ENVIRONMENTAL IMPACT ASSESSMENT STUDY
OF
DUGAR HYDRO ELECTRIC PROJECT (500 MW)
TEHSIL PANGI, DISTRICT CHAMBA
HIMACHAL PRADESH

EXECTUIVE SUMMARY

October, 2021

Prepared for:

NHPC LTD.

Prepared by:

R. S. Envirolink Technologies Pvt. Ltd.

403, BESTECH CHAMBER COMMERCIAL PLAZA,
B-BLOCK, SUSHANT LOK-I, GURGAON
Phone: +91-124-4295383: www.rstechnologies.co.in

EXECUTIVE SUMMARY

1. PROJECT DESCRIPTION

Dugar HEP is proposed on Chenab River to harness the hydropower potential of river Chenab. The present project proponent is NHPC Ltd., (formerly known as National Hydroelectric Power Corporation) was incorporated on 7th November 1975 as Central Govt. Enterprise for development of Hydro Power in Central Sector. NHPC is a Schedule 'A' Enterprises of Govt. of India with Mini Ratna status since 2008 under the Ministry of Power, Govt. of India.

. The construction of the dam and underground powerhouse for the Dugar HEP (500 MW) is proposed near Luj village in Pangi Tehsil of Chamba district of Himachal Pradesh. Location map of proposed Dugar HEP given in Figure 1.

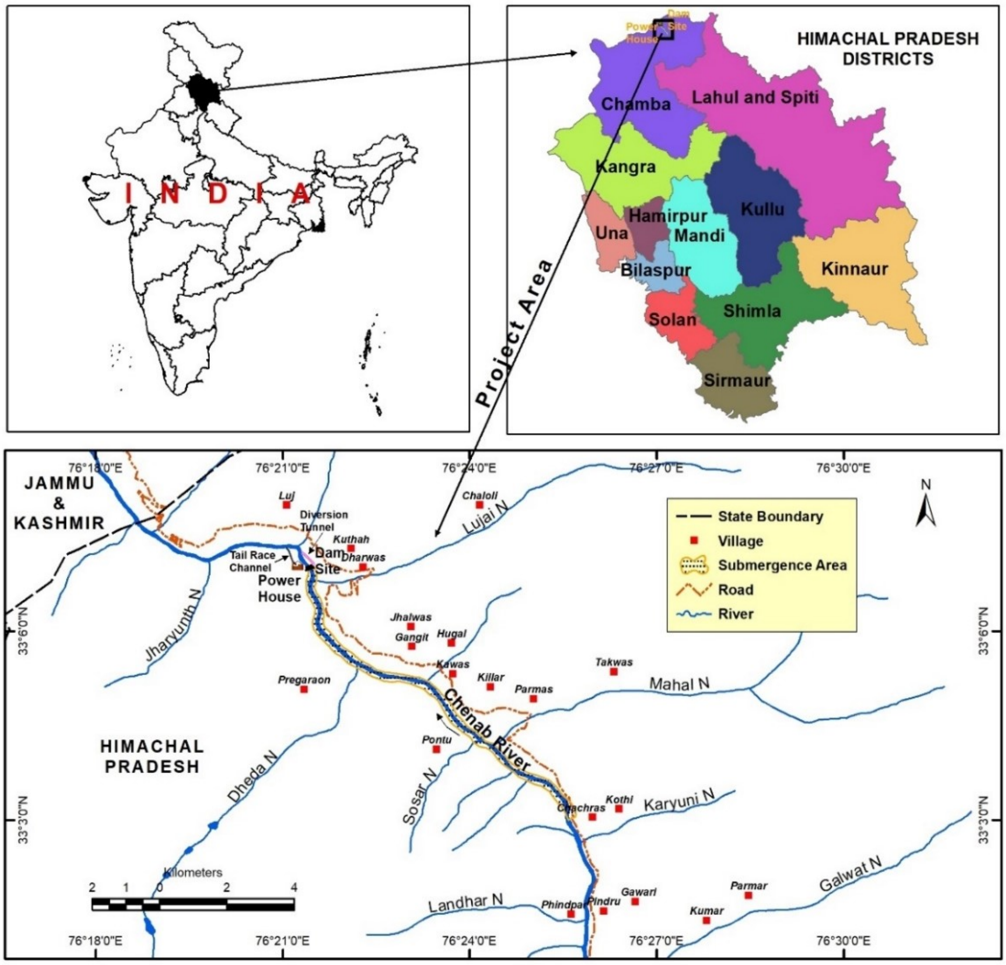
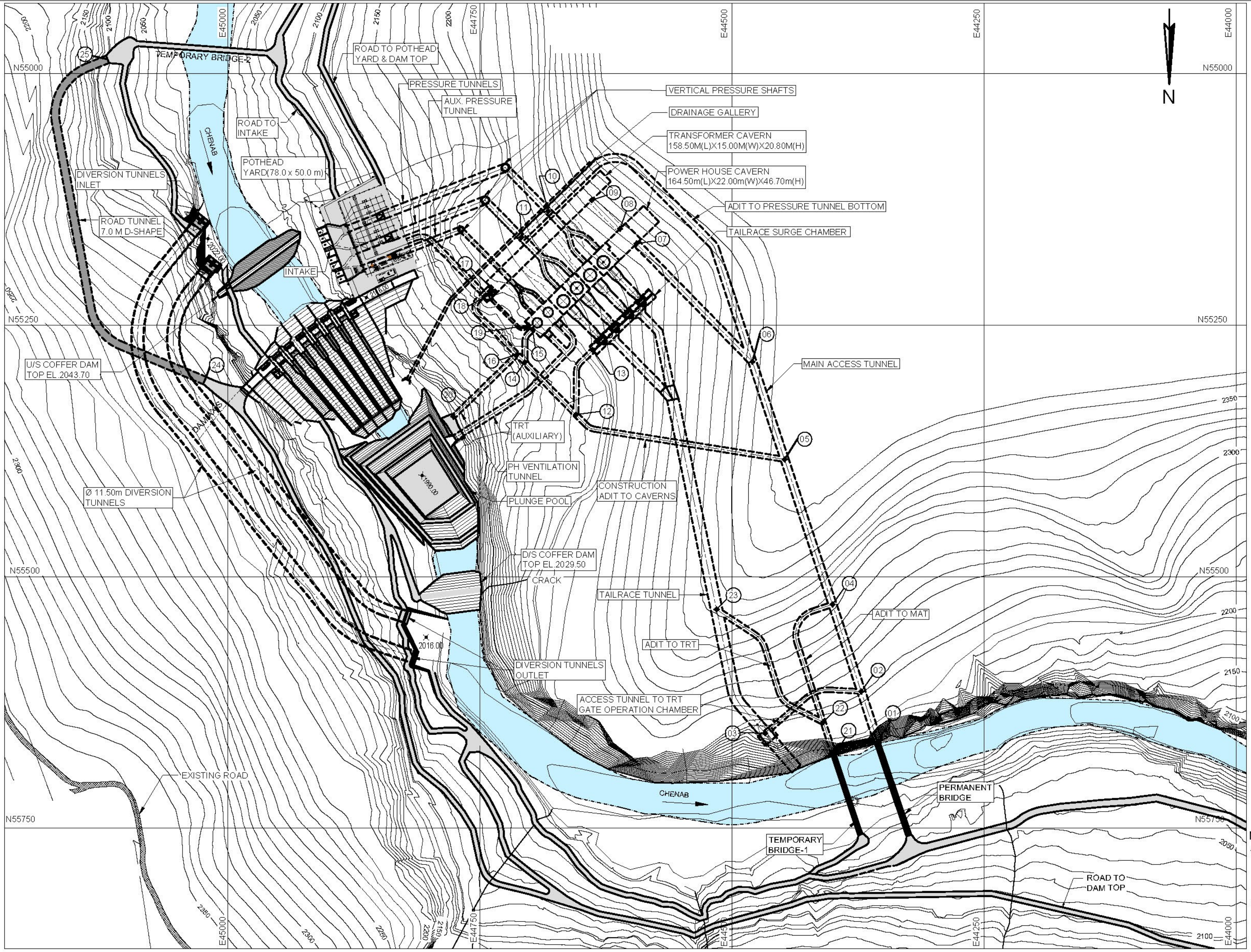


Figure 1: Location Map of Dugar HEP

Dugar HEP envisages the construction of a 128m high dam from the deepest foundation level. The reservoir storage is 61.58 MCM at Full Reservoir Level EL. 2114m and the live storage capacity is 16.57 MCM. The powerhouse will accommodate four units of 103 MW each for the main plant and two units of 44 MW each for the auxiliary plant (4 x 103 MW + 2 x 44 MW). Two nos. 8.5m dia tailrace tunnels combined into a single TRT having a finished diameter of 12.1 m and length of 400 m located on the left bank of Chenab River, about 780 m downstream of the dam axis. Layout Plan of proposed Dugar HEP is given in Figure 2.



POINTS	ELEVATION
1	2036.00
2	2036.00
3	2036.00
4	2030.00
5	2020.00
6	2014.50
7	2014.50
8	2014.50
9	2014.50
10	1999.15
11	1999.15
12	2036.67
13	2035.00
14	2033.00
15	2031.30
16	2033.00
17	2030.00
18	2014.50
19	2014.50
20	2046.00
21	2022.00
22	2021.00
23	2006.00
24	2116.00
25	2080.00

SCHEDULE OF ADITS

S.NO	DESCRIPTION	ALIGNMENT	LENGTH IN (m)	SIZE (m) & SHAPE
1	MAIN ACCESS TUNNEL	01,02,04,05,TO 06	397.00	8.0 D-SHAPE
		06 TO 07	164.00	7.0 D-SHAPE
2	ACCESS TUNNEL TO TRANSFORMER CAVERN	08 TO 09	40.00	7.0 D-SHAPE
3	ACCESS TUNNEL TO SURGE CAVERN	05 TO 13	285.00	5.0 D-SHAPE
4	ADIT TO PH CAVERN CROWN	12,14 TO 15	108.00	5.0 D-SHAPE
5	ADIT TO TRANSFORMER CAVERN CROWN	14, 16 TO 17	100.00	5.0 D-SHAPE
6	PH VENTILATION TUNNEL	16 TO 20	114.00	4.5 D-SHAPE
7	FIRE ESCAPE	18 TO 19	59.00	2.5X3.0 D-SHAPE
8	ADIT TO PRESSURE TUNNEL BOTTOM	06,10 TO 11	378.00	8.0 D-SHAPE
9	ADIT TO TRT	21,22 TO 23	198.00	5.0 D-SHAPE

SCHEDULE OF ADITS

S.NO	DESCRIPTION	ALIGNMENT	LENGTH IN (m)	SIZE (m) & SHAPE
10	ACCESS TO TRT GATE OPERATION CHAMBER	02 TO 03	98.00	4.5 D-SHAPE
11	ADIT TO MAT	22 TO 04	139.00	5.0 D-SHAPE
12	ACCESS TUNNEL FROM DAM TOP TO TEMPORARY BRIDGE-2	24 TO 25	417.50	7.0 D-SHAPE

FOR DPR PURPOSE ONLY

DATE	NO.	REVISION OR ISSUES	BY.	APP.

DESIGN MEMO NO.- डिज़ाइन मेमो संख्या

एन एच पी सी लिमिटेड
NHPC Limited
(A Govt. of India Enterprises)

डुगर जलविद्युत परियोजना (हि.प्र.)
DUGAR HYDROELECTRIC PROJECT (H.P.)

PROJECT AREA
GENERAL LAYOUT PLAN

DRAWN उद्रेखित	SUBMITTED प्रस्तुत	RECOMMENDED अनुशंसित		APPROVED अनुमोदन

DATE दिनांक	AUG - 2020	DRG. NO. उद्रेख संख्या	NHDGR	D	41	GA	003	00

IMS/DED/F-02 REV. NO: 03 EFF. DATE : 21/07/2016

Figure 2: Layout map of Dugar HEP *(Source: DPR Dugar HEP)*

2. DESCRIPTION OF THE ENVIRONMENT

Data on the existing environmental parameters in the study area delineated as per the approved Terms of Reference (TOR) for EIA studies by Ministry of Environment, Forests & Climate Chang (MoEF&CC), Government of India was collected to understand the present setting of the environment at the project site. The base line status is described briefly in the following sections:

2.1.1 Land Use/ Land Cover

The land use/ land cover pattern of the study area was interpreted from the latest satellite data and out of the classified land use/ land cover categories, Evergreen/Semi-Evergreen Forest and Grazing land constitute the predominant land use classes in the study area (More than 56%). Scrub land and Barren Rocky land each cover around 14.70% of the study area. Snow/Glacier is comprised of 8%. Waterbody covers around 1.38% of the study area.

2.1.2 Physiography

The study area of the proposed project lies between 1908 m and 5386 m elevation. More than three-fourth of the project study area lies in 500 to 2500 m elevation band (refer **Figure 3.2** and **Table 3.8** of Chapter 3) and about 37% of project components are restricted to 3200 to 4000m elevation band. Nearly 42% of the study area is characterised by steep slopes and about 30% area by moderately steep slopes (refer **Figure 3.3** and **Table 3.9** of Chapter 3).

2.1.3 Geology

Geologically the project is located within the Central Crystalline represented by the Vaikrita Group of rocks. The project area is dominated by a variety of gneissic rocks. Regionally, the area around the project comprises a litho-stratigraphic sequence from the Proterozoic age to the Quaternary period including Salkhala Group and Chamba, Manjir, Katarigali, Bhaderwah, and Dul Formations.

2.1.4 Meteorology

The study area of the proposed project lies in Pangi valley of Chamba District of Himachal Pradesh. The average maximum temperature of 40^0C was recorded during the month of June and minimum temperature of 7.4^0C during the month of January. The area receives maximum rainfall during south-west monsoon i.e. between June and September. The Humidity is generally low throughout the year, except during monsoon months, humidity in the study area is close to 66% in the month of August. The average maximum wind speed of 4.17 m/s is observed during May.

2.1.5 Soil

Soils in the project area in general are predominantly Entisols and Inceptisols i.e. they have weakly developed soil profiles. These are Typic Udorthents (33.52%) which is found at middle slopes characterized by rock outcrops, deep well drained, mesic, loamy skeletal soils on very steep slopes with severe erosion. Typic Cryorthents second predominant soil type found near the ridge slopes and is characterized by rock outcrops, with shallow depth, excessively drained, loamy skeletal soils on very steep slopes prone to severe erosion.

The soil fertility based upon Nutrient Index in terms of NPK shows that Nitrogen is in the 'Low' range Potassium fertility rating 'Medium' range during Winter but in pre-monsoon and monsoon season is in the 'Low' range whereas, Phosphorus fertility status of soil in the 'Low' range.

2.1.6 Ambient Air and Noise Quality

The Ambient Air Quality monitoring was carried out conforming to the National Ambient Air Quality Standards for Industrial Residential, Rural & Other Areas and Ecologically Sensitive Areas. The concentrations of $PM_{2.5}$, PM_{10}, SO_2, and NO_2 at all the sites were well within the Residential & Rural area permissible limits prescribed by National Ambient Air Quality Standard 2009 notified by CPCB.

Air quality was also assessed using 24h averages of $PM_{2.5}$, PM_{10}, SO_2, and NO_2 levels in the AQI calculator of CPCB and calculated AQI values given in the table below. All the locations fall under the 'Good' category during different seasons in the study area except AQ4/near Killar Village and AQ6/near Findru village during winter and pre-monsoon seasons respectively, which fall under 'Satisfactory' category in the study area.

2.1.7 Water Quality

The data on water quality has been collected to evaluate surface water quality in study area. Ground water sources are not available in the study area. The water quality in the study area, in general, is good. This is primarily due to the absence of any industrial establishment and low population density in the project area.

Surface water quality of Chenab and its tributaries samples collected during winter, pre-monsoon, and monsoon seasons was compared with the Water Quality Criteria of Central Pollution Control Board (http://www.cpcb.nic.in/Water_Quality_Criteria.php) fall under Class 'A' with Drinking-Water Source without conventional treatment but after disinfection.

2.1.8 Floristic Diversity

Forest is dominant land use dominant land use pattern in the study area as more than 50% of the study area is under good forest cover. These forests are comprised primarily of Northern Dry Mixed Deciduous Forest classified according to 'A Revised Survey of the Forest Types of India' by Champion and Seth (1968).

Among the tree species *Cedrus deodara, Pinus gerardiana, Pinus wallichiana, Picea smithiana*, *Abies spectabilis,* are the conifer species forming the top canopy. *Celtis australis, Juglans regia*, *Salix tetrasperma, Salix denticulata, Populus ciliata, Corylus jacquemontii, Ulmus wallichiana, Fraxinus xanthoxyloides, Robinia pseudo-acacia* and *Alnus nitida* are the associated tree species in the forest area.

Shrub vegetation in the area was represented by *Abelia triflora*, *Artemisia maritima*, *Berberis aristata*, *Berberis lycium*, *Cotoneaster bacillaris*, *Daphne oleoides, Clematis montana, Rabdosia rugosa*, *Ephedra gerardiana*, *Jasminum humile*, *Olea ferruginea*, *Rosa macrophylla*, *Rosa moschata*, *Rubus foliolosus*, *Rubia cordifolia*, *Rubus niveus*, *Sambucus wightiana*, and *Sorbaria tomentosa. Carex inanis*, *Kyllinga squamulata*, *Agrostis pilosula*, *Arthraxon lancifolius*, *Bromus japonicus*, *Eragrostis pilosa*, *Poa annua*, *Stipa roylei*, etc. are the grass species in the catchment, mostly grown on barren rocky steep slopes.

The project area harbors 182 plant species belonging to different plant groups like Angiosperms (160 species), Gymnosperms (9 species), Pteridophytes (5 species),, Bryophytes (3 species), and Lichen (4 species).

As per the IUCN Red List of Threatened Species 2021-2, *Angelica glauca is* list under the Endangered (EN) category*, Saussurea costus* under Critically Endangered (CR), *Ephedra gerardiana* and *Ulmus wallichiana* are under the Vulnerable (VU) category, and *Abies spectabilis* and *Pinus gerardiana* under Near Threatened (NT) category. The rest of the species evaluated are either List Concern (LC) or Data Deficient (DD) category.

2.1.9 Faunal Diversity

Mammals: During field surveys only Rhesus macaque (*Macaca mulatta*), Common mongoose (*Herpestes edwardsii*), and Common langur (*Semnopithecus entellus)* are the species sighted in the study area.

Presence of Common Leopard (*Panthera pardus*), Hanuman Langur (*Semnopitheaus entellus*), Himalayan Goral (*Naemorhedus goral*), Indian Muntjac (*Muntiacus muntjac*), and Himalayan black bear (*Ursus thibetanus*) was confirmed by forest officials and villagers in the project area.

Avifauna: A total of 34 species of bird species 8 Order and 20 families were recorded during the field survey from the study area. Most commonly found birds are Rock Pigeon, Chukar partridge, Jungle Babbler, Drongo, Plumbeous water redstart, Red-vented Bulbul, Blue Whistling Thrush, Myna House sparrow, and Crow. A large portion of avifauna species is comprised of resident birds in the project study area.

Herpetofauna: During the survey, Garden lizard (*Calotes versicolor*), Kashmir Rock Agamid (*Laudakia tuberculata*), and Skinks (*Asymblepharus ladacensis)* are the species sighted in the area.

Butterflies: 11 species of butterflies were recorded during the field survey. Indian cabbage white, Pearl white, and Indian Tortoiseshell were the frequently sighted species observed all along the water bodies.

Aquatic Ecology: Among the aquatic organisms, 22 species of phytobenthos and 11 species of phytoplaktons were recorded from river Chenab and its tributaries. During sampling 3 species of zooplankton and 8 genera of macro-invertebrates (MI) were recorded from various sampling site.

Fish fauna: During the experimental fishing no fish was captured during experimental sampling. According to published literature, no fish species was reported from the area. According to the villagers, Snow trout (*Schizothorax richardsonii*) is the only species occasionally sighted and captured from Chenab River in the area

Conservation Status

As per the IUCN Red List of Threatened Species Version 2021-2, Common Leopard (*Panthera pardus*) and Himalayan black bear (*Ursus thibetanus*) are the species listed under the Vulnerable (VU) category. Himalayan Goral (*Naemorhedus goral*) is the species listed under the Near Threatened category of IUCN. As per Wildlife (Protection) Act (1972), Common Leopard (*Panthera pardus*) is listed as a Schedule I species.

Among the avifaunal species sighted from the study area only one species Indian Spotted Eagle (*Clanga hastata*) is listed as Vulnerable (VU) under IUCN 2021-2, the rest of the species fall under Least Concern (LC) category. As per WPA (1972), all the species recorded from the area are listed as Schedule IV except House crow and Jungle crow which are listed as Schedule V species.

2.1.10 Proximity to Protected Area

Sechu Tuan Wildlife Sanctuary is the nearest protected area from the proposed Dugar Hydro Electric project. All project components are outside the boundary of the Wildlife Sanctuary and its nearest boundary is about 12 km from the tail end of the proposed reservoir area and about 20 km from the proposed Dam site.

2.1.11 Social Environment

The majority of the project study area falls under Pangi Sub-division of Chamba district of Himachal Pradesh with small portion under Kishtwar district of Union Territory of Jammu & Kashmir. However, all the proposed components of Dugar HEP, like Dam, Powerhouse and submergence area of the proposed project falls in Pangi Sub-division of Chamba district.

The Pangi Sub-division has been declared as Schedule V area as per the Scheduled Areas (Himachal Pradesh) Order,1975(CO 102) dated the 21st November, 1975.

Only one village i.e. Luj is directly affected by the project due to proposed acquisition of land. A total of 8.78 ha of private land from Luj village will be acquired for proposed project. Survey and consultation was carried out in the project surrounding villages. A total of 8 revenue villages (including Luj village), in the direct proximity of project construction area has been surveyed to access the socio-economic status of the study area villages.

These villages comprise 622 households with a total population of 3214 persons of which 1592 are males 1622 are females. The sex ratio is 1019 females per thousand males. About 89.0% of the total population comprises Schedule tribe population. The Schedule Castes and general category comprise 7.0% and 4.0% respectively. There is 70.55% literacy in the surveyed villages. Agriculture is the main occupation of the people in the area with 60.29% of the total working population engaged in agriculture and allied activities.

The education facilities in the area are moderate up to middle school but for secondary and senior secondary education students travel up to 5 to 8 km. There is one Govt. Degree college in the area, which is located at Killar. Medical facilities in the area are limited, there is only one PHC at Dharwas and one Civil hospital at Killar to cater to the medical needs of the locals. Road & transportation facility in the area is good. The important roads in the area are SH26 and SH37 connecting to State capital and district headquarter. The telecommunication and internet facilities are limited to Killar town. The mobile cellular network is not available in the villages or along the highways.

3. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

3.1 Ambient Air Quality

Construction Phase Impacts: The air environment around project site is free from any significant pollution source at present. The sources and activities that might affect air quality in the project area during construction phase are vehicular traffic, material handling and storage, dust arising from unpaved village roads, construction activities including operation of construction plant and machinery and domestic fuel burning.

Additionally, construction activities including operation of crushers, concrete batch plants, construction work and movement of vehicles along unpaved road will generate dust & gaseous emission and impact air quality. The burning of waste will also affect air quality. In absence of proper fuel, construction workers at the project site may use wood for fuel burning and space heating. This will also impact air quality.

Operation Phase Impacts: In hydropower project, air pollution occurs mainly during project construction phase. During operation phase, no impacts are envisaged on air environment.

3.2 Noise Environment

Construction Phase Impacts: Noise in and around the construction site may affect the wildlife and residents in the nearby areas. Sources of noise will be increased vehicular traffic due to project construction on approach roads and at construction sites. Due to construction activity in the area, noise levels will increase during the period of construction, however, they will remain limited to the work area mainly where large-scale construction activity will progress. Other sources of noise and vibration will be the use of explosives for blasting purposes for construction activities.

Operation Phase Impacts: No major impacts are envisaged on noise environment during project operation phase.

3.2.1 Water Environment

Construction Phase Impacts: Water is used in construction activities leading to wastewater generation with high suspended solids. Similarly, effluents due to washing from truck or equipment etc. would have high concentration of oil and grease. Assessment of quantum of wastewater from such activities is difficult however, they can impact the nearby water bodies if surface run off with high suspended solid is washed into them. Domestic wastewater will be generated from worker’s colony to be set up during construction phase, which if finds its way to river/ground water without any treatment will become significant impact on water environment.

Operation Phase Impacts: Construction of dam to regulate water for power generation will lead to permanent change in flow regime of the river – both upstream as well downstream. Chenab river flows along a steep gradient and carries a significant amount of sediment load. Due to the creation of a reservoir sediments will tend to accumulate in the riverbed as the suspended load settles down due to a decrease in flow velocity.

3.3 Land Environment

Construction Phase: The following impacts are anticipated on Land environment during construction phase

- **Impact due to Land Requirement and change in land-use:** Major impact of land acquisition is permanent change of land use, which is irreversible impact. These impacts cannot be mitigated; however, compensation in terms of implementation of Compensatory Afforestation Plan, Biodiversity Conservation Plan, Green Belt Development Plan will help in managing and reducing the magnitude of such impacts.
- **Impact Due to Muck Generation:** Muck generation, transportation and disposal can significantly impact the land environment, if not managed properly.
- **Impact due to Waste Generation**: The main sources of waste generation can be categorized as:
  i. Municipal waste (includes commercial and residential wastes generated in either solid or semi-solid form excluding industrial hazardous wastes and bio-medical wastes)
  ii. Construction and demolition debris (C&D waste)
  iii. Bio-medical waste
  iv. Hazardous waste (generated from construction machinery and equipment)

- **Impacts due to Road Construction:** The major impacts likely to accrue because of the construction of the roads are loss of vegetation and geological.
- **Impacts due to Quarrying**: Quarrying is normally done by cutting the face of the hill. The rock from the exposed face of the quarry under the action of wind and other erosion forces gets slowly weathered and they become a potential source of landslide.

3.4 Impacts on Forests and Forest Land

211.84 ha of forest land will be diverted for the construction of the project components. This shall lead to loss of some of the plant species used for various economic purposes. This impact is partially mitigated by implementation of Compensatory Afforestation Plan as well as Biodiversity Conservation and Wildlife Management Plan.

3.5 Flora and Fauna

Construction Phase

Impact on Terrestrial Flora: Increase in human interference could have an impact on terrestrial ecosystem. The workers may also cut trees to meet their requirements for fuelwood, construction of houses, furniture. Thus, it is necessary to provide training and awareness, maintain cooking fuel supply and implement adequate surveillance to mitigate the adverse impacts on terrestrial flora during project construction phase.

Impact on Terrestrial Fauna: During the construction period, large number of machinery and construction workers shall be mobilized, which may create disturbance to wildlife population in the vicinity of project area. The operation of various equipment will generate significant noise; noise and vibration will also increase during blasting which will have adverse impact on fauna of the area.

Operation Phase

On completion of the construction of the project, the land used for construction activities will be restored. Construction workers who have resided in that area will move to another project site. Operation phase impacts on flora and fauna will be positive due to green belt development, and restoration of construction areas. Increase of greenery in the area and creation of reservoir, will have positive impact on avifauna.

3.6 Socio-Economic Environment

a) Positive Impacts on Socio-Economic Environment

The following positive impacts are anticipated on the socio-economic environment of the local people of villages of project area during the project construction and operation phases:

i) A number of marginal activities and jobs would be available to the locals during construction phase.
ii) Developer bringing large scale investment to the area will also invest in local area development and benefit will be reaped by locals. Education, medical, transportation, road network and other infrastructure will improve.
iii) The availability of alternative resources provided by developer in the rural areas will reduce the dependence of the locals on natural resources such as forest.

b) Negative Impacts on Socio-Economic Environment

i) Loss of agriculture land
ii) Impact due to influx of outside population may lead to various social and cultural conflicts during the construction stage.
iii) Increased incidence of Diseases

3.7 Mitigation Measures for Air, Water and Noise Pollution

Proposed project involves construction of dam, powerhouse, reservoir, roads and other associated infrastructure, and construction period is planned for 98 months. Major construction activities have serious potential of pollution generation and impacts all components of environment as discussed above. Impacts arising out of construction activities can be mitigated significantly by taking appropriate mitigation measures, as discussed below.

Control of Air Pollution: For the control of air pollution during construction phase of the project, it is suggested that it should be made mandatory for the contractor/s engaged in the construction works to ensure the implementation of pollution control measures as per CPCB guidelines with regular monitoring of ambient air quality in the project area.

Control of Noise Pollution:

- Diesel Generator sets are to be placed in acoustic enclosures to reduce the noise.
- Proper and regular maintenance/lubrication of machines should be done.
- Noise producing machines (such as crushers, aggregate processing plants, etc.) should be provided with sound barriers.
- Quieter machines and vehicles with high quality silencers should be used.

- Ambient noise should be monitored periodically at different locations.

Control of Water Pollution:

- Provision of septic tank/ soak pit of adequate capacity for labour camp.
- Commission of suitable treatment facilities to treat the sewage generated from the colony
- Oil interceptors shall be provided and residue of petroleum products will be disposed off in accordance with PCB guidelines.
- Provision of sedimentation cum grease traps to prevent entry of contaminants to the water bodies.

A lump sum budget of **Rs. 50 lakh** per annum has been proposed for the mitigation measures for control of air, noise and water pollution during project construction phase.

4. ENVIRONMENTAL MONITORING PROGRAMME

Environmental Monitoring shall be performed during all stages of the project (namely: construction and operation) to ensure that the impacts are no greater than predicted, and to verify the impact predictions.

The monitoring will be carried out by an NABL accredited laboratory for a period of 10 years during the project construction phase or extended if the project construction period gets extended. The monitoring program for the proposed project will be undertaken to meet the following objectives:

- To monitor the environmental conditions of the project area and nearby villages;
- To check on whether mitigation and benefit enhancement measures have actually been adopted and are proving effective in practice;

A total of **Rs. 111.50 lakh** have been allocated to implement various activities envisaged under Environmental Monitoring Programme.

5. ADDITIONAL STUDIES

5.1 Resettlement & Rehabilitation Plan

For the development of Dugar Hydro Elelctric Project, land requirement has been worked out as 220.6227 ha. Out of which 211.8427 ha is forest land, 8.71 ha is private land and 0.07 ha is community land.

The entire private land identified for the project falls in one revenue village - Luj, tehsil Pangi, District Chamba. The private land proposed for procurement belongs to a total of 121 land owners. All the 121 families will be losing part of their agricultural land and none of the families will be losing any house or any other assets. Private land identified for the project will be acquired as per Himachal Pradesh Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (Compensation, Rehabilitation and Resettlement and Development Plan) Rules, 2016.

With reference to the above the relevant limits on extent of land under Section 2(3)(a) are prescribed by the Government of Himachal Pradesh under **Section 15** of The Himachal

Pradesh Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (Compensation, Rehabilitation and Resettlement and Development Plan) Rules, 2016. As per the said rules:

15. Limits of extent of land under sub-section (3) of section 2.—The limit of extent of land referred to in clause (a) of sub-section (3) of section 2 shall be twenty hectares in urban areas and forty hectares in rural areas.

In view of the above, it is noted that the total private land proposed to be purchased through private negotiations for the above Project is about 8.78 ha. The cost of land and final award will be declared by District Collector. A budget of rs. 1.00 crore is made towards monitoring and implementation.

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5.2 Local Area Development Fund

The aim of Local Area Development Activities is focused sustainable development to improve the quality of life of neighborhood communities through equitable and proactive smart initiatives in spheres of education, health, rural development, environment and livelihoods resulting in improvement of the overall local social, economic and environmental conditions.

As per Govt. of Himachal pradesh notification MPP-F(10)-24/211 dated 5 October 2011, provision has been made to contribute 1.5% of the total project for Local Area Development Fund. Therefore,the total fund allocated for implementing the various local area development acitivities in affected area around the project has been kept as Rs. **51.00 crore**.

The activities proposed under Local Area Development Activities will be refined after Public Consultation meeting, keeping in view the needs and requirement of local population following the guidelines under the Local Area Development Fund notification of Govt. of Himachal Pradesh. Activities to be implemented will be discussed with Government of District Administration and finalized by LADC.

6. PROJECT BENEFITS

Dugar Hydro Electric Project will help in harnessing potential of river Chenab for generating electricity to the tune of 1758.98 MUs in a 90% dependable year annually and bring benefits of renewable energy to state of and country. In addition to this other benefits form the projects are;

a. As per the Memorandum of Understanding (MoU), Government of Himachal Pradesh, NHPC Limited shall be liable to deposit an equivalent amount of 100 units of electricity, per month for a period of 10 years.
b. NHPC Limited shall contribute 1.5 % of the cost of the project towards pre-commissioning Local Area Development Fund (LADF).
c. Increase in green cover of the region
d. Conservation of Biodiversity and Wildlife through implementation of Biodiversity and Wildlife Conservation and Management Plan.
e. Large scale investment in the region will bring about several positive changes in the region and expected to improve the quality of life of local population. The project will help improve local infrastructure and employment generation for local during construction and operation phase.

f. There will be secondary employment opportunities for locals in terms of catering to the daily need of migratory labour and floating population of transporters and material suppliers to the site.

7. ENVIRONMENT MANAGEMENT PLAN (EMP)

Pollution generation mainly during construction phase will be in the form of air, water and noise pollution; which will be mitigated by adopting various mitigation measures and implementation of environment management plans.

The project level Environment Monitoring Cell (EMC) would coordinate with necessary stake holder for effective implementation of all environmental safeguard measures prescribed in the EMP.

7.1 Catchment Area Treatment Plan

The Catchment Area Treatment (CAT) plan highlights the management techniques to control erosion in the catchment area of a water resource project. The life span of a reservoir is greatly reduced due to erosion in the catchment area. Adequate preventive measures are thus needed for the treatment of catchment for its stabilization against future erosion.

In the present study, CAT Plan has been formulated for the free draining catchment till the proposed dam site on Chenab river. The total area of the free draining catchment is **1131.64 sq km**.

The catchment area treatment involves

- Understanding of the erosion characteristics of the terrain and,
- Suggesting remedial measures to reduce the erosion rate.

The estimated cost of implementation of CAT plan including monitoring and evaluation is **Rs. 5090.00 lakh**.

7.2 Compensatory Afforestation Plan

The Dugar Hydro Electric Project is being constructed in the jurisdiction of Pangi Forest Division. The total land required for the construction of proposed project activities is approximately **220.62 ha** with **211.842 ha** of forest land.

As per the guidelines of Forest Conservation Act, 1980 block plantation is to be taken up two times of the above ground component of forest land diversion **[221.842 ha x 2 = 423.684 ha]**. So the compensatory afforestation to be taken up on **423.684 ha** on forestland over degraded forest areas, it is also proposed to have avenue plantation along the proposed roads with iron guard fencing work around the new plantation with angle iron in the diverted land to maintain the ecological balance of the areas.

The estimated cost of Compensatory Afforestation programme is **Rs. 6,20,58,797/-.** In addition, the total cost under Net Present Value (NPV) is **Rs. 20,66,35,822/-.**

The total cost of the compensatory afforestation plan and Net present Value is **Rs. 26,86,94,619/-**.

7.3 Biodiversity Conservation & Wildlife Management Plan

Keeping in view of the anticipated impacts of proposed project on the biodiversity of area, the mitigation measures suggested for biodiversity conservation and wildlife management plan and conservation of Schedule-I species are as follows:

i. Wildlife Habitat Preservation & Improvement
ii. Establishment of Eco Park
iii. Biological fencing
iv. Prevention and Control of Forest Fire
v. Development of Grazing land/ Pastures
vi. Awareness promotion
vii. Strengthening of Infrastructural Facilities of Forest Department
viii. Biodiversity Management Committee (BMC)

The estimated cost of implementation of various activities envisaged in the Biodiversity Conservation and Management Plan would be **Rs. Rs. 173.36 lakh**.

7.4 Fisheries Management Plan

In a publication by ZSI (2010-2011) and Cumulative Environmental Impact Assessment Study of Chenab Basin in Himachal Pradesh, reported that there are no records of fishes from Pangi valley.

Reservoir area of proposed Dugar HEP will spread over an area of 1.605 sq.km. The reservoir of proposed project is expected to retain water throughout the year and offers an opportunity for fishery development. Therefore, to explore the possibility of reservoir fisheries in Chenab River and its tributaries, it is proposed that detailed study will be carried out by State Fisheries Department along with Directorate of Coldwater Fisheries Research, Bhimtal.

