Environmental Assessment Report

Summary Environmental Impact Assessment
Project Number: 41627
August 2009

India: Himachal Pradesh Clean Energy Development Investment Program
(Sainj Hydroelectric Project (100 MW) and Kashang Integrated Stage II and III Hydroelectric Project)

Prepared by Himachal Pradesh Power Corporation Limited (HPPCL), Government of Himachal Pradesh, for the Asian Development Bank (ADB)

CURRENCY EQUIVALENTS

(as of 01 August 2009)

Currency Unit	–	Indian Rupees (INRs)
INRs1.00	=	$.0208
$1.00	=	INRs 48.06

ABBREVIATIONS

ADB	–	Asian Development Bank
BOD	–	biological oxygen demand
CAT	–	catchment area treatment
CDM	–	Clean Development Mechanism
CO_2	–	carbon dioxide
CPCB	–	Central Pollution Control Board
EIA	–	environmental impact assessment
EMP	–	environmental management plan
ESMU	–	environment and social management unit
GHNP	–	Greater Himalayan National Park
GOHP	–	Government of Himachal Pradesh
GRC	–	grievance redress committee
HEP	–	hydroelectric project
HPPCL	–	Himachal Pradesh Power Corporation Limited
HPSEB	–	Himachal Pradesh State Electricity Board
HPSPCB	–	Himachal Pradesh State Pollution Control Board
HRT	–	headrace tunnel
IEE	–	initial environmental examination
LADC	–	local area development committee
MOEF	–	Ministry of Environment and Forests
NO_x	–	nitrogen oxides
O&M	–	operation and maintenance
PAF	–	project-affected family
PAP	–	project-affected person
PIU	–	project implementation unit
PMU	–	project management unit
ROW	–	right-of-way
SEIA	–	summary environmental impact assessment
SMP	–	social management plan
SO_2	–	sulfur dioxide
SPM	–	suspended particulate matter
TSS	–	total suspended solids

WEIGHTS AND MEASURES

cm	–	centimeter
cumec	–	cubic meters per second
dB(A)	–	decibels (acoustic)
GWh	–	gigawatt-hour (1,000 megawatt-hours)
ha	–	hectare
kg	–	kilogram

km	–	kilometer
km^2	–	square kilometer
kV	–	kilovolt (1,000 volts)
m	–	meter
m^2	–	square meter
m^3	–	cubic meter
mg/l	–	miligrams per liter
mm	–	millimeter
MT	–	metric ton
MW	–	megawatt (1,000 kilowatts)
pH	–	measure of the acidity or basicity of a solution
t	:	Ton
yr	:	Year

GLOSSARY

khad	–	small river or stream
nallah	–	stream
panchayat	–	village
tehsil	–	a division of land for administrative and taxation purposes; typically consists of a town that serves a grouping of villages.

NOTES

(i) The fiscal year (FY) of the Government of India and its agencies begins on 1 April and ends on 31 March. “FY” before a calendar year denotes the year in which the fiscal year ends. For example, FY2009 ends on 31 March 2009.

(ii) In this report “$” refers to US dollars.

CONTENTS

I. INTRODUCTION

1. India's economically viable hydropower potential is enormous. Conventional hydropower capacity is assessed to be about 84,000 megawatts (MW) at a load factor of 60% (140,000 MW installed capacity). Only about 21% of India's hydroelectric potential has been harnessed so far; 10% more is being developed. Recognizing the importance of increasing the share of hydroelectric generation in the energy mix, the Government introduced the 50,000 MW Hydropower Initiative in 2003. Under this initiative, the northwestern and northeastern states (including Himachal Pradesh) are given special incentives to develop hydropower.

2. Himachal Pradesh has abundant water resources in the five major rivers flowing through the state from the western Himalayas. It has hydropower potential of 20,415 MW, about 25% of India's total, and around 6,150 MW of this has been developed. The main strategy of the government of Himachal Pradesh (GOHP), outlined in its hydropower policy,[1] is to become the "hydropower state" of the country, providing affordable, reliable power to its residents, and deriving major revenue for the state from the sale of excess power to the national grid. GOHP created a corporate entity, the Himachal Pradesh Power Corporation Limited (HPPCL), to develop and operate new hydropower projects in the state.

3. **Himachal Pradesh Clean Energy Development Investment Program.** In October 2008, the Board of Directors of the Asian Development Bank (ADB) approved the Himachal Pradesh Clean Energy Development Investment Program (the Program), an $800 million multitranche financing facility that combines physical investments in hydroelectric power generation in Himachal Pradesh with nonphysical interventions in capacity development. The projects selected for the Program come from the state's overall hydropower development plan—the Sawra Kuddu (111 MW), Kashang I, II, and III (195 MW in total), Sainj (100 MW), and Shongtong-Karcham (402 MW) hydroelectric projects. These projects will provide a total capacity of 808 MW with a combined generation of 3,256.3 gigawatt-hours (GWh) per year at 90% dependability. They will have a run-of-river design.[2] The estimated total cost of these projects is $1.4 billion. Of this amount, $800 million (57%) will be financed by ADB, $420 million (30%) by the GOHP, and $180 million (13%) from other sources.

4. **First-Tranche Loan.** The first-tranche loan under the Program, the agreement for which was signed in November 2008, consisted of $150 million and funded portions of the Sawra Kuddu and Kashang stage I hydroelectric projects. Clearances and approvals for the 65 MW Kashang stage I project had been obtained by GOHP, and it was ready for financing by the time of the first-tranche loan. Kashang stage I was independently evaluated and had its own environmental impact assessment (EIA) and summary environmental impact assessment (SEIA).[3] Project construction began in October 2008.

5. **Second-Tranche Loan.** The second tranche loan under the Program will finance portions of the Sainj project as well as of the Kashang stage II and III projects. The construction of tunnels at Sainj will start in 2010, and the generating units are scheduled for commissioning in June 2015. Kashang II and III will begin construction in 2010, with commissioning expected

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[1] Government of Himachal Pradesh. 2006. *Hydro Power Policy 2006.* Shimla.

[2] Run-of-river plants are characterized by low weirs (or barrages) with minimal storage (pondage). The weirs divert a portion of the river flow through the project waterways to the powerhouse and return the water to the river downstream. The pondage provides for increased flow to the powerhouse for maximum generation at peak load demand periods of the day.

[3] The SEIA is available at www.adb.org/Documents/Environment/IND/default.asp.

by 2014. They will add 130 MW of capacity, bringing the total capacity of the Kashang project to 195 MW.

6. **Need for Second-Tranche Projects.** The tranche II projects, **w**hen completed, will add 230 MW of installed capacity, vital to meeting all of the power demand in Himachal Pradesh. The state now generates only about 50% of its power needs. Excess power can be exported to benefit poorer and power-deficient states, particularly those in the Northern Indian grid, to which Himachal Pradesh is connected. In addition, the state's emphasis on clean energy development will further the country's goal of meeting its energy needs through clean, indigenous sources. Jobs will be provided to state residents, and, by addressing capacity development needs, the Program will further improve planning, implementation, management, and governance in the state's power sector.

7. **Detailed Project Reports and Summary Environmental Impact Assessments.** Detailed project reports were prepared for the Kashang projects in August 2005 (with an update in 2008) and the Sainj project in September 2007. The reports evaluated the technical and economic feasibility of the projects, and included design calculations based on hydrologic and geologic data. The present report contains SEIAs for the Sainj project and Kashang stage II and III. The SEIA for the Sainj hydroelectric project (HEP) in the next section is based on the comprehensive EIA prepared for the Himachal Pradesh State Electricity Board (HPSEB) and HPPCL by Water and Power Consultancy Services (India) Ltd. (WAPCOS) in July 2008, which also includes the catchment area treatment (CAT) plan documents.[4] HPPCL is now drawing up disaster management plans. WAPCOS consultants also conducted a socioeconomic survey of the project-affected persons (PAPs) at the project sites in 2007–2008.

8. The SEIA for the Kashang stage II and III HEP in the third section is based on the EIA and the environmental management plan (EMP) prepared by the Himachal Forest Research Institute and Mantech Consultants Pvt. Ltd. in 2008, which includes the CAT plan.[5] Socioeconomic surveys were part of this process. The detailed project report for the Kashang stage II and III HEP has been submitted to the Central Electricity Authority for techno-economic clearance. The case of diversion of forestland is under process. The forest compensatory afforestation case has been submitted to the Forest Department of the state for further submission to the national Ministry of Environment and Forests (MOEF). Approval in principle from MOEF was expected by mid-2009. HPPCL and the Himachal Pradesh State Pollution Control Board (HPSPCB) have issued notification and held public hearings at Lippa and Pangi villages on 28 and 29 May 2009.

9. This SEIA will be posted on ADB's website 120 days before the requested loan is considered for approval by ADB. The proposed developments are classified as ADB environmental category A because of the reduction in river flows in the river section between the weir and the tailrace outlet. The environmental assessment and review framework for the overall Program was completed in 2007 and remains valid for the duration of the Program. All necessary national and state government approvals for both projects have been or are being obtained, as outlined in the table below.

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[4] Water and Power Consultancy Services (India) Limited. 2008. *Environment Impact Assessment and Environment Management Plan of Sainj Hydroelectric Project*. New Delhi.

[5] Himalayan Forest Research Institute in Association with Mantec Consultants Pvt. Ltd. 2008. *Environment Impact Assessment For Integrated Kashang Hydroelectric Project of Himachal Pradesh*. New Delhi.

Table 1: Status of Project Documentation and Clearances

Item	Sainj (100 MW)	Kashang II and III (130 MW)
Reports		
PFR	1988–1989 (prepared by Jindal Hydro Electric Company Limited)	
Comprehensive EIA document	Final report received on 17 Oct. 2008	18 Nov. 2008
CAT plan	Approved by Forest Department	Submitted with forest compensatory afforestation case
Detailed project reports	August 2005; update provided in 2008	Prepared by HPPCL
Disaster management plan	Being prepared	Prepared as part of EMP
Detailed socioeconomic survey (village and household surveys) of all project-affected families	Surveys conducted (206 project-affected families); RP being prepared	Surveys conducted; RP being prepared
Public consultations	Two consultations were held on 7 December 2007 and 19 May 2008	Three consultations were held on 16–17 October 2008, 18–19 February 2009, and 28–29 May 2009
Clearances		
TEC from HPSEB	HPSEB (Sect.) 401-sainj/06-45088-101, 29 July 2006	Will be obtained only after CEA approval of DPR, which is under process
CEA clearance	Awaited	In progress
Environmental clearance from MOEF	MOEF J-12011/30/2008-IA.I, 4 May 2009	FCA case submitted to Forest Dept. of the state for further submission to MOEF
First award by LAO	Sections 10 and 11 in progress (no award made so far)	Notification under section 4 to be issued by LAO
No-objection certificate from Himachal Pradesh Environment Protection and Pollution Control Board	HPSPCB (153)/Sainj HEP Kullu/23008-8289-97, 16 July 2008	In process
Forest clearance from MOEF	Approved in principle (formal approval letter awaited)	In process

CAT= catchment area treatment, CEA = Central Electricity Authority, DPR = detailed project report, EIA = environmental impact assessment, EMP = environmental management plan, FCA = Forest Conservation Act, HEP = hydroelectric project, HPPCL = Himachal Pradesh Power Corporation Limited, HPSEB = Himachal Pradesh State Electricity Board, HPSPCB = Himachal Pradesh State Pollution Control Board, LAO = land acquisition officer, MOEF = Ministry of Environment and Forests, MW= megawatt, PFR = project feasibility report, RP = resettlement plan, TEC = techno-economic clearance.
Source: Himachal Pradesh Power Corporation Limited (HPPCL).

II. SAINJ HYDROELECTRIC PLANT (100 MW)

A. Description of the Project

10. **Type of Project and Location.** The Sainj HEP is a run-of-river hydropower generation project on the Sainj river, a tributary of the Beas river. The Project is upstream of the Parbati stage III (520 MW) project, which is now being built. The proposed Sainj HEP envisages the construction of a gated barrage 24.5 meters (m) high on the Sainj river near Niharni village, Godapur panchayat of Sainj sub-tehsil in Kullu district, at a distance of about 35 kilometers (km) from National Highway 21. The powerhouse is to be located near Suind village of Rohilla panchayat in Sainj sub-tehsil, Banjar main tehsil, Kullu district.

11. **Size and Magnitude of Operation.** The Project has the following features:

(i) A 24.5-m-high diversion gated barrage at an elevation of +1733 m, downstream of Niharni village on the Sainj river;
(ii) A full reservoir level at an elevation of +1752 m and a minimum drawdown level at an elevation of +1738.50 m, for live storage of +38.41 hectare meters to meet the daily peaking requirement during lean months;
(iii) Two underground desilting tanks (145 m x 15 m x 7.5 m) to exclude all silt particles down to 0.2 mm in size;
(iv) A headrace tunnel (HRT), about +6.3 km long and 3.76 m in diameter, on the right bank of the Sainj river, designed to carry a discharge of 28.7 cubic meters per second (cumec);
(v) Two 4 m D-shaped intermediate adits 320 m and 430 m long at a reference distance of 930 m and 4750 m, respectively, to facilitate the construction of the HRT;
(vi) An underground restricted-orifice surge shaft at the end of the HRT adit to a top elevation of +1766.5 m, and another adit at a bottom elevation +1672.37 m, to facilitate the construction of the surge shaft;
(vii) An underground pressure shaft +2.75 m in diameter and 550 inches in length, to carry discharge into the powerhouse;
(viii) An underground powerhouse on the right bank of the Sainj river near its confluence with the Jiwa nallah, with two 50 MW units for a total installed capacity of 100 MW; and
(ix) A 4.8 m D-shaped tailrace tunnel, 400 m long, to discharge the water back into the Sainj river.

12. **Implementation Schedule.** The Project is to be completed in 4.5 years. The various components will be carried out, and equipment selected, with the objective of commissioning the first hydroelectric generation unit by the end of the 3rd month of the 5th year, and the second unit by the end of the 6th month of the 5th year. All infrastructure works on the Project—land acquisition, geographic exploration, road building, adit construction, establishment of workshops and stores, utility works, surveys, development of quarries, leveling of area for installation of equipment and plants, prequalification of bidders, award of contracts, detailed design of components, and other preliminary works—will be taken up in the first 6 months and will continue up to the 4th year of project implementation. The proposed implementation schedule is in Table 2.

Table 2: Implementation Schedule for the Sainj Hydroelectric Project

Activity	Status	Year 1				Year 2				Year 3				Year 4				Year 5			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
		Apr[a]				Apr				Apr				Apr				Apr			
Pre-construction Activities																					
Acquisition of land																					
Upgrading of access roads																					
Installation of batching/mixing plants, workshops, and offices																					
Construction of buildings and stores																					
Excavation of adit																					
Tender and Contracts																					
Civil works	Started 12																				
Finalization of E&M works	months earlier																				
Construction Schedule																					
Mobilization of plant and machinery																					
Excavation of trench weir, slabs, bank walls																					
Excavation of conveyance channel and desilting basin																					
Excavation of HR tunnel	Continuous																				
Concreting	activity on all																				
Grouting and cleanup	components																				
Surge shaft																					
Excavation																					
Concreting																					
Grouting and cleaning																					
Pressure shaft																					
Excavation																					
Concreting and lining																					
Powerhouse																					
Excavation																					
Concreting																					
Structure																					
Superstructure																					
Tailrace tunnel																					
Excavation																					
Concreting																					
Commissioning of units I and II																					

Apr = April, E&M = electrical and mechanical.
Source: HPPCL.
[a] The fiscal year begins in April (1 April through 31 March of the following year).

B. Description of the Environment

1. Physical Resources

13. **Air Quality.** The project area is mainly rural. Most of the air pollution in the region comes from vehicular traffic, dust from unpaved village roads, and domestic fuel burning. Ambient air quality was monitored at four locations 5 days a week to develop a pre-project baseline for total suspended particulates, sulfur dioxide (SO_2), and nitrogen oxides (NO_x). The findings of the ambient air quality survey in the summer, post-monsoon, and winter seasons indicate that ambient air quality in the area is quite good and that air pollution is below permissible levels.

14. **Climate.** The temperature continuously rises from March to June. June is the hottest month, with a mean maximum monthly temperature of about 32.9°C and a mean minimum temperature of 26.6°C. The temperature appreciably drops with the onset of the monsoon in early July, and both day and night temperatures decrease after the monsoon withdraws, by about mid-September. January is the coldest month. During winter, the temperature goes below the freezing point some days, especially at night. The monsoon rainfall occurs mainly in July–September. Rainfall is at its maximum in July and August. The project area receives average yearly rainfall of 1,459.2 mm, mostly under the influence of the southwest monsoon. Winter precipitation from January to April, associated with the passage of western disturbances, accounts for nearly 40% of annual rainfall. Relative humidity is at its maximum (91%) during the monsoon months, and at its minimum (50%) in the summer months of April–May. Humidity is normally higher in the morning than in the afternoon hours. The skies are very cloudy to overcast during the monsoon months from July to September, and for a few days during the winter months as a result of the passage of western disturbances. The rest of the year, skies are mostly clear to lightly cloudy. Western disturbances affect the weather over the district during winter. Thunderstorms occur in March–October, especially in April–June. Fog appears occasionally in the valleys during the winter months.

15. **Water Quality.** As part of the field studies, water samples were taken from the Sainj river, upstream and downstream of the barrage site, and also from Kartaul khad and the drinking water in Sainj village. Total hardness was 55–65 milligrams per liter (mg/l) in summer, 47–60 mg/l in the post-monsoon season, and 53–77 mg/l in the winter. The softness of the water is due to its low calcium and magnesium content. Low electrical conductivity and values of total dissolved solids indicate a lower concentration of cations and anions. The concentration of dissolved solids was 124–145 mg/l in summer, 109–139 mg/l during the monsoon months, and 126–140 mg/l in winter, well below the permissible limit of 500 mg/l for water for domestic use.

16. There are no major sources of organic pollution in the basin. Population density in the Sainj river basin is low, and so is cropping intensity. Low cropping intensity, coupled with low agrochemical dosing, also means low pollution from agrochemicals. Moreover, the absence of industries implies that these are not polluting sources. Biological oxygen demand (BOD) values are well within permissible limits: there is no organic pollution loading, mainly because of the low population density and the absence of industries in the area. The low chemical oxygen demand values also indicate the absence of chemical pollution loading. The marginal quantity of pollution load that enters the Sainj river becomes diluted. In fact, even at minimum flow, more than enough water is available for dilution. The concentration of heavy metals in the study area is below the permissible limit for drinking water. The total coliform count is zero. Water quality was generally observed to be quite good, as various parameters are well below the permissible limit for domestic requirements.

17. **Noise.** The daytime equivalent noise level at various sampling stations ranged from 32 decibels (dB[A]) to 45 dB(A) in the summer, from 34 dB(A) to 46 dB(A) in the monsoon season, and from 37.5 dB(A) to 39.6 dB(A) in the winter, well within the permissible limits set for residential areas. As there are no industries in the area, and the population is sparse, nighttime noise levels are not likely to be materially different, other than the reduced noise from human activity.

18. **Topography and Soils.** Geologically, the area falls within the Lesser Himalayan segment of the northwest Himalayas. The project area is in the geological domain of the Larji-Rampur tectonic window zone. This window zone exposes two granitoid complex bodies—the Bandal granitoid gneisses in the northwest, and the Jeori-Wangtu granitoid gneiss in the southwest. The Bandal granitoid gneiss is considered equivalent to the Jeori-Wangtu gneissic complex in tectonic position, lithology, and chronology of rocks. The Bandal gneissic complex, spread over 500 square kilometers (km^2), is exposed in Garash valley in the northwest to the Sainj valley in the southeast, where it has reportedly been enveloped by the Manikaran quartzite. The Bandal granitoid gneiss with litho trend along the north-northwest–south-southeast comprises porphyroclastic as well as medium- to coarse-grained gneiss and mylonitic gneiss. The Rampur group presents an association of metabasalts and metasediments.

19. **Seismology.** The project area is in seismic zone V, as per IS: 1893: 2002[6], the highest seismic zone in the western Himalayas. In the past, the region has been affected by a number of strong earthquakes. Since 1905, 16 earthquakes of intensity greater than 5 on the Richter scale have been reported in the area. The most devastating earthquake recorded in the region was the Kangra earthquake of 1905, which caused considerable damage to life and property in Kullu district. Other major quakes were those in Chamba in 1945 (magnitude 6.5), 1947 (6.6), and 1950 (5.5); Dharamshala in 1978 (5.0) and 1986 (5.7); and Kathua in 1980 (5.3). The project area falls within isoseismals of 4.0 of the Kangra earthquake. The major earthquakes enumerated above were generated along the main boundary thrust. An appropriate seismic coefficient from this zone is proposed to be taken up for the design of the barrage and other appurtenant structures.

2. Ecological Resources

20. **Fisheries and Aquatic Ecology.** The Sainj river and its tributaries have a variety of cold-water fishes, dominated by trout. The cold water, with high oxygen and rich benthic flora and fauna, offers an excellent habitat for the breeding of these fishes. The fish catch composition observed during the survey showed that fish species were observed near the powerhouse site. However, at the barrage site only *Schizothorax richardsoni* was observed. The catch per person-hour was 250 grams with a size of 100–200 mm.

21. **Forests and Vegetation Composition in the Study Area.** The proposed Sainj HEP envisages the construction of a gated barrage 24.5 m high on Sainj river near Niharni village of Sainj sub-tehsil in Kullu district. The forest area on the left bank of the river comes under the Sainj range while the area on the right bank is part of the Jiwa range. The total land requirement for the various project appurtenances is 56.763 hectares (ha), including 5.17 of submergence area. The project area lies in the vicinity of the Great Himalayan National Park (GHNP). The tail

[6] The main seismic code for India is referred to as "IS: 1893-1962" and was periodically revised with the latest revision in 2002. Bureau of Indian Standards. 2002. *Indian Seismic Code (IS 1893-2002)*, New Delhi.

end of the submergence is situated about 1.00 km from the boundary of GHNP and 1.5 km from the Sainj wildlife sanctuary.

22. **Forest Diversity.** As part of the EIA study, a detailed ecological survey was conducted for summer (in April 2007), post-monsoon (October 2007), and winter (January 2008). During the vegetation survey, herbaria were prepared for those plants that had flowers. The Red Data Book of India[7] and other available literature consider floral herbaria of rare or endangered species for the identification of endemic, rare, and other threatened categories of plants. The altitude in the project area ranges from 1,330 m to 1,750 m above mean sea level. The major forest type in the project area is conifer mixed with broadleaf forest. A total of 115 plant species were recorded during the floristic survey in the project area.

23. **Rare Species in the Study Area.** Of the 27 tree species present in the study area, *Betula alnoides* is rare and economically very important. Efforts should therefore be made to minimize damage to this tree species. Two shrub species in the area (*Desmodium gangeticum* and *Sorbus aucuparia*) and two species of herbs (*Bistorta macrophylla* and *Polygonatum verticiltum*) are rare. On-site protection and rehabilitation of rare and threatened species in the vicinity of the project area and off-site conservation are suggested in the EMP.

24. **Faunal Status in Study Area.** The project area is in the vicinity of GHNP, so the national park was included in the area studied. A large amount of information on the faunal aspects of the area is available in the project report prepared by the Wildlife Institute of India on the GHNP.[8] Secondary information from work-plan reports and interaction with the Forest Department was also referred to.

25. Mammals in the study area comprise six orders and 30 species—primates (2 species), carnivora (12), Artiodactyla (7), Insectivora (3), Rodentia (5), and Lagomorpha (1). Primates are represented by the rhesus macaque (*Macaca mulatta*) and the common langur (*Presbytis entellus*), and are found to occur between 1,440 m and 3,420 m. Among large carnivores, the common leopard (*Panthera pardus*) and the Asiatic black bear (*Ursus thibetanus*) are sighted rarely at altitudes ranging from 1,440 m to 3,660 m. The black bear is found mostly in oak forests, and occasionally also in conifer forests. The presence of the snow leopard (*Panthera uncia*) in the Jiwa and Sainj catchment area above 3,600 m has also been reported (footnote 8). The Himalayan brown bear (*Ursus arctos isabellinus*) inhabits the alpine meadows of the Jiwa and Sainj areas above 3,500 m and descends to lower elevations for feeding. Among small carnivores, the red fox *(Vulpes vulpes*) is encountered in the alpine pastures. Yellow-throated marten (*Martes flavigula*) is commonly found on steep slopes of temperate and subalpine areas in an altitude range of 1,800–3,400 m. The white Himalayan palm civet (*Paguma larvata*) is rarely sighted in the area. The jungle cat (*Felis chaus*) is reported at elevations above 2,000 m. The most frequently encountered mammal in the area is the goral (*Nemorhaedus goral*), which occupies a wide range of habitat, from temperate to subalpine forests. The goral is found most frequently on open grassy slopes between 2,400 m and 2,800 m, inhabiting the steep south-facing slopes in the temperate forests, which have a considerable area under grass cover developed because of frequent fires and grass cutting. The goral is a major prey for the common leopard.

26. **Endangered Species.** Both the Himalayan tahr (*Hemitragus jemlahicus*) and the Himalayan musk deer (*Moschus chrysogaster*) are found occasionally between 2,800 m and

[7] This is a publication detailing flora and fauna of India.
[8] Wildlife Institute of India. 1999. *Conservation of Biodiversity Project*. Dehradun.

4,000 m. The tahr is found on steep rocky slopes in the upper Jiwa nallah areas. The musk deer is one of the most endangered ungulates inhabiting the subalpine and alpine areas. The GHNP provides only limited suitable habitats for musk deer (footnote 8), which has been reported from only a few restricted patches. The Himalayan tahr is one of the most hunted species in the area. This species mainly inhabits steep south-facing slopes of upper temperate, subtemperate, subalpine, and alpine regions. The barking deer (*Muntiacus muntjak*) is another heavily poached animal in the area and is rarely seen nowadays. The blue sheep (*Pseudois nayaur*) has not been reported from most of these areas. Other rarely encountered mammals are the serow (*Capricornis sumatraensis*), the Himalayan ibex (*Capra ibex sibirica*), the Himalayan weasel (*Mustela sibirica*), and the flying squirrel (*Petaurista petaurista and Hylopetes fimbriatus*). The pika, or Himalayan mouse hare (*Ochotona roylei*), is encountered frequently in the alpine meadows.

27. The information on reptiles and amphibians is based on secondary sources as well as from the project report on the GHNP (footnote 4). Common reptiles that are likely to occur in the area are the agama (*Agama tuberculata*), the gecko (*Cyrtodactylus lawderanus*), the Himalayan pit viper (*Agkistrodon himalayanus)*, the Russell's viper (*Vipera russelli*), the skink (*Mabuya sp.*), the Indian rat snake (*Ptyas mucosus*), the marbled toad (*Bufo stomaticus*), the stream frog (*Amolops formosus*), and the Stoliczka's frog (*Rana vicina*). Insects in general are suited to the monitoring of landscape changes because of their abundance, species richness, ubiquitous occurrence, and importance in the function of the natural ecosystem. Insects are the major component of the biodiversity; by virtue of the vast numbers of both species and individuals, they are vital determinants of terrestrial ecological processes. The GHNP, because of its strategic location and large variation in altitude, provides a diverse habitat of fauna and flora. A total of 37 families of different groups of insects representing 108 genera and 125 species have been reported from GHNP. The order Lepidoptera (butterfly and moth) represents higher diversity in terms of 55 genera and 61 species.

28. The GHNP supports an extremely diverse wildlife population. It harbors one of the few known viable populations of the Western tragopan (*Tragopan melanocephalus*), along with more than 300 species of birds and over 30 species of mammals. Among the mammals, the GHNP has the serow (*Capricornis sumatraensis*), the Himalayan tahr (*Hemitragus jemlahicus*), the goral (*Nemorhaedus goral*), the Himalayan blue sheep (*Pseudois nayaur*), the Himalayan black bear (*Selenarctos thibetanus*)*,* the Himalayan brown bear (*Ursus arctos*)*,* the Himalayan red fox (*Vulpes vulpes*), and the musk deer (*Moschus moschiferus*)*.* The Red Data Book (footnote 7) lists the musk deer as a vulnerable species. The GHNP has recorded 183 bird species including 132 passerines and 51 nonpasserines. Galliforms in the GHNP constitute a very important and spectacular component of biodiversity. The GHNP is one of two national parks in the world with a population of endangered Western tragopan (*Tragopan melanocephalus*)*.* Another endangered pheasant, the cheer (*Catreus wallichii*), is present on the steep, south-facing grassy slopes. The monal (*Lophophorus impejanus*) and the koklas (*Pucrasia macrolopha*) are abundant in the temperate forest zone, while the kalij (*Lophura leucomelana*) occurs in small numbers below 2,000 m. Sightings of the snow partridge (*Lerwa lerwa*), the hill partridge (*Arborophila torqueola*), and the Himalayan snow cock (*Tetragallus himalayensis*) are very few.

29. **Avifauna in the Study Area.** The catchment of the Sainj river offers a diversity of habitats for avifauna. The Sainj catchment and its environs including the GHNP fall within one of the globally important endemic bird areas identified by the International Council of Bird Preservation. The avifaunal diversity mainly comprises a number of species of babblers, barbets, blackbirds, bulbuls, bullfinches, buntings, chats, choughs, creepers, crossbills,

cuckoos, dippers, doves, drongos, eagles, finches, flycatchers, forktails, goldcrests, greenfinches, griffons, grosbeaks, hawks, kestrels, kites, martins, minivets, mynas, nightjars, niltavas, nutcrackers, nuthatches, owls, parakeets, partridges, peafowl, pheasants, pigeons, pipits, redstarts, rosefinches, shrikes, sparrows, swifts, thrushes, tits, tragopan, vultures, wagtails, warblers, woodpeckers, and wren-warblers.

30. **Protected Area: Great Himalayan National Park.** The GHNP has a total area of 754.4 km^2. The park consists of the upper catchment areas of the Tirthan, Sainj, Parbati, and Jiwa nallahs flowing east to west, which are tributaries of the Beas river. The park is contiguous to the Rupi Bhabha sanctuary (269 km^2) in the southeast, the Pin Valley National Park (675 km^2) in the east, and the Kanawar wildlife sanctuary in the north. The altitude in the park area ranges from 1,300 m to 6,100 m. The terrain is characterized by numerous high ridges (over 4,000 m high), deep gorges and precipitous cliffs, rocky crags, glaciers, and narrow valleys. A little over half of the park lies above an altitude of 4,000 m.

31. **Eco-development Zone.** The ecozone is naturally protected on the northern, eastern, and southern boundaries by areas under permanent snow or by impassable ridges. The western boundary of the park has historically supported communities that were economically dependent on the designated area of the park. Realizing the environmental pressures these villages would exert on the park's biodiversity, the GOHP has set up an area of over 250 km^2 as a buffer. This ecozone contains 160 small villages with a population of about 14,000. Almost 90% of the ecozone is forest habitat, which, when properly managed, can fulfill the forest-based needs of the local people. To address the economic impact of the park's creation on their lives, the local villagers have organized themselves into a nongovernment organization, the Society for Advancement of Hill and Rural Areas (SAHARA). Working with the park management, SAHARA members are developing innovative approaches and solutions, such as community-based ecotourism, to address many of the complex issues associated with nature conservation and village livelihoods. Community-based ecotourism is ecologically sustainable, financially viable, acceptable, and beneficial to village communities, and encourages nature conservation education. The World Bank supported an eco-development project in 1994 called FREE-GHNP in an area of 265.60 km^2 around the western periphery of the park. The project adopted a participatory approach to ensure the participation of the local community in protection and management by developing livelihood alternatives and reducing the dependence of locals on the forests in the area. This was to be achieved through ecologically sustainable development (eco-development) in the area. The park management has involved all the villagers, who were traditionally dependent on the forest and park resources.

32. The eco-development zone areas are adjacent to the park and provide a combination of natural and cultural experiences. The trails go through villages and are generally easy to moderate. The best time to visit is during the festival season (October), and treks offer an opportunity to interact with villagers and observe their daily activities, including weaving, basket weaving, cooking, and farming. Some popular tour routes are: the Neuli-Shangarh Loop, 24 km; the Neuli-Manu Temple, 12 km (round trip); the Gushaini-Tinder village, 12 km; and the Siund–Saran–Ghat Seri–Pashi villages, 10 km. In addition, there are two wildlife sanctuaries adjacent to the park, the Sainj (90 km^2) and the Tirthan (61 km^2). The total area under the national park administration is 1,171 km^2. Details are given in Table 3.

Table 3: Details of the Great Himalayan National Park Conservation Area

Park/Sanctuary	Area (km^2)	Remarks
Great Himalayan National Park	754	
Sainj wildlife sanctuary	90	
Tirthan wildlife sanctuary	61	
Additional forestland	266	Land adjoining GHNP managed and administered by park management
Total	**1,171**	

GHNP = Great Himalayan National Park, km^2 = square kilometer.
Source: Environmental impact assessment report (footnote 4).

33. The plant communities are representative of the temperate and alpine regions. About one third of the national park area is under closed canopy forests (from valley bottom to 3,300–3,600 m), and more than half of the area lies above 3,500–4,000 m, the upper limit for alpine meadow communities in the Himalayas. The forest area consists of extensive stands of oak (*Quercus semecarpifolia*), coniferous forests of blue pine (*Pinus wallichiana*), west Himalayan silver fir (*Abies pindrow*), west Himalayan spruce (*Picea smithiana*), and Himalayan cedar (*Cedrus deodara*). The broadleaf forests contain *Aesculus indica, Rhododendron arboreum, Quercus leucotrichophora, Q. floribunda* at lower altitudes, and pure patches of birch (*Betula utilis*) at higher altitudes. The yew (*Taxus baccata*) is an important medicinal tree of the understory. A rich variety of shrubs and patches of ringal bamboo (*Arundinaria spathiflora*) are found as a dense understory. Shrubs of *Rhododendron campanulatum* form the Krummholz patch in the subalpine zone. Other shrubs that are found at elevations above 3,700 m are *Juniperus communis, J. pseudosabina, Lonicera, Berberis, Cotoneaster, Vibemum,* and *Rosa*. There are a number of clearings in the forest areas, locally known as "thach." These are grazing and camping grounds for migratory livestock (cattle, sheep, and goats). The alpine flora occurring above 4,000 m is characterized by species-rich meadows with medicinal and economic value. They include *Aconitum violaceum*, *Salvia moorcraftiana*, *Viola serpens*, *Jurinea macrocephala*, *Rheum emodi*, *Berginia ciliata*, *Picrorhiza kurroo*, and *Saussurea graminifolia*, among others.

