















Environmental and Social Impact Assessment: *192 MW Hydroelectric Power Project, Tehsil Manali, District Kullu, Himachal Pradesh*

AD Hydro Power Limited

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Revised and Updated Report

February 2009

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REVISED & UPDATED REPORT

AD Hydro Power Limited

Environmental and Social Impact Assessment: *192 MW Hydroelectric Power Project, Tehsil Manali, District Kullu, Himachal Pradesh*

25 February 2009

Reference I5724

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Approved by:	Subir Gupta *Managing Director*	

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1 INTRODUCTION

AD Hydro Power Limited, a Bhilwara Group Company (hereinafter referred to as ADHPL or the Company) is in the process of setting up Allain - Duhangan Hydroelectric Project (hereinafter referred to as ADHEP or the Project) of 192 Mega Watt (MW) [i.e. 2 x 96 MW] hydropower generation facility on Allain and Duhangan tributaries of the Beas river in tehsil Manali, district Kullu, Himachal Pradesh in India. The Project is located near village Prini, approximately three kilometers (km) southeast (SE) of Manali town.

Accordingly, ADHPL has retained ERM India Private Limited, New Delhi to undertake ESIA Study to fulfil the IFC requirements in accordance to their applicable International Standards.

1.1 BACKGROUND

The proposed hydro Project is a run-of-the-river scheme utilising the combined discharge of Allain and Duhangan streams. The Project is expected to be commissioned by end of year 2009. The Project will consist of an underground power plant that would utilise flows from a combination of glacial snow melt and monsoon rains to supply a total storage capacity of 37 Hectare meter (ha m) i.e. 0.37 million cubic meter (m^3) [refer to *Table 2.9* in *Section 2* for more detail] via tunnels from catchment basins of the Allain and Duhangan rivers.

The environmental setting for the Project is in the steep terrain of the Himalayas with the diversion structures on the two streams and an intermediate storage reservoir. All these facilities will be located above elevation of 2700 meter (m) fed by a 1.69 km steel lined pressure shaft and 853 m head Pelton turbine power house to be located in rock cavern. The Project will divert a portion of the flow of the Duhangan to the Allain and combine the flows of the two streams to feed a single powerhouse with two units of 96 MW capacities each. A 220 kilovolt (kV) double circuit transmission line (of approximately 175 km) will evacuate the power to the northern grid at Nalagarh in district Solan, Himachal Pradesh.

The Project has received Environmental Clearance from Ministry of Environment and Forests (MoEF), Government of India (GoI) in December 2000 based on a previously conducted Environmental Impact Assessment Study (EIA) prepared by the Group's in-house consultants. The Project has got Forest Clearance from MoEF as well from Himachal Pradesh State Environmental and Forest Departments. The details of approvals/ clearances obtained for the Project are described in detail in *Section 3* and copies of approvals are provided in ***Annex A*.**

1.2 *OBJECTIVES FOR THE REVISED & UPDATED ESIA STUDY*

The objectives for revised and updated ESIA study for the Project include the following:

- ADHPL has taken up partial financing arrangement for the Project from the International Finance Corporation (IFC). To fulfil IFC's Environmental and Social requirements, the Project required revision and updating of Environmental and Social Impact Assessment (ESIA) study along with separate ESIA study for transmission line corridor;
- Ensure potential adverse environmental and social impacts arising from the Project that are identified, evaluated and minimised through implementation of appropriate mitigation measures. Where residual impacts or significant uncertainties remain, additional mitigation measures have been formulated to minimise such impacts; and
- Developing environmental and social management plan for effective implementation of mitigation measures to minimise identified environmental and social impacts due to the Project during its entire life cycle.

With the above background and objectives, the draft Final ESIA report for the Project was submitted in December 2003 followed by an addendum to the ESIA in September 2004. Studies on Wildlife Surveys (including Terrestrial Ecology) by World Pheasant Association and River Ecology by Foundation for Ecological Security were completed in June 2006 and May 2006 respectively. This "Revised and Updated ESIA Report" of the Project covers requirements of Performance Standards and Environmental, Health and Safety (EHS) guidelines of IFC.

1.3 *NEED FOR THE PROJECT*

Electricity consumption in India steadily increased from 1995 to 2007, driven by high economic growth. Although India's generation and distribution capacity has grown significantly over the last decade, many parts of the country continue to suffer power shortages both in terms of unmet demand during peak periods and an overall energy shortage.

In order to narrow down energy supply and demand gap, the Government of India has come out with economic reforms in energy sector by inviting public/private investments and is offering a series of incentives to private entrepreneurs.

According to data published by the Central Electricity Authority (CEA), Government of India, (website - www.cea.nic.in) in its report on power supply position and peak demand/peak met (actual) for the month of July 2008, the peak demand of power for the northern region was 32,727 MW as against the peak met of 29,504 MW indicating a deficit of 3,223 MW i.e. -9.8%. As per forecast given in XVI Electric Power Survey of India (EPS) published by CEA, the expected demand for the northern region during the year 2011-12 (end of 11th Plan) will be 49,674 MW. The status of Hydroelectric Potential Development in the State of Himachal Pradesh is 18,820 MW as on 31 August 2008. Of this, 6,085.5 MW (32.34%) is the installed capacity and 4,435.0 MW (23.57%) is under construction. As per CEA report "Power Scenarios at a Glance", October 2008, the capacity addition by Himachal Pradesh is expected to be 2273.37 MW by end of the eleventh plan in year 2011-12.

Due to limited resources available with the Central and State governments, the Government of India has approved participation of the private sector in the generation, supply and distribution of electricity in the country in order to overcome the current and the anticipated power shortage. As a result, the Himachal Pradesh State Government has decided to allow private sector participation in respect of hydroelectric power projects.

Himachal Pradesh has only about 830 MW of demand and peak met of 845 MW showing relatively low growth prospects and is a power surplus state. The Allain Duhangan Hydroelectric Project is a private sector merchant power plant a run-of-the-river Project with a four-hour peaking capacity that will help alleviate short falls in the northern region power system. The Project will contribute free 12% of power generated (during first 12 years and 15% of the power generated subsequently) to the Himachal Pradesh state which the state can sell to neighbouring states; hence the Project contributes positively to the state's economy.

1.4 *PROJECT CATEGORISATION*

The Project falls under environmental Category A[1] as per criteria described in IFC's Performance Standards and safeguard document OP 4.01. Environmental Assessment (EA) for a Category A project examines the Project's potential positive and negative impacts, compares them with those of feasible alternatives (including the "Without Project" scenario), and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve performance. Projects categorised as A or B, requires the borrower to assess all possible environmental and social impacts and risks.

1.5 *SITE & SURROUNDINGS*

The catchment area of the Project lies within the latitudes 32° 07' to 32° 21' North and longitudes 77° 11' to 77° 22'East. The Project components extend within villages of Pirni, Hamta and Jagatsukh in tehsil Manali in district Kullu, Himachal Pradesh. The Project lies to the east of the Beas River. The location map of Project area and its layout plan are shown in *Figures 1.1* and *1.2* respectively.

The topography of the region is marked by hilly terrain rising from the altitudes of 1,700 m above mean sea level (amsl) near Beas River (western limits of the catchment area) to 4,800 m amsl in the glaciers of the Himalyan ranges (eastern

(1)Category A projects are the projects with potential significant adverse social or environmental impacts that are diverse, irreversible or unprecedented limits of the catchment area). The Allain stream is formed by Hamtal and Patroi streams which originate at an elevation of 4,680 m amsl and 4,800 m amsl respectively in the Himalyan ranges, while Duhangan stream originates at an elevation of 4,400 m amsl from Chandratal glacier in the Himalayan ranges. The two streams are joined by several streams and glacier before these empty into the Beas River.

1.6 ACCESSIBILITY OF THE PROJECT SITE

The Project site is accessible by road from the nearest town Manali, which is connected by road, rail and air links as per the following details:

Road

The Project area lies on the eastern side of the Beas River in the Kullu valley, near tourist town of Manali and is approachable by National Highway NH-21 from Chandigarh to Manali Road (via Chandigarh - Ropar – Kiratpur – Bilaspur – Mandi – Kullu - Patlikuhal – Manali – Pirni village). Access to the Project site at Pirni village can be made either from Manali town on Manali-Nagar Road or from Patlikuhal on Nagar – Manali Road. The distance of Manali from Chandigarh is 320 km, from Shimla it is 280 km and from Pathankot it is 330 km.

Rail

The nearest railway links to Manali is through broad gauge up to Chandigarh, Kiratpur, Una or Pathankot, following which, the remaining distance has to be covered by road. The alternate route through narrow gauge goes up to Kalka, Shimla or Jogindernagar followed by remaining distance covered by road up to the Manali town.

Air

The airport nearest to Manali is at Bhuntar (near Kullu), which is approximately 50-km away. The other linking airports are at Chandigarh and Delhi.

1.6.2 Access to the Project Components

The access to the Project components is through newly constructed roads from:
A) Manali – Nagar Road near Prini village to Allain barrage site passing through

- Associated infrastructure (for temporary and permanent residential and non-residential buildings, stores, sheds etc);
- Powerhouse complex and its associated works including tail race tunnel and switchyard;
- Surge shaft, pressure shaft and associated works; and
- Intermediate storage reservoir.

B) Manali – Nagar Road near Jagatsukh village to Duhangan weir site.

Refer to *Figures 1.1 & 1.2* for site location and Project schematic map.

Figure 1.1 Project Site Location Map (Indicative)

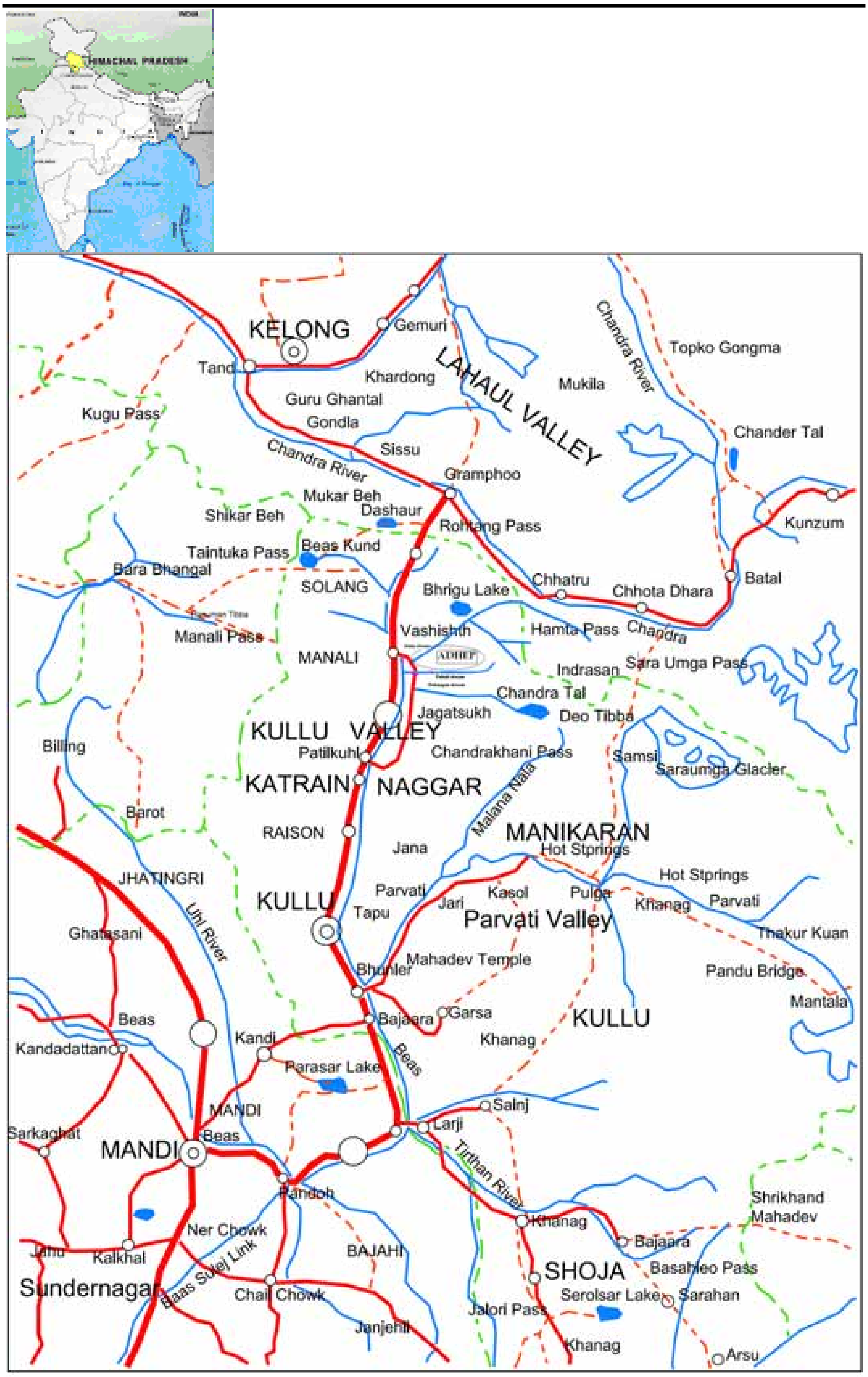
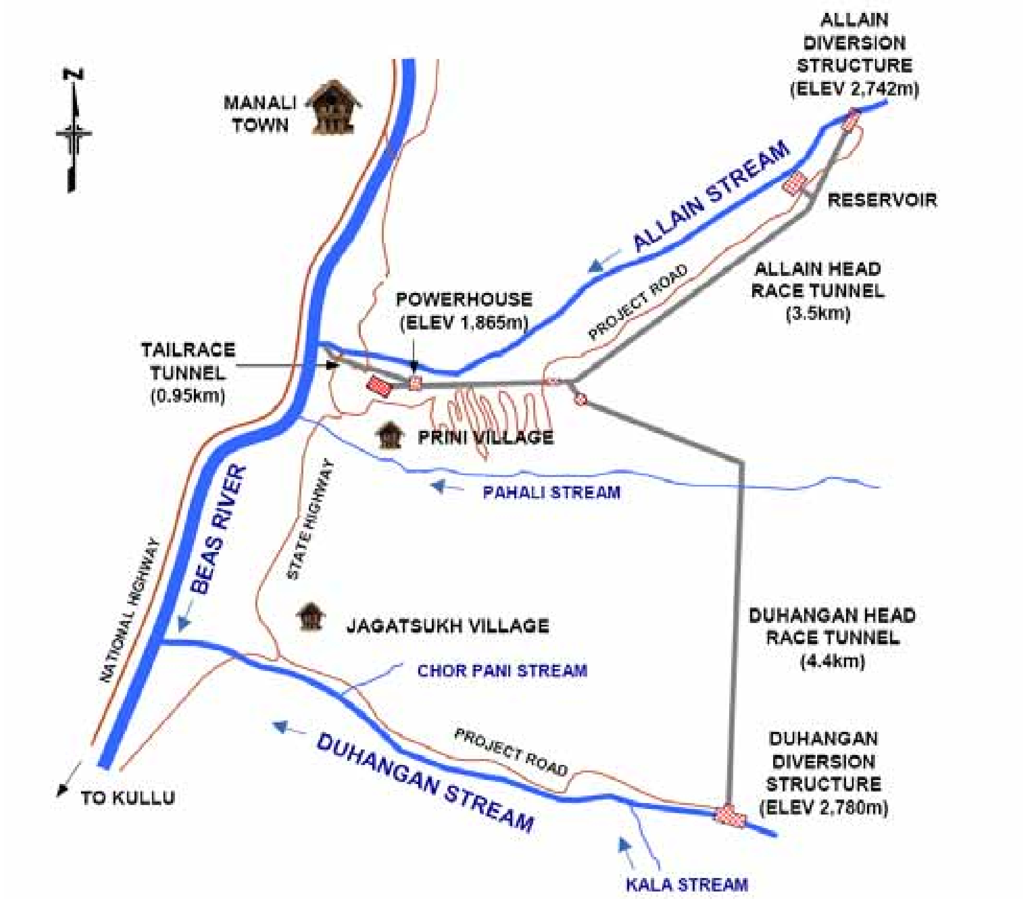


Figure 1.2 Schematic Diagram of the Project Site



Note: Road distances a) Prini to Allain Barrage 16 km: 5 km; Prini to Jagatsukh: 6 km; & Jagatsukh to Duhangan Weir Site:12 km

1.7 *APPROACH & METHODOLOGY ADOPTED FOR THE ESIA STUDY*

The Project had previously undertaken EIA study through Rail India Technical and Economic Services (RITES) Limited, a Government of India Enterprise, which was subsequently updated by in-house Indo-Canadian Consultancy Services (ICCS). The ICCS study required further strengthening and revision in order to meet IFC's requirement of its applicable International Standards. The earlier EIA study related to baseline data collected in 1993 – 94[(1)], has been updated with reference to the recent scenario.

The approach adopted for this revised and updated ESIA study included the following:

1) Review of previous studies and approvals obtained by the Project;
2) Site reconnaissance surveys of the Project catchment area, consultations with the Project officials, state government agencies, non governmental organisations (NGOs) and local communities;
3) Environmental and Social Baseline data collection including household survey;
4) Review of applicable local, state, national and international environmental and social regulatory and institutional framework;
5) Collating available primary and secondary baseline information;

(1) This 1996 study is available at the company's Project Office at Prini, Manali.

6) Assessment of environmental and social impacts based on collated baseline information and community consultations within the catchments of Allain and Duhangan rivers;
7) Release of draft ESIA report in August 2003 and revised ESIA in December 2003. The revised ESIA of December 2003 was disclosed in English and Hindi languages to the public at village Panchyats and Project office;
8) Specialised studies conducted for the Project that has informed the ESIA and the ESMP. The compendium includes the following sub-studies:

a) Socio-economic Impact Assessment Study

This study was conducted based on:

- Primary information through observation, census surveys, interviews and discussions with the Project officials, local community and village institutions; and
- Secondary sources (information and reports provided by the Project, available maps, published statistics from District Census Handbooks, District level statistical profiles, etc.).

The socio-economic impact assessment covered the villages of Jagatsukh, Prini, Aleo, Shuru, Hamta and Old Manali. General information was collected for the entire community; however, the study focused specifically on those families directly affected by the loss of private land. The socio-economic impact assessment was undertaken as per the *Guidelines for Social Assessment of IFC Investment Projects* and included the following:

- Socio-economic Profile of the communities in the villages in the Project area;
- Impact assessment of Project activities (on the community in general and those losing private land in particular);
- Developing mitigation measures for each of social impacts identified;
- Documentation of public consultations and information dissemination undertaken by Project;
- Resettlement Action Plan; and
- Community development opportunities, as part of a Community Development Plan (CDP).

b) Public Consultation & Disclosure Plan

The public consultation process for the Project has been ongoing since 1993 and has continued to date. In 2002, the Company approached IFC to gauge their interest in providing financing for the Project. As a condition of IFC's consideration of the Project, the Company was required to undertake further public consultation and disclosure measures, which included an update of the previous EIA conducted by RITES and a public meeting with the project-affected people (PAP).

c) Environmental and Social Impact Assessment of Transmission Line Corridor

A separate ESIA study was conducted for the 175 km long double circuit power transmission line from the Project site to Nalagarh in district Solan, Himachal Pradesh.

d) Wildlife and Floral Studies in Allain - Duhangan Catchments

A study on wildlife surveys in the catchments of Allain and Duhangan streams (June 2006) was conducted by World Pheasant Association (WPA), New Delhi. The wildlife and florisitic surveys were conducted to represent one year baseline conditions.

e) Study on Fish Fauna and Aquatic/Riverine Ecology

A study on fish fauna and aquatic/riverine ecology of Allain and Duhangan river basins were carried out by the Foundation for Ecological Security (May 2006) to determine the baseline conditions of fish populations, identify potential impacts and suggest appropriate mitigation measures.

f) Reservoir Safety

Hydraulic model testing to confirm the safety of the water storage structures proposed for the Project was undertaken. The Project, reportedly, has carried out hydraulic model tests to confirm the safety of the reservoir structures by engaging Lasalle Laboratory, Montreal, Canada. The relevant details of mitigation measures on safety design, regular inspection and maintenance of diversion structure and other requirements are elaborated in this revised and updated ESIA.

9) Public Consultations between May 2003 and September 2004 followed the following sequence:
   - May 2003: First public meeting in Prini village;
   - August 2003: Summary of project information and ESIA disclosed on IFC's website;
   - November 2004: IFC meetings with local NGOs at Prini
   - December 2004: Revised ESIA disclosed locally with Summary and ESMMP translated in Hindi and distributed to each project-affected family;
   - January 2004: Revised ESIA disclosed on IFC website and a list of "Frequently Asked Questions', with responses, distributed to project-affected families;
   - January 2004: Second public meeting held in village Jagatsukh;
   - February 2004: Hindi translation of entire ESIA disclosed;
   - March, April, May 2004: Focus group meetings led by independent facilitators;
   - May 2004: Third public meeting facilitated by independent panel of experts held in both Prini and Jagatsukh;
   - July 2004: Focus group meetings with project affected people led by independent facilitator;
   - September 2004: ESIA Addendum disclosed locally and on IFC website in both English and Hindi.

   Note: The public meetings were facilitated by independent third parties including Sh Shekhar Singh, Sh Harsh Mander and a Pune based NGO Kalpravriksh).
10) Environmental and Social commitment register – status as on 1 November 2007;
11) Review of compliance against requirements of Performance Standards of IFC, July 2006 for Environmental and Social Assessment studies of various category A and B projects. This revised and updated ESIA report covers IFC specified requirements to the extent of their applicability to the Project.
12) The development of revised and updated ESIA study which included the following:
   - Non Technical Executive Summary
   - Revised & Updated ESIA: The revised and updated ESIA and Environmental and Social Management and Monitoring Plan (ESMP) report that consolidate information from both original and baseline data generated for the Project, including specialised studies and a detailed ESMP that specifies what actions the Project has to take to mitigate all adverse identified impacts. The ESMP includes an environmental, social, health and safety monitoring plan that describes monitoring actions for Project to implement during the Project life cycle.

1.8 *LAYOUT OF THE ESIA REPORT*

The revised and updated ESIA report covers the following sections:

Section 1 - Introduction

The section provides description of project background, site and surroundings, objectives, scope and organisation of the study and format of this report.

Section 2 - Project Description

This section outlines technology and specifications of the Project. This section describes related infrastructural development undertaken as a part of the Project, sources of pollution from the Project activities and related control measures.

Section 3 – Environmental and Social Policy, Legal & Administrative Framework

This section provides information on Policy, Legal and Administrative framework applicable to hydropower projects. This section also defines relevant international standards applicable to the Project to meet the requirements of EPFIs and IFC.

Section 4 - Baseline Environmental Status

This section presents methodology and findings of field studies conducted with respect to geology; hydrology; meteorology; quality of ambient air, surface and ground water quality, soils, noise levels; ecology and landuse to define the existing environmental status in the Project catchment area.

Section 5 – Socio-economic Survey

This section presents socio-economic profile of the Project villages and Project affected people.

Section 6 – Impact Assessment

This section identifies and assesses potential impacts due to the Project construction and operation activities, which could cause significant environmental and social concerns. This discussion forms the basis for environmental and social management plan and the social entitlement matrix. The section also describes siginifcance of environmental and social impacts due to the Project activities.

Section 7 – Analysis of Alternatives

This section presents comparison of alternatives of power generation, Project site, technology, design, and operation including 'no project' situation in terms of potential environmental impacts.

Section 8 Environmental and Social Management and Monitoring Plan (ESMP)

This section provides recommendation for an environmental and social management and monitoring plan aimed at minimising the negative impacts due to the pre-construction, construction and post construction phases of the Project. Environmental and social monitoring requirements for effective implementation of suggested mitigation measures during Project development as well as implementation of catchment area treatment plan and operation phase of the Project have been delineated along with requisite institutional arrangements for their implementation.

Section 9 Conclusion

Annexes:

Annex A: List of Approvals obtained by the Company for the Project

Annex B: Management Plans – for implementation during construction phase
- *Annex B-1: Construction Labour Management Plan;*
- *Annex B-2: Traffic Management Plan;*
- *Annex B-3: Muck Disposal Plan;*
- *Annex B-4: Health Management Plan (Construction Phase);*
- *Annex B-5: Construction Demobilisation Plan*

Annex C: Management Plans – for implementation during the Project life cycle
- *Annex C-1: Resettlement Action Plan (RAP);*
- *Annex C-2: Indigenous People's Development Plan (IPDP);*
- *Annex C-3: Community Development Plan;*
- *Annex C-4: Biodiversity & Wildlife Management Plan;*
- *Annex C-5: Catchment Area Treatment Plan;*
- *Annex C-6: Minimum Water Discharges & Fisheries Monitoring Plan*
- *Annex C-7: Emergency Response Plan; and*
- *Annex C-8: Desiltation Management Plan (for Desilting Chambers on Allain & Duhangan Streams).*

Annex D: Photo-documentation depicting Project site and field studies

Annex E: Barrage & Dam Height Classification as per ICOLD

Annex F: Details on Ecological Baseline Conditions

Annex G: Consolidated Report on River Ecology Study conducted by FES

Annex H: Wildlife Surveys in Allain – Duhangan Catchments, Himachal Pradesh by WPA India

Annex I: Office Orders on Grievance Redressal Cell and Independent Appeal Mechanism

Annex J: Water Flows Observed on Allain and Duhangan Streams by HPSEB

2 *PROJECT DESCRIPTION*

2.1 *LOCATION*

The Project components extend within villages of Pirni, Hamta and Jagatsukh in Tehsil Manali in the district of Kullu, Himachal Pradesh. The location map of the Project location and its layout plan are shown in *Section 1* (*Figures 1.1 & 1.2).* Also refer to *Figure 2.1* for location of the Project components as shown on satellite imagery of the Project catchment.

2.2 *THE PROPOSED PROJECT: CONSTRUCTION, OPERATION & DECOMMISSIONING*

The following sections identify the key activities of Project life cycle.

2.2.1 *Construction Phase Activities*

A) Infrastructure and Civil Works

The infrastructure and civil works of the Project includes the following:

1. Access roads, bridges, slope stabilization and cross drainage works, permanent and temporary buildings, water supply, electrification of colonies, communication systems, workshops and stores etc;
2. Allain barrage, head regulator, de-silting arrangement, intake structure and Allain head race tunnel (HRT);
3. Duhangan weir, head regulator, de-silting arrangement, intake structure and Duhangan head race tunnel (HRT);
4. Intermediate reservoir, surge shaft and its associated works;
5. Pressure shaft and associated works; and
6. Powerhouse complex and its associated works including tail race tunnel/ channel and switchyard.

The Project construction envisages setting up of the following components:

B) Allain Upstream Works

i) Diversion Barrage

A gated barrage comprising of two sluice-bays (5m width each) and two number of spillway-bays (of 10.0m width each) are being set up on the southern bank of Allain stream. The crest levels of under sluice and spillway bays are kept at El 2738.5m and El 2746.3m respectively. The maximum height of the barrage has been kept as less than 14.5m with a total storage of 12.0 ha-m i.e. 0.12 million m^3 of water.

ii) Head Regulator

The head regulator is located on the upstream side of barrage to divert a maximum flow of 23.625m^3/second [1] (cumecs).

iii) Head Race Tunnel

The water discharge of 21.0 cumecs is diverted into the surge shaft through a 4 m wide and 3.4 m high 4093.0 m long, concrete lined circular headrace tunnel.

iv) De-silting Basin (Desanders)

The de-silting basin (Desanders) comprises of 3+1 (1 spare) longitudinal chambers, each chamber size 8m x 12m, suited for de-silting of particles of 0.2mm and above.

C) Duhangan Upstream Works

i) Trench weir

A trench type of weir of 18-m wide sill has been provided at El 2787.0 m in Duhangan stream to divert the 9.875 cumecs discharge. The average bed level of the stream at weir site is about El.2781 m.

ii) De-silting Chamber (Desanders)

A 70m long and 10m wide de-silting chamber (Desander) is located at the northern bank of Duhangan stream in an underground cavern, and is provided with 7 hoppers.

D) Head Race Tunnel & Surge Shaft

Discharge from the two head race tunnels from Allain and Duhangan is proposed to be conveyed into a common pooling point, the surge shaft located near a relatively flat hill terrace near Hamta village. The junction shaft into which the two tunnels empty out and the pressure shaft take-off point is founded in rock to ensure its complete stability. The de-silted water of 9.875 cumecs is diverted into the common pooling point at surge shaft through a 3.4 m wide x 3.4 m high D-shaped, concrete lined, 4440.0 m long head race tunnel excavated in rock.

E) Intermediate Storage Reservoir

Live storage will be provided at an intermediate reservoir of capacity 22.5 ha-m. The effective height of the reservoir will be less than 14.5m. The storage will be provided between full reservoir level (FRL) at elevation (El.) 2751.5m and minimum reservoir level El 2748.0m, to meet the peaking requirements.

(1) 1 cubic meter (m^3) per second = 1 cumec (In plural it is also written as cumecs)

F) Pressure Shaft

A vertical inclined pressure shaft of internal diameter varying from 3000 to 2400 millimeter (mm) bifurcating 31 m upstream of the powerhouse cavern into two branches each of 1,800 mm internal diameter, steel lined back filled with concrete running to a depth of 800 m, followed by a horizontal run of 350 m long that carries the design discharge of 26.8 cumecs with a maximum gross head of 876.0 m and a net head of +858.0 m.

Figure 2.1 Project Components as shown on Satellite Imagery of the Project Catchment

G) Power House and Switchyard

The power house includes two main caverns on the left bank of Allain river; the machine hall of 68 m long x 34 m high x 15.3 m wide housing the two Pelton turbine units, auxiliary equipment, services, control room, etc. and transformer cavern 68 m long x 12.5 m high x 12.5 m wide housing seven transformers. A surface switchyard is provided on the southern bank of Allain stream. A bridge will be provided to have an access to the switchyard.

H) Tail Race Tunnel

Tail water will be discharged into Allain downstream through a tunnel 4.2 m width x 4.2 m height x 884 m length through an open trapezoidal channel of 75 m width.

I) Transmission Line

One 220 kV double circuit transmission feeder with a line length of approximately 175 km to Nalagarh sub station of Power Grid Corporation of India Limited (PGCIL) is under construction. The transmission line traverses through four districts of Himachal namely Kullu, Mandi, Bilaspur and Solan. The transmission line starts from Prini village of Manali Tehsil. The starting point is at a height of El. 1987 m (above sea level). The transmission line would pass over the hills maintaining similar height or as the terrain permits to avoid habitation and fields to the extent possible and the proposed ground clearance of the line is 15 m. Its destination is a sub-station at Nallagarh, in district Solan, where it feeds into the National Grid. For details refer to ESIA study separately conducted for the Transmission Line for the Project.

J) Access Roads to the Project Components

To access various components of the Project (also refer to *Figure 1.2* in *Section 1*), construction of the following roads and bridges are included:

1. An approach road of 8 m width and approximately 16 km length located on the southern bank of Allain stream from Prini village to Allain Barrage site via villages Hamta and Saithan. The road initially traverses through a fairly levelled land. After some 600 m, the road passes on to forestland until it reaches the power-house site at 900 m;
2. Two diversion roads taking off to approach the pressure shaft adit at El 1970 m and the Pressure shaft adit at EL 2415 m on Prini - Hamta surge-shaft road at about 1.25 km and about 6 km respectively from Prini village. These roads are meant for approaching the adits for construction of the pressure shaft; and
3. An approach road of 8 m width and approximately 12 km length connecting Duhangan weir site from the existing Manali -Nagar road, near village Jagatshukh.

Besides these main roads, following approach roads are also included as per the requirements of construction. These approach to:

- explosive magazines storage areas;
- Batching and mixing plants;
- Contractors staff and labour camps;
- Workshops;

- Haulage roads for removal of excavated muck to fill dumping areas; and
- Internal roads within the colony.

K) Communication

Telecommunication link between powerhouse, barrage and the project will be provided by extending the existing telephone network of Post and Telegraph (P&T) Department, through the nearest P&T exchange. An internal automatic exchange (EPABX) with 150 lines capacity for the project will also be provided. All important sites of work, offices and residences of senior officers shall be connected by telephone. The powerhouse and the permanent colony at Prini shall also be provided with very high frequency (VHF) wireless link to keep contact with other power stations and substations in the grid. The powerhouse will ultimately be connected by carrier communication system.

L) Construction Materials – Procurement, Storage & Transportation

The contractors for each package are to make arrangements for procurement / production of construction materials (including explosives for drilling and blasting operations), their transportation and storage. The storage and handling of explosives are required to be under strict supervision of ADHPL. The requirement of aggregate for construction of various Project structures is estimated to be about 85,000m^3 for coarse aggregates and 60,000m^3 for fine aggregates. Survey was conducted to assess the availability and suitability of the construction material available in the vicinity of Project area. The Project area comprises of green schists and granite schists belonging to Banjar and Kullu formation group of rocks. The Project has selected two quarry sites in the Beas River upstream of Manali town to meet the requirement of coarse/ fine aggregates. Natural sand deposits of the required quantity are not available in the Project area. Grinding mills of 2 x 125 tons per hour (tph) capacities are installed for making sand.

Besides the two quarry sites, reconnaissance survey was conducted along the access trail to assess the possibility of establishing separate aggregate production facilities and concrete batching plants both at barrage site and power house areas so that the lead could be reduced. A quarry site with coarse aggregate 500m upstream of the Allain barrage site has been identified. Tunnel muck is used as construction material. Total quantity of concrete required for various structures is estimated in the *Table 2.1*:

Table 2.1 Concrete Requirement for Various Structures

S.N.	Structure	Concrete Quantity (m^3)
1.	Allain Barrage	15,000
2.	Allain Head regulator & desilting basin	35,915
3.	Duhangan weir	1,040
4.	Duhangan Head regulator & desilting basin	2,600
5	Intermediate Storage Reservoir	48,500
6.	Allain Head Race Tunnel	26,680
7.	Duhangan Head Race Tunnel	32,960
8.	Surge Shaft	2,787
9.	Pressure Shaft Adit	160
10.	Pressure Shaft	16,320

S.N.	Structure	Concrete Quantity (m^3)
11.	Main Cavern & Transformer Cavern & Bus duct	8,593
12.	Tail race tunnel and channel	9,556
13.	Switchyard	3,814
	Total	203,925

Source: ADHPL

M) Land Acquisition

ADHPL has acquired land permanently for the structures, stores, workshops, colonies, etc. as per the details given in *Table 2.2*.

Table 2.2 Details of Land Acquisition

Land Type	Prini	Jagatsukh	Aleo	Hamta	Total	%
Private, Ha	8.880	0.330	0.540	-	9.750	14.42
Forest*, Ha	-	-	-	-	47.179	69.79
Government, Ha	-	-	-	10.67	10.67	15.79
				Total	67.599	100

Source: ADHPL; Note: * Includes 5.512 ha of forestland involved for underground activities

The details of acquisition of private land acquisition in village Prini are as follows:

- The Negotiation Committee constituted by the Government of Himachal Pradesh, under the Chairmanship of Deputy Commissioner, Kullu held negotiations with the land owners of village Prini on 28 August 2003 to finalise the value of land; and
- Thereafter during a public consultation held on 20 May 2004, the villagers demanded an increase in the land rates negotiated and finalized earlier. Subsequently, the Company accepted the demand and agreed to a higher compensation rate. The Company also agreed enhancement of the rate of other three types of land in the same proportion.

N) Water Requirement

Water requirement during construction phase is for domestic purposes as well as for construction activities like concrete preparation and wet drilling during excavation for tunnels.

It has been estimated that around 360m^3/day of water will be required to meet the domestic requirement (including contractor's camps sites) during the construction stage. Another 40m^3/day (approximately) will be required to meet the other requirements of construction activities.

Table 2.3 Construction Phase Water Balance (Peak Water Requirement)

S.N.	Input, Discharge and Output	Peak Water m3/day
1	Input for domestic use	360.0
2	Input for Utility and Service Activities	40.0
A	**Total Input**	**410.0**
B	**Total Domestic Wastewater Discharge**	**288**
1	Utilities and Services Discharge	40
2	Other Losses	72
C	**Total Output**	**410**

Source: ADHPL

The wastewater generated from utilities and services during construction phase will be approximately 40m^3/day. It is estimated that about 2000 people will be working during peak construction phase with a total water consumption of about 360m^3/day. The expected peak domestic wastewater during construction phase would be 288m^3/day. A water treatment plant has been provided for prior treatment of domestic wastewater generated during construction at the office/colony site, while for the three camp sites, septic tanks with soak pits are provided.

O) Power Requirement

A requirement of power needed for operation of construction equipment, quarries, lighting of work areas, colonies, labour camps, de-watering and water-supply has been made as shown in the *Table 2.4*.

Table 2.4 Estimated Peak Power Requirement during Construction Period

Year	Power Requirement (MW)
First year	1.5
Second	5.0
Third year	7.0
Fourth year	7.0
From fifth year to commissioning	5.0

Source: ADHPL

The power requirement for the Project construction is maintained through Himachal Pradesh State Electricity Board (HPSEB) supply as well through diesel generators, which are installed at some strategic feeder points. Power is being supplied to the individual contractors from one point, where it is metered. The contractors make arrangements for taking power to different work areas themselves by adhering to the required safety provisions.

Diesel fuel requirement for a maximum power generation of 7MW is approximately 1.65 m^3/hour. To meet construction power demand diesel generators are located near 1) Drift Tunnel, 2) Intermediate Storage Reservoir, 3) Allain barrage and 4) Duhangan weir. Depending upon ongoing activities at the particular site, a mix of 750 kilo Watt (kW), 1250 kW and 1500 kW diesel generators are in use at these locations (with a combination of 750+1500 = 2250 kW at three locations and 1250+1250 =2500 kW at one location).

P) Construction of Core Project Components

i) Head Works at Allain and Duhangan Streams

The head works at Allain Barrage included approach road to Allain Barrage site, diversion of channel of the Allain, construction of cofferdam from excavated material, compacting, concreting and installation of gates and hoists.

The head works at Duhangan stream included approach road to Duhangan weir site, diversion of channel, construction of cofferdam from the excavated material, compacting and concreting followed by excavation of the head race tunnel (HRT) from Duhangan heading and erection of gates and hoists.

ii) Allain & Duhangan Head Race Tunnels (HRT)

The tunnel length of Allain HRT and Duhangan HRT is 4093.0 m and 4440.0 m respectively. Both the tunnels are circular and lined with concrete. The HRTs to carry water from Allain barrage and Duhangan weir sites have been provided with two intermediate adits each, i.e. Allain HRT has adits of 157 m and 235 m. The HRTs would be completed in following phases:

- excavation and clearing up of excavation equipment;
- concrete lining/shot-krate;
- overt and invert clearing including grouting; and
- final cleaning up.

Excavation work has been taken up by conventional method of drilling and blasting. Drilling activities have been carried out by hydraulic drill jumbos.

iii) Storage Reservoir, Intake/Junction shaft, Bridge & Pressure Shaft

The storage reservoir is designed to have a live storage of 22.5ha-m with a full reservoir level of 2748.0m and a minimum reservoir level of 2738.0m. The reservoir will have gravity type reinforced cement concrete (RCC) retaining wall with maximum height of 14.5m including 1m freeboard). The overflow structure at the reservoir would consist of a crest at 2751.5m level and with a width of 50.0m.

Muck is removed through out the adits and the powerhouse by conventional methods. The entire length of the pressure shaft (1,545m long) is lined by lowering segments of liners from the adits, which is welded to the one preceding it at the site.

iv) Power House, Switchyard and Tailrace Tunnel

The powerhouse cavern is approached through a 7.5m diameter D-shaped 750m long tunnel starting near the Prini village. The excavation would be of the order of 50,000m^3 in the powerhouse, transformer cavern, bus ducts and cable cum ventilation tunnel. This includes the installation of support systems i.e. rock bolting and shotcreting.

An 884m long 4 m-diameter D-shaped tailrace tunnels is to open into a 75m long trapezoidal open channel. Conventional methods for excavation of tunnel and for the open channel would be adopted.

Q) Workforce Arrangements – Labour Camps

The contractors for each package are to make their own arrangements for labour required for construction works, their staying arrangements near the work sites in labour camps for easy mobilisation of the workforce. The six labour camps are set up at the following locations:

1. At Main gate of ADHEP;
2. Tail Race Discharge near Aleo village;
3. Along Allain near Bhujdar;
4. Along Allain near Hamta potato farm;
5. Along Duhangan near Khanoon; and
6. At Duhangan Wier site.
7. At Pandu Ropa

The peak labour strength expected during the Project construction is around 2000 persons. ADHPL is ensuring separate colonies for the labour force with segregated facilities, and all contractors are bound through contractual provisions to observe local, national and IFC's requirement on environmental, health and safety regulations policies and procedures, including compliance with local security requirements. Violations of these regulations would result in fines for the erring contractors and/or cancellation of their contracts.

ADHPL has constructed a building as a colony for its staff, at Prini village. This colony is provided with following facilities:

1. Potable Water-supply arrangements;
2. Sanitation and sewage disposal arrangements;
3. Drainage arrangements;
4. Internal roads and cross-drainage works;
5. Electrical supply;
6. Fencing and security;
7. A well-equipped medical centre;
8. A recreation centre;
9. A telephone exchange; etc

ADHPL is directly responsible to supervise and suggest any specific requirement with respect to workforce. ADHPL is ensuring that no child labour is engaged for the Project.

R) Shift Operation

It is proposed to operate in shifts for construction phase as per the following details. The timings of different shifts are as under:

- Shift I : 08.00 AM to 08.00 PM
- Shift II : 08.00 PM to 08.00 AM
- General Shift : 09.00 AM to 06.00 PM

S) Maintenance and Working of Construction Equipment

The programme for construction equipment operation includes the following:

- Installing aggregate crushing , classification and sand producing plants of 30 and 40 tons per hour near quarry site;
- Installing concrete batch mixing plants near Allain barrage and Duhangan weir sites for construction of Allain and Duhangan tunnels;
- Establishing batching plant of 40 m^3 per hour capacity near surge shaft and intermediate reservoir area to cater to the concrete requirements of both the tunnel headings and also the pressure shaft; and

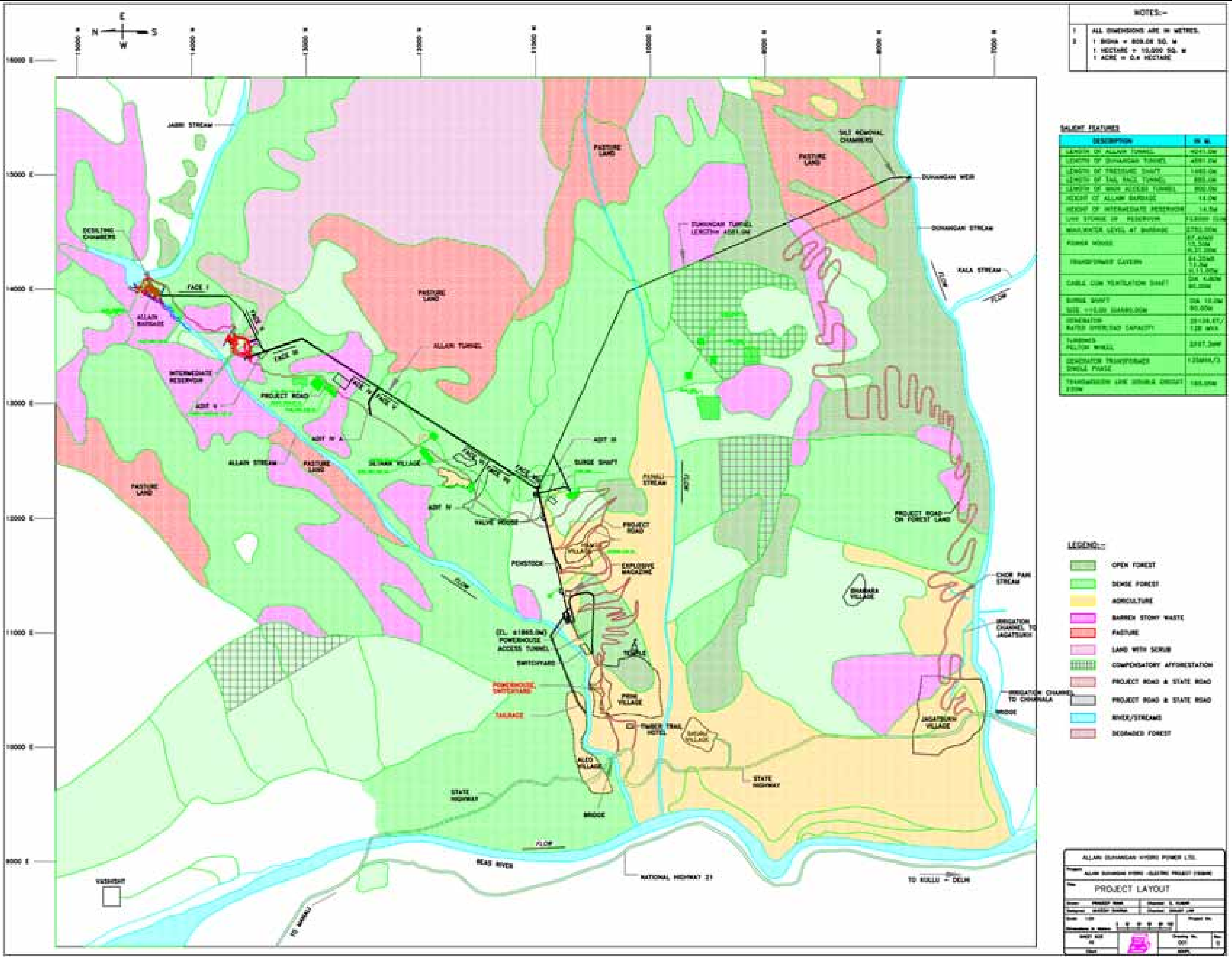
- Installing hydraulic press in the workshop area for bending of ribs.

T) Transportation

Transportation arrangement will include the following:

- Transportation of quarry material from quarry sites to the batching plant by trucks; and
- About 116,500 truck trips per annum (i.e. almost 58 truck trips per day considering 365 days of working per year) are expected during 66 months of construction phase for disposal of muck left after backfilling.

Figure 2.2 Layout Plan of the Allain Duhangan Hydroelectric Power Project (Source ADHPL)



U) Blasting for Tunnel Development

Blasting is done by drilling holes at certain fixed points to a depth of (maximum 42 mm diameter holes up to 3.5m of depth). For blasting of 132 m^3 of rock there is a need of 120 kg of charge dynamite (explosive) [20 kg of charge per delay for six delays]. The drilling is done through mechanised drilling machines. *Table 2.5* describes the time cycle of operation for excavation of tunnels. Charging and blasting would be of 1 hour duration during 24-hour cycle time. ADHPL will ensure use of personal protective equipment and other control measures (including defuming) during tunnel blasting and excavations.

Table 2.5 Time Cycle of Operation for Tunnel Excavation

S.N.	Description	Time Required, Hour (s)
1	Drilling and Shifting of Drill Jumbos	4
2	Charging and Blasting	1
3	Defuming	1
4	Scaling	1
5	Mucking	4
6	Mapping / Survey etc.	1
7	Shotcreting, rock bolting, rib erection and backfill concreting	12
	Total	24

Source: ADHPL

De-fuming after blasting is done by ventilation blowers installed in series at an appropriate spacing in air duct pipes of suitable diameter. Compressed air requirement is met from the compressors kept near the inlet and outlet portals. The muck is loaded by 0.38m^3 electric convey muckers into muck cars of 1 m^3 capacity hauled by 3.5m^3 battery operated loco to outside dump areas. Spreading and compaction of muck is done through 180 horse power (hp) bulldozers.

V) Decommissioning of Construction Equipment & Commencement of Production

Decommissioning/demobilisation of construction activities is expected to be started by end of year 2009. All care will be taken up to bring the non-Project sites to their original condition to the extent possible. The anticipated commencement of power generation level will be achieved by mid of the year 2010.

W) Project Construction Cost

The anticipated capital outlay is given in *Table 2.6*.

Table 2.6 Capital Outlay Envisaged

Description	Cost in INR * (Million)
Civil Works	4118.30
Electro-mechanical Works	2142.54
Associated Transmission System	897.09
Sub Total	7157.93
Interest During Construction	1997.83
Fund Management Expenses	67.79
Total INR	9223.55

Source: ADHPL, The above total cost as approved by CEA.

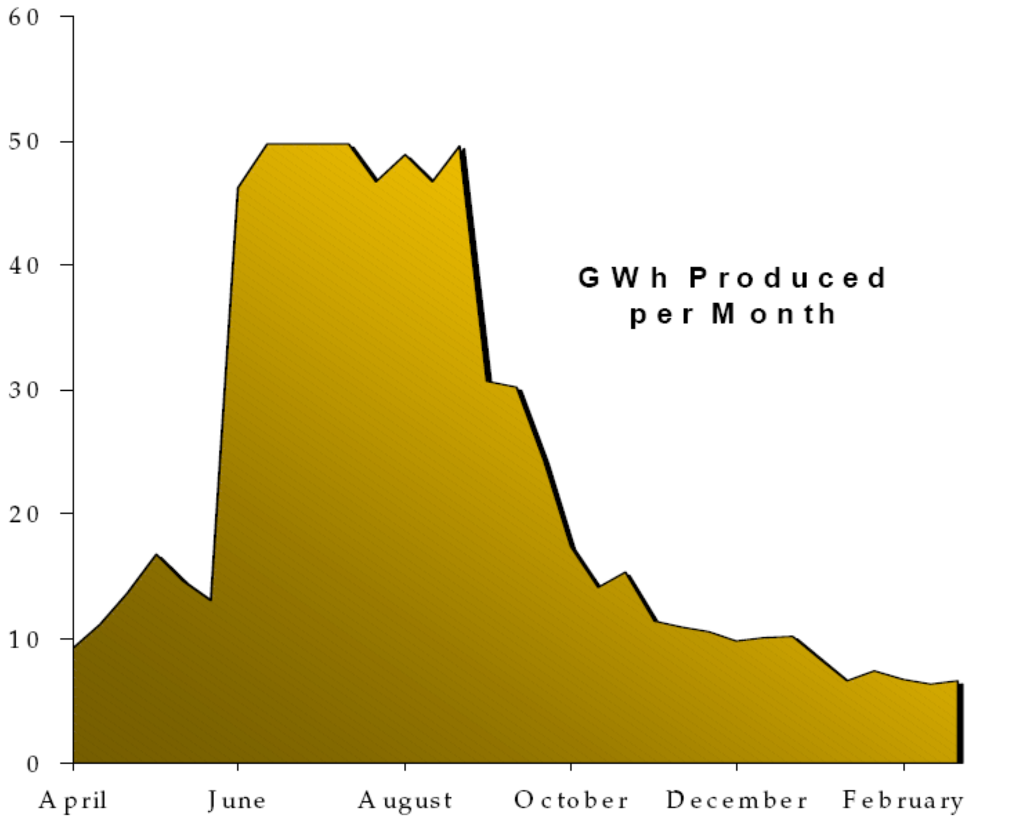
2.2.2 *Operation Phase Activities*

The water sources for the Project are the two streams viz.; Allain and Duhangan. The layout of the Project is shown in *Figure 2.2*.

A) Life Cycle Overview

The Project is a peaking plant that generates electricity four hours per day during dry period while during monsoon season it will operate round the clock. Depending on assumptions, annual generation could be as much as 821 million kilo watt hour units (MU) per year (about 4,300 hours of 192 MW full load operation). During wet periods the tailrace will flow continuously, but the flow will be obscured by the larger flow in the Allain. *Figure 2.3* presents the power generation curve for the Project with an annual production of 821 MU.

Figure 2.3 *Power Generation Curve for the Project*



Source: ADHPL

B) Water Requirement for the Project Operation

The Project would be a run-of-the river type development with diurnal pondage facility to enable the power station to cater to daily variations in power requirement and providing peaking power. The energy benefits would follow the pattern of flows in the Allain and Duhangan streams and would be higher during monsoon months (June to September) decreasing significantly during the rest of the year as the stream flows are characterised by large seasonal variations.

Table 2.7 Operation Phase Peak Water Balance

S.N.	Input, Discharge and Output	Water Quantity m^3/day
1	Domestic Water Input	4.5
2	Utility and Service Activities	1.3
3	Power Generation	2315000
A	**Total Input**	**2315,005.8***
1	Tail Race Discharge	2315,000
2	Desilting Chambers Flushings	400
3	Domestic Wastewater	3.6
B	**Total Discharge**	**2315,403.6**
1	Utilities and Services Discharge	1.3
2	Other Losses	0.9
C	**Total Output**	**2315,405.8**

Source: ADHPL, Note: *Based upon 24 hours a day block operation

The wastewater generated from utilities and services during operation phase will be 1.3 m^3/day. It is estimated that about 100 people will be working during the operation phase requiring about 4.5 m^3/day of water. It is expected that approximately 3.6 m^3/day of domestic wastewater will be generated during operation phase. A water treatment plant has been proposed near power house for prior treatment of domestic wastewater generated during operation phase.

The peak tail race discharge from the turbines is expected to be 31m^3/second i.e. 111,600m^3/hour.

C) Number of Employees Envisaged

There will be approximately 100 permanent and non-permanent employees working during operation phase of the Project.

D) Shift Operation

Project personnel will be working as per the following shift timings:

- Shift I : 06.00 AM to 14.00 PM
- Shift II : 14.00 PM to 22.00 PM
- Shift III : 22.00 PM to 06.00 PM
- General Shift : 08.00 AM to 17.30 PM

Employees (permanent and contractor) working in shifts will work on 6 days a week basis with one weekly holiday to be observed on basis of shift arrangement. Employees working in general shift will be observing Sunday as a weekly holiday.

E) Organogram

The organogram for construction and operation phases is presented in *Section 8* on ESMP.

2.2.3 Operational Life of the Project

ADHPL will own and operate the ADHEP for a period of 40 years, which is extendable to another 20 years.

2.2.4 *Decommissioning of the Project*

After the completion of the operational life of the Project, ADHPL will decommission the Project by restroing Project site and its components to best achievable conditions.

Prior to decommissioning a detailed ESIA will be required to include all possible measures to restore best achievable environmental conditions of the Project components. Some of the important requirements for decommissioning of the Project are included in *Section 8* on ESMP.

2.3 SALIENT FEATURES OF TECHNICAL ASPECT OF THE PROJECT

The salient features of the Project in technical terms are given in *Table 2.8*.

Table 2.8 Salient Features of the ADHEP

S.N.	Description	Salient Features	
1.	Location		
	State	Himachal Pradesh	
	District	Kullu	
	River	Allain and Duhangan streams	
	Vicinity	Near Manali Town	
		Allain Stream	**Duhangan Stream**
2.	Hydrology		
	Catchment area at barrage axis	128.9 sq. km	66.2 sq. km
	Design Flood 100 Year Return period	730.0 cumecs	316.0 cumecs
	Discharge with 90% availability	3.028 cumecs	1.301 cumecs
	Discharge with 50% availability	5.940 cumecs	2.950 cumes
3.	Diversion Structures		
	Type	Gated Barrage	Trench Weir
	Maximum water level	2752.5 m	2788.0 m
	Average riverbed level at barrage axis	2742.0 m	2782.0 m
	Crest level of Spillway bays	2745.3 m	2782.0 m
	Crest level of undersluice bays	2737.5 m	Not applicable
	Bridge Deck Level	2754.50 m	Not applicable
	Length of structures between abutments	22.5 m	18.0 m
	Nos. of Spillway bays	Two (2 Nos.)	Not applicable
	Width of each bay	10.0 m	Not applicable
	No. of under sluice bays	2	Not applicable
	Width of each under sluice bay	5.0 m	Not applicable
	Thickness of intermediate Piers	2.0 m	Not applicable
	Gate Nos. Type & Size		
	i. Spillway	2 Nos. Vertical lift fixed. Wheel type 10m x 7.0 m	Not applicable

	ii. Undersluice	2 nos. vertical lift fixed, wheel type 5.0 m x3.0 m	Not applicable
	Energy Dissipation system	Hydraulic jump formation on sloping glacis.	
4.	Head Regulator		
	Width of Head regulator	17.4 m	4.3 m
	No. of Bays	4	1
	Width of each bay	3.25 m	2.30 m
	Regulator gates	4 Hydraulic vertical lift fixed wheel type 2.5m x 2.5m	1 Hydraulic vertical lift fixed wheel type 3.4m x 4.2m
	Design Discharge	22.6 cumecs	8.4 cumecs
5.	Desilting Arrangement		
	No. & Size of de-silting basin	4 rows each, 8 m x 80 m	1 row, under ground de-silting chamber with 7 hoppers, 90 m x10 m
	Particle size to be excluded	0.2 mm and above	0.2 mm and above
	Flow through velocity	0.19 m/sec	0.19 m /sec
	Flushing velocity	6.50m/sec	6.50 m/sec
	Gates at desilting basin	Allain and Duhangan 1 vertical lift slide type 3.4m x 4.0m	Not applicable
	Stop log gates at the end of desilting basin	2 nos. vertical lift fixed wheel type, 8mx 4.5m	Not applicable
	Gates at end of the flushing conduit	4 nos. vertical lift slide type 2m x 1.5 m	1 no. vertical lift fixed wheel type 2m x 1.5 m
6.	Head Race Tunnel		
	Size and type	4.5m wide x 4.5m high, circular shaped, concrete lined	4.5m wide x 4.5 high, D-shaped, concrete lined
	Velocity	1.83m/sec	0.77m/sec
	Length	4025 m	4340.0 m/sec
	Design discharge	22.6cumecs	8.4cumecs
	Slope	1 in 123	1 in 67
	Adits	1x157m	1x700 m
		1x235	1x246 m
7	Intermediate Reservoir (live storage)	22.5 ha m	
	Full supply reservoir level	2748.0m	-
	Minimum reservoir level	2734.0m	-
	Type of retaining wall	Gravity RCC retaining wall, with max. height of 14.5m	-
8.	Overflow Structure		
	Width of crest	50.0m	
	Level of crest	2751.00m	
	Design discharge	26.8 cumecs	
9	Surge Shaft	Diameter 10m, Height 60m	Conmcrete lined
10	Pressure Shaft		
	Length and type	1750 m long (including length after bifurcation) steel lined, back filled with concrete.	

	Diameter	Varies from 3000 to 2400mm internal diameter bifurcating 31m upstream of the power house cavern into two branches each of 1800 mm internal diameter	
	Adits	310 m and 198 m long	
	Type and thickness of steel liner	ASTM-537-Class II varying in thickness from 16mm to 68mm	
11	Power House		
	Type	Underground	
	Installed Capacity	2x 96 MW	
	Size:		
	- Main Cavern	66.5m (L)x15.3 m(W)x33m (H)	
	- Transformer Cavern	64.5m(L)x12.5m(W)x12.5 m(H)	
	Capacity of EOT Crane	200/35Tons	
	Maximum Gross Head	880.0m	
	Minimum Gross Head	866.5m	
	Rated Net Head	853.0m	
	Nozzle Head	1872.0m	
	Service bay level	1882.4m	
	Top of Crane Rail Level	1890.4m	
	Maximum TWL (below runner)	1868.0m	
	Highest flood level on tail race side	1868.0m	
12	Tail Race		
	Type	Free flow modified horseshoe shaped	
	No. & Size of tail race duct	2 Nos., 4.0m, D-Shaped	
	Tail Race Tunnel	885.0m(L), 4.6m(W) x 4.6m(H) , D- shaped,	
	Bed Gradient	1 in 425	
	Gates for tailrace duct	1 Service Gate at outfall of tailrace	
	Open channel	30m x 4m x 4m	
13	Turbine		
	No. & type	2 Nos. vertical pelton	
	Rated power	96 MW each	
	Number of jets	5	
	Rated Net Head	858.0 m	
	Max/min net head	880 m/847 m	
	Maximum discharge	15.5 m3/sec. per machine	
	Speed	500rpm	
	Specific Speed/Jet	Mkw	
	Specific Speed of Wheel	42.1mkw	
	Wheel diameter (PCD)	1.98m	
14	Main inlet Valve		
	Type	Spherical / 2 nos.	
	Diameter	1400mm	
	Location	Power House Cavern	
15	Generator		

	Type	Vertical shaft Synchronous Machine	
	Number	2	
	Rated Capacity	106.67/128 MVA	
	Speed	500rpm	
	No of Phases	3	
	Frequency	50Hz	
	Power Factor	0.90	
	Rated Terminal Voltage	11kV	
	Excitation System	Static type	
16	Generator Step-up Transformer		
	Location	Transformer cavern	
	No. of banks	2nos.	
	No. of Single Phase Transformers	6+1 (spare)	
	Rated Voltage	11/220 kV/3KV	
	Rated Output	135MVA/3 OPWF	
	Frequency	50Hz	
	Type of Cooling	Water cooled	
17	Switchyard		
	Area	110m x 54m	
	Type	Surface	
18	Transmission Lines (220kV)		
	Numbers	One Double Circuit	
	Terminating Station	Nalagarh in Himachal Pradesh	
	Length of Line	175km	
19	Power Benefits	678MU	
20	Construction Period`	66months	

Source: ADHPL

2.3.1 General Description of the Project Components

Allain Barrage site and Intermediate Storage Reservoirs

Water is to be diverted from barrage site through underground headrace tunnel to intermediate reservoir and surge shaft. This stretch falls on the steep gorge of the Allain stream having mostly evergreen coniferous forests.

Downstream of the Allain Barrage (facing west), there is a glacier prone stream namely Marasu which is a tributary of Allain. The confluence of this stream with Allain is at about 1100m downstream of the Allain Barrage site. By road, the proposed intermediate adit location is about 1500m downsteam from the barrage site. The intermediate reservoir area is located in section of the hills - bereft of any human habitation, trees and water pond/ shed, etc. The adit for construction of the tunnel is located in this section of the hill slope between the two wooded areas as shown in background in the Photo-documentation (*Annex I Figures I-17 & 18*). As such, the Intermediate Reservoir is located in the foreground while the adit face will be in the area visible in the background of these photographs. The live water storages and sizes will be as per *Table 2.9*.

Table 2.9 Proposed Live Water Storages & Sizes

S.N.	Structure	Height of structure	Area	Storage Capacity
1	Intermediate Reservoir	Height less than 14.5 m	4.6 ha.	22.5 ha-m (0.225 million cum)
2	Allain Barrage	height less than 14.0 m	3.8 ha.	12.0 ha- m (0.120million cum)
3	Duhangan Tunnel	-	-	2.5 ha-m (0.025 million cum)
	Total Storage			37.0 ha m (0.37 million cum)

The road to Allain barrage criss-crosses through a steep terrain of forestland and gains height before it comes back to private land beside a small temple located in Hamta Village. The alignment of the road in this stretch is on some private land. The private lands in this settlement have a primarily agricultural land-use which is divided between food crops and apple orchards. The road alignment reaches the surge shaft site by passing through forest land after the Hamta Village. The main species noted in the forests were Pine, Deodar and Kail. The surge shaft site is spread over in 8 hectares of land which was previously owned by the state government's Agricultural Department and was used for potato farming. The surge shaft site is surrounded by forests on all sides and involved cutting down of some trees for site clearance. The site boundary is demarcated by a low stone wall.

After, the surge shaft, the trail traverses through forest land and alpine grasslands until it reaches the Sethan village about a km away. On the way to village, a religious structure made of stone with attached '*devata*' property falls in the way of the alignment. The village consisted of some 20 odd houses and was found to be deserted as the people had migrated to the lower reaches because of the winter season. It was reported that most of the people of the village were shepherds (gujjars) and have houses in Prini. From village Sethan onwards, the entire stretch to the Allain barrage is interspersed by forests and alpine pastures. On the way, there was a small patch of wetland called 'Panduropa,' which is of mythological significance and is linked, to a temporary resting place for the Pandavas in the Mahabharata epic.

The setting up of Allain barrage would lead to inundation of about 3.8 ha of land and would be constructed just downstream of the point where Jabri and Allain streams meet.

Duhangan Weir site

An 8 m wide approach road of approximately 12 km in length is built to the Duhangan Weir site. The road branches off from the Manali-Nagar road from the village of Jagatsukh, which is 6km by road from Manali. The initial stretch of the road traverses through the village before it aligns with the Duhangan stream and is expected to pass through the northern valley side of a very steep gorge. The entire stretch after it emerges from the village passes through forestland consisting of species like Moru, Pine and Deodar until it reaches alpine grassland at Khanoon (approximately 5 km from the Jagatsukh). The other bank of the river is heavily forested in this area. A small distance upstream from Khanoon, there is confluence of the Kala-nala and the Duhangan stream. From here, the road runs a very steep slope up to the Duhangan weir site.

Power House Complex

Power house site shall be located on the left bank of the Allain stream and is very close to the existing motorable road from Manali to Nagar on the left bank of the Beas River. A 6-m wide and approximately 1 km long approach road shall be constructed to the power house on the left bank of Allain stream from Manali – Nagar Road. Access to the underground powerhouse complex shall be through a 900m long 7m x 7m D-shaped tunnel. The access tunnel branches off into separate tunnels with one branch leading to the power house cavern and the other to the transformer cavern.

The switchyard shall be located on the left bank of Allain stream and is located on a stable area. It is easily accessible from the nearest project road.

Roads

The alternative to road construction, which can pose high impacts on forests and other areas, is development of trolley system. However this option could not be worked out due to difficulty of carrying construction material to higher elevations with high spread in different directions.

2.4 POLLUTION CONTROL MEASURES

2.4.1 Construction Phase

a) Air Emissions and Control Measures

a1) Grinding Mills and Crusher

To prevent the dust emission emitted from the stack of grinding mills and crusher if any installed at site, bag filter will be provided to curtail dust emission within a limit of 150 mg/Nm^3. The emission from the grinding mills/ crusher will be controlled through stack of height above the roof level of existing building nearby or as stipulated by HPPCB for wider dispersion of particulates.

a2) DG Set Operation

To meet peak construction phase power demand of 7 MW, a combination of DG sets of 750 kW (say 3 nos.), 1250 kW (say 2nos.) and 1500 kW (say 3 nos.) rating which are to be installed at strategic locations. These locations include Allain Barrage, Intermediate Storage Reservoir, Powerhouse and Duhangan Weir Site (with a likely DG sets combination of 750+1500 = 2250kW at three locations and 1250+1250 =2500 kW at one location). It is important to note that these locations are geographically located at varying distances (minimum 2 km from each other) with hilly topography. Pollution control measures for reduction of emissions include the following:

- Use of liquid fuel, resulting in particulate matter emission well below the Indian standard of 150mg/Nm^3;

- Use of low sulphur HSD fuel oil (with maximum 0.1% of Sulphur content) to restrict the SO_2 emission;
- Periodical maintenance to ensure designed low emission of NO_x
- Provision of silencers/mufflers to control the noise levels.
- Provision of stack height as per the stack height criterion of CPCB: $H = h + 0.2\ (KVA)^{0.5}$, where H is the total height of stack in metres; h is the total height of the building in metres where the generator is installed; and KVA is the total generator capacity of the set in kilo volt ampere

a3) Fumes from Blasting Operations – During Excavation of Tunnels

Following blasting de-fuming is done by ventilation blowers installed in series at an appropriate spacing in air duct pipes of suitable diameter using compressed air by installing compressors near inlet and outlet portals. The ventilation blowers are provided with adequate ducting for safe escape without affecting people working in the area.

a4) Emissions from Incinerator (meant for domestic waste disposal)

An incinerator of 50 kg/hour capacity of domestic solid waste disposal has been provided near the Project office. The incinerator is provided with a combustion efficiency of 99.00%. Refer to *Section 3.3* of this report for applicable emission noms from the incinerator.

b) Wastewater Generation, Treatment and Disposal

Wastewater during construction activities is likely to get generated from the following sources:

- Construction sites: Drilling water from excavation of tunnels, workshops for machinery maintenance and fleet maintenance; and
- Domestic: Colony, project office, etc.

b1) Drilling Wastewater from Excavation of Tunnels

The wet drilling of tunnels is expected to result in discharge of wastewater, comprising of fine particles of suspended solids and may contain machine oil and grease. Approximate 40 m^3/day of such wastewater is expected to be generated and treated prior to discharge by passing it through oil traps followed by sedimentation tanks and solid waste lagoons.

b2) Wastewater from Colony

Wastewater of approximately 75m^3/day is likely to be generated from the project offices, stores, workshop, guest house and colony catering to approximately 550 persons. A sewage treatment plant (STP) of 100m^3/day is provided for treatment of collected wastewater. The STP is electro-coagulation system which comprises of the following:

- A bar screen to take care of flow fluctuation and screen out any large floating impurities;
- An oil trap for removal of any oil and grease;
- An equalisation tank for primary treatment by settling of insoluble impurities;

- A brine equaliser to produce chlorine which is led to equalisation tank to disinfect raw sewage,
- Electro-coagulation cell unit along with sand filteration. Electrolysis system generates ions which coagulate together with suspended solids and opposite ionic charge within the sewage;
- Air floatation system where coagulated solids move upwards by force of electro floatation and are skimmed off into a slurry tank for disposal;
- Sand filters followed by activated carbon filters to fine tune further impurities in the treated sewage;
- Filter press for treatment of slurry/sludge waste; and
- Backwash pump for back washing of sand and activated carbon filters. The backwash is taken back into the equaliser tank for treatment.

The quality of outlet of the STP contains BOD content <30 mg/L and total suspended solids <100 mg/L and is reportedly reused in watering plantation in and around the Project area.

Wastewater from the Project Office

The wastewater generation from the Project office is likely to be of the order of 4.5m^3/day (@45 lpcd x 100 persons), which is diverted to the STP installed for treatment of sewage from colony.

c) Solid Waste Generation & Disposal

c1) Muck Generation and Disposal

The possible solid waste generation can be in form of overburden and blasted rocks during excavation of tunnels. Quantities of total excavation of various structures are estimated as per *Table 2.10*.

Table 2.10 Quantities of Excavation – Muck Generation for the ADHEP

S.N.	Structure	MuckGeneration (m^3)
1.	Allain Barrage	150,000
2.	Allain Head Tunnel (including regulator and desilting basin)	86,000
3.	Duhangan weir	14,000
4.	Duhangan Head Tunnel (including regulator and desilting basin	87,272
5	Intermediate Reservoir	250,000
8.	Surge Shaft (including Adit 3)	9,728
9.	Pressure Shaft Adit 1	21,000
10.	Pressure Shaft Adit 2	11,239
11.	Power House Access Tunnel, Escape Tunnel	47,746
13.	Main Cavern & Transformer Cavern & Bus duct	36,325
14.	Cable cum Ventilation Tunnel	1628.6
15.	Tail race tunnel and channel	22,000
16	Switchyard	0
17	Road	150,000
	Total	886,938.6

Source: ADHPL; Note: The muck generated also includes excavated soil.

The total quantity of muck generation from the Project is approximately 887,000m^3 of which about 409,700 (46%) is reused in backfilling. The remaining 477,300m^3 shall be disposed-off in an area of about 11.6ha with a fill height of 4.44m at different locations as per *Tables 2.11 and 2.12*. The disposal of muck is planned at locations as shown in *Figure 2.5*.

Figure 2.4 Muck Disposal Sites

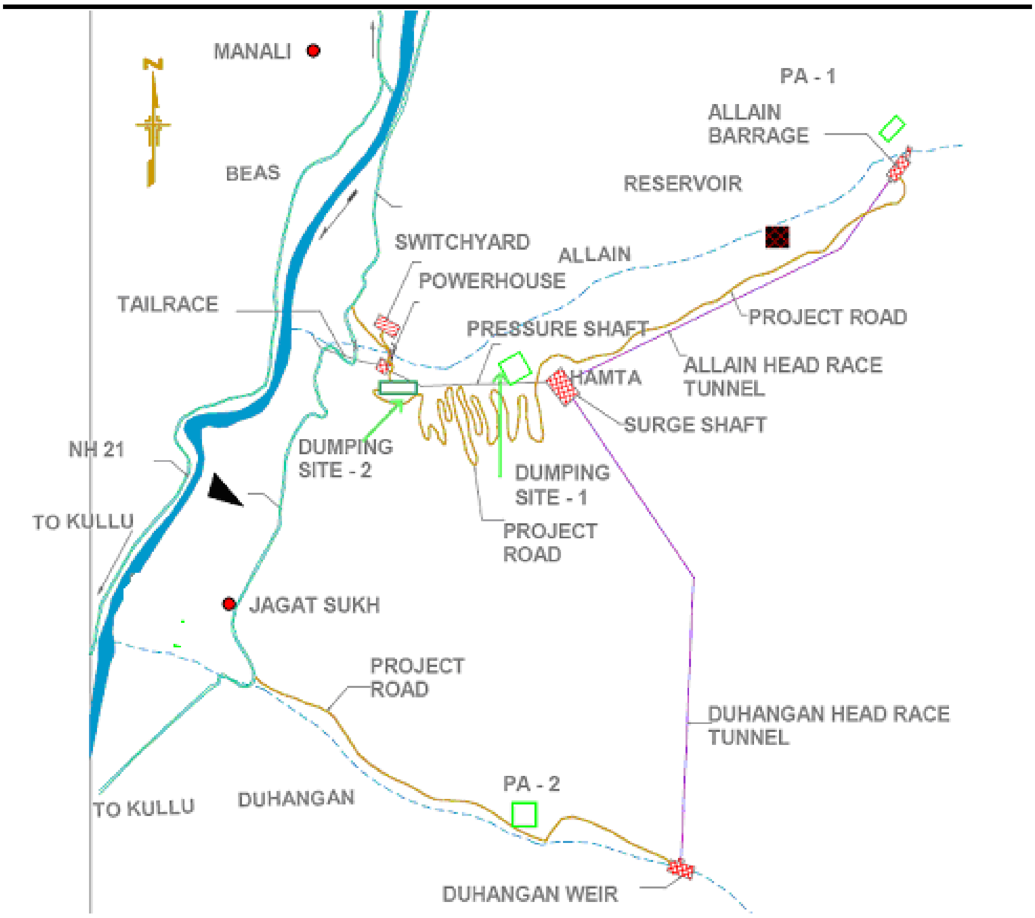


Table 2.11 Identified Muck Disposal Sites

S.N.	Disposal Site	Location	Component
1	PA 1a	Between Barrage & Reservoir	Allain Barrage
2	PA 1a,b,c,d & DS 1	Between Reservoir & Potato Farm	Reservoir
3	PA 2	Khanoon	Duhangan Weir
4	DS 1	Potato Farm	Sruge Shaft
5	DS 1 & PA 1e	Potato Farm & Near Sethan	Allain HRT
6	PA 2 & DS 1	Khanoon & Potato Farm	Duhangan HRT
7	DS 2	Swithyard	Pressure Shaft
8	DS 2	Swithyard	Power House
9	PA 3	Near Aleo Power House	TR Tunnel
10	DS 1	Potato Farm	Road

Source: ADHPL

Table 2.12 Muck Disposal Arrangement

S. N.	Disposal Site	Area Available	Quantity Disposal (tons)
1	PA 1a	1	40000
2	PA 1b	0.24	9600
3	PA 1c	2	80000
4	PA 1d	1	40000
5	PA 1e	0.16	6400
6	PA 2	1	40000
7	PA 3	0.31	16800

S. N.	Disposal Site	Area Available	Quantity Disposal (tons)
8	DS 1	5	200000
9	DS 2	0.89	44500
	Total	11.6	477300

Note: Based on average available height of retaining wall of 4.44 m.

In order to properly stabilise the muck disposal at dumping sites, the dumps are provided with proper retaining wall and rip-rap treatment.

c2) Other Solid Wastes

Solid waste generation from the project includes the following:

c2-1) Domestic Solid Waste from Colony, Office, Workshop etc,

The domestic organic solid wastes from workshops, colony and project office is expected to be about 350 kg/day. An incinerator of 50 kg/hour capacity has been provided for domestic solid waste generation.

c2-2) Solid Waste from Sewage Treatment Plant

A sewage treatment plant has been set up near colony for treatment of domestic wastewater from colony, office, workshop, stores etc. The plant generates approximately 0.05 to 0.3 tons per day (tpd) depending upon the number of people working in the Project area. The solid waste from filter press is collected in drums for subsequent use as manure in plantation onsite.

c2-3) Solid Waste from Labour Camps

Solid waste is collected from labour camps on daily basis for disposal through onsite incineration.

d) Project and Construction Waste

Other wastes like metal scraps, waste oils, machine oils, drill cutting oil, cables and domestic waste cloths. Such waste disposal will be done as per the norms of HPPCB.

2.4.2 *Operation Phase*

The expected pollution during operation phase will include the following:

a) Air Emissions

No air emissions are expected from the Project during operation phase except from a small diesel generator of 125 kVA to be installed near power house to meet any situation of power outage of backup power connection from the state grid.

b) Wastewater Generation

Wastewater generation during operation phase includes from

a) Domestic wastewater generation (for 100 employees); and

b) Desilting of the desiltation chambers installed near Allain barrage and Duhangan weir sites. Desiltation at both Allain barrage and Duhangan weir sites is expected to be achieved by breaking the respective velocity of the streams (Allain and Duhangan) to 0.19 m/sec to induce settle down of particles of 0.2 mm and above size. It is assumed that a flushing water velocity of 6.50 m/sec will be maintained for regular flushing of silt from desilting basins near Allain barrage and Duhangan weir sites (refer to *Section 7* on Impact Assessment for more detais).

c) Solid Waste

Domestic solid waste generation during operation phase is expected to be about 35 kg to 50 kg per day (350 g to 500 g per day per person x 100 persons). The Project will be incinerating domestic solid waste generated onsite on daily basis using the incinerator already installed onsite for incineration of construction phase domestic solid waste.

d) Hazardous Waste

Approximately 500 kg per month of waste/used oil (hazardous waste) is expected to be generated from the moving machinery of the Project during operation phase. The waste/used oil from the Project will be collected from Project components and stored at a well prepared impervious site provided with a shed. The waste/used oil will be disposed of through authorised vendors of CPCB/HPPCB.

3 LEGISLATIVE, REGULATORY & POLICY REQUIREMENTS

3.1 INTRODUCTION

This section highlights the environmental and social regulations applicable to the proposed Hydro Power Project. The section broadly focuses on:

- Institutional Framework;
- Constitutional provisions safeguarding individual rights and the environment;
- Overview of Various Policies of Government of India
- Environmental and Social Legislative Framework
- Applicable Standards;
- International Finance Corporation's Performance Standards on Social and Environmental Sustainability
- Applicable International Conventions/Protocols; and
- ADHPL's Groups Environment Policy
- Applicable Permits – Licences, approvals and Consents
- Current Status Permits and Clearances of the Project.

Primary legislations in India are in the form of Acts, which provide a framework for environmental protection and control. The regulatory framework identifies the key institutions and departments that have a role to play in environment management of the country and state and also describes the laws and policies that govern environmental management and may be applicable to the project. The description given in this section will be helpful in identifying regulatory agencies for effective implementation of the Environment Management Plan.

3.2 INSTITUTIONAL FRAMEWORK - ENFORCEMENT AGENCIES

A brief description of the relevant enforcement agencies of the Government of India and State Government of Himachal Pradesh with respect to the institutional framework applicable to the Project is described in the following sub-sections.

3.2.1 Government of India Institutions

a) Central Electricity Authority

The Ministry of Power (MoP) in India is concerned with planning, policy formulation, processing investment needs of public sector projects, monitoring the implementation of power projects, training, and manpower development. The MoP also administers and enacts legislation pertaining to generation, transmission, and distribution of thermal and hydropower.

The Central Electricity Authority (CEA) is a statutory organization constituted under Section 3 of the repealed Electricity (Supply) Act, 1948. It was established as a part-time body in the year 1951 and made a full-time body in the year 1975 (http://www.cea.nic.in/about_us/functions_cea.html). As per section 73 of the

Electricity Act, 2003, the Central Electricity Authority shall perform such functions and duties as the Central Government may prescribe or direct. Some of the functions performed by CEA include the following:

- advise the Central Government on the matters relating to the national electricity policy, formulate short-term and perspective plans for development of the electricity system and coordinate activities of the planning agencies for the optimal utilization of resources to sub-serve the interests of the national economy and to provide reliable and affordable electricity to all consumers;
- specify the technical standards for construction of electrical plants, electric lines and connectivity to the grid;
- specify the safety requirements for construction, operation and maintenance of electrical plants and electric lines;
- promote and assist in the timely completion of schemes and projects for improving and augmenting the electricity system;
- collect and record the data concerning the generation, transmission, trading, distribution and utilization of electricity and carry out studies relating to cost, efficiency, competitiveness and such like matters;
- make public from time to time the information secured under this Act, and provide for the publication of reports and investigations; etc.

b) Ministry of Environment and Forests

The Ministry of Environment and Forests (MoEF) is responsible for the environment. The specific functions of MoEF are as follows:

- Environmental policy planning;
- Effective implementation of legislation;
- Monitoring and control of pollution;
- Environmental Clearances for industrial and development projects covered under EIA notification;
- Promotion of environmental education, training and awareness; and
- Forest conservation, development, and wildlife protection.

The MoEF is responsible for the implementation and enforcement of the Environment Protection Act, 1986, and Rules issued under the Act, including the EIA notification. Under sections 3 and 5 of the EP Act, 1986, it retains enormous powers to issue directions in the interests of environment protection.

c) Central Pollution Control Board

The Central Pollution Control Board (CPCB) has been created for the control of water, air and noise pollution, land degradation and hazardous substances and waste management.

The CPCB was established in September 1974, for the purpose of implementing provisions of the Water (Prevention and Control of Pollution) Act, 1974. The executive responsibilities for the industrial pollution prevention and control are primarily executed by the CPCB at the Central level, which is a statutory body, attached to the MoEF. The specific functions of CPCB are as follows:

- Prevent pollution of streams and wells;
- Advise the Central Government on matters concerning prevention, control and abatement of water and air pollution;

- Co-ordinate the activities of State Pollution Control Boards and provide them with technical and research assistance;
- Establish and keep under review quality standards for surface water, groundwater and ambient air quality; and
- Planning and execution of national programme for the prevention, control and abatement of pollution through the Water and Air Acts.

The CPCB is responsible for the overall implementation and monitoring of air and water pollution control under the Water Act, 1974, and the Air Act, 1981.

d) Petroleum and Explosives Safety Organisation (PESO)

The PESO is functioning under the Ministry of Commerce and Industry, Government of India. The Chief Controller of explosives is responsible to deal with provisions of

- The Explosive Act 1884 and Rules, 1983,
- The Petroleum Act 1934 and the Rules 2002,
- The Static and Mobile pressure vessels {Unfired} Rules, 1981 and amendment 2000, 2004;
- Manufacture, Storage and Import of Hazardous Chemical Rules, 1989 and amendment 2000.

The use of any explosives during excavation in rocky area for setting up transmission towers foundations requires prior approval from PESO.

3.2.2 *State Government of Himachal Pradesh*

a) Department of Science and Technologies, Himachal Pradesh

The functions and mandate of the Department of Science and Technologies for environmental and pollution control include the following (source: http://himachal.nic.in/environment/mandate.htm):

- To exercise all the powers vested under all Act and Rules pertaining to protection of environment and control of pollution;
- Implementation/ enforcement of all environment legislation on behalf of the State Government, which cannot be implemented by State Board, or any other agency;
- To consider the validity and facts contained in the Environmental Impact Assessment and monitoring of Environment Management Plan prepared by the Project Proponents;
- Collection, preparation and dissemination of "Environmental Inventory" on the State Resources in particular and on the Himalayan Region in general;
- To deal with all matters pertaining to environmental awareness among the masses, trainings, and research on the environment and pollution control;
- Monitoring and assessment of impact of development of projects on environment;
- Dovetailing of the environmental concerns in the development processes through Environmental Planning to ensure environmentally compatible land use and ecosystem specific conservation and sustainable use of all resources;
- Research and Development on the environment protection and pollution control independently as well as in collaboration with premier institutions in the field of environment;

- Inventorisation of sources of hazardous chemicals and waste, creation of database on the treatment technologies and providing consultancy for the concerned;
- To study the likely impacts of agricultural and horticultural activities and study of "Non-Point Sources of Pollution" such as chemical fertilizers, pesticides, insecticides and other chemicals on soil and water resources, flora, fauna and communities in the State and to suggest mitigation measures/alternatives in this regard;
- To advise the Government on the Environmental issues;
- To examine the cases of Environment Impact Assessment and recommend the same to the Government of India;
- Complete control of SEIA, SEIAA & SEAC under EIA mechanism;
- To consider the validity and facts contained in the Environment Impact Assessment and monitoring of Environment Management Plan prepared by the Project Proponents.
- Monitoring of implementation of Environmental Safeguards as specified by the Government of India at the time of Environment Clearance to the various project Proponents in the State;
- Monitoring of Pollution Control measures/ devices adopted by the various industries/proponents;
- All matters pertaining to Natural and man-made disasters and to suggests mitigation/ remedial action plan programmes;
- To create data bank on disaster management related to potential industrial accidents and mitigation through instruments such as Onsite and Offsite Emergency Plan and Public Liability Insurance cover etc.
- To make coordination among the various agencies of the State Government, which are involved in environment protection and pollution control such as H.P. State Environment Protection and Pollution Control Board;
- To deal with all matters relating to Bio-diversity, Biosphere, Mitigation and Management of Natural Disasters, Protection and Conservation of the Wetlands, Grass-lands etc;
- To deal with all environmental education programmes, awareness programmes and to promote pro-active disclosure of environment monitoring and management information by the project proponents and the regulators;
- To deal with all matters relating to the environmental litigation with respect to aforesaid rules and regulation and Acts;
- Formulation/ maintenance of environmental standards in respect of various pollutants in the State; and
- Natural Disaster and Climate Change.

b) Himachal Pradesh Pollution Control Board (HPPCB)

The Himachal Pradesh State Pollution Control Board (HPPCB) was constituted to control pollution from any activities in the States. HPPCB also provides advisory support to the Department of Environment in the States on Environmental Policy matters. The HPPCB implements and enforces the policies of the Department of Environment in addition to those formulated by the MoEF. The specific functions of HPPCB are as follows:

- Planning and execution of state wide programmes for prevention, control and abatement of water and air pollution;
- Advise the State Government on prevention, control and abatement of water and air pollution and siting of industries;
- Ensure compliance with the provisions of relevant environmental legislation;

- Establish and review local effluent and emission standards;
- Ensure legal action against defaulters; and
- Develop cost effective methods for treatment, disposal and utilisation of effluent.

c) Himachal Pradesh Department of Forests

The Department is a Nodal Department for dealing with forest management of the State. Chief Conservator of Forests (CCF) is responsible for forest related management in the State. CCF is supported by Divisional Forest Officers for all matters related to diversion of forestland and management of forest in the divisions within the State.

Department of Wildlife is managed by Chief Wildlife Warden of the State who is supported by Wildlife Wardens and Rangers for management and upkeep of wildlife in the State.

d) Transport Departments, Government of HP

Transport Departments is established for enforcement of the provisions of the Central Motor Vehicles Act, 1988 and Rules, 1989. Transport Department is responsible for management of traffic on roads and compliance of requirement for freight of hazardous goods including (flammable hazardous petroleum products) as per safety codes and safety requirements as laid down in Central Motor Vehicles Rules.

e) HP State Electricity Board

HP State Electricity Board was formed in the year 1971 in accordance with the provisions of Electricity Supply Act, 1948. The board performs functions of generation, execution of hydro electric projects, power supply and distribution to consumers.

f) Department of Fisheries

The Fisheries Department has been set up with following mandate:

- To increase fish production in the State by judicious management of all the culturable water resources;
- To develop reservoir fishery of the State with an aim to increase per hectare production from the open impoundments;
- To undertake breeding programme of Indian and exotic carps, mahseer, trouts and other sub-temperate species for augmenting the seed stocking programme in reservoirs, river and streams; and tributaries;
- To protect and conserve reservoir and lacustrine fisheries resources of the state;
- To promote game fishery in the state with particular emphasis on promotion of Tourism;
- To promote commercial farming of Rainbow Trout in the high altitude areas;
- To promote aquaculture in the state by providing technical and financial assistance to the fishermen and rural youths; and
- To generate employment opportunities in the fishery sector and ameliorating the condition of fishermen of the state.

g) Department of Labour and Employment

The Department has two wings called Labour and Employment (http://himachal.gov.in/Employment/About.htm). The Labour wing is responsible for the implementation of 28 Labour Laws (Central & State) with a view to establishing and maintaining peace in the Industrial Establishments. Under the provisions of the Industrial Disputes Act 1947, Labour Courts-cum-Industrial Tribunals have been set up at Shimla & Dharamsala to decide industrial disputes. Under the Factories Act,1948, registration and renewal of factories licenses is done as also ensuring safety of workers. The Employment wing is responsible for Registration, Sponsoring and giving Vocational Guidance to the interested candidates and collection of Employment Market Information, as per provisions of the Employment Exchanges (Compulsory Notification of Vacancies) Act, 1959 and Persons with Disabilities Act (Equal opportunities, Protections of Rights and Full Participation) Act, 1995.

In Himachal Pradesh, Inspectorate of Factories is located in Shimla in the office of Labour Commissioner-cum-Director of Employment. Labour Commissioner is also functioning as Chief Inspector of Factories for the state of Himachal Pradesh.

