SALIENT FEATURE

General

Source of River	:	Jwala Mai Loding Khola
Location	:	Tamakhani VDC, Solukhumbu
Altitude	:	2310 m above msl. (Power House Elevation)
Ward no	:	1, 2, 4, 5, 6&7 of Tamakhani VDC
Road head	:	
Name:		Jiri (Dolakha) - (All weather)
Distance (km)	:	65 km from Jiri
Beneficiary Households (Nos)	:	169
Load Center	:	Jwala Mai Tallo Tole, Pisung, Nathung, Jwala Mai Tallo Tole, Tamakhani and School Tole.

GPS Coordinate:

Intake	:	X: 0752615, Y: 3048684**,** Z: 2334 m
Forebay	:	X: 0752934, Y: 3048447**,** Z: 2331 m
Power House	:	X: 0752952, Y: 3048451**,** Z: 2310 m

Technical Parameters

Gross Head	:	20.57 m
Net Head	:	19.67 m
Measured Flow & Date	:	297 Lps, 2nd Feb, 2009 (Salt Dilution Method)
Least Flow	:	187.43 Lps in March
Design discharge	:	159 Lps
Overall efficiency	:	53 %
Power Output	:	17 kW
Length of Power Canal	:	355 m (Excluding Settling Basin) 312m-Stone masonry in 1:4 C/S and 43m -HDPE Pipe (400mm dia)
Power House	:	Internal dimension (5m x 4m x 2.5m) for machine room and (3m x 4m x 2.5, m) for operator room Stone masonry with mud mortar
Type of Turbine	:	"Crossflow turbine (T15) Runner dia 300mm, Runner length 155 mm, RPM 605.
Type of Generator	:	45 kVA, 3 Phases, Synchronous, Brushless 400V, 50 Hz, 1500 RPM with AVR

Type of Load Controller	:	ELC 17 kW with Ballast tank (7 kW per phase)
Drive System	:	V- Belt, Turbine-Pulley (200 mm)
		Generator-Pulley (90 mm)
Penstock Type & Length	:	M.S 300 mm ID, 3.5 mm, 47 m length
Length of T & D Lines (m)	:	L.T. (400 V/230 V) is 5645.0 meters
Pole Type & No	:	Wooden, 114-8.0 m ht, 17-7.0 m ht,
Ownership	:	Community
Productive End uses	:	Agro-Processing Mill, Rural Carpentry,
		Bakery, Photo Copy and photo studio, Computer
		Lab and High Vision Hall.
Proposed Tariff	:	Rs. 2.0 /Watt/month for HH lighting
		Rs. 10.0 /kWh for end uses
Average Subscribed Power	:	100 Watt per HH

Project Costs

Total Project Cost (Rs.)	:	4,712,880.00
Cost per kW (Rs.)	:	277,228.00
Total Non Local Cost (Rs.)	:	4,111,093.00
Non Local Cost per kW (Rs.)	:	241,829.00
Source of Finance (Rs.)		
Subsidy	:	2,592,500.00
Community Investment (Bank Loan)	:	691,449.00
Community Equity (Local costs)	:	601,787.00
Community Cash Contribution	:	591,500.00 (5,000 per HH)
DDC+VDC Investment	:	235,644.00 (5% of Total Project Costs)

Financial Analysis

Interest Payment	:	10 %
IRR	:	11.48 %
NPV (Rs.)	:	166617.00at 10 % rate (Discount Rate of 6%, 15 yrs)
B/C Ratio	:	1.27
Payback Period	:	7.0 yrs.

TABLE OF CONTENT

EXECUTIVE SUMMERY

Jwala Mai Loding Khola Micro-Hydro Project is located on the left bank of Tamakhani VDC of Solukhumbu District.

The Jwala Mai Loding Khola MHP is found to be feasible technically, economically and socially as well. The site for the scheme is in stable region and hence the components of the scheme do not need any major protection measures**.** The geology of the site is sound which has made the project feasible geologically too. The project is feasible technically in the sense that its fundamental components have been designed without consideration of severe consideration of natural forces as high debris movement, intermittent land slide, flood, fault zone, cracking possibilities and many more anticipated natural forces that may turn the project unfeasible if they are likely to occur in the topography of proposed scheme.

Jwala Mai Loding Khola Micro- Hydro Project is a runoff river type with the source as Loding Khola. Analysis shows that the source is perennial and has sufficient discharge even in dry season. The plant is designed with installed capacity of 17.0 kW in according to the present demand. The scheme will provide electricity to the residents of ward no -1,2,4,5,6 and 7 of Tamakhani VDC of Solukhumbu. The electricity generated will be utilized mostly for household uses along with some end uses. Altogether 169 households from the settlement will be benefited from the scheme. The gross head and design discharge of the scheme is 20.57 m and 159 Lps respectively resulting the total power generation of 17.0 kW with overall efficiency of 53 %.

The survey team measured the discharge of 297 lps on 2nd Feb 2009. The date of discharge measurement doesn't imply to the date specified by the MGSP standard but the discharge during measurement was quite low. The lowest flow in the Loding Khola based on hydrological calculations for ungauged MHP River is 144.17 lps in April. Taking consideration of 5% and 10 % of measured discharge for water losses due to evaporation /flushing/ seepage and downstream water release due to environmental reasons respectively, 159 lps with 11 month exceedance probability is taken as the design discharge for the proposed MHP. The detailed survey data shows that there will be end use diversification with the implementation of the project in years to come. Amongst the different end use possibilities, agro processing mill, rural carpentry, bakery and photo Copy and photo studio, computer lab and high vision hall will also be potentially installed after the project implementation.

The total cost of the project is Rs. 4,712,880.00 and the cost per kW is Rs. 277,22800.. The project would receive Rs 2,592,500.00 as subsidy to the MHP through the AEPC/ESAP. An amount of Rs. 691,449.00 would be mobilized from the bank. Besides, the community people would mobilize Rs. 601,787.00 through voluntary labor and local material contribution. The villager will contribute Rs. 591,500.00 from the cash contribution of Rs. 3,500 per household. The DDC+VDC will also invest Rs. 235,644.00 (5% of the Total Project Costs).

ACKNOWLEDGEMENT

The Detailed-feasibility study of Jwala Mai Loding Khola MHP was brought to effect after awarding the assignment to GREAT Nepal JV Development Network P.Ltd. For the purpose of fulfilling the above task, a well managed survey team with sufficient equipment was mobilized.

We would like to express our sincerely acknowledge to Alternative Energy Promotion Center / Energy Sector Assistance Programme (AEPC/ESAP) for providing this opportunity to conduct the feasibility survey. Required drawing and design is prepared according to the information and guidelines provided by AEPC/ESAP. And the cost estimate report is prepared considering present market rate of materials and local material rate.

And at last but not the least, we would like to express our acknowledgement to the survey team member Madhu Awal, Prakash Magar and the local villagers for their support and for delivering valuable information, co-operation during the site visit and as well as for their hospitality during that period and also I would like to special thanks to report preparation team Mr. Manoj Pathak for electrical design and drawing and Mr. Rajan Shrestha for civil and mechanical design and drawings.

We hope that the study will truthfully reflect the villagers lighting problem and their desire to implement the proposed MHP scheme.

