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No. 32

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

HIS MAJESTY'S GOVERNMENT OF NEPAL
MINISTRY OF WORKS AND TRANSPORT
DEPARTMENT OF ROADS

AFTERCARE STUDY
FOR
SINDHULI ROAD CONSTRUCTION PROJECT

FINAL REPORT

VOLUME I
EXECUTIVE SUMMARY

JULY 1993

NIPPON KOEI CO., LTD. TOKYO

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CURRENCY EQUIVALENTS
(As of March 1993)

Currency Unit - Nepalese Rupees (NRs)

US $ 1.00=Yen 115.08 =NRs 45.88 (NRs 1.0=Yen 2.51)

PREFACE

In response to a request from His Majesty's Government of Nepal, the Government of Japan decided to conduct an aftercare study on Sindhuli Road Construction Project and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Nepal a study team headed by Mr. Hiroki Shinkai, Nippon Koei Co., Ltd. Tokyo, two times between January 1993 and June 1993.

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

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

I wish to express my sincere appreciation to the officials concerned of His Majesty's Government of Nepal for their close cooperation extended to the team.

July 1993

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

July 1993

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. K. Yanagiya:

Letter of Transmittal

It is my great pleasure to submit herewith the Final Report on Aftercare Study for Sindhuli Road Construction Project in Nepal. The report contains all the study results as well as the study conclusions and recommendations for the Project. These study results were fully discussed with the Nepalese counterparts so as to select an optimum development scheme of the Project and to formulate the realistic and practical implementation program.

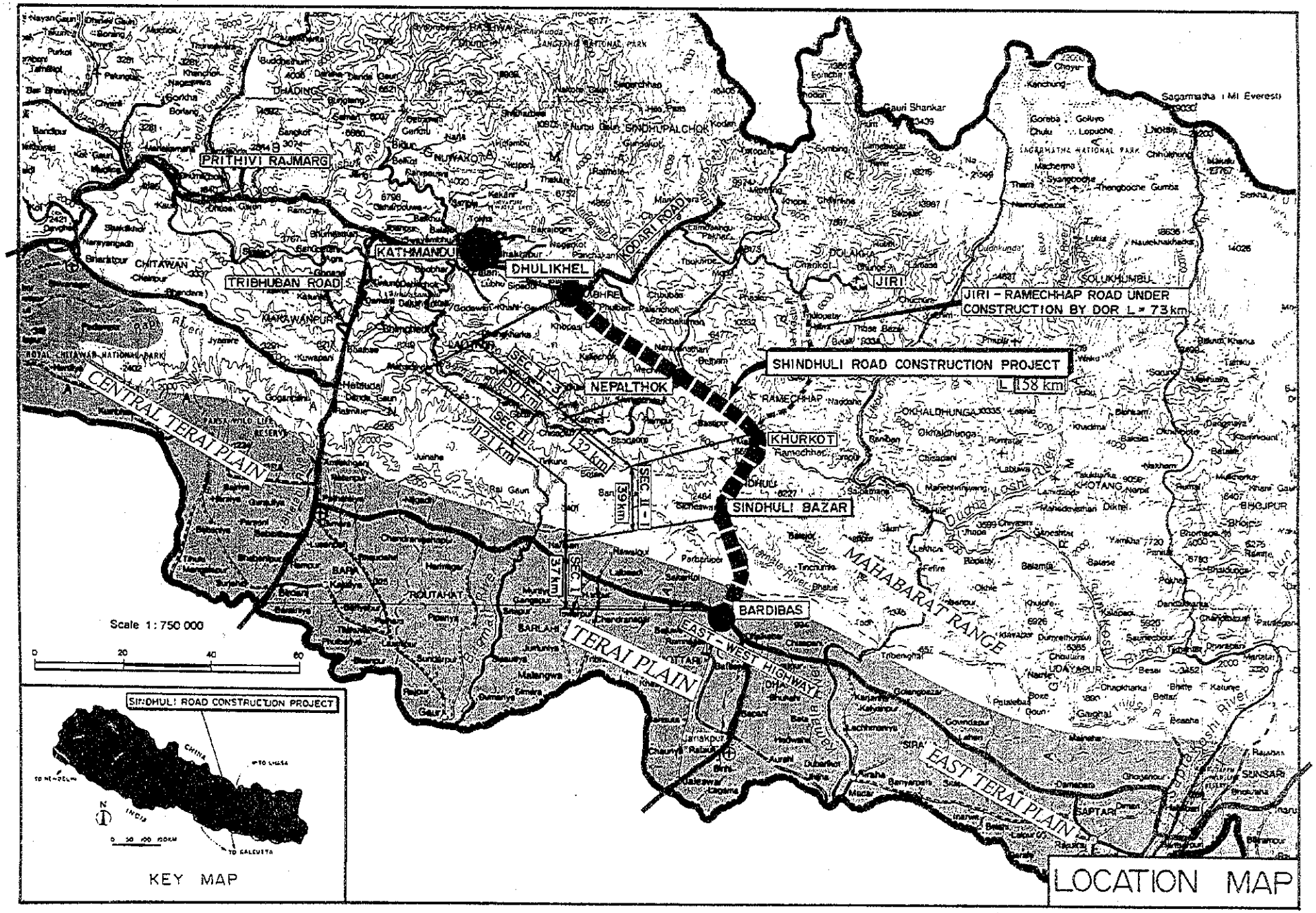
In view of the necessity of Sindhuli Road which will directly connect Dhulikhel on the Kodari Road Bardibas on the East West Highway, I earnestly wish His Majesty's Government of Nepal materializes the project within the earliest possible time in accordance with the Government's Eighth Plan covering 1992- 1997.

On behalf of the Study Team, I would like to express my deepest appreciation to Department of Roads in His Majesty's Government of Nepal and various agencies concerned with the Study for their close cooperation and assistance and also for the warm hospitality which they extended to the Study Team during their stay in Nepal.

I am also deeply indebted to Japan International Cooperation Agency, the Ministry of Foreign Affairs, the Embassy of Japan in Nepal, JICA Kathmandu Office, and respective members of the Advisory Committee for giving us valuable suggestions and assistance during the field survey and preparation of the reports.

Very truly yours

Hiroki Shinkai
Team Leader for Aftercare Study on
Sindhuli Road Construction Project


SHINDHULI ROAD CONSTRUCTION PROJECT
L = 58 km
JIRI – RAMECHHAP ROAD UNDER CONSTRUCTION BY DOR L = 73 km
KATHMANDU
DHULIKHEL
JIRI
SOLUKHUMBU
NEPALTHOK
KHURKOT
SINDHULI BAZAR
BARDIBAS
PRITHIVI RAJMARG
TRIBHUBAN ROAD
KODARI ROAD
SEC. I - 30 km
SEC. II - 32 km
SEC. II - 39 km
SEC. I - 37 km
121 km
CENTRAL TERAI PLAIN
TERAI PLAIN
EAST - WEST HIGHWAY
MAHABARAT RANGE
EAST TERAI PLAIN
ROYAL CHITAWAN NATIONAL PARK
PARSA WILD LIFE RESERVE
LANGTANG NATIONAL PARK
SAGARMATHA NATIONAL PARK
Scale 1 : 750 000
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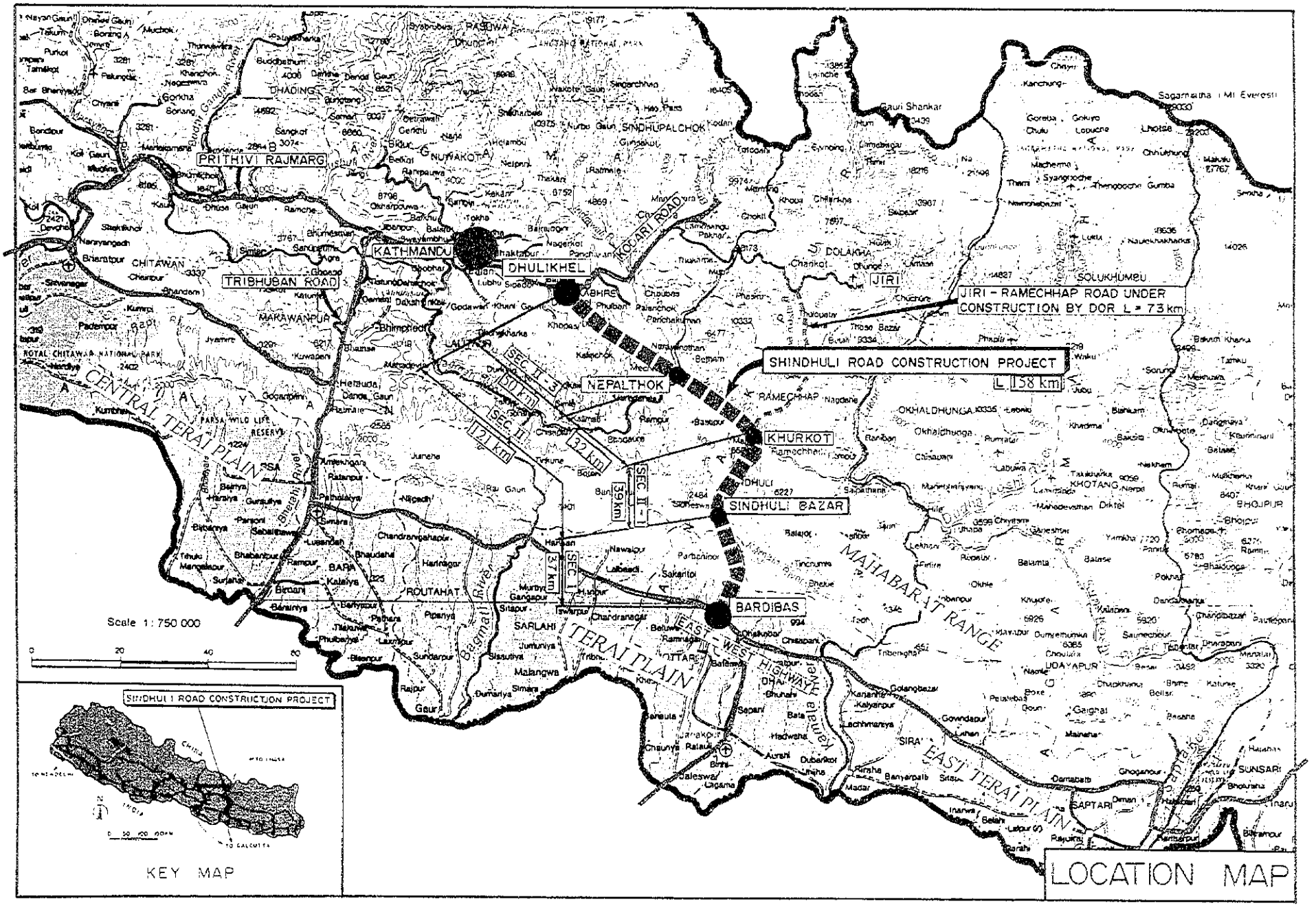
SINDHULI ROAD CONSTRUCTION PROJECT
CHINA
INDIA
TO LHASA
TO KATHMANDU
TO CALCUTTA
KEY MAP
LOCATION MAP


KATHMANDU
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SHINDHULI ROAD CONSTRUCTION PROJECT
L 158 km
SEC I
SEC II
SEC II-1
SEC II-2
50 km
112 km
32 km
39 km
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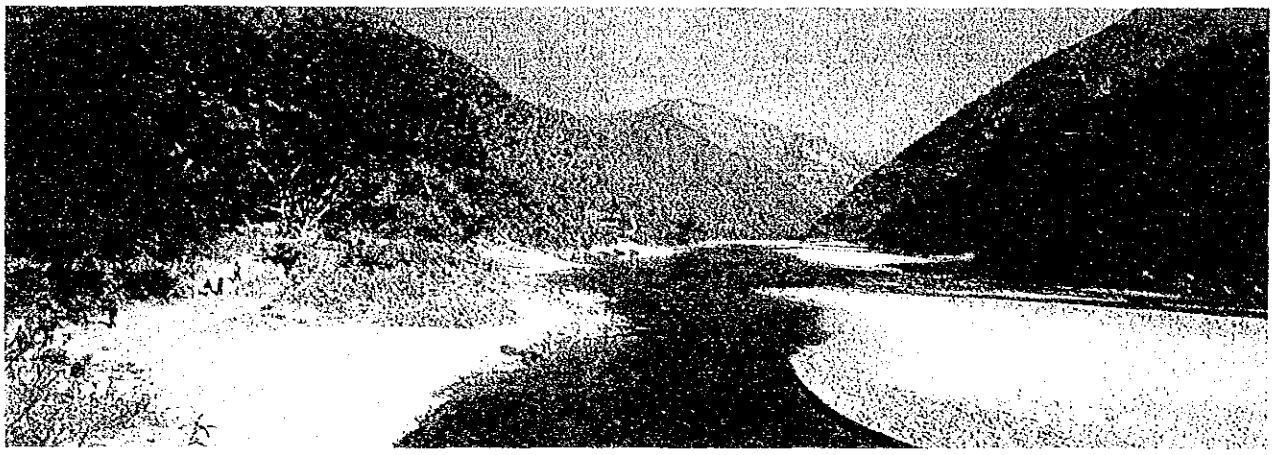
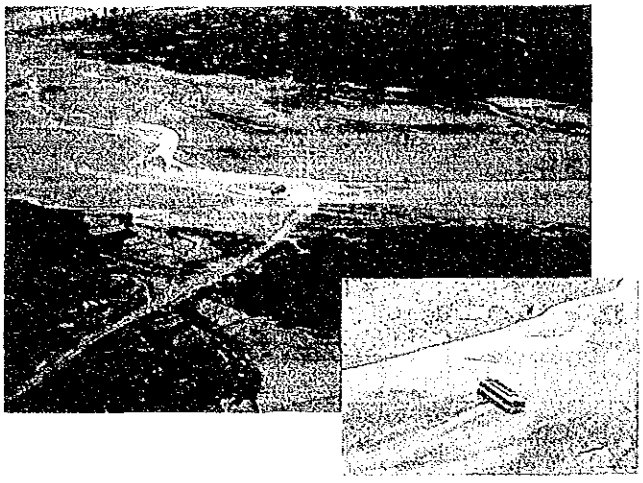


The starting point of Section II-2, commands the view of upper reach of the Sun Kosi river.
The route is proposed on the foot of hill on the left.

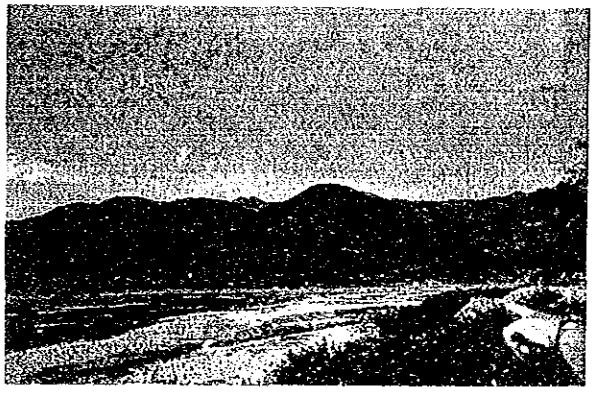
Proposed passing point of Section II-2, near the quiet mountain-village of Jhanga Jhuli.
The route is proposed on the hill side above the village on the left.

View of the town of Dhulikhel, proposed end point of Section II-3, with the Himalay Mountains for the background. The route is proposed to pass on the hill on the left side of the town and to merge Kodali Road at the point in the left bottom corner of the picture.



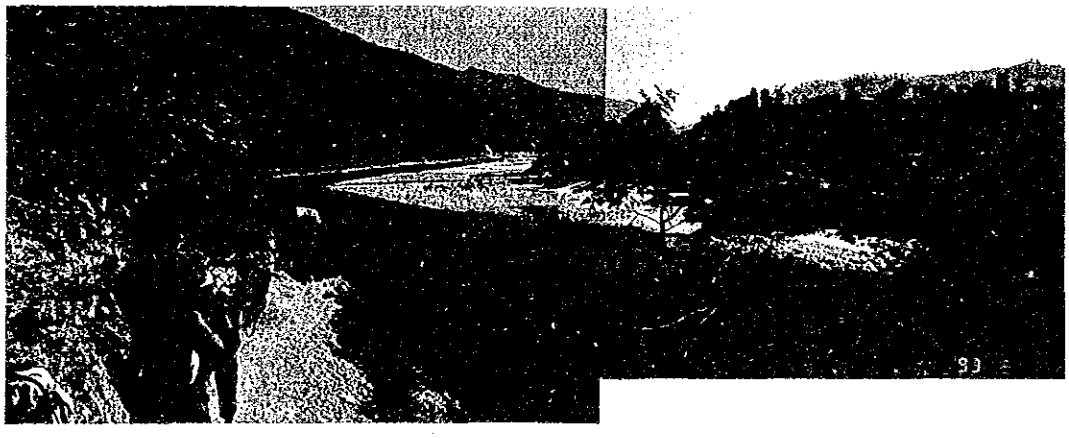
A stalled long-distant bus in the Ratu Khola during the rainy season, near the proposed crossing point of the rive.