For the proposed project, Chief Inspector of Factories will be the agencies issuing prior factory licence, approving building designs/plans and compliance related to health and safety, welfare, working conditions etc as required under the Factories Act.

h) District Administration for Acquisition of Land - Kullu District Authority;

Any land acquisition, if any under the Land Acquisition Act, 1894 for the proposed transmission line purposes will be regularised by the State government through district collector's office.

i) Local Area Development Committee (LADC)

Local Area Development Committee (LADC) was constituted by the Government of Himachal Pradesh as per Government of HP Notification no. MPP-F (10)15/2006 dated 11 December 2006. The functions of LADC include

i) oversee restoration of facilities adversely affected due to implementation of the project;
ii) Oversee the implementation of the Rehabilitation and Relief Plan, employment related monitoring;
iii) Oversee the implementation of CAT Plan, compensatory afforestation, EMP, EIA, Quality Control mechanism of the Projects;
iv) Local development activities related to development of agriculture, horticulture, animal husbandry, irrigation and public health (I&PH), Health, Forest, Fisheries, Rural development, Education, PWD, Power and other Social Religious and Cultural activities;
v) Review of recommendations and implementation thereof the Forum of Hydroelectric Power Procedures;
vi) Review of progress of all statutory clearances, time and cost overruns of the project, if any.

j) Department of Irrigation and Public Health

The department of Irrigation and Public Health (IPH) was set up to achieve the objective of development of water related infrastructure such as

- Drinking Water Supply Schemes;
- Sewerage Systems;
- Irrigation systems through source development, lifting water, boring of tube wells & providing distribution systems;
- Flood protection works to protect life and property in the State.

The Department is also responsible for the operation and maintenance of these systems

k) Department of Revenue

The Department of Revenue is responsible for maintaining land records (http://himachal.gov.in/himbhoomi/LandRecords.htm) as per the provisions of Himachal Pradesh Land Revenue Act. The department maintains following types of periodical documents.

1. Shajra Nasb (Pedigree Table);
2. Jamabandi and associated statements (Records of Rights);
3. Intkal (Mutation Register);
4. Khasra Girdawari (Harvest Inspection) Register;
5. Khatoni (Field Map); and
6. Village, Tehsil & District Note Book (Lal Kitab)

l) Municipalities and Panchayats

Municipalities and panchayats are expected to play an increasing role in the environmental management at the District level. Under the 73rd and the 74th Constitutional amendments the State Government can delegate certain functions to these bodies. Under the XI Schedule of the 73rd amendment, panchayats would also be responsible for soil conservation, water management and non-conventional energy sources. Under the XII Schedule Municipalities would also be responsible for water supply for industrial use, solid waste management and protection of the environment. No rules have, however, been made to put this amendment into practice.

Gram Panchayats are local self governaning bodies set up under the provisions of Constitution of India with local village level representatives selected on 5 yearly basis. In terms of local self-governance, the three tier *Panchayati Raj* Institutions influence rural development and decision making in the villages with schemes being executed and funds being allocated from the district level (*Zilla Parishad*), to the block level (*Panchayat Samiti*) to the village level as the *Gram Panchayat*. The influential people at the village/*Panchayat* level are the ex-*Sarpanches* and their family members along with the schoolmaster, the *Gram Sevak*, *patwaris* and the village elders.

Gram Panchyats of Prini and Jagatsukh villages are working in the Project area.

3.3 OVERVIEW OF POLICIES OF GOVERNMENT OF INDIA

Environmental and Forest management are contained in various policies released by the Government of India from time to time. Some of the policies (including sector specific) include the following

- Hydro Power Policy, 1998
- National Water Policy, 2002
- National Agriculture Policy, 2000;
- National Forest Policy, 1988,
- Environment Policy 2006
- National Policy for Resettlement and Rehabilitation, 2003 and 2007

A brief discussion on these policies is given in the following sub sections.

3.3.1 *Hydro Power Policy, 1998*

The Government of India formulated Hydropower Development Policy in August 1998. The objective of the Policy is to prevent a decline in hydro share and to undertake measures for the maximisation of the vast hydroelectric potential in the country especially in the North and Northeastern Regions. Hydro stations presently account for only 25% of the total installed capacity as against the ideal hydro - thermal mix of 40:60. The total hydro potential assessed by CEA at 60% load factor is 84,044 MW. With the completion of the hydel projects under construction, the hydro potential utilised would increase to 22%. The objectives of the policy include the following:

1. Ensuring targeted capacity addition during 9th Plan (and the subsequent plans – the 11th Plan aims capacity addition of 18,781 MW in the hydropower sector);
2. Exploitation of vast hydroelectric potential at a faster pace;
3. Promoting small and mini hydel projects;
4. Strengthening the role of PSUs/SEBs for taking up new hydro projects;
5. Increasing private investment in development of hydropower; and
6. Supporting public sector by greater private investment through IPPs and joint ventures. Private sector participation is considered vital for large scale development of hydropower.

3.3.2 *National Water Policy, 2002*

The National Water Policy of India with respect to hydropower generation states that "water resource development projects should, to the extent possible, be planned and developed as multipurpose projects. Provision of drinking water should be a primary consideration. The projects should provide for irrigation, flood mitigation, hydroelectric power generation, navigation, pisciculture and recreation wherever possible".

India has water treaties with neighbouring countries like Pakistan, Nepal and Bangladesh. The present project is proposed on Allain and Duhangan streams, which are tributaries of River Beas, which in turn, is a tributary of River Sutlej. The Sutlej is a tributary of River Indus, which flows into Pakistan along with some other rivers from India. India signed the Indus Water Treaty in 1960 with Pakistan under the aegis of International Bank for Reconstruction and Development (IBRD, part of the World Bank group). The Project will not alter the water flow downstream the Indus River, therefore, does not attract the provisions of Indus Water Treaty with Pakistan.

3.3.3 *National Forest Policy, 1988*

The present Forest Policy of 1988 was formulated with the following basic objectives:

- Maintenance of environmental stability through preservation and, where necessary, restoration of the ecological balance that has been adversely disturbed by serious depletion of the forests of the country;
- Conserving the natural heritage of the country by preserving the remaining natural forests with the vast variety of flora and fauna, which represent the remarkable biological diversity and genetic resources of the country;
- Checking soil erosion and denudation in the catchment areas of rivers, lakes, and reservoirs in the interest of soil and water conservation, for mitigating floods and droughts and for the retardation of siltation of reservoirs.
- Checking the extension of sand dunes in the desert areas of Rajasthan and along the coastal tracts;
- Increasing the sustainability of the forest/tree cover in the country through massive afforestation and social forestry programmes, especially on all denuded degraded and unproductive lands;
- Meeting the requirements of fuel wood, fodder, minor forest produce and small timber of the rural and tribal populations;
- Increasing the productivity of forests to meet essential national needs;
- Encouraging efficient utilization of forest produce and maximising substitution of wood; and
- Creating a massive people's movement with the involvement of women for achieving these objectives and to minimise pressure on existing forests.

3.3.4 *National Environmental Policy 2006*

Government of India has recently released the National Environment Policy, 2006. The present national policies for environmental management are contained in the National Forest Policy, 1988, the National Conservation Strategy and Policy Statement on Environment and Development, 1992; and the Policy Statement on Abatement of Pollution, 1992. Some sector policies such as the National Agriculture Policy, 2000; National Population Policy, 2000; and National Water Policy, 2002; have also contributed towards environmental management. All of these policies have recognized the need for sustainable development in their specific contexts and formulated necessary strategies to give effect to such recognition.

The dominant theme of this policy is that while conservation of environmental resources is necessary to secure livelihoods and well-being of all, the most secure basis for conservation is to ensure that people dependent on particular resources obtain better livelihoods from the fact of conservation, than from degradation of the resource.

The policy describes seven objectives i.e. conservation of critical environmental resources, inter and intra-generation equity, integration of environmental concerns in economic and social development, efficiency in environmental resource use, environmental governance and enhancement of resources for environmental conservation. These objectives are to be realized through various strategic interventions by different public authorities at Central, State, and Local Government levels. The strategic interventions are premised diverse principles.

3.3.5 *Wildlife Conservation Strategy 2002*

Conservation of wildlife, involves the protection of entire ecosystems. No diversion of forest land for non-forest purposes from critical and ecologically fragile wildlife habitat shall be allowed. Lands falling within 10 km of the boundaries of National Parks and Sanctuaries are notified as eco-fragile zones under the Environment (Protection) Act.

3.3.6 *Resettlement & Rehabilitation Policy in India*

National Policy for Resettlement and Rehabilitation 2003 & 2007

India has brought out the National Policy on Resettlement and Rehabilitation (NPRR) in February 2003. NPRR addresses issues related to project-induced displacements and covers projects that would displace 500 families *enmasse* or more in plain areas, and 250 families *enmasse* in hilly areas, desert development programme blocks, areas mentioned in Schedule V and Schedule VI (scheduled tribes areas) of the Constitution. **On this basis, this project does not trigger the policy as no family will get displaced.**

The National Policy for Resettlement and Rehabilitation 2007 and associated measures aim at striking a balance between the need for land for developmental activities and, at the same time, protecting the interests of the land owners, and others, such as the tenants, the landless, the agricultural and non-agricultural labourers, artisans, and others whose livelihood depends on the land involved. The benefits under the new Policy shall be available to all affected persons and families whose land, property or livelihood is adversely affected by land acquisition or by involuntary displacement of a permanent nature due to any other reason, such as natural calamities, etc. The Policy will be applicable to all these cases irrespective of the number of people involved.

The benefits to be offered under the new Policy to the affected families include; land-for-land, to the extent Government land would be available in the resettlement areas; preference for employment in the project to at least one person from each nuclear family within the definition of the 'affected family', subject to the availability of vacancies and suitability of the affected person; training and capacity building for taking up suitable jobs and for self-employment; scholarships for education of the eligible persons from the affected families; preference to groups of cooperatives of the affected persons in the allotment of contracts and other economic opportunities in or around the project site; wage employment to the willing affected persons in the construction work in the project; housing benefits including houses to the landless affected families in both rural and urban areas; and other benefits.

Adequate provisions have also been made for financial support to the affected families for construction of cattle sheds, shops, and working sheds;

transportation costs, temporary and transitional accommodation, and comprehensive infrastructural facilities and amenities in the resettlement area including education, health care, drinking water, roads, electricity, sanitation, religious activities, cattle grazing, and other community resources, etc.

The benefits expressed in monetary terms have been linked to the Consumer Price Index, and the same shall also be revised suitably at appropriate intervals.

The Requiring Bodies shall be responsible for development of designated areas on the periphery of the project site, and shall earmark funds for the purpose of such periphery development activities.

A special provision has been made for providing life-time monthly pension to the vulnerable persons, such as the disabled, destitute, orphans, widows, unmarried girls, abandoned women, or persons above 50 years of age (who are not provided or cannot immediately be provided with alternative livelihood).

Special provision for the STs and SCs include preference in land-for-land for STs followed by SCs; a Tribal Development Plan which will also include a programme for development for alternate fuel which will also include a programme for development for alternate fuel and non-timber forest produce resources, consultations with Gram Sabhas and Tribal Advisory Councils, protection of fishing rights, land free-of-cost for community and religious gatherings, continuation of reservation benefits in resettlement areas, etc.

A strong grievance redressal mechanism has been prescribed, which includes standing R&R Committees at the district level, R&R Committees at the project level, and an Ombudsman duly empowered in this regard. The R&R Committees shall have representatives from the affected families including women, voluntary organisations, Panchayats, local elected representatives, etc. Provision ahs also been made for post-implementation social audits of the rehabilitation and resettlement schemes and plans.

The key changes that have been proposed in the policy of 2007 include:

- It includes displacement for any reason, unlike the 2003 policy that focused on displacement due to land acquisition;
- The minimum number of people being displaced to trigger the policy has been reduced both in plains and in the hills, tribal areas and DDP blocks. Now the NPRR will get triggered if there are more than 400 families getting displaced in plain areas and more than 200 in hills and DDP areas;
- It will be mandatory for the Requiring Body to prepare a Social Impact Assessment (SIA);
- SIAs will go through a clearance process similar to the Environmental Clearance process, and public hearings will include social impact issues and, where the EC process does not require a Public Hearing, a separate hearing for the SIA will be held;
- Draft resettlement and rehabilitation plans need to be discussed in the gram sabha in rural areas and through public hearings in urban and rural areas without gram sabhas; and

- Provision of shares, cash benefits, employment, pensions etc to the affected family as a part of the rehabilitation grant, if the Requiring Body is a corporate organization/company

The land acquisition in India is covered by a national law, the 1894 Land Acquisition Act (LAA) and its subsequent amendments. The LAA allows for land acquisition in the national interest for water reservoirs, canals, plants, fly-ash ponds, transmission lines and highways to be carried out by the respective States, in accordance with its provisions. Under the LAA, compensation is in cash for the loss of land, other productive assets (such as standing crops and fruit and fodder trees), house plots and residences.

3.4 ENVIRONMENTAL & SOCIAL LEGISLATIVE FRAMEWORK

Allain Duhangan Hydroelectric Project is governed by various rules and regulations set by H.P. State Environment Protection & Pollution Control Board and Ministry of Environment and Forests (MoEF). Various specifications and guidelines of CPCB are also applicable.

3.4.1 *Applicable Environmental, Health & Safety Legislative Requirements*

Applicable environment, health and safety legislative requirements for the proposed Project (during its life cycle) are described as following:

1) Constitutional Provisions

1a) Constitutional Provisions Safeguarding Individual Rights and Environmental Provisions

In India environmental and community relations are governed by the 'intent of law' apart from specific acts and regulations. Any facility / business operations/ corporate/ private/ public sector units can be held accountable for its impact on the larger community based on the interpretation of certain constitutional safeguards and provisions. The Constitution of India guarantees every citizen the fundamental right to life and personal liberty. The fundamental *Right to Life* is guaranteed under *Article 21* that states "No person shall be deprived of his life or except according to the procedure established by law". *Article 21* has been used by the courts in a number of judgements, dealing with a range of social and environmental issues and has constantly progressed to include a number of rights, which interpret the "right to life". These include the 'right to food, water, clothing, environment, education, medical care and shelter.' The Article 48-A of the Constitution of India states that the State shall endeavour to protect and improve the environment and to safeguard the forest and wild life of the country. At the same time, it shall be the fundamental duty of every citizen of India under Article 51-A (g) of the Constitution of India, to protect and improve the natural environment including forests, lakes, rivers and wild life, and to have compassion for living creatures.

1b) Constitutional Provisions Protecting Tribes and Extending Special Status

The Constitution of India identifies certain groups/communities as tribal groups and lays out special provisions for such group with the objective of promoting and safeguarding the social, educational and economic interests of the Schedules Tribes. The President is empowered to specify, after consultations with the Governor of a state "tribes or tribal communities" to be listed under the Schedules tribe list. In conjunction with this certain areas have been declared as "Scheduled Areas" in the constitution. Thus the specification of Scheduled Areas in relation to a particular State/Union Territory is by a notified Order of the President, after consultation with the State Governments concerned. Regulations are framed under the Fifth schedule of the Constitution to prevent the exploitation of tribals by non-tribals and alienation of agricultural land of tribals being passed on to non-tribals. The Constitutional provisions (fifth schedule and article 224) empower the governor of a state to regulate and make regulations for Scheduled Areas and Scheduled Tribes.

1c) Judicial remedy under the Constitution of India through Public Interest Litigations

Public Interest Litigation (PIL) has become one of the most important tools of legal aid and has served to bring justice in cases involving social and environmental concerns. Under a PIL, any public-spirited individual or group can move the court of law (under *Article 226* of the Constitution for High Courts, and *Article 32* for the Supreme Court) in case of breach of any fundamental right, to seek judicial redressal. The PIL is a form of writ petition, which can be filed by anybody, even if he or she is not directly affected by the perceived injustice. This has enabled environmentally conscious, public-spirited individuals or groups, which are not an aggrieved party, to have easy access to the highest court of the nation.

Indian courts are taking an increasingly aggressive stance towards defaulters and the legal system is moving towards the principle of 'polluter pays'.

2) Environment Protection related Regulations

2a) The Environment (Protection) Act; 1986 and Environment (Protection) Rules 1986 and amendments

This Act is an umbrella legislation that provides a single focus for the protection of the environment and seeks to plug the loopholes of earlier legislation relating to the environment. Several sets of Rules and notifications are promulgated under the E(P) Act ranging from approvals required for a new development project to those required for environmental management during their operation phases. The salient provisions of the Act include but not limited to the following:

- Restrict or prohibit industries, operations or processes in specified areas;
- Undertake environmental impact assessment for certain categories of industries to inform the decision making in approval of new or expansion projects;
- Restrict or prohibit handling of hazardous substances in specified areas;
- Protect and improve the quality of the environment and prevention, control and abatement of environmental pollution;

- Lay down standards for the quality of the environment, emissions or discharges of environmental pollutants from various sources;
- Lay down procedures and safeguards for the prevention of accidents, which may cause environmental pollution;
- Bar on filling of any suit or legal proceedings against the Government or officials empowered by it for action taken in good faith, in pursuance of the Act; and
- Bar of jurisdiction to Civil Court to entertain any suit or proceedings in respect of anything done, action taken or directions issued by the Central Government or any other authority empowered by it, in pursuance of the Act.

2b) EIA Notification 2006 - Environmental Clearance and Public Consultation

With the recent suppression of Environmental Impact Assessment (EIA) Notification of January 1994, Environmental Clearance is now subject to the requirements of EIA notification SO no. 1533 dated 14 September 2006. As per schedule to the notification, which lists down 39 types of projects or activities (formulated from eight heads), which pertain to either of the two categories i.e. Category A or B, based on their threshold and likely spatial extent of potential impacts on human health and natural and manmade resources. All 'Category A' projects or activities require Environmental Clearance from Environmental Impact Assessment Authority (EIAA) constituted at MoEF, Government of India. The EIAA will issue Environmental Clearance based on recommendations of the Expert Appraisal Committee (EAC), while projects under Category 'B1' (Category B is subdivided into B1 and B2 categories as per description given below under *Stage I - Screening*) require prior Environmental Clearance from State /Union territory Environment Impact Assessment Authority (SEIAA), based on recommendations of a State level Expert Advisory Committee (SEAC).

The prior Environmental Clearance granted for a project or activity is valid for a period of 10 years in the case of River Valley projects [item 1(c) of the Schedule], project life as estimated by EAC or SEAC subject to a maximum of 30 years for mining projects and 5 years in the case of all other projects and activities. However, in the case of Area Development projects and Townships [item 8(b)], the validity period is limited only to such activities as may be the responsibility of the applicant as a developer. This period of validity may be extended by the concerned EIAA/SEIAA by a maximum period of 5 years provided an application is made to the authority by the applicant within validity period, together with an updated Form 1.

The notification also suggests post project monitoring wherein it is mandatory for project management to submit half-yearly compliance reports in respect of the stipulated prior Environmental Clearance terms and conditions on 1st June and 1st December of each calendar year. All such compliance reports submitted by the project management are considered as public documents. Copies of the compliance reports can be given to any person on application to the concerned EIAA/SEIAA. The latest such compliance report is also a subject to be displayed on the web site of the concerned regulatory authority.

A prior Environmental Clearance granted for a specific project or activity to an applicant is transferable during its validity to another legal person entitled to undertake the project or activity on application by the transferor, or by the transferee with a written "no objection" by the transferor, to, and by concerned EIAA/SEIAA, on the same terms and conditions under which the prior Environmental Clearance was initially granted, and for the same validity period. No reference to EAC or SEAC concerned is necessary in such cases.

Applicability: The Project got Environmental Clearance under the provision of EIA notification, 1994. The Project was submitted for environmental clearance to Ministry of Environment and Forests prior to 1997 therefore was exempted from Environmental Public Hearing. However, any change or modernisation in the Project design is subject to approval of MoEF under the provisions of EIA Notification, 2006. ADHPL is to comply with the conditions stipulated in the Environmental Clearance for the Project as well report to MoEF (regional office at Chandigarh) on six monthly basis about the compliance status of the stipulated conditions. Copy of Environmental Clearance obtained for the Project is shown in Annex A.

2c) The National Environment Appellate Authority (NEAA) Act, 1997

This Act was established to hear appeals arising out Environmental Clearance cases under the Environmental (Protection) Act. The NEAA is located in Delhi and has a Judge of the Supreme Court or a Chief Justice of High Courts as its Chairperson.

A person aggrieved by an order granting environmental clearance in a given area for establishing an industry may, within 30 days from the date of such an order, appeal to the NEAA. The timeframe can be extended to 90 days if there are good grounds for delay. The appellant can be a person who owns or controls the project, an association of persons, Central or State Government or any local authority. The NEAA while trying a suit is vested with the powers of a Civil Court under the Code of Civil Procedure, 1908. It can therefore summon and enforce the attendance of any person and production of documents, receive evidence on affidavits and requisition public records or documents. The NEAA has the power to review its own decisions and decide *ex-parte*.

No civil court or other authority has jurisdiction to entertain any appeal in respect of any matter with which the NEAA is empowered. All proceedings before the NEAA are deemed to be judicial proceedings.

Penal provisions: Failure to comply with any order made by the NEAA is punishable with imprisonment for a term of up to seven years or with a fine which may extend to one lakh or both. The corporate liability is pinned on the person in-charge of and responsible to the company.

Applicability: Deals with appellate provisions related to Environmental Clearance under the EIA notification, 1994 and 2006.

2d) Environmental Statement

Environmental Statement is required to be submitted under Rule 14 to the Environment (Protection) Rules, 1992 as amended in 1993 in a prescribed format i.e. FORM V by 30 September each year for the relevant financial year ending 31 March. This applies to every person carrying on an industry, operation or process requiring consent to operate under the Water Act, Air Act, or both or authorization under the HWM Rules 2003, issued under the EPA 1986. This condition is also generally stipulated in facility's consent to operate for air emissions as well as the consent to operate for wastewater discharges. The environmental statement covers description of information about activities, raw materials consumption, products, air and wastewater management, water consumption, solid and hazardous waste management etc.

Applicability: The Project will have to annually report to the regulatory agencies as per the prescribed format once the Project becomes operational.

2e) Bio-Medical Waste (Management and Handling) Rules, 1998 as amended in September 2003

The Rules apply to all persons who generate, collect, receive, store, transport, treat, dispose, or handle bio medical waste in any form. The Schedule 1 to the rules describes 10 categories of bio-medical waste. Prior Authorisation is required for collection, reception, storage, transportation, treatment and disposal of bio-medical wastes. A facility generating bio medical waste also requires filing annual return, maintaining records and proper labelling of bio-medical wastes as prescribed in the Rules.

Applicability: Prior authorisation and regular compliance is required for any medical establishment set up by the Project.

2f) The Hazardous Wastes (Management and Handling) Rules, 2008

The Rules require industries to classify wastes into categories and manage them as per the prescribed guidelines and obtain prior authorisation for handling, treatment, storage and disposal of Hazardous Wastes.

Applicability: All hazardous wastes generated during construction and operation phases will have to be collected, stored, treated and disposed of as per the provisions of these rules.

2g) Manufacture Storage & Import of Hazardous Chemicals (MSIHC) Rules 1989 and Amendment 2000

These rules apply to the activities, which involve handling, storage and import of hazardous chemicals as specified in Schedule 1 of the Rules. The indicative criteria are specified in the Part 1 of the same schedule. The rule also applies to the industrial activity involving isolated storage in the quantities mentioned in Schedule 2. The information on various requirements and clearances under the MSIHC Rules will have to be furnished to the SPCB office.

The MSIHC Rules also require provision for the proper storage and handling of chemicals. Definition and classification of the chemicals as dangerous/hazardous is specified under the MSIHC Rules and listed in Schedules 1, 2 & 3.

Applicability: The Project is to comply with the requirements of these rules for handling and storage of listed hazardous chemicals.

2h) Batteries (Management and Handling) Rules, 2001

The Rules identify specific responsibilities for consumers and bulk consumers, manufacturers, importers, assemblers, re-conditioners, dealers, recyclers, and auctioneers involved in the processing, trade and use segments of the lifecycle of a lead-acid battery. As per these Rules, it is the responsibility of the consumer to do the following to:

- Ensure that used batteries are not discarded in any other manner except by depositing it with the dealer, importer, assembler, authorized recycler, re-conditioner or at the designated collection centres;
- Avail the discount provided by the dealer in lieu of used battery;
- Return all used batteries to the manufacturer or authorized recycler as per the provisions of buy-back agreement with the manufacturer in case of bulk consumers;
- File half yearly returns by manufacturers, assembler and re-conditioner under Form 1;
- Undertake registration for import of new lead-acid batteries/primary lead by importer; and

File of half yearly return by bulk consumers and auctioneers of batteries to State Pollution Control Board as per Form 8 and 9 under Rules10 (2) (ii) and 11(ii) respectively.

Applicability: The Project is to comply with the requirements of these rules.

2i) Ozone Depleting Substances (Regulation) Rules, 2000 as amended in 2005

As a party to the Vienna Convention on the protection of the ozone layer and the Montreal Protocol, India has released the Ozone Depleting Substances (Regulation) Rules 2000 pursuant to the Environment (Protection) Act, 1986. The Rules regulate production, consumption, export, import, sale, purchase and use of ozone depleting substances in specified time bound programme in line with the Montreal Protocol. The Rules subject many activities to prior registration or to obtaining a license from the relevant authorities. Of the 20 chemicals controlled under the amended Montreal Protocol, India uses and produces seven (7) ODSs. These include – Chlorofluorocarbons (CFC-11, CFC-12, and CFC-113), Carbon tetrachloride (CTC), Methyl Chloroform (MCF), and Halons (H-1211, and H-1301).

Applicability: The Project is to use only permitted ODSs.

3) Forests & Wildlife Resources related Regulations

3a) Forests (Conservation) Act, 1980 and Rules 1981

The FCA was adopted in 1980 to protect and conserve forests. The Act restricts the powers of the State in respect of de-reservation of forests and the use of forestlands for non-forest purposes. An advisory committee has been created to oversee the implementation of the statute. The FCA is relevant for the power sector for the siting guidelines for hydroelectric power plants, and for passage of transmission through forest areas, since it would involve use of forestland for "non-forest" purposes. According to Section 2 of the Act "notwithstanding anything contained in any other law for the time being in force in a State, no State Government, or other authority shall, except with the prior approval of the Central Government, make any order directing:

- De-reservation of a reserved forest
- Use any forest land for any non -forest purpose
- Assign any forest land to any private person or entity not controlled by the Government
- Clear any forest land of naturally grown trees for the purpose of using it for reforestation

The term 'non -forest purpose' includes clearing any forestland for cultivation of cash crops, plantation crops, horticulture or medicinal plants and any purpose other than re-afforestation. FCA applies to any forestland irrespective of whether or not it has been declared reserved. It covers the extended meaning of a tract of land covered with trees; shrubs, vegetation and undergrowth intermingled with trees and pasture, be it of natural growth or man-made forestation. Such extended meaning is justified in order to make FCA effective "as well as to preserve forest land from deforestation, to maintain ecology and to prevent environmental degradation". Therefore, the term forests includes not only forests in the dictionary meaning but also any area recorded as forests in Government records irrespective of the ownership.

The Forest (Conservation) Rules, 1981 empower the Central Government to constitute a seven -member committee to advise the Central Government on proposal made by a State Government for conversion of a forestland. The rules contain a detailed format for the State Government to follow, while asking for approval from the Central Government. The proposal requires the following: Project details;

- Location land involved (legal status, details of flora and fauna, density, vulnerability to erosion, existence of a national park, wildlife sanctuary etc.,);
- Details of displacement of people due to the project;
- Details of possible impact on the forest land;
- Cost-benefit analysis; and
- Opinion of the head of the State Forest Department.

The MoEF circulated guidelines for submission of proposal for diversion of forest area to non-forest activity under the FCA through letter no. 2-3/86-FC dated July 31, 1986. The parameters for evaluation of loss of forests are as described in ***Table 3.1***.

Table 3.1 Parameters for Evaluation of Benefit/Loss

S.N.	Parameter	Evaluation of benefit / loss
1	Loss of value of timber, fuel wood and minor forest produce on an annual basis, including loss of man hours per annum of people who derived livelihood And wages from the harvest of these commodities.	To be quantified and expressed in monetary terms
2	Loss of animal husbandry productivity including loss of fodder.	-
3	Cost of human resettlement	-
4	Loss of public facilities and administrative Infrastructure	-
5	Environmental losses: (Soil erosion, wildlife habitat, hydrological cycle, etc.)	Technical judgment is Necessary to determine the Monetary value, but, as a thumb rule the environmental loss of one hectare of fully stocked forest (density 1.0) would be taken as Rs.126.74 lakhs to accrue over 50 years, with the value decreasing Proportionately with a decrease in density. Moreover, the value will also change with a change in the bank rate, the change being proportionate to the percentage increase in bank rate.

Besides, the following cost/loss needs to be considered too, according to the guidelines, in order to obtain a balanced value of the benefits derived from the project in terms of production, economy, employment, etc. The costs to be considered are as follows:

- Cost of acquisition of facilities on forest and non-forest land, wherever feasible;
- Loss of agricultural and animal husbandry production due to diversion of forest land;
- Cost of rehabilitating the displaced community, which is different from the compensation package provided to them for displacement;
- Cost of supply of free fuelwood to workers residing in or near the forest area during the period of construction.

Applicability: ADHPL to comply with the requirements of FCA including comply with the conditions of Forest Clearance obtained for diversion of forestland for non forest purposes. Refer to Annex A for the Forest Clearance obtained for forestland diverted for the Project.

3b) The Wildlife (Protection) Act, 1972

The Wildlife (Protection) Act (W(P)A), 1972 provides for protection to listed species of flora and fauna and establishes a network of ecologically important protected areas. The W(P)A empowers the Central and State Governments to declare any area to be a Wildlife Sanctuary, National Park or a closed area. There is a blanket ban on carrying out any industrial process or activity inside any of these protected areas. In case forestland within the protected areas network is to be diverted for any non-wildlife use, a no objection has to be obtained from the Indian Board of Wildlife and the State Legislature, before the final consideration by MoEF.

The W(P)A covers 11 chapters, 121 sections and six schedules. The schedules categorize animals, birds, and plants. Schedule I lists endangered species of mammals, reptiles, amphibians, birds, crustaceans and insects. Any possession, transportation etc. of these species without prior permission is offence under the Act.

Applicability: The Project is to ensure compliance of the provisions of Wildlife (Proection) Act.

3c) The Biodiversity Act, 2002

The Biodiversity Act is meant to conserve biological diversity, sustainable use of its components and fair and equitable sharing of the benefits arising out of the use of biological resources, knowledge and for connected matters.

3d) The Himachal Pradesh Fisheries Act, 1976 and Rules, 1979

This Act empowers the state government of Himachal Pradesh to make rules for prohibition or regulation of:

- erection and use of fixed engine's and
- the construction, temporary or permanent, of weirs, dams and bunds; and killing of fish by diversion of natural waters

The HP Fisheries Rules, 1979 identifies water bodies and regulates on methods for fishing in the identified water bodies in the State.

4) Air, Noise Water Pollution Control related Regulations

4a) The Air (Prevention and Control of Pollution) Act, 1981 Including Rules 1982 and 1983

The Act prohibits the construction and operation of any industrial plant without the consent of SPCBs. The Act assigns powers and functions to the CPCB and the SPCBs for prevention and control of air pollution and all other related matters. For the prevention and control of air pollution, the State Government, in consultation with the SPCB has the powers to set standards for emissions from automobiles, impose restrictions on use of certain industrial plants and prohibit emissions of air pollutants in excess of the standards laid down by the SPCB. It can also make an application to the court for restraining persons from causing air pollution. In addition, it also has the power of entry and inspection, power to obtain information and power to take samples of air emissions and conduct the appropriate follow up. The CPCB, as well as the SPCBs are eligible for contributions from the Central as well as the State Government, respectively, to perform their functions appropriately. The Act also allows for appropriate penalties and procedures for non-compliance.

Applicability: The Project is to obtain prior consent to establish for construction activities and consent to operate for operational activities under the Air Act.

4b) Noise Pollution (Regulation and Control) Rules, 2000

As per the Noise Pollution (Regulation and Control) Rules 2000, every operating facility is required to take all possible steps to meet the ambient noise level standards prescribed in the Rules. The rules prescribe maximum permissible values of day and night time noise levels for zones A, B, C and D representing industrial, commercial, residential and silence zone respectively.

Further, there is an additional requirement for those facilities that have stationary diesel generators operating onsite to ensure compliance with the Environment (Protection) Rules 1986, as amended by the Environment (Protection) Second Amendment Rules 2005. The requirements under the rules include the following:

- All diesel generators manufactured after 1 January 2005 with rated capacity of up to 1000 KVA shall be 75 dB(A) at 1 m from the enclosure surface. The diesel generator should be provided with acoustic enclosure at the manufacturing stage itself;
- For the diesel generators manufactured prior to 1 January 2005 and not covered with enclosure are required to limit exposure to noise by providing an acoustic enclosure or by treating the room acoustically. The acoustic enclosure or acoustic treatment of the room shall be designed for a minimum insertion loss of 25 dB(A) or for meeting the ambient noise standards (whichever is on higher side). The measurement for insertion loss may be done at different points at 0.5 m from the acoustic enclosure/room, and then averaged. The diesel generator shall be provided with a proper exhaust muffler with a minimum insertion loss of 25 dB(A). The installation of diesel generator shall be strictly in compliance with the recommendations of the manufacturer. The facility shall have a proper routine and preventive maintenance programme for the diesel generator, decided in consultation with its manufacturer to prevent increase in noise levels from operation of diesel generator with age.

Applicability: The Project is to ensure compliance of the provisions under these Rules.

4-3) The Water (Prevention and Control of Pollution), Act, 1974 including Rules, 1975 (as amended up to 1988)

This Act provides for the prevention and control of water pollution and maintaining or restoring good water quality for any establishment. The Act assigns functions and powers to the CPCB and SPCBs for prevention and control of water pollution and all related matters. Subject to the provisions of the Act, the functions and powers of CPCB as well as the SPCBs have been delineated individually and with respect to each other.

Applicability: The Project is to obtain prior consent to establish for construction activities and consent to operate for operational activities under the Water Act.

4-4) The Water (Prevention and Control of Pollution), Cess Act, 1977 including Rules 1978 and 1991

This Act provides for levy and collection of Cess on water consumed and water pollution caused. It also covers specifications on affixing of meters, furnishing of returns, assessment of Cess, interest payable for delay in payment of Cess and penalties for non-payment of Cess within the specified time. Industries consuming water less than $10m^3$/day have been exempted from levy of cess provided they are not generating hazardous wastes.

Applicability: The Project is to pay cess on water consumption and wastewater disposal to the HPPCB.

5) Health and Safety related Regulations

5a) Explosives Act, 1884 and Explosives Rules, 1983

This is an act to regulate manufacture, use, sale and transport of explosives. A license is granted for manufacture, trade and/or use of explosives under the Explosives rules 1983 only after a NOC from District Administration.

Applicability: The Project is to obtain prior licence for use of explosives required for the Project construction and ensure compliance of the rules.

5b) The Petroleum Act, 1934 and the Petroleum Rules

This Act and Rules provide procedures and safety measures to be taken up for handling, storage and transportation of petroleum products. The Rules define the quantity and class of petroleum for which prior permission from the concerned authorities are required. The storage requiring prior licences are as following:

- Petroleum class A (having flash point less than 23ºC) not intended for sale of the total quantity in possession does not exceed 30 litres. Petroleum Act, 1934, Section 8);
- Petroleum class B (having flash point from 23 to 65ºC) if the total quantity in possession at any one place does not exceed 2,500 litres and none of it is contained in a receptacle exceeding 1,000 litres; (Petroleum Act, 1934, Section 7);
- Petroleum class C (having flash point above 65 to 93ºC) if the total quantity in possession at any one place does not exceed 45,000 litres (Petroleum Act, 1934, Section 7).

Applicability: The Project is to obtain prior licence for storage and handling of petroleum products required for the Project construction activities. The Project is to ensure compliance of various provisions of these rules.

5c) Gas Cylinder Rules and Static and Mobile Pressure Vessels (Unfired) Rules, 1981

Gas Cylinder Rules 1981 and Static and Mobile Pressure Vessels (Unfired) Rules 1981 were framed to restrict handling and transportation of gas cylinders and provide procedures and approvals for manufacturing detail of the cylinder including the reference of safety relief devices, its manufacturing and usage specification. The rules also describe labelling of cylinders by colour to identify the type of gas present in the cylinder.

Applicability: The Project is to obtain prior licence for storage and handling of pressurized gas cylinders required for the Project construction activities. The Project is to ensure compliance of various provisions of these rules.

5d) The Indian Factories Act, 1948 and State Rules

The Indian Factories Act was promulgated in 1948, to ensure general welfare of the industrial workers. The Act is divided into nine chapters with three chapters exclusively on health and safety (H&S) issues. The Act in its preamble states that "it is the general duty of the occupier (defined in the act as person having the ultimate control over the affairs of the factory) to ensure as far as practicable health, safety and welfare of all workers while they are at work in the factory".

A general policy with respect to H&S of the workers at work should be in the form of a written statement and brought to the notice of the workers per the provision of the Act. The Act covers guidelines on health aspects as following:

- Cleanliness;
- Disposal of waste & effluent;
- Dust and fumes;
- Artificial humidification;
- Drinking water;
- Latrines and Urinals;
- Overcrowding;
- Lighting;
- Spittoons;

The Act in its Chapter 4 deals with the provisions relating to Safety. The specific areas of safety are those relating to the usage of machinery, handling of hazardous substances and the latest amendments include safety measures for hazardous processes. For the usage of machinery there are Acts related to the fencing, casing of the machinery. Restriction of young persons and the employment of women and children to work on machines that is dangerous in nature. The Act also has regulations for working near machinery in motion; development of adequate safety measures during installation and various types of operation of the machinery.

The Act also explains preventive and protective measures in safety including proper consideration of explosive or inflammable substances so that the workers are not exposed to hazards during operation. Some of the sections deal with various precautions that are required for handling pressure plants, fire, inflammable dust, gas or explosive. The factory occupier is responsible to maintain safety of the buildings and machinery per this legislation. The Act also gives power to States to make relevant rules to supplement the need of safety in the facility.

The Act also covers provisions for hazardous processes for an occupier to take all practicable measures to ensure prevention of any sorts of explosion due to manufacturing process which are hazardous. There are permissible limits for exposure of chemicals and toxic substances in the workplace. Workers have the right to know about imminent danger and their participation in safety management. The Act also requires medical check ups of workers with access to workers to look for outcome of the medical reports. An occupier is to develop a safety policy and form safety committees and provide power to the Central

Government to appoint inquiry committee if some extraordinary situation had occurred in the factory which is engaged in the hazardous process.

Applicability: The Project is to obtain Factory Licence and ensure compliance of various provisions of the Factories Act and related Rules prior to start of the Project and during its operations.

A brief applicability of some of the above described EHS legislation is summarised in the *Table 3.2*.

Table 3.2 Applicable Environmental Laws and Regulations

S.N.	Issues	Applicable Legislation	Agency Responsible	Applicable Permits and Requirement
1	Protection and improvement of Natural Environmental Resources	Article 51-A Clause (g) of the & Directive Principles of State Policy (Article 47) (Applicable throughout the Project life cycle)	• Every Citizen of India	• Article 51-A of the Constitution of India states that it will be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for all living creatures. • Article 47 of the Constitution of India requires not only a Protectionist stance by the state but also compels the state to seek the improvement of polluted environments
2	Environmental Protection	The Environment (Protection) Act 1986, as amended in April 2003; EPA Rules 1986, as amended in 2002; (Applicable throughout the Project life cycle)	• HPPCB • MoEF • CPCB	• Compliance under the rules to maintain stipulated standards and environmental management through various supporting rules promulgated under the Act.

S.N.	Issues	Applicable Legislation	Agency Responsible	Applicable Permits and Requirement
3	Environmental Clearance	• The Environmental Impact Assessment (EIA) Notification, 1994; • Environmental Public Hearing Notification, 1997; • EIA Notification, 2006 • National Environment Appellate Authority Act • National Environment Tribunal Act, 1995 (Applicable throughout the Project life cycle)	• MoEF (including Regional Office at Chandigarh) • HPPCB	• Prior Environmental Clearance • Compliance of stipulated conditions. • Environmental monitoring and reporting. • Implementation of ESMP
4	Land acquisition	The Land Acquisition Act,1894 The Act provides for notification for affected land, notification for payment for damages, hearing of objections, declaration of the intended acquisition, enquiry into measurement, values and claims & award and finally taking possession of the land. (Applicable for Project related land acquisition)	• Local Administration - District Collector • Revenue Officer	• The project involved land acquisition under the Land Acquisition through the State Government. Social land related aspects are covered in this ESIA study.
5	Recognition of Forest Rights	The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 & Rules 2007 The Act provides framework for recognising forest rights to STs and other traditional forest dwellers).	• State Forsest Department • Tribal Development Department • Local Administration • Gram Sabhas	• The affected community to present their case to the Gram Sabha for conferring of forest rights under the Act.

S.N.	Issues	Applicable Legislation	Agency Responsible	Applicable Permits and Requirement
6	Hazardous Wastes Management	Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008 under the Environment (Protection) Act, 1986 (Applicable throughout the Project life cycle)	• HPPCB	• Authorisation for collection, reception, storage, transportation and disposal of hazardous wastes. • ADHPL to handle and dispose hazardous waste management as per the prior authorisation from HPPCB. • Filing of annual return under Form 4 to the rules • Other compliance under the rules • Authorisation by Central Pollution Control Boards to vendors accepting waste/used oil • The occupier and operator of a facility will also be liable to reinstate or restore damaged or destroyed elements of the environment; • The occupier and operator of a facility will be liable to pay a fine as levied by the HPPCB with the approval of the CPCB for any violation of the provisions under these rules.

S.N.	Issues	Applicable Legislation	Agency Responsible	Applicable Permits and Requirement
7	Diversion of Forest land And Protecction of Forests	The Forest (Conservation) Act (FCA), 1980 as amended in 1988 and revised Rules, 2003 (in suppression of FC Rules of 1981) require prior Forest Clearance from Central and State Government depending upon type and extent of forestland. Under the Act, an Advisory Committee advises GoI for grant/rejection of Forest Clearance and matters connected with conservation of forests. The other forest related acts include the following: • The Indian Forest Act, 1927 • The Himachal Pradesh Private Forest Act 1954. • The Himachal Pradesh Forest (Sale of Timber) Act 1968. • The Himachal Pradesh Forest Produce (Regulation of the Trade) Trades Act 1982 (Applicable throughout the Project life cycle).	• MoEF, • HP State Department of Forests	• Forest Clearance for diversion of forestland for non forest purposes. • Compliance of stipulated conditions. • Compensatory afforestation • Catchment area treatment plan; and • Payment of Net Present Value for diversion of forestland • Cutting of trees only subject to prior enumeration and timber disposal as per Local Forest office.

S.N.	Issues	Applicable Legislation	Agency Responsible	Applicable Permits and Requirement
8	Disturbance to Wildlife	Wildlife (Protection) Act, 1972 The Act inter-alia deals with prohibition of hunting of wild animals except in certain cases; protection of specified plants; declaration and protection of sanctuaries; restrictions on entry in sanctuary; prohibition on destruction in sanctuary except under a permit; declaration of national parks; power of Central Government to declare areas as sanctuaries or national parks; regulations for trade and commerce in wild animals, animal articles and trophies; prohibition of dealings in trophy and animal articles without a licence; forfeiture of property derived from illegal hunting and trade; penalties for contravention; etc. The Wild Birds and Animals Protection Act, 1912 The Indian Arms Act, 1978 (Applicable throughout the Project life cycle)	• State Department of Forests • Chief Wildlife Warden	• The Act primarily deals with regulating or prohibiting activities inside a National Park or Sanctuary. • The Project being located in montane region, necessary precautions will be required for any area sheltering scheduled wildlife under the Act.
9	Prevention and Control of Water Pollution	The Water (Prevention and Control of Pollution) Act, 1974, amended in 1988 The Water (Prevention and Control of Pollution) Cess Act, 1977 (Applicable throughout the Project life cycle)	• HPPCB	• Consent for Establishment for the Project construction activities including camp site activities • Compliance of stipulated conditions • Periodical reporting to HPPCB
10	Prevention and Control of Air Pollution	The Air (Prevention and Control of Pollution) Act, 1981, amended in 1987. (Movement of vehicles, excavation of pits for tower erection, operation of diesel generators for power at campsite or other construction activities). (Applicable throughout the Project life cycle)	• HPPCB	• As above

S.N.	Issues	Applicable Legislation	Agency Responsible	Applicable Permits and Requirement
11	Noise Emissions	The Noise (Regulation & Control) Rules, 2000 as amended in October 2002 As per the Environment (Protection) Act (EPA) 1986 the ambient noise levels are to be maintained as stipulated by the Central Pollution Control Board (CPCB) for different categories of areas like, commercial, residential and silence zones etc (Applicable throughout the Project life cycle)	• HPPCB • District administration	• Compliance under the rules to maintain stipulated standards
12	Surface Transportation	The Motor Vehicles Act 1988, as amended by Motor Vehicles (Amendment) Act 2000, dated 14th August 2000 The Central Motor Vehicles Rules 1989, as amended through 20th October 2004 by the Central Motor Vehicles (Fourth Amendment) Rules 2004. (Applicable throughout the Project life cycle	• Ministry of Road Transport and Highways • State Transport Authority	• Compliance of stipulated standards under rule 115 • Display of emergency information panel by vehicles carrying hazardous substances as per Rule 134 • Other environmental and safety compliance under the rules
13	Storage and use of Explosives and or Petroleum products	The Explosive Act 1884 and Rules, 1983 The Petroleum Act 1934, The Petroleum Rules 1976, as amended in March 2002. (Applicable during Project construction phase)	PESO (Chief Controller of Explosives)	• Licence for use and storage of explosives required for excavation of rocky structures for tower erection during construction phase. • No use of petroleum products is reportedly required by the project.
14	Fisheries	The Himachal Pradesh Fisheries Act, 1976.and Fishereis Rules, 1976 (Applicable throughout the Project life cycle)	HP Fisheries Department	• The Act describes regulation for construction of any dam, weir or other structure. • The rules identifies waters for fisheries and methods of fishing in these waters.

S.N.	Issues	Applicable Legislation	Agency Responsible	Applicable Permits and Requirement
15	Lay out approval of plant & facilities	The Factories Act 1948, as amended in April 2001 (Applicable prior to Project commissioning and operation)	Chief Inspector of Factories, Shimla	Factory Licence for establishing a factory; Compliance for Health, Safety, and Welfare of employees Provision of Safety officer for employing more than 1000 employees and additional safety officer for more than 2000 employees Provision of medical officer and ambulance room for employing 500 or more employees Provision of welfare officer for employing 500 or more employees Other compliance including maintaining work environment standards and periodic check ups of health of workers etc.
16	Medical & infected waste	The Bio-Medical Waste (Management and Handling) Rules 1998, as amended in September 2003; (Applicable for Project run medical centre in case of 1000 or more patients visit per month)	HPPCB CPCB	Authorisation as per form 1 under the Rule 8 for generation, collection, reception, storage, transpiration, treatment and disposal and any other form of handling of bio-medical wastes Annual report as per Rule 10 Other compliance including reporting, labelling etc.
17	Regulation on Use of ODS	The Ozone Depleting Substances (Regulation) Rules 2000, as amended through 26th September 2005;	MoEF Director General of Foreign Trade Other relevant agencies like Small Industrial Development Organisation.	Regulation on consumption of Ozone Depleting Substances on end use basis (Year 2010 for Group I, III, IV & V ODS; Year 2015 for Group VII and Year 2040 for Group VI); Annual reporting of ODS Regulation on import/export /sale/purchase of ODS Regulation on manufacture, import and export and sale of compressors

S.N.	Issues	Applicable Legislation	Agency Responsible	Applicable Permits and Requirement
18	Safe management of Lead acid batteries	The Batteries (Management and Handling) Rules 2001;	HPPCB CPCB MoEF	Filing of Half Yearly returns by manufacturers, assembler and re-conditioner under Form 1 Registration for import of new lead-acid batteries/primary lead by importer Filing of Half Yearly return by bulk consumers and auctioneers of batteries to State Pollution Control Board as per Form 8 and 9 under Rules10 (2) (ii) and 11 (ii) respectively
19	Environmental Emissions & Quality Standards	Applicable environmental standards as specified by CPCB and by H.P. State Environment Protection & Pollution Control Board. Environmental Statement (Audit) Notification, 1992	HPPCB MoEF	• Standards for discharge of environmental pollutants • Requires submission of environmental statement on annual basis

3.4.2 *Land and Social related Regulations*

1) The Land Acquisition Act, 1894

The Land Acquisition Act of 1894 is summarized below:

- Land identified for the purpose of a project is placed under Section 4 of the LAA. This constitutes notification. Objections must be made within 50 days to the Collector (highest administrative officer) of the concerned District. The LAA requires 30 days for objections;
- The land is then placed under Section 6 of the LAA. This is a declaration that the Government intends to acquire the land. The Collector is directed to take steps for the acquisition, and the land is placed under Section 9. Interested parties are then invited to state their interest in the land and the price. Under Section 11, the Collector shall make an award within two years of the date of publication of the declarations. Otherwise, the acquisition proceedings shall lapse;
- In case of disagreement on the price awarded, within six weeks of the award the parties (under Section 18) can request the Collector to refer the matter to the Courts to make a final ruling on the amount of compensation;
- Once the land has been placed under Section 4, no further sales or transfers are allowed. However, since the time lag between Sections 4 and the others following it is about three years, land transfers are not uncommon;
- Compensation for land and improvements (such as houses, wells, trees, etc.) is paid in cash by the project authorities to the State government, which in turn compensates landowners. In the case of acquisition for coal projects, the coal companies make direct payments to landowners;
- The price to be paid for the acquisition of agricultural land is based on sale prices recorded in the District registrar's office averaged over the three years

preceding notification under Section 4. The compensation is paid after the area is acquired, actual payment by the State taking about two or three years. An additional 30 percent is added to the award as well as an escalation of 12 percent per year from the date of notification to the final placement under Section 9. For delayed payments, after placement under Section 9, an additional 9 percent per annum is paid for the first year and 15 percent for subsequent years.

2) The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006 & rules 2007

The act basically vests the forest rights and occupation in forest land in forest dwellers (ST and other traditional forest dwellers) who have been residing in forests for generations but whose rights could not be recorded. The act provides a framework for recognising the forest rights and the nature of evidence required for such recognition and vesting of forest land.

The main rights so vested are as follows-

- right to hold and live in the forest land under the individual or common occupation for habitation or for self-cultivation for livelihood by a member or members of a forest dwelling Scheduled Tribe or other traditional forest dwellers;
- community rights such as nistar, by whatever name called, including those used in erstwhile Princely States, Zamindari or such intermediary regimes;
- right of ownership, access to collect, use, and dispose of minor forest produce which has been traditionally collected within or outside village boundaries;
- other community rights of uses or entitlements such as fish and other products of water bodies, grazing (both settled or transhumant) and traditional seasonal resource access of nomadic or pastoralist communities;
- rights including community tenures of habitat and habitation for primitive tribal groups and pre-agricultural communities;
- rights in or over disputed lands under any nomenclature in any State where claims are disputed;
- rights for conversion of Pattas or leases or grants issued by any local authority or any State Government on forest lands to titles;
- rights of settlement and conversion of all forest villages, old habitation, unsurveyed villages and other villages in forests, whether recorded, notified or not into revenue villages;
- right to protect, regenerate or conserve or manage any community forest resource which they have been traditionally protecting and conserving for sustainable use;
- rights which are recognised under any State law or laws of any Autonomous District Council or Autonomous Regional Council or which are accepted as rights of tribals under any traditional or customary law of the concerned tribes of any State;
- right of access to biodiversity and community right to intellectual property and traditional knowledge related to biodiversity and cultural diversity;
- any other traditional right customarily enjoyed by the forest dwelling Scheduled Tribes or other traditional forest dwellers, as the case may be, which are not mentioned in clauses above but excluding the traditional right of hunting or trapping or extracting a part of the body of any species of wild animal; and
- right to in situ rehabilitation including alternative land in cases where the Scheduled Tribes and other traditional forest dwellers have been illegally evicted or displaced from forest land of any description without receiving their legal entitlement to rehabilitation prior to the 13th day of December, 2005.

3.4.3 Consultations and Public Disclosure related Regulations

This section briefs national laws, policies, regulations pertaining to consultations and disclosure with respect to land acquisition and environmental impacts in India and IFC requirements.

1) Land Acquisition Act

At every stage of the land acquisition process there is adequate flow of communication by virtue of publication of various notifications, declarations, notices etc in the Government Gazette, local press, local areas etc. This ensures provision of timely and reasonable opportunity to all the interested persons to claim rights and compensation.

At the first level the method is transparent and also provides for due opportunities to all the concerned before the determination of the quantum of compensation and the persons entitled to receive it. At the second level the method provides for redressal of any grievance arising out of the aforesaid first level determinations. An aggrieved person can seek reference to the court to look into the grievances concerning the measurement of the land, the amount of compensation, eligibility to receive compensation, apportionment of compensation amongst the interested persons etc.

The LAA initially stated that a notification for land acquisition would have to be issued under section 4(1) indicating the intention of the Government to acquire land or other property in official gazette. However, the 1984 amendment requires the section 4 (1) notification to be also published in two local newspapers, of which at least one should be in a regional language. In addition to the public notice, the substance of such notification made by the Collector has to be made available at convenient places in the locality where the land is situated. Compensation for the land acquired has to be paid on the basis of market value as on the data of notification under section 4(1).

This notification gives the affected/interested parties an opportunity to file objections before the Collector. In case any objection is filed, Collector has to arrange for an oral hearing and thereafter submit a report to the concerned Government department. If the Government after reviewing the objections and responding to it wishes to go ahead with the Land Acquisition, it has to make a declaration under section 6 of the Act. The declaration under section 6 has to be published in a similar manner as section 4(1).

2) Right to Information Act, 2005

The Right to Information[1] Act applies to the whole of India (except the State of Jammu and Kashmir). The Act includes the right to:

(1) [1] 'Information' means any material in any form including records, documents, memos, e-mails, opinions, advice, press releases, circulars, orders, logbooks, contracts, reports and papers, samples, models, data material held in any electronic form and information relating to any private body which can be accessed by public authority under any other law for the time being in force but does not include 'file notings'.

- Inspects works, documents, records;
- Take notes, extracts or certified copies of documents or records;
- Take certified samples of materials; and
- Obtain information in the form of printouts, diskettes, floppies, tapesm video cassettes or in any other electronic mode.

The Act does not include information including commercial confidence, trade secrets or intellectual property, the disclosure of which would harm the competitive position of a third party, unless the competent authority is satisfied that larger public interest warrants the disclosure of such information.

3.4.4 *Labour related Regulations*

There are several laws and rules that govern labour issues in India. The issues covered include:

1) Child Labour

The Constitution of India (Part III, Article 24 - Fundamental Rights) describes that no child below the age of fourteen years shall be employed to work in any factory or engaged in any other hazardous employment

2) The Child Labour (Prohibition and Regulation) Act, 1986

A child is defined as a person who has not completed 14years of age. The Act prohibits employment of children in certain occupation and processes (part II, Section 3). The Act also specifies conditions of work for children, if permitted to work. These include a working day of maximum of 6 hours a day (including rest), no work period exceeding 3 hours at a stretch, and no overtime (Section 7). The Act requires maintenance of a register for employed children (Section 11).

3) Forced Labour

Constitution of India (Part III, Fundamental Rights No 23): Right against Exploitation

The Bonded Labour (Abolition) Act 1976: States that all forms of bonded labour stands abolished and every bonded labourer stands freed and discharged from any obligations to render any bonded labour (Ch II, Section 4)

4) Freedom of Association

The Trade Union Act, 1926: Provides procedures for formation and registration of Trade Unions and lists their rights and liabilities. It encompasses any combination, permanent or temporary, that gets formed to regulate relationship between workmen and their employers.

5) Wages

Minimum Wages Act, 1948 requires the Government to fix minimum rates of wages and reviews this at an interval of not more than 5 years. The Payment of

Wages Act, 1936, amended in 2005. Every employer shall be responsible for the payment to persons employed by him of all wages required to be paid under this Act.

As per the Equal Remuneration Act 1976, it is the duty of an employer to pay equal remuneration to men and women workers for same work or work of a similar nature.

6) Compensation

Workmen's Compensation Act, 1923 requires if personal injury is caused to a workman by accident arising out of and in the course of his employment, his employer shall be liable to pay compensation in accordance with the provisions of this Act.

7) Welfare and working conditions

As per the Maternity Benefit Act, 1961 no employer shall knowingly employ a woman in any establishment during the six weeks immediately following the day of her delivery or her miscarriage. No pregnant woman shall, on a request being made by her in this behalf, be required by her employer to do during the period any work which is of an arduous nature or which involves long hours of standing, or which in any way is likely to interfere with her pregnancy or the normal development of the foetus, or is likely to cause her miscarriage or otherwise to adversely affect her health.

8) Other Legislations

Other labour related legislations applicable for the Project include the following:

- The E.P.F. and Miscellaneous Provisions act, 1952
- Payment of Bonus Act, 1965 and Amendment Act No.43 of 1977 and No.48 of 1978 and amendments
- Payment of Gratuity Act, 1972
- Public Provident Fund Act, 1968
- ESI Act , 1948 (Employees State Insurance Act, 1948)
- The Contract Labour (Regulation & Abolition) Act, 1970 and Rules
- Employer's Liability Act, 1938 (as amended).
- The Industrial Employment (Standing Orders) Act, 1946 (as amended).
- The Industrial Disputes Act, 1947 (as amended).
- The Personal Injuries (Compensation Insurance) Act, 1963 (as amended).

Rules include:

- Contract Labour (Regulation & Abolition) Central Rules, 1971
- Industrial Disputes (Central) Rules, 1957
- Minimum Wages (Central) Rules, 1950
- Payment of Bonus Rules, 1975
- The Personal Injuries (Compensation Insurance) Rules

3.5 *APPLICABLE ENVIRONMENTAL STANDARDS*

The MoEF has stipulated general wastewater discharge standards and emission standards. These standards limit the concentration and volumes of the effluents and emissions released into the atmosphere. There are specific standards for certain activities (no separate standards for hydroelectric power generation), and the standards are generally more stringent for the new plants than the existing ones.

The national ambient air quality is determined on the basis of the impact of pollutants on the human health, vegetation and property. Like the location-specific effluent standards, SPCBs can also make the emission standard s stringent on the considerations of the carrying capacity of a specific airshed and the existing pollution level of ambient air quality. The CPCB has evolved the methodology of emission monitoring systems with respect to air pollutants, which are prescribed under emission regulations.

The applicable standards, unless otherwise stated by the regulatory agencies will include the following:

3.5.1 *Air Emissions*

The Project will have air emissions for power generation mainly for construction purposes and will have to comply with the following standards:

1) Stack Height

Discharge of gaseous emissions, for easy dispersion of the gaseous pollutants is achieved through elevated stacks for diesel generators. The minimum height of stack to be provided on small diesel generators is calculated using following formula:

$$H = h + 0.2(KVA)^{0.5}$$

Where
H = Total height of stack in metre
h = Height of the building in metres where the generator set is installed
KVA = Total generator capacity of the set in KVA

For other stacks involving discharge of sulphur dioxide following formula is used:

$$H = 14\ Q^{0.3}$$

Where
H = Total height of stack in metre
Q = Total SO_2 emission in kg/hour

2) Emission Standards

a) Diesel Generators

a1) From Diesel Generators of less than 19 KW capacity

Emission limits for diesel engines (up to 19 KW) for are present in *Table 3.3.*

Table 3.3 *Emission Limits for Diesel Generators up to 19 KW*

Class	Displacement (CC)	CO (g/kw-hr)	HC+ (g/kw-hr)
1	<65	519	54
2	>65<99	519	30
3	> 99 <=225	519	16.1
4	> 225	519	13.4

a2) From Diesel Generators of 19 to 800 KW capacity

Emission limits for diesel engines (up to 800 KW) for generator applications are present in *Table 3.4*.

Table 3.4 *Emissions Limits for New Generator Sets*

Capacity	Emission Limits (g/kw-hr)			
	Oxides of Nitrogen (NO_x)	Hydrocarbons (HC)	Carbon monoxide (CO)	Particulate Matter (PM)
19 kW up to 800 kW	9.2	1.3	3.5	0.3

Source: Environment (Protection) Second Amendment Rules, 2004

b) Domestic Solid Waste Incinerator

Table 3.5 *Indicative Emission Norms for Incinerator (for Incineration of Municipal Waste)*

S.N.	Parameter	Norm
1	Particulate matter (PM)	150 mg/Nm^3 (at 12% of CO2 correction)
2	Nitrogen Oxides (NOx)	450 mg/Nm^3 (at 12% of CO2 correction)
3	Hydrogen Chloride (HCl)	50 mg/Nm^3 (at 12% of CO2 correction)
4	Minimum Stack Height	30 m
5	Volatile organic compounds in ash	Not more than 0.01%
6	Combustion efficiency	99%

Note: The above standards are indicative standards applicable for incinerators installed by Municipal Authorities. The above standards as applicable to ADHEP are subject to change as per the requirement of HPPCB.
1. Suitably designed pollution control devices shall be installed or retrofitted with the incinerator to achieve the above emission limits, if necessary.
2. Wastes to be incinerated shall not be chemically treated with any chlorinated disinfectants
3. Chlorinated plastics shall not be incinerated.
4. Toxic metals in incineration ash shall be limited within the regulatory quantities as specified in the Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008.
5. Only low sulphur fuel like Light Diesel Oil (LDO), Low Sulphur Heavy Stroke (LSHS) or Diesel shall be used as fuel in the incinerator.

3.5.2 Ambient Air Quality Standards

Ambient air quality standards prescribed for different landuses are as given in *Table 3.6*.

Table 3.6 *National Ambient Air Quality Standards*

Pollutant	Time weighted Average	Concentration in Ambient Air		
		Industrial Area	Residential, Rural & Other Areas	Sensitive Areas
Sulphur dioxide (SO_2)(µg/m³)	Annual Average*	80	60	15
	24 Hours**	120	80	30
Oxides of Nitrogen (NOx) (µg/m³)	Annual Average*	80	60	15
	24 Hours**	120	80	30
Suspended Particulate (SPM) (µg/m³)	Annual Average*	360	140	70
	24 Hours**	500	200	100
Respirable Particulate Matter (Size < 10 microns) (µg/m³)	Annual Average*	120	60	50
	24 Hours**	150	100	75
Lead (Pb) (µg/m³)	Annual Average*	1.0	0.75	0.50
	24 Hours**	1.5	1.0	0.75
Carbon monoxide (CO) (µg/m³)	8 Hours	5000	2000	1000
	1 Hour**	10000	4000	2000

*Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.; ** 24 hourly/8 hourly values should be met 98% of the time in a year. However 2% of the time, it may exceed but not on two consecutive days.

3.5.3 Ambient Noise Standards

Noise standards notified by the MoEF vide gazette notification dated 26th December 1989 based on *A* weighted equivalent noise level (L_{eq}) are as presented in ***Table 3.7*.**

Table 3.7 *Ambient Noise Standards*

Area Code	Category of Area	Limits in dB(A) Leq	
		Day time*	Night Time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone**	50	40

*Day time is recconned from 0600 to 2200 hours; Night time is recconned from 2200 to 0600 hours
**Silence zone is defined as area up to 100 meters around premises of hospitals, educational institutions and courts. Use of vehicle horns, loud speakers and bursting of crackers are banned in these zones.

3.5.4 Noise Standards for Occupational Exposure

Noise standards in the work environment are specified by Occupational Safety and Health Administration (OSHA-USA) which in turn are being enforced by

Government of India through model rules framed under the Factories Act. These are given in *Table 3.8* as follows.

Table 3.8 *Standards for Occupational Noise Exposure*

Total Time of Exposure per Day in Hours (Continuous or Short term Exposure)	Sound Pressure Level in dB(A)
8	90
6	92
4	95
3	97
2	100
3/2	102
1	105
¾	107
½	110
¼	115
Never	>115

Note: *No exposure in excess of 115 dB(A) is to be permitted.; For any period of exposure falling in between any figure and the next higher or lower figure as indicated in column (1), the permissible level is to be determined by extrapolation on a proportionate scale.*

3.5.5 Water Quality Standards

The designated best use classification as prescribed by CPCB for surface water is as given:

Table 3.9 *Primary Water Quality Criteria for Designated-Best-Use-Classes*

Designated-Best-Use	Class	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	Total Coliforms OrganismMPN/100ml shall be 50 or less pH between 6.5 and 8.5 Dissolved Oxygen 6mg/l or more Biochemical Oxygen Demand 5 days 20°C 2mg/l or less
Outdoor bathing (Organised)	B	Total Coliforms Organism MPN/100ml shall be 500 or less pH between 6.5 and 8.5 Dissolved Oxygen 5mg/l or more Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	Total Coliforms Organism MPN/100ml shall be 5000 or less pH between 6 to 9 Dissolved Oxygen 4mg/l or more Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Propagation of Wild life and Fisheries	D	pH between 6.5 to 8.5 Dissolved Oxygen 4mg/l or more Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	pH between 6.0 to 8.5 Electrical Conductivity at 25°C micro mhos/cm Max.2250 Sodium absorption Ratio Max. 26 Boron Max. 2mg/l
	Below-E	Not Meeting A, B, C, D & E Criteria

Source: Central Pollution Control Board

3.5.6 Drinking Water Standards

Drinking water standards as specified by Bureau of Indian Standards IS:10500, 1991 as reaffirmed in 2001.

3.5.7 *General Standards for Discharge of Environmental Pollutants*

General standards for discharge of environmental pollutants as per EPA Rules are described in *Table 3.10.*

Table 3.10 General Standards for Discharge Environmental Pollutants

S N	Parameter	Standards			
		Inland surface water	Public sewers	Land for Irrigation	Marine/coastal areas
1.	Colour and odour	Refer to Note 1	-	Refer to Note 1	Refer to Note 1
2	Suspended solids mg/l, max.	100	600	200	For process waste water 100 For cooling water effluent 10 per cent above total suspended matter of influent.
3	Particle size of suspended solids	Shall 850 micron IS sieve	-	-	Floatable solids, solids max 3 mm; Settleable solids, max 850 microns
4	PH value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
5	Temperature	Shall not exceed 5^0 C above the receiving water temperature	-	-	Shall not exceed 5^0 C above the receiving water temperature
6	Oil and grease, mg/l max,	10	20	10	20
7	Total residual chlorine, mg/l max	1.0	-	-	1.0
8	Ammonical nitrogen (as N), mg/l max.	50	50	-	50
9	Total kjeldahl nitrogen (as N); mg/l max	100	-	-	100
10	Free ammonia (as NH3), mg/l max	5.0	-	-	5.0
11	Biochemical oxygen demand (3 days at 27^0 C), mg/l max	30	350	100	100
12	Chemical oxygen demand, mg/l max	250	-	-	250
13	Arsenic (as As)	0.2	0.2	0.2	0.2
14	Mercury (As Hg) mg/l max.	0.01	0.01	-	0.01
15	Lead (as Pb) mg/l, max	0.1	1.0	-	2.0
16	Cadmium (as Cd) mg/l, max	2.0	1.0	-	2.0
17	Hexavalent chromium (as Cr +6) mg/1 max	0.1	2.0	-	1.0
18	Total chromium (as Cr) mg/1 max	2.0	2.0	-	2.0
19	Copper (as Cu) mg/1, max	3.0	3.0	-	3.0
20	Zinc (as Zn)	5.0	15	-	15
21	Selenium (as Se)	0.05	0.05	-	0.05
22	Nickel (as Ni) mg/1,max	3.0	3.0	-	5.0
23	Cyanide (as CN) mg/1,max	0.2	2.0	0.2	0.2
24	Fluoride (as F) mg/1,max	2.0	15	-	15

S N	Parameter	Standards			
		Inland surface water	Public sewers	Land for Irrigation	Marine/coastal areas
25	Dissolved phosphates (as P) mg/1,max	5.0	-	-	-
26	Sulphide (as S) mg/1,max	2.0	-	-	5.0
27	Phenolic compounds (as C_6H_5OH) mg/1,max	1.0	5.0	-	5.0
28	Radioactive materials: (a) Alpha emitters micro curie mg/1,max	10^{-7}	10^{-7}	10^{-8}	10^{-7}
	(b) Beta emitters micro curie mg/1	10^{-6}	10^{-6}	10^{--7}	10^{-6}
29	Bio-assay test	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent
30	Manganese	2 mg/1	2 mg/1	-	2 mg/1
31	Iron (as Fe)	3mg/1	3mg/1	-	3mg/1
32	Vanadium (as V)	0.2 mg/1	0.2 mg/1	-	0.2 mg/1
33	Nitrate Nitrogen	10 mg/1	-	-	20 mg/1

Note: All efforts shall be made to remove colour and unpleasant odour as far as practicable
The standards mentioned in the notification shall apply to all the effluents discharged such as industrial, mining and mineral processing activities, municipal sewage etc.

3.6 INTERNATIONAL FINANCE CORPORATION'S PERFORMANCE STANDARDS ON SOCIAL & ENVIRONMENTAL SUSTAINABILITY

3.6.1 Policies and Procedures

The International Finance Corporation (IFC) is a member of the World Bank Group. IFC's business is investment in private sector projects through loans, equity investment, and other financial instruments. It is IFC policy that all its operations are carried out in an environmentally and socially responsible manner. To this end, IFC projects must comply with applicable IFC environmental, social and disclosure policies. In addition, IFC applies World Bank Group environmental, health and safety guidelines to all projects.

IFC applies the Performance Standards (April 2006) to manage social and environmental risks and impacts and to enhance development opportunities in its private sector financing in its member countries eligible for financing. Furthermore, the project sponsor must ensure compliance with host country requirements.

For this Project, IFC environmental and social policies that were in use as fundamental to the project appraisal, approval and supervision process included operational policies i.e. OP 4.01, *Environmental Assessment;* OP 4.04, *Natural Habitats;* OP 4.09, *Pest Management;* OP 4.10, *Indigenous Peoples* (forthcoming); OP 4.11, *Safeguarding Cultural Property in IFC-Financed Projects* (forthcoming); OP 4.12, *Involuntary Resettlement* (forthcoming); OP 4.36, *Forestry;* OP 4.37, *Safety of Dams*; and OP 7.50, *Projects on International Waterways*.

3.6.2 IFC Pereformance Standards

The Performance Standards (PS) replaces the earlier policies may also be applied by other financial institutions choosing to support them for the proposed Project.

Together, the eight Performance Standards establish standards that the client is required to meet throughout the life of an investment by IFC or other relevant financial institution:

- Performance Standard 1: Social and Environmental Assessment and Management System;
- Performance Standard 2: Labour and Working Conditions;
- Performance Standard 3: Pollution Prevention and Abatement;
- Performance Standard 4: Community Health, Safety and Security;
- Performance Standard 5: Land Acquisition and Involuntary Resettlement;
- Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management;
- Performance Standard 7: Indigenous Peoples; and
- Performance Standard 8: Cultural Heritage.

The PS 1 establishes the importance of:

(i) Integrated assessment to identify the social and environmental impacts, risks, and opportunities of a project;

(ii) Effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them ; and

(iii) The client's (ADHPL's) management of social and environmental performance throughout the life of the Project.

The potential social and environmental impacts that require particular attentions with the relevant social and environment risks and impacts assessed are described throughout PS 2 through 8. They establish requirements to avoid, reduce, mitigate or compensate for impacts on people and the environment, and to improve conditions where appropriate.

These performance standards and guidelines provide ways and means to identify impacts and affected stakeholders and lay down processes for management and mitigation of adverse impacts. A brief on the requirements as laid down in the performance standards is described in the following subsections. More detail on the applicability of the Performance Standards is discussed in Environmental and Social Management Plan (ESMP) in Section 8 of this ESIA report.

PS 1: Social and Environmental Management Principles

The PS-1 requires Social and Environmental Assessment and Management Systems for managing social and environmental performance throughout the life cycle of this Project and runs through all subsequent PSs. The main elements of PS - 1 include:

- A Social and Environmental Assessment to understand the social and environmental impacts and risks;

- A Management Program for mitigating the impacts and minimizing the risks identified in the assessment;
- Establishing and ensuring organizational capacity and requisite trainings to the staff to implement the Management Programme;
- Engagement with the community to ensure constructive relationship all through the project life cycle; and
- Adequate monitoring and reporting systems to measure and report the effectiveness of the Management Programs.

The social and environmental performance is a continuous process to be initiated by the management (of ADHPL) and would involve communication between ADHPL, its workers and local communities directly affected by the Project. The PS requires that ADHPL initiate regular assessment of the potential social and environmental risks and impacts and consistently mitigate and manage strategy on an ongoing basis.

PS 2: Labour and Working Conditions

The economic growth through employment creation and income generation is recognised and balanced protecting the basic rights of workers. The PS 2 is guided by the various conventions of International Labour Organization (ILO) and outlines the minimum requirements of working conditions, protection to the workforce (including issues of child and forced labour) and ensuring occupational health and safety of both its 'employees' as well as 'non employees' working through contractors. The PS requires:

- Establishment of a sound worker-management relationship;
- Encouraging equal opportunity and fair treatment of workers;
- Promoting compliance with national labour and employment laws; and
- Promoting healthy and safe working conditions for workers.

PS 3: Pollution Prevention and Abatement

The PS 3 outlines approach to pollution prevention and abatement in line with internationally disseminated technologies and practices with objectives to a) avoid or minimize adverse impacts on human health and the environement by avoiding or minimizing pollution from activities; and b) promote the reduction of emissions that contribute to climate change. The PS 3 requires a project to avoid, minimize, or reduce adverse imopacts on human health and environment by adopting pollution preventive and control tecnologies throughout the Project life cycle.

PS 4: Community, Health, Safety and Security

The PS 4 concentrates on the responsibility that must be undertaken by the client to avoid or minimize the risks and impacts to the community's health, safety and security that may arise from project activities. The PS 4 requires a project to evaluate risks and impacts to the health and safty of the affected community during the Project life cycle and establish measures to avoid, minimize and reduce risks and impacts from the Project.

PS 5: Land Acquisition and Involuntary Resettlement

The objectives of this PS are to:

- Avoid or at least minimize the involuntary resettlement wherever feasible by exploring alternative project designs;
- Mitigate adverse social and economic impacts from land acquisition or restrictions on affected persons' use of land by:
  - Providing compensation for loss of assets at replacement cost; and
  - Ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected.
- Improve or at least restore the livelihoods and standards of living of displaced persons;
- Improve living conditions among displaced persons through provision of adequate housing with security of tenure at resettlement sites.

The PS 5 requires a project to consider various processes and systems to avoid /minimise social and economic impacts related to land acquisition and resettlement.

PS 6: Biodiversity Conservation & Sustainable Natural Resource Management

The PS 6 aims at protecting and conserving biodiversity, the variety of life in all its forms, including genetic, species and ecosystem diversity and its ability to change and evolve, is fundamental to sustainable development. The components of biodiversity, as defined in the Convention on Biological Diversity, include ecosystems and habitats, species and communities, and genes and genomes, all of which have social, economic, cultural and scientific importance. This PS addresses how clients can avoid or mitigate threats to biodiversity arising from their operations as well as incorporate sustainable management of renewable natural resources.

PS 7: Indigenous Peoples

The PS 7 acknowledges the possibility of vulnerability of indigenous people owing to their culture, beliefs, institutions and living standards, and that it may further get compromised by one or other project activity throughout the life cycle of the project. The PS underlines the requirement of avoiding / minimizing adverse impacts on indigenous people in the project area, respecting the local culture and customs, fostering good relationship and ensuring that development benefits are provided to improve their standard of living and livelihoods.

PS 8: Cultural Heritage

The PS 8 aims to protect the irreplaceable cultural heritage and to guide clients on protecting cultural heritage in the course of their business operations. In addition, the requirements of this Performance Standard on a project's use of cultural heritage are based in part on standards set by the Convention on Biological Diversity.

3.6.3 *EHS Guidelines of IFC*

The Environmental, Health, and Safety (EHS) General Guidelines (refer to: http://www.ifc.org/ifcext/sustainability.nsf/AttachmentsByTitle/gui_EHSGuidelines2007_GeneralEHS/$FILE/Final+-+General+EHS+Guidelines.pdf) will be applicable for this Project. Specific gudielines for Electric Power Transmission are separately provided in the ESIA for Project's Double Circuit Transmission Line.

3.7 *APPLICABLE INTERNATIONAL CONVENTIONS*

Transboundary environmental problems are those problems that migrate beyond the jurisdiction with the power to control that problem through international co-operation by either becoming a Contracting Party (CP) i.e. ratifying treaties or as a Signatory by officially signing the treaties and agreeing to carry out provisions of various treaties. The *Table 3.11* describes applicable International Conventions ratified and signed by India.

Table 3.11 International Conventions

S.N	Convention	Remarks
1	Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) 1973.	India is signatory to CITES and is responsible for identification and protection of wild flora and fauna which are internationally as endangered.
2	UN (Rio) Convention on Biological Diversity	India is a party to the CBD.
3	Conventions on the Conservation of Migratory species of wild animals and migratory species	India is contacting party to the convention on conservation of migratory species of wild animals and migratory species.
4	Ramsar Convention	India is signatory to the Ramsar convention, which includes wetlands of international significance in terms of ecology, botany, zoology, limnology or hydrology.
5	International Labour Organization conventions including: • C1 Hours of Work (Industry), 1919; • C5 Minimum Age (Industry), 1919: • C11 Right of Association (Agriculture), 1921; • C14 Weekly Rest (Industry), 1921; • C29 Forced Labour, 1930; • C105 Abolition of Forced Labour, 1957; • C100 Equal Remuneration, 1951; • C107 Indigenous and Tribal Populations, 1957; • C111 Discrimination (Employment and Occupation), 1958.	India has also ratified many of the International Labour Organization conventions that are relevant to ADHPL's Project.
6	Montreal Protocol on Ozone Depleting Substances	India signed the Montreal Protocol along with its London Amendment on 17-9-1992 and also ratified the Copenhagen, Montreal and Beijing Amendments on 3rd March, 2003.

S.N	Convention	Remarks
7	Basel Convention	Basel convention was signed by India in March 1990 and ratified in June 1992. The import and export norms for the hazardous waste have been provided in conformance with the Basel Convention.
8	The Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Hazardous Chemicals & Pesticides in international Trade	India adopted the PIC for required hazardous chemicals and pestcides at the Conference of Plenipotentiaries at Rotterdam in 1998
9	Kyoto Protocol	India signed the Kyoto protocol in August 2002 and ratified in February 2005. The convention pertains to the United Nations framework on Climate Change. The 3rd Conference of the Parties to the Framework Convention on Climate Change (FCCC) in Kyoto in December 1997 introduced the Clean Development Mechanism (CDM) as a new concept for voluntary greenhouse-gas emission reduction agreements between industrialized and developing countries on the project level. The Project becomes the basis for CDM mechanism.

3.7.1 ADHPL EHS Policy

ADHPL's EHS policy (as shown in *Figure 3.1*) will be applicable for the proposed transmission line project till new policy is brought into force.

Figure 3.1 ADHPL's EHS Policy

adhpl
AD HYDRO POWER LIMITED

Environment, Occupational Health & Safety (EHS) Policy

Allain Duhangan Hydro Power Limited (ADHPL) is committed to undertaking its power generation activities in environmental friendly and safe working environment. We shall strive to achieve and sustain excellence in Environment, Occupational Health and Safety performance through:

- Preventing pollution and conserving natural and key input resources such as biodiversity, raw materials and energy and with emphasis to use safe and eco-friendly technology to reduce/recycle wastes;
- Creating safe and healthy work environment;
- Complying applicable laws and regulations with integrity;
- Bringing continual improvement, in operational efficiency viz-a-viz equipment, processes, operations, maintenance and support services;
- Enhancing awareness and training amongst our employees, contract workers and business associates.

We shall communicate and make this policy available to our stakeholders and interested public.

Date : 01.02.2008
Place: Manali

Ashok Joshi

AD Hydro Power Limited

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3.8 ENVIRONMENTAL PERMITS REQUIRED FOR THE PROPOSED HYDEL PROJECT

Techno-economic clearance of the proposal is required from the CEA. In continuation of the Guidelines for Formulation of Project Reports in the Private Sector, issued by the (CEA in June, 1995, it has been decided, in consultation with CEA**,** to minimise the number of major clearances from State/Central Government and their agencies required by CEA while according its techno-economic clearance to generation, supply and distribution projects proposed by a private sector registered company after due compliance of Section 29(2) of the Electricity (Supply) Act, 1948.

As per the policies and legal framework, for a hydro electric project following approvals/clearances are required:

1. Techno Economic Clearance from Central Electricity Authority CEA);
2. State Electricity Board/ State Government Clearance;
3. Environmental Public Hearing Proceedings by SPCB (The proposed ADHEP project being initiated for Environmental Clearance prior to release of

notification for environmental public hearing, no environmental public hearing was conducted for the project);
4. Environmental Clearance by the MoEF;
5. Forest Clearance by the MoEF for any proposal on diversion of forestland in areas under project components including power transmission line route (necessary approvals are in process);
6. Water utilisation from Ministry of Water Resources
7. No Objection Certificate/Consent to Establish by the Himachal Pradesh Pollution Control Board (HPPCB);
8. No Objection Certificate from Department of Fisheries, Himachal Pradesh; and
9. Consent to Operate by the HPPCB (to be obtained prior to commissioning of the project);
10. Other approvals including for storage and handling of flammable substances, gas cylinders etc. (during construction phase) from PESO (Chief Controller of Explosives), Nagpur.

3.9 *CURRENT STATUS OF PERMITS & CLEARANCES OF THE PROJECT*

The list of the statutory clearances and approvals obtained for the Allain Duhangan hydroelectric project are provided in the *Table 3.12*. The copies of some of the major approvals are enclosed in *Annex A*.

Table 3.12 List of Approvals/Clearances/Requirements for the ADHE Project (in chronological order)

S. N.	Description	Remarks
1	MOU with Govt of Himachal Pradesh	MOU with Govt. of H.P on 28 Aug 1993
2	Declaration of ADHPL Ltd. as a generating company under Section 2(4-a) of the Indian Electricity Supply Act, 1948 in the Memorandum of Articles of Association of ADHPL.	Govt. of HP Letter No.MPP-F(2)-14/93 dated 24 June 1994
3	In-principle Clearance of CEA	CEA Letter No. 2/HP/18/96-PAC/282 dated 31 March 1996
4	Beneficiary of Power	MOU with the DVB signed on 16.06.2000.
5	Evacuation of Power by PGCIL from Nalagarh to Delhi.	PGCIL Letter no.C-BDD-14 dated 26 June 2000 and PGCIL's detailed system study report Ref. No. C-BDD-162 dated 07 Aug01. Construction of power transmission line already initiated.
6	Forest Clearance by Ministry of Environment & Forests, (MoEF), Govt. of India.	MoEF letter No. 8-109/99-FC dated 25 October 2000
7	Environmental Clearance by MoEF	MOEF letter No.J-12011/33/96-IA-I dated 12 December 2000
8	Implementation Agreement	Implementation Agreement with the Govt. of H.P. dated 22 Feb 2001
9	Govt. of Himachal Pradesh orders under Section 18-A of ES Act to establish, operate & maintain ADHEP(192 MW), District Kullu, HP.	Govt. of HP order under Section 18-A of the ES Act vide Letter No.MPP-F(2)/14/93-III dated 13 March 2001
10	Govt. of Himachal Pradesh Certificate under Section 72 of ES Act, 1948 in respect of water availability.	Govt. of HP Certificate under Section 72 of the ES Act vide Letter No.MPP-F(2)/14/93-III dated 13 March 2001
11	Construction of Transmission line within Himachal Pradesh for Evacuation of Power from Pirni (Project Powerhouse) to Nalagarh to be carried out by HPSEB.	HPSEB Letter no. HPSEB (Sectt)/ CE(PSP&SO)/401(H)/ALD-2000/548-49 dated 13 March 2001

S. N.	Description	Remarks
12	Gazette Notification under Section 29 of ES Act to invite objections &/or representations if any from any licensee or other person or member of general public.	Notification published in Newspapers & Gazette dated 08 Aug 2001 and 11 Sep 2001 respectively
13	Availability of Funds	ADHPL Certificate confirming equity funds dated 22 Jan 2002
		ICICI letter confirming debt funds vide letter No.EOG/8019 dated 27 Sep 2001.
14	Objections or representations received against the Gazette Notification under Section 29 of the ES Act	Letter No.D/AD/CEA-02 from ADHPL Ltd/Generating Company dated 31 Jan 2002
15	Extension of MOU upto the date of signing of Implementation Agreement	Govt. of HP Letter No.MPP-F(2)14/93-III dated 1 Feb 2002
16	Revised Certificate of HPSEB as per "Approach Paper" of CWC/CEA for according Techno-Economic Clearance based upon revised DPR dated April 2001.	HPSEB Letter no. HPSSEB(SECTT)/ CE(PSP&SO)/ 401(H)/ALD/ 2001-2600-01 dated 18 Jan 2002
17	Clearance of Revised DPR & Cost from Govt of HP	Govt. of HP letter no. MPP-F(2) 14/93-III dated 01 Feb 2002.
18	Clearance for construction of explosive magazine by Chief Controller of Explosives, Government of India	Jt. Chief Controller of Explosives, Faridabad Letter No. FBD/APP/4295 dated 23 May 02
19	Gazette Notification under Section 4A of the Land Acquisition Act, 1894	Notification published in Gazette dated 06 June 02
20	Permission of Government of Himachal Pradesh for pre-construction investigation	Letter no. MPP-F(2)-14/93-III dated 13 June 2002
21	Techno - Economic Clearance accorded by Central Electricity Authority	Letter no. 2/HP/18/96-PAC/8108-39 dated 20 Aug 2002.
22	Consent to Establish by Himachal Pradesh State Environment Protection & Pollution Control Board (HPSEPPCB).	Letter no. EPPCB/Allain Duhangan HEP - Prini-Manali/2002-3211-18 dated 28 May 2004
23	Forest Clearance (final clearance) by MoEF for diversion of 32.167 ha of Forestland	Letter no. 8-109/99-FC dated 18.10.2002 and 17 January 2005
24	Judgement of High Court Division Bench on minimum water discharge downstream the trench weir in Duhangan Stream and Report of Irrigation and Public Health Department	Judgement dated 24 April 2006. A minimum water discharge of 335.85 litres per second for the current needs and 387.09 for future needs (year 2045) is to be ensured by the Project.
25	Local Area Development Committee set up by the State Government for monitoring of hydro power projects. The Project is to report to the committee for the requirements.	Notification of Government of HP dated 11 December 2006
26	Forest Clearance for diversion of 9.55 ha forestland (over and above 32.629 ha obtained earlier) by MoEF	MoEF letter no. 8-109/99-FC dated 08 April 2008

Source: Developed as per discussion with ADHEP officials.

4 BASELINE DESCRIPTION

4.1 INTRODUCTION

The baseline environmental status is important to understand region's existing physical, biological, cultural and social environmental characteristics. Data presented in this section is as per the following information:

- Primary studies and surveys conducted by ERM;
- Key secondary data/ information sources relied upon by ERM; and
- Key data provided by, or studies conducted by the Client.

The information on the baseline environmental conditions forms the basis to analyze the probable impacts of the proposed hydroelectric power activities vis-à-vis the present background environmental quality of the core study area.

4.2 THE STUDY AREA

The Project study area considered for the ESIA study includes the whole catchment area of the Allain and Duhangan rivers, which is approximately 128.9 km^2 and 66.2 km^2 respectively, totalling to approximately 195 km^2 (the core study area). The project components extend within villages of Prini, Hamta and Jagatsukh in tehsil Manali in the district of Kullu, Himachal Pradesh. The Project lies to the east of the Beas River. The location map of project area and its layout plan are shown in *Figures 1.1 & 1.2* in *Section 1*. The catchment of the two Allian and Duhangan streams is shown in *Figure 4.1*.

The core study area considered for the Project covers whole of the catchment (i.e. 6 to 8 km from surge shaft location covering area between the trench weir on Duhangan, Allain Barrage and tail race discharge point. For socio-economic assessment, the villages of Jagatsukh, Hamtah, Prini and Shuru have been considered as per description given in *Section 5*.

4.3 GENERAL FEATURES OF MANALI & SURROUNDINGS

Until recently, settlements in the Manali area have been relatively small agricultural communities such as Manaligarh (Old Manali), Goshal, Chichoga, Prini, Shanag, Vashisht, etc. The Manali region is developed on relatively steep colluvial, and debris flow fan deposits and, more recently, on steep, valley-side slopes.

The elevation at Manali in general is 2,000 m. The immediate valley-side slopes rise at gradients of 20° to 40° to about 4,500 m and above this, isolated peaks and ridges rise to 6,500 m. The best known peaks in the area include Hanuman Tibba, Deo Tibba, and Indrasan, all marked by extensive glacier and snow covers. At the head of the Kullu Valley is Rohtang Pass (4,310 m) which has served as an important access route to and from the greater Himalayan Ranges, Lahul - Spiti, Ladakh, and Tibet.

