6.4.3 Unit Costs of Land and House Acquisition

The land and housing acquisition costs are calculated on the basis of standard rate obtained through Ministry of Housing and Physical Planning as shown in Table 6.5.:

Table 6.5 Unit Cost of Land/House Acquisition Cost

Description	Unit	Unit Price (NRs.)	Remarks
Unit Cost of Land Acquisition			
Residential Area	ha	40 million	
Commercial Area	ha	80 million	
Industry Area	ha	24 million	
Agriculture Area	ha	12 million	
Unit Cost of Building Acquisition			
Commercial Building			
(Good Condition)	m2	7,000	
(Average Condition)	m2	4,250	
(Poor Condition)	m2	2,750	
(Bad Condition)	m2	1,000	
Residential Building			
(Good Condition)	m2	7,000	
(Average Condition)	m2	4,250	
(Poor Condition)	m2	2,750	
(Bad Condition)	m2	1,000	

Source : Kathmandu Urban Development Project
Project Preparation Report, March 1992

6.5 Construction Quantities

Construction quantities are calculated on the basis of preliminary design. Summary of major work quantities is show in Table 6.6. Detailed quantities calculation is presented in Appendix 6.5.1

6.6 Estimated Project Cost

6.6.1 Construction Cost

The estimated construction cost at middle of November 1992 prices for all construction packages are summarized in Table 6.7. Detailed construction cost estimation by section is presented in Appendix 6.6.1.

Table 6.6 Work Quantities for Each Proposed Road

Description	Unit	South link of Inner Ring Road	Sanepa Access	Patan Core Access	Koteswor Access	Central bus terminal Access	New Bagmati Bridge No.2	Intersections (3 Places)	TOTAL
Clear site and stripping	m2	76,464	8,830	3,556	45,000	38,012		2,500	174,362
Removal of existing pavement material	m3	100					100		200
Removal of existing bridge at Thaphatali	L.S						1		1
Removal of existing structures	m3	100					100		200
Fill in soft material	m3	121,575	9,582	2,511	68,173	41,384	1,300	5,000	249,525
Spoil in soft material	m3	5,655	1,373	275	11,004	196	130		18,633
Sodding	m2	25,648	2,414	1,086	15,599	10,856		1,250	56,853
Plant selected trees	no.	744							744
Gabion	m3	3,460			620		3,210		7,290
Stone Masonry	m2	5,136		490	250		1,250	150	7,276
Excavation in soft material for structures	m3	9,390			2,630	120	14,610		26,750
Backfilling with selectedmaterials for structures	m3	6,900			2,020	40	10,460		19,420
Side block	m	2,840							2,840
Kerb stone (A)	m	2,521	990	400	4,064	3,730			11,705
Kerb stone (B)	m	1,795			150		400		2,345
Kerb stone for bridge	m	546			120		276		942
Pipe culvert D300	m	1,155	188	80	1,600	750			3,773
Pipe culvert D600	m	1,770	240	200	1,060	760	100	60	4,190
Pipe culvert D1000	m	205	74		81	133	80		573
U shaped drain ditch (0.3 x 0.3m)	m		940	365					1,305
U shaped drain ditch (0.5 x 0.5m)	m	3,167			3,615	3,572			10,354
U shaped drain ditch (1.0 x 1.0m)	m	300				132			432
Side drain with stone pitching	m	1,934						500	2,434
Catch pit	no.	158	47	20	206	187	20	3	641
Manhole	no.	96	102	4	114	90	4	3	413
Subbase course	m3	13,028	638	423	2,894	4,875	290	750	22,898
Base course	m3	11,298	552	368	2,504	4,219	310	500	19,751
Prime coat, 1.0 litre/m2	m2	38,968	4,880	1,600	22,620	18,650	5,565	2,500	94,783
Tack coat, 0.4litre/m2	m2	71,288	4,880	1,600	22,140	18,650	4,185	1,000	123,743
Asphalt concrete binder course t=6cm	m2	1,750	4,880	1,600	22,140	18,650	2,910	2,500	54,430
Asphalt concrete binder course t=10cm	m2	35,100					1,280		36,380
Asphalt concrete surfase course t=4cm	m2	4,480	4,880	1,600	22,620	18,650	4,700	2,500	59,430
Asphalt concrete surfase course t=5cm	m2	35,100					1,280		36,380
Side walk t=13cm	m2	19,335	2,440	1,600	11,370	9,325	1,490		45,560
Road lighting	no.	42					22		64
Traffic signal	portion	4	1	1	1	2	1	2	12
Lane marking 15cm	m	12,694	1,575	690	6,741	5,775	1,258	2,400	31,133
Information sign	no.	19	3	3	3	6	4	9	47
Steel pile D800	m	4,474			1,530		1,680		7,684
Steel pile D500		1,840					1,640		3,480
Concrete class-A, 240kg	m3	3,970			970	73	2,170		7,183
Concrete class-C, 180kg	m3	120			30	8	3,136		3,294
Formwork for superstructures	m2	4,100			910		2,170		7,180
Formwork for all structures other than superstructur	m2	3,290			880	245	8,706		13,121
Reinforcement	ton	472			112	8	250		842
Prate girder (material,assemble,transportation,electi	ton	678			117		405		1,200
Bridge railing	m	546			120		276		942
Excavation for diversion of the river	m3	2,680							2,680
Construction and removal of temporary road	m3	8,290			1,670				9,960
Temporary bridge	m	12					70		82
Steel sheet pile	m						8,260		8,260

Table 6.7 Summary of Construction Cost

Description	South Inner Ring Road Incl. Br.No1&No3, Patan Inter. & Pedest. Br.	New Bagmati Bridge Incl. Thapathali Inter Pedestrian Br. Check Dam	Sanepa Access	Koteswor Access Incl. Br. No.4	Patan Core Access	New Bus Terminal Access	Traffic Manag. at Intersections	Total
Clear site and stripping	1,529,280	0	176,600	900,000	71,120	760,240	50,000	3,487,240
Removal of existing pavement material	38,500	38,500	0	0	0	0	0	77,000
Removal of existing bridge at Thaphatali	0	0	0	0	0	0	0	0
Removal of existing structures	195,800	195,800	0	0	0	0	0	391,600
Fill in soft material	50,939,925	544,700	4,014,858	28,564,487	1,052,109	17,339,896	2,095,000	104,550,975
Spoil in soft material	1,702,155	39,130	413,273	3,312,204	82,775	58,996	301,000	5,909,533
Sodding	5,001,360	0	470,730	3,041,805	211,770	2,116,920	243,750	11,086,335
Plant selected trees	961,248	4,834,200	0	0	0	0	0	5,795,448
Gabion	7,964,920	8,661,220	0	1,427,240	0	0	0	18,053,380
Stone Masonry	31,400,416	2,008,000	0	1,526,500	2,991,940	0	915,900	38,842,756
Excavation in soft material for structures	438,500	571,200	0	131,500	0	6,000	0	1,147,200
Backfilling with selectedmaterials for struc.	301,500	148,500	0	90,900	0	1,800	0	542,700
Side block	2,263,480	0	0	0	0	0	0	2,263,480
Kerb stone (A)	4,870,572	0	1,912,680	7,851,648	772,800	7,206,360	1,545,600	24,159,660
Kerb stone (B)	6,840,745	1,524,400	0	571,650	0	0	0	8,936,795
Kerb stone for bridge	444,444	224,664	0	97,680	0	0	0	766,788
Pipe culvert D300	3,481,170	0	566,632	4,822,400	241,120	2,260,500	0	11,371,822
Pipe culvert D600	9,405,780	531,400	1,275,360	5,632,840	1,062,800	4,038,640	318,840	22,265,660
Pipe culvert D1000	2,180,175	850,800	786,990	861,435	0	1,414,455	0	6,093,855
U shaped drain ditch (0.3 x 0.3m)	0	0	1,858,380	0	721,605	0	1,581,600	4,161,585
U shaped drain ditch (0.5 x 0.5m)	8,652,244	0	0	9,876,180	0	9,758,704	0	28,287,128
U shaped drain ditch (1.0 x 1.0m)	1,981,800	0	0	0	0	871,992	0	2,853,792
Side drain with stone pitching	3,318,744	0	0	0	0	0	858,000	4,176,744
Catch pit	1,537,340	194,600	457,310	2,004,380	194,600	1,819,510	29,190	6,236,930
Manhole	1,560,576	65,024	1,658,112	1,853,184	65,024	1,463,040	48,768	6,713,728
Subbase course	10,552,680	234,900	516,780	2,344,140	342,630	3,948,750	607,500	18,547,380
Base course	16,562,868	454,460	809,232	3,670,864	539,488	6,185,054	733,000	28,954,966
Prime coat, 1.0 litre/m2	1,324,912	189,210	165,920	769,080	54,400	634,100	85,000	3,222,622
Tack coat, 0.4litre/m2	784,168	46,035	53,680	243,540	17,600	205,150	11,000	1,361,173
Asphalt concrete binder course t=6cm	1,160,250	1,929,330	3,235,440	14,678,820	1,060,800	12,364,950	4,972,500	39,402,090
Asphalt concrete binder course t=10cm	39,066,300	1,424,640	0	0	0	0	2,782,500	43,273,440
Asphalt concrete surfase course t=4cm	2,136,960	2,241,900	2,327,760	10,789,740	763,200	8,896,050	3,577,500	30,733,110
Asphalt concrete surfase course t=5cm	20,673,900	753,920	0	0	0	0	1,472,500	22,900,320
Side walk t=13cm	8,932,770	688,380	1,127,280	5,252,940	739,200	4,308,150	254,100	21,302,820
Road lighting	11,546,262	6,048,042	0	0	0	0	5,498,220	23,092,524
Traffic signal	23,461,275	4,692,255	4,692,255	4,692,255	4,692,255	9,384,510	9,384,510	60,999,315
Lane marking 15cm	698,170	69,190	86,625	370,755	37,950	317,625	132,000	1,712,315
Information sign	4,314,672	908,352	681,264	681,264	681,264	1,362,528	2,043,792	10,673,136
Steel pile D800	100,987,128	37,920,960	0	34,535,160	0	0	0	173,443,248
Steel pile D500	20,766,240	18,509,040	0	0	0	0	0	39,275,280
Concrete class-A, 240kg	18,627,240	10,181,640	0	4,551,240	0	342,516	0	33,702,636
Concrete class-C, 180kg	444,120	11,606,336	0	111,030	0	29,608	0	12,191,094
Formwork for superstructures	3,702,300	1,959,510	0	821,730	0	0	0	6,483,540
Formwork for all struc. other than superstruc	1,918,070	5,075,598	0	513,040	0	142,835	0	7,649,543
Reinforcement	18,260,736	9,672,000	0	4,333,056	0	309,504	0	32,575,296
Prate girder (material,assemble,transp.,elec.)	348,573,360	208,218,600	0	60,152,040	0	0	0	616,944,000
Bridge railing	12,495,756	6,316,536	0	2,746,320	0	0	0	21,558,612
Excavation for diversion of the river	134,000	0	0	0	0	0	0	134,000
Construction and removal of temporary road	3,473,510	0	0	699,730	0	0	0	4,173,240
Temporary bridge	658,812	3,843,070	0	0	0	0	0	4,501,882
Steel sheet pile	0	23,243,640	0	0	0	0	0	23,243,640
TOTAL	818,267,133	376,659,682	27,287,161	224,522,777	16,396,450	97,548,383	39,541,770	1,600,223,356

6.6.2 Land Acquisition Cost and Compensation Cost

Table 6.8 shows the summary of the estimated land and house acquisition costs and replacement of public utilities (i.e. local currency component).

6.6.3 Summary of Estimated Project Cost

Summary of estimated project cost including construction cost, land/house acquisition cost, physical and price contingency, engineering cost (detailed design and construction supervision) is presented in Table 6.9.

6.7 Maintenance Cost

Road maintenance cost includes the following three items:

Road maintenance cost:

(1)	Electricity cost	;	cost of electricity for lighting and signal operation
(2)	Cleaning cost	;	cost of cleaning the road surface, drainage facilities, guardrails, regulatory traffic sign and other traffic devices.
(3)	Repair cost	;	cost of road surface repair, overlays, painting of bridges and guardrails, etc. inspection of structures, inspection and repair of electricity and traffic control facilities.

Referring to the annual budget of DOR and relevant data, the annual cost for maintenance and operation required for the Project is roughly estimated at NRs. 20,000 per km of the proposed road for 2 lane. After widening to 4 -lane, it is estimated to increase by 10 %.

Tax and duties which are used for conversion between financial cost and economic cost, are estimated as 10 % of the financial cost.

Table 6.8 Land and House Acquisition Cost

Unit: NRs. x 1,000

Description	Unit	Unit Price (NRs.x1,000)	South link of inner ring road		Sanepa access		Patan access		Koteswor access		Central bus terminal access		Intersection at Thaphatali side		Intersection at Patan side	
			Area	Cost	Area	Cost	Area	Cost	Area	Cost	Area	Cost	Area	Cost	Area	Cost
Cost of Land Aquisition																
Residential Area	m2	4.00	29,250	117,000	2,440	9,760	3,110	12,440	26,200	104,800	5,900	23,600	220	880	580	2,320
Commercial Area	m2	8.00														
Industry Area	m2	2.50														
Agriculture Area	m2	1.20	29,940	35,928	7,830	9,396			21,040	25,248	33,030	39,636				
Cost of Building Aquisition																
Commercial Building																
(Good Condition)	m2	7.00														
(Average Condition)	m2	4.25														
(Poor Condition)	m2	2.75														
(Bad Condition)	m2	1.00														
Residential Building																
(Good Condition)	m2	7.00														
(Average Condition)	m2	2.75	11,000	30,250	730	2,008	580	1,595	2,410	6,628	5,430	14,933	80	220	1,110	3,053
(Poor Condition)	m2	2.75														
(Bad Condition)	m2	1.00														
TOTAL				183,178		21,164		14,035		136,676		78,169		1,100		5,373

Source : Kathmandu Urban Development Project
Project Preparation Report, March 1992

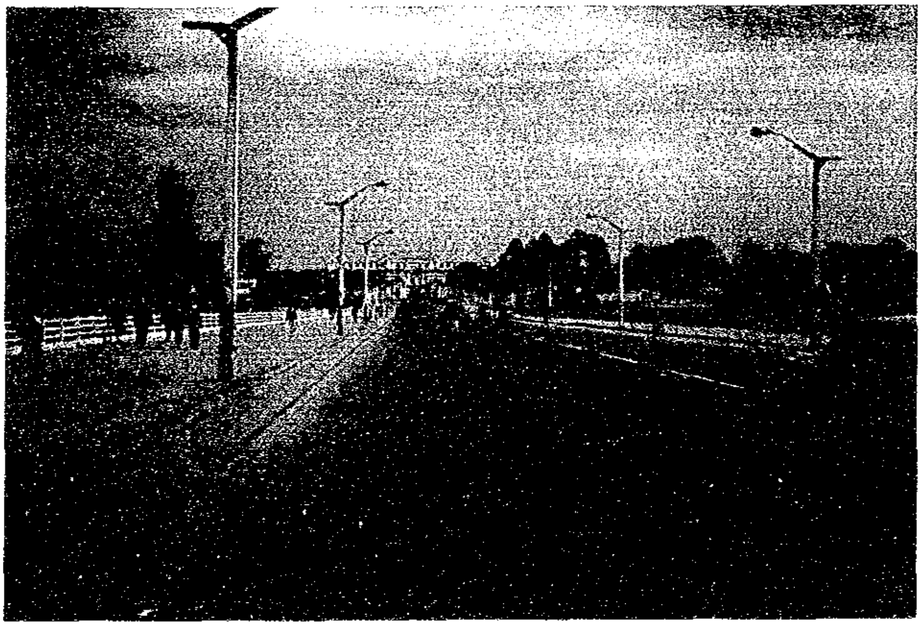
Table 6.9 Estimated Project Cost

Unit : 1,000NRs.

No.	Sub-project	Amount Foreign Portion	Local Portion	Total	(1,000yen)
A-1	NEW BAGMATI BRIDGE WITH TWO INTERSECTIONS				
	Demolishing of existing old truss bridge	4,802	1,201	6,003	15,959
	Construction of New Bagmati Bridge at Thaphatali	215,142	10,700	225,842	600,401
	Construction of Patan side Intersection	9,288	1,572	10,860	28,871
	Construction of Thaphatali side Intersection with signal	20,536	2,571	23,107	61,430
	Pedestrian bridge at Thaphatali side Inersection	87,734	4,026	91,760	243,944
	River Improvement, scoring protection by check dam	31,948	4,003	35,951	95,576
	Relocation of water main, electrical wire, telephone line, etc.	36,868	752	37,620	100,013
	TOTAL	406,318	24,825	431,143	1,146,194
A-2	WESTERN SECTION OF SOUTH INNER RING ROAD				
	Construction of road with 2 lanes	107,909	22,617	130,526	347,003
	Construction of No.1 Bridge	243,722	11,594	255,316	678,758
	Riverside protection (1000m x 2.5m = 2500m2 stone masonry	12,213	3,053	15,266	40,585
	TOTAL	363,844	37,264	401,108	1,066,346
A-3	SANEPA ACCESS				
	Construction of road with 2 lanes	22,467	4,820	27,287	72,542
A-4	EASTERN SECTION OF SOUTH INNER RING ROAD				
	Construction of road with 2 lanes	107,909	22,617	130,526	347,003
	Pedestrian bridge at Patan side Inersection and signal	102,833	4,599	107,432	285,608
	Construction of No.3 Bridge	174,153	9,455	183,608	488,122
	Riverside protection (1000m x 2.5m = 2500m2 stone masonry	12,213	3,053	15,266	40,585
	TOTAL	397,108	39,724	436,832	1,161,318
A-5	KOETSWOR ACCESS				
	Construction of road with 2 lanes	89,899	22,500	112,399	298,813
	Construction of No.4 Bridge	106,927	5,197	112,124	298,082
	Riverside protection (1000m x 2.5m = 2500m2 stone masonry	12,213	3,053	15,266	40,585
	TOTAL	209,039	30,750	239,789	637,479
A-6	PATAN ACCESS				
	Construction of road with 2 lanes	13,977	2,419	16,396	43,589
	TOTAL	1,412,753	139,802	1,552,555	4,127,467
	Consultant Fee 10%			155,256	412,747
	A-TOTAL			1,707,811	4,540,214
B-1	CENTRAL BUS TERMINAL ACCESS				
	Construction of road with 2 lanes	79,188	18,360	97,548	259,331
	Consultant Fee 10%			9,755	25,933
	B-TOTAL			107,303	285,264
C-1	IMPROVEMENT OF INTERSECTIONS				
	Intersections at Mitighar, Tripureswar and Koteswor	35,282	4,260	39,542	105,122
	Consultant Fee 10%			3,954	10,512
	C-TOTAL			43,496	115,635
	GRAND TOTAL			1,858,610	4,941,113

CHAPTER 7

IMPLEMENTATION PLAN



CHAPTER 7 IMPLEMENTATION PLAN

7.1 Executing Agency

The Director General of Department of Roads (DOR), Ministry of Works and Transport, is the government agency responsible for the execution of the construction of the project roads.

The land acquisition and compensation required for the implementation of the project will be undertaken by the same agency prior to the start of construction.

7.2 Construction Packages

The project is divided into three packages with three (3) sub packages taking into consideration the nature of project feature, scale of the work volume and ease of implementation from the land acquisition view point as follows:

Package A : Improvement of Bagmati Transport Corridor, dividing into;

- A-1 New Bagmati Bridge at Thapathali
- A-2 Western Section of South Link of Inner Ring Road including Sanepa Access
- A-3 Eastern Section of South Link of Inner Ring Road including Koteswor Access and Patan Access

Package B : Construction of New Bus Terminal Access at Balaju

Package C : Improvement of Intersections at Maitighar, Tripureswar and Koteswor

7.3 Implementation Programme

Construction period is set up taking into account the work volume, weather condition required funds for each package and urgency of the project, etc. as follows:

Package A : Improvement of Bagmati Transport Corridor

Package A-1 Construction of New Bagmati Bridge ; 2 years

Package A-2 Construction of Western Section of South Link of Inner Ring Road ; 2 years

Package A-3 Construction of Eastern Section of South Link of Inner Ring Road ; 2 years

Package B : Construction of New Bus Terminal Access at Balaju ; 2 years

Package C : Improvement of Intersections at Mitighgar, Tripureswar and Koteswor ; 6 months

The recommended implementation time schedule is as shown in Fig. 7.1.

7.4 Investment Programme

Investment programme of the project is prepared on the basis of the implementation time schedule and summarized in Table 7.1.

Fig. 7.1: Proposed Implementation Schedule of High Priority Projects

Package No.	Proposed Roads and Bridges To be Improved	Target for Development:	High Priority projects to be Implemented in the Short-term Plan (1) Improvement of Bottlenecks in Urban Traffic Conditions (2) Relief of Transportation-Poor				
			1st Year	2nd Year	3rd Year	4th Year	5th Year
		Year:	1993	1994	1995	1996	1997
(1) Package A-1:	Construction of New Bagmati Bridge (2 Lanes) with Improvement of Thapathali Intersection, Exsiting Bagmati Bridge and River Protection		xxxxxxxxxxxxxx	xxxxxxxxxxxxxx			
(2) Package B:	Construction of Access to New Bus Terminal		xxxxxxxxxxxxxx	xxxxxxxxxxxxxx			
(3) Package A-2:	Western Section of South Inner Ring Road including Bagmati Bri. No.1 Sanepa Access			xxxxxxxxxxxxxx	xxxxxxxxxxxxxx		
(4) Package A-3:	Eastern Section of South Inner Ring Road including Bagmati Bri. No.3 Patan Intersection, Patan Access and Koteswor Access including Bagmati Bri. No.3					xxxxxxxxxxxxxx	xxxxxxxxxxxxxx
(5) Package C:	Improvement of Intersections at Maitighar, Tripureswar and Koteswor		xxxxxxx				

Table7.1: Tentative Investment Programme of High Priority Projects

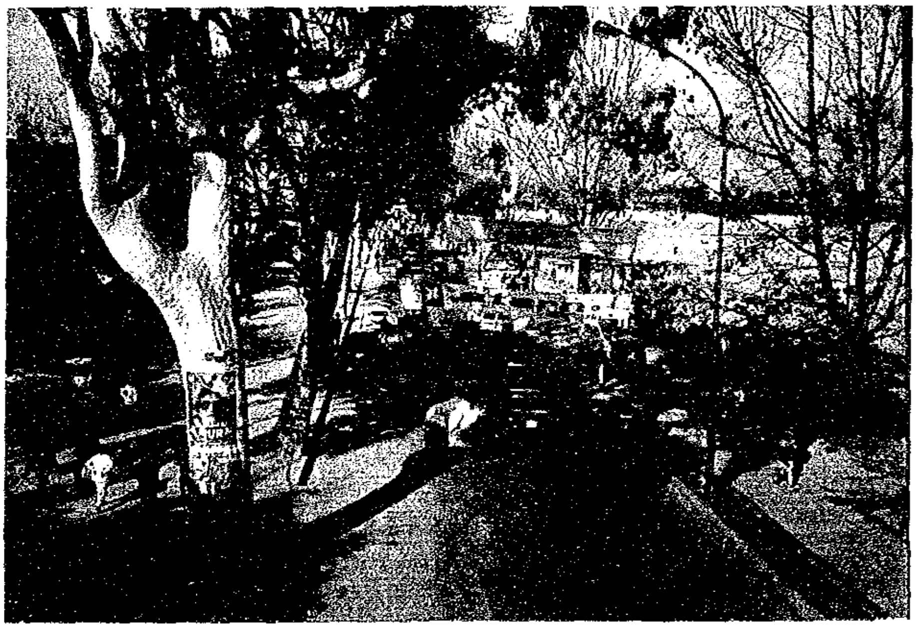
Unit: NRs. million

Phase	High Priority Projects	Const. Cost	Land/House	Construction	Land/House	Construction	Land/House	Construction	Land/House	Construction	Land/House	Construction	Land/House
	Target for Development:	High Priority projects to be Implemented in the Short-term Plan: (1) Improvement of Bottlenecks in Urban Traffic Conditions (2) Relief of Transportation-Poor										Total	
	Year:	1st Year 1993		2nd Year 1994		3rd Year 1995		4th Year 1996		5th Year 1997			
(1) Package A-1:	Construction of Bagmati Bridge No.2 (2lanes) including:	250	6	181								431	6
	Construction of New Bagmati Bridge	170		55									
	Improv. of Existing Bagmati Bridge & River Protection	36											
	Thapathali Intersection with Pedestrian Bridge,			126									
	Demolishing of Existing Old Truss Bridge,	6											
	Relocation of Water Main, Electric Line, etc.	38											
(2) Package B:	Construction of Access to New Bus Terminal	59	78	39								98	78
(3) Package A-2:	Western Section of South Inner Ring Road including:		204	150		278						428	204
	Bagmati Bridge No.1 (2 lane),												
	Sanepa Access,												
	Riverside Protection.												
(4) Package A-3:	Eastern Section of South Inner Ring Road including;						151	350		343		693	151
	Bagmati Bridge No.3 (2 lane) and River Protection												
	Patan Intersection including Pedestrian Bridge												
	Patan Access												
	Koteswor Access including Bagmati Bri. No.4												
(5) Package C:	Improvement of 3 Intersections (Maitighar,Tripureswar and Koteswor)	40										40	
	Total :	349	289	370	0	278	151	350	0	343	0	1,690	439
Consultant Fee : D/D & S/V = 10 % of Construction cost in each phase		35		37		28		35		34		169	
	Grand Total :	383	289	407	0	306	151	385	0	377	0	1,859	439
Equiv. to Yen (Million)	Total :	1,019		1,082		814		1,024		1,003		4,942	

Exchange Rate: 1US$ = NRs. 46.568 = ¥ 123.8 (Average rate in the past 6 months from June, 1992 to December, 1992), or 1 NRs. 1.0 = ¥ 2.6585

CHAPTER 8

ECONOMIC EVALUATION



CHAPTER 8 ECONOMIC EVALUATION

8.1 General

8.1.1 Introduction

In this chapter, the two proposed high priority packages as introduced in the previous chapter are economically evaluated. Initially, estimated project costs for each package of the project were economically evaluated in relation to the expected amount of benefit produced by each package to ascertain the overall economic feasibility in national economy. Second, the estimated project costs for these high priority projects have also been evaluated financially in terms of financial program of the eighth national development plan.

8.1.2 Procedure for Economic Evaluation

The procedure for economic evaluation is given in Fig. 8.1, and projects are evaluated through such indicators as Benefit/Cost Ratio (B/C ratio), Net Present Value (NPV) and Internal Rate of Return (IRR). For the application of these indicators, cost and benefit expressed in economic term and stream of them throughout the project life must be prepared as well as the premise of evaluation.

8.1.3 Indicators for Economic Evaluation

Three indicators are used for the evaluation of road construction projects as explained below :

(1) B/C Ratio

B/C ratio = B/C

$$B = \sum_{t=1}^{n} Bt/(1+r)^t, \qquad C = \sum_{t=1}^{n} Ct/(1+r)^t$$

Where

Bt : Benefit in the year t
Ct : Cost in the year t
r : Discount rate
n : Project life in years

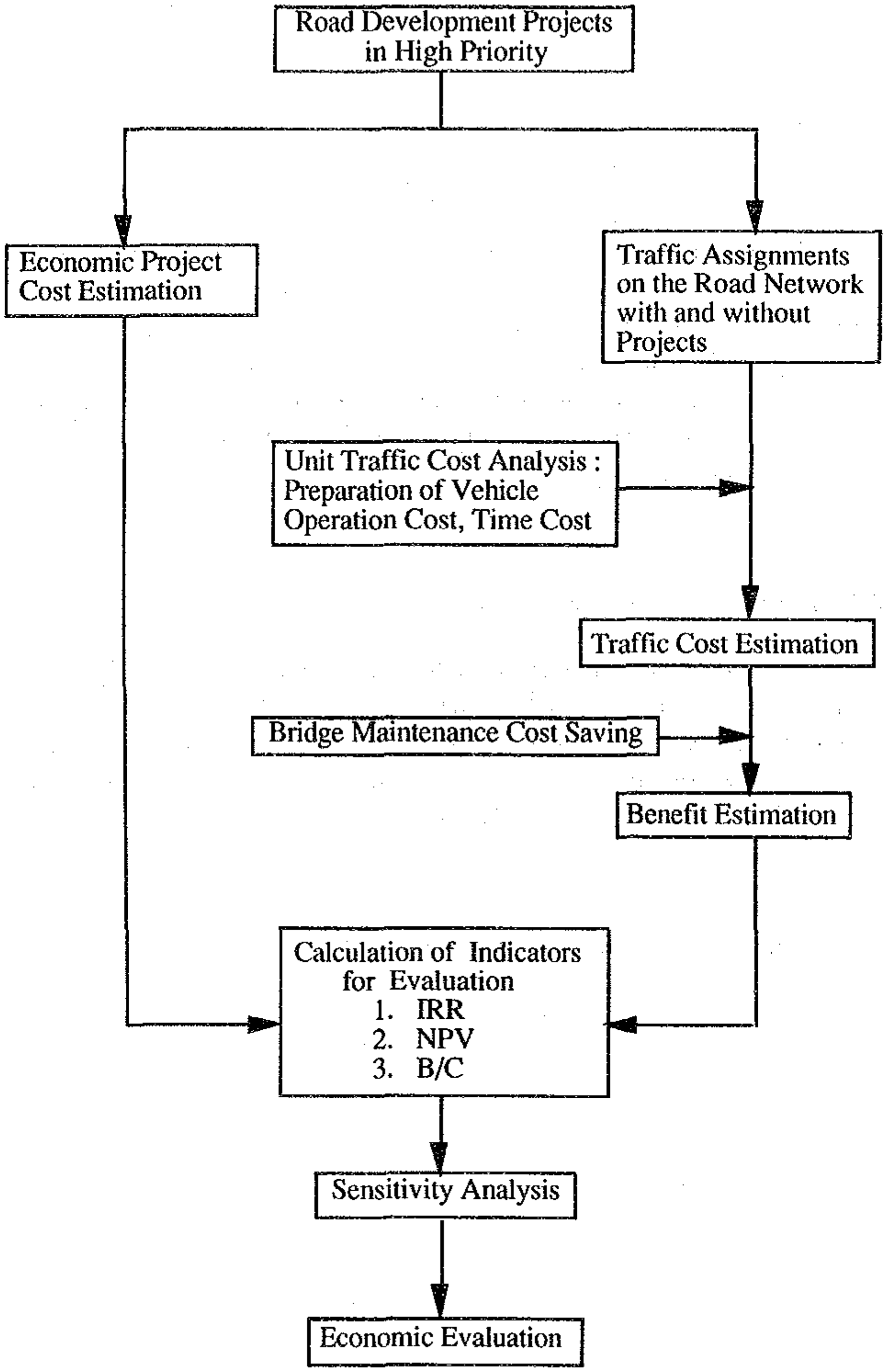


Fig. 8.1 Procedure for Economic Evaluation

The B/C ratio is the ratio of discounted benefit to discounted cost. Consequently, a ratio which is greater than 1.0 means a project is economically feasible.

