Crop	Without Project				With Project				Incremental	
	Area (ha)	% of CCA	Yield (ton)	Total Gross Margin (1,000 Rs.)	Area (ha)	% of CCA	Yield (ton)	Total Gross Margin (1,000 Rs.)	Yield (ton)	Total Gross Margin (1,000 Rs.)
Paddy	166	45	332	1,904	221	60	663	5,156	331	3,252
Maize	166	45	116	699	147	40	294	2,470	178	1,771
Wheat	-	-		-	221	60	486	5,972	486	5,972
Total	332	-	448	2,603	589		1,443	13,598	995	10,995

6.3.5 Project Cost

The total project cost consists of construction cost, replacement cost of pump facilities, O/M cost and electric charges of pump operation. The O/M cost is estimated at three percent of direct construction cost. The electric charges of pump operation per annum are Rs. 3,723 thousand. The breakdown of construction cost is as follows :

Work item	Cost (unit : thousand Rs)
Diversion facilities	4,000
Pump and mechanical equipment	19,000
Electrical equipment	4,000
Transmission line	11,000
Irrigation facilities	6,000
Total	44,000

6.3.6 Project Evaluation

The project was evaluated in economic viability. Conditions given for the economic evaluation are as follows:

(a) Construction costs are disbursed into three years;
20 %, 10 %, 70 %.
Pumping equipment is assummed to be installed in the third year.

(b) Production benefits increase following the completion of construction as follows;
4th year to 7th year : 50 %,70 %, 90 %, 100 %.

(c) Economic cost is 85 % of total construction cost.

(d) O/M cost is 3 % of direct construction cost.

(e) Electrical charge is Rs. 3,723 thousand per annum.

Based on the foregoing costs and the benefits, economic internal rate of return (EIRR) was estimated at 7.3 % for the project life of 30 years.

6.4 Garjyangkot Irrigation Scheme

6.4.1 Project Description

The project is located in Garjyandkot village, Jumla district, in the Mid Western Development Region as shown in Figure 6.4.1. The command area extends on the northern slope of hills lying on the right bank of the Tila River. A feasibility study of the scheme was carried out in 1986 under the Feasibility Study Project, DOI, indicating main features of a 5.8 km long canal and a net command area of 200 ha.

6.4.2 Present Condition

The District Irrigation Office of Jumla has already started canal construction. A 3.8 km long canal has been excavated, of which about 350 m near the intake is lined. Due to budgetary constraints, the works have not proceeded further. However, local people made a temporary intake at a new site 200 m downstream of the original site. People have placed a half hollowed tree trunk in the stream to introduce water into the canal in May and June. About 100 m from the intake, the canal runs through landslide-prone hill.

6.4.3 Water Sources

The water source for the scheme is the Talpunerd Khola or called Dudeli Khola. The stream originating from the hills with snowfall has a catchment area of about 16 km^2 at the intake site about 500 m upstream of the confluence with the Tila River. The minimum flow recorded in winter, which is about 800 l/sec, increases with snow melt staring in March and reaches a peak during the monsoon season. Water available in the stream meets the irrigation demand.

6.4.4 Cropping Pattern

Single cropping is applied at present due to unavailability of water and climatic conditions. Paddy is grown in about 40 ha of land with limited irrigation. Seeds are sown in nursery beds in early June and saplings are planted after one month. The harvesting of paddy is done in November/December. Wheat is another major crop grown in the area. The seeds are sowed during December/January. After the snow melts, the wheat stalks come up and harvest is in May/June. The case is similar for barley and millet. A stretch of land near the intake site cited in the feasibility report as command area is used now as grazing land. Apples and apricots are planted in a small orchard.

The following cropping pattern has been proposed in the command area to make maximum utilization of available water:

NCA = 200 ha

Crop	Area Planned (ha)	% of total cropped area	Growing Season
Paddy	200	50	May to Oct and Jun to Nov
Wheat	80	20	Jan to May
Barley	60	15	Jan to May
Potato	60	15	Jan to June
Total	400	100	
Cropping intensity (200 %)			

6.4.5 Benefits

Incremental gross margin of with and without project at economic price in 1993 was calculated. The project will result in the incremental gross margin of Rs. 6.0 million and gross production of 932 tons per annum. Individual incremental gross margin of crops per annum is as follows:

	Without Project				With Project				Incremental	
Crop	Area (ha)	% of CCA	Yield (ton)	Total Gross Margin (1,000 Rs.)	Area (ha)	% of CCA	Yield (ton)	Total Gross Margin (1,000 Rs.)	Yield (ton)	Total Gross Margin (1,000 Rs.)
Paddy	40	20	80	459	200	100	600	3,893	520	3,434
Wheat	80	40	88	741	80	40	176	1,969	88	1,228
Barley	60	30	60	149	60	30	90	227	30	78
Millet	60	30	66	176	-	-	-	-	-66	-176
Potato	-	-	-	-	60	30	360	1,436	360	1,436
Total	240	-	294	1,524	400			7,525	932	6,000

6.4.6 Project Cost

The scheme consists of a weir type structure at Talpunera Khola. The total length of the canal is 5.8 km, of which 400m is the idle length. At present the first 3.8 km long portion of the canal has been excavated. The summary of cost estimate is as follows:

Work items	Cost (thousand Rs.)
Intake	7,400
Drop structures	3,000
Cross draining works	400
Outlets	650
Escape	100
Canal works (L =5.8 km)	8,400
Irrigation Facility	3,000
Land acquisition	400
Miscellaneous cost of 5 %	1,000
Contingency of 10 %	2,100
Total	26,450

6.4.7 Project Evaluation

The project was evaluated in economic viability. Conditions given for the economic evaluation are as follows:

(1) Construction costs are disbursed into three years;
30 %, 40 %,30 %.

(2) Production benefits increase following the completion of construction as follows;
4th year to 7th year : 50 %,70 %, 90 %, 100 %.

(3) Economic cost is 85 % of total construction cost.

(4) O/M cost is 3 % of direct construction cost.

Based on the foregoing costs and the benefits, economic internal rate of return (EIRR) was estimated at 14.7 % for the project life of 30 years. It is noted that the construction cost for the existing 3.8 km long canal is treated as sunk cost in the economic evaluation.

6.5. River Training Works for the Dodhara and Chandani Areas

6.5.1 Selection of Flood Mitigation Priority Scheme

The river training work scheme of Dodhara and Chandani areas is selected as a flood mitigation priority scheme in the Study Area taking into account the following : First of all, area losses due to the bank erosion have brought about a serious problem in spite of the fact that the agricultural production in Dodhara and Chandani area greatly contributes to food supply in Kanchanpur District. Secondly, the field investigation and preliminary design for the work have been carried out by the Mahakali Irrigation Project Office well enough to proceed to further steps. High priority is, therefore, recommended to be given to this scheme.

6.5.2 Overview of Dodhara and Chandani Area

(1) Project Area

The Nepal-India international border forms the area boundary in the north, west and south, and the right bank of the Mahakali River forms the boundary in the east. The total land area is estimated to be some 5,000 ha; 4 to 1 km in width and 22 km in length. Southern part of the areas is named Dodhara village, and the northern part is called Chandani village respectively.

This area had initially been a forest land. At present, the forest still covers some 10 % of the areas and villages cover some 20 %. The remaining 70 % of the area, or some

3,300 ha, is farm land, out of which some 1,000 ha is irrigated by shallow tube wells and the remaining is a rain-fed farm land.

(2) Social Situation

Although a population census is not available, the chairman of the village development committee reports that the population in 1992 is estimated to be some 27,000 persons with households of 4,000 in Dodhara village and 28,000 persons with households of 4,200 in Chandani Village. Most of the people, 90 %, are engaged in agriculture. The average size of land holding is approximately one ha. Some of the remaining are engaged in marketing of daily goods. Production of vegetable oil from oilseeds and sugar from sugarcane by mills is also one of the business in these areas.

(3) Agricultural Situation

This area is a food surplus region of Kanchanpur district. Sugarcane is the primary cash crop, followed by wheat, oilseeds and paddy. Main markets are Mahendranagar and its adjacent town, Gadda Chowki, in India.

Although no surface water source is available at present, there exist 300 shallow tube wells for irrigation. No failure of construction of tube wells has been reported in the area. Groundwater development seems to be prospective for future irrigation development in the area.

As for irrigation development relying on a surface water source, a main irrigation canal with a length of 7.5 km is planned to be constructed to supply river water from the Maleriya Nala (Maleriya Creek) to the gross command area of 2,000 ha. Although the construction of intake weir and the excavation of the main canal were completed, the remaining construction works are interrupted due to the shortage of budget.

6.5.3 River Training Works for Dodhara and Chandani Area

(1) Existing River Training Works

The Mahakali River has shifted its right bank towards Dodhara and Chandani area. The northern part of the left riverbank of the Mahakali River has been protected by the construction of dykes and spurs. The right bank river training works have part by part been constructed since 1987 under the Mahakali Irrigation Project by means of gabion, revetment, bank pitching and spurs as plotted in Figure 6.5.1. Construction of the river

training works in recent years, however, has been constrained due to the shortage of budget.

(2) Proposed River Training Works

A proposal by Mahakali Irrigation Project Office, which aims not to control inundation by embankment but to mitigate a permanent loss of the land due to bank erosion, seems more important, because the loss of land is considered more serious for local residents than damages caused by inundation. Figure 6.5.2 shows the proposed river training works. The total project cost was estimated to be Rs. 21.1 million including engineering service fee and physical contingencies but excluding the cost of G.I. wire for gabions.

Another proposal is included in Pancheshwar Multipurpose Project. A field investigation of the Pancheshwar Multipurpose Project was completed in 1991. This project includes a 260 m high dam to be constructed 2.5 km downstream of the confluence of the Mahakali River and the Sarju River. This planned dam is expected to bring flood mitigation effects to the Terai area by creating a reservoir with a total volume of 6,800 million m^3. Further step to proceed on this project is also under discussion with India at present.

6.5.4 Economic Evaluation for Dodhara and Chandani River Training Works

(1) Review of Construction Cost

The total project cost, estimated at Rs. 21.1 million by the Mahakali Irrigation Project Office, is updated by (a) revising the unit rate of each work item and (b) including the cost of G.I.wire. The updated direct construction cost is estimated to be Rs. 48.79 million, in which indirect costs for administration work, further surveys and physical contingency are updated with a rate of 3 %, 7 % and 10% of the direct construction cost respectively, totalling Rs. 10.00 million. The total project cost is, therefore, estimated to be Rs. 58.58 million by accumulating the direct and indirect costs. Breakdown of the total cost is shown in Table 6.5.1.

(2) Assessment of Flood Mitigation Benefit

Figure 6.5.3 shows the decreasing area due to the bank erosion. This Figure shows that the Dodhara and Chandani areas will decrease to be some 4,000 ha in further 30

works are expected to protect the farm land of 300 ha in 10 years, 450 ha in 20 years and 500 ha in 30 years from loss due to the bank erosion.

The average economic prices of the agricultural products per hectare is assumed as the annual unit flood mitigation benefit. Economic prices of the agricultural products as international tradable commodities were estimated by referring to the World Bank projections of world market prices for the year 2000 at the 1992 price level. The forecasted prices were adjusted to the 1993 price level by multiplying the factor of 1.032 on the basis of Manufacturing Unit Value (MUV) index computed by the World Bank. The economic prices of crops per kg, therefore, were estimated at Rs. 9.7 for paddy, Rs. 10.4 for maize and Rs. 12.7 for legumes. The average annual unit flood mitigation benefit is assessed by multiplying the economic prices of crops by the crop distribution and yield in the rainy season. As a result, the annual unit flood mitigation benefit is assessed at Rs. 31,620 per hectare as shown in Table 6.5.2.

(3) Preliminary Economic Evaluation

A preliminary economic evaluation was made to assess the economic viability based on the following assumptions :

- Economic project cost is assumed by multiplying the project cost by an average economic conversion factor of 85 %. The total economic project cost is assessed to be Rs. 49.8 million.

- The total economic project cost is assumed to be disbursed into two-year construction period; 60 % for the first year and 40 % for the second one.

- Annual operation and maintenance costs are estimated to be Rs. 2.79 million by accumulating five percent of the construction cost related to the gabion work and ten percent of that related to the earth work on the basis of the Design Manual prepared by WECS in 1988. The economic annual operation and maintenance costs are assumed to be Rs. 2.37 million by multiplying the annual operation and maintenance costs by the average economic conversion factor.

- Annual flood mitigation benefit is calculated by multiplying the annual unit flood mitigation benefit, Rs. 31,620, per hectare, by the expected acreage of the farm land to be protected, which corresponds to 70% of the area to be protected. The annual flood mitigation benefit is assessed to be Rs. 6.6 million in 10 years after

the completion of the proposed river training works, Rs. 9.9 million in 20 years and Rs. 11.0 million in 30 years respectively.

- An evaluation period is set at 30 years after the completion of the construction on the basis of the Design Manual prepared by WECS in 1988. A cash flow prepared for the evaluation is shown in Table 6.5.3.

The economic internal rate of return is calculated to be 5.8 % and the net benefit is a negative value of Rs. 22.1 million by applying a discount rate of 10 %. Economic evaluation of the Dodhara and Chandani river training works was carried out under the condition that crops are yielded only in the rainy season, i.e. without introduction of irrigation. This implies that the introduction of irrigation to the areas will increase the economic viability of the works.

6.5.5 Recommendations

In evaluating the Dodhara and Chandani area river training work, it should be considered that (a) the protection of the fertile land from erosion calls for urgent needs for the local residents and (b) the land use might be enhanced by extension of the irrigation system with groundwater development. Therefore, it is recommended that this flood mitigation priority scheme be proceeded to further studies for implementation. It is also recommended that the recession of the river bank and the high water level be monitored at floods.