The climate of the area is characterized by cool, snowy winters and relatively warm, wet monsoonal summers. Above 3,000 m above mean sea level(amsl), snow falls in all months of the year and above 2,300 m amsl, copious winter snowfall produces a well-developed snow cover on an annual basis and a significant snow avalanche hazard. Snow cover melting during April, May and June is an important source of water for the Beas and its tributaries. Summer monsoon-rain, and snow at higher elevations, is another important water source.

The eastern watershed of Beas comprises of extensive snow and ice-covered area which give rise to important tributaries of the Chandra and Spiti Rivers and large, flood-producing glaciers such as the Bara Shigri Glacier.

The biotic and soil conditions of the upper Beas River watershed are typically variable with elevation and slope aspect. Climatic tree-line is at about 3,500 m. However, actual tree-line has been influenced over long periods of time by anthropogenic factors, including grazing practices and collecting of fuel wood and plants. Above tree-line are found extensive areas of high elevation alpine vegetation while below the tree-line is a mixed deciduous-coniferous forest interspersed with meadows or clearings known locally as thatches. This results into typical Himalayan temperate coniferous forest dominated by deodar (cedar), spruce and fir. Under natural conditions, such forest would encompass the entire lower slopes and valley floors of the area under consideration.

It is important to note that the dominant material over most of the surface is bedrock. The lower slopes are generally cloaked by colluvium, which may include modified glacial deposits such as sub-glacial and ice-marginal glacio-fluvial deposits. Coarse-grained alluvium and debris-torrent deposits characterizing surficial deposits on the valley bottom in the vicinity of Manali region.

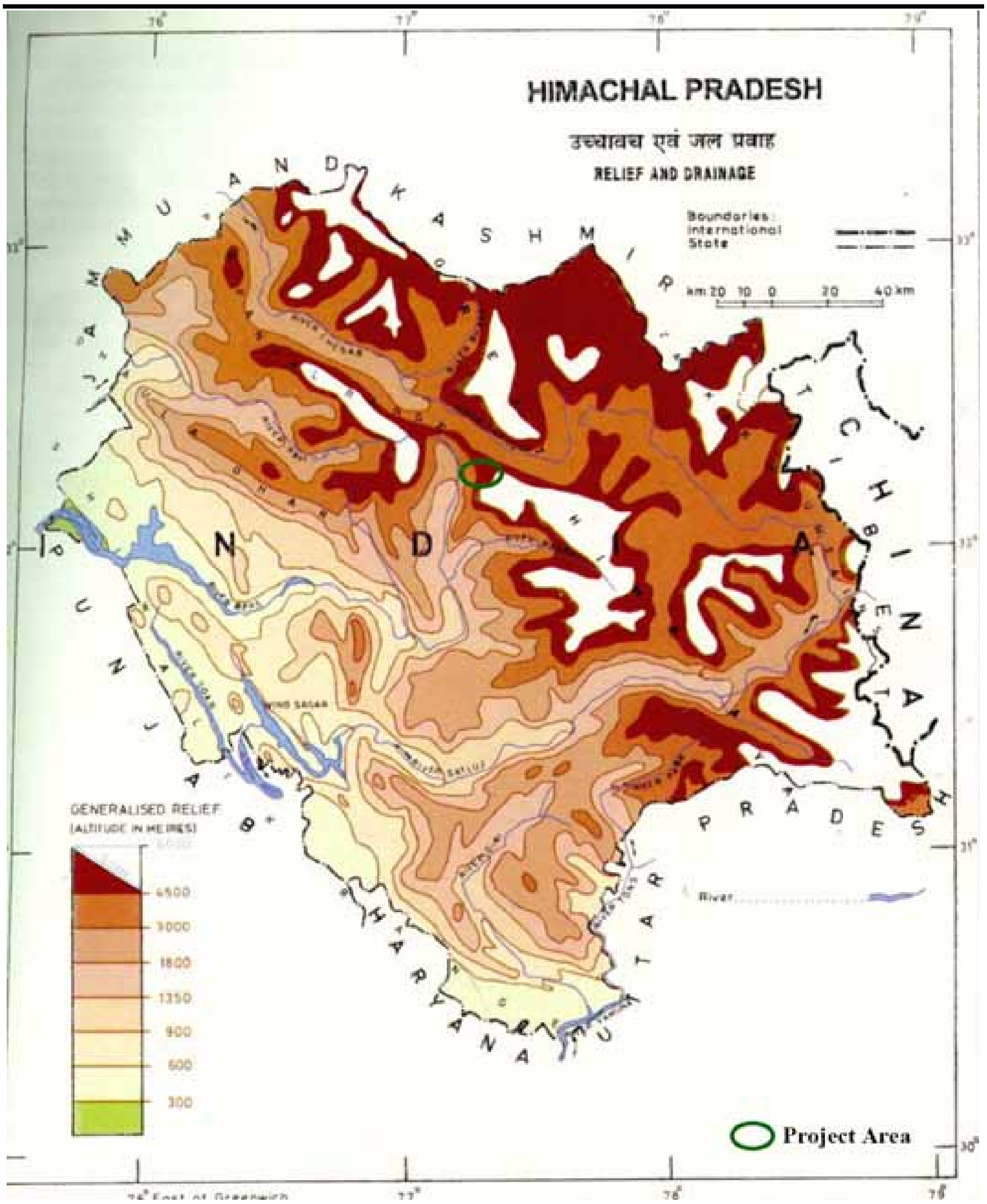
4.4 *DESCRIPTION OF PHYSICAL ENVIRONMENT*

4.4.1 *Physiography*

The Project lies in Manali region of Kullu district, which is bound by Lahul and Spiti in the North, Kangra in the West, Manali in the Southwest, Shimla in the South and Kinnaur in the East.

The physiography of the region is marked by hilly terrain rising from the altitudes of the 1,700 m amsl near Beas river (western limits of the catchment area) to 4,800 m amsl in the glaciers of Himalyan ranges (eastern limits of the catchment area). The catchment area (drainage area) of the Project is dependant on Allain and Duhangan streams which lie between the latitudes 32° 07' N & 32° 21' N and longitudes 77° 11' E & 77° 22'E. Both these streams flow east to west before joining Beas River.

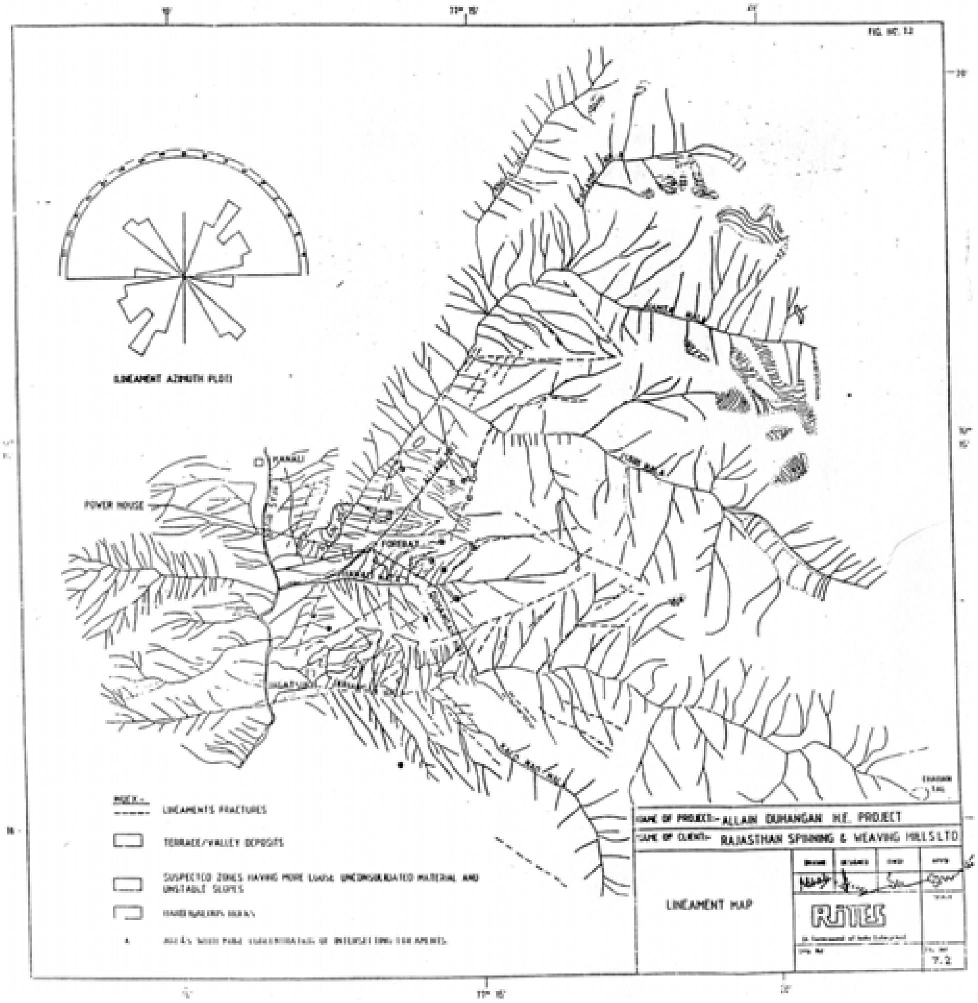
Figure 4.1 Relief Map of Himachal Pradesh with Project Site Location



Source: Census of India, Series 9, Himachal Pradesh.

Allain stream joins Beas near village Aleo in Manali while Duhangan stream joins Beas River near village Jagatsukh located on the outskirts of Manali. The Allain stream is formed by Hamtal and Patroi streams which originate at an elevation of 4,680 m amsl and 4,800 m (amsl) respectively in the Himalyan ranges and traverses a distance of 18.5 km before it joins Beas River at an elevation of about 1,800 m. A comprehensive relief and drainage map of the state is shown in *Figure 4.2* and of the project area in *Figure 4.3*. The Duhangan stream originates at an elevation of 5,229 m amsl from Chandratal glacier in the Himalayan ranges and traverses a distance of 19.1km before it joins Beas River. Both streams have a number of vertical falls, joined by several streams before emptying into Beas River. On an average these streams have a steep gradient of 1:7 indicating their suitability for hydroelectric power generation. However, such areas are prone to soil erosions.

Figure 4.2 Relief Map of the Project Catchment



Source: EIA Report for the Allain Duhangan Project by RITES (as provided by ADHPL)

Also refer to Contour map of the Catchment area as shown in ***Figure 4.3***.

4.4.2 Geology

The regional geological studies carried out by Geological Survey of India (GSI) have established that the rock formations in the area belong to the un-folloferous Palezoic Group of rock having thrusted contact with older rocks. Three well-defined structural units characterize the region, viz.:

- Central crystalline;
- Kullu formation; and
- Dibilana granites.

Each structural unit/formation has a thrusted contact with the other. In the Project area, the rock units exposed belong to central crystallines. The general trend of the foliation of the rocks in the area varies from NNE-SWW to NW-SE. The area has undergone intense folding which is manifested by mega-scopic and meso-scopic folds observed in the rock. The folds are asymmetrical and are of plunge type drag folds, mostly seen in gneissic rocks.

Figure 4.3 Contour Map of the Project Catchment Area

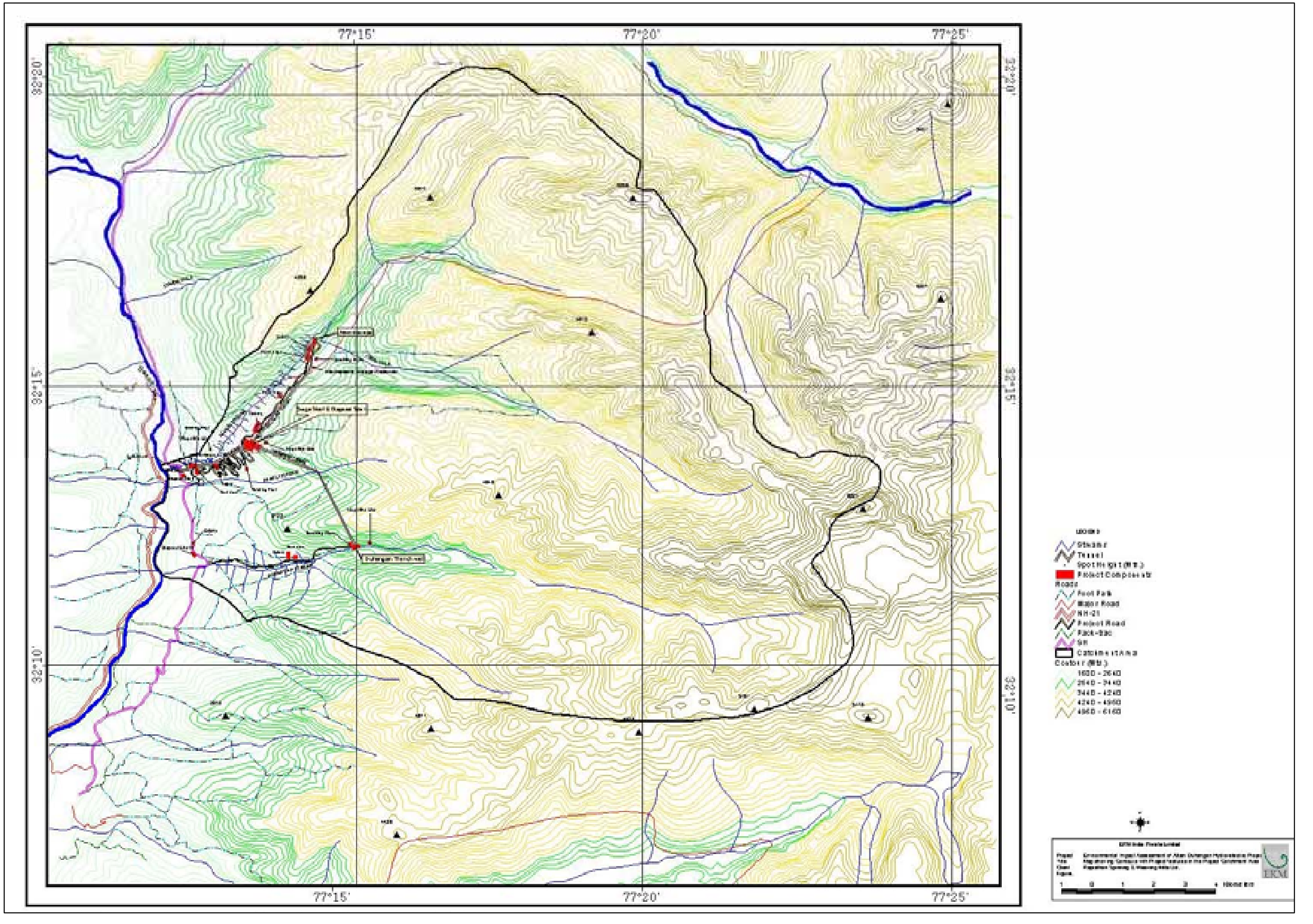
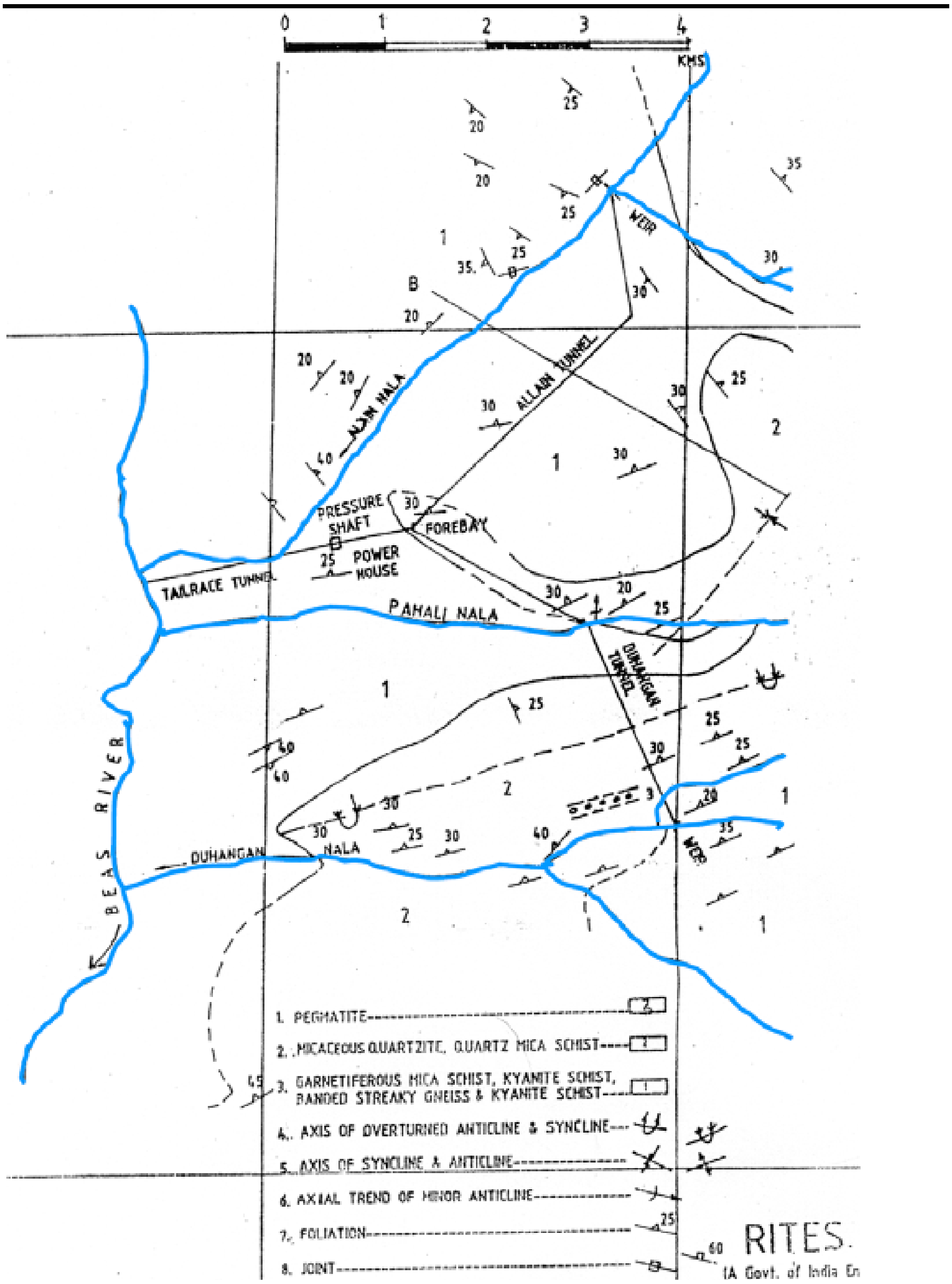


Figure 4.4   *Geological Map of the Project Catchment*



Source: EIA Report for the Allain Duhangan Project by RITES (as provided by ADHPL)

The stratigraphic succession of lithological units is described in *Table 4.1*.

Table 4.1   *Stratigraphic Sequence of Rocks*

Age	**Formation**	**Lithology**
Recent to Sub-Recent	-	Fluvial and Fluvio-Glacial unconsolidated sediments.
Post Cambrian	Dabinala	Intrusive folinated granite biotite granite, pegmatite and aplites.
Upper Pre Cambrian	Kully Formation	Micaceous quartzites, quartz mica-schists.
Pre Cambrian	Central	Garnetiferous mica schists Crstallines banded and steaky gneisses and migmatites

Central crystallines are the oldest formations in the area which consist of garnetiferous mica schist, kyanite schist, staurolite schist, banded and streaky gneiss and migmatites. The gneiss and schist bands vary in thickness from a few cm to over 50m. These bands grade into each other un-perceptibly both along and across their foliation. Mocaceous quartizities, quartz – mica schist, caretiferious mica – schist are exposed in the upper reaches of Allain and Duhangan streams. The gneisses and schist show intense folding. The geological map of the region is shown in ***Figure 4.4***. Geological map of the state showing soil types is shown in ***Figure 4.5***, highlighting the soil type of the Project and surrounding area.

Local Geological Setting of Project Components

Allain Barrage Site

The Allain barrage site is at an elevation of about 2,740 m amsl and the valley base at the site is about 50 m wide with steep banks. The entire section of the Allain stream is filled with 15 to 20 m thick river fill material while highly jointed and massive gneisses are well exposed on right abutment. The left abutment is covered by hill out wash. The strike of foliation generally varies from N 50^{o} W – S 50^{o} E to N 60^{o} S to N 60^{o} E and dip is of the order of 20^{o} to 25^{o} towards Southwest direction. At the barrage axis, the steep abutment slopes in massive gneisses are generally stable. The de-silting basin is located on the left bank of Allain stream where space for locating the surface structure is available.

Dunagan Weir Site

The Duhangan weir site is located at about 5.5 km upstream of its confluence with river Beas. At this site the valley has very steep banks. Fluio-glacial deposits occupy almost the entire valley section, while porphyritic granitic gneiss with occasional schist bands are exposed on the banks. The strike of foliation here generally varies from N 70^{o} E – S 70^{o} W to N 85^{o} W - S 85^{o} E and the dip towards Southwest direction. The weir axis has been selected mainly from topographic considerations and slide prone zones are encountered downstream of the chosen site. In terms of geology, gneisses are well exposed on steep abutments where rock slopes appear to be stable. In view of fresh and hard nature of rock the de-silting chamber has been designed as an underground structure on the right bank of Duhangan stream.

Allain Head Race Tunnel

The Allain head race tunnel portal is located on the left bank of Allain stream where bed rock is generally covered by overburden comprising of hill out wash barring exposures of gneisses and mica schist at the cross drainage location. The tunnel alignment passes mainly through granitic gneisses and micaceous quartzites with occasional schist bands. The strike of foliation of rock varies from N 50^{o} W – S 50^{o} W to N 60^{o} W - S 60^{o} E and dip is of the order of 5^{o} to 25^{o} towards Southwest direction.

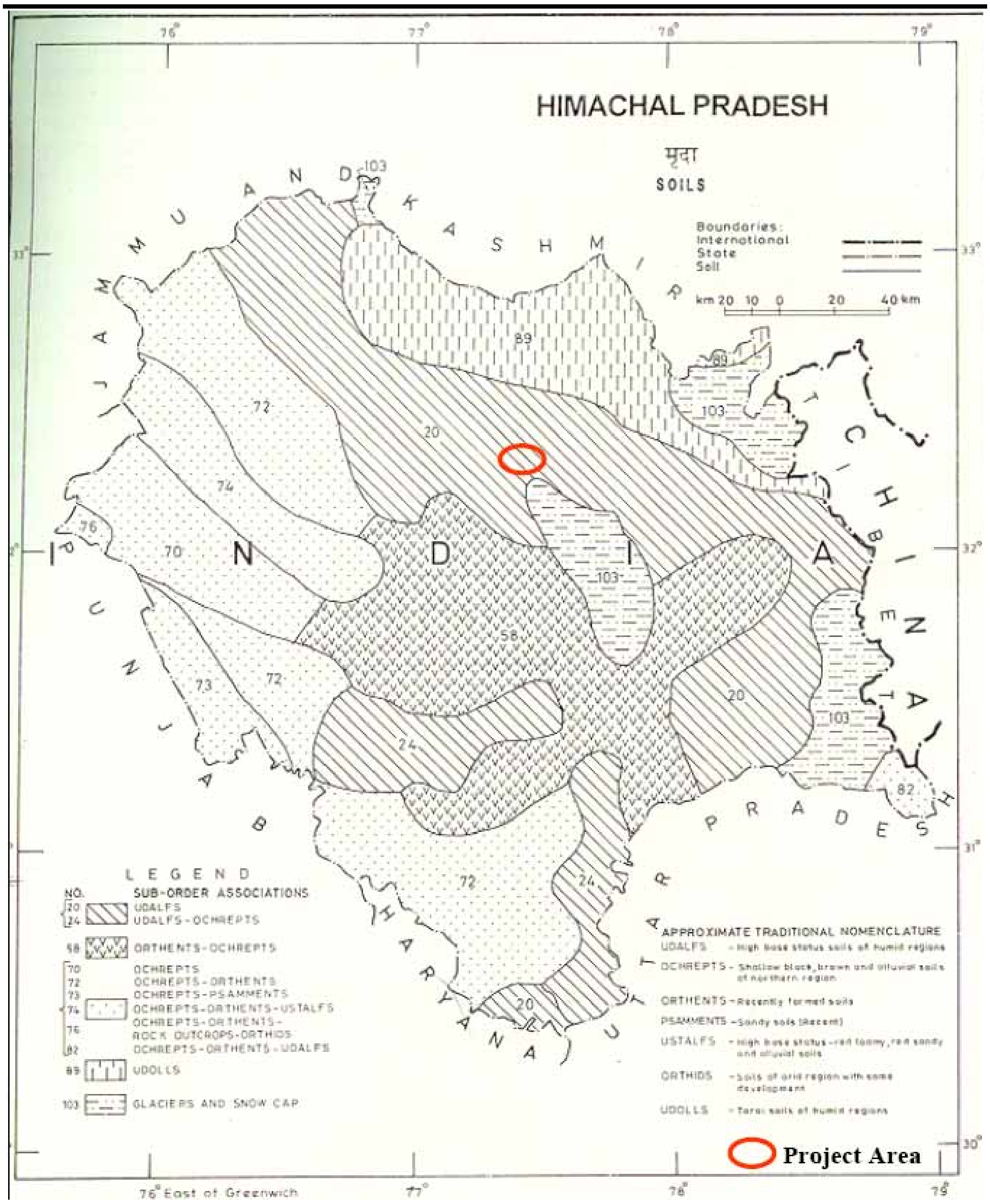
Duhangan Head Race Tunnel

The Duhangan headrace tunnel passes through micaceous quartzite, granitic – gneiss and micaschist with occasional pegmatite veins and shear seams. The strike of foliation of rock varies from N 60º E – S 60º W to E – W with a dip of the order of 20º to 30º towards North direction.

Surge shaft Site

The area around the surge shaft site is occupied by quaternary deposits in the form of glacial moraines, fluvio-glacial deposits and outwash materials. No rocky exposures are present close to this site and its vicinity.

Figure 4.5 *Geological Map of Himachal Pradesh showing Soil Types of the Project and Surrounding Areas*



Source: Census of India, Series 9, Himachal Pradesh.

Power House and Pressure Shaft Sites

The underground power house and pressure shaft sites are located in a hill on the left bank of Allain stream where streaky gneisses with quartz-mica schist bands are well exposed. These rocks are fresh and fairly hard but jointed in nature. The strike of foliation varies from N - S to N 35° E - S 35° E with a dip towards East direction. The rock is at places intruded by quartz and pegmatite veins along foliation.

Tailrace Tunnel

The tailrace tunnel from the powerhouse crosses Allain stream below the stream bed and after short-cutting the bend in the course of stream it comes out from the right bank of Allain stream. Bedrock comprising streaky hard and massive gneisses is well exposed on both the banks. The strike of foliation varies from N - S to N 20° W - S 20° E and the dip is of the order of 10° to 15° towards East direction.

4.4.3 *Landuse*

The landuse pattern of catchment area has been worked out based on earlier study done by ADHPL through RITES and additional information generated by ERM India. In order to assess landuse under both studies, base maps were prepared from Survey of India topographical sheets of 1:50000 scale, no. 521-Y3, 521Y4, 52FY7, 521-US. Satellite data was interpreted and landuse information was transferred on this base map using PROCOM instrument. Aerial photographs (Panchromatic Aerial Photographs on 1:50,000 scale) were interpreted with the help of mirror stereoscope and additional information was added on to the base map.

The Satellite data used for the interpretation is as follows:

- IRS-IA - LISS-2 - P-30, R-45 23 October 1998
- IRS-IB - LISS-2 - P-30, R-46 03 November 1993
- IRS-1C- LISS-3 – P-95, R-98 16 January 2001

For satellite data interpretation, false colour coding (FCC) of the above mentioned images were used. On the basis of colour composition, shape and texture of spectral signatures different forest groups were categorised. These vegetation classes were confirmed on the aerial photographs. With the help of aerial photographs and satellite images for the total geographical area of catchment (19,400-ha), the classification key was prepared for various categories of land use as shown in the following subsections:

1) Forest

These have been classified into three categories, viz. dense forest, open forest, and degraded forests.

a) *Dense forest* represents well-stocked forest having good crown cover which ranges from 40% and above with no visible canopy cover gaps in between the trees as observed under the mirror stereoscope. In satellite images it is seen as deep red colour with uniform textures and smooth regular pattern;

b) *Open forest* represents not so well stocked forest with sparse vegetation cover with average crown cover. The crown cover ranges between 10% and 40% as observed under the mirror stereoscope. Satellite data shows red colour patches with non-uniform pattern; and

c) *Degraded forests* are identified as those, which are very poorly stocked and degraded due to natural or anthroropoganic interference. The canopy cover ranges below 10% and some of the patches are devoid of any forest cover or undergrowth and may be considered as forest blanks.

2) Agricultural Area

Agricultural areas were shown as the total area representing cropped, un-cropped and habitation around the villages as per the following details:

a) *Cropped Area* is recorded in satellite data as pinkish red colour, irregular in pattern with very smooth texture when the crop is in full vigor; and in blue grey tone after the harvest season. In aerial photographs it is recorded as grey toned areas.

b) *Uncropped Area* is represented by yellowish red tinge with uniform texture in satellite data.

3) Grass Land:

These are represented along gentle to steep sloping surfaces with regular and uniform pale yellow colour in the month of November in satellite imageries.

4) *Pasture*:

These are recorded at higher altitudes and were represented by reddish brown colour with regular smooth texture in satellite data in the month of November.

5) Stoney Rocky Waste Area

a) Stoney rocky waste: This area is located at higher altitude along the snowline and represents a dark grey colour with irregular pattern and are recorded sub parallel to the water divide. In aerial photographs these are clearly distinct with other mountainous features like scree, waste debris, alluvial fans etc.; and

b) Glaciers: These are seen as linear elongated valleys at higher elevation. These valleys are filled with ice cover alongwith moraineous debrie in linear pattern as observed in satellite and aerial photographs.

The details of Landuse /Landcover of the Catchment Area in terms of above key classification are given in *Table 4.2.* The landuse of the entire Himachal Pradesh is shown in *Figure 4.5* whereas the catchment area landuse interpretation of different satellite imageries are shown in *Figures 4.6.*

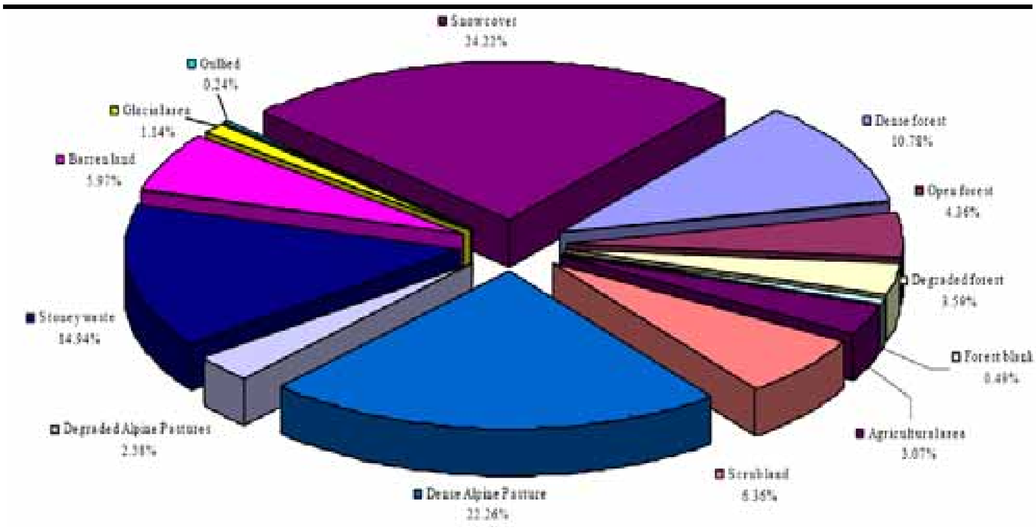
Table 4.2 Distribution of Landuse / Landcover in the Catchment Area

S.N.	Landuse system	Area (km^2)	% of Total Area
1.	Forest		
	- Dense forest	20.92	10.78
	- Open forest	8.46	4.36

S.N.	Landuse system	Area (km²)	% of Total Area
	- Degraded forest	6.97	3.59
	- Forest blank	0.95	0.49
2.	Agricultural area	5.96	3.07
3.	Scrub land	12.32	6.36
4.	Alpine pasture		
	- Dense pasture	43.19	22.26
	- Degraded pastures	5.00	2.58
5.	Stoney/Rocky Waste		
	- Stoney waste	28.98	14.94
	- Barren land	11.58	5.97
	- Glacial area	2.21	1.14
	- Gullied	0.47	0.24
6.	Snow cover	46.99	24.22
	Total	194.0	100

The above mentioned landuse distribution is also shown in *Figure 4.6* and the landuse patten of the Catchment area is shown in *Figure 4.7*.

Figure 4.6 Landuse Distribution of the Project Catchment Area



The landuse evaluated includes the land required for the following project features:

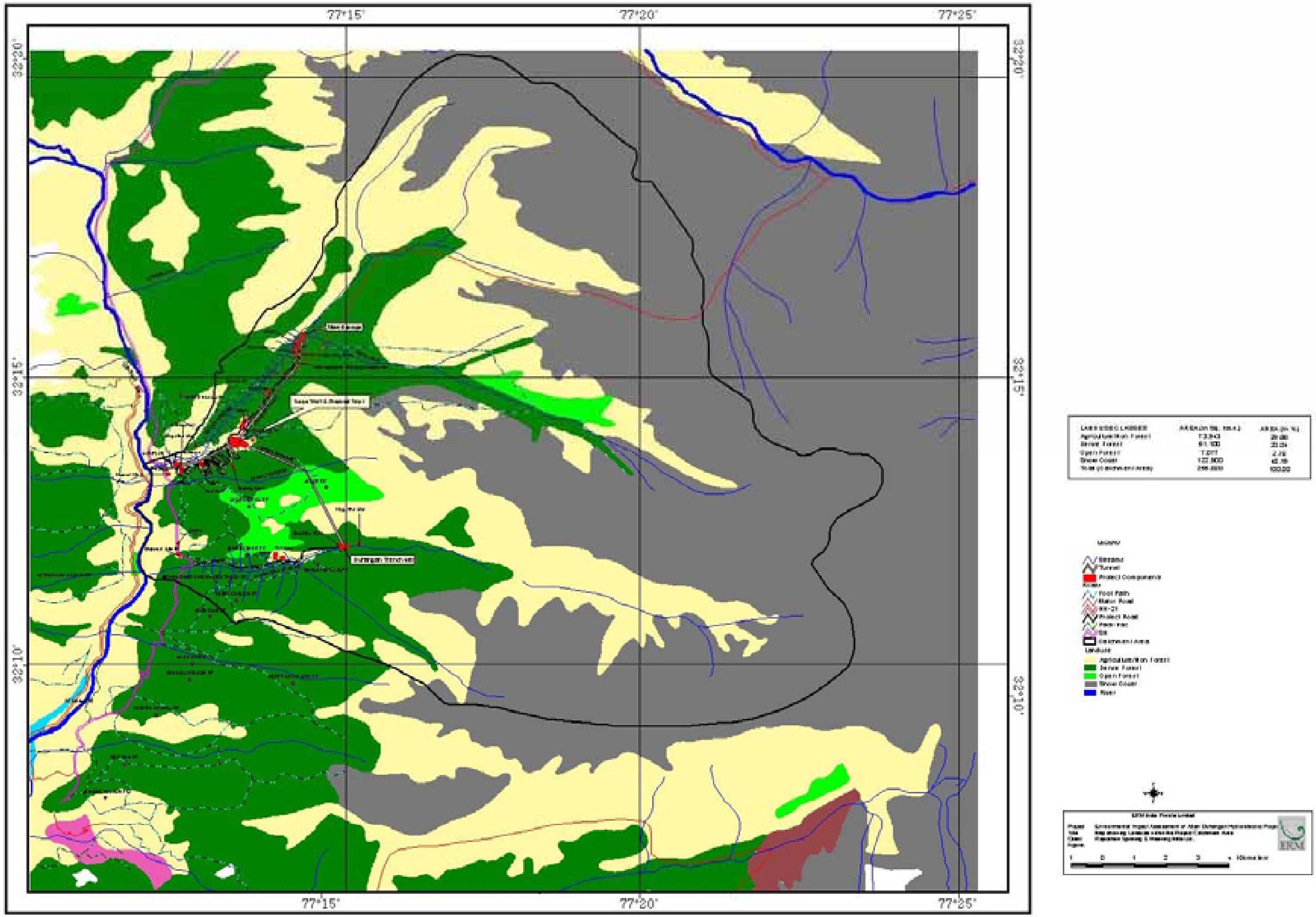
- Barrage/weir;
- Silt removal chambers;
- Storage reservoir/ Surge shaft;
- Roads;
- Plant areas;
- Switchyard & Tailrace;
- Colonies, Offices & transit camps;
- Powerhouse;
- Dumping areas; and
- Magazine sites.

There are three classes of ownership considered for classification and the *Table 4.3* provides the quantitative figures for the same.

Table 4.3 Project Land - Ownership basis

S.N.	Land ownership / type	Area (ha)	% of total area
1.	Forest	47.179	69.79
2.	Private	9.75	14.42
3.	Government	10.67	15.79
	Total	67.599	100

Figure 4.7 Landuse Map of the Project Catchment Area



The lives of the people in Himachal Pradesh are closely intertwined with the natural resource base, as 90% of the population is dependent on agriculture and animal husbandry. Valuable timber species such as deodar cedar (*Cedrus deodara*) and blue pine (*Pinus wallichiana*) have long been a source of income. The common oaks (*Quercus incana*, *Q. dilatata* and *Q. semecarpifolia)* are used as fuel and fodder. In some locations entire groups of people, such as the Gujjars, depend on alpine grazing lands for their living.

4.4.4 *Visual Landscape / Aesthetics*

Manali is located in the heart of the Pir Panjal Range of the Himalaya, close to the source of the Beas River. Together with the Chandra-Chenab, Ravi and Sutlej Rivers, which also drain in this region of the Himalaya, the Beas serves as an important water source for agricultural and industrial development in the Punjab and Haryana. In its upper reaches, the Beas River flows north to south or transversely through the mountain ranges to form what is known as the Kullu Valley. In its lower reaches, that is downstream from Bhuntar, the river is antecedent, cutting a deep and confined gorge, flowing alternately north to south and east to west through the southern Himalayan Ranges and foothills.

The Project area lies in the hilly terrain of Rohtang Range of the Great Himalayan Zone with high steep hill slopes dissected by streams having steep bank slopes and narrow width characteristics of glacial terrain. Mainly Allain, Duhangan and Pahali streams, which are tributaries of Beas River on its eastern bank, drains the catchment area. The Allain and Duhangan streams have their source in permanent snow covered mountains at altitude of the order of 3,400 to 5,000 m. The snow cover in the Project area extends down to an altitude of about 2,600 m in the month of April and recedes back to an altitude above 4,500 m by October – November. All these streams join the Beas River at acute angles by cutting deep into the river terrace deposits and maintain nearly E – W trend.

4.4.5 *Hydrology*

The Project is being set-up by utilising the perennial flows of the Allain and Duhangan, the snow-fed tributary streams of the Beas. The Allain stream originates from the glacier zone in the Pir Pinjal range at EL 4,800 m amsl while the Duhangan stream originates from Chander Tal glacier at EL 5,229 m amsl. The catchments lie in Zone-7 (Western Himalayas) of India. This zone covering Jammu & Kashmir, Punjab, Himachal Pradesh and Uttarakhand, is located between latitude 32°07′ to 32°21′ N and longitude 77°07′ to 77°11′ E, mostly bounded by International boundaries – Indo China border in the north and north-east, Indo-Pakistan border in the west and Indo-Nepal border in the east.

The standard followed by HPSEB for the Project to arrive at the snow-fed catchment areas is – permanent snow line for catchments at EL 4,280 m and area below EL 4,280 m designated as rainfed catchment. The catchment areas of the two streams are indicated in the *Table 4.4.*

Table 4.4 Catchment area of Allain and Duhangan streams

Stream & Location	Catchment area in km².		
	Above permanent snow-line (EL 4280m)	Below permanent Snow-line (EL4280m)	Total
Allain Stream:			
At Barrage site	51.5	77.4	128.9
At confluence with the Beas	51.5	93.2	144.7
Duhangan Stream:			
At Weir site	36.1	60.1	66.2
At confluence with the Beas	40.2	51.6	91.8

Considering the catchment area below EL 4,280 m (as per HPSEB standard) to be rainfed for assessing design floods is an very conservative basis for assessing design flood peaks.

No meteorological data is available to assess the snow-line in the case of the catchments for the Project. Hence the snow line is assumed on the basis of available data for similar projects and locations. Examination of various published reports and documents infers that snow-line during severe rainfall storms could be lower than EL 4,280m. The estimated snow-line of 3,675m for Dul Hasti Hyroelectric Project in the adjacent Chenab basin (which also originates in Pir Pinjal ranges) needs particular mention.

Water Availability

Hydrological discharges were observed by the HPSEB using float method thrice a day at Aleo gauging station on the Allain from January 1973 to May 1995 and at Jagtsukh gauging station on the Duhangan from January 1971 to May 1995. Thus, the data availability is for a period of 22 years for Allain and 24 years for Duhangan streams, respectively. Consistency checks have been carried out on the flow data, adopting the standard procedure/practices including applicable codes of Bureau of Indian Standards. The 24 year 10-daily average series obtained (with some regression of flow records to cover two more years) were then transferred to the diversion sites on catchment area proportion basis. Based on these field data, 10-daily average flow series were computed for analysis and power planning.

In absence of precipitation stations in the catchments of Allain and Duhangan, (particularly in the upper reaches) it was not possible for ADHPL to check precipitation-runoff consistency. However, attempts were made to arrive at an estimate of glacier/snow melt contribution during monsoon season to assess the reasonability of the average annual yields of the project catchments in the region. This estimate has been made based on the mean monsoon yield of Allain-Duhangan catchments and the average observed glacier/snowmelt contribution in Zone-7 (Western Himalayas) as recorded and analysed by Central Water Commission (CWC). The rainfall-runoff factor is estimated to be around 34% for Allain-Duhangan catchments, which can be considered as reasonable.

As it is planned to utilise combined flows of the two streams, a combined flow sequence was prepared and statistical parameters of the flow sequence and the flows at different dependabilities have been worked out using Weibull distribution. The average, 50% and 90% dependable flows on 10-daily average flow basis at diversion sites worked oute are presented in the following *Table 4.5*

Comparison of Seasonal Flows of Streams in the Project Region

Stream flow data of hydro-electric projects in the region have been obtained and processed for comparing the trend followed by the average 10-daily flows for the project catchments with those of others. Corresponding values for monsoon, non-monsoon and annual average run-offs of the streams of these projects have been compared with that for Allain and Duhangan streams.

Comparison reveals that all other catchments follow similar trend, except in the case of Hurla-Manihar catchment. This can be considered as an exception, since the catchment area for Hurla-Manihar is very small and the average runoff of 5,578mm considered seems to be out of tune with annual rainfall normal in the region.

Allain stream drains a catchment area of 128.9 km^2, out of which 51.5 km^2 is under permanent snow cover. Similarly Duhangan has a catchment area of 66.2 km^2, out of which 36.1 km^2 is under snow cover. The inflow in both streams comes from snow melt and rainfall.

Table 4.5 Dependable Flow Estimates at Diversion Sites (in Cumecs)

Catchment Diversion Site	Average	50% Dependable year	90% Dependable year
Allain Stream	9.133	5.940	3.028
Duhangan Stream	4.817	2.950	1.301
Combined Flows	13.950	8.871	4.467

About 3.028 m^3/sec and 1.301 m^3/sec water is available at Allain barrage and Duhangan weir sites respectively at 90% dependability. The 90% dependable combined flow available is 4.467 m^3/sec. The minimum flows in a year are observed during January and February being 1.54 m^3/sec and 1.08 m^3/sec for Allain and Duhangan streams respectively. The combined minimum flow will be about 2.73 m^3/sec. The pattern of combined flows of Allain and Duhangan streams has been estimated as per *Table 4.6*.

Table 4.6 Pattern of Combined Flows of Allain & Duhangan Streams in Cumecs

Periods	Spell of Flows	Average Year	50% Dependable Year (76-77)	90% Dependable Year (73-74)
Jun	1st 10 days	21.579	18.042	23.185
	2nd 10 days	23.381	18.359	34.266
	3rd 10 days	26.897	17.592	26.566
Jul	1st 10 days	29.124	23.891	31.365
	2nd 10 days	35.008	33.041	26.619
	3rd 10 days	32.146	36.205	21.268
Aug	1st 10 days	32.958	40.278	24.489
	2nd 10 days	30.103	36.689	23.426
	3rd 10 days	26.895	34.997	22.577
Sep	1st 10 days	22.582	32.446	15.339
	2nd 10 days	19.027	28.441	15.120
	3rd 10 days	15.218	20.443	12.203
Oct	1st 10 days	12.561	13.072	8.674

Periods	Spell of Flows	Average Year	50% Dependable Year (76-77)	90% Dependable Year (73-74)
	2nd 10 days	10.629	9.225	7.064
	3rd 10 days	9.213	9.5983	6.968
Monsoon Average		23.147	24.863	19.883
Nov	1st 10 days	8.095	10.469	5.686
	2nd 10 days	7.265	8.851	5.481
	3rd 10 days	6.617	8.434	5.284
Dec	1st 10 days	5.980	8.376	4.912
	2nd 10 days	5.508	6.204	5.033
	3rd 10 days	5.191	5.538	4.625
Jan	1st 10 days	5.052	5.577	4.206
	2nd 10 days	4.935	5.229	3.283
	3rd 10 days	4.813	4.506	3.377
Feb	1st 10 days	4.688	4.234	3.356
	2nd 10 days	4.587	4.158	3.172
	3rd 8 days	4.654	4.248	4.121
Mar	1st 10 days	4.764	3.908	3.065
	2nd 10 days	5.093	4.224	3.506
	3rd 10 days	5.561	4.635	4.028
Apr	1st 10 days	6.476	4.263	4.618
	2nd 10 days	7.887	4.173	5.575
	3rd 10 days	10.029	5.332	6.852
May	1st 10 days	13.420	6.341	8.408
	2nd 10 days	15.456	8.000	7.302
	3rd 10 days	18.818	13.395	5.958
Non-Monsoon Average		7.421	6.229	4.850
Annual Average		14.008	14.040	11.152

Source: ADHPL

There is village Jagatsukh downstream of Duhangan stream. The Prini village draws water from the Pahali stream while Jagatsukh uses water from chorpani natural spring water and Duhangan stream.

Both Allain and Duhangan streams are joined by several other major streams downstream of the barrage/weir sites.

The Project will have to ensure that minimum water in both of the streams during any given period of time as per the recommendations of the State Government Department of Irrigation and Public Health.

Measurement of Flow Volumes: Float velocity method was used to measure flow of Allain and Duhangan streams during the survey. The average depths of the streams were taken at one foot interval at evenly flowing stretches of the streams, and the width at that place also measured. Floating balls were used for measuring the velocity of the streams. For measuring the flow of the stream, the width of stream, the average depth and the velocity of water was multiplied.

As per the report of river ecology study undertaken by Foundation for Ecological Security, engaged by ERM all three sub-watersheds were traversed extensively depending on the snow conditions right from their confluence with the Beas and up to the glaciers of origin. The flora and fauna was studied for the vicinity of the streams. Intensities and trajectories of land-use were also sought to be understood by discussions with alpine shepherds, buffalo herders, herb collectors, fishermen, agriculturists and other residents of the villages.

Table 4.7 *Alleo Stream-Flow Measurement (m^3/s)*

S. N.	Season	500 meters above Confluence	At Barrage site
1	Post winter [February 2005]	2.19	-
2	Pre monsoon [June 2005]	30.92	-
3	Post monsoon [September 2005]	13.99	9.944
4	Winter [January 2006]	3.52	3.307

Table 4.8 *Duhangan Stream- Flow Measurement (m^3/sec)*

S. N.	Season	500m above Confluence*	Below Chhika, at Weir site
1	Post winter [February 2005]	1.04	-
2	Pre monsoon [June 2005]	21.88	-
3	Post monsoon [September 2005]	5.776	4.052
4	Winter [January 2006]	2.102	1.314

* This includes flows in the two irrigation aqueducts at the banks of Duhangan near Jagatsukh.

Table 4.9 *Pahali Stream- Flow Measurement (m^3/s)*

S. N.	Season	500 meters above Confluence
1	Post winter [February 2005]	0.23
2	Pre monsoon [June 2005]	0.78
3	Post monsoon [September 2005]	0.798
4	Winter [January 2006]	0.216

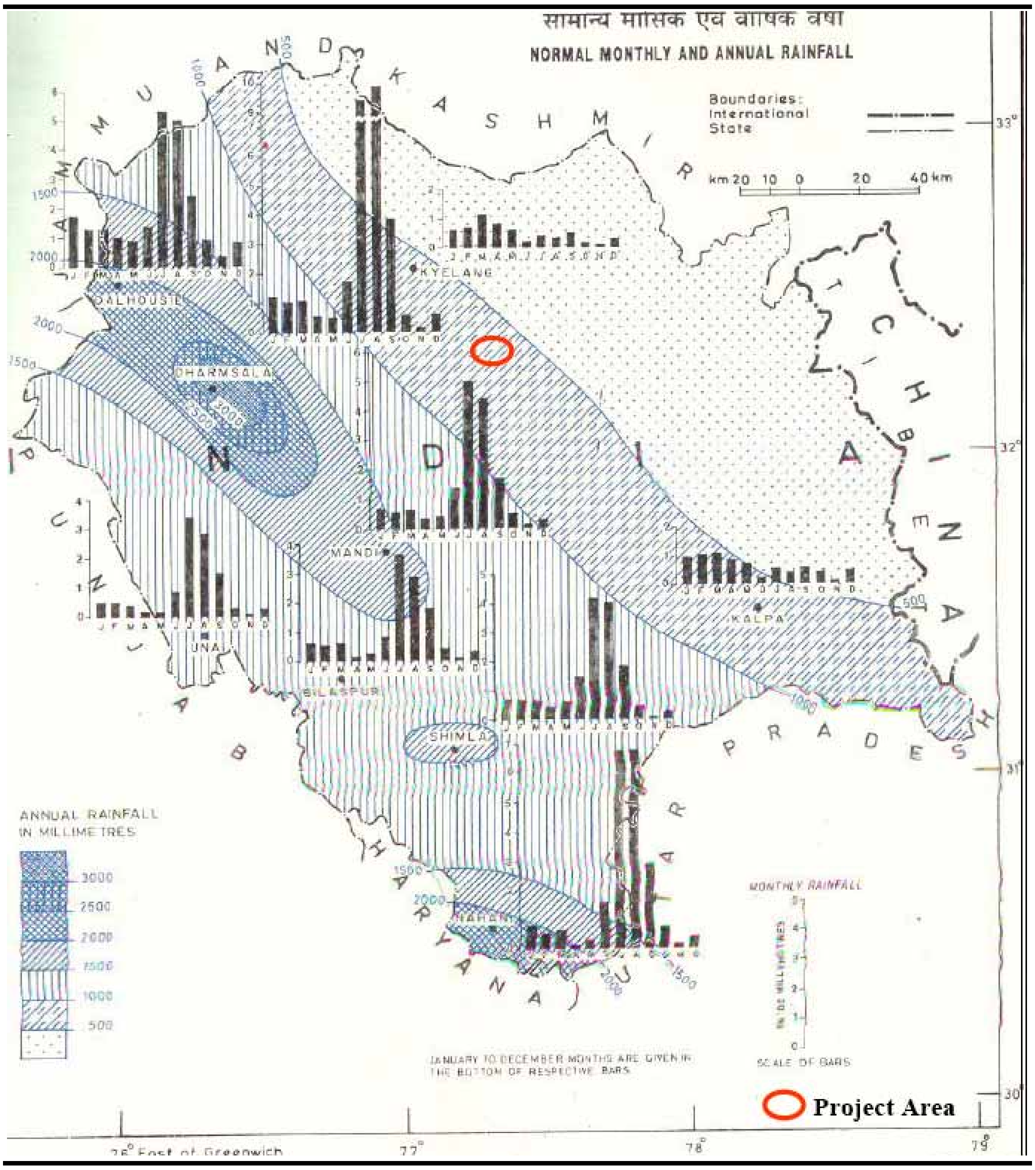
4.4.6 *Climate & Meteorology*

The climate of the Project area is cool and dry. In general three seasons are prevailing in the area i.e.

- Summer season (April to June);
- Monsoon season (July to September); and
- Winter season (October to March).

Snowfall generally occurs during December to February at high elevations and most of the region gets cut off from the district headquarters. The project area as a whole reaches a minimum ambient temperature as low as - 6°C during winter. August is the wettest month through out the district. Rainfall is very heavy during monsoon and very little during winter and summer seasons. The major portions of the monsoon rainfall in lower reaches of the catchment finds its way as surface runoff due to steep slopes, contributing to high river discharge in this season. The winter precipitation falls either as rain or snow depending upon the altitude and other meteorological conditions. It does not contribute directly to the stream discharge significantly and mostly feeds the snow/glacier bound area of the catchment.

Figure 4.8 Normal Monthly and Annual Rainfall



Source: Census of India, Series 9, Himachal Pradesh.

The nearest India Meteorological Department (IMD) station is located at Manali (2039 m above mean sea level), at Lat 32° 16′ N and long 77° 10′ which is about 10 km (linear distance) to the Northwest of the proposed hydropower site. Available Climatological information (1968 to 1980) for Manali from IMD has been considered to understand the meteorology of the region (refer to *Table 4.10*). *Figure 4.8* shows the rainfall distribution over the year in Himachal Pradesh and at the Project Area.

Table 4.10 Meteorological Information for Manali (Climatological Table 1968-80)*

Month	Daily Temp (°C)		Relative Humidity (%)		Mean Wind Speed m/sec	Prevailing Wind Direction	Rainfall total
	Min	Max	Mor.	Eve.		Mor. & Eve.	(mm)
January	-1.8	10.1	76	68	1.0	N, NE, E	145
February	-1.0	11.1	72	65	1.2	N, NE, E	145.6
March	2.8	15.9	60	55	1.4	N, NE, NW	187.3
April	6.1	21.6	56	48	1.5	N, NE, NW	111.3
May	8.6	24.9	57	50	1.6	NE, E, SE	69.1
June	12.4	26.6	71	58	1.9	SE, E, NE	94.5

Month	Daily Temp (°C)		Relative Humidity (%)		Mean Wind Speed m/sec	Prevailing Wind Direction	Rainfall total
	Min	Max	Mor.	Eve.		Mor. & Eve.	(mm)
July	14.8	25.5	86	75	2.1	SE, NE, S	235.0
August	14.6	25.0	91	81	1.9	SE, E, N	243.6
September	10.4	24.7	86	73	1.8	SE, N, S	108.4
October	5.4	22.5	73	65	1.4	N, NE, E	33.1
November	1.3	18.4	62	58	1.1	N, E, NE	39.8
December	-0.3	14.0	60	54	1.0	N, NE, E	46.5
Annual Avg.	6.1	20.0	71	63	1.5	-	-
Total Annual	-	-	-	-	-	-	1603.4

* Based on morning (0830 am) and evening (0530 pm) readings in a day except that of Rainfall; Source: India Meteorological Department

Temperature and humidity were monitored at various locations in the study area as described in *Table 4.11*. Both temperature and humidity were monitored at five different locations and the results are tabulated below.

Table 4.11 Results of Meteorological Observations

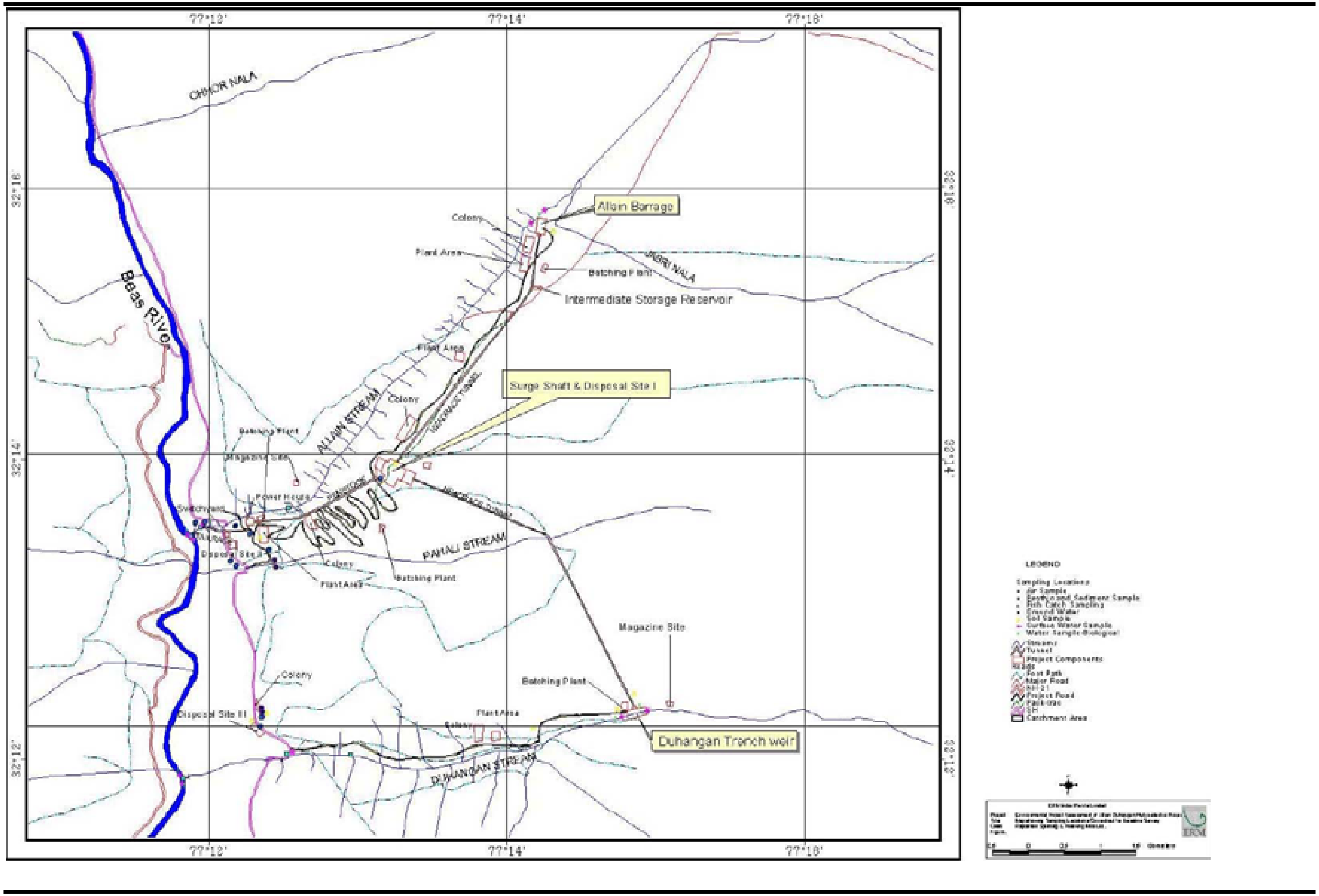
Location	Humidity %			Temperapture °C		
	Min	Max	Avg	Min	Max	Avg
Plant / colony area (village Prini)	48.3	86.3	63.57	5.2	16.3	11.74
Camp office site (village Prini)	50.8	79.50	62.91	4.3	14.60	10.12
Village Jagatsukh)	49.80	71.30	61.22	8.30	13.90	11.94
Surge shaft site (village Hamta)	49.80	71.20	60.97	5.00	13.90	8.38
Switchyard site (village Prini)	48.30	70.10	61.10	10.80	17.30	13.77

Source: As monitored during the month of February 2003.

4.4.7 *Ambient Air Quality*

The existing ambient air quality of the study area serves as an index for assessing the pollution load and the assimilative capacity of any region and forms an important tool for planning further development in the area. A detailed assessment of the existing air environment was undertaken for the purpose mentioned above. Atmospheric air samples were taken from five locations within the study area. The sampling locations have been shown in the *Figure 4.9.*

Figure 4.9 Sampling Locations for Baseline Surveys



The air samples were collected for the following air quality determinants:

- Suspended Particulate Matter (SPM);
- Oxides of Nitrogen (NOx);
- Sulphur Dioxide (SO2); and
- Carbon Monoxide (CO).

Sampling schedule: 24 hourly samples for SPM, SO_2 and NOx were collected from all the five stations, by continuous monitoring by Himachal Pradesh State Pollution Control Board (HPPCB), Shimla using standard techniques as prescribed by Central Pollution Control Board (CPCB) during October 2002. The CO samples were analysed by Shriram Industrial Research Institute (SIRI), Delhi using NDIR based online CO analyser at a frequency of 3 hours once during 24-hour period from all the 5 locations during the month of February 2003 commissioned by ERM and subsequently by the Project during summer 2007. The results of air quality are presented in ***Tables 4.12 through 4.15.*** The results were compared with the national ambient air quality standards prescribed by CPCB for residential, rural and other areas.

Table 4.12 Ambient Air Quality Monitored in 2007 with respect to RSPM and SPM

Date, 2007	Prini village		Aleo village		Saithan village		Shuru village		Jagatsukh village	
	RSPM	SPM	RSPM	SPM	RSPM	SPM	RSPM	SPM	RSPM	SPM
April 2	30.0	88.0	41.0	95.0	38.0	92.0	41.0	61.0	42.0	98.0
April 3	36.0	95.0	44.0	97.0	40.0	81.0	40.0	59.0	36.0	89.0
April 9	39.0	99.0	42.0	98.0	41.0	86.0	44.0	67.0	40.0	95.0
April 10	40.0	97.0	43.0	100.0	43.0	92.0	49.0	75.0	43.0	99.0
April 16	43.0	100.0	40.0	99.0	46.0	99.0	53.0	83.0	44.0	100.0
April 23	30.0	84.0	40.0	72.0	38.0	70.0	39.0	69.0	30.0	69.0
April 24	33.0	90.0	42.0	88.0	40.0	86.0	40.0	73.0	32.0	75.0
April 30	37.0	97.0	44.0	92.0	43.0	91.0	45.0	80.0	39.0	86.0
May 1	39.0	100.0	47.0	97.0	47.0	97.0	46.0	84.0	43.0	93.0
May 14	26.0	90.0	35.0	89.0	36.0	89.0	38.0	65.0	40.0	90.0
June 5	25.0	75.0	29.0	79.0	30.0	82.0	34.0	60.0	27.0	67.0
June 11	27.0	86.0	38.0	93.0	38.0	92.0	37.0	64.0	32.0	76.0
June 12	35.0	97.0	41.0	100.0	40.0	99.0	42.0	72.0	37.0	86.0
Minimum	**25.0**	**75.0**	**29.0**	**72.0**	**30.0**	**70.0**	**34.0**	**59.0**	**27.0**	**67.0**
Maximum	**43.0**	**100.0**	**47.0**	**100.0**	**47.0**	**99.0**	**53.0**	**84.0**	**44.0**	**100.0**
Average	**33.8**	**92.2**	**40.5**	**92.2**	**40.0**	**88.9**	**42.2**	**70.2**	**37.3**	**86.4**
98-percentile	**42.3**	**100.0**	**46.3**	**100.0**	**46.8**	**99.0**	**52.0**	**83.8**	**43.8**	**99.8**
Standard*	**100**	**200**	**100**	**200**	**100**	**200**	**100**	**200**	**100**	**200**

*Source: ADHPL; * Standard as applicable for Residential and Rural Areas (Refer to Table 3.6 in Section 3)*
RSPM= Respiratory Particulate Matter; SPM= Suspended Particulate Matter

Table 4.13 Ambient Air Quality Monitored in 2007 with respect to SO_2 and NO_x

Date, 2007	Saithan village		Aleo village		Prini village		Shuru village		Jagatsukh village	
	SO_2	**NOx**	**SO_2**	**NOx**	**SO_2**	**NOx**	**SO_2**	**NOx**	**SO_2**	**NOx**
April 3	11.56	20.05	16.50	17.40	14.21	19.10	8.36	17.02	16.55	18.16
April 10	13.38	21.15	6.98	17.05	16.70	20.61	8.78	17.58	9.04	19.25
April 30	15.85	24.49	13.75	17.04	19.61	24.03	10.65	19.64	24.56	22.48
May 14	15.98	21.92	9.62	17.22	16.43	22.27	10.08	18.28	17.02	21.26
June 5	15.05	22.28	8.50	19.50	18.65	21.30	10.25	20.06	16.25	19.59
June 11	16.25	21.14	12.97	20.15	19.55	24.25	10.25	20.23	8.33	20.52
Minimum	**11.56**	**20.05**	**6.98**	**17.04**	**14.21**	**19.10**	**8.36**	**17.02**	**8.33**	**18.16**
Maximum	**16.25**	**24.49**	**16.50**	**20.15**	**19.61**	**24.25**	**10.65**	**20.23**	**24.56**	**22.48**

Date, 2007	Saithan village		Aleo village		Prini village		Shuru village		Jagatsukh village	
Average	**14.68**	**21.84**	**11.39**	**18.06**	**17.52**	**21.93**	**9.73**	**18.80**	**15.29**	**20.21**
98-percentile	**16.22**	**24.27**	**16.23**	**20.09**	**19.61**	**24.23**	**10.61**	**20.21**	**23.81**	**22.36**
Standard*	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**

*Source: ADHPL; * Standard as applicable for Residential and Rural Areas (Refer to Table 3.6 in Section 3)*
SO_2= Sulphur Dioxide; NOx= Oxides of Nitrogen

Table 4.14 Results of Ambient Air Quality (SPM, SO_2 and NO_X) monitored in 2003

Monitoring Locations	SPM (µg/m³)			SO_2 (µg/m³)			NO_x (µg/m³)		
	Min.	Max.	Avg	Min.	Max.	Avg	Min.	Max.	Avg
Plant / colony area (Vill.Prini)	49.40	63.10	55.17	8.40	19.70	17.55	12.05	24.70	12.10
Camp office site (Vill.Prini)	57.40	67.30	61.69	8.80	26.30	21.46	13.60	25.90	13.03
Colony site (Vill.Jagatsukh)	54.40	62.60	58.46	8.30	18.90	13.06	15.30	30.40	22.85
Surge shaft site (Vill.Hamta)	47.20	68.70	53.05	4.10	15.40	10.23	12.10	24.80	18.22
Switchyard site (Vill.Prini)	62.40	66.90	66.18	11.40	19.50	15.12	20.60	31.60	24.94

Source: As monitored by Shriram Institute during the month of February 2003.

Table 4.15 Results of Ambient air quality (CO) monitoring carried out in the area

S.N.	Name of the site	Time of sampling (hrs)	Carbon Monoxide as CO (mg/m³)	Detection Limit (mg/m³)
1.	Hotel Imperial	0700	Not detected	0.1
		1100	Not detected	0.1
		1500	Not detected	0.1
		1900	Not detected	0.1
2.	Camp Office	0730	Not detected	0.1
		1130	Not detected	0.1
		1530	Not detected	0.1
		1930	Not detected	0.1
3.	Village Jagatsukh	0900	Not detected	0.1
		1200	Not detected	0.1
		1600	Not detected	0.1
		2000	Not detected	0.1
4.	Power House	0930	Not detected	0.1
		1730	Not detected	0.1
		1630	Not detected	0.1
		2030	Not detected	0.1
5.	Village Pirni	0945	Not detected	0.1
		1245	Not detected	0.1
		1645	Not detected	0.1
		2045	Not detected	0.1

Source: As monitored by Shriram Institute during the month of February 2003.

On perusal of the above results, it is evident that all monitored values are well within the limits prescribed by CPCB for residential, rural and other areas. The results are summarised below:

SPM: The SPM concentration as monitored at five locations during year 2007 (refer to *Table 4.12*) ranged from 59.0 to 100.0µg/m³ in the ambient air. Average concentrations at all the locations varied from 70.2 to 90.2µg/m³. The concentrations monitored are relatively higher than the concentrations as monitored during 2003, showing incremental concentrations due to Project construction activities. The observed values were lower than the limit of 200µg/m³ as prescribed for residential and rural areas. The SPM concentrations as monitored during February 2003 ranged from 49.4 to 66.9µg/m^3 in the ambient air recorded at five locations. The maximum concentration was found at the present camp office site. Average SPM concentration for all the five locations varied from 53.05 to 66.18µg/m^3. All monitored values of SPM were well below the specified national limit of 200µg/m^3 for residential, rural and other areas.

RSPM: The RSPM concentration as monitored at five locations during year 2007 (refer to *Table 4.12*) ranged from 25.0 to 53.0µg/m^3 in the ambient air. Average concentrations at all the locations varied from 33.8 to 42.2µg/m^3. The observed values were lower than the limit of 100µg/m^3 as prescribed for residential and rural areas.

SO_2: The SO_2 concentration as monitored at five locations during year 2007 (refer to *Table 4.13*) ranged from 6.98 to 24.0µg/m^3 in the ambient air. The concentrations monitored were similar to those monitored during 2003 (refer to *Table 4.14*) and were within the limit of 80µg/m^3 as prescribed for residential and rural areas.

The SO_2 concentration ranged from 15.4 to 26.30 µg/m^3 in the ambient air recorded during February 2003 at the five locations. The maximum concentration was found at the present camp office site. Average SO_2 concentration for all the five locations varied from 10.23 to 21.46 µg/m^3. All monitored values of SO_2 were well below the specified national limit of 80 µg/m^3 for residential, rural and other area.

NO_x: The SO_2 concentration as monitored at five locations during year 2007 (refer to *Table 4.13*) ranged from 17.02 to 24.49µg/m^3 in the ambient air. The concentrations monitored were similar to those monitored during 2003 and were within the limit of 80µg/m^3 as prescribed for residential and rural areas.

The maximum NO_x concentration ranged from 24.70 to 31.60 µg/m^3 in the ambient air recorded during February 2003 at five locations. The maximum concentration was found near proposed switchyard site. Average values of NO_x for all the locations seasons ranged from 12.10 to 24.94 µg/m^3. All the monitored values were well below the specified national limit of 80 µg/m^3 for residential, rural and other areas.

CO: Measurable presence of CO could not be detected in any of the monitoring events, indicating concentrations less than the level of detection of 0.1 mg/m^3 (100 µg/m^3). All monitored values of CO were, therefore, well below specified national limit of 2000 µg/m^3 for residential, rural and other areas.

4.4.8 *Noise Environment*

Noise, in general, is sound that is composed of many frequencies distributed over the audible frequency range. The noise levels were recorded using acceptable norm for hearing by human ears (suitable for 20-20,000 Hz) i.e. Ä-weighted on decibel (dB) scale. The noise from construction and operational activities, vehicular traffic, etc can be undertaken by taking into consideration, various factors like potential to hearing, physiolgical responses, annoyance and general community responses which have several effects varying from Noise Induced Hearing Losses (NIHL) etc.

The ambient noise monitoring was conducted during May 2007 and October 2002 and during the period of study by HPPCB (sponsored by ADHPL). Noise monitoring has been conducted in the study area to assess the background noise levels. The monitoring was conducted in different noise zones. For this purpose, five noise monitoring locations have been chosen during the monitoring conducted. Noise was measured in dB(A) at all the locations. Various statistical parameters like msaximum, minimum and average values for day and night were then computed and presented.

Table 4.16 Results of Noise Monitoring (May 2007)

Monitoring Location	L_{eq} hourly dB(A) Minimum	L_{eq} hrly dB(A) Maximum	L_{eq} day dB(A) 06-22 hours	L_{eq} night dB(A) 22-06 hours
Prini village	40.4	56.9	55.6	52.1
Sethan village	40.4	51.9	50.6	47.2
Jagatsukh village	48.9	54.4	53.0	49.9
Prescribed limit for residential areas	-	-	55.0	45.0

Source: ADHPL.

Table 4.17 Results of Noise Monitoring (October 2002)

Monitoring Location	**Noise level – Day (dBA) L_d**			**Noise level – Night (dBA) L_N**		
	L_{eq} hourly dB(A) Min (day time)	L_{eq} hrly dB(A) Max (daytime)	L_{eq} day dB(A) 06-22 hours	L_{eq} hourly dB(A) Min (night time)	L_{eq} hrly dB(A) Max (night time)	L_{eq} night dB(A) 22-06 hours
Plant / colony area (village Prini)	40.6	82.10	47.34	31.40	66.30	43.00
Camp office site (village Prini)	40.30	70.60	55.38	30.30	66.30	44.54
Colony site (village Jagatsukh)	44.60	81.30	56.40	40.30	56.40	52.00
Surge shaft site (village Hamta)	36.30	49.30	44.85	30.80	45.20	41.90
Switchyard site (village Prini)	55.30	76.80	57.80	50.30	63.40	53.30

Source: As monitored by HPPCB during the month of October 2002.

On perusal of the *Table 4.16* the day time equivalent noise levels were found within the prescribed limit of 55 dB(A) for villages sethan and Jagatsukh, however, for Prini village, it was found marginally higher than the prescribed limit. The night time equivalent noise levels for all the three monitored villages were found higher than the prescribed limit of 45 dB(A).

On comparison of noise levels monitored in October 2002 with the ambient noise standards, the values were found exceeding the prescribed standard of 55 dB(A) at all locations except at Hamta village. Similarly, night time noise levels were found exceeding the prescribed standard of 45 dB(A). The results monitored in May 2007 are relatively higher than those monitored in October 2002. The reasons for high baseline could be associated with commercial activities in villages and noise generated by running water streams as well ongoing construction activities for the Project area.

4.4.9 Water Environment

Water Resources

Allain stream drains a catchment area of 128.9 km^2, out of which 51.5 km^2 is under permanent snow cover. Similarly Duhangan stream drains a catchment area of 66.2

km², out of which 36.1 km² is under snow cover. The inflow in both streams comes from snow melt and rainfall. About 3.028 and 1.301 m^3/sec water is available at Allain barrage and Duhangan weir site, respectively, at 90% dependability. The combined 90% dependable flow is 4.467 m^3/sec. The minimum flows in a year as observed during January and February were 1.54 m^3/sec and 1.08 m^3/sec for Allain and Duhangan, respectively. The combined minimum flow will be about 2.73 m^3/sec. *Table 4.6* summarises average, 50% and 90% dependable year flow pattern for Allain and Duhangan streams.

Field observations on flow of surface water were done at 12 different locations on Beas River and other streams. The locations of various sampling points (as given in *Table 4.18*) are shown in *Figure 4.9*.

Table 4.18 Discharge and Velocities Measured for Beas River & Other Streams

Code	Location	Discharge (Cumecs)	Velocity (m/sec)
R-1	U/s Confluence of River Allain to River Beas, River Beas	31.26	1.40
R-2	D/s Confluence of River Allain to River Beas, River Beas	83.25	1.60
R-3	Confluence of River Dhuhangan to River Beas, River Beas	53.09	1.52
R-4	D/s Confluence of River Dhuhangan to River Beas, River Beas	63.43	1.22
SRF-1	U/s Bridge, Pahali Nala at Prini	0.11	0.11
SRF-2	U/s Bridge, Dhuhangan River, at Jagat Sukh	0.25	0.11
SRF-3	U/s Bridge, Allain River, at Prini	0.04	0.11
SRF-4	Hamta Nala, Village Hamta	0.01	0.15
SRF-5	In take point on River Allain at Bhujdhar	1.84	0.61
SRF-6	Marasu Nala, Proposed Plant Area, Marasu Dhar	0.07	0.30
SRF-7	D/s In take point on Dhuhangan River	0.13	0.11
SRF-8	U/s In take Point on Dhuhangan River	0.13	0.11

Source: As monitored by HPPCB during the month of October 2002.

Field observations were carried out, also for discharge of water from various natural water springs. These observations were carried out during the period October 2002. The results of these field observations are tabulated below.

Table 4.19 Field observations (discharge) for various Natural Water Springs

Code	Location of natural spring	Discharge (litres/min)
GW-1	Near Residence of Sh. Girdhari Lal Jagatsukh	Bawari, 0.01
GW-2	Near Residence of Sh. Lot Ram, Jagatsukh	Bawari, 0.005
GW-3	Near Residence of Sh. Balak Ram Dogra, Jagatsukh	0.033
GW-4	Near Residence of Sh. Karma, Jagatsukh	1.00
GW-5	IPH, WSS, Jagatsukh	0.50
GW-6	Hot Water Spring Village Cloth, U/s Bridge	Spring Source, 0.01
GW-7	IPH, WSS, Karadu Pather, Prini	1.25
GW-8	IPH, WSS, Village Shuru	2.50

Source: As monitored by HPPCB during the month of October 2002.

Groundwater Quality

The study area has a number of natural springs. Representative samples from eight such springs were collected by HPPCB in October 2002 and analysed for their quality. The parameters for which these samples were analysed constitute almost all the important physico-chemical attributes as well as microbiological parameters. The results of the analysis carried out for the sampling undertaken are presented in ***Table 4.19***. The spring water quality monitored showed pH ranging from 7.01 to 8.84 while temperature ranged from 3.0 to 35.0ºC (the maximum temperature recorded in sample from a hot water spring). BOD ranged from 0.3 to 0.9mg/l. The critical parameters observed was presence of Total Coliform, making the water unsuitable for drinking without prior treatment.

Table 4.20 Water Quality of Natural Springs in the Area

Sample Code *	pH	Temp (°C)	Cond µmho/cm	BOD	NO_2	NO_3	TC MPN/ 100ml	FC MPN/ 100ml	Turb NTU	Alk.	CI	COD	T.K.N	NH_3	$CaCo_3$	Ca as CaCo3	SO_4	Na
GW-1	7.35	15.0	553.0	0.6	0.0001	9.33	>2400	34	-ND-	184.0	28.54	0.9	0.5	0.2	122.0	48.90	8.02	7.0
GW-2	7.01	13.0	395.0	0.8	ND	6.19	350	34	-ND-	79.0	22.83	9.0	0.29	0.13	72.0	28.86	0.86	5.0
GW-3	7.71	8.0	192.0	0.8	ND	0.28	>2400	>2400	-ND-	63.0	13.04	30.0	0.29	0.08	38.0	15.23	ND	2.0
GW-4	9.07	3.0	60.0	0.5	ND	0.31	2400	2400	-ND-	34.0	9.78	17.0	ND	ND	24.0	9.62	ND	ND
GW-5	7.84	3.5	97.0	0.5	ND	0.48	<0	<0	-ND-	40.0	8.97	22.0	ND	ND	28.0	11.22	1.30	1.0
GW-6	6.80	35.0	1470	0.2	ND	ND	<0	<0	3.8	Int.	Int.	26.0	0.88	0.34	90.0	36.07	13.44	55.0
GW-7	8.84	4.5	112.0	0.9	ND	ND	<0	<0	-ND-	55.0	8.15	26.0	0.2	0.052	40.0	16.03	1.08	1.0
GW-8	7.95	3.0	689.0	0.9	ND	0.27	2	<0	-ND-	49.0	17.94	35.0	0.59	0.21	22.0	88.82	0.21	1.0

*****Note: pH and Temperature were measured on the spot, rest were analysed at the HPEP SEB laboratory, Shimla for samples collected during October 2002; All values are in mg/l unless otherwise specified; GW1: Near Residence of Sh. Girdhari Lal Jagatsukh, GW2 Near Residence of Sh. Lot Ram, Jagatsukh; GW3 Near Residence of Sh. Balak Ram Dogra, Jagatsukh; GW4: Near Residence of Sh. Karma, Jagatsukh; GW5: IPH, WSS, Jagatsukh; GW 6: Hot Water Spring Village Cloth, U/s Bridge; GW7: IPH, WSS, Karadu Pather, Prini; GW8: IPH, WSS, Village Shuru

In cont..

Water Sampling Location*	TDS	TSS	TFS	T.Phos	B	Mg	F	T. Hard.	Cd	Cu	Pb	T.Cr.	Ni	Zn	Hg	T.Fe	CN	K
GW-1	326.5	4.50	331.0	3.97	0.13	1.90	0.25	130.0	-ND-	-ND-	0.04	-ND-	0.01	0.03	-ND-	1.70	-ND-	92.0
GW-2	249.0	3.50	201.0	0.96	0.11	3.41	0.21	86.0	-ND-	-ND-	0.01	-ND-	-ND-	0.02	-ND-	0.39	-ND-	47.0
GW-3	161.0	1.50	106.0	0.03	0.062	2.44	0.115	48.0	0.01	0.59	-ND-	-ND-	-ND-	0.02	-ND-	0.46	-ND-	6.0
GW-4	33.5	2.0	100.0	0.003	-ND-	0.97	0.062	28.0	-ND-	2.97	0.02	0.01	0.03	0.07	-ND-	0.9	-ND-	3.0
GW-5	50.5	1.50	64.0	-ND-	-ND-	3.41	0.071	42.0	0.03	0.59	0.01	0.01	-ND-	0.04	-ND-	0.07	-ND-	4.0
GW-6	1081.0	6.0	995.0	-ND-	0.15	3.41	0.262	104.0	-ND-	0.01	-ND-	-ND-	0.01	0.03	-ND-	1.33	-ND-	47.0
GW-7	85.5	1.0	88.0	0.018	0.004	0.49	0.082	42.0	0.01	-ND-	0.01	-ND-	0.06	0.03	-ND-	1.0	-ND-	5.0
GW-8	478.5	3.0	11.0	-ND-	0.03	1.46	0.182	28.0	0.01	-ND-	-ND-	0.01	0.01	0.02	-ND-	0.39	-ND-	6.0

*Note: pH and Temperature were measured on the spot, rest were analysed at the HPEPSEB laboratory, Shimla; All values are in mg/l unless otherwise specified; GW1: Near Residence of Sh. Girdhari Lal Jagatsukh, GW2 Near Residence of Sh. Lot Ram, Jagatsukh; GW3 Near Residence of Sh. Balak Ram Dogra, Jagatsukh; GW4: Near Residence of Sh. Karma, Jagatsukh; GW5: IPH, WSS, Jagatsukh; GW 6: Hot Water Spring Village Clath, U/s Bridge; GW7: IPH, WSS, Karadu Pather, Prini; GW8: IPH, WSS, Village Shuru

4.4.10 *Surface Water Quality*

Field observations were made for important physical parameters at 12 different points on Beas river and other streams. These observations were carried out during the period October 2002. The results of these field observations are tabulated in *Table 4.21*.

Table 4.21 Field Observations (pH, Temp. & DO) of Surface, River water

Code	Location	pH	DO mg/l	Temp. °C
R-1	U/s Confluence of River Allain to River Beas, River Beas	7.43	9.5	2.80
R-2	D/s Confluence of River Allain to River Beas, River Beas	7.79	9.50	2.80
R-3	Confluence of River Dhuhangan to River Beas, River Beas	8.81	9.70	4.00
R-4	D/s Confluence of River Dhuhangan to River Beas, River Beas	7.10	9.90	4.50
SRF-1	U/s Bridge, Pahali Nala at Prini	9.03	8.20	8.00
SRF-2	U/s Bridge, Dhuhangan River, at Jagat Sukh	7.10	8.30	8.00
SRF-3	U/s Bridge, Allain River, at Prini	8.89	7.80	8.00
SRF-4	Hamta Nala, Vill. Hamta	7.41	8.50	5.00
SRF-5	In take point on River Allain at Bhujdhar	7.55	9.20	-2.00
SRF-6	Marasu Nala, Proposed Plant Area, Marasu Dhar	9.15	8.90	-1.10
SRF-7	D/s In take point on Dhuhangan River	9.33	9.50	-2.00
SRF-8	U/s In take Point on Dhuhangan River	7.65	9.60	-2.50

Source: As monitored by HPPCB during the month of October 2002.

The study area has a number of streams besides the Beas river, Allain and Duhangan streams. Representative samples from the Beas river and the associated streams were collected by HPPCB in October 2002 from various points, considering their significance during Project commissioning and operation. The samples were then analysed for their quality. The parameters for which these samples are analysed constitute almost all the important physico-chemical attributes as well as microbiological parameters. Results of the analysis carried out for the sampling undertaken is presented in *Table 4.22*.

Table 4.22 Water quality at various points of Beas River and the associated streams

Code	**Cond µmho /cm**	**BOD mg/1**	**NO_2 mg/l**	**NO_3 mg/l**	**TC MPN/ 100ml**	**FC MPN/ 100ml**	**Turb NTU**	**Alk.**	**CI**	**COD**	**T.K.N**	**$CaCO_3$**	**Ca as $CaCO_3$**	**SO_4**	**Na**	TDS	TSS	TFS	T. Phos	B	Mg	F	T. Hard.	Cd
R-1	116	1.5	-ND-	0.38	4.0	4.0	-ND-	39.0	8.97	31.0	-ND-	40.0	16.03	6.93	-ND-	96.0	11.0	28.0	ND	ND	1.46	0.05	46.0	0.01
R-2	99.0	0.8	-ND-	0.41	9.0	6.0	-ND-	34.0	13.04	9.0	0.59	34.0	13.63	4.98	-ND-	71.0	10.0	57.0	ND	0.010	0.97	0.076	38.0	0.01
R-3	115	1.0	-ND-	0.47	6.0	6.0	-ND-	45.0	12.23	4.0	0.29	42.0	16.83	3.68	1.0	93.5	5.5	90.0	ND	0.01	0.49	0.066	44.0	-ND-
R-4	115.0	1.5	-ND-	0.15	170.0	33.0	-ND-	45.0	16.3	35.0	0.29	32.0	12.83	28.39	3.0	121.0	5.5	34.0	ND	0.009	0.97	0.068	36.0	0.01

*****Note: Analysed at the HPPCB laboratory, Shimla; All values are in mg/l unless otherwise specified; For Codes of Sampling Locations refer to the previous *Table 4.20*.

Water Sampling Location	Cu	Pb	T.Cr.	Ni	Zn	Hg	T.Fe	CN	K
R-1	0.59	ND	0.01	0.01	0.02	ND	0.09	ND	4.0
R-2	ND	0.01	ND	0.01	0.03	ND	0.58	ND	4.0
R-3	ND	0.01	ND	ND	0.01	ND	0.35	ND	4.0
R-4	ND	-ND-	0.01	ND	0.03	ND	0.35	ND	5.0

Note :Analysed at the HPEPSEB laboratory, Shimla; All values are in mg/l unless otherwise specified; For Codes of Samplingn Locations refer to the previous *Table 4.20*.

Water Sampling Location	Cond Umho/c m	BOD mg/1	NO2 mg/a	NO3 mg/a	TC MPN/ 100ml	FC MPN/ 100ml	Turb NTU	Alk. mg/1	CI mg/1	COD mg/1	T.K.N mg/1	BH3 mg/1	CaCo 3 mg/1	Ca as CaCo3 mg/1	SO4 mg/1	Na mg/1
SRF-1	58.0	0.7	-ND-	0.10	>2400	>2400	-ND-	31.0	10.60	2.0	-ND-	-ND-	16.0	46.41	-ND-	-ND-
SRF-2	57.0	3.2	-ND-	-ND-	350	350	-ND-	23.0	10.60	8.0	-ND-	-ND-	16.0	6.41	-ND-	-ND-
SRF-3	66.0	1.5	-ND-	0.10	7	7	-ND-	35.0	8.15	25.0	-ND-	-ND-	24.0	9.62	-ND-	-ND-
SRF-4	36.0	1.6	-ND-	0.28	17	17	1.0	21.0	11.41	24.0	-ND-	-ND-	10.0	4.0	-ND-	-ND-
SRF-5	45.0	0.8	-ND-	-ND-	9	2	-ND-	20.0	8.97	13.0	-ND-	-ND-	16.0	6.41	-ND-	-ND-
SRF-6	48.0	1.3	-ND-	0.17	4	2	-ND-	32.0	11.41	21.0	-ND-	-ND-	20.0	8.02	-ND-	-ND-
SRF-7	63.0	0.6	-ND-	0.14	17	9	-ND-	35.0	11.41	33.0	-ND-	-ND-	28.0	11.22	-ND-	-ND-
SRF-8	99	0.3	-ND-	0.44	2	<0	-ND-	20.0	9.79	30.0	-ND-	-ND-	14.0	5.6	-ND-	-ND-

Note: Analysed at the HPEPSEB laboratory, Shimla; All values are in mg/l unless otherwise specified; For sampling location codes refer to the previous *Table 4.20*.

