Kalpan Hydro

KHC Lethang Hydro Project Private Limited

EIA Executive Summary for 96 MW Lethang HE Project, West Sikkim District, Sikkim

COMPLETE SOLUTIONS
IN WATER & ENVIRONMENT

Asian Consulting Engineers Pvt. Ltd., New Delhi

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EXECUTIVE SUMMARY

1.0 Introduction

KHC Lethang Hydro Project Private Limited proposes to develop a hydro power project in west district, Sikkim for harnessing the power potential of Rathang Chu River. KHC (Kalpan Hydro Company) plan to be a 1000 MW run-of-the-river hydro power producer. It has already acquired the rights to develop four 'Run of the River' hydro projects. Two projects are expected to be operational in early 2011 and other two by late 2011. Kalpan has experienced team with extensive expertise in successful hydro power projects delivery, carbon credits financing and Corporate Social Responsibility initiatives. The Kalpan team members have extensive work experience in across most of the river basins of North and North-East India.

Detailed Project Report for this project has been prepared by AF-Colenco Limited after extensive analysis of hydrology, geology and detailed design over the last 12 months.

M/s Asian Consulting Engineers Pvt. Ltd. has been retained by KHC as an independent EIA consultant for carrying out environmental impact assessment studies for the proposed project.

2.0. Scope of EIA Study

The scope of the EIA study includes:

- Detailed characterization of the existing status of the land, air, water, soil, biotic and socio-economic environment within 10 km study area around the project site.
- Identification of the potential environmental impacts of the project, suggestion of appropriate remedial/ mitigation measures and formulation of an effective environmental management plan (EMP) to prevent, control and mitigate the adverse impacts, and ensure the environmental compliance.
- Apart from suggesting mitigation measures to the negative impacts, the report reserves implementation of various enhancement measures as a part of project benefit program to people of the nearby areas.

The EIA report for the proposed project is structured into seven chapters.

Chapter 1: Introduction - provides a background to the project, the company, scope, process and methodology adopted for environmental impact assessment studies.

Chapter 2: The Project Description - describes the characteristics of the Barrage, tunnel and other underground structures like surge shaft, pressure shaft and power house etc. and operations associated with the construction, operational activities

Chapter 3: The Existing Environment - describes the background environmental characteristics and the other economic activities in the area.

Chapter 4: Assessment of Impacts - describes the potential impacts from the project on various environmental components.

Chapter 5: Environmental Management Plan - the environmental management plan provides a set of measures for amelioration of anticipated adverse impacts likely to accrue as a result of the proposed project. The approach for formulation of an EMP is to maximize the positive environmental effects and minimize the negatives ones.

Chapter 6: Environmental Monitoring Program - describes the mechanism to address the adverse environmental impacts during different phases of the project (construction and operational phases).

Chapter 7: Catchment Area Treatment Plan – The CAT plan is based as per the prioritization of sub-watersheds using the Silt Yield Index (SYI) as per AISLUS methodology.

The structure of executive summary is set out under the following sub-headings:

- Introduction
- Salient Features
- Project Location
- Project Description
- Baseline Environmental Status
- Impact Assessment and Environmental Management Plan
- Environmental Monitoring Plan
- Environmental Management Budget

3.0. Salient Features

The Lethang Hydro Power Project (96 MW), is a run of river scheme on Rathang Chu River, which is one of the major tributaries of River Rangit. It will have a small pondage with full reservoir level and minimum drawdown level at barrage as 1575 meters and 1571.5 meters above mean sea level, respectively The proposed Hydro Power Project involves construction of a barrage 23.5 m high from the river bed level across the Rathang Chu River which is about 4 km. Yuksam Village, HRT (Head Race Tunnel) is located on the right bank of the Rathang Chu River and has a total length of 2.236 km with a finished diameter of 3.8 m. The underground power house is located near Lethang village on the right bank of river Rathang Chu and houses three generating units of capacity 32 MW each.

The Salient Features of the project are delineated below :

a) **Project Location**

State	Sikkim
District	West Sikkim
River	Rathang Chu River
Nearest Village	Lethang Village
Latitude - Diversion Site	27° 23’ 18 ” N
Longitude – Diversion Site	88° 12’ 48 ” E
Latitude - Power House Site	27°22’0.1”N
Longitude – Power House Site	88°12’22.9”E
Nearest Railway Station	New Jalpaiguri – 156 Km
Nearest Airport	Bagdogra – 155 Km
Nearest National Highway Road	National Highway – 31 A

b) **Hydrology**

Catchment area	km^2	360
Snow fed catchment area	km^2	160
Total annual inflow in 90% dependable year	$10^6 m^3$	686.20
Average discharge in 90% dependable year	m^3/s	21.69
Minimum ecological water release taken	m^3/s	0.55
Flood discharge for river diversion (~Q_{25}) Non monsoon Flow	m^3/s	100
Design Flood discharge for spillway arrangement (100 yr).	m^3/s	1844
Standard Project Flood (SPF).	m^3/s	2798
Probable Maximum Flood (PMF).	m^3/s	3082

c) **Pondage**

Maximum normal reservoir level	m	1575.0
Average normal reservoir level	m	1573.8
Minimum normal reservoir level	m	1571.5
Design flood level (corresponding to 100yr)	a.m.s.l	1575.0
Total storage volume	$10^6 m^3$	0.074

d) Barrage

Water Way		
Type		Surface
Design Flood Level	m	1575.00
Average river bed level at Barrage axis	m	1555.00
Bridge Deck Level	m	1578.50
Barrage Crest elevation	m	1555.00
Gate type and size (H XW)	m	Radial, 20 x 9.25
Number	---	3
Width of Bay	m	13.25
Height (from river bed Level)	m	23.50
Max. Head above crest	m	20
Flood Discharge Capacity (N-1)	m^3/s	1844
Energy Dissipation System		Erosion Protection

e) River Diversion

Diversion Tunnel (D-Shape) Length, Diameter	m	275, 4.5
Inlet and Outlet Elevations	m a.s.l	1570, 1552.25
Upstream Cofferdam Elevation	m a.s.l	1575
Height of Cofferdam	m	12.5
Average Length	m	43

Downstream Cofferdam not required		
Gate		
Gate number	--	1
Type	--	Fixed Wheel
- Sill elevation	m a.s.l.	1570
- Dimensions (H x W)	m	5 x 4.5
- Max. Head	m	5

f) Tunnel Intake Gate

Number of openings	--	1
Invert sill elevation	m a.s.l	1563
Nominal discharge	m^3/s	38.43

g) Service Gate

Number	--	1
Type - Sill elevation - Dimensions (H x W) m - Max. Head	-- m a.s.l. m m	Fixed Wheel 1563 3.8 x 3.8 12
Dimension of trash rack units (H x W)	m	3.5 x 8
Number of trash rack sets	--	2Nos.
Bulk head gate (H xW)	m	3.8 x 3.8

h) Desilting Basins

Type	--	Underground
Number of Desilting basins	--	2 Nos.
Size of Desilting basin (L x W x H)	m	145 x 7.8 x 10.95
Maximum discharge	m^3/s	38.43
Flow through velocity	m/s	0.25
Flushing Tunnel (D-Shape) Length ,Diameter	m	75, 6.4

i) Head Race Tunnel

Excavated Shape	--	Horse Shoe
Finished Shape	--	Horse Shoe
Length	m	2236
Excavation Diameter	m	4.6
Finished Diameter	m	3.8
Velocity for Nominal Discharge	m/s	2.92
Slope	%	0.97
Nominal discharge	m^3/s	34.94
Lining type	--	Concrete

Thickness	m	0.30

j) Adits

Number of Adits	--	3
Type and Size	--	D-Shape, 4.5 m
Length of first Adit (after desander)	m	110
Length of second Adit (about mid of HRT)	m	185
Length of third Adit (at valve house)	m	130

k) Surge Shaft

Vertical Shaft		Underground
Top elevation	m.a.s.l	1595.5
Bottom elevation	m.a.s.l	1546.7
Total height	m	48.8
Max. upsurge level	m.a.s.l	1585.75
Min. down surge level	m.a.s.l	1556.95
Lining	m	0.6
Diameter	m	15
Restricted Office Diameter	m	3.80

l) Valve Chamber

Type and Number		Underground, One
Dimensions (L x H x W)	m	15 x 13.6 x 8
Butterfly valves		
Number	--	One
Diameter	m	2.8

m) Pressure Shaft

Type	--	Underground
Quality of steel	--	ASTM A– 537
Thickness of liner	mm	15-35
Number	--	One
Length	m	495
Internal Diameter	m	2.8
Velocity for nominal discharge	m/s	5.67
Nominal discharge	m^3/s	34.94
Unit Pressure tunnels		
Number	--	3
Internal diameter	m	1.6
Length (Unit-1)	m	34
Length (Unit-2)	m	23

Length (Unit-3)	m	43

n) Unit Tail Race Tunnels

Number	m	3
Length	m	95,86,76
Internal Diameter	m	3m, D shape

o) Tail Race Gate Carven

Elevation	m a..s.l	1270
Dimensions (L x H x W)	M	33 x 7 x 9

p) Power House

Access Tunnel		
Diameter, Shape	m	7.0, D-Shape
Length	m	155
Power House		
Type		Underground
Dimensions (L x H x W)	m	65 X 36.3 X15.0
Turbine type	--	Francis
Number of units	--	3
Turbine setting elevation	m a.s.l.	1256.7
Rated discharge per unit	m^3/s	11.65
Turbine speed	rpm	600
Max. / Min. net head	m	301.13/294.13
Rated head	m	298.79
Installed capacity per unit	MW	32
Inlet valve type		Spherical
Number	--	3
Axis elevation	ma.s.l	1256.7
Diameter	m	1.38
Generator type		3 phase
Number	--	3
Nominal speed	rpm	600
Voltage / Frequency	kV / Hz	11.0/50
Power factor	cos φ	0.9

q) Transformer Hall Carvern

Dimensions (L x H x W)	m	48.5 x 16.85 x 13.0
Transformer type	--	3 phase
Location		Underground
Number	--	3 + 1 Spare

Unit capacity	MVA	40
Voltage ratio	kV / kV	11.0/220
Cable Tunnel		
Dimensions, Type	m	3.5, D-Shaped
Total Length		125

r) Main Tail Race Tunnel

Number	--	1
Length	m	40
Slope	%	16.66%
Nominal discharge	m^3/s	34.94
Outlet sill elevation	m a.s.l.	1259.50

s) Potyard

Type	--	Outdoor
Area (L x W)	m	60x25
GIS (Underground)	m	Transformer Hall
GIS Area (LXW)	m	48.5 x 13

t) Land Requirement

S.No.	Land Requirement	Type of Land	Area (Ha)
Land for Surface Components			
1.	Road to Barrage Area	Forest Land	0.555
		Private Land	4.091
2.	Upstream Works	Forest Land	4.380
		Private Land	0.402
3.	Road to Power House Area	Forest Land	3.066
		Private Land	5.224
Land for Underground Components			
4.	For Underground Components	Forest Land	1.628
	Muck Dumping (On Lease)	Private Land	5.283
A) Total Forest Land			9.629
B) Total Private Land			15.00
** Total Land Required (A+B)			24.629
** In addition, 20 Ha of Land to be taken on lease for residential area, construction facilties like crushing and batching plant.			

u) Estimated Project Cost

Civil Works including pre-operative works	INR in crores	Rs. 312..00
E and M Works	INR in crores	Rs. 138. 97
Total basic cost (excl. transmission line cost)	INR in crores	Rs. 450. 97
Interest during construction and financing charges	INR in crores	Rs. 44.66
Total Project Cost	INR in crores	Rs. 495. 63
Cost per MW installed	INR in crores	Rs. 5.16
Cost of transmission line works	INR in crores	Rs. 46.00
Interest during construction and financing charges (transmission line works)	INR in crores	Rs. 5.45
Total Project Cost (with transmission lines)	**INR in crores**	**Rs. 547.09**

v) Power Benefits

50% dependable. energy	GWh	512.55
75% dependable. energy	GWh	460.73
90 % dependable energy	GWh	429.74
90% dependable. energy with 95% Plant availability	GWh	415.85

w) Construction Period

Construction Period	Months	44

4.0 Project Location

The proposed project is located on Rathang Chu River, a tributary of River Rangit near Yuksam Village, a famous tourist spot due to its proximity with "Kanchendzonga Biosphere Reserve and National Park". Yuksam is 156 Km from Siliguri, West Bengal by traveling on National Highway – 31 A via Pelling. The nearest railway station is New Jalpaiguri (NJP) about 156 km and nearest airport is Bagdogra at about 155 km from project site. The nearest district headquarter is in Geyzing, West Sikkim.

