agricultural production and development of other sectors, 2) dependability on the other sectors, 3) capacity of implementing agency.

During the first 5 years of the master plan period, only the supply of inputs in the central level will be implemented. Other components will be suspended because most of the components of marketing and processing aspects are depending upon the progress of the construction of the basic infrastructure and promotion of agricultural production. During the second and third 5 years, most of the components will start. Establishment of the large scale public wholesale market in the Terai area will be started in the last (third) 5 years.

2.4 Organization for Project Implementation

The central level projects will be implemented under the executing agencies in charge of each component such as AIC and NFC. Public wholesale market will be constructed by formulating a committee which will consist of members from the agencies concerned. The district level projects will be implemented under the local administration, mainly district panchayats.

2.5 Organization for Project Operation

After the completion of the construction, the executing agencies operate the projects through training of staff.

3. COST ESTIMATE AND PRICE FORECAST

3.1 Cost Estimate

The project cost of the master plan consists of the construction cost of buildings and facilities, operation and maintenance cost, other recurrent costs such as training of staff and farmers, and initial operation cost of marketing organizations. The construction cost includes equipments necessary to the facilities.

The project cost is estimated on the basis of the price level of the middle of 1989. In terms of exchange rate, US$ 1.00 is equivalent to Rs. 28.00 and to ¥ 141.00. Foreign currency portion is assumed at 60% of the construction cost. Price escalation factor is assumed at 12.0% for local currency portion and 3.5% for foreign currency portion.

The project cost is summarized as follows;

(Unit : 1,000)

Item	Central	District	Total
Construction			
(direct cost)	221,000	84,800	305,800
(price escalation)			716,600
O & M	11,050	4,240	15,290
Recurrent	18,595	4,000	22,595
Operation fund	2,000	28,900	30,900

3.1.1 Construction Cost

The construction cost includes costs for the the central level projects and the district level projects. The construction costs include equipments necessary to the building and facilities. The direct construction costs are summarized as follows.

Direct Construction Cost

(Unit : Rs 10^3)

Central Level Project	
(1) Agricultural Input Supply	
Agricultural Input Corporation	15,000
(2) Marketing of Agricultural Products	
Public wholesale market	200,000
Nepal Food Corporation	6,000
(3) Processing of Agricultural Products	-
(4) Total	221,000
District Level Project	
(1) Agricultural Input Supply	
Cooperatives	21,000
District warehouses	9,000
(2) Marketing of Agricultural Products	
Haat bazar	44,400
Producers' groups and associations	1,600
Marketing groups	400
(3) Processing of Agricultural Products	
Grain mills	400
Processing facilities of cash crops	8,000
(4) Total	84,800
Total	305,800

Price escalation is estimated at Rs. 716.7 million for 15 years of the project period. The annual disbursement schedule is shown in Table D.3.2.

3.1.2 Operation and Maintenance Cost

The annual costs for operation and maintenance includes the salaries of the technical and administrative staff, costs of fuel and electricity for operation, repair and maintenance cost of the facilities and equipments, etc. Since the salaries of the technical and administrative staff of the district panchayat administration will be born by the government budget, the costs for operation and maintenance include the salaries of staff newly employed. The operation and maintenance cost is assumed at 5% of the direct construction cost as follows.

Operation and Maintenance Cost

(Unit : Rs 10^3)

Central Level Project	
(1) Agricultural Input Supply	
Agricultural Input Corporation	750
(2) Marketing of Agricultural Products	
Public wholesale market	10,000
Nepal Food Corporation	300
(3) Processing of Agricultural Products	-
(4) Total	11,050
District Level Project	
(1) Agricultural Input Supply	
Cooperatives	1,050
District warehouses	450
(2) Marketing of Agricultural Products	
Haat bazar	2,220
Producers' groups and associations	80
Marketing groups	20
(3) Processing of Agricultural Products	
Grain mills	20
Processing facilities of cash crops	400
(4) Total	4,240
Total	15,290

3.1.3 Recurrent Cost

After the implementing each project components, training of staff and supply of inputs will be carried out every year during project periods. These costs are estimated as a recurrent cost as follows.

Recurrent Cost

(Unit : Rs 10^3/year)

Item	Agricultural Input Supply	Marketing System Agricultural Products	Processing Agricultural Agricultural Products	Total
(1) Training of Staff				
Central level	500	1,000	-	1,500
District level	1,000	2,000	1,000	4,000
(2) Supply of certified seed				
Central level	17,095	-	-	17,095
District level	-	-	-	-
(3) Total	18,595	3,000	1,000	22,595

3.1.4 Operational Fund for Marketing Organization

After establishment of marketing organizations, operational fund will be provided as a revolving fund to each organization as follows.

Operational Fund

(Unit : Rs 10^3)

Central Level Project	
(1) Agricultural Input Supply	
Agricultural Input Corporation	-
(2) Marketing of Agricultural Products	
Public wholesale market	2,000
Nepal Food Corporation	-
(3) Processing of Agricultural Products	-
(4) Sub-total	2,000
District Level Project	
(1) Agricultural Input Supply	
Cooperatives	4,200
District warehouses	-
(2) Marketing of Agricultural Products	
Haat bazar	22,200
Producers' groups and associations	1,600
Marketing groups	400
(3) Processing of Agricultural Products	
Grain mills	-
Processing facilities of cash crops	500
(4) Sub-total	28,900
Total	30,900

3.2 Price Forecast of Agricultural Inputs and Products

Financial Prices of farm inputs and outputs were estimated on the basis of the current market or farmgate prices prevailing in the project area of 1989.

Economic prices for tradable products such as paddy, wheat, soybean, mustard, and farm inputs such as fertilizers and agro-chemicals were estimated on the basis of the projected world market prices of the World Bank in the long term range for the periods of 1988 to 1995. The world market prices of tradable goods were converted to 1989 constant prices by the rate of 1.495 based on the manufacturing unit value index. Details of those forecast are presented in Table D.3.3. Economic prices of domestic cost elements and other products are multiplied by standard conversion factor (SFC) of 0.90. Financial and economic prices of products and inputs are shown in Table D.3.4.

4. PRIORITY PROJECT

4.1 Selection of the Priority Project

Development of marketing and processing aspect will be required in the various levels of agencies or individuals to promote agricultural production according to the demand raised by the progress of development of other sectors such as agricultural production promotion, rural road, plan implementation capacities of local administrations, human resources, etc. Out of the components of the marketing and processing aspect, some are heavily depending on the developments of other sectors, and the following components should be carried out according to the progress of the development of the other sectors.

1) Improvement and reinforcement of agricultural supply in the distributors and farmers levels,

2) Improvement of marketing system of agricultural products, and

3) Development of processing and preserving aspects of agricultural products.

On the other hand, the input supply system of AIC should be improved especially in the hill area as the essential prerequisite investment of agricultural production, because the present supply of inputs are too small to promote agricultural production. In this regard, construction of storages for inputs as the distribution bases along the main road side in the hill area is selected as the priority project of the marketing and processing aspects.

4.2 Location

Presently, AIC has the storage facilities of 250 ton at Tamghas in Gulmi district and 150 ton at Sandhikharkha in Arghakhanchi district. Although these capacity and locations are not enough to promote agricultural production planned in the master plan, it is not practical to increase locations and storage capacity in large scale. Besides AIC has the policy to minimize the administration cost. In addition to the improvement and rehabilitation of facilities of the present locations, Ridi Bazar in Gulmi district is selected because of convenience of distribution.

Capacity of facility is estimated at 900 ton for fertilizers and agro-chemicals and 100 ton for certified seeds at each location, on the basis of the covering area of these locations.

(1) Location (Gulmi and Arghakhanchi districts)

- Ridi Bazar and Tamghas (2 locations) in Gulmi district.
- Sandhikharkha (1 location) in Arghakhanchi district.

(2) Facilities in Each Site

1) 3 storage for fertilizers and agro-chemicals (capacity : 300 ton)
   Total storage capacity : 900 ton
2) 2 storage for certified seeds (capacity: 50 ton)
   Total storage capacity : 100 ton
3) Office building and quarter.

4.3 Estimated Construction Cost

Construction cost of the facilities are roughly estimated on the basis of the unit construction cost by referring the other projects.

3 storage for fertilizers and agro-chemicals	:	Rs. 2.5 million
2 storage for certified seeds	:	Rs. 1.0 million
Office building and quarter and equipments	:	Rs. 1.5 million
Total in 1 location	:	Rs. 5.0 million

Rs 5 million x 3 locations = Rs 15 million.

TABLES

Table D.1.1 Price of Inputs

Item		Unit	Price (Rs)
Fertilizers	Ammonium Sulfate (N=21%)	Rs/ton	3,050
	Urea (N=46%)	Rs/ton	3,990
	Complex (NPK=20:20:0)	Rs/ton	4,375
	Potash (KCl, K=60%)	Rs/ton	2,190
	TSP (P=48%)	RS/ton	3,700
Seed	Paddy	Rs/kg	650
	Wheat	Rs/kg	625
	Maize	Rs/kg	845
	Tomato	Rs/kg	250
	Radish	Rs/kg	74
	Cowliflower	Rs/kg	195
	Peas	Rs/kg	30
	Cabbage	Rs/kg	120
	Onion	Rs/kg	135
	Oilseed	Rs/kg	65
	Carrot	Rs/kg	120
	Cucumber	Rs/kg	310
	Lady's finger (Okura)	Rs/kg	40
	Bringer	Rs/kg	155
	Bean	Rs/kg	60
Agro-chemicals	Parathion	bottle	30.18
	Quickphos	bottle	9.30
	Zinc-phosphate	kg	177.56
	V.H.P.	100kg	527.42
	Malathion	kg	9.52
	Metacid	bottle	37.91
	Thiodon	bottle	36.11
	Diothene	45kg	173.27
	Aldrin	kg	49.13
	Vitabex	kg	232.68
	Sumichidon	bottle	42.05
	Sumithion	bottle	20.05
	Agri-lime	100kg	215.42
	Tolkan	kg	580.27
	24-D	kg	153.37
	Bebiston	kg	892.50
Instruments	Sprayer	no.	1,251.15
	Sprayer washer set	set	48.48
	Shower (10 liter)	no.	73.12
	Shower (5 liter)	no.	57.50
	Small Hoe	no.	17.0
	Leki	no.	36.61
	Small spade	no.	15.0
	Weeding spade	no.	5.41
	Spade	no.	37.94
	Sickle	no.	32.20
	Grass cutting	no.	21.37

Source: Agricultural Input Corporation, 1988.

Table D.1.2 Sales Amount of Fertilizer in the Project Area
(Nutrient Content Base)

(Unit:ton)

Item	Rupandehi	Kapilvastu	Gulmi	Arghakhanchi	Total
Nitrogen content (Urea, D.A.P, Complex))					
1983/84	1,622	845	111	73	2,651
1984/85	1,560	1,104	33	79	2,776
1985/86	1,734	1,130	170	81	3,115
1986/87	1,855	1,113	178	93	3,239
1987/88	2,281	1,538	165	104	4,088
Average	1,810	1,146	131	86	3,174
	(57%)	(36%)	(4%)	(3%)	(100%)
Phosphorus content (T.S.P, Complex)					
1983/84	529	390	61	37	1,017
1984/85	661	541	66	52	1,320
1985/86	708	589	74	41	1,412
1986/87	804	586	90	46	1,526
1987/88	1,096	789	55	40	1,980
Average	760	579	69	43	1,451
	(52%)	(40%)	(5%)	(3%)	(100%)
Potasium content (Potash)					
1983/84	25	62	2	2	91
1984/85	21	33	1	1	56
1985/86	21	96	4	3	124
1986/87	9	28	3	3	43
1987/88	31	41	4	5	81
Average	21	52	3	3	79
	(27%)	(65%)	(4%)	(4%)	(100%)

Source: Agricultural Input Corporation.
Remarks; N content Urea:46%, D.A.P.:21%, Complex:20%
P content T.S.P.:48%, Complex:20%
K content Potash (KCl):60%

Table D.1.3 Estimation of the Marketable Surplus in the Kapilvastu and Rupandehi Districts

District	Crop	Total Production (ton)	Seed/1 and Waste (ton)	Total Consumable Amount (ton)	Total Population in 1987 (preson)	Per/2 Capita Consumption (kg/year)	Total Annual Consumption (ton)	Marketable Surplus (ton)
		(1)	(2)	(3)=(1)-(2)	(4)	(5)	(6)=(4)x(5)	(7)=(3)-(6)
Kapilvastu								
	Paddy	137,100	17,800 /3	119,300	309,900	147.6	45,700	73,600
	Wheat	23,400	3,000	20,400	309,900	24.8	7,700	12,700
	Maize	2,100	300	1,800	309,900	5.7	1,800	0
	Total	162,600	21,100	141,500	309,900	178.0	55,200	86,300
Rupandehi								
	Paddy	140,200	18,200 /3	122,000	472,300	148.7	70,200	51,800
	Wheat	29,800	3,900	25,900	472,300	24.8	11,700	14,200
	Maize	2,400	300	2,100	472,300	4.5	2,100	0
	Total	172,400	22,400	150,000	472,300	178.0	84,000	66,000
Total								
	Paddy	277,300	36,000 /3	241,300	782,200	148.2	115,900	125,400
	Wheat	53,200	6,900	46,300	782,200	24.8	19,400	26,900
	Maize	4,500	600	3,900	782,200	5.0	3,900	0
	Total	335,000	43,500	291,500	782,200	178.0	139,200	152,300
Marchawar								
	Paddy	20,490	2,660 /3	17,830	89,700	174.4	15,640	2,190
	Wheat	100	10	90	89,700	1.0	90	0
	Maize	270	40	230	89,700	2.6	230	0
	Total	20,860	2,710	18,150	89,700	178.0	15960	2,190

/1 : Seeds and waste are estimated at 13% of the production.
/2 : Per capita consumption is estimated at 178.0 kg of grains, on the basis of the age structure and 210.0 kg of the average per capita consumption of Nepal in 1983 (FAO Food Balance Sheet).
/3 : Paddy (not milled rice).

Table D.1.4 Estimation of the Food Balance in the Hill Area

Crop	Seed[1] Total Production (ton)	Total and Wastes (ton)	Total Consumable Amount (ton)	Per Population in 1987 (person)	Total Capita Consumption (kg/year)	Annual Consumption (ton)
	(1)	(2)	(3)=(1)-(2)	(4)	(5)=(3)/(4)	(3)=(1)-(2)
Paddy	14,900	1,900	13,000	421,600	30.8[2]	13,000
Wheat	9,400	1,200	8,200	421,600	19.4	8,200
Maize	42,300	5,500	36,800	421,600	87.3	36,800
Millet	0	0	0	421,600	0.0	0
Others[3]	0	0	0	421,600	0.0	0
Subtotal[4]	66,600	8,600	58,000	421,600	137.6	58,000
Transported from Terai area	18,000	0	18,000	421,600	71.2[5]	18,000
Total	84,600	8,600	76,000	421,600	208.8	76,000

/1: Seeds and wastes are estimated at 13% of the Production.
/2: Paddy (not milled rice).
/2: Others include millet, barley, etc.
/4: Other cereals are not included in the consumption, because millet and others are usually utilized to prepare local wines and sometime feeded for livestock.
/5: Converted to rice as follows;
18,000 ton / 421,600 persons = 42.7 kg rice / person,
42.7 kg rice/person / 60% milling rate = 71.2 kg paddy / person)

Table D.1.5 Results of Interview Survey on Marketing of Cereals and Other Crops (1/5)

Bhutwal

No.	Procurement from		Commodity	Ammount (ton)	Destination to		No. of Dealers
No.1	100%	Farmers, Small middleman	Rice	100	60%-70% 30%-40%	Local retailer Small middlemen (Tansen, Palpa, Gulmi, Tamghas)	
No.2	99% 1%	Rice mills Small farmers	Rice	400	20% 80%	Local market Wholesellers 25 - 30 (Gulmi, Ridi, Tamghas, Palpa, Baglung)	10-20 dealers
	80% 20%	Middlemen Local farmers &retailers	Maize	150	20% 80%	Local market Wholesellers (Gulmi, Ridi, Tamghas, Palpa, Baglung)	
	90% 10%	Dal mill Bhairahawa Local market	Mill Dal	40	20% 80%	Local market Wholesellers (Gulmi, Ridi, Tamghas, Palpa, Baglung)	
	75% 25%	Farmers Middlemen	Paddy and wheat	800	20% 80%	Local market Wholesellers (Gulmi, Ridi, Tamghas, Palpa, Baglung)	
No.3	70%	Local retailer & middlemen (Taulihawa, Nawalparasi, Krishnanagar)	Rice	600	75%	Gulmi 25%	13 dealers Arghakhanchi
	30%	Middlemen from other area (Dhangadi, Mhendra Nagar, Dang, Nepalganj)					
	100%	Lumbini flour mill	Wheat flour	160	5% 95%	Gulmi, Arghakhanchi Local market	
	40% 60%	Local agents Middleman (Dang, Nepalganj, Mahendranagar, Dhangadi)	Maize	200	90% 10%	Gulmi, Arghakhanchi Local market	
	100%	Dal mill Bhairahawa	Mill Dal	300	90% 0.1	Gulmi, Arghakhanchi Local market	

Table D.1.5 Results of Interview Survey on Marketing of Cereals and Other Crops (2/5)

Bhutwal

No.	Procurement from		Commodity	Ammount (ton)	Destination to		No. of Dealers
No.4	100%	Farmers, rice mills, local markets	Rice	840	80%	Gulmi, Arghakhanchi (5-10 dealers)	
					20%	Local market	
	75%	Dal mill (Nepalganj)	Milled dall	150	80%	Gulmi, Arghakhanchi (5-10 dealers)	
	25%	Dal mill (Bhairahawa)		(low grade)			
					20%	Local market	
	100%	Nepalgaji oil mill, middleman, Local oil mill	Mustard oil	600tin (15kg/tin)	80%	Gulmi, Arghakhanchi (5-10 dealers)	
					20%	Local market	
		Farmers, middlemen	Wheat	100	60%	Birganji Mill	
					20%	Bairahawa Mill	
					20%	Local retail market	
No.5	20%	Farmers	Rice	240	98%	Local middlemen	
	80%	Middlemen			2%	Retailer (Barghat)	
	2%	Dall mill Bhairahawa	Dall	150		Local market	
	98%	Retailer					

Table D.1.5 Results of Interview Survey on Marketing of Cereals and Other Crops (3/5)

Taulihawa

		Procurement from	Commodity	Ammount		Destination to	No. of Dealers
No.1	100%	Local	Wheat	2.5		Local wholeseller and retailors	100
			Paddy	10			
			Rice	2.5			
No.2	100%	Farmers, small commision agents	Wheat	50-70	80-85%	Arghakhanchi	
			Paddy	200	15-20%	Local	
Remark	25-30%	Indian	Wheat			Rice mill	10 - 15
	20%	Indian	Paddy				
	0.2	Indian	Rice				
No.3		Farmers	Paddy	1000	75%	Tamghas/Sandhikharkha	
Rice mill		Middleman		62% milling	0.25	"Kathmandu, Bhairahawa, Butwal"	
No.4		Farmers	Paddy	600	30%	Arghakhanchi	
Rice mill		Middleman	Wheat		0.7	Bhairahawa	

Table D.1.5 Results of Interview Survey on Marketing of Cereals and Other Crops (4/5)

Krishnanagar

	Procurement from	Commodity	Ammount	Destination to		No. of Dealers
No.1	Farmers	Rice	250	40%	"Bhairahawa, Butwal, Local market"	10
	Small agents			10%	Kathmandu	
				50%	Narayanghat	
	Farmers	Wheat	200 - 300	50%	Bhairahawa/Kathmandu/Janakapur flour mills	
No.2	Farmers	Paddy	150	80%	Narayanghat	
	Small agents			20%	"Bhairahawa, local market"	
	Farmers	Wheat	500	25%	Hetauda flour mill	12
No.3		Custom milling				
No.4	Farmers	Paddy	200	75%	Bhairahawa	9
	Small agents			25%	Local market	
	Farmers	Wheat	100	65%	Hetauda mill	
	"Small agents, middlemen"			35%	Lumbini mill	
No.5	Farmers	Paddy	200	60%	Narayanghat	10
	Small agents			20%	Pokhara	
				20%	"Kathmandu, Bhairahawa, Birganji, Local market"	
	Farmers	Mustard seed	60 - 70	75%	Khathmandu	
	Small agents			25%	"Bhairahawa, Bitganji, Narayanghat, Biratnagar"	
	Farmers	Wheat	200 - 300	75%	Hetauda mill	
	Farmers	Dal	40	75%	Nepalganj	
No.6	Farmers	Paddy	650	20%	NFC	
Rice mill	Middlemen			20%	"Middleman, Butwal"	
				20%	"Middleman, Dang"	
	30% of wholesell grain from India			20%	"Middleman, Bhairahawa"	
No.7	Mill' depot	Paddy	1300	90%	Middlemen & marchants	
Rice mill	Middlemen				"(Dang, Narayanghat, Kathmandu, Bhairahawa)"	
				10%	"NFC, local market"	

Table D.1.5 Results of Interview Survey on Marketing of Cereals and Other Crops (5/5)

Bhairahawa

	Procurement from	Commodity	Ammount	Destination to	No. of Dealers
No.1	Middleman	Paddy	1500	40% Kathmandu	100
Mill owner				25% "Pokhara, hill area"	
	"10,000ton fron India"			0.35 "Narayani, Gandaki, Janakapur"	
No.2		Paddy	250	40% Kathmandu	
Mill owner				25% "Pokhara, hill area"	
				0.35 "Narayani, Gandaki, Janakapur"	
No.3			500	50% Kathmandu	40 - 50
Mill owner				0.5 Janakapur	
No.4 50%	"Dang,Chitowan"	Mustard	20	local	25 mill
Oil mill 0.5	Local				
No.5	"Bhairahawa, Naarparasi, Krishnanagar"	Wheat	6000	Kathmandu	
Flour mill	Narayani zone			Local	
	Nepalganji				
No.6	"Farmers, middleman, small agents"	dall	3000	40% Kathmandu	
Dall mill				0.6 "Hill (Walling, Pokhara, Palpa), local"	
No.7	Middlemen	dall	250	80% Kathmandu	
Dal mill	Depot in Bhairahawa			0.2 "Bhairahawa, Birganji"	
No.8	India	potato	480	Local	
Cold Store				Tansen	
	"Capacity:2,100ton"				

Table D.1.6 Deposits, Credits and Primary Sector Lendings of Commercial Banks

(Unit : Rs1,000)

District	Location	Bank	Total Deposit	Total Credit	Primary Sector Credit			
					Total	Agriculture	Industry	Service
Gulmi	Ridi Bazar	Rastriya Banijya Bank	11,761	3,746	825	274	423	128
	Tamghus	Rastriya Banijya Bank	26,074	9,433	56	25	31	0
	Purtighat	Rastriya Banijya Bank	3,082	3,199	212	51	99	62
	Sub-total		40,917	16,378	1,093	350	553	190
					100%	32%	51%	17%
Arghakhanchi	Balkot	Nepal Bank Limited	963	838	0	0	0	0
	Samdhikharkha	Rastriya Banijya Bank	13,522	11,728	236	14	155	67
	Thada	Rastriya Banijya Bank	1,363	665	382	124	197	62
	Sub-total		15,848	13,231	618	138	352	129
					100%	22%	57%	21%
Kapilvastu	Krishnanagar	Nepal Bank Limited	34,900	3,415	244	12	215	17
	Taulihawa	Rastriya Banijya Bank	38,227	3,783	866	92	556	218
	Bahadurganji	Rastriya Banijya Bank	7,933	3,156	1,109	234	635	240
	Kopahawa	Napal Arab Bank Limited	0	0	0	0	0	0
	Sub-total		81,060	10,354	2,219	338	1,406	475
					100%	15%	63%	21%
Rupandehi	Bairahawa	Nepal Bank Limited	72,984	110,062	28,606	828	26,589	1,189
	Butwal	Nepal Bank Limited	12,046	13,088	4,530	134	4,008	388
	Khasauli	Nepal Bank Limited	40,053	27,594	5,505	0	5,505	0
	Mahendra Sugar Mill	Nepal Bank Limited	9,556	31,614	960	831	129	0
	Manigram	Nepal Bank Limited	16,429	13,281	9,147	2,684	6,009	454
	Lumbini	Nepal Bank Limited	5,639	961	194	28	122	44
	Ram nagar	Nepal Bank Limited	2,623	1,216	321	162	62	94
	Bairahawa	Rastriya Banijya Bank	59,818	23,080	727	0	157	570
	Khasauli	Rastriya Banijya Bank	31,954	18,410	802	0	802	0
	Butwal Ind.Sector	Rastriya Banijya Bank	1,392	3,235	1,405	182	990	233
	Kotihawa	Rastriya Banijya Bank	1,847	867	0	0	0	0
	Dayanagar	Napal Arab Bank Limited	0	0	0	0	0	0
	Asuraina	Napal Arab Bank Limited	0	0	0	0	0	0
	Surajpura	Rastriya Banijya Bank	1,824	822	0	0	0	0
	Sub-total		256,165	244,230	52,197	4,849	44,373	2,972
					100%	9%	85%	6%
Total in the Project Area			393,990	284,193	56,127	5,675	46,684	3,766
					100%	10%	83%	7%