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Technical Director
GREAT NEPAL Pvt. Ltd
Kathmandu

ACRONYMS AND ABBREVIATIONS

ACSR	-	Aluminum Conductor Steel Reinforced
AEPC	-	Alternate Energy Promotion Centre
Amp	-	Ampere
BOQ	-	Bill of Quantity
CM	-	Community Mobilizer
Cu.m	-	Cubic Meter
DDC	-	District Development Committee
EIA	-	Environment Impact Assessment
E/M	-	Electromechanical
ESAP	-	Energy Sector Assistance Programme
kg	-	Kilogram
km	-	Kilometer
kV	-	Kilo volt
kVA	-	Kilo Volt Ampere
kW	-	Kilo Watt
kWh	-	Kilo Watt Hour
LA	-	Lightning Arrestor
LPS	-	Liter per second
LT	-	Low Tension
MCB	-	Miniature Circuit Breaker
m	-	Meter
MHP	-	Micro Hydro Project
MIP	-	Medium Irrigation Project
PCC	-	Plain Cement Concrete
PCD	-	Pitch Circle Diameter
PDP	-	Power Development Project
RCC	-	Reinforced Cement Concrete
REDP	-	Rural Energy Development Programme
RPM	-	Revolution per Minute
Rs.	-	Rupees
Sq. m.	-	Square Meter
UNDP	-	United Nations Development Programme
VCDP	-	Vulnerable Community Development Plan
VDC	-	Village Development Committee

Chapter 1
INTRODUCTION

1.1 Back ground

Nepal is a mountainous country. Hence most of the areas are very remote and are far from the approach of the modern technology. The rural sector is occupying an important place in the national economy of the country in the sense that high percentage of population, more than 80 % live in the rural areas. The overall performance of the country in the area of socio-economic development is largely influenced by the development of the rural areas. The level of development of the rural areas as compared that of the urban areas lagged far behind even to this day. The rural sector is largely traditional and under developed in the country.

The Jwala Mai Loding Khola Micro Hydro Project was reported as feasible for detail study, after preliminarily surveyed done by field verification adopting carpet approach. For detail feasibility study of the Jwala Mai Loding Khola MHP, a contract was signed between GREAT Nepal JV Development Network P.Ltd and developer of Jwala Mai Loding Khola MHP. In accordance to that contract, this report is the final outcome of the technical and socio economic aspects of the field survey and interaction during meeting with Jwala Mai Loding Khola MHP beneficiary.

The site was visited by a Engineer hired by the consultant. The site was visited from 1st Feb to 4th Feb 2009. Professionals as enlisted below visited the site:

Table 1: Name Of Manpower

Name	Designation
Madhu Awal	Engineer
Prakash Magar	Assistant

1.2 Objective of the Study

Power is the basic tool for development activities in any village. With the realization of this fact this study has been carried out. Basically, the followings are the objectives of the study. From analyzing various projects, the study shows that most of the project fails due to the improper analysis of the hydrology, failure in civil structure and also in selection of the appropriate and sufficient electro-mechanical components. Considering all the issues following objectives have been noted to carry out the feasibility study of the project.

- Hydrological study and flow measurement
- Carry out survey for appropriate structures, their location and design
- Design appropriate and suitable electro-mechanical equipment
- Design transmission / distribution lines
- Identification of potential load and load center / demand of power
- Identification of environment and issues related to water left

- Identify any other suitable measures for the futures sustainability

- Discuss about the technical and socio- economic aspects of the proposed scheme

1.3 Methodology

The entire work of the Detailed Feasibility Study was carried out in two stage viz fieldwork and desk (office) work.

1.3.1 Field Work

The survey team comprised of an Engineer and surveyor was employed for carrying out technical survey. The survey was performed with the active participation of the developer and the villagers.

To start with, the team made a comprehensive reconnaissance survey around the village and along the canal and stream bank with the villagers. Consultations were made with local teachers, social workers, politicians and senior citizens of the locality, who were present in the village during the time. With the thorough analysis of the situation, detailed measurements were carried out to locate the best suitable intake, proper canal alignment, settling basin, stable forebay location, tailrace route and powerhouse.

The team carried out detailed engineering survey of intake area, alignment of the headrace conveyance, settling basin, forebay and power house locations and exit of the water (tailrace and spillway). The transmission / distribution line was also measured with tape and compass due considerations of having least adverse impact on environment and aesthetics. The team tried to make the T/D lines shortest possible and the alignment in the stable place. Due attention was given to have multipurpose use of water, both for irrigation and power generation.

The detail survey was done with the help of an Abney Level, 50m and 5 m tapes and GPS. The detail survey was done within the principles of leveling. The flow measurement was done by the salt dilution method using conductivity meter.

1.3.2 Office Work

After the completion of the fieldwork, the team proceeded to analyze the data and work out designs of various components. All the data and information were carefully analyzed to come to the final and detailed designs of all the necessary components. The views and suggestions were duly taken into consideration while carrying out the detail designs of the scheme. The design of all civil as well as electro-mechanical components was carried out following AEPC/ESAP guide lines & design spread sheets. And necessary drawings were prepared. This detailed feasibility study report is the outcome of the survey conducted.

Chapter 2
GENERAL PROJECT DESCRIPTION

2.1 Locations and Accessibility

The proposed micro-hydro project is in Tamakhani VDC of Solukhumbu District. Solukhumbu District lies in the Sagarmatha zone, Eastern Development Region of Nepal. It is one of the mountainous regions with full of slope terrain. The proposed site is situated at about 2310 m above msl.

It takes about 2 days walk for normal and about 4 days for loaded porter to reach the site from the nearest road head Jiri of Dolakha district and 4 days walk from the nearest airfield, Solukhumbu district. The proposed site is only 65 km far from the all weather road Jiri.

2.2 Topography and Geography

The topography and geography condition of the proposed site is found to be fairly stable enough. The average altitude of the proposed site is situated in 2310 AMSL (Power house elevation). Most of the proposed project area lies in moderate sloppy area with full of slope terrain. No any sign of major landslide and other instability were found during the site visit. The headrace alignment is along the cultivated clayey land, boulder mix and Common soil.
All the components of the proposed micro hydro project, lies on the left bank of the Loding khola.

The proposed intake and diversion location is at the left bank of Loding Khola, and lies in stable place and possibility of bed scouring is also less. The bank of the Khola is also strong and stable enough. The alignment of the headrace runs through left bank of the Khola, which consists of uncultivated rocky and cultivated clayey terrain. Overall Headrace canal is designed to convey water from intake to Forebay.

2.3 Climates and Vegetation.

The proposed project site is located in Solukhumbu District, Eastern Development Region of Nepal. The District lies in the MIP region 1. The two seasons of the year are well marked with typical variations. Due to the moderate altitude the climate is suitable for growing different types of plant and vegetation. The natural vegetation in this project area changes with the variation in elevation, soil regime and slope. Agriculture is the most predominant land use pattern of the area both geographically and economically. Major land use category of the VDC includes agriculture land, forest and bushes, hard rock and mountain, rivers and stream banks. The natural vegetation around the project area consists of bushes, soft wood trees and hard wood trees. Major agricultural products are Millet, maize, wheat, potatoes etc

2.4 Project Area and Facilities

The target area covers ward no-1,2,4,5,6&7 of Tamakhani VDC. The number of household in beneficiary area is 169. There is Primary School as well as higher secondary school. The area is facilitated with health post, post office and telephone service.