Water Sampling Location	TDS	TSS	TFS	T. Phos	B	Mg	F	T. Hard.	Cd	Cu	Pb	T.Cr.	Ni	Zn	Hg	T.Fe	CN	K
SRF-1	48.5	1.50	62.0	-ND-	-ND-	2.44	0.062	26.0	-ND-	0.47	0.02	0.01	0.03	0.02	-ND-	0.29	-ND-	12.0
SRF-2	35.5	1.5	40.0	-ND-	-ND-	1.95	0.059	24.0	0.01	-ND-	-ND-	-ND-	0.04	0.01	-ND-	0.36	-ND-	2.0
SRF-3	48.0	6.0	36.0	-ND-	-ND-	0.49	0.06	26.0	0.02	0.59	-ND-	0.01	0.04	0.02	-ND-	0.36	-ND-	2.0
SRF-4	31.0	16.0	47.0	-ND-	-ND-	1.46	0.055	16.0	-ND-	-ND-	-ND-	-ND-	0.01	0.03	-ND-	0.53	-ND-	2.0
SRF-5	37.5	6.5	21.0	-ND-	-ND-	0.49	0.042	18.0	0.01	0.59	0.06	-ND-	0.01	0.02	-ND-	0.44	-ND-	2.0
SRF-6	33.5	4.5	16.0	-ND-	-ND-	0.97	0.05	24.0	-ND-	-ND-	0.07	-ND-	0.02	0.01	-ND-	0.07	-ND-	2.0
SRF-7	48.0	6.5	28.0	-ND-	-ND-	1.46	0.05	34.0	-ND-	0.26	0.20	0.01	0.09	0.05	-ND-	0.34	-ND-	1.0
SRF-8	40.0	6.5	25.0	-ND-	-ND-	0.97	0.053	18.0	-ND-	1.18	0.09	-ND-	0.09	0.06	-ND-	0.34	-ND-	1.0

Note: Analysed at the HPPCB laboratory, Shimla; All values are in mg/l unless otherwise specified; For sampling location codes - refer to the previous *Table 4.20*.

Detailed physico-chemical analyses were carried out for water in Allain and Duhangan streams. The results are shown in *Table 4.23*.

Table 4.23 *Results of Physico-Chemical Analysis of Allain & Duhangan Surfacewater Samples*

S.N.	Parameter	Unit	Desirable Standards	Results of samples	
				Allain	Duhangan
1	pH		6.5 – 8.5	7.10	7.02
2	Colour	Hazen Unit	Max 5	<5	<5
3	Suspended Solids	mg/l	<1	30	34
4	Total Hardness as $CaCO_3$	mg/l	300	9.97	10.05
5	Ca	mg/l	75	2.38	2.66
6	Mg	mg/l	30	0.98	0.83
7	CI	mg/l	250	5.87	6.85
8	SO_4	mg/l	200	5.66	5.19
9	Total dissolved solids	mg/l	500	110	50
10	F	mg/l	1	0.2	0.2
11	NO_3	mg/l	45	9.15	9.00
12	Cu	mg/l	0.05	<0.025	<0.025
13	Fe	mg/l	0.3	<0.05	<0.05
14	Mn	mg/l	0.1	0.03	0.04
15	Hg	mg/l	0.001	0.058	0.052
16	Cd	mg/l	0.01	0.026	0.0832
17	Pb	mg/l	0.05	<0.06	<0.06
18	Zn	mg/l	5	0.015	0.011
19	As	mg/l	0.01	<0.01	<0.01
20	Cr	mg/l	0.05	<0.025	<0.025
21	Se	mg/l	0.01	<0.01	<0.01
22	CN	mg/l	0.05	0.10	0.13
23	PO4	mg/l	-	0.04	0.11
24	Ag	mg/l	-	0.096	0.064
25	Na	mg/l	-	1.4	0.6
26	K	mg/l	-	0.6	0.4

Source: As monitored by HPPCB during the month of October 2002.

The results on the surface water quality show pH ranging from 7.1 to 9.33 showing alkaline characteristics due to limestone rocky strata. Temperature of the surface water was observed in the range of –2.5 to 8.0ºC showing it to be a mix of snowmelts. Dissolved oxygen ranged from 7.8 to 9.7 mg/l showing it being rich.

On the basis of Primary Water Quality Criteria, it can be concluded that quality of Beas river falls under 'A' category of water with respect to pH, DO and BOD. A critical parameter observed is presence of Total Coliform according to which, the category of river comes down to 'C' in some stretches, which are close to towns.

4.4.11 *Sediment Quality*

Sediment samples were collected from various locations of Allain and Duhangan streams. Sampling was carried out at six different locations by HPPCB during Sep to November 2002. During sampling, the temperature of water stream was approximately 2 to 3°C and the surroundings were covered by snow. Sampling was carried out over an area of 189 cm^2 and at a depth of 8 cm. The samples were analysed for sulphur content. Further biological examination was also carried out for diversity indices of benthos.

Table 4.24 Physical, Mineral Phase Analysis of Sediment from Duhangan River

Nomenclature	**Clay**	**Silt**			**Sand**	
Sub-divisions	-	Fine	Medium	Coarse	Fine	Coarse
Size Scale (µ)	0.2-2 µm	2 –5 µm	5 -20 µm	20-50µm	50µ-0.2mm	0.2mm-2mm
Wt (in gm) in 100 ltrs						
Sampled on 17/8/2002	0.22550	7.95957	5.64832	0.47179	0.24683	0.12133
7/9/2002	0.54230	2.59821	0.20821	0.01154	0.002	-
22/9/2002	0.42553	3.05179	0.24438	0.06109	-	-
14/11/2002	0.58116	2.95366	0.10017	0.02650	-	-
Maximum	0.58116	7.95957	5.64832	0.47179	0.24683	0.12133
Average	0.3549	3.31265	1.24022	0.11418	0.04977	0.02427

Source: ADHPL

The average clay and silt in the Duhangan surface water stream is about 50.22 mg/l with a maximum of 1.2 mg/l of coarse sand to be removed. The majority of the content is in the form of fine silt followed by medium and coarse silt. The mineral phases present in various size fractions in the Duhangan stream is shown in *Table 4.25* below.

Table 4.25 Mineral Phases Present in Various Size Fractions of Sediment from Duhangan Stream

Mineral phase	**Chemical composition**	**Shape**	**Hardness**		**Sp.Gr**	**Date of Sampling**	**No. of particles in 10 lit**
			Mohs'	Absolute			
(Coarse Sand 0.2 to 2mm)							
			6.0-6.5	64-75	2.6-2.62	17/08/2002	20
						07/09/2002	-
						22/09/2002	0
						14/11/2002	-
Biotite	$K(Mg,Fe)_3(AlSi_3O_{10})(OH)$	Needle shaped flakes	2.5-3.0	12-16	2.8-3.2	17/08/2002	21
						07/09/2002	60
						22/09/2002	50
						14/11/2002	0
Hornblende	$(Ca,Mg,Fe,Na,Al)^{7}$-$_{8}(Al,Si)8°_{22}(OH)_2$	Prismatic Rounded Corners	5.0-6.0	31-64	3.0-3.47	17/08/2002	10
						07/09/2002	30
						22/09/2002	55
						14/11/2002	0
Magnetite	Fe_3O_4	Square or rounded	5.5-6.5	37-75	5.18	17/08/2002	24
						07/09/2002	-
						22/09/2002	65
						14/11/2002	0
Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$	Sheet like	2.5-3.0	12-16	2.76-2.88	17/08/2002	105
						07/09/2002	90
						22/09/2002	350
						14/11/2002	0
Orthoclase	$KAlSi_3O_8$	Rectangular, sub-rounded	6.0	64	2.57	17/08/2002	35
						07/09/2002	60
						22/09/2002	25

Mineral phase	Chemical composition	Shape	Hardness		Sp.Gr	Date of Sampling	No. of particles in 10 lit
						14/11/2002	0
Quartz	SiO_2	Angular	7.0	112	2.65	17/08/2002	210
						07/09/2002	60
						22/09/2002	60
						14/11/2002	0
(Fine Sand 50 µm to 0.2mm)							
Albite	$NaAlSi_3O_8$	Tabular with rounded corners	6.0-6.5	64-75	2.6-2.62	17/08/2002	42
						07/09/2002	-
						22/09/2002	-
						14/11/2002	-
Biotite	$K(Mg,Fe)_3(AlSi3O_{10})(OH)$	Needle shaped flakes	2.5-3.0	12-16	2.8-3.2	17/08/2002	252
						07/09/2002	-
						22/09/2002	-
						14/11/2002	-
Hornblende	$(Ca,Mg,Fe,Na,Al)^{7-}8(Al,Si)8O_{22}(OH)_2$	Prismatic Rounded Corners	5.0-6.0	31-64	3.0-3.47	17/08/2002	84
						07/09/2002	-
						22/09/2002	-
						14/11/2002	-
Magnetite	Fe_3O_4	Square or rounded	5.5-6.5	37-75	5.18	17/08/2002	55
						07/09/2002	-
						22/09/2002	-
						14/11/2002	-
Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$	Sheet like	2.5-3.0	12-16	2.76-2.88	17/08/2002	952
						07/09/2002	-
						22/09/2002	-
						14/11/2002	-
Orthoclase	$KalSi_3O_8$	Rectangular, sub-rounded	6.0	64	2.57	17/08/2002	94
						07/09/2002	-
						22/09/2002	-
						14/11/2002	-
Quartz	SiO_2	Angular	7.0	112	2.65	17/08/2002	210
						07/09/2002	-
						22/09/2002	-
						14/11/2002	-
Coarse Silt (20 – 50µm)							
Kaolinite	$Al_4Si_4O_{10}(OH)_8$	Rounded to sub-rounded	2-2.5	10-12	2.6	17/08/2002	11537
						07/09/2002	1936
Montmorillonite	$Al_4Si_4O_{10}(OH)_8$	Rounded to sub-rounded	1-2	5-10	2-3	22/09/2002	750
						14/11/2002	1800
Medium Silt (5– 20µm)							
Kaolinite	$Al_4Si_4O_{10}(OH)_8$	Rounded to sub-rounded	2-2.5	10-12	2.6	17/08/2002	746251
						07/09/2002	19721
Montmorillonite	$Al_4Si_4O_{10}(OH)_8$	Rounded to sub-rounded	1-2	5-10	2-3	22/09/2002	9329
						14/11/2002	5000

Mineral phase	**Chemical composition**	**Shape**	**Hardness**		**Sp.Gr**	**Date of Sampling**	**No. of particles in 10 lit**
Fine Silt (2– 5µm)							
Kaolinite	$Al_4Si_4O_{10}(OH)_8$	Rounded to sub-rounded	2-2.5	10-12	2.6	17/08/2002	1056714
						07/09/2002	819664
Montmorillonite	$Al_4Si_4O_{10}(OH)_8$	Rounded to sub-rounded	1-2	5-10	2-3	22/09/2002	218410
						14/11/2002	639914
Clay(<2µm)							
Kaolinite	$Al_4Si_4O_{10}(OH)_8$	Rounded to sub-rounded	2-2.5	10-12	2.6	17/08/2002	28001
						07/09/2002	289130
Montmorillonite	$Al_4Si_4O_{10}(OH)_8$	Rounded to sub-rounded	1-2	5-10	2-3	22/09/2002	152848
						14/11/2002	113307

Source: ADHPL

Table 4.26 Physical, Mineral Phase Analysis of Sediment from Allain River

Nomenclature	**Clay**	**Silt**			**Sand**	
Sub-divisions	-	Fine	Medium	Coarse	Fine	Coarse
Size Scale (µ)	0.2-2 µm	2 –5 µm	5 -20 µm	20 -50µm	50µ-0.2mm	0.2mm-2mm
Wt (in gm) in 100 ltrs						
Sampled on 17/8/2002	0.24249	7.79749	4.07600	1.40050	0.08600	0.14375
7/9/2002	0.7876	7.49418	10.53108	7.68675	0.37189	0.0105
22/9/2002	0.25	2.37276	0.21517	0.04687	-	-
14/11/2002	0.53170	2.16347	0.52347	0.21939	-	-
Average	0.36236	3.96558	3.06914	1.8707	0.09158	0.03085
Maximum	0.7876	7.79749	10.53108	7.68675	0.37189	0.14375

Source: ADHPL

The average clay and silt in the Allain surface water stream is about 92.7 mg/l with a maximum of 1.4 mg/l of coarse sand to be removed. The majority of the content is in the form of fine silt followed by medium and coarse silt. The mineral phases present in various size fractions in the Duhangan stream is shown in the *Table 4.27*.

Table 4.27 Mineral Phases Present in Various Size Fractions of Sediment from Allain Stream

Mineral phase	**Chemical composition**	**Shape**	**Hardness**		**Sp.Gr**	**Date of Sampling**	**No. of particles in 10 lit**
			Mohs'	Absolute			
(Coarse Sand 0.2 to 2mm)							
Albite	$NaAlSi_3O_8$	Tabular with rounded corners	6.0-6.5	64-75	2.6-2.62	17/08/2002	32
						07/09/2002	8
						22/09/2002	-
						14/11/2002	-
Biotite	$K(Mg,Fe)_3(AlSi_3O_{10})(OH)$	Needle shaped flakes	2.5-3.0	12-16	2.8-3.2	17/08/2002	72
						07/09/2002	16

Mineral phase	Chemical composition	Shape	Hardness		Sp.Gr	Date of Sampling	No. of particles in 10 lit
						22/09/2002	-
						14/11/2002	-
Hornblende	$(Ca,Mg,Fe,Na,Al)^{7-}8(Al,Si)_8O_{22}(OH)_2$	Prismatic Rounded Corners	5.0-6.0	31-64	3.0-3.47	17/08/2002	75
						07/09/2002	12
						22/09/2002	-
						14/11/2002	-
Magnetite	Fe_3O_4	Square or rounded	5.5-6.5	37-75	5.18	17/08/2002	16
						07/09/2002	24
						22/09/2002	-
						14/11/2002	-
Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$	Sheet like	2.5-3.0	12-16	2.76-2.88	17/08/2002	288
						07/09/2002	102
						22/09/2002	-
						14/11/2002	-
Orthoclase	$KalSi_3O_8$	Rectangular, sub-rounded	6.0	64	2.57	17/08/2002	35
						07/09/2002	18
						22/09/2002	-
						14/11/2002	-
Quartz	SiO_2	Angular	7.0	112	2.65	17/08/2002	328
						07/09/2002	30
						22/09/2002	-
						14/11/2002	-
(Fine Sand 50 µm to 0.2mm)							
Albite	$NaAlSi_3O_8$	Tabular with rounded corners	6.0-6.5	64-75	2.6-2.62	17/08/2002	47
						07/09/2002	18
						22/09/2002	-
						14/11/2002	-
Biotite	$K(Mg,Fe)_3(AlSi_3O_{10})$ (OH)	Needle shaped flakes	2.5-3.0	12-16	2.8-3.2	17/08/2002	158
						07/09/2002	72
						22/09/2002	-
						14/11/2002	-
Hornblende	$(Ca,Mg,Fe,Na,Al)^{7-}8(Al,Si)_8O_{22}(OH)_2$	Prismatic Rounded Corners	5.0-6.0	31-64	3.0-3.47	17/08/2002	79
						07/09/2002	24
						22/09/2002	-
						14/11/2002	-
Magnetite	Fe_3O_4	Square or rounded	5.5-6.5	37-75	5.18	17/08/2002	32
						07/09/2002	60
						22/09/2002	-
						14/11/2002	-
Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$	Sheetlike	2.5-3.0	12-16	2.76-2.88	17/08/2002	347
						07/09/2002	60
						22/09/2002	-
						14/11/2002	-
Orthoclase	KalSi3O8	Rectangular, subrounded	6.0	64	2.57	17/08/2002	79
						07/09/2002	30
						22/09/2002	-
						14/11/2002	-
Quartz	SiO_2	Angular	7.0	112	2.65	17/08/2002	95

Mineral phase	Chemical composition	Shape	Hardness		Sp.Gr	Date of Sampling	No. of particles in 10 lit
						07/09/2002	90
						22/09/2002	-
						14/11/2002	-
Coarse Silt (20 – 50µm)							
Kaolinite	$Al_4Si_4O_{10}(OH)_8$	Rounded to subrounded	2-2.5	10-12	2.6	17/08/2002	14359
						07/09/2002	54905
Montmorillo nite	$Al_4Si_4O_{10}(OH)_8$	Rounded to subrounded	1-2	5-10	2-3	22/09/2002	11500
						14/11/2002	4168
Medium Silt (5– 20µm)							
Kaolinite	$Al_4Si_4O_{10}(OH)_8$	Rounded to subrounded	2-2.5	10-12	2.6	17/08/2002	49088
						07/09/2002	205622
Montmorillo nite	$Al_4Si_4O_{10}(OH)_8$	Rounded to subrounded	1-2	5-10	2-3	22/09/2002	16941
						14/11/2002	43018
Kaolinite	$Al_4Si_4O_{10}(OH)_8$	Rounded to subrounded	2-2.5	10-12	2.6	17/08/2002	1774435
						07/09/2002	848898
Montmorillo nite	$Al_4Si_4O_{10}(OH)_8$	Rounded to subrounded	1-2	5-10	2-3	22/09/2002	524424
						14/11/2002	599082
Kaolinite	$Al_4Si_4O_{10}(OH)_8$	Rounded to subrounded	2-2.5	10-12	2.6	17/08/2002	89576
						07/09/2002	41810
Montmorillo nite	$Al_4Si_4O_{10}(OH)_8$	Rounded to subrounded	1-2	5-10	2-3	22/09/2002	98048
						14/11/2002	65522

Source: ADHPL

Table 4.28 Results of Sulphur content in the Sediment samples

S.N.	Date of sampling	Sampling location	Sulphur, as SO_4 (% by mass)
1	02/02/2003	Duhangan near Chorpani, 3 km u/s of Jagatsukh bridge.	<0.005
2	02/02/2003	Duhangan near Jagatsukh bridge	<0.005
3	02/02/2003	Duhangan – Beas confluence	<0.005
4	01/02/2003	Allain, u/s of powerhouse, near gauge.	<0.005
5	02/02/2003	Allain, near Hotel Imperial	<0.005
6	02/02/2003	Allain-Beas confluence	<0.005

Source: As per analysis conducted by Shriram Institute in February 2002

The sediments exhibit a succession of increasing granulometry including clay, sand-silty-clay, clayey sand and sand. The sediment fraction analysis show that the sub-status of the sediment was silty-clay at five locations; silty-clay-loam at four locations, clayey-silt at three locations and sandy-silt at two locations. The corresponding analysis during post monsoon season exhibits the sub-status of the sediment being silty-clay at nine locations, clayey-silt at three locations and sandy-silt at two locations.

4.4.12 Soil Quality

Ten surface soil samples were collected by Shriram Institute in February 2003 to assess soil quality of the catchment area. The pH of the soil evaluates acidic or basic character of the soil. The electrical conductivity evaluates the salt content of the grounds and gives an indication of the type of crop response and tolerance of various vegetables. The contents of cations like calcium, sodium and magnesium, which are measured in the soil extracts are related through the

SAR (Sodium Absorption Ratio). The SAR mainly evaluates the effect caused by the sodium content to the characteristics of the soils, such as infiltration, permeability and compaction degree, when it is combined with the presence of Calcium and Magnesium. The Sodium has the effect of spreading particles of the soil favouring the formation of crusts. Besides these parameters, the following parameters were analysed in the sampled soil media:

- anions (Bi-carbonate, chloride);
- Nutrients (major-organic carbon and minor-nitrogen, phosphorus);
- Metals (Ni, Zn, Cu); and
- Percent ESP and Moisture content

The soil sampling locations selected for studying the characteristics of soil in the area and the analysis results are described in the ***Table 4.28***.

The results of the soil quality of the area collected from 10 locations showed varying pH i.e. slightly acidic to slightly alkaline (5.39 to 7.91). The available nitrogen levels were in the range of 0.130 to 0.693 mg/100g. The potassium and total phosphorus levels were varying in the range of 5.75 to 47.85 mg/100g and 5.9 to 13.69 mg/100g. The levels of organic matter in the soils were reported in the range of 2.26 to 11.14 mg/100g. Nickel in soil varied in the range of 35 to 1350 mg/kg. The high Nickel content of 1350 mg/kg was found in soil sample from Duhangan Weir Site, which appears to be of geologic origin. Zinc in soil varied in the range of 80 to 116 mg/kg while Cu in soil varied from 28 to 60 mg/kg.

Table 4.29 Soil sampling and Analysis Results

Sample code	pH	Electrical Conductivity	Ca	Mg	Na	K	HCO_3	Cl	N-available	T. Phosphorus	O-Phosphorus	Org. Carbon	ESP	Ni	Zn	Cu
	-	µmhos/cm	mg/100g										%	mg/100g		
SL-1	7.72	94.54	206.01	9.23	5.15	18.85	1.46	7.0	0.263	6.37	1.89	5.76	0.00515	40	114	73
SL-2	6.42	61.92	122.25	4.88	9.35	5.75	0.12	5.0	0.182	11.96	2.70	2.26	0.00935	45	82	44
SL-3	5.68	52.11	218.44	19.52	3.25	11.8	0.12	5.0	0.131	13.69	3.10	5.27	0.00325	50	80	32
SL-4	6.19	57.12	192.39	28.06	2.55	41.3	0.12	5.0	0.163	13.20	3.06	4.07	0.00255	66	81	33
SL-5	5.39	72.69	192.39	28.06	2.85	9.25	0.12	7.0	0.462	11.60	2.80	4.37	0.00285	67	84	28
SL-6	6.02	96.57	360.5	28.06	3.95	26.05	0.12	7.0	0.372	27.82	8.34	4.37	0.00395	55	131	40
SL-7	5.61	159.8	408.82	48.8	2.2	40.65	0.12	5.0	0.693	5.90	0.98	9.034	0.0022	35	86	60
SL-8	6.24	180.1	881.76	84.18	7.1	47.85	0.12	6.0	0.431	2.23	0.56	11.14	0.0071	1350	82	41
SL-9	7.91	91.31	332.65	29.28	5.55	15.45	0.24	7.0	0.130	11.05	2.80	2.26	0.00555	35	93	29
SL-10	5.92	133.0	246.49	24.4	5.1	37.45	0.12	6.0	0.179	9.66	1.85	4.52	0.0051	36	116	32

SL-1 Village Jagat Sukh, near GW-1 Location; SL-2 Village Jagatsukh; SL-3 Village Hamta near Surge shaft Site; SL-4 About 2 km from Village Sethan near Plant Site; SL-5 Bhuj Dhar near intake point river Allain; SL-6 Village Sethan near Residence of Sh. Karma; SL-7 near Dump Site on Dhuhangan River; SL-8 Beraj Site, on Dhuhangan River; SL-9 Near Switch Yard Site, Village Prini; SL-10 Village Prini

Source: As per baseline data survey of February 2003 by Shriram Institute as engaged by ERM

4.5 *TERRESTRIAL ECOLOGY OF THE PROJECT CATCHMENT AREA*

Further to an addendum to draft ESIA study, ADHPL made a commitment for conducting specialised studies for detailed ecological assessment by conducting following specialised studies:

1) Wildlife and Floral Studies in Allain - Duhangan Catchments: A study on wildlife surveys in the catchments of Allain and Duhangan streams (June 2006) by *World Pheasant Association, New Delhi*. The wildlife and florisitic surveys were conducted to represent one year baseline conditions.

2) Study on Fish Fauna and Aquatic/Riverine Ecology: A study on fish fauna and aquatic/riverine ecology of Allain and Duhangan river basins has been carried out by the *Foundation for Ecological Security* (May 2006) to determine the baseline conditions of fish populations and identify potential impacts and appropriate mitigation measures. The study was conducted to represent one year baseline conditions.

This section has been developed based on outputs of the above mentioned two studies.

4.5.1 *Introduction*

The Project area falls in Biotic Province 2A (Northwest Himalaya) of bio-geographic zone of Himalaya (Rodgers and Panwar, 1988). The area exhibits dense and open forests and low forests cover at some places coupled with infrastructural development. Kullu district accounts for a geographical area of 5,503 km^2, out of this 1,631 km^2 and 343 km^2 are dense and open forest cover, respectively. Hence, Kullu district has 35.87% forest cover. Kullu district is one of the forests rich areas in Himachal Pradesh (refer to *Table 4.30*).

Table 4.30 Forest Area of Kullu District, Himachal Pradesh

Area	Geo-graphical Area	Legally classified forest area	Dense forests	Open forests	Total forest area	Percentage of total forests w.r.t. geographical area
Kullu district	5,503	5,065	1,631	343	1,974	35.87%

Source: (WII – HPFD Project, 2005)

A perusal of available literature about the area shows that large mammal species like - goral, barking deer, serow, musk deer, Himalayan thar, leopard, black bear, brown bear, and at higher altitude (over 4,300 m), bharal and Himalayan ibex, are present in the area. Some smaller mammals present include porcupine, yellow throated marten, red fox and Himalayan weasel.

Among birds, Himalayan monal, koklass and kalij pheasants are present with over 100 other bird species.

The entire area is inhabited by villages, having agricultural and pasture lands. Pahali, Jabri, Allain, Duhangan, and Kala Nala are major streams which are located within the Project catchments and ultimately empty into the Beas river.

The following sections provide the details of terrestrial and riverine fauna and flora studied during one year i.e. year 2005 - 06.

4.5.2 *Terrestrial Faunal Survey*

A) Approach & Methodology

The study area was divided into three main altitude zones i.e. lower zone from 2,200 to 2,800 m amsl representing temperate vegetation; middle zone from 2,800 to 3,400 m amsl representing sub alpine vegetation; and upper zone > 3,400 m amsl representing alpine vegetation. Following surveys were conducted during three seasons in the three zones:

- Post monsoon season i.e. November 2004 and October – November 2005 covering lower and middle altitudes.
- Winter season i.e. January to March 2005 and February 2006 covering only lower altitudes (restricted due to heavy snowfall in middle and upper regions during winter season); and
- Summer season i.e. May to June 2005 covering all the three altitude zones.

Within each altitude zone, point counts were conducted with the five broad habitat types for measuring bird abundance and diversity (Bibby et al. 1992). Each count was of seven minutes duration and successive counts were conducted on a trail after every 10 minutes of walking. Three hundred and five point counts were conducted in all during this survey and were located on trails passing through all the broad habitat categories identified. Point counts were generally conducted on fair weather days between 0800 to 1200 hours and from 1600 to 1830 hours (as permitted by availability of ambient light).

Bird richness (Margalef's index) and diversity indices (Shanon/Brillouin index) were calculated using 'Biodiversity Pro' software package. In addition to indices of diversity, a general species list for birds in the area was produced.

Mammal abundance was estimated by generating encounter rates on trails and paths. Encounter rate for each mammal species sighted was produced by dividing number of individuals sighted by the number of man-hours spent in the field.

B) Habitat Types Observed

Within these altitude zones, following broad forest types were identified and sampling was stratified according to these broad forest/vegetation types:
a) Conifer forests: These are pure stands of conifer having close canopy and mature trees. Undergrowth was found to generally low in all forests in Allain area. However, some patches in Duhangan area were found with good undercover. Conifer is the most dominant type of vegetation in the area.

b) Degraded Areas: These were forest areas have conifers but now under sparse tree cover and with no under storey. The area above Prini village up to Hamta village is a good example.

c) Mixed forests: These are mixed broadleaf and conifer forests. The broad leaf species are mainly Juglans, Acer, Lyonia and Aesculus forming small pure or mixed stands within conifer.

d) Open areas: These are open grasslands and scrub areas forming the sub-alpine and alpine meadows.

e) Orchards: Close to villages and pre-dominantly with apple trees. In certain areas, especially in moist drains running through the orchards, undergrowth is heavy.

f) Alpine areas: Above the tree-line, this area is predominantly grassland with some shrub species.

C) Survey Observations on Terrestrial Avifauna and Mammals

C.1) Autumn Season

The autumn survey was conducted during October – November 2005, covering lower and middle altitude ranges.

Avifauna

Diversity indices were calculated for bird diversity in different altitude zones. The Bruillion diversity index for birds in altitude category I (2200-2800 m) was 1.122, much higher than 0.881 for the altitude category II (2800-3400 m). The richness index (Margalef's index) also was higher in low altitudes than for mid altitude (5.423 and 3.047 respectively). The indices suggest that the number of species was higher at lower altitudes. Their dispersion also was more even than in the higher areas. This is expected since many breeding birds found in the Western Himalaya migrate to the foothills during winter and, therefore, lower altitudes were more populated than higher ones

Diversity indices were calculated to see the diversity and richness patterns of birds in the five broad habitat categories. These are given in *Table 4.31*.

Table 4.31 Indices of Avian Diversity in Various Vegetation Types Surveyed in Allain-Duhangan Catchment Area

Vegetation Types/Index	Brillouin Diversity index	Margalef richness index
Conifer	0.921	3.909
Degraded	1.001	3.816
Mixed	0.793	3.152
Open	0.817	2.864
Orchard	0.732	3.147

The above Table suggests that the avian diversity was similar in most vegetation types. Although conifer forests were more species rich, the diversity was highest in degraded forests. Open areas had the lowest richness and this was probably due to low cover availability and also because some of the points fell in the high altitude grasslands, which had little bird life in winter.

Similarity indices (Sorensen's quantitative index) were generated to see how similar or dissimilar avifauna was in the vegetation types surveyed. From these analyses it is clear that avifuana (in terms of similarity of species) of orchards was quite different from those of conifer forests, whereas the rest were quite similar in their content.

A comparison was done of bird diversity indices in areas expected to be directly affected by project activities and those which lie away from project activities. The comparisons are given shown in *Table 4.32*.

Table 4.32 *Avian Diversity Indices between Point Counts at Project Site and Allain Duhangan Project Catchment*

Indices	Allain		Duhangan	
	Project Site	Catchment	Project Site	Catchment
Margalef's	3.892	3.672	4.202	4.262
Shanon	1.017	1.006	1.104	1.139
Brillouin	0.872	0.884	0.978	1.038

The above Table suggests that there is not much difference in the diversity values of birds between the project activity area and those away from the activity areas (Catchments) during the autumn season.

In both the streams (Allain and Duhangan), similarity indices of Project areas and catchments area were high suggesting that in terms of bird life (species and individual numbers), there was little difference between the two areas in both the streams.

Mammals

Four species of mammals were sighted along Allain stream. Pika was sighted in a bouler-strewn area within a grassy glade. A solitary Langur was sighted at 2,800 m within a mixed forest. A pair of yellow-throated marten was seen in a fir forest at 2,900 m and lower down, a jackal was seen within a conifer forest close to village Hamta. Scat of leopard was seen above the Hamta village.

Table 4.33 *Encounter Rates (groups/100 man hours) for Mammals in Allain Catchment*

Species	Conifer	Degraded	Mixed	Open	Orchard	Overall
Pika	0	0	0	7.4	0	1.28
Langur	0	0	5.31 (1)	0	0	1.28
Yellow-throated Marten	5.15	0	0	0	0	1.28
Jackal	5.15	0	0	0	0	1.28
Total E/R	**10.30**	**0**	**5.31**	**7.4**	**0**	**5.12**

Note: (*Ochotona royeli*), Langur (*Semnopithecus entellus*), Yellow-throated marten

In the Duhangan area, four groups of Langur were seen, one in a conifer area (1 individual), one in mixed forest (50+) and two in open areas (40+ and 5). A solitary goral (*Nemorhaedus goral*) was seen on a cliffy hillside, while a group of yellow-throated marten (3 individuals) was seen in an open area.

Table 4.34 Encounter Rates (groups/100 man hours) for Mammals in Duhangan Catchment

Species	Conifer	Degraded	Mixed	Open	Orchard	Overall
Langur	10.98(1)	0	7.49 (50)	9.31 (22.5)	0	5.88
Yellow-throated Marten	0	0	0	4.65 (3)	0	1.47 (3)
Goral	0	0	0	4.65	0	1.47
Total E/R	**10.98**	**0**	**7.49**	**18.61**	**0**	**8.82**

Encounter rates were produced for all mammalian sightings and converted into individuals seen for every 100-man hours. The highest encounter rate was for Langur in both the sites (refer to *Tables 4.33 & 4.34*). In terms of the altitude, the highest encounter rate was also in Langur (*Table 4.35*), while the lowest encounter rate was obtained for Pika. The encounter rate was higher in the high altitude zone compared to the lower zone.

Table 4.35 Encounter rates (groups/100 man hrs) for mammals in Duhangan area

Species	Lower Zone 2,200 – 2,800m amsl			Middle Zone: 2,800-3,400m amsl		
	Allain	Duhangan	Overall	Allain	Duhangan	Overall
Pika	1.78	0	0.99	0	0	0
Langur	0	6.66	2.97	3.44	9.09	5.00
Yellow throated marten						
Jackal	1.78	0	0.99	0	0	0
Goral	0	0	0	0	9.09	2.5
Total			**3.96**			**12.5**

Inferences

Both Allain and Duhangan areas have forests with many trees measuring over seven meter girth at breast height (gbh). Therefore, the forests are mature. While forests on the side of the Allain stream appear to be dry, on the Duhangan side they appear to be moister. Undergrowth was mainly in the form of fern species, which had dried out during the time of survey, thus providing no under-storey to the forests along Allain stream. The forests on the Allain side appeared also to be over-grazed, as evident from the abundance of dung piles from domestic livestock in this area. There were comparatively less signs of grazing on the Duhangan side.

A higher encounter with Pheasant species also suggests better habitat in Duhangan valley. The overall diversity indices, however, suggest little difference in the avifauna of the two areas. The high similarity indices between Allain and Duhangan valleys also indicate a close similarity between the species content of the two areas. However, this may change as more breeding species appear in spring and summer.

The habitats at lower altitudes seemed to be disturbed, which is probably the reason for low mammalian encounter rates. Although spending of time at high altitudes was restricted owing to presence of snow, yet encounters of various species were much higher here.

These surveys were conducted in early winter and thus only a part of the avifauna was present in the study site.

List of birds and mammals observed in Allain and Duhangan catchments during November 2004 is given as *Annex F*.

C.2) Winter Season

The winter survey of the Allain-Duhangan catchments was conducted during 17 January to 27 March 2005. Owing to heavy snowfall in the region, the winter surveys were restricted to a few areas but these were representative of the lower altitudes of the whole area under study. The aim of the survey was to obtain information about the winter use by animals of the areas falling within the project site.

It was assumed that certain animal species may be utilizing lower altitudes in winter during times of heavy snowfall and thus increasing the importance of the otherwise less frequently used and probably less important lower altitudes. Thirty two point counts were conducted for birds during this survey.

Avifauna

A total of 30 species of birds were recorded during the winter survey. Of these, 13 species were biome restricted and thus of some conservation importance. The over all richness index (Margalef) was 3.76, where as the diversity index (Brillouin) was 0.936.

Mammals

Eight species of mammals were recorded from the areas surveyed (*Annex F*). However, only two species were actually sighted - Rhesus (3.05 groups/100 hrs; mean group size 4.5 individuals) and Langur (4.58 groups/100 hrs; mean group size 6.6 individuals). Other animals recorded included Goral, Porcupine, Pika, Marten, Jackal and Black bear.

An analysis of animal use of the area was also done by looking for animal dung within a 10 m x 10 m plot. Forty eight percent plots contained only dung from domestic animals while 37% plots contained dung of wild mammal species. Only 10% plots contained dung of both, domestic and wild animals.

Inference

The low avifaunal richness and diversity can be attributed to the prevalence of winter. Although the number of species present in the low altitude zone was not very different from that found in November, their abundance was lower suggesting that most individuals had moved to lower altitudes. This also caused a decline in the density indices as suggested by the data.

The mammal encounters were low and confined to only two species of primates – the Himalayan Langur and the Rhesus Macaque. Although tracks of Black bear (*Ursus thibetanus*) and Goral (in snow) were found, there was only one set suggesting low abundance. It was not possible to access altitudes above 2,600 m due to heavy snow cover.

Most of the lower altitude areas were heavily used by domestic cattle as was evident from the proportion of plots found with dung from domestic cattle. The plots with dung from wildlife species appeared to be free from domestic animal use, implying that the wild animals frequented areas were relatively free of domestic cattle (in other words, human disturbance).

C.3) Summer Season

The summer surveys were conducted during the month of May –June 2005.

Avifauna:

Diversity indices were calculated for bird diversity in different altitude zones. The Shannon diversity index for birds in lower altitude (2200-2800m) was 0.975, as compared to 0.966 for the middle altitude (2800-3400 m). The Margaleff's richness index was also almost similar for bird richness at the lower and middle altitudes (i.e. 19.348 and 19.799 respectively). These indices suggest that at both the altitudinal categories, the number and dispersion of species was almost similar.

Indices were calculated to see the patterns of bird diversity and richness within the broad habitat categories (*Tables 4.36 & 4.37*) in Allain and Duhangan catchments.

Table 4.36 Indices of Avian Diversity and Richness in Various Vegetation Types Surveyed in Allain Catchment

Vegetation Types/Indices	Shannon's Diversity Index	Margaleff's Richness Index
Alpine	0.596	22.514
Conifer	0.829	16.892
Degraded	0.741	20.485
Mixed	0.928	19.028
Open	0.586	24.16
Orchard	0.558	20.283

Table 4.37 Indices of Avian Diversity and Richness in Various Vegetation Types Surveyed in Duhangan Catchment

Vegetation Types/Indices	Shannon's Diversity Index	Margaleff's Richness Index
Alpine	0.794	14.981
Conifer	0.951	17.717
Degraded	0.535	29.665
Mixed	0.989	24.029
Open	0.743	29.665

The above Tables show differences in the avian diversity and richness in different vegetation types. In the Allain area, maximum avian diversity was encountered in the mixed forest areas followed by areas with conifer and degraded forests. The species richness was maximum in the alpine areas, followed by areas with degraded forests and orchards. Lowest avian diversity and richness were observed in orchard and conifer areas respectively.

In the Duhangan area, although the degraded and open areas were more species rich, the diversity was higher in the mixed and conifer forests. In this area, lowest avian diversity and richness were observed in the degraded and alpine areas, respectively.

Similarity indices (Sorensen's quantitative index) were generated to see how similar or dissimilar avifauna was in the vegetation types surveyed. From these analyses, it was clear that avifuana (in terms of similar species) of alpine areas was different whereas the rest were quite similar in their content.

A comparison of bird diversity and richness indices in areas expected to be directly affected by project activities and those which lie away from project activities was also carried out (*Table 4.38*)

Table 4.38 Avian Diversity and Richness Indices between Point Counts at Allain and Duhangan Catchments and Project Sites

Diversity Indices	**Allain**		**Duhangan**	
	Catchment	Project sites	Catchment	Project sites
Shannon's Diversity Index	1.045	0.747	1.196	0.822
Margaleff's Richness Index	20.381	26.666	21.792	35.336

There were differences in avian diversity indices between catchments and project site areas. The catchments turned out to be higher with diversity where as species richness was more in the Project site areas.

Mammals

In Allain area, seven species of mammals were sighted. These were Pika (*Ochotona royeli*), Leopard (*Panthera pardus*), Brown Bear (*Ursus arctos*), Long-tailed Mormot (*Marmota caudata*), Red Fox (*Vulpes vulpes*), Kashmir Flying Squirrel (*Hylopetes fimbriatus*) and Macaca (*Macaca mulatta*). The mammalian species encountered are given in *Annex F*.

In the Duhangan area, six species of mammals recorded were Pika, Leopard, Brown Bear, Black Bear (*Ursus thibetanus*), Himalayan Weasel (*Mustela sibirica*) and Langur (*Semnopithecus entellus*).

Encounter rates were generated for all mammalian sightings. Encounter rates for mammals were higher in Duhangan area as compared to Allain area. The highest encounter rate was for Pika in both the sites, which was followed by Langur. In terms of altitude, highest encounter rate was for Langur. The encounters were high at higher altitude as compared to lower altitude.

Table 4.39 Encounter Rates (individuals/man hour) for Mammals in Allain Area

Species	Conifer	Degraded	Mixed	Open	Orchard	Overall
Pika	0	0	0	0.54	0	0.54
Leopard	0	0	0	0.02	0	0.02
Brown Bear	0.06	0	0.04	0.04	0	0.13
Long-tailed Marmot	0	0	0	0.02	0	0.02
Red Fox	0.04	0	0.04	0	0	0.08
Kashmir Flying Squirrel	0.10	0	0	0	0	0.10
Macaca	0.08	0	0	0	0	0.08
Total E/R	**0.27**	**0**	**0.08**	**0.62**	**0**	**0.96**

Table 4.40 Encounter Rates (individuals/man hour) for Mammals in Duhangan Area

Species	Conifer	Degraded	Mixed	Open	Orchard	Overall
Pika	0.29	0	0	0.03	0	0.32
Leopard	0.03	0	0	0	0	0.03
Brown Bear	0.03	0	0	0.03	0	0.06
Black Bear	0.03	0	0.06	0	0	0.09
Himalayan Weasel	0	0	0	0.03	0	0.03
Langur	0.50	0	0	0.50	0	1.00
Total E/R	**0.88**	**0**	**0.06**	**0.59**	**0**	**1.44**

Table 4.41 Encounter Rates for Various Mammal species according to Altitude Zones

Species	Lower Zone 2,200 – 2,800m amsl			Middle Zone: 2,800-3,400m amsl		
Species	Allain	Duhangan	Overall	Allain	Duhangan	Overall
Pika	0.17	0	0.10	0.37	0.32	0.35
Leopard	0	0.03	0.01	0.02	0	0.01
Brown Bear	0	0.03	0.01	0.13	0.03	0.09
Black Bear	0	0.09	0.03	0	0	0
Long-tailed Marmot	0	0	0	0.02	0	0.01
Himalayan Weasel	0	0	0	0	0.03	0.01
Red Fox	0.04	0	0.02	0.04	0	0.02
Kashmir Flying Squirrel	0.10	0	0.06	0	0	0
Langur	0	0.18	0.07	0	0.82	0.33
Macaca	0	0	0	0.08	0	0.05
Total E/R	**0.31**	**0.32**	**0.31**	**0.65**	**1.21**	**0.87**

Inference

There was a significant increase in the number of bird species and this was due to the breeders moving up from the plains. The increase in Margalef's index in summer compared to other seasons for all habitats suggests that there was an overall increase in species numbers. The dispersion of species also was more during summer, again suggesting that the number of individuals of each species had showed an increase.

Twenty three species found in the catchments area were biome-restricted and therefore of some conservation concern although none of the bird species seen were in the threatened list of the IUCN. However, some pheasants like HImalayan Monal and Koklas and Kalij are listed in Schedule I of the Wildlife (Protection) Act, 1972, making them important species for conservation. Maximum avian diversity was found in the mixed forests followed by conifer forests. Therefore, some loss of bird habitat may occur if any forest of the types preferred by birds is lost.

Bird diversity was more in the general catchments area than in the project site areas. This was perhaps because of better habitat and so also the dispersion of birds. However, an inverse result for Margalef's index suggests that because of patchy habitats in project impact areas, the number of species was probably higher but their individual numbers were low.

The catchments and project impact area continued to be a low mammal encounter area. Surveys on earlier occasions (Garson and Gaston, 1992) had recorded presence of Himalayan Thar in high altitude areas of the catchments but none was reported during the present survey. Absence of many large mammals could also suggest local hunting pressures and signs of this were encountered during the survey. Most mammal sightings occurred above 2,700 m amsl except during winter when species like Goral were seen much lower down elevations. The project impact area mainly had Jackal, Pika and Langur whereas, in winter Goral were also seen.

List of birds and mammals observed during the survey of Allain-Duhangan catchments in May – June 2005 is given in *Annex F*.

D) Butterfly Survey

As in lowland ecosystems even at high altitudes, butterflies are dominantly found and flourish at highest limits of existence of animal life.

As butterflies are very specific to any minute change in the environment hence, they show distinct pattern of habitat utilization. The nature of vegetation is an important factor which determines the distribution, dependence, and survival of butterfly species in particular habitat. Being highly sensitive to change in environment, they are easily affected by any minor perturbations in the habitat so much, so they have been considered as indicator of environmental quality and also treated as indicator of the health of the ecosystem (Rosenberg et al. 1986).

The presence of butterfly emphasizes availability of larval food plant in great abundance. Most butterflies have specific habitat requirements; females usually tend to lay eggs only on selective food plants (Uniyal and Mathur, 1998). There is an intimate association between butterflies and plants as their lives are exceptionally interlinked (Feltwell, 1986). A study specifically focussing on butterflies in the project area was therefore undertaken.

D1) Objectives

The following objectives have been outlined for the proposed study to:

- cover the representative habitats of butterflies;
- measure abundance indices of butterflies;
- document a general list of butterflies biodiversity;
- identify impacts of proposed Project on population and richness of butterflies.

D2) Study Sites

The whole project area was divided into two major areas and further transects and sections were made for the ease in monitoring butterfly. The details of division of study area are provided in *Table 4.42.*

Area I- Allain stream: A total of four transects were made in this area i.e. transects 1, 2, 3 and 4 which were further divided into a sections of 16, 18, 8 and 16 respectively. Each section was of 300 m each hence, all transects covered a distance of 18 km. (refer to *Figures 4.10, 4.11 & 4.12* for transects locations).

Area – II Duhangan stream: It was further divided into three transects i.e.. transects 5, 6 and 7 which were further divided into a section of 12, 15 and 8 respectively. Hence, total covering an area of 12km (refer to *Figures 4.13 & 4.14*).

Table 4.42 Major Areas, Transects, Sections & Their Description

Transects	Site Location	Sections
Area I (Allain Stream)		
1.	Allain barrage to surge shaft site.	16
2.	Pasture land (Above surge shaft site).	18
3.	Surge shaft site to Hamta village.	8
4.	Hamta village to Kullu-Manali state highway.	16
Total distance covered (km)		18
Area II (Duhangan Stream)		
5.	Jagatsukh to Kala Nala.	12
6.	Kala Nala to Duhangan weir site.	15
7.	Kala Nala stream.	8
Total distance covered (km)		12

Figure 4.10 Location of Transect 1 for Butterfly Survey

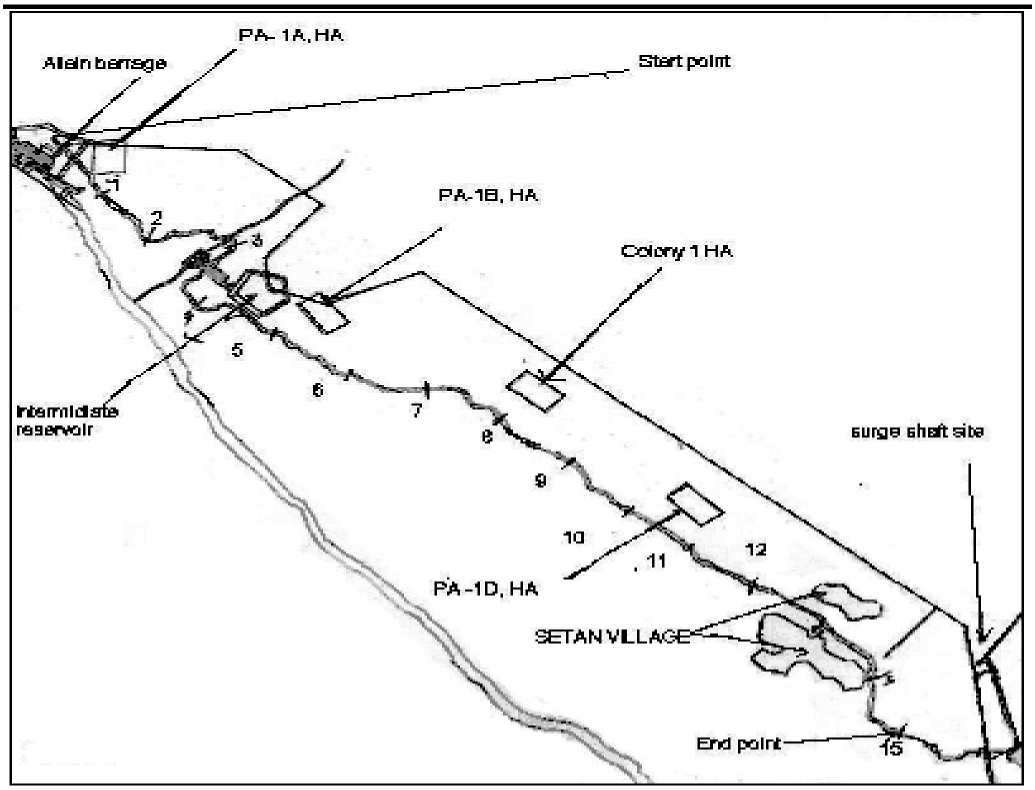


Figure 4.11 Location of Transect 2 for Butterfly Survey

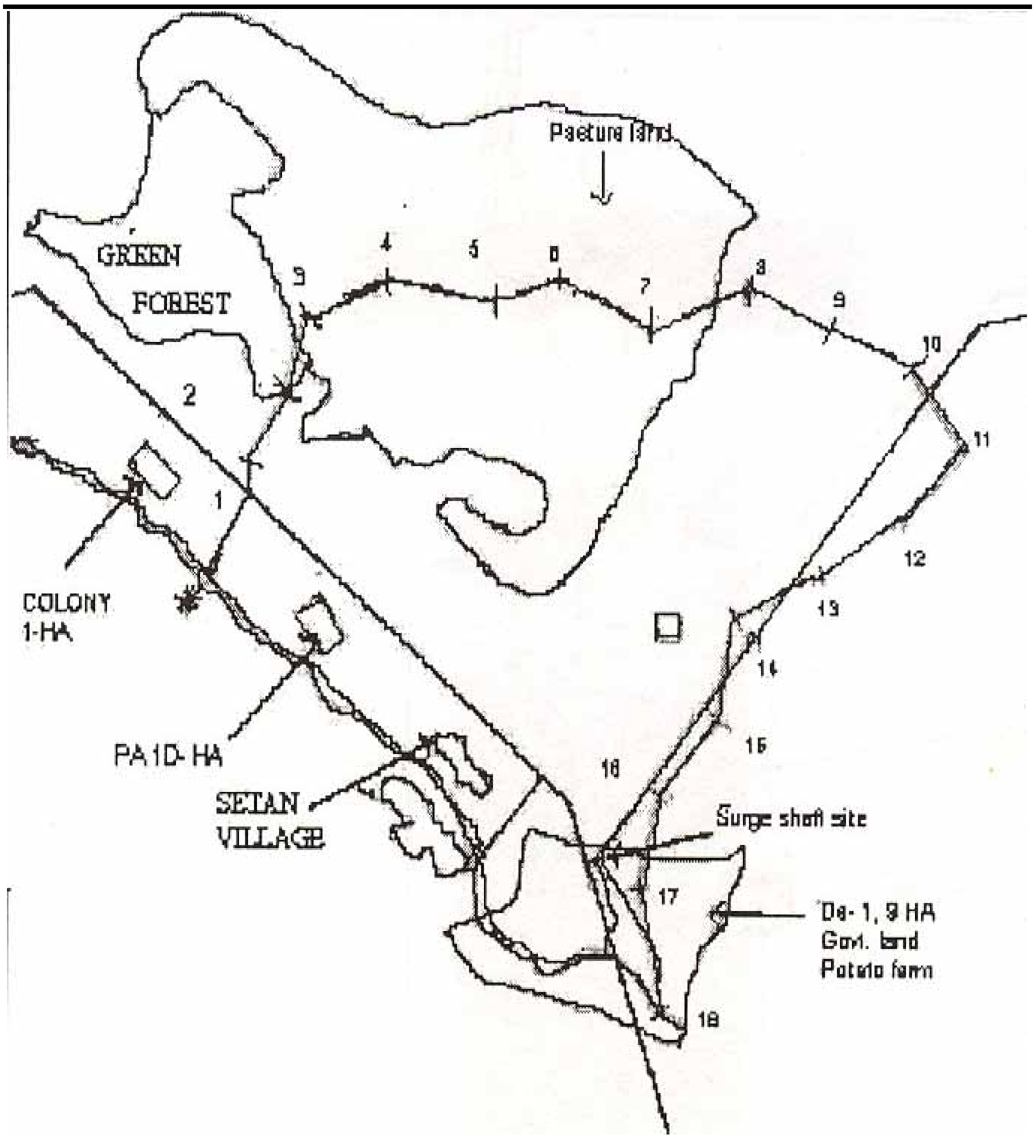


Figure 4.12 Location of Transects 3 & 4 for Butterfly Survey

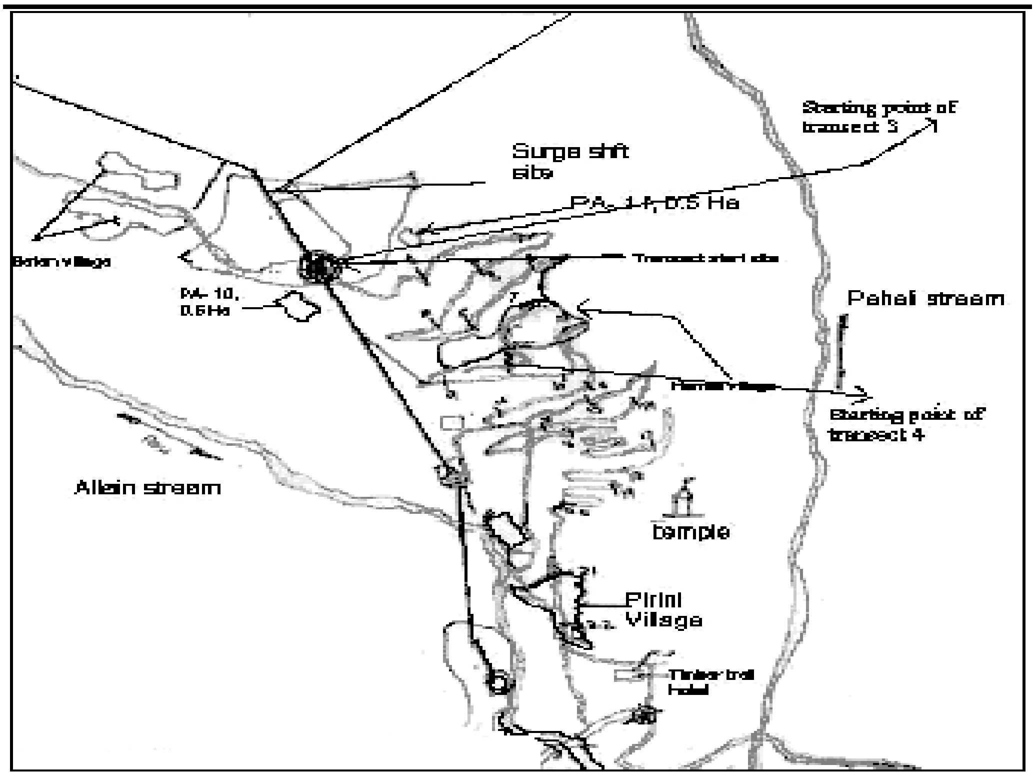


Figure 4.13 Location of Transect 5 for Butterfly Survey

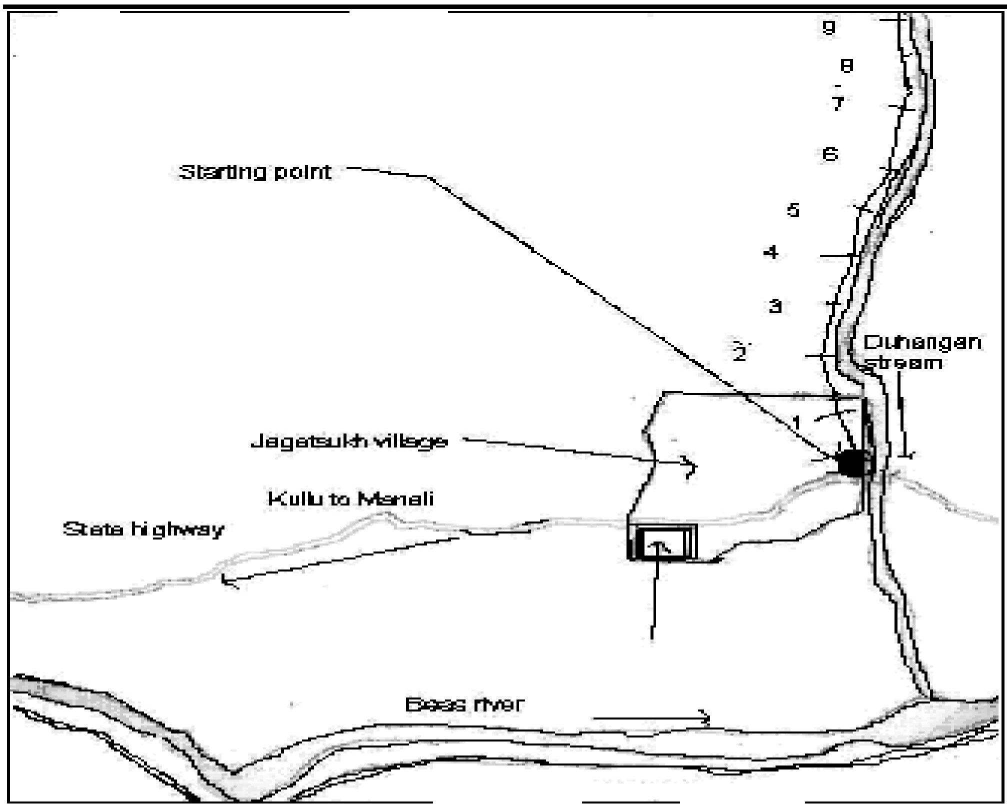
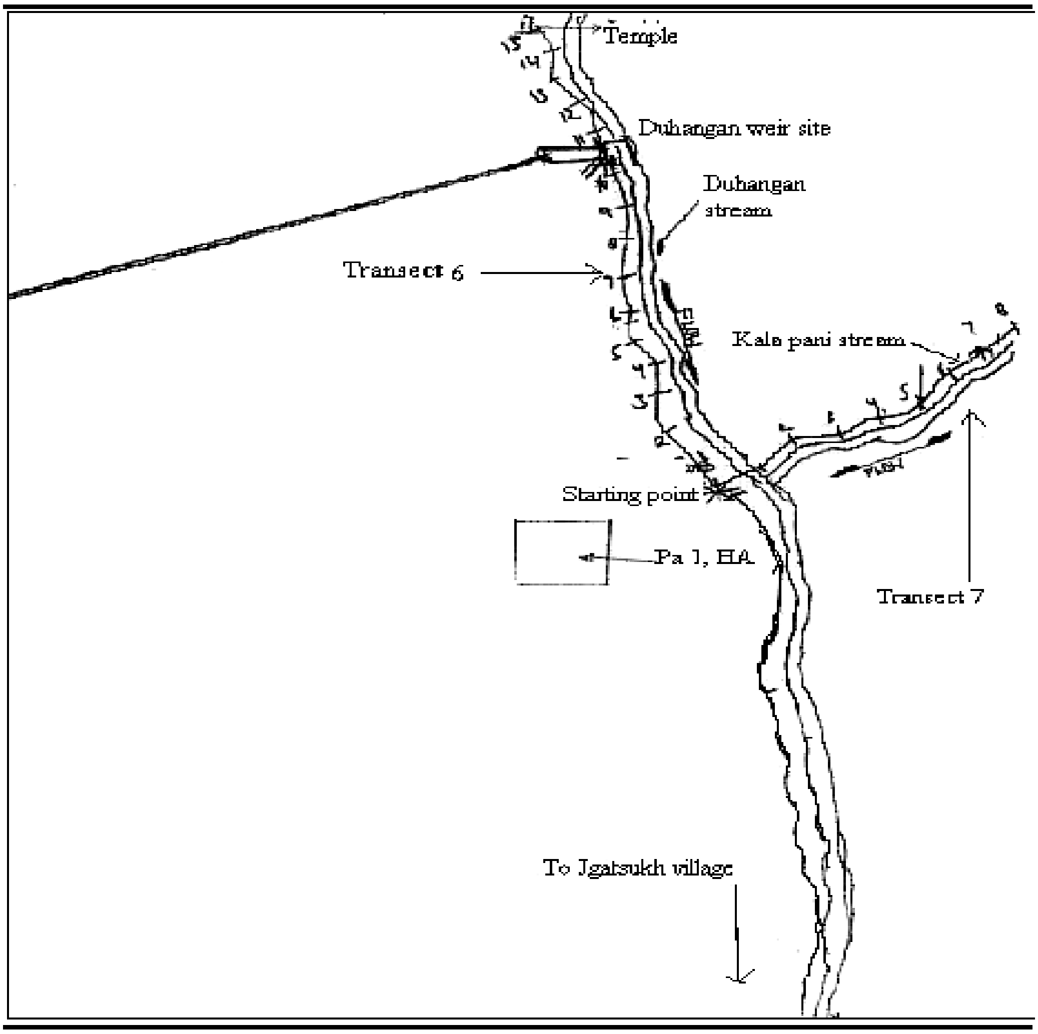


Figure 4.14 Location of Transects 6 &7 for Butterfly Survey



D3) Methodology

Collections of various families of butterflies were made around Allain and Duhangan streams. The study area comprised of various forest types, scrubs, and alpine pastures ranging from 2,300 m to over 3,500 m above sea level. The survey for butterfly was conducted in the month of October 2005.

The butterfly collections were carried out in the early hours of the day because butterflies are usually active at early sunrise therefore, it was easy to observe and collect them. Broadly, following methods were adopted for the collection.

D3(a) Aerial netting

Aerial net was used to collect flying butterflies. Soft bodied butterflies were gently removed from the bottom of the bag, after it becomes enclosed in the bag; often the fold of the net enclosing the butterfly was removed after killing vapours of the killing agent.

D3(b) Equipment

Killing bottle: Killing bottle was used to kill and preserve insect without affecting its colour. Glass jar with a layer of Benzene was used as a killing agent. The liquid was poured over a layer of cotton and one or two filter paper were used to soak cotton and also to prevent the specimen form coming in direct contact with cotton. The butterflies were handled carefully while, they are put inside the bottle or taken out to prevent any morphological damage.

Polythene packets: Polythene packets were used to keep butterflies in the field. The extreme care was taken while keeping butterflies in the polythene packets to avoid any damage till preservation.

D3(c) Preservation for taxonomic study

Spreading: It is a process to arrange the wings for taxonomic study, with the help of spreading board which consist of two parallel pieces of soft wood with an inner groove lined by cork. A properly relaxed specimen with a pin thrust vertically, was inserted inside the groove so that the wing bases remain at level with the edge of top part. Two narrow paper strips were used to hold and spread the wings, and after adjustment of the wings at a desirable position the collected specimen was pinned using a fine pin.

Pinning: Collected butterflies were pinned for detailed identification.

Butterflies were collected and preserved in such a manner so as to allow examination of the specimens even after along lapse of time. This necessitates undistorted spreading, pinning and labeling with complete information of the collection *viz*, date, time, location, scientific name and family. The specimens once pinned were arranged in wooden insect collection boxes. Naphthalene balls were used in the insect boxes for safe preservation against any pest or fungal attack.

D3(d) Taxonomic keys for identification

The purpose of a taxonomic key is to facilitate identification of a specimen (Mayer, 1974). For identification of butterflies the reference key, pictorial key and illustrations as provided by Mani (1986); Haribal (1992) and Evans (1932) were used.

D3(e) Butterfly monitoring

Butterfly was monitored to measure abundance indices in proposed project area. The whole area was traversed by foot and butterflies were recorded 5 m ahead of the recorder. Separate counts were made for each section and transect. The butterfly recorded once was neglected, if it comes to the trail next time. The location of each transects and their sections in study area are shown in ***Figures 4.10 to 4.14***.

D3(f) Line transect technique

Line transect technique is used to measure abundance indices of butterflies. It has been referred as standard for butterfly monitoring (Pollard, 1977). Four transects were made in Area I and three transects in Area II, respectively. Each specimen was recorded and separate count was made in each section.

D4 Observations on Butterfly Survey

The study area was extensively surveyed in order to find out abundance indices, species richness, biodiversity and occurrence variation of the butterflies from 14 October to 4 November 2005. A total of 14 species belonging 14 genera of 5 families were recorded in all 7 transects of study area.

D4(1) Allain Stream - Area I

In transect 1: A total 3 families belonging to 10 genera and 10 butterfly species were documented. The dominant species was Dark clouded yellow (*Colias electo fieldi*). About 80 specimen of this species were observed along the transect. The second dominant species was viz., Common brimstone (*Gonepteryx rhamni nepalensis*), Queen of Spain fritillary (*Issorea lanthania*) etc. *Aulocera brahminus* was rarely found in this area.

In transect 2: A total 4 families belonging to 12 genera and 12 butterfly species were found. The dominant species was Large hedge blue (*Celastrina huegeli*). About 138 specimen of this species were observed along transect 2. The second dominant species was viz., Common brimstone (*Gonepteryx rhamni nepalensis*), Dark clouded yellow (*Colias electo fieldi*) etc. Hill jezebel (*Delias belladona*) was rarely found in this area.

In transect 3: A total 4 families belonging to 11 genera and 11 butterfly species were documented. The dominant species was Queen of Spain fritillary (*Issorea lanthania*). About 24 specimen of this species were observed along transect 3. Lofty path white (*Pontia callidice*) Yerburis sailor (*Neptis yerburi*) were rarely found in this area.

In transect 4: A total 5 families belonging to 13 genera and 13 butterfly species were documented. The dominant species was Large hedge blue (*Celastrina huegeli*). About 71 specimen of this species were observed along transect 4. The second dominant species was viz., Common brimstone (*Gonepteryx rhamni nepalensis*), Queen of Spain fritillary (*Issorea lanthania*) etc. While, Dark clouded yellow (*Colias electo fieldi*) was rarely found species in this area.

D4(2) Duhangan Stream - Area II

In Transect 5: Queen of Spain fritillary (*Issorea lanthania*) was totally absent from this transect. A total 5 families belonging to 11 genera and 11 butterfly species were documented. The dominant species was Large hedge blue (*Celastrina huegeli*). About 328 specimen of this species were observed along the transect. The secondly dominant species were *viz*, Indian cabbage white (*Pieris canidia* *indica*) and Common copper (*Lycaenia phlaeas*) was rarely found in this area. While, Common fourring *(Ypthima hubenri)* was totally absent in this area.

In transect 6: A total 5 families belonging to 11 genera and 11 butterfly species were documented. The dominant species was Large hedge blue (*Celastrina huegeli*). About 232 specimen of this species were observed along the transect. The secondly dominant species were *viz*, Indian cabbage white (*Pieris canidia indica*) and Common copper (*Lycaenia phlaeas*). Common fourring (*Ypthima hubenri*) was rarely found in this area.

In transect 7: A total 4 families belonging to 10 genera and 10 butterfly species were documented. The dominant species was Large hedge blue (*Celastrina huegeli*). About 29 specimen of this species were observed along the transect. Indian tortoiseshell (*Vaneesa kashmiriensis*) was rarely found species in this area.

Figure 4.15 to 4.20 show the fluctuation in the number of specimen recorded of rare and dominant species throughout the Transects 1 to 7 in Areas I and II.

Table 4.43 List of butterflies found in the study area

S.N.	Scientific name	Vernacular name	Family
1.	*Gonepteryx rhamni nepalensis*	Common brimstone	Pieridae
2.	*Pieris canidia indica*	Indian cabbage white	Pieridae
3.	*Pontia callidice*	Lofty path white	Pieridae
4.	*Colias electo fieldi*	Dark clouded yellow	Pieridae
5.	*Delias belladona*	Hill jezebel	Pieridae
6.	*Aulocera brahminus*	-	Nymphalidae
7.	*Vaneesa kashmiriensis*	Indian tortoiseshell	Nymphalidae
8.	*Issorea lanthania*	Queen of Spain fritillary	Nymphalidae
9.	*Neptis yerburi*	Yerburis sailor	Nymphalidae
10.	*Ypthima hubenri*	Common fourring	Nymphalidae
11.	*Lycaenia phlaeas*	Common copper	Lycaenidae
12.	*Celastrina huegeli*	Large hedge blue	Lycaenidae
13.	*Parage schakra*	Common wall	Satyridae
14.	*Graphium sarpedon sarpedon*	Common blue-bottle	Papilionidae

Figure 4.15 *Occurrence of Variation of Dominant and Rare species of Butterflies in Transect 1*

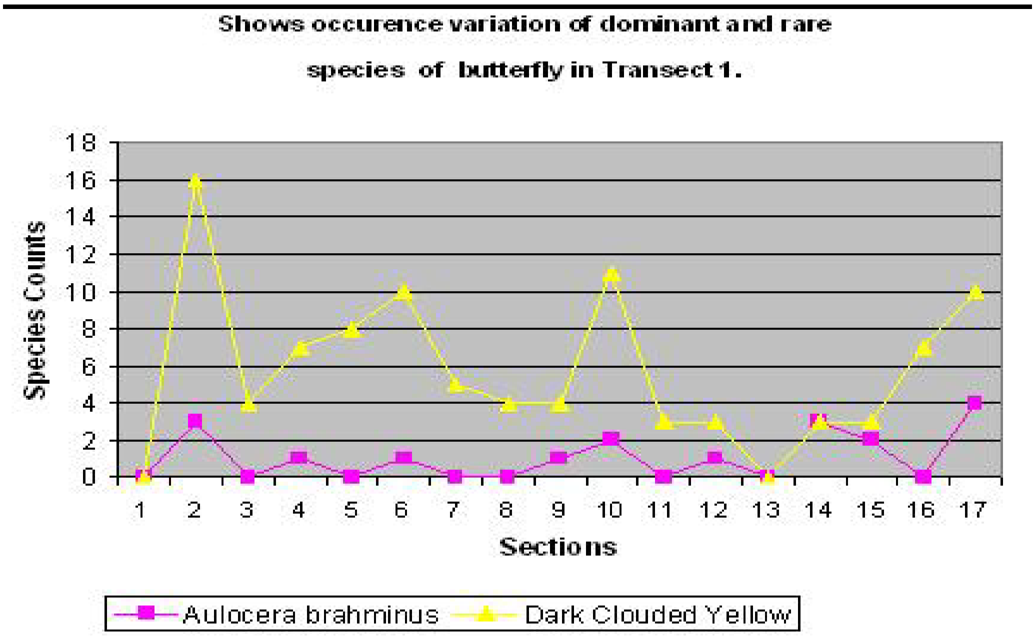


Figure 4.16 *Occurrence of Variation of Dominant and Rare species of Butterflies in Transect 2*

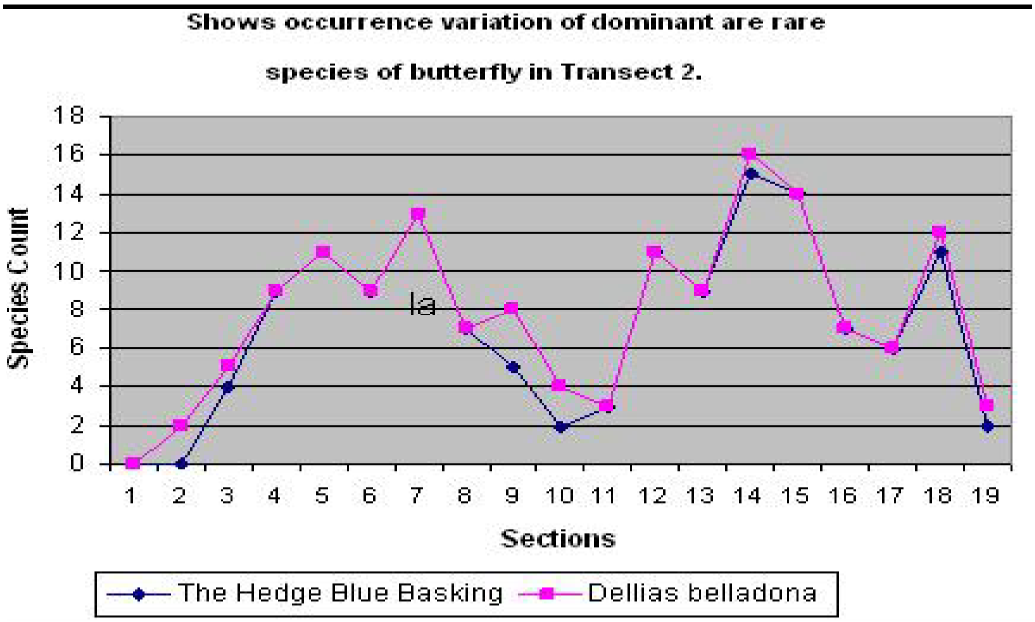


Figure 4.17 *Occurrence of Variation of Dominant and Rare species of Butterflies in Transect 3*

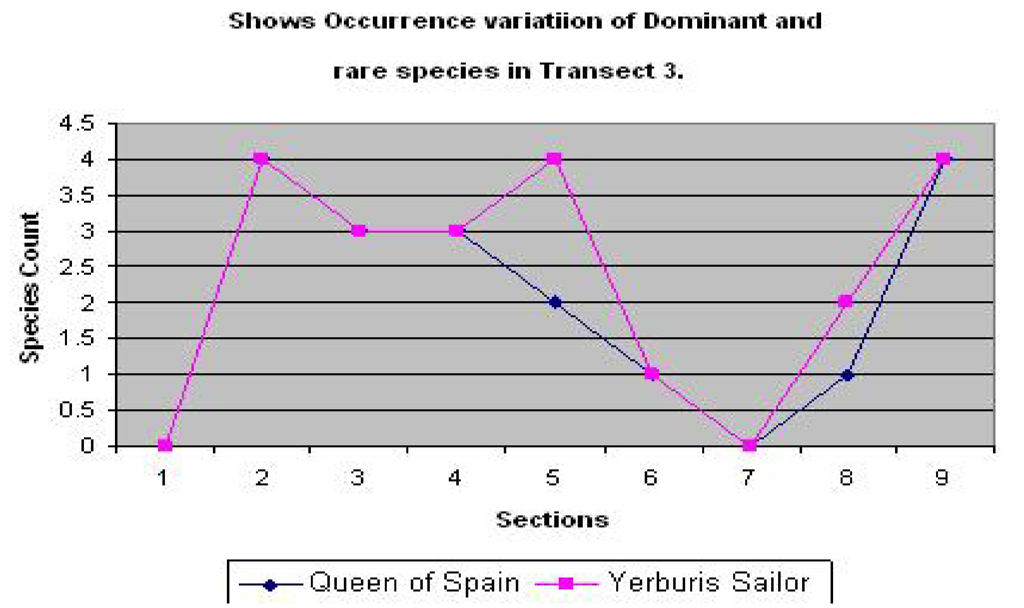


Figure 4.18 *Occurrence of Variation of Dominant and Rare species of Butterflies in Transect 4*

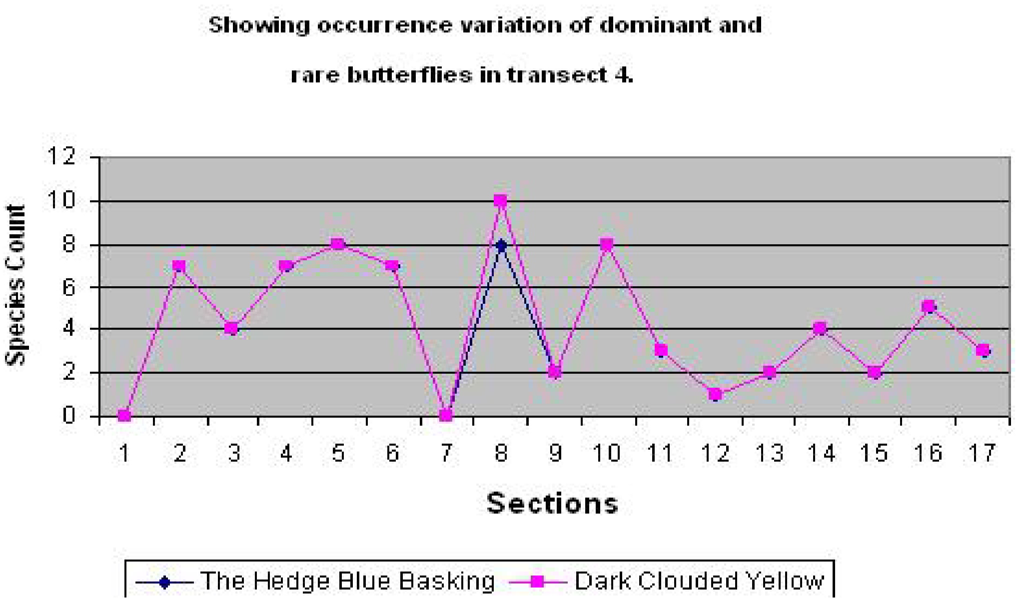


Figure 4.19 Occurrence of Variation of Dominant and Rare species of Butterflies in Transect 5

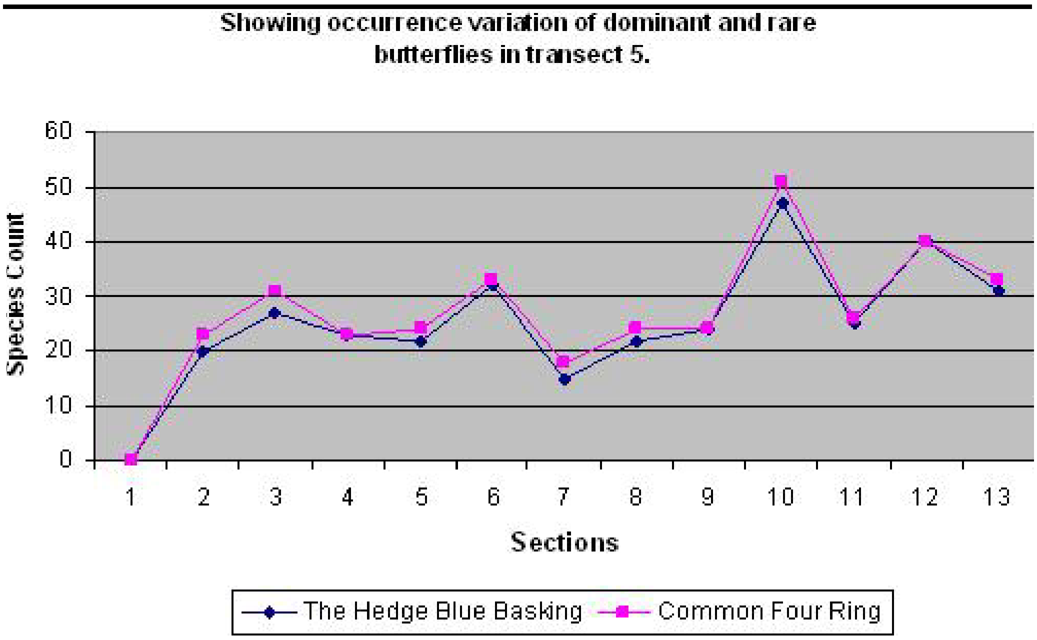
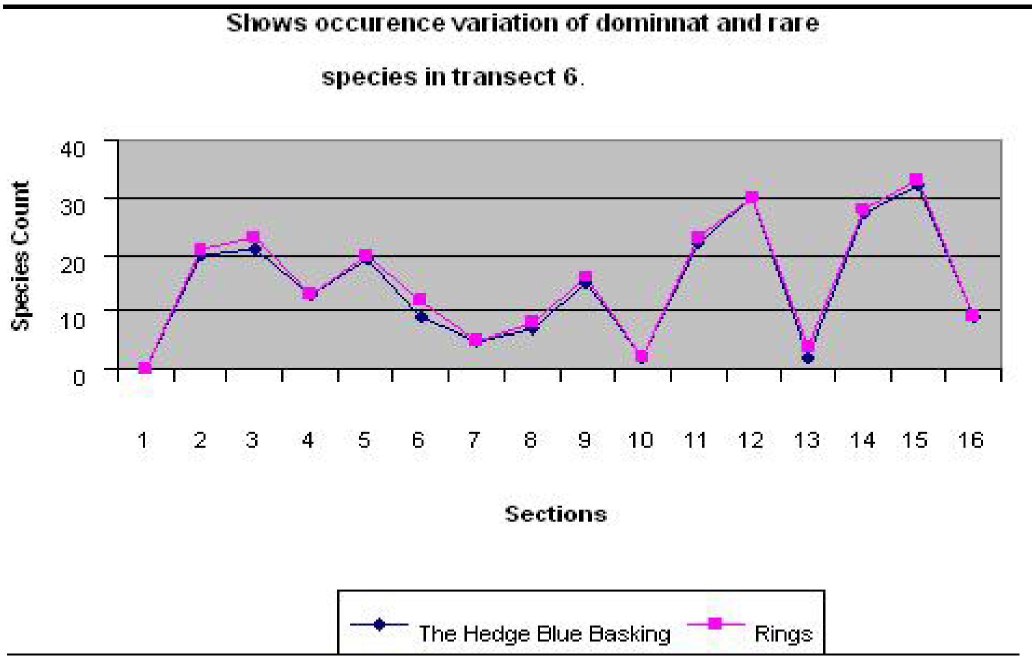


Figure 4.20 Occurrence of Variation of Dominant and Rare species of Butterflies in Transect 6



4.5.3 Terrestrial Flora of the Study Area

Methodology and Approach

Surveys were conducted between 1800-4000 m in Hamta and Jagatsukh catchments throughout the year. The samples of the plant species were collected, and identified with the help of local flora (Choudhury & Wadhawa, 1984; Dhaliwal & Sharma, 1999; Singh & Rawat, 2000). For each species, information on altitudinal range, habitat (s), life forms, etc. was gathered. All the identified species were listed, and analyzed for floristic diversity.

Selection of Sites and Habitats for Vegetation Sampling

Sites were selected on each and every accessible aspect between 1800-4000 m along an altitudinal gradient. The habitats were identified based on the physical characters and dominance of the vegetation. Sites having closed canopy with high percent of humus and moisture were considered as moist habitats whereas low percent of the same as dry habitats. The sites having >50% boulders over the ground cover had been considered as bouldary habitat, and the sites facing high anthropogenic pressures had been considered as degraded habitat.

Survey, Sampling, Identification and Analysis of Data

The field surveys and samplings were conducted during the summer season within the selected sites along an altitudinal gradient. In each site, a plot of 50x50 m was laid. Trees, saplings and seedlings were sampled by randomly placed 10, 10x10m quadrats; shrubs by 10, 5x5 m quadrats; herbs by 20, 1x1 m quadrats in each plot. The size and number of quadrats were determined following Misra, 1968 and Kersaw, 1973. For the collection of data from these quadrats standard ecological methods (Curtis & McIntosh, 1950; Grieg-Smith, 1957; Kersaw, 1973; Muller-Dombois & Ellenberge, 1974; Dhar *et al.*, 1997; Joshi & Samant, 2004; and Samant & Joshi, 2004) were followed. Circumference at breast height (cbh at 1.37 m from ground) for each tree individual was recorded.

Based on cbh, the tree individuals were considered as tree (cbh ≥ 31.5 cm), sapling (cbh 10.5-31.4 cm) and seedling (cbh < 10.5 cm). Shrubs were considered as the woody species having several branches arising from their base (Saxena & Singh, 1982) and herbs are those plants aerial parts of which survive only one season however, may survive by underground roots/rhizomes/bulbs, *etc.* From each site, samples of each species were collected and identified in the Institute with the help of florulas and research papers (Choudhury & Wadhawa, 1984; Dhaliwal & Sharma, 1999; Singh & Rawat, 2000; Khullar, 1994, 2000, *etc.*).

Data analysis has been done following standard ecological methods (Curtis & Mc Intosh, 1950; Grieg-Smith, 1957; Kersaw, 1973; Muller-Dombois & Ellenberge, 1974; Dhar *et al.*, 1997; Samant *et al.*, 2002, Samant & Joshi 2004; and Joshi & Samant, 2004). Community wise frequency and abundance of species has been calculated as:

$$Frequency = \frac{Number\ of\ Communities\ in\ which\ species\ is\ present}{Total\ number\ of\ Communities}\ X\ 100$$

$$Abundance = \frac{Total\ number\ of\ communities\ x\ mean\ density\ of\ species}{Total\ number\ of\ communities\ of\ species\ occurrence}$$

For trees, Basal Area and Importance Value Index (IVI) have also been computed. Basal Area and Total Basal Area were calculated as:

Basal Area= πr^2 where r= radius
Total Basal Area (TBA) = Mean basal area x density

IVI has been calculated as the sum of relative frequency, relative density and relative basal area. The abundance data of different sites were pooled to get community averages in terms of density, Total Basal Area and IVI. Communities were identified based on the IVI.

Assessment of Resource Utilization Pattern

Seven villages *i.e.*, Prini, Hamta, Chhaleth, Sethan, Jagatsukh, Bhanara, and Shuru located in these catchments have been selected to generate information on the resource utilization pattern of the inhabitants. Knowledgeable persons, Vaidhyas from each village were interviewed. Among the village experts, one person was hired to survey and collect the useful plant species from wild habitats. Information on the local names, altitudinal range, life forms, part (s) used, and use values including indigenous knowledge and practices was gathered. Fresh samples of the useful species were collected and identified with the help of florulas (Choudhury & Wadhawa, 1984; Dhaliwal & Sharma, 1999; Singh & Rawat, 2000; Khullar, 1994, 2000, *etc.*). The information was compiled and analyzed for the utilization pattern following Samant *et al.* (2002a).

Identification of the Rarity of the Species

The rarity of the species has been identified based on the habitat preference, population size, distribution range and anthropogenic pressure (Samant *et al.*, 1998, 1996b) and also, categorization of these species as Critically Endangered, Endangered, Vulnerable, Near Threatened, *etc.* have been done following (Samant *et al.*, 1998a&b; Dhar *et al.*, 2002; Ved *et al.*, 2003; and Samant & Pal, 2003).

4.5.4 Observations

A) Qualitative assessment of plant diversity of the Hamta Jagatsukh catchments

A-1) Species Diversity

The present study recorded 619 species of vascular plants i.e., Angiosperms (97 families, 227 genera and 560 species), Gymnosperms (3 families, 6 genera and 8 species) and *Pteridophytes (16* families, 25 genera and 51 species). Of the total species, 45 species were trees, 85 species shrubs, 438 species herbs and 51 species pteridophytes (***Table 4.38***). Among the angiosperm families, Asteraceae (59 spp.); Rosaceae (38 spp.); Poaceae (31spp.); Lamiaceae (26 spp.); Ranunculaceae (24 Spp.); Fabaceae and Apiaceae (20 spp. each); and Scrophulariaceae (19 spp.) are the dominant families. Papavaraceae, Podophyllaceae, Linacae, Aquifoliaceae, Vitaceae, Tiliaceae, Meliaceae, Vitaceae, Coriariaceae, Begoniaceae, Dipsacaceae, Morinaceae, Myrsinaceae, Buxaceae, Cannabaceae, Cuscutaceae, Polemoniaceae, Verbenaceae, Phytolaccaceae, Loranthaceae, Corylaceae, Asparagaceae, Loganiaceae, Malvaceae, Moraceae, Juglandaceae and Cucurbitaceae etc. were the monotypic families. Among genera, *Carex* (9 spp.), *Pedicularis* (7 spp.), *Potentilla* (6 spp.) and *Galium*, *Rubus*, *Clematis*, *Impatiens*, *Prunus* (5 spp., each) were the dominant genera. Among gymnosperms, the family Pinaceae (04 spp.), and Genus, *Juniperus* (3 species) are dominant. Amongst Pteridophytes, the families, Dryopteridaceae (10 spp.), Athyriaceae (06 spp.) and Aspleniaceae (05 spp.), and generas, *Polystichum* (10 spp.), *Athyrium* (6spp.), *Asplenium* (5spp.), *Pteris*, *Lepisorus* and *Adiantum* (4 spp., each) were species rich.

Table 4.44 Taxonomic description of the floristic diversity of Hamta and Jagatsukh Catchments

Taxonomic group	Families	Genera	Species	Trees	Shrubs	Herbs	Ferns
Angiosperms	97	227	560	39	83	438	-
Gymnosperms	3	6	8	5	3	-	-
Pteridophytes	16	25	51	-	-	-	51
Total	116	258	619	44	86	438	51

A-2) Altitudinal distribution

Altitudinal distribution of the species is presented in *Figure 4.20.*

Maximum species (554 nos.) were reported in the altitude zone of 1800 m to 2800 m, followed by the altitude zone 2800-3800 m (314 species). The altitude zone >3800 m showed minimum number of species (107).

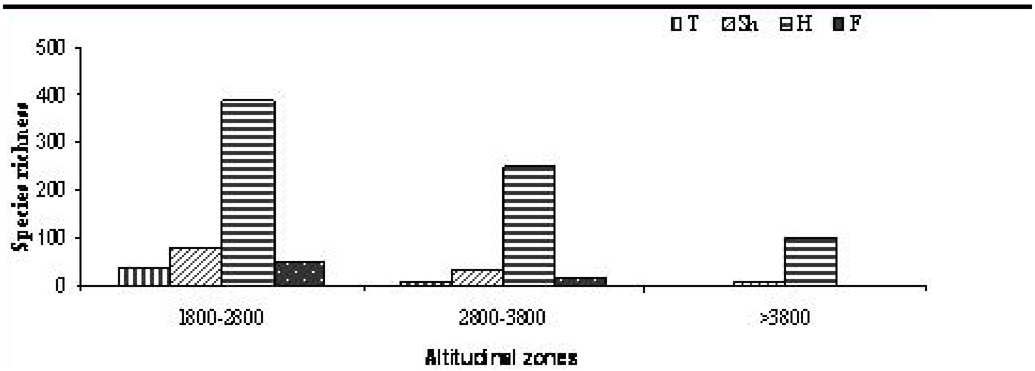
Some important species of the altitudinal zone, 1800-2800 m are *Pinus wallichiana, Picea smithinana, Abies pindrow, Ulmus villosa, U.wallichiana, Taxus baccata* subsp. *wallichiana, Quercus floribunda, Indigofera heterantha, Sorbaria tomentosa, Berberis lycium, Paris polyphylla, Podophyllum hexandrum, Polygonatum verticillatum, Angelica glauca, Dioscorea deltoidea, Viola biflora*, etc. The Important species of the altitudinal zone, 2800-3800 m are *Acer acuminatum, Betula utilis, Abies pindrow, Quercus semecarpifolia, Rhododendron campanulatum, R. anthopogon, Berberis jaeschkeana, Arnebia benthamii, Dactylorhiza hatagirea, Bergenia stracheyi, Rheum australe, Picrorhiza kurrooa, Aconitum heterophyllum, Meconopsis aculeata.* The notable species of the altitudinal zone >3800 m were *Betula utilis, Dactylorhiza hatagirea, Juniperus recurva, J. indica, Bergenia stracheyi, Rheum webbianum, Oxyria digyna, Picorhiza kurrooa, Aconitum heterophyllum*, etc. Some of the species have wide range of distribution. The notable species are *Geranium nepalense, Cerastium fontanum, Selinum tenuifolium, Heracleum candicans, Taraxacum officinale, Swertia angustifolia, Leucas lanata*, etc.