7. SELECTION OF TOP PRIORITY SCHEME

Further discussions for the selected nine priority schemes were carried out as dealt with in the preceding Chapters. The results of those discussions are summarized as follows:

For hydropower

Scheme	Installed Capacity MW	Annual Generation Energy GWh/yr	Construction Cost, million US$	Net Benefit, million US$	EIRR, %
BR-1	82.9	601	174.0	40.5	13.4
LR-1	81.0	323	142.9	2.3	10.2
SR-3	56.4	373	142.0	11.3	11.0
CR-2	24.1	160	69.4	1.4	10.3

For irrigation

Scheme	Irrigation Type	Net Command Area, ha	Construction Cost, million Rs (million US$)	EIRR, %
Bheri-Babai	Gravity	74,270	12,145 (260.3)	17.1
Surkhet Valley	Gravity	2,700	440 (9.4)	6.0
Korelli Khola	Lift	368	44 (0.9)	7.3
Garjyangkot	Gravity	200	26 (0.6)	14.7

For flood mitigation

Scheme	Type of Works	Project Area, ha	Construction Cost million Rs (million US$)	EIRR, %
Dodhara and Chandani	River training	5,000	58.8 (1.3)	5.8

All the priority schemes selected in the hydropower sector gained the economic internal rate of return (EIRR) higher than 10 %, judged to be viable for development in economic terms. As for irrigation, the Bheri-Babai and Garjyangkot schemes gained high economic viability as endorsed by the EIRR higher than 10 %, even though a part of construction costs, which have already been invested, is treated as sunk costs for project evaluation. Thus, those two schemes are recommended to continue their development.

The Surkhet Valley and Korelli Khola schemes obtained rather low EIRR of 6.0 and 7.3 % respectively. However, the fact that both the schemes lie in the hill area where food

shortage is severe tells that those two schemes should be retained for future development. In particular, investigation to search for water sources should be continued for the Surkhet Valley scheme, whilst the key issue for the Korelli Khola scheme is to secure stable electric power required for lifting irrigation water.

The river training works of the Dodhara and Chandani area was evaluated under the condition that crops are yielded only in the rainy season, i.e. without introduction of irrigation. This promises the high economic viability of the scheme with the introduction of irrigation, and therefore the scheme is recommended to proceed to further studies for implementation. It is noted that another severe flood hit the areas in September 1993.

The most promising candidate for the top priority scheme is BR-1 in the hydropower priority schemes, since economic viability is highest, i.e. 13.4 % in EIRR and US$40.5 million in net benefit, among the four priority schemes. Furthermore, the development of BR-1 has such merits that its power generation judging from the development scale (82.9 MW) will induce industrial development in western Nepal, resulting in the contribution to the economic development of the region, and will also enable the expansion of national power supply system into the rural areas of western Nepal, contributing to the socio-economic development in the region.

The Bheri-Babai irrigation scheme gained the highest economic viability, i.e. 17.1 % in EIRR, among the irrigation priority schemes, and thus is selected as the candidate for the top priority scheme. The development of 74,270 ha in the Bheri-Babai irrigation scheme is planned with the premise that the Bheri River water is diverted to the Babai River by BR-1; that is, full development of this irrigation project is possible, only after BR-1 becomes operational. BR-1 should thus be implemented prior to the Bheri-Babai irrigation project.

It is clear in comparison between BR-1 and the Dodhara and Chandari river training project that the former will by far give a greater impact on the socio-economic development of the Study Area than the latter. It is recommended as a consequence that the top priority scheme be set on the development of BR-1 hydropower project in view of a great impact on the reduction of regional imbalance.

It is recommended in the coming feasibility study of the BR-1 hydropower scheme that thorough investigation be carried out for geology and natural environment due to the reasons that an underground type is proposed for the powerhouse and that the tailrace outlet lies in the Royal Bardiya National Park. Terms of Reference for the feasibility study of BR-1 named Bheri River Hydropower Development Project is prepared as attached in Annex I.

8. LIST OF DATA AND DOCUMENTS COLLECTED

Data and documents were collected by the Study Team during the field investigation in collaboration with the counterpart personnel of the MWR, other ministries and organizations concerned. The list of these data and documents is attached in Annex II, List of Data and Documents Collected.

ANNEX I

TERMS OF REFERENCE FOR FEASIBILITY STUDY ON BHERI RIVER HYDROPOWER DEVELOPMENT PROJECT

HIS MEJESTY'S GOVERNMENT OF NEPAL

MINISTRY OF WATER RESOURCES DEVELOPMENT

TERMS OF REFERENCE

FOR

FEASIBILITY STUDY

ON

BHERI RIVER HYDROPOWER

DEVELOPMENT PROJECT

OCTOBER 1993

TERMS OF REFERENCE
FOR
FEASIBILITY STUDY
ON
BHERI RIVER HYDROPOWER
DEVELOPMENT PROJECT

1. Background of the Project

Power demands in the electric power supply system of Nepal Electricity Authority, NEA, are projected to rapidly grow to a level of 290 MW in year 1995, 460 MW in year 2000, 680 MW in year 2005 and 990 MW in year 2010. Generating capacities in the system at present stay at a level of 280 MW in the installed capacity and 250 MW in the effective capacity.

To meet the growing power demand, such hydropower plants as Arun III (201 MW), Kali Gandaki A (90 MW), Jhimruk Piuthan (12.5 MW) and Khimti (60 MW) are planned to be developed in a period of the second half of 1990's to the first half of 2000's. Even with the commissioning of those projects, the electric power supply system in NEA will require the development of some 170 MW by year 2005 and 520 MW by year 2010 including a reserve capacity of 15% for power demand.

Power supply in the system will face a more severe situation in winter corresponding to dry seasons than the balance between power supply and demand, since the system mainly relies on the run-of-river type hydropower plants, outputs of which are vulnerable to the change of weather. In fact, the system experienced load shedding in winters of year 1992 and 1993 due to dry weather.

As a regional discussion, the Mid Western and Far Western Development Regions, which will be the supply areas of energy generated from the proposed Bheri River hydropower project, will be linked to the national power grid with the extension of a 132 kV transmission line. This extension will require power supply of 30 MW by year 2005 and 50 MW by year 2010 in the regions. Taking into consideration the peripheral condition of the regions in terms of electric power supply as well as national and regional power demands, installation of a hydropower plant with a capacity of 50 to 100 MW is an urgent requirement not only for stable power supply but also for economic development in the regions.

2. General Feature of the Project

The Bheri River hydropower project is a run-of-river type scheme to efficiently generate electric power by taking advantage of head created by diverting water from the Bheri River to the Babai River with an 9,000 m long waterway. The proposed diversion weir built in the Bheri River lies 45 km upstream of the confluence with the Karnali main stem, whilst the tailrace outlet to release water used for power generation is located in the Babai River, 20 km upstream of the existing diversion weir of the Bheri-Babai irrigation project.

Due to the diversion of river water from the Bheri River to the Babai River, the project will have a conflict in water use with the Karnali (Chisapani) multipurpose project, which aims to develop hydropower of 10,800 MW, irrigation with a net command area of 191,000 ha and flood control for the alluvial plain extending in its downstream reaches. Since the implementation of the Karnali project is expected to be delayed for a considerable time, say at least 25 years, the Bheri River hydropower development project is conceived as the one to make up for a part of benefits which are originally gained from the Karnali project in economic terms by its early implementation. That is to say that the Bheri River hydropower development project will cease its project life after the implementation of the Karnali project, or will require the modification of the development plan of the Karnali project.

The Bheri River hydropower project has a nature of multipurpose development, since water released from the tailrace outlet after power generation can be supplied to the irrigation command areas extending in Bardiya and Banke districts, which are more or less 70,000 ha. At present, a diversion weir to introduce irrigation water to the command areas has been built in the Babai River, and subsequently a 28 km long main canal will be constructed. Thus, the project will seek the optimal development scale taking into account the development of irrigation. Review work will in turn be necessary for the detailed design of the irrigation project conducted in year 1981 following the obtained optimal development scale of the project.

According to the results of the Master Plan Study for Water Resources Development of the Upper Karnali River and Mahakali River Basins, the project can generate power of 82.9 MW and annual energy of 601 GWh with diversion discharge of 58.2 m^3/sec from the Bheri River to the Babai River. Project viability was assessed at 13.4 % in terms of economic internal rate of return, EIRR. In this assessment, evaluated is the trade-off between the energy generated from the project for a period of 25 years prior to the implementation of the Karnali project and the net energy losses in the Karnali project resulted from the reduction of discharge flowing into its reservoir.

The tailrace outlet of the project will lie in the Royal Bardiya National Park. A thorough investigation is required to protect natural and social environments in the national park and in the project area from their devastation.

3. Study Area

The Study covers an area extending between the diversion site lying in the Bheri River and the tailrace outlet situated in the Babai River. Furthermore, the areas, which lie in Bardiya and Banke districts, to receive diverted water as irrigation water, are included as the ones to conduct surveys.

4. Executing Agency

The executing agency of the Study is the Electricity Development Centre (EDC) of the Ministry of Water Resources (MWR) with the cooperation of concerned agencies.

5. Objective of the Study

The objective of the Study aims at formulating an optimal development plan for the Bheri River Hydropower Development Project and to assess its technical, economic and financial viability.

6. Scope of Work

The Study will be carried out by dividing its study period into three stages; Preliminary Investigation Stage, Field Investigation Stage and Feasibility Design Stage (refer to Figure 1).

(1) Preliminary Investigation Stage

The work of this stage will commence with review of previous study reports, collection of existing data and information and field reconnaissance which will bring in grasping the current condition on the development of the Bheri River Hydropower Development Project.

The work following the incipient study such as the review of previous study reports is power demand projection, hydrological analysis, preliminary irrigation survey, preliminary environmental investigation and socio-economic analysis. Based on these

analyses and surveys, the basic concept for the development of the project will be dealt with. The work of this stage will be completed with the preparation of the Interim Report (1).

(2) Field Investigation Stage

Based on the basic concept drawn up for the development of the project, field work such as topographic map preparation, geological investigation, environmental study and discharge observation will be carried out in and around the project site. Following the completion of field work, a study to seek the optimal development scale of the project will be conducted taking into consideration the irrigation development in the areas extending downstream of the Babai River, the future reservoir scheme lying in the upper reaches of the Bheri River and the seasonal variation of river flow.

Study results in this Field Investigation Stage will be summarized in the Interim Report (2). As for natural environment impact assessment including the social environmental impact study, the report with a title of Draft Environmental Assessment Report will be prepared and will be finalized by incorporating the comments and suggestions raised up from the MWR.

(3) Feasibility Design Stage

The work of this stage will commence with the feasibility level design for the main and appurtenant structures, followed by the preparation of construction schedule, the estimate of project cost and the economic and financial evaluation. An overall evaluation of the project will finally be carried out taking into consideration the impacts to the natural and social environments.

The Draft Final Report will be prepared at the end of this stage for summarizing all the study results discussed in this feasibility study, and will be finalized by incorporating the comments and suggestions raised up from the MWR.

7. Work Schedule and Reports

The Study will require a time period of twenty-two (22) months for its completion as given in Figure 1. Through the cource of the Study, following reports will be prepared:

(1) "Inception Report" within 2 months after the commencement of the Study, describing the objective of the Study, initial findings and detailed plans for the operation and methodology of the study.

(2) "Interim Report (1)" within 5 months after the commencement of the Study, dealing with the results obtained in the Preliminary Investigation Stage.

(3) "Progress Report (1)" within 8 months after the commencement of the Study, discussing the work progress of the Field Investigation Stage.

(4) "Progress Report (2)" within 11 months after the commencement of the Study, dealing with the results obtained through the geological investigation.

(5) "Draft Environmental Assessment Report" within 11 months after the commencement of the Study, discussing the results of natural environmental impact assessment and social environmental impact study.

(6) "Environmental Assessment Report" within 13 months after the commencement of the Study, incorporating the comments and suggestions to the Draft Environmental Assessment Report raised up by the Government of Nepal.

(7) "Interim Report (2)" within 14 months after the commencement of the Study, giving all the study results obtained in the Field Investigation Stage.

(8) "Draft Final Report" within 20 months after the commencement of the Study, describing all the results discussed in the Study.

(9) "Final Report" within 22 months after the commencement of the Study, reflecting the comments and suggestions to the Draft Final Report raised up by the Government of Nepal.

8. Expert Input

Following experts and engineers will be required for carrying out the Study:

Feasibility Study

1) Team Leader
2) Hydropower Planner
3) Hydrologist

4) Electrical Engineer

5) Electric Structure Designer

6) Geologist

7) Seismic Exploration Expert (1)

8) Seismic Exploration Expert (2)

9) Boring Work Expert

10) Structural Designer (1)

11) Structural Designer (2)

12) Photogrammetrist (1)

13) Photogrammetrist (2)

14) Construction Planner

15) Project Economist

16) Agronomist

17) Irrigation Engineer

Environmental Study

1) Environmental Study Coordinator

2) Terrestrial Fauna Specialist

3) Aquatic Fauna Specialist

4) Botanical Specialist

5) Social Environment Specialist

6) Compensation Specialist.

9. Surveys and Investigation

Topographic maps with a scale of 1 to 1,000 or so will be prepared for the sites where the structures are proposed to be build by applying a technique of photogrammetry.

Geological investigation by core boring, seismic exploration and drilling of a test adit will be undertaken at the proposed site.