The barrage site has been proposed at 4 km upstream from Yuksam Village, having geographical coordinates as 27° 23′ 18″ N and 88° 12′ 48″ E. Power House site is proposed near Lethang village which is about 8 km distance from Yuksam village by road having geographical coordinates 27° 22′ 0.1″ N and 88° 12′ 22.9″ E . The Catchment Area for the proposed project lies between Latitude: 27° 36' 54″ N to 27° 22′ 46″ N and Longitude: 88° 07′ 21″ E to 88° 13′ 46″ E. The location map of the proposed project is shown in **Figure – 1** and the study area map is given in **Figure-2**

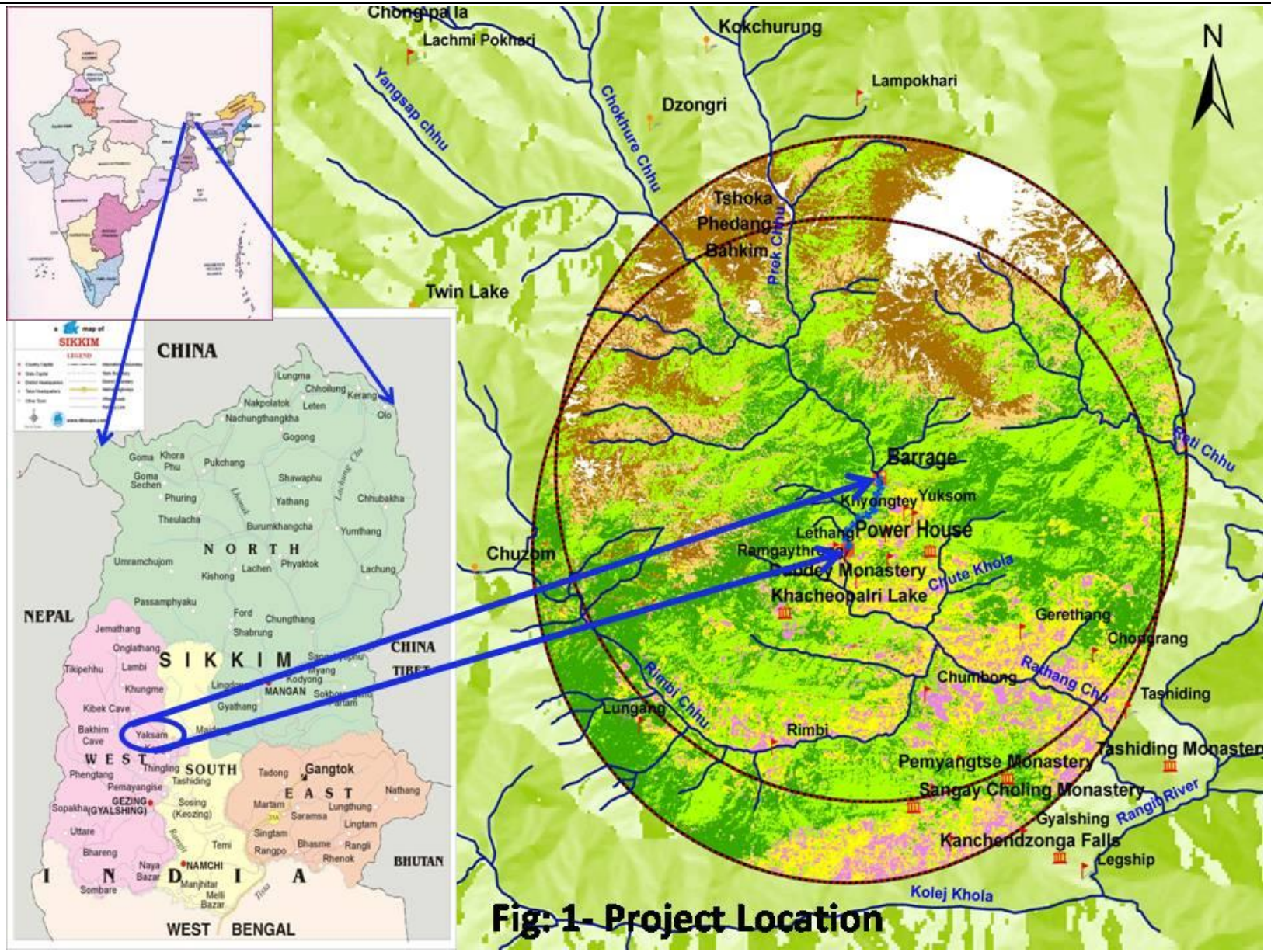

Fig: 1- Project Location

5.0 Brief Project Description

Lethang HEP is a run of the river development scheme envisaging utilization of water from Rathang Chu River. The project site is located near Yuksam Village in West District in the State of Sikkim. After optimizing the potential, barrage location has been identified upstream from Yuksam Village and Power House near Lethang Village with overall installed capacity of 96 MW.

The project has been planned to optimize the power potential between EL 1575 m a.s.l and 1260.39 m a.s.l. The Barrage axis is selected at about 300 m downstream of Paukhola Nallah near Yuksam village and under ground power house is selected just upstream of existing steel bridge near Lethang Village. The selected reach is straight and having sound abutments. The barrage is a low control structure with an invert elevation 1555 m a.s.l which is similar to the average natural river bed elevation EL 1525 m a.s.l and top elevation at 1578 m a.s.l. The height of the barrage is 23.5 m which is less than 30m from the river bed level; therefore the design flood level for the structure is Standard Project Flood (SPF). The barrage is a gated bay structure having three bays of size 13.25 m x 20 m controlled by radial gates for a maximum discharge of 2798 m^3/sec (SPF).

6.0 Infrastructure Facilities

Following Infrastructure facilties will be required for the construction of project.

- Bridges and Cross Drainage Structures.
- Project Staff and Workers township including their electricity and provision for water supply, drainage works and sanitation.
- Power for construction works.
- Roads network for accessibility to various work sites, camps, offices, muck disposal area.
- Telecommunication network.

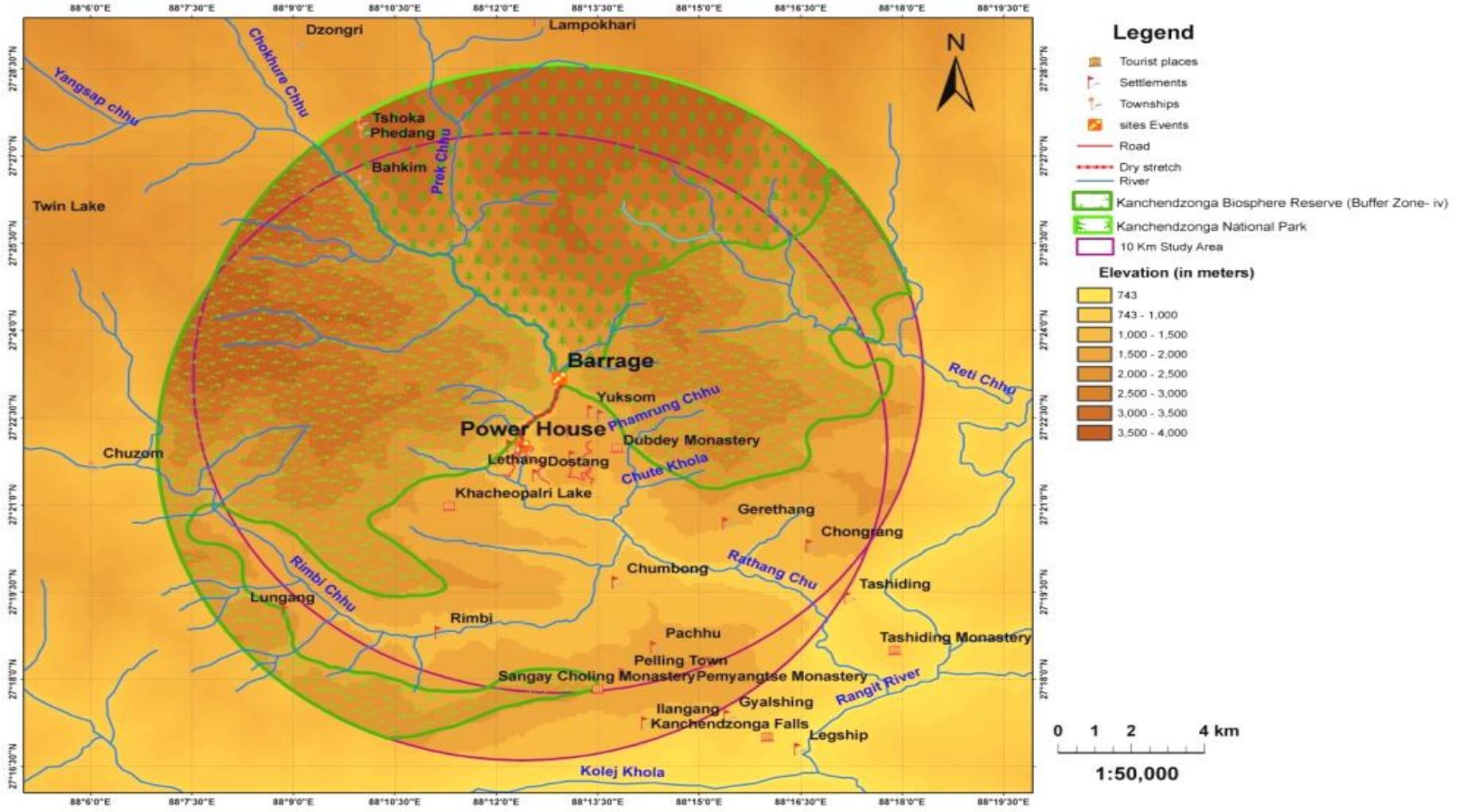

Figure 2: Lethang Hydro Power Project Study Area Map

7.0 Baseline Environmental Status

7.1 Physiography

The topography of the study area can be termed as hilly with steep slopes bounding the ridges. Study area consists of tangled series of interlacing ridges, rising from one above from south to the foot high peaks, which mark the abode of snow in the north. The project site elevation varies between 740 m to 4500 m.The important ridges originating from the main Singhalila Ridge (running North South) forming the western boundary of the study area. The major ridges arising from Singhalila ridge mostly run from West to East direction rise from different altitudes as low as 305m and ascending the elevation as high as to 7318 m.