Table D.3.1 Estimation of Project Cost (1/2)

(Unit : Rs 1,000)

Itm	Quantity	Unit	Price	Amount
(1) Agricultural Input Supply				
1) Agricultural Input Corporation				
a) Establishment of Distribution in the Hill Area	3	locations	5,000	15,000
b) Training of Staff	1	L.S./year	500	500
c) Procurement of Inputs (cost of fertilizers is estimated in Annex A)				17,095
Certified Seed	2,630	ton/year	6.50	17,095
d) Operation and Maintenace	5%	of a)		750
e) Total				33,345
2) Establishment and Improvement of Cooperatives				
a) Construction	42	locations	500	21,000
b) Training of Staff	1	L.S./year	500	500
c) Operation Fund	42	L.S.	100	4,200
d) Operation and Maintenace	5%	of a)		1,050
e) Total				26,750
3) Establishment of Facilities in the District				
a) Construction	18	locations	500	9,000
b) Training of Staff	1	L.S./year	500	500
c) Operation Fund	18	L.S.		0
d) Operation and Maintenace	5%	of a)		450
e) Total				9,950
4) Total				
a) Construction	63	locations		45,000
b) Training of Staff	1	L.S./year		1,500
c) Operation Fund	1	L.S.		21,295
d) Operation and Maintenace	5%	of a)		2,550
e) Total				70,345
(2) Marketing System of Agricultural Products				
1) Establishment of Public Wholesale Market				
a) Construction	1	locations	200,000	200,000
b) Training of Staff	1	L.S./year	500	500
c) Operation Fund	1	L.S.	2,000	2,000
d) Operation and Maintenace	5%	of a)		10,000
e) Total				212,500
2) Reinforcement of Function of NFC				
a) Construction	3	locations	2,000	6,000
b) Training of Staff	1	L.S./year	500	500
c) Operation Fund	3	L.S.	0	0
d) Operation and Maintenace	5%	of a)		300
e) Total				6,800
3) Haat Bazar				
a) Construction	222	locations	200	44,400
b) Training of Staff	1	L.S./year	500	500
c) Operation Fund	222	L.S.	100	22,200
d) Operation and Maintenace	5%	of a)		2,220
e) Total				69,320

Table D.3.1 Estimation of Project Cost (2/2)

(Unit : Rs 1,000)

Itm	Quantity	Unit	Price	Amount
4) Formation of Producers' Groups and Associations				
a) Construction	16	locations	100	1,600
b) Training of Staff	1	L.S./year	500	500
c) Operation Fund	16	L.S.	100	1,600
d) Operation and Maintenace	5%	of a)		80
e) Total				3,780
5) Establishment of Small Marketing Group				
a) Construction	4	locations	100	400
b) Training of Staff	1	L.S./year	500	500
c) Operation Fund	4	L.S.	100	400
d) Operation and Maintenace	5%	of a)		20
e) Total				1,320
6) Trainig of District Staff				
a) Construction	0	locations	0	0
b) Training of Staff	1	L.S./year	500	500
c) Operation Fund	0	L.S.	0	0
d) Operation and Maintenace	5%	of a)		0
e) Total				500
7) Total				
a) Construction		locations		252,400
b) Training of Staff		L.S./year		3,000
c) Operation Fund		L.S.		26,200
d) Operation and Maintenace	5%	of a)		12,620
e) Total				294,220
(3) Processing of Agricultural Products				
1) Provision of Grain Mills				
a) Construction	2	locations	200	400
b) Training of Staff	1	L.S.	500	500
c) Operation Fund	1	L.S.		0
d) Operation and Maintenace	5%	of a)		20
e) Total				920
2) Processing Facilities of Cash Crops				
a) Construction	16	locations	500	8,000
b) Training of Staff	1	L.S./year	500	500
c) Operation Fund	1	L.S.	500	500
d) Operation and Maintenace	5%	of a)		400
e) Total				9,400
3) Total				
a) Construction		locations		8,400
b) Training of Staff		L.S./year		1,000
c) Operation Fund		L.S.		500
d) Operation and Maintenace	5%	of a)		420
e) Total				10,320
(4) Grand Total				
a) Construction		locations		305,800
b) Training of Staff		L.S./year		5,500
c) Operation Fund		L.S.		47,995
d) Operation and Maintenace	5%	of a)		15,590
e) Total				374,885

Table D.3.2 Annual Disbursement Schedule of Agriculture Marketing and Processing

(Unit : Rs 1,000,000)

Itm	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year	11th year	12th year	13th year	14th year	15th year	Total
CENTRAL LEVEL PROJECT																
(1) Agricultural Input Supply																
1) Agricultural Input Corporation	-	-	-	5.0	5.0	5.0	-	-	-	-	-	-	-	-	-	15.0
(2) Marketing System of Products																
1) Public Wholesale Market	-	-	-	-	-	-	-	-	-	-	66.7	66.7	66.7	-	-	200.1
2) Nepal Food Corporation	-	-	-			2.0	2.0	2.0	-	-	-	-	-	-	-	6.0
(3) Total	0.0	0.0	0.0	5.0	5.0	7.0	2.0	2.0	0.0	0.0	66.7	66.7	66.7	0.0	0.0	221.1
DISTRICT LEVEL PROJECT																
(1) Agricultural Input Supply																
1) Storage for Cooperatives	-	-	-	-	-	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	21.0
2) Storage for District	-	-	-	-	-	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	9.0
(2) Marketing System of Products																
1) Haat Bazar	-	-	-	-	-	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	44.4
2) Producers' Groups and Associations	-	-	-	-	-	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.6
3) Small Marketing Group	-	-	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
(3) Processing of Agricultural Products																
1) Provision of Grain Mills	-	-	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
2) Processing Facilities of Cash Crops	-	-	-	-	-	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	8.0
(4) Total	0.0	0.0	0.0	0.0	0.0	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	84.8
Total	0.0	0.0	0.0	5.0	5.0	15.5	10.5	10.5	8.5	8.5	75.2	75.2	75.2	8.5	8.5	305.9
Local currency portion (60%)	0.0	0.0	0.0	3.0	3.0	9.3	6.3	6.3	5.1	5.1	45.1	45.1	45.1	5.1	5.1	183.5
Foreign currency portion (40%)	0.0	0.0	0.0	2.0	2.0	6.2	4.2	4.2	3.4	3.4	30.1	30.1	30.1	3.4	3.4	122.4
Price escalation	0.0	0.0	0.0	6.6	7.1	23.6	17.3	18.7	16.3	17.7	170.5	185.3	201.8	24.8	27.1	716.7
Grand Total	0.0	0.0	0.0	11.6	12.1	39.1	27.7	29.1	24.8	26.2	245.6	260.5	276.9	33.3	35.6	1,022.6

Table D.3.3 Structure of Ecomic Price of Tradable Goods (1/3)

Itm	Unit	
Rice		
1) Projected 1995 World Market Price at 1989 constantprice (Thai 5% broken, FOB Bangkok)	US$/ton	259
2) Quality adustment	15%	220
3) Ocean freight and insurance at Calcutta	US$/ton	35
4) Transport/handling to Nepal Border	US$/ton	50
5) Total at Nepal Border	US$/ton	305
6) Equivalent in NRs(US$1=NRs28.00)	NRs/ton	8,540
7) Domestic transport/handling to wholesale point or mill	NRs/ton	-200
8) Wholesale price	NRs/ton	8,340
9) Processing ratio		65%
10) Ex-factory price of paddy	NRs/ton	5,420
11) Processing cost	NRs/ton	-180
13) Transport/handling to farmgate	NRs/ton	-90
14) Economic farmgate price	NRs/ton	5,150
Wheat	Unit	
1) Canadian No.1, Thunderbay, 1985 Constant Price	US$/ton	106
2) Projected 1995 World Market Price (MUV:1.495)	US$/ton	158
3) Ocean freight and insurance (Bangkok-Calcutta)	US$/ton	55
4) CIF Price at Calcutta Port	US$/ton	213
5) Transport and Handling from Nepal Border	US$/ton	50
6) Total at Nepal Border	US$/ton	263
7) Equivalent in NRs/ton (US$1=NRs28.00)	NRs/ton	7,380
8) Domestic Transport and Handling to/from Wholesale Point	NRs/ton	-200
9) Wholesale price	NRs/ton	7,180
10) Transport/Handling to/from Farmgate	NRs/ton	-90
11) Economic Farmgate Price	NRs/ton	7,090
Maize	Unit	
1) FOB US Gulf Port, 1985 Constant Price	US$/ton	68
2) Projected 1995 World Market Price (MUV:1.495)	US$/ton	102
3) Ocean freight and insurance (Bangkok-Calcutta)	US$/ton	55
4) CIF Price at Calcutta Port	US$/ton	157
5) Transport and Handling from Nepal Border	US$/ton	50
6) Total at Nepal Border	US$/ton	207
7) Equivalent in NRs/ton (US$1=NRs28.00)	NRs/ton	5,790
8) Domestic Transport and Handling to/from Wholesale Point	NRs/ton	-200
9) Wholesale price	NRs/ton	5,590
10) Transport/Handling to/from Farmgate	NRs/ton	-90
11) Economic Farmgate Price	NRs/ton	5,500

Table 3.3 Structure of Ecomic Price of Tradable Goods (2/3)

	Unit	
Oil Seed		
1) CIF Europe, 1985 Constant Price	US$/ton	327
2) Projected 1995 World Market Price (MUV:1.495)	US$/ton	489
3) Ocean freight and insurance (Calcutta)	US$/ton	40
4) CIF Price at Calcutta Port	US$/ton	529
5) Transport and Handling from Nepal Border	US$/ton	50
6) Total at Nepal Border	US$/ton	579
7) Equivalent in NRs/ton (US$1=NRs28.00)	NRs/ton	16,210
8) Domestic Transport and Handling to/from Wholesale Point or Mill	NRs/ton	-200
9) Wholesale price	NRs/ton	16,010
10) Processing Ratio		32%
11) Ex-factory price of paddy	NRs/ton	5,120
12) Processing Cost	NRs/ton	-750
13) Transport/Handling to/from Farmgate	NRs/ton	-90
14) Economic Farmgate Price	NRs/ton	4,280
Pulse/Soybeans	Unit	
1) CIF Rotterdam, 1985 Constant Price	US$/ton	198
2) Projected 1995 World Market Price (MUV:1.495)	US$/ton	296
3) Ocean freight and insurance (Calcutta)	US$/ton	40
4) CIF Price at Calcutta Port	US$/ton	336
5) Transport and Handling from Nepal Border	US$/ton	50
6) Total at Nepal Border	US$/ton	386
7) Equivalent in NRs/ton (US$1=NRs28.00)	NRs/ton	10,810
8) Domestic Transport and Handling to/from Wholesale Point	NRs/ton	-200
9) Wholesale price	NRs/ton	10,610
10) Transport/Handling to/from Farmgate	NRs/ton	-90
11) Economic Farmgate Price	NRs/ton	10,320
Sugarcane	Unit	
1) FOB Greater Caribbean port, 1985 Constant Price	US$/ton	224
2) Projected 1995 World Market Price (MUV:1.495)	US$/ton	335
4) Ocean freight and insurance (Calcutta)	US$/ton	40
5) CIF Price at Calcutta Port	US$/ton	375
6) Transport and Handling from Nepal Border	US$/ton	40
7) Total at Nepal Border	US$/ton	415
8) Equivalent in NRs/ton (US$1=NRs28.00)	NRs/ton	11,620
9) Domestic Transport and Handling to/from Wholesale Point or Mill	NRs/ton	-200
10) Wholesale price	NRs/ton	11,420
11) Processing Ratio		6%
12) Ex-factory price of sugarcane	NRs/ton	690
13) Processing Cost	NRs/ton	-100
14) Transport/Handling to/from Farmgate	NRs/ton	-50
15) Economic Farmgate Price	NRs/ton	540

Table D.3.3 Structure of Economic Price of Tradable Goods (3/3)

	Unit	Urea	T.S.P.	KCl
1) FOB, 1985 constant price	US$/ton	141	138	72
2) Projected 1995 world market price (MUV:1.495)	US$/ton	211	206	108
3) Ocean freight and insurance (Calcutta)	US$/ton	60	102	92
4) CIF price at Calcutta port	US$/ton	271	308	200
5) Transport/handling to Nepal border	US$/ton	40	40	40
6) Total at Nepal border	US$/ton	311	348	240
7) Equivalent in NRs (US$1=NRs28.00)	NRs/ton	8,700	9,750	6,710
8) Domestic transport/handling to wholesale point	NRs/ton	700	700	700
9) Transport and handling to farmgate	NRs/ton	50	50	50
10) Economic farmgate price	NRs/ton	9,450	10,500	7,460
11) Nutrient content	%	46%	48%	60%
12) Price per ton of nutrient content	NRs/ton	20,500	21,900	12,400

Urea:FOB Europe
T.S.P.(Triple Superphospate):FOB US Gulf
KCl (Potassium Chloride):FOB Vancouver

Table D.3.4 Financial and Economic Price of Inputs and Outputs (1/2)

Products		Unit	Financial price		Economic price	
			Terai	Hill	Terai	Hill
Paddy*		Nrs/kg	4.00	6.50	5.15	5.70
Wheat*		Nrs/kg	4.10	6.00	7.09	7.80
Maize*		Nrs/kg	4.40	5.50	5.50	6.10
Pulses*		Nrs/kg	16.13	17.17	10.32	11.40
Mustard*/oilseed*		Nrs/kg	13.00	14.00	4.28	4.70
Sugarcane*		Nrs/ton	400.00	400.00	540.00	-
Millet		Nrs/kg	5.50	6.88	4.95	6.19
Barley		Nrs/kg	5.00	6.25	4.50	5.63
Potato		Nrs/kg	4.50	4.00	4.05	3.60
Onion		Nrs/kg	4.00	7.00	3.60	6.30
Tomato		Nrs/kg	18.00	22.50	16.20	20.25
Dry chilly		Nrs/kg	36.00	45.00	32.40	40.50
Radish		Nrs/kg	8.00	10.00	7.20	9.00
Mandarine orange		Nrs/piece	2.00	2.50	1.80	2.25
Lemon		Nrs/piece	0.40	0.50	0.36	0.45
Chestnut		Nrs/kg	-	40.00	-	36.00
Coffee			-	22.00	-	19.80
Fish	common & grass carp	Nrs/kg	~~28.00~~	-	~~25.20~~	-
	indian major carp	Nrs/kg	~~30.00~~	-	~~27.00~~	-
	silver & big head carp	Nrs/kg	~~25.00~~	-	~~22.50~~	-
	average	Nrs/kg	27.67	-	24.90	-
Honey		Nrs/kg	100.00	100.00	90.00	90.00
Meat	Chiken	Nrs/kg	40.00	50.00	36.00	45.00
	goat	Nrs/kg	50.00	62.50	45.00	56.25
	buffalo	Nrs/kg	20.00	25.00	18.00	22.50
	mutton	Nrs/kg	54.60	68.25	49.14	61.43
	pork	Nrs/kg	18.00	22.50	16.20	20.25
Egg		Nrs/piece	2.00	2.50	1.80	2.25
Milk		Nrs/kg	7.50	9.38	6.75	8.44
Ghee		Nrs/kg	75.00	75.00	67.50	67.50

Table D.3.4 Financial and Economic Price of Inputs and Outputs (2/2)

Products		Unit	Financial price		Economic price	
			Terai	Hill	Terai	Hill
Fertilizer						
N	Urea	NRs/kg	3.99	3.99	9.45	10.40
	net N content	NRs/kg	8.67	8.67	20.50	22.60
P	TSP	NRs/kg	3.70	3.70	10.50	11.60
	net P content	NRs/kg	7.71	7.71	21.90	24.10
K	KCl	NRs/kg	2.19	2.19	7.46	8.20
	net K content	NRs/kg	3.65	3.65	12.40	13.60
Labour		man/day	15.00	15.00	13.50	13.50
Bullock		day	20.00	20.00	18.00	18.00
Seed						
	paddy	NRs/kg	6.50	6.50	5.85	6.40
	wheat	NRs/kg	6.25	6.25	5.63	6.20
	maize	NRs/kg	8.45	8.45	7.61	8.40
	other cereals	NRs/kg	7.07	7.07	6.36	7.00
	oil seed	NRs/kg	65.00	65.00	58.50	58.50
	vegetables and others	NRs/kg	120.00	120.00	108.00	118.80
	orchard seedling	NRs	50.00	50.00	45.00	49.50
Agro-chemicals						
	liquid	NRs/liter	117.00	117.00	105.30	115.80
	dust/granular	NRs/kg	79.00	79.00	71.10	78.20
	lime	NRs/kg	2.15	2.15	1.94	2.10

FIGURES

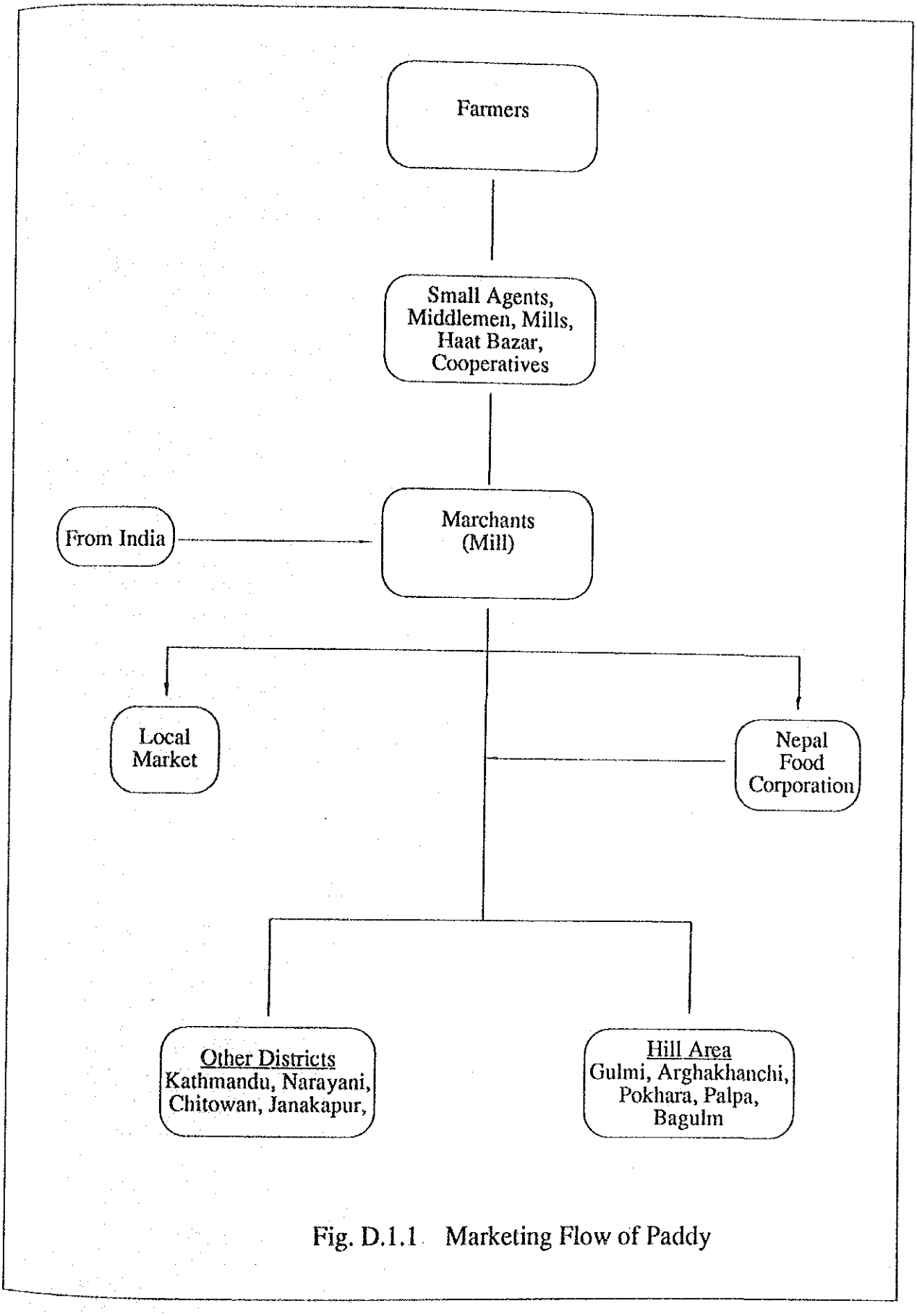

Fig. D.1.1 Marketing Flow of Paddy

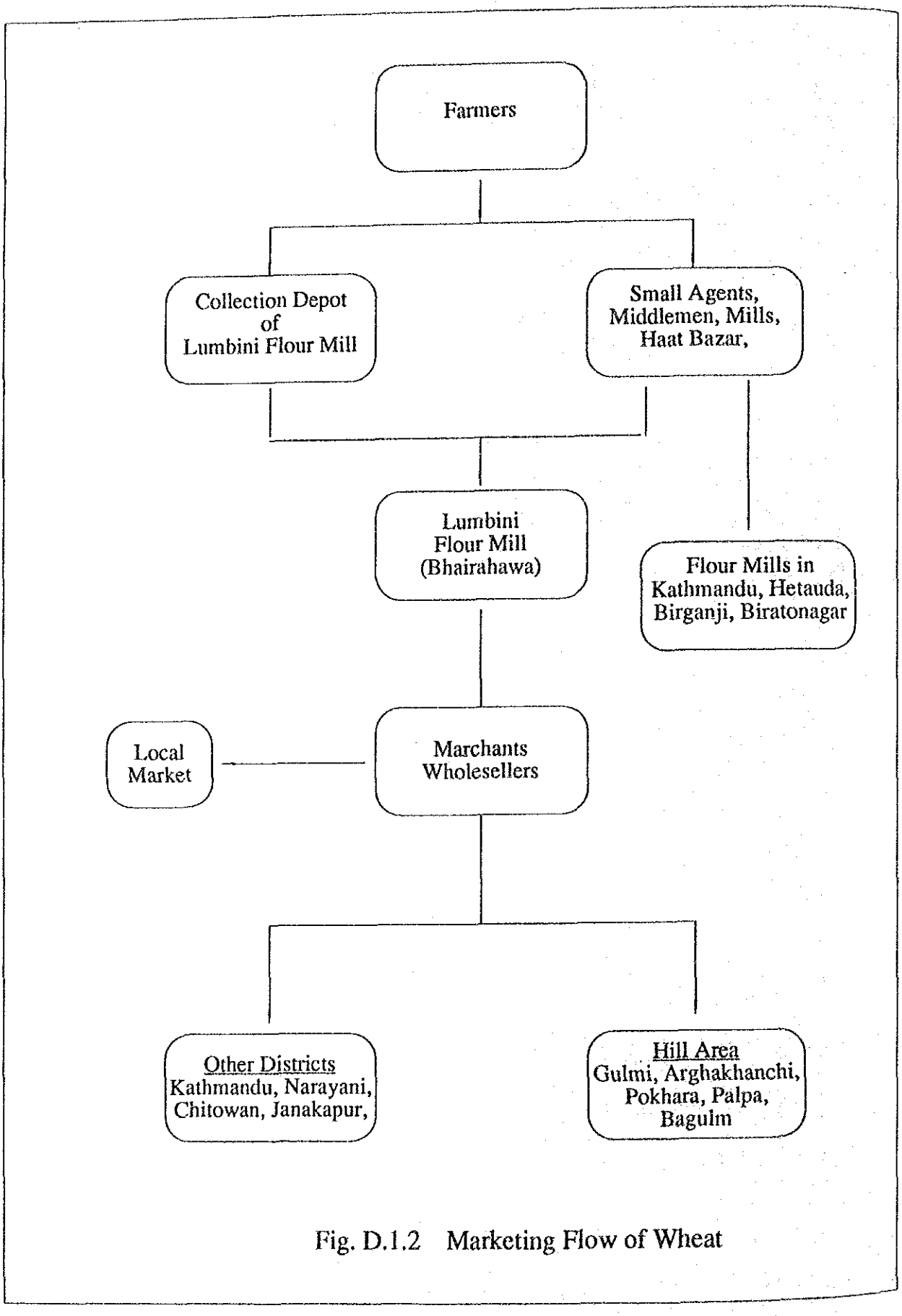

Fig. D.1.2 Marketing Flow of Wheat

ANNEX E

RURAL ROADS

THE MASTER PLAN STUDY
ON
THE INTEGRATED RURAL DEVELOPMENT PROJECT
IN
THE LUMBINI ZONE

ANNEX E RURAL ROADS

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1. PRESENT SITUATION

1.1 General

Major means of transportation at present is mainly roads linking the four districts in the project area and Kathmandu, the capital of Nepal, Pokhara, a center of the Western Development Region and principal cities. The major roads are illustrated in Fig E.1.2.