Budgetary provision of **Rs. 40.00 lakh** has been proposed to explore the possibility of reservoir fisheries in the proposed reservoir of Dugar Hydro Electric Project.

7.5 Muck Management Plan

The construction would involve about 3,70,880 cum of soil excavation and 9,23,970 cum of rock excavation. About 60% of rock excavation is expected to be used for producing coarse and fine aggregate for concrete production and in fillings for developing areas for construction facilities. The total area for the dumping of muck is **8.58 ha** which can accommodate more than **8.75 lakh** cum though the estimated muck to be disposed of is **7.17** lakh cum.

The estimated cost of the relocation and rehabilitation of excavated material will be **Rs. 670.80 lakh.**

7.6 Landscaping and Restoration of Construction Sites

Landscaping and restoration of construction sites will focus restoration of sites like, Quarry & Borrow sites, job facility area, colony area, and project roads, After the completion of mining activity, these areas will be restored to their normal habitat conditions.

These activities will result either in the modification or destruction of the existing landscape of the area. It is therefore imperative that after the project work and related activities are over restoration work should be carried out in these disturbed areas. Various engineering and biological measures will be implemented for the restoration of proposed project affected areas. The landscaping and restoration plan will be implemented with help of landscaping experts and in consultation with Pangi Forest Division and the coordination and funding will be provided by the project proponent.

The estimated cost for the landscaping and restoration works of quarry and borrow area, job facility area, colony area, and project roads areas, would be **Rs. 354.80 lakh**.

7.7 RESERVOIR RIM TREATMENT PLAN

The construction of the Dugar Hydro Electric Project will create a reservoir upstream of the proposed dam in the Chenab River. An area of 160.45 ha upto 2114 m elevation will be submerged in the submergence. The objective of the Reservoir Rim Treatment plan is to check sedimentation in the reservoirs, and to mitigate the effects of debris flow and landslides along the reservoir rim especially during the drawdown period of the reservoir. The Reservoir rim area is sparsely vegetated and mostly inaccessible. The upper reaches of the reservoir rim can be approached via Killar, Chamba, and Punto roads.

The left bank is characterized by steep bare rocky cliffs all along the length of the reservoir. The right bank of the reservoir area has a gentle to moderate slope covered by slope wash and thick overburden deposits at a higher level. There is one small landslide is seen on the left bank which is in stable condition.

Though no major active landslide or slope instability is present in the reservoir area, however in order to take care and treat any slope instability / slide in future during construction / operation stage a lumpsum amount **of Rs. 40 lakh** has been kept.

7.8 Green Belt Development Plan

Green belt development will comprise plantations at various places like alongside roads, around the construction areas, and at different project offices and colonies.

During plantation for development of green belt, precaution should be exercised by not planting large size trees around buildings to avoid accidents. Besides this, it is also proposed to develop a green belt around the working areas for trapping the dust and noise, which will rise from the crusher plant, plantation must be done around the crusher plant area. Plantation of avenue, ornamental, and fruit trees are proposed in these areas along with the area around the office complex. The plants of recreational value, horticultural importance shall be planted within the colony area. The ornamental and fruit plants will be procured from the horticulture department and local market while plants for avenue plantation will be procured from the forest department nursery. For the protection of trees from cattle, iron tree guards shall be required.

A budgetary provision of **Rs. 397.80 lakh** has been kept for the development of Green Belt in and around the project area.

7.9 Sanitation and Solid Waste Management

Solid waste generated from temporary and permanent colonies in construction as well as operation phase requires special management for disposal. The project authorities will ensure sewage generated from labour colonies and site office is treated and disposed as per the SPCB guidelines. Various aspects of solid waste management include:

- Reuse/Recycling
- Storage/Segregation
- Collection and Transportation
- Disposal

The waste generated from the project area will be collected, segregated and disposed off in line with the provisions laid down in Solid Waste Management Rules, 2016. The total budget in order to manage the solid waste generated from this population, has been proposed as **Rs. 316.40 lakh.**

7.10 Public Health Delivery System

Project construction and operation will bring about several changes in the socio-economic environment of the area including increased threats to health of the community.

i. New Diseases due to Migratory Population
ii. Chances of increase in water borne diseases as malaria, and dengue are high
iii. Chances of increase in respiratory troubles due to increase in suspended particles during the construction phase.
iv. Chances of occurrence of gastroenteritis, cholera and typhoid in the labour camps.

Medical services at secondary level play a vital and complimentary role to the tertiary and primary health care systems and together form a comprehensive district-based health care system. Following activities are proposed:

- Ambulance: 2 no. with all the basic Medicare facilities to cater for villages in the project area.
- Budget for running the ambulances including driver, fuel and maintenance for 10 years.
- Two first aid posts including sheds, furniture and basic equipment.
- Budget for running the first aid posts for 10 years.
- Budget for strengthening existing medical facilities.
- Measures to control COVID19 in the project area
- Budget for Health Awareness/ Vaccination Camps for 10 years.

Budgetary estimates for public health delivery system to be implemented have been worked out as **Rs. 335.00 lakh.**

7.11 Energy Conservation Measures

The existing facilities will become insufficient for supply of kitchen fuel for the migrant population during the construction of the project. Therefore, the project authorities would make adequate arrangements such as Community kitchen, Supply of Kitchen fuel, efficient cooking facilities and solar lantern either directly by developer or through contractor to reduce the pressure on natural resources in the project area and minimize impacts on this count. A total budget of **Rs. 300.00 lakh** have been proposed under Energy Conservation Plan.

7.12 Labour Management Plan for their Health and Safety

Construction work has many associated risks and health impacts for the workers who are directly exposed to such health and safety risks. Therefore, there is a need to prepare complete health and safety documents for workers either by project proponent/contractor and proponent shall ensure its implementation. A detailed plan will be prepared covering the above activities before start of construction work. A tentative budget of **Rs. 140.00 lakh** for labour management have been proposed under EMP.

7.13 Disaster Management Plan

In order to visualize the worst-case scenario Dam Break Modeling exercise was undertaken and an inundation map was prepared. Based upon the outputs generated from this modeling, a Disaster Management Plan has been formulated. This plan presents warning and notification procedures to be followed in case of failure or potential failure of the dam. The purpose is to provide timely warning to the population likely to be affected and alert key people who have to take respective actions in case of an emergency. The estimated total cost of execution of disaster management plan including the equipment would be **Rs. 155.00 lakh.**

8. SUMMARY OF COST

The costs involved for implementation of Environmental Management Plan for Dugar Hydro Electric are summarized in the table given below.

Table 1: Cost for Implementing Environmental Management Plan

Sl. No	Component of EMP	Capital Cost (Rs. In lakh	Recurring Cost (Rs. In lakh)										Total Cost (Rs. In lakh)
			Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	
1	Catchment Area Treatment Plan	5090.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5090.00
2	Compensatory Afforestation Plan	2686.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2686.95
3	Biodiversity Conservation & Wildlife Management Plan	173.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	173.36
4	Fisheries Conservation and Management Plan	40.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.00
5	Muck Dumping and Management Plan	0.00	50.00	80.50	80.50	80.50	80.50	80.00	70.00	50.30	50.50	48.00	670.80
6	Landscaping, Restoration of Quarry and Construction Sites	0.00	1.63	0.00	0.00	0.00	10.00	10.00	333.17	20.00	20.00	10.00	404.80
7	Reservoir Rim Treatment Plan	40.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.00
8	Green Belt Development Plan	0.00	0.00	40.00	50.00	55.00	70.85	60.85	45.60	30.50	25.00	20.00	397.80
9	Sanitation and Solid Waste Management Plan	110.00	20.64	20.64	20.64	20.64	20.64	20.64	20.64	20.64	20.64	20.64	316.40
10	Public Health Delivery System	75.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	335.00
11	Energy Conservation Measures	60.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	300.00
12	Labour Management Plan	50.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	140.00
13	Disaster Management Plan	135.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	155.00
14	Control of Air, Noise and Water Pollution	0.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	50.00
15	Environmental Monitoring Programme	0.50	11.10	11.10	11.10	11.10	11.10	11.10	11.10	11.10	11.10	11.10	111.50
16	Rehabilitation and Resettlement Plan*	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
17	LADF @ 1.5% of Rs.3393.21 crore (project cost)	5100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5100.00
Total		**13660.81**	**149.37**	**218.24**	**228.24**	**233.24**	**259.09**	**248.59**	**546.51**	**198.54**	**193.24**	**175.74**	**16111.61**

*Final award for purchasing of private land will be finalized by district administration.

पर्यावरण प्रभाव आकलन
डूगर जल विद्युत परियोजना (500 मेगावाट)
तहसील पांगी, जिला चंबा
हिमाचल प्रदेश

कार्यकारी सारांश

अक्टूबर, 2021

Prepared for:

NHPC LTD.

Prepared by:

R. S. Envirolink Technologies Pvt. Ltd.

403, BESTECH CHAMBER COMMERCIAL PLAZA,

B-BLOCK, SUSHANT LOK-I, GURGAON

Phone: +91-124-4295383: www.rstechnologies.co.in

कार्यकारी सारांश

1. परिचय

पर्यावरणीय प्रभाव आकलन (ई.आई.ए) का उद्देश्य प्रस्तावित परियोजना का स्थानीय पर्यावरण पर प्रभाव का आंकलन करना है। संभावित पर्यावरणीय प्रभावों की पहचान करने और उन्हें कम करने या कम करने के तरीकों का सुझाव देने के लिए यह पर्यावरणीय प्रभाव आकलन (ई आई ए) अध्ययन आयोजित किया गया है। डूगर जल विद्युत् परियोजना (500 MW) पांगी तहसील, जिला चम्बा, हिमाचल प्रदेश में चेनाब नदी पर प्रस्तावित है।

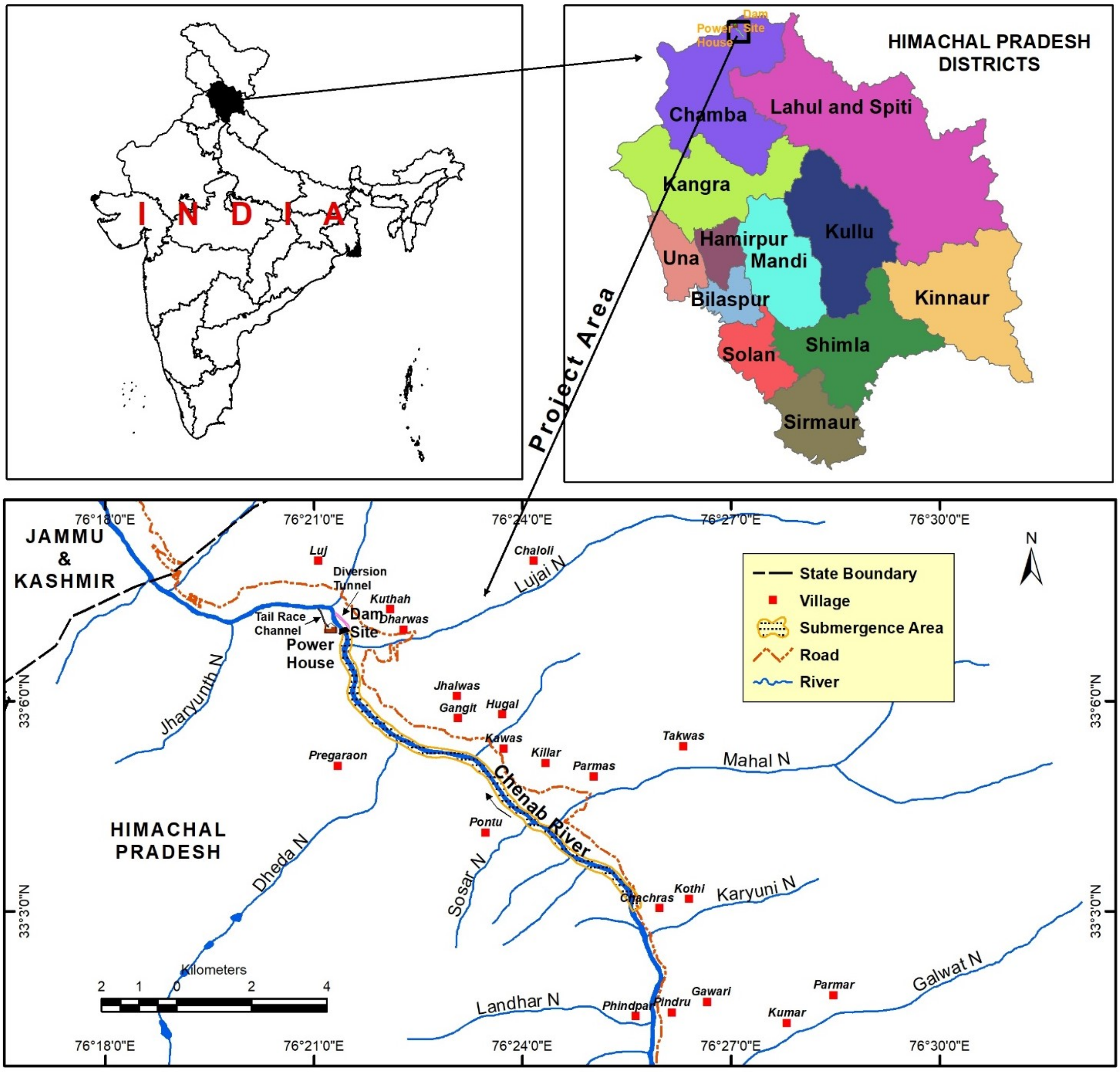
पर्यावरण वन एवं जलवायु परिवर्तन मंत्रालय द्वारा 449 मेगावाट डूगर जल विद्युत् परियोजना के लिए दिनांक 05 अगस्त 2020 को पत्रांक संख्या J-12011/08/2020-IA-I द्वारा स्कोपिंग क्लीयरेंस प्रदान की। परियोजना की उत्पादन क्षमता 449 मेगावाट से 500 मेगावाट संसोधित होने पर पर्यावरण वन एवं जलवायु परिवर्तन मंत्रालय द्वारा डूगर जल विद्युत् परियोजना (500 मेगावाट) के लिए पुनः दिनांक 08 फ़रवरी 2021 को पत्रांक संख्या J-12011/08/2020-IA-I द्वारा पर्यावरणीय प्रभाव आकलन (ई.आई.ए) हेतु स्कोपिंग क्लीयरेंस प्रदान की गई।

2. परियोजना का विवरण

डूगर जल विद्युत् परियोजना (500 मेगावाट) पांगी तहसील, जिला चम्बा, हिमाचल प्रदेश में चेनाब नदी पर प्रस्तावित है। परियोजना का लोकेशन एवं ले-आउट मानचित्र क्रमशः चित्र संख्या 1 व 2 में दर्शाया गया है। परियोजना की मुख्य विशेषताएं तालिका 1 में दी गई हैं। परियोजना के मुख्य घटक निम्न्न प्रकार से हैं:

- 128 मीटर ऊंचे कंक्रीट ग्रैविटी डैम
- एक भूमिगत बिजलीघर प्रस्तावित है, जिनमें से प्रत्येक में 103 मेगावाट के 4 यूनिट तथा 44 मेगावाट के 2 यूनिट प्रस्तावित है।
- इसका पूर्ण जलाशय स्तर (एफआरएल) और जलाशय के न्यूनतम ड्रा डाउन स्तर (एमडीडीएल) क्रमशः 2114 मीटर और 2102.35 मीटर क्रमशः हैं।
- जलमग्न होने का कुल क्षेत्रफल 160.45 हेक्टेयर है।

डूगर जल विद्युत् परियोजना के निर्माण कार्य पूर्ण होने का अनुमानित समय शुरू होने की तारीख से 98 माह अनुमानित है।



चित्र 1: परियोजना का स्थान

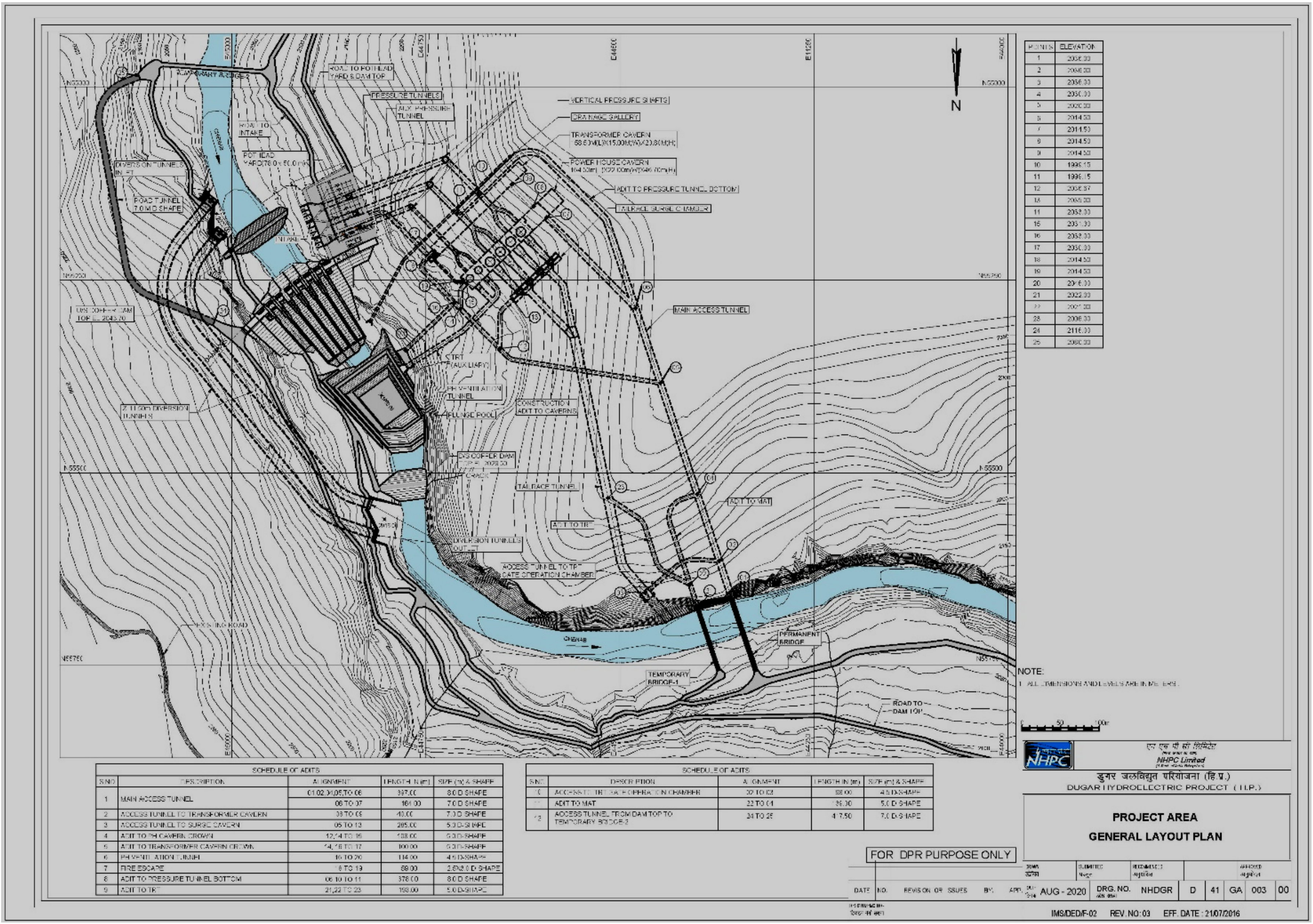
तालिका 1: परियोजना की मुख्य घटक

Project Location	
State	Himachal Pradesh
District	Chamba
River	Chenab river
Vicinity	Luj Village
Coordinates	33^{0}07’05” N, 76^{0}21’20.7” E
Nearest Railhead	Udhampur, J&K (270 km)
Hydrology	
Catchment area	7823 km^2
Snow fed Catchment Area	4458 km^2
Average Discharge in 90% dependable year	267.1 m^3/s
Average Annual rainfall	859.5 m
Flood discharge for river diversion	2700 m3/s
Probable Maximum Flood	9425 m^3/s
Reservoir	

Full Reservoir Level (FRL)	2114.0 m asl
Maximum Water Level (corresponding to PMF)	2114.0 m asl
Maximum Draw Down Level (MDDL)	2102.35 m asl
Gross Storage at FRL	61.58 M m^3
Gross Storage at MDDL	45.01 M m^3
Live Storage	16.57 M m^3
Dam	
Type	Concrete Gravity
Design Flood (PMF)	9425 m^3/s
Top of the dam	2116.0 m asl
Full reservoir level (FRL)	2114.0 m asl
Average Riverbed Level at Dam Axis	2017.0 m
Deepest foundation elevation	1988.0 m asl
Height of Dam (Above deepest Foundation Level)	128.0 m
Length of Dam at the top	210.65 m
Total number of blocks	13
Number of overflow blocks	6
Number of non-overflow blocks	7
Spillways	
Upper-level Spillway	
Number of Upper-level Spillway	1
Size (WXH), m	8.2 X 11.7
Gate type and No. of Gates	Radial, 1
Width of block	15.20 m
Crest Elevation	2102.30 m asl
Lower-level Spillway	
Number of Lower-level Spillway	5
Size (WXH), m	8.2 X 10.65
Gate type and No. of Gates	Radial, 5
Total width of LLS blocks	76.0 m
Crest Elevation	2052.50 m asl
River Diversion	
River diversion flood	2700 m^3/s
Diversion scheme	Diversion tunnels and cofferdams
Location	Right bank
No. of diversion tunnels	2
Diameter of each diversion tunnel	11.5 m, Horse-shoe shape
Length of diversion tunnel	463.0 (DT1), 577.0 (DT2)
Top of the upstream cofferdam	2043.70 m
Height of upstream cofferdam	~23.7 m
Top of the downstream cofferdam	2029.50 m
Height of downstream cofferdam	~ 13.5 m
Power Intake	
Main Power Plant	
Location	Left bank
No. and Size	02 Nos., 23.05m (W) x 34.35m (H)
Design discharge for each intake	252 m^3/s
Type and Size of intake gate	Fixed wheel, 6.40 m (W) x 8.10 m (H)
Auxiliary Power Plant	
Location	Left bank
No. and Size	01 No., 13.5m (W) x 28.7m (H)

Design discharge	113.66 m^3/s
Centreline elevation	2091.95 m
Type and size of intake gate	Fixed wheel, 4.65 m (W) x 5.90 m (H)
Pressure Tunnel/Shaft	
Main Plant	
No. of pressure tunnel/shaft	2
Design discharge for each pressure tunnel/shaft	252 m^3/s
Diameter of steel-lined pressure tunnel/shaft	7.25 m
Length	314.3 m and 274.6 m
Internal diameter of steel-lined pressure tunnel after bifurcation	4.85 m
Length of each steel-lined pressure tunnel after bifurcation	37.2 m
Auxiliary Plant	
No. of pressure tunnel/shaft	1
Design discharge for each pressure tunnel/shaft	113.66 m^3/s
Internal diameter of steel-lined pressure tunnel/shaft	5.1 m
Length	251.7 m
Internal diameter of steel-lined pressure tunnel after bifurcation	3.7
Length of each steel-lined pressure tunnel after bifurcation	29.9m
Powerhouse	
Powerhouse for main units	
Type	Underground
Size (L x W x H) including auxiliary units	164.5m x 22m x 46.7m
Gross head (Average)	94.8 m
Nos. & type of Turbine	4 Nos., Francis
Turbine c/l elevation	2002.5
Design discharge per unit	126 m^3/s
Rated head	90.10 m
Installed capacity per Unit	103 MW
Normal tailwater level	2015.34 m
Probable maximum tailwater level	2033.04
Powerhouse for auxiliary units	
Type	Underground
Gross head (Average)	92
Nos. and type of Turbine	2 Nos., Francis
Turbine c/l elevation	2006.50 m
Rated discharge per unit	56.83 m^3/s
Rated head	87.69 m
Installed capacity per Unit	44 MW
Normal tailwater level	2018.1 m
Probable maximum tailwater level	2042.03 m
Transformer Cavern	
Type	Underground
Cavern Size (L x W x H)	158.5m x 15 x 20.8m
Transformer floor elevation	2014.50 m
Tailrace Tunnel	
Main Plant	
Nos. & Dia. of draft tube tunnels	04 Nos., 7.7m
Length of each draft tube tunnel	58 m
Diameter of tailrace tunnel (two draft tube tunnels	8.5 m

combined to one TRT)	
Length of tailrace tunnel (two draft tube tunnels combined to one TRT)	93 m and 82 m
Diameter of single tailrace tunnel (two TRTs of 8.5 m diameter combined to one TRT)	12.1 m
Length of single TRT	400 m
Design discharge for single TRT	504 m^3/s
Nos. and Size of TRT gates	02 Nos., 5.1m (W) x 12.1m (H)
Auxiliary Plant	
Nos. & Dia. of draft tube tunnels	02 Nos., 6.2m
Length of each draft tube tunnel	29 m and 39 m
Diameter of tailrace tunnel (two draft tube tunnels combined to one TRT)	6.2
Length of single TRT	134 m
Design discharge for single TRT	113.66 m^3/s
Nos. and Size of TRT gates	01 Nos., 5.1m (W) x 6.2m (H)
Estimated cost	
Civil works (Including Pre-operative Works)	₹ 2562.23 (in crores)
E&M works	₹ 821.88 (in crores)
Cost of Miscellaneous Works (Including indirect Charges)	₹ 9.09 (in crores)
Total basic cost	**₹ 3393.21 (in crores)**
IDC and financing charges	₹ 527.22 (in crores)
Total Project cost	**₹ 3920.43 (in crores)**
Financial aspects	
Tariff as per CERC	
Cost of generation (1st Year Tariff) per kWh at powerhouse bus bars (including IDC) during 90% dependable year as per CERC Guidelines	₹4.09 /kWh
Cost of generation (Levellised Tariff) per kWh at powerhouse bus bars (including IDC) during 90% dependable year as per CERC Guidelines	₹4.10/kWh
Construction period	
Total construction period including preconstruction works	98 months
Construction period for preconstruction works	24 months



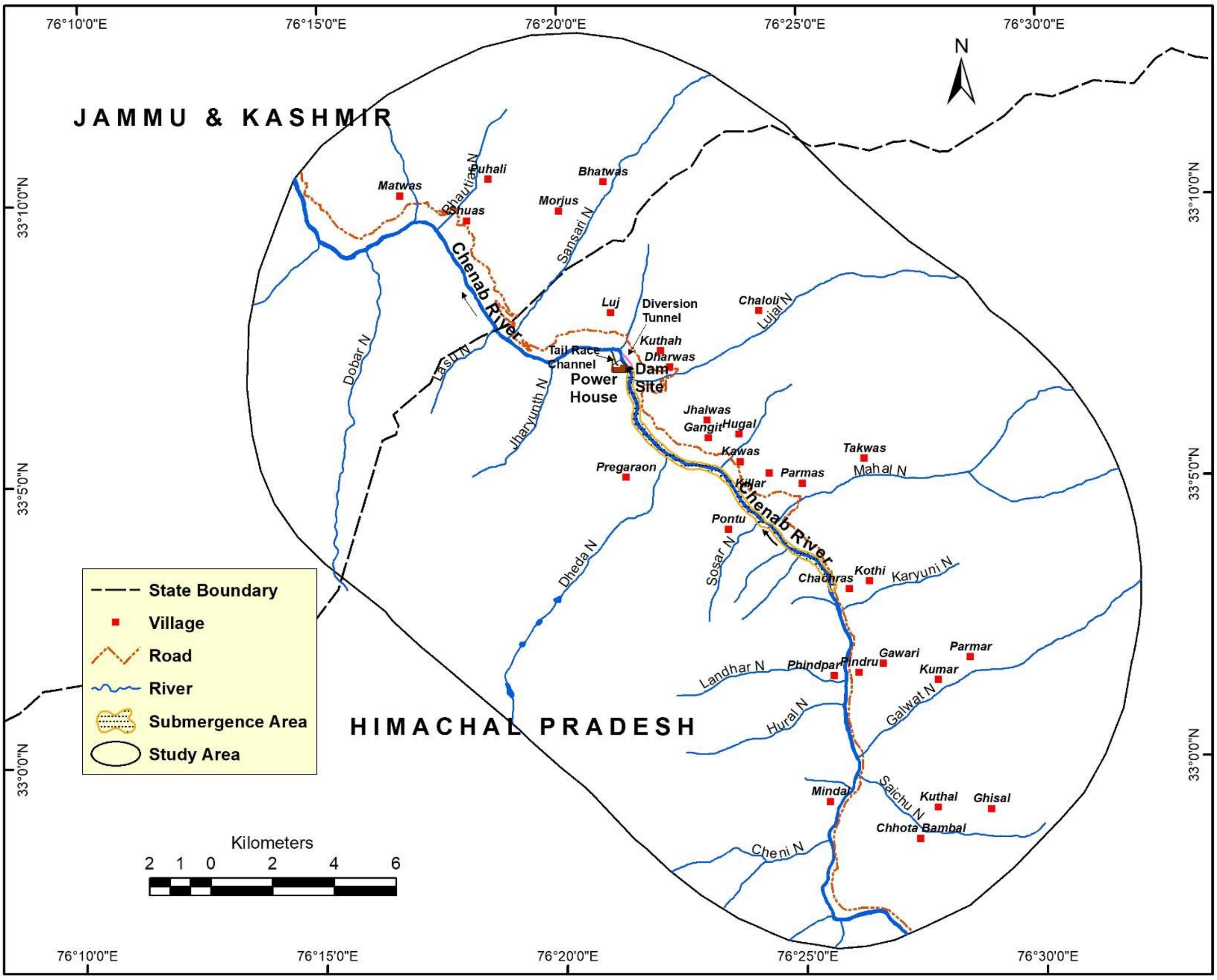
चित्र 2: परियोजना का ख़ाका

3. परियोजना हेतु भूमि की आवश्यकता

परियोजना लेआउट के आधार पर, परियोजना हेतु कुल 220.62 हेक्टेयर भूमि की आवश्यकता है। जिसमें से 8.71 हेक्टेयर निजी भूमि, 0.07 हेक्टेयर सामुदायिक भूमि तथा 211.84 हेक्टेयर वन भूमि है।

4. अध्ययन क्षेत्र

पर्यावरणीय आधारभूत स्थिति के आकलन के लिए अध्ययन क्षेत्र का चित्रित किया गया था। अध्ययन क्षेत्र हिमाचल प्रदेश के जिला चम्बा और केन्द्रशासित प्रदेश जम्मू कश्मीर के किश्तवार जिले में आता है। चित्र 3 में अध्ययन क्षेत्र दर्शाया गया है।



चित्र 3: डूगर जल विद्युत् परियोजना का अध्ययन क्षेत्र

5. पर्यावरण आधारभूत स्थिति

- अध्ययन क्षेत्र के भू-उपयोग तथा वानस्पतिक आवरण के अनुसार परियोजना अध्ययन क्षेत्र का अधिकतम भूभाग वन एवं चारागाह भूमि क्षेत्र (लगभग 50%) के अंतर्गत आता है। अध्ययन क्षेत्र का 14.70% भूभाग बंजर एवं पथरीली भूमि तथा 8% भूभाग बर्फीले एवं हिमनद क्षेत्र 1.38% भूभाग जल क्षेत्र के अंतर्गत आता है।
- डिजिटल एलिवेशन मॉडल (डीईएम) से पता चलता है कि अध्ययन क्षेत्र में ऊंचाई एमएसएल से

1908 मीटर से 5386 मीटर के मध्य है। अध्ययन क्षेत्र एक पहाड़ी असमतल क्षेत्र में है जिसमे खड़ी पहड़ियां और गहरी घाटियाँ हैं। अध्ययन क्षेत्र का अधिकांश हिस्सा (लगभग 42%) खड़ी ढलान वाले क्षेत्र के अंतर्गत आता है।

- **मृदा की गुणवता**: मिट्टी परीक्षण परिणामों के आधार पर क्षेत्र की मृदा उर्वरता की स्थिति का आकलन किया गया है। मिट्टी की उर्वरता जानने हेतु न्यूट्रिएंट इंडेक्स (नाइट्रोजन, फॉस्फोरस और पोटेसीयम के उपलब्धता) के अनुसार मिट्टी में नाइट्रोजन एवं फॉस्फोरस उर्वरता निम्न श्रेणी में है जबकि पोटेशियम के मामले में यह मध्यम श्रेणी में है।
- **वायु एवं ध्वनी स्तर**: अध्ययन क्षेत्र में किए गए परिवेशी वायु एवं ध्वनी स्तर की गुणवत्ता निगरानी के आधार पर यह निष्कर्ष निकाला गया है कि अध्ययन क्षेत्र में हवा की गुणवत्ता अच्छी और संतोषजनक है और वायु एवं ध्वनी स्तर केंद्रीय प्रदुषण नियंत्रण बोर्ड द्वारा निर्धारित मानकों के अनुसार निर्धारित सीमा के भीतर है।
- **जल की गुणवता**: सतही जल गुणवत्ता के लिए परियोजना क्षेत्र चेनाब नदी एवं जल गुणवत्ता की निगरानी की गई है। केंद्रीय प्रदुषण नियंत्रण बोर्ड द्वारा निर्धारित मानकों के अनुसार अध्ययन क्षेत्र में सतही जल 'बी' श्रेणी के तहत है। बी' श्रेणी में आने वाले पिने योग्य नहीं होता है, इसका उपयोग स्नान तथा अन्य घरेलू कार्यों के लिए लिए किया जा सकता है। पेयजल (2012) के लिए BIS मानकों के अनुसार अध्ययन क्षेत्र से एकत्रित सभी भूजल के नमूने निर्धारित सीमाओं के भीतर आते हैं।
- **वनस्पति:** अध्ययन क्षेत्र में वन क्षेत्र पांगी वन प्रभाग के अंतर्गत आते हैं। अध्ययन क्षेत्र में इन जंगलों को चैंपियन और सेठ (1968) द्वारा हिमालयी शुष्क शीतोष्ण वन के अंतर्गत वर्गीकृत किया जा सकता है।
  - पारिस्थितिकीय सर्वेक्षण के दौरान, 182 पौधों की प्रजातियां दर्ज की गई हैं। जिनमे 160 प्रजातियाँ आवृतबीजी (angiosperm) पोधों की, अनावृतबीजी (gymnosperm) पोधों की, 8 प्रजातियाँ फ़र्न (pteridophyte and bryophyte) और 4 प्रजातियाँ लाइकेन (lichen) की हैं।
  - अध्ययन क्षेत्र देवदार, मिरी/ चिल्गोज़ा, चैत/ कैल, तोश, राई, पिन्डरो, अखरोट, बैस/ विलो, चलाजू/ पापुलर, थान्गी, मोरल, मोहाल, भीय, खरक, संजल, रोबिनिया और पियाक अध्ययन क्षेत्र में मुख्य रूप से पाए जाने वाले पेड़ों की प्रजातियाँ हैं।
  - **जन्तु:** जीवों के सर्वेक्षण के दौरान अध्ययन क्षेत्र में, बंदर तथा लंगूर सामान्यतः दिखाई देने वाले जन्तु हैं। पांगी वन प्रभाग के अनुसार, तेंदुवा, गोराल, भालू, काखड, परियोजना क्षेत्र में पाई जाने वाली स्तनधारि जीवों की प्रजातियों हैं।
  - सर्वेक्षण के दौरान अध्ययन क्षेत्र में पक्षियों की 34 प्रजातियाँ, सरीसर्प की 3 प्रजातियाँ तथा तितलियों की 11 प्रजातियाँ को दर्ज किया गया।
  - अध्ययन क्षेत्र में चेनाब तथा उसकी सहायक नदियों नदियों में मछ्लियाँ नहीं पाई गई।
  - अध्ययन क्षेत्र में पाए जाने वालों जीवों में तेंदवा (Loepard; *Panthera pardus*) को वन्यजीव संरक्षण अधिनियम 1972 की अनुसूची-I में रखा गया है।
- **संरक्षित क्षेत्र से निकटता:** सेचु तुआन वन्यजीव अभयारण्य प्रस्तावित डूगर जल विद्युत् परियोजना से निकटतम संरक्षित क्षेत्र है। परियोजना के सभी घटक वन्यजीव अभयारण्य की सीमा के बाहर हैं और इसकी निकटतम सीमा प्रस्तावित जलाशय क्षेत्र से लगभग 12 किमी और

