3 COST ESTIMATE FOR CDPP PRIORITY PLANS FOR COMMUNITY INFRASTRUCTURE DEVELOPMENT

Chapter 3 carries out the cost estimate for the four priority plans presented in Chapter 2.

3.1 Basic Conditions of Cost Estimate

The cost estimate of the project was made under the following two conditions:

(1) People's Participatory Program (PPP) Basis
(2) Local Competitive Bidding (LCB) Basis

3.1.1 People's Participatory Program (PPP) Basis

Civil engineering works will be carried out on the contract basis under an initiative involvement and participation of beneficiary villagers (refer to as "villagers" herein after) in associate with NGO(s), for the following projects:

(1) Rural Road Rehabilitation Project in Namtar/ Tilar Area,
(Described in Section 2.1 in detail)

(2) Rural Water Supply Network Development Project in Chisapani Area.
(Described in Section 2.4 in detail)

The NGO(s) who undertake these works will be selected, judging from their management and supervising experiences and skills in the past similar project they had been involved, evaluated by some third parties.

i) These organisations or groups should consist of several engineers, and they are expected to train villagers for the maintenance work as well as for a further sustainable development in the future.

ii) Collection and transportation of materials are classified into two types as described in Section 3.2.1 (listed in Table 3.3.1 for detail). Basically, aggregates such as boulder, rubbles, cobbles, etc. will be collected by villagers. However, other construction materials such as steel bars, gabion wire, cement, and other ready-made/ precast materials such as pipes and plastic tanks will be fully supplied by a certain agency or organisation under accurate quantity estimation by NGO(s). These materials will be transported by vehicles up to motorable road-head, and then transported by villagers to the respective sites.

iii) Compensation to the villagers for participation effort will be made in cash payment within the respective project budget.

iv) The construction of the above civil works will be mostly carried out by common labourer under proper technical instruction by project engineers, using simple construction tools and equipment, such as portable mixer, portable lammer, vibrator, etc. However if machinery and equipment are required, it will basically be provided by the NGO(s), in co-operated with funding agencies..

3.1.2. Local Competitive Bidding (LCB) Basis

Civil engineering works will be constructed on the contract basis. The contractors who undertake these works will be selected through local competitive bidding. The construction of such civil works will be carried out by using construction machinery and equipment which will be provided by the contractors. Villagers may participate in simple labour works, such as collection of materials or simple construction works with tools, or light equipments, if required. The following projects will be carried out under LCB basis.

3) Micro-Hydropower Plant Project in Namtar/ Tilar Area
(Described in Section 2.3 in detail)

4) Rehabilitation of Namtar Irrigation Project in Namtar/ Tilar Area
(Described in Section 2.2 in detail)

The Contractors who undertake these works will be expected to transfer some sustainable skills and technologies to the villagers useful for the maintenance of the system, through partially employing them as common labourers.

3.2 Market Price Survey

3.2.1 Material Price and Labour Cost

The unit prices of materials and labour waged are estimated at 1996/ 97's price level, making reference to the Garrigaon Irrigation Project, an example scheme conducted under people's participation program. This project had been carried out in Phedigaon, Palung VDC, Makwanpur District, during February, 1996 to July, 1996, under assistance of HMG-N/ ILO/ IFAD/ WFP. Information was also obtained from the Makwanpur district, the Ministry of Local Development, District Irrigation Office of Makwanpur District and the market investigation was done in Hetauda and Kathmandu. The list of unit price obtained through investigation in the Makwanpur District (Hetauda) as well as Kathmandu are shown in Table 3.2.1.

Other assumptions are as the following:

(1) The cost estimate for the community infrastructure project is in local (L.C.) currency portions only.

(2) The exchange rate used for the cost estimate is as follows:

US$ 1.00 = NRs. 55.75 = ¥ 109.10, as of June 11th, 1996.

3.3 Unit Rate Analysis

The unit price for construction materials at respective sites are analysed under the following conditions:

3.3.1 Unit Rate for Major Construction Materials

Construction materials are classified into two groups; aggregates and other construction materials.

Aggregates,

Aggregates, such as boulder, rubbles, cobbles, etc., are assumed to be collected within 2 km from the respective sites, under people's participation program. Therefore, cost for collection of these materials are assumed to bear associated transportation cost. For sand, transportation cost is added at Chisapani and Namtar areas. In Chisapani, sand has been transported from quarry site in Palung bazaar by porters who charges NRs. 1 / kg. In Namtar, sand is available within 2 km from the respective sites, and assumed to be transported by trucks. In Phedigaon and Phatbazar area, sand quarry is nearby and villagers effort has been expected.

Other materials

On the other hand, the cost for other materials are assumed to be supplied and transported by private parties, hence the unit rate for materials at site bear transportation cost and indirect costs, such as contractors profit and government tax.

The unit rate for construction materials at each of three construction sites (Namtar, Chisapani, Phedigaon) are listed in Table 3.3.1.

3.3.2 Unit Price Schedule for Major Construction Work Items

The unit price schedule for the major construction work items at respective sites are analysed under the following conditions:

Unit price for major construction work items on PPP basis

The unit price schedules for the major work items on PPP basis merely consist of costs for specified quantity of labour, materials ("other materials" bear indirect cost, as described in the previous paragraph) and equipments (tools). Finally, indirect cost such as contractor's profit and government tax will not be added to these unit prices schedule, therefore, the government tax should be exempted from PPP based construction works.

Unit price for major construction work items on LCB basis

The unit price schedules for the major work items on LCB basis are estimated based on those of PPP basis. Since transportation cost as well as indirect cost have been omitted in the unit rate of aggregates as described in section 2.1.3, 10 % is added on price schedule for PPP basis at first. Then 15 % of total price is added as contractor's profit, and finally another 5 % of total price is added as the government tax portion. Therefore, the unit prices on LCB basis have increased by a total of 30.25 % from those of PPP basis.

Tables 3.3.2 through 3.3.4 summarise the site-wise unit prices for major construction work items on both PPP and LCB bases (Table 3.3.2), the cost of labour components within each site-wise unit price on PPP basis (Table 3.3.3) and LCB basis (Table 3.3.4) , respectively.

The unit prices are divided into the following four (4) work groups:

Work Group	Price Item No.		
Earth works	01	-	05
Concrete works	06	-	07
Stone works	08	-	14
Other miscellaneous works	15	-	16

3.4 Cost Estimate

The cost estimate is made at the price level in 1996/97. For all works, the cost is estimated first at the unit price level, based on the work quantities shown in Bill of Quantities. The Bill of Quantities are estimated for preliminary design under feasibility level.

As described in the Main Report, the feasibility level preliminary design was made for the following three priority out of four priority plans for infrastructure development works in the Study Areas, respectively:

Priority plans

Namtar Area:

- Rural Road Improvement Project
- Micro-Hydropower Development Project

Chisapani Area:

- Rural Water Supply Network Development Project

Priority plan (Designed by District Irrigation Office)

In Namtar area, preparation of an irrigation rehabilitation project is undertaken by District Irrigation Office of Makwanpur District. Therefore, only the features of this project will be introduced in Section 3.5.2.

- Rehabilitation and Improvement of Namtar Irrigation Project

3.4.1. Direct Construction Cost

The cost estimate was therefore made for each work based on the unit prices described in the previous sections and work quantities obtained through its feasibility level design. The total construction cost for civil works for each of the above four projects has been estimated and summarised as follows:

(1) Rural Road Improvement Project in Namtar/ Tilar Area:

NRs. 3.038 millions (US$ 54.5 thousands, Table 3.5.1)

(2) Rehabilitation and of Namtar Irrigation Project:

NRs. 4.50 to 6.00 millions (US$ 75 to 110 thousands, Table 3.5.3)

(3) Micro-Hydropower Scheme in Namtar/ Tilar Area:

NRs. 5.454 millions (US$ 97.8 thousands, Table 3.5.4)

(4) Rural Water Supply Network Development Project in Chisapani Area:

NRs. 1.968 millions (US$ 35.3 thousands, Table 3.5.5)

3.4.2 Indirect Cost

For small scale projects, especially for people's participation program basis, indirect cost mainly consists of engineering service/ technical support and physical contingency. The cost for preparatory work, which may be relatively very small compared to those of construction of mechanical measures for disaster prevention, is assumed to be covered within the former category.

(1) Engineering service/ Technical support

Engineers are expected to conduct detailed survey, detailed designs as well as a further technical support to a community based project for some period of time, so that the people will be trained and the project becomes sustainable. This cost is assumed to be 30 % of the construction direct cost (20 % for Micro-hydropower Project in Namtar/ Tilar, due to its characteristics as "plant type".

(2) Physical contingency

Physical contingency covers the fluctuation of direct construction costs, and assumed to be 20 % of the sum of direct construction cost and cost for engineering service/ technical support.

3.4.3 Cost Estimate for Total Project Cost

Finally, cost estimate for the total project cost is the sum of direct and indirect costs. The total project cost for each of the four prioritised/ project for community infrastructure development was estimated and summarised as follows:

(1) Rural Road Improvement Project in Namtar/ Tilar Area:

NRs. 4.739 millions (US$ 85.0 thousands, Table 3.5.1)

(2) Rehabilitation and of Namtar Irrigation Project:

NRs. 7.0 to 8.0 millions (US$ 125 to 145 thousands, Table 3.5.3)

(3) Micro-Hydropower Scheme in Namtar/ Tilar Area:

NRs. 7.854 millions (US$ 140.9 thousands, Table 3.5.4)

(4) Rural Water Supply Network Development Project in Chisapani Area:

NRs. 3.070 millions (US$ 55.1 thousands, Table 3.5.5)

Cost estimate for each of the individual project will be explained in detail in the following sections 3.5.1 through 3.5.4.

3.5. Cost Estimate for Priority Projects for Community Infrastructures

3.5.1 Rural Road Improvement Project in Namtar/ Tilar Area:

The cost estimate of the project was made under the conditions of 'People's participation program" basis at Namtar/ Tilar, as described in the preceding sections.

The major components for the rural road improvement are as follows:

Gabion structures (checkdams, prop walls), Side-ditch (wet masonry and dry rubble masonry types), Surface drainage (stone pitching), Drainage pipe culvert (RCC pipes) and Drop-chutes (vegetated riprap). Based on the work quantities estimated in Section 2.1.1 of this Sector Report, the construction cost as well as the total project cost for the rural road improvement project in Namtar/ Tilar Area are estimated. The total project cost is estimated at NRs. 4.739 millions (US$ 85 thousands), among which the total construction cost is estimated at NRs. 3.038 million (US$ 54.5 thousands) as is summarised in Table 3.3.1. It is noted that the miscellaneous cost, which is given as 20 % of the total direct construction cost for major works, basically should bear the cost for the following items: minor work items such as for vegetation and extra materials for the future development as well as spare parts for the maintenance of the system, such as gabion wires, cement, RCC pipe for culverts, etc.

Table 3.3.2 shows the breakdown cost for the major work items. Besides the cost estimation on PPP basis, estimation on LCB basis, which includes contractor's profit as well as government tax, is given in the right column of the same table as a reference.

The organisations or groups who undertake these works should consist of several engineers, and they are expected to technically support the community through training villagers for the basic construction works, maintenance works as well as a further sustainable development in the future. In this way, it is expected that basic appropriate technologies and skills, such as an adequate establishment of gabion boxes, excavation of side-ditches, etc. to be transferred to the community.

3.5.2 Rehabilitation and of Namtar Irrigation Project:

The survey, design and cost estimate of the system has been undertaken by the District Irrigation Office of Makwanpur since July 1996. The proposed major construction work items are as follows

Intake structure (side intake type); Head reach canal (reshaping of existing canals: 1.0 km on Dungeon side, and 2.5 km on Namtar side); Suspended aqueduct over Manhari khola (clear span; about 100 m); Crossing structures (15 nos.); and reshaping of main canal

(about 3.5 km). Among these works, the most expensive item will be the suspension aqueduct, of which the cost for construction is estimated to be in the range of NRs. 2 to 3 millions (on direct cost basis), and the total construction cost of whole system is to be in the range of NRs. 4 to 5 million (on direct cost basis), respectively. Thus, the cost for the said aqueduct will be estimated to be about 55 to 65 % of the total construction cost. Finally, .the total project cost is estimated to be in the range of NRs. 700 to 800 millions.

3.5.3 Micro-Hydropower Scheme in Namtar/ Tilar Area

The cost estimate of the project was made under the conditions of "Local Competitive Bidding (LCB)" basis at Namtar/ Tilar area, thus the construction cost bears contractors profit as well as the government taxes, as described in the preceding sections.

The major components of the scheme are as follows:

Intake works (constructed on Checkdam D-1) on the Manahari Khola; Desilting basin with Spillway (wet stone masonry and valves); Connecting pipe (6 kgf/cm2 HDP pipe I.D. 250 mm), Revert/ Stream crossing structures (wet stone masonry, 5 nos.); Forebay tank (wet stone masonry and sluice gate); Generating plant and distribution system (Plant: 20 kW, distribution line: 9.4 km).

The work quantities for construction is estimated on a preliminary design basis as is summarised in Section 2.3 of this Sector Report. The total project cost is estimated at NRs. 7.854 million or US$ 140.9 thousands, of which the construction costs have been estimated at NRs. 5.442 million (or US$ 97.6 thousands), as is summarised in Table 3.5.3.

It is noted that an amount of 100 lit./ sec. of water will be introduced through intake constructed on Checkdam D-1, and generates about 18 kW of electricity, distributed to 140 households as well as community facility such as Kalika Secondary school, health post, etc. Surplus amount of water could be used for supplemental irrigation by initiative effort of the villagers in the area.

3.5.4 Rural Water Supply Network Development Project in Chisapani Area

The cost estimate of the project was made under the conditions of 'People's participation program" basis at Chisapani, as described in the preceding sections.

The feasibility level preliminary design was made for the rural water supply network development in Chisapani Area for 78 households and a school, as described in the Section 2.4 of this Sector Report. The major components for the network are as follows:

Intake protection structure (precast unit), storage tanks, distribution tanks (both in RCC), delivery tanks, household storage tanks (both in plastic tanks), related structures (precast unit), and HDP pipelines.

Based on the quantity estimate given in Chapter 2 hereof, the project cost, including costs for engineering service as well as physical contingencies, is estimated at NRs. 3.07 million (US$ 55.1 thousands). Among this, total construction cost for the project was estimated at NRs. 1.968 million (US$ 35.3 thousands) as summarised in Table 3.5.5. It is noted that the miscellaneous cost, which is given as 20 % of the direct construction cost, basically should cover the cost of extra materials and spare parts for the maintenance

of the system, such as pipes, cement, pipe fittings, extra plastic tanks for the future development, sprinkler unit, etc.

Since the network is divided into three major blocks (systems), system-wise breakdown of the associated direct construction cost for the major components are also summarised in Table 3.5.6.

Table 1.1.1 Important Factors in Design of Rural Water Supply Scheme (1/4)

Design Criteria for the Design Guidelines for Community Based Gravity Flow Rural Water Supply Schemes published by HMG-N/ UNICEF

1.	Table A-1: Domestic Water consumption Figures: It shows the common basic water demand on per capita basis.
2.	Table A-2: Institutional Water Consumption Figures: It shows some basic idea of water demand at school and health post
3.	Table A-3: Water Demand Projections: It explains the definition of how water demand should be estimated
4.	Safe Yield = 0.9 * measured source yield at the peak of the dry season.
5.	Consumption Pattern: It shows water consumption pattern during a day in percentage.
6.	Peak Flow Factor for the above consumption pattern = 3: The peak hours of a daily consumption is explained as between 7:00 - 12:00
7.	Storage Tank Capacity: A suggested method for determining storage tank capacity is explained by a graph and table
8.	Flow Velocity: Suggested maximum and minimum flow velocities within the pipeline are explained for various cases.
9.	Table A-9: Suggested Tap Flow Rates: Suggested tap flow rates are explained for design water supply level
10.	Static Head: Acceptable static head for various types of pipelines are explained.
11.	Table A-11: Residual Head Acceptable residual head for each of the components are explained
12.	Table A-12: Maximum Distance of Standpost Location from Users Guideline for determining a location of a standpost/ tapstand is explained.

Table 1.1.1 Important Factors in Design of Rural Water Supply Scheme (2/4)

Design Criteria for the Design Guidelines for Community Based Gravity Flow Rural Water Supply Schemes published by HMG-N/ UNICEF

1. Table A-1: Domestic Water consumption Figures

Type of Supply Area	Daily Water consumption
Rural Village	45 lcd
Bazaar Area	60 lcd

lcd = litre. per capita. per day

2. Table A-2: Institutional Water Consumption Figures

- School	10 l/d	per student
- Health Post	1000 l/d	for out patients only and without improved sanitary condition e.g. WC
	3000 l/d	for out patient only with improved sanitary condition

3. Table A-3: Water Demand Projections

- Present Water Demand	At the time of survey
- Base Year Water Demand	When construction is completed and water scheme is commissioned.
- Design Water Demand	After 15 or 20 years service life

4. Safe Yield = 0.9 * measured source yield at the peak of the dry season.

5. Consumption Pattern

Table A-4: Water Consumption Pattern

Hours	% of Daily Demand
05:00 - 07:00	25
07:00 - 12:00	35
12:00 - 17:00	20
17:00 - 19:00	20
19:00 - 05:00	Negligible

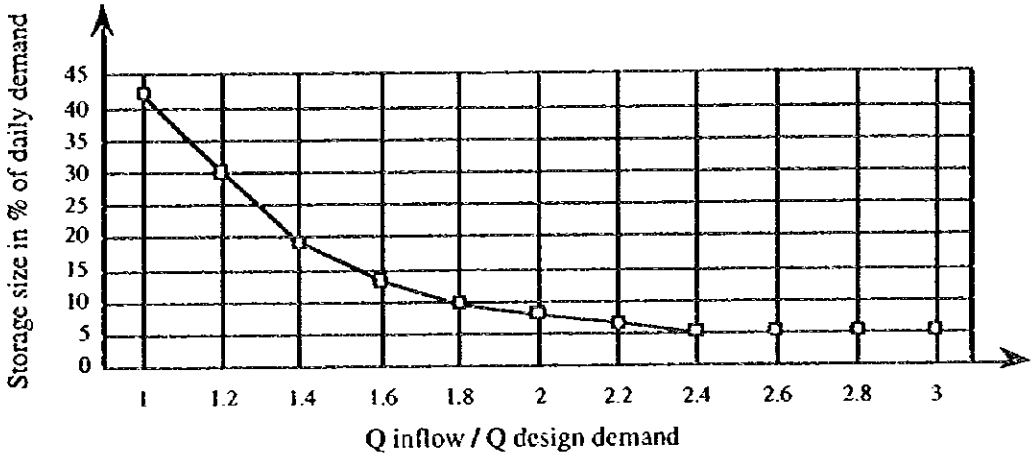
6. Peak Flow Factor for the above consumption pattern = 3

Table 1.1.1 Important Factors in Design of Rural Water Supply Scheme (3/4)

Design Criteria for the Design Guidelines for Community Based Gravity Flow Rural Water Supply Schemes published by HMG-N/ UNICEF

7. Storage Tank Capacity

The storage tank capacity should be estimated on the basis of following graph:



Preliminary storage can also be estimated on the basis of following method.

Table A-5: Balancing Storage

Supply Meets Demand In	Hours 18-24	Hours 15-18	Hours 12-15	Hours 9-12	Hours <9
Storage Volume (hours of average demand)	10	8	6	4	0

8. Flow Velocity

a) Minimum velocity

On stream intakes, if no sedimentation is provided, the minimum flow velocity shall be:

- In down hill stretches 0.8 m/s
- In up-hill stretches 1.0 m/s

If a sedimentation is provided, the minimum flow velocity can be reduced to:

- In down hill stretches 0.4 m/s
- In up-hill stretches 0.5 m/s

b) Maximum velocity

- Desirable 2.3 m/s
- Maximum 3.0 m/s

Table 1.1.1 Important Factors in Design of Rural Water Supply Scheme (4/4)

Design Criteria for the Design Guidelines for Community Based Gravity Flow Rural Water Supply Schemes published by HMG-N/ UNICEF

9. Table A-6: Suggested Tap Flow Rates

Design Water Demand (l/d)	Peak Flow Rate (l/s)	Remarks
4,500 - 6,000	0.20	Bazaar
3,300 - 4,500	0.15	Bazaar
3,375 - 4,500	0.15	Village

When the design demand is less than 3,300 l/day, the tap flow is 0.1 l/s.

10. Table A-7: Static Head

a) Transmission main

- For HDP pipes pressure class 10 kg/cm^2 not more than 100 m
- For GI pipes pressure class conforming to BS 1387 medium grade not more than 160 m
- For more than 160 m use welded joints for pipe & fittings

b) Distribution lines

- Acceptable	60 m
- Exceptional cases	80 m
- With self-closing taps (e.g. Jayson Taps)	20 m

11. Table A-8: Residual Head

Structure		Residual Head
- Standpost	Desirable	5 m
	Acceptable	up to 15 m
- BPCS and Storage tanks		10 to 15 m

12. Table A-9: Maximum Distance of Standpost Location from Users

Walking Distance	Desirable	In Exceptional Cases
- Horizontal	150 m	250 m
- Vertical	50 m	40 m

Design population per standpost: 100

Table 1.1.2
Check List for Implementation of Rural Water Supply Network Development

Responsibility of Beneficiaries / Users Committee

For implementing a community water scheme, the responsibilities of the implementing agencies should be clearly defined. The responsibilities of the users committee at different stages of the scheme implementation cycle would be as follows:

Planning Phase

The committee will participate in the following tasks during the planning phase:

- Make innitial request for the scheme based on demand-led approach
- Form a Water Users' committee with at least two woman members
- Selection of source and its regular measurement
- Involve actively during both pre-feasibility and feasibility study
- Resolve source disputes
- Clear the source area where intake is to be built and make access track wherever needed
- Get fully informed and agree for deisgn and cost estimate of the scheme
- Collect maintenance fund at the agreed rate for each Delivery tank (equivalent to Tap stand)
- Establish a protection zone around and on the catchment of the source and plant suitable tree species with assistane of district forest office
- Identify and recruit a VMW for the operation and maintenance caretaker (preferablyfemale) and two health workers (sewikas) for each delivery tank
- Involve the actual beneficiaries (women members also) to decide delivery tank location

Note: VMW = Village maintenance worker; OnG = on going; NY = not yet done

Construction Phase

The committee will mobilise the local community for the following tasks:

- Digging trench and backfilling
- Collecting and supply local materials such as stones, sand etc.
- Excavating at intake, storage tank, distribution tank, etc.
- Transporting pipes and other construction material from road-head to scheme site
- Unskilled labour for construction of intake, storage tank, distribution tank, etc.
- Organizing and managing store taking responsibility of cement, pipes, together with implementing agency.
- Keeping minutes of all expenditure and decision on the scheme development.
- Organising regular meeting and solve all local problems
- Providing necessary support to the construction in charge
- Acquiring land for intake, storage tank, delivery tank, etc.
- Supervising construction and control quality in co-operation with the construction in charge

Operation and Maintenance Phase

Users' Committee will undertake the folllowing activities during the operation and maintenance phase

- Collect money on regular basis to pay the VMW and purchase spares
- Supervise the VMW
- Organise labour contribution for maintenance and repairs
- Supervise the delivery tank group and encourage them to participate more in spreading the health and hygiene education message to beneficiaries
- Co-ordinate with village development committee

Table 1.1.3 Check List for Step by Step Implementation Procedure for Rural Water Supply Network

The steps for implementation for a community based gravity flow rural water supply network development in Chisapani Area are as follows:

* Request for the scheme by the user with VDC's recommendation
* Pre-feasibility study
* Formation of Users' Committee
* District Assembly priorities for feasibility study
* Feasibility study
    - Hydrological
        - survey of all potential water sources
        - regularly monitor the selected sources
    - Social aspects
        - assessment of the felt need
        - assessment of the community cooperation and interest
        - location of the delivery tanks (equivalent to "Tapstand")
    - Health / sanitation activities
        - Selection of villge woman workers
    - Technical
        - Altimeter (or Abney level) survey of the altitudes of intake, storage tanks, distribution tanks, etc.
* Initial layout
* Preliminary cost estimate of different optins
* Districts assembly selects scheme for construction
* Detail Survey with Abney or Theodolite or Automatic level
* Final assessment of the safe source yield
* Final layout of the scheme
* Design, cost estimate preparation
* Users' Committee agrees on the service level, the design and cost estimates of the scheme
* Agreement with Users' Committee
* Identification of the VMW and the formation of Delivery tank Group
* Training of the users' committee Village Health Workers
* Procurement of the materials, and then transportation to site
* Construction activities
* On the job training ofnthe VMW and health workers
* Completion Ceremony
    - Provide ownership certificare
    - Fix renumeration of VMW
    - Provide extra tools and materials to VMW
    - Fill completion Report
* Operation and maintenance
* Training of VMW, Users' committee, Village Health Workers, Delivery tank Groups
* Monitoring and Evaluation
* Provision of spares and materials through cooperatives

Table 1.3.1 Present Status of FMIS in the CDPP Area

Name of River	Name of Scheme	Command Area	Approximate Canal Length	Facilities Damaged by the 1993 Disaster	Present Condition	Remarks
Manahari Khola,	Upper (ILO) Scheme, Right bank, Namtar No.2	50 ha in Namtar/ Tilar	6.0 km (Head reach: 2.5 km)	Intake and Head reach, Crossing structures along distributing canal	Not In Use	- Rehabilitation project proposed by villagers. - Under Appraisal by DIO, for integration with Dungeon scheme (40 ha)
	Lower scheme, Right bank, Namtar No.2	3 ha in Namtar/ Tilar	1.5 km (Head reach: 0.5 km)	Intake, Head reach	In Use	- Rehabilitated by villagers. - Lost most of its command area (right bank) by scouring in the 1993 disaster
	Upper (Dungeon) Scheme, Left bank, Namtar No.4	40 ha in Dungeon	3.5 km (Head reach: 1.0 km)	Intake, Head reach	In Use	- Rehabilitated by villagers. - Irrigating over 30 ha out of 40 ha - Under Appraisal by DIO, for integration with ILO scheme (50 ha)
	Lower scheme, Left bank, Namtar No.4	-	1.5 km (Head reach: 0.5 km)	Intake, Head reach	Not In Use	- Lost all most of its command area (left bank) by scouring in the 1993 disaster - Used only by a water mill
Gorduwa Khola	Upper (Gorduwa) Scheme, Left bank, Namtar No.2	10 ha in Namtar	3.0 km (Head reach: 1.8 km)	Intake, Head reach	In Use	- Rehabilitated by villagers. - Low efficiency due to its irregular canal bed slope
	Lower scheme, Left bank, Namtar No.2	2 ha in Namtar	1.0 km (Head reach: 0.4 km)	Intake, Head reach	In Use	- Rehabilitated by villagers. - Lost most of its command area (right bank) by scouring in the 1993 disaster
	Lower Scheme, Right bank, Namtar No.7	30 ha in Northern Ward-7	5.0 km (Head reach: 0.8 km)	Intake, Head reach	In Use	- Rehabilitated by villagers.
Khade Khola	Khade scheme, Right bank, Namtar No.4	30 ha in Jyarpu/ Bhadaure	3.0 km (Head reach: 0.7 km)	Intake, Head reach	In Use	- Rehabilitated by villagers - Irrigating about 20 ha out of 30 ha - Villagers hope to get additional water from Syarse scheme
Syarse Khola	Syarse scheme, Right bank, Namtar No.4	15 ha in Jyarpu	1.0 km (Head reach: 0.3 km)	Intake, Head reach, Distributing canal	In Use	- Rehabilitated by villagers. - Irrigating about 8 ha out of 15 ha, due to disconnection at a landslide section
Dhungakate Khola	Garrigaon Irrigation Project, Right bank, Palung No. 8 (Phatbazaar), 9 (Phedigaon)	100 ha, Phedigaon 20 ha, Phatbazar (Garrigaon) 80 ha	Pipe: 0.85 km; Canal: 2.0 km (Head reach: 1.0 km)	Intake, Head Reach	In Use	Intake and head reach, Rehabilitated by IFAD/WFP/ILO, in July 1996
		15 ha, Left bank Phedigaon	0.3 km	Intake, Head Reach	Not In Use	Intake site was eroded deeply down to foundation rock. Deep gap is seen between intake and head reach.
Ghatte Khola	Ghatte small schemes, Right bank, Palung No. 9 (Phedigaon)	15 ha, Right bank Phedigaon	0.3 km	Intake, Head Reach	Not In Use	Intake can be rehabilitated relatively cheap. Check whether irrigation would induce further landslide
Bhottekhona Khola	Soltu Scheme, Left bank, Palung No.7 (Soltu), 9 (Phedigaon)	70 ha, Left bank Phedigaon 20 ha, Soltu 50 ha	3.0 km (Head reach: 1.2 km)	Intake, Head Reach, Pipe Aqueducts 4 nos.	Not In Use	New intake and major work required, including 4 nos. of pipe aqueduct
Mahadev Khola	Small schemes, Left & Right bank Bangkhona, Karkigaon, Palungbazar (Ward 4, 5, 6)	70 ha, Right bank Bangkhona, Karkigaon, Palungbazar (Ward 4, 5, 6)	1.0 km 1.0 km 1.2 km (Head reach: 0.1km)	3 Intakes and Head Reaches	In Use	Rehabilitated by farmers. Amount of intake water has been decreased down to 60 %

Source: Field survey in May - June, 1996, by the Study Team

Table 1.4.1 Available Turbines in Nepal (under 100 kW)

Turbine Type	Power Output(Max) (kW)	Power Output(Min) (kW)	Head(Max) (m)	Head(Min) (m)
Propeller	5	1	5	1
Turgo	10	2	20	4
Turgo	10	2	20	4
Crossflow	50	1	30	5
Crossflow	50	5	50	5
Crossflow	50	1	-	12
Crossflow	250	3	100	3
Pelton	50	1	150	25
Pelton	100	1	150	30
Pelton	1000	100	1000	100
Francis	1000	100	150	5

Source; Micro-Hydro Design Manual by Intermediate Technology Publications 1993,

Note; The above turbines can be supplied by Nepalese manufacturers.