In the project area, roads working almost thoroughly are only the East-West Highway, the Siddharta Highway, the Taulihawa-Lumbini and the Chandrauta-Krishunanagar. There are great difference between Hill Districts and Terai Districts in regards to roads' status in the project area. The present situation is as follows:

(1) Hill Districts

The percentage of road coverage per km^2 is inferior to the national average. Roads are not paved with gravel or asphalt. Some roads are not passable in rainy seasons due to shortage of drainage facilities and retaining walls. Some others have been partly constructed and can not be passed through. Other roads linking villages are only small-scale foot paths and suspension bridges.

(2) Terai Districts

The Siddharta Highway and the East-West Highway are two arterial roads. Besides, there are also asphalt or gravel paved roads on a few route. The percentage of completed roads is more than the national average. The roads running from east to west have the traffic problems in the rainy seasons, because of no bridge over the Banganga River and the Kothi River, and the shortage of structures to cross rivers. Access roads and foot paths linking main roads and villages, have also the traffic problems in the rainy seasons because of shortage of consolidation on the roads' surface, heights of roads, and drainage facilities.

1.2 Situation of Existing Roads

The condition of existing roads is referred to Tables E.1.1-E.1.3 and Fig. E.1.2. Benefited areas and benefited population of the roads are given in Fig. E.1.3.

(1) National Highway

1) East-West Highway (Mahendra Raj Marg: MRM)

This highway links the Eastern Development Region, the Central Development Region involving Kathmandu, and the Mid-Western Development Region. It runs north side of Rupandehi District and Kapilvastu District from east to west. The distance in the two districts is about 106 km. Asphalt pavement carriage way is about 6 m, while the total width of the road is about 10 m.

2) Siddharta Highway

This highway links Pokhara, Headquarters of the Western Development Region, and Bhairahawa, the capital of Rupandehi District and extends to the Indian Border. The span between Butwal, the capital of Lumbini Zone, and Paklihawa on the Indian Border is 34 km, and asphalt pavement carriage way is 6 m, while the total width of the road is 11 m.

(2) Feeder Roads

The Feeder Road is defined as the road linking the capital of the Zone or major towns. There are five Feeder Roads in the project area.

(3) District Roads

The definition of the District Road is the road between major towns and major villages or between villages. There are five district roads in Gulmi District, seven in Arghakhanchi District, four in Kapilvastu and three in Rupandehi District.

(4) Village Roads

This is the path that inhabitants could carry daily necessaries on foot or by livestock.

1.3 Density of Roads

The comparison of the roads in Terai Districts and Hill Districts in Lumbini Zone with those of the whole Hill Districts and the whole Terai Districts in Nepal is as below:

(For detail, see Table E.1.4.)

Road Density

District	Asphalt paved (km)	Gravel paved (km)	Fair weather type (km)	Total (km)	Road Density km per 1,000 people	Road Density km per km^2
Hill area in project area	-	-	90	90	0.21	0.039
Hill area in whole Nepal	1,330	565	1,186	3,081	0.38	0.052
Terai area in project area	204	114	68	386	0.49	0.122
Terai area in whole Nepal	1,507	756	1,162	3,425	0.42	0.101

From the above table followings can be given:

1) Road length per 1,000 people in the Hill Districts of the project area is only 0.21 km, equivalent to only about 50% of that of the whole hill area in Nepal.

2) Road length per area in the Hill Districts of the project area, that is road density, is also low at 0.039 km/km^2: about 80% of the whole Nepal.

3) In the national level, even in hill districts asphalt or gravel paved roads are more than 50%. But there is no paved roads in the Hill Districts in the project area.

4) On the other hand, road length per 1,000 people and road density in the Terai Districts of the project area are more than the whole Terai in Nepal by about 20%. As far as roads concerned, this area is not considered less-developing.

5) There are two arterial roads: the East-West Highway and the Siddharta Highway; and some district roads in the two districts in Terai. They are passable in the rainy seasons, though not completely enough.

6) Length of roads being passable by vehicles in the two districts of the Hill area is 90 km. It is very short, comparing to 386 km in the two districts in the Terai; and there is no roads passable throughout year.

7) Smallest length of roads per 1,000 people in the project area is for Gulmi District, and smallest length per area is for Arghakhanchi District.

Table E.1.1 Situation of the Existing Highways

Highway	Location	Distance within Project Area	Nos. of Lane	Width(m)		Condition	
				Carriage Way	Total Width	Surface	Traffic
East-West Highway (MRM)	Chor River (Kapilvastu) to Rohini River (Rupandehi)	106 km	2	6.0	10.0	Asphalt	All weather
Siddarta Highway	Butwal to Pokliha (Indian Border)	34 km	2	6.0	11.0	Asphalt	All weather

Table E.1.2 Situation of the Existing Feeder Roads

District	Location	Distance	Width (m)		Condition	
			Carriage way	Total	Surface	Traffic
Gulmi	Tansen - Tamghas	75 km	2.5 - 3.5	4.0 - 5.0	Graveled 4.5 km & Earthen 70.5 km	Fair weather
Arghakanchi	Gorusinge (MRM) - Sandhikarka	69 km	2.5 - 4.5	4.0 - 8.0	-ditto-	Fair weather
Kapilvastu	Gorusinge - Taulihawa - Khunuwa	25 km	3.5	6.5	Asphalt 14 km & Graveled 11 km	Fair weather
Kapilvastu	Chanda(MRM) - Bahadurganj - Krishnanagar	20 km	6.0	8.0	Asphalt	All weather
Rupandehi	Bairahawa - Lumbini - Kakharhawa	30 km	4.2	10.5	Asphalt	All weather

Fig. E.1.3 District Roads and Village Roads

District	Location (Name of Road)	Distance	Condition
Gulmi	Tamghas-Aglung (-Pyuthan)	42 km	Under construction by DOR
"	Wamitaksar-Ridibazar	64 km	Under construction by peoples parti.
"	Gaundakot-Debisthan	5 km	Tractors passable
"	Charket-Rupakot-Shantipur	15 km	Under construction by peoples parti.
"	Tamghas(Simcahaur)-Ridibazar	51 km	Under construction by peoples parti.
Arghakhanchi	Sandhikarka-Tamghas	45 km	Under construction by DOR
"	Sandhikarka-Pyuthan	30 km	- ditto -
"	Sandhikarka-Kandaha	20 km	- ditto -
"	Pokharitok-Dhakabang	13 km	Under planning
"	Suguradhugra-Dhadacatary	4 km	- ditto -
"	Narpani-Nuwakot	20 km	- ditto -
"	Narpani-Pali	14 km	Tractors passable
Kapilvastu	Taulihawa-Jitpur	24 km	Under construction (Gravel, Bridge)
"	Taulihawa-Kothi River-Lumbini	16 km	Under graveling
"	Taulihawa-Bahadurganj	22 km	Under construction
"	Krishnanagar-Bhagwanpur	25 km	Under graveling
Rupandehi	Lumbini-Kothi River	9 km	Under construction (Kothi R. Bridge)
"	Bithari-Taraini	20 km	Completed with partial graveling
"	Bhairahawa-Parsa	27 km	Under graveling

Table E.1.4 Density of Existing Roads

District	Asphalt	Gravel	Fair Weather	Total	Population (x 1,000)	Road Length (km/ 1,000 persons)	Area (km^2)	Road Density (km/km^2)
Hill								
Gulmi	-	-	49	49	252.9	0.19	1,079	0.045
Arghakanchi	-	-	41	41	173.4	0.24	1,232	0.033
Total	-	-	90	90	426.3	0.21	2,311	0.039
Whole Nepal	1,330	565	1,186	3,081	8,152.1	0.38	59,476	0.052
Terai								
Kapilvastu	95	78	48	221	317.0	0.70	1,757	0.126
Rupandchi	109	36	20	165	489.8	0.34	1,414	0.117
Total	204	114	68	386	806.8	0.48	3,171	0.122
Whole Nepal	1,507	756	1,162	3,425	8,207.6	0.42	34,019	0.101
Total of Four Districts	204	114	158	476	1,233.1	0.39	5,482	0.087
Whole Nepal (Hill+Terai)	2,837	1,321	2,348	6,506	16,359.7	0.40	93,495	0.070
Whole Nepal	2,837	1,426	2,348	6,611	17,876.6	0.37	147,200	0.045

Source: Nepal Road Statistic, 1988, Department of Road

1.4 Areas and Population Benefited by Roads

Benefited areas and benefited population of roads in the project area are shown in Fig. E.1.3. Some of them, having large benefited area/cultivated land/population are referred to Table E.1.5.

Table E.1.5 Area and Population Benefited by Roads

Road	Benefited area (km^2)	Cultivated land (km^2)	Population (1,000)
Tansen - Tamghas	1,253	293	264
MRM - Sandhikharka	918	149	149
Jitpur - Taulihawa	447	400	110
Wamitaksar - Ridibazar	492	94	105
Tamghas - Aglung	341	92	75
Kakarhawa - Bitharai	444	309	49
Taulihawa - Bahadurgans	166	155	51

1.5 Traffic Volume

Traffic volume data and the growth rate of the traffic volume in highways in the vicinity of Butwal on MRM in the project area are referred to Table E.1.6.

Table E.1.6 Traffic Volume Survey
(Vicinity of Butwal)

(Unit: Vehicles/day)

Survey Date	Average daily traffic (4 days count average)				
	Lights	Buses	Trucks	Total	AADT
Nov. 1984	94	101	176	371	368
Mar. 1985	95	108	205	408	364
Jul. 1985	73	107	111	291	318
Sep. 1985	48	126	165	339	403
Nov. 1985	87	120	213	420	416
Total Nov. 1984- Nov. 1985	Annual increasing rate (%)				
	-7.4	18.8	21.0	13.2	13.0

Source: National Traffic Data Base for the Feeder Roads project, August, 1986
AADT: Average annual daily traffic

Present situation of traffic volume in the feeder roads of Tansen-Tamghas and MRM-Sandhikharka is shown in Table E.1.7, and that of bus utilization in Table E.1.8.

Table E.1.7 Traffic Volume of Feeder Roads

(Unit: Vehicles/day)

Road	Bus	Truck	Tractor	AADT
Tansen - Tamghas	12	30-40	10-20	52-72
MRM - Sandhikharka	9	9	7	25

Table E.1.8 Bus Transportation

Route		Bus charge	Persons/vehicle	Vehicles/day
Bhairahawa	- Narayangadh	30	50	4
"	- Butwal	5	40	30
"	- Lumbini	5.5	20	12
"	- Lamdi	23	10	3
"	- Taulihawa	16.5	30	1
Butwal	- Krishnanagar	19	30	10
Bhairahawa	-Tamghas	75	40	1

In the Table E.1.6, the growth rate of traffic volume have increased by 13.2% per annum. That of Lamosangu-Jili Road by SATA have also increased by 10-15% per annum. This route works as a feeder road linking the national highway with district roads. Besides, in the future, it will formulate a ring road connecting Siddharta Highway, Tansen-Tamghas and Sandhikharka-MRM, and will work as traffic network in the whole Lumbini Zone. The traffic volume will be increased necessarily.

1.6 Maintenance

DOR maintains roads every year, but as shown in Table E.1.9, numbers of machinery for maintenance is short in Western Development Region, and roads damaged by landslides and floods have not been repaired rapidly. As shown in Table E.1.10, roads require maintenance cost every year.

Table E.1.9 Machinery for Maintenance in the Project Area

Machinery	Weight (ton)	Place	Number	Condition (As of 1989)
1) Truck dozer	20	MRM-Sandhikharka	1	Under repair
2) Wheel dozer	11	Lumbini	1	Working
3) Wheel loader	22	Lumbini	3	Working
"	"	"	1	Under repair
4) Motor grader	22	Lumbini	1	Under repair
5) Wheel excavator	3	Lumbini	1	Working
6) Road roller	67	Lumbini	8	Working
"	"	"	1	Under repair
7) Tire Roller	12	Lumbini	1	Working
8) Crane Car	6	Butwal	1	Working
9) Tank Car	22	Lumbini	1	Working
10) Backhoe loader	6	Lumbini	1	Working

Table E.1.10 Maintenance Cost

Classification	Expenditure for	Cost (Rs.)	Remarks
Two lanes road	Repair of asphalt pavement	65,000-70,000 /km/year	Excluding drainage and shoulder repair
One lane road	Repair of road surface Drainage Shoulder	35,000-40,000 /km/year	-
	Gravel road	15,000-20,000 /km/year	-
	Earth road	10,000- 5,000 /km/year	-

2. NEEDS FOR DEVELOPMENT

In the project area, improvement of road network is indispensable to attain the following purposes:

1) To satisfy the transportation condition not only for farming input/products but also materials necessary for daily life such as food, kerosene, drug, etc..

2) To facilitate human movement derivable from economic and social activities.

3) To activate communication derivable from human movement, postal services and others.

4) To promote smoothly various projects other than the road projects.

Details on improvement work of roads are as mentioned below.

2.1 Hill Districts

(1) Ensuring Year-Round Access by Roads

- Width enlargement:
  Width enlargement work for ensuring side drainage and road shoulder which is mainly occupied by excavation.

- Pavement:
  Pavement work utilizing pebbles and/or asphalt protecting muddying in the monsoon season, dust in the dry season and erosion by rainfall.

- Slope protection:
  Protection work against damages of slope which might occur in the monsoon seasons.

(2) Improving Rural Roads Connecting to Villages

- Crossing small stream:
  Ensuring traffic in the monsoon season.

- Improving slope:
  Ensuring traffic in the monsoon seasons.

- Slope protection:
  Control work for damages which might occur mainly in the monsoon seasons.

- Installation of suspension bridges:
  Ensuring traffic in the monsoon seasons, and shortening traffic distance.

2.2 Terai Districts

(1) Ensuring Year-Round Access of Trunk Roads

- Asphalt pavement and maintenance of paved road:
  Asphalt pavement and the maintenance work should be positively carried out in view of the necessity for transporting and the high speed traffic for the commercial trade with India.

- Bridge:
  Construction of bridges for ensuring traffic in the monsoon seasons and shortening traffic distance.

- Drainage:
  Ensuring transportation in the monsoon seasons.

(2) Improvement of Roads Connecting to Villages

- Crossing of small streams:
  Ensuring transportation in the monsoon seasons.

- Improvement of road surface:
  Ensuring traffic in the monsoon seasons.

3. CONSTRAINTS FOR DEVELOPMENT

3.1 Constraints for Planning and Design

(1) Topographic maps of 1/50,000-1/25,000 in scale necessary for route selection, comparison and decision of the plan, and topographic maps of 1/10,000-1/25,000 in scale necessary for preliminary design are not available.

(2) Road register and related records involving data and information necessary for rehabilitation and reconstruction for improving roads are scarcely available. Records on road damages should be collected and filed in order in the near future.

(3) Technician, supervisor, topographic surveyor, etc. who will be engaged in grasping the existing conditions, feasibility study, detailed design and cost estimate are lack, especially in implementing at the district level.

3.2 Constraints for Implementation

(1) Personnel for management and implementation of projects is short in general. Road should be maintained in the proper conditions by conducting appropriate operation and maintenance.

(2) Shortage of machinery and personnel should be solved by improving systems on operation and maintenance to avoid deterioration and damage of roads.

4. PRIORITY OF THE DEVELOPMENT

In view of fulfilling basic needs of villagers, the execution of agricultural development and present conditions of the project area, priority of the roads will be given in the following order:

1) Areas where the road improvement ratio is low.
2) Roads of which benefited population is much and benefited area is wide.
3) Basic roads.

namely,

1) Feeder roads linking each district with highway.
2) District roads linking among districts and the headquarters with major villages.
3) Rural roads connecting major villages and villages to farmlands.

In view of this aspect, the early execution of the following projects is required.

Table E.4.1 List of Road Project

District	Road	Distance	Development Degree
Hill Area			
Gulmi	Tamghas-Tansen	75 km	Improvement
	Wamitaksar-Ridibazar	64 km	Improvement
	Tamghas-Aglung	42 km	Improvement
	Rural roads connecting the above-said feeder roads, district roads and major villages	20 km	Improvement
Arghakhanchi	MRM-Sandhikarka	69 km	Improvement
	Sandhikarka-Tamghas	45 km	Improvement
	Sandhikarka-Pyuthan	30 km	Improvement
	Rural roads connecting the above-said feeder roads, district roads and major villages	20 km	Improvement
Terai Area			
Kapilvastu	Taulihawa-Jitpur	24 km	Improvement
	Taulihawa-Lumbini	16 km	Improvement
	Taulihawa-Bhadurganj	22 km	Improvement
	Total	427 km	

5. DEVELOPMENT PLAN OF RURAL ROADS

5.1 Selection of the Central Level Projects

The existing road condition is inadequate in aspects of both distance and quality, and it is considered that the present condition of the roads is one of the major obstructing factors in implementing other development projects. Development of road network mentioned in "Chapter 4. Priority of the Development" proposes the medium/long term rural road development plan. However, as it requires considerable amount of implementation cost, a balanced disbursement schedule is to be established.

Under the integral judgment on difference of preliminary construction costs between this road development project and other development projects the overall development schedule is described separating the priority into the first to the third.

(1) Category of the First Priority

In the higher priority development, roads in the hill area which are not perennially accessible should be improved, first of all, to the year-round accessible conditions. In this meaning, development of two roads of "Tamghas-Tansen Road" and "MRM-Sandhikarka Road " should be taken up as urgent development projects.

(2) Category of the Second Priority

The above-said is a grade-up development for year-round accessibility, therefore the road ratio will not be changed. The ratio of the roads in the hill area remains inferior both to the national average and that of Terai area. From the viewpoint, the following development should be taken up secondly.

1) Wamitaksar - Ridi Bazar Road

This is located in the hill area, and the development effect is considered rather high.

2) Tamghas - Sandhikarka Road

This is an important road connecting the two headquarters which are administrative and economic centers in Gulmi and Arghakhanchi Districts though the direct benefited area and the benefited cultivated area are not so wide and the benefited population is not so much; and it is considered that the demonstration effect is remarkable. With the formation of circulation road of " (Siddarta Highway) - (Tansen) - (Tamghas) -(Sandhikarka) - (East-West Highway)", an additional connecting route will be ensured in the hill area at the time of disaster in the monsoon seasons.

(3) Category of the Third Priority

Roads which do not belong to the categories of the first and second priorities correspond to the category of the third priority.

(4) Consideration and Pre-Feasibility Study

Comments on priority of development presented by MPLD and DOR are same as above.

Judging from data collected, as for MRM-Sandhikarka road the early implementation is expected because the feasibility study was completed.

In this project the pre-feasibility study on Tamghas-Tansen Road and MRM-Sandhikarka Road will be conducted.

5.2 Selection of the District Level Projects

It is also necessary to construct or improve terminal roads to transport materials for daily life such as food, cloths, kerosene, medicine etc., as well as agricultural equipment and products. The work for the terminal roads will include casting road surface, construction of suspension bridges, and provision of small-scale drainages and slop protection works etc.

5.3 Cost Estimates and Implementation Schedule

(1) Costs for Construction and Maintenance

Construction cost and maintenance cost for the above roads were studied and summarized in the following table:

Table E.5.1 Construction Cost and Maintenance Cost of the Roads (at 1989 price level)

Road	Distance (km)	Construction cost (Mil. Rs.)	Unit cost for maintenance (Rs.x 1,000/km)	Distance to be maintained per year	Maintenance period after completion (years)	Total maintenance cost till year 2005 (Rs.x 1,000)
Tansen-Tamghas	75 km	240	100	5 km	12	6,000
MRM-Sandhikarka	69 km	290	100	5 km	10	5,000
Wamitaksar-Ridibazar	64 km	210	100	5 km	6	3,000
Sandhikaraka-Tamghas	45 km	190	100	5 km	4	2,000
Lumbini-Taulihawa	16 km	10	150	3 km	7.5	3,375
Jitpur-Taulihawa	24 km	20	150	3 km	5.5	2,475
Taulihawa-Bahadurganji	22 km	90	100	5 km	0.5	250
Tamghas-Aglung	42 km	130	100	5 km	2	1,000
Sandhikarka-Pyuthan	30 km	120	100	5 km	1	500
Village roads in Gulmi	20 km	60	80	3 km	15	3,600
Village roads in Argha	20 km	80	80	3 km	15	3,600
Total	427 km	1,440				30,800

The total construction cost for the above roads, 427 km in total distance, is estimated at Rs. 1,440 millions. The accumulated cost for maintenance of the above roads, after completion till the year 2005, will be Rs. 30.8 millions. After the year 2005, the annual maintenance cost is estimated at Rs. 4.9 millions.

(2) Implementation Schedule

The above-mentioned projects of road development will be implemented in the following manner:

The two major roads with higher priority, Tansen-Tamghas Road and MRM-Sandhikarka Road will be implemented in the initial stage of 1990-1985, within the period of the Eighth Five-Year Plan.

Other major roads will be done thereafter, continuously till the year 2005.

Village roads in the hill area, Gulmi District and Arghakanchi District, will be implemented step by step, by each village, from 1990 to 2005.

(For detail, refer to Fig. E.5.1.)

6. PRE-FEASIBILITY STUDY ON THE PRIORITY PROJECTS

Based on the study conducted in the previous chapter, a pre-feasibility study including preliminary design, construction cost estimate on Tansen-Tamghas road and MRM-Sandhikarka road will be carried out.

6.1 Project Outline

(1) Tansen-Tamghas Road

1) Location

This is a feeder road which connects Tansen City and Tamghas. In Tansen city, there is District Headquarters of Palpa District, and Tamghas has the Headquarters of Gulmi District.

The feeder road is a kind of mountainous roads connecting Tansen to Tamghas. The road crosses Ridi River at the point of 26 km from Tansen City.

Tansen City is located at the point of about 20 km northward from Butwal, and connected to Siddarta Highway and Tansen-Ring road (L=3 km) as illustrated in Fig. E.6.6. A section extending about 45 km from the crossing point of Ridi River belongs to Gulmi District.

2) Topography and Climate

This road belongs to the middle mountain zone, one of five topographic zones in Nepal. As illustrated in Fig. E.6.2, the road passes areas altitudes of 1,000-1,600 m, and even the crossing point with Ride River, the lowest point, its altitude ranges about 700 m. Slope of mountains through which road passes is very steep and the vegetation is poor, therefore land slides derived from rainfall causes frequently.

Monsoons which occur during June to September is very characteristic in Nepal. Average annual rainfall in this region reaches about 1,800 mm as illustrated in Fig. E.6.4, and about 80% of rainfall concentrates in the monsoon season. During this

period the above-said land slides occur frequently, and such land slides disturb the traffic remarkably.

3) Geology

Geology is illustrated in Fig. E.6.1.

4) Route

The route of the existing Tansen-Tamghas road is illustrated in Fig. E.6.6. As seen in the figure, about 70% of the road pass the ridge. Generally, in the steep mountain road, it is necessary to avoid to access the gorge, large mash and mountain for operation and maintenance of road, protection of land slides and saving of construction cost. Consequently, it is considered that a route along the ridge is most feasible. Since the existing road passes the ridge excepting a crossing point of Ridi River, the present route is finally recommended.

As for the section between the point at 14 km and Deli River, the route which is based on the existing road was selected taking into account that passing Raguo and Ageri where the farm lands widely extend in the hill area is very important for agricultural development.