Existing road of part of Section II



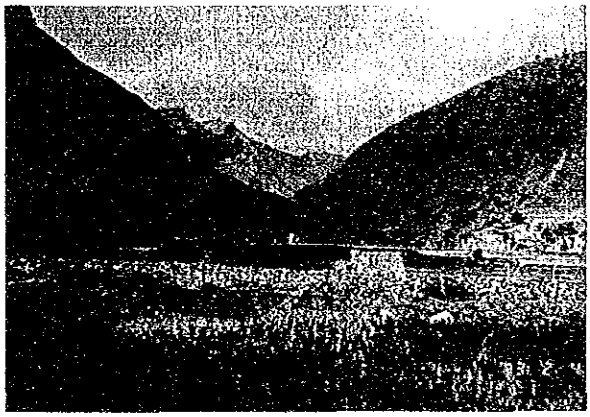
The end point of Section I, command the view of the Mahabarat Mountains from Sindhuli Bazar.

The proposed route of Section II-1 passing down to the town of Khurkot after the Mahabarat Mountains.



The end point of Section II-1 in the town of Kulukot. On the left is the Sun Kosi river. In the left bottom corner of the picture, porters carrying staffs on their backs to the town of Ramechhap from Sindhuli Bazar.

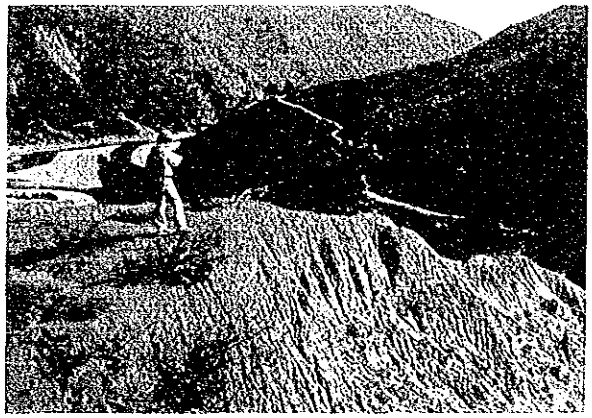
The Sun Kosi river during the rainy season. High water level is recognized compared with the picture of the same river on the right.



The junction point of Section II-2 and Section II-3 near Nepalthok. The proposed route heads for the river valley of the Roshi Khola after the Sun Kosi river.

Section II-3 passes the confluence of the Roshi Khola and the Dapcha Khola, tributary of the Roshi. The route is proposed below the mountain path seen in the picture.

Probable point of Causeway
Interview survey to villagers was carried out about the probable location of causeway.



The middle way of Section II, proposed to pass above the mountain pass on the middle part of the hill on the right.

The middle way of the Section II-3 near the Roshi Khola. The proposed route passes on the foot of the hill on the right.

The study team during the site inspection of the project road.

PRINCIPAL EXECUTIVE SUMMARY

PART- A INTRODUCTION

In response to the request from His Majesty's Government of Nepal (HMG), the Government of Japan (GOJ) decided to conduct the Aftercare Study for Sindhuli Road Construction Project (the Study). Accordingly, the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of technical cooperation programs of GOJ, organized an Advisory Committee to provide advice and guidelines, and a Study Team to carry out the Study. The Study Team was dispatched to Nepal in the middle of January 1993 and the Study officially commenced with the submission of the Inception Report. By the end of May 1993, the Study was substantially completed with submission of the Draft Final Report.

The objectives of the Study is to establish practical and realistic development schemes and to formulate an implementation program for the optimum development scheme based on a review of the previous feasibility study report carried out by JICA in 1988. For this purpose, the study includes a comparative study of two basic alternatives (single lane and double lane) in conjunction with several other alternatives in terms of pavement and bridges to select the optimum development scheme. The Study covers the following sections:

Section-I: Preliminary design of bridges between Bardibas and Sindhuli Bazar

Section-II: Feasibility Study of the renewed road project between Sindhuli Bazar and Dhulikhel.

The conclusions and recommendations presented were formulated not only after thorough evaluation of all the study results such as traffic forecast, field reconnaissance, environmental impact assessment, formulation of the development scheme alternatives, preliminary design, construction planning and formulating the Department of Roads (DOR), maintenance formation, project cost estimate, project evaluation, and establishment of the implementation program, but also assessment of the need to materialize the project within the earliest possible time.

PART- B CONCLUSIONS

B-1 Necessity of Sindhuli Road Construction

The insufficient and deficient items of the present road network in Nepal, especially for the roads connecting the Kathmandu Valley and Terai Plain where the main agricultural belt of Nepal is located, are as follows:

- Sole trunk road available is not stable or reliable during the rainy season because of frequent landslides and slope failures,

- The road network linking the Kathmandu Valley to Eastern Terai is very indirect for instance, the distance from Janakpur to Kathmandu is about 390 km by road, however, the actual straight-line distance is only 130 km,

- The development of roads linking north and south in the Central Development Region has lagged because of difficulty in crossing the ranges which stretch in east - west direction and are in steep topography and fragile geology.

Rapid agricultural development as well as enhancement of the economic activities in these areas have led to the urgent necessity of a direct connection between Eastern Terai and the Kathmandu Valley, and a reliable trunk road has been envisaged from security, economic growth and expansion viewpoints in the capital city of Kathmandu.

Taking into account the above-mentioned necessity to directly connecting Kathmandu with Eastern Terai, HMG formulated the "Sindhuli Road Construction Project" linking Bardibas on East West Highway and Dhulikhel on Kodari Road, and has given high priority to the Project as stressed in "Eighth Plan " (1992-1997) issued by National Planning Commission.

B-2 The Desirable Development Scheme

In formulation of the development scheme alternatives taking into account the roles of Sindhuli Road and the basic concepts applied, five alternatives were established as listed below:

Alternative-1;	Stage wise construction of minimal development scheme
Alternative-2;	Stage wise construction of minimal development scheme considering bridge widening
Alternative-3;	Stage wise construction of medium development scheme with bituminous pavement
Alternative-4;	Stage wise construction of medium development scheme with bituminous pavement and bridge widening
Alternative-5;	Full scale construction

Alternatives		Nos of Lanes	Pavement	River Crossing Structures		Slope Protection
				Bridges	Causeway/1	
ALT-1	1st Stage	1 lane	Gravel	4 m /4 m /2	Applied	Minimum
	2nd Stage	2 lane	As Macadam	Adding	Replacement	Full Const
ALT-2	1st Stage	1 lane	Gravel	4.75/6.5m/3	Applied	Minimum
	2nd Stage	2 lane	As Macadam	Widening	Replacement	Full Const
ALT-3	1st Stage	1 lane	As Macadam	4 m/4 m/2	Applied	Minimum
	2nd Stage	2 lane	Widening	Adding	Replacement	Full Const
ALT-4	1st Stage	1 lane	As Macadam	4.75/6.5m/3	Applied	Minimum
	2nd Stage	2 lane	Widening	Widening	Replacement	Full Const
ALT-5	Full	2 lane	As Macadam	2 Lane Br.	2 Lane Br.	Full Const

Notes; 1) Alt-1 through Alt-4 are in stage construction.
2) Alt-5 is a full scale construction plan.
/1; Most of the causeways installed in the first stage are replaced by 2 lane bridges in the 2nd stage.
/2; A single lane bridge with 4 m wide superstructure and substructure.
/3; A single lane bridge with 4.75 m wide superstructure and full width for substructure.

Through the preliminary design, construction planing and schedule, cost estimate, and project evaluation carried out for the above respective alternatives, the results are summarized below:

Alternatives		Const. Period	Construction Cost		Economic IRR	Final Selection
			Mil.NRs	(Mil. yen)		
Alt-1	1st	5 years	3,562	(8,940)	4.19	Selected
	2nd	4 years	5,128	(12,870)	8.08	
Alt-2	1st	5 years	3,791	(9,520)	4,32	Discarded
	2nd	4 years	4,888	(12,270)	8.24	
Alt-3	1st	5 years	4,181	(10,490)	6.74	Discarded
	2nd	4 years	4,633	(11,630)	8.51	
Alt-4	1st	5 years	4,410	(11,070)	7.05	Discarded
	2nd	4 years	4,449	(11,170)	8.78	
Alt-5	Full	7 years	7,566	(18,990)	8.45	Discarded

Full construction, Alternative-5 is considered inferior to stage wise construction, Alternative-1 through Alternative-4 as indicated by the IRRs. Among the stage wise construction alternatives, Alternative-1 was selected as a desirable development scheme, in spite of low IRR, taking into account the low cost principle and comparative extent of indirect benefits derived from the respective alternatives.

B-3 The Project Implementation

On the basis of the development scheme of Alternative-1 selected above, the implementation program was prepared taking into consideration the following assumptions and conditions:

(1) The 2nd stage construction shall be completed by the year 2010 to cope with the traffic demand.

(2) Preparatory works including engineering services and land/house acquisition and forest clearance arrangements shall be done before commencing the construction works.

(3) The Project is assumed to be implemented with the financial assistance of foreign aid.

(4) Participation of DOR on a force account basis in the construction aiming at self-reliance as well as the technology transfer through the Project.

(5) Strengthening of DOR's maintenance formation including construction of maintenance offices and supply of materials and equipment shall be included in the part of Sindhuli Road Construction Project.

Three (3) alternative implementation cases were prepared to achieve the following objectives:

Case A: Earliest Opening (1999) of the Project
Case B: Sufficient time given for land acquisition
Case C: Maximum participation of DOR

The evaluation was made from the practical viewpoints paying due attention to the availability of financial sources, land/house acquisition procedures, as well as limited local funds. The evaluation results are as follows:

Case A This alternative has the shortest construction period (5.5 years in total), however, the period of land/house acquisition to be conducted before the construction is very short, and annual funds required for the construction is the largest among the three alternatives.

Case B Construction period of Case B is 7 years, however, a sufficient time is given for land/house acquisition as well as forest clearance arrangement before commencing the construction.

Case C Total construction cost is the cheapest among the three (3) alternatives, however, local funds to be arranged by HMG for the construction of Section II-3 is NRs. 70 million per annum, which may impose a heavy burden on the local budget since it would be 15% of the local budget allocated for road construction by Nepalese Government. In addition, the overall construction period of 10 years is not practical from the viewpoint of needs and urgency of the Project.

Among the three (3) alternatives stated above, Case B is recommended for the implementation of Sindhuli Road Construction Project from the viewpoint of practical implementation in terms of limited foreign aid and local budget as well as land/house acquisition procedure.

The total project cost is presented below:

		NRs.M	(¥ M)
A. Funds to be covered by foreign aid			
A-1	Construction cost	3,500	(8,790)
A-2	Materials/equipment supply for construction of Sec.-I	48	(120)
A-3	Maintenance office cost	78	(200)
A-4	Maintenance materials/equipment for maintenance office	231	(580)
A-5	Engineering services	352	(880)
A-6	Contingency (10% of Const. cost)	350	(880)
	Total	4,559	(11,440)
B. Funds to be covered by local budget			
B-1	Construction by DOR	24	-
B-2	Land/house acquisition	279	-
B-3	Forest clearance arrangement	20	-
	Total	323	-

(Exchange rate: US$ 1.0= NRs. 45.88=¥ 115 or NRs. 1.0=¥2.51)
(March 1993)

PART- C RECOMMENDATIONS

C-1 Strengthening DOR's Formation For Maintaining Sindhuli Road

The optimum development scheme in the first stage was formulated on condition that the road and bridge maintenance team be adequate to secure the construction investment and provide road serviceable at all times. It is therefore absolutely necessary to carry out inspection and maintenance of the Sindhuli Road on a DOR's force account basis, not only after substantial completion of certain sections and structures, but also after handing over all sections from Bardibas to Dhulikhel.

However, there are no DOR district offices at present in Sindhuli and Kabhre Districts where nearly 90 % in length of the Sindhuli Road passes through. To make matters worse, the maintenance budget in DOR is very limited and the amounts of equipment for road maintenance is insufficient.

In view of the above situation, it is strongly recommended that DOR's maintenance formation for the Sindhuli Road be established with financial assistance from a funding agency.

C-2 Desirable Pavement Type And Bridge Scheme For The Project

(1) Desirable Pavement Type

Two alternative pavements consisting of gravel surface and penetration macadam were considered, and the gravel surface was selected form the economical viewpoint.

In this regard, it is recommended, if additional budget available, that penetration macadam pavement be adopted taking into account riding comfort, less maintenance, and environmental aspects. This selection, with a small additional budget, (17% of the construction cost of Alternative-1) results in more than a 60 % increase in IRR from 4.19% to 7.05%.

(2) Bridge Scheme

Out of the two bridge alternatives comprising a single-lane bridge with 4.0 m minimal width (Scheme-A), and a full substructure with a partial superstructure having 4.75 m width (Scheme -B), Scheme-A was the best optimum from economical viewpoint.

However, it could be difficult to construct the 2nd stage bridges in Scheme-A because of relatively high construction cost and technical difficulties. The bridges in Scheme-B can be easily widened in to double-lane bridges by only installation of an additional girder on one side or cantilever brackets on both sides with relatively small budget compared with the widening cost for Scheme-A. Moreover, Scheme-A is not cost effective as temporary works such as installation of coffer dams and river access, preparation and cleaning of erection yards would have to be done twice, which is disadvantageous from the total cost viewpoint.

Therefore, it is recommended that the Scheme-B bridge option be adopted, if additional budget is available.

EXECUTIVE SUMMARY

VOLUME-I

PREFACE
LETTER OF TRANSMITTAL
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PHOTOS
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CHAPTER I
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CHAPTER I

INTRODUCTION

I-1 Background of the Study

In response to the request from His Majesty's Government of Nepal (HMG), the Government of Japan (GOJ) decided to conduct the feasibility study on the Sindhuli Road Construction Project (the Project) in 1986. The feasibility study was carried out by the Japan International Cooperation Agency (JICA) during the period from November 1986 to March 1988 and the Final Report was submitted to HMG in June 1988. The conclusions and recommendations mentioned in the Final Report are summarized as follows:

- Project Feasibility
  The Project a two-lane paved road of total length of 155 km was technically and economically feasible with the highest internal rate of return of 9.88%.
- Project Cost
  The total Project cost was estimated to be NRs. 3,884 million which is equivalent to US$ 185 million or ¥ 24,040 million.
  Note: Exchange rate applied in the cost estimate was
  US$ 1.0=¥130.0=NRs.21.0, as of Jan. 1988
- Implementation Schedule
  Construction period of 8 years was recommended for the implementation of the Project.

Since the construction cost derived from the feasibility study was considerably large, all the efforts taken by HMG to look for possible funding sources have not been successful to date, while demand for the Project has increased. As a result of this situation, HMG has still given high priority to the "Sindhuli Road Construction Project" as stressed in the "Eighth Plan" (1992-1997) published by the National Planning Commission, Nepal, July 1992.

Recognizing the importance and necessity of the Project, even if the minimal development scheme is applied, HMG again requested GOJ to provide technical assistance for formulating a practical and realistic development scheme and implementation program. In response to the request of HMG, GOJ decided to conduct the "Aftercare Study for Sindhuli Road Construction Project" (the Study) in accordance with the relevant laws and regulations in force in Japan, and entrusted it to JICA, the official agency responsible for implementation of the technical cooperation programs of GOJ.

Accordingly, JICA dispatched a preparatory study team headed by Dr. Yasuyuki KOGA to Nepal from 13 to 22 September 1992 for the purpose of formulating the Scope of Work for the Study. The Scope of Work was signed between the Department of Roads

(DOR) representing HMG and JICA on 22 September 1992. Points of agreement reached during the discussions held prior to the signing were officially recorded in the Minutes of Meeting also signed on 22 September 1992.

Subsequently, JICA organized an Advisory Committee consisting of three members chaired by Dr. Yasuyuki KOGA and a Study Team comprising nine members headed by Mr. Hiroki SHINKAI of Nippon Koei Co., Ltd. in December 1992.