Table 1.4.2.1 Potential Number of Biogas Plants and Potential Biogas Production(1/2)

District	Potential Number of Biogas Plants (No.)	(%)	Potential Biogas Production (1000 x m3)	(%)
Mountain Region:	*9,656*	*0.75*	*3,715*	*0.56*
Sindhupalchoke	1,578	0.12	598	0.09
Dolakha	1,493	0.12	397	0.06
Sankhuwasabha	933	0.07	369	0.06
Bajhang	906	0.07	362	0.05
Taplejung	805	0.06	362	0.05
Bajura	790	0.06	348	0.05
Kalikot	699	0.05	287	0.04
Darchula	659	0.05	248	0.04
Solukhumbu	489	0.04	203	0.03
Jumla	427	0.03	162	0.02
Mugu	276	0.02	115	0.02
Humla	267	0.02	89	0.01
Rasuwa	146	0.01	83	0.01
Dolpa	106	0.01	62	0.01
Mustang	61	0.00	22	0.00
Manang	21	0.00	8	0.00
Hill Region:	*455,038*	*35.46*	*243,023*	*36.48*
Syangja	27,895	2.17	11,547	1.73
Gulmi	19,658	1.53	10,677	1.60
Sindhuli	18,086	1.41	10,114	1.52
Khotang	17,734	1.38	9,822	1.47
Dhading	17,528	1.37	9,261	1.39
Kavrepalanchok	16,966	1.32	8,751	1.31
Baglung	16,337	1.27	8,695	1.31
Surkhet	15,915	1.24	8,477	1.27
Bhojpur	15,699	1.22	8,151	1.22
Arghakhanchi	14,723	1.15	7,845	1.18
Ilam	14,492	1.13	7,797	1.17
Aghham	14,486	1.13	7,789	1.17
Palpa	14,200	1.11	7,673	1.15
Salyan	13,867	1.08	7,628	1.15
Makwanpur	13,348	1.04	7,519	1.13
Dailekh	13,334	1.04	6,777	1.02
Tanahu	13,239	1.03	6,689	1.00
Rukum	12,606	0.98	6,570	0.99
Panchthar	12,478	0.97	6,383	0.96
Pyuthan	12,140	0.95	6,344	0.95
Baitadi	12,088	0.94	6,108	0.92
Rolpa	11,736	0.91	6,105	0.92

Source: Present Structure of Biogas Sector in Nepal by Consolidated Management Services Nepal, 1993

Table 1.4.2.1 Potential Number of Biogas Plants and Potential Biogas Production(2/2)

District	Potential Number of Biogas Plants (No.)	(%)	Potential Biogas Production (1000 x m3)	(%)
Okhaldhunga	11,632	0.91	5,772	0.87
Ramechhap	11,565	0.90	5,694	0.85
Kaski	10,872	0.85	5,618	0.84
Kathmandu	9,140	0.71	4,873	0.73
Parbat	8,119	0.63	4,837	0.73
Myagdi	7,586	0.59	4,798	0.72
Lamjung	7,490	0.58	4,761	0.71
Dhankuta	7,362	0.57	4,660	0.70
Terhathum	7,266	0.57	4,011	0.60
Udayapur	7,240	0.56	3,962	0.59
Jajarkot	6,314	0.49	3,870	0.58
Bhaktapur	5,897	0.46	3,768	0.57
Nuwakot	5,236	0.41	3,458	0.52
Lalitpur	5,108	0.40	2,735	0.41
Dadeldhura	3,986	0.31	2,120	0.32
Gorkha	1,670	0.13	1,364	0.20
Tarai Region:	*818,504*	*63.79*	*419,450*	*62.96*
Rupandehi	63,367	4.94	32,856	4.93
Siraha	62,658	4.88	32,751	4.92
Dhanusa	55,466	4.32	28,753	4.32
Morang	54,533	4.25	28,027	4.21
Sarlahi	53,704	4.19	26,380	3.96
Saptari	49,988	3.90	25,166	3.78
Rautahat	45,596	3.55	23,138	3.47
Chitawan	41,767	3.25	23,031	3.46
Nuwalparasi	41,141	3.21	21,604	3.24
Kapilbastu	39,728	3.10	18,878	2.83
Parsa	37,310	2.91	18,212	2.73
Dang	37,133	2.89	17,968	2.70
Bara	36,885	2.87	17,881	2.68
Kailali	35,975	2.80	17,648	2.65
Banke	32,018	2.50	17,591	2.64
Kanchanpur	32,006	2.49	15,888	2.38
Mahottari	31,833	2.48	15,645	2.35
Sunsari	31,773	2.48	14,850	2.23
Jhapa	27,753	2.16	13,425	2.02
Bardiya	7,870	0.61	9,758	1.46
Total in Nepal :	1,283,198	100	666,188	100

Source: Present Structure of Biogas Sector in Nepal by Consolidated Management Services Nepal, 1993

Table 1.4.2.2 Construction Materials and Appliances

Particular	Unit	4 m3-type	6 m3-type	8 m3-type	10 m3-type	15 m3-type	20 m3-type
1. Building Materials:	piece						
Bricks	bag	1,200	1,400	1,700	2,000	2,400	2,800
Sand	bag	60	70	80	90	110	120
Gravel	bag	30	35	40	50	60	70
Cement	bag	11	13	16	19	27	34
6 mm rod	metre	50	60	70	70	90	100
Paint	litre	1	1	1	2	3	4
2. Building Labour							
Skilled labour	days	8	8	11	11	13	15
Unskilled labour	days	20	25	30	35	45	55
3. Pipes & Appliances:							
Vert. mixer device	piece	1	1	1	1	1	-
Hor. mixer device	piece	-	-	-	-	-	1
Inlet pipe	piece	2	2	2	2	2	2
Dome gas pipe	piece	1	1	1	1	1	1
GI pipe	piece	12	12	12	12	18	24
Socket	piece	3	3	3	5	5	6
Elbow	piece	5	6	8	8	10	12
Tee	piece	1	2	2	3	4	5
Union	piece	1	1	1	1	1	1
Nipple	piece	3	3	4	4	6	6
Main gas valve	piece	1	1	1	1	1	1
Water drain	piece	1	1	1	1	1	1
Rubber hose	metre	1	1	1	2	2	2
Gas stove	piece	1	1	1	2	2	2
Gas lamp	piece	-	1	1	1	2	3
Teflon tape	roll	2	2	2	3	3	4

Remarks: In case of stone masonry: for 4 and 6 m3, :1 extra bag of cement
for 8 and 10 m3, : 8 and 10 m3, 2 extra bag of cement
for 15 and 20 m3, :15 and 20 m3, 3 extra bag of cement

Source: Construction Manual by Biogas Support Programme 1994

Table 1.4.2.3 Plant Construction Cost

(1) Sample Plant Cost Quotated by GGC for FY 1992/93

Unit: NRs

Description/Plant Size	4 m3	6 m3	8 m3	10 m3	15 m3	20 m3
1. Biogas Accessories	1,765	1,765	1,765	2,130	3,125	3,480
2. Pipe and Fittings	3,142	3,241	3,922	4,523	5,359	7,070
3. Cement	2,420	2,860	3,520	4,180	5,940	7,480
4. Bricks, Pebbles, Sand Labour, Transport	4,985	5,970	7,180	8,225	9,850	11,590
5. Construction Charge + Guarantee	2,400	3,150	3,850	4,500	5,850	7,000
Calculated Total	14,712	16,986	20,237	23,558	30,124	36,620
Approximate Cost	15,000	17,000	21,000	23,500	30,000	36,500

Source: Present Structure of Biogas Sector in Nepal by Consolidated Management Services Nepal, 1993

(2) Materials and Labour Supplied by Users according to Quotation of GGC for FY 2049/50

Description/Plant Size		4 m3	6 m3	8 m3	10 m3	15 m3	20 m3
1. Cement	(bag)	11	13	16	19	27	34
2. Brick	(piece)	1,250	1,500	1,750	2,000	2,400	2,800
3. Sand	(bag)	60	70	80	90	110	120
4. Pebble	(bag)	30	35	40	50	60	70
5. Labour	(days)	25	30	40	45	54	70

Source: Present Structure of Biogas Sector in Nepal by Consolidated Management Services Nepal, 1993

Table 2.1.1 Main Features of Site-wise Problems and Proposed Improvement Works on the Rural Road Improvement in Namtar Area

Site No.	Problems and Symptoms	Geological / Topographical Conditions	Mechanical Measures	Vegetative Measures	Expected Effects	Material	Remarks
Site - 1	Slope Collapsed on ms	- Located on a Devastated ravine	Gabion checkdam, Side-ditch	Line-sodding with locally dominant grasses over surface of embankment, possibly with Straw-mat / Jute-net	Stabilisation of slopes; Check further collapse	Gabion, Wet masonry, Vegetated Riprap,	- Vegetation should be done by villagers' participation;
			Drop-chute channels with Vegetated riprap		Effective drainage of rain water	Vegetation (Rooted-cuttings of grasses and shrubs),	- Rooted cuttings of grass should be planted in rainy season for a better growth
	Slope Collapsed on vs		Gabion prop wall		Stabilisation of slopes	Straw-mat, Jute-net	- Backfill with soil firmly; - Confirm bearing strength of the earth
Site - 2 - a	Road shoulder failure on vs due to slope failure	- Saddle portion of hill slopes;	Gabion prop wall	(Natural vegetation)	Retain required road-width	Gabion	
Site - 2 - b	Hill slope Collapsed on ms	- Insufficient drainage of rain water	Gabion prop wall, Side-ditch	Natural vegetation enhanced by backfill soil (behind) and soil dressing (over) on gabion wall	Stabilisation of slopes on ms	Gabion, Dry rubble masonry	- Installation of proper drainage facilities along and across the road will be effective
			Surface drainage, Drainage pipe culvert, Drop-chute		Effective drainage of rain water	Stone-Pitching, Drainage pipe culvert,	
Site - 3	Tendency of mass soil movement over a long downward slope on vs	- Situated above the layer of a past large-scale landslide; - Appearance of weathered rock in the middle of slope on vs;	Gabion prop wall piled on levelling cement mortar and wet masonry layers	Vegetated gabion	Stabilisation of slopes on vs	Gabion, Cement mortar, Dry rubble masonry, Vegetation	- Prop wall can be based on the weathered rock by placement of a thin layer of levelling cement mortar and small volume of wet masonry in between
	Development of gully/ rill erosion over natural vegetation on ms	- Irregular slopes	Removal of unstable surface soil, grading of irregular slopes in advance; Gabion prop wall, Side-ditch	Plantation of rooted cuttings of grasses along contour lines	Secure the safety of road by Check further gully/ rill erosion; Rapid drainage of rain water		
Site - 4	Tendency of mass soil movement over a long downward slope on vs	- Situated above the layer of a past large-scale landslide; - High water contents; - High undulation of slopes due to repeated landslide	Surface drainage, Side-ditch, Drainage pipe culvert, Drop-chutes	Plantation of grass and shrubs over naked slopes	Highly focused on an effective drainage of rain water	Stone-Pitching, Wet masonry, Drainage pipe culvert	- Drainage of rain water is very important
			Gabion checkdam, Gabion prop wall,	Vegetated gabions	Control washouts of soil particles	Gabion, Vegetation	- Remove unstable surface soil, and grade or trim irregular slopes in advance
Site - 5	Subsidence and destruction of road subgrade caused by Clumsy drainage of rain water	- Cavity development due to pipe clogging and careless embankment	Removal of embankment, Surface drainage, Side-ditch, Drainage pipe culvert, Drop-chute	Vegetated drop-chute	Rapid and effective drainage of existing excess water	Gabion, Wet masonry, Stone-Pitching, Drainage pipe culvert,	- Road-shoulder should be protected by gabions drain culvert across the road
			Gabion checkdam, Gabion prop wall,	Vegetated gabions	Road shoulder protection	Vegetated Riprap	

Source: Field Survey by the Study Team in May - June, 1996

Note: vs = Valley side; ms = Mountain side

Table 2.1.2 Summary of Proposed Major Construction Works on the Rural Road Improvement in Namtar Area

S.N	Major Construction Works	Material	Design of Major Construction Work Items Count (nos.)	Dimension B (m)	L (m)	Unit Quantity	Unit	Quantity	Remarks
1. Site - 1									
	Gabion checkdam (Upper)	Gabion box	2 rows	-	35.00	2.50 m3 / m	m3	88	Vegetation
	Gabion prop wall (ms)	Gabion box	2 rows	-	20.00	2.50 m3 / m	m3	50	should
	Gabion prop wall (vs)	Gabion box	2 rows	-	15.00	2.50 m3 / m	m3	38	be done by
	Side-ditch (Type-A)	Wet masonry	1 nos.	-	20.00	0.31 m3 / m	m3	6	villagers'
	Drop-Chute	Vegetated Riprap	1 nos.	2.00	5.00	10.00 m2/ nos.	m2	10	participation
	Vegetation	Rooted Cuttings	As per required						
2. Site - 2									
	Site - 2-a								
	Gabion prop wall (vs)	Gabion box	3 rows	-	15.00	4.50 m3 / m	m3	68	
	Site - 2-b								
	Gabion prop wall (ms)	Gabion box	2 rows	-	20.00	2.50 m3 / m	-	50	Installation of
	Side-ditch (Type-B)	Rubble stone	1 nos.	-	20.00	0.31 m3 / m	m	6	side-ditch, stone
	Surface Drainage	Stone-Pitching	3 nos.	3.00	5.00	15.00 m2/ nos.	m2	45	piching, and
	Drainage pipe culvert pipe d = 200 mm	Aggregates, RCC pipe, etc.	3 nos.	-	5.00	- -	nos	3	3 drain culvert across the road
	Drop-Chute	Vegetated Riprap	3 nos.	2.00	5.00	10.00 m2/ nos.	m2	30	will be effective
	Vegetation	Rooted Cuttings	As per required						
3. Site - 3									
	Gabion checkdam (Upper)	Gabion box	2 rows	-	50.00	2.50 m3 / m	m3	125	Prop wall can be
	Gabion prop wall (vs)	Gabion box	5 rows	-	60.00	9.00 m3 / m	m3	540	based on the
	Side-ditch (Type-B)	Rubble stone	1 nos.	-	60.00	0.31 m3 / m	m	19	weathered rock
	Vegetation	Rooted Cuttings	As per required						
4. Site - 4									
	Gabion checkdam (Upper)	Gabion box	2 rows	-	80.00	2.50 m3 / m	m3	200	
	Gabion prop wall (ms)	Gabion box	2 rows	-	50.00	2.50 m3 / m	m3	125	
	Gabion prop wall (vs)	Gabion box	4 rows	-	25.00	6.50 m3 / m	m3	163	
	Side-ditch (Type-A)	Wet masonry	1 nos.	-	50.00	0.31 m3 / m	m	16	Drainage of
	Surface Drainage	Stone-Pitching	3 nos.	3.00	5.00	15.00 m2/ nos.	m2	45	rain water
	Drainage pipe culvert pipe d = 200 mm	Aggregates, RCC pipe, etc.	3 nos.	-	5.00	- -	nos	3	is very important
	Drop-Chute	Vegetated Riprap	3 nos.	2.00	5.00	10.00 m2/ nos.	m2	30	
	Vegetation	Rooted Cuttings	As per required						
5. Site - 5									
	Gabion prop wall (ms)	Gabion box	2 rows	-	10.00	2.50 m3 / m	m3	25	Road-shoulder
	Gabion prop wall (vs)	Gabion box	2 rows	-	10.00	2.50 m3 / m	m3	25	should
	Side-ditch (Type-A)	Wet masonry	1 nos.	-	10.00	0.31 m3 / m	m	3	be protected
	Surface Drainage	Stone-Pitching	3 nos.	3.00	5.00	15.00 m2/ nos.	m2	45	by gabions
	Drainage pipe culvert pipe d = 200 mm	Aggregates, RCC pipe, etc.	3 nos.	-	5.00	- -	nos	3	
	Drop-Chute	Vegetated Riprap	3 nos.	2.00	5.00	10.00 m2/ nos.	m2	30	
	Vegetation	Rooted Cuttings	As per required						
6. Drainage Facilities Development Over all Area									
	Side-ditch (Type-B)	Rubble stone	- m	-	6,000.00	0.31 m3 / m	m3	1,860	Drainage Structures
	Surface Drainage	Stone-Pitching	30 nos.	3.00	5.00	15.00 m2/ nos.	m2	450	Are Proposed
	Drainage pipe culvert pipe d = 200 mm	Aggregates, RCC pipe, etc.	30 nos.	-	5.00	- -	nos	30	to be provided every 200 m
	Drop-Chute	Vegetated Riprap	30 nos.	2.00	5.00	10.00 m2/ nos.	m2	300	along the Road
	Vegetation	Rooted Cuttings	As per required						

Note: 1. Quantity is rounded to integer
2. vs = Valley side; ms = Mountain side

Table 2.2.1 Rehabilitation/ Development Plans for Farmer Managed Irrigation Schemes in Namtar/ Tilar

Source	Location	Scheme Name	Structures to be Improved/ added	Effect on Community (Infrastructure)
Manahari Khola	Right bank	Namtar/ Tilar Namtar Upper Scheme	New Intake, Improve Head reach, New Suspension Aqueduct over Manahari	- Total area of 50 ha will be Irrigated in Namtar/ Tilar
Manahari Khola	Left bank	Dungeon (Upper) Scheme	Improve Intake and Head reach, Enlargement of Canal Section	- Total area of 40 ha will be fully Irrigated in Dungeon
Gorduwa Khola	Left bank	Gorduwa (Upper) Scheme	Improve Head reach and Canal bed slope Improve Landslide sections by HDP pipe	- Total area of 20 ha (part of Namtar scheme) will be Irrigated.
Khade Khola	Right bank	Khade scheme	Improve Intake with Screen pipe and Head reach using HDP, New Regulating unit	- Total area of 30 ha will be Irrigated in Jyarpu/ Bhadaure
		Upper scheme	New Distributing (HDP) Pipeline	- Orchard field will be Irrigation in Bhadaure
Syarse Khola	Right bank	Syarse scheme	Improve Intake with Screen pipe and Head reach using HDP, New Regulating unit	- Total area of 15 ha will be irrigated - Micro hydropower plant using surplus water

Source: Field survey in May - June, 1996, by the Study Team

Table 2.3.1 MINIMUM MONTHLY AND YEARLY DISCHARGES (m3/s) at MANAHARI

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEARLY Mini
1963	4.3	3.5	3.0	2.8	1.9	1.8	5.9	18.2	16.2	12.2	7.2	5.5	1.8
1964	4.3	3.3	2.9	2.5	1.9	1.8	5.9	23.5	24.5	11.6	7.5	5.6	1.8
1965	4.3	3.7	3.0	2.6	1.8	1.8	10.6	21.0	26.6	15.4	9.9	6.9	1.8
1966	5.1	4.5	3.7	2.8	2.5	2.2	16.3	23.5	24.9	13.3	9.4	6.8	2.2
1967	4.7	3.4	3.1	2.5	1.6	1.3	7.3	28.5	29.7	10.4	7.3	5.8	1.3
1968	5.1	3.5	2.6	2.0	1.7	5.6	16.0	12.3	15.9	15.9	9.4	6.7	1.7
1969	4.7	3.4	3.1	2.6	2.2	3.9	6.7	17.1	32.4	12.8	7.5	5.5	2.2
1970	4.3	3.2	3.7	5.8	3.0	3.5	9.8	26.8	19.0	9.2	7.2	7.0	3.0
1971	6.5	5.8	5.3	3.0	4.3	5.3	28.6	40.0	25.5	14.0	9.8	5.7	3.0
1972	4.4	3.7	2.9	2.6	2.5	2.5	7.3	25.3	21.8	15.5	9.8	6.0	2.5
1973	4.5	3.5	3.0	2.3	2.8	3.0	24.2	22.4	23.0	14.5	7.5	5.0	2.3
1974	4.5	3.7	3.1	3.9	3.4	3.7	38.0	32.4	26.5	14.6	8.8	6.1	3.1
1975	4.9	4.0	3.5	3.2	3.2	3.1	12.8	31.0	47.4	18.0	12.6	6.6	3.1
1976	5.2	3.4	2.0	2.0	2.0	7.8	37.0	34.0	29.0	13.0	8.2	5.8	2.0
1977	4.3	3.3	2.8	3.6	3.3	3.3	15.4	28.0	20.0	12.0	7.7	6.0	2.8
1978	4.8	4.0	3.6	3.3	4.8	5.7	20.0	31.0	30.0	15.5	9.5	6.7	3.3
1979	5.3	4.6	3.3	3.1	2.5	2.3	9.0	36.0	28.6	13.4	9.4	6.1	2.3
1980	4.3	3.4	2.3	1.8	3.9	3.4	7.8	23.0	14.0	8.7	6.9	5.8	1.8
1981	5.6	4.8	4.4	4.6	4.6	3.4	8.4	23.0	23.0	12.0	8.1	5.2	3.4
1982	4.2	3.6	2.8	2.6	2.2	3.9	6.2	16.0	20.0	21.6	12.6	7.0	2.2
1983	5.4	4.6	4.2	3.0	4.2	1.2	12.6	35.8	51.2	11.4	6.9	5.0	1.2
1984	3.8	2.6	2.4	2.4	2.4	2.8	5.8	20.5	28.0	10.1	5.6	4.8	2.4
1985	4.3	3.5	3.3	3.3	3.3	4.1	6.1	16.1	37.2	17.2	8.7	6.6	3.3
1986	5.6	5.2	4.6	4.4	52.8	4.8	28.8	68.8	19.7	8.4	5.7	5.0	4.4
1987	3.4	3.0	3.1	3.1	3.4	3.3	13.0	96.0	68.8	6.8	7.0	11.4	3.0
1988	8.4	7.6	6.2	6.8	8.2	7.3	7.6	17.9	13.8	11.4	8.7	8.2	6.2
1989	8.2	7.9	7.9	8.2	9.8	14.6	17.0	18.8	9.0	5.2	2.8	1.7	1.7
1990	1.1	1.0	0.9	0.8	0.8	5.0	8.4	6.8	31.2	17.9	7.6	5.5	0.8
EXTREME	1.1	1.0	0.9	0.8	0.8	1.2	5.8	6.8	9.0	5.2	2.8	1.7	0.8

NAME OF SITE	MANAHARI	LATITUDE	27° 33′ 00″ N
STATION No.	465	LONGITUDE	84° 48′ 10″ E
EST.DATE	13 JUN. 1963	ELEVATION	305m
NAME OF RIVER	MANAHARI	CA. AREA	427km2

Table 2.3. 2 MINIMUM MONTHLY AND YEARLY DISCHARGES (m3/s) at CHECK DAMSITE

Discharge estimated from Specific Discharge at Manahari

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEARLY Mini
1963	0.36	0.29	0.25	0.24	0.16	0.15	0.50	1.54	1.37	1.03	0.61	0.47	0.15
1964	0.36	0.27	0.25	0.21	0.16	0.15	0.50	1.99	2.07	0.98	0.63	0.47	0.15
1965	0.36	0.31	0.25	0.22	0.15	0.15	0.90	1.78	2.25	1.30	0.84	0.58	0.15
1966	0.43	0.38	0.32	0.23	0.21	0.18	1.38	1.99	2.11	1.12	0.79	0.57	0.18
1967	0.39	0.29	0.26	0.21	0.14	0.11	0.61	2.41	2.51	0.88	0.61	0.49	0.11
1968	0.43	0.29	0.22	0.17	0.14	0.48	1.35	1.04	1.34	1.34	0.79	0.56	0.14
1969	0.40	0.29	0.26	0.22	0.19	0.33	0.56	1.45	2.74	1.08	0.64	0.47	0.19
1970	0.36	0.27	0.31	0.49	0.25	0.30	0.83	2.27	1.61	0.78	0.61	0.59	0.25
1971	0.55	0.49	0.45	0.25	0.36	0.45	2.42	3.38	2.16	1.18	0.83	0.48	0.25
1972	0.38	0.31	0.24	0.22	0.21	0.21	0.62	2.14	1.84	1.31	0.82	0.51	0.21
1973	0.38	0.30	0.25	0.19	0.23	0.25	2.05	1.89	1.94	1.23	0.63	0.42	0.19
1974	0.38	0.31	0.26	0.33	0.29	0.31	3.21	2.74	2.24	1.23	0.74	0.52	0.26
1975	0.42	0.33	0.29	0.27	0.27	0.26	1.08	2.62	4.01	1.52	1.07	0.55	0.26
1976	0.44	0.29	0.17	0.17	0.17	0.66	3.13	2.87	2.45	1.10	0.69	0.49	0.17
1977	0.36	0.28	0.24	0.30	0.28	0.28	1.30	2.37	1.69	1.01	0.65	0.51	0.24
1978	0.40	0.34	0.30	0.28	0.40	0.48	1.69	2.62	2.54	1.31	0.80	0.56	0.28
1979	0.44	0.38	0.28	0.26	0.21	0.19	0.76	3.04	2.42	1.13	0.79	0.52	0.19
1980	0.36	0.29	0.19	0.15	0.33	0.29	0.66	1.94	1.18	0.74	0.58	0.49	0.15
1981	0.47	0.41	0.37	0.39	0.39	0.29	0.71	1.94	1.94	1.01	0.68	0.44	0.29
1982	0.36	0.30	0.23	0.22	0.19	0.33	0.52	1.35	1.69	1.83	1.07	0.59	0.19
1983	0.46	0.39	0.36	0.25	0.36	0.10	1.07	3.03	4.33	0.96	0.58	0.42	0.10
1984	0.32	0.22	0.20	0.20	0.20	0.24	0.49	1.73	2.37	0.85	0.47	0.40	0.20
1985	0.36	0.30	0.28	0.28	0.28	0.35	0.52	1.36	3.15	1.45	0.74	0.56	0.28
1986	0.47	0.44	0.39	0.37	4.46	0.41	2.43	5.82	1.67	0.71	0.48	0.42	0.37
1987	0.29	0.25	0.26	0.26	0.29	0.27	1.10	8.12	5.82	0.57	0.60	0.96	0.25
1988	0.71	0.64	0.52	0.57	0.69	0.62	0.64	1.51	1.17	0.96	0.74	0.69	0.52
1989	0.69	0.67	0.67	0.69	0.83	1.23	1.44	1.59	0.76	0.44	0.24	0.14	0.14
1990	0.09	0.08	0.07	0.06	0.06	0.42	0.71	0.57	2.64	1.51	0.64	0.46	0.06
EXTREME	0.09	0.08	0.07	0.06	0.06	0.10	0.49	0.57	0.76	0.44	0.24	0.14	0.06

Remarks: Catchment Area at Manahari is 472 km2 and that at the Proposed Check Damsite is 36.1 km2.