2.5 Hydrology and Water Left Issues

The source of flow is Loding Khola, which is a perennial stream. The flow in the stream was measured following salt dilution method using conductivity meter. The flow was measured on 2nd Feb 2009, which doesn't follow the MGSP guideline of measurement of discharge but the water during the measurement was quite low and sounded feasible.

The hydrological calculation is based on MIP method. The site lies on the MIP region 1. The design discharge was calculated considering about 85% of 11-month exceedance, 5% for water losses and 10% for downstream release and found to be 159 lps which is quite safe. The average monthly flow using the MIP method is presented in the table below.

Table 2: Mean Monthly Flow, Jinakhu_Khola

Date of Flow Measurement: 2nd Feb 2009, Flow Measured: 297 lps

Month	Flow at River, lps
January	346.02
February	259.51
March	187.43
April	144.17
May	**374.85**
June	865.05
July	2090.53
August	3604.37
September	2378.88
October	1153.40
November	591.12
December	446.94
Annual Average	**460.571**

So far as the water left issues concerned, there is not as such any serious conflict on water use. The water needed for the plant can be diverted without any conflicts. The matter of water use was thoroughly discussed amongst the community people.

2.6 Energy Consumption Pattern

2.6.1 Present Situation

All most all the people in the village used wood as their sources of energy for cooking and kerosene for lighting. Firewood is being used extensively as the major source of energy and it is being largely consumed for residential purposes. Consequently, massive encroachment of forests has taken place due to fuel wood collection. Kerosene is mainly used for lighting. Based upon the household survey, the fuel wood consumption per HH per month is approximately on an average, 5-6 *bhari* (~280 kg) and 2.50 litre of kerosene per HH per month in the project area. However most of the people have no records of energy consumption, the general energy use pattern of this settlement (community) has been summarized in the following table.

Table 3: Energy Source and Use

Items	Unit	Rate/ Unit	Qty. (per HH per month)	Average Monthly Use				Remarks
				Cooking	%	Lighting	%	
Fuel Wood Per HH	Bhari	40	5-6 Bhari (280 kg)	-	100	-	-	Free of cost normally, pressure on forest is maximum
Kerosene	Litre	95	2.50	-	-	2.50	100	People buy from Local bazar
Dry Cell Batteries	Pair	40	2	-	-	1.0	40	60 % for radio, cassette.

2.6.2 Domestic Demand of Electricity

The study shows that almost the entire village has minimum 3 to maximum 4 rooms. That means an average demand of electricity is between 3 to 4 bulbs, which will be enough. Considering the average demand and the production of electricity about 101 watt per household is proposed for the electricity, which is just sufficient to illuminate three to four incandescent bulbs of 25 watt. Furthermore, the technological advancement in the area of efficient lighting (CFLs) would solve the future demand of peak hour lighting. The community people discussed in length about the matter during the detail survey of the MHP and came to the conclusion to include all the households of the locality (169 households). Study shows that the peak demand of electricity has been coming from household lighting in morning and in the evening. In addition to household lighting, for the use of daytime energy there is possibility to promote different kinds of end-uses by providing technical training and other kinds of supports.

2.6.3 Potential End Uses

Electrical energy is one of the least cost options for income generating activities in the remote rural area. The proposed MHP is designed to produce 17.0 kW, which can only meet the peak demand for lighting, so the end-use application will be done mostly during daytime. As per survey of the area and views of the local people, the following end uses of electricity seem possible with optimum and managed use of available electric power.

Agro-Processing

Based on the survey on agriculture production and the assessment of quantities that could be processed in the beneficiary area it has been found that there is the potentiality for the establishment of an agro-processing mill. At present most of the local people are using the traditional way of agro-processing which is time consuming and also needs more strength. As per the survey and discussion with the local people, people seem interested to operate the agro-processing mill themselves. Based on the survey, there seems a good potentiality for an agro-processing mill. An agro-processing mill of 4 kW running for 5 hours per daytime (7 am to 12 am) and 200 days per year is established in the surveyed as well as other near villages also.

Bakery

Also the community wants to have a bakery with them. It is estimated that the bakery will consume 3 kW running for 4 hours per day during nighttime (11 pm to 3 pm) and 250 days per year.

Rural Carpentry

The area has very good vegetation of forest with different types of trees. So it is very much possible to run a saw mill for wood works to promote rural carpentry. There are skilled carpenters in the project area, who make furniture by using manual tools to meet local demand. With the establishment of the industry, the quality of the products would be enhanced, thus would also increase their demand. As per discussion with the community people, such workshops would be established in the community, which would consume 3 kW for 5 hours a day during daytime (12 pm to 5 pm) and 275 days per year. This industry would be registered in the District Cottage and Small Industry Office and/or District Forest office at the District Level.

Photo Copy and Photo Studio

The micro hydro project covered the main local bazaar of the Tamakhani VDC where the post office, Health post, Higher Secondary school and telephone are facilities. So there is a possibility of Photo copy and Photo studio as according to local people they have to interest to propose a photo copy and photo studio of 3 kW running for 4 hours a day during morning time (7 am to 11 am) and 220 days per year.

Computer Lab

The micro hydro project covered the only one higher secondary school of Tamakhani VDC. So the power to be utilized in school and for computer and other works in school which would be consume 3 kW running for 5 hours a day during day time or school time (10 am to 5 pm) and 250 days per year.

High Vision Hall

The micro hydro project covers the local bazaar of the VDC. So there is a possibilities of of high vision hall which would consume 2.50 kW running for 3 hours a day during morning time (7 am to 10 am) and 120 days per year.

Table 4: Possible End Uses

End Uses	kW Demanded	Tariff Rate (Rs./kWh)	Operation		Annual Energy Consumption (kWh)	Income (Rs.)	Remarks
			Hrs./Day	Days/Years			
Agro-processing mill	4	11.00	5	200	4000	44000.00	7am - 11.00 am
Bakery	3	11.00	5	250	3750	41250.00	11 pm - 4.00am
Rural Carpentry	3	11.00	5	275	4125	45375.00	12.00 pm- 5pm
Photo Copy and Photo Studio	3	11.00	4	220	1760	19360.00	7.00am - 11.00 am
Computer Lab	3	11.00	6	250	4500	49500.00	11.00am - 5.00 pm
High Vision Hall	2.5	11.00	3	120	900	9900.00	7.00am - 10.00 am
Total					**19915**	**219065**	

2.6.4 Expected Load Demand Pattern

The expected load demand pattern (Watt) over 24 hours period has been provided in the following table.