(2) NPV

NPV = B - C

$$B = \sum_{t=1}^{n} Bt/(1+r)^t , \qquad C = \sum_{t=1}^{n} Ct/(1+r)^t$$

Where

Bt : Benefit in the year t
Ct : Cost in the year t
r : Discount rate
n : Project life in years

NPV is a balance between discounted benefit and discounted cost. Therefore, a positive value of this indicator means a project is economically feasible.

(3) IRR

IRR is obtained through the following formula :

B(R) - C(R) = O

$$B(R) = \sum_{t=1}^{n} Bt/(1+R)^t , \qquad C(R) = \sum_{t=1}^{n} Ct/ (1+R)^t$$

Where,

R: IRR
Bt : Cost in the year t
Ct : Cost in the year t
n : Project life in years

IRR is interpreted as a discount rate which gives a break even point between the discounted benefit and cost. Value greater than the assumed opportunity capital costs in a nation means a project is economically feasible.

8.1.4 Precondition for the Calculation of Economic Indicators

For the calculation of economic indicators, following precondition were given:

(1) Projects to be evaluated

As stated in Chapter 7, two high priority packages, namely Package A: "Improvement of Bagmati Transport Corridor" consisting of New Bagmati Bridge (Corresponding to Package A-1 in Chapter 7) and South Link of Inner Ring Road (Corresponding Package A-2 and A-3 in Chapter 7), and Package B: "Improvement of Access to New Bus Terminal" were recommended to be implemented in the short-term.

Economic calculation has been conducted for the following package:

Case 1:	Construction of New Bagmati Bridge and South Link of Inner Ring Road (Package A-1, A-2 and A-3 combined)
Case 1-1:	New Bagmati Bridge (Package A-1 only)
Case 1-2:	South Link of Inner Ring Road (Package A-2 and A-3 only)
Case 2:	Construction of New Bus Terminal Access

The Package C, consisting of improvements of three intersections, have not been evaluated due to the difficulty of quantification of potential benefits i.e., reduction of traffic accidents, increased increments of traffic safety and a decrease in overall traffic delays at intersections.

(2) Project life

25 years of project life was assumed.

(3) Discount Rate

A 10% discount rate was applied throughout the project life on the basis of estimated opportunity cost of capital in Nepal.

8.2 Estimation of Economic Project Cost

8.2.1 Cost Disbursement Schedule

Cost Disbursement Schedule for the investment of the two high priority project packages in the short-term plan are established in as shown in Table 7-1.

8.2.2 Estimation of Economic Project Cost

The project cost estimated in Chapter 6 was converted into economic cost through the following procedure :

- Deduction of Tax and Duty

  Transfer factors included in the project cost, such as taxes and duties, were deducted assuming 10% of the project cost is transfer factors.

- Exemption of Price Escalation

  The price escalation portion included in the project cost was deleted.

- Deduction of Land Acquisition Cost

  The land acquisition cost was deducted from the total project cost. It is generally accepted that the land acquisition cost is not included in the economic cost, because it is natural to think that increased land values due to the construction of roads will offset the initial land acquisition cost.

The stream of economic costs obtained through the above procedure are given in Table 8.1.

8.2.3 Maintenance Cost

Annual routine maintenance costs required after the opening of the Project Roads was estimated conservatively assuming that 5% of the total project cost is maintenance cost for the entire project life which is assumed 25 years. Based on this information, maintenance costs were allocated throughout the project life as shown in Table 8.1.

Table 8.1 Economic Project Cost and Maintenance Cost Stream by Projects

(Unit: Million NRs.)

Year	Case 1			Case 1-1			Case 1-2			Case 2		
	Project Cost	Maintenance Cost	Total	Project Cost	Maintenance Cost	Total	Project Cost	Maintenance Cost	Total	Project Cost	Maintenance Cost	Total
1993	153	-	153	153	-	153	-	-	-	53	-	53
1994	185	-	185	50	-	50	135	-	135	35	-	35
1995	250	-	250	-	-	-	250	-	250	-	-	-
1996	315	-	315	-	-	-	315	-	315	-	-	-
1997	309	-	309	-	-	-	309	-	309	-	-	-
1998	-	2	2	-	-	-	-	2	-	-	-	-
1999	-	2	2	-	-	-	-	2	-	-	-	-
2000	-	2	2	-	-	-	-	2	-	-	-	-
2001	-	2	2	-	-	-	-	2	-	-	-	-
2002	-	2	2	-	-	-	-	2	-	-	-	-
2003	-	2	2	-	-	-	-	2	-	-	-	-
2004	-	2	2	-	-	-	-	2	-	-	-	-
2005	-	2	2	-	-	-	-	2	-	-	-	-
2005	-	2	2	-	-	-	-	2	-	-	-	-
2006	-	2	2	-	-	-	-	2	-	-	-	-
2007	-	2	2	-	-	-	-	2	-	-	-	-
2008	-	2	2	-	-	-	-	2	-	-	-	-
2009	-	2	2	-	-	-	-	2	-	-	-	-
2010	-	2	2	-	-	-	-	2	-	-	-	-
2011	-	2	2	-	-	-	-	2	-	-	-	-
2012	-	2	2	-	-	-	-	2	-	-	-	-
2013	-	2	2	-	-	-	-	2	-	-	-	-
2014	-	2	2	-	-	-	-	2	-	-	-	-
2015	-	2	2	-	-	-	-	2	-	-	-	-
2016	-	2	2	-	-	-	-	2	-	-	-	-
2017	-	2	2	-	-	-	-	2	-	-	-	-
2018	-	2	2	-	-	-	-	2	-	-	-	-
2019	-	2	2	-	-	-	-	2	-	-	-	-
2020	-	2	2	-	-	-	-	2	-	-	-	-
2021	-	2	2	-	-	-	-	2	-	-	-	-
2022	-	2	2	-	-	-	-	2	-	-	-	-
Total	1212	50	1262	203	-	203	1009	50	1059	88	-	88

8.3 Estimation of Traffic Cost

8.3.1 General

In order to estimate the total benefit from these Projects, road user's costs were estimated. Road user's costs here are composed of two types of cost : Vehicle operating cost and travel time cost.

For the estimation of road user's cost, unit vehicle operating cost and unit time cost, e.g. NRs./km and NRs./minute have been estimated. These unit costs were applied to the traffic volume obtained from the results of traffic assignments.

8.3.2 Vehicle Operating Cost

Vehicle operating costs are composed of fuel, lubricating oil consumption, tire and tube consumption, depreciation and capital cost, repair and maintenance cost (parts and labor), crew cost and overhead. Levels for vehicle operating costs differ by vehicle type, model, driving speed and other factors related to driving conditions.

(1) Representative Vehicle

Representative vehicles for each vehicle type were selected as shown in Table 8.2 primarily based on recent market shares in Nepal.

Table 8.2 Representative Vehicle

Vehicle Type	Representative Vehicle	Market Share
Motor Cycle	Hero Honda	50%
Passenger Car	Toyota Corolla (Hi-deluxe)	65%
Truck	7-8 Ton, TATA	70%
Bus	63 Seats, Long Chassis, TATA	70%

Source : The Study Team

(2) Unit Vehicle Operating Cost

Unit vehicle operating costs were estimated by vehicle types as shown in Table 8.3 after the examination of consumption rate of sub components.

(3) Unit Vehicle Operating Cost by Level of Speed

Each component of vehicle operating cost is categorized into two types of costs, i.e. time-related cost and distance-related cost.

- Time-related Vehicle Operating Cost

  Those costs, (unit costs/per km) which are affected by the level of vehicle speed, such as fuel, oil, capital and crew costs are classified in this category of costs.

- Distance-related Vehicle Operating Cost

  Those costs (unit costs/per km) which are independent from the level of vehicle speed, such as tire costs, depreciation and maintenance costs are classified in this category.

As for time and distance-related vehicle operating costs, unit costs were estimated by speed level applying information about unit vehicle operation cost by speed level in Japan. Estimated unit vehicle operating costs by level of speed are summarized in Table 8.4.

Table 8.3 Unit Vehicle Operating Cost (Economic Cost)*

(Unit : NRs. /1000 km)

Items	Vehicle Type			
	Motorcycle	Passenger Car	Truck	Bus
Fuel	565	1,884	1,451	1,920
Oil	204	174	286	315
Tire and Tube	52	166	1,700	1,700
Maintenance (Parts)	64	1,108	1,422	1,746
Maintenance (Labor)	18	89	83	83
Depreciation	43	74	47	58
Crew Cost	0	150	354	354
Capital Cost	18	382	265	326
Overhead	145	605	1,402	1,625
Total	1,108	4,636	7,010	8,126

Source : The Study Team

* 50 km/h of running speed is assumed considering road condition in Nepal.

Table 8.4 Unit Vehicle Operating Cost by Speed

(Unit : NRs. /1000 km)

Speed (km/hr)	Vehicle Type			
	Motorcycle	Passenger Car	Truck	Bus
5	2,845	14,306	18,851	21,733
10	2,250	9,926	13,320	15,542
15	1,898	8,055	11,008	12,876
20	1,648	6,919	9,661	11,316
25	1,487	6,210	8,763	10,253
30	1,363	5,693	8,207	9,491
35	1,267	5,301	7,704	8,996
40	1,205	5,035	7,438	8,605
45	1,144	4,793	7,160	8,354
50	1,108	4,636	7,010	8,126
55	1,081	4,513	6,897	7,969
60	1,063	4,422	6,860	7,852
65	1,053	4,360	6,831	7,850
70	1,060	4,349	6,853	7,937
75	1,068	4,342	6,922	8,029
80	1,083	4,361	7,081	8,233
85	1,099	4,384	7,266	8,468

Source : The Study Team

8.3.3 Time Cost

(1) General

Time costs are another factor which composes total traffic costs. Unit time cost is estimated based on what is called "income approach method" in which time value is closely associated with income level of road users.

(2) Estimation of Time Value of Vehicle - user

1) Per Capita Income in Study Area

Due to lack of data on Gross Regional Product (GRP) in Kathmandu Valley, per capita income in the Study Area was estimated using a proportional formula of the Gross Domestic Product (GDP) per capita in Nepal as explained below:

$$\frac{GRP\ k.\ 1991}{P\ k.\ 1991} = A\ 1991 \times \frac{GDP\ n.\ 1991}{P\ n.\ 1991}$$

where

GRP k. 1991	:	GRP of Kathmandu Valley in 1991
P k. 1991	:	Population of Kathmandu Valley in 1991
GDP n. 1991	:	GDP of Nepal in 1991
P n. 1991	:	Population of Nepal in 1991
A 1991	:	Parameter in 1991

As for the estimation of the parameter, difference on an average residential land value between Kathmandu and all of Nepal was considered. As the result, per capita income in the Study Area was calculated as follows:

$$A\ 1991 = \frac{\text{Average Resident Land Value in Kathmandu Valley in 1991}}{\text{Average Resident Land Value in rural area of Nepal in 1991}}$$

$$\frac{GRP\ k.\ 1991}{P\ k.\ 1991} = \frac{32\ \text{million NRs./ha}}{6\ \text{million NRs./ha}} \times \frac{129{,}975\ \text{million NRs.}}{18{,}462\ \text{thousand persons}}$$

$$= 5.3 \times 7{,}040\ \text{NRs./person}$$

$$= 37{,}300\ \text{NRs./person}$$

2) Estimation of Hourly Income

Assuming the total number of working days in Nepal as 290 and one day's net working hour as 6 hours, total working hours in a year is calculated at about 1,740 hours.

6 hours/day x 290 days = 1,740 hours/year

From this, average per capita income for one hour is estimated as below :

Average Per Capita Income for one hour

= Per Capita Income in 1991/Working Hours

= 37,300 (NRs./person)/1,740 (hours/year)

= 21.4 NRs./person hour

3) Estimation of Unit Time Cost

Unit time costs for each vehicle type were estimated as shown in Table 8.5, applying average number of passengers on board*1, share of economic activities among them*2 and the probability of selecting the productive activities*3 to the hourly per-capita incomes obtained above.

*1 Results of traffic surveys conducted by the Study Team and information from DOR were used for the set-up.

*2 The shares for economic activities such as business trips etc. among passengers were estimated based on share of trip-purposes obtained in the traffic survey (Ref. Article 4.2.2)

*3 Assuming all the time saved will not be used for "income-yielding activity".

Table 8.5 Unit Time Cost by Type of Vehicles

Vehicle Type	Hourly Per capita Income (NRs.) (1)	Average Number of Passengers*1 (Person) (2)	Share of Business Trip*2 (3)	Probability of income-yielding activity*3 (4)	Unit Time Cost (NRs./hr) (5)=(1)x(2)x(3)x(4)
Motorcycle	21.4	1.5	0.37	0.5	5.9
Passenger Car	21.4	2.7	0.27	0.5	7.8
Truck	21.4	3.2	0.37	0.5	12.7
Bus	21.4	45.8	0.20	0.5	98.0

*1, 2 : Result of traffic survey conducted by the Study Team (Ref. Table A-6-3 of appendix 6 and Article 4.2.2) (Drivers not included).

*3 : One-half of opportunity for selecting productive activity was assumed.

8.4 Benefit Estimate

8.4.1 Benefit Account

Theoretically, a variety of benefits will be brought about by the implementation of the Project. However many of these benefits are difficult to quantify because of the uncertainty in the processes in which these benefits are produced and lack of data. In this study, vehicle operating cost savings, travel time cost savings and bridge maintenance cost saving are quantified.

8.4.2 Estimation of Benefit

Benefit from the projects were estimated through the following procedure :

1) Vehicle operating cost (VOC) savings and time cost savings were deemed two of the major sources of benefit (road user benefit) from road development project.

2) For the estimation of road user's costs, unit vehicle operating costs, and unit time costs were applied to the total vehicle running distance and travel time simulated in traffic assignment.

3) Road user's benefit was obtained as the balance between road user's traffic costs for two different traffic assignment cases, i.e. "without the Project" case and "with the Project case".

4) Bridge maintenance cost savings were also estimated as one of the benefits for the bridge improvement project. Bridge maintenance cost savings were obtained as the balance of bridge maintenance costs for two different scenarios, i.e. "without bridge improvements case" and "with bridge improvements case" .

8.4.3 Benefit Flow

Benefit flows throughout the project life were estimated as shown in Table 8.7 in which annual increasing rates of benefit after the opening of the projects were assumed at 3.5% for Case 1, 3.1% for alternative Case 1-1, 2.5% for Case 1-2, and 3.6% for alternative Case 2.

Table 8.6 Road-User Benefit and Bridge Maintenance Benefit by Projects

(Unit: Million NRs.)

	Benefit	Projects Case 1	Case 1-1	Case 1-2	Case 2
Year 1997:					
VOC:	Without Project case (1)	3,099	3,054	3,088	3,067
	With Project case (2)	3,054	3,054	3,054	3,054
	Saving (3) = (1)-(2)	45	0	34	12
Time Cost:	Without Project case (4)	324	282	295	261
	With Project case (5)	257	257	257	257
	Saving (6) = (4)-(5)	67	25	38	4
Road User Benefit:	(7) = (3)+(6)	112	25	72	4
Bridge	Without Project case (8)	30	30	30	-
Maintenance:	With Project case (9)	-	-	-	-
	Saving (10) = (8)-(9)	30	30	30	-
Total Benefit:	Without Project case	3,453	3,366	3,413	3,328
	With Project case	3,311	3,311	3,311	3,311
	Saving	142	55	102	16
Year 2015:					
VOC:	Without Project case (1)	5,826	5,741	5,806	5,765
	With Project case (2)	5,741	5,741	5,741	5,741
	Saving (3) = (1)-(2)	85	0	65	24
Time Cost:	Without Project case (4)	608	537	552	490
	With Project case (5)	483	483	483	483
	Saving (6) = (4)-(5)	125	54	69	7
Road User Benefit:	(7) = (8)-(9)	210	54	134	31
Bridge	Without Project case (8)	10	10	10	-
Maintenance:	With Project case (9)	-	-	-	-
	Saving (10) = (8)-(9)	10	10	10	-
Total Benefit:	Without Project case	6,444	6,288	6,368	6,255
	With Project case	6,224	6,224	6,224	6,224
	Saving	220	64	144	31

Source: The Study Team

Table 8.7 Benefit Stream by Projects

(Unit: Million NRs.)

Year	Case 1				Case 1-1				Case 1-2				Case 2			
	VOC	TC	BMS	T	VOC	TC	BMS	T	VOC	TC	BMS	T	VOC	TC	BMS	T
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	22	30	52	0	22	30	52	0	0	0	0	11	4	0	15
1996	0	23	0	23	0	23	0	23	0	0	30	30	11	4	0	15
1997	0	25	30	55	0	25	30	55	0	0	0	0	12	4	0	16
1998	47	70	0	117	0	27	0	27	36	40	30	106	13	4	0	17
1999	49	73	30	152	0	28	30	58	37	41	0	78	13	4	0	17
2000	52	77	0	129	0	30	0	30	39	43	30	112	14	4	0	18
2001	54	80	30	164	0	31	30	61	41	45	0	86	15	5	0	20
2002	56	83	0	139	0	33	0	33	43	47	30	120	15	5	0	20
2003	58	86	30	174	0	35	30	65	44	48	0	92	16	5	0	21
2004	61	90	0	151	0	36	0	36	46	50	30	126	17	5	0	22
2005	63	93	30	186	0	38	30	68	48	52	0	100	17	5	0	22
2006	65	96	0	161	0	39	0	39	49	53	30	132	18	5	0	23
2007	67	99	10	176	0	41	10	51	51	55	0	106	19	6	0	25
2008	69	102	0	171	0	43	0	43	53	57	10	120	19	6	0	25
2009	72	106	10	188	0	44	10	54	55	59	0	114	20	6	0	26
2010	74	109	0	183	0	46	0	46	56	60	10	126	21	6	0	27
2011	76	112	10	198	0	48	10	58	58	62	0	120	21	6	0	27
2012	78	115	0	193	0	49	0	49	60	64	10	134	22	6	0	28
2013	81	119	10	210	0	51	10	61	62	66	0	128	23	7	0	30
2014	83	122	0	205	0	52	0	52	63	67	10	140	23	7	0	30
2015	85	125	10	220	0	54	10	64	65	69	0	134	24	7	0	31
2016	87	128	0	215	0	56	0	56	67	71	10	148	25	7	0	32
2017	89	131	10	230	0	57	10	67	68	72	0	140	25	7	0	32
2018	92	135	0	227	0	59	0	59	70	74	10	154	26	7	0	33
2019	94	138	10	242	0	60	10	70	72	76	0	148	27	8	0	35
2020	74	78	0	152	*	*	*	*	74	78	10	162	*	*	*	*
2021	75	79	10	164	*	*	*	*	75	79	0	154	*	*	*	*
2022	77	81	0	158	*	*	*	*	77	81	10	168	*	*	*	*
Total	177	259	260	463	0	102	250	127	140	150	260	317	467	140	0	607

VOC: Vehicle Operation Cost Saving

TC: Time Cost Saving

BMS: Bridge Maintenance Cost Saving

T: Total Cost Saving

8.5 Economic Evaluation

8.5.1 Premise

Premises for economic evaluation was set up as below :

- Implementation Schedule and Cost Disbursement

  According to the implementation schedule described in Table 7-1, disbursements of cost by alternative are prepared as shown in Table 8.1.

- Project Life and Discount Rate

  25 years of project life after opening of the projects has been assumed.

- Discount Rate

  10% of discount rate throughout the project life has been applied.

8.5.2 Evaluation

IRR, B/C and NPV obtained through the above procedure are listed in Table 8.9.

IRR for Case 1, Case 1-1 and Case 2 are higher than 10% of opportunity cost of capital with the maximum of 19.5% in the Case 1-1 scenario. The B/C ratio is over 1.0 in Case 1, Case 1-1 and Case 2.

Table 8.8 Results of Economic Evaluation

		IRR (%)	B/C *	N.P.V. * (in Million NRs.)
Case 1		11.5	1.13	136
	Case 1-1	19.5	1.95	189
	Case 1-2	9.7	0.91	-63
Case 2		18.8	1.99	85

8.6 Sensitivity Analysis

Sensitivity analysis was conducted to check the evaluating system and to check the viability of the projects in possible changes in cost and benefit. The result of sensitivity analysis is given in Table 8.9.

Table 8.9 (1) Result of Sensitivity Analysis (Case 1)

IRR (%)

Benefit	Cost				
	20% up	10% up	Original	10% down	20% down
20% up	11.5	12.6	13.8	15.4	16.9
10% up	10.5	11.5	12.7	13.9	15.7
Original	9.8	10.4	11.5	12.8	14.4
10% down	9.4	9.7	10.3	11.5	12.9
20% down	8.8	9.3	9.6	10.1	11.5

B/C

Benefit	Cost				
	20% up	10% up	Original	10% down	20% down
20% up	1.13	1.24	1.36	1.51	1.70
10% up	1.04	1.13	1.25	1.38	1.56
Original	0.94	1.03	1.13	1.26	1.42
10% down	0.85	0.93	1.02	1.13	1.27
20% down	0.75	0.82	0.90	1.01	1.13

NPV (Million NRs.)

Benefit	Cost				
	20% up	10% up	Original	10% down	20% down
20% up	163	261	360	459	558
10% up	50	149	248	347	445
Original	-62	37	136	234	333
10% down	-174	-76	23	122	221
20% down	-287	-188	-89	10	108

Table 8.9 (2) Result of Sensitivity Analysis (Case 1-1)

IRR (%)

Benefit	Cost				
	20% up	10% up	Original	10% down	20% down
20% up	19.5	20.8	22.7	24.7	27.0
10% up	17.8	19.5	20.8	22.8	25.0
Original	16.5	17.7	19.5	20.9	23.6
10% down	14.8	15.9	17.6	19.5	21.5
20% down	13.3	14.5	15.7	17.5	19.5

B/C

Benefit	Cost				
	20% up	10% up	Original	10% down	20% down
20% up	1.95	2.12	2.34	2.60	2.92
10% up	1.78	1.95	2.14	2.38	2.68
Original	1.62	1.77	1.95	2.16	2.43
10% down	1.46	1.59	1.75	1.95	2.19
20% down	1.30	1.41	1.56	1.73	1.95

NPV (Million NRs.)

Benefit	Cost				
	20% up	10% up	Original	10% down	20% down
20% up	227	246	266	286	306
10% up	188	208	228	247	267
Original	149	169	189	209	229
10% down	110	130	150	170	190
20% down	72	92	111	131	151

Table 8.9 (3) Result of Sensitivity Analysis (Case 1-2)

IRR (%)

Benefit	Cost				
	20% up	10% up	Original	10% down	20% down
20% up	9.7	10.0	11.2	12.5	13.8
10% up	9.4	9.7	10.1	11.4	12.8
Original	9.0	9.3	9.7	10.3	11.6
10% down	8.4	8.9	9.3	9.7	10.4
20% down	7.8	8.3	8.8	9.2	9.7

B/C

Benefit	Cost				
	20% up	10% up	Original	10% down	20% down
20% up	0.91	1.00	1.10	1.22	1.37
10% up	0.84	0.91	1.01	1.12	1.26
Original	0.76	0.83	0.91	1.02	1.14
10% down	0.68	0.75	0.82	0.91	1.03
20% down	0.61	0.66	0.73	0.81	0.91

NPV (Million NRs.)

Benefit	Cost				
	20% up	10% up	Original	10% down	20% down
20% up	-76	3	82	161	240
10% up	-148	-70	9	88	167
Original	-221	-142	-63	16	95
10% down	-294	-215	-136	-57	22
20% down	-366	-287	-208	-130	-51

Table 8.9 (4) Result of Sensitivity Analysis (Case 2)

IRR (%)

Benefit	Cost				
	20% up	10% up	Original	10% down	20% down
20% up	18.8	20.5	21.8	23.8	25.9
10% up	17.6	18.8	20.6	22.0	24.6
Original	16.4	17.6	18.8	20.7	22.7
10% down	14.7	15.8	17.5	18.8	20.8
20% down	13.4	14.4	15.6	17.0	18.8

B/C

Benefit	Cost				
	20% up	10% up	Original	10% down	20% down
20% up	1.99	2.17	2.39	2.66	2.99
10% up	1.83	1.99	2.19	2.44	2.74
Original	1.66	1.81	1.99	2.21	2.49
10% down	1.49	1.63	1.79	1.99	2.24
20% down	1.33	1.45	1.59	1.77	1.99

NPV (Million NRs.)

Benefit	Cost				
	20% up	10% up	Original	10% down	20% down
20% up	102	110	119	127	135
10% up	85	93	102	110	119
Original	68	76	85	93	102
10% down	51	59	68	76	85
20% down	34	42	51	59	68

8.7 Financial Analysis/Considerations

8.7.1 Objective

The required amount of implementation cost for all high priority projects analyzed in the economic evaluation is estimated to be NRs. 2,298 million as shown in Table 7-1. It is recommended that the implementation of these projects should be carried out by means of grants and external borrowing as shown in article 9.2.3 of the Master Plan Report of this study. The main purpose of this financial analysis is to check the estimated project cost if it is within the scope of foreign aid in the Eighth Plan and scheduled development expenditure for the transport sector in the Eight Plan.

8.7.2 Analysis of Past Investment for Transport Sector

(1) National Expenditure and Sources of Finance

The overall budgetary situation of His Majesty's Government of Nepal (HMG) shows an excess of expenditures over revenue. In the fiscal year 1990/91, the revenue of HMG was NRs 10,698 million whereas total expenditures were NRs 24,479 million. The internal revenue of HMG is able to cater the country's total general expenditures plus a portion of development expenditure. The remaining development expenditures have been covered by foreign grants, internal and foreign loans. The reliance on external aid sources is steadily increasing. The total expenditure of the governments in the past 6th and 7th Plans is given in the Table 8.10.

(2) Sector Expenditure in Development Expenditure

According to the statistics of HMG for the past ten years, the development expenditure for roads and bridges is on the increase every year so as to achieve development projects for roads and bridges (Refer Table 8.11).

From the recognition of the importance of transportation and communication in the socio-economic development of the country, special attention has been being given to the development of these sectors since the first Five Year Plan. Various efforts have been made in construction of roads and bridges and in the improvement projects of accessibility to isolated small villages in Nepal.

Average shares of allocation to transportation, communication and road bridge sectors in total development expenditures were 14% and 10% respectively during the 7th plan perod while maximum of those shares during the same period were 18% and 12% respectively.

(3) Foreign Aid for Transport Sector

The statistics data on foreign loan and grant disbursement for roads and bridges for the past ten years show that grant aid is larger than bilateral loan aid as shown in Table 8.12. During the 7th plan period, the total amount of foreign aid disbursement was NRs 4,137 million, almost one half of which was for transport and communication sectors. Average compositions of grants and loans were 43% and 57% respectively.

Table 8.10 Government Expenditure and Sources of Finance (Million Rs) *

	6th 5-year Plan Period						7th 5-year Plan Period						
	81/82	82/83	83/84	84/85	85/86	Total	86/87	87/88	88/89	89/90	90/91	91/92	Total
Total Expenditure	-	6,979	7,437	8,395	9,791	32,602	11,513	14,105	18,005	19,669	24,479	26,641	114,412
Revenue	-	2,842	3,409	3,917	4,645	14,813	5,975	7,350	7,777	9,288	10,698	12,557	53,645
Deficit **	-	4,137	4,028	4,478	5,146	17,789	5,538	6,755	10,228	10,381	13,781	14,084	60,767

Source : Statistical Pocket Book 1988, 1990 and 1992, Central Bureau of Statistics, Nepal

Table 8.11 Government Development Expenditure for Roads and Bridges *

	6th 5-year Plan Period						7th 5-year Plan Period					
	81/82	82/83	83/84	84/85	85/86	Total	86/87	87/88	88/89	89/90	90/91	Total
Total Development Expenditure (Million Rs)	3,727 100	4,982 100	5,164 100	5,489 100	6,213 100	25,575 100	7,378 100	9,428 100	12,329 100	12,997 100	16,551 100	84,258 100
Transportation Communi-cation (Million Rs)	793 21	876 18	844 16	1,013 18	807 13	4,333 17	1,126 15	1,734 18	2,232 18	1,718 18	1,667 13	12,810 14
Road &Bridge (Million Rs)	-	-	657 13	573 10	616 10	1,846 -	835 11	1,071 11	1,506 12	1,172 9	1,511 9	7,941 10

Source : Statistical Pocket Book 1988, 1990 and 1992, Central Bureau of Statistics, Nepal

Table 8.12 Foreign Aid *

	6th 5-year Plan Period						7th 5-year Plan Period					
	81/82	82/83	83/84	84/85	85/86	Total	86/87	87/88	88/89	89/90	90/91	Total
Foreign Aid Disbursemnt for Transportation	415	265	301	556	343	1,880 (100)	405	607	1,018	750	1,357	4173 (100)
- Grant	308	171	196	156	227	1,058 (56)	145	257	334	371	687	1,794 (43)
- Loan	107	94	105	400	116	822 (44)	260	350	684	379	670	2343 (57)

* In Million NRs at Current

Source : Economic Survey 1989 and 1992, Ministry of Finance, Nepal

** Foreign Grants, Foreign Loan and Internal Loans

8.7.3 Analysis of Eighth Plan

The total gross fixed investment during the Eighth Plan period is estimated at NRs 170,332 million as shown in Table 8.13. This is 65% of increase of that of Seventh Plan.

Sector investment which includes both private and government investments will be NRs. 113,479 million of which the investment for transport and communication sectors will be NRs. 20,030 million which accounts for 17.7 percent of the total development expenditure.

An amount of NRs 95,977 million or 56.3 percent will be financed through national savings, the remaining NRs 74,355 million or 43.7 percent is required to be financed by foreign aid, of which NRs 19,761 million will be by grant and NRs 54,594 million by loan.

