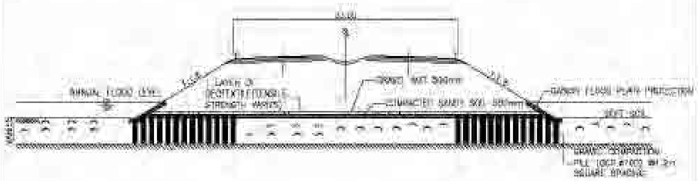
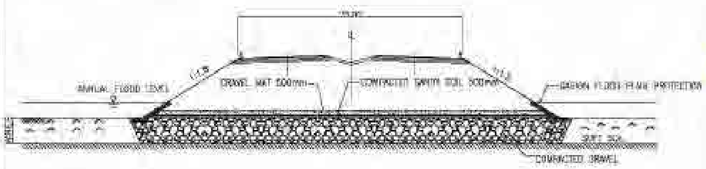
**Fig. 5.1** to **Fig. 5.4** shows the geographical profile of the area that the OCHNS1 traverses. This area is widely covered with soft ground that ranges in depth from about 1 to 8m. At some locations, soft ground layers even reach a depth of around 10m near Sta.16+400. The basic countermeasures for soft soil are as shown in **Table 5.1** and **Table 5.2**.

Table 5.1 Typical Soft Soil Countermeasures

| Soft Soil Counter -measure Method | Embankment Height H:(m) | Depth of Soft Soil D:(m) | Consis-tency of Soil | Countermeasures for Soft Soil | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Compacted Sandy Soil (t=0.5m) +Gravel Mat (t =0.5m) | Geo-textile | Band Drain | GCP (Slope of embank -ment) | GCP (Center part of embank -ment) |
| A | 3≦H<6 | 0<D<1 | Soft | ○ | — | — | — | — |
| B | 6≦H<12 | 1≦ D<2 | Soft | ○ | 1sheet | — | — | — |
| C | 3≦H<6 | 3≦ D<6 | Very soft | ○ | 1sheet | ○ | — | — |
| D | 6≦H<12 | 1≦ D<2 | Very soft | ○ | 1sheet | — | ○ | — |
| E | 6≦H<12 | 2≦ D<3 | Soft | ○ | — | ○ | ○ | — |
| F | 6≦H<12 | 3≦ D<6 | Very Soft | ○ | 1sheet | ○ | ○ | — |
| G | 10≦H<12 | 6≦D | Very soft | ○ | 1sheet | — | ○ | ○ |
| H (Replacement) | Narrow valley part of Section 2 | 1≦ D<6 | Soft | ○ | — | — | — | — |

Based on the soil conditions and planned embankment height, countermeasures along the OCHNS1 have been studied and planned as shown in **Fig. 5.5** and **Fig. 5.6**.

## Table 5.2 Types of Countermeasures

| Type | Cross Section | Descriptions | Type | Cross Section | Descriptions |
|---|---|---|---|---|---|
| **A** |  | Gravel Mat | **E** |  | Gravel Mat<br>Band Drains<br>Gravel Compaction Pile |
| **B** |  | Gravel Mat<br>1 layer of Geotextile | **F** |  | Gravel Mat<br>1 Layer of Geotextile<br>Band Drains<br>Gravel Compaction Pile |
| **C** |  | Gravel Mat<br>1 layer of Geotextile<br>Band Drains | **G** |  | Gravel Mat<br>1 Layer of Geotextile<br>Gravel Compaction Pile (Whole Area) |
| **D** |  | Gravel Mat<br>1 layers of Geotextile<br>Gravel Compaction Pile | **H** |  | Replacement By Excavation. |

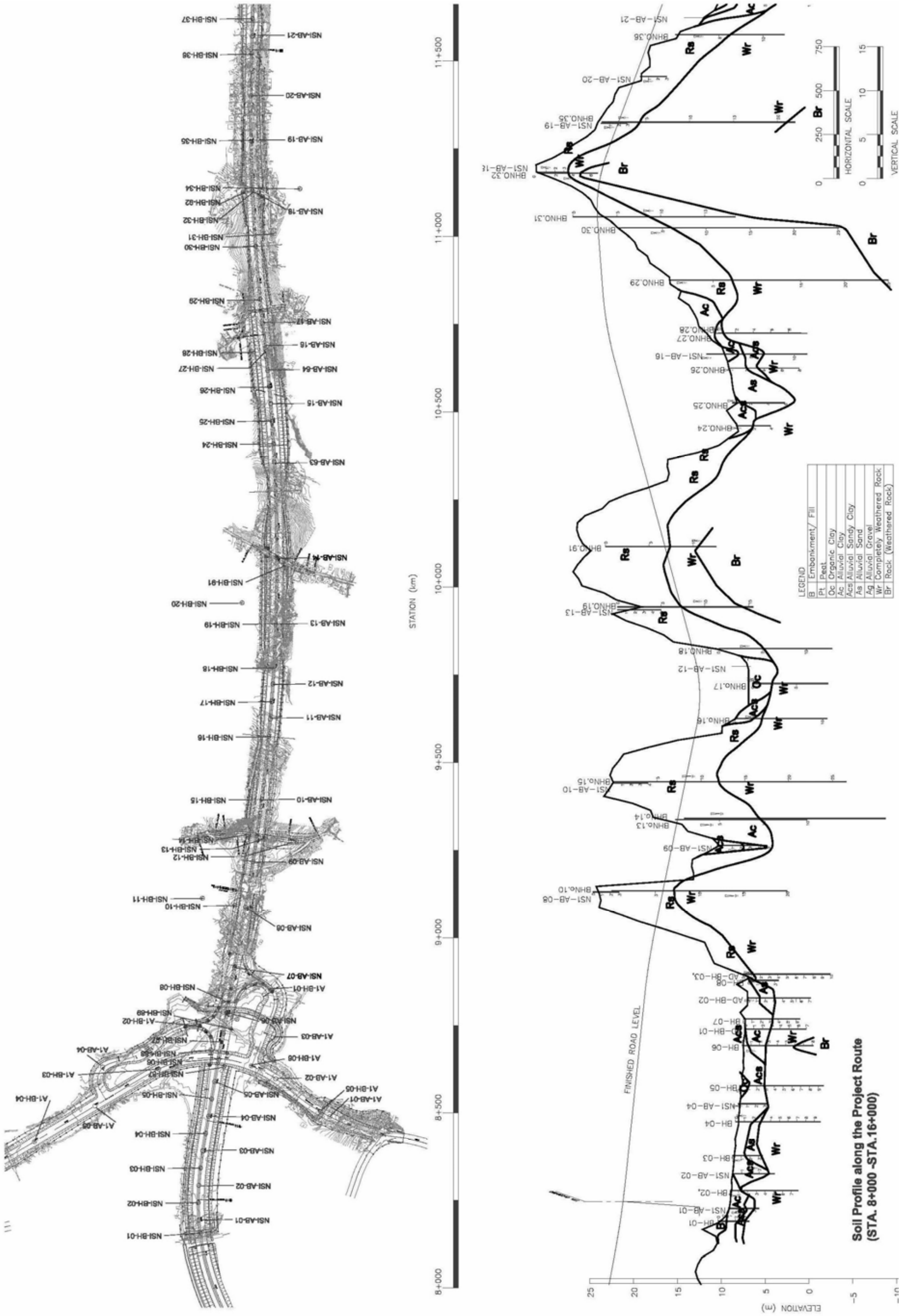



Fig. 5.1 Geological Profile of OCH NS1 (1/4)

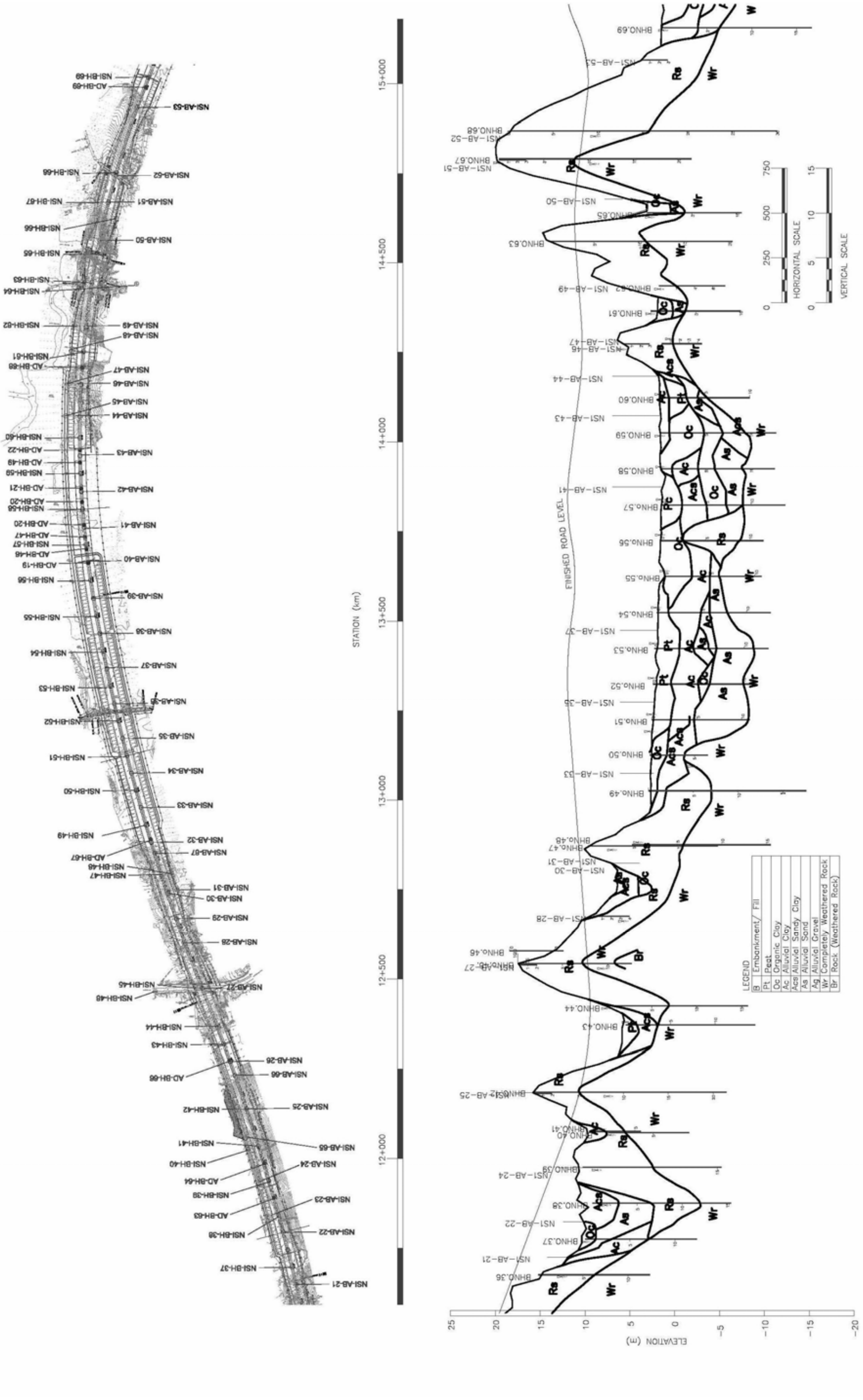


Fig. 5.2 Geological Profile of OCH NS1 (2/4)