Table 5: Expected Load Demand Pattern

Load	4 am – 7 am	7 am – 10 pm	10 am – 11 pm	11 am – 12 pm	12 am - 5 pm	5 pm – 11 pm	11 pm -4 am	Remarks
HH Lighting	17 kW					17kW		9 hrs/day, 330 days/ year
Agro-processing mill		4 kW	4 kW	4 kW				5 hrs/day, 200 days/year operation
Bakery							3 kW	5 hrs/day, 250 days/year operation
Rural Carpentry					3 kW			5 hrs/day, 275 days/year operation
Photo Copy and Photo Studio		3 kW	3 kW					4 hrs/day, 220 days/year operation
Computer Lab				3 kW	3 kW			6 hrs/day, 250 days/year operation
High Vision Hall		2.5 kW						3 hrs/day, 120 days/year operation
Total	**17,000 Watt**	**8,500 Watt**	**7,000 Watt**	**7,000 Watt**	**6,000 Watt**	**17,000 Watt**	**3,000 Watt**	

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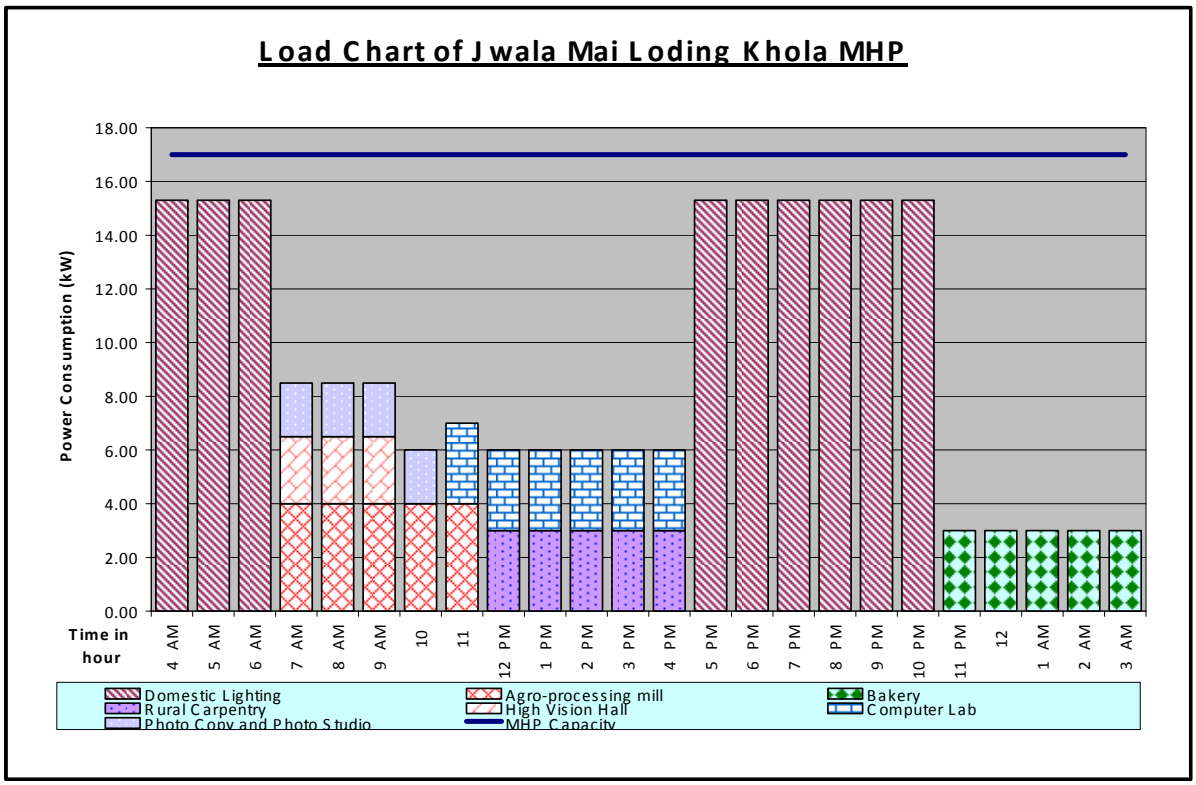


The agro-processing units and other end use should be run at different times during the day without overloading the plant.

2.7 Socio-economic Condition and Affordability

The proposed project area is situated in Eastern Development Region. There are 169 houses benefited from the project. The dominant ethnic of the proposed project area is Brahmin, Magar, Chettri and dalit.

Agriculture and cattle rising is the main source of income of the people. In recent days most of the young generation are interested in foreign employment and several has been also gone aboard. The project area is economically active area of the district and most of the people have well understanding and commitments on work.

The average landholding per household in the village is about 10 ropanis. Wheat, maize and potato are the main crops. People also keep livestock to improve their economy. Cow, Goat, Sheep, etc. are species kept by the villagers. The economic status of the villagers is good. About 90 % of the population is capable to pay the electricity bill and have good understanding about the electricity.

The educational background of the project area is also good. There is at least a literate in each household, more than 301 people with education of SLC or more, more than 30 people with education of +2 or more and more than 30 people with education of university or more.

The status and interest of the women in the area is fair and possess high levels of enthusiasm for the development of project, which is expected to change the current status of the village and the villagers with the implementation of the MHP.

Due to the implementation of the micro hydro project, high quality of lighting system would improve living condition along with the health and environment. It will also provide more

time for students to study and will improve the education system in result. The efficient end uses will reduce time and cost, and will also generate new sources of income, which ultimately will improve economic condition of the local people.

Table 6: House hold to be electrified:

S.N	Name of Village	No of House (HH)	Remarks
1.	Jwala Mai Tallo Tole	30	Tamakhani - 5
2.	Pisung	8	Tamakhani - 5
3.	Mathung	24	Tamakhani - 4
4.	Jwala Mai Mathillo Tole	37	Tamakhani - 6
5.		8	Tamakhani - 7
6.		22	Tamakhani - 1
7.		32	Tamakhani-2
		3	Tamakhani-6
8.	School Tole	5	Tamakhani - 6
	Total	**169**	

2.8 Plant Size and Power Requirements

Before effective design of hydropower project, one must consider the coordinated use of the stream water for power generation as well as other local purposes. The site for the powerhouse is selected in such a way that the water from the tailrace can safely be discharge to the parent stream. No serious water left issues have been observed during the survey. The hydrology and water left issues were already discussed in 2.5.

Power (P) = η x Q x H_g x g

= 17.0 kW

Where,

Q = Discharge in lps- 159 lps

H = Gross Head in m- 20.57 m

η= Overall Efficiency of System (53 %)

g = Acceleration due to gravity, 9.81 m/sec2

Where,

Penstock = 95%

Efficiency of turbine = 65% (Cross flow turbine (T_{15}))

Efficiency of Drive system = 97%

Efficiency of Generator = 88%

All the project structures are proposed to be constructed on the left bank of Jwala Mai Loding Khola. The tail water will be safely discharged to river. The length of the tailrace canal is 20 m.

Chapter 3
TECHNICAL ASPECTS OF THE MHP

3.1 Civil Components

3.1.1 Intake Structure and Diversion

The intake structure is proposed at left bank of Jwala Mai Loding Khola. In consideration of the flow of the river, semi temporary type diversion structure of gabion fill with stone of approximate height of 1 m and 28 meter long is proposed to be built across the Khola. The proposed weir is of low cost and utilizes locally available materials which could be easily maintained after damaging by the flood during rainy seasons and also a gabion structure is proposed on the left side of Jwala Mai Loding Khola which protect the canal from flood in rainy season The respective position of weirs and other fundamental components of MHP are shown in drawing entitled 'General Layout'.