3. Economic Development

34. **Population.** The study area comprises 21 villages—18 in the influence zone, and 3 in the impact zone. Among the 21 villages, 1 is in Kullu tehsil, 14 are in Sainj tehsil and sub-tehsil, and 6 are in Banjar tehsil in Kullu district. The total population of the study area is 29,438, in 5,459 households. Of the total population, 50.99% are males and 49.01% are females. The average sex ratio in the study area is 961 females for every 1000 males. The population below the age of 6 years (infant population) accounts for about 16.49% of the total population. The average family size in the study area villages is five. On the other hand, the total population in the project-affected villages is about 4,453, residing in about 797 households. Of this total, 50.93% are males and 49.07% are females. The average sex ratio is 963 females for every 1,000 males. The population below the age of 6 years (infant population) accounts for about 18.10% of the total population in project-affected villages. The average family size is 5.6.

35. **Land Use.** The project components, including roads and tunnels, fall within 12 villages, which will be affected if land is acquired for project appurtenances or tunnels, if roads or settlements are constructed, or if the water regime is disturbed. The land required for the Project totals 56.763 ha.

36. The major land-use category in the study area is forest, which accounts for almost 81.83%. The other major category is barren land (9.64%). Agricultural land accounts for about 3.32%, the area under snow for about 2.76%, the area under water bodies for about 2.36%, and the area under settlement or exposed rock for about 0.60%.

37. **Agriculture, Industry, and Infrastructure.** According to details of livestock holding patterns from the survey, all the affected families rear domesticated animals for milk, meat, eggs, and farm labor. Among the livestock, cattle are the most commonly observed. Cows are mainly reared for their milk, while bulls are used extensively for plowing the agricultural fields.

38. Agriculture is the main activity; there are no industries in the area. Of the 436 persons surveyed, about 36.47% were gainfully engaged in an economic activity. This group consisted of persons engaged in cultivation (29.81% of the population surveyed), government service (3.89%, private service (0.92%), business (0.46%), artisan trades (0.46%), and labor (0.92%).

39. About 53.89% of the population surveyed was not contributing economically or in monetary terms, but was nevertheless engaged in some activity. This group consisted of persons doing household chores (primarily women) (23.16% of the population surveyed) and students (21.33%), and those that were engaged in various vocations and drawing pensions, or aged persons and small children (9.40%).

4. Social and Cultural Resources

40. **Communities.** A survey of all the project-affected families (PAFs) was conducted in 11 project-affected villages and hamlets where land is to be acquired for the Sainj HEP, including areas under the barrage site and the powerhouse site, and other project working areas such as those for contractor facilities and storage. Vertically, the impact area will extend from the riverbed to the full reservoir level at 1,752 m mean sea level, proposed adits, dumping areas, proposed road alignments, and surge shaft area. Of the 146 PAFs (436 persons), about 93.8% belong to the upper castes (Brahmins, Kshatriyas, and Vaishyas). The scheduled castes account for about 3.4% of the PAFs, followed by the backward castes (0.68%). Caste details could not be obtained for about 2.05% of the PAFs. According to the data, none of the PAFs belong to the scheduled tribes.

41. Of the total affected population, 54.36% are males and 40.82% are females, and the average family is made up of two to six persons.

42. The educational profile of the surveyed population, as collected through the primary survey, indicates that about 39.45% of the project-affected population is illiterate. The remaining 60.55% is either literate or in school. Among those surveyed, about 23.39% have reached no higher than primary school, 16.28% have completed or are still in middle school, 17.66% have completed or are still in high school, and 3.21% have completed or are taking up higher education.

43. **Socioeconomic Structure.** Information on various material assets owned by the surveyed population was also collected. These assets include television sets, tape recorders, transistor radio, liquefied petroleum gas cylinders, refrigerators, bicycle, motorcycles, and four-wheelers. In addition, some families own agricultural implements such as plows, pump sets, cultivators, chaff cutters, and threshers as shown in the table below.

Table 4: Material Assets Owned by Project-Affected Families

Village/Hamlet	Television Set	Tape Recorder	Radio Set	LPG Cylinder	Refrigerator	Bicycle	Thresher	Pump Set	Two-Wheeler	Four-Wheeler	Plow	Cultivator	Chaff Cutter
Bahuti	0	0	0	0	0	0	0	0	0	0	2	0	0
Darmeda	3	1	1	1	0	0	0	0	0	0	7	0	0
Jangla Bihali	11	4	5	3	1	0	0	1	0	0	9	0	1
Jeeva	5	0	0	0	0	0	0	0	0	0	9	0	0
Kartah	9	2	2	2	2	0	0	0	0	0	11	5	0
Khayan	0	0	0	0	0	0	0	0	0	0	0	0	0
Mail	0	0	0	0	0	0	0	0	0	0	0	0	0
Majhan	0	0	0	0	0	0	0	0	0	0	0	0	0
Manahara	4	1	2	2	1	1	0	0	0	1	3	0	0
Niharni	21	7	10	13	1	0	2	0	3	1	17	2	1
Wahi-Thi	1	0	1	0	0	0	0	0	0	0	1	0	0
Other	1	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	**55**	**15**	**21**	**21**	**5**	**1**	**2**	**1**	**3**	**2**	**59**	**7**	**2**

Source: Primary survey, October 2007, Government of Himachal Pradesh.

44. As part of the survey, information regarding the number of fruit-bearing and commercial trees owned by the PAFs was also collected. Details of trees owned by the PAFs are given in Table 5.

Table 5: Ownership of Trees, by Village

Type of Tree	Darmeda	Jangla Bihali	Kartah	Manahara	Niharni	Wahi-Thi	Grand Total
Adu	56	13		10	3	2	84
Akhrot		5	2	4			11
Amrut					0		0
Apple	159	184	30	198	219	60	850
Barlot					10		10
Japani		3					3
Khuani	47		4		5	1	57
Lemon		3			2		5
Narab		50		99			149
Nashpati	55	99	42	99	16	2	313
Orange		3			2		5
Plum	65	20	20	70			175
Ringal			38				38
Sathi		8					8
Surai				99			99
Grand Total	**382**	**388**	**136**	**579**	**257**	**65**	**1,807**

Source: Primary survey, October 2007, Government of Himachal Pradesh.

45. **Archaeological and Heritage Sites.** Apart from a village temple, no monuments of cultural, religious, historical, or archaeological importance were reported in the project and study areas. Thus, no impact on such structures is envisaged.

C. Alternatives

1. Without Project

46. The two "without project" scenarios are as follows:

(i) **Scenario 1: No action at all (business as usual).** Without the Project, the significant energy deficit in the Northern region (9.9% deficit in 2006–2007) would not be reduced by 399.57 GWh per year from this renewable energy source. The expansion of industry in the state and adjoining states would be stifled and residential consumption of electricity curbed. An equal amount of power would have to be generated by alternative means, most likely from a fossil fuel–powered plant.

(ii) **Scenario 2: No new generation plants are constructed, and power is purchased via utility companies from the Northern grid.** Both this scenario and scenario 1 have been dismissed by the Ministry of Power and HPPCL, as there is a power shortage in the state, combined with good potential for hydropower, and a need to develop a power surplus for economic growth.

47. Without the Project, tree density in the study area would remain thin. The hydrology and the socioeconomic structure are also not likely to change. However, the supply of electricity to the Northern grid would not be enhanced in the absence of the Project and the hydroelectric potential would remain unharnessed. This would result in the exploitation of more renewable resources and exert pressure on thermal energy production. With the Project, on the other hand, apart from the benefit of generating electricity, vegetation cover in the area is expected to improve through the proposed greenbelt development, strengthening the ecological environment. Socioeconomic benefits such as direct employment and economic development of the periphery are also anticipated. Hence, the "with project" option is preferred.

2. With Project

48. **Fuel Type**. The country is giving priority to hydropower development to improve the hydro/thermal mix, optimize the efficiency of the country's power system and thereby save fuel, minimize greenhouse gas emissions, and promote sustainable, environmentally friendly use of resources. The emission factors from a comparable coal-fired power plant that will be offset by power generation from a "clean" source, hydropower, can be calculated as in Table 6:

Table 6: Emissions from Coal-Fired Plant (≤100 MW) Offset by Clean Generation (tonnes per year)

Item	CO_2	SO_2	NO_x	TSP
Current Generation				
970.5 MW at 50% load factor, 8 months/year	13,664	72	51	48
Projected Generation in the 10th Plan				
4000 MW at 50% load factor, 8 months/year	56,314	294	210	197

CO_2 = carbon dioxide, MW = megawatt, NO_x = nitrogen oxides, SO_2 = sulfur dioxide, TSP = total suspended particulates.
Source: Government of India, Asian Development Bank estimates.

49. **Location.** The "with project" alternative is the proposed expansion program for hydropower in the state of Himachal Pradesh. It entails proper environmental mitigation planning and careful site selection to avoid or minimize the potential adverse environmental impact associated with HEPs. The following factors were considered in selecting the alignment and optimum route:

(i) Ecologically significant or environmentally sensitive areas, such as national parks, nature reserves, or wetlands designated by the MOEF will be avoided.
(ii) Potential environmental and social impact (including resettlement, land take, adverse effects on cultural or religious sites) associated with initial alignments and locations will be minimized through the selection of alternative sites.
(iii) Involuntary resettlement will be minimized.
(iv) Monuments of cultural or historical importance will be avoided.
(v) Indigenous peoples, including tribal communities, will not be threatened.
(vi) Social infrastructure such as playgrounds or schools will not be directly affected,
(vii) The clearing of existing forest resources will be avoided as far as possible, and where unavoidable will be minimized and compensated according to the regulatory criteria of the Government of India.
(viii) Affected people will be consulted and offered adequate compensation options as appropriate.

50. The following other safeguards were also taken into account:

(i) Road alignments and dumping sites will be generally sited 10–15 km away from major towns, whenever possible, to allow for future urban expansion.
(ii) Forests will be avoided if possible, in consultation with the local divisional forest officer, to minimize damage to forest resources. National parks and sanctuaries and other forest areas rich in wildlife will be totally avoided.
(iii) Channel, road, and transmission line alignments will avoid riverbeds and unstable areas.

51. **Alternative Project Sites.** Various alternative project sites were considered as part of the technical feasibility study. Appropriate site selection criteria were reported in the EIA to avoid unnecessary problems, and the project location will avoid ecologically sensitive areas such as reserve forests and wildlife sanctuaries. Three proposals are described below.

(i) **Proposal 1**. This proposal envisages the diversion of Sainj river inflow through a diversion barrage near Niharni at elevation ±1,730 m. The diversion barrage will be ±24.50 m high, and it will have an HRT 6.30 km long and 3.76 m in diameter with two adits. One adit will be ±320 m long and will meet the HRT at reference distance (RD) 930 m on the left bank of Kartaul nallah; the other will be ±430 m long and will meet the HRT at RD 4,750 m, upstream of the surge shaft. The other components, besides the surge shaft, are a ±560-m-long pressure shaft and an underground powerhouse at elevation ±1,347.80 m on the right bank of the Sainj river near Suind village, to generate 100 MW of power using a gross head of 409.60 m and two units of 50 MW vertical-axis Pelton turbines. About 399.57 GWh of energy will be generated per year at 90% dependability. The feasibility of all the proposed components was checked at the site along with the Geological Survey of India team. This proposal was found to be most suitable, as the two construction adits to the HRT will reduce the tunnel excavation time.

(ii) **Proposal 2.** The alignment of the water conductor system in this proposal is about 400 m toward the uphill side of proposal 1. The proposal features are similar to those of proposal 1, except that the HRT length is increased from 630 km to 645 km and only one adit ±600 m long in reverse grade is available at Kartaul nallah. During the site visit along with the Geological Survey of India team, no rock face was encountered on the left bank of Kartaul nallah for the adit portal and an adit to the tunnel alignment that would reduce the tunnel construction time was found to be available. On the other hand, the tunnel alignment also passes under a maximum cover of ±1180 m, resulting in maximum stresses on the HRT. In addition, all approaches to the tunnel face will be longer; construction time will therefore increase. In view of the above factors, this alternative was ruled out.

(iii) **Proposal 3.** The alignment of the water conductor system in this proposal is about ±450 m toward the valley side of proposal 1. Proposal 3 envisages the construction of a rock-fill dam ±30 m high at elevation 1728 m, near Niharni village. It will have an HRT 625 m long and 3.50 m in diameter with one adit about 1.5 km upstream of the surge shaft, to carry a design discharge of 27.60 cumecs. In this proposal the HRT opens onto the banks of Kartaul nallah and crosses it through an pipe aqueduct ±120 m long, supported on reinforced-cement concrete pillars. The other components are a surge shaft, a ±545-m-long pressure shaft, and an underground powerhouse at elevation 1,336 m, generating 100 MW of power with a gross head of 415.10 m and two units of 50 MW vertical-shaft Francis-type turbines. About 409 GWh of energy will be generated each year at about 90% dependability. This proposal was not adopted for the following reasons:

(a) The aqueduct over Kartaul nallah could be washed away by flashfloods in the nallah resulting from heavy rains and cloudbursts in the catchment area.
(b) The hill slope along the banks of Kartaul nallah at the aqueduct crossing requires significant expenditure on slope protection works. The structure will also be under threat from boulders falling on the pipe aqueduct.
(c) The aqueduct pipe has to be supported on reinforced-cement concrete pillars ±25 m high. A water conductor system of this kind in a highly seismic-prone area will always be under threat from earthquakes.

52. All three proposals were studied, and proposal 1 was found to be most favorable and viable on techno-economical grounds and was finally adopted. The proposed location is considered most suitable environmentally, as the least number of trees will be cut. This project alternative also has the easiest access route and entails minimal civil works; both factors translate into minimal disturbance to the project area ecosystem.

D. Anticipated Environmental Impact and Mitigation Measures

53. The main adverse impact that the Project is likely to have on the environment, based on type, duration, extent, and severity, will be changes in the river hydrology, loss of agricultural and forestland, a decline in the quality of aquatic ecosystems, and resettlement (Table 7). Most of this impact will occur during project operation because of the altered river hydrology between the barrage and the tailrace outlet.

Table 7: Main Adverse Environmental and Social Impact of Sainj HEP

Issue/Feature	Impact	Extent	Duration
Hydrology	Reduced river flows between barrage and tailrace outlet	Along 8.5 km stretch of river	Permanent
	Decline in river water quality		Permanent
Aquatic ecosystems	Altered river ecosystem	8.5 km of Sainj river	Permanent
	Prevention of upstream fish movement	Pondage inundation area of 2.5 ha	Permanent
Land resources	Loss of agricultural and forestland	56.763 ha total land conversion	Permanent
Social	No resettlement or relocation of households	206 pre-located project-affected families, whose land will be acquired (71 will lose homestead and 135 will lose land)	Permanent
Groundwater	Remote possibility of damage to water supply (to be restored in case of damage, even if not directly attributable to project activity)	17 water supply systems and 12 natural springs, according to latest inventory	Temporary [a]

ha = hectare, HEP = hydroelectric project, km = kilometer.
[a] The extent of damage to water supply can be assessed only during and after the underground excavation of the project components, as well as the social impact assessment studies of the Project.
Source: Environmental impact assessment report (footnote 4).

1. Environmental Impact due to Project Location and Design

54. **Altered Volume of River Flow.** The abstraction of water from the river changes the riverine ecology significantly. It not only hinders the longitudinal connectivity of the water passage, affecting fish migration, but also has an impact on drinking water needs, irrigation, water mills, and health downstream. The Hydro Power Policy of Himachal Pradesh (footnote 1) provides safeguards to ensure a minimum flow of 15% of water immediately downstream of the diversion structures at all times, including the lean season from November to March. HPPCL commits to comply with the provisions of the Hydro Power Policy and notifications issued in this regard by GOHP. The observed minimum inflow at the barrage site in the lean season is 4.8 cumecs (according to the EIA), of which 1 cumec will be maintained immediately below the diversion barrage.[9] The riparian environment between the diversion barrage and the tailrace outlet covers an elongated area of about 8.5 km along a well-defined and narrow river channel. The steep riverbed slope in this section of about 500 m/km indicates a fast water flow, amply illustrated by the downward transport of huge boulders strewn along the river course. After the Sainj barrage is built, water will be diverted for power generation. The tailrace discharge will again enter the Sainj river 8.5 km downstream of the barrage site. Thus, the stretch of about 8.5 km between the barrage and the confluence of the river and the tailrace channel from the powerhouse may have lower flow during the lean season. The proposal is to release 1.0 cumec from the barrage. But many streams (nallahs) join the river between the barrage site and the confluence with the tailrace channel from the powerhouse, entering the river at the affected stretch. The discharge will be supplemented from the Kartol nallah (2.5 km downstream), joining Sainj river on its right bank, and other small khads joining the river from the left bank. These small khads include Kotli khad (4 km downstream), Shana khad (6 km downstream), and

[9] State policy dictates that 15% of the observed minimum flow should be maintained. In this case, MOEF in its final clearance required 1 cumec (21%), more than the required minimum.

Nuhara khad (7.5 km downstream) of the barrage. These streams have a total discharge of about 1.4 cumec during the lean season.

55. Because the base flow of water below the diversion barrage will be less, silt may be expected to deposit at least temporarily in the river section above the tailrace outlet. Flashfloods and also the flood-season discharge will, however, redistribute the silt irregularly and move it downstream. An electronic flow-measuring device will be installed, in addition to conventional engineering devices such as weirs and flumes, to determine and monitor the obligatory environmental downstream discharge of 15% of inflow. A fish pass, to be constructed to facilitate fish migration, will allow the required 15% inflow (environmental flow or discharge) during the lean season and help protect the environment. The abstraction of water at the diversion barrage usually means that the riverbed will be laid partially dry below the barrage at periods of low water. However, the flood-season water will pass the barrage and continue in the old riverbed.

56. **Disruption of Fish Migration.** The project may have adverse or beneficial effects on fish fauna, depending on the situation and the fish fauna inhabiting the particular river, just as it may variously affect the people who depend on fishing for their livelihood. The regulation of a river leads to the fragmentation of habitat and may have adverse effects on indigenous and migratory fish. On the other hand, pondage provides a large volume of water, which is beneficial to fish culture and can have an important role in economic growth. No specific spawning or breeding ground was observed in the study area. However, the presence of fingerlings in the catch near the confluence with Jiwa nallah indicates the possibility of breeding in the area near the proposed powerhouse area. Snow trout (*Schizothorax richardsonii*) is the only commercial species observed in Sainj river in the project area. The presence of these species near the confluence with the Jiwa nallah indicates the possibility of migration of these species in Jiwa nallah.

57. The barrage on Sainj will not hinder the free movement of fish species, as a fish pass will be provided and a minimum discharge will also be maintained. A fish ladder to be provided in the barrage will allow a minimum flow of 1.0 cumec to be released downstream, for a cumulative flow downstream of 2.03 cumec. But project impact on fishing livelihoods must be addressed. Viable options can be supported by the local area development committee (LADC) from funds provided by the Project. Also, the reservoir and fisheries[10] are likely to draw more tourists to the area, thereby providing indirect employment opportunities.

58. **Land Acquisition and Land Use Conversion.** Change in land use entails a realignment of anthropogenic forces, exerting varying degrees of pressure on land and initiating a pressure readjustment process. The diversion of forestland shifts the exercise of usage rights to adjoining areas, where the pressure increases and degradation may result. The total catchment intercepted at the barrage site is 39,730 ha. The catchment area considered for treatment under the Project is 13,234 ha, in the category of very high erosion.

59. About 56.763 ha of land is to be acquired for the Sainj HEP. Part of this land will be needed for labor camps, quarry sites, muck disposal, storage of construction material, and siting of construction equipment. This requirement will be temporary, and the land will be returned after the construction. On the other hand, land will be permanently acquired for the barrage axis, the submergence area, the project colony, and other project-related structures.

[10] According to the environmental clearance from MOEF, the reservoir will stock 20,000 fingerlings per year, and additional rearing space will be set up at a farm located at Hamini.

60. About 8.77 ha of private land is to be acquired from Suchen Kothi Vanogi, Shainshar Kothi Shainshar, and Gara Parli Kothi Shainshar revenue fati. In the EMP survey of 2007, it was observed that about 206 PAFs are likely to lose land (agricultural, nonagricultural, or homestead) in varying proportions.

61. **Resettlement.** These 206 PAFs will be entitled to compensation for their land under the Land Acquisition Act. In addition, PAPs and PAFs that lose their homestead will receive compensation based on an assessment of the age of buildings, materials used for construction, and other factors, to be carried out by a deputed agency. Other properties, such as fruit-bearing and timber trees, have been assessed and compensation will be paid to the PAFs. Compensation will also be paid for the various public utility buildings, structures, and spaces that will be assigned to the concerned departments and agencies.

62. The affected households have expressed a preference to resettle within the vicinity of their present places of residence, to minimize disruption and to benefit from mutual support from kin groups, and from new development opportunities generated by the Project. The Project will facilitate the completion of relocation activities within a reasonable time frame. Affected households will be resettled locally, with compensation from HPPCL. Assistance in relocation is to be provided to the affected households by the Project. A resettlement plan for the Project, detailing its impact and the measures to be taken to mitigate various project losses, is being prepared. The plan is based on the general findings of the census and social survey, field visits, and meetings with various PAPs.

63. About 56.763 ha of land, including about 47.993 ha of forestland, is to be acquired for the Sainj HEP. During project construction, land will be required for construction equipment, construction material storage, muck disposal, road widening, and new road construction. The forest in the area has already been degraded by large-scale human intrusion. Tree density is about 610 trees/ha in the submergence area and about 270 trees/ha in the powerhouse area. Normally in a dense forest, tree density is about 1,000–1,200 trees/ha. Thus, in land to be acquired for the Project, tree density is low to moderate.

64. Some plant species that are rare and endangered by virtue of their small population will be selected for conservation and preservation. These species—including *Betula alnoides, Desmodium gangaticum, Sorbus accuparia, Bistorta macrophylla, and Polygonatum verticillatum*—will be taken up for on- or off-site conservation. The on-site measures will involve species rehabilitation in similar habitats around the area. Nurseries, about 1 acre in area, will be located at appropriate sites in the broadleaf forests, and the relocation habitats will be selected among the forests in the area. In cases of extremely small population sizes, efforts will be made to augment the natural population through off-site conservation measures like seed collection, in vitro seed germination and nursery establishment, artificial multiplication, and in vitro regeneration of medicinally important plant species. Off-site conservation will be pursued for threatened species with low reproductive potential and efficiency. It is proposed that various research institutions be involved in the development of protocols for in vitro micro propagation and the subsequent reintroduction of these species into their natural habitats. Among these institutions are Y. S. Parmar University, Himachal Pradesh; Department of Botany, Punjab University, Chandigarh; National Bureau of Plant Genetic Resources, New Delhi; Himalayan Forest Research Institute of the Indian Council of Forestry Research and Education at Shimla; and G. B. Pant Institute of Himalayan Environment and Development, Regional Center, Mohal (Kullu district). The necessary funding support for setting up the laboratory and offices, chemicals and equipment, hardening facility and greenhouses, chicken houses, and related maintenance for 5 years would come from HPPCL.

65. The area has a large bird population. The whole area supports good vegetation and the birds are well distributed in the region. Increased vehicular movement, blasting, and increased human interference could adversely affect the avifaunal population in the area. Appropriate management measures are recommended in the EMP. A positive impact predicted for avifauna in the area is that, after the Project is commissioned, the reservoir could become a nesting and breeding ground for water birds, and other birds may also come to feed, as fish stocking and farming in the reservoir would increase the availability of food for them. Moreover, migratory birds may also take to this area to rest during their migration to and from the wintering grounds in the plains. The creation of a greenbelt around the reservoir area, which would provide shelter and a roosting place for the birds, would further strengthen this positive impact.

66. **Geological Impact.** Geological impact is related to damage due to seismic conditions. A standard seismic zoning map,[11] based on tectonic features and earthquake records, has been developed for the country by the Bureau of Indian Standards. The area under the Project primarily falls within zone IV, according to the map, and is referred as a zone of high damage risk. Hence, the foundation design of the towers and powerhouses must consider the probability of earthquakes, using suitable seismic coefficients, e.g., acceleration due to earthquake in horizontal and vertical directions.

67. **Transmission Interconnection.** This will be an 8 km power evacuation line of 132 kilovolts (kV) from the powerhouse up to the pooling point of Parbati stage III near Bihali. This line will be developed by the state transmission utility using HPPCL funds (ADB is not funding this interconnection). The state transmission utility will prepare a separate initial environmental examination (IEE) when the requisite siting, surveying, and design is completed. This transmission line will be classified as environmental category B.[12]

2. Environmental Impact of Pre-construction and Construction Activities

68. The construction of Sainj HEP will involve the removal of trees at the project site, excavation work, the installation of equipment, and civil works related to the construction of a desilting chamber, forebay, penstock, powerhouse, and other related works. Standard construction impact, pertaining mainly to specific construction activities, site disturbance, spoil disposal, river flow disruption, and the influx of workers into the area, will occur. These types of construction impact, common to most hydroelectric projects, are described below, together with the associated mitigation measures.

a. Physical Resources

69. **Impact on Topography.** The topography will change during construction as tunnels are excavated, buildings put up, and fills and cuts made to level the power channel and construction powerhouse, forebay, desilting chamber, and penstock. Surface features will change as trees and soil are removed at the HEP powerhouse, trench weir, tunnel construction site, and all along the rights-of-way (ROW), to facilitate construction. The most conspicuous impact on the surface topography will be in the hilly region along the reserve forest for HEP. The impact will be local but irreversible as the presence of the HEP changes the features along the ROW.

70. **Material Extraction.** A project of this magnitude will require a significant amount of

[11] Geological Survey of India. 2002. *Seismic Zoning Map of India*. New Delhi.

[12] Projects judged to have some adverse impact but of lesser degree or significance than that of category A projects. ADB. 2006. *Operations Manual, Operational Procedures, Section F1/OP*. Manila.

construction materials. Details are shown in Table 8. The most likely sources of air pollution are primary crushing and fugitive dust from the heap of crushed material, followed by emissions from diesel-powered machines and transport vehicles.

Table 8: Details of Construction Materials Required

Material	Quantity
Coarse aggregate (million m^3)	0.111
Fine aggregate (million m^3)	0.066
Cement (tons)	63,800
Structural steel (tons)	1,000
Reinforced steel (tons)	10,400
BQ steel (tons)	1,190

m^3 = cubic meter.
Source: Environmental impact assessment report (footnote 4).

71. The concrete aggregates will be met from a 3 ha quarry at Silly Larji, about 30 km from the barrage site, which has been acquired for the Larji project and will be used for the Sainj project as well. The muck generated during the tunnel excavation and the construction of the powerhouse and other project appurtenances can also be crushed into the required size to meet part of the concrete requirement. The amount of muck that can be used as construction material will depend on its engineering properties and suitability for construction. Crushing operations will generate fugitive emissions of the suspended particulate. Quarrying, in association with stone crushing, can cause noise, air (dust), and water pollution if suitable measures are not taken. Similarly, the proposed project will require a significant amount of fine material, which can be met either by crushing aggregates or by excavating material from borrow areas.

72. **Impact on Air Quality.** Excavation of the HEP channel and the movement of vehicles carrying construction materials will give rise to dust particles, temporarily affecting air quality at the site. Spraying the excavation site with water will greatly reduce the dust emission.

73. **Impact on Noise Levels**. The major sources of noise pollution during construction are vehicles transporting construction materials and equipment to the site.[13] Since most of the access roads cannot be used by motorized vehicles, equipment has to be transferred by nonmotorized transport. The major construction work is expected to take place in the daytime. As already discussed, land along most of the alignment is used mainly for agriculture and reserve forest. Faunal population in the reserve forest will be disturbed marginally by noise during construction and may be driven into other areas in the forest. Using low-noise-generating equipment and restricting construction activity to a limited period will minimize the disturbance to forest fauna. Under the worst-case scenario, considered for predicting noise levels during construction, all the equipment is assumed to generate noise from a common point.

74. There are no vehicles transporting construction materials near the barrage site at present, but vehicular movement is expected to increase during construction up to a maximum of 5–6 trucks an hour. Setting such a ceiling on vehicular movement will help reduce noise. The EMP also addresses this issue by requiring vehicles to be equipped with mufflers recommended by the vehicle manufacturer.

75. **Impact on Surface Water Quality.** Runoff from the construction sites will tend to flow toward the Sainj river or its tributaries, increasing turbidity, with adverse impact on

[13] Noise is also expected to come from blasting activities. However, precise quantitative data is not available for underground blasting activity. During the public consultations, it was agreed that no blasting would occur at night.

photosynthesis and biological productivity. The impact on the streams and rivulets would thus be significant. To mitigate this adverse impact, adequate measures need to be implemented, including using settling tanks to reduce suspended solids, and collecting sludge from the settling tanks periodically for proper disposal or use as landfill. Rivers and streams are used primarily to meet drinking, washing, and cleaning requirements. PAFs were observed to use pipes and taps connected to pipe and storage networks that were either locally assembled or provided by the government. The construction will have no major impact on surface water and groundwater quality in the area. Water bodies may be contaminated by construction materials and surface runoff from adjoining construction sites. Turbidity, total suspended solids (TSS), and other chemical parameters like BOD may increase at points where the proposed road alignment crosses the river. Careful selection of sites and access roads so that the surface runoff does not spill into the river will avoid this problem.

76. Care will be taken to locate temporary settlements of construction workers away from water bodies. The settlements should be provided with adequate drinking water facilities, sanitary facilities, and drainage to avoid surface water pollution. The site should have sedimentation ponds, oil-confining basins, and oil traps to separate oily waste. The sludge in the traps should be kept in a specified place inside the premises and later sold to authorized contractors or third parties. No sludge disposal on land should be allowed.

77. **Impact on Soil and Geology.** Excavation activity and land clearance can lead to soil erosion at the construction site and along the access routes. Erosion-prone areas will be strengthened before construction, and construction sites will be leveled and stabilized after construction. Construction chemicals must be handled properly to avoid soil contamination.

78. **Spoil Disposal.** The construction of the Sainj HEP—including tunnels, diversion barrage, desilting tank, powerhouse cavern, and access roads—is expected to generate about 0.805 million cubic meters (m^3) of muck. It is proposed that 0.283 million m^3 of this be used for various project works. The unused excavated material can then be disposed of properly at the designated muck disposal sites.

79. Seven muck dumping sites with a total area of about 10.729 ha and a combined capacity of 1.16 million m^3 of uncompacted muck have been identified. Such sites are normally prepared by being cleared of vegetation. Appropriate protection walls with deep foundations will keep the muck from flowing into streams and rivers. According to the bio-fertilizer technique developed by the National Environmental Engineering Research Institute (NEERI), the muck would be compacted, stacked at the sites with proper slopes and benches for stabilization, and, if needed, sprayed with water so that dust does not blow in hot and dry weather. Ample space would be provided for planting trees to consolidate the biotechnological approach. Suitable species of about 1,000–1,200 trees/ha would be planted. Because muck generally lacks nutrients and is difficult to revegetate, fungus (vesicular-arbuscular mycorrizae, or VAM) and nitrogen-fixing bacteria would be inoculated into the seeds before they are planted, supplementing traditional methods of afforestation. The VAM and bacteria grow on the roots and provide water and nutrition, especially phosphorus, to plants at a faster rate. The plants grow faster, especially in a medium devoid of nutrients. Major species recommended for plantation are listed in Table 9:

Table 9: Species Recommended for Plantation on Muck Disposal Sites

Botanical Name	Local Name
Trees	
Betula alnoides	Bhoj patra
Populus ciliate	Poplar
Pinus roxburghii	Chir
Cedrus deodara	Deodar
Salix acutifolia	Bhains
Shrubs	
Artemisia nilgarica	Kunja
Berberis aristata	Kingor
Berberis lyceum	Kingor
Rosa moschata	

Source: Environmental impact assessment report (footnote 4).

80. **Road Construction Impact.** The construction of roads can have the following impact:

(i) The topography of the project area is steep to precipitous, with slopes descending rapidly into narrow valleys. These conditions can lead to erosion from the downhill movement of soil aggregates.
(ii) Removing trees from slopes and reworking slopes in the immediate vicinity of roads can produce landslides or erosion gullies. In some cases, the roads themselves may be washed out.
(iii) New roads make previously undisturbed areas more accessible, and the the ecosystem more vulnerable.
(iv) The movement of vehicles transporting large construction materials and the operation of heavy equipment during construction will increase air pollution and noise.

81. Some roads in the project area may have to be widened. Access roads 5–7 m wide and 17.50 km in total length will have to be built to connect the different project sites. The widening of the existing road from Suind to Neuli (8 km long) has also been proposed, as has the construction of five reinforced-cement concrete bridges on the Sainj river and other nallah crossings to connect the existing road with the project roads. Muck and dust will be generated during construction, when vehicular movement will perhaps be at its highest and the roads cannot be tarred. But the dust is not expected to travel long distances. The access roads will pass through Dharmera, Kherla, Nathra, Niharni Manahra, Baretha, Manjhan, and Mail villages, and will also benefit local people who now have no access to any kind of motor road.

82. **Traffic Tunnel.** A 200- to 300-m-high hill mass 200 m in length and with the potential for slides is in the path of a proposed road route, but a detour would add about 4 km of road length and require the cutting of 1,900 more trees. The road will therefore be built instead on the right bank of the river (near adit I), where the rock is more sound. Two traffic tunnels about 150 m and 250 m in length are proposed to avoid damage to forest and keep debris or muck from falling into the river. This alignment will also be more economical. The two traffic tunnels will generate 20,953.40 m^3, compared with 22,400 m^3 from the previous road route. This case has been put before MOEF for clearance of the proposed forestland diversion. No other road network exists inside GHNP and the Sainj wildlife sanctuary.

83. **Traffic and Transport.** Avoiding high-density areas, using proper traffic signs, making

proper access roads available, and avoiding roadblocks will minimize traffic disturbance during construction.

b. Ecological Resources

84. **Impact on Terrestrial Ecology.** Land clearing, cutting, filling, and leveling may cause loss of vegetation, with irreversible impact on ecology. Transmission towers should not be located in thick vegetation to minimize tree loss and the need to compensate the tree owners. Tree cutting and compensatory afforestation must be done in consultation with the Forest Department of the state. Soil erosion generally results when herbaceous vegetation is removed from the soil and topsoil is loosened. But the impact would be confined primarily to the project site during the early stages of construction and must be minimized through paving and surface treatment, water sprinkling, and other mitigation measures.