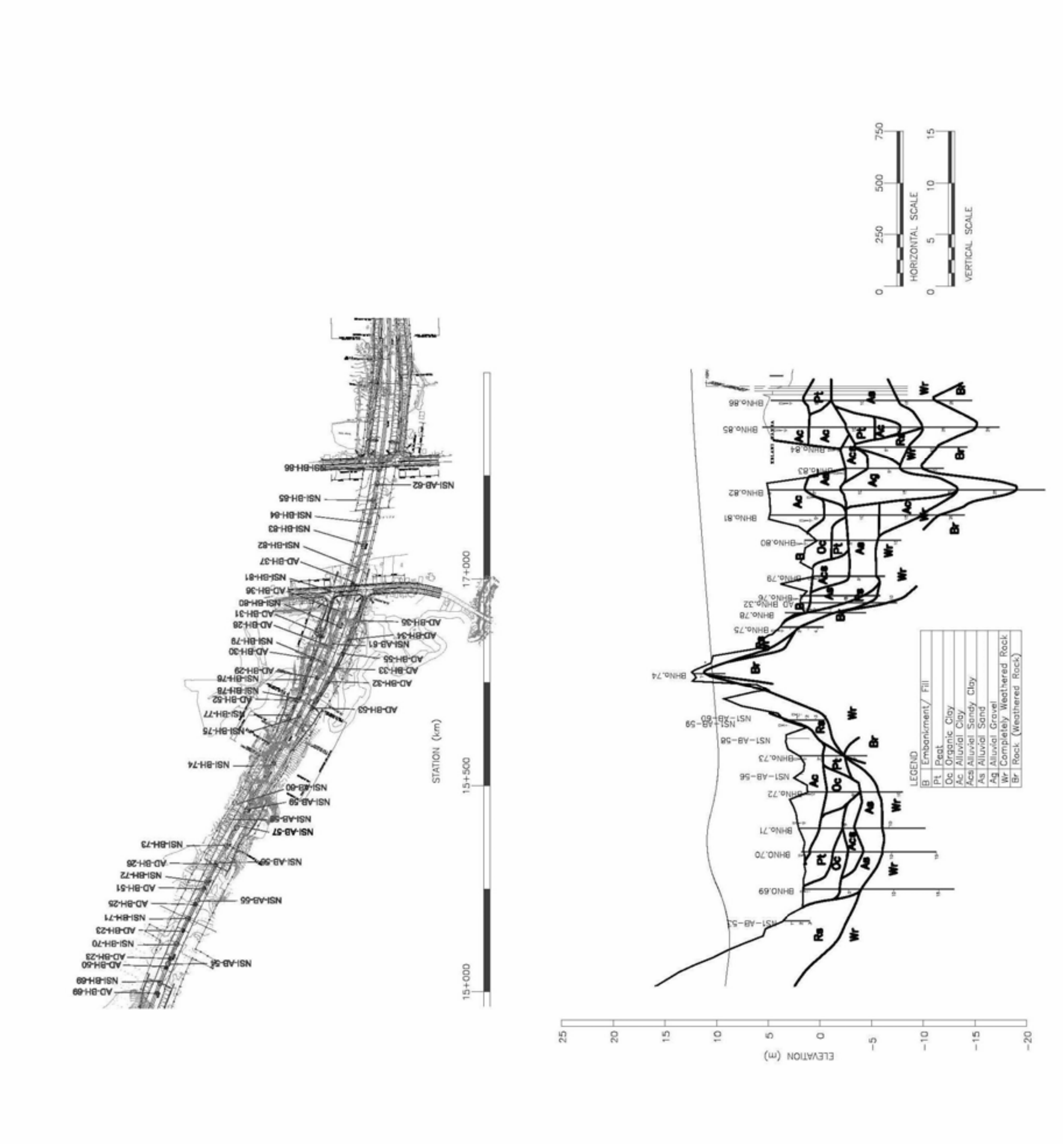



Fig. 5.3 Geological Profile of OCH NS1 (3/4)

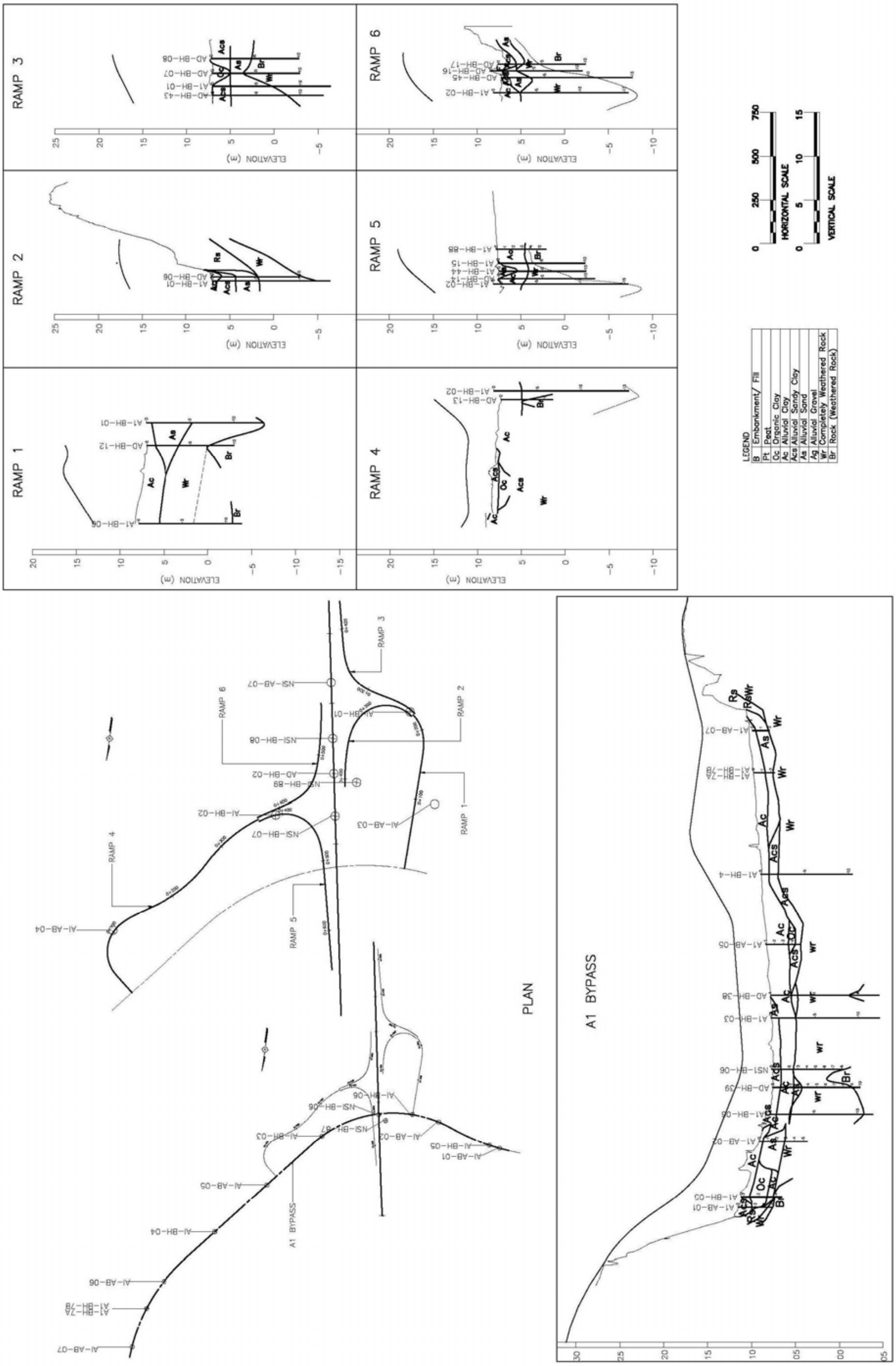



Fig. 5.4 Geological Profile of OCH NS1 (4/4)

