CHAPTER 18 COST ESTIMATE

18.1 General

The project cost estimate was conducted, starting from extensive data collection, reconnaissance of the Project site and interviewing contractors and 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 assuming that the Project is executed by the international contractor(s).

The composition of the project cost is shown in Figure18-1. The project cost consists of construction cost, design & supervision cost, administration cost, land acquisition cost, house compensation cost, agricultural compensation cost, contingency and tax and duty. Construction cost consists of direct construction cost and indirect construction cost.

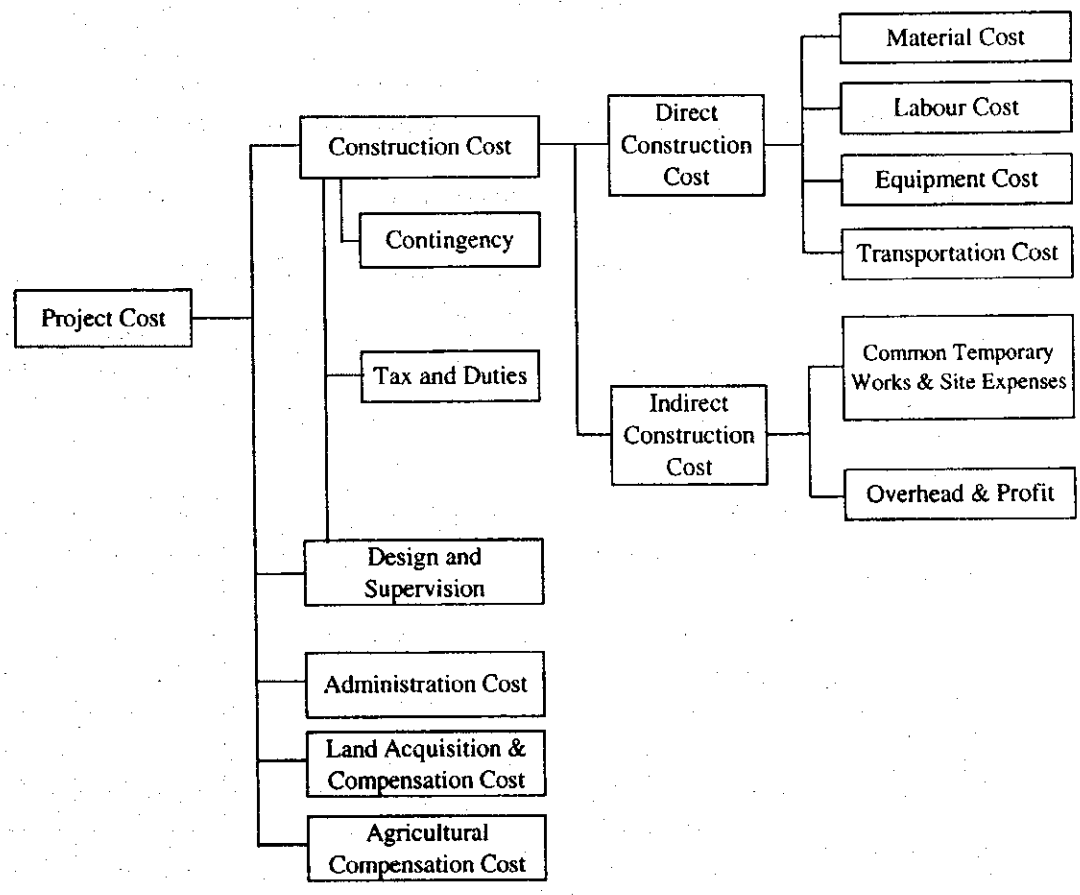


Figure 18.1 Composition of the Project Cost

The adapted exchange rates for the cost estimate were established by calculation of the average rate during 6 months from 1st July to 31st December 2000. The calculated exchange rates are as follows:

1USD	=	72.57 NRs	(Nepalese Rupee)
1USD	=	109.76 JPY	(Japanese Yen)
1USD	=	42.34 TLB	(Thailand Bahts)

All prices are based on the price level in December 2000.

18.2 Basic Prices and Procurement Sources

18.2.1 Procurement Sources

Possible procurement sources of material, equipment and manpower for the construction are studied through the Nepalese market investigation. According to the investigation, it was found that common material, equipment, and manpower used for the construction of road and RC structure can be procured in the Nepalese market.

On the other hand, a part of material, equipment, and manpower related to the construction works of tunnel and steel bridge must be procured outside of Nepal.

The possible procurement sources of major items are presented in Table 18.1.

Table 18.1 Procurement Sources of Major Items

Items	Procurement Country			
	Nepal	India	Thailand	Japan
Cement	○	○		
Asphalt	○			
Emulsified asphalt	○			
Crucher run	○			
Sand	○			
Re-bar	○			
Petrol	○			
Diesel fuel	○			
Kerosene	○			
Wood	○			
Steel Girder			○	
related materials to Tunnel		○		○

Remark :

Cement: Nepalese cement satisfies the quality requirement. However, the product quantity of that is unstable. By the interview survey from contractors, it is realistic to procure from Indian factory also.

Steel Girder: Considering the cost performance and the quality of steel girder especially its fabrication, its procurement source was proposed and led to the procurement from Thailand.

Tunnel Materials: Procurement from Japan was proposed considering many experiences of tunnel construction.

18.2.2 Basic Prices of Construction Material

Basic prices of the construction material were studied based on the information obtained from contractors and suppliers in Nepal or other countries according to their procurement sources. The applied unit prices of the major materials are shown in Table 18.2.

The foreign and local currency component is assumed considering shadow costs related to the foreign material and equipment in its total production cost.

Table 18.2 Material Unit Price

Item	Description	Unit	Quoted Price	Divided into F/C and L/C			
				USD	Ratio of F/C	NRs	Ratio of L/C
Cement		ton	**5,200 NRs**	14.3	20%	4,160	80%
Asphalt	Penetration 80~100	ton	**20,400 NRs**	281.1	100%	0	0%
Emulsified Asphalt		ton	**21,600 NRs**	297.6	100%	0	0%
Reinforcement Bar		ton	**26,000 NRs**	215.0	60%	10,400	40%
Diesel Fuel		liter	**27 NRs**	0.4	100%	0	0%
Petrol		liter	**47 NRs**	0.6	100%	0	0%
Kerosene		liter	**22 NRs**	0.3	100%	0	0%
Electric Charge	industrial use	kWh	**6.1 NRs**	0	0%	6.1	100%
H-shaped Steel		ton	**28,800 NRs**	396.9	100%	0	0%
Concrete Pipe Culvert	Dia. = 300mm	m	**1,000 NRs**	2.8	20%	800	80%
- ditto -	Dia. = 900mm	m	**3,360 NRs**	9.3	20%	2,688	80%
- ditto -	Dia. = 1200mm	m	**4,400 NRs**	12.1	20%	3,520	80%
Rock Bolt	l=3m	nos.	**12 USD**	12.0	100%	0	0%
Bridge Superstructure	Steel	ton	**777 USD**	777.0	100%	0	0%

18.2.3 Construction Equipment and Machine

Most common construction equipment and machines can be procured in Nepal. For these equipment and machines, operation costs were estimated based on the leasing prices. On the other hand, as concerns special equipment and machines, which are not available in Nepalese market, operation costs were estimated based on a depreciation basis.

Rate of the depreciation of each equipment and machines are assumed to be 60%-90% per Project, depending on the characteristics of equipment and machines and these working conditions.

In total operation cost, operator cost and fuel cost are also included. The applied unit prices of the major construction equipment and machines are shown in Table 18.3.

Table 18.3 Equipment Operation Unit Rate

Item	Specification	Unit	F/C portion (USD)	L/C portion (NRs)
Bulldozer	15t	hr	22.10	1720
Backhoe	0.6m^3	hr	15.90	916
- ditto -	0.35m^3	hr	11.34	836
Dump Track	6t	hr	4.06	311
- ditto -	8t	hr	5.66	386
- ditto -	10t	hr	7.45	557
Truck with Crane	4.0t lifting capacity	hr	6.14	386
Truck Mixer	3.2m^3	hr	18.55	1632
- ditto -	4.4m^3	hr	19.76	1632
Truck Crane	4.8t lifting capacity	day	37.79	3899
- ditto -	15t lifting capacity	day	121.50	12904
- ditto -	25t lifting capacity	day	151.68	16120
Road Roller	10-12t	hr	5.77	434
Asphalt Finisher	2.4-5.0m blade	hr	9.94	755
Vibratory Roller	3～4t	hr	8.57	916

18.2.4 Manpower

Labour unit costs were estimated based on the obtained information from the local contractors. Table 18.4 shows the unit rates of labours.

Table 18.4 Labour Unit Rate

Item	Specification	Unit	Wages (NRs.)
For ordinary road work			
Foreman	15 years experience	M.Day	400
Skilled Labour		M.Day	200
Common Labour		M.Day	112
Operator	Heavy equipment	M.Day	400
Mason		M.Day	200
Steel worker		M.Day	200
Form worker		M.Day	240
For tunnel work (2 shift)			
Foreman	15 years experience	M.Day	700
Skilled Labour		M.Day	300
Common Labour		M.Day	150
Operator	Heavy equipment	M.Day	700
Concrete worker		M.Day	200
Steel worker		M.Day	250
Form worker		M.Day	250

18.2.5 Transportation

Special equipment and material, which are not available in Nepalese market, will be imported from abroad. Transportation routes are assumed as below, and cost of the transportation is included in the direct construction cost.

1) India – Project Site (ex. cement etc.)

2) Bangkok – Calcutta – Project Site (ex. steel girder for bridge etc.)

3) Japan – Calcutta – Project Site (ex. tunnel materials and equipment etc.)

18.2.6 Tax and Duties

The rate of Value Added Tax (VAT) is 10% on invoiced amount and the rate of custom duties depends on type of products and goods. VAT and the custom duties might be exempted for the loan project, if the Ministry of Finance agrees to it while entering the loan agreement with donor agency.

In accordance with the instances of the past F/S reports in Nepal, only VAT is simply estimated for the Project.

18.2.7 Ability of Local Contractors

The local contractors in Nepal have some experience of highway construction and they are considered to be capable for common highway construction work.

However some special works such as erection of steel girder and tunneling works should be conducted by qualified international contractors or under their supervision.

18.3 Cost Estimate

18.3.1 Construction Quantity

The quantities of the construction works were calculated by the CAD system based on the surveyed digital terrain map.

18.3.2 Unit Cost Analysis

For the estimation of unit prices of individual work items, input requirements of manpower, material, and equipment should be established. There is an official Nepalese cost estimate guideline, "Construction Works Rate Analysis Norms 2041", however it introduces those input requirements only for such minor works as gabion works and wet masonry work.

Therefore, unit price estimate of all major work items are conducted using Japanese cost estimate manuals issued by the Ministry of Construction, Japan.

As for some minor works, for which unit price estimate can be referred to Nepalese guideline, the unit price estimate was carried out based on it.