85. Construction activities may disturb the fauna in the reserve forests and cause the animals to move elsewhere in the forest. Care will be taken not to disturb the major wildlife habitat. The catchment area is part of the habitat of rare and important Himalayan fauna. This habitat is degrading and the wildlife population is dwindling at a very fast pace. To preserve and increase the fauna in the area, wildlife development and management plans must be considered. The following actions are suggested to conserve fauna in the region, in view of the sudden influx of labor population into wildlife-rich areas:

(i) The project authorities should be mindful of the breeding season from October to December and the nesting season from March to June, and restrict activities like blasting or heavy machine operations that produce noise levels of more than 80–100 dB(A) during these periods. Violators should be made to pay heavy penalties. These aspects will be included in the tender documents for the construction contractor.
(ii) Information underscoring the need for wildlife and forest conservation and the legal consequences of violating the Forest and Wildlife (Protection) acts should be publicized. Laborers engaged in construction activities should also be made aware of the need to exercise great restraint, especially during the critical months of breeding and nesting.
(iii) Signboards stating the penalties for rule violations should be put up in the labor settlements. The signboards will also emphasize the importance of conserving wildlife.
(iv) Education and awareness campaigns including audiovisual screenings should stress the harmful consequences of collecting herbs and gucchhi (morels) in the early stages of their growth.
(v) Firearms should not be allowed in the valley, and visitors should be made to deposit firearms at forest checkpoints before entering the area.

86. **Impact on Aquatic Ecology.** The construction of the Sainj HEP will involve large-scale extraction of different types of construction material from the riverbed including boulders, stones, gravel, and sand. Extraction will destabilize the substratum, increase the turbidity of water, silt the channel bottom, and modify the flow, which in turn may result in the erosion of the river channel. These alterations will have a significant impact on the benthic fauna. Turbidity is likely to stay high during the dredging. Suspended solids in excess of 100 parts per million (ppm) can affect the gills of young fish. Fine solids in concentrations greater than 25 mg/l can adversely affect the development of fish eggs and fish. Normally, fish species migrate from the

area and return to the site only after the dredging or extraction. This phenomenon, reported in many projects, is expected in the proposed project.

c. Human Environment

87. **Health and Safety.** The proposed project will require large quantities of fines, which will have to be excavated from borrow pits. Such sites are normally left untreated afterward. The pits thus created impede natural drainage, increase the potential for soil erosion, and store rainwater and runoff. Mosquitoes can breed in these pools of water, increasing the incidence of vector-borne diseases. The magnitude of breeding sites for mosquitoes and other vectors in the impounded water is in direct proportion to the length of the shoreline. Since this is a run-of river project in a mountainous region, the increase in water storage (or pondage) will be marginal and will be confined mostly to the gorge of the river; hence, no increase in the incidence of water-borne disease is expected. But other project appurtenances at lower elevations could face increased incidence of malaria as a result of the aggregation of labor, the formation of stagnant pools near labor camps and settlements, and other factors.

88. **Human Interference.** A large population (3,200), including workers, technical staff, and other groups of people, is likely to congregate in the area during construction. Domestic wastewater and human waste must be well managed, and so must any friction arising from social, cultural, and economic differences between these groups and the local communities. The technical staff, assumed to be of higher economic status and used to more urbanized surroundings, will not be likely to use wood as fuel if adequate alternative sources are provided. But the workers and other groups of people (about 2,400) may use fuelwood. On average, the yearly fuelwood requirement will be about 876 m^3 (1.0 x 365 x 2,400 x 10^{-3}). One tree will yield about 2–3 m^3 of fuelwood. Thus, to meet the yearly requirement about 400–500 trees will be cut and about 1–2 ha of forest area will be cleared if no other sources of fuel are provided. To minimize the impact, community kitchens using liquefied petroleum gas or diesel as fuel are recommended. The workers may also cut trees to build houses and to meet other needs. If proper measures are not taken, the terrestrial flora could be adversely affected. Since the labor camps are to be built by the contractor with the necessary facilities, the impact can be mitigated.

89. **Water Supply.** The large number of workers and technical labor in the project area during construction is likely to put considerable stress on the ecosystem. The labor camps will probably be clustered near Kartaul village, near adit I, the barrage, and the proposed powerhouse sites. The contractor can make blocks of two large rooms each for about 30–40 workers, with community toilets close by. During the winter months, a central heating system can also be provided so that the workers are not forced to cut trees to get the fuel they need to heat water. Water for drinking is collected from the rivers or streams flowing upstream of the labor camps and stored in tanks. The water quality is generally good and does not need elaborate treatment, but it should be disinfected before distribution. The labor camps and settlements will be placed far from the sources of drinking water. Water for HEP operation will be drawn only from the Sainj river and not from the intermediate streams above the HRT. The reduction in flow or drying of the river in the intervening stretch is not likely to have an adverse impact on the downstream population, which uses water from streams flowing beside their settlements, and not water from the Sainj river, for irrigation. Thus, no significant impact is anticipated as a result of changes in the hydraulic regime of the Sainj river.

90. **Sewage.** The domestic water requirement is estimated at 70 liters per person per day, and the total water requirement at 0.22 million liters per day (mld). About 80% of this total

(0.18 mld) is assumed to be generated as sewage, discharged untreated. The BOD load from domestic sources will be about 144 kilograms (kg) per day. The dissolved oxygen level in the river is assumed to be 8.0 mg/l. About 160 community latrines and an oxidation ditch can be built to treat the sewage from the labor camps before it pollutes the river water. About 2 cumec of minimum flow is needed to dilute the sewage.

91. **Solid Waste Generation.** The labor camps will produce about 1.6 tonnes/day of solid waste. Adequate facilities need to be developed for its collection, conveyance, and disposal. The solid waste will be disposed of at the designated landfill sites. A landfill can be designed in the following way: a layer of impervious clay at the bottom, followed successively by layers of impervious liner (geo-membrane), sand, well-compacted solid waste, clay, and finally soil. The topmost layer can be vegetated to improve appearance.

(i) **Refuse storage.** Labor camps in the Project are proposed at two or three locations. Each camp will have provisions for the separate storage of degradable and non-degradable solid waste. A truck will collect the solid waste. If possible, degradable and non-degradable solid waste will be collected separately. Two separate dustbins will be set aside for this purpose. Workers will be trained to segregate degradable and bio-degradable wastes through a sustained awareness program.

(ii) **Disposal.** The degradable portion of the solid waste will be disposed off at the muck disposal sites. The non-degradable portion, such as plastic bottles and cans, will be segregated and disposed off at separate sites identified by the district administration.

d. Socioeconomics

92. Job opportunities for the local population during construction will give great impetus to the local economy. Shops, food stalls, and tea stalls, aside from a variety of suppliers, traders, and transporters, will flock to the area and benefit greatly as demand for almost all types of goods and services increases. The business community as a whole will benefit. Opportunities arising from the Project will boost local incomes. Infrastructure facilities in the area will also improve.

93. **Resettlement.** Private land (about 8.77 ha) is to be acquired from Sachen Kothi Vanogi, Shanshar Kothi Shainshar, and Gara Parli Kothi Shainshar revenue fati. About 206 PAFs are likely to lose their land (agricultural, nonagricultural, or homestead), in varying proportions. The issues related to resettlement and rehabilitation are discussed separately in the social assessment report.

94. **Agriculture.** Agriculture will be affected by the permanent or temporary loss of agricultural land and crops due to construction activity. Land will be acquired for the construction of the HEP. As far as possible, prime agricultural land will be avoided and the construction will be done after crop harvesting. Adequate compensation will be given in exchange for the land and crops lost. The extent of land required for the Project and the compensation to be given are dealt with separately in the social assessment report.

95. **Cultural Sites.** Apart from a village temple, no monuments or sites of cultural, religious, historical, or archaeological importance were reported in the project and the study area and in the alignments for the barrage and the powerhouse; hence, no impact is envisaged in this regard.

3. Environmental Impact of Operations

96. During operation, most of the impact from construction will stabilize and the impact during project operation and maintenance (O&M) will be very limited.

a. Physical Resources

97. **Impact on Topography.** No topographic changes are foreseen during operation, as existing access routes will be used during O&M.

98. **Impact on Climate.** The study area along the HEP also includes forest areas. The removal of some trees for the construction of the HEP could lead to climatic changes in the area. The impact of tree removal will be monitored.

99. **Impact on Hydrology.** The headworks for the HEP consist of a small barrage for diversion; hence, the operation will not have a significant impact on hydrology, including the water table in the area. Some erosion will take place, mainly on the terraces and slopes covered with soil. The terraces are glaco-fluvial in origin and the soil is eroded by runoff water. Also, fragmented rock boulders along the steep slopes and escarpment commonly fall because of gravity.

100. **Imbalances.** Tectonically, the project area has undergone three to four phases of deformation. It is located north of the main central thrust, a well-defined tectonic lineament; however, the entire stretch of scheme is located over a stable area. In the stretch of power channel, leakages may cause saturation of debris material, which may result in slope failure. However, there is no danger of any significant damage being caused through the action of the Project.

101. **Sediment.** The project area is characterized by steep slopes covered with thickly vegetated soil. Small streams are the main source of erosion in the area, as runoff water causes flow of soil and small rock masses from the slopes. Sedimentation is not significant, as streams have enough capacity to carry sediment. During the rainy season, large blocks or boulders carried from the upper zones are often dumped in the riverbed at lower reaches because of changes in gradient or the broadening of the riverbed.

102. **Impact on Air Quality.** Since the Project does not involve any air emissions, it will have no negative impact on air quality in the region during its operation.

103. **Impact on Noise Levels.** During operation, the noise from the powerhouse and switchyard will be heard only within 15–30 m. The major source of noise in a hydroelectric generation project is the operation and movement of various pieces of equipment. There are habitations within 2–3 km from the project site. The daytime equivalent noise level at various sampling stations ranged from 32 dB(A) to 45 dB(A) in the summer, from 34 dB(A) to 46 dB(A) in the monsoon season, and from 37.5 dB(A) to 39.6 dB(A) in the winter, well within the permissible limits set for residential areas by the Central Pollution Control Board (CPCB). The increase in noise levels has been estimated, with the above assumption, to be of the order of 10 dB(A) at a distance of 1 km from the noise source. However, given this range of baseline noise, the noise levels in the area may remain until water is abstracted for diversion through the HRT. Once the Project is commissioned, the noise levels are bound to reduce significantly.

104. **Impact on Surface Water Quality.** The operation of the proposed HEP will not have any major impact on the quality of surface water and groundwater in the area. The equipment that will be used in the powerhouses and switchyards will be free of polychlorinated biphenyls and chlorofluorocarbons.

105. **Decline in Water Quality.** The operation of a run-of-river type of project necessitates abstracting water from rivers or streams and diverting it into water conductor systems, thereby disrupting the longitudinal connectivity of the natural aquatic system. Such a disruption has many adverse effects on the downstream as well as the upstream environment. Many aquatic fauna and planktonic flora either cannot traverse the length of the river or are severely restricted in their movement by the obstruction created. The viability of their population and the aquatic environment of the river are, in turn, affected. At Sainj, the groundwater position of this area will not change, because of the steep slope surface and the watertight lining of the tunnels. There is no major irrigation scheme in the area. In view of the above, the Project will not have any adverse impact on irrigation, or on the ground and surface water position of the area. In the first few years, the ground will stabilize. The runoff from the road and project sites will have a natural tendency to flow toward the Beas river or its tributaries. For some distance downstream of the barrage and adits, sediment levels could increase, reducing light penetration and increasing turbidity.

106. **Impact on Groundwater Quality.** Groundwater can be polluted by chemical substances and oily waste leached by the precipitation of water and percolating to the groundwater table. Avoiding spills at the powerhouse will minimize the chances of leaching chemicals to groundwater. Adequate treatment facilities should be provided at the substation areas, as stated above, to avoid groundwater pollution.

107. **Impact on Soil and Geology.** No impact on soil is expected during operation.

b. Ecological Resources

108. **Impact on Terrestrial Ecology.** New roads will make the area more accessible but also more vulnerable to human interference leading to adverse impact on the terrestrial ecosystem. The interference can take the form of illegal logging, lopping of trees, and collection of non-timber forest produce. Since the region does not have a significant wildlife population, the adverse impact of such interference is likely to be marginal.

109. **Impact on Aquatic Ecology.** The Project will significantly change the riverine ecology, as the river transforms from a fast-flowing water system to a quiescent lacustrine environment. Such an alteration of the habitat will bring changes in physical, chemical, and biotic life. Among the biotic communities, certain species can survive the transitional phase and adapt to the changed riverine habitat. However, for varied reasons related to feeding and reproductive characteristics, other species among the biotic communities cannot acclimatize to the changed environment and may disappear in the early years of water impoundment. Micro-biotic organisms, especially diatoms like blue-green and green algae, have their habitats beneath boulders, stones, and fallen logs along the river, at a depth where light can penetrate. But the depth will increase with the construction of the barrage; as a result, these organisms may perish.

110. Among aquatic animals, the migratory fish species, e.g., snow trout and brown trout, are likely to be adversely affected by the obstruction created by the barrage. The completion of the barrage will considerably reduce the flow in the downstream stretch of the river, more so during the

lean period. This situation may adversely affect the benthic community and fish. The following measures can be adopted for the management of impact during operation:

(i) **Release of desired flow of 15% minimum discharge during the lean season.** The tailrace channel will merge again about 8.5 km downstream of the barrage. However, MOEF clearance requires a release of 1.0 cumec from the barrage, which is 21% of minimum flow.

(ii) **Provision of fish pass.** Snow trout (*Schizothorax richardsonii*) is the endemic species. The barrage on the Sainj will be a barrier to the free movement of fish species. Therefore, a fish ladder has been provided in the barrage. The cumulative flow downstream will be 2.03 cumec.

(iii) **Supplementary stocking of fish.** *S. richardsonii* is categorized as a vulnerable species among the threatened fishes of India. Scientific management of the existing stock therefore needs to be adopted. The water-spread area in the Project is quite small and the Project is envisaged as a run-of-river scheme, with significant diurnal variations. Hence, reservoir stocking in the Project is not recommended. To offset the fishery losses in the stream and develop fishery, additional infrastructure for the rearing of fish hatchlings can be constructed to make trout seed available for stocking.

111. **Eutrophication Risks.** Fertilizer use in the project area is negligible. The use of phosphates, the main agents of eutrophication, is only about 0.002 mg/l, according to the water quality assessment. Hence, runoff at present does not contain a significant amount of nutrients. Even after the Project, the use of fertilizers (particularly phosphates) in the project catchment area is not expected to rise significantly.

c. Human Environment

112. **Health and Safety.** Accidents due to electrocution, fires and explosions, and exposure to electromagnetic fields along the tunnel alignment and at the powerhouse may occur. Houses will not be allowed within the vicinity of the Project. At the HEP level, a safety and emergency procedures manual will be kept. Necessary training regarding safety aspects for personnel working at the project site and line inspectors will be provided. Personal protective equipment like safety gloves, helmets, and mufflers will be provided during construction and during maintenance work. Importance will be given to maintaining hygienic conditions and good aesthetics at the substations.

113. **Vector-Borne Diseases.** The change in population density through the influx of immigrants may cause new health problems in the region. People may carry different types of contagious diseases that could spread in the locality. The new arrivals may also stress available drinking water sources and sanitary facilities. The additional domestic sewage generated may cause contamination of drinking water, resulting in the spread of enteric diseases if proper precautionary measures are not taken. The Project will increase the water-spread area and, correspondingly, the shoreline. The incidence of malaria in the project area and its surroundings is therefore also expected to increase. The wider water-fringe area will provide suitable habitats for vectors of various diseases, leading to a higher incidence of water-related diseases. Malaria is the major water-related vector-borne disease. Thus, malaria control measures aimed at destroying the habitat and interrupting the life cycle through mechanical, biological, or chemical means need to be implemented. The anopheles mosquito, which is responsible for malaria, is not found in high altitudes, and the impounding of water will not allow mosquitoes to start breeding and pose a health risk.

114. **Increased Human Interference.** The project area is already accessible by road. Increased accessibility can mean increased human interference. The Project will also make the villages on the left bank more accessible. Increased human interference could have marginal adverse impact on the terrestrial ecosystem.

115. **Solid Waste Generation.** Solid waste, such as metal scraps, wooden packing material, and oily waste, may be generated. Separated oily waste and scrap will be collected and disposed of in compliance with the Environmental Protection Act (1986) and applicable regulations and rules.

d. Socioeconomics

116. Beneficial impact on socioeconomic conditions is foreseen, as there will be rural and urban electrification and social infrastructure around the project areas. A permanent residential as well as nonresidential complex for project planning and design will be constructed in Sundarnagar, in Mandi district. A permanent residential and nonresidential colony for the construction of the Project is to be established in Ropa village, midway to the proposed barrage and powerhouse sites. Labor huts, stores, and field offices will be built in Kartaul near the barrage and adits, and in Suind near the surge shaft. An office complex in Ropa village for the construction of the barrage, powerhouse complex, penstock, surge shaft, and tunnels is likewise proposed. Adequate provisions have been made in the Project for the building of a hospital and a school to cater to the needs of the construction force. First-aid posts will be set up at all project sites. Industrial development, triggering economic growth in this backward region of the state, is likely.

E. Economic Assessment

117. Electricity from the proposed hydroelectric plants under the Program will go directly to the local grid (only the surplus during the season of peak water flow will be exported to the Northern grid), thus helping to meet the local demand for more energy resources. The overall objective of expanding clean energy generation will contribute to the economic development of the state on several fronts, with no adverse effects on air quality. The Project is expected to result in more reliable power to consumers, particularly commercial, industrial, and agriculture consumers in the state, thus promoting commercial activities. Furthermore, the Program will create considerable jobs in the state, both during construction and throughout the life of the Project. Social services in Himachal Pradesh will also improve. Poor and vulnerable consumers (including hospitals, schools, and other social utilities), which are often hit hardest by inadequacies in power supply and quality, and by load shedding, will benefit directly from the Program. Clean energy development, as promoted by the Project, will contribute to local, regional, and global environment initiatives. The Program will likewise benefit all electricity consumers connected to the Northern grid by allowing the state to export excess power, and do away with the need for Himachal Pradesh to import power from the Northern grid. GOHP can thus increase its overall generating capacity and meet its objective of universal electrification under the 11th Five Year Plan.

118. The Program makes the following key assumptions: (i) macroeconomic growth will remain stable; (ii) the state government will remain committed to power sector reforms and institutional improvement; and (iii) GOHP will carry out its investment plan, which successfully combines physical infrastructure investments with nonphysical investments in capacity development for a sustainable power sector. Among the risks to the Program would be a slowdown in the depth and pace of policy and sector reforms, including those related to

regulation, governance, financial management, institutional change, and tariff regimes. These risks can be mitigated through concerted action, political commitment, and sound supervision. GOHP is fully committed to expanding its power supply and continuing with a second generation of sector reforms. The reforms will involve further improvements in tariffs and corporate governance, institutional change, and increased private sector participation. The state is closely following the implementation of the long- and medium-term plans for the sector, with hydropower development having a prominent role, and recognizes that capacity development is a major part of the process.

119. The Program will contribute to economic development in Himachal Pradesh through expanded power supplies from clean energy sources, and from a sustainable state electricity sector. The proposed outcomes are: (i) increased production and use of clean energy in a financially sustainable manner, (ii) improved state finances and power sector financial viability, (iii) improved sector governance, and (iv) improved capacity in HPPCL for the planning, implementation, and management of hydroelectric plants, as well as the implementation of Clean Development Mechanism (CDM) initiatives and energy efficiency through a power trading program. More specifically, the Program makes the following assumptions related to the hydropower plant projects: (i) HPPCL will be committed to the timely construction and operation of the projects and will exercise proper supervision over their implementation, including the implementation of safeguard plans; (ii) tariffs for the projects or appropriate arrangements for the sale of excess power will be concluded without material delay; (iii) GOHP will continue to support capacity development and will assume ownership of the Program's capacity development component; and (iv) the subprojects will be eligible for CDM financing (purchase of carbon credits), and the CDM will be extended beyond its 2012 end date.

F. Potential Cumulative and Induced Impact

120. The proposed project will minimize the environmental costs of providing the required increase in power-evacuating capacity of the state. Run-of-river hydroelectric projects of the type proposed are recognized internationally as the preferred option over fossil fuel plants. An alternative power plant using fossil fuels (coal or oil) would have a capital cost per kilowatt installed significantly in excess of that of the proposed plant. Energy markets in India are now shifting toward least-cost-based economy of operation. Generation costs from thermal plants are expected to increase with escalating costs of fuel and transportation, while generation costs from hydropower plants normally decline every year with respect to first-year tariffs, although these tariffs may be marginally high. Hydropower development is being given priority to improve the hydro/thermal mix for optimizing the efficiency of the country's power system and its use of resources for sustainable power generation in an environment-friendly manner. Apart from being an environmentally clean source of energy, hydroelectric power will also provide a peaking-power option for the country. From the operational angle, hydroelectric projects provide synergy for optimizing generation, save on fuel, minimize greenhouse gases, and produce power in an environment-friendly manner, supporting sustainable development. Such projects as proposed have minimal environmental impact while providing energy in remote and hilly areas where the extension of grid systems is either impossible or uneconomical. Hydroelectric projects, especially run-of-river projects, are economically viable and environmentally benign, and have relatively short gestation periods.

121. The Program does entail potential cumulative and induced impact, which will be largely positive. The Program will transfer low-carbon energy from hydroelectric plants in Himachal Pradesh to state-level transmission companies, which, in turn, will transmit energy to distribution

companies. The direct negative impact might result from (i) the acquisition of land for roads and ROW, power evacuation lines, and transmission lines and substations; and (ii) upstream and downstream hydroelectric projects in Himachal Pradesh and adjoining states, and are summarized in the table below.

Table 10: Assessment of Cumulative Impact

Parameter	Without Project	With Project	Net Change	Magnitude of Impact
Crops	Nil	Negative	Small	Low
Natural Vegetation	Nil	Negative	Small	Low
Land Use	Nil	Negative	Small	Medium
Forests	Nil	Negative	Small	Medium
Natural Reserves/Sanctuaries	Nil	Negative	Small	Low
Fisheries	Nil	Negative	Small	Medium
Eutrophication	Nil	Negative	Small	Low
Wildlife	Nil	Negative	Small	Low
Rare Species	Nil	Negative	Small	Low
Endangered Species	Nil	Negative	Small	Low
Species Diversity	Nil	Negative	Small	Low
Minerals	Nil	Nil	Nil	Nil
Water Pollution	Nil	Negative	Small	Low
Air Pollution	Nil	Negative	Small	High
Noise Pollution	Nil	Negative	Small	Low
Solid Waste	Nil	Negative	Small	Low
Land Pollution	Nil	Negative	Small	Medium
Soil Erosion	Nil	Negative	Small	Medium
Health	Nil	Positive	Big	High
Benefits to Economy	Nil	Positive	Big	High
Displacement of People	Nil	Negative	Small	Low
Employment Opportunities	Nil	Positive	Big	High
Infrastructure	Nil	Positive	Big	High
Hydrological Balance	Nil	Negative	Small	Low
Social Upliftment	Nil	Positive	Big	High
Aquaculture Potential	Nil	Negative	Small	Low
Archaeological Monuments	Nil	Nil	Nil	Nil
Water Availability	Nil	Negative	Small	Low
Siesmicity	Nil	Negative	Small	Low
Alignment	Nil	Negative	Big	Medium
Tourism	Nil	Positive	Small	Low

Source: Environmental impact assessment report (footnote 4).

122. The positive impact includes (i) the expansion of low-carbon energy, offsetting emissions from thermal power plants; (ii) the improvement of transmission system efficiency and the promotion of renewable energy; and (iii) economic growth related to improved power supply to millions of consumers. The Project is expected to reduce carbon dioxide (CO_2) emissions by about 0.26 million metric tons (MT) per year. In addition, the Project is expected to offset the emission of 9.2 MT/day of SO_2 and 4.6 MT/day of NO_x, given the emissions from an equivalent amount of electricity generated from the National Thermal Power Corporation's Sipat Thermal Power Plant, a modern coal-fired plant. These emission offsets will lessen the negative impact of local, regional, and global air pollution.

123. **Socioeconomic Aspects.** The direct benefits include employment creation and capital infusion. While the direct employment opportunities in the Project will be limited, thousands of employment opportunities will be created indirectly for local people in the region because of the state policy of giving preference to local people for unskilled and semiskilled jobs. Apart from these, many other livelihood opportunities will become available to the entire population in the area through facilities like roads, hospitals, and schools. The Project will bring much-needed

clean hydropower from a remote area of the country to the most densely populated region. The development of the Project as well as the present transmission project will create jobs for local people and thereby help raise their economic status.

124. The Sainj is a major tributary of the Beas river. The Sainj HEP, one of the first such projects on the Sainj, will help meet the ever-increasing power requirement of the Northern region. The Parbati III HEP is the next downstream project on the Sainj river, with a proposed installed capacity of 520 MW. There are number of other projects in the Beas basin, for which a CAT plan either being prepared or being implemented. A detailed summary of HEPs under operation, construction or proposed in the Beas river basin is given in Table 11. The downstream projects generate similar impact that, in the same manner as for the Sainj project, will need to be incorporated in the environmental impact assessments and environmental management plans by each project's proponent.

Table 11: Major Hydroelectric Projects Proposed, under Construction, or in Operation on the Beas River

Project Name	Capacity (MW)	Remarks
Larji HEP	126.0	In operation (HPSEB)
Parbati stage II and III HEP	800.0 520.0	800 MW under construction 520 MW DPR ready, under study
Malana stage II HEP	100.0	Being implemented with the private sector
Allian Dhuhangan HEP	192.0	Being implemented with the private sector
Khauli stage II HEP	6.6	Being implemented
Fozal HEP	9.0	DPR by M/S Cosmos Consulting Ltd. ready; allotted to private sector
Baragaon HEP	11.0	DPR by M/S Padmini Traders ready; allotted to private sector
Lambadug HEP	25.0	DPR by M/S Himachal Consortium ready; allotted to private sector
UHL stage III HEP	100.0	Being implemented (HPSEB)
Neogal HEP	15.0	DPR M/S Om Power Ltd. ready
Kilhi Balh HEP	7.5	Advertised for implementation by IPP
Sanj HEP	100.0	Being implemented with HPPCL
Patikari HEP	16.0	DPR by M/S East India Petroleum Ltd. ready; in operation with private sector participation
Dhaula Sidh HEP	40.0	M/S GVK Industries Ltd.

DPR = detailed project report, HEP = hydroelectric project, HPPCL = Himachal Pradesh Power Corporation Limited, HPSEB = Himachal Pradesh State Electricity Board, IPP = independent power producer, MW = megawatt.
Source: Public information, HPPCL.

G. Environmental Management Plan

125. The EMP summarizes the anticipated impact, the monitoring requirements, and the proposed mitigation measures for the following stages: (i) pre-construction, (ii) construction, and (iii) O&M. Detailed, site-specific mitigation measures and monitoring plans are being developed for all core subprojects. Project environmental management is being undertaken by HPPCL in accordance with the management measures proposed in the comprehensive EIA. A number of abatement measures have already been suggested, along with the likely impact. The objective of the EMP is to minimize stress on natural resources within the carrying capacity.

126. The implementation of the Sainj HEP covers the infrastructure components listed in Table 12. These subprojects are divided into core and noncore subprojects on the basis of their

duration and urgency for project implementation.

Table 12: Summary of Infrastructure Components of the Sainj HEP

Main Components	Infrastructure	Core/Noncore	ADB Funding
Electrical and Mechanical Equipment	Buildings	Core	Yes
	Equipment, housing	Core	Yes
Tunnels	Diversion structures–surface water intake	Core	Yes
	Peaking storage	Core	Yes
	Desiltation tanks / Reservoirs	Core	Yes
	Access roads	Core	No
	Muck dumping sites	Core	No
Civil Works	Buildings	Core	No
	Barrage, gates	Core	Yes
	Construction workers' temporary settlements	Core	No
	Staff housing	Noncore	No
	Access roads to quarters	Noncore	No
Power Evacuation	Switchyard	Core	No
	Transmission line to pooling point	Noncore	No

ADB = Asian Development Bank.
Source: HPPCL.

1. Institutional Arrangements

127. The Multipurpose Projects and Power Department of the GOHP will be the executing agency of the Program, and HPPCL will be the implementing agency, with a specific project management unit (PMU). Each of the component HEPs will be implemented independently through project implementation units (PIUs). An environment and social management unit (ESMU) headed by a chief environmental specialist and a chief resettlement specialist has been set up within the PMU along with other engineering units to address environmental and social issues of the Program. The ESMU will have one environment and one social development/resettlement specialist at each PIU level to assist the chief specialist. For each subproject EMP, the PMU will take charge of overall coordination, preparation, planning, implementation, and financing. HPPCL will ensure that key institutions, including local governments, are involved in EMP updating and implementation. The Program includes a $12 million capacity development component with funds for HPPCL staff training. Environmental personnel will receive training in environmental management under this component.

128. **Monitoring Responsibilities.** Monitoring during the construction of the HEP will be the responsibility of HPPCL. Monitoring will be a continuous process at all stages—site selection, construction or maintenance, compliance with construction contracts, state and health of the environmental resource, and effectiveness of mitigation measures. It is proposed that HPPCL set up PIUs to report regularly to ADB. Although the EMP has been formulated to minimize recurrent responsibilities and costs in circumstances where staff, expertise, and finances are limited, some aspects of subproject design will require continuous monitoring to guard against negative environmental impact. Apart from the site managers, who will be reviewing the progress daily, regular project review meetings where the environmental aspects of the subprojects are discussed and the required remedial measures taken should be held at least monthly. Excerpts from these meetings will be submitted to the PIU. The mitigation measures suggested require monitoring of environmental attributes both during construction and during the operation of the Project. Details on agencies responsible for EMP activities are given in Table 13.

Table 13: Institutional Roles and Responsibilities for EMP Implementation Activities

Activity	Responsible Agency
Subproject start	
Establishment of ESMU and staff	HPPCL
Disclosure of project EMP details through public notice	PMU/ESMU
Community/Household meetings with PAPs	ESMU/PMU/PIU
Updating of EMP mitigation measures on startup	
Census of all affected persons	PMU/PIU/ESMU/district administration
Discussions/Meetings/Workshops with affected persons and other stakeholders	PMU/PIU/ESMU
Incorporation of any changes in the EMP	PMU/PIU/ESMU
EMP implementation	
Implementation of mitigation measures proposed in the EMP	PMU/PIU/ESMU
Consultations with affected persons during implementation of EMP mitigation measures	PMU/PIU/ESMU
Grievance redress	PMU/PIU/ESMU/NGO/GRC
Internal monitoring	PMU/PIU/ESMU
External monitoring	External agency

ADB = Asian Development Bank, ESMU = environment and social management unit, EMP = environmental management plan, GRC = grievance redress committee, HPPCL = Himachal Pradesh Power Corporation Limited, NGO = nongovernment organization, PAPs = project-affected persons, PIU = project implementation unit, PMU = project management unit.
Source: HPPCL.

2. Organization Support System

129. **Environmental Monitoring Program in HPPCL: Implementing Agency/Corporate Level.** This environmental management and social unit at the corporate level, headed by a senior HPPCL official with environmental and social monitoring responsibilities at the highest level, will have the following duties:

(i) Monitor and implement mitigation measures;
(ii) Prepare and implement environmental policy guidelines and environmental good practices;
(iii) Advise and coordinate the activities of regional environmental management cells toward effective environment management;
(iv) Coordinate with MOEF and the state Department of Environment and seek their help in solving environment-related issues during project implementation;
(v) Advise the project planning cell on environmental and social issues to avoid negative environmental impact; and
(vi) Train project staff and increase their awareness of environmental and social issues related to hydroelectric projects.

130. **Environmental Monitoring Program in HPPCL: Project Implementation Unit Level.** At the PIU, HPPCL has made the project head responsible for implementing the environmental and social aspects of the Project. The duties of the environmental cell at the divisional level are:

(i) Implement the environment policy guidelines and environmental good practices at the sites;

(ii) Advise and coordinate the activities of the field offices toward effective environmental management;
(iii) Coordinate with the HPSPCB and seek its help in solving issues related to environment monitoring;
(iv) Carry out environmental and social surveys in conjunction with the project planning cell to avoid negative environmental impact;
(v) Train the field offices and increase awareness of environmental and social issues related to hydroelectric projects;
(vi) Implement the EMP and the social management plan (SMP); and
(vii) Monitor the EMP and the SMP and produce periodic reports on these.

3. Grievances

131. An efficient grievance redress mechanism will be developed to help answer the queries and complaints of PAPs. Each PIU will have specific grievance redress mechanisms pertaining to the EIA/EMP. The grievances of PAPs will first be brought to the attention of the PIU at the appropriate level. Grievances not redressed by the PIU staff will be brought before the grievance redress committee (GRC), composed of representatives from PAPs, the PMU, the PIU, the ESMU, field staff, the district magistrate, the local administration, the revenue authority, and the local community. Records will be kept of all grievances received including: contact details of the complainant, the date the complaint was received, the nature of the grievance, the agreed corrective actions and the date these were effected, and the final outcome. The GRCs will continue to function during the life of the Project including the defects liability period.

4. Monitoring and Evaluation

132. The implementation of mitigation measures will be audited to identify ineffective measures or implementation procedures, and thus enable the design of better measures and the implementation of corrective actions. Both internal and external monitoring of the EMP will be carried out.

133. **Internal Monitoring.** Internal monitoring will be the joint responsibility of the PMU, the PIU, and the ESMU. The local PIU will be responsible for the actual monitoring of the EMP implementation with oversight from the PIU and the ESMU. The internal monitoring will include administrative monitoring: daily planning, implementation, feedback, and troubleshooting in EMP monitoring. Monitoring and evaluation reports documenting progress in EMP implementation as well as subproject completion reports will be provided by the PMU to ADB for review.

134. **External Monitoring.** HPPCL will hire an independent agency or civil society organization not associated with project implementation to undertake external monitoring and evaluation. The external monitor will monitor and verify EMP implementation to determine whether its goals have been achieved, and livelihood and living standards have been restored, and will provide recommendations for improvement.

135. **Reporting.** The PIU will forward quarterly progress reports on monitoring progress to the chief environment specialist at HPPCL headquarters. The reports will deal with the progress made in EMP implementation, with particular attention to compliance with the principles and matrix set out in the EMP. HPPCL will submit a semiannual monitoring report to ADB. Also, the external monitoring agency will report directly to ADB every 6 months, stating whether sound

environmental management practices have been achieved, and suggesting suitable recommendations and remedial measures for midterm correction and improvement.

5. Environmental Assessment and Review Procedures for Noncore Subprojects

136. Noncore subprojects, also listed in Table 12, include the construction of staff quarters, access roads, and transmission lines associated with the core subprojects and similar in nature. The scale and characteristics of the potential environmental impact of noncore subprojects are expected to be similar to those already assessed in this SEIA, and based to a significant extent on local conditions. HPPCL will prepare site-specific measures to assess the potential impact of these noncore subprojects on the environment.