Table 2.3.3 Hydraulic & Power Calculation for Micro-Hydropower

Item	Calculation/Dscription

1. Pipe, its Discharge & Hydraulic Gradient

1) Applied Pipe: HDP pipe (10 kgf/cm^2) from view-points of cost, durability and flexibility

ϕ 10 inch (250 mm: Maximum size in common use in Nepal)

Flow velosity: 2.3 m/sec (Desirable Velosity for HDP)

2) Discharge: 0.113 m3/sec (= 1/4 * π * 0.25^2 * 2.3)

3) Hydraulic Gradient, I :

by Hazen-Williams formula for pipe flow

$$I = \left(\frac{V}{0.84935 \cdot C \cdot R^{0.63}}\right)^{1.852}$$

where, V: Flow velocity in pipe (m/sec: =2.3 m/sec for HDP)

C: Velocity Coefficient of pipe (150 for HDP)

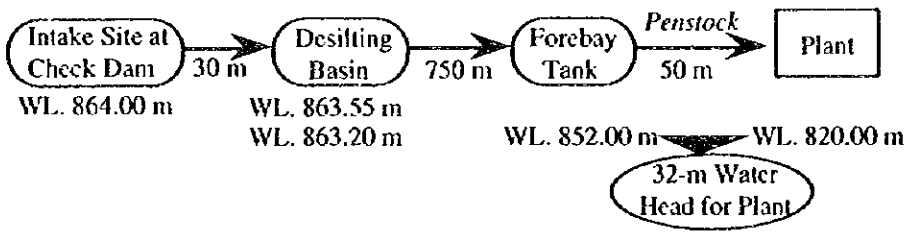
R: Hydraulic Depth(m: =1/4 * pipe Diameter = 0.0625 m)

Accordingly,

$$I = \left(\frac{2.3}{0.84935 \cdot 150 \cdot 0.0625^{0.63}}\right)^{1.852}$$

$$= 0.015 \text{ or } 1/67$$

2. Water Levels along the Pipe



3. Power received by Consumers

$$P_{net} = e_o \cdot 9.8 \cdot Q \cdot h_{gross} = 0.50 \cdot 9.8 \cdot Q \cdot h_{gross}$$

= 0.50 • 9.8 • 0.113 m3/sec • 32 m

= 17.70 kW > Power Demand: 15,000 w OK!

(Refer Annex-8, Section 1.5.1 Micro-hydropower)

Table 2.3.4 Work Quantity for Micro-hydropower Project in Namtar / Tilar Area

Item	Works	Unit	Quantity	Remarks
1	**Intake Works**			
1.1	Steel pipe	m	11	ϕ 250mm
1.2	Screen	kg	350	
1.3	Screen Frame, etc	kg	170	
1.4	Stone Masonry for Step	m3	5.5	
1.5	Excavation for Step	m3	4	
1.6	Stop Valve	set	1	ϕ 250mm
1.7	Miscellaneous Works	%	10	
2	**Desilting Basin with Spillway**			
2.1	Steel Plate for Top Cover	kg	180	10 m2, t=2.3mm
2.2	Stone Masonry(CM 1:3)	m3	27	
2.3	Concrete(1:2:4)	m3	0.5	
2.4	Excavation	m3	50	
2.5	Backfill	m3	20	
2.6	Stop Valve	set	1	ϕ 250mm
2.7	Sluice gate (circle type)	set	1	ϕ 450mm
2.8	Miscellaneous Works	%	10	
3	**Connecting Pipe**			
3.1	HDP pipe	m	830	I.D. ϕ 250mm, 6kgf/cm2
3.2	Excavation	m3	125	
3.3	Backfill	m3	58	
3.4	Stone Soling	m3	25	
3.5	S.Masonry for pipe Support	m3	28	15-m interval, 0.5 m3/pc
3.6	Pipe fixing for pipe Support	set	56	
3.7	Miscellaneous Works	%	10	
4	**Rivert/Stream Crossing Structure (5 locations)**			
4.1	Stone Masonry	m3	13	(2.62 m3/pc)
4.2	Excavation	m3	12	(2.50 m3/pc)
4.3	Backfill	m3	8	(1.50 m3/pc)
4.4	Pipe fixing	set	10	(2 set/pc)
4.5	Miscellaneous Works	%	10	
5	**Forebay Tnak**			
5.1	Stone Masonry	m3	25	
5.2	Excavation	m3	29	
5.3	Backfill	m3	12	
5.4	Screen for Penstock	kg	220	
5.5	Sluice gate (circle type)	set	1	ϕ 450mm
5.6	Miscellaneous Works	%	10	
6	**Generating Plant & Distribution Sytem**			
6.1	Generating Plant & Distribution Sytem (Plant: 20 kW, Distribution Line: 9.4 km)	L.S.		

Table 2.4.1 Potential Water Supply for Network Development in Chisapani Area

Name of Group	Number of Household	Nos. / Name of Source	Amount of Water Supply (l/min.)				Potential Amount of Water Supply				
			Chhap W	Chhap E	Majuwa	Total	l/ day	-	l/ hh/ day.	l/ hh/ hr.	l/ hh/ 10 min.
S-1	36	6	20.0	10.0	-	30.0	43,200.0	-	1,200.0	50.0	8.3
S-2	21	2	-	10.0	-	10.0	14,400.0	-	960.0	40.0	6.7
S-3	21	3	-	-	20.0	30.0	43,200.0	-	1,600.0	66.7	11.1
Total	**78**	-	**20.0**	**20.0**	**30.0**	**70.0**	**100,800.0**	**Average**	**1,292.3**	**53.9**	**9.0**
Bhattidanda (D-1-3, T-1-2)	17	S-1	16.0	-	-	16.0	23,040.0	-	1,355.3	56.5	9.4
Upper West (D-1-2)	5	S-1	4.0	-	-	4.0	5,760.0	-	1,152.0	48.0	8.0
Mid West (D-1-1)	14	S-1	-	10.0	-	10.0	14,400.0	-	1,028.6	42.9	7.2
Lower west (D-2-1, 2-2, 2-3)	21	S-2 / S-3	-	10.0	10.0	20.0	28,800.0	-	1,371.4	57.1	9.5
Majuwa (D-3-2)	11	S-3	-	-	10.0	10.0	14,400.0	-	1,309.1	54.5	9.1
Mid Majuwa (D-3-1)	5	S-3	-	-	5.0	5.0	7,200.0	-	1,440.0	60.0	10.0
Lower Majuwa (D-3-3)	5	S-3	-	-	5.0	5.0	7,200.0	-	1,440.0	60.0	10.0
Total	**78**	-	**20.0**	**20.0**	**30.0**	**70.0**	**100,800.0**	**Average**	**1,292.3**	**53.8**	**9.0**

Source: Simulated by the Study Team in July, 1996

Note: hh = Household, hr = Hour

Table 2.4.2 Daily Available Water Amount and Potential Irrigation Performance

Irrigation Conditions	Case-A (Standard)	Case-B (Deficit)
Irrigation Interval	7 (days)	5 (days)
Application Rate	28.0 (mm/m²)	15.0 (mm/m²)
Daily Application Rate	4.0 (mm/m²/day)	3.0 (mm/m²/day)
Crop Density Coefficient	0.6	0.6

Daily Available Water Amount (m³/day)	Total Net Potential Irrigable Area per day (m²/day)	Total Net Potential Irrigable Area per Schedule (m²)	Total Gross Potential Irrigable Area Per Schedule (m²)	Total Gross Potential Irrigable Area Per Schedule (Ropani)	Total Net Potential Irrigable Area per day (m²/day)	Total Net Potential Irrigable Area per Schedule (m²)	Total Gross Potential Irrigable Area Per Schedule (m²)	Total Gross Potential Irrigable Area Per Schedule (Ropani)
150	37.50	262.50	437.50	0.88	50.00	250.00	416.67	0.83
200	50.00	350.00	583.33	1.17	66.67	333.35	555.58	1.11
250	62.50	437.50	729.17	1.46	83.33	416.65	694.42	1.39
300	75.00	525.00	875.00	1.75	100.00	500.00	833.33	1.67
350	87.50	612.50	1,020.83	2.04	116.67	583.35	972.25	1.94
400	100.00	700.00	1,166.67	2.33	133.33	666.65	1,111.08	2.22
450	112.50	787.50	1,312.50	2.63	150.00	750.00	1,250.00	2.50
500	125.00	875.00	1,458.33	2.92	166.67	833.35	1,388.92	2.78
550	137.50	962.50	1,604.17	3.21	183.33	916.65	1,527.75	3.06
600	150.00	1050.00	1,750.00	3.50	200.00	1000.00	1,666.67	3.33
700	175.00	1225.00	2,041.67	4.08	233.33	1166.65	1,944.42	3.89
800	200.00	1400.00	2,333.33	4.67	266.67	1333.35	2,222.25	4.44
900	225.00	1575.00	2,625.00	5.25	300.00	1500.00	2,500.00	5.00
1,000	250.00	1750.00	2,916.67	5.83	333.33	1666.65	2,777.75	5.56
			(Divided by crop Dens. coef.)				(Divided by crop Dens. coef.)	

Table 2.4.3 Description of Water Storage and Supply Tanks

Tank Name	Sub- Type	Nos of Household to Supply			Tank Capacity (litre)			Supply Source	Destinations & Remarks
		Total	Indirect	Direct	Total	Required	Reserved		
S-1 System									
Storage Tank									
S-1	I	36	36	-	9,000	7,200	1,800	S-1A,C-F	Distribution tanks D-1-1, 2, 3 & Delivery tank T-1-2
Distribution Tank									
D-1-1	II-a,b,c	14	14	-	4,000	2,800	1,200	S-1	Storage tank S-2 (S-2 System), Delivery tanks T-1-1-1, 2
D-1-2	II-a,c	5	5	-	1,500	1,000	500	- ditto -	Dist'n tank D-1-1 & 5 hh Direct Supply from S-1B
D-1-3	II-b	14	14	-	3,000	2,800	200	- ditto -	Delivery tanks T-1-3-1, 2, 3
Delivery Tank									
T-1-1-1	II-c-750	4	-	4	800	800	D-1-1	D-1-1	4 household
T-1-1-2	II-c-1000	5	-	5	1,000	1,000	-	- ditto -	5 household
T-1-1-3	II-c-1000	5	-	5	1,000	1,000	-	- ditto -	5 household
T-1-2	II-c-750	3	-	3	600	600	-	D-1-2	3 household
T-1-3-1	II-c-750	4	-	4	800	800	-	D-1-3	4 household
T-1-3-2	II-c-1000	5	-	5	1,000	1,000	-	- ditto -	5 household
T-1-3-3	II-c-1000	5	-	5	1,000	1,000	-	- ditto -	5 household
Household Storage Tank									
hh	II-c-200	36	-	36	200	200	-		
S-2 System									
Storage Tank									
S-2	I	22	22	-	6,000	4,800	1,200	S-2A, B, D-1-1	Distribution tanks D-2-1, 2, 3
Distribution Tank									
D-2-1	II-a,b,c	7	4	3	2,700	2,000	700	S-2	Deliv. tanks T-2-1-1,2 & 3 hh D-2-2 (S-2 System)
D-2-2	II-a,b	10	10	-	3,000	2,000	1,000	- ditto -	Delivery tanks T-2-2-1, 2, 3 Additional Supply from D-2-1
D-2-3	II-b,c	5	3	2	1,000	1,000	-	- ditto -	Deliv. tank T-2-3-1 & 2 hh
Delivery Tank									
T-2-1-1	II-c-750	3	-	3	600	600	-	D-2-1	3 household
T-2-1-2	II-c-750	1	-	1	600	600	-	- ditto -	School Tap
T-2-2-1	II-c-750	4	-	4	800	800	-	D-2-2	4 household
T-2-2-2	II-c-750	4	-	4	800	800	-	- ditto -	4 household
T-2-2-3	II-c-400	2	-	2	400	400	-	- ditto -	2 household
T-2-3-1	II-c-750	3	-	3	600	600	-	D-2-3	3 household
Household Storage Tank									
hh	II-c-200	21		21	200	200	-		
S-3 System									
Storage Tank									
S-3	I	21	21	-	6,000	4,200	1,800	S-3A,B,C	Disribution tanks D-3-1, 2
Distribution Tank									
D-3-1	II-a,c	5	5	-	1,500	1,000	500	S-3	Dist'n tank D-3-3 (surplus) & Deliv. tanks T-3-1-1, 2
D-3-2	II-b,c	11	6	5	2,500	2,200	300	- ditto -	Deliv. tanks T-3-2-1, 2 & 5 household
D-3-3	II-a,b,c	5	2	3	2,000	1,000	1,000	D-3-1	Deliv. tank T-3-3-1 & 3 hh Dist'n tank D-2-1 (S-2 System)
Delivery Tank									
T-3-1-1	II-c-400	2	-	2	400	400	-	D-3-1	2 household
T-3-1-2	II-c-750	3	-	3	600	600	-	- ditto -	3 household
T-3-2-1	II-c-750	3	-	3	600	600	-	D-3-2	3 household
T-3-2-2	II-c-750	3	-	3	600	600	-	- ditto -	3 household
T-3-3-1	II-c-400	2	-	2	400	400	-	D-3-3	2 household
Household Storage Tank									
hh	II-c-200	21	-	21	200	200	-		

Table 2.4.4 Design for Water Storage and Supply Tanks

Storage Tank			Dimension (m)				Required Capacity (m3)			Required Water Depth (m)		
Name	Sub-Type	Capacity (m3)	B	L	H	Hf	a	b	c	Ha	Hb	Hd
S - 1	I	9.00	2.00	3.00	1.50	1.80	1.80	7.20	-	1.60	1.30	0.10
S - 2	I	6.00	2.00	2.00	1.50	1.80	1.80	4.20	-	1.60	1.15	0.10
S - 3	I	6.00	2.00	2.00	1.50	1.80	1.80	4.20	-	1.60	1.15	0.10

Distribution Tank			Dimension (m)				Required Capacity (m3)			Required Water Depth (m)				Float Valve
Name	Sub-Type	Capacity (m3)	B	L	H	Hf	a	b	c	Ha	Hb	Hc	Hd	Required
D-1-1	II-a,b,c	3.50	1.50	2.00	1.25	1.40	0.80	2.20	0.60	1.25	1.00	0.30	0.10	No
D-1-2	II-a,c	1.50	1.00	1.50	1.05	1.20	0.50	-	1.00	1.05	-	0.75	0.10	No
D-1-3	II-b	3.00	1.25	2.00	1.15	1.30	0.20	2.80	-	1.15	1.10	-	0.10	Yes
D-2-1	II-a,b,c	2.50	1.25	2.00	1.00	1.15	0.70	1.20	0.60	1.00	0.75	0.30	0.10	No
D-2-2	II-a,b	3.00	1.25	2.00	1.20	1.35	1.00	2.00	-	1.20	0.80	-	0.10	No
D-2-3	II-b,c	1.00	1.00	1.00	1.10	1.25	-	0.60	0.40	-	1.10	0.50	0.10	Yes
School	II-a,c	1.50	1.00	1.50	1.05	1.20	0.50	-	1.00	1.05	-	0.75	0.10	Yes
D-3-1	II-a,c	1.50	1.00	1.50	1.05	1.20	0.50	-	1.00	1.05	-	0.75	0.10	No
D-3-2	II-b,c	2.50	1.25	2.00	0.95	1.10	0.30	1.20	1.00	-	0.95	0.50	0.10	Yes
D-3-3	II-a,b,c	3.00	1.25	2.00	1.25	1.40	2.00	0.40	0.60	1.25	0.45	0.30	0.10	No

Ready-made Plastic Tank		Dimension (m)		Number	Design Requirement		Float Valve	Nos. of Tanks in Each System			
Sub- Type	Capacity (m3)	D	H	of House	Qr (m3)	Hr (m)	Required	S-1	S-2	S-3	Total
II-c-1000	1.10	1.077	1.204	5	1.00	1.10	Yes	4	-	-	4
II-c-750	0.83	0.976	1.103	3 to 4	0.80	1.07	- do -	3	5	3	11
II-c-400	0.41	0.772	0.874	2	0.40	0.86	- do -	-	1	2	3
II-c-200	0.23	0.696	0.595	1	0.20	0.53	- do -	36	21	21	78

Table 2.4.5 Summary of Pipeline Design in Chisapani Area

Pipe Line			Hydraulic Design of Pipeline						Breakdown of Pipe Length			Related Structures	
Line	Tank Name		Inside Dia. D	Flow Rate Q	Velocity V	Head Loss (Hf)	Static Head	Length L	12.5 mm	25.0 mm	38.0 mm		
Name	From	To	(mm)	(l/s)	(m/s)	(m)	(m)	(m)	(m)	(m)	(m)	BP	VC
S-1 System													
S-1A	S-1A	S-1	12.5	0.083	0.679	15.24	56.76	260.0	260	0	0	0	1
S-1C	S-1C	S-1	12.5	0.083	0.679	37.86	154.14	646.0	646	0	0	1	2
S-1D	S-1D	S-1	12.5	0.083	0.679	47.83	184.17	816.0	816	0	0	1	3
S-1E	S-1E	S-1	12.5	0.083	0.679	21.04	80.96	359.0	359	0	0	1	1
S-1F	S-1F	S-1	12.5	0.083	0.679	24.79	97.21	423.0	423	0	0	1	1
D-1-1	S-1	D-1-1	25.0	0.417	0.849	16.16	8.84	409.0	0	409	0	0	2
S-1B	S-1B	D-1-2	12.5	0.067	0.544	35.65	104.35	918.0	918	0	0	1	4
Sub-Total of Transmission Main for S-1								**3,831.0**	**3,422**	**409**	**0**	**5**	**14**
D-1-2	S-1	D-1-2	12.5	0.030	0.244	4.18	2.82	473.0	473	0	0	0	2
D-1-1A	D-1-2	D-1-1	12.5	0.020	0.163	0.49	34.51	117.0	117	0	0	0	1
D-1-3	S-1	D-1-3	25.0	0.170	0.346	0.41	4.59	55.0	0	55	0	0	1
Sub-Total of and Distribution line for S-1								**645.0**	**590**	**55**	**0**	**0**	**3**
T-1-1-1	D-1-1	T-1-1-1	12.5	0.050	0.407	2.07	32.93	91.0	91	0	0	0	1
T-1-1-2	D-1-1	T-1-1-2	12.5	0.060	0.489	4.56	15.44	143.0	143	0	0	0	1
T-1-1-3	D-1-1	T-1-1-3	12.5	0.060	0.489	2.90	32.10	91.0	91	0	0	0	1
T-1-2	D-1-2	T-1-2	12.5	0.040	0.326	5.98	19.02	397.0	397	0	0	0	2
T-1-3-1	D-1-3	T-1-3-1	12.5	0.050	0.407	1.28	2.00	56.0	56	0	0	0	1
T-1-3-2	D-1-3	T-1-3-2	12.5	0.060	0.489	2.68	80.81	84.0	84	0	0	1	0
T-1-3-3	D-1-3	T-1-3-3	12.5	0.060	0.489	2.84	9.16	89.0	89	0	0	0	1
Delivery line (30 m) for 36 hh			12.5	0.012	0.098	-	-	1,080.0	1,080	0	0	0	0
Sub-Total of Delivery line in S-1				-	-	-	-	**2,031.0**	**2,031**	**0**	**0**	**1**	**7**
Sub-Total of S-1				-	-	-	-	**6,507.0**	**6,043**	**464**	**0**	**6**	**24**
S-2 System													
S-2A	S-2A	S-2	25.0	0.167	0.340	9.32	202.68	1,288.0	0	1288	0	1	5
S-2B	D-1-1	S-2	25.0	0.500	1.019	30.89	61.11	558.0	0	558	0	1	2
D-2-1	S-2	D-2-1	12.5	0.120	0.978	23.51	14.49	204.0	204	0	0	0	1
D-2-1A	D-3-3	D-2-1	38.0	0.500	0.441	2.10	5.90	292.0	0	0	292	0	1
D-2-2	S-2	D-2-2	38.0	0.666	0.587	7.42	27.58	606.0	0	0	606	0	3
D-2-2A	D-2-1	D-2-2	38.0	0.600	0.529	5.22	1.78	517.0	0	0	517	0	3
Sub-Total of Transmission Main for S-2								**3,465.0**	**204**	**1,846**	**1,415**	**2**	**15**
D-2-3	S-2	D-2-3	12.5	0.060	0.489		78.81	194.0	194	0	0	1	0
Sub-Total of Distribution line for S-2								**194.0**	**194**	**0**	**0**	**1**	**0**
T-2-1-1	D-2-1	T-2-1-1	12.5	0.040	0.326	2.77	26.73	184.0	184	0	0	0	1
T-2-1-2	D-2-1	T-2-1-2	12.5	0.040	0.326	0.50	4.00	33.0	33	0	0	0	1
T-2-2-1	D-2-2	T-2-2-1	12.5	0.050	0.407	1.64	2.86	72.0	72	0	0	0	1
T-2-2-2	D-2-2	T-2-2-2	12.5	0.050	0.407	2.25	2.25	99.0	99	0	0	0	1
T-2-2-3	D-2-2	T-2-2-3	12.5	0.030	0.244	2.53	1.97	286.0	286	0	0	0	1
T-2-3-1	D-2-3	T-2-3-1	12.5	0.037	0.299	6.19	1.31	482.0	482	0	0	0	2
Delivery line (30 m) for 22 hh			12.5	0.012	0.098	-	-	660.0	660	0	0	0	0
Sub-Total of Delivery line in S-2				-	-	-	-	**1,816.0**	**1,816**	**0**	**0**	**0**	**7**
Sub-Total of S-2				-	-	-	-	**5,475.0**	**2,214**	**1,846**	**1,415**	**3**	**22**
S-3 System													
S-3A	S-3A	S-3	38.0	0.500	0.441	2.50	1.50	347.0	0	0	347	0	2
D-3-1	S-3	D-3-1	38.0	0.500	0.441	1.27	3.73	176.0	0	0	176	0	1
D-3-3	D-3-1	D-3-3	38.0	0.500	0.441	1.59	60.41	221.0	0	0	221	0	1
Sub-Total of Transmission Main for S-1								**744.0**	**0**	**0**	**744**	**0**	**4**
D-3-2	S-3	D-3-2	25.0	0.140	0.285	0.86	2.14	165.0	0	165	0	0	1
Sub-Total of and Distribution line for S-1								**165.0**	**0**	**165**	**0**	**0**	**1**
T-3-1-1	D-3-1	T-3-1-1	12.5	0.024	0.196	0.71	4.29	121.0	121	0	0	0	1
T-3-1-2	D-3-1	T-3-1-2	12.5	0.036	0.293	1.69	28.31	136.0	136	0	0	0	1
T-3-2-1	D-3-2	T-3-2-1	12.5	0.040	0.326	1.46	23.54	97.0	97	0	0	0	1
T-3-2-2	D-3-2	T-3-2-2	12.5	0.040	0.326	4.38	80.62	291.0	291	0	0	0	1
T-3-3-1	D-3-3	T-3-3-1	12.5	0.024	0.196	0.72	49.28	123.0	123	0	0	0	1
Delivery line (30 m) for 22 hh			12.5	0.012	0.098	-	-	660.0	660	0	0	0	0
Sub-Total of Delivery line in S-3				-	-	-	-	**1,428.0**	**1,428**	**0**	**0**	**0**	**5**
Sub-Total of S-3				-	-	-	-	**2,337.0**	**1,428**	**165**	**744**	**0**	**10**
Grand-Total				-	-	-	-	**14,319.0**	**9,685**	**2,475**	**2,159**	**9**	**56**

Note: BP = Break Pressure Tank; VC = Valve Chamber w/ GI Air/ Flush Valve

Table 2.4.6 Summary of Quantity for Rural Water Supply Network System in Chisapani Area

Name of Major Component	Description	Unit	Quantity S-1	S-2	S-3	Total	Remarks
1 Intake Protection Structure		nos.	6	2	3	11	Precast Unit
2 Storage Tank	9,000 lit.	nos.	1	-	-	1	
	6,000 lit.	nos.	-	1	1	2	
	Sub-Total	nos.	**1**	**1**	**1**	**3**	RCC (1:4) Tank
3 Distribution Tank	3,500 lit.	nos.	1	-	-	1	
	3,000 lit.	nos.	1	1	1	3	
	2,500 lit.	nos.	-	1	1	2	
	1,500 lit.	nos.	1	1	1	3	S-2: School Tank
	1,000 lit.		-	1	-	1	
	Sub-Total	nos.	**3**	**4**	**3**	**10**	RCC (1:4) Tank
4 Delivery Tank	1000 lit.	nos.	4	-	-	4	
	750 lit.	nos.	3	5	3	11	
	400 lit.	nos.	-	1	2	3	
	Sub-Total	nos.	**7**	**6**	**5**	**18**	Plastic Tank
5 Household Tank	200 lit.	nos.	**36**	**21**	**21**	**78**	Plastic Tank
6 Related Structures	BP Tank	nos.	6	3	-	9	Plastic Tank
	Valve Ch.	nos.	24	22	10	56	Precast Unit
	Sub-Total	nos.	**30**	**25**	**10**	**65**	
7 HDP Pipeline	12.5 mm	m	6,043	2,214	1,428	9,685	
	25.0 mm	m	464	1,846	165	2,475	
	38.0 mm	m	0	1,415	744	2,159	
	Sub-Total	m	**6,507**	**5,475**	**2,337**	**14,319**	10 kgf / cm2
8 Burying length of pipeline	Burying	m	**4,800**	**4,100**	**1,800**	**10,700**	75 % of Pipeline

Table 3.2.1 Price Investigation

Item	Unit	Rate (NRs)	Remarks
Laboarer			
Foreman	m.d	95	
Skilled labour	m.d	105	
Common labour	m.d	60	
Mason	m.d	105	
Carpenter	m.d	105	
Steel worker	m.d	105	
Electrician	m.d	95	
Plumber	m.d	95	
Driver	m.d	85	Light vehicle (80)
Operator (B)	m.d	85	Light equipment
Material			
Sand	m3	140	
Gravel	m3	500	
Boulder	m3	190	
Cement	bag (50 kg)	270	Hetauda (Ex factory)
Steel bar	t	27,500	Varies by size
Timber	m3	900	
Gabion wire	kg	40	Medium coated
*HDP Pipe (Inside Dia. mm) **			
12.5	m	17	10 kgf /cm2
25	m	41	10 kgf /cm2
38	m	96	10 kgf /cm2
50	m	154	10 kgf /cm2
100	m	460	10 kgf /cm2
150	m	978	10 kgf /cm2
250	m	1,976	6 kgf /cm2
*Ready Made Plastic Water Storage Tank (litre) **			
200	Nos	830	
400	Nos	1,660	
750	Nos	3,113	
1000	Nos	4,150	
Concrete Pipe (Dia. mm)		NP-2 / NP-3	
200	m	280 / 800	NP-2: Light duty
300	m	420 / 960	NP-3: Heavy duty
600	m	890 / 1,850	
900	m	1,720 / 3,640	
1200	m	2,400 / 5,200	
Fuel and Oil			
Petrol	liter	31.5	
Diesel	liter	11	
Lubricant (Engine) Oil	liter	48	

Note: (1) Rates are obtained from Makwanpur District Office for the Fiscl Year 95/96

(2) * Market Price at Kathmandu

Table 3.3.1 List of Unit Rate for Materials (at Site) in the Study Area

S.N	Description of Item	Unit	Unit Rate (NRs.)		Unit Rate (NRs.)						Remarks
			Market	Quarry	Namtar (30 km)		Chisapani (82 km + porter)		Phedigaon (82 km)		
			Price	Site	Transportation	@ site	Transportation	@ site	Transportation	@ site	
											Gravel,Boulder, Stone,
01.	Sand	m3	-	140.00	99.62	239.62	1,699.62	1,839.62	-	140.00	Timber are collected at
02.	Gravel	m3	-	500.00	-	500.00	-	500.00	-	500.00	each site
03.	Boulder	m3	-	190.00	-	190.00	-	190.00	-	190.00	Sand: transported from Palung to Chisapani
04.	Cement	bag	270.00	-	23.68	293.68	100.78	370.78	23.20	293.20	@ Porter charge NRs.1 /kg
05.	Stone	m3		330.00	-	330.00	-	330.00	-	330.00	Namtar: within 2km
06.	Steel bar	kg	27.50	-	0.47	27.97	2.02	29.52	0.46	27.96	
07.	Timber	m3	-	900.00	-	900.00	-	900.00	-	900.00	
08.	Gabion wire	kg	40.00	-	0.80	40.80	2.00	42.00	0.46	40.46	
09.	HDP Pipe (Inside Dia.)										Loading, unloading and
	12.5 mm	Rm	17.00	-	0.20	17.20	0.50	17.50	0.40	17.40	Transportational Cost
	25 mm	Rm	41.00	-	0.20	41.20	0.70	41.70	0.50	41.50	and Distance for
	38 mm	Rm	96.00	-	0.40	96.40	1.00	97.00	0.80	96.80	HDP Pipes and fittings,
	50 mm	Rm	154.00	-	0.60	154.60	1.60	155.60	1.20	155.20	Tanks and Hume Pipes:
	100 mm	Rm	460.00	-	1.20	461.20	2.60	462.60	2.20	462.20	Ex-Hetauda:
	150 mm	Rm	978.00	-	1.70	979.70	3.80	981.80	3.20	981.20	Namtar (30 km)
	250 mm	Rm	1,976.00	-	1.70	1,977.70	4.10	1,980.10	3.20	1,979.20	@ NRs. 2,900 / crane truck
09.	Plastic Water Tank										Ex-Kathmandu:
	200 litre	Nos.	830.00	-	216.00	1,046.00	276.00	1,106.00	216.00	1,046.00	Phedigaon (60 km)
	400 litre	Nos.	1,660.00	-	270.00	1,930.00	330.00	1,990.00	270.00	1,930.00	Chisapani (60 km + Porter)
	750 litre	Nos.	3,112.50	-	360.00	3,472.50	480.00	3,592.50	360.00	3,472.50	@ NRs. 5,400 / crane truck
	1,000 litre	Nos.	4,150.00	-	540.00	4,690.00	690.00	4,840.00	540.00	4,690.00	
10.	Concrete Hume Pipe										
	dia. 200 mm	Rm	800.00	-	72.00	872.00	190.00	990.00	72.00	872.00	
	dia. 300 mm	Rm	960.00	-	72.00	1,032.00	-	-	72.00	1,032.00	
	dia. 600 mm	Rm	1,850.00	-	240.00	2,090.00	-	-	240.00	2,090.00	
	dia. 900 mm	Rm	3,640.00	-	360.00	4,000.00	-	-	360.00	4,000.00	
	dia. 1200 mm	Rm	5,200.00	-	540.00	5,740.00	-	-	540.00	5,740.00	

