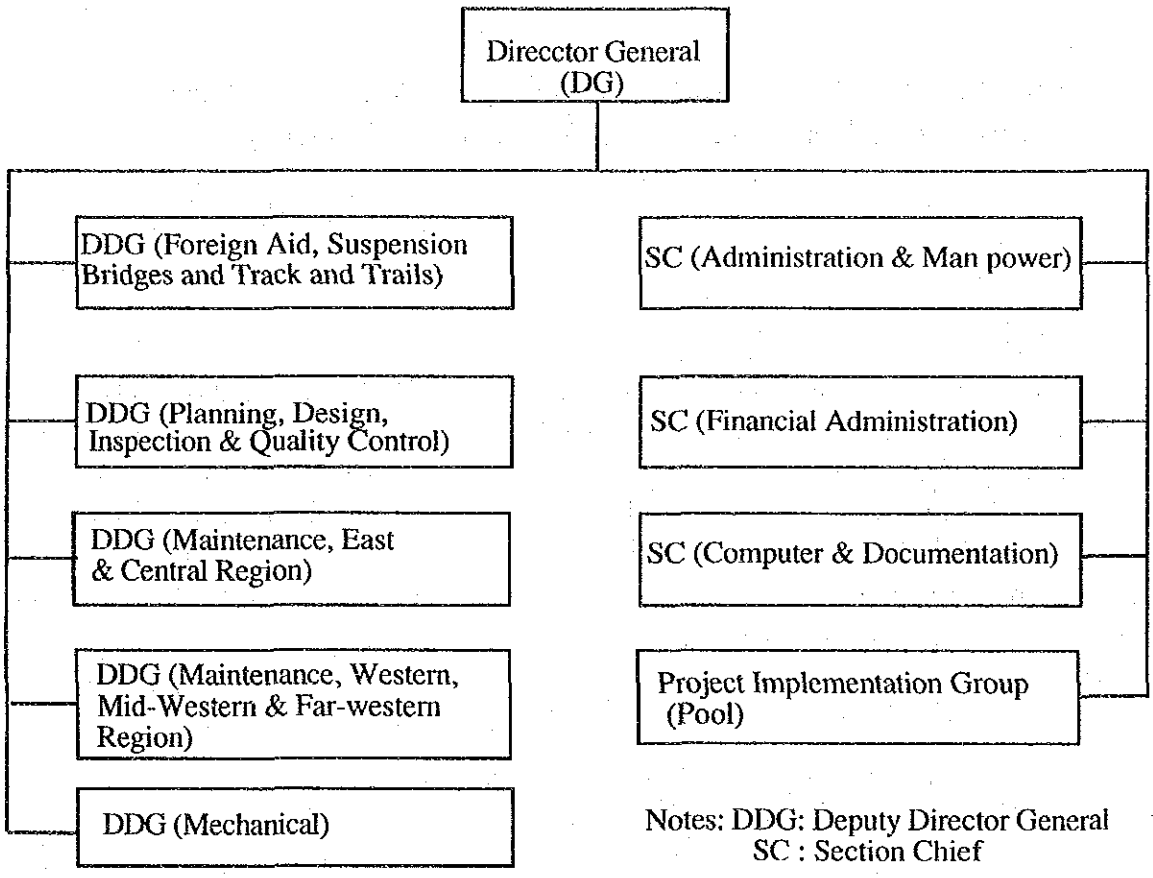
Figure 5-1 Present Organization of Central DOR

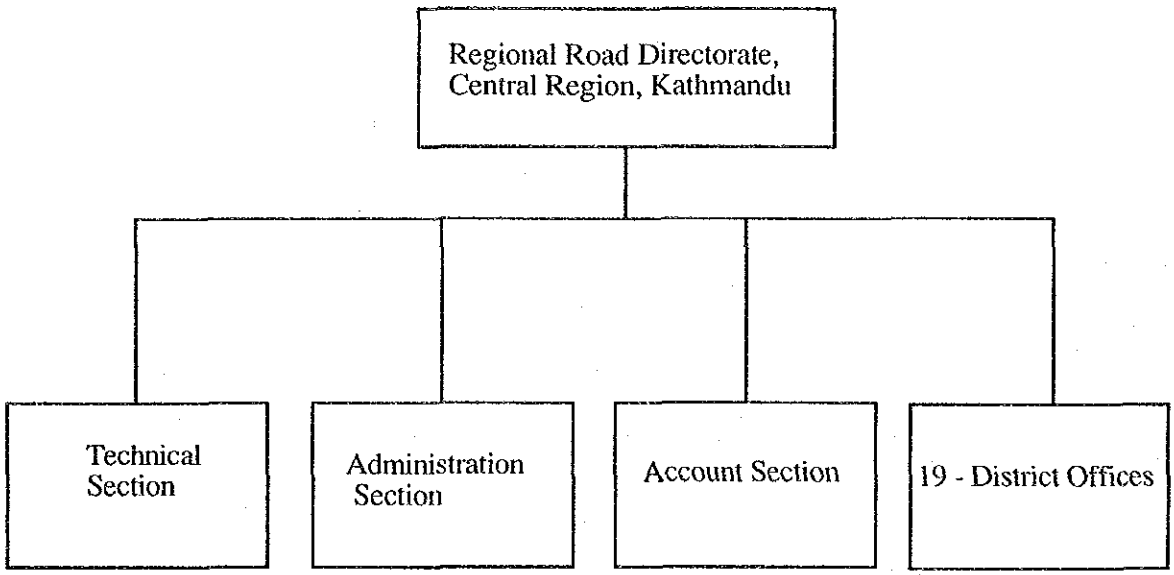


(2) DOR, Regional Road Directorate

The Directorate of Central Region, where Sindhuli Road is located, is presently headed by Deputy Director General (DDG) for Maintenance and he is responsible for inspection, supervision and monitoring of road construction and maintenance projects within the central region.

The present organization of Central Regional Road Directorate is shown in Figure 5-2.

Figure 5-2. Present Organization of Central Road Directorate, DOR.



NOTE : Out of 19 districts offices, only 15 have been established to date.

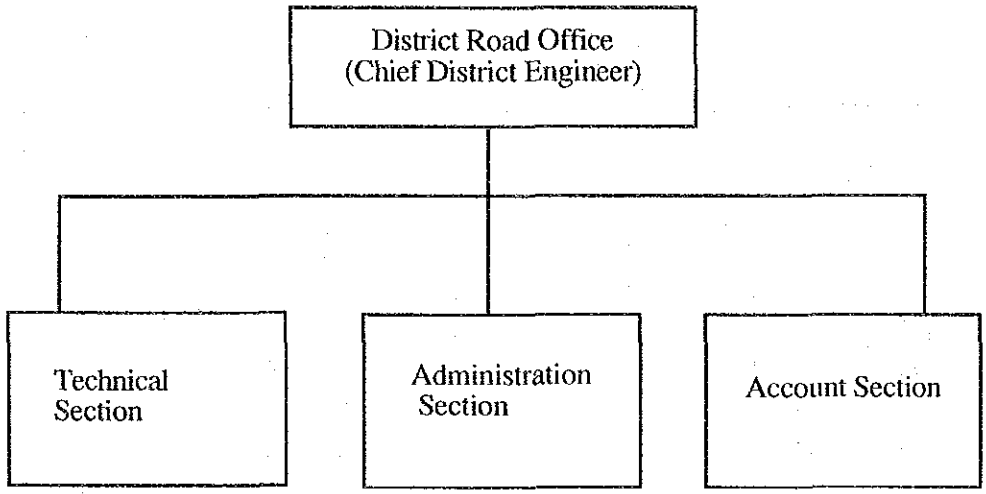
The present staffing of the Central Regional Road Directorate is very limited and are only one Divisional Engineer, 5- Assistant Engineers and a few administrative staff.

(3) DOR District Road Office

The District Road Office is headed by Chief District Engineer who is responsible for carrying out planning, design, implementation of road construction and maintenance within his jurisdiction. He has also responsibility to work with Local District Development Council for district level road projects.

The District Road Offices are classified into 3 classes depending upon the total road network and their physical locations. HMG/N has planned to establish District Road Offices in all 75 districts, but so far 44 District Road Offices have been established. Out of 19 Districts in the Central Region, only 15 District Road Offices have been established to date. In the Districts of Ramechap, Sindhuli and Kavrepalanchowk, where the Sindhuli Road passes through, the District Offices are not established yet. The general organization of the District Office is depicted in Figure 5-3.

Figure 5-3 General Organization of District Office, DOR



5.3 Budget Allocation and DOR Financial Situation

For the construction of new roads and maintenance and rehabilitation of the existing roads, the budget allocation is annually made by the Ministry of Finance (MOF) to DOR at the beginning of each fiscal year (June/July). Over the past five years, the allocated budget are tabulated in Table 5-1. The budget divided into HMG and foreign sources, and break down into construction and maintenance are shown in Figure 5-4 and 5-5 respectively.

Table 5-1 Budget Allocation Over the Past 5 Years.

(Unit in Million NRs)

Fiscal Year	Total Budget	HMG Source	Foreign Source
88/89	1,953.0	757.0 (38%)	1,196.0 (62%)
89/90	2,070.0	757.0 (36%)	1,313.0 (63%)
90/91	1,571.0	464.0 (30%)	1,107.0 (70%)
91/92	2,202.0	886.0 (40%)	1,316.0 (60%)
92/93	2,810.0	928.0 (33%)	1,882.0 (67%)

Figure 5-4 Budget Allocation Divided into HMG and Foreign Sources

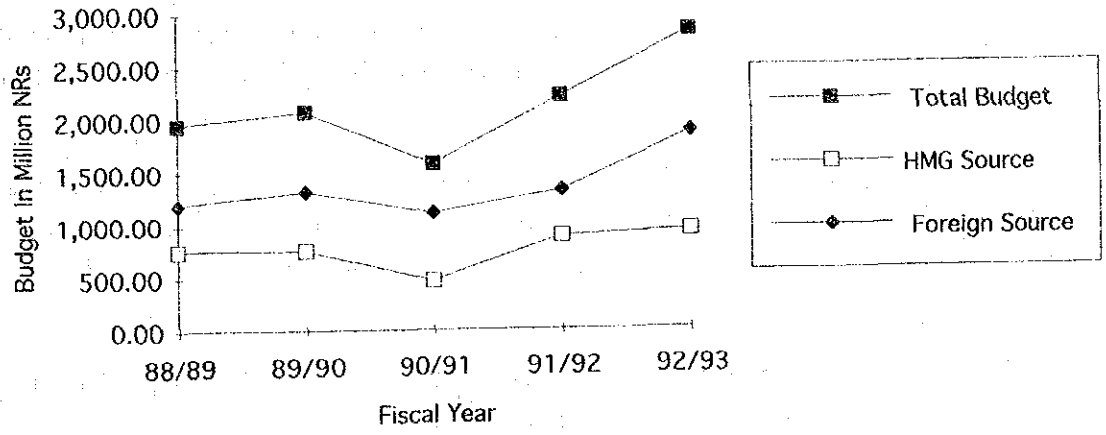
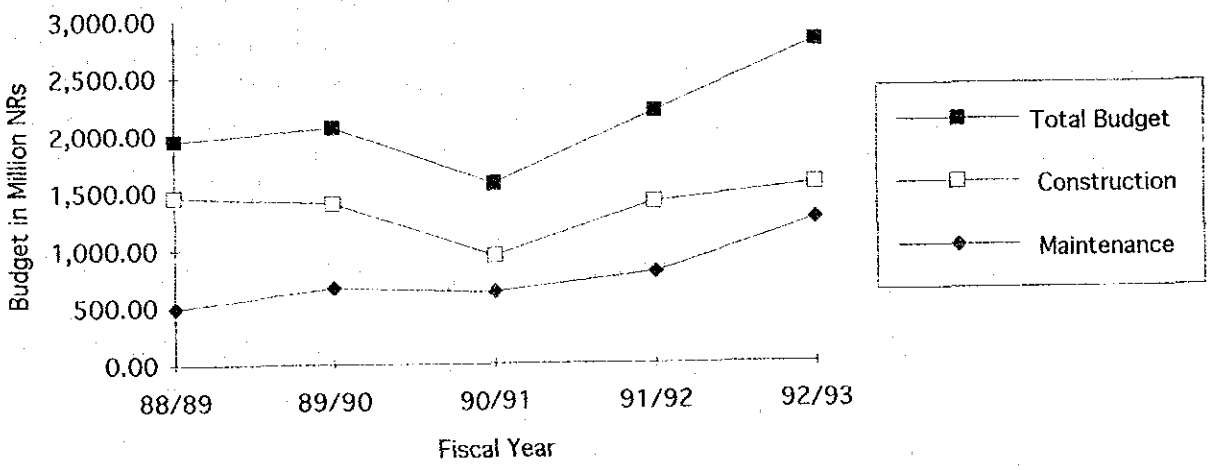


Figure 5-5 Budget Allocation Broken Down Construction and Maintenance



As revealed by the above figures and table, the followings are findings with regard to DOR's financial situation.

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

(2) The annual total budget has gradually increased, especially 30-40% increase annually after F/Y 90/91. From the funding source view point, the percentage difference in HMG source between 91/92 budget and 92/93 is less than 5%, while in the foreign source, the percentage is more than 40% increase which is quite considerable.

(3) Although the total budget in F/Y 90/91 decreased due to the 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 10% increase in the construction budget is seen during the same period. This trend could not be changed in the future taking into account the necessity of maintenance of the existing roads.

(4) Assuming that total construction cost and annual maintenance cost of Sindhuli Road Project is 3,000 million NRs. and 20 million NRs respectively, the construction cost is more than three times of the HMG source annual budget, and the maintenance cost shares 2% of the HMG source budget in F/Y 92/93.

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

5.4 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 5-2 and major projects of each category are shown in Table 5-3.

Table 5-2 Summary of Road Construction and Maintenance Projects On Going

Project Category	No's of Projects	Target Qty	Allocated Budget in Million NRs
Highway Construction	10	1050 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		2810.2

Table 5-3 List 0f Major Projects On Going

Name of Project	Type of Work	Implementation Mode	Budget for 1992/93 in Million NRs	Funding Source
A. Construction				
Kohalpur Mahakali	Highway Construction	Contract basis	135.00	India and IDA
Pokhara Baglung	Hill road construction	Turnkey	105.00	China
Phidim Taplejung	Hill road construction	Force Account and Contract basis	40.00	HMG
Patan-Baitadi-Darchula	Hill road construction	Force Account and Contract basis	30.00	HMG
Charali-Ilam	Hill road construction	Contract Basis	106.00	ADB
Godawari-Bhatkanda-Patan	Hill road construction	Contract Basis	33.50	ADB
Bhatkarda-Doti	Hill road construction	Contract Basis	120.00	ADB
M.R.M.-Gaighat	Hill road construction	Force Account and Contract basis	55.00	HMG
Silgadi-Sanfebagar	Hill road construction	Force Account and Contract basis	60.00	ADB
Bhalubang-Pyuthan	Hill road construction	Force Account and Contract basis	70.00	HMG
B. Maintenance and Rehabilitation				
Road Resealing works	Pavement Improvement works	Contract basis	50.00	OPEC
Second Road Improvement Project	Highway widening & pavement construction	Contract basis	500.00	ADB
Lamosangu-Jiri	Hill road maintenance	Force Account and Contract basis	22.17	SDC
Arniko Highway Maintenance Project	Slope protection & pavement construction	Contract basis	18.23	SDC
M.R.M. Belbari-Chaurahara	Highway widening & pavement construction	Contract basis	150.00	ADB
Naubise-Mugling	Widening of Road and pavement construction	Contract basis & partly management contract	75.00	IDA and ODA
Road Flood Rehabilitation Project	Road & Bridge works with slope protection & river training	Contract basis	230.00	IDA
Road Maintenance (Different Roads)	All type of road Maintenance work	Force Account and Contract basis	130.00	HMG
Eastern Region Road maintenance	Maintenance and Rehabilitation	Force Account and Contract basis	50.00	ODA
C. Bridges				
Valley Bridges	Bridge Construction	Turnkey	100.00	JAPAN
Trishulee Bridge	Bridge Construction	Contract basis	10.00	GTZ
D. Other Projects	City Road, Road Bridge, Suspension Bridge, Track and Trails	Force account and Contract basis	721.00	
Total			2810.20	

As shown in Table 5-3, modes of project implementation depends on the funding agencies in general. The projects financed by ADB and IDA are usually implemented on a contract basis, in which the contractors undertake the project construction. While the project financed by HMG are usually executed either on a force account basis or on a contract basis depending on the scale or type of the projects. In general, the road maintenance projects with a small to medium scale are being implemented by DOR on a force account basis.

For this purpose, certain construction equipment are available in the Heavy Equipment Division in DOR. For instance, in the Central Regional Road Directorate, DOR, located in Kathmandu, following major equipment are available and operational.

Equipment	Stationed at		Total in Central Region
	Kathmandu	Hetauda	
Track Dozers	4	5	9
Wheel Dozers	4	1	5
Wheel Loaders	8	8	16
Graders	4	6	10
Rollers	15	17	32
Tipping Truck	34	25	59
Flat Bed Trucks	5	6	11

On the other hand, the projects under grant aid are generally implemented on a turnkey basis except Jogbani - Dhankuta Road Project which is under grant-aid from ODA, is being implemented on both contract basis and force account basis.

Institutional data and information on Dharan-Dhankuta Road Project and Lamosangu-Jiri Road Project are presented for reference purpose in Appendix-E.

CHAPTER 6

FORMULATION OF DEVELOPMENT SCHEME ALTERNATIVES

CHAPTER 6

FORMULATION OF THE DEVELOPMENT SCHEME ALTERNATIVES

6.1 General

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

Taking into account the above reasons, which are also the background of the Study, the purpose of this study presented herein is to formulate the realistic and practical development schemes which should be materialized within the earliest possible time. The scheme alternatives including several options are prepared based on expected roles of the Road, basic concepts for the development, and the results of traffic forecast and environmental impact assessment carried out. DOR's project implementation capability as well as financial situation are also taken into account in formulating the schemes. In light of these scheme alternatives, the succeeding studies such as the preliminary design, construction scheduling, cost estimate are carried out and the optimum development scheme among the alternatives is selected in the project evaluation in Chapter 10.

6.2 Roles of Sindhuli Road

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

(1) Sole trunk road available is not stable and reliable in the rainy season because of the frequent landslides and slope failure.

(2) Roundabout road linking in between Kathmandu Valley and Eastern Terai where the main part of agricultural production center is located.

(3) Lagged road development linking north and south because of hindrance due to the ranges which stretch in east-west direction and are of steep topography and fragile geology.

In full consideration of the above three points with regard to the present road network, Sindhuli Road is planned to form a new road link connecting Kathmandu Valley and Eastern Terai with aim of the following four aspects;

(1) playing an alternative trunk road in the function of serving as "the second backbone" to ensure security, economic growth and expansion in Kathmandu,

(2) providing a reliable transport route for international trade between Kathmandu and India, especially for the traffic to and from Calcutta Port which handles about 95% of Nepalese overseas trade except that with India,

(3) reducing the travel distance as well as time for all the traffic between Kathmandu Valley and Eastern Terai Plain, especially for the traffic transporting agricultural products in Eastern Terai Plain, and

(4) stimulating and enhancing social and economic activities in the remote hill area of Central Development Region especially in Sindhuli, Ramechhap and Kavrepalanchok Districts.

In view of the above roles and expected function of Sindhuli Road, it is concluded that the Road shall be defined as "National Highway" in accordance with Nepal Road Standards.

6.3 Basic Concepts in the Formulating Development Scheme Alternatives

Recognizing the necessity to materialize the Project within the earliest possible time, following basic concepts are applied in formulating the realistic and practical development scheme alternatives.

(1) Opening to Traffic in Entire Section of the Road

In view of the expected function of Sindhuli Road, i.e. alternative trunk road, and the shortest transportation route connecting Kathmandu Valley and Eastern Terai Plain, it is beneficial that entire section of the route shall be opened to the traffic rather than stage wise opening in length. Thus, basic concept with regard to opening to the traffic is in the entire section in principle, but stage wise opening concept is not discarded and be maintained as an alternative in the project implementation schedule from conservative view point.

(2) Introduction of Stage Wise Construction

The function of road serving as "National Highway" and the result of traffic demand forecasts study leads the requirement of double lane road in principle.

While single lane road at the initial stage, provided the future widening to double lane is considered as an alternative taking into account the initial traffic volume, minimizing adverse environmental effect and initial construction cost as well as early opening to the traffic. Consequently, it is prudent to prepare two basic alternatives as listed below in order to enable to select the most viable development scheme.

- Double lane road for the entire section (full construction alternative), and
- Single lane road at the first stage and the widening to double lane at the second stage (stage construction alternative)

In the full construction alternative and the second stage of the stage wise alternative, the concept of all weather road is totally introduced in accordance with the requirements of National Highway, while this concept is not fully applied in the first stage of the stage wise construction alternatives in order to reduce the initial construction cost. As the concrete examples, low cost river crossing structures such as causeways & submersible bridges and partial slope protection works, which sometimes cause traffic interruption during rainy season for removing river deposits and sledded materials, are applied in the first stage of the stage wise construction. And in the second stage of the stage wise construction alternatives, it is planned to replace the major low cost river crossing structures by bridges and to install full scale slope protection after the demolishing the partial slope protection and widening the road width.

Furthermore, stage wise construction concept is introduced in pavement design in order not only to reduce the initial cost but also to result in cost effective approach. In view of those points, there would be two alternatives consisting of gravel surface, and penetration macadam pavement.

(3) Introduction of "Kid - Glove" Approach

As most of the route passes through steep slope on the mountainous topography and on the fragile geology, the construction of road is a massive interference with the environment and should be undertaken with the utmost care. In other words, if one has to tread without leaving load imprints, it is better to tread lightly. It is therefore significant to apply "Kid - Glove Approach" toward the road and bridge construction which was applied in the Lamosangu - Jiri Road Project and led the project construction with success. This concept will be reflected especially in selecting route alignment and balancing cut and fill volume, and in designing slope protection and channel treatment works.

(4) Maximum Usage of Local Materials Available and Know - How Developed

It was observed that huge amount of boulders, cobble stones, and sand have been deposited on the river beds along or across the route. The concept with regard to maximum usage of these available materials without special treatments leads to apply gabion and masonry structures instead of reinforced concrete structures applied in the previous F/S, and consequently results in the cost saving.

Furthermore, vegetation structures developed from bio-engineering view point in Dharan-Dhankuta Road Project will be applied for stabilizing slopes as much as possible.

(5) Strengthening DOR Maintenance Formation.

At present, there are no DOR district offices in Sindhuli and Kavre Palanchok Districts where most of the proposed route passes through. However, introduction of the above concepts in the study requires routine inspection and maintenance works such as removal of falling debris, river deposited on the causeways, sediments in side ditches, resurfacing, and so on. Cost for these maintenance works will be estimated separately and will be taken into account in the project evaluation. On the other hand, it is requisite to establish new maintenance offices at several locations along the route. Location, organization, staffing, type and number of required equipment, etc. regarding this issue will be further studied after an optimum development scheme is selected. The future maintenance program with the above requirements should be also formulated as a part of the project implementation program in the Study.

6.4 Possible Features of the Road Elements

Based on the basic concepts mentioned in the previous section, concrete pictures and definite figures for major road elements are studies and the possible features are presented below.

6.4.1 Roadway Widths

(1) Double Lane (Full Construction Alternative and Final Stage)

The standard carriage way width of National Highway is 7.0 meters with double lanes according to the Nepal Road Standard (NRS) (2027). However, the reduced carriageways of 6.0-5.5 m were applied in the previous F/S considering topographic condition and those in the existing similar trunk roads such as Narayangadh-Mugling Road, Dharan-Dhankutta Road etc. In this Study, the

following criteria which are the same width as those in the previous F/S are applied based on the same reasons:

(a) Flat and Rolling Section (Especially in Section-I)

Carriageway width	:	6.00 m
Shoulder width	:	0.75 m x 2
Roadway width	:	7.50 m

(b) Mountainous and Steep Section (Especially in Section-II)

Carriageway width	:	5.50 m (Intermediate lane width on NRS 2027)
Shoulder width	:	0.50 m x 2
Roadway width	:	6.50 m

(2) Single Lane (First Stage of Stage Construction)

In the stage wise construction, a single lane road having 4.75 m road width is recommended according to the NRS (2027) i.e.; 3.75 m carriageway and 0.5 m shoulder width at both sides. In this case, passing places having additional 2.75 m wide and 20 m long are provided at certain intervals depending upon the topographic condition as well as curves and sight distance applied. Furthermore, hairpin bend sections and high cut sections that could be too difficult to widen the road in the second stage are considered to be widened as much as possible even in the first stage. It should be noted from traffic capacity view point that the single lane road, of which traffic volume capacity is expected to be 4250 pcu/day, can cope with the traffic volume estimated upto a year of 2010, assuming the first stage is completed in 2000 .

(a) Flat, Rolling and Mountainous Section (Basically for entire Section)

Carriageway width	:	3.75 m
Shoulder width	:	0.50 m x 2
Roadway width	:	4.75 m

(b) Extremely Steep Section (As an Exceptional Section)

Carriageway width	:	3.00 m
Shoulder width	:	0.50 m x 2
Roadway width	:	4.00 m

In the sections where topography is extremely steep and/or geology is very fragile, minimal width of 4.0 m (3.0 m carriageway plus 0.5 m shoulder at both sides) will be applied as an exceptional case in the first and final stage construction.

With regard to bridge width, 6.5 m and 4.75 m between curbs will be generally applied in double lane (final stage) bridge and single lane bridge (initial stage) respectively. In case of single lane bridge, 4.0 m width between curbs is considered as a minimal alternative.