B) Quantitative assessment of vegetation in Hamta Jagatsukh catchments

B-1) Site Characteristics

Total 54 sites have been sampled in both Hamta and Jagatsukh catchments for the analysis of vegetation. 29 sites were sampled in Allain catchment along an altitudinal range, 1990-3700 m and 25 sites in Duhangan catchment along an altitudinal range, 1860-3850 m. The sampling of the vegetation was done between latitudes $32^0$11.206″ N to $32^0$16.120' N and longitudes $77^0$12.415' E to $77^0$18.885' E**.** Study covers all the accessible habitats and aspects. Shady Moist habitat represented maximum sites (15 sites) in both the Hamta and Jagatsukh catchments, followed by riverine habitat (10 sites), degraded and bouldary (6 sites, each) and Alpine meadows (4 sites). Maximum sites (17 sites) represented in North West aspect, followed by West (12 sites) and South (7) aspects. Slope ranges form 10^0 to 75^0. Site characteristics and geo-references of the sampled sites have been presented in *Table 4.38*.

Figure 4.21 Altitudinal distribution of Floristic Diversity



Abbreviations used: T=Trees; Sh=Shrubs; H=Herbs; F=Ferns

Table 4.45 Site Characteristics and Geo-references of the sites sampled in Hamta and Jagatsukh Catchments

Site No.	Altitude (m)	Habitat	Community	Slope (°)	Latitude	Longitude	Aspect
A. Hamta Catchment							
1*	1992	D	PP -ID	55	$32^0$13.683′ N	$77^0$12.497′ E	N W
2*	2012	SM	QF	35	$32^0$13.486′ N	$77^0$12.415′ E	N W
3*	2020	SM	PW	35	$32^0$13.419′ N	$77^0$12,443′ E	N W
4*	2780	SM	PS	60	$32^0$13.522′ N	$77^0$13.199′ E	N W
5*	2481	D	UV	60	$32^0$13.951′ N	$77^0$12.905′ E	W
6*	2730	SM	PS	45	$32^0$13.647′ N	$77^0$13.346′ E	SW
7*	2804	R	PS	40	$32^0$13.489′ N	$77^0$13.521′ E	SE
8*	2229	D	CD	40	$32^0$13.362′ N	$77^0$12.621′ E	W
9	2105	R	UV	55	$32^0$13.946′ N	$77^0$12.762′ E	NW
10*	2250	Dr	PW	65	$32^0$13.604′ N	$77^0$12.670′ E	W
11	2221	SM	PS	50	$32^0$13.215′ N	$77^0$12.493′ E	NW
12	2903	R	AP	52	$32^0$16.010′ N	$77^0$14.050′ E	W
13	3029	AM	VG	50	$32^0$16.120′ N	$77^0$15.009′ E	W
14	3248	B	BU	50	$32^0$16.012′ N	$77^0$15.281′ E	NW
15	3131	SM	AP	65	$33^0$15.391′ N	$77^0$15.621′ E	NW
16*	2771	R	AA	40	$32^0$15.540′ N	$77^0$14.571′ E	NW
17*	2785	R	QS	10	$32^0$15.643′ N	$77^0$14.472′ E	NW
18*	2790	SM	AP	50	$32^0$15.261′ N	$77^0$14.231′ E	SW
19	3180	Ro	BU-AA	65	$32^0$14.770′ N	$77^0$14.430′ E	N
20	3440	AM	JI	45	$32^0$14.533′ N	$77^0$14.690′ E	NW
21	3560	B	CF-SC-AV	45	$32^0$14.372′ N	$77^0$14.849′ E	W
22	3491	Sc	RS-BJ	53	$32^0$14.214′ N	$77^0$14.676′ E	SW
23*	2735	S	AP	50	$32^0$14.604′ N	$77^0$13.655′ E	W
24*	2748	D	PS	45	$32^0$14.234′ N	$77^0$13.418′ E	NW
25	2818	S	AP	65	$32^0$14.689′ N	$77^0$13.394′ E	S
26	3050	S	AP-QS	30	$32^0$13.576′ N	$77^0$13.865′ E	SE
27	3147	SM	QS	35	$32^0$13.662′ N	$77^0$14.009′ E	SW
28	3013	OS	VG	50	$32^0$13.640′ N	$77^0$13.430′ E	S

Site No.	Altitude (m)	Habitat	Community	Slope (^{o})	Latitude	Longitude	Aspect
29*	2618	B	JR	30	32^{0}14.114′ N	77^{0}13.195′ E	W
B. Jagatsukh Catchment							
1	2266	SM	PS	75	32^{0}11.613′ N	77^{0}13.571′ E	NE
2	2225	R	PS	40	32^{0}11.552′ N	77^{0}13.345′ E	NW
3	2170	SM	PS	60	32^{0}11.667′ N	77^{0}13.216′ E	N
4	2063	Dr	PS	20	32^{0}11.698′ N	77^{0}12.919′ E	N
5	2445	D	PS	65	32^{0}11.261′ N	77^{0}12.882′ E	W
6	2461	SM	AP	65	32^{0}11.279′ N	77^{0}12.946′ E	N
7	2508	R	AP	50	32^{0}11.206′ N	77^{0}12.938′ E	NW
8	2479	D	PS	45	32^{0}11.283′ N	77^{0}13.158′ E	NW
9	2456	SM	AI-PS	70	32^{0}11.411′ N	77^{0}13.479′ E	NE
10	2510	Ro	PS	80	32^{0}11.340′ N	77^{0}13.501′ E	SW
11*	2067	B	QF	40	32^{0}11.842′ N	77^{0}12.924′ E	S
12*	2130	Sh/B	IH-ST	45	32^{0}11.795′ N	77^{0}13.773′ E	SW
13*	2380	OG	IH-RR-SC	20	32^{0}11.834′ N	77^{0}14.019′ E	W
14	2389	SM	PW	70	32^{0}11.951′ N	77^{0}14.005′ E	S
15*	2291	B	PS-AI	45	32^{0}11.748′ N	77^{0}13.842′ E	SW
16	2365	Ro	PW	75	32^{0}11.799′ N	77^{0}13.514′ E	S
17*	2693	SM	AP	65	32^{0}11.959′ N	77^{0}14.816′ E	W
18	2788	R	AA	50	32^{0}12.005′ N	77^{0}15.077′ E	NW
19	3713	AM	RB-PA-AT-PB	55	32^{0}11.500′ N	77^{0}18.436′ E	NW
20	3777	B	DI-AT- SC	35	32^{0}11.445′ N	77^{0}18.751′ E	S
21	3851	AM	RA	60	32^{0}11.302′ N	77^{0}18.504′ E	N
22	3230	R	BU-AA	35	32^{0}11.918′ N	77^{0}16.885′ E	S
23	3160	SM	BU	50	32^{0}11.958′ N	77^{0}16.212′ E	N
24*	3185	S	AA	40	32^{0}11.850′ N	77^{0}16.153′ E	NW
25*	3120	R	BU-AA	10	32^{0}12.018′ N	77^{0}16.192′ E	W

Abbreviations Used: PP-ID=Pyrus pashia-Ilex dipyrena; QF= Quercus floribunda; PW=Pinus wallichiana; PS=Picea smithiana; UV=Ulmus villosa; AP=Abies pindrow; AA=Acer acuminatum; JR=Juglans regia; QS-AP=Quercus semecarpifolia-Abies pindrow mixed; QS=Quercus semecarpifolia; BU-AA=Betula utilis-Acer acumintum; PS-AI= Picea smithiana-Aesculus indica; PW=Pinus wallichiana; VG=Viburnum grandiflorum; JI=Juniperus indica; RS-BJ=Rosa sericea-Berberis jaeschkeana; RA=Rhododendron anthopogon; IH-ST=Indigofera heterantha-Sorbaria tomentosa; IH-RR-SC=Indigofera heterantha-Rabdosia rugosa-Spiraea canescens mixed; RB-PA-AT-PB=Rhodiola bupleuroides-Potentilla atrosanguinea–Anaphalis triplinervis-Phlomis bracteosa; DI-AT-SC=Dipsacus inermis -Anaphalis triplinervis-Sibbaldia cuneata; CF-SC-AV=Carex foliolosa-Sibbaldia cuneata-Artemisia vestita; S=South; W=West; N=North, SW=South West; NW=North West; SE=South East; D=Degraded; SM=Shady Moist; R=Riverine; Dr=Dry forest; AM=Alpine Meadows; B=Bouldary; Ro=Rocky; Sc=Shrubbery; OS=Open Slope
* Sites representing high project impact area

B-2) Community Diversity, Distribution Pattern, Species Composition and Structure

A total of 23 communities (Forests: 14; Shrubs: 02; Alpine Scrubs: 4; & Alpine Herbs: 03) have been identified based on Importance Value Index and Relative density, respectively from the Hamta Jagatsukh Catchments between 1800-4800 m. Forest communities were represented by evergreen coniferous communities (*i.e., Abies pindrow, Pinus wallichiana, Picea smithiana* and *Cedrus deodara*); broad leaved evergreen communities (*i.e., Quercus floribunda,* and *Q. semecarpifolia*); evergreen coniferous-broad leaved deciduous communities (*i.e., Abies pindrow-Acer acuminatum, Picea smithiana-Aesculus indica*); evergreen coniferous and broad leaved community (i.e. *Abies pindrow- Quercus semecarpifolia*); evergreen-deciduous broad leaved community (i.e. *Ilex Dipyrena- Pyrus pashia* mixed); broad leaved deciduous communities (*i.e., Acer acuminatum, Ulmus villosa, Betula utilis, Juglans regia* and *Betula utilis-Acer acuminatum* mixed). The community types, altitudinal distribution, representation in sites, habitats, and major tree associates have been presented in *Table 4.39.*

Amongst the communities, *Picea smithiana* community represented maximum sites (12 sites), followed by *Abies pindrow* (08 sites), *Pinus wallichiana* (04 sites), and remaining communities represented < 4 sites. The alpine communities were represented by Scrub communities (i.e., *Juniperus indica*; *Rhododendron anthopogon*; *Rosa sericea-Berberis jaeschkeana*; and *Viburnum grandiflorum*. herb communities (i.e., *Rhodiola bupleuroides-Potentilla atrosanguinea–Anaphalis triplinervis-Phlomis bracteosa*; *Dipsacus inermis-Sibbaldia cuneata-Anaphalis triplinervis*; *Carex foliosa-Sibbaldia cuneata-Artemisia vestita*). The distribution patterns of communities along an altitudinal gradient and within the habitats are presented in *Table 4.40.*

Over all, 324 species (Trees: 23; Shrubs: 53; Herbs: 249) were recorded. Amongst the communities, *Picea smithiana* showed maximum number of species i.e., 192 species (Trees: 14; Shrubs: 29; Herbs: 149), followed by *Abies pindrow* 136 species (Trees: 11; Shrubs: 21; Herbs: 104) and *Ulmus villosa* 119 species (Trees: 5; Shrubs: 20; Herbs: 94) communities. Minimum number of species were recorded in *Quercus semecarpifolia* (Trees: 5; Shrubs: 2; Herbs: 34).

Amongst the identified forest communities, in the Hamta-Jagatsukh Catchments, the total tree density ranged from 30.0-1280.0 Ind ha^{-1} and total basal area from 0.74-1964.20 m^2 ha^{-1}. *Pinus wallichiana* community had maximum tree density (120-1280 Ind ha^{-1}), followed by *Betula utilis-Acer acuminatum* mixed community (240-1020 Ind ha^{-1}), *Quercus semecarpifolia* (880-930 Ind ha^{-1}) and *Betula utilis* (850-920 Ind ha^{-1}), communities. *Abies pindrow* community showed maximum range of total basal area (12.4-1964.2 m^2 ha^{-1}), followed by *Quercus semecarpifolia* (382.2-1725.1 m^2 ha^{-1}) and *Picea smithiana* (10.8-1597.5 m^2 ha^{-1}). *Quercus semecarpifolia-Abies pindrow* (1289.6 m^2 ha^{-1}) and *Cedrus deodara* (845.6 m^2 ha^{-1}), communities were represented in one site only.

Among the alpine scrub communities, density ranged from 260-2090 Ind ha^{-1} and herb density ranged from 5390-9830 Ind ha^{-1}. *Rasa sericea-Berberis jaeschkeana* mixed community had maximum density (2090 Ind ha^{-1}), followed by *Juniperus indica* (1010 Ind ha^{-1}) and *Rhododendron anthopogon* (750 Ind ha^{-1}) communities. Amongst the alpine herb communities, *Carex foliosa-Sibbaldia cuneata-Artemisia vestita* mixed community had maximum herb density (9830 Ind ha^{-1}), followed by *Rhodiola bupleuroides-Potentilla atrosanguinea–Anaphalis triplinervis-Phlomis bracteosa* mixed community (9190 Ind ha^{-1}).

Table 4.46 *Community types, their Distribution, Density and Total Basal Area in Hamta and Jagatsukh Catchments, Himachal Pradesh*

SN	Communities	SR	Habitat (s)	Altitudinal range (m)	Slope (°)	TBA (m^2ha^{-1})	Density (Ind ha^{-1})
A.	Forests						
1	Pyrus pashia-Ilex dipyrena mixed	1	D	1992	55	0.74	60
2	Picea smithiana	12	SM, Ro, D, R	2063-2804	40-70	10.8-1597.5	30-640

SN	Communities	SR	Habitat (s)	Altitudinal range (m)	Slope (°)	TBA (m^2ha^{-1})	Density (Ind ha^{-1})
3	Pinus wallichiana	4	SM, Ro, D	2020-2389	35-75	38.6-680.9	120-1280
4	Abies pindrow	8	SM, R	2461-3131	50-65	12.5-1964.2	70-720
5	Quercus floribunda	2	B, SM	2012-2067	35-40	31.4-83.6	250-330
6	Acer acuminatum	3	R, SM,	2771-3185	40-50	356.0-375.9	380-410
7	Betula utilis	2	SM, B	3160-3248	50	109.9-353.3	520-850
8	Ulmus villosa	2	D, R	2481-2105	55-60	3.4-382.8	50-370
9	Quercus semecarpifolia	2	R, SM	2785-3147	10-35	382.9-1725.1	880-930
10	Cedrus deodara	1	D	2229	40	845.6	230
11	Betula utilis-Acer acuminatum mixed	3	R, RO	3120-3231	10-65	223.3-941.1	240-1020
12	Picea smithiana-Aesculus indica mixed	2	SM, B, SW	2291-2456	45-70	10.1-427.8	150-360
13	Juglans regia	1	B	2618	30	694.2	380
14	Quercus semecarpifolia-Abies pindrow mixed	1	SM	3050	30	1289.6	810
B.	Shrubs						
15	Sorbaria tomentosa-Indigofera heterantha mixed	1	D	2130	45	-	520
16	Indigofera heterantha – Rabdosia rugosa -Spiraea canescens mixed	1	D	2380	20	-	3890
C.	Alpine Scrubs						
17	Juniperus indica	1	AM	3440	45	-	1010
18	Rosa sericea-Berberis jaeschkeana mixed	1	AS	3851	60	-	2090
19	Viburnum grandiflorum	2	AM	3013-3030	50	-	260-350
20	Rhododendron anthopogon	1	Sc	3491	53	-	700
D.	Alpine Herbs						
21	Dipsacus inermis-Sibbaldia cuneata-Anaphalis triplinervis mixed	1	B	3777	35	-	5390
22	Carex foliosa-Sibbaldia cuneata-Artemisia vestita mixed	1	B	3560	45	-	9830
23	Rhodiola bupleuroides-Potentilla atrosanguinea-Anaphalis triplinervis-Phlomis bracteosa mixed	1	AM	3713	55	-	9190

Abbreviations used: SR=Site Representation; TBA=Total Basal Area; IVI=Importance Value Index; S=South; W= West; N= North; E=East; SW=South West; NW= North West; SE=South East; D=Degraded; SM=Shady Moist; R=Riverine; Dr=Dry forest; AM=Alpine Meadows; B=Bouldary; Ro=Rocky; Sc= Alpine Scrubs; OS=Open Slope

Table 4.47 *Distribution pattern, latitude and longitude ranges of communities and their major associates in Hamta and Jagatsukh catchments*

SN	Communities	Altitude range (m)	Aspects	Latitude	Longitude	Major associate
A	Forests					
1	Pyrus pashia-Ilex dipyrena mixed	1992	NW	$32^0$13.683′ N	$77^0$12.497′ E	*Quercus floribunda*
2	Picea smithiana	2063-2804	NW, NE, N, W, SW, SE	$32^0$11.261′ - $32^0$14.234′ N	$77^0$12.493′- $77^0$13.571′ E	*Aesculus indica, Abies pindrow, Juglans regia*
3	Pinus wallichiana	2020-2389	S, NW, W	$32^0$11.799′ - $32^0$13.604′ N	$77^0$12.443′- $77^0$14.005′ E	*Cedrus deodara, Picea smithiana*
4	Abies pindrow	2461-3131	W, N, NW	$32^0$11.206′ - $32^0$16.010′ N	$77^0$12.938′- $77^0$15.842′ E	*Aesculus indica, Picea smithiana, Acer acuminatum*
5	Quercus floribunda	2012-2067	NW, S	$32^0$11.842′ - $32^0$13.604′ N	$77^0$12.415′- $77^0$12.924′ E	*Picea smithiana*
6	Acer acuminatum	2771-3185	NW	$32^0$11.850′ - $32^0$15.540′ N	$77^0$14.571′- $77^0$16.153′ E	*Betula utilis, Abies pindrow, Quercus semecarpifolia*
7	Betula utilis	3160-3248	N,NW	$32^0$11.958′ - $32^0$16.012′ N	$77^0$15.281′- $77^0$16.212′ E	*Acer acuminatum, Abies pindrow*
8	Ulmus villosa	2481-2105	W	$32^0$13.683′ - $32^0$13.951′ N	$77^0$12.767′- $77^0$12.905′ E	*Prunus cornuta, Salix daphnoides, Celtis australis*
9	Quercus semecarpifolia	2785-3147	NW, SW	$32^0$13.662′ - $32^0$15.643′ N	$77^0$14.009′- $77^0$14.472′ E	*Betula utilis, Taxus baccata subsp. wallichiana, Abies pindrow*
10	Cedrus deodara	2229	W	$32^0$13.362′ N	$77^0$12.621′E	*Picea smithiana, Pinus wallichiana*
11	Betula utilis- Acer acuminatum mixed	3120-3231	S, W, N	$32^0$11.918′ - $32^0$14.770′ N	$77^0$14.430′- $77^0$16.885′ E	*Prunus cornuta, Abies pindrow*
12	Picea smithiana-Aesculus indica mixed	2291-2456	NE	$32^0$11.799′ - $32^0$13.486′ N	$77^0$13.479′- $77^0$13.742′ E	*Abies pindrow, Cedrus deodara*
13	Juglans regia	2618	W	$32^0$14.144′ N	$77^0$12.493′- $77^0$13.195′ E	*Aesculus indica, Picea smithiana*
14	Q uercus semecarpifolia-Abies pindrow mixed	3050	SE	$32^0$13.576′ N	$77^0$13.665′ E	Taxus baccata subsp. *wallichiana, Picea smithiana*
B.	Shrubs					
15	Indigofera heterantha -Sorbaria tomentosa mixed	2130	SW	$32^0$11.795′ N	$77^0$13.773′ E	*Cyathula tomentosa, Spiraea canescens*
16	Indigofera heterantha – Rabdosia rugosa - Spiraea canescens mixed	2380	W	$32^0$11.834′ N	$77^0$14.019′ E	*Prinsepia utilis, Sorbaria tomentosa*
C.	Alpine Scrubs					
17	Juniperus indica	3440	NW	$32^0$14.533′ N	$77^0$14.690′ E	*Rosa sericea, Cotoneaster acuminatum*
18	Rosa sericea -Berberis jaeschkeana mixed	3851	N	$32^0$14.214′ N	$77^0$14.676′ E	*Juniperus indica, cotoneaster acuminatus*
19	Viburnum grandiflorum	3013-3030	S, W	$32^0$13.640′- $32^0$16.120′ N	$77^0$13.430′- $77^0$15.009′E	*Rosa sericea, Cotoneaster*

SN	Communities	Altitude range (m)	Aspects	Latitude	Longitude	Major associate
						acuminaum
20	Rhododendron anthopogon	3491	SW	32⁰11.302′ N	77⁰18.504′ E	*Rosa sericea*
D.	Alpine Herbs					
21	Dipsacus inermis-Sibbaldia cuneata-Anaphalis triplinervis mixed	3777	S	32⁰11.445′ N	77⁰18.751′ E	*Potentilla atrosanguinea, Sibbaldia cuneata*
22	Carex foliosa-Sibbaldia cuneata-Artemisia vestita mixed	3560	NW	N32⁰14.372′ N	77⁰14.849′ E	*Anaphalis busua, Potentilla atrosanguinea*
23	Rhodiola bupleuroides-Potentilla atrosanguinea-Anaphalis triplinervis-Phlomis bracteosa mixed	3713	NW	32⁰11.500′ N	77⁰18.436′ E	*Anemone rupicola*

Abbreviations used: SR=Site Representation; S=South; W=West; N=North; E=East; SW=South West; NW=North West; SE=South East; D=Degraded; SM=Shady Moist; R=Riverine; Dr=Dry forest; AM=Alpine Meadows; B=Bouldary; Ro=Rocky; Sc=Alpine Shrubbery; OS=Open Slope

C) Community Diversity, Distribution Pattern, Species Composition and Structure in High Project Area at Hamta and Jagatsukh Catchments

A total of 14 communities (Forests: 12; shrubs: 2) have been identified based on Importance Value Index and Relative density, from High Project Impact Area of the Hamta and Jagatsukh Catchments between 1800-3200m. Forest communities were represented by evergreen coniferous communities (*i.e., Abies pindrow, Pinus wallichiana, Picea smithiana* and *Cedrus deodara*); broad leaved evergreen communities (*i.e., Quercus floribunda*, and *Q. semecarpifolia*); Evergreen coniferous-broad leaved deciduous communities (*i.e., Abies pindrow-Acer acuminatum* mixed, *Picea smithiana-Aesculus indica* mixed,); Evergreen-deciduous broad leaved community (i.e., *Ilex dipyrena- Pyrus pashia* mixed); broad leaved deciduous communities (*i.e., Acer acuminatum, Ulmus villosa, Juglans regia*, and *Acer acuminatum-Betula utilis* mixed). Amongst the communities, *Picea smithiana* and *Abies pindrow* community (3 sites, each), represented maximum sites, followed by *Pinus wallichiana*, *Acer acuminatum* and *Quercus floribunda* (2 sites, each), and remaining communities represented < 2 sites.

Over all, 284 species (Trees: 18; Shrubs: 46; Herbs: 220) were recorded. Amongst the communities, *Picea smithiana*community showed maximum number of species 137 (Trees: 8; Shrubs: 29; Herbs: 100), followed by *Pinus wallichiana* 95 species (Trees: 8; Shrubs: 20; Herbs: 67) and *Abies pindrow* 94 species (Trees: 8; Shrubs: 14; Herbs: 72) communities. Minimum numbers of species were recorded in *Cedrus deodara* community 44 species (Trees:3; Shrubs:8; Herbs:33).

Amongst the identified forest communities in the high project impact area, the total tree density ranged from 60.0-1280.0 individuals ha^{-1} and total basal area from 0.74-1964.20m^2 ha^{-1}. *Pinus wallichiana* community had maximum tree density (160-1280 Ind ha^{-1}), followed by *Quercus semecarpifolia* (930 Ind ha^{-1}), *Acer acuminatum-Betula utilis* mixed community (470-720 individuals ha^{-1}), and *Picea smithiana* (220-640 individuals ha^{-1}), communities. *Abies pindrow* community showed maximum range of total basal area (1122.20-1964.20 m^2 ha^{-1}), followed by *Picea smithiana* (580.80-1126.40m^2 ha^{-1}), *Cedrus deodara* (845.60m^{2}ha^{-1}) and *Juglans regia* (694.20 m^{2}ha^{-1}), communities. Refer to *Annex F* for quantitative details.

D) Communities: Composition, Structure and Regeneration Pattern

Composition, structure and regeneration pattern of the communities identified in Hamta- Jagatsukh Catchments have been presented in *Annex F*

Followed by the zone, 2800-3800 m (Herbs:179; Shrubs: 70; Trees:10 and Ferns: 3).The species was comparatively very low in > 3800 m (Herbs:64; Shurbs: 6 and Tree: 1). Details of floral distribution regarding the Diversity and utilization pattern of economically important plants of Hamta and Jagatsukh catchments is provided in *Annex F*.

E) Assessment and identification of Rare Endangerd Species

E-1) Diversity and categorization

A total of 49 species have been identified as rare/endangered (***Table 4.42***). However, using current criteria of International Union for Conservation of Nature and Natural Resources (IUCN):

- 5 species have been categorized as **"Critically Endangered"** (*Saussurea obvallata, Gentiana kurroo, Arnebia benthamii, Dactylorhiza hatagirea* and *Saussurea costus*);
- **12** species as "**Endangered"** (*Aconitum heterophyllum, Angelica glauca, Betula utilis, Bergenia stracheyi, Dioscorea deltoidea, Meconopsis aculeata, Paris polyphylla, Podophyllum hexandrum Polygonatum cirrhifolium, Picrorhiza kurrooa, Taxus baccata subsp. wallichiana and Zanthoxylum armatum*);
- **8** species as "**Vulnerable"** (*Aconitum violaceum, Polygonatum verticillatum, P.multiflorum, Rheum australe, R. webbianum, Rhododendron campanulatum, R. anthopogon* and *Valeriana jatamansi*);
- **1** species as "**Near threatened'** (*Hippophae salicifolia*);
- **1** species as **"Exinct in wild"** (*Saussurea costus*) (Samant & Pal, 2003; Ved et al.,2003); and
- **22 species were idenfied as "Rare"**

In general, *Saussurea costus* has been placed under "Critically Endangered" cartegory, however, in Himachal Pradesh this species has been placed under the category, "Extinct in Wild".

Similarly, other species which have not been categorized but facing habitat degradation and over exploitation may be considered under "Vulnerable" category whereas species presently not facing such problems may be considered under "Near Threatened" or "Least Concern" categories.

Table 4.48 Diversity and Distribution Pattern of Rare Endangered Plants of Hamta Jagatsukh Catchments

Taxa	Locality	Altitudinal range (m)	Life Form	Status in H.P./ Global
Ranunculaceae				
Aconitum heterophyllum Wall.ex Royle	I,J,L,M	3000-4200	H	CR (CR)
A. violaceum Jacq. ex Stapf`	I,J,L,M	3500-4000	H	VU (VU)
Delphinium denudatum Royle	A,B,F,H	2000-2600	H	R
Violaceae				
Viola biflora L.	A,B, D, H, F,O	2400-2600	H	R
Papaveraceae				
Meconopsis aculeata Royle	J, L, M, N	3000-3500	H	EN(EN)
Podophyllacaeae				
Podophyllum hexandrum Royle	A, B, H, D, F, I, L, O	1800-4000	H	EN
Rutaceae				
Zanthoxylum armatum DC.	A, F	2000-2500	H	EN
Aquifoliaceae				
Ilex dipyrena Wall.	A, F, G	1800-3000	T	R
Aceraceae				
Acer caesium Wall. ex Brandis	C,D,H, O	2400-3200	T	R
Fabaceae				
Caragana gerardiana Royle ex Benth.	I, J, M, N	2000-2400	Sh	R
Saxifragaceae				
Bergenia stracheyi (Hk. f. & Th.) Engl.	B, D, H, I, L,M	2800-4000	H	EN
Apiaceae				
Angelica glauca Edgew.	A, B, F, O	2100-2800	H	EN (EN)
Chaerophyllum villosum Wall. ex DC.	I, E, K, L, M	2500-3500	H	R
Heracleum candicans Wall. ex DC.	A,B, F, O	2000-4000	H	R
Valerianaceae				
Valeriana jatamansi Jones	A, B,F, H,G	2000-3000	H	VU
Asteraceae				
Saussurea costus (Falk.) Lipsch.	D	2500-3500	H	EW (CR)
S. obvallata (DC.) Edgew.	I, M, K	3500-4000	H	CR
Campanulaceae				
Codonopsis rotundifolia Benth.	N, I	3000-4000	H	R
C. viridis (DC.) Roxb.	I,M	2500-3300	H	R
Ericaceae				
Rhododendron arboreum Sm.	G	2500-2700	T	R
R. campanulatum D.Don	L, I, J, K, M,	3000-4000	Sh	VU
R. anthopogon D.Don	J, K, N	3000-4000	Sh	VU
Gentianaceae				
Gentiana kurrooa Royle	K, M, N	2400-4000	H	CR (CR)
Boraginaceae				
Arnebia benthamii (Wall. ex G.Don) Johnst.	I, K, M, N	3300-4000	H	CR (CR)
Cynoglossum zeylanicum Vahl ex Harnem	A, F	1900-2500	H	R
Scrophulariaceae				
Picrorhiza kurrooa Royle	L, M, N, I,	3000-4200	H	EN
Polygonaceae				
Rheum australe D.Don	J, M, N	3000-4200	H	VU
R. webbianum Royle	I, K, L, M, N	3000-4200	H	VU (VU)
Elaeagnaceae				
Hippophae salicifolia D. Don	G	2400-2900	Sh	NT
Betulaceae				

Taxa	Locality	Altitudinal range (m)	Life Form	Status in H.P./ Global
Betula alnoides Buch.-Ham. ex D.Don	F	2000-2500	T	R
B. utilis D.Don	G, J, L, M, F,O	3000-4500	T	EN
Corylaceae				
Corylus jacquemontii Decne	H	1900-2700	T	R
Orchidaceae				
Dactylorhiza hatagirea (Don) Soo	L, J, M	3000-4000	H	CR
Oreorchis indica Hk. f.	H, F, G, E	2500-2800	H	R
Dioscoreaceae				
Dioscorea deltoidea Wall.	A, B, C, F,G	1800-2500	H	EN (EN)
D. melanophyma Burkill & Prain	A, B, C	1800-2500	H	R
Liliaceae				
Fritillaria roylei Hk.	F	2100-2700	H	EN (EN)
Paris polyphylla Sm.	F, D	2000-3000	H	EN
Polygonatum cirrhifolium (Wall.) Royle	A,B,D, F, H	1900-3000	H	EN
P. verticillatum (L.) All.	A,B,D, F, H, O	1900-3500	H	VU
P. multiflorum (L.) All.	A,B,D, F, H	1900-3000	H	VU
Gymnosperms				
Cupreassaceae				
Juniperus communis L.	J, M,L	2500-3500	Sh	R
Taxaceae				
Taxus baccata subsp. wallichiana (Zucc.) Pilger	A, B, C, F,H,O	2500-3500	T	EN
Pteridophytes				
Botrychiaceae				
Botrychium ternatum (Thunb.) Stz.	D, E, H,	2500-3000	F	R
Osmundaceae				
Osmunda japonica Thunb.	A, B, F	1900-2500	F	R
Dryopteridaceae				
Polystichum nepalense (Spreng.) C.Chr.	B, D, E, F, O	1900-2500	F	R
Aspleniaceae				
Asplenium septentrionale (L.) Hoffm.	E	1900-2500	F	R
Phymatopteris stracheyi (Ching) P. Sermolli	I, M, D	2500-3300	F	R
Hemionitidaceae				
Gymnopteris vestita (Wall. ex Moore) Underwood	A, F, G, D, E	1800-2500	F	R

Abbreviations used: H=Herb; Sh=Shrub; T=Tress; F=Fern; R=Rare; EW=Extinct in wild; EN= Endangered; VU= Vulnerable; and LC= Least Concern. NT= Near Threatened; A=Prini Nallah; B=Hamta; C=Hamta potato farm; D=Sethan; E=Pandu Ropa; F=Jagatsukh nallah; G=Khanoor; H=Brun Dhar; I=Chhika; J=Seri; K= Banshiru; L=Bujh Dhar; M= Jabri Nallah; N=Marasu Nallah; and O=Dam site *CR, EN, VU, EW and NT is based on IUCN; ( ) =category in parenthesis global status

4.6 *RIVERINE ECOLOGY OF THE PROJECT CATCHMENT AREA*

4.6.1 *Approach and Methodology*

A study was undertaken to assess variations across seasons during a year, especially fluxes in flow volumes, water temperatures, TDS and pH values, as well as seasonal presence-absence of fish fauna.

Fish fauna: Fishing nets (cast-nets of two weave densities) and a rod were used in the main stream, and a dip net was used for catching small fishlings from slow flowing pools at the side.

Benthic Macro Invertebrates: A D-net and a sieve were used for studying insects present in the sand and sticking to the undersides of stones and other substrate.

Water parameters

a) Temperature

Both alcohol and mercury thermometers were used for recording water temperature. The temperatures mentioned here are from the mercury thermometer.

b) pH, electrical conductivity, total dissolved solids, total acidity, potassium & sodium

Samples were taken seasonally from all three rivers and tested at the Irrigation and Drainage Department of Govind Ballabh Pant University of Agriculture and Technology Pantnagar, Udham Singh Nagar, Uttaranchal.

c) Measurement of Flow Volumes

The Float Velocity Method was used to measure the flow volume. The average depths of the rivers were taken at one foot interval at evenly flowing stretches of the river, and the width at that place also measured. Floating balls were used for measuring the velocity [meter per Second] of the river. For measuring the flow of the river, the width of river, the average depth and the velocity of water was multiplied.

All three sub-watersheds were traversed in the four seasons, depending on the snow conditions, right from their confluence with the Beas and upto the glaciers of origin. The flora and fauna was studied for the vicinity of the streams. Intensities and trajectories of land-use were also sought to be understood by discussions with alpine shepherds, buffalo herders, herb collectors, fishermen, agriculturists and other residents of the villages. Discussions were also held with the Project Staff, officials of the Fisheries Department, the National Research Centre for Cold Water Fisheries at Bhimtal, as well as ERM Officers, who also provided some data.

4.6.2 Habitat Types & Ecological Features

The Allain and Duhangan rivers have a continuum of Stream Orders 1 to 3. The Pahli stream is of Stream Orders 1 and 2. All three streams consist of ephemeral, intermittent and perennial flows and are steeply cascading, descending rapidly with-in the short distance that they traverse, through a series of waterfalls and cascades. Accretion zones of gravel, shingle and sand were in the lower stream reaches close to their confluence with the Beas. Numerous detention ponds for the collection of sand were found constructed in the lower reaches of the Alleo stream only. The pool-riffle ratios and sequence in both Alleo and especially the Duhangan stream were excellent, often 1:1, bearing a very desirable combination of riffles, plunge pools, step pools, runs and glides in the Duhangan. The richness of fish catches in the Duhangan also supports presence of a good fish habitat, in the lower stream reaches. River lengths from glaciers/points of origin, to their confluence with the Beas river is presented in *Table 4.48* below.

Table 4.49 Stream lengths and profiles

Stream	Length (km)
Duhangan stream	= 18.6 km
Alleo stream	= 15.38 km
Pahli stream	= 6.26 km
Sum total of length of rivers including tributaries	
Total length of Duhangan stream	= 20.29 km
Total length of Alleo stream including Jabri nala	= 44.25 km
Altitude difference between source and confluence of stream	
Duhangan stream	4880 m to 1760 m
Alleo stream	4240 m to 1840 m
Pahli stream	3920 m to 1840 m

Spatial Profiles of the three streams is given in the *Figure 4.22-4.25*

Figure 4.22 Alain stream -Spatial profile

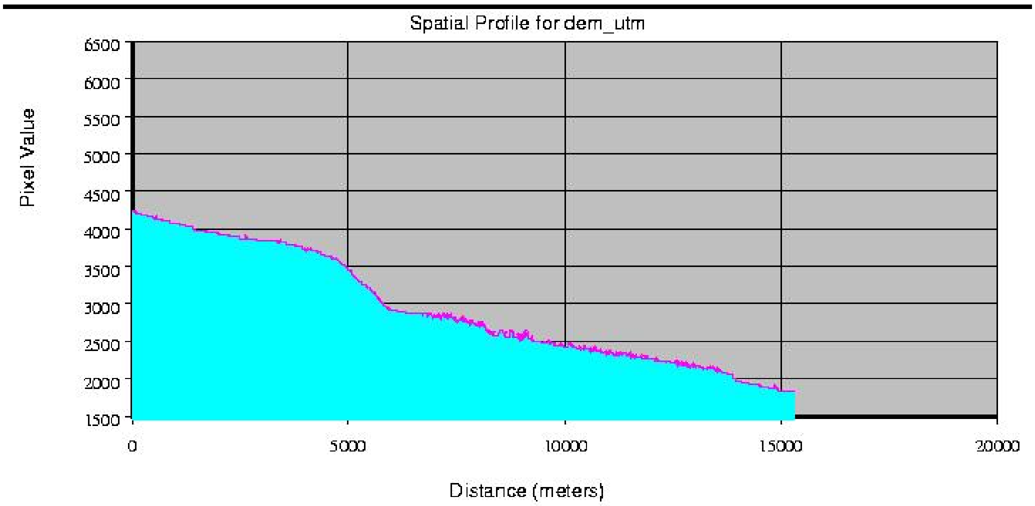


Figure 4.23 ***Duhagan Stream -Spatial Profile***

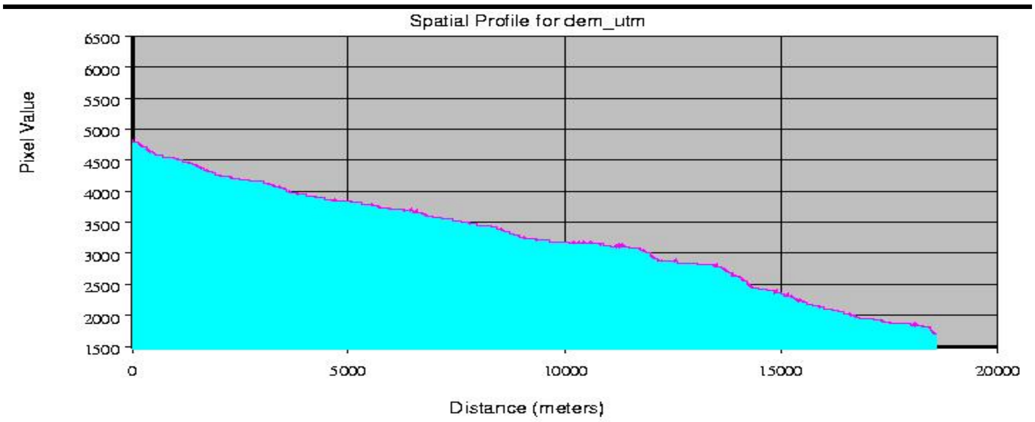
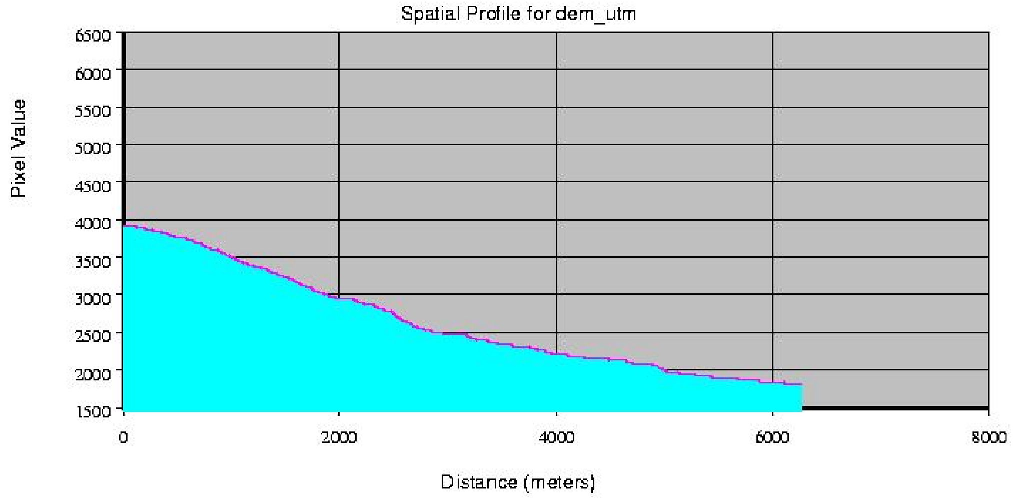


Figure 4.24 ***Pahali Stream -Spatial Profile***



Details of water quality of all the three streams during the survey period (in year 2005) are provided in the *Annex G*.

4.6.3 Riverine Fauna

The fish species found in these two streams were Schizothorax richardsonii (Gray) generically known as Snow trout, and Salmo trutta fario, generically the Brown trout.

Table 4.50 ***Ichthyfauna in the Allain, Pahli and Duhangan streams***

Month	Alleo	Duhangan	Pahali
February	Four spp. of Mollusc Class Pelecypoda.	Schizothorax richardsonii (Gray)	
March		Salmo trutta fario	--
April	Salmo trutta fario	--	--
May	--	--	--
June	Schizothorax richardsonii (Gray)	Salmo trutta fario	Schizothorax richardsonii (Gray)
July	Schizothorax richardsonii (Gray)	--	--
August	--	--	--

Month	Alleo	Duhangan	Pahali
September	--	Salmo trutta fario	--
October	--	--	--
November	--	--	--
December	--	--	--
January	--	--	--

The fisheries Department has a general list of fish species found in Allain, Duhangan, Ravi, Tirthan, Sainj, Uhl, Baspa, Pabar, Lambadug, Giri, Rana, Nugal Gai, Baner and Bata, among other streams of the Beas. These cover a very large altitude gradient of the Beas, and therefore also include species such as the Mahseer, Nemachilus, Barils, Crossocheilus and Glyptothorax as well, which are not found in Alleo or Duhangan.

While the catches were reasonably frequent, and indicated a very good age diversity, the low species diversity could be for two reasons; one being that the altitude gradients of the streams studied falls under the trout waters which are rather cold for the other species in the general list, and also because of the introduction of Salmo trutta, the Brown Trout and Oncorhynchus mykiss, the Rainbow Trout in the Beas by the Fisheries Department. Both these fish are exotics, and very effective predators of other fish and BMIs. Other than the Schizothoracids, perhaps none of the other species have the speed and agility to match them, or a chance to escape predation should they encounter each other even seasonally in transitional or briefly overlapping river habitats.

In both the Duhangan and the Alleo streams there are successive waterfalls about 1 km and 1.5 km upstream of the confluence, respectively. These waterfalls are over 10 m high with deep plunge pools, and because of the nature of the fall over overhanging rock, are not possible for fish to climb or leap over. Fish fauna was observed only upto these waterfalls in the two streams. In the Pahli stream fish were found up to about 500 m above the bridge.

Due to very steep gradient profiles and subsequent oxygenation, as well as retention of Dissolved Oxygen in stream due to low temperatures in all the three streams, and Duhangan in particular, the waters can be termed as Salmonid. This was further evidenced by the presence of Salmo trutta of great age diversity in the lower reaches of the Duhangan. The DO of Duhangan is by inference, anywhere between 9 and 12 mg/ litre, depending on the season.

Benthic macro invertebrates observed in the streams are listed in the *Table 4.50.*

Table 4.51 Benthic Macro Invertebrates

Benthic macro Invertebrates	Classification
Larvae of May Fly	Order Ephemeroptera
Two species of Caddis fly case maker larvae	Order Tricoptera
Moulted remnants of the Common Stone Fly	Order Plecoptera
Larvae of the Dragonfly	Order Odonata, Suborder Anisoptera
Larvae of the Damselfly	Order Odonata, Suborder Zygoptera
Larvae of the Alderfly	Order Megaloptera, Family Sailidae
Larval grub of the Watersnipe Fly Larvae	Diptera, family Athericidae

Benthic macro Invertebrates	Classification
Predaceous Diving Beetle	Order Coleoptera
4 species of very small Mollusc filter feeders	Class Pelecypoda

Reptiles

Unusually patterned juvenile Himalayan Pit Viper Gloydius himalayanus was identified. Skink Asymblepharus ladacensis was found in large populations at the lateral moraines of the glaciers at the head of both the Alleo and Duhangan streams. In the warm temperate zone in the lower reaches of these streams, the rock agama Laudakia himalayanus was a common sight basking on rocks on sunny days in summer.

Avifauna

The bird fauna sighted during the survey period were:

- Spotted Forktail- *Enicurus maculatus*
- Little Forktail- *Enicurus scouleri*
- Brown Dipper- *Cinclus pallasii*
- Citrine Wagtail- *Motacilla citreola*
- Snow Pigeon- *Columba leuconota*
- Red-billed Chough- *Pyrrhocorax pyrrhocorax*
- Lammergeier- *Gypaetus barbatus*
- Himalayan Snow Cock- *Tetraogallus himalayansis*

4.6.4 Riverine Flora

The Forest Types within the Project catchment area broadly fall under the following, based on the Champion and Seth classification system:

- Western Mixed Coniferous Forests
- Moist Temperate Deciduous Forests
- Kharsu Oak Forests
- Western Himalayan Upper Oak Forests
- Himalayan Temperate Pastures
- Western Himalayan Sub Alpine Fir Forests
- Western Himalayan Sub Alpine Birch-Fir Forests
- Sub Alpine Pastures
- Birch Rhododendron Scrub Forests
- Dwarf Rododendron Scrub
- Dwarf Juniper Scrub
- Alpine Pastures.

The upland mountain slopes contain some rich stands of spruce-fir associations, prime communities of blue pine and deodar, and mixed oak forests with an under-storey of yew and maple and the hornbeam. Tree species that were encountered within 100 m of the three streams included the following:

- *Quercus dilatata*
- *Quercus semecarpifolia*
- *Aeschulus indica*
- *Alnus nitida*
- *Populus ciliata*

- *Carpinus viminea*
- *Juglans regia*
- *Acer ceasium*
- *Corylus jacquemontii*
- *Ulmus wallichiana*
- *Prunus spp.*
- *Salix tetrasperma*
- *Pinus wallichiana*
- *Cedrus deodara*
- *Picea morinda*
- *Betula utilis*
- *Rhododendron campanulatum.*

A few Chlorophycean members of green freshwater algae such as Volvox, and Chlamydomonas that form scum, and Oedogonium, Cladophora and Chaetophora on submerged substrata were found, and exhibit a diversity of decomposition rates. This is especially significant for the Schizothorax fish populations in the streams under study as well as the Beas, as they feed primarily on micro-algae which remain attached to rocks. Obligate wetland plants such as Equisetum growing on hydric soils were few, owing to the great fluxes in flow, but fulcative vegetation such as Salix tetrasperma and Alnus nitida, an important nitrogen fixer, were very rich in the lower stream reaches of the Duhangan.

4.6.5 Bio monitoring

Bio monitoring of surface water as well as sediment was also carried out in the study area. Bio monitoring of surface water was carried out to evaluate the quality of water. There are two methods adopted for biological water quality evaluation.

Saprobic Score (BMWP) method involves inventory of the presence of benthic macro-invertebrate fauna up to the family level with the taxonomic precision. All possible families having saprobic indicator value are classified on score scale of 1 to 10 according to their preference for saprobic water quality. The saprobic scores of all the families are registered and averaged to produce BMWP score. Diversity Score (Sequential Comparison) method involves pairwise comparison of sequentially encountered individuals and the difference of two benthic animals can be observed upto the species level, where no taxonomic skill is required. The diversity is the ratio of total number of different animals (runs) and the total number of organisms encountered. The ratio of diversity has a value between 0 and 1.

Table 4.52 Results of Bio Monitoring of Surface Water in Study Area

Sampling Point	Diversity Index	Saprobity Index	Water Quality	Remarks
BW-1RI	4.5	0.50	C	Poor Water Quality
BW-2R2	6.0	0.33	B	Slightly Polluted Water
BW-3-R3	7.25	0.47	A	Clean Water
BW-4-R4	7.0	0.29	A	Clean Water
BW-5-SRF-1	7.25	0.67	A	Clean Water

Sampling Point	Diversity Index	Saprobity Index	Water Quality	Remarks
BW-6-SRF-2	7.0	0.43	A	Clean Water
BW-7-SRF-3	8.33	0.62	A	Clean Water
BW-8-SRF-4	4.5	0.50	C	Poor Water Quality
BW-9-SRF-5	7.25	0.66	A	Clean Water
BW-10-SRF6	7.25	0.70	A	Clean Water
BW-11-SRF7	6.33	0.50	B	Slightly Polluted Water
BW-12-SRF-8	4.55	1.00	C	Poor Water Quality

BW-1-R-1-U/s Confluence of River Allain to River Beas, River Beas; BW-2-R-2-D/s confluence of River Allain to River Beas, River Beas; BW-3-R-3- U/s Confluence of River Dhuhangan to River Beas, River Beas; BW-4-R-4-D/s Confluence of River Dhuhangan to River Beas, River Beas; BW-5-SRF-1-U/s Bridge, Phali Nal at Prini; BW-6-SRF-2-U/s Bridge; Dhuhangan River, at Jagat Sukh; BW-7-SRF-3-U/s Bridge, Allain River, at Prin; BW-8-SRF-4-Hamta Nala, Vill. Hamta; BW-9-SRF-5-In take point on River Allain at Bhujdhar; BW-10-SRF-6-Marasu Nala, Proposed Plant Area, Marasu Dhar; BW-11-SRF-7-D/s In take point on Dhuhangan River; BW-12-SRF-8-U/s In take Point on Dhuhangan River.

Biological examination of the benthic sediments was carried at 6 different locations in Allain and Duhangan streams. The benthic sediments comprised mostly of rocks. Results of biological examination performed for the various samples collected are tabulated under *Tables 4.53–4.58*.

Table 4.53 *Results of Biological Examination in the Sediments from Duhangan near Chorpani, 3 km upstream Jagatsukh Bridge*

S N	Name of the fauna	Number	Plates used for comparison
1	Larva with cause of Ochroticha sp.; Family Hydropapsychidae	31	Plate 24 (J)
2	Larva of order Diapters	37	Plate 23
3	Larva of Tahanus sp.; Family : Tabaniae	30	Plate
	Total number of fauna	98	

** Refer to Annex F1 for reference of Plates*

Table 4.54 *Results of Biological Examination in the Sediments from Duhangan near Jagatsukh bridge*

S N	Name of the fauna	Number	Plates used for comparison
1	Larva with cause of Ochroticha sp.; Family Hydropapsychidae	20	Plate 24 (J)
2	Family: Pteronarcidae	05	Plate 21
3	Larva of Tabanus sp. Family : Tabaniae	03	Plate 26 (E)
4.	Larva of Narpus sp.; Family: Elmidae	05	Plate 27 (E)
5.	Larva of Simulium sp.; Family: Simulidae	09	
6	Larva/pupa of Antocha; Family: Tipulidae	12	Plate 26 (G)
	Total number of fauna	54	

** Refer to Annex F1 for reference of Plates*

Table 4.55 Results of Biological Examination in the Sediments from Duhangan Stream near Beas confluence

S.N	Name of the fauna	Number	Plates used for comparison	Remarks if any
1	Larva Narpus sp.; Family : Elimidae	05	Plate 27 (B)	
2	Larva/midge of Nalabesmyia sp; Family: Chironomidae	10	Plate 25 (C)	
3	Larva of Tabanus sp.; Family : Tabaniae	06	Plate 26 (F)	
4.	Larva with case of Ochroticha sp. ; Family: Hydropsychidae	16	Plate 24 (J)	10 Shells Were Empty
5.	Identified Molluse	02	-	Emty Molluse shell
6.	Larva of Chaoborous sp Family : Culicidae	02	Plate 21 (E)	
7	Larva/midge of Chironomous sp.; Family : Chironomidae	03	Plate 25 (B)	
	Total number of fauna	44		

** Refer to Annex F1 for reference of Plates*

Table 4.56 Results of Biological Examination in the Sediments from Allain Stream, upstream of Powerhouse Location near Guage

S N	Name of the fauna	Number	Plates used for comparison	Remarks if any
1	Larva with cause of Ochroticha sp.; Family Hydropapsychidae	16	Plate 24 (J)	
2	Larva of non-insect	05	-	
3	Unidentified Larva	07	-	Very early stage of development
	Total number of fauna	28		

* Refer to Annex G for reference of Plates

Table 4.57 Results of Biological Examination in the Sediments from Allain near Beas Confluence

S. N.	Name of the fauna	Number	Plates used for comparison	Remarks if any
1	Larva with case of Ochroticha sp Family: Hydropsychidae	19	Plate 24 (J)	
2	Larva of Tabanus sp. Family: Tabanidae	07	Plate 26 (E)	
3	Larva of Narpus sp; Family: Elmidae	05	Flate 27 (B)	
4.	Larva/midge of Ablabesmyia sp. Family: Chironomidae	10	Plate 25 (C)	
5.	Larva of non-insect Arthropod	07		
6.	Un-identified larva	02		Very early stage of development
	Total number of fauna	50		

** Refer to Annex F1 for reference of Plates*

Table 4.58 *Results of Biological examination in the Sediments from Allain, near Hotel Imperial*

S.N.	Name of the fauna	Number	Plates used for comparison	Remarks if any
1	Larva with cause of Ochroticha sp.; Family Hydropapsychidae	17	Plate 24 (J)	
2	Larva of non-insect arthopod	08		
3	Unidentified Larva Very early stage of development	06		All larva are similar in structure
	Total number of fauna	31		

** Refer to Annex F1 for reference of Plates*

Diversity indices for benthos observed for each sampling location are:

Table 4.59 *Diversity Indices for Benthos observed for each Sampling Location*

Stream	Benthos Sampling Location	Diversity index
Duhangan	near Chorpani, 3 km u/s of Jagatsukh bridge	2.28
	near Jagatsukh bridge	4.54
	Duhangan – Beas confluence	4.85
Allain	U/s of powerhouse, near guage	2.50
	Near Hotel Imperial	3.60
	Allain-Beas confluence	4.55

4.7 NATURAL HAZARDS IN THE AREA

4.7.1 Earthquakes

The Project catchment lies within Zone V as per the seismic zoning map of India as per Bureau of Indian Standars [IS 1893 (part1): 2002], which are characterized by frequent occurrences with Richter magnitudes varying up to 8 and corresponds to intensity IX on comprehensive intensity scale (MSK64). This is seismically a very active region and there is no doubt that earthquakes must be factored into design consideration of risk from natural hazards.

Notable earthquake events in the general region include 1905 Kangra earthquake; 1975 Kinnaur-Spiti earthquake; and the 1991 Uttarkashi earthquake.

4.7.2 Floods

Upstream from Manali, the channel morphology of the Beas River is indicative of periodic, high energy flooding. Occasionally, as in early July 1993, early monsoon rainfall coupled with late snowmelt at higher elevations produced a strong flood flow. Other high magnitude flood events occurred in late August and early September in each of 1994, 1995 and 1996. Likewise, coincident flood flows have occurred on major tributaries of the Beas, such as Manalsu stream. Torrents occur from time to time in most streams, including both those with perennial and ephemeral flows. The occurrence of several such events with disastrous consequences in August 1994 in the Kullu District led to suggestions that the frequency and magnitude of such events is on the increase as a consequence of deforestation (G. B. Pant Institute, 1995). There is relatively little physical evidence to suggest this is the case. Examination of historical documents provides evidence of similar torrents in the same locations in the past.

4.7.3 *Forest Fires*

Historical information suggests that, from time to time, forest fires occur in the study area. This is not unusual in forested mountain areas generally. However, there is no evidence from the study area to indicate that extensive burns have occurred in the recent historical period.

4.7.4 *Landslides/Avalaunch*

Mass wasting processes, namely landslides and rockfalls, are common in high mountain environments. Physical evidence indicates that the study area is no exception. Over the years, human activity has contributed to an increase in slope failures in the Himalayas because of the expansion of road networks, settlements, and other developmental activities. Apart from disruption to road transportation and high-sediment delivery into the river system, the landslides also contribute to loss of human lives.

Land surface features indicate large-scale landslide masses and scars in the vicinity of the villages of Chichoga and Solang. These appear to have developed in valley-side colluvial and/or glacial deposits and are probably progressive. The Chichoga feature is evident in photos taken in the early part of this century. It is less evident today, largely because of human alteration of the land surface for agricultural purposes. Nonetheless, progressive failure is likely still occurring. The Solang example is clearly evident today. Minor rockfall activity occurs from most vertical rock slopes throughout the area and, of course, is one of the ongoing processes that leads to the build-up of colluvial deposits. Physical evidence of large-scale rockfall activity is present on the approach to Rohtang Pass.

A devastating landslide occurred on 12 September 1995 near Luggar Bhatti, Kulu, Himachal Pradesh, and killed 65 people. An estimated 0.96 x 106 m^3 of unconsolidated mass slid down the terminal part of a thick alluvial fan, on the left bank of the Beas River. About 0.03 x 106 m^3 of dislodged material formed a 15 m high and 150 m long hump at the bottom of the failed slope; a shallow sag pond developed in the rear. The slide occurred after heavy rains between 3 - 6 September in the region when the Beas rose to a bankfull position. Factors involved in this toppling debris slide included a steep slope, continuous seepage with high pore water pressure in unconsolidated material, a road-cut obliterating the foot of the fan slope, and impinging by the Beas River during the flood. A survey in the area showed that a variety of mass movement processes were triggered by the heavy rains in September; the most predominant being a series of slope failures on the outside of meander loops and bank erosion caused by turbulence of the overflowing Beas River. National Highway-21 (NH-21), a bridge ramp near Bhuntar, a suspension bridge at Kulu and two other bridges upstream sustained extensive damage. Most damage occurred in the Manali area where massive buildings were washed away by the flash flood. Whereas some smaller events occurred in the early and middle part of this century, the recurrence and intensity of mass movements are recent phenomena attributed mainly to escalating socio-economic development, growth of tourism, and population pressure. Recently in March 2008, a landslide occurred in Nehru Kund, which is approximately 4 km from Manali. The landslide was spread over 200 meters and took lives of 25 people.

Snow avalanches are common throughout the upper Beas River watershed during the winter. High snowfall and the development of a deep snowcover makes the region, including parts of Spiti, Kinnaur, Lahul and adjacent Kashmir, one of the most avalanche-prone, inhabited areas of the Himalaya. Because of this and the hazard to habitation and transportation, the Indian government created the Snow and Avalanche Study Establishment at Manali. This is a world-class snow and avalanche research and forecasting center.

Snowstorms and cold spells occur from time to time in the region. From the hazard perspective, these events are most dangerous when they are least expected. The most recent example stemmed from the early July 1993 storm, which created flooding in the upper Beas River watershed. This event also resulted from an unusually late (in the year) occurrence of a strong westerly system, which brought a cold, continental air mass into contact with a warm, moist air mass, representing an early incursion of monsoonal air into the region. At elevations above 3,000 m in the upper Beas, Spiti, and north into Lahul, this system produced very heavy snowfall and an extended period of cold temperatures. This, in turn resulted in road closures and disruption of transhumance grazing activities.

5 SOCIO-ECONOMIC SURVEY

5.1 INTRODUCTION

This section provides details of the socio-economic surveyof the Project area.

5.2 APPROACH AND METHODOLOGY

Although the scope of work envisaged that the baseline would cover villages Prini, Jagatsukh and Hamta, the actual survey was done in villages of Prini, Jagatsukh, Aleo and Old Manali.

The primary information was collected through visits to the affected villages for meetings with the Gram Panchayats (of Prini and Jagatsukh), household survey, consultations with villagers and focussed group discussions with women and below poverty line (BPL) persons. The field survey also included visits to the Project sites for different project components (i.e. colony and approach roads to Project components) in separate villages to observe present use of land to be acquired and nature of losses in the form of agricultural produce and apple trees. At each village a pre-determined set of information was collected as per the following description:

5.2.1 *Gram Panchayat(s) (GPs) Level*

At Gram Panchayat(s) level following information was collected:

- Spread of revenue villages, member villages in the GPs, geographic distance from main GPs, what are the interactions/relationships between the GPs and the other revenue villages and member villages in terms of participation in GPs, decision making process, type of work undertaken by the GPs in recent past and the location of these activities (in the main village or also member villages);
- Demographic profile;
- Tribal groups-migration pattern, economic activity/integration/socio-economic profile;
- Average land holding and asset ownership, income levels, occupational pattern;
- Land ownership, uses and legal rights;
- Formal and informal rights on common property/natural resources;
- Accessibility and linkages of habitation;
- GPs resource allocation;
- Key developmental issues; and
- Opinion on the proposed project – possible positive and negative impacts.

5.2.2 *Village Level*

The consultations with villagers and focussed groups discussions were designed to seek the following sets of information:

1) Socio-economic Profile & Impact

- Social profile in the community dynamics and poverty structures;
- Loss of Income/Livelihood through agriculture/plantation and any other activity like fishing;
- Access to water from Allain and Duhangan;
- Access to fuel wood and other natural resources like grazing areas;
- Disturbance in social fabric/structure/values;
- Job prospects;
- Development (infrastructure) of the area;
- Social and economic opportunities;
- Pressure on local resources through influx of additional people in the area;
- Impact of access to metalled road;
- Impact on wider interactions with outside community;
- Opportunities for infrastructure development through the project
- Community Development Opportunities; and
- Opportunities for social and economic development of the area

2) Public Health

- Common diseases;
- Access to health facilities; and
- Any epidemic/outbreak.

3) Religious/Archaeological

- Religious sites in the vicinity of the project;
- Archaeological sites; and
- Access/influence.

4) Gender

- Role and status of women in the community;
- Division of labour within the household;
- Potential impacts of the project on women; and
- Their views, opinions about the development of the area and mitigation measures to counter adverse impacts.

5.2.3 Household Level

Information collected at household level included the following:

- Social classification;
- Family details at the individual level – education, marital status, occupation and income;
- Vulnerability classification; family profession and income details from – agriculture, horticulture, shop, service, labour or any other;
- Project impacts – loss of land, structure, assets, income, etc.;
- Sharecropping or lease arrangement;
- Village record/land identity number (khasra numbers); and
- Loss of common property resources – land, cremation ground, burial ground, school, etc.

5.2.4 Secondary Information

The secondary sources of information included various documents published by the government of Himachal Pradesh such as district census handbook, statistical abstract, economic survey report and relevant laws/acts and policies.

The NTPC's scheme for rehabilitation and resettlement of the oustees of Kol Dam project was also referred since it was accepted by the H.P. government as a good policy and hence has become a benchmark for projects undertaken by other agencies. Un-published material included land records at the Patwari's office and land-use records at the District Collector's (DC) office. Field visits included visit to office of the Sub-divisional District Magistrate (SDM) and Block Divisional Officer (BDO) to know about the development initiatives being planned for the area, to Patwari's office to understand procedure of land transfers, land acquisition and procure for calculating the land prices. Visit to state capital Shimla included meetings with horticulture department to understand the procedure for valuation of apple trees, cropping pattern across the Tehsil/district and maximum/minimum yield. Meetings were also held with Tribal development department for understanding special provisions for Scheduled Tribes (STs) in project area.

5.3 SOCIO-ECONOMIC PROFILE OF THE PROJECT AREA

5.3.1 Kullu District at a glance

A) Introduction

This section presents a profile of Kullu district within which the Project area is located in comparison with the other districts of the state. The physical features, demography, developmental indicators of the district have been covered.

Location & Administrative Divisions

Kullu was made into a separate district in 1963 on the separation of Himachal Pradesh and Punjab as two distinct states. Prior to that Kullu was a tehsil of Kangra district.

Kullu is a sparsely populated, centrally located district of the state. It is bounded on the North and East by Lahul & Spiti district, on the Southeast by Kinnaur district, on the South by Shimla district, on the Southwest and West by Mandi district and on the Northwest by Kangra district. The valley of Beas river, the entire stretch from Kullu to Mandi, has gentle slopes patched with fields and apple orchards against the blackdrop of lush green mountain ranges.

Kullu district has six Community Development (CD) blocks namely Kullu, Manali, Banjar, Narmand, Sainj and Ani. *Table 5.1* gives the administrative divisions and population of different divisions of the district.

Table 5.1 Population in Tehsil, Subtehsil and Towns of Kullu District

Area	Category of Administrative divisions	Population
Kullu	Tehsil	1,77,920
Nermand	Tehsil	47,904
Manali	Tehsil	44,239
Banjar	Tehsil	38,629
Ani	Sub-Tehsil	50,495
Sainj	Sub-Tehsil	20,678
Kullu	Town	18,306
Manali	Town	6,265
Bhuntar	Town	4,260
Banjar	Town	1,262
Kullu	District	379,865

Source: Census of Himachal Pradesh, 2001

In 1991, there were only 5 C.D. blocks after which Manali was established as a tehsil in 2001.

B) Social & Cultural Characteristics

Religion

Main population consists of Hindus followed by Buddhists and fraction of Sikh and Christian populations. No record of above-mentioned classification is available. The predominant castes of the area include Rajputs, Brahmins and scheduled castes.

Food habits

The staple food of the people is rice, wheat, maize and barley and minor millets. However with growing improvement in the standard of life barley consumption is being abandoned in favour of wheat, maize and rice.

Language

The language spoken by people of Kullu is known as Kulbi, which is one of the several languages that come under western pahari. Kullu group of languages comes under Indo-European family of languages.

C) Economy

The economy of Kullu district is basically agriculture. More than 80% of the working population are engaged in agricultural activities.

Agriculture

The elevation of Kullu district ranges from 914 - 4,084 m above mean sea level with agro-climatic conditions. The texture of soil varies from sandy loam to clay loam. The agro-climatic conditions provide a range of potentialities for growing cash crops, off season vegetables, seed potatoes, pulses and temperate fruits apart from the cereals, millets and oilseeds.

The holdings are small and cultivation is done by orthodox techniques of farming. The sources of irrigation are Khuls, Lift and Tanks, where rainwater is stored. The total cultivated area in the district, according to District Census Handbook, Kullu, 1991 is 39,112 hectares.

Horticulture

Development of horticulture occupies an important place in the economy of district. Agro-climatic conditions offer a great scope for the production of temperate and sub-tropical fruits especially apple, peach, apricot, chestnut, almonds, japani phal, cherries, goose berries and olive are being planted. Bee keeping is a subsidiary source of income. The particular suitability of climate has resulted in shifting of land use pattern from agriculture to fruit crops in past few decades.

Animal Husbandry

Livestock is an important source of income as well as wealth in the agriculture-based economy of the district. Besides providing income, livestock also serves as subsistence. Most of the households invariably keep livestock such as cows, buffaloes, sheep, goats, pig and ponies.

Fisheries

Most of the inhabitants in Kullu district are found in the interior valleys having rivers, streams and nallahs. The waters of these rivers contain lots of minerals and are most suited to Pisciculture.

Forests

Forests occupy a prominent place in the economy of the district and forest division, Kullu, administers these. Forests constitute a major proportion of the land use in the district. The Kullu forests considerably resemble those in adjacent parts of Kangra and Mandi. Extensive forests of common Himalaya oak are found largely in the Hurla valley above 2,400m elevation. The principal forest products are major trees like Deodar, Kail, Cheel, Pine, Walnut, Horse chestnut and Oak, minor trees like Hazal, Hornbeam, Yew, Bird cherry, Birch, Moru, Ban, Willows, Ash, Wild, Apple, Juniper and Rhododendron products used for medicinal purposes like Karu, Dhoop, Muskwala, Mushrooms and Kakarsingi

Industry

Due to its location the district does not have any large or medium scale industrial units. However, the district is known for some of its beautiful traditional handicrafts in weaving like multi-coloured caps and shawls that are well known in the country.

D) Demographic Profile

Population and Density

Among the 12 districts Kullu has relatively low population, which is 6.25% of the total state population. The highest among the districts is Kangra which also has the highest density and the lowest is Lahul & Spiti with a density as low as two persons per square kilometre.

Kullu showed the highest decadal growth rate in 1981-1991, but it decreased marginally to 25.60% in 1991-2001. In 1991-2001, Solan showed the highest growth rate of 30.64%, followed by Sirmaur and Una districts.

Rural & Urban Population

Rural population has registered an increase of 16.15% during 1991-2001. Due to hilly profile of Himachal Pradesh, the highest population resides in rural areas and Kullu district has the highest increase i.e. 24.29% in rural population, followed by Solan with 21.86% for the period of 1991-2001. On the other hand, Shimla has the highest urban population 23.90% of the state and has shown a growth of 39.12% during the last decade. Manali town has recorded the highest growth of 157.50% followed by Rohru nagar Panchayat 96.26 and Solan Town 57.23% during 1991-2001.

Table 5.2 District-wise Population and Density

District	Area (sq km)	Populat ion	Pop. to the state, %	Rural Pop %	Urban Pop, %	Growth Rate 1981-91	Growth Rate 1991-2001	Density per sq km 1991	Density per sq km 2001
Bilaspur	1167	340735	5.60	5.8	3.7	19.41	15.35	253	292
Chamba	6528	460499	7.58	7.8	5.8	26.40	17.09	60	71
Hamirpur	1118	412009	6.78	7.0	5.1	16.17	11.62	330	369
Kangra	5739	1338536	22.02	23.1	12.1	18.50	14.01	205	233
Kinnaur	6401	83950	1.38	1.5	0.0	19.69	17.79	11	13
Kullu	5503	379865	6.25	6.4	5.1	26.68	25.60	55	69
L & S	13835	33224	0.55	0.6	0.0	-2.51	6.17	2	2
Mandi	3950	900987	14.83	15.3	10.2	20.40	16.05	197	228
Shimla	5131	721745	11.88	10.1	28.0	20.84	16.90	120	141
Sirmaur	2825	458351	7.54	7.5	8.0	23.72	20.72	134	162
Solan	1936	499380	8.22	7.4	15.3	26.02	30.64	197	258
Una	1540	447967	7.37	7.5	6.6	19.17	18.43	246	291
H.P.	55673	6077248	100	90.2	9.8	-	-	93	109

Source: Census of Himachal Pradesh, 2001

Sex Ratio

Kullu has a low sex ratio i.e. 928 compared to districts like Hamirpur, Kangra that show a favourable ratio. Some districts like Kinnaur, Lahul & Spiti, Solan have shown a decline in the sex ratio from 1981-91 to 1991-2001 whereas sex ratio in Kullu has improved from 920 in 1981-1991 to 928 in 1991-2001. The low sex ratio in certain areas may indicate large scale migration of male workers, though there are also other related factors.

Literacy

There is an increase of 14% in overall literacy of the state from 1981-1991 to 1991-2001. Sirmaur, Chamba and Kullu districts have shown the highest growth in literacy rates by 19.23%, 19.03% and 18.54% respectively. Hamirpur has the highest literacy rate of 83.16% followed by Una with 81.09% in 1991-2001.

Table 5.3 *Literacy Rate*

District	Literacy Rate 1981-1991	Literacy Rate 1991-2001
Bilaspur	67.17	78.80
Chamba	44.70	63.73
Hamirpur	74.88	83.16
Kangra	70.57	80.68
Kinnaur	58.36	N.A.
Kullu	54.82	73.36
L & S	56.82	73.17
Mandi	62.74	75.86
Shimla	64.61	79.68
Sirmaur	51.62	70.85
Solan	63.30	77.16
Una	70.91	81.09
H.P.	63.86	77.13

Source: Census of Himachal Pradesh, 2001

Occupational Pattern

In the overall state as per the 2001 census, non working population is more than total working population. Bilaspur, Kangra, Sirmaur and Una have higher percentage of non workers. However, in these districts there has been an overall decrease in the non working population from 1991 to 2001.

Table 5.4 *Occupational Profile*

District	Total Workers		Main Workers		Marginal workers		Non Workers	
	1991	2001	1991	2001	1991	2001	1991	2001
Bilaspur	44.60	48.95	31.03	32.52	13.57	16.43	55.40	51.05
Chamba	48.58	50.04	32.55	27.88	16.03	22.16	51.42	49.96
Hamirpur	41.87	49.90	29.87	29.34	12.00	20.56	58.13	50.10
Kangra	34.37	44.04	27.55	25.20	6.82	18.84	65.63	55.96
Kinnaur	52.42	60.54	47.32	50.79	5.10	9.75	47.58	39.46
Kullu	47.93	57.05	42.44	43.96	5.49	13.09	52.07	42.95
L & S	64.93	63.50	54.18	57.88	10.75	5.62	35.07	36.50
Mandi	45.72	50.44	37.46	29.89	8.26	20.55	54.28	49.56
Shimla	48.62	51.19	43.08	42.19	5.54	9.00	51.38	48.81
Sirmaur	46.59	49.30	40.11	38.38	6.48	10.92	53.41	50.70
Solan	45.05	52.70	34.98	34.57	10.07	18.13	54.95	47.30
Una	33.45	45.03	27.45	26.60	6.00	18.43	66.55	54.97
H.P.	42.83	49.28	34.41	32.36	8.42	16.92	57.17	50.72

Source: Census of Himachal Pradesh, 2001

Kullu in 2001 has higher working population than non working population which has changed from the 1991 figures where the reverse was true.

Growth rate of main workers has shown a decrease by 2.05%, but the growth rate of marginal workers has increased by 8.5% from 1991 to 2001. Bilaspur, Kinnaur, Kullu and Lahul and Spiti districts have positive growth rate in main workers.

Rural areas on an average have more people working as main workers as compared to the urban areas. Almost 36% people are engaged in main workers category.

Agriculture

Agriculture is the main source of occupation in the state. Out of the working population, more than 40% of the population is categorised under main workers. Maximum land has been brought under cultivation.

Table 5.5 *District wise Classification of Agriculture Area (in Thousand Hectares)*

District	Current Fallows	Other fallows	Total	Net Sown area (in Hec.)	Total cropped area	Area sown more than once
Bilaspur	1.2	1.6	2.8	30.8	59.4	28.6
Chamba	2.0	.2	2.2	42.4	66.3	23.9
Hamirpur	7.6	1.0	8.6	36.4	71.6	35.2
Kangra	7.9	1.1	9.0	11	222.6	103.6
Kinnaur	1.6	.1	1.7	7.6	10.0	2.4
Kullu	2.6	.2	2.8	36.6	63.1	26.5
L & S	.2	-	.2	3.2	3.3	.1
Mandi	5.8	.3	6.1	91.1	163.6	72.5
Shimla	12.5	1.4	13.9	71.1	107.1	36
Sirmaur	4.5	.9	5.4	42.2	78.4	36.2
Solan	4.9	.8	5.7	39.4	65.6	26.2
Una	4.6	15.1	19.7	40.3	75.2	34.9

Source: Statistical Outline of H.P., 1999

Kangra has the largest area under the category of sown more than once. Large number of districts comes in the category of 60-225 hectare cropped area. Except in Kangra, Kinnaur and Lahul and Spiti, more than 60% of the total area is under cultivation.

Major Crops

Rice, wheat and maize are important cereal crops of the state. The state Government is laying emphasis on production of off-season vegetables seeds, potato, ginger, pulses and oilseeds.

Area under rice, wheat and maize is highest in Kangra and Mandi. Apart from this, both the districts also lead in area under total foodgrains, potato, onion, tomato, and chillies, ginger and edible oilseeds to other districts. Area under crops in Kullu district is below average except Barley, Common Millets, Other Cereals and Pulses.

Mandi and Kangra are showing the maximum production in all the crops. Foodgrain is the largest produce of the state. According to Economic survey

2002, the food grain production for 2001-2002 is expected around 14.37 lakh metric tons.

5.3.2 *Size of Land Holding*

Average size of land holding for the state is 1.16 hectare. As is evident form the *Table 5.6*, districts like Sirmaur, Solan, Lahul & Spiti, Una, Shimla have the larger size of land holdings while Kullu has the smallest average land holding size.

Table 5.6 District Wise Operational Holding and Area

District	Number of Holders	Area (in Hect.)	Average size of holding (in Hect.)
Bilaspur	48,656	52,619.98	1.08
Chamba	64,524	56,697.36	0.88
Hamirpur	69,193	76,579.09	1.11
Kangra	2,24,759	2,09,505.09	0.93
Kinnaur	9,693	14,310.84	1.48
Kullu	57,061	44,233.44	0.78
L & S	3,960	6,422.71	1.62
Mandi	1,36,710	1,29,689.20	0.95
Shimla	90,112	1,25,917.16	1.40
Sirmaur	45,048	1,02,510.28	2.28
Solan	49,854	91,579.82	1.85
Una	64,137	89,034.71	1.39
Himachal Pradesh	8,64,437	9,99,099.68	1.16

Source: Statistical Outline of H.P., 1999

Distribution of land holdings, in the whole state shows that 84.5% of land comes under small and marginal farmers.

Irrigation

Agriculture in Himachal Pradesh is primarily done with the rainfall. Apart form this, the four major sources of irrigation in the state includes canals, tanks, wells and tube wells. The area irrigated by different sources in the state from 19991-98 is given in the *Table 5.7*. As per the *Table 5.7* the net irrigated area under all the four sources has decreased from 1992 to 1998. Although there has been a decrease in the net irrigated, the gross cropped area has shown a gradual increase.

Table 5.7 Area covered by different Sources of Irrigation (in Hectares)

Agricultural year	Canal	Tanks	Wells & Tube wells	Other sources	Total
1991-92	-	663	3,711	95,362	99,736
1992-93	9,076	798	5,5592	83,360	98,826
1993-94	-	122	5,120	94,404	99,646
1994-95	3,631	871	11,998	83,954	1,00,454
1995-96	3,393	397	13,082	87,918	1,04,790
1996-97	3,574	325	11,830	89,063	1,04,792
1997-98	3,398	255	11,820	87,144	1,02,617

Source: Statistical Outline of H.P., 1999

Area covered by tanks increased in 1994-95, but then there is steep decline in this source of irrigation.

5.3.3 *Profile of the Project Villages*

Majority of land acquisition pertained to three villages viz. Prini, Jagatsukh and Aleo. In this section, a profile of these three villages in terms of their location, demography, access to amenities etc is presented. It also looks at the type of development projects being implemented and the kind of development activities that local people would like to have in their villages.
All the three villages are a part of the Manali Tehsil, District Kullu. Jagatsukh and Aleo fall on the main road while Prini is about 0.5 km from the main road. However, it is connected to the main road by a narrow concrete path.

Socio-economic Profile

The three villages are quite different in terms of socio-economic conditions. The population varies from about 300 in Aleo to about 2000 in Jagatsukh. Jagatsukh has relatively higher Scheduled Tribe (ST) population.[1]

Table 5.8 *Demography profile*

Village	Total Population			Scheduled Caste			Scheduled Tribe		
	Total	M	F	Total	M	F	Total	M	F
Aleo	300	-	-	110	-	-	75	-	-
Prini	511	264	247	155	83	72	33	17	16
Jagatsukh	1995	1035	960	326	173	153	180	95	85
TOTAL	2806			591			288		

*Source: Gram Panchayat; M: Males, F: Females

The STs in the area have mostly migrated from Lahul- Spiti. Initially the migration was annual phenomenon when the people would come to the lower altitudes in the winters, as it was difficult to live in the harsh conditions. Some of them still own land in Lahul - Spiti as well in the project impacted villages. A member of the family generally lives in Lahul – Spiti to take care of the land, while the rest of the family visits at least once a year. They depend largely on agriculture and animal husbandry for their livelihood. Most ST families in the area practice Buddhism. They also have distinct cultural identity and have their own festivals and customs.

There are Scheduled Caste (SC) families in each village. These SC families, like others in the village, practice agriculture as their main occupation. The social discrimination against the SCs still exists, although it has been diluted over a period of time. They are however, given preference in the development schemes implemented by the government.

(1) [1] Scheduled Caste (SC) and Scheduled Tribes are identified/notifid by the Constitution of India (Articles 341 & 342 respectively), as groups that are marginalised/vulnerable and lays out special provisions for such group with the objective of promoting and safeguarding their social, educational and economic interests

Literacy rate

The literacy rate in all the three villages has shown an increase in the last two decades. While most of the elderly people were either illiterate or had studied only till class V, most people in the younger generation had studied till at least class VIII. The presence of at least a primary school in these villages has ensured that all the children have access to some basic education.
The literacy levels in the project villages varied from 50-80%. According to the GP members, the literacy rate was about 60% in Prini and 80% in Jagatsukh. In both these villages the literacy rate was reported to be comparatively higher among men.

Occupational Pattern

There are limited job opportunities in the regions as there is very little industrial development, and the government jobs are very few. Absence of good technical training institute makes it difficult for local people to acquire adequate skills to apply for jobs in the nearby districts where there could be better job opportunities. The tourism industry in the area is unable to provide work for the entire year.

Agriculture is, therefore, the primary occupation in all the villages. It is followed by animal husbandry as many people sell milk or other dairy products like *Ghee* (pure oil). Very few people have regular jobs, of which the government jobs are even fewer. Most of the private jobs are in the local hotels/restaurants and as drivers. Significant numbers of people in Aleo have leased their land for commercial activities, which are largely tourist centred. Some people also operate their vans/jeeps/cars etc as tourist vehicles.

Table 5.9 Occupational pattern

Village	Agriculture	Animal Husbandry	Private/govt Jobs	Labour	Any other
Aleo	100%	80%	5%	30%	30% (land on lease to hotels, van owners, business etc)
Prini	90%	30%	10%	10%	4-5% (own business)
Jagatsukh	80%	75%	5%	25%	5% (own business)

* Information as provided by GP members and is an indicative estimate

Settlement Pattern

All the three villages have other villages in the Gram panchayat. Prini and Jagatsukh have Panchayat headquarters in the village, while Aleo is a part of the Vashisht GP. The other villages in Prini GP are Shuru, Gadrai, Chalet, Saithan and Hamta. Similarly, Jagatsukh GP has Banara, Chanala, Bhanu and Shaminala.

Jagatsukh is one of the oldest settlements in the district and was reported to be the old capital of Kullu state. The village had the largest number of villages in the GP till a few years ago and is famous for its ancient temples.

As all the three villages are quite close to Manali, a popular tourist destination, they are exposed to a large number of visitors. Prini is along a popular trek route that is frequently visited by tourists. Both Jagatsukh and Prini can attract a large number of tourists, but have been unable to exploit the tourism potential so far.

While both Jagatsukh and Prini are dispersed settlements, only Jagatsukh is divided into different clusters. Aleo's main hamlet is the central one where most houses have been built quite close to each other while the remaining houses are spread along the hill.

Social Infrastructure

Jagatsukh is the most developed village in terms of social infrastructure, Prini has some of the basic amenities in the village while Aleo is almost a part of the Manali town now. *Table 5.10* presents the details of access to different amenities in the three villages.

Table 5.10 *Access to amenities*

Village	Primary School	High School	College	PHC	Hospital	Post Office	Bank
Aleo	Village	Manali, 1.5 km	Kullu, 35km	Manali, 1.5 km	Manali, 1.5 km	Manali, 1.5 km	Manali, 1.5 km
Prini	Village	Village	Kullu, 35km	Jagatsukh, 3 km	Manali, 4 km	Village	Manali, 4 km
Jagatsukh	Village	Village	Kullu, 30km	Village	Manali, 6 km	Village	Village

All the villages have an *Aanganwadi*, a government run playschool for young children. Jagatsukh has a well developed market, Prini has few shops that cater to daily needs like grocery, confectionary etc. Aleo has many shops like tea stalls, small eating joints etc. that cater to the needs of Manali as well.

All the villages are connected by telephones and many families in all the three villages have their private telephone connections. Some households have mobile phones as well. Power supply is quite regular and problems arise only during snowfall when it is difficult to repair local faults.

Access to Drinking Water

None of the villages reported any water problems. They have access to clean drinking water from the streams that flow through the villages. Piped water supply is available and has also been upgraded in last 5-6 years in Prini and Aleo.

Almost all the families in Aleo have private connections while in Jagatsukh and Prini about 60-70 households have individual connections. The number of stand posts varies between 5 in Prini to as many as 40 in Jagatsukh. The water is available 24 hrs a day.

Access to Sanitation

Jagatsukh is the only village to be partially covered by the drains. All the villages have very few households with private latrines. In Jagatsukh, some latrines had been made through a government scheme but most of them are no longer being used.

Public Health

The villagers reported that incidence of disease was quite low in the area and fever and cold were common ailments. No epidemics were reported in the recent past. There were however a number of handicapped people in the villages, some of them afflicted by polio in their childhood. In terms of access to health infrastructure, only Jagatsukh had a public health centre (PHC) in the village itself, while villagers from Prini and Aleo had to travel from 1.5 to 3.0 km to access a PHC. The nearest hospital for all the villages was in Manali.

Land Use Pattern

While Jagatsukh and Prini are spread over large areas, no data is available for area of Aleo. In fact in Kullu district the forest area has not been calculated so far.

Each village other than the private land and the *aabadi* (residential area) land has ownership over "*gauchar*" (grazing grounds) and streams. Most of the villages are surrounded by forests, which are used by the community. Each village is reported to a have a well-defined boundary and people from other villages are not allowed either to graze their cattle or collect fuel wood. The Gram Panchayat is allowed to penalise if people from other villages break these rules. However, if the land belongs to forest department or any other government department, the Panchayats do not intervene (information provided by a local *patwari*).

Majority of land in all the villages is used for cultivation. The following table provides the land use of Prini and Jagatsukh.

Table 5.11 Land use pattern

Village	Total Area (in Ha)	Irrigated	Unirrigated	Culturable waste (including pastures & groves)	Area not available for cultivation
Prini	249	80	100	-	69
Jagatsukh	259	168	89	-	2

Source: District Census Handbook, Kullu- 1991

Ownership of Private Land

Land ownership in the state started some time in 1800s. Due to the hilly terrain, the cultivable land in the state is divided into very small plots. However, to prevent the division of these small plots into fragmentation, the Government of Himachal Pradesh enacted Himachal Pradesh Holdings (Consolidation and

Prevention of Fragmentation) Act, 1971 to provide for consolidation of agricultural holdings and preventing fragmentation of agricultural holdings in the state and for assignment or reservation of land for common purposes of the villages.

In Himachal Pradesh, both the sons and the daughters inherit the land. However, in majority cases the daughters hand over their shares to their brothers.

The land records in the state are updated after five years. The mutation deeds in case of the death of the landowner have to be made within 6 months. Similarly, in case of sale, a copy of the registration documents is provided to the *'patwari'* to update the land records. In 1990s, the state government launched a campaign for "settlement" of land records. In Prini, this campaign was launched in 1994 and completed in 2001.

Development Projects in the Villages

Himachal Pradesh has initiated a number of projects for the development of villages. Many departments like forest department, watershed development department, agriculture department etc have recently started seeking people's support in their projects. The GPs also implement many projects from the government grants received every year. The grants received by the three GPs and the revenue generated in the last financial year is presented below:
- Aleo- approximately 2,00,000 as grants and Rs. 8,000 –10,000 as tax collection;
- Prini- Rs 93,829 as grants and Rs. 5,000 as tax collection
- Jagatsukh- Rs 5,00,000 in form of government allocation and Rs 60,000 in form of taxes.

Details of some of the projects that have been implemented in the recent years in the projects villages are provided below.

Aleo

Aleo being a very small village usually gets neglected in the development projects. Very few projects have, therefore, been implemented in the village.
- Piped water supply;
- The GP undertakes village cleanliness campaign annually and everyone in the village participates in it;
- Watershed development related activities were undertaken in the GP headquarters in Vashisht; and
- Establishing a nursery in the village by Forest department.

Prini

The Gram Panchayat undertakes works like maintenance of roads, water supply, construction of irrigation channels, construction of small bridges and providing grants under Indira Awas Yojana. Some other development projects that have been undertaken in the village included:
- Enhancement of piped water supply through Prime Minister's Fund;

- Watershed development through forest department in about 3 bighas[1] of land;
- Afforestation activity is undertaken every year through support from forest department and watershed development department. A Joint Forest Management (JFM) committee has been formed with about 11-12 members in the village.
- One self help group (SHG) for the BPL households had been initiated.

Jagatsukh

The present GP has constructed two school buildings (in other villages of the GP), a rest house, community hall and cremation ground in the village. It has also developed a stage for cultural activities in the village, small irrigation channels and bridges etc. Some other development projects in the village include:

- Drains covering about 50% of the village have been made;
- Individual latrines through a government scheme constructed, but only few are being used;
- Soil conservation efforts initiated since last year. A watershed development committee (WDC) has been formed. 5 self help groups (3 groups for men, 1 for women and 1 for SC community) have been formed as a part of the Project;
- Afforestation activities have also been started by the forest department. There was a problem of co-ordination earlier. However, things have now become smooth and the community is willing to contribute 10% in the project. The GP was, however, not very clear about the kind of activities to be undertaken in the Project; and
- Vermi-composting through self help groups has been started. The GP plans to promote it further.