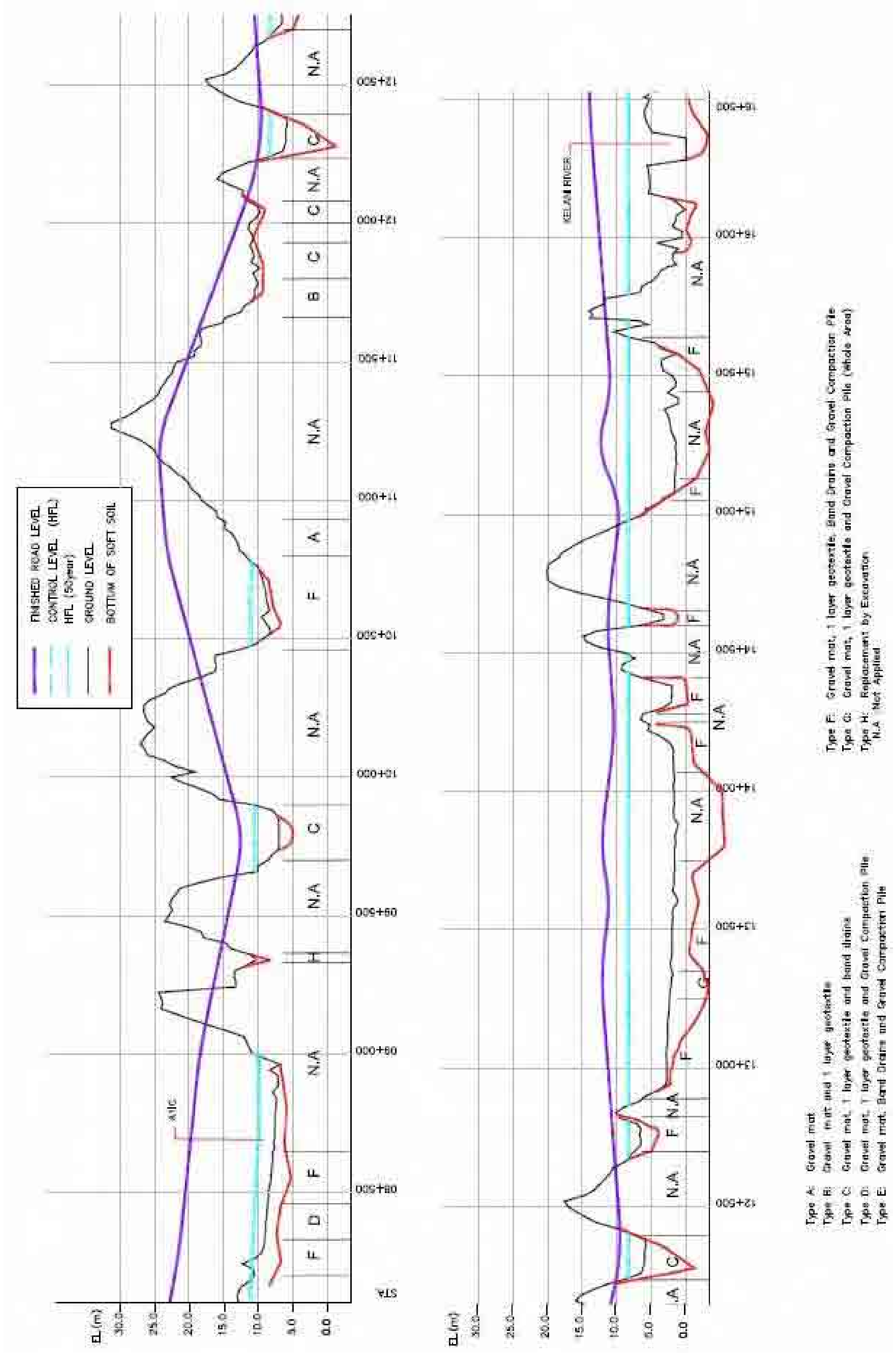



Fig. 5.5 Soft Soil Countermeasures along OCHNS1 (1/2)

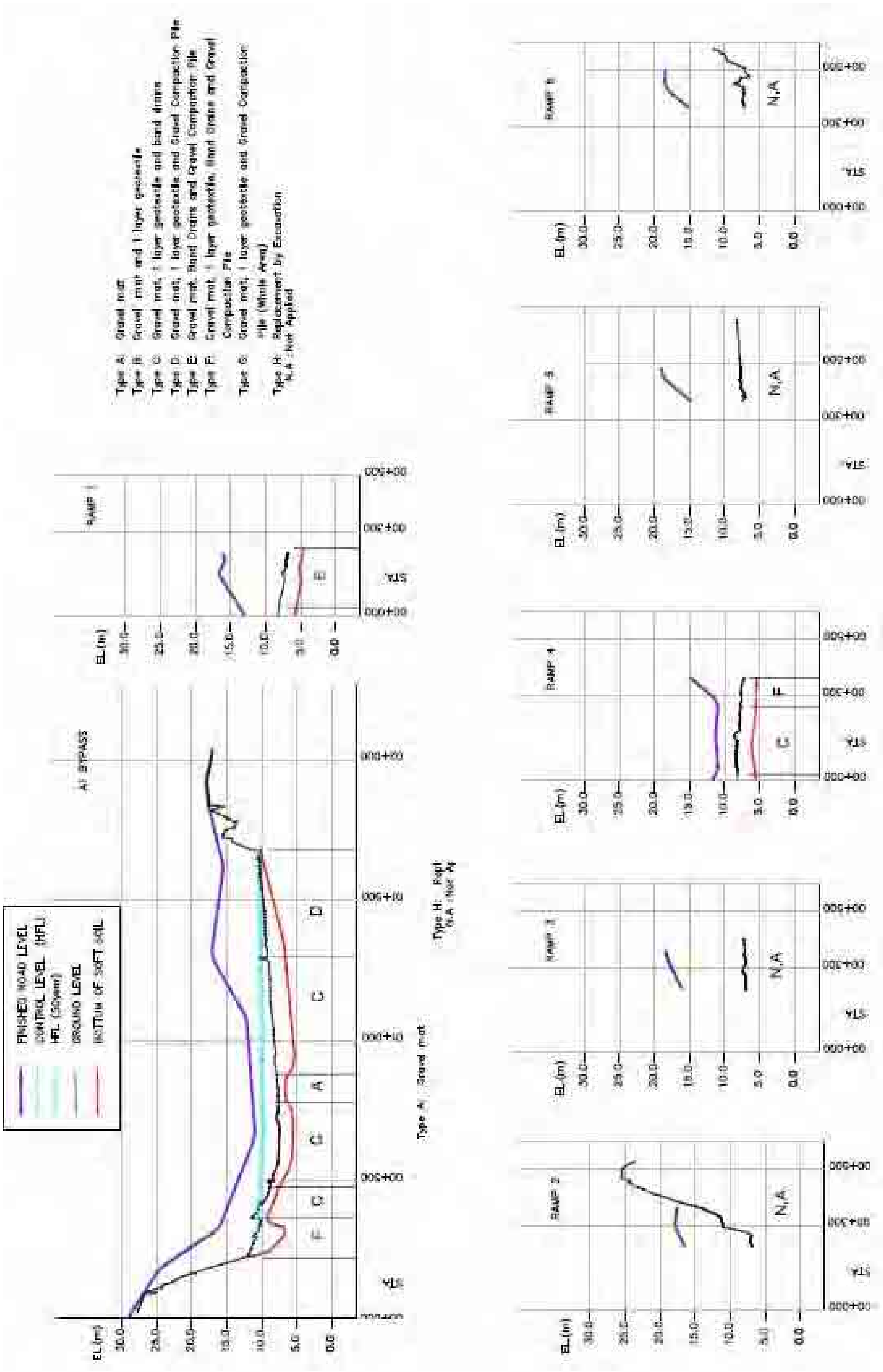



Fig. 5.6 Soft Soil Countermeasures along OCHNS1 (2/2)

# CHAPTER 6 DRAINAGE

## 6.1. Outline

Drainage provisions were designed based on the design criteria approved by RDA in consultation with DOI and SLLRDC. The OCHNS1 traverses the flood plain of the Kelani River and the intermittent hilly and low-lying areas crossing a Kelani River tributary and several small waterways. The A1 Interchange to A1 Road section is also located in a low-lying area consisting of marsh and paddy field. However, the newly designed viaduct structure remarkably minimizes any adverse impacts to the prevailing hydrological environment that the construction of the OCH might have had.

## 6.2. Design Standard

Design rainfall return periods, which were agreed to by RDA, are as shown below:

Table 6.1 Return Periods for Drainage Facility Design

| Type of Facilities | Return Period (Years) |
|---|---|
| Bridge for Main River (Kelani River) | 100 |
| Bridge for River Tributary | 50 |
| Drainage Culvert for OCH, Ramps & A1 Bypass | 50 |
| Drainage Culvert for Crossing Roads | 10 |
| Road Side Ditch/Canal | 10 |
| Road Surface Drainage for OCH | 10 |

## 6.3. Major Drainage Facilities

As for the design of the major drainage facilities for OCHNS1, the following hydrological and hydraulic analyses were carried out.

- Analysis of the required bridge opening width at the Kelani River crossing
- Analysis of the required bridge opening at the crossing point of the Rakgahawatta Ela (Mudun Ela) tributary and the design of a new flood protection structure at the confluence with Kelani River.
- Analysis of the drainage provisions for waterways crossing the OCH trace.

The applied methodologies and the results are summarized in **Table 6.2** below.

Table 6.2 Methodologies & Results of Major Drainage Facilities Study

| Item | Methodology | Result |
|---|---|---|
| <Kelani River><br>Required Width of Span | MIKE 11 Mathematical Model | Span width of 350m for the bridge proposed to minimize adverse hydraulic impacts |
| <Mudun Ela Tributary><br>1) New Flood Gate<br>2) Required Span Width at OCH Crossing Points | HEC-HMS & HEC-RAS mathematical model | 1) Improved new flood gate is required for adequate and smooth water flow<br>2) A 35m opening for OCH crossing point is required (If OCH constructed as an embankment, a 40m opening required) |
| <Minor Waterway Crossings at OCH> | Rational Formula | Sufficient drainage provisions such as culverts/side canals/ditches provided. |

# CHAPTER 7 BRIDGES & OTHER STRUCTURES

## 7.1 Outline

The bridges, viaducts and overpasses of the OCHNS1 are as shown in Table 7.1.There are four viaducts and two IC lamp bridges, and they were adopted in order to minimize haulage from soft ground areas and large embankments. Moreover, six overpasses over the main line are also planned.

As for the design level of the bridges, the Kelani River Bridge and overpasses have been prepared at the detailed design level, while viaducts and rump bridges have been prepared at the basic design level. Note that the Bridge Design Manual (1997, RDA) and BS5400 were referred to mainly, while Japanese highway bridge design criteria were used as a supplement.

In addition, 40 reinforced concrete box culverts (RCBC) for crossing roads, drainage, canals and irrigation, as well as several mass concrete retaining walls, are to be utilized in this design as part of the required structures of OCHNS1 after conferring with the RDA, DOI, SLLRDC, etc.