137. **Noncore Subproject Selection Criteria.** The specific environmental criteria for subproject selection are:

(i) The transmission lines and roads will not be located within or cross areas of virgin forests, or ecologically significant or environmentally sensitive areas such as national parks, nature reserves, or wetlands designated by MOEF.
(ii) The potential environmental impact associated with initial alignments and locations will be minimized through realignment or selection of alternative access roads.
(iii) Monuments of cultural or historical importance will be avoided.
(iv) The clearing of forest resources will be avoided as far as possible, and where unavoidable will be minimized and compensated according to the regulatory criteria of the Government of India.
(v) An EMP with adequate budget will be developed for each subproject.
(vi) Environment category A transmission subprojects will be avoided to the extent possible. All noncore subprojects will be subject to ADB classification, and any subprojects deemed "sensitive" will require justification and documentation that the anticipated impact can be effectively mitigated.

138. **Application of Selection Criteria.** Any noncore subproject that does not meet the criteria listed above will be rejected. A final check on conformity with the selection criteria will be the submission of selected noncore subprojects for ADB clearance. On the basis of the assessment of subprojects in previous sections of this SEIA, if any category A project component is selected, the EIA will have to undergo a full, rigorous review before implementation. However, any candidate subproject confirmed by ADB as category B sensitive[14] during implementation will require an EMP for ADB review. The summary IEE for the Project along with its EMP will be made available to the general public at least 120 days before the approval of the subproject, in line with ADB OM section F1/OP, para. 15 (footnote 12).

139. **Environmental Classification.** Environmental categorization using a checklist approach in compliance with ADB's *Environmental Assessment Guidelines* (2003) will be applied. Any category A subproject selected will be treated in accordance with these guidelines for full review before implementation.

[14] Category B–sensitive projects could involve projects that (i) are near environmentally sensitive areas; (ii) involve deforestation or loss of biodiversity in protected areas; (iii) involve voluntary resettlement issues; (iv) involve the processing, handling, and disposal of toxic and hazardous substances; or (v) involve other environmentally sensitive activities that may also be of concern to a wide group of external stakeholders.

140. **Public Consultations.** At least one public consultation will be conducted with the local community and potentially affected people for each category B subproject. Any EIA/IEE that has been approved before the start of detailed design must be communicated to the local community before construction. One more consultation will be carried out before the appraisal of the project activities by ADB.

141. **Responsibilities and Authorities of Various Agencies.** The PIUs will be solely responsible for the implementation of the entire environmental assessment and review procedures for the selection of noncore subprojects. This responsibility includes, among others, ensuring that the EMP is adhered to strictly, in a timely and adequate manner, environmental monitoring and institutional requirements are fully met, and public consultations are carried out satisfactorily. The PIUs will submit the categorization checklist, complete rapid environmental assessment (REA) checklists, and submit monitoring reports to ADB for review. ADB will be responsible for the regular review and timely approval of subproject checklists and compliance with the EMP for each subproject. If needed, ADB will provide technical guidance to the PIU. ADB will also review the monitoring reports and officially disclose on its website the status of subproject compliance with ADB's environmental guidelines for selected subprojects.

142. **Detailed Design.** Detailed design work for each additional subproject must follow the recommendations of the draft EMP. To ensure this, detailed designs will be vetted by PIUs before contracts are finalized, and modifications will be made if considered necessary. Certification must be made to ADB that the detailed designs comply with the EMP recommendations before contracts can be finalized.

143. **Preparation of Construction Contracts.** Early in the implementation period, model construction contracts incorporating general environmental safeguards and practices will be prepared. Specific, individual contracts will be based on the model contracts, but vetted by PIUs to ensure that they incorporate specific safeguards recommended for the particular subproject.

144. **Monitoring during Construction**. Monitoring during construction will be the responsibility of the PIU. Monitoring will relate to compliance with construction contracts, and assessment of the state and health of the environmental resource and the effectiveness of mitigation measures. The monitoring results will be reported regularly to ADB.

145. **Monitoring of Subproject Operations.** Although the draft EMP is formulated in such a way as to minimize recurrent responsibilities and costs in circumstances where staff, expertise, and finances are limited, some aspects of subproject design will require continuous monitoring to guard against negative environmental impact. For additional noncore projects, the implementing agency is expected to do the primary categorization, to be confirmed by ADB according to the ADB guidelines.

146. The subprojects will have both internal and external monitoring. The PIU will be responsible for internal monitoring of EMP implementation, and will forward quarterly progress reports to HPPCL headquarters. The report will discuss the progress made in EMP implementation, with particular attention to compliance with the principles and matrix set out in the EMP. HPPCL will submit a monitoring report to ADB twice a year.

6. Preliminary Cost Estimates

147. **Catchment Area Treatment Plan.** A CAT plan and a muck management plan are also attached to the EMP document prepared by HPPCL. The directly draining catchment area is 39,730 ha in total. The basis for the selection for biological and engineering treatment measures under CAT are given in Table 14.

Table 14: Basis for Selection of Catchment Area Treatment Measures

Treatment Measure	Basis for Selection
Social forestry, fuelwood, and fodder grass development	Near settlements to control tree felling
Contour bunding	Control of soil erosion from agricultural fields
Pasture development	Open canopy, barren land, degraded surface
Afforestation	Open canopy, degraded surface, high soil erosion, gentle to moderate slope
Step drain	To check soil erosion in small streams, steps with concrete base are prepared in sloppy area where there is silt erosion in the stream and bank erosion is high because of the turbidity of the current
Check dam	Stone masonry with cement mortar in 1:6 ratio with concrete base 1:4:8 and galvanized-iron crate walls on steep slopes, sliding surfaces, where there is less vegetative cover and silt erosion is high
Nursery	Centrally located points for better supervision of proposed afforestation, minimized cost of transportation of seedling, and better chances of survival

Source: Environmental management plan report (footnote 4).

148. As part of the CAT plan, various biological and engineering treatment measures have been recommended. The CAT plan highlights the management techniques for controlling erosion in the catchment area of a water resource project. The life span of a reservoir is greatly reduced by erosion in the catchment area. Adequate preventive measures are thus needed for the treatment of the catchment and its stabilization against future erosion. The total catchment intercepted at the barrage site is 39,730 ha. The catchment area considered for treatment under the present project is 13,234 ha, putting it in the “very high and high” erosion category. The total budget estimated for the implementation of the CAT plan is Rs993.15 lakh. The cost summary is given in Table 15.

Table 15: Cost Summary for the Catchment Area Treatment Plan for Sainj HEP (100 MW)

Activity	Unit	Rate (Rs)	Quantity	Financial (Rs lakh)
WORKS				
Biological Measures				
Afforestation	ha	79,000	101	79.79
Gap plantation	ha	59,600	195	116.22
Pasture development	ha	11,800	150	17.70
Fuelwood plantation	ha	59,600	40	23.84
Fodder (silvipasture)	ha	59,600	40	23.84
Social forestry	ha	59,600	90	53.64
Establishment of new nurseries	no.	200,000	5	10.00
Subtotal Biological Measures			621	325.03
Engineering Measures				
Contour bunding	ha	25,000	401	100.25
Stepped drain	Rmt	25,000	105	26.25
Check dams	no.	200,000	15	30.00
Subtotal Engineering Measures				156.50
Wildlife Improvement and Development				94.00
Training, Awareness				20.00
Silt Observatory				40.00
Subtotal Works				635.53
Departmental Charges @ 17.5%				111.22
Total Works				**746.75**
SERVICES				
Eco-Tourism @ 1% of Total Works				7.47
Payment for Environmental Services[a]	L/S			60.00
Eco Task Force	ha			150.00
Total Services				**217.47**
Total Works and Services				**964.22**
Monitoring and Evaluation @ 3% of Total Works				28.93
Grand Total				**993.14**
			Rupees in crores	**9.931**

ha = hectare, HEP = hydroelectric project.
Note: Rates are inclusive of maintenance for 5 years.

[a] To be paid to communities for conservation behavior related to silt load as monitored
Source: Environmental management plan report (footnote 4).

149. The total cost of implementing the EMP is Rs417.75 million, inclusive of the cost of the resettlement and rehabilitation plan. It includes the O&M cost, as well as the cost of various components of the EMP, at 1.5% per year, wherever applicable. Funds for some items like fisheries and health are to be routed through the LADC. Though the commitment for LADC is 1.5% of the total project cost, only those components that are relevant to the EMP are listed here. Summaries of the estimated costs associated with implementing the environmental mitigation measures and monitoring the core subprojects are provided in Tables 16 and 17.

Table 16: Cost of Implementing the Environmental Management Plan

Item	Cost (Rs million)
Compensatory afforestation NPV, cost of trees, and biodiversity conservation	119.26
Catchment area treatment	99.32
Fisheries management	10.00
Public health delivery system	5.19
Environmental management in labor camp	8.36
Muck management	9.75
Restoration and landscaping of construction sites	8.50
Environmental management in road construction	8.84
Greenbelt development	4.00
Water pollution control	2.00
Resettlement and rehabilitation plan (option 2: cash in lieu of land)	136.00
Environmental monitoring during construction	6.53
Total	**417.74**

NPV = net present value.
Source: Environmental management plan report (footnote 4).

Table 17: Budget for Implementation of Compensatory Afforestation and Biodiversity Conservation Plan

Item	Cost (Rs million)
Compensatory afforestation	8.69
NPV	40.55
Cost of trees	34.36
Biodiversity conservation plan	35.65
Total	**119.26**

NPV = net present value.
Source: Environmental management plan report (footnote 4).

150. The cost of implementing the environmental monitoring program during construction is Rs6.53 million, at Rs1.07 million a year. A 10% annual price increase may be considered. The construction period for the estimation of the cost of implementing the environmental monitoring program during construction is taken to be 5 years.

151. Table 18 provides a summary of the environmental monitoring program for the various stages of the Project, and Table 19 and the Appendix summarize the environmental impact, suggested management measures, and responsible implementing agencies. The cost of implementing the environmental monitoring program during operation is about Rs1.16 million a year.

Table 18: Summary of Environmental Monitoring Program during Project Stages

Item	Parameters	Frequency	Location	Cost (Rsmillion)/year
Construction Phase				
Effluent from septic tanks	pH, BOD, COD, TSS, TDS	Once a month	Before and after treatment in oxidation ditch	0.18
Water-related diseases	Identification of water-related diseases, adequacy of local vector control, and curative measures	Three times a year	Labor camps and colonies	0.10
Noise	Equivalent noise level (L_{eq})	Once in 3 months	At major construction sites	
Air quality	SPM, RPM, SO_2, NO_x	Once every season	At major construction sites	0.29
Meteorological aspects	Wind direction and velocity, temperature, humidity, rain	Once every season	At one of the ambient air quality sampling sites	
Ecology	Assessment of flora, fauna, muck disposal area; ecological survey covering forestry, fisheries, wildlife	Once a year	At the total construction site	0.50
SUBTOTAL				**1.07**
Operation Phase				
Water	pH, temperature, EC, turbidity, total dissolved solids, calcium, magnesium, total hardness, chlorides, sulfates, nitrates, DO, COD, BOD, iron, zinc, manganese	Thrice a year	1 km upstream of barrage site, reservoir area; 1 km, 5 km, and 10 km downstream of tailrace discharge	0.46
Effluent from sewage treatment plant	pH, BOD, COD, TSS, TDS	Once every week	Before and after treatment at sewage treatment plant	
Erosion and siltation	Soil erosion rates, stability of bank embankment	Twice a year		
Ecology	Status of afforestation programs for greenbelt development, migration patterns of terrestrial fauna	Once in 5 years	Barrage site	0.10
Water-related diseases	Identification of water-related diseases, sites, adequacy of local vector control measures.	Three times a year	Villages adjacent to project sites	0.30
Aquatic ecology	Phytoplanktons, zooplanktons, benthic life, fish composition	Once a year	1 km upstream of barrage site, reservoir area; 1 km, 5 km, and 10 km downstream of tailrace discharge	
Land use	Landuse pattern using satellite data	Once in a year	Catchment area	0.30
Soil	pH, EC, texture, organic matter	Once in a year	Catchment area	
SUBTOTAL				**1.16**

BOD = biological oxygen demand, COD = chemical oxygen demand, DO = dissolved oxygen, EC = electrical conductivity, km = kilometer, NO_x = nitrogen oxides, RPM = respirable particulate matter, SO_2 = sulfur dioxide, SPM = suspended particulate matter, TDS = total dissolved solids, TSS = total suspended solids.
Source: Environmental management plan report (footnote 4).

Table 19: Summary of Environmental Impact, Suggested Management Measures, and Implementing Agencies

Parameters	Impact	Management Measures	Implementing Agency
WATER ENVIRONMENT			
Water Quality			
Construction phase	Water pollution due to disposal of sewage from labor colonies	Provision of community toilets and oxidation ditch	HPPCL and project contractor
	Deterioration in water quality due to effluent from crusher	Provision of settling tank	Project contractor
	Project appurtenances at lower elevation could face increased incidence of malaria as a result of aggregation of labor, formation of stagnant pools	Ensure water does not stagnate	Project contractor
Operation phase	Deterioration of water quality in the dry stretch of river due to reduced flow during the lean season	Minimum flow of 1.0 cumec will be released	HPPCL
	Disposal of sewage from project colony	Commissioning of sewage treatment plant	HPPCL
	Eutrophication problem	Eutrophication risks are minimal; hence, specific management measures are not required	
	Magnitude of breeding sites for mosquitoes in the impounded water is in direct proportion to the length of the shoreline	Increase in incidence of mosquitoes is not expected at the barrage site because of high elevation; health gacilities provided at district HQ and site offices.	HPPCL
Water Resources			
Operation phase	River stretch from barrage site to tailrace outfall will have reduced flow during lean season	Minimum flow of 1.0 cumec will be released	HPPCL
AIR ENVIRONMENT			
Construction phase	Fugitive emissions due to crusher operation at various sites	Commissioning of cyclone on crusher.	Project contractor
	Increase in SPM level due to vehicular movement during construction	Provision of water sprinkler to settle SPM	Project contractor
	Emission of SO_2 due to combustion of fuel in construction equipment	SO_2 not expected to increase significantly	
NOISE ENVIRONMENT			
Construction phase	Marginal increase in noise levels due to operation of construction equipment	Maintenance of construction equipment; provision of earplugs/ear muffs	
LAND ENVIRONMENT			
Construction Phase	Erosion due to quarrying operation for coarse and fine aggregates; pits and burrows filled with water could increase incidence of malaria as a result of stagnant pools	Proper mining plan for quarrying operation	Project contractor and HPPCL

		Rehabilitation plan for quarry sites after extraction of construction material	Project contractor and HPPCL
	Generation of muck due to underground work	Disposal of muck at designated muck disposal site	Project contractor and HPPCL
		Restoration of muck disposal sites after disposal	Project contractor and HPPCL
	Erosion due to construction of road	Cut-slope to be protected by breast walls	Project contractor and HPPCL
		Provision of catch water and intercepting drain	Project contractor and HPPCL
	Acquisition of about 56.763 ha forest and private land	Plantation of trees along roadside	Forest Department
		Compensatory afforestation for loss of vegetation in lieu of forest land through on-site and off-site conservation	Forest Department
		Net productivity value and cost of tree to be cut to be given to Forest Department	HPPCL
		Resettlement and rehabllitation plan formulated for families losing land according to provisions of the resettlment and rehabilitation policy for Sainj hydroelectric project	GHNP director, HPPCL, and Revenue Department
Operation Phase	Reclamation of muck disposal sites Solid waste from labor camps	Engineering measures, proper plantation done at identified dumping sites Designated landfill sites; storage and disposal will be managed	HPPCL, Forest Department, contractor
BIOLOGICAL ENVIRONMENT			
Terrestrial Flora			
Construction phase	Cutting of trees to meet fuelwood requirements of laborers	Provision of subsidized kerosene and liquefied petroleum gas to construction labor and technical staff	Project contractor/ HPPCL
Operation phase	Acquisition of about 47.993 ha forestland	Compensatory afforestation	Forest Department
Fauna			
Construction phase	Damage to habitats and migration routes of animals	Actions suggested for the conservation of fauna in the region	Project contractor/ HPPCL
Operation phase	Degradation of habitats and migration routes of animals	Strict monitoring of laborers and associated workers	Project contractor/ HPPCL

cumec = cubic meters per second, ha = hectare, HPPCL = Himachal Pradesh Power Corporation Limited, SO_2 = sulfur dioxide, SPM = suspended particulate matter.
[a] Individual costs for each item not made available in the EIAssessment documents.
Source: Environmental management plan report (footnote 4).

H. Disaster Management

152. In the eventuality of any barrage or dam failure, the disaster would be catastrophic, depending on the size and storage capacity of barrages and dams, though in the case of diversion barrages, where storage is only behind the gates, the eventuality of failure of the structure is remote. The probability of structural failure gets reduced further when there is an un-gated portion with a provision for overflow above the structure. Despite such a possibility being very remote, safety measures are to be included in the construction and planning for the safety of the barrages so that loss can be minimized to the extent possible in case of structural failure. The design of the project diversion structure and hydro-mechanical works takes into account the earthquake design parameters developed by the Department of Earthquake Engineering of the Indian Institute of Technology–Roorkee, and verified by the National Committee on Seismic Design Parameters.

I. Public Consultation and Disclosure

153. **Schedule of Public Consultations.** The first public consultation meeting was held on 7 December 2007. It was conducted by officials of HPPCL and was attended by the local villagers. About 26 villagers from the affected villages attended. The public consultation delved into many issues relating to environment and socioeconomic conditions.

154. One of the issues that came to light was the disposal of the muck that would be extracted during project construction.The participants urged HPPCL officials to ensure the proper disposal of muck at designated sites and the protection of the environment and natural water sources. The participants were also of the view that the forests in the vicinity of the project area, which serve many of their needs, should be protected. The participants also suggested that at least 15% of stored water be released (according to government norms) to promote the survival of fish, and that fish ladders be constructed for the upstream and downstream movement of fish in the river. They talked about the poor health-care facilities in the project area and the low employment rate (about 10%). The local economy is primarily agrarian: the people grow wheat, maize, paddy, pulses, and apples. The participants seems to perceive benefits from the construction of the Project in terms of rising opportunities for employment, better education, and health-care facilities.

155. The second public consultation and disclosure of information about the Project occurred on 19 May 2008. HPPCL had submitted the draft EIA report and executive summary to the HPSPCB beforehand. HPSPCB advertised the public hearing in the *Hindustan Times*, *Tribune*, *Danik Bhaskar*, and *Danik Jagran* newspapers on 16 May 2008.

156. The second public hearing took place in Neuli village, Ropa village, Sainj (Banjar) sub-tehsil, Kullu district. It was conducted by HPSPCB in the presence of the additional district magistrate, who chaired the hearing. The participants were briefed regarding the objectives of the hearing, the main HEP mitigation measures, and the salient features of the Project. for the participants were encouraged to discuss and give their views on various issues relevant to the Project. The main issues raised pertained to the stability of the geology; the impact of the Project on water quality, infrastructure development, schooling, and local employment; the treatment of sewage from labor camps and townships; the development of alternative medicinal practices; and compensatory forest planting.

157. A third consultation is planned before loan approval. It will be advertised in the

newspapers and the EIA document will be made available in the local language at the local office of HPPCL.

J. Due-Diligence Review of Associated Facilities

158. The facilities described below are not part of the Sainj HEP (neither core nor noncore) but are associated with the general electrical system of the state of Himachal Pradesh. However, because of their proximity and the likelihood that they will share some transmission line facilities, they are examined below.

159. **Downstream Hydroelectric Projects.** The Sainj river originates at Rakti Dhar at an elevation of about 5,500 m, and drains a catchment of about 729 km^2 in Himachal Pradesh. The proposed barrage site for the 100 MW Sainj HEP project is at Niharani. The total catchment of the Project above the barrage is 408 km^2. Sainj HEP is, chronologically, the last project to be developed in the Sainj valley. Therefore, the baseline data collection and survey for the Project included the cumulative impact of other projects already constructed or under construction. Moreover, Sainj HEP is in the uppermost catchment; hence, its own impact in the valley is negligible. Other HEPs will undergo due-diligence review by HPPCL for the Beas basin. There is only one immediate downstream hydroelectric project, the Parbati stage III project (520 MW), on the Sainj river, which is being constructed by the National Hydropower Corporation. The downstream projects, Parbati stages II and III, have been accorded forest clearance and environment clearance from MOEF. The tailwater level of the Sainj HEP is higher than the maximum reservoir level of Parbati stage III. Therefore, there is no adverse effect on the generation of Parbati stage III. After the construction of barrage, silt content will deposit in the reservoir and minimize the tendency of silting in the downstream reservoir.

160. **Transmission Lines.** The power generated from the Sainj HEP, once transmitted to the electrical grid at the pooling point, will be transmitted along with the power generated from the rest of the hydroelectric projects in the Beas valley through a common transmission line. This will not only produce financial savings but will also lessen the environmental impact. The proposal for such a common transmission line is being prepared separately by the state utility. However, it is significant to mention here that the land requirement and the number of trees involved in the proposal would be kept to the barest minimum. About 19.2 ha of land requirement has been estimated and a case of forestland diversion for this proposal has been submitted by the state transmission utility.

161. The potential adverse environmental impact associated with transmission lines and roads can be avoided or minimized through careful route and site selection. Preliminary site selection will be done on the basis of the topographic sheets prepared by the Survey of India[15] and in the *Forest Atlas.*[16] Transmission line projects are exempted from EIA by MOEF. However, for transmission lines traversing a forest,[17] the project executing agency must obtain forest clearance from MOEF. Under the sector loan modality, the environmental assessment of

[15] Survey Of India is the national survey and mapping organization of the country.

[16] Survey of India. 1982. *Forest Atlas.* New Delhi.

[17] The Indian Forest Act of 1927 regulates the classification and declaration of different categories of forests. Any forestland or wasteland owned by the government or over which the government has proprietary rights, or the whole or any part of the forest produce to which the government is entitled, may constitute a reserved forest or protected forest in the manner provided in the act. A reserved forest usually has good-quality woods with limited rights of inhabitants until clearances are obtained. A protected forest is usually near villages or human settlements where the people are entitled to the existing forest activities, such as fuelwood collection and grazing. Clearance procedures for development activities in both forests are the same.

each subproject has to be undertaken following ADB's *Environment Policy* (2002) and *Environmental Assessment Guidelines* (2003), and the environmental assessment guidelines and regulations of the Government of India.

III. KASHANG INTEGRATED STAGE II AND III HYDROELECTRIC PROJECT

A. Description of the Project

162. **Type of Project and Location.** The integrated Kashang HEP is in the state of Himachal Pradesh, Kinnaur district, 31°05′50″–32°05'15" N latitude and 77°00′45"–79°00′45" E longitude. The state is largely a subdivision of western Himalaya in the Northern mountain unit. The district is bounded by the People's Republic of China to the east, Shimla district to the west and southwest, the state of Uttarakhand to the south, Lahul and Spiti district to the north and Kullu district in the northwest. It has a total area of 6,401 km^2. The Satluj river divides the district into two parts. In its traverse, the river crosses three roughly parallel mountain ranges—Zasker range, the Great Himalayas, and the Dhauldhar ranges.

163. **Size and Magnitude of Operation.** The integrated Kashang project would have a total installed capacity of 243 MW, comprising four distinct stages of development. Integrated Kashang was originally contemplated to be built in several stages over time, with subsequent stages adding additional capacity to the initial, smaller project. Necessary clearances were therefore obtained earlier for the 65 MW stage I project. It was later decided to develop later stages much sooner, and overlapping with stage I, as this would save on construction cost. Stage I was funded in tranche I of the Program and stages II and III (130 MW) are proposed for ADB funding in tranche II. Stage IV consists of a 48 MW stand-alone subproject that is not part of the ADB-funded program, and may be built separately at a later date. Its environmental impact has, however, been evaluated.

164. **Kashang Stages II and III (Kerang–Kashang Link).** These stages will add 130 MW of capacity to the 65 MW stage I by diverting water from the Kerang khad to the Kashang khad via a link tunnel (described further below). This will increase the amount of water entering the original stage I powerhouse, which was designed to be large enough to accomodate the later stages. The diversion structure for stages II and III is in a narrow valley, some 60 m below the road from Lippa to Asrang. A trench weir–type diversion structure is proposed, with its crest at elevation 2,872 m. The diversion structure (channel) is 15 m wide and the trash rack is 3 m in length.

165. **Kerang–Kashang Link Tunnel.** The Kerang–Kashang link tunnel extends from the downstream end of the desanding basins to the left bank of Kashang khad, where it joins a cut-and-cover channel. The latter brings additional water from the Kerang khad to the Kashang water conductor system, downstream of the surface desanding basins. The link tunnel is about 6.5 km long and has been provided with a vertical drop some 30 m from the desanding basins. The drop in elevation accounts for the difference in head between the diversion elevation in Kerang and the junction point in the Kashang water conductor.

166. The location of the drop is such that there is space upstream of the diversion tunnel for adding 48 MW of capacity from the stage IV subproject at a later date to maximize the power potential from the Kerang khad.

167. **Balancing Reservoir (for the Integrated Powerhouse).** From an operational standpoint, additional balancing storage would be required for the integrated powerhouse (which would thus accommodate 195 MW of capacity rather than the initial, Stage I capacity of 65 MW). For the purpose of work scheduling and cost estimation, this balancing reservoir is considered as part of stage II civil works. The reservoir is placed parallel to the reservoir for stage I, near the upstream end of the pressure shaft, and comprises a 10-m-wide and 960-m-long underground cavity, 40 m from the reservoir of the stage I scheme. A connecting tunnel is provided so that the two reservoirs work in tandem.

168. **Integrated Powerhouse (for the Kashang Stage II and III Scheme).** The underground powerhouse complex is on the right bank of the Sutlej river, near Powari village, just below the National Highway. The major component of the stage II and III development is theaddition of the second and third (2 x 65 MW) units within the powerhouse constructed as part of the stage I powerhouse (but with additional space to accommodate these additions). The water conductor system for stage I, downstream of the junction where the Kerang water enters via the Kerang–Kashang link tunnel, is already sized for the design discharge of all three generating units. The general arrangement of the integrated Kashang powerhouse (to accommodate stages I–III) has been designed for three 65 MW vertical-axis Pelton turbines.

169. Of these three, one unit will be installed in stage I and the second and third units will be installed as stage III, along with the implementation of the Kerang–Kashang link scheme. The excavation required for both stage I and stages II and III of the Project (e.g., a powerhouse large enough for three 65 MW generating units, rather than a single 65 MW unit) would be completed within the scope of the stage I works.

170. The machine-hall cavern is 16 m wide and 87 m long. The control room, 16m x 20 m, is located at the north end of the machine hall cavern, away from the construction work required for stages II and III. The service bay and the main construction adits are at the southern end of the machine hall. The main access to the machine hall is by means of the main access tunnel, which is 7 m and D-shaped. The transformer-hall cavern is 15.5 m wide and 88.2 m long and is designed to house 10 single-phase transformers and the gas-insulated station equipment.

171. **Implementation Schedule.** The proposal is to complete the Project and commission the third unit in Kashang powerhouse within 4 years from the start of the project. The construction of all the components of the Kerang–Kashang link (stages II and III) will begin simultaneously so that all the works can be completed within 45 months, including 3 months for initial filling and testing of the water conductor system and commissioning of the third unit. The implementation schedule is in Table 20.

Table 20: Implementation Schedule for Kashang Stage II & III

		Year 1				Year 2				Year 3				Year 4				YEAR 5			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Activity	**Status**	**Apr[a]**				**Apr**				**Apr**				**Apr**							
Construction of stage I	25th month																				
Kerang–Kashang link (stage II) and Kashang stage III																					
Pre-construction Activities																					
Acquisition of land	Started 12 months before																				
Upgrading of access roads																					
Installation of batching/mixing plants, workshops, and offices																					
Selected income-generating projects																					
Construction of buildings and stores, etc.																					
Excavation of adits, etc.																					
Tender and Contracts																					
Civil works	Finalized 9 months before																				
Finalization of E&M works																					
Construction Schedule																					
Mobilization of plant and machinery																					
Excavation of trench weir, slabs, bank walls																					
Excavation of conveyance channel and desilting basin																					
Excavation of link tunnel																					
Completion of trench weir, continuation of concreting																					
Excavation and concreting of desilting basin																					
Completion of excavation of flushing tunnels and start of concreting																					
Continuation of link tunnel excavation																					
Continuation of excavation of balancing reservoir parallel to stage I																					
Installation of control structure at trench weir site																					
Completion of desilting basin excavation and continuation of concreting																					
Start of link tunnel excavation and concreting																					
Concreting of balancing reservoir																					

		Year 1				Year 2				Year 3				Year 4				YEAR 5			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Activity	**Status**	**Apr[a]**				**Apr**				**Apr**				**Apr**							
Completion of link tunnel concreting, grouting																					
Completion of tunnel construction																					
Erection of turbine generator for unit 3 and completion of auxiliary electromechanical system																					
Completion of installation of transformer, bus ducts, electrical equipment for 3rd unit																					
Testing of link water conductor system after completion of works																					
Commissioning of unit 3 commissioned																					

APR = April, E&M = electrical and mechanical.
Source: HPPCL.
[a] The fiscal year begins in April (1 April through 31 March of the following year).

B. Description of the Environment

1. Physical Resources

172. **Climate.** Precipitation in the Kashang project area occurs mostly in the form of snow, which can be described as moderate to heavy, depending on the altitude. The average annual precipitation is about 630–700 mm, most of it snow during the winter months. Annual rainfall at Kalpa averages only 320 centimeters (cm), while annual snowfall averages about 437 cm. The temperature at the trench weir sites is expected to be lower because of the higher altitudes—elevation of 2,820 m above mean sea level for stage I, 2,872 m for stages II and III, and 3,155 m for stage IV. The temperature falls below 0°C during the winter season from November (−2°C) to April (−1.8°C), with the lowest recorded temperature during the year in January (−13.2°C). The maximum temperature during these months ranges from 10.4°C to 22.0°C. In the summer months, temperature is highest in June (27.3°C) and the minimum temperature is 2.1°C.

173. At the diversion sites of the Project, where elevation is near 3,000 m, dry-season temperatures are close to or below the freezing point, and precipitation occurs as snow from December to early March. At the powerhouse site near Powari, where the elevation is close to 2,000 m, freezing temperatures and snowfall rarely occur. The higher-elevation parts of the study area remain covered with snow long into the summer months, and areas above 4,200 m are permanently covered by glaciers.

174. **Air Quality.** An air quality assessment was carried out to assess the status of ambient air quality in the project area. The parameters studied were suspended particulate matter (SPM), SO_2, NO_x, and respirable particulate matter. The monitoring, using a respirable dust sampler, was done at four stations twice a week for two weeks in March 2008 for the winter season and in June 2008 for the pre-monsoon season. The samples were collected and analyzed according to methods specified by the Bureau of Indian Standards. The objective was to assess the level of air pollutants. Sampling every 24 hours for 2 consecutive days was done at each station. The results showed that air quality in the proposed project area and its surroundings is pollution free. The pollutant concentration in the air is well below the permissible limit, as there are no industries in the area and the density of vehicular traffic is low. The forest cover in and around the site is quite dense and serves as a carbon sink. All the pollutant gases in the atmosphere are also within safe limits. In addition, there are plenty of water vapors in the air, acting as a diluent and not allowing dust to scatter much.

175. **Hydrology.** The effect of the melting of the snow is reflected in the behavior of Satluj river. The valleys are generally so deep and narrow that there is hardly any possibility of serious flooding of the countryside. But sporadic flats and moderate slopes occasionally get inundated. The danger of glacier movement and severe winds pose problems in the shape of landslides or landslips. The discharge characteristics of the Kashang khad are very favorable. The unique parameter is that the difference between the minimum and maximum discharge is much less than in most other rivers, because of the unique orientation of the catchment of this khad. Most of the catchment area is under permanent snow, resulting in more winter discharge.

176. **Water Quality.** Since the Kashang khad is fed by snowmelt, the temperature of the water remains very low even during the summer (15.7°C in September). In winter, the stream surface freezes while the subsurface flow continues, although the volume becomes considerably reduced. The overall quality of the waters of Kashang khad is very good, because these are direct snowmelt waters, free from any significant human impact. Both streams have very low BOD and chemical oxygen demand (COD) content, indicating good water quality. This

is expected, as there is no significant discharge from any settlement adjoining the riverbank into the rivers. The area also does not have industries, and hence there are no effluent discharges into the khad.

177. **Topography and Soils.** The integrated Kashang HEP is in the Higher Himalayas. The area exposes high-grade metamorphic rocks belonging to the Vaikrita group of the middle to late Proterozoic age, consisting of felspathic gneiss, quartzite, high-grade schist, and migmatites. These rocks are exposed in an arcuate pattern and rest over the Jutogh, Salkhala, and Rampur group of rocks along the Vaikrita thrust. The Jutogh, Salkhala, and Rampur groups also have thrusted contact. These rocks are intruded by Rakcham and Nako granites.

178. The soil in the area has the characteristics of soils of the Higher Himalayas. The soil of summits, ridgetops, and glacier valleys is shallow, excessively drained, sandy skeltial soil with severe erosion. Taxonomically, such soils belong to suborder Orthents, great group Cryorthents, and subgroup Lithic Cryorthents. The soil of side-exposed slopes belongs to the subgroup Typic Cryorthents, and is medium deep (50–100 cm) excessively drained, loamy skeltial, calcareous soil on very steep slopes with loamy surface, severe erosion.

179. **Seismology.** The project area lies in an active seismic zone IV on the seismic zoning map of India (IS:1893-2002) (footnote 6). Available data on seismicity, within a radius of 150 km of the Project, shows that earthquakes having a magnitude greater than 5.0 on the Richter scale occur at frequent intervals. Important seismic events that have taken place within a radius of 200 km from the project area in the past 150 years have caused significant damage. These include the quakes in Kangra in 1905 (magnitude 8+), Kullu in the 1908 (6.0), Chamba in 1945 (6.5) and 1947 (6.6), Kinnaur in 1975 (6.8), Uttarkashi in 1991 (6.6), and Chamoli in 1999 (6.8).

180. The tributary streams and rivers that flow into the Satluj river from the south or along its left bank are, in successive order, the Tidong, Hogis, Gymthing, Baspa, Duling, Sholding, and Manglad. Likewise, those entering from the north or the right bank of the Satluj are the Spiti, Ropa, Kerang, Kashang, Pangi, Choling, Bhabha, Sorang, Kut, and Ganwi streams.