I-2 Objectives of the Study

The objectives of the Study are to establish practical and realistic development schemes and to formulate an implementation program for the optimum development scheme based on a review of the previous feasibility study report carried out by JICA in 1988. For this purpose, the study includes a comparative study of two basic alternatives (single lane and double lane) in conjunction with several other alternatives in terms of pavement and bridges to select the optimum development scheme. The Study covers the following sections:

Section-I :	Preliminary design of bridges between Bardibas and Sindhuli Bazar
Section-II :	Feasibility Study of the renewed road project between Sindhuli Bazar and Dhulikhel.

I-3 Scope of the Study

The Study is broadly divided into two phases. Each phase is further subdivided into two: (A) involving work in Nepal and (B) involving work in Japan as follows:

(1) Phase I (A) : From the middle of January to the middle of March 1993, involving field reconnaissance, formulation of development scheme, and establishment of design criteria.

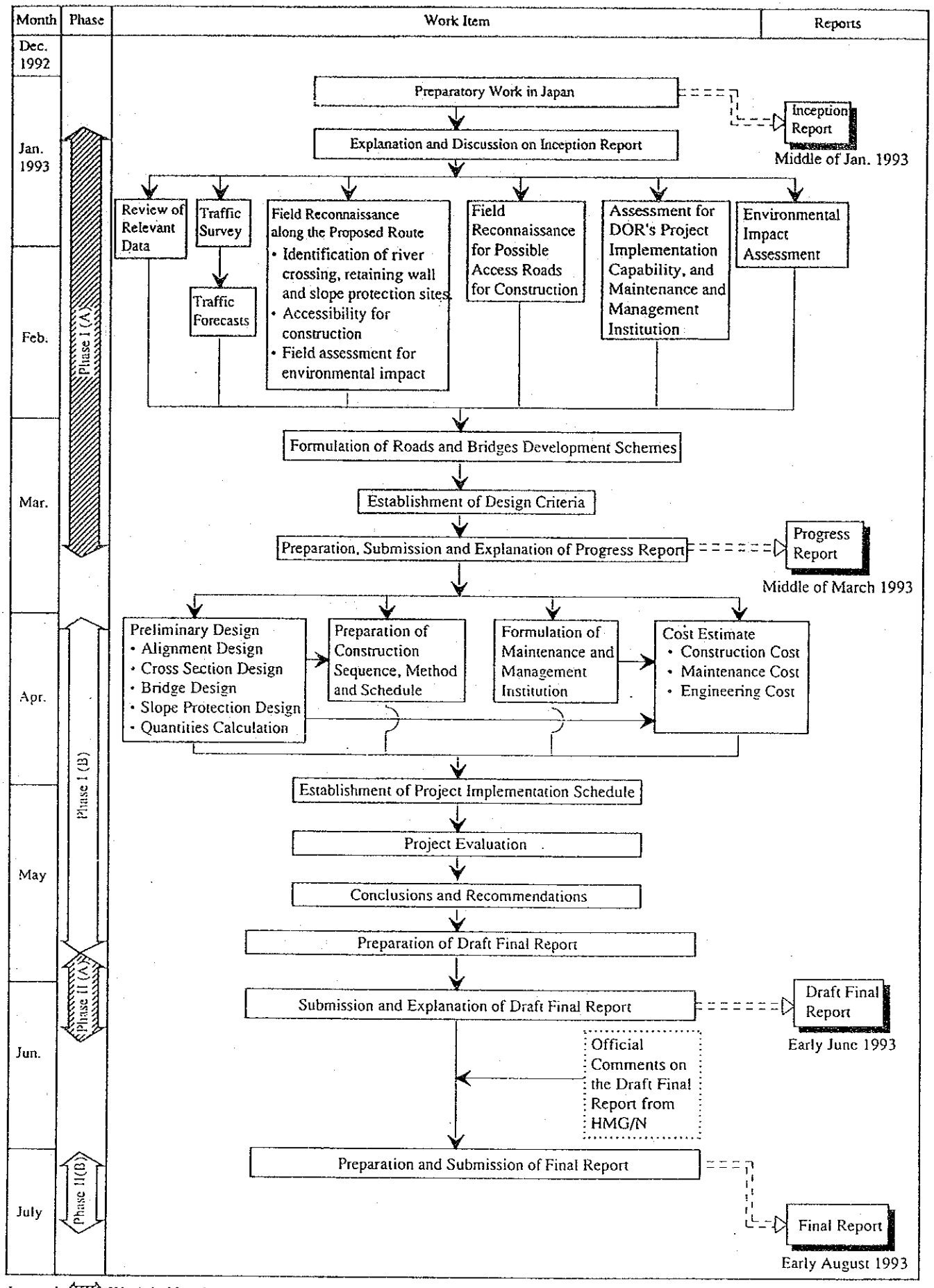
(2) Phase I (B) : From the end of March to the end of May 1993, including preliminary design, cost estimate, and project evaluation.

(3) Phase II (A): From the beginning of June to the middle of June, including submission of Draft Final Report.

(4) Phase II (B) : From early July to the middle of July 1993, including preparation and submission of Final Report.

The work flow diagram of the Study showing the interrelation of the above major study items is depicted in Figure I-1.

Figure I-1 Overall Work Flow of the Study



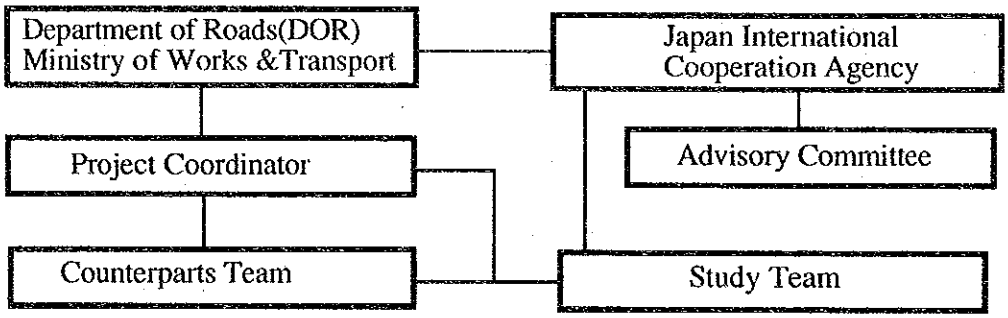
Legend: Work in Nepal
Work in Japan

I-4 The Study Organization

To facilitate and ensure the smooth conduct of the Study, JICA organized an Advisory Committee consisting of three members to provide advice and guidelines, and a Study Team composed of nine specialists to carry out the Study in close collaboration with a Counterpart Team from DOR. On the other hand, HMG appointed DOR as the counterpart agency and also as the coordination body between agencies concerned. A Counterpart Team comprising two engineers from DOR was formed in accordance with the agreement stated in the Minutes of Meeting signed on 22 September 1992.

The interrelationship between the above mentioned Agency, Committee, and Teams are shown in Figure I-2.

Figure I-2 Study Organization



I-5 Composition of the Report

The Final Report consists of three volumes as listed below:

Volume I	Executive Summary
Volume II	Main Text
Volume III	Drawings

CHAPTER II
CONCLUSIONS AND RECOMMENDATIONS

CHAPTER II

CONCLUSIONS AND RECOMMENDATIONS

II-1 Conclusions

(1) Necessity of Sindhuli Road Construction

In the present road network in Nepal, especially for the roads connecting the Kathmandu Valley and Terai Plain where the main agricultural belt of Nepal is located, the followings are the insufficient and deficient points;

- The sole trunk road available is not stable or reliable during the rainy season because of frequent landslides and slope failures,

- Roundabout transport distance linking the Kathmandu Valley to Eastern Terai, for instance, the distance from Janakpur to Kathmandu is about 390 km by road, however, the actual straight-line distance is only 130 km,

- Lagged road development linking north and south in the Central Development Region because of difficulty in crossing the ranges which stretch in east - west direction and are in steep topography and fragile geology.

Rapid agricultural development as well as enhancement of the economic activities in these areas have led to the urgent necessity of a direct connection between Eastern Terai and the Kathmandu Valley, and a reliable trunk road has also been envisaged from security, economic growth, and expansion viewpoints in the capital city of Kathmandu.

Taking into account the above-mentioned necessity for a new road directly connecting Kathmandu with Eastern Terai, HMG formulated the "Sindhuli Road Construction Project" linking Bardibas on the East West Highway and Dhulikhel on the Kodari Road , and has given high priority to the Project as stressed in the "Eighth Plan " (1992-1997) issued by National Planning Commission.

(2) The Desirable Development Scheme

During formulation of the development scheme alternatives, taking into account the roles of the Sindhuli Road and the basic concepts applied, five alternatives were established as listed below:

Alternative-1 Stage wise construction of minimal development scheme
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Alternative-5 Full scale construction

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ALT-4	1st Stage	1 lane	As Macadam	4.75/6.5m/3	Applied	Minimum
	2nd Stage	2 lane	widening	Widening	Replacement	Full Const
ALT-5	Full	2 lane	As Macadam	2 Lane Br.	2 Lane Br.	Full Const

Notes; 1) Alt-1 through Alt-4 are in stage construction.
2) Alt-5 is a full scale construction plan.
/1: Most of the causeways installed in the first stage are replaced by 2 lane bridges in the 2nd stage.
/2: A single lane bridge with 4 m wide superstructure and substructure.
/3: A single lane bridge with 4.75 m wide superstructure and full width for substructure.

The construction planing and schedule, cost estimate, and project evaluation carried out for the above respective alternatives are summarized below:

Alternatives		Const. Period	Construction Cost		Economic IRR	Final Selection
			Mil.NRs	(Mil. yen)		
Alt-1	1st	5 years	3,562	(8,940)	4.19	Selected
	2nd	4 years	5,128	(12,870)	8.08	
Alt-2	1st	5 years	3,791	(9,520)	4,32	Discarded
	2nd	4 years	4,888	(12,270)	8.24	
Alt-3	1st	5 years	4,181	(10,490)	6.74	Discarded
	2nd	4 years	4,633	(11,630)	8.51	
Alt-4	1st	5 years	4,410	(11,070)	7.05	Discarded
	2nd	4 years	4,449	(11,170)	8.78	
Alt-5	Full	7 years	7,566	(18,990)	8.45	Discarded

Full construction, Alternative-5 is considered inferior to stage-wise construction Alternative-1 through Alternative-4 as indicated by the IRRs of the 2nd stage. Among the stage wise construction alternatives, Alternative-1 was selected, in spite of a low IRR, as the desirable development scheme taking into account the lowest cost principle and the identical extent of indirect benefits derived from each alternative.

(3) The Project Implementation

On the basis of the development scheme of Alternative-1 selected above, the implementation program was prepared taking into consideration the following assumptions and conditions:

(1) The 2nd stage construction shall be completed by the year 2010 to cope with the traffic demand.
(2) Preparatory works including engineering services and land/house acquisition and forest clearance arrangements shall be done before commencing the construction works.
(3) It is assumed that the Project shall be implemented with the financial assistance of foreign aid.
(4) It is assumed that DOR will partly participate in the construction works for the purpose of self-reliance as well as technology transfer through the Project.
(5) DOR's maintenance formation, including construction of maintenance offices and supply of materials and equipment shall be strengthened during Sindhuli Road Construction Project.

Three (3) alternative implementation cases were prepared to achieve the following objectives:

Case A: Earliest Opening (1999) of the Project
Case B: Sufficient time given for land acquisition
Case C: Maximum participation of DOR

Evaluation was made from practical viewpoints paying due attention to the availability of financial sources, land/house acquisition procedures as well as the limited local funds. The evaluation results are as follows:

Case A This alternative has the shortest construction period (5.5 years in total), however, the period for land/house acquisition to be conducted before construction is very short, and annual funds required for construction is the largest among the three alternatives.

Case B Construction period of Case B is 7 years, however, a sufficient time is given for land/house acquisition as well as forest clearance arrangement before commencing the construction.

Case C Total construction cost is the cheapest among the three (3) alternatives, however, local funds to be arranged by HMG for the construction of Section II-3 is NRs. 70 million per annum, which may impose a heavy burden on the local budget since it would be 15% of the local budget allocated for road construction by HMG. In addition, the overall construction period of 10 years is not practical from the viewpoint of needs and urgency of the Project.

Among the three(3) alternatives stated above, Case B is recommended from the viewpoint of practical implementation in terms of limited funds of foreign aid, local budget, and land/house acquisition procedure.

The overall implementation program for Case B, including disbursement schedule, is presented in Figure II-1.

The total project cost is presented below:

		NRs.M	(¥ M)
A. Funds to be covered by foreign aid			
A-1	Construction cost	3,500	(8,790)
A-2	Materials/equipment supply for construction of Sec. I	48	(120)
A-3	Maintenance office cost	78	(200)
A-4	Maintenance materials/equipment for maintenance office	231	(580)
A-5	Engineering services	352	(880)
A-6	Contingency (10% of Const. cost)	350	(880)
	Total	4,559	(11,440)
B. Funds to be covered by local budget			
B-1	Construction by DOR	24	-
B-2	Land/house acquisition	279	-
B-3	Forest clearance arrangement	20	-
	Total	323	-

(Exchange rate: US$ 1.0= NRs. 45.88=¥ 115 or NRs. 1.0=¥2.51)

Figure II-1 Overall Implementation Program

Description	Construction Section	Construction Unit	Works to be done	F or L	Constr. Period	1993 4	3	1994 1	1995 2	1996 3	1997 4	1998 5	1999 6	2000 7	Total
Engineering Services															
(i) Basic Design	Sec.1 & Sec.2	Consultant	All works		2 M	xx									
(ii) Detailed Design	Sec.1	Consultant	All works		4 M		xxx								
	Sec.2	Consultant	All works		1 Y		xxx	xxxxx							
(iii) Supervision	Sec.1	Consultant	All works		2 Y			xxxxxxxxx	xxxxxxxxx						
	Sec.2	Consultant	All works		5 Y					xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	
Land/House Acquisition	Sec.1	DOR	Not required		0										
	Sec.2	DOR	Required		2 Y			xxxxxxxxx	xxxxxxxxx						
Forest Clearance	Sec.1	DOR	Not required		0										
	Sec.2	DOR	Required		1 Y				xxxxxxxxx						
Construction Works	Sec. 1	Contractor	Bridge only		2 Y			xxxxxxxxx	xxxxxxxxx						
		DOR	Earthwork and Causeway		2 Y			xxxxxxxxx	xxxxxxxxx						
		Suppiler	Materials/Equipment Supply					V							
	Sec. 2-1	Contractor	All works		5 Y					xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	
	Sec. 2-2	Contractor	All works		4 Y						xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	
	Sec. 2-3	Contractor	All works		5 Y					xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	
Strengthening of Maintenance	Sec. 1	Supplier	Materials/Equipment Supply						V						
Office	Sec. 2	Contractor	Construction of office		1 Y						xxxxxxxxx			xxxxxxxxx	
		Suppiler	Materials/Equipment Supply								V1			V2	

Construction Cost and Disburesement Schedule

A. Funds to be covered by foreign aid												
A.1 Construction works by an international contractor	F			155	154	491	676	675	675	674	3,500	
A.2 Construction equipment and materials supply	F			48							48	
A.3 Maintenance office construction by an international contractor	F					54		24			78	
A.4 Maintenance equipment and materilas supply	F				63	106		62			231	
A.5 Engineering services including detailed design and supervision	F		141	10	10	29	40	40	40	40	350	
A.6 Physical contingency (10% of the construction cost)	F			16	15	49	68	68	68	67	350	
Total amount to be assisted with foreign aid	F		141	229	242	729	784	869	783	781	4,557	
Equiv. to yean million	F		350	570	610	1,830	1,970	2,180	1,960	1,960	11,430	
B. Funds to be covered by local source												
B.1 Construction works by DOR on force account basis	L			12	12						24	
B.2 Land/house acquisition cost	L			191	88						279	
B.3 Forest clearance arrangement cost	L			10	10						20	
Toatl amount to be arranged by DOR	L		0	213	110	0	0	0	0	0	323	

II-2 Recommendations

(1) Strengthening DOR's Formation For Maintaining the Sindhuli Road

The optimum development scheme selected was formulated on condition with provision of the road and bridge maintenance to secure the construction investment and provide road serviceable at all times. It is therefore absolutely necessary to carry out inspection and maintenance of the Sindhuli Road on a DOR's force account basis, not only after substantial completion of certain sections and structures, but also after handing over all sections from Bardibas to Dhulikhel.

However, there are no DOR district offices, at present, in Sindhuli and Kabhre Districts where nearly 90 % in length of the Sindhuli Road passes through. To make matters worse, the maintenance budget and number of experienced staff and amount of equipment for road maintenance are insufficient.