Table 3.3.2 List of Unit Price for Major Work Items (People's Participation Program Basis (PPP) and LCB Basis)

S.N	Description of Item	Unit	Unit Rate (NRs.)					
			Namtar		Chisapani		Phedigaon	
			PPP	LCB	PPP	LCB	PPP	LCB
01.	E/W Excavation in Soft Soil	m3	43.00	57.00	43.00	57.00	43.00	57.00
02.	E/W Excavation in BMS and Hard soil	m3	98.00	130.00	98.00	130.00	98.00	130.00
03.	E/W Excavation in Boulder Mixed Soil under Shallow Water (Depth < 2.0 m)	m3	222.00	295.00	222.00	295.00	222.00	295.00
04.	E/W Backfill with common soil	m3	34.00	45.00	34.00	45.00	34.00	45.00
05.	Stone Soling in Foundation	m3	194.00	258.00	194.00	258.00	194.00	258.00
06.	P.C.C. 1:2:4 incl/ formwork	m3	4,505.00	5,984.00	5,710.00	7,584.00	4,458.00	5,921.00
07.	R.C.C. 1:2:4, incl/ steel & formwork	m3	7,076.00	9,399.00	8,428.00	11,194.00	7,027.00	9,334.00
08.	Stone Masonry Wall (CM 1:3)	m3	2,075.00	2,756.00	3,046.00	4,046.00	2,031.00	2,698.00
09.	Stone Masonry Wall (CM 1:4)	m3	1,876.00	2,492.00	2,841.00	3,774.00	1,830.00	2,431.00
10.	Rubble Masonry (CM 1:3)	m3	1,921.00	2,552.00	2,892.00	3,841.00	1,877.00	2,493.00
11.	Rubble Masonry (CM 1:4)	m3	1,722.00	2,287.00	2,687.00	3,569.00	1,676.00	2,226.00
12.	Dry Rubble Masonry Wall	m3	441.00	586.00	441.00	586.00	441.00	586.00
13.	Plastering 20 mm (CM 1:4)	m2	80.00	106.00	127.00	169.00	77.00	102.00
14.	Gabion Box	m3	751.00	998.00	760.00	1,009.00	748.00	994.00
15.	HDP Pipe Joining, Laying							
	250 mm	Rm	1,990.00	2,643.00	1,993.00	2,647.00	1,992.00	2,646.00
	150 mm	Rm	992.00	1,318.00	994.00	1,320.00	994.00	1,320.00
	50 mm	Rm	161.00	214.00	162.00	215.00	161.00	214.00
	38 mm	Rm	103.00	137.00	103.00	137.00	103.00	137.00
	25 mm	Rm	47.00	62.00	48.00	64.00	48.00	64.00
	12.5 mm	Rm	23.00	31.00	24.00	32.00	24.00	32.00
16	Transportation							
	Cement	100 kg	18.00	24.00	146.00	194.00	46.00	61.00
	G.I. Wire	100 kg	18.00	24.00	146.00	194.00	46.00	61.00
	Binding Wire	100 kg	18.00	24.00	146.00	194.00	46.00	61.00

Note: Contractor's Profit and tax are: Excluded for People's Participation Program (PPP) basis BMS: Boulder mixed soil

Included for Local Competitive Bidding (LCB) basis

Table 3.3.3 List of Unit Price for Major Work Items (People's Participation Program Basis)

S.N	Description of Item	Unit	Unit Rate (NRs.)					
			Namtar		Chisapani		Phedigaon	
			Total	Labour	Total	Labour	Total	Labour
01.	E/W Excavation in Soft Soil	m3	43.00	42.00	43.00	42.00	43.00	42.00
02.	E/W Excavation in Boulder Mixed Soil	m3	98.00	95.00	98.00	95.00	98.00	95.00
03.	E/W Excavation in Boulder Mixed Soil under Shallow Water (Depth < 2.0 m)	m3	222.00	216.00	222.00	216.00	222.00	216.00
04.	E/W Backfill with common soil	m3	34.00	33.00	34.00	33.00	34.00	33.00
05.	Stone Soling in Foundation	m3	194.00	161.00	194.00	161.00	194.00	161.00
06.	P.C.C. 1:2:4 incl/ formwork	m3	4,505.00	1,481.00	5,710.00	2,028.00	4,458.00	1,450.00
07.	R.C.C. 1:2:4, incl/ steel & formwork	m3	7,076.00	1,620.00	8,428.00	2,167.00	7,027.00	1,589.00
08.	Stone Masonry Wall (CM 1:3)	m3	2,075.00	896.00	3,046.00	1,397.00	2,031.00	867.00
09.	Stone Masonry Wall (CM 1:4)	m3	1,876.00	880.00	2,841.00	1,409.00	1,830.00	849.00
10.	Rubble Masonry (CM 1:3)	m3	1,921.00	788.00	2,892.00	1,289.00	1,877.00	759.00
11.	Rubble Masonry (CM 1:4)	m3	1,722.00	772.00	2,687.00	1,301.00	1,676.00	741.00
12.	Dry Rubble Masonry Wall	m3	441.00	371.00	441.00	371.00	441.00	371.00
13.	Plastering 20 mm (CM 1:4)	m2	80.00	35.00	127.00	60.00	77.00	33.00
14.	Gabion Box	m3	751.00	336.00	760.00	337.00	748.00	336.00
15.	HDP Pipe Joining, Laying							
	250 mm	Rm	1,990.00	111.00	1,993.00	111.00	1,992.00	111.00
	150 mm	Rm	992.00	61.00	994.00	61.00	994.00	61.00
	50 mm	Rm	161.00	14.00	162.00	14.00	161.00	14.00
	38 mm	Rm	103.00	11.00	103.00	11.00	103.00	11.00
	25 mm	Rm	47.00	8.00	48.00	8.00	48.00	8.00
	12.5 mm	Rm	23.00	7.00	24.00	7.00	24.00	7.00
16	Transportation							
	Cement	100 kg	18.00	2.00	146.00	105.00	46.00	5.00
	G.I. Wire	100 kg	18.00	2.00	146.00	105.00	46.00	5.00
	Binding Wire	100 kg	18.00	2.00	146.00	105.00	46.00	5.00

Note: Contractor's Profit and tax are: Excluded for People's Participation Program (PPP) basis BMS: Boulder mixed soil

Included for Local Competitive Bidding (LCB) basis

Table 3.3.4 List of Unit Price for Major Work Items (Local Competitive Bidding (LCB) Basis)

S.N	Description of Item	Unit	Unit Rate (NRs.)					
			Namtar		Chisapani		Phedigaon	
			Total	Labour	Total	Labour	Total	Labour
01.	E/W Excavation in Soft Soil	m3	57.00	56.00	57.00	56.00	57.00	56.00
02.	E/W Excavation in Boulder Mixed Soil	m3	130.00	126.00	130.00	126.00	130.00	126.00
03.	E/W Excavation in Boulder Mixed Soil under Shallow Water (Depth < 2.0 m)	m3	295.00	287.00	295.00	287.00	295.00	287.00
04.	E/W Backfill with common soil	m3	45.00	44.00	45.00	44.00	45.00	44.00
05.	Stone Soling in Foundation	m3	258.00	214.00	258.00	214.00	258.00	214.00
06.	P.C.C. 1:2:4 incl/ formwork	m3	5,984.00	1,967.00	7,584.00	2,694.00	5,921.00	1,926.00
07.	R.C.C. 1:2:4, incl/ steel & formwork	m3	9,399.00	2,152.00	11,194.00	2,878.00	9,334.00	2,111.00
08.	Stone Masonry Wall (CM 1:3)	m3	2,756.00	1,190.00	4,046.00	1,856.00	2,698.00	1,152.00
09.	Stone Masonry Wall (CM 1:4)	m3	2,492.00	1,169.00	3,774.00	1,872.00	2,431.00	1,128.00
10.	Rubble Masonry (CM 1:3)	m3	2,552.00	1,047.00	3,841.00	1,712.00	2,493.00	1,008.00
11.	Rubble Masonry (CM 1:4)							
12.	Dry Rubble Masonry Wall	m3	586.00	493.00	586.00	493.00	586.00	493.00
13.	Plastering 20 mm (CM 1:4)	m2	106.00	46.00	169.00	80.00	102.00	44.00
14.	Gabion Box	m3	998.00	446.00	1,009.00	448.00	994.00	446.00
15.	HDP Pipe Joining, Laying							
	250 mm	Rm	2,643.00	147.00	2,647.00	147.00	2,646.00	147.00
	150 mm	Rm	1,318.00	81.00	1,320.00	81.00	1,320.00	81.00
	50 mm	Rm	214.00	19.00	215.00	19.00	214.00	19.00
	38 mm	Rm	137.00	15.00	137.00	15.00	137.00	15.00
	25 mm	Rm	62.00	11.00	64.00	11.00	64.00	11.00
	12.5 mm	Rm	31.00	9.00	32.00	9.00	32.00	9.00
16	Transportation							
	Cement	100 kg	24.00	3.00	194.00	139.00	61.00	7.00
	G.I. Wire	100 kg	24.00	3.00	194.00	139.00	61.00	7.00
	Binding Wire	100 kg	24.00	3.00	194.00	139.00	61.00	7.00

Note: Contractor's Profit and tax are: Excluded for People's Participation Program (PPP) basis BMS: Boulder mixed soil

Included for Local Competitive Bidding (LCB) basis

Table 3.5.1 Summary of Quantity and Construction Cost for Rural Road Improvement Project in Namtar Area

S.N	Major Construction Works	Unit	Quantity	Unit Price (NRs.)	Amount (NRs.)	Remarks
1. Site - 1						
	Gabion Structure	m3	176	751	132,176	1 Checkdam, 2 Prop wall
	Excavation in soft soil	m3	35	43	1,505	20 % of Gabion Volume
	Side-ditch (Type-A)	m	20	(644)	12,880	Wet stone masonry
	Drop-Chute	nos.	1	900	900	Vegetated riprap (10m2/nos)
	Sub-total				147,461	
2. Site - 2						
	Site - 2-a					
	Gabion Structure	m3	68	751	51,068	Prop wall (vs)
	Excavation in soft soil	m3	14	43	602	20 % of Gabion Volume
	Sub-total Site - 2-a				**51,670**	
	Site - 2-b					
	Gabion Structure	m3	50	751	37,550	Prop wall (ms)
	Excavation in soft soil	m3	10	43	430	20 % of Gabion Volume
	Side-ditch (Type-B)	m	20	(154)	3,076	Dry rubble masonry
	Surface Drainage	nos	3	2,550	7,650	Stone pitching (15 m2/ nos)
	Drainage pipe culvert	nos	3	6,248	18,744	RCC Pipe (D = 200mm)
	Drop-Chute	nos	3	900	2,700	Vegetated riprap (10m2/nos)
	Sub-total Site - 2-b				**70,150**	
	Sub-total				**121,820**	
3. Site - 3						
	Gabion Structures	m3	665	751	499,415	1 Checkdam, 1 Prop wall
	Excavation in soft soil	m3	159	43	5,719	20 % of Gabion Volume
	Side-ditch (Type-B)	m	60	(158)	9,497	Dry rubble masonry
	Sub-total				**636,451**	
4. Site - 4						
	Gabion Structures	m3	488	751	366,488	1 Checkdam, 2 Prop wall
	Excavation in soft soil	m3	159	43	4,214	20 % of Gabion Volume
	Side-ditch (Type-A)	m	50	(686)	34,275	Wet stone masonry
	Surface Drainage	nos	3	2,550	7,650	Stone pitching (15 m2/ nos)
	Drainage pipe culvert	nos	3	6,248	18,744	RCC Pipe (D = 200mm)
	Drop-Chute	nos	3	900	2,700	Vegetated riprap (10m2/nos)
	Sub-total				**434,071**	
5. Site - 5						
	Gabion Structures	m3	50	751	37,550	1 Checkdam, 1 Prop wall
	Excavation in soft soil	m3	10	43	430	20 % of Gabion Volume
	Side-ditch (Type-A)	m	10	(644)	6,440	Wet stone masonry
	Surface Drainage	nos	3	2,550	7,650	Stone pitching (15 m2/ nos)
	Drainage pipe culvert	nos	3	6,248	18,744	RCC Pipe (D = 200mm)
	Drop-Chute	nos	3	900	2,700	Vegetated riprap (10m2/nos)
	Sub-total				**73,514**	
6. Drainage Facilities Development Over all Area						
	Side-ditch (Type-B)	m3	1,860	(161)	949,260	Dry rubble masonry
	Surface Drainage	nos	30	2,550	76,500	Stone pitching (15 m2/ nos)
	Drainage pipe culvert	nos	30	6,248	187,440	RCC Pipe (D = 200mm)
	Drop-Chute	nos	30	900	27,000	Vegetated riprap (10m2/nos)
	Sub-total				**1,240,200**	
Sub-total of Major Construction Works					**2,531,697**	
7. Miscellaneous Works		20 % of Major Works			506,000	
	Sub-total of Direct Cost				**3,037,697**	
8. Engineering Service		30 % of Direct Cost		30%	911,309	
	Sub-total				**3,949,006**	
9. Physical Contingency		20 % of Major Works		20%	789,801	
	Grand Total				**4,738,807**	
			(Say,		**4,739,000)**	

Note: 1. Quantity is rounded to integer
2. Unit Price in ( ) vary accordance with the volume ratio between excavation and material
3. vs = Valley side; ms = Mountain side
4. Miscellaneous works includes Cost for: Vegetation, Spare parts (wire, RCC pipes, etc.), Equipments

Table 3.5.2 Summary of Quantity and Construction Cost for Construction Work Items for Rural Road Improvement Project in Namtar Area

S N	Work Items	Unit	Q'ty	PPP Basis (NRs.) Unit Price	PPP Basis (NRs.) Amount	LCB Basis (NRs.) Unit Price	LCB Basis (NRs.) Amount
1.	Site-1						
1-1.	Gabion (Checkdams, Prop-wall)	m3	176	751	132,176	998	175,648
1-2.	Excavation in soft soil	m3	45	43	1,935	57	2,565
1-3.	Stone Masonry Wall (CM1:3)	m3	6	2,075	12,450	2,756	16,536
1-4.	Vegetated Riprap (t=15cm)	m2	10	90	900	120	1,200
Total of Site-1					**147,461**		**195,949**
2.	Site-2						
	Site-2-a						
2-1.	Gabion	m3	68	751	51,068	998	67,864
2-2.	Excavation in soft soil	m3	14	43	602	43	798
	Total of Site-2-a				**51,670**		**68,662**
	Site-2-b						
2-3.	Gabion (Upper Checkdams)	m3	50	751	37,550	998	49,900
2-4.	Excavation in soft soil	m3	20	43	860	57	1,140
2-5.	Excavation in hard soil	m3	15	98	1,470	130	1,950
2-6.	Backfill w/ common soil	m3	3	34	102	45	135
2-7.	Backfill w/ Boulder, Gravel	m3	12	341	4,092	453	5,436
2-8.	Dry Rubble Masonry Wall	m3	6	441	2,646	586	3,516
2-9.	Stone Pitching (t=20cm)	m2	45	170	7,650	226	10,170
2-10.	RCC Hume Pipe, NP-3, 200	m	15	872	13,080	1,050	15,750
2-11.	Vegetated Riprap (t=15cm)	m2	30	90	2,700	130	3,600
	Total of Site-2-b				**70,150**		**91,597**
Total of Site-2					**121,820**		**160,259**
3.	Site-3						
3-1.	Gabion	m3	665		499,415		663,670
3-2.	Excavation in soft soil	m3	159	43	6,837	57	9,063
3-3.	Dry Rubble Masonry Wall	m3	19	441	8,379	586	11,134
Total of Site-3					**514,631**		**683,867**
4.	Site-4		Q'ty				
4-1.	Gabion	m3	488	751	366,488	998	487,024
4-2	Excavation in soft soil	m3	123	43	5,289	57	7,011
4-3.	Excavation in hard soil	m3	15	98	1,470	130	1,950
4-4.	Backfill w/ common soil	m3	3	34	102	45	135
4-5.	Backfill w/ Boulder, Gravel	m3	12	341	4,092	453	5,436
4-6.	Stone Masonry Wall (CM1:3)	m3	16	2,075	33,200	2,756	44,096
4-7.	Stone Pitching (t=20cm)	m2	45	170	7,650	226	10,170
4-8.	RCC Hume Pipe, NP-3, 200	m	15	872	13,080	1,050	15,750
4-9.	Vegetated Riprap (t=15cm)	m2	30	90	2,700	130	3,600
Total of Site-4					**434,071**		**575,172**
5.	Site-5		Q'ty				
5-1.	Gabion		50	751	37,550	998	49,900
5-2.	Excavation in soft soil	m3	15	43	645	57	855
5-3.	Excavation in hard soil	m3	15	98	1,470	130	1,950
5-4.	Backfill w/ common soil	m3	3	34	102	45	135
5-5.	Backfill w/ Boulder, Gravel	m3	12	341	4,092	453	5,436
5-6.	Stone Masonry Wall (CM1:3)	m3	3	2,075	6,225	2,756	8,268
5-7.	Stone Pitching (t=20cm)	m2	45	170	7,650	226	10,170
5-8.	RCC Hume Pipe, NP-3, 200	m	15	872	13,080	1,050	15,750
5-9.	Vegetated Riprap (t=15cm)	m2	30	90	2,700	120	3,600
Total of Site-5					**73,514**		**96,064**
6.	Drainage Facilities Development Over all Area (Side-ditch: 6km; Surface Drainage & culvert: nos. / 200m).						
6-1.	Excavation in soft soil	m3	3,000	43	129,000	57	171,000
6-2.	Excavation in hard soil	m3	150	98	14,700	130	19,500
6-3.	Backfill w/ common soil	m3	32	34	1,088	45	1,440
6-4.	Backfill w/ Boulder, Gravel	m3	117	341	39,897	453	53,001
6-5.	Dry Rubble Masonry Wall	m3	1,860	441	820,260	586	1,089,960
6-6.	Stone Pitching (t=20cm)	m2	450	170	76,500	226	101,700
6-7.	RCC Hume Pipe, NP-3, 200	m	150	872	130,800	1,050	157,500
Total of 6					**1,241,155**		**1,630,101**
Sub-total of Cost for Major Construction Works					**2,531,697**		**3,341,412**
7. Miscellaneous		**20% of Sub-total**			**506,000**		**668,000**
	Sub-total of Direct Cost				**3,037,697**		**4,009,412**
8. Engineering Service		**30 % of Direct Cost**		**30%**	**911,309**	**(Say,**	**1,202,824**
	Sub-total				**3,949,006**		**5,212,236**
9. Physical Contingency		**20 % of Major Works**		**20%**	**789,801**		**1,042,447**
	Grand Total				**4,738,807**		**6,254,683**
					4,739,000)		**6,255,000)**

Table 3.5.3 Anticipated Cost for Rehabilitation of Namtar Irrigation Project

S.N	Major Work Items	Unit	Quantity	LCB Basis (NRs.) Unit Price	Amount	Remarks	Conditions
Dungeon Scheme:							
	Intake structure	nos.	1	180,000	180,000	Diverting 400 lit./sec.,	Newly constructed
	Headreach canal-1	m	800	65	52,000	Intake - T/O: Earth canal	Existing Enlarged
	Headreach canal-2	m	250	100	25,000	T/O - R/B-1: Earth canal	Newly constructed
	Turnout structure	nos.	1	200,000	200,000	220 lit./sec. Diverted to Aqueduct;	Newly constructed
	Regulating basin-1	nos.	1	200,000	200,000	Located at the Entrance to the Suspended Aqueduct	Newly constructed
	Main canal-1	m	1,200	65	78,000	T/O - Road-head: Existing Earth canal	Partially Reshaped
	Crossing structures	nos.	2	60,000	120,000	Existing wooden structures	Reinforced
Namtar Scheme:							
	Suspended Aqueduct	nos.	1	3,000,000	3,000,000	Clear span: 70 m; Pipe (HDP) suspended by cable and scaffold; 2 Abutments (RCC recommended)	Newly constructed
	Regulation basin-2	nos.	1	200,000	200,000	Located at the Exit from the Suspended Aqueduct	Newly constructed
	Headreach canal-3	m	600	100	60,000	R/B-2 - Farmland: Earth canal	Reshaped
	Main canal-2	m	1,600	65	104,000	Passing Farmland - Water tank near school	Reshaped
	Crossing structures	nos.	2	30,000	60,000	Existing Aqueduct	Rehabilitated
		nos.	7	60,000	420,000	Box Culvert and Gabion Protections	Reconstructed
	Retaining wall	nos.	2	40,000	80,000	Total length of 25 m slided	Rehabilitated
		nos.	1	80,000	80,000	Total length of 10 m	Newly constructed
	Recovery from Landslide:	m	100	130	13,000	4 locations: Total length of 100 m;	Excavated
		m	70	2,200	154,000	Total length of 70 m	HDP Pipe burried
	Total of Anticipated Direct Construction Cost				**5,026,000**		

Note: Cost of structures are referred to the Cost Estimate in Rural Road Improvement (3.5.1), Micro-Hydropower Scheme (3.5.3) in Namtar/ Tilar Area

Table 3.5.4 Work Quantity & Construction Cost for Micro-hydropower

Item	Works	Unit	Quantity	Unit Price (NRs)	Cost (NRs)	Remarks
1 Intake Works						
	1.1 Steel pipe	m	11	10,560	116,160	ϕ 250mm
	1.2 Screen	kg	350	31	10,780	
	1.3 Screen Frame, etc	kg	170	31	5,236	
	1.4 Stone Masonry for Step	m3	5.5	2,756	15,158	
	1.5 Excavation for Step	m3	4	130	520	
	1.6 Stop Valve	set	1	190,300	190,300	ϕ 250mm
	1.7 Miscellaneous Works	%	10	-	33,815	
	Sub-total				**371,969**	
2 Desilting Basin with Spillway						
	2.1 Steel Plate for Top Cover	kg	180	30	5,445	10 m2, t=2.3mm
	2.2 Stone Masonry(CM 1:3)	m3	27	2,756	74,412	
	2.3 Concrete(1:2:4)	m3	0.5	9,399	4,700	
	2.4 Excavation	m3	50	130	6,500	
	2.5 Backfill	m3	20	45	900	
	2.6 Stop Valve	set	1	190,300	190,300	ϕ 250mm
	2.7 Sluice gate (circle type)	set	1	163,350	163,350	ϕ 450mm
	2.8 Miscellaneous Works	%	10	-	44,561	
	Sub-total				**490,167**	
3 Connecting Pipe						
	3.1 HDP pipe	m	830	1,990	1,651,700	ϕ 250mm, 6 kgf/cm2
	3.2 Excavation	m3	125	130	16,250	
	3.3 Backfill	m3	58	45	2,610	
	3.4 Stone Soling	m3	25	258	6,450	
	3.5 S.Masonry for pipe Support	m3	28	2,756	77,168	15-m interval, 0.5 m3/pc
	3.6 Pipe fixing for pipe Support	set	56	1,430	80,080	
	3.7 Miscellaneous Works	%	10	-	183,426	
	Sub-total				**2,017,684**	
4 Rivert/Stream Crossing Structure (5 locations)						
	4.1 Stone Masonry	m3	13	2,756	35,828	(2.62 m3/pc)
	4.2 Excavation	m3	12	130	1,560	(2.50 m3/pc)
	4.3 Backfill	m3	8	45	360	(1.50 m3/pc)
	4.4 Pipe fixing	set	10	1,430	14,300	(2 set/pc)
	4.5 Miscellaneous Works	%	10	-	5,205	
	Sub-total				**57,253**	
5 Forebay Tnak						
	5.1 Stone Masonry	m3	25	2,756	68,900	
	5.2 Excavation	m3	29	57	1,653	
	5.3 Backfill	m3	12	45	540	
	5.4 Screen for Penstock	kg	220	30	6,655	
	5.5 Sluice gate (circle type)	set	1	163,350	163,350	ϕ 450mm
	5.6 Miscellaneous Works	%	10	-	24,110	
	Sub-total				**265,208**	
6 Generating Plant & Distribution Sytem						
	6.1 Generating Plant & Distribution Sytem (Plant: 20 kW, Distribution Line: 9.4 km)	L.S.			2,240,000	(US$40,000)
	Total of Direct Cost				**5,442,281**	
7 Engineering Service	20 % of Direct Cost				1,088,000	Include Technocal Service
	Sub-total				**6,530,281**	
8 Physical Contingency	20 % of above sub-total				1,306,000	
Total Cost					**7,836,281**	
				(Say,	**7,836,000)**	

Table 3.5.5 Summary of Components and Construction Cost for Water Supply Network System in Chisapani Area

Name of Major Component Description		Unit	Quantity	Unit Rate (NRs.)	Amount (NRs.)	Remarks
1 Intake Structure		nos.	**11**	**1,610**	**17,710**	Precast concrete unit, w/ HDP Strainer, Steel Screen
2 Storage Tank		nos.	**3**	-	**260,080**	RCC Tank, incl/ pipe fittings, 9,000 lit.: 1 nos.; 6,000 lit. 2 nos.
3 Distribution Tank	System					RCC Tank, incl/ pipe fittings,
	S-1 System	nos.	3	-	120,420	3,500, 3,000, 1,500 lit.
	S-2 System	nos.	4	-	139,560	3,000, 2,500, 1,500, 1,000 lit.
	S-3 System	nos.	3	-	113,450	3,000, 2,500, 1,500 lit.
Sub-total		nos.	**10**	-	**373,430**	
4 Delivery Tank	size					
	1000 lit.	nos.	4	7,130	28,520	Ready-made Plastic Tank,
	750 lit.	nos.	11	5,700	62,700	incl/ Pipe fittings,
	400 lit.	nos.	3	3,850	11,550	Precast valve chamber
Sub-total		nos.	**18**	-	**102,770**	
5 Household Storage Tank	200 lit.	nos.	**78**	**2,490**	**194,220**	Ready-made Plastic tank, incl/ Pipe fittings, Sprinkler set (extra pipe 20m)
6 Related Structures						
Break Pressure Tank		nos.	9	2,180	19,620	Plastic tank 200 lit.
Precast Valve Chamber			56	810	45,360	w/ pipe fittings,
Sub-total		nos.	**65**	-	**64,980**	Precast chamber with valve
7 HDP Pipeline	(Inside dia.)					
	12.5 mm	m	9,685	24	232,440	Household line: 2,400 m
	25.0 mm	m	2,475	48	118,800	Another 10 % in the air
	38.0 mm	m	2,159	103	222,377	
Sub-total		m	**14,319**	-	**573,617**	
8 Burying Community Pipelines						
75 % of total length		m	10,700	5	**53,500**	
Sub-Total of Items 1 to 8					**1,640,307**	
9 Miscellaneous		%	20		**328,000**	20 % of Sub-total
Total Direct Cost					**1,968,307**	
10 Engineering Service		%	30		590,000	30 % of Total Direct Cost
Sub-Total					2,558,307	
11 Physical Contingency		%	20		512,000	30 % of Sub-total
Grand Total					**3,070,307**	
				(say, NRs.	**3,070,000)**	