प्रस्तावित बांध स्थल से लगभग 20 किमी दूर है।

- **सामाजिक परिवेश:** अध्ययन क्षेत्र की 10 किलोमीटर की परिधि क्षेत्र का अधिकांश भाग हिमाचल प्रदेश के चंबा जिले के पांगी तहसील/ उप-मंडल के अंतर्गत आता है। अध्ययन क्षेत्र का कुछ हिस्सा केंद्र शासित प्रदेश जम्मू और कश्मीर के किश्तवाड़ जिले के अंतर्गत आता है।
- डूगर जल विद्युत् परियोजना सभी प्रस्तावित घटक, जैसे बांध, बिजलीघर और प्रस्तावित परियोजना के जलमग्न क्षेत्र चंबा जिले के पांगी तहसील/ उप-मंडल में आते हैं।
- पांगी तहसील/ उप-मंडल को आदेश, 1975 (सीओ 102) दिनांक 21 नवंबर, 1975 (हिमाचल प्रदेश) के अनुसार Schedule-V क्षेत्र (अनुसूचित क्षेत्र) घोषित किया गया है।
- भूमि अधिग्रहण के कारण परियोजना से लुज गाँव सीधे तौर पर प्रभावित होगा। प्रस्तावित परियोजना के लिए लुज गांव से कुल 8.78 हेक्टेयर निजी/ सामुदायिक भूमि का अधिग्रहण किया जाना प्रस्तावित है।
- अध्ययन क्षेत्र के गाँवों की सामाजिक-आर्थिक स्थिति तक पहुँचने के लिए परियोजना निर्माण क्षेत्र आने वाले कुल 8 राजस्व गाँवों (लुज गाँव सहित) का सर्वेक्षण किया गया है।
- इन गांवों में कुल आबादी 3214 हैं। जिनमें 1592 पुरुष तथा 1622 महिलाएं हैं। लिंगानुपात 1091 महिलाएं प्रति हजार पुरुषों है। कुल जनसंख्या का लगभग 89% अनुसूचित जनजाति में शामिल है। अनुसूचित जाति और सामान्य जाति क्रमशः 7% और 4% है।
- सर्वेक्षण किए गए गांवों में साक्षरता लगभग 70% है। कृषि और संबद्ध गतिविधियों अध्ययन क्षेत्र में आय का मुख्य का श्रोत हैं। कुल आबादी का लगभग 60% भाग कृषि और संबद्ध गतिविधियों पर निर्भर है।
- क्षेत्र में शिक्षा सुविधाएं प्रथामिक विद्यालय तक सभी गाँव में उपलब्ध हैं, लेकिन माध्यमिक और उच्च माध्यमिक शिक्षा के लिए छात्र-छात्रों को 5 से 8 किमी तक की यात्रा करनी पढ़ती है। क्षेत्र में उच्च शिक्षा के लिए किल्लार में डिग्री कॉलेज है।
- क्षेत्र में चिकित्सा सुविधाएं सीमित हैं, धारवास में एक पीएचसी है और किलार में एक सिविल अस्पताल उपलब्ध है।
- क्षेत्र में सड़क और परिवहन की सुविधा अच्छी है। इस क्षेत्र की सबसे महत्वपूर्ण सड़कें राज्य राजमार्ग 26 और राज्य राजमार्ग 37 हैं, जो क्रमशः परियोजना क्षेत्र को राज्य की राजधानी और जिला मुख्यालय से जुड़ती हैं।
- दूरसंचार और इंटरनेट सुविधाएं किल्लार शहर तक सीमित हैं। मोबाइल सेलुलर नेटवर्क गांवों में या राजमार्गों के किनारे उपलब्ध नहीं है।

6. प्रभावों का आकलन

- जल विद्युत् परियोजनाओं के निर्माण कार्य के संचालन के दौरान वायु और ध्वनि गुणवता पर प्रभाव पड़ता है। उत्खनन, निर्माण उपकरण के संचालन, सामग्री का भंडारण इत्यादि जैसी निर्माण गतिविधियां वायु और शोर प्रदूषण उत्पन्न करती हैं। इस तरह के प्रभावों को उचित प्रबंधन एवं निगरानी द्वारा नियंत्रित किया जाएगा।
- निर्माण गतिविधियों में पानी का उपयोग किया जाता है जिससे अपशिष्ट जल उत्पादन होता है

जो आसपास के जल निकायों को प्रभावित कर सकता है। नियंत्रण उपायों से इस प्रभाव को कम किया जाएगा।

- भूमि अधिग्रहण का प्रमुख प्रभाव भूमि उपयोग का स्थायी परिवर्तन है, जो अपरिवर्तनीय प्रभाव है। इन प्रभावों को कम नहीं किया जा सकता है; हालांकि, क्षतिपूरक वृक्षारोपण योजना, जैव विविधता संरक्षण योजना, हरित पट्टी विकास योजना और जलागम प्रबंधन योजना के कार्यान्वयन से ऐसे प्रभावों के प्रबंधन करने में मदद मिलेगी।
- बांध निर्माण के लिए उत्खनन से उत्सर्जित होने वाले मक (अनुपयोगी मर्दा) का यदि सही तरीके से उत्सर्जन, निपटान एवं प्रबंधन न किया जाए तो मक इसका पर्यावरण पर प्रतिकूल प्रभाव हो सकता है।
- श्रमिक आवासिय क्षत्रों से सीवेज और ठोस अपशिष्ट उत्पन्न होगा। किसी भी नदी या नाला के पास ठोस अपशिष्ट नहीं डाला जाएगा। पर्यावरणीय प्रबंधन योजना के अंतर्गत ठोस अपशिष्ट प्रबंधन योजना तैयार की गई है, जिसका उद्देश्य परियोजना के आवासिय क्षत्रों से उतपन्न होने वाले ठोस अपशिष्ट के प्रभावों को कम करना है।
- परियोजना निर्माण के लिए 211.84 हेक्टेयर वन भूमि अधिग्रहण किया जाना प्रस्तावित है। परियोजना के निर्माण के लिए सभी वनस्पतियों को हटा दिया जाएगा। यह एक स्थायी प्रभाव है और केवल क्षतिपूरक वृक्षारोपण योजना, जैव विविधता संरक्षण योजना, हरित पट्टी विकास योजना और जलागम प्रबंधन योजना द्वारा क्षतिपूर्ति की जाएगी।
- निर्माण अवधि के दौरान, बड़ी संख्या में मशीनरी का प्रयोग होगा और श्रमिकों की संख्या बढ़ेगी, जिसका। विभिन्न उपकरणों के संचालन से ध्वनी स्तर बढेगा और शोर उत्पन्न होगा; साथ ही साथ ब्लास्टिंग के दौरान भी शोर और कंपन भी बढ़ेगा जिसका क्षेत्र के जीवों पर प्रतिकूल प्रभाव पड़ेगा। वन्यजीवों पर प्रभाव को नियंत्रित करने के लिए जैव विविधता संरक्षण और वन्यजीवन प्रबंधन योजना प्रस्तावित की गई है। जिसका क्रियान्वयन वन विभाग द्वारा किया जाना प्रस्तावित है।

- **सामाजिक परिवेश पर प्रभाव:**
  - निर्माण चरण के दौरान स्थानीय लोगों रोजगार के लिए उपलब्ध होंगे।
  - क्षेत्र में शिक्षा, चिकित्सा, परिवहन, सड़क और अन्य बुनियादी ढांचे में सुधार होगा जिसका प्रत्यक्ष लाभ स्थानीय क्षेत्र के विकास होगा।
  - स्थानीय युवाओं के लिए रोजगार के अवसर उतपन्न होंगे।
  - ग्रामीण क्षेत्रों में डेवलपर द्वारा उपलब्ध कराए गए वैकल्पिक संसाधनों की उपलब्धता से प्राकृतिक संसाधनों पर स्थानीय लोगों की निर्भरता कम हो जाएगी।
  - परियोजना से होने वाले का नकारात्मक सामजिक एवं आर्थिक प्रभाव निम्न प्रकार से हैं:
    - ➢ कृषि भूमि का नुकसान
    - ➢ बाहरी आबादी के प्रवाह के कारण निर्माण चरण के दौरान विभिन्न सामाजिक और सांस्कृतिक संघर्ष हो सकता है।
    - ➢ बाहरी आबादी के प्रवाह के कारण रोगों की वृद्धि हो सकती है।

7. वायु, जल और ध्वनी प्रदूषण के नियंत्रण योजना

इस योजना के अंतर्गत परियोजना निर्माण चरण में जल, वायु एवं ध्वनी प्रदूषण को नियंत्रण करने के उपाय सुझाए गए हैं। इसमें दूषित जल को नियंत्रण करने, वायु एवं ध्वनी प्रदुषण के मुख्य श्रोतों के प्रबंधन के लिए **रुपए 50.0 लाख** का प्रावधान रखा गया है।

8. पर्यावरणीय निगरानी योजना

इस योजना के अंतर्गत परियोजना निर्माण चरण के समय प्रबंधन योजना के क्रियावयन की निगरानी प्रस्तावित है। इसके अंतर्गत परियोजना क्षेत्र और आसपास के गांवों की पर्यावरणीय स्थितियों की निगरानी करना तथा प्रबंधन योजना के प्रभाव का आंकलन किया जाना है। इस योजना का की कुल अनुमानित लागत **रुपए 111.50** लाख है तथा इसका क्रियान्वयन वन विभाग द्वारा किया जाएगा।

9. पुनर्वास और पुनर्वास योजना

प्रस्तावित परियोजना के विकास के लिए कुल 220.62 हेक्टेयर भूमि की आवश्यकता है। जिसमें से 211.84 हेक्टेयर वन भूमि है, 8.71 हेक्टेयर निजी भूमि और 0.07 हेक्टेयर सामुदायिक भूमि है।

परियोजना के लिए अधिग्रहित की जाने वाली निजी भूमि ग्राम लुज, पांगी तहसील, जिला जिला चम्बा में आती है। खरीद के लिए प्रस्तावित निजी भूमि कुल 121 भूमि मालिकों की है। परियोजना से कोई भी परिवार विस्थापित नहीं होगा। परियोजना के लिए आवशयक निजी भूमि का अधिग्रहण हिमाचल प्रदेश भूमि अधिग्रहण, पुनर्वास और पुनर्स्थापन (मुआवजा, पुनर्वास और पुनर्वास और विकास योजना) नियम, 2016 में उचित मुआवजे और पारदर्शिता का अधिकार के तहत किया जाएगा।

स्थानीय क्षेत्र का विकास योजना

इस योजना के अंतर्गत कार्यदायी संस्था द्वारा परियोजना प्रभावित क्षेत्र में सामाजिक एवं आर्थिक विकास हेतु कार्य किया जाना प्रस्तावित है जिसके लिए कुल **रुपए 51.0 करोड़** का प्रावधान रखा गया है।

10. पर्यावरणीय प्रबंधन योजना

पर्यावरणीय प्रबंधन के अंतर्गत प्रस्तावित योजनाए निम्न प्रकार हैं।

10.1 जलग्रहण क्षेत्र उपचार योजना

जलग्रहण क्षेत्र उपचार योजना (CAT Plan) के अंतर्गत जलग्रहण क्षेत्र में क्षरण को नियंत्रित करने के लिए इंजीनियरिंग और जैविक प्रबंधन तकनीकों को वित्तीय प्रावधान के साथ प्रस्तावित किया गया है। इस योजना का की कुल अनुमानित लागत **रुपए 5090.00** लाख है तथा इसका क्रियान्वयन वन विभाग द्वारा किया जाएगा।

10.2 क्षतिपूरक वनीकरण योजना

प्रस्तावित परियोजना गतिविधियों के निर्माण के लिए आवश्यक कुल वन भूमि 211.84 हेक्टेयर है। अधिग्रहित की जाने वाली वन भूमि की एवज में क्षतिपूरक वनीकरण, वन सरक्षण अधिनियम, 1980 के अनुसार किया जाना प्रस्तावित है। प्रस्तावित परियोजना के अंतर्गत क्षतिपूरक वनीकरण एवं NPV की अनुमानित लागत **रुपए 2686.95 लाख** है।

10.3 जैव विविधता संरक्षण और वन्यजीव प्रबंधन

अनुमानित प्रभावों को ध्यान में रखते हूए, जैव विविधता संरक्षण और वन्यजीवन प्रबंधन योजना का मुख्य उद्देश्य पारिस्थितिक संतुलन का रखरखाव, वन्य जीवों के प्राकृतिक आवासों का संरक्षण एवं विकास, जागरूकता अभियान एवं वन विभाग की बुनियादी सुविधाओं की सुद्दढ़ीकरण करना है। उक्त योजना के मुख्य घटक इस प्रकार हैं:

- वन्यजीव पर्यावास संरक्षण और सुधार
- ईको पार्क की स्थापना
- जैविक बाड़ लगाना
- जंगल की आग की रोकथाम और नियंत्रण
- चराई भूमि/ चारागाहों का विकास
- जागरूकता अभियान आयोजित करना
- मानव वन्यजीव संघर्ष को कम करना
- वन विभाग की ढांचागत सुविधाओं का सुद्दढ़ीकरण
- जैव विविधता प्रबंधन समिति (बी.एम.सी.)

जैव विविधता संरक्षण और वन्यजीव संरक्षण योजना की अनुमानित लागत **रुपये 173.36 लाख** है।

10.4 मत्स्य विकास योजना

परियोजना क्षेत्र के अंतर्गत चेनाब नदी में जलाशय मात्स्यिकी की संभावना का पता लगाने के लिए यह इस योजना के अंतर्गत राज्य मत्स्य विभाग एवं शीतजल मात्स्यिकी अनुसंधान निदेशालय, भीमताल के सहयोग से मत्स्य विकास हेतु विस्तृत अध्ययन किया जाना प्रस्तावित है। प्रस्तावित शोध एवं अध्यन हेतु कुल **रुपए 40.0 लाख** का प्रावधान रखा गया हैं।

10.5 मलवा निस्तरण प्रबंधन योजना

परियोजना के अंतर्गत डैम तथा अन्य संरचनाओं के निर्माण हेतु उत्खनन से भारी मात्रा में मिटटी व पत्थर उत्पन्न होंगे जिन्हें मक कहा गया है। उत्खनन से उतप्पन होने वाले इस मक (मिटटी व पत्थर) के निष्पादन हेतु 8.58 हेक्टेयर भूमि को चिन्हित किया गया है, इस भूमि में अनुमानित कुल 7.17 लाख m^3 मक का निस्तारण किया जायेगा। इस योजना के अंतर्गत इस तरह के मलवे सुरक्षित निस्तारण में संदर्भ में बताया गया है। प्रस्तावित योजना के क्रियान्वयन हेतु कुल **रुपए 670.80 लाख** का प्रावधान रखा गया हैं।

10.6 भू-निर्माण एवं और निर्माण स्थलों की बहाली

भूनिर्माण और निर्माण स्थलों की बहाली योजना के अंतर्गत परियोजना के लिए इस्तेमाल में लाये जाने वाले भूभाग जो कार्य पूर्ण होने के पश्चयात उपयोग में नहीं रहेंगे, जैसे की खदान क्षेत्र, अस्थाई कॉलोनी क्षेत्र, क्रेशर प्लांट के लिए उपयोग में लाई गई भूमि, आदि के रख्र रखाव से सबंधित है। इस प्रकार के भूभाग को जैविक और इंजीनियरिंग उपायों द्वारा व्यवस्थित किया जायेगा। भूनिर्माण और बहाली कार्यों के लिए अनुमानित लागत **रुपए 404.80 लाख** है।

10.7 जलाशय रिम उपचार योजना

प्रस्तावित योजना चेनाब नदी पर प्रस्तावित है और जलाशय के कुल क्षेत्रफल 160.5 हेक्टेयर है। चूँकि परियोजना का जलाशय क्षेत्र को दोनों किनारों पर स्थिर चट्टान अवस्थित हैं तथा प्रस्तावित जलाशय क्षेत्र में किसी प्रकार भुस्खलन क्षेत्र नहीं हैं, अतः प्रस्तावित प्रबंधन योजना में जलाशय रिम उपचार का प्रावधान नहीं रखा गया है। वर्तमान में प्रस्तावित जलाशय क्षेत्र में कोई बड़ा सक्रिय भूस्खलन या अस्थिरता नहीं है। निर्माण / संचालन चरण के दौरान भविष्य में किसी भी ढलान अस्थिरता / स्लाइड की स्थिती में उपचार हेतू एकमुश्त **रुपए 40.00 लाख** का प्रावधान रखा गया है।

10.8 हरित पट्टी विकास योजना

हरित पट्टी विकास योजना में सड़कों के किनारे, बिजलीघर क्षेत्र, और विभिन्न परियोजना कार्यालयों और कॉलोनियों की परिधि जैसे विभिन्न स्थानों पर वृक्षारोपण द्वारा हरित पट्टी का विकास प्रस्तावित है। हरित पट्टी का उद्देश्य वन्य जन्तुओं मुख्यतः पक्षियों के लिए निवास स्थान प्रदान करने और क्षेत्र के सौंदर्यीकरण है। कॉलोनी और कार्य स्थलों के आसपास हरित पट्टी विकास योजना की अनुमानित लागत **रुपए 397.80 लाख** है।

10.9 ठोस अपशिष्ट प्रबंधन योजना

इस योजना में निर्माण चरण में प्रोजेक्ट कॉम्प्लेक्स/ प्रोजेक्ट कॉलोनी/ श्रम कॉलोनी में उत्पन्न कोई भी ठोस अपशिष्ट के संग्रह एवं निस्तारण सम्बन्धित प्रस्ताव वित्तीय प्रावधानों के साथ बताया गया है। ठोस अपशिष्ट प्रबंधन योजना के क्रियान्वयन हेतु कुल **रुपए 316.40 लाख** का वित्तीय प्रावधान रखा गया हैं।

10.10 सार्वजनिक स्वास्थ्य वितरण प्रणाली

सार्वजनिक स्वास्थ्य वितरण प्रणाली अंतर्गत परियोजना के निर्माण चरण में स्वास्थ्य सुविधाओं के प्रबन्धन तथा परियोजना क्षेत्र में सार्वजनिक सवास्थ सेवाओं हेतु योजना प्रस्तावित है। जिसके अंतर्गत कार्य क्षेत्र के साथ साथ परियोजना क्षेत्र में स्वास्थ्य सम्बन्धी सार्वजनिक स्वास्थ्य सेवाओं के विकास के लिए वित्तीय प्रावधान रखा गया है। इस प्रबंधन योजना के क्रियान्वयन की अनुमानित लागत कुल **रुपए 335.00 लाख** है।

10.11 ऊर्जा संरक्षण उपाय

इस योजना के अंतर्गत परियोजना के निर्माण के दौरान परियोजना से सम्बंधित प्रवासी आबादी के

लिए रसोई ईंधन की आपूर्ति सुनिश्चित करने हेतु प्रावधान रखे गए हैं। जिससे क्षेत्र की प्राक्रतिक संसाधनों के संरक्षण एवं अत्यधिक दोहन को कम करने में सहयोग होगा। इस प्रबंधन योजना के लिए कुल **रुपए 300.00 लाख** का प्रावधान रखा गया है।

10.12 श्रमिक रक्षा एवं पर्यावरणीय प्रबन्धन

निर्माण कार्य का श्रमिकों के स्वास्थ्य पर कई प्रकार के जोखिम और प्रभाव होते हैं। गर्मी, अतियाधिक ध्वनी और धूल से लंबे समय के सीधे संपर्क में आने पर स्वास्थ्य पर असर पड़ सकता है। दूसरी ओर अप्रशिक्षित श्रमिकों पर गंभीर दुर्घटनाएँ का खतरा हो सकता है। साथ ही साथ निर्माण चरण के दोरान प्राकृतिक दुर्घटनाएँ जैसे भूस्खलन, भूकंप भी परियोजना स्थल पर श्रमिकों के जीवन के लिए खतरा पैदा करते हैं। इसलिए श्रमिकों के लिए पूर्ण स्वास्थ्य और सुरक्षा हेतु प्रबंधन योज्ना तैयार करने तथा इसके क्रियान्व्यन्न को सुनिश्चित करना आवश्यक है। इस योजना में सुरक्षा सम्बन्धी प्रशिक्षण एवं सुरक्षा उपकरणों का प्रावधान भी रखा गया है। इस प्रबंधन योजना के लिए कुल **रुपए 140.00 लाख** का प्रावधान रखा गया है।

10.13 आपदा प्रबन्धन योजना

इस योजना के अंतर्गत आपदा जैसे की बांध की संभावित विफलता की स्थिति की परिकल्पना करते हुए, विफलता के प्रभावों का आंकलन डैम ब्रेक मॉडलिंग द्वारा किया गया और एक मानचित्र तैयार किया गया जिसमे संभावित आपदा क्षेत्र को चिन्हित किया गया है। इस मॉडलिंग से उत्पन्न आउटपुट के आधार पर एक आपदा प्रबंधन योजना तैयार की गई है। इस योजना के अंतर्गत बांध की संभावित विफलता के समय में चेतावनी और अधिसूचना प्रक्रियाओं प्रस्तावित हैं। इसका उद्देश्य आकस्मिक आपदा की स्थिति समय पर चेतावनी देना है और आपातकालीन स्थिति में महत्वपूर्ण कार्रवाई करने वाले प्रमुख लोगों को सतर्क करना है। जिससे किसी भी प्रकार के नुक्सान से बचा जा सके।

आपदा प्रबंधन योजना के क्रियान्वयन की अनुमानित कुल लागत **रुपए 155.00 लाख** है।

11 पर्यावरणीय प्रबन्धन के वितीय प्रावधान

पर्यावरणीय प्रबन्धन के लिए वितीय प्रावधान विवरण **तालिका 2** में दिया गया है।

तालिका 2: वित्तीय प्रावधान

Sl. No	Component of EMP	Capital Cost (Rs. In lakh	Recurring Cost (Rs. In lakh)										Total Cost (Rs. In lakh)
			Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	
1	जलग्रहण क्षेत्र उपचार योजना	5090.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5090.00
2	क्षतिपूरक वनीकरण योजना	2686.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2686.95
3	जैव विविधता संरक्षण और वन्यजीव प्रबंधन योजना	173.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	173.36
4	मत्स्य विकास योजना	40.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.00
5	मलवा निस्तरण प्रबंधन योजना	0.00	50.00	80.50	80.50	80.50	80.50	80.00	70.00	50.30	50.50	48.00	670.80
6	भूनिर्माण और निर्माण स्थलों की बहाली योजना	0.00	1.63	0.00	0.00	0.00	10.00	10.00	333.17	20.00	20.00	10.00	404.80
7	जलाशय रिम उपचार योजना	40.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.00
8	हरित पट्टी विकास योजना	0.00	0.00	40.00	50.00	55.00	70.85	60.85	45.60	30.50	25.00	20.00	397.80
9	ठोस अपशिष्ट प्रबंधन योजना	110.00	20.64	20.64	20.64	20.64	20.64	20.64	20.64	20.64	20.64	20.64	316.40
10	सार्वजनिक स्वास्थ्य वितरण प्रणाली	75.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	335.00
11	ऊर्जा संरक्षण उपाय	60.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	300.00
12	श्रमिक रक्षा एवं पर्यावरणीय प्रबन्धन	50.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	140.00
13	आपदा प्रबन्धन योजना	135.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	155.00
14	वायु, जल और ध्वनी प्रदूषण के नियंत्रण योजना	0.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	50.00
15	पर्यावरणीय निगरानी योजना	0.50	11.10	11.10	11.10	11.10	11.10	11.10	11.10	11.10	11.10	11.10	111.50
16	पुनर्वास और पुनर्वास योजना*	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
17	स्थानीय क्षेत्र का विकास योजना LADF @ 1.5% of Rs.3393.21 crore (project cost)	5100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5100.00
Total		**13660.81**	**149.37**	**218.24**	**228.24**	**233.24**	**259.09**	**248.59**	**546.51**	**198.54**	**193.24**	**175.74**	**16111.61**

* निजी भूमि की कीमत के सम्बन्ध में भूमि मालिकों से बात कर अंतिम निर्णय जिला प्रशासन द्वारा लिया जाएगा

ENVIRONMENTAL IMPACT ASSESSMENT DUGAR HYDRO ELECTRIC PROJECT (500 MW)

DRAFT REPORT

OCTOBER, 2021

Prepared for:

NHPC Ltd.

Prepared by:

R. S. Envirolink Technologies Pvt. Ltd.

402, BESTECH CHAMBERS COMMERCIAL PLAZA,

B-BLOCK, SUSHANT LOK-I, GURGAON

Ph: +91-124-4295383: www.rstechnologies.co.in

QCI Certificate No.:	**NABET/EIA/1922/RA 0152**
Laboratory:	**AGSS Analytical and Research Lab (P) Ltd.** **An ISO-9001: 2015 Accredited Laboratory**(NABL Accredited Testing Laboratory)
Baseline Data: Monitoring Period	**Winter (March 2021)** **Summer/ Pre-Monsoon (May-June 2021)** **Monsoon (August-September 2021)**

Quality Council of India

National Accreditation Board for Education & Training

CERTIFICATE OF ACCREDITATION

R S Envirolink Technologies Pvt. Ltd., Gurugram

403, Bestech Chamber Commercial Plaza, B Block, Sushant Lok 1, Gurugram – 122009

Accredited as Category - A organization under the QCI-NABET Scheme for Accreditation of EIA Consultant Organizations: Version 3 for preparing EIA-EMP reports in the following Sectors:

Sl. No.	Sector Description	Sector (as per) NABET	Sector (as per) MoEFCC	Cat.
1	Mining of minerals- opencast only	1	1 (a) (i)	A
2	River Valley projects	3	1 (c)	A
3	Oil & gas transportation pipeline (crude and refinery/ petrochemical products), passing through national parks/ sanctuaries/coral reefs /ecologically sensitive Areas including LNG terminal	27	6 (a)	A
4	Jetties only	33	7 (e)	A
5	Highways	34	7 (f)	A

Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in RAAC and Supplementary minutes dated Nov 15, 2019 and Jan 31, 2020 dated posted on QCI-NABET website.

The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in QCI-NABET's letter of accreditation bearing no. QCI/NABET/ENV/ACO/20/1237 dated Feb 18, 2020. The accreditation needs to be renewed before the expiry date by R S Envirolink Technologies Pvt. Ltd., Gurugram following due process of assessment.

Sr. Director, NABET
Dated: Feb 18, 2020

Certificate No.
NABET/EIA/1922/RA 0152

Valid till
August 14, 2022

For the updated List of Accredited EIA Consultant Organizations with approved Sectors please refer to QCI-NABET website.

Declaration by Experts contributing to the Draft EIA Report of Dugar Hydro Electric Project.

I, hereby, certify that I was a part of the EIA team in the following capacity that developed the above EIA.

EIA Coordinator: Ravinder P S Bhatia

Name: Ravinder P S Bhatia

Signature & Date: Date-29/10/2021

Period of Involvement: January 2021 – October 2021

Contact Information: 0124-4295383

Functional Area Experts:

S.No.	Functional Areas	Name of the expert/s	Involvement (Period & Task)	Signature
1	AP	Vimal Garg	• Baseline Data Review and Analysis • Impact Assessment • Preparation of Air Management Plan	
2	WP	Ravinder P S Bhatia	• Baseline Data Review and Analysis – Water Quality • Impact Assessment and Management Plan	
3	SHW	Ravinder P S Bhatia	• Impact Assessment • Preparation of Waste Management Plan • Public Health Delivery System • Muck generation analysis and Dumping Plan	
4	SE	Mrinal Kumar	• Social Data Collection and Interpretation • Social Impact Assessment • Preparation of R&R Plan	
		Zahoor A Wani		
5	EB	Arun Bhaskar	• Impact Assessment • Preparation of Biodiversity Management Plan • Compensatory Afforestation Plan	
		Vivek Jhaldiyal	• Baseline Data Collection, Analysis and Interpretation	
6	SC	Arun Bhaskar	• Baseline Data Review and Analysis • Impact Assessment	

		Vivek Jhaldiyal	• Sampling and Interpretation	
7	AQ	Ravinder P S Bhatia	• Impact Assessment of Air Environment	
8	NV	Ravinder P S Bhatia	• Baseline Data Review and Analysis – Sound levels, Impact Assessment and Mitigation Plan	
9	HG	Vimal Garg	• Impact Assessment	
10	LU	Vimal Garg	• Impact Assessment • Data Review and Analysis	
		Dimple Razdan	• Field Investigation and Data Collection • Sampling and Interpretation • Preparation of Thematic maps	
11	RH	Harsh Pandya	• Risk Assessment	
12	GEO	Trilochan Singh Kaith	• Geological & Geotechnical Investigations	
Team Member				
1	AP AQ	Parshant Tomar	• Baseline data collection, Analysis and Interpretation	

Declaration by the Head of the Accredited Consultant Organization/ authorized person

I, Ravinder P S Bhatia, hereby, confirm that the above-mentioned experts prepared the Draft EIA Report of Dugar Hydro Electric Project. I also confirm that the consultant organization shall be fully accountable for any mis-leading information in this statement.

Signature:

Name: Ravinder P S Bhatia

Designation: Director

Name of the EIA Consult Organization: RS Envirolink Technologies Pvt. Ltd.

NABET Certificate No. & Issue Date: NABET/EIA/1922/RA0152, 18th February 2020

S.No.	Functional Areas	Complete name of the Functional Areas
1	AP	Air Pollution Prevention, Monitoring & Control
2	WP	Water Pollution Prevention, Control & Prediction of Impacts
3	SHW	Solid Waste and Hazardous Waste Management
4	SE	Socio-Economics
5	EB	Ecology and Biodiversity
6	SC	Soil Conservation
7	AQ	Meteorology, Air Quality Modeling & Prediction
8	NV	Noise/ Vibration
9	HG	Hydrology, Ground Water & Water Conservation
10	LU	Land Use
11	RH	Risk Assessment & Hazard Management

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Chapter 1 INTRODUCTION

1.1 PURPOSE OF THE REPORT

The Environmental Impact Assessment (EIA) process is an interdisciplinary and multistep approach to ensure that environmental risks and impacts are included in decision making regarding project's feasibility. It helps to identify the possible environmental impacts of a proposed activity leading to the development of a strategy or management plan to mitigate impacts to the extent possible. The purpose of the EIA document is to inform the decision-makers and the public of the environmental consequences of implementing a proposed project and therefore an EIA document is considered as a technical tool that identifies, predicts, and analyses impacts on the physical, biological environment, as well as social, cultural, and health impacts.

The purpose of the Environment Impact Assessment (EIA) report prepared for Dugar HEP (500 MW) is to ensure that decision-makers consider the environmental impacts during project design. Therefore, the EIA document of Dugar HEP was prepared to present the baseline status of various environmental parameters in project surrounding, to assess the impacts of the project on the surrounding area and to suggest mitigation and management measures to minimize such impacts. EIA study for such projects is mandatory as per EIA Notification of September 2006, which describes the environment clearance procedure.

1.2 IDENTIFICATION OF PROJECT AND PROJECT PROPONENT

Dugar HEP is proposed to be developed on Chenab River to harness the hydropower potential of Chenab as a part of cascade development plan of Himachal Pradesh Government for Chenab basin in Himachal Pradesh. This project was previously allotted to M/s Dugar Hydro Power Ltd. (A Joint Venture of Tata Power & Statkraft) which prepared the DPR of the project and submitted it to CEA for Techno-Economic Clearance (TEC). However, the project allotment to M/s DHPL was cancelled by the Government of Himachal Pradesh on 23.09.2017 and the same was allotted to NHPC Ltd. Government of Himachal Pradesh (GoHP) has signed Memorandum of Understanding (MoU) with NHPC Limited on 25th September 2019 for the implementation of Dugar HEP on Build Own Operate & Transfer Basis (BOOT) for a period of 70 years including DPR and pre construction periods.

The present project proponent is NHPC Ltd., (formerly known as National Hydroelectric Power Corporation) was incorporated on 7th November 1975 as Central Govt. Enterprise for development of Hydro Power in Central Sector. NHPC is a Schedule 'A' Enterprises of Govt. of India with Miniratna status since 2008 under the Ministry of Power, Govt. of India.

RS Envirolink Technologies Pvt. Ltd. has been entrusted with the preparation of the EIA and EMP report of Dugar HEP to meet the requirement of environmental clearance process. RS Envirolink Technologies Pvt. Ltd., Gurgaon is category 'A' NABET accredited consultant for 'River Valley Projects'. NABET certificate is enclosed at the beginning of the report.

1.3 BRIEF DESCRIPTION OF NATURE, SIZE, LOCATION OF THE PROJECT AND ITS IMPORTANCE TO THE COUNTRY, REGION

1.3.1 Brief Description of Nature of the Project

The Dugar HEP is envisaged as a run-of-river scheme with a 500 MW installed capacity located near Luj village for utilizing the flows of Chenab River to harness the head created by constructing a 128 m high dam (from the deepest foundation) with a top length of 210.65 m; and Full Reservoir Level (FRL) and Minimum Draw Down Level (MDDL) levels at 2114.0 m and 2102.35 m. respectively. An underground powerhouse consisting of the main plant of 412MW (4 units of 103 MW) and auxiliary plant of 88 MW (2 units of 44 MW).

1.3.2 Sector Classification

As the proposed project envisages hydroelectric power generation, therefore, it gets covered in the Schedule of EIA Notification, 2006 at item 1(c), Category 'A' i.e. >50 MW installed capacity.

1.3.3 Size of the Project

As per the Indian Standard Guidelines for Fixing Spillway Capacity (IS: 11223 – 1985, reaffirmed in 1995) which lays down the guidelines for fixing spillway capacity consistent with the safety of the dam, the proposed dam comes under the category of 'Large Dams' as its height is more than 30 m. The reservoir has a gross capacity of 61.58 MCM at FRL.

According to ICOLD a dam with a height of 15 m or greater from lowest foundation to crest or a dam between 5 m and 15 m impounding more than 3 MCM is considered a 'Large Dam'.

1.3.4 Location

The project is located on river Chenab, near Luj village in district Chamba, Himachal Pradesh which is about 10 km from the nearest town, Killar. The nearest railheads are the railway stations Udhampur and Pathankot. Udhampur Railway Station is in Udhampur city in the Union Territory of Jammu & Kashmir, while Pathankot Railway Station is in Pathankot city in the state of Punjab. The distance from Udhampur to the project site is about 270 km. The nearest airports are Bhuntar and Jammu. The distance from Bhuntar to the project site is about 279 km and from Jammu to the project site is about 332 km.

1.3.5 Importance to the Country, Region

The implementation of the proposed Dugar HEP (500 MW), will contribute to meeting the power and energy demand in the Northern Region which comes under the purview of the Northern Eastern Western and North- Eastern (NEWNE) grid and will displace electricity that would otherwise have to be produced through the construction of fossil fuel-based thermal power plants. Dugar HEP will help in harnessing the potential of river Chenab by generating electricity and bring benefits of renewable energy to state and country. The proposed project has therefore been considered in the context of power shortage in the Northern region in general and in the country as a whole.

1.3.6 Cascade Development On River Chenab

The Chenab river basin is part of Indus River System. The Chenab originates from the south-eastern side of the Bara-Lacha La at 6194m. The water flowing south from the pass are known as the Chandra River and those that flow north-northwest are called the Bhaga River. The Chandra and Bhaga meet to form the Chenab River at Tandi. After this it is known by the name of Chandrabhaga river as well as Chenab river. It leaves Himachal Pradesh near the confluence of Sansari Nala and enters Jammu & Kashmir after crossing Pangi valley. Total catchment area of Chenab river in Himachal Pradesh is 7878 sq km and its length is about 260 km.

Downstream of the confluence of Chandra and Baga river at Tandi, there are 8 proposed projects on Chenab river in Himachal Pradesh viz. Tandi, Rashil, Bardang, Seli, Reoli Dugli, Purthi, Sach Khas and Dugar. Dugar is the last project proposed on Chenab river within Himachal Pradesh boundary; thereafter Chenab enters Jammu and Kashmir. Longitudinal profile of Chenab river showing proposed projects upstream and downstream of Dugar HEP is given in **Figure 1.1**. The upstream project (Sach Khas HEP) has tail water level as 2149 m asl and Barinium HEP is on downstream of Dugar HEP having full reservoir level as 1992 m asl.