In view of the above situation, it is recommended that DOR's formation for maintaining the Sindhuli Road be established with financial assistance from a funding agency.

(2) Desirable Pavement Type And Bridge Scheme For The Project

(i) Desirable Pavement Type

Two alternative pavements consisting of gravel surface and penetration macadam were considered: gravel surface and penetration macadam. The gravel surface was selected from the economical viewpoint.

In this regard, it is recommended, if additional funds are available, that penetration macadam pavement be selected taking into account riding comfort, less maintenance, and environmental aspects. This alternative requires a small additional budget (17 % increase of construction cost) but results in a significant increase of IRR from 4.19% to 7.05%.

(ii) Bridge Scheme

Out of the two bridge alternatives, a single lane bridge with 4.0 m minimal width (Scheme-A) and a full substructure (6.5 m width) with a partial superstructure having a width of 4.75 m (Scheme-B), Scheme-A was selected as an optimum from the economical viewpoint.

However, it could be difficult to construct the 2nd stage bridges in Scheme-A because of relatively high construction cost and technical difficulties. On the other hand, in Scheme-B, the bridges can be easily widened in to a double lane bridge by only installation of an additional girder on one side or

cantilever brackets on both sides. The cost for Scheme-B is relatively small when compared with the widening cost for Scheme-A.

Furthermore, Scheme-A is not cost effective because temporary works would have to be implemented twice. This is disadvantageous from the total cost viewpoint.

Therefore, it is recommended that Scheme-B bridge option be adopted if additional budget is available.

CHAPTER III
ABSTRACT OF THE STUDY

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ABSTRACT OF THE STUDY

III-1 Traffic Survey and Traffic Demand Forecast

III-1-1 Traffic Survey

The objective of the Study is to obtain basic information to review the future traffic demand on the Project road by means of 24-hour roadside traffic counts at Banepa, Thankot, Hetauda, Dhalkebar, Bharatpur, Pathlaiya and Bardibas on 3 February 1993. These locations are the same as those in the previous survey. The results of the traffic counts are shown in Table III-1 and compared with those in 1986.

Table III-1 Comparison of Traffic Volume Between 1986 and 1993

(Unit:vpd)

Year	Point	Locations	Passenger Car	Bus	Truck*)	Motorcycle	Total
1986	1	Banepa	210	299	112	74	695
	2	Thankot	265	463	626	47	1,401
	3	Hetauda	99	185	505	47	836
	4	Dhalkebar	88	156	215	34	493
	5	Bharatpur	152	218	449	23	842
	6	Pathlaiya	64	153	388	34	639
	7	Bardibas	46	9	20	4	79
1993	1	Banepa	315	450	350	402	1,517
	2	Thankot	339	516	1,342	207	2,404
	3	Hetauda	192	395	1,129	136	1,852
	4	Dhalkebar	90	258	388	48	784
	5	Bharatpur	296	477	1,203	105	2,081
	6	Pathlaiya	113	256	585	53	1,007
	7	Bardibas	6	13	11	20	50
1993/1986 Ratio	1	Banepa	1.50	1.51	3.13	5.43	2.18
	2	Thankot	1.28	1.11	2.14	4.40	1.72
	3	Hetauda	1.94	2.14	2.24	2.89	2.22
	4	Dhalkebar	1.02	1.65	1.80	1.41	1.59
	5	Bharatpur	1.95	2.19	2.68	4.57	2.47
	6	Pathlaiya	1.77	1.67	1.51	1.56	1.58
	7	Bardibas	0.13	1.44	0.55	5.00	0.63

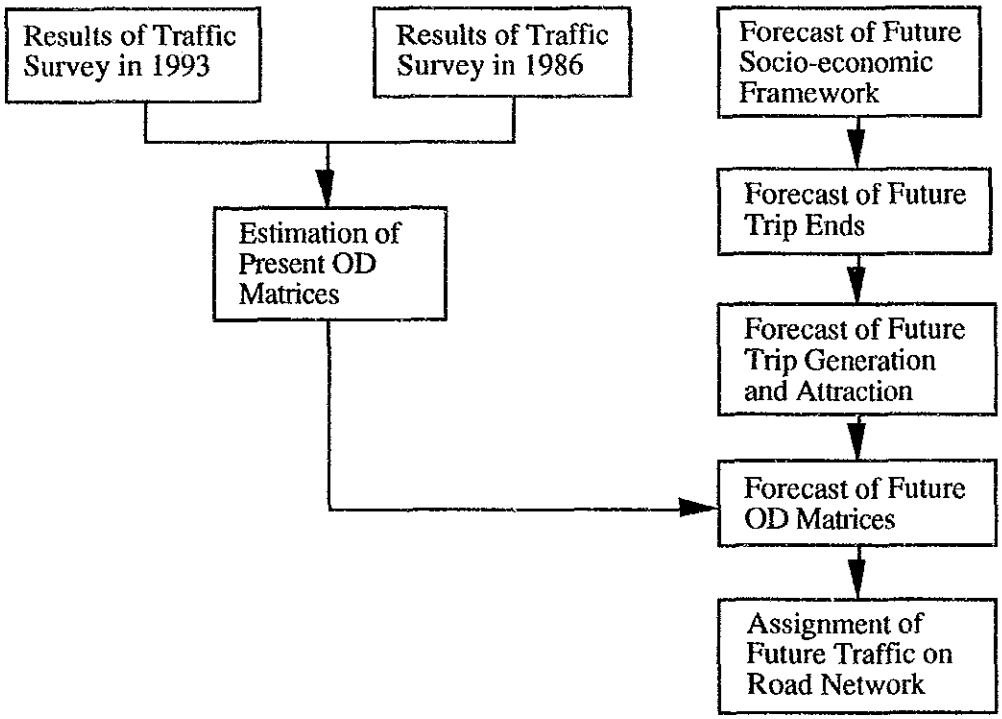
*); Include Others

Results of the survey indicated that daily traffic volumes at the survey points on the major highways are more than 1,000 vpd. Among these, the traffic volume at Thankot on Tribhuvan Highway was the largest recorded with 2,404 vpd. Comparing these results with those of 1986, it is evident that there has been a great traffic increase during the last six (6) years on the major roads. Traffic volumes on the major roads have increased at a rate of between 8% and 16% annually.

III-1-2 Traffic Demand Forecast

The methodology of the traffic demand forecast applied in this Study, which is almost the same as the one established in the 1986 study, is depicted in Figure III-1.

Figure III-1 Procedure for Traffic Forecast



Taking into account the arget year of the traffic demand forecast that is 1999 (the expected opening year of the Project Road) and 2010 (for evaluation of the long term plan), future traffic volumes on the Project Road were forecasted according to the methodology mentioned above. The forecasted volumes on the Project Road are 1,058 vpd in 1999 and 2,561 vpd in 2010. In term of pcu, the above traffic volumes are equivalent to 2,750 and 6,613 passenger cars respectively.

Traffic Demand on the Project Road

(Unit: vpd)

	Passenger Car	Bus	Truck	Motorcycle	Total	pcu
1999	186	368	478	26	1,058	2,750
2010	452	963	1,063	83	2,561	6,613

III-2 Field Reconnaissance and Findings

Field reconnaissance carried out in the Study was divided into two parts: (1) field reconnaissance along the proposed route for confirming adaptability of counterplans prepared in Japan, and (2) field reconnaissance for the purpose of confirming accessibility of all the conceivable access roads which could be used for the construction. These study results were reflected in formulating the alternative development schemes, preliminary design, and construction planning.

III-2-1 Findings of Field Reconnaissance (1)

The road survey was conducted along the proposed route to identify the sections where possible design changes could be made in order to reduce the construction cost. The sections identified through the survey are classified into the following five groups:

(1) Possible realignment sections due to alteration to causeways have a total length of 19,500 m as detailed in Table III-2.

Table III-2 Possible Realignment Sections Due to Alteration to Causeways

Description	Section				
	I	II-1	II-2	II-3	Total
Nos. of sections to be modified	9	1	10	5	25
Total Length(m)	4,000	2,800	8,200	4,500	19,500

Note : Total length is calculated along the original alignment and includes causeway length.

(2) Possible realignment sections due to alteration to culverts, 3,300 m in total, are detailed in Table III-3.

Table III-3 Possible Realignment Sections Due to Alteration to Culverts

Description	Section				
	I	II-1	II-2	II-3	Total
Nos. of sections to be modified	2	3	6	9	20
Total Length(m)	1,300	300	800	900	3,300

Note: Total length is calculated along the original alignment and includes culvert width

(3) Possible realignment sections resulting from reducing height of cut and fill, 5,440 m in total are detailed in Table III-4.

Table III-4 Possible Realignment Sections for Reducing Height of Cut and Fill

Description	Section				
	I	II-1	II-2	II-3	Total
No. of sections to be modified	0	4	6	4	20
Total Length(m)	0	1,889	2,250	1,310	5,440

(4) Possible sections where the minimum road width can be applied because construction will be extremely difficult due to very steep terrain and unstable geological conditions, 18,360 m in total are detailed in Table III-5.

Table III-5 Possible Sections where Min. Road Width could be Applied

Section II-1		Section II-2		Section II-3	
STA	length (m)	STA	length (m)	STA	length (m)
18.2-19.2	1,000	3.5-4.2	700	0.3-0.6	300
20.0-21.0	1,000	6.1-6.8	700	3.1-3.7	600
		22.0-22.5	500	5.7-6.0	300
		23.5-27.1	3,600	8.1-8.5	400
		28.7-29.66	960	12.7-13.3	600
				13.7-14.0	300
				15.7-16.1	400
Total	2,000		6,460		9,900

(5) Possible realignment sections due to land acquisition problems were estimated at 7,000 m in total as detailed in Table III-6.

Table III-6 Possible Re-alignment Sections due to Land Acquisition Problems

Section II-I		Section II-2		Section II-3	
STA	length (m)	STA	length (m)	STA	length (m)
	0		0	42.0-49.0	7,000
Total	0		0		7,000

As a result of the survey, the bridges proposed in the previous F/S were broadly classified into three categories and further subdivided into the five groups depending on the type of possible alteration. The total number of bridges that could be altered to low cost structures, short span bridges, etc. was 86 as detailed in Table III-7.

Table III-7 Summary of Possible Bridge Alteration

Type of Alteration	Number of Bridges and Length in (m)				
	Sec. I	Sec. II-I	Sec.II-2	Sec.II-3	Total
G1	7(190m)	3(185m)	11(695m)	7(676m)	28(1,820m)
G2	0	17(410m)	12(315m)	12(300m)	41(971m)
G3	2(315m)	2(130m)	0	2(100m)	6(389m)
G4	0	0	0	4(170m)	4(170m)
G5	5(365m)	1 (35m)	0	0	6 (400m)
Total	15(870m)	23(760m)	23(1.010m)	25(1,240m)	86(3,880m)

Notes: G1-Bridges to be altered to causeways or submersible bridges
G2-Bridges to be altered to slab or pipe culverts
G3-Bridges to be altered to the short span bridges
G4-Bridges to be altered to another type of bridge
G5-Bridges with no alteration

III-2-2 Findings of Field Reconnaissance (2)

The findings of the field reconnaissance (2) for the purpose of confirming accessibility of all the conceivable access roads are as follows:

Conceivable Access Route	Evaluation Results
1. Jiri (Busti) - Ramechap Road	Not Usable
2. Banepa-Shreekhandapur - Kabhrebhanjyang - Namobuddha - Dapcha Road	Not Usable
3. Banepa-Shreekhandapur - Kabhrebhanjyang Buchakot - Bhakundebesi Road	Usable but requires maintenance works and strengthening of two existing bridges
4. Sunkoshi River Bank Route from Dolalghat to Nepalthok	Not usable
5. Sunkoshi River Bank Route from Nepalthok to Khurkot	Partially usable only during the dry season, provided bulldozer work
6. Roshi Khola River Bank Route from the Junction with Dapcha Khola to Nepalthok	Usable only during the dry season, a few sections require temporary embankment work.

III-3 Environmental Impact Assessment (EIA)

EIA was in principle carried out in accordance with "National Environmental Impact Assessment Guideline" except where the Guideline was not clear then "Environmental Impact Assessment Guideline for Development of Infrastructures" issued by JICA in 1992 was also referred to the Study.

Referring to those Guidelines, the environmental field survey was carried out along the proosed route. The rating and required information for each environmental parameter based on the results of field survey were filled in a check list form for the Initial Environmental Assessment(IEA) and the results are shown in Table III-8. As revealed by Table III-8, it was presumed that considerable adverse effects on the environmental parameters of hazards, topography, geology, and soil erosion could be caused by the Project implementation, while other parameters have slight to negligible impacts.

The environmental impact on each parameter due to construction and operation of the Project were further elaborated based on the present field conditions and the assumed development scheme of the Project, in order to formulate possible mitigation measures which are actions to reduce, avoid or offset the potential adverse environmental consequence.

Based on the assessment mentioned above, the findings from the environmental viewpoint were prepared and broadly divided into two; impact monitoring to be carried out in future stages including construction period; and recommendations for formulating a development scheme for the Project.

Table III-8 Environmental Rating Check List

Environmental Parameters	Rating	Comments
SOCIO-ECONOMIC EFFECT		
1 Resettlement	C	The route mainly passes through remote and less population areas.
2 Economic Activities	D	No major economic activities along the route.
3 Traffic and public facilities	D	Limited traffic volume estimated and scattered public facilities.
4 Split of communities	D	The route bypasses villages and small towns in general.
5 Cultural property	D	No major cultural properties except Gadhi Fort and other religious interests which were avoided in the route alignment.
6 Water rights. Right of common	C	Scattered and isolated rice field observed; in some sections, local irrigation canals are affected due to the road construction.
7 Sanitation	D	No effect.
8 Waste	C	The road construction in mountainous terrain resulting in waste soil materials.
9 Hazards	B	Steep/unstable slope and fragile geology.
NATURAL EFFECTS		
10 Topography and geology	B	Most of the route runs through steep/unstable slopes in mountainous terrain and weathered/decomposed geological formations.
11 Soil Erosion	B	Steep/unstable slope and fragile geology.
12 Groundwater	D	Rich ground water
13 Hydrological situation	D	No water ways and fisheries.
14 Coastal zone	D	Not applicable.
15 Flora and fauna	D	The route passes through less forestry and no special flora and fauna was observed.
16 Meteorology	D	No effect.
17 Landscape	C	The project area is located in remote and sparsely populated areas except Dhulikhel where a tourist spot exists.
POLLUTION		
18 Air pollution	D	Little traffic volume estimated.
19 Water pollution	C	Possible due to waste soil during construction.
20 Soil contamination	D	Very limited fertile soil located in the Project area.
21 Noise and vibration	C	Possible during and after construction but the area has a scattered and sparse population.
22 Ground settlement	D	No effect.
23 Offensive odour	D	No effect.

Rating Grade
- A : Severe impact
- B : Considerable impact
- C : Slight impact
- D : Almost no impact

(1) Impact Monitoring

Environmental monitoring is one of the most important components of an environmental impact assessment. It is essential for (1) Ensuring that impacts do not exceed legal standards, (2) Checking the implementation of mitigation measures, and (3) Providing early warning of potential environmental damage.

For the purpose of impact monitoring, the following methods shall be applied.

- **Base Line Monitoring**
- **Impact Monitoring**
- **Compliance Monitoring**

(2) Environmental Recommendations For Formulating the Development Scheme

Extent and magnitude of adverse effects depend on the scale of the development scheme, i.e. a small scale development scheme causes relatively slight impact which could be mitigated by the appropriate measures, while a large and full scale development scheme induces severe to critical adverse effects which could be beyond economic mitigation measures.

Taking into account the above mentioned relationship between the extent of environmental effects and the project development scale, it was strongly recommended that (1) a stage wise construction method should be introduced in formulating the project development scheme, (2) a minimal development scheme meeting the initial demand shall be implemented at the first stage, and (3) the succeeding development scheme shall be finalized based on the results of the environmental monitoring to be carried out after the first stage is completed.

III-4 Assessment of DOR's Road Construction, Maintenance And Management Formation.

The present DOR's organization and staffing are to be reviewed, and DOR's project implementation capability from institutional, managerial and financial viewpoints are to be assessed.

III-4-1 Present Organization and Staffing in DOR

From an institutional viewpoint, re-organization including staffing in DOR is still in progress based on the Report of Administrative Reforms Commission headed by the Prime Minister on November 1992. Therefore, it is difficult to comment on this matter.