18.3.3 Indirect Construction Cost

Indirect construction cost consists of common temporary works & site expenses cost and overhead & profit. Each cost was estimated at 10% of total direct construction cost.

18.3.4 Contingency

Contingency was estimated at 10% of total direct construction cost.

18.3.5 E/S Cost

E/S cost (Design and supervision cost) for the consultant was estimated at 18% of total construction cost.

18.3.6 Tax and Duties

Value Added Tax (VAT) was simply estimated at 10% of total construction cost and E/S cost.

Table 18.5 Summary of the Direct Construction Cost

Major Item	Unit	Unit Cost			Quantity			Total Cost of Package 1			Total Cost of Package 2			Total Cost of Package 3			Total Cost (*1)			Remarks
		F/C (USD)	L/C (USD)	Total (USD)	Package1	Package2	Package3	F/C (USD)	L/C (USD)	Total (USD)	F/C (USD)	L/C (USD)	Total (USD)	F/C (USD)	L/C (USD)	Total (USD)	F/C (USD)	L/C (USD)	Total (USD)	
1.Preparation Work								61,069	73,609	134,677	13,659	16,464	30,122	57,628	69,462	127,089	132,000	160,000	292,000	
1-1 Clearing (forest area)	m2	0.2	0.3	0.5	291,009	65,088	274,613	61,069	73,609	134,677	13,659	16,464	30,122	57,628	69,462	127,089	132,000	160,000	292,000	
2.Earthwork								477,599	516,388	993,987	1,174,116	926,715	2,100,832	1,607,475	1,343,013	2,950,488	3,260,000	2,786,000	6,046,000	
2-1 Excavation (Common Soil)	m3	0.7	0.7	1.4	359,055	57,245	342,874	249,557	264,891	514,448	39,788	42,232	82,020	238,311	252,953	491,264	528,000	560,000	1,088,000	
2-2 Excavation (Rock)	m3	6.2	4.0	10.3	0	140,169	164,184	0	0	0	872,564	564,195	1,436,759	1,022,059	660,858	1,682,918	1,895,000	1,225,000	3,120,000	
2-3 Excavation (Spoil)	m3	2.3	2.3	4.5	17,264	82,522	27,398	37,809	39,946	77,754	180,725	190,941	371,666	60,002	63,394	123,396	279,000	294,000	573,000	
2-4 Embankment	m3	0.6	0.6	1.2	341,791	115,107	479,668	190,233	211,552	401,785	64,066	71,246	135,312	266,968	296,886	563,854	521,000	580,000	1,101,000	
2-5 Structural Excavation	m3	0.0	1.9	1.9	0	22,119	26,238	0	0	0	0	40,964	40,964	0	48,593	48,593	0	90,000	90,000	
2-6 Back Filling	m3	0.8	0.8	1.5	0	22,119	26,238	0	0	0	16,974	17,137	34,111	20,135	20,328	40,463	37,000	37,000	74,000	
3.Drainage								167,746	677,636	845,382	30,774	209,062	239,836	152,380	651,073	804,453	352,000	1,538,000	1,890,000	
3-1 Side Ditch	m	2.0	23.4	25.4	14,363	6,107	14,474	28,907	336,560	365,467	12,291	143,102	155,393	29,131	339,161	368,291	70,000	819,000	889,000	
3-2 Pipe Culvert (dia.900mm)	m	14.5	58.1	72.6	475	15	195	6,875	27,589	34,464	217	871	1,088	2,823	11,326	14,149	10,000	40,000	50,000	
3-3 Pipe Culvert (dia.1200mm)	m	28.9	97.2	126.1	337	77	376	9,755	32,753	42,508	2,229	7,484	9,713	10,884	36,544	47,428	23,000	77,000	100,000	
3-4 Box Culvert (2m*2m)	m	202.1	393.5	595.6	231	42	190	46,687	90,907	137,594	8,488	16,529	25,017	38,400	74,772	113,172	94,000	182,000	276,000	
3-5 Box Culvert (3m*4m)	m	403.9	743.0	1,146.9	127	0	42	51,289	94,364	145,653	0	0	0	16,962	31,207	48,169	68,000	126,000	194,000	
3-6 Box Culvert (3m*4m*2shell)	m	735.0	1,334.8	2,069.9	0	0	40	0	0	0	0	0	0	29,402	53,394	82,795	29,000	53,000	82,000	
3-7 Shoa Drainage (for C-Pipe)	m	9.6	39.6	49.2	59	198	218	564	2,336	2,900	1,893	7,840	9,733	2,084	8,632	10,716	5,000	19,000	24,000	
3-8 ShoeDrainage (for C-box)	m	20.9	84.9	105.8	25	50	80	524	2,122	2,646	1,047	4,244	5,291	1,676	6,790	8,466	3,000	13,000	16,000	
3-9 Catch Pit (for C-Pipe)	nos.	49.0	151.5	200.4	3	4	6	147	454	601	196	606	802	294	909	1,203	1,000	2,000	3,000	
3-10 Catch Pit (for C-Box)	nos.	160.8	524.1	684.9	2	1	3	322	1,048	1,370	161	524	685	482	1,572	2,055	1,000	3,000	4,000	
3-11 Catch Basin (for C-Pipe)	nos.	28.0	114.6	142.6	3	4	6	84	344	428	112	458	570	168	687	856	0	1,000	1,000	
3-12 Gabion Work	m3	12.8	13.9	26.7	56	10	83	712	771	1,483	125	135	261	1,068	1,156	2,225	2,000	2,000	4,000	
3-13 Miscellaneous	L.S.				1	1	1	21,880	88,387	110,267	4,014	27,269	31,283	20,006	84,923	104,929	46,000	201,000	247,000	15% of (3-1 to 3-12)
4.Slope Protection								14,331	161,868	176,199	491,433	1,086,349	1,578,282	528,965	1,236,840	1,765,804	1,034,000	2,484,000	3,518,000	
4-1 Wet Masonry Wall	m2	2.0	19.7	21.7	7,175	9,507	17,504	14,331	141,559	155,890	18,989	187,568	206,557	34,963	345,345	380,307	68,000	674,000	742,000	
4-2 T-shaped wall	m3	30.6	85.6	136.2	0	6,183	8,815	0	0	0	312,644	529,484	842,128	445,731	754,877	1,200,608	758,000	1,284,000	2,042,000	
4-3 Concrete Foundation for T-shaped Wall	m3	29.7	66.8	96.4	0	5,360	1,593	0	0	0	158,937	357,945	516,883	47,236	106,382	153,618	206,000	464,000	670,000	
4-4 Gravity Wall	m3	3.5	33.7	37.2	0	246	295	0	0	0	863	8,289	9,151	1,034	9,940	10,974	2,000	18,000	20,000	
4-5 Vegetation Work (Sodding)	m2	0.0	0.2	0.2	115,143	20,200	115,071	0	20,309	20,309	0	3,563	3,563	0	20,296	20,296	0	44,000	44,000	
5.Bridge								1,306,966	640,264	1,947,230	627,126	353,894	981,020	201,889	115,242	317,131	2,136,000	1,109,000	3,245,000	
5-1 RC Hollow Slab	L.S.	125,813.5	101,495.9	227,309.4	1			125,814	101,496	227,309	0	0	0	0	0	0	126,000	101,000	227,000	
5-2 RC Hollow Slab	L.S.	113,899.1	88,942.7	202,841.8	1			113,899	88,943	202,842	0	0	0	0	0	0	114,000	89,000	203,000	
5-3 RC Hollow Slab	L.S.	88,320.2	68,351.9	156,672.2	1			88,320	68,352	156,672	0	0	0	0	0	0	88,000	68,000	156,000	
5-4 Steel Box Girder + RC Hollow Slab	L.S.	627,125.8	353,893.7	981,019.5		1		0	0	0	627,126	353,894	981,020	0	0	0	627,000	354,000	981,000	
5-5 RC Hollow Slab	L.S.	88,750.9	68,652.3	157,403.2			1	0	0	0	0	0	0	88,751	68,652	157,403	89,000	69,000	158,000	
5-6 Steel I Girder	L.S.	113,138.4	46,589.8	159,728.2			1	0	0	0	0	0	0	113,138	46,590	159,728	113,000	47,000	160,000	
5-7 Steel Box Girder + RC Hollow Slab	L.S.	292,940.4	139,380.3	432,320.7	1			292,940	139,380	432,321	0	0	0	0	0	0	293,000	139,000	432,000	
5-8 Steel Box Girder	L.S.	173,890.5	72,707.8	246,598.3	1			173,890	72,708	246,598	0	0	0	0	0	0	174,000	73,000	247,000	
5-9 Steel I Girder	L.S.	171,644.8	72,363.9	244,008.7	1			171,645	72,364	244,009	0	0	0	0	0	0	172,000	72,000	244,000	
5-10 Steel Box Girder	L.S.	340,457.5	97,021.5	437,479.0	1			340,457	97,021	437,479	0	0	0	0	0	0	340,000	97,000	437,000	
6.Mitigation Measure								7,571	154,293	161,864	0	33,014	33,014	5,504	87,095	92,599	13,000	273,000	286,000	
6-1 Canal Relocation(Existing Ditch)	m	2.0	23.4	25.4	2,503	0	2,038	5,038	58,651	63,689	0	0	0	4,102	47,755	51,857	9,000	106,000	115,000	
6-2 Canal Relocation(C-pipe Dia.300)	m	5.2	21.2	26.4	488	0	270	2,534	10,337	12,871	0	0	0	1,402	5,719	7,121	4,000	16,000	20,000	
6-3 Planting Tree Work	L.S				1	1	1		5,159	5,159		2,535	2,535		2,668	2,668	0	10,000	10,000	
6-4 Electric pole and Line Relocation	L.S				1	1	1		8,268	8,268		4,134	4,134		6,890	6,890	0	19,000	19,000	
6-5 Sound Insulation Cost	L.S.				1	1	1		71,877	71,877		26,345	26,345		24,063	24,063	0	122,000	122,000	
7.River Treatment								95,822	195,843	291,665	1,985	3,611	5,596	0	0	0	97,000	199,000	296,000	
7-1 Excavation(weathered rock)	m3	5.6	4.4	10.0	14,688	313	0	82,557	64,819	147,377	1,759	1,381	3,141	0	0	0	84,000	66,000	150,000	
7-2 Rivetment	m2	2.0	19.7	21.7	6,641	113	0	13,265	131,023	144,288	226	2,229	2,455	0	0	0	13,000	133,000	146,000	
8.Pavement								917,659	1,087,162	2,004,821	131,363	153,292	284,656	650,450	777,342	1,427,792	1,700,000	2,018,000	3,718,000	
8-1 Subbase Course (purchase)	m3	1.3	12.5	13.8	9,965	0	2,342	12,558	124,645	137,203	0	0	0	2,951	29,290	32,241	16,000	154,000	170,000	
8-2 Subbase Course (in site)	m3	1.8	6.0	7.7	25,660	5,681	25,660	45,079	153,335	198,414	9,980	33,948	43,929	45,079	153,335	198,414	100,000	341,000	441,000	
8-3 Base Course	m3	2.8	15.3	18.1	35,108	5,314	26,542	97,780	537,376	635,156	14,800	81,338	96,138	73,932	406,262	480,194	187,000	1,025,000	1,212,000	
8-4 Asphalt Concrete	m2	6.2	2.2	8.4	122,894	17,184	85,208	762,242	271,807	1,034,049	106,583	38,006	144,589	528,497	188,456	716,953	1,397,000	498,000	1,895,000	
9.Tunnel								0	0	0	7,703,448	1,543,954	9,247,402	0	0	0	7,704,000	1,544,000	9,248,000	
9-1 Tunnel	L.S.					1					5,710,412	1,433,716	7,144,127				5,710,000	1,434,000	7,144,000	
9-2 Muddy Water Treatment	L.S.					1					365,645	0	365,645				366,000	0	366,000	
9-3 Lighting	L.S.					1					774,508	0	774,508				775,000	0	775,000	
9-4 M&E	L.S.					1					599,257	0	599,257				599,000	0	599,000	
9-5 Emergency Facilities	L.S.					1					253,626	0	253,626				254,000	0	254,000	
9-6 Wiring Works	L.S.					1					0	110,238	110,238				0	110,000	110,000	
10.Miscellaneous								497,254	124,334	621,588	298,757	240,827	539,584	724,292	526,210	1,250,502	1,521,000	891,000	2,412,000	
10-1 Guard Rail	m	92.6	40.4	133.0	1,926	1,268	6,849	178,348	77,762	256,110	117,417	51,195	168,612	634,219	276,527	910,746	930,000	405,000	1,335,000	
10-2 Side Walk	m2	1.8	7.5	9.3	1,412	0	0	2,572	10,618	13,189	0	0	0	0	0	0	3,000	11,000	14,000	
10-3 Traffic Signal	L.S.	167,096.4	0.0	167,096.4	1			167,096	0	167,096	0	0	0	0	0	0	167,000	0	167,000	
10-4 Access Road No.1	L.S.	53,194.0	94,138.1	147,332.1		1		0	0	0	53,194	94,138	147,332	0	0	0	53,000	94,000	147,000	
10-4 Access Road No.2	L.S.	26,709.8	202,096.5	228,806.3			1	0	0	0	0	0	0	26,710	202,096	228,806	27,000	202,000	229,000	
10-5 Toll Gate and Maintenance Office	L.S.	0.0	50,268.7	50,268.7		1		0	0	0	0	50,269	50,269	0	0	0	0	50,000	50,000	
10-6 Others(Road mark, km post etc.)	L.S.				1	1	1	33,968	35,954	69,922	103,445	45,225	148,670	38,662	47,587	86,249	176,000	129,000	305,000	1% of (1-1 to 10-5)
10-7 Transportation	L.S.	164,671.3	0.0	164,671.3	0.70	0.15	0.15	115,270	0	115,270	24,701	0	24,701	24,701	0	24,701	165,000	0	165,000	
11.Total Direct Construction Cost								3,546,017	3,631,398	7,177,415	10,472,661	4,567,682	15,040,343	3,929,581	4,806,277	8,735,858	17,948,000	13,005,000	30,953,000	