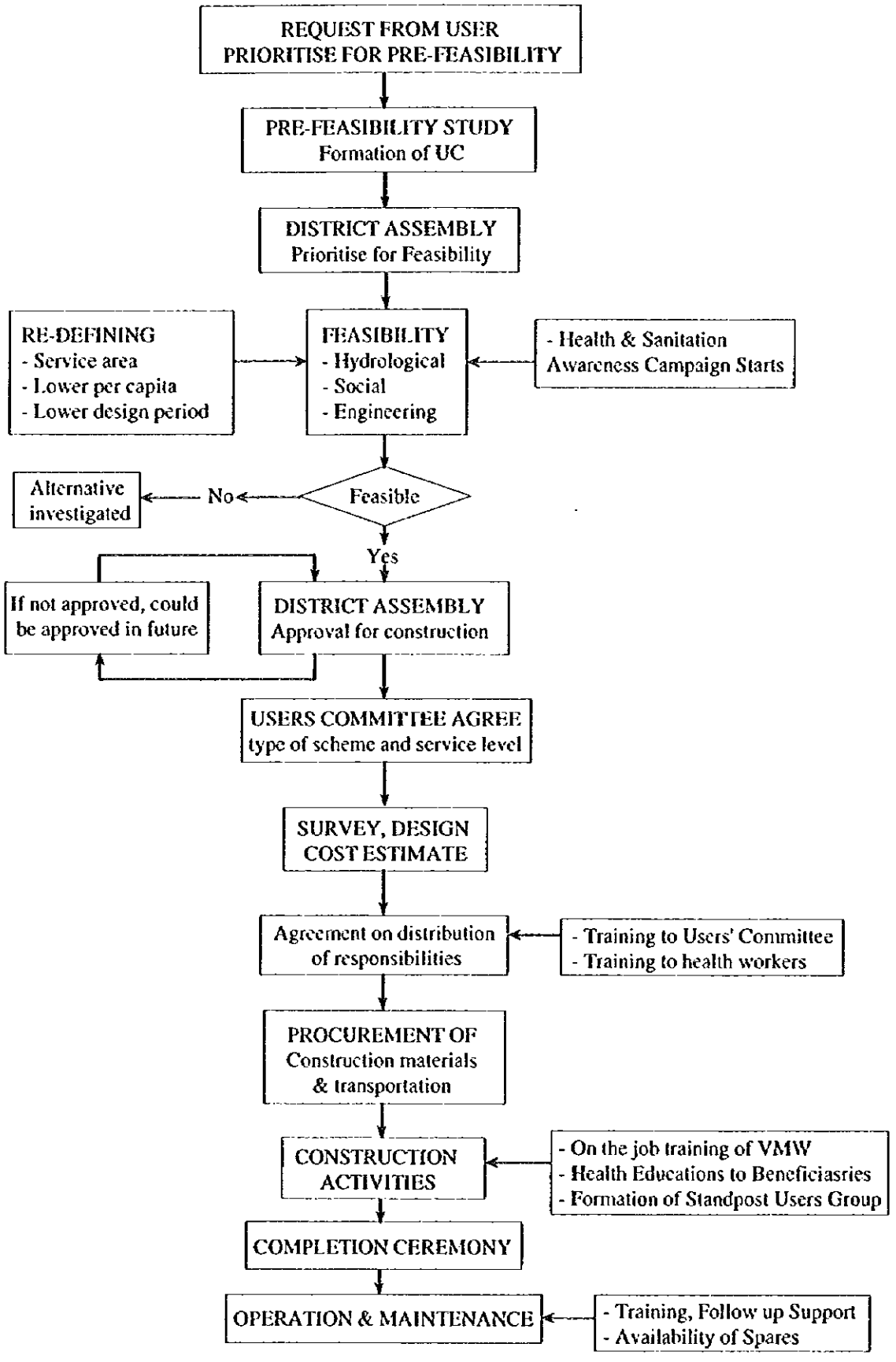
Table3.5.6 Summary of Cost Breakdown for Water Supply Network System in Chisapani Area

Name of Major Component		Unit	Quantity	Unit Rate (NRs.)	Amount (NRs.)	Remarks
S-1 System						
1-1 Intake Structure		nos.	6	1,610	9,660	
1-2 Storage Tank	S-1	nos.	1	100,820	100,820	9,000 litre
1-3 Distribution Tank	D-1-1	nos.	1	47,400	47,400	3,500 litre
	D-1-2	nos.	1	31,120	31,120	1,500 litre
	D-1-3	nos.	1	41,900	41,900	3,000 litre
1-4 Plastic Tank	1000 lit.	nos.	4	7,130	28,520	Delivery tanks
	750 lit.	nos.	3	5,700	17,100	- do -
	400 lit.	nos.	-	3,850	-	- do -
	200 lit.	nos.	36	2,490	89,640	Household tank
1-5 Related Structures	BP Tank	nos.	6	2,180	13,080	
	Valve Ch.	nos.	24	810	19,440	
1-6 HDP Pipeline	12.5 mm	m	6,043	24	145,032	Household line: 1080m
	25.0 mm	m	464	48	22,272	
	38.0 mm	m	0	103	-	
	Burying	m	4,800	5	24,000	
Total of S-1 System					**589,984**	
S-2 System						
2-1 Intake Structure		nos.	2	1,610	3,220	
2-2 Storage Tank	S-2	nos.	1	79,630	79,630	6,000 litre
2-3 Distribution Tank	D-2-1	nos.	1	39,690	39,690	2,500 litre
	D-2-2	nos.	1	42,640	42,640	3,000 litre
	D-2-3	nos.	1	26,110	26,110	1,000 litre
	School	nos.	1	31,120	31,120	1,500 litre
2-4 Plastic Tank	1000 lit.	nos.	-	7,130	-	Delivery tanks
	750 lit.	nos.	5	5,700	28,500	- do -
	400 lit.	nos.	1	3,850	3,850	- do -
	200 lit.	nos.	21	2,490	52,290	Household tank
2-5 Related Structures	BP Tank	nos.	3	2,180	6,540	
	Valve Ch.	nos.	22	810	17,820	
2-6 HDP Pipeline	12.5 mm	m	2,214	24	53,136	Household line: 660m
	25.0 mm	m	1,846	48	88,608	
	38.0 mm	m	1,415	103	145,745	
	Burying	m	4,100	5	20,500	
Total of S-2 System					**639,399**	
S-3 System						
3-1 Intake Structure		nos.	3	1,610	4,830	
3-2 Storage Tank	S-3	nos.	1	79,630	79,630	6,000 litre
3-3 Distribution Tank	D-3-1	nos.	1	31,120	31,120	1,500 litre
	D-3-2	nos.	1	38,950	38,950	2,500 litre
	D-3-3	nos.	1	43,380	43,380	3,000 litre
3-4 Plastic Tank	1000 lit.	nos.	-	7,130	-	Delivery tanks
	750 lit.	nos.	3	5,700	17,100	- do -
	400 lit.	nos.	2	3,850	7,700	- do -
	200 lit.	nos.	21	2,490	52,290	Household tank
3-5 Related Structures	Valve Ch.	nos.	10	810	8,100	
	12.5 mm	m	1,428	24	34,272	Household line: 660m
3-6 HDP Pipeline	25.0 mm	m	165	48	7,920	
	38.0 mm	m	744	103	76,632	
	Burying	m	1,800	5	9,000	
Total of S-3 System					**410,924**	
Grand Total					**1,640,307**	

Table 3.5.7 Breakdown Quantities and Cost for Rural Water Supply Network in Chisapani Area

S.N	Works Items	Unit	Quantity	PPP Basis (NRs.) Unit Rate	PPP Basis (NRs.) Amount	LCB Basis (NRs.) Unit Rate	LCB Basis (NRs.) Amount
Tanks							
1	**Reinforced Concrete Tanks**	**nos.**	**13**				
	Storage Tanks	**nos.**	**3**				
	Distribution & School Tanks	**nos.**	**10**				
1-1.	Excavation	m3	3.948	43	168	57	225
1-2.	Reinforced Concrete *	m3	49.767	8,428	419,436	11,194	557,092
1-3.	Levelling Concrete *	m3	6.672	5,710	38,102	7,584	50,600
1-4.	Wet Stone Masonry	m3	9.852	3,046	30,008	4,046	39,861
1-5.	Stone Soling	m3	13.344	194	2,590	258	3,443
1-6.	Precast Manhole Cover	nos.	13	288	3,744	348	4,524
1-7.	Precast Chamber Cover-S	nos.	3	1,055	3,165	1,274	3,822
1-8.	Precast Chamber Cover-D	nos.	10	740	7,400	894	8,940
1-9.	Pipe fittings-Strage tank	nos.	3	2,122	6,366	2,562	7,686
1-10.	Pipe fittings- Dist'n tank	nos.	10	1,692	16,920	2,043	20,430
	Sub-Total				**527,898**		**696,623**
1-11.	Miscellaneous Works	%	20	-	105,612	-	139,325
	Total				**633,510**		**835,948**
2.	**Delivery Tanks**	**nos.**	**18**				
2-1.	Ready-made Plastic Tank (1000 lit	set	4	4,840	19,360	5,844	23,376
2-2.	Ready-made Plastic Tank (750 lit.)	set	11	3,593	39,523	4,339	47,729
2-3.	Ready-made Plastic Tank (400 lit.)	set	3	1,990	5,970	2,403	7,209
2-4.	Pipe fitting for Deliv. Tank	set	18	748	13,464	903	16,254
2-5.	Precast Valve Chamber	nos.	18	611	10,998	738	13,284
	Sub-Total				**89,315**		**107,852**
2-6.	Installation and Other Misc. 15 %		15%		13,455		16,178
	Total				**102,770**		**124,030**
3.	**Household Tank 200 lit.**	**nos.**	**78**				
3-1.	Ready-made Plastic Tank (200 lit.)	set	78	1,106	86,268	1,335	104,130
3-2.	Pipe fitting incl/ Sprinkler set	set	78	1,154	90,012	1,393	108,654
	Sub-Total				**176,280**		**212,784**
3-3.	Installation and Other Misc. 10 %		10%		17,940		21,278
	Total				**194,220**		**234,062**
4.	**HDP Pipelines**	**m**	**14,319**				
4-1.	12.5 mm	m	9,685	24	232,440	32	309,920
4-2.	25.0 mm	m	2,475	48	118,800	64	158,400
4-3.	38.0 mm	m	2,159	103	222,377	137	295,783
4-4.	Burying Pipelines (75 % of total)	m	10,700	5	53,500	7	74,900
Total of HDP Pipelines					**627,117**		**839,003**
Related Structures							
5.	**Break Pressure Tank**	**nos.**	**9**				
5-1.	Ready-made Plastic Tank (200 lit.)	set	9	1,106	9,954	1,335	12,015
5-2.	Pipe fitting for BP Tank	set	9	265	2,385	320	2,880
5-3.	Precast Valve Chamber	nos.	9	611	5,499	738	6,642
	Sub-Total				**17,838**		**21,537**
5-4.	Installation and Misc. 10 %		10%		1,782		2,154
	Total				**19,620**		**23,691**
6.	**Intake Protection Structure**	**nos.**	**11**				
6-1.	Excavation	m3	1.020	43	44	57	44
6-2.	Stone Soling	m2	4.990	194	968	258	968
6-3.	Dry Rubble Masonry	m3	0.698	441	308	586	308
6-4.	Precast Unit (PCC 1:4)	nos.	11	1,069	11,759	1,291	14,201
6-5.	HDP Strainer "1/2	nos.	11	156	1,716	188	2,068
	Sub-Total				**14,795**		**17,589**
6-6.	Installation and Misc. 20 %		20%		2,915		3,518
	Total				**17,710**		**21,107**
7.	**Precast Valve Chamber**	**nos.**	**56**				
7-1.	Excavation	m3	3.910	43	168	57	44
7-2.	Stone Soling	m2	14.146	194	2,744	258	968
7-3.	Precast Unit (PCC 1:4)	nos.	56	555	31,080	670	37,520
7-4.	Valve and Pipe Fittings	nos.	56	129	7,224	156	8,736
	Sub-Total				**41,216**		**47,268**
7-5.	Installation and Misc. 10 %		10%		4,144		4,727
	Total				**45,360**		**51,995**
Grand Total of Direct Construction Cost					**1,640,307**		**2,129,836**

Note: * = including Formwork



Source: DESIGN GUIDELINES FOR COMMUNITY BASED GRAVITY FLOW RURAL WATER SUPPLY SCHEMES, HMG-N/UNICEF, January 1993

Fig. 1.1.1
Implementation Flowchart for Community Based Gravity Water Supply Schemes

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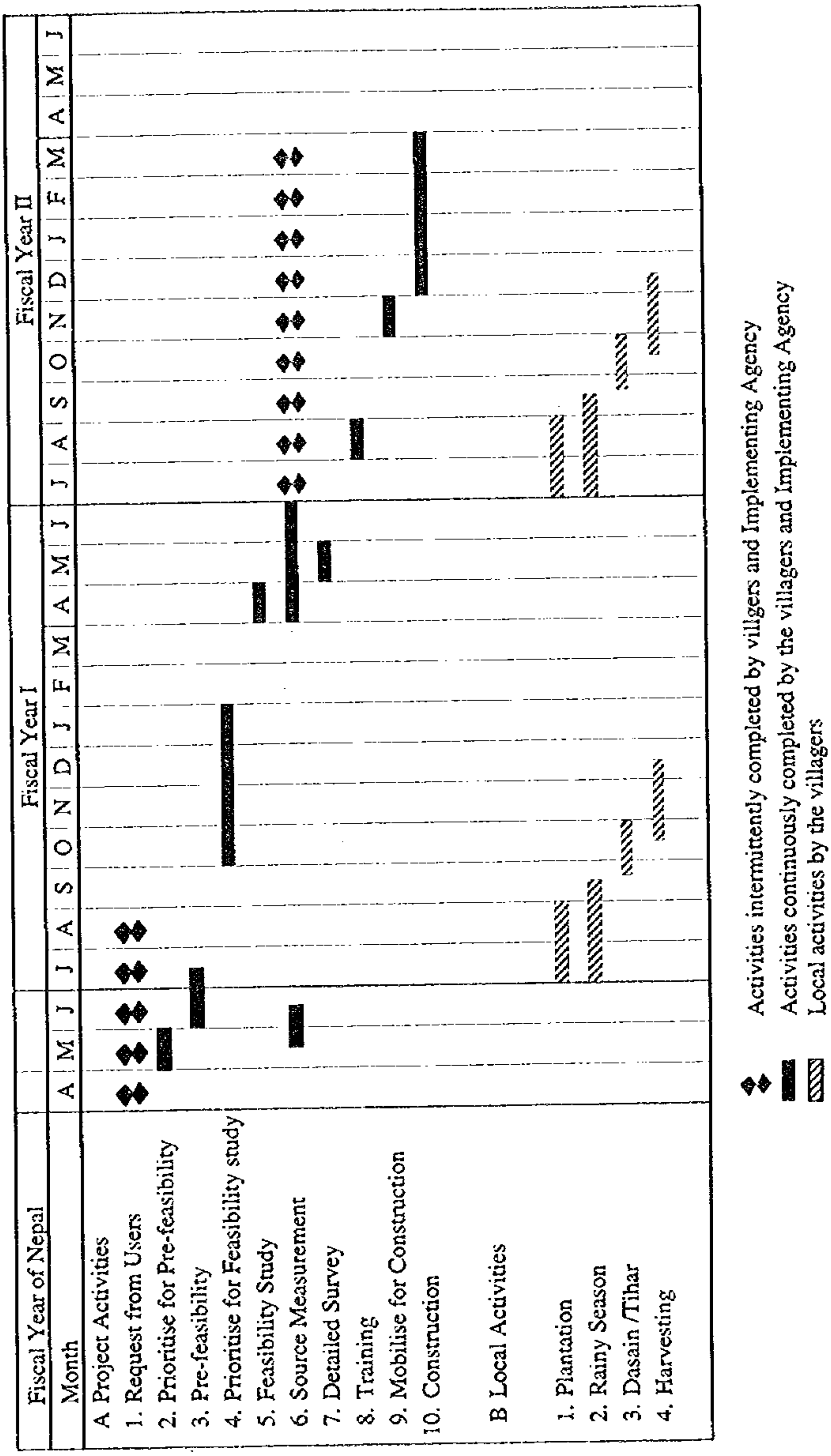

Fig. 1.1.2
Sequence of Activities and Implementation Schedule for the Rural Water Supply Network Development

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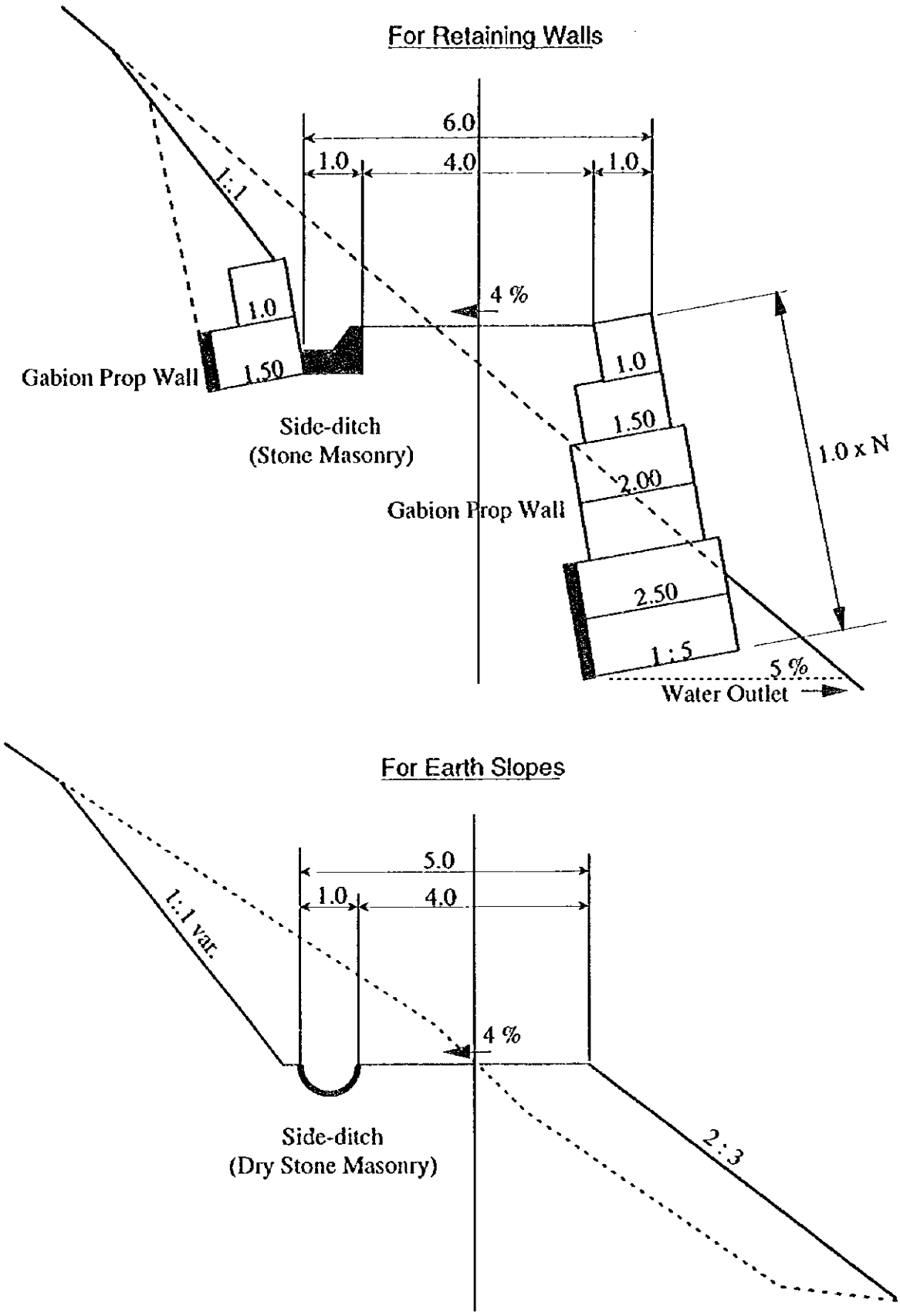

Fig. 1.2.1
Standard Cross Section of Road

Source: Road Construction in the Nepal Himalaya:
The Experience from The Lamosangu - Jiri Road Project.
ICIMOD, March 1987

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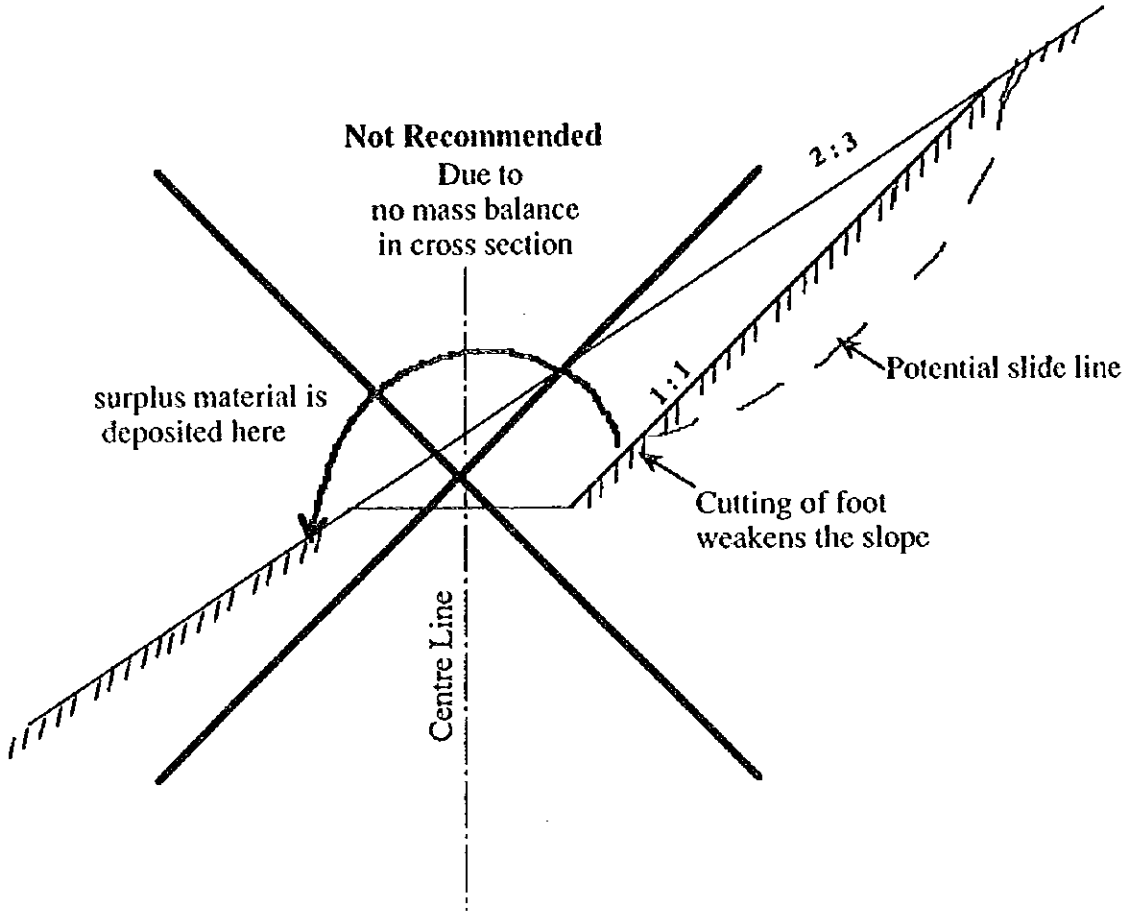

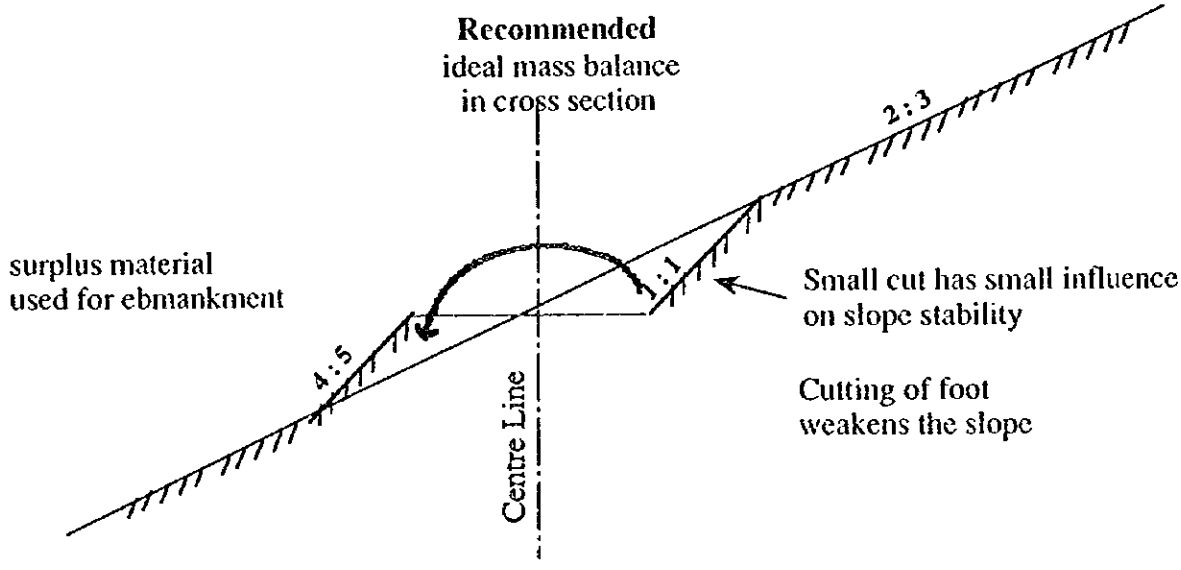

Fig. 1.2.2
Fixing of Centreline in Slope

Source: Road Construction in the Nepal Himalaya:
The Experience from The Lamosangu - Jiri Road Project.
ICIMOD, March 1987

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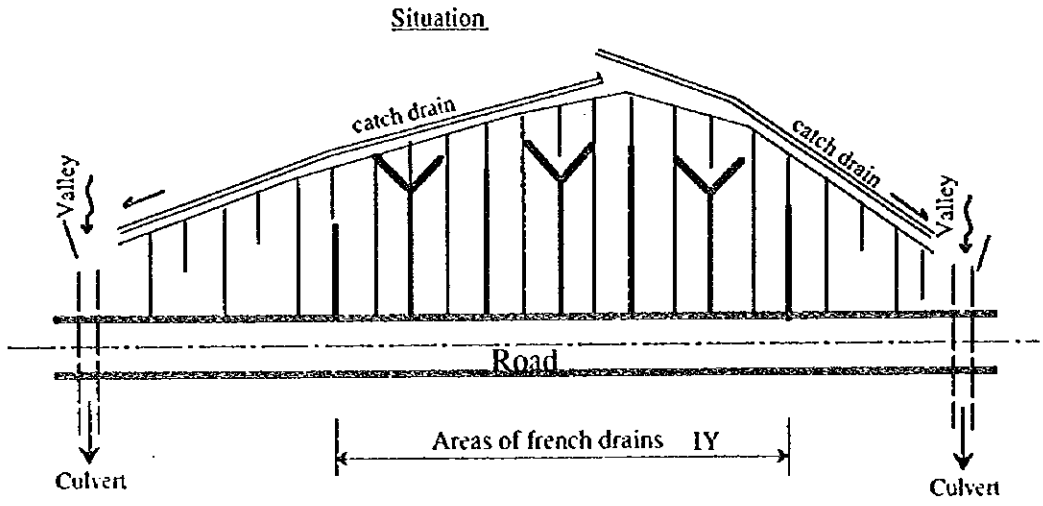
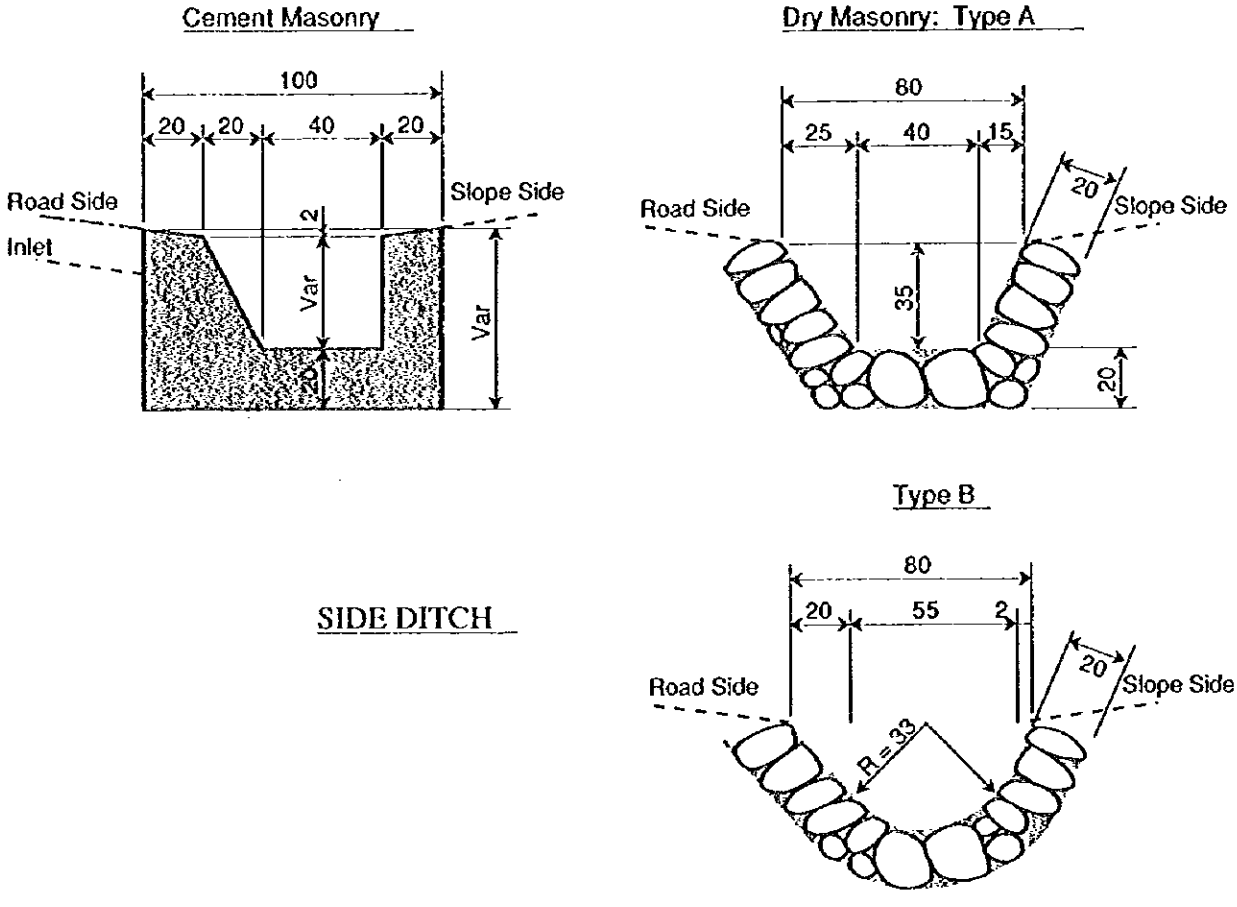