181. **Catchment Area.** The total catchment area up to the trench weir for stage II is 400 km^2, of which 96.95 km^2 lies under a permanent snow line. The Kerang khad traverses the area for 44 km from its origin before merging with the Satluj, where the khad widens as it passes through less-steep terrain amid rocky and gravel-covered slopes. The riverbed has rock outcrops, pebbles, and large boulders offering resistance to the stream flow and making the flow turbulent. The bed slope of the khad reduces gradually from Lippa village downward. Pager Garang, a major tributary of Kerang khad (Taiti Garang), meets it at its left bank near Lippa village. The project area interacts with only three surface water bodies—Kashang khad, Kerang khad, and the Sutlej river. A CAT plan has been prepared for the free-draining catchment.

182. **Surface Water.** The integrated Kashang HEP is conceived to harness the water of Kashang and Kerang khads for nonconsumptive use of power generation by diverting water from Kashang khad through a vertical-drop diversion weir at village Dolo Dogri (stage I), and from Kerang khad through diversion weirs at Toktu (stage IV, once it is developed at a later date) and Lappo (stage II). At present, no micro- or mini-hydro electric projects have been constructed on these khads; nor is there any industry using the water of these streams or discharging effluent into the streams.

183. **Consumptive Use of Khad Water.** The 18 km length of Kashang khad, from its origin to the point of confluence with the Satluj river, is not intercepted by any substantial stream or nallah. The point of diversion is about 4 km from the confluence with the Satluj river. In this

reach of the stream, there exists neither any flow irrigation scheme nor any water supply scheme tapping directly from the stream.

184. Consumptive use of Kerang khad, upstream of the proposed diversion weir site at Toktu (stage IV), is being made through a flow irrigation scheme 3 km long at Porang khad (0.07 cumecs) off-taking from Porang nallah, a tributary of Kerang khad. Another 1.5-km-long flow irrigation sheme at Toktu (0.015 cumecs) off-takes from a local rivulet that joins Kerang khad in between Toktu and Lappo villages. Still another flow irrigation scheme, this one 9.5 km long at Keran Khad to Lippa (0.1 cumecs), is under construction. It will irrigate 82 ha of culturable command area[18] and off-take from Kerang khad near Asrang village.

2. Ecological Resources

185. **Aquatic Ecology.** There are no fish in these glacier-melt water; hence, no fishing or fisherman was encountered during the field study in the area. Moreover, the steep gradient, high turbulence, rocky substratum, high silt content, and low temperature of the water does not offer a favorable environment for fish growth. Public consultation with local people and government officials confirmed the absence of any fishes in the Kashang khad.

186. The stream is also free from mollusks and from floating or submerged aquatic vegetation. The commercially important fish species, which are going to be mainly affected in the downstream of the tailrace tunnel, are snow trout (*Schizothorax sp.*) and exotic trout (*Salmo trutta fario* and *Onchorhyncus mykiss*). The enumeration for the same has not been done for lack of significant catch in the project area.

187. **Forests.** The vegetation consists of forests, alpine grasslands, meadows, fruit orchards, and agricultural fields. The major part of the catchment area is under permanent snow; vegetation is therefore sparse or nonexistent. Along the right bank of the khad, there is degraded forest with few trees and bushes. There is also degraded forest and a strip of terraced agricultural land along the northern bank of the Kashang khad.

188. The project area is surrounded by forest areas that are severely degraded and declared protected forests. The forests of the Kashang khad and Kerang valley fall within the dry climatic zone. Mostly blue pine and Bhoj Patra (*Betula utilis*) forests are found at higher elevations in the valley. In these degraded forests and around (in uncultivated wasteland), a wealth of various kinds of plant species of ecological and commercial importance are found.

189. A survey was conducted in Pangi, Akpa, Asarang, Lippa, and Toktu villages to document the plant species used by the people for their day-to-day requirements. During the survey, ethno-botanical information on 62 plant species was documented. It was found that these plant species are used for medicine, timber, fuelwood, fodder, ornament, agricultural tools, thatching, fencing, etc. This supports the truth that the local vegetation greatly influences human life.

190. **Endangered Species.** Endangered plant species recorded within 7 km from the precincts of the project according to the International Union for Conservation of Nature nomenclature are listed in Table 21:

[18] An area that can be irrigated from a planned system and is fit for cultivation.

Table 21: Endangered Plant Species

Critically Endangered	Endangered Species	Vulnerable Species
Aconitum chasmanthum	*Fritillaria roylei*	*Acorus calamus*
Aconitum heterophyllum	*Trillidium govinanu*	*Allium humile*
Atropa acuminata	*Saussurea gossypiphora*	*Arnebia benthamii*
Dactylorhiza hatagirea		*Delphinum denudatum*
Dioscorea deltoidea		*Hedychium spicatum*
Gentiana kurroo		*Jurinea dolomiaea*
Picrorhiza kurrooa		*Meconopsis aculeata*
Podophyllum hexandrum		*Phlomis bracteosa*
Polygonatum verticillatum		*Phytolaca acinosa*
Rheum australe		*Potentilla nepalensis*
		Rheum webbiana
		Saussurea lapps
		Taxus baccata

Source: Environmental impact assessment report (footnote 5).

191. **Fauna.** The area has considerable variation in elevation and climate and is endowed with varied fauna. The main wildlife species found in the area are the leopard and snow leopard, the Himalayan black bear, the musk deer, the ghoral, the serrow, bharal, the Himalayan tahr, the langoor, and other smaller mammals. Among birds, five species of pheasants, namely, the Western tragopan, the cheer pheasant, the monal, the koklash, and the white-crested kalij, are also found in the valley. In addition to these, a number of reptiles, amphibians, and smaller birds can be found. There are no endangered species within the project area.

192. **Land Use.** The construction of the project will require 85.7 ha of land—61.9 ha of forestland and 23.8 ha of private land. The Kinnaur district has 6,401 km^2 of forest area, of which 5,093 km^2 is legally classified as forest.

193. The total forestland requirement of 61.9 ha for the Project falls under the Kinnaur Forest Division at Reckong Peo under the Forest Circle at Rampur. As such, compensatory afforestation is proposed in lieu of 61.9 ha of forestland. Of the total land (32.5 ha) required for the construction of Kashang stage I, forestland accounts for 18.7 ha. The forestland is in Kalpa subdivision. Since MOEF already approved the diversion of 18.7 ha of forestland for stage I on 23 June 2004, only 43.2 ha of forestland still has to be diverted. Accordingly, compensatory afforestation on double the degraded forest area (86.37, or 86.40, ha) is proposed. A total of 21.0 ha of land area, forest and private land, is to be diverted or acquired for the construction of Kashang stage II and III; 17.7 ha of this is forestland. The forestland is mostly in Lippa panchayat of Pooh subdivision. Forestland has already been acquired for Kashang stage I with the award of the forest clearance. But the forest diversion case in Kashang stage II and III is still under process.

194. All the spoil tips (muck disposal sites) will be developed through plantation using the bio-technological method to generate a thick forest canopy. Among the factors that were considered in the selection of the sites was the scope for afforestation works.

195. **Protected Areas.** Wildlife sanctuaries that fall within the catchment area of the Satluj basin include the Pin valley, Rupi Bhabha, Lippa Asrang, Rakcham Chitkul, Majathal, Gobind Sagar, and Darlaghat. Wildlife surveys carried out by the Forest Department in nearby sanctuaries (in Rupi Bhabha) in other valleys have shown a rich population of herbivores and carnivores. Most of these species are also found in the catchment of the Kashang khad, as the altitudinal zonation and other habitats are similar. However, the population is much less dense than in the sanctuary area studied.

196. The Rupi Bhabha wildlife sanctuary is on the north side of the catchment area. There are

no sanctuaries or wildlife or nature reserves in the valley within and contiguous to the Project that would be adversely affected. The two sanctuaries at Rupi Bhabha and Lippa Asrang are in two different valleys, not contiguous to the Project. Further, the quantity of fish available in the khads and tributaries is too small for any adverse effect to be registered.

197. The Lippa-Asrang wildlife sanctuary is in Moorang tehsil of Pooh subdivision in Kinnaur district, and falls within the west Himalayan zone of the Himalayan mountain chain. It was first notified as a sanctuary in 1962 and then re-notified in March 1974.[19] The sanctuary is situated between 31°40′15″ and 31°44′18″ N latitude and between 78°13′ and 78°18′ E longitude. It is under the wildlife administrative control of the Sangla Wildlife Range, which is a part of the Sarahan Wildlife Division, about 140 km away from the sanctuary. The study area also covers parts of the Lippa-Asrang wildlife sanctuary area, but the project area lies outside the core and buffer zone of the sanctuary.

3. Economic Development

198. **Population.** There is little migratory habitation in the catchment area. The Kinnaur district has 660 villages and 62 panchayats with a total population of about 78,334 (according to the 2001 census), the majority living in the rural areas. In this district, cultivators constitute the greater part of the population.

199. The sex ratio in the district is 979:1,000, compared with the statewide ratio of 970:1,000. The literacy rate in Kinnaur is 75.2%; the statewide figure is around 77.13%. According to the socioeconomic survey,[20] four villages fall within the affected zone.

200. The project area mainly comprises Pangi village, which has a population of 2,239 and a total area of 23.9 km^2, according to a household survey of the village conducted by the Forest Department in 1999. The joint family system and polyandry are in vogue. More than 99% of the affected population belongs to the Hindu community. The prominent occupations are agriculture, horticulture, and pastoral work. Most of the families are nuclear. An average family consists of husband, wife, and children, married or unmarried. Families have 1–10 members; the average size is 4–7.

201. In Pangi village, there are 65 students in nursery school, 146 in primary school, and 300 in junior high school. In Lippa village, 150 students are in primary school and 8 in intermediate college. In Toktu village, there are 15 students in nursery school and 26 in primary school. Asrang village has 35 students in nursery school, 40 in primary school, and 20 in junior school.

202. **Communities.** Villagers use the Lippa-Asrang for grazing and for gathering fuelwood, timber, and minor forest produce. Unsustainable pressure on the natural resources has led to the degradation of many parts of the sanctuary. Lippa, Asrang, and Toktuo, with a total population of 1,600, are within the sanctuary, and so is Porang Dogri, where the people migrate seasonally. Agriculture is the chief source of livelihood. The people of Lippa-Asrang usually get only one crop a year, because of the high altitude and harsh winter. They grow barley, wheat, and vegetables. The farmers have to make a living on infertile, shallow, and stony land. At the onset of winter, they move down to lower elevations to sell indigenous items like wool.

203. **Agriculture, Industry, Infrastructure.** The socioeconomic survey revealed that 22.09%

[19] As per Himachal Pradesh Government Notification No. 5-11/70-SF, dated 27 March 1974.

[20] Demographic information, as well as information on livestock and other household assets, was generally obtained through door-to-door household surveys, whereas details of land likely to be acquired in different (project-affected) villages were obtained from the revenue authorities and HPSEB.

of the people in Pangi village, 11.50% in Lippa, 8.05% in Toktu, and 7.78% in Asrang are engaged in agriculture.

204. The low productivity in agriculture is due to the deteriorating soil cover. Cereals and millet crops (including barley, wheat, phapra (buckwheat), and ogla), vegetables (potato and cabbage), and fruits (apple and chulli) are grown. In spite of poor soils and soil erosion, agriculture is practiced at high elevations between 2,000 m and 3,500 m. Grazing occurs at higher elevations in the alpine meadows. At lower elevations, rain-fed channel systems irrigate the crops. In the elevated areas that receive no summer rains, the water channels (khuls) are supplied from natural springs and melting snow.

205. Agriculture and horticulture are the main occupations in the project-affected area and the primary and most important sources of income. Most of the areas in the zone benefit from a well-developed irrigation system with water channels drawn from natural springs through pipes. Twenty-nine households use their land for orchard growing, and only one household uses the land for cultivation.

206. **Archaeological and Heritage Sites.** No archaeological monument or cultural heritage site exists near from the Project. However, there is a famous Buddhist temple at Kalpa, about 15 km from the intake for stage I. Another Buddhist temple of some fame exists at Jangi but is 14 km from the nearest stage II intake point at Lappo. Thus, no immediate impact on these religious structures is anticipated, and the question of damage to or loss of monuments does not arise. Unlimited opportunities are available to nature tourists to enjoy nature in its pristine state—lofty snow-covered peaks, meandering rivers, perennial springs, vast stretches of alpine meadows, and lush green forests. There is biodiversity in the form of plants and animals. Eco-tourism is ushering in a new era of nature enjoyment and learning. Forest rest houses and forest treks provide the basic infrastructure. The state is promoting eco-tourism as a policy.

C. Alternatives

1. Without Project

207. There are two “without project” scenarios, as follows.

(i) **Scenario 1: No action at all (business as usual).** Without the Project, the significant energy deficit in the Northern region (9.9% deficit in 2006–2007) would not be reduced by 735.2 GWh per year from this renewable energy source. The expansion of industry in the state and adjoining states would be stifled and residential consumption of electricity curbed. An equal amount of power would have to be generated by alternative means, most likely from a fossil fuel–powered plant.

(ii) **Scenario 2: No new generation plants are constructed, and power is purchased from the Northern grid via PGCIL (a central utility).** Both this scenario and scenario 1 have been dismissed by the Ministry of Power and HPPCL, as there is a power shortage in the state, combined with good potential for hydropower, and a need to develop a power surplus for economic growth.

208. Without the Project, tree density in the study area would remain thin. The hydrology and the socioeconomic structure are also not likely to change. However, the supply of electricity to the Northern grid would not be enhanced in the absence of the Project and the hydroelectric

potential would remain unharnessed. This would result in the exploitation of more renewable resources and exert pressure on thermal energy production. With the Project, on the other hand, apart from the benefit of generating electricity, vegetation cover in the area is expected to improve through the proposed greenbelt development, strengthening the ecological environment. Socioeconomic benefits such as direct employment and economic development of the periphery are also anticipated from the project. Hence, the "with project" option is preferred.

2. With Project

209. **Fuel Type.** The country is giving priority to hydropower development to improve the hydro/thermal mix, optimize the efficiency of the country's power system, and thereby save fuel, minimize greenhouse gas emissions, and promote sustainable, environment-friendly use of resources. Hydropower helps achieve avoided emissions from equivalent thermal plants. The integrated Kashang HEP, including all four stages, will have a total installed capacity of 243 MW and generate 1,659 GWh of energy annually at 90% dependability. In the "without project" scenario, to generate this power by thermal power plant, considering specific fuel (coal) consumption as 1.06 kg/KWh, about 1.76 million tons of coal would be required annually. Thus with the implementation of the integrated Kashang HEP a saving of equal amount of coal i.e. 1.76 million tons/year shall accrue which implies a direct benefit of about Rs5,280 million per year assuming the rate of coal of plant of Rs300/ton. In addition, there shall be reduction in greenhouse gas (CO_2) emission, if a thermal power plant were established. The emission of carbon dioxide depends on quality of coal, combustion characteristics, and excess air available in the combustion. Assuming about 997 gm/KWh emission factor for CO_2 generation (based on a study made by the Central Pollution Control Board) about 1.65 million tons of CO_2 will be emitted from 243 MW coal-fired thermal power plant for generating 1,659 Gwh power. Thus with the proposed HEP, equal amount of carbon emission will be eliminated and a pollution load caused by other major pollutants like NO_x and SO_2 will be reduced annually to the tune of 450 tons and 6,500 tons respectively.

210. **Location.** The "with project" alternative is the proposed integrated generation expansion program for hydropower in the state of Himachal Pradesh. It entails proper environmental mitigation planning and careful site selection to avoid or minimize the potential adverse environmental impact associated with HEPs. The following factors were considered in selecting the alignment and optimum route:

(i) Ecologically significant or environmentally sensitive areas, such as national parks, nature reserves, or wetlands designated by the MOEF will bee avoided.
(ii) Potential environmental and social impact (including resettlement, land take, and impact on cultural or religious sites) associated with initial alignments and locations will be minimized through the selection of alternative sites.
(iii) Involuntary resettlement will be be minimized.
(iv) Monuments of cultural or historical importance will be avoided.
(v) Indigenous peoples, including tribal communities, will not be threatened.
(vi) Social infrastructure such as playgrounds or schools will not be directly affected.
(vii) The clearing of existing forest resources will be avoided as far as possible, and where unavoidable will be minimized and compensated according to the regulatory criteria of the Government of India.
(viii) Affected people will be consulted and offered adequate compensation options as appropriate.

211. The following other safeguards were also taken into account:

(i) Road alignments and dumping sites will be generally sited 10–15 km away from major towns, whenever possible, to allow for future urban expansion.
(ii) Forests will be avoided if possible, in consultation with the local divisional forest officer, to minimize damage to forest resources. National parks and sanctuaries and any other forest areas rich in wildlife will be totally avoided.
(iii) Channel, road, and transmission line alignments will avoid riverbeds and unstable areas.

212. **Alternate Project Site Plan.** Two alternatives for the integration of the two streams were assessed:

(i) **Alternative 1: Diversion of Kerang khad at elevation 3,150 m to an underground powerhouse on the left bank of Kashang khad, near the site from where the Kashang khad is to be diverted.** The differential head is dissipated through power generation and the tail water is channelized into Kashang water conductor for additional generation of power in Kashang powerhouse. The scheme entails working in high altitudes with logistic as well as working-season constraints and could seriously jeopardize the economic merits of the integration, as its implementation schedule would be susceptible to delays.

(ii) **Alternative 2. Diversion of Kerang khad at a lower elevation so that the Kerang water can be brought directly to the Kashang water conductor through a "link" tunnel.** Development of the power potential of the two streams as originally envisaged through Integration can be completed by exploiting the remaining head available in Kerang khad (between the lower and the upper sites) through an underground powerhouse-based scheme located on the right bank of Kerang khad.

213. Alternative 2 was found to be most favorable and viable on techno-economical grounds and was finally adopted. Many of the logistic difficulties involved in the first alternative would be circumvented in this scheme, as all work sites are easily accessible and no major infrastructure development work is involved. The Kerang water will be efficiently and expediently used over the high head available in Kashang scheme, resulting in significant economic benefits. The proposed location has been considered most suitable environmentally as the least number of trees will be cut in this option. This project alternative also has the easiest access route and minimal civil work, both of which environmentally translate into minimal disturbance to the ecosystem of the project area. There would be easy access to the educational and health facilities and there would be improvement of forest resources and also job improvement and availability of additional labor.

D. Anticipated Environmental Impact and Mitigation Measures

214. The main adverse impact that the Project is likely to have on the environment, in terms of duration, extent, and severity, will be changes in the river hydrology, loss of agricultural and forestland, a decline in water quality, and resettlement, as outlined in the table below. Most of this impact will occur during project operation, the most significant being the altered river hydrology between the barrage and the tailrace outlets in Kashang and Kerang.

Table 22: Likely Primary Adverse Environmental and Social Impact of Kashang Integrated HEP

Issue/Feature	Impact	Extent	Duration
Hydrology	Reduced river flows between barrage and tailrace outlet	Along an 18 km stretch of Kashang river	Permanent
	Decline in river water quality	9.8 km of Kerang river affected	Permanent
Aquatic ecosystems	Altered river ecosystem	11 km Kashang and 6.3 km of Kerang–Kashang link tunnel	Permanent
		9.8 km of Kerang: Flushing of shoals in Kerang along banks	Temporary
	Prevention of upstream fish movement	No fishery possible because of low temperatures	Permanent
Land resources	Loss of agricultural and forestland	85.73 ha total land conversion	Permanent
		879,962 cumec of muck shall be dumped in designated areas	Permanent
Social	Resettlement of households	253 total to be affected by integrated Kashang project	Permanent

Cumec = cubic meters per second, ha = hectare, HEP = hydroelectric project, km = kilometer.
Source; Environmental impact assessment report (footnote 5).

1. Environmental Impact due to Project Location and Design

215. **Altered Volume of River Flow.** Being a glacier-fed river, the temperature as such is low. This along with other physical attributes has resulted in very low biological diversity in the khad that is insufficient to support the fish population. In view of this, the impact that will result from the constructional and operational phase of the project is considered insignificant to the aquatic ecology of Kashang and Kerang. The water from Kashang and Kerang khads is not used for irrigation or drinking purposes owing to its low temperature and lack of irrigational facilities. There are neither many settlements along the river that need water from the khad.

216. Environmental consideration requires a minimum flow into the river downstream of the diversion structures to meet the requirements for aquatic life, drinking water, wildlife, fisheries, riparian rights, and religious rites. The state's Hydro Power Policy of 2006 (footnote 1) requires a minimum flow of 15% of water immediately downstream of the diversion structure of run-of-river schemes at all times including the lean season. Compliance and appropriate appreciation of the mitigation measures proposed will minimize the adverse impact envisaged in the project. It is strongly suggested that no more than 85% of the khad water be diverted into the power channel, in conformance to the current practice being followed by MOEF for grant of environmental clearance. The minimum flow has been worked out on the basis of the average of lean months' flow in December to February in a year of 90% dependability (as 1997 was) for Kerang and Kashang khads, and were measured at 3.90 and 1.74 cumecs respectively. The required minimum flows once the projects are operational are 0.65 cumecs for the Kerang Khad and 0.3 cumecs for the Kashang khad.

217. **Disruption of Fish Migration.** Further negligible fish is available in the Khads/tributaries for any adverse effect to be registered. There is little habitation in the catchment area.

218. Baseline ecological studies carried out in Kashang and Kerang khads indicates that on account of poor nutrient status, an extremely low content of chlorophyll, the primary productivity of Kashang khad water is very low. This is corroborated by the low volumes of biomass and

poor biodiversity of the stream. Extremely low primary productivity, steep gradient and rocky substratum and low temperature of the water do not offer a favorable environment for fish growth. Further, in the downstream from the trench weir, >15% of existing water flow will be maintained in Kashang Kkad. Therefore, no impact on the aquatic ecology of the Kashang and Kerang khads is anticipated.

219. **Land Acquisition and Land Use Conversion.** The impact of the Project includes: loss of land (agricultural and residential), structures (residential and community), income and livelihood (owners), and community and cultural sites. For the construction of the Project about 85.7 ha of land will be acquired from private owners and the Forest Department. Out of this 23.8 ha of land will be private land—agricultural land to be used for settlements, road construction, and project components. The land use of about 6.0 ha of private land for settlements will not change, as it will still fall under the land-use category “agriculture and settlement,” but the land use of the balance of 17.8 ha will change from agriculture to forest, as extensive plantation in the area along roads and the dump area has been proposed. The underground components falling in forest area will not cause any impact on the land use. Similarly the land use of forest area diverted for dump areas and quarry sites will not cause any impact on land use as these shall continue to be under forest land use class. Overall land requirement of the project is 85.7 ha out of which forestland is 61.9 ha and private land 23.8 ha.

220. **Resettlement.** Since the project is a run-of-river type with trench weirs and hence no dam, no storage and therefore no submergence. Hence no dwellings, houses hamlets will be submerged. In fact, the area to be used for the Project is not populated; hence, no displacement or resettlement of population is involved. No rehabilitation is involved as no person is rendered landless. According to the socioeconomic survey, 4 villages are falling in affected zone. The field survey for demographic profile of affected villages revealed that in Pangi village, 11.8 ha private land will be affected. According to the land records and ground truth survey 253 household in Pangi village of Kinnaur district are likely to be affected due to the acquisition of land/house/shops for Kashang project. Only a part of the land is being acquired from the 253 households and none of the landowners is being displaced or is becoming land less/houseless.

221. Only one household is being resettled from the area being acquired for the Project in the Pangi village. Land of other three project affected villages has not yet been acquired. The affected household has expressed a preference to resettle within the vicinity of their present locations, to minimize disruption and to benefit from mutual support from kin groups, as well as new development opportunities generated by the Project. The Project will facilitate completion of relocation activities within a reasonable time frame. The affected households, whose agricultural lands have been acquired are using the compensation provided by HPPCL.

222. Diversion of forestland and felling of trees adversely affects the environment and also causes stress on the adjoining lands due to shifting of biotic pressure. Out of the total land i.e. 85.7356 ha required for the construction of Kashang HEP, forestland involved is 61.9 hectares. Looking to diversion of forestland for the construction of the Project and limited felling of around 500 trees, changes are inevitable. About 23.8 ha of private land is to be acquired for construction of Kashang Integrated HEP permission. The diversion of forest land would be made good through double the area taken up under compensatory afforestation and afforestation/soil conservation under CAT plan works. There are no sanctuaries, wildlife or nature reserves within or contiguous to the Project, in the valley, which would be adversely affected. The two sanctuaries at Rupi Bhabha and Lippa Asrang may be near but are in two different valleys, not contiguous to the Project.

223. Diversion of forestland and felling of trees adversely affects the environment and also

causes stress on the adjoining lands because of the shifting of biotic pressure. The total forestland loss for the project is about 36.3999 ha for the integrated Kashang HEP (stages I, II, and III) including underground components. In all, a total of 913 trees belonging to 8 species having 796.97 m^3 by volume would be felled for the project purposes. It is stipulated to afforest little over double the area of forestland being diverted, since non-forest land is not available. Thus, a total of 72.7998 ha (36.3999 x 2) of land needs to be afforested by the Forest Department. All the areas of compensatory afforestation are located within the following forest areas: Karelhla, Riara, Baiyaugi, Ranaga, Mail, Thnour, Sawankanda, and Ratana. During project construction phase, land in addition to reservoir submergence will also be required for location of construction equipment, storage of construction material, muck disposal, widening of existing roads and construction of approach roads for project appurtenances. Such lands have vegetation of some kind on them either as trees or it is in the shape of grass and bushes.

224. The impact of removal of trees and submergence of land is likely to be felt by the local population in the form of increased hardship for grazing and fuelwood collection. This would be addressed through compensatory afforestation and the implementation of the CAT plan. The plan has been formulated to take care of immediate needs of the population residing in the close vicinity and also downstream of barrage. Afforestation is an important activity to bring the erosion-prone/degraded forest land under vegetation cover so as to further minimize the soil erosion. The locality factors prevalent in the area are very adverse for raising new plantation. The quality of soil is poor. Rainfall too is inadequate. The winter is harsh and the wind velocity is high. Thus it is difficult to ensure survival of new plantation. The level of the degradation of the pasture is high in the project area. The pastures affected badly will be closed and supplemented with planting of grasses and medicinal herbs.

225. The results of baseline survey on the flora carried out during the study in the project and its adjoining area revealed that some species recorded in the region, namely, *Hyoscyamus niger, Ephedra gerardiana, Ferula jaeschkeana, Heracleum candicans, Betula utilis, Juniperus macropoda, Dactylorhiza hatagirea, Datisca cannabina, Rheum webbianum, Dioscorea deltoidea,* and *Rheum austral* fall under category of threat status (rare, endangered, or vulnerable) according to the Red Data Book on Indian Plants and conservation assessment and management plan reports. Since most of the project works are underground and threatened plant species do not coincide with the project activities. Moreover, plant species found in the study area and its adjoining areas also occur in other parts of cold desert of Kinnaur district and therefore, as there is no threat for extinction of these species from the region. Sixty-two plant species with medicinal, timber, fuelwood, fodder, ornamental value were recorded from the study area. In other words, the proposed project and its adjoining area provide food, fodder, and fuelwood to the local people because of the large number of species present. Hence, to sustain livelihood of the rural people, massive plantation of species with medicinal, fodder, fuel wood values should be done in suitable areas.

226. **Geological Impact.** Geological impact is related to damage due to seismic conditions. A standard seismic zoning map, based on tectonic features and earthquake records, has been developed for the country by the Bureau of Indian Standards. The area under the Project primarily falls within zone IV, and is referred to as a zone of high damage risk. Hence, the foundation design of the towers and powerhouses must consider the probability of earthquakes, using suitable seismic coefficients, e.g., acceleration due to earthquake in horizontal and vertical directions.

2. Environmental Impact of Pre-construction and Construction Activities

227. The construction of the Kashang HEP will involve the removal of trees at the project site, excavation work, the installation of equipment, and civil works related to the construction of a

desilting chamber, forebay, penstock, powerhouse, and other related works. Standard construction impact, pertaining mainly to specific construction activities, site disturbance, spoil disposal, river flow disruption, and the influx of workers into the area, will occur. These types of construction impact, common to most hydroelectric projects, are described below, together with the associated mitigation measures.

a. Physical Resources

228. **Impact on Topography.** The topography will change during construction as tunnels are excavated, buildings put up, and fills and cuts made to level the power channel and construction powerhouse, forebay, desilting chamber, and penstock. Surface features will change as trees and soil are removed at the HEP powerhouse, trench weir, tunnel construction site, and all along the ROW to facilitate construction. The most conspicuous impact on the surface topography will be in the hilly region along the reserve forest for HEP. The impact will be local but irreversible as the presence of the HEP changes the features along the ROW.

229. **Material Extraction.** HPPCL will ensure that mining and quarrying practices comply with the guidelines and directives of the relevant authorities. The contractor's excavation plans must be approved and monitored by engineers. No construction material will be extracted from the riverbed. The impact of excavation of construction materials such as rock mass/boulder and sand for construction of hydroelectric projects on environment depends on the excavation process, local hydrologic conditions, climate, rock types, size and type of operations, and topography. Impact also varies with the stage of development at quarry sites, e.g., development of working platforms has less impact than the excavation of aggregates and sand. Physical changes in the soil, water, and air associated with environment impact would be due to excavation and degradation of land aground the quarry and on biota around it. Maximum excavated material from the proposed under ground works shall be used together with rock mass/stone obtained from Quarry No-1. The rock face areas do not require any major restoration measures. However, keeping in view that due to blasting, the rock features along the joint surfaces may get weak or disturbed, for overcoming which some rock bolting and shotcrete measures along the exposed face are proposed to be done. The river shoal areas fall in the riverbed/plain, as such no restoration measures are proposed for them. The river shoal at Jangi quarry site will be restored during the flood season as it falls within the river coarse of River Satluj. Therefore, the riverbed quarry activity will not lead to any negative impact either during the functioning of the quarry or at a later date. Blasting shall not be allowed in the riverbed. Copious use of sprinkler shall be resorted to stock piles of aggregate and the washing of the aggregate shall be first allowed to settle in the setting tanks before disposing into river.

230. **Impact on Air Quality.** Dust emission from project's roads would be minimized by laying grits, ramming and compaction with regular water sprinkling. Besides, Project would be raising multitiered plantations (grasses, bushes, shrubs, and trees) along its roads not only to stabilize it but also reduce silt flow and reduce other adverse environmental impact like noise and air pollution. The adverse impact (on air, water, and noise levels) of operations aboveground will be negligible. During construction, excavation of the HEP channel and the movement of vehicles carrying construction materials will give rise to dust particles, temporarily affecting air quality at the site. Spraying the excavation site with water will greatly reduce the dust emission.

231. The ambient air quality recorded SPM concentration below the Central Pollution Control Board (CPCB) standard of 500 ug/m^3 for 24 hours for industrial areas. The level of gaseous air pollutants (SO_2 and NO_2) are also within limits. During major construction related activities i.e. site clearance, earth work excavation, blasting, boring, crusher operations and transportation of equipment, the marginal increase in the ambient air pollutants such as SPM, SO_2, and NO_2

would be localized, temporary, and limited to the construction phase.

232. The pollutant concentration in the air is well below the permissible limit as there are no industries in the area and the density of vehicular traffic is not alarming. The forest cover in and around the site is quite dense and serves as a carbon sink. All the pollutant gases in the atmosphere are also within safe limits. In addition to this there are plenty of water vapors in the air, acting as a dilutant and do not allow the dust to scatter much. The phenomenon like smog and acid rains have never been observed in these areas and neither do such conditions are likely to occur.

233. **Exhaust Fumes from Vehicles.** Most of the machineries and equipments would be operating underground except transportation vehicles and DG sets. All machinery and vehicles are either electricity or diesel operated; as such SPM levels would not rise as ash contents are absent. DG set is only a standby arrangement to be run only is case of electricity breakdown. It would be located at tunnel and adit portals, which are away from habitations. Hence, its impact on air and noise environment would be negligible. Combustion of fuel (diesel) emits SO_2. There may be short-term increase in SO_2 emissions, on assumption that all equipment operate at a common point and common time. Even that would be quite low (less than 04 $\mu g/m^3$). Hence, no major adverse impact on air quality is anticipated.

234. However, with the construction of the trench weir, powerhouse, colonies, and other infrastructure facilities in the area, air quality will be affected during construction. The movement of heavy vehicles and operation of other construction equipment will also add to the amount of noxious gases released into the atmosphere. The concentration of these kinds of gases and dust emission, however, will be cleared daily as the area is located in a valley and gusty winds are common in the morning and evening hours.

235. **Impact on Noise Levels.** Noise environment is not likely to be affected much by project construction. Habitations are about 1–2 km away and most of the project activities are underground. The baseline for noise is 49–56 dB(A) in the daytime and 36–42 dB(A) at night attributable to river turbulence. The expected rise in noise levels would be around 2–3 dB(A). After passing through a range of noise-absorbing barriers like air, buildings, and vegetation, the noise would diminish to tolerable limits. Thus, no increase in noise levels is anticipated as a result of various activities, during project construction.[21] In the operation phase, water abstraction would reduce the noise significantly.

236. The major sources of noise pollution during construction are vehicles transporting construction materials and equipment to the site. Since most of the access roads cannot be used by motorized vehicles, equipment has to be transferred by nonmotorized transport. The major construction work is expected to take place in the daytime. The noise produced during the construction will not have a significant impact on the existing ambient noise levels.

237. **Impact on Surface Water Quality.** The construction will have no major impact on surface water and groundwater quality in the area. Water bodies may be contaminated by construction materials and surface runoff from adjoining construction sites. Turbidity, TSS, and other chemical parameters like BOD may increase at points where the proposed road alignment crosses the river. Careful selection of sites and access roads so that the surface runoff does not spill into the river will avoid this problem.

[21] Another noise impact is expected to result from blasting. Since blasting activities will occur underground, and often very deep underground, precise quantitative data is not available. However, during public consultations, it was discussed that no blasting at night time will occur.

238. Care will be taken to locate temporary settlements of construction workers away from water bodies. The settlements should be provided with adequate drinking water facilities, sanitary facilities, and drainage to avoid surface water pollution. The site should have sedimentation ponds, oil-confining basins, and oil traps to separate oily waste. The sludge in the traps should be kept in a specified place inside the premises and later sold to authorized contractors or third parties. No sludge disposal on land should be allowed.