Table 18.6 Summary of the Project Cost

Major Item	Unit	Package 1			Package 2			Package 3			Total Cost (rounded)			Remarks
		F/C (USD)	L/C (USD)	Total (USD)	F/C (USD)	L/C (USD)	Total (USD)	F/C (USD)	L/C (USD)	Total (USD)	F/C (USD)	L/C (USD)	Total (USD)	
1. Construction Cost														
1-1.Direct Construction Cost														
- Preparation Work		61,069	73,609	134,677	13,659	16,464	30,122	57,628	69,462	127,089	132,000	160,000	292,000	
- Earthwork		477,599	516,388	993,987	1,174,116	926,715	2,100,832	1,607,475	1,343,013	2,950,488	3,260,000	2,786,000	6,046,000	
- Drainage		167,746	677,636	845,382	30,774	209,062	239,836	153,380	651,073	804,453	352,000	1,538,000	1,890,000	
- Slope Protection		14,331	161,868	176,199	491,433	1,086,849	1,578,282	528,965	1,236,840	1,765,804	1,034,000	2,484,000	3,518,000	
- Bridge		1,306,966	640,264	1,947,230	627,126	353,894	981,020	201,889	115,242	317,131	2,136,000	1,109,000	3,245,000	
- Mitigation Measure		7,571	154,293	161,864	0	33,014	33,014	5,504	87,095	92,599	13,000	273,000	286,000	
- River Treatment		95,822	195,843	291,665	1,985	3,611	5,596	0	0	0	97,000	199,000	296,000	
- Pavement		917,659	1,087,162	2,004,821	131,363	153,292	284,656	650,450	777,342	1,427,792	1,700,000	2,018,000	3,718,000	
- Tunnel		0	0	0	7,703,448	1,543,954	9,247,402	0	0	0	7,704,000	1,544,000	9,248,000	
- Miscellaneous		497,254	124,334	621,588	298,757	240,827	539,584	724,292	526,210	1,250,502	1,521,000	891,000	2,412,000	
Total Direct Construction Cost		3,546,017	3,631,398	7,177,415	10,472,661	4,567,682	15,040,343	3,929,581	4,806,277	8,735,858	17,948,000	13,005,000	30,953,000	
1-2.Indirect Construction Cost														
- Common Temporary Works & Site expenses	L.S.	531,903	544,710	1,076,612	1,570,899	685,152	2,256,051	589,437	720,942	1,310,379	2,692,000	1,951,000	4,643,000	15% of total (1)
- Overhead & Profit	L.S.	354,602	363,140	717,741	1,047,266	456,768	1,504,034	392,958	480,628	873,586	1,795,000	1,301,000	3,096,000	10% of total (1)
Total Indirect Construction Cost		886,504	907,849	1,794,354	2,618,165	1,141,920	3,760,086	982,395	1,201,569	2,183,965	4,487,000	3,251,000	7,738,000	
Total Construction Cost		4,432,522	4,539,247	8,971,769	13,090,827	5,709,602	18,800,429	4,911,977	6,007,846	10,919,823	22,435,000	16,257,000	38,692,000	
2. Design & Supervision	L.S.										4,875,500	2,089,500	6,965,000	18% of total (1)
3. Contingency		443,252	453,925	897,177	1,309,083	570,960	1,880,043	491,198	600,785	1,091,982	2,244,000	1,626,000	3,870,000	10% of total (1)
Sub Total (1+2+3)											29,554,500	19,972,500	49,527,000	total(1+2+3)
4. Administration Cost	L.S.											457,000	457,000	1% of (1+2)
5. Land Acquisition and Compensation Cost	L.S.											2,394,000	2,394,000	*1
6. Tax and Duties												4,566,000	4,566,000	10% of total (1+2)
Sub Total (3+4+5)	L.S.											7,417,000	7,417,000	
Total Project Cost											**29,554,500**	**27,389,500**	**56,944,000**	

*1 : The land acquisition cost, resettlement cost and agricultural compensation cost were estimated as 93.8 million NRs, 55.4 million NRs and 24.5 million NRs, respectively. (refer to Chapter 16)

18.3.7 Administration Cost

Administration cost which shall be expenses of DOR was estimated at 1% of total construction cost and E/S cost.

18.3.8 Land Acquisition Cost and House Compensation Cost

Land acquisition and house compensation cost was calculated based on the site investigation. Detailed breakdown of this cost was shown in Chapter 16 "Land Acquisition and Resettlement Plan".

18.3.9 Agricultural Compensation

Agricultural compensation cost was calculated based on the site investigation. Detailed breakdown of this cost was shown in Chapter 16 "Land Acquisition and Resettlement Plan".

18.3.10 Result of Cost Estimate

Summary of the direct construction cost and the project cost are shown in Table 18.5 and 18.6 respectively.

According to the estimate, direct construction cost of the tunnel for cuvil works was estimated to be 10,650 US$(1.17 million J.Yen) per tunnel linear meter. The standard direct construction cost of 2-lane highway tunnel in similar geological condition in Japan is esteemed to be about 2 million J.Yen per linear meter, so that the estimated tunnel cost of the Project is equivalent to 60% of the standard cost in Japan approximately.

CHAPTER 19 PROJECT EVALUATION

19.1 Economic Evaluation

The main purposes of an economic evaluation are to assess the degree of contribution of the Project to the national economy and to investigate whether the implementation of the Project is justified or not from an economic point of view.

The economic evaluation of the Project is usually done by the "With Project" and "Without Project" comparison method. The following procedure for the project evaluation was conducted:

- Estimation of economic costs
- Estimation of economic benefits
- Estimation of EIRR, NPV and B/C

19.1.1 Economic Costs

The basic adjustment to convert financial prices to economic basis is to exclude from the price any taxes, duties or subsidies, and land acquisition and compensation cost.

Based on the construction plan and cost estimate described in Chapter 17 and 18, the estimated economic costs are summarized in Table 19.1.

Table 19.1 Economic Cost Stream

unit: million US$

2001	2002	2003	2004	2005	2006
0.43	1.71	13.23	19.65	14.66	0.30

19.1.2 Economic Benefits

There exist many types of benefits on the national economy by the Project. Those are classified conveniently into "Direct Benefits" and "Indirect Benefits".

Direct benefits are defined as the benefits enjoyed by road users who use the Project Road directly. The following two kinds of benefits were estimated quantitatively in this economic evaluation:

- Vehicle Operating Cost Savings
- Travel Time Costs Savings of passengers

The vehicles adopted for calculation of economic benefits were motorcycles, passenger cars, trucks, mini trucks, buses and mini buses.

The traffic volumes and the travel speed in 2010 and 2020 presented in Chapter 7 were used for the calculation of economic benefits. Both existing and projected road conditions such as width, length, alignment, and roughness were taken into consideration for the benefits calculation.

Indirect benefits, on the other hand, are kinds of induced effects generated through the direct benefits and realised as socio-economic impacts that are described in 19.3.

In addition to those benefits, the interruption time due to landslide and other structures of road was analysed based on the traffic interruption survey conducted by the Study Team.

1) Calculation of Vehicle Operating Costs

The economic vehicle operating costs were estimated by using Highway Design Maintenance Standards Model (HDM) which is a computer model developed by the World Bank.

VOCs consist of the following components:

- Fuel cost
- Oil cost
- Maintenance parts
- Maintenance labour
- Tyre cost
- Depreciation
- Interest
- Crew cost
- Overhead and insurance cost

Price data and technical parameters of VOCs in the Fourth Road Improvement Project were updated by using the recent economic growth.

Calculated VOCs are summarised in Table 19.2.