An intake canal with coarse trash rack is proposed to avoid the coarse sediments entering the canal. The intake canal runs from intake to Settling Basin at 35 m from the intake. The intake canal is proposed of stone masonry in 1:4 cement mortars. The size of orifice is 0.40m x 0.35m which controls the discharge. A coarse Trashrack size of 0.70mx0.60m is provided at the entrance of intake towards the settling basin and also a sluice gate of 1.60m height and 0.65mx0.65mopening is proposed on intake to control the flow. Details of the head works are given in the drawing.

3.1.2 Headrace Conveyance

Headrace Canal is proposed for conveyance of water. The stone masonry canal is proposed of cement mortar of 1:4 with inner surface plaster with 1:4 c/s. The stone masonry canal is proposed to be of 30 cm wall thickness with 45 cm depth including 15 cm freeboard and 55 cm width. The details of the headrace profile and section are shown in drawing. The length of headrace canal is about 355 m excluding settling basin. A HDPE pipe 42 m long of 400 mm OD is also proposed at canal due to construction of stone masonry canal and a coarse Trashrack of is 0.70m x .60 m is also proposed at in front of HDPE pipe.

3.1.3 Settling Basin

Settling Basin is proposed at 35 m from intake. The basin is fed by the canal and discharges to headrace canal. The basin is designed for settling particles. The settling basin is designed considering 2 kg/cm3 sediment concentration in order to settle particles larger than 0.3 mm. The internal size of the basin is proposed of 8.0 m x 1.6 m (inside of settling area only). The basin is designed to flush at every 12 hours and manually. A flushing gate is of 1.20 m height and 0.55m x 0.55m opening is proposed for flushing settled sediments. . A spillway of 9.0 m is provided to spill excess flow if entered the settling basin.

3.1.4 Forebay

The Forebay is proposed at the end of headrace canal. It is designed for settling particles that escaped the settling basin and to discharge water to penstock. The forebay is designed considering 1 kg/cm3 sediment concentration in order to settle particles larger than 0.2 mm. The internal size of the basin is proposed of 8.0 m x 1.6 m (same as settling basin). The forebay is designed to flush at every 12 hours and manually. A flushing cone of 300 mm dia 1.60 m height is provided to flush the settled particles. A spillway of 35 m is provided to spill excess flow if entered the forebay which meets the tailrace canal which meets the Loding khola. A canal as the same dimension of headrace canal is proposed for safely discharging flushed sediments as well as over flow to the river. A fine trash rack (0.80m x 1.60m) is provided in order to prevent any debris entering the turbine via penstock. And also air vent pipe of 50 mm dia GI pipe is proposed on the forebay.

Both the structures are proposed to be made of stone masonry with 1:4 c/m with inner surface plaster with 1:4 c/s. The details of the both structures are given in the drawing.

3.1.4 Penstock, Anchor Block & Support Piers

According to the available head, a mild steel pipe of 300 mm ID is proposed. The overall length of the penstock is 47 meter and 3.5 mm thickness.

The M.S pipes are proposed of about 2.5 meters in length, rolled/ welded having flange at each end connected together. Flange should have 14 mm thickness and properly welded together with the pipe. The details of penstock profile are given in the drawing.

The anchor blocks and the support piers are designed to support the penstock pipe. Anchor blocks are proposed to be designed at every vertical bend and at 30 meter spacing at the straight section. Altogether 3 numbers of anchor blocks are required along the penstock pipe. After each anchor block expansion joints are placed. Each anchor block is constructed of 1:3:6 PCC with 40% plum concrete. Altogether 10 nos. of support piers are designed. Spacing of support piers varies and shown in drawing. Support piers are constructed of stone masonry in 1:6 c/s mortars. These blocks are designed considering the stability, bearing capacity of soil, thrust pressure and water pressure. The details of the blocks are given in the drawing.

3.1.5 Powerhouse, Machine Foundation & Tailrace

The powerhouse is proposed to be located on the thick bushes land. It is located in flatter portion of land having sufficient space for building the house. The powerhouse is sufficiently above the flood level. The powerhouse consists of internal dimensions of 5.0 m lengths, 4m widths and 2.5m heights for machine room. Similarly operator room of internal dimension 3.0 m lengths, 4.0 m widths and 2.5 m heights. The building is to be built of locally available stone masonry walls with mud mortar. The roof is to be covered with CGI sheets and CGI sheet riding with wooden rafters and purlins.

Machine foundation has been designed as required to be in safer side against overturning, bearing pressure and sliding considering the forces due to maximum expected surge head, weight of turbine and weight of generator. A minimum of 20 mm diameter, 700 mm long anchor bars are to be used to fix base frame to the machine foundation. 10 mm diameter tor steel bars are to

be used for reinforcement. Maximum spacing to be provided is 150 mm in turbine pit and 300 mm on other faces. Lap length will be 400mm on other faces. Lap length
shall be 400 mm min. Minimum reinforcement cover shall be 50 mm. Structural concrete shall be 1:2:4 mix. 10 mm width of sand and gravel has been placed at periphery of machine foundation down to depth of powerhouse floor. The details of the machine foundation are given in the drawing.
A stone masonry tailrace canal is proposed from the powerhouse after the turbine to discharge the water back into the stream. The length of the tailrace canal is about 20 m. It will be of about 45 cm width and 45 cm depth in dimensions which bigger than headrace canal.

3.2 Electro-mechanical Works:

Most of the electromechanical components would be manufactured / fabricated in Nepal. The topic gives a brief description about design and selection of the components proposed for the project.

3.2.1 Trash rack

A coarse trash rack is proposed at the intake. The proposed size of the coarse trash rack is 60 cm x 70cm. The trash rack is proposed of 5 x 40 mm steel plate with 50 mm c/c spacing of the bars and inclined at 1:3.

A fine trash rack is proposed at the forebay. The proposed size of the fine trash rack is 80 cm x 160 cm. The size of angle iron of the proposed trash rack is 30x30x5 mm as well as the size of flat iron is 30x5mm @ 35 mm c/c spacing of the bar

The details of the trash racks are given in respective drawings.

3.2.2 Penstock layout, Expansion Joints & Pressure Gauge

According to the available head, a mild steel pipe of 300 mm ID is proposed. The overall length of the penstock is 47 meter and 3.5 mm thickness.

The M.S pipes are proposed of about 2.5 meters in length, rolled/ welded having flange at each end connected together. Flange should have 14 mm thickness and properly welded together with the pipe. The details of penstock profile are given in the drawing.

Expansion joints are also designed for the movement of the pipes during the temperature variation. The thickness and size of the joints are decided on the basis of the temperature variation of the scheme. The maximum temperature of the site is considered 40 degree and minimum as 4 degree. Altogether 3 nos of expansions joints are enough. An air vent pipe of 50 mm diameter is proposed at the starting point of the penstock pipe.

Pressure gauge measures the pressure head at the end section of the penstock. The size of the pressure gauge depends upon the gross head of the scheme. For the gross head of 20.57 m we need the pressure gauge of size 5 BAR and considering factor of safety pressure gauge of 10 BAR is proposed.