6.4.2 Outline of Typical Cross Sections

Typical cross sections of the double lane road are roughly designed based on the following basic concepts and these are shown in Figures 6-1 and 6-2.

(1) To balance cut and fill volume in a section, especially in steep slope section,

(2) To retain fill by certain structures, in other word, to avoid exposed fill slope,

(3) To install breast walls at toe of cut slope, and

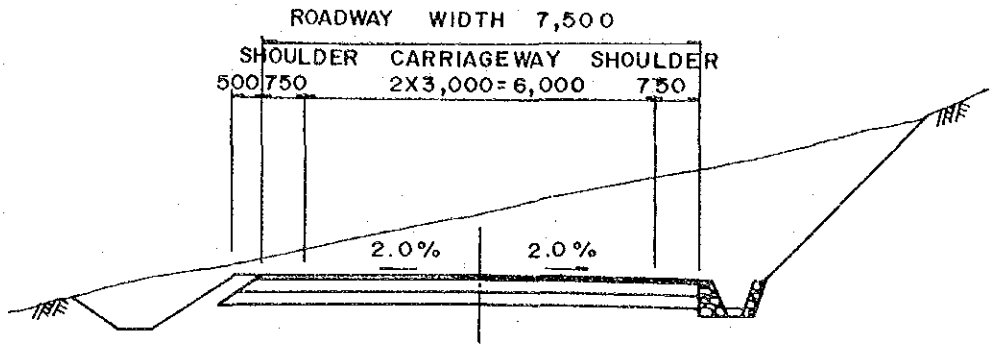
(4) To drain surface water to both sides

While, the typical cross sections for the single lane road, provided the future widening to double lane, are outlined taking into account not only the above basic concepts (1) and (2), but also minimizing adverse environmental effect L^1 and double investment in costly structures L^2, of which idea is illustrated in Figure 6-3.

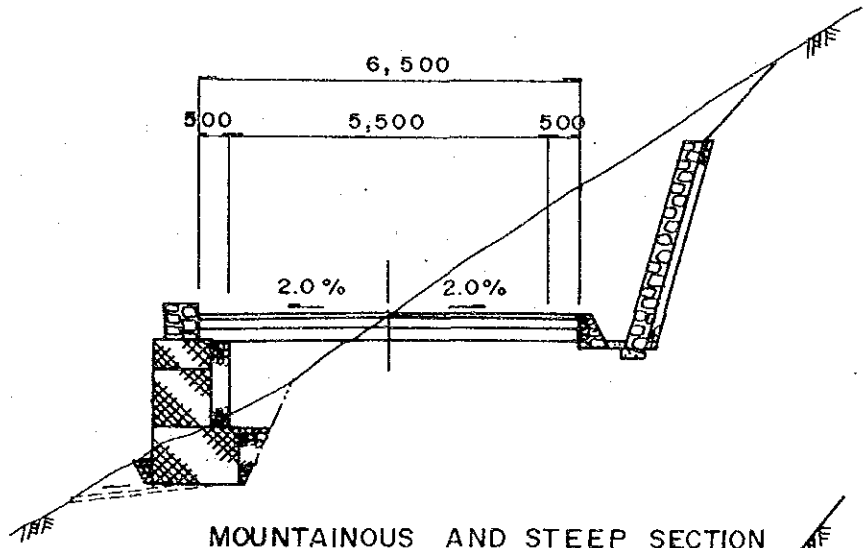
Figures 6-4 shows the typical cross sections for the fist stage road construction, i.e. the single lane road provided the future widening to double lane.

Notes: L^1 In the first stage construction, it is too difficult to haul the excavated materials to a specific spoil area because of limited spoil area and less hauling access. It is inevitable to dispose the surplus material to the valley side, which method will generate severe adverse environmental effect. As such, it is appropriate to position the center line in the valley sides rather than in the mountain side taking into account balance of cut and fill volume in a section.

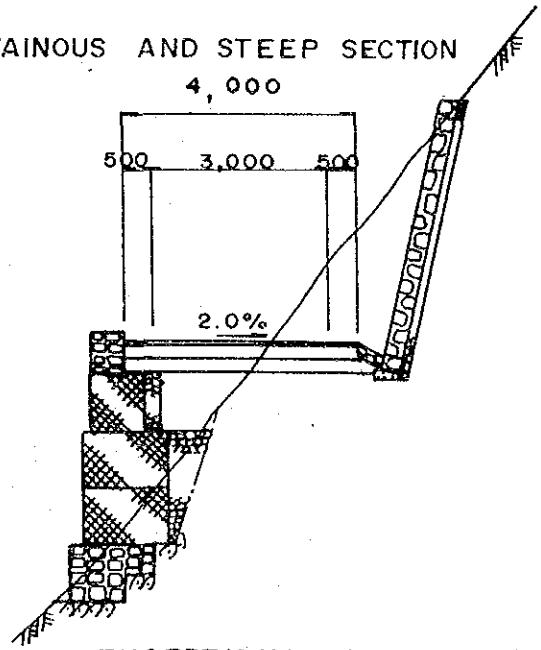
L^2 Widening to double lane road requires some demolition of the structures installed in the first stage such as side ditches in mountain side or retaining wall in the valley side. Based on cost comparison between those structures, it is desirable to position the center line in the valley side to minimize double investment in costly structures.



LEVEL AND ROLLING SECTION



MOUNTAINOUS AND STEEP SECTION

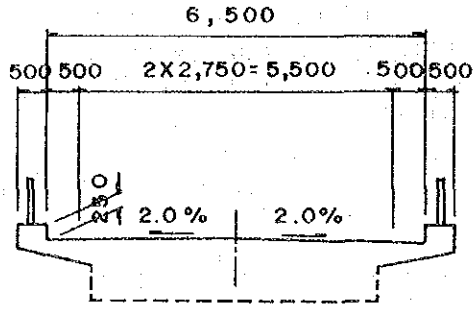


EXCEPTIONAL SECTION

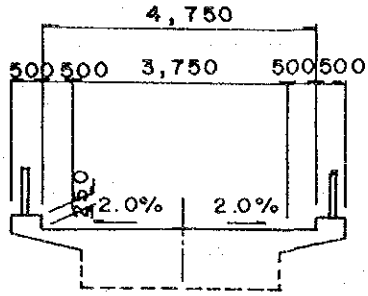
Notes:

- The slope protections will be selected according to the geological and topogrphical condtions of the slope.
- The dimentions are millimetar.
- Not to scale
- Tentatative drawing only

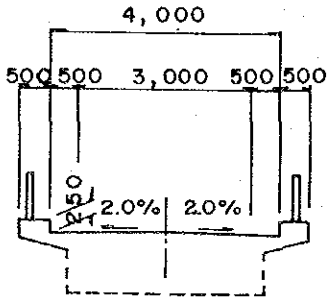
AFTERCARE STUDY FOR SINDHULI ROAD CONSTRUCTION PROJECT	**Figure 6-1** TYPICAL CROSS SECTIONS OF DOUBLE LANE ROAD



TYPICAL CROSS SECTION OF DOUBLE LANE BRIDGE
(FINAL STAGE)



TYPICAL CROSS SECTION OF SINGLE LANE BRIDGE
(ALT - 1)

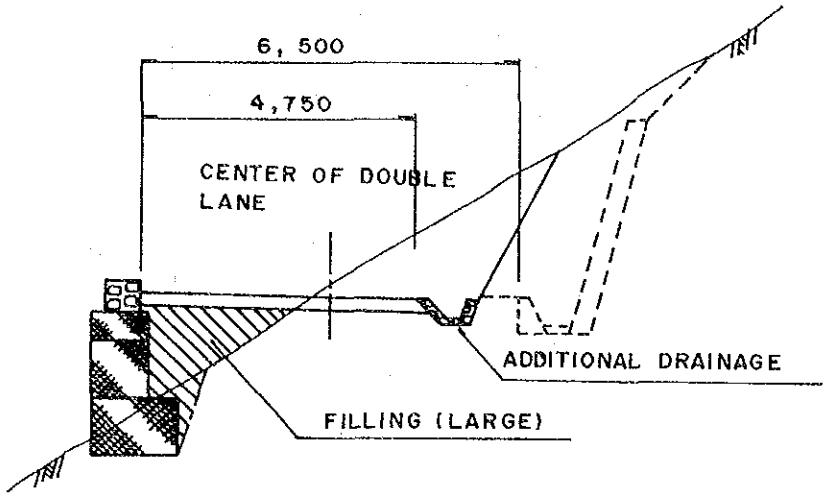


TYPICAL CROSS SECTION OF SINGLE LANE BRIDGE
(ALT-2 AS EXCEPTIONAL CASE)

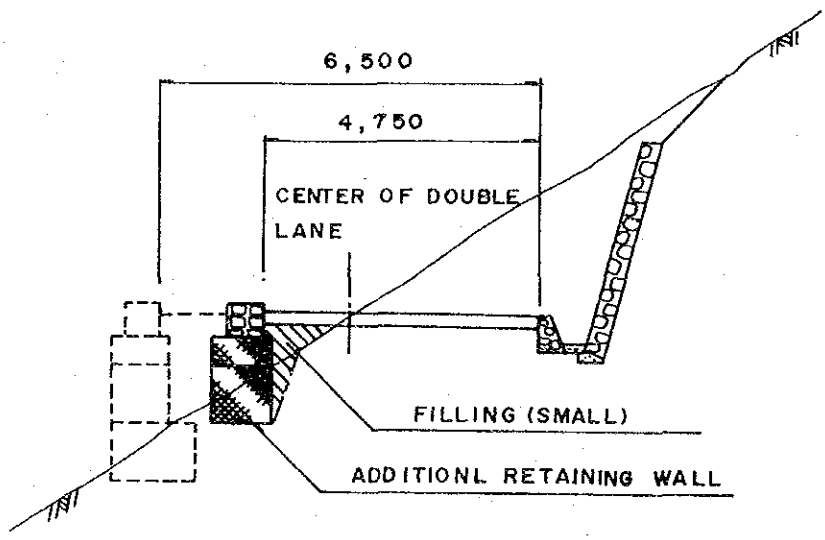
Notes:

- The dimentions are millimeter.
- Not to scale
- Tentative drawing only

AFTERCARE STUDY FOR SINDHULI ROAD CONSTRUCTION PROJECT	Figure 6-2 TYPICAL CROSS SECTIONS OF BRIDGE



TYPICAL CROSS SECTION TO CONSTRUCT SINGLE LANE ROAD ON VALLEY SIDE OF DOUBLE LANE ROAD

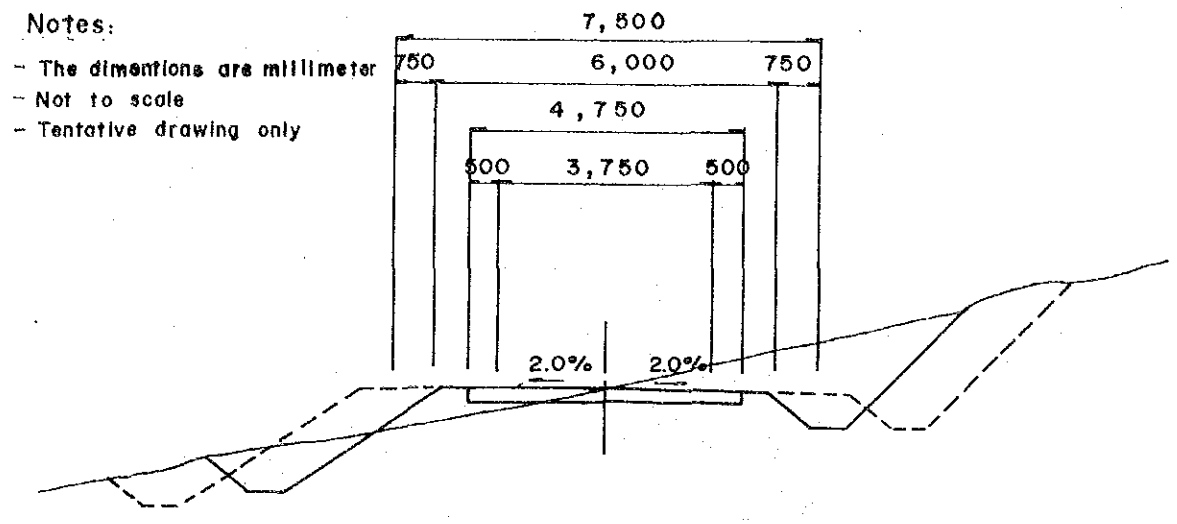


TYPICAL CROSS SECTION TO CONSTRUCT SINGLE LANE ROAD ON MOUNTAIN SIDE OF DOUBLE LANE ROAD

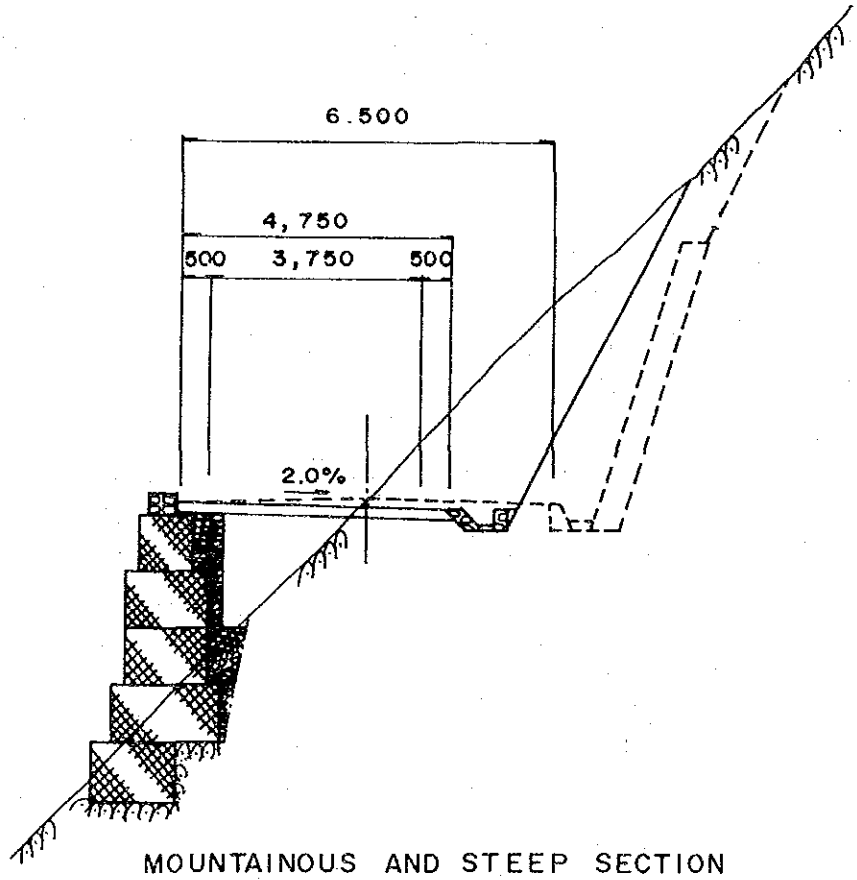
Notes:

- The dimentions are millimeter
- Not to scale
- Tentative drawing only

AFTERCARE STUDY FOR SINDHULI ROAD CONSTRUCTION PROJECT	**Figure 6-3** TYPICAL CROSS SECTIONS SHOWING ALTERNATIVE OF EXTENTION PLAN



LEVEL AND ROLLING SECTION

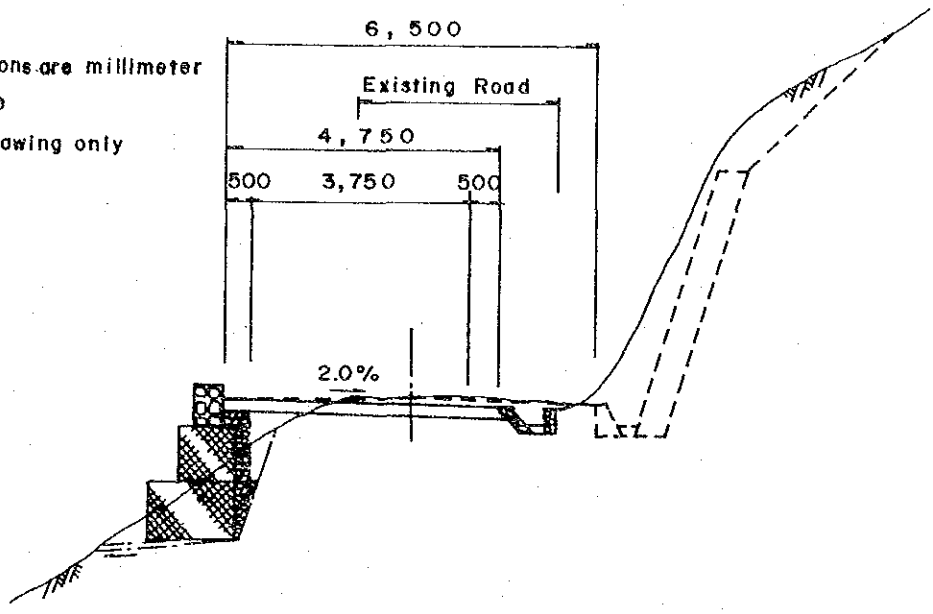


MOUNTAINOUS AND STEEP SECTION

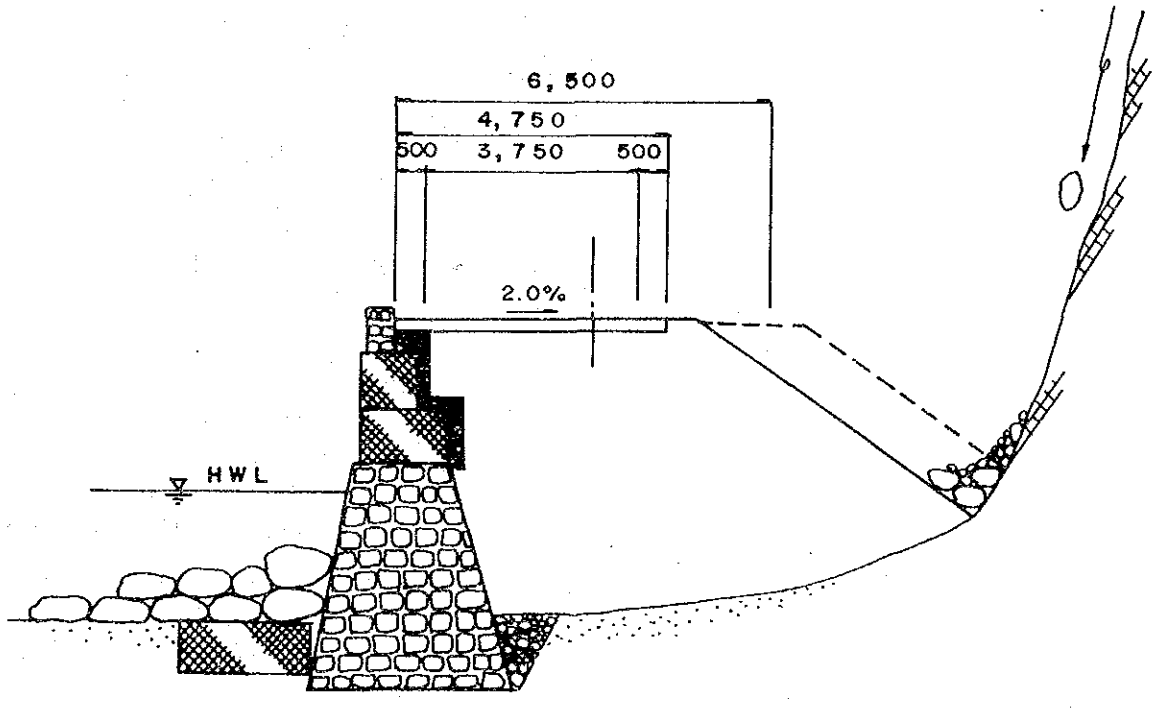
AFTERCARE STUDY FOR SINDHULI ROAD CONSTRUCTION PROJECT	**Figure 6-4 (1)** TYPICAL CROSS SECTION OF STAGE CONSTRUCTION

Notes:

- The dimentions are millimeter
- Not to scale
- Tentative drawing only



TYPICAL CROSS SECTION OF SINGLE LANE ROAD
ALONG EXISTING ROAD



TYPICAL CROSS SECTION OF SINGLE LANE ROAD
ALONG RIVER

AFTERCARE STUDY FOR SINDHULI ROAD CONSTRUCTION PROJECT	**Figure 6-4 (2)** TYPICAL CROSS SECTION OF STAGE CONSTRUCTION

6.4.3 Road Alignment

Basically, the proposed road alignments in the Study will follow those planned in the previous F/S, except the following sections;

(1) In the section where the bridges were planned in the previous F/S and those have been changed to causeways in the first stage of the stage construction alternative.

(2) In the sections where the alignment in the F/S did not follow the existing roads and footpaths, the proposed alignment in this study will be shifted to follow the existing road alignment.

(3) In the sections where the minor bridges were planned to span valleys in the F/S, the alignment will be shifted to the mountain side and the bridges will be altered to R.C. culverts.

(4) In the section where the existing serious disasters such as land slides and rock fallings are processing, the alignment will be modified to minimize the effect due to the disasters and to mitigate the risk by bypassing the area.

(5) In the sections where the alignment has hitted several permanent houses and buildings, the alignment will be modified to avoid the effect.

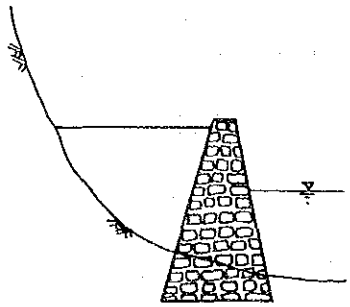
6.4.4 Retaining and Breast Walls, and Slope Protection

The retaining walls and slope protection will be designed based on the following concepts.

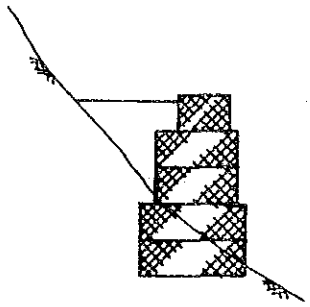
- To adopt the local materials and techniques such as gabion, dry stone pitching, stone masonry etc. as much as possible.
- To adopt the bio-technical stabilization method.
- To adopt the disaster mitigation structures such as gabion wall, surface and subsoil drains, etc. instead the prevention structures such as rock shed, rock bolts, rock fence, rock net and concrete spray adopted in the previous F/S Report.

The retaining and breast walls and slope protection structures to be adopted in the Project Road are shown in Figure 6-5.

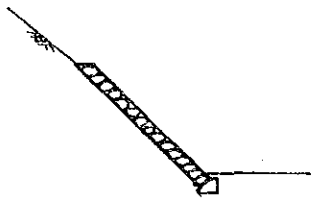
In the first stage construction as a single lane road, the breast walls will be provided to the minimum requisite sections only in order to avoid the double investment.



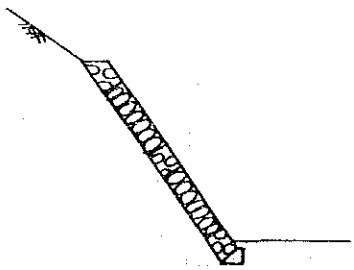
STONE CEMENT MASONRY RETAINING WALL (OR PLUN CONCRETE WALL)



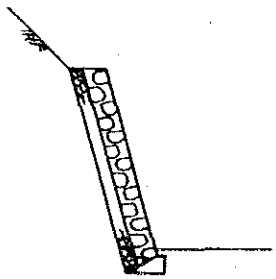
GABION RETAINING WALL



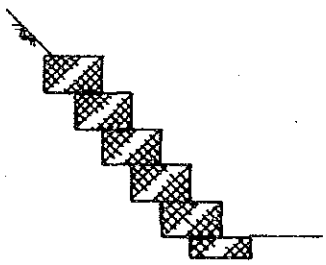
DRY STONE BREAST WALL



BANDED DRY STONE BREAST WALL



STONE CEMENT MASONRY BREAST WALL

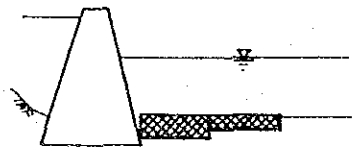


GABION BREAST WALL

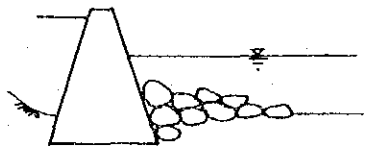
Notes :

— Not to scale

— Tentative drawing only



GABION MATRESS



BOULDER PROTECTION WORK

(TOE PROTECTION WORK IN RIVER SIDE)

AFTERCARE STUDY FOR SINDHULI ROAD CONSTRUCTION PROJECT	**Figure 6-5** APPLICABLE RETAINING WALL, BREAST WALL AND TOE PROTECTION

6.4.5 Drainage Structures

The high concentration of precipitation in the project area makes it very difficult to achieve a controlled and slow water run-off. The basic concept which is almost the same as that applied in the previous F/S is to collect not only the water from the slope above the road, but the whole road surface too in the mountain side side ditch and lead it to the nearest natural rivulet or brook. In addition, the following concepts are also taken into account:

- To adopt concentrated drainage system in hairpin bend sections,
- To apply inlet and outlet treatment works to the rivulet and brook, and
- To apply minimum dimension of sideditchs in the first stage construction of single lane road.

6.4.6 Pavement

In the preliminary design, the following two types of pavement will be considered as alternatives taking into account the initial traffic volume, and stage wise construction aiming the deduction of initial construction cost.