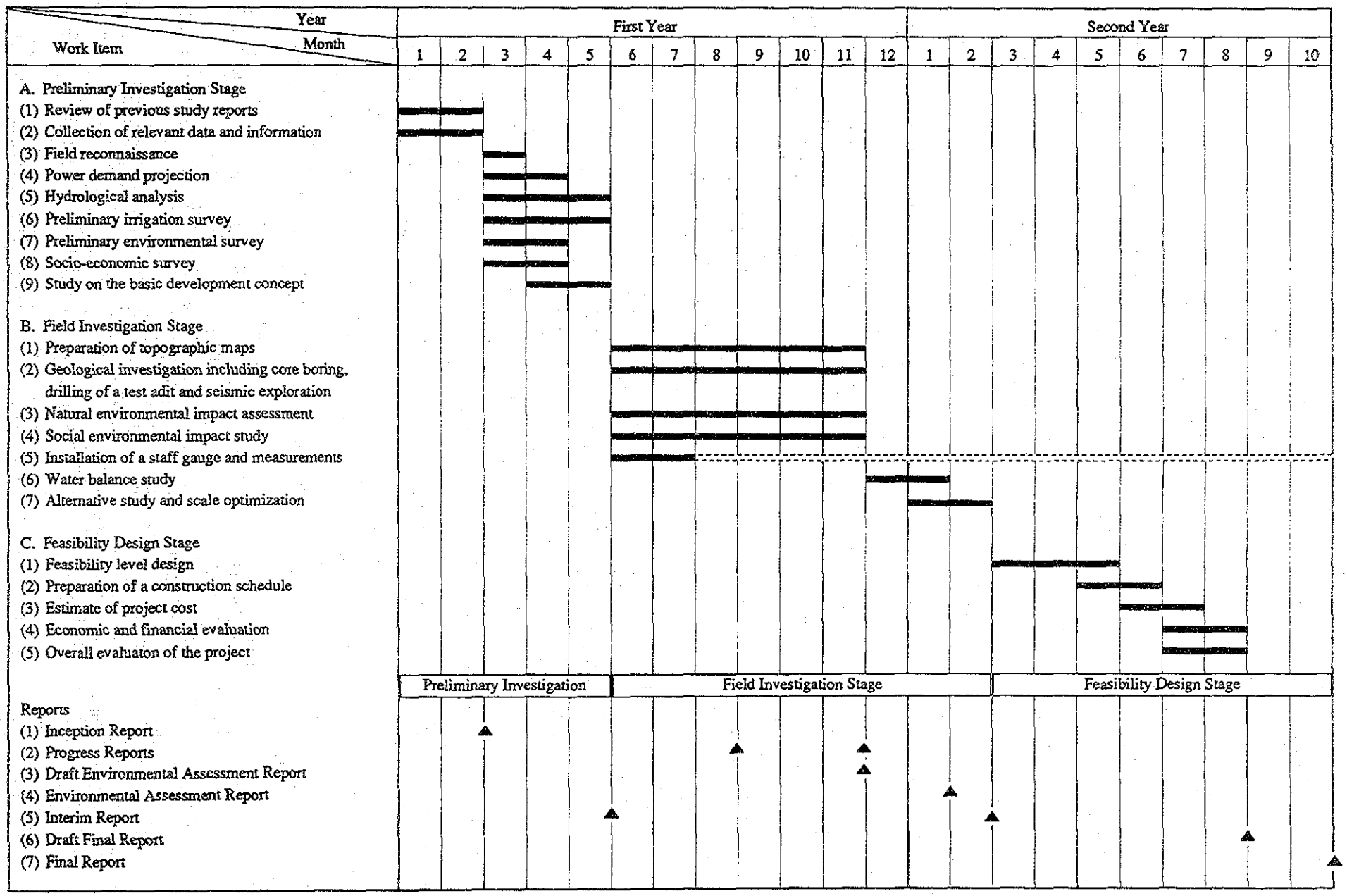
Natural environmental assessment and social environmental study will be conducted in and around the project site to evaluate the impacts to the natural and social environments.

10. Transfer of Technology

Transfer of technology will be made in the following manner to the counterpart personnel during the course of the Study:

- On-the-job training through the execution of the survey, investigation and analysis.

Figure 1 Work Schedule



Note: ------ Hydrological measurements

ANNEX II

LIST OF DATA AND DOCUMENTS COLLECTED

	Title of Data and Documents Collected	Authors / Organizations	Year of Issue
(1)	**National and regional socio-economic data**		
-	Statistical Year Book of Nepal	Central Bureau of Statistics	1989
-	Statistical Year Book of Nepal Development Co-operation	UNDP	1987
-	Census of Manufacturing Establishments Nepal	Central Bureau of Statistics Administrative	1986
-	Population Census 1991	Central Bureau of Statistics Administrative	1991
-	Population Density Maps	Ministry of Works and Transport	1988
-	Population of Nepal 1981 Census	Central Bureau of Statistics	1981
-	Economic Survey, Fiscal Year 1990/91	Ministry of Finance	1990
-	Agricultural Statistics of Nepal 1990	Ministry of Agriculture	1990
-	Migration Statistics from Demographic Sample Survey	Central Bureau of Statistics, 1986/87	1988
-	Population Monograph of Nepal	Central Bureau of Statistics, 1986/87	1987
-	Census of Manufacturing Establishment Nepal 1986/87	Central Bureau of Statistics, 1986/87	1988
-	Quarterly Economic Bulletin	Nepal Rastra Bank	1991
-	Population Census 1981 (Economic Characteristics)	Central Bureau of Statistics	1984
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-	A Reconnaissance Inventory of the Major Ecological Land Units and their Watershed Condition in Nepal	Dept. of Soil Conservation and Watershed Management, HMG	1980
-	Watershed Condition of the Districts of Nepal	B.D. Shrestha et al.	1983
-	Master Plan for the Forestry Sector Nepal	HMG, FINNDA and ADB	1988
	: Vol. Revised Executive Summary	HMG, FINNDA and ADB	
	: Vol. Main Report	HMG, FINNDA and ADB	
	: Vol. Soil Conservation and Watershed Management Plan	HMG, FINNDA and ADB	
	: Vol. Forestry Research Development Plan	HMG, FINNDA and ADB	
	: Vol. Impacts and Monitoring Plan	HMG, FINNDA and ADB	
	: Vol. Plan in the Conservation of Ecosystems and Genetic Resources	HMG, FINNDA and ADB	
-	Managing Mountain Watershed	AIT. Bagnkok	
-	Soil Conservation in Nepal, A Brief Introduction	Department of Soil Conservation & Watershed Management	1992
-	National Environmental Impact, Assessment Guidelines	National Planning Commission/The World Conservation Union (IUCN)	1992
-	Environmental Management and Sustainable Development in the Arun Basin Draft Report Volume 2, Action Program	The King Mahendra Trust for Nature Conservation	1991
-	Environmental Management and Sustainable Development in the Arun Basin Draft Report Volume1, Summary and Synthesis	King Mahendra Trust for Nature Conservation	1991

	Title of Data and Documents Collected	Authors / Organizations	Year of Issue
(16)	**Watershed Management**		
	- Application of Geographical Information System (GIS) for Watershed Surveys and Planning	Watershed Management, Training in Asia (GCP/RAS/129/NET)	1992
	- Watershed Development Plan of Doti District (Seti Zone)	Department of Soil Conservation and Watershed Management Project (FAO)	1986
(17)	**Fisheries**		
	- Effect of Impoundment on the Indigenous Fish Population in Indrasarobar Reservior, Nepal.	Fisheries Development Division (Deep B. Swar)	1993
	- A Survey Report of Gandak River System (Part-one)	Department of Fisheries	1993
	- Report on the Study of Aquatic Ecology and the Potential of Fisheries Development in Bagmati River Project	GTZ Bagmati Multipurpose Project (By Sundar B. Shrestha Tej K. Shrestha and Bhola R. Pradhan)	1979
	- Survey Report of Gandaki River System Part Two and Four Combined Report Marsyangdi River	Natural Water Unit Fisheries Development Section Department of Agriculture, Ministry of Agriculture/ Japan Overseas Cooperation Volunteers	1986
(18)	**Health**		
	- A Report on the Epidemic of Acute Diarrhoeal Disease in Nepal	Dr. M. B. Bista, Dr. U. N. Devkota, Dr. S. P. Bastola and Mr. Akshaya Gautam	1992
	- Weekly Epidemiological Record Releve Epidemiologique Heb. domedaire	World Health Organization	1992
	- Water Borne Diseases in Seti and Mahakali Zone	Department of Epidemiology	1993
	- Nepal Resettlement Company (An Introduction), Previous Report	Nepal Resettlement Company	1981
	- Environmental Assessment andManagement, Executive Summary	Nepal Electricity Authority (Arun III-Hydroelectric Project)	1992
	- Comparative Reservior Evaluation, Chisapani Bridging Studies	Himalayan Power Consultants/ITECO Nepal (P) Ltd.	1992
	- Karnali (Chisapani) Multipurpose Project Feasibility Study, Additional Environmental Studies (Draft)	Himalayan Power Consultants	1992
	- Karnali (Chisapani) Multipurpose Project Feasibility Study, Additional Environmental Studies (Draft)	Himalayan Power Consultants	
	- - do -, Annex E Karnali (Chisapani) Multipurpose Project. Chisapani Additional Environmental Studies Impacct Management Strategy for Royal Bardiya National Park (Draft)		
(19)	**Previous Reports**		
	- The Upper Karnali Hydroelectric Project	Himalayan Power Consultants / MWR	1989
	- Upper Karnali Hydroelectric Project	Himalayan Power Consultants/ NEA	1989

	Title of Data and Documents Collected	Authors / Organizations	Year of Issue
-	Gandaki River Basin Power Study	Snowy Mountain Engineering Consultants	1979
-	Kosi River Water Resources Development, Master Plan by JICA	JICA	1985
-	Karnali Multipurpose Project Feasibility Study Report : Exceptive Summary by Himalayan Power Consul. : Main Report : Annex A, Geology and Site Investigations - Volume 1 : Annex A, Geology and Site Investigations - Volume 2 : Annex B, Construction Materials - Volume 1 : Annex B, Construction Materials - Volume 2 : Annex C, Seismology : Annex I, Main Dam : Annex J, Power Facilities : Annex K1, Spillway : Annex K2, Diversion and Outlet Facilities : Annex L, Re-regulating Facilities : Annex P, Construction Planning : Annex Q, Capital Cost Estimates : Annex M1, Irrigation Development Within Nepal : Annex M2, Irrigation in India : Annex N, Environmental Impact and Mitigation : Annex R, Project Evaluation : Annex O, Socioeconomics and Resettlement : Annex H, Project Optimization : Annex G, Power System Studies : Annex F, Reservoir Simulation : Annex D, Hydrology : Annex E, Sedimentation	Himalayan Power Consultants / MWR	1989
-	The Karnali Multipurpose Project Environmental and Socio-Economic Situation Report : Volume I, Main report : Volume II, Maps : Volume III, Household Survey Report	Himalayan Power Consultants / MWR	

	Title of Data and Documents Collected	Authors / Organizations	Year of Issue
-	Rapti Development Project Mid-Term Evaluation Final Report	Development Alternatives Inc.	1990
-	Socio-Economic Benchmark Study, Mahakali Irrigation Project, Stage-I	Agricultural Projects Services Center	1983
-	Socio-Economic Bench Mark Survey of Babai Irrigation Project	APROSC	1982
-	Pancheshwar Multipurpose Project Report, Field Investigation Report : Inception report : Vol.I, II, III : Vol.IV, App.A Survey and Topographic Mapping App. B Mahakali River Survey : Vol.V, App. C Geotechnical Data - Part 1 : Vol.VI, App. C Geotechnical Data - Part 2 : Vol.VII, App. D Hydrologic Data App. E Sediment Data App. F Meteorological Data : Vol.VIII, App. G Access Road App. H Infrastructure App. I Agriculture, Land Use and Irrigation : Vol.IX, App. J Flood Mitigation Data App. K Environmental Impacts App. L Socioeconomic Impacts : Vol.X, App. M Submerged Site Study App. N Scope of Work	Pancheshwar Consortium / MWR	1991
-	West Seti Hydroelectric Project, Feasibility Study (F.R.) : Vol. I -Main Report : Vol. II - Power Demand in Nepal : Vol. III - Geological and Geotechnical Investigations, Report 1 : Vol. III - Geological and Geotechnical Investigations, Report 2 : Vol. IV - Hydrology : Vol. VII - Indian Power System	Sogreah	1987
-	Bagmati Command Area Development Project, Main Report, Vol. - I	Nippon Koei Co., Ltd	1991

	Title of Data and Documents Collected	Authors / Organizations	Year of Issue
	: Annexes, Vol. - II		
	: Drawings, Vol. - III		
-	Rajapur Irrigation Rehabilitation Project	Euroconsult	1990
(20)	**Other related references**		
-	An Assessment Trained Manpower Needs for Agricultural Development in Nepal	ADB	1989
-	Methodology for the Study of Agricultural Manpower	ADB	1989
-	Institutions and Mountain Development : Report of the International Workmanship on the Role of Institutions in Pakistan	ICIMOD	1990
-	Mountain Resources Management in Pakistan	ICIMOD	

TABLES

Table 2.4.1 COMPARISON OF DEVELOPMENT ALTERNATIVES OF BR-1

	Items	Alternatives Alternative-I	Alternative-II	Alternative-III
PROJECT FEATURES				
	Operation Hours	8 hours	12 hours	16 hours
	Full Supply Level (EL.)	420.00	420.00	420.00
	Tailwater Level (EL.)	240.00	240.00	240.00
	Plant Discharge (m3/sec)	58.2	38.8	29.1
	Installed Capacity (MW)	82.9	55.3	41.5
COST ESTIMATE				
1.00	Preparatory Works	10,612,026	8,477,030	7,339,507
2.00	Civil Works			
2.10	Intake dam	11,085,780	10,977,540	10,868,400
2.21	Desanding Basin	9,328,825	5,413,925	3,198,800
2.22	Flushing Tunnels	860,895	610,575	538,808
2.31	Intake	293,480	253,143	208,175
2.32	Penstock Line	1,503,390	1,258,950	1,023,435
2.33	Tailrace Tunnel	39,938,430	28,209,437	22,762,950
2.34	Work Adits	1,914,990	1,714,545	1,513,785
2.35	Outlet Channel	936,650	798,050	635,140
2.41	Access Tunnel	9,500,085	8,349,075	7,269,964
2.42	Underground Powerhouse	4,794,460	3,968,800	3,498,000
2.43	Gate Chamber	109,305	81,438	71,757
2.44	Tailrace Surge Tank	2,250,360	1,729,245	1,560,720
2.45	Outdoor Switchyard	635,800	488,675	417,340
2.50	Architectural Buildings	550,000	440,000	385,000
2.60	Access Road	12,450,000	12,450,000	12,450,000
2.70	Check Dam	320,513	320,513	320,513
	Civil Works total	96,472,963	77,063,911	66,722,787
3.00	Metal Works	4,340,000	3,451,000	2,860,000
4.00	Generating Equipment	28,181,500	21,439,200	17,385,400
5.00	Transmission Lines and Substations	690,000	690,000	690,000
	Total of Direct Cost	140,296,489	111,121,141	94,997,694
6.00	Land Aquisition and Compensation	1,402,965	1,111,211	949,977
7.00	Administration Expenses	1,402,965	1,111,211	949,977
8.00	Engineering Servives	9,820,754	7,778,480	6,649,839
9.00	Physical Contingency	21,044,473	16,668,171	14,249,654
	Total of Construction Cost (US$)	173,967,646	137,790,215	117,797,140
ECONOMIC EVALUATION				
	Annual Firm Energy (GWh/yr)	236	236	236
	Annual Secondary Energy (GWh/yr)	365	197	105
	EIRR (%)	13.4	12.5	11.6