## 7.2 Selection of Bridge Type

### (1) Superstructure

Pre-stressed Concrete I-Girders (PC I-Girder: post-tensioned) with 2 to 4 continuous spans (connected girders after launched at pier) and steel plate girders (I and box section) were chosen for the superstructure taking into consideration cost-effectiveness, durability, ease of construction, etc.

### (2) Substructure

Reversed T-type abutments and wall-type piers were adopted taking into account ease of construction and cost-effectiveness.

### (3) Foundation

Gravel bed and weathered rock with an N value of 50 or more were used as bearing stratum. A spread foundation was adopted for shallow bearing stratum (depth being approximately less than 5m), and cast-in-situ concrete bored piles with a diameter of 1.5 m used for a depth of 5m or more.

## 7.3 Bridge/Viaduct & RCBC List

The list of bridges/viaducts and RCBC for OCHNS1 are as shown in **Table 7.1 and 7.2**, respectively:

# Table 7.1 Bridge/Viaduct List

| No | Category | ID No. | Station | Crossing Object | Class | Length (m) | Span Arrangement (m) | 1st Stage Effective Width (m) | Required Vertical Clearance (m) | Total Width (m) | Skew Angle (degree) | Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Highway | V1 | 8+648.00 - 8+687.00 | A1 Interchange (Soft Ground) | A | 322.0 | 18.0+21.0 | 2@10.75 with widening | 5.10 | Varies | 90-00-00 | Steel-I (2-Span Continuous) |
| | | | 8+687.00 - 8+830.00 | | | | 3@47.67 | | --- | | 90-00-00 | Steel-I (3-Span Continuous) |
| | | | 8+830.00 - 8+970.00 | | | | 3@46.67 | | --- | | 90-00-00 | Steel-I (3-Span Continuous) |
| 2 | | V2 | 13+755.00 - 14+070.00 | (Soft Ground) | A | 315.0 | 9@35.0 | 2@10.75 | --- | 31.40 | 90-00-00 | PC-I (3-Span Continuous x 3) |
| 3 | | V3 | 15+095.00 - 15+515.00 | (Soft Ground) | A | 420.0 | 12@35.0 | 2@10.75 | --- | 31.40 | 90-00-00 | PC-I (3-Span Continuous x 4) |
| 4 | | V4 | 15+895.00 - 16+169.50 | Mudun Ela (Soft Ground) | A | 274.5 | 7@35.0+29.5 | 2@10.75 | --- | 31.40 | 90-00-00 | PC-I (3-Span Continuous x 2 & Simple) |
| 5 | | H9 | 16+169.50 - 16+524.50 | Kelani River | A | 355.0 | 10@35.5 | 2@10.75 | (5.10) | 31.40 | 68-00-00 (P4) | PC-I (3 or 4-Span Continuous) |
| 6 | Ramp | V5 | 0+241.285 - 0+363.785 | A1 Interchange Ramp-2 | A | 122.500 | 3@40.80 | 7.0, 7.0 with widening | --- | 7.9, Varies | 90-00-00 | Steel Box (3-Span Continuous) |
| 7 | | V6 | 0+239.766 - 0+361.835 | A1 Interchange Ramp-3 | A | 122.069 | (35.069+2@43.50) | 7.0, 7.0 with widening | --- | 7.9, Varies | 90-00-00 | Steel Box (3-Span Continuous) |
| 8 | | V7 | 0+365.448 - 0+489.070 | A1 Interchange Ramp-5 | A | 123.622 | 3@41.207 | 7.0, 7.0 with widening | --- | 7.9, Varies | 90-00-00 | Steel Box (3-Span Continuous) |
| 9 | | V8 | 0+365.448 - 0+503.019 | A1 Interchange Ramp-6 | A | 137.571 | 3@45.857 | 7.0, 7.0 with widening | --- | 7.9, Varies | 90-00-00 | Steel Box (3-Span Continuous) |
| 10 | | V9 | 0+108.155 - 0+275.655 | B214 Interchange Ramp-1 | A | 167.500 | 2*25.0+3*35.0 | 7.0, 7.0 with widening | --- | 7.9, Varies | 90-00-00 | PC-I (3 or 4 Span Continuous) |
| 11 | | V10 | 0+73.330 - 0+312.830 | B214 Interchange Ramp-2 | A | 239.500 | 4*29.5+3*35.0 | 7.0, 7.0 with widening | --- | 7.9, Varies | 90-00-00 | PC-I (3 or 4 Span Continuous) |
| 12 | Overpass | O8 | 9+415.00 | Gonahena Ihala Biyanwila Road | C | 42.0 | 2@21.0 | 10.00 | 5.10 | 10.90 | 90-00-00 | PC-I (2-Span Continuous) |
| 13 | | O9 | 10+210.00 | B169 Road | B3 | 50.0 | 2@25.0 | 13.00 | 5.10 | 13.90 | 62-00-00 | PC-I (2-Span Continuous) |
| 14 | | O10 | 11+261.00 | B401 Road | B3 | 44.0 | 2@22.0 | 13.00 | 5.10 | 13.90 | (Curved) | PC-I (2-Span Continuous) |
| 15 | | O11 | 12+518.921 | Sapugaskanda - Biyagama Road | B2 | 45.0 | 2@22.5 | 21.20 | 5.10 | 22.10 | 71-04-23 | PC-I (2-Span Continuous) |
| 16 | | O12 | 14+843.00 | Jayanthi Mawatha | C | 45.0 | 2@22.5 | 10.00 | 5.10 | 10.90 | 72-00-00 | PC-I (2-Span Continuous) |

## Table 7.2 RCBC List

| No. | Station | Object | Road Class | Skew Angle (degree) | Cell | Inner Width (m) | Inner Height (m) | Length (m) | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| Road | | | | | | | | | |
| 1 | 10+917.0 | Main Expressway | D | 90-00-00 | 1 | 7.4 | 5.25 | 35.4 | |
| 2 | 13+327.0 | Main Expressway | D | 82-00-00 | 1 | 7.4 | 5.25 | 39.2 | |
| 3 | 14+619.0 | Main Expressway | D | 90-00-00 | 1 | 7.4 | 5.25 | 35.8 | |
| 4 | 15+840.0 | Main Expressway | E | 90-00-00 | 1 | 6.8 | 4.95 | 50.0 | |
| 5 | 0+136.297 | A1 IC Ramp-1 | C | 79-02-43 | 1 | 10.9 | 5.6 | 41.5 | |
| 6 | 0+285.0 | A1 Bypass | D | 90-00-00 | 1 | 7.4 | 5.25 | 27.5 | |
| 7 | 1+293.0 | A1 Bypass | D | 82-00-00 | 1 | 8.0 | 5.25 | 26.0 | |
| Drainage | | | | | | | | | |
| 8 | 9+340.0 | Main Expressway | - | 90-00-00 | 1 | 3.25 | 2.0 | 41.4 | |
| 9 | 9+760.0 | Main Expressway | - | 70-00-00 | 2 | 3.25 | 3.0 | 54.2 | |
| 10 | 10+530.0 | Main Expressway | - | 90-00-00 | 1 | 3.25 | 2.0 | 53.4 | |
| 11 | 10+690.0 | Main Expressway | - | 75-00-00 | 1 | 3.25 | 2.0 | 59.6 | |
| 12 | 11+740.0 | Main Expressway | - | 90-00-00 | 1 | 3.25 | 2.0 | 44.2 | |
| 13 | 11+935.0 | Main Expressway | - | 90-00-00 | 1 | 3.25 | 2.0 | 35.4 | |
| 14 | 12+350.0 | Main Expressway | - | 90-00-00 | 2 | 3.25 | 3.0 | 36.8 | |
| 15 | 12+735.0 | Main Expressway | - | 90-00-00 | 1 | 3.25 | 3.0 | 35.6 | |
| 16 | 13+210.0 | Main Expressway | - | 90-00-00 | 2 | 3.25 | 3.0 | 52.0 | |
| 17 | 13+550.0 | Main Expressway | - | 90-00-00 | 1 | 3.25 | 2.0 | 51.8 | |
| 18 | 14+340.0 | Main Expressway | - | 90-00-00 | 1 | 3.25 | 2.0 | 53.6 | |
| 19 | 15+585.0 | Main Expressway | - | 90-00-00 | 1 | 3.25 | 2.0 | 54.8 | |
| Canal | | | | | | | | | |
| 20 | 0+675.0 | A1 Bypass | - | 90-00-00 | 1 | 3.25 | 3.00 | 32.2 | |
| 21 | 0+990.0 | A1 Bypass | - | 90-00-00 | 1 | 3.25 | 3.00 | 32.8 | |
| 22 | 1+312.0 | A1 Bypass | - | 90-00-00 | 1 | 3.35 | 3.00 | 47.0 | |
| 23 | 0+252.0 | Approach Road 8+808 | - | 90-00-00 | 1 | 2.00 | 1.50 | 15.0 | |
| 24 | 0+40.0 | Approach Road 13+327 | - | 90-00-00 | 1 | 3.25 | 2.00 | 15.0 | |
| 25 | 0+230.0 | Approach Road 0+102 A1 BP | - | 33-00-00 | 1 | 3.25 | 2.00 | 20.0 | |
| 26 | 0+107.0 | Approach Road 0+285L A1 BP | - | 90-00-00 | 1 | 2.00 | 1.50 | 10.0 | |
| 27 | 0-25.0 | Approach Road 1+294 A1 BP | - | 90-00-00 | 1 | 3.25 | 2.00 | 7.0 | |
| 28 | 0+30.0 | Approach Road 1+294 A1 BP | - | 90-00-00 | 1 | 3.25 | 2.00 | 7.0 | |
| 29 | 0+280.0 | Frontage Road Ramp-2 | - | 72-00-00 | 1 | 2.00 | 1.50 | 20.0 | |
| 30 | 0+515.0 | Frontage Road Ramp-6 | - | 58-00-00 | 1 | 2.00 | 1.50 | 15.0 | |
| 31 | 0-40.0 | Approach Road 13+327 | - | 90-00-00 | 2 | 3.25 | 2.00 | 11.0 | |
| 32 | 0+575.0 | A1 Bypass | - | 90-00-00 | 3 | 3.25 | 2.00 | 36.0 | |
| 33 | 0+25.0 | A1 IC Ramp-4 | - | 90-00-00 | 3 | 3.25 | 3.00 | 35.0 | |
| 34 | 0+55.0 | Approach Road 8+808 | - | 90-00-00 | 5 | 3.25 | 3.00 | 11.0 | |
| Irrigation | | | | | | | | | |
| 35 | 9+726.0 | Main Expressway | - | 53-00-00 | 1 | 3.25 | 2.0 | 60.0 | |
| 36 | 9+876.0 | Main Expressway | - | 69-00-00 | 1 | 3.25 | 2.0 | 50.0 | |
| 37 | 10+497.5 | Main Expressway | - | 60-00-00 | 1 | 3.25 | 2.0 | 60.6 | |
| 38 | 12+250.0 | Main Expressway | - | 56-00-00 | 1 | 3.25 | 2.0 | 51.0 | |
| 39 | 12+395.0 | Main Expressway | - | 84-00-00 | 1 | 3.25 | 2.0 | 41.0 | |
| 40 | 0+500.5 | A1 Bypass | - | 78-00-00 | 1 | 3.25 | 2.0 | 40.0 | |
| 41 | 0+634.0 | A1 Bypass | - | 90-00-00 | 1 | 3.25 | 2.0 | 35.0 | |
| 42 | 1+665.0 | A1 Bypass | - | 90-00-00 | 1 | 3.25 | 2.0 | 55.0 | |