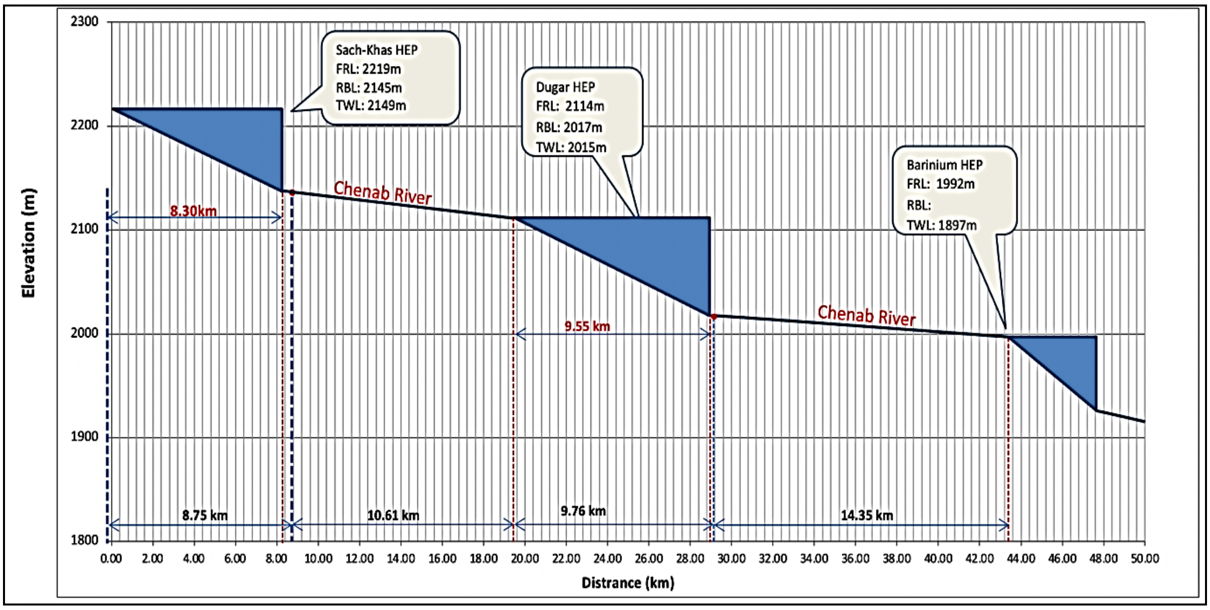


Figure 1.1: L-section of Chenab River showing Proposed Dugar HEP along with U/s and D/s proposed projects

1.4 SCOPE OF THE STUDY

The project was discussed by the Expert Appraisal Committee (EAC) in its 33rd meeting held on 24/06/2020 where scoping clearance was recommended. Scoping clearance letter was issued by MoEF&CC vide letter no. J-12011/08/20120-IA-I dated 5th August 2020 for 449 MW installed capacity (refer to **Annexure Ia**). Subsequently, due to enhancement of installed capacity after updating Water availability series from 1974 – 2012 to 1981 - 2020, scoping clearance was revised for Installed capacity of 500 MW for which letter was issued by MoEF&CC vide letter no. J-12011/08/2020-IA-I dated February 08, 2021 (refer to **Annexure Ib**).

EAC recommended the scoping clearance with the following additional conditions:

1. Land acquired for the project shall be suitably compensated as per the law of the land with the prevailing guidelines. Private land shall be acquired as per provisions of the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation, and Resettlement Act, 2013.

2. The project involves the diversion of about 211.842 ha of forest land. Forest clearance shall be obtained as per prevailing norms of the Forest (Conservation) Act, 1980.

3. Application to obtain prior approval of Central Government under the Forest (Conservation) Act, 1980 for diversion of forest land required, if not submitted, should be submitted as soon as the actual extent of forest land required for the project is known, and in any case, within six months of issuance of this letter.

4. Fund allocation for Corporate Environment Responsibility (CER) shall be made as per O.M. No. 22-65/2017-IA.III dated 01.05.2018 for various activities therein.

5. The details of fund allocation and activities for CER shall be incorporated in EIA/EMP report.

6. Consolidated EIA/EMP report is to be submitted as per the generic structure (Appendix III & IIIA) given in the EIA Notification, 2006

7. The EIA report should clearly mentioned activity wise EMP and CER cost details and should earmarked clear break-up of the capital and recurring cost along with the time line for incurring the capital cost.

8. Conservation Plan for Schedule-I species shall be prepared and submitted to the competent authority for approval.

9. Pre-DPR Chapter viz., Hydrology and Power Potential Studies approved by CWC/ CEA be submitted.

10. Dam Break Analysis, Disaster Management Plan, and Fisheries Management Plan be prepared and submitted in the EIA/EMP report.

11. Environmental Matrix during construction and operational phase needs to be submitted.

12. Both Capital and Recurring expenditure under EMP shall be submitted.

13. Impact of development activity/ project on the wildlife habitat within 10 km of the project boundary shall be studied.

14. NOC from the earlier project proponent i.e., Dugar Hydro Electric Project Ltd. is obtained and submitted during appraisal of EIA/EMP.

15. The consultant engaged for preparation of EIA/ EMP report has to be registered with Quality Council of India (QCI/ NABET) under the scheme of Accreditation & Registration of MoEF&CC. This is a pre-requisite.

16. Consultant shall include a “Certificate” in EIA/EMP report regarding portion of EIA/EMP prepared by them and data provided by the other organisition(s)/ laboratories including status of approval of such laboratories. Declaration by the consultant that information submitted in the EIA/EMP is factually correct and shall be submitted along with EIA EMP report.

17. An undertaking as part of the EIA/EMP report from Project proponent, owing the contents (information and data) of the EIA report with the declaration about the contents of the EIA report pertaining to a project have not been copied from other EIA reports.

18. The draft EIA/EMP report prepared as per the Generic Structure (Appendix III of EIA Notification, 2006) incorporating information as per the Standard ToR, should be submitted to the State Pollution Control Board concerned for conducting Public consultation, district wise, as per the provision stipulated in EIA Notification, 2006. Public Hearing, which is part of Public Consultation, shall be held district wise at the site or in its close proximity as prescribed in Appendix (IV) of EIA Notification, 2006. The Draft EIA/EMP report is to be submitted to SPCB sufficient before the expiry of the ToR validity so that necessary amendments in EIA/EMP can undertaken based on Public Hearing and the same is to be submitted to MoEF&CC before the expiry of validity.

19. All the tasks including conducting public hearing shall be done as per the provisions of EIA Notification, 2006 and as amended from time to time. Public hearing issues raised and compliances of the same shall be incorporated in the EIA/EMP report in the relevant chapter. Clearance only after incorporating these issues, before the expiry of validity of ToR.

20. As per the Minsitry’s Notification 17.02.2020, the ToR will remain valid for period of 5 years from the date date of issue of this letter for submission of EIA/Emp report along with public consultation. The ToR will stand lapsed after completion of 5 years in case final EIA/EMP is not submitted.

21. Baseline Data and Public Consultation shall not be older than 3 years at the time of submission of the proposal, for grant of Environmental Clearance.

22. In case of any change in the scope of the project such as capacity enhancement, changes in submergence, etc., fresh scoping clearance has to be obtained.

23. Details of the name and number of posts to be engaged by the project proponent for implementation and monitoring of environmental parameters be specified in the EIA report.

24. The EIA/EMP Report must contain an Index showing details of compliance of all ToR conditions. The Index will comprise of page No. etc., vide which compliance of a specific

ToR is available. It may be noted that without this index, EIA/EMP report will not accepted.

25. Appropriate Biodiversity Conservation and Management Plan for the Native, Rare and Endangered floral and faunal species getting affected due to the project shall be prepared.

26. The PP should complete aal the tasks as per the provision of EIA Notification 2006 and as amended time to time and submit the application for final clearance within the stipulated time.

27. Also you are advised to prepare the EIA/EMP report following the Terms of Reference granted vide Ministry letter dated 05.08.2020 and shall be submitted to the Ministry within the ToR validity period. "*The EIA study should be undertaken in accordance with recommendations of the Chenab river basin study and the project parameters/ salient features of the project such as Dam height, FRL, Submergence area, total land requirement, e-flow, etc. as discussed/deliberated during the Chenab basin study should remain unchanged*."

28. Further the ministry in suppression of OM dated 1st May 2018 regarding CER has issued an another OM dated 30.09.2020. In this regard, it is advises that issues raised during Public Hearing and activities proposed to address the such issues shall be made part of EMP.

To ensure compliance with the EAC's recommendations, baseline data were collected on physio-chemical and biological parameters covering three seasons. The final EIA study report has been prepared, in compliance with the scoping clearance issued by MoEF&CC. The compliance of TOR with references is given in **Annexure II.**

The project involves diversion of **211.842 ha** of forest land for non-forestry purposes i.e., for the construction of various project components. The entire forest land required for the project falls in Pangi Forest Division. For diversion of 211.842 ha of forest land, an online application has been submitted to MoEF&CC vide proposal No.: FP/HP/HYD/123533/2021 (http://forestsclearance.nic.in/viewreport.aspx?pid=FP/HP/HYD/123533/2021).

Chapter 2 PROJECT DESCRIPTION

2.1 TYPE OF PROJECT

Dugar HEP is a Run-of-the-River (RoR) project with 500 MW installed capacity and therefore is a Category 'A' project, listed in item 1(c) in Schedule of EIA Notification, 2006. Such projects do impact the environment during the construction and operation phase and therefore, an EIA study is undertaken in line with the scope of work issued by MoEF&CC, Government of India.

2.2 NEED FOR THE PROJECT

India has been facing electricity shortages despite appreciable growth in electricity generation. The demand for electrical energy has been growing at a much faster rate and is expected to increase further to match the projected growth of the Indian economy. The per capita electricity consumption which was 18.17 kWh during 1950 has increased to approx. 1181 kWh during the year 2018-19.

Keeping in view the future electricity demand central government and the state governments have planned to increase the energy generation in their annual and 5-year plans. As per the annual plan 2008-09 of the Government of Himachal Pradesh the total identified hydro potential is 20415.62 MW. Out of this 2251.0 MW is in the Chenab basin. All the available hydro potential of Chenab Basin is unexploited so far. In the annual plan 2008-09, 24 projects have been identified for allotment to IPPs, out of 24 projects, 14 projects are in the Chenab basin. Dugar HEP is one of these 14 projects identified by the Government of Himachal Pradesh for allotment to IPP.

The implementation of the proposed Dugar HEP (500 MW), will contribute to meeting the power and energy demand in the Northern Region which comes under the purview of the Northern Eastern Western and North- Eastern (NEWNE) grid and will displace electricity that would otherwise have to be produced through the construction of fossil fuel-based thermal power plants.

2.3 LOCATION

Dugar HEP is located in Chenab River in district Chamba, Himachal Pradesh, and is being developed by NHPC Ltd. The construction of the dam and underground powerhouse for the Dugar HEP (500 MW) is proposed near Luj village in Pangi Tehsil of Chamba district of Himachal Pradesh. The proposed dam site is located at latitude $33^0$07'05"N and longitude $76^0$21'20.7"E (Refer **Figure 2.1**).

The project site is located near Luj village, which is about 10 km from the nearest town, Killar. The nearest railheads are the railway stations Udhampur and Pathankot. Udhampur Railway Station is in Udhampur city in the Union Territory of Jammu & Kashmir, while Pathankot Railway Station is in Pathankot city in the state of Punjab. The distance from Udampur to the project site is about 270 km. The nearest airports are Bhuntar and Jammu. The distance from Bhuntar to the project site is about 279 km and from Jammu to the project site is about 332 km.

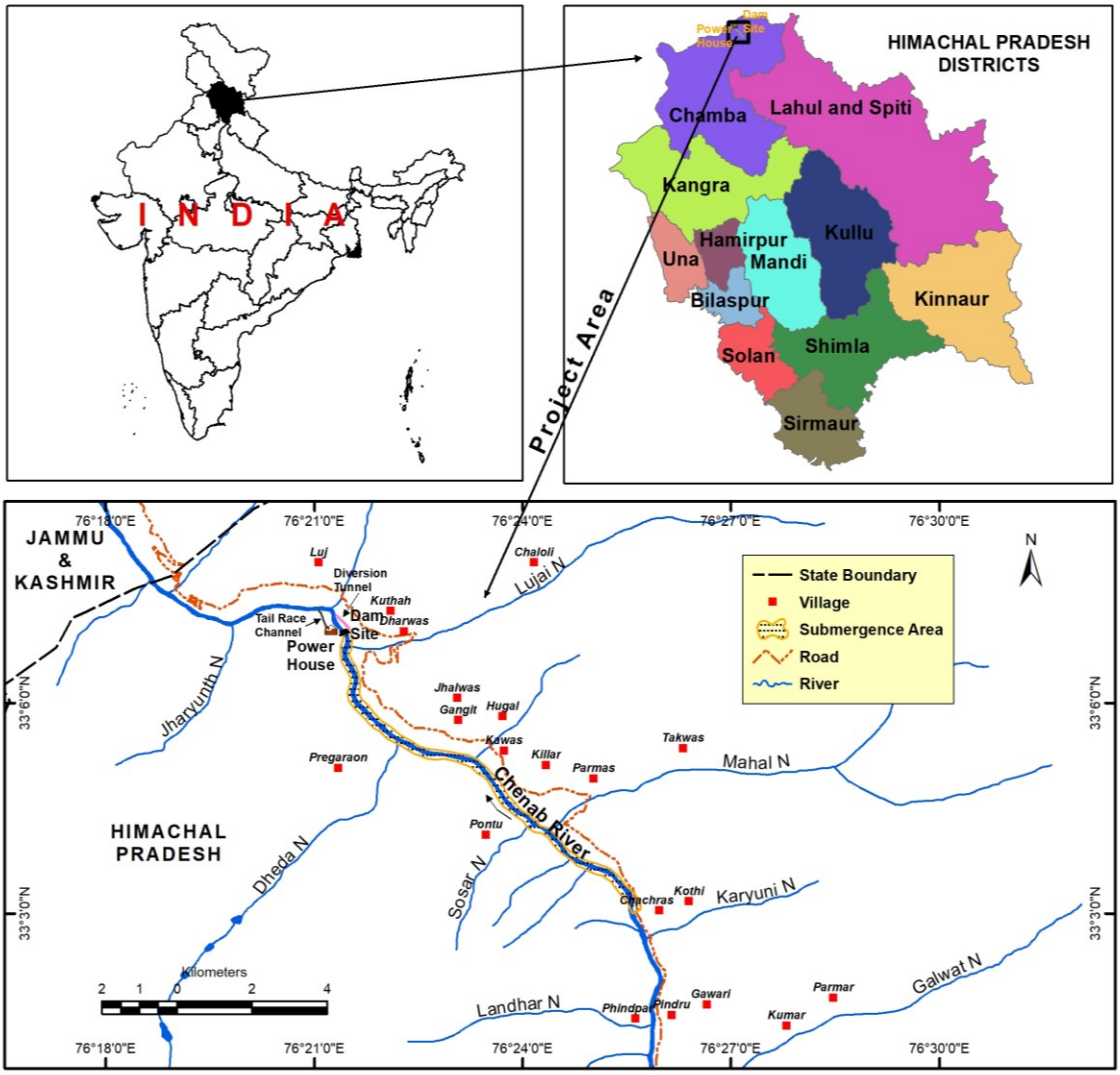


Figure 2.1: Location Map of Dugar HEP

2.4 SIZE OR MAGNITUDE OF OPERATION

Dugar HEP envisages the construction of a 128m high dam from the deepest foundation level. The reservoir storage is 61.58 MCM at Full Reservoir Level EL. 2114m and the live storage capacity is 16.57 MCM. The powerhouse will accommodate four units of 103 MW each for the main plant and two units of 44 MW each for the auxiliary plant (4 x 103 MW + 2 x 44 MW). The salient features of the project are given in **Table 2.1**. The layout map of the Dugar HEP is given in **Figure 2.2.** Major project components and associated requirements are discussed below to give an insight into size or magnitude of operation during project construction and operation.

2.4.1 Diversion Tunnels

River diversion scheme envisaged using cofferdams and diversion tunnels to divert the Chenab River for construction of 128 m high concrete gravity dam and plunge pool. Diversion scheme has been planned to serve their purpose during the period of construction without any damage to the permanent structure under construction and not to cause any interruption in the progress of dam construction works as scheduled. Two 11.5 m diameter, horseshoe-shaped, gated diversion tunnels, located at the right bank, are proposed along with upstream and downstream cofferdams for diverting the Chenab River. The diversion tunnels are provided for a design flood of 2,700 m^3/s, which corresponds to a 25-year occurrence period for monsoon season. A diameter of 14.5 m (Excavated diameter 16.9 m) is found to be the most economic one, which is not desirable from geological and constructability aspects. Hence two diversion tunnels, horseshoe-shaped each of 11.5 m dia. and length 463m and 577m respectively are proposed on the right bank.

2.4.2 Coffer Dam

To facilitate the construction of the concrete dam, two cofferdams located upstream and downstream of the dam axis have been proposed with top-level fixed at El. 2043.7m and El 2029.5m, respectively.

2.4.3 Concrete Gravity Dam

The dam axis is situated near the village Luj that is located at the right bank of the Chenab River. The river bed at the dam axis has an elevation of approximately 2017.00 m.

The main features of the dam include:

- Dam height from deepest foundation level	128.0 m
- Length of dam at the top	210.65 m
- Design Flood (PMF)	9,425 m^3/s
- Maximum Reservoir Level (MRL)	2114.00 m asl
- Full Reservoir Level (FRL)	2114.00 m asl
- Minimum Draw-Down Level (MDDL)	2102.35 m asl
- Energy Dissipation	Flip bucket

2.4.4 Spillway

Considering the nature and amount of solid materials that are likely to be brought by the river and also considering the stipulations of the Indus Water Treaty, the spillway crest is kept at the highest possible level. The proposed gated ogee spillway shall consist of free overflow gated ogee spillway (Upper-Level Spillway, ULS) bay as well as gated sluice spillway bays with breast wall (Lower-Level Spillway, LLS). One bay of 8.2 m (W) and 11.7 m (H) for ULS has been proposed for removal of logs and debris and also the inflow design flood at an elevation of 2102.3m (equal to MDDL) and has a discharging capacity of 512.5 m^3/s at FRL. ULS has been provided on the right bank, away from the intake. Trash boom will be provided with one end near the ULS this will prevent surface debris and logs from being drawn into the dam intake.

2.4.5 Power Intake

The intake structures are located on the left bank of the Chenab River about 15 m upstream of the dam axis and the invert level of power intake structure is fixed at an elevation of 2083 m.

2.4.6 Pressure Shafts/Tunnels (HRT)

Two nos. 7.25m dia underground circular pressure tunnels/shafts are proposed to convey water from intake to powerhouse for power generation. Two upper horizontal pressure tunnels of the initial length of 36 m in cut and cover followed by 65.91 m and 96.32 m length underground up to the bend respectively to carry water from power intake structure to their respective vertical pressure shafts.

Two numbers of vertical pressure shafts of length 118.09 m bifurcated into two lower horizontal pressure tunnels of lengths 53.66 m and 62.98 m respectively through a vertical bend. The upper horizontal portion and the vertical shaft up to the lower bend are proposed to be concrete lined. The lower bend of the vertical shaft and the lower horizontal pressure tunnels are proposed to be steel-lined.

2.4.7 Main Access Tunnel (MAT)

Main access tunnel shall be excavated in two different dimensions- 8.0 m dia and D-shaped for its initial length of 397m which will reduce to 7.0m dia and D-shaped for the final length of 164m before opening into the service bay area of the powerhouse. Portals of the Main Access Tunnel (MAT) shall be located downstream of the TRT outfall in the rocky cliff marking the left bank of the river. Excavation of MAT shall be carried out through a 5.0m dia. construction adit of length 139m located on the left bank.

2.4.8 Powerhouse Complex

An underground powerhouse of dimension 164.5 m (L) x 22.0 m (W) x 46.7 m (H) is proposed on the left bank of Chenab River, just downstream of the dam. Powerhouse will accommodate four units of 103 MW each for main plant and two units of 44 MW each for auxiliary plant. Access to the powerhouse shall be made through a 560 m long Main Access Tunnel (MAT). Transformer cavern of dimension 158.5m (L) x 15.0m (W) x 20.8m (H) is located 40 m upstream of powerhouse cavern. Surge Cavern is located approximately 40 m downstream of the powerhouse cavern. The dimension of the surge cavern is 81.8 m (L) x 10.8 m (W) x 47.85 m (H).

2.4.9 Tail Race Tunnels

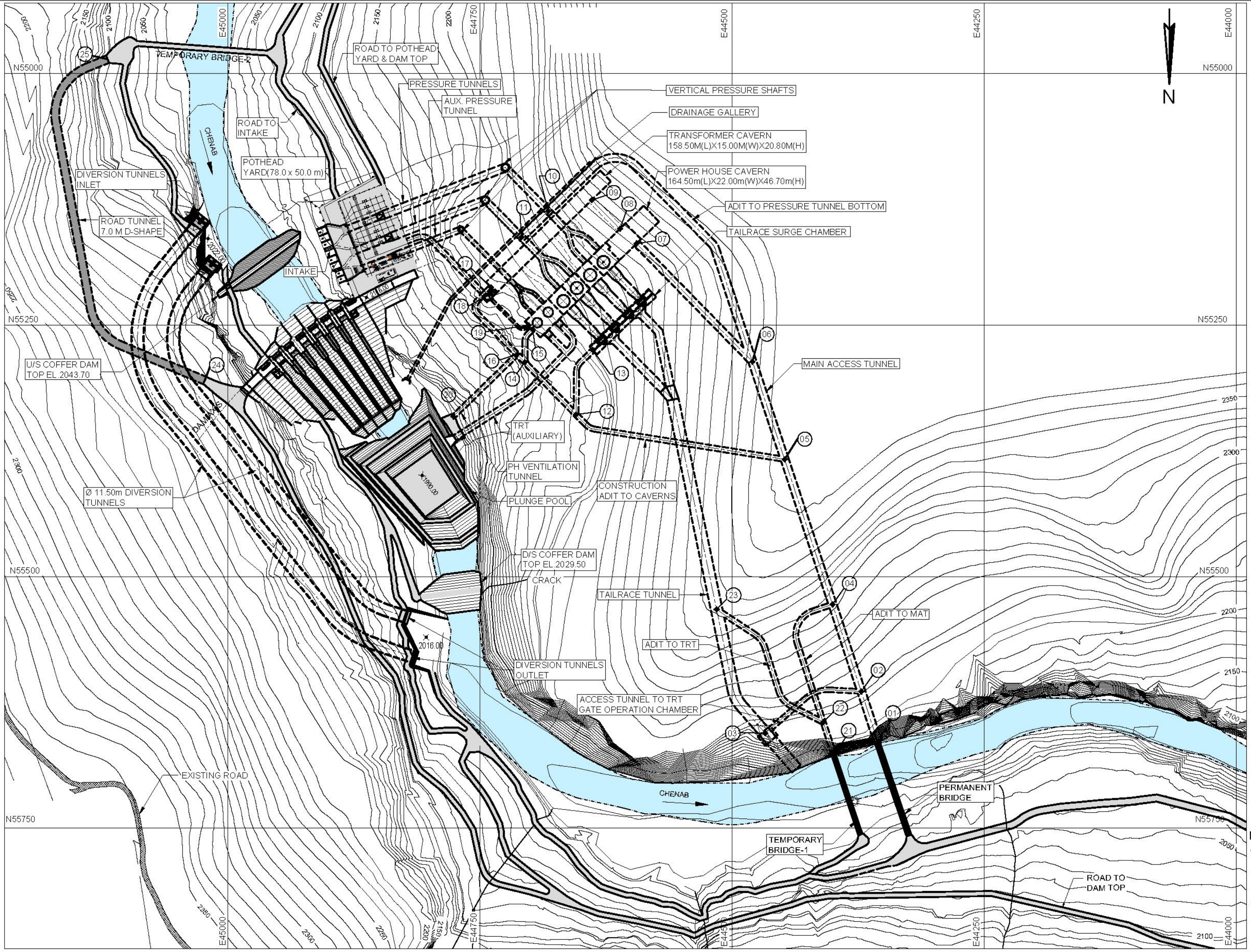
Two nos. 8.5m dia tailrace tunnels combined into a single TRT having a finished diameter of 12.1 m and length of 400 m located on the left bank of Chenab River, about 780 m downstream of the dam axis. The outfall structure shall be housed within more than a 200m high cliff.

2.4.10 Auxiliary Powerhouse Arrangement

To tap the environmental flow during lean season and non-lean non-monsoon season, two units of 44 MW each are also housed in the powerhouse main cavern. The invert elevation for the power intake of the auxiliary plant has been kept at El. 2089m.

2.4.11 Pothead Yard

Due to optimization of intake structure (i.e. shifting further towards the river), space has been created just above the Power intake top where an outdoor Pothead yard of size 70m x 50m has been proposed just upstream of the dam area.



POINTS	ELEVATION
1	2036.00
2	2036.00
3	2036.00
4	2030.00
5	2020.00
6	2014.50
7	2014.50
8	2014.50
9	2014.50
10	1999.15
11	1999.15
12	2036.67
13	2035.00
14	2033.00
15	2031.30
16	2033.00
17	2030.00
18	2014.50
19	2014.50
20	2046.00
21	2022.00
22	2021.00
23	2006.00
24	2116.00
25	2080.00

NOTE:
1. ALL DIMENSIONS AND LEVELS ARE IN METERS .

0 50 100m

SCHEDULE OF ADITS

S.NO	DESCRIPTION	ALIGNMENT	LENGTH IN (m)	SIZE (m) & SHAPE
1	MAIN ACCESS TUNNEL	01,02,04,05,TO 06	397.00	8.0 D-SHAPE
		06 TO 07	164.00	7.0 D-SHAPE
2	ACCESS TUNNEL TO TRANSFORMER CAVERN	08 TO 09	40.00	7.0 D-SHAPE
3	ACCESS TUNNEL TO SURGE CAVERN	05 TO 13	285.00	5.0 D-SHAPE
4	ADIT TO PH CAVERN CROWN	12,14 TO 15	108.00	5.0 D-SHAPE
5	ADIT TO TRANSFORMER CAVERN CROWN	14, 16 TO 17	100.00	5.0 D-SHAPE
6	PH VENTILATION TUNNEL	16 TO 20	114.00	4.5 D-SHAPE
7	FIRE ESCAPE	18 TO 19	59.00	2.5X3.0 D-SHAPE
8	ADIT TO PRESSURE TUNNEL BOTTOM	06,10 TO 11	378.00	8.0 D-SHAPE
9	ADIT TO TRT	21,22 TO 23	198.00	5.0 D-SHAPE

SCHEDULE OF ADITS

S.NO	DESCRIPTION	ALIGNMENT	LENGTH IN (m)	SIZE (m) & SHAPE
10	ACCESS TO TRT GATE OPERATION CHAMBER	02 TO 03	98.00	4.5 D-SHAPE
11	ADIT TO MAT	22 TO 04	139.00	5.0 D-SHAPE
12	ACCESS TUNNEL FROM DAM TOP TO TEMPORARY BRIDGE-2	24 TO 25	417.50	7.0 D-SHAPE

FOR DPR PURPOSE ONLY

DATE	NO.	REVISION OR ISSUES	BY.	APP

DESIGN MEMO NO.- डिज़ाइन मेमो संख्या

एन एच पी सी लिमिटेड
NHPC Limited
(A Govt. of India Enterprise)

डुगर जलविद्युत परियोजना (हि.प्र.)
DUGAR HYDROELECTRIC PROJECT (H.P.)

PROJECT AREA
GENERAL LAYOUT PLAN

DRAWN आरेखित	SUBMITTED प्रस्तुत	RECOMMENDED अनुशंसित		APPROVED अनुमोदन

DATE दिनांक AUG - 2020 | DRG. NO. आरेख संख्या NHDGR | D | 41 | GA | 003 | 00

IMS/DED/F-02 REV. NO: 03 EFF. DATE : 21/07/2016

Figure 2.2: Layout map of Dugar HEP *(Source: DPR Dugar HEP)*

Table 2.1: Salient features of Dugar HEP

Project Location	
State	Himachal Pradesh
District	Chamba
River	Chenab river
Vicinity	Luj Village
Coordinates	$33^0$07’05” N, $76^0$21’20.7” E
Nearest Railhead	Udhampur, J&K (270 km)
Hydrology	
Catchment area	7823 km^2
Snow fed Catchment Area	4458 km^2
Average Discharge in 90% dependable year	267.1 m^3/s
Average Annual rainfall	859.5 m
Flood discharge for river diversion	2700 m3/s
Probable Maximum Flood	9425 m^3/s
Reservoir	
Full Reservoir Level (FRL)	2114.0 m asl
Maximum Water Level (corresponding to PMF)	2114.0 m asl
Maximum Draw Down Level (MDDL)	2102.35 m asl
Gross Storage at FRL	61.58 M m^3
Gross Storage at MDDL	45.01 M m^3
Live Storage	16.57 M m^3
Dam	
Type	Concrete Gravity
Design Flood (PMF)	9425 m^3/s
Top of the dam	2116.0 m asl
Full reservoir level (FRL)	2114.0 m asl
Average Riverbed Level at Dam Axis	2017.0 m
Deepest foundation elevation	1988.0 m asl
Height of Dam (Above deepest Foundation Level)	128.0 m
Length of Dam at the top	210.65 m
Total number of blocks	13
Number of overflow blocks	6
Number of non-overflow blocks	7
Spillways	
Upper-level Spillway	
Number of Upper-level Spillway	1
Size (WXH), m	8.2 X 11.7
Gate type and No. of Gates	Radial, 1
Width of block	15.20 m
Crest Elevation	2102.30 m asl
Lower-level Spillway	
Number of Lower-level Spillway	5
Size (WXH), m	8.2 X 10.65
Gate type and No. of Gates	Radial, 5
Total width of LLS blocks	76.0 m
Crest Elevation	2052.50 m asl
River Diversion	
River diversion flood	2700 m^3/s
Diversion scheme	Diversion tunnels and cofferdams

Location	Right bank
No. of diversion tunnels	2
Diameter of each diversion tunnel	11.5 m, Horse-shoe shape
Length of diversion tunnel	463.0 (DT1), 577.0 (DT2)
Top of the upstream cofferdam	2043.70 m
Height of upstream cofferdam	~23.7 m
Top of the downstream cofferdam	2029.50 m
Height of downstream cofferdam	~ 13.5 m
Power Intake	
Main Power Plant	
Location	Left bank
No. and Size	02 Nos., 23.05m (W) x 34.35m (H)
Design discharge for each intake	252 m^3/s
Type and Size of intake gate	Fixed wheel, 6.40 m (W) x 8.10 m (H)
Auxiliary Power Plant	
Location	Left bank
No. and Size	01 No., 13.5m (W) x 28.7m (H)
Design discharge	113.66 m^3/s
Centreline elevation	2091.95 m
Type and size of intake gate	Fixed wheel, 4.65 m (W) x 5.90 m (H)
Pressure Tunnel/Shaft	
Main Plant	
No. of pressure tunnel/shaft	2
Design discharge for each pressure tunnel/shaft	252 m^3/s
Diameter of steel-lined pressure tunnel/shaft	7.25 m
Length	314.3 m and 274.6 m
Internal diameter of steel-lined pressure tunnel after bifurcation	4.85 m
Length of each steel-lined pressure tunnel after bifurcation	37.2 m
Auxiliary Plant	
No. of pressure tunnel/shaft	1
Design discharge for each pressure tunnel/shaft	113.66 m^3/s
Internal diameter of steel-lined pressure tunnel/shaft	5.1 m
Length	251.7 m
Internal diameter of steel-lined pressure tunnel after bifurcation	3.7
Length of each steel-lined pressure tunnel after bifurcation	29.9m
Powerhouse	
Powerhouse for main units	
Type	Underground
Size (L x W x H) including auxiliary units	164.5m x 22m x 46.7m
Gross head (Average)	94.8 m
Nos. & type of Turbine	4 Nos., Francis
Turbine c/l elevation	2002.5
Design discharge per unit	126 m^3/s
Rated head	90.10 m
Installed capacity per Unit	103 MW
Normal tailwater level	2015.34 m
Probable maximum tailwater level	2033.04
Powerhouse for auxiliary units	

Type	Underground
Gross head (Average)	92
Nos. and type of Turbine	2 Nos., Francis
Turbine c/l elevation	2006.50 m
Rated discharge per unit	56.83 m^3/s
Rated head	87.69 m
Installed capacity per Unit	44 MW
Normal tailwater level	2018.1 m
Probable maximum tailwater level	2042.03 m
Transformer Cavern	
Type	Underground
Cavern Size (L x W x H)	158.5m x 15 x 20.8m
Transformer floor elevation	2014.50 m
Tailrace Tunnel	
Main Plant	
Nos. & Dia. of draft tube tunnels	04 Nos., 7.7m
Length of each draft tube tunnel	58 m
Diameter of tailrace tunnel (two draft tube tunnels combined to one TRT)	8.5 m
Length of tailrace tunnel (two draft tube tunnels combined to one TRT)	93 m and 82 m
Diameter of single tailrace tunnel (two TRTs of 8.5 m diameter combined to one TRT)	12.1 m
Length of single TRT	400 m
Design discharge for single TRT	504 m^3/s
Nos. and Size of TRT gates	02 Nos., 5.1m (W) x 12.1m (H)
Auxiliary Plant	
Nos. & Dia. of draft tube tunnels	02 Nos., 6.2m
Length of each draft tube tunnel	29 m and 39 m
Diameter of tailrace tunnel (two draft tube tunnels combined to one TRT)	6.2
Length of single TRT	134 m
Design discharge for single TRT	113.66 m^3/s
Nos. and Size of TRT gates	01 Nos., 5.1m (W) x 6.2m (H)
Estimated cost	
Civil works (Including Pre-operative Works)	₹ 2562.23 (in crores)
E&M works	₹ 821.88 (in crores)
Cost of Miscellaneous Works (Including indirect Charges)	₹ 9.09 (in crores)
Total basic cost	**₹ 3393.21 (in crores)**
IDC and financing charges	₹ 527.22 (in crores)
Total Project cost	**₹ 3920.43 (in crores)**
Financial aspects	
Tariff as per CERC	
Cost of generation (1st Year Tariff) per kWh at powerhouse bus bars (including IDC) during 90% dependable year as per CERC Guidelines	₹4.09 /kWh
Cost of generation (Levellised Tariff) per kWh at powerhouse bus bars (including IDC) during 90% dependable year as per CERC Guidelines	₹4.10/kWh
Construction period	
Total construction period including preconstruction works	98 months
Construction period for preconstruction works	24 months

Source: DPR of Dugar HEP

2.4.12 Aggregate Processing and Batching & Mixing (BM) Plant

The peak requirement of concrete and raw aggregates has been estimated to decide the plant capacities for Aggregate Processing (APP) and Batching & Mixing (BM). The **Table 2.2** shows the location and capacities of aggregate processing and concrete batching & mixing plants.

Table 2.2: Size and location of the aggregate processing and batching plants

S. No.	Site	Nos.	Capacity
1	Aggregate Processing Plant (APP)	02	240 TPH and 120 TPH
2	Batching & Mixing (BM) Plant	02	180 Cum/hr and 90 Cum/hr

Source: DPR Dugar HEP

2.4.13 Quarry Areas

The total requirement of coarse and fine aggregate for the construction of the project has been estimated to be around 11.30 lakh m^3 and 5.65 lakh m^3, respectively. As per CWC guidelines, 38% of the quantity of coarse as well as fine aggregate is to be added for wastage, etc. for estimating the total requirement. In addition, 0.10 lakh m^3 of rockfill material shall be required for the construction of the downstream cofferdam. To cater to the above requirement, investigations have been carried out to identify and explore suitable borrow areas/ rock quarries.