Table 2.8.1 Relevance Matrix of Initial Environmental Examination of BR-1

Relevance Matrix for Initial Environmental Examination

Project : **BR-1**

Evaluation
xx : Significant Impact
x : Moderate Impact
: Insignificant Impact

	Potential Areas Affected	PHYSICAL				BIOLOGICAL		AESTHETIC						SOCIAL		
	ACTIVITIES	WATER	NOISE	LAND	ATMOSPHERE	SPECIES AND POPULATIONS	HABITATS AND COMMUNITIES	LAND	ATMOSPHERE	WATER	FLORA AND FAUNA	MAN MADE OBJECTS	COMPOSITION	INDIVIDUAL ENVIRONMENTAL INTERESTS	INDIVIDUAL WELL-BEING	SOCIAL INTERACTIONS
Site Selection and Preparation	ACCESS ROAD	XX	XX	XX	XX	XX	XX	X	XX		X					
	SITE SURVEYING		XX												XX	X
	SOIL TESTING															
	HYDROLOGICAL TESTING															
	ENVIRONMENTAL SURVEY					X	X									
	SITE CLEARING	X	XX	XX	X	X	X	X	X		X					
	BURNING															
	EXCAVATION															
	DRAINAGE ALTERATION															
	STREAM CROSSING															
	EQUIPMENT															
	WASTE DISPOSAL AND RECOVERY															
	PRODUCT STORAGE															
Construction Stage	ACESS ROADS	XX	XX	XX		XX	XX				XX					
	SITE CLEARING (DEFORESTATION)	XX	X	XX	XX	XX	XX	X	X		XX					
	EXCAVATION	XX	XX	XX	XX	X	X	X	X		X					
	BLASTING AND DRILLING	X	X	X												
	DEMOLITION															
	BUILDING RELOCATION															
	CUT AND FILL	XX		X	XX			X								
	TUNNELS AND UNDERGROUND STRUCTURES	XX	XX	XX	XX			X	XX	XX						
	EROSION															
	DRAINAGE ALTERATION	XX			X	XX	XX				XX				XX	
	STREAM CROSSING															
	EQUIPMENT MOVEMENTS		XX		X	XX	XX				XX					
	LABOUR FORCE	XX			XX	XX	XX		X		XX					
	WASTE DISPOSAL	XX			X		X		X	X			XX			
	PRODUCT DISPOSAL															
	PRODUT STORAGE															
	ABANDONMENT															
	RECLAMATION															
	REFORESTATION			X	X			X	X		X		X	X		
	FERTILISATION															
	ANCILLARY TRANSMISSION LINES AND PIPELINES		XX	X	X	X	X		X							
Operation and Maintenance	FOREST CLEARING															
	EXCAVATION															
	SPOIL AND OVERBURDEN															
	BLASTING AND DRILLING															
	DREDGING	XX	XX		X	X	X								X	
	EQUIPMENT OPERATION		XX													
	OPERATIONAL FAILURES															
	ENERGY REQUIREMENTS															
	ENERGY GENERATION															
	AUTOMOBILE AIRCRAFT VESSEL MOVEMENT		XX		XX	X	X		X		X					
	PEDESTRIAN MOVEMENT													X	X	X
	UTILITIES															
	WASTE DISPOSAL AND RECOVERY															
	PRODUCT STORAGE															
	SPILLS AND LEAKS															
	EXPLOSIONS															
	DEICING SNOW REMOVAL AND DISPOSAL															
	PEST CONTROL															
	DUST CONTROL															
	ABANDONMENT															
Future and Related Activities	URBANISATION															
	INDUSTRIAL DEVELOPMENT															
	TRANSPORTATION															
	ENERGY REQUIREMENTS															

Table 2.8.2 ENVIRONMENT SURVEY RESULTS (1/2)

Factors	BR-1	CR-2	SR-3	LR-1
1. Social Environment				
(1) Population affected				
No. of villages	Hariharpur VDC	5,6 houses (Ganna Bari)	Chainpur, Deval	4 (Chupra, Khaitara, Khara, Sandhu)
Mother tongue	Nepali	Nepali (Darchula dralect)	Nepali (Bajhangi dialect)	Nepali
Extent of people's area of activity (markets, etc.)	Surkhet, 6 hours	Jhulaghat 1 day	Dadeldhura 3 days Doti 2 days	Surkhet 12 hrs. of walk
(2) Industry				
Fishery				
No. of Fishermen	some houses	Not specific	Not specific	Not speific
Migration of Fish	upstream during monsoon			Small number in monsoon from Karnali
Fishing season	March - June / Aug - sept	All year	All year	Monsoon
Agriculture				About 25 bigha in Barah Chaur, 12 bigha
Inundated arable land	almost none	if any, very small area	Small area	in Chupra, small patches in other villages
Mining	no	no	no	no
Tourism	no	no	no	(enroute to Dailekh from Surkhet)
Others	no	no	Wood works	None
(3) Transporatation				
Bridges	Suspension bridge	None	One	2 (Suspension) 1 - Lohore
Road	Surkhet - Rajapur Trail	None	Trails only (Chainpur - Dadeldhura)	1 - Chhan Gad
Inland Navigation	Rafting by Tiger Tops	None	None	Not possible
Frequency of people's river crossing	` 25 people a day			
(4) Historical assets inundated ?	None	none	None	2 temples newly constructed None historical
(5) Sanitation				
Water-borne diseases				
types	Gastroentretis, Typhoid etc.	Gastroentretis to some extent	Gastsoentretis, typhoid etc.	Gastroentretis to some extent
frequency	every year rainy season	rainy season	3-4 months in a year (July - Sept.)	June / July / August
Water source for drinking				
Well, river, water tap	Bheri river and tributaries	Small streams for drought periods, river	Springs in high mountains (Dhami Lek)	
Is this located higher in altitude than the river	Yes if tributaries	yes	Yes	Yes
Is this source permanent or does it dry up in summer ?	Yes, permanent	in dry season very less to nil	Permanent	Yes, permanent
Distance from house to water source		500 - 1000m	Taps in corners of lanes	100 ~ 400m
Fetching time	1/2 hour	15min - 1/2 hour	Morning and Evening	15 ~ 30 mins.
Fetching frequency	morning and evening, twice a day	morning and evening	For washing most people go to river	mostly two times in a day

Table 2.8.2 ENVIRONMENT SURVEY RESULTS (2/2)

Factors	BR-1	CR-2	SR-3	LR-1
(6) Water right				
Usage of river water downstream				
Irrigation	from tributary, Pakma khola	None	SHIP irrigation schemes	None
Water mill	none on the main stream	6	3 ~ 4	1 ~ 2
Others	-	-	-	-
Do they have serious problem when drought ?	No	No	No	No
(7) Activities in Watershed				
Terraced land				on both .....
annual crops	Paddy, Maize, Wheat, Barley	Rice, Wheat, Maize, Sugercane	Rice, Maize and Wheat, Barley	Paddy, Wheat, Maize, Millet
tree crops	Lemon, Citrus fruits	Orange, Guava, Peach, etc	Pine	Growth on Slope sides
Grazing	not fixed, forest areas	not fixed	No fixed pasture land	Not fixed
Forest	no community type forest but some natural forest	none	3-4 small areas around Chainpur village on hills, now plantations done about 5 years back.	Scattered trees of Sal, Salls, Kapok on hills,
2. Natural Environment				
(1) Fauna				
Major animals	Deer, Wild Boar etc.	Domesticated animals only	Deer, Bear, Leopard, Tiger in high attitude forests.	Domesticated animals only
Major birds	Common birds only	Common birds only	Pheasants, Lopophorus (comes down during svare winter)	Not specific (crows, swallows, pigeons, and common birds)
(2) Flora				
Important plants	Sal , Sissoo	Fruit trees, some pine species	Various species of Pine	Sal, Pine species, Kapok, Simal

Table 3.4.1 COMPARISON OF LAYOUT ALTERNATIVES OF LR-1

	Items	Alternatives Alternative-I	Alternative-II	Alternative-III	Alternative-IV
PROJECT FEATURES					
	Dam Crest (EL.)	803.00	803.00	793.00	793.00
	Full Supply Level (EL.)	798.00	798.00	788.00	788.00
	Tailwater Level (EL.)	680.00	630.00	670.00	630.00
	Waterway Length (m)	750	5,150	650	4,300
	Installed Capacity (MW)	59.0	84.0	61.0	81.0
COST ESTIMATE					
1.00	Preparatory Works	7,928,038	10,121,110	6,977,775	8,847,617
2.00	Civil Works				
2.10	Diversion Tunnel	5,309,010	5,309,010	4,420,448	4,420,448
2.20	Coffer Dam	4,737,920	4,737,920	4,737,920	4,737,920
2.30	Main Dam	46,304,895	46,304,895	38,598,735	38,598,735
2.40	Spillway	10,458,250	10,458,250	10,246,170	10,246,170
2.50	Waterway				
2.51	Intake	1,018,710	1,018,710	1,018,710	1,018,710
2.52	Headrace Tunnel	1,790,775	20,609,925	1,266,825	16,977,975
	Surge Tank		3,111,570		2,815,395
2.53	Penstock	874,775	874,775	702,900	874,775
2.60	Open Powerhouse	3,515,600	3,515,600	3,515,600	3,515,600
2.70	Tailrace	220,440	220,440	220,440	220,440
2.80	Architectural Buildings	1,100,000	1,100,000	1,100,000	1,100,000
2.90	Access Road	3,950,000	3,950,000	3,950,000	3,950,000
	Civil Works total	79,280,375	101,211,095	69,777,748	88,476,168
3.00	Metal Works	1,780,000	2,050,000	1,780,000	2,050,000
4.00	Generating Equipment	10,521,000	11,926,000	10,521,000	11,926,000
5.00	Transmission Lines and Substations	92,000	368,000	92,000	368,000
	Total of Direct Cost	99,601,413	125,676,205	89,148,523	111,667,785
6.00	Land Aquisition and Compensation	4,980,071	6,283,810	4,457,426	5,583,389
7.00	Administration Expenses	996,014	1,256,762	891,485	1,116,678
8.00	Engineering Servives	6,972,099	8,797,334	6,240,397	7,816,745
9.00	Physical Contingency	14,940,212	18,851,431	13,372,278	16,750,168
	Total of Construction Cost (US$)	127,489,808	160,865,542	114,110,109	142,934,765
ECONOMIC EVALUATION					
	Annual Firm Energy(GWh/yr)	167	239	173	231
	Annual Secondary Energy (GWh/yr	73	97	72	92
	EIRR (%)	8.6	9.5	9.7	10.2

Table 3.8.1 Relevance Matrix of Initial Environmental Examination of LR-1

Relevance Matrix for Initial Environmental Examination

Project : **LR-1**

Evaluation
xx : Significant Impact
x : Moderate Impact
: Insignificant Impact

		Potential Areas Affected	PHYSICAL				BIOLOGICAL		AESTHETIC						SOCIAL		
	ACTIVITIES		WATER	NOISE	LAND	ATMOSPHERE	SPECIES AND POPULATIONS	HABITATS AND COMMUNITIES	LAND	ATMOSPHERE	WATER	FLORA AND FAUNA	MAN MADE OBJECTS	COMPOSITION	INDIVIDUAL ENVIRONMENTAL INTERESTS	INDIVIDUAL WELL-BEING	SOCIAL INTERACTIONS
Site Selection and Preparation	ACCESS ROAD																
	SITE SURVEYING			X	X												
	SOIL TESTING																
	HYDROLOGICAL TESTING																
	ENVIRONMENTAL SURVEY																X
	SITE CLEARING		X	X	XX				X	X							
	BURNING																
	EXCAVATION																
	DRAINAGE ALTERATION																
	STREAM CROSSING																
	EQUIPMENT																
	WASTE DISPOSAL AND RECOVERY																
	PRODUCT STORAGE																
Construction Stage	ACESS ROADS																
	SITE CLEARING (DEFORESTATION)		XX	X	XX	X	X	X									
	EXCAVATION		XX	XX		X	X	X	X	X	X	X		X	X	XX	XX
	BLASTING AND DRILLING		XX	XX	XX	XX	X	X									
	DEMOLITION																
	BUILDING RELOCATION			X	X	X										X	X
	CUT AND FILL		XX	XX	XX	XX	X	X	X	X	X	X					
	TUNNELS AND UNDERGROUND STRUCTURES			X													
	EROSION																
	DRAINAGE ALTERATION		XX			X	XX	XX			XX					XX	
	STREAM CROSSING																
	EQUIPMENT MOVEMENTS			XX		X				X							
	LABOUR FORCE									X		X				XX	XX
	WASTE DISPOSAL		XX			X				X	X						
	PRODUCT DISPOSAL																
	PRODUT STORAGE																
	ABANDONMENT																
	RECLAMATION																
	REFORESTATION																
	FERTILISATION																
	ANCILLARY TRANSMISSION LINES AND PIPELINES																
Operation and Maintenance	FOREST CLEARING																
	EXCAVATION																
	SPOIL AND OVERBURDEN																
	BLASTING AND DRILLING																
	DREDGING		XX	X			X					X					
	EQUIPMENT OPERATION																
	OPERATIONAL FAILURES																
	ENERGY REQUIREMENTS																
	ENERGY GENERATION																
	AUTOMOBILE AIRCRAFT VESSEL MOVEMENT			X													
	PEDESTRIAN MOVEMENT																
	UTILITIES																
	WASTE DISPOSAL AND RECOVERY																
	PRODUCT STORAGE																
	SPILLS AND LEAKS																
	EXPLOSIONS																
	DEICING SNOW REMOVAL AND DISPOSAL																
	PEST CONTROL																
	DUST CONTROL																
	ABANDONMENT																
Future and Related Activities	URBANISATION																
	INDUSTRIAL DEVELOPMENT																
	TRANSPORTATION																
	ENERGY REQUIREMENTS																

Table 4.4.1 COMPARISON OF LAYOUT ALTERNATIVES OF SR-3

	Items	Alternatives Alternative-I	Alternative-II
PROJECT FEATURES			
	Operation Hours	8 hours	8 hours
	Full Supply Level (EL.)	1250.00	1250.00
	Tailwater Level (EL.)	1070.00	1125.00
	Plant Discharge (m3/sec)	39.6	39.6
	Installed Capacity (MW)	56.4	39.2
COST ESTIMATE			
1.00	Preparatory Works	9,089,546	7,804,113
2.00	Civil Works		
2.10	Intake dam	18,398,400	18,398,400
2.21	Desanding Basin	5,074,960	5,074,960
2.22	Flushing Tunnels	1,761,480	1,761,480
2.31	Intake	248,490	248,490
2.32	Headrace Tunnel	24,733,275	15,354,675
2.33	Work Adits	1,620,360	1,145,235
2.34	Surge Tank	2,049,245	1,670,350
2.35	Penstock	943,635	1,018,710
2.40	Open Powerhouse	3,049,475	2,605,460
2.50	Tailrace	396,900	341,513
2.60	Architectural Buildings	1,320,000	1,265,000
2.70	Access Road	16,150,000	16,150,000
	Civil Works total	75,746,220	65,034,273
3.00	Metal Works	4,590,000	4,120,000
4.00	Generating Equipment	22,366,000	18,500,000
5.00	Transmission Lines and Substations	2,714,000	2,990,000
	Total of Direct Cost	114,505,766	98,448,386
6.00	Land Aquisition and Compensation	1,145,058	984,484
7.00	Administration Expenses	1,145,058	984,484
8.00	Engineering Servives	8,015,404	6,891,387
9.00	Physical Contingency	17,175,865	14,767,258
	Total of Construction Cost (US$)	141,987,150	122,075,998
ECONOMIC EVALUATION			
	Annual Firm Energy (GWh/yr)	163	113
	Annual Secondary Energy (GWh/yr)	210	146
	EIRR (%)	11.0	9.1