239. **Impact on Soil and Geology.** Excavation activity and land clearance can lead to soil erosion at the construction site and along the access routes. The result of the soil analysis shows that the soil is slightly basic in nature having pH varies from 7.80 to 8.50. The texture of the soil varies from sandy to sandy loam having predominantly sand. The moisture content of the soil varies from 6.20 to 12.10% and sodium absorption ration varies from 1.30 to 1.80. The micro nutrients are found in all the samples. Erosion-prone areas will be strengthened before construction, and construction sites will be leveled and stabilized after completion of the construction activity. Construction chemicals must be handled properly to avoid contaminating the soil.

240. **Spoil Disposal.** The Hydro Power Policy of 2006 of GOHP (footnote 1) requires the use such material for the project activities as may be found suitable for construction and the remaining material shall be allowed to be used by other development departments like the Public Works Department and the Irrigation and Public Health departments. Even the private crusher owners etc and private users shall also be allowed to use such material from the site free of cost. In the present case it is proposed of utilize about 25% of the excavated material on the project activities and about 10% of the muck generated through free-of-cost lifting by other government agencies and private users. The balance 65% shall have to be disposed off away from sites so as to make available the clear site for construction activities. The balance muck will be properly stacked and roller-compacted or laid on slopes and treated to match the surroundings. Suitable biotechnical measures are prescribed for stabilizing the muck dumping sites at project cost. This material is being disposed of in the vicinity of excavation sites, on riversides and on lower-slope government and acquired land, with protection works (mainly retaining walls) installed to stabilize the new landforms. Retaining walls, generally built from rock gabions, are being constructed on the contour at surveyed spoil disposal sites to provide stable disposal areas. Spoil is being placed and compacted behind the retaining walls to form stable landforms. No spoil is being placed in watercourses or on grades that have the potential to fail. Completed spoil disposal areas are revegetated with a cover of topsoil and seeded or planted with tube-stock. Crate wire walls would be erected to ensure that the dump is kept in hold and muck debris does not pass directly into river water. After the dump sites are exhausted, planting with soil binders and species with lateral roots shall be got done by the Project authorities from the Forest Department. The dump sites were chosen so as to avoid/minimize use of government/public/forest land.

241. Subsequently, all the spoil tips (muck disposal sites) will be developed by taking up plantation through bio-technological method to generate a thick forest canopy over them. Along water lines, *Alnus nitida*, *Salix spp.*, and poplar need to be propagated. At a little higher altitude conifers and oaks can be propagated. Species planted should have fodder value and should also be aesthetically pleasing. Where the soil cover is poor *Aesculus indica*, kudzu vine, and *Ailanthus spp.* should be planted.

242. **Road Construction Impact.** There is an existing road from Reckong Peo to Pangi village. Under Kashang stages I–III, project roads 13.715 km in total length are to be widened or built to link the various sites with the main road.

243. The construction of project roads could destabilize slopes and lead to erosion. Such impact will be kept to a minimum through minimized clearance of vegetation, balancing of cut and fill where possible to generate less spoil, controlled disposal of excess spoil, stabilization of excavated slopes, and controlled rock blasting.

b. Ecological Resources

244. **Impact on Terrestrial Ecology.** Land clearing, cutting, filling, and leveling may cause loss of vegetation, with irreversible impact on ecology. Transmission towers should not be located in thick vegetation to minimize tree loss and the need to compensate the tree owners. Tree cutting and compensatory afforestation must be done in consultation with the Forest Department of the state. Soil erosion generally results when herbaceous vegetation is removed from the soil and topsoil is loosened. But the impact would be confined primarily to the project site during the early stages of construction and must be minimized through paving and surface treatment, water sprinkling, and other mitigation measures.

245. **Terrestrial Fauna.** Construction activities may disturb the fauna in the reserve forests and cause the animals to move elsewhere in the forest. Care will be taken not to disturb major wildlife habitat. Measures will include maintaining a greenbelt area around the project areas rich in vegetation. Restrictions on the number of trucks per hour and efforts to control noise levels will also help mitigate impact. There are no significant commercial fisheries that could be affected by the impact of construction on water quality.

c. Human Environment

246. **Agriculture.** Agriculture will be affected by the permanent or temporary loss of agricultural land and crops due to construction activity. Land has already been acquired for the construction of the HEP. As far as possible, prime agricultural land has been avoided and in areas where the crop is standing, construction will be done after crop harvesting. Adequate compensation will be given in exchange for the land and crops lost. The extent of land acquired for the Project and the compensation to be given are dealt with separately in the social assessment report.

247. **Socioeconomics.** Job opportunities for the local population during construction will give great impetus to the local economy.

248. **Resettlement.** The issues related to resettlement and rehabilitation are discussed separately in the social assessment report.

249. **Cultural Sites.** There are no archaeological, historical or cultural important sites in the alignments for the barrage and the powerhouse; hence, no impact is envisaged in this regard.

250. **Traffic and Transport.** Avoiding high-density areas, putting up proper traffic signs, providing proper access roads, and avoiding roadblocks will minimize traffic disturbance during construction.

251. **Health and Safety.** Construction of the proposed project may have the following impact on the health of local residents and the workforce. The execution of the integrated Kashang HEP and appurtenant works is to be carried out under contract in 48 months' time. Infrastructure facilities will be developed at the same time. When construction starts the labor force of skilled, semiskilled, and unskilled labor will be deployed, and at a given point in time, a workforce of 1,200 will be engaged. The skilled manpower of about 360 persons will be imported from other

parts of the country while the other workers shall be deployed locally. The temporary labor camps will be established at suitable location in the project area. The fuel need of the laborers and workers has to be attended in an organized manner otherwise the labor may resort to indiscriminate felling of trees and shrubs owing to their cost free and easy availability at leisure. The influx of labor force during construction warrants providing proper sanitation and hygiene facilities to avoid diseases like typhoid, cholera, and gastroenteritis that are related to sewage pollutants.

252. **Sewage.** The total construction time for the Project is about 4 years, which has the same processes as that of the Sainj project. At the peak of construction, there will be an estimated 1,200 workers, of which it is expected that 50% will be locally available. The domestic water requirement has been estimated as 70 liters per person per day. Thus, total incremental water requirements work out to 42,000 liters per day. It is assumed that about 80% of the water supplied will be generated as sewage. Thus, total quantum of sewage generated is expected to be of the order of 33,600 liters per day. Community latrines and oxidation ditches can be constructed for the treatment of sewage from the labor camp so that it does not pollute the river water. Even though no significant impact is envisaged on water quality of the Kashang and Kerang khads, as a result of disposal of untreated sewage, it is recommended to commission units for treatment of sewage generated from labor camps.

253. **Solid Waste Generation.** During construction, there will be an influx of technical staff, laborers, and other service providers into the project area. The proposed project has also envisaged four colonies to house 600 project employees including personal for other utility services with their families. Sewage and solid waste will be generated from the temporary settlements. Sewage management and solid waste disposal facilities should be conceptualized from the planning stage to maintain the health of the people and the environment. The main sources of wastes in case of the proposed project can be divided into following categories:

(i) Municipal waste from residential areas;
(ii) Solid wastes from labor camps; and
(iii) Biomedical wastes from the dispensary.

254. Since most of the dam operations will be automated or mechanized, very few people shall be staying in the project during its operation phase. The solid waste is primary problem during construction. Solid waste generated from temporary and permanent colonies in construction as well as operation requires special management to dispose off as warranted under the Municipal Solid Wastes (Management and Handling) Rules 2000.

255. Consequent deforestation if continued will adversely affect the ecosystem; therefore, pre-emptive action plan has to be devised to meet the fuel needs of workers especially those residing in the labor camps. These objects can be best accomplished by mandatory banning of the use of fuelwood in the labor camps.

3. Environmental Impact of Operations

256. During the operation phase most of the construction phase impact will stabilize and the impact during project O&M will be very limited.

a. Physical Resources

257. **Impact on Topography.** No topographic changes are foreseen during operation, as

existing access routes will be used during O&M.

258. **Impact on Climate.** The study area along the HEP also includes forest areas. Some trees will have to be removed for the construction of the HEP, leading to climatic changes in the area.

259. **Impact on Hydrology.** The headworks for the HEPs consist of trench-type weirs for diversion; hence, the operation will not have a significant impact on hydrology, including the water table in the area. Some erosion will take place, mainly on the terraces and slopes covered with soil. The terraces are glaco-fluvial in origin and the soil is eroded by runoff water. Also, fragmented rock boulders along the steep slopes and escarpment commonly fall because of gravity.

260. **Imbalances.** Tectonically, the project area has undergone three to four phases of deformation. It is located north of the main central thrust, a well-defined tectonic lineament, but the entire stretch of scheme is located over a stable area. In the stretch of power channel, leakages may cause saturation of debris material, possibly resulting in slope failure. Any damage caused by the Project, however, will not be significant.

261. **Sediment.** The project area is characterized by steep slopes covered with thickly vegetated soil. Small nallahs (or streams) are the main source of erosion in the area, as runoff water causes soil and small rock masses to flow from the slopes. Sedimentation is practically insignificant, as streams have enough capacity to carry sediment. During the rainy season, large blocks or boulders carried from the upper zones are often dumped in the riverbed at lower reaches because of changes in gradient or the broadening of the riverbed. Regarding sediment load, the assessment (of sediment load) is not required on the discharge site, as this a run-of-river project, proposed with trench weir and with no storage. The question of sedimentation does not arise as the boulders and other coarser sediment would pass over the trench weir while the sediment of size 0.2 mm and above will settle in the desilting tank from where the same can be flushed out. The silt load is bound to remain within natural limits and would have no adverse consequence on the Project as the catchment area is without built-up area, population and thus has negligible biotic interference. No felling has taken place and the vegetation in the catchment area is mostly virginal. Only negligible geological erosion is there. In order to increase the life of the reservoir by maintaining a low level of inflow of sediments into the reservoir, the soil needs to be protected right in the catchment through effective afforestation and various soil conservation measures both vegetative and engineering i.e. gully plugging, check dams etc.

262. **Impact on Air Quality.** Since the Project does not involve any air emissions, it will have no negative impact on air quality in the region during its operation.

263. **Impact on Noise Levels.** During operation, the noise from the powerhouse and switchyard will be heard only within 15–30 m. The major source of noise in a hydroelectric project is the operation and movement of various pieces of equipment during construction. There are habitations within 2–3 km from the project site. Noise levels would range between 45 dB(A) and 52 dB(A) in the colony, and between 40 dB(A) and 45 dB(A) in sensitive areas (such as the dispensary). This is well within the CPCB standards. Even in peak traffic, the noise level would not rise above 70 dB(A), which is within CPCB standards. The noise level at the quarry and crushing sites, the reservoir, and the powerhouse construction sites would remain within the standards set by the Occupational Safety and Health Administration (OSHA). The noise levels would range from 80 dB(A) to 95 dBA and workers exposed to these noise levels, considering the 8-hour work shift, will not get adversely affected. The project area is such that because of its

location, with reference to forests and hills, any noise pollution would be insignificant.

264. **Impact on Surface Water Quality.** Since no effluents are being discharged by the Project, surface water would remain unaffected. The operation of the proposed HEP will not have any major impact on the quality of surface water and groundwater in the area. The equipment that will be used in the powerhouses and switchyards will be free of polychlorinated biphenyls and chlorofluorocarbons.

265. **Decline in Water Quality.** About 4 km and 9.8 km of river stretches would be affected due to water abstraction caused by reduced flows due to Stage I and II - IV. A minimum downstream discharge of 0.30 cumes from the Kashang khad and 0.67 cumecs from the Kerang khad, being 15% of inflow of lean season flow, would be maintained immediately below the intake of stages I and II respectively. Regarding the Kerang khad, about 0.20 cumecs of water from Pager Khad and 0.13 cumecs from Chakra Khad which meet Kerang Khad downstream 6.8 km and 6.3 km respectively, will also add to the minimum flow. Thus, total downstream discharge would be about 1.0 cumecs, which is sufficient for environmental and local needs. As there is no irrigation scheme in the area, the Project will not have any adverse impact on irrigation, ground, and surface water in the area.

266. Regarding the Kashang khad, the Khad flows in deep gorge beneath the intake with a slope of about 200 m/km. As there is neither any consumptive use of water in this reach nor any effluent is added, the minimum flow of 0.3 cumecs is deemed sufficient for environmental needs. Moreover, people are not dependent on the river water in these downstream areas. This measure will facilitate longitudinal connectivity of the natural aquatic system. As such, no adverse impact is foreseen. An electronic flow-measuring device to be installed by the project would facilitate monitoring.

267. **Impact on Groundwater Quality.** There is no impact on groundwater foreseen as the tunnels are to be lined watertight and more than 150–200 m deep below ground surface for Stage-I & IV tunnels and up to 1,400 m for Kerang–Kashang link tunnel. However, the water sources must be documented and in case of damage, the project proponents have committed to restore the same or make alternative arrangements.

268. **Impact on Soil and Geology.** No impact on soil is expected during operation.

b. Ecological Resources

269. **River Water Quality.** River water quality could substantially decline during construction from sewage discharge from construction camps; site disturbance activities (barrage, intake, and outlet construction; river sand extraction); sediment from material stockpiles, crushing activities, and spoil disposal; and pollution from fuel storage, workshops, camps, etc. Mitigation measures that are being implemented or will be implemented include: the provision of community latrines, septic tanks, and soak pits for sanitation in the construction labor camps; the provision of suspended sediment settling tanks for the treatment of crusher and tunneling effluent; sludge disposal as solid waste; spoil stabilization and erosion and sediment control; quarry restoration; and the operation of a sewage treatment plant to serve the permanent project workforce. At operation stage, the water of the khads will be diverted for power generation and the natural course downstream of the same will have a minimum flow to maintain the aquatic life. The sediments from the diversion will also be discharged in the natural source during rainy season. Further the water coming through turbine will also not contain any significant pollutant to change water quality. The sewage and municipal solid waste would not be permitted to be discharged through the water bodies. Thus the surface water quality, at construction and operation stage will be protected and

not allowed to be polluted.

270. There will be some disturbance to planktonic population during the construction of trench weirs for the HEPs but there will be no adverse affect on aquatic fauna like fish which is absent owing to the low temperatures in the water. There are no working commercial fisheries in the project area.

271. **Impact on Aquatic Ecology.** The operation of a run-of-river type of project necessitates abstracting water from rivers or streams and diverting it into water conductor systems. This disrupts the longitudinal connectivity of the natural aquatic system. Such a disruption has many adverse impact on the downstream as well as upstream environment. Many of the aquatic fauna and planktonic flora are either unable to traverse the length of the river or are severely restricted in their movement by the obstruction created. This, in turn, affects the viability of their population and the aquatic environment of the river. At Kashang I, the groundwater position of this area will not change due to existing steep slope of surface and watertight lining of the tunnels. The runoff from the construction sites will have a natural tendency to flow toward the khad. For some distance downstream of major construction sites, such as the barrage and adit, here is a possibility of increased sediment levels which will lead to reduction in light penetration and increase in turbidity.

272. **Flora.** Sixty-two plant species with medicinal, timber, fuelwood, fodder, or ornamental value have been recorded in the study area. But most of the operations are underground. Moreover, the plant species found in the project area and adjoining areas also occur in other parts of Kinnaur district and are therefore in no threat of extinction.

273. **Terrestrial Fauna.** Compared with the impact during the pre-construction and construction phases, from the number of trucks in the area, construction noise, and the presence of temporary workers, the impact during operation phase will be less significant, as most of the project operations will occur underground.

c. Human Environment

274. **Health and Safety.** Accidents may occur because of electrocution, fires and explosions, and exposure to electromagnetic fields along the tunnel alignment and at the powerhouse. Houses will not be allowed within the vicinity of the Project. At the HEP level, a safety and emergency procedures manual will be kept. Personnel working at the substation and line inspectors will be provided with the necessary training in safety aspects. Personal protective equipment like safety gloves, helmets, and mufflers will be provided during construction and during maintenance work. Importance will be given to maintaining good hygiene and aesthetics at the substations.

275. **Increased Human Interference.** The project area is already accessible by road, and increased accessibility can mean increased human interference. The project operation would increase human interference, leading to marginal adverse impact on the terrestrial ecosystem. A construction period of 5 years is envisaged for the Kashang integrated HEP. Due to terrain characteristics, the direct impact of construction activity for any water resource project in a Himalayan terrain is generally limited to the vicinity of the construction sites. Additional impact mitigation measures that will be implemented by HPPCL or its contactors include: provision of electricity supply in camps; provision of solid waste collection and disposal facilities; greenbelt planting using native trees; provision of first-aid posts at each major construction site and a dispensary; provision of personal noise protection equipment to workers exposed for extended periods; and regular machinery maintenance to keep noise at the design level.

276. **Vector-Borne Diseases.** No ethnic disease is associated with people of the region, but acute dysentery, gastrointestinal problems, and acute respiratory infection are common endemic diseases prevalent in the area. The incidence of hypothyroidism has reduced with the mandatory sale of iodized salt. There is no incidence of malaria.

277. **Solid Waste Generation.** The labor colonies will be located at the Dolo Dogri, Powari, Lapo, and Tokto project sites. Around 300 laborers are expected to reside with their families in the labor colonies and 300 more in bachelor accommodation at any given time at the peak of construction. for a population of 1,500 residents and 100 floating population i.e. for 1,600 persons. It is estimated that total solid waste generation per day by labor population residing in the labor colony would be about 1,200 kg dry weight. This would be to 36,000 kg dry weight per month, and 432,000 kg dry weight per year. Proper care must be taken to manage the solid waste from the labor colony. The collected biodegradable wastes will be disposed off at a suitable landfill site to be developed.

278. Sewage and solid waste will be generated from the colonies. The main sources of wastes in case of the proposed project comes from Municipal waste from residential areas, Solid wastes from labor camps, and Bio-medical wastes from Dispensary.

279. **Water and Wastewater.** The domestic wastewater from colonies and other residential areas would find way into the river only after it is treated previously for prevention of fecal contamination. The treatment should be suitably designed for such waste water if discharged in river. Provision of adequate water supply for drinking to the labor and officials is required at project site. Further also, adequate sanitation facilities must be provided, so that the water sources are not polluted and disease proneness in the area is not affected. As a rough index one community toilet is to be provided for 25 persons while one septic tank would be required for 500 persons. The drinking water facility and also the waste disposal site must be located very far from each other. The project authorities would take into account, the fact, that during peak of construction phase, increased population would require adequate provisions for drinking water and sewage treatment which would later taper down. Thus provisions need to be made both for temporary and permanent arrangements.

280. **Sewage.** Considering water requirement of about 70 liters per person per day in mountainous areas, and on an average a person generates about 50 liters of sewage per day, therefore, about 30,000 liters per day of domestic sewage along with other waste are expected to be generated from the colony. Since conventional septic tank systems are expensive, require a large volume of water for flushing, and have other problems like periodic cleaning and sludge disposal, flush compost toilets shall be used. These require only 1.5–2.0 liters of water for flushing, versus 12 to 14 liters for conventional systems. Proper provision for water storage in sufficient quantities will be needed to maintain a hygienic environment. Septic tanks of appropriate size are to be constructed and care is to be taken to avoid mixing of wastewater and sewage with local water bodies, especially during the rainy season.

281. Due to the reduced flow in Kashang and Kerang Khads due to the abstraction of water for power generation, it is essential to have proper sewage management in nearby villages, which now drain sewage directly into the khads. Viewing this, Sewage Treatment Plants should be provided for Dolo Dogri, Toktu, Asrang, Lapo, and Lippa villages.

282. **Construction Waste.** Solid waste, such as metal scraps, wooden packing material, and oily waste, may be generated during construction. Most of the iron scrap and packing

material can be recycled or resold. But the 50 kg plastic cement bags require proper disposal through public auction.

iv. Socioeconomics

283. Beneficial impact on socioeconomic conditions is foreseen, as there will rural and urban electrification and social infrastructure around the project areas. Industrial development, triggering economic growth in this backward region of the state, is likely.

284. According to the Hydro Power Policy of 2006 (footnote 1), the executing agency shall ensure employment to bonafide Himachalis in all the unskilled/skilled and other nonexecutive categories of staff with the contractors and subcontractors as may be required to implement the project. If it is not possible to recruit 100% staff from Himachalis for justifiable reasons, then no less than 70% of the employee total should be bona fide Himachalis.

E. Economic Assessment

285. Electricity from the proposed hydroelectric plants under the Program will go directly to the local grid (only the surplus during the season of peak water flow will be exported to the Northern grid), thus helping to meet the local demand for more energy resources. The overall objective of expanding clean energy generation will contribute to the economic development of the state on several fronts, with no adverse effects on air quality. The Project is expected to result in more reliable power to commercial, industrial, agricultural, and other consumers, thus promoting the growth of industry and commerce. It will also create considerable jobs in the state, both during construction phase and throughout the life of the Project. Social services in the state will improve as poor and vulnerable consumers (including hospitals, schools, and other social utilities), which are often hit hardest hit by inadequacies in power supply and quality, and by load shedding, will benefit directly.

286. Clean energy development, as promoted by the Project, will contribute to local, regional, and global environmental initiatives. The program will benefit all electricity consumers connected to the Northern grid by enabling the state to export excess power, instead of having to import power from the grid. GOHP can thus increase its overall generating capacity and meet its objective of universal electrification under the 11th Five Year Plan.

287. The proposed project will minimize the environmental costs of providing the required increase in power-evacuating capacity of the state. Run-of-river hydroelectric projects of the type proposed are recognized internationally as the preferred option over fossil fuel plants. An alternative power plant using fossil fuels (coal or oil) would have a capital cost per kilowatt installed significantly in excess of that of the proposed plant. Energy markets in India are now shifting toward least-cost-based economy of operation. Generation costs from thermal plants are expected to increase with escalating costs of fuel and transportation, while generation costs from hydropower plants normally decline every year with respect to first-year tariffs, although these may be marginally high. Hydroelectric development is being given priority to improve the hydro/thermal mix for optimizing the efficiency of the country's power system and its use of resources for sustainable power generation in an environment-friendly manner. Apart from being an environmentally clean source of energy, hydroelectric power will also provide a peaking-power option for the country. From the operational angle, hydroelectric projects provide synergy for optimizing generation, save on fuel, minimize greenhouse gases, and produce power in an environment-friendly manner, supporting sustainable development.

288. Hydroelectric projects as proposed have minimal environmental impact while providing energy in remote and hilly areas where it may be impossible or uneconomical to extend grid systems. Hydroelectric projects, especially run-of-river projects, are economically viable and environmentally benign, and have relatively short gestation periods.

289. The Program will contribute to economic development in Himachal Pradesh through expanded power supplies from clean energy sources, and from a sustainable state electricity sector. The proposed outcomes are: (i) increased production and use of clean energy in a financially sustainable manner, (ii) improved state finances and power sector financial viability, (iii) improved sector governance, and (iv) improved capacity in HPPCL for the planning, implementation, and management of hydroelectric plants, as well as the implementation of CDM initiatives and energy efficiency through a power trading program. More specifically, the Program makes the following assumptions related to the hydropower plant projects: (i) HPPCL will be committed to the timely construction and operation of the projects and will exercise proper supervision over their implementation, including the implementation of safeguard plans; (ii) tariffs for the projects or appropriate arrangements for the sale of excess power will be concluded without material delay; (iii) GOHP will continue to support capacity development and will assume ownership of the Program's capacity development component; and (iv) the subprojects will be eligible for CDM financing (purchase of carbon credits), and the CDM will be extended beyond its 2012 end date.

F. Potential Cumulative and Induced Impact

290. The Program entails potential cumulative and induced impact, which will be largely positive. The Program will transfer low-carbon energy from hydroelectric plants in Himachal Pradesh to state-level transmission companies, which in turn, will transmit energy to electric distribution companies. The direct negative impact might result from (i) the acquisition of land for roads and ROW, power evacuation lines, and transmission lines and substations; and (ii) upstream and downstream hydroelectric projects in Himachal Pradesh and adjoining states, and are summarized in the table below.

Table 23: Assessment of Cumulative Impact

Parameter	Without Project	With Project	Net Change	Magnitude of Impact
Crops	Nil	Negative	Small	Low
Natural Vegetation	Nil	Negative	Small	Low
Land Use	Nil	Negative	Small	Medium
Forests	Nil	Negative	Small	Medium
Natural Reserves/Sanctuaries	Nil	Negative	Small	Low
Fisheries	Nil	Negative	Small	Medium
Eutrophication	Nil	Negative	Small	Low
Wildlife	Nil	Negative	Small	Low
Rare Species	Nil	Negative	Small	Low
Endangered Species	Nil	Negative	Small	Low
Species Diversity	Nil	Negative	Small	Low
Minerals	Nil	Nil	Nil	Nil
Water Pollution	Nil	Negative	Small	Low
Air Pollution	Nil	Negative	Small	High
Noise Pollution	Nil	Negative	Small	Low
Solid Waste	Nil	Negative	Small	Low
Land Pollution	Nil	Negative	Small	Medium
Soil Erosion	Nil	Negative	Small	Medium
Health	Nil	Positive	Big	High
Benefits to Economy	Nil	Positive	Big	High
Displacement of people	Nil	Negative	Small	Low
Employment opportunities	Nil	Positive	Big	High

Infrastructure	Nil	Positive	Big	High
Hydrological Balance	Nil	Negative	Small	Low
Social Upliftment	Nil	Positive	Big	High
Aquaculture Potential	Nil	Negative	Small	Low
Archaeological Monuments	Nil	Nil	Nil	Nil
Water Availability	Nil	Negative	Small	Low
Seismicity	Nil	Negative	Small	Low
Alignment	Nil	Negative	Big	Medium
Tourism	Nil	Positive	Small	Low

Source; Environmental impact assessment report (footnote 5).

291. The positive impact includes (i) the expansion of low-carbon energy, offsetting emissions from thermal power plants; (ii) the improvement of transmission system efficiency and the promotion of renewable energy; and (iii) economic growth related to improved power supply to millions of consumers. The Project is expected to reduce CO_2 emissions by about 0.1835 million MT) per year. In addition, the Project is expected to offset the emission of 6.507 MT/day of SO_2 and 3.30 MT/day of NO_x, given the emissions from an equivalent amount of electricity generated from the HPPCL Sipat Thermal Power Plant, a modern coal-fired plant. These emission offsets will lessen the negative impact of local, regional, and global air pollution.

292. **Socioeconomic Aspects.** The direct benefits include employment creation and capital infusion. While the direct employment opportunities in the Project will be limited, thousands of employment opportunities will be created indirectly for local people in the region because of the state policy of giving preference to local people for unskilled and semiskilled jobs. Apart from these, many other livelihood opportunities will become available to the entire population in the area through facilities like roads, hospitals, and schools. The Project will bring much-needed clean/green hydro power from a far-flung area of the country to the most densely populated region. The development of the Project as well as the present transmission project will create jobs for local people and thereby help raise their economic status.

293. In the Northern region, the availability of power will push the desired improvement in infrastructure and industrial growth which is hampered due to non availability of reliable power in the region. These industrial activities shall help in creation of employment for local people which shall boost their economic status. Since the proposed project is for development of reliable power network all communities will get the benefit of proposed project.

294. The integrated Kashang Project is the only HEP located on the two streams that supply its water, namely the Kashang khad and the Kerang khad. However, these streams flow into the Satluj river, where there are other projects located. As per the assessment of the hydroelectric potential of the country conducted by the Central Electricity Authority during 1978-1987, the hydroelectric potential of the Satluj basin has been assessed as 7,298 MW at 60% load factor from over 30 potential HEPs with probable installed capacity of 11, 574 MW. These projects will generate similar impact that, in the same manner as for the Kashang project, will need to be incorporated in the environmental impact assessments and environmental management plans by each project's proponent.

G. Environmental Management Plan

295. The EMP summarizes the anticipated impact, the monitoring requirements, and the proposed mitigation measures for the following stages: (i) pre-construction, (ii) construction, and (iii) O&M. Detailed, site-specific mitigation measures and monitoring plans are being developed for all core subprojects. Project environmental management is being undertaken by HPPCL in accordance with the management measures proposed in the comprehensive EIA. A number of abatement measures have already been suggested, along with the likely impact. The objective

of the EMP is to minimize stress on natural resources within the carrying capacity.

296. The Kashang HEP project implementation consists of several infrastructure components that are listed in Table 24. Accordingly, these subprojects are divided into core and noncore subprojects based on the period and their nature of urgency for the project implementation. These noncore projects are decided on the basis of whether they directly contribute the electric generating function of the project or are more ancilliary in nature.

Table 24: Summary of Infrastructure Components of Kashang Integrated HEP

Component	Infrastructure	Core/ Noncore	ADB Funding
Electrical and Mechanical Equipment	Buildings	Core	Yes
	Equipment, housing	Core	Yes
Tunnels	Diversion structures–surface water intake	Core	Yes
	Peaking storage	Core	Yes
	Desiltation tanks/Reservoirs	Core	Yes
	Access Roads	Core	No
	Muck dumping sites	Core	No
Civil Works	Buildings	Core	Yes
	Barrage, gates	Core	Yes
	Construction workers' temporary colonies	Core	No
	Staff housing	Noncore	No
	Access roads to quarters etc.	Noncore	No
Power Evacuation	Switchyard	Core	No
	Transmission line to pooling point	Noncore	No

ADB = Asian Development Bank, HEP = hydroelectric project.
Source: Environmental management plan report (footnote 5).

1. Institutional Arrangements

297. The Multipurpose Projects and Power Department of GOHP will be the executing agency of the Program, and HPPCL will be the implementing agency, with a specific PMU. Each of the component hydroelectric projects will be implemented independently through PIUs. The environment and social management unit headed by a chief environmental specialist and a chief resettlement specialist has been set up within the PMU along with other engineering units to address environmental and social issues of the Program. The ESMU will have one environment and one social development/resettlement specialist at each PIU level to assist the chief specialist. For each subproject EMP, the PMU will take charge of overall coordination, preparation, planning, implementation, and financing. HPPCL will ensure that key institutions, including local governments, are involved in EMP updating and implementation. The Program includes a $12 million capacity development component with funds for HPPCL staff training. Environmental personnel will be trained in environmental management under this component.

298. **Monitoring Responsibilities.** Monitoring during the construction of the HEP will be the responsibility of HPPCL. Monitoring will be continuous at all stages—site selection, construction or maintenance, compliance with construction contracts, and assessment of the state and health of the environmental resource and the effectiveness of mitigation measures. It is proposed that HPPCL set up PIUs to report regularly to ADB. Although the EMP has been formulated to minimize recurrent responsibilities and costs in circumstances where staff, expertise, and finances are limited, some aspects of subproject design will require continuous monitoring to guard against negative environmental impact. Apart from the site managers reviewing the progress daily, regular project review meetings where the environmental aspects of the subprojects are discussed and the required remedial measures taken should be held at least monthly. The excerpts of these meetings will be submitted to the PIU. The mitigation measures suggested requires monitoring of environmental attributes both during construction

and during the operation of the Project. Details on the agencies responsible for EMP activities are given in Table 25.

Table 25: Institutional Roles and Responsibilities for EMP Implementation Activities

Activity	Responsible Agency
Subproject start	
Establishment of ESMU and staff	HPPCL
Disclosure of project EMP details through public notice	PMU/ESMU
Community/Household Meetings with PAPs	ESMU/PMU/PIU
Updating of EMP mitigation measures on startup	
Census of all PAPs	PMU/PIU/ESMU/district administration
Discussions/Meetings/Workshops with PAPs and other stakeholders	PMU/PIU/ESMU
Incorporation of any changes in the EMP	PMU/PIU/ESMU
EMP implementation	
Implementation of mitigation measures proposed in the EMP	PMU/PIU/ESMU
Consultations with PAPs during implementation of EMP mitigation measures	PMU/PIU/ESMU
Grievance redress	PMU/PIU/ESMU/NGO/GRC
Internal monitoring	PMU/PIU/ ESMU
External monitoring	External agency

ADB = Asian Development Bank, EMP = environmental management plan, ESMU = environment and social management unit, GRC = grievance redress committee, HPPCL = Himachal Pradesh Power Corporation Limited, NGO = nongovernment organization, PAPs = project-affected persons, PIU = project implementation unit, PMU = project management unit.
Source: HPPCL.

2. Organization Support System

299. **Environmental Monitoring Program in HPPCL: Implementing Agency/Corporate Level.** This environmental management and social unit at the corporate level, headed by a senior HPPCL official with environmental and social monitoring responsibilities at the highest level, will have the following duties:

(i) Monitor and implement mitigation measures;
(ii) Prepare and implement environmental policy guidelines and environmental good practices;
(iii) Advise and coordinate the activities of regional environmental management cells toward effective environment management;
(iv) Coordinate with MOEF and the state Department of Environment and seek their help in solving environment-related issues during project implementation;
(v) Advise the project planning cell on environmental and social issues to avoid negative environmental impact; and
(vi) Train project staff and increase their awareness of environmental and social issues related to hydroelectric projects.

300. **Environmental Monitoring Program in HPPCL: Project Implementation Unit Level.** At thePIU, HPPCL has made the project head responsible for implementing the environmental and social aspects of the Project. The duties of the environmental cell at the divisional level are:

(i) Implement the environment policy guidelines and environmental good practices at the sites;

(ii) Advise and coordinate the activities of the field offices toward effective environment management;
(iii) Coordinate with the HPSPCB and seek its help in solving issues related to environment monitoring;
(iv) Carry out environmental and social survey in conjunction with the project planning cell to avoid negative environmental impact;
(v) Train the field offices and increase awareness of environmental and social issues related to hydroelectric projects;
(vi) Implement the EMP and the SMP; and
(vii) Monitor the EMP and the SMP and produce periodic reports on these.

3. Grievances

301. An efficient grievance redress mechanism will be developed to help answer the queries and complaints of the PAPs. Each PIU will have specific grievance redress mechanisms pertaining to the EIA/EMP. The grievances of PAPs will first be brought to the attention of the PIU at the appropriate level. Grievances not redressed by the PIU staff will be brought before the GRC, composed of representatives from PAPs, the PMU, the PIU, the ESMU, field staff, the district magistrate, the local administration, the revenue authority, and the local community. Records will be kept of all grievances received including: contact details of the complainant, the date the complaint was received, the nature of the grievance, the agreed corrective actions and the date these were effected, and the final outcome. The GRCs will continue to function during the life of the Project including the defects liability period.

4. Monitoring and Evaluation

302. The implementation of mitigation measures will be audited to identify ineffective measures or implementation procedures, and thus enable the design of improved measures and the implementation of corrective actions. Both internal and external monitoring of the EMP will be carried out.

303. **Internal Monitoring.** Internal monitoring will be the joint responsibility of the PMU, the PIU, and the ESMU. The local PIU will be responsible for the actual monitoring of the EMP implementation with oversight from the PIU and ESMU. The internal monitoring will include administrative monitoring: daily planning, implementation, feedback, and troubleshooting in EMP monitoring. Monitoring and evaluation reports documenting progress in EMP implementation as well as subproject completion reports will be provided by the PMU to ADB for review.