One of these originates from Kabru (Thyabala), at an elevation of 7318 m passes through Goechela (5183 m), Pandim (6710m), Tinchinkang (5954m), Longjong or Batasedanra (4,712m) via. Aaralongchuk, Kasturi Orar (3327m), Dubbdi Gumpa (2439.20m), Senon Gumpa (2009m), then Chongrang and finally ending at Tashiding at an elevation 4644m sear Laxmi Pokhari. It passes through Pongmerong (4789 m), Topong (2134m) Melli, Rimbi ending at an elevation of about 1067 m.

The next main ridge, which lies in this part, descends from Amphora at an altitude of 3903 in to Gyalshing at Yangtey 1067 m) opposite Tashiding Monastery via Nambu (2439.20m), Ranidunga, Changey, Sangacholing Gumpa, Pemayangtse, Rabdentse and Sakyong.

The fourth ridge originating from Singhalila range starts from Chewabhanjang at an altitude of 3659 m and descends to Hilltop -- Hilley — Nase - Sungri barsey, Phunsebung, Dethang jIangalbare and Sikep ending at an altitude of 366m. These 4 main ridges have further branches of ridges divergence from different points and location and spread towards different direction.

7.2 Geology

a) Regional Geology

The region has been subdivided into distinct geotectonic domains like other sectors, which are separated from one other by thrust faults. These geological formations are starting from south to north disposed in reverse tectonic order.

- **Sub- Himalayan**: Consists of mollases type of deposits of the Siwaliks (Mid Miocene to Pleistocene).
- **Lesser – Himalayan**: Consists of Carboniferous-Permian, Buxa, a thick metasedimentary sequence of dominantly pelites with subordinate psammite and wacke formations.
- **Higher- Himalayan**: The higher himalayan is composed of medium to high grade crystalline rocks dominantly of pelithic composition commonly known as HHCS (Higher Himalayan Crystalline Structure).
- **Tethyan Himalayas** : The Tethyan Himalayas consists of fossiliferous Cambrian to Eocene sedimentary rocks.

b) Project Site Geology

The project area is located northwest of the Rangit tectonic window of the Sikkim Himalayas and comprises of medium to high grade metamorphic domain of the Central Himalayan Crystalline The daling metasediments displaying low grade metamorphism are exposed in a wide zone along the Rangit valley but in Rathang Chu River Valley these rocks have been terminated by the Main Central Thrust, which has brought higher grade metamorphic rocks of Darjeeling Group/ Lingste gneisses in juxtaposition with the daling group of rocks. Stratigraphically, the Lethang HEP placed in the high grade gneisses of the Higher Himalayan Crystalline Sequences.

Barrage Site: The barrage site is located in a natural gorge with widely jointed strong to very strong gneiss rock in the abutments and in the foundation. On the right bank the gneiss forms a strong and generally stable semi vertical gorge side. The left bank of the barrage site exposes gneissic rock and the orientations of the joint sets are consistent with the right bank. The left bank of the river in general has rock exposures to about 5-10m above the river bed. The conditions of the rocks are moderately to slightly weathered along the surface and joints with iron staining seen at few places.

Power House Site: The underground powerhouse complex is in the same strata strong gneissic rock as exposed throughout the area. The rock is strong to very strong, widely jointed; with generally clean rough joints, occasionally stepped. The rock conditions are very suitable for the underground complex, allowing traditional powerhouse construction with appropriate rock support and monitoring systems.

All other project components like Intake Structure, Desilting Basins, Head Race Tunnel Pressure and Surge Shaft and Tail Race Tunnel are to be build up on similar type of rock formation.

7.3 Climate and Meteorology

The climate of the district varies from subtropical to alpine depending upon the elevation of the place. The tropical climate is observed at lower elevation while temperate climate prevails in the higher elevation. Climatologically the region is divided into four distinct seasons: Pre-Monsoon, Monsoon, Post – Monsoon and winter in the region. The temperature in the region varies from season to season, having maximum temperature of about 23 - 25 °C as observed in summers and Minimum of about 6 - 8 °C as observed in winters. The relative humidity in the area remains high in monsoon season at about 90 % - 80 % and gradually declines to 50 % - 60 % in winter season. The wind direction in the area remains in NNW (North North West) dominantly because of surrounding cliffs and high ridges. The windspeed in the area varies throughout the seasons between 2.5 – 7.5 m/sec. The sky remains clear during summer season but with mean monthly cloud between 5 - 6 Octas (as per IMD); mostly cloudy weather prevails throughout the year. The snow cover calculated in the catchment is 65.26 Sq. km. as per the LISS III imagery of October 2009 procured from Indian Remote Sensing Satellite ID/P6, LISS III sensor, National Remote Sensing Agency.

7.4 Seismicity and Seismo-tectonic Evaluation

The project area falls under seismic zone – IV that is susceptible to high magnitude earthquakes, as per the seismic map of India (IS 1893–2002: Part –I). The great earthquake of magnitude +8 are related to the under thrusting of the upper crust of the Indian plate, below the sedimentary wedge along a low angle northerly dipping decollement surface

located south of the Basement Thrust Front. This source, is located south of Rangit Fault, that run parallel to Rangit River tectonic Flux Fault having focus at 40 km., a concentration of moderate magnitude in a 35 km. wide E-W domain located north of the Rangit River, majority of > 4.5 magnitude are present in this within this domain The NNW-SSE trending other arm is located at a distance of 40 km. as such because of larger distance the Peak Ground Acceleration values for the same would be much less than the NNE-SSW. However, there is no immediate threat perception to human life due to occurrence of an earthquake specifically by the project itself as no large reservoir is involved.

7.5 Land Environment

The land use/ Land cover map of 10 km. study area with reference to barrage site and power house site was prepared using satellite imagery from the Indian Remote Sensing (IRS) Satellite 1D/P6, LISS III sensor from National Remote Sensing Agency. The accuracy of the interpretation of the satellite imagery has been enhanced using the reference data from ground truthing. The land of the study area is covered with 60 % of vegetation (including dense forest, Open Forest, Alpine Scrub); 15 % alpine barren (transition between snow cover and vegetation) and agriculture about 10 %; settlements and snow cover of about 5 % respectively. The soils of the study area as observed are relatively neutral in nature with average pH level of 7.0, possessing fewer amounts of nutrient elements, nitrogen, phosphorous, potassium and other essential elements that are within the limits. The soil receives moisture from rainfall mostly as there is no vertical capillary movement of water in the hilly area. The soil types as per NBSS & LUP in the study area are –Pachic Haplumbrets, Umbric Dystrochrepts, Typic Udorthents, Lithic Haplumberts, Typic Haplumberts and over fragmented Typic Undorthents.The dominant soil type in the study area is Fine –Loamy Typic Haplumbrets Fine Loamy Umbric Dystrochrepts. The overall fertility status of the soils within the study area can be considered as satisfactory and non detrimental to the growth of agricultural and forest crops. The study area has high ranges in the northern and north western corner. Moving south the ranges drop in height and Rathang Chu and its tributaries form v-shaped valleys. In the southern most part of the study area elevation is the lowest at about 700 m. This trend continues in the north-south direction. The western part of the study area has ranges of medium height and it drops to 700 m. in the east direction to form the Rathang Chu valley. In the eastern part the topography again rises to about 2000 m.

7.6 Landslides

The landslide detailed investigations were carried out along the periphery of the proposed barrage in order to delineate the active and potential landslide areas. No major landslide prone area were identified while surveying along the periphery of the barrage. However, few minor landslide prone areas were identified in between the project stretch and one near power house site, therefore it becomes imperative to provide certain engineering measures for treating landslide areas and these are being dealt separately in environmental management plan.

7.7 Ambient Noise, Air and Traffic Density

7.7.1 Noise Environment

Ambient Noise level monitoring was conducted at seven locations viz. Yuksam, Dubbdi Monastry, Yuksam School, BDO Colony, Primary Health Care Centre, Barrage site and Power House site etc. The noise equivalent levels observed in the area in the day time were recorded between 48.0 dB (A) the lowest recorded at Yuksam health centre and the highest

61dB (A) near '17 miles bridge' and in the night time were between 35.95dB(A) (recorded near Dubbdi monastery)– 49.0 dB(A) (recorded near 17 miles bridge), relatively below the permissible limits in compliance with CPCB 2009 norms.

7.7.2 Air Environment

At present there is no industrial activity in the study area. The main source of air pollution is fuel wood burning. The region is totally covered with dense forests even the villages are having natural vegetation, which serves as natural sink of air pollutants, therefore, the chances of air pollution in that area is relatively low. The ambient air quality for SPM, RSPM, NOx and SO2 was monitored at three different locations as per the CPCB guidelines. The emission levels were found SPM were between 86.2 µg/m3 – 48.6µg/m3, for RSPM was recorded between 27.1 µg/m3 - 19.8 µg/m3, SOx was recorded between 13.1 µg/m3 - 10.9 µg/m3, NOx was recorded between 13.8 µg/m3 - 11.2 µg/m3. The ambient air quality through out the study area was found to be below the permissible limits as per the CPCB 2009 norms.

7.7.3 Traffic Density

The Lethang HEP project is surrounded by two major villages Lethang and Yuksam. Barrage site is 4 kms upstream from Yuksam Village, which is the nearest settlement. This is connected by state highway with Geyzing via pelling, the same roads also connect Lethang village. The other major road of the area is connecting Yuksam and Jorthang via Topsing. The traffic fluctuates with season, peak traffic is observed during April and October months when tourists visit these places for trekking towards Dzongri and Kanchendzonga. As per the traffic survey, which was conducted during this study, the maximum traffic was observed at Lethang in the month of April 2010. The total vehicle count recorded was 429, out of which cars contributes the major traffic load in the area i.e., 191, followed by LMV contributing 164, HMV contributing 46, 2-wheelers contribution of about 22 counts, due to tourist flux in the area as compared to the rest of the part of year . Compared to this, traffic load of total 57 counts was recorded in winter season (lean season) including cars contributing 24 counts, LMV contributing 14, 2-wheelers contributing 11 counts and HMV contributing 4 counts. The traffic survey was also carried out in Yuksam, the traffic trend observed and recorded was about 238 counts in pre monsoon (peak season), out of which LMV traffic was major contribution to the total counts accounting for 105, followed by Cars 68, HMV 26 and 2 wheelers about 20 counts, compared to total 195 counts recorded in Winter Season (Lean Season), where contribution of LMV about 76 was recorded as major traffic in the area, followed by 64 counts for HMV, 40 counts for 2-wheelers and 8 counts for Cars .