- **Gravel Surface.**

  Gravel Surface is considered as "The Lowest Grade Pavement" and is applicable to the Project in the initial stage, provided routine/ frequent maintenance and the future upgrading to bituminous penetration macadam (BPM) in the entire section. However, in steep longitudinal gradient section, bituminous surface treatment or other surface treatment is requisite from road serviceability and maintenance view point.

- **Bituminous Penetration Macadam**

  Bituminous surface treatment is considered as "Medium Grade Pavement" and is applicable to the Project, provided routine/periodical maintenance.

6.5 Possible Features of Major River Crossing Structures.

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

From the basic concepts mentioned in the previous section, concrete pictures for major river crossing structures are studied and the possible features are presented herein.

6.5.1 Basic Concepts for Selection of Major River Crossing Structures

(1) Application of Causeways in the First Stage

Basic concept for selection of major river crossing structures should basically depend upon natural characteristics at the crossing sites such as topography, river scale, catchment area, cross section, maximum high flood level, longitudinal gradient, flood velocity, etc. as well as the approach road alignment and construction condition.

The natural characteristics of river crossings sites in Section-I and Section-II are quite different in regarding topography, geology and river characteristics such as longitudinal gradient, type of river deposit and velocity. A brief natural characteristics of river crossing sites in Section-I and Section-II are summarized herein under.

Section	Topography	Geology		River Deposit			
		Zone	Characteristics	Longitudinal Gradient	Velocity	Deposit Type	Deposit Grading
I	Flat to Hill	Siwalik Zone	Neogene's sandstone and mudstone, soffrocks	0.5 to .2 (%)	2 to 3 (m/sec)	Coarse sand and Gravel	0.6 to 200 mm
II	Mountain	Mahabharat , Sunkosi-Tectonic, Chaunri Zone	The Mesozoic's hard rocks. But almost rocks have been weathered and decomposed to soft rocks. Faults, and joints have been developed.	3 to 6 (%)	3 to 6 (m/sec)	Gravel & Boulders	200 to 4000 mm

From the above findings, it is conclusive that the characteristics at river crossing sites in Section-I are in stable/gentle from topographic and geological view points and are of long flood duration with relatively high flood level resulting from the higher rainfall intensity, while those in Section II are primitive and harsh condition; (i.e. continuos process of debris deposite resulting from high probability of landslide),and are of flash type of flood with short duration.

Under such conditions, bridges are definitely required as a river crossing structure in Section-I to span the above rivers. While in Section-II, causeways which cope with the river conditions and are classified as a low cost river crossing structure are adopted to reduce the initial construction cost in the stage wise construction alternative, provided that (1) frequent maintenance (removal of debris) is required especially during monsoon season ,and (2) consequently inevitable traffic interruption will arise during peak flood period.

It is planned that the major causeways constructed in the first stage are replaced in the second stage by bridges in accordance with the basic concept of all weather road which is applicable to the full stage construction alternative and the second stage of the stage wise alternative.The replacement results in decrease of the traffic interruption and maintenance work volume remarkably.

(2) Alternatives of Bridge Development Scheme

As mentioned in Section 6.3, stage wise construction is likely to be practical and realistic taking into account the background and purposes of the Study. From the basic concept in terms of the stage wise construction method as well as the bridge cost which is relatively high, and the bridge function which is strategically important in road links, the following two alternatives are established for the further study.

(a) Minimal Scale Development Scheme (Alt - 1)

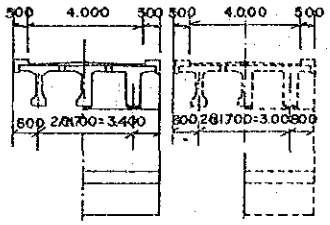
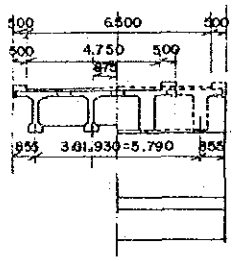
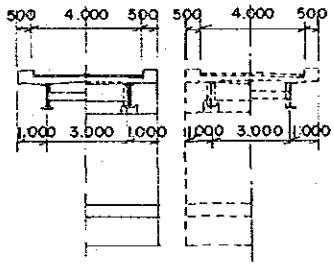
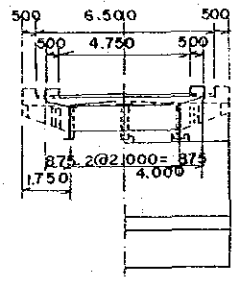
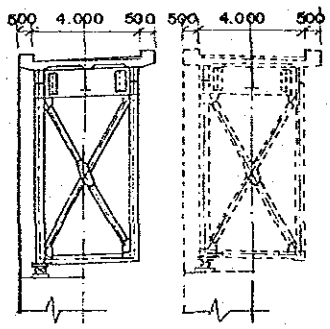
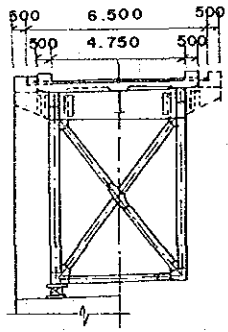
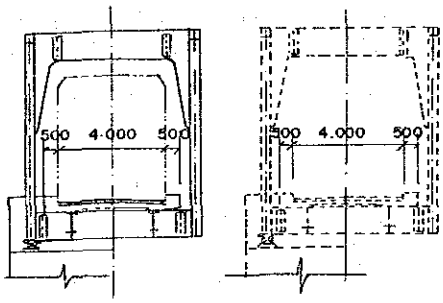
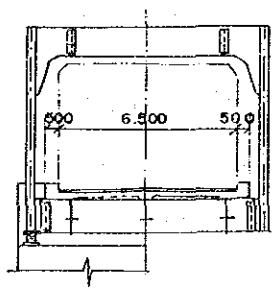
Recognizing expensive cost of bridge construction, roadway width of 4.0 m (3.0 m carriageway plus 0.5 m shoulders at both sides) which is exceptional case in the roadway typical cross sections is applied to this scheme. In the first stage, single lane bridge with 4.0 m wide will be constructed and the same type of bridge including substructure and superstructure will be constructed in the second stage, besides the first bridge location.

(b) Development Scheme Considering the Second Stage Widening (Alt - 2)

In the above minimal scheme, it is not cost effective to twice implement the temporary work such as coffer dams and river access roads installation, preparation and clearing of erection yard. In view of the above disadvantageous aspect, the development scheme considered the second stage widening is formulated. This scheme includes construction of full-substructure and partial-superstructure having 4.75 m road width in the first stage and provision of widening to dual lane (6.5 m wide) by installation of additional girders at one side or cantilever brackets at both sides.

It should be noted that a through type truss bridge is required to construct full width of 6.5 m at the first stage, because of the difficulty of widening.

The above two alternatives are illustrated by bridge type in Figure 6-6.

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 6-6
ALTERNATIVES OF BRIDGE DEVELOPMENT SCHEME

6.5.2 Possible Features of Major River Crossing Structures

Major river crossing structures are broadly divided into causeways and bridges. Possible features of these are studied and presented herein.

(1) Causeways

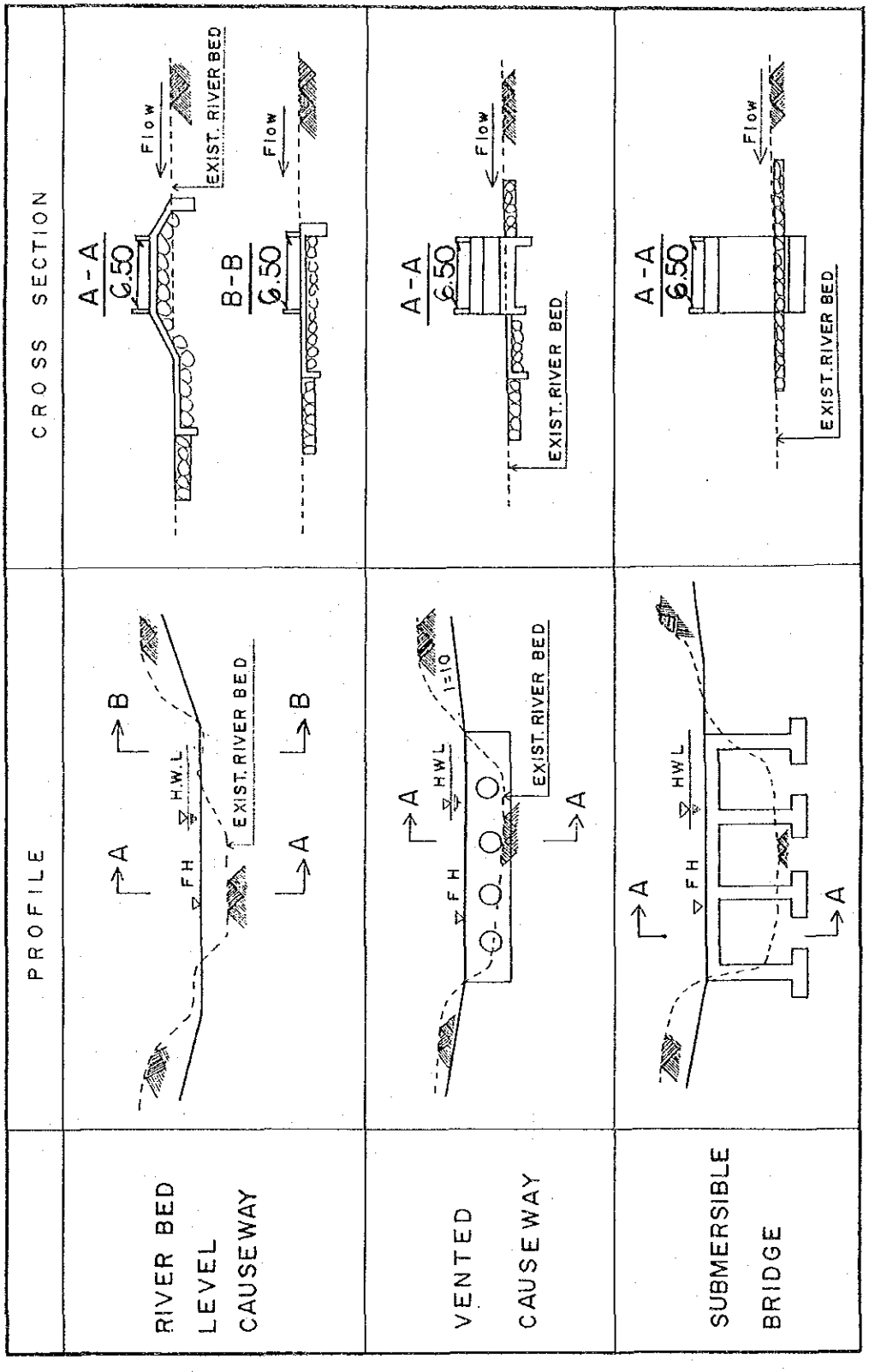
The causeways are classified into three types consisting of bed level type, vented type and submersible bridges. The application of these causeways depends on flood discharge, debris flow, flood velocity, flood depth, flood duration and cross section of a crossing site. The type of the causeway and the corresponding application criteria by the above parameters are summarized below:

Parameters / Type of Causeway	Application Criteria					
	Flood Run-of	Velocity	Flood depth	Duration of flood	Floating debris	Profile
Bed level causeway	Small to medium	Slow/fast	Shallow	Short	A little or considerable	Generally Flat
Vented causeway	Small to medium	Slow/fast	Shallow to deep	Short	A little	Flat
Submersible bridge	Considerable	Slow/fast	Considerably deep	Relatively Short	A little or considerably	Eroded Section

It is recommended to apply causeway width of 6.5 m since the initial stage taking into account rooms for river deposit and maintenance equipment. The typical cross section of each type of causeways is shown in Figure 6-7. Referring to the above application criteria, possible river crossing sites confirmed in the field reconnaissance are assessed and causeway type is tentatively selected for each site. The tentative selection results in this regard are tabulated in Table 6-1.

(2) Bridges

In general, bridge structures shall be adopted as river crossing structures in case as (a) considerable flood discharge, (b) long flood duration, (c) perennial river, (d) river cross section of deep valley shape.



AFTERCARE STUDY
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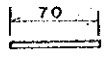
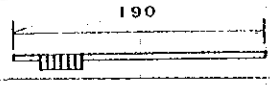
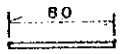
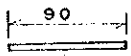
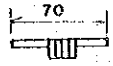
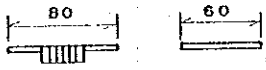
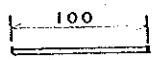
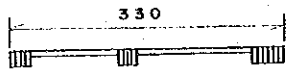
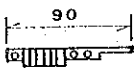
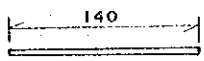
PROJECT

Figure 6-7
TYPICAL CROSS SECTION OF CAUSEWAY

Table 6-1 List of Major Causeways And Selected Types

Section	Name of Causeway	Station No.	Total length (m)	Type & Length of Causeway	Run of Peak (m^3/sec)	Prevailing reasons of selection (# 1)	Profile (# 2)
I	SHINDHUSE	282 + 10	70	BLC (70)	80	A-1	
II-1	ANDHERI	401 + 40	160	BLC + SB (120) (40)	390	D-2 E-2 F-2	
II-2	NIGAURI	43 + 80	190	BLC + SB (160) (30)	405	D-2 E-2 C-2 F-2	
	ARUBOTE	93 + 80	80	BLC (80)	301	D-1 F-1	
	KHAHARE	106 + 95	90	BLC (90)	108	D-1 F-1	
	BHOTE	153 + 95	70	BLC + SB (50) (20)	267	D-2 E-2 C-2 F-2	
	GANGATE	183 + 85	140	BLC + SB (110) (30)	343	E-2 C-2 F-2	
	DHAMILE	202 + 05	50	BLC + VC (20) (30)	500	D-2 E-1 C-2 F-2	
	SANDI	230 + 50	100	BLC (100)	170	D-1 C-1	
II-3	GHAMPE	12 + 20	330	BLC + SB (260) (70)	332	D-2 E-2 F-2	
	MANTI	41 + 80	90	BLC + VC + SB (30) (30) (30)	319	D-2 E-2 C-2 F-2	
	BHYAKURE	100 + 80	140	BLC (140)	442	C-1 F-1	

REMARKS

(# 1) : A-1 : Flood Volume is relatively small
A-2 : Flood Volume is realtively much
B-1 : Velocity is relatively slow
B-2 : Velocity is relatively fast
C-1 : Water depth is relatively shallow
C-2 : Water depth is relatively deep
D-1 : Duration of flood is realtively short
D-2 : Duration of flood is realtively long (Numbers of flood and time of impossible traffic)
E-1 : Floating debris is relatively a little
E-2 : Floating debris is relatively much
F-1 : Crossing river or main stream shape is flat
F-2 : Crossing river or main stream shape is channel

(# 2) : Bed Level Causeway (BLC)
: Vented Causeway (VC)
: Submersible Bridge (SB)

In selection of appropriate bridge types, the following evaluation aspects shall be taken into account ;

- Low construction cost
- Less maintenance
- Short construction period
- Easy construction

Referring to respective characteristics at each river crossing site, especially of availability of erection yard and access roads and the above evaluation aspects, following bridge types are tentatively selected:

- Prestressed Concrete Girders (P.C.G)
- Steel Beams (S.B.)
- Steel Deck Truss (S.D.T.)
- Steel Through Truss (S.T.T.)

For the span arrangement, the minimum span determined by the following formula, topographic and geological conditions, and river conditions including size of floating debris and boulders are considered:

The minimum span of bridge as per the peak run off discharge of rivers is as:

$$L=20+0.005\ Q$$

Where, L=Minimum span of bridge in meter

Q=Peak run off discharge of river in m^3/sec

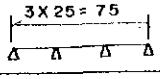
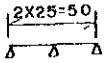
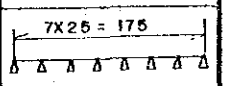
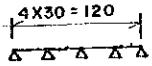
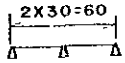
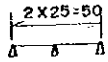
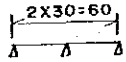
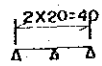
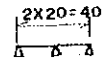
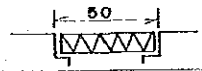
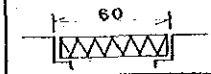
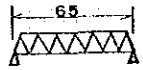
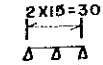
Based on the above initial study, bridge configuration and type of bridge at each of 17-major river crossing sites are outlined as listed in Table 6-2

It should be noted that sidewalk on a bridge will be provided if the bridge is located in populated area or in its proximity with institutional public facilities such as schools, hospitals, temples and other landmarks to the bridge.

6.6 The Development Scheme Alternatives

The alternatives of road and bridge elements such as no's of lane, river crossing structures, pavement structure, and slope protection were formulated in the previous sections. Based on combination of the alternatives of each element, Sindhuli Road's development scheme alternatives are established as listed below and a summary of these are tabulated in Table 6-3.

Table 6-2 List of Major Bridges And Selected Types

Section	Name of Bridge	Station No.	Total length (m)	Span Arrange-ment (m)	Type of Bridge	Availabity of erection yard	Run of Peak (m^3/sec)	Prevailing reasons of selection (# 1)	Profile (# 2)
I	BHOGATE	77 + 90	75	3@25	P.C.Beam	Available	199	R-1	
	KAREKARE	82 + 05	50	2@25	P.C.Beam	Available	157	R-1	
		82 + 90	25	1@25	P.C.Beam	Available		R-1	
	RATU	125 + 25	175	7@25	P.C.Beam	Available	960	R-1	
	KAMALA	289 + 60	120	4@30	P.C.Beam	Available	2,857	R-1	
	PHITTANG	323 + 65	60	2@30	P.C.Beam	Available	246	R-1	
	BUKA	344 + 40	50	2@25	P.C.Beam	Available	406	R-1	
	GADEULI	352 + 60	60	2@30	P.C.Beam	Available	779	R-1	
II-1	GWANGU	79 + 55	40	2@20	Steel Beam	Not Available	418	R-1 R-2	
	SIURANI	81 + 90	40	2@20	Steel Beam	Not Available		R-1 R-2	
		90 + 00	40	2@20	Steel Beam	Not Available		R-1 R-2	
II-3		31 + 10	20	1@20	Steel Beam	Not Available		R-1 R-2	
	DAUNE	135 + 85	50	1@50	Steel Deck Truss	Not Available	213	R-2	
	NARKE	159 + 50	60	1@60	Steel Deck Truss	Not Available	343	R-2	
	ROSI	213 + 15	65	1 @65	Steel Through Truss	Not Available	3,258	R-2	
		249 + 35	30	2 @15	(# 3) Steel Beam	Not Available		R-2	
		285 + 55	25	1@25	P.C.Beam	Available		R-1	

REMARKS (# 1) R-1 : Economical view point
R-2 : Short construction period
(# 2) : All the bridges are simply supported types applied.
(# 3) : This bridges shall be built with double lane as an exceptional case because widening is required due to small radius curvature widening of road plan curve.

ALTERNATIVE-1 STAGE WISE CONSTRUCTION OF MINIMAL DEVELOPMENT SCHEME

Single lane with gravel surface and minimal slope protection ,and minimal 1 lane bridges and causeways in the first stage. Widening to double lane with installation of bituminous pavement and full slope protection, and adding 1 lane bridge 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 1 lane bridge 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 to 2 lane bridge 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 1 lane bridges and causeways in the first stage. Widening to double lane with installation of full slope protection, and adding 1 lane bridge and replacement of causeways by bridges in the second stage.

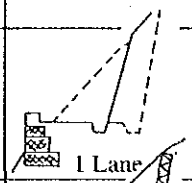
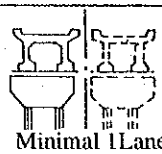
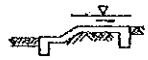
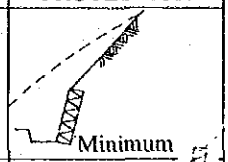
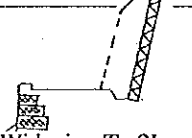
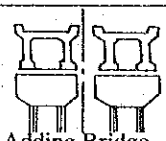
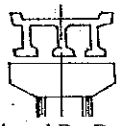
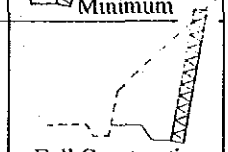
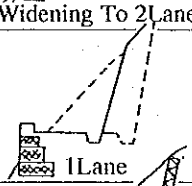
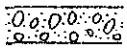
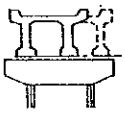
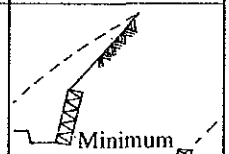
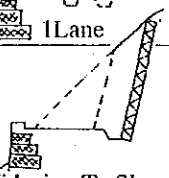
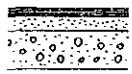
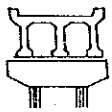
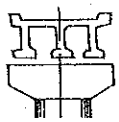
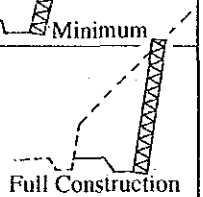
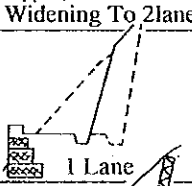
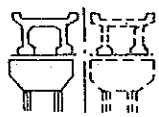
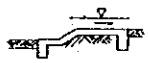
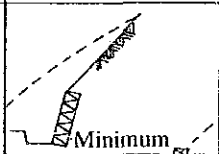
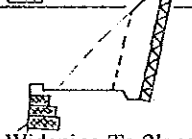
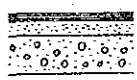
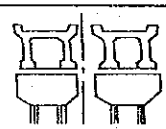
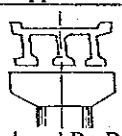
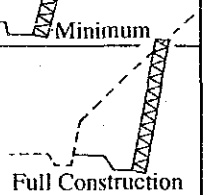
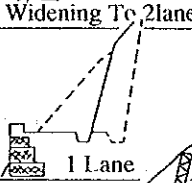
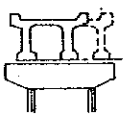
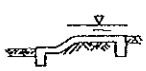
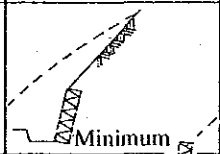
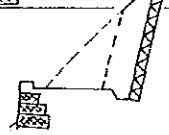
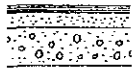
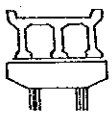
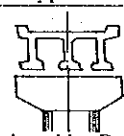
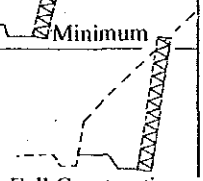
ALTERNATIVE-4 STAGE WISE CONSTRUCTION OF MEDIUM DEVELOPMENT SCHEME WITH BITUMINOUS PAVEMENT AND BRIDGE WIDENING

Single lane with bituminous pavement and minimal slope protection , and 1 lane bridge considering the second stage widening and causeways in the first stage. Widening to double lane with full slope protection, and widening to 2 lane bridge 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 2 lane bridges.

Table 6-3 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.

CHAPTER 7

PRELIMINARY DESIGN

CHAPTER 7

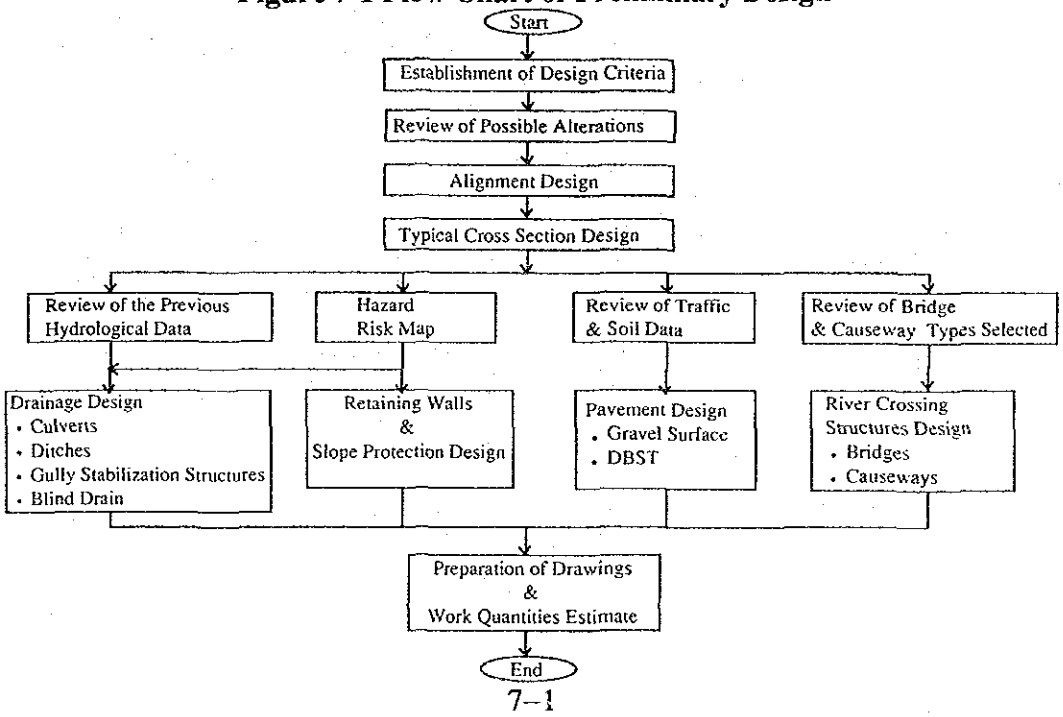
PRELIMINARY DESIGN

7.1 General

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. These study results are subsequently utilized in the construction planning project cost estimate and project evaluation.