5.4 STAKEHOLDERS

Stakeholders refer to persons or groups who have stake in a proposed program or project and who may play a key role in influencing the project policy, planning and implementation. Stakeholders' identification and analysis is a precondition for social assessment and for setting the framework of participatory planning and implementation. It would help to generate information critical to planning, implementation and monitoring of the Project. It would also help avoid or minimize the adverse impacts of the Project and simultaneously support the realization of its positive effects.

The Project has several sub-components namely

- Power Station and other civil structures;
- Colonies for the project staff;
- Transmission lines; and
- Connecting roads.

While the power station is being built on government land, private land acquisition would be required for development of colonies and some parts of roads.

(2) [1] Bigha is the local measure of land area. 1 bigha is equivalent to .08 ha.

Landowners

A major set of stakeholders consists of the people who are affected by the land acquisition. The intensity of impact varies according to the scale of acquisition in relation to the land holding of each household and the proportion of livelihood derived from such land holdings. In Himachal Pradesh, the land is inherited equally by all the children. In practice, the daughters give away their rights to the sons. However, such mutations are not formally recorded in the land records. Similarly, the family members informally divide the land among themselves, and hence although their names may appear in different *Khasras* or plots, they cultivate only some of these parcels of land. In absence of updated land records, it may be difficult to ascertain the actual land ownership of some of the affected parcels of land.

Key Concerns & Expectations

For people losing a large part of their land, their major concern is availability of alternate land in the village for cultivation. They expect good compensation for loss of land and would like assistance in shifting of apple trees wherever possible. It is feared that delay in compensation would increase uncertainty about the project and might affect the incomes from these affected parcels.

Non-legal cultivators

A large part of the land in some of the villages is classified as '*Devta*' land, which has been handed over to some families to cultivate. Similarly, there are pockets of forestlands, which are being illegally cultivated by some members of the community. Although many of such non-legal ownership had been regularised in the state, there are still such cases where have people have been cultivating the same parcel of land for many years without a legal title. There is a likelihood of '*Devata*' or forestland being cultivated by some individual families.

Key Concerns & Expectations

The government generally does not recognise non legal cultivators and hence, their major concern is that they will not only get compensated for the loss of land but would also be affected by loss of income from these lands. They expect that they will be treated at par with the legal titleholders or at least compensated for loss of trees and income.

Share Croppers

As the land holding of many families is quite small, it is difficult for them to sustain themselves on small parcels of land. Therefore, many families cultivate land belonging to other people as sharecroppers. The sharecropping arrangement many vary from sharing 50% of the costs as well as well as 50% produce while in other cases it may be 60-40 for both the costs and the produce. In the sample survey, no family reported a sharecropper on any of the affected parcels of land. However, some o f the project affected families (PAFs) did mention that they cultivate others' lands on the basis of sharecropping.

Key Concerns & Expectations

With the loss of land, these shareholders stand to lose a part of their family income. They expect to be compensated for loss of income from the affected parcel.

Labour

Most of the people involve their family members (cousins, in-laws etc) to work as labour during the agricultural season. In return, they assist their relatives by working their land as labour. However, there are few families in all the villages who are landless and earn their livelihood by working as labour. As there are very few opportunities to work as a wage labour in the area, many of these landless families depend on owners of large land holdings to work as agricultural labour. The project might affect some people belonging to this category as well.

Key Concerns & Expectations

The labour community is apprehensive about losing a more reliable source for work and would like to be compensated for loss of income.

Women Groups

The women generally belong to two different groups. The women from the economically well off families generally do not go out in the agricultural fields to work. They are more involved in the household activities, taking care of the cattle and livestock as well as weaving of shawls, carpets etc. The women from the economically weaker section not only do the household work but also spend a considerable time working in their own fields and earning incomes by working as wage labour in others' agricultural fields. During the winter season when no agricultural activity is possible, they take up weaving activity, which helps them meet the domestic need and also provide them with an additional source of income.

Key Concerns & Expectations

Women fear that they might lose their freedom if the people from outside come to live in their village and their movements within the village might be restricted at some hours of the day. An impact on their social culture and customs was a major concern. As Jagatsukh as been rated as one of the best villages in the district, they felt that a large community from outside may also affect the cleanliness of the village. Their expectations from the project ranged from better education facilities to opportunities for income generation. Of those losing land, most wanted employment for at least one member of the family.

Women in Jagatsukh are also very concerned about the availability of water for their domestic purposes, after Dunhangan river gets diverted for the project.

Tribal Communities

The tribal community in the area belongs to Lahul - Spiti area and migrated about 25-30 years ago. Some of them still maintain a house and land in Lahul. One member of the family, usually the elder son, may be stationed in Lahul to take care of that land. The family also visits Lahul at least once a year. There are a few tribal families who would be affected by loss of plantations for the road construction. As these tribal families are among the marginalized communities, there concerns will have to be addressed on the priority basis during the implementation of the project.

Key Concerns & Expectations

The tribal communities expect a fair compensation for the affected land and additional financial support as they consider themselves more vulnerable.

Other Vulnerable Groups

The vulnerable groups in the Project area comprise families that are headed by women, handicapped people affected by the Project and people who will be pushed below the poverty line due to loss incurred as a result of the Project. While the Project affects some people marginally by acquiring only a portion of their land, for some people who stand to lose a major part of their land holding, the land acquisition might push them below the poverty line. Special attention will have to be paid to such vulnerable groups to ensure the restoration of their income levels.

Key Concerns & Expectations

Main apprehension of this group is the loss of land as it is the main source of income for them. As most of them have limited resources, they are concerned about the future. They expect employment, if possible, for one member in the family to ensure a regular source of income.

Common Property Resources (CPR) Users

Each village in the area has its well defined '*gauchar*' land where the community is allowed to graze their cattle. They also collect dry wood for fuel. It is reported that for these villages, this is the major grazing ground and the availability of alternate land is low as the other villages might not allow these communities to graze their cattle or collect fuel wood from their '*gauchar*' lands. Once the project gets into the construction phase then it will not be possible for these cattle and goats to graze freely in the '*gauchar*' as they will be affected by the increased volume of traffic and construction activity. The local streams, especially the Duhangan stream, are major source of irrigation, primarily for Jagatsukh.

Key Concerns & Expectations

People had apprehensions that by trapping the water from the Duhangan stream, water available for irrigation downstream would be severely reduced. Lack of irrigation facility would then affect their crops. They wanted the Project to ensure that adequate flow is maintained for irrigation. There were also concerns that the construction of roads might cut off their grazing areas especially in the forests, even if temporarily.

Downstream Water Users

The residents of Jagatsusk use water from Duhangan stream for their domestic and irrigation purposes. Their drinking water sources are also linked with this stream. Jagatsukh villagers attach religious and cultural sentiments to the Duhangan stream which enhances the value of the river.

Key Concerns & Expectations

The villagers are very concerned that the Project activities will adversely affect the drinking water sources of Jagatsukh and Prini at Chor Pani/Dhani Stream and Jamlu Devta/Pahali streams respectively. They are also worried that the amount of water left after the diversion of the Duhangan river, may be inadequate to meet their irrigation needs.

People Affected by Overhead Transmission Line

The construction of overhead transmission line is likely to result in disruption in agricultural activity. Although the extent of impacts on land is unlikely to be significant, the period during which the poles are erected and the cables are laid, it is likely that agricultural activity will be temporarily disrupted by the machinery and labour activities involved, before the land can be made available for agriculture again. Cutting of some of the trees for stringing the cables may be required. The construction phase of the transmission line may also affect access to common property resources.

Key Concerns & Expectations

Usually the erection of towers is done in three phases. One of the common concern is that their standing crops might be affected in all the three phases. Affected people would therefore expect compensation for loss of standing crops for all the three phases.

Village Institutions

The Gram Panchayat in all the villages is a major stakeholder and likely to play a key role in the project implementation. Apart from the Panchayat, there are self help groups, watershed development committees, afforestation groups that are involved in the development activities of the affected villages. These institutions represent either interests of specific groups or provide an independent forum for interaction for the village people. These institutions are considered to be an important stakeholder to whom providing the accurate information will facilitate the building of the right process of a dialogue. Some of these like watershed development committee or the afforestation committees could be involved in implementation of environment management plan.

Key Concerns & Expectations

The GPs are concerned about the impact of large number of outsiders coming and living in their villages and the impact on local resources like water, fuel wood etc. They expect the project to enhance the existing infrastructure or provide basic amenities that might be required in the village.

5.4.2 Other Stakeholders

Political Parties

Since the opposition of any political party may lead to the delay in the implementation of the Project, it is necessary to take them on board during various stages of the Project.

Government Departments

Various branches of the government play an important role in the successful execution of the Project. These roles consist of land acquisition, transfer of money to the landowners and obtaining permission from the concerned departments like Himachal Pradesh State Electricity Board, Himachal Pradesh Pollution Control Board, Department of Power, Department of Finance, Forest Department, Tribal Development Department, District Treasurer and the local self-government institutions like the Panchayat and the Zilla Parishad.

NGOs and Media

There are a couple of small NGOs working in Prini and Jagatsukh villages, and focus on very local issues. There are a larger number of NGOs who have been working in the Manali district on a wide range of development issues. It would be worthwhile to engage some NGOs in mobilising the community in favour of the project and involve them in the implementation of the Rehabilitation Action Plan.

In Himachal Pradesh, the media provides a vibrant forum for information access. So far they have not been actively involved by the project proponents, although there has been some coverage of the project in the local media. At appropriate stages, the project has to provide accurate information to the media, which will help in percolation of information to all the other stakeholders.

Service Providers

The service providers such as the tour operators, transporters and the input providers would be positively affected by the project. It would also provide additional opportunities for more business through the project.

Financial Institutions

The financial institutions, both in India as well as the international institutions, which are involved in the Project finance, have stakes in terms of the investment in the Project. The financial institutions need to ensure that the Project does not get delayed resulting in escalation of costs and reduced profitability of the investment. They would also like to ensure that other risks are minimised. Any adverse impacts of the Project will also reflect on the image of the financial institution.

5.5 PROFILE OF THE PROJECT AFFECTED PERSONS

5.5.1 Introduction

This section presents the socio-economic profile of the project-affected persons in terms of their religion, education levels, occupational profile and income levels. This profile is based on the census survey of 286 titleholders belonging to 185 families[1] spread across Prini, Jagatsukh, Aleo, Shuru and Old Manali. The land impacted is however restricted within the boundaries of Jagatsukh, Hamta, Aleo and Prini villages. The titleholders covered in the survey include those who are likely to lose their land for the proposed colony and the roads leading to the project sites. The distribution of titleholders and families is shown in the *Table 5.12*.

Table 5.12 Distribution of Project Affected Families[2]

Category	Prini	Aleo	Jagatsukh	Total
Number of Titleholders	230	40	16	286
Number of PAFs	161	12	12	185

Note: Of the 286 titleholders identified, 10 Titleholders from Prini village were not traceable, in addition 3 Titleholders from Old Manali refused to participate in the survey. Hence the socio economic profile is based on information collected from 172 PAFs (273 Titleholders) covered during the survey.

(3) 1 In many cases a family/household has more than one titleholder. In few cases, in addition to the husband, the wife also has separate title over property inherited from her father. Likewise there are few cases where the father and son(s) are separate titleholders within the same family. Hence, the number of families impacted is less than the number of titleholders losing land.

(4) 2 As per the revenue records the land acquisition is from Aleo, Jagatsukh and Prini villages. During survey it was found that significant number of titleholders who are losing land in Prini are residents of Shuru, Old Manali and Hamta villages.

5.5.2 *Limitations of the Survey*

In addition to the difficulty in tracing about 10 families there were few other limitations faced during the survey, which have implications for the impact assessment findings. These are discussed below:

- The survey as usual has relied on information supplied by the respondents about their total land holding details. Some of it could be cross verified with relatives and neighbours, yet the information may not be completely accurate.
- In the initial stages of the survey and in some cases even towards the end, many PAFs were not fully aware about the impacts on their land and trees. Therefore land acquisition documents have been used for determining exact impacts on individual THs and subsequently on each PAF. Consequently, analysis of impact on income from plantations has been calculated using averages derived from available information from the survey, which was also verified with some key informants. The averages used included - returns from apple trees = Rs.1,650 per tree per annum and density of apple plantations = 30 trees per bigha. The existing landuse, the ratio between matured trees and young trees and between plantation land and non-plantation land has been taken as informed by the respondents for total land and assumed to be similar for impacted land.
- The land records do not entirely reflect the actual situation on ground since possession of land depends more on informal sharing arrangements between the family members. That is why it is possible to find families that are not impacted but included in the list of PAFs. In such cases it is upto the individual THs to agree upon the claim over compensation as per their sharing arrangements. The arrangement may vary from one family to another and in some cases may also invite disputes. The impact analysis for the sake of objectivity has relied on documented losses for the purpose of determining impacts.

5.5.3 *Social Structure*

Most of the families covered in the survey are Hindus. The majority among these Hindus (88%) belong to upper castes, with few families belonging to Scheduled Castes and Scheduled Tribes. *Table 5.13* presents the detailed break up of the project affected families.

Table 5.13 Social classification

Category	%age of PAFs	Number of PAFs
General	88.4	152
OBC	1.7	3
ST	2.3	4
SC	7.6	13

Most of the affected families in Prini, Jagatsukh and Aleo are *Rajputs* and *Brahmins*. Although no social discrimination was reported against any community, the upper castes obviously have a larger say in the village development matters. However, there were no separate hamlets for the Scheduled castes or other backward classes in any of the villages. ST households were interspersed within the larger community.

5.5.4 *Family Size*

The average family size in the project area was reported to be high. Although nuclear families do exist, the survey revealed that the majority still remain joint families[1] or households. The average family size among the affected households is 5.3, though a significant percentage (approximately 15%) had 8 or more number of family members. The following table presents the range of family members among the PAFs.

Table 5.14 Family Size

No. of family members	%age of PAFs	Number of PAFs
0-4	34.7	60
5 to 7	50.3	86
8 to 10	14.4	25
More than 10	0.6	1

In the project-affected villages, some nuclear families stayed in the same residential structure as other members of the family, but were identified as ones having separate kitchens. These have been considered separate families.

5.5.5 *Education*

The education levels among the PAPs varied from being illiterate to being post-graduates. As all three villages have at least a primary school, the literacy levels are high among the younger generation. Most of the elderly people were either illiterate or had not studied beyond Class V. Most of the younger people had however, studied till Class X at least. There were a few graduates (less than 10%) among the PAPs.

5.5.6 *Migration Pattern*

Seasonal Migration in the hills is a very common phenomenon as people generally move to the lower altitude regions during the winter season, when snow covers their fields. These people generally maintain two houses and in some cases even have land holdings in the two villages or hamlets.

During the course of the survey, it was observed that in some villages like Hamta the men moved to the lower regions to find work, while women with the children remained in the village to look after the livestock. The village during these months is inhabited entirely by women and children. The women not only look after the livestock, they also involve themselves in weaving activity. While most of the weaving is done to meet their own needs, some women do it to enhance their family incomes.

5.5.7 *Vulnerability*

Vulnerability of families has been linked with the following factors:

- Women headed households;

(5) 1 Defined as a family where married children (and their parents) live in the same house and share the kitchen

- Families with aged members above the age of 60;
- Families with members who are mentally or physically challenged; and
- Families with Income levels below the poverty line.

About 7% of the affected families or 13 families surveyed were below the poverty line (Rs 20,000 per annum[1]). About 13% (23 nos.) of the families surveyed were women headed households. About 10% (16 nos.) families had at least one physically or mentally challenged person in the family. As many as 34% (58 nos.) families had at least one person above the age of 60 years.

Many families showed more than one vulnerability indicator. Two BPL households were headed by women. Of these one had members above 60 years of age. Two BPL families also had one handicapped member while five of the BPL families had at least one member above the age of 60 years.

5.5.8 *Occupational Profile*

Plantation and agriculture is the predominant occupation among the project-affected families. Most people in the villages (and the PAFs as well) depend on agriculture and plantation for their livelihood. However, some of the PAFs with the smaller land holdings have secondary occupations like labour, dairy or petty business. Additionally in a family there could be more than one occupation being followed. The following table presents the number of Project Affected Persons involved in different types of occupations.

Table 5.15 Occupational profile

Occupation	Number of PAPs
Agriculture	11
Plantation	144
Service	33
Petty Business	16
Labour	16
Others	18

Although most people mentioned agriculture as the main occupation, most reported that they did not earn anything from it and only practised agriculture for subsistence purposes. Some people, especially in Old Manali reported that they did not cultivate the land themselves, and that some other people (relatives or friends) had been given the responsibility of taking care of their land. The titleholders, in such cases sometimes get a share of the produce.

Some people (especially in Old Manali) reported tourism related activities like running a guesthouse or a shop exclusively during the season. However, majority did not report this to be their primary source of income

(6) [1] The information was provided by the revenue department. In addition to the annual income, asset holding like two wheelers, television sets is also a criteria for declaring a family above poverty line

Land Holding

The landholding among the PAFs is quite varied. The land holding is also spread over many different parcels in some families. In some cases, people own land in more than one village. Most people with large landholdings mentioned that at least some of the land is left barren or uncultivated

The average land holding size (0.69 ha) among the project-affected families is lower than the average land holding of the Kullu district (0.78 ha). More than 50% of the PAFs surveyed owned less than half a hectare of land. The range of land holding owned by the PAFs is presented in the following table.

Table 5.16 Land Holdings

Size of Land holding (in sq.m)	%age of PAFs	Number fo PAFs
Less than 1000	11.7	19
1001-5000	43.2	70
5001-10000	24.1	39
10001 to 15000	10. 5	17
More than 15000	10.5	17

Note: This information not available for 10 PAFs
I Ha = 10000 sq.m.; 1 bigha = 809.42 sq.m.

The smallest size of land holding is 0.0012 ha while the largest is 4.05 ha.

Irrigation

Irrigation in the area is necessary for crops like rice, wheat and mustard. Most farmers had irrigation facility in at least a part of their land holding. Source of irrigation was usually a stream in all the three villages, which had been diverted into irrigation channels. Most of the apple orchards did not have irrigation facility and were rain fed crops. The following table provides details of irrigation of the PAFs' land holdings.

Table 5.17 Status of Irrigation

Status of Irrigation	%age of Land holdings
Fully irrigated	26.5
Partially irrigated	49.4
Not irrigated	24.1

Note: This information was not available for 10 PAFs

5.5.9 Income Levels

In all the project-affected villages, most affected people practised agriculture to meet their own domestic needs, while plantations were a source of income for most of them. Income levels of the families were arrived at by adding incomes from different sources like agriculture, plantation, business, service, labour etc. As it is difficult for most community members to correctly recollect or assess the incomes from agriculture and plantation, incomes were derived on the basis of types of land holding size, crops cultivated, market value of the crops and expenditures incurred for each crop. Similarly, for income from labour, the

PAFs were asked about the kind of labour, average number of days when such work is available and average wage rate. *Table 5.18* presents percentage of families in different ranges of total family income per month.

Table 5.18 *Total family incomes (per month)*

Income range	%age of PAFs	Number of PAFs
Less than 2000	10.2	16
2001-4000	14.0	22
4001-6000	8.9	14
6001- 10000	21.0	33
10001-15000	12.7	20
More than 15000	33.2	52

The table above shows relatively high levels of income as compared to rural incomes in other states. However, it should be mentioned that incomes from agriculture and plantation were taken on the basis of good crops. As both agriculture and plantation depend heavily on suitable climatic conditions, the production is quite low in some years. For example, in the project-affected villages, the harvest in the last two years was much better than the poor harvest of the previous three years. Many people who reported incomes above Rs 100,000 per annum during the survey mentioned that during bad years, they have even had to take out their children from the local schools, as it was difficult to pay even the meagre school fees.

Most people were also unable to give accurate information about incomes earned from business activities like PCO/STD shops, guesthouses, travel agencies, etc. It was also difficult to assess income of those people who acted as tour guides and/or operators.

Income from Agriculture

As mentioned earlier, most people practice agriculture on a subsistence basis, taking two crops *Kharif* and *Rabi* every year. Due to the climatic conditions they are unable to take the third crop. Some of the common crops mentioned by the PAFs are rice, maize, mustard, wheat, barley, pulses (including *rajma (*kidney beans).

Some families reported that they cultivated vegetable or cereals and pulses. Almost all of the surveyed families were unable to specify the incomes from agriculture and at most could mention either the number of months the produce could sustain them, or the expenditure equivalent if they had to buy the same from the market.

Some of them cultivate fodder crops which they were not able to quantify in terms of money saved.

Table 5.19 present the incomes of the PAFs from agriculture and percentage of income from agriculture to the total family income.

Table 5.19 Income from Agriculture per Month

Income range (in Rupees)	%age of PAFs	Number of PAFs
No income	93.1	145
1-500	1.7	3
501-1000	3.4	6
1001-2000	0.6	1
More than 2001	1.2	2

Table 5.20 Income Dependence on Agriculture

Dependence	%age of PAFs	Number of PAFs
Nil	92.4	145
1-15%	7.0	11
15-30%	0.0	0
More than 30%	0.6	1

Income from Plantation

Almost all the PAFs covered had plantations and were earning at least some income from the plantations. Many PAFs are largely dependent on plantations for their livelihood. There were a few families who even thought the had apple orchards, were not earning any income from them as all the trees were immature. As with the agriculture, apple production depends heavily on favourable climatic conditions. People mentioned that only in the years of heavy snowfall could they expect a good harvest. The income from the harvest is further dependent on the size of the fruits, overall production in the area etc. While most people sell it to the middlemen, some sell it directly in the bigger markets (like Delhi) or give the entire plantation on contract. Those families that do not have sufficient support to undertake the management of crop harvest and its subsequent sale in the market usually contracted the crop. The contracts also act as a safeguard against a poor crop as the contracts are given before the fruiting season and the loss is entirely borne by the contractors.

During 'bad years' it is difficult to break even for most farmers. It was also mentioned that it takes as many as 10 years of care (including substantial expenses) for the apple trees to mature and start bearing fruits. The table below provides an overview of monthly income from the plantations.

Table 5.21 Income from Plantation

Income (in Rupees)	%age of PAFs	Number of PAFs
No income	8.3	13
1 to 2000	10.2	16
2001 to 5000	17.2	27
5001 to 10000	24.8	39
10001-15000	12.1	19
More than 15001	27.4	43

Note: This information was not available for 15 PAFs

Table 5.22 presents the dependence on plantation for the total family income.

Table 5.22 Dependence on income from Plantation

Dependence (in %age)	%age of PAFs	Number of PAFs
No dependence	8.3	13
1-15%	0.0	0
15-30%	3.2	5
30-50%	3.9	6
50-75%	12.7	20
75-99%	19.7	31
100%	52.2	82

Note: This information was not available for 15 PAFs

5.5.10 Community Expectations

The expectations for development in all the three villages, though almost similar, varied in terms of priorities. This sub section presents the communities' priorities village wise as they emerged during consultations with them.

Aleo

- Consistent/improved power supply in winter;
- Construction of bathrooms;
- Community toilets that can either be maintained by the projects or GP.
- People would also be willing to contribute in their maintenance.

Prini

- Improvement in agricultural practices through support from government
- Improved variety of cattle and goats
- At least one dispensary in the village.
- Community toilets

Jagatsukh

- Employment opportunities
- Improved education facilities
- Access to better and regular irrigation facilities
- Hospital
- Better roads
- Street lights
- Improved drainage facilities
- Sewerage

Expectations from the Project

People in Aleo were mostly positive about the project, as the road development is expected to present increased economic opportunities. However, in Jasgatsukh and Prini people were apprehensive about the project activities in their village as they were losing productive land in large chunks. The community expressed its apprehension about the proposed residential colony and the idea of a large number of outsiders living in the vicinity of the village. Some people who stand to lose a large part of their landholding and hence their livelihood, expressed their feelings quite strongly.

When asked about the expectations from the Project, other than getting a fair compensation, employment topped the list, especially for those families losing a part of the land. Some of the expectations from the project are presented below.

Aleo

- Employment
- Improvement of existing school building, development of a middle school
- Street lights
- Increased opportunities for tourism through road development

Prini

- Employment
- School. It was suggested that the current school building could be used for locating a PHC while the school could be shifted to a new building located in a quieter area.
- A local meeting place (specifically a small stadium for Panchayat and village level meetings)

Jagatsukh

The GP along with community members in Jagatsukh insisted that they would like to discuss it with the project proponents. They have already sent 2 GP resolutions to the project requesting them to come and discuss the project. They expressed their displeasure at not receiving any response from the project authorities. It was also mentioned that the GP might be willing to provide Panchayat land in stead of private land, which is to be acquired as it is the most productive land in the village.

5.6 *DESCRIPTION OF CULTURAL ASPECTS & TOURISM IN STUDY AREA (AS EXTRACTED FROM SECONDARY SOURCES)*

Manali developed somewhat in 1950's when the descendants of some of the original British settlers established tourist "guest houses". The best known were the Banon's (Banon 1952). At this time, the road was extended beyond Manali to the base of Rohtang Pass and in the subsequent decade, over the Pass to Keylong, the capital town of Lahul, and Leh in Ladakh. Until the late 1960's, Kullu, and Manali specifically, remained a destination summer vacation spot for relatively small numbers of expatriate individuals and families and small mountaineering expeditions. Toward the end of this period, Manali itself became a seasonal destination of large numbers of foreign young people, otherwise described as "hippies", and known for the associated "drug" culture. With the extension and improvement of the road network, which was done for national security purposes and to support the growing commercialization of agriculture in the area, more short-term visitors were attracted to the area.

Domestic (i.e. Indian) tourists dominate the tourist economy with the peak visitation seasons being in June (pre-monsoon) and mid-September to mid-October (post-monsoon). The latter coincides with the well-known Kullu Dussehra (religious festival). Growing affluence in a segment of the population of India, in addition, has increased the tourist demand. Manali is seen as an easily accessible and affordable mountain paradise in which to escape the heat of the pre-monsoon and post-monsoon seasons south of the Himalaya.

More recently, the Manali area has developed a small winter tourist trade. For the adventurous, a helicopter ski operation has developed and is advertised worldwide. It is modeled on successful operations in Canada, U.S.A. and New Zealand and, like them, attracts affluent foreign tourists. For the domestic market, Manali is being presented as a "winter wonderland" and place to come to learn to ski. These attractions extend even into June and early July when people are encouraged to visit the remaining snowfields at Rohtang Pass.

Both a cause and an effect of the growth in tourism in Kullu, is the development of infrastructure to transport and accommodate tourists. Tourism has spawned related services in the area. The indigenous work force of the area is insufficient in number and training to support this growth in economic activity. In its turn, this has stimulated the in-migration of seasonal and permanent workers and their families, which further stresses available accommodations and services. The stress on available land has been particularly notable in the Manali vicinity where suitable building sites are at a premium. Small areas of agricultural land have been converted to residential and commercial uses. Much of the traditional agricultural land is retained in the village use areas and some is being used forthe equally lucrative commercial orchardry and horticulture.

5.6.1 Pressure on Forest Resources

The historical land settlement provided with relatively well-defined rights to resources in this area. Since the villages in this area have resource use areas and livelihoods to a large extent tied to the land, the threats to biophysical sustainability in the study area were also threats to the economic and social wellbeing of the people. These threats included the replacement of biologically diverse traditional field crops with orchard monocultures; the heavy use of government-subsidized pesticides; and the loss of collective decision-making traditions in certain kinds of landuse area, which had been privatized. Extensive illegal felling of trees was a major threat to the forest environment as well as to the villagers' collective livelihoods. Local institutions as well as government agencies were struggling with these resource management problems.

The framework of law which structured the use of resources in the Manali area and Kullu valley is the 1886 Anderson settlement report and a later report prepared by A.H.Diack (1898). Under this settlement village rights in the Kullu district appear to have been more generously defined than elsewhere. Contrary to indications from other areas in India, the process of settlement rights in Kullu valley did not result in the termination of local people's rights, but rather their acceptance and formalisation. Anderson's report seemed to have a concern for village rights, noting that rights to forest resources were important to the livelihoods of villagers: "The people are dependant on these rights for their very existence, and extinction of the rights would be the most unjustifiable expropriation"

However, these concerns for village rights still had to operate under the framework of the 1878 Indian Forest Act which was intended to affirm the state ownership of Indian forests and abridge village forest rights. One method to define local rights, under the overall state ownership of forests, was to assign a forest area based on precolonial tributary use areas to each revenue village created by the settlement process. These forest rights were vested in the individual landholder and recorded at the time of the revenue settlement. The vesting of forest rights in the individual, rather than the village, made it difficult for a village to regulate the activities of their members. In law, the village was given a portion of a state forest, within which each landholder of the village could exercise recorded forest rights, but management, regulation and enforcement were carried out by the Forest Department. The result was a state forest divided into village forest right areas, to be utilized by villagers, but managed by the state, as determined on the basis of the *de jure* property rights established in 1886. Eventhough, these rights were initially defined as *individual* rights by the colonial administration following the European tradition, they were in fact practised as *communal* rights, following the Indian and Pahari tradition. Considering the importance of the diversity of *interdependent* uses of the local mountain environment, this shift in practice may help explain how "tradegy of the commons" in the use of resources was avoided. Because of the interdependence of many kinds of livelihood activities, common property resources were the key to sustainability, and common property institutions made possible the complex of diverse and shifting relationships.

5.6.2 *Social Setup of Pirni, Hamta, and Jagatsukh villages*

Sacred Groves

In Himachal Pradesh, as in many other regions of India, religion and belief systems have traditionally been integrated with natural resource use and management. This complex of religion and natural resources often forms the core of social and cultural life. This integration is exemplified in the institution of the “devaban”. Devaban is the local term used to refer to forests that are considered sacred in Himachal Pradesh.

Devaban are found all over Himachal Pradesh, particularly in the moist temperate regions of the state that are densely forested. Often, such forests are visible markers in the landscape. They stand out as oases of dense diverse forests amidst an agricultural landscape or monoculture forests. Local communities through the devaban institutions, aided by a system of beliefs that encompass the lives and livelihoods of these communities manage these forests. Such devaban are found in the study area.

These devabans today are traditional institutions that lie at the intersection of cultural and ecological practices. Changing religious beliefs, transmuting cultural practices, economic transition, and an emergent green consciousness have all left their mark on this traditional institution. They now lie in the discursive terrain of tradition, culture, modernity, markets, and conservation. They represent a religio-social system that is today isolated in small pockets, challenged continually by broader cultural and economic forces. On the other hand, they have entered the conservation discourse and politics since they represent unique ecological islands.

Sacred groves have generally been seen as examples of traditional conservation practices, repositories of indigenous knowledge, and models of community based biodiversity conservation. There are at least three major types of sacred forests that can be distinguished. First are forests that have been defined as sacred by some community of users. These forests are sacred and have religious/cultural/ emotional value in local discourse and practice, irrespective of the actual legal ownership of the land or trees. Thus it is possible that what is a reserved forest in legal ownership documents, is considered in local discourse as a sacred grove. In this form of sacred grove, the entire forest ecosystem including the entire fauna and flora enjoy protection. Second, there are particular species of trees that have sacred value, and thus clusters of this species form a sacred forest. Here the value attached is to the particular species and other coexisting species may not be protected. Specific deodar (cedar/Cedres deodara) trees in Kullu are often considered sacred, believed to hold the spirit of some devata. The Vanshira of Kullu is one example, where a particular deodar tree is believed to be the guardian of the forest. It is relatively common to find iron nails driven into trees, pieces of red cloth or old iron articles left below such a tree. Third, there are forests that are the legal property of the devata. In general, the property of the devata is sacred, although conversion from one form of property to another may be entirely acceptable. This is significant since sacredness is not embodied in the particular object or place; it is sacred mainly by way of ownership. This does not provide the same level of ecological protection as the earlier two types of sacred groves. Harvest or sale of forest produce for conversion into other forms of temple property could be legitimized more easily under this system. All three types of sacred forests are found in Himachal Pradesh, often with one type overlapping or intermixed with the other. The management of these sacred forests is closely interwoven with the entire devata system that forms the core of rural social life.

Devaban range in size from a few trees to forest tracts spread over several acres. They are managed on the basis of rules of use, which are specific to each devaban. There is a significant distinction made between using the forest for the devatas own use, such as in temple repairs and in communal cooking during *devata's* fairs, and the use for human needs like fuel-wood, fodder, poles and timber. Human use is believed to be determined according to devata's willingness and wishes. There is no one set of rules that is operative for all devaban or for all times. Generally in the forests of devatas like *Nag*, *Vanshiras*, and *Jognies*, which are manifestations of animistic and natural spirits, rules regarding use of their devaban are more stringent.

Cultural fairs

Fairs (“melas”) held in honour of devatas are an important economic and cultural space in this area. They encompass religious rites and rituals, games and entertainment, trade, and cultural events. Melas serve an important social function in cementing social relations within the community and between neighbouring villages. These are occasions for social interaction. Since each community hosts its own mela, relations of reciprocity in hosting and visiting each other are established. The hospitality of particular families and communities are remembered and reciprocated. Thus even though two families may not meet during the year, relationships are maintained through close interaction during the melas. News from the entire valley circulates in the region. Melas are important locations and times when marriages are fixed and conducted. It is an opportunity for informal cross-gender interaction, where young people select their own partners. It is also a site where more formal marriages are arranged through interaction and agreement between families.

Livestocks

There is livestock population of within the study area mainly includes cattles (local dwarf breeds), sheeps, goats and poultry birds.

6 IMPACT ASSESSMENT

6.1 INTRODUCTION

This section covers potential social and environmental impacts due to setting up of proposed Allain - Duhangan 192 MW capacity hydropower Project in Manali, Himachal Pradesh.

Environmental and social impacts refer to any change that the Project may cause in the environment, including any effect of any such change on health and socio-economic conditions, on physical and cultural heritage, on the current landuse and resources for traditional purposes, or on any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.

The potential environmental and social issues and concerns have been identified as part of impact assessment process including public consultations (as documented in Addendum to ESIA) to include potential impacts on location and design, construction, demobilisation of construction activities, operation and maintenance, and decommissioning phases of the Project. The identified significant adverse impacts have formed the basis for development of mitigation measures to be implemented as part of Environmental and Social Management Plan (*Section 8*).

6.2 CRITERIA TO DETERMINE SIGNIFICANCE OF IMPACTS

The following criteria were used to determine siginificance of impacts for the ADHEP:

6.2.1 For Environmental Components other than Ecology

1) Extent (Context)

The extent refers to spatial or geographical extent of impact due to Project activities. In this revised and updated ESIA Study, impacts were classified as per the following extent:

- Very Local (very low spread, when an impact is restricted within the foot prints of each of the Project component;
- Local (low spread), when an impact is restricted within the foot prints of each of the Project component and extends up to 0.5 km from footprint boundary of the Project component;
- Medium (medium spread) when an impact is spread from 0.5 to 2 km from the footprint boundary of each of the Project component; and
- Regional (high spread) when impact is spread beyond 2 km from footprint boundary of each of the Project component.

The above extent has been selected based on the understanding of the Project and prevailing environmental and social baseline conditions. The Project relates to development of hydropower generation units involving water from Allain and Duhangan rivers having a catchment area of 194 sq km. The catchment is spread over in hilly areas dominated with forests and relatively low population mainly concentrated in clustered areas of villages Jagatsukh, Prini, Aleo, Shuru, and Saithan.

2) Duration

The duration of impact indicates whether the impact would be short-term, medium-term or long-term. The impacts have been assessed considering the time taken by the environment to recover back to its best achievable pre-project state. For the proposed hydropower Project, impacts were classified based on their existence in temporal scale as follows:

- Short term (*low duration*) when impact is likely to be restricted for duration of less than 1 year other than ecology); this is based on the understanding that the recovery of the effected environmental component (other than ecology) will be within 2 years.
- Medium term (*medium duration*) when impacting up to three years; this will result in the recovery of the effected environmental component (other than ecology) within 10 years; and
- Long term (*high duration*) when impacting beyond three years (other than ecology); and will result in recovery of prevailing conditions in 10 years or beyond or upon decommissioning after completion of the Project life.

3) Magnitude (Intensity)

Indicators of the magnitude (intensity) of an impact, whether it is insignificant, minor, moderate, or major, was based on the following criteria adopted for the proposed hydropower Project:

- Insignificant intensity, when resulting in changes in the environmental baseline conditions of less than 20% in regional context or 20 to 30% in medium context or up to 30% in local context but for short duration of less than 1 year;
- Low intensity, when resulting in changes in the baseline conditions up to 20% in regional context or up to 30% in medium context or more than 30% in local context or for ecology minimal changes in the existing ecological baseline conditions in terms of their reproductive capacity, survival or habitat suitability;
- Moderate intensity, when resulting in changes in the baseline conditions for up to 30% in regional context or more than 30% in medium context or for ecology changes are expected to be recoverable in terms of medium duration of three years; and
- High intensity, when change resulting in the baseline conditions beyond 30% in regional context or for ecology changes result in serious impairment to species, productivity or their habitat.

4) Type

The type of impact refers to whether the effect is considered beneficial or adverse. Beneficial impacts would improve resource conditions. Adverse impacts would deplete or negatively alter resources.

Details regarding application of the above mentioned criteria are presented for each of the identified environmental impacts in this section of the report considering significance assessment matrix as given in *Table 6.1*.

Table 6.1 Impact Significance Criteria for environmental components other than Ecology

Significance	Extent	Duration	Magnitude
Insignificant	Local	Short	Low
Minor	Local	Short	Moderate
	Local	Medium	Low
	Local	Medium	Moderate
	Medium	Short	Low
	Local	Long	Low
Moderate	Local	Medium	High
	Local	Long	Moderate
	Medium	Short	Moderate
	Medium	Medium	Low
	Medium	Medium	Moderate
	Medium	Long	Low
	Medium	Long	Moderate
	Regional	Short	Low
	Regional	Short	Moderate
	Regional	Medium	Low
	Regional	Medium	Moderate
Major	Local	Short	High
	Local	Long	High
	Medium	Short	High
	Medium	Medium	High
	Medium	Long	High
	Regional	Short	High
	Regional	Medium	High
	Regional	Low	Low
	Regional	Low	High
	Regional	Low	High

Note: Positive impacts are termed as beneficial while negative ones are adverse

6.2.2 *For Ecological Impact Assessment*

Following criteria were used to assess ecological significance of impacts from development of ADHEP:

- Minor: when the Project affects specific group of localised individuals wihtin a population for a short period of time (i.e. limited to less than one generation) but does not affect other trophic levels or the population itself;
- Moderate: when the Project affects a portion of a population and may bring about changes in abundance and or distribution over one or more generations, but does not threaten the integrity of that population or any population dependent upon it.

- Major: when the project affects entire population or species in sufficient magnitude to cause a decline in abundance and or change in distribution beyond which reproduction, immigration from unaffected areas would not return that population or species or any population or species or depndant upon it to its former level within several generations.

6.3 IMPACT IDENTIFICATION

The impact of Project activities on environmental resources during the Project life cycle (without mitigation measures in place) are identified as per *Table 6.2*:

Table 6.2 Identification of Potential Adverse Impacts of Project Activities

S. N.	Activity	Potential Impact
1	Land Take	▪ Loss of agriculture land ▪ Resettlement and rehabilitation of livelihood and other socio economic ▪ Loss of Forestland
2	Construction activities ▪ Access roads - road from Prini to Allain barrage site and Jagatsukh to Duhangan weir site ▪ Bridges along roads, slope stabilization and cross drainage works, ▪ Construction vehicles transporting men and machinery ▪ Construction of diversion structures on Allain - barrage, head regulator, de-silting arrangement, intake structure and Allain head race tunnel (HRT); ▪ Construction of diversion structure on Duhangan - weir, head regulator, de-silting arrangement, intake structure and Duhangan head race tunnel (HRT); ▪ Intermediate reservoir, surge shaft and its associated works; ▪ Pressure shaft and associated works; ▪ Powerhouse complex and its associated works including tail race tunnel/ channel and switchyard; and ▪ Permanent and temporary buildings, water supply, electrification of colony, communication systems, workshops, stores, ▪ Transportation, funcitioning of office and deployment of security etc.	▪ Changes in land uses, topography and drainage ▪ Deployment of work force – cultural impacts, health and sanitation issues, pressure on forest resources, ▪ Employment and other business opportunities for local population ▪ Changes in hydrology and hydrogeology ▪ Water quality - deterioration of downstream water quality ▪ Air pollution deteriorating ambient air quality ▪ Disturbance to flora and fauna including aquatic biology and fish resource ▪ Blasting causing ground vibrations and effecting ambient noise quality ▪ Occupational health and safety issues ▪ Visual intrusion caused by construction activity ▪ Socio-economic, cultural and historical issues ▪ Traffic and other infrastructure development resulting in air and noise emissions and traffic hazards, ▪ Community, health, safety and security ▪ Tourism ▪ Potential incidence of natural hazards – flood, cloudburst, forest fire, avalaunch etc.

S. N.	Activity	Potential Impact
3	Operational activities ▪ Diversion of Allain and Duhangan streams ▪ Flow of diverted water through tunnels to intermediate reservoir ▪ Power house – turbines generating power ▪ Discharge of water from tailrace near Aleo in Allain stream ▪ De-silting/flushing of de-sanders at Allain and Duhangan streams. ▪ Transportation, funcitioning of office and deployment of security etc.	▪ Change in hydrology and hydrogeology; ▪ Decrease in dilution capacity of stream; ▪ Decrease in water availability downstream – specifically Duhangan stream and flow disruption - irrigation and drinking water issues; ▪ Deterioration of water quality downstream during generation or spilling and flushing of silt from de-sander units at Allain barrage and Duhangan weir sites; ▪ Changed water temperature and velocity downstream tailrace discharge; ▪ Loss of aquatic flora and fauna affecting water flows; ▪ Provides increased habitat for mosquitoes which are vectors of diseases like malaria; ▪ Erosion of banks downstream tailrace discharge. ▪ Socio-economic issues - community health, safety and security
4	De-commissioning ▪ Dismantling of structures of Project components causing ▪ Impacts due to tunnels closure, dewatering and desilting of water storages, ▪ Land transfer ▪ Landscape development	▪ Adverse impacts similar to those specified in S.N. 1 (for construction activities); ▪ Positive impacts due to site and forest restoration, landscape development, flow restoration

Note: Impacts due to Power Transmission are covered separately in ESIA for Power Transmission from Prini to Nalagarh

Based on the above discussion (*Table 6.2*) following potential impacts/issues have been identified:

- Land use, Topography, Soil Erosion/Sedimentation;
- Water Resources and Quality - Hydrology, Hydro-geology and Surface and Groundwater Quality;
- Ambient Air Quality;
- Ambient Noise Quality
- Ground Vibrations;
- Ecology - Forests, Terrestrial wildlife, Aquatic Biology and Fisheries;
- Health & Sanitation;
- Safety including Road Safety due to Project Traffic;
- Socio-economic
  - Land Acquisition, and compensation;
  - Resettlement and rehabilitation of livelihoods;
  - Employment generation & induced impacts due to development in the area;
  - Agriculture/Irrigation;
  - Cultural and Tourism Aspects;
  - Community helath, safety and security
- Impacts due to natural hazards - flood, cloudburst, forest fire, earthquake, landslides/avalanches; and

- Impacts due to transmission line construction and operation (covered in separate ESIA for proposed transmission line).

The potential environmental impacts of various activities pertaining to Project components are elaborated in the following sub-sections.

6.4 IMPACTS ON LAND USE, TOPOGRAPHY AND SOIL EROSION/ SEDIMENTATION

6.4.1 Impact on Land use

a) Pre-construction Phase

The Project is bound to change land use pattern of the areas of planned project components.

As shown in *Table 2.2* (*Section 2*), a total of 67.599 ha of land is acquired for the project of which 47.179 ha is forestland. Out of total land, forestland involved is about 69.79%, while 14.42% is private land and rest (15.79%) is state government land. The private and government land involved for the Project would impact agricultural land i.e. for apple and plum fruit bearing plants on private land and potato farm on government land. The loss to forestland will be compensated through compensatory afforestation.

b) Construction and Post Construction (Operation) Phase

During construction and post construction phases, there will be induced change in land use due to change in economic conditions of the villagers and demand for various daily need requirements by families of construction employees. It is estimated that there will be peak labour requirement of 1,500 people, who with their family members will be approximately 2,000 in number, requiring their daily need items from the nearby markets. These factors will improve the economic conditions of the people in the vicinity but will have adverse impact on land-use of the area.

During post construction (operation) phase, there will be rehabilitation of all open areas by growing plantation and development of landscape resulting in positive impact on landuse.

6.4.2 Impact on Topography

a) Construction Phase

The construction of road links to Project component sites, cross drainage works, excavation work for establishing Project components, excavation of tunnels, excavation of other areas and disposal of spoil material (muck) has resulted in permanent change of topography. A total of about 14.0-km of tunnels is involved for the Project components.

The construction activities of various Project components are expected to result in moderate, adverse and permanent impacts on local topography and geology of the Project area during construction phase of the project. The drilling, cutting, blasting and quarrying operations needs to be optimised using advance techniques so that their impacts are minimised. It is expected that adequate measures are undertaken to maintain stability of the prevailing geological structures in the Project component areas.

b) Operation Phase

No further changes are expected in geology during operation phase of the project. Any maintenance work is to be restricted to Project component areas.

6.4.3 *Impact on Soil Erosion/ Sedimentation*

Impact on soil is expected to be localised in the area surrounding the Project components. Runoff from unprotected excavated areas and dam faces can result in soil erosion. About 40% of this area is likely to remain exposed and will be subject to soil erosion due to change in land use and local drainage pattern. Another impact on soil will be during construction period as there will be contamination with dust and surface run-off.

A majority of the structures are underground in this project. All excavated muck has to be dumped in a planned manner so as not to pollute/disturb natural sources. In order to do this a total area of 11.6 ha of land has been used as muck disposal area.

6.4.4 *Solid Waste Disposal*

a) Construction Phase

The construction material is required for various structures. Generally such materials are collected from quarry. The quarry sites approved by Himachal Government are about 35 km from the project site. Generally open cast mining has been recommended. However, where it is not possible blasting is to be carried out.

A total of 887,000 m^3 of earthwork (involving muck generation) is carried out during the Project construction.

A total of 150,000 m^3 of rock and soil excavation is carried out in approximately 28 km long road construction for both Allain and Duhangan areas. Of the excavated soil, approximately 120,000 m^3 (80% of total muck) is used in filling of roads, road soling and building retaining walls etc. Balance 30,000 cum of muck is disposed off at identified muck disposal areas (refer to muck disposal plan in *Section 8* on ESMP).

The construction of Project components is expected to generate about 737,000 m^3 (also refer to *Table 2.10*) of soil and rock spoils, mainly in form of rock cuttings. It is expected that 40% of this quantity is reused in project construction works such as wire crates, retaining walls, rip-rap, soling, etc. As per current figures, a total of about 442,000 m^3 muck is disposed in the identified muck disposal sites as per the Muck Disposal Plan (refer to *Section 8* on ESMP).

Overall, approximately 47% of the total muck generated would be reused in backfilling and remaining would be disposed-off in identified muck disposal areas of 11.6 ha with a fill height of approximately 5 m at dumping sites. It is expected that more than half of the excavated material is expected to be soil, hence sufficient care is to be taken not only to prevent the erosion of such masses of soil into the streams, but to withstand serious earthquake events, and possible landslide, flood episodes and snow avalanches from upslope as well.

The other source of solid waste generation is in from sedimentation tanks, which is estimated to be approximately 0.1 to 0.5 tonnes per day and from Activated Sludge Process based wastewater treatment plant to the tune of approximately 0.1 to 0.15 tpd. The solid waste from domestic wastewater treatment is expected to be rich in Nitrogen and Phosphorus nutrient contents and can used as manure in plantation activities.

Solid wastes from fabrication workshops include metal scraps, waste oils, machine oils, drill cutting oil, cables and domestic waste cloths. Such wastes disposal is to done as per the norms of HPPCB.

Mitigation measures include careful planning and selection of borrow pits, timing of cut and fill operations and re-vegetation campaigns. In general construction works are stopped during monsoon/heavy snowfall seasons. For disposal of excavated spoil material (muck) maximum reuse is to be ensured. The left over muck to be disposed of at identified dumping sites only thus limiting local land use change. The present land-use of land pieces identified for muck disposal sites are privately owned. Proper attention is required for stabilisation of the dump by proper slope stabilisation and rehabilitation of the surface by adding soil and growth of grass of local region suitable to merge with the local land use.

b) Operation Phase

During operation phase, it is expected that solid waste generation approximately 0.1 tons per day of solid waste from Activated Sludge Process based wastewater treatment plant. This solid waste being rich in Nitrogen and Phosphorus nutrient contents will be used as manure in plantations.

Other solid wastes are expected from fabrication workshops, which include metal scraps, waste oils, machine oils, drill cutting oil, cables and domestic waste cloths. Such waste disposal will be done as per the norms of HPSEB.

6.4.5 *Impact Significance - Land use, Topography and Soil Erosion/ Sedimentation*

Impact significance for potential changes in landuse, topography and soil erosion/sedimentation as identified in the above sections is as per *Table 6.3*.

Table 6.3 Impact Assessment: Land-use and Soil

Impact Area	Nature of Impact [1]	Targets/ Interests[2]	Magnitude[3]	Extent[3]	Overall significance [4]
Land use	Longterm change in original land use, land degradation, (major)	Reduction of vegetation, loss of top soil	Moderate	Local - Project component areas, beneficial effect in terms of compensatory afforestation with higher success percentage expected	* Moderate
Topography	Long duration change – due to excavation of tunnels, development of other areas and construction of roads	Physiography of the area	Moderate	Medium spread - within the Project component areas, irreversible	* Moderate
Derogation of land and soil quality	Medium duration change - Cumulative contamination with dust, surface run-off and Project solid waste excavated muck disposal; reversible	Soil quality, flora and fauna, including grazing livestock	Low	Local –Localised near sources; contribution to existing background levels, provided dust control and overburden is managed	❍ Minor with mitigation measures in place
	Physical effects on soils due to topsoil removal, nutrient loss.	Soil quality, flora	Low	Local - Project component areas only	❍ Minor

[1] Description; short or long term; reversible or permanent; associated with construction, operation, decommissioning; cumulative, accidental, etc

[2] Targets and interests potentially affected.

[3] Adverse or beneficial; low, moderate or high magnitude; very localised (Project component sites only), local, medium, regional extent.

[4] Overall significance against criteria (❍ minor; *moderate; * *major)

6.5 *HYDROLOGY, HYDRO-GEOLOGY & WATER QUALITY*

6.5.1 *Hydrology*

a) Construction Phase

It is proposed to divert the Allain and Duhangan flows to a storage reservoir. The design flood discharges for 50 years return period for the Allain and Duhangan are 662 and 287 m^3/sec respectively. Diversion structures - barrage on Allain and weir on Duhangan are located at an elevation of 2,740 m and 2,781 m respectively.

The construction of diversion structures and de-silting chambers on Allain and Duhangan streams are on run-of-the river schemes. The proposed diversions would result in higher water levels, backlogging and submergence of water into some unoccupied flat forestland in the vicinity through which it ultimately finds its way into respective streams. However, construction of temporary channel with adequate bunding (check wall, cofferdam) arrangement would avoid submerging of flat areas during construction phase.

The associated environmental impact of such a cross-stream diversion is expected to be severe or total reduction of flow immediately downstream of the diversion and consequently, of water levels and water currents downstream. This in turn may effect erosion, water temperature, water quality and an increase in retention time. The magnitude of the impact is a function of the ecosystems affected, particularly its aquatic ecology, and the length of river/streams with diminished flow. An additional impact has to do with the increased flow in the Beas River the reverse effects on water levels and currents. However, diversions of flows for construction purposes are expected to be short term in terms of their variation.

Thus, it is anticipated that there will be some impact on the land in the vicinity and change of flow pattern within the flood channels of Allain and Duhangan streams.

b) Operation Phase

The average inflow observed in the past at diversion sites indicates a variation of flows from 1.54 to 21.78m^3/sec in Allain and 1.38 to 7.31m^3/sec in Duhangan stream. The average, 50% and 90% dependable flows on ten-daily basis on Allain and Duhangan streams as per *Table 6.4*. Thus 90% dependable combined flow estimated is 4.467m^3/sec. The diversion structures during operation phase will result in disturbance of the existing flow pattern of the two streams. It is anticipated that present flow on Allain stream from barrage site to tailrace discharge point (about 5.6km) will be reduced, which may result in significant impact on downstream flow, velocity and levels in comparison to the present flow pattern. Similarly, on Duhangan stream the diversion is proposed to join flow into common pooling point, the surge shaft and the proposed diversion will result in reduced flow in its stretch of about 6.5km downstream weir location till its confluence in Beas River. This may result in significant impact on downstream flow, velocity and levels in comparison to the present flow pattern.

Table 6.4 *Flow Estimates in Allain & Duhangan Streams at Diversion Structures*

Catchment at Diversion Site	Flow (m^3/sec)			
	Minimum	Average	50%Dependable	90%Dependable
Allain Stream	1.54	9.133	5.940	3.028
Duhangan Stream	1.08	4.817	2.950	1.301
Combined Flows	-	`13.950	8.871	4.467

An analysis of flow pattern (as monitored by HPSEB) has been carried out for the two streams for the period of minimum discharge (i.e. between October and March) during 1973 - 74 to 1994 – 95. The flow pattern represents locations monitored at the proposed Allain barrage site and downstream at village Aleo on Allain stream. Similarly, on Duhangan the flows were monitored by HPSEB at locations of weir site and downstream near Jagatsukh village. A detailed comparative discharge measurements for Allain stream at Aleo and barrage site and Duhangan stream at Jagatsukh and weir site is enclosed as *Annex J*.

The minimum flows observed in a year during January and February being 1.54 m^3/sec for Allain stream and 1.08m^3/sec for Duhangan stream. As per notification no. PC-F (2)-1/2005 dated 09 September 2005 by the Principal Secretary (Pollution Control) to the Government of Himachal Pradesh, a minimum discharge of 15% is to be ensured by hydroelectric power projects. Accordingly, a minimum discharges after diversion from the Allain and Duhangan streams that have to be maintained by the Project has to be 0.231m^3/sec for Allain stream and 0.1623m^3/sec for Duhangan stream during the lean flow. The Project will ensure a minimum of 15% of available flow at any given point of time.

Further, it is important to note that village Jagatsukh requires water downstream Duhangan for their domestic and irrigation needs also. As per the findings of the Honourable High Court of India, the Project is required to discharge a total of 249.37litres per second (0.24937m^3/sec) and an additional 15% of minimum flow i.e. to a total discharge of 335.87litres per second as minimum flow to be maintained by the Project downstream the Duhangan weir. This flow will have to commensurate with increase of population of Jagatsukh village over the years. A minimum flow of 387.09litres per second is to be maintained by the Project till the Project life of 40 years and has to be re-assessed subsequently for any extended Project life.

The flow measurements were also compared with the flow available at diversion sites and downstream at Aleo in Allain and at Jagatsukh in Duhangan streams. An exercise has been undertaken to assess the lean season water availability in the Allain and Duhangan streams through other streams, post proposed diversion structures on respective streams. The difference of the flows i.e. additional flows available in Allain and Duhangan streams are as presented in *Table 6.5*. The table shows available additional flows ranges from 0.408 to 0.880m^3/sec through other channels post diversion structure on Allain stream (as per data recorded by HPSEB from 1973 through 1995). The minimum flow contributed by other channels post diversion structure on Allain has been found to be 0.226m^3/sec in the month of February during driest year of 1973-74. The minimum flow (i.e. of 15% of available flow) to be discharged along with flow available through other channels downstream the Allain would make the available total flow of 0.597 (0.231+0.226) m^3/sec i.e. 51,580 m^3/day, which is about 38% of the minimum flow ever observed during lean flow period on Allain at Aleo.

Similarly, *Table 6.5* also shows available additional flow in the range of 0.519 to 1.341m^3/sec through other channels post diversion structure on Duhangan stream as per data recorded by HPSEB from 1973 through 1995. The minimum flow contributed by other channels post diversion structure on Duhangan has been found to be 0.360m^3/sec in the month of February during 1987-88. The minimum flow (15% of the available flow) to be discharged along with flow available through other channels downstream the Duhangan stream would make the available flow to be more than 0.60939 (0.24939+0.360) m^3/sec i.e. 52,651 m^3/day, which is approximately 60% of the ever observed minimum flow observed during lean season on Duhangan stream at Jagatsukh.

Table 6.5 Additional Flow (m^3/sec) Available through other streams charging Allain and Duhangan Streams post Diversion Structures

Months		**Difference of Flow at Diversion Structure and Downstream before confluence with Beas River (Additional Flow Available downstream) m³/sec**																					
	73-74	74-75	75-76	76-77	77-78	78-79	79-80	80-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95	Avg. 22 Yrs
Allain Stream																							
Oct.	0.421	***0.380***	1.623	0.834	1.194	0.857	0.749	0.722	0.692	0.830	1.183	0.716	0.842	0.775	0.951	0.893	1.659	0.620	0.778	0.922	0.738	0.976	0.880
Nov.	0.333	***0.333***	1.001	0.794	0.813	0.615	0.557	0.555	0.522	0.682	0.801	0.700	0.585	0.573	0.548	0.391	0.565	0.483	0.482	0.663	0.488	0.765	0.602
Dec.	0.281	***0.257***	0.693	0.550	0.593	0.534	0.453	0.453	0.399	0.572	0.656	0.553	0.515	0.492	0.345	0.351	0.438	0.392	0.421	0.438	0.368	0.457	0.464
Jan.	***0.235***	0.265	0.509	0.420	0.490	0.449	0.428	0.381	0.412	0.519	0.645	0.555	0.510	0.505	0.305	0.351	0.341	0.324	0.405	0.363	NA*	0.440	0.422
Feb.	***0.226***	0.294	0.424	0.340	0.402	0.413	0.397	0.375	0.417	0.475	0.467	0.500	0.514	0.513	0.335	0.344	0.348	0.337	0.418	0.348	NA	0.671	0.408
March	***0.261***	0.283	0.468	0.334	0.371	0.453	0.457	0.410	0.443	0.548	0.534	0.499	0.547	0.585	0.425	0.366	0.420	0.415	0.441	0.350	NA	0.434	0.431
Duhangan Stream																							
Oct.	***0.901***	1.384	2.829	1.418	1.436	1.545	0.941	1.053	0.900	0.920	1.392	1.011	1.575	1.216	1.001	1.741	1.018	1.031	1.427	1.569	1.551	1.636	1.341
Nov.	1.042	1.205	1.737	1.016	0.898	0.898	0.631	0.630	0.668	0.704	0.875	0.679	1.002	0.870	0.751	0.841	0.693	***0.616***	0.720	0.815	0.959	0.950	0.873
Dec.	0.966	0.714	1.041	0.817	0.618	0.668	0.522	0.563	0.502	0.693	0.724	0.559	0.685	0.779	***0.440***	0.554	0.518	0.448	0.568	0.502	0.666	0.761	0.650
Jan.	0.641	0.782	0.902	0.617	0.603	0.596	0.465	0.508	0.497	0.662	0.633	0.488	0.523	0.592	***0.388***	0.420	0.496	0.415	0.468	0.437	NA	0.567	0.557
Feb.	0.641	0.929	0.878	0.532	0.531	0.567	0.454	0.465	0.524	0.555	0.434	0.498	0.437	0.442	***0.360***	0.408	0.471	0.416	0.469	0.422	NA	0.467	0.519
March	0.523	0.865	0.891	0.568	0.545	0.645	0.472	0.518	0.594	0.659	0.598	0.588	0.538	0.498	0.481	***0.415***	0.567	0.544	0.656	0.562	NA	0.563	0.585

* NA - Flow Data Not Available; The italicized and bold figures represents minimum flow available.

The minimum recommended discharges downstream the Allain and Duhangan are to be maintained so as to maintain ecological sustenance and local demand downstream. ADHPL is to ensure this monitoring of minimum recommended water flow by installing electronic and manual measurements devices at the diversion structures. ADHPL has to ensure participation of local government and villagers to monitor these devices on periodical basis.

Further, there will be change in flow of Allain stream in the stretch of about 1.5km falling between tailrace outlet to the point of confluence in Beas River. In this stretch, a peak flow of approximately 26.8m^3/sec (96,480 m^3/hr) will be discharged during 4 hours of peak power generation period. This increased flow through tailrace discharge would result in increased level and discharge rate by 8.85 times the present 90% dependable flow in Allain would result in significant impact of current downstream the tailrace discharge.

Apart from the above, during operation phase, there will be permanent submergence of flat forestland to the tune of 4 ha near proposed Allain barrage for erection of diversion structure and submergence of another 2.3 ha of land proposed for Intermediate Reservoir.

Another low probable potential impact on hydrology during operation phase can be due to failure of intermediate or Allain impoundments resulting in high soil erosion, loss to ecology and structures along its path with a risk of accidents. However, construction of two reservoirs in place of one may result in low risk of damage to the downstream ecology and other resources.

6.5.2 *Irrigation and Domestic Water Requirement*

The irrigated land in village Prini is approximately 80 ha while the same in Jagatsukh village is approximately 168 ha. Presently, the major source of water for domestic and irrigation water in the area is met through Pahali stream (Nallah), which has its own catchment area and is located in between the Allain and Duhangan streams. The Allain and Duhangan streams near the project site are separated by approximately 5.5 km of distance.

Some of the irrigation done in Jagatsukh village is dependent upon water from Duhangan stream. Here, villagers have separated out a stream (called *Kuhl* in local language), which is sourced from Kala Nala downstream the proposed diversion point on Duhangan, thus it is expected that proposed diversion will not have much of the impact on irrigation water requirement by Jagasukh village for irrigation purposes.

Construction activities and their impact on water resources will be jointly monitoried by ADHPL and the representatives of the affected communities. ADHPL has assured the villagers that the Dhani, Pahali, Chor Pani or Jamlu Devta drinking water sources will not be disturbed.

In the event of any disturbance to the drinking water sources due to Project construction activity or during the life of the Project, ADHPL will provide sufficient water of potable quality to the affected community to offset any shortages.

ADHPL has given an undertaking to the State Government that the riparian rights, that is the rights of access to drinking and irrigation water, of the Project affected villages will be respected.

In respect of the issue of wastewater disposal by the Project leading to possible health hazards and damage to the agricultural crops, the Project will provide treatment plants for wastewater from campsites, colony and workshop, sewage treatment plant for domestic wastewater and controlled discharge of flushing from de-silting chambers. The Project shall also make provision for regular participatory monitoring of treated wastewater before it is discharged.

6.5.3 Impact on Hydro-geology (Groundwater Regime)

a) Construction Phase

As mentioned above the project will require drilling of tunnels for

- diversion of water from Allain to intermediate reservoir and further to common pooling point, the surge shaft along with Duhangan stream;
- shaft carrying water through penstock to powerhouse; and
- tailrace discharge tunnel from powerhouse to Allain stream

The drilling of these tunnels poses potential impact on groundwater regime. The tunnel from Duhangan to intermediate reservoir will pass underneath the Pahali stream. The Project has planned a passage of the tunnel from Duhangan at a depth of 200 m underneath the current level of the Pahali stream to minimise adverse impact on flow regimes of Pahali stream.

As these tunnels are to be drilled in hills with high elevation differences, it is expected that there will be low impacts on groundwater regime.

b) Operation Phase

The possible impacts on aquifers can be along:

- Allain stream beds in the stretch measuring 5.6km between diversion structures to tailrace; and
- Duhangan stream beds in the stretch measuring approximate 6.5km between diversion structures to the confluence point on Beas River.

6.5.4 Impact on Water Quality

a) Construction Phase

It is anticipated that there will be significant impact on water quality due to escape of suspended solids from various construction activities like the tunnel and land excavation, temporary diversions, road construction etc. Further, deforestation activities and incidences of soil erosion and deforestation from the

Project area and surroundings will deteriorate quality of water downstream if allowed unchecked.

Similarly, domestic and construction activities wastewater discharges can pose significant impact, if discharged untreated. It is anticipated that approximately 288m^3/day of domestic and 50m3/day from wet drilling of tunnels and other construction activities (like workshops, vehicle/equipment maintenance bays) wastewater will be generated during the peak construction phase.

The above mentioned wastewater if discharged untreated will have significant impact on water quality downstream, therefore, warrants prior treatment of such wastewater.

b) Operation Phase

b1) Desilting

During operation phase there will be requirement of flushing de-sanders for de-silting of settled silt in them. It is understood that there will be diversion of annual average water flow of 9.082 m^3/sec from Allain and 4.871 m^3/sec from Duhangan streams containing a maximum sand levels of 1.43 mg/l (>=0.2 mm size) and 1.21 mg/l (>=0.2 mm size) respectively as observed during non monsoon periods (refer to ***Section 4.4.11*** of this ESIA report). The proposed de-sanders (de-silting chambers) will be designed for removal of particles of 0.2mm and higher size only.

On Allain stream there will be four de-sanders (de-silting chambers) to be installed at its diversion structure. The settled silt from four de-sanders will be flushed mostly during monsoon season on rainy days through a total planned 65 number of flushes per annum with a variable frequency of 10 (15%) flushes during June; 29 (45%) flushes during July, 20 (30%) flushes during August and 6 (10%) flushes during September using automatic de-silting mechanism. Provision for manual de-silting mechanism will also be available as a standby arrangement.

On Duhangan stream there will be one de-sander (de-silting chamber) to be installed at its diversion structure. The settled silt from de-sander will be flushed mostly during monsoon season on rainy days through a total planned 15 number of flushes per annum with a variable frequency of 2 (13%) flushes during June; 7 (47%) flushes during July, 4 (27%) flushes during August and 2 (13%) flushes during September using automatic de-silting mechanism. Provision for manual de-silting mechanism will also be available as a standby arrangement.

The discharges (flushes) from de-sanders both from Allain and Duhangan streams will be mostly restricted to monsoon season on rainy days to get maximum dilution. The Project will ensure that the discharge will be of about 1200 m^3 per flushing through vertical lift slide type de-silting gates with a velocity of approximately 6.5 m/sec and discharge time of more than one hour to restrict incremental concentration of silt in the final water of Allain and

Duhangan streams remain restricted to 100 to 500 mg/litre as per the description given in the following *Table 6.6*.

Table.6.6 *Incremental silt concentration from due to de-silting of de-sanders*

S.N.	Description	Units	Allain stream	Duhangan stream
(1)	Available annual average flow at diversion site (per sec)	m3/sec	9.082	4.817
(2)	Available annual average flow at diversion site (per day) [(1)*3600*24]	m3/day	784684.8	417052.8
(3)	Silt content (0.2mm and above)	g/m3	1.43	1.21
(4)	Silt load accumulated in the de-sanders [(1)*(2) /10^6]	tons /day	1.122099	0.504634
(5)	Number of days considered in a year	nos.	365	365
(6)	Total silt deposition (load) in De-sanders load [(3)*(4)]	tons /year	409.5662	184.1914
(7)	Flushes planned from De-sanders	nos.	65	15
(8)	De-silting per flush from a De-sander [(6)/(7)]	tons per flush	6.301019	12.27942
(9)	Quantity of water per flush	m^3	1200	1200
(10)	Expected concentration in de-silted flush [(8)/(9)*10^6]	g/m^3	5250.849	10232.85
(11)	Average flow available during monsoon season	m^3/sec	14.668	8.245
(12)	Average flow per hour (considering a flush is completed in an hour)	m^3/hour	52804.8	29682.0
(13)	Expected incremental concentration [(8)/(12)*10^6]	g/m^3	119.3266	413.6994
(14)	Expected incremental concentration [(13)*1000/1000]	mg/litre	119.3266	413.6994

From the above Table, it is clear that during non-monsoon period there will be no adverse impact due to deterioration of water quality as no de-silting is planned to be taken up during non monsoon months except during some emergency situation of sudden rain during non monsoon months. During monsoon months due to planned flushes in the stretch between diversion structure and tailrace in Allain stream and up to Beas River in Duhangan stream, there will be incremental 100 to 500 mg/litre silt concentrations.

The specific mitigation measures for de-silting will include the following:

- Flushes of de-sander(s) at Allain and Duhangan water diversion structures will be only during monsoon season;
- There will be approximately 65 flushes per annum for desilting on Allain and 15 flushes per annum on Duhangan stream;
- Flushing rate for 1200 m^3 flush per incidence will be for over an hour to minimise adverse impacts during monsoon months.

b2) Thermal Stratification & Reduction of Dissolved Oxygen

Another impacts on water quality can be from thermal stratification of reservoir water prior to its feeding into powerhouse, which could cause thermal stratification downstream the tailrace outlet. There is a potential that the upper layers of the intermediate reservoir may get warmer during summer and colder during winter months in comparison to the lower layers of the water along the column. The Project will be experiencing mostly 4 hours of power generation cycle resulting in low retention time and hence low chances of thermal stratification. However, the power generation during non monsoon may vary up to 20 hours depending upon snowmelt and unexpected rainfall.

As the water storage will have low retention period due to mostly of four hour peaking power generation during non monsoon months, the expected changes in the dissolved oxygen content of water storage is expected to be low. While during monsoon months, there will be round the clock power generation and water replenishment in the intermediate reservoir will be continuous resulting in insignificant depletion of dissolved oxygen.

6.5.5 *Impact Significance: Water Resources*

Impact significance for potential changes in hydrology, hydrogeology and water quality as defined in the above sections is given in *Table 6.7*.

Table 6.7 Impact Significance: Water Resources

Impact Area	Nature of Impact[1]	Targets/ Interests affected [2]	Magnitude[3]	Extent [3]	Overall significance[4]
Surface Water					
Sub-mergence of land	Long term Submergence of Land in the vicinity of Allain barrage structure	Local wildlife and ecology on nearby flat land	Low	Local	* Moderate
Hydrology	Long term – change in Hydrological Regime - Long term Flow modification due to diversion of water and installation of structures on Allain and Duhangan streams	Local inhabitants depending on the downstream water of Allain, Pahali and Duhangan streams.	High	Local/ Regional	** Major
Water quality	Medium term - increase in siltation load due to construction activities	Allain and Duhangan Streams within the catchment area	Moderate	Regional	* Moderate
Risk of high water flow	Short term - Failure of Intermediate and Allain impoundments - risk of occurrence very low	Increase in siltation load due to high soil erosions, destruction of ecology, accident	Low	Local/ Regional	O Minor, but would have major impact if occurred
Water quality	Short term contamination of surface water flows due to de-siltation and thermal stratification.	Downstream diversions structures Tailrace outlet at Allain stream	Medium	Local, small scale - mostly restricted during monsoon season	O Minor

Impact Area	Nature of Impact[1]	Targets/ Interests affected [2]	Magnitude[3]	Extent [3]	Overall significance[4]
Potential for Decreased dissolved Oxygen	Short term depletion of DO in reservoir due to reduced turbulence	Tailrace Discharge point at Allain stream		Local, small scale	O Minor
Ground Water					
Ground-water quantity	Long term, medium reduction	Aquifers along Allain stream beds stretch (5.6km) between diversion point and tailrace outlet; and Duhangan stream beds stretch (6.5km) between diversion point to confluence of Beas River	Low	Local/ Regional	❍ Minor * Moderate

[1] Description; short or long term; reversible or permanent; associated with construction, operation, decommissioning; cumulative, accidental, etc

[2] Targets and interests potentially afffected.

[3] Adverse or beneficial; low, moderate or high magnitude; very localised (Project component sites only), local, medium, regional extent.

[4] Overall significance against criteria (❍ minor; * moderate; * * major)

6.6 *AIR QUALITY*

6.6.1 *Ambient Air Quality - Construction Phase*

To meet the power requirement during construction phase, the project proponent will take power connection from the State Electricity Board; however, during peak hour of power restrictions or in case of erratic power supply, the project proponent will meet the power requirement through onsite power generation using DG sets. The DG sets will be operated at four strategic locations during two shift operations only. It is proposed that a mix of DG sets of 750 kW, 1250 kW and 1500 kW rated capacity be installed at sites like Allain Barrage, Power House, Surge shaft, Intermediate Reservoir and Duhangan to get a maximum total construction power output of 7 MW. At any point of time a maximum of 2500 kW of construction power generation will be undertaken using a combination of above mentioned rated capacity DG sets.

With the operation of these DG sets, it is anticipated that there will be significant impact on air quality due to onsite power generation using DG sets. The likely emissions of potential pollutants NOx and SO_2 to be generated due to operation of DG sets are described in *Table 6.8*.

Table 6.8 Emissions from DG sets proposed for the Project

S.N.	Particulars	Characteristics of DG Sets		
		750 kW	1250 kW	1500 kW
1	Height above ground level (m)	5.50	7.00	7.75
2	Average Fuel Consumption (kg per hour)	97.824	163.04	329.20
3	Diameter (m)	0.2032	0.254	0.3048
4	Gas Temperature (°C)	250	250°C	250°C
5	Gas Velocity (m/sec)	25.1	26.8	22.3
6	Emissions (g/sec)			
	- SO_2	0.0567	0.0927`	0.1113
	- NO_x	0.0928	0.1546	0.1856

Using Industrial Source Complex model ISC3, for emissions from a combination of DG sets with 2500 kW of maximum power generation at any location, the maximum incremental GLC of 27µg/m^3 for NO_x and 16µg/m^3 for SO_2 were found. These are well within the limits prescribed by CPCB.

Another potential impact on air quality will be due to de-fuming of blasting operations undertaken during tunnel development. It is to be noted that the project require a total of approximately 14-km of tunnel development for various project components, which poses adverse impacts on air quality in terms of high NO_x and SPM levels.

The potential fugitive sources of dust emissions are expected from project traffic movement, open excavations, road construction, quarrying, blasting and transportation. Emissions from hot mix plants and concrete mixers during construction activities pose potential impacts on air quality.

Topography of the project area being hilly in nature with high gradient differences, vehicular movements during construction phases will be restricted subject to development of proposed network of roads connecting various project components. This shows that there will be high vehicular movements down at village Prini, requiring regulated movement of fleet.

The average ambient air quality monitored in villages show SPM in the range of 49.6 to 66.9µg/m^3 as against a CPCB standard of 200µg/m^3 (for residential, rural and other areas). Similarly, SO_2 and NO_x concentrations in AAQ ranged from 15.4 to 26.3µg/m^3 and 24.7 to 31.6µg/m^3 respectively as against corresponding CPCB limits of 80µg/m^3 both for SO_2 and NO_x for residential, rural and other areas. With the addition of incremental levels in the baseline, the AAQ will remain within the prescribed limits.

The prevailing winds in Manali blow from N, NE, E and SE directions. Easterly winds may transport pollutants to villages in the west. There is advantage of elevation differences for project components as such are located at higher elevations than Prini and Jagatsukh villages, which are comparatively populated in the study area.

6.6.2 *Ambient Air Quality - Operation Phase*

Impacts to air quality post construction phase will be mainly due to vehicular traffic movement connecting network of roads with various project components. The Project will result in positive impacts in terms of reduction of GHG emissions as described in the following section.

6.6.3 *Green House Gas (GHG) Emission Free Electricity Generation*

The Project operation will have beneficial impacts on ambient air quality. The Project pertains to 192 MW of electricity generation utilising hydro power from Allain and Duhangan streams. The electricity generation and its transmission to to HP State grid (from Prini to Nalagarh) will be free from GHG emissions. The Project is expected to generate electricity of 821 Million Units per annum and thereby displacing an equivalent proportion of fossil fuel generated electricity in the State grid. It is expected that the Project will reduce GHG emission of approximately 0.63 million tons equivalent of CO_2 every year. In the absence of this Project, the electricity would have been supplied to the State grid through some fossil fuel based power plant.

6.6.4 *Occupational Health Hazards Due to Dust Pollution - Construction Phase*

Progressive disintegration of suspended solid particles or dust results in major health problems. Smaller the particle size (less than 10 μm) higher is the chemical and biological reactivity, resulting in increased toxicity than the parent lump. These micron sized particles, once air-borne, are extremely difficult to be collected or trapped. Due to the `minute size of the particles, the ambient environment remains clear, giving a deceptive sense of security to the workers and the management. This restorable dust has serious impact on the health of the workers. Lung functions are impaired due to both respirable and non-respirable dust particles. Chronic exposure leads to respiratory illnesses like asthma, emphysema, severe dyspnea (shortness of breath), bronchitis and in extreme cases pneumoconiosis or the black-lung disease of miners. There may be several components of limestone dust. The effect of dust may be harmful to the human health. The probable effects of air pollutants on plants and animals are listed in the following *Table 6.9.*

6.6.5 *Occupational Health Hazards Due to Dust Pollution – Operation Phase*

No dust or other air pollutants are expected to be generated from the Project during operation phase. The development of landscape and compensatory afforetation will have beneficial impact and will result in improvement of work environment.

Table 6.9 Effects of Air Pollutants on Plants and Animals

Pollutants	Principal Source	Effects
Carbon Dioxide	Fuel combustion for heating, transport, energy production	No direct effect on people, however, can contribute to increase in global warming
Carbon Monoxide	Incomplete fuel combustion – vehicles etc.	Deprives tissues of oxygen. People with respiratory diseases.
Sulphur Dioxide	Burning of sulphur containing fuels like diesel in DG sets	Combined with smoke, increases risk and effects of respiratory diseases. Causes suffocation, irritation of throat and eyes. Combines with atmospheric water vapour to produce acid rain, leads to acidification of soils. Reduces crop yield. Corrodes buildings.
SPM	Smoke from domestic, industrial and vehicular sources	Possible toxic effects depend on specific composition, aggravates effects of SO_2 Reduces sunlight.

6.6.6 Impact Significance: Air Quality

Impact significance for potential changes in ambient air quality as defined in the above sections is given in *Table 6.10.*

Table 6.10 Impact Significance: Air Quality

Impact Area	Nature of Impact [1]	Targets/ Interests [2]	Magnitude[3]	Extent [3]	Overall significance [4]
Ambient air quality	Medium term - deterioration of ambient air quality during Project construction. However, impacts would largely be reversible. Emissions of SPM (dust) and to a smaller extent SO_2, NO_x, would occur during all stages of the project construction phase (of 66 months); and increase in traffic on Nagar – Manali Road	Nearby villages. Workers onsite. Vegetation and Wildlife.	High - dust emissions can be quickly suppressed to insignificant levels.	Local/ Medium - impact mostly within the Project components areas may travel to some distances from project component locations.	* * Major significance
Deposition of pollutants, SPM (dust) in human beings and in local area	Medium term - Potentially impact due to accumulation of SPM deposition	Potential effect on human health due to SPM deposition in the lungs; Potential effect on land and soil quality of nearby agricultural fields (Apple Orchards); Minor/Moderate effect on flora	Moderate	Localised adverse effect. Magnitude dependent on emissions and management of dust control.	* Moderate (In case of human health, as immediate consequences of dust will be on human beings) ❍ Minor/ moderate significance, in case of land, flora and fauna.

Impact Area	Nature of Impact [1]	Targets/ Interests [2]	Magnitude[3]	Extent [3]	Overall significance [4]
		and fauna			However, should the control measures fail, the potential impact could be of major significance)
Ambient air quality during operation phase of the Project	Long term - beneficial impacts due to Project operation	Project operation will generate electricity without emitting conventional pollutants like from other power projects	High – beneficial	Regional – beneficial	* * Major positive impact

1 Description; short or long term; reversible or permanent; associated with construction, operation, decommissioning; cumulative, accidental, etc

2 Targets and interests potentially affected.

3 Adverse or beneficial; low, moderate or high in magnitude; very localised (within the project component locations only), local, medium, regional in extent.

4 Overall significance against criteria (❍ minor; *moderate; * *major)

6.7 *NOISE QUALITY & GROUND VIBRATIONS*

6.7.1 *Noise Quality*

a) Construction Phase

The following activities during the construction phase have potential to cause impact on noise environment:

- Drilling & Blasting during tunnel development;
- Rock Excavations;
- Road Construction;
- Operation of concrete mix plants, DG sets, cranes, & all heavy machinery;
- Vehicular movement.

Tunnel and rock blasting would also result in generating ground vibrations. Noise due to vehicular movement will be intermittent and will be restricted to project component locations as new roads proposed to be constructed will be dedicated to the project only at least during the construction phase.

The following activities during the construction phase will have potential to cause ground vibrations, which in turn might result in sudden intermittent noise and also destabilise near by structures, if any.

- Blasting operations during quarrying.
- Blasting operations during tunnel development.

It has been observed that construction activities generally lead to higher noise levels if not properly controlled. It is expected that construction activities will involve noise generation above 90-dB (A). The sound pressure level generated by a noise source decreases with increasing distance from the source due to wave divergence. Noise attenuation with respect to distance in all directions over horizontal distance can be given by the following equation:

Sound level dB(A) = L_w - 20 $\log_{10}$ R-8
Where L_w = Sound level of source, dB(A)&
R = Source distance, m

The project proponent is proposing to further minimise ground vibrations by using specialised techniques and special explosives. For an approximate estimation of dispersion of noise in the ambient air from the source point, a standard mathematical model for sound wave propagation is used by considering 95dB(A) as the resultant noise level generated from the construction activities including DG set operations in the vicinity of major project component locations. The output of the sound wave propagation is shown in ***Figure 6.1***. On perusal of graph as shown in ***Figure 6.1***, it is clear that noise generated during construction activities will be attenuated to 55 dB(A) at a distance of 40 m from the source and will merge with the background noise level of 55 dB(A) (during day time) at a distance of 300 m and beyond from the source.

The noise source of 95 dB(A) during night time will be attenuated to 45 dB(A) at a distance of 224 m from the source and will merge with the background noise level of 45 dB(A) at a distance of 1km m and beyond from the source.

There will not be any noise impact from the project components of hydropower project during night time as the construction activities will be restricted to two shifts only and no machinery operation will take place during night time. 65 dB(A) and 55 dB(A) are the limits during day time and night time respectively for mixed areas prescribed by CPCB. Therefore, no negative impacts are anticipated at the nearest villages i.e. Hamta, Prini and Jagatsukh.

The noise produced by blasting would be for extremely short duration of a few seconds, though with a high intensity. The impacts over the surrounding habitat can be minimised by adopting adequate precautions during blasting and also by properly scheduling it as indicated in the ESMP. Creation of noise bunds near the periphery is expected to act as an effective barrier against its propagation of sound waves towards the human settlements, particularly when such activities are close to human settlements.

Occupational Noise

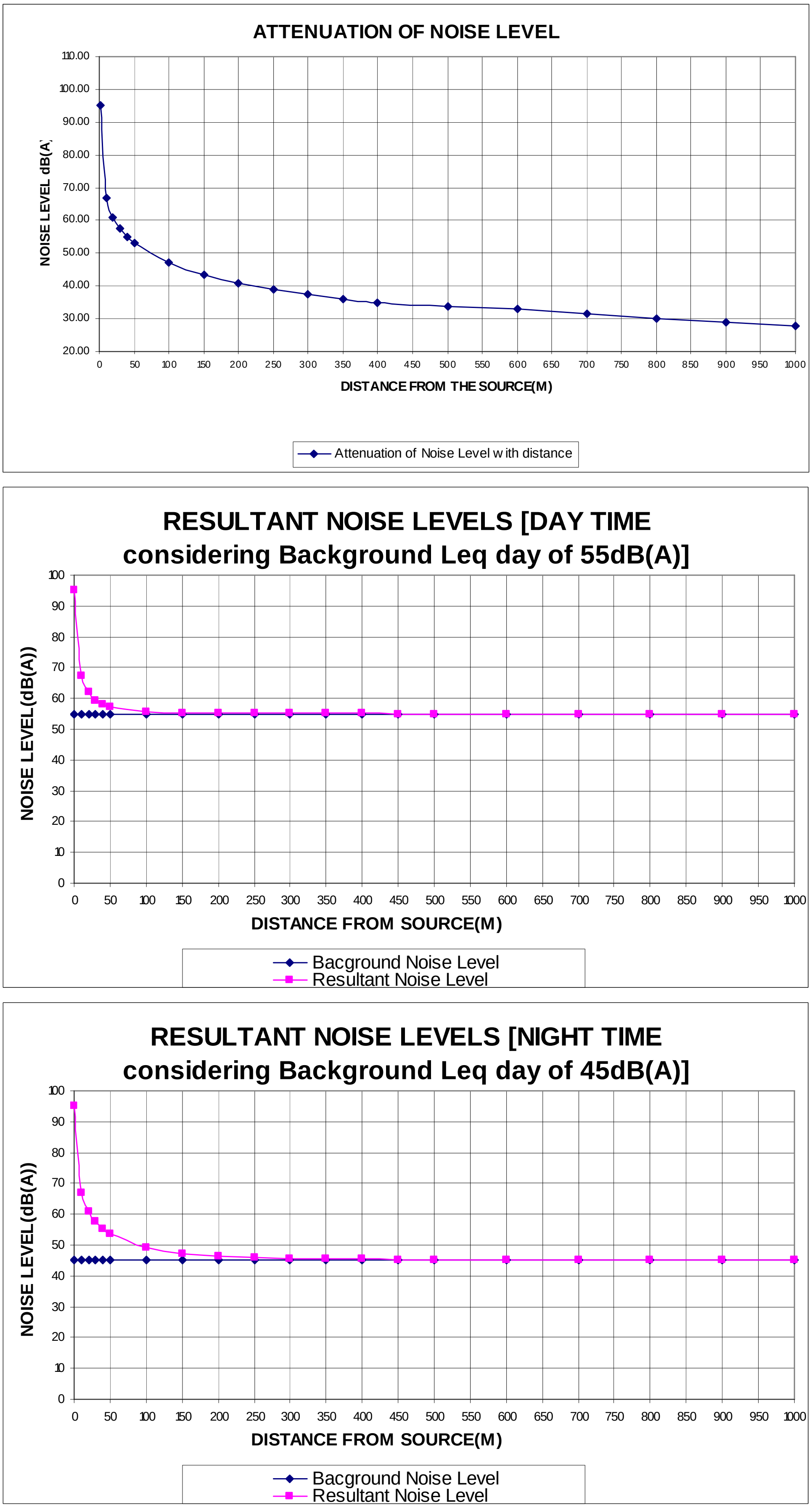
The noise levels in many situations would be above TLV. Exposure to noise levels, above TLV, has been found to have detrimental effect on the workers' health. During construction phase workers engaged for more than 4 to 4.5 hours per shift in high noise generating areas would be greatly affected, unless suitable mitigatory measures are taken. The adverse effects of high noise levels on exposed workers may result in irritability; fatigue; temporary shift of threshold limit of hearing; permanent loss of hearing; and hypertension and high blood cholesterol, etc.

Noise pollution poses a major health risk to the workers. When noise in the form of waves impinges the eardrum, it begins to vibrate, stimulating other delicate tissues and organs in the ear. If the magnitude of noise exceeds the tolerance limits, it is manifested in the form of discomfort leading to annoyance and in extreme cases to loss of hearing. Detrimental effects of noise pollution are not only related to sound pressure level and frequency, but also on the total duration of exposure and the age of the person. *Table 6.11* below gives frequency levels and associated mental and physical response of humans.

Table 6.11 Noise Exposure Levels & Its Effects

Noise Levels (dB(A))	Exposure Time	Effects
85	Continuous	Safe
85-90	Continuous	Annoyance and irritation
90-100	Short term	Temporary shift in hearing threshold, generally with complete recovery
Above 100	Continuous	Permanent loss of hearing
	Short term	Permanent hearing loss can be avoided
100-110	Several years	Permanent deafness
110-120	Few months	Permanent deafness
120	Short term	Extreme discomfort
140	Short term	Discomfort with actual pain
150 and above	Single exposure	Mechanical damage to the ear

Figure 6.1 Noise Propagation Graph



b) Operation Phase

Impacts to noise quality post construction phase will be mainly due to project related vehicular traffic movement connecting network of roads with various Project components.

6.7.2 *Ground Vibrations*

a) Construction Phase

Due to blasting, the vibrations can cause damage to the nearby structures if appropriate control measures are not adopted. Therefore, the control measures suggested in the environmental action plan should be adhered to.

When an explosive charge is fired in a hole, stress waves propagate radically in all directions and cause the rock particles to oscillate. This oscillation is felt as ground vibration. The blasting operations using short-hole drilling and blasting using delay detonators propagate some ground vibrations.

The vibrations are measured as per the assessment criteria given under Bureau of Indian Standard *Criteria for Safety and Design Structures Subject to Underground Blasts – IS : 6922 – 1973 (Reaffirmed 1995).*

As per the assessment criteria, the value of ground vibrations i.e. peak particle velocity may be computed from the following expression:

$$V = K_1[Q^{2/3}/R]^{1.25}$$

Where

V = Peak particle velocity in mm/sec

K1 = Constant which may be normally taken as 880 for soft rocks and soil and 1400 for hard rocks

Q = Charge per delay (kg), and

R = Distance (m) from blast point

Based on the above equation, the peak particle velocities at different distances (50m, 80m, 100m, 190m, 400m and 500m are calculated considering K_1 to be 880 for soft rocks and 1400 for hard rocks. The charge proposed for the biggest tunnel is estimated to be 120kg of explosive charge for removal of about 132 m^3 of rock during single incidence of blasting. The maximum charge per delay is estimated as 20kg for 6 delays.