Table 8.13 Investment and Financing Sources of Eighth Plan

	Seventh Plan (1986 '90)		Eighth Plan (1993-'97)	
	Amount *	Share(%)	Amount *	Share(%)
Sector Investment Requirement **				
Total Gross Fixed Investment	103,014	100.0	170,332	100.0
Transport & Communication	15,881	15.4	26,119	15.4
Sector allocation of Development Expenditure				
Total Development expenditure	74,174	100.0	113,479	100.0
Transport & Communication	11,657	15.7	20,030	17.7
Transport	-	-	13,567	11.95
Source of finance				
Total Gross Fixed Investment			170,332	100.0
National Saving			95,977	56.3
Foreign Aid			74,355	43.7
- Grant			19,761	11.6
- Loan			54,954	32.1

* in million NRs at 1991/92 prices
** Sector investment includes private and government investment

Total cost required for the implementation of the proposed high priority projects is estimated at NRs 2,298 million which is only 3.1% of the total proposed foreign aid in the Eight Plan. Furthermore, an assumed share of the project cost required in the transport and communication sectors of the Eighth Plan is 11.5% as shown below:

$$S = \frac{PC}{TC} \times 100$$

Where

S : Assumed Share of the Project Cost (%)
PC : Project Cost = 2,298 million NRs
TC : Proposed Development Expenditure on Transport and Communication Sectors
= 20,030 million NRs.

$$S = \frac{2{,}298 \text{ million NRs}}{20{,}030 \text{ million NRs}} \times 100$$
$$= 11.5\%$$

8.7.4 Conclusion and Recommendation

Although the assumed share of 11.5% for the projects might be a slightly higher portion in the transportation development expenditure, it could be recommended that the arrangement of the project implementation should be given a high priority taking the role of Kathmandu Valley in the national economy into account.

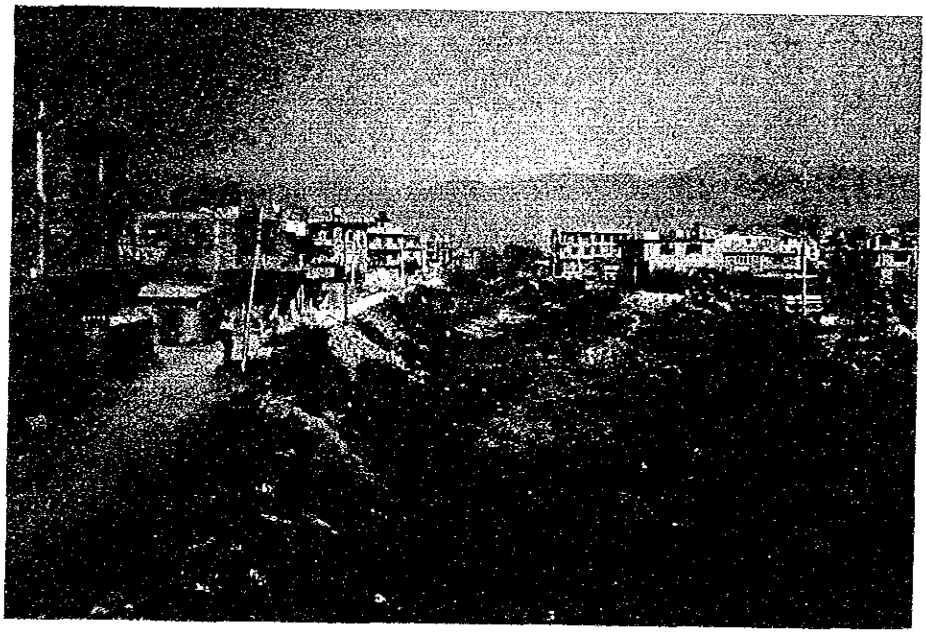
In addition, the required project cost for Package C and other additional works for Package A-1 mentioned in Table 7.1 is estimated at NRs 246 million which is only 1.2% of the development expenditure on transport and communication sectors of the Eighth Plan. Furthermore, it could be assumed that the Improvement Project for intersections and other additional works are economically feasible ; in reference to similar projects in other cities in the world.

On the other hand, the Eighth Plan sets forth the concept of a nation-wide highway network development, along with the policy of feeder and rural road development which was proposed in the previous fifth year plan. However, these road development programs would require a great deal of coordination in terms of scope of plans, reorganization of implementing agencies and implementation schedule. In this context, road development in the Valley should be proceeded in the balance between nationwide and region-oriented scopes of development scheme.

Regarding the individual proposed projects in this study, Case 1 is rather oriented in nation-wide scope of road development while Case 2 rather regional oriented.

CHAPTER 9

ENVIRONMENTAL CONSIDERATION



CHAPTER 9 ENVIRONMENTAL CONSIDERATIONS

9. 1 Present Condition of the Bagmati Corridor

The tradition of using the flood-plain areas as the agricultural land is prevalent in Kathmandu Valley. Rapid growth of population and lack of zoning has changed almost all of flood plain into urban area and this trend is continuing at accelerated rate. The settlement in these flood plain has very poor infrastructure facility and living condition there is very poor.

The Bagmati corridor is not homogeneous in terms of land use and activities, however, the area is predominantly used for agricultural purposes. There are presently three squatter sites with about 50 houses within the corridor. Within these squatter areas there exists no public service and standards of the housings is extremely low. The people living in these areas use the river bed as the place of living, washing place and toilet. The river is also used for dumping place of solid waste and discharging urban sewer from surrounding area.

The Bagmati river is a tributary of the Ganges river and is a holy river in Hindu beliefs. Along the river, there exist many temples and places of historical and religious importance. In the vicinity of proposed Bagmati transport corridor, Shankhamul temple, Tripureswor temple complex, Pachli and Ram ghats are important religious places.

People collect sand from the Bagmati river for construction of building. Large amount of sand is taken from the river annually which is lowering the water level of the river. The temples are losing their original approach to the water and religious activities are being hampered.

The sources of air pollution are dust, vehicle emissions and industrial emissions. According to the survey made by the Norwegian Institute of Technology in August, 1991, the level of dust in the air exceeds acceptable level and the lead content in air is at critical level.

9.2 Effect on Economic and Social Activities

Urban sprawl has lead transportation system to very inefficient one and charging high transportation cost to the users. Poor provision of road is one of the causes of the uncontrolled urban development. Due to uncontrolled urban development, the Valley is poorly served with infrastructure. It is expected that better land-use pattern will be realized with the road development.

The rapid population growth, as high as 6 % per annum in Kathmandu, has brought about a great pressure in the housing market in the city. The opening up of areas along the Bagmati Transport Corridor will relief these tension in housing market.

The project road will improve the accessibility in the area and encourage the economic and social activities and will enhance land value in the areas, while construction or road will accompany the issues of relocation of housing. To minimize these negative effects, the proposed alignment of South Link of Inner Ring road is proposed to pass in the areas nearby the river bank, where the lands are mostly owned by government.

Short-term impacts brought about by the project

The alignment of the proposed roads is proposed along the river bank of the Bagmati river so as to minimize the land acquisition cost, however, the following impacts are expected in a short-term:

(1) About 110 houses including squatters have to be demolished by the construction of roads and about 92,000 m2 (or 9.2 hectare) of the agricultural land will be converted into road. The owner of land will lose their income temporarily.

(2) The road will hinder religious activity centered around the river.

Long-term impacts brought about by the project

(1) The project road will open up a new area and will promote new type of secio-economic activities there. The resident will receive some benefit by increased land value.

(2) The project road will provide access to areas that have poor access or no access at present, which will promote systematized urban development in a long-term.

9.3 Traffic Impacts

(1) Improvement of transportation-poor

The proposed road will give improved access to the areas which currently have poor road access. The improvement of accessibility to the areas will relief the transportation-poor in the areas. With improved access, many inhabitants will be able to satisfy their minimum level of transportation need.

(2) Improvement of traffic flow

The proposed South Link of Inner Ring Road will provide a new east-west connection in the northern part of Lalitpur, which will reduce the traffic congestion near the existing Bagmati Bridge. Relief of traffic congestion on the Bagmati Bridge at Thapathali is urgent since the bridge is now bottleneck of urban traffic, causing great amount of delays and accidents.

(3) Formation of urban road network in Kathmandu

South Link of Inner Ring Road will be a major arterial road forming a basic frame of urban road network in Kathmandu in a long-term. The construction of South Link is epoch-making as the initial step to build up the urban road network in the Valley.

9.4 Improvement on Environment of Bagmati Corridor

The positive impacts on the river environment is described as below;

(1) The proposed road will prevent further pollution of the river due to clearance of sub-standard housings along the river.

(2) Open space between the road and river bank could be used for public facilities, such as play ground, park, pedestrian and bicycle road, green belt, open market and so on.

9.5 Negative Impacts on Natural Environment

Air quality

The vehicle exhaust gas is one of the major causes of air pollution. Provision of new road network as well as the improvement of major intersections proposed in this study will streamline the traffic flow in the city greatly and improve the driving condition of road to the level that reduces amount of exhaust gas from the vehicles.

For the more controle of air pollution in the Valley, it is inevitable to introduce air monitoring system based on scientific study. Introduction of car inspection system is another measure to be introduced to relief the issue.

Noise and other environmental problems

Noise will cause sleeping disturbance, build-up of stress and poor concentration for the residents nearby the road. The proposed route, however, is located far from the residential area, so that noise will not be a major issue even after the opening of the road.

CHAPTER 10

CONCLUSION AND RECOMMENDATIONS

CHAPTER 10 CONCLUSION AND RECOMMENDATIONS

The following are the conclusion and recommendations related to the project.

10.1 Conclusion

The feasibility study proved that project roads, both of Package A and B are technically and economically feasible with a high economic internal rate of return of 11.5% and 18.8% respectively.

Therefore, the projects should be realized within the earliest possible time, in the following priority order.

Priority	Proposed Roads
(1)	Construction of New Bagmati Bridge (2 lanes) including; - Thapathali intersection with pedestrian bridge, - Improvement of existing Bagmati Bridge for scoring, - Removal of existing old truss bridge, and - River improvement against lowering river bed
(2)	Construction of New Bus Terminal Access at Balaju
(3)	Improvement of Intersections at Mitighar, Tripureswar and Koteswor
(4)	Construction of Western Section of South Link of Inner Ring Road including, - Snapper Access - Bagmati Bridge No.1 at Sanepa - Riverside Protection
(5)	Construction of Eastern Section of South Link of Inner Ring Road including, - Koteswor Access and Patan Access - Bagmati No.3 and No.4 Bridges

Table 10.1 shows the summary of the project features for the above roads.

Table 10.1: Summary of Project Feature

	Project	Major Work Items	Lane Nos.	Design Speed (Km/hr)	Length (m)	Carriageway (m)	Sidewalk (m)	Right-of-way (m)	Remarks
1	New Bagmati Bridge	Main Bridge	2	60	140 m	10 m	3.0m(one side)	50 m	
	(No.2 Bagmati Bridge)	Intersection with Pedestrain							
		Protection of exisiting bridge							
		Removal of old truss bridge							
		Protection against river bed							
2	South Inner Ring Road								
	(i) First stage (2 lanes);	Project Road	2	60	3,750 m	10 m	3.0m(one side)	50m (min. 25m)	Right-of-way shall be acquired for
		No. 1 Bagmati Bridge	2		145 m	8 m	2.5m(both side)		4 lane roads at this first stage.
		No. 3 Bagmati Bridge	2		120 m	8 m	2.5m(both side)		
		Protection of riverside bank							Protection of river bank of Bagmati.
	(ii) Second stage;	Project Road	(total 4	60		2 x 8 m	3.0m(both side)	-	with median slip (3.0m)
	(Widening to 4 lanes)					w/median (3m)			
		No. 1 Bagmati Bridge	4		145 m	8 m	2.5m(one side)		
		No. 3 Bagmati Bridge	4		120 m	8 m	2.5m(one side)		
3	Access Roads								
	(i) Sanepa Access	Project Road	2	60	510 m	10 m	3.0m(both side)	30m (min. 20m)	
	(ii) Koteswar Access	Project Road	2	60	2,180 m	10 m	3.0m(both side)	30m (min. 20m)	
		No. 4 Bagmati Bridge	2		60 m	8 m	2.5m(both side)		
	(iii) Patan Core Access	Project Road		40	220 m	8 m	2.5 m (both side)	13 m	
	(iv) New Bus terminal Access	Project Road	2	40	1,865 m	10 m	3.0 m (both side)	30 m	
4	Improvement of Intersections	Mitighar Intersection	4						Signal with minor improvement
		Tripureswar Intersection	4						Signal with minor improvement
		Koteswor Intersection	4						Improvement of shape of intersection

The following are the significance and benefits expected from the project:

(1) Removal of Traffic Bottleneck between Kathmandu and Patan

Proposed New Bagmati Bridge will not only facilitate the anticipated traffic demand in between Kathmandu and Lalitpur but also release the traffic congestion and solve the bottleneck of the traffic movement in the areas of Thapathali which will improve economic and social activities in both cities.

(2) Securing the Alternative Route between Kathmandu and Lalitpur

So far, there is the only existing Bagmati Bridge at Thapathali connecting Kathmandu and Lalitpurinside the Ring Road. Since lowering of the Bagmati River is still progressing, securing of new reliable alternative transport routes between Kathmandu and Lalitpur is essential not only for economic activities but also for the daily life of the people in the cities.

(3) Build-up of the Basic Frame of Urban Road Network inside Kathmandu City

South Link of Inner Ring Road is a part of the Inner Ring Road and forms a basic frame of urban road network in Kathmandu city in the long-term. The construction of South Link is significant as the first step to build up the proposed urban road network in Kathmandu Valley.

(4) Improvement of Accessibility and Enhancement of Regional Development

Proposed South Link of the Inner Ring Road including Sanepa and Koteswor Access will improve the accessibility from the existing roads to the inner low density areas, which will enhance the development of these inner areas along the corridor.

(5) Improvement of Environment along Bagmati River

Proposed South Link as well as Koteswor access would improve the environment of Bagmati river-side through the provision of slope protection of river bank. The open space between the proposed road and the river could be used for public facilities, such as, riverside park, pedestrian and bicycle road, green belt, play ground and so on.

10.2 Recommendation

In order to materialize the projects, the Study Team recommends DOR to take the following actions:

(1) Urgent Implementation of New Bagmati Bridge

It is strongly recommended for DOR to implement the construction of New Bagmati Bridge within the earliest possible time.

The traffic condition of existing Bagmati Bridge at Thapathali is getting worse due to rapid increase of traffic between Kathmandu and Lalitpur cities. Moreover, this bridge is in a serious and dangerous situations and requires immediate protection and repair work on the bridge foundation against the lowering of river bed. (It is noted that the traffic was suspended from August 1991 to March 1992 due to the collapse of foundation of the existing Bagmati Bridge.) At least, emergency protection work on pier No.5 (nearest to Lalitpur side) as well as reshaping of gabion checkdam located 20 m downstream should be conducted before coming rainy season which will last from June to September, 1993 this year.

Since the existing Bagmati Bridge is the only vehicular bridge connecting Kathmandu and Lalitpur inside the Ring Road, construction of New Bagmati Bridge is essential not only for facilitating the traffic demands but also for securing a alternative bridge as a detour connecting Kathmandu with Lalitpur.

(2) Securing Bus Route from New Bus Terminal at Balaju

Construction of a new bus terminal project is progressing at Balaju, and is expected to be completed in early March, 1993. Since the new bus terminal is located at Balaju where accessibility from the central area of Kathmandu city is very limited, the provision of suitable access is essential for smooth operation of the New Bus Terminal.

It is, therefore, recommended to construct the New Bus Terminal Access as soon as possible to secure proper and reliable bus route for bus operation, since the bus services is the only means of transportation in Kathmandu.

In the meantime, the Study team also recommends to improve the roads nearby city center which might be utilized as bus routes if proposed New Bus Terminal Access is materialized, especially on the following routes:

(i) Trisuli Road from Royal Palace to Paknajor (reconstruction of pavement and drainage as well as widening of certain section might be necessary)

(ii) Feeder road starting from Kanti Path at Ambassador Hotel up to the New Access through U.K. Embassy, Indian Embassy and Samakhusi Road.(This road is recommended to be utilized for bus route employing one-way system from Kanti path up to Samakhusi Road. Pavement and widening of the road from the entrance of Indian Embassy to Samakhusi road is recommended).

Improvement of the above roads is essential for maintaining the smooth operation of bus services between city center and New Bus Terminal.

(3) Securing of 4 Lane Right-of-way Width for South Link of Inner Ring Road

Staged construction is recommended for the implementation of the Inner Ring Road. Widening of the Inner Ring Road from 2-lane to 4-lane should be done in future when traffic demand exceeds the traffic capacity of 2-lane road, however, right-of way width should be secured for 4-lane at this moment. Additional land acquisition in future might be very difficult because of expected increase of land price.

(4) Allocation of Local Budget for Acquiring Land/House

It is recommended to allocate the necessary amount of local budget for acquiring the lands and houses which might be necessary for implementation of the project.

Land and house acquisition should be conducted in accordance with the project implementation schedule as follows:

Year	Schedule of Land/House Acquisition
1st year (1993)	Acquiring lands and houses located in the vicinity of New Bagmati Bridge including the intersections at Thapathali and Patan side
2nd year (1994)	Within the ROW along Western section of South Link of the Inner Ring Road from the beginning point up to the proposed New Bagmati Bridge including Sanepa Access
3rd year (1995)	Within the ROW along Eastern section of South Link of the Inner Ring Road from proposed New Bagmati Bridge up to the end on Arniko Highway including Koteswor Access and Patan Core Access

(5) Improvement Traffic Management at Intersection

In order to reduce traffic accidents and to secure a smooth traffic movement on the arterial city roads, it is recommended to improve traffic management at the following intersections:

Location of Intersections	Improvement of Intersections and Traffic Management
- Intersection at Maitighar (Beginning of Arniko H'way)	Installation of traffic signals with minor improvement
- Tripureswar near National Stadium	Installation of traffic signals with minor improvement
- Intersection at Koteswor (Arniko H'way with Ring Road)	Improvement of intersection shape to the roundabout intersection

APPENDIX

APPENDICES

Appendix 4.2.1 Description of Detailed Geological Conditions

(1) General

A comparative study of the borehole logs shows that the soil in the bridge sites at Koteswor and Kuleswor show similar sequences of deposition and the predominating soil type in these sites is very soft to firm lacustrine deposit of high capacity clayey silt capped with about 1.5 m to 6.5 m thick coarse to medium sand of medium relative density. The clay layer below the sand at the top extends right down up to investigated depth of 40 m and contain seams of silty fine sands at places. On the other hand the soils at Thapathali and Chakupat are of two types and consist mainly of dark grey soft to stiff clayey silt of high plasticity and coarse to medium sand of medium to dense compactness deposited in alternate layers.

A detail description of soil encountered in bore holes is presented below. The cross sections of bridge sites showing subsoil strata presented in Fig. A4.2.1 to Fig. A4.2.4 provide better picture of stratification. To get the general idea of soil of Kathmandu valley, Fig. A 4.2.5 is presented.

Kuleswor

In this site the soil at the top is 1.5 m (right bank) to 3.00 m (left bank) thick deposit of light grey fine to coarse loose sand and fine gravel. Underlying this layer of sand and gravel, the soil upto the investigated depth of 40 m is a deposit of highly plasticity clayey silt of dark grey colour. (Fig. A4.2.1).

Thapathali

The sub-surface soil at this site consists of alternate layers of clayey silt and sand of varying density and thickness. Six different layers are seen. Thickness of individual layers varies from 2 m to 12 m.

At the top most part both the bore holes show the presence of yellow brown fine to medium dense fine to coarse sand. The right bank borehole shows presence of some gravel in the sand. The thickness is 2.5 - 5.0 m.

Further down, the sand is underlain by a 9-18m thickness of dark grey firm to stiff clayey silt of high plasticity. The thickness in the right bank is twice as much as in the left bank.

The layer of clayey silt is underlain further by 2-8.5m thickness of dark grey medium to coarse sand. This layer is also relatively thick, about 2 m in the left bank while it is about 8.5 m in the right bank. Underlying the sand is again the dark grey to light black stiff to very stiff clayey silt of high plasticity. This layer is about 3 m thick in the right bank while it is about 7 m in the left bank.

The clay layer is again underlain by light yellow brown to dark grey medium dense to dense fine to coarse sand which extends down in the right bank from EL. 1251 to EL.

1242 (depth of exploration) whereas in the left bank this sand layer of about 6 m thickness is underlain by more than 17 m thickness of dark grey firm to stiff clayey silt of high plasticity. This clayey silty layer was not encountered in the right bank within the drilled depth.

The soil profile in Fig. A4.2.2 has been prepared by interpolating the logs of the two boreholes located much apart. Given the variation in the thickness of individual of the alternating strata it can not be excluded that some of the layers are in the form of lenses.

Chakupat

In this site also the soil conditions between the left and right bank of the river differ in terms of depositional sequence. (Fig. A4.2.3). In left bank the soil at the top 2.0 m is a mixture of very loose sand and gravel. Below this layer up to a depth of 12 m the soil is a grey soft to firm highly plasticity clayey silt. Following this layer, a layer of light grey coarse to medium sand of medium to dense compactness extends to a depth of 20 m. Up to the investigated depth of 40 m the layer below 20 m is again a layer of dark grey soft to firm highly plastic clayey silt.

The soil at the right bank, on the other hand, right from the surface up to the depth of about 38 m is dark grey soft to firm, highly plastic clayey silt followed by a layer of dark grey medium to coarse sand. Explored thickness of this sand layer is 2 m which obviously may continue beyond the drilled depth.

Koteswor

The soil at this site on both banks of the river are quite similar both in terms of depth and extent (Fig. A4.2.4). The soil encountered at top 6.5 m to 7.0 m in both of the bore holes is light grey medium to fine sand of loose to medium compactness. The soil underlying the to sand layer in both of the bore holes is dark grey soft to firm high plasticity clayey silt.

Table A.4.2.1 Test Result Summary Sheet of Bridge Sites

Bridge No. 1 — Location : Kuleshwor

Sample Type	B. H. No.	Depth m	Percentage Gravel	Sand	Silt	Clay	LL %	PL %	PI %	NMC %	Bulk Density gm/cm3	Speficif Gravity gm/cm3	SPT Value N	Qu kg/cm2	Consolidation mv cm2/kg	Remarks
DS	Right	8	-	4	84	12	96.75	61.18	35.57	86.03	-	2.52	5			
DS	Bank	12	-	3	82.5	14.5	95.20	63.39	31.81	86.20	-	2.63	5			
UD	(1)	7	-	3	91	6	85.30	59.78	25.52	86.90	-	2.46	-			
UD		13	-	2.5	93.5	4	85.20	43.79	41.41	79.43	-	2.43	-			
DS	Left	4	-	2	75	23	83.40	45.35	38.05	72.00	-	2.49	5			
DS	Bank	14	-	5	76	19	70.40	47.22	23.18	70.07	-	2.53	5			
UD	(2)	5	-	5	72	23	82.70	55.19	27.51	63.19	1.50	2.43	-	0.55		
UD		9	-	7	79	24	83.75	43.08	40.67	78.13	1.83	2.59	-	0.65	0.0251	

Table A.4.2.2 Test Result Summary Sheet of Bridge Sites

Bridge No. 2 — Location : Thapathali

Sample Type	B. H. No.	Depth m	Percentage Gravel	Sand	Silt	Clay	LL %	PL %	PI %	NMC %	Bulk Density gm/cm3	Speficif Gravity gm/cm3	SPT Value N	Qu kg/cm2	Consolidation mv cm2/kg	Remarks
DS	Right	4	-	6	78.0	16.0	89.5	69.09	20.14	73.63	-	2.56	15			
DS	Bank	12	-	10	66.0	24.0	95.0	65.68	29.32	70.13	-	2.65	16			
UD	(1)	17	-	7	84.0	9.0	103.2	65.52	37.68	77.10	1.43	2.49	-	1.63	0.0201	
UD		10	-	7	80.5	12.5	100.7	60.18	40.52	79.45	1.41	2.63	15	1.32	0.0195	
DS	Left	8	-	10.5	69	20.5	102.3	57.29	45.01	95.09	-	2.66	13			
DS	Bank	11	36.8	62.0	2	1.8	-	-	-	30.71	-	2.66	-			
UD	(2)	9	-	8.0	80	12.0	78.2	38.78	39.42	55.95	-	2.56	-			
UD		28	-	5.0	77	18.0	92.2	64.33	27.67	77.63	1.54	2.46	12	1.34	0.0212	

Table A.4.2.3 **Test Result Summary Sheet of Bridge Sites**

Bridge No. 3

Location : Chakupat

Sample Type	B. H. No.	Depth m	Percentage							NMC %	Bulk Density gm/cm3	Speficif Gravity gm/cm3	SPT Value N	Qu kg/cm2	Consolidation mv cm2/kg	Remarks
			Gravel	Sand	Silt	Clay	LL %	PL %	PI %							
DS	Right	4	-	3	74	23	65.75	46.13	19.62	44.96	-	2.65	5			
DS	Bank	8	-	8	66.5	25.5	66.55	43.02	23.53	46.86	-	2.65	8			
UD	(1)	5	-	5	76	19	68.95	44.22	24.73	87.21	1.54	2.49	-	1.05		
UD		10	-	5	81	14	107.15	58.53	48.62	94.21	1.41	2.38	12	1.21	0.0232	
DS	Left	4	-	17	59	24	64.75	46.68	18.07	55.94	-	2.56	7			
DS	Bank	8	-	5	78	17	90.50	54.18	36.32	100.90	-	2.66	7			
UD	(2)	6	-	3	70	27	66.90	43.89	23.01	68.57	-	2.56	2			
UD		11	-	12	78	10	64.00	46.11	17.90	87.18	-	2.53	-			

Table A.4.2.4 **Test Result Summary Sheet of Bridge Sites**

Bridge No. 4

Location : Koteshwor

Sample Type	B. H. No.	Depth m	Percentage							NMC %	Bulk Density gm/cm3	Speficif Gravity gm/cm3	SPT Value N	Qu kg/cm2	Consolidation mv cm2/kg	Remarks
			Gravel	Sand	Silt	Clay	LL %	PL %	PI %							
DS	Right	4	35	61.5	3.5	-	-	-	-	16.28	-	2.62	17			
DS	Bank	10	-	7	78.5	14.5	90.8	57.57	33.23	92.71	-	2.46	7			
UD	(1)	7.5	-	5	87.0	8.0	90.0	55.77	34.23	88.67	1.46	2.49	-	0.84	0.0252	
UD		13	-	5	92.5	2.5	98.1	61.35	36.75	80.67	1.45	2.43	-	0.76	0.0231	
DS	Left	4	17	80	3	-	-	-	-	15.11	-	2.66	17			
DS	Bank	14	-	6	78	16	98.0	59.93	38.07	92.46	-	2.59	7			
UD	(2)	9	-	5	83	12	81.0	58.21	22.79	78.22	-	2.49	-			
UD		13	-	7	81	12	96.9	57.38	39.52	86.36	-	2.52	-			

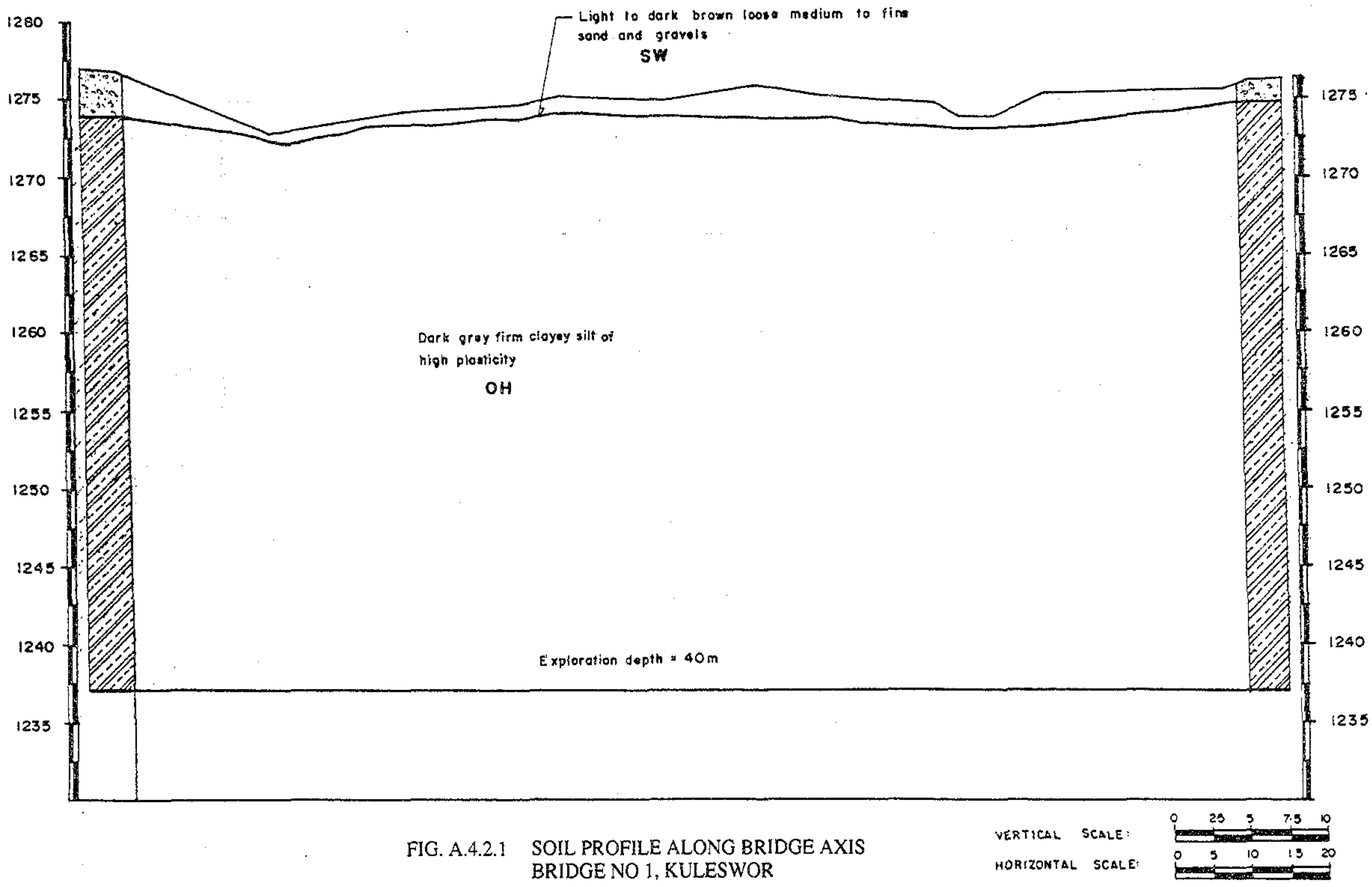


FIG. A.4.2.1 SOIL PROFILE ALONG BRIDGE AXIS BRIDGE NO 1, KULESWOR

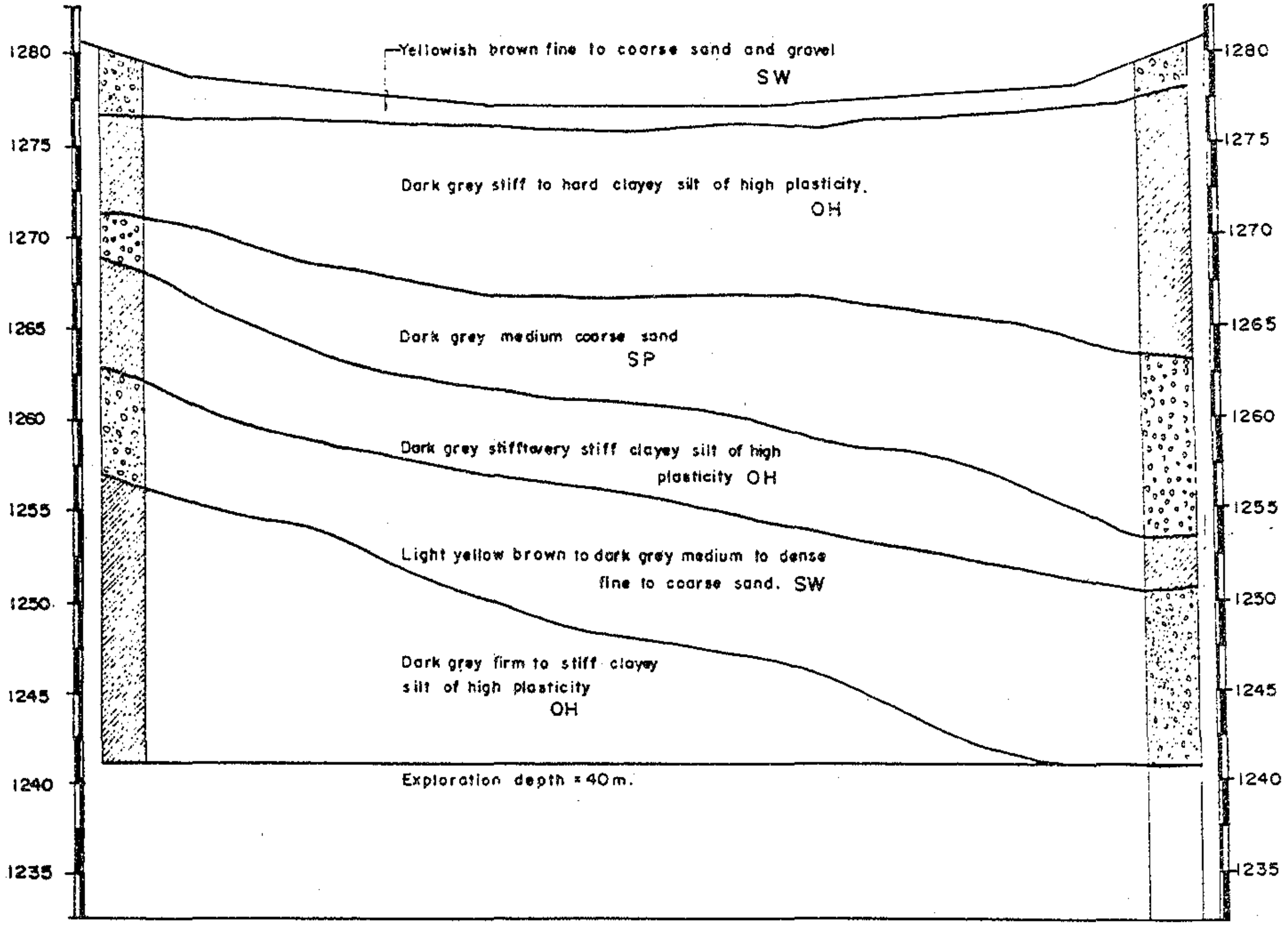
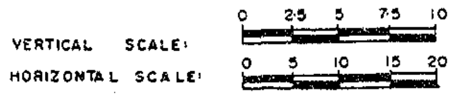