Three rock quarries (excluding excavated material from diversion tunnels, dam abutments & powerhouses) and two river shoal deposits, have been identified.

a) Rock Quarries

Three rock quarries and excavated materials from DT, Dam, and PH excavation have been shortlisted to fulfil the requirement of coarse and fine aggregate, rock fill, and riprap material. Individual sources are discussed in succeeding paragraphs.

i. Upstream of Hasku Bridge Quarry (DRQ-01)

This rock quarry is located 17.5 km upstream of the dam site along the right side of Chenab River near Hasku Bridge (u/s) and is presently well connected with the road network. It is estimated that 7.7 lakh m^3 of suitable rock material will be available from this quarry and may serve as the principal rock quarry for non-wearing surface concrete.

ii. Rock Quarry along Dharwas Road (DRQ-06)

This rock quarry is located 6.0 km upstream of the dam site along the right side of Luj Nala and is presently well connected with the road network. It is estimated that 4.30 lakh m^3 of suitable rock material will be available from this quarry and may serve as the nearest rock quarry for sourcing coarse aggregate for non-wearing surface aggregate for concrete production.

iii. Downstream of Hasku Bridge Quarry (DRQ-02)

This rock quarry is located 17.0 km upstream of the dam site along the right side of Chenab River near Hasku bridge (d/s) and is presently well connected with the road network. The main rock is micaceous quartzite with minor bands of pegmatite and schist. It is estimated that 1.20 lakh m^3 of suitable rock material will be available from this quarry for non-wearing surface aggregate.

iv. Excavated muck from DT, Dam, and PH (MR-01&ML-01)

The excavated materials from DT, left & right abutment of dam and powerhouse have been assessed for their suitability for use as construction material. As such crushed rock samples from the drifts at the left & right abutment of the dam and powerhouse site have been collected and got tested. The test results of muck from both exploratory drifts (MR-01&ML-01) indicated that the same is not suitable for use as a coarse aggregate however they may be utilized as fine aggregate in concrete. Excavated material of DT can be utilized for the construction of U/S and D/S cofferdams (being temporary structures).

b) River Shoal Deposits

i. Near TRT Outfall (FAS-01)

This river shoal is located downstream of the dam site, near the proposed TRT outfall area. The natural river sand available from the river shoal is found suitable for use as fine aggregate in concrete. A total 2.1 ha area will be available during the lean season which will provide 3.26 lakh m^3 of aggregate.

ii. Tail End of Reservoir (FAS-02)

This river shoal is located at the tail end of the reservoir, approximately 28 km upstream from the dam near Findru village. The natural river sand available from the river shoal is found suitable for use as fine aggregate in concrete. A total of 6.2 ha area will be available during the lean season which will provide about 9.54 lakh m^3 of aggregate.

2.4.14 Muck Disposal Areas

The construction would involve about 3,70,880 cum of soil excavation and 9,23,970 cum of rock excavation. About 60% of rock excavation is expected to be used for producing coarse and fine aggregate for concrete production and in fillings for developing areas for construction facilities. The total quantity of excavation in common soil and balance quantity of rock excavation would have to be disposed of in designated muck disposal areas. Thus, considering swell factors 0.63 for rock and 0.80 for common soil as adopted from CWC Guidelines and redeposit compaction factor of 83%, the total muck disposal area should have a capacity of about 8,71,706 cum.

Keeping the above requirement and vicinity of the excavation sites in view, one muck disposal zone has been identified downstream of the proposed powerhouse with a total area of 8.58 ha and capacity has been worked as 8,75,000 cum.

2.4.15 Explosive Magazine

Explosive is mainly required for open and underground rock excavation. Explosive magazines of 60 MT capacity shall be provided at a suitable location selected at the site keeping sufficiently away from the human habitat. The explosive magazine complex has been planned to keep the distance traveled by the explosive van to a minimum. All safety codes and regulations prescribed by the central and state government in this respect will be followed and magazines will be suitably guarded round the clock. As laid down in the

Explosive Rules, 2008, safe distance will be maintained from public roads, etc.

2.4.16 Fuel Station

No Fuel station is available near the Project site. It is necessary to provide a petrol pump/ fuel station for catering to the fuel and lubricants requirement of the construction activities, one 1000 KL Fuel station shall be established at the Project site. A petrol pump of about 200m^2 area (20m x 10m) to be established to cater to the daily fuel requirements. Further, three (3) nos. of 10 KL Petrol / Diesel tankers would be provided at the site for carrying the Petrol/diesel from the depot to the site storage facility. Lubricant drums shall be transported by trucks.

2.4.17 Construction Material

Major Construction materials required for the construction of the Project are Cement, Water, Coarse Aggregate, Fine Aggregate, Reinforcing Steel, Structural Steel, Rock bolts and rock anchors, etc.

i. **Water:** Water of River Chenab shall be used for all construction purposes after due testing of Water. In case the water is not found suitable, bore wells shall be installed to obtain groundwater for construction purposes. In any case, tested and approved water sources shall be used for construction purposes.

ii. **Cement**: The peak requirement of cement is estimated to be about 500 MT per day. The total quantity of cement for the civil works for this project is estimated to be about 3.44 lakh MT. Keeping a lead time for the cement to reach the site about 3 days, we need reserve storage of about 5 days i.e., 2500 MT at least. However, keeping the winter period of approaches not available it would be prudent to stock for the maximum requirement from January to March. This requirement would be approximately 5600MT.

iii. **Coarse and Fine Aggregate:** Total requirement of coarse and fine aggregate for the construction of the project has been estimated to be around 11.30 lakh m^3 and 5.65 lakh m^3. Since local crushers are not available in the vicinity of the project it is proposed to install two nos. of Aggregate Processing Plants (APP) at the project site to cater to the initial requirement of works. Details of the source and APP are discussed in the next section.

iv. **Reinforced and Structural Steel:** The peak requirement of reinforcement steel would be about 10 MT per day for each Reinforced and Structural steel. Keeping a lead time for the material to reach the site about 3 days, reserve storage of about 5 days would be needed. However, keeping the winter period of approaches not available it would be prudent to stock for the maximum requirement from January to March. This requirement would be approximately 250 MT for Reinforced steel and 150 MT for Structural steel, accordingly, a steelyard of 300 MT and 150MT capacity shall be provided for Reinforced steel and Structural steel, respectively at the Project site.

2.4.18 Land Requirement

The total land requirement for Dugar HEP is estimated as 220.62 ha. Out of which, 8.78 ha is private land, and the remaining 211.84 ha is forest land. The submergence area will cover 160.45 ha which is completely forested land. Prima facie no site of archaeological and religious importance is getting affected due to the project. The details are given in **Table 2.3.**

Table 2.3: Land requirement for the project

S. No	Component	Forest Land (ha)	Non-Forest Land (ha)	Total (ha)
1	Submergence including river area	160.45	0	160.45
2	Dam	5.83	0	5.83
3	Approach Roads	8.168	0	8.168
4	Quarry area	8.625	0	8.625
5	Borrow Areas	3.88	0	3.88
6	Muck Dumping area	8.5797	0	8.5797
7	Job facility area	7.08	0	7.08
8	Construction Facility Area	0	6.62	6.62
9	Owner's Colony	0	1.98	1.98
10	Owner's Office	0	0.18	0.18
11	Powerhouse	3.64	0	3.64
12	HRT	0.40	0	0.4
13	TRT	1.81	0	1.81
14	TRT Outfall	0.74	0	0.74
15	Diversion tunnel	1.84	0	1.84
16	MAT	0.80	0	0.80
	Total	**211.8427**	**8.78**	**220.6227**

Source: DPR Dugar HEP

2.4.19 Manpower Requirement

About 2500 workers (labour and staff) would be engaged temporarily during the peak construction period. It is expected that 70% of the total workforce shall be available from the State of Himachal Pradesh. After completion of the project only a staff of about 250 persons shall be permanently required for the operation of the project.

2.4.20 Water Requirement

Water for construction will be drawn from the Chenab River. Water tanks of adequate capacity will be constructed at each work location and water will be pumped from the river to water tanks. Water tanks of adequate capacity will be constructed near aggregate processing and batching plants to meet the requirement of plants. A water tank will also be provided at camps & colonies considering the total manpower and average daily consumption. A suitable distribution network will be developed in the camps and colony for the supply of water. A detailed layout of water supply facilities shall be developed during the stage of detailed design.

2.4.21 Construction Power Requirement

Based on preliminary planning, work methodology, and equipment planning, the power requirement for construction works, lighting of works, office and camp lighting, etc. has been worked out as 5.2 MW.

Presently there is an acute shortage of power at the Project site. In response to the availability of Construction Power, Sr. Executive Engineer, Pangi Valley Electrical Division, HPSEBL has intimated that 25 KW electric load in summer and 20 KW in the winter season can only be provided for the construction purpose against the requirement of approx. 5.2 MW. To provide uninterrupted supply and considering the economy of operating DG sets for varying loads the following DG sets have been provided. The details of the proposed DG sets are given in **Table 2.4**.

Table 2.4: Details of proposed DG sets

S. No.	Particulars	Power Rating (KVA)	Numbers	Power Factor	Total Generating Capacity (KW)
1	DG Sets	1000	4	0.85	3400.00
2	DG Sets	500	4	0.85	1700.00
3	DG Sets	125	4	0.85	425.00
	Total Generation Capacity				**5525.00**

Source: DPR Dugar HEP

2.5 PROPOSED SCHEDULE FOR APPROVAL AND IMPLEMENTATION

Once the draft EIA report is ready it will be submitted to Himachal Pradesh Pollution Control Board along with the Executive Summary for conducting Public Hearing at the site. The final EIA report will be prepared after incorporating the feedback received during the public hearing. The final EIA report will be submitted to MoEF&CC for obtaining environmental clearance.

It is proposed to complete the project and commission the four units of 103 MW and two units of 44 MW within 98 months i.e., 8 years and 2 months including the pre-construction period. A pre-construction period of 24 months is estimated for the construction of infrastructure works mainly roads & bridges to start the main construction works.

2.6 TECHNOLOGY AND PROCESS DESCRIPTION

The proposed project is a hydel scheme that envisages the construction of a Concrete Gravity Dam on Chenab River to divert the flows into the two underground circular pressure shafts to the underground powerhouse proposed for power generation. Water is then released back into the river through a tailrace channel.

The construction cost and time depend to a great extent on the technology and methodology adopted to carry out the construction work. As there are several alternative methods/ equipment, due care must be exercised in the selection of the most efficient construction method/equipment to optimize construction cost and time. A balanced approach will be followed to optimize construction cost and construction period after comparative evaluation of price escalation and interest during construction versus lost benefits due to delay in completion. Mechanized construction has been planned for almost all types of construction activities to achieve consistent quality at a faster progress rate. The sequencing of construction activities, wherever possible, has been attempted in such a way that equipment from one activity, on its completion can be shifted to the other. This way, the total requirement of equipment at a time would be reduced and, enough utilization of equipment on the project would be ensured.

2.7 PROJECT DESCRIPTION

Project description has already been covered in detail in section 2.4. Details of infrastructure facilities which were not covered in section 2.4 are provided in ensuing paragraphs.

2.7.1 Approach to the Project

The project site is located near Luj village which is well connected through SH-26 Tandi-Kisthwar road via Udaipur. SH-26 is along the right bank of Chenab River near the project site. The nearest railheads are the railway stations Udhampur and Pathankot. Udhampur Railway Station is in Udhampur city in the Union Territory of Jammu & Kashmir, while Pathankot Railway Station is in Pathankot city in the state of Punjab. The distance from Udhampur to the project site is about 270 km. The nearest airports are Bhuntar and Jammu. The distance from Bhuntar to the project site is about 279 km and from Jammu to the project site is about 332 km.

Therefore, there are three alternate routes to approach the project. These are:

Route-1: Chandigarh - Manali - Rohtang Tunnel - Udaipur - Project site (518 km) – All-weather

Route- 2: Jammu-Udhampur-Kishtwar-Gulabgarh-Project site (332 km)

Route- 3: Pathankot-Banikhet-Chamera Dam I-Koti- Bairagarh - Such Pass - Project site - Killar (272km)

All the three routes have their advantages and disadvantages and it proposed to utilise each these routes judiciously after critical analysis of economic, safety, and terrain characteristics of each of the routes.

2.7.2 Project Roads and Bridges

The project site is located near Luj village which is well connected through SH-26 Tandi-Kisthwar road via Udaipur. SH-26 is along the right bank of Chenab River near the project site. On the left bank of the Chenab River, there is no access to the project area. The road from Ghangit to Chamba crosses the river Chenab and reaches to left bank through a bridge called Shukrali Bridge, about 3.5 km upstream of the Project area. A possibility of constructing a road on the left bank may be considered for approaching the Project area on the left bank, however, this is not considered now.

The existing Tandi-Kishtwar Road near Luj village on the right bank is available at an elevation of about 2,260m near the Project area. However, going a little downstream the off-take point (R1) of the main Project Road is taken at an elevation of about 2220m. An approach road has been planned from this to reach project area to elevation about 1988m i.e., the bottom of Dam. Considering a gradient of 1:15 (6.6%) a length of about 3.5 km would be required. From this road various permanent and temporary project roads and bridges are proposed for communication requirements in the project vicinity during the construction stage and that of during the Operation and Maintenance stage. A road would be required to reach the top of the Diversion Tunnel inlet at elevation 2079m and bridge upstream of the dam proposed at El. 2080m from the top of Dam to reach these areas even after completion of Dam. Since a very steep rock face exists in this area, a 7m dia D-shaped road tunnel is proposed to access these areas. The left area of Project shall be reached through a tunnel & a temporary bridge u/s to Dam during Construction. The proposed roads and bridges in the project area are summarized in **Table 2.5 and Table 2.6,** respectively.

The existing Sukhrali Bridge which is a communication connection between Killar and Chamba is going under submergence of Dugar HEP reservoir along with a portion of approach road to the right abutment of this will need realignment. Thus, construction of this alternative approach arrangement i.e., alternative bridge to the existing Sukhrali bridge and with approach roads of about 1000 m to abutments of this bridge is planned to be completed before initial filling of Dugar reservoir.

Table 2.5: Proposed Roads in Project Area of Dugar HEP

S. No.	Description	Type	Road length (m)
A	**Right Bank Roads**		
1	Road from existing Tandi-Kishtwar Road (offtake point R0) to Junction R2 of Road to Bottom of Dam and DT inlet and Outlet.	Permanent	1140
2	Road from R1 to Junction R2 of Road to Explosive Magazine	Permanent	415
3	Road from R2 to Explosive Magazine	Temporary	563
4	Road from R2 to Junction R3 of Road to MAT Bridge BDG-1	Permanent	563
5	Road from R3 to Junction R4 of Road to Bottom of Dam and DT inlet and Outlet.	Temporary	189
6	Road from Junction R4 to R5 Right Abutment of Bridge-BDG1	Permanent	531
7	Road from MAT Bridge Junction R5 to existing Tandi-Kishtwar Road (offtake point R11 near U Bends) passing through Muck Disposal Area.	Permanent	2695
8	Road from Junction R3 to Junction R6 Dam top on right bank	Permanent	623
9	Road from Junction R6 to Toad Tunnel Portal T1	Temporary	33
10	Road from Tunnel Portal T2 to Bridge BDG-2	Permanent	35
11	Road from Tunnel Portal T2 to top of DT Inlet Structure R7	Permanent	197
12	Road from Junction R4 to DT Outlet Portals R12	Temporary	104
13	Road from Junction R4 to Junction R13 of road to d/s Cofferdam	Temporary	263
14	Road from Junction R13 to D/s Cofferdam	Temporary	78
15	Road from Junction R13 to DT Inlet Portals R14 through Dam and U/s Coffer Dam Area	Temporary	314
16	Road from existing Tandi-Kishtwar Road (offtake point R10) to Junction R1 through camp and construction facility area	Permanent	2540
B	**Left Bank Roads**		
1	Road from Junction B2L on left abutment of Bridge BDG-2 to Power Intake R8.	Temporary	254
2	Road from Junction B2L on left abutment of Bridge BDG-2 to Pothead Yard, Cable Tunnel Portal and Dam Top	Temporary	710
3	Road to dam Bottom extended from Power Intake Bottom	Temporary	900

Table 2.6: Proposed Bridges in Project Area of Dugar HEP

S. No.	Description	Type	Deck Level (m asl)	Span (m), approx.
1	Bridge - BDG1: Access Bridge to MAT	Permanent	2036	110
2	Bridge - BDG2: Upstream Dam	Temporary	2080	130

S. No.	Description	Type	Deck Level (m asl)	Span (m), approx.
3	Bridge - BDG3: New Sukhrali Bridge	Permanent	2118	202
4	Approach Bridge to MAT-TRT Adit	Temporary	2025	100

2.7.3 Existing and Proposed Infra Structure Facilities in Project Area

2.7.3.1 Medical Facilities

Some medical facilities are available at Killar town about 10km from the Project site. This is not adequate to cater to the Project. Kishtwar district hospital is about 120km from the Project site. Chamba and Manali are not dependable for the Project's medical care requirement. To cater for the medical care and emergency needs of the project workers, it is proposed to provide a medical Clinic well equipped to provide first aid and take care of any construction-related injuries, common sickness, and medical emergencies along with a 5-bed ward, under the charge of a qualified medical officer supported by sufficient support staff. 3 no of well-equipped ambulances shall also be provided at the clinic under the control of the medical officer. A tie-up with an air ambulance (Ambulance Helicopter) facility provider is proposed to be arranged for extreme emergencies. Adequate medical equipment, stretchers, medical oxygen cylinders, etc. shall always be kept in a ready-to-service position. Sufficient stock of medicines shall be kept at the clinic to meet the requirements at the Project Site.

2.7.3.2 Sanitation and Sewage

All offices, workshops, laboratories, and other work-occupied buildings will be provided with toilets, water supply, and regularly maintained septic tanks. The campsites will be provided with a properly maintained and operated sewage system including septic tanks and sewage disposal facilities. Facilities for washing clothes will be provided and linked to the sewage system. Adequate sanitary installations and sewage treatment arrangements such as septic tanks will be provided in the main camp as well as in the labour camps. Adequate arrangements shall be provided for water storage and piped water supply to the camp and various activity centers. The area for the sewage treatment has been provided as 750 sqm.

2.7.3.3 Project Colonies

To execute the project, it has been envisaged that proper infrastructure such as permanent and temporary staff residential buildings, administrative buildings, guest houses, etc. will be established. Accommodation for owners required for operations has been provided as permanent and additional requirements during construction shall be provided with temporary accommodation.

a) Camps and Accommodation

Based on manpower requirement, accommodation and its area have been worked assessed for Owners and contractors. Accommodation for owners required for operations has been provided as permanent and additional requirements during construction shall be provided with temporary accommodation. The owner’s office shall be a permanent structure. Temporary accommodation has been planned for contractor’s establishments. Since the Project is of long duration, appropriate, though limited, family accommodation is also proposed for those who would like to keep their families at the Project site. Field hostels/ Bachelor's accommodation is proposed for remaining executives, non-executives, and workers.

b) Contractor's Camp

The contractor would require providing accommodation and other facilities like mess, recreation center, etc. for about 43 executives and 239 non-executives. For executives, 22 families and 21 single-seated field hostels are proposed. For non-executives, 120 families and 119 seats in double-seated field hostels are proposed.

c) Labour Camp

Labour camp shall be provided for the accommodation of skilled and unskilled workers of owner/ developer and contractors as well. Labour camps shall accommodate family accommodation and field hostels. Temporary and permanent structures shall be constructed as per finalized plans during the detailed planning stage. Labour camp shall include living space, kitchen space in family accommodation, and community common amenities like toilets, bathrooms and washing space, etc. During construction, About 66 skilled and 49 unskilled workers and during operation, About 58 skilled and 30 unskilled workers would be required by owner/ developers. For their accommodation, it is proposed to provide 29 permanent family accommodation and 59 seats in field hostels. This will provide accommodation during operation also. In addition to the above 27 temporary seats in the field, hostels have been provided to cater for additional needs during construction Contractor’s skilled and unskilled workers including civil, HM, and EM works are assessed to be 1675. Family accommodation has been provided for about 25% of workers and field hostels have been provided for the balance workers. As such 419-family accommodation and 628 double seated field hostel rooms are proposed for the duration of construction. All accommodation for contractor’s workers shall be temporary.

d) Owner's Accommodation

Owner's accommodation and allied facility area shall be developed for the residences for engineers, managers, officers, supervisors, and other staff and servicemen. Field Hostels shall be constructed as bachelor staff accommodation. This accommodation shall be constructed as a permanent residential building complex with family/ bachelor accommodation with space for associated activities such as mess, recreational rooms, etc. adequate for the operation and maintenance staff for the power station at Dugar HEP near the Powerhouse area. In addition to permanent facilities, some temporary accommodation and facilities shall also be provided for engineers, managers, officers, supervisors and other staff and servicemen, etc. who would be required during construction in addition to numbers required for operation and maintenance. Facilities for Owner shall be permanent for the requirement during operation and maintenance however the balance accommodation shall be of a similar standard but temporary.

Owner/ Developer would require providing accommodation and other facilities like mess, recreation center, etc. for about 15 executives and 51 non-executives. For executives, 9 permanent families and 6 temporary single-seated field hostels are proposed. For nonexecutives, 23 permanent families and 28 double seated field hostels are proposed.

Guest House

A Guest House facility shall be developed for visiting engineers, managers, and officers. The guest house shall be provided with accommodation for three rooms for senior management officers and six rooms for middle management officers. It will also have a kitchen, dining room, and Common/ drawing-room. The Guest House shall be a permanent building that shall be retained throughout the life of the Project.

Table 2.7 shows the proposed land requirement for the establishment of temporary and permanent colonies for the project workers.

Table 2.7: Land requirement for Temporary and Permanent Project Colony

S. No	Component	Forest Land (ha)	Non-Forest Land (ha)	Total (ha)
	Construction Facility Area	0.0	6.62	6.62
	Owner's Colony	0.0	1.98	1.98
	Owner's Office	0.0	0.18	0.18
		0.0	**8.78**	**8.78**

Source: DPR Dugar HEP

2.7.3.4 Telecommunication Facilities

Proper communication facilities need to be established for better connectivity between the Supervisors Engineers & site activity centres for faster control and speedy progress of work. Presently, there are few service providers i.e. BSNL, JIO & Airtel, whose services are not at all reliable. The following telecommunication facilities are required during the construction phase.

Internal communication: Internal communication system shall comprise the following two systems:

VHF Walkie-Talkie sets

Telephones - A telephone exchange (PABX) of at least 128 ports with 5 trunk lines or PRI service shall be installed for maintaining telephonic communication at various offices, facility centres, stores, workshops camps, and residences of senior officers.

External communication: External communication system is also equally required for transmission of a message to another, for which the following communication system is proposed to be developed.

Telephones: The same telephone exchange of 128 ports with 5 trunk lines or PRI service as mentioned above, shall also connect the Project site through 5 incoming trunk lines with the national and international telephonic system.

Public Mobile Phones

Internet and Emails- For Internet, E-Mails, and ERP services, 02 No. Internet leased line and 02 No MPLS are needed in the area through local service providers.

Satellite Communication: 02 No. V-SAT communication is required for establishing communication.

Satellite Phone (INMAR SAT): Being a remote location and un-availability of reliable mobile signal, 02 no. I-Sat phones are required for the project which can be used during the transit at a different site of the project.

2.7.3.5 Fire Protection

An adequate and appropriate arrangement shall be provided for the protection and prevention of fires. Water outlets shall be provided through the pipelines near all offices, workshops camps, and other fire-prone areas. Wherever required ABC type fire extinguishers shall be provided in sufficient quantities. If required special extinguisher shall be provided at fuel stations and electrical installations and a special warning sign for not using water for extinguishing fire in electrical installations shall be displayed. Workers shall be given the training to use fire extinguishers and tactically handle the situation in case of fire to minimize the damage.

2.8 MITIGATION MEASURES INCORPORATED INTO THE PROJECT

Minimizing Loss of Flora

At the investigation stage of project, the height of dam has been determined to minimize the submergence of forest and non-forest land thereby taking first mitigation step to bring the loss and damage to the ecology of the area to the minimum.

Minimizing loss of agricultural land and No Displacement

The land requirement was optimized considering various alternatives and choosing alternative involving least land requirement and minimum impact on environment. Also the project does not involve displacement of people and minimum loss of agricultural land i.e. only around 8.78 ha private land shall be acquired for the project.

Sedimentation of the Reservoir

Sedimentation in reservoir will reduce water-storage capacity due to the exchange of storage space for sediment which is generally reflected by the formation of shoals / islands near tip of reservoir. The problem of siltation will not be serious as the reservoir shall be regularly flushed during monsoon when enough water is available for conducting flushing operation though spillways.

In addition engineering as well as bio-engineering measures are proposed under Catchment Area Treatment to minimize the inflow of sediments into the reservoir.

Seismicity & Earthquake

Dugar Project is located in the Seismic zone IV as per seismic zoning map of India BIS-1893 (Part 1). The site specific seismic design parameter studies for the project have been carried out by DEQ-IIT Roorkee. The Response spectra and Seismic design parameters as recommended by DEQ-IITR in its study report have been approved by NCSDP in its 27th meeting held in June 2014. The NCSDP approved Response spectra and seismic coefficients (horizontal- α_h=0.17 and vertical-α_v =0.11g) as recommended in the site-specific seismic study report shall be used for design purposes.

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2.9 ASSESSMENT OF NEW & UNTESTED TECHNOLOGY FOR THE RISK OF TECHNOLOGICAL FAILURE

Hydropower projects are based on tested technology and there is no risk of technology failure in this project.

Chapter 3 DESCRIPTION OF THE ENVIRONMENT

Environmental baseline data is the basic requirement to define, understand and assess the potential impacts of a project on physical and biological environment near the project as well as in the area around the project and its components. Baseline data is collected to serve two purposes in the EIA study. First, it helps us understand the current environmental conditions of the area, and how the project needs to be implemented considering these conditions. Second, and most importantly, it helps us assess and predict the possible environmental changes that could occur, once the project is underway.

The parameters have been selected according to the Terms of Reference (TOR) issued for this project by Expert Appraisal Committee (EAC) of the Ministry of Environment, Forests and Climate Change (MoEF&CC), Government of India as part of scoping clearance.

Environmental components are described based on the primary and secondary data collected during the study period and discussed in the ensuing text.

3.1 STUDY AREA, PERIOD, COMPONENTS & METHODOLOGY

3.1.1 Study Area

The study area for the collection of data on various baseline environmental parameters has been defined as per the Terms of Reference (TOR) issued by EAC, MoEF&CC, Govt. of India as part of scoping clearance.

The project study area is delineated as the area within a 10 km radius of major project components like dam site, powerhouse, the tip of the proposed reservoir due to submergence on Chenab River, and 10 km downstream of the tailwater discharge point of Dugar HEP (refer to **Figure 3.1**).

3.1.2 Study Period

The field surveys for the collection of primary data were conducted between March 2021 and September 2021 covering winter, pre-monsoon/summer, and monsoon seasons to collect data/ information on terrestrial ecology and physical environment. Entire baseline data collection work was carried out ensuring social distancing and following government Covid-19 directives. The details of the sampling schedule are given in **Table 3.1**.

During the surveys ground-truthing for refining land use/ land cover maps. For this purpose, various attributes such as land features, rivers, forests, and vegetation types were recorded on the ground with the help of GPS.

Table 3.1: Sampling schedule for various Environmental Parameters

Parameters	Winter	Summer/ Pre-Monsoon	Monsoon
Soil	March 2021	May-June 2021	August-September

Parameters	Winter	Summer/ Pre-Monsoon	Monsoon
Air Environment	March 2021	May-June 2021	August-September
Noise & Traffic	March 2021	May-June 2021	August-September
Water Quality	March 2021	May-June 2021	August-September
Vegetation	March 2021	May-June 2021	August-September
Fauna surveys	March 2021	May-June 2021	August-September
Socio-economic survey of Project affected villages	August-September 2021		

3.1.3 Study Components

Environmental Impact Assessment defines and assesses the potential physical, biological, and socio-economic impact of the proposed project in a manner that allows for a logical and rational decision to be made about the proposed action. Environmental baseline data is the basic requirement to define, understand and assess the potential impacts of a project on the physical, biological, and social environment near the project as well as in the area around the project and its components. Baseline data includes:

The baseline data presented in this chapter has been prepared from primary data collected during field studies which were then supplemented with data/information gathered during interaction with concerned persons of various government departments and available literature and reports published by various institutions and organizations. Baseline data is the data collected about various factors of the project study. This includes:

- Physical Environment: It covers land, air, and water environment. It includes a description of physiography, drainage, geology, land use/ land cover, meteorology, soil, ambient air quality, noise/ sound levels and average daily traffic, water quality (surface as well as groundwater), and groundwater development.

- Biological Environment: It covers both floral and faunal components, terrestrial and aquatic. It describes forest type, floristics as well as faunal diversity, the occurrence of RET species if any, and the presence of sensitive ecosystems like any notified Protected Areas in the vicinity of the proposed project.

- Socio-economic Environment: It provides the overall socio-economic profile of the villages located in the study area and the district/s in which the project is located. It also describes the socio-economic status of project-affected villages. It covers aspects like demography, social structure, literacy, working population, infrastructure, amenities, educational and health facilities, presence of any archaeological and/or religious sites, etc.

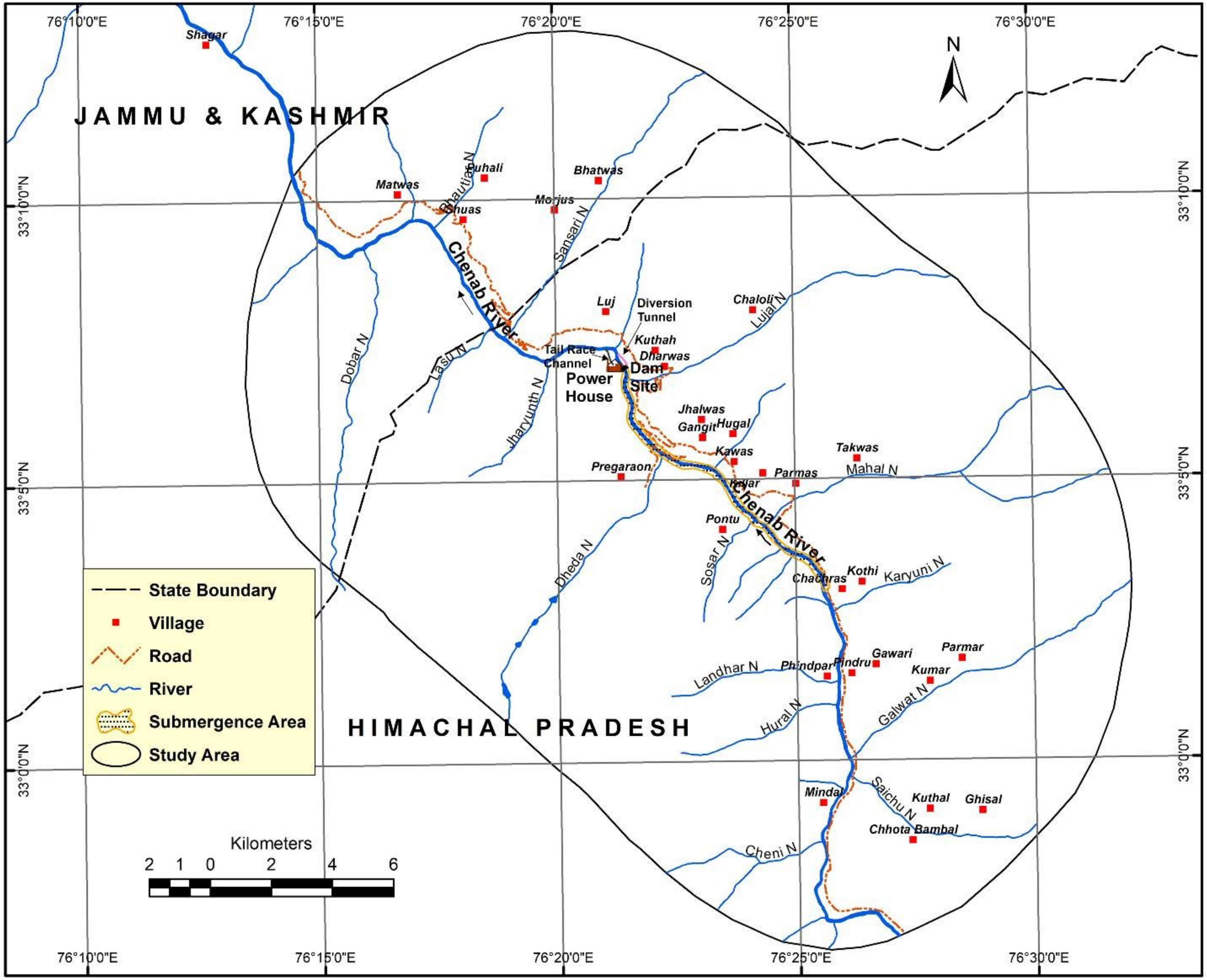


Figure 3.1: Map showing the study area of Dugar HEP

3.1.4 Methodology

Baseline data on environmental parameters were collected at two levels – primary and secondary. Primary data generated from sampling done during field surveys for physical and chemical attributes of soil, surface as well as ground water quality, ambient air quality, noise, and traffic and sampling and surveys for collection of data on floral and faunal elements covering terrestrial as well as the aquatic environment. In addition to primary surveys conducted as mentioned above, substantial secondary data was also collected through interaction with various state and project officials and sourced from published reports and literature. The sources for secondary data so collected have been mentioned below:

- For the preparation of soil map of the study area Soils of Himachal Pradesh for Optimising Land Use, NBSS Publ.57b, 1997 by National Bureau of Soil Survey & Land Use Planning (NBSS & LUP).
- Meteorological data for Temperature, Relative Humidity, Rainfall, Wind Speed, and Wind Direction were downloaded from https://www.worldweatheronline.com for the last 10 years.
- The description of the Geology of the area was sourced from the DPR of the proposed project prepared by the project proponent.
- For Land use/ landcover, thematic maps prepared by the National Remote Sensing Centre (NRSC), Indian Space Research Organisation (ISRO) of Dept. of Space with Remote Sensing Applications Centre, Himachal Pradesh Council of Science & Technology as a partner for the period 2015-16 were downloaded from their web portal http://bhuvan.nrsc.gov.in/gis/thematic/index.php.
- Landsat 8 data for the generation of FCC and the refinement of Land use/Land cover
- 'A Revised Survey of the Forest Types of India' by Champion and Seth (1968) was used for forest type classification of forests in the study area
- Office of Divisional Forest Officer, Forest Working Plan, Pangi Forest Division, Himachal Pradesh for documentation of flora and fauna in the study area.
- National Ambient Air Quality Series: NAAQMS/36/2012-13, Guidelines for the measurement of Ambient Air Pollutants.
- Water Quality Criteria of Central Pollution Control Board (http://www.cpcb.nic.in/Water QualityCriteria.php).
- For describing the socio-economic profile of the study area and available infrastructure in the area, Village and Town Directory, District Census Handbook, Chamba, Series -3, Part-XIIA and Village and Town wise Primary Census Abstracts (PCA) Directory, District Census Handbook, Chamba, Series -3, Part-XIIB published by Census of India Demographic profile of the study area from Census of India 2011, Directorate of Census Operations, Himachal Pradesh were consulted.
- DPR of Dugar HEP (500 MW), prepared by NHPC Ltd.
- Cumulative Environmental Impact Assessment Study of Chenab Basin in Himachal Pradesh, 2015.

3.1.4.1 Physical Environment

a. Soil

To assess the soil fertility at different locations in the study area the soil sampling locations/ sites were selected using land use/landcover map prepared as above and accordingly soil samples were collected from 6 locations covering different land uses like the forest and fallow land, etc. The sampling site locations on the map are given later in the chapter under the section on soil describing soil characteristics. Soil samples were collected with help of *Khurpi* from a depth of 15cm from the surface after removing the grasses and litter, foreign material like roots, stones, pebbles, and gravel. Samples were collected in a polythene bag and were brought to the laboratory for analysis. These soil samples were analyzed for physical and chemical characteristics at the AGSS Analytical and Research Lab Pvt. Ltd., Delhi (NABL accredited Lab.).

Table 3.2: Soil sampling locations

Site Code	Sampling Location	Land Use
S1	Near Sansari Nala	Forest Area
S2	Near Luj Village	Forest Area
S3	Near Dharwas Village	Forest Area
S4	Near Gangit Village	Forest Area
S5	Near Killar Village	Fallow Land
S6	Near Kothi Village	Forest Area

The following parameters were analysed for soil

Texture - Sand (%), Slit (%) and Clay (%)	Calcium (mg/kg)	Potassium (kg/ha)
Porosity (%)	Magnesium (mg/kg)	Phosphorus (kg/ha)
Bulk Density (g/cc)	Alkalinity (mg/l)	Nitrogen (kg/ha)
Water Holding Capacity (%)	Chloride Content (mg/kg)	Salinity (ppt)
pH	Organic Carbon (%)	Sodium (mg/kg)
Electrical Conductivity (µS/cm)	Alkalinity (mg/l)	Potassium (kg/ha)
Sodium Adsorption Ratio		

b. Air Environment

The ambient air quality monitoring sites were selected based upon the wind roses in different seasons (given later in the chapter) and was done at 6 locations in the study area during the Winter, Pre-monsoon, and Monsoon seasons by the RSET team with the help of a team of NABL accredited laboratory (refer to **Table 3.3**).