Table 19.2 VOCs

unit: million US$

Vehicle Type	2010		2020	
	With Project	Without Project	With Project	Without Project
Motorcycle	1.36	1.77	3.97	4.35
Passenger Car	10.36	13.31	28.38	31.31
Truck	14.73	19.88	19.99	22.84
Mini Truck	2.18	3.38	3.94	5.19
Bus	7.66	10.08	8.22	9.08
Mini Bus	1.36	2.08	2.11	2.60
Total	37.65	47.89	66.62	75.38

2) Calculation of Travel Time Costs

The time values of drivers and assistants for commercial vehicles have been included in VOCs as crew costs. And, therefore, only the time values for passengers were used applying the results of the Fourth Road Improvement Project. The time values for car passengers and bus passengers are NRs 11.7 and NRs 4.7 per hour, respectively. The time values for car and bus were calculated with NRs 43.3 and NRs 105.3, respectively by using the occupancy rates that come from the results of OD survey conducted by Study Team. The time value for motorcycle was calculated with Nrs 18.3 based on the occupancy ratio of motorcycle and passenger car. The time value for mini bus was calculated with NRs 37.3 by using the occupancy ratio of bus and mini bus.

Table 19.3 shows calculated travel time costs based on the time values, the traffic volume and the travel speed which were obtained from the results of the traffic assignment, presented in Chapter 7.

Table 19.3 Travel Time Costs

unit: million US$

Vehicle Type	2010		2020	
	With Project	Without Project	With Project	Without Project
Motorcycle	0.58	0.79	1.71	1.98
Passenger Car	2.05	2.92	5.52	6.44
Bus	1.58	2.35	1.46	1.74
Mini Bus	0.14	0.22	0.21	0.27
Total	4.36	6.28	8.90	10.43

3) Analysis of Interruption Time

In order to gain information about the interruption characteristics that generally occur in Tankot-Naubise Road, interview survey with drivers who use this road generally was conducted by the Study Team on September of 2000. According to

the results of the survey, total interruption time due to landslide and defect of structures on road was 12 hours per year. Based on the time values by vehicle type, traffic volume and interruption time, the interruption time costs were estimated at 0.02 million US$ per year.

In case of the With Project, vehicles go through the existing road can pass the Project Road. Consequently, a large part of the interruption time costs will be reduced. These costs are not so big comparing the VOCs and travel time costs savings, so that the interruption time costs savings were not included in this economic evaluation.

Also, in the interview, opinions of road users on the matter of minimizing interruption were asked. The general opinions are as follows:

- Widening of the existing road
- Construction of an alternate road
- Providing parking bays on certain interval
- Restriction of over load trucks

4) Estimation of Economic Benefits

Based on the VOCs and travel time costs, the economic benefits are estimated and presented in Table 19.4.

Table 19.4 Economic Benefits

unit: million US$

	Economic Benefits	
	2010	**2020**
VOCs Saving	10.24	8.76
Travel Time Costs Saving	1.92	1.53
Total Benefits	12.16	10.29

19.1.3 Economic Evaluation

In general, three types of indicators namely EIRR, NPV, and B/C are used for the economic evaluation of a road construction project. In calculation of each indicator, the following conditions were assumed:

- Opening year of the Project is scheduled to be at the beginning of the year 2006 in accordance with the implementation plan.
- The evaluation period of the Project was assumed as 25 years after opening year.
- Benefit streams are estimated by means of interpolation and extrapolation based on the benefits in benchmark years (2010 and 2020) and growth of the traffic demand.
- A standard discount rate is at 12%.

- Annual maintenance costs is assumed at 1% of the initial construction cost. The adjustment factor to convert financial prices to an economic basis is 0.9 recommended by the Maintenance and Rehabilitation Co-ordination Unit (MRCU) of DOR.

The results of calculation of EIRR, NPV, and B/C are shown in Table 19.5. The benefit and cost cash flow is presented in Table 19.6.

Table 19.5 EIRR, NPV and B/C Calculation

EIRR (%)	NPV (million US$)	B/C
18.1	19.17	1.57

Table 19.6 Cost Benefit Cash Flows

(Unit: Million US$)

Year	Capital Costs	O & M Costs	Total Costs	Benefits	B-C
2001	0.43		0.43		-0.43
2002	1.71		1.71		-1.71
2003	13.23		13.23		-13.23
2004	19.65		19.65		-19.65
2005	14.66		14.66		-14.66
2006	0.30	0.26	0.56	7.22	6.66
2007		0.35	0.35	10.21	9.86
2008		0.35	0.35	10.82	10.47
2009		0.35	0.35	11.47	11.12
2010		0.35	0.35	12.16	11.81
2011		0.35	0.35	13.13	12.78
2012		0.35	0.35	14.18	13.83
2013		0.35	0.35	15.32	14.97
2014		0.35	0.35	16.54	16.19
2015		0.35	0.35	17.87	17.52
2016		0.35	0.35	7.56	7.21
2017		0.35	0.35	8.17	7.82
2018		0.35	0.35	8.82	8.47
2019		0.35	0.35	9.53	9.18
2020		0.35	0.35	10.29	9.94
2021		0.35	0.35	11.11	10.76
2022		0.35	0.35	12.00	11.65
2023		0.35	0.35	12.96	12.61
2024		0.35	0.35	14.00	13.65
2025		0.35	0.35	15.12	14.77
2026		0.35	0.35	16.33	15.98
2027		0.35	0.35	17.64	17.29
2028		0.35	0.35	19.05	18.70
2029		0.35	0.35	20.57	20.22
2030		0.35	0.35	22.22	21.87

EIRR	18.1%
NPV	19.17
B/C	1.57

19.1.4 Sensitivity Analysis

The sensitivity tests for the Project Road was conducted changing the following factors:

- Changing costs in total (+10%, +20%)
- Changing benefits in total (-10%, -20%)
- Combinations of above changes

The results of test are shown in Table 19.7.

If the project costs go up by 20% and benefits go down by 20% simultaneously, an EIRR of more than 12% is still maintained.

The Project Road is economically feasible and implementation of the Project is justified from the viewpoint of national economy.

Table 19.7 Sensitivity Analysis for EIRR (%)

Base Case: 18.1	Cost: ±0%	Cost: +10%	Cost: +20%
Benefit: ±0%	18.1	16.7	14.2
Benefit: -10%	16.5	15.2	14.0
Benefit: -20%	14.9	13.6	12.6

19.2 Financial Analysis

19.2.1 Toll Collection System

Barrier type toll system is planned with installation of two barrier gates. One is in the Kathmandu side of the tunnel for traffic from Kathmandu to Naubise and another in the Naubise side of the tunnel for the traffic from Naubise to Kathmandu, is adopted.

Toll rate established in Table 19.8 is to be collected at each gate as illustrated below:

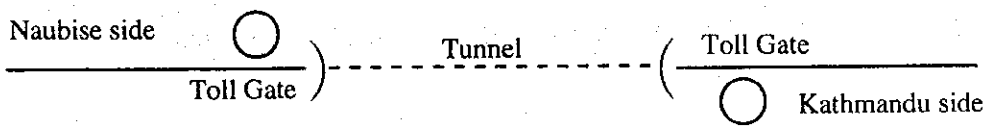


Figure 19.1 Location of Toll Gate on the Project Road

Existing toll rates by vehicle type on Tribhvan Highway are used for traffic demand forecast in order to maximise both the benefits to traffic and the toll revenues as shown in Table 19.8.

Table 19.8 Unit Toll Rate

Vehicle Type	Toll Rate (NRs/vehicle)
Motorcycle	5
Passenger Car	25
Bus	35
Truck	35

19.2.2 Estimation of Toll Revenue

Toll revenues are estimated as shown in Table 19.9 based on future traffic volume and above mentioned toll rate. It is obvious that expected toll revenue from the Project Road will not be large enough to cater to whole of the project cost.

Table 19.9 Toll Revenue by Vehicle Type

Unit US$

Vehicle Type	2010	2020
Motorcycle	15,843	31,435
Passenger Car	174,780	287,946
Truck	174,277	154,912
Mini Truck	42,752	66,643
Bus	77,456	51,051
Mini Bus	13,831	12,574
Total	498,939	604,561

19.2.3 DOR Budget and Expenditure

The activities of the DOR are financed through appropriation from the National Budget. Tale 19.10 shows DOR budget and expenditure in last five years.

The percentage of annual expenditure for the DOR to the National Expenditure is about 4 – 10% in recent three years.

Table 19.10 DOR Budget and Expenditure

Unit: NRs

Fiscal Year	Budget	Expenditure	% of National Expenditure
1994/95	3,162,750,000 (43,582,000)	1,738,293,899 (23,953,000)	4.4%
1995/96	3,821,207,690 (52,655,000)	3,182,041,305 (43,848,000)	6.8%
1996/97	4670,301,000 (64,356,000)	5,000,779,997 (68,910,000)	9.9%
1997/98	4,767,257,000 (65,692,000)	3,979,376,472 (54,835,000)	-
1998/99	5,192,926,000 (71,557,000)	3,579,619,537 (49,326,000)	-

Source: Central Financial Statements, DOR
Note: Figures in parentheses show US$.

19.2.4 Financial Evaluation

Given the financial costs and toll revenue, Financial Internal Rate of Return (FIRR) was calculated at -9.7%. If toll rate as high as double of the above toll rates are

applied, the FIRR will increase but still remain at -6.4%. Figure 19.2 shows relationship between toll rate and FIRR.

In this case, traffic volume in 2010 was 2,820 vehicle per day, in 2020 4340 vehicle per day.

Estimated toll revenue is over the level of catering to annual maintenance cost and a part of the project costs, which would result in saving in maintenance cost for DOR.

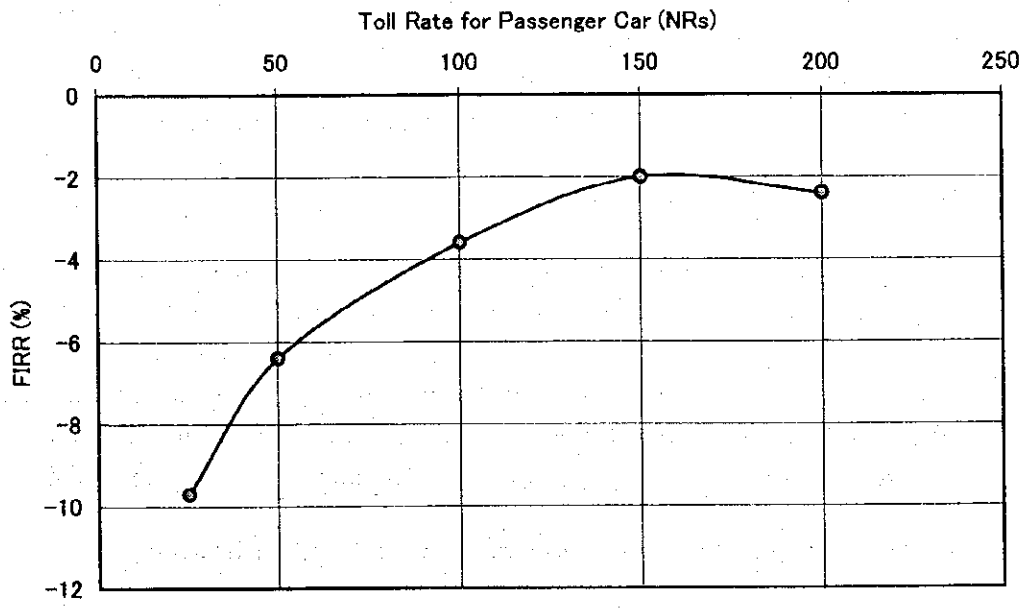


Figure 19.2 Toll and FIRR

19.3 Indirect Benefits

It is necessary and important to construct the Project Road for alternate road to the existing Trivhuvan Highway. Beside the direct benefits, following effects are indirectly brought in the area along the Project Road.