FIG. A.4.2.2 PROFILE ALONG BRIDGE AXIS
BRIDGE NO 2, THAPATHALI



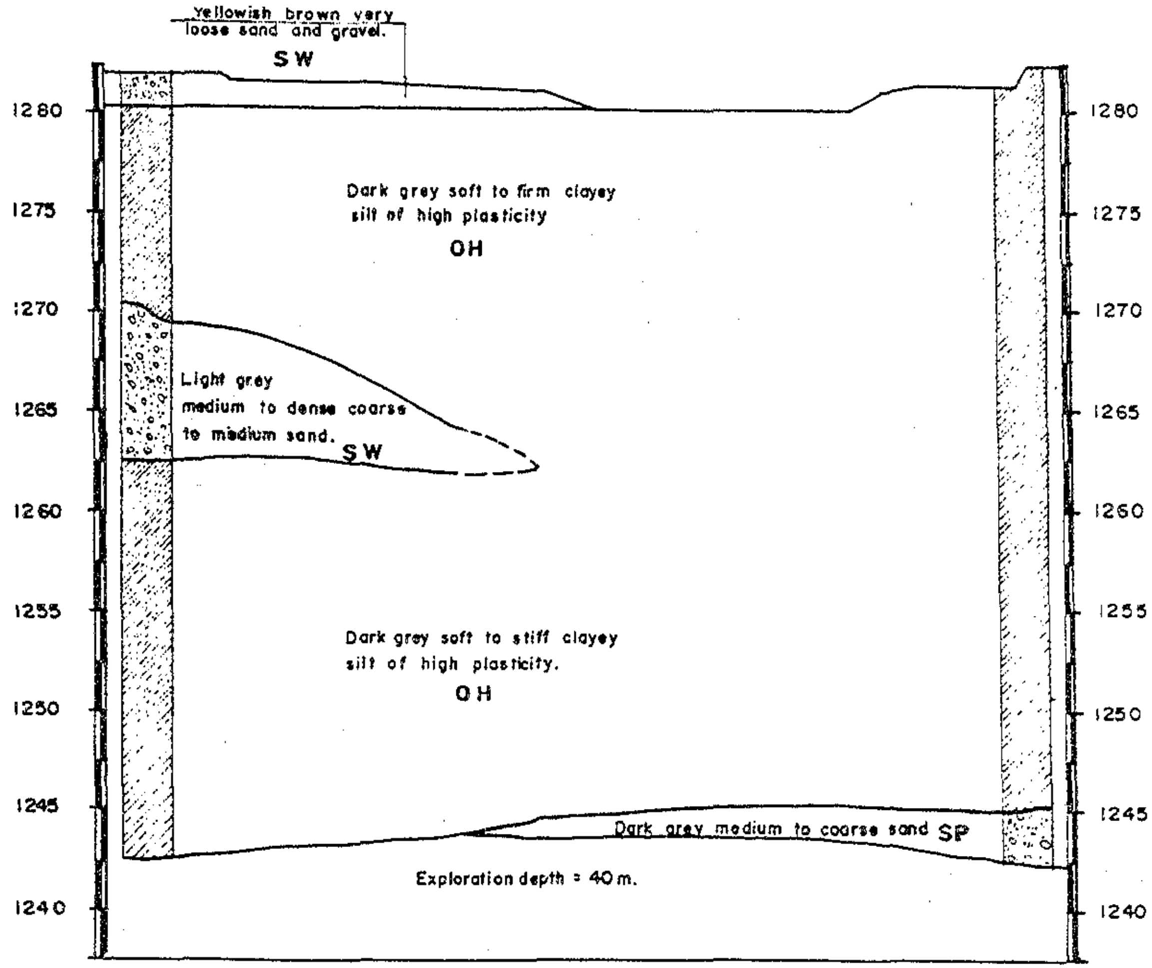
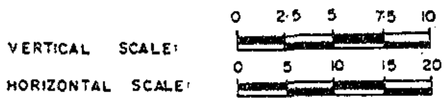


FIG. A.4.2.3 SOIL PROFILE ALONG BRIDGE AXIS
BRIDGE NO 3, CHAKUPAT



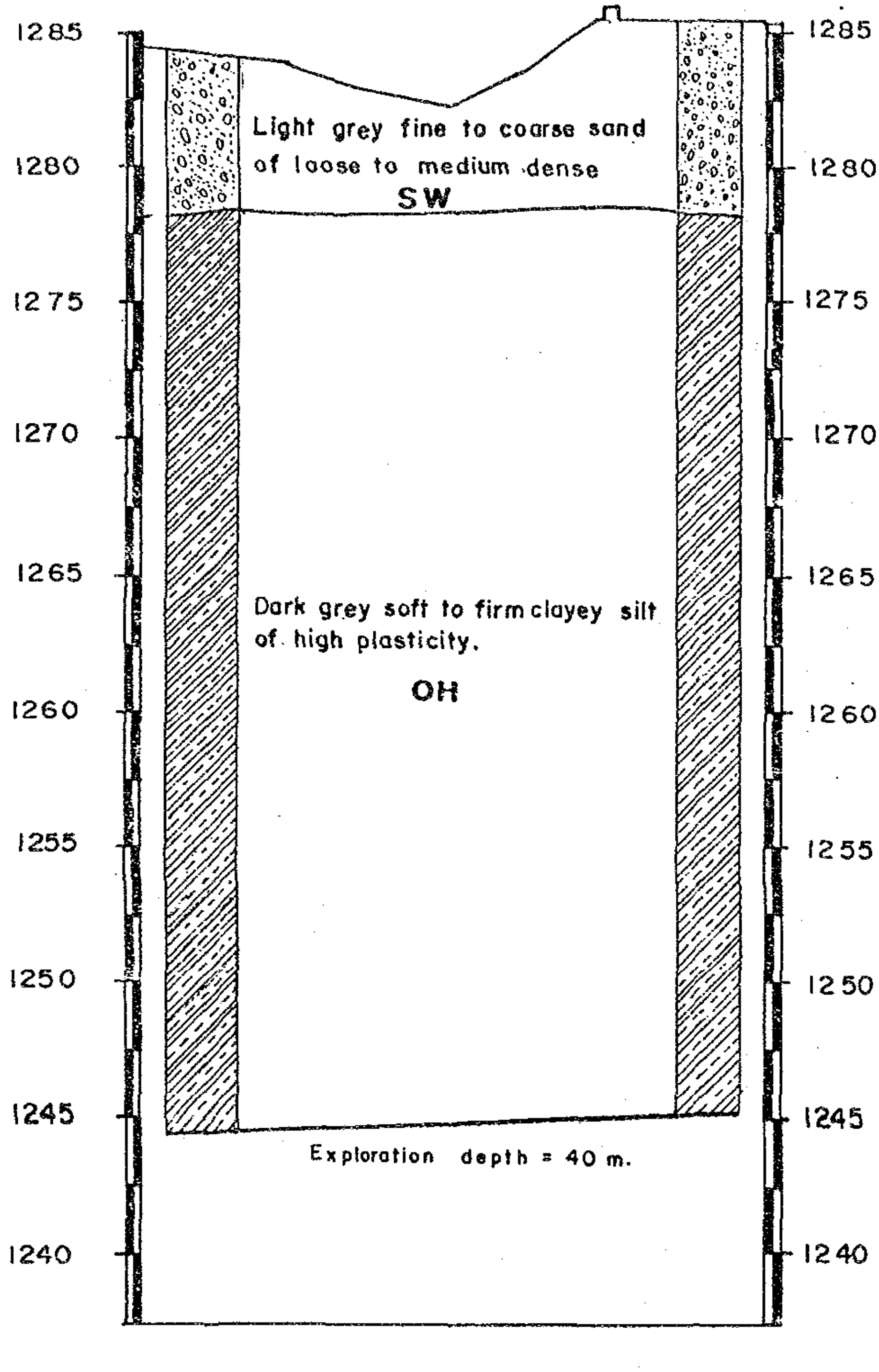


FIG. A.4.2.4 SOIL PROFILE ALONG BRIDGE AXIS
BRIDGE NO 4, KOTESWOR

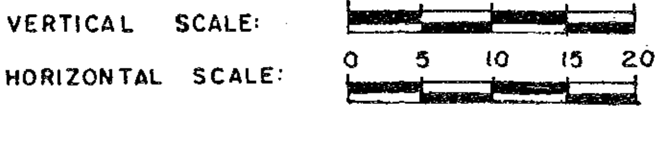


TABLE A.4.2 5 FIELD DENSITY TEST

Road Pits	RP1	RP2	RP3	RP4	RP5	RP6	RP7	RP8	RP9	RP10	RP11
Field Density gm/cm^3	1.79	1.58	1.76	1.59	1.77	1.87	1.67	1.83	1.87	1.69	1.87

TABLE A. 4.2.6 LOCATIONS OF DCPT AND NUMBER OF BLOWS TO PENETRATE 80cm

Location	CP1	CP2	CP3	CP4	CP5	CP6	CP7	CP8	CP9	CP10	CP11
No of blows	10	12	6	15	17	17	12	15	22	13	25
Location	CP12	CP13	CP14	CP15	CP16	CP17	CP18	CP19	CP20	CP21	CP22
No of blows	1	8	7	7	20	22	8	16	9	11	32

TABLE A.4.2.7 CBR VALUE COMPUTED FROM GRAPH

Location	CP2	CP4	CP8	CP10	CP11	CP13	CP14	CP17	CP18	CP20	CP21
CBR (Correle-ted)	5.0	7.4	7.8	5.4	7.0	4	3.4	10.4	4.0	4.6	12

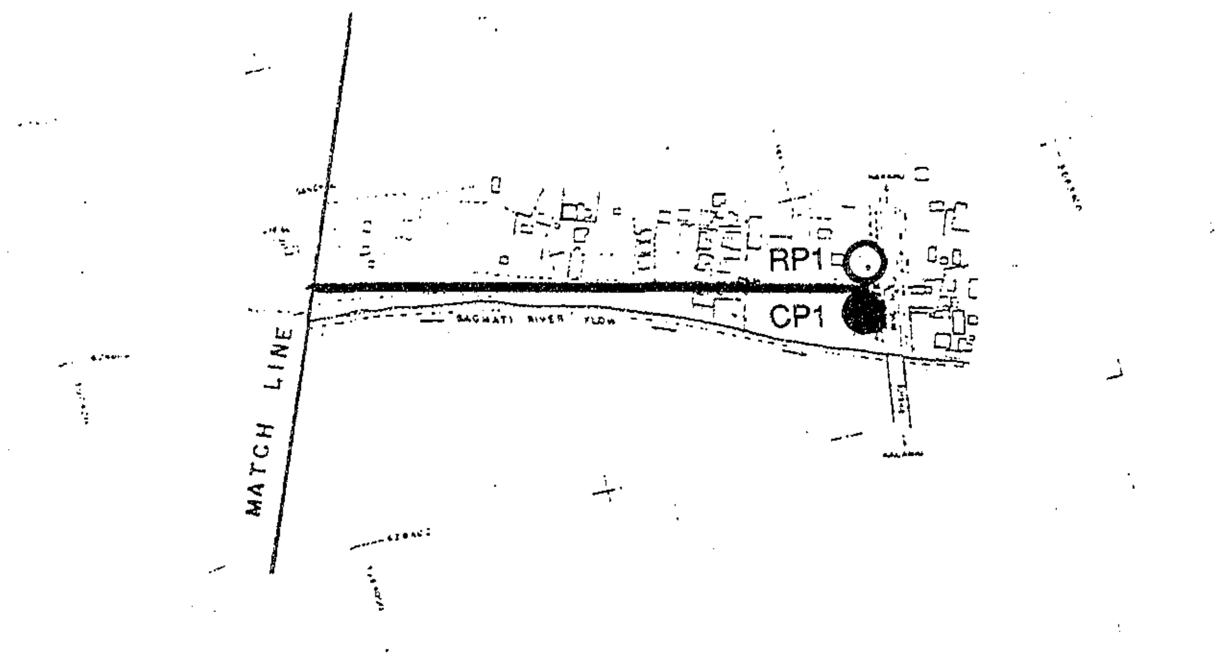
Appendix 4.2.2 Description of Subgrade

In total eleven test pits (RP) along the proposed road were excavated at an interval of 1 km. to assess their properties. Samples from those pits were collected from different depths. General description of soil strata upto 1 m for all eleven road pits (RP) are presented in following table.

Pit No	Depth (cm)	Description of soil
RP1	0-0.15 cm	Light grey silty clay with few fine sand
	0.15-0.35	Light grey clayey sandy silt with some gravels
	0.35-1.0 m	Light brown micacious silty fine sand with gravels & traces of boulders
RP2	0.0-0.25	Grey to light brown silty clay with some fine sand
	0.25-0.50	Light brown micacious silty clay with fine sand
	0.50-1.0	Light brown sandy clayey silt with traces of gravel
RP3	0.0-0.25	Grey micacious silty clay with fine sand
	0.25-1.0	Light grey micacious sandy silt with gravels and clay
RP4	0.0-0.10	Dark grey silty clay with few micacious sand
	0.10-1.0	Brown sandy silt with gravels & clay
RP5	0.0-0.15cm	Light brown micacious silty clay with some sand
	0.15-0.45	Light grey sandy silt with some gravels & traces of clay
	0.45-0.55	Light brown micacious medium to fine sand
	0.55-1.0m	Grey & brown colour mixed silty clay with few micacious sand
RP6	0.0-0.25cm	Light grey micacious silty fine sand with traces of clay
	0.25-0.45cm	Light grey silty sand with clayey gravels
	0.45-1.0m	Light grey to white micacious medium to coarse sand with some gravels
RP7	0.0-0.25cm	Light grey to brown micacious silty fine sand with clay
	0.25-0.60	Dark grey micacious sandy silt with clay and gravels
	0.60-1.0	Light brown micacious fine sand
RP8	0.0-0.20	Dark grey silty clay
	0.20-0.50	Dark grey sandy silt with clay & gravels
	0.50-1.0	Light grey to brown micacious silty medium to fine sand
RP9	0.0-0.20	Dark grey silty clay
	0.20-0.60	Dark grey sandy silt with traces of gravel & clay
	0.60-1.0	Light grey micacious silty medium to coarse sand
RP10	0.0-0.10	Light grey fine micacious silty clay with fine sand
	0.10-1.0	Light grey silty sand with traces of clayey gravels
RP11	0.0-0.15	Dark grey silty clay
	0.15-1.0	Light grey to brown sandy silt

Table A.4.2.8 **Test Result Summary Sheet of Road Pits**

S. N.	Road Pit No.	Depth	Description of Soil	Percentage of Gravel	Sand	Silt	Clay	Atterberg Limits LL %	PL %	PI %	NMC %	Bulk Density gm/cm3	Specific Gravity gm/cm3	Compact %	CBR
1.	RP1	0.30	Light Gray Clayey Sandy Silt with some Gravels	7.20	24.68	62.62	5.50	37.25			33.63	1.79	2.66	101.0	4.93
2.	RP2	0.80	Light Brown Sandy Clayey Silt with Traces of Gravels	1.18	22.00	70.32	6.50	28.20			25.68	1.58	2.59	101.5	3.04
3.	RP3	0.80	Light Grey Micacious Sandy Silt with Gravels and Clay	5.20	42.24	50.76	1.80	29.00			25.00	1.76	2.52	101.6	12.18
4.	RP4	0.25	Brown Sandy Silt with Gravels and Clay	9.48	25.40	58.12	7.00	43.65	27.95	16.7	40.00	1.59	2.66	98.0	8.89
5.	RP5	0.25	Light Grey Sandy Silt with Gravels and Traces of Clay	19.23	25.00	53.27	2.50	33.80			30.33	1.77	2.55	95.0	7.22
6.	RP6	0.25	Light Grey Silty Sand with Clay and Gravels	0.95	78.16	18.21	2.68	33.75			4.94	1.87	2.73	96.4	12.99
7.	RP7	0.45	Dark Grey Micacious Sandy Silt with Clay and Gravels	1.07	28.70	60.77	10.00	31.35			12.14	1.67	2.731	99.6	5.07
8.	RP8	0.40	Dark Grey Sandy Silt with Clay and Gravels	2.97	20.16	69.37	7.50	35.08			13.26	1.83	2.69	97.47	3.05
9.	RP9	0.50	Dark Grey Sandy Silt with Traces of Clay and Gravels and Clay	4.23	44.37	48.4	3.00	22.30			12.32	1.87	2.63	96.2	8.96
10.	RP10	0.70	Light Grey Silty Sand with Traces of Clay and Gravels and clay	0.30	60.03	38.07	1.60				25.38		2.55	97.25	8.5
11.	RP11	0.75	Light Grey to Brown Sandy Silt	11.30	65.15	19.75	3.80				13.84	1.87	2.73	100	14.98



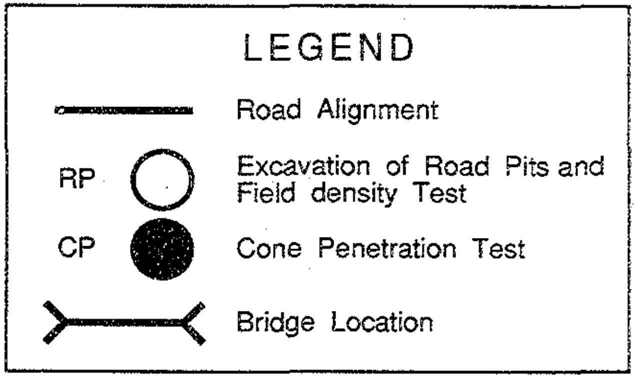
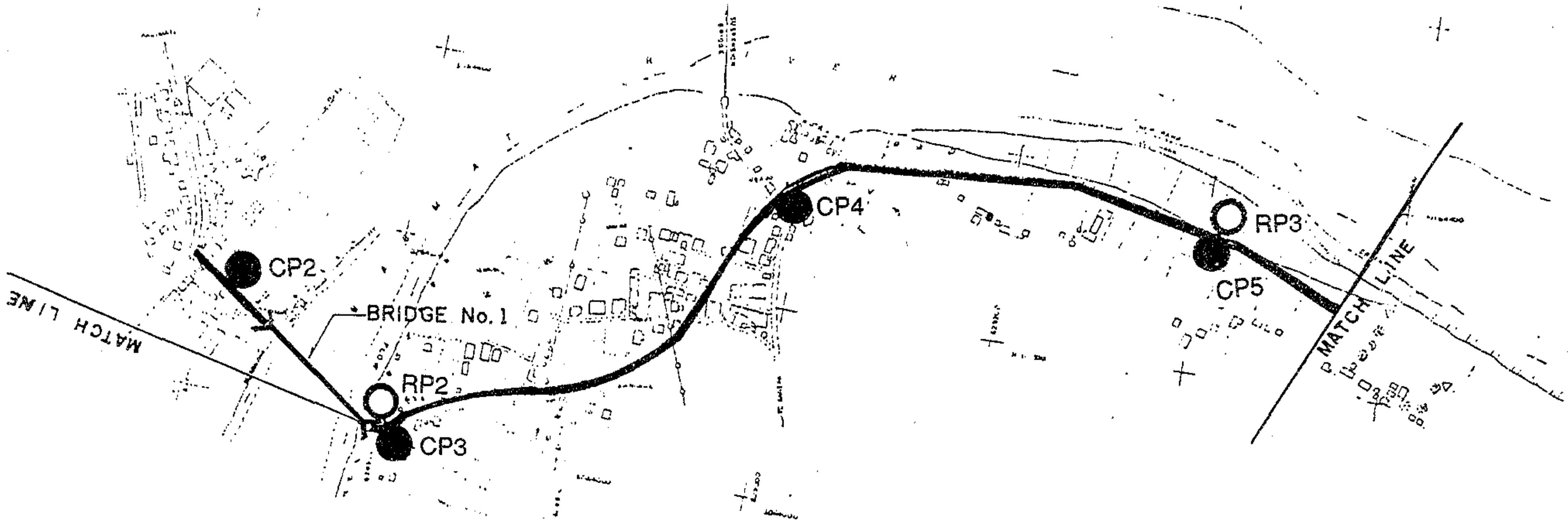


FIGURE A 4.2.1 LOCATION OF ROAD PITS (1/8)



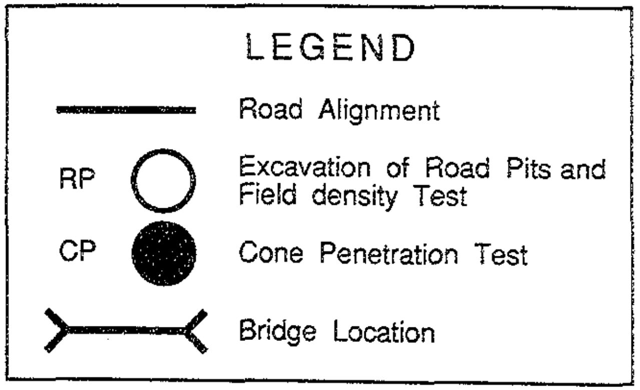


FIGURE A 4.2.1 LOCATION OF ROAD PITS (2/8)

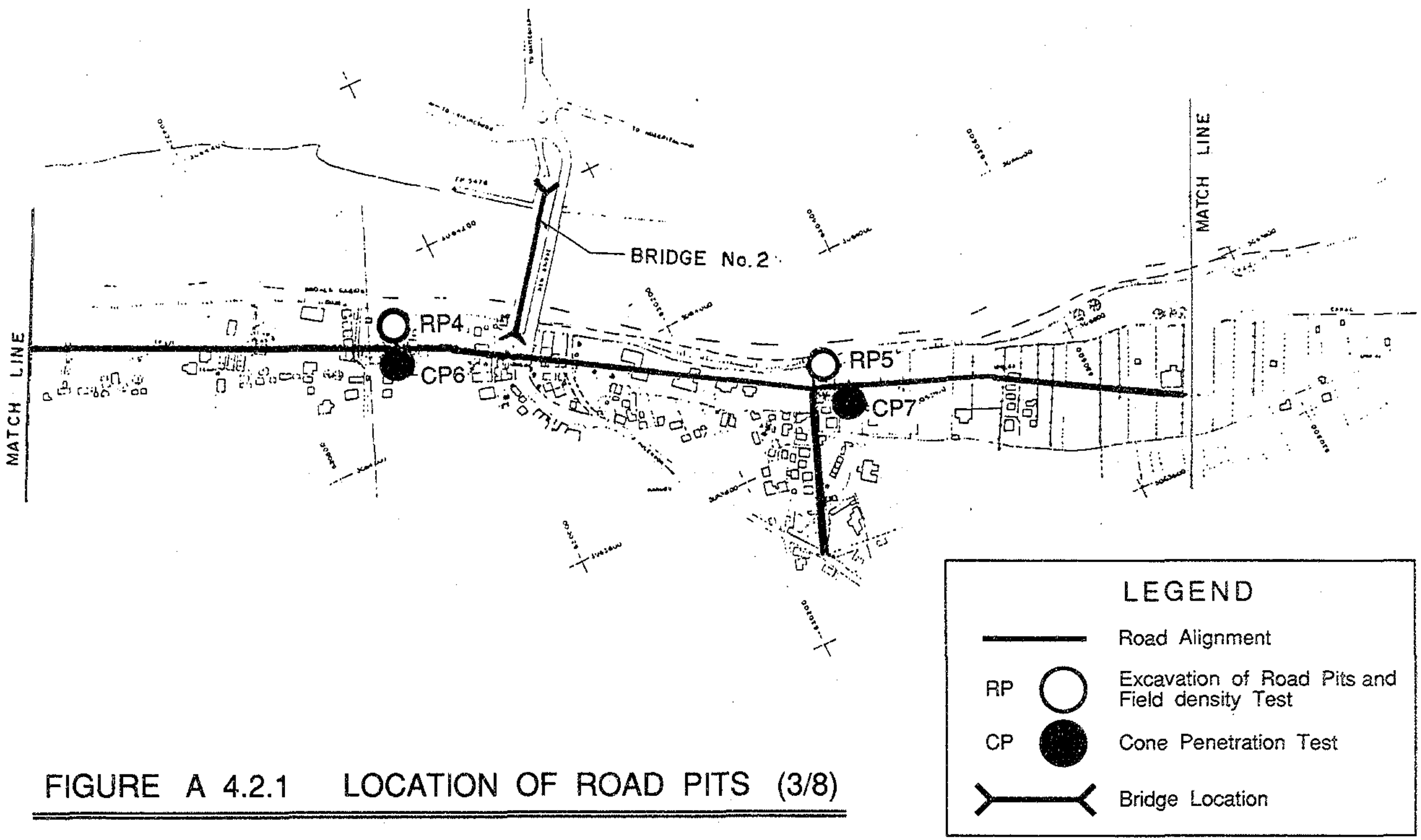


FIGURE A 4.2.1 LOCATION OF ROAD PITS (3/8)