5) Population

The present and future population of Gulmi District are given in Table E.6.1.

Table E.6.1 Population in Gulmi

(Population: X 1,000)

Year	1987	1990	1995	2000	2005
Population	250.6	257.5	266.0	275.0	284.1
Benefited Population	266.0	271.3	280.2	289.7	299.3

(2) MRM-Sandhikarka Road

1) Location

This is a feeder road of 67 km long connecting Gorusinge and Sandhikarka. Gorusinge is situated on the East-West Highway (MRM) running in the almost central part of Kapilvastu District. The Headquarters of Arghakhanchi District is situated in Sandhikarka.

As well as the Tansen-Tamghas Road, this road is one of the arteries for socio-economic activities in the hill area. This road was constructed by Bureau of Road, the Government of Nepal, though Tansen-Tamghas Road was constructed by the assistance of the people's participation.

2) Topography and Climate

This road is located among Terai and mountains ranging several hundred meters to three thousand meters high, and the altitudes at MRM and Narupani are 113 m and 1,694 m respectively.

A section which connects MRM to the point of 11 km is almost flat, and the road maintenance is under good conditions. Agriculture in the area has been well developed, but high mountains with steep slopes are ranging on the northern side. Rivers in the valley do not have so much water in the dry seasons, but in the monsoon seasons flood damages usually occur.

Due to the steep slopes, poor vegetation and irrational geology, land slides occur severely after the heavy rainfalls. Average rainfall in this area reaches 1,270 mm in monsoon season during June to September. During the dry season of January to March monthly rainfall is about 50 mm. Snow is found at places above 2,000 m of altitude, and sometimes below 1,500 m of altitude.

3) Geology

Geology is illustrated in Fig. E.6.1.

4) Route

In the section in the Terai connecting Gorusinge (Sta.O+000) and Patharkot (Sta.11+000), a gravel road was constructed by the Bureau of Road, the Government of Nepal based on the design speed of 60-80 km/hr.

As well as the Tansen-Tamghas Road, the existing road is running along the ridge without crossing valleys and mountains, and the new route was selected based on the existing road route.

5) Population

The present and future population of Arghakhanchi District is shown in Table E.6.2.

Table E.6.2 Population in Arghakanchi

(Population: X 1,000)

Year	1987	1990	1995	2000	2005
Population	171	178.3	187.6	197.4	207.5
Benefited Population	149	155.1	163.2	171.7	180.5

Table E.6.3 Characteristics of Physiographic Regions of Nepal

Item	Terai	Siwaliks	Middle Mountain	High Mountain	High Himal
Geology	Quaternary alluvium	Tertiary sandstone, silt stone, shale and conglo-merates	Phyllite quartzite limestone & islands of granites	Gneiss, quartzite & mica shists	Gneiss, schist, limestone & Tethy sediments
Elevation	60-330 m	200-1500 m	800-2400 m. Relief 1500 m with isolated peaks to 2700 m	2200-4000 m. High relief 3000 m from valley floor to ridges	4000 m -
Climate	Subtropical	Subtropical (but warm temperate in higher hill spurs)	Warm temperate (but sub-tropical in lower river valleys and cool tempe-rate on high rides)	Warm to cool temperate	Alpine to Arctic (snow 6-12 months)
Moisture Regime	Subhumid in FW+ MWDR humid W+C & EDR & Dun valleys	Subhumid in most of the area; humid in N-aspect	Subhumid; humid above 2000 m N-aspect and 1000 m S-aspect	Subhumid N-aspect; humid throughout the region below 3600 m	
Rainfall Intensity	High	High	Medium	Low	Low

6.2 Preliminary Design

(1) Road Standards in Nepal and Application for the Project

1) Classification of Roads in Nepal

Based on the characteristics of road service and transportation activities, roads in Nepal are largely classified into four categories as given in Table E.6.4. Furthermore, based on the width of carriage way, type of topography and traffic volume, roads are subdivided into five classes as shown in Table E.6.5.

Table E.6.4 Classification of Roads in Nepal

Road	Specification
National Highway	Distributed widely in the whole country and utilized for the transportation and communication among districts.
Highway Feeder Road	Connecting major cities,districts and district headquarters to the high way.
District Road	Linking major villages and the feeder roads.
Village Road	Other roads than the above-said; and utilized for dwellers, commerce and industry.

Table E.6.5 Classification of Road by Traffic

Class	Kind of motor way	Type of topography	Average daily traffic volume (Vehicles)
I AA	4 lanes with median strip; width of single lane is 3.5 m; paved with asphalt or concrete cement.	Flat land Undulating land Mountain	7,000 5,000 3,000
I A	4 lanes without median strip; width of single lane is 3.5 m.	Flat land Undulating land Mountain	3,000 2,500 1,500
I	2 lanes without median strip; width of single lane is 3.5 m; surface treatment	Flat land Undulating land Mountain	1,500 1,000 300
II	Single lane; width of single lane is 3.5 m; surface treatment	Flat land Undulating land Mountain	300 150 75
III	Single lane; width of single lane is 3.5 m; gravel	Without considering type of topography	Less than 75

2) Geometric Structure Standard in Nepal

(a) Design Speed

In due consideration of topographic conditions and regions, the design speed is designated as shown in Table E.6.6.

Table E.6.6 Design Speed

Type of Road	Type of Topography	Design Speed
National Highway	Flat land	120 km/h
	Undulating land	80 km/h
	Mountain	50 km/h
Feeder Road	Flat land	100 km/h
	Undulating land	60 km/h
	Mountain	40 km/h
District Road	Flat land	60 km/h
	Undulating land	40 km/h
	Mountain	30 km/h

(b) Horizontal Alignment

a) Horizontal Curve

Relation between design speed and minimum radius is shown in Table E.6.7.

Table E.6.7 Minimum Radius

Design Speed (km/h)	Radius (m)	
	Normal	Exceptional
120	710	570
100	460	380
80	280	230
60	150	120
50	100	80
40	60	50
30	30	-
20	15	-

b) Stopping Sight Distance

Stopping sight distance is the governing factor among various road alignment factors. It is a function of speed, reaction time, and friction coefficient as given below:

Table E.6.8 Stopping Sight Distance

Design speed (km/h)	120	100	80	60	50	40	30	20
Stopping sight distance (m)	200	145	110	85	65	45	30	20

(c) Vertical Gradient

In due consideration of topographic conditions the vertical gradient is designated as shown in Table E.6.9.

Table E.6.9 Vertical Gradient

Item		Type of Topography		
		Flat land	Undulating land	Mountain
National Highway	Maximum vertical gradient	3	4	5
	Maximum vertical gradient (Exceptional)	5	6	8
	Minimum length of recovery at grade specified	600	300	210
Feeder Road	Maximum vertical gradient	5	6	7
	Maximum vertical gradient (Exceptional)	7	8	10
	Minimum length of recovery at grade specified	300	150	150
District Road	Maximum vertical gradient	5	6	7
	Maximum vertical gradient (Exceptional)	7	10	12
	Minimum length of recovery at grade specified	150	150	150

(d) Combination of Horizontal Alignment and Vertical Alignment

When horizontal alignment is combined with vertical alignment, attention must be paid to the followings:

- To overlap horizontal alignment on vertical alignment.
- To keep a balance on horizontal alignment.
- To select a linear combination in which appropriate compound will be obtained.

It is necessary to avoid drawing sharp horizontal curve on the top or the bottom of summit vertical curve and valley vertical curve.

(e) Shoulder Width

Shoulder should be provided attaching to roadway.

Table E.6.10 Shoulder Width

Classification	I AA-I	II	III
Shoulder width (both side) (m)	4.0-6.0	4.0-5.0	3.0-5.0

Note: Side drain is not included in the shoulder width.
Slope of the shoulder is 8% in the case of pebbles, and 8% in grass.

(f) Right of Way

In accordance with the kind of road the right of way is classified as shown in Table E.6.11.

Table E.6.11 Right of Way

Item	National Highway	Feeder Road	District Road
Right of way	50	30	20
Distance between building lines	62	42	32

(g) Vertical Curve

Vertical curve is designated in Table E.6.12.

Table E.6.12 Vertical Curve

Design speed (km/hr)	Curve radius (m)		Minimum vertical curve length (m)
	Summit vertical curve	Valley vertical curve	
80	3,000	2,000	70
60	1,400	1,000	50
40	450	450	35
25	200	200	25

(h) Crossing of Road

a) Carriageway Width

Carriageway width has been designated at 3.5 m per one lane based on the road standard of Nepal. But in areas where ensuring the standard carriageway width is difficult due to topographic conditions in the case of hill and mountain areas, shortening the carriageway width is permissible.

b) Shoulder Width

In the case of Class III, the shoulder width is designated at 2.0-2.5 m (one side), but in the case of the existing roads belonging to this class, there is no roads having such a wide shoulder. In the Japanese Road Standard, in the case of less than 5.5 m of carriageway width, the shoulder width of 0.25-0.5 m is designated. According to the technical comparison between both figures, the shoulder width designated by the Road Standard of Nepal is too wide in view of reducing construction cost and planning uniformity of neighboring roads. In this project in which steep crossing shapes specialized by the hill must be applied, avoiding any risks which might be derived from collapse of slope and ensuring feeling of drivers' security. In this meaning 0.75 m of shoulder width was taken as the standard.

3) Adopted Standard

In accordance with the road classification, the following standards are prepared.

(a) Road Classification

The roads in the project area are characterized by small amount of traffic volume. According to the conversion of the existing average daily traffic to the transport unit mentioned in the road standard in Nepal, the road is classified in the boundary of II and III which is about 70-120 TU.

The roads are to be improved to the all weather type, and after that therefore the traffic volume is expected to increase steadily. According to the result of Jite Road Project, the traffic volume of light vehicles has been remarkably increased.

Since the projected roads will function not only as feeder roads linking the national highway and the district roads, but also as the whole road network for Lumbini Zone forming the circulating road along the Siddharta boundary, it is expected that the traffic volume will increase remarkably. Therefore, this road will be classified in Class III.

(b) Road Geometric Structure

a) Design Speed

Because of less traffic volume and steep topography, the design speed of the roads is proposed as given in Table E.6.13.

Table E.6.13 Design Speed

Topography	Design Speed (km/hr)	
	Road Standard in Nepal	Adopted Standard
Level	100	80
Rolling	60	60
Hill	-	40
Mountainous	40	25

In the case of hairpin curves found in topographically steep places, the design speed of 15 km/hr is applied as a particular case.

b) Stopping Sight Distance

Stopping sight distance is calculated in adding running distance within reaction time in second to distance necessary for braking. The calculation formula is as below:

$$S = (V/3.6)xt + V^2/2.g.f\ (3.6)^2$$

Where,

S : Stopping sight distance (m)

V : Running speed (km/hr)

= 85% of design speed
(design speed >= 80 km/hr)

= 90% of design speed
(60 km/hr >= design speed >= 40 km/hr)

= 100% of design speed
(30 km/hr >= design speed)

t : Reaction time for driver = 2.5 sec
(based on Japanese Road Standards)

f : Coefficient of longitudinal friction = 0.3
(in the case of gravel road)

c) Overtaking Sight Distance

An example of calculating overtaking sight distance is as shown in Table E.6.14.

Table E.6.14 Overtaking Sight Distance

Vehicle running speed for overtaking, facing	80	60	40	25
Vehicle to be overtaken	60	45	30	15
All overtaking sight distance	550	350	200	120
Minimum needed overtaking sight distance	350	250	159	90

d) Radius of Horizontal Curve

Minimum radius of horizontal curve is calculated by the following formula, and the result is shown in Table E.6.18.

$$R\ mini >= V^2 / [3.6^2 g\ (f + i)]$$

Where,

g : Gravity acceleration (9.8 m/s^2)
f : Side friction factor (0.12-0.15)
i : Rate of roadway super elevation (Tan 2)
v : Design speed (km/hr)

e) Widening

Widening of carriageway is decided by the curve radius as given in Table E.6.15.

Table E.6.15 Widening

Design Speed 80 km/h	Design Speed 80 km/h>	Widening (m)
50 <= R < 250	100 <= R < 150	0.25
100 <= R < 150	55 <= R < 100	0.50
70 <= R < 100	40 <= R < 55	0.75
50 <= R < 70	30 <= R < 40	1.00
	25 <= R < 30	1.25
	20 <= R < 25	1.50
	18 <= R < 20	1.75
	15 <= R < 18	2.0

f) Vertical Gradient

Table E.6.16 Vertical Gradient

Vertical Gradient	Design Speed (km/hr)	Gradient (%)	Length (m)
Minimum Vertical Gradient	80-25	0.5-1.0	-
Maximum Average Vertical Gradient	80	4	-
	60	5	-
	40	7	-
	25	9	-
Maximum Vertical Gradient	80	5	600
		6	500
		7	400
	60	6	500
		7	400
		8	300
	40	8	400
		9	300
		10	200
	25	10	300
		11	200
		12	100

g) Crossfall

Crossfall of roads is necessary for removing rainwater on the roads to its outside. Crossfall is designated in accordance with kind of road surface as shown in Table E.6.17. In the project, 3% of crossfall is applied since gravel pavement is planned.

Table E.6.17 Crossfall

Type of Roadway	Crossfall(%)
Cement or asphalt Concrete pavement	More than 1.5%; less than 2%
Gravel road & others	More than 3%; less than 5%

h) Right of Way

Considering the future improvement to high grade road and operation and maintenance, it is desirable to take a wide right of way. Based on the Road

Standard of Nepal the prospective right of way will be designated at 15 m for one side; and 30 m for whole width.

(c) Summary of Adopted Road Geometric Structure

Table E.6.18 Adopted Road Geometric Structure

Item	Topography	Flat land	Undulating land	Hill	Mountain
Design Speed	(km/hr)	80	60	40 (15)	25 (15)
Carriageway width	(m)	5.0	5.0	3.5	3.0
Shoulder width	(m)	2.5	1.5	1.5	0.0
Total width	(m)	7.5	6.5	5.0	3.0
Right of way	(m)	30	30	30	30
Horizontal alignment					
Minimum radius	(m)	>230	>120	>24	>24
Switch back	(m)	-	-	>15	>15
Vertical alignment					
Summit vertical curve length	(m)	>200	>200	>50	>50
Valley vertical curve length	(m)	>200	>200	>40	>40
Slope					
Normal		<4%	<5%	<7%	<10%
Particulars		<7%	<8%	<10%	<12%
Maximum vertical curve length in case of special value	(m)	>600	>500	>200	>200
Stopping sight distance	(m)	>110	>75	>40	>40
Width of side ditch	(m)	1.5	1.5	1.0	1.0

(2) Design of Roads

1) Vertical & Horizontal Alignment

MRM-Sandhikharka Road is shown in Fig. E.6.6 and Tansen-Tamghas Road in Fig. E.6.7. The alignments of both roads are studied according to the Adopted Standards in 6.2.

(3) Cross Section Design

1) Cross Section

By topographic conditions, the cross section is divided into four classes. Fig. E.6.8 is a cross section standards applicable for this project.

Table E.6.19 Cross Section Standards

Topography		Flat	Rolling	Hilly	Mountain
Design speed	(km/h)	80	60	40	25
(For hair-pin curve)	(km/h)		(15)	(15)	
Carriageway width	(m)	5.0	5.0	3.5	3.0
Shoulder width	(m)	2.5	1.5	1.5	0.0
Total width	(m)	7.5	6.5	5.0	3.0
Side ditch of road	(m)	1.5	1.5	1.0	1.0
Right of way	(m)	30	30	30	30

2) Cutting

a) Cut Slope Gradient

Table E.6.20 Cut Slope Gradient

Geology	Standard Gradient	Application
Soil	1:0.8 - 1:1.5	1:1.0
Weathered rock	1:0.5 - 1:1.2	1:0.5
Hard rock	1:0.3 - 1:1.0	1:0.3

b) Stabilization of Slope

In order to protect the surface of slope from collapse, the stabilization should be executed on the sloped surface by providing small steps. Where any large-scale collapse of slope is feared, it should be protected by counter embankment work, sub drainage work and cutting work as shown in Figs. E.6.9 to E.6.12.

c) Stabilization of Rock Slope

On rock slopes at such as steep cliff, overhangs and joins of large-scale, falling of rocks occurs sometimes. When cutting of rocks is difficult, the safety measurements must be assured by utilizing protection net, strengthening concrete and others as given in Fig. E.6.13.

3) Embankment

Slope gradient of embankment is as shown in Table E.6.21.

Table E.6.21 Embankment Slope

(Unit of banking height : Meter)

Filling material	Banking Height	Gradient
Well-graded sand	0 - 6	1:1.5
Gravely sand	above 6	*1:1.5
Poor graded sand	0 - 6	1:1.5
	above 6	*1:1.5
Rock mass	0 - 6	1:1.5
Rock muck	above 6	*1:1.5
Sandy soil	0 - 6	1:1.5
	above 6	*1:1.5

Besides vegetation works, washing of embankment surface, controlling of collapse, wicker worker works etc. as shown in Fig. E.6.14 should be considered.

(4) Major Structures

1) Structure Design Standard

A standard established by the American Association of State Highway and Transportation (AASHTO) will be applied, and at the same time a standard established by the Indian Road Congress will be employed.

a) Load

(a) Dead Load

Unit weight to be utilized for the calculation of dead load is designated in Paragraph 1.2.2. of AASHTO Standard.

(b) Live Load

As for vehicle load and pedestrian load designated in AASHTO HS 20-44 will be utilized.

(c) Impact Coefficient

$I = 15.24(L+38)$

Where,

I = Impact coefficient (Maximum 30%)
L = Span Length

(d) Wind Load

Wind velocity is designated as 225.3 km/hr in Paragraph 1.2.14 of AASHTO. Actually, after the conversion to wind load, the following application will be done.

- For upper structure (girders and beams) : 479 kg/m^2
- For Lower structure (substructures) : 383 kg/m^2

(e) Earthquake Load

Since the road is situated in the area where earthquake is not frequent, earthquake load of 0.05 of dead load will be applied.

(f) Range of Temperature

As a calculation value by which the influence derived from change of temperature of structures, 17°C will be applied in accordance with the standards established by Indian Road.

(g) Stream Current Force

As for stream current force, a formula of $P=52\ KV^2$ will be applied in accordance with the standard by I.R.C.

P = Pressure in kg/m^2
V = Velocity of water in m/sec
K = Coefficient designated in Paragraph 213 of I.R.C. Standard

(h) Earth Pressure

In calculating the earth pressure the Coulomb's formula will be applied.

a) Material

(a) Concrete

Pressure scale of concrete during 28 days is as follows:

- PC slab concrete : $Fc > 350\ kg/cm^2$
- RC slab concrete : $Fc > 210\ kg/cm^2$
- Substructure : $Fc > 210\ kg/cm^2$

(b) Reinforcing Steel Bar

Allowable tensile stress	(Plain: local product)
	$Fs < 1{,}260\ kg/cm^2$
- ditto -	Deformed bar: imported product
	$Fs < 1{,}800\ kg/cm^2$

b) Application to Respective Structures

Application to respective structures will be made as shown in Table E.6.22.

Table E.6.22 Classification of Structures

Adopted Structure	Length of the Structure
Culvert	Length <= 6.0 m
Minor bridge	6.0 < Span <= 10.0
Medium bridge	10.0< Span <= 20.0
Major bridge	Span > 20

c) Vertical Clearance

Vertical clearance of motor way is designated at 4.75 m, and in the case of electric wires which cross roads the vertical clearance will be designated at more than 7.0 m.

d) Flood Return Period and Clearance of Respective Structures

Table E.6.23 Free Board for Structures

River structure	Return period (Years)	Free board (m)
Road way and road side drainage	5	-
Box pipe culvert	10	0.5
Minor and medium bridge	25	1.0
Major bridge	50	2.0

2) Bridge Work

As for proposed concrete bridge, in accordance with span length, the type of super structures will be designated as shown in Table E.6.24. Various elements for proposed bridge are shown in Tables E.6.25 and E.6.26.

Table E.6.24 Type of Super Structure

Span Length	Type of Super Structure
<12 m	RC Slab
12 m-25 m	RC T-Beam
25 m-50 m	PC Beam

Table E.6.25 MRM-Sandhikarka Road (1)

Site	Patharkot	Kondve	Supa	Khanchi
Location	12 km	15 km	46 km	47 km
Span of bridge	30 m	30 m	20 m	25 m
Super structure	PC Beam	PC Beam	T Beam	T Beam
Sub structure	RC Canti-lever Type	RC Canti-lever Type	RC Canti-lever Type	RC Canti-lever Type

Table E.6.25 MRM-Sandhikarka Road (2)

Site	Pharjeng	Riri	Alua
Location	62+925	63+260	64+835
Span of bridge	2@15=30 m	30 m	25 m
Super structure	T Beam	PC Beam	T Beam
Sub structure	RC Canti-lever Type	RC Canti-lever Type	RC Canti-lever Type

Table E.6.26 Tansen-Tamghas Road

Site	Jorelung	Goinghot
Location	20 km	25 km
Span of bridge	20 m	30 m
Super structure	T beam	PC beam
Sub structure	RC cantilever	RC cantilever

3) Wall Works

a) Gabion Wall

Gabion is locally available and economical. Its transportation and utilization are very simple, therefore in Nepal it has been widely utilized. Since the structure is flexible it will become familiar to local conditions and also useful for drainage works. Generally, structures of 1.5-2.0 m^3 like box are utilized.

b) Stone Masonry

In accordance with the height of wall for protecting relatively large embankment and collapse of basement, this wall is divided into two, namely dry masonry and wet masonry as shown in Table E.6.27.

Table E.6.27 Type of Masonry

Type of Stone Masonry	Height of Wall
Dry Masonry	2 <= h < 3
Wet Masonry	3 <= h < 5

4) Drainage

Removing rainwater and groundwater from roads is very important for the protection from washing-out stable slopes founded on sub grade and sub base. Especially in the monsoon seasons in Nepal,appropriate drainage facilities are very important.

(5) Flood Analysis

1) Design Condition

a) Runoff Amount (Rational Formula)

$Q=(1/3.6) \times f \times Iy \times A$

Where,

Q : Discharge capacity (m^3/s)
f : Runoff coefficient
Iy : Rainfall intensity (mm/hr)
A : Area of catchment basin (km^2)

b) Time of Concentration

$$Tc=0.00032L^{0.77} \times S^{-0.335}$$

Here,

Tc : Time of concentration (hr)
L : Maximum distance of travel of water (m)
S : M/L

c) Runoff Coefficient

Runoff coefficient shows the degree of rainfall runoff, and it is affected by rainfall intensity, slope of land, soil and vegetation.

d) Probable Daily Rainfall

Maximum daily rainfall observed during 1977-1986 at Khanchikot, is shown in Table E.6.28, and maximum daily rainfall observed during 1981-1986 at Tamghas in Table E.6.29. On the basis of the Khanchikot data the probable daily rainfall by year has been calculated utilizing Gambel method, and the result is shown in Table E.6.30.

Table E.6.28 24 Hours Maximum Rainfall

Station: Khanchikot
Period: 1977-1986

No.	Year	Max.24 hrs. Rainfall	No.	Year	Max.24 hrs. Rainfall
(1)	1977	200 mm	(6)	1982	158 mm
(2)	1978	130 mm	(7)	1983	192 mm
(3)	1979	104 mm	(8)	1984	159 mm
(4)	1980	354 mm	(9)	1985	155 mm
(5)	1981	389 mm	(10)	1986	123 mm

Table E.6.29 24 Hours Maximum Rainfall

Station: Tamghas
Period: 1981-1986

No.	Year	Max.24 hrs. Rainfall	No.	Year	Max.24 hrs. Rainfall
(1)	1981	138 mm	(4)	1984	105 mm
(2)	1982	105 mm	(5)	1985	142 mm
(3)	1983	126 mm	(6)	1986	115 mm

Table E.6.30 Probable Daily Rainfall

Station: Khanchikot

Return period	2 years	5 years	10 years	20 years	50 years	100 years
Daily rainfall	156 mm	252 mm	315 mm	375 mm	453 mm	512 mm

Table E.6.31 Number of Rainy Days at Khanchikot

(Unit: days)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1977	2	1	0	4	9	4	16	10	8	4	0	4	62
1978	1	1	3	2	7	2	9	13	9	5	1	1	54
1979	3	1	1	2	5	3	7	10	7	2	0	0	41
1980	1	1	2	1	3	11	13	8	3	1	0	0	44
1981	2	2	6	4	8	8	7	14	4	0	2	0	57
1982	1	5	5	3	2	8	8	8	4	2	1	1	48
1983	1	1	2	3	13	4	9	17	7	5	0	0	62
1984	0	3	1	3	3	8	6	14	5	0	0	2	45
1985	3	1	0	2	4	14	8	11	8	6	0	0	57
1986	0	0	3	7	10	6	11	9	8	4	0	0	58

Table E.6.32 Number of Rainy Days at Tamghas

(Unit: days)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1981	2	4	6	2	7	9	11	11	6	0	1	0	59
1982	2	4	7	5	3	9	8	14	3	1	1	1	58
1983	1	1	5	5	9	6	5	11	10	3	0	0	56
1984	0	2	0	3	4	10	5	10	5	1	0	1	41
1985	3	1	0	1	5	8	6	14	4	8	0	0	50
1986	1	0	2	5	13	10	9	9	10	2	1	1	63

6.3 Construction Cost

Construction cost for priority road project is estimated, in the 1989 price level, at Rs. 236,958,000- for Tansen-Tamghas Road, and at Rs. 288,153,000- for MRM-Sandhikarka Road. (See Tables E.6.33 and 34.)