3.2.3 Turbine

The scheme has gross head 20.57 m and design flow is 159 lps. So the generated power is 17.0 kW. For this purpose, Cross flow turbine is recommended. Though, each manufacturer has their own design and product specification we have recommended the following major specifications of the turbine. (Detail design will be as per the manufacturer at the time of manufacturing with required output.)

Specification of the proposed turbine is as follows:

Type	: Cross flow (T15)
Valve	: Butterfly (Gear Operated)
Runner rpm	: 605
Runner Length	: 155 mm
Runner width	: 300 mm
Discharge	: 159 lps.
Turbine Shaft Power	: 19 kW
Efficiency	: 65 %

3.2.4 Generator

A three phase self-excited and regulated, synchronous generator that is rated to continuously deliver 17 kW at 0.8 power factor at the given site condition is proposed. The generator size and type should be compatible with the electronic regulation system i.e. ELC. The construction and bearings of the generator should be rated to withstand runway speed under fault condition. The bearings should further take the static load exerted on them by the drive system. The brush less synchronous generator of 45 KVA is proposed for the scheme. The proposed generator has following specification:

Type	: 3 Phase, brushless synchronous Generator
Frame size	: GR200SA
Capacity	: 45 KVA
Speed	: 1500 rpm
Frequency	: 50 Hz
Power factor	: 0.8
Efficiency	: 88%
Nos. of pole	: 4
Generation Voltage	: 400 V
Connection	: Star
Insulation Class	: B
Environment Protection	: IP21
Standards	: BS-4999/1977

Excitation System: The generator field obtains the excitation from the overhung exciter and rotating bridge rectifier. The exciter field is controlled by Automatic Voltage Regulator (AVR) which is mostly internally mounted on the generator. Its voltage regulation is +/- 2.5%

3.2.5 Drive System

The drive system transfers the mechanical energy from the Turbine shaft to the generator rotor at required speed. Here, the speed of the turbine is 605 rpm and the generator rated speed is 1500 rpm. So, the gear ratio should be 1:2.20. For this, Flat Havasit Belt with pulley is recommended. The belt could get loose after some period of operation. A sliding mechanism should be incorporated in the generator base to tight the belt. Also the belt guard is to be provided for the safety of the operator.

Specification of the drive system

Type	: Flat Havasit Belt
Gear ratio	: 1:2.20
Pulley on Generator Shaft	: 200 mm diameter.
Pulley on Turbine Shaft	: 90 mm diameter.

3.2.6 Control System

Electronic Load Controller (ELC):
The Electronic load controller is recommended to maintain the speed and frequency of electricity generated. An ELC with ballast unit is proposed to control the system load such that the generator is always operating at full load. In other words, it is necessary to keep the supply in balance with the demand in order to avoid the overloading and underloading of the generators. The specifications of the proposed ELC are as follows.

Type	: Locally assembled
Capacity/Phase/Voltage	: 17 kW/3ph/400V
Frequency	: 50Hz
Frequency Regulation	: +/- 0.5-1%
Accessories	: Thyristor, ELC Board along with OV/UV, OF/UF Protection system

The box enclosing ELC (Panel Board) should contain meter showing current, voltage and frequency output of the generator, kW meter and one energy meter (kWh meter).

Ballast load:

It is used as a dummy load to work along with ELC to maintain constant load to the generator. Water immersion heater with tank of 21 kW/ 400V/ 3ph is proposed to be installed as dummy load at separate water tank with continuous inlet and outlet flow of water. Though, we have recommended the above major specifications of the ballast load, each manufacturer has its own design and product specification (Detail design will be as per the manufacturer at the time of manufacturing with required output).

3.2.7 Powerhouse Cabling

25 mm², 4-core armored copper power cables are proposed to connect generator, panel and dummy load inside the powerhouse and 35 mm^2, 4 core aluminum armored power cables are proposed for the connection between the main switch and the first pole. Cable ratings are proposed such that they can+ carry at least 150 percent of the required maximum current. At least 3 light points with incandescent lamps and one power point with necessary switches and fuses are proposed for the powerhouse use. The details of power single line diagram are given in the drawing in Annex.

3.2.8 Transmission / Distribution Network

The generated power is proposed to be transmitted and distributed to the load centers via 3 phases, 0.4 kV Low-Tension (L. T.) overhead lines and single phase 230V overhead lines. The design and construction has been simplified with an overview to reducing the project cost by using locally available resources as much as possible.

The total length to be covered by L.T. (400 V/230 V) is 5,265 meters. The transmission and distribution network consists of poles, conductors and insulators.
The transmission and distribution network consists of poles, conductors and insulators.

Poles

8 meter wooden poles are proposed for three phase line and 7 m wooden poles for single phase lines. Altogether 131 wooden poles have been proposed (114 wooden poles of 8m for three phase lines and 17 wooden poles of 7m for single phase lines). At least 1.5 m in case of tubular and 8 m wooden poles, and 1.2 m in case of 7 m wooden pole should be inserted into the ground. The lower portion of the pole should be coated with bitumen paint in such a way that at least 0.3 m painted length would be above the ground level.. The recommended pole-to-pole distance for wooden pole should be spanned by 35 meters. It is recommended not to exceed the wooden pole span more than 40 meters.
The specification of the poles is as follows:

Specifications	Wooden poles for 3 phase Lines.	Wooden Poles for single phase lines
No. of Poles	137	27
Spacing	35 m	35 m
Pole Height	8m	7 m
Min. ground clearance	5 m	4.0-4.2 m
Conductor spacing	30 cm (vertical)	30 cm (vertical)
Min. top diameter	140 mm	125 mm

* NOTE: L.T. lines are placed vertically. For L.T. lines, the conductor spacing is 30 cm vertically. The details of diagram are given in the drawing.

Stay set

Stay sets are required at every bends, first pole and last pole of the transmission and distribution and in steep slope upward. Generally, for safety, every 5^{th} pole is to be stayed on both sides even if the poles are in straight line, so as to provide protection from storms according to the standard. The stay set consists of MS rod, stay bow, stay insulator, turn buckle and anchor plate. There is need of 27 numbers of stay sets. However, the number of stay sets may vary depending upon the site condition.

Conductor

For the transmission/distribution of the generated power, the following Aluminum conductor Steel Reinforced (ACSR) has been proposed.

Conductor	Length (m)
Dog Rabbit Weasel	941 2525 2717
Ghopher	660
Squirrel	17061

Total Households:169 Households

Above lengths of ACSR conductors are incorporating 10% additional length due to sag. The conductor sizing has been done by keeping in mind anticipated peak load demand in each of the branch. The line material has been designed in such a way that maximum voltage drop at peak hours at the end of each distribution line will not exceed by 10 percent.

The details about the conductor used for transmission and distribution are shown in Annex.

Overhead Line Protection

The overhead ACSR transmission/distribution lines are to be protected from high voltage surge of atmospheric lightning by 0.5 kV lightning arrestors along L. T. Lines. 31 nos. of lightning arrestors have been proposed for L. T. Lines (1 nos of lighting arrester for single phase line and 30nos (10 sets) of lighting arrester for three phase line). The positioning of the lightning arrester has been shown in details in the transmission line diagram in the Annex. The lightning arresters are proposed to be installed in 500 meters distance along the transmission/distribution line and not to exceed 750meters.