Prior to conducting the preliminary design, design criteria are established and subsequently, review of the possible alterations identified in the field reconnaissance follows. At the beginning of the preliminary design, the alignment design is carried out for sections where the original alignments have been modified and the typical cross sections are scrutinized referring to basic concepts applied in formulating the development scheme alternatives. Following these design, river crossing structures design, pavement design, drainage design retaining, slope protection design are carried out simultaneously. Finally, the preliminary design drawings are prepared based on the above design results and the respective work quantities are estimated. The preliminary design flow is depicted in Figure 7-1 which also indicates the interrelationship of above work items.

Figure 7-1 Flow Chart of Preliminary Design



7.2 Design Criteria

In view of the project development scheme alternatives formulated in the previous Chapter, design criteria to be applied for the Project Road are established in this section referring to Nepal Road Standard (2027), those established in the previous F/S and the other relevant standards. The design criteria cover mainly geometric criteria, bridge design criteria, drainage design criteria and right of way requirements. Based on these criteria, the preliminary design is carried out in the succeeding sections.

7.2.1 Geometric Design Criteria

The geometric design criteria to be applied in the study is in principle based on NRS (2027) except where the standard is not clear, then the Japan Road Standard published by Japan Road Association is applied.

In establishing geometric design criteria, applicable design speed which directly affect the construction cost is carefully assessed taking into account not only the requirements stipulated in the above Standards, but also terrain where the project road runs through, the traffic volume estimated and the project viability. Based on the assessment results, the design speed is firstly determined and accordingly the other geometric elements are decided.

Geometric design criteria recommended to be applied in the Study are tabulated in Table 7-1.

Table 7-1 Geometric Design Criteria

	Classification of Terrain		
Geometric Elements	Flat/Rolling	Mountainous	Extremely Steep Section
Design Speed (km/hr)	40-50	30-40 $(20)_L$[1]	20
Super elevation (%)	2 $(4)_L$[2]	2 $(4)_L$[2]	2 $(4)_L$[2]
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_L[3] (at 20 km/hr)	10_L[3]
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 planed 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 the gravel road.

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

7.2.2 Bridge Design Criteria

Applicable Standards

The Design Standard to be applied for bridge design is in principle RNS (2027) published by Department of Roads of HMG. In case of no design specifications covered in NRS (2027), Highway Bridge Specification (HBS) published by Japan Road Association (JRA) shall be applied in the Study. However, local requirements arising from natural phenomenon such as wind, earthquake and temperature follow on the Indian Road Congress (I.R.C.) , Bridge Code.

Loads

Dead load, live load, impact fraction, wind load, earthquake load, thermal effects, stream current force and earth pressure are taken into account in the preliminary bridge and structure design.

Design Live Load

TL-20, which is equivalent to HS20-44 in AASHTO, shall be applied as design live load in accordance with HBS in Japan.

Seismic Load

Horizontal seismic coefficient of 0.14 shall be applied in accordance with Indian Standard, Criteria for Earthquake Resistant Design of Structure, Third Revision 1980.

7.2.3 Drainage Design Criteria

The review with regard to the hydrological study in the previous F/S report indicates that the analysis results are reliable and acceptable. Thus, these results are utilized in this Study expect the following criteria.

Return Period

Ten years and two years of return period shall be applied to culvert design and ditch design respectively.

Allowable Velocity

The minimum allowable velocity should be 0.8 m/sec to prevent sedimentation and the maximum velocity be 3.5 m/sec to avoid scour.

7.2.4 Right of Way (ROW)

The right of way width varies in general depending on the heights of cut and embankment. The minimum ROW width required for the Project road should be in collaboration with DOR and other Government Agencies concerned. In this regard, 50 m width for the whole section is determined in accordance with the HMG's regulation.

7.3 Highway Design

7.3.1 General

The preliminary highway design was conducted by means of Computer Aided Design (CAD) for the whole streches , using a topographic map with a scale of 1: 2,000.

The results of the preliminary highway design were presented in the following drawing forms and a set of the drawing is enclosed in Volume II Drawings as a separate booklet.

Drawings	Scale	Nos of Sheets
Plans	1:2,000	65
Profiles	V=1:500, H=1:2,000	139
Typical Cross Sections	1: 100	7

7.3.2 Methodology

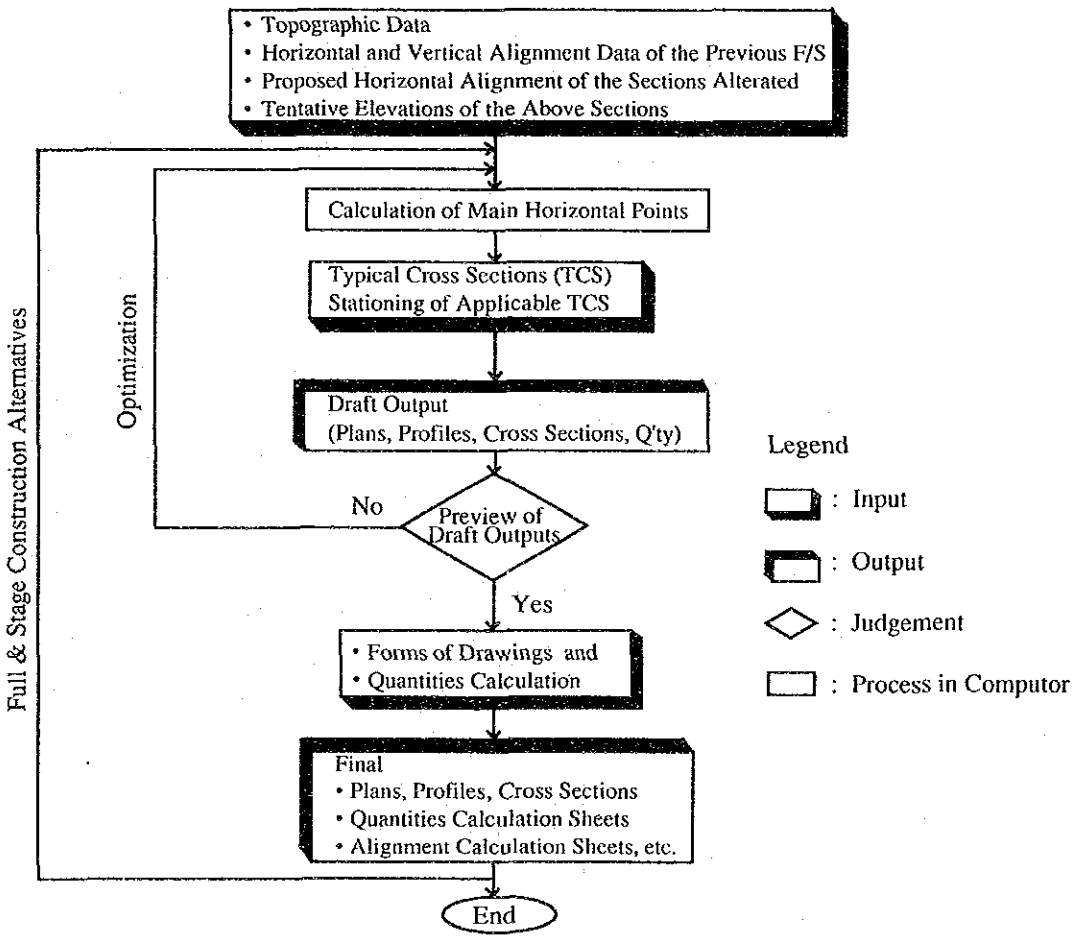
The highway design was carried out by means of Computer Aided Design (CAD) system for the respective alternatives mainly comprising of 1 lane case and 2 lane case. In this system, various data such as topographic data, the previous horizontal and vertical alignment data with the proposed horizontal alignment of altered sections, 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 work was repeated until optimizing the road elements. After the optimization work, final plans showing horizontal alignment, profiles, individual cross sections were outputted in a form of drawings by means of CAD system.

The above design work was carried out for each alternative of 1 lane and 2 lane and various work quantities such as cut and fill volumes, slope protection, retaining walls are also calculated in the system.

The above highway design flow is depicted in Figure 7-2 which also indicates interrelationship of the above work items.

Figure 7-2 Flow of Highway Design



7.3.3 Design Speed

Referring to the geometric design criteria established in the previous Section 7.2, the design speeds ranging from 50 km/hr to 20 km/hr were adopted according to the terrain where the route passes through. A summary of design speed applied to respective stretches are shown in Table 7-2.

Table 7-2 Summary of Design Speed Applied

Section	Stretch	Length	Dominant Design Speed	Minimum Design Speed
Section-I	Sta 00-Sta 37	35 km	40 km/hr	30 km/hr
Section II-1	Sta 00-Sta 7	7 km	30 km/hr	-
	Sta 7-Sta 37/1	30 km	30 km/hr	20 km/hr
	Sta 37 -Sta 39	2 km	30 km/hr	-
Section II-2	Sta 0-Sta 6	6 km	30 km/hr	-
	Sta 6-Sta 14/1	8 km	30 km/hr	20 km/hr
	Sta 14-Sta 30	16 km	30 km/hr	-
Section II-3	Sta 0-Sta 31	31 km	40 km/hr	-
	Sta 31- Sta 47/1	16 km	30 km/hr	20 km/hr

Notes; /1 The design speed of 20 km/hr was adopted as an exceptional case for (i) the hairpin bend sections and the section where terrain is extremely steep.

7.3.4 Alignment Design

Due to the very severe natural preconditions in the mountains of the Project area, the choice of alignment should be made very carefully to find the best alternative within the 30m band taking into account the road's function, safety for traffic, its service life, influence on the environment, and its economy.

In the alignment design, possible re-alignment sections identified in the field reconnaissance were firstly scrutinized referring to the design criteria, hazard risk map, location and elevation of the major structures, environmental parameters causing adverse effects.

On the basis of these refinement works, the following sections were selected to revise the previous alignments in the F/S Report.

(1) Sections where realignment was made in relation to the alteration of river crossing structures from bridges to causeways (This realignment is applicable only in the first stage.)

It is planned that the sections in which the major causeways are replaced by bridges will be realigned again to the original position in the second stage.

(2) Sections where realignment was made so as to reduce the cut and fill volumes.

(3) Sections where realignment was made due to extremely steep topography and/or fragile geology in order to minimize the environmental adverse effects.

(4) Sections where realignment was made to minimize land acquisition and compensation cost.

In terms of the road width, the following are exceptional sections regardless the stages.

(1)Sections where double lane width is applied even in the first stage considering difficulty of the future widening.

Sections		
Section II-1	Section II-2	Section II-3
Sta 114.0-Sta 115.25(L=125m)	N/A	Sta 126.90-127.15(L=25m)
Sta 134.25-Sta146.00((L=1,175m)		Sta 251.25-Sta 251.75(L=50m)
Sta 161.75-170.00(L=825m)		Sta 268.60-268.90(L=30m)
Sta 229.50-Sta 230.0(L=50m)		
Sta 233.95-234.0(L=100m)		
Sta237.00-Sta 237.50(L=50m)		
Sta 240.75+Sta241.50(L=75m)		
Sta 245.25-Sta 246.00(L=75m)		
Sta 249.00-250.00(L=100m)		
Sta 264.25-Sta278.50(L=1,425m)		
Sta 283.75-Sta 293.50(L=975m)		
Total L=4,975 m		Total L=105 m

(2) Sections where single lane is applied even in the final stage and the full construction alternative taking into account magnitude of the hazard risks

Sections

Section II-1	Section II-2	Section II-3
Sta183.50-193.25(L=975m)	Sta75.00-82.50(L=750m)	Sta134.00-137.75(375m)
Sta200.50-211.25(L=1,075)	Sta139.00-145.00(L=600m)	
Sta278.75-283.75(L=500m)	Sta152.50-158.25(L=575m)	
Sta296.25-302.00(L=575m)	Sta238.00-242.00(L=400m)	
Sta326.75-330.25(L=350m)		
Total L=3,475m	L=2,325m	L=375m

7.3.4 Cross Section Design

(1) Typical Cross Section Design

As already mentioned, the alignments were basically fixed in a way to achieve a mass balance within a sectional area and the single lane road in the stage construction alternative is widened to the M/S in the 2nd stage in principle taking into minimizing the adverse environmental effects and double investment.

Referring to the final alignment selected, the typical cross sections were classified into the following three types and configuration of respective types were designed with the corresponding design concepts as outlined below;

Type of Section	Application Criteria	Design Concept
Fill Type (1)	River side sections along the Sun Kosi River and the Rosi River	Fill(H1.5:V1.0) with vegetation and provision of room for falling debris in the M/S, and installation of solid revetment structure in the R/S.
Half Cut and Half Fill Type(1)	Half cut and half fill sections in flat and rolling terrain	Fill (H1.5:V1.0) with sodding and provision of lined ditch at slope toe in the R/S, and cut (H1.0:V1.0 in common soil) and provision of lined side ditch in the M/S.
Half Cut and half Fill Type(2)	Half cut and half fill sections in mountainous terrain	Provision of gabion retaining walls in the R/S and cut slope(H0.3:V1.0) with various types of breast walls depending on subsoil conditions

Notes: M/S means mountain side. R/S means river side.

Respective typical cross sections mentioned in above are shown in Volume-II -Drawings.

(2) Cross Section Design

Based on stationing applicable typical cross sections for the whole stretch, individual cross sections were taken off from the topographical map with a scale of 1:2,000 and drawn in a scale of 1:200. The interval of cross section was 25 m. The cut and fill area at each station were computed in the computer and earth volumes were derived from those by the End Area Method.

7.4 River Crossing Structures Design

7.4.1 General

River crossing structures are broadly divided into bridges and causeways. The former are applicable to the inevitable sites where the causeways will not cope with the river conditions. The latter are applied to the river sites and creeks, that have flash type flood. The causeways are applied in the initial stage of the stage construction alternative and a part of them, which are crossing large to medium scale rivers, are replaced by bridges in the final stage

In the river crossing structure design, structure types and their configuration which were tentatively determined in Chapter 6 were scrutinized referring to bridge planing criteria and bridge alternative study results presented in the previous F/S report and taking into account the final alignment selected and the river conditions. Subsequently, individual structures were designed in preliminary level based on the design criteria and relevant standards. The design results are presented in a drawing form as attached in Volume II and the work quantities were estimated as attached in Appendix-F accordingly.

The river crossing structures are divided into three scale groups depending on total structure length as defined below.

Major Structure----------Total structure length > 50m
Medium Structure----------20m<Total structure length <50m
Minor Structure----------10m<Total structure length < 20m

7.4.2 Bridge Design

(1) Scrutiny of Bridge Types Selected

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 view points, provided that 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 to the bridge site where 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 fabrication yard is not available and the accessibility is poor, i.e. work progress of the bridge construction interfere with road construction progress beyond the bridge site.

In light of the above principle, the bridge type, tentatively selected in the previous Chapter was reviewed and after the bridge configuration 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 following bridge types and configurations were selected for preliminary bridge design.

Table 7-3 List of Bridge Selected

Station	Name of Bridge	Type	Length	Main Reason of Bridge Type Selected
SECT-I				
78+35.0	Bhogate	PCCB	50.0m=2@25	Availability of fabrication yard and good accessibility
82+30.0	Karekare	PCCB	40.0m=2@25	ditto
126+87.5	Ratu	PCCB	175.0m=7@20	ditto
291+50.0	Kamala	PCCB	120.0m=4@30	ditto
323+90.0	Phittang	PCCB	50.0m=2@25	ditto
343+20.0	Buka	PCCB	50.0m=2@25	ditto
351+35.0	Gadeuli	PCCB	50.0m=2@25	ditto
SECT-II-1				
80+00.0	Gwangu	HBCB	40.0m=2@20	No fabrication yard and poor accessibility
82+30.0	Siurani	HBCB	40.0m=2@20	ditto
90+30.0		HBCB	20.0m=1@20	ditto
SECT-II-3				
32+00.0		HBCB	20.0m=1@20	ditto
133+50,0	Daune	D.Truss	50.0m	ditto
162+97.3	Narke	D.Truss	55.0m	ditto
216+75.0	Rosi	T.Truss	65.0m	ditto
252+ 2.5	Dapcha	HBCB	25.0m=1@25	ditto
288+30.0		PCCB	20.0m=1@20	Availability of fabrication yard and good accessibility

Notes PCCB means prestressed concrete composite beam bridge.
HBCB means H sharp beam bridge.
D. Truss means Deck type steel truss bridge.
T.Truss means Through type steel truss bridge.

It is noted that each bridge has two alternatives consisting of minimal scale development scheme and development scheme considering the second stage widening by superstructure.

(2) Bridge Design

In the preliminary bridge design, beam arrangement of each bridge type was firstly assessed for each alternative referring to bridge design data and main dimensions of superstructure such as deck slab thickness, beam size were analyzed according to the design criteria. Secondly, stability calculation of substructure comprising abutments and piers was carried out based on design criteria, reaction force, and soil data to determine dimensions of each structure. Finally, all the analysis results were transferred to a drawing form as listed below:

Title of Drawings	No of Sheets
General View of Major Bridge	9
Standard Medium Scale Bridge	2

7.4.3 Causeway Design

(1) Scrutiny of Causeway Types Selected

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 a part of them 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).

To this end, the causeway type and length were tentatively determined based on the flood information obtained from the field interview, the field distance measurement, the qualitative application criteria of the respective causeways.

In this subsection, the above application criteria was reviewed to establish as qualitative as possible and the previous study results were scrutinized based on the profile of river crossing site taken from leveling survey, in addition to the flood information.

Type of Causeway	Application Criteria
River Bed Level Causeway	Normal flood depth is shallow, say less than 2 m,. Flood duration per a flood is short, say less than 2 hr. and flood frequency during rainy season is not often ,say less than 10 times/ 3 months rainy season. Drifting logs and debris flow are accepted.
Vented Causeway	Flood condition is more or less the same as the above , but it is desirable to apply this type to perennial streams without drifting logs and debris flow.
Submersible Bridge	Normal flood depth is relatively deep ,say more than 2m but less than 4m, Flood duration per a flood is relatively short, say less than 5-6 hr flood frequency during rainy season is not often, say less than 10 times. It is desirable to apply this type to perennial streams without drifting logs.

Referring to the above application criteria, suitable causeway type was selected 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 2nd stage are also identified from maintenance view point,(i.e. it is inevitable to interrupt the traffic due to peak flood and river deposits during and after the flood in the causeway over several times during rainy season and consequently to reduce traffic benefit. In order to minimize the traffic interruption, major causeways are planned to be replaced by the bridges.)

Following is a list of the causeways together with the 2nd stage replacement plan.

Table 7-4 List of Causeways with the 2nd Stage Replacement Plan

Station	Initial Stage Causeway Type	Length	2nd Stage Bridge Type(Name)	Length
SECT-I				
172+50.0	RBLC	60.0M	N/A	-
183+75.0	RBLC	30.0M	N/A	-
194+20.0	RBLC	40.0M	N/A	-
201+20.0	RBLC	40.0M	N/A	-
212+00.0	RBLC	30.0M	N/A	-
217+90.0	RBLC	30.0M	N/A	-
223+35.0	RBLC	30.0M	N/A	-
226+90.0	RBLC	40.0M	N/A	-
229+80.0	RBLC	60.0M	N/A	-
234+45.0	RBLC	60.0M	N/A	-
239+15.0	RBLC	40.0M	N/A	-
246+60.0	RBLC	80.0M	N/A	-
250+15.0	RBLC	80.0M	N/A	-
258+65.0	RBLC	30.0M	N/A	-
261+00.0	RBLC	30.0M	N/A	-
265+90.0	RBLC	80.0M	N/A	-
272+55.0	RBLC	50.0M	N/A	-
282+95.0	RBLC	40.0M	PCCB(Shindhuse)	50.0M=-2@25
SECT-II-1				
378+50.0	RBLC	30.0M	N/A	-
376+15.0	RBLC+VC	100+35=135M	PCCB(Andheriel)	125M=5@25
381+40.0	RBLC	30.0M	N/A	-
SECT-II-2				-
3+85.0	RBLC	50.0M	N/A	-
18+50.0	RBLC	20.0M	N/A	-
23+25.0	RBLC	20.0M	N/A	-
54+51.0	RBLC+VC	182+8=190M	PCCB(Nigauli)	150M=6@25
108+85.0	RBLC	70.0M	PCCB(Arubote)	100M=5@25
121+45.0	RBLC	90.0M	PCCB(Khahare)	50M=2@25
167+55.0	RBLC+VC	40M+30=70M	PCCB(Bhote)	75M=2@25
201+81.0	RBLC+VC	212+36=248M	PCCB(Gangate)	50=2@25,25M
219+80.0	RBLC+VC	20M+30M	PCCB(Dhamile)	75M=3@25M
247+55.0	RBLC	90.0M	PCCB(Sandi)	100M=4@25M
SECT-II-3				
13+62.5	RBLC+SB	270+55=325M	PCCB(Ghyampe)	300=10@30M
40+95.0	VC+SB	50M+40M	PCCB(Mamti)	100=4@25M
98+92.5	RBLC	125.0M	PCCB(Bhyakure)	100=4@25M
102+75.0	RBLC	50.0M	PCCB	40=2@20M
113+43.0	RBLC+VC	81+25M	N/A	-
195+95.0	RBLC	30.0M	N/A	-

Notes: RBLC means River Bed Level Causeway.
VC means Vented type Causeway.
SB means Submersible Bridge.
PCCB means Prestressed Concrete Composite Beam Bridge.
N/A means Not Applicable.

(2) Causeway Design

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

Typical sections of respective causeways are illustrated in Volume II - Drawings.

7.5 Drainage Structure Design

7.5.1 General

The project road runs through steep mountainous terrain and the annual average rainfall in the project area is assumed to vary from 1,000 mm to 1,500 mm in Section-II and from 2,000 mm to 2,500 mm in Section-I. In these conditions, the extremely high concentration of precipitation makes it very difficult to achieve a controlled and slow water run-off. Taking into account the possible road disasters mainly due to poor water management, it is essential to install adequate drainage facilities to keep the road function and to minimize maintenance cost, even in the initial stage of the stage wise construction alternative.

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

7.5.2 Cross Drainage Structure Design

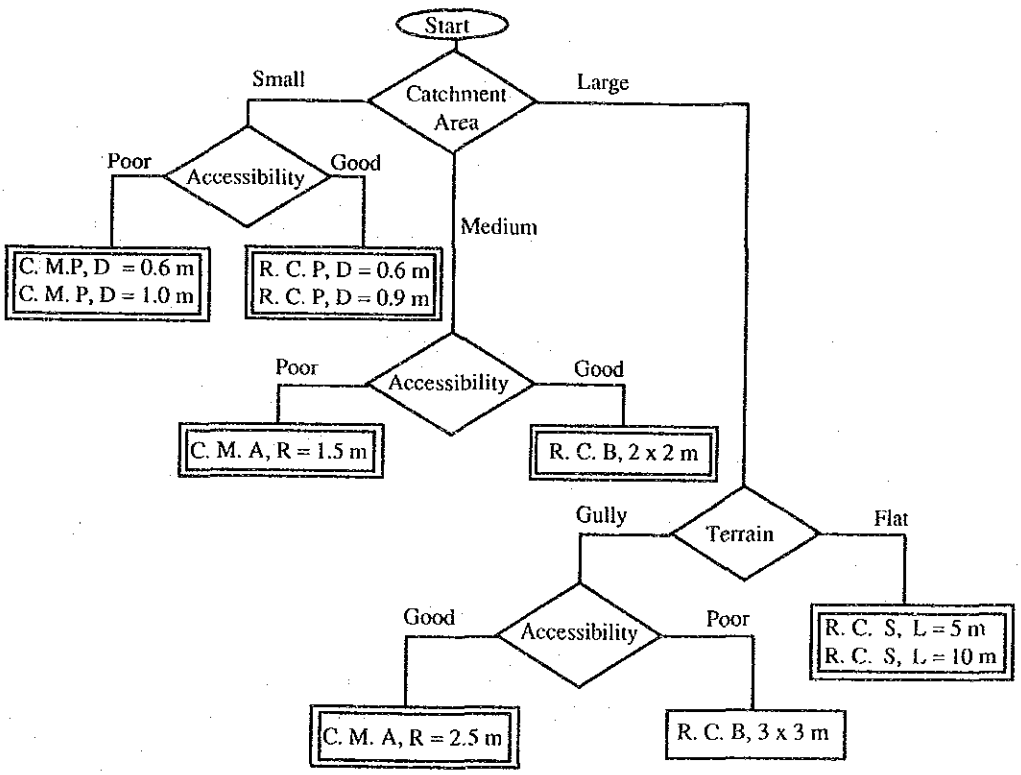
The cross drainage structures applied in this Study included the following 9 types:

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 gully shape or flat shape.

Taking into account above three selection parameters, selection flow of the drainage structures is depicted in Figure 7-3.

Figure 7-3 Selection Flow of Drainage Structures



7.5.3 Ditch Design

The basic principle in the mountain road design is to collect not only the water from the slope above the road, but the whole road surface water too immediately in the side ditch and lead it to the nearest natural rivulet or the cross drainage structures Therefore, side ditches should be provided in all the cut sections at the M/S and in the fill sections at the toe of the R/S slope in principle and are lined by grouted rip rap to prevent erosion and to provide easy maintenance.

The following four types of side ditches are designed with the corresponding application criteria.

(i) Side Ditch in Cut Sections

Type A(Trapezoidal section W=50 cm, D=30 cm) is applicable to all the cut sections in the initial stage and was designed considering provision of the minimum requirements , since this ditch is demolished in the 2nd stage.