Table E.6.33 Construction Cost of Tansen-Tamghas Road

Item	Quantity	Unit Cost (Rs.)	Amount (Rs.x 1,000)
(1) Earth work			
- Excavation (ordinary soil)	67,500 m^3	30	2,025
- Excavation (soft/medium rock)	90,000 m^3	90	8,100
- Excavation (hard rock)	67,500 m^3	150	10,125
- Embankment			
- Cleaning and rubbing			
- Subgrade preparation	37,5000 m^2	5	1,875
Sub Total (1)			22,125
(2) Drainage work			
- French type slope drain	22,500 m	570	12,825
- Side drain (Turfe'd trape)	7,500 m	4	30
- Side drain (Dry masonry)	22,500 m	176	3,960
- Side drain (Wet masonry)	37,500 m	213	7,987
- Side drain (Concrete U-type)	7,500 m	940	7,050
- Shoulder drain	18,750 m	16	300
- 2-box culvert	8 nos.	600,000	4,800
- 1-box culvert	28 nos.	370,000	10,360
- Pipe culvert	340 nos.	40,000	13,600
Sub Total (2)			60,912
(3) Slope protection work			
- Retaining wall (Gabion type)	20,250 m^3	750	15,187
- Retaining wall (Dry masonry)	36,750 m^3	420	15,435
- Retaining wall (Wet masonry)	12,000 m^3	1,200	14,400
- Turfing	450,750 m^2	4	1,803
Sub Total (3)			46,825
(4) Pavement work			
- Sub base	56,250 m^3	165	9,281
- Base	56,250 m^3	240	13,500
Sub Total (4)			22,781
(5) Bridge work			
- Bridge (1)	1 L.S.		2,400
- Bridge (2)	1 L.S.		1,700
- Bridge (3)	1 L.S.		1,700
Sub Total (5)			5,800
Sub Total (1)+(2)+(3)+(4)+(5)			=158,443

- Continued -

Item	Quantity	Unit Cost (Rs.)	Amount (Rs.x 1,000)
(6) Miscellaneous (10%)			= 15,844
Total Direct Cost = (1)+(2)+(3)+(4)+(5)+(6)			=174,287
Contingency (10%)			= 17,428
Total			=191,715
Overhead and profit (15%)			= 28,757
Contract tax (5%)			= 9,585
Total			=230,057
Engineering supervision cost (3%)			= 6,901
Grand Total			=236,958

Table E.6.34 Construction Cost of Sandhikarka Road

Item	Quantity	Unit Cost (Rs.)	Amount (Rs.x 1,000)
(1) Earth work			
- Excavation (ordinary soil)	269,000 m^3	30	8,070
- Excavation (soft/medium rock)	77,000 m^3	90	6,930
- Excavation (hard rock)	38,000 m^3	150	5,700
- Embankment	228,000 m^3	30	6,840
- Cleaning and rubbing	110,000 m^2	2	220
- Subgrade preparation	360,000 m^2	5	1,800
Sub Total (1)			29,520

- Continued -

Item	Quantity	Unit Cost (Rs.)	Amount (Rs.x 1,000)
(2) Drainage work			
- French type slope drain	33,500 m	570	19,950
- Side drain (Turfe'd trape)	55,000 m	176	9,680
- Side drain (Dry masonry)	10,500 m	213	2,236
- Side drain (Wet masonry)	3,500 m	940	3,290
- Side drain (Concrete U-type)	17,250 m	16	276
- Shoulder drain	33 nos.	600,000	19,800
- 2-box culvert	12 nos.	370,000	4,480
- 1-box culvert	399 nos.	40,000	15,960
- Pipe culvert			75,632
Sub Total (2)			
(3) Slope protection work			
- Retaining wall (Gabion type)	15,500 m^3	750	11,625
- Retaining wall (Dry masonry)	31,300 m^3	420	13,146
- Retaining wall (Wet masonry)	9,100 m^3	1,200	10,920
- Turfing	348,580 m^2	4	1,394
Sub Total (3)			37,000
(4) Pavement work			
- Sub base	43,000 m^3	165	7,177
- Base	51,750 m^3	240	12,420
Sub Total (4)			19,597
(5) Bridge work			
- Bridge construction	7 nos.	4,400,000	30,800
Sub Total (5)			30,800
Sub Total (1)+(2)+(3)+(4)+(5)			=192,674
(6) Miscellaneous (10%)			= 19,267
Total Direct Cost = (1)+(2)+(3)+(4)+(5)+(6)			=211,947
Contingency (10%)			= 21,194
Total			=233,135
Overhead and profit (15%)			= 34,970
Contract tax (5%)			= 11,656
Total			=279,761
Engineering supervision cost (3%)			= 8,392
Grand Total			=288,153

6.4 Implementation Schedule

The two roads of Tansen-Tamghas Road and MRM-Sandhikarka Road will be implemented within the period of the Eighth Five-Year Plan. Construction period will require 40 months (1991-1994) for the former road, and 36 months (1993-1995) for the latter road. (For detail, see Figs. E.6.20 and E.6.21)

FIGURES

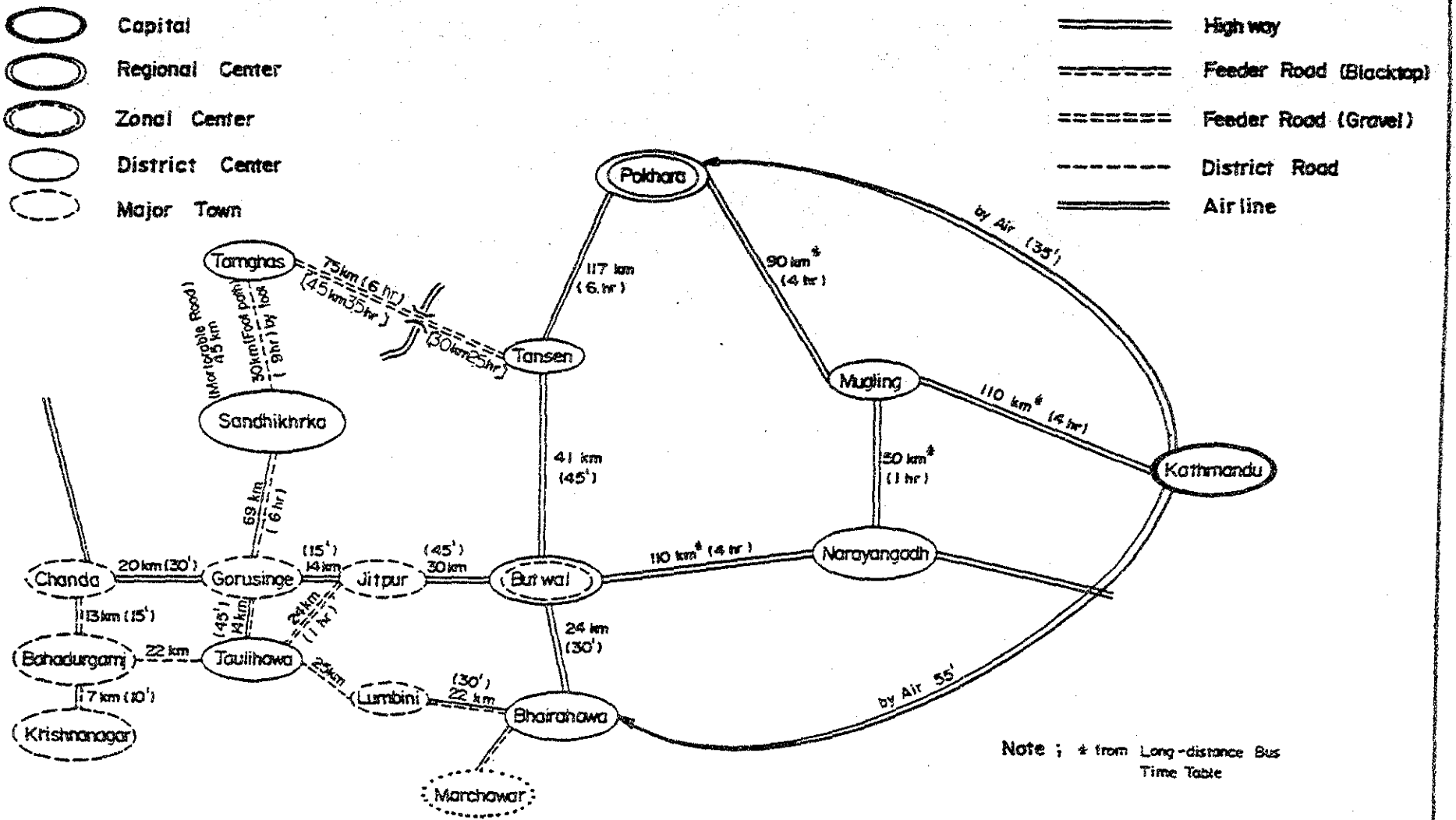


Fig. E.1.1 Transportation around the Project Area

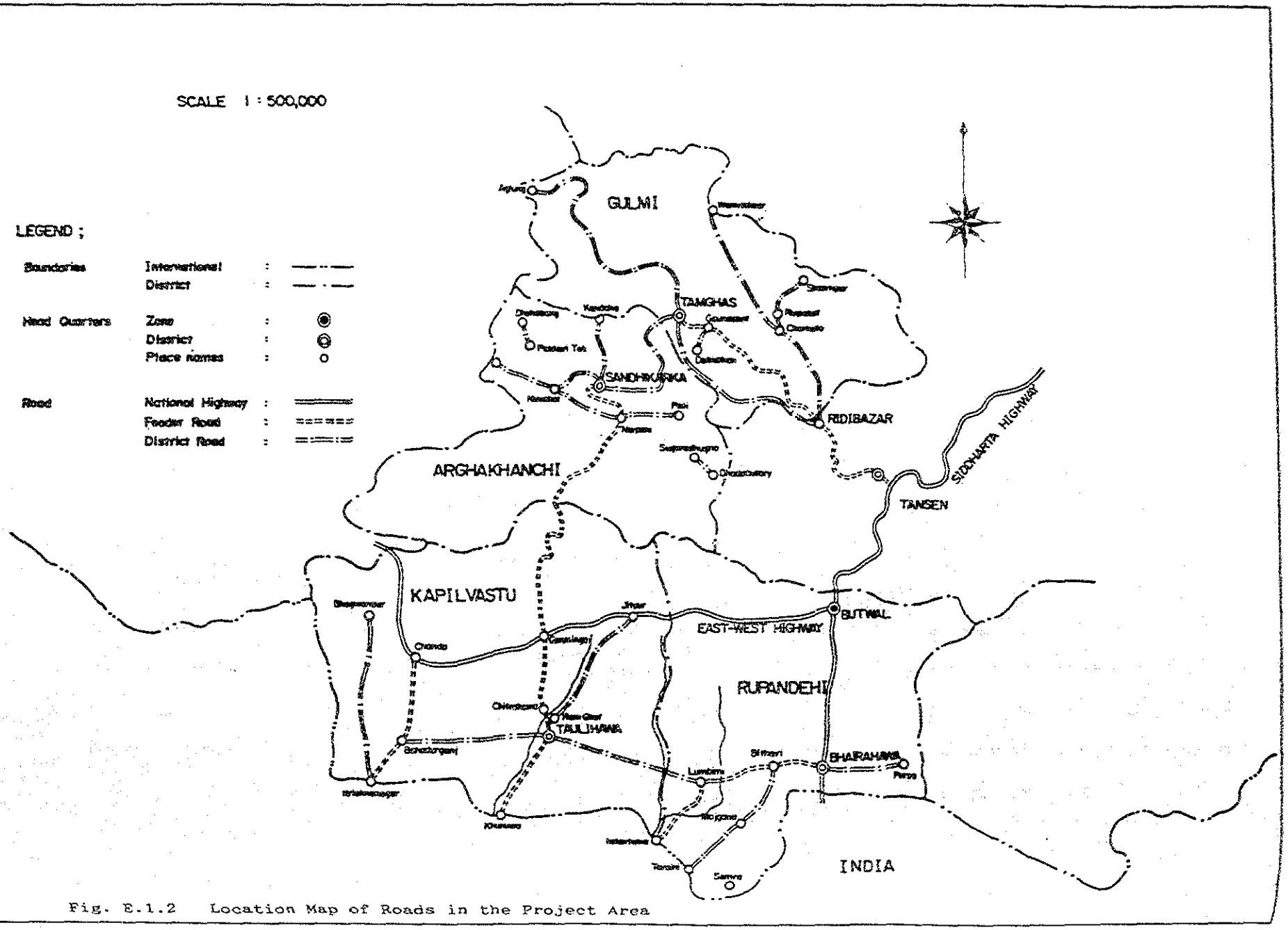


Fig. E.1.2 Location Map of Roads in the Project Area

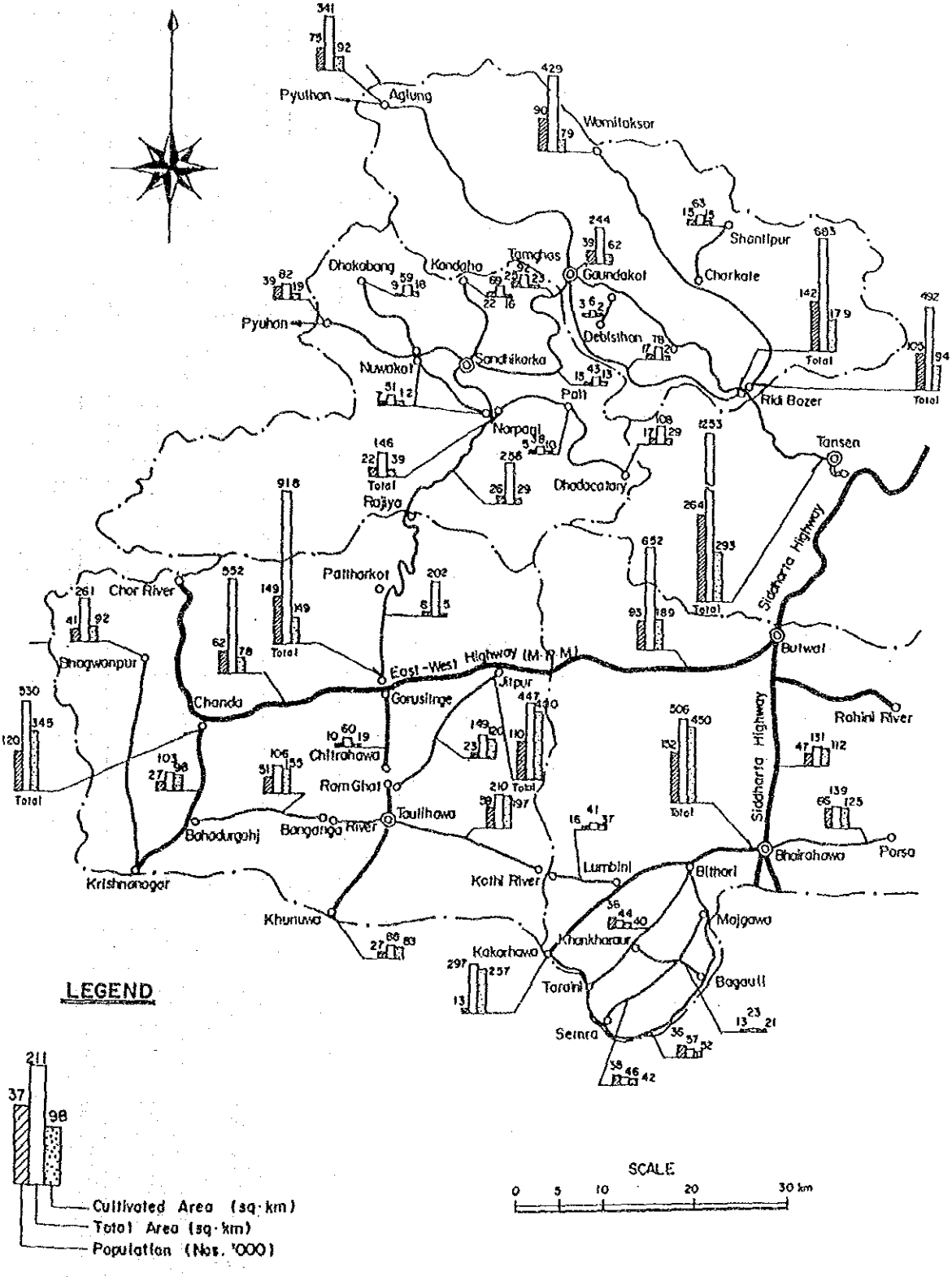


Fig. E.1.3 Benefited Area and Population

Fig. E.5.1 Implementation Schedule of the Rural Roads

District	Name of Road	Construction Period (15 years)															
		1990	,91	,92	,93	,94	,95	,96	,97	,98	,99	2000	,01	,02	,03	,04	,05
Gulmi	Tamghas ~ Tansen L = 75Km																
Arghak-anchi	M·R·M ~ Sandhikarka L = 69Km																
Gulmi	Wamitaksar ~ Ridibazar L = 64Km																
Arghak-anchi	Sandhikarka ~ Tamghas L = 45Km																
Kapilvastu	Lumbini ~ Taulihawa L = 16Km																
Kapilvastu	Jitpur ~ Taulihawa L = 24Km																
Kapilvastu	Taulihawa ~ Bahadurganj L = 22Km																
Gulmi	Tamghas ~ Aglung L = 42Km																
Arghak-anchi	Sandhikarka ~ Pyuthan L = 30Km																
Gulmi	Village Roads in the District L = 20Km																
Arghak-anchi	Village Roads in the District L = 20Km																
Total	427Km																