Ambient air quality monitoring was carried out for sulphur dioxides (SO_2), nitrogen dioxides (NO_2), $PM_{10,}$ and $PM_{2.5}$. Air quality monitoring was carried out conforming to the National Ambient Air Quality Standards for Industrial Residential, Rural & Other Areas, and Ecologically Sensitive Areas. The location of the monitoring station was finalized keeping in view the proposed construction area, wind direction, and villages in the vicinity.

Table 3.3: Sites for ambient air quality monitoring in the study area

Site Code	Monitoring Location	Remarks
AQ1	Near Sansari Nala	Residential area

Site Code	Monitoring Location	Remarks
AQ2	Near Luj Village	Residential area
AQ3	Near Dharwas Village	Residential area
AQ4	Near Killar	Residential area
AQ5	Near Chacharwas Village	Residential area
AQ6	Near Findru Villlage	Residential area

c. Sound Levels & Traffic Monitoring

Sound levels were monitored during the studies at various locations in the study area. Monitoring locations were selected keeping in view the project activity area along the roadside and the location of receptors. The monitoring was carried out during Day time (7.00 am to 10.00 pm) and Night-time (from 10.00 pm to 12.00 am and from 5 am to 7 am). The exercise was carried out for 6 to 8h in the said time frame of day and night. All the monitoring sites are located along the roads and names of monitoring sites are given in **Table 3.4**.

Table 3.4: Sites for Sound and Traffic monitoring in the study area

Site Code	Monitoring location	Remarks
NT1	Near Sansari Nala	Killar to Kishtwar Road
NT2	Near Luj Village	Killar to Kishtwar Road
NT3	Near Dheda Nala	SH 37 Killar to Chamba Road
NT4	Near Killar	SH37 Near Killar
NT5	Near Chacharwas Village	SH26 Killar to Tindi Road
NT6	Near Findru Village	SH26 Killar to Tindi Road

Traffic volume data was recorded by physically counting the number of different types of vehicles passing through a point in a fixed time interval. In some major villages along the road, towns were considered as nodes for monitoring the movement of traffic. The analysis of traffic counts provides an estimate of average daily traffic (ADT). To convert recorded vehicles into a common scale, the passenger car units (PCUs) equivalent factor as per IRC: 64 -1990 was adopted.

d. Water Environment

The data on water quality has been collected to evaluate surface water quality in the study area. Due to the absence of any ground water source (handpump, tubewell, open well, etc.) sampling for ground water was not carried out.

Selection of Sampling Sites

The study on various physico-chemical and biological characteristics of the Chenab River and its tributaries was carried out at 6 different locations (**Table 3.5**).

Table 3.5: Sampling Sites for Water Quality and Aquatic Ecology

Site Code	Sampling Location
SW1	Chenab River near the confluence with Sansari Nala
SW2	Chenab River: Proposed Dam Site
SW3	Lujai Nala: Right bank tributary of Chenab River near Dharwas
SW4	Chenab River near confluence Dheda Nala

Site Code	Sampling Location
SW5	Mahal Nala: Right bank tributary of Chenab River near Killar
SW6	Chenab river near confluence with Sosar Nala

Sampling Parameters

Water temperature, hydrogen ion concentration (pH), Electrical Conductivity (EC), Total Dissolved Solids (TDS), Dissolved Oxygen (DO), and Turbidity were recorded in the field. Phoenix Professional Waterproof pH Meter for pH and Temperature Probe Backlight Built with Automatic Compensation (Model pH-035) for temperature while EC and TDS were measured using probes of Hanna instruments (Model HI 98130) and Lutron PDO-520 Dissolved Oxygen Meter was used for Dissolved Oxygen. Turbidity was measured using Secchi disc. The water samples were collected in polypropylene bottles from the different sampling sites and brought to the laboratory for further analysis after adding formalin as a preservative. The turbidity was measured with the help of the Digital Turbidity meter and other parameters such as total alkalinity, total hardness, chloride, nitrate, phosphate, and silica were analyzed at the AGSS Analytical and Research Lab Pvt Ltd, Delhi (NABL accreditation of the Lab). These parameters were analysed as per the standard procedures given by Adoni (1980) and APHA (1992) and Bureau of Indian Standards (BIS): IS 3025 (Indian Standard: methods of sampling and test (physical and chemical) for water used in industry).

3.1.4.2 Biological Environment

Even though the majority of the study area is characterized by agricultural crop fields there are scattered patches of forests covering small hillocks in the area and scrub forests around agricultural fields and abandoned/ fallow land and around existing pipelines in the area. Therefore, natural vegetation is found mainly at those locations. The sampling was carried out around these areas covering vegetation as well as faunal elements. For vegetation, traditional quadrat sampling was used and for mammals and birds transect surveys were conducted.

a) Phyto-sociological Studies

Phyto-sociological studies were undertaken to understand the community structure i.e., species composition, their density, abundance, dominance, and diversity at different locations in the study area in three seasons.

i. Sampling Site Selection

The study has been conducted covering the locations of proposed project components. Vegetation sampling was done to cover different land use/ land cover categories like Forest, Scrubland, fallow/abandoned land, etc. Phytosociological surveys of the vegetation were conducted at 6 sampling locations. The selection of sampling sites for vegetation analysis was based on the land use pattern in the study area. A list of sampling locations is given in **Table 3.6.**

Table 3.6: Sampling Locations for Vegetation Sampling

Site Code	Sampling Location
V1	Near Sansari Nala confluence with Chenab River
V2	Luj Village near the proposed Dam site

Site Code	Sampling Location
V3	Near Dheda Nala confluence with Chenab
V4	Near Killar
V5	Near Kothi village
V6	Near Findru Village

ii. Sampling Methodology

Standard methods of vegetation sampling were used for quantitative analysis of community structure. The quadrats (a sampling unit) of different sizes were used depending upon the habitat. For sampling of trees at each sampling location 10 quadrats were laid with a quadrat size of 10m x 10m. In the case of shrubs quadrats of 5m x 5m were laid while for herbs quadrat size of 1m x 1m was used. For shrubs and herbs, 10 quadrats were laid at each sampling site. At each site, an area was demarcated where the quadrats were laid randomly to ensure maximum possible representative coverage of the vegetation of the area. In each quadrat laid for trees, shrubs, and herbs, individuals of each plant species present were counted.

The data thus obtained was compiled in tabular form and analysed for different attributes like density, frequency, and basal cover (basal area).
The density was calculated as follows:

$$\textbf{Density} = \frac{\text{Total no. of individuals of a plant species recorded from all quadrats}}{\text{Total number of quadrats laid}}$$

$$\textbf{Abundance} = \frac{\text{Total no. of individuals of a plant species recorded from all quadrats}}{\text{Total number of quadrats of occurrence of a species}}$$

$$\textbf{Frequency (\%)} = \frac{\text{Number of quadrats of occurrence of a species}}{\text{Total number of quadrats laid}} \times 100$$

A/F Ratio was calculated to understand the dispersion pattern of tree species in the area as suggested by Cottam and Curtis (1956). A/F ratio <0.025 indicates regular distribution, between 0.025 and 0.05 indicates random distribution while >0.05 indicates clumped or contagious distribution.

Calculation of Dominance & Diversity Indices

Dominance: For calculation of dominance Basal area/cover of trees was calculated by measuring the 'cbh' (the circumference at breast height) of each individual tree belonging to different species, which was then converted into the basal area using the formula as follows:

Basal area = πr^2
where r value was calculated from *cbh* using the formula cbh= $2 \pi r$
The data on density and basal cover obtained above was then converted into per ha.

The **Importance Value Index (IVI)** for trees was determined as the sum of relative density, relative frequency, and relative dominance as per Curtis, 1959.
A/F Ratio was calculated to understand the dispersion pattern of tree species in the area as suggested by Cottam and Curtis (1956). A/F ratio <0.025 indicates regular distribution,

between 0.025 and 0.05 indicates random distribution while >0.05 indicates clumped or contagious distribution.

Species diversity of the vegetation was calculated by using the Shannon-Wiener Diversity Index (1963).

The index of diversity was computed by using the Shannon Wiener Diversity Index (Shannon Wiener, 1963) as:

$H = - \Sigma (ni/n) \times \ln (ni/n)$

Where ni is the individual density of a species and n is the total density of all the species

b) Faunal Surveys

The faunal survey were carried out for the species of Mammals, Birds, Herpetofauna, and butterflies. The coverage of the study area was hampered by the inaccessibility of certain areas due to inaccessible terrain. The study area was divided into different strata based on topography and vegetation cover. Sampling for habitat and animals was done in different strata. The normal systematic transects for mammals and birds were not possible in this study area due to difficult terrain, so maximum numbers of smaller trails were used for faunal sampling.

For the preparation of the checklist of animals, the Forest Working Plan of the Pangi Forest Division was consulted. In addition, data was compiled from published literature like Prater (1998) for mammals, Daniel (2002) for reptiles, and Ali & Ripley (1983) for birds.

i. Sampling Methodology & Constraints

A systematic field visit was carried out in the study area during day hours. The survey of wild animals was conducted by using 10x50 prismatic field binocular and handheld GPS 72 in different locations. The presence of wildlife was also confirmed by the local inhabitants depending on the animal sightings and the frequency of their visits in the catchment and study area. In addition to these, secondary sources mainly literature was also referred to for preparing checklists and other analysis in the study of animals and wildlife in the region. Coordinates of sampling trails used for faunal surveys are given in **Table 3.7**.

Table 3.7: Sampling Sites for Faunal Surveys

Transect	Sampling Location
Tr1	Along Chenab River near Sansari Nala confluence with Chenab River
Tr2	Near proposed Dam site
Tr3	Along Dheda Nala near Dheda Nala confluence with Chenab River
Tr4	Forest area near Killar
Tr5	Forest area near Kothi village along Karyuni Nala
Tr6	Forest area near Findru Village

c) Aquatic Ecology

The samples for aquatic ecology sampling were collected from the same locations (W1-W6) from where samples for physico-chemical parameters were collected. Among the aquatic organisms sampling for phytoplankton (periphyton), phytobenthos, zooplankton, and macro-invertebrates were undertaken during the field surveys in three seasons in the Chenab River and its tributaries**.**

Sampling Methodology

i. Phytoplankton (Periphyton) and Zooplankton

For the quantification of ‘plankton’ both Phytoplankton (periphyton) and zooplankton water samples were collected as follows. For each community at each site separately 50 liters of water was filtered by using a plankton net made up of fine silk cloth (mesh size 25 µm). Repeated the process three times at each site and pooled the samples as a composite sample. Collected the filtrates in separate sample bottles for phytoplankton and zooplankton and adding 1% Lugol’s Iodine solution to the samples as a preservative.

ii. Phytobenthos and Zoo-benthos

For phytobenthos sampling was performed across the width of the river at the depth of 15 - 30 cm. Took grab samples from the accessible banks only. Picked pebbles (64 - 128 mm size) about 4 - 5 in number, from the riffle and pools, in different flows such as stones above and below gushing waters, swift flow, and slow flow conditions to obtain a representative sample. Collected samples of benthic diatoms samples by scraping the pebbles with a brush of hard bristles to dislodge benthos from crevices and minute cavities on the boulder surface from an area of 3 x 3 cm^2, using a sharp-edged razor. Collected the scrapings from each cobble in 25µ mesh and transferred them to storage vials. Preserved samples of phytobenthos separately in 1% Lugol’s Iodine solution.

Collected samples for Macro-invertebrate samples from a 1 sq ft area by the lifting of stones and sieving of substratum from the wide able portion of the river. Sieved the material through a 125 µm sieve and preserved in 70% ethyl alcohol. Collected samples in three replicate and pooled them for further analysis.

iii. Identification of Phytoplankton & Zooplankton

For preparing permanent mounts from the treated samples, smeared the slide first smeared Mayer’s albumen. Agitated the sample to render it homogeneous. Placed a drop of known volume (0.04 ml) of the processed material on the slide quickly and heated it gently till it dried. Dehydrated it using 95% and 100% alcohol, consecutively. Transferred the dehydrated material to Xylol twice before finally mounting in Euparol.

Analysed the permanent mounts under a phase-contrast binocular microscope using an oil immersion lens of x 100 magnification. For identifying the various diatom species, varieties, and forms, used morphological characteristics like length, width (µm), number of striae, raphe, axial area, central area, terminal, and central nodules. Identification was done using standard literature (Schmidt 1914 - 1954, Hustedt 1943, Hustedt 1985, Krammer & Lange - Bertalot 1986, 1991, 1999, 2000 a & b, Lange - Bertalot, H. Krammer, K. 2002, Metzeltin & Lange - Bertalot 2002, Krammer 2000, 2003, Lange Bertalot *et al.* 2003, Werum & Lange - Bertalot 2004., Metzeltin et al., 2005). For Oriental species consult Sarode & Kamat (1984), Prasad (1992), and Gandhi (1998).

Took the help of laboratory at CISMHE, the University of Delhi for the slide preparation and identification of phytoplankton as well as zooplankton and adequately store the permanent mounts there. **The taxonomic classification and nomenclature of algal species (Phytoplankton) were done as per** http://www.algaebase.org/.

The identification of Zooplankton was done with the help of Ward and Whipple (1959) and Battish (1992) and was classified as per https://www.itis.gov/.

iv. Calculation of Density of Phytoplankton and Zooplankton

After the removal of supernatant plankton free water, the settled phytoplankton and zooplankton were separately enumerated by the 'Sedgewick-Rafter Counting Chamber' method. Identification of zooplankton species was performed under the microscope by using keys and monographs of standard references like Ward and Whipple (1959) and Battish (1992).

For samples that were preserved in 1% Lugol's Iodine solution, acid treatment was done according to Reimer (1962) method adopted earlier by (Nautiyal & Nautiyal 1999, 2002) to process the samples for light microscopy. The treated samples are washed repeatedly to remove traces of acid. Samples were treated with hydrogen peroxide with high organic content to clean the diatom frustules. The permanent mounts were prepared in Naphrax for further analysis. They were examined using a BX-40 Trinocular Olympus microscope (x10 and x15 wide field eyepiece) fitted with a Universal condenser and PLANAPO x 100 oil immersion objective under bright field using appropriate filters to identify the species.

The density of different taxa was calculated as follows:

a) Density of phytoplankton (cells/lit)

b) Density of phytobenthos (cells/cm^2)

c) Density of zooplankton (Indiv./lit)

$$\frac{\text{No. of individuals in 1 ml x Sample volume (ml)}}{\text{Volume of water filtered (liters)}}$$

Total count of cells × cover glass size/length of the visual field of microscope × counted rows × total sample volume (ml)/observed sample / sampled area

Species Diversity Index (Shannon & Wiener 1963): The Shannon diversity indices are determined based on counts (500 - 600 valves).

Shannon-Wiener Diversity Index H = - Σ (ni/n) x ln (ni/n)

Where:

pi is the proportion of the total number of species made up of the ith species

v. Identification of Macro-invertebrates (Zoo-benthos)

The organisms collected and preserved during site visits were counted after identifying them up to the family and genus level. Standard keys were used for the identification of macro invertebrate samples (Pennek 1953; Edmondson 1959; Macan 1979; Edington and Hildrew 1995). The classification of macro-invertebrates was followed as per https://animaldiversity.org/.

Crude density of MI (Indiv. /m^2) = total numbers of individuals in each quadrat/ total no. of quadrats × 11

3.2 ESTABLISHMENT OF BASELINE FOR VALUED ENVIRONMENTAL COMPONENTS

3.2.1 Physical Environment

The description of physical environment deals with physiography, geology, hydrology, meteorology, soil characteristics, ambient air, noise, and traffic monitoring, and water quality.

3.2.1.1 Physiography

Physiography is one of the important characteristics to realize the landscape of any area. To understand the topography of the study are, the Digital Elevation map, Relief map, and Slope map were prepared from the Digital Elevation Model (DEM) of Shuttle Radar Topography Mission (SRTM) 1 Arc-Second Global data. The data was downloaded from https://earth explorer.usgs.gov/ from which the mask of the study was extracted to prepare above mentioned thematic maps.

Accordingly, Digital Elevation Model (DEM) was generated from SRTM data and the same is given in **Figure 3.2** and according to it, the study area lies between 1908m and 5386m elevation. From the DEM, then relief map of the study area was prepared. The data on relief is given in **Table 3.8** and **Figure 3.3.** The majority of the study area lies in the 3200 to 4000m elevation band.

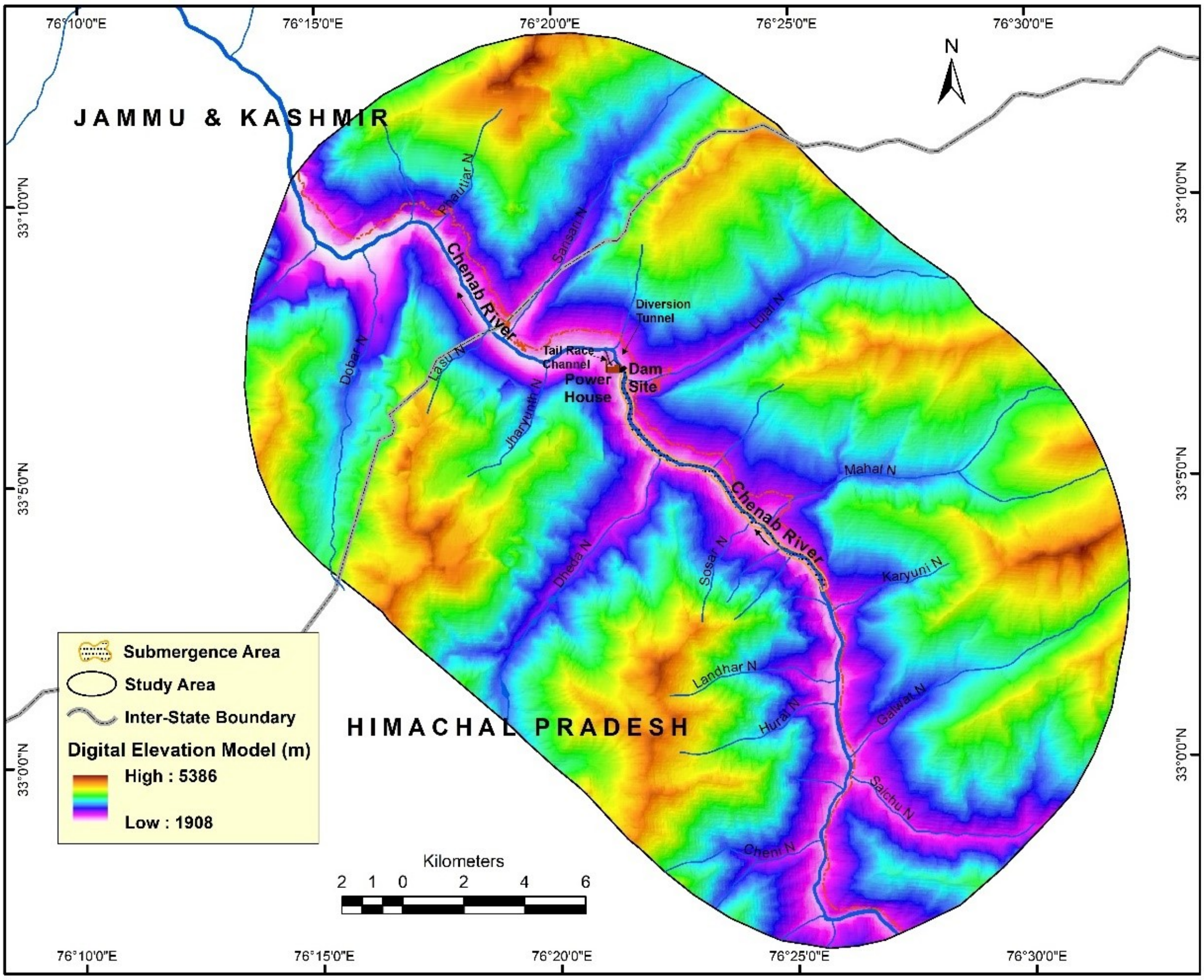


Figure 3.2: Digital Elevation Model (DEM) of the Study Area

Table 3.8: Area under different elevation bands in the Study area

Elevation (m)	Area (ha)	Area (%)
Up to 2000	283.68	0.48
2001-2400	3696.60	6.31
2401-2800	6622.57	11.30
2801-3200	8744.85	14.92
3201-3600	11035.99	18.83
3601-4000	10919.77	18.63
4001-4400	9320.91	15.90
4401-4800	6637.92	11.32
4801-5200	1320.44	2.25
Above 5200	38.28	0.07
	58621.00	**100.00**

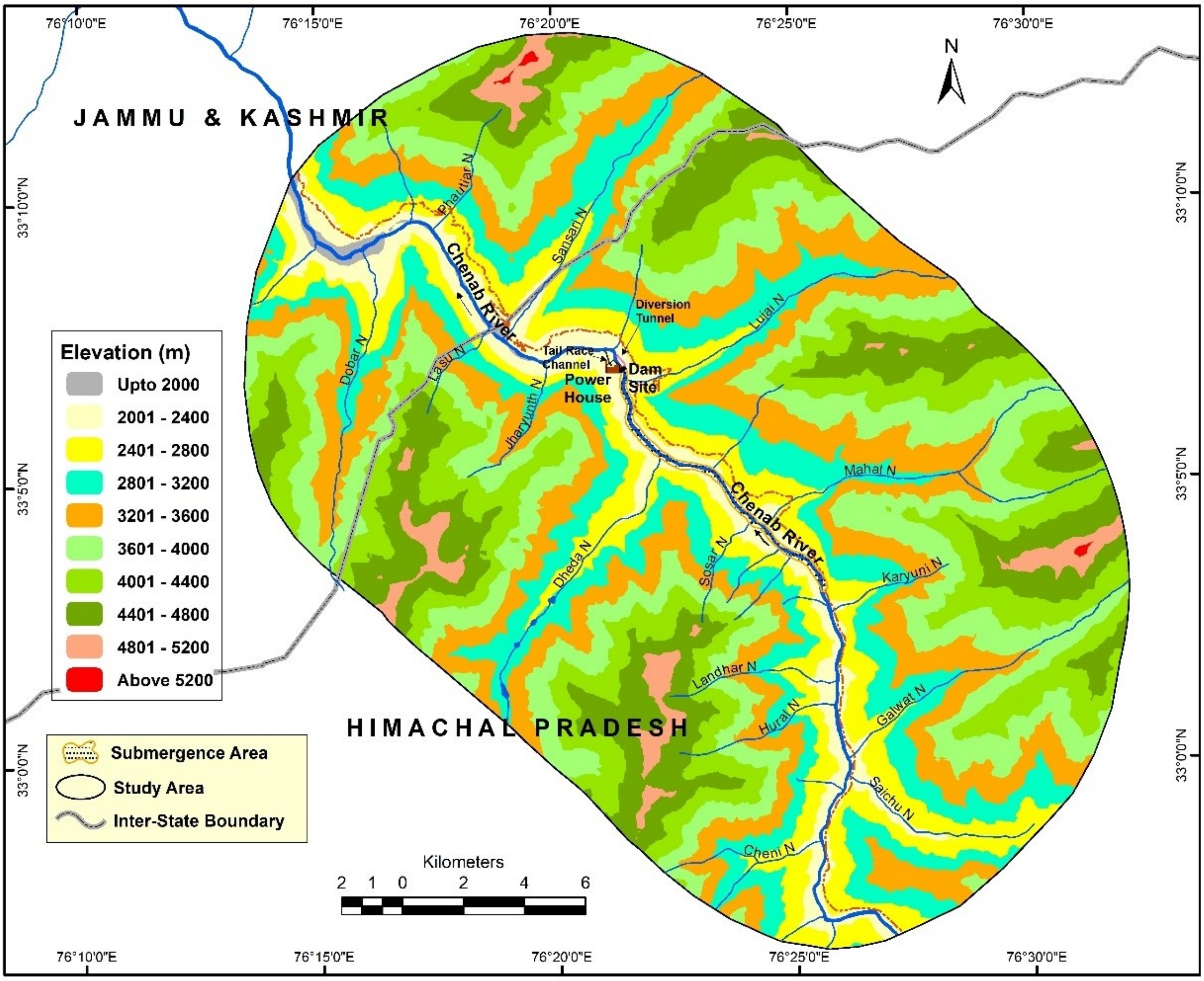


Figure 3.3: Relief Map of the Study Area

The slope map of the study area and data are given in **Table 3.9** and **Figure 3.4** shows that predominantly the study area is moderately sloping. As seen from the map and the table that around 42% of the study area falls under the steep category.

Table 3.9: Area under different slope categories in the Study Area

Slope (Degree)	Area (ha)	Area (%)
Gently Sloping (Up to 2)	45.75	0.08
Moderately Sloping (2 - 8)	730.71	1.25

Strongly Sloping (8 - 15)	2626.14	4.48
Moderately Steep (15 - 30)	18016.92	30.73
Steep (30 – 45)	24692.73	42.12
Very Steep (45 – 60)	10571.48	18.03
Extremely Steep (60 – 70)	1578.58	2.69
Escarpments (Above 70)	358.69	0.61
	58621.00	**100.00**

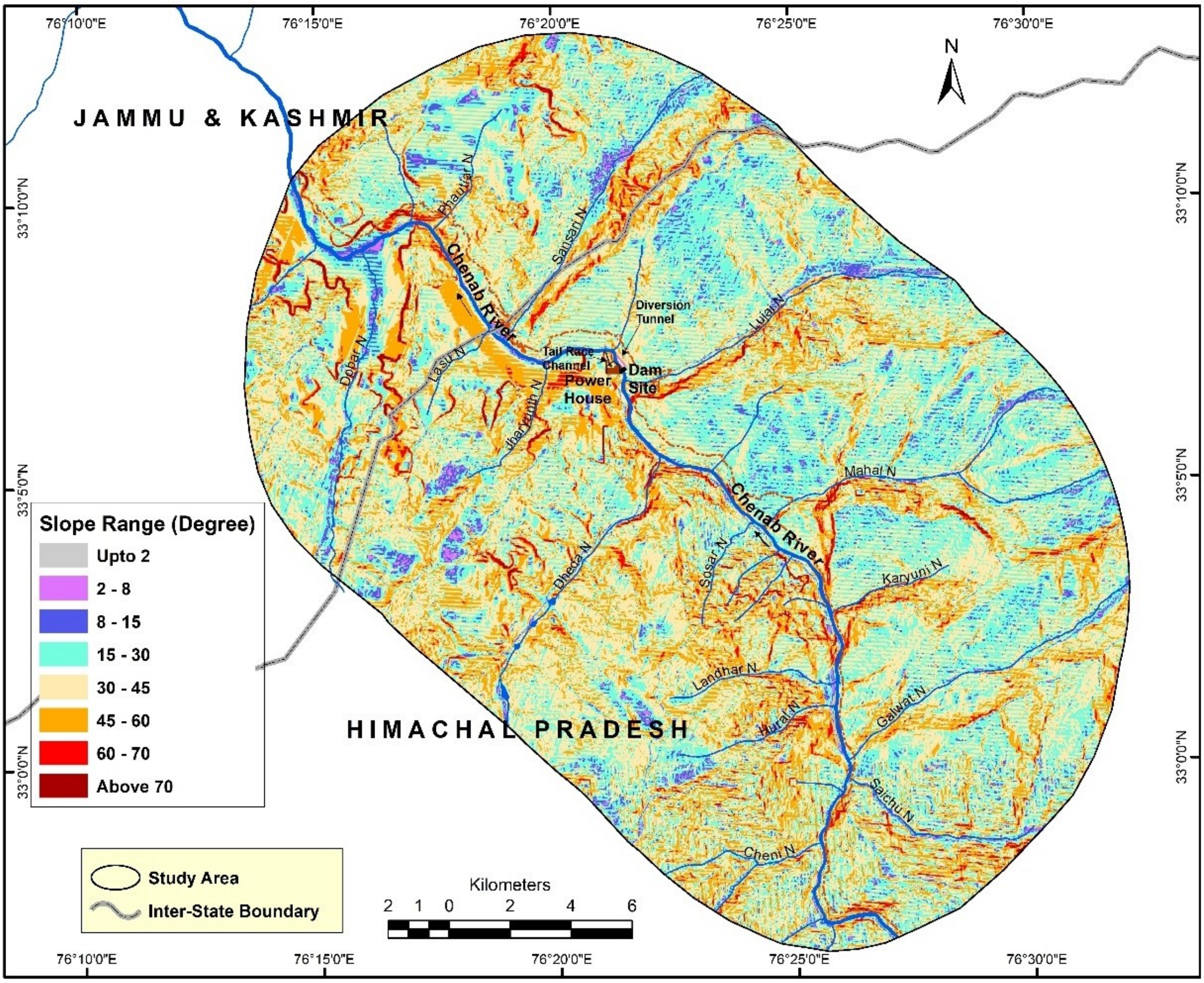


Figure 3.4: Slope map of the Study Area

3.2.1.2 Land use and Land cover

For the present study, IRS P6-LISS IV digital satellite data was used for interpretation & classification (**Figure 3.5**). The data has been procured in raw digital format and has been geo-referenced using Survey of India topographical sheets with the help of standard data preparation techniques in standard image processing software. The interpretation of geo-referenced satellite data has been done using standard enhancement techniques, ground checks and experiences of qualified professionals. A detailed ground truth verification exercise has been undertaken as a part of field survey to enrich the image interpretation process. In addition, help from Google Earth has also been taken to delineate various land use/ land cover categories.

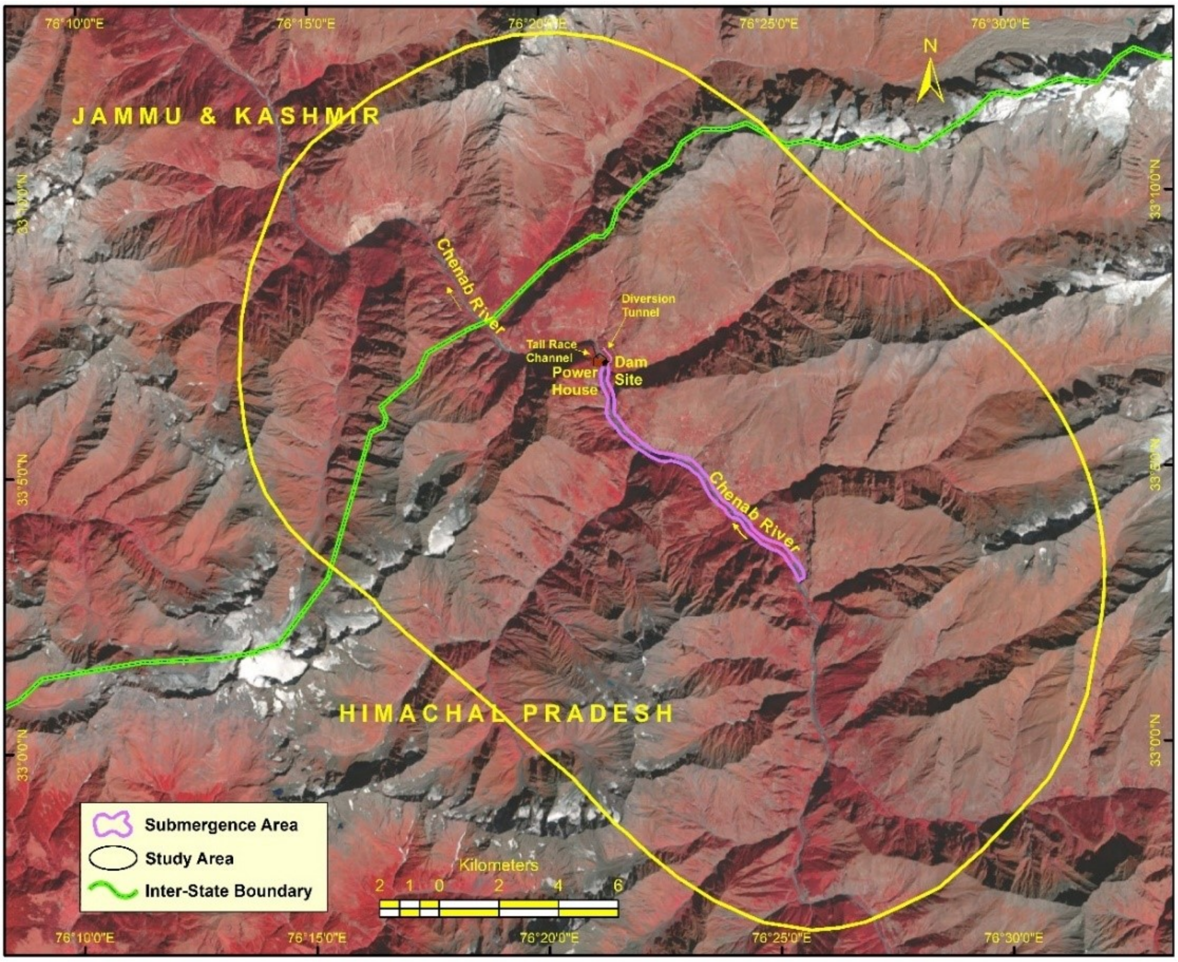


Figure 3.5: FCC generated from Satellite imagery of the study area

The land use/land cover classes were followed as per the NRSC classification. The land use/ land cover map of the study area is shown in **Figure 3.6**. The land use/ land cover of the study area is classified into 11 different classes. Evergreen/Semi-Evergreen Forest and Grass/Grazing land constitutes predominant land use in the study area (More than 50%) (see **Figure 3.6** & **Table 3.10**). Scrub land and Barren Rocky each covers around 14.70% of the study area. Snow/Glacier is comprised of 8%. Waterbody covers around 1.38% of the study area. Each of the other class covers less than 5% of the study area.

Table 3.10: Area under different land use/ land cover classes in the Study Area

S. No	Land use/ land cover classes	Area (in Ha)	Area (per cent)
1	Evergreen/Semi-Evergreen Forest	13050.55	22.26
2	Deciduous Forest	1047.64	1.79
3	Scrub Forest	2315.61	3.95
4	Scrub Land	8622.38	14.71
5	Agricultural Crop Land	1575.58	2.69
6	Agricultural Plantation	1128.13	1.92
7	Grass/ Grazing Land	16497.24	28.14
8	Barren Rocky	8654.06	14.76
9	Settlement	73.95	0.13
10	Snow/ Glacier	4847.28	8.27
11	River/ Waterbodies	808.59	1.38
	Total Area	**58621.00**	**100.00**

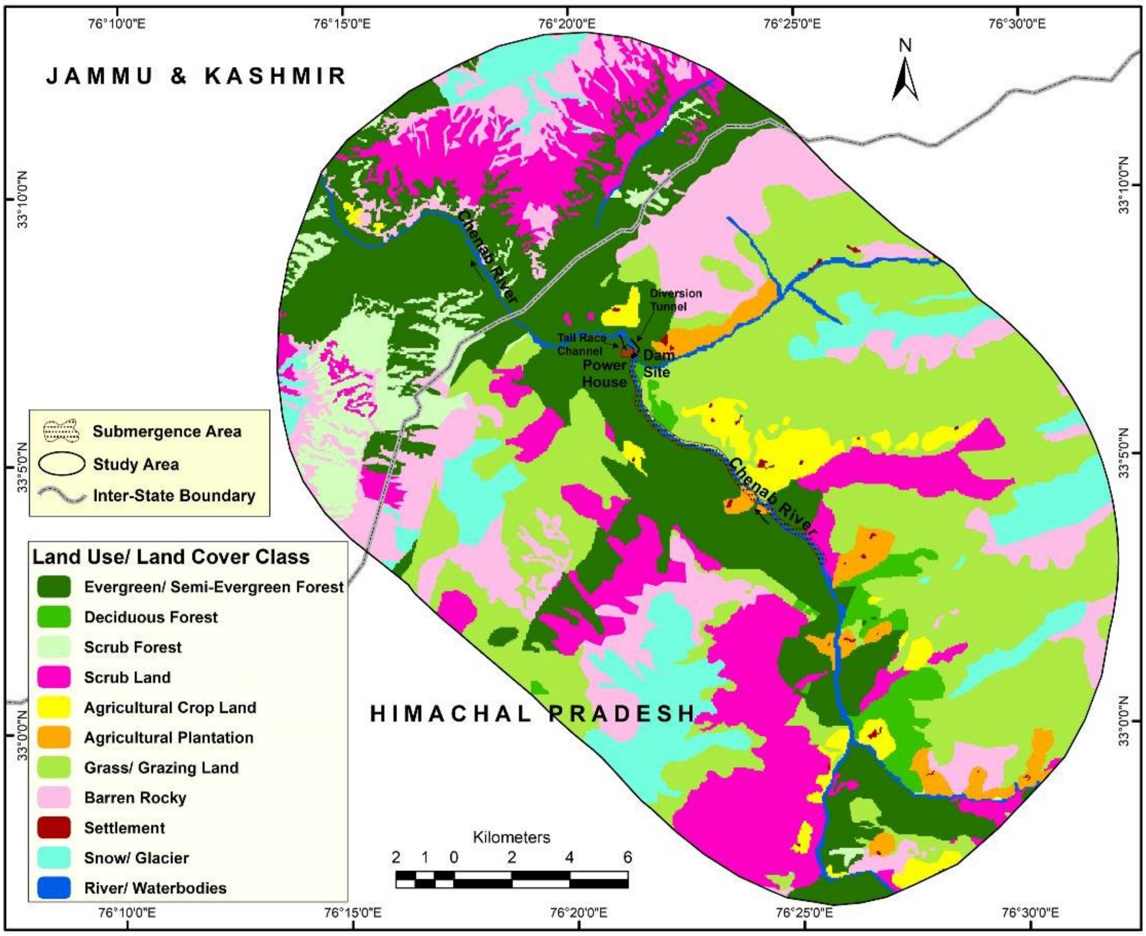


Figure 3.6: Land Use/ Land Cover map of the study area

3.2.1.3 Geomorphology

The Pangi region, a part of the Central Himalayas, is a mountainous terrain bounded by the Zanskar range in the east, and the Pir Panjal Range in the west. The project area is crisscrossed by a series of gullies and ravines which have given rise to sharp vertical escarpments and ridges. The average height of the area is about El. 2000m from the mean sea level and the imposing ridges on either side rise to elevations of up to El. 6000m. The gullies and the ravines are usually narrow and practically vertical near the confluence with the main river. Some of the nala's even show a hanging nature. Higher up i.e., upstream, where they still retain traces of glaciers the valleys are generally broad and 'U' shaped. The project domain, which lies in the Pangi area, a mountainous terrain forms a part of the great Himalaya Range. A rugged topography with high ranges, deep valleys, flat or gently sloping meadows, slopes, escarpments, and cliffs with a great variation in elevation from El. 2015m to El. 5162m characterize this part. Huram jot the highest pass is at El. 5000m, which connects the Lujai area. Pangi Tehsil, with Huram area of Jammu & Kashmir.