Type B(Trapezoidal section W=75cm, D=50 cm) is applicable to all the cut section in the 2nd stage and the full construction alternative.

(ii) Side Ditch in Fill Sections

Type C (Rectangle section W=40 cm, D=30 cm) is installed at toe of the fill slope which is located beside rice field in order to not only use irrigation channel but the toe protection.

Type D(Trapezoidal section W=140cm, D=30cm) is installed at toe of the fill slopes to drain the water from road surface to the nearest rivulets.

7.5.4 Other Drainage Facilities Design

The drainage facilities classified in the others are gully stabilization structures and sub-surface drains.

(1) Gully Stabilization Structures

Where side drain water is discharged into a rivulet or brook, the previous run off volume is considerably increased and side as well as depth erosion of the gully is the consequence. Therefore, gully stabilization structures made by series of checkdams or checkwalls (so called as "Cascade") as a energy dissipater have to be provided at such gullies as far down as they are endangered in erosion in order to break the velocity.

The gully stabilization structures applied in the Study are divided into check wall type and checdam type depending on a scale of the gully.

(i) Checkwall Type (Cascade)

This type is applicable to a small scale gully in general and consists of series of checkwalls and aprons made by gabion or grouted rip rap. The gabion checkwall type is applied to the small scale gully in flat to rolling terrain, while the rip rap checkwall type is in mountainous terrain.

(ii)Checkdam Type

This type is applicable to a medium to large scale gully and comprises series of gabion checkdams and aprons. The checkdams should not be higher than 4m in order to avoid a too high water energy built up. The crown of the checkdam as well as its steps are protected by concrete or masonry slabs too where the water flows to avoid the destruction of the gabion wire

(2) Sub-Surface Soil Drain

Where seepage is expected and sections run beside a rice field, sub-surface drains are provided beneath side ditch installed at cut sections in order to prevent saturation of the pavement materials

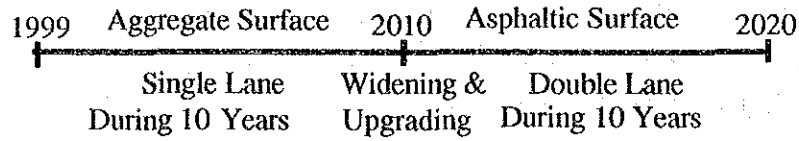
7.6 Pavement Design

7.6.1 General

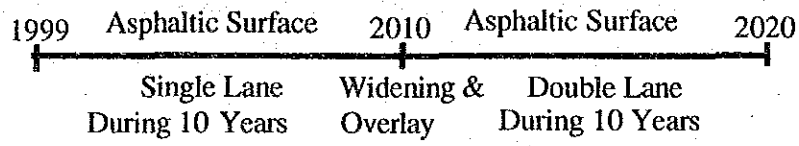
The pavement structures including several alternatives for the project road were designed in accordance with the AASHTO GUIDE FOR DESIGN OF PAVEMENT STRUCTURES, 1986.

The pavement alternatives applied in the Study consist of aggregate surface and cold mixing asphalt surface (penetration macadam) as stated in the previous Chapter. Taking into account these alternatives and the other development scheme alternatives such as number of lanes and timing of asphalting as well as traffic volume estimated, the following design cases were formulated in the design.

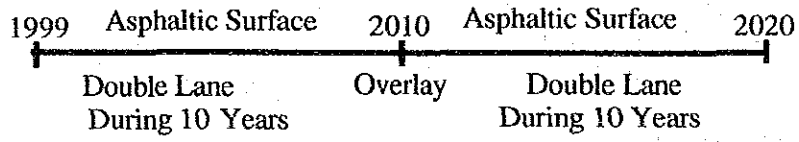
Case-1- 1 lane with aggregate surface and the future widening to 2 lane with asphalted surface.



Case-2 1 lane with asphalted surface and the future widening to 2 lane with the same surface type.



Case-3 2 lane with asphalted surface and the future overlay by the same surface type.



7.6.2 Design Condition

The following design conditions were applied in the pavement design.

(1) Traffic Load

The traffic load are based on cumulative expected 18-kip equivalent single axle loads(ESAL) during design period. The mixed traffic volume estimated in Chapter 2 were converted into the 18 kip ESAL units and the results are shown in below.

Case	Section	ESAL in the first 10 years	ESAL in the last 10 years
Case-1	Section-I	1,550,000	2,964,000
	Section-II	1,468,000	2,975,000
Case-2	Section-I	1,550,000	2,964,000
	Section-II	1,468,000	2,975,000
Case-3	Section-I	1,299,000	2,964,000
	Section-II	1,229,000	2,975,000

(2) Indices and Engineering Values

The following indices and engineering values are applied for each section in the design.

Indices and Engineering Value		Section-I	Section-II
Reliability,R		80%	80%
Overall Standard Deviation So		0.45	0.45
Effective Resilient Modules of Roadbed Material, MR		10,600 (CBR=15)	7,300 (CBR=8)
Design Serviceability Loss		2.5	2.5
Structural Number,SN	Case-1	N/A(3.2)	N/A(3.6)
	Case-2	3.0(3.2)	3.3(3.2)
	Case-3	2.9(3.2)	3.2(3.2)

Note: The figures in ( ) indicate SN in the last 10 years.

7.6.2 Pavement Structures

In accordance with the above design conditions, respective pavement structures were designed as attached in Appendix-F 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

7.7 Slope Protection Design

7.7.1 General

The design concept with regard to slope protection applied in this Study is broadly divided into two categories, one is applicable for the initial stage of the stage wise construction alternative and the other is for the 2nd stage construction and for the full construction alternative of 2 lane highway. 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 the M/S in the 2nd stage. The latter is installation of full scale protection work wherever sections are required at both sides. In addition to the above concept, followings are applicable to all the stages.

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

The slope protection works are mainly twofold;

(1) Cut slope protection by breast walls, slope treatments such as guite shooting, concrete frame with rock anchors.

(2) Fill slope protection by retaining walls, slope treatments such as sodding, concrete rip rap, etc.

7.7.2 Cut Slope Protection

As mentioned in above, the applicable cut slope protection work is divided into two categories comprising of the minimal scale under the single lane case and the full scale under double lane case.

(1) Minimal Scale Cut Slope Protection Under Single Lane Case

-Banded Dry Stone Masonry --------This type of breast wall is applicable to where rock fissures developed regularly is expected and where the slant direction of these fissures coincides with slant direction of the face of the cut slope. Range of height shall be less than 8.0m and front batter is H 0.3: V 1.0.

(2) Full Scale Cut Slope Protection Under Two Lane Case

-Dry Stone Breast Wall-------Is installed where soil classification is common soil in flat and rolling terrain and constant height is 1.0m with front batter of H 0.3 : V 1.0. Above the wall, cut slope treated by sodding.

-Banded Dry Stone Masonry ------Is applicable to where soil classification is common soil in mountainous terrain and where rock fissures developed regularly and where the slant direction of these fissures coincides with slant direction of the face of the cut slope. Range of height shall be less than 8.0m front batter is H 0.3:V 1.0.

-Concrete Frame with Rock Anchor Breast Wall --------Is applicable to where rock fissures extremely developed is expected and which the slant direction coincides with slant direction of the face of the cut slope. Range of height shall be less than 8m and the front batter is the same as the above.

-Stone Masonry Breast Wall --------Is applicable to where colluvial deposit is expected. Range of height shall be less than 6m and the front batter is H 0.3 : V 1.0.

-Gabion Breast Wall ----------Is applicable to where soft foundation and seepage condition is assumed. Range of height shall be less than 6m and the front batter is H 0.5: V 1.0.

-Gunite Shooting----------Is installed above the breast walls and where rock fissures developed is assumed on cut slope of H 0.5:V 1.0.

-Gunite Shooting with Rock Anchors---------Is installed above the breast walls and rock fissures extremely developed and which the slant direction coincides with slant direction of the face of the cut slope

It is noted that alignments of certain stretches where huge amount of falling debris are expected have been shifted to R/S and run along the river bank with room for the debris.

7.7.3 Fill Slope Protection

Because of limited access roads for the construction, especially in Sections II-1 to II-2, the development concept with regard to local material usage, and steep topography and fragile geology in most of the project area, gabion walls are applied in principle, with exceptional sections. They act as a homogeneous and monolithic system and are very flexible against deformation without losing its strength.

In the above mentioned exceptional sections that alignment runs through flat and rolling terrain, fill slopes are protected by installation of vegetation, and in the alignment running along the Rivers, fill slopes are retained by solid masonry structures.

As a summary , the following types of fill slope protection were applied in this Study.

-Gabion Retaining Wall Without Rock Anchors----------Is applicable to most of the sections, except where topography is flat and geology is stable. Range of height shall be less than 5.0m and the front batter is H 0.1:V 1.0.

-Stone Masonry Retaining Wall ----------Is applicable where the alignment runs on the river banks along the Sun Kosi River and Rosi Khola. The front batter and embedded depth are determined based on the runoff discharge and the local scouring effect. Height of the wall above the river bed depends on high water level and free board. Armored stones and gabion mattress are also provided as a foot protection at toe of the wall.

Concrete Rip rap----------Is applicable to the fill slopes above the Stone Masonry Retaining Wall at the above sections with a slope of H 1.5:V 1.0 to prevent the surface erosion

Vegetation----------Is applicable to all the fill slopes except the above sections

It should be noted as a special case that series of gabion retaining walls with adequate berms are provided at the sections running on deep gullies.

7.8 Drawings And Work Quantities

All the results of the preliminary design were compiled in a drawing form as enclosed in VolumeIII- Drawings, while the work quantities of the major pay items were also estimated as attached in Appendix -F.

CHAPTER 8

CONSTRUCTION PLANNING AND FORMULATING DOR'S MAINTENANCE FORMATION

CHAPTER 8

CONSTRUCTION PLANNING AND FORMULATING DOR'S MAINTENANCE FORMATION

8.1 General

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

Furthermore, DOR's maintenance formulation including the offices, staffing equipment for Sindhuli Road are presented based on assessment of the maintenance work items and assumed quantities after completion of the Road.

8.2 Construction Plan And Method

(1) Construction Section

The four construction sections as divided in the previous F/S report were applied in this study The sections were determined due consideration of topographical condition, section length and work volumes, difficulty of the construction, and location of towns and villages, and these sections are as follows:

Section	From Town To Town		Length
Section I	Bardibas-Sindhuli Bazar		37 km
Section II-1	Sindhuli Bazar - Khurkot		39 km
Section II-2	Khurkot - Nepalthok		32 km
Section II-3	Nepalthok - Dhulikhel		50 km
		Total	158 km

(2) Basic Conditions

Following basic conditions are taken into account in the construction planning.

-Rainy season from June up to the end of September

-Following access roads are considered to be usable with specific conditions.

Access Routes	Specific Conditions
Banepa-Shreekhandapur-Buchakot-Bhakundebesi Road	Usable but requires the maintenance and strengthening work of the two existing bridges
Roshi Khola River Bed from the Junction with Dapcha Khola to Nepalthok	Usable only during dry season, except a few sections
Sunkoshi River Bed Route From Nepalthok to Khurkot	Usable only during dry season

-The construction for Section - II is tackled from the both ends.

-Mechanical construction method is applied to the work items of earth work, base and subbase courses, and structural excavation in principle.

-Labor intensive construction method is applied to the work items of retaining walls, drainage structures,, and slope protection.

-Bridges are erected using track cranes together with supporting.

(3) Typical Construction Methods

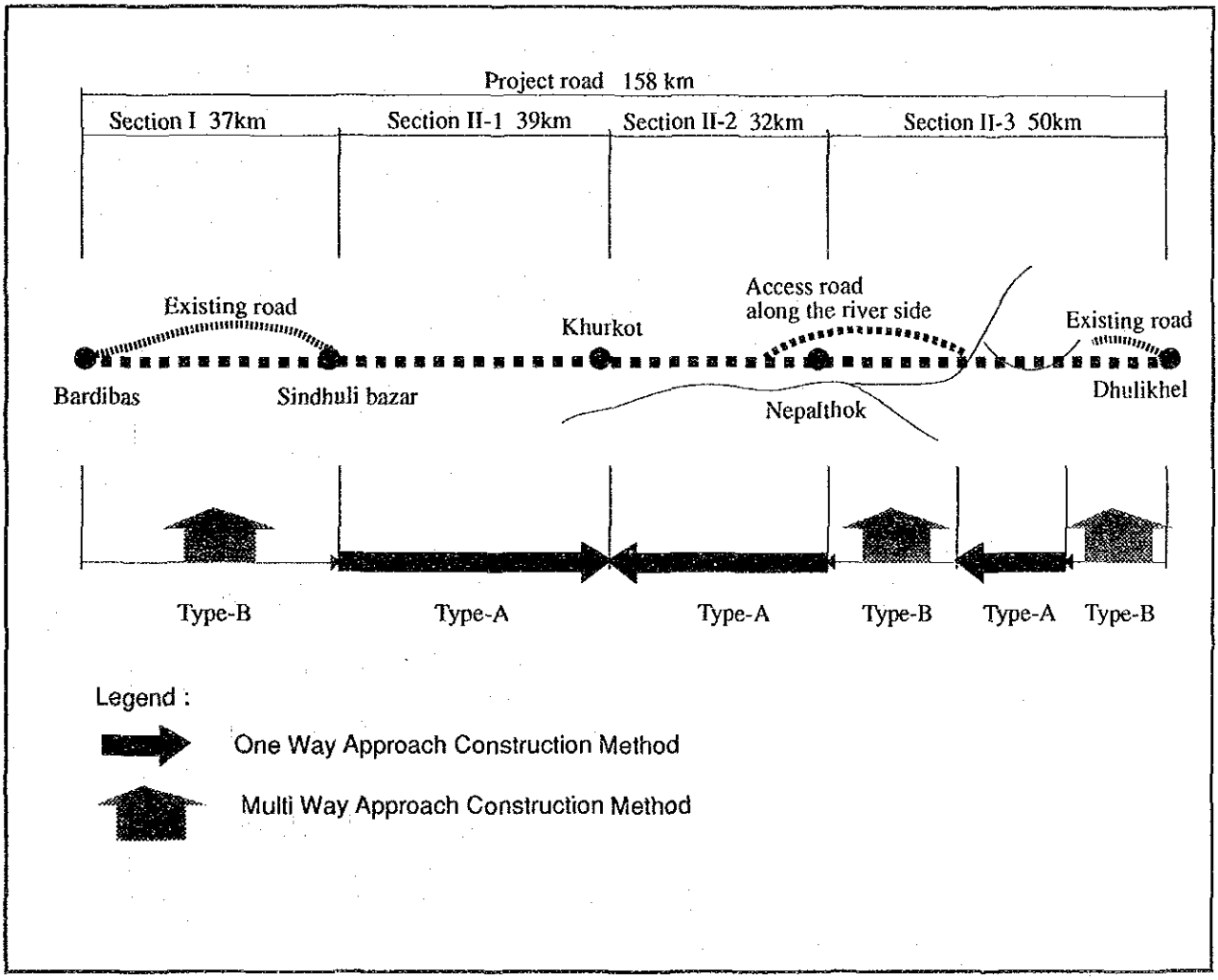
Typical construction methods applicable to Sindhuli Road are broadly divided into two categories mainly depending on availability of access roads. One is named "One Way Approach Construction Method" that is to construct on a work item by work item basis in a certain sequence and to proceed to the further stations due to limited access roads available, and which is applicable to the whole sections of II-1 and II-2 and one fifth of section II-3 in length. The other is " Multi Way Approach Construction Method" that is to commence the construction at any stations and of any work items because of availability of access roads ,and which is applicable to the entire section-I and the rest part of Section II-3.

In the one way approach construction method, the concrete work sequence is firstly installation of gabion retaining walls at V/S and road cutting at M/S and filling at R/S follows. Subsequently, the drainage work such as installation of culverts and side ditches comes next. Finally pavement crew proceeds. In this method, the gabion retaining walls are installed by men power, while mechanical construction method is applied in the cutting and filling works. As such, installation of gabion walls will be critical items in the construction scheduling.

In the mult- way approach construction method, construction can be initiated at any stations or for any work items in principle. For instance, earth work and drainage work can be carried out simultaneously at different stations. However, in the earth work operation, installation of gabion retaining walls shall be in advance before cutting and filling operation. As such, the gabion walls can be installed at any places, so that cutting and filling work by using equipment could be critical item in the construction scheduling but depending on a number of equipment.

The above concepts with regard to two types of the construction method are illustrated in Figure 8-1.

Figure 8-1 Concept of Typical Construction Method



8.3 Construction Schedule

In the construction schedule, construction period of the main work items were firstly analyzed based on the assumed workable day, unit progress rate and the estimated quantities, and subsequently, the construction schedule of the each alternative was established applying the period analyzed.

(1) Workable Day

An average workable days per year for earth work which is the most critical item are estimated based on the meteorological data and it is assumed to be 12 days (40 % of a month) during rainy season and 21 days (70 % of a month) during dry season , and 211 days (58 %)of a year in an average.

(2) Unit Progress Rate

Based on the production rate of each pay item to be implemented by a set of equipment combined or a set of combination of equipment and manpower, or by labor intensive method, unit progress rate of each major work item was analyzed. The unit progress rate of major and critical work items are tabulated in Table 8-1.

Table 8-1 Unit Progress Rate

Description	Kind of work	Capacity
Excavation Rock	Mechanical work	85m3/day-party
Excavation Common	Mechanical work	370m3/day-party
Gabion box	Hand work	3:6m3/day-party(20persons)
Road side structure (Stone mansonry parapet)	Hand work	2m3/day-party(20persons)
Pavement Base,Subbase course	Mechanical work	500m2/day-party
Pavement Surface course	Hand work	224m2/day-party(20persons)

(3) Work Quantities and Construction Period

Referring to the above unit progress rate and the estimated total work quantity of major work items on a alternative by alternative, construction period of the major and critical work items were estimated. The total quantity and corresponding construction period of each major work items are shown in Table 8-2

(4) Construction Schedule of Each Alternative

Taking into account the typical construction method applicable to respective sections, i.e. Section -I is implemented by the mult way approach construction method, Sections -II-1 and II-2 by the one way approach construction method, and Section II-3 by combination of both methods, required construction period of the major work item was arranged in the work sequence order and the overall construction schedule of each alternative was formulated and these are shown in Table 8-3 to 8-5.

In scheduling the second stage construction for the respective alternatives, the basic conditions especially for availability of access roads (i.e. completed Sindhuli Road with one lane in the first stage) , and the work quantities are almost the same for all the alternatives. Therefore, it is concluded that the second stage construction takes 4 years for all the alternatives, and is recommended that the construction commences in 2006 and complete by the end of 2009 in order to cope with the estimated traffic volume.

Table 8-2 Work Quantity and Construction Period

Description	Alternatives	Unit	Section I			Section II-1			Section II-2			Section II-3		
			Quantuty	party	Period(year)	Quantuty	party	Period(year)	Quantuty	party	Period(year)	Quanntuty	party	Period(year)
Excavation , Rock	Alternative-1-4	m3				245,000	3.0	4.5	56,000	1.6	1.9	142,000	3.1	2.5
	Alternative-5	m3	106,000	3.0	2.0	528,000	4.5	6.5	185,000	2.6	4.0	283,000	6.4	2.5
Excavation, Common	Alternative-1-4	m3				683,000	2.0	4.4	309,000	2.1	1.9	484,000	2.5	2.5
	Alternative-5	m3	303,000	2.0	1.9	755,000	1.5	6.4	397,000	1.3	3.9	810,000	4.2	2.5
Gabion box	Alternative-1-4	m3				93,400	27.0	4.5	47,400	31.0	2.0	58,700	33.0	2.3
	Alternative-5	m3	7,600	5.0	2.0	99,000	29.0	4.5	50,100	19.0	3.5	62,000	35.0	2.3
Road side structure	Alternative-1-4	m3				6,200	3.7	4.0	3,600	4.2	2.0	4,500	4.3	2.5
	Alternative-5	m3	600	1.0	0.3	6,200	3.7	4.0	3,600	2.5	3.4	4,500	4.2	2.5
Pavement Subbase course	Alternative-1,3	m2	5,700	1.0	0.0	195,000	1.0	0.9	158,000	1.0	0.7	251,000	1.0	1.2
Pavement Base, Subbase course	Alternative-2,4	m2	5,700	1.0	0.1	195,000	1.0	1.8	158,000	1.0	1.5	251,000	1.0	2.4
	Alternative-5	m2	277,000	2.0	1.3	292,000	1.0	2.8	237,000	1.0	2.2	376,000	1.5	2.4
Pavement Surface course	Alternative-1,3	m2				81,000	1.0	1.7	48,000	1.0	1.0	51,000	1.0	1.1
	Alternative-2,4	m2	5,700	1.0	0.1	195,000	1.1	3.7	158,000	1.7	2.0	251,000	2.0	2.6
	Alternative-5	m2	277,000	3.0	1.9	292,000	1.6	3.8	237,000	2.0	2.5	376,000	2.5	3.2