304. **External Monitoring.** HPPCL will hire an independent agency or civil society organization not associated with project implementation to undertake external monitoring and evaluation. The external monitor will monitor and verify EMP implementation to determine whether its goals have been achieved, and livelihood and living standards have been restored, and recommend improvements.

305. **Reporting.** The PIU will forward quarterly progress reports on monitoring progress to the chief environment specialist at HPPCL headquarters. The reports will deal with the progress made in EMP implementation, with particular attention to compliance with the principles and matrix set out in the EMP. HPPCL will submit a semiannual monitoring report to ADB. Also, the external monitoring agency will report directly to ADB every 6 months, stating whether sound environmental management practices have been achieved, and suggesting suitable

recommendations and remedial measures for midterm correction and improvement.

5. Environmental Assessment and Review Procedures for Noncore Subprojects

306. Noncore subprojects, also listed in Table 24, include the construction of staff quarters and access roads associated with the core subprojects and similar in nature. The scale and characteristics of the potential environmental impact of noncore subprojects, are expected to be similar to those already assessed in this SEIA, and based to a significant extent on local conditions. HPPCL will prepare site-specific measures to assess the potential impact of these noncore subprojects on the environment.

307. **Noncore Subproject Selection Criteria.** The specific environmental criteria for subproject selection are:

(i) The transmission lines and roads will not be located within or cross areas of virgin forests, or ecologically significant or environmentally sensitive areas such as national parks, nature reserves, or wetland designated by MOEF.
(ii) The potential environmental impact associated with initial alignments and locations will be minimized through realignment or selection of alternative access roads.
(iii) Monuments of cultural or historical importance will be avoided.
(iv) The clearing of forest resources will be avoided as far as possible, and where unavoidable will be minimized and compensated according to the regulatory criteria of the Government of India.
(v) An EMP with adequate budget will be developed for each subproject.
(vi) Environment category A transmission subprojects will be avoided as far as possible. All noncore subprojects will be subject to ADB classification, and any subprojects deemed “sensitive” will have to be justified, and the anticipated impact and mitigation measures documented.

308. **Application of Selection Criteria.** Any noncore subproject that does not meet the criteria listed above will be rejected. A final check on conformity with the selection criteria will be the submission of selected noncore subprojects for ADB’s clearance. On the basis of the assessment of subprojects in previous sections of this SEIA, if any category A project component is selected, a full, rigorous review of the EIA will be necessary before implementation. However, any candidate subproject confirmed by ADB as category B sensitive (footnote 14) during implementation will require an EMP for ADB review. The summary IEE for the Project along with its EMP will be made available to the general public at least 120 days before the approval of the subproject, in line with ADB OM Section F1/OP, paragraph 15 (footnote 12).

309. **Environmental Classification.** Environmental categorization using a checklist approach in compliance with ADB’s *Environmental Assessment Guidelines* (2003) will be applied. Any category A subproject selected will be treated in accordance with these guidelines for full review before implementation.

310. **Public Consultations.** At least one public consultation will be conducted with the local community and potentially affected people for each category B subproject. Any EIA/IEE that has been approved before the start of detailed design must be communicated to the local community before construction. One more consultation will be carried out before the appraisal of the project acitivities by ADB.

311. **Responsibilities and Authorities of Various Agencies.** The PIUs will be solely responsible for the implementation of the entire environmental assessment and review procedures for the selection of noncore subprojects. This responsibility includes, among others, ensuring that the EMP is adhered to strictly, in a timely and adequate manner, environmental monitoring and institutional requirements are fully met, and public consultations are carried out satisfactorily. PIUs will submit the categorization checklist, complete rapid environmental assessment (REA) checklists, and submit monitoring reports to ADB for review. ADB will be responsible for the regular review and timely approval of subproject checklists and the compliance with the EMP for each subproject. If needed, ADB will provide technical guidance to the PIU. ADB will also review the monitoring reports and officially disclose on its website the status of subproject compliance with ADB's environmental guidelines for selected subprojects.

312. **Detailed Design.** Detailed design work for each additional subproject must follow the recommendations of the draft EMP. To ensure this, detailed designs will be vetted by PIUs before contracts are finalized, and modifications will be made if considered necessary. Certification must be made to ADB that the detailed designs comply with the EMP recommendations before contracts can be finalized.

313. **Preparation of Construction Contracts.** Early in the implementation period, model construction contracts incorporating general environmental safeguards and practices will be prepared. Specific, individual contracts will be based on the model contracts, but vetted by PIUs to ensure that they incorporate specific safeguards recommended for the particular subproject.

314. **Monitoring during Construction.** Monitoring during construction will be the responsibility of the PIU. Monitoring will relate to compliance with construction contracts, the state and health of the environmental resource, and the effectiveness of mitigation measures. The monitoring results will be reported regularly to ADB.

315. **Monitoring of Subproject Operations.** Although the draft EMP is formulated in such a way as to minimize recurrent responsibilities and costs in circumstances where staff, expertise, and finances are limited, some aspects of subproject design will require continuous monitoring to guard against negative environmental impact. For additional noncore projects, the implementing agency is expected to do the primary categorization, to be confirmed by ADB according to the ADB guidelines.

316. The subprojects will have both internal and external monitoring. The PIU will be responsible for internal monitoring of the EMP implementation, and will forward quarterly progress reports to HPPCL headquarters. The report will discuss the progress made in EMP implementation, with particular attention to compliance with the principles and matrix set out in the EMP. HPPCL will submit monitoring report to ADB twice a year.

6. Preliminary Cost Estimates

317. **CAT Plan Costs.** The biotic pressure of land being acquired by the Project (total 85.74 ha, of which forest land is 61.90 ha) is likely to shift to adjoining areas and may result in curtailment of rights' usage of local communities. Project is funding compensatory afforestation over double the forestland acquired and CAT Plan (Rs1,820 lakh) to address this impact besides paying the NPV for environment improvement.

318. In the light of the fact that MOEF has already accorded environment clearance for the

erstwhile Kashang HEP to be built in the Kashang sub-watershed[22] and according to its instruction of 12 December 2007, the CAT plan for stage I, with the appropriate changes, will be made an integral part of the present CAT plan that also involves the Kerang sub-watershed.[23] Inaccessible areas (those with a slope of more than 55°), areas under permanent snow or glaciers, and areas above the tree line having a natural ecosystem with little human interference will be excluded to arrive at those areas where appropriate treatment measures can be undertaken. Degraded forestland in the Kalpa and Moorang forest range has been identified for compensatory afforestation. The cost of compensatory afforestation is fixed at Rs3,366,650. The catchment of the Project is 231 km^2.

319. The catchment area above the permanent snow line (elevation 4,200 m) is 98 km^2. This means the work would effectively be done over 133 km^2. The altitude of the Kashang khad catchment ranges from 2,000 m at its confluence with the Satluj river, to 5,938 m in the glacier zone. The khad has an average slope of 1:15 up to the diversion site and thereafter has a steep descent (slope 1:5), making it ideal for hydropower development. The catchment area above the weir site comprises steep mountains with only a portion covered with forest; the major part is under permanent snow. To avoid soil erosion, wire crates, check dams, or check walls are proposed at various junctions of the nallah under catchment area treatment. Further plantation is proposed on the wasteland and degraded forest along Kashang khad and nallahs. The impact of gushing water must be reduced. Soil conservation measures (check dams, etc.) would reduce momentum and thereby lower soil erosion along the nallahs.

320. The cost of all the works proposed in the CAT plan, after incorporating the cost of the CAT plan for the former Kashang HEP, is enumerated in Table 26.

Table 26: CAT Plan Cost Estimate

Item	Amount (Rs lakh)
Treatment Works in Free-Draining Catchment	
Biological measures	495.56
Engineering measures	418.90
Treatment Works in Impact Area	
Biological measures	60.00
Engineering measures	40.01
Treatment Works on Private Land	
Biological measures	29.77
Engineering measures	10.49
Subtotal Treatment Works	**1,054.72**
Implementation of Support Infrastructure	29.50
Fuelwood Saving Devices	28.80
Training and Extension Program	8.00
Preparation of Micro Plans	10.55
Documentation	5.28
Gender Support	5.00
Funds for Educational Activities Related to Medicinal Plant Sector	6.00
Monitoring of Silt	15.00
Development of Eco-tourism	20.00
Provision for Floristic Survey	4.00
Support for Eco Task Force	52.75
Provision for Monitoring and Evaluation Activities	52.75
Provision for Environmental Services	105.47
	343.10

[22] The clearance was given in its letter of 15 November 2002.
[23] There was further instruction dated 12 December 2007 regarding the incorporation of the CAT plan for Kashang HEP (now stage I) in the new EMP for the integrated project.

Item	Amount (Rs lakh)
10% yearly escalation for 4 years on cost of treatment works (Rs105.715 lakhs)	421.89
Grand Total	**1,819.72**

CAT = catchment area treatment.
Source: Environmental management plan report (footnote 5).

321. **EMP Costs.** Tables 27 and 28 provide summaries of the EMP during the construction and operating phases, whereas Table 29 gives the cost of the EMP. The detailed EMP list of environmental impact, suggested management measures, and implementing agencies is shown in Table 30 and the Appendix. Table 31 provides the summary environmental monitoring program with cost estimates.

Table 27: Summary of Environmental Management Program during Project Construction

Item	Parameters	Frequency	Location
Effluent from septic tanks	pH, BOD, COD, TSS, TDS	Once a month	Before and after treatment in oxidation ditch
Water-related diseases	Identification of water-related diseases, adequacy of local vector control and curative measures, etc.	Thrice a year	Labor camps and settlements
Noise	Equivalent noise level (L_{eq})	Once every 3 months	At major construction sites
Air quality	SPM, RPM, SO_2, NOx	Once every season	At major construction sites
Meteorological aspects	Wind direction and velocity, temperature, humidity, rain	Once every season	At one of the ambient air quality sampling sites

BOD = biological oxygen demand, COD = chemical oxygen demand, NOx = nitrogen oxides, RPM = respirable particulate matter, SO_2 = sulfur dioxide, SPM = suspended particulate matter, TDS = total dissolved solids, TSS = total suspended solids,
Source; Environmental management plan report (footnote 5).

Table 28: Summary of Environmental Monitoring Program during Project Operation

Items	Parameters	Frequency	Location
Water	pH, temperature, EC, turbidity, total dissolved solids, calcium, magnesium, total hardness, chlorides, sulfates, nitrates, DO. COD, BOD, iron, zinc, manganese	Thrice a year	1 km upstream of barrage site, reservoir area; 1 km, 5 km, and 10 km downstream of tailrace discharge
Effluent from sewage treatment plant	pH, BOD, COD, TSS, TDS	Once a week	Before and after treatment at sewage treatment plant
Erosion and siltation	Soil erosion rates, stability of bank embankment, etc.	Twice a year	
Ecology	Status of afforestation programs for greenbelt development	Once in 2 years	
Water-related diseases	Identification of water-related diseases, sites, adequacy of local vector control measures, etc.	Three times a year	Villages adjacent to project sites
Aquatic ecology	Phytoplanktons, zooplanktons, benthic life, fish composition	Once a year	1 km upstream of barrage site, reservoir area; 1 km, 5 km, and 10 km downstream of tailrace discharge
Land use	Land-use pattern using satellite data	Once a year	Catchment area
Soil	pH, EC, texture, organic matter	Once a year	Catchment area

BOD = biological oxygen demand, COD = chemical oxygen demand, EC = electrical conductivity, km = kilometer, NO_x = nitrogen oxides, TDS = total dissolved solids, TSS = total suspended solids.
Source: Environmental management plan report (footnote 5).

322. The total cost of implementing this EMP is estimated to be Rs3,600.00 lakhs. The cost is

exclusive of the cost of the resettlement and rehabiliation plan. However, it includes O&M costs on various components of the environment monitoring program at Rs46 lakh. Funds for some of the items like health care are to be routed through the LADC. Though commitment for the LADC is 1.5% of the total project cost, this expenditure is considered outside the scope of the Project. Only those components that are relevant to the EMP are listed here. Itemized costs involved are shown in Table 29:

Table 29: Cost of Implementing Environment Management Plan

Item	Amount (Rs lakh)
Catchment area treatment plan	1,820.00
Compensatory afforestation	541.00
Greenbelt development	55.00
Wildlife management and biodiversity conservation plan	100.00
Muck management plan	552.00
Restoration plan for quarry sites	64.00
Landscape and restoration plan	26.00
Health management plan	65.00
Provision for subsidized fuel	113.00
Solid waste management	178.00
Disaster management plan	40.00
Environment monitoring plan	46.00
Total	**3,600.00**

Source: Environmental management plan report (footnote 5).

Table 30: Detailed Environmental Management Plan

Project Activity/Stage	Potential Impact	Proposed Mitigation Measure	Parameter to be Monitored	Measurement and Frequency	Institutional responsibility	Implementation schedule
Pre-construction						
Location of adits, tunnels, access roads, alignment and design of muck sites	Exposure to safety risks	Setback of dwellings to designed in accordance with permitted level of air quality deterioration and the regulation of supervision at sites.	Air quality, alignment selection of roads, adits, muck disposal points with respect to nearest dwellings	Setback distances to nearest houses; once	HPPCL	Detailed alignment survey and design
Equipment specifications and design parameters	Release of chemicals and gases in receptors (air, water, land)	PCBs not used in transformers or other project facilities or equipment.	Equipment design	Exclusion of PCBs in transformers stated in tender specification; once	HPPCL	Part of tender specifications for the equipment
		Processes, equipment, and systems not to use chlorofluorocarbons, including halon, and their use, if any, in existing processes and systems should be phased out and to be disposed of in a manner consistent with the requirements of the Government	Process, equipment and system design	Exclusion of CFCs stated in tender specification; once	HPPCL	Part of tender specifications for the equipment
				Phase out schedule to be prepared in case still in use; once		Part of equipment and process design
Power Evacuation line design	Exposure to electromagnetic interference	Power evacuation line design to comply with the limits of electromagnetic interference from overhead power lines	Electromagnetic field strength for proposed line design	Power evacuation Line design compliance with relevant standards; once	HPPCL	Part of detailed alignment survey and design
HPP location and design	Exposure to noise	Design of plant enclosures to comply with noise regulations	Expected noise emissions based on design	Compliance with regulations; once	HPPCL	Part of detailed siting survey and design
Location of powerhouse, headworks	Impact on water bodies and land	Consideration of site location at where they could be located to avoid water bodies or agricultural land.	Site location, line alignment selection (distance to water and/or agricultural land)	Consultation with local authorities and land owners; once	HPPCL	Part of project siting survey and detailed survey and design
	Social inequities	Careful site selection to avoid existing settlements	Site location, selection (distance to nearest dwellings or social institutions)	Consultation with local authorities and landowners;- once	HPPCL	Part of detailed project siting and survey and design
		Minimise need to acquire agricultural land	Site location, selection (distance to agricultural land)	Consultation with local authorities and land owners; once	HPPCL	Part of detailed project siting and survey and design
Involuntary resettlement or land acquisition	Social inequities	Compensation paid for temporary/ permanent loss of productive land according to LADC and its process	RP implementation	Consultation with affected parties; once in a quarter	HPPCL	Prior to construction phase
Encroachment into precious ecological areas	Loss of precious ecological values/ damage to precious species	Avoid encroachment by careful site selection	Power line alignment selection (distance to nearest designated ecological protection area)	Consultation with local authorities; once	HPPCL	Part of detailed siting and alignment survey /design
		Minimise the need by using existing towers and ROW wherever possible	Power evacuation line alignment selection	Consultation with local authorities and design engineers - once	HPPCL	Part of detailed siting and alignment survey/design

Project Activity/Stage	Potential Impact	Proposed Mitigation Measure	Parameter to be Monitored	Measurement and Frequency	Institutional responsibility	Implementation schedule
Power evacuation line through forestland	Deforestation and loss of biodiversity	Avoid encroachment by careful site and alignment selection	Line alignment selection (distance to nearest protected or reserved forest)	Consultation with local authorities; once	HPPCL	Part of detailed siting and alignment survey/design
		Minimize the need by using existing towers, tall towers and ROW, wherever possible		Consultation with local authorities and design engineers - once		
		Obtain statutory clearances from the government	Statutory approvals from Government	Compliance with regulations; once for each subproject		
Encroachment into farmland	Loss of agricultural productivity	Avoid siting new towers on farmland wherever feasible	Line alignment selection	Consultation with local authorities and design engineers - once		Part of detailed siting and alignment survey /design
		Farmers compensated for any permanent loss of productive land	Design of Implementation of Crop Compensation (based on affected area)	Consultation with affected parties – once in a quarter		Prior to construction phase
Noise related	Nuisance to neighbouring properties	Powerhouse, headworks, tunnel sited and designed to ensure noise will not be a nuisance.	Noise levels	Noise levels to be specified in tender documents - once	HPPCL	Part of detailed equipment design
Interference with drainage patterns/Irrigation channels	Flooding hazards/loss of agricultural production	Appropriate siting of power evacuation line towers to avoid channel interference Appropriate tunnel alignments to avoid channel interference	Site location and line alignment selection (distance to nearest flood zone)	Consultation with local authorities and design engineers – once	HPPCL	Part of detailed alignment survey and design
Escape of polluting materials	Environmental pollution	Transformers designed with oil spill containment systems, and purpose-built oil, lubricant and fuel storage system, complete with spill cleanup equipment.	Equipment specifications with respect to potential pollutants	Tender document to mention specifications - once	HPPCL	Part of detailed equipment design /drawings
		Powerhouses to include drainage and sewage disposal systems to avoid offsite land and water pollution.	Powerhouse sewage design	Tender document to mention detailed specifications - once	HPPCL	Part of detailed substation layout and design /drawings
Equipment submerged under flood	Contamination of receptors (land, water)	Powerhouse constructed above the high flood level by raising the foundation pad.	Powerhouse design to account for HFL (elevation with respect to HFL elevation)	Base height as per flood design - once	HPPCL	Part of detailed powerhouse layout and design/drawings
Explosions/Fire	Hazards to life	Design of Powerhouse to include modern fire control systems/firewalls.	Design compliance with fire prevention and control codes	Tender document to mention detailed specifications - once	HPPCL	Part of detailed Powerhouse layout and design /drawings
		Provision of fire fighting equipment to be located close to power generation equipment.				
Construction						
Equipment layout and installation	Noise and vibrations	Construction techniques and machinery selection seeking to minimize ground disturbance.	Construction techniques and machinery	Construction techniques and machinery creating minimal ground disturbance - once at	HPPCL, Contractor through contract provisions	Construction period

Project Activity/Stage	Potential Impact	Proposed Mitigation Measure	Parameter to be Monitored	Measurement and Frequency	Institutional responsibility	Implementation schedule
				the start of each construction phase		
Physical construction	Disturbed farming activity	Construction activities on cropping land timed to avoid disturbance of field crops (within one month of harvest wherever possible).	Timing of start of construction	Crop disturbance – Post harvest as soon as possible but before next crop - once per site	HPPCL, Contractor through contract provisions	Construction period
Mechanized construction	Noise, vibration and operator safety, efficient operation	Construction equipment to be well maintained.	Construction equipment – estimated noise emissions	Complaints received by local authorities - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
	Noise, vibration, equipment wear and tear	Proper maintenance and turning off plant not in use.	Construction equipment – estimated noise emissions and operating schedules	Complaints received by local authorities - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
Construction of roads for accessibility	Increase in airborne dust particles	Existing roads and tracks used for construction and maintenance access to the site wherever possible.	Access roads, routes (length and width of new access roads to be constructed)	Use of established roads wherever possible - every 2 weeks	HPPCL, contractor through contract provisions	Construction period
	Disturb wildlife habitat	Maintaining a greenbelt area, restrictions on the number of trucks	Vegetation maintenance, noise level.	Presence of target species following vegetation clearance – once per site	HPPCL, contractor through contract provisions	Construction period
	Increased land requirement for temporary accessibility	New access ways restricted to a single carriageway width within the ROW.	Access width (meters)	Access restricted to single carriageway width within ROW - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
Temporary blockage of utilities	Overflows, reduced discharge	Temporary placement of fill in drains/canals not permitted.	Temporary fill placement (m^3)	Absence of fill in sensitive drainage areas - every 4 weeks	HPPCL, Contractor through contract provisions	Construction period
Site clearance	Vegetation	Marking of vegetation to be removed prior to clearance, and strict control on clearing activities to ensure minimal clearance.	Vegetation marking and clearance control (area in m^2)	Clearance strictly limited to target vegetation - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
	Disturb wildlife habitat	Maintaining a green belt area, restrictions on the number of trucks	Vegetation maintenance, noise level.	Presence of target species following vegetation clearance – once per site	HPPCL, Contractor through contract provisions	Construction period
Cutting of trees within Rights of Way of power evacuation line	Fire hazards	Trees allowed growing up to a height within the Rights of Way by maintaining adequate clearance between the top of tree and the conductor as per the regulations.	Species-specific tree retention as approved by statutory authorities (average and maximum tree height at maturity, in meters)	Presence of target species in Rights of Way– once per site	HPPCL, Contractor through contract provisions	Construction period
	Loss of vegetation and deforestation	Trees that can survive pruning to comply should be pruned instead of cleared.	Species-specific tree retention as approved by statutory authorities	Presence of target species in Rights of Way following vegetation clearance – once per site	HPPCL, Contractor through contract provisions	Construction period
		Felled trees and other cleared or pruned vegetation to be disposed of as authorized by the statutory bodies.	Disposal of cleared vegetation as approved by the statutory authorities (area cleared, in m^2)	Use or intended use of vegetation as approved by the statutory authorities	HPPCL, Contractor through contract provisions	Construction period

Project Activity/Stage	Potential Impact	Proposed Mitigation Measure	Parameter to be Monitored	Measurement and Frequency	Institutional responsibility	Implementation schedule
				– once per site		
Wood/vegetation harvesting	Loss of vegetation and deforestation	Construction workers prohibited from harvesting wood in the project area during their employment, (apart from locally employed staff continuing current legal activities).	Illegal wood /vegetation harvesting (area in m^2, number of incidents reported)	Complaints by local people or other evidence of illegal harvesting - every 2 weeks	HPPCL, contractor through contract provisions	Construction period
Surplus earthwork/soil	Runoff to cause water pollution, solid waste disposal	Excess soil excavation from powerhouse disposed of next to roads or around houses, in agreement with the local community or landowner.	Location and amount (m^3) of fill disposal	Appropriate fill disposal locations - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
		Soil excavated from tunnel disposed of by placement along backfill dams, etc.	Soil disposal locations and volume (m^3)	Acceptable soil disposal sites; every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
Powerhouse construction	Loss of soil	Fill for the powerhouse foundations obtained by creating or improving local water supply ponds or drains, with the agreement of local communities.	Borrow area siting (area of site in m^2 and estimated volume in m^3)	Acceptable borrow areas that provide a benefit - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
Powerhouse construction	Water pollution	Construction activities involving significant ground disturbance (i.e., powerhouse land forming) not undertaken during the monsoon season.	Seasonal start and finish of major earthworks (pH, BOD/COD, suspended solids, other)	Timing of major disturbance activities; before start of construction	HPPCL, Contractor through contract provisions	Construction period
Site clearance	Vegetation	Tree clearances for easement establishment to only involve cutting trees off at ground level or pruning as appropriate, with tree stumps and roots left in place and ground cover left undisturbed.	Ground disturbance during vegetation clearance (area, m^2)	Amount of ground disturbance - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
			Statutory approvals	Statutory approvals for tree clearances – once for each site	HPPCL, Contractor through contract provisions	Construction period
Storage of chemicals and materials	Contamination of receptors (land, water, air)	Fuel and other hazardous materials securely stored above high flood level.	Location of hazardous material storage; spill reports (type of material spilled, amount (kg or m^3) and action taken to control and clean up spill)	Fuel storage in appropriate locations and receptacles - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
Construction schedules	Noise nuisance to neighbouring properties	Construction activities only undertaken during the day and local communities informed of the construction schedule.	Timing of construction (noise emissions, [dB(a)])	Daytime construction only - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
Provision of facilities for construction workers	Contamination of receptors (land, water, air)	Construction workforce facilities to include proper sanitation, water supply and waste disposal facilities.	Amenities for Workforce facilities	Presence of proper sanitation, water supply and waste disposal facilities - once each new facility	HPPCL, Contractor through contract provisions	Construction period
Encroachment into farmland	Loss of agricultural productivity	Use existing access roads wherever possible	Usage of existing utilities	Complaints received by local people /authorities - every 2	HPPCL, Contractor through contract provisions	Construction period
		Ensure existing irrigation facilities	Status of existing facilities			

Project Activity/Stage	Potential Impact	Proposed Mitigation Measure	Parameter to be Monitored	Measurement and Frequency	Institutional responsibility	Implementation schedule
		are maintained in working condition		weeks		
		Protect /preserve topsoil and reinstate after construction completed	Status of facilities (earthwork in m^3)			
		Repair /reinstate damaged bunds etc after construction completed	Status of facilities (earthwork in m^3)			
	Social inequities	Compensation for temporary loss in agricultural production	Implementation of Crop compensation (amount paid, dates, etc.)	Consultation with affected parties – once in a quarter	HPPCL	Prior to construction
Uncontrolled erosion/silt runoff	Soil loss, downstream siltation;	Need for access tracks minimised, use of existing roads.	Design basis and construction procedures (suspended solids in receiving waters; area re-vegetated in m^2; amount of bunds constructed [length in meter, area in m^2, or volume in m^3])	Incorporating good design and construction management practices – once for each site	HPPCL, Contractor through contract provisions	Construction period
		Limit site clearing to work areas				
		Regeneration of vegetation to stabilise works areas on completion (where applicable)				
		Avoidance of excavation in wet season				
		Water courses protected from siltation through use of bunds and sediment ponds				
Nuisance to nearby properties	Losses to neighbouring land uses/ values	Contract clauses specifying careful construction practices.	Contract clauses	Incorporating good construction management practices – once for each site	HPPCL (Contractor through contract provisions)	Construction period
		As much as possible existing access ways will be used.	Design basis and layout	Incorporating good design engineering practices – once for each site		
		Productive land will be reinstated following completion of construction	Reinstatement of land status (area affected, m^2)	Consultation with affected parties – twice – immediately after completion of construction and after the first harvest		
	Social inequities	Compensation will be paid for loss of production, if any.	Implementation of Tree/Crop compensation (amount paid)	Consultation with affected parties – once in a quarter	HPPCL	Prior to construction
Flooding hazards due to construction impediments of natural drainage	Flooding and loss of soils, contamination of receptors (land, water)	Avoid natural drainage pattern /facilities being disturbed /blocked /diverted by the on-going construction activities	Contract clauses (e.g., suspended solids and BOD/COD in receiving water)	Incorporating good construction management practices – once for each site	HPPCL (Contractor through contract provisions)	Construction period
Inadequate siting of borrow areas	Loss of land values	Existing borrow sites will be used to source aggregates, therefore, no need to develop new sources of aggregates	Contract clauses	Incorporating good construction management practices – once for each site	HPPCL (Contractor through contract provisions)	Construction period
Health and safety	Injury and sickness of workers and members of the	Contract provisions specifying minimum requirements for construction camps	Contract clauses (number of incidents and total lost-work days caused by	Contract clauses compliance – once every quarter	HPPCL (Contractor through contract provisions)	Construction period

Project Activity/Stage	Potential Impact	Proposed Mitigation Measure	Parameter to be Monitored	Measurement and Frequency	Institutional responsibility	Implementation schedule
	public	Contractor to prepare and implement a health and safety plan.	injuries and sickness)			
		Contractor to arrange for health and safety training sessions				
Solid waste generated from workers' colonies	Influences to health of the people and the environment.	Sewerage management and solid waste disposal facilities conceptualized from the planning stage	Municipal waste from residential area, solid waste from labor camps, bio-medical wastes from dispensary	Municipal Solid Waste Rules 2000	HPPCL (Contractor through contract provisions)	Construction period
Inadequate construction stage monitoring	Likely to maximise damages	Training of HPPCL environmental monitoring personnel	Training schedules	Number of programs attended by each person – once a year	HPPCL	Routinely throughout construction period
		Implementation of effective environmental monitoring and reporting system using checklist of all contractual environmental requirements	Respective contract checklists and remedial actions taken thereof.	Submission of duly completed checklists of all contracts for each site - once		
		Appropriate contact clauses to ensure satisfactory implementation of contractual environmental mitigation measures.	Compliance report related to environmental aspects for the contract	Submission of duly completed compliance report for each contract - once		
Operation and Maintenance						
Location of evacuation power line alignment, powerhouse and design	Exposure to safety related risks	Setback of dwellings to overhead line route designed in accordance with permitted level of power frequency and the regulation of supervision at sites.	Compliance with setback distances ("as-built" diagrams)	Setback distances to nearest houses – once in quarter	HPPCL	During operations
Equipment submerged under flood	Contamination of receptors (land, water)	Equipment installed above the high flood level (HFL) by raising the foundation pad.	Substation design to account for HFL ("as-built" diagrams)	Base height as per flood design - once	HPPCL	During operations
Oil spillage	Contamination of land/nearby water bodies	Switchyard transformers located within secure and impervious bunded areas with a storage capacity of at least 100% of the capacity of oil in transformers and associated reserve tanks.	Substation bunding ("as-built" diagrams)	Bunding capacity and permeability - once	HPPCL	During operations
Inadequate provision of staff/workers health and safety during operations	Injury and sickness of staff /workers	Careful design using appropriate technologies to minimise hazards	Usage of appropriate technologies (lost work days due to illness and injuries)	Preparedness level for using these technologies in crisis – once each year	HPPCL	Design and operation
		Safety awareness raising for staff.	Training/awareness programs and mock drills	Number of programs and percent of staff /workers covered – once each year		
		Preparation of fire emergency action plan and training given to staff on implementing emergency action plan				
		Provide adequate sanitation and water supply facilities	Provision of facilities	Complaints received from staff /workers every 2 weeks		

Project Activity/Stage	Potential Impact	Proposed Mitigation Measure	Parameter to be Monitored	Measurement and Frequency	Institutional responsibility	Implementation schedule
Electric Shock Hazards	Injury/mortality to staff and public	Careful design using appropriate technologies to minimise hazards	Usage of appropriate technologies (number of injury incidents, lost work days)	Preparedness level for using these technologies in crisis – once a month	HPPCL	Design and Operation
		Security fences around powerhouse/ headworks	Maintenance of fences	Report on maintenance – every 2 weeks		
		Barriers to prevent climbing on/dismantling of equipment	Maintenance of barriers			
		Appropriate warning signs on facilities	Maintenance of warning signs			
		Electricity safety awareness raising in project areas	Training /awareness programs and mock drills for all concerned parties	Number of programs and percent of total persons covered – once each year		
Operations and maintenance staff skills less than acceptable	Unnecessary environmental losses of various types	Adequate training in O&M to all relevant staff/maintenance crews.	Training/awareness programs and mock drills for all relevant staff	Number of programs and percent of staff covered – once each year	HPPCL	Operation
		Preparation and training in the use of O&M manuals and standard operating practices.				
Inadequate periodic environmental monitoring.	Diminished ecological and social values.	HPPCL staff to receive training in environmental monitoring of project operations and maintenance activities.	Training/awareness programs and mock drills for all relevant staff	Number of programs and percent of staff covered – once each year	HPPCL	Operation
Equipment specifications and design parameters	Release of chemicals and gases in receptors (air, water, land)	Processes, equipment and systems using cholofluorocarbons including halon, should be phased out and to be disposed of in a manner consistent with the requirements of the Government.	Process, equipment and system design	Phase out schedule to be prepared in case still in use – once in a quarter	HPPCL	Operations
Power Evacuation line maintenance	Exposure to electromagnetic interference	Evacuation line design to comply with the limits of electromagnetic interference from overhead power lines	Required ground clearance (meters)	Ground clearance - once	HPPCL	Operations
Powerhouse maintenance	Exposure to electromagnetic interference	Powerhouse design to comply with the limits of electromagnetic interference within floor area	Required vibrations level, instrumentation	Instrumentation regular	HPPCL	Operations
Noise related	Nuisance to neighboring properties	Powerhouse sited and designed to ensure noise will not be a nuisance.	Noise levels (dB[A])	Noise levels at boundary nearest to properties and consultation with affected parties if any - once	HPPCL	Operations

BOD = biological oxygen demand, COD = chemical oxygen demand, HPPCL = Himachal Pradesh Power Corporation Limited, m^2 = square meter.
Source: Environmental management plan report (footnote 5).

Table 31: Summary of Environment Monitoring Program with Cost Estimates

Aspect	Parameters to be monitored	Frequency		Location	Cost Estimates (Rs lacs)			Implementing Agency
		During Construction	During Operation		During Construction	During Operation	Total	
Air Quality monitoring	SO_2, NO_X, CO, SPM etc except Co during operation stage	Quarterly for 4 years	Quarterly a year for 3 years	Dolo Dogri, Toktu, Lappo P/H Site & Rekong Peo	2.40	1.80	4.20	HPSPCB or any approved agency of MoEF
Noise Quality Monitoring	Noise level	Quarterly for 4 years	Quarterly a year for 3 years	Pangi village, Toktu, Lappo, Lippa village and P/H site	2.00	1.50	3.50	HPSPCB or any approved agency of MoEF
Water quality monitoring	All parameters given in water quality	Quarterly a year for 4 years	Quarterly a year for 3 years	Dolo Dogri, Pangi, Toktu, Lappo and confluence of Kerang and Kashang Khad with river Satluj	4.80	3.60	8.40	HPSPCB or any approved agency of MoEF
Water-related diseases	Identification of water-related diseases, adequacy of local vector control and curative measures etc.	Twice a year for 4 years	Twice a year for 3 years	Villages adjacent to project sites & labor colonies	3.00	1.50	4.50	Chief Medical Officer of Reckong Peo
Erosion and Siltation	Soil erosion rates, Stability of banks	Twice a year summer and post monsoon	Daily Silt observation	Intake points at Dolo-Dogri, Toktu, and Lappo	4.00	2.00	6.00	HPPCL
Ecosystem monitoring : - Terrestrial and aquatic fauna - Environmental studies - Public awareness program	Wildlife census, field surveys	Once	Once	Catchment area of Kashang and Kerang Khads up to trench weir site and downstream upto confluence with River Satluj	5.00	5.00	10.00	Himachal Pradesh Forest Dept. or Wildlife Institute of India
Celebration of Environment Day and other awareness-raising programs		Once every year for 4 years		At village Pangi and Lappo	2.00		2.00	Himachal Pradesh Forest Dept.
Miscellaneous like payment to HPSPCB for fees in regard to consent to establish the project					8.00	2.00	10.00	HPPCL
Total Cost (Rs).							**48.60**	

HPPCL = Himachal Pradesh Power Corporation Ltd., HPSPCB = Himachal Pradesh State Pollution Control Board, MOEF = Ministry of Environment and Forests, NO_x = nitrogen oxides, SO_2 = sulfur dioxide, SPM = suspended particulate matter.
Source: Environmental management plan report (footnote 5).