SLOPE DRAINAGE SYSTEM



SIDE DITCH

Fig. 1.2.3
Slope Drainage System and Standard Cross Section of Side Ditch

Source: Road Construction in the Nepal Himalaya: The Experience from The Lamosangu - Jiri Road Project. ICIMOD, March 1987

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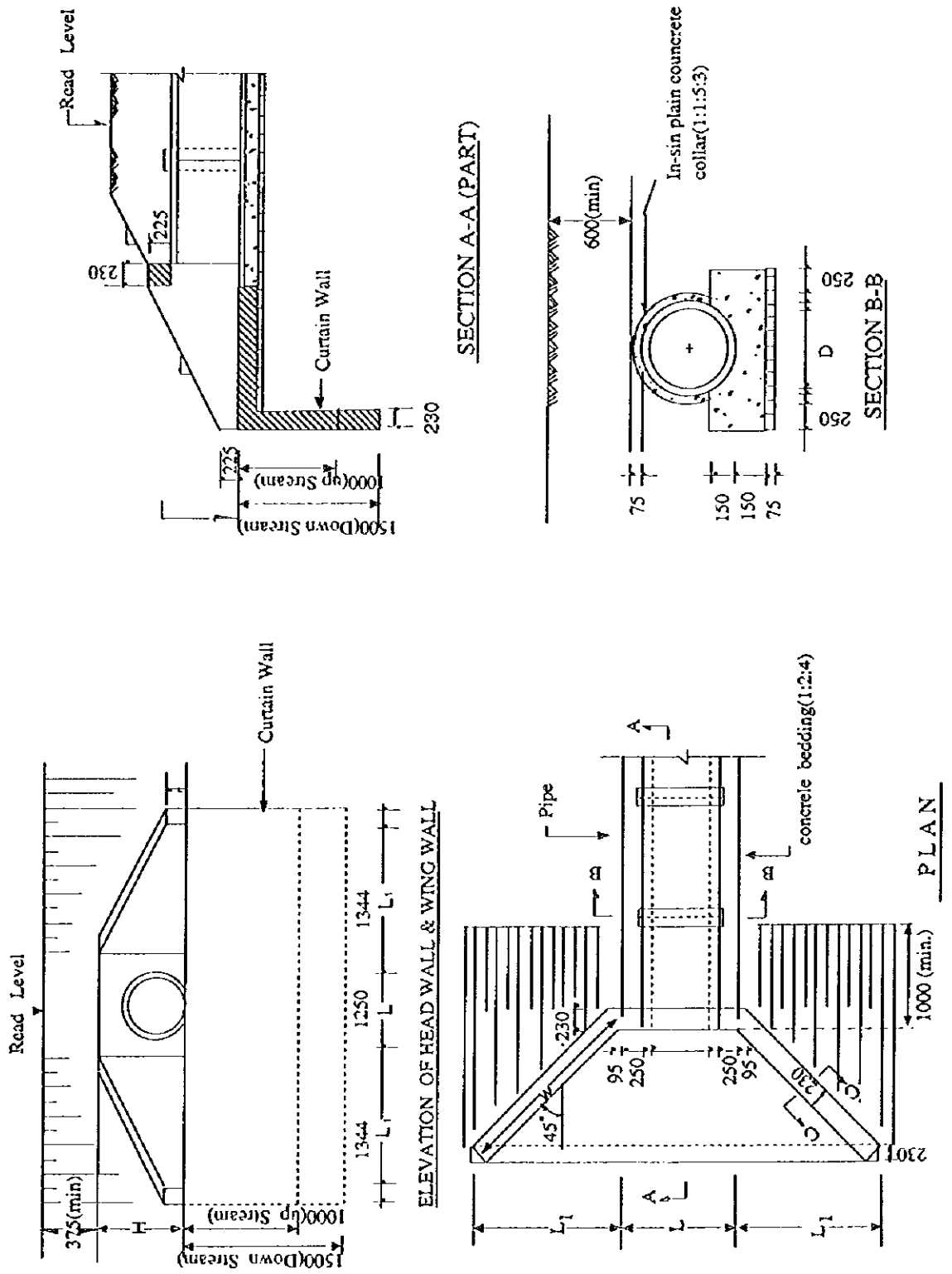

Fig. 1.2.4
Standard Design for Pipe Culvert

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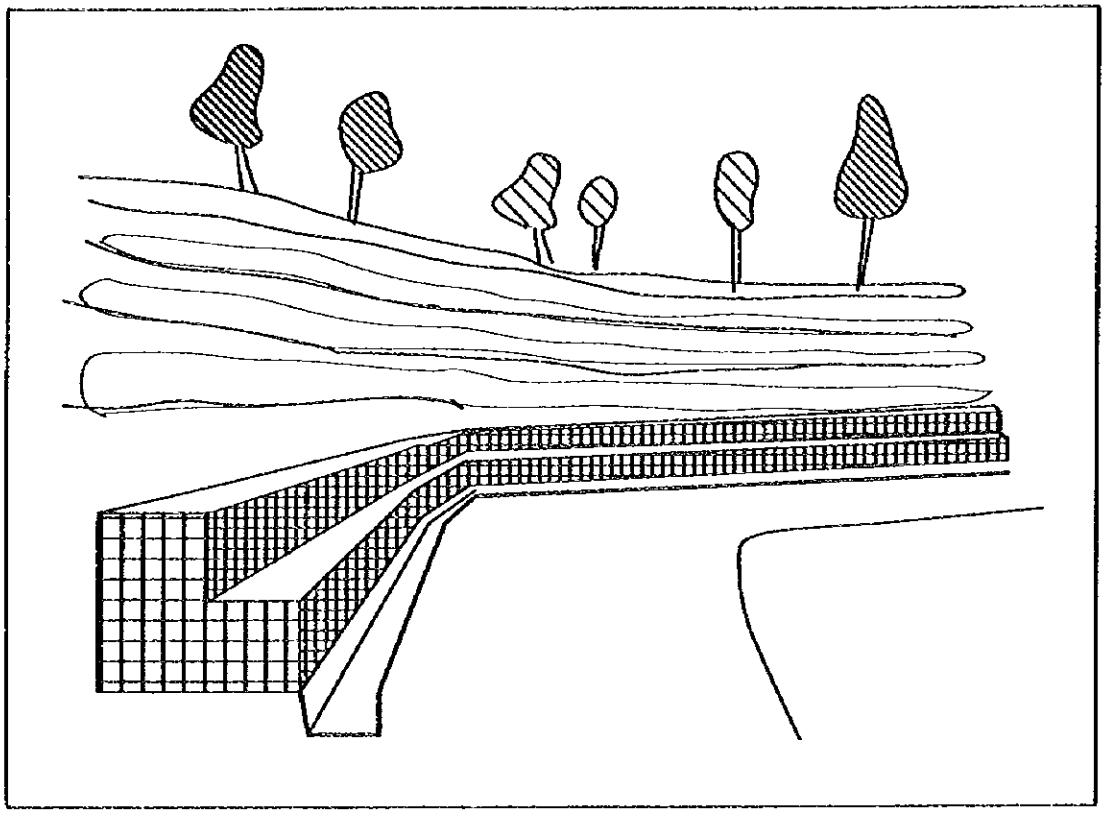

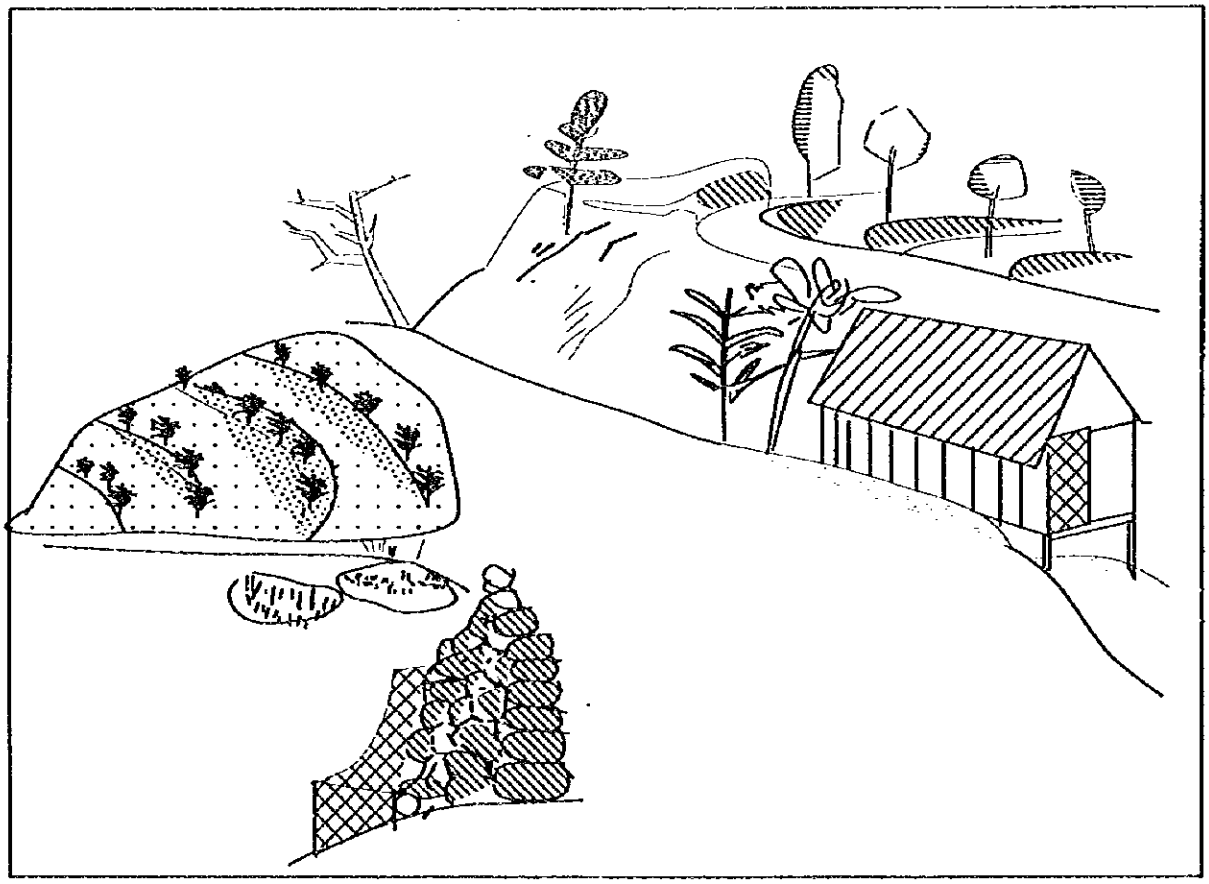

Fig. 1.2.5
Schematic Drawing of Slope Protection

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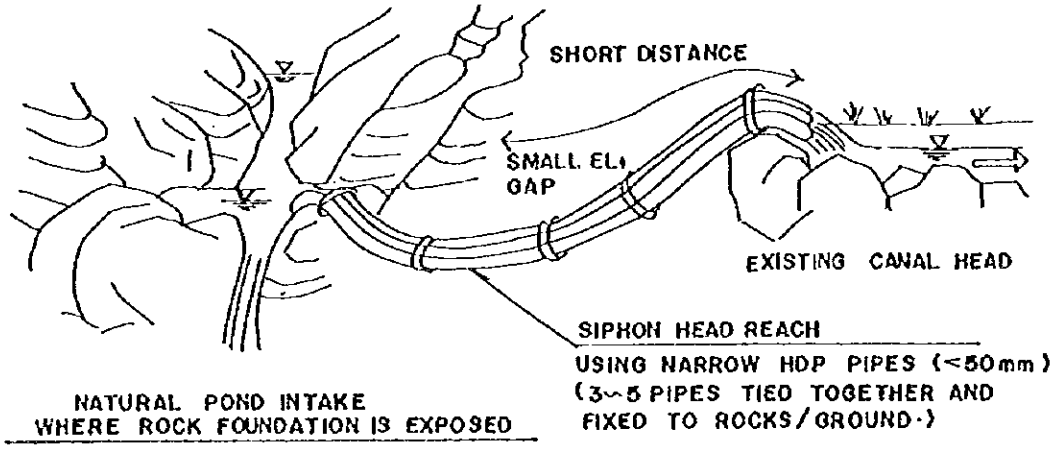

SYSTEM CAN BE ADOPTED WHERE A HEAD REACH WAS WASHED AWAY AND WHERE THE HYDRAULIC GRADIENT IS MAINTAINED BETWEEN INTAKE AND EXISTING CANAL HEAD

SHORT DISTANCE (<20.0m)
SMALL ELEVATION GAP (<1.0m)

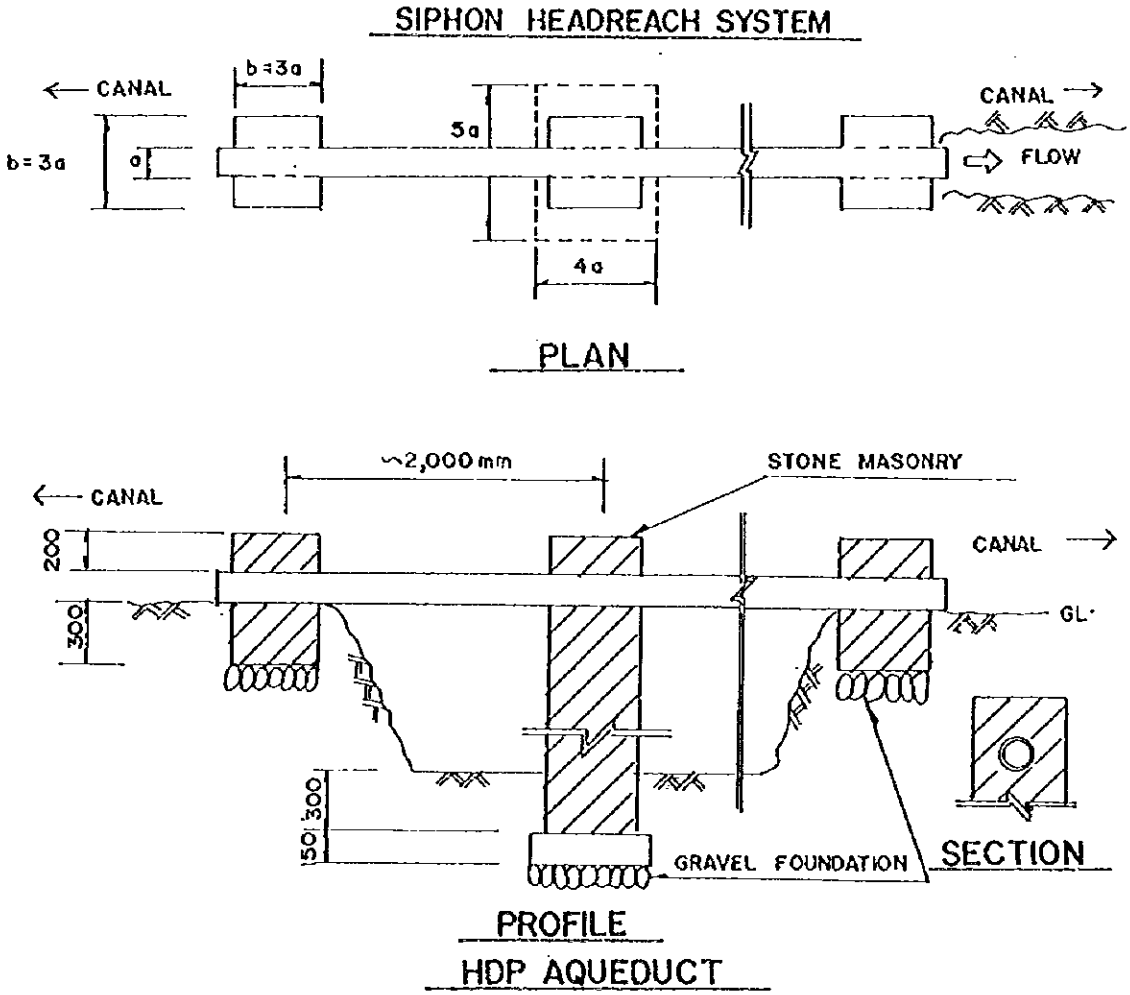

Fig. 1.3.1 Schematic Diagram for Siphon and Aqueduct with HDP Pipes

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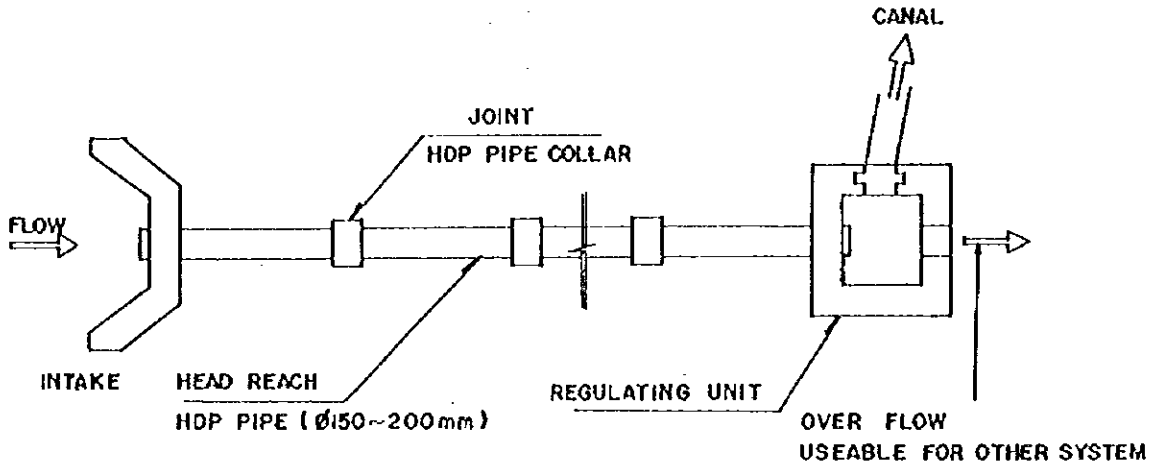
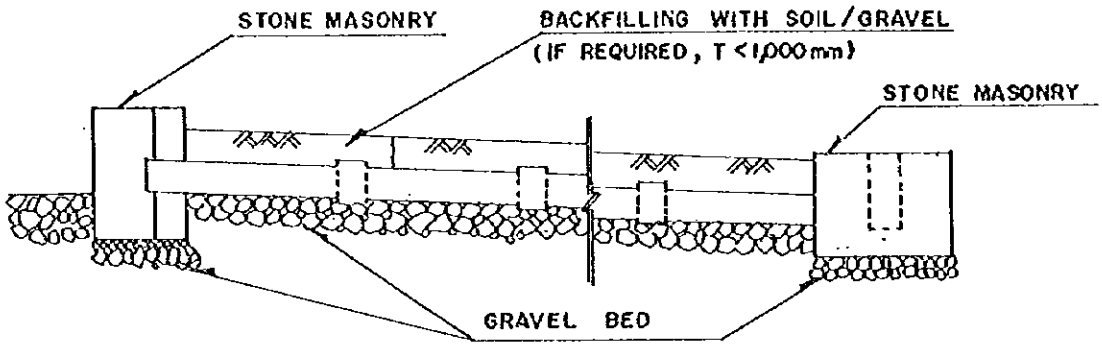


PLAN
NOT TO SCALE



PROFILE
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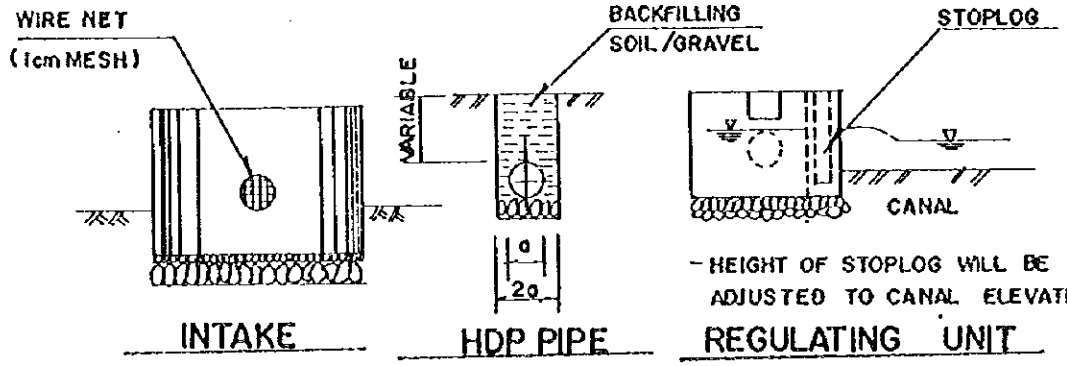

Fig. 1.3.2 Schematic Diagram for Intake & Headreach Using HDP in Fmis

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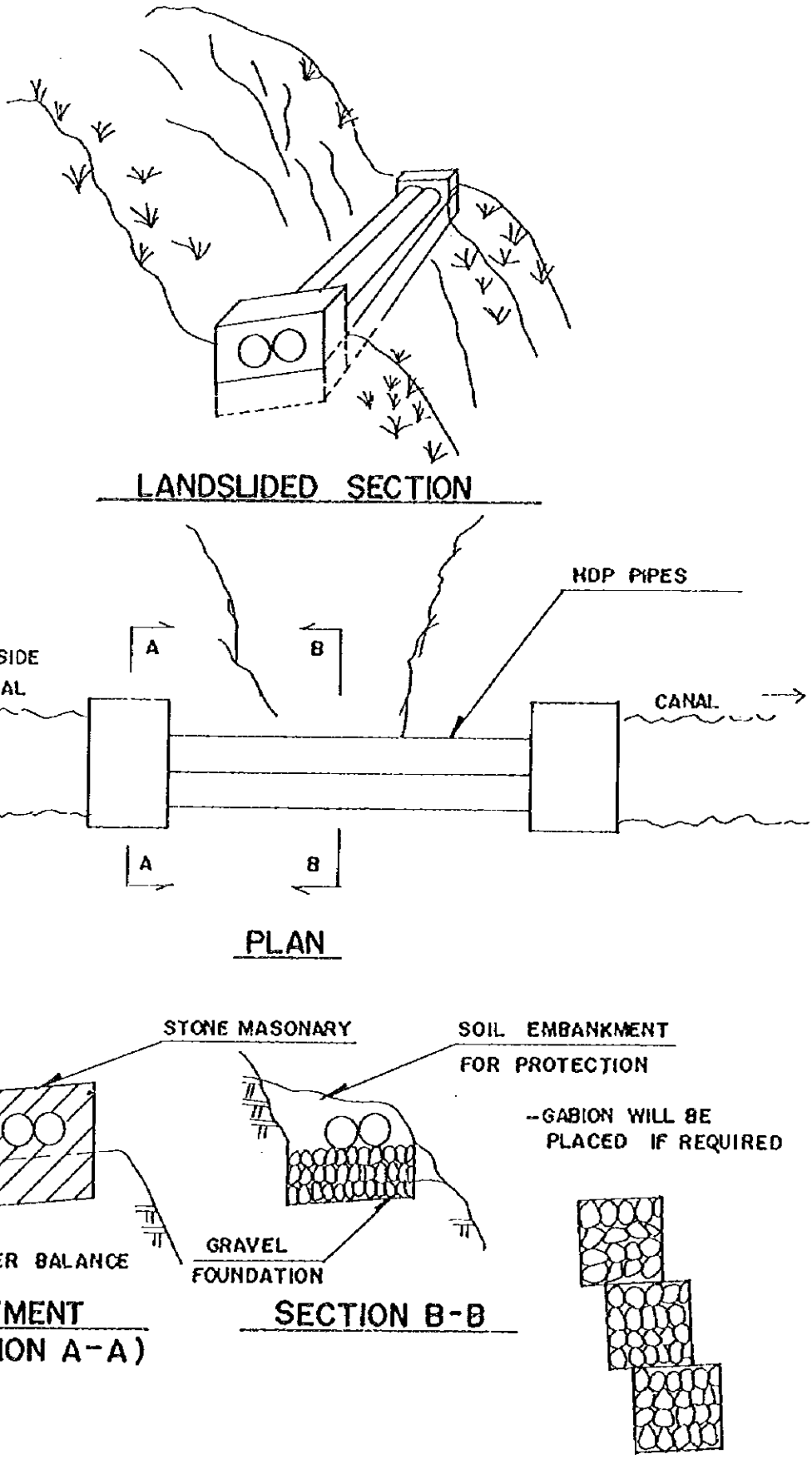

Fig. 1.3.3 Schematic Diagram for Recovery of Canal at Landslide Section

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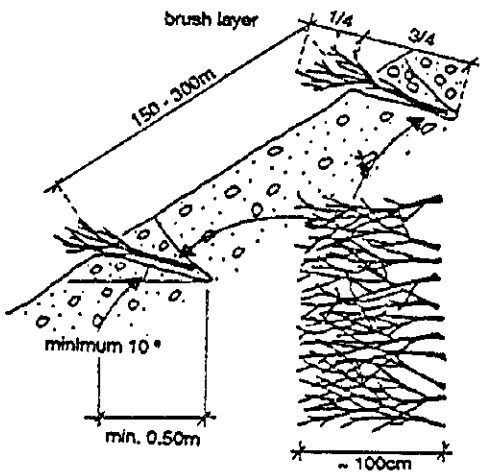
Fig. 1.3.4 Vegetative Measures (1/5)
: Brush Layer

Name:
Brush Layer

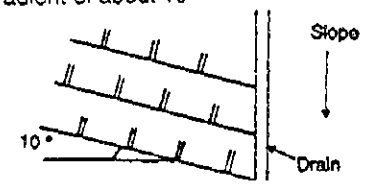
Sketch:



Function:
Instantaneous and effective stabilisation of steep slopes. Reinforced earth after construction, deep stabilisation after rooting. Very important deep stabilisation method for wet slopes or steep and rocky slopes.

Construction Steps:
1. Small terraces 0.5-1 m at an angle of 10 - 30° inclination, beginning at toe of slope.
2. Brush layer is placed cross-wise, one fourth of each branch should extend over the edge of the terrace.
3. The lower ditch is filled with material from the ditch above, etc.