The specifications of the lightning arrester required are as follows:

Specifications	For L.T. lines
Rated Voltage	0.5kV
Type and designation	MFTOVAR
Nominal rated current (peak)	10kA
Numbers	31

3.2.9 Earthings & Lightening Arrestors

All exposed metal parts of the generating equipments and generator neutral terminal are proposed to be earthed separately in a proper manner. Similarly, each lighting arrestors installed should be separately earthed. Apart from earth continuity from the powerhouse through the armoured cable up to the main distribution board, each distribution box is proposed to be properly connected to earth. It is proposed to do the earthing work with the same conductor and plate.

Three different earth pits at the Power House for

- One for neutral earthing.
- Equipment Earthing.
- Lighting Arrester Earthing.

The positioning of the Earthing system is shown in details in the transmission/Distribution diagram in the Annex

Specifications:
- For earthing at the power house and for the 3 phase L.T., 600mm*600mm*3mm copper plate.
Numbers: 13
Earthing wire: 8 SWG copper wires

GI pipe for the protection of Earth wire is also recommended. The copper earthing plate should be buried in a trench of minimum depth 2.5 m.

3.2.10 Protection System

The OV/UV and OF/UF Protection system senses the voltage and frequency of electrical output of the generator continuously. If the voltage or frequency exceeds prescribed level, the protection system output relay trips out. This trip can be used to set off an alarm or to completely shut down the power plant.
Specifications:

Input voltage range: 140-300 Vac
Output: Relay contact 250V/5A
Internal power supply: 12V+ regulated
Low- voltage trip level: 150-230Vac (adjustable)
High- voltage trip level: 230-290 Vac (adjustable)
Low frequency trip level: 35-50Hz (adjustable)
High frequency trip level: 50-65Hz (adjustable)
Trip indication: 4 LEDs

Moreover, the protection system should also include adequately sized MCCBs to protect against overload as well as short circuits without damaging the generator and other control equipment.
Specifications:
IEC: 898, IS: 8828

Description	MCCB on the generator side	MCCB after ELC
No. of poles	4 pole with 4 pole switched neutral	4 pole with 4 pole switched neutral
Operating voltage	400V	400V
Rated Current at 415V	60A	40A
Breaking Capacity	10kA	10kA
Frame Size	GS	GS

Moreover, Rewirable type Triple pole and neutral (TP &N) switch fuse of 50A is recommended to be used as main switch.

3.2.11 Service Wire and Current Limiting Devices

At an average of 35m per household, 5915.0 m long service wire is required. The service wire is of 6 mm^2 concentric cables. All consumer connections should be protected through MCBs of appropriate rating to suit consumer's peak wattage subscription. But wiring in each household is to be done by the owner. But the cost of the MCBs of 0.5A for each house holds also included.

3.2.12 Insulators, D-iron Clamp

To lay the wire in poles different sizes small shackle insulators are used. Shackle type insulators are used for the single phase and three phase L.T. lines.
Each set of Shackle type insulators is provided with D clamp, nuts and bolts.

The specifications of the insulators required are as follows.

Shackle Type:

S.N.	Size	Dimension	Used in Conductor	Numbers
1	Large	100mmx110mm	Dog	26 units
2	Medium	75mx90mm	Rabbit and Weasel	161 units
3	Small	55mmx55mm	Squirrel	524 units

Chapter 4
FINANCIAL ASPECTS OF THE MHP

4.1 Quantity Estimate and Rate Analysis

Rate analysis for the construction activities of the MHP has been done using Nepal Government norms. A district rate, published by DDC at Solukhumbu has been also considered while analyzing the rates. Since the project is in far remote place and will be constructed by the local people using available local materials, so the local available materials rates and local labor rates are also consider in the rate analysis. The rate of electro-mechanical equipments has been workout as per the quotation issued by manufacturer.

After the detailed engineering designed was complete than the quantity and volume of work were worked out. The details of rate analysis and quantities of work are presented in the annex of this report.

4.2 Summary of Cost

The total cost estimation of the project has been carried out from the costing of mechanical works, electrical works, civil works, tools, spare parts, transportation cost, and installation, testing commissioning and contingency. The total project cost is Rs. 5,309,989.00. The cost per kW is Rs. 312,352.00. The detailed cost estimate of the project is presented in the annex of this report.

	Summary Of Project Costs				
S.No	**Description**	**T.Costs (NRs.)**	**Local (Rs.)**	**Non-Local (Rs.)**	**% of Total Cost**
1.0	Site Clearance	1200.0	1200.0	0.0	0.03
2.0	Intake and Diversion	52,492	10,249	42,243	1.11
3.0	Settiling Basin	100,569	39,956	60,613	2.13
4.0	Headrace Canal	569,378	231,514	337,864	12.08
5.0	Forebay	178,172	63,784	114,388	3.78
6.0	Penstock, Support & Anchor Blocks	81,908	30,617	51,291	1.74
7.0	Power House	151,416	117,291	34,125	3.21
8.0	Machine Foundation	26,545	15,816	10,729	0.56
9.0	Tail Race Canal	35,321	14,852	20,469	0.75
10.0	Intake accessories	17,500	0	17,500	0.37
11.0	Forebay & Settling Basin accessories	23,500	0	23,500	0.50
12.0	Pipe accessories	423,300	0	423,300	8.98
13.0	Turbine & Power Transmission	436,000	0	436,000	9.25
14.0	Generator & Accessories	195,000	0	195,000	4.14
15.0	Protection System	371,401	0	371,401	7.88
16.0	Wiring	79,700	0	79,700	1.69
17.0	Conductor	695,088	0	695,088	14.75
18.0	Fittings	128,830	0	128,830	2.73
19.0	Poles	48,150	39,650	8,500	1.02

20.0	Packing & Transportation	393,426	0	393,426	8.35
21.0	Electro-mechanical Installation	81,795	8,200	73,595	1.74
22.0	Testing Commissoning	65,000	0	65,000	1.38
23.0	Tools and Spare Parts	29,280	0	29,280	0.62
Sub Total		**4,184,972**	**573,131**	**3,611,841**	**88.80**
13% VAT for Non Local Cost of Electro-Mechanical Components		**303,485**	**0**	**303,485**	**6.44**
Total		**4,488,457**	**573,131**	**3,915,327**	
Contengencies		**224,423**	**28,657**	**195,766**	**4.76**
Grand total		**4,712,880**	**601,787**	**4,111,093**	**100**
Capacity		**17 kW**			
Cost per kW		**277,228**			
Cost per HH		**17,263**			

4.3 Financial Mix

For the implementation of this MHP, major source of finance will be provided by AEPC/ESAP as a subsidy. The total subsidy amount for the MHP will be Rs. 2,592,500.00 according to government policy of Rs. 125,000 per kW for and Rs. 500 per km per kW transportation subsidy.

Besides, the community people would mobilize Rs. 601,787.00 through voluntary labor and local material contribution and remaining Rs. 691,449.00 would be mobilized from the Bank in the form of loan and Rs. 591,500.00 (Rs. 5,000 per H/H) by the community cash contribution and also the DDC+VDC invest Rs. 235,644.00, 5%of Total costs of the project.