III-4-2 DOR Financial Situation

The allocated budget for the last five years is tabulated in Table III-9.

Table III-9 Budget Allocation Over the Past 5 Years

(Unit: Million NRs)

Fiscal Year	Total Budget	HMG Source	Foreign Source
1988/89	1,953.0	757.0 (38%)	1,196.0 (62%)
1989/90	2,070.0	757.0 (36%)	1,313.0 (63%)
190/91	1,571.0	464.0 (30%)	1,107.0 (70%)
1991/92	2,202.0	886.0 (40%)	1,316.0 (60%)
1992/93	2,810.0	928.0 (33%)	1,882.0 (67%)

DOR's financial situation as revealed by the above figures is as follows:

(1) On average, 65% of the total annual budget is provided by various foreign sources such as ADB, IDA (World Bank), and Grant Aid from ODA, Japan, India, and China.

(2) The annual total budget has gradually increased, especially after F/Y 90/91 when increases of 30-40% have occured annually. From the funding source viewpoint, the percentage difference in HMG source between 91/92 and 92/93 budget is less than 5%, while in the foreign source the percentage has increase by more than 40%.

(3) Although the total budget in F/Y 90/91 decreased due to political change, the budget for maintenance has gradually increased over the past five years, especially from F/Y 91/92 to 92/93 (57% increase), while only a 10% increase in the construction budget has occurred during the same period. This trend seems unlikely to change in the future taking into account the necessity of maintaining existing roads.

In view of the above, a development scale and implementation program of the Project should be formulated to minimize the burden to HMG.

III-4-3 Present Road Construction And Maintenance Projects

In the current fiscal year 92/93, DOR has been undertaking 10-major highway construction projects, 21-feeder road construction projects, 11-road maintenance and rehabilitation projects, 42-urban road projects, 10-bridge construction projects 7-district level and suspension bridge projects and 9-minor miscellaneous projects. A summary of the above projects together with targeted quantities and the grand total budget allocated is tabulated in Table III-10.

Table III-10 Summary of On Going Road Construction and Maintenance Projects

Project Category	No of Projects	Target Qty	Allocated Budget (Mil.NRs)
Highway Construction	10	1,050 km.	619.5
Feeder Road Construction	21	929 km.	308.1
Maintenance & Rehabilitation	11	718 km.	1,243.6
Urban Roads Construction	4	-	61.0
Bridges Construction	10	14 No.	151.7
District Level and Suspension Bridges	7	-	334.7
Miscellaneous Projects	9	-	91.6
Total	72		2,810.2

A review of on going projects from the implementation method viewpoint revealed that the method of project implementation depends on the funding agencies in general, and the road maintenance projects on small to medium scale are being implemented by DOR on a force account basis.

III-5 Formulation of the Development Scheme Alternatives

The main reasons for the Project not being successfully implemented to date, in spite of HMG's keen emphasis, are: (1) a huge construction cost (NRs. 3,884 million) was required resulting from the development and design policies adopted in the previous F/S and consequently (2) no funding sources were available or no funding agencies were interested in the Project implementation.

Taking into account the above reasons, which are also the background of the Study, realistic and practical development schemes should be formulated and materialized within the earliest possible time. The scheme alternatives, including several options, are prepared based on the expected roles of the Sindhuli Road, basic concepts for the development, and the results of traffic forecasts and environmental impact assessment. DOR's project implementation capability as well as financial situation are also taken into account in formulating the schemes.

III-5-1 Roles of Sindhuli Road

In view of insufficient and deficient points in the present road network in Nepal, the expected roles of the Sindhuli Road were identified as follows:

- Playing an alternative trunk road to ensure security, economic growth and expansion in Kathmandu,
- Providing a reliable transport route for international trade between Kathmandu and India,
- Reducing the travel distance as well as time for all the traffic between Kathmandu Valley and Eastern Terai Plain, and
- Stimulating and enhancing social and economic activities in the remote hill area of the Central Development Region.

In view of the above roles, it was concluded that the Sindhuli Road shall be defined as a "National Highway" in accordance with NRS (2045).

III-5-2 Basic Concepts in Formulating the Development Scheme Alternatives

Recognizing the necessity to materialize the Project within the earliest possible time, the following basic concepts were applied in formulating development scheme alternatives:

- Opening of the Sindhuli Road the entire sections to traffic, in principle,
- Introduction of stage wise construction,
  - Option-1 : Double lane road for the entire sections, and
  - Option-2 : Single lane road, providing the future widening to double lane.

    In the full construction alternative and the second stage of the stage wise alternative, the concept of an all weather road is totally introduced in accordance with the requirements of a National Highway, however, this concept is not fully applied in the first stage of the stage wise construction alternatives in order to reduce the initial construction cost.
- Introduction of "Kid - Glove" approach,
- Maximum usage of local materials and know-how and,
- Strengthening DOR Maintenance Formation.

III-5-3 Possible Features of the Road Elements

- Roadway width

  Due to introduction of the stage-wise construction concept, the following two options were considered in the preliminary design.

	Double Lane (Final Stage)		Single Lane (Initial Stage)	
	Flat/Rolling Section	Mountainous/ Steep Section	Flat, Rolling, Mountainous Section	Extremely Steep Section L^1
Carriageway	6.00m	5.50m	3.75m	3.00m
Shoulders	0.75^m x 2	0.50^m x 2	0.50^m x 2	0.50^m x 2
Roadway	7.50m	6.50m	4.75m	4.00m

Note L^1; Minimum width of 4.0m is applied in exceptional cases for a few sections even in the final stage.

- Typical cross section Typical cross sections are depicted in Figure III-2. (It is noted that a double lane, even in the first stage of the stage wise construction alternatives, is applied for exceptional sections that are too difficult to widen in the second stage.)
- Road alignment in the Study basically follows that planned in the previous F/S except for several sections identified in the field reconnaissance.

- Pavement consisting of gravel surface, and bituminous penetration macadam, are considered as alternatives.

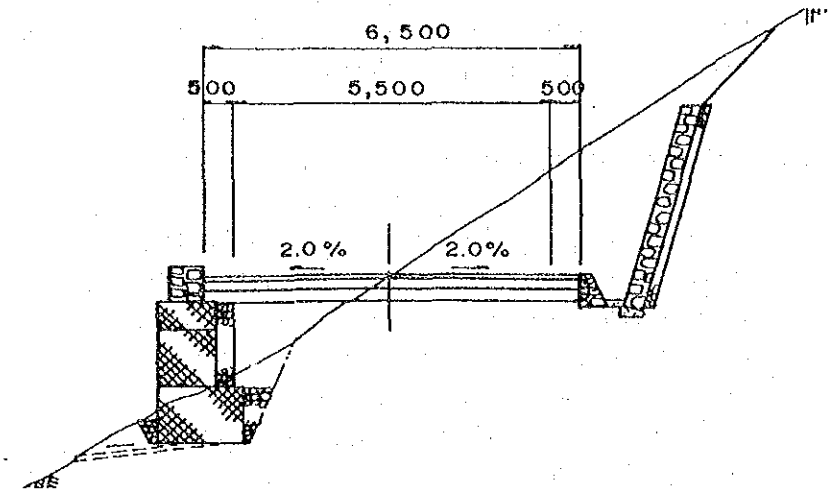
III-5-4 Possible Features of Major River Crossing Structures

- Basic concepts for selection of major river crossing structures.

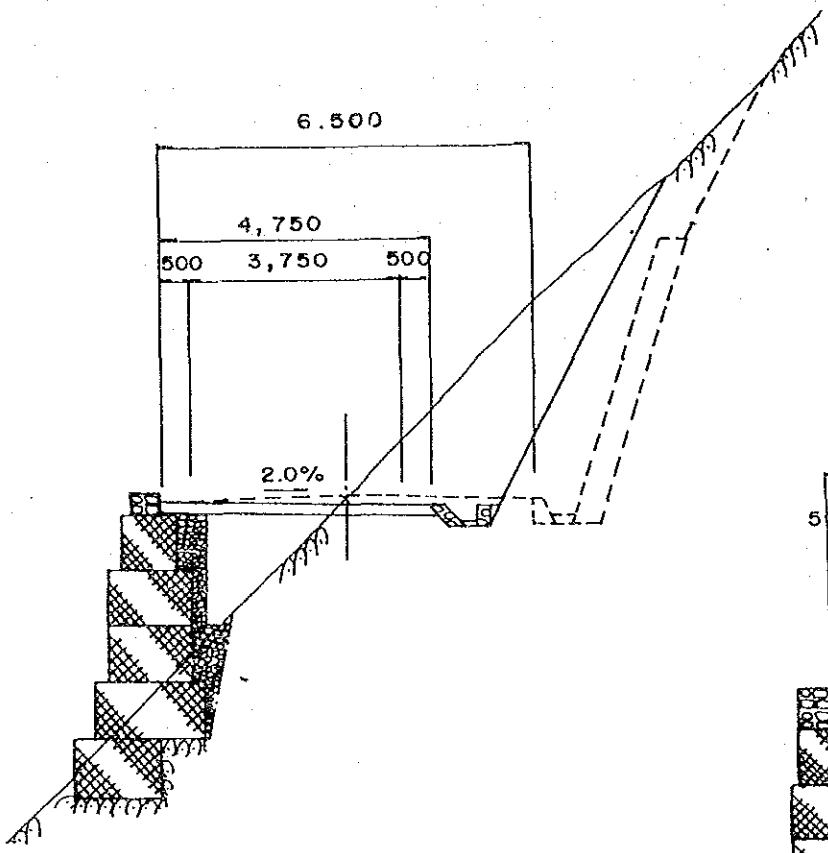
  River crossing structures were broadly divided into causeways and bridges. The former are applicable in the first stage of the stage wise construction alternative where rivers and creeks have flash type flood. The latter are applicable to the inevitable sites where the causeways can not cope with the river conditions such as long flood duration, high frequency and high flood level.

- Application of causeways in the first stage

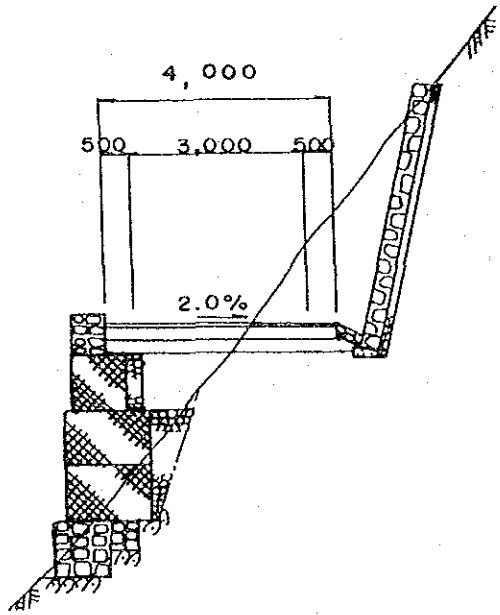
  The causeways applied in the Study are classified into three types consisting of river bed level type, vented type, and submersible bridges, depending on flood discharge, flood depth, size of floating debris, etc at a crossing site. It is planned that most of the major causeways installed in the first stage are replaced by 2 lane bridges in the second stage considering the all weather concept introduced in the second stage.



DOUBLE LANE IN MOUNTAINOUS AND STEEP SECTION



SINGLE LANE IN MOUNTAINOUS AND STEEP SECTION



EXTREMELY STEEP SECTION (EXCEPTIONAL SECTION)

NOTES :
- The dimensions are millimeter.
- Not to scale
- Tentative drawing only

AFTER CARE STUDY FOR SINDHULI ROAD CONSTRUCTION PROJECT	**Figure III-2 Typical Cross Sections**

- Alternatives for the bridge development scheme.

  In view of the basic concept of stage-wise construction and the bridge cost which is relatively high among the other road facilities, the following two alternatives were prepared for the further comparative study.

  - Minimal Scale Development Scheme
  - Development Scheme Considered the Second Stage Widening

The above two alternatives are illustrated by bridge type in Figure III-3.

III-5-5 The Development Scheme Alternatives

Based on combination of the alternatives of each element mentioned above, Sindhuli Road's development scheme alternatives were established as listed below and a summary of these is tabulated in Table III-11.

ALTERNATIVE-1 STAGE-WISE CONSTRUCTION OF MINIMAL DEVELOPMENT SCHEME

Single lane with gravel surface and minimal slope protection, and minimal one lane bridges and causeways in the first stage. Widening to double lane with installation of bituminous pavement and full slope protection, and adding one lane bridges and replacement of causeways by bridges in the second stage.

ALTERNATIVE -2 STAGE-WISE CONSTRUCTION OF MINIMAL DEVELOPMENT SCHEME CONSIDERING BRIDGE WIDENING

Single lane with gravel surface and minimal slope protection, and one lane bridges considering the second stage widening and causeways in the first stage. Widening to double lane with installation of bituminous pavement and full slope protection, and widening bridges to two lane and replacement of causeways by bridges in the second stage.

ALTERNATIVE-3 STAGE-WISE CONSTRUCTION OF MEDIUM DEVELOPMENT SCHEME WITH BITUMINOUS PAVEMENT

Single lane with bituminous pavement and minimal slope protection, and minimal one lane bridges and causeways in the first stage. Widening to double lane with installation of full slope protection, and adding one lane bridges and replacement of causeways by bridges in the second stage.

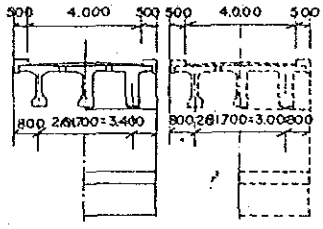
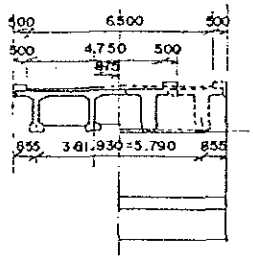
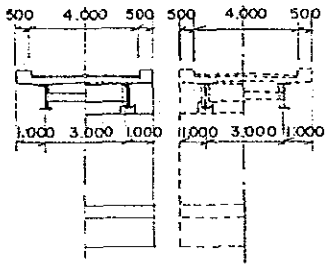
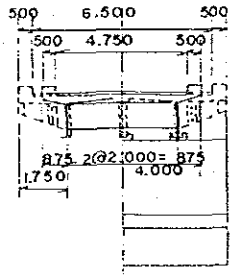
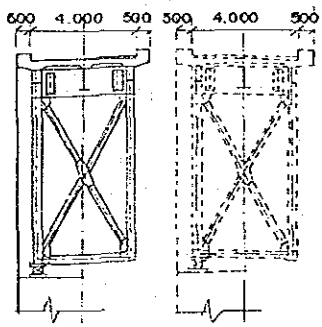
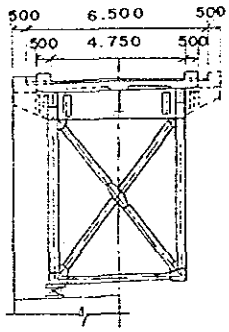
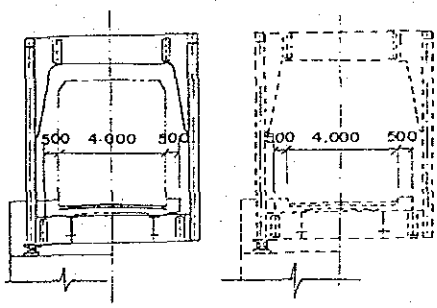
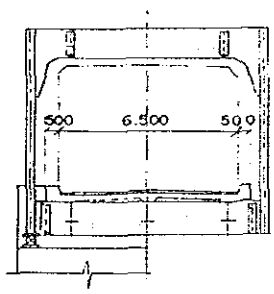
ALTERNATIVE-4 STAGE-WISE CONSTRUCTION OF MEDIUM DEVELOPMENT SCHEME WITH BITUMINOUS PAVEMENT AND BRIDGE WIDENING

Single lane with bituminous pavement and minimal slope protection, and one lane bridges considering the second stage widening and causeways in the first stage.

Widening to double lane with full slope protection, and widening bridges to two lane and replacement of causeways by bridges in the second stage.

ALTERNATIVE-5 FULL SCALE CONSTRUCTION

Construction of double lane road with bituminous pavement and full scale slope protection and two lane bridges.