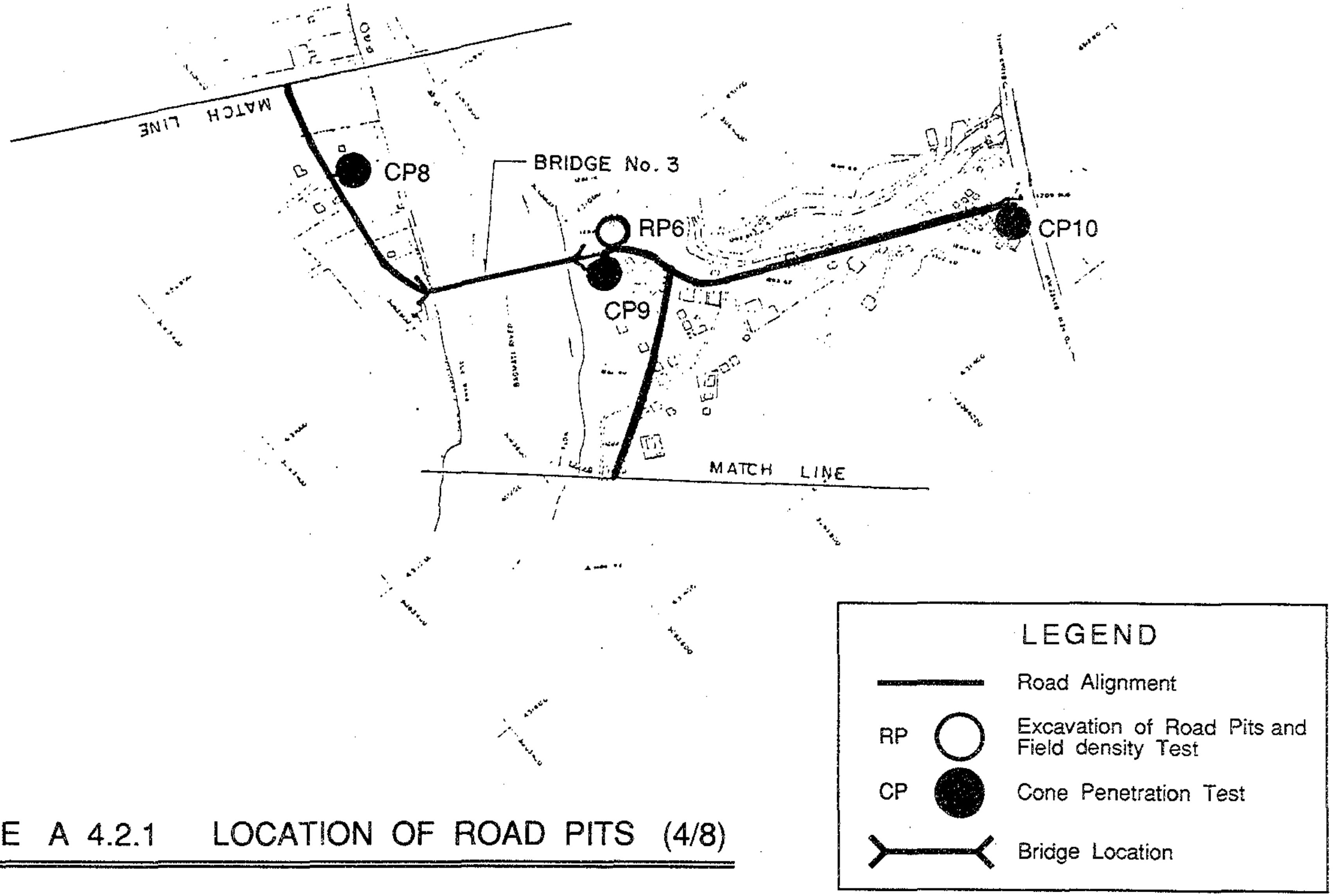
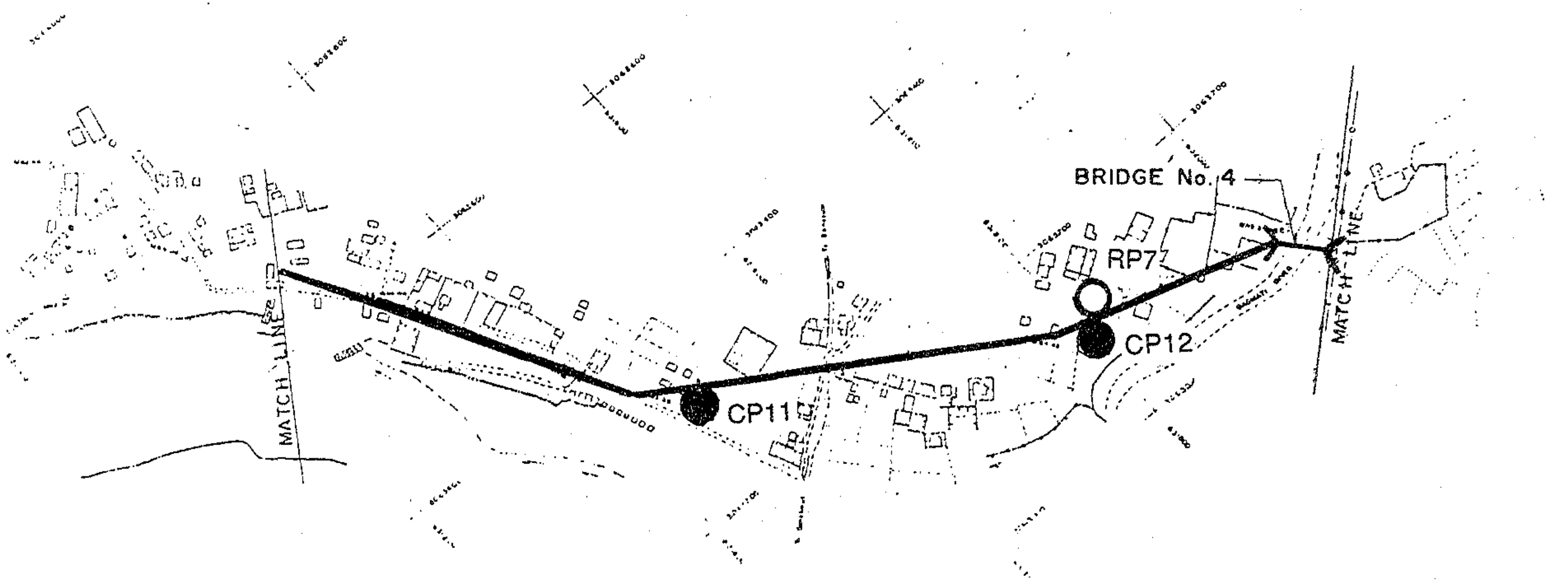


FIGURE A 4.2.1 LOCATION OF ROAD PITS (4/8)



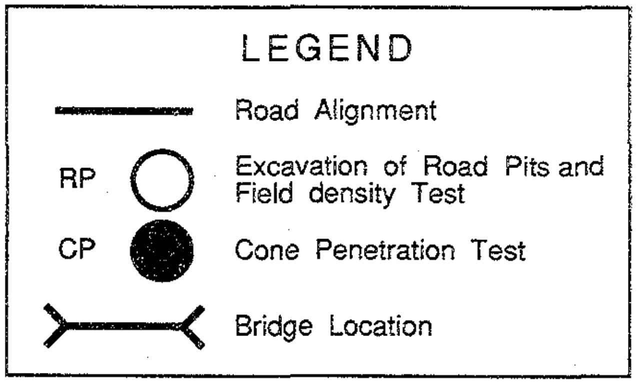


FIGURE A 4.2.1 LOCATION OF ROAD PITS (5/8)

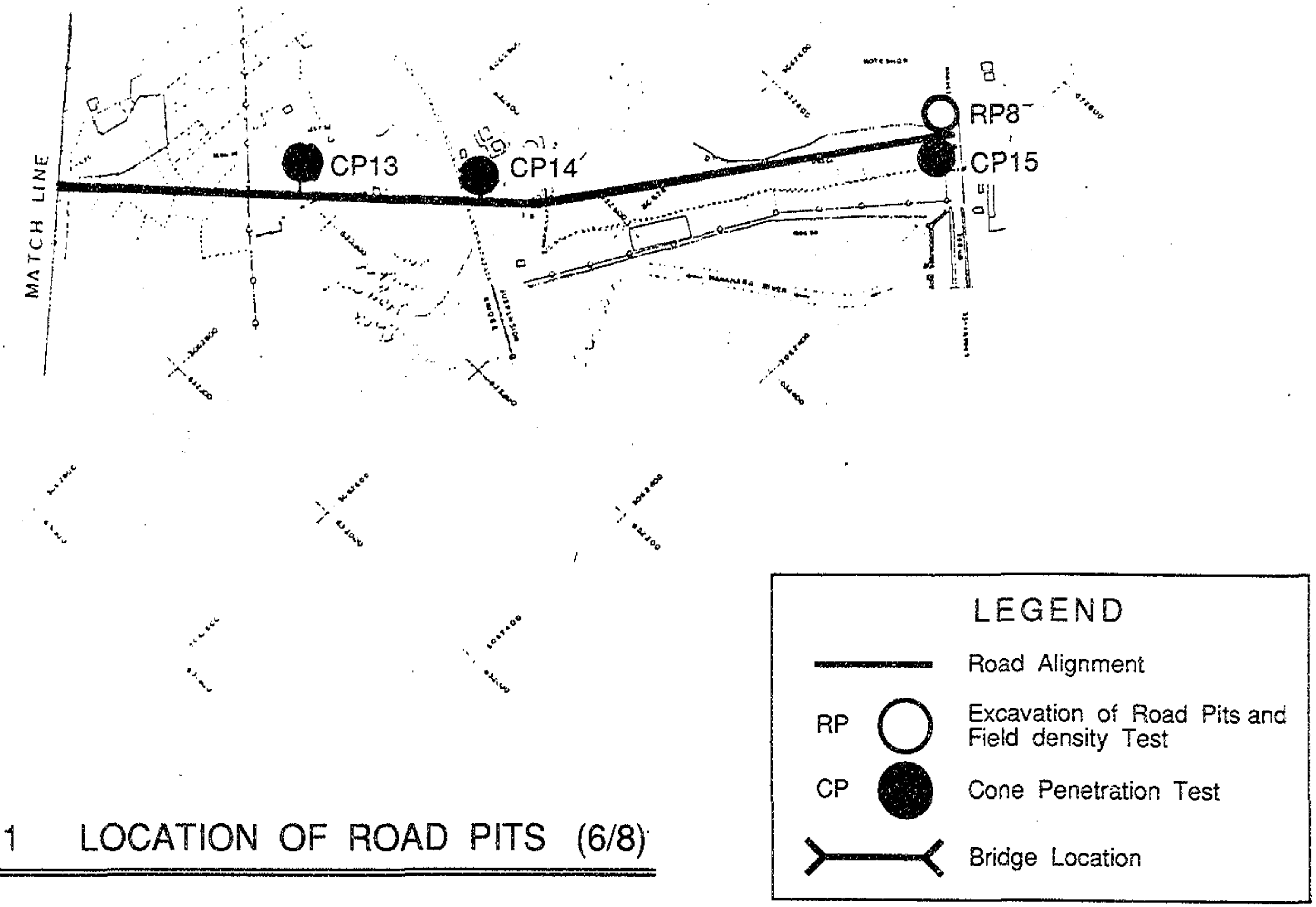


FIGURE A 4.2.1 LOCATION OF ROAD PITS (6/8)

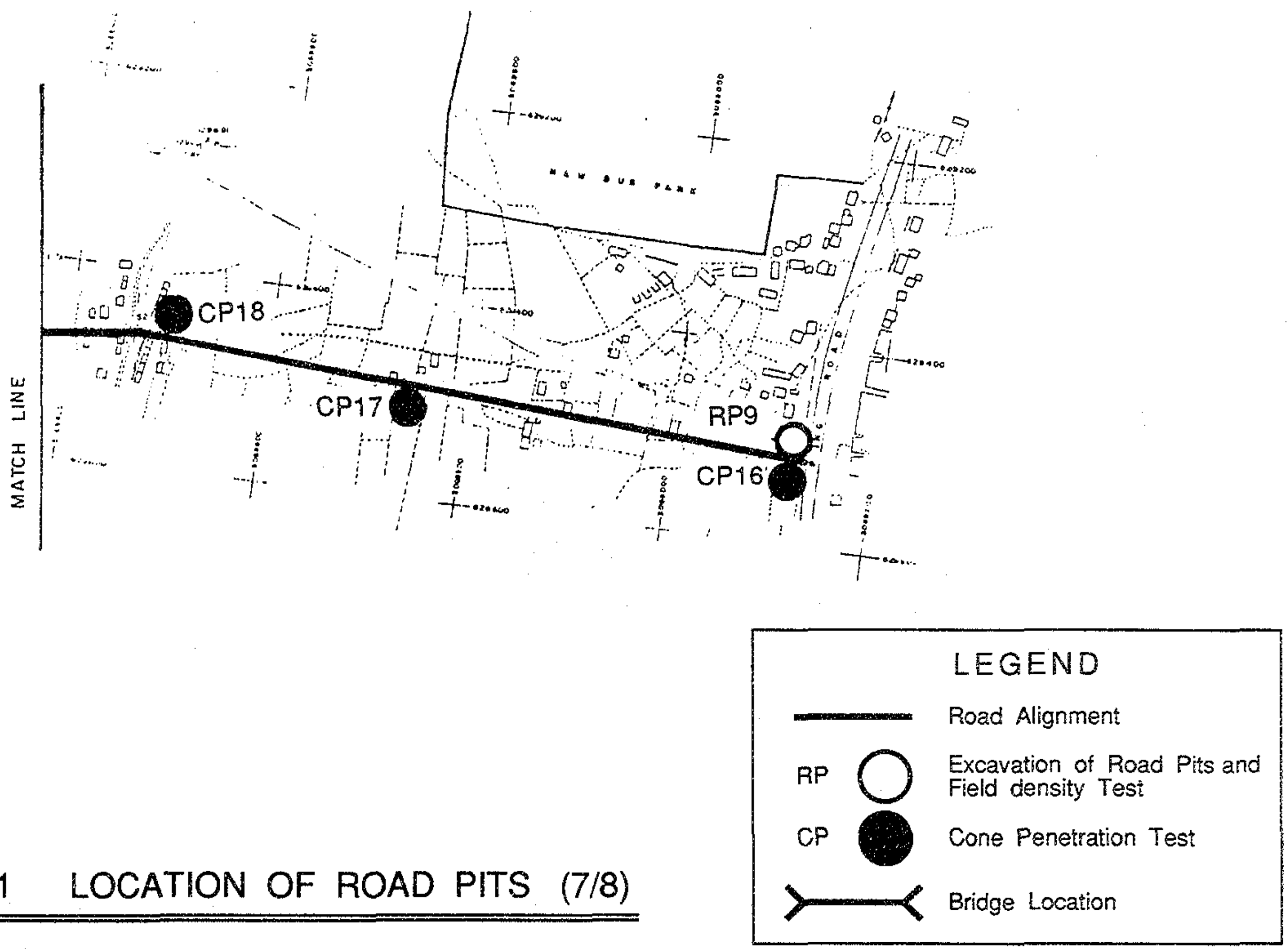


FIGURE A 4.2.1 LOCATION OF ROAD PITS (7/8)

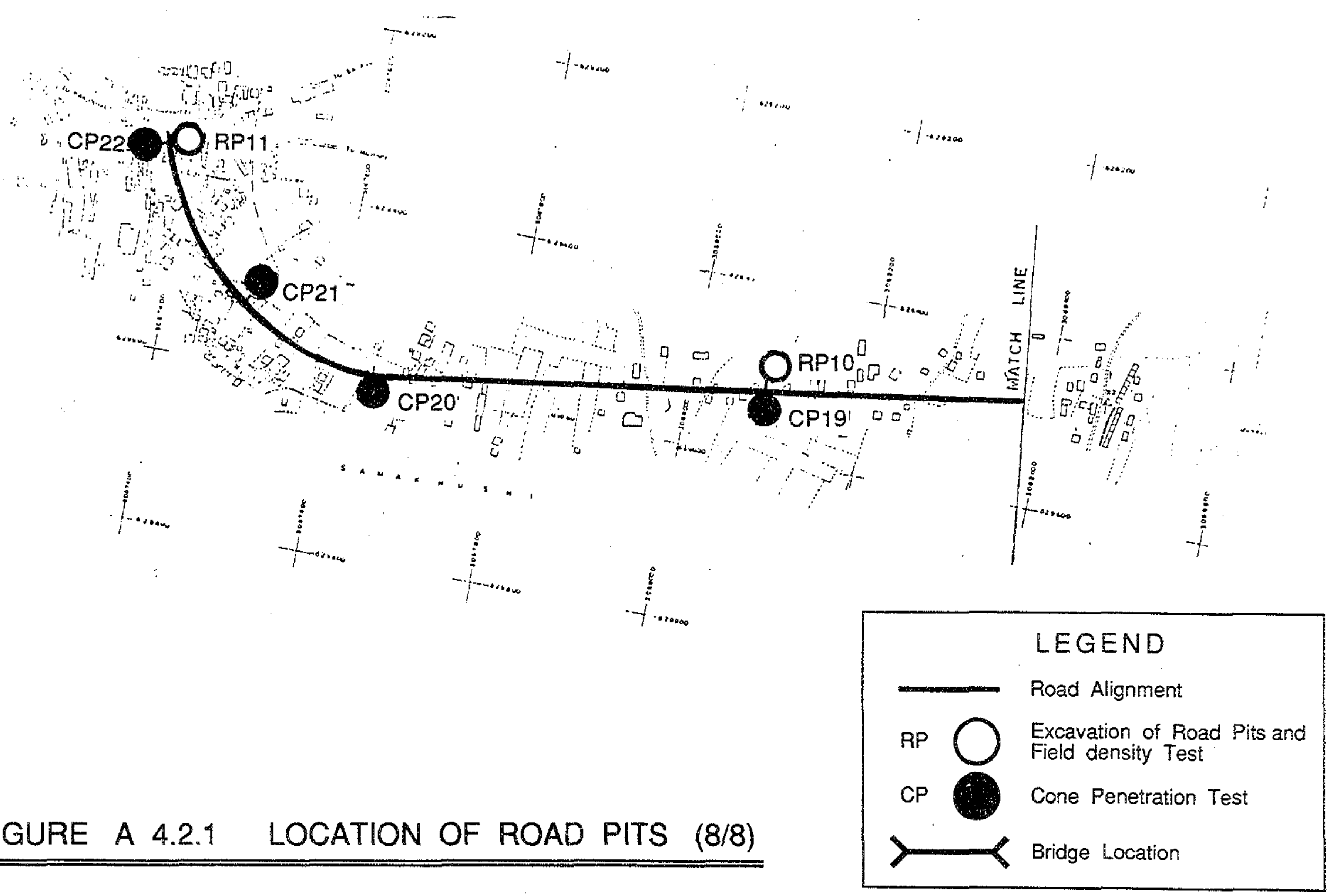


FIGURE A 4.2.1 LOCATION OF ROAD PITS (8/8)

Appendix 4.2.3 Description of Construction Materials

(1) Borrow Pits of Soils

Three sites were identified for the borrow pits of soil (subgrade materials). They were: Thimi, Gokarna Ban and Kapan:

Thimi borrow pit

Thimi borrow pit is located along the Kathmandu-Bhaktapur road. The quarry site is in the form of hillock approximately 15-20m high from sorrounding ground level. Huge quantity of soil were already exavated from that part as a filling material for construction of building complexes.

Two samples were collected from that borrow pit, one from 3 m high from ground level and another from the toe of the hillock. Both the samples were similar and according to visual classification they were classified as light grey to grey sandy silt with some clay.

It is estimated that around 15,00,000 m^3 of soil can be excavated from that area.

Gokarna Ban

The site lies just opposite of Gokarna Safari Park along Kathmandu-Sankhu road. One sample was collected from there. The soil was classified as dark grey clayey silt with medium to fine sand.

The site is accessable throughout the year and the estimated quantity which could be borrowed from there is approximately 20,00,000 m^3.

Kapan

The site is located one kilometer north from the Mahankal Chaur. At present the borrow pit is being used for extraction of sands, which is underlain by 3-5m thick soil. The soil is classified as light grey silty sand with traces of gravels. It is estimated that approximately 50,000 m^3 of soil can be borrowed from there.

(2) Borrow Pit for Gravels

Two samples of gravels were collected from chunnikhel, which is located 4 kilometer south from Nakkhu. The samples collected were dark brown sandy gravels. The estimated quantity of gravels, which can be extracted from there is approximately 1,00,000 m^3 to 2,00,000 m^3.

(3) Borrow Pit of Sands

Three sites namely Pikhel, Kapan and Basundhara were identified for quariying of sands. Two samples were extracted from each site. Brief description of site and visual classification of sands are presented below.

Pikhel

The site is situated 4 km north from Bhaktapur, Unlike in other borrow pit areas, the sands at Pikhel is being extracted by digging holes. The sand of the area is of very good quality containing less then 1% of silt. Samples were extracted from two holes. The samples collected are classified as white micacious medium to fine sand. Available quantity is estimated to be around 1,00,000 m^3 (Deposit unlimited)

Kapan

Sands were extracted from the same area, from where the soil sample was collected. Two samples; one from the lower part and another from the top was extracted for assessment of their basic properties. The sands which were available were light grey white micaceous gravelly sand with traces of silt. The estimated quantity of sand, which could be extracted from there is 1,00,000 m^3 and further extension of 1,00,000 m^3 is possible.

Basundhara

The site is located close to the Ring Road near Marajganj. Two samples were collected from there, which were similar and are classified as light grey to white micaceous sand with gravels and traces of silt. Approximately from 50,000 m^3 of sand can be extracted from that borrow area. Further extension of 1,00,000 m^3 is possible.

(4) Borrow Pits for Crushed Stone

Three sites were identified for borrow areas of crushed stones. They were:

- Godavari Marble Industries, Godavari
- Thankot crushing plants, Thankot
- Purna Roda Dhunga Udyog, Jhalungtar

Brief description about the sites and their daily capacity is given below.

Godavari Marble Industries, Godavari

The crushing plant is located 12 km south from Kathmandu. The plant produces mainly two sizes of stones; from 12.5 mm to 19.05 mm and from 19.05 mm to 50 mm. The capacity of plant in average is 60 m^3 per day.

Thankot crushing plant

In Thankot areas, there are seven crushing plant. Sources of stone quarry for all the plants is Mahadev Besi. The sizes of aggregate which they produce is also same as from Godavari. Total capacity of all the plants is 40m3 per day.

Purna Road Dhunga Udyog

The Purna Roda Udyog is located near Bajrabarahi and is approximately 12 km south of Kathmandu. The sizes of aggregate which they produce is also from 12.50 mm to 40.00 mm and from 19.05 mm to 50.00 mm. The estimated capacity of plant is 50 m^3 per day.

Table A.4.2.9 Test Result Summary Sheet of Borrow Pits

Location	No.	Description of Soil	Percentage of				Atterberg Limits			NMC %	Bulk Density gm/cm3	Specific Gravity gm/cm3	Compact %	CBR
			Gravel	Sand	Silt	Clay	LL %	PL %	PI %					
Gokarna	2.	Dark Grey Clayey Silt Medium to Fine Sand	2.12	30.88	60.20	6.80				31.36	1.93	2.73	97.6	3.13
Thimi	1.	Grey Clayey Silt with Fine Sand		21.30	78.70					32.98	2	2.63	95.3	4.13
Thimi	2.	Light Grey Micacious Sandy Silt with Clay		16.77	81.18	3.05	38.95			21.98	1.87	2.69	102.4	4.5
Kapan	3.	Light Grey Silty Sand and Traces Gravels	9.46	63.47	25.07	2.00	25.45			18.84		2.66	97.6	6.73
Chunikhel	1.	Dark Brown Sandy Gravels	76.70	20.15	2.35	0.75				12.89	1.87	2.58	98.4	38.3
Chunikhel	2.	Dark Brown Sandy Gravels	77.80	19.25	2	0.95				14.99	1.59	2.62	98.75	45.33
Kapan	Upper	Light Grey to White Micacious Gravelly Sand	14.53	84.12	1.35					5.4	1.77	2.66		
Thankot	1.	Bluish Grey Fourty Down Gravels	100.00							0.435		2.67		
Thankot	2.	Blush Grey Fifty Down Gravels	100.00							0.1		2.71		
Godawari	1.	Redish Brown Fourty Down Gravels	100.00							0.24		2.64		
Godawari	2.	Radish Brown fifty Down Gravels	100.00							0.32		2.61		
Jhalungtar	1.	Light Brown Fourty Down Gravels	100.00							0.1		2.63		
Jhalungtar	2.	LIght Brown Fifty Down Gravels	100.00							0.2		2.73		

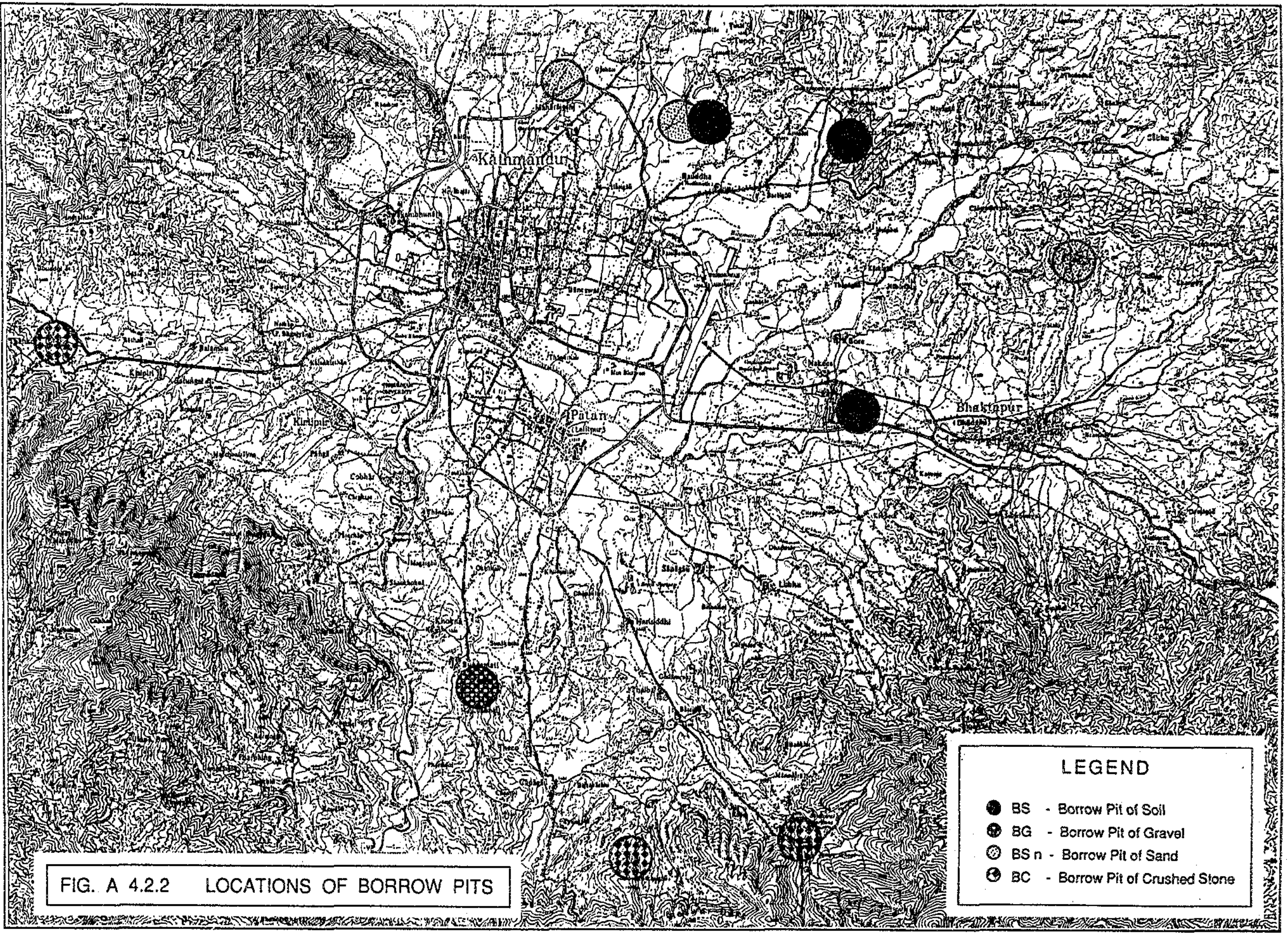


FIG. A 4.2.2 LOCATIONS OF BORROW PITS

Appendix 4.2.4 Pile Foundation Analysis

The foundation analysis was carried out for precast and driven and bored and cast-in-place piles. For both pile types analysed, the diameter assumed in case of bored and cast in place pile is 600 mm and in case of precast and driven pile, it has been assumed as 450 mm. At this stage when the actual load coming on foundation is not known, a tentative load of 1000 tons likely to be imposed on foundation soil from bridge super-structure and sub- structure, has been assumed in the analysis.

(1) Piles in clay

Piles in clay may fail individually or as a group. The capacity of the pile was computed considering both of the above cases and the minimum value obtained was taken as the capacity of the pile.

(a) Carrying Capacity of a Single Pile

The ultimate capacity for a single pile in clay was computed using the relation, as recommended by Simons and Menzies, 1974 (Ref. 2).

$$Q_u = A_s \cdot \alpha \cdot S_u + A_b.S_u.N_c \quad \text{---------} \quad E_q. (2.1)$$

Where,

Q_u	=	ultimate capacity of a single pile
A_s	=	Area of staff
α	=	adhesion factor
	=	0.8 for driven piles (assumed)
	=	0.45 for bore piles (assumed)
S_u	=	Shear strength at base
A_b	=	Area at base
N_c	=	bearing capacity factor

The total capacity of pile in a group on the basis of piles failing individually was computed as given in Tomlinson, 1967 (Ref. 3).

$$Q_g = n\ Q_s \quad \text{------------} \quad Eq. (2.2)$$

Where,

Q_g	=	carrying capacity of the pile group
n	=	number of piles
Q_s	=	carrying capacity of a single pile

(b) Carrying Capacity of Pile in a Group

The capacity of the pile foundation with the piles in group was computed by carrying out block analysis as suggested by Terzaghi and Peck (1967) (Ref. 1).

A pile spacing equal to the perimeter of the pile was used in the analysis. The recommended relationship which was utilised in the present analysis is

$$Q_g = \frac{\alpha S_u \, 2(L+B) \times D + N_c . S_b . \, L \times B}{3} \quad \text{Eq. (2.3)}$$

Where,

α	=	adhesion factor
S_u	=	average shear strength over the peripherial area of the group
S_b	=	shear strength at base
Q_g	=	carrying capacity of pile group
L	=	length of group
B	=	width of group
D	=	depth of pile

The minimum value obtained from Eq. (2.2) and Eq. (2.3) was taken as the capacity of group.

(c) Settlement of pile group

The settlement of a pile group in clay was computed using the relation proposed by Tomlinson, 1969 (Ref. 3).

$$\delta = 0.55 \, q_n \times m_v \times 1.5 \, B \quad \text{Eq. (2.4)}$$

Where,

δ	=	settlement of pile group
q_n	=	net increase in pressure
m_v	=	co-efficient of volume compressibility
B	=	width of foundation

The settlement of the pile groups was estimated on the assumption that the group behaves as a raft having dimensions in plan equal to the overall dimensions of the group plus the additional width given by the 1 in 4 spread of load. The base of the "virtual raft foundation" was assumed to be at a depth of two-third of the length of piles.

(2) Piles in sand

(a) Ultimate capacity of a single pile

The ultimate capacity of a single pile was computed using the following relation as given in Simons & Menzies, 1974 (Ref. 2).

$$Q_u = A_s \, K \, p_{avg} \tan\delta + A_b \, p_o \, (N_q - 1) \quad \text{Eq. (2.5)}$$

Where,

Q_u	=	Ultimate pile capacity
A_s	=	Area of the shaft
K	=	Co-efficient of earth pressure
p_{avg}	=	Average effective overburden pressure over the embedded length of pile.
tan	=	Co-efficient of friction between soil and pile material.
A_b	=	Area of base
p_o	=	Effective overburden pressure at base
N_q	=	Bearing capacity factor as suggested by Berezantsev (1961).

To obtain pile capacity, a factor of safety of 2.5 was used.

The capacity of the pile group is computed by the relation.

$$Q_g = n\,Q_s \quad \text{--------------- Eq. (2.6)}$$

Where,

n	=	number of piles
Q_s	=	capacity of a single pile

In sands, driving of piles increases the relative density of sand considerably and the average load per pile in a group at failure is more than that for the failure of single comparable pile. Therefore, check of pile group against block failure was not necessary.

b) Settlement

The settlement of the pile group in sand was computed by assuming a virtual raft foundation at the level of the base of piles. The area of "virtual raft" was taken to be equal to the plan area of the pile group, (Tomlinson, 1969) (Ref. 3) and the settlement of the pile group was estimated using the Eq. 3.