- promotion of agriculture
- promotion of commerce
- improvement of living conditions
- Rise of value on resources and changes for land utilisation
- Influence of project investment

Promotion of Agriculture

Effects given to agriculture in area along the Project Road by construction of the Road are expansion of market and improvement of agricultural structure by easy access to Kathmandu City. Jiwanpur and Chhatre Deurali VDC in which agriculture is

prosperous will experience great benefit by shortening of time distance to Kathmandu City. Although there is no road linking with Kathmandu, these areas are a major supply source of cash crops to Kathmandu. Therefore the Project Road will contribute to the change in agricultural structure from lower priced production to cash crops in these areas, and also to the stable supply of the agricultural product to Kathmandu.

Promotion of Commerce

Market area is magnified by construction of the Project Road. Business activities in each VDC along the road will be activated. When access to Kathmandu City is improved, anybody can easily go to shopping to Kathmandu City. As a result, it seems that a local retail will make effort by themselves. Competition among them can produce, and the commerce whole becomes active and attractive.

Improvement of Living Conditions

The improvement in traffic conditions through construction of the Project Road will help people in a rural area in utilising and gaining access to such social facilities as government offices, hospitals, schools, etc. located far from their residence. Furthermore, they will be able to enjoy shopping, sports, watching movies, etc., and will also gain access to libraries, cultural centers and museums in Kathmandu City. Accordingly, life conditions of people will be wider without changing their residences.

Rise of Value on Resources and Changes for Land Utilisation

The most conspicuous effect of constructing the Project Road is land utilisation near the Project Road. A change of land use is brought from farmland to a residential area and industrial area. Especially the areas located outside of Kathmandu Valley in the west, such as Jiwanpur and Chhatre Deurali VDC, have relatively flat land and water source from the Mahesh River, so opportunity to develop these area as industrial area will increase by the construction of the Project Road. These activities will accelerate decentralisation of the Kathmandu Valley and contribute to reduction of such urban problems of the Valley as over population and serious air pollution.

Influence of Project Investment

When construction of the Project Road begins, a wage is paid to worker who engages in Project Road construction, and construction materials are purchased. As a result, income of employer and business profit of company for production of construction materials will increase.

CHAPTER 20 PROJECT IMPLEMENTATION PLAN

20.1 Implementation Plan of the Project

20.1.1 General

In this chapter, several crucial subjects necessary for the project implementation, such as financial source, organizational arrangement, employment of the Consultant and procurement of the Contractor, are discussed.

Besides the Kathmandu – Naubise Alternate Road Project, implementation plan of the Kathmandu – Terai Alternate Road Project, which is deeply related to the Project, is also examined in this chapter for the clarification the Project implementation

20.1.2 Executing Agency

The Department of Roads (DOR), Ministry of Physical Planning and Works, HMG/N will be responsible for construction and operation/maintenance of the Project.

It is recommended that DOR shall establish a Project Management Unit (PMU) headed by the Project Managing Director during detailed design and construction stage. Proposed project organization during detailed design and construction stage is illustrated in the Figure 20.1. Major tasks of the PMU are the execution of land acquisition and compensation, tendering and coordination with local people and agencies concerned.

In the operation and maintenance stage, it is recommended that a Project Operation Unit (POU) is established particularly for the operation of the Project Road. POU will be responsible for routine and periodic maintenance of the Project Road, repair of structures, safe operation of the tunnel, and toll collection. The collected toll of the Project Road should be allocated to the POU and used for the operation and maintenance of the Project Road. Proposed organization of the POU is presented in Figure 13.1 in the previous Clause 13.6.

20.1.3 Expected Financial Source

Considering annual budget constraint of DOR, it is obviously impossible to implement the Project under DOR local fund. Through discussions with agencies and authorities concerned during the study period, it is considered that foreign financial assistance by soft loan will be most probable financial source for the Project. Up to the present no definitive donor is fixed, the HMG/N should find the donor for the Project and apply for financial assistance for the Project based on the result of this Feasibility Study.

20.1.4 Implementation Schedule of the Project

After the Feasibility Study, the following several steps need to be cleared before the commencement of the construction.

- Application of the foreign financial assistance for detailed design, construction supervision and construction works to the donor agency and/or country by HMG/N
- Appraisal of the financial assistance by the donor
- Conclusion of the Loan Agreement
- Employment of the Consultant for the detailed design and construction supervision
- Preparation of the detailed design and tender documents
- Procurement of the Contractor (Pre-qualification and tender)
- Construction

a) Application of the Foreign Financial Assistance for Detailed Design, Construction Supervision and Construction

After the feasibility study is completed, the application should be done by HMG/N to the donor agency or country based on the results of this feasibility study. Required time for this procedure depends on the official procedure in HMG/N.

b) Appraisal of the financial assistance by the donor

After receipt of the application, the donor agency or country will conduct appraisal of the financial assistance for the Project. It will take three (3) months or longer for the project appraisal. After the appraisal is successfully completed, Loan Agreement of the Project will be concluded.

c) Employment of the Consultant

Employment of the Consultant will be done according to the regulations and guideline of the donor agency. Normally selection of the Consultant will be done by international competitive bidding. Time required for this procedure will be six months including period for approval of HMG/N and the donor agency on the procedure of the selection and its result.

d) Detailed Design

The Consultant will conduct detailed design and preparation of the tender documents for the Project in this stage. It takes at least ten months for the detailed design including detailed topographic survey and geological survey.

e) Procurement of the Contractors

The procurement process will be conducted according to the regulation and guideline of the donor agency. Usually for such scale and kind of project as this Project, pre-qualification method will be employed to ensure technical and financial capability of the invited tenderer. Invitation for tender will be issued to the pre-qualified tenderer only. Tender evaluation results will be subject to the final approval of the donor agency.

Required period for this process will be nine months or longer including pre-qualification, tender, tender evaluation, negotiation and necessary approvals by HMG/N and the donor agency.

Procurement of the Contractors will be done for respective construction packages independently.

d) Construction

After signing of the contracts, the construction works will be started. The estimated construction periods of each construction package are as follows:

Package 1-1 and 1-2	:	25 months
Package 2	:	32 months
Package 3	:	27 months

e) Land Acquisition

Land acquisition should be done in parallel with the above procedure. It is strongly recommended that the land acquisition should be commenced during detailed design stage and completed before commencement of the construction works.

The above implementation schedule is presented in Figure 20.2 together with annual fund requirement.

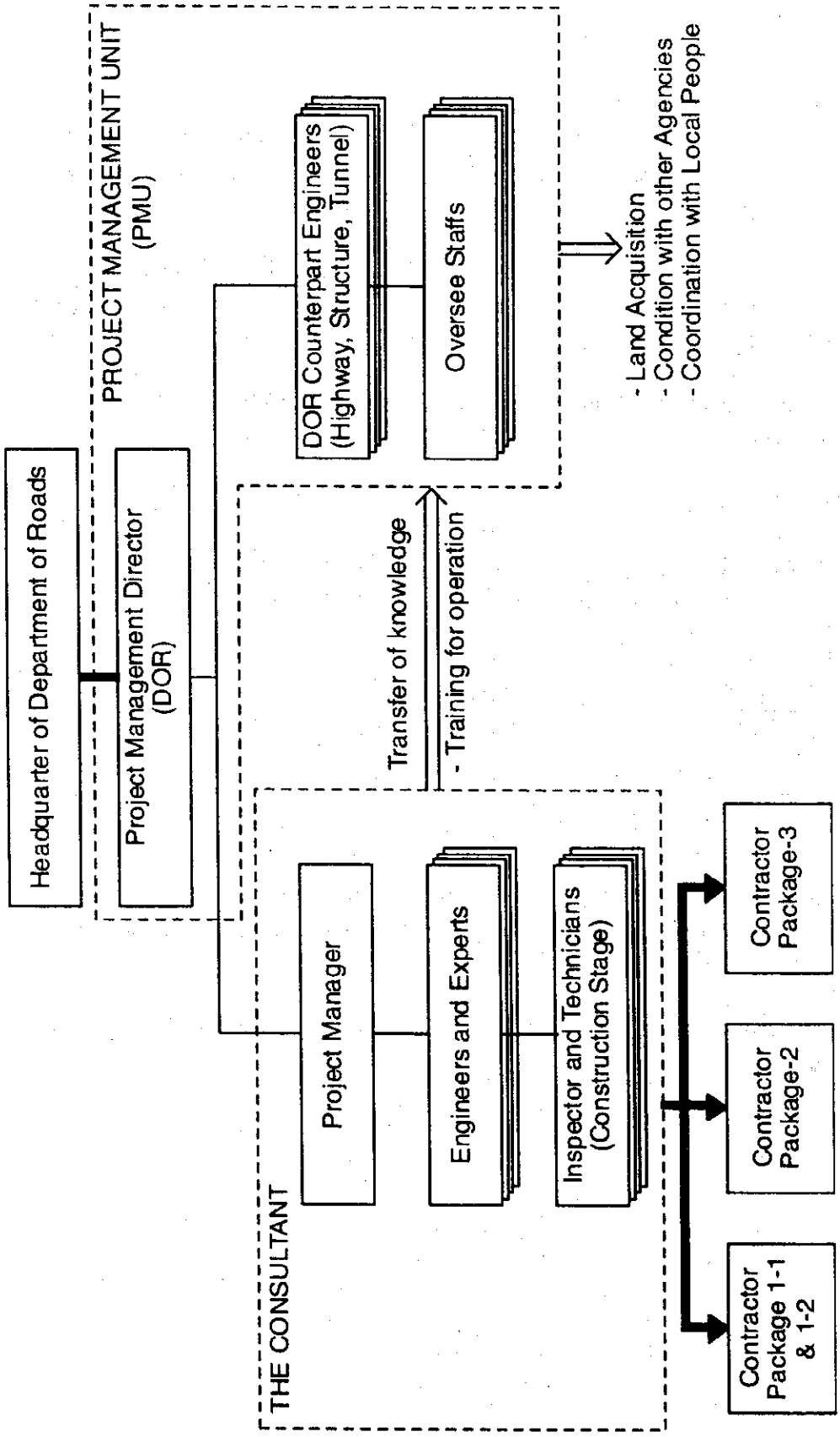
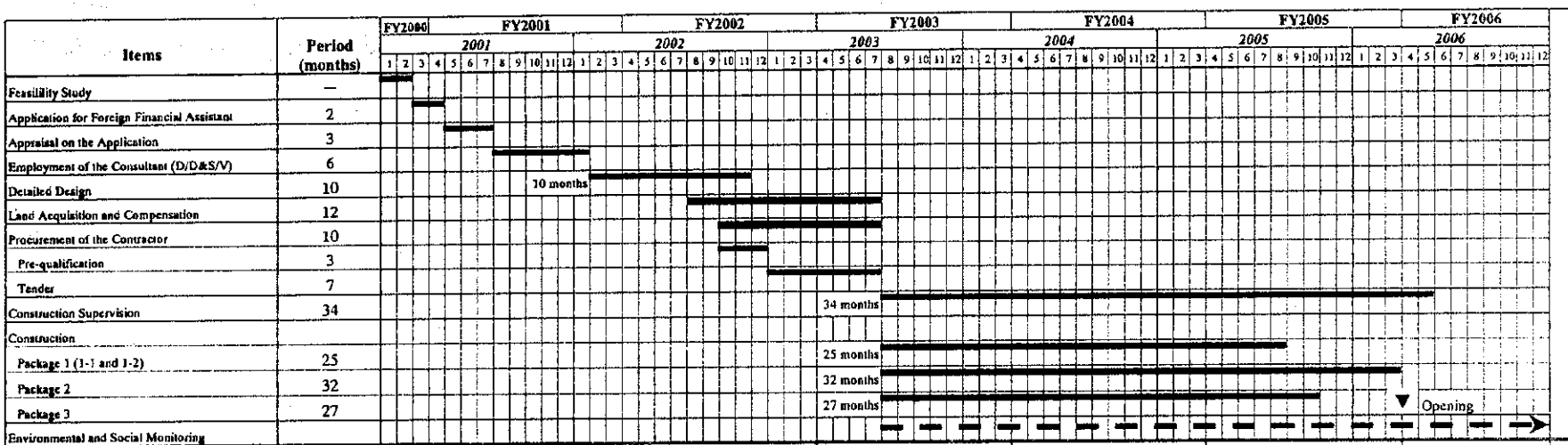