# CHAPTER 8 CONSTRUCTION PLANNING

## 8.1. General

The construction plan for OCHNS1 has concentrated on reducing the social and environmental impacts of the Project by minimizing the haulage and mining of materials due to construction. For these reasons, the Gravel Compaction Pile (GCP) Method was applied as a soft soil countermeasure to eliminate spoilage and viaduct construction proposed at high embankment sections to minimize the use of borrow and quarry materials. As a result, total bridge length (including the Kelani River Bridge) accounts for 20% of the total length of OCHNS1.

In addition, the earthwork plan is to reduce the number of construction trucks traveling on the congested A1 Road by utilizing cut soil between Sta. 9+000 and Sta. 12+500 for the A1-IC area. Also, the JICA Study Team recommended that the RDA secure borrow pits before the start of the Project to ensure the smooth accomplishment of the Project.

Table 8.1 Quantities of the Major Construction Works

| Item | | | Unit | Volume |
|---|---|---|---|---|
| Road Works | Soft Soil Treatment works | GCP | m | 382,000 |
| | | Band Drain | m | 532,000 |
| | Earthworks | Cutting & Filling | $m^3$ | 607,000 |
| | | Embankment (Borrow material) | $m^3$ | 800,000 |
| | Pavement Works | Asphalt Concrete | Ton | 61,000 |
| | | Aggregate Base | $m^3$ | 56,000 |
| | | Sub base | $m^3$ | 47,000 |
| | | Selected Material | $m^3$ | 38,000 |
| Bridge Works | Kelani River Bridge Viaduct | PC Bridge | m | 1,365 |
| | | Metal Bridge | m | 322 |
| | Ramps | PC Bridge | m | 407 |
| | | Metal Bridge | m | 506 |
| | Overpass Bridge | PC Bridge | m | 226 |
| Box Culvert | | Underpass, Drainage | no. | 27 |
| Interchange | | A!-IC, B214-IC | no. | 2 |

## 8.2. Construction Work Process

The construction process of OCHNS1, which is influenced by viaduct and Kelani River Bridge construction, is planned to require three years and has been prepared taking into account such factors as borrow pit and quarry locations, transport routes, and daily operation (after factoring in bad weather and holidays). Table 8.2 shows the construction work process for OCHNS1.

Table 8.2 Construction Schedule for OCHNS1

| Work Items | Unit | Qty. | 1 | | | | | | | | | | | | 2 | | | | | | | | | | | | 3 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 |
| 1 Preparatory Works | l.s. | 1 | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 Soft Ground Treatment Works | m | 382,000 | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | |
| 3 Earthworks (Cut & Fill) | m3 | 600,000 | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | |
| (Embankment) | m3 | 778,000 | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | |
| 4 Pavement Works | ton | 60,000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| 5 Bridge Works (V1) | l.s. | 1 | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | |
| (V5 ~ V8) | l.s. | 1 | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | |
| (V2) | l.s. | 1 | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | |
| (V3) | l.s. | 1 | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | |
| (V4) | l.s. | 1 | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | |
| (V9 ~ V10) | l.s. | 1 | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | |
| (Kelani River) | l.s. | 1 | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | |
| (Over Bridges) | l.s. | 1 | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | | |
| 6 Box Culvert Works | nr. | 27 | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | | |
| 7 Ancillary Works | l.s. | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ |

# CHAPTER 9 ENVIRONMENTAL STUDY

An Environmental Impact Assessment (EIA) was carried out in the Feasibility Study (FS) for the OCH by JICA Study Team between 1998 and 2000 and approved by the Central Environmental Authority (CEA) in February 2001 with conditions. The environmental certificate had three years validity and the conditional letter of approval recommended a deviation in the alignment passing through mainly marsh and paddy land in the Kaduwela area. Although the Detailed Design for the OCH by the JICA Study Team started in July 2001, it was suspended in November 2001 due to problems of land acquisition.

Afterwards, it was decided to prepare a Supplementary Environmental Impact Assessment (SEIA) report for all of the deviations related to the OCH at the Monitoring Committee of the CEA held in March 2003. Note that a SEIA study for the Kaduwela deviation was conducted during the Detailed Design for the Southern Section of the OCH by the JICA Study Team, and the report submitted in November 2004 and approved by CEA in July 2005.

OCHNS1 contains two deviations (i.e., the Biyagama deviation and the deviation at the Kadawatha Interchange), and based on requests from the CEA SEIA studies have been conducted by RDA and the SEIA report for the Biyagama deviation approved by CEA in February 2007. As for the SEIA report for the deviation at Kadawatha Interchange, it was prepared by RDA and approved by CEA in November 2007.

As mentioned previously, the validity of the original environmental certificate was three years. Note that an application to extend the validity by three years was made in May 2004 and then again in November 2007.

## 9.1. SEIA for Biyagama Deviation

A SEIA study for the Biyagama deviation was conducted and the report has been already approved by CEA. In the Detailed Design for OCHNS1, the SEIA report was reviewed and examined to confirm its conformity with *"JICA Environmental Social Guidelines"*

### 9.1.1. Outline of SEIA Report

#### (1) Hydrological Aspects

The flood level in the deviated trace will increase slightly due to the construction of the OCH. However, further increases can be minimized with the provision of appropriate drainage. Construction of the road embankment in the deviated trace will cause drainage problems for paddy fields, and this needs to be carefully studied and suitable remedial measures provided. In order to assess the effectiveness of any remedial measures, continuous monitoring of water levels and water quality will be established with benchmarks.

#### (2) Ecological Aspects

The deviation of the OCH does not pass through any natural forest, scrubland or any protected areas. Although the length of the ROW of the proposed deviation is somewhat longer than the previous one, if the mitigation measures recommended are implemented, the impacts on the ecology of wetlands would not be significant.

(3) Social Aspects

Except for a few houses, there are no significant or sensitive religious, historical or cultural places affected by the construction of the proposed road. The appropriate compensation packages should be provided to the affected households in a timely manner. It is also essential to provide clear and accurate information on the construction program. As much as possible, the existing road network should not be disturbed as local people use these roads for various purposes.

### 9.1.2. Examination of Compliance with JICA Guidelines

With regards to the SEIA report, compliance with the JICA Guidelines for Environmental and Social Considerations was carried out.

(1) EIA Documents

The SEIA addresses not only ecological and hydrological aspects but also social aspects. The SEIA conducts an examination of multiple alternatives via a review of the FS report for the OCH (2000). The SEIA report is then prepared in English first, and then consequently in Sinhala and Tamil.

(2) Accessibility to EIA documents

The accessibility to the SEA report was ensured through public inspection.

(3) Compliance with Laws, Standards & Plans

The SEIA was implemented under the National Environmental Act(NEA）of Sri Lanka.

(4) Social Acceptability

The existence of the SEIA report was made known to the public via public notice before implementation and opened to the public for inspection.

(5) Involuntary Resettlement

The purpose of the deviation is to minimize social impacts caused by involuntary resettlement. However, for people who need to be resettled involuntarily and whose means of livelihood will be affected or lost, compensation and support will be provided by the Project based on a resettlement implementation plan.

(6) Monitoring

Although the SEIA report does not contain any monitoring plan, the environmental management plan (EMP), which will include an environmental monitoring plan (EMNP), will be established in the course of the detailed design activities for OCHNS1.

Considering the results of the above examination of the SEIA, it could be concluded that the SEIA report is acceptable in terms of compliance with the JICA Guidelines.

## 9.2. Environmental Management Plan (EMP)

The EMP (including the Environmental Monitoring Plan) for OCHNS1 has been formulated based on the EIA findings, and the SEIA for the Biyagama deviation and further studies carried out on specific environmental impacts of the Project. The EMP presents the implementation details of the environmental protection measures recommended for the pre-construction, construction and operational phases of the Project. The Environmental Monitoring Plan has been prepared to ensure the effectiveness of the mitigation measures proposed in the EMP. The draft of the EMP has been finalized in close discussions with the Environmental and Social Division (ESD) of the RDA. The discussion focused on the clarification of the responsibility of the PMU of OCH to ensure effective environmental management of the Project.

The sampling locations proposed for monitoring included in this EMP have been determined through joint field inspection with the Industrial Technology Institute (ITI), which together with the CEA will be the responsible organization for the monitoring activities. The establishment of baseline data for existing water quality, air quality and noise levels have been proposed in the EMP.

Note that the EMP will be included as part of the tender documents for bidders for the construction of OCHNS1, and the bidders will be required to submit an Environmental Management Action Plan when they tender their bid documents.