Legend : Major Work Minor Work

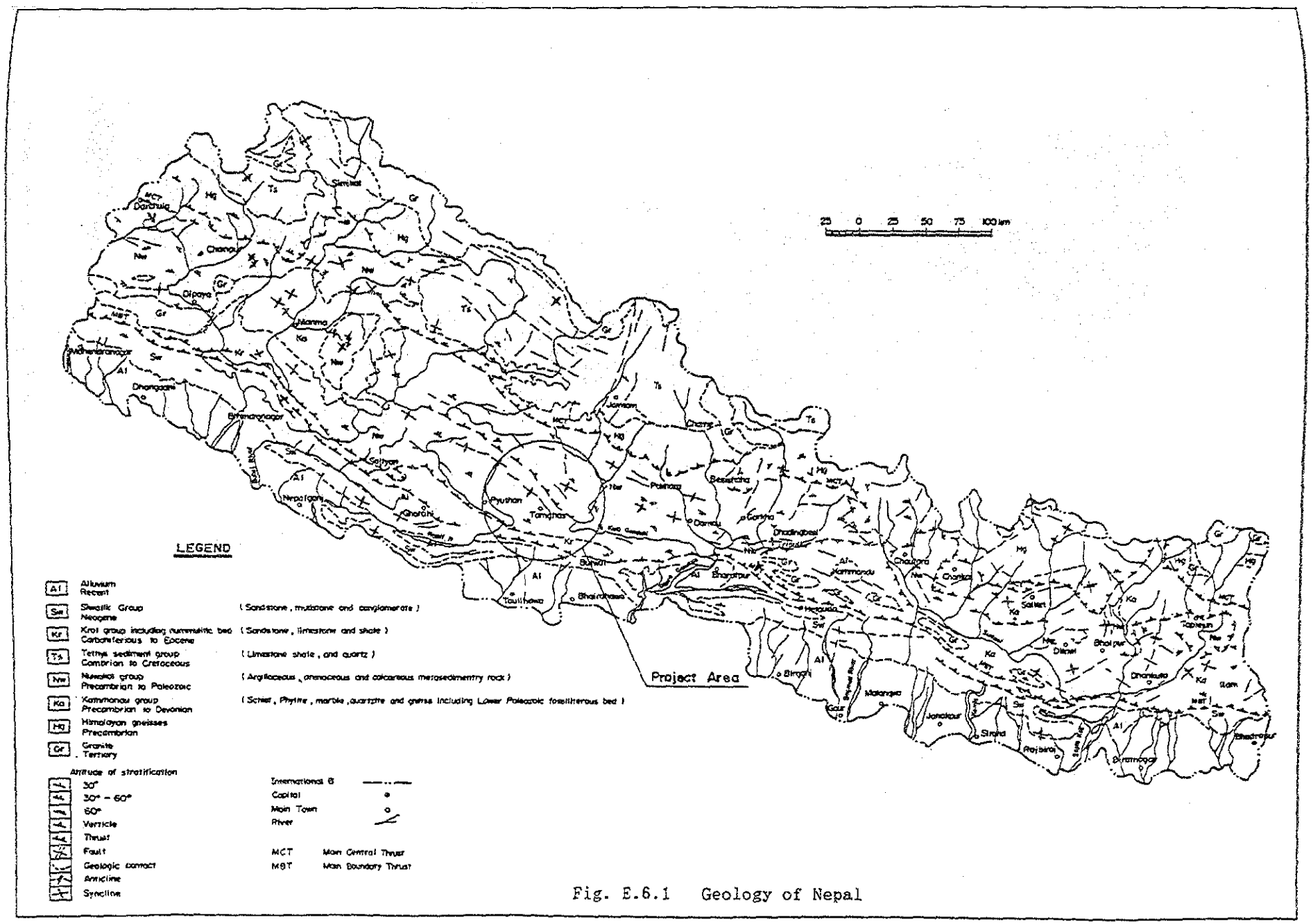


Fig. E.6.1 Geology of Nepal

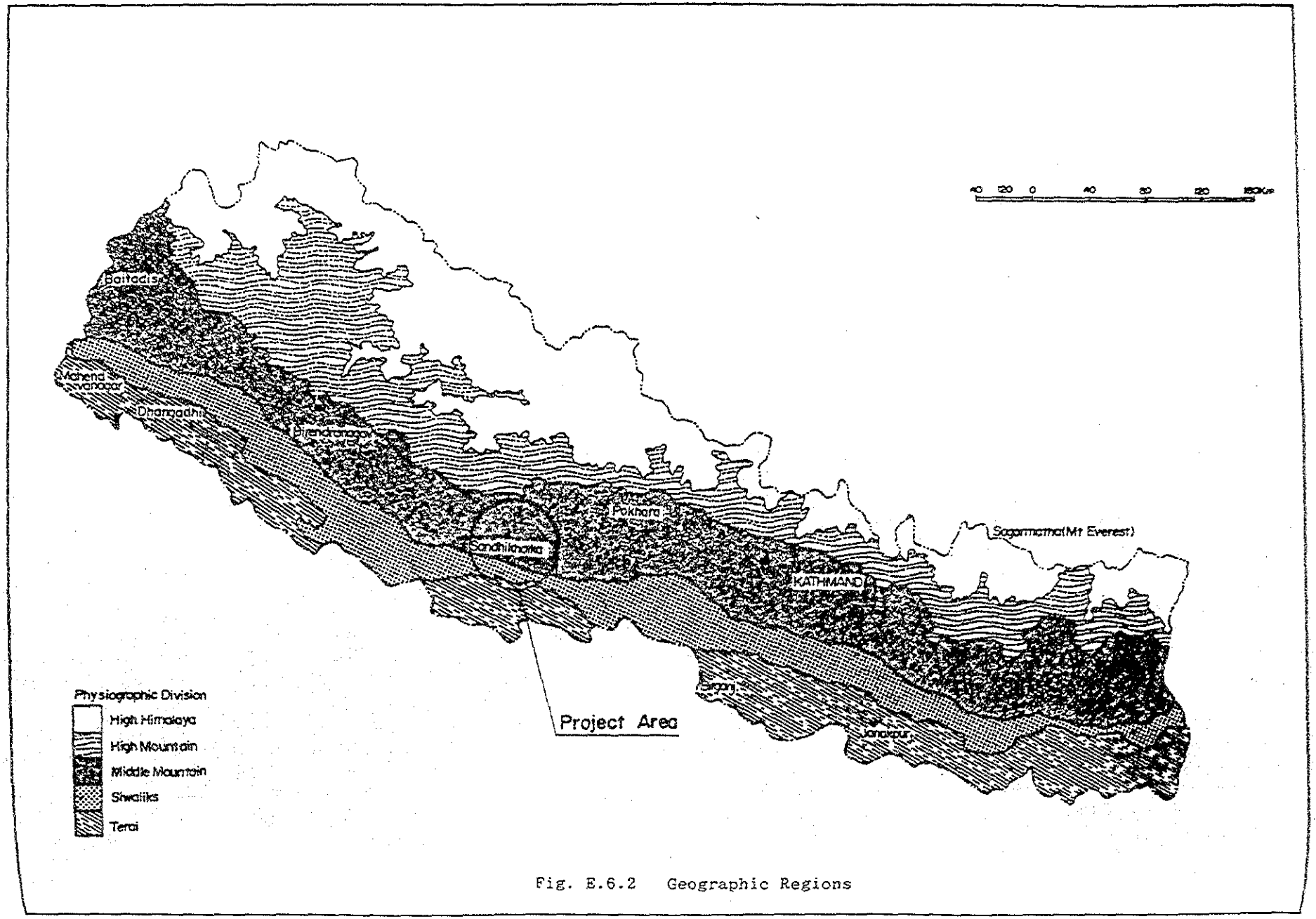


Fig. E.6.2 Geographic Regions

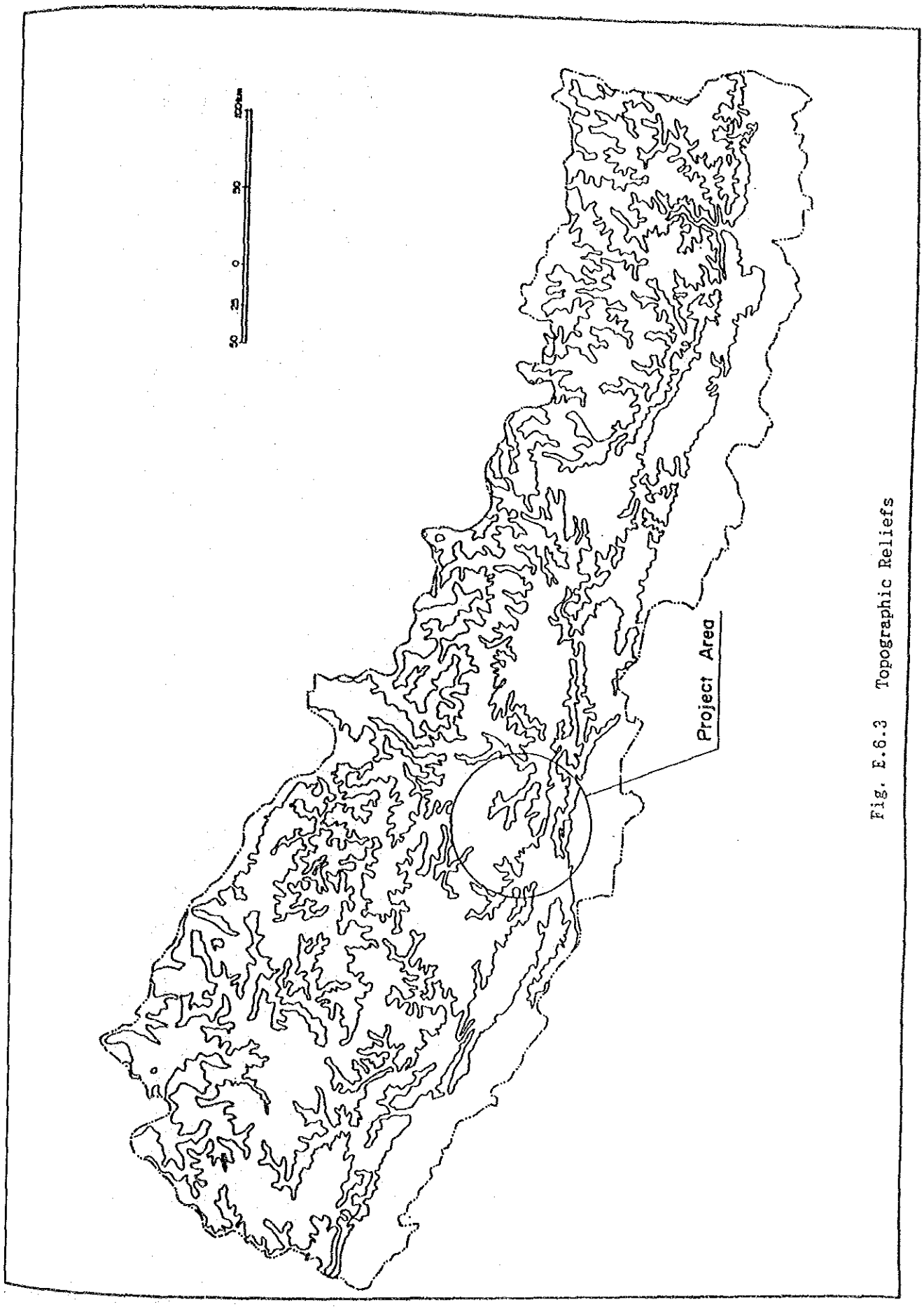


Fig. E.6.3 Topographic Reliefs

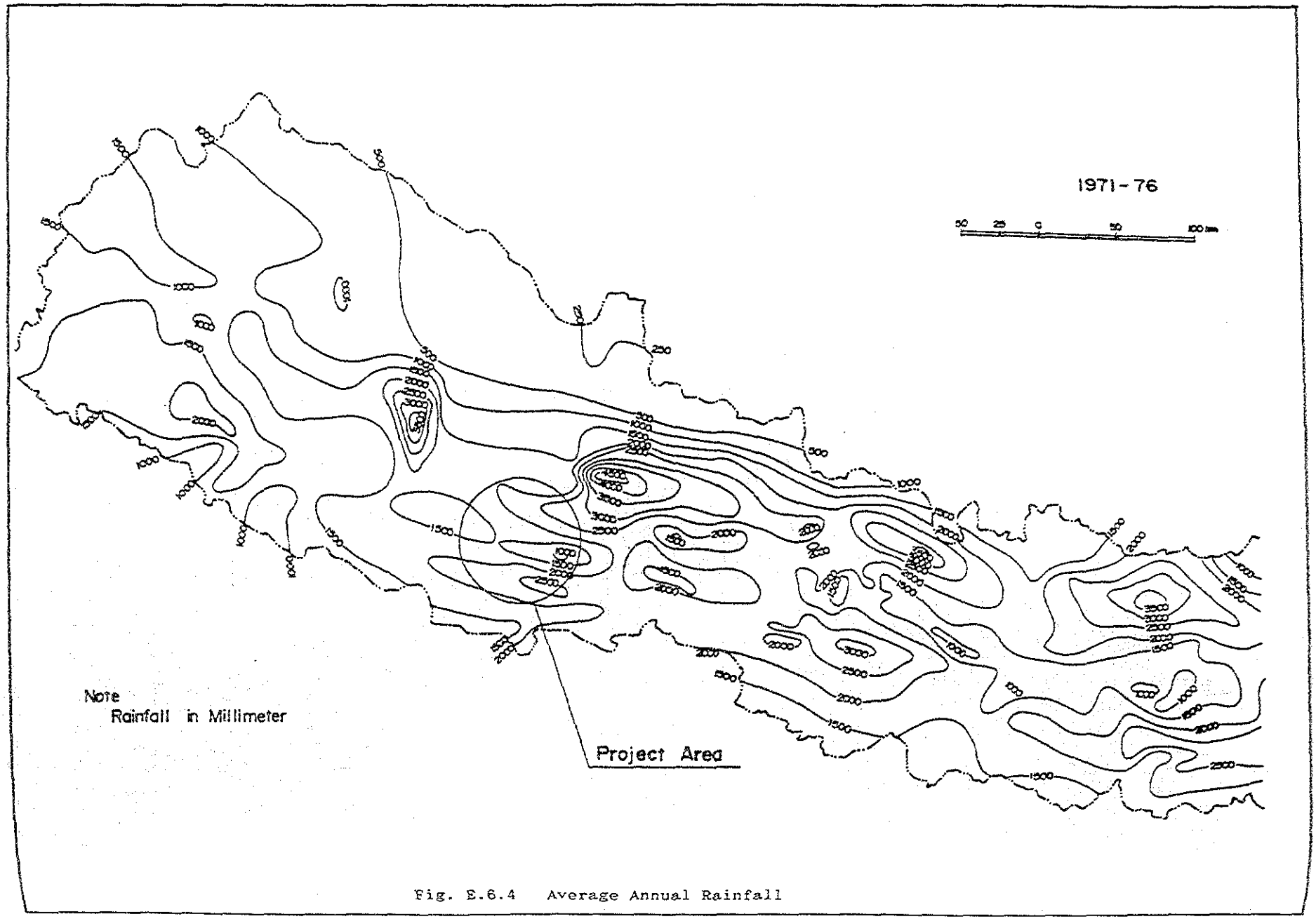


Fig. E.6.4 Average Annual Rainfall

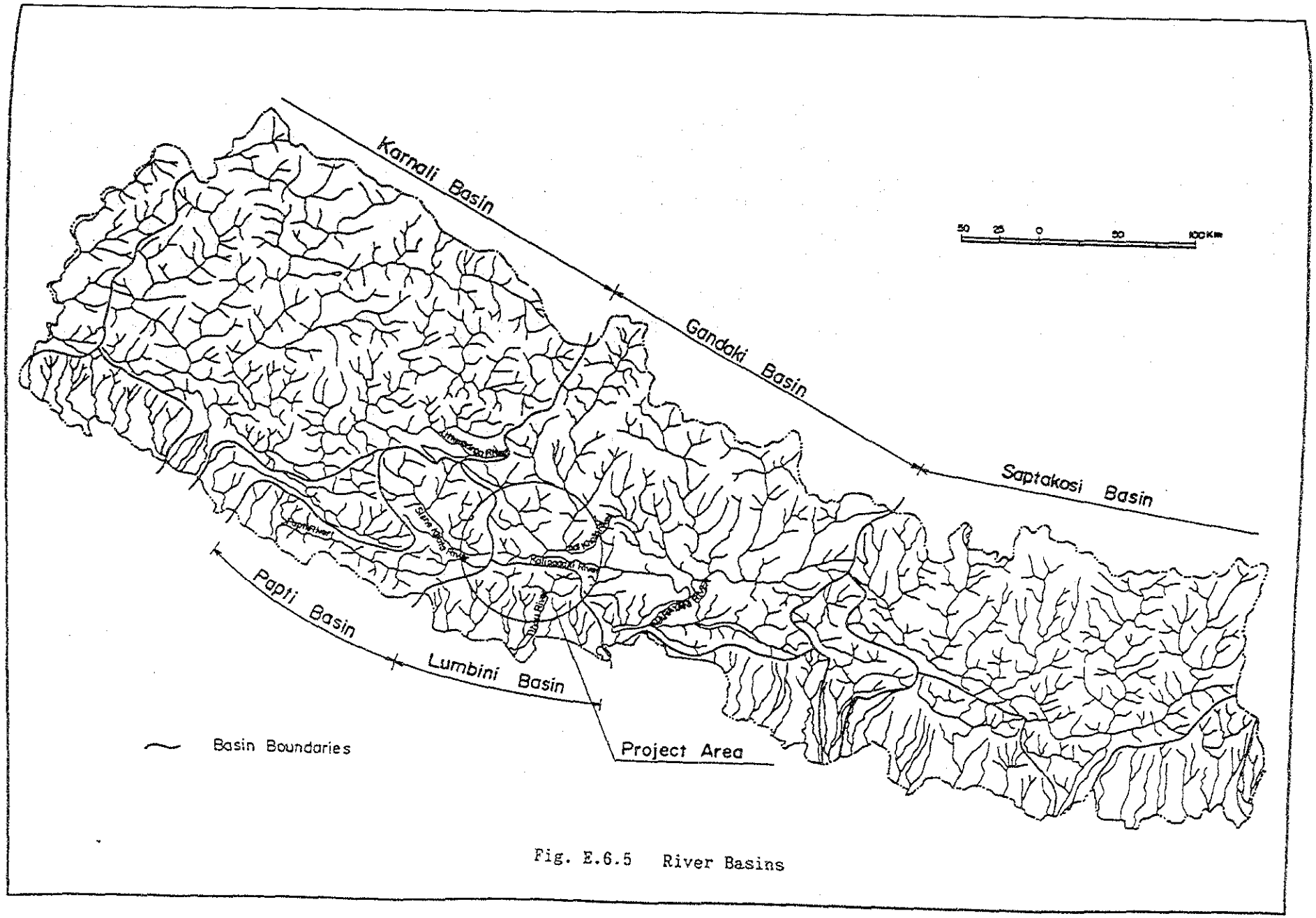


Fig. E.6.5 River Basins

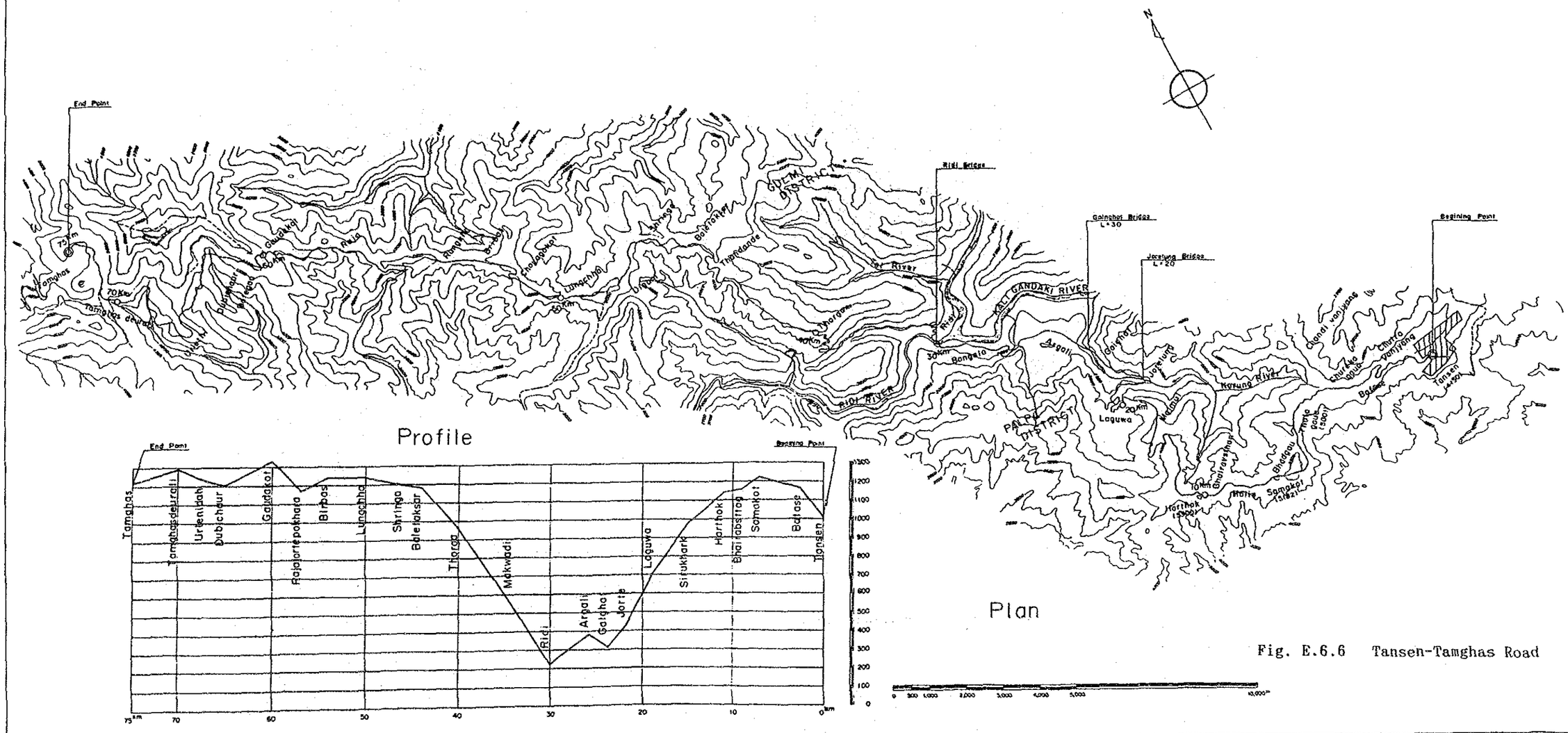


Fig. E.6.6 Tansen-Tamghas Road

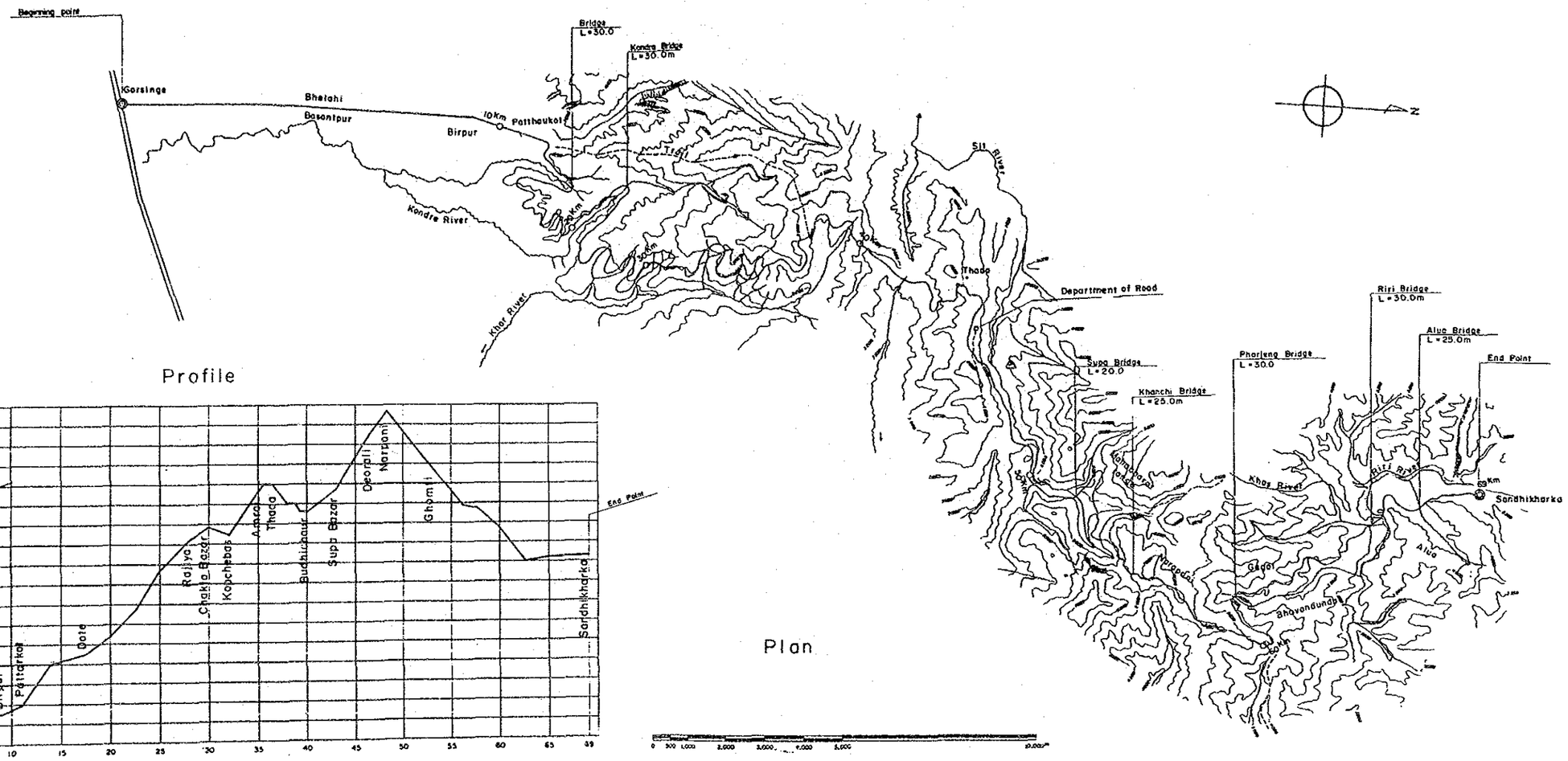
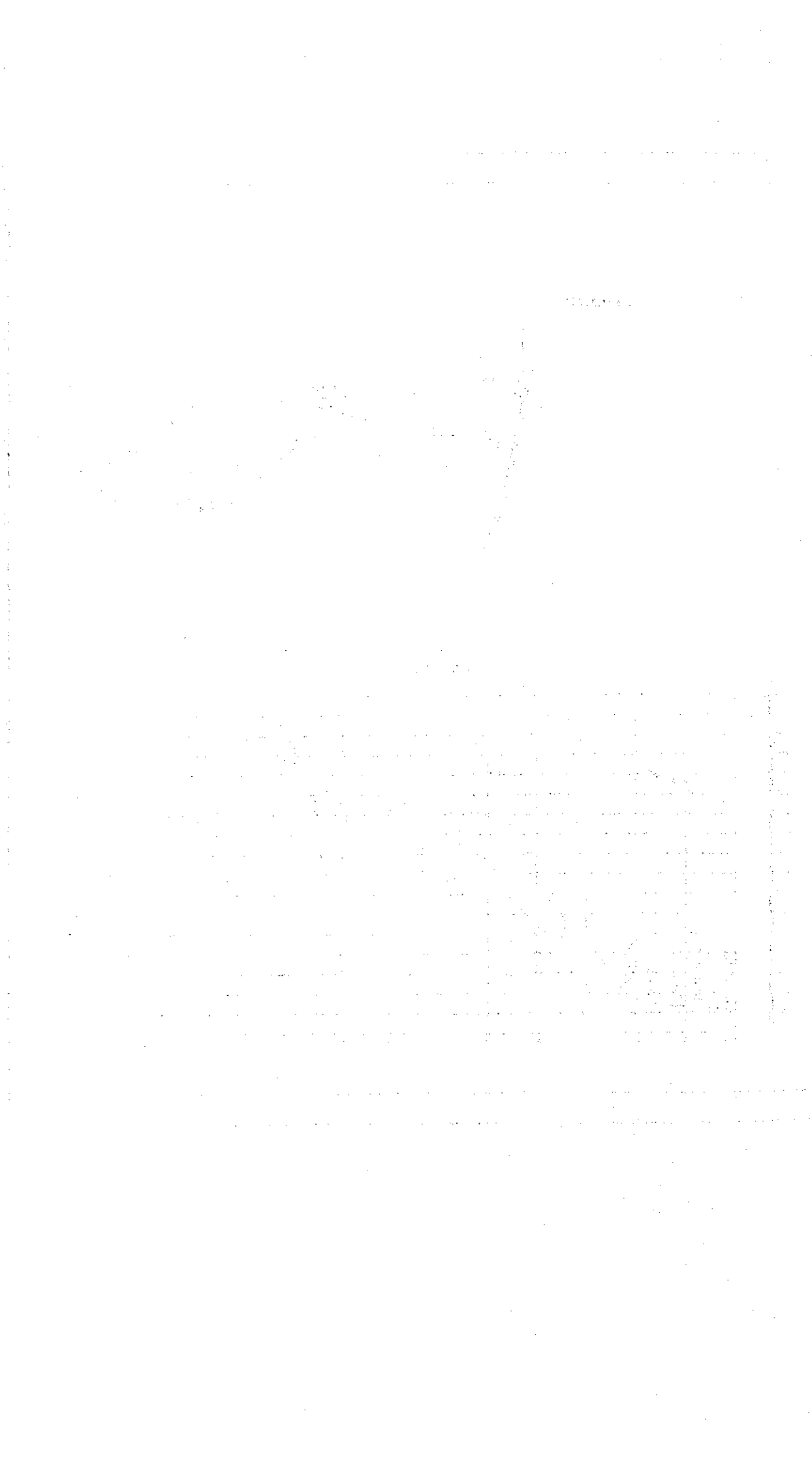