Table 4.8.1 Relevance Matrix of Initial Environmental Examination of SR-3

Relevance Matrix for Initial Environmental Examination

Project : **SR-3**

Evaluation
xx : Significant Impact
x : Moderate Impact
: Insignificant Impact

		Potential Areas Affected	PHYSICAL				BIOLOGICAL		AESTHETIC						SOCIAL		
	ACTIVITIES		WATER	NOISE	LAND	ATMOSPHERE	SPECIES AND POPULATIONS	HABITATS AND COMMUNITIES	LAND	ATMOSPHERE	WATER	FLORA AND FAUNA	MAN MADE OBJECTS	COMPOSITION	INDIVIDUAL ENVIRONMENTAL INTERESTS	INDIVIDUAL WELL-BEING	SOCIAL INTERACTIONS
Site Selection and Preparation	ACCESS ROAD																
	SITE SURVEYING			X	X												
	SOIL TESTING																
	HYDROLOGICAL TESTING																
	ENVIRONMENTAL SURVEY														X	X	X
	SITE CLEARING		XX	XX	X	X	XX	XX				X				X	
	BURNING																
	EXCAVATION																
	DRAINAGE ALTERATION																
	STREAM CROSSING																
	EQUIPMENT																
	WASTE DISPOSAL AND RECOVERY																
	PRODUCT STORAGE																
Construction Stage	ACESS ROADS		X	X	X												
	SITE CLEARING (DEFORESTATION)																
	EXCAVATION		XX	XX	X	X	XX	XX		X							
	BLASTING AND DRILLING		XX	XX	X	X	XX	XX									
	DEMOLITION																
	BUILDING RELOCATION				XX												
	CUT AND FILL		XX	XX	XX	X	X	X	X	X	X						
	TUNNELS AND UNDERGROUND STRUCTURES		XX	XX	X	X											
	EROSION																
	DRAINAGE ALTERATION		XX				X	X									
	STREAM CROSSING																
	EQUIPMENT MOVEMENTS			X		X											
	LABOUR FORCE					X				X							
	WASTE DISPOSAL		XX							X	X					XX	X
	PRODUCT DISPOSAL																
	PRODUT STORAGE																
	ABANDONMENT																
	RECLAMATION																
	REFORESTATION																
	FERTILISATION																
	ANCILLARY TRANSMISSION LINES AND PIPELINES																
Operation and Maintenance	FOREST CLEARING																
	EXCAVATION																
	SPOIL AND OVERBURDEN																
	BLASTING AND DRILLING																
	DREDGING		XX	XX							X						
	EQUIPMENT OPERATION																
	OPERATIONAL FAILURES															X	
	ENERGY REQUIREMENTS																
	ENERGY GENERATION																
	AUTOMOBILE AIRCRAFT VESSEL MOVEMENT			XX		X											
	PEDESTRIAN MOVEMENT																
	UTILITIES																
	WASTE DISPOSAL AND RECOVERY																
	PRODUCT STORAGE																
	SPILLS AND LEAKS																
	EXPLOSIONS																
	DEICING SNOW REMOVAL AND DISPOSAL																
	PEST CONTROL																
	DUST CONTROL																
	ABANDONMENT																
Future and Related Activities	URBANISATION																
	INDUSTRIAL DEVELOPMENT																
	TRANSPORTATION																
	ENERGY REQUIREMENTS																

Table 5.4.1 COMPARISON OF LAYOUT ALTERNATIVES OF CR-2

	Items	Alternatives Alternative-I	Alternative-II
PROJECT FEATURES			
	Operation Hours	8 hours	8 hours
	Full Supply Level (EL.)	930.00	880.00
	Tailwater Level (EL.)	790.00	790.00
	Plant Discharge (m3/sec)	21.7	21.7
	Installed Capacity (MW)	24.1	15.5
COST ESTIMATE			
1.00	Preparatory Works	4,116,871	2,868,109
2.00	Civil Works		
2.10	Diversion Tunnel	3,754,275	0
2.20	Cofferdam	1,211,650	0
2.30	Intake dam	10,683,200	6,144,050
2.40	Desanding Basin	4,263,215	3,932,500
2.51	Intake	254,760	240,300
2.52	Headrace Tunnel	6,747,405	5,949,930
2.53	Work Adits	410,340	178,185
2.54	Surge Tank	857,300	697,590
2.55	Penstock	764,558	697,725
2.60	Open Powerhouse	1,254,550	1,086,965
2.70	Tailrace	344,850	321,475
2.80	Architectural Buildings	880,000	825,000
2.90	Access Road	6,000,000	6,000,000
	Civil Works total	37,426,103	26,073,720
3.00	Metal Works	2,240,000	2,020,000
4.00	Generating Equipment	8,621,750	7,717,550
5.00	Transmission Lines and Substations	1,850,000	1,850,000
	Total of Direct Cost	54,254,724	40,529,379
6.00	Land Aquisition and Compensation	2,712,736	2,026,469
7.00	Administration Expenses	542,547	405,294
8.00	Engineering Servives	3,797,831	2,837,057
9.00	Physical Contingency	8,138,209	6,079,407
	Total of Construction Cost (US$)	69,446,047	51,877,605
ECONOMIC EVALUATION			
	Annual Firm Energy (GWh/yr)	70	45
	Annual Secondary Energy (GWh/yr)	90	58
	EIRR (%)	10.3	8.9

Table 5.8.1 Relevance Matrix of Initial Environmental Examination of CR-2

Relevance Matrix for Initial Environmental Examination

Project : **CR-2**

Evaluation
xx : Significant Impact
x : Moderate Impact
: Insignificant Impact

	ACTIVITIES	Potential Areas Affected	PHYSICAL				BIOLOGICAL		AESTHETIC						SOCIAL		
			WATER	NOISE	LAND	ATMOSPHERE	SPECIES AND POPULATIONS	HABITATS AND COMMUNITIES	LAND	ATMOSPHERE	WATER	FLORA AND FAUNA	MAN MADE OBJECTS	COMPOSITION	INDIVIDUAL ENVIRONMENTAL INTERESTS	INDIVIDUAL WELL-BEING	SOCIAL INTERACTIONS
Site Selection and Preparation	ACCESS ROAD		XX	XX	XX	XX											
	SITE SURVEYING			XX													
	SOIL TESTING																
	HYDROLOGICAL TESTING																
	ENVIRONMENTAL SURVEY														X	X	X
	SITE CLEARING		X	XX	XX				XX		X						
	BURNING																
	EXCAVATION																
	DRAINAGE ALTERATION																
	STREAM CROSSING																
	EQUIPMENT																
	WASTE DISPOSAL AND RECOVERY																
	PRODUCT STORAGE																
Construction Stage	ACESS ROADS		XX	XX	XX				X					X		X	
	SITE CLEARING (DEFORESTATION)																
	EXCAVATION		XX	XX			XX	XX								XX	
	BLASTING AND DRILLING		XX	XX	X	XX	XX										
	DEMOLITION																
	BUILDING RELOCATION				X												
	CUT AND FILL		XX	XX	XX				XX		X						
	TUNNELS AND UNDERGROUND STRUCTURES			XX	X												
	EROSION		XX			X	XX										
	DRAINAGE ALTERATION		XX		X		XX	XX									
	STREAM CROSSING																
	EQUIPMENT MOVEMENTS			XX		X										X	
	LABOUR FORCE					X				X						XX	X
	WASTE DISPOSAL									X	X						
	PRODUCT DISPOSAL																
	PRODUT STORAGE																
	ABANDONMENT																
	RECLAMATION																
	REFORESTATION																
	FERTILISATION																
	ANCILLARY TRANSMISSION LINES AND PIPELINES					X			X	X							
Operation and Maintenance	FOREST CLEARING																
	EXCAVATION																
	SPOIL AND OVERBURDEN																
	BLASTING AND DRILLING																
	DREDGING		XX	XX							X						
	EQUIPMENT OPERATION																
	OPERATIONAL FAILURES															X	
	ENERGY REQUIREMENTS																
	ENERGY GENERATION															X	
	AUTOMOBILE AIRCRAFT VESSEL MOVEMENT			XX		X											
	PEDESTRIAN MOVEMENT																
	UTILITIES																
	WASTE DISPOSAL AND RECOVERY																
	PRODUCT STORAGE																
	SPILLS AND LEAKS																
	EXPLOSIONS																
	DEICING SNOW REMOVAL AND DISPOSAL																
	PEST CONTROL																
	DUST CONTROL																
	ABANDONMENT																
Future and Related Activities	URBANISATION																
	INDUSTRIAL DEVELOPMENT																
	TRANSPORTATION																
	ENERGY REQUIREMENTS																

Table 6.1.1 RELEVANCE MATRIX FOR INITIAL ENVIRONMENTAL EXAMINATION OF BHERI-BABAI IRRIGATION

Relevance Matrix for Initial Environmental Examination

Project : **Bheri-Babai Irrigation**

Evaluation
xx : Significant Impact
x : Moderate Impact
: Insignificant Impact

	ACTIVITIES	Potential Areas Affected	PHYSICAL				BIOLOGICAL		AESTHETIC						SOCIAL		
			WATER	NOISE	LAND	ATMOSPHERE	SPECIES AND POPULATIONS	HABITATS AND COMMUNITIES	LAND	ATMOSPHERE	WATER	FLORA AND FAUNA	MAN MADE OBJECTS	COMPOSITION	INDIVIDUAL ENVIRONMENTAL INTERESTS	INDIVIDUAL WELL-BEING	SOCIAL INTERACTIONS
Site Selection and Preparation	ACCESS ROAD																
	SITE SURVEYING			XX											X	X	X
	SOIL TESTING																
	HYDROLOGICAL TESTING																
	ENVIRONMENTAL SURVEY						X	X									
	SITE CLEARING																
	BURNING																
	EXCAVATION																
	DRAINAGE ALTERATION																
	STREAM CROSSING																
	EQUIPMENT																
	WASTE DISPOSAL AND RECOVERY																
	PRODUCT STORAGE																
Construction Stage	ACESS ROADS		XX	XX	XX	XX	XX	XX	XX	X							
	SITE CLEARING (DEFORESTATION)				XX	XX	X	XX	XX	X		XX					
	EXCAVATION		XX	XX	XX	XX	X	X	X	X	X	X	XX			XX	
	BLASTING AND DRILLING																
	DEMOLITION																
	BUILDING RELOCATION				XX											XX	
	CUT AND FILL		XX	XX	XX				X	X	X		XX		X	XX	
	TUNNELS AND UNDERGROUND STRUCTURES																
	EROSION																
	DRAINAGE ALTERATION		XX	X	XX	X			X	X	X		XX				
	STREAM CROSSING																
	EQUIPMENT MOVEMENTS		X	XX	X	X			X	X	X						
	LABOUR FORCE		XX			XX	XX	XX		X		X			X	XX	XX
	WASTE DISPOSAL		XX			X		X		X	X						
	PRODUCT DISPOSAL																
	PRODUT STORAGE																
	ABANDONMENT																
	RECLAMATION																
	REFORESTATION																
	FERTILISATION																
	ANCILLARY TRANSMISSION LINES AND PIPELINES																
Operation and Maintenance	FOREST CLEARING																
	EXCAVATION																
	SPOIL AND OVERBURDEN																
	BLASTING AND DRILLING																
	DREDGING		XX	X	X	X										X	
	EQUIPMENT OPERATION																
	OPERATIONAL FAILURES																
	ENERGY REQUIREMENTS																
	ENERGY GENERATION																
	AUTOMOBILE AIRCRAFT VESSEL MOVEMENT																
	PEDESTRIAN MOVEMENT																
	UTILITIES																
	WASTE DISPOSAL AND RECOVERY																
	PRODUCT STORAGE																
	SPILLS AND LEAKS																
	EXPLOSIONS																
	DEICING SNOW REMOVAL AND DISPOSAL																
	PEST CONTROL		X			X	X								X	X	
	DUST CONTROL																
	ABANDONMENT																
Future and Related Activities	URBANISATION																
	INDUSTRIAL DEVELOPMENT																
	TRANSPORTATION																
	ENERGY REQUIREMENTS																

Table 6.1.2 QUESTIONNAIRE RESULT OF IRRIGATION AREA (BHERI-BABAI-SCHEME)

	Resettler	Non-resettler
1. Socio-economy		
(1) If settlement		
Name of settlement	Jamuni-Sitapur village	
Population of the settlement	340 Houses	
When did you come ?	1971	
From where did you come ?	Gorkha	
Implementing agency	Nepal Resettlement Company	
Programme detail :		
land provided	2 ha	
house		
food	No	
education	No	
loan etc.	Loan for 2 oxen; Duration for first 9 months	
Any conflict with the host people ?	No	
(2) If not resettlement		
Name of village		Lathawa (Sauraha VDC)
Population		100
Name of ethnic group		Vishokarma
Land holding system		0.17 - 0.34 ha
Own farm		0.68 - 1.36 ha
Lease holder		
(3) For both cases		
Agricultural extension service	Only for cotton cultivators	No
Are farm inputs available ?	Available, but use is minimal	Available, but not used
Fertilizer	Urea for wheat	
Pesticide	Not used	
Seed	Not popular	
How do you sell your farm products ?	Local Market of Khajura, Nepalgunj	Home consumption only
Yield of Major crops		
Rice	3.7 - 4.4 t/ha	2.9 - 3.7 t/ha
Barley	1.5 - 2.9 t/ha	1.5 - 1.8 t/ha
Maize	2.2 t/ha	1.5 - 1.8 t/ha
2. Water-borne Diseases		
Types	Cholera, Meningitis, Malaria	Cholera, Typhoid, Malaria
Season	Rainy season	May - August
3. Water-right		
Drinking Water Source	Tubewell	Tubewell
Irrigation	Private pump from Babai river	
4. Source of Fuel	Rice husk, hay, cowdung firewood	Rice husk, hay, cowdung firewood
5. Food damage		
Any damage ?	Bank cutting of main river	No
If any, how often	Flood time	
6. Others		
Extent of people's activities	Khajura, Nepalgunj	Khajura, Nepalgunj
Main transportation	Cart-Trail from Nepalgunj-Gulariya road	Nepalgunj-Gulariya road