Figure 20.1 Proposed Organization during Detailed Design and Construction Stage

Figure 20.2 Implementation Schedule and Annual Disbursement Schedule



Items	Period (months)
Feasibility Study	–
Application for Foreign Financial Assistant	2
Appraisal on the Application	3
Employment of the Consultant (D/D&S/V)	6
Detailed Design	10
Land Acquisition and Compensation	12
Procurement of the Contractor	10
Pre-qualification	3
Tender	7
Construction Supervision	34
Construction	
Package 1 (1-1 and 1-2)	25
Package 2	32
Package 3	27
Environmental and Social Monitoring	

Annual Disbursement Schedule	Total Cost (USD)	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	Remarks
1. Total E/S Cost	6,965,000		365,663	1,619,363	1,251,651	1,720,765	1,720,765	286,794	
1-1. Detailed Design Stage	1,828,313		365,663	1,462,650					
1-2. Tendering Stage	261,188			156,713	104,475				
1-3. Supervision Stage	4,875,500				1,147,176	1,720,765	1,720,765	286,794	
2. Total Construction Cost	38,692,021				10,806,576	16,209,865	11,675,580		
2-1. Package 1 (1-1 and 1-2)	8,971,769				2,870,966	4,306,449	1,794,354		
2-2. Package 2	18,800,429				4,700,107	7,050,161	7,050,161		
2-3. Package 3	10,919,823				3,235,503	4,853,255	2,831,065		
3. Contingency	3,869,202				1,080,658	1,620,986	1,167,558		10% of 2
Subtotal 1+2+3 (million USD)	**49.53**		**0.37**	**1.62**	**13.14**	**19.55**	**14.56**	**0.29**	1+2+3
4. Land Acquisition and Compensation Cost	2,394,000			1,596,000	798,000				
5. Administration Cost	457,000		63,034	94,552	94,552	94,552	94,552	15,759	1% of (1+2)
6. Tax and Duties	4,566,000		36,566	161,936	1,205,823	1,793,063	1,339,634	28,679	10% of (1+2)
Subtotal 4+5+6 (million USD)	**7.42**		**0.10**	**1.85**	**2.10**	**1.89**	**1.43**	**0.04**	
Total (million USD)	**56.94**		**0.47**	**3.47**	**15.24**	**21.44**	**16.00**	**0.33**	

20.2 Overall Implementation Schedule for Road Improvement between Kathmandu and Terai

In the previous chapters and clauses, the feasibility of Kathmandu – Naubise Alternate Road Project and its implementation plan were examined and proved to be viable.

The Kathmandu – Naubise Alternate Road is to be a part of the Kathmandu – Narayangadh Road, which is the most important trunk road in Nepal linking Kathmandu with the other parts of Nepal and India. Therefore it is essential to evaluate the Project in relation to the whole stretch of the Kathmandu – Narayangadh Road and other Projects related to the Kathmandu – Terai linking scheme.

In this clause, based on an assessment of current condition of the remaining section of the Kathmandu – Nayaghat Road in terms of road disaster and traffic viewpoints and evaluation of the other related projects, the overall improvement schedule for the road improvement between Kathmandu and Terai is proposed.

20.2.1 Related existing roads and road development plans

In advance to the assessment, the related existing road and road development plans are examined, as the basic consideration for establishment of the improvement plan.

The related existing roads and road development plans are shown in the Figure 20.3

1) The Existing Tribhuvan Road, Naubise – Hetauda section

The road links Naubise with Hetauda via the Daman Pass with 123 km length. The road is the shortest route to reach India from Kathmandu in terms of total road length, however very little traffic uses the road. Reasons for the low traffic situation are deemed to be as follows.

a) Since the road is single lane road, it is very difficult for the vehicles to pass each other.
b) Since the road runs very steep mountainous terrain, the road has extreme steep grade and numbers of sharp curves and hairpin bends.
c) Due to the above conditions, not only traffic capacity of section is limited to be small but also the road appears very dangerous situation for running cars.
d) Furthermore the road is frequently closed during rainy season by slope failures and landslide.

Taking the above situation into consideration, it shall be evaluated that although the road is classified into national strategic road, the road does not satisfy requirement as the national strategic road and main role of the road is limited to the local service level. However the road must play important role as a sole

alternative route when Naubise – Narayangadh road is blocked by some disasters like landslides.

This road is incorporated in present and future road network in the traffic demand forecast in this study.

2) Sindhuli Road Project (under construction)

The Sindhuli Road project was planned to connect Bardibas at East-West Highway with Dhulikhel at Arniko Highway aiming to facilitate the Kathmandu Valley with a new link to Terai for east direction. The road is designed as single lane road with a total length of about 158 km and being implemented under Japanese Grant Aid Program. Section between Bardibas – Sindhuli Bazar (37 km in length) had been completed in 1998 and section 35 km from Dhulikhel is going to be completed in March 2001. The construction of the whole project road is planed to be completed by around year 2007.

After the whole section of the road is opened, the traffic between Kathmandu and east region of Nepal will divert to the road. According to the implementation schedule of the Sindhuli Road, the road is included in the road network of year 2010 as single lane road and 2020 as 2-lane road in the traffic demand forecast in this study.

3) Kathmandu – Terai Alternate Road Project (plan)

The Kathmandu – Terai Alternate Road is the project to construct a new direct link between Kathmandu and Terai with shorter distance and higher highway standard. DOR has conducted several preliminary and/or pre-feasibility studies on the project. At latest, the project was examined by PIP Study, which is the master plan study for road network development in Nepal, and the study concluded that although the project appears to be economical viable, it is not considered practical in the short to medium term due to the high construction cost.

Based on the above study result, the Kathmandu – Terai Alternate Road is incorporated in the future road network of year 2020 in the traffic demand forecast of this study.

The implementation plan of the road is reviewed in this clause.

4) Kanti Rajpath Road Project (plan)

This project aimed to construct a new roadway link between Kathmandu – Hetauda by improvement of existing footpath. The feasibility study was conducted in 1999 under Korean technical assistance through Korean International Cooperation Agency (KOICA).

According to the preliminary design of the feasibility study, outline of the road is as follows.

- Major part of the road is designed as single lane road with 5.5 m total pavement width
- Since the road alignment follows existing footpath, the alignment has very steep gradient section steeper than 13 % and very sharp horizontal curve at several places.
- The road alignment passes extreme steep terrain and fragile geological area.

Judging from the above project outline, the road does not play a role as national truck road due to it low geometric standard but can provide service level as feeder road. Therefore the road is excluded from the future road network for the traffic demand forecast in this study.

20.2.2 Present Condition of the Naubise – Narayangadh Section

1) Naubise – Mugling Section

The road in this section is a part of the Prithivi Highway and construction of the road was completed in 1974 by Chinese financial assistance. The road runs along the Mahesh River and the Trisuli River, and has a total length of 83 km. Currently the road has 2-lane carriage-ways after improvement completed in 1992.

In 1993 the section was seriously damaged by heavy rainfall. Three bridges were lost and slope failures and landslide were caused at many places. The largest landslide happened at Jagimara site. The landslide still remain unstable until now and has disturbed traffic during rainy season every year.

In August 2000, another big scale landslide was caused at Krishnebhir site. It took 12 days till the road was reopened temporarily. Since no preventive countermeasure has been taken, the site is still in a very dangerous situation.

The geometry of road alignment in this section is relatively good compared to the Naubise – Thankot section and the traffic capacity in this section is estimated to be 6,500 vehicle/day as shown in the Table 20.3. On the other hand, according to the DOR logger data in year 2000, traffic volume in this section was counted at around 2,300 vehicle/day. Therefore it is considered that the section has sufficient traffic capacity for the present traffic volume.

2) Mugling – Narayangadh Section

Construction of the Mugling – Narayangadh road was completed in year1982 by Chinese assistance. The road runs through extremely steep ravine formed by the

Narayani River. The road is 36 km in total length and has 2-lane carriageways except a section between Muguling and Dakhani, where the road width is relatively narrow with 5.5 pavement width.

There are several active landslide sites exist in this section and slope failures and/or collapses often take place during rainy season. These landslides are considered to be caused by scoring of riverbank due to the river flow.

Similarly to the Naubise – Mugling section, the geometry of road alignment in this section is better than that in Naubise – Thankot section and traffic capacity of this section is estimated to be around 5,800 vehicle/day. Since present traffic volume obtained from DOR logger data is 2,400 vehicle/day, it is judged that this section also has enough traffic capacity to accommodate current traffic volume.

20.2.3 Future Traffic Demand of the Kathmandu – Narayangadh Road

Future traffic demend of the Naubise – Narayangadh section was roughly estimated based on the result of the traffic demand forecast introduced in Chapter 6 and DOR logger data in this section. For the traffic in year 2020, traffic volume of 2 cases, namely "with Kathmandu – Terai Alternate Road" and "without Kathmandu – Terai Alternate Road", were estimated respectively. The result of the estimate is shown in the Table 20.1.