Fig. E.6.7 MRM-Sandhikarka Road



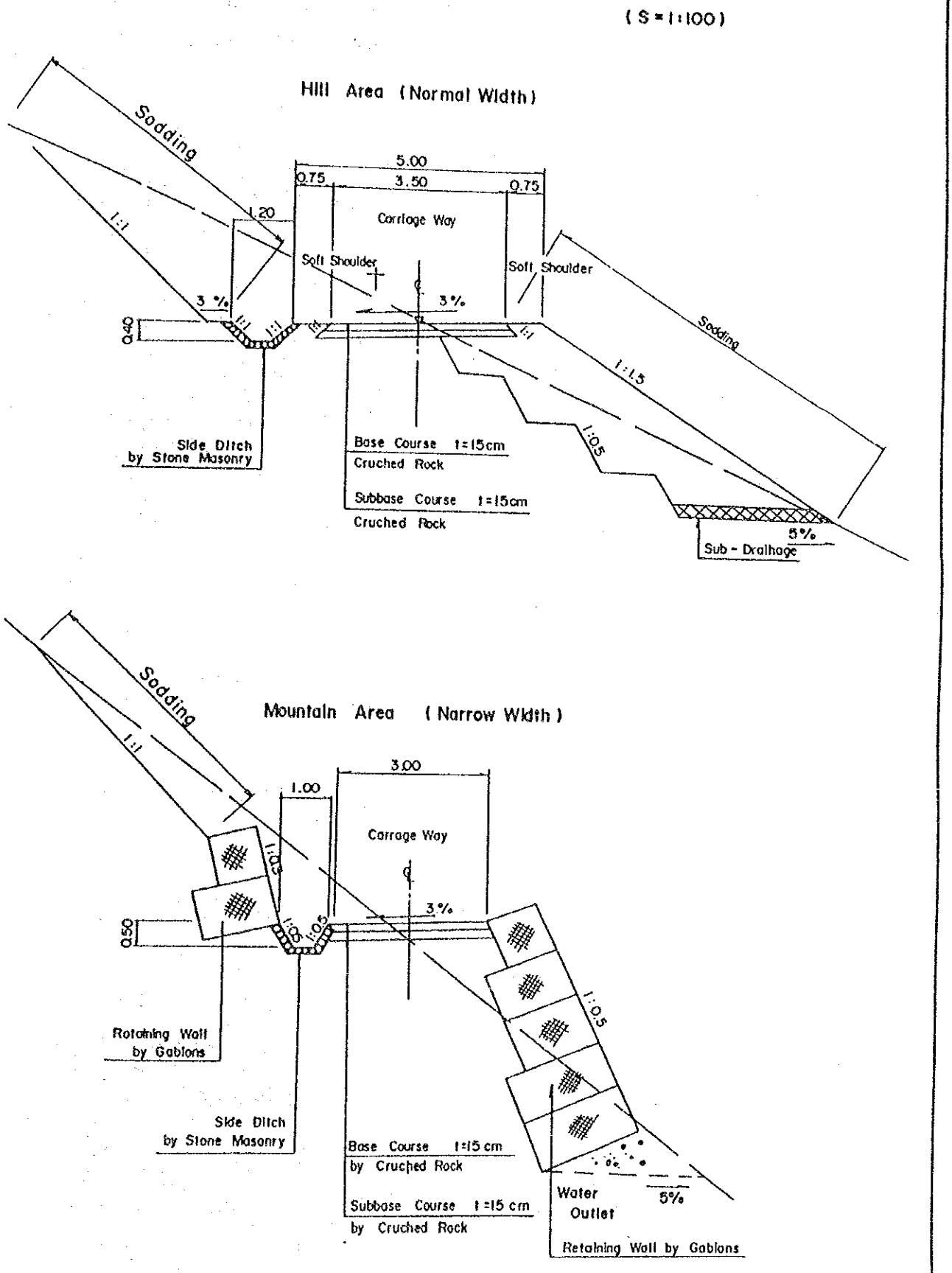


Fig. E.6.8 Typical Cross Sections

Fig. E.6.9 General Methods of Slope Stabilization No.1
(Reducing the Driving Forces and Increasing the Resisting Forces)

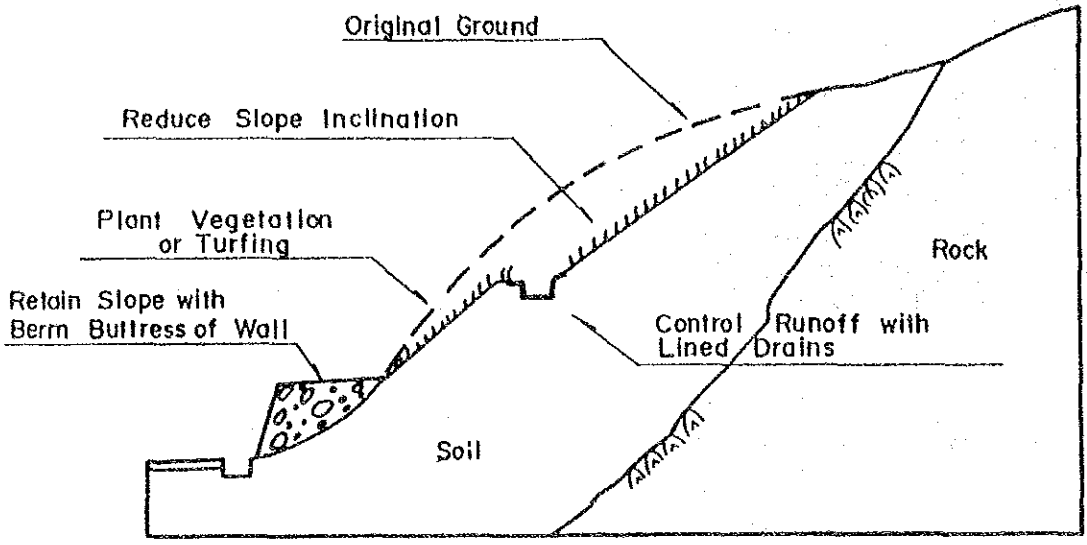


Fig. E.6.10 General Methods of Slope Stabilization No.2
(Control of Seepage Forces)

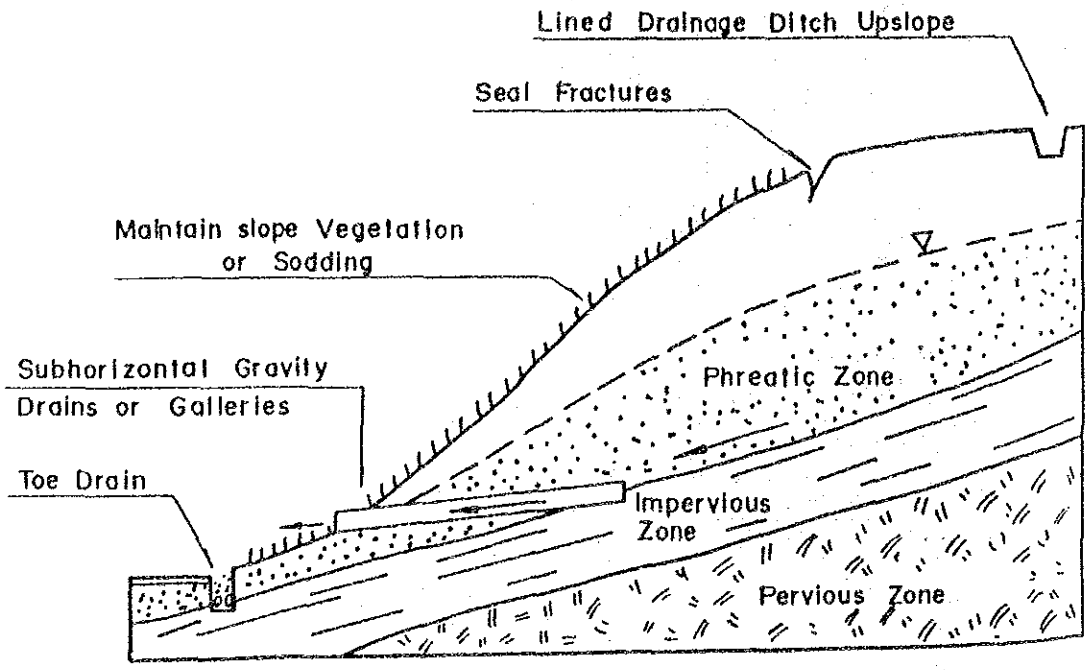


Fig. E.6.11 Stabilization of Rock-Filled Buttress

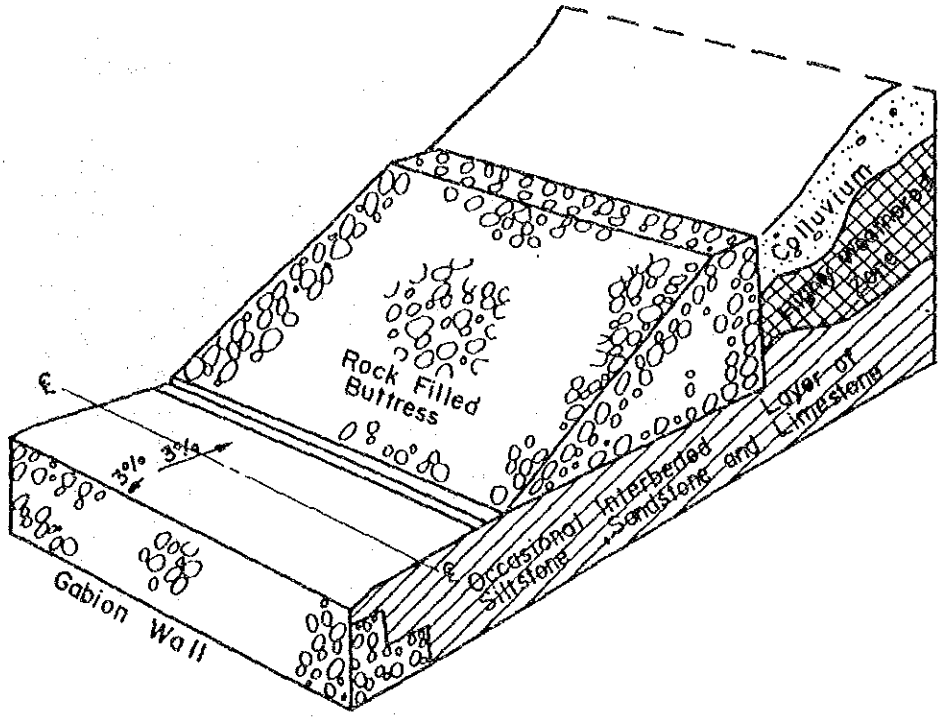


Fig. E.6.12 Stabilization of Gabion Wall

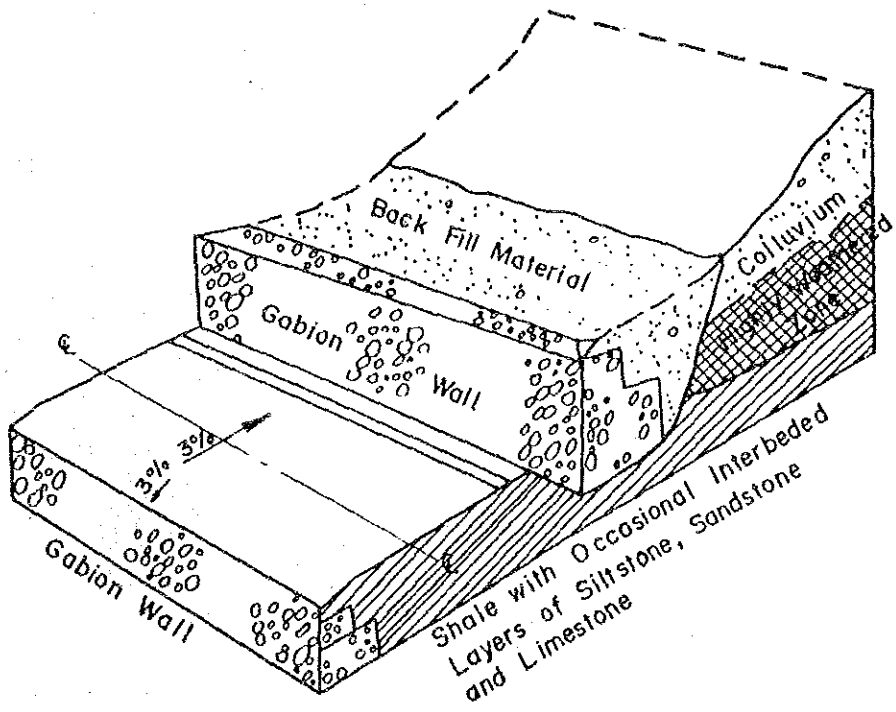


Fig. E.6.13 W & Y Shaped French Drain

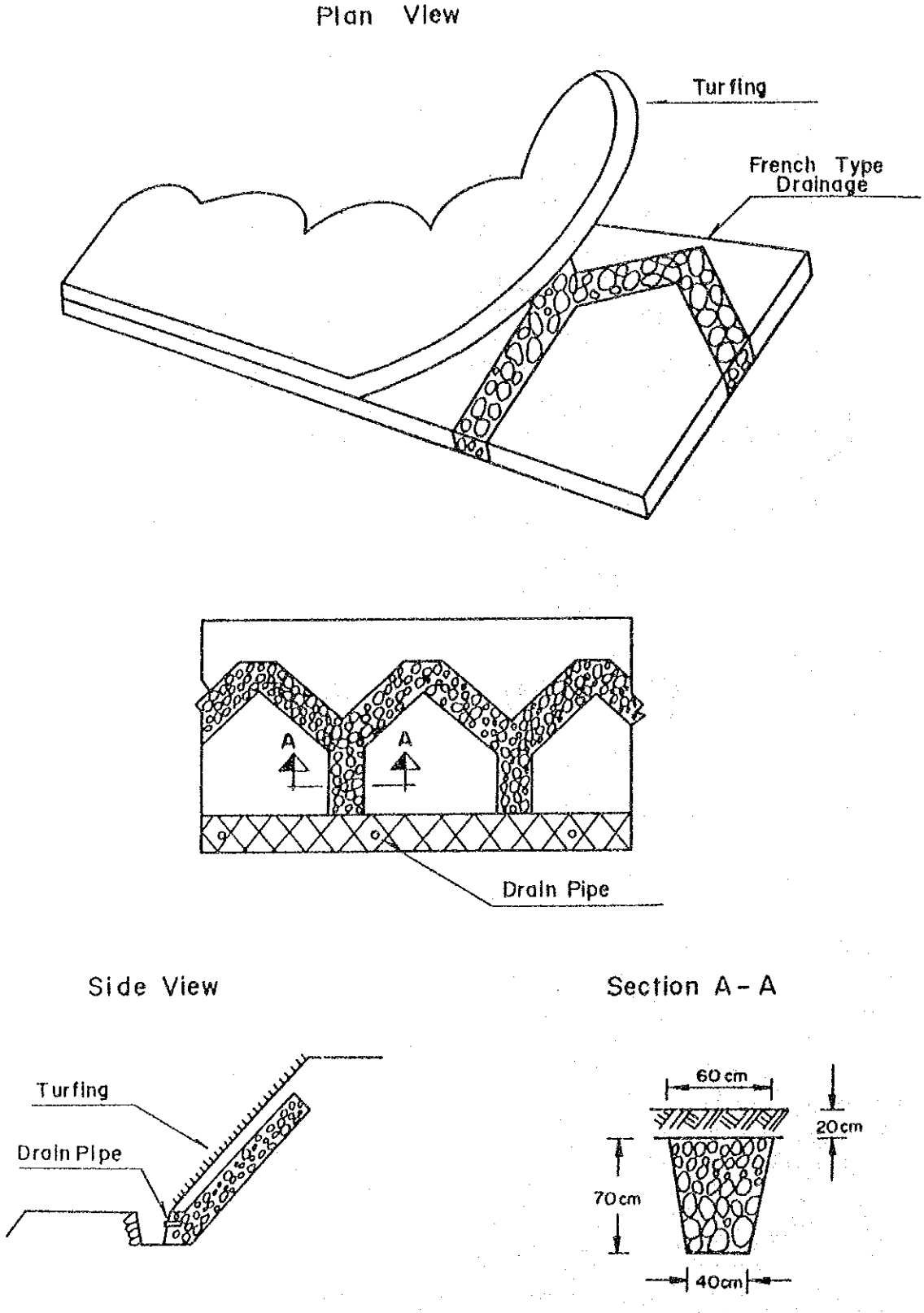


Fig. E.6.14 Stabilization of Rock Slope

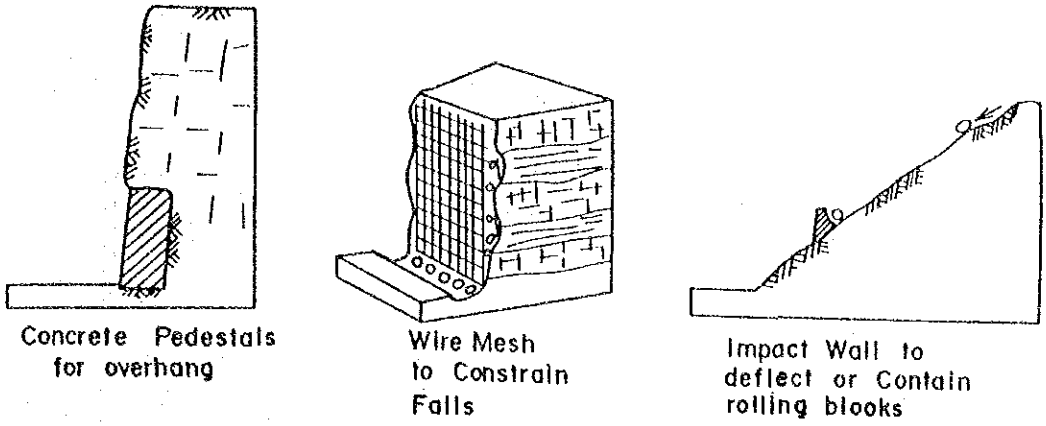


Fig. E.6.15 Erosion Control by Terracing

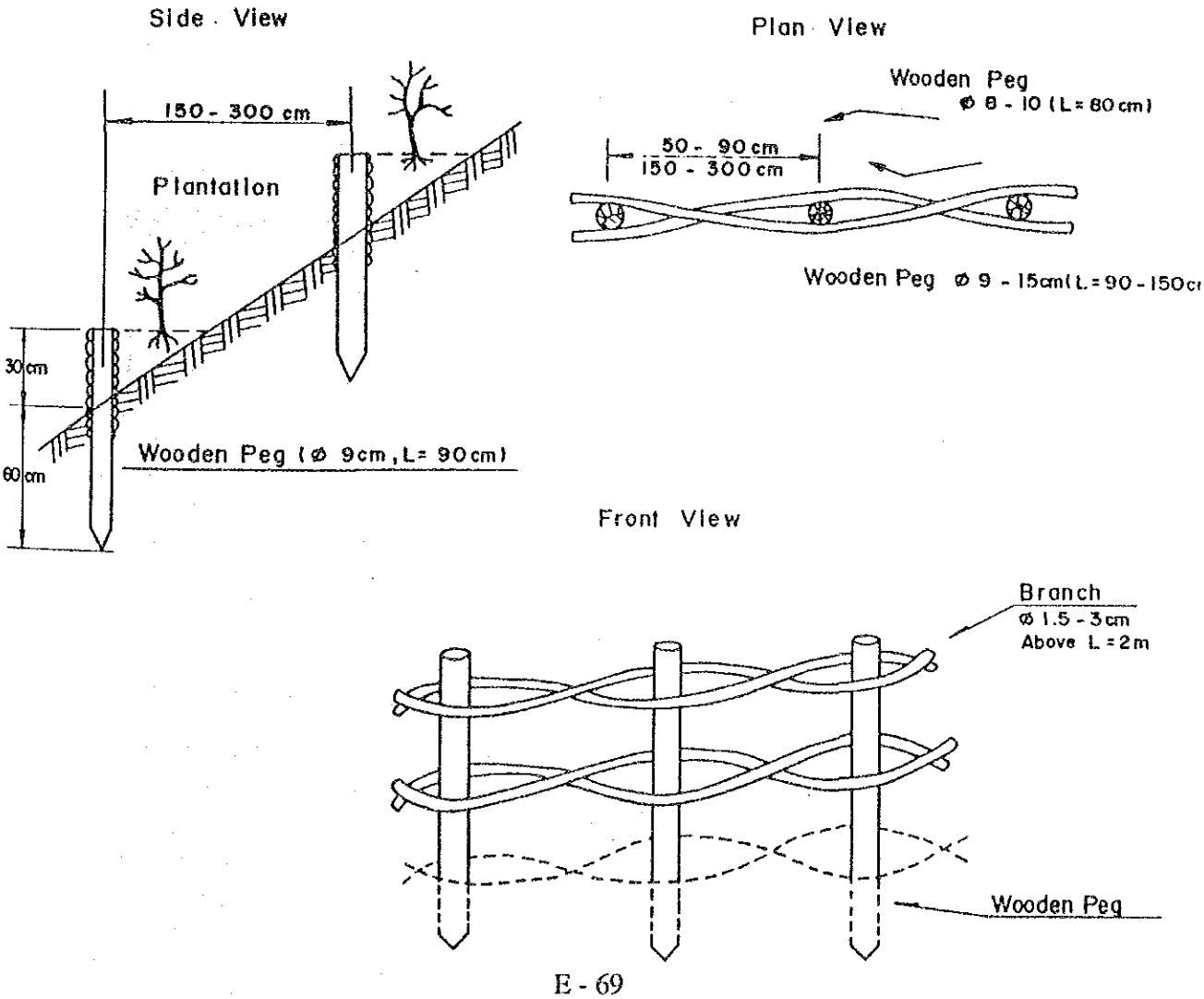


Fig. E.6.16 Proposed Bridge Cross Section No.1
(B = 6.5, P.C Beam)

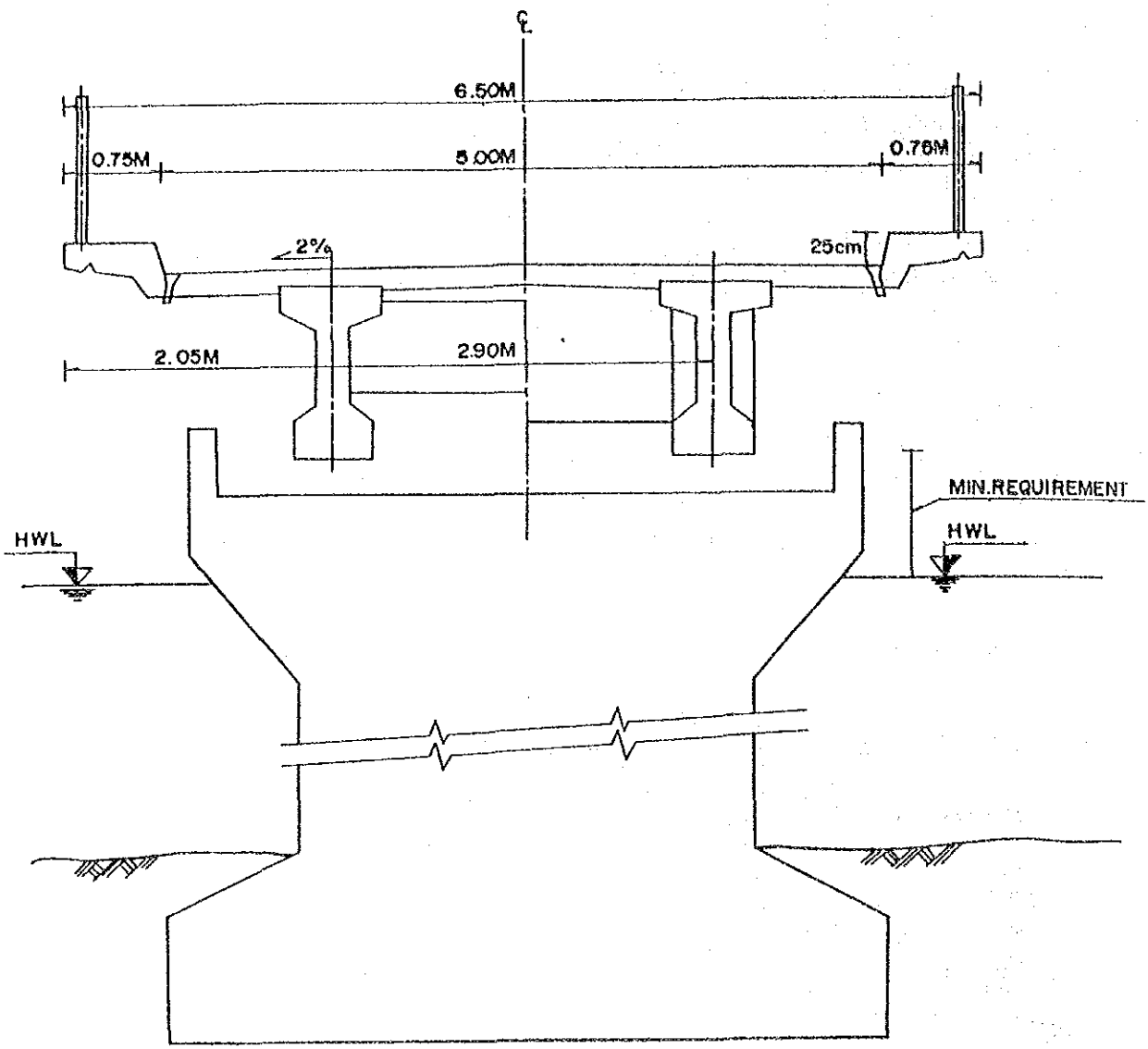


Fig. E.6.17 Proposed Bridge Cross Section No.2
(B = 6.5m, T-Girder)