Table 8-3 Construction Schedule of Alternative 1 and 3

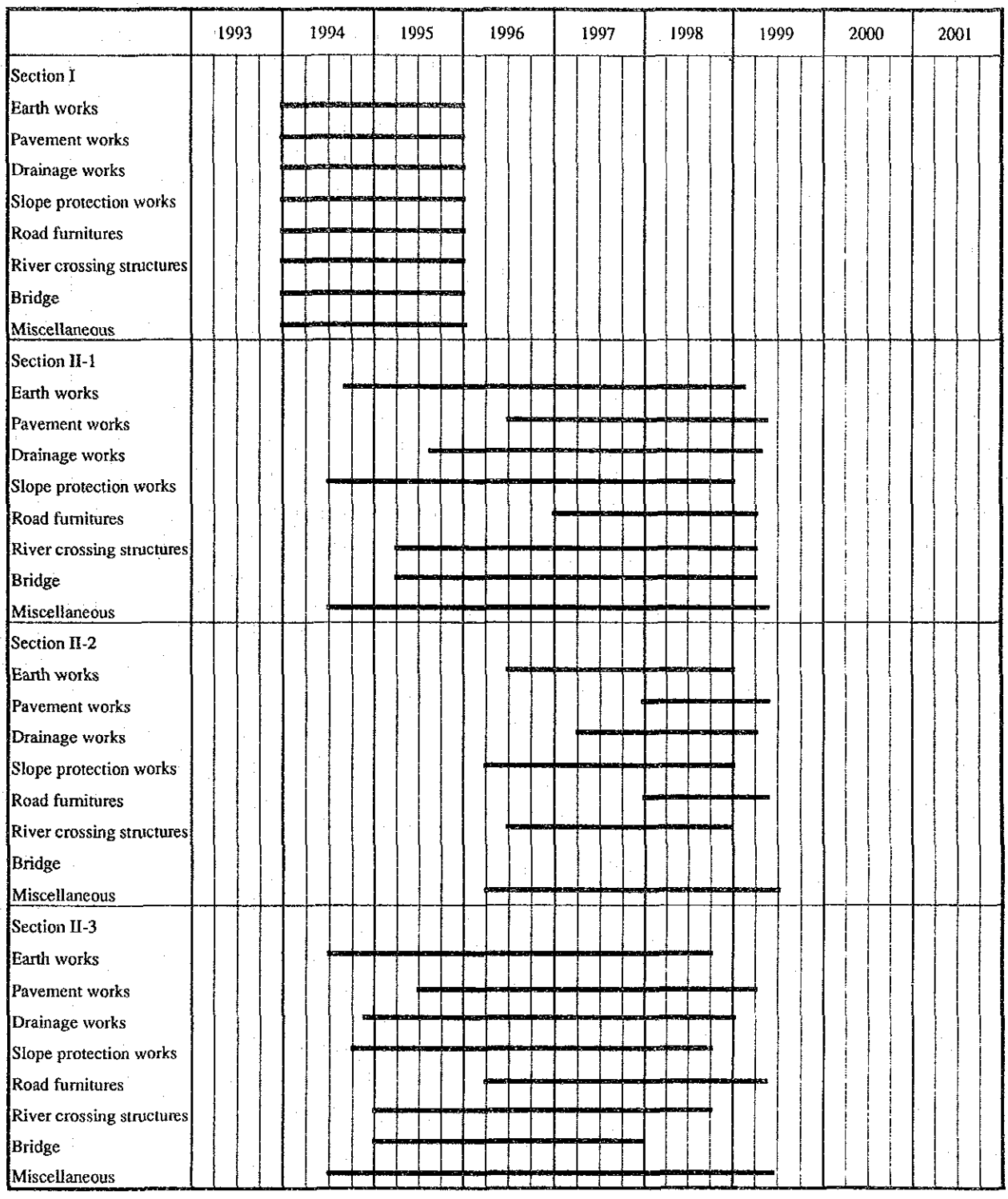


Table 8-4 Construction Schedule of Alternative 2 and 4

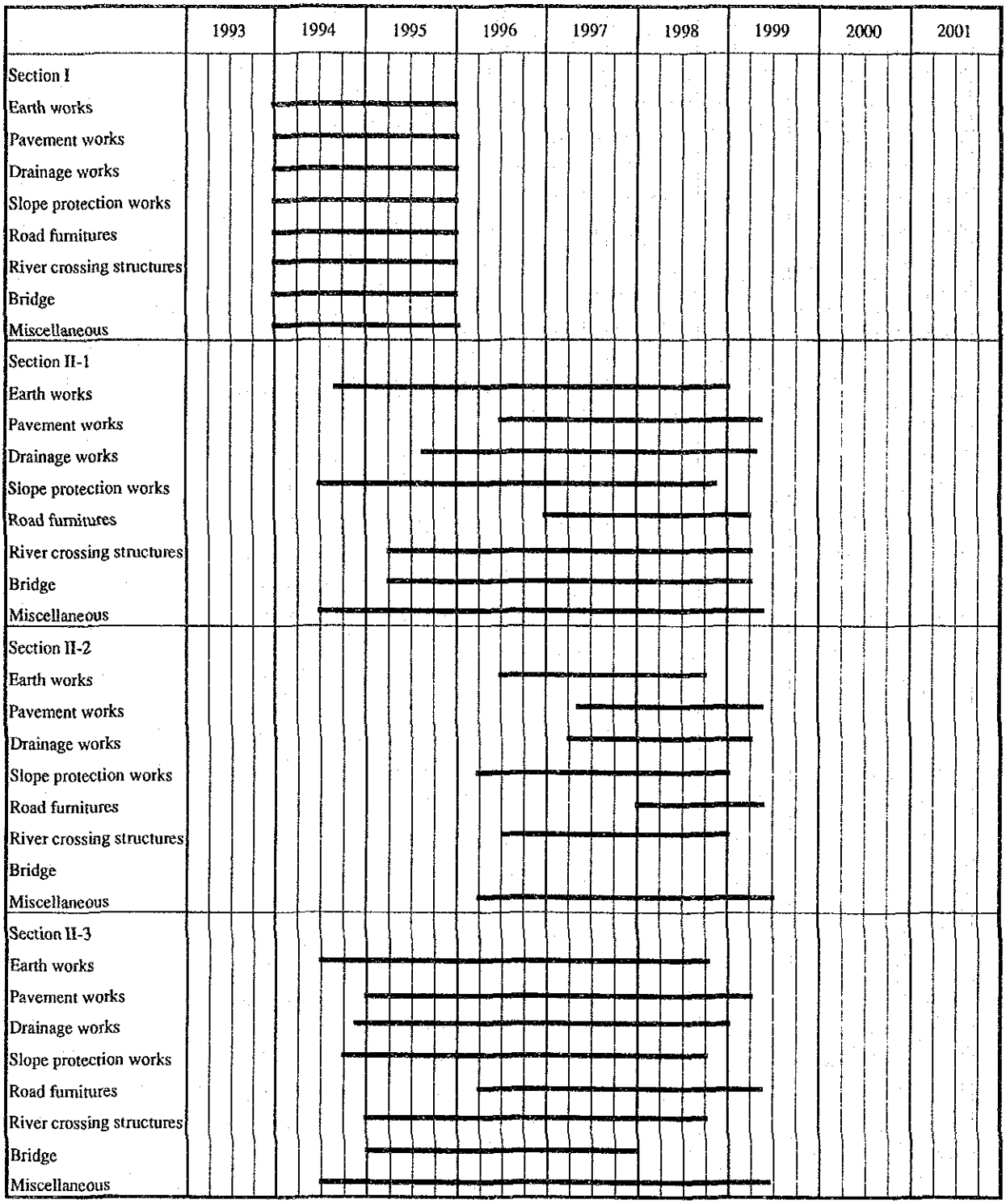
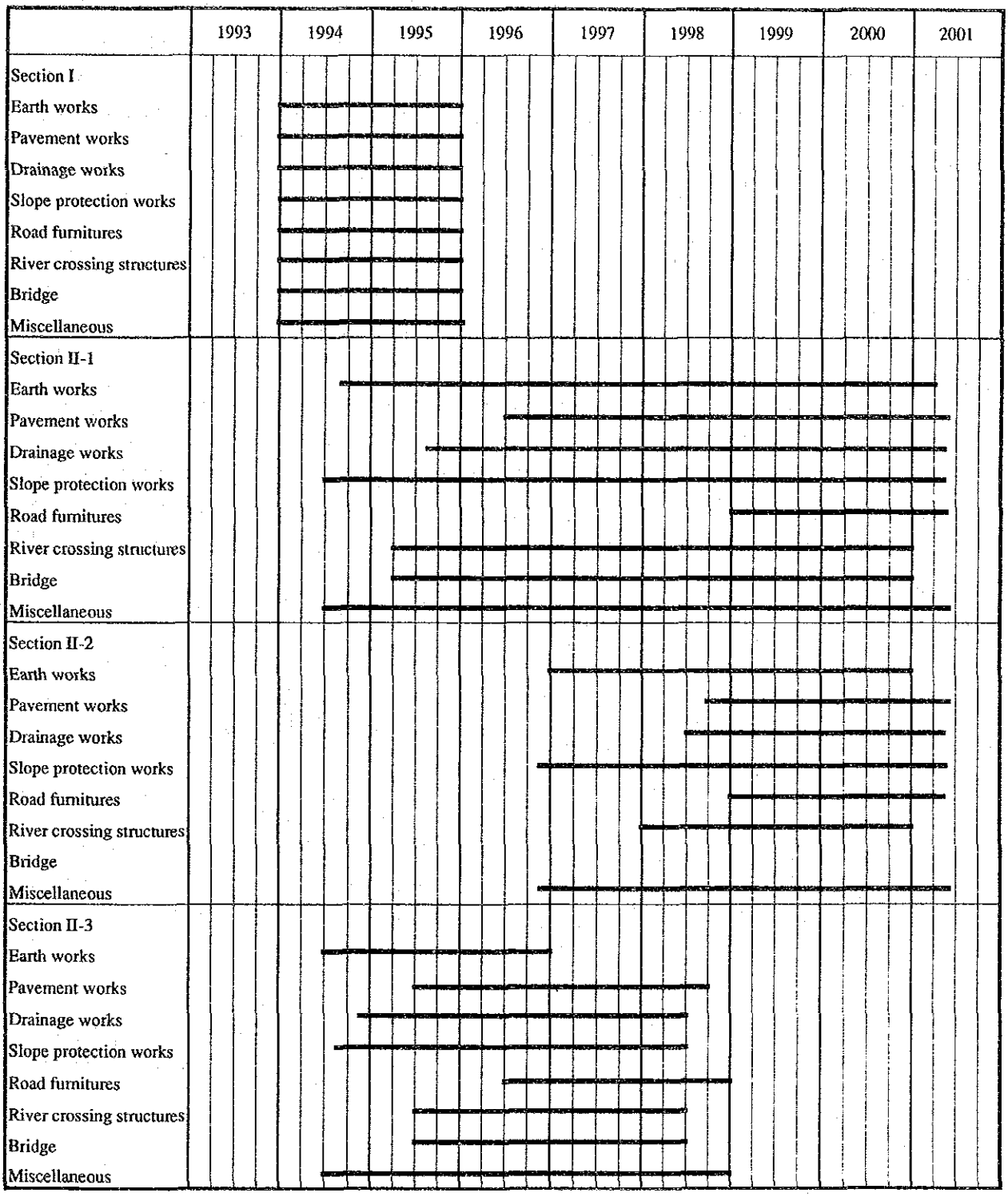


Table 8-5 Construction Schedule of Alternative 5



8.4 Maintenance Features

As mentioned in the previous chapter 6, all the development scheme alternatives, especially in the stage construction plans, were formulated on condition with provision of the road and bridge maintenance to secure the construction investment, and to provide the road serviceable in all the time. It is therefore absolutely necessary and requisite to conduct inspection and maintenance of Sindhuli Road on a DOR's force account basis, not only after substantial completion of certain sections and structures, but also after handing over the whole sections from Bardibas to Dhulikhel.

In this regard, it is assumed that the partial maintenance operation and the full swing maintenance operation by DOR should initiate tentatively in 1996 and 2000 respectively, referring to the construction schedule as formulated in the previous section.

As a matter of fact, it is reported that in the Lamosangu - Jiri Road Project, 2.1% per year of the construction cost was allocated to the road maintenance , and the Multi Agency Seminar Paper on December 1990 stated that the maintenance cost of hill road in Nepal were amounted to NRs 293,000 for graveled roads and NRs 268,000 for black topped roads (Notes; The cost including expenses of routine, periodic and emergency ,maintenance and the unit is per kilo meter per year for single lane road)

For Sindhuli Road, the required maintenance work items and the assumed work quantities are roughly assessed to formulate DOR maintenance formation to be set up and to estimate the maintenance cost, referring to the preliminary design of each development scheme alternative and the construction schedule.

The maintenance to be carried out by DOR includes three types comprising routine maintenance, periodic maintenance and emergency maintenance, and the work items and assumed quantities of each type are as follows;

(1) Routine Maintenance

This type of maintenance is conducted including the work needed to further prevent deterioration and other minor works which are repetitive and technically simple.

Work Items	Assumed Quantities
-Potholes patching	5 m2x5 places/kmx 157km = 4,000m2
-Cleaning of sideditches, cross drainage structures including catch-basins	10 labors /km x 157 km= 1,570 m/m
-Removal of river deposits and drifts on causeways/1	250 m3/ place x 2 times/6 months x 37 places = 18,500 m3
-Removal of surface sledded materials	50 m3/ place x 5 places/km x2 times/ 6 month x 70 km= 35,000 m3
-Regravelling/2	50 m3/km x 157 km= 8,000 m3
-Minor repairs of structures made by stone masonry, grouted riprap, gabions	20 m3/place x 3 places /km x 157 km = 9,420 m3
-Sodding and replanting	200 m2/km x 157 m2 =31,400 m2
-Installation of traffic signs and other misllenious works	10 % of the above in terms of cost

Notes;/1: This activity is applicable to the maintenance period after completion of the first stage of alternatives 1, 2, 3 and 4.

/2: This activity is applicable to the maintenance period after completion of the first stage of alternatives 1 and 2.

(2) Periodic Maintenance

Work Items	Assumed Quantities
-Overlay by DBST	4.75m x 157,000 m=746,000 m2 (T=3 cm)
-Repainting of steel bridges	3,000 ton x 18 m2 /ton = 54,000 m2
-Replacement of expansion joints	48 places x 5m/ place =240 m
-Reinstallation of deteriorated structures	10 % of the above in terms of cost

(3) Emergency Maintenance

The emergency maintenance is carried out in connection with unusual circumstances such as large scale land slide, collapse of retaining walls, washed out structures ,etc. due to heavy monsoon or earthquake.

Work Items	Assumed Quantities
-Removal of land slided materials	According to Mult- Agency Seminar Paper, it is reported that 400 to 700 m3 due to landslides per km per year are occurring in the hill roads in Nepal, and 10 to 25 percent of hill roads following river valley are completely washed out every 4 to 5 years./1
-Slope stabilization work	
-Restoration of road failures such as slided road body, washed out culverts or retaining walls	

Note /1 Taking into account this fact, the preliminary design were carried out to prevent these failures. However, it is so difficult to estimate the quantities for emergency maintenance.

8.5 DOR's Road Maintenance Formation for Sindhuli Road

Due to limited maintenance budget and shortage of experienced staff and equipment, road maintenance activities by DOR are not well organized except that in Dharan - Dhankuta Road and Lamosangu - Jiri Road. These roads were constructed under grant aid and the maintenance has been still on going with the donors' assistance.

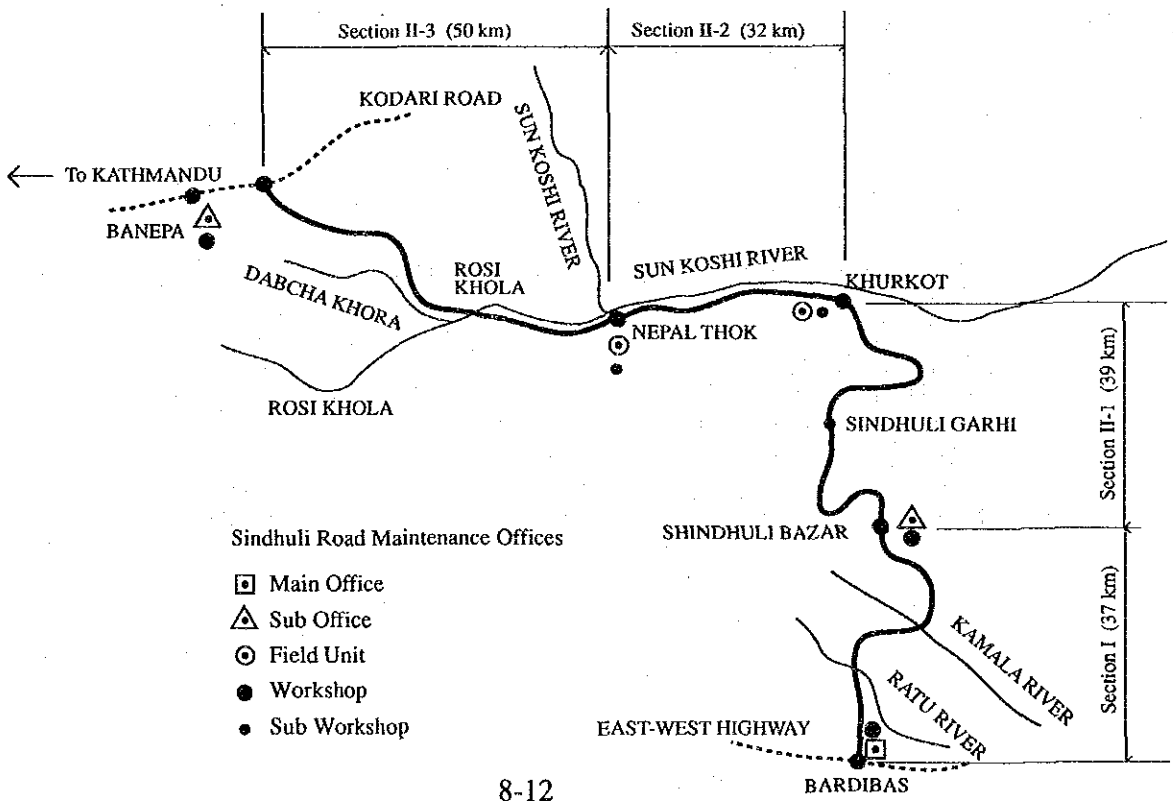
While, the various types and huge work volumes with regard to maintenance of Sindhuli Road are required as revealed in the previous section , but presently, these are no DOR district offices in Sindhuli and Kabhre Districts where nearly 90 % in length of Sindhuli Road passes through. In view of this situation, this section presents DOR's road maintenance organization, staffing, offices and required equipment which are strictly used for Sindhuli Road.

(1) Maintenance Offices

Taking into account the maintenance features and their locations as well as the present office available at Bardibas, following offices and workshops are proposed to establish on a timely manner.

Location	Type of Office and Workshop	Remarks
Bardibas	Main Office and Workshop	Utilized existing Facilities
Sindhuli Bazar	Sub-Office and Work shop	Newly Installed
Banepa	Sub-Office and Work shop	Newly Installed
Khurkot	Field Unit and sub - work shop	Newly Installed
Nepalthok	Field Unit and sub-work shop	Newly Installed

Location of the above offices and workshops are shown in below.



(2) Required Maintenance Equipment

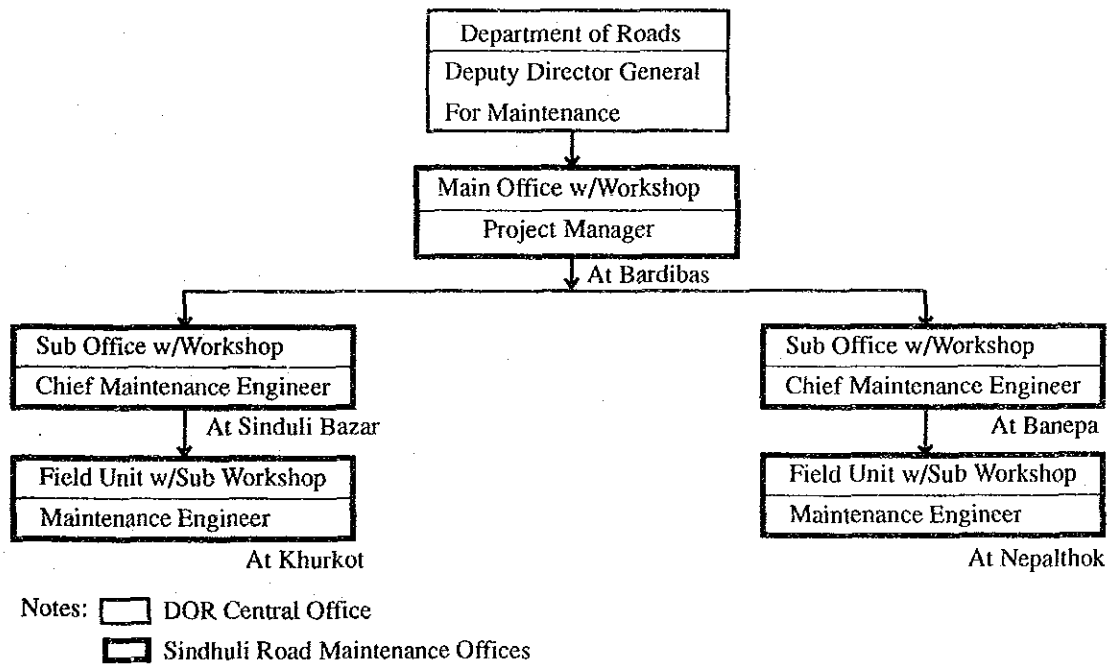
The equipment required to carry out adequate maintenance are listed in below considering the work items and volumes assumed.

Unit; Number of Equipment

Type	Capacity	Bardubas	Sindhuli Basar	Banepa	Khurkot	Nepalthok	Total
Wheel Loader	1.4 m3	1	1	1	1	1	5
Backhoe	0.6 m3	1	1	1	-	-	3
Grader	2.5m	1	1	1	1	1	5
Dump Truck	8 ton	3	3	3	1	1	11
4 Wheel Jeep	3000cc	3	3	3	1	1	11
Compactor	5-6 ton	1	1	1	1	1	5
Movable Crusher	10 ton/ hr	1	1	1	-	-	3
Concrete Mixer	0.5 m3	1	1	1	-	-	3
Truck crane	4 ton	1	1	1	1	1	5
Generator	60 kva	2	2	2	1	1	8

(3) Maintenance Organization

A successful management and implementation of the maintenance rely on the organization and staffing. Interrelations between the above offices ,and DOR Central and the offices are illustrated below;



(4) Staffing of Each Office

The quality of maintenance work generally depends on the staffing and their capability and working experience. The staffing requirements of each office is recommended as follows;

Position	Main Office At Baidibas	Sub-Office At Sindhuli Bazar	Sub-Office At Banepa	Field Unit At Khurkot	Field Unit At Nepalthok	Total
Project Manager	1	-	-	-	-	1
Chief Maint. Eng'er	-	1	1	-	-	2
Sr. Maintenance Eng'er	1	-	-	1	1	3
Sr. Mechanical Engineer	1	1	1	-	-	3
Mechanical Engineer	-	-	-	1	1	2
Chief Inspector	2	2	2	1	1	8
Forman	3	3	3	2	2	13
Mechanical Technician	3	3	3	2	2	13
Operator/ Drivers	10	10	10	4	4	38
Administration Staff	6	4	4	2	2	18

CHAPTER 9

PROJECT COST ESTIMATE

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PROJECT COST ESTIMATE

9.1 General

The project cost estimate started with an extensive data collection exercise, field survey at several construction sites and interview survey to material suppliers to ensure that the unit price analysis and results are firmly based on the real situation in Nepal. The project cost estimate was carried out for the each development scheme alternative on the basis of the preliminary design and the construction plan and schedule, assuming that the project implementation is executed by an international contractor.

9.2 Basic Conditions

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. The foreign and local currency components of each unit price are computed based on the following classification of basic cost elements.

The foreign currency componet includes the cost of;
- -Imported equipment, materials and supplies;
- -Imported materials in the local market;
- -Wages of expatriate personnel;
- -Overhead and profit.

The local currency component includes the cost of:
- -Domestic materials and supplies;

-Wages of local personnel;
-Duties and tax.

(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 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 Nepalese local conditions.

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

9.3 Structure of Project Cost

The project cost on a contract basis consist of construction cost, land aquisition and compensation, and engineering cost. The construction cost is divided into direct conctruction cost and indirect construction cost. The main cost items are briefly described below;

(1) Direct Construction Cost
The direct cost comprises of labour coat, material cost and equipment cost.

(2) Indirect Construction Cost
This item includes contractor's overhead and profit, transportation cost and expendirtures to run contractor's site warehous, and laboratory and for other common temporary works. It is assumed to be 35.0 % of the direct construction cost, taking into account the construction by an international contractor.

(3) Enginnering Cost
The engineering cost consists for detailed design and supervision and it assumed to be 10.0 % of the direct construction cost.

(4) Land Acquisition and Compensation Cost
This cost items are estinmated on the basis of unit cost data obtained from DOR.

9.4 Unit Rate

(1) Material Cost

The material cost applied in the coat estimate are on the basis of price level on March 1993. The unit rates of the major materials are shown in Table 9-1.

(2) Labours' Unit Rate

The labours' unit rate was derived from daily wage rate obtained from the DOR. Following is the unit rate by major labour classification.

Table 9-2 Labour Unit Rate

Unit : NRs

Description	Unit	Foreign currency	Local currency	Total
Forman	m.d		105	105
Skilled labor	m.d	30	70	100
Unskilled labor	m.d	18	42	60
Driver	m.d	30	70	100
Operator(plant)	m.d	30	70	100
Mechanic	m.d	30	70	100
Carpenter	m.d	30	70	100
Reinforcement worker	m.d	30	70	100

(3) Equpiment Unit Rate

The equipment unit rates are the privailing prices on March 1993, in Japan. The equipment cost is divided into foreign and local currency portions. The former includes depreciation cost, spare parts and comsumable cost, while the latter includes the cost of mechanical repair and administration expenses. The unit rates of major construction equipment are tabulated in Table 9-3.

(4) Land Acquisition and Compensation Costs

The land acquisition and compensation costs are calculated based on the area to be acquired and on land prices and compensation cost obtained from DOR.

Classification	Unit Rate
Developed Area	NRs. 600,000/ha
Less developed Area	NRs. 200,000/ha
Compensation of houses	NRs. 200,000/each

Table 9-1 Material Unit Rate

Unit : NRs.

Description	Unit	Foreign currency	Local currency	Duty Tax	Total
Hard wood	m3	137	47,173	9,423	56,733
Medium wood	m3	137	35,395	7,067	42,599
Soft wood	m3	137	8,156	1,620	9,913
Plywood 12mm for concrete work	m2	407	0	0	407
R.C.C hume pipe (NP3) 600mm	m	868	851	168	1,887
R.C.C hume pipe (NP3) 900mm	m	1,549	1,520	300	3,369
Cement	kg	3.5	0.1	0.9	4.4
Diesel	litre	10	0	2	12
Petrol	litre	21	0	9	29
Kerosine	litre	9	0	0	10
Asphalt 80/100	ton	13,350	150	650	14,150
Asphalt emulsion	ton	13,350	150	650	14,150
Reinforcement	ton	32,332	0	0	32,332
Gabion wire	kg	31.9	0.4	4.5	36.7
Corrugated pipe 600mm,1.6mm	m	4,164	0	0	4,164
Corrugated pipe 1000mm,2.0mm	m	7,907	0	0	7,907
Corrugated pipe (arch)H3000,B1560,3.2mm	m	22,675	0	0	22,675
Corrugated pipe (arch) H5000,B2560,5.3mm	m	61,698	0	0	61,698
Explosive (jlatine)	kg	0	78	0	78
Cape (Detonator) General	pc.	2	0	0	2
Cape (Detonator) Electric	pc.	5	0	0	5
Fuse	m	3	0	0	3
Cord	m	6	0	0	6

1$ = NRs.45.88 = ¥ 115.08

Table 9-3 Equipment Rate

Unit : NRs.

Description	Unit	Foreign currency	Local currency	Duty Tax	Total
Bulldozer 15ton	hr	2,291	354	36	2,681
Bulldozer 21ton	hr	3,638	554	53	4,245
Backhoe 0.6m3	hr	1,817	254	32	2,103
TRactor shovel 1.4m3	hr	1,430	232	18	1,680
Dump truck 2ton	hr	594	65	9	668
Dump truck 11ton	hr	1,954	167	27	2,148
Truck 8ton	hr	717	120	17	854
Truck crane 4.8-4.9ton	hr	1,069	173	26	1,268
Truck crane 20ton	hr	2,229	369	16	2,614
Motor grader 3.1m	hr	1,522	261	17	1,800
Macadam roller 10ton	hr	936	172	14	1,122
Tire roller 8-20ton	hr	1,045	190	15	1,250
Vibrating roller 1ton	hr	325	59	2	386
Water sprinkler 5500litre	hr	779	134	11	924
Asphalt sprayer 200litre	day	286	70	22	378
Air compressor 3.7m3/min	day	1,061	159	10	1,230
Air compressor 10m3/min	day	3,184	445	64	3,693
Diesel generator 10kva	day	631	73	22	726
Diesel generator 45kva	day	1,690	196	78	1,964
Diesel generator 60kva	day	2,092	232	109	2,433
Breaker 1,300kg with base equipment	hr	3,253	400	32	3,685

1$ = NRs.45.88 = ¥ 115.08

9.5 Unit Price Analysis

In order to analyze unit price of the respective work items, required material kinds, equipment types and labour kinds are listed and the unit quantity of each item is firstly calculated based on standard construction methods.

It is, however, difficult to estimate the accurate production rate of respective items in each pay item because of the lack of cost break down data in Nepal.

To this end, the following procedures are taken so as to ensure the analysis results are as precise as possible.

(1) The production rate stated in the Cost Estimate Manual published by the Ministry of Construction in Japan is modified taking into account labours' skillfulness, unit material usage, efficiency of equipment, operator's capability and so on in Nepal as well as based on those in the similar proejcts.