7.8 Water Environment

7.8.1 Hydrology

Water availability for this project was calculated using rain fall data of seven rain gauges (RG) of Rangit basin. The average annual rainfall value of Rangit Catchment is 2414 mm. (approx. as 2400 mm.). The key rain gauge stations are located very near to this project site are Dentam (2640 mm.), Yuksam (2540 mm.) and Geyzing (2100 mm.). The KHC Lethang has also installed its own rain gauge station at the project site.

The flood hydrograph was estimated by adding a uniform base flow of 10.4 m^3/s and snowmelt contribution of 26m^3/s to the ordinates of the surface flow hydrograph. The Standard Project Flood (SPF) comes out to be 2798 m^3/s. The flood hydrograph peaks

corresponding to 50 year and 100 year return periods are 1693 m³/s and 1844 m³/s. The flood peak value corresponding to 100 year return period is 1844(m³/s) and SPF of 2798 (m³/s) are being used for planning purpose. Minimum Ecological Release of water taken is 0.55 (m³/s). The probable maximum flood discharge is 3082 (m³/s). The Design Flood as non monsoon for river diversion is 100 m3/s. The silt concentration data was obtained from Saklang Site on River Teesta from the period of 1999 – 2005. The majority of the time the silt concentration is between 150 to 500 ppm.

7.8.2 Water Bodies:

The water environment of the study area comprises of main Rathang-Chu River formed by Prek Chu, Chokhure Chu and Yangsap Chu. The Rathang Chu River traverses the study area from North (from middle part) to South-East and drains in Rangit River at further south near between tashiding and legship. Another important stream is Rimbi-chu which flows through the southern part of the area from west to east and meet with Rathang-chu near chumbong. Some of the small streams existing in the study are Pakhola Nallah, Chute Khola, Rimbi Khola, Phamrung Chu, Kanchendzonga water falls.The other water bodies existing in the study area are Khecheopalri lake and Kathog-Bla-TshoLakeThe area is drained by the Rathang Chu river and its tributary streams.

7.8.3 Water Quality

The water quality analysis for three different season Pre–Monsoon, Winter and Monsoon season. The water quality assessment was carried out for surface water and drinking water in the study area. The surface water samples were collected from Rathang Chu River at five locations. The drinking water samples were collected from three villages – Yuksam, Ramgaythrong and Lethang. The river is the fastest flowing devoid of any industrial pollutants and chemicals, the water bears a good concentration of dissolved oxygen (ranging between 18.0 mg/l – 21.0 mg/l) more than sufficient for the sustenance of aquatic life. The pH varies along the river from barrage site to power house site (6.5 – 8.0) within the permissible limits as per CPCB 2009 norms. The physico-chemical parameters of drinking water were found to be within the desirable limits as per IS: 10500 standards but the Total Coliform Count (MPN/100ml) was more than the recommended limit. Level of hardness was low, which means water is good for drinking and cooking. There are no major sources of organic pollution loading in the stretch of the river.

7.9 Biotic Environment

The landscape is entirely hilly and covered by vegetation. The project area is located in closed proximity to Kanchendzonga Biosphere Reserve and National Park. The topography of the area has steep (near the ridges) to gentle slopes. The ridges are mostly run from West to East direction and most of the rivulets and streams flow from West to East, except Pakhola Nallah and its associated nallas, which flows from East to West to drain in Rathang-chu. The barrage axis is proposed at about 300m downstream of Paukhola Nallah, the boundary of the biosphere reserve. The study area (10 km radii) surrounding the Rathang Chu River was divided into four different influence zones – A,B,C and D. The Zone A includes Central part of the study area towards north, which falls in KNP core Zone; Zone B includes the North - East part of study area, which falls in KNP buffer zone IV, Zone C includes part of the West Territorial Division of West Sikkim Gyalshing (forests block Gyalshing and Pelling), Yuksam (Yuksam and Khechuperi forests block) and Tashiding forests ranges; Zone D includes North West to South-South –West of study area, which falls in KNP buffer zone IV.

7.9.1 Terrestrial Ecology

7.9.1.1 Forest Cover

The part of study area (Zone **A**, part of the KNP core Zone) is having dense forests of mixed vegetation. This patch of forests harbour mixed vegetation of coniferous and broad leaf species of trees. Type of vegetation varies depending on the altitude. The altitude varies from 2100 m to 3100 m. Height increases towards north-east direction. The forests here can be categorized as 'East Himalayan Mixed Temperate Forests'. The canopy is formed both by Coniferous and broad leaf trees. Under story is also dense and diverse, consists both shrubs and herbs. Ground cover also rich in diversity. NNW corner of the Zone-A, where altitude is above 4350 m found no tree, only dense clumps of bushy vegetation intermingled with pastures lands are seen.

The North East (Zone B) and North West to South-South –West (Zone D) part comes under buffer zone-IV of Kanchendzonga National Park where altitude varies from 2500 to 3450 m gradually goes down to 1800 m. towards rathang-chu river bank in the east (right bank of river, nearest point of project component is Power house and its down stream stretch up to river Rimbi, which is form the south boundary of KNP as well as Zone D). The altitude rises up to 4050 m. at the central part of west boundary of Zone D.

Forests of 2500 m. to 3400 m. of both Zone-B and Zone-C having similar kind of vegetation cover. Except the south and south-east boundary of Zone -D, this is having lower altitude (av. 1800 m) covered with mixed type of forests. The forests of this part may be categorized as 'East Himalyan Wet Hill Forests'. Forests are diverse and rich in biodiversity comprises with woody upper story, shrubby middle story and herbaceous ground cover.

The rest of the part of study area designated as Zone -C, comes under the Gyalshing (includes forests block Gyalshing and Pelling), Yuksam (includes Yuksam and Khechuperi forests block) and Tashiding forests ranges of West Territorial Division of West Sikkim. Near the streams and rivers, where altitude is lower (av. 750m) found sal dominated mixed forests.

7.9.1.2 Terrestrial Ecological Survey

Fifteen accessible sites were surveyed within the direct impact zone i.e., proximity with barrage and power house of project stretch of Rathang-chu river so that the type of ecosystem and land use are well represented. Sites are selected primarily based on its vegetation cover and accessibility. The Shannon Wienner Index has also been worked out, separately for woody and non-woody plant species are presented below:

Zone	Species Richness (Woody)	Species Richness (Non-woody)	Shannon Index (Woody flora)	Shannon Index (Non-woody flora)
B	38	13	2.9198	1.8566
C	42	4	3.2794	1.1616
D	49	13	3.5667	2.2939

Zone A is the part of Core Zone of KNP, which was not accessible.

The study area comprises mostly of Broad Leaf Sub Tropical Forests. The Floral diversity in the study area was surveyed into two categories – woody flora and Non Woody Flora. There are about 13 different types of shrubs and 65 types of tree species in woody flora and about 14 types of Herbs and 7 types of Climbers species in the non woody flora.

Some of the dominant tree species (woody flora) of the study area are *Alnus nepalensis, Castanopsis Hystrix, Cedrela febrifuga, Engelhardtia spicata, Ficus roxburghii, Juglans regia, Macaranga gmelinaefolia, Maesa chisia , Rhus insignis, Saurauia sp, Viburnum cordifolium.* The Shrubs like *Edgeworthia gardnerii, Polygonum molle and Rubus ellipticus* were found to be dominant in the study area.

Some of the dominant herbs species (non-woody flora) in the study area are *Nasturtium officinale, Eupatorium adenophorum, Artemisia dubia, Oxalis corniculatus, and Thysanolaena maxima*. Some of the dominant climbers in the study area are *Piper longum, Cissus adnata, Cissus repanda, Dioscorea sp.*

Bryophytic and Pteridophytic plants, as well as both, epiphytic and parasitic, angiosperms were observed growing on trunks and branches of old-wood trees. Equisetum sp., an aquatic pteridophyte, was also observed in a pool of water along the Pau-Khola stream. Crustose and foliose lichens were seen on rocks, tree-trunks and fallen wood.

7.9.1.3 Faunal Diversity

An exhaustive list of wild animals that are either present or that visit the forests in and around the study area were made, collecting information from various sources and their conservation status as per ***Wildlife Protection Act, 1972 and amendments thereto*** were also noted. The information on wild fauna of the area were mainly gathered from forest officials like Asst. Conservator of Forest ,West Sikkim District; Yuksam Range Officers; forests guards; villagers; trekking guide; and volunteers of Kanchendzonga Conservation Committee (an NGO working on conservation of wild animals of the area). The list was also verified using KNP management plan and preliminary forest working plan and from the forest office. Total 141 species of wild animals were listed, in which 34 were mammals, 74 species were of birds, 11 species of reptiles and 22 were of Butterflies. In these, 21 are categorised as scheduled- I species, 15 are as scheduled- II, 19 are as scheduled- IV species and 1 species in Schedule –V . The WPA status of the identified species is depicted below in Table 1.

The Rare/ Endangered/ Threatened Mammals in study area as per IUCN & WPA Schedule number are given in Annexure – I.

Table 1: Species Distribution as per WPA Schedule

Species	Total No.	WPA Schedule Number				
		I	II	III	IV	V
Mammals	34	14	10	-	-	-
Birds	74	1	-	-	19	1
Reptiles	11	1	5	-	-	-
Insects(Butterfly)	22	5	-	-	-	-
Total	141	21	15	-	19	1

* ***WPA schedule number as per Wildlife Protection Act, 1972 and amendments thereto.***

During the field study many direct evidence like visual sightings, and indirect evidence such as calls, nests, burrows, droppings, scats, moults, tracks, etc. were also observed, which confirm their presence in the area. Details of the wild animal recorded in the study area are given below:

Mammals: Importants mammals recorded in the study area are Snow Leopard, Clouded Leopard, Himalayan Musk Deer, Himalayan Brown Bear, Asiatic Black Bear, Wolf, Mainland Serow, Himalayan Thar, Blue Sheep, Bear cat, Marbled Cat, Yak, Monkey, Red Fox, Jackal, Ghoral, Barking Deer etc.

Avi-fauna : About 50 species of Aviafauna was found in the study area. Frequently seen aviafauna in the study area are Great Barbet, Rock Pigeon, Crested serpent Eagle, Grey Treepie, White-throated Fantail, Blue Whistling Thrush, Grey-headed Canary Flycatcher, White-capped Water Redstart, Plumbeous Water Redstart, Green-backed Tit, Wire-tailed Swallow, Golden-spectacled Warbler, White-spectacled Warbler, and Red-billed Leiothrix. None of the bird species are of Schedule I as per Wild Life Protection Act, 1972. Birds of prey, especially Aquila eagles, have also been found to use this part of Himalayas as an east-west pathway in autumn.

Butterfly: Butterfly Species listed in the study area are the Golden Birdwing, Common Birdwing, Brown Gorgon, Yellow Gorgon, Spectacle Swordtail, Chain Swordtail, Great Zebra, Veined Jay, Great Mormon, Dark Blue Tiger, Chestnut tiger, Hill Jezebel, Redbase Jezebel, Tree Yellow,

Chocolate Grass Yellow, Forest Pierrot, Metallic Green Hairstreak, Striped Punch, Tailed Red Forester, French Duke, Northern Jungle Queen, Jungle Glory and Kohinoor.