Table A.4.2.10 Foundation Analysis

Bridge Site	Type of Pile Foundation											
	Precast and Driven 450 mm spuare						Bored and cast in place 600 mm dia					
	Length m	Pile Capacity tons	Spacing m	No. of Piles	Size of Group mxm	Expected settlement mm	Length m	Pile Capacity tons	Spacing m	No. of Piles	Size of Group mxm	Expected settlement mm
Kuleswar	24	22.5	1.9	45	15.8 by 8.2	94	27	22.5	1.9	45	15.8 by 8.2	94
Thapathali	12	22.5	1.9	45	15.8 by 8.2	85	14	22.5	1.9	45	15.8 by 8.2	87
Chakupat	14	22.5	1.9	45	15.8 by 8.2	89	15	22.5	1.9	45	15.8 by 8.2	100
Koteswor	19	22.5	1.9	45	15.8 by 8.2	95	20	22.5	1.9	45	15.8 by 8.2	98

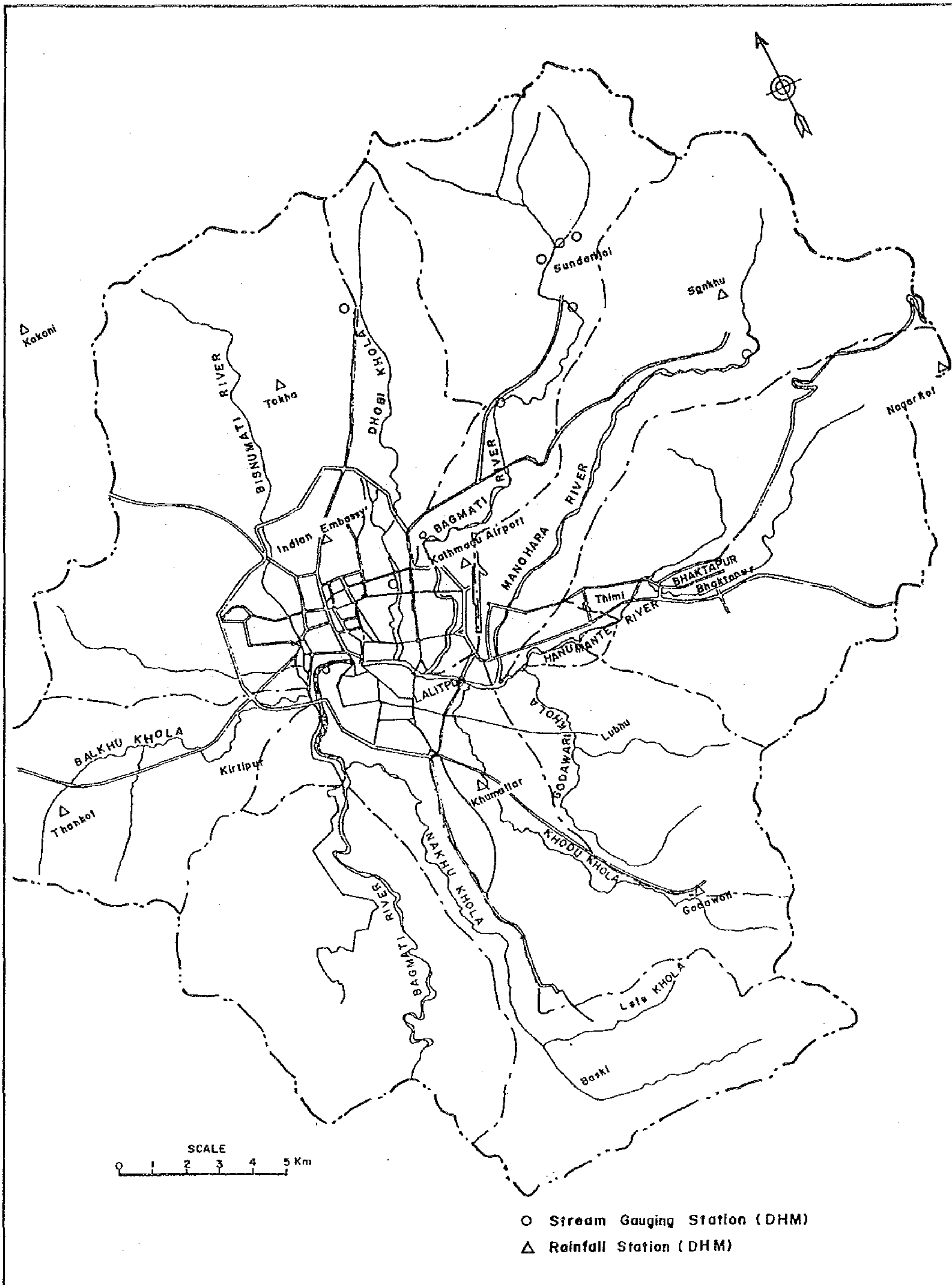


Figure A 4.3.1 LOCATION MAP OF RAINFALL STATION AND STREAM GAUGING STATION

Table A4.3.1 RAINFALL RECORD IN KATHMANDU VALLEY

YEAR	ANNUAL TOTAL							
	KTM. Airport	Godavari	Kakani	Khumaltar	Bhaktapur	Sankhu	Thankot	Nagarkot
1977	1298.0	1617.0	2392.0	1145.0	*	*	*	1798.0
1978	1556.0	2211.0	3241.0	1698.0	*	*	*	2700.0
1979	1356.0	1584.0	1734.0	950.0	*	*	*	1658.0
1980	1341.0	1548.0	2843.0	1009.0	*	*	*	1783.0
1981	1370.0	1698.0	2375.0	1159.0	*	*	*	1066.0
1982	1168.0	1672.0	*	1158.0	*	*	*	1045.0
1983	1449.0	1918.0	2986.0	1309.0	*	*	*	1266.0
1984	1313.0	2214.0	2672.0	1330.0	*	*	*	1435.0
1985	1786.0	2553.0	3288.0	1535.0	*	*	*	*
1986	1495.0	1910.0	3054.0	1367.0	*	*	*	2089.0
1987	1395.2	2061.1	2322.0	1449.2	1484.6	1728.0	2254.0	1645.2
1988	1373.8	1973.7	2774.9	1496.8	1784.8	1905.5	2024.4	1581.2
1989	1132.0	1644.7	3162.0	996.3	1095.0	2117.2	2029.6	*
1990	1532.7	2086.7	2993.8	1173.9	1752.7	2372.7	2111.6	2132.0
1991	997.5	1509.1	2689.5	870.0	896.9	1439.0	1619.6	1742.2
MEAN	1370.9	1880.0	2751.9	1243.1	1402.8	1912.5	2007.8	1687.7

Table A.4.3.2 RAINFALL AT KATHMANDU ARPORT

Year	Jan.			Feb			Mar.			Apr.			May.			Jun.			Jul.			Aug.			Sep.			Oct.			Nov.			Dec.			Annual	Annual
	max	total	mean daily	max	total	mean daily	max	total	mean daily	max	total	mean daily	max	total	mean daily	max	total	mean daily	max	total	mean daily	max	total	mean daily	max	total	mean daily	max	total	mean daily	max	total	mean daily	max	total	mean daily	max	Total
1977		12.0	0.4	12.0	12.0	0.4	9.0	17.0	0.5	21.0	104.0	3.5	27.0	90.0	2.9	50.0	266.0	8.9	51.0	323.0	10.4	58.0	338.0	10.9	18.0	79.0	2.6	10.0	29.0	0.9	8.0	14.0	0.5	10.0	14.0	0.5	58.0	1298.0
1978	3.0	5.0	0.2	8.0	11.0	0.4	39.0	69.0	2.2	14.0	42.0	1.4	18.0	143.0	4.6	36.0	299.0	10.0	67.0	324.0	10.5	71.0	392.0	12.6	30.0	160.0	5.3	71.0	109.0	3.5	0.0	0.0	0.0	1.0	2.0	0.1	71.0	1556.0
1979	2.0	6.0	0.2	22.0	39.0	1.4	0.0	1.0	0.0	12.0	42.0	1.4	12.0	37.0	1.2	48.0	258.0	8.6	86.0	447.0	14.4	76.0	320.0	10.3	52.0	99.0	3.3	12.0	36.0	1.2	4.0	6.0	0.2	51.0	65.0	2.1	86.0	1356.0
1980	1.0	1.0	0.0	9.0	18.0	0.6	19.0	46.0	1.5	7.0	10.0	0.3	32.0	124.0	4.0	100.0	349.0	11.6	50.0	296.0	9.5	31.0	238.0	7.7	54.0	184.0	6.1	38.0	69.0	2.2	0.0	0.0	0.0	6.0	6.0	0.2	100.0	1341.0
1981	11.0	14.0	0.5	0.0	0.0	0.0	22.0	60.0	1.9	38.0	101.0	3.4	54.0	216.0	7.0	35.0	141.0	4.7	36.0	304.0	9.8	47.0	257.0	8.6	50.0	225.0	7.5	0.0	0.0	0.0	16.0	42.0	1.4	0.0	0.0	0.0	54.0	1370.0
1982	9.0	14.0	0.5	10.0	22.0	0.8	16.0	36.0	1.2	10.0	49.0	1.6	14.0	40.0	1.3	88.0	200.0	6.7	52.0	238.0	7.7	52.0	384.0	12.4	38.0	155.0	5.2	8.0	9.0	0.3	18.0	18.0	0.6	3.0	3.0	0.1	88.0	1168.0
1983	16.0	18.0	0.6	2.0	4.0	0.1	15.0	30.0	1.0	14.0	79.0	2.6	29.0	110.0	3.5	39.0	81.0	2.7	72.0	500.0	16.1	45.0	194.0	6.3	44.0	288.0	9.6	43.0	130.0	4.2	0.0	0.0	0.0	15.0	15.0	0.5	72.0	1449.0
1984	14.0	14.0	0.5	14.0	17.0	0.6	14.0	14.0	0.5	21.0	60.0	2.0	19.0	96.0	3.1	70.0	275.0	9.2	30.0	250.0	8.1	77.0	302.0	9.7	45.0	260.0	8.7	17.0	18.0	0.6	0.0	0.0	0.0	7.0	7.0	0.2	77.0	1313.0
1985	6.0	10.0	0.3	3.0	3.0	0.1	4.0	4.0	0.1	13.0	25.0	0.8	22.0	133.0	4.3	36.0	161.0	5.4	51.0	418.0	13.5	52.0	434.0	14.0	69.0	376.0	12.5	52.0	167.0	5.4	0.0	0.0	0.0	28.0	55.0	1.8	69.0	1786.0
1986	0.0	0.0	0.0	20.0	23.0	0.8	7.0	16.0	0.5	24.0	93.0	3.1	21.0	97.0	3.1	65.0	316.0	10.5	78.0	381.0	12.3	62.0	219.0	7.1	48.0	221.0	7.4	26.0	80.0	2.6	0.0	0.0	0.0	32.0	49.0	1.6	78.0	1495.0
1987	2.7	3.2	0.1	25.0	43.3	1.5	9.6	35.9	1.2	11.0	34.4	1.1	18.0	57.6	1.9	16.8	116.4	3.9	86.5	498.8	16.1	39.3	256.3	8.3	45.6	171.2	5.7	124.4	159.3	5.1	0.0	0.0	0.0	18.3	18.8	0.6	124.4	1395.2
1988	0.6	0.6	0.0	9.7	19.1	0.7	21.9	68.0	2.2	14.7	42.3	1.4	37.3	152.9	4.9	36.5	239.5	8.0	66.0	397.3	12.8	60.5	278.7	9.0	27.0	134.4	4.5	11.5	17.6	0.6	7.4	11.7	0.4	7.4	11.7	0.4	66.0	1373.8
1989	31.3	47.4	1.5	9.7	10.7	0.4	5.8	12.1	0.4	3.3	4.0	0.1	46.0	148.7	4.8	29.3	135.5	4.5	57.0	328.0	10.6	27.0	206.0	6.6	38.7	196.5	6.6	18.9	42.4	1.4	0.0	0.0	0.0	0.7	0.7	0.0	57.0	1132.0
1990	0.0	0.0	0.0	18.0	42.2	1.5	15.8	59.5	1.9	26.2	116.2	3.9	73.2	108.3	3.5	47.0	285.5	9.5	56.4	345.6	11.1	53.8	308.5	10.0	39.2	188.2	6.3	48.2	78.7	2.5	0.0	0.0	0.0	0.0	0.0	0.0	73.2	1532.7
1991	14.6	20.7	0.7	10.0	11.4	0.4	19.2	45.2	1.5	17.1	26.3	0.9	42.8	145.3	4.7	24.4	114.4	3.8	36.9	190.3	6.1	44.7	280.7	9.1	27.6	137.7	4.6	0.4	0.4	0.0	0.2	0.2	0.0	21.5	24.9	0.8	44.7	997.5
Max	31.3			25.0			39.0			38.0			73.2			100.0			86.5			77.0			69.0			124.4			18.0			51.0			124.4	1786.0
Mean		11.1	0.4		18.4	0.7		34.2	1.1		55.2	1.8		113.3	3.7		215.8	7.2		349.4	11.3		294.5	9.5		191.7	6.4		63.0	2.0		6.1	0.2		18.1	0.6	74.6	1370.9

Table A.4.3.3 RAINFALL AT GODAVARI

Year	Jan.			Feb.			Mar.			Apr.			May.			Jun.			Jul.			Aug.			Sep.			Oct.			Nov.			Dec.			Annual	Annual
	max	total	mean daily	max	total	mean daily	max	total	mean daily	max	total	mean daily	max	total	mean daily	max	total	mean daily	max	total	mean daily	max	total	mean daily	max	total	mean daily	max	total	mean daily	max	total	mean daily	max	total	mean daily	max	Total
1977	7.0	12.0	0.4	15.0	18.0	0.6	6.0	11.0	0.4	20.0	104.0	3.5	26.0	135.0	4.4	56.0	194.0	6.5	114.0	656.0	21.2	51.0	299.0	9.6	28.0	90.0	3.0	12.0	35.0	1.1	7.0	7.0	0.2	56.0	56.0	1.8	114.0	1617.0
1978	2.0	2.0	0.1	10.0	25.0	0.9	51.0	78.0	2.5	34.0	66.0	2.2	21.0	128.0	4.1	71.0	368.0	12.3	83.0	414.0	13.4	87.0	626.0	20.2	67.0	374.0	12.5	99.0	124.0	4.0	0.0	1.0	0.0	4.0	5.0	0.2	99.0	2211.0
1979	5.0	6.0	0.2	30.0	52.0	1.9	1.0	1.0	0.0	16.0	48.0	1.6	24.0	64.0	2.1	81.0	330.0	11.0	97.0	548.0	17.7	93.0	345.0	11.1	21.0	70.0	2.3	14.0	34.0	1.1	5.0	7.0	0.2	63.0	79.0	2.5	97.0	1584.0
1980	0.0	0.0	0.0	7.0	12.0	0.4	8.0	25.0	0.8	15.0	19.0	0.6	31.0	111.0	3.6	103.0	440.0	14.7	68.0	439.0	14.2	45.0	390.0	12.6	54.0	75.0	2.5	16.0	31.0	1.0	0.0	0.0	0.0	6.0	6.0	0.2	103.0	1548.0
1981	10.0	30.0	1.0	0.0	0.0	0.0	12.0	45.0	1.5	24.0	96.0	3.2	24.0	138.0	4.5	32.0	186.0	6.2	36.0	420.0	13.5	58.0	350.0	11.3	169.0	413.0	13.8	0.0	0.0	0.0	18.0	20.0	0.7	0.0	0.0	0.0	169.0	1698.0
1982	10.0	15.0	0.5	6.0	16.0	0.6	31.0	55.0	1.8	16.0	44.0	1.5	20.0	80.0	2.6	55.0	304.0	10.1	68.0	375.0	12.1	65.0	523.0	16.9	66.0	229.0	7.6	6.0	11.0	0.4	14.0	18.0	0.6	2.0	2.0	0.1	68.0	1672.0
1983	18.0	21.0	0.7	4.0	8.0	0.3	5.0	7.0	0.2	17.0	59.0	2.0	51.0	214.0	6.9	23.0	91.0	3.0	84.0	587.0	18.9	65.0	455.0	14.7	48.0	298.0	9.9	56.0	164.0	5.3	0.0	0.0	0.0	14.0	14.0	0.5	84.0	1918.0
1984	26.0	26.0	0.8	17.0	20.0	0.7	12.0	12.0	0.4	25.0	65.0	2.2	43.0	158.0	5.1	71.0	417.0	13.9	49.0	449.0	14.5	61.0	490.0	15.8	110.0	538.0	17.9	25.0	28.0	0.9	0.0	0.0	0.0	10.0	11.0	0.4	110.0	2214.0
1985	9.0	20.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	16.0	27.0	0.9	23.0	140.0	4.5	42.0	226.0	7.5	120.0	847.0	27.3	62.0	484.0	15.6	90.0	455.0	15.2	82.0	274.0	8.8	0.0	0.0	0.0	47.0	80.0	2.6	120.0	2553.0
1986	0.0	0.0	0.0	20.0	24.0	0.9	10.0	26.0	0.8	24.0	85.0	2.8	35.0	133.0	4.3	80.0	461.0	15.4	96.0	432.0	13.9	60.0	316.0	10.2	51.0	314.0	10.5	13.0	56.0	1.8	3.0	3.0	0.1	36.0	60.0	1.9	96.0	1910.0
1987	2.0	3.0	0.1	30.5	74.9	2.7	19.8	60.5	2.0	23.5	56.3	1.9	12.6	38.2	1.2	79.0	198.5	6.6	83.6	801.1	25.8	86.4	430.2	13.9	46.0	181.9	6.1	172.0	201.0	6.5	0.0	0.0	0.0	15.0	15.5	0.5	172.0	2061.1
1988	2.0	3.0	0.1	16.0	25.0	0.9	28.9	81.3	2.6	23.2	68.8	2.3	21.7	125.4	4.0	48.5	279.5	9.3	57.5	465.1	15.0	52.5	523.7	16.9	53.5	253.7	8.5	14.0	15.3	0.5	24.7	30.7	1.0	63.5	102.2	3.3	63.5	1973.7
1989	33.3	53.0	1.7	9.7	12.3	0.4	11.3	16.3	0.5	2.8	2.8	0.1	30.2	155.3	5.0	27.7	150.0	5.0	61.8	541.3	17.5	68.2	321.3	10.4	46.8	339.7	11.3	17.2	52.7	1.7	0.0	0.0	0.0	0.0	0.0	0.0	68.2	1644.7
1990	0.0	0.0	0.0	23.5	60.4	2.2	12.2	60.5	2.0	22.4	68.9	2.3	32.9	148.6	4.8	44.0	241.5	8.1	91.3	659.3	21.3	110.0	576.7	18.6	58.0	244.8	8.2	9.4	24.6	0.8	0.0	0.0	0.0	1.4	1.4	0.0	110.0	2086.7
1991	23.2	38.7	1.2	10.5	15.5	0.6	35.4	61.1	2.0	42.0	63.0	2.1	11.2	45.7	1.5	49.8	228.0	7.6	92.8	356.8	11.5	57.4	506.3	16.3	31.0	168.2	5.6	0.0	0.0	0.0	0.0	0.0	0.0	24.5	25.8	0.8	92.8	1509.1
Max	33.3			30.5			51.0			42.0			51.0			103.0			120.0			110.0			169.0			172.0			24.7			63.5			172.0	2553.0
Mean		15.3	0.5		24.2	0.9		36.0	1.2		58.2	1.9		120.9	3.9		274.3	9.1		532.7	17.2		442.4	14.3		269.6	9.0		70.0	2.3		5.8	0.2		30.5	1.0	104.4	1880.0

Table A4.3.4 TEMPERATURE AT KATHMANDU AIRPORT

Year	Jan.			Feb			Mar.			Apr.			May.			Jun.			Jul.			Aug.			Sep.			Oct.			Nov.			Dec.			Mean in Year
	mean			mean			mean			mean			mean			mean			mean			mean			mean			mean			mean			mean			
	max	min	daily	max	min	daily	max	min	daily	max	min	daily	max	min	daily	max	min	daily	max	min	daily	max	min	daily	max	min	daily	max	min	daily	max	min	daily	max	min	daily	
1977	16.8	0.5	8.7	20.3	3.0	11.7	25.4	7.1	16.3	25.0	11.3	18.2	25.7	13.5	19.6	27.9	17.6	22.8	27.8	19.7	23.8	27.6	19.0	23.3	27.1	17.4	22.3	24.0	11.6	17.8	21.7	8.6	15.2	17.6	2.2	9.9	17.4
1978	16.1	-0.4	7.9	18.7	2.0	10.4	21.6	5.1	13.4	25.6	10.4	18.0	27.2	17.0	22.1	27.4	19.2	23.3	27.4	19.8	23.6	28.4	20.0	24.2	26.7	18.5	22.6	24.6	13.8	19.2	21.0	9.0	15.0	19.8	3.3	11.6	17.6
1979	18.4	2.5	10.5	18.8	4.1	11.5	24.0	6.2	15.1	27.4	12.6	20.0	30.4	15.6	23.0	28.9	19.2	24.1	27.7	20.5	24.1	27.2	20.1	23.7	26.7	17.6	22.2	24.9	13.3	19.1	22.7	9.8	16.3	17.9	5.0	11.5	18.4
1980	17.5	1.9	9.7	19.5	4.9	12.2	23.0	8.0	15.5	29.4	12.1	20.8	28.2	16.9	22.6	27.8	20.2	24.0	27.8	20.8	24.3	27.8	20.4	24.1	26.9	19.0	23.0	24.5	12.1	18.3	22.4	7.2	14.8	19.3	4.1	11.7	18.4
1981	16.8	2.9	9.9	20.3	4.8	12.6	22.2	8.2	15.2	24.2	12.5	18.4	26.1	16.3	21.2	28.0	19.1	23.6	27.0	20.6	23.8	27.8	20.4	24.1	26.7	18.6	22.7	25.6	13.3	19.5	22.7	6.8	14.8	19.4	2.1	10.8	18.0
1982	18.9	2.8	10.9	18.5	3.5	11.0	22.8	7.5	15.2	26.5	10.9	18.7	29.9	14.4	22.2	28.5	18.5	23.5	28.7	19.6	24.2	28.9	20.2	24.6	27.3	17.8	22.6	25.6	11.2	18.4	21.3	7.9	14.6	18.8	3.9	11.4	18.1
1983	17.1	0.1	8.6	20.7	2.4	11.6	26.0	8.3	17.2	28.3	11.2	19.8	27.5	17.1	22.3	28.2	20.0	24.1	28.1	20.3	24.2	29.2	19.8	24.5	26.3	17.3	21.8	27.2	14.4	20.8	22.6	5.8	14.2	19.4	3.4	11.4	18.4
1984	16.7	1.0	8.9	19.0	1.6	10.3	23.4	5.8	14.6	25.1	10.2	17.7	26.8	15.3	21.1	30.4	18.1	24.3	28.3	20.5	24.4	28.7	20.2	24.5	27.8	19.1	23.5	26.0	13.7	19.9	22.9	7.0	15.0	18.9	1.5	10.2	17.8
1985	18.1	2.4	10.3	20.1	3.7	11.9	26.3	9.0	17.7	28.6	12.1	20.4	28.0	15.5	21.8	28.9	19.2	24.1	27.1	19.6	23.4	28.8	20.2	24.5	26.7	18.3	22.5	24.4	13.7	19.1	22.2	7.0	14.6	19.3	4.8	12.1	18.5
1986	18.3	2.7	10.5	20.1	3.5	11.8	24.6	7.2	15.9	26.4	11.1	18.8	27.1	13.9	20.5	28.9	18.9	23.9	28.2	20.1	24.2	28.7	19.5	24.1	26.9	18.0	22.5	24.8	12.3	18.6	22.3	8.1	15.2	18.7	2.8	10.8	18.0
1987	18.5	2.4	10.5	20.6	5.3	13.0	23.2	8.0	15.6	27.1	10.9	19.0	29.1	13.4	21.3	28.8	19.0	23.9	27.6	20.1	23.9	27.5	19.4	23.5	27.4	18.4	22.9	25.6	12.9	19.3	23.4	7.8	15.6	20.6	4.2	12.4	18.4
1988	19.1	3.0	11.1	21.6	5.3	13.5	23.9	7.6	15.8	28.6	10.9	19.8	28.9	15.7	22.3	28.4	18.5	23.5	28.3	19.9	24.1	27.9	19.7	23.8	28.6	18.5	23.6	28.4	13.3	20.9	24.4	6.4	15.4	20.3	5.0	12.7	18.8
1989	17.5	2.7	10.1	21.7	2.3	12.0	25.6	7.0	16.3	30.0	8.6	19.3	29.7	15.6	22.7	29.4	18.9	24.2	28.1	19.5	23.8	29.5	19.2	24.4	28.9	18.6	23.8	28.6	13.3	21.0	23.7	6.0	14.9	20.7	1.8	11.3	18.6
1990	22.2	3.2	12.7	19.9	5.2	12.6	22.1	7.0	14.6	26.2	10.8	18.5	27.1	16.1	21.6	29.2	19.6	24.4	27.6	20.1	23.9	28.3	19.4	23.9	27.5	18.5	23.0	25.6	13.0	19.3	24.4	7.3	15.9	20.2	3.7	12.0	18.5
Mean	18.0	2.0	10.0	20.0	3.7	11.8	23.9	7.3	15.6	27.0	11.1	19.1	28.0	15.5	21.7	28.6	19.0	23.8	27.8	20.1	24.0	28.3	19.8	24.1	27.3	18.3	22.8	25.7	13.0	19.3	22.7	7.5	15.1	19.4	3.4	11.4	18.2
Max	22.2			21.7			26.3			30			30.4			30.4			28.7			29.5			28.9			28.6			24.4			20.7			
Mini		-0.4			1.6			5.1			8.6			13.4			17.6			19.5			19			17.3			11.2			5.8			1.5		

Table A4.3.5 RELATIVE HUMIDITY AT KATHMANDU AIRPORT

Year	Jan.			Feb			Mar.			Apr.			May.			Jun.			Jul.			Aug.			Sep.			Oct.			Nov.			Dec.			Mean in Year
	mean			mean			mean			mean			mean			mean			mean			mean			mean			mean			mean			mean			
	max	min	daily	max	min	daily	max	min	daily	max	min	daily	max	min	daily	max	min	daily	max	min	daily	max	min	daily	max	min	daily	max	min	daily	max	min	daily	max	min	daily	
1977	96.0	66.0	81.0	90.0	50.0	70.0	79.0	46.0	62.5	78.0	57.0	67.5	78.0	58.0	68.0	77.0	71.0	74.0	86.0	80.0	83.0	86.0	80.0	83.0	86.0	76.0	81.0	89.0	72.0	80.5	91.0	75.0	83.0	96.0	73.0	84.5	76.5
1978	94.0	65.0	79.5	92.0	59.0	75.5	83.0	51.0	67.0	75.0	54.0	64.5	81.0	67.0	74.0	83.0	74.0	78.5	85.0	78.0	81.5	85.0	70.0	77.5	90.0	80.0	85.0	94.0	75.0	84.5	95.0	77.0	86.0	97.0	65.0	81.0	77.9
1979	99.0	66.0	82.5	96.0	61.0	78.5	85.0	41.0	63.0	92.0	56.0	74.0	87.0	46.0	66.5	90.0	65.0	77.5	94.0	80.0	87.0	96.0	82.0	89.0	96.0	75.0	85.5	98.0	76.0	87.0	97.0	72.0	84.5	97.0	74.0	85.5	80.0
1980	95.0	64.0	79.5	90.0	52.0	71.0	80.0	50.0	65.0	-65.0	41.0	53.0	72.0	58.0	65.0	82.0	74.0	78.0	84.0	78.0	81.0	84.0	77.0	80.5	88.0	79.0	83.5	91.0	72.0	81.5	92.0	72.0	82.0	97.0	68.0	82.5	75.2
1981	96.0	65.0	80.5	90.0	55.0	72.5	84.0	57.0	70.5	78.0	56.0	67.0	80.0	66.0	73.0	79.0	68.0	73.5	86.0	81.0	83.5	85.0	78.0	81.5	89.0	75.0	82.0	91.0	67.0	79.0	95.0	78.0	86.5	97.0	73.0	85.0	77.9
1982	97.0	67.0	82.0	95.0	62.0	78.5	80.0	52.0	66.0	71.0	47.0	59.0	61.0	44.0	52.5	76.0	67.0	71.5	83.0	71.0	77.0	83.0	81.0	82.0	88.0	79.0	83.5	93.0	71.0	82.0	95.0	77.0	86.0	97.0	70.0	83.5	75.3
1983	94.0	68.0	81.0	91.0	65.0	78.0	81.0	61.0	71.0	78.0	60.0	69.0	77.0	73.0	75.0	73.0	64.0	68.5	87.0	83.0	85.0	82.0	81.0	81.5	85.0	80.0	82.5	89.0	76.0	82.5	98.0	72.0	85.0	98.0	70.0	84.0	78.6
1984	96.0	62.0	79.0	95.0	52.0	73.5	81.0	48.0	64.5	66.0	43.0	54.5	78.0	68.0	73.0	82.0	77.0	79.5	85.0	82.0	83.5	82.0	79.0	80.5	90.0	78.0	84.0	88.0	71.0	79.5	89.0	64.0	76.5	93.0	67.0	80.0	75.7
1985	94.0	66.0	80.0	90.0	58.0	74.0	74.0	41.0	57.5	65.0	38.0	51.5	72.0	58.0	65.0	76.0	68.0	72.0	84.0	82.0	83.0	84.0	79.0	81.5	87.0	79.0	83.0	91.0	77.0	84.0	98.0	72.0	85.0	97.0	72.0	84.5	75.1
1986	97.0	65.0	81.0	96.0	58.0	77.0	79.0	43.0	61.0	74.0	54.0	64.0	73.0	58.0	65.5	79.0	71.0	75.0	84.0	81.0	82.5	84.0	78.0	81.0	87.0	81.0	84.0	93.0	71.0	82.0	97.0	72.0	84.5	98.0	68.0	83.0	76.7
1987	97.7	64.5	81.1	95.8	58.0	76.9	93.2	58.4	75.8	74.8	50.8	62.8	65.0	50.5	57.8	75.6	70.2	72.9	86.2	84.8	85.5	87.3	79.4	83.4	87.3	76.9	82.1	92.3	73.9	83.1	96.1	68.7	82.4	96.6	64.3	80.5	77.0
1988	96.3	57.8	77.1	92.2	52.6	72.4	86.3	49.5	67.9	69.6	45.0	57.3	75.1	58.6	66.9	78.8	70.9	74.9	83.4	80.7	82.1	87.6	80.2	83.9	87.3	74.8	81.1	91.5	73.0	82.3	91.6	60.2	75.9	93.3	67.2	80.3	75.1
1989	96.1	72.2	84.2	93.9	56.3	75.1	82.5	45.4	64.0	61.8	30.7	46.3	69.7	60.8	65.3	75.6	71.4	73.5	83.9	79.1	81.5	85.4	77.9	81.7	85.8	79.6	82.7	89.6	74.5	82.1	94.0	67.3	80.7	94.5	66.9	80.7	74.8
1990	90.6	59.3	75.0	95.5	66.7	81.1	84.7	53.5	69.1	76.6	57.0	66.8	75.4	62.2	68.8	77.5	74.1	75.8	84.4	81.8	83.1	86.1	78.1	76.2	86.9	77.3	82.1	87.0	71.9	79.5	92.4	62.6	77.5	95.4	61.2	78.3	76.1
Mean	95.6	64.8	80.2	93.0	57.5	75.3	82.3	49.8	66.1	73.2	49.3	61.2	74.6	59.2	66.9	78.9	70.4	74.6	85.4	80.2	82.8	85.5	78.6	89.0	88.1	77.9	83.0	91.2	73.0	82.1	94.4	70.7	82.5	96.2	68.5	82.4	76.6
Max	99.0	72.2	84.2	96.0	66.7	81.1	93.2	61.0	75.8	92.0	60.0	74.0	87.0	73.0	75.0	90.0	77.0	79.5	94.0	84.8	87.0	96.0	82.0	77.5	96.0	81.0	85.5	98.0	77.0	87.0	98.0	78.0	86.5	98.0	74.0	85.5	80.0
Mini	90.6	57.8	75.0	90.0	50.0	70.0	74.0	41.0	57.5	61.8	30.7	46.3	61.0	44.0	52.5	73.0	64.0	68.5	83.0	71.0	77.0	82.0	70.0	76.2	85.0	74.8	81.0	87.0	67.0	79.0	89.0	60.2	75.9	93.0	61.2	78.3	74.8