Layout:
The brush layers should have an inclination towards the horizontal gradient of about 10°



Species:

Trees:

Phaledo	Golainchi
Lahare Pipal	Bainsh
Kavro	Khirro
Dabdabe	

Bushes:

Asuro	Sajiwan
Nilkanda	Simali
Siudi	Bihaya

Any other species recommended by farmers and concerned professionals

Construction Period:
During dormant season
Just before monsoon
(Jesth)

Material:
Branches of rooting plants/trees (about 20 pieces per metre with all side branches)

Remarks:

Source: Nepal SPWP Manual No.1; Environmental Protection Measures

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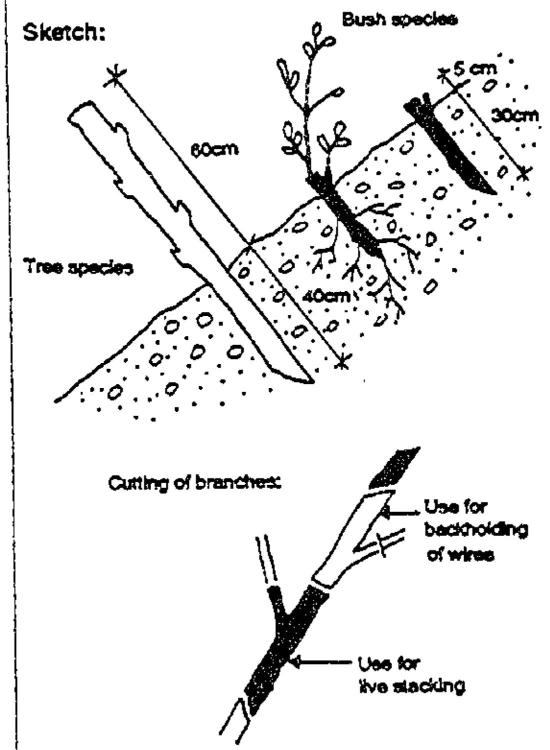
Name:
Live Stacking

Sketch:



Function:
A quick and effective measure of secure a vegetative cover.
Stabilisation of soil only after rooting of the plants

Construction Steps:
1. Prepare hole with iron bar (crow bar).
2. Plant cutting right side up as deep as possible.
3. Tamp the soil around the cutting. The cutting must be firm in the ground so that it cannot be readily moved or pulled out.

Species:

Trees:

Sisau	Golainchi
Phaledo	Bainsh
Lahare Pipal	Khirro
Kavro	
Dabdade	

Bushes:

Asuro	Sajiwan
Nilkanda	Simali
Siudi	Bihaya

Grasses:
Napier

Bamboos:

Any other species recommended by farmers and concerned professionals

Construction Period:

Tree species:	During dormant season Falgun, Chaitra Keep cuttings in moist place for two weeks
Bush species:	Before start of monsoon (Jesth)

Material:
- Long, straight stems of trees and brushes that root easily (approx lm/m²)
- Crow bar to prepare holes

Remarks:

Source: Nepal SPWP Manual No.1; Environmental Protection Measures

Fig. 1.3.4 Vegetative Measures (2/5)
: Live Stacking

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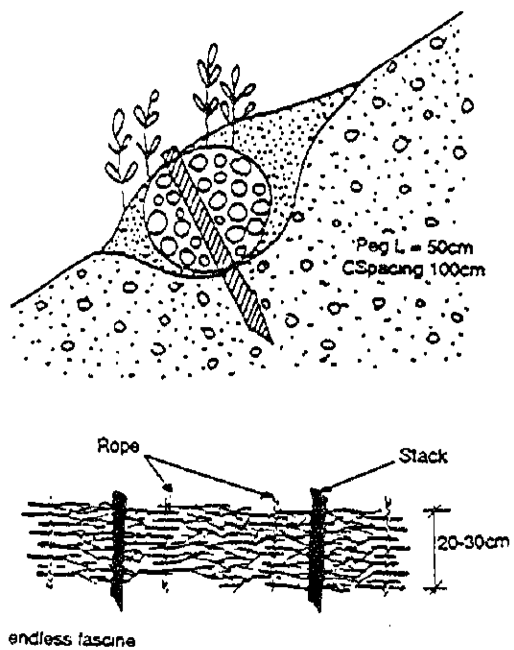
Name:
Brush Wattles (Slope Fascines)

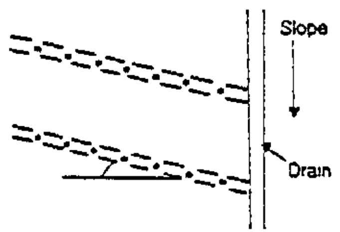
Sketch:



Function:
Stabilisation and drainage of backcuts and slides at surface.
Holds back sediments, also useful for bank protection.
Fast and simple protection. Establishes a microsite for other plants.

Construction Steps:
1. Excavation of small terrace 1/2 diameter of bundle.
2. Prepare endless bundles (fascines) and place it into terrace.
3. Add stake through bundle.
4. Cover wattle with soil, tamp firmly.

Layout:
Parallel rows at an angle of 10° towards the horizontal.



Species:

Bushes, Shrubs:

Asuro	Sajiwan
Nilkanda	Simali
Bihaya	

Live stacks for anchoring pegs

Phaledo	Dabdabe
Lahare Pipal	Golainchi
Kavro	Khirro

Construction Period:
During dormant season
Just be'ore Monsoon (Jesth)

Material:
- Cutting of long, straight and flexible plants which root easily with at least 5 branches for one bundle
- Wire to prepare bundle 1.5 - 2 mm
- Pegs (stakes) L = 50 cm, every metre dead or live stacks

Remarks:

Source: Nepal SPWP Manual No.1; Environmental Protection Measures

Fig. 1.3.4 Vegetative Measures (3/5)
: Brush Wattles

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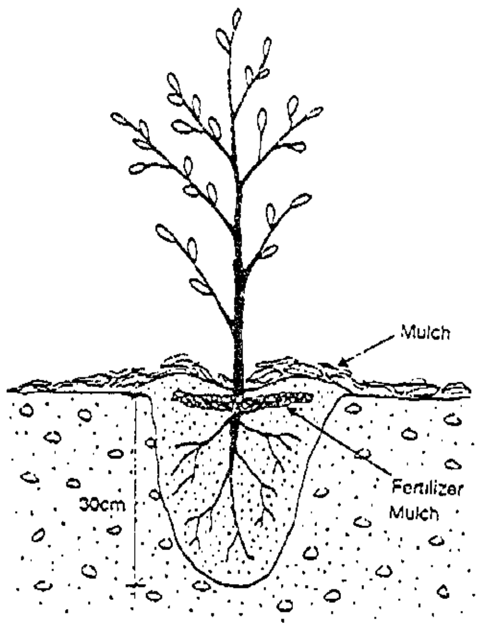
Name: Pioneer Plantation	**Function:** The mulching helps the plants to grow faster by regulating the moisture. Stabilises slope and and provides fuel, fodder, fruits.	**Species:**
Sketch:  	**Construction steps:** 1. Dig the pits 30 x 30 x 30 cm. 2. Remove plastic tube from seedling . 3. Plant seedling. 4. Cover with soil and mulch and tamp gently (Soil preferably topsoil or forest soil).	Tree Seedlings (From nursery give preference to farmers interest) *Fodder:* Badahar, Kutmero, Koiralo, Khanyu, etc *Fruits:* Citrus *Other:* Rittha, Tuni, Okhar, Sisau, Tea, Coffee, Alainchi
Construction period: At beginning of vegetation period (Asar - Shrawan)	**Material:** - 1-2 rooted plants per m² (from nursery) - Mulching material such as compost, chopped grass	**Remarks:**

Source: Nepal SPWP Manual No.1; Environmental Protection Measures

Fig. 1.3.4 Vegetative Measures (4/5)
: Pioneer Plantation

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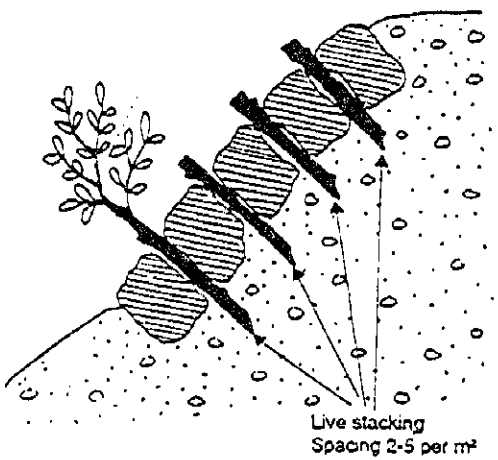
Fig. 1.3.4 Vegetative Measures (5/5)
: Vegetated Riprap

Name: Vegetated Dry Masonry Wall/Rip Rap	**Function:** Punctual and linear stabilisation of slopes and toe protection. Due to vegetation, dry masonry wall becomes more flexible, plants reinforce the fill behind the wall and help blending the wall into the surroundings. Good drainage through wall by the plants. Soft and hard stones can be used.	**Species:**
Sketch:  	**Construction Steps:** 1. Live staking or planting of rooted plants may be done during construction of masonry wall, if construction takes place in the proper season. 2. Fill the interstices with the available soil. 3. Cuttings should be long enough to reach into soil if a portion of the backfill consists of small rocks or gravel.	*Bushes, Shrubs:* Asuro Bihaya Nilkanda Sajiwan Siuli Simali Any other species recommended by farmers or concerned professionals
Construction Period: During dormant season Just before Monsoon (Baisakh, Jesth)	**Material:** - Stones, boulders for the dry masonry wall - Live stacking, long straight stems of brushes (no trees) that root easily	**Remarks:**

Source: Nepal SPWP Manual No.1; Environmental Protection Measures

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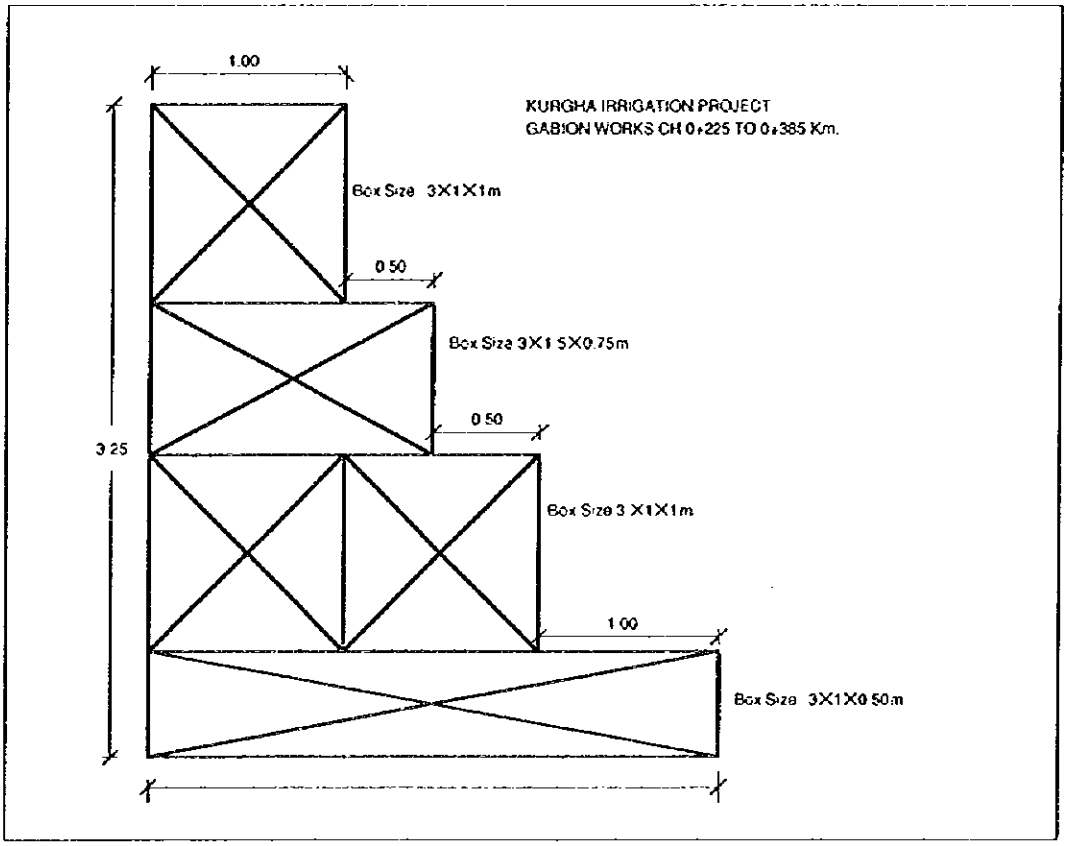

Fig. 1.3.5
Cross-section of Gabion Revetment Wall

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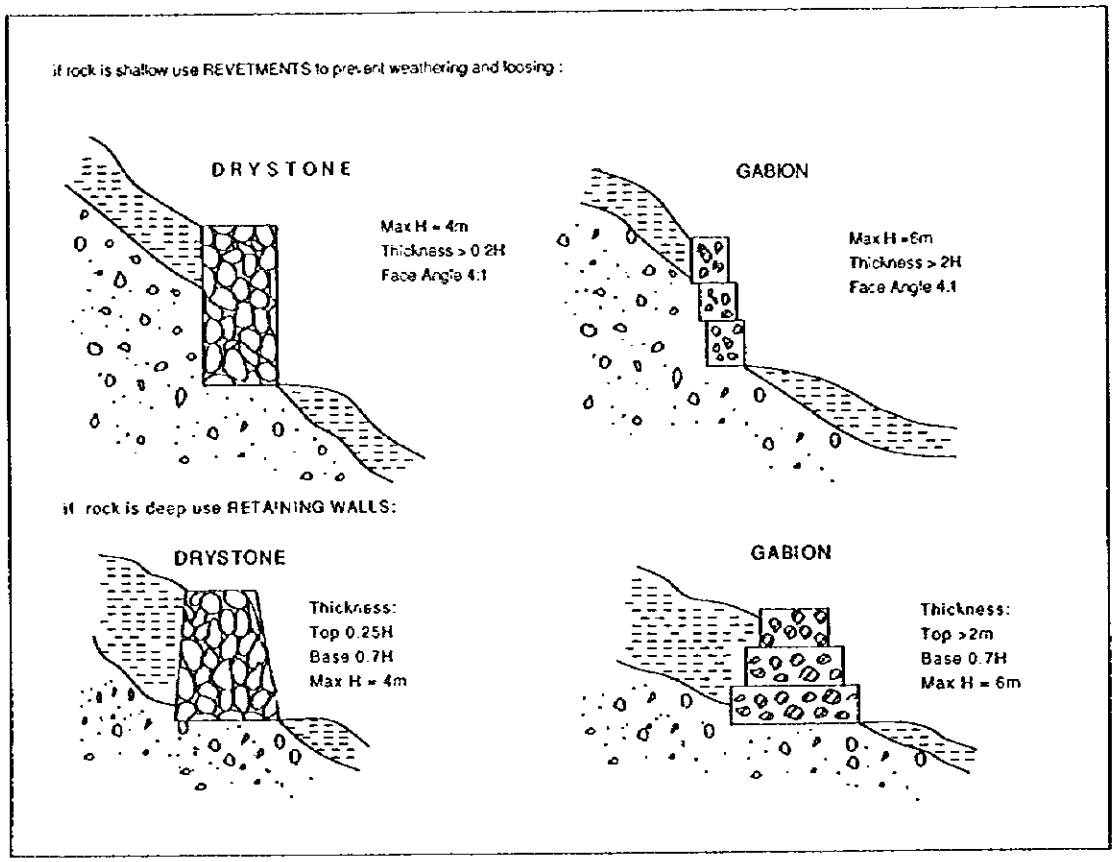

Fig. 1.3.6
General Design of Retaining Wall

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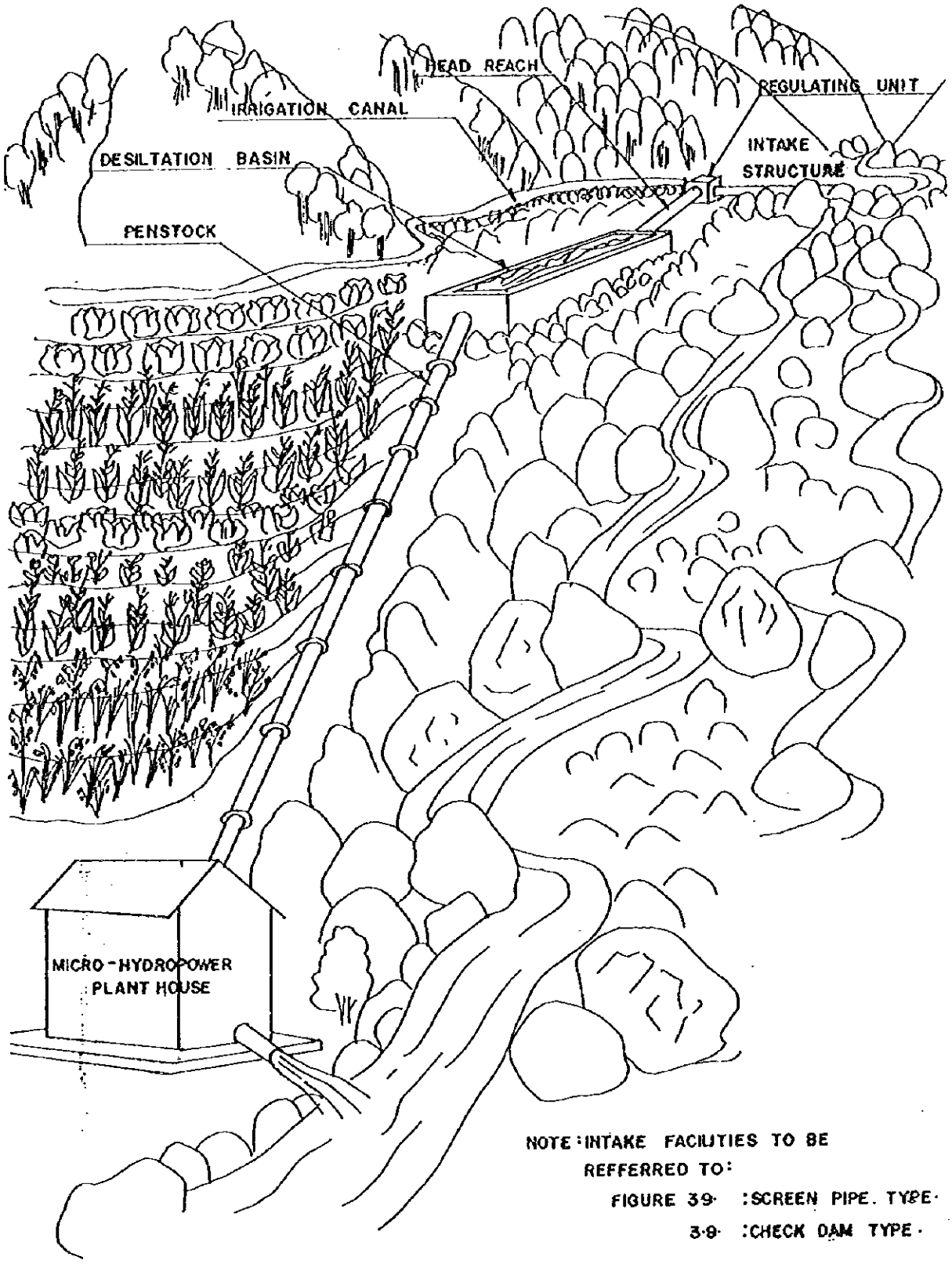

Fig. 1.4.1
Schematic Diagram for Micro-hydropower Plant

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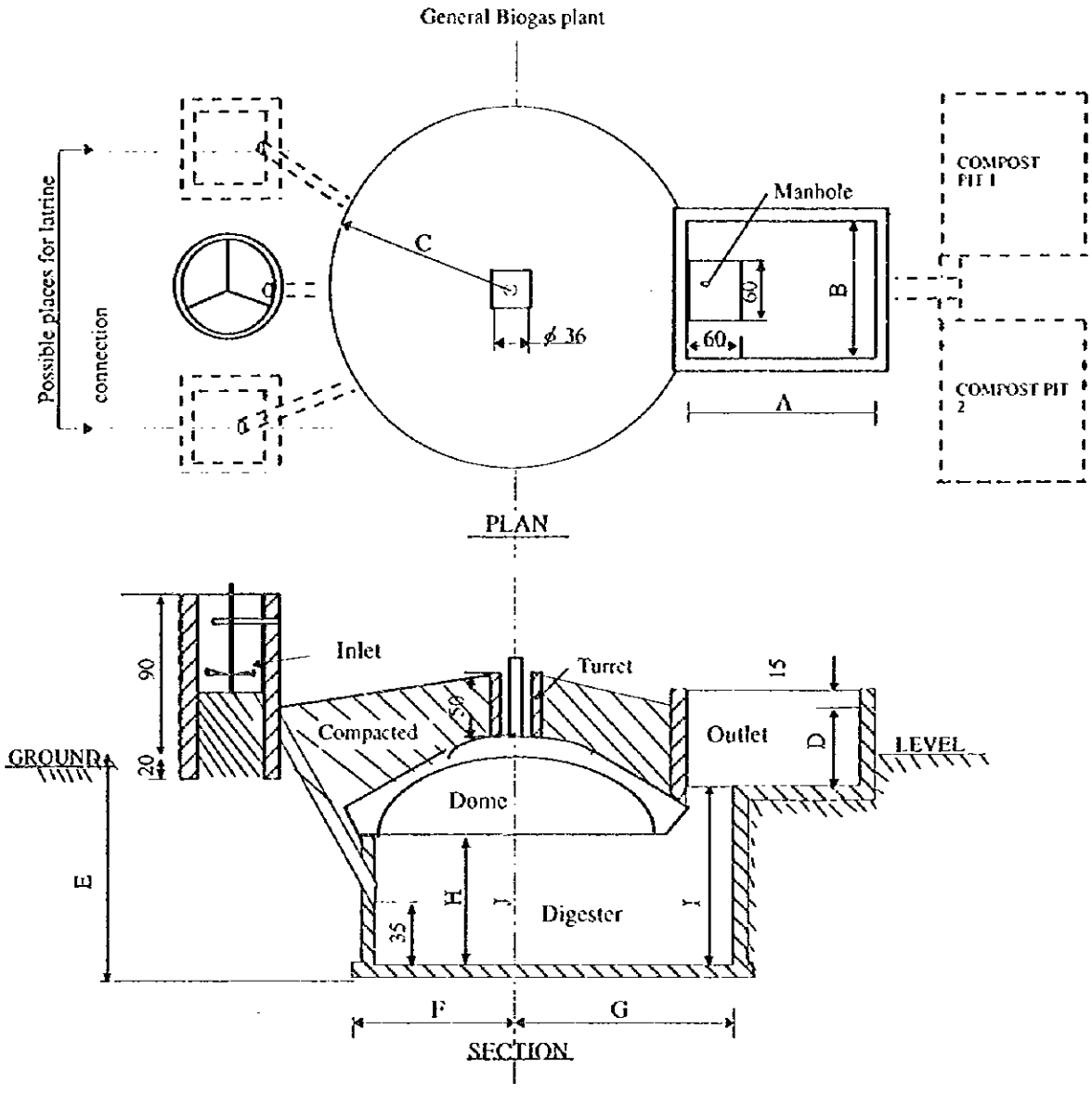

Dimension of Diffrent Component of Various Sized Plants

COMPONENTS	PLANT SIZE (m3)					
	4	6	8	10	15	20
A	140	150	170	180	248	264
B	120	120	130	125	125	176
C	135	151	170	183	205	233
D	50	60	65	68	84	86
E	154	155	172	168	180	203
F	102	122	135	154	175	199
G	195	211	230	243	265	293
H	86	92	105	94	115	115
I	112	116	127	124	132	137
J	151	160	175	171	193	203

Fig. 1.4.2.1
General Dimensions of Biogas Plant

Source: Construction Manual by Biogas Support Program (BSP), 1994

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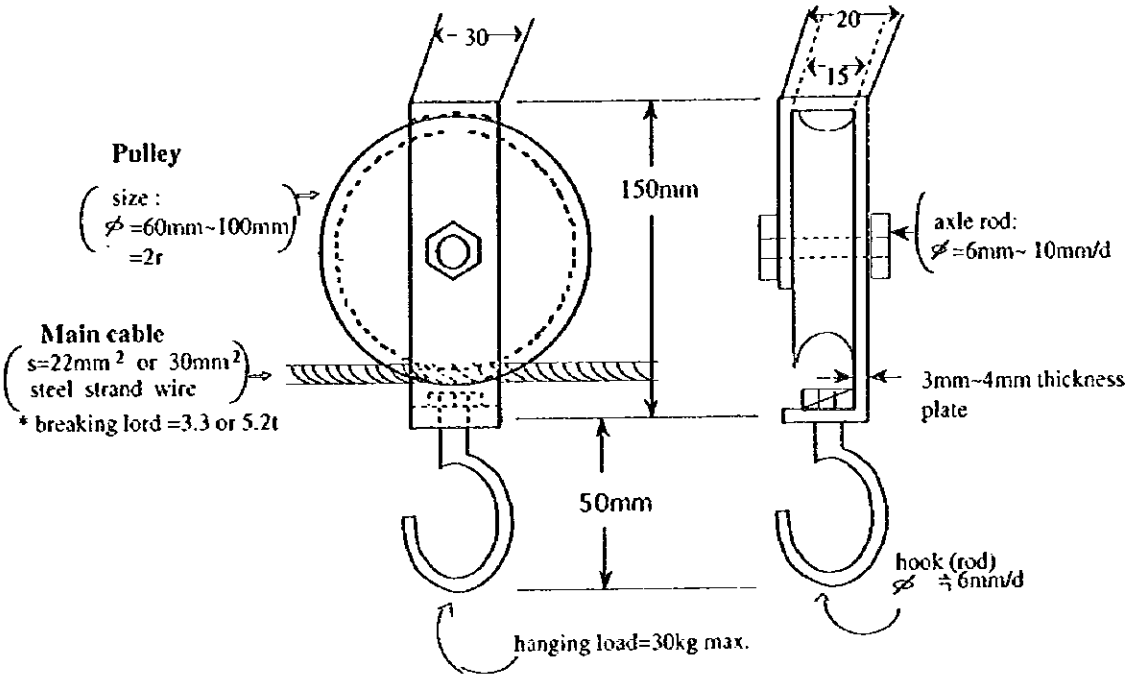