7.9.2 Aquatic Ecology

7.9. 2.1 Fish Fauna

The major fish species found in the project stretch of River Rathang Chu river are *Schizopyge Progastus* (Chuchay Asala), *Schizopyge richardsoni* (Dothay Asala) , *Acrossocheilus hexagonolepsis* (Katlay), which are migratory to this stretch in monsoon period. Other indigenous species are *Danio aequipinnatus*, *Danio naganensis* (bhitti), *Barilius vagra* (Chirkey), *Semiplotus semiplotus* (Chefiti), *Garra annandalei* (budune) etc.

The fishing season in the Rathang Chu River starts from mid of March and continues till May depending on the weather condition. The sample netting was done in the study stretch. It was observed and also verified from local people and fisheries department that no large scale fishing activities are being practiced in this stretch. Moreover, no spawning/feeding ground is recorded from this stretch or it's immediate up stream and down stream.

7.9.2.2 Food chain Organism

Seasonal sampling was collected for planktons and benthos from six location between Pau Khola Nallah upto downstream of Dosthang Village. The phytoplankton species recorded are *Gyrosigma* sp, *Acharanthes affinis, Pandorina sp, Pediastrum boryanum, Scenedesmus bijuga, Melosira gracilis, Cyclotella meneghiana, Microcystis sp, Navicula gracilis, Nitzschia gracilis, Pinnularia braunii, Synedra tabulate, Navicula radiosa, Cymbella Sp.* Major Zooplanktons specie found are *Keratelia monospina, Brachirous caudatus, Ceriodaphina reticulate, Mesocyclops hyallinus, Coleps hirsutus, Arcella sp, Actinophyros sp, Aspiancha sp.* and *Mesocyclops.*

7.10 Socio – Economic Environment

The sociological aspects of this study include human settlements, demography and social strata and literacy levels besides infrastructure facilities available in the area.

The Socio – Economic survey was conducted in seven hamlets Norbugang, Khyogtey, Khopchey, Ramgaythrong, Lethang, Yuksam Bazar and BDO Colony. About 168 household having the population 923 is covered under the study area.

It was found from the survey that:

- The literacy rate of the study area is 64.90 percent, constituting about 599 literates.

- Around 52 % of households in the project zone are living in nuclear family and 48 % are living in joint family.
- The population of the area comprises of 90 % schedule tribes, 5 % OBC, 2 % each belonging to schedule caste and general category, 1 % belonging to major backward classes.
- About 85.20 % of households have faith in Buddhism, 13.60 % in Hinduism and 1.20 % in Christianity.
- About 55 % are below poverty line and 42 % category above poverty line, remaining two percent category no information was available. The average annual income of the families ranges between Rs. 25000 per to 140000. Out of 168 HH families 82% of the families are having annual income less than 25000, 15% of the families are having annual income ranging between Rs. 25000 to Rs. 1,40,000 , no information was available for remaining 3 % HH.
- The main occupation of the persons living the project zone are labourers (unskilled), others are engaged in cultivation of crops and animal rearing practices. About 15% of the population is engaged under the NREGA (National Rural Employment Guarantee Act) scheme for employment.
- Tourism industry is the largest economic activity in the area, which provides employment to people directly or indirectly.

8.0 Impact Assessment and Environmental Management Plan

Various impacts on environmental components were assessed in two different phases - constructional phase and operation phase. The impact and their mitigation measures are given in Table 5 below.

Table 5 : Project Associated Environmental Impacts and Mitigative Measures

Environmental Attribute		Potential Impacts	Nature of Impacts	Magnitude of Impacts	Mitigation Plan	Project Phase
A. PHYSICAL RESOURCES						
1.	Topography	Change in surface features and present aesthetics due to construction at various project sites	Direct irreversible impact, restricted only in the site of above ground structures.	Medium	• Plantation surrounding the submergence area, colonies and side of the access roads to improve aesthetics.	**Construction**
2.	Climate	Change in the micro climate due to removal of trees for construction site /RoW of roads etc.	Localized but direct impact certain extent irreversible.	Low	• Compensatory afforestation and plantation around the project structures, access roads and colonies.	**Construction and Operation**
3.	Hydrology	Operation of head works	Impact is direct, localized but irreversible.	Low	• Construction of barrage	**Operation**
		Ground water	No significant impact is envisaged.			
		Reduction of flow due to stream diversion and ponding at diversion.	Impact is direct, localized but irreversible. More prominent during lean period.	Medium	• The studies for Minimum environmental discharge are going on and the recommended discharge shall be released. .	**Operation**
		Change in land use by submergence of land due to the construction of impoundment at diversion.	0.844 ha of land, which is at present having vegetation cover will be lost permanently.	Low	•Plantation around the submergence area, colonies and side of the access roads are suggested to mitigate loss of green cover.	**Operation**
		Daily fluctuation in peaking water flow situation at Barrage .	Variation in flow volume and quality of water.	Low	• The proposed project is run of river scheme.	**Operation**

Environmental Attribute		Potential Impacts	Nature of Impacts	Magnitude of Impacts	Mitigation Plan	Project Phase
		Sedimentation	Increase in silt load during flushing period.	Low	• Effective management of desilting basin during high monsoon period.	**Operation**
		Riverine Ecology	Reduction of flow will bring change in the existing ecosystem.	Medium	• Environmental flow as observed in the Environmental Flow Assessment, which will be decided depending on the existing fish and other parameters, will be maintained through out the year. • To facilitate 'to and fro' fish migration fish pass will be constructed.	**Operation**
		Infestation of pests and weeds	No significant impact is envisaged.	Low	• Fish can be stocked in the reservoir to mitigate pests and weed propagation in the pondage area.	**Operation**
B. ENVIRONMENTAL RESOURCES						
1.	Air quality	Project will have marginal impact on air quality during the construction period due to dust emission.	Impact is direct, localized and temporary; restricted only during construction phase.	Low and reversible	• Watering at construction sites, limited bare soils, covering the materials during transportation and storing, maintenance of project vehicles etc.	**Construction**
		Due to crushers activities	Impact is direct, localized and temporary; restricted only during construction phase.	Low	• Installation of wet crusher to control the dust. • Covering and stacking the fine aggregates till the time they are utilised. • Regular water sprinkling on the stacked fine aggregates and its surrounding area to prevent the dusts.	**Construction**
2.	Noise	Due to general construction activities, and vehicular movement.	Impact is direct, localized and temporary; restricted only and reversible also during construction phase.	Low	• Restriction on noisy activities during night time. (10 pm – 6 am). • Avoid the noisy construction in the barrage site, which is near to forests patches. • Use of personal protective equipment	**Construction**

Environmental Attribute		Potential Impacts	Nature of Impacts	Magnitude of Impacts	Mitigation Plan	Project Phase
					like ear plugs, mufflers etc. for the worker exposed to noisy construction activity. • Implement good working practices to minimize noise.	
		Noise arising from blasting for construction.	Impact is direct and temporary; restricted only during construction phase for 2 years	Medium	• Timetable for blasting to be maintained during day time to minimise disturbance to wild animals. • Proper design of blast hole to be developed. • Use of noiseless trunk delays to minimize the noise due to air blast. • Use of non-electric system of blasting for true bottom-hole initiation. • Use of muffling mats to arrest the dust and fly rocks.	**Construction**
3.	Surface water quality	• Washings from muck disposal sites may lead to increase turbidity	Impact is direct and Reversible	Low	• Construction of garland drain around the bottom of the muck disposal site and settling pit.	**Construction**
		• Run off from the construction site leading to increase in COD, BOD, oil and grease etc. if mixed with any water body or stream.			• Setting up of vehicle garages, away from slope. Construction of oil trap. • Turffing in the slop along the access road, wherever possible to prevent spread of contaminated flushing	
		Domestic wastewater from construction camp sites and during operation leading to	Impact is direct but localised.	Low	• Portable septic tanks both at the construction labour camp site and construction site will be installed. • Sewage Treatment Plant will be made	**Construction and Operation**

Environmental Attribute		Potential Impacts	Nature of Impacts	Magnitude of Impacts	Mitigation Plan	Project Phase
		increase in COD, BOD, oil and grease etc.			for project colony.	
		Oil spillage and Oil contamination during maintenance	Impact is indirect, localised but Reversible.	Low	• Oil interceptor will be provided for vehicle parking, wash down and refuelling areas. • Field storage will be in proper bounded areas. • Oily wastes will be disposed off to the approved disposal sites. All spills and collected petroleum products will be disposed off in accordance with MoEF guidelines of Sikkim govt.	**Construction and operation**
4	Soils and Geology	Soil erosion, loss of productive top soil	Impact is indirect, localised but Reversible.	Low	• Avoiding sites, which are prone to soil erosion and landslides • Levelling of construction site. Rehabilitation and stabilisation of disturbed land. • Preserving the topsoil from all the construction sites ,wherever ground will be used for construction ,i.e., roads, materia storing vehicle and construction equipmen garages etc. in stockpile at the edge of the site to use it to the extent possible for site restoration later.	**During and after the construction activities**
		Improper debris removal/ accumulation	Impact is indirect, localised but Reversible.	Medium	• All the debris removed from tunnel, power house to be stored temporarily to use it in other site preparation/ levelling /for site reclamation/ concrete production. Excess material will be disposed in the muck dumping sites and will be suitably stabilized	**Pre-construction and construction**

Environmental Attribute		Potential Impacts	Nature of Impacts	Magnitude of Impacts	Mitigation Plan	Project Phase
		Damage due to seismic activity	Impact is direct regional and reversible	Low to high depending on the seismic intensity	• Design and site selection for the entire project component will be made considering local geology and seismic condition. However, a study has been conducted by IIT, Roorkee to determine the seismic parameters.	**Before the construction activity**
C. ECOLOGICAL RESOURCES						
1	Terrestrial Ecology	Loss of vegetation	Impact is direct, local and irreversible	Medium	Following precautionary measures will be taken to avoid un wanted tree cutting: ▶ Selecting minimum corridor width for power evacuation line, access roads etc. ▶ Marking road and site boundaries. ▶ Identifying the trees need to be cut and marking them before hand. • Plantation of indigenous species around the constructed site, wherever possible will be made and Compensatory afforestation will be implemented. • Training will be given to all bulldozer operators and other manual labourers involved in road and site preparation to strictly confine to their works within the defined site boundaries. • Punitive measures will be enforced against unwanted tree cutting and damage to natural resources.	**Pre construction and construction phase**
2.	Terrestrial Fauna	Disturbance to the local fauna during construction and	Impact is direct , local/ Reversible	Low	• All construction work and transportation of construction material to the site of barrage and power house, which are close	**During Pre Construction and Operation phase**