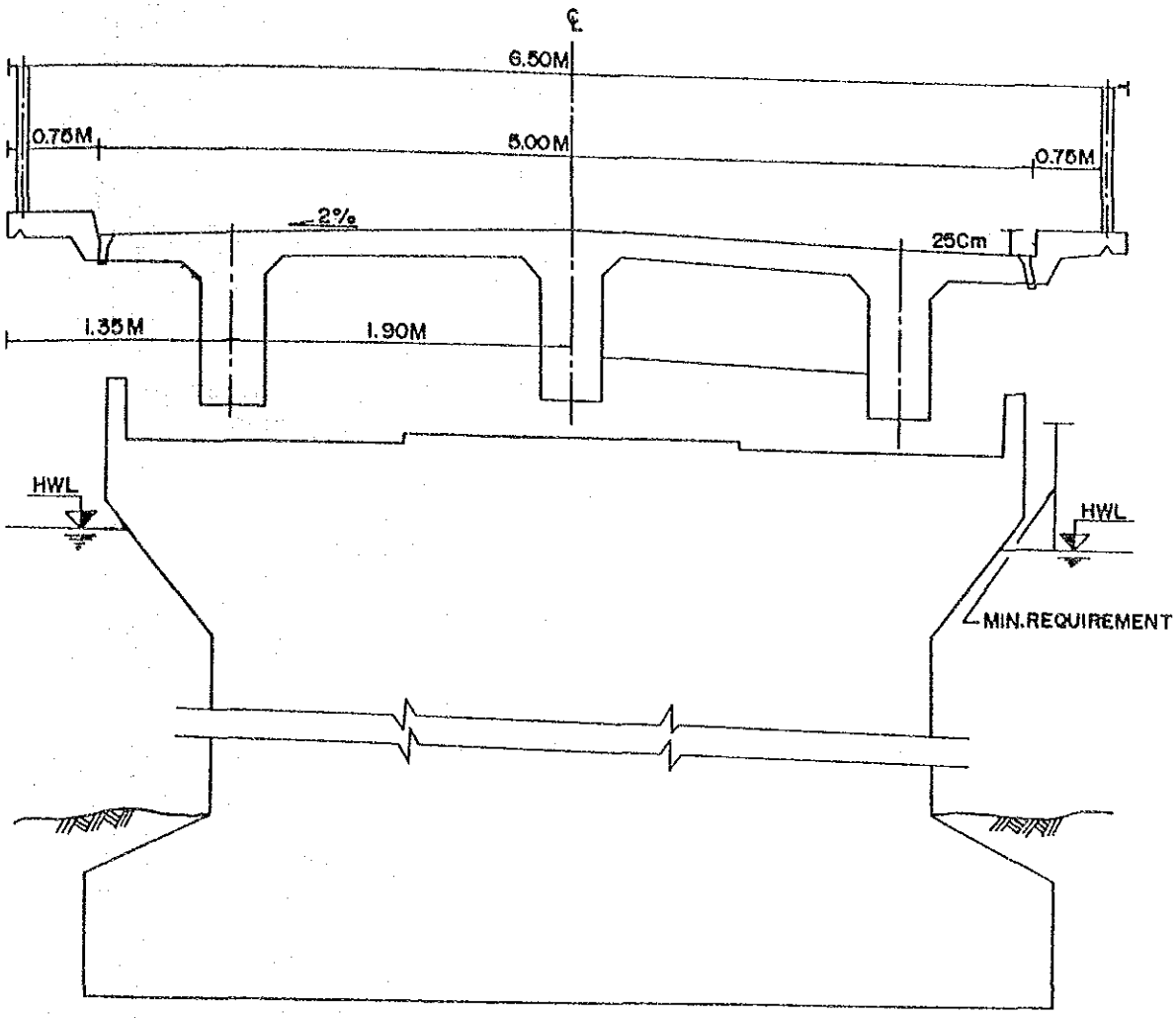


Fig. E.6.18 Typical Section of Water Outlet

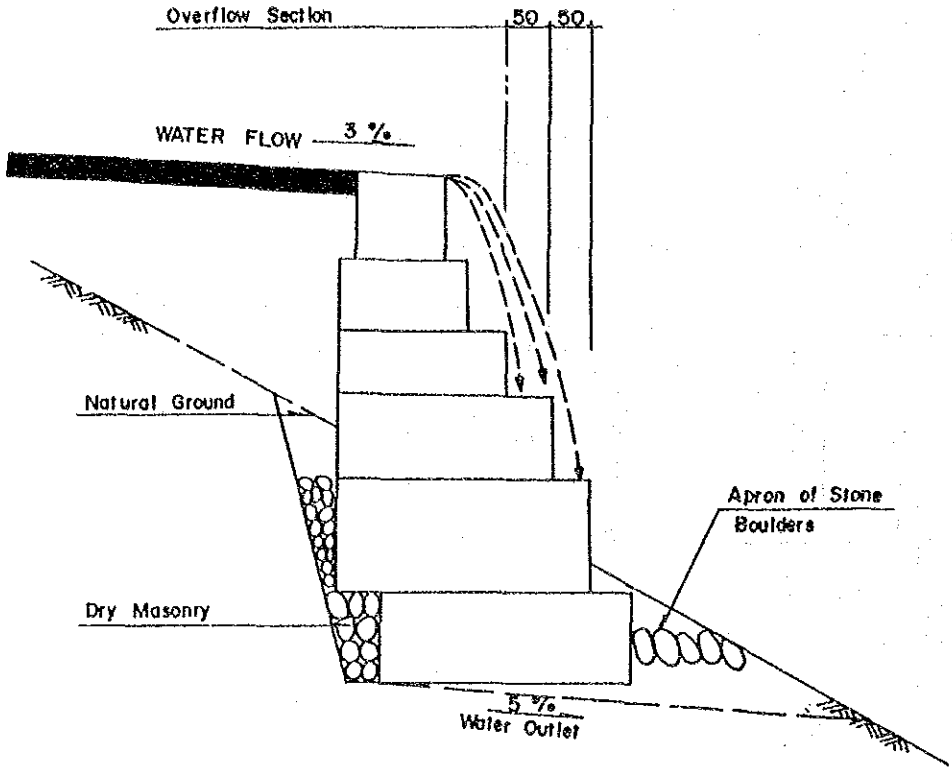


Fig. E.6.19 Typical Section of Masonry

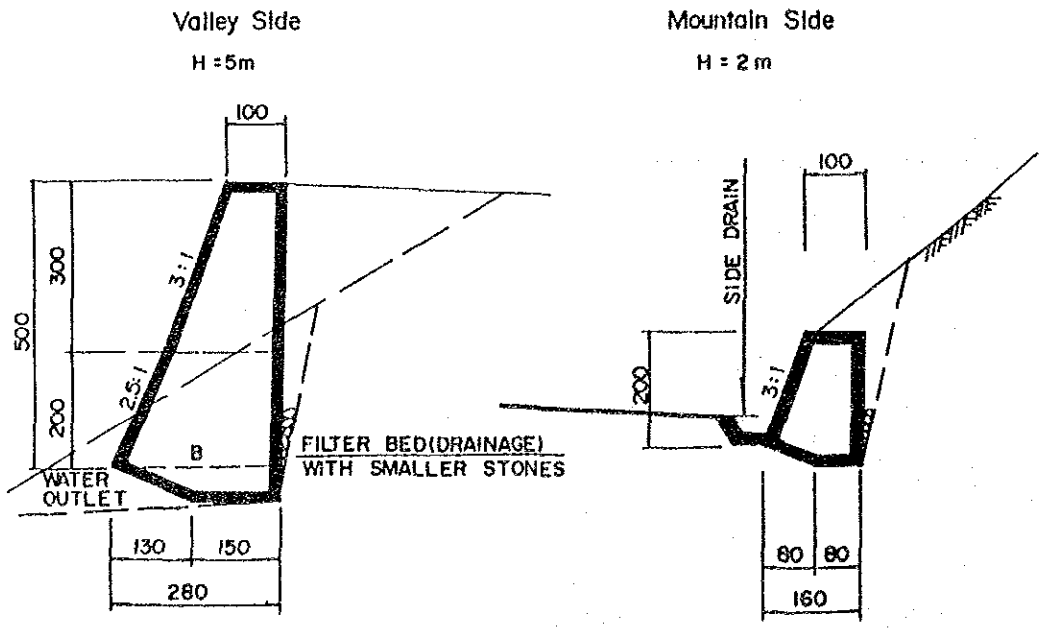


Fig. E.6.20 Implementation Schedule of Tansen - Tamphas Road

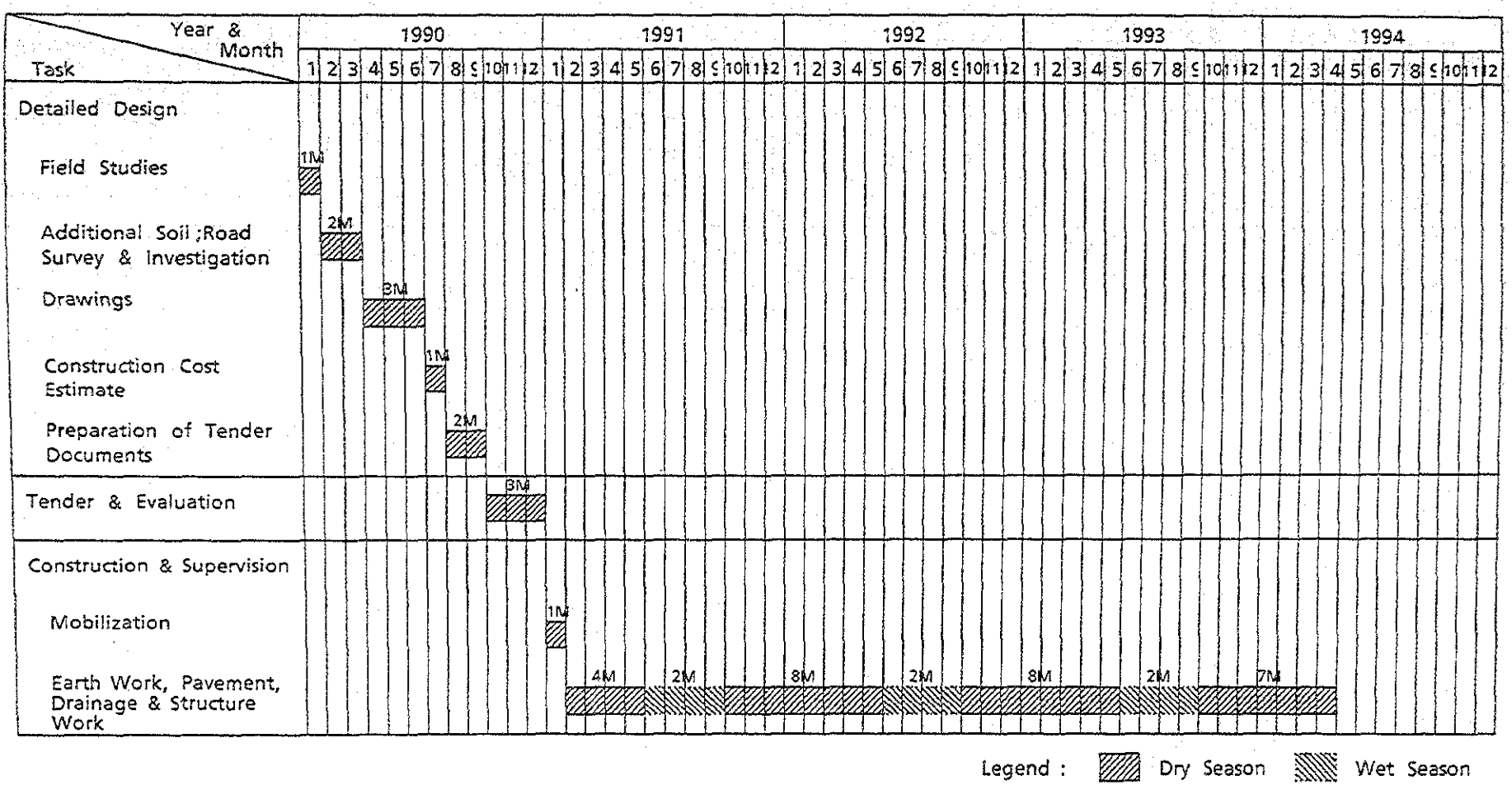
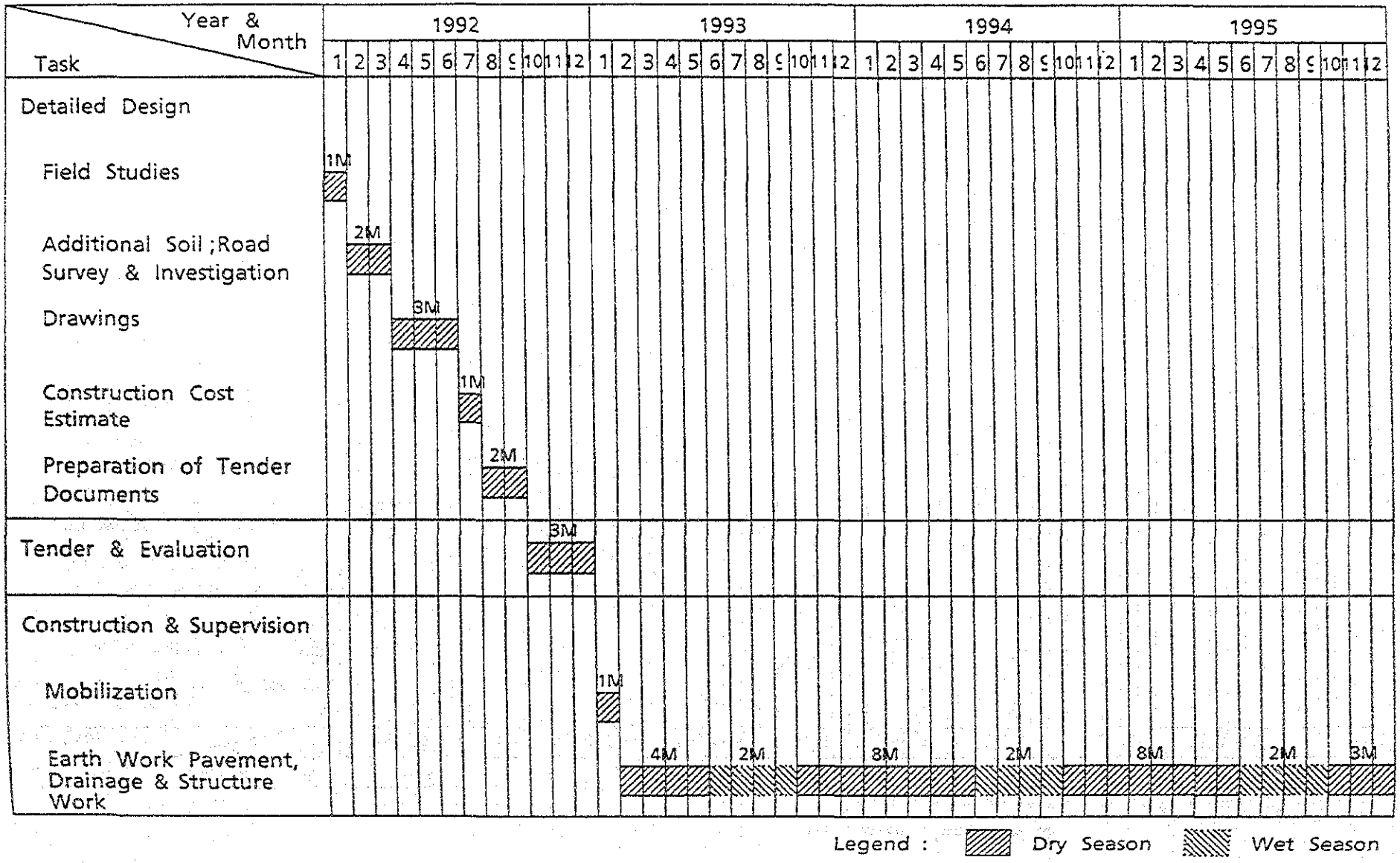


Fig. E.6.21 Implementation Schedule of MRM - Sandhikarka Road



ANNEX F

RURAL WATER SUPPLY

THE MASTER PLAN STUDY
ON
THE INTEGRATED RURAL DEVELOPMENT PROJECT
IN
THE LUMBINI ZONE

ANNEX F RURAL WATER SUPPLY

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1. PRESENT STATUS

1.1 Present Situation

(1) Water Supply Coverage

According to the Ten-Year Development Plan on Drinking Water Supply and Sanitation formulated by DWSS in 1978 and the Seventh Plan by the National Planning Commission (NPC) in 1985, the national development targets on drinking water supply in every five years were made as follows:

Population Served in Nepal

Year	Total	Population x 1,000						Total Population Served	Population Coverage %
		Urban			Rural				
		Sub-Total	Served	% Served	Sub-Total	Served	% Served		
1980	14,432	734	610	83	13,698	900	6.6	1,510	10.5 (*1)
1985	16,329	982	884	90	15,374	5,598	36	6,482	40 (*1)
1990	17,976	3,596	3,380	94	13,468	9,024	67	12,404	69 (*2)

Source: (*1) International Drinking Water Supply & Sanitation Decade, 1981 - 1990, November 1978
(*2) The Seventh Plan, NPC, June 1985

On the table, the water supply coverage was targeted in rural areas at the rate of 67% in 1990. However, in 1985 (the final year of the Sixth Plan), the accomplishment remained at a lower rate of 17.9% in spite of the targeted 36%, on the authority of A Summary of the Seventh Plan published in June 1985. Accordingly, the actual achievement in 1990, the final year of the Seventh Plan, will be comparatively lower than the target defined in the above table. It will be in a range of 30%-40%.

On the other hand, the rate of the water supply coverage in the four districts of the project area ranges 35%-9%, 22% on the average, in 1988/89.

Water Supply Coverage in the Project Area

(Year: 1988/89)

District	Total Population	Population Served	Rate of Coverage
a) Gulmi	267,877	94,812	35%
b) Arghakhanchi	176,967	62,261	35%
c) Kapilvastu	379,839	34,900	9%
Sub Total	824,683	191,973	23%
d) Rupandehi	543,487	114,169	21%
Total	1,368,170	306,142	22%

As clearly understood from the above table, rates of the coverage vary much between the hill area (Gulmi District and Arghakhanchi District: 35% each) and the Terai area (Kapilvastu District: 9%). It is supposed because of that in the hill area water source is scarcely available in the vicinity of houses and peoples have to carry water from distant water sources such as small streams and springs: this condition required construction of public piped water supply systems. On the other hand, in the Terai area groundwater is available and peoples could obtain water relatively easily near their houses by way of shallow wells, though water quality was not always guaranteed. It might be a reason that development of public water supply systems in Kapilvastu District was behind to great extent. Furthermore, the system in the hill area is gravity flow from streams or springs located at higher places in elevation making operation easy; but pumped system in the Terai area causes difficulty and high cost in maintenance and operation - this seems also one of the reasons that the development was behind in the Terai area.

(2) Water Source and Water Quality

Water sources currently used are classified into two categories. In the hill area (Gulmi and Arghakhanchi), small streams and springs are common water sources, and in the Terai area (Kapilvastu and Rupandehi), it is groundwater. This situation will not be altered in the near future because of their availability.

As to flow quantity of water sources, streams and springs meet in general present water demands, though they are not very abundant and water flow becomes naturally smaller in dry seasons. Groundwater in the Terai area is comparatively stable in yield throughout

year in the case of deep well groundwater of public water supply systems, though private-owned shallow wells often fall in water shortage in the dry seasons.

Regarding water quality, small streams and spring water in the hill area are usually drinkable; however, careful attention should be paid on pollution by human activities and livestock, and turbidity in heavy rainy days. In a particular case, some water in the hilly area contains much concentration of calcium and it caused pipes clog with heavy sediments of the calcium. In the case of shallow groundwater, drilled tube wells with handpumps have little chances to be contaminated; but dug wells (usually 1.5 m in diameter) are likely to be polluted since the dug wells are not protected by covers and located nearby houses. On the other hand, deep wells' water is considered safe in quality. Though some deep wells reportedly seem to contain high value of iron concentration, the water test carried out in September 1989 during the site survey showed very low value of iron contents, less than 0.01 ppm (According to WHO's drinking water standard, the maximum allowable iron content is 1.0 ppm). (Refer to Table F.2, for detail).

In the project area, water treatment has never been practiced regardless of water sources and quality (In Nepal, water treatment plants exist in only Kathmandu.). Even chlorination treatment has not been carried out. This is due to difficulty of treatment technology and operation and maintenance, and procurement of chemicals and spare parts of equipment, and due to shortage of operation cost. Accordingly in general, raw water is supplied directly to consumers, without removal of suspended solids and without chlorination feeding. This status, that is, no treatment and no chlorination will be continued even in future, considering situations in the project area. Treatment of iron and calcium is not easy; therefore the first subject to plan water supply systems is to find suitable water sources which should be safe in hygiene and have no problem of water quality.

In the Terai area, there are several large rivers such as Banganga, Kothi and Tinau, flow of which is enough in general for domestic water demand; however, they will not be utilized for drinking water sources in the near future because they require proper treatment for drinking purpose.

(3) Supply System

In the hill area of Gulmi and Arghakhanchi, water sources (small streams and springs) are found at higher-elevation places and supply is gravitated through pipelines as shown below. A system covers about several hundred to several thousand persons.

Stream/spring → Intake structure → Reservoir → Pipelines → Water taps

In the Terai area of Kapilvastu and Rupandehi, water source is groundwater and supply of public water system is made by pumping-up via overhead tanks as shown below. A system supplies in general several thousand to ten thousand people.

Deep groundwater → Deep well → Pump → Overhead tank →

→ Pipelines → Water taps

On the one hand, there exist small-scaled drinking water facilities of shallow tube wells equipped with handpumps (in some cases by self-flowing without handpumps) in the Terai area. This facility is called a "point source" and does not have pipelines for supply. They have been constructed by funds of the Nepal Red Cross Society, UNICEF and MPLD. Their population coverage is about a hundred people in the vicinity of the each tube well.

(4) Water Charge and Maintenance

Currently water is supplied to consumers free of charge, in the project area, excepting the case of private house connections. In almost all cases, water is taken from public stand taps without charge. Private taps are charged Rs.13 per tap monthly; however, number of the private taps is very small (though 20-25% of houses is planned to have private taps in the future), and neither construction cost nor operation and maintenance cost could be recovered by water charges from consumers. In the case of deep well systems using power-driven pumps, power/operation cost, being relatively large amount, is borne by the DWSS's annual budget.

In other countries, at least the cost of operation and maintenance is to be paid by beneficiaries in principle. The plan to charge on public taps' users has been proposed occasionally; however, to realize it will take much time considering the present situation.

As for facilities of pipelines in the hill area and handpumps in the Terai area, village people organize "Users Committee" to maintain and to repair their facilities to some extent, but repair or rehabilitation requiring considerable technology and cost is dependent on the local governments or public contributors.