As per the Standard, for safety of structures from threshold damage, the peak particle velocity should not exceed the following:

Soil, Weathered or Soft rock	50 mm/sec
Hard Rock	70 mm/sec

The results are presented in the ***Table* 6.*12*** below for the maximum charge.

Table 6.12 Peak Particle Velocities (V)

S.N.	Constant K1	Charge per Delay	Peak Particle Velocity (V) mm/second							
			Distance from the Blasting (meters)							
			50	**80**	**100**	**150**	**190**	**250**	**400**	**500**
1	880	Q = 20 kg	80.3	44.6	33.8	20.3	15.1	10.7	6.0	4.5
2	1400	Q = 20 kg	127.8	71.0	53.7	32.4	24.1	17.1	9.5	7.2

It is clear that with Q = 20kg charge per delay the peak particle velocity up to 81m is above the permissible level for hard rock, however, at subsequent distances the peak particle velocities are expected to be within the safe limits for any structures.

Thus, it can be seen that the ground vibrations generated by blasting during the tunnel excavations will not likely to affect the structures proposed in the vicinity of > 81m from the point of blast.

The project proponent is proposing further minimise ground vibrations by using specialised techniques and special explosives.

b) Operation Phase

No significant impacts are anticipated to ground vibrations quality due to the Project operation.

6.7.3 *Impact Siginifiance: Noise & Ground Vibrations*

Impact significance for potential changes in ambient noise levels and ground vibrations as defined in the above sections is given in *Table 6.13.*

Table 6.13 Impact Significance: Noise Quality & Ground Vibrations

Impact Area	Nature of Impact [1]	Targets/ Interests [2]	Magnitude[3]	Extent [3]	Overall significance [4]
Ambient noise quality	Medium term - deterioration of ambient noise quality during Project construction and due to movement of traffic on roads to barrage along Allain stream and weir site along Duhangan stream. However, impacts would largely be reversible.	Nearby villages. Workers onsite. Vegetation and Wildlife.	Moderate - noise mitigations to include provision of noise barriers; use of controlled blasting techniques including delay detonators; Vehicular movements restricted to day time only etc.	Local/ Medium - will be restricted to short distances	* Moderate significance
Occupational noise	Medium term - occupational impacts on health of workforce	Potential effect on human health due to high noise	Moderate	Localised adverse effect. Magnitude	* Moderate (In case of human health, as immediate

Impact Area	Nature of Impact [1]	Targets/ Interests [2]	Magnitude[3]	Extent [3]	Overall significance [4]
	engaged for construction activities	emissions at the work place;		dependent on noise emissions and use of personal protective equipment (PPE).	consequences of high noise will be on human beings) ❍ Minor, in case of mitigation measures and use of PPEs.
Ground vib-rations	Medium term - ground vibrations due to tunnel development for each of the Project components.	Nearby villages. Workers onsite. Vegetation and Wildlife.	Low – mostly underground tunnelling. Mitigations to include use of controlled blasting techniques including delay detonators and restricting only day time blasting; avoid blasting during bad weather etc.	Local Medium - Ground vibrations are expected to remain within less than 100 m of the prescribed levels.	* * Moderate (with the mitigations in place).

1 Description; short or long term; reversible or permanent; associated with construction, operation, decommissioning; cumulative, accidental, etc

2 Targets and interests potentially affected.

3 Adverse or beneficial; low, moderate or high in magnitude; very localised (within the project component locations only), local, medium, regional in extent.

4 Overall significance against criteria (❍ minor; *moderate,; * *major)

6.8 ECOLOGY

Specialised studies were conducted for baseline conditions on terrestrial and aquatic flora and fauna in and around the Project components and within the catchment area of the Project. Refer to *Section 4.5* for Terrestrial Ecology within the Project catchment and *Section 4.6* for Riverine Ecology within the Project catchment.

6.8.1 *Terrestrial Plant Species Observed*

Over all, 324 plant species (Trees: 23; Shrubs: 53; Herbs: 249) were recorded from the Hamta- Jagatsukh catchments whereas 284 species (Trees: 18; Shrubs: 46; Herbs: 220) were recorded in the Project and surrounding area.

Amongst the communities, *Picea smithiana* showed maximum number of species i.e., 192 species (Trees: 14; Shrubs: 29; Herbs: 149) in Hamta-Jagatsukh catchments and 137 species (Trees: 8; Shrubs: 29; Herbs: 100) from high project impact area, followed by *Abies pindrow*, 136 species (Trees: 11; Shrubs: 21; Herbs: 104) in the Hamta-Jagatsukh catchments and 94 species (Trees: 8; Shrubs: 14; Herbs: 72) from high project impact area. Minimum number of species (41) were recorded in *Quercus semecarpifolia* community (Trees: 5; Shrubs: 2; Herbs: 34) in the Hamta-Jagatsukh catchments whereas *Cedrus deodara* 44 species (Trees: 3;

Shrubs: 8; Herbs: 33) from Project impact area.

A total of 49 species have been identified as rare-endangered (refer to *Table 4.48* in *Section 4*). Five species have been categorized as **Critically Endangered** (*Saussurea obvallata, Gentiana kurroo, Arnebia benthamii, Dactylorhiza hatagirea and Saussurea costus*); **12** species as **Endangered** (*Aconitum heterophyllum, Angelica glauca, Betula utilis, Bergenia stracheyi, Dioscorea deltoidea, Meconopsis aculeata, Paris polyphylla, Podophyllum hexandrum Polygonatum cirrhifolium, Picrorhiza kurrooa, Taxus baccata subsp. wallichiana and Zanthoxylum armatum*); **8** species as **Vulnerable** (*Aconitum violaceum, Polygonatum verticillatum, P.multiflorum, Rheum australe, R. webbianum, Rhododendron campanulatum, R. anthopogon and Valeriana jatamansi*); **1** species as **Near Threatened** (*Hippophae salicifolia*); **1** species as **Extinct in Wild** (*Saussurea costus*) (Samant & Pal, 2003; Ved et al.,2003) and **22** species were identified as **Rare.**

In general, *Saussurea costus* has been placed under Critically Endangered cartegory, however, in Himachal Pradesh this species has been placed under the category, Extinct in Wild. Similarly, other species which have not been categorized but facing habitat degradation and over exploitation may be considered under vulnerable category whereas species presently not facing such problems may be considered under Near Threatened or Least Concerned categories.

The Project catchment area is mainly inhabitated by villages i.e. Prini, Aleo, Hamta, Chhaleth, Saithan Shuru, Banara and Jagatsukh. The inhabitants are dependednt on the plant resources for medicine, wild edible food, fuel, fodder, house building making of agricultureal tools, religious and various other purposes.

As the proposed project involve diversion of forestland and will require cutting of trees, the impacts on ecology are described as per details given below.

6.8.2 *Diversion of Forestland*

Tree species of the forests communities notably *Quercus floribunda, Q. semecarpifolia, Acer acuminatum, Ulmus villosa, Juglans regia, Prunus cornuta, Aesculus indica, Pinus wallichiana, Abies pindrow, Picea smithiana, Betula utilis and Taxus baccata subsp. wallichiana* may be affected by the project. The project will result in loss of forest due to diversion 47.179 ha of forestland for reservoir, buildings, roads and other ancillary facilities as per details given in *Table 6.14.*

Table 6.14 Loss of Forestland due to the Project

S.N.	Description	Allain Location	Duhangan Location	Composite	Total Forest to be acquired (Ha)
1	Silt Removal Chambers	0.096	0.091	-	0.187
2	Barrage	2.010	2.530	-	4.540
3	Intermediate Reservoir	-	-	2.300	2.300
4	Roads	7.20	4.75	0.0	11.950
5	Plant Area	4.000	1.000	-	5.000
6	Switchyard & Tailrace	-	-	5.140	5.140

S.N.	Description	Allain Location	Duhangan Location	Composite	Total Forest to be acquired (Ha)
7	Colonies, Offices & Transit Camps	1.0	0.0	0.0	1.000
8	Powerhouse	-	-	1.000	1.000
9	Magazine	0.750	0.250	-	1.000
				Sub Total – I	32.12
10	Surface Area over Underground Works				
(i)	Tunnel	1.402-	1.760-	-	3.162
(ii)	Interconnecting Tunnel	-	-	-	.115
(iii)	Allain Adit				0.12
(iv)	Surge Shaft				.008
(v)	Valve House 1 amd 2				.006
(vi)	Valve House and Branches				0.14
(vii)	Duhangan Desilting Basin				0.16
(viii)	Pressure Shaft				0.403
(ix)	Adit -1 to Pressure Shaft				0.124
(x)	Adit -2 to Pressure Shaft				0.08
(xi)	Power House and Transformer Cavern				0.223
(xii)	Tail Race Tunnel				0.37
(xiii)	Main Access Tunnel				0.601
				Sub Total - II	5.51
11	Additional diverted Forestland				9.55
				Grand Total	47.179

Source: ADHPL

Of the 47.179 ha of forestland, 9.55 ha is additional diverted forestland and 6.192 ha involving underground works. The value of wood to be lost from 47.179 ha of forestland is given in *Table 6.15*.

Table 6.15 Loss of Forest Products

Tree species		Nos. of individuals	Timber Volume (cu m)
Scientific Name	**Common Name**		
Quercus semicarpifolia	Kharshu	232+82=314	458.39
Acer acuminatum	Mapple	88+42=130	220.50
-	Kosh	1	0.10
-	Mohran	2	17.50
Juglans nigra	Walnut	10+10=20	55.00
Prunus	Bird Cherry	49+4=53	76.46
Quercus dialtata	Mohru	273+47=320	710.20
Aesculus indica	Khanor	1	4.30
Cedrus deodara	Deodar	90+5=95	224.50
Pinus wallichiana	Kail	136+16=152	307.30
Picea smithiana	Rai	196+42=238	1125.28
Abies pindrow Royle	Tosh	264+110=374	1574.70
Salix tetrasperma	Willow	4+4=8	6.10
Bettula bhojpatra	Bhojpatra	8+7=15	20.60
-	Rekhel	6	2.00
-	Hemari	7+5=12	5.40
-	Kainth	1	4.00
-	H/Nut	4	13.20
Total		**1746**	**4825.53**

Source: ADHPL

6.8.3 *Loss of Floristic Diversity by Construction of Tunnels & Roads*

During the construction of tunnels high labour pressure may cause the damage to ground layer (herbs) of the vegetation by trampling and using woody species as fuel wood.

A total of 1746 trees are to be affected by the Project. Maximum number of individuals included of *Abies pindrow* (374 individuals), *Quercus dialtata* (320 individuals), *Quercus semecarpifolia* (314), *Picea smithiana* (238), *Pinus wallichiana* (152), *Acer acuminatum* (130) and *Cedrus deodara* (95). Construction of the tunnels may cause damage to rootstock of the tree species. These tree species are being affected by the construction of tunnels, reservoir and roads (refer to *Table 6.15).* None of these species are reportedly fall under rare or endangered category.

6.8.4 *Loss of Floristic Diversity in Allain Barrage Submergence Area*

A total of 58 species (Trees: 5; Shrubs: 5; Herbs: 42: Ferns: 6) were reported from the Allain barrage submergence area (*Table 6.16*).

Table 6.16 List of Plant Species Reported from the Submergence Area for Barrage & Reservoir

Taxa	Local name	Altitudinal Range (m)	Life Form	Status	Utilization Pattern
Abies pindrow Royle	Tosh	2200-3600	T	Co	Timber, Fuel, Minor forest products
Adiantum capillus-veneris L.		1800-3000	F	Co	-
Aesculus indica Coleb. ex Wall.	Khanor	1900-2800	T	Co	Fodder, Fuel, Medicinal, Edible
Anemone rupicola Camb.		2000-3600	H	Co	Fodder
Angelica glauca Edgew.	Chora	2100-2800	H	EN	Medicinal, Edible
Arctium lappa L.	Nakli kunth	2500-3500	H	Oc	Medicinal
Arisaema intermedium Bl.	Kida alu	2000-25000	H	Co	
A. jacquemontii Bl.	Kida alu	2500-4000	H	Co	Medicinal
Anemone rupicola Camb.		2000-3600	H	Co	Fodder
Anaphalis busua (Buch. – Ham. ex D. Don) DC.	Bacha	2000-3500	H	Co	Fibre
A. triplinervis (Sims.) Cl. var. intermedia (DC.) Airy Shaw	Bacha	2400-3500	H	Co	Fumitory
Bistorta amplexicaulis (D.Don) Greene	Dori ghass	2000-2800	H	Co	Medicinal, Fodder
Boehmeria platyphylla Jacq.		1800-2500	Sh	Co	-
Caltha palustris L.	Shomalap	2500-2800	H	Co	Medicinal
Calanthe tricarinata Lindl.		2000-3000	H	Co	-
Campanula colorata Wall.		2200-3500	H	Co	Medicinal
Carex foliosa D. Don		1800-3000	H	Oc	Fodder
Corydalis diphylla Wall.		2500-3000	H	Co	-
Cirsium wallichii DC.	Bhoosh	1900-2500	H	Co	-
Clematis buchananiana DC.	Belwala safed	1800-3000	Sh		Medicinal
Epilobium latifolium L.		2800-3500	H	Oc	-
Fragaria nubicola L.	Bumbra	2000-3000	H	Co	Edible

Taxa	Local name	Altitudinal Range (m)	Life Form	Status	Utilization Pattern
Galium asperifolium Wall.		2000-3000	H	Co	
Geranium wallichianum D.Don ex Sw.	Chowarhi	2000-3500	H	Co	Medicinal, Fodder
Hackelia uncinata (Benth.) Fisher		2000-3500	H	Co	-
Heracleum candicans Wall. ex DC.	Padiyala	2000-4000	H	R	Medicinal, Edible
Impatiens arguta Hk. f.	Tilpara	2000-3000	H	Oc	Edible, Fodder
Indigofera heterantha Wall.		1800-2800	Sh	Co	Fodder, Fuel, Medicinal
Lepisorus nudus (Hk.) Ching		1900-2900	F	Co	
Malva verticillata L.	Siddu	1800-2600	H	Co	Medicinal, Edible
Nepeta leavigata (D.Don) Hand.-Mazz.		2500-4000	H	Co	-
Onychium contiguum Wall. ex Hope		1900-2500	F	Co	-
Origanum vulgare L.	Ban tulsi	1800-2800	H	Co	Medicinal
Osmunda claytoniana L.		1900-2500	F	Co	-
Oxalis corymbosa DC.	Malori	1900-2500	H	Co	Fodder
Persicaria capitata Gross	Kalovar	1800-2500	H	Co	Medicinal
P. nepalensis (Meisn.) Gross	Trod	2000-3500	H	Co	Medicinal, Edible
Pilea scripta (Buch.-Ham. ex D.Don) Wedd.		1900-2200	H	Co	Fodder
Plantago ovata Phil.		1800-2800	H	Co	Medicinal
Podophyllum hexandrum Royle	Ban kakri	1800-4000	H	EN	Medicinal
Polygonatum verticillatum (L.) All.	Salam misri	1900-3500	H	VU	Medicinal, Edible
Polysticum.prescottianum (Wall. ex Mett.) T.Moore		2200-2800	F	Co	-
Prunus cornuta (Wall.ex Royle) Steud.	Jammun	1800-2600	T	Co	Edible, Fuel, Medicinal
Pteris cretica L.	Baran	2200-2500	F	Co	Medicinal
Quercus semecarpifolia J.E.Sm.	Kharshu	2600-2700	T	Co	Fuel, Fodder, Agri. Tool
Rumex hastatus D.Don	Malora	1800-2500	H	Co	Medicinal, Edible
Salix denticulata (Anders.) Svensk	Belli	2000-2600	Sh	Co	Fuel, Fodder
S. daphnoides L.		1900-2800	Sh	Co	Fuel, Fodder
Sedum ewersii Ledeb.	Moshu ghas	2500-4000	H	Co	Medicinal
Spiraea canescens D.Don	Chakhu	1800-2500	Sh	Co	Agri. Tools , Fuel
Selinum. tenuifolium Wall.	Bhae	2000-4000	H	Co	Medicinal
S. vaginatum Cl.	Butkesh	2500-4000	H	Co	Medicinal
Sibbaldia cuneata Hornemm ex O. Ktze.		2000-2500	H		Fodder
Skimmia laureola Sieb. & Zucc. ex Walp.		2000-3000	Sh	Co	Medicinal, Religious
Stellaria monosperma Buch.-Ham.		2000-3500	H	Co	-
Taraxacum officinale Weber		1900-4000	H	Co	Medicinal
Taxus baccata subsp. wallichiana (Zucc.) Pilger	Rakhal	2500-3500	T	EN	Medicinal, Fuel
Thalictrum foliolosum DC.	Mamiri	1800-3300	H	Oc	Medicinal, Fodder
Trifolium pratense L.		1900-2500	H	Co	Fodder

Taxa	Local name	Altitudinal Range (m)	Life Form	Status	Utilization Pattern
Viburnum cotonifolium D.Don	Thallana	2000-2600	Sh	Co	Edible, Fuel Fodder, Medicinal,
Viola biflora L.		2400-2600	H	R	Medicinal

The trees that are felled are centrally managed by Divisional Forest Department (DFO), Kullu. The department has demarcated and hammered the identified trees prior to their felling following deposition of requisite money by ADHPL. Once hammering on trees is done, the trees are felled under direct supervision of Forest Department. Wood generated from felling of the trees in the Project area will be the property of the Project. HPSFC fells the trees and sell the generated wood and give the sale proceeding to the Project after deducting their commission.

With the construction of road and availability of access to general people, there is potential for increase of illegal tree felling as a result of improved access to the forest. The local population may collect (legally and illegally) a variety of wood and non-wood products from these areas. These include fuel wood and utility wood for house and furniture construction purposes.

The Company will require all contractors, to observe National regulations, policies and IFC's environmental, health and safety guidelines including compliance with a prohibition on the felling of trees for meeting fuel wood requirements. Construction contracts will contain terms and conditions to ensure that illegal felling is not done by the contract labour. Violations of these regulations will result in fines and/or cancellation of contracts.

Another impact can be due to construction and maintenance of Project roads resulting in falling of boulders down slope damaging the vegetation. ADHPL is to ensure that the contractors engaged take mitigation measures including precautions to to provide barricades to arrest any boulder escaping down the slope. In case of any damage happen, the ADHPL to ensure revegetation of areas damaged by Project activities.

6.8.5 Wildlife

The Project area falls within and near the forestland with dependent wildlife. The area under Allain valley is prominently degraded as green patches are out of sight at some places, like surge shaft and saithan village areas. The forests on Allain side are relatively drier than on Duhangan side which appeared to be relatively moister. Also the incidences of overgrazing and human interferences observed due to relatively easy terrain on Allain side than on Duhangan side.

The Project work during construction activitieis would certainly affect the ecosystem and the species like yellow white and purple brown butterfly can be in danger. Bird diversity was observed to be high in the lower elevation areas (2200 to 2800 m amsl) than in the upper elevation areas (2800 to 3400 m amsl). This is due to many breeding birds in Western Himalya migrate to the lower elevation areas during winter perhaps because of better habitat and so also the dispersion of birds while the catchment and project impact area both were low mammal encounter area. Among mammals, the observed wildlife in and surrounding the Project area included jackal, pika, langur, yellow throated marten, goral, black bear, brown bear, red fox etc. None of the bird species observed fall in threatened list of IUCN, however, the observed pheasants like Himalayan monal, koklas and kalij fall in schedule 1 of the Wildlife Protection Act, 1972 making them important species of conservation.

The construction activities of headrace tunnel surge shaft and pressure shaft will be underground. The impact on wildlife due to Project construction will be mainly due to disturbance to wildlife due to human interference, noise and vibration generation as well as movement of Project traffic on roads during construction activities. The diversion of forestland will result in loss of habitats for avifauna and wildlife depending on such forestland. The adverse impacts during construction impacts are certain, although the surrounding area comprises of sufficiently suitable feeding areas for the wild species and there is no indication that the area has corridor functions to other wildlife refuges. The Project is required to ensure mitigation measures as suggested in ESMP including the following:

- Restricting construction activities and movement of Project traffic during day time only;
- Blasting activities for tunnel development to be taken up by using delayed detonator techniques to minimise vibrations. The blasting timings to be fixed between 1300 to 1500 hours during day time only;
- All openings of all the tunnels/adits to be lighted during night time and guarded all the time. If unguarded these tunnel openings must be temporarily closed to avoid any wildlife finding refuge in such tunnels during night time or periods of no construction activities;
- In case any wildlife found having taken up a refuge in any such tunnels, all construction labour to leave that place immediately, trained personnel from Department of Forests and Wildlife Warden's office and approved experts should be intimated for called for rescue of such wildlife. Any construction activities to be taken up only after any trapped wildlife finds its safe escape;
- The Project is to take up plantations on all areas damaged due to Project construction in addition to statutory compensatory afforestation to be taken up by the Project through State Department of Forests; and
- Follow up Biodiversity and Wildlife Management and Catchment Area Treatment Plans as given in *Annexes C-4* and *C-5* respectively.

6.8.6 Fisheries & Other Aquatic Flora & Fauna Change in Hydrological Regime and Impact on Fish

The riverine ecological assessment baseline on fish species are found in both of the streams at the lower level before confluence with the Beas River. In both the Duhangan and the Alleo streams there are successive waterfalls about a kilometer and a kilometer and a half upstream of the confluence respectively. These waterfalls are over 10 meters high with deep plunge pools, and because of the nature of the fall over overhanging rock, it is not possible for fish to climb or leap over. Fish fauna was observed only up to these waterfalls in the two streams. In the Pahli stream fish were found up to about 500 meters above the bridge.

Due to very steep gradient profiles and subsequent oxygenation, as well as retention of Dissolved Oxygen in stream due to low temperatures in all the three streams, and Duhangan in particular, the waters can be termed as Salmonid. This was further evidenced by the presence of *Salmo trutta* of great age diversity in the lower reaches of the Duhangan. Benthic macro invertebrates and micro flora were also observed in these streams.

Changes in water flow would definitely result in disturbance to existing species particularly fish species observed at the lower ranges of the Allain and Duhangan streams. However, a flow of 0.609m^3/second is expected (including water from Kala Nala) to be available at the lower ranges which is 60% of the minimum water flow ever observed in the Duhangan stream during lean months of January – February. In Allain steam, the impacts of reduced flow will be in the area between barrage and tail race discharge. A flow of 0.597 is expected (after getting flow from other channels downstream the barrage structure). In Allain stream after tail race discharge, there will be high flow and impacts will be due to high currents, requiring mitigation measures of even flow distribution across the discharge to minimise steep currents on fish fauna downstream.

As per the recommendation of Foundation for Ecological Society, water flow of not be less than 10% of the annual water flow of baseline flow, is required to sustain short term survival habitat for most aquatic life forms. At this flow rate, the system will provide nesting, nursery and refuge habitat. Stream banks will provide cover for fish, the riparian vegetation will not suffer from lack of water, and large fish can move over riffle areas. Sixty percent of the average flow provides excellent to outstanding habitat for most streams. This flow rate also creates favourable conditions in the adjoining shallow riffle and shoal areas. Tennant also suggested that at this flow rate pools, runs and riffles will be formed and provide the necessary feeding and nursery habitat for most fish, and fish migration would face no problem.

The minimum flow available in Duhangan is 1.08m^3/second (refer to ***Table 6.4***). As per the recommendation of the Honourable High Court, the Project will be discharging 0.335 m^3/second of flow downstream the diversion structure on Duhangan. This flow is 31% of the minimum flow available in the Duhangan stream. It is expected that this flow together with flow from other streams being available all the time downstream the diversion structure on Duhangan stream would result in support to ecological sustenance of the riverine ecosystem.

The minimum flow available in Allain is 1.54m^3/sec. The Project will be maintaining a minimum of 15% (i.e. 0.231m^3/sec) of the regular flows available in the Allain downstream the Allain diversion structure.

The minimum flow of 0.231m^3/sec downstream the Allain barrage and 0.335m^3/second downstream the Duhangan weir site all the time. The diversion points on both streams are in the upper reaches, at least half way to the points of origin from the confluence. The Project will maintain 15% of regular flows available in Duhangan stream. Therefore flow volumes in at least half the stream lengths will be altered radically.

There are smaller perennial first order tributary streams further downstream of the diversion points on both Alleo and Duhangan, where some year-round flows will remain and be augmented by seasonal precipitation and run-offs. In the Duhangan stream the downstream supplemental minimum flow of 0.376m^3/second is available from other streams. These supplemental flows together with minimum mandatory Project discharges will enable the river in flowing condition. Mountain streams having beds that would need to be saturated and rendered hydric by larger and constant flows, and be highly permeable towards subsurface flows in places, would not take these the minimum discharges very far, if they were not augmented by confluences further downstream, or by intermittent seasonal flows as well.

It is therefore suggested that a minimum regular water flow is maintained all the time with suitable temperature and velocity in both Allain and Duhangan streams for sustenance of any biological life (macrophytes and benthic fauna) and local demand. The Project will implement, a Fisheries Monitoring Plan as suggested in *Annex C-6*.

6.8.7 *Impact Siginifiance: Ecology*

Impact significance for potential changes in ecology as defined in the above sections is given in *Table 6.17*.

Table 6.17 Impact Significance: Ecology

Impact Area	Nature of Impact [1]	Targets/ Interests[2]	Magnitude[3]	Extent[3]	Overall significance [4]
Forestland	Long term – Loss of Forestland, vegetation, trees removal from 41.669 ha of land (excluding 5.51 ha of foresland required for underground work) – impact irreversible	Loss of floristic diversity by reduction of vegetation, standing trees, loss of top soil supporting vegetation	Moderate - beneficial effect in terms of compensatory afforestation with higher success percentage expected	Local -within Project component areas	* Moderate
Wildlife	Long term - excavation of tunnels, construction activities, movement of vehicles on Project roads	Disturbace to wildlife, including grazing livestock	Moderate - beneficial effect in terms of compensatory afforestation, pasture development	Local – near Project component areas	* Moderate
Fisheries - construction phase	Medium term – construction activities resulting	Water quality affecting aquatic flora,	Low – considering mitigation	Regional contribution to existing	❍ Minor with mitigation measures in

Impact Area	Nature of Impact [1]	Targets/ Interests[2]	Magnitude[3]	Extent[3]	Overall significance [4]
	in silt, erosion affecting quality of water downstream Allain and Duhangan streasm	fauna and dependent birds	measures are in place	background levels.	place
Fisheries – Operation phase	Long term – reduced water flows downstream Allain and Duhangan streams - desilting of desanders during monsoon season	Water quality affecting aquatic flora, fauna and dependent birds	Low – the desilting is mostly restricted during monsoon season to minimise adverse impact. Minimum discharges to be maintained for ecological sustenance of the streams	Regional	* Moderate
Physical impact	Long term Submergence of Land in the vicinity of Allain barrage structure	Local wildlife and ecology on nearby flat land	Low	Local	* Moderate
Compen-satory Afforestation and landscape and pasture development	Long term – beneficial impact due to compensatory afforestation	Increase of floristic diversity, standing trees, improvement in grazing areas for livestock	Moderate – beneficial	Medium – beneficial	* Moderate beneficial

[1] Description; short or long term; reversible or permanent; associated with construction, operation, decommissioning; cumulative, accidental, etc

[2] Targets and interests potentially affected.

[3] Adverse or beneficial; small, large, etc; very localised (Project component sites only), local, medium, regional.

[4] Overall significance against criteria (❍ minor; *moderate; **major)

6.9 NATURAL HAZARDS

Natural Hazards could lead to structural damage to the project components, which in turn would lead to widespread damage in the surrounding area. The project proponent will ensure inclusion of adequate engineering measures during the detailed design and engineering of the project to protect the structures from natural hazard.

6.9.1 *Risks due to Earthquakes*

The project area falls within the seismic zone V as per Seismic Zoning Map of India (IS:1893-1975) where shocks of the intensity of 6 to 7 on Richter Scale have been reported. This area is expected to correspond to basic horizontal seismic co-efficient of 0.05 to .08 g. Necessary safety factors have been incorporated in designing the structures under the worst combination of forces.

6.9.2 *Risk due to Failure of Intermediate Reservoir*

The intermediate reservoir in case it fails poses risks to the area falling under its spread and could lead to widespread damage. As the capacity of reservoir has been limited to 0.195 million m^3 of water with a spread area of 23,000m^2, the water height of half a meter will be dissipated along with the spread area and hill slope before it meets Allain stream. Water released from such occurrence will immediately raise the water level in Allain stream.

Adequate mitigation measures will be taken up to meet such eventuality as described in Environmental and Social Management Plan (ESMP).

6.9.3 *Risk due to Forest Fires*

Forest fire is not unusual in forested mountain areas generally. However, there is no evidence from the study area to indicate that extensive burns have occurred in the recent historical period. Adequate precaution and education on prevention of forest fires will be provided to the people in the villages and who will be deputed for construction in the project area.

6.9.4 *Risks due to Slope Failures - Landslides*

Landslides are common events in the geo-dynamically sensitive Himalayas, especially during high intensity monsoon rains. Over saturation of slopes fractured by tectonic forces, compounded by human interference may lead to frequent slope failure in this high relief mountain system. Slope failures may occur due to movement of vehicles with heavy loads on the Project roads and availability of easy access to local inhabitants to exploit forest resources in the higher elevation areas

Uncontrolled project activities pose landslide risks due to slope failures. The Project needs to identify areas prone to landslide and periodically take suitable measures for slope stabilisation as per the need. Particular emphasis of such inspections is required before onset of monsoon season.

6.9.5 *Avalanche*

There is possibility of avalanche at places of heavy snowfall deposit particularly during December to February. Higher probability of such avalanche can be at project locations like Allain Barrage, Intermediate Reservoir and Duhangan Weir Site.

To avoid triggering of any incidence of avalanche in areas known for heavy snowfall deposit, ADHPL need to restrict their construction activities in such a way that these do not spin-off any avalanche.

6.10 SOCIO-ECONOMIC IMPACTS & INDUCED IMPACTS DUE TO ECONOMIC SPIN–OFF IN THE AREA

As presented in the socio-economic profile of the project affected people, majority of the people in the project area own land, which is used primarily to grow plantations, of mainly apple. The major impacts of the project, as a result of land acquisition or land selling would include:

- Loss of private property
- Loss of asset including plantations
- Loss of livelihood and income directly linked to the above two losses
- Other indirect losses

In addition people have voiced concerns on issues such as safety, pollution, loss of lifestyle, and threat to their crops and see these as possible impacts of the project.

The project will not impact any homestead land or residential structures, hence no physical resettlement is envisaged. Here resettlement is specifically in the context of livelihoods.

6.10.1 *Land required by the project*

The project will require land in three villages in Manali Tehsil and Kullu District. The villages are:

- Prini
- Jagatsukh
- Aleo /Vashisht

A fourth village, Hamta, will be affected by the proposed road through that village.

The *Table 6.18* summarises the land requirement in the different villages.

Table 6.18 Land required by the project

Village	Village wise private land to be acquired (Ha)	Number of khasras	Purpose
Prini	8.88*	117	Colony and road
Jagat Sukh	0.33	75	Colony and Road
Aleo/Vashisht	0.54	20	Road
Hamta	-	-	-
Total	9.75	212	

These figures of land are based on the land records provided by the project proponent for the three project affected villages. While the location and land requirement of the colony has more or less been decided, the final road alignment is yet to be decided. Hence the total land that will be acquired for construction of the road is not yet known.

The project has however prepared an assessment of total land under different categories, to be acquired for the project. This includes:

- Private: 9.75 ha;
- Forest: 47.179 ha; and
- Government land: 10.67 ha.

The total land requirement is envisaged as 67.599 ha (refer to *Table 2.2* in *Section 2*).

6.10.2 Number of Families Loosing Land

The land records in Manali, as everywhere, are maintained in terms of *Khasra* or plot numbers, which are to be updated regularly by the Revenue Department. There can be one or more claimant to that plot number. Typically, a plot may have belonged to the original owner (grandfather to the current generation) and that plot has now been formally or informally split among the children. If it has formally been split then the mutation need to be recorded in land records. This sometimes does not get done regularly and therefore mutation records may not reflect the actual land holding pattern on the ground.

Another situation could be when the land has been equally spilt between the brothers and sisters but informally its possession and ownership is transferred to the brothers. The ownership pattern in such cases does not correctly reflect in the land record documents.

However on the basis of the list of khasra numbers provided by the project proponents and the census survey by the social assessment team, it was found that the total number of families losing land is 185. In all 286 titleholders from these 185 families are losing their land due to different project activities. Of these 87% are in Prini, 6.5 % in Jagat Sukh and the remaining 6.5% are in Aleo.

The following sections highlight each of the project impacts, based on the sample survey conducted among the project affected families.

6.10.3 Impacts on Land

The land that is being acquired for the project is being primarily used for apple plantations, and apple is the major source of income for majority of the PAFs. At some other places where the apple trees are young, the land is also used for cultivating seasonal crops. Based on the census survey, the following table shows the current use of the land plots impacted by the project.

Table 6.19 Current Use of Impacted Land

Land Use	PAFs	% of PAFs
Plantation	127	84.7 %
Agriculture	0	0
Mixed (Agriculture and Plantation)	23	15.3 %

Note: This information not available for 22 PAFs

Plantation dominates the current land use in the project areas. Agriculture is the secondary source of income and the produce is mostly used for household

consumption. The mountainous terrain and absence of steady water sources also make agriculture an unviable livelihood source for the local people.
On the other hand the climate and the economic viability of the apple cultivation has made it the main source of income for the people of the region.

a) Land Holding of the Affected Families

Land holding pattern of the impacted families reflects large land holdings for around 60% of the affected families. This large land holding does not necessarily reflect the economic strength of the household as a large chunk of this land often lies barren on the hilly slopes. The table below outlines the land holding patterns of the affected families in the project area.

Table 6.20 Land Holding of the Affected Families

Land holding	Number	% PAFs
Large (>5 bighas)	91	58.33
Medium (2-5 bighas)	46	29.49
Small (1-2 bighas)	6	3.85
Marginal (<1 bigha)	13	8.33

Note: This information not available for 16 PAFs.

Around 8% of the affected families are marginal farmers owning less than one bigha of land. Any impact on their land holding will directly have an impact on their livelihood sources. These households are the ones that are most vulnerable and are likely to be impacted the most in the entire process.

b) Impact on Land Holding

A separate analysis was done to estimate what percentage of total land owned were the PAFs losing. The survey showed that while a significant 65% of PAFs were losing less than 10% of their total land, approximately 2.5% of PAFs were losing more than 75% of their total land owned. The table below reflects the percentage land loss of affected families.

Table 6.21 Land Loss of Impacted Families

% Impact	Number of families	% of PAFs
Less than 10%	102	65.38
10-50%	47	30.13
50-75%	3	1.92
More than 75%	4	2.56

Note: This information not available for 16 PAFs.

Land loss was significantly high in case of four families where more than 75% of the total land owned was being acquired for different project activities. In most of the cases the land acquisition was too small to make any significant impact on the economic and social status of the family.

6.10.4 *Impacts on Family Income*

Land loss directly impacts the income from land. Impacts are greater in cases where dependence on land-based livelihoods are high.

Most of the land in affected villages is being used mainly for growing apple orchards, with few families also growing rice, pulses and vegetables primarily for self-consumption. Apples are the main cash crop and primary source of income for most families. Whatever little is grown in the form rice, maize, pulses, etc, meets the food and fodder requirement of farmers for few months, which in the event of land-loss would translate into additional expenses on food. It would therefore be appropriate to consider agricultural production as income or savings even if it is not sold in the market.

In case of the affected families, all grow apple plantations on their land holdings. Interestingly just 15.3% use a part of their land for cultivation of food grains while rest completely rely on cash income from plantations.

Recent years have seen significant transition in the cropping pattern in the villages in and around the Manali Tehsil. The land that was traditionally being used for growing rice, wheat and pulses has also been converted into apple orchards. Better roads and transportation services have ensured higher returns from apples. Of the total land holdings 1060101 Sq.m. reported by the PAFs in the survey, 636353 Sq.m (60 %) was reported to be under apple plantations. The distribution of families on the basis of proportion of their land under plantations is given below.

Table 6.22 Distribution of PAFs according proportion of Plantation land

Proportion of Land under plantation	Number of PAFs	% Distribution
100%	37	22.7 %
50% – 99%	64	39.3 %
1% - 50%	41	25.2 %
Nil	21	12.9 %

Note: This information not available for 9 PAFs.

Income from apples is calculated per box or *peti*, which contains approximately 20kg of Apples. Depending on the quality of apples the cost of 20 kg box varies between Rs 300 and Rs 700, while the input costs per box ranges between Rs 60 to Rs 90 per box. Input costs included inputs of fertilisers and pesticides during cultivation, cost of packaging and cost of labour and transportation. Thus, apple is a costly crop to grow, nevertheless the income is substantial, and hence some of the PAFs are losing a significant amount of their incomes due to the land acquisition.

6.10.5 *Incomes from Apple Plantations*

Apple plantations are the primary source of income in the project-affected families. The dependence on income from plantation becomes apparent when it is seen as a part of total household income. The findings are presented in the following table.

Table 6.23 Distribution of PAFs according to Proportion of Income from Plantations

Proportion of Plantation Income (Range)	Total PAFs	% Distribution
100 %	83	52.2 %
Between 50 % – 100 %	51	32.1 %
Below 50 %	13	8.2 %
Nil	12	7.5 %

Note: This information not available for 13 PAFs.

It can be seen that more than 80% people have significant dependence on income from plantations.

6.10.6 Impacts on Plantation Income

As stated earlier the impact on income from plantations is significant due to higher proportion of land under plantation. The average loss of plantation income amounts to Rs.21,156/- per family per year with a range between Rs. 1,650/- and Rs. 2,70,600/-. The following table presents the distribution of families as per loss in plantation income. Majority are losing less than Rs.10,000/-, however, this amount is significant considering the low family income of some affected families.

Table 6.24 Loss of Plantation Income

Range of loss (in Rs.)	Number of PAFs	% Distribution
Nil	10	6.2%
<10,000	115	71.4%
10000-25000	20	12.4%
25000-50000	9	5.6%
50000-100000	5	3.1%
>100000	2	1.2%

Note: This information not available for 11 PAFs.

The impact in terms of extent of loss in plantation income can also be seen as percentage loss as presented in the following table.

Table 6.25 Percentage Loss of Family Plantation Income

Range of loss in Plantation income (in %)	% PAFS
< 25	41.6
25-50	22.6
50-75	8.1
75-100	17.7

6.10.7 Impact on Total Household Incomes

While the above sections focus on impacts related to plantation income alone, there is also need to look at the impacts on total household income. The same is presented in the following table taken as percentage loss from total family income.

Table 6.26 Impacts on Total Household Income

Range of Loss (%)	Number of PAFs	% PAFS
No Impact	9	5.4%
< 25	131	78.0%
25-50	17	10.1%
50-75	8	4.8%
75-100	3	1.8%

Some families are not impacted in terms income loss due to loss of land because either their land is lying vacant or the trees are too young to give fruits. Loss of income for most PAFs is in the range of 25%, nevertheless impacts on livelihood could be significant especially in case of the small and marginal landowners.

6.10.8 Loss of Structure

None of the PAFs in the survey reported any permanent structure in the impacted land.

6.10.9 Loss of Assets

Trees

Apple trees are the main assets that would be impacted in this project, as primarily plantation land is being acquired. Some of the trees are matured trees, which are generating substantial incomes for the families. The other trees are yet to mature, but would be generating incomes in a few years.

The table shows that approximately 13.7% families will be losing more than 100 apple trees while a majority of the PAFs stand to lose less than 50 trees.

Table 6.27 Loss of Trees

No of trees	No of PAFs
0	0
1-25	58
25-50	50
50-75	5
75-100	8
> 100	19

On an average a 6 year old tree starts bearing fruit while a 10-year tree is considered to be a fully matured tree. Hence the percentage of matured trees being impacted gives a more accurate idea of the project impact on assets. The sample survey showed that as many 66.7% of the PAFs were losing all matured trees, which indicates a more severe impact on these families. Only 13.7% of families had no matured trees growing in the land to be acquired.

Table 6.28 Loss of Matured Trees

% loss of matured trees	No of PAFs
0	19
1-25	5
25-50	3
50-75	17
75-100	96

Other assets

In terms of other assets, 3.3% of the PAFs reported that they had irrigation channels constructed in the land to be acquired for the project. These channels are quite old and people estimate that it would take 3-4 days of labour to construct such channels. No other asset were reported to be potentially impacted by the project.

Impact on Apple Crops

Apple and other fruit tree production in the Project affected villages are affected by high dust levels generated by the increased vehicular traffic and construction activities. However, since the roads will be bitumen topped, a very small, if at any, increase in level of dust due to vehicular movement is anticipated. During the construction of roads, the Company will ensure that water is sprinkled at 3 to 4 hour intervals.

Additional mitigation measures include traffic management, proper covering of construction material vehicles while moving, and options of crop insurance for the community. The Project Company will consider any and all claims of impact on crop production through the established grievances redressal mechanism.

Availability of Potato Seeds

There will be impact on the local potatao crop due to acquisition of the Government Potato farmland at Hamta by the Project, the Company will however make arrangements to provide seeds of similar quality to the village Panchayats as required at similar rates.

Employment Opportunities

The Company will ensure that preferential employment opportunities are given to all Project Affected Families and local communities

Access to Pastureland

The Project Company will ensure that access to pasture land will be maintained throughout the construction and later during the operation phase of the Project. Any footpath damaged during the construction of the roads will be repaired and passages and ramps will be provided wherever necessary. Restoring degraded areas in consultation with the community will enhance existing pasturelands. An additional 200 hectares of pastures will also be developed as identified in the Catchment Area Treatment plan as per the *Table 6.29*.

Table 6.29 Pastureland Development by the State Forest Department

SN	Location	Pasture Development (ha)
1	Sethan village	30
2	Ustream storage reservoir	90
3	Pahali Nallah	20
4	Hamta Garh	30
5	Tangra/ Chikka Springs	30
	Total	200

Loss of Access to Cultural and Common Property

The project has made every effort to avoid any impact on common property like places of worship, grazing grounds etc. The local patwari in each village has affirmed through a written document that no such property is getting affected in any of the three villages of Aleo, Prini and Jagat Sukh.

6.10.10 Indirect Impacts

None of the families in the survey reported that the impacted land involved sharecroppers. However sharecropping is commonly practised in the area and some of the PAFs reported that as their own land holdings were small, they practised sharecropping in other people's field.

Similarly, none of the PAFs reported that the land acquisition would result in loss of income for any of their employees. In fact less than 2% families said they employed any permanent employee to work in their fields. The work was mostly done by family members of temporary labour hired during the cropping seasons. *The Census survey did not identify any farm employees.*

6.10.11 Community Concerns

While the direct and indirect impacts have been summarised in the above section, consultations with villagers at all three locations brought out some concerns and apprehensions that people have about the project, which need to be highlighted and addressed in the mitigation plans as well as focussed in the PCDP. Some of the concerns are arising primarily due to lack of adequate information with the local people, and this will be rectified in the course of public consultations.

a) Access to water from Duhangan Stream

People in Jagat Sukh stressed that they depended heavily on the waters of Duhangan stream for irrigation of their plantations and crops, and while the project plans to leave adequate water from this stream for downstream users, the villagers are not convinced that the remaining water will be adequate. They also place significant cultural and religious value on the Duhangan stream, which they feel will get violated/eroded by the project activities.

Specific measure to address this concern have been outlined in the ESMP.

b) Impacts on Crop

The project will involve construction of roads and other structures such as colonies, ands increase in plying of vehicles, which would lead to pollution and dust. The villagers are apprehensive that exposure to this may impact their apple crops, which presently grow in a relatively pristine environment. These fears were not only expressed by the PAFs but the larger village community in all the villages.

The project proponents have assured that they will take all preventive measures to ensure that impacts on crops are minimised. Many of these measures are already outlined within the Environment and Social Mitigation and Management Plan.

c) Health Impacts

There is a general apprehension that with damming of the rivers, and consequent water stagnation, there could be an increase in incidence of malaria. In addition, with outside labour coming to the area during the construction phase, there is a likelihood of increase in sexually transmitted diseases like HIV AIDS. Both these issues would need management interventions on the part of the project proponent and a focussed awareness campaign about its cause/effect and precautionary measures, among the local community.

The steps to monitor health impacts and has been outlined in Health Management Plan under section 8 on ESMP to which the project proponent is committed.

d) Increase in Security Risks and Change in Lifestyles.

Like any other rural areas, people in the three affected villages live simple lives and move around freely without fear. This is especially true for women. However there are apprehensions that the project, during construction and implementation, will bring in a large number of outsiders, with varied backgrounds and cultures, into the area. The women feel that this might lead to them restricting their movements, and a general concern for their personal safety among strangers. It would change the lifestyle they were accustomed to for decades. While the local community has been exposed to tourists from outside for a long time, this project will entail a more permanent interaction through setting up of colonies in the vicinity of the villages.

e) Increased pressures on local infrastructure

With an influx of people and traffic, especially during the construction phase, the local communities fear that the pressure on existing local infrastructure and amenities (health facilities, water, drains and solid waste disposal systems etc.)

may significantly increase, and without a commensurate investment on this infrastructure, the quality of life in the area may be affected.

The project proponent has assured that separate infrastructure would be provided for people coming into the area for the project, including housing, water and fuel needs, and pressure on local infrastructure will be closely monitored.

6.11 *IMPACT ON CULTURAL ASPECTS & TOURISM*

Problems could arise due to differences in customs of outside workers and local residents. These risks could be reduced by providing adequate facilities in workers camps and by employment of preferably local labour.

The cultural aspects available near to the project components include the ancient temple at village Pirni, a Tibetan Monastery near village Saithan, Lord Shiva's Temples at Jagatsukh, Pandurupa pond of historical importance up the village Saithan and a graveyard under the bridge on Nagar - Manali road near village Jagatsukh. The project road for an access along Duhangan stream is to start from the bridge area. The project proponent has already taken steps to change the path of the road so as to minimize hindrances to the graveyard area.

The Nagar - Manali, near Manali area comprises of a few hotels (some of the hotels include Holiday Inn, Timber Trail, Hamta View, Imperial Palace etc.), two trekking lines and an ancient temple each at Prini and Vashist. A few springs are also there in Vashist and Jagatsukh (refer to *Figure 1.1*). A historical pond called Pandorupa (Refer to *Figure B-7* in *Annex B*) is located upstream the Sainthan village after forebay reservoir. Another area of tourism interest is skiing undertaken at about 5 km upstream the Allain barrage location. In this area skiing is done by foreigners who directly fly to this region through helicopter service available in Manali.

None of the project components is falling on any of the area of known tourism interest. The project during construction phase may have some minor impact on trekking for which adequate mitigating measures are to be followed.

None of the project components is falling on any of the area of known tourism interest. The project during construction phase may have some minor impact on trekking for which adequate mitigating measures are to be followed. It is also important to mention that the area being of some historical significance, ADHPL has already agreed in the MoU with the State Government for immediate reporting of any thing, which has historical significance if discovered during the project construction phase. ADHPL will develop its procedures for any 'Chance Find".

The socio-economic studies conducted indicate that the dependence of the local population on employment in tourism-related businesses (e.g., porters, trekking guides, lodge operators and taxi operators) was not significant. While construction activities are likely to discourage trekking in the Project area temporarily, the construction of roads to Allain and Duhangan barrage sites will attract day visitors as well as trekkers and tourists and thus, create additional employment opportunities for the local population.

6.12 *IMPACT OF PROJECT ROAD CONSTRUCTION: INCREASE OF TRAFFIC - ROAD SAFETY*

It is expected that during construction phase approximately 58 truck trips per day will be added apart from other project traffic on Nagar - Manali Road. The increase in traffic volume poses potential for additional safety risks to other users of the road. Presently, Nagar - Manali road has very less traffic volume due to additional 10-km distance required to be covered if commuters from Kullu to Manali have to travel through Nagar - Manali Road. The road covers traffic specific to this road. The addition of traffic needs to be properly managed with least problems to users of this road.

6.13 *IMPACT ON HEALTH & SANITATION*

Health risk includes potential disease hazards due to lack of hygienic/sanitation (water supply and human waste disposal), vector and water borne diseases and spread of sexually transmittable diseases like AIDS.

Incidences of Malaria, Dengue, Jaundice, Dysentery etc are reported in and around the project area. With the development of project, potential health risks would also grow if left unchecked.

Mitigation measures include proper sanitary health care and human waste disposal facilities. Sanitation facilities are included in the project estimate to take care of cost to be borne towards human waste disposal facilities.

6.14 *CUMULATIVE IMPACTS*

Cumulative impacts are those impacts, which act together with other impacts to affect the same environmental resource or receptor. In this section, an effort is made to identify impacts of the proposed hydroelectric project, which when act together with other possible existing or future foreseeable impacts of activities on the same environmental resource or receptor will achieve higher significance and gravity of such impacts.

6.14.1 *Cumulative Impacts of Existing & Foreseable Hydroelectric Projects*

The present project is a run-of-the-streams project on Allain and Duhangan streams, which are perennial tributaries of Beas River. The Allain stream is formed by Hamtal and Patroi streams which originate at an elevation of 4680 m amsl and 4800 m amsl respectively in the Himalyan ranges, while Duhangan stream originates at an elevation of 4400 m amsl from Chandratal glacier in the Himalayan ranges. Thus two streams have independent catchments. The diversion structures for Allian and Duhangan streams will be located at an elevation of 2740 m and 2781 m respectively.

The possible cumulative impacts can be due to present and future foreseeable projects in the project area, either upstream or downstream or both up and downstream. As far upstream is concerned, it is important to mention that there is remote possibility of projects coming up upstream either Allain or Duhangan streams as upstream the diversion points on both of the streams there are further streams which combine together to give rise to streams with present flow levels at the diversion points. For example, upstream the diversion point on Allain stream, the streams like Hamtal and Patroi combine together to form Allain stream. Similarly, Duhangan stream upstream the diversion point, is joined by two streams giving rise from Chandratal glacier. The area above diversion points is mostly snow covered with lesser availability of head and difficult topography/ access or having different catchment (i.e. leading to Chenab river in the Lahul Spiti District) rendering lesser feasibility of coming up of projects upstream either Allain or Duhangan streams.

However, there are many projects which have been identified downstream the Beas River in the Kullu district. Some of them include the following:

Table 6.30 Hydroelectric Projects Downstream the Proposed Allain Duhangan Streams – Beas River

SN	Name of Project	Location	Installed capacity (MW)
1	Allain Duhangan by Rajasthan Spinning & Weaving Mills Ltd.	Distt. Kullu	192.0
2	Malana by M/s Rajasthan Spinning & Weaving Mills Ltd.	Distt. Kullu	86.0
3.	Parbati Valley Projects :- Parbati Stage-I Parbati Stage-II Parbati Stage-III	Distt. Kullu	 750.0 800.0 501.0
4.	Larji HEP	Thalout, Distt. Mandi	126.0
5	Uhl – III by Ballarpur Industries Ltd.	Distt. Mandi	100.0

All the above projects are either under construction phase or have been commissioned in the Beas Catchment. The construction work for the proposed project is expected to take off by this yearend.

Other possible hydropower projects under small hydropower category downstream the proposed project in Beas River catchment include the following:

Table 6.31 Other Small Scale Hydropower Potential Projects Downstream Allain – Duhangan – Beas River

S.N.	Name of the Project	District	Actual Cap. in MW	S.No.	Name of the Project	District	Actual Cap. in MW
1.	Prini	Kullu	1	35	Bathad	Kullu	2.5

S.N.	Name of the Project	District	Actual Cap. in MW	S.No.	Name of the Project	District	Actual Cap. in MW
2.	Aleo	Kullu	3 (inititally) 1 (subsequently)	36	Kartaul	Kullu	0.9
3.	Jagatsukh	Kullu	2.4	37	Beas Kund	Kullu	2.4
4.	Kala	Kullu	1.5	38	Jigrai	Kullu	1.6
5.	Jigrai	Kullu	0.5	39	Barseu	Kullu	2
6.	Jiwa-Kothiari	Kullu	1	40	Chaksi	Kullu	1
7	PalchanA	Kullu	2.5	41	Ani-II	Kullu	1.5
8.	Hurla	Kullu	1.00	42	Ani-III	Kullu	1.5
9.	Brahmganga	Kullu	2.2	43	Suman Sarbari	Kullu	3
10	Mandroi	Kullu	3	44	Soiel Dahsal	Kullu	1
11.	Charor	Kullu	0.65	45	Marhi	Kullu	2
12.	Manalsu	Kullu	3	46	Banjar	Kullu	2
13.	Baragran	Kullu	3	47	Behna	Kullu	2.2
14	Shirir	Kullu	1	48	Rojag	Kullu	1
15	Kakhnal	Kullu	0.6	49	Sarsadi	Kullu	3
16	Tirthan	Kullu	3	50	Tirthan-II	Kullu	3
17	Sarbari	Kullu	1.7	51	Choor	Kullu	0.5
18	Ani	Kullu	3	52	Tirthan Ghusheni	Kullu	5
19	Sharan	Kullu	1.5	53	Tirthan Manglore	Kullu	2.5
20	Pakhnoj	Kullu	0.75	54	Baggi	Mandi	1.5
21	Shamshar	Kullu	1	55	Roolang	Mandi	0.6
22	Mahul	Kullu	1.1	56	Bajgar A	Mandi	0.55
23	Kurpan	Kullu	3	57	Gurahan	Mandi	1.4
24	Beas	Kullu	1.1	58	Dulchi	Mandi	0.65
25	Charror	Kullu	0.13	59	Chachyot	Mandi	2.5
26	Dadka (Sarbari)	Kullu	0.26	60	Jahl	Mandi	0.4
27	Sarbari-II	Kullu	3	61	Swad	Mandi	1
28	Tichu	Kullu	3	62	Surah	Mandi	1
29	Kotlu	Kullu	0.75	63	Uhl	Mandi	2
30	Baragran	Kullu	0.9	64	Jakhwan	Mandi	1
31	Nashala	Kullu	0.5	65	Shagnal	Mandi	1
32	Tanang	Kullu	3	66	Annun	Mandi	1.8
33	Farari	Kullu	2	67	Bakhli	Mandi	4
34	Banogi	Kullu	2.2	68	Chul	Mandi	1.5

From the above table, it is clear that there are many potential small hydropower projects, which pose high cumulative impacts on the Beas River. It is therefore important that the proposed project is implemented with utmost care to implement Environmental Action Plan to minimise cumulative impacts on the Beas Catchment. With the development of the proposed project, ADHPL has approached HPSEB for waiver of the two of the downstream small hydropower projects at Prini and Aleo, for which HP-SEB has reportedly cancelled the MoUs with the private entrepreneurs.

6.14.2 *Cumulative Impacts on International Waterways*

The present project on Allain and Duhangan streams falls on the tributaries of River Beas, which in turn is a tributary of River Satluj and finally River Satluj being a tributary of Indus river, a subject falling outside Indian territory i.e. into the territory of neighbouring country Pakistan.

The ADHEP is seeking funding from IFC, which is a part of the World Bank, requiring applicability of Indus Water Treaty of 1960 undertaken by the two countries India and Pakistan under the aegis of International Bank for Reconstruction and Development (World Bank). The Treaty was signed at Karachi by Field Marshal Mohammad Ayub Khan, the then President of Pakistan, Shri Jawaharlal Nehru, the then Indian Prime Minister and Mr. W.A.B. Ill of the World Bank on 19 September, 1960. The Treaty however is effective from 1 April 1960.

The Indus System of Rivers comprises three Eastern Rivers (the Satluj, the Beas and the Ravi) and three Western Rivers (the Indus, the Jhelum and the Chenab). Any project on western rivers requires prior intimation to the Pakistan authorities. The present project being run-of-the-river-stream project on tributaries of eastern River Beas/Satluj will have insignificant impact on Indus River and requires no such formalities as per the Treaty.

6.15 *IMPACT OF PROPOSED POWER TRANSMISSION LINE*

ADHPL is proposing to develop a 220 kV power transmission line of approximately 175 km length to evacuate the power from the ADHEP to the state grid. Refer to separate ESIA study conducted for the transmission line.

6.16 *MIITGATION MEASURES*

Mitigation measures have been suggested in Section 8 on Environmental and Social Management Plan (ESMP). To minimise adverse impacts of the Project activities, adequate care is required during entire life cycle of the Project. Various control measures such as afforestation programme, catchment area treatment, wastewater treatment plants, health check ups and required mitigation measures, dust suppression measures etc. have been proposed for mitigating the adverse impacts. With regular monitoring of implementation of the suggested environmental management measures, it is expected that environmental quality of various affected parameters would be controlled to a great extent and it will be possible to maintain the ecological setting of the region.

7 ANALYSIS OF ALTERNATIVES

7.1 NEED FOR POWER GENERATION

Electricity consumption in India steadily increased from 1995 to 2007, driven by high economic growth. Although India's generation and distribution capacity has grown significantly over the last decade, many parts of the country continue to suffer power shortages both in terms of unmet demand during peak periods and an overall energy shortage.

Refer to details on 'Need for the Power Project' in *Section 1.4* in this ESIA.

7.2 WITHOUT PROJECT SCENARIO

The "without project" option would see the current power supply shortage in the northern region. While India's generation and distribution capacity has grown significantly over the last decade due to high economic growth, many parts of the country continue to suffer power shortages, both in terms of unmet demand during peak periods and an overall energy shortage. The annual deficit in peak power demand for the northern region was 3,040 MW as of August 2008.[1]

The alternative without the Project is undesirable as even greater power shortage would further constrain economic growth and poverty reduction.

7.3 WHY HYDROPOWER? - ALTERNATIVES FOR POWER GENERATION

The alternative sources of power generation in India include the following:
- Thermal power;
- Hydro power;
- Non Conventional Energy Sources (power through Solar/Wind/Bio-mass energy); and
- Nuclear power.

The general consensus on the above mentioned alternatives includes the following:
- Alternative power generation though nuclear fuel route cannot be called a viable alternative as it involves complexities in handling and poses high environmental risks;
- Further, keeping in mind size of the country and its sizable power demand, the tapping of wind, solar and biomass energy can be considered as alternative to the power generation to meet the large gap between demand and supply;
- The current contribution of power generation mix by thermal power plants stands at 64%. Thermal power plants are based on fossil fuels cannot be considered as sustainable alternatives;

[1]Source: Power Scenarios at Glance, September 2008 by CEA (http://www.cea.nic.in/).

- It is the hydroelectric power, which has high potential. Presently a large portion is lying untapped. Comparatively there are a few advantages of hydroelectric power generation versus schemes/projects based upon renewable energy sources that have low gestation periods and relatively lesser impacts on environment and ecology.
- The Central Electricity Authority, Government of India in has been identified untapped hydropower potential of India as on 31 August 2008 (Refer to *Table 7.1)*. The CEA in its 12th Five Year plan has identified number of units and plan to tap hydro power of 30,920 MW. (Refer to *Table 7.2*)

Table 7.1 States/Regionwise Hydro Power Generation Capacity

Region/State	Capacity, MW	Capacity Developed		Capacity U/ Construction		Cap Developed + U/ Construction		Capacity Yet to be Developed	
Northern NR		MW	%	MW	%	MW	%		
J & K	14146	1864.2	13.18	899	6.36	2763.2	19.53	11382.9	80.47
Himachal Pr.	18820	6085.5	32.34	4435	23.57	10520.5	55.9	8299.6	44.1
Punjab	971	1297.7	100	0	0	1297.7	100	0	0
Haryana	64	62.4	97.5	0	0	62.4	97.5	1.6	2.5
Rajasthan	496	430	86.69	0	0	430	86.69	66	13.31
Uttaranchal	18175	3056.1	16.81	1850	10.18	4906.1	26.99	13269	73.01
Uttar Pr.	723	510.2	70.57	0	0	510.2	70.57	212.8	29.43
Sub Total (NR)	53395	13305.9	24.92	7184	13.45	20489.9	38.37	32905.1	61.63
Western WR									
Madhya Pr.	2243	2438.5	108.72	400	17.83	2838.5	100	0	0
Chhattisgarh	2242	137	6.11	0	0	137	6.11	2105	93.89
Gujarat	619	555	89.66	0	0	555	89.66	64	10.34
Maharashtra	3769	2653.3	70.4	0	0	2653.3	70.4	1115.7	29.6
Goa	55	0	0	0	0	0	0	55	100
Sub total (WR)	8928	5783.8	64.78	400	4.48	6183.8	69.26	2744.2	30.74
Southern									
Andhra Pr.	4424	2095.5	47.37	566	12.79	2661.5	60.16	1762.5	39.84
Karnataka	6602	3448.3	52.23	230	3.48	3678.3	55.71	2923.7	44.29
Kerala	3514	1838.5	52.32	160	4.55	1998.5	56.87	1515.5	43.13
Tamilnadu	1918	1757.5	91.63	60	3.13	1817.5	94.76	100.6	5.24
Sub total (SR)	16458	9139.8	55.53	1016	6.17	10155.8	61.71	6302.3	38.29
Eastern ER									
Jharkhand	753	237.2	31.5	0	0	237.2	31.5	515.8	68.5
Bihar	70	44.9	64.14	0	0	44.9	64.14	25.1	35.86
Orissa	2999	2011.5	67.07	0	0	2011.5	67.07	987.5	32.93
West Bengal	2841	156.5	5.51	292	10.28	448.5	15.79	2392.5	84.21
Sikkim	4286	594	13.86	1919	44.77	2513	58.63	1773	41.37
A& Nicobar	0	5.3							
Sub total (ER)	10949	3049.4	27.85	2211	20.19	5260.4	48.04	5688.7	51.96
North Eastern NER									
Meghalaya	2394	185.2	7.74	124	5.18	309.2	12.92	2084.8	87.08
Tripura	15	15	100	0	0	15	100	0	0
Manipur	1784	105	5.89	0	0	105	5.89	1679	94.11
Assam	680	375	55.15	0	0	375	55.15	305	44.85
Nagaland	1574	99	6.29	0	0	99	6.29	1475	93.71
Arunachal Pr.	50328	423.5	0.84	2600	5.17	3023.5	6.01	47304.5	93.99
Mizoram	2196	0	0	0	0	0	0	2196	100
Sub total (NER)	58971	1202.7	2.04	2724	4.62	3926.7	6.66	55044.3	93.34
ALL INDIA	148701	32481.5	21.84	13535	9.1	46016.5	30.95	102684.5	69.05

Source: CEA (as on 31 August 2008)

Table 7.2 12th Five Year Hydro Development Plan (2012 to 2017)

SN	State	Central		State		Private		Total	
		No.	MW	No.	MW	No.	MW	No.	MW
1	Himachal Pradesh	2	816	7	892	6	749	15	2457
2	Jammu & Kashmir	4	2450	4	1473	0	0	8	3923
3	Uttarakhand	12	4374	7	1655	5	829	24	6858
4	Punjab	0	0	1	168	1	75	2	243
5	Madhya Pradesh	3	166	0	0	0	0	3	166
6	Andhra Pradesh	0	0	3	1560	0	0	3	1560
7	Kerala	0	0	6	373	0	0	6	373
8	Karnataka	0	0	2	400	0	0	2	400
9	West Bengal	1	120	2	66	0	0	3	186
10	Sikkim	1	520	0	0	10	1935	11	2455
11	Arunachal Pradesh	3	1610	0	0	23	7969#	26	9579
12	Assam	0	0	1	150	0	0	1	150
13	Manipur	2	1566	0	0	0	0	2	1566
14	Tamil Nadu	0	0	1	500	0	0	1	500
15	Meghalaya	0	0	1	54	1	450	2	504
	TOTAL	28	11622	35	7291	46	12007	109	30920

Source: Hydro Development Plan for 12th Five Year Period of 2012 to 2017 of Central Electricity Authority, September 2008

The above *Table 7.1*, the country has a hydro power generation potential of 148,701 MW, of which only 21% has been developed and remaining yet to be developed or under development. The Table also show that about 69% of the capacity is is lying untapped. Thus it can be seen that there is enormous viable hydropower potential to be tapped. The *Table 7.2* shows the planned hydropower generation for the 12th Five year plan.

Owing to several advantages of hydrelectric power generation over other alternative sources of power generation in India, selection of hydroelectricity for power generation is a judicious alternative due to the following reasons:

- It is one of the most common renewable, economic, non-consumptive, non-radioactive, non-polluting and environmentally benign sources of energy;
- Hydropower stations have an inherent ability for instantaneous starting, stopping, load variations, etc, and help in improving the reliability of power system;
- Hydropower stations are the best choice for meeting the peak demand;
- The power generation cost reduces with time;
- Hydro projects have a long useful life extending over 50 years and help in conserving scarce fossil fuels and thereby helping in offsetting GHG emissions.

7.4 *WHY IN HIMACHAL PRADESH? ALTERNATIVE HYDROPOWER DEVELOPMENT SITES*

There were options available for development of hydroelectric projects in different states of India. The Bhilwara Grouop had an experience of developing its another Project at Malana in the state Himachal Pradesh and also had fairly good resources in this State, hence selected development of ADHPE in this State. Also in the state of Himachal Pradesh, there was a high potential available for hydro power generation [18,820 MW - as *Table 7.1*]. The maximum potential available is in the Sutlej river basin followed by Beas, Chenab, Ravi and Yamuna river basins. Of the total identified potential capacity, 32% of the potential is already developed and another 23% is under construction/ development. Approximately 44% of the potential is yet to be tapped. The details of other ongoing hydroelectric projects in the State of Himachal Pradesh include the following:

Table 7.3 Projects likely to be commissioned in Himachal Pradesh

SN	Project	Type	Agency	Installed Capacity, MW	Year of Commissioning
1	Bajoli Holi	ROR	IPP	180	2015-16
2	Chirgaon (Majhgaon)	ROR	HPPCL	42	2013-14
3	Dhaula Sidh	ROR	SJVNL	40	2015-16
4	Kutehr	ROR	IPP	260	2014-15
5	Luhri	ROR	SJVNL	776	2016-17
6	Renuka dam	STO	HPPCL	40	2014-15
7	Sainj	ROR	HPPCL	100	2013-14
8	Kashang – I	ROR	HPPCL	130	2012-13
9	Kashang-II & III	ROR	HPPCL	130	12th. Plan
10	Kashang ROR	ROR	HPPCL	48	12th. Plan
11	Shongtong Karcham	ROR	HPPCL	402	2013-14
12	Tangnu Romai	ROR	IPP	44	2012-13
13	Lambadug	ROR	IPP	25	2012-13
14	Tidong-I	ROR	IPP	100	2012-13
15	Chango Yangthang	ROR	IPP	140	2015-16
	Total			2457	

Source: Extracted from 12th Five Year Plan of CEA, September 2008; ROR = Run of the River; IPP=Independent Power Producer; HPPCL = Himachal Pradesh Power Corporation Limited; SJVNL = Satuluj Jal Vidhut Nigam Limited.

To narrow down energy supply and demand gap, the Government of India has come out with economic reforms in energy sector by inviting public/private investments and offering a lot of incentives to private entrepreneurs.

The government and the state-owned power sector have no alternative but to look for ways of increasing efficiency of the existing electricity generating capacity and augment additional power generation with particular emphasis on hydroelectric power having high potential.

With the above consideration coupled with high potential available in the Himachal Pradesh, ADHPL considered options for installing hydropower projects in Himachal Pradesh.

7.4.1 *Present Status of Hydroelectric power potential in the Five Rivers Basins of Himachal Pradesh*

7.5 *ALTERNATIVES CONSIDERED TO MINIMISE & MITIGATE IMPACTS OF ADHEP*

There are a few potential adverse impacts of the proposed project, which are described in detail in Section on Impact Assessment. To mitigate the impacts, following alternatives have been used in selection of best possible location of project components and technologies are described in following sub-sections:

7.5.1 *Why Run-of-the-stream Project – Alternatives of type of the Project*

The run-of-the-stream projects pose lesser adverse impacts and lower risk of dam break failure than the conventional hydroelectric projects involving large storage of water. Government of Himachal Pradesh has come up with most of the run-of-the-stream projects and ADHPL selected the proposed Project as per the requirements of Himachal Pradesh Government.

7.5.2 *Alternative Sites in the Bease River Basin for Hydroelectric Power Generation*

The state Government of Himachal Pradesh has identified a number of locations in various basins within the state for developing hydroelectric power generation facilities. There exists a large potential of hydroelectric power in the state. In doing so, the State Government had invited private sector participation in implementing these projects at certain selected locations.

Based on options available for selecting hydropower projects locations, ADHPL selected run-of-the-river sites on tributaries to Beas River from among the private sector private projects, listed as above in the year 1992-93. ADHPL selected Malana and Allain - Duhangan Projects due to relatively low cost and environmental and social impacts.

7.5.3 *Selection Criteria*

Himachal Pradesh has a fairly good hydro power generation potential due to its natural terrain and rivers/streams flowing across. The Project site has been allocated by the Government of Himachal Pradesh mainly based on following considerations:

- availability of perennial water flow from catchment of snow glaciers and rain fed Allain and Duhangan streams;
- suitability of topographical, hydrological, geological, environmental and logistical considerations in the project area for adequately tapping water from the two streams with maximum head for power generation;
- availability of comparatively flat hill terrace for development of intermediate storage reservoir with sufficient gradient. Two connecting head race tunnels from Allain barrage and Duhangan weir locations will feed to surge shaft;
- availability of sufficient head for the proposed power generation potential
- adequate geological constituents of the hills for development of underground power house, thereby avoiding shear zone impacts; and
- comparatively low cost of hydro power generation at the proposed location.

The selection of Allain Duhangan hydropower project also relate with following advantages:

Table 7.4 Advantages for the Allain Duhangan Project

S.N.	Project Features	Advantage Alternatives
1	Run-of-the-river scheme to utilise the combined discharge of Allain	The two streams are perennial. The Allain stream is formed by Hamtal and Patroi streams which originate

S.N.	Project Features	Advantage Alternatives
	and Duhangan streams	at an elevation of 4680 m amsl and 4800 m amsl respectively in the Himalyan ranges, while Duhangan stream originates at an elevation of 4400 m amsl from Chandratal glacier in the Himalayan ranges. Thus two streams have independent catchments
2	The topography of the catchment area is marked by hilly terrain rising from the altitudes of the 1700 m above mean sea level (amsl) near Beas river (western limits of the catchment area) to 4800 m amsl in the glaciers of Himalyan ranges.	No hydel project envisaged upstream the proposed barrage on Allain and weir location on Duhangan streams High head of 853 m leading to high power generation potential
3	Impoundment heights: Diversion barrage structure on Allain stream with less than 14.5 m of barrage height. Diversion weir structure on Duhangan with an impounding arrangement of 5 m height. Intermediate storage reservoirs of 0.225 million m^3 with reservoir height of less than 14.5 m	Relatively, lesser impacts to downstream users as: • instead of one storage of big size in the intermediate reservoir, the Allain barrage and Duhngm HRT have an additional storages to mitigate impacts of impoundment failure. Height of dam structures will be less than 14.5 m; • the two streams are joined by several nallahs and glacier before these empty into Beas river • availability of another independent stream called Pahali nallah (located between the Allain and Duhangan streams), which is the major source of domestic water usage by Hamta and Prini villages.
4	The intermediate reservoirs will be located above elevation of 2700 m.	Located on almost flat land on hilltop. The project will divert a major portion of the flow of the Duhangan to the Allain and combine the flows of the two streams to feed a single powerhouse with 2 units each of 96 MW capacity
5	Project components like two tunnels (3.5km and 4.4km), a 1.69-km steel lined pressure shaft, an 853- m head - 2 unit Pelton turbine Power House would be located in a rock cavern.	The underground locations will have lesser impacts on ecology and aesthetic visuals
6	Administrative Approvals and Funding Arrangements	The project has already got Clearances from Ministry of Environment and Forests from Environment and Forest Angles. The proposed hydroelectric project is expected to be commissioned by end of year 2009 AD.
7	A 220 kv power transmission line (of approximately 175km) will evacuate the power to the northern grid at Nalagarh in the district Solan, Himachal Pradesh.	Transmission line to route through existing transmission lines corridor.

7.5.4 *Evaluation of Alternative configurations at Allain-Duhangan*

Alternative configurations for location and design of all the project components were considered and the final selected configuration has been arrived at, based on topographical, hydrological, geological, environmental and logistical considerations. There could also be possibility of using individual streams for power generation. At the earlier stages, the State Electricity Board had considered only Allain stream as the project. Similarly, there is possibility of power generation on Duhangan stream alone, however for both streams in their individual capacities the project viability of the proposed magnitude is very low. Hence the State Electricity Board has undergone survey of both streams together and suggested of viable project scenario.

The scheme of the proposed project as envisaged by HPSEB and study done by Geological Survey of India includes two trench weir one each on Allain and Duhangan nalas, two water conductor systems of 4 and 4.25 km length a common forebay/surge shaft for generation of 192 MW of hydropower.

Earlier project had selected three impoundments i.e. at Allain barrage, Intermediate reservoir and forebay reservoir (at current surge shaft location). In order to reduce impoundments and alleviate risks, the project has eliminated setting up of forebay reservoir and presently the project set up involves only two imoundments i.e. at Allain Barrage and Intermediate reservoir. The storage at Allain Barrage (0.120 Mm^3) and Intermediate reservoir (0.225 Mm^3) shows storage to be of moderate category as specified by International Committee on Large Dams (ICOLD) (refer to *Table 7.6* and *Annex E).* As per the definition of the ICOLD, a dam is considered large when it has a height of 15 m or more from the foundation or it has a height between 5 m and 15 m high and has a reservoir volume of more than 3 million m^3.

Table 7.5 Specification categorizing various types of Reservoir

Risk Factor	**Extreme**	**High**	**Moderate**	**Low**
Storage Capacity (Mm^3)	>120 (6)	1-120 (4)	0.1-1 (2)	<0.1 (0)
Height (m)	>45 (6)	30-45 (4)	15-30 (2)	<15 (0)
Evacuation Requirement	>1000 (12)	100-1000 (8)	1-100 (4)	None (0)
Potential d/s	High (12)	Moderate (8)	Low (4)	None (0)

Source: As per International Committee on Large Dams (ICOLD)

Similarly, with the inception of the project, there were three options for setting up of power house, out of which Option III was selected. The details of options available for power house and reasons for selection are given as under:

- Option I: site on the left bank of river Beas, which involved huge quantities of excavations in overburden terrace deposits for lcoating structures and laying of 1.5km length penstock.
- Option II: The other alternative option was setting up of underground powerhouse, near village Jagatsukh to accommodate the tail race channel on middle level terraces, which involved deep excavations and unforeseen environmental problems, and was near to habitation, this site was rejected;
- Option III: A site on the left bank of Allain stream was the third option which was considered as viable option as it comparatively involved lesser excavation and was away from habitation

7.5.5 *Alternatives of Power Transmission Line*

The power transmission line route is based on the approval by the State Government of Himachal Pradesh. The transmission line is approved by the

State Government as per the network of transmission lines of e line are still ongoing and require detailed environmental and social impact assessment following finalisation of confirmed location, however, a reconnaissance survey of likely route has been carried out to describe likely profile of the corridor.

8 ENVIRONMENTAL & SOCIAL MANAGEMENT PLAN OF ADHEP, MANALI, HIMACHAL PRADESH

8.1 PURPOSE

The ESMP provides a delivery mechanism to address potential adverse impacts, to instruct project executing teams, contractors and to implement standards of good practice to be adopted for all project work.

The ESMP has been developed into a stand-alone document covering each stage of the project (life cycle approach). The purpose of ESMP is to:

- list all suggested mitigation measures identified though the ESIA process;
- describe standards, guidelines and management system adopted for the ESIA;
- describe tasks involved in the monitoring to ensure that ADHPL meets all of its environmental and social obligations, including:
    - environmental and social commitments identified as mitigations and action plans in the ESIA;
    - compliance with all relevant legislation and Conditions of Environmental Clearance, Forest Clearance, Consent for Establishment and other approvals and permits obtained for the project;
- document roles and responsibilities for implementing, managing and reporting compliance with the legal requirement and proposed mitigations.

ADHPL will own and operate the ADHEP for a period of 40 years, which is extendable for another 20 years. During this time ADHPL will have the sole responsibility to meet the identified environmental and social requirements under the ESMP.

8.2 STANDARDS, GUIDELINES & ENVIRONMENTAL MANAGEMENT SYSTEM

8.2.1 Standards and Guidelines

The ESMP reflects requirements of

- Government of India - MoEF's conditions of Environmental Clearance issued under the EIA Notification, 1994 and Forest Clearance conditions issued under the Forest (Conservation) Act, 1980;
- Himachal Pradesh State Pollution Control Board (HPPCB) imposed conditions of Consent for Establishment (to be obtained prior to project commissioning) and Consent to Operate under the Air and Water Acts and Authorisation for Collection, Treatment, Storage and Disposal of Hazardous Wastes under the Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008;
- Issues identified for the project as part of public consultation and focus group discussions following disclosure of draft Final ESIA and Addendum to draft Final ESIA;
- ADHPL's corporate operational guidelines; and
- IFC and EPFIs guidelines for projects requiring private funding viz.,
    1) Guidance on Equator Principles Financial Institutions' Performance Standards;

2) EHS guidelines published by the World Bank/IFC;
3) International conventions applicable to the proposed project;
4) IFC Performance Standards which include:
    - PS -1: Social and Environmental Assessment and Management Systems
    - PS- 2: Labour and Working Conditions
    - PS- 3: Pollution Prevention and Abatement
    - PS-4: Community Health, Safety and Security
    - PS-5: Land acquisition and involuntary resettlement,
    - PS-6: Biodiversity Conservation and Sustainable Natural resource Management
    - PS-7: Indigenous People
    - PS-8: Cultural Heritage

The actions required to be taken up under different performance standards are described in the following sections.

8.3 *PS -1: SOCIAL AND ENVIRONMENTAL ASSESSMENT AND MANAGEMENT SYSTEMS*

PS-1 calls for thorough assessment of all potential environmental and social impacts and risks due to project development from pre-construction to decommissioning/closure, including those related to third parties (*e.g.*, governments and contractors). The environmental and social assessment will be based on accurate and complete project information and appropriate social and environmental baseline data as well will take into account all applicable laws and regulations. The proposed project with potential significant adverse impacts that are diverse, irreversible (*i.e.*, for Category A projects) requires issues identified in Performance Standards 2 through 8.

PS-1 further requires the establishment of an environmental and social management system that "provides order and consistency for mitigating and managing these (risks) on an ongoing basis." The management system must favour avoidance and prevention of impacts over minimization, mitigation or compensation. Measurable events and results should be incorporated with performance indicators that can be tracked. The Action Plan for the project must include descriptions and priorities of actions needed to implement mitigation measures and corrective actions with a time-line for implementation. This information must be disclosed to the affected communities.

8.3.1 *Regulatory Requirements*

The relevant approvals/permits obtained for ADHEP are as listed in *Table 3.12* in *Section 3*.

Specific compliance provisions stipulated under the Forest Clearance and Environmental Clearance to the project are given in the following sections:

a) Provisions stipulated under the Forest Clearance by MoEF

ADHPL has received Forest Clearance (through letters dated 17 January 2005 and 8 April 2008) for diversion of forestland of 47.179 ha (including 6.192 ha for underground tunnlingn work) with the following conditions for monitoring and control during the construction phase of the Project:

- Non-usage of forestland for any purpose other than that specified in the proposal;
- Unchanged legal status of forestland;
- Compensatory afforestation of degraded forest land twice in extent to the Forestland proposed to be diverted. ADHPL to transfer the cost of implementing the catchment area treatment plan to the State Forest Department, in a phased manner;
- Reservoir area created due to submergence shall be declared as reserved forest under the Indian Forest Act, 1927. However, regulated fishing shall be allowed;
- Catchment Area Treatment plan should be implemented as per the proposal submitted by the State Government. The user agency will transfer the cost of implementing the eCAT plan to the State Forest Department;
- No tree felling in the area between Intermediate Reservoir level and 4m below FRL of the reservoir;
- Felling of minimum number of trees wherever possible;
- No setting up of labour camps in the forest areas. ADHPL should make labour camps in the adjoining villages and make necessary arrangements for transport of the labour to and fro from the project site;
- Proper utilisation of excavated material for construction purposes or stabilisation and not throwing the excavated material on the slopes or inside the forestland;
- Carrying out the rehabilitation as per the scheme submitted;
- Ensure that muck does not roll down the slopes. All such areas where muck has rolled down the slope shall be rehabilitated at the cost of user agency and under the supervision of State Forest Department;
- Dumping areas should be stabilized and reclaimed and plantation of suitable species be carred out over dumping area at the cost of user agency under the supervision of State Forest Department;
- Construction of check dams, retention walls to arrest sliding down of the excavated material along the contour;
- Complying with all the conditions which the State Government or Conservator of Forests (Central), Regional Office-Chandigarh may stipulate from time-to-time in the interest of conservation, protection or development of forests; and
- Furnishing a progress report regularly (not less than once in a year) to the State Government about ADHPL on compliance of all the conditions specified, to Regional Office of MoEF at Chandigarh.

b) Provisions stipulated under the Environmental Clearance by MoEF

ADHEP received environmental clearance from MoEF on 12 December 2000 with the following conditions for environmental control and monitoring during the construction phase of the project:

- Resting of full responsibility of environmental safeguards with project proponent;
- Strict adherence to the action plan for Catchment Area Treatment for seven years, as per the plan submitted. This involves year-wise physical targets for the activities:
- Afforestation at 7 locations;
- Pasture development at 5 locations;
- Engineering treatment consisting of building checkwalls with boulders, stones and with/without wire mesh (at 5 different locations), check dam with boulders & stones (at 4 different locations) and Spur (at 5 different locations);

- Strict adherence to the action plan for Health Settlement and Fuel Supply to the labourers for five years;
- Inclusion of species of medicinal plants (identified in the region) under afforestation programme;
- Submission of six monthly monitoring reports to the Ministry and its Regional Office, at Chandigarh for review;
- Restoration of construction area including dump site of excavated materials by levelling, filling up of burrow pits, landscaping etc. The area should be properly afforested with suitable plantation; and
- Arrangement of adequate free fuel to the labour force engaged in the construction work at project cost, to prevent indiscriminate felling of trees.

Coordination with Local/State/Regional Authorities

ADHPL will work with key concerned authorities, agencies and institutions for prevention and control of any major impact on the local environment and people. A description of roles and responsibilities for co-ordination of ESMP is given in *Section 8.3.8*.

8.3.2 *Environmental Management System (EMS) and Safety Management System (SMS) Procedures*

ADHPL has defined EMS and SMS procedures under ISO 14001 and OHSAS 18001 certifications respectively. The project is developing mechanism for verifying criteria laid down on standards and practices for effective control on whether these are met or exceeded, as well as for recording and reporting of results.

The following components are taken to establish an EMS:
- Organisational Commitment;
- Environmental Policy;
- Environmental Action Plan;
- Objectives and Targets;
- Documentation;
- Responsibilities and Reporting Structure;
- Training;
- Environmental Review Audits; and
- Emission and performance monitoring.

ADHPL has also obtained OHSAS 18001 certification. The key components on OHSAS 18001 include the following:
- Housekeeping;
- Electrical, Mechanical and Personal Safeguarding;
- Fire Protection and Prevention;
- Accident Recording and Investigation; and
- Safety Organisation.

8.3.3 *Inspection, Monitoring & Audit*

Inspection and monitoring of the environmental and social impacts of construction and operation phase activities will increase the effectiveness of suggested mitigations.

Through the process of inspection, audit, and monitoring ADHPL will ensure that all the contractors comply with the requirements of EC, FC, and other permits including suggested APs. The inspections and audits will be done by trained team of ADHPL's Environment, Health, Safety and Social (EHS&S) Department as well subject to be reviewed and conducted by external agencies/experts. The entire process of inspections and audits are being documented. The inspection and audit findings are to be implemented by the contractors in their respective areas.

8.3.4 *ESMP Review and Amendments*

This ESMP is an environment management tool which needs to be reviewed periodically to address changes in the organisation, process or regulatory requirements.

Following a review, DGM EHS&S will be responsible for making the amendments in the ESMP and seeking approval from the senior management. The amended ESMP will be communicated to all the staff.

8.3.5 *Reporting and Review*

ADHPL has developed and implemented a programme of reporting through all stages of the project construction. Contractors are required to fully comply with the reporting programme in terms of both timely submissions of reports as per acceptable level of detail. Reporting are to be done in form of environmental check list, incident record register, environmental and social performance reports (weekly, monthly, quarterly, half yearly, yearly etc.).

External Reporting and Communication

Half yearly compliance statements and annual environmental report known as 'Environmental Statement' are to be submitted to the regulatory agencies. DGM EHS&S is the responsible person for ensuring that communication with regulatory agencies and stakeholders are maintained as per the requirement. All complaints and enquiries are to be appropriately dealt with and records be maintained in a Complaint/Enquiry Register by the DGM EHS&S or delegated staff.

Internal Reporting and Communication

Inspection and audits finding along with their improvement program are to be regularly reported to the senior management for their consideration. The same are also to be communicated within the staff working on the project.

To maintain an open communication between the staff and management on EHS&S issues the followings are being used:

- Team Briefings,
- On-site work group meetings;
- Work Specific Instructions; and
- Meeting with stakeholders.

8.3.6 Documentation and Record Keeping

Documentation and record keeping system is established to ensure updating and recording of requirements specified in ESMP. Responsibilities have to be assigned to relevant personnel for ensuring that the ESMP documentation system is maintained and that document control is ensured through access by and distribution to, identified personnel in form of the following:

- Master environment management system document;
- Legal Register;
- Operation control procedures;
- Work instructions;
- Incident reports;
- Emergency preparedness and response procedures;
- Training records;
- Monitoring reports;
- Auditing reports; and
- Complaints register and issues attended/closed.

This ESMP will be placed for review by stakeholders and kept at the project office near Prini village in Manali. The documents should be kept as hardcopies as well as in electronic format. Documents must be revised as required by changing circumstances. Records will be kept till project achieves best achievable pre-project conditions of the environment to the satisfaction of regulatory agencies.

8.3.7 Post Project Construction, Operation and Post Decommissioning Monitoring

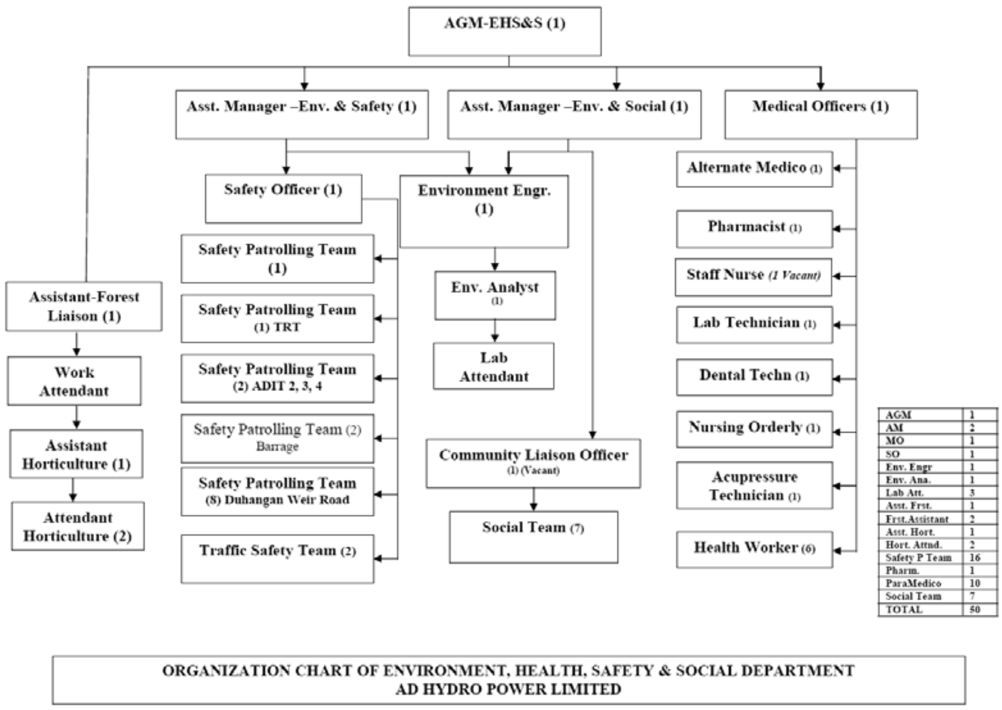
The project monitoring and its reporting to agencies like HPPCB and MoEF is to be undertaken on every six month throughout project life. After attaining the project life, the project extension or post project decommissioning and its reporting should be subject to fresh approvals and conditions of MoEF, HPPCB and other regulatory agencies. Reporting can be discontinued only subject to the condition that the site is restored to its best achievable original condition to the satisfaction of the regulatory agencies.

8.3.8 Organisation, Roles and Responsibilities

ADHPL Management

The overall management and coordination of the project is being managed through DGM EHS&S who is currently reporting directly to President of the Project. Local staffs have been hired for different project activities. An organisational set up for the EHS&S department is given in ***Figure 8.1***.