Environmental Attribute		Potential Impacts	Nature of Impacts	Magnitude of Impacts	Mitigation Plan	Project Phase
		operation activities			to forest path will be restricted between daytime and close it before sunset preferably day time to avoid disturbance to the wild animals in the project area. • Animal movement corridors will be identified with the help of local forest officials and all works will be carried out away from the same. • The project areas located close to forests will be adequately fenced and security guard will be appointed to discourage animals coming close to the project location/ workers entering into the forests. • Guard will be appointed to monitor the power evacuation lines especially for bird's strikes during the operation. • Punitive measures will be adopted incase of any killing of wild animals even the small one and birds by the workers by DFO (Wild Life) of the district.	
3.	Aquatic Ecology	Disturbance to fish during construction of barrage, tunnel as well as operation of powerhouse	Impact is direct , local and irreversible	Medium	• Minimum flow will be maintained; in the river even during lean period, hence aquatic life will have no significant impact. • Fish pass will be made to facilitate to and fro movement of fish. • Proper briefing will be made to the labour force, so that unauthorised fishing does not take place. To ensure this, punitive measures will be adopted and guard will be appointed to keep vigil on such activities by the worker.	**During construction/ operation phase**

D. HUMAN ENVIRONMENT						
	Activity	**Potential Impacts**	**Nature of Impact**	**Magnitude of Impacts**	**Mitigation Plan**	**Project Phase**
1.	Land acquisition	Total 24.629 ha of land will be acquired for the project, in this 15 ha area is of private land and rest area is government land.	Impact is direct, local and irreversible	Low	• All the land owners will get compensation as per the protocols (NRRP 2007). • It will be ensure that appropriate legal requirements have been met with regard to land occupancy, land ownership or usage rights, notice and compensation prior to the legal transfer. • Proper land agreement will be made with owners, users and state authorities (Forest Department). Prior to that boundaries of the property will be marked and all transaction will be clearly documented following the legal process. •All necessary approvals from State Authorities will be acquired prior to all transaction.	**Pre construction**
2.	Resettlement & Rehabilitation	No family will be displaced for this project. Hence, no resettlement is envisaged in this project.	Nil	Nil	• Compensation of the land and employment opportunities to the locals.	**Construction and operation**

3.	Socio-Economics	Job opportunities during construction phase	Impact is positive, direct and regional	High	To give the maximum benefit to the local community following measures will be taken: • Locals will be given first preference to fulfill all manpower requirement depending on their skill and efficiency. • The electricity, generated from the project will be provided to the local villages. • Various social welfare projects for the local communities through well thought out CSR strategy will be taken to improve the living standard of the near by villages.	**Construction and operation**
Others General Issues						
1	Cultural sites	No archaeological, historical or cultural important sites are present in near vicinity of the project	Nil	Nil	• No mitigation measured is envisaged. • In case any fossils, coins, articles of value of antiquity, structures and other remains or things of geological or archaeological interest discovered on the site shall be the property of the Government, and shall be dealt with as per provisions of the relevant legislation.	**Operation**
2	Traffic and transportation	Traffic diversion, congestion due to movement of construction vehicle	Direct/ Local/ Reversible	Low	• Before taking up of construction on near to any existing lanes, a traffic control plan will be devised. • All necessary measures for the safety of traffic during construction will be taken such as barricades, including signs, marking, and flags, will be installed for the information and protection of traffic approaching or passing through the section of any existing cross roads. • Before taking up of construction on any section of the existing lanes of the highway, a traffic	**During construction phase**

					control plan will be devised to avoid traffic congestion.	
3.	Oily waste generation	Probability of surface and ground water pollution	Impact is indirect, localised and reversible	Low	• The oil sludge should be separately stored in the containers. • Used oil to be collected and reclaimed by Contractors through the office of stores and purchase. • Separated oily waste and scrap will be collected and disposed of in compliance with the Environmental Protection Act, 1986, and applicable regulations and rules thereunder.	**During construction and operation phase**
4.	Solid Wastes	Contamination of land and water	Impact is indirect, localised and reversible	Low	• A secured land fill site will be developed in a suitable location within the project acquired land following the protocol due the absence of municipal solid wastes dumping ground in Yuksam or Lethang or any other near by places. • Garbage bins will be provided in the labour camps and also in the construction site, which will be regularly emptied and disposed off in a hygienic manner. • Degradable and non-degradable solid wastes will be separated. • Common container will be taken to the dumping ground, which need to be developed for the the project. • Biodegradable solid wastes will be covered with soil on daily basis to avoid any odor nuisance due to purification and check any contact with the flies or insects. • Non biodegradable wastes will be segregated and saleable material will be sold through the project office to authorized vendor, non saleable wastes will	**Constructional Phase**

					be dumped in the secured land filling area.	
5.	Labour camp	1.Living conditions of workers	Impact is direct, local, reversible	Low	• Labour camps will be constructed at least 1 km away from existing settlement and from any water body etc. • Necessary (temporary) living accommodation (30-40 m² size dwelling unit to each of the labour family with all ancillary facilities, i.e., uncontaminated water supply for drinking, cooking and washing, Latrines and urinals in an accessible place/ distance will be provided and maintained. • Adequate vaccination and immunization facilities shall be provided for workers at construction site • Public awareness programmes for increase knowledge about various diseases and actions will be taken in case of out break of any epidemic. • Periodic free health check up camp will be organised for the entire family of the worker.	**Construction phase**
		2. Diseases due to contamination of water bodies and pondage of water	Impact is direct, local, reversible	Low	• Precaution will be taken to prevent temporary pondage of water. Disinfectants like bleaching powder etc. will be regularly sprinkled around the drain or garbage disposal area and temporary toilet areas in the construction site.	**Construction phase**
		Issue due to water supply	Impact is direct local and reversible	Low	• Appropriate water supply sources will be identified .	**Pre construction and construction**

					• Appropriate infrastructure for storage and disinfections (chlorination facilities etc.) will be provided. • Drinking water shall be regularly tested for: - Orthotolodine tests for chlorine - Lead Acetate Paper test for bacterial infection	
		Sewage Treatment and Maintenance of drinking water Quality	Impact is direct local and reversible .	Medium	• Sewage from toilets will be treated in septic tanks. • Effluent from septic tanks will be disposed off through absorption trenches. • Drinking water facilities and sewage disposal site will be located far away from each other to avoid contamination of water.	**Construction**
		Absence of free fuel for workers	Impact is direct local and reversible.	Low	• A mandatory clause will be put in the contract of every contractor involved in project construction to provide supply of fuel to their labourers so that trees are not cut for meeting their fuel demands.	**Pre construction and construction**
6.	Health and safety	Exposure to electromagnetic fields	Impact is direct , localized and persisting	Low	• Alignment for route power evacuation lines situated away from the settlement. • No house will be allowed near power house	**Operation phase**

7.	Positive Impact On socio-economy of the Area	Project will be beneficial for the area.	Positive direct impact on the regional economy	High	Implementation of the following enhancement measures: • Power supply to the surrounding areas from the power generated in the project. • Facilities for higher education, training, skill development. • Employment for local people • Improvement in accessibility • Improvement in tele-communication system. • Improved health care facilities.	**During construction and operational phase**

8.1 Catchment Area Treatment Plan

The lethang hydro electric project forms part of the 3A1A7 watershed of the Watershed Atlas of India, Ministry of Agriculture and Cooperation (Government of India), New Delhi (1992). It is a still large unit for watershed development as such has been divided into three sub watersheds, five macro watersheds and thirty eight micro watersheds, which are the lowest hydrologic units for preparing the treatment plan.

Since the life of the dam is directly affected by the rate of siltation, the Silt Yield Index methodology developed by the soil and land use survey of India was adopted for prioritizing micro watersheds into very high, high to medium low and low priorities. This methodology consists of delineating Erosion Intensity Mapping Units (EIMU) in the Lethang Catchment. The EIMU is a composite expression of physiography slope, landuse/landcover, soil erosion status and conservation methodology adopted.

Briefly, catchment characterization of Lethang HEP exhibit hilly and mountainous terrain wit elevations ranging from 1500 to 6800 m above mean sea level. Four Altitudinal zones are met with namely AZ III (1500 – 2700 m), AZ – IV (2700 – 4000 m), AZ –V (4000 – 6000 m) and AZ – VI (> 6000) above mean sea level. There is a vertical zonation from the diversion dam in the south to north with the increase in the altitude By and large; maximum coverage is met with under AZ IV (2700 – 4000 m amsl). Of the 10 slope classes, a few patches are seen under slope class IV, V and VI i.e 5 -10 %, 10 – 15 % and 15- 25 % respectively. Maximum coverage is noticed under the slope classes IX and X i.e 50 – 75 % and > 75 %, respectively.

They are scattered throughout the catchment. The remaining area is equally shared by slope Class VII (25 - 35%) and VIII (35 – 50%). Geologically, quartzite, calcgneiss, calgranulite and bands of biolite, schist, amphiboles and apetite veins are met with giving rise to entisols soils of variable depth, loamy skeletal to loamy in texture under the influence of water and glacial erosion. Areas, which remain under snow covered for a period of seven months or so are subjected to severe soil erosion. Soils are usually with AC horizon with least profile development. Sub group met with are Typical Udorthents, Typic Cryorthents and Glaciated areas experiences cryic (< 8 – 10 ° C) and mesic (>15 ° C) temperature regimes. Rocky and snowy areas are the two extremes in landscapes. Seven landscapes namely: i) Snowy ii) Glaciated Valley and glacial with seasonal variation, iii) Rocky and iv) Rocky with seasonal vegetation, v) forests and vi) riverine and vii) undifferentiated are identified in lethang catchment and are further subdivided into 33 landform combinations. They are herein referred as Erosion Intensity Mapping Units (EIMUs) with differential attributes contributing to erosion, i.e silt/ soil detachment potential. These are given Arabic numbers and have unique weightages and delivery ratios.

These 33 EIMU's were delineated based on the two season's cloud free satellite data of IRS, P6, and LISS III geocoded imagery of October 2009 and Feb 2010. Each EIMU has been assigned a weightage to connote the erosion status and delivery ratio to express the likely hood of detached material reaching the reservoir site. In fixing, delivery ratios, distance from the reservoir relief-length ratio, entrapment through tanks etc. are considered to reduce the delivery ratio in stages. For calculation of Silt Yield Index (SYI) following empirical formula was used :

$$\mathbf{SYI} = \sum \frac{\mathbf{W \times A\,(EIMU) \times DR}}{\mathbf{A\,(Microwatershed)}}$$

$\sum$ = Summation
A (microwatershed) = Area in hectares of micro watershed
A (EIMU) = Area in Hectares of the EIMU
DR = Delivery Ratio

Higher the SYI, higher the priority for taking up soil and water conservation measures. Of the 38 microwatersheds, 14 micro watersheds falls in very high and high priority covering 9.76% and 20.7 % of

the catchment area, respectively. The central water commission recommended the micro watersheds around reservoir and some directly draining one for taking up the soil and water conservation measures. In addition, adopted the concept of Bio-Industrial watershed for which certain provisions of aromatic oil distillation plant / horticulture or forest product processing units have been considered. The environment management group will consists of forestry, horticulture, soil conservation personnel to execute the following item wise suggestions. Approximate treatment needs areas have been intelligently estimated from the definitions of the EIMU and locations of SRDs (Silt Retention Dams) have been suggested based on the satellite.