3.2.1.4 Geology

a. Regional Geology

Geologically the project is located within the Central Crystalline represented by the Vaikrita Group of rocks. The project area is dominated by a variety of gneissic rocks. Regionally, the area around the project comprises a litho-stratigraphic sequence from the Proterozoic age to the Quaternary period including Salkhala Group and Chamba, Manjir, Katarigali, Bhaderwah, and Dul Formations.

The rock formations in the vicinity of the project area include granitoid belonging to the Rohtang Crystalline Complex towards north and east and Batal Formation of Haimanta Group further north and towards the south. Biotite gneiss/granitic gneisses are the most dominant rock types with several pegmatite and granitic intrusive occurring as concordant as well as discordant bodies. In addition to the Biotite gneisses, beds of banded gneiss, augen gneiss, granite gneiss, micaceous quartzite, and mica schist are also observed in the project area.

b. Geology of the project area of Dugar HEP

In general, biotite gneiss is the most dominant rock type in the project area. The strata have been intruded by several pegmatite and granite bodies which are both concordant as well as discordant. In addition to the biotite gneisses, beds of banded gneiss, augen gneiss, granite gneiss, micaceous quartzite, and mica schist are found in the reservoir area.

The broad lithological sequence in the project area from upstream to downstream comprises coarse-grained biotite gneiss at the tail end of the reservoir, followed by fine-grained, dark micaceous quartzite, biotite schist, micaceous quartzite, and finally medium to coarse-grained gneisses and mica schist, intruded by pegmatite that continues up to and beyond dam site.

c. Seismicity

Dugar Project is located in the Seismic zone IV as per seismic zoning map of India BIS-1893 (Part 1). The site specific seismic design parameter studies for the project have been carried out by DEQ-IIT Roorkee. The Response spectra and Seismic design parameters as recommended by DEQ-IITR in its study report have been approved by NCSDP in its 27th meeting held in June 2014. The NCSDP approved Response spectra and seismic coefficients (horizontal- αh=0.17 and vertical-αv =0.11g) as recommended in the site-specific seismic study report shall be used for design purposes.

3.2.1.5 Hydrology

a) Drainage

The Dugar HEP is located on the River Chenab. The Chenab is a major river of the Indus Basin originating from the Bara-Lacha pass at an elevation of 4,891 m having snow-covered slopes. The river is formed by two major tributaries in the upper reaches i.e., Chandra and Bhaga. The Chandra originates from Bara-Lacha la and is further augmented by the Chandra Tal whereas the Bhaga takes off from the Suraj Tal in the vicinity of the Bara-Lacha and is further joined by the Jankar and the Milang Nala before it joins the Chandra at Tandi to form the Chandra Bhaga or Chenab. Further downstream of the confluence, it is joined by other significant tributaries namely Shansha Nala near Rashil and Thirot Nala at Thirot, Miyar Nala at Udaipur, Saichu Nala at Dawag, Mahal Nala at Killar, Dheda Nala, and Lujai Nala d/s of Killar. The river in its course traverses through Lahaul and Pattan and Pangi Valley (Chamba) of Himachal Pradesh before it crosses into Jammu & Kashmir downstream of Sansari Nala. The length of the Chenab River up to the proposed dam site is around 250.0 km.

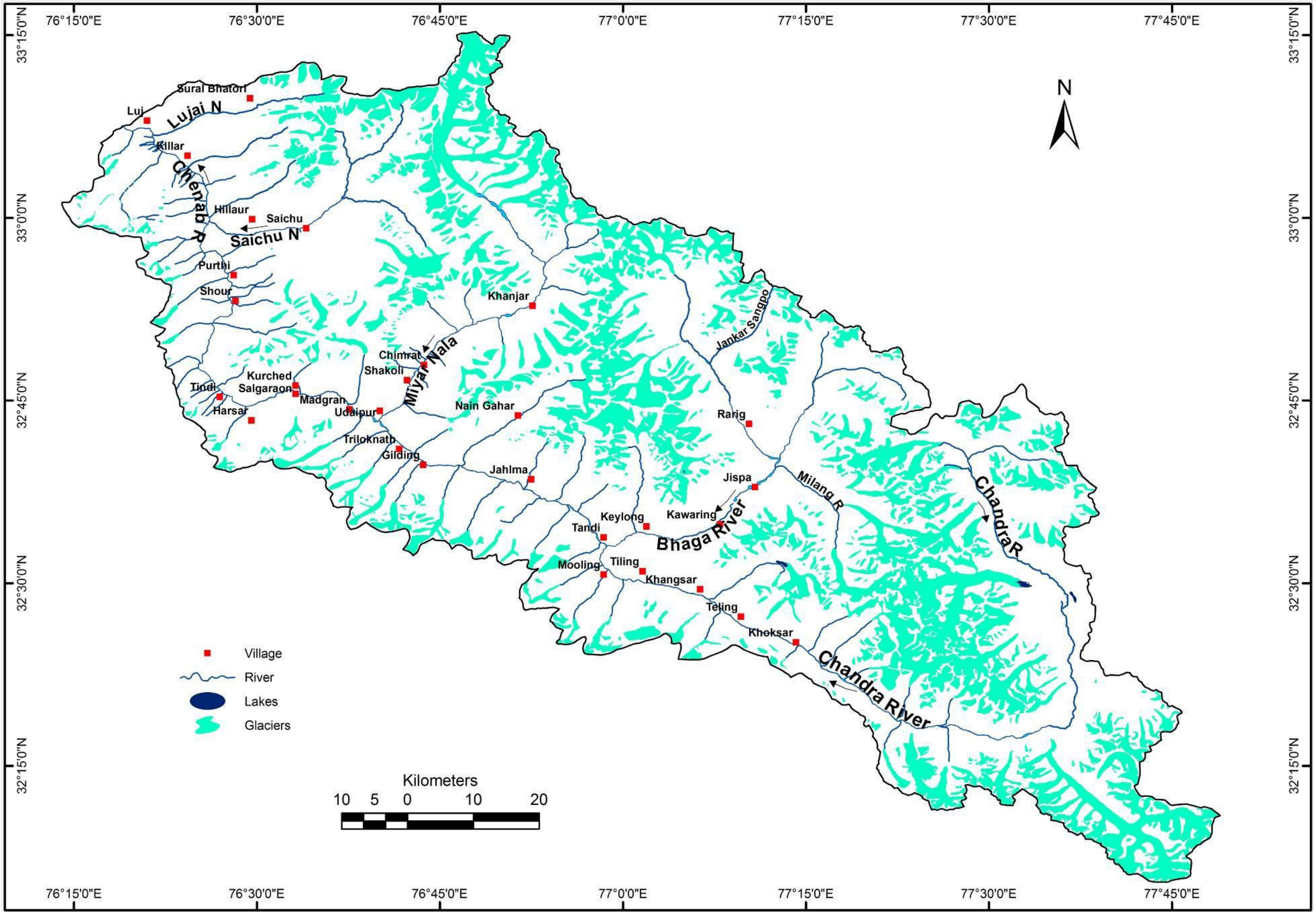


Figure 3.7: Drainage map of Chenab Basin

b) Catchment

The total catchment area of Chenab River in Himachal Pradesh is 7878 sq km and its length in the study area is about 260 km. The total catchment area of Dugar HEP up to dam site had been worked out as 7823 sq km, out of this 4458 sq km is permanent snow-fed area and remaining 3365 sq km is rainfed area.

c) Water Availability

There were six G&D sites in the Chenab basin where long-term discharges were available with DHPL. Gauge and discharge sites at which long-term data was available on the main Chenab River are shown in the **Table 3.11.**

Table 3.11: Data Status of G&D Sites (Available with DHPL at time of DPR)

Site	Data Base
Tandi	1972-2012
Ghousal	1979-2012
Miyar	1993-2012
Udaipur	1974-2012
Gulabgarh	1990-2013
Benzwar	1967

The 10-daily observed flow series at Udaipur G&D of CWC for the period 1974-75 to 2011-12 had been utilized for study and transferred to Dugar HEP diversion site in the catchment area (direct) proportion. The average 10 daily water availability series so developed at the Dugar HEP dam site by DHPL was submitted to CWC for clearance. CWC cleared the water availability series vide 1/HP/48/2012/Hyd (N) /534 dated 10/12/2013.

Additional average 10 daily discharge data at Udaipur G&D site for the period June 2012 – May 2020 has been received from Central Water Commission. Accordingly, the average 10 daily water availability series (data base 1974-2012) as approved by the Central Water Commission has been updated up to the year 2020 by transferring the CWC observed discharge data at Udaipur G&D site to Dugar HEP dam site by catchment area proportion (factor = 1.324) following the same methodology as adopted earlier.

The average 10 daily water availability series, updated up to 2020 has been checked for internal and external consistencies and found to be consistent. The water availability series for the period June 1974- May 2020 was submitted to CWC for clearance.

Central Water Commission approved water availability series (**data base 1981-2020**) is given below in the **Table 3.12**. The average annual yield has been computed as 10123 MCM.

Table 3.12: Average 10 Daily Water Availability Series at Dugar HEP Dam Site Unit: Cumec

Year	10-Daily	Jun	Jul	Aug	Sep	Oct	Nov	Dec	JAN	FEB	MAR	APR	MAY	AVG.
1981-82	I	386.8	770.8	919	490.3	165.3	99.9	64.9	47	47.8	49	59.2	182.7	284.6
	II	411	1031.6	830.7	292.7	142.3	75.8	59.3	45.8	46.9	48.3	74.3	144.4	
	III	976.4	1082.3	618.2	278.6	122.4	69.6	58.8	43.7	48.3	50.5	105.9	236.9	
1982-83	I	423.2	769.7	1139.8	447.8	110.9	70.7	56.1	41.4	36.3	34.8	57.6	132.8	283
	II	710.7	932.7	879.2	448.2	94.5	63.5	55.9	38.9	33.9	40.2	59	228.6	
	III	686.7	1195.3	562.7	180.4	83	58.4	52.2	36.8	31.8	41.9	59.8	221.1	

Year	10-Daily	Jun	Jul	Aug	Sep	Oct	Nov	Dec	JAN	FEB	MAR	APR	MAY	AVG.
1983-84	I	349.6	657.2	1195.8	790.2	188.2	66.2	55.5	48.5	39.4	43.2	55.1	170	291.1
	II	409.7	463.2	908.6	537	130.9	63.9	52.2	48.5	36.4	43.2	67.1	237.7	
	III	734.3	959.8	922.8	257.6	82.3	58.5	48	42	28.8	48.2	91.1	467.7	
1984-85	I	814.3	762.3	791.2	479	102.6	63.1	49.9	47.8	40.8	43	47.9	123.4	272
	II	734.3	578.1	845.2	316.5	86.3	56.7	48.8	44.7	39.3	41.4	55.3	158.4	
	III	850.6	736.6	709.4	147.7	80	54.3	47.8	41.5	40.4	47.2	83	510.8	
1985-86	I	502.2	766.9	774.8	519.3	167.3	71.2	54	49.5	44.3	46.3	48.4	188.6	267.1
	II	620.1	880.9	746.2	318	106.2	65.5	50.2	46.2	45.1	64.3	86.3	333.7	
	III	675.9	708.3	688.9	218.5	83.6	61.2	47.5	40.9	46.5	46.3	135.5	225.6	
1986-87	I	274.5	914.8	921.9	560.7	144.7	70.7	53.3	45.5	41	56	85.6	145.5	293.5
	II	661.1	1055	863.8	260.6	110.1	65.3	48.7	43.4	47	69.2	108.3	146.5	
	III	1054.8	1083.3	637.5	239.6	84.5	59.8	45	42	49.8	71.6	135.4	207.7	
1987-88	I	437.3	948.6	825.5	705.1	174.9	103.4	90.1	77.2	66.8	75.5	132.8	322.3	348.1
	II	513.5	938.9	763.9	738.4	135.3	99.3	84.5	72.8	66.6	102.5	189.3	464	
	III	722.7	1142.2	838.7	361.4	106.5	101.4	82.4	68.5	63.8	92.1	247.4	508.5	
1988-89	I	556.5	1258.4	940	550.9	224.5	113.2	75.5	51.6	45.3	43.9	47.3	68	333.6
	II	707.9	1072.8	931.1	405.2	174.3	99.4	69.1	46.3	45.7	45.4	53.5	96.6	
	III	1268.4	1217.3	652.8	362.8	129.6	84.2	62.1	48	42.7	56.6	58.4	239.6	
1989-90	I	657.9	663.6	694.3	507.9	231.2	119.4	103.2	80.3	67.4	57.2	59.4	175.4	331.1
	II	589.3	918.8	845.4	431	173.7	112.6	92.3	74.5	62.2	57.5	78	460.5	
	III	715.1	1312.9	753.8	339.5	133.5	107.5	85.3	70.2	57.4	64.5	108.5	721.6	
1990-91	I	665.2	1173.2	1085.2	560.8	116.7	76.5	51.8	44.7	37.1	41	129.3	235.1	324.2
	II	606.9	955.3	770.3	284.1	95.3	56.9	49.4	38.9	36.9	59.2	179.8	290.9	
	III	1309.5	839.1	781.5	165.3	84.1	40.9	49.5	38.4	40	90.6	214.8	325.6	
1991-92	I	779.5	1198.1	1084.8	626	215.5	116.1	95.2	74.7	77.7	69.1	96.8	201.5	382.2
	II	1025.6	1288.7	644.5	549.1	165.2	108.3	90.1	72	70.9	80.3	111.2	308.7	
	III	1093.9	1357.1	675.1	309.1	127.1	102.7	83.2	71.8	68.4	95.3	145.7	430.9	
1992-93	I	647.9	1091.8	1079.5	624.3	179.9	109.1	90.3	62.9	54.5	60.1	56.1	155.7	348.1
	II	926.7	1143.9	835.1	288.3	137.7	106.2	80.6	61	54.8	57.7	66.3	164.3	
	III	1202.8	1258.1	860.2	215.9	118.3	99.4	73.8	57.8	53.9	56.9	98.1	222.7	
1993-94	I	403.5	857.5	656.3	471.4	172.5	101.8	89.9	66.1	60.4	58.8	90.3	152.6	258.8
	II	623.7	860.3	527	325.9	142.7	105.5	88.8	63.8	60	69.8	91.6	177.6	
	III	606.4	597.2	620.5	264.9	105.9	98	73.8	59.7	80.1	84.6	116.1	256.9	
1994-95	I	512.9	1233.8	996.1	662.9	155.3	96.9	85.1	83.4	79.2	79.2	91.2	128.3	325.3
	II	479.2	976.5	810.8	291.6	127.5	92.5	79.7	83	83.6	82.9	102.3	133	
	III	1318.8	957.6	863.8	171	97	89.2	79.9	80.4	81.4	84.6	116.1	169.7	
1995-96	I	541.4	1026.9	725.2	598	176.3	132.6	78	76.4	77	81.9	106.3	164.8	325.2
	II	1100.6	1107.4	871.1	365.6	138.8	97.7	74	74.9	82.1	88.4	129.5	173.1	
	III	780	896	810.1	270.2	116.5	81.3	70	76.5	81.3	109.5	147.5	159.8	
1996-97	I	334.4	185.4	285.9	538.7	248.1	112.8	89	80	79.2	111.9	89.1	103.1	215.5
	II	716.8	394.9	241.4	484.9	209.8	90.9	85.2	75.7	78.6	140.6	84.5	71.5	
	III	931.1	413.2	215.9	393.4	174.8	82.5	82.4	75.6	89	128	96.1	145.7	
1997-98	I	332.5	455.5	753	579	127.1	82.7	70.2	62.9	54.7	76.1	113.3	268.3	259.9
	II	280	693.5	799.4	389.7	75.5	77.8	65.9	61.7	56.1	76.4	151.2	323.4	
	III	479.3	674.7	692.1	224.4	77.6	73.3	65.1	60	59.1	92.1	227.9	527.1	
1998-99	I	618.2	1281.6	937.4	667	201.2	120.5	80.9	65	75.7	73.2	95.3	338.1	358.6
	II	441.2	1078.7	898.5	425.4	174.7	107.1	72.9	62.7	76.2	73.2	155.8	476.9	
	III	950	807.8	746.3	346.1	145.7	93.1	64	59.9	73.3	79.4	371.6	526.1	
1999-00	I	360.7	1365.4	1166	622.7	267.3	127.1	87.6	69.6	63.8	62.3	91.5	254.9	375.9
	II	781.5	1201.9	778.3	564.6	159.6	112.5	83.1	65.3	61.4	62.2	128.8	543.8	
	III	1028.5	942.3	782.2	422.3	144	96.1	80.7	65.5	63.1	68.2	154.7	568.8	
2000-01	I	383.9	867.5	892.2	661.1	220.3	171.3	113.2	104.2	86.8	87.5	95.4	200.7	347.9
	II	597	973.4	887	443.7	189.8	137.7	110.1	96.5	86	94.1	113.2	340.2	
	III	893.4	1245.7	848.5	274.4	179.9	120.5	105.9	93.6	86.5	99.3	130.3	388.1	
2001-02	I	538.5	1049.9	807.2	624	189.3	121.1	92.5	80.7	72.8	67.1	103.5	249.6	353.7
	II	775.9	1097.9	1002.7	345.6	149.6	104.4	86.6	79.2	70.2	76	140.4	677.9	
	III	630.9	954.6	832.6	225	136.7	98.9	84.7	76.4	68.8	97.2	175.4	654.7	

Year	10-Daily	Jun	Jul	Aug	Sep	Oct	Nov	Dec	JAN	FEB	MAR	APR	MAY	AVG.
2002-03	I	919	1336.9	1190.4	483.1	188.8	126.1	102.1	80	77.2	85.2	113.7	275.1	
	II	1033.9	1184.8	1047.3	316.5	171.8	115	99.5	78.1	76.4	90.1	187.2	532.4	406.5
	III	1065.3	1016.1	876.3	227.5	155.7	108.4	91.8	79.2	83.4	103.3	199.4	640.6	
2003-04	I	1133.3	1176.4	1021	601.4	167.3	127.1	91.7	86	80.9	93.7	133.7	170.5	
	II	1106.5	1146.3	841.5	437.4	152.6	108.4	90.1	86.3	91.2	107.9	140.4	365.6	398.1
	III	1251.2	1221.9	669.8	344.6	138.5	97.4	84	85.6	90.3	115	177.9	469.1	
2004-05	I	423.6	1290.3	785.9	464.8	182.7	113.2	96.5	72	66	77.7	81.8	264.7	
	II	1037.4	999	995.9	590.2	140.2	105.5	87.8	70.6	87.2	82.5	89.4	183.3	324.1
	III	757.8	839.3	598.1	236.4	125.8	103.3	85.1	70.4	73.8	83.6	112.3	173.3	
2005-06	I	334.5	911.5	1046.5	638.2	110.8	79.4	67.8	59.2	54.1	58.6	70.2	178.4	
	II	541.9	1018.8	774.5	354.1	94.5	73.5	63.3	58.4	54.4	59.2	71.7	362.6	305.3
	III	1057.4	1025	610.2	172.5	87.8	64.2	61.4	58	57.8	61.5	108.8	423.3	
2006-07	I	802.4	1251.4	1314.2	545.2	152.1	88	69.4	59.4	59	59.9	87.9	323	
	II	482.1	974.8	989.2	538.1	129.5	75.7	67.2	58.5	58.1	82.3	137.9	463	361.2
	III	864.4	1326.3	850.1	170.4	104.8	73.5	62.7	59.3	58.8	75.3	161.5	248.5	
2007-08	I	393.9	974.5	894.8	580	124.7	91.3	75.6	63.5	62.2	65.5	69.5	197.8	
	II	841.9	655	862.1	328.5	100.1	84.6	69.4	62.6	62.2	66.2	73.1	390.5	315.9
	III	1042.1	996.4	808.8	237.9	97.4	79.8	64.6	62.2	62.7	68.5	94.8	504	
2008-09	I	709.2	898.9	902.5	355.4	250	166.1	131.3	78.1	82.1	86.6	101.1	189.8	
	II	1052.2	871	793.4	312.7	213.4	157.1	114.8	77.6	83.9	89.6	112.4	264.6	338.3
	III	901.8	896.6	693	262	178.7	141.6	83.6	80.9	85.6	97	141.4	458.6	
2009-10	I	615.3	805.6	1087.9	394.2	173	103.6	99.1	92.3	72	73.6	93.4	268.4	
	II	482.6	1073.4	1086.1	202	123.1	98.8	94.3	89.5	74.1	74.7	103.3	232.8	322.7
	III	892	910	872.3	215.8	104.7	98.8	93.3	79.3	73.6	87.5	141.1	360.3	
2010-11	I	446.2	753.2	2895.3	843.9	262.5	142.4	121.7	107.5	102.8	82.1	93.2	352	
	II	384.3	967.6	1954.8	438.4	221.1	126.5	117.6	107.2	77.2	85.9	106.2	450.6	456.3
	III	807.3	1652.7	835.1	338.9	207.7	83.7	115.2	106.1	81.9	89.4	184.5	570.5	
2011-12	I	510.5	731.1	761.7	680.4	303.3	140.1	113.4	103	87.2	83.4	119.3	167.3	
	II	697.8	737.3	691.2	560.5	222.5	130.5	110.4	101.5	84.3	87.8	137.1	244	324.6
	III	1001.2	882.5	686.3	336.8	163.2	119.3	105.4	92.8	80.6	99.8	142.4	336.1	
2012-13	I	439.9	849.2	933.6	659.6	228.6	129.8	110.4	88.1	81	74.9	91.5	180.9	
	II	456.3	828.1	714.9	551	172.2	119.3	96.5	84.8	78	79.3	128.3	293.2	321.2
	III	686.7	920.1	801.2	304.8	142.8	116.3	90.4	81.5	73.6	82.6	159.5	542.2	
2013-14	I	843.6	922.8	888.2	555.5	278.6	123.2	89.5	97.4	98	100.7	101.5	181.8	
	II	847.5	932	737.3	390.3	242.1	102.9	88.8	99.6	96.1	107.2	109.9	171.4	330
	III	795.5	905.9	687.3	295.4	150.5	96.1	85.2	93.3	99.5	107.1	126.7	194.6	
2014-15	I	332	860.3	742.6	384.6	183.1	91.5	73.5	58	55.6	72.8	77.4	265.9	
	II	704.8	1026.6	619.7	236.3	109.4	84.1	67.5	56.8	66.9	63.2	89.8	375.1	283.8
	III	670.3	989.4	484.2	197.8	92.2	80.2	66.5	49.3	100.7	73.4	149.9	500.4	
2015-16	I	353.6	1294.4	849.9	186.1	81.3	87.8	46.1	69.7	62.4	77	79.6	265.9	
	II	821.7	1318.8	403.4	178	80.9	74.8	42.9	70.7	60.9	66.8	78.3	375.1	294.5
	III	873	1295	260.7	108.4	79.3	57.2	66.2	65	71.9	72.1	76.9	500.4	
2016-17	I	443	840.6	923.8	351	205.9	88.7	76.2	74.2	92.3	88.4	97.2	177.9	
	II	801.9	848.4	635.4	330.5	129	82.3	70.9	70.1	87.1	85.4	165.6	349.3	294.9
	III	804.2	674.1	516.9	249.4	107.8	80.5	67.3	81.9	90.4	84.4	202.7	504.8	
2017-18	I	470.6	875.6	805.8	314.2	178.1	122.6	79.9	82.6	82.6	90.6	101.2	174	
	II	433.9	1110.3	519.5	235.6	143.8	108.7	80.1	84.6	81.6	94.3	105.4	169.7	276
	III	692.3	1045.6	448.5	232.8	124.9	83	77.3	88.8	83.9	94.5	139.2	225.2	
2018-19	I	507	513.6	767.2	500.7	172.6	113.1	97.4	85.9	74.1	66.2	120.7	202.4	
	II	502.4	695.3	723.7	324.1	137.1	107.1	90.9	82.5	81.9	70.2	142.3	237.1	267.1
	III	528.1	763.3	605.5	222.1	121.8	100.8	86.5	77.9	81.5	74.1	185.2	298.8	
2019-20	I	447	942.2	1244.7	585.1	182.4	100.2	78.2	67	62.5	59.5	63	104.5	
	II	435.9	1108.1	1143.9	467.9	112.4	88.5	77.5	65.6	60.3	62.3	70.1	175.3	311.5
	III	532.5	1156.3	558	351.6	103.5	86.2	76.2	63.5	58.8	63.3	82.8	244.5	
Average	I	**529.4**	**936.6**	**967.4**	**549**	**184.7**	**107.2**	**83.2**	**71.4**	**66.7**	**69.6**	**88.4**	**202.6**	
	II	**676.4**	**952.3**	**826**	**392.3**	**144**	**96**	**78.4**	**69.2**	**66.7**	**75.1**	**109.6**	**297.1**	**321**
	III	**875.2**	**997.4**	**691.7**	**260.8**	**120.5**	**87.2**	**74.5**	**67.3**	**68.3**	**80.4**	**143.8**	**382.3**	

d) Design Flood and Diversion Flood

The total catchment area of Chenab River at Dugar HEP dam site is 7823 sq km out of which 4458 sq km is snow-fed area and 3365 sq km is a rainfed area at El. 4500 m snowline. The IS-1223-1985 standards have been followed for the selection of inflow design flood for the safety of the dam.

The gross storage capacity is more than 60 Mcum and the static head is more than 30 m. Therefore, the spillway of the proposed dam shall be designed to negotiate probable maximum flood. 1-day PMP of 12.6 cm as suggested by IMD was used for the design flood study. The Probable Maximum Flood (PMF) value for the Dugar HEP thus calculated and proposed was 9902 cumec. CWC vide letter no. 1/HP/48/2012/Hyd (N) /103 dated 20/02/2014 recommended the design flood value of 9425 cumec.

As per DPR diversion flood was assessed both by considering monsoon and non-monsoon peaks. Observed Flood peaks available for the period 1974 to 2012 for the non-monsoon period. The flood values for different return periods at Udaipur were then transferred to Dugar HEP dam site by Dickens formula. Considering the monsoon period, 1 in 25 years return period flood of monsoon was estimated as 2517 cumec by Gumble EV I method. However, the maximum observed annual flood peak at Udaipur is 1750 cumec. To compensate for the effect of the instantaneous flood peak, the observed value is increased by 25% in magnitude i.e instantaneous flood peak at Udaipur is 2187.5 cumec. The transposition of this diversion flood to Dugar HEP Diversion site, using Dicken's Formula (Factor = 1.23), resulted in a diversion flood of 2700 cumec at Dugar HEP dam site. The above study conducted by DHPL was entrusted to CWC for clearance. "CWC vide letter no. 1/HP/48/2012/Hyd(N)/133-135 dated 26.05.2020 confirmed that the design flood of 9425 cumec approved by CWC in the year 2014 is in order and there is no necessity of its revision at present".

e) Reservoir Elevation Area Capacity

The Reservoir Elevation Area Capacity curve is available in the DPR of Dugar HEP prepared by DHPL. The reservoir elevation-area-capacity at the proposed diversion site is prepared using a reservoir contour map available at a 5m contour interval (**shown in Figure 3.8**). At Full Reservoir Level (El. 2114 m), the reservoir storage capacity is 61.58 Mcum, and reservoir surface area is 160.45 ha. At MDDL i.e at El. 2102.35 reservoir storage capacity is 45.01 Mcum and live storage is 16.57 Mcum. The live capacity of 16.57 MCM has been mentioned by CEA in power potential studies clearance vide their letter no. NR/201/49/2014/HPA/473-476 dated 16.10.2014. CEA also approved the same pondage vide letter no. 6/36/2014/Dugar/HP&I(1)/9 dated 03.01.2014.

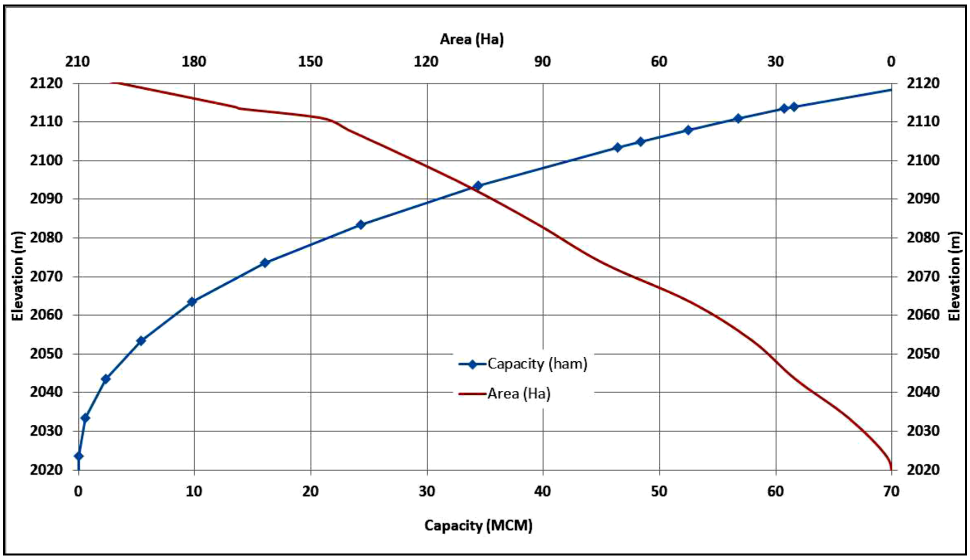


Figure 3.8: Reservoir Elevation Area Capacity Curve

f) Sedimentation Study

The sediment distribution in Dugar HEP reservoir was studied based on the Empirical Area Reduction method using the graphs and design curves. Revised Reservoir Elevation Area Capacity curve, as well as new zero elevation, was computed for different years of sedimentation considering annual sediment rate of 0.058 Ham/sq km/year at Dugar HEP project site. Based on the study of analytical and two-dimensional numerical modeling MIKE-21C for reservoir sedimentation following conclusion was drawn:

- The developed scour cone is below the spillway crest.
- The sediment bed profile is well below the power intake for a distance of 195 m
- Operating/Opening two gates shear cone was generated in all situations. This shear cone helps to keep sediment-free in front of the sluice gate and maintain live storage to the extent possible
- The crest level of the gate has an impact on the volume of the shear zone. Lowering crest level from El. 2062.5 m to El. 2052.5 m is favourable situation.
- 42.9%, 20.3% and 8.2% of 0.2 mm, 0.25 mm, and 0.3 mm coarse particle will be entering to intake based on Rouse-Vannoni profile after 19 years of deposition with spillway crest at El. 2052.5 m.

CWC cleared the sedimentation studies vide letter no. CWC UO No. 7/19/2014-HCD(N&W)/1336 dated 13/10/2016. "The sedimentation studies, Central water Commission vide File no. T-12024/8/2020-CMDD(NW) dated 09.10.2020 has mentioned that "spillway layout and its crest elevation meet the requirements of the guidelines from the reservoir sedimentation considerations'.

g) Glacial Lake Outburst Flood (GLOF):

A study has been carried out by NHPC for the largest existing Glacial Lake (Area 160 ha) located at around 205 km from dam site. The peak discharge at dam site, due to GLOF event was estimated as 1145 cumec. CWC vide letter no. 6/11/2009/FE&SA dated 23/12/2020 cleared the GLOF studies and recommended GLOF value of 1145 Cumec for an assumed condition that the lake burst and 100 year flood (2939 cumec) occur simultaneously at dam site.

3.2.1.6 Catastrophic Events

The following recent catastrophic events like cloud bursts or avalanches have been documented as per District Disaster Management Plan (DDMP) 2020-21, Chamba in the study area of Dugar project which falls in in Pangi Sub-division of Chamba district.

S.No.	Date	Affected Area
A	**Cloud Brust**	
1	25th July 2018	Affect the operation of Himurja Power House, sural and Sach Power House in Pangi Valley
B	**Avalanche**	
2	7th Feb 2019	Snow avalanche occurred at Village Moorch, Gram Panchayat Sechu, Tehsil Pangi
3	5th March 2019	An Avalanche was reported in Urr, Dhank in Gram Panchayat Dharwas

3.2.1.7 Meteorology

The study area of the project lies in the Chamba district, which experiences mostly hot summer. The southwest monsoon rainfall occurs from June to September in the study area with maximum rainfall occurring between these months. The temperature in the study area starts rising in February and attains its maximum value in May and then decreases. May and January are the hottest and coldest months of the year, respectively. In summer, though the day temperature remains high, nights are colder and pleasant. The meteorological data for Killar (Sub-divisional headquarter) of Chamba district was downloaded from the online weather portal https://www.worldweatheronline.in/. Monthly averages of data on temperature, rainfall, relative humidity, and wind speed for the last 10 years 2011-2020 are given in **Annexure-IIIa.** A brief account of different meteorological attributes is given in the succeeding paragraphs.

i. Temperature

The temperature of the study area recorded monthly data for the year from 2011 to 2020. In the study area, the average maximum temperature of 40.0°C was recorded in Killar (Sub-divisional headquarter) during June. The average minimum temperature of 7.4°C was recorded during January. The monthly variation of average maximum and minimum temperatures is shown in **Figure 3.9.**

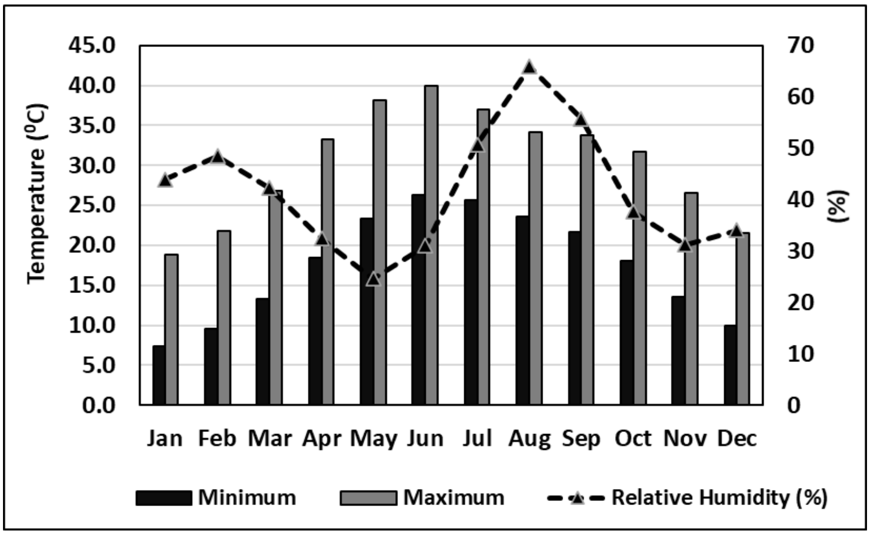


Figure 3.9: Average Mean Monthly Maximum and Minimum Temperature in the study area for the Years 2011-2020

ii. Relative Humidity

The relative humidity is generally low throughout the year, except during monsoon months when the average humidity in the study area is close to 66% in August. The summer months are generally the dry months of the year with average humidity as low as 25% in the study area (the reference year 2011-2020). The average monthly variation in humidity is given in **Figure 3.9**.

iii. Rainfall

The area receives maximum rainfall during the southwest monsoon i.e., between June and September (**Figure 3.10**) when about 63.0% of the annual average rainfall is received and 37.0% of the annual average rainfall occurs between October and November post-monsoon or retreating monsoon season. The mean annual average rainfall of the Killar (Sub-divisional headquarter) was recorded as 1189.9 mm. Maximum Rainfall in the area was recorded in 2013 with an annual rainfall of 1774.5 mm with 124 rainy days. Minimum annual rainfall was recorded in the year 2016 with an annual average of 657.67 mm (see **Figure 3.11**.