Figure 8.1 Organisational Set Up for ADHPL EHS&S Management



Note: DGM EHS&S reports directly to The President

The usual activities of the DGM EHS&S and his team will be as following:

- Preparation of required EMS and SMS documents;
- Ensuring availability resources and appropriate institutional arrangements for implementation of ESMP;
- Selection of appropriate monitoring agency for carrying out various monitoring and analysis;
- Compliance of legislative and IFC/EPFIs requirements including ADHPL's policies, programs and contractual terms and ESMP and communication with the regulatory agencies;
- Overall implementation of EHS&S mitigations by construction contractors, sub contractors, workforce at site etc;
- Carryout audits, and inspection of all the project activities;
- Preparation of necessary documents and record keeping system; and
- Review and updating of ESMP for effective its implementation.

As the project proponent, ADHPL senior management will have the overall responsibilities for the project to provide adequate resources (funds and manpower) for continual improvement EHS&S performance.

The project has a geologist and blasting specialists responsible for supervising and guiding safe blasting operations undertaken for tunnel development. The geologist also provides guidance for stabilisation/ integrity of the tunnels etc.

Construction Contractors

Prior to tender for and assigning any contract, Company should pre-qualifies each contractor according to commercial, technical, quality assurance and its past performance on EHS&S standards so as to satisfy Company requirements and policies.

All Contractors providing services to the Company are required to have in place EHS policy and implemented for the effective management of Environment, Health, Safety standards.

Regulatory Agencies

The authorities/agencies to be coordinated for ESMP implementation include the following:

- Local Area Development Committee (LADC) constituted as per Government of HP Notification no. MPP-F (10)15/2006 dated 11 December 2006. The functions of LADC include
  - vii) oversee restoration of facilities adversely affected due to implementation of the project;
  - viii) Oversee the implementation of the Rehabilitation and Relief Plan, employment related monitoring;
  - ix) Oversee the implementation of CAT Plan, compensatory afforestation, EMP, EIA, Quality Control mechanism of the Projects;
  - x) Local development activities related to development of agriculture, horticulture, animal husbandry, irrigation and public health (I&PH), Health, Forest, Fisheries, Rural development, Education, PWD, Power and other Social Religious and Cultural activities;
  - xi) Review of recommendations and implementation thereof the Forum of Hydroelectric Power Procedures;
  - xii) Review of progress of all statutory clearances, time and cost overruns of the project, if any.
- Kullu District Authority;
- Land Revenue Department;
- Gram Panchayat of Prini and Jagatsukh villages
- Irrigation and Public Health Department;
- Fisheries Department;
- Department of Forests and Environment;
- Himachal Pradesh State Pollution Control Board;
- Department of Science and Technology, Government of Himachal Pradesh;
- Ministry of Environment and Forests, through its regional office in Chandigarh; and
- Petroleum and Explosives Safety Organisation (PESO), erstwhile Chief Controller of Explosives, Nagpur.

8.3.9 Training of ADHPL Personnel and Contractors

DGM EHS&S will ensure that the job specific training and EHS Induction Training needs are identified based on the specific requirements of ESMP and existing capacity of site and project personnel (including the Contractors and Sub-contractors) to undertake the required ESMP management actions and monitoring activities.

Also general environmental awareness will be increased among the project's team to encourage the implementation of environmentally sound practices and compliance requirements of the project activities. This will help in minimising adverse environmental impacts, compliance with the applicable regulations and standards, and achieving performance beyond compliance. The same level of awareness and commitment will be imparted to the contractors and sub contractors prior to the commencement of the project.

An environmental management training programme will be project related construction activities. This will ensure effective implementation of the management and control measures on various project activities. The training programme will ensure that all concerned members of the team understand the following aspects:

- Purpose of management plan for the project activities;
- Requirements of the management plan and specific Action Plans;
- Understanding of the sensitive environmental and social features within and surrounding the project areas; and
- Aware of the potential risks from the Project activities.

8.3.10 Action Plans under ESMP

The mitigations are prepared considering all possible strategies oriented towards effective environmental and social management including pollution prevention and control, waste minimisation and management and social resettlement actions for the project. Specific Action Plans (APs) have been formulated to address following key environmental and social issues as included in Annex B and Annex C to this ESIA:

Annex B: Management Plans – for implementation during construction phase
Annex B-1: Construction Labour Management Plan;
Annex B-2: Traffic Management Plan;
Annex B-3: Muck Disposal Plan;
Annex B-4: Health Management Plan (Construction Phase);
Annex B-5: Construction Demobilisation Plan

Annex C: Management Plans – for implementation during the Project life cycle
Annex C-1: Resettlement Action Plan (RAP);
Annex C-2: Indigenous People's Development Plan (IPDP);
Annex C-3: Community Development Plan;
Annex C-4: Biodiversity & Wildlife Management Plan;
Annex C-5: Catchment Area Treatment Plan;
Annex C-6: Minimum Water Discharges & Fisheries Monitoring Plan
Annex C-7: Emergency Response Plan; and
Annex C-8: Desiltation Management Plan (for Desilting Chambers on Allain & Duhangan Streams).

Note: The above plans will be implemented by ADHPL during the entire Project life cycle and will be further improved, where required while being practised.

8.4 *PS 2- LABOUR AND WORKING CONDITIONS*

The standard applies to both employees and non-employee workers. The Management of ADHPL has to establish systems that focuses on its employees as well as ensures that the workers employed indirectly through contractor work in good work environment, and get a fair treatment.

There is currently no Trade Union in the company, though there is no policy barring formation of TUs. The Management has however put in place a grievance redressal system that allows people to communicate their opinions and grievances to the senior management. The process requires that the employees get a response to their issues as soon as possible.

Health and Safety is a key concern, and an important aspect of induction as well as training. ADHPL is to ensure that safe and healthy work environment is provided to employees. There is an HR Department, consisting of 08 people who manage people issues. For contract labour, the HR Department strictly monitors the labour and working conditions provided by the labour contractors, and ensure that the workers get their full payments on time, that the PF is deposited according to the law, and there is a workmen compensation policy in place. Workers have access to medical and some basic recreational services, and are exposed to awareness campaigns on HIV/AIDS, Polio, Malaria and the Vaccination programs. Men and women get the same wages for similar tasks and above the minimum wages ascertained by the government as below:

- Unskilled: INR 100.00/day
- Semi-skilled: INR 110.00/day
- Skilled: INR 126.00/day
- Highly Skilled: INR 161.50/Day

ADHPL is to ensure that no child labour is engaged for the project and also to ensure not to employ forced labour.

8.5 *PS- 3: POLLUTION PREVENTION AND ABATEMENT*

PS- 3 addresses measures to avoid or minimize adverse impacts on human health and the environment by minimizing pollution and to promote reduction of emissions contributing to climate change. Under this PS, over the life of the project, the ADHPL must apply pollution prevention and control technologies that are technically and financially feasible and cost effective. The draft Final ESIA report notes, wastewater will be treated and a part of the treated wastewater discharge will be for use in plantation. The ESMP describes waste minimization; follow up of pollution prevention measures and disposal of all wastes in compliance with the regulatory requirement.

8.6 *PS – 4: COMMUNITY HEALTH, SAFETY AND SECURITY*

PS 4 requires to evaluate risks and impacts to the health and safety of the affected community during design, construction, operation and decommissioning of the project and will establish preventive measures to address them commensurate with the identified risks and impacts. The Standard also requires ensuring that the security personnel engaged do not use force except when used for preventive and defensive purposes in proportion to the nature and extent of threat. A grievance mechanism allows the affected community to express concerns about the security arrangements and acts of security personnel. ADHPL is to disclose Action Plan and other relevant information to enable affected communities and government agencies understand these risks and impacts and engage communities and agencies on an ongoing basis about these risks and impacts. This ESMP describes community health, safety and security issues and their management.

8.7 *PS-5- LAND ACQUISITION AND INVOLUNTARY RESETTLEMENT*

PS-5 requires considering feasible alternatives project design to avoid or at least minimize physical, or economic displacement, while balancing environmental, social and financial costs and benefits. The PS requires that when displacement cannot be avoided, project proponent is tooffer displaced persons and communities compensation for loss of assets at full replacement cost and other assistance to help them improve or at least restore their standards of living or livelihoods. Consultation, grievance mechanism and resettlement planning and implementation are the key requirements to be included in the resettlement action plan. This ESMP describes the requirement under the PS-5.

8.8 *PS – 6: BIODIVERSITY CONSERVATION AND SUSTAINABLE NATURAL RESOURCE MANAGEMENT*

PS- 6 applies to all habitats, whether or not previously disturbed or legally protected. The standard is on protection and conservation of biodiversity, including endangered species and sensitive ecosystems in modified, natural and critical habitats, and identification of legally protected areas.

The project involves diversion of forestland (approximately 47.179 ha) for non forest purposes as well felling of about 1746 trees and requirement of compensatory afforestation on 83.40 ha of double degraded land and deposit of money (INR 186.7 million) to the Forest Department as cost for environmental resources. This ESMP describes the requirement under the PS-6.

8.9 *PS-7 INDIGENOUS PEOPLE*

PS-7 addresses the protection of Indigenous Peoples. The standard notes that there is no universally accepted definition of Indigenous Peoples but describes characteristics related to distinct cultural identity, collective attachment to geographically distinct areas or territories, institutions separate from those of the dominant society, and an indigenous language that may differ from the official language of the country. This ESMP describes the requirement under the PS-7.

8.10 *PS-8: CULTURAL HERITAGE*

PS-8 focuses on the preservation of irreplaceable cultural heritage and its protection from the impact of project activities. It also addresses the equitable sharing of benefits from the use of cultural heritage in business activities. In this PS, the term cultural heritage refers both to tangible property and to any sites that have significance from the standpoint of prehistoric archaeology, palaeontology, history, culture, art and religion. It also applies to any unique natural features that encompass cultural importance, such as a specific natural feature considered sacred in the local culture. With respect to the use of cultural heritage in the business of the project, it also refers to intangibles, such as cultural knowledge, practices, *etc*. The provisions of this PS apply regardless of whether there are legal protections for cultural heritage in the country or whether relevant property or sites have already been disturbed. This ESMP describes the requirement under the PS-8.

8.11 *SUGGESTED MITIGATIONS*

The suggested mitigations for the AD hydro project are as given in *Table 8.2*.

Table 8.1 Environmental Mitigations and Management for Hydroelectric Power Project

S.N.	Project Activities/Aspects	Associated Impacts	Mitigations – Action Plans	Timeline	Responsibility
A	**Construction Phase**				
	Social Impacts:				
A-1	Land acquisition for the project components	Loss of land, livelihood, assets etc. broader socio-economic impacts	Compensation for land and assets negotiated on the basis of current HP government norms No physical displacement of people A Rehabilitation Action Plan to restore loss of livelihood. Rehabilitation Assistance (Transition Allowance, income restoration measures and employment) for vulnerable families and families losing more than 25% of their total land An option between land-for- land or cash compensation for families losing more than 75% of their total land and Scheduled Tribe families. Community Development Programme for the project area.	Prior to project construction	ADHPL - EHS&S Local Administration Appointed Agency for Monitoring
A-2	Women's safety and security	Women's safety and security may be adversely affected due to influx of outside labour force	The Company will fund a police station to be set up at village Prini. Company will provide security staff at all project component sites. Security Staff will have instructions to ensure women's safety Provision of security will also be considered at additional locations if requested by the villagers. Separate colony for labour force with segregated facilities and regular checks to monitor the same The Government will be requested to depute women police staff at the Prini Police station to register local	Throughout the Project life	ADHPL - EHS&S Local Administration Respective village community

S.N.	Project Activities/Aspects	Associated Impacts	Mitigations – Action Plans	Timeline	Responsibility
			complaints related to women. It is suggested that the GRC will liaise with the Police Station to monitor complaints relating to women's security in particular. All contractors will be bound through contractual provisions to observe environmental, health and safety regulations of the Company, including compliance with local security requirements. Violations of these regulations will result in fines and/or cancellation of contracts.		
A-3	Community Safety	Safety of community due to falling objects from higher elevation during road construction. and maintenance	Ensure following safety measures during road construction and maintenance: • Areas with steep slopes to be protected from falling boulders by providing temporary barricades/ net/ bruggmesh. • Construction/maintenance of the road must be done in close supervision of the safety office; • Restrict speed of vehicles in areas with steep slopes • Vegetate/revegetate areas damaged due to falling boulders;	Throughout the Project life	ADHPL - EHS&S Local Administration Village community
A-4	Acquisition of the Government Potato farm land at Hamta for the project	Loss of availability of potato seeds to local people	• Project would provide seeds of similar quality to the village Panchayats, as requested. • Company will make arrangements to provide potato seeds at same rate at which farmers procured it from the potato farm.	Throughout the Project life	ADHPL - EHS&S Local Administration Respective village community
A-5	Loss of land	Loss of income generation opportunity by Project Affected Families.	The Company will ensure that preferential employment opportunities are given to the Project Affected Families and local communities to address their employment issues by; Skill up gradation and training program for income restoration. Identifying suitable jobs, training to the villagers for jobs and educating for bank loans for trucks to the local youth, Providing indirect employment opportunities to	Construction Phase	ADHPL - EHS&S Local Administration Respective village community

S.N.	Project Activities/Aspects	Associated Impacts	Mitigations – Action Plans	Timeline	Responsibility
			women's group by offering them plantation work to be given to women's groups Offering contracts to local people as per their skill set Giving priority in jobs to the local people with first priority given to the project affected family Giving transition allowance for the vulnerable families Ensuring no deployment of child labour. Employment in project to at least one member of each project affected family as per clause No.5.16 of the Implementation Agreement with the Govt of HP. For rehabilitation assistance including skill development all family members above 18 yrs have been considered as a separate unit Hiring of taxis from village where requirement and rates match with Company's needs.		
A-6	Influx of labour force in the area	The migratory labour would disturb the social and cultural fabric of the affected villages Large influx of migratory	Regular check to control interference of labour force with local residents • Construction Labour Management Plan, which includes management for labour accommodation, fuel arrangement for labour and issues related to their health management. • The Company will stipulate in its labor contracts that preference will be given to hiring local laborers first, and then to Pahari/Nepali laborers • Labour camps will be set up catering to all migrant labour force. This should be located at a suitable distance from the nearest settlement. This clause will be included in the contract. The contractors will be required to provide of civic	During Construction	ADHPL - EHS&S Respective village community

S.N.	Project Activities/Aspects	Associated Impacts	Mitigations – Action Plans	Timeline	Responsibility
		labour would lead to adverse sanitation conditions	amenities for construction labour including toilets, sewage collection systems, • Company will implement awareness programmes on various communicable diseases, hygiene and sanitation; • Company will establish treatment plants for wastewater from workshops & colonies, and make provision of fuel for labour force, conversion of biodegradable waste into compost.		
A-7	Deployment of Security	Threat of force community	• Security personnel engaged do not use force except when used for preventive and defensive purposes in proportion to the nature and extent of threat. • For any issue with the community, take support of local administration; • A grievance mechanism to allow the affected community to express concerns about the security arrangements and acts of security personnel.		
A-8	Tourism	Interference on tourism	• Company will ensure regular check and measures to control interference of construction labour with local residents and tourists. • Any damage to the trekking route due to construction work would be repaired. • Company to maintain that the number of trekkers and tourists is likely to increase due to the construction of road up to Allain and Duhangan barrage sites, which will create additional employment opportunities for the local population.	Throughout the Project life	ADHPL EH&S Village commujties Local administration
A-9	Social upliftment activities	Beneficial impacts to the affected communities	• Community will provide health and clinical facilities to the local communities; • Company to engage in improving education, sport and cultural activities of the affected villages • Provide training to younger people for support in livelihood earning. • Participate in LADA required activities	Throughout the Project life	ADHPL EH&S Village commujties Local administration

S.N.	Project Activities/Aspects	Associated Impacts	Mitigations – Action Plans	Timeline	Responsibility
	Temporary Occupation by Construction Labour				
A-10	Establishment of buildings, storage facilities, workshops for maintenance of vehicles and machinery/equipment	Deterioration in surface water quality or soil and ground water quality when discharged untreated	Treatment plants for wastewater generated from workshop and domestic wastewater generated from office and colony	Ongoing	ADHPL - EHS&S Construction Engineer HPPCB
A-11	Camp Activities - Provision of civic amenities for construction labour, and - movement of truck drivers for transporting construction material.	Health Risks due to - lack of health and sanitation conditions through disposal of sewage on open land which may cause mosquito nuisance, water borne diseases etc. - Chances of spread of sexually transmittable diseases like AIDS	Construction of toilet facilities and sewage collection system for treatment. Provision of treatment plant for sewage before its disposal, meeting the stipulated standards of discharge. Construction of a hospital at Prini and a mobile dispensary unit at Jagatsukh, Hamta, Khnoon and Duhangan Weir sites. Community Awareness programmes on HIV/AIDS, Malaria, Tuberculosis and other communicable diseases. Health checkups facilities for employees and contract labourers	During Construction	ADHPL - EHS&S Local Health Administration HP Factory Inspectorate
A-12	Water supply	Impact due to drawing of water for domestic purposes	Emphasis on optimisation water usage, including, where feasible, recycling.	Ongoing	ADHPL - EHS&S Construction Engineer
A-13	Fuel requirement of workers during construction phase	Pressure on forest produce for fuel use	ADHPL will require all contractors, to observe Indian national and World Bank Group environmental, health and safety regulations, policies and guidelines including compliance with a prohibition on the felling of trees for meeting fuel wood requirements. Labour contracts will contain conditions to ensure that illegal felling is not done by the contract labour. Provisions for use of kerosene oil or LPG as the primary fuel by the labour. This will be the contractor's responsibility and included in the contract.	During Construction	ADHPL - EHS&S Construction Engineer

S.N.	Project Activities/Aspects	Associated Impacts	Mitigations – Action Plans	Timeline	Responsibility
			Use of fuel wood as secondary option. This will be sourced from the State Forest Department and records of procurement and distribution for use will be maintained by the contractor. All contractors will be bound through contractual provisions to observe environmental, health and safety regulations of the Company, including compliance with conditions regarding no-illegal-felling of trees for meeting fuel wood requirements. Violations of these regulations will result in fines and/or cancellation of contracts.		
A-14	Solid waste disposal	Improper solid waste disposal could lead to health hazards. During construction of retaining walls for roads, adequate toilets were not provided to the labourers.	Company will implement measures for Solid waste disposal which includes the following: • Identification of all solid waste generation sources. All bio-degradable including kitchen waste to be put into humus pit, which can be covered with soil for composting. • Construction of toilet facilities and sewage collection & treatment systems for labour camps; • Construction of public toilets in the village; • Provision of toilets at all construction sites; and • Development of codes of practice for safety and disposal of muck and solid waste prior to taking up construction activities	During Construction	ADHPL - EHS&S Construction Engineer/ Contractor
A-15	General	Health, Safety, Solid Waste Disposal (domestic and project)	Develop codes of practice for safety and disposal of muck and solid waste prior to taking up of construction activities	During Construction	ADHPL - EHS&S, HPPCB & Factory Inspectorate
	Site Preparation – Construction of Roads etc.				
A-16	Forestland diversion for establishing project components	Loss of 47.5 ha of forestland and removal of trees and other vegetation	Compensatory afforestation over 83.4 ha of double degraded land.	During Construction	ADHPL - EHS&S DFO MOEF

S.N.	Project Activities/Aspects	Associated Impacts	Mitigations – Action Plans	Timeline	Responsibility
A-17	Demolition and Removal of structures, if any	Noise disturbance and dust	Water sprinkling and Demolition limited to day time only	During Construction	ADHPL - EHS&S Construction Engineer/ Contractor
A-18	Construction of Roads and Development of other areas	Dust raised during various construction activities; Soil erosion; Reduction in water quality	Realignment of road, where feasible to avoid cutting of large trees and area falling under forest/ devbans. Sprinkle water on unpaved roads to reduce incidence of dust in air Proper engineering designs of access roads. High slope area is provided with adequate erosion control measures like grass turfing etc. Provide adequate culverts and drainage channels Provision of adequate steps for access to local people	During Construction	ADHPL - EHS&S Construction Engineer/ Contractor DFO
A-19	Transportation -Vehicular movement, Loading/ unloading	Causes dust nuisance as well as NO_x pollution due to vehicular emissions	Traffic Management through daily arrangements for fleet management, sprinkling of water on construction road	During Construction	ADHPL EHS&S - Safety Officer HR Manager Community Liaison Officer
	Water Resources				
A-20	Diversion of Allain and Duhangan streams for construction of Allain Barrage and Duhangan weir.	Soil erosion and Reduction in water quality.	Adequate provision for proper channel for carrying diverted water from both streams. Ensure constant natural flow of water.	During Construction	ADHPL EHS&S Construction Engineer Contractor
A-21	Construction may adversely affect the drinking water sources of Jagatsukh & Prini village at Chor Pani /Dhani stream, & Jamlu Devta/Pahali	Potential impact on water springs (Chor Pani) used as drinking water supply to Jagatsukh village (near road to Duhangan weir)	▪ Ensure best available civil engineering techniques to preserve working of the drinking water sources i.e. Dhani, Pahali, Chor Pani or Jamlu Devta. ▪ Ensure joint monitoring mechanism for protection of drinking water resources	During Construction	ADHPL EHS&S Construction Engineer Contractor

S.N.	Project Activities/Aspects	Associated Impacts	Mitigations – Action Plans	Timeline	Responsibility
	streams respectively.		▪ In case of any abruption to the water source, ensure drinking water supply to the effected village. (The company has given an undertaking that the riparian rights (i.e. the rights of access of drinking and irrigation) will be restored in case of any disturbance to such sources.		
A-22	Access to and impact on pastureland	Access to existing pasture land may be disturbed due to construction of road and the livestock may get difficulty in reaching these pastures.	▪ Ensuring access to pasture land is maintained through the construction and later during the operation phase of the project. ▪ Repairing of any footpath damaged during the construction of the roads. ▪ Providing appropriate steps along the retaining wall structures of the project roads to facilitate movement of people and livestock to the pastures ▪ Providing ramps where necessary (temporary or permanent) with slopes appropriate for animal movement. ▪ Realigning road where feasible ▪ Enhancing existing degraded pasturelands by restoring degraded areas in consultation with the community. ▪ Developing 200 hectares of pastures as identified in the Catchment Area Treatment plan with the help of State Forest Department.	Throughout the project phases	
	Construction of Other Project Components				
A-23	Excavation and blasting during tunnel development	High Impulsive Noise levels	▪ Adopting optimised blasting techniques using delay detonators, blasting in confined areas (inside the tunnels)	Ongoing	ADHPL EHS&S - Safety Officer Construction Engineer

S.N.	Project Activities/Aspects	Associated Impacts	Mitigations – Action Plans	Timeline	Responsibility
					Blasting Specialist Contractor
A-24	Blasting Operations for Tunnel Development	Impulsive ground vibrations. Impacts short term and reversible.	▪ Adopting optimised blasting techniques using delay detonators, blasting in confined areas (inside the tunnels) ▪ Ensuring ground vibrations do not affect structures beyond 81 m from point of blast. ▪ Periodical monitoring of ground vibrations. ▪ Adoption of optimized blasting techniques using delay detonators, blasting in confined areas. ▪ Regular monitoring of ground vibrations will be undertaken. ▪ Intimating blast timings to villagers and ensure prior sounding of prior siren as well that any cattle and local people are away from the locations at the time of blasting.	Ongoing	ADHPL EHS&S - Safety Officer Construction Engineer Blasting Specialist Contractor
A-25	Blasting Operations for Tunnel Development	Affects wild life through air & noise pollution. Short term and reversible impacts	▪ Optimised blasting operation. ▪ Controlled Traffic management. ▪ Provision of enclosures and other measures for high noise generating machinery/equipment	Ongoing	ADHPL – EHS&S Construction Engineer Blasting Specialist Environment Engineer Safety Officer
A-26	Excavation and blasting during tunnel development	Occupational health hazards Deteriorates workers health (occupational health	▪ Optimised blasting restricted to tunnels (confined area) only provided with adequate exhaust system ▪ Compulsory use of respiratory personal protective equipment.	Ongoing	ADHPL EHS&S Safety Officer Construction Engineer

S.N.	Project Activities/Aspects	Associated Impacts	Mitigations – Action Plans	Timeline	Responsibility
		hazards) due to air & noise pollution, accidents & injuries. Restricted to construction phase – short term and reversible	▪ For those working in deep caverns, arrangement of life line should also be made. ▪ Use of fire proof cables inside the tunnels for lighting during construction phase.		Contractor
A-27	Excavation and blasting during tunnel development	Occupational safety hazards Construction place safety hazards	▪ Provision of safety management on daily basis under direct supervision of a permanent safety officer on site during construction and operation phases; Provision of adequate safety personal protective equipment like safety helmets, safety goggles, gum boots, gloves etc. ▪ Provision of fireproof cables inside the tunnels to prevent any short- circuiting during construction phase. ▪ Develop code of practice for safety and entry procedures to excavated tunnels during construction phase.	Ongoing	ADHPL EHS&S - Safety Officer Construction Engineer Contractor
A-28	Excavations, drilling, transportation and other project activities	Soil erosion/sedimentation during construction phase	▪ Reuse of over 30% of muck in road construction, ▪ Proper staking and their compacting, afforestation, improvement of landscape measures and catchment area treatment to reduce incidence of soil erosion. ▪ Provision of measures to control silt/sediments during construction phase, provision of check walls, check dams and spurs.	Ongoing	ADHPL EHS&S – Env Engr Safety Officer Construction Engineer Contractor DFO HPPCB
A-29	Impact of dust on apple crops	The dust raised by the increased vehicular traffic may lead to reduction in apple production in the affected project villages.	▪ Water trucks will sprinkle roads under construction to minimise dust; ▪ All roads will be bitumen topped; ▪ Traffic management through daily fleet management to avoid accidents and congestions at various points; ▪ Vehicles carrying construction material to be covered and use of water sprinkling, ▪ The Company will be restricting vehicular movements		

S.N.	Project Activities/Aspects	Associated Impacts	Mitigations – Action Plans	Timeline	Responsibility
			at the areas other than project sites; ▪ Loads of construction waste material will be sprinkled with water; ▪ The Company will discuss explore crop insurance with the community during construction phase of the project; ▪ The Company will consider any and all claims of impacts on crop production for appropriate compensation through the established grievance redressal mechanism to verify the same.		
A-30	Water withdrawal for construction purposes i.e. for dust suppression, workshop, domestic supply at construction site and colony etc.	Reduced flow - Impact due to drawing of water reversible	▪ Optimise water use ▪ Emphasis on reuse of water during wet drilling of tunnels.	Ongoing	ADHPL EHS&S – Env Engr
A-31	Muck and other solid waste including associated overburden disposal	Impact on landuse, topography, soil etc.	▪ Reuse of maximum solid waste. Minimum 30% of muck to be reused in road construction, improvement of landscape measures ▪ Disposal of Muck (excavated rock and soil) as per Muck Disposal Plan. Refer to *Annex B* ▪ Further possibility for reuse of muck is to be considered by getting it tested for feasible strength and other features.	Ongoing	ADHPL EHS&S – Env Engr Safety Officer Construction Engineer Contractor HPPCB
A-32	Stock piling of solid waste (spoil) and muck their disposal	Increase in SPM level during high winds	▪ Proper staking and compacting of muck and spoil, ▪ Afforestation and improvement of landscape as per catchment area treatment plan ▪ Other dust preventive measures like water sprinkling etc to reduce incidence of high SPM during windy conditions.	Ongoing	ADHPL EHS&S – Env Engr Construction Engineer Contractor DFO
A-33	Construction phase – DG Set operation for power	Increase in SO_2 and NO_x levels	▪ Standby operation during construction phase only ▪ Provision of stipulated stack height, DG set	Ongoing	ADHPL EHS&S – Env Engr

S.N.	Project Activities/Aspects	Associated Impacts	Mitigations – Action Plans	Timeline	Responsibility
	generation in case of abrupt power supply form State Electricity Board		operations at dispersed locations ▪ DG sets will be spread at 4 locations within the project area		Construction Engineer HPPCB
A-34	DG sets, Concrete Mixing Plants and other machinery generating noise and vibrations	Increase in noise and vibrations	▪ Provision of enclosures for high noise producing machinery like concrete mixing plants, DG sets and other equipment, ▪ Provision of mufflers (silencers) on DG sets ▪ Provision of temporary but proper foundation supported with rubber padding to control vibrations. ▪ Optimised operation of construction related machinery	Ongoing	ADHPL EHS&S – Env Engr Construction Engineer HPPCB
A-35	Construction equipment operation	Noise generation	▪ Day time operation of high noise generating equipment ▪ Regular maintenance of equipment ▪ Provision of enclosures for high noise generating equipment	Ongoing	ADHPL EHS&S Construction Engineer Contractor
A-36	Transportation – vehicular movements	Increase in noise levels Adverse effect due to air and noise pollution due to vehicular traffic movement	▪ Fleet management on daily basis ▪ Restricted vehicular movement during non peak traffic hours. ▪ Vehicles carrying construction material will be properly covered and water sprinkling, ▪ Vehicular traffic is mainly confined to project area and vehicles carrying construction material will be properly covered	Ongoing	ADHPL EHS&S – Safety Officer Construction Engineer Contractor
A-37	Transportation – Due to increase in vehicular Traffic on Manali – Nagar roads	Increase of traffic will lead to increased incidences of road accidents Blocking of roads due to transportation on the	▪ Regulated traffic on daily basis with the help of local administration so as to avoid blocking of the roads. ▪ Nagar – Manali road although not commonly used by tourists en-route Manali. Regulated traffic on daily basis with the help of local administration so as	Ongoing	ADHPL EHS&S – Env Engr, Safety officer Local Traffic Administration

S.N.	Project Activities/Aspects	Associated Impacts	Mitigations – Action Plans	Timeline	Responsibility
		Nagar – Manali Road	to avoid blocking of the roads.		
A-38	Deployment of construction labour not belonging to the project area and restriction on employment of child labour.	Influx of people of various cultures will have substantial effect on local culture. Employment of child labour would be in violation of IFC norms.	▪ Regular check and measures to control through supervisors that construction labour does not interfere with the local inhabitants for their cultural values. ▪ Labour contractors to give priority on hiring local labourers ▪ Labour camps to be establish for all migrant labourers. Camps to be located at a suitable distance from the nearest settlement. ▪ Provision of civic amenities at the camps.		ADHPL EHS&S – Env Engr, Social Scientist
A-39	Wildlife habitat and flora	Impact on Flora and Fauna-wildlife, biodiversity and riverine ecology.	▪ Compensatory afforestation over 100.30 ha. of degraded forest land; ▪ Optimized blasting to control air pollution, controlled traffic management; ▪ Discharge of accumulated silt in controlled manner to minimise impact on riverine ecology. Monitoring of fish throughout the project life ▪ Ensuring silt levels does not increase 30% of the baseline in Allain and Duhangan streams. ▪ Maintenance of minimal light to avoid disturbance to night animals/birds, if any, and for safe and secured project operations; ▪ All openings of all the tunnels/adits to be lighted during night time and guarded all the time. If unguarded these tunnel openings must be temporarily closed to avoid any wildlife finding refuge in such tunnels during night time or periods of no construction activities;	Throughout project phases	ADHPL EHS&S – Env Engr Construction Engineer DFO

S.N.	Project Activities/Aspects	Associated Impacts	Mitigations – Action Plans	Timeline	Responsibility
			▪ In case any wildlife is found to have taken up a refuge in any such tunnels, all construction labour to leave that place immediately, trained personnel from Department of Forests and Wildlife Warden's office and approved experts should be intimated for called for rescue of such wildlife. Any construction activities to be taken up only after any trapped wildlife finds its safe escape; ▪ The Project is to minimise damage to plantation in and surrounding the Project component areas. If any damage is noted, the Project is to take up plantations in all areas damaged due to Project construction in addition to statutory compensatory afforestation to be taken up by the Project through State Department of Forests; ▪ Catchment Area Treatment Plan involving afforestation over 800 ha will be implemented; ▪ Provision of contractual agreements with employees/contractors for not to hunt or gather and otherwise disturb wild life and vegetation in the project area. In case of otherwise is proved, erring person will be fined heavily or leading to cancellation of contracts.		
	Catchment Area Treatment				
A-40	Repair of slope failures and erosion	Reduced downstream sedimentation	▪ Strict implementation of Catchment Area Treatment Plan through periodical internal and external monitoring and evaluation. ▪ (Refer to CAT Plan – Annex B)	Ongoing	ADHPL EHS&S – Env Engr Construction Engineer DFO
A-41	General maintenance and ecological protection	Improvement of terrestrial habitation by compensatory afforestation	▪ Strict implementation of Catchment Area Treatment Plan - refer to Annex B	Ongoing	ADHPL EHS&S – Env Engr

S.N.	Project Activities/Aspects	Associated Impacts	Mitigations – Action Plans	Timeline	Responsibility
		conservation of flora and fauna through periodical monitoring by internal and external agencies. Conservation of water resources			DFO
B	**Demobilisation of Temporary Construction Infrastructure**				
B-1	Demobilisation and removal of all temporary buildings and magazines	Aesthetics, health, safety, reduction in water quality	▪ Convert accommodation to schools/ local welfare activities if close to any village else demolish or remove such temporary building from site ▪ Re-vegetate bare areas ▪ Remove all construction equipment from project site ▪ Remove all waste from site and dispose it off appropriately as per the requirement of HPPCB ▪ Rehabilitate muck and other spoil dumping sites. ▪ All adits gates must be closed, locked and sealed before commissioning of the Project.		ADHPL EHS&S – Env Engr DFO Construction Engineer Safety Officer HPPCB DFO
B-2	Los of jobs/economic dependence	Socio-economic	▪ Prepare a demobilisation plan and communicate to concenred contractors, sub contractors and temporary staff engaged for the Project; ▪ Develop alternatives with the local administrations and village communities for the affected temporary staff		
C	**Operation Phase**				
C-1	Water diversion for hydroelectric power generation	Impact due to diversion of water for power generation during operation phase and reduced flow in	▪ Provision of maintaining minimum recommended minimum flow of 15% of regular flows downstream of Allain and Duhangan diversion structures. The minimum flow of 387.09 LPS downstream of	Throughout during operation phase	ADHPL EHS&S – Env Engr Liaison officer

S.N.	Project Activities/Aspects	Associated Impacts	Mitigations – Action Plans	Timeline	Responsibility
		stretches between diversion structure and tail race discharge point on Allain and downstream of the Duhangan stream.	Duhangan streams. (The discharge on Duhangan stream will be as per the findings of I&PH Committee set up by the Hon'ble High Court as per their order June 2006) ▪ Installation of flow measuring gauges (meter with recording provisions) both electronic and manual measurement basis.		I&PH Department
C-2	Wastewater generation from project workshop and project offices/campsites	Improper wastewater disposal by the Project could lead to health hazards and could also damage agricultural crops or deterioration of surface water quality if discharged untreated	▪ Company will ensure the proper management of wastewater/sewage generated by the project in the following manner: ▪ Provision of treatment plants for wastewater (from camp, colony and workshop) ▪ Provision of sewage treatment plant for domestic sources ▪ Compliance with the standards for discharge as prescribed by HPPCB ▪ Regular participatory monitoring of treated water before it is discharged into disposal outlet.	Throughout during operation phase	ADHPL EHS&S – Env Engr HPSCB
C-3	Flushing of silt accumulated in the de-silting chambers	Deterioration of quality of downstream of Allain and Duhangan water	▪ Ensuring controlled discharge of accumulated silt from desilting chambers to a level not exceeding 30% of the baseline in Allain and Duhangan streams. ▪ Restricting flushing mostly during mosoon season; ▪ Follow the Desilting Plan – *Annex C-5.*	Throughout during operation phase	
C-4	Vehicular movement and hydropower generation	Minor increase in noise levels	▪ Limited vehicular movement during operation phase ▪ Regular maintenance of company owned vehicles	Throughout during operation phase	ADHPL EHS&S – Env Engr Safety Officer
C-5	Development of Reservoir	Beneficial impacts to avi-fauna	▪ Regular cleaning and maintenance of the reservoir ▪ Pasture Development and Afforestation in the reservoir surroundings	Throughout during operation phase	ADHPL EHS&S – Env Engr Environment Engineer

S.N.	Project Activities/Aspects	Associated Impacts	Mitigations – Action Plans	Timeline	Responsibility
C-6	Reduction of water flow in the stretch between diversion point to tailrace discharge in Allain stream while in Duhangan stetch between diversion point to its confluence in Beas River	Reduced flow and increased silt level during operation phase	▪ Provision of maintaining minimum recommended flow as mentioned in SN C.1 both in Allain and Duhangan streams immediately after diversion points; ▪ Sewage Treatment plant for domestic wastewater; ▪ Controlled discharge of flushing from de-silting chambers over pro-longer period or during high flow periods ▪ Provision of check walls with boulders, stones and with/ without meshes at 5 locations, check dams with boulders & stones at 4 locations and spurs at 5 locations as per details given in Catchment Area Treatment – Refer to Annex B.	Throughout during operation phase	ADHPL EHS&S – Env Engr HPPCB DFO
C-7	Illumination – provision of light along all the project component areas	Poses potential of disturbance to mammals and birds at nights	▪ Minimum light will be maintained for safe and secured project operations	Throughout during operation phase	ADHPL EHS&S – Env Engr Security Officer Safety Officer
C-8	Development of water storage reservoir and submergence area near Allain diversion point	During project operation water storage poses potential to provide breeding grounds for vector and water borne diseases – Impacts will be long term and irreversible if not controlled	▪ Provision for control of water borne diseases vectors through regular health monitoring and taking up mitigations as suggested in this ESIA ▪ Regular Cleaning and maintenance of the area to attract avi-fauna	Throughout during operation phase	ADHPL – EHS&S Health Officer I&PH Department
C-9	Community Health, Safety and Security	Projecr related health, safety and security of community	▪ A grievance redressal cell will be functional through the Project operation phase, to look at all EHS and security related issues.	Throughout during operation phase	ADHPL – EHS&S Health Officer Village communities
C-10	Wildlife Conservation and Biodiversity Developmennt	Flora and Fauna	▪ Ensuring silt levels does not increase 30% of the baseline in Allain and Duhangan streams.		

S.N.	Project Activities/Aspects	Associated Impacts	Mitigations – Action Plans	Timeline	Responsibility
			▪ All adits gates must be closed, locked and sealed throughout during operation phase. In case of any routine maitenace, all such opening should be monitored as per the details given in serial number A-39 above; ▪ Follow up Biodiversity and Wildlife Management and Catchment Area Treatment Plans.		
C-11	Disaster Management - Natural Hazards Control	Any incidence of natural hazards can hamper with local resources and affect people in the surroundings	▪ Ensuring height of the Allain barrage and the intermediate reservoir measured from the base to full reservoir level is 12m and 14m respectively. With the free board provisions, the heights are 14 m and 14.5 m respectively. Both Allain Barrage and the Intermediate Reservoir structures lie within low risk category with reference to height criteria as specified by International Commission On Large Dams. However, with reference to the water storage capacity, both Allain barrage and Intermediate reservoir having 0.125 and 0.225 million cubic meter respectively of storage capacity fall in moderate risk category of 0.1 to 1 million cubic meter capacity of International Commission On Large Dams. The measures for the safety of water storage structures include: ▪ Provision of detailed engineering by taking adequate engineering measures of earthquakes, cloudburst in the detailed engineering design aspects for project components like Allain barrage and intermediate reservoir sites. For other components also measures of landslides, avalanche, forest fires etc. will be taken up ▪ The project structures need to be verified for its designs with the highest applicable safety factor for the Himalayan Zone (Zone - V) as per the detailed findings of Roorkee University, Roorkee, on seismic impacts on tunnels as well ensuring through hydraulic model testing to confirm the safety of the water storage structures proposed for	Throughout during operation phase	ADHPL EHS&S – Env Engr Security Officer Safety Officer Emergency Response Team

S.N.	Project Activities/Aspects	Associated Impacts	Mitigations – Action Plans	Timeline	Responsibility
			the project. Company has carried out hydraulic model tests to confirm the safety of the structures. ▪ Undertake Dam Break Analysis for the impoundments to ensure safety measures are taken up prior to Project commissioning; ▪ Provision of automatic shutoff of powerhouse in case of natural calamity ▪ Provision of linkage of cut off of water flow from diversion points into the intermediate reservoir ▪ Company is to undertake regular inspection and maintenance of diversion structure safety design and appoint an independent engineer to verify design and conduct inspections during project construction phases of the project. ▪ Comprehensive maintenance inspection of tunnels for any leakage after every five years cycle. In case any leakage is noticed from outside, review the emergency situation and arrange for corrective measures accordingly; ▪ An independent-engineer will periodically report to project lenders about review findings of the safety of all structures at the design, construction and operation stages. ▪ Regular education to downstream users or likely affected people about do's and don'ts in case of any mishap. ▪ Provision of warning system for any major release due to any natural hazard/accident ▪ Company will ensure a well-rehearsed emergency response plan to be in place before project commissioning with mechanisms of mock trials for regular checks and controls to effectively meet any emergency.		
D	Decommissioning/Abandonment				
D-1	Decommissioning / Abandonment	Restoration of Project Area and Alain and Duhangan	▪ Conduct detailed ESIA for decommissioning of the Project;	Decommissio ning phase	ADHPL – EHS&S Civil Engineer

S.N.	Project Activities/Aspects	Associated Impacts	Mitigations – Action Plans	Timeline	Responsibility

	Restoration of Area	Channels	▪ Obtain environmental clearance and related approvals prior to decommissioning from HPPCB and MoEF and other agency to be inforce at that point of time;
			▪ Develop Decommissioning Environmental and Social Management Plan (DESMP) to include the following:
			  ▪ Dewatering and desilting plan (of water storages);;
			  ▪ Original flow restoration plan (in Allain and Duhangan streams);
			  ▪ Tunnels closure plan i.e. to plug the tunnels;
			  ▪ Dismantling plan for structures of Project components;
			  ▪ Waste management plan;
			  ▪ Land transfer plan (to include transfer of forestland back to forest department, roads to local administration, other areas to local community etc. in consultation with local administration and respective Panchayats of villages Prini and Jagatsukh); and
			  ▪ Landscape development plan (by revegetating forest and open land in consultation with the forest and horticulture departments) of the Project ;
			▪ Develop and implement Post Decommissioinng Monoitoring Plan;
			▪ Remove sediments and dispose of properly
			▪ Demolish intermediate reservoir/ dam structures. Keep an option of converting intermediate reservoir back to an agricultural field or re-vegetate in discussion with the local administration and or
					Contractor
					Safety Officer
					Env Engr.
					DFO
					I&PH
					LADC
					HSPCB
					MoEF

S.N.	Project Activities/Aspects	Associated Impacts	Mitigations – Action Plans	Timeline	Responsibility
			divisional forest department. ▪ Re-vegetate exposed areas at Allain barrage and Duhangan weir sites ▪ Plug tunnels/adits/surge shaft ▪ Ensure implementation of post project monitoring plan for annual inspection of the Project components including tunnels/adits plugged.		
D-2	Loss of Jobs/economic dependence	Socio-economic	▪ Prepare a demobilisation plan and communicate to the employees/sub contractors/community dependents (for their livelihood on the Project); ▪ Ensure implementation of statutory provision in force at the time of decommissioning ▪ Work with affected employees/community to find alternative income generation resources and develop a post project community development plan.	Decommissioning Phase	ADHPL Repective Village Community Project Employees Local Administration

8.12 *ENVIRONMENTAL & SOCIAL CONTROL & MONITORING PROGRAMME*

ADHPL has established EHS&S Department for management of mitigations and monitoring for environment and social issues as well as for ensuring proper implementation of the public consultation and disclosure programmes and the rehabilitation action plan/community development plan. The functions of the Department include the following:

- Overseeing implementation of social and environment mitigations and action plans.
- appointing an independent Monitoring and Evaluation agency
- establishing village development funds with 50% contribution from the project in each of the villages where the CDP will be planned and implemented.
- monitoring of RAP activities.
- addressing grievances not addressed by the project office
- Ensuring that the RAP and ESMP is implemented in accordance to the guiding policies of ADHEP and IFC
- Arranging training programmes for officers to be involved in the RAP and RAP.
- Developing corporate linkages with financial institutions and banks to facilitate financing of income generating schemes for the PAFs.
- Complying with stipulated conditions by the regulatory agencies and reporting of the same as per the specified period.
- Undertaking mid term corrective actions, if required.

8.12.1 *Grievance Redressal Mechanism*

The RAP includes a mechanism to ensure that entitlements are effectively transferred to the beneficiaries and there is proper disclosure of information and consultations with the affected community. However there is an additional need for an effective and efficient grievance redressal mechanism which will respond to people's queries and problems and address key issues, concerns and complaints.

A Grievance Redressal Cell has been established in the Project/ Field Office. It consists of the Manager (Social and Environment), CLO, 1 member of the Land Acquisition cell, Manager of the concerned project site and two key district government representatives (if possible the Additional District Magistrate or ADM and the local patwari). While the representation from district officials is not mandatory, it is definitely a preferred situation as they would be able to swiftly handle grievances related to land acquisition and legal claims.

The GRC looks into complaints and concerns about ownership disputes, inheritance of assets, distribution of compensation among heirs, missing affected assets and persons in the census etc. The procedure do not replace existing legal processes but, based on consensus, seeks to resolve the issues quickly in order to expedite the receipt of compensation, without resorting to expensive and time-consuming legal actions.

In addition to the above, if there are any grievances related to environmental management issues in the project area, the GR cell records these grievances and suggestions and pass it on to the Environmental Engineer and the Manager (Environment and Social) in the project site for necessary action in consultation with the higher management (General Management).

The GRC meets every month. At every meeting it summarises the issues raised in the last meeting and report on action taken against each of the issue. Issues that cannot be resolved at the GRC are to be referred to the responsible General Manager in the corporate office for resolution. The PCDP informs the PAFs of the GRC structure and processes and encourage PAFs to approach this cell with their problems and suggestions.

Once the construction phase is over, the GRC will continue to operate throughout the life of the Project.

ADHPL constituted a grievance redressal cell as per its office order dated 23 May 2004. The Company also released an office order for Indpendent Appeal Mechanism as per its office order dated 24 June 2004. (Refer to *Annex I*)

8.12.2 Monitoring & Evaluation

Internal and external monitoring is proposed in the project. Internal monitoring of the suggested mitigations, RAP & CDP implementation is the responsibility of the EHS&S Department. This DGM EHS&S regularly interacts internally with the Environmental Engineer for the mitigations and Community Liaison Officer for the RAP and reports to the President. The department has prepared formats for monitoring both social and environment mitigation and action plans. These formats are to be duly filled every month by respective cells and reports are collated and circulated.

It is important to note that the internal and external monitoring and evaluation will be an ongoing process and will continue to remain effective even after the construction is over.

A) Internal Monitoring

Aa) EHS & S Cell

The EHS & S cell of the Project prepares a formal report on environmental and social management and mitigation for review by the President on Monthly basis. Reports on any urgent or significant issues may be prepared at shorter intervals. Apart from responsibilities listed above, the cell has the responsibility of the following:

- Regular monitoring of water, air and noise quality within and outside the project component areas;
- Implementation of the control and protective measures;
- Implementation of Catchment Area Treatment Plan;
- Co-ordination of the environment related activities within ADHEP;
- Collection of the statistics of health of workers;

- Afforestation including nursery management;
- Awareness and implementing safety programmes; and
- Monitor the progress of implementation of ESMP.

Ab) Rehabilitation and Community Development (R&CD) Cell

The R & CD cell will regularly monitor the following:

- Review of schedule integrating land acquisition and RAP and CDP implementation
- Census of PAFs to fix cut-off dates for identification of PAFs.
- Delivery of compensation and rehabilitation assistance
- Consultation and public disclosure programme
- Setting up and functioning of the GRC
- Valuation of assets, land and trees.
- Determining the market value or replacement costs.
- Preparation of individual entitlement packages
  Effectiveness of land purchase and tree shifting assistance etc.

B) External Monitoring and Evaluation

Ba) Resettlement Action Plan

Monitoring

The external monitoring of the process will be conducted by an independent agency. The agency, besides reviewing some of the issues being covered under the internal monitoring will also assess/evaluate:

- Adequacy of compensation
- Adequacy of project staff and training programmes,
- Effectiveness of the EAP implementation
- Effectiveness of the GR mechanisms.
- Transparency of the entire process etc.
- Consultation and participation of stakeholders, specially women
- Process and effectiveness of income restoration programmes (numbers that availed the assistance, kind of skills and programmes people opted for, availability of micro-credit and loans, training, present status etc.)

Employment opportunities created and availed of.

- Specific opportunities for women

Evaluation

There will be a mid-term at the end of one and a half years and an ex-post evaluation of the implementation of the RAP at the end of three years. On both occasions, a comprehensive socio-economic survey of the PAFs will be conducted. The results of these surveys will be compared to the baseline information obtained from the census survey conducted before the rehabilitation process commenced, to gauge the effectiveness of the R&R process over time. The socio-economic surveys will verify, among others:

- Effectiveness of the Rehabilitation assistance
- Income and living standards of PAPs (before and after rehabilitation
- Effectiveness of various institutional arrangements made for the project
- Quality of interaction between project proponents and local communities.
- Opinions and perception of local communities regarding the project and project people.
- Issues such as sense of security among people, disruption in lifestyles, in –migration, pressures on local infrastructure

Effectiveness of Action Plans

ADHPL will evaluate the effectiveness of specified Action Plans as detailed in *Annexes B* and **C** as well management of suggested mitigation measures, periodical monitoring of the important environmental and social parameters on annual basis. The schedule, duration and parameters to be monitored are shown in the *Table 8.2*.

Table 8.2 Monitoring Schedule and Parameters

S.N.	Description of Parameters	Schedule and duration of monitoring
1. Air Quality (SPM, RPM, CO, SO_2, NOx)		
1.A	In the vicinity of the villages Hamta, Jagatsukh (near proposed colony) and Prini (near camp sites)	One sample over 24 hours continuous duration, twice a week on a quarterly basis except during monsoon & Snowfall.
1.B	In the surrounding areas near Reservoir (village Hamta) and Switchyard site near village Prini	One sample over 24 hours continuous duration, twice a week on a quarterly basis except during monsoon & Snowfall.
2. Water Quality		
2.A	Treated Wastewater quality generated from Workshop and STP	Twice a week for selected parameters like, pH, TSS, TDS, COD, BOD and Oil and Grease. The detailed analysis should be carried out once in three months.
2.B	Surface & groundwater quality in the vicinity of the downstream Allain and Duhangan streams and nearby springs for groundwater quality as per Drinking Water Standard IS: 10500 :1991, as re-confirmed in 2002.	Once in three months.
3. Ambient Noise		
3.A	Ambient Noise level at the locations of ambient air quality	Quarterly
4. Ecological Resources		
4.A	Inventory of flora and fauna at intermediate reservoir and along Allain and Duhangan streams	Once in two years in project monitoring area
5. Soil Quality		
5.A	Soil quality at all the locations	Once a year on all reclaimed

S.N.	Description of Parameters	Schedule and duration of monitoring
	reported under baseline	areas and adjoining villages

In addition to the above, all conditions specified by the regulatory bodies governing environmental control and monitoring required during operational phase are listed below:

Monitoring by HPPCB and Department of Environment & Science and Technology, Government of H.P.

The conditions of Consent for Establishment under the Air and Water Acts and Authorisation under the Hazardous Wastes Management and Handling Rules will be complied by the project during construction phase.

The conditions of Consent to Operate under the Air and Water Acts will be complied. The project will also comply, monitor and report to HPPCB (including conditions issued under the Environment Clearance) the following during operational phase of the project:

- Maintenance of requisite percentage of water flow downstream of the diversion works in order to maintain the riverine ecology and furnish basis of arriving at this percentage.
- Monitor the impact on macro-invertebrates with diversion of the flow and also correlate it with maintenance of a minimum percentage of water flow downstream of the diversion works.
- Get a third party post environmental monitoring of the project in order to assess the implementation of various components of EMP including CAT plan.
- Department of Environment and Scientific Technologies, Govt. of Himachal Pradesh will monitor directly the implementation of EMP and the projected expenses of Rs. 5.0 Million will be borne by ADHPL.

Ministry of Environment & Forests (Forest Clearance)

The project will comply, monitor and report to MoEF the conditions issued under the Forest Clearance (both during construction and operational phases) as per the following details:

- Annually furnishing of progress on compliance of all the conditions specified in the Forest Clearance to Regional Office of MoEF at Chandigarh.
- Complying with all the conditions which the State Government or Conservator of Forests (Central), Regional Office-Chandigarh may stipulate from time-to-time in the interest of conservation, protection or development of forests.
- Provide full co-operation, facilities and documents/data during inspection by officials from Regional Office MoEF (Chandigarh), who would be monitoring the implementation under the Forest (Conservation) Act;

Ministry of Environment & Forests (Environmental Clearance)

The project will comply, monitor and report to MoEF conditions issued under the Environment Clearance (both during construction and operational phases) as per the following details:

- Six monthly monitoring reports to the Ministry and its Regional Office, at Chandigarh for review;
- Complying with all the conditions which the State Government, Regional Office-Chandigarh may stipulate from time-to-time in the interest of environment protection;
- Provide full co-operation, facilities and documents/data during inspection by officials from Regional Office MoEF (Chandigarh), who would be monitoring the implementation of environmental safeguards.

8.12.3 Reporting

RAP

The internal monitoring process will share its findings through monthly monitoring reports in the first year of the project, which it will share with the Manager (Social and Environment). All the reports on the Social and Environment development from EHS&S department are submitted to IFC on quarterly and annual basis.

The external monitoring for Resettlement Action Plan will be held every quarter during the implementation process. Evaluations will be conducted once in mid term (1.5 years) and once at the end of the rehabilitation process (3 years). The reports will be shared with the corporate office and IFC

ESMP and Action Plans

For effective implementation and mid-term corrective measures, if required, monitoring and control of programme implementation are essential ESMP and action plans, external auditing will be carried out half yearly during the construction phase. All the reports on Social and Environment development from EHS&S deptt. are submitted to IFC on quarterly and annually basis. During Operation phase, the external auditing can be done on an annual basis.

8.13 ENVIRONMENTAL AND SOCIAL COMMITMENTS

ADHPL will continually work to meet all identified environmental and social commitments. The identified commitments will be reviewed on six monthly basis by senior Project team with the support of external consultant(s). The identified environmental and social commitments are presented in ***Table 8.3.***

Table 8.3 Environmental & Social Commitments by the Project

S. N.	Issue	Commitment (as per Addendum to ESIA, Sep '04)	Responsible Parties	Remarks
1	Public Consultation And Disclosure Plan	The Project will disseminate project documents in both Hindi and English.	ADHPL	As part of ongoing process – throughout the Project life cycle. ADHPL will maintain the following: Ensure ESIA copies are available for public access; Ensure a public consultation calendar is made every year for scheduled consultations with the communities
		Will hold focus group and public meetings facilitated by independent specialists.	ADHPL	Public disclosure events were organized for the Project as per ESIA addendum.
		Will set up social management cell at the project office to implement the various plans.	ADHPL	ADHPL to ensure functioning of the social management cell
2	Acquisition of private land & Rehabilitatio n Action Plan (RAP)	Company will deposit land compensation packages with the local Land Acquisition Officer, as directed by the Himachal Pradesh state government, who will then disburse these packages to affected landowners.	ADHPL, Local Land Acquisition Officer	ADHPL to ensure compliance as per its commitment registere as communicated earlier on 1 November 2007
		In accordance with RAP provision, the company will provide a project-affected people's transitional allowance at Rs. 2000 per month for one year.	ADHPL	ADHPL to ensure compliance as per its commitment registere as communicated earlier on 1 November 2007
		Families losing more than 75% of their land after acquisition will be provided an option of cash compensation or an alternative land equivalent in size, value, and quality to what they are losing. The company will seek the assistance of the revenue department of the Himachal Pradesh State Govt. for this purpose.	ADHPL	ADHPL to ensure compliance as per its commitment registere as communicated earlier on 1 November 2007
		In accordance with RAP provision, the company will build capacity for income generation.	ADHPL	Ensure ongoing benefits to villagers as per commitment register.
		In accordance with RAP provision, the company will implement a community development program using a participatory approach.	ADHPL	ADHPL to ensure compliance as per its commitment registere as communicated earlier on 1 November 2007
		In accordance with RAP provision, the company will establish a Monitoring & Evaluation Cell for monitoring of RAP.	ADHPL	As above

S. N.	Issue	Commitment (as per Addendum to ESIA, Sep '04)	Responsible Parties	Remarks
		Company will provide "rehabilitation assistance including skill development family members above 18 yrs have been considered as a separate unit."	ADHPL	As above
		The company will provide a budget of Rs 50.1 Lakh for RAP.	ADHPL	As above
		All monitoring under the Environmental & Social Management & Monitoring Plan will be participatory and will include representatives of the affected villages.	ADHPL	As above
3	Availability of previous ESIA reports	Copies of previous ESIA reports prepared by RITES in 1996 and updated by the company in 2001 are available at the project office in Prini.	ADHPL	As above
4	Impact Assessment Of 185 km Transmission Line from switchyard at Prini to Nalagarh	After finalization of pooling point by Power Grid Corporation of India, a detailed ESIA shall be carried out.h	ADHPL	Impact assessment already done, ADHPL can ensure its availability at the site.
5	Financial Res-ponsibilities to Local Govts. and Individuals	The company will make payments for works within the state of Himachal Pradesh and deposit the tax deducted at source with the Income Tax Dept. Offices located in Himachal Pradesh.	ADHPL	ADHPL to ensure compliance of the requirement
		The company will be fully responsible for any damage or loss arising out of the construction, operation, or maintenance of the project to any property or person.		ADHPL to ensure compliance as per its commitment registere as communicated earlier on 1 November 2007
	Drinking & Irrigation Water	There will be no disturbance to the Chor Pani drinking water source.		ADHPL to ensure regular monitoring
		Impacts to the Chor Pani source will be monitored jointly with the community.	ADHPL and Community	ADHPL to ensure compliance as per its commitment registere as communicated earlier on 1 November 2007
		There will be no disturbance to the Pahali drinking water source.		ADHPL to ensure compliance as per its commitment registere as communicated earlier on 1 November 2007. ADHPL to also ensure periodical monitoring of flows of the Pahali stream and make them available for access by communities.

S. N.	Issue	Commitment (as per Addendum to ESIA, Sep '04)	Responsible Parties	Remarks
		Impacts to the Pahali source will be monitored jointly with the community.	ADHPL and Pahali Community	As above
		There will be no disturbance to the Chor Pani drinking water source.	ADHPL and Jagatsukh village community	ADHPL to half yearly review the source.
		Impacts to the Chor Pani source will be monitored jointly with the community.	ADHPL and Jagatsukh village community	ADHPL to ensure compliance as per its commitment registere as communicated earlier on 1 November 2007.
		There will be no disturbance to the Jamlu Devta drinking water source.	ADHPL	As above
		Impacts to the Jamlu Devta source will be monitored jointly with the community.	ADHPL and community	As above
		There will be no disturbance to any of the existing irrigation water sources in Prini.	ADHPL	As above
		In the event of any disturbance to drinking water sources the company will provide sufficient water of potable quality to cover the gap to the affected community.	ADHPL	As above
		In the event of any disturbance to the quality or quantity of surface and/or groundwater, the company will respect the riparian rights of users and compensate accordingly.	ADHPL	As above
		The company will install mechanical and electronic flow measuring devices to monitor flow of water for downstream users.	ADHPL	ADHPL to ensure flow measurements for downstream Allain, Duhangan, Kala Nala and Pahali stream at least once a week for 24 hours and make the results available for access by community
		Town & Country Planning Dept. letter dated 17 June 2002 has confirmed a water requirement of 100 LPS (litres per second) for Allain & Duhangan streams. Company has agreed to ensure that the project releases a minimum discharge of 150 LPS from the Duhangan barrage, if necessary, even at the cost of generation. In addition, the downstream tributaries of Duhangan add a minimum of 360 LPS of water, making a minimum water to be available downstream to be 510 LPS.	ADHPL	ADHPL to ensure compliance as per its commitment registere as communicated earlier on 1 November 2007.

S. N.	Issue	Commitment (as per Addendum to ESIA, Sep '04)	Responsible Parties	Remarks
7	Forests	Compensatory afforestation as approved by Govt. of India (GOI) will be carried out.n Company will deposit money for compensatory afforestation with the Govt. of Himachal Pradesh for 64.334 ha of degraded forest land.	ADHPL Forest Deptt.	As above
		Catchment Area Treatment (CAT) Plan, as approved by the MoEF GOI and the State Forest Dept., along with detailed budget, will be developed.	ADHPL Forest Deptt.	As above
		GOI has approved diversion of 32.167 ha of forestland for the project	ADHPL Forest Deptt.	As above
		1352 trees have been enumerated for felling for the Project.	ADHPL Forest Deptt.	As above
		Only the Mohru trees that have been approved and have been marked for felling by the Himachal Pradesh State Forest Dept. will be removed.	ADHPL Forest Deptt.	As above
		Company will pay compensation against loss of environmental value (loss of trees) at the market rate to the Himachal Pradesh State Govt.	ADHPL Forest Deptt.	ADHPL to ensure compliance as per its commitment registere as communicated earlier on 1 November 2007.
		Provision of an estimated Budget of Rs 39.8 million for CAT plan covering cost of afforestation of 800 ha, pastureland development of 200 ha, engineering measures like check dams, spurs etc. and their maintenance. The funds will be provided in a phased manner over seven years.	ADHPL Forest Deptt.	ADHPL to ensure compliance as per its commitment registere as communicated earlier on 1 November 2007.
		AD Hydro memo (Dec 09, 2006) reports that company has deposited, to date, 6.16 Rs. Crores with Himachal Pradesh State Forest Authorities for the CAT plan. The company will carry out tree felling on the basis of GOI's approval. The tree felling will be done by the Himachal Pradesh State Forest Dept.	AD Hydro and GOHP Forest Dept.	As above.
		Joint Monitoring Committees will be constituted by the Govt. for ensuring implementation of CAT plan and compensatory afforestation program.	AD Hydro and GOHP and Communities	As above

S. N.	Issue	Commitment (as per Addendum to ESIA, Sep '04)	Responsible Parties	Remarks
		The company will request the Govt. to include a provision for local participation in the monitoring of the felling and compensatory afforestation program.	AD Hydro and Govt.	As above
		As a part of the company's community development support, local afforestation activities will develop their own nurseries and carry out plantation in agreed areas.	AD Hydro and Communities	As above
8	Fuel wood for force	Labour contracts will contain conditions to ensure that illegal felling is not done by the contract labour.	AD Hydro and subcontractors	As above
		Provisions for use of kerosene oil or LPG as the primary fuel by the labour. This will be the contractor's responsibility and included in the Contract.	AD Hydro and subcontractors	As above
		Use of fuel wood as secondary option. This will be sourced from the Himachal Pradesh State Forest Dept. and records of procurement and distribution for use will be maintained by the contractor.	AD Hydro and subcontractors	ADHPL to ensure supply of free fuel wood to the labourers as committed in the commitment register on 1 November 2007.
		All contractors will be bound through contractual provisions to observe Environmental, Health and Safety regulations of the company, including compliance with conditions regarding no-illegal felling of trees for meeting fuel wood requirements. Violations of these regulations will result in fines.	AD Hydro and Subcontractors	ADHPL to ensure compliance by the contractors through contractual obligations with the contractors.
9	Access to and impact on pastureland	The company will deposit Rs. 19,000,000 with the State Govt. for pasture development in Sathan, Pahali Nallah, Hamta Garh, Tangra/Chikka Springs, and upstream of storage reservoir to be distributed over seven years, as outlined in CAT.	AD Hydro and Himachal Pradesh State. Govt.	ADHPL to follow with the H.P. Forest Department to develop the pasture in Sethen, Pahali Nalla, Hamta Garh, Tangra/Chikka Spring and upstream of reservoir. ADHPL to ensure compliance as per its commitment register.
		The company will ensure that access to pasture land is maintained through the construction and later during the operation phase of the project.	ADHPL	ADHPL to ensure compliance as per its commitment registere as communicated earlier on 1 November 2007.
		Any footpath damaged during the construction of the roads will be repaired.	ADHPL	ADHPL to repair of damaged footpath and ensure compliance by the contractors through contractual obligations with the contractors.

S. N.	Issue	Commitment (as per Addendum to ESIA, Sep '04)	Responsible Parties	Remarks
		Appropriate steps will be provided in the retaining wall structures to facilitate movement of people and livestock to the pastures.	ADHPL	Ensure periodical maintenance of stair cases, retaining walls and movement of livestock through out the Project life in consultation with the village community.
		Ramps will be provided where necessary (temporary or permanent) with slopes appropriate for animal movement.	ADHPL	As above
		Realigning road where feasible.		Reportedly, roads have been realigned wherever possible to save some trees from felling.
		Enhance existing degraded pasturelands by restoring degraded areas in consultation with the community.	ADHPL	ADHPL to ensure afforestation amd restoration of degraded areas in consultation with the village community.
		Develop 30 ha. of pasture in Sathan, as identified in the CAT plan with the help of State Forest Dept.	AD Hydro and State Forest Dept.	Ensure implementation of CAT plan for the Pasture development
		Develop 20 ha. of pasture in Pahali Nallah, as identified in the CAT plan with the help of State Forest Dept.	AD Hydro and State Forest Dept.	As above
		Develop 30 ha. of pasture in Hamta Garh, as identified in the CAT plan with the help of State Forest Dept.	AD Hydro and State Forest Dept.	As above
		Develop 30 ha. of pasture in Tangra/Chikka Springs, as identified in the CAT plan with the help of State Forest Dept.	AD Hydro and State Forest Dept.	As above
		Develop 90 ha. of pasture upstream of reservoir, as identified in the CAT plan with the help of State Forest Dept.	AD Hydro and State Forest Dept.	As above
10	Muck Disposal	Muck will not flow during rains because catchment and toe drains will carry excess water to natural streams.	ADHPL	Ensure compliance when required maintenance to be taken up to avoid incidence of failure of muck disposed areas.
		Muck from the Allain and Duhangan Head Race Tunnels will be disposed in muck Disposal Site. No. 1 near Hamta.	ADHPL	As above
		Reuse of minimum 30% of muck, disposal as per Muck Disposal Plan, proper staking and compaction of muck and spoil, afforestation and landscaping of filled muck sites.y	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007

S. N.	Issue	Commitment (as per Addendum to ESIA, Sep '04)	Responsible Parties	Remarks
		Temporary muck dumping site to be provided with adequate safeguards – location compatibility with topography, retaining wall of suitable material with adequate weepholes.y	ADHPL	As above
11	Impact on wildlife habitat and flora	World Pheasant Association (WPA), will carry out three seasons monitoring to establish baseline for terrestrial flora and fauna studies.	ADHPL	Refer to Revised and Updated ESIA and its Annex G
		Maintenance of minimal light to avoid disturbance to night animals/birds, if any, and for safe and secured project operations.	ADHPL	Ensure minimal light is maintained in the night at all possible areas and for safe movement of traffic in the nights, fluorescents stickers on the roadside railings and delineators are fixed.
		The contractors and their employees will be bound through contractual provisions to observe environmental, health and safety regulations of the company, and those who hunt or gather and otherwise disturb wildlife and vegetation in the project area will be fined heavily leading to cancellation of contracts.	AD Hydro and Subcontractors	Ensure compliance as committed in commitment register of 1 November 2007
12	Impact on fisheries	It is already recommended that minimum flows shall be maintained downstream of diversion structures for sustenance of any aquatic ecology downstream.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		A Fisheries Monitoring Plan will also be implemented during the construction and operation phases.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		Although no fish were found in fish catch attempts in Allain and Duhangan streams, a 12 month aquatic/riverine biodiversity study will be carried out by the Foundation for Ecological Security (FES).	ADHPL	Refer to Revised and Updated ESIA and its Annex H
		The company will implement the recommendations of FES.	ADHP:L	Refer to Revised and Updated ESIA and its Annex G

S. N.	Issue	Commitment (as per Addendum to ESIA, Sep '04)	Responsible Parties	Remarks
13	Potential "shrinkage" of glaciers not considered	"The likely emissions of green house gases from the project is limited to construction phase that too during power interruption from the state electricity supply whendiesel generators are run to meet construction power requirement. The operation phase of the project will actually result in saving fossil fuel emissions due to combustion of over 40 tonnes per hour of fuel oil equivalent to generate 192 MWh of power. Thus the proposed hydropower project does not have global warming concerns. Further, the diversion structures at Allain and Duhangan streams are at a much lower elevation than the glaciers.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
14	Women's safety and Security	The company will fund a police station to be set up at village Prini.	ADHPL Local Administration	Ensure compliance as committed in commitment register of 1 November 2007
		Company will provide security staff at all project component sites. Security Staff will have instructions to ensure women's safety.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		Provision of security will also be considered at additional locations if requested by the villagers.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		Separate colony for labour force with segregated facilities and regular checks to monitor the same.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		The Govt. will be requested to depute women police staff at the Prini Police station to register local complaints related to women. It is suggested that the GRC will liaise with the Police Station to monitor complaints relating to women's security in particular	AD Hydro and GOI and local police	Ensure compliance as committed in commitment register of 1 November 2007
		All contractors will be bound through contractual provisions to observe environmental, health and safety regulations of the company, including compliance with local security requirements. Violations of these regulations will result in fines and/or cancellation of contracts.	AD Hydro and subcontractors	Ensure compliance as committed in commitment register of 1 November 2007
15	Influx of labour force in the area	In Prini, the company will give contractors direction to prevent their labourers from entering villages unnecessarily.	AD Hydro and contractors	Ensure compliance as committed in commitment register of 1 November 2007

S. N.	Issue	Commitment (as per Addendum to ESIA, Sep '04)	Responsible Parties	Remarks
		The Construction Labour Management Plan will address laborers' accommodations, laborers' fuel use, and health management issues.	ADHPL Contractors	Ensure compliance as committed in commitment register of 1 November 2007
		Labor camps will be set up catering to all migrant labor force. This should be located at a suitable distance from the nearest settlement. This clause will be included in the contract.ee	AD Hydro and Subcontractors	Ensure compliance as committed in commitment register of 1 November 2007
		The contractors will be required to provide civic amenities for construction labor including toilets and sewage collection systems.	AD Hydro and subcontractors	Ensure compliance as committed in commitment register of 1 November 2007
16	Solid waste disposal	Identification of all solid waste generation sources. All biodegradable including kitchen waste to be put into humus pit.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		Construction of toilet facilities and sewage collection & treatment systems for labor camps.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		Provision of toilets at all construction sites.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		Development of codes of practice for safety and disposal of muck and solid waste prior to taking up construction activities.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
17	Waste water treatment	Provision of treatment plants for wastewater (from camp, colony and workshop).	ADHP:	Ensure compliance as committed in commitment register of 1 November 2007
		Provision of sewage treatment plant for domestic wastewater, controlled discharge of flushing from desilting chambers.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		Regular participatory monitoring of treated water before it is discharged into disposal outlet.	ADHPL	Ensure participatory monitoring of treated water. Keep records of external sample collection and analysis. Ensure corrective action in case of sampling results show non compliance.
		Organic sludge from treatment plant will be used as manure for plantation activities around project area.	ADHPL	Water and Organic sludge from the SWRP will be used for greenery development.
18	Noise pollution and Blasting	Limiting demolition and removal of structures, if any, limited to daytime only	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		Daytime operation, regular maintenance and provision of enclosures for high noise generating equipment.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007

S. N.	Issue	Commitment (as per Addendum to ESIA, Sep '04)	Responsible Parties	Remarks
		Adoption of optimized blasting techniques and controlled traffic management to minimize noise	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		Provision of mufflers on DG sets,rubber padding of enclosure foundation of DG sets to control vibrations, optimized operation ofconstruction related machinery.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		Fleet management, vehicular traffic confined to project area.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007. Also refer to
		Limited vehicular movement during operation phase, regular maintenance of company owned vehicles.	ADHPL	Vehicular movement by the project authorities is expected to be low during operation phase. ADHPL to ensure proper maintenance and enaging only trained drivers for safe movement of vehicles.
		Provision of barrier sheets along road construction especially in areas near settlements.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		Use of specialized techniques and explosives, ground vibrations will not affect structures beyond 81 m from point of blast.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		Adoption of optimized blasting techniques using delay detonators, blasting in confined areas.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		Regular monitoring of ground vibrations will be undertaken.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		The company will intimate blast timings to villagers and ensure cattle and local people are away from the locations of blasting.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		Ground vibrations generated by blasting during tunnel excavations will not affect existing structures beyond 80 m from point of blast.	ADHPL	Ensure compliance
19	Reservoir safety	Hydraulic model testing toconfirm the safety of the water storage structures proposed for the project. The company is carrying out such hydraulic model tests to confirm the safety of the structures.	ADHPL Independent Engineer	ADHPL to ensure inclusion of Hydraulic Model Testing and Dam Break Analysis for the impoundments in the Project design before commissioning of the Project. Indpendent Engineer to verify the outcome.
		The company is to undertake regular inspection and maintenance of diversion structure safety design and appoint an independent engineer to verify design and conduct inspections during project construction phases of the project.	ADHPL Independent Engineer	Ensure independent engineer's inspections on verification of Project design

S. N.	Issue	Commitment (as per Addendum to ESIA, Sep '04)	Responsible Parties	Remarks
		An independent-engineer will periodically report to project lenders about review findings of the safety of all structures at the design, construction and operation stages	ADHPL	As above
		The company will ensure a well rehearsed emergency response plan to be in place before project commissioning with mechanisms of mock trials for regular checks and controls to effectively meet any emergency.	ADHPL	Ensure availability of Emergency Response Plan prior to commissioning of the Project. Also ensure that emergency management teams are idenfified briefed, and situations are rehearsed prior to Project commissioning.
20	Risk due to natural Hazards(earthquakes, forest fires, landslides, Etc.)	Inclusion of adequate engineering measures during detailed design and engineering of project structures to protect them from natural hazards.	ADHPL Independent Engineer	ADHPL to ensure compliance and verification their through independent engineer
		The project structures need to be verified for its designs with the highest applicable safety factor for the Himalayan Zone (Zone - V).	ADHPL Independent Engineer	As above
		The company has engaged Roorkee University to carry out studies to assess seismic impacts on tunnels.	ADHPL	Ensure the mitigations as suggested in the study are included to counter the seismic impacts on tunnels.
		The company will ensure a wellrehearsed emergency response plan to be in place before project commissioning with mechanisms of mock trials for regular checks and controls to effectively meet any emergency.	ADHPL	Ensure availability of Emergency Response Plan prior to commissioning of the Project. Also ensure that emergency management teams are idenfified briefed, and situations are rehearsed prior to Project commissioning.
21	Potential public health impacts of labor force and construction /operations (including disease transmission and air quality)	The compulsory use of all stipulated personal protective equipment.	ADHPL	Ensure personal protective equipments wherever applicable are mandatory to use. Conduct periodical safety audits.
		Health Management Plan including budgetary support.nn	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007

S. N.	Issue	Commitment (as per Addendum to ESIA, Sep '04)	Responsible Parties	Remarks
		New First Aid Centres have been made operational at Duhangan Weir Site and Hamata Potato Farm. Monthly budget for the medicines is increased to Rs. 1,70,000/- from Rs. 1,00,000/- earlier. Above budget doesn't include the expenditure incurred by our contractors such as M/s Larsen & Toubro Ltd. is spending about Rs. 60,000/- on medicines every month on the workers. Maintenance of health and settlement and provision of medical facilities for the labor force as stipulated under the Environmental Clearance		Ensure compliance as committed in commitment register of 1 November 2007
		Company will conduct regular field surveys and will takenecessary actions to curb the spread of diseases.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		Conduct community awareness programs on AIDS among villages and labour camps.	ADHPL	Ensure compliance
		Water trucks will sprinkle roads under construction to minimise dust.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		All roads will be bitumen topped.	ADHPL	Ensure periodical maintenance of roads to avoid dust generation and safe movement of Project vehicles.
		Traffic management through daily fleet management to avoid accidents and congestions at various points.	ADHPL	Ensure compliance
		Vehicles carrying construction material to be covered and use of water sprinkling.	ADHPL Sub contractors	Ensure compliance
		The company will be restricting vehicular movements at the areas other than project sites.	ADHPL Sub contractors	Ensure compliance
		The company will ensure DG sets adhere to norms specified by HP State Environment Protection and Pollution Control Board (including emission standards).	ADHPL	Ensure compliance
22	Impact on apple crops	The company will discuss crop insurance with the community during construction phase of the project.	ADHPL	Ensure compliance
		The company will help farmers relocate their trees.	ADHPL	Ensure compliance

S. N.	Issue	Commitment (as per Addendum to ESIA, Sep '04)	Responsible Parties	Remarks
		The company will compensate for standing crops on acquired private lands per Govt. guidelines.	ADHPL Local Administration	Ensure compliance
		The company will consider any and all claims of impacts on crop production for appropriate compensation through the established grievance redressal mechanism.	ADHPL Village community Local Administration	Ensure Grievance Redressal Cell (GRC) Mechanism is functional and such cases are considered as and when they arise.
	Availability of potato seeds	Project will provide seeds of similar quality to the village Panchayats, as requested.	ADHPL Village community Local Administration	Ensure compliance as committed in commitment register of 1 November 2007
		The company will make arrangements to provide potato seeds at same rate at which farmers procured it from the Hamta potato farm.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
24	Employment Opportunities	The company will stipulate in its labor contracts that preference will be given to hiring local laborers first, and then to Pahari/Nepali laborers.	ADHPL Sub contractors	Ensure compliance as committed in commitment register of 1 November 2007
		Restriction on deployment of child labor.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		Participatory approach to prepare and implement Community Development Plan.	ADHPL Vilalge community Local Adminsitration	Ensure compliance as committed in commitment register of 1 November 2007
		Employment in project to at least one member of each project affected family as per clause No.5.16 of the Implementation Agreement with the Govt of HP.	ADHPL Vilalge community Local Adminsitration	Ensure compliance as committed in commitment register of 1 November 2007
		Hiring of taxis from village where requirement and rates match with company's needs.	ADHPL Village community	Ensure compliance as committed in commitment register of 1 November 2007
25	Impact on local culture and tourism	Any damage to the trekking route due to construction work would be repaired.	ADHPL Village community Local Administration	Ensure compliance as committed in commitment register of 1 November 2007
26	Religious Sentiments	The company respects all the religious sentiments of the villagers and will discuss construction schedules along the streams with the community to flag religious and cultural sensitivities, and observe the advised safeguards as applicable and to the extent possible.	ADHPL	Ensure compliane

S. N.	Issue	Commitment (as per Addendum to ESIA, Sep '04)	Responsible Parties	Remarks
		The company will ensure that all employees and contracted staff of the project will be required to adhere to the provisions related to the World Bank policy on Cultural Property, where applicable.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
27	Availability of Education and health Facilities	The company will construct a school building on the land provided by the village Panchayat	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		The company also has a plan to set up a hospital in the village Prini. The company will build a dispensary in village Jagatsukh.	ADHPL	Ensure compliance
		The company will establish some public conveniences in Prini.	ADHPL	Ensure compliance
		Medical facilities constructed for project staff will be available to villagers.	ADHPL	Ensure compliance
		Three ambulances will be provided for urgent medical calls, including emergency calls from local villagers.	ADHPL	Ensure compliance
		Available facilities will include diagnostics, emergency operating facilities, oxygen (cylinders), fracture attendance, as well as pre-natal and post-natal care for mother and child.	ADHPL	Ensure compliance
		The company will appoint a medical officer, a compounder, a lab technologist, an epidemiologist and other health care workers to staff the facilities.	ADHPL	Ensure complianc e
28	Public access to project roads	People and vehicular movement will have full access to the project roads with the safety rider that they follow all safety rules and regulations for the construction period.	ADHPL	Ensure compliance
29	Access to cremation ground	The company has agreed to build access road to the cremation ground once the village Panchayat provides theland without trees with all statutory approvals.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
30	Provision of public lighting & electricity	In Prini, the company will provide 10 poles and tube lights for electrification of the village road.vv	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007

S. N.	Issue	Commitment (as per Addendum to ESIA, Sep '04)	Responsible Parties	Remarks
		Electrification of roads within the village shall be carried out by the company in the village as per the terms of the Agreement signed with the village Panchayat.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
31	Implementation of Environmental Action Plan	Compliance of environmental action plans under statutory approvals of the Ministry of Environment & Forests and the Himachal Pradesh State Environment Protection and Pollution Control Board.	ADHPL HPPCB MoEF	Ensure compliance
		Setting up of Environmental cell to implement, manage and monitor the environmental action plans drawn up for the project.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		The company's environmental and social programs will be evaluated by an environmental audit carried out by an independent party during the operational phase of the project.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		All monitoring under the environmental & Social Management & Monitoring Plan will be participatory and will include representatives of the affected villages.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
32	Recourse compliance Mechanism	Company will set up a Grievance Redressal Cell.zz	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
		Company will set up a separate committee, that includes representatives of affected villages, to act as an Independent Appeal Mechanism for redressing grievances and ensuring that the GRC works properly.	ADHPL	Ensure compliance as committed in commitment register of 1 November 2007
33	Recreation Grounds	The company agrees that in the event of Prini Panchayat providing land, the company will level the land so that it may be used for recreational purposes and social gatherings.	ADHPL Prini Panchayat	Ensure compliance as committed in commitment register of 1 November 2007

8.13.1 *Estimated Budget for ESMMP*

Capital Cost Estimated for ESMP: The *Table 8.4* below gives overall investment on the environmental safeguards and measuring for successful monitoring and implementation of control measures.

Table 8.4 Budget for EHS

S.N.	Budget Heads for EHS&S	Amount INR Million
A)	**Environmental Management**	
1	Pollution Control Provisions in Project Areas	
1a	Water Management and Quality including Water Lorries/Sprinklers and Effluent Treatment Plant	3.0
1b	Drainage system – Adequate Culverts and Cross Drainage along roads and places where obstruction/ diversion is taken up so as to prevent soil erosion	1.0
1c	Exhaust System for Tunnels	1.0
1d	Adequate stacks height, provision of mufflers, rubber padded foundation etc. for DG sets	0.3
1e	Sewage Treatment Plant and incinerator	2.7
2	Environmental Monitoring - Air, Water, Noise, Soil and Bio-Monitoring and related Laboratory Equipment. for In-house and external monitoring by HPPCB and other laboratories	8.6
3	Excavation Muck and Soil-Solid Waste Management i.e. Restoration of Soil Disposal Sites (Filling and redressing)	190.0
4	Environment Awareness Programme	2.0
5	Fisheries Management (For depositing with Department of Fisheries, Government of H.P. towards fisheries development)	2.0
B)	**Forest Related Management**	
1	Catchment Area Treatment (CAT) Plan -Catchment, Afforestation, Pasture Development and Civil Engineering Works	61.58
2	Cost of Soil Conservation and Reclamation Plan (i.e. for reclamation of forest resources damaged due to Project Activities. Govt. being requested to reconsider rate.)	66.82
3	Compensatory Afforestation for diversion of forest land of 47.18 ha. i.e. (32.117 ha. surface + 5.512 ha. underground area + 8.87 ha surface + 0.68 ha underground) including additional compensatory afforestation	6..68
4	Loss of Environmental Value (or Net Present Value) of 32.167 / 47.18 ha of forest land proposed to be diverted for the project (Original Net Present Value was paid for 37.629 Ha of land @ Rs. 920000/Ha. The requirement of land now has increased up to 47.179 Ha, thus increasing by 9.55 Ha. Therefore, NPV for 9.55 Ha. needs to be deposited @ Rs. 991000/Ha.)	46.75
5	Cost of Fence Post for compensatory Afforestation (Includes cost for 37.629 Ha + 9.55 Ha of forestland) and additional compensatory afforestation)	1.80
6	Cost of Trees [includes amount of INR52.892 million (for 1370 trees & 2586 sapling) + 20.032 million (for increased no. of trees increased due to realignment and damages to trees on the slopes for the construction of Duhangan road i.e. cost of 376 trees and 140 saplings.]	72.92
7	Additional amount paid to H.P. Forest Department for loss to forest resources during construction activities	69.40
8	Provisions of Fuel wood	5.0
C)	**Health Management**	
1	Health Management Plan - Health Facilities (Provisions of Hospital at Prini, dispensary at Jagatsukh, Medicines	27.15
2	Health awareness programmes and preventive measures for	
D	**Community Development**	

S.N.	Budget Heads for EHS&S	Amount INR Million
1	Additional plantation of trees by ADHPL in the areas available in project, in association with women groups of affected villages.)	15.00
2	Transition Allowance (Earlier transition allowance @ Rs. 2000/- per family for 1 year was allocated. However, later no family was required to transit from the original location.)	1.20
3	Start-Up-Assistance (Start up assistance provided in terms of jobs and contract provided on priority in the project.)	0.03
4	Tree Shifting Assistance (Tree Shifting assistance provided in terms of cost of trees as agreed by villagers.)	0.28
5	Income Restoration Assistance (Income restoration provided in terms of jobs and contract provided on priority to the affected villagers in the project.)	0.70
6	Community Development Plan (Community development plan is being conducted in consultation with Panchayat of the concerned village. Budget increased in view of needs of the villages.)	22.00
E	**Safety Management**	
1	Technical Assistance (Training, Advisors etc.)	2.80
2	Provisions of Emergency response planning	
3i	Water Hydrant system	1.00
3ii	Other Safety Provisions	0.50
4	Safety equipment - safety alarm system, siren, megaphone, hard hats, boots, rescue, hiring of external agency for implementation of safety norms.	10.00
	TOTAL	622.21

The estimated budget for ESMP would be Indian Rupees 622.21 million excluding the cost of land acquisition. The budget does not include many of the measures, which are integrated by ADHPL in the Project Cost.

9 CONCLUSION

9.1 REVISED & UPDATED ESIA PREPARATION

This revised and updated ESIA study has assessed the potential environmental and social impacts that could arise from the ADHEP being set up in Manali, Himachal Pradesh.

The revised and updated ESIA has been prepared to meet the requirements of IFC Performance Standards for environmental sustainability.

The revised and updated ESIA includes the prevailing baseline conditions, impact assessment, mitigation measures and environmental and social management plan. Inputs were taken up from specialsied studies conducted over one year period on a) Wildlife and Flora in the Project catchment area by the World Pheasant Association, New Delhi; and b) Riverine Ecology including Fish Fauna by Foundation for Ecological Security, Pithoragarh.

9.2 POTENTIAL IMPACTS & CONSULTATIONS

The revised and updated ESIA has undertaken a process of identification of all potential impacts and assessment of their significance against a structured set of criteria that have been developed for this Project.

As part of the Project development various consultations and focus group discussions were carried out by the Project and independent observers. The ESIA process has resulted in development of various issues as specified in the ESMP. ADHPL will continually work to meet all identified environmental and social commitments. The identified commitments will be reviewed on six monthly basis by senior Project team with the support of external consultant(s).

9.3 MITIGATION MEASURES & MANAGEMENT PLANS

Mitigations measures have been suggested in the ESMP for entire Project life cycle. The impacts and associated mitigation measures identified through the revised and upadated ESIA process will be implemented and managed through design processes as well as EHS&S management systems to achieve the desired objectives. Where it is not possible to "design out" impacts, the requirements for mitigating the impacts are carried through to the management plans to be implemented during construction phase and throughout the life of the Project. Management plans that have been developed for implementation by the Project included the following:

- *Construction Labour Management Plan (Annex B-1);*
- *Traffic Management Plan (Annex B-2);*
- *Muck Disposal Plan (Annex B-3);*
- *Health Management Plan (Annex B-4);*

- *Construction Demobilisation Plan (B-5);*
- *Resettlement Action Plan (RAP) (Annex C-1);*
- *Indigenous People's Development Plan (IPDP) (Annex C-2);*
- *Community Development Plan (Annex C-3);*
- *Biodiversity & Wildlife Management Plan (Annex C-4:);*
- *Catchment Area Treatment Plan (Annex C-5);*
- *Minimum Water Discharges & Fisheries Monitoring Plan (Annex C-6);*
- *Emergency Response Plan (Annex C-7);*
- *Desiltation Management Plan (Annex C-8)*

ADHPL will follow the management plans as detailed in this revised and updated ESIA report together with conditions of Forest Clearance, Environmental Clearance, Consent to Establish, Consent to Operate and other necessary permit requirements.

ADHPL will continually remain engaged with the affected village communities as per the structured programme. Greivance Redressal Cell will actively work for the redressal of grievances of the community throughout the life of the Project.

The inspections and audits will be done by trained team of ADHPL's Environment, Health, Safety and Social (EHS&S) Department as well subject to be reviewed and conducted by external agencies/experts. The entire process of inspections and audits will be documented and findings will be implemented.

Upon achieving life of the Project, the Project decommissioning will be subject to prior ESIA, necessary approvals and plans as described in the ESMP.

ADHPL will ensure required Dam Break Analysis for implementation and verification of design aspects of the Project components. Periodical internal and external monitoring requirements and inspections by indpendent engineer will be ensured up by ADHPL.

ADHPL will prepare an ESIA for Project decommissioning related activities after completion of Project life. Necessary prior statutory approvals will be obtained.