Table 6.2.1 WATER BALANCE CASE STUDY FOR SURKHET VALLEY

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Paddy (Area : 2,300 ha)														
Net Monthly Irrigation Requirement	(mm)							178.28	245.08	246.4	217.96			
	(l/s/ha)							0.67	0.92	0.95	0.81			
Intake Efficiency	(60%)							1.11	1.53	1.58	1.36			
A. Gross Water Requirement	**(l/s)**							**2,552**	**3,508**	**3,644**	**3,119**			
Summer Vegetable (Area : 1,000 ha)														
Net Monthly Irrigation Requirement	(mm)			20.07	124.17	90.65	13.22							
	(l/s/ha)			0.15	0.48	0.34	0.05							
Intake Efficiency	(60%)			0.26	0.80	0.56	0.09							
B. Gross Water Requirement	**(l/s)**			**258**	**798**	**564**	**85**							
Wheat (Area : 700 ha)														
Net Monthly Irrigation Requirement	(mm)	68.16	75.07	19.34								16.13	45.08	
	(l/s/ha)	0.25	0.31	0.15								0.12	0.17	
Intake Efficiency	(60%)	0.42	0.52	0.25								0.21	0.28	
C. Gross Water Requirement	**(l/s)**	**297**	**362**	**174**								**145**	**196**	
Potato (Area : 300 ha)														
Net Monthly Irrigation Requirement	(mm)	64.28	82.74	115.71								32.14	33.75	
	(l/s/ha)	0.24	0.34	0.43								0.12	0.13	
Intake Efficiency	(60%)	0.40	0.57	0.72								0.20	0.21	
D. Gross Water Requirement	**(l/s)**	**120**	**171**	**216**								**60**	**63**	
Mustard (Area : 200 ha)														
Net Monthly Irrigation Requirement	(mm)	37.69	72.94	48.29									10.54	
	(l/s/ha)	0.14	0.56	0.18									0.08	
Intake Efficiency	(60%)	0.23	0.94	0.30									0.14	
E. Gross Water Requirement	**(l/s)**	**47**	**188**	**60**									**27**	
Total Water Requirement(A+B+C+D+E)	**(m3/s)**	**0.46**	**0.72**	**0.71**	**0.80**	**0.56**	**0.09**	**2.55**	**3.51**	**3.64**	**3.12**	**0.21**	**0.29**	**16.65**
Water Discharge of Chingar Khola	**(m3/s)**	**2.10**	**1.17**	**0.99**	**1.98**	**1.98**	**1.76**	**2.98**	**5.86**	**4.62**	**3.05**	**2.75**	**2.92**	**32.15**

Table 6.5.1 ESTIMATED COST OF RIVER TRAINING WORKS OF DODHARA AND CHANDANI AREAS

	Work items	Unit of work quantity	Work quantity	Original estimate		Revised estimate	
				Unit prices Rs.	Amount 1,000 Rs.	Unit prices Rs.	Amount 1,000 Rs.
< Direct construction cost >							
(1)	G.I.wire crate weaving works	m2	244,500	13.41	3,280	13.41	3,280
(2)	Collection and transportation of boulders	m3	52,038	145.34	7,560	185.75	9,670
(3)	Boulder filling in crate	m3	52,038	42.26	2,200	67.60	3,520
(4)	River bed material dowla inspection track : Loading, unloading & transp. of river bed material	m3	55,000	68.90	3,790	180.00	9,900
(5)	Earthwork in excavation for catch drain & construction of dowla	m3	22,400	76.60	1,720	76.60	1,720
(6)	Masonry terminal structure to inlet drain water to the river	nos	25	25,000	630	40,000	1,000
(7)	Sod facing on bank slope	m2	90,000	2.17	200	4.00	360
(8)	RBM dykes and core of sours with riverbed material	m3	1,200	68.90	80	180.00	220
(9)	Sod facing for catch drain slope	m2	40,000	2.17	90	4.00	160
(10)	Earthwork in excavation in gravel mixed soil for foundation of masonry terminal structures	m3	10,000	73.56	740	79.09	790
(11)	Cost of G.I. wire	kg	499,200		-	36.00	17,970
(12)	Transportation of G.I. wire from Dhangadhi by truck(up to 70 km) incl. loading and unloading	Rs/ kg	499,200		-	0.40	200
(13)	Installation of water level measurement with staff gages		3			10,000.00	30
*	Total direct construction cost				20,290		48,820
< Indirect construction cost >							
(14)	Administration expenses : 3% to direct cost				50		1,460
(15)	Engineering services : Survey, design, contracting : 7% of direct cost				170		3,420
(16)	Physical contingency : 10% of the total direct cost				600		4,880
*	Total indirect construction cost				820		9,760
** Grand total of direct and indirect costs					21,110		58,580

Note : Original estimate was made by Mahakali irrigation Project Office in 1991 and its unit prices are reviewed by this Study.

Table 6.5.2 **ANNUAL UNIT FLOOD MITIGATION BENEFIT IN DODHARA AND CHANDANI AREAS**

Crops	Proportion of cropped area (%)	Crop yield (ton / ha) : A	Economic prices for major crops (Rs. / ton) : B	Economic prices per hectare (Rs. / ha) : C=A*B
- Paddy	85	3.5	9,660	33,810
- Maize	10	2.4	10,410	24,980
- Legumes	5	0.6	12,660	7,600
: Average unit flood mitigation benefit per annum				31,620

Note : Economic prices of the crops are referred to the World Bank projections of world market prices.

Table 6.5.3 CASH FLOW FOR ECONOMIC EVALUATION (DODHARA AND CHANDANI AREA)

: Unit: Rs. 1,000

Year	Capital cost : C1	O&M cost : C2	Total cost : C=C1+C2	Benefit : B	Net benefit : B-C
-2	19,920	0	19,920	0	-19,920
-1	29,880	950	30,830	550	-30,280
0	0	2,370	2,370	1,100	-1,270
1	0	2,370	2,370	1,650	-720
2	0	2,370	2,370	2,200	-170
3	0	2,370	2,370	2,750	380
4	0	2,370	2,370	3,300	930
5	0	2,370	2,370	3,850	1,480
6	0	2,370	2,370	4,400	2,030
7	0	2,370	2,370	4,950	2,580
8	0	2,370	2,370	5,500	3,130
9	0	2,370	2,370	6,050	3,680
10	0	2,370	2,370	6,600	4,230
11	0	2,370	2,370	6,930	4,560
12	0	2,370	2,370	7,260	4,890
13	0	2,370	2,370	7,590	5,220
14	0	2,370	2,370	7,920	5,550
15	0	2,370	2,370	8,250	5,880
16	0	2,370	2,370	8,580	6,210
17	0	2,370	2,370	8,910	6,540
18	0	2,370	2,370	9,240	6,870
19	0	2,370	2,370	9,570	7,200
20	0	2,370	2,370	9,900	7,530
21	0	2,370	2,370	10,010	7,640
22	0	2,370	2,370	10,120	7,750
23	0	2,370	2,370	10,230	7,860
24	0	2,370	2,370	10,340	7,970
25	0	2,370	2,370	10,450	8,080
26	0	2,370	2,370	10,560	8,190
27	0	2,370	2,370	10,670	8,300
28	0	2,370	2,370	10,780	8,410
29	0	2,370	2,370	10,890	8,520
30	0	2,370	2,370	11,000	8,630

FIGURES

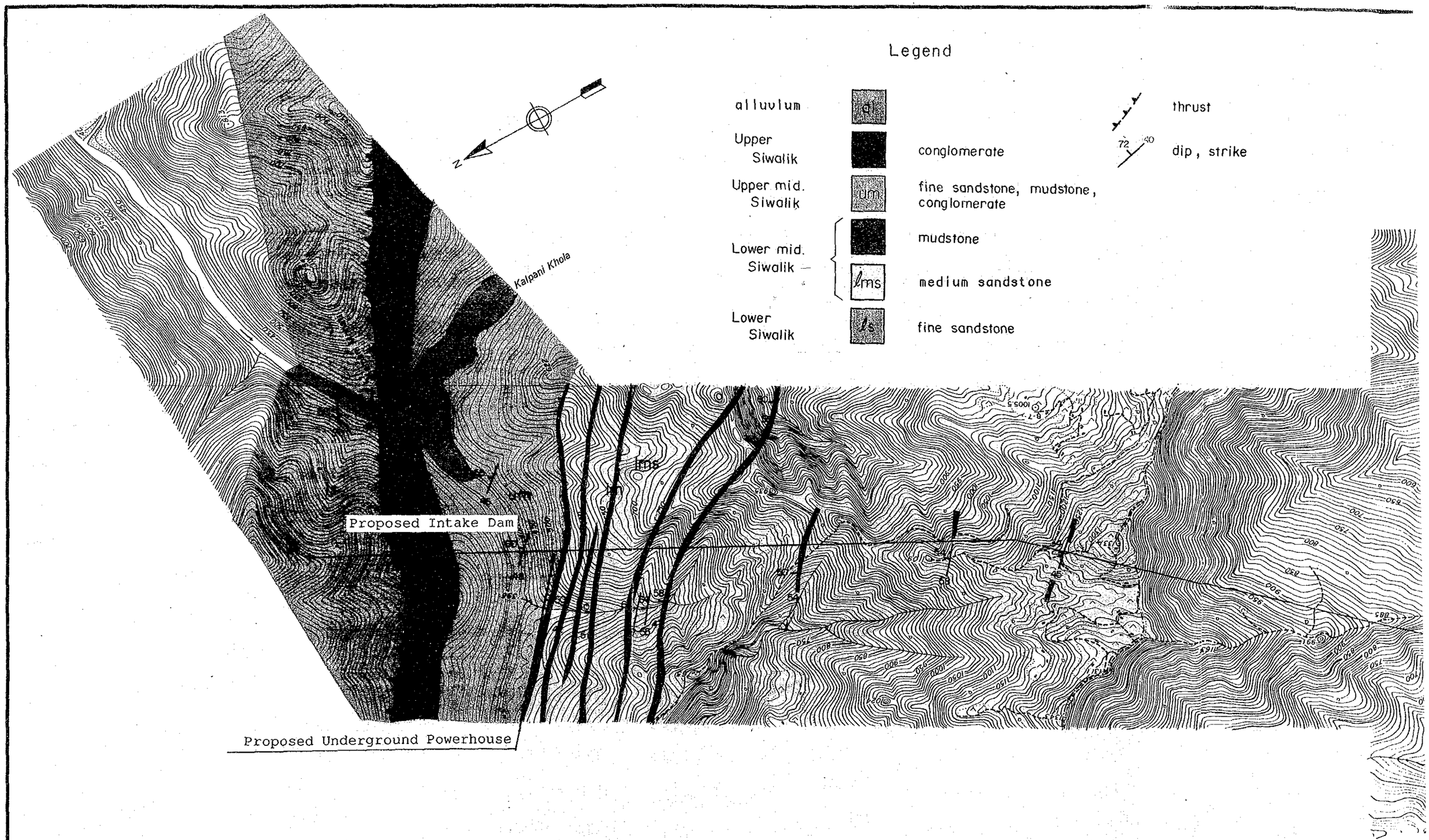


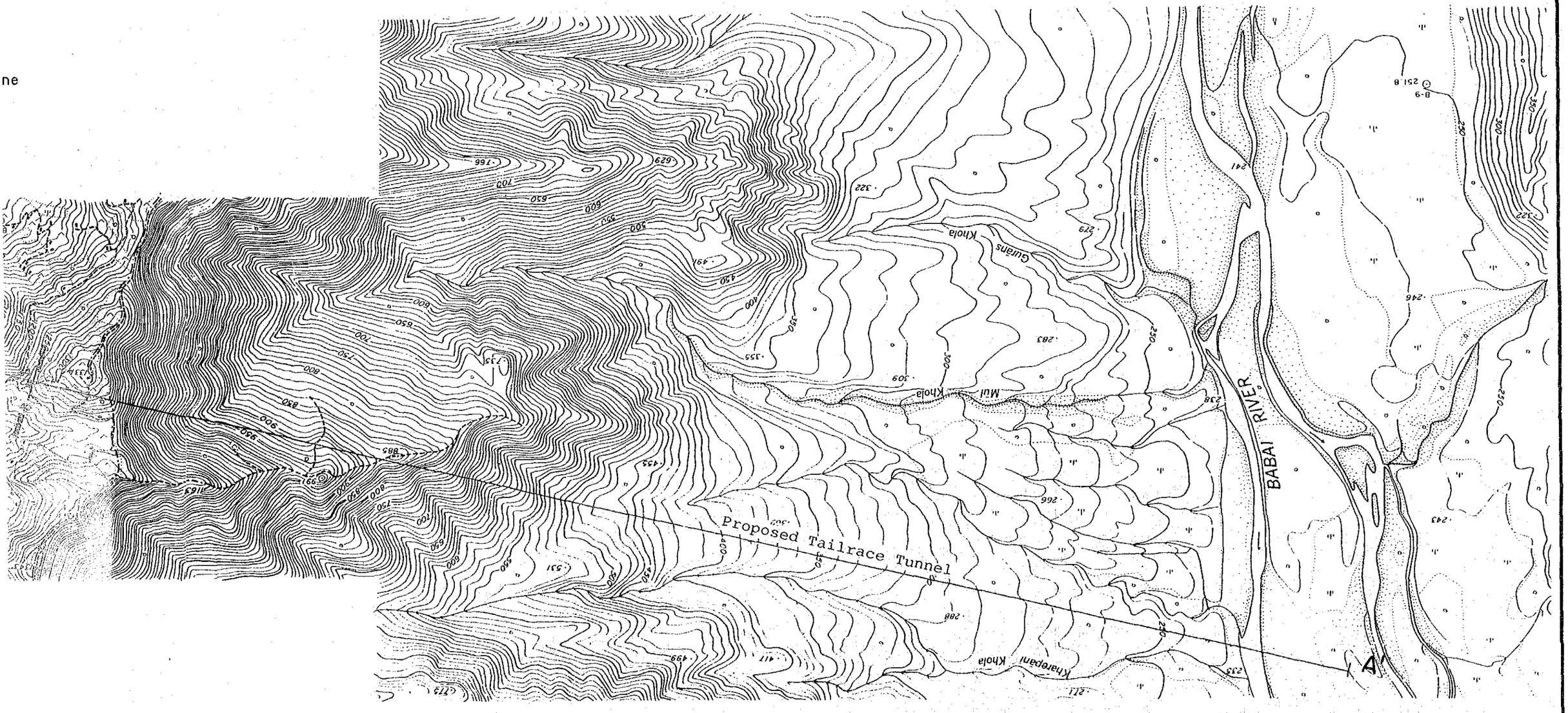
Figure 2.3.1 Geological Map of BR-1 Scheme Site

thrust

72 40 dip , strike

nudstone ,

ne



SCALE 1 : 20,000

HIS MAJESTY'S GOVERNMENT OF NEPAL
WATER RESOURCES DEVELOPMENT OF
THE UPPER KARNALI RIVER AND MAHAKALI RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY

Legend

alluvium — al

Upper Siwalik — conglomerate

Upper mid. Siwalik — um — fine sandstone, mudstone, conglomerate

Lower mid. Siwalik — mudstone; lms — medium sandstone

Lower Siwalik — ls — fine sandstone

thrust

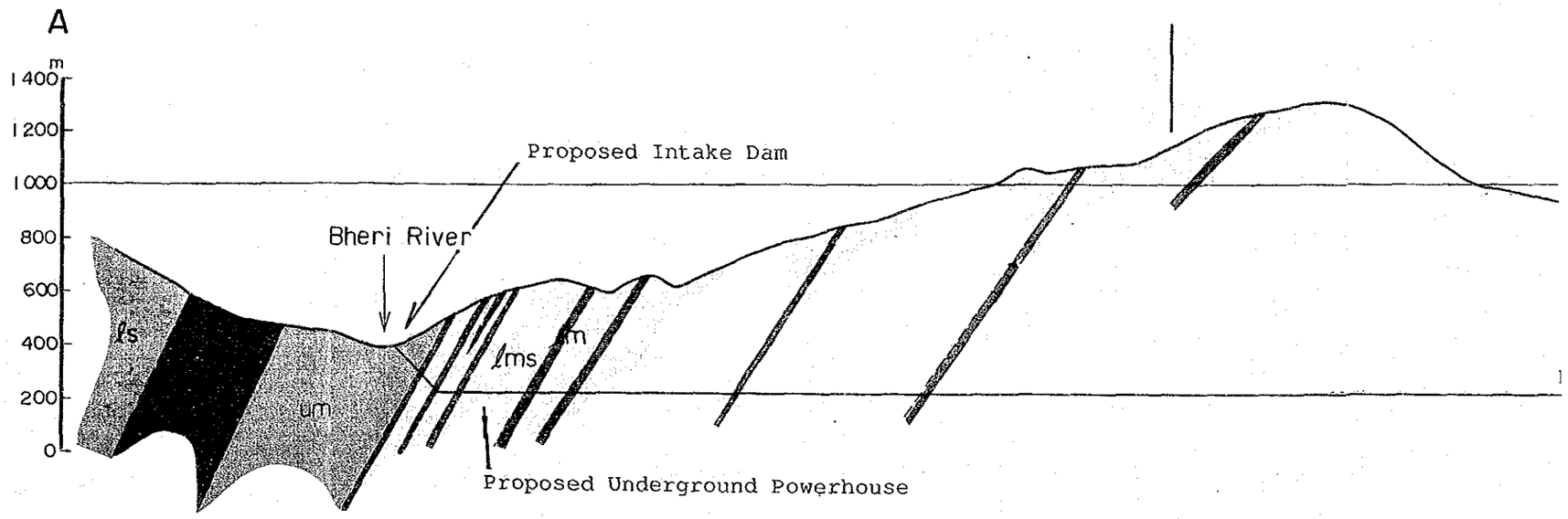
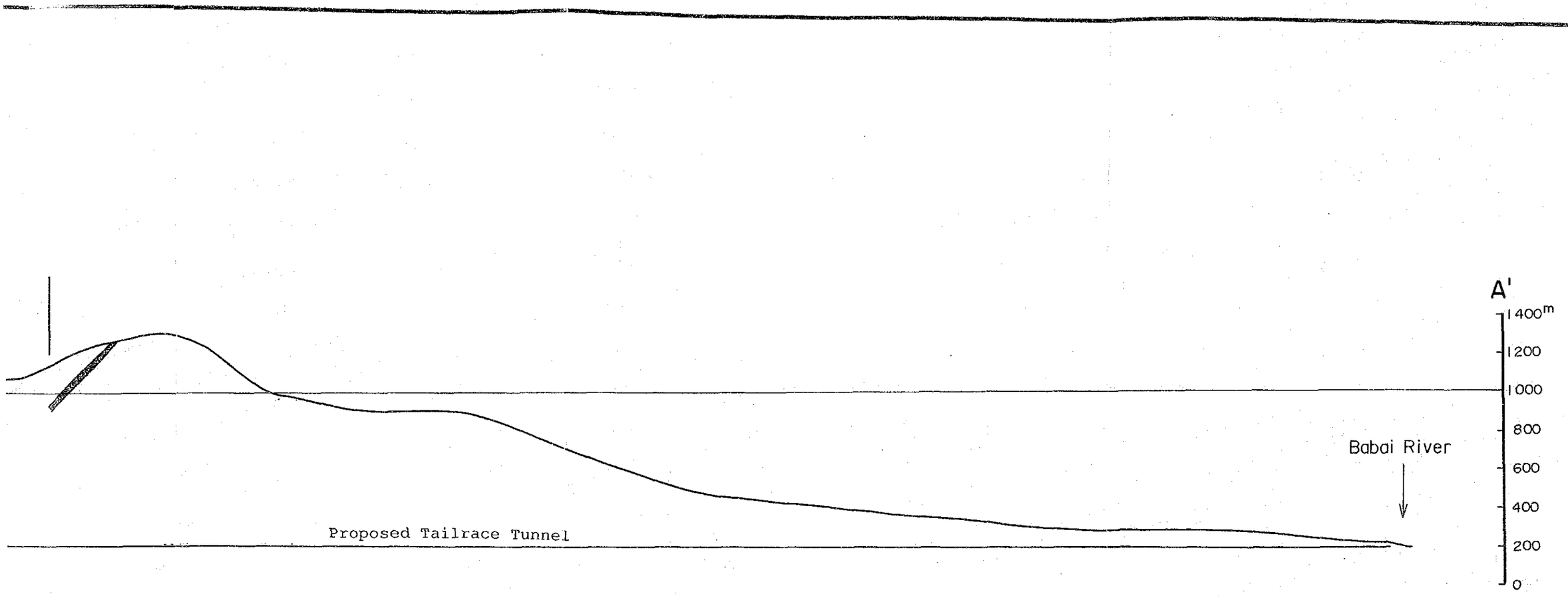


Figure 2.3.2 Geological Profile of BR-1 Scheme Site



SCALE 1 : 20,000

HIS MAJESTY'S GOVERNMENT OF NEPAL
WATER RESOURCES DEVELOPMENT OF
THE UPPER KARNALI RIVER AND MAHAKALI RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY

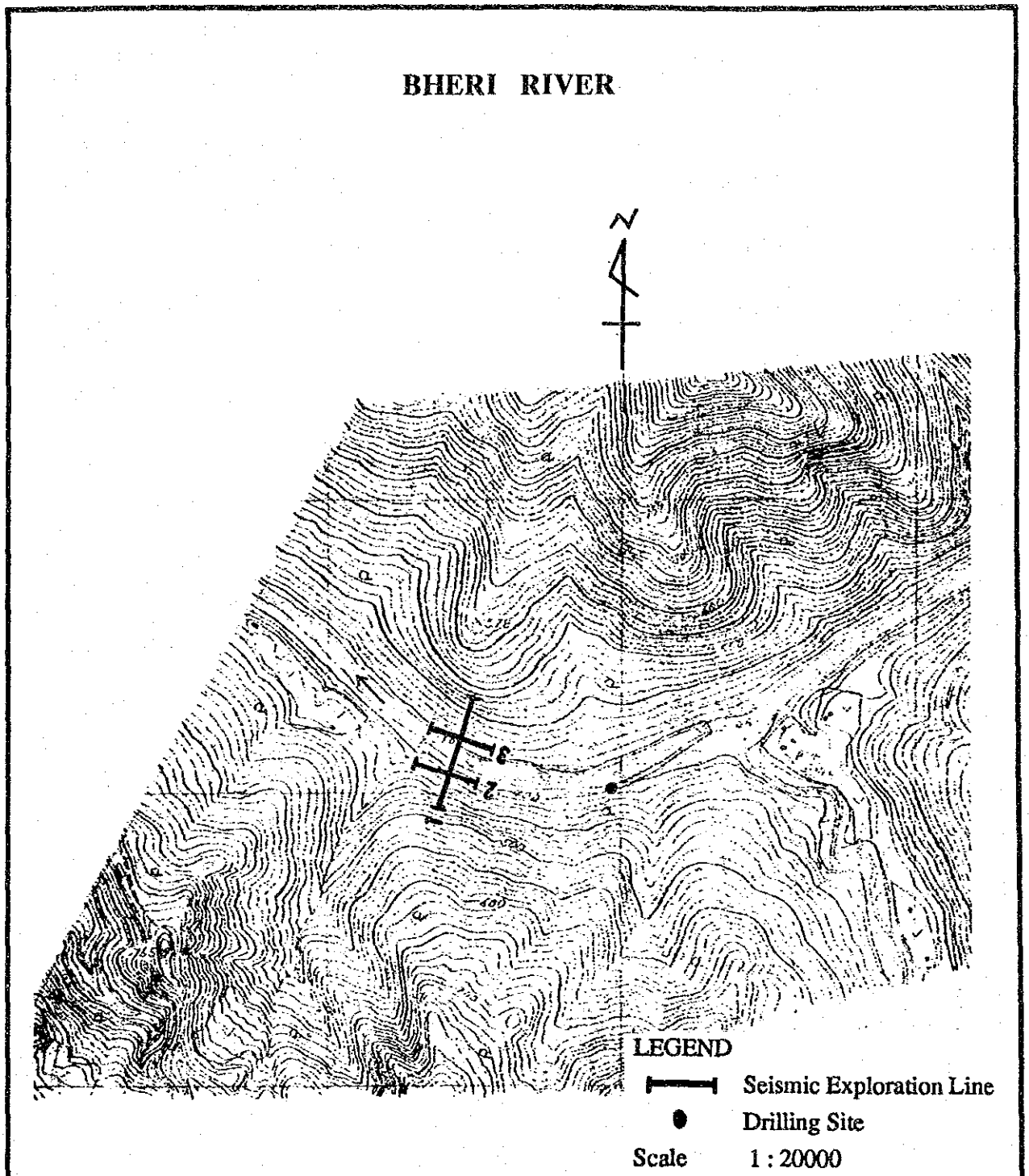
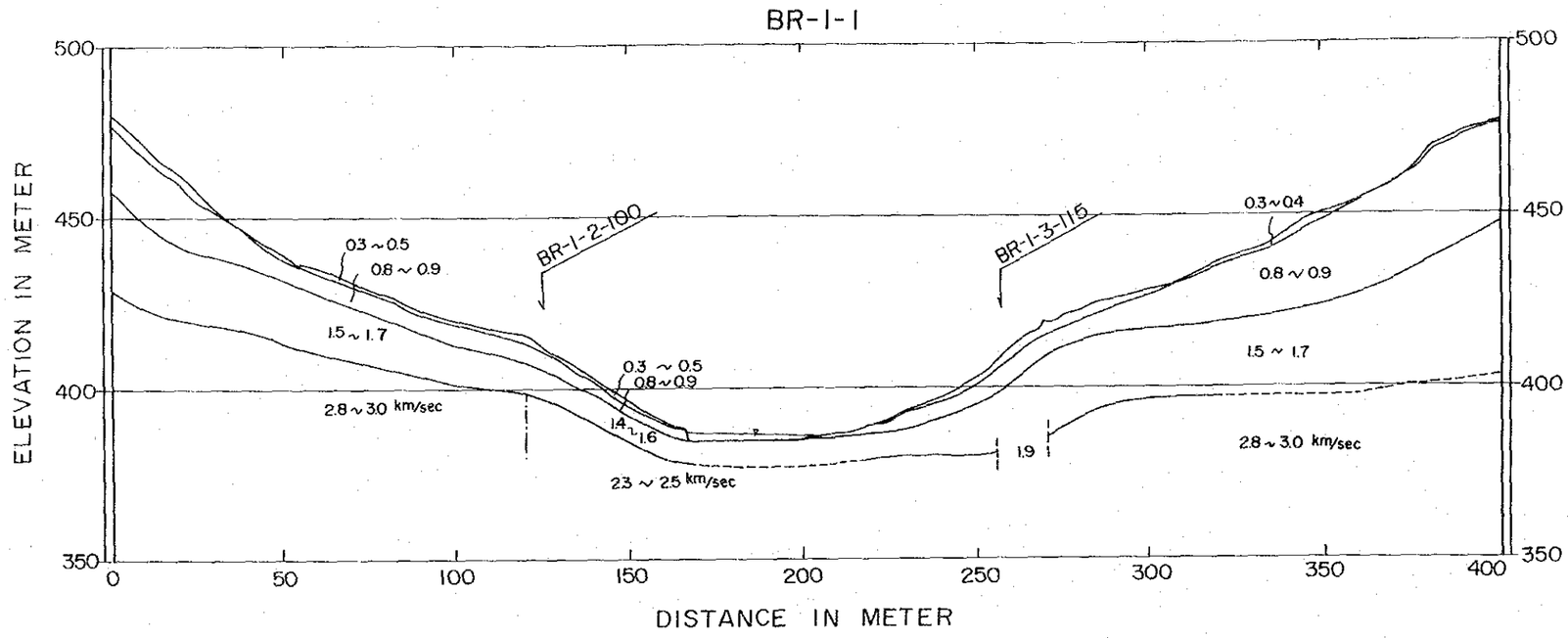


Figure 2.3.3 Location of Seismic Exploration in BR-1

HIS MAJESTY'S GOVERNMENT OF NEPAL
WATER RESOURCES DEVELOPMENT OF
THE UPPER KARNALI RIVER AND MAHAKALI RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY



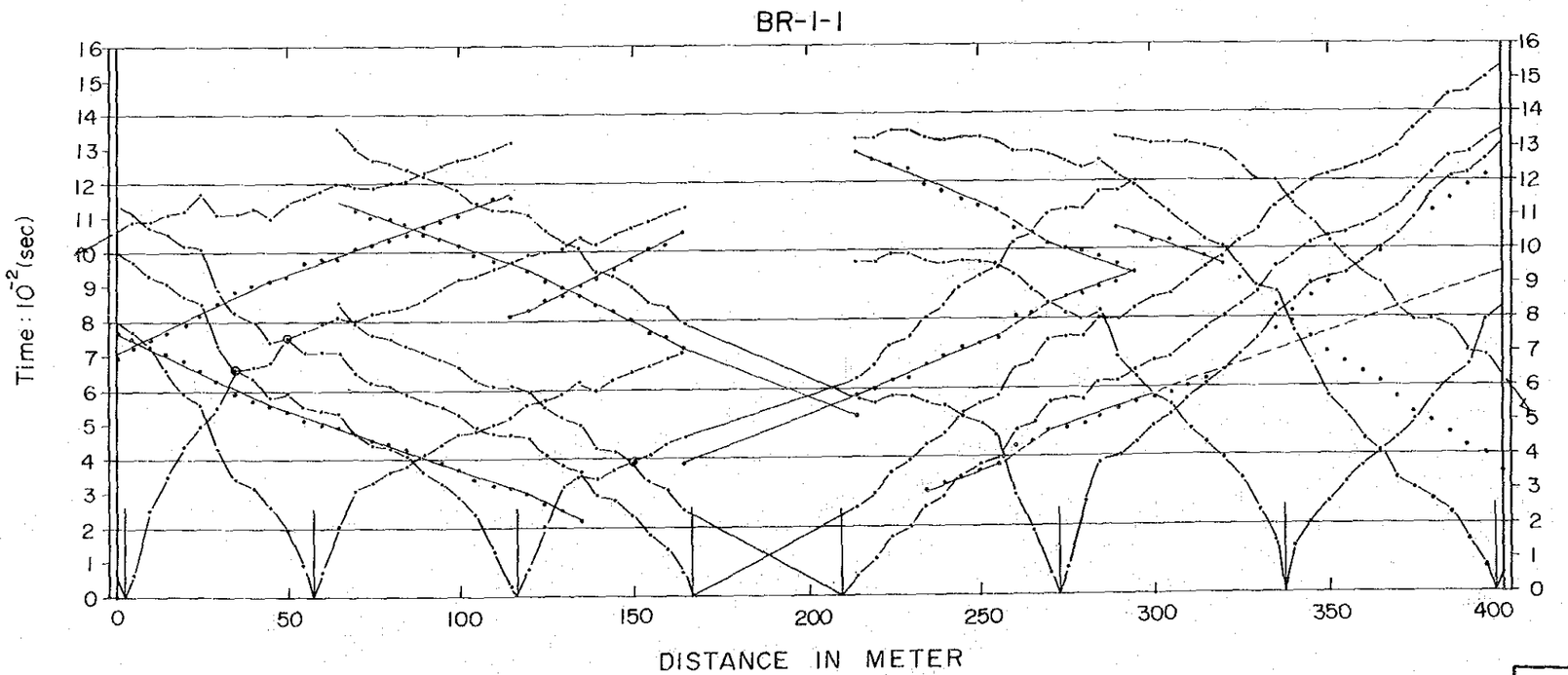


Figure 2.3.4 Seismic Velocity Profile and Time Distance Curve of Line 1 in BR-1

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WATER RESOURCES DEVELOPMENT OF
THE UPPER KARNALI RIVER AND MAHAKALI RIVER BASINS
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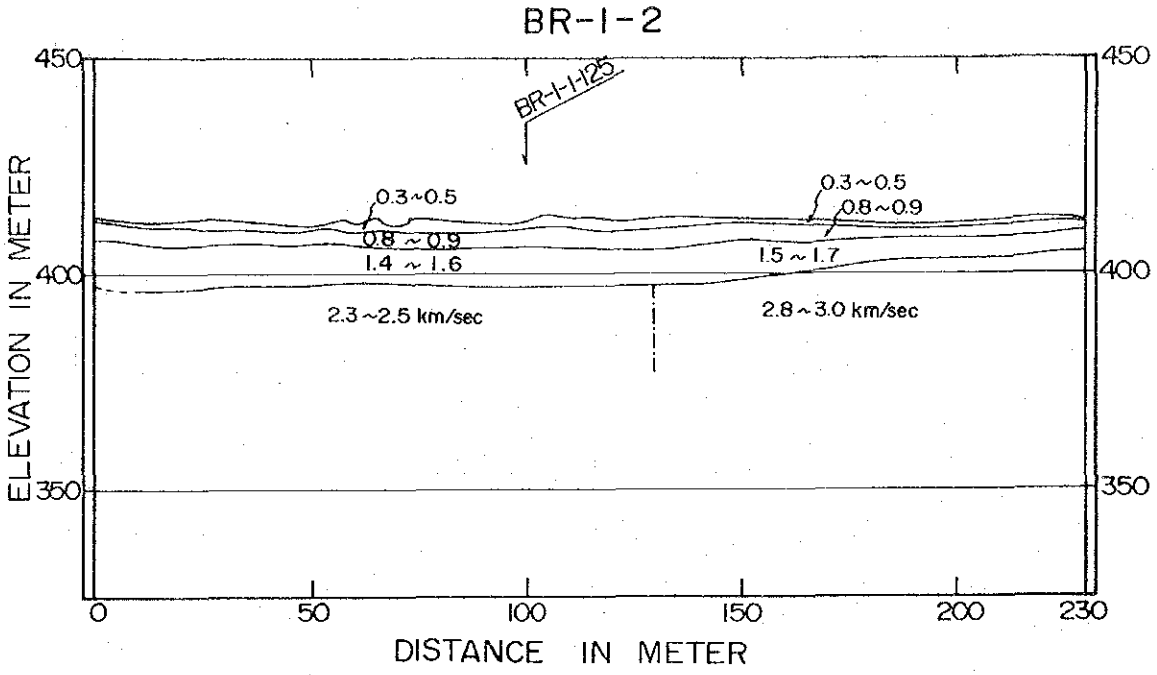


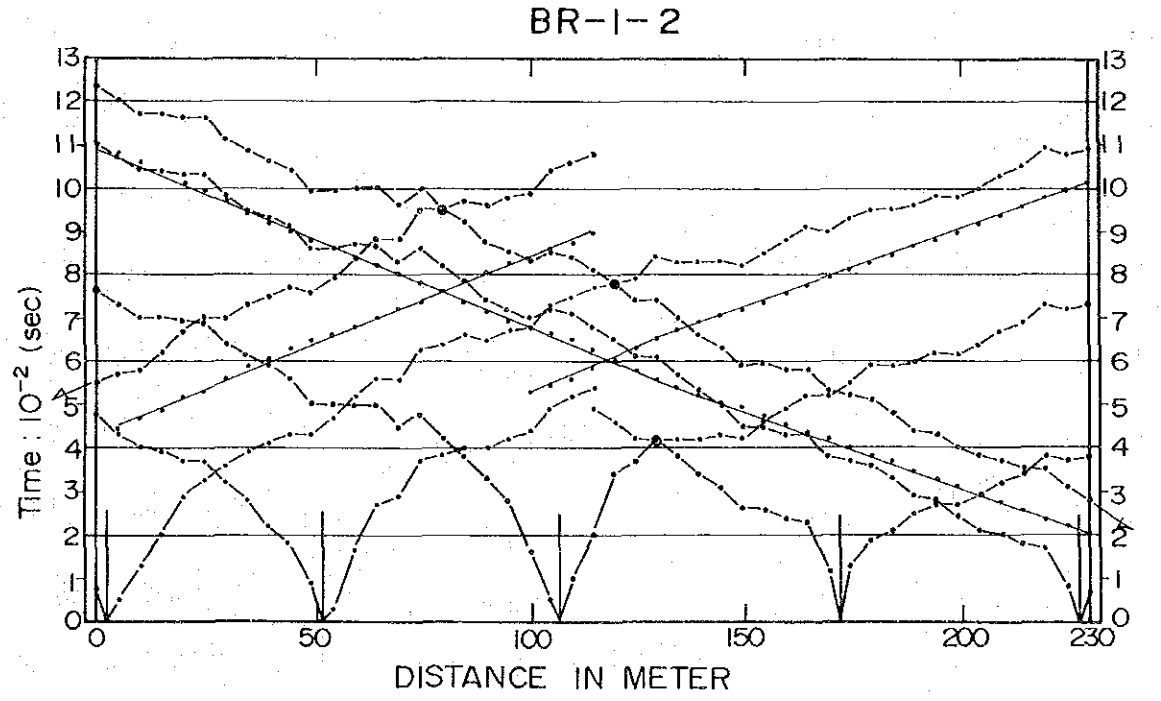
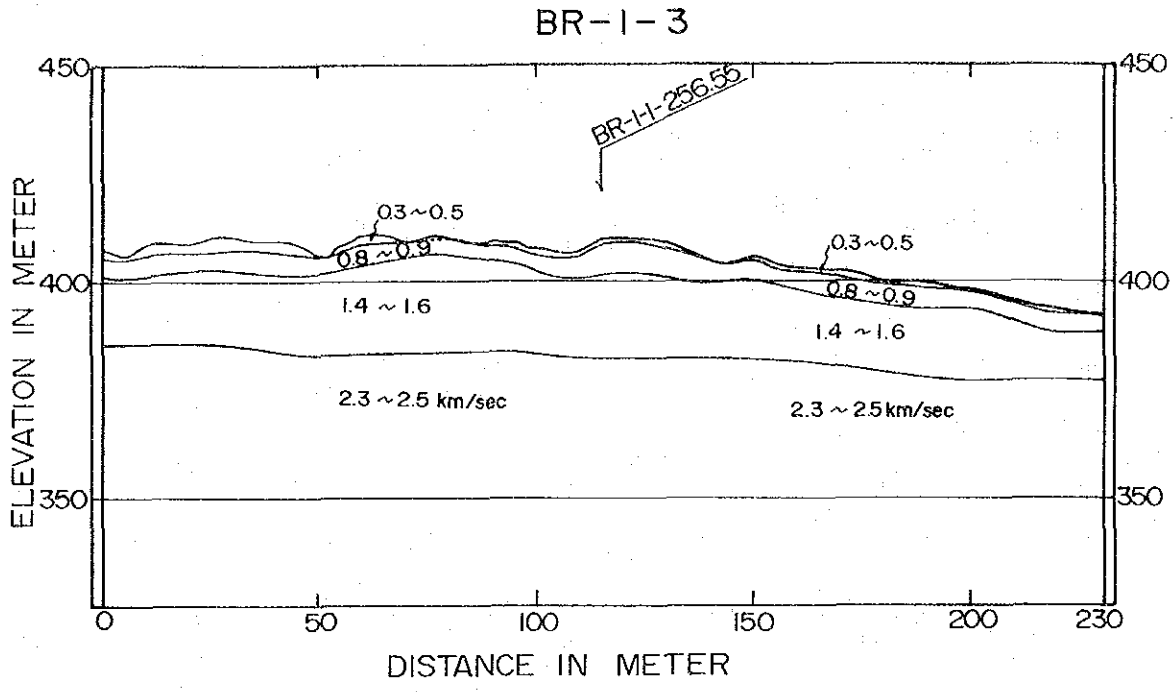


Figure 2.3.5 Seismic Velocity Profile and Time Distance Curve of Line 2 in BR-1

HIS MAJESTY'S GOVERNMENT OF NEPAL
WATER RESOURCES DEVELOPMENT OF
THE UPPER KARNALI RIVER AND MAHAKALI RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY



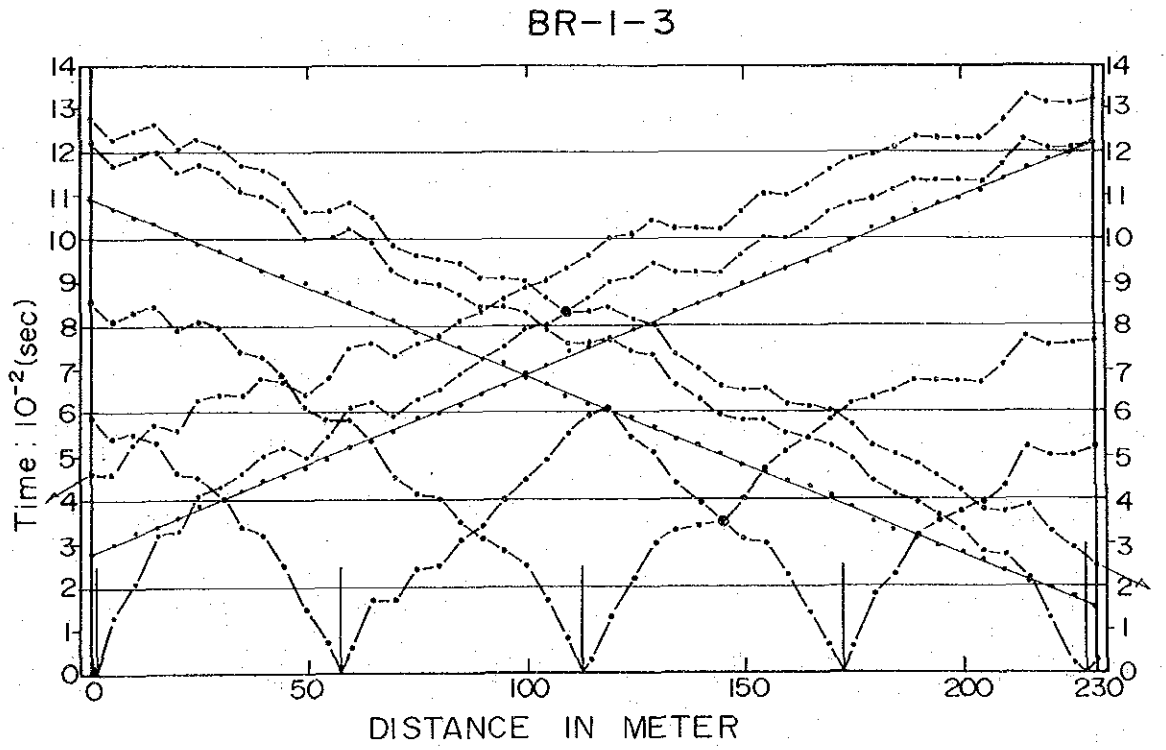


Figure 2.3.6 Seismic Velocity Profile and Time Distance Curve of Line 3 in BR-1

HIS MAJESTY'S GOVERNMENT OF NEPAL
WATER RESOURCES DEVELOPMENT OF
THE UPPER KARNALI RIVER AND MAHAKALI RIVER BASINS
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