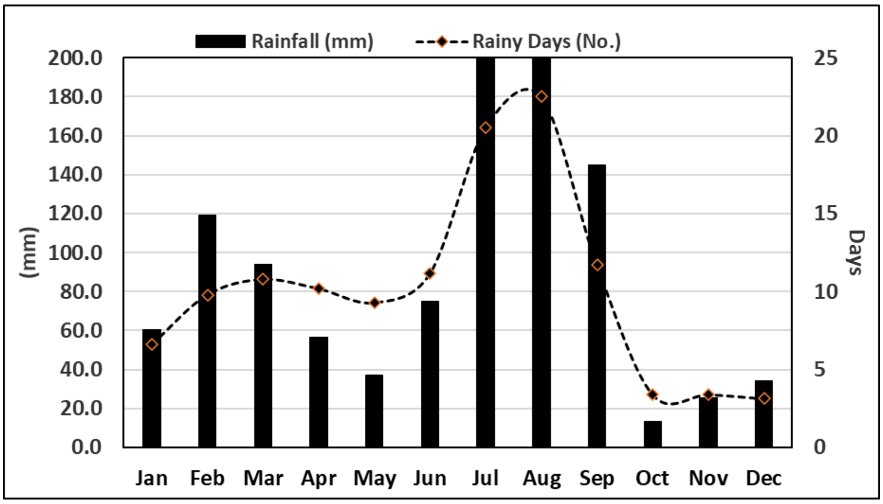


Figure 3.10: Mean Monthly Average Rainfall and Number of Rainy Days in the study area for the Years 2011-2020

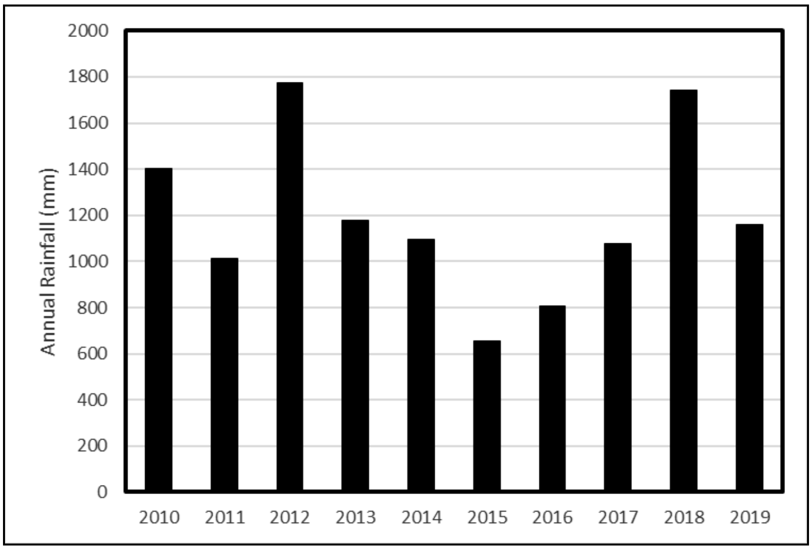


Figure 3.11: Annual Rainfall for the last decade in the study area (reference Years 2011-2020)

iv. Wind Speed

The wind speed is higher during the monsoon period as compared to the post-monsoon period. The average maximum wind speed of 4.17 m/s is observed during May. The monthly variation in wind speed during reference years 2011-2020 is given in **Figure 3.12**. Wind speed and direction data are useful in identifying the influence of meteorology on the air quality of the area. Based on the world weather online meteorological data, wind-rose diagrams i.e., the diagrammatic representation of wind speed and wind direction were generated from September 2020 to August 2021. Wind-rose diagrams of the study are given in **Figure 3.13** and a summary of the same is given in **Table 3.13**. Detailed hourly and daily month-wise data on wind direction is given in **Annexure-III b**.

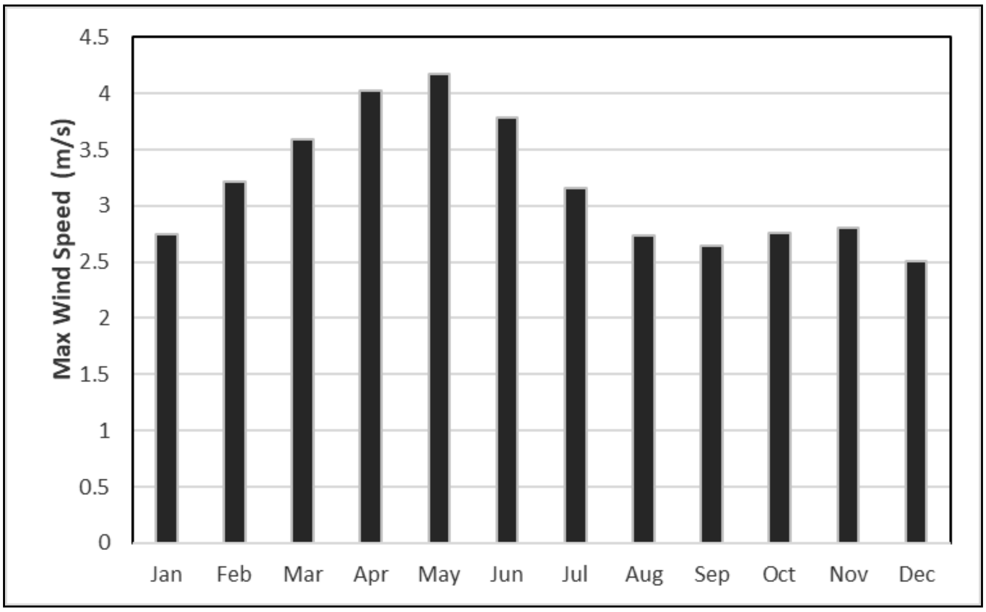
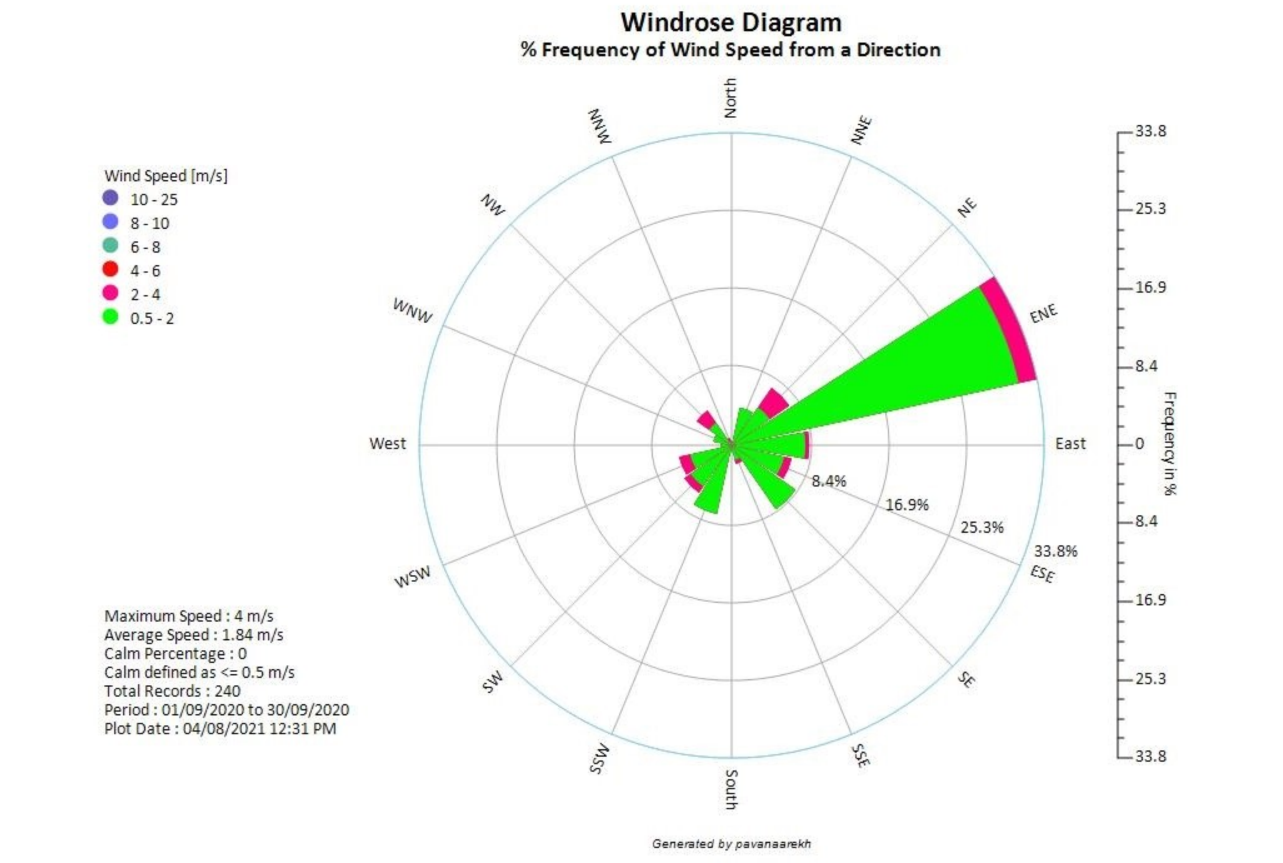


Figure 3.12: Mean Monthly Average Max Wind Speed in the study area

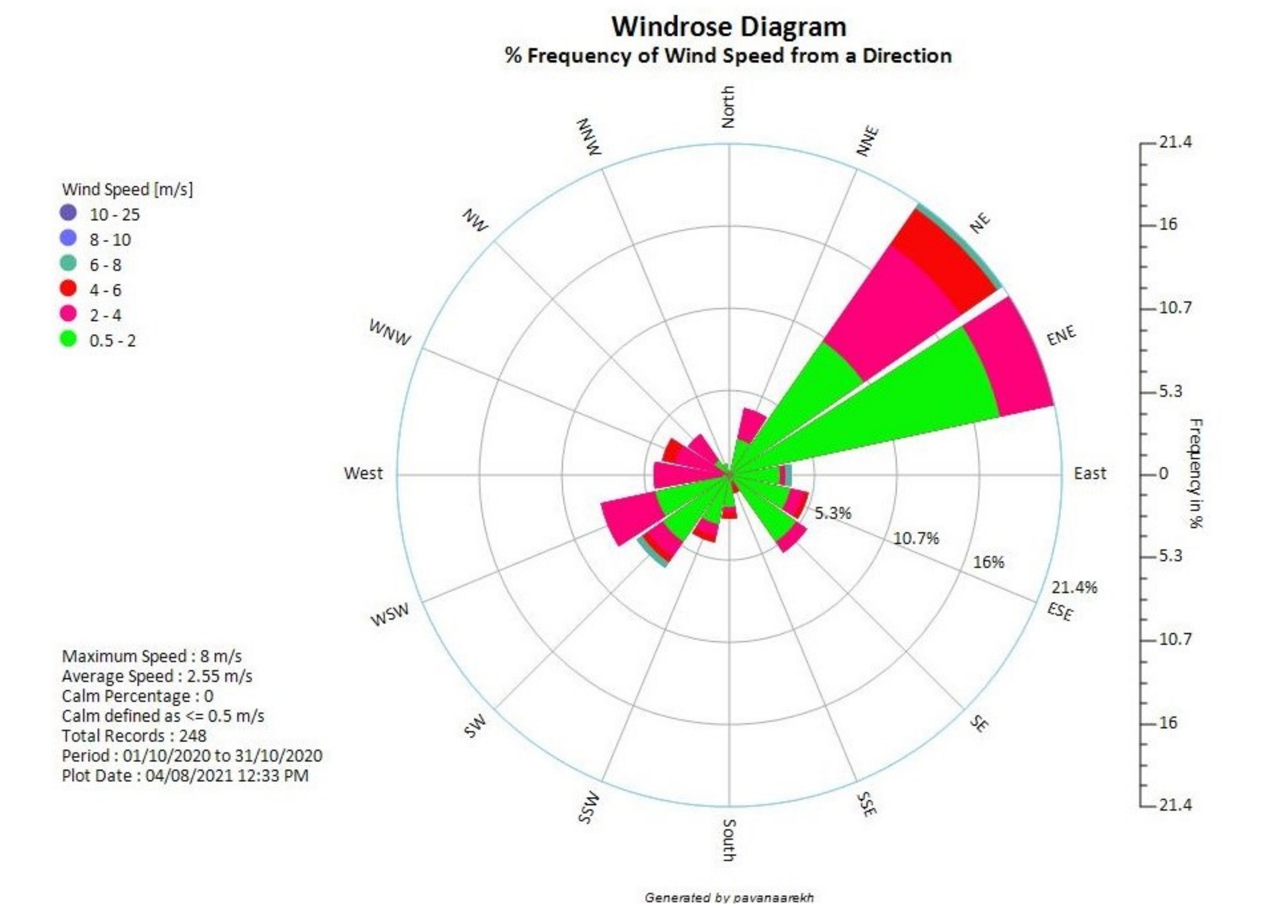
The predominant wind direction is from East Northeast as on average 22.08% time it blows in this direction. It remains so from September 2020 to January 2021 and again from May and August 2021.

Table 3.13: Summary of Wind Pattern in the study area during different Months

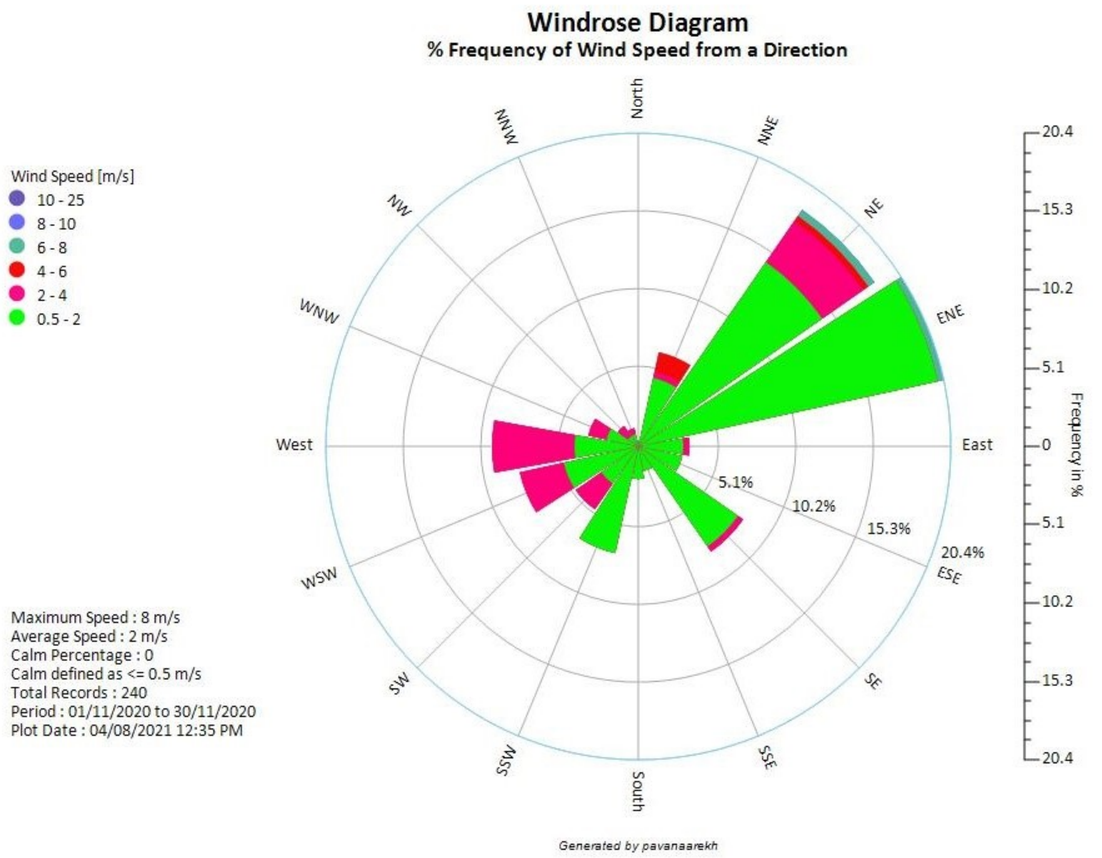
Month	First Predominant wind Direction	Second Predominant Wind direction	Calm
Sep-20	ENE (33.75%)	East (8.34%)	0.00%
Oct-20	ENE (21.37%)	NE (21.36%)	0.00%
Nov-20	ENE (20.42%)	NE (18.75%)	0.00%
Dec-20	ENE (19.42%)	NE (10.91%	3.24%
Jan-21	ENE (18.54%)	NE (11.69%)	7.26%
Feb-21	NE (20.98%)	ENE (16.97 %)	0.45%
Mar-21	NE (22.58%)	ENE (14.51%)	0.00%
Apr-21	NE(29.17 %)	ENE (11.25%)	0.00%
May-21	ENE (16.53 %)	NE (13.3 %)	0.00%
Jun-21	ESE (12.92 %)	ENE (12.09%)	0.00%
Jul-21	East (20.56 %)	ESE (15.72%)	0.81%
Aug-21	ENE (24.59 %)	East (12.5 %)	0.81%



September 2020



October 2020



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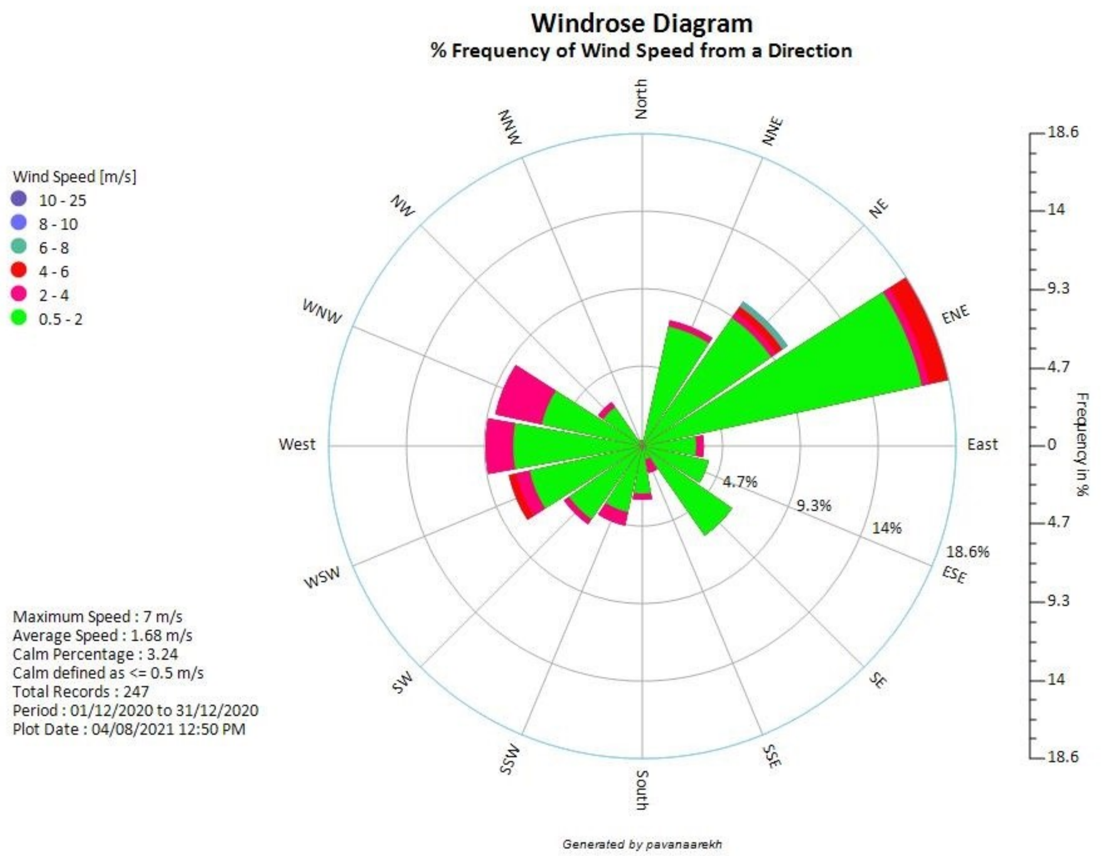

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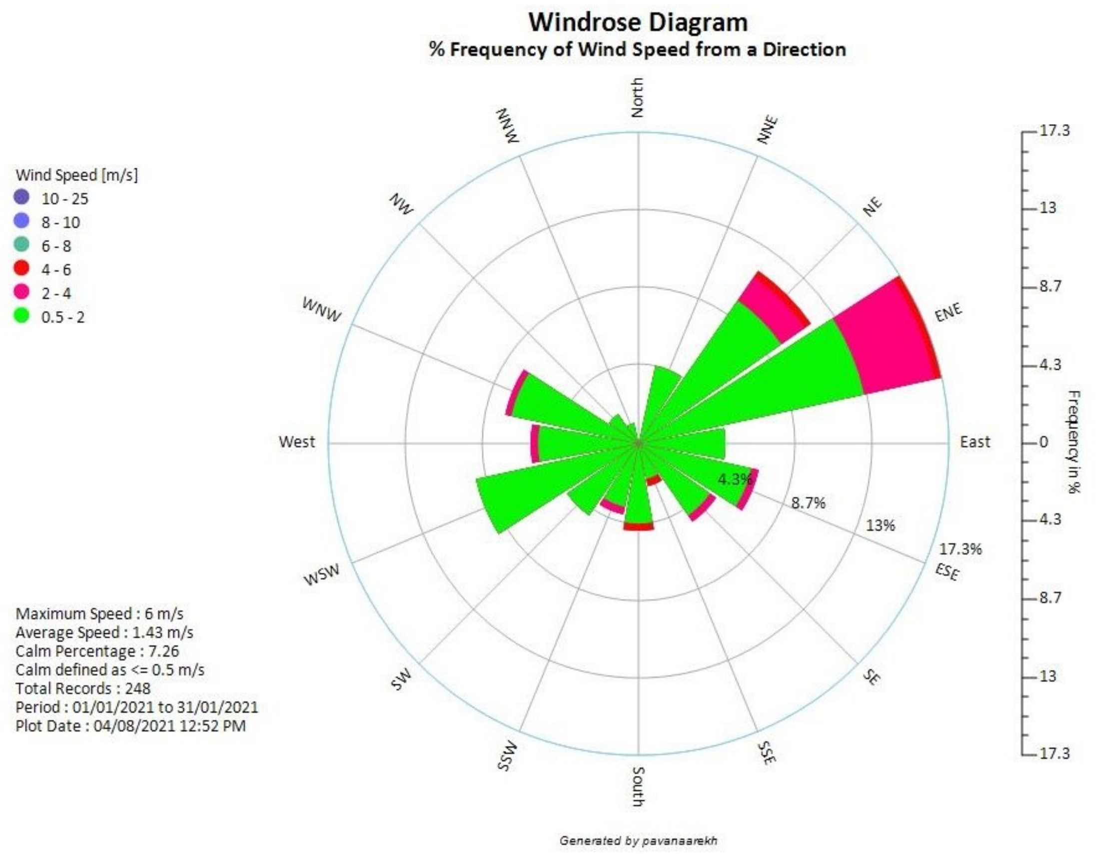

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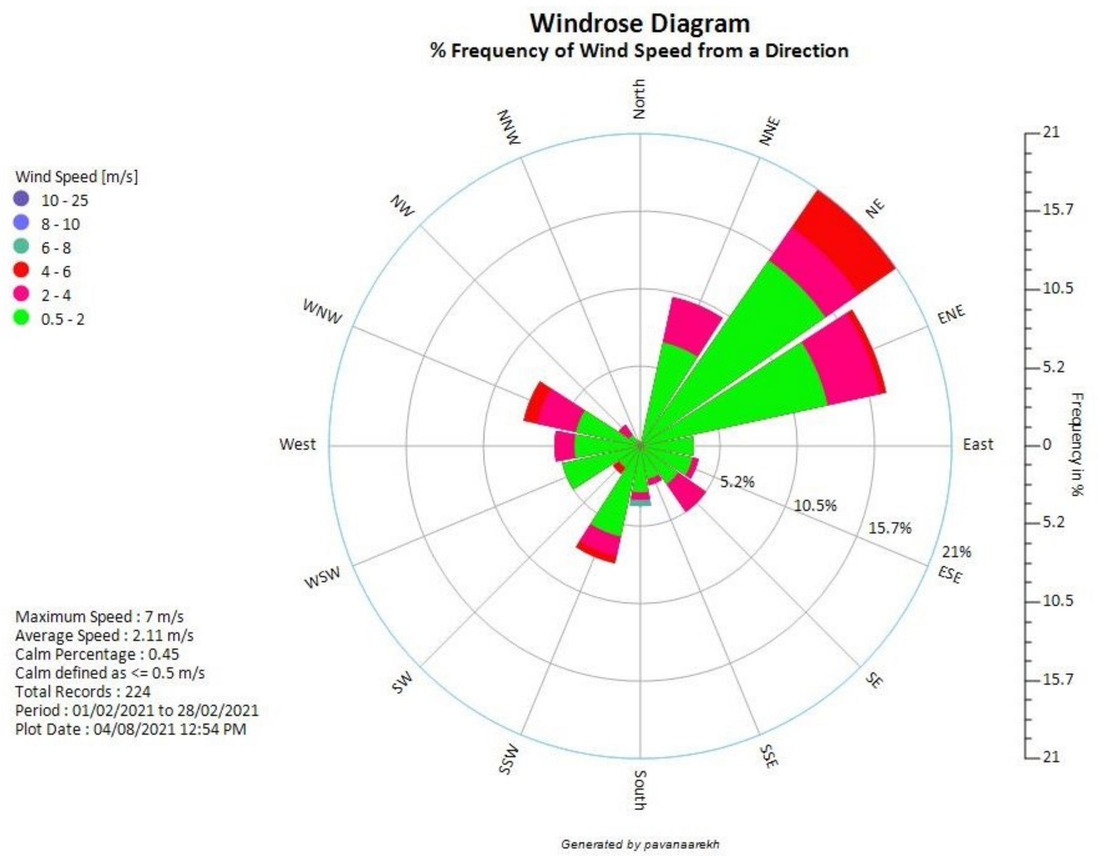

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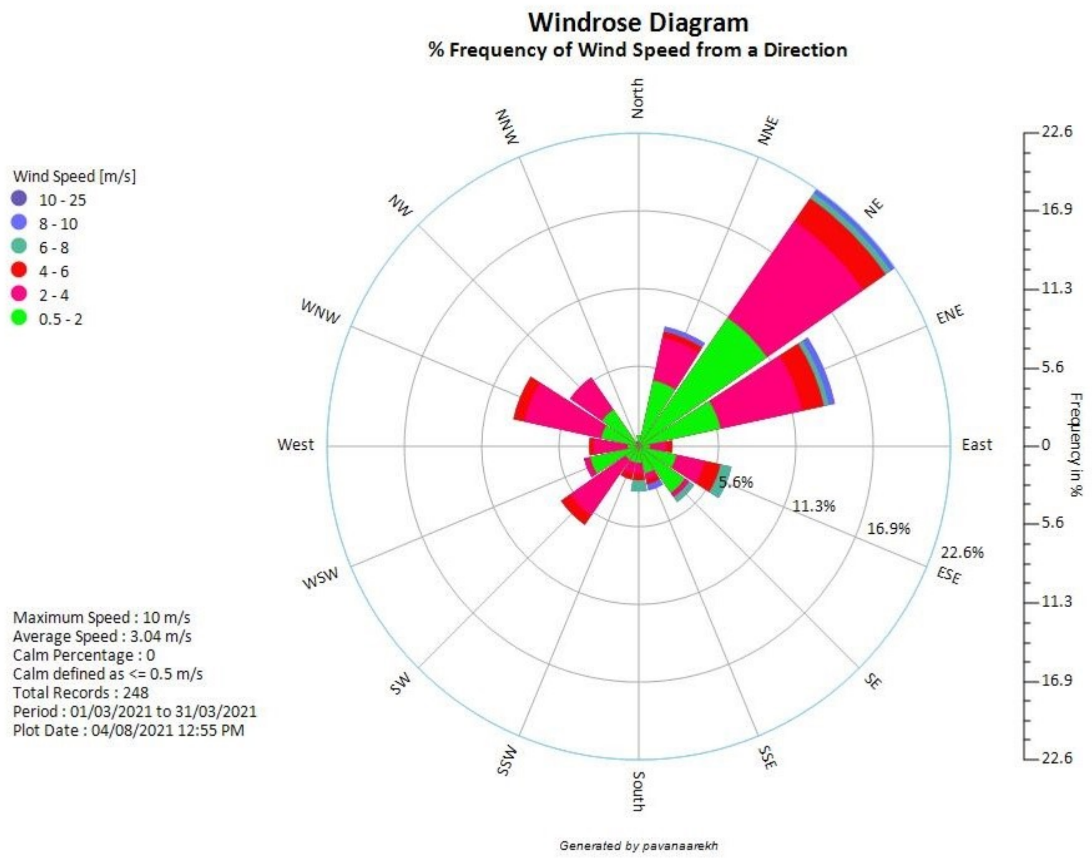

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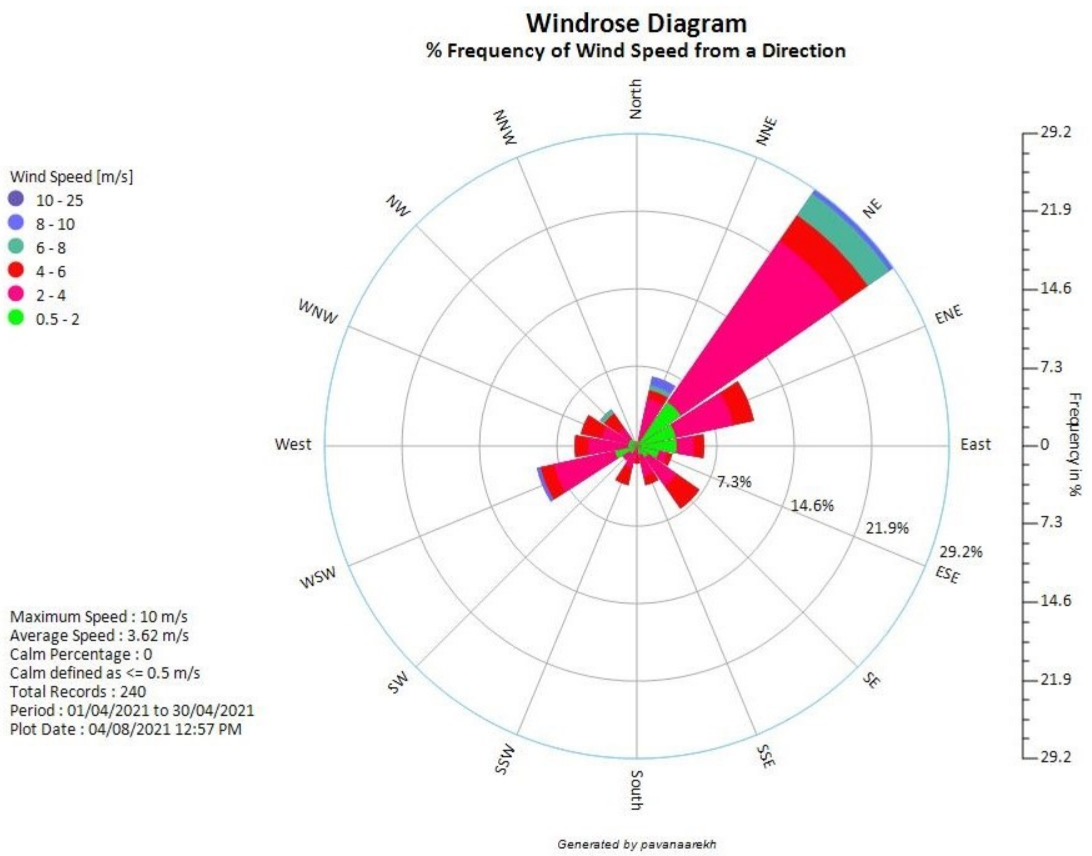
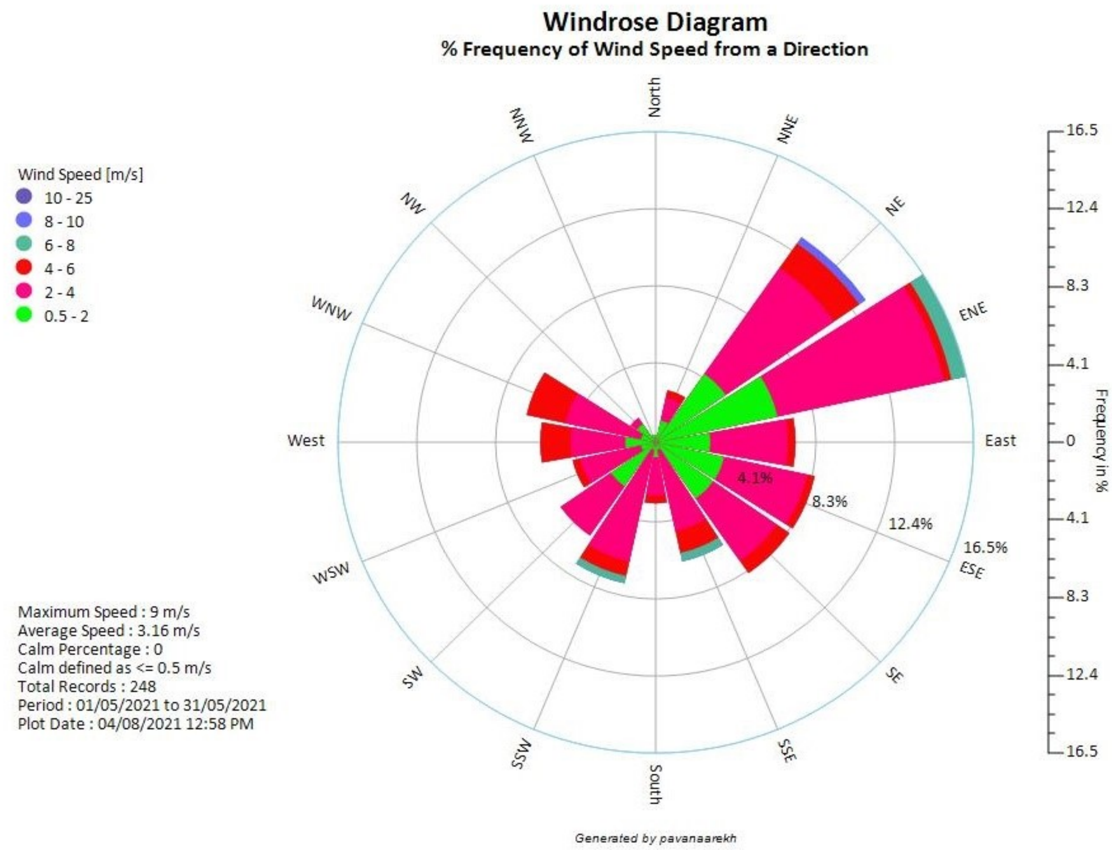


April 2021



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