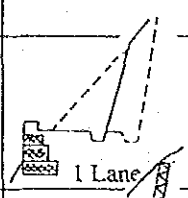
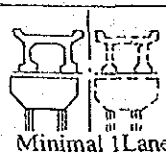
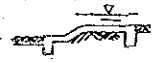
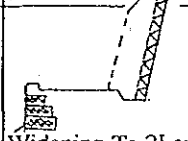
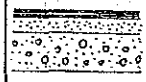
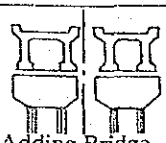
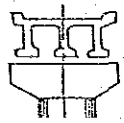
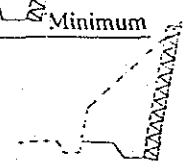
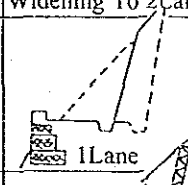
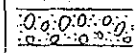
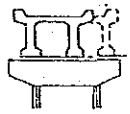
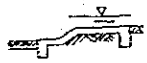
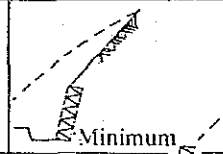
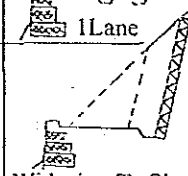
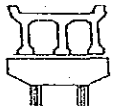
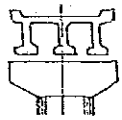
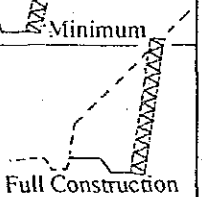
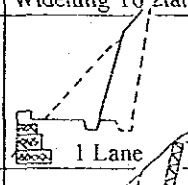
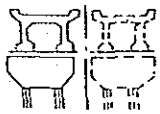
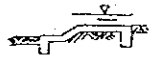
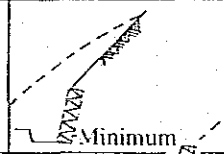
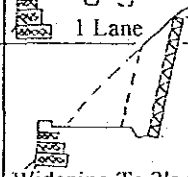
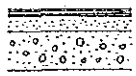
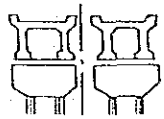
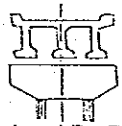
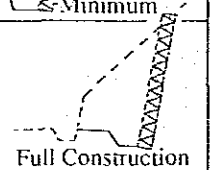
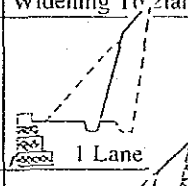
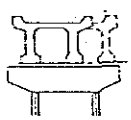
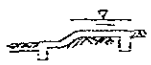
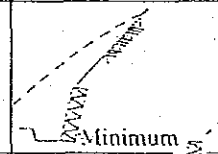
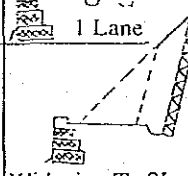
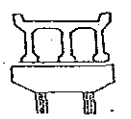
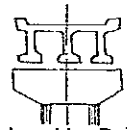
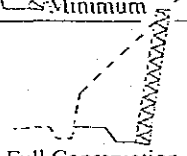
Alt / Type	Minimal Scale Development Scheme (Alt - 1)	Development Scheme Considered the Second Stage Widening (Alt - 2)
P.C Beam		
Steel Beam		
Steel Deck Truss		
Steel Through Truss		

(Remark) ——; Construction in the first stage
……; Construction in the second stage

AFTER CARE STUDY
FOR
SINDHULI ROAD CONSTRUCTION
PROJECT

Figure III-3
ALTERNATIVES OF BRIDGE
DEVELOPMENT SCHEME

Table III-11 Summary of Development Scheme Alternatives

ELEMENTS / TERNATIVES		NO'S OF LANE	PAVEMENT	MAJOR RIVER CROSSING STRUCTURES		SLOPE PROTECTION
				BRIDGE	CAUSEWAY/1	
ALT-1	1st Stage	 1 Lane	 Gravel,	 Minimal 1Lane	 Applicable	 Minimum
	2nd Stage	 Widening To 2Lane	 As. Macadam	 Adding Bridge	 Replaced By Bridge.	 Full Construction
ALT-2	1st Stage	 1Lane	 Gravel	 1 Lane Bridge	 Applicable	 Minimum
	2nd Stage	 Widening To 2lane	 As. Macadam	 Widening	 Replaced by Bridge.	 Full Construction
ALT-3	1st Stage	 1 Lane	 As. Macadam	 Minimal 1Lane	 Applicable	 Minimum
	2nd Stage	 Widening To 2lane	 Widening	 Adding Bridge	 Replaced By Bridge	 Full Construction
ALT-4	1st Stage	 1 Lane	 As. Macadam	 1 Lane Bridge	 Applicable	 Minimum
	2nd Stage	 Widening To 2Lane	 Widening	 Widening	 Replaced by Bridge.	 Full Construction
ALT-5		2Lane Const.	As. Macadam	2 Lane Bridge	2 Lane Bridge	Full Construction

NOTES 1) Alt-1 to Alt-4 are in stage construction.

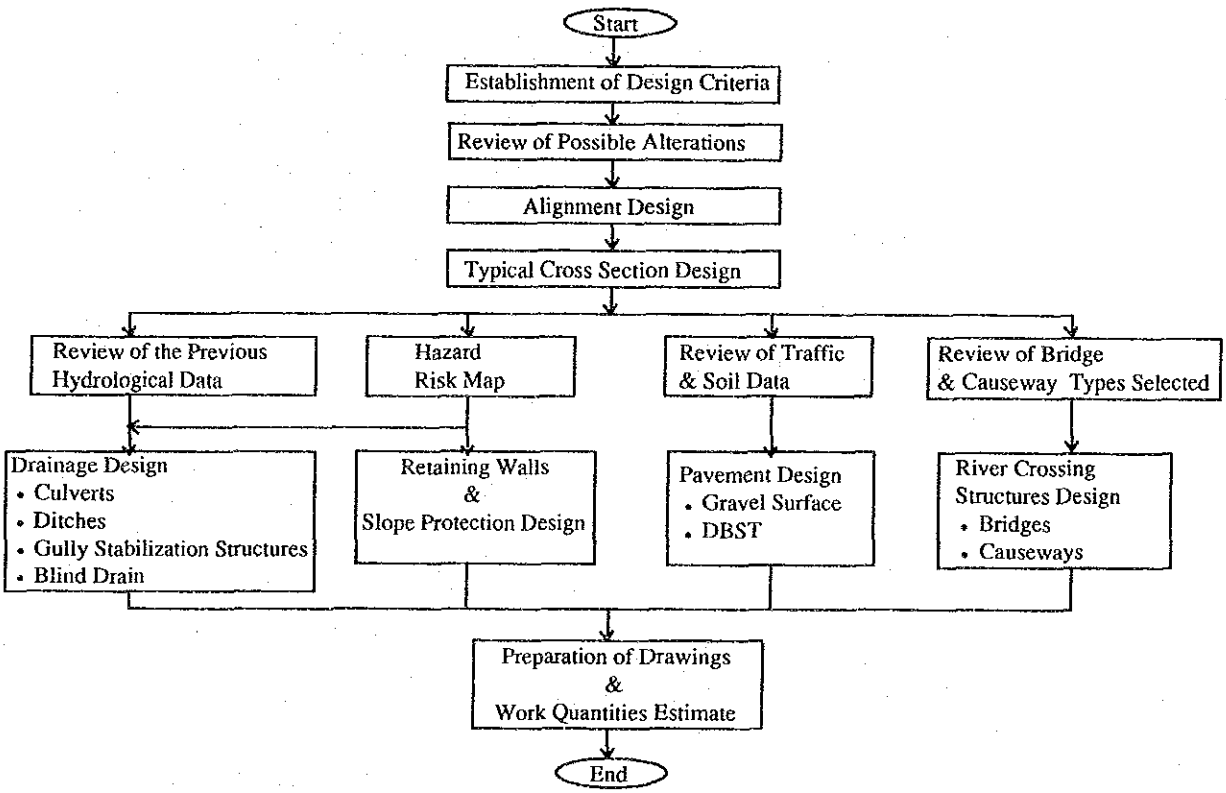
2)Alt-5 is a plan to implement the full scale construction.

/1 Most of the causeways installed in the 1st stage are replaced by bridges in 2nd stage.

III-6 Preliminary Design

The purposes of preliminary design covering all the development scheme alternatives are to determine size and dimension of the various road and bridge elements, and to estimate the work quantities.

Prior to conducting the preliminary design, design criteria were established and subsequently, a review of the possible alterations identified in the field reconnaissance followed. At the beginning of the preliminary design, the alignment design was carried out for sections where the original alignments could be modified and the typical cross sections were scrutinized referring to basic concepts applied in formulating the development scheme alternatives. River crossing structures design, pavement design, drainage design, and slope protection design were then carried out simultaneously. Finally, the preliminary design drawings were prepared based on the above design results and the respective work quantities were estimated. The preliminary design flow is depicted as shown below:



III-6-1 Design Criteria

The design criteria cover mainly geometric criteria, bridge design criteria, and right of way requirement .

- Geometric Design Criteria

  The following criteria was recommended to be applied to the Study:

Geometric Elements	Classification of Terrain		
	Flat/Rolling	Mountainous	Extremely Steep Section
Design Speed (km/hr)	40-50	30-40 (20)$_{L1}$	20
Super elevation (%)	2 (4)$_{L2}$	2 (4)$_{L2}$	2 (4)$_{L2}$
Max. Super elevation (%)	10	10	10
Minimum Radius (m)	70 (at 50 km/hr) 45 (at 45 km/hr)	45 (at 40 km/hr) 25 (at 30 km/hr) 10$_{L3}$(at 20 km/hr)	10$_{L3}$
Maximum Gradient (%)	6	9	9
Minimum Stopping Sight Distance (m)	65 (at 50 km/hr) 45 (at 40 km/hr)	45 (at 40 km/hr) 30 (at 30 km/hr) 20 (at 20 km/hr)	20

Notes : L^1 : The design speed of 20 km/hr shall be adopted as an exceptional case for (i) the sections where hairpin bends are planned in mountainous area, and (ii) the sections where the alignment will be shifted to the mountain side to alter minor bridges to R.C. culverts.

L^2 : The super elevation of 4% shall be applicable to gravel roads.

L^3 : The minimum radius of 10 m shall be only applicable to hairpin bend sections.

- Bridge Design Criteria

  The Bridge Design Standard to be applied for bridge design is in principle NRS (2045) published by DOR. In the case of no design specifications covered in NRS (2045), Highway Bridge Specification (HBS) published by the Japan Road Association (JRA) shall be applied in the Study. However, local requirements arising from natural phenomenon such as wind, earthquake, rainfall and temperature follow the Indian Road Congress (IRC) Bridge Code.

- Right of Way (ROW)

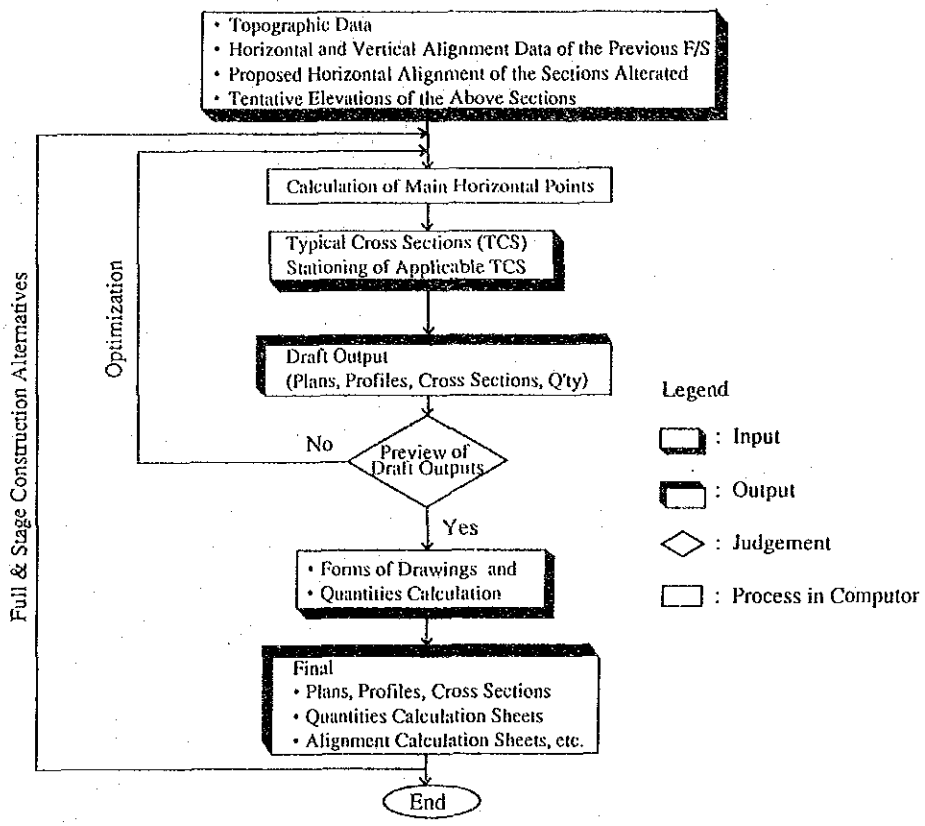
  In accordance with HMG's regulations, right of way of 50 m width is applied to all sections.

III-6-2 Highway Design

The highway design was carried out by means of Computer Aided Design (CAD) system for the respective alternatives mainly comprising of single lane case and double lane case. In the CAD system, various data such as topographic data, the previous horizontal and vertical alignment data with the proposed horizontal alignment of altered sections, and the typical cross sections are initially inputted in the computer. Secondly, the first draft outputs such as vertical alignment, cross sections on the monitor screen are reviewed and revised for optimization of each road element taking into account design criteria and construction cost. This process was repeated until optimizing the road elements. After the optimizing the road elements, final plans showing horizontal alignment, profiles, and individual cross sections were outputted in a form of drawings by means of CAD system. Based on the above design work carried out for each alternative of single lane and double lane, various work quantities such as cut and fill volumes, slope protection, retaining walls were also calculated in the system.

The above highway design flow is depicted in Figure III-4 which also indicates interrelationship of the above work items.

Figure III-4 Flow of Highway Design



III-6-3 River Crossing Structures Design

(1) Bridge Design

The bridge alternative study carried out in the previous F/S indicated that concrete bridges are superior to steel bridges from construction and maintenance cost viewpoints, provided that a fabrication yard is available beside the bridge site and accessibility to the bridge site is good. These study results were reflected in the bridge type selection. Namely, concrete bridges are selected for the bridge site where a fabrication yard is available and good accessibility is provided, i.e. work progress of the bridge construction does not interfere with the further progress of road construction beyond the bridge site. On the other hand, steel bridges are limitedly applied to the bridge sites where a fabrication yard is not available and the accessibility is poor, i.e. work progress of the bridge construction will interfere with road construction progress beyond the bridge site.

In light of the above principle, the bridge type selected was reviewed, and after the bridge configurations were designed taking into account the final

alignment, bridge site profiles as well as peak run-off discharge, length of drifting logs, size of boulders, local scouring depth, free board, and sediment deposition. Through the above exercise, the bridge types and configurations were selected and the preliminary design was carried out referring to design criteria.

Table III-12 List of Selected Bridge

Section	PC Bridge	Steel Bridge	Total
Section-I	7 no.-535 m	-	7 no.-535 m
Section II-1	-	3 no.-100 m	3 no.-100 m
Section II-3	1 no.- 20 m	5 no.-215 m	6 no.-235 m
Total	8 no.-555 m	8 no.-315 m	16 no.-870 m

(2) Causeway Design

Because of the river characteristics in Section-II and in order to reduce the initial investment cost, causeways as a low cost river crossing structure were introduced in the initial stage of the stage wise development scheme and some crossing major rivers are planned to be replaced by bridges in the final stage. The causeways applied in this Study are broadly divided into three types comprising of river bed level causeway (RBLC), vented type causeway, and submersible bridge (SB).

The causeway type and length were tentatively determined based on the flood information obtained from the field interview, the field distance measurement, and the qualitative application criteria of the respective causeways. The application criteria was reviewed in the preliminary design as qualitative as possible and the previous study results were scrutinized based on the profile of river crossing sites taken from leveling survey, in addition to the flood information.

Referring to the application criteria, suitable causeway types were selected as listed in Table III-13 taking into account mainly the flood conditions and the profile of each river crossing site. In this selection work, the causeways which are replaced by bridges in the second stage are also identified from the maintenance viewpoint, i.e. it is inevitable to interrupt the traffic due to peak flood and river deposits during and after floods at the causeways several times during the rainy season and consequently to reduce traffic benefit. In order to minimize the traffic interruption, major causeways are planned to be replaced by bridges.