## 9.3. Land Acquisition & Resettlement Implementation Plan (RIP)

Regarding the land acquisition for OCHNS1, all of the procedures (including payment and vacating of premises) will be completed by the end of November 2008. Presently, monumentation has been completed and advance tracing is proceeding forward and Lay Out Map (to confirm land owner and land boundary) is expected to be completed by at end of March 2008.

The RIP (Resettlement Implementation Plan) for the OCH was submitted to the JBIC and Ministry of Lands in March 2005. Since considerable progress has already been made by the OCH Project, the OCH PMU prepared an addendum for the initial RIP for the first 12km (Maharagama to Kaduwala) in August 2006. The OCH PMU intends to prepare a similar addendum for OCHNS1, too, which will commence after collection of IOL data and is expected to be completed by at end of February 2008.

# CHAPTER 10 PROJECT COST ESTIMATES

## 10.1 General

Project cost was estimated for the OCHNS1 based on the results of the detailed design, and the basic assumptions and methods for this work are as follows:

1) Private contractor(s) carry out all construction work.
2) The unit cost of each cost component is estimated by applying the HSR for fiscal year 2006, the Japanese Civil Work Estimation Standards, the Japanese Cost Estimation for Bridge Erection, and the Japanese Steel Bridge Manual.
3) When the HSR and Japanese standards are inadequate for providing the unit cost for a particular item, then interviews are held with local contractors to gather the necessary data to determine the appropriate cost.
4) Land acquisition cost is based on market prices and on data from the Sri Lanka Land Acquisition Department.
5) Special machinery and equipment (bore pile machine, GCP machine, girder erection facilities) are supplied from outside of Sri Lanka.
6) Steel girders will be produced in Japan and transported to Sri Lanka by ship.
7) The labor cost for GCP execution applies foreign labor unit prices.
8) Engineering services for OCHNS1 have already been contracted so it is not included in this estimation.
9) Physical contingency is estimated to be 10% of the total cost for construction and engineering services and includes an allowance for price escalation for labor, material and equipment.
10) Currency exchange rate: Rs. 1 = JPY 1.099 (average for April 2007)
11) Taxation on Construction Work: 15% VAT

Note that the unit prices applied in the report are in April 2007 prices.

## 10.2 Total Project Cost

The estimation of the Project cost for OCHNS1 is as shown in Table 10.1.

Table 10.1 Total Project Cost for OCHNS1

Unit: million Rs.

| No. | Work Item | Cost |
|---|---|---|
| A | Construction Cost Total | 18,712 |
| B | Contingency (10% of A) | 1,871 |
| | Total of A + B | 20,583 |
| C | Administration Cost for RDA (0.5% of A) | 103 |
| D | Land Acquisition & Resettlement | 2,829 |
| | Total Project Cost* | 23,515 |

*VAT not included.

# CHAPTER 11 ROAD MAINTENANCE & OPERATION

## 11.1. Background & Objective

In order to execute appropriate road maintenance after the completion of the OCH, a preliminary examination is carried out and the factors of organization, funding, and capacity in Sri Lanka taken into consideration.

## 11.2. Organizational & Regulatory Framework

As Table 11.1 indicates, the main road network of Sri Lanka can be divided into three tiers. The first tier consists of national roads maintained by RDA, the second tier of provincial roads maintained by Provincial Road Development Authorities, and the third tier of town and village roads looked after by local road maintenance units.

Table 11.1 Overview of Road Network & Entities in Sri Lanka

| Category | Class | Length (km) | Function | Administrative Entity | Implementation Entity |
|---|---|---|---|---|---|
| National Roads | A | 4,192 | Inter-provincial trunk road connecting major cities & ports | Ministry of Highways & Road Development | Road Development Authority (RDA) |
| | B | 7,510 | Intra-provincial arterial road connecting major urban areas | | |
| Provincial Roads | C | 8,457 | Major feeder road & road for connecting settlements with markets, etc. | Ministry of Provincial Councils & Local Government | Provincial Road Development Authority (PRDA) of relevant Provincial Council |
| | D | 5,756 | Minor feeder road & road for connecting settlements with markets, etc. | | |
| Municipal, Town, Village Roads | E | | Local road to provide access to specific locations | Ministry of Provincial Councils & Local Government | In-house Road Maintenance Unit of Municipal/ Urban Council or Local Authority |
| | Unclassified | 75,069 | | | |
| Other Roads | Unclassified | | Plantation, forest, irrigation, roads | Ministry of Rural Development (MORD), Private Company, Agricultural Cooperative | For MORD Village Development Society; otherwise, usually contracted out |
| Total | - | 100,984 | - | - | - |

Sources: Road Development Authority, 2006.

## 11.3. Road Maintenance Funding

### 11.3.1. Overview of Current Status

Funding is one of the most important issues for road maintenance. Almost without exception, the indications are that at all levels of government funding is insufficient to satisfy maintenance needs. In the case of the RDA actual expenditures have exceeded the budget for seven of ten years between 1996 to 2006 by a margin of 1.13 to 2.48 times, with the shortage in funding met by the reallocating of monies internally, indicating a chronic lack of money that is being dealt with by last minute stopgap measures. As for provincial and local roads as well, the situation is serious. In the case of the PRDA-WP, the difference between the amounts requested for road maintenance and the actual funds received are large and only 40% to 50% of the funding needed is made available. On the other hand, in the case of the CMC, a request for Rs. 205 million for the year 2005 was made for road maintenance but only about 49% of that was allocated. In 2007 the situation for CMC was also the same.

### 11.3.2. Existing Sources of Revenue for Road Maintenance

Previously, all money for road maintenance for Class A and B roads came from the consolidated account of the Ministry of Finance (MOF) of the Central Government via the Ministry of Highways. However, with the establishment of a Road Maintenance Trust Fund (RMTF) in 2006 as part of the World Bank's Road Sector Assistance Project (RSAP), monies for maintenance for RDA now also come from the RMTF, with the Government of Sri Lanka (GOSL) to allocate funds as agreed upon in a loan covenant with the World Bank for the implementation of the RSAP. That is, as indicated in Table 11.2, the GOSL is to provide US$ 30 million in 2006 and afterwards to increase that amount by US$ 4 million annually till the year 2010, which will total US$ 46 million.

Table11.2 Tranches of Funds from Gov't to RMTF

| Year | Funds to be Allocated to RMTF from MOF (US$ million) |
|---|---|
| 2006 | 30 |
| 2007 | 34 |
| 2008 | 38 |
| 2009 | 42 |
| 2010 | 46 |

As for provincial and local roads, the vast majority of funds come from the finance commission of a provincial council, which receives monies from MOF's general account via the MOPCLG, as well from local taxes on items such as property and rents from public facilities. In addition to finance commission funds, there are also two small discretionary sources of money known as the District Development Council for Improvement and the Decentralized Budget.

As the above makes clear, a dedicated fund for road maintenance has only been set up recently and maintenance is still insufficiently funded. On the other hand, road sector revenue (see Table 11.3) is more than sufficient to fund the current maintenance budget of the entire classified road network, which is about 27,000km in total length.

Table11.3 Road Sector Revenue (2006)

| Type of Tax or Fee | SLR (billions) |
|---|---|
| Excise Duty on Petroleum* | 14.1 |
| Vat on Petroleum Sales** | 12.0 |
| Excise Duty on Motor Vehicle Imports*** | 20.7 |
| Excise Duty on Spare Parts Imports* | 0.5 |
| Motor Vehicle License*** | 3.0 |
| Total | 50.3 |

Source) *: Sri Lanka Customs Dept. **: Ceylon Petroleum Corp. ***: Dept. of Fiscal Policy

## 11.4. Performance & Capacity for Road Maintenance

As shown in Table 11.4, in 2005, only 18.4% of Class A and B roads were in good condition while 51.8% were in poor to bad condition. This is also substantiated by the World Bank, which says that more than 50% of all national roads have a poor or bad surface condition.

Table11.4 Condition of Road Surface of Sri Lankan Roads (2005)

| Type of Road | Good (%) | Fair (%) | Poor (%) | Bad (%) |
|---|---|---|---|---|
| National Road | 18.4 | 29.8 | 35.4 | 16.4 |
| Provincial Road | 8.0 | 40.0 | 36.0 | 16.0 |
| Local Road | 5.0 | 30.0 | 40.0 | 25.0 |
| Total | 7.2 | 31.7 | 38.7 | 22.4 |

Source: Final Report on Road Sector Master Plan (ADB TA 4315-SL), 2005.

Although lack of money is one of the reasons for the poor performance just cited, it should be noted that institutional and capacity problems are also contributing factors.

## 11.5. Private Sector Participation in Road Maintenance

Depending on the organization, the level of private sector participation (PSP) in road maintenance at present will vary greatly in Sri Lanka (see Table 11.5). As for RDA, all of its routine maintenance is by force account while 90% of its periodic maintenance is outsourced. Note that worldwide private contractors undertake the majority of periodic maintenance while the majority of routine maintenance is by force account.

Table11.5 Percentage of Force Account & Contracted Out Work by Organization and Type of Maintenance

| Organization | Routine Maintenance | | Periodic Maintenance* | |
|---|---|---|---|---|
| | Force Account | Contracted Out | Force Account | Contracted Out |
| RDA | 100% | 0% | 10% | 90% |
| PRDA of Western Prov. | 50% | 50% | 0% | 100% |
| CMC | 100% | 0% | 100% | 0% |

*: In the case of RDA this includes minor improvement works.

Although the above indicates that PSP in road maintenance in Sri Lanka is already relatively high, consideration could be given to outsourcing more routine maintenance, and thereby creating a more competitive environment that could reduce costs for this type of work as well.

PSP in the form of performance-based contracting (PBC) has been a particularly successful method in regards to carrying out road maintenance in a cost-effective manner. Unlike the traditional way of contracting out maintenance work, which is based on a schedule of unit prices and estimates of quantities, PBC pays the contractor on how well he manages to comply with performance standards and not on the amount of work he does. Typical indicators would include the IRI (i.e., the international roughness index), the absence of potholes, the control of cracks and rutting, and the absence of siltation of drainage structures.