(2) Applying the modified production rates of the various items, the unit prices are calculated.

(3) The production rates applied in the above calculation is calibrated based on comparison with unit prices obtained from DOR and market research.

(4) Finally, the unit price of each work item is recalculated using the calibrated production rate.

9.6 Project Cost Estimate

The project cost on a contract basis for each development scheme alternative were estimated on the basis of the equantities estimated in the preliminary design and the unit price for each pay item.

The total project cost estimated based on March 1993 are summarized in Table 9-4 and the cost break down of each alternative are shown in Table 9-5 to Table 9-9

Table 9-4 Summary of Project Cost On a Contract Basis

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 projeat cost of each stage.

Table 9-5 Project Cost Break Down of Alternative - 1

Table 9-5 Cost Break Down of Alternative -1

US$ 1.0 = NRs.45.88 = Yen 115.08

Section I

Description	Stage	Foreign currency (1,000NRs)	Local currency (1,000NRs)	Duty & Tax (1,000NRs)	Total (1,000NRs)	Equiv. Yen (1,000Yen)
GENERAL	1st. Stage	0	0	0	0	0
	2nd. Stage	0	0	0	0	0
EARTH WORKS	1st. Stage	9,319	1,112	111	10,542	26,460
	2nd. Stage	184,478	23,578	2,405	210,461	528,257
PAVEMWNT WORKS	1st. Stage	1,675	183	22	1,880	4,719
	2nd. Stage	242,651	24,112	5,023	271,786	682,183
DRAINAGE WORKS	1st. Stage	2,067	894	131	3,092	7,761
	2nd. Stage	51,641	22,488	3,699	77,828	195,348
SLOPE PROTECTION WORKS	1st. Stage	0	0	0	0	0
	2nd. Stage	42,712	20,232	3,228	66,172	166,092
ROAD FURNITURE	1st. Stage	0	0	0	0	0
	2nd. Stage	4,761	2,072	303	7,136	17,911
RIVER CROSSING STRUCTURES	1st. Stage	37,576	6,188	2,823	46,587	116,933
	2nd. Stage	0	0	0	0	0
MAJOR BRIDGE	1st. Stage	281,667	2,162	712	284,541	714,198
	2nd. Stage	329,929	2,732	888	333,549	837,208
MINNER BRIDGE	1st. Stage	23,755	324	109	24,188	60,712
	2nd. Stage	23,755	324	109	24,188	60,712
MISCELLANEOUS	1st. Stage	0	0	0	0	0
(Maintain of access road & Removal of debris)	2nd. Stage	0	0	0	0	0
TOTAL	1st. Stage	356,059	10,863	3,908	370,830	930,783
	2nd. Stage	879,927	95,538	15,655	991,120	2,487,711

Section II-1

Description	Stage	Foreign currency (1,000NRs)	Local currency (1,000NRs)	Duty & Tax (1,000NRs)	Total (1,000NRs)	Equiv. Yen (1,000Yen)
GENERAL	1st. Stage	12,150	12,150	0	24,300	60,993
	2nd. Stage	12,150	12,150	0	24,300	60,993
EARTH WORKS	1st. Stage	393,747	51,916	5,087	450,750	1,131,383
	2nd. Stage	318,003	37,906	3,954	359,863	903,256
PAVEMWNT WORKS	1st. Stage	72,161	7,622	1,319	81,102	203,566
	2nd. Stage	196,472	19,100	4,496	220,068	552,371
DRAINAGE WORKS	1st. Stage	136,522	32,178	7,565	176,265	442,425
	2nd. Stage	18,996	8,755	1,287	29,038	72,885
SLOPE PROTECTION WORKS	1st. Stage	168,753	79,893	14,586	263,232	660,712
	2nd. Stage	150,345	53,709	12,399	216,453	543,297
ROAD FURNITURE	1st. Stage	6,478	2,952	408	9,838	24,693
	2nd. Stage	0	0	0	0	0
RIVER CROSSING STRUCTURES	1st. Stage	13,275	2,051	925	16,251	40,790
	2nd. Stage	0	0	0	0	0
MAJOR BRIDGE	1st. Stage	0	0	0	0	0
	2nd. Stage	120,731	1,427	439	122,597	307,718
MINNER BRIDGE	1st. Stage	50,360	1,007	372	51,739	129,865
	2nd. Stage	50,360	1,007	372	51,739	129,865
MISCELLANEOUS	1st. Stage	80,486	9,407	946	90,839	228,006
(Maintain of access road & Removal of debris)	2nd. Stage	53,400	5,637	808	59,845	150,211
TOTAL	1st. Stage	933,932	199,176	31,208	1,164,316	2,922,433
	2nd. Stage	920,457	139,691	23,755	1,083,903	2,720,597

Section II-2

Description	Stage	Foreign currency (1,000NRs)	Local currency (1,000NRs)	Duty & Tax (1,000NRs)	Total (1,000NRs)	Equiv. Yen (1,000Yen)
GENERAL	1st. Stage	2,700	2,700	0	5,400	13,554
	2nd. Stage	2,700	2,700	0	5,400	13,554
EARTH WORKS	1st. Stage	199,999	24,596	2,786	227,381	570,726
	2nd. Stage	276,616	33,901	3,423	313,940	787,989
PAVEMWNT WORKS	1st. Stage	55,298	5,889	949	62,136	155,961
	2nd. Stage	159,362	15,492	3,647	178,501	448,038
DRAINAGE WORKS	1st. Stage	101,974	25,484	5,943	133,401	334,837
	2nd. Stage	13,436	6,193	910	20,539	51,553
SLOPE PROTECTION WORKS	1st. Stage	118,311	46,196	12,960	177,467	445,442
	2nd. Stage	139,415	32,039	11,138	182,592	458,306
ROAD FURNITURE	1st. Stage	5,670	2,540	358	8,568	21,506
	2nd. Stage	0	0	0	0	0
RIVER CROSSING STRUCTURES	1st. Stage	42,714	6,867	3,119	52,700	132,277
	2nd. Stage	0	0	0	0	0
MAJOR BRIDGE	1st. Stage	0	0	0	0	0
	2nd. Stage	579,299	6,846	2,107	588,252	1,476,513
MINNER BRIDGE	1st. Stage	0	0	0	0	0
	2nd. Stage	0	0	0	0	0
MISCELLANEOUS	1st. Stage	61,639	7,418	661	69,718	174,992
(Maintain of access road & Removal of debris)	2nd. Stage	34,553	3,647	523	38,723	97,195
TOTAL	1st. Stage	588,305	121,690	26,776	736,771	1,849,295
	2nd. Stage	1,205,381	100,818	21,748	1,327,947	3,333,147

Section II-3

Description	Stage	Foreign currency (1,000NRs)	Local currency (1,000NRs)	Duty & Tax (1,000NRs)	Total (1,000NRs)	Equiv. Yen (1,000Yen)
GENERAL	1st. Stage	12,150	12,150	0	24,300	60,993
	2nd. Stage	12,150	12,150	0	24,300	60,993
EARTH WORKS	1st. Stage	284,190	36,985	3,778	324,953	815,632
	2nd. Stage	401,598	48,428	4,901	454,927	1,141,867
PAVEMWNT WORKS	1st. Stage	82,902	8,902	1,330	93,134	233,766
	2nd. Stage	252,575	24,554	5,780	282,909	710,102
DRAINAGE WORKS	1st. Stage	151,446	39,777	10,049	201,272	505,193
	2nd. Stage	24,529	11,305	1,662	37,496	94,115
SLOPE PROTECTION WORKS	1st. Stage	193,209	73,210	21,450	287,869	722,551
	2nd. Stage	138,930	51,544	11,293	201,767	506,435
ROAD FURNITURE	1st. Stage	8,081	3,662	520	12,263	30,780
	2nd. Stage	0	0	0	0	0
RIVER CROSSING STRUCTURES	1st. Stage	62,263	8,183	3,716	74,162	186,147
	2nd. Stage	0	0	0	0	0
MAJOR BRIDGE	1st. Stage	121,214	688	236	122,138	306,566
	2nd. Stage	603,839	6,392	1,991	612,222	1,536,677
MINNER BRIDGE	1st. Stage	43,574	2,682	633	46,889	117,691
	2nd. Stage	37,904	657	228	38,789	97,360
MISCELLANEOUS	1st. Stage	91,481	10,568	1,113	103,162	258,937
(Maintain of access road & Removal of debris)	2nd. Stage	64,394	6,797	974	72,165	181,134
TOTAL	1st. Stage	1,050,510	196,807	42,825	1,290,142	3,238,256
	2nd. Stage	1,535,919	161,827	26,829	1,724,575	4,328,683

Total

Description	Stage	Foreign currency (1,000NRs)	Local currency (1,000NRs)	Duty & Tax (1,000NRs)	Total (1,000NRs)	Equiv. Yen (1,000Yen)
GENERAL	1st. Stage	27,000	27,000	0	54,000	135,540
	2nd. Stage	27,000	27,000	0	54,000	135,540
EARTH WORKS	1st. Stage	887,255	114,609	11,762	1,013,626	2,544,201
	2nd. Stage	1,180,695	143,813	14,683	1,339,191	3,361,369
PAVEMWNT WORKS	1st. Stage	212,036	22,596	3,620	238,252	598,013
	2nd. Stage	851,060	83,258	18,946	953,264	2,392,693
DRAINAGE WORKS	1st. Stage	392,009	98,333	23,688	514,030	1,290,215
	2nd. Stage	108,602	48,741	7,558	164,901	413,902
SLOPE PROTECTION WORKS	1st. Stage	480,273	199,299	48,996	728,568	1,828,706
	2nd. Stage	471,402	157,524	38,058	666,984	1,674,130
ROAD FURNITURE	1st. Stage	20,229	9,154	1,286	30,669	76,979
	2nd. Stage	4,761	2,072	303	7,136	17,911
RIVER CROSSING STRUCTURES	1st. Stage	155,828	23,289	10,583	189,700	476,147
	2nd. Stage	0	0	0	0	0
MAJOR BRIDGE	1st. Stage	402,881	2,850	948	406,679	1,020,764
	2nd. Stage	1,633,798	17,397	5,425	1,656,620	4,158,116
MINNER BRIDGE	1st. Stage	117,689	4,013	1,114	122,816	308,268
	2nd. Stage	112,019	1,988	709	114,716	287,937
MISCELLANEOUS	1st. Stage	233,606	27,393	2,720	263,719	661,935
(Maintain of access road & Removal of debris)	2nd. Stage	152,347	16,081	2,305	170,733	428,540
TOTAL	1st. Stage	2,928,806	528,536	104,717	3,562,059	8,940,768
	2nd. Stage	4,541,684	497,874	87,987	5,127,545	12,870,138

Table 9-6 Project Cost Break Down of Alternative - 2

Table 9-6 Cost Break Down of Alternative -2

US$ 1.0 = NRs.45.88 = Yen 115.08

Description		Section I					Section II-1					Section II-2					Section II-3					Total				
		Foreign currency (1,000NRs)	Local currency (1,000NRs)	Duty & Tax (1,000NRs)	Total (1,000NRs)	Equiv. Yen (1,000Yen)	Foreign currency (1,000NRs)	Local currency (1,000NRs)	Duty & Tax (1,000NRs)	Total (1,000NRs)	Equiv. Yen (1,000Yen)	Foreign currency (1,000NRs)	Local currency (1,000NRs)	Duty & Tax (1,000NRs)	Total (1,000NRs)	Equiv. Yen (1,000Yen)	Foreign currency (1,000NRs)	Local currency (1,000NRs)	Duty & Tax (1,000NRs)	Total (1,000NRs)	Equiv. Yen (1,000Yen)	Foreign currency (1,000NRs)	Local currency (1,000NRs)	Duty & Tax (1,000NRs)	Total (1,000NRs)	Equiv. Yen (1,000Yen)
GENERAL	1st. Stage	0	0	0	0	0	12,150	12,150	0	24,300	60,993	2,700	2,700	0	5,400	13,554	12,150	12,150	0	24,300	60,993	27,000	27,000	0	54,000	135,540
	2nd. Stage	0	0	0	0	0	12,150	12,150	0	24,300	60,993	2,700	2,700	0	5,400	13,554	12,150	12,150	0	24,300	60,993	27,000	27,000	0	54,000	135,540
EARTH WORKS	1st. Stage	9,319	1,112	111	10,542	26,460	393,747	51,916	5,087	450,750	1,131,383	199,999	24,596	2,786	227,381	570,726	284,190	36,985	3,778	324,953	815,632	887,255	114,609	11,762	1,013,626	2,544,201
	2nd. Stage	184,478	23,578	2,405	210,461	528,257	318,003	37,906	3,954	359,863	903,256	276,616	33,901	3,423	313,940	787,989	401,598	48,428	4,901	454,927	1,141,867	1,180,695	143,813	14,683	1,339,191	3,361,369
PAVEMWNT WORKS	1st. Stage	1,675	183	22	1,880	4,719	72,161	7,622	1,319	81,102	203,566	55,298	5,889	949	62,136	155,961	82,902	8,902	1,330	93,134	233,766	212,036	22,596	3,620	238,252	598,013
	2nd. Stage	242,651	24,112	5,023	271,786	682,183	196,472	19,100	4,496	220,068	552,371	159,362	15,492	3,647	178,501	448,038	252,575	24,554	5,780	282,909	710,102	851,060	83,258	18,946	953,264	2,392,693
DRAINAGE WORKS	1st. Stage	2,067	894	131	3,092	7,761	136,522	32,178	7,565	176,265	442,425	101,974	25,484	5,943	133,401	334,837	151,446	39,777	10,049	201,272	505,193	392,009	98,333	23,688	514,030	1,290,215
	2nd. Stage	51,641	22,488	3,699	77,828	195,348	18,996	8,755	1,287	29,038	72,885	13,436	6,193	910	20,539	51,553	24,529	11,305	1,662	37,496	94,115	108,602	48,741	7,558	164,901	413,902
SLOPE PROTECTION WORKS	1st. Stage	0	0	0	0	0	168,753	79,893	14,586	263,232	660,712	118,311	46,196	12,960	177,467	445,442	193,209	73,210	21,450	287,869	722,551	480,273	199,299	48,996	728,568	1,828,706
	2nd. Stage	42,712	20,232	3,228	66,172	166,092	150,345	53,709	12,399	216,453	543,297	139,415	32,039	11,138	182,592	458,306	138,930	51,544	11,293	201,767	506,435	471,402	157,524	38,058	666,984	1,674,130
ROAD FURNITURE	1st. Stage	0	0	0	0	0	6,478	2,952	408	9,838	24,693	5,670	2,540	358	8,568	21,506	8,081	3,662	520	12,263	30,780	20,229	9,154	1,286	30,669	76,979
	2nd. Stage	4,761	2,072	303	7,136	17,911	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4,761	2,072	303	7,136	17,911
RIVER CROSSING STRUCTURES	1st. Stage	37,576	6,188	2,823	46,587	116,933	13,275	2,051	925	16,251	40,790	42,714	6,867	3,119	52,700	132,277	62,263	8,183	3,716	74,162	186,147	155,828	23,289	10,583	189,700	476,147
	2nd. Stage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MAJOR BRIDGE	1st. Stage	392,440	3,642	1,233	397,315	997,261	0	0	0	0	0	0	0	0	0	0	189,863	931	332	191,126	479,726	582,303	4,573	1,565	588,441	1,476,987
	2nd. Stage	162,300	570	176	163,046	409,245	120,731	1,427	439	122,597	307,718	579,299	6,846	2,107	588,252	1,476,513	498,726	5,704	1,755	506,185	1,270,524	1,361,056	14,547	4,477	1,380,080	3,464,001
MINNER BRIDGE	1st. Stage	32,966	474	173	33,613	84,369	76,819	1,423	554	78,796	197,778	0	0	0	0	0	53,599	2,877	715	57,191	143,549	163,384	4,774	1,442	169,600	425,696
	2nd. Stage	28,944	0	0	28,944	72,649	73,440	0	0	73,440	184,334	0	0	0	0	0	49,140	0	0	49,140	123,341	151,524	0	0	151,524	380,325
MISCELLANEOUS	1st. Stage	0	0	0	0	0	80,486	9,407	946	90,839	228,006	61,639	7,418	661	69,718	174,992	91,481	10,568	1,113	103,162	258,937	233,606	27,393	2,720	263,719	661,935
(Maintain of access road & Removal of debris)	2nd. Stage	0	0	0	0	0	53,400	5,637	808	59,845	150,211	34,553	3,647	523	38,723	97,195	64,394	6,797	974	72,165	181,134	152,347	16,081	2,305	170,733	428,540
TOTAL	1st. Stage	476,043	12,493	4,493	493,029	1,237,503	960,391	199,592	31,390	1,191,373	2,990,346	588,305	121,690	26,776	736,771	1,849,295	1,129,184	197,245	43,003	1,369,432	3,437,274	3,153,923	531,020	105,662	3,790,605	9,514,419
	2nd. Stage	717,487	93,052	14,834	825,373	2,071,686	943,537	138,684	23,383	1,105,604	2,775,066	1,205,381	100,818	21,748	1,327,947	3,333,147	1,442,042	160,482	26,365	1,628,889	4,088,511	4,308,447	493,036	86,330	4,887,813	12,268,411

Table 9-7Project Cost Break Down of Alternative - 3

Table 9-7 Cost Break Down of Alternative -3

US$ 1.0 = NRs.45.88 = Yen 115.08

Description		Section I					Section II-1					Section II-2					Section II-3					Total				
		Foreign currency (1,000NRs)	Local currency (1,000NRs)	Duty & Tax (1,000NRs)	Total (1,000NRs)	Equiv. Yen (1,000Yen)	Foreign currency (1,000NRs)	Local currency (1,000NRs)	Duty & Tax (1,000NRs)	Total (1,000NRs)	Equiv. Yen (1,000Yen)	Foreign currency (1,000NRs)	Local currency (1,000NRs)	Duty & Tax (1,000NRs)	Total (1,000NRs)	Equiv. Yen (1,000Yen)	Foreign currency (1,000NRs)	Local currency (1,000NRs)	Duty & Tax (1,000NRs)	Total (1,000NRs)	Equiv. Yen (1,000Yen)	Foreign currency (1,000NRs)	Local currency (1,000NRs)	Duty & Tax (1,000NRs)	Total (1,000NRs)	Equiv. Yen (1,000Yen)
GENERAL	1st. Stage	0	0	0	0	0	12,150	12,150	0	24,300	60,993	2,700	2,700	0	5,400	13,554	12,150	12,150	0	24,300	60,993	27,000	27,000	0	54,000	135,540
	2nd. Stage	0	0	0	0	0	12,150	12,150	0	24,300	60,993	2,700	2,700	0	5,400	13,554	12,150	12,150	0	24,300	60,993	27,000	27,000	0	54,000	135,540
EARTH WORKS	1st. Stage	9,319	1,112	111	10,542	26,460	393,747	51,916	5,087	450,750	1,131,383	199,999	24,596	2,786	227,381	570,726	284,190	36,985	3,778	324,953	815,632	887,255	114,609	11,762	1,013,626	2,544,201
	2nd. Stage	184,478	23,578	2,405	210,461	528,257	318,003	37,906	3,954	359,863	903,256	276,616	33,901	3,423	313,940	787,989	401,598	48,428	4,901	454,927	1,141,867	1,180,695	143,813	14,683	1,339,191	3,361,369
PAVEMWNT WORKS	1st. Stage	166,395	16,559	3,411	186,365	467,776	186,142	18,619	3,739	208,500	523,335	150,996	15,103	3,033	169,132	424,521	239,329	23,939	4,808	268,076	672,871	742,862	74,220	14,991	832,073	2,088,503
	2nd. Stage	120,084	11,123	3,375	134,582	337,801	126,357	11,706	3,553	141,646	355,531	102,522	9,496	2,883	114,901	288,402	162,536	15,055	4,570	182,161	457,224	511,529	47,380	14,381	573,290	1,438,958
DRAINAGE WORKS	1st. Stage	19,869	7,430	1,084	28,383	71,241	136,522	32,178	7,565	176,265	442,425	101,974	25,484	5,943	133,401	334,837	151,446	39,777	10,049	201,272	505,193	409,811	104,869	24,641	539,321	1,353,696
	2nd. Stage	14,390	6,632	975	21,997	55,212	18,996	8,755	1,287	29,038	72,885	13,436	6,193	910	20,539	51,553	24,529	11,305	1,662	37,496	94,115	71,351	32,885	4,834	109,070	273,766
SLOPE PROTECTION WORKS	1st. Stage	0	0	0	0	0	168,753	79,893	14,586	263,232	660,712	118,311	46,196	12,960	177,467	445,442	193,209	73,210	21,450	287,869	722,551	480,273	199,299	48,996	728,568	1,828,706
	2nd. Stage	42,712	20,232	3,228	66,172	166,092	137,861	47,955	11,554	197,370	495,399	129,393	27,420	10,459	167,272	419,853	122,929	44,169	10,209	177,307	445,041	432,895	139,776	35,450	608,121	1,526,384
ROAD FURNITURE	1st. Stage	0	0	0	0	0	6,478	2,952	408	9,838	24,693	5,670	2,540	358	8,568	21,506	8,081	3,662	520	12,263	30,780	20,229	9,154	1,286	30,669	76,979
	2nd. Stage	4,761	2,072	303	7,136	17,911	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4,761	2,072	303	7,136	17,911
RIVER CROSSING STRUCTURES	1st. Stage	37,576	6,188	2,823	46,587	116,933	13,275	2,051	925	16,251	40,790	42,714	6,867	3,119	52,700	132,277	62,263	8,183	3,716	74,162	186,147	155,828	23,289	10,583	189,700	476,147
	2nd. Stage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MAJOR BRIDGE	1st. Stage	281,667	2,163	712	284,542	714,200	0	0	0	0	0	0	0	0	0	0	121,214	688	236	122,138	306,566	402,881	2,851	948	406,680	1,020,767
	2nd. Stage	329,929	2,732	888	333,549	837,208	120,731	1,427	439	122,597	307,718	579,299	6,846	2,107	588,252	1,476,513	603,839	6,392	1,991	612,222	1,536,677	1,633,798	17,397	5,425	1,656,620	4,158,116
MINNER BRIDGE	1st. Stage	23,755	324	109	24,188	60,712	50,360	1,007	372	51,739	129,865	0	0	0	0	0	43,574	2,682	633	46,889	117,691	117,689	4,013	1,114	122,816	308,268
	2nd. Stage	23,755	324	109	24,188	60,712	50,360	1,007	372	51,739	129,865	0	0	0	0	0	37,904	657	228	38,789	97,360	112,019	1,988	709	114,716	287,937
MISCELLANEOUS	1st. Stage	0	0	0	0	0	80,486	9,407	946	90,839	228,006	61,639	7,418	661	69,718	174,992	91,481	10,568	1,113	103,162	258,937	233,606	27,393	2,720	263,719	661,935
(Maintain of access road & Removal of debris)	2nd. Stage	0	0	0	0	0	53,400	5,637	808	59,845	150,211	34,553	3,647	523	38,723	97,195	64,394	6,797	974	72,165	181,134	152,347	16,081	2,305	170,733	428,540
TOTAL	1st. Stage	538,581	33,776	8,250	580,607	1,457,324	1,047,913	210,173	33,628	1,291,714	3,242,202	684,003	130,904	28,860	843,767	2,117,855	1,206,937	211,844	46,303	1,465,084	3,677,361	3,477,434	586,697	117,041	4,181,172	10,494,742
	2nd. Stage	720,109	66,693	11,283	798,085	2,003,193	837,888	126,543	21,967	986,398	2,475,859	1,138,519	90,203	20,305	1,249,027	3,135,058	1,429,879	144,953	24,535	1,599,367	4,014,411	4,126,395	428,392	78,090	4,632,877	11,628,521

Table 9-8 Project Cost Break Down of Alternative - 4

Table 9-8 Cost Break Down of Alternative -4

US$ 1.0 = NRs.45.88 = Yen 115.08

Description	Stage	Section I Foreign currency (1,000NRs)	Section I Local currency (1,000NRs)	Section I Duty & Tax (1,000NRs)	Section I Total (1,000NRs)	Section I Equiv. Yen (1,000Yen)	Section II-1 Foreign currency (1,000NRs)	Section II-1 Local currency (1,000NRs)	Section II-1 Duty & Tax (1,000NRs)	Section II-1 Total (1,000NRs)	Section II-1 Equiv. Yen (1,000Yen)
GENERAL	1st. Stage	0	0	0	0	0	12,150	12,150	0	24,300	60,993
	2nd. Stage	0	0	0	0	0	12,150	12,150	0	24,300	60,993
EARTH WORKS	1st. Stage	9,319	1,112	111	10,542	26,460	393,747	51,916	5,087	450,750	1,131,383
	2nd. Stage	184,478	23,578	2,405	210,461	528,257	318,003	37,906	3,954	359,863	903,256
PAVEMWNT WORKS	1st. Stage	166,395	16,559	3,411	186,365	467,776	186,142	18,619	3,739	208,500	523,335
	2nd. Stage	120,084	11,123	3,375	134,582	337,801	126,387	11,706	3,553	141,646	355,531
DRAINAGE WORKS	1st. Stage	19,869	7,430	1,084	28,383	71,241	136,522	32,178	7,565	176,265	442,425
	2nd. Stage	51,641	22,488	3,699	77,828	195,348	18,996	8,755	1,287	29,038	72,885
SLOPE PROTECTION WORKS	1st. Stage	0	0	0	0	0	168,753	79,893	14,586	263,232	660,712
	2nd. Stage	42,712	20,232	3,228	66,172	166,092	137,861	47,955	11,554	197,370	495,399
ROAD FURNITURE	1st. Stage	0	0	0	0	0	6,478	2,952	408	9,838	24,693
	2nd. Stage	4,761	2,072	303	7,136	17,911	0	0	0	0	0
RIVER CROSSING STRUCTURES	1st. Stage	37,576	6,188	2,823	46,587	116,933	13,275	2,051	925	16,251	40,790
	2nd. Stage	0	0	0	0	0	0	0	0	0	0
MAJOR BRIDGE	1st. Stage	392,440	3,642	1,233	397,315	997,261	0	0	0	0	0
	2nd. Stage	162,300	570	176	163,046	409,245	120,731	1,427	439	122,597	307,718
MINNER BRIDGE	1st. Stage	32,966	474	173	33,613	84,369	76,819	1,423	554	78,796	197,778
	2nd. Stage	28,944	0	0	28,944	72,649	73,440	0	0	73,440	184,334
MISCELLANEOUS	1st. Stage	0	0	0	0	0	80,486	9,407	946	90,839	228,006
(Maintain of access road	2nd. Stage	0	0	0	0	0	53,400	5,637	808	59,845	150,211
& Removal of debris)											
TOTAL	1st. Stage	658,565	35,405	8,835	702,805	1,764,041	1,074,372	210,589	33,810	1,318,771	3,310,115
	2nd. Stage	594,920	80,063	13,186	688,169	1,727,304	860,968	125,536	21,595	1,008,099	2,530,328