Table 20.1 Future Traffic Demand of the Kathmandu – Narayangadh Road

Section	Traffic Demand (Vehicle/day)			
	Year 2000	Year 2010	Year 2020	
			without KTM-Terai Alt. Road	with KTM- Terai Alt. Road
- KTM- Naubise	3,000	5,500	11,300	6,700
- Naubise-Mugling	2,340	[1] 4,200	[1] 8,570	[2] 3,970
- Mugling-Narayangadh	2,370	[1] 4,260	[1] 8,700	[2] 4,100

Note: 1) The figures are obtained using the same traffic increase ratio as that of the OD table and deducting diversion traffic to the Sindhuli Road
2) The figures are obtained using the same traffic increase ratio as that the OD table and deducting diversion traffic to the Sindhuli Road and Kathmandu –Terai Alternate road.

On the other hand, traffic capacity of each road section is estimated for further study. For the estimation, method introduced in the following guideline, which is the same as the method used in PIP study, was applied.

"Guide to Traffic Engineering Practice, Part 2 – Roadway Capacity (AUSTROADS 1988)"

Calculation of the traffic capacities are introduce in Table 20.3 and the result is summarized in Table 20.2. Remarkable difference in the traffic capacities of the existing road between Kathmandu –Naubise section and other sections is mainly

depending on the difference of profile grade of each section. Since the profile grade of Kathmandu – Naubise section, especially in Thankot – Naubise section, is much steeper than that of the other sections, the traffic capacity of this section is estimated to be much smaller.

Table 20.2 Traffic Capacity of Kathmandu – Narayangadh Road

Section	Traffic Capacity (vehicle/day)
1) KTM – Naubise	
- Tribhuvan Highway (existing)	2,930 [1)]
- KTM – Naubise Alternate Road (plan)	5,030 [1)]
2) Naubise-Mugling (existing)	6,560
3) Mugling-Narayangadh (existing)	
- Mugling - Dakhani	4,800
- Dakhani - Narayangadh	5,790

1) see Table 5.2 in Chapter 5.

20.2.4 Overall Implementation Schedule for Roads improvement between Kathmandu and Terai

Figure 20.4 shows traffic demand of each section with relation to the traffic capacity.

From the results shown in the figure, following matters are clearly understood.

1) Despite of the biggest traffic demand, traffic capacity of the Kathmandu – Naubise section appears the smallest figure along the whole Kathmandu – Narayangadh road. Present traffic volume has reached the traffic capacity of the existing road. Therefore construction of the alternate road in this section, which is proved in the previous chapter to be more feasible than 4-lanes improvement of the existing road, is urgently required.

2) The Naubise – Mugling sections has sufficient level of traffic capacity to accommodate future traffic demand till year 2010. Therefore the critical issue in this section is only to strengthen the road against road disasters.

3) The Mugling - Narayangadh section has sufficient level of traffic capacity to accommodate future traffic demand of year 2010, except about 10-kilometer section where the road width is relatively narrow and the road does not have 2-lane carriageway. Traffic condition of this narrow section will be close to saturated level in 2010.

4) The traffic demand of year 2020 will exceed traffic capacity in all sections, even if the Kathmandu – Naubise Alternate Road is provided. On the other hand, if the Kathmandu –Terai Alternate Road is assumed to exist in 2020, the traffic demand in the Naubise – Narayangadh section will be so reduced that the traffic can be accommodated under the existing road condition except the narrow

section between Mugling - Narayangadh. At the same, as for the Kathmandu – Naubise section, the future traffic demand can be accommodated by total capacity of the existing Tribhuvan Highway and the Kathmandu – Naubise Alternate Road in this case. Therefore it is concluded that the Kathmandu – Terai Alternate Road shall be constructed before year 2020.

Based on the above study results, necessity of urgent implementation of the Project is justified and the Study Team recommend the following overall implementation schedule for the road improvement between Kathmandu and Terai.1) Objectives of short to medium term plan

1) Objective of short term plan

- Construction of the Kathmandu – Naubise Alternate Road

  The Kathmandu – Terai section was identified to be the most critical section in the existing Kathmandu – Narayangadh Road from the traffic point of view. Furthermore the existing Tribhuvan Highway is the sole corridor and no alternate route exist in this section at present. Therefore the section is the most critical section from the viewpoint of the national security of Nepal.

  The Study Team recommends implementing the Project with top urgent priority.

- Road Disaster Prevention for the Existing Kathmandu – Narayangadh Road

  Traffic demand forecast shows the result that the Kathmandu – Narayangadh Section has no traffic capacity problem for the future traffic demand under existing road condition. The study also shows importance of the road in the future road network even the Kathmandu – Naubise Alternate Road and the Kathamndu – Terai Alternate Road are constructed in future. The section will have an important role to maintain expected economical benefits of the Kathmandu – Naubise Alternate Road.

  The critical issue in this section can be concluded to be road disaster prevention, since the section has been facing dangerous situation by landslides and slope failures since the section was opened.

  The Study Team recommends implementation of the Road Disaster Prevention Project for the existing Kathmandu – Naubise section in short term plan.

2) Objective of medium term plan

- Improvement of Mugling - Narayangadh Section

The Mugling - Narayangadh Section has sufficient level of traffic to accommodate future traffic demand of year 2010, except about 10-kilometer section where the road width is relatively narrow and the road does not have 2-lane carriageway. Traffic condition of this narrow section will be close to saturated level in 2010.

The Study Team recommends implementation of the improvement of Mugling - Narayangadh Section in medium term plan.

3) Objective of long term plan

- Construction of the Kathmandu – Terai Alternate Road

The traffic demand forecast indicates that traffic demand in 2020 will exceed the traffic capacity in whole section of the Kathmandu – Narayangadh Road, if no Kathmandu – Terai Alternate road exists at the time. In the PIP study, viability of the project is proven and the Study Team recommends implementation of this project in long term plan targeting the project completion before year 2020.

It shall be noted that there are some alternatives to the Kathmandu – Terai Alternate Road, namely 4-lane improvement by widening of existing road or construction of a new 2-lane road in parallel with the existing corridor or its combination. The examination of the alternatives shall be conducted in further study.