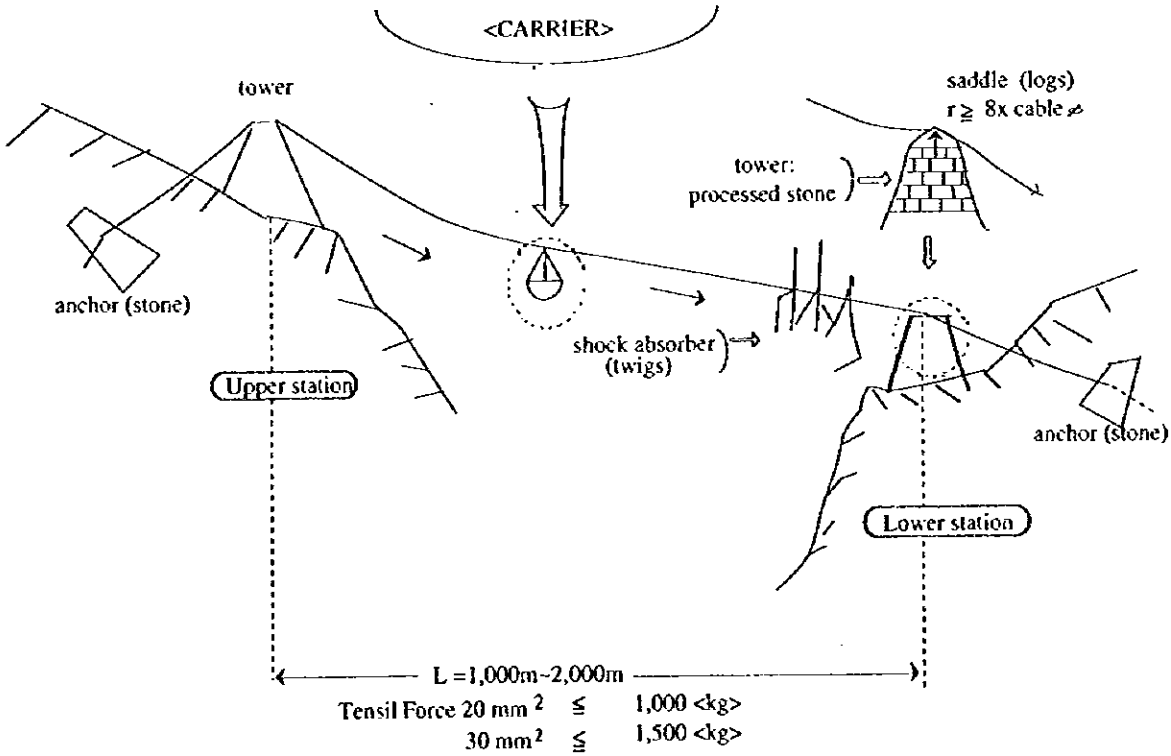

Fig. 1.4.3.1
Schematic Diagram for Ropeline

Source: Mr. T. Chino, Former JICA Expert

His Majesty's Government of Nepal
Ministry of Forest and Soil Conservation / Department of Soil Conservation
THE STUDY ON THE DISASTER PREVENTION PLAN FOR SEVERELY AFFECTED AREAS BY 1993 DISASTER IN THE CENTRAL DEVELOPMENT REGION OF NEPAL
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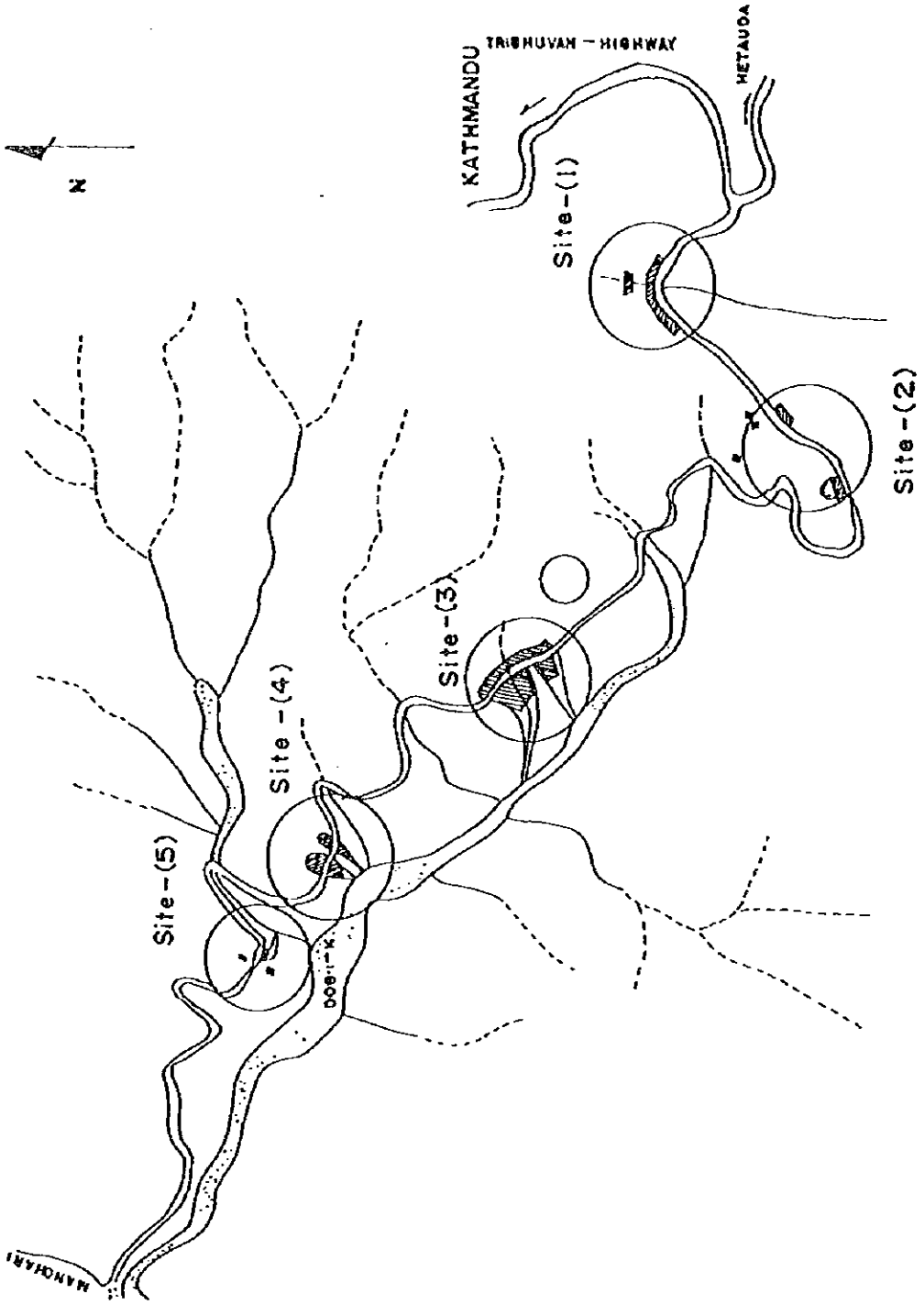

Fig. 2.1.1
General Layout for Rural Road in Namtar

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THE STUDY ON THE DISASTER PREVENTION PLAN FOR SEVERELY AFFECTED AREAS BY 1993 DISASTER IN THE CENTRAL DEVELOPMENT REGION OF NEPAL
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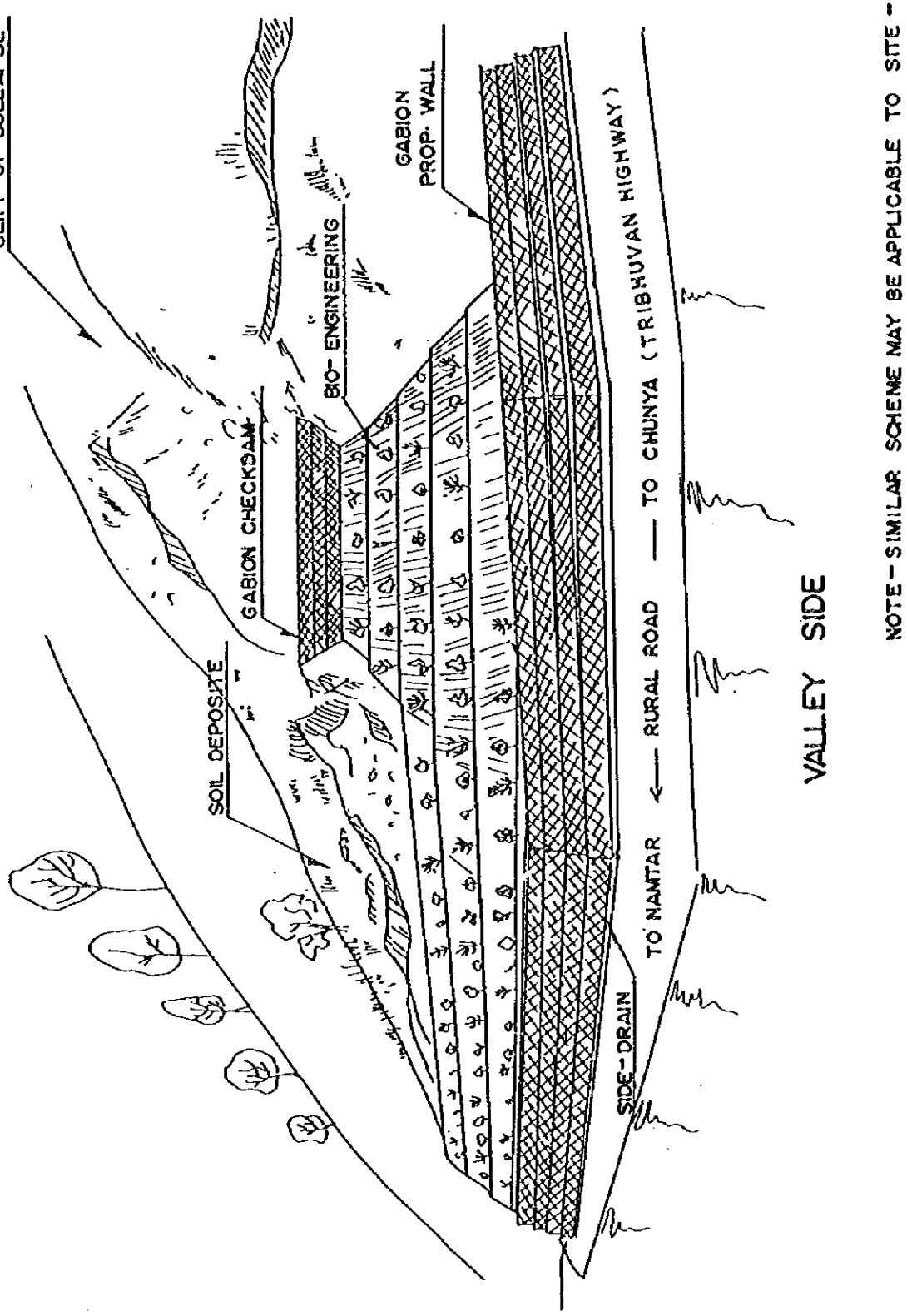

Fig. 2.1.2
Schematic Diagram for Hillside Protection with Gabion and Bio-Engineering

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THE STUDY ON THE DISASTER PREVENTION PLAN FOR SEVERELY AFFECTED AREAS BY 1993 DISASTER IN THE CENTRAL DEVELOPMENT REGION OF NEPAL
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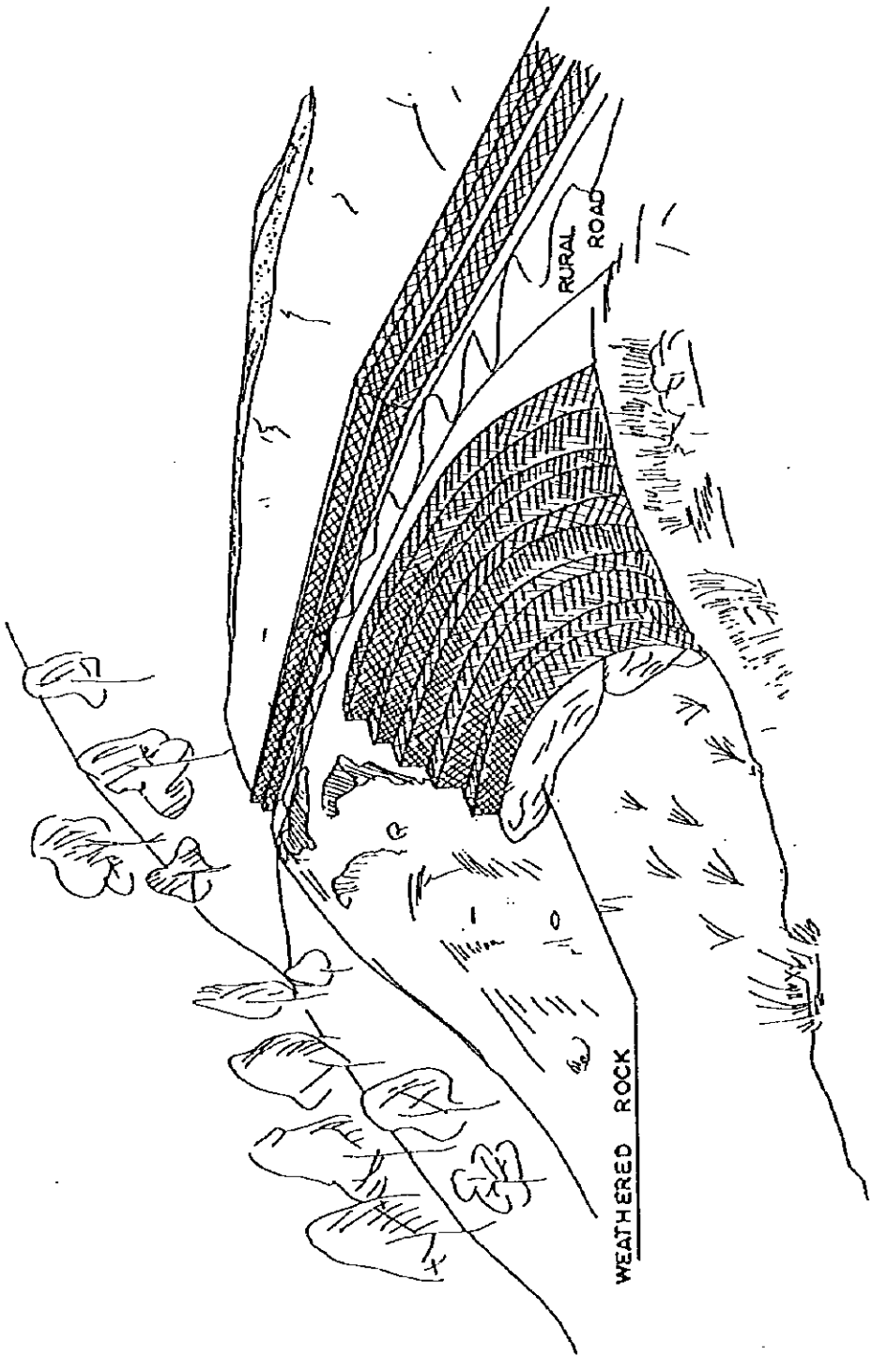

Note : Similar scheme may be applicable for Site-2, 3

Fig. 2.1.3
Schematic Diagram for Valley Side Protection with Gabion

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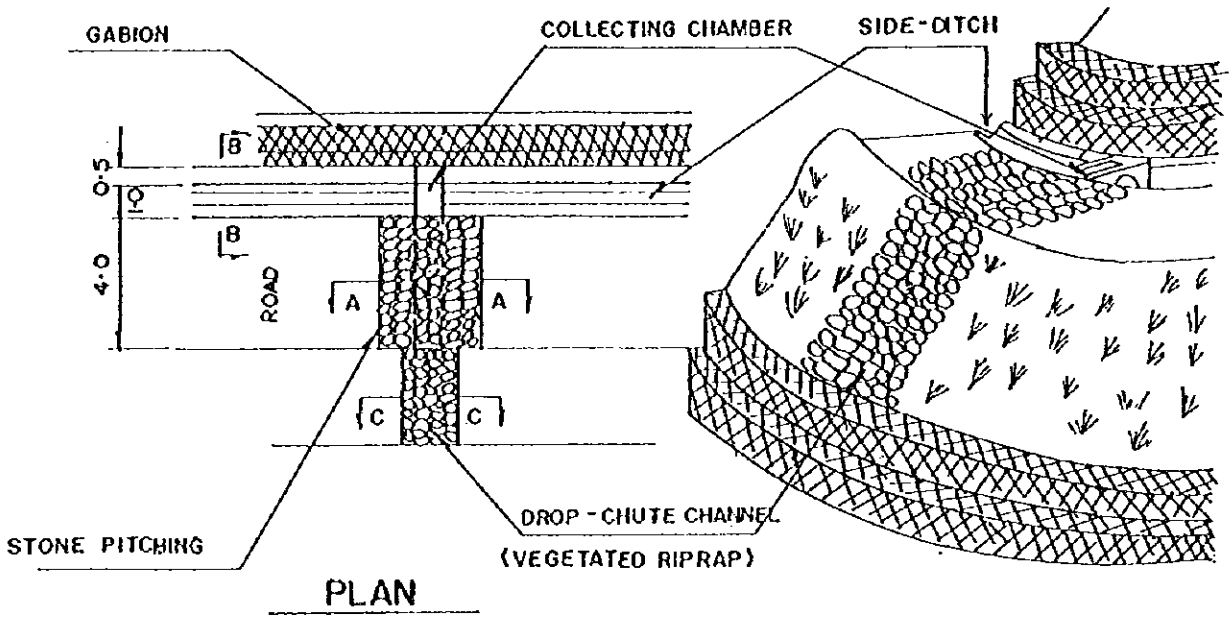
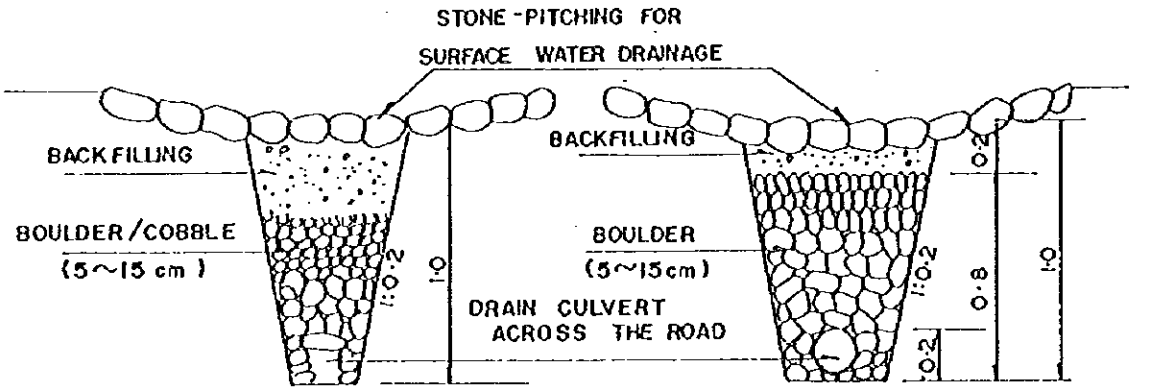


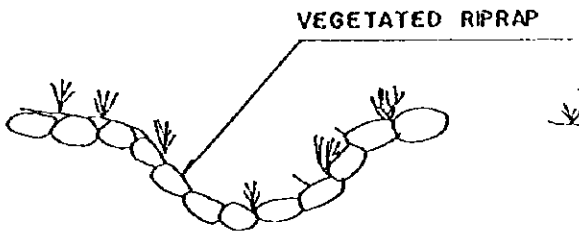
PLAN



FRENCH (RUBBLE) DRAIN

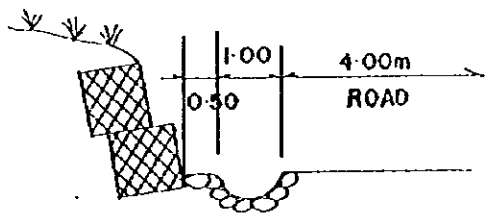
DRAIN PIPE CULVERT

SECTION A-A



DROP-CHUTE

SECTION C-C



GABION AND SIDE-DITCH

SECTION B-B

NOTE : SCHEMATIC APPLICABLE TO ALL SITE ESPECIALLY Site-(4),(5)

Fig. 2.1.4
Schematic Diagram for Road Surface Drainage System

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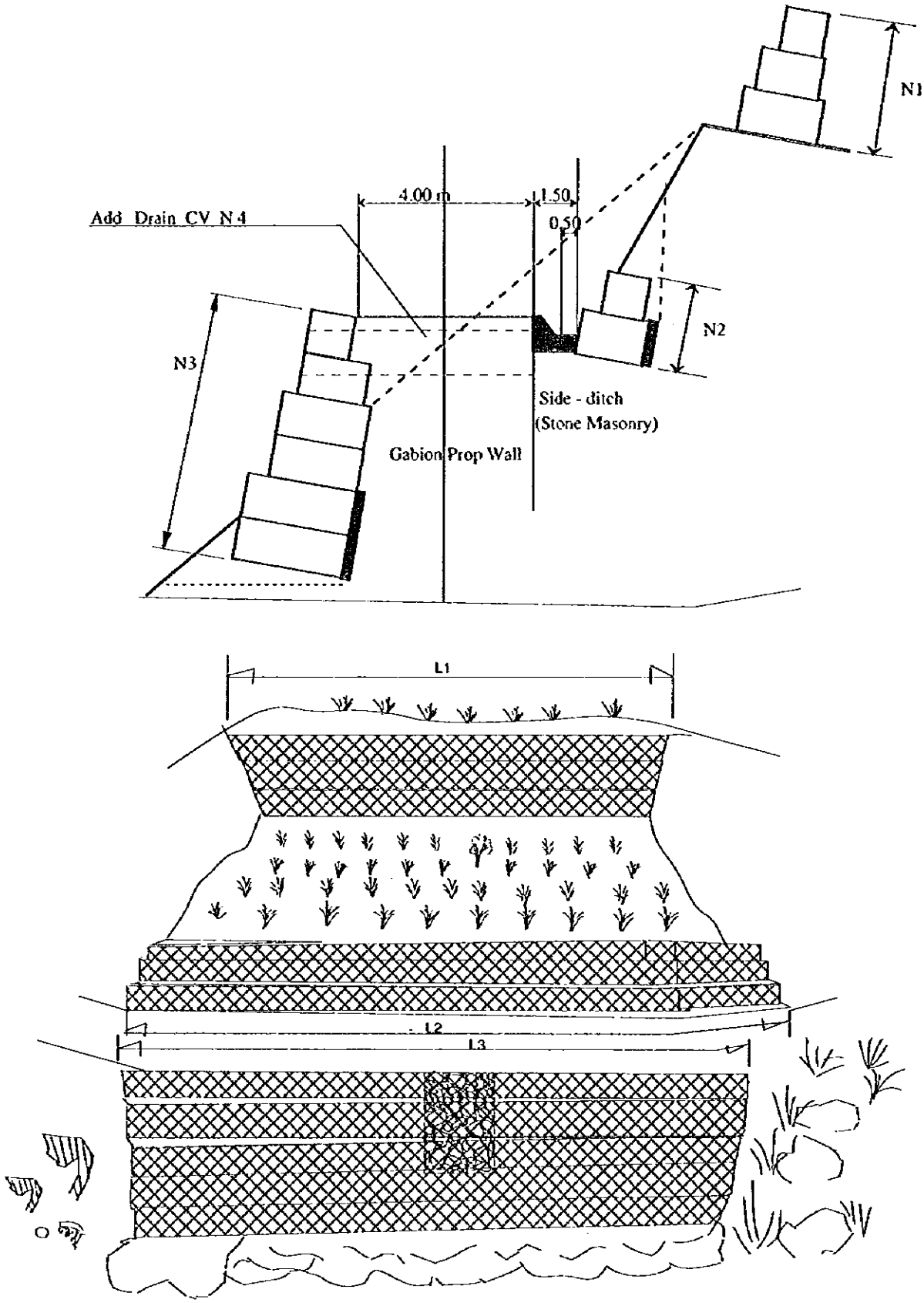

NOTE: N1 - N3 in nos.
L1 - L3 metres.

Fig. 2.1.5
Schematic Diagram for Typical Protection Formation

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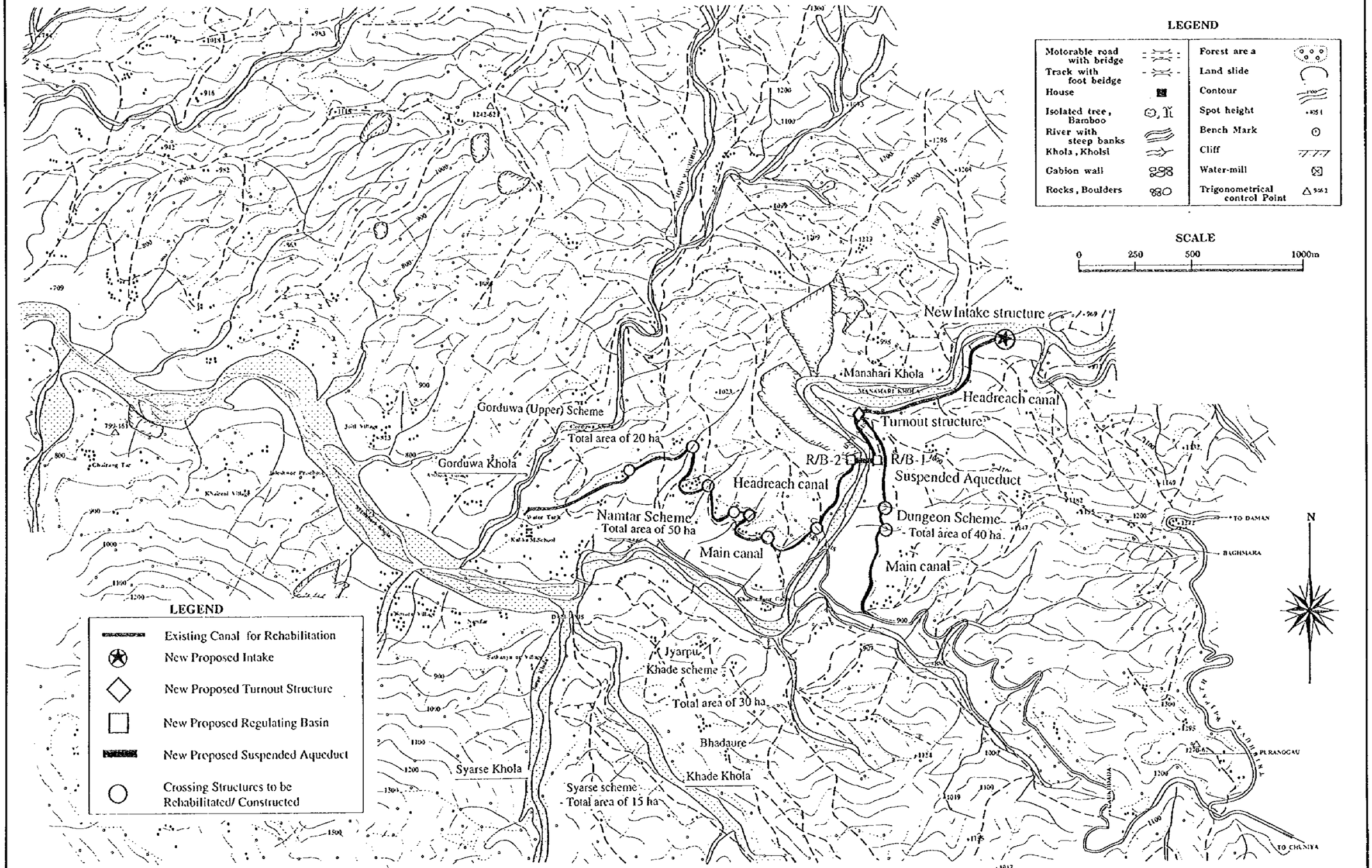

Fig. 2.2.1
Rehabilitation Plan for Namtar Irrigation Project in Namtar/Tilar Area

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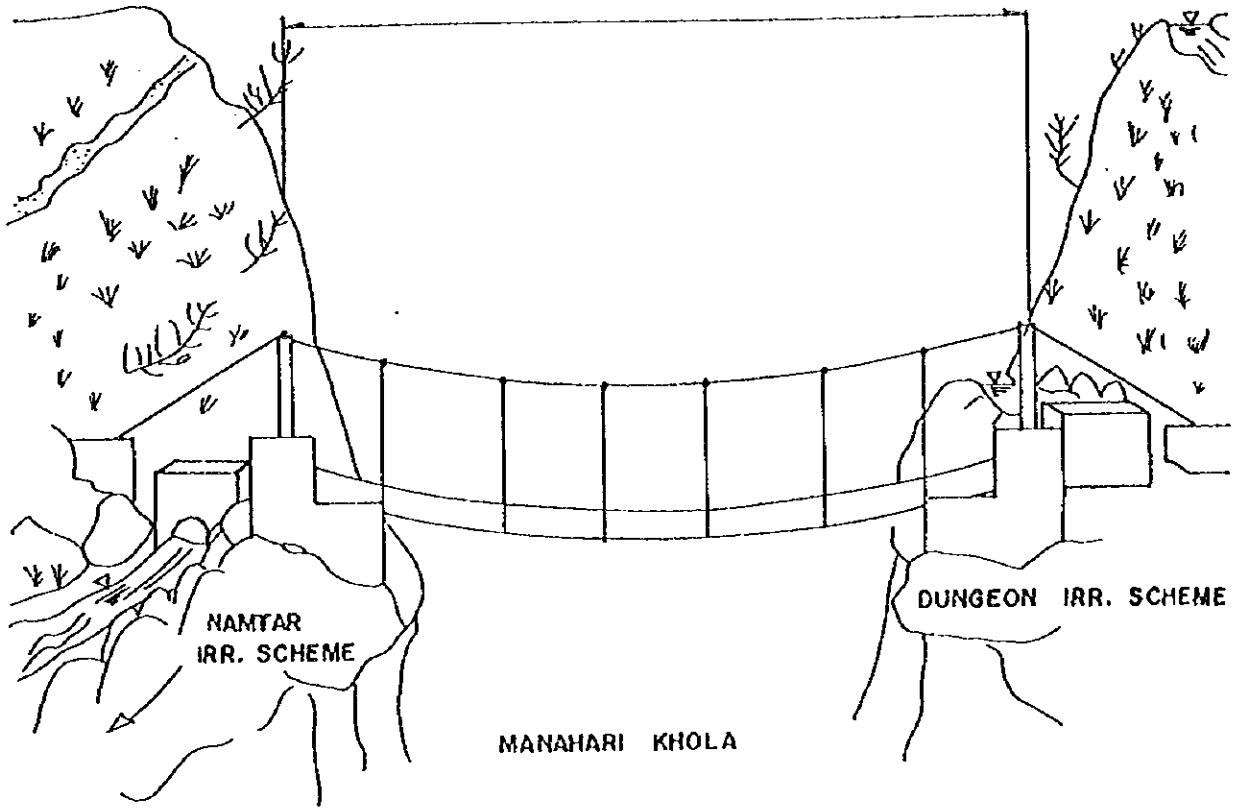
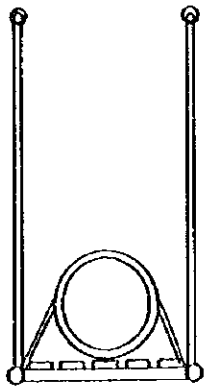


PROFILE
NOT TO SCALE



SECTION
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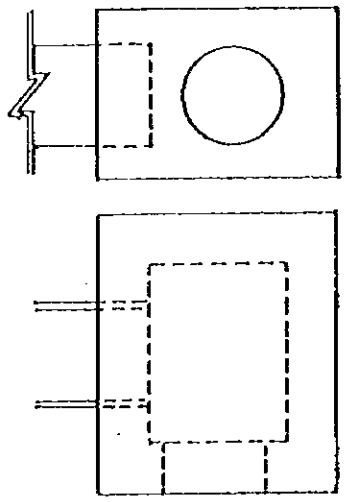

COLLECTION CHAMBER
NOT TO SCALE

Fig. 2.2.2
Schematic Diagram for Suspension Aqueduct

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