Prioritization

Out of 38 MWS, priority was given to 12 MWS having very high and high priority categories. Out of these 12 MWS, one micro watershed falls under very high priority category, namely G1H with a total area of about 805 ha constituting about 2.4 % of the total catchment area. The other remaining 11 MWS fall under high priority category and are namely G1D, H1A, H1F, H1D, F1A, G1F, F1B, F1C, H2B, G1B, G1A with a total area of about 7040 ha (constituting about 20.7 % of the total catchment area.) Out of these 24 remaining MWS, 16 MWS are categorized under medium priority having a total area of 14801 ha (constituting about 43.6 % of the total catchment area.) The remaining eight MWS are categorized under low and very low priority categories. Out of these eight MWs about, six MWs under low priority category having a total area of 9697 ha (constituting about 28.6 % of the total catchment area.) The other two MWs fall under very low priority categories having a total area of about 1612 ha (constituting about 4.7 % of the total catchment area.) These all MWs add up to total catchment area of about 33955 ha.

8.2 Biodiversity Conservation and Management Plan

The Responsibility for implementation of Biodiversity Management Plan in project influence area will lie with State Forest Department of Sikkim. Local people will be involved by the forest department on its discretion, for encouraging community participation.

Illegal cutting of trees will be prevented by adequate security measures and for creating public awareness. All sites where project components will be located and 500 m area around these sites will be covered by these actions. As part of biodiversity management, Compensatory Afforestation, Catchment Area treatment (including Wild Life Management activities) will be implemented. Moreover, animal movement corridors will be identified with the help of local forest officials and all works will be carrying out away from the same. These actions will be joint responsibility of KHC and State Forest Department. Local Community will be involved to encourage community participation. Redevelopment and reinstatement of the muck disposal areas and quarry areas, avenue plantation and landscaping will be implemented by KHC.

Various measures suggested are summarized below:

1. Anti poaching Measures

- Engagement of part time informers and contractual staff.
- Purchase of anti poaching kits.
- Construction of Watch Towers.
- Construction of Inspection Paths
- Monitoring of Cattle sheds.
- Construction of Check post.
- Implementation of communication system and survey equipments.

2. Noise Mitigation and Management

- No construction work near the forest patch after sun set
- Restriction of blasting work in day time.

3.Eco Development Works

- Compensation
- Awareness and Publicity
- Observing Wildlife Week, Nature Club and Website Development

4. Habitat Improvement Programme -

- Pasture Development,
- Nursery development,
- Afforestation.

5. Quarry/Muck Disposal Area Redevelopment Plan

The vegetative measures will be used for redevelopment of quarry and muck disposal areas. Plantation will be done extensively for slope stabilization. Plantation of grass along with some trees such as *Alnus nepalensis, Shorea robusta, Bombax malabarica, Albeizzia procera, Ailanthus grandis, Dendrocalmus hemiltonii, Terminalia chebula etc.* It will increase aesthetic nature of these areas and also catalyze growth of biodiversity on the land and in surrounding area. The soil binders will be used for slope stabilization.

8.3 Land Slide Treatment

The proposed project area is influenced by several landslide prone areas, therefore, it becomes imperative to adopt certain engineering measures to avoid and prevent any landslides during operational phase of the project. Some of the mitigative measures involved are soil mulching, contour bunding, contour trenching, channel terrace, bench terracing method.

8.4 Muck Disposal Plan

About 2, 90,000 m³ of construction waste (90,000 m³ in tunnels and additional, 50,000 m³ in barrage, 50,000 m³ in power house, transformer hall, penstock, tail race, surge shaft and 1, 00,000 m³ in roads) would be generated from various construction activities. Out of which 1, 50,000 m³ shall be used during construction and rest of 1, 40,000 m³ muck shall be disposed at suitable muck dumping areas as per MoEF Guidelines. The Muck Disposal Planning and Management Plan shall include environmental studies and consultation, which analyses the potential impacts of each proposed muck deposit and will be complete at least three months prior to commencement of construction activities in the particular area.

Six suitable muck dumping sites have been identified near the project area namely MD-1, MD-2, MD-3, MD-4, MD-5 and MD-6. The MD Site - 1 is located near barrage area on the right bank of Rathang Chu River, other two disposal sites namely MD–2 and MD- 3 are upstream from Yuksam village near the left bank of Rathang chu river, MD–4 is located on the left bank downstream Yuksam village. Muck Disposal Sites – 5 and 6 are near downstream TRT (MD-5 on left bank and MD-6 on right bank.). A total 5.283 ha private land area is envisaged to be taken on lease basis for muck disposal facilties. The identified Muck Dumping facilties has been provided with adequate retention walls and slopes for preventing any subsidence due to runoff as a result of heavy rains, which can adversely affect the river flow pattern and also riverine ecology.

The contractor shall identify muck materials, which have potential for use by others in future construction work. Such muck will be stockpiled and secured by the contractor according to those requirements relevant and in such a manner to allow future use of the muck by others. The Muck Dumping Areas with there average length, volume and area are delineated below in Table - 6:

Table 6 : Muck Dumping Areas, Volume and Length

S .No.	Description of MD Area	Avg Area	Avg Length	Avg Volume
A	**UPSTREAM WORKS**			
1.	MD 1 Plan Area = 2350 m^2	180	65	11720
2.	MD 2 Plan Area = 5400 m^2	125	185	23125
3.	MD 3 Plan Area = 8000 m^2	600	65	39000
4	MD 4 Plan Area = 2700 m^2	1600	130	216000
B	**DOWNSTREAM WORKS**			
1.	MD 5 Plan Area = 24000 m^2	950	215	200000
2.	MD 6 Plan Area = 14000 m^2	565	200	113000

The net quantity of muck to be dumped for upstream works in MD-1, MD-2, MD-3 and MD-4 is 2,90,000 m^3 and net muck quantity from downstream works to be dumped in MD 5 and MD 6 is 3, 12,000 m^3 .

The spoil will be placed on reverse order of excavation, with finer materials in layers towards the top of the spoil dump, and stockpiled topsoil placed as the final layers. All layers will be of uniform thickness and compacted sufficiently to minimize future settlement, in accordance with agreed procedure.

KHC will be responsible for supervising and to assure that the spoil is placed in the appropriate sites, to evaluate potential for failure of the slopes, and to monitor the effectiveness of erosion control at each of the sites.

Engineering & Biological Measures for Rehabilitation of Muck Disposal Areas:

(a) Providing retaining wall varying from two to seven meter of height for preventing sliding of dumped material.
(b) One meter terracing along the contour at five meter interval along the slope in staggered manner.
(c) Providing walls/edge of 50 cm. height and 50 cm. thicknesses to protect the uphill side of the terraces from slipping.
(d) Levelling & spreading of soil.
(e) Plantation of bamboo, native species with some grass.
(f) Vegetative measures like plantation of native species of the area.
(g) After the completion of civil works in the dumping sites will be fenced with the barbed wire in strands with two diagonal strands using wooden fence posts of eucalyptus three meters apart.
(h) Possibility for watering the plants at least for early two or three years of planting will be explored. Maintenance of the plants will be for five years. The dead plants will be replaced and fencing, if damaged be repaired.

8.5 Landscaping and Re-Vegetation of Working Areas

The construction of approach roads, project colony, labour camps etc. would hamper the existing aesthetic view of the area and will also cause disturbance to the area due to increase in population and traffic movement.The landscaping and re-vegetation of the areas would be done; so that the natural surroundings and the aesthetic look of the area are restituted. Prior to initiation of quarrying activities and other constructional activities. The restoration will depend on the topography of the area, type of construction activities and their detrimental effects on the terrain and the natural habitats. A total of 65 Lakhs INR has been proposed for restoration and landscaping of the project area. For this the following enhancement measures are suggested:

- **Drainage system for diversion of run-off:** An effective drainage system will be provided for avoiding infiltration of run-off water into quarry sites and also to avoid its erosion in future.

- **Filling up of Depressions:** The existing quarry sites would result in formation of craters/ depressions due to different construction works. These depressions will be filled up by the dumping materials comprising of rocks, boulders, gravels and soil from nearby project sites.

- **Development of Orchid Garderns:** A rock gardern will be developed, which will have the orchids and other ornamental plants with the landscaping matching with the surroundings as an additional attraction for tourists and as well as the locals. The orchids such as *Chiloschista usneoides, Cymbidium irridiodes, Dendrobium chrysanthum, Cypripedium himalaicun rolfe, Cymbibium eburneum lindley, Dendrobium candidum, Dendrobium densiflorum etc.* would be planted.

- **Creation of Scenic Observatory:** Certain locations will be developed as a scenic beauty observatory spots, which will compensate the disturbance caused due to the construction of project components. Location, for example, Lethang Bridge, helipad point or any other site from where scenic view can be observed. These spot will have a slab type extension /above ground reinforced structure along with ladder and shed. This will be guarded by iron fencing and decorated with potted plants, i.e., orchids, ferns and creepers and flowering herbs.

- **Landscaping:** Appropriate sites along the newly developed access road, Muck dumping area, and quarry area will be stabilized by constructing a series of benches. The wall to be developed for providing the adequate slope will be embedded with local stones to integrate and enhance the aesthetic look of the area. The area will be enhanced with plantation of trees, shrubs, herbs and creepers found in surrounding.

Spoil heaps and excavated slopes will be re-profiled to stable batters and grassed to prevent erosion. Topsoil stripped from the areas occupied by the spoil heaps will be used for landscaping works. Re-establishment of vegetation will be commenced at the earliest possible opportunity. Appropriate local species of vegetation will be used.

Local depressions created by construction activities will be either backfilled or drained to prevent ponding possible. Where the local depressions cannot be reasonably drained, the contractor shall minimize their number and consult with the local populations as to that population's preference for their location for reuse for fish forming or other community purposes.

All hazardous materials construction equipments and wastes will be removed from site and safely disposed of in an environmentally acceptable manner. Reusable construction materials will be either removed from site or, with the approval of the KHC, left in a secure manner such that they do not constitute a risk to health and safety or a source of environmental damage.

8.6 Public Health Delivery System

The proposed project will implement public health and hygiene programme in the project affected area as an environmental enhancement measures for ensuring the safety of overall population against any kind of epidemic spread of various kinds of diseases. Public health delivery system as proposed for this project is listed below:

- Imparting awareness among the workers and labourers on general health issues.
- Additional malaria control measures in the area.
- Awareness against HIV/AIDS spread and its preventive measures.
- Arrangement of fully equipped ambulance with all kind of medicinal facilties.
- Implementation of programme for communicable diseases
- Awareness and Vaccination campaigns like pulse polio programme, Hepatitis B vaccination programme, nutrition and dietetics programme in the area for improving overall health and hygiene of the project affected people.

8.7 Reservoir Rim Treatment

The Reservoir Rim Treatment involves development of Green Belt around the reservoir (barrage) to avoid erosion of soil and prevention of land slips from direct draining of catchment into the reservoir. The creation of greenbelt on either side of the reservoir will ensure protection of the reservoir rim area from any minor slips due to fluctuation in the water level. The slopes on the banks will be planted with suitable indigenous plant species.

8.8 Resettlement and Rehabilitation

A socio – economic survey was conducted for the families whoes land was likely to be acquired for the proposed project. As per the survey list there are 37 Project Affected families.