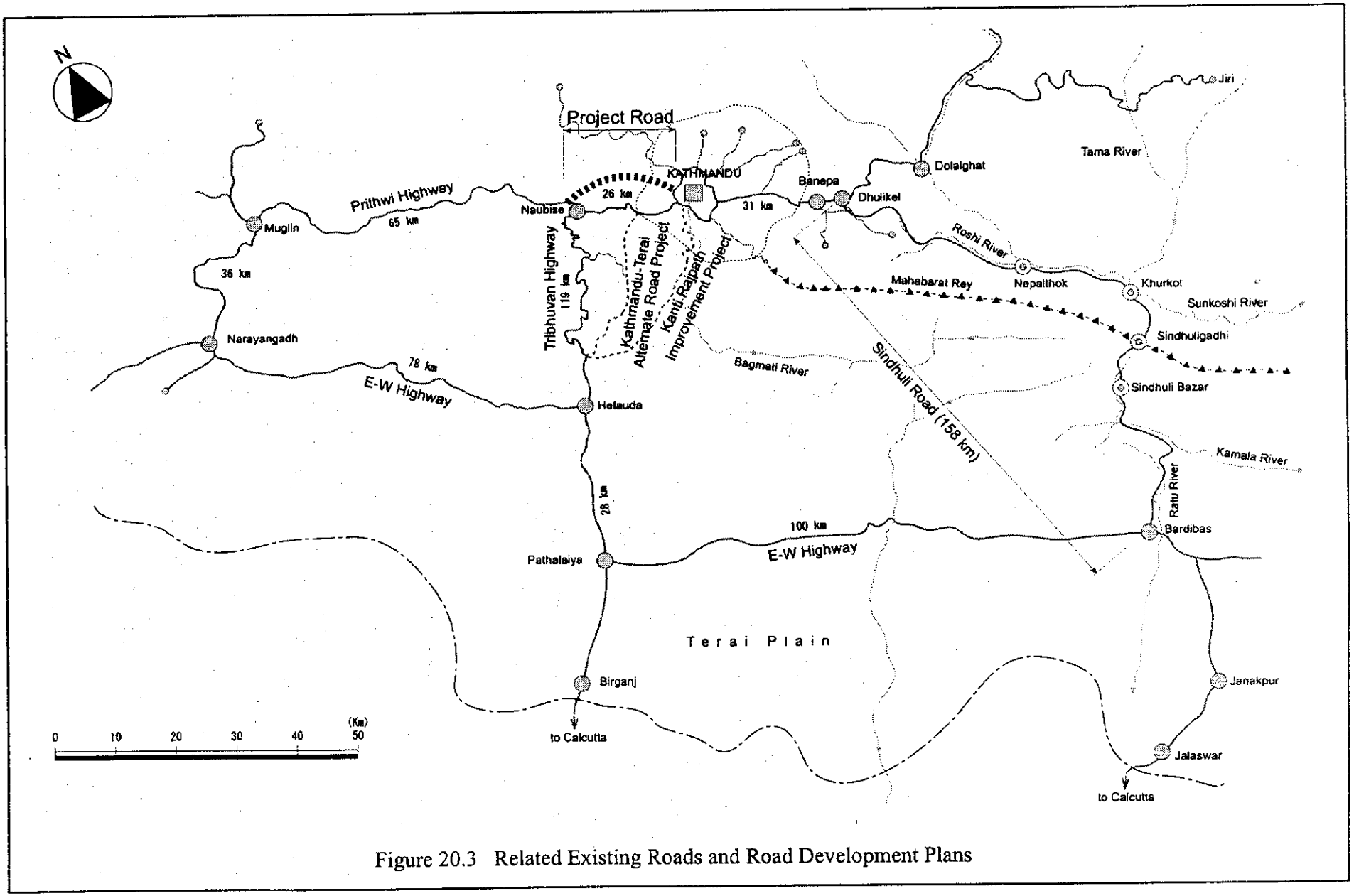


Figure 20.3 Related Existing Roads and Road Development Plans

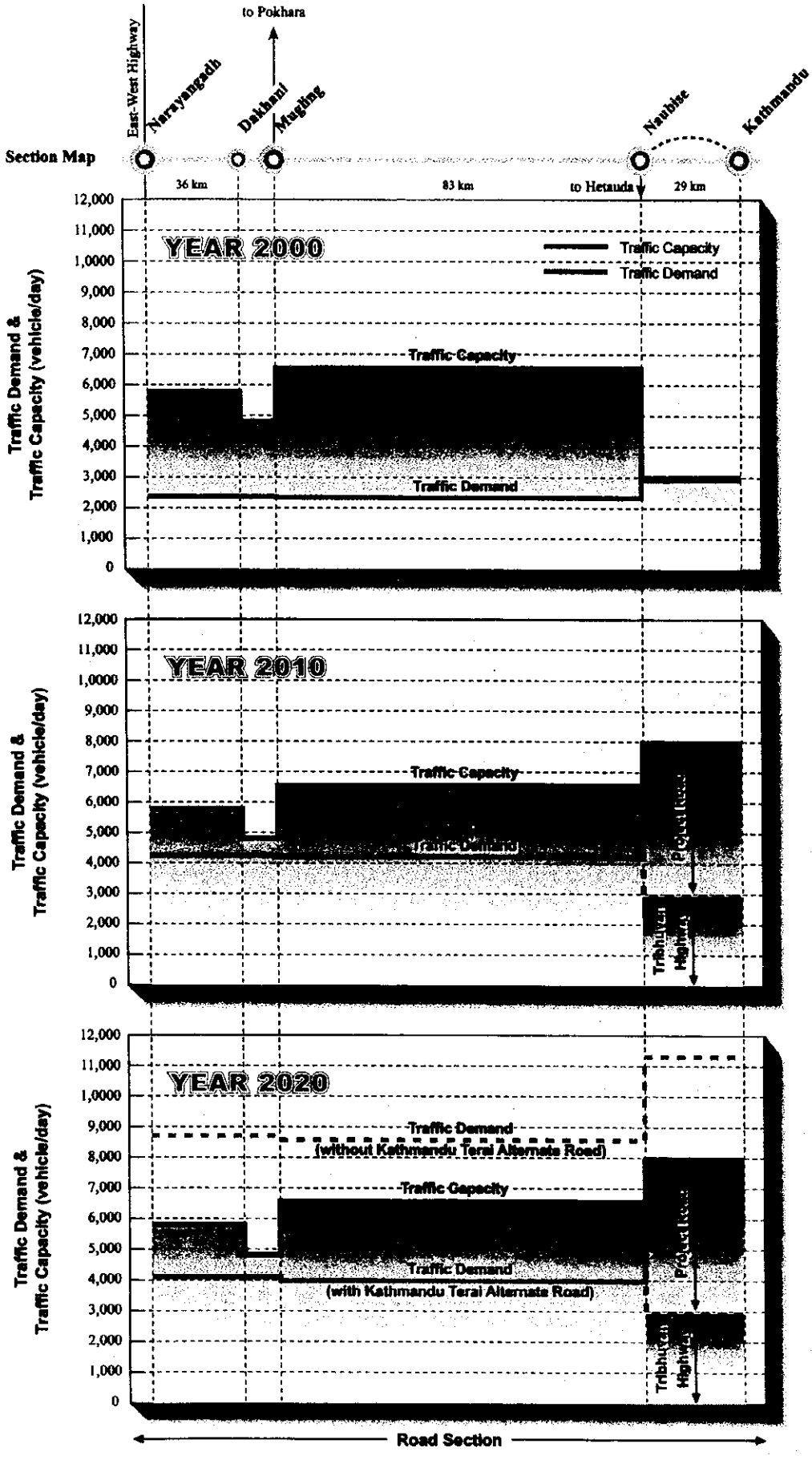


Figure 20.4 Traffic Demand of Each Section with Relation to the Traffic Capacity

Table 20.3 Calculation of the Traffic Capacity

Factor		Basic Data	Project Road	Tribhuvan Highway			
			2010	KTM-Naubise	-Muguling	-Dakhani	-Narayanghat
$(v/c)_i$	Ratio of Flow Rate	Grade	5.0%	6.0%	4.0%		
		Average Upgrade Speed	less than 56km/h	less than 56km/h	less than 56km/h		
		No Passing Zones	more than 80%	more than 80%	more than 80%		
			1.00	**0.98**	**1.00**	**1.00**	**1.00**
f_d	Adjustment Factor for Directional Distribution	Percent of Traffic on Upgrade	60%	60%			
			0.87	**0.87**	**0.87**	**0.87**	0.87
f_w	Adjustment Factor for Narrow Lanes and Restricted Shoulder Width	Lane Width	3.5m	3.7m	3.7m	2.7m	3.7m
		Usable Shoulder Width	1.5m	0 m	0 m	1.0m	0 m
			0.91	**0.88**	**0.88**	**0.73**	**0.88**
fg	Adjustment Factor for the Operational Effects of Grades on Passenger Cars	Proportion of Passenger Cars	39%	23%	32%	24%	24%
		Passenger-car Equivalent for 0 Percent Grade	1.3	1.3	1.3	1.3	1.3
		Maximum Grade	about 5% (4.7%)	about 6% (5.3%)	about 4%		
		Length of Maximum Grade	more than 6km (about 9.6km)	more than 6km (about 8.0km)	more than 6km		
		Passenger-car Equivalent for Given Percent Grade Length of Grade,and Speed Percent Grade	10.0	16.0	6.9	6.9	6.9
			0.94	**0.94**	**0.97**	**0.97**	**0.97**
f_{HV}	Adjustment Factor for the Presence of Heavy Vehicles	Proportion of Heavy Vehicles	61%	77%	68%	76%	76%
		Proportion of Truck among Heavy Vehicles	57%	44%	55%	60%	60%
		Passenger-car Equivalent for Specific Mix of Heavy Vehicle	8.38	11.35	5.72	6.02	6.02
			0.18	**0.11**	**0.24**	**0.21**	**0.21**
	Adjustment Factor for the Presence of Motorcycle		**1.00**	**1.00**	**1.00**	**1.00**	1.00
ft	Adjustment Factor for the Situation on the Roadside		**1.00**	**1.00**	**1.00**	**1.00**	1.00
SF_i	Total Service Flow Rate in Both Direction (vehicle/h)		**377**	**219**	**492**	**360**	**434**
PHF	Peak Hour Factor		0.075	0.075	0.075	0.075	0.075
	Maximum Traffic Volume for Both Direction (vehicle/h)		-	-	-	-	-
	Maximum Traffic Volume for Both Direction (vehicle/day)		**5,031**	**2,925**	**6,555**	**4,799**	**5,785**

(Based on Australian Capacity Manual)

CHAPTER 21 CONCLUSION AND RECOMMENDATION

The necessity of the urgent implementation of the Project has been justified by the following reasons:

- The Kathmandu – Naubise section of the Existing Tribhuvan Highway was justified to be the most critical section in the present road network linking Kathmandu with Terai in terms of traffic volume and capacity. The traffic of the Kathmandu-Naubise section has already reached its traffic capacity, and either 4-lane improvement of the existing road or construction of an alternative road is urgently required.

- The 4-lane improvement of the existing road, however, will cost more than that of construction of the alternative road due to it fragile geology and steep terrain and it must cause tremendous traffic disturbance of the traffic during construction period. The 4-lane improvement option was therefore judged to be practically impossible.

- Socio-economic activities in the Kathmandu valley, however, depend on this road, since the road is the sole route to other area in Nepal and India. Therefore construction of more reliable alternate road is necessary from the national security point of view.

This chapter presents the conclusion and recommendation of the Study.

1) The Project is assessed as technically feasible with scope of construction being a 2-lane paved road with a total length of 21.4km including a 705m highway tunnel.

2) The Project is assessed as economically feasible with IRR of 18.1%, NPV of 19.1 million US$ and B/C ratio of 1.57 with the assumption of Kathmandu - Terai Alternate Road opening in the year 2016.

3) The Project is assessed as financially not feasible. Toll revenue can not recover full financial cost invested to the Project. However, the toll revenue can recover annual operation and maintenance cost from the beginning of operation.

4) The existing Tribhuvan Highway, especially Thankot-Naubise Section, is considered to be high disaster potential area. Improvement of alignment and improvement of disaster prevention were studied. These study results indicate that the improvement of alignment is technically not feasible and cost for full scale countermeasures for disaster prevention will be beyond practical range.

5) The 4-lane improvement of the existing Tribhuvan Highway alternative was studied for justification of the Project. The result shows that construction cost

and land acquisition cost of all conceivable alternatives for the 4-lane improvement will be far higher than those of the Kathmandu – Naubise Alternate Road. Therefore it was concluded that the Project is economically more preferable to the 4-lane improvement alternatives.

6) Total project cost is estimated to be 56.9 million US$. Breakdown of the project cost is as follows.

Construction Cost	38.7 million US$
Engineering Cost	6.9 million US$
Contingency	3.9 million US$
Tax and Duty	4.5 million US$
Administration Cost	0.5 million US$
Land Acquisition and Compensation Cost	2.4 million US$
Total Project Cost	56.9 million US$

7) Traffic volume of the Project Road in the year 2010 and 2020 are expected to be about 3,900 vehicle/day and 5,340 vehicle/day, respectively. Traffic volume in the year 2020 is estimated under an assumption that Kathmandu - Terai Alternate Road is opened. Diversion traffic to Shindhuli Road is incorporated in the traffic demand forecast for year 2010 and 2020 as well.

8) It is proposed that the Project is divided into three (3) contract packages taking into consideration magnitude of the Project as well as the characteristic of the individual package. Construction period of each section is estimated as follows.

Package 1-1 & 1-2	:	25 months
Package 2	:	32 months
Package 3	:	27 months

9) It is recommended that the Project is implemented under foreign financial assistance by soft loan.

10) According to the examination on the overall implementation schedule on the road improvement between Kathmandu and Terai, the following schedule is recommended.

Objectives of short term plan (2002-2006):

- Construction of Kathmandu – Naubise Alternate Road
- Road Disaster Prevention for the existing Kathmandu - Narayangadh Road

Objectives of medium term plan (2007-2011):

- Improvement of Mugling - Narayangadh Section

Objectives of long term plan (2012 – 2020)

- Construction of Kathmandu – Terai Alternate Road

11) Initial Environmental Examination and Environment Impact Assessment carried out in the Study identified no serious negative environmental/social impact. Appropriate mitigation measures should be considered in detailed design stage and conducted during construction stage. After the Project Road is open, monitoring program should be employed as well.

12) Potential study on wind and solar power generation indicates a possibility to utilize these power generation systems for operation of the tunnel. It is recommended to conduct feasibility study on utilization of wind and solar generation for operation of tunnel in detailed design stage of the Project consecutively.

13) It is strongly recommended that new truck terminal near the beginning of the Project Road is constructed in order to secure efficient operation of the Project Road and improvement of traffic condition of Kathmandu.

Table 21.1 Major Features of the Project Road

Classification	
Road Classification	National Highway
Annual Average Daily Traffic	3,900 veh (2010 A.D.), 5,340 veh (2020 A.D.)*
Pavement Surface	Asphalt Concrete
Road Network	
Beginning Point	Ring Road (about 1km North of Kalanki Intersection)
Ending Point	On Prithvi Highway at Dharke
Total Length	21.4 km
Alignment	
Minimum Curve Radius	60 m (55 m at hairpin bends)
Maximum Vertical Grade	5 %
Cross Section	
Lane Width	7 m (2 × 3.5 m)
Formation Width	12 m
Paved Shoulder Width	3 m (2 × 1.5 m)
Side Ditch Top Width	1 m
Major Structures	
Tunnel Length	0.7 km
Major Bridge at Dharke	50 m
Project Cost	
Total Construction Cost	38.7 Million US$
Total Compensation Cost	2.4 Million US$
Total Project Cost	56.9 Million US$
Economic Indices	
EIRR (Economic Int. Rate of Return)	18.1 %
NPV (Net Present Value)	19.1 Million US$
B/C (Benefit/Cost Ratio)	1.57

Note: * Traffic volume in 2020 A.D. is with Kathmandu-Terai Road assumed to be implemented.