Table A.4.3.6 TEMPRATURE AT GODAVARI

Year	Jan. mean max	Jan. mean min	Jan. mean daily	Feb mean max	Feb mean min	Feb mean daily	Mar. mean max	Mar. mean min	Mar. mean daily	Apr. mean max	Apr. mean min	Apr. mean daily	May. mean max	May. mean min	May. mean daily	Jun. mean max	Jun. mean min	Jun. mean daily
1977	14.2	2.1	8.2	17.4	4.3	10.9	23.0	8.8	15.9	23.0	10.6	16.8	23.0	12.2	17.6	25.6	15.7	20.7
1978	12.9	2.0	7.5	15.9	4.4	10.2	18.6	7.6	13.1	23.4	11.7	17.6	25.3	15.5	20.4	24.7	17.4	21.1
1979	15.3	3.9	9.6	15.6	4.3	10.0	21.2	7.2	14.2	24.8	12.2	18.5	27.6	14.8	21.2	26.3	17.4	21.9
1980	13.9	2.9	8.4	16.0	4.9	10.5	20.3	8.2	14.3	27.1	13.0	20.1	25.7	14.9	20.3	24.9	18.1	21.5
1981	13.0	3.9	8.5	17.6	6.1	11.9	19.6	8.7	14.2	22.0	11.8	16.9	23.9	14.7	19.3	25.8	17.5	21.7
1982	15.1	3.7	9.4	14.8	4.1	9.5	19.2	8.4	13.8	23.3	11.7	17.5	26.3	15.1	20.7	25.2	17.6	21.4
1983	12.5	2.7	7.6	15.4	3.4	9.4	20.9	8.0	14.5	22.8	11.3	17.1	24.0	14.3	19.2	26.9	17.5	22.2
1984	12.9	1.8	7.4	16.7	4.1	10.4	22.3	9.8	16.1	24.9	12.5	18.7	24.5	16.0	20.3	25.0	18.4	21.7
1985	13.8	3.5	8.7	16.2	4.6	10.4	23.4	10.7	17.1	25.6	13.6	19.6	24.9	14.6	19.8	25.7	17.8	21.8
1986	13.8	3.6	8.7	16.5	5.0	10.8	20.9	8.6	14.8	23.4	11.7	17.6	24.1	13.5	18.8	25.6	18.3	22.0
1987	14.3	3.9	9.1	16.7	5.9	11.3	19.5	8.2	13.9	24.0	12.1	18.1	26.0	13.4	19.7	26.2	15.0	20.6
1988	14.7	4.1	9.4	17.2	5.7	11.5	20.3	8.0	14.2	25.1	11.4	18.3	25.4	15.4	20.4	25.2	17.8	21.5
1989	12.7	3.0	7.9	16.5	3.5	10.0	20.8	8.5	14.7	25.9	11.9	18.9	26.0	16.0	21.0	25.6	17.8	21.7
1990	16.4	5.5	11.0	15.1	5.4	10.3	18.2	7.3	12.8	23.4	11.1	17.3	24.3	15.1	19.7	26.6	18.6	22.6
Mean	14.0	3.3	8.6	16.3	4.7	10.5	20.6	8.4	14.5	24.2	11.9	18.0	25.1	14.7	19.9	25.7	17.5	21.6
Max	16.4			17.6			23.4			27.1			27.6			26.9		
Mini		1.8			3.4			7.2			10.6			12.2			15	

Year	Jul. mean max	Jul. mean min	Jul. mean daily	Aug. mean max	Aug. mean min	Aug. mean daily	Sep. mean max	Sep. mean min	Sep. mean daily	Oct. mean max	Oct. mean min	Oct. mean daily	Nov. mean max	Nov. mean min	Nov. mean daily	Dec. mean max	Dec. mean min	Dec. mean daily	Mean In Year
1977	24.8	17.6	21.2	25.0	17.0	21.0	24.2	16.2	20.2	21.1	12.2	16.7	18.7	9.1	13.9	15.0	4.7	9.9	16.1
1978	24.8	12.6	18.7	25.1	18.1	21.6	23.8	16.0	19.9	22.2	12.4	17.3	18.4	8.2	13.3	16.8	4.8	10.8	15.9
1979	25.0	18.4	21.7	24.6	17.8	21.2	24.1	15.6	19.9	21.6	12.2	16.9	19.5	9.9	14.7	14.1	4.8	9.5	16.6
1980	24.5	18.5	21.5	24.2	18.1	21.2	21.9	16.0	19.0	19.7	10.5	15.1	18.4	7.9	13.2	15.2	5.4	10.3	16.3
1981	24.0	18.9	21.5	24.7	18.5	21.6	23.5	16.8	20.2	22.1	12.5	17.3	17.7	7.6	12.7	13.7	4.3	9.0	16.2
1982	25.5	18.6	22.1	24.9	18.4	21.7	23.2	16.7	20.0	21.3	11.9	16.6	16.8	8.5	12.7	14.4	4.9	9.7	16.2
1983	25.2	18.6	21.9	24.9	18.5	21.7	23.9	17.5	20.7	21.2	13.1	17.2	17.3	8.3	12.8	13.9	3.4	8.7	16.1
1984	23.8	18.6	21.2	24.9	17.9	21.4	22.3	15.6	19.0	22.2	13.9	18.1	17.1	7.5	12.3	14.6	4.3	9.5	16.3
1985	23.2	18.3	20.8	24.9	18.7	21.8	22.6	16.6	19.6	20.5	13.1	16.8	17.2	7.7	12.5	14.8	5.0	9.9	16.5
1986	24.7	16.0	20.4	25.0	14.9	20.0	22.7	13.4	18.1	20.4	10.2	15.3	17.3	8.4	12.9	14.5	4.3	9.4	15.7
1987	24.1	15.7	19.9	24.2	15.2	19.7	23.8	15.8	19.8	21.3	12.2	16.8	18.3	7.3	12.8	15.8	4.4	10.1	16.0
1988	24.8	19.1	22.0	24.1	18.6	21.4	24.4	17.4	20.9	22.8	12.8	17.8	18.8	7.4	13.1	15.5	5.7	10.6	16.7
1989	24.5	18.4	21.5	24.4	18.2	21.3	23.5	17.5	20.5	22.3	13.1	17.7	17.6	7.3	12.5	14.7	3.8	9.3	16.4
1990	24.0	18.9	21.5	24.7	18.6	21.7	23.7	17.5	20.6	21.1	12.7	16.9	19.5	8.8	14.2	15.8	5.5	10.7	16.6
Mean	24.5	17.7	21.1	24.7	17.8	21.2	23.4	16.3	19.9	21.4	12.3	16.9	18.0	8.1	13.1	14.9	4.7	9.8	16.3
Max	25.5			25.1			24.4			22.8			19.5			16.8			
Mini		12.6			14.9			13.4			10.2			7.3			3.4		

Table A.4.3.7 RELATIVE HUMIDITY AT GODAVARI

Year	Jan '0845	Feb. '0845	Mar. '0845	Apr. '0845	May. '0845	Jun. '0845	Jul. '0845	Aug. '0845	Sep. '0845	Oct. '0845	Nov. '0845	Dec. '0845	Mean in Year
1977	78.0	72.0	67.0	66.0	69.0	74.0	84.0	78.0	81.0	81.0	82.0	82.0	76.2
1978	75.0	75.0	66.0	64.0	76.0	83.0	85.0	81.0	83.0	80.0	67.0	74.0	75.8
1979	72.0	72.0	55.0	57.0	60.0	69.0	83.0	84.0	81.0	84.0	82.0	82.0	73.4
1980	76.0	78.0	65.0	50.0	68.0	83.0	89.0	90.0	90.0	82.0	78.0	81.0	77.5
1981	89.0	81.0	78.0	78.0	80.0	81.0	93.0	92.0	91.0	77.0	79.0	82.0	83.4
1982	77.0	79.0	77.0	69.0	65.0	85.0	86.0	86.0	86.0	84.0	87.0	86.0	80.6
1983	80.0	75.0	70.0	68.0	82.0	80.0	95.0	94.0	93.0	84.0	82.0	77.0	81.7
1984	74.0	70.0	80.0	72.0	84.0	90.0	94.0	90.0	93.0	84.0	85.0	85.0	83.4
1985	83.0	84.0	71.0	68.0	82.0	86.0	95.0	93.0	94.0	89.0	85.0	87.0	84.8
1986	83.0	78.0	73.0	74.0	79.0	85.0	91.0	86.0	91.0	85.0	86.0	80.0	82.6
1987	82.1	81.1	84.9	72.1	65.7	80.6	92.3	90.6	92.6	89.9	80.3	80.3	82.7
1988	84.1	82.2	81.4	72.2	84.8	91.1	95.1	94.9	93.8	85.0	80.8	85.9	85.9
1989	86.2	70.5	76.2	63.0	76.7	86.5	88.2	93.9	94.7	87.7	82.2	77.0	81.9
1990	85.3	81.0	81.1	76.2	84.8	87.9	93.3	93.9	91.6	81.1	76.2	80.4	84.4
Mean	80.3	77.1	73.3	67.8	75.5	83.0	90.3	89.1	89.7	83.8	80.9	81.4	81.0
Max	89.0	84.0	84.9	78.0	84.8	91.1	95.1	94.9	94.7	89.9	87.0	87.0	
Mini	72.0	70.0	55.0	50.0	60.0	69.0	83.0	78.0	81.0	77.0	67.0	74.0	

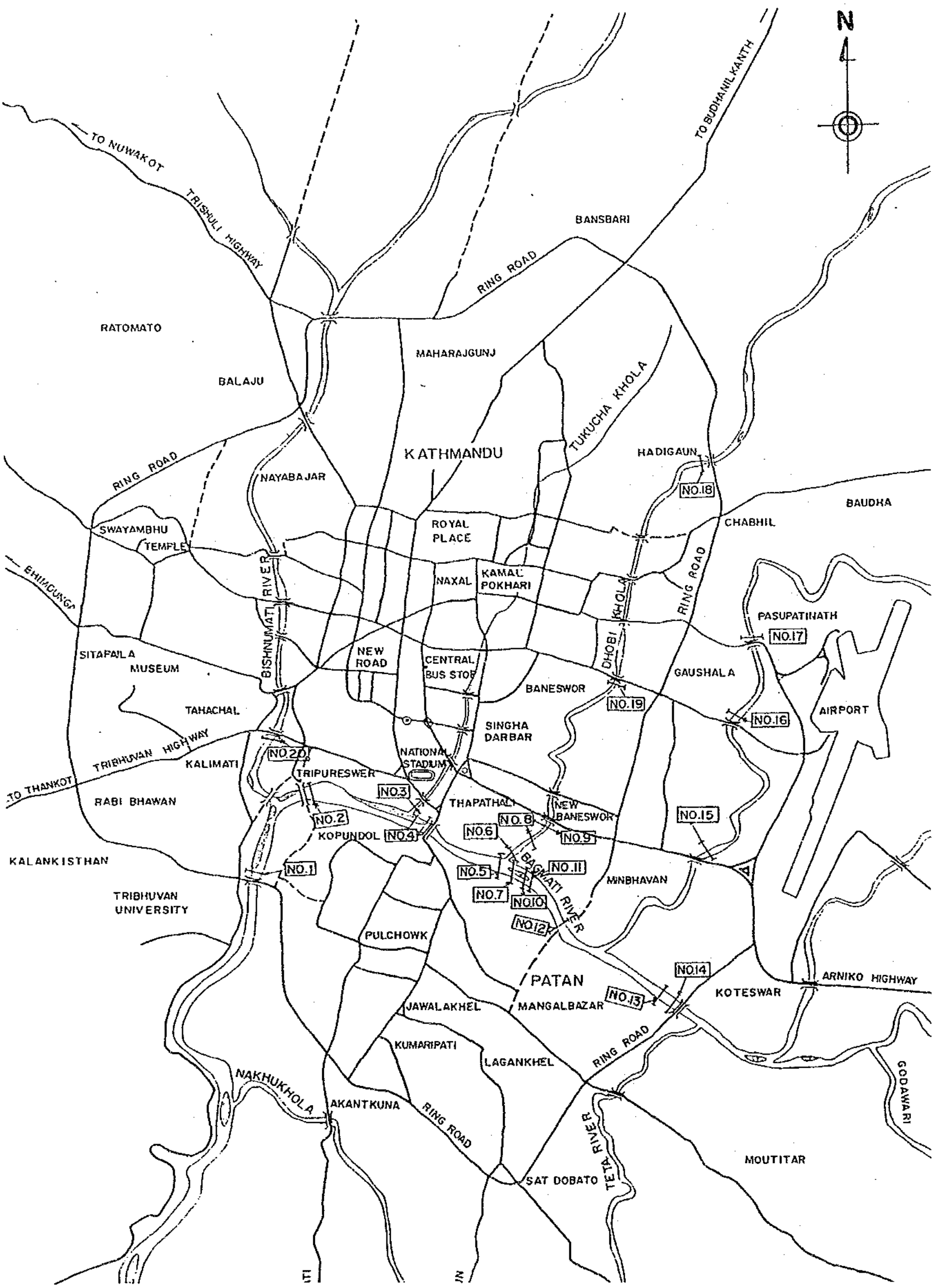
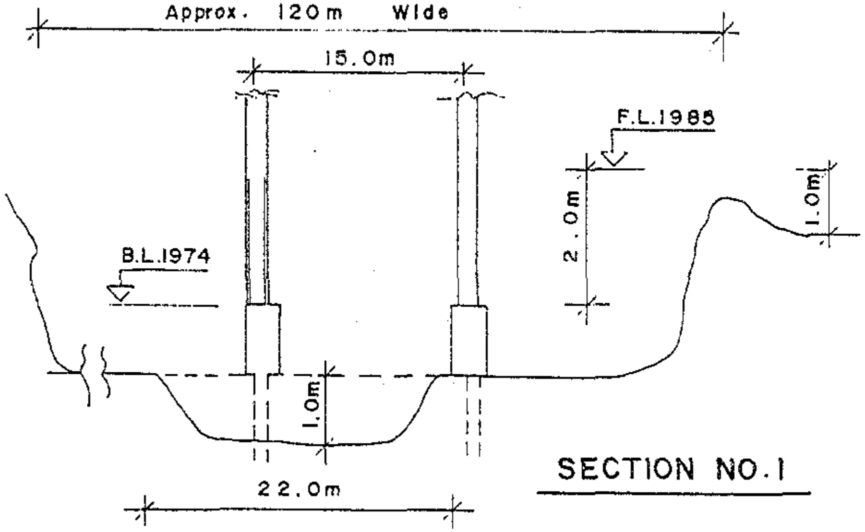


Figure A 4.3.2 LOCATION OF REFERED FLOOD LEVEL ENQUIRY SECTION

DATE : 6|9|92

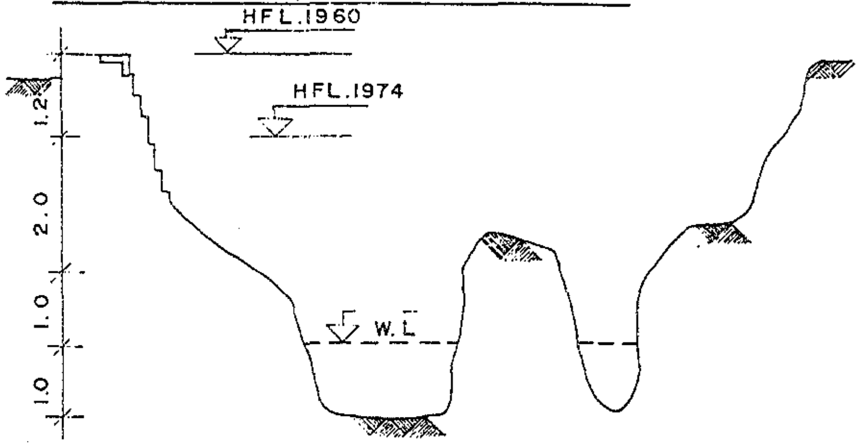
BAGMATI BRIDGE; BALKHU, RING ROAD (Br. No.7)



SECTION NO.1

DATE: 14|9|92

BAGMATI RIVER; BIRAUTA, KOPUNDOL

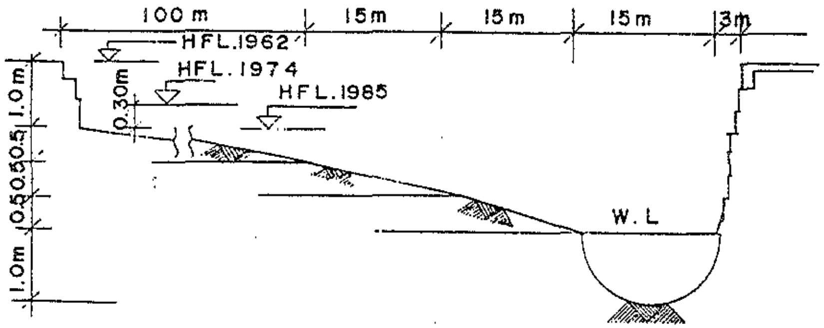


SECTION LOCATION: 200m D S OF BAGMATI BRIDGE

SECTION NO.3

DATE: 14|9|92

BAGMATI RIVER; RAJDAHA TIRTHA, SANEPA

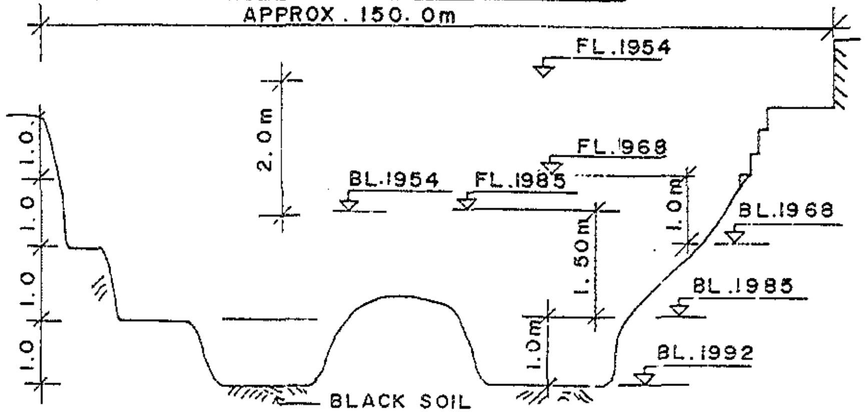


SECTION LOCATION: 100m U/S OF SUSPERISION BRIDGE, TEKU

SECTION NO.2

DATE: 7|9|92

BAGMATI BRIDGE; THAPATHALI, Br. No.5

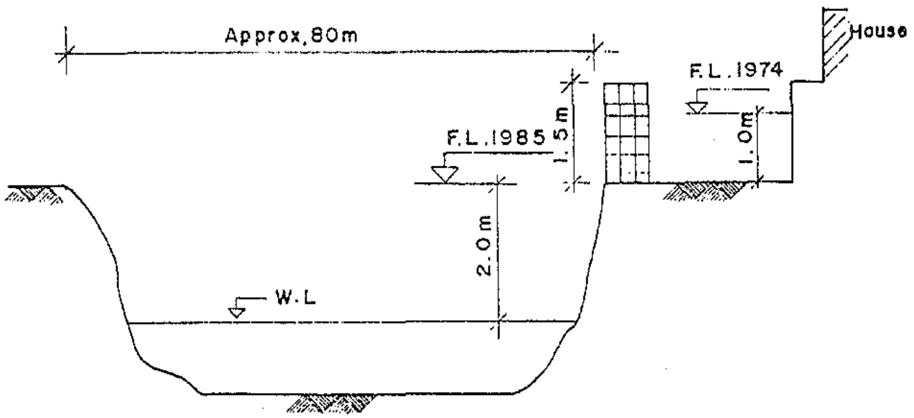


SECTION LOCATION;40m D/S OF BRIDGE

SECTION NO.4

DATE: 8|9|92

BAGMATI RIVER; D/S OF DHOBIKHOLA

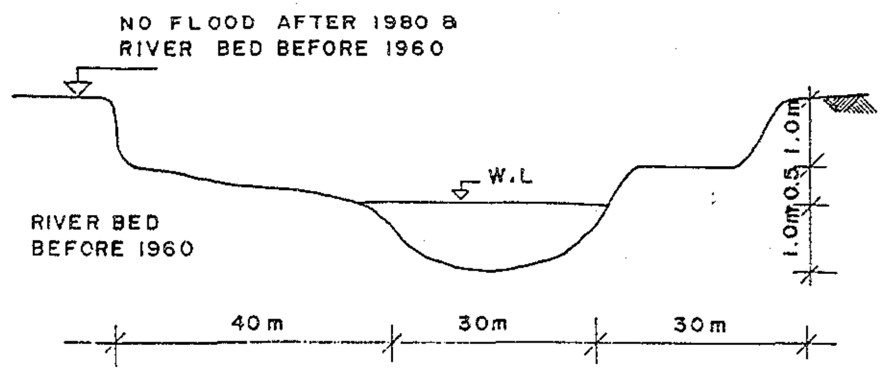


SECTION LOCATION: 20m D/S OF CONFLUENCE OF DHOBI KHOLA

SECTION NO. 5 (SURVEY SECTION NO 7)

DATE: 11|9|92

BAGMATI RIVER U/S OF DHOBI KHOLA CONFLUENCE

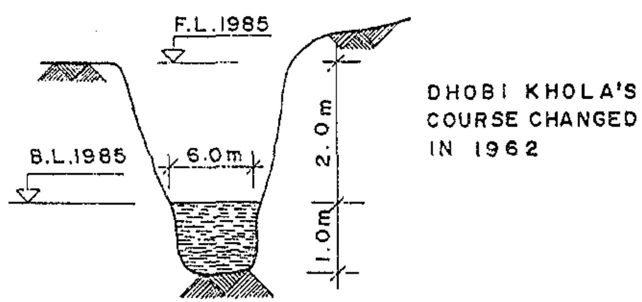


SECTION LOCATION: 150m D/S OF PHANTAL BARAHI AT L/S

SECTION NO. 7

DATE: 8|9|92

DHOBI KHOLA; CONFLUENCE WITH BAGMATI

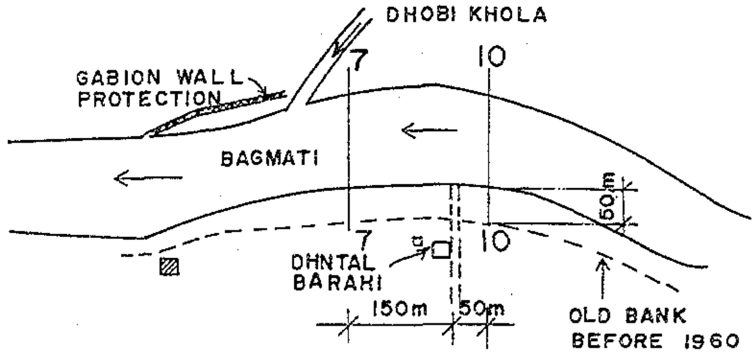


SECTION LOCATION: 15m U/S OF CONFLUENCE WITH BAGMATI

SECTION NO. 6

DATE: 11|9|92

LOCATION PLAN OF SECTIONS AT DHNTAL BARAHI

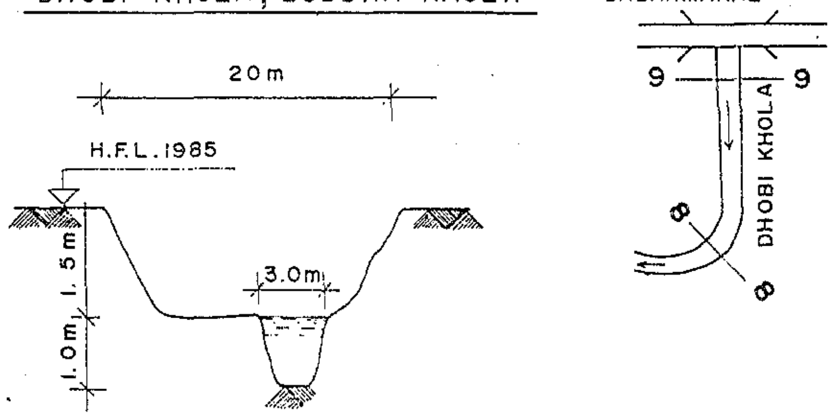


LOCATION: DHOBI KHOLA CONFLUENCE WITH BAGMATI

FOR SECTION NO. 7 & 10

DATE: 8|9|92

DHOBI KHOLA; BUDDHA NAGER

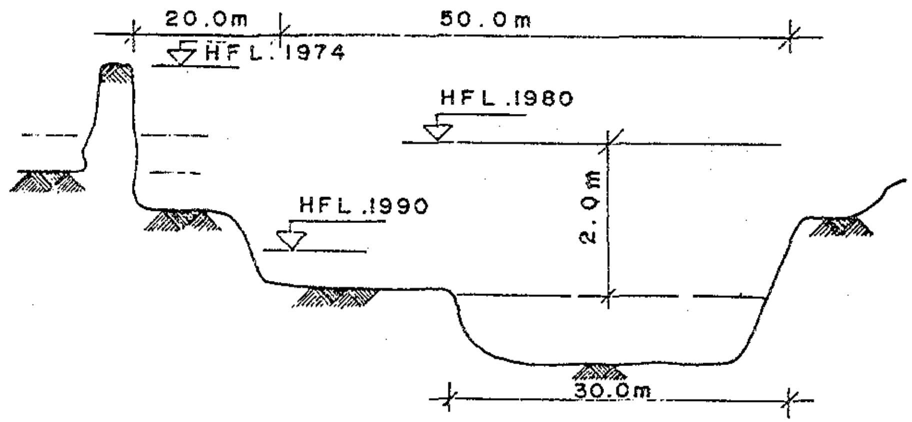


SECTION LOCATION: 500m D/S OF BRIDGE (BABARMAHAL)

SECTION NO. 8

DATE: 11|9|92

BAGMATI AT DHANTAL BARAHI

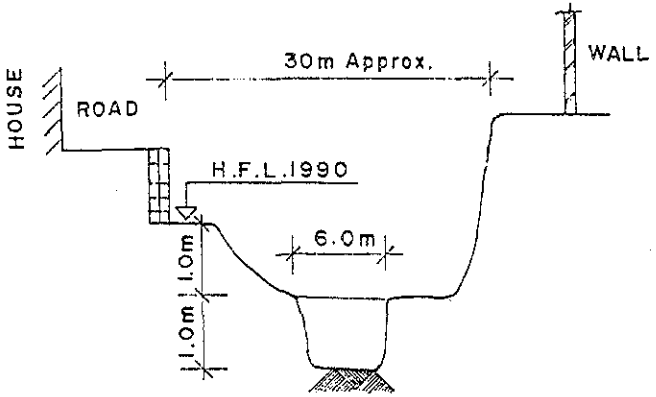


SECTION LOCATION: 50m U/S OF DHANTAL BARAHI AT L/B

SECTION NO. 10

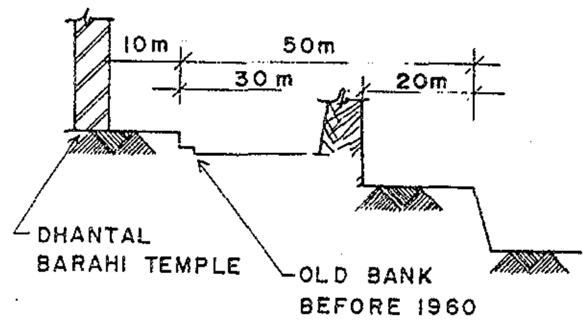
DATE: 8|9|92

DHOBI KHOLA BRIDGE BABARMAHAL BR. NO



SECTION LOCATION: 15 m D/S OF DHOBIKHOLA BRIDGE

SECTION NO.9 (SURVEY SECTION NO.10)

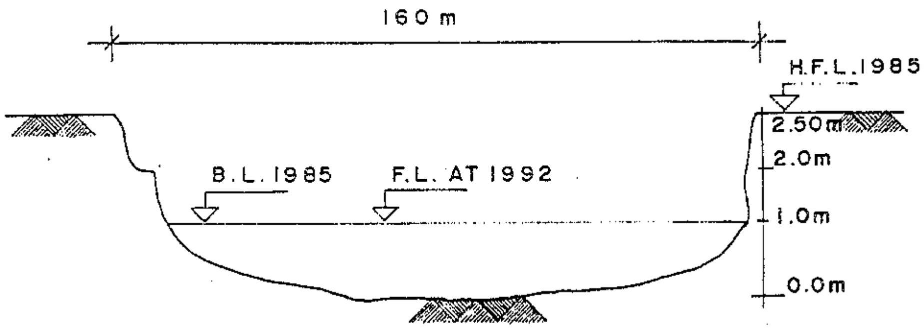


SECTION LOCATION: 50m U/S OF DHANTAL BARAHI AT L/B

SECTION: NO. 10 CONTINUED

DATE : 8|9|92

BAGMATI RIVER, BUDDHANAGAR

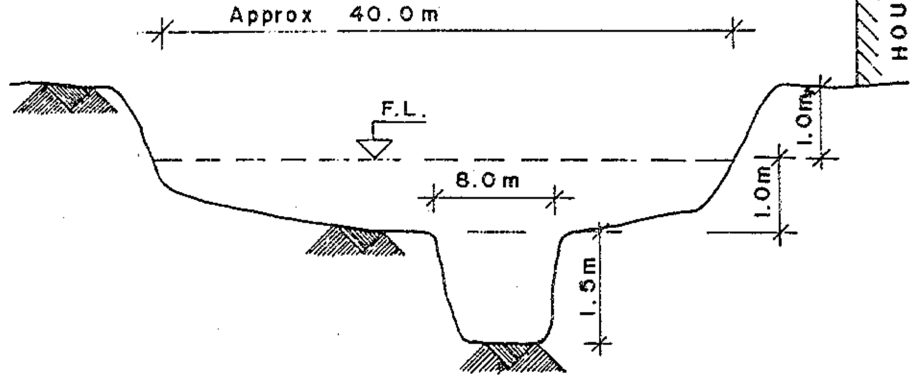


SECTION LOCATION : 400 m U/S OF DHOBIKHOLA CONFLUENCE

SECTION NO. 11

DATE : 8|9|92

MANOHARA BRIDGE (NEAR SUPENSION BRIDGE)