Total land requirement for the project is 24.629 ha out of which 15 ha is private land and 9.629 ha is forests land. In addition, about 5.283 ha of private land would be taken on lease basis for muck dumping purposes. The Land area to be acquired from PAF (Project Affected Families) in Yuksam (Yuksam Revenue Block) accounts for about 4.4926 ha and in Lethang (Chojjo Block) accounts for about 5.2240 ha.

Out of these 37 families, 17 families have total land area more than one hectare and remaining 20 families have land less than one hectare. None of these families would be rendered landless. Only two families would require land acquisition of more than one hectare.

The Resettlement and Rehabilitation of the PAFs (Project Affected Families) has been done as per the National Resettlement and Rehabilitation Policy G.O.I Guidelines of 2007 as at present there is no Resettlement and Rehabilitation policy in state of Sikkim. The Resettlement and Rehabilitation Policy is formulated by the Department of Land Resources, Ministry of Rural Development. The Resettlement and Rehabilitation Plan would include subsistence grant to farmers, rehabilitation grant, vocational training and scholarship for child education, etc. The tentative Resettlement and Rehabilitation budget for PAFs is 380 INR Lakh.

As a part of CSR – Corporate Social Responsibility Activities, Kalpan Hydro Company has initiated a Kalpan Foundation (the "Foundation") that seeks to positively affect the lives of the underserved and most vulnerable segments of a community, which include those residing at the base of the income pyramid, women and children.

The Strategic Objectives of Kalpan Hydro Company as part of CSR Activities are as follows:

- Education: Improve the quality of elementary education, provide greater access to higher education and enhance the employability prospects of local youth.
- Healthcare: Provide affordable, accessible and quality health care to segments of the community residing at the base of the pyramid, women and children.
- Infrastructure: Build critical infrastructure projects that have community 'ownership' ensure common access and possess robust operations and management systems.
- Livelihood Improvement: Link individual capacity to opportunity by supporting social initiatives that capitalize on existing assets (skills, natural resources, and others) and thus provide economic security for those at the base of the pyramid.

8.9 Fisheries Conservation and Management Plan

The regulation of a river flow leads to the change in the existing habitat and may have adverse effects on indigenous and migratory fish.

Effect of project on fish migration and habitat degradation

The project will affect the migration of fish from downstream to upstream and vice-versa. The construction activities will also disturb the fish habitat, although to a limited extent, i.e. only at barrage site. Some of the adverse impacts envisaged are:

• Increase in turbidity
• Reduction of flow
• Change in Water quality.

Managed River Flow

The Lethang HEP will lead to reduction in flow for a stretch between diversion structure and tail race outfall of power house about a stretch of 2.5 km. The reduced flow rates may have some extent have adverse effect on the aquatic ecology (although impact on fish species is expected to be low). As a result of reduction in flow at the downstream of the barrage, benthic and planktonic population may be affected. Thus, objective of the managed river flow is to minimize, to the extent possible, potential impacts on aquatic and terrestrial habitats from the planned diversion of river water.

Minimum Release

The minimum flow during March reduces to 0.55 m^3/sec; maximum flow during August to October month increases to 80.00 m^3/sec. The downstream release with minimum sacrifice discharge is 10 % of the minimum discharge in winter. In addition to this, two perennial nallas are joining the stretch between barrage and TRT, which also will add up considerable the flow of the project stretch. After the discharge point of TRT, natural flow in river will be retained again.The detailed environmental flow studies have been carried out by IIT, Delhi.

Provision of Fish Ladder

As such no localised fish fauna is found and no fish landing site is also present in this stretch. The fish species, which are reported from this stretch, are seasonal migratory species. Keeping it in mind, provision of fish ladder has been proposed in the barrage.

9. 0 Environment Monitoring Plan

An environmental monitoring plan provides a delivery mechanism to address the adverse environmental impacts of a project during its execution, to enhance project benefits, and to introduce standards of good practice to be adopted for all project works. The Environmental Monitoring Plan for the proposed project is delineated in **Table 7** for construction and operation phase, respectively.

Table 7 : Environmental Monitoring Plan

Constructional Phase			
Item	**Parameters**	**Frequency**	**Location**
Effluent from septic tanks	pH, BOD, COD, TSS, TDS	Once every month	After treatment for each septic tank
Water related diseases	Identification of water related diseases, adequacy of local control and curative measure etc.	Three times a year	Labour camps and colonies
Noise	Equivalent noise level	Once in a week	At major construction site
Air quality	SPM, RPM, SO_2 and NO_x,	Once every season	At major construction site (total 3 stations)
Meteorological aspects	Wind direction and velocity, temperature, humidity, rain.	Once every season	At one of the ambient air quality sampling sites
Flora and Fauna	Qualitative and quantitative assessment of flora and fauna (Visual observation). Animal movement corridors and man/animal conflicts will be identified.	Once every year for the entire construction period	-
Aquatic Ecology	Qualitative and quantitative assessment of fish fauna, plankton and benthic organisms.	Once every year for the entire construction period	-
Operational Phase			
Items	**Parameters**	**Frequency**	**Location**
Water	pH, temperature, EC, turbidity, total dissolved solids, calcium, magnesium, total hardness, chlorides, sulphates, nitrates, DO, COD, BOD, Iron, Zinc and Manganese.	Thrice a year	1 km up-stream of intake site 3km. downstream of the confluence of the tail race discharge, with the river.

Treated Effluent from STP	pH, BOD, COD, TSS, TDS	Once in every week	Before and after treatment from STP
Erosion and Siltation	Soil erosion rates, stability of bank, embankment etc.	Twice a year	Around the barrage and power house, access roads
Ecology	Status of afforestation programs of green belt development	Once in a year	All planted areas
Water-Related diseases	Identification of water related diseases, sites, adequacy of local control measures etc.	Three times a year	Villages adjacent to project sites
Aquatic Ecology	Phytoplankton, zooplanktons, benthic life, fish composition	Thrice a year	1 km up-stream of intake site 3 km downstream of the confluence of the tail race discharge with the river
Land Use	Land use pattern using satellite data	Once in a year	Catchment area
Soil	pH, EC, texture, organic matter	Once in a year	Catchment area

10.0 Environmental Management Budget

The tentative overall budget for implementing the EMP is given in **Table-8** below.

Table – 8 : Environmental Management Budget

Description	Total Costs (INR Lakhs)
Biodiversity Conservation Plan	123
Catchment Area Treatment Plan	377
Sustenance of Riverine Fisheries	100
Public Health / Health Delivery System	51
Environment Management in Labour Camps including provisions of Fuel for Labour	127
Stabilization of Muck Disposal Sites	100
Landscaping and Restoration of Construction Area including Road side plantation.	185
Resettlement and Rehabilitation Plan	298.15
Compliance of Environmental Monitoring Programme during construction phase	17
Compliance of Environmental Monitoring Programme during Operation phase	8
Purchase of Weather Station, Rain Gauges , Noise meters etc.	6
CSR Activities	40
Total EMP – Costs	**1432.15**

ANNEXURE – I

LIST OF MAMMALS IN STUDY AREA

S.No.	Ecological Zone	Local Name	Common Name	Zoological Name	Status/WPA Schedule No.
1.	ST	Mirga	Barking Deer	*Muntiacus muntjak*	T/ Schedule II
2.	AL	Nervati	Bharal	*Pseudois nayaur (Hodgeson)*	V
3.	ST	Nilgai chituwa	Clouded leopard	*Neofelis nebulosa Griffith*	V/Schedule I
4.	TE	Hanuman Bander	Common langur	*Presbytis entellus Dufresae*	C/ Schedule II C
5.	TE	Himal Ko Goral	Ghoral	*Nemorhaedus goral Hardwicke*	R/ Schedule II
6.	AL	Tibet Kobhcran	Great Tibetan Sheep	*Ovis ammom Hudgsioni Blyth*	E
7.	AL	Wamu	Hill Fox	*Vulpes V. Montana Linn.*	LC/ Schedule II
8.	TE	Konthe Bhalu	Himalayan black bear	*Selenarctos thibetanus (Cuvier)*	V/ Schedule I
9.	AL	Jharal	Himalayan Thar	*Hemi tragus jemlahicus Smith*	E/ Schedule I
10.	ST	Malasampro	Himalayan yellow throated marten	*Martes flavigula Boddaert*	E
11.	ST	Dumsi	Indian Porcupine	*Hystrix indica Kerr*	C
12.	ST	Bandel	Indian wild pig	*Sus scrofa Linn*	Schedule II
13.	TE	Jungali Biraloo	Marbled cat	*Felis marmorata Martin*	V/ Schedule I
14.	AL	Kasturi	Musk Deer	*Moschus charysogaster*	E/ Schedule I
15.	ST	Lotharkay	Orange Belled Squirrel	*Dremomyths lokhriah Hodgeson*	C
16.	TE	Kundo	Red Panda	*Ailurus fulgens Cuvier*	E/Schedule I
17.	AL	Thar	Serow	*Capricornis sumatraensis Bechstein*	V/ Schedule I
18.	AL	Semu	Snow Leopard	*Uncia uncial Schreber*	E/ Schedule I
19.	AL	Buanso	Tibetan Wolf	*Canis lupus Chanko*	V/ Schedule I
20.	TE	NA	Asiatic Black Bear	*Ursus thibetanus*	V/ Schedule I
21.	TE	Chouri gai	Yak	*Bos grunniens*	V/ Schedule I
22.	TE	Chitta	Leopard	*Panthera pardus*	E/ Schedule I
S.No.	**Ecological Zone**	**Local Name**	**Common Name**	**Zoological Name**	**Status/WPA Schedule No.**
23.	NA	N.A	Mainland Serow	*Naemorhedus sumatrensis*	LW/ Schedule I

24.	TE	Sa-ryok (lepcha)	Leopard Cat	Prionailurus bengalensis	LW
25.	NA	Lao (Bhutia) Kasturi mrig (nepali)	Himalayan Musk Deer	*Moschus moschiferus*	E/Schedule I
26.	NA	NA	Himalayan Crestless Porcupine	*Hystrix brachyura*	Schedule II
27.	NA	NA	Himalayan Marmot	*Marmota himalayana*	Schedule II
28.	NA	NA	Pallas's Squirrel	*Callosciurus erythraeus*	NA*
29.	ST	Suhutum (Lepcha) Paoho (Bhutia)	Wild Dog	*Cuon alpinus primavus*	Schedule II
30.	ST	Ka lok (Lepcha)	House Rat	*Rattus rattus*	LC
31.	ST	NA	House Mouse	*Mus musculus homourus*	LC
32.	NA	NA	Bear cat	*Artictis binturong*	Schedule I
33.	NA	Suhu (Lepcha) ,Pihu (Bhutia)	Rhesus Monkey	*Macaca mulatta mulatta*	Schedule II

NA: Not Available; WPA: Wild Life Protection Act, 1972*

Note:

Ecological Zone:

ST = Sub-Tropical
TE = Temperate
AL = Alpine

Status:

E = Endangered
V = Vulnerable
C = Common
LW = Lower Risk
T = Threatened
R = Rare
LC = Least Concern