## 11.6. Stance of International Donors on Road Maintenance in Sri Lanka

Most, if not all, donors would agree that stable funding and private sector participation are two of the most important factors for sustainable and efficient road maintenance. Usually for this to occur in developing countries, institutional reform and capacity building are necessary. In response to this, the ADB and GOSL came to an agreement in 2002 to reform the road sector via the Road Sector Development Project (or RSDP). The framework of the RSDP serves as a roadmap for the sector's reform, and based on that the World Bank and the Japan Bank for International Cooperation (JBIC) agreed to coordinate their activities in November 2004 with the ADB. That is, the World Bank is to address the issue of sustainable road maintenance funding and JBIC the issue of private sector development in the road construction industry, while the ADB is to focus on institutional strengthening and capacity development.

## 11.7. Operation & Maintenance (O&M) of the OCH

In the near future in Sri Lanka there will be a total of about 172 km of expressway with the completion of the Southern Highway, CKE and OCH. From the viewpoint of realizing effective integration and economies of scale, it would seem to make sense to have one organization manage this network. On the other hand, given that the CKE is to be constructed under a PPP scheme and the Southern Highway (SH) and OCH with government-guaranteed loans from international donors, this may prove hard to do, as the CKE would have its O&M scheme determined by the organization contracted to carry out its construction. It is therefore suggested at present that consideration be given to having the SH and OCH managed by a single organization. There are basically four possible options for establishing an entity to manage the SH and OCH and they are:

(1) An operating division within an existing government agency such as the RDA
(2) A public corporation or authority
(3) A private corporation
(4)A joint public-private venture

Based on an examination of the merits and demerits of each option, Option (2), which would result in a public corporation (hereafter referred to as SLEA (or the Sri Lanka Expressway Authority)) seems to be the most desirable operational structure for the management of the expressway network. In fact, the Cabinet of the GOSL granted its approval in June 2007 to the Ministry of Highways and Road Development to establish such an entity and directed the Legal Draftman's Department to draft an "Expressway Authority Act".

### 11.7.1. Operational Aspects

The operation of the systems comprising SLEA will be in compliance with all systemic and legal requirements designated by the GOSL. The day-to-day operations of the expressway will be directed from a control center with two to three staff manning it and will function 24 hours a day 365 days a year. As for the maintenance of the expressway, it is recommended that SLEA outsource all of its maintenance work to a private contractor under a performance-based contract scheme.

To carry out the demanding requirements of a PBM contract, it is important that excellent maintenance manuals be available. At present, there are no up-to-date pocket-sized manuals for use in the field to carry out the inspection, evaluation, and execution of maintenance. The current manual that is in use was prepared in 1989 and is a large and unwieldy A4-sized document. It is therefore recommended that three new user-friendly manuals for field use be prepared, which would be divided up into those for inspection, evaluation, and execution.

### 11.7.2. Cost Considerations

In order for SLEA to function properly, it is important that costs be taken into account accurately. Here, O&M costs for the OCH portion of SLEA are considered. Note that it is assumed that the OCH will extend from Rt. A4 to Rt. A1. Given that there are no existing expressways in Sri Lanka, unit costs for the routine maintenance of the road and bridges of the OCH (see Table 11.6) are calculated by referring to information in RDA's Highway Schedule of Rates for Western Province. As for periodic maintenance, it is estimated that it would cost approximately Rs. 265 million in 2007 prices and consist of an overlay (including the carriageway and shoulder). Finally, operation costs are calculated based on actual operational costs incurred by the maintenance unit of the Baseline Road (see Table 11.7).

Table11.6 Annual Routine Maintenance Costs for 4-Lane OCH from Rt. A1 to Rt. A4 (2007 Prices)

| Work Item | Annual Unit Cost in Rs.[1)] | Unit of Measurement[2)] | Quantity | Annual Routine Maint. Cost (Rs.) |
|---|---|---|---|---|
| 1. Spot Patching | 245,133 | ln-km | 79.8 | 19,561,613 |
| 2. Clearing of Vegetation | 66,780 | Km | 23.4 | 1,562,652 |
| 3. Repair of Guardrail | 453,600 | Km | 23.4 | 10,614,240 |
| 4. Maint. of Signals | 147,368 | light | 4 | 589,472 |
| 5. Maint. of Street Lighting | 4,524 | Light | 273 | 1,235,052 |
| 6. Shoulder Maintenance | 179,285 | Km | 23.4 | 4,195,269 |
| 7. Road Furniture | 65,744 | Km | 23.4 | 1,538,410 |
| 8. Edge Repair | 146,758 | Km | 23.4 | 3,434,137 |
| 9. Maint. of Steel Bridges | 992 | $m^2$ | 12,400 | 12,300,800 |
| 10. Maint. of Concrete Bridges | 974 | $m^2$ | 43,600 | 42,466,400 |
| Total | | | | 97,498,045 |

1) Unit costs are based on RDA's Highway Schedule of Rates for 2007 for Class A roads.
2) All data measured in km and ln-km includes ramp length.

Table11.7 Annual Operational Costs for OCH from Rt. A1 to Rt. A4

| Work Item | Annual Unit Cost in Rs. [1)] | Unit Measurement[2)] | Quantity | Annual Operation Cost in Rs. [3)] |
|---|---|---|---|---|
| 1. Overhead incl. Office Staff Salaries & rent | 418,950 | Km | 23.4 | 10,403,430 |
| 2. Maint. of Vehicles incl. Salary of Drivers | 219,450 | Km | 23.4 | 5,135,130 |
| 3. Electricity Bill for Street Lights | 44,460 | Light | 273 | 12,137,580 |
| 4. Electricity Bill for Traffic Signals | 194,560 | Signal Set | 4 | 778,240 |
| Total | | | | 28,454,380 |

1) Unit costs are estimated by referring to costs for Baseline Road O&M unit.
2) All data measured in km includes ramp length.
3) Tolling is not considered so the cost of operating tolling facilities and collecting toll revenue are not considered.

As the above tables indicate, the annual O&M cost for OCH would be approximately Rs.126 million at current prices in years with no periodic maintenance. In the case of years with periodic maintenance, total annual O&M cost would be about Rs.382 million.

### 11.7.3. Potential of Utilizing Existing Revenue Sources & Level of Sufficiency

#### (1) Existing Revenue Sources & Level of Sufficiency

As for the concept of a road fund, which has only been recently implemented in Sri Lanka, there is no guarantee that this will be applied to expressways. In fact, there seems to be an understanding within the GOSL, as well as by the donors, that the expressways should be able to pay for their own operation and maintenance costs without relaying on the road fund.

#### (2) Tolling

Given the above, it is recommended that a tolling scheme be introduced to cover the O&M costs of SLEA. It is also suggested that this be done from the beginning of operation, as it would be extremely difficult from a social viewpoint to introduce tolls later if users are accustomed to using facilities free of charge.

Below, a brief examination of whether or not it is realistic to expect that the tolling revenue of the OCH (from Rt. A1 to Rt. A4) could cover its O&M cost is considered.

(1) It is assumed that tolling for the OCH would vary with distance and therefore be a closed tolling system, with a relatively low toll of Rs.2 per km for light vehicles and Rs.4 per km for trucks and buses. Furthermore, it is assumed that road users on average would use at least half of the OCH (or 10km), meaning that light vehicles would on average spend Rs. 20 and heavy vehicles Rs.40 when using the OCH.

(2) Assuming that there would be a minimum of 50,000 vpd, toll revenue in 2020 would total Rs. 390 million (see Table 11.8). As the above table indicates, the annual toll revenue that could be expected in 2020 would be about Rs.390.0 million and is much larger than the costs for maintenance and operation. In other words, there will be sufficient revenue to carry out the required maintenance and operation of the OCH.

Table11.8 Indicative Forecast of Toll Revenue for 2020
for OCH (Rt. A1 to Rt. A4)

| Type of Vehicle | Share of Total Traffic (Approx.) | Daily No. of Vehicles | Toll Rate (Rs./km) | Average Dist. Traveled on OCH (km) | Annual Expansion Factor* | Annual Toll Revenue (SLR million) |
|---|---|---|---|---|---|---|
| Light Vehicle | 70% | 35,000 | 2 | 10 | 300 | 210.0 |
| Trucks & Buses | 30% | 15,000 | 4 | 10 | 300 | 180.0 |
| Total | | | | | | 390.0 |

*Norte that this expansion factor has been used in other studies in Sri Lanka as well.

### 11.7.4.Recommendations for O&M Scheme for OCH

It is recommended that the following be considered in order to ensure that the investment in the OCH is optimized:

- Timely enactment of the Expressway Authority Act.
- Determination in a timely manner on the level and use (operation/maintenance) of tolls.
- Determination on how tolls are to be collected and the timely execution of the detailed design of toll facilities.
- Determination of the location of maintenance facilities for the OCH, together with facilities for police and emergency services, taking into account the facility location plans for the SH.
- Establishment of a performance-based contract that would be used for the execution of maintenance for the OCH.

# CHAPTER 12 TENDER DOCUMENT PREPARATION

## 12.1. General

Bidding documents for the tender of OCHNS1 have been prepared referring to following documents, which is basically from the tender documents for OCHSS (September 2007):

(1) OCH Southern Section tender documents (September 2007)
(2) Sample Bidding Documents, JBIC, November 1999 (amended in March 2005)
(3) Sample Prequalification Documents, JBIC, November 1999 (amended in April 2005)
(4) Handbook for Procurement under JBIC ODA Loans, JBIC, January 2005
(5) Check List for One-Sided Contracts, JBIC, December 2006
(6) Evaluation Guide for Prequalification and Bidding, JBIC, June 2000 (amended in January 2007)
(7) Various comments on OCHNS1 tender documents from RDA and JICA

## 12.2. Bidding Method

For the OCHNS1, the two-envelope method was recommended and the draft tender documents were prepared based on that method.

## 12.3. STEP Loan

For the OCHNS1, JBIC's Special Terms for Economic Partnership (STEP) loan will be applied in order to utilize and transfer advanced Japanese technologies and know-how, as these are expected to provide significant benefits to the Project. Therefore, one of the conditions of this loan is that the prime contractor is to be a Japanese firm and not less than 30% of the total amount of the goods and services purchased must be Japanese.