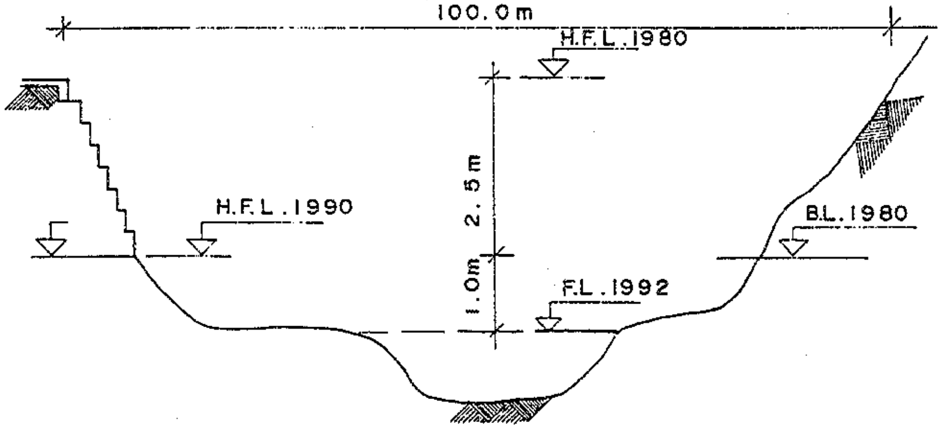


SECTION LOCATION: 100m U/S OF SUSPENSION BRIDGE

SECTION NO. 13

DATE : 8|9|92

BAGMATI BRIDGE SANKHAMUL PEDESTRAN CROSSING

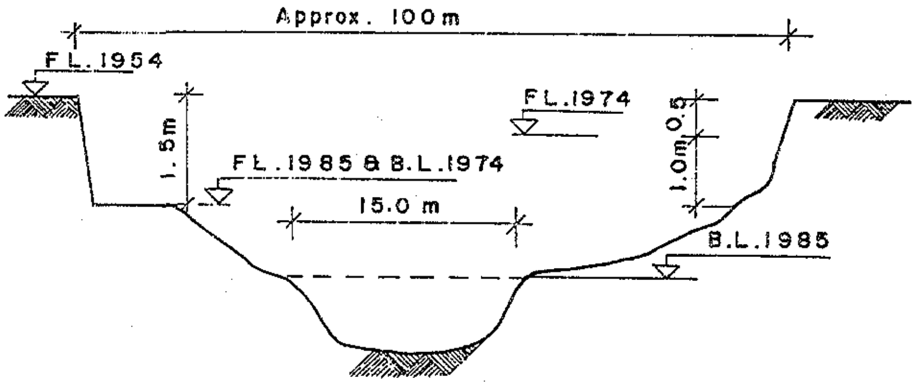


SECTION LOCATION: 10m D/S OF PEDESTRIAN CROSSING

SECTION NO.12

DATE: 7|9|92

MANOHARA BRIDGE; RING ROAD, BALKUMARI



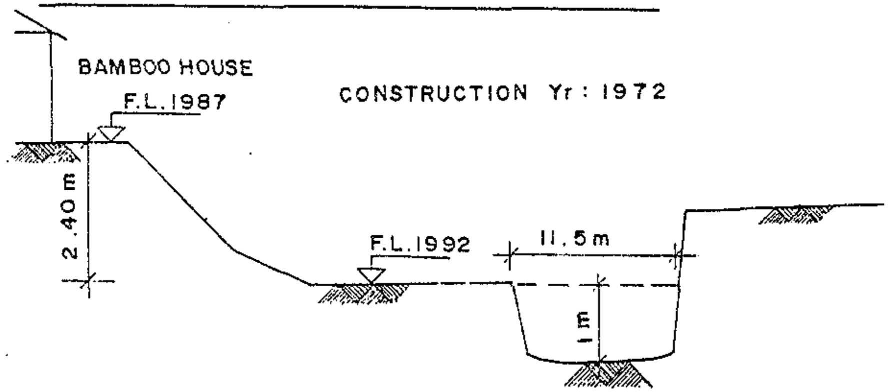
SECTION LOCATION: 15m D/S OF BRIDGE

SECTION NO.14

DATE: 6|9|92

BAGMATI BRIDGE; MINBHAWAN (Br. No.3)

CONSTRUCTION Yr: 1972

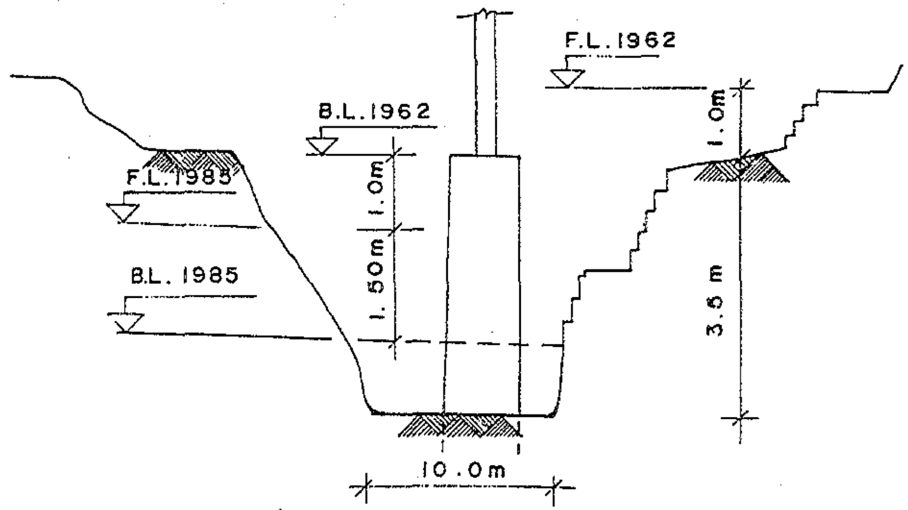


SECTION LOCATION: 30m U/S OF BRIDGE

SECTION NO. 15

DATE: 7|9|92

BAGMATI BRIDGE, PRAYAG GHAT (Br. No 2)



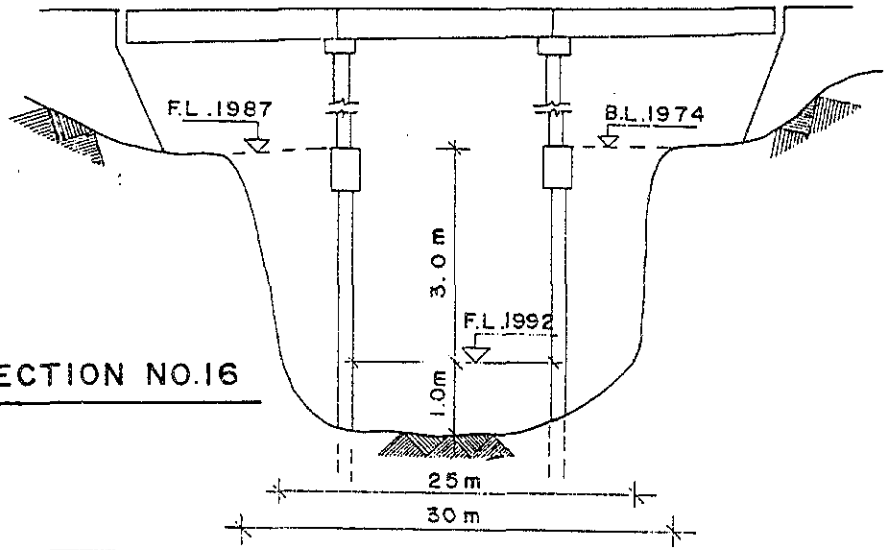
LOCATION: 20m U/S OF BRIDGE

SECTION NO. 17

DATE: 6|9|92

BAGMATI BRIDGE; TIL GANGA, PASUPATI (Br. No 1)

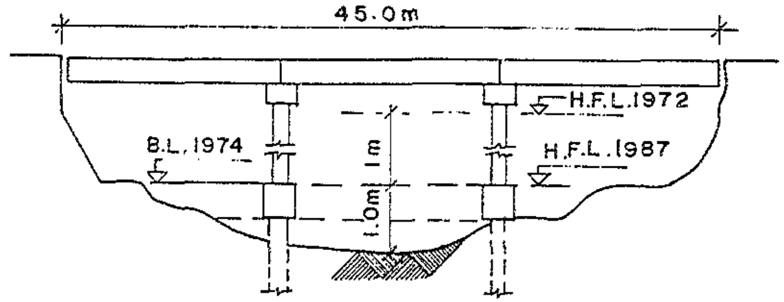
CONSTRUCTION 1974



SECTION NO.16

DATE: 6|9|92

DHOBI KHOLA; CHABAHIL RING ROAD (Br.No11)

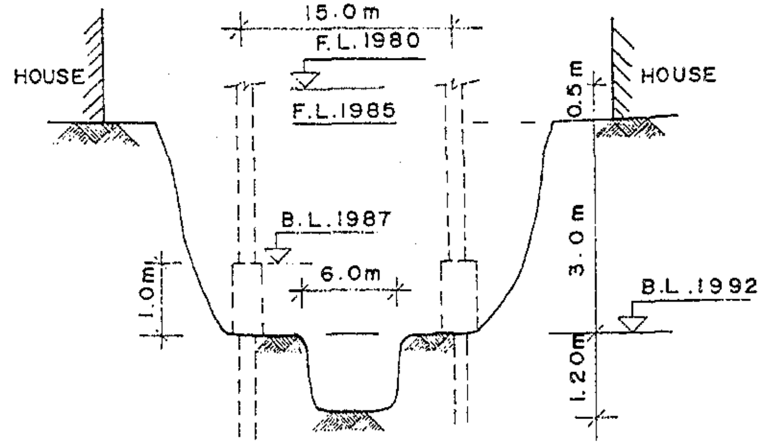


SECTION LOCATION: 15m D/S OF BRIDGE

SECTION NO.18

DATE: 7|9|92

DHOBI KHOLA; MAITI DEVI (Br. No13)

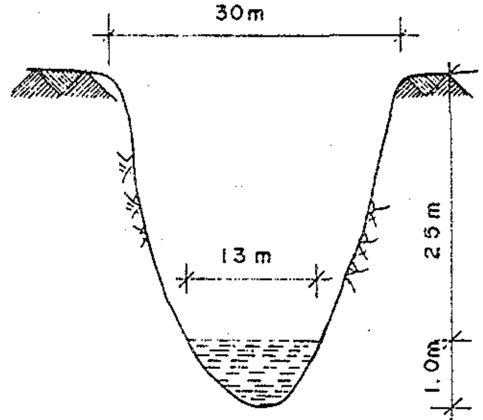


SECTION LOCATION: 10m D/S OF BRIDGE

SECTION NO.19

DATE: 24|9|92

BAGMATI RIVER, CHOVAR

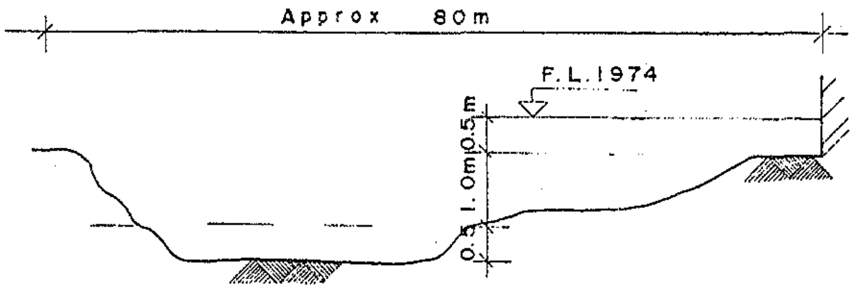


SECTION LOCATION: 15m U/S OF BRIDGE AT CHOVAR

SECTION NO.21

DATE: 6|9|92

BISHNUMATI BRIDGE; TEKU (Br. No.10)

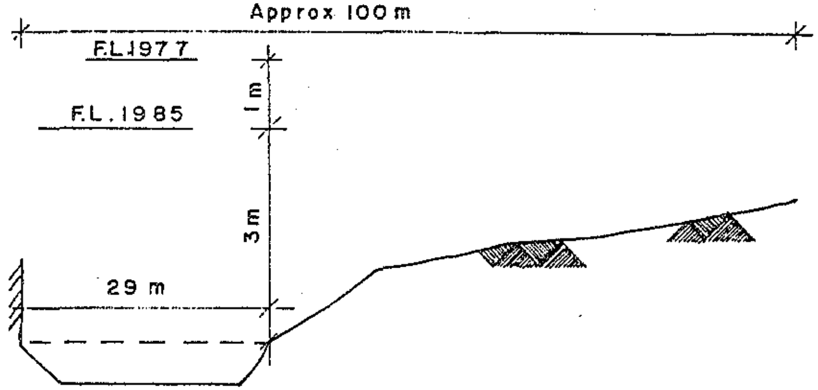


SECTION LOCATION: 15m D|S OF BRIDGE.

SECTION NO.20

DATE: 24|19|92

BAGMATI RIVER, KHOKANA VILLAGE, KHOKANA BRIDGE



SECTION LOCATION: 10m U/S OF KHOKANA BRIDGE

SECTION NO.22

Table A.4.3.3(1) MAXIMUM DAILY RAINFALL RECORD (1)

YEAR	KAKANI		TOKHA		SUNDARIJAL		INDIAN EMBASSY	
	DATE	RAINFALL	DATE	RAINFALL	DATE	RAINFALL	DATE	RAINFALL
1940	-	-	-	-	*	*	-	-
1941	-	-	-	-	AUG.08	102.1	-	-
1942	-	-	-	-	AUG.14	111.8	-	-
1943	-	-	-	-	JUL. 20	137.4	-	-
1944	-	-	-	-	AUG. 10	91.4	-	-
1945	-	-	-	-	AUG. 02	126.5	-	-
1946	-	-	-	-	JUL. 05	147.6	-	-
1947	-	-	-	-	*	*	*	*
1948	-	-	-	-	AUG.26	95.0	AUG. 27	81.8
1949	-	-	-	-	JUL. 01	58.0	MAY. 18	61.0
1950	-	-	-	-	JUL. 14	87.1	JUN. 21	104.6
1951	-	-	-	-	AUG. 17	51.3	JUN. 30	66.0
1952	-	-	-	-	AUG.27	74.7	AUG. 27	58.7
1953	-	-	-	-	JUL. 01	105.9	JUL. 02	115.6
1954	-	-	-	-	JUL. 27	162.6	JUL. 27	173.2
1955	-	-	-	-	*	*	JUL. 26	52.8
1956	-	-	-	-	AUG.17	72.4	MAY. 25	54.4
1957	-	-	-	-	AUG. 30	58.4	AUG. 06	57.9
1958	-	-	-	-	*	*	SEP. 06	58.9
1959	-	-	-	-	AUG.11	86.4	JUL. 14	48.1
1960	-	-	-	-	JUL. 25	61.0	JUL. 29	59.4
1961	-	-	-	-	MAR. 16	127.0	AUG. 13	87.4
1962	JUN. 13	146.8	-	-	JUN. 10	116.8	JUN.10	72.4
1963	AUG. 19	92.2	-	-	AUG.31	121.9	JUL. 21	54.0
1964	AUG. 18	127.5	-	-	JUL. 14	83.8	JUN. 21	84.2
1965	JUL. 09	73.4	-	-	JUL. 08	66.5	JUN. 18	72.0
1966	-	-	-	-	JUN. 30	86.4	AUG. 24	115.2
1967	-	-	-	-	AUG. 23	85.0	JUL. 10	134.0
1968	-	-	-	-	JUL. 15	82.0	OCT. 05	75.4
1969	-	-	-	-	AUG.19	77.4	AUG. 19	59.1
1970	-	-	-	-	MAY. 21	95.2	JUL. 15	68.0
1971	-	-	-	-	JUN. 11	93.1	JUN. 12	109.0
1972	JUL. 28	161.0	-	-	NOV. 27	92.4	JUL. 28	107.4
1973	SEP. 18	160.0	JUL. 19	120.0	*	*	AUG. 11	96.9
1974	MAR. 30	100.0	JAN. 15	83.5	MAY. 31	90.2	SEP.11	53.4
1975	JUL. 08	74.0	JUL. 30	94.4	AUG. 03	131.2	JUL. 28	89.9
1976	JUL. 23	80.0	JUL. 10	71.2	MAY. 21	99.4		
1977	JUL. 04	100.0	AUG. 01	80.4	AUG. 22	87.4		
1978	JUN . 06	148.7	MAR.12	61.4				
1979	JUL. 02	139.0	JUL. 23	90.6				
1980	JUN. 25	156.0	JUN. 19	130.0				
1981	AUG. 30	131.0						
1982	*	*						
1983	JUN. 24	144.0						
1984	AUG. 26	124.0						
1985	AUG. 04	100.0						
1986	JUL. 16	116.0						
1987	OCT. 20	88.0						
1988	AUG. 07	83.2						
1989	JUL. 30	132.0						
1990	AUG. 15	97.6						
1991	AUG. 07	85.5						

Table A.4.3.3(2) MAXIMUM DAILY RAINFALL RECORD (2)

YEAR	SANKHU		KATHMANDU AIRPORT		NAGARKOT		THANKOT	
	DATE	RAINFALL	DATE	RAINFALL	DATE	RAINFALL	DATE	RAINFALL
1940	-	-	-	-	-	-	-	-
1941	-	-	-	-	-	-	-	-
1942	-	-	-	-	-	-	-	-
1943	-	-	-	-	-	-	-	-
1944	-	-	-	-	-	-	-	-
1945	-	-	-	-	-	-	-	-
1946	-	-	-	-	-	-	-	-
1947	-	-	-	-	-	-	-	-
1948	-	-	-	-	-	-	-	-
1949	-	-	-	-	-	-	-	-
1950	-	-	-	-	-	-	-	-
1951	-	-	-	-	-	-	-	-
1952	-	-	-	-	-	-	-	-
1953	-	-	-	-	-	-	-	-
1954	-	-	-	-	-	-	-	-
1955	-	-	-	-	-	-	-	-
1956	-	-	-	-	-	-	-	-
1957	-	-	-	-	-	-	-	-
1958	-	-	-	-	-	-	-	-
1959	-	-	-	-	-	-	-	-
1960	-	-	-	-	-	-	-	-
1961	-	-	-	-	-	-	-	-
1962	-	-	-	-	-	-	-	-
1963	-	-	-	-	-	-	-	-
1964	-	-	-	-	-	-	-	-
1965	-	-	-	-	-	-	-	-
1966	-	-	-	-	-	-	*	*
1967	-	-	-	-	-	-	*	*
1968	-	-	OCT. 05	80.4	-	-	*	*
1969	-	-	AUG. 19	48.5	-	-	AUG.12	46.2
1970	-	-	JUL. 16	73.5	-	-	May-18	92.0
1971	AUG.07	44.0	JUN. 12	83.6	*	*	JUN. 12	126.8
1972	JUN. 03	90.0	JUL. 28	102.8	JUL. 16	60.8	JUL. 28	134.8
1973	JUL. 05	46.0	JUL. 25	102.0	AUG. 07	94.0	OCT. 13	112.0
1974	JUL. 31	46.0	AUG. 21	71.2	JUL. 23	80.8	May-02	132.4
1975	SEP. 27	44.0	AUG. 03	89.2	JUL. 28	81.2	JUL. 28	100.4
1976	May-11	40.8	JUN. 10	73.2	AUG. 23	82.0	JUN. 02	106.4
1977	JUL. 02	40.8	AUG. 05	57.6	JUN. 20	88.5	AUG. 10	60.8
1978	JUL. 16	126.0	AUG.10	71.2	JUL. 28	92.1	JUL. 16	135.0
1979	AUG. 14	90.0	JUL. 24	86.0	JUL. 24	96.4	JUL. 24	132.0
1980	JUL. 14	80.0	JUN. 09	100.1	JUN. 09	95.5	JUN. 09	84.4
1981	May-16	67.5	May-21	53.5	JUL. 29	79.3	SEP. 29	100.3
1982	JUL. 06	60.0	JUN. 28	87.6	AUG. 15	69.0	SEP. 14	41.3
1983	JUL. 22	102.0	JUL. 17	72.0	AUG. 02	72.5	SEP. 22	75.9
1984	AUG. 13	85.0	AUG. 16	76.5	JUN. 28	85.0	SEP. 08	75.1
1985	May-01	80.5	SEP. 17	69.3	*	*	SEP. 15	80.1
1986	JUL. 31	80.0	JUL. 16	77.6	JUL. 31	179.4	JUN. 24	100.5
1987	OCT. 20	95.5	OCT. 20	124.4	OCT. 20	90.6	OCT. 20	157.4
1988	AUG.1,JUN18	65.0	JUL. 12	66.0	AUG. 01	72.4	SEP. 08	122.4
1989	AUG. 08	82.0	JUL. 30	57.0	AUG. 08	97.6	JUL. 16	70.3
1990	JUL.9, AUG. 9	92.0	May-29	73.2	JUL. 14	101.2	AUG. 27	116.2
1991	AUG. 08	91.0	AUG. 15	44.7	JUN.01	92.5	AUG.28	54.3

Table A.4.3.3(3) **MAXIMUM DAILY RAINFALL RECORD (3)**

YEAR	BHAKTAPUR		KHUMALTAR		GODAVARI	
	DATE	RAINFALL	DATE	RAINFALL	DATE	RAINFALL
1940	-	-	-	-	-	-
1941	-	-	-	-	-	-
1942	-	-	-	-	-	-
1943	-	-	-	-	-	-
1944	-	-	-	-	-	-
1945	-	-	-	-	-	-
1946	-	-	-	-	-	-
1947	-	-	-	-	-	-
1948	-	-	-	-	-	-
1949	-	-	-	-	-	-
1950	-	-	-	-	-	-
1951	-	-	-	-	-	-
1952	-	-	-	-	-	-
1953	-	-	-	-	JUL. 27	57.2
1954	-	-	-	-	JUL. 26	174.0
1955	-	-	-	-	AUG. 06	83.2
1956	-	-	-	-	May-24	90.0
1957	-	-	-	-	AUG. 05	66.2
1958	-	-	-	-	OCT. 03	60.7
1959	-	-	-	-	JUL. 25	111.5
1960	-	-	-	-	JUL. 06	77.5
1961	-	-	-	-	*	*
1962	-	-	-	-	JUN. 28	97.2
1963	-	-	-	-	*	*
1964	-	-	-	-	*	*
1965	-	-	-	-	*	*
1966	-	-	-	-	*	*
1967	-	-	*	*	*	*
1968	-	-	OCT. 05	117.0	*	*
1969	-	-	AUG. 19	45.0	-	-
1970	-	-	JUL. 16	100.0	*	*
1971	*	*	JUN. 12	90.0	JUN.11	123.0
1972	JUL. 28	58.8	JUL. 28	48.0	JUL. 20	109.4
1973	*	*	JUL. 25	85.0	JUL. 25	122.2
1974	*	*	-		JUL. 15	88.0
1975	JUN. 28	41.6	JUL. 28	101.6	JUL. 28	159.6
1976	AUG. 08	54.4	SEP. 19	62.0	JUN. 10	117.4
1977	AUG. 28	67.2	JUN. 07	60.2	JUL. 08	114.2
1978	OCT. 06	74.3	JUL. 03	135.0	OCT. 06	99.4
1979	JUL. 24	73.8	AUG. 21	86.0	JUL. 24	96.8
1980	JUN. 09	69.5	JUN. 09	58.2	JUN. 19	103.1
1981	SEP.29	51.9	SEP. 29	85.5	SEP. 30	168.5
1982	JUL. 04	41.3	APR. 27	76.0	JUL. 07	68.0
1983	JUL. 16	80.5	JUL. 05	70.0	JUL. 04	84.0
1984	AUG. 26	69.1	SEP. 06	65.5	SEP. 06	110.0
1985	SEP. 05	78.6	SEP. 05	71.5	JUL. 07	119.5
1986	JUN.29	107.6	JUN. 29	73.0	JUL. 26	96.0
1987	AUG. 06	62.0	OCT. 21	118.0	OCT. 20	172.0
1988	JUN. 18	96.0	DEC. 27	78.0	DEC. 26	63.5
1989	SEP. 21	68.8	JUL. 01	51.0	AUG. 07	68.2
1990	AUG. 12	62.6	JUL. 14	62.6	AUG. 13	110.0
1991	JUL. 08	41.0	APR. 01	44.2	JUL. 08	92.8

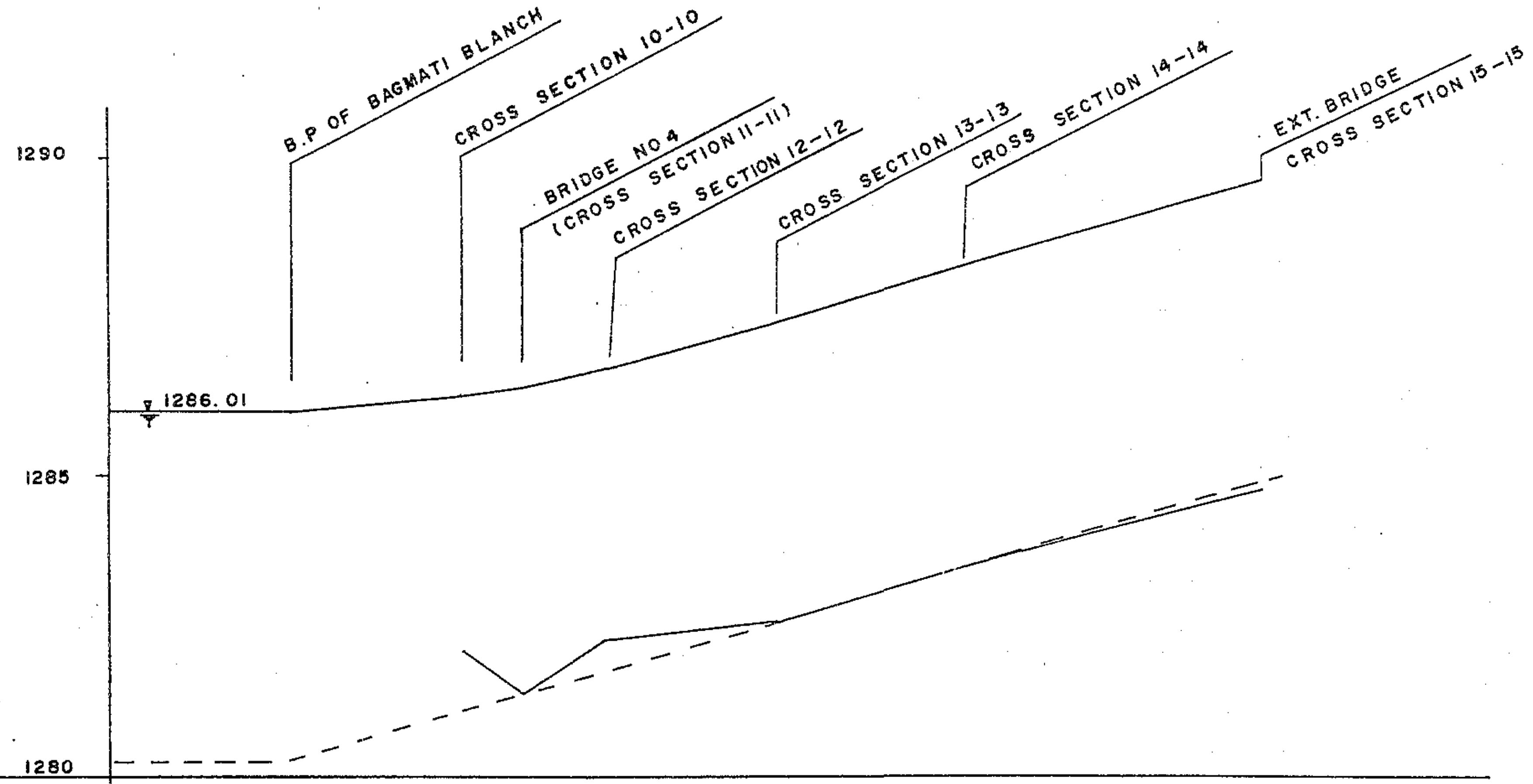
Table A.4.3.3(4) PROBLE DAILY RAINFALL

Return Period (Years)	Method		
	Hazen	Gambel	Pearson III
2	98.79	98.60	98.29
5	128.26	130.90	127.43
10	146.35	152.29	146.48
20	164.45	172.80	164.23
50	186.89	199.35	188.18
80	198.40	212.86	200.05
100	203.71	219.25	205.94
200	220.30	239.07	223.91

Table A.4.3.8 **Calculation Of Flood Water Level**

	Return Period (Years)	W.D. (m)	A (Sq. m.)	P (m)	R (m)	I	V (m/s)	Q=A.V (m^3/s)	Design F.D. (m^3/s)	W.L. Of Flood
Bagmati	100	4.30	500.00	220.00	2.27	1/400	2.88	1440.51	1367.49	1277.30
Bridge NO. 1	10	4.10	410.00	210.00	1.95	1/400	2.60	1067.44	972.66	1277.10
Bagmati	100	4.20	354.00	129.18	2.74	1/400	3.26	1155.38	1121.01	1280.10
Bridge NO. 2	10	3.70	285.00	125.00	2.28	1/400	2.89	822.84	797.35	1279.60
Bagmati	100	4.20	390.00	182.00	2.14	1/400	2.77	1080.38	1061.28	1284.20
Bridge NO. 3	10	3.48	324.54	182.09	1.78	1/400	2.45	795.13	754.86	1283.68
Bagmati *	100								217.17	1286.45
Bridge NO. 4	10								154.47	1285.94
Manahara Ri.	100	4.64	280.00	117.00	2.39	1/400	2.98	834.94	822.14	1286.07
(C.S.-16-16)	10	4.14	240.00	107.00	2.24	1/400	2.86	685.40	584.77	1285.57
Dhobi Khola	100	3.01	60.72	62.45	0.97	1/250	2.07	125.63	104.68	1284.15
(C.S. 18-18)	10	2.50	45.00	50.00	0.90	1/250	1.97	88.43	74.45	1283.60

* Given by non-uniform flow calculation



FLOOD WATER LEVEL	1286.01	1286.10	1286.45	1286.50	1286.85	1288.35	1289.72
RIVER BED LEVEL		1282.09	1281.39	1283.31	1283.57	1284.52	1285.73
DISTANCE	0.00	290.00	390.00	530.00	810.00	1140.00	1620.00

FIG. A.4.3.3 FLOOD WATER LEVEL OF BAGMATI BLANCH