Table III-13 List of Causeways with Second Stage Replacement Plans

Section	Initial Stage (Causeway)	Second Stage (Replaced By Bridges))
Section I	18 no. - 850 m	1 no. - 50 m
Section II-1	3 no. - 195 m	1 no. - 125 m
Section II-2	10 no. - 898 m	7 no. - 600 m
Section II-3	6 no. - 726 m	4 no. - 540 m
Total	37 no. -2,669 m	13 no. - 1,315 m

The river bed level causeway was designed referring to the design specification for river bed protection works stipulated in the Technical Specification for River and Sabo Works published by the Ministry of Construction in Japan, while the vented type causeways and the submersible bridges were also designed referring to the design specification for the submersible fixed weirs in the same Specification.

III-6-4 Drainage Structures Design

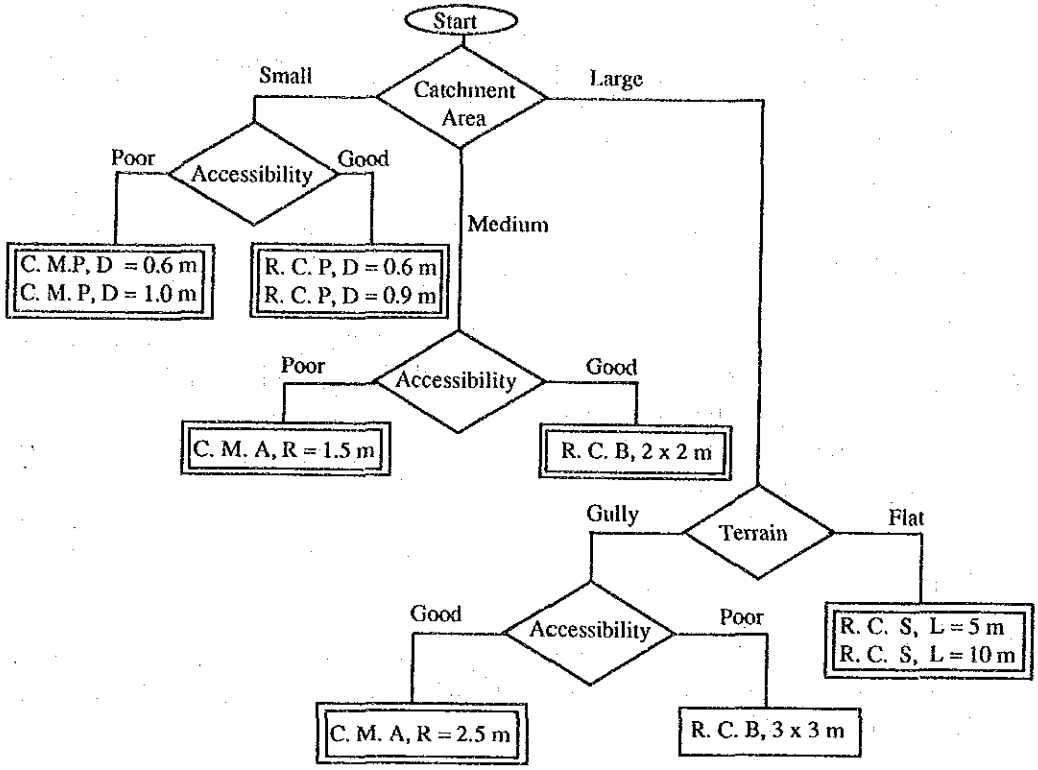
The drainage structures applied in the Study are broadly divided into three types: cross drainage structures, side ditches and the other facilities such as sub-surface drains and gully stabilization structures

The cross drainage structures applied in the Study included the following 9 types:

Reinforced Concrete Pipe D=0.6m	(R.C.P, D=0.6)
Reinforced Concrete Pipe D=0.9m	(R.C.P, D=0.9)
Corrugated Metal Pipe D=0.6 m	(C.M.P, D=0.6)
Corrugated Metal Pipe D=1.0m	(C.M.P, D=1.0)
Reinforced Concrete Box H2.0mxW2.0m	(R.C.B,2x2)
Corrugated Metal Arch R=1.5 m	(C.M.A,R=1.5)
Reinforced Concrete Box H3.0mxW3.0m	(R.C.B.3x3)
Corrugated Metal Arch R=2.5m	(C.M.A,R=2.5)
Reinforced Concrete Slab L=5.0m	(R.C.S L=5)
Reinforced Concrete Slab L=10.0m	(R.C.S L=10)

Selection criteria of the above structures depends on catchment area, i.e. whether assumed run off discharge is small, medium, or large; accessibility, i.e. whether the work progress of a specific drainage structure will or will not interface with the further progress of the road construction beyond the drainage site; and site terrain, i.e. whether a gully shape or flat shape. Taking into account the three selection parameters, selection flow of the drainage structures is depicted in Figure III-5.

Figure III-5 Selection Flow of Drainage Structures

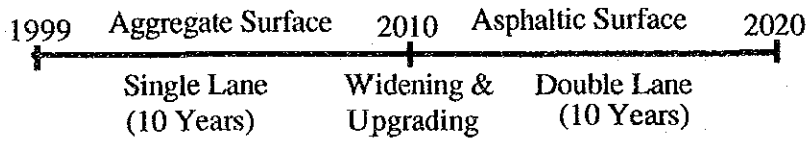


III-6-5 Pavement Design

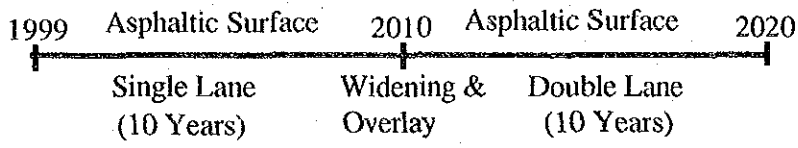
The pavement structures including several alternatives for the project road were designed in accordance with the AASHTO Guide for Design of Pavement Structures, 1986.

The pavement alternatives applied in the Study consist of aggregate surface and cold mixing asphalt surface (penetration macadam). The following design cases were formulated:

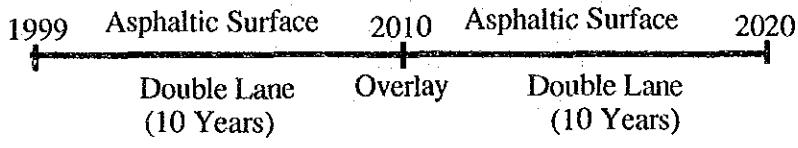
Case-1 Single lane with aggregate surface and future widening to double lane with asphalted surface.



Case-2 Single lane with asphalted surface and future widening to dobule lane with the same surface type.



Case-3 Double lane with asphalted surface and future overlay with the same surface type.



In accordance with the above design conditions, respective pavement structures were designed and the results are summarized below:

Cases	Layers	Pavement Structure in the First 10 Years		Pavement Structure in the Second 10 Years	
		Section-I	Section-II	Section-I	Section-II
Case-1	Surface	N/A	N/A	5 cm	5 cm
	Base	N/A	N/A	25 cm	24 cm
	Sub-Base	30 cm	30 cm	35 cm	45 cm
Case-2	Surface	5 cm	5 cm	5 cm	5 cm
	Base	21 cm	18 cm	25 cm	24 cm
	Sub-Base	35 cm	45 cm	35 cm	45 cm
Case-3	Surface	5 cm	5 cm	5 cm	5 cm
	Base	19 cm	17 cm	25 cm	24 cm
	Sub-Base	35 cm	45 cm	35 cm	45 cm

III-6-6 Slope Protection Design

The design concept with regard to slope protection applied in the Study is broadly divided into two: one is applicable for the initial stage of the stage wise construction alternative and the other is for the second stage construction and for the full construction alternative. The former concept is installation of full scale slope protection work at R/S and of minimal scale slope protection work at M/S in general, to minimize the double investment since the road is planned to be widened to M/S in the second stage. The latter is installation of full scale protection work wherever it is required. In addition to the above concept, the following are applicable to all the stages:

- To adopt local materials, techniques, and structures such as gabions, and dry stone pitching, as much as possible.
- To adopt the bio-technical slope stabilization method.
- To apply disaster mitigation instead of prevention measures.

The slope protection works are mainly twofold:

(1) Cut slope protection by breast walls; slope treatments such as guite shooting, and concrete frames with rock anchors.
(2) Fill slope protection by retaining walls; slope treatments such as sodding, and concrete rip rap, etc.

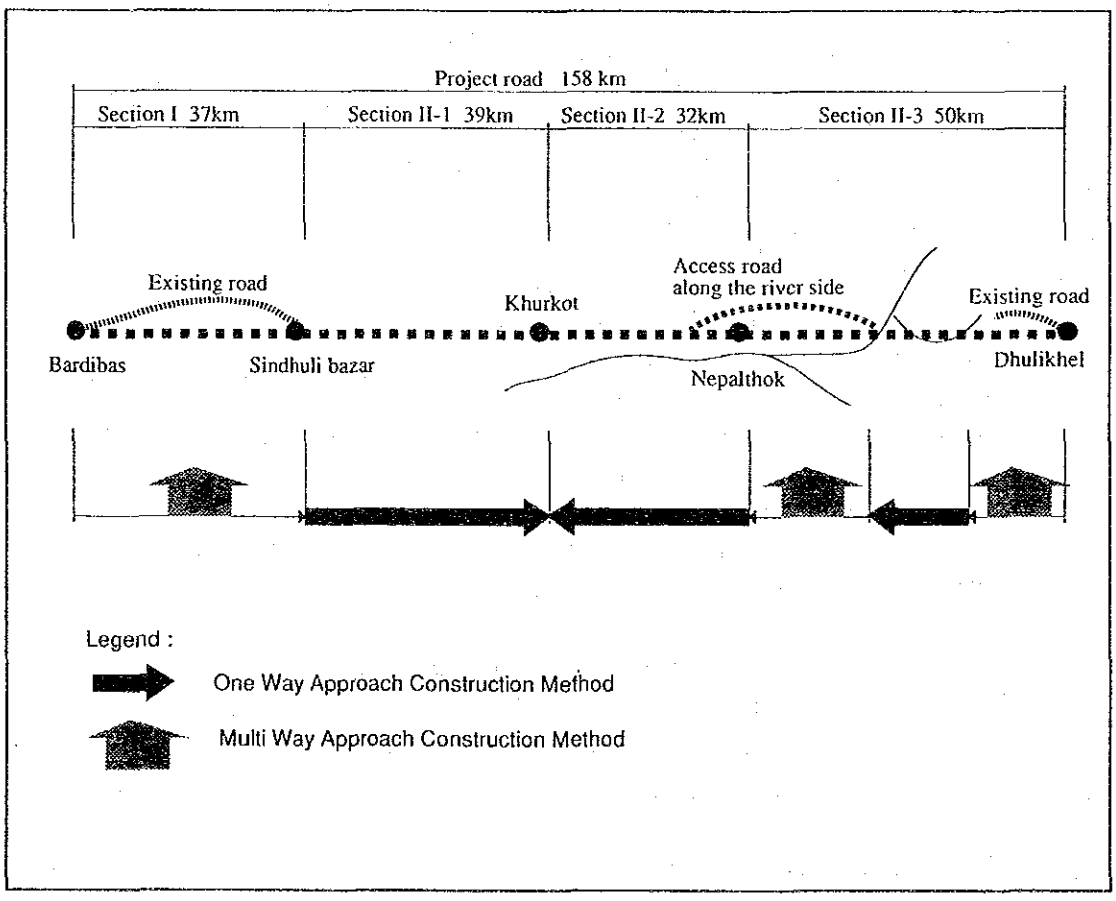
III-7 Construction Planning and Formulating DOR's Maintenance Formation

(1) Construction Planing

The construction plan and schedule of the respective alternatives were formulated based on the work quantities derived from the preliminary design, and taking into account the topographic, geological and meteorological conditions in the project site as well as minimizing environmental adverse effects.

Typical construction methods applicable to the Sindhuli Road are broadly divided into two mainly depending on availability of access roads. One is named "One Way Approach Construction Method" which is applicable to all of Sections II-1 and II-2 and one fifth of Section II-3. The other is " Multi Way Approach Construction Method" which is applicable to all of Section-I and the rest of Section II-3. The typical construction method is illustrated in Figure III-6.

Figure III-6 Concept of Typical Construction Method



In the construction schedule, the required construction period of the main work items were firstly analyzed based on the assumed workable days, unit progress rate, and estimated quantities, and subsequently the construction schedule of the respective major work items was estimated by applying the period analyzed. The overall construction schedule of each alternative, as illustrated in Figure III-7, was finally formulated taking into account the period for pre-construction activities and the traffic demand forecast.

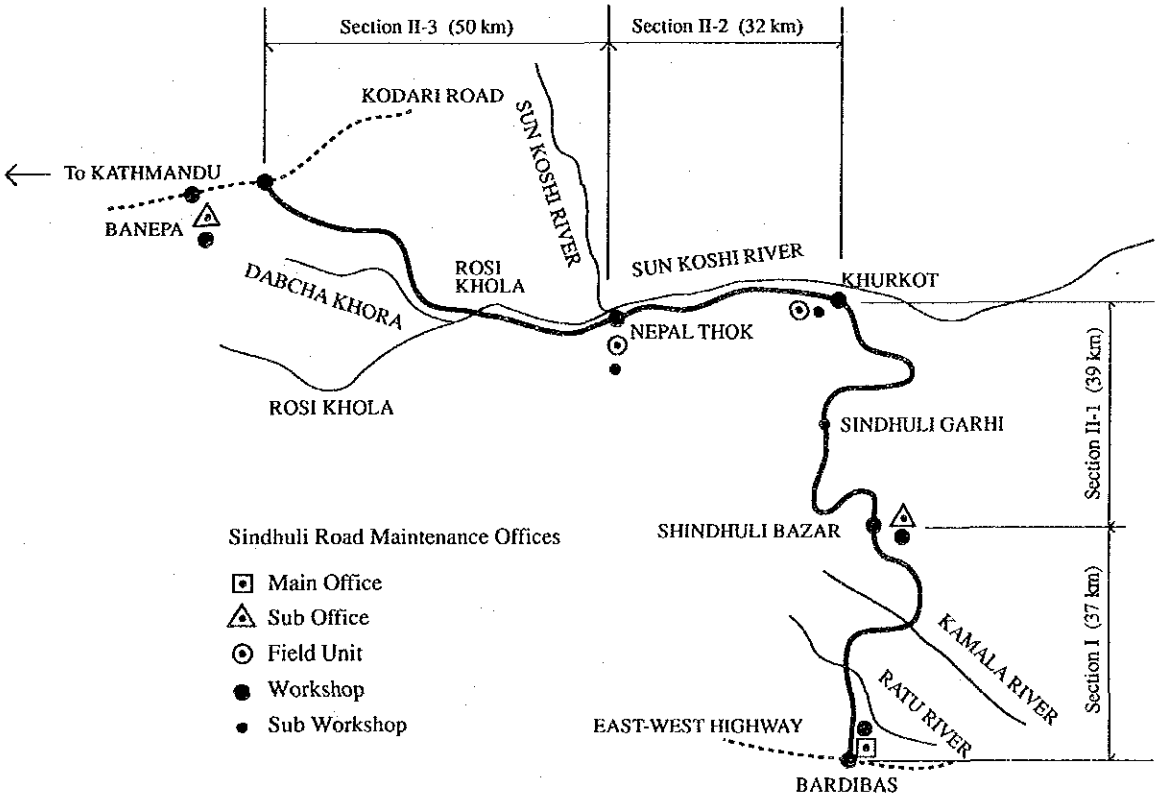
Figure III-7 Overall Construction Schedule

		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Alternatives 1to 4	Section -I																	
	Section -II																	
Alternative 5	Section -I																	
	Section -II																	

(2) DOR's Road Maintenance Formation

DOR's maintenance formulation including the required offices, organization and staffing, and equipment for the Sindhuli Road were formulated based on assessment of the maintenance work items and assumed quantities. The location of maintenance offices and work shops required are proposed as shown in Figure III-8;

Figure III-8 Location of Maintenance Offices and Workshops



III-8 Project Cost Estimate

The project cost including direct and indirect construction cost, engineering cost, and land acquisition and compensation cost was analyzed for each development scheme alternative on the basis of the preliminary design and the construction plan and schedule, assuming that the construction is executed by an international contractor.

The following assumption and conditions were applied in the project cost estimate.

(1) Price level of labor, material and equipment is based on March, 1993.

(2) The exchange rate applied to convert the US Dollar to Japanese Yen and Nepalese Rupees are:

US $1.00=Yen 115.08 =NRs. 45.88 (NRs.1.0=Yen 2.51)

(3) The costs are divided into foreign currency (indicated in NRs.) and local currency (indicated in NRs.) portions.