H. Disaster Management Plan

323. According to the standard seismic zoning map prepared by the Bureau of Indian Standards (BIS:1893:2002) (footnote 6), the project area lies in an active seismic zone (IV), indicating severe seismic intensity in the area. Available data on seismicity, within a radius of 150 km of the project, shows that earthquakes with a magnitude greater than 5.0 on the Richter scale, occur at frequent intervals. Important seismic events that have taken place within a radius of 200 km from the project area, in the past 150 years, have caused significant damage, include the quakes in Kangra in 1905 (magnitude 8+), Kullu in 1908 (6.0), Chamba in 1945 and 1947 (6.5 and 6.6), Kinnaur in 1975 (6.8), Uttarkashi in 1991 (magnitude 6.6), and Chamoli in 1999 (magnitude 6.8). Through detailed field investigations, it has been ensured that all components of the Project are founded on firm rock foundation, designed according to suitable seismic design parameters. Yet the eventuality of a disaster cannot be ignored. The abutments and hill slopes at project sites will be stabilized through appropriate engineering measures to avoid the possibility of slope failure, which could jeopardize project operation. Even if the trench weir were damaged, catastrophic damage downstream would be unlikely, as the pondage has no storage capacity. The structural design of the trench weir is such that there is no static head difference on upstream and downstream of weir site. The provision of an upstream and downstream cutoff wall at the end of the upstream and downstream bed protection will minimize any progression or retrogression of the bed.

I. Public Consultation and Disclosure

324. HPSEB has organized numerous meetings with the villagers in order to disseminate information about the project, answer questions and receive feedback. Subsequent to these meetings, a list of demands has also been submitted by the people, and based on these views obtained, scientific studies involving secondary data review and field monitoring were conducted, and expert opinions were sought to verify the validity of the findings. An environment management and monitoring plan based on the results of the consultations, field observations and studies has been proposed.

325. Awareness and attitude in the present context mean awareness among the respondents regarding construction of the project, acquisition of land and compensation offer. The attitude and opinion of local population toward the project and related issues has been collected under the survey. People were divided on the issue of support regarding the construction of the Project. But project awareness among the respondents was high (94.46%).

326. During and after the conduct of the EIA for the integrated Kashang HEP, three public consultation hearings were conducted by the EIA team on the following dates: 16 October 2008, 19 February 2009, and 29 May 2009 in Pangi village; and 17 October 2008, 18 February 2009, and 28 May 2009 in Lippa village.

327. The discussions were primarily focused on receiving maximum inputs from the participants regarding their acceptability and environmental concerns arising out of the project. To begin with they were given a brief outline of the project to which their opinion was sought. Issues were discussed in depth with the government officials and nongovernment organizations while those with the villagers touched upon mainly what is relevant to them. The villagers were informed of the project activities in their area and the likely benefits or adverse effects that may arise out of the activities during both construction and operation. The villagers were however well aware of the project development stages and informed of the consequences. Issues such

as reduced flow in the khads and the effect of air pollution during construction on agriculture and fruit orchards were discussed.

328. Information on aquatic life, especially fish population and downstream use of water from the diversion site of the Kashang khad was discussed at length. Project acceptance among government officials is mixed. While they are in agreement regarding the benefits of the project vis-à-vis national importance of power supply, some have even sited local problems that may arise due to the project. The agriculture officer has no apprehensions from the project and confirmed that since there is no use of water for any irrigation (and other purposes) downstream of the diversion site of Kashang khad, the project reducing the flow in the river drastically will not affect the local villagers. There is also no fishing or any other economic and/ or social significance of the khad in the area.

329. The elected members in the village as well as the village residents expressed considerable apprehension from the project construction. They feared there may be landslides and water streams lost due to the project. They however confirmed that there is no use of the water form the Kashang Khad after the diversion site and its reduced flow is not a point of concern for them. They also expressed their concern at the poor quality of apple and apple yield that may results from increasing dust in the area, as they have experienced in the past. This has a direct correlation to the market price fetched by these fruit that are a major source of income in these areas. An appropriate method of waste disposal has also been sought arising from the same concern. It was suggested that trees as sal, dehar, kail, betula and bemi be planted in the afforestation programmes as these are both native and of economical importance. Plants as pine and poplar were not desired as they withdraw excess amount of water. Improvement of village schools and strengthening of the existing hospital with modern equipments is also sought and a part of the supply from the electricity generated is hoped for the village use including irrigation.

J. Due-Diligence Review of Associated Facilities

330. **Subprojects: Transmission Lines.** To avoid impact from laying separate transmission lines for each of the HEPs planned in the valley, only a single corridor for a common transmission line is being laid by the state transmission utility. The transmission line projects are exempted from environmental impact assessment (EIA) by the MOEF. However, for the transmission lines traversing through a forest (footnote 17), the project executing agency is required to obtain forest clearance from MOEF. For the Kashang integrated project, the transmission line has already been constructed by HPSEB before the start of the ADB funding for tranche 1. The HPSEB has assured that the transmission line for the Kashang Integrated Project has been erected as per the required procedures of the Government for environmental and forest clearances.

331. Accordingly, diversion of 57.881 ha of additional forestland for the construction of a 220 kV transmission line from Nathpa to Kashang was approved on 20 February 2006 by the MOEF. This land was in addition to the 73.02 ha of forestland approved on 12 August 2003 for the Kashang project. This approval was based proposal from the HPSEB (the state transmission utility) to the Government of India. Based on this approval, the 200 kV transmission line has been developed by HPSEB to evacuate power from the Kashang project. The integrated transmission plan makes use of the existing 220 kV Bhaba–Kunihar line. It is proposed to loop in loop out (LILO) of the 220 kV Bhaba Kunihar feeder at Kashang. These 50 km power evacuation LILO lines of 220 KV have already been developed by HPSEB. These transmission

lines are classified by the Government of India as environmental category B2,[24] and were part of the EIAs for the particular HEPs. Beyond the substation at Jangi, the 220 kV line to the 400/220 kV power grid transmission line is capable of evacuating about 527 MW of power from Kashang stage I (65 MW), Kashang stage II and III (130 MW), Kashang stage IV (48 MW), Tidong I (100 MW), Tidong II (60 MW), and Kut (24 MW) HEPs.

332. Potential adverse environmental impact associated with transmission lines will be avoided or minimized through careful route and site selection. Preliminary site selection was done based on the topographic sheets of the *Forest Atlas* (footnote 16). For associated facilities, transmission projects normally are classified as category B under ADB's classification of environmental impact.

333. The state transmission utility has given its assurance that the transmission line route was selected to avoid communities (particularly tribal communities), monuments of cultural or historical importance, conservation areas (e.g., sanctuaries, national parks, wildlife reserves, forest reserves), and other natural resource areas (e.g., agricultural land). In addition, the route has been set back from major towns where possible to accommodate future urban expansion, and avoids wetlands and unstable areas. Alternative transmission line routes were initially considered. The selection of the proposed route was based on minimum ROW area and tree clearance. The MOEF, in its clearance procedure, found no endangered, rare, or threatened species of flora or fauna near the transmission line and has ensured that HPSEB will take adequate measures for environmental mitigation and monitoring.

IV. CONCLUSIONS

334. Demand for electricity in India continues to outstrip supply, with the total shortfall in electricity supply across the country estimated to be 8.3% per annum. Industrial, commercial, and domestic electricity consumption is restricted by supply; thus, additional generation is required for economic growth and poverty alleviation. The Sainj HEP will provide Himachal Pradesh with 399.57 GWh of electricity per year, and the Kashang HEP will provide an additional 735.2 GWh per year. Increased electricity supply from these run-of-river hydroelectric projects will avoid the generation of a similar amount of energy from fossil fuel–powered generation plants, thus reducing net greenhouse gas production. The projects will also create short-term construction employment and long-term operational jobs. Both projects have received all necessary MOEF and HPSEP and PCB clearances and approvals following the preparation of EIAs and the conduct of public hearings in accordance with government requirements.

335. The main adverse environmental impact of the HEP will be changes in river hydrology, a decline in the quality of aquatic ecosystems, loss of agricultural and forestland, and resettlement. Impact on rivers will be mitigated by the release of a 15% minimum environmental flow from the barrage in the dry season from the Sainj diversion structures, and the trench weirs of the Kashang and Kerang khads as well as the release of monsoon season flushing flows, and the yearly restocking of rivers above and below the barrage sites with snow trout. The loss of private agricultural and forestland has been or will be mitigated by the acquisition of private land at an above-market rate. The social impact of the projects will be mitigated by HPPCL's

[24] MOEF in a notification dated 14 September 2006 specified that projects should be classified as either category A or category B with reference to their environmental impact. Category B projects are further classified as either B1 or B2, with B2 projects having lesser impact.

resettlement and rehabilitation procedures, with fair compensation being paid by HPPCL.

336. The project proponents and their teams of consultants and contractors should develop a strategy for effective communication with the local people. The construction team should effectively follow the suggestions made in the EMP or any other environmental measures so as not to damage the fragile and serene environment in the project areas. The clean environment is of immense importance as it is essential to the local economy, which is heavily dependent on apple orchards and other dry fruits. The environmental features that relate to the main project impact will be monitored regularly for compliance with project approval conditions and pollution standards. The principal parameters to be monitored will be river flow volumes, water quality and aquatic ecology downstream of the barrages, and local meteorology.

Table A.1: Checklist of Anticipated Impact and Proposed Resource Management Plan

No.	Environmental Attribute	Potential Impact	Nature of Impact	Magnitude of Impact			Management Plan	Project Phase
				Low	Medium	High		
A.	**Physical Resources**							
1.	Topography	Change in the surface features and present aesthetics due to the construction at various project sites	Direct/Local/ irreversible	X			Plantation surrounding the powerhouse area to improve aesthetics. No other mitigation required	Operation
2.	Climate	Impact on the climatic conditions unknown as removal of trees along alignment and hydropower project to be done	Direct/Local/ irreversible	X			Compensatory afforestation	Construction and Operation
3	Hydrology	Operation of headworks	Direct/Local/ irreversible	X			Construction of Trench type weir	Operation
		Groundwater table	No impact					
		Dewatered riverbed (during lean period) due to stream diversion	Direct/Local/ irreversible			X	Since rivers are snow fed, even during lean period flow would be optimum. Only one turbine operation during lean period	Operation
		Change in flow regime (during lean period) due to stream diversion	Direct/Local/ irreversible			X	Since rivers are snow fed, even during lean period flow would be optimum. Only one turbine operation during lean period	Operation
		Flow disruption (during lean period) due to pondage at diversion	Direct/Local/ irreversible	X			Since rivers are snow fed, even during lean period flow would be optimum	Operation
		Change in land use by submergence of land due to pondage at diversion	Direct/Local/ irreversible			X	Land to be submerged negligible	Operation
		Sedimentation	No impact	X				Operation
		River morphology	Direct/Local/ irreversible	X			Large blocks/boulders get dumped in river bed due to change of gradient	Operation
		Pests & Weeds	No impact					Operation
B.	**Environmental Resources**							
1.	Air Quality	Project will have marginal impact on air quality during the construction period due to dust emissions.	Direct/Local/ reversible		X		Watering at construction site, limited bare soils, maintenance of project vehicles, etc.	Construction
2.	Noise	Noise due to general construction activities.	Direct/Local/ reversible		X		Restriction of noise-generating activities at night and use of personal protective equipment like ear plugs and mufflers	Construction
		Noise arising from switch yard operation and corona noise from conductors.	Direct/Local/ permanent	X			Locate transformers away from the settlement area. Monitoring of possible corona noise to identify and correct problems. Proper maintenance of equipments/ machineries so the ambient noise standard is met.	Operation
3.	Surface and Groundwater quality	Runoff from the construction site leading to increase in COD, BOD, oil and grease, etc.	Direct/Local/ reversible		X		Careful siting of access roads. Sedimentation ponds.	Before construction activity
		Domestic wastewater from	Direct/Local/	X			Domestic waste treatment by providing septic	During construction and

No	Environmental Attribute	Potential Impact	Nature of Impact	Magnitude of Impact			Management Plan	Project Phase
				Low	Medium	High		
		construction sites and during operation leading to increase in COD, BOD, oil and grease, etc.	reversible				tank.	operation
		Oil spillage	Indirect/Local/ reversible	X			Containment structures, oil water separation, adopting good practices for oil handling and maintenance works .	During construction and operation
		Oil contamination during maintenance	Indirect/Local/ reversible		X		Oil trap installation for separation of oil from	During operation
4.	Soils and Geology	Soil erosion due to clearing of vegetation in access roads	Direct/Local/ reversible		X		Avoiding sites, which are prone to the soil erosion. Leveling of construction sites. Use of few access roads/power evacuation lines. Rehabilitation and stabilization of disturbed land.	During and after the construction activity
		Soil erosion due to tunnel excavation and clearing of vegetation in the powerhouse and power evacuation line and access roads	Direct/Local/ reversible		X		Avoiding sites, which are prone to the soil erosion. Leveling of powerhouse construction sites. Use of few access roads. Rehabilitation and stabilization of disturbed land.	During and after the construction activity
		Improper Debris removal/accumulation	Direct/local/ reversible		X		Proper planning for debris removal from tunnel, powerhouse to be stored temporarily/used for site reclamation	Pre-construction and construction
		Damage due to seismic activity	Direct/regional /reversible		X		Site selection and design considering the geological conditions and seismicity.	Before the construction activity
C.	**Ecological Resources**							
1.	Terrestrial Ecology	Loss of vegetation	Direct/Local/ Irreversible		X		Minimum corridor width for power evacuation line, access roads. Location of powerhouse at the thinly vegetated area and waste lands which will minimize tree loss. Compensatory afforestation.	Before the construction Phase
2.	Terrestrial Fauna	Disturbance to the local fauna during construction	Direct/Local/ reversible		X		Some wildlife species are reported to be seen. Minimal impact.	No mitigation required
		Disturbance to the local fauna during operation	Direct/Local/ reversible	X			Monitoring of power evacuation lines especially for bird strikes during the operation and deflectors will be added if required.	During operation phase
3.	Aquatic Ecology	Disturbance to fish during construction of trench weir	Direct/Local/ irreversible		X		No mitigation required. Since the rivers are snow fed, even during the lean period, minimum flow is there; hence aquatic ecology will have no impact.	During construction/operation phase
D.	**Human Environment**							
1.	Health and Safety	Exposure to electromagnetic fields	Direct/Local/ continuous	X			Alignment route away from the settlement. No houses will be allowed near powerhouses	Before and after the construction phase.
		Fires, explosion and other accidents at the substations/power house.	Direct/Local	X			Use of personal protective equipments during construction and maintenance. Prepare and implement safety and emergency manual at	During operation phase

No.	Environmental Attribute	Potential Impact	Nature of Impact	Magnitude of Impact			Management Plan	Project Phase
				Low	Medium	High		
							the substation. Regular inspection of lines for faults prone to accidents.	
2.	Agriculture	Permanent and temporary loss of agricultural land due to powerhouse and due to access routes	Direct/Local/ reversible		X		Avoid prime agricultural land. Assessment of land required and compensation. Construction activity after crop harvesting and selection of few access routes.	Before construction phase
3.	Socioeconomics	Beneficial impact from rural and urban electrification. Job opportunities during construction	Direct/regional			X	Overall industrial and economic growth of the region.	During operational phase
4.	Resettlement	Resettlement of the house falling in project.	Direct/Local/ reversible		X		Resettlement issues and mitigation measures are separately discussed in the social assessment report.	Before the construction phase
5.	Cultural sites	No archaeological, historical or cultural important sites are affected by the construction of the project.	--	--	--	--	No mitigation required	--
6	Traffic and Transportation	Traffic congestion due to movement of construction vehicles	Direct/Local/ Reversible	X			Avoid high density areas, proper traffic signs at the construction site, ensuring proper access roads	During construction
E	Solid Waste Generation	Probability of surface and ground water pollution	Indirect/Local/reversible	X			The oil sludge should be separately stored in the containers. Used oil to be collected and reclaimed by contractors through the Office of Stores and Purchase. Separated oily waste and scrap will be collected and disposed of in compliance with the Environmental Protection Act, 1986, and applicable regulations and rules.	During operation phase

BOD = biological oxygen demand, COD = chemical oxygen demand.
Source: HPPCL

Table A.2: Environmental Management Plan

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule
Pre-construction						
Location of adits, tunnels, access roads, alignment and design of muck sites	Exposure to safety related risks	Setback of dwellings to designed in accordance with permitted level of air quality deterioration and the regulation of supervision at sites.	Air quality, alignment selection of roads, adits, muck disposal points with respect to nearest dwellings	Setback distances to nearest houses - once	HPPCL	Detailed alignment survey and design
Equipment specifications and design parameters	Release of chemicals and gases in receptors (air, water, land)	PCBs not used in transformers or other project facilities or equipment.	Equipment design	Exclusion of PCBs in transformers stated in tender specification - once	HPPCL	Part of tender specifications for the equipment
		Processes, equipment and systems not to use chlorofluorocarbons (CFCs), including halon, and their use, if any, in existing processes and systems should be phased out and to be disposed of in a manner consistent with the requirements of the Government	Process, equipment and system design	Exclusion of CFCs stated in tender specification – once	HPPCL	Part of tender specifications for the equipment
				Phase out schedule to be prepared in case still in use – once		Part of equipment and process design
Power Evacuation line design	Exposure to electromagnetic interference	Power evacuation line design to comply with the limits of electromagnetic interference from overhead power lines	Electromagnetic field strength for proposed line design	Power evacuation Line design compliance with relevant standards - once	HPPCL	Part of detailed alignment survey and design
HPP location and design	Exposure to noise	Design of plant enclosures to comply with noise regulations.	Expected noise emissions based on design	Compliance with regulations - once	HPPCL	Part of detailed siting survey and design
Location of powerhouse, headworks	Impact on water bodies and land	Consideration of site location at where they could be located to avoid water bodies or agricultural land.	Site location, line alignment selection (distance to water and/or agricultural land)	Consultation with local authorities and land owners - once	HPPCL	Part of project siting survey and detailed survey and design
	Social inequities	Careful site selection to avoid existing settlements	Site location, selection (distance to nearest dwellings or social institutions)	Consultation with local authorities and land owners - once	HPPCL	Part of detailed project siting and survey and design
		Minimize need to acquire agricultural land	Site location, selection (distance to agricultural land)	Consultation with local authorities and land owners - once	HPPCL	Part of detailed project siting and survey and design
Involuntary resettlement or land acquisition	Social inequities	Compensation paid for temporary/ permanent loss of productive land as per LADC & its process	RP implementation	Consultation with affected parties – once in a quarter	HPPCL	Prior to construction phase

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule
Encroachment into precious ecological areas	Loss of precious ecological values/ damage to precious species	Avoid encroachment by careful site selection	Power line alignment selection (distance to nearest designated ecological protection area)	Consultation with local authorities - once	HPPCL	Part of detailed siting and alignment survey /design
		Minimize the need by using existing towers and RoW wherever possible	Power evacuation line alignment selection	Consultation with local authorities and design engineers - once	HPPCL	Part of detailed siting and alignment survey/design
Power evacuation line through forestland	Deforestation and loss of biodiversity	Avoid encroachment by careful site and alignment selection	Line alignment selection (distance to nearest protected or reserved forest)	Consultation with local authorities - once	HPPCL	Part of detailed siting and alignment survey/design
		Minimize the need by using existing towers, tall towers and RoW, wherever possible		Consultation with local authorities and design engineers - once		
		Obtain statutory clearances from the Government	Statutory approvals from Government	Compliance with regulations – once for each subproject		
Encroachment into farmland	Loss of agricultural productivity	Avoid siting new towers on farmland wherever feasible	Line alignment selection	Consultation with local authorities and design engineers - once		Part of detailed siting and alignment survey /design
		Farmers compensated for any permanent loss of productive land	Design of Implementation of Crop Compensation (based on affected area)	Consultation with affected parties – once in a quarter		Prior to construction phase
Noise related	Nuisance to neighboring properties	Powerhouse, headworks, tunnel sited and designed to ensure noise will not be a nuisance.	Noise levels	Noise levels to be specified in tender documents - once	HPPCL	Part of detailed equipment design
Interference with drainage patterns/Irrigation channels	Flooding hazards/loss of agricultural production	Appropriate siting of power evacuation line towers to avoid channel interference Appropriate tunnel alignments to avoid channel interference	Site location and line alignment selection (distance to nearest flood zone)	Consultation with local authorities and design engineers – once	HPPCL	Part of detailed alignment survey and design
Escape of polluting materials	Environmental pollution	Transformers designed with oil spill containment systems, and purpose-built oil, lubricant and fuel storage system, complete with spill cleanup equipment.	Equipment specifications with respect to potential pollutants	Tender document to mention specifications - once	HPPCL	Part of detailed equipment design /drawings
		Powerhouses to include drainage and sewage disposal systems to avoid offsite land and water pollution.	Powerhouse sewage design	Tender document to mention detailed specifications - once	HPPCL	Part of detailed substation layout and design /drawings
Equipment submerged under flood	Contamination of receptors (land, water)	Powerhouse constructed above the high flood level (HFL) by raising the foundation pad.	Powerhouse design to account for HFL (elevation with respect to HFL elevation)	Base height as per flood design - once	HPPCL	Part of detailed powerhouse layout and design/drawings

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule
Explosions/Fire	Hazards to life	Design of Powerhouse to include modern fire control systems/firewalls.	Design compliance with fire prevention and control codes	Tender document to mention detailed specifications - once	HPPCL	Part of detailed Powerhouse layout and design /drawings
		Provision of fire fighting equipment to be located close to power generation equipment.				
Construction						
Equipment layout and installation	Noise and vibrations	Construction techniques and machinery selection seeking to minimize ground disturbance.	Construction techniques and machinery	Construction techniques and machinery creating minimal ground disturbance - once at the start of each construction phase	HPPCL, Contractor through contract provisions	Construction period
Physical construction	Disturbed farming activity	Construction activities on cropping land timed to avoid disturbance of field crops (within one month of harvest wherever possible).	Timing of start of construction	Crop disturbance – Post harvest as soon as possible but before next crop - once per site	HPPCL, Contractor through contract provisions	Construction period
Mechanized construction	Noise, vibration and operator safety, efficient operation	Construction equipment to be well maintained.	Construction equipment – estimated noise emissions	Complaints received by local authorities - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
	Noise, vibration, equipment wear and tear	Proper maintenance and turning off plant not in use.	Construction equipment – estimated noise emissions and operating schedules	Complaints received by local authorities - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
Construction of roads for accessibility	Increase in airborne dust particles	Existing roads and tracks used for construction and maintenance access to the site wherever possible.	Access roads, routes (length and width of new access roads to be constructed)	Use of established roads wherever possible - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
	Increased land requirement for temporary accessibility	New access ways restricted to a single carriageway width within the RoW.	Access width (meters)	Access restricted to single carriageway width within RoW - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
Temporary blockage of utilities	Overflows, reduced discharge	Temporary placement of fill in drains/canals not permitted.	Temporary fill placement (m_3)	Absence of fill in sensitive drainage areas - every 4 weeks	HPPCL, Contractor through contract provisions	Construction period
Site clearance	Vegetation	Marking of vegetation to be removed prior to clearance, and strict control on clearing activities to ensure minimal clearance.	Vegetation marking and clearance control (area in m_2)	Clearance strictly limited to target vegetation - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule
Cutting of trees within RoW of power evacuation line	Fire hazards	Trees allowed growing up to a height within the RoW by maintaining adequate clearance between the top of tree and the conductor as per the regulations.	Species-specific tree retention as approved by statutory authorities (average and maximum tree height at maturity, in meters)	Presence of target species in RoW– once per site	HPPCL, Contractor through contract provisions	Construction period
	Loss of vegetation and deforestation	Trees that can survive pruning to comply should be pruned instead of cleared.	Species-specific tree retention as approved by statutory authorities	Presence of target species in RoW following vegetation clearance – once per site	HPPCL, Contractor through contract provisions	Construction period
		Felled trees and other cleared or pruned vegetation to be disposed of as authorized by the statutory bodies.	Disposal of cleared vegetation as approved by the statutory authorities (area cleared in m_2)	Use or intended use of vegetation as approved by the statutory authorities – once per site	HPPCL, Contractor through contract provisions	Construction period
Wood/vegetation harvesting	Loss of vegetation and deforestation	Construction workers prohibited from harvesting wood in the project area during their employment, (apart from locally employed staff continuing current legal activities).	Illegal wood /vegetation harvesting (area in m_2, number of incidents reported)	Complaints by local people or other evidence of illegal harvesting - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
Surplus earthwork/soil	Runoff to cause water pollution, solid waste disposal	Excess soil excavation from powerhouse disposed of next to roads or around houses, in agreement with the local community or landowner.	Location and amount (m^3)of fill disposal	Appropriate fill disposal locations - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
		Soil excavated from tunnel disposed of by placement along backfill dams etc.	Soil disposal locations and volume (m^3)	Acceptable soil disposal sites - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
Powerhouse construction	Loss of soil	Fill for the powerhouse foundations obtained by creating or improving local water supply ponds or drains, with the agreement of local communities.	Borrow area siting (area of site in m sq. and estimated volume in m sq.	Acceptable borrow areas that provide a benefit - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
Powerhouse construction	Water pollution	Construction activities involving significant ground disturbance (i.e. powerhouse land forming) not undertaken during the monsoon season.	Seasonal start and finish of major earthworks (pH, BOD/COD, Suspended solids, other)	Timing of major disturbance activities - prior to start of construction activities	HPPCL, Contractor through contract provisions	Construction period
Site clearance	Vegetation	Tree clearances for easement establishment to only involve cutting trees off at ground level or pruning as appropriate, with tree stumps and roots left in p l ace an d ground cover l e ft undisturbed.	Ground disturbance during vegetation clearance (area, m_2)	Amount of ground disturbance - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
			Statutory approvals	Statutory approvals for tree clearances – once for each site	HPPCL, Contractor through contract provisions	Construction period

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule
Storage of chemicals and materials	Contamination of receptors (land, water, air)	Fuel and other hazardous materials securely stored above high flood level.	Location of hazardous material storage; spill reports (type of material spilled, amount (kg or m_3) and action taken to control and clean up spill)	Fuel storage in appropriate locations and receptacles - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
Construction schedules	Noise nuisance to neighbouring properties	Construction activities only undertaken during the day and local communities informed of the construction schedule.	Timing of construction (noise emissions, [dB(a)])	Daytime construction only - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
Provision of facilities for construction workers	Contamination of receptors (land, water, air)	Construction workforce facilities to include proper sanitation, water supply and waste disposal facilities.	Amenities for Workforce facilities	Presence of proper sanitation, water supply and waste disposal facilities - once each new facility	HPPCL, Contractor through contract provisions	Construction period
Encroachment into farmland	Loss of agricultural productivity	Use existing access roads wherever possible	Usage of existing utilities	Complaints received by local people /authorities - every 2 weeks	HPPCL, Contractor through contract provisions	Construction period
		Ensure existing irrigation facilities are maintained in working condition	Status of existing facilities			
		Protect /preserve topsoil and reinstate after construction completed	Status of facilities (earthwork in m_3)			
		Repair /reinstate damaged bunds etc after construction completed	Status of facilities (earthwork in m_3)			
	Social inequities	Compensation for temporary loss in agricultural production	Implementation of Crop compensation (amount paid, dates, etc.)	Consultation with affected parties – once in a quarter	HPPCL	Prior to construction
Uncontrolled erosion/silt runoff	Soil loss, downstream siltation;	Need for access tracks minimized, use of existing roads.	Design basis and construction procedures (suspended solids in receiving waters; area re-vegetated in m_2; amount of bunds constructed [length in meter, area in M^2, or volume in m^3])	Incorporating good design and construction management practices – once for each site	HPPCL, Contractor through contract provisions	Construction period
		Limit site clearing to work areas				
		Regeneration of vegetation to stabilize works areas on completion (where applicable)				
		Avoidance of excavation in wet Season				
		Water courses protected from siltation through use of bunds and sediment ponds				
Nuisance to nearby properties	Losses to neighboring land uses/ values	Contract clauses specifying careful construction practices.	Contract clauses	Incorporating good construction management practices – once for each site	HPPCL (Contractor through contract provisions)	Construction period
		As much as possible existing access ways will be used.	Design basis and layout	Incorporating good design engineering practices – once for each site		

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule
		Productive land will be reinstated following completion of construction	Reinstatement of land status (area affected, m_2)	Consultation with affected parties – twice – immediately after completion of construction and after the first harvest		
	Social inequities	Compensation will be paid for loss of production, if any.	Implementation of Tree/Crop compensation (amount paid)	Consultation with affected parties – once in a quarter	HPPCL	Prior to construction
Flooding hazards due to construction impediments of natural drainage	Flooding and loss of soils, contamination of receptors (land, water)	Avoid natural drainage pattern /facilities being disturbed /blocked /diverted by the on-going construction activities	Contract clauses (e.g., suspended solids and BOD/COD in receiving water)	Incorporating good construction management practices – once for each site	HPPCL (Contractor through contract provisions)	Construction period
Inadequate siting of borrow areas	Loss of land values	Existing borrow sites will be used to source aggregates, therefore, no need to develop new sources of aggregates	Contract clauses	Incorporating good construction management practices – once for each site	HPPCL (Contractor through contract provisions)	Construction period
Health and safety	Injury and sickness of workers and members of the public	Contract provisions specifying minimum requirements for construction camps	Contract clauses (number of incidents and total lost-work days caused by injuries and sickness)	Contract clauses compliance – once every quarter	HPPCL (Contractor through contract provisions)	Construction period
		Contractor to prepare and implement a health and safety plan.				
		Contractor to arrange for health and safety training sessions				
Inadequate construction stage monitoring	Likely to maximize damages	Training of HPPCL environmental monitoring personnel	Training schedules	Number of programs attended by each person – once a year	HPPCL	Routinely throughout construction period
		Implementation of effective environmental monitoring and reporting system using checklist of all contractual environmental requirements	Respective contract checklists and remedial actions taken thereof.	Submission of duly completed checklists of all contracts for each site - once		
		Appropriate contact clauses to ensure satisfactory implementation of contractual environmental mitigation measures.	Compliance report related to environmental aspects for the contract	Submission of duly completed compliance report for each contract - once		
Operation and Maintenance						
Location of evacuation power line alignment, powerhouse and design	Exposure to safety related risks	Setback of dwellings to overhead line route designed in accordance with permitted level of power frequency and the regulation of supervision at sites.	Compliance with setback distances (“as-built” diagrams)	Setback distances to nearest houses – once in quarter	HPPCL	During operations
Equipment submerged under flood	Contamination of receptors (land, water)	Equipment installed above the high flood level (HFL) by raising the foundation pad.	Substation design to account for HFL (“as-built” diagrams)	Base height as per flood design - once	HPPCL	During operations

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule
Oil spillage	Contamination of land/nearby water bodies	Switchyard transformers located within secure and impervious bunded areas with a storage capacity of at least 100% of the capacity of oil in transformers and associated reserve tanks.	Substation bunding ("as-built" diagrams)	Bunding capacity and permeability - once	HPPCL	During operations
Inadequate provision of staff/workers health and safety during operations	Injury and sickness of staff /workers	Careful design using appropriate technologies to minimize hazards	Usage of appropriate technologies (lost work days due to illness and injuries)	Preparedness level for using these technologies in crisis – once each year	HPPCL	Design and operation
		Safety awareness raising for staff.	Training/awareness programs and mock drills	Number of programs and percent of staff /workers covered – once each year		
		Preparation of fire emergency action plan and training given to staff on implementing emergency action plan				
		Provide adequate sanitation and water supply facilities	Provision of facilities	Complaints received from staff /workers every 2 weeks		
Electric Shock Hazards	Injury/mortality to staff and public	Careful design using appropriate technologies to minimize hazards	Usage of appropriate technologies (number of injury incidents, lost work days)	Preparedness level for using these technologies in crisis – once a month	HPPCL	Design and Operation
		Security fences around powerhouse/ headworks	Maintenance of fences	Report on maintenance – every 2 weeks		
		Barriers to prevent climbing on/dismantling of equipment	Maintenance of barriers			
		Appropriate warning signs on facilities	Maintenance of warning signs			
		Electricity safety awareness raising in project areas	Training /awareness programs and mock drills for all concerned parties	Number of programs and percent of total persons covered – once each year		
Operations and maintenance staff skills less than acceptable	Unnecessary environmental losses of various types	Adequate training in O&M to all relevant staff/maintenance crews.	Training/awareness programs and mock drills for all relevant staff	Number of programs and percent of staff covered – once each year	HPPCL	Operation
		Preparation and training in the use of O&M manuals and standard operating practices.				
Inadequate periodic environmental monitoring.	Diminished ecological and social values.	HPPCL staff to receive training in environmental monitoring of project operations and maintenance activities.	Training/awareness programs and mock drills for all relevant staff	Number of programs and percent of staff covered – once each year	HPPCL	Operation

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule
Equipment specifications and design parameters	Release of chemicals and gases in receptors (air, water, land)	Processes, equipment and systems using cholofluorocarbons (CFCs), including halon, should be phased out and to be disposed of in a manner consistent with the requirements of the Government.	Process, equipment and system design	Phase out schedule to be prepared in case still in use – once in a quarter	HPPCL	Operations
Power Evacuation line maintenance	Exposure to electromagnetic interference	Evacuation line design to comply with the limits of electromagnetic interference from overhead power lines	Required ground clearance (meters)	Ground clearance - once	HPPCL	Operations
Powerhouse maintenance	Exposure to electromagnetic interference	Powerhouse design to comply with the limits of electromagnetic interference within floor area	Required vibrations level, instrumentation	Instrumentation regular	HPPCL	Operations
Noise related	Nuisance to neighboring properties	Powerhouse sited and designed to ensure noise will not be a nuisance.	Noise levels (dB(a))	Noise levels at boundary nearest to properties and consultation with affected parties if any - once	HPPCL	Operations

BOD = biological oxygen demand, CFC = chlorofluorocarbons, COD = chemical oxygen demand, HPPCL = Himachal Pradesh Power Corporation Ltd., PCB = Polychlorinated biphenyl., RoW = rights of way, RP = resettlement plan
Source: Himachal Pradesh Power Corporation Ltd.