## 12.4. Alternative Bid

For OCHNS1, an alternative bid is allowed for the following work:

- Basic Design level Viaducts

If any alternative bid is proposed by the Contractor and accepted by the Employer, the Contractor shall take full responsibility for his design.

## 12.5. Detailed Designs Required

In connection with the above alternative, the demarcation between Basic Design and Detailed Design for bridges has been made clear.

# CHAPTER 13 IMPLEMENTATION PROGRAM

## 13.1. Project Implementation Plan

**Fig. 13.1** shows the flow of the Project activities from the E/N and L/A to the signing of the contract and the commencement of construction. Note that, this plan is prepared under following conditions.

- Consultant employment period is not considered in this plan, because it was decided that the consultant for OCHSS will also charge OCHNS1.
- Ensuring of Borrow Pits for necessary earthwork volume will be completed before awarding the Contract.
- Land acquisition and resettlement will be completed before awarding the Contract.

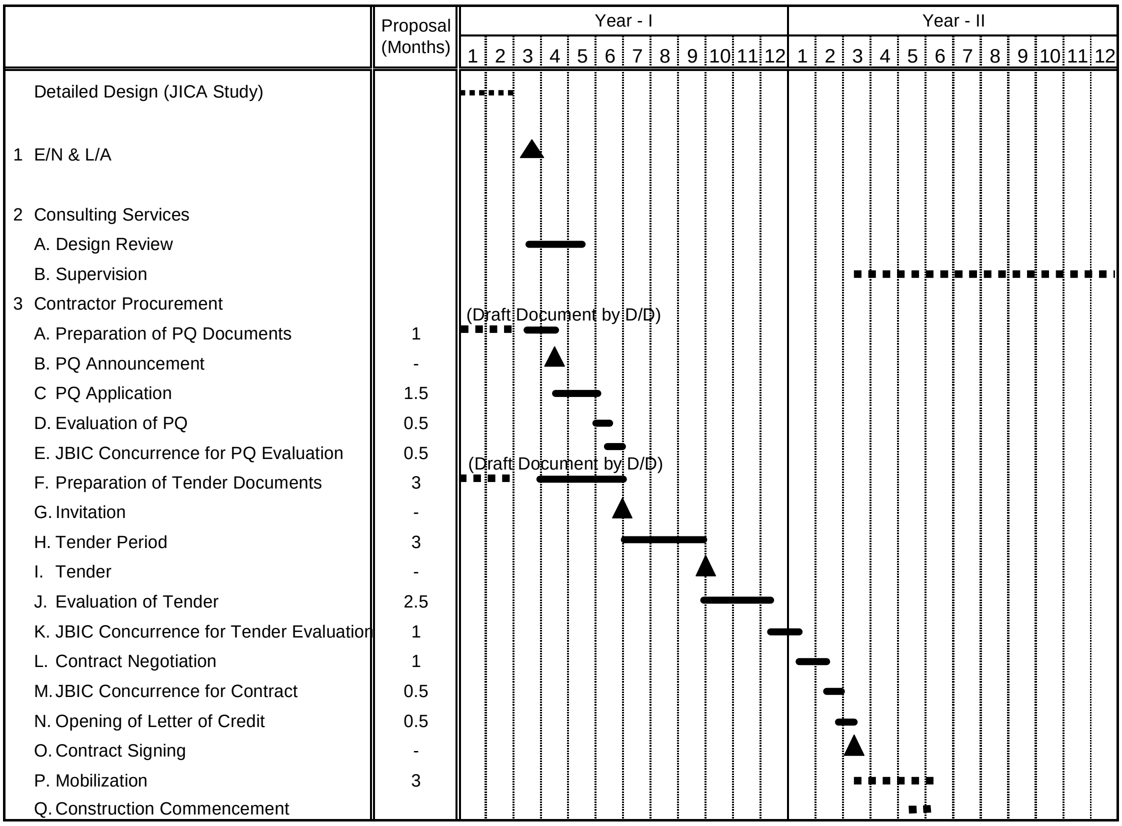
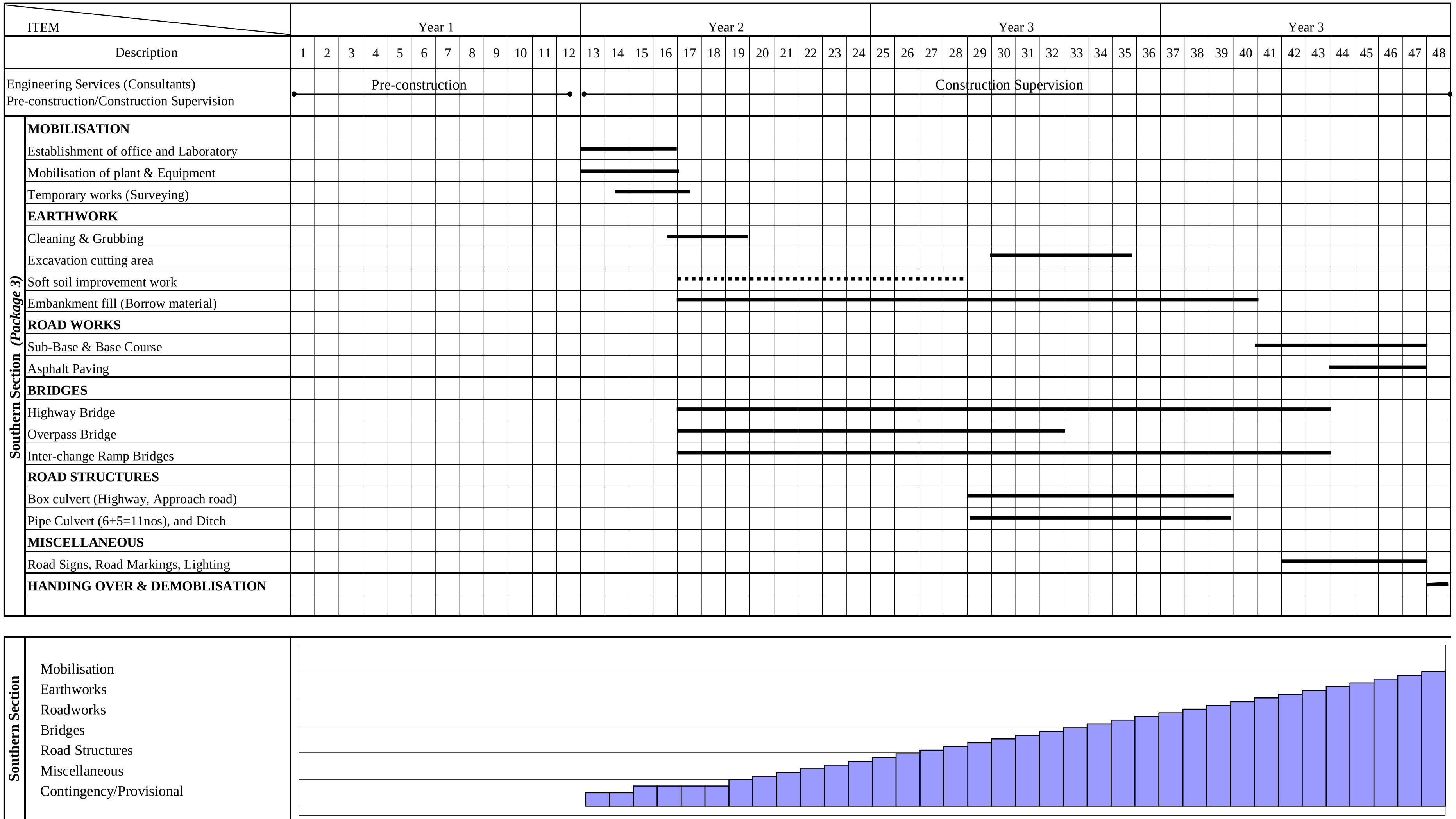



Fig. 13.1 Project Implementation Plan

## 13.2. Financing Plan

**Table 13.1** indicates a financing plan suited to the construction work process of the OCH to ensure that the necessary monies are available as needed.




| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Disbursement Amount / % | | | | | | | | | | | | | 10 | 10 | 15 | 15 | 15 | 15 | 20 | 22 | 25 | 28 | 31 | 33 |

| Month | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Disbursement Amount / % | 36 | 39 | 42 | 44 | 47 | 50 | 53 | 56 | 58 | 61 | 64 | 67 | 69 | 72 | 75 | 78 | 81 | 83 | 86 | 89 | 92 | 94 | 97 | 100 |

Table 13.1 Disbursement Schedule for OCH

# CHAPTER 14 CONCLUSIONS & RECOMMENDATIONS

The route of the OCH passes through marsh and paddy field and was selected with the aim of minimizing social impacts. For that reason, the size of the embankments increased and large-scale soft soil countermeasure became necessary, requiring huge quantities of spoilage, borrow pit material, and quarry material to be hauled in the case of applying the replacement method to remove soft soil.

However, the experiences of the Southern Highway (which is currently under construction) and the OCH Southern Section (which will be constructed in the near future), indicate that hauling such large quantities of materials will result in significant social and environmental problems and that there will be great difficulty in securing the necessary borrow pits and dumping sites.

Based on the preceding, various proposals were considered that included the application of the Gravel Compaction Pile (GCP) method, which will essentially eliminate spoilage, and viaducts on sections with deep layers of soft ground or high embankments. Finally, an optimum proposal was determined by examining the technical and economic merits of these proposals.

Furthermore, RDA requested that a JBIC STEP loan be utilized for the Project in order to utilize Japanese technology, which will provide significant advantages regarding soft soil countermeasure and rapid construction in congested and/or confined areas. In response to this request, it is recommended that a low-noise and low-vibration type of GCP method and steel bridges, which will reduce the amount of on-site labor and thereby shorten the construction schedule, be applied as countermeasures.

Finally, the Southern Highway is now on the peak of construction process and the construction of the OCH Southern Section is to commence shortly. Furthermore, it is expected that the CKE will also be taken up sometime in the near future. In order for these highways to function as intended, the realization of the OCH Northern Section 2 is extremely important. It is therefore hoped that the Sri Lankan Government will continue with its sincere efforts to obtain the understanding of local residents regarding the implementation of this project.

JICA