Table 11: Mobilization of Resources

S.N.	Sources	Amount (Rs)	Share (%)	Remarks
1	AEPC Subsidy (MH Subsidy + transportation subsidy)	2,592,500	55.01	Rs.125000 per KW + Rs. 500 per km per kW transportation subsidy
2	Community Cash Contribution	591,500	12.55	3500/HH
3	Bank Loan	691,449	14.67	
4	(DDC+VDC) Investment	235,644	5.00	5% of Total Project Costs
5	Community Equity	601,787	12.77	Local Costs
	Total Source of Finance:	**4,712,880**	**100**	

4.4 Annual Expenses

The total annual expenses are tabulated below.

Table 12: Annual Recurring Expenses

S.N	Description	Amount (Annual), Rs	Remarks
1	Salary-Manager	48,000	3000/ month
2	Salary-Operator	54,000	3500/ month
3	Repair and Maintenance	141,386	3% of TPC
4	Office expenses	2,000	
5	Miscellaneous	1,200	
	Total	**246,586**	

4.5 Annual Incomes

Based on the investment required, annual expenses and other necessary provisions, tariff rate has been proposed herewith but this might have to be revised regularly to incorporate the changes in price and other relevant factors over time. Considering these, fixed tariff rate of Rs. 2.0 per watt per month for domestic lighting and Rs. 10.00 per kWh for end-use activities have been proposed for this scheme.

Table 13: Annual Income

Probable Business									
S.N	**Type of Business**	**Location**	**Power (kW)**	**Operating Hours**	**Operating Days / Month**	**Operating Months / Year**	**Total Energy Consumption (kWh)**	**Tariff / kWh**	**Total Income**
1	Agro-processing mill	Village	4	5	20	10	4000	10.00	40000.00
2	Bakery	Village	3	5	25	10	3750	10.00	37500.00
3	Rural Carpentry	Village	3	5	25	11	4125	10.00	41250.00
4	Photo Copy and Photo Studio	Village	3	4	20	11	1760	10.00	26400.00
5	Computer Lab	Village	3	6	25	10	4500	10.00	45000.00
6	High Vision Hall	Village	2.5	3	10	12	900	10.00	9000.00
						Total	**19915**		**199150**

Annual income from Lighting:

S.N	No of House	Location	Power per HH (W)	Operating Hours	Operating Months / Year	Tariff / w/m	Total Income	Remarks
1	169	Village	100	9	11	2.0	371800.00	4pm-7am & 5 pm -11 pm

Total Annual income from lighting and end use (NRs)	**570,950**	
Total Energy Production Potential (kWh)	**134640**	
Productive End uses (%)	**15**	**(330 days Operation / Year)**

4.6 Financial Analysis

This section of the report presents the brief cost analysis of the proposed scheme. The cost evaluation is undertaken to assess the economic viability (soundness) of the project. This will be useful to judge the project from the developer's and financial institution's perspective. The following parameters are considered for the cost analysis of the project.

- Capital Investment
- Construction Period
- Economic Life of the Project
- Running Cost Involved
- Revenues from the Project

The financial analysis of the scheme focuses on the source of funding for the project, annual income, annual loss, and financial indicator of the project such as Net Present Value, Benefit Cost Ratio, and Internal Rate of Return etc. The Financial Analysis Sheet has been attached in Annex V. Main financial indicators are presented below.

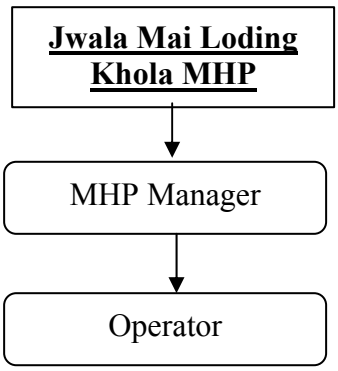
NPV at 10% (Discount Rate 6%)	=	166617.00
IRR	=	11.48 %
Pay Back Period	=	7 year
Benefit Cost Ratio	=	1.27

Chapter 5
OPERATION AND MANAGEMENT ASPECTS OF THE MHP

The success of a project depends on its operation and management. As the project itself is the property of the local people, so it is the responsibility of the local people to look after the project. Considerable benefits can be reaped from MHP if it is operated and managed properly. Neither the entrepreneurs nor the consumers will gain from the MHP that is not operated and managed properly. Prospective MHP entrepreneurs should bear in mind the aspects of operation and management i.e. management of daily operations, availability of operators and resource management.

The ownership type of the MHP is community owned. However, with no any experience as such in MHP, the manager and operators must be given training for the proper operation and maintenance of the MHP. The manager and the operator will be responsible for the daily operation and management of the MHP. The monitoring should be carried out regularly based on information collection, decision making from follow up and reports. A periodic reports and information received at different places in different intervals should be reviewed and evaluated.

Operational rules administered by the MHP should be provided for connection condition, collection of tariffs, fines for late and disconnection for non-payment. The manager will be responsible for ensuring timely payment of electricity bills by consumers and for dealing with tampering, theft etc. In order to monitor the activities and the participatory achievements at regular intervals, the reporting system will be devised in such a way that a coherent picture of the different activities would be emerge to the management in a timely manner.



Chapter 6
CONCLUSIONS AND RECOMMENDATIONS

From the preceding analyses and discussions, it is found out that the project is technically and financially feasible. The implementation of the project will provide high quality lighting for household purpose as well as reliable and environmentally safe power for end-use applications. The MHP will help in saving carbon annually due to the replacement of kerosene and diesel by micro hydro electricity.

As seen through the financial analysis, the NPV of the project is positive (6% discount rate, 15 years) with Payback period of 7 years, B/C ratio of 1.27 and IRR being 11.48%. Thus the project should be considered beneficial from all aspects viz. financially, environmentally and socially. The cost/kW of the proposed project is about 277,228.00.

During installation, it is highly recommended to involve only experienced parties or technicians.

Obviously, the socio-economical status of the village will be improved with the implementation of the project. Presently used resources to mitigate the lighting energy demand will be replaced by converting the water potential to electrical energy as discussed above. It will definitely reduce forest product consumption. After implementation of the scheme, there will several end uses like agro-processing mill, rural carpentry, bakery and photo copy and photo studio are installations, which will automatically make life easier and rising the level of people.

Thus the project is feasible and recommended for its construction.

REFERENCES

- DHM Climatologically Records of Nepal (1987 – 1998)
- DHM surface water records of Nepal
- Micro Hydro Design Manual – Adam Harvey, 1983
- Micro Hydro Sources Book – NRECS, 1986
- Statistical Book Nepal – Central Bureau of Statistics, 1998
- Final Report of Jharkot Micro Hydro/Irrigation Scheme – IITDG, Nepal
- Course Hand book for Bio-engineering Training Program– DOR/HMG
- Engineering problems of Nepalese Himalayan – C.K. Sharma, Kathmandu
- National Environmental Impact Assessment Guidelines, NPC/IUCN, – 1992
- Environmental Management Guidelines – REDP, 1997
- Report on Galkot MHP, Baglung – BPC, Butwal , 1997
- Financial Guide Line – ITDG, Nepal