(4) Major material items included in the unit costs are cement, galvanised gabion wire, crushed stone, rebars, structural steel, P.C tendon, and fuel.

(5) Imported equipment and materials are assumed to be exempted from tax and duty by the Nepalese Government.

(6) Production rate in the unit price analysis is in general based on standard production rates of various work items in Japan after some modification was made with due consideration of local Nepalese conditions.

(7) Except for the direct cost, other costs such as contractor's overhead and profit, engineering cost are computed using the multiplier factors.

The project cost estimated based on March 1993 price level are summarized below:

(Unit:Million NRs.)

Alternatives		Major Cost Item	Foreign Currency	Local currency	Total Cost
Alt-1	Initial Stage	Const. Cost	2,929	633	3,562
		Eng'ing Cost	356	-	356
		Land Acq'tion Cost	-	279	279
		Sub-Total	3,285	912	**4,197**
	Final Stage	Const. Cost	4,542	586	5,128
		Eng'ing Cost	513	-	513
		Land Acq'tion Cost	-	-	-
		Sub-Total	5,055	586	**5,641**
Alt-2	Initial Stage	Const. Cost	3,154	637	3,791
		Eng'ing Cost	379	-	379
		Land Acq'tion Cost	-	279	279
		Sub-Total	3,533	916	**4,449**
	Final Stage	Const. Cost	4,308	579	4,887
		Eng'ing Cost	489	-	489
		Land Acq'tion Cost	-	-	-
		Sub-Total	4,797	579	**5,376**
Alt-3	Initial Stage	Const. Cost	3,477	704	4,181
		Eng'ing Cost	418	-	418
		Land Acq'tion Cost	-	279	279
		Sub-Total	3,895	983	**4,878**
	Final Stage	Const. Cost	4,126	506	4,632
		Eng'ing Cost	463	-	463
		Land Acq'tion Cost	-	-	-
		Sub-Total	4,589	506	**4,795**
Alt-4	Initial Stage	Const. Cost	3,703	707	4,410
		Eng'ing Cost	441	-	441
		Land Acq'tion Cost	-	279	279
		Sub-Total	4,144	986	**5,130**
	Final Stage	Const. Cost	3,930	519	4,449
		Eng'ing Cost	445	-	445
		Land Acq'tion Cost	-	-	-
		Sub-Total	4,375	519	**4,894**
Alt-5		Const. Cost	6,515	1,051	7,566
		Eng'ing Cost	756	-	756
		Land Acq'tion Cost	-	279	279
		Sub-Total	7,271	1,330	**8,601**

Note; Figures shown in bold mean the total project cost of each stage.

Furthermore, the maintenance cost per km per annum was estimated in round figures referring to the maintenance work items and the corresponding work quantities.

(Unit: MRs./km)

Maintenance Items	Alternative1&2 After 1st stage	Alternative3&4 After 1st stage	Alternative 5 & After 2nd stage
(1) Routine Maintenance			
Cleaning of paved road	-	7,000	9,600
Patching	-	25,000	25,000
Re-shaping of gravel surface	80,000	-	-
Removal of debris	67,750	67,750	13,500
Cleaning of causeway	35,800	35,800	-
Subtotal	183,550	135,550	48,100
(2) Periodic Maintenance	225,000	156,250	175,000
Total Cost	408,550	291,800	223,100

III-9 Project Evaluation

The respective development scheme alternatives were evaluated both from economic and technical viewpoints. In economic evaluation, the schemes were evaluated in terms of IRR, saving in road users' cost, socio-economic impact, and total project cost. The appropriateness of stage construction, single-lane road and then widening to double -lane, was justified on the basis of IRR calculated, anticipated socio-economic impact, and cost efficiencies.

Though all the IRRs calculated have smaller values of less than 12% of the official discount rate in Nepal, the role of the road in regional development and in satisfaction of basic human needs is immense. These will be attained even if the Sindhuli Road is single-lane at the first stage.

In technical evaluation, the appropriateness of single-lane road was justified from minimum cost principle. In this context, Alternative-1, the unpaved/one-lane road at the first stage, is the most recommendable.

However, should circumstances allow, higher standard of road development such as Alternative-4 among single-lane alternatives should be adopted for the easy implementation of the second stage works. This idea is also ascertained in the fact that only about NRs. 680 million pavement cost at the first stage would enhance the value of IRR from 4.19% of Alternative-1 to 7.05% of Alternative-4.

Result of Economic Evaluation
– Internal Rate of Return –

	Total Evaluation (with Second Stage Investment)	Partial Evaluation (Initial Investment Only)
Alternative-1	0.0808	0.0419
Alternative-2	0.0824	0.0432
Alternative-3	0.0851	0.0674
Alternative-4	0.0878	0.0705
Alternative-5	0.0845	N/A

III-10 Establishment of Project Implementation Program

An implementation program for the optimum development scheme alternative selected (Alternative-1) was formulated on the basis of the construction plan and method, project cost estimate, and project evaluation.

III-10-1 Framework for Programming

The following basic conditions and assumptions were considered in the formulation of the implementation program:

(1) Stage construction is introduced assuming:
- Commencement of construction for Section-I is in 1994.
- Second stage construction will be commenced in 2006 and be opened to traffic in 2010.

(2) Implementation program is formulated on the basis of the development scheme Alternative-1 which was selected as the optimum design scheme for the project road as summarized below:
- Single-lane road with gravel (unpaved road)
- Minimum provision of bridges by introduction of causeways
- Minimum provision of slope protection

(3) It is assumed that the Project will be materialized with financial assistance of foreign aid.

(4) DOR will participate in the Project as much as possible.

(5) During the construction of the Project, DOR shall take over the maintenance obligation from the contractor after a 1-year maintenance period.
Strengthening of DOR's maintenance capability is essential for maintaining the road facilities, especially in sever mountainous areas. The improvement of DOR's maintenance capability is included in the implementation of the Sindhuli Road Construction Project.

(6) The following preparatory works are required before commencing the construction work:
   (i) Engineering Services including Basic Design and Detailed Design shall be conducted by an international consultant.
   (ii) Land/house acquisition and compensation and forest clearance arrangement shall be undertaken by DOR before commencing the construction work.

(7) 10 % of physical contingency should be allocated in the project cost.

III-10-2 Alternatives of Implementation Program

Taking into account the period of engineering services, land acquisition, construction work, and participation of DOR in the Project, three alternative implementation cases were prepared:

Case A: Earliest Opening (1999) of the Project
- (1) Land acquisition and forest clearance arrangement is done in parallel with detailed design work in 1993 -1994,
- (2) Construction of Section-II will commence in 1994 and be completed in 1999.
- (3) Earthwork and causeways in Section-I are done by DOR

Case B: Sufficient time given for land acquisition
- (1) Sufficient time is given for land/house acquisition
- (2) Section-II is assumed to be commenced in 1996 after finishing land/house acquisition and forest clearance arrangement.
- (3) Earthworks and causeways in Section-I are done by DOR

Case C: Maximum participation of DOR
- (1) Sufficient time is given for land/house acquisition
- (2) Earthworks and causeways in SectionII-3 are constructed by DOR in addition to Section-I.
- (3) Construction period is spread over 8 years taking into account the limited local budget.

III-10-3 Selection of Optimum Implementation Program

Evaluation is made from the practical viewpoints paying due attention to the availability of financial sources, land/house acquisition procedures as well as limited local funds to be arranged by HMG, etc. Following is the evaluation results:

Case A
- (1) Case A has the shortest construction period (5.5 years in total), however, the period of land/house acquisition to be conducted

before construction is very short which may cause trouble between the land owner and contractor during the construction which will affect the work progress.

(2) Annual funds required for construction is the largest among the three alternatives.

Case B

(1) Construction period of Case B is 7 years, however, a sufficient time is given to DOR for land/house acquisition as well as forest clearance arrangement before commencing the construction, which may reduce trouble and problems between the land owner and the contractor during the construction.

(2) Annual cost to be allocated for the construction is smaller than that of Case A, though total construction cost is the same as that of Case A.

Case C

(1) Total construction cost is the cheapest among the alternatives, however, local funds to be arranged by HMG for the construction of Section II-3 will be NRs. 70 million per annum, which is about 15% of the total local budget allocated for road construction in 1993. Though this program was made aiming at maximum self-reliance of the Nepalese government, NRs. 70 million per annum will impose a heavy burden on the local budget.

(2) Overall construction period including Section-I and all of Section-II requires 10 years in total, which seems to be not realistic from the viewpoint of needs as well as the urgency of the Project.

Among the three (3) alternatives stated above, it is concluded that Case B is recommended for the implementation of the Sindhuli Road Construction Project from the viewpoint of limited foreign aid, and the local budget as well as land/house acquisition procedures.

The overall implementation program of Case B including the total project cost and disbursement schedule is presented in Table III-14. (Exchange rate: US$ 1.0= NRs. 45.88=¥ 115 or NRs. 1.0=¥2.51)

Table III-14 Overall Implementation Program

Description	Construction Section	Construction Unit	Works to be done	F or L	Constr. Period	1993 4	1993 3	1994 1	1995 2	1996 3	1997 4	1998 5	1999 6	2000 7	Total
Engineering Services															
(i) Basic Design	Sec.1 & Sec.2	Consultant	All works		2 M	xx									
(ii) Detailed Design	Sec.1	Consultant	All works		4 M		xxx								
	Sec.2	Consultant	All works		1 Y		xxx	xxxxx							
(iii) Supervision	Sec.1	Consultant	All works		2 Y			xxxxxxxxx	xxxxxxxxx						
	Sec.2	Consultant	All works		5 Y					xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	
Land/House Acquisition	Sec.1	DOR	Not required		0										
	Sec.2	DOR	Required		2 Y			xxxxxxxxx	xxxxxxxxx						
Forest Clearance	Sec.1	DOR	Not required		0										
	Sec.2	DOR	Required		1 Y				xxxxxxxxx						
Construction Works	Sec. 1	Contractor	Bridge only		2 Y			xxxxxxxxx	xxxxxxxxx						
		DOR	Earthwork and Causeway		2 Y			xxxxxxxxx	xxxxxxxxx						
		Suppiler	Materials/Equipment Supply					V							
	Sec. 2-1	Contractor	All works		5 Y					xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	
	Sec. 2-2	Contractor	All works		4 Y						xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	
	Sec. 2-3	Contractor	All works		5 Y					xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	
Strengthening of Maintenance	Sec. 1	Supplier	Materials/Equipment Supply						V						
Office	Sec. 2	Contractor	Construction of office		1 Y						xxxxxxxxx			xxxxxxxxx	
		Suppiler	Materials/Equipment Supply								V1			V2	

Construction Cost and Disburesement Schedule

A. Funds to be covered by foreign aid											
A.1 Construction works by an international contractor	F			155	154	491	676	675	675	674	3,500
A.2 Construction equipment and materials supply	F			48							48
A.3 Maintenance office construction by an international contractor	F					54		24			78
A.4 Maintenance equipment and materilas supply	F				63	106		62			231
A.5 Engineering services including detailed design and supervision	F		141	10	10	29	40	40	40	40	350
A.6 Physical contingency (10% of the construction cost)	F			16	15	49	68	68	68	67	350
Total amount to be assisted with foreign aid	F		141	229	242	729	784	869	783	781	4,557
Equiv. to yean million	F		350	570	610	1,830	1,970	2,180	1,960	1,960	11,430
B. Funds to be covered by local source											
B.1 Construction works by DOR on force account basis	L			12	12						24
B.2 Land/house acquisition cost	L			191	88						279
B.3 Forest clearance arrangement cost	L			10	10						20
Toatl amount to be arranged by DOR	L		0	213	110	0	0	0	0	0	323

III-10-4 Project Management and Organization

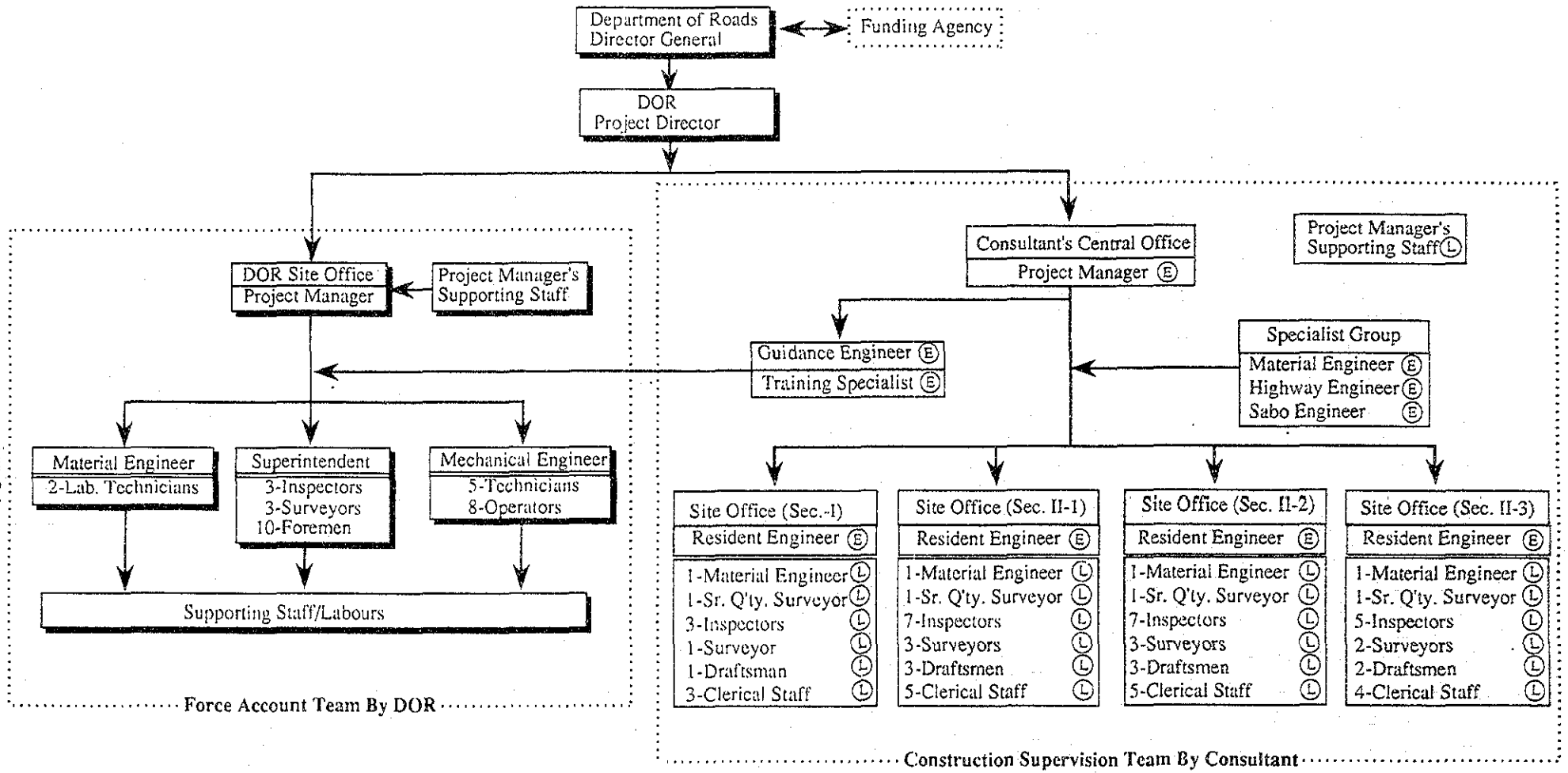
DOR shall be the executing agency for the project implementation and acts as a coordination body between HMG and funding agency as well as between the Government agencies concerned.

The project implementation method is broadly divided into two as formulated in the previous section. The first is the implementation by DOR on a force account basis for earthworks and causeway work in Section-I and the second is by an international contractor on a turn key basis for all Section-II and bridge work in Section-I.

Accordingly, the field implementation team under the overall management of DOR's Project Director is also divided into two, one is the force account team comprising of engineers and staff from DOR, and the other is a consultant team to supervise the construction to be executed by an international contractor. In this regard, it is recommended to second DOR engineers to the consultant team in order to ensure maximum technology transfer and training to DOR's staff through the project implementation.

The proposed organization chart is presented in Figure III-9.

Figure III-9 Organization Chart of Project Implementation



Legend:
- DOR's Unit
- Consultant's Unit
- Chain of Command

(E) means expatriate engineer.
(E) means engineer and staff seconded from DOR or local consultants.

JICA