Description	Stage	Section II-2 Foreign currency (1,000NRs)	Section II-2 Local currency (1,000NRs)	Section II-2 Duty & Tax (1,000NRs)	Section II-2 Total (1,000NRs)	Section II-2 Equiv. Yen (1,000Yen)	Section II-3 Foreign currency (1,000NRs)	Section II-3 Local currency (1,000NRs)	Section II-3 Duty & Tax (1,000NRs)	Section II-3 Total (1,000NRs)	Section II-3 Equiv. Yen (1,000Yen)
GENERAL	1st. Stage	2,700	2,700	0	5,400	13,554	12,150	12,150	0	24,300	60,993
	2nd. Stage	2,700	2,700	0	5,400	13,554	12,150	12,150	0	24,300	60,993
EARTH WORKS	1st. Stage	199,999	24,596	2,786	227,381	570,726	284,190	36,985	3,778	324,953	815,632
	2nd. Stage	276,616	33,901	3,423	313,940	787,989	401,598	48,428	4,901	454,927	1,141,867
PAVEMWNT WORKS	1st. Stage	150,996	15,103	3,033	169,132	424,521	239,329	23,939	4,808	268,076	672,871
	2nd. Stage	102,522	9,496	2,883	114,901	288,402	162,536	15,055	4,570	182,161	457,224
DRAINAGE WORKS	1st. Stage	101,974	25,484	5,943	133,401	334,837	151,446	39,777	10,049	201,272	505,193
	2nd. Stage	13,436	6,193	910	20,539	51,553	24,529	11,305	1,662	37,496	94,115
SLOPE PROTECTION WORKS	1st. Stage	118,311	46,196	12,960	177,467	445,442	193,209	73,210	21,450	287,869	722,551
	2nd. Stage	129,393	27,420	10,459	167,272	419,853	122,929	44,169	10,209	177,307	445,041
ROAD FURNITURE	1st. Stage	5,670	2,540	358	8,568	21,506	8,081	3,662	520	12,263	30,780
	2nd. Stage	0	0	0	0	0	0	0	0	0	0
RIVER CROSSING STRUCTURES	1st. Stage	42,714	6,867	3,119	52,700	132,277	62,263	8,183	3,716	74,162	186,147
	2nd. Stage	0	0	0	0	0	0	0	0	0	0
MAJOR BRIDGE	1st. Stage	0	0	0	0	0	189,863	931	332	191,126	479,726
	2nd. Stage	579,299	6,846	2,107	588,252	1,476,513	498,726	5,704	1,755	506,185	1,270,524
MINNER BRIDGE	1st. Stage	0	0	0	0	0	53,599	2,877	715	57,191	143,549
	2nd. Stage	0	0	0	0	0	49,140	0	0	49,140	123,341
MISCELLANEOUS	1st. Stage	61,639	7,418	661	69,718	174,992	91,481	10,568	1,113	103,162	258,937
(Maintain of access road	2nd. Stage	34,553	3,647	523	38,723	97,195	64,394	6,797	974	72,165	181,134
& Removal of debris)											
TOTAL	1st. Stage	684,003	130,904	28,860	843,767	2,117,855	1,285,611	212,282	46,481	1,544,374	3,876,379
	2nd. Stage	1,138,519	90,203	20,305	1,249,027	3,135,058	1,336,002	143,608	24,071	1,503,681	3,774,239

Description	Stage	Total Foreign currency (1,000NRs)	Total Local currency (1,000NRs)	Total Duty & Tax (1,000NRs)	Total Total (1,000NRs)	Total Equiv. Yen (1,000Yen)
GENERAL	1st. Stage	27,000	27,000	0	54,000	135,540
	2nd. Stage	27,000	27,000	0	54,000	135,540
EARTH WORKS	1st. Stage	887,255	114,609	11,762	1,013,626	2,544,201
	2nd. Stage	1,180,695	143,813	14,683	1,339,191	3,361,369
PAVEMWNT WORKS	1st. Stage	742,862	74,220	14,991	832,073	2,088,503
	2nd. Stage	511,529	47,380	14,381	573,290	1,438,958
DRAINAGE WORKS	1st. Stage	409,811	104,869	24,641	539,321	1,353,696
	2nd. Stage	108,602	48,741	7,558	164,901	413,902
SLOPE PROTECTION WORKS	1st. Stage	480,273	199,299	48,996	728,568	1,828,706
	2nd. Stage	432,895	139,776	35,450	608,121	1,526,384
ROAD FURNITURE	1st. Stage	20,229	9,154	1,286	30,669	76,979
	2nd. Stage	4,761	2,072	303	7,136	17,911
RIVER CROSSING STRUCTURES	1st. Stage	155,828	23,289	10,583	189,700	476,147
	2nd. Stage	0	0	0	0	0
MAJOR BRIDGE	1st. Stage	582,303	4,573	1,565	588,441	1,476,987
	2nd. Stage	1,361,056	14,547	4,477	1,380,080	3,464,001
MINNER BRIDGE	1st. Stage	163,384	4,774	1,442	169,600	425,696
	2nd. Stage	151,524	0	0	151,524	380,325
MISCELLANEOUS	1st. Stage	233,606	27,393	2,720	263,719	661,935
(Maintain of access road	2nd. Stage	152,347	16,081	2,305	170,733	428,540
& Removal of debris)						
TOTAL	1st. Stage	3,702,551	589,180	117,986	4,409,717	11,068,390
	2nd. Stage	3,930,409	439,410	79,157	4,448,976	11,166,930

Table 9-9 Project Cost Break Down of Alternative - 5

Table 9-9 Cost Break Down of Alternative -5

US$ 1.0 = NRs.45.88 = Yen 115.08

Description		Section I					Section II-1					Section II-2					Section II-3					Total				
		Foreign currency (1,000NRs)	Local currency (1,000NRs)	Duty & Tax (1,000NRs)	Total (1,000NRs)	Equiv. Yen (1,000Yen)	Foreign currency (1,000NRs)	Local currency (1,000NRs)	Duty & Tax (1,000NRs)	Total (1,000NRs)	Equiv. Yen (1,000Yen)	Foreign currency (1,000NRs)	Local currency (1,000NRs)	Duty & Tax (1,000NRs)	Total (1,000NRs)	Equiv. Yen (1,000Yen)	Foreign currency (1,000NRs)	Local currency (1,000NRs)	Duty & Tax (1,000NRs)	Total (1,000NRs)	Equiv. Yen (1,000Yen)	Foreign currency (1,000NRs)	Local currency (1,000NRs)	Duty & Tax (1,000NRs)	Total (1,000NRs)	Equiv. Yen (1,000Yen)
GENERAL	1st. Stage	0	0	0	0	0	12,150	12,150	0	24,300	60,993	2,700	2,700	0	5,400	13,554	12,150	12,150	0	24,300	60,993	27,000	27,000	0	54,000	135,540
	2nd. Stage																					0	0	0	0	0
EARTH WORKS	1st. Stage	177,580	22,700	2,317	202,597	508,518	679,756	87,784	8,551	776,091	1,947,988	358,887	45,416	4,643	408,946	1,026,454	398,662	50,191	5,127	453,980	1,139,490	1,614,885	206,091	20,638	1,841,614	4,622,451
	2nd. Stage																					0	0	0	0	0
PAVEMWNT WORKS	1st. Stage	242,651	24,112	5,023	271,786	682,183	274,795	27,466	5,548	307,809	772,601	222,959	22,285	4,502	249,746	626,862	353,348	35,317	7,134	395,799	993,455	1,093,753	109,180	22,207	1,225,140	3,075,101
	2nd. Stage																					0	0	0	0	0
DRAINAGE WORKS	1st. Stage	51,641	22,488	3,699	77,828	195,348	139,370	33,696	7,754	180,820	453,858	98,786	24,260	5,764	128,810	323,313	144,428	37,256	9,675	191,359	480,311	434,225	117,700	26,892	578,817	1,452,831
	2nd. Stage																					0	0	0	0	0
SLOPE PROTECTION WORKS	1st. Stage	42,712	20,232	3,228	66,172	166,092	313,171	130,976	26,726	470,873	1,181,891	249,226	74,465	23,555	347,246	871,587	320,003	119,223	32,005	471,231	1,182,790	925,112	344,896	85,514	1,355,522	3,402,360
	2nd. Stage																					0	0	0	0	0
ROAD FURNITURE	1st. Stage	4,761	2,072	303	7,136	17,911	6,478	2,952	408	9,838	24,693	5,670	2,540	358	8,568	21,506	8,081	3,662	520	12,263	30,780	24,990	11,226	1,569	37,805	94,891
	2nd. Stage																					0	0	0	0	0
RIVER CROSSING STRUCTURES	1st. Stage	35,808	5,897	2,690	44,395	111,431	2,652	437	199	3,288	8,253	3,979	655	299	4,933	12,382	12,328	1,892	851	15,071	37,828	54,767	8,881	4,039	67,687	169,894
	2nd. Stage																					0	0	0	0	0
MAJOR BRIDGE	1st. Stage	526,136	6,218	1,913	534,267	1,341,010	120,731	1,427	439	122,597	307,718	579,299	6,846	2,107	588,252	1,476,513	693,152	6,600	2,113	701,865	1,761,681	1,919,318	21,091	6,572	1,946,981	4,886,922
	2nd. Stage																					0	0	0	0	0
MINNER BRIDGE	1st. Stage	38,602	526	177	39,305	98,656	81,835	1,636	605	84,076	211,031	0	0	0	0	0	67,344	3,094	776	71,214	178,747	187,781	5,256	1,558	194,595	488,433
	2nd. Stage																					0	0	0	0	0
MISCELLANEOUS	1st. Stage	0	0	0	0	0	80,486	9,407	946	90,839	228,006	61,639	7,418	661	69,718	174,992	91,481	10,568	1,113	103,162	258,937	233,606	27,393	2,720	263,719	661,935
(Maintain of access road & Removal of debris)	2nd. Stage																					0	0	0	0	0
TOTAL	1st. Stage	1,119,891	104,245	19,350	1,243,486	3,121,150	1,711,424	307,931	51,176	2,070,531	5,197,033	1,583,145	186,585	41,889	1,811,619	4,547,164	2,100,977	279,953	59,314	2,440,244	6,125,012	6,515,437	878,714	171,729	7,565,880	18,990,359
	2nd. Stage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

9.7 Maintenance Cost

Referring to the maintenance work items and the corresponding quantities estimated in Section 8.4 as well as the maintenance cost data obtained from DOR, the maintenance cost per km per annum was estimated in round numbers applying the unit prices analyzed in the above.

Maintenance Items	Alternative1&2 After 1st stage	Alternative3&4 After 1st stage	Alternative 5 & After 2nd stage
(1) Routine Maintenance			
Cleaning on 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 of routine maintenace in NRs/km	183,550	135,550	48,100
(2) Reriodic Maintenace	225,000	156,250	175,000
Total Maintenace Cost in NRs/km	408,550	291,800	223,100

CHAPTER 10

PROJECT EVALUATION

CHAPTER 10

PROJECT EVALUATION

10.1 General

In this chapter, alternatives of development plan of the Project Road proposed in Chapter 6 are evaluated by each alternatives. Optimum road development plan is selected based on these evaluation. Alternatives of road development plans are evaluated through amount of benefit, Internal Rate of Return, (IRR) and total cost required for the implementation of the plan. In financial evaluation, revenue from toll road is studied under the probable toll rates to be charged as well as toll collecting system. Total evaluation is carried out considering these results as well as technical constraint of implementation and socio-economic impact expected of.

10.2 Economic Evaluation

10.2.1 Basic Stance for Economic Evaluation

In order to evaluate alternatives of road development plan by stage of construction, two types of economic evaluation method, say Total Evaluation and Partial Evaluation are introduced as explained hereunder:

Total
Evaluation : Evaluation of road development plan which includes evaluation of second stage road construction.

Partial
Evaluation : Evaluation of first-stage of road construction in partial.

The opening year of the Project Road is set at 1999 for the alternative 1-4 of road development plan and 25 years of project life after the opening is assumed for these cases. Opening year of alternative 5 is set at 2002, and same period of project life is assumed.

Discount rate or opportunity cost of capital in Nepal, which is basic information for the evaluation of the alternatives, is fixed at 12% through the consultation with Nepal government.

10.2.2 Cost Disbursement Schedule

Cost disbursement schedule which includes annual maintenance expenditure for each the road development plan is prepared as shown in Table 10-1 after the subtraction of transfer factor (tax and customs) which is included in the project cost estimated in Chapter 9. Second stage construction is assumed to begins in 2006 and end in 2009 in alternative 1-4, all of which are cases of one-lane road construction at the first stage.

Table 10-1 Cost Disbursement Schedule (Economic Cost)

Alternative 1

Case 1. Total Development Plan (include 2nd Stage Dev. Plan)

Stage Constr.	Construction Section	Works to be done	Project Life	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	1st Stage	2nd Stage	Total
										1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25			
1st Stage										V : Opened to traffic											V: widening completed															
	Sec. 1	Single-lane road	2 Y		xxxxx	xxxxx																														
	Sec. 2	Single-lane road	5 Y		xx	xxxxx	xxxxx	xxxxx	xxxxx	xxx																										
2nd Stage																																				
	Sec. 1 and Sec. 2	Widening to 2 lane	4 Y														xxxxx	xxxxx	xxxxx	xxxxx																
Engineering Services Cost				142	36	36	36	36	36	34						204	78	78	77	76															356	513	869
Construction Cost					577	577	576	576	576	576							1,245	1,245	1,244	1,244															3,458	4,978	8,436
Operation and Maintenance Cost										115	26	26	26	26	26	26	26	26	15	10	7	7	7	7	7	7	221	7	7	7	7	7	7	7	271	389	660
Total				142	613	613	612	612	612	725	26	26	26	26	26	230	1,349	1,349	1,336	1,330	7	7	7	7	7	7	221	7	7	7	7	7	7	7	4,085	5,880	9,965

Unit: million NRs.

Case 2 Partial Development Plan (exclude 2nd Stage Dev. Plan)

Stage Constr.	Construction Section	Works to be done	Project Life	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	1st Stage	2nd Stage	Total
										1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25			
Engineering Services				xxxxxx																																	
Construction of 1st Stage										V : Opened to traffic																											
	Sec. 1	Single-lane road	2 Y		xxxxx	xxxxx																														
	Sec. 2	Single-lane road	5 Y		xx	xxxxx	xxxxx	xxxxx	xxxxx	xxx																											
Engineering Services Cost				142	36	36	36	36	36	34																									356	0	356
Construction Cost					577	577	576	576	576	576																									3,458	0	3,458
Operation and Maintenance Cost										115	26	26	26	178	26	26	26	26	178	26	26	26	26	26	178	26	26	26	26	178	26	26	26	26	178	423	1,076	1,500
Total				142	613	613	612	612	612	725	26	26	26	178	26	26	26	26	178	26	26	26	26	26	178	26	26	26	26	178	26	26	26	26	178	4,237	1,076	5,314

Unit: million NRs.

Alternative 2

Case 1 Total Development Plan (include 2nd Stage Dev. Plan)

Stage Constr.	Construction Section	Works to be done	Project Life	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	1st Stage	2nd Stage	Total
										1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25			
1st Stage										V : Opened to traffic											V: widening completed															
	Sec. 1	Single-lane road	2 Y		xxxxx	xxxxx																														
	Sec. 2	Single-lane road	5 Y		xx	xxxxx	xxxxx	xxxxx	xxxxx	xxx																										
2nd Stage																																				
	Sec. 1 and Sec. 2	Widening to 2 lane	4 Y														xxxxx	xxxxx	xxxxx	xxxxx																
Engineering Services Cost				151	38	38	38	38	38	38						194	73	72	72	72															379	483	862
Construction Cost					614	614	614	613	613	613							1,187	1,186	1,186	1,186															3,681	4,745	8,426
Operation and Maintenance Cost										115	26	26	26	26	26	26	26	26	15	10	7	7	7	7	7	7	221	7	7	7	7	7	7	7	271	389	660
Total				151	652	652	652	651	651	766	26	26	26	26	26	220	1,286	1,284	1,273	1,268	7	7	7	7	7	7	221	7	7	7	7	7	7	7	4,331	5,617	9,948

Unit: million NRs.

Case 2 Partial Development Plan (exclude 2nd Stage Dev. Plan)

Stage Constr.	Construction Section	Works to be done	Project Life	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	1st Stage	2nd Stage	Total
										1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25			
Engineering Services				xxxxxx																																	
Construction of 1st Stage										V : Opened to traffic																											
	Sec. 1	Single-lane road	2 Y		xxxxx	xxxxx																														
	Sec. 2	Single-lane road	5 Y		xx	xxxxx	xxxxx	xxxxx	xxxxx	xxx																											
Engineering Services Cost				151	38	38	38	38	38	38																									379	0	379
Construction Cost					614	614	614	613	613	613																									3,681	0	3,681
Operation and Maintenance Cost										115	26	26	26	178	26	26	26	26	178	26	26	26	26	178	26	26	26	26	178	26	26	26	26	178	423	1,076	1,500
Total				151	652	652	652	651	651	766	26	26	26	178	26	26	26	26	178	26	26	26	26	178	26	26	26	26	178	26	26	26	26	178	4,483	1,076	5,560

Unit: million NRs.

Alternative 3

Case 1 Total Development Plan (include 2nd Stage Dev. Plan)

Stage Constr.	Construction Section	Works to be done	Project Life	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	1st Stage	2nd Stage	Total
										1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25			
1st Stage										V : Opened to traffic											V: widening completed															
	Sec. 1	Single-lane road	2 Y		xxxxx	xxxxx																														
	Sec. 2	Single-lane road	5 Y		xx	xxxxx	xxxxx	xxxxx	xxxxx	xxx																										
2nd Stage																																				
	Sec. 1 and Sec. 2	Widening to 2 lane	4 Y														xxxxx	xxxxx	xxxxx	xxxxx																
Engineering Services Cost				167	42	42	42	42	42	41						184	70	70	70	69															418	463	881
Construction Cost					677	677	677	676	676	676							1,125	1,124	1,124	1,124															4,059	4,497	8,556
Operation and Maintenance Cost										115	20	20	20	20	20	20	20	20	15	10	7	7	7	7	7	7	221	7	7	7	7	7	7	7	235	377	610
Total				167	719	719	719	718	718	832	20	20	20	20	20	204	1,215	1,214	1,209	1,203	7	7	7	7	7	7	221	7	7	7	7	7	7	7	4,712	5,337	10,047

Unit: million NRs.

Case 2 Partial Development Plan (exclude 2nd Stage Dev. Plan)

Stage Constr.	Construction Section	Works to be done	Project Life	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	1st Stage	2nd Stage	Total
										1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25			
Engineering Services				xxxxxx																																	
Construction of 1st Stage										V : Opened to traffic																											
	Sec. 1	Single-lane road	2 Y		xxxxx	xxxxx																														
	Sec. 2	Single-lane road	5 Y		xx	xxxxx	xxxxx	xxxxx	xxxxx	xxx																										
Engineering Services Cost				167	42	42	42	42	42	41																									418	0	418
Construction Cost					677	677	677	676	676	676																									4,059	0	4,059
Operation and Maintenance Cost										115	20	20	20	20	20	20	195	20	20	20	20	20	20	20	195	20	20	20	20	20	20	20	195	20	235	885	1,120
Total				167	719	719	719	718	718	832	20	20	20	20	20	20	195	20	20	20	20	20	20	20	195	20	20	20	20	20	20	20	195	20	4,712	885	5,597

Unit: million NRs.

Alternative 4

Case 1 Total Development Plan (include 2nd Stage Dev. Plan)

Stage Constr.	Construction Section	Works to be done	Project Life	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	1st Stage	2nd Stage	Total
										1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25			
1st Stage										V : Opened to traffic											V: widening completed															
	Sec. 1	Single-lane road	2 Y		xxxxx	xxxxx																															
	Sec. 2	Single-lane road	5 Y		xx	xxxxx	xxxxx	xxxxx	xxxxx	xxx																											
2nd Stage																																					
	Sec. 1 and Sec. 2	Widening to 2 lane	4 Y														xxxxx	xxxxx	xxxxx	xxxxx																	
Engineering Services Cost				176	44	44	44	44	44	45						179	67	67	66	66															441	445	886
Construction Cost					714	714	714	714	713	713							1,080	1,080	1,080	1,079															4,282	4,319	8,601
Operation and Maintenance Cost										115	20	20	20	20	20	20	20	20	15	10	7	7	7	7	7	7	221	7	7	7	7	7	7	7	235	377	610
Total				176	758	758	758	758	757	873	20	20	20	20	20	199	1,167	1,167	1,161	1,155	7	7	7	7	7	7	221	7	7	7	7	7	7	7	4,958	5,141	10,097

Unit: million NRs.

Case 2 Partial Development Plan (exclude 2nd Stage Dev. Plan)

Stage Constr.	Construction Section	Works to be done	Project Life	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	1st Stage	2nd Stage	Total
										1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25			
Engineering Services				xxxxxx																																	
Construction of 1st Stage										V : Opened to traffic																											
	Sec. 1	Single-lane road	2 Y		xxxxx	xxxxx																															
	Sec. 2	Single-lane road	5 Y		xx	xxxxx	xxxxx	xxxxx	xxxxx	xxx																												
Engineering Services Cost				176	44	44	44	44	44	45																									441	0	441
Construction Cost					714	714	714	714	713	713																									4,282	0	4,282
Operation and Maintenance Cost										115	20	20	20	20	20	20	195	20	20	20	20	20	20	20	195	20	20	20	20	20	20	20	195	20	235	885	1,120
Total				176	758	758	758	758	757	873	20	20	20	20	20	20	195	20	20	20	20	20	20	20	195	20	20	20	20	20	20	20	195	20	4,958	885	5,840

Unit: million NRs.

Table 10-1 Cost Disbursement Schedule (Economic Cost)

Alternative 5

Case 1 Total Development Plan (include 2nd Stage Dev. Plan)

Stage Constr	Construction Section	Works to be done	Project Life	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2021	2022	2023	2024	1st Stage	2nd Stage	Total
										1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27			
Full Construction										V : Opened to traffic																													
	Sec. 1	Double-lane road	2 Y		xxxxx	xxxxx																																
	Sec. 2	Double-lane road	5 Y		xx	xxxxx	xxxxx	xxxxx	xxxxx	xxxxx	xxxxx	xxx																										
Engineering Services Cost				302	76	76	76	76	75	75																										756	0	756
Construction Cost					919	919	918	918	918	918	918	918																								7,346	0	7,346
Operation and Maintenance Cost										7	7	7	7	7	7	7	221	7	7	7	7	7	7	7	221	7	7	7	7	7	7	7	221	7	7	7	49	782	830
Total				302	995	995	994	994	993	1,000	925	925	7	7	7	7	221	7	7	7	7	7	7	7	221	7	7	7	7	7	7	7	221	7	7	7	8,151	782	8,930

Unit: million NRs.

10.2.3 Benefit Estimation

(1) General

Vehicle operating cost and time cost are defined as the two of the components of road user's cost in this Study. Benefit by the road development is obtained as the balance of two of the road user's costs estimated through the following traffic simulations:

Case A : Without Project Case
Traffic simulation on the future road network which does not include the Project Road.

Case B : With Project Case
Traffic simulation on the future road network including the Project Road by alternative of road development concept.

Unit vehicle operating cost and time cost, which are essential inputs for the above calibration, is obtained from related study including "The Study on Kathmandu Valley Urban Road Development" done by JICA (1993) as explained in (3) and (4) of this Section.

(2) Road Driving Condition

Road driving condition is one of the major factors which decide the sizes of vehicle operation and time costs on the Project Road. Especially, vehicle speed and period of interception due to probable natural disaster and malfunction of road are two of the major components which decide the road driving condition. With this consideration, regarding the road driving condition, following assumptions are introduced:

1) Vehicle Speed

As a matter of fact number of lanes, pavement condition, surface condition, and road alignment (straight or curve) are major factors which affect on vehicle speed. Vehicle speed by item has been obtained as shown in Table 10-2.

2) Period of Interception

Period of interception by cause is assumed as follow:

- Malfunction of Causeway : 2 days
- Interception due to Land Slide : 3 days

Frequency of interception is assumed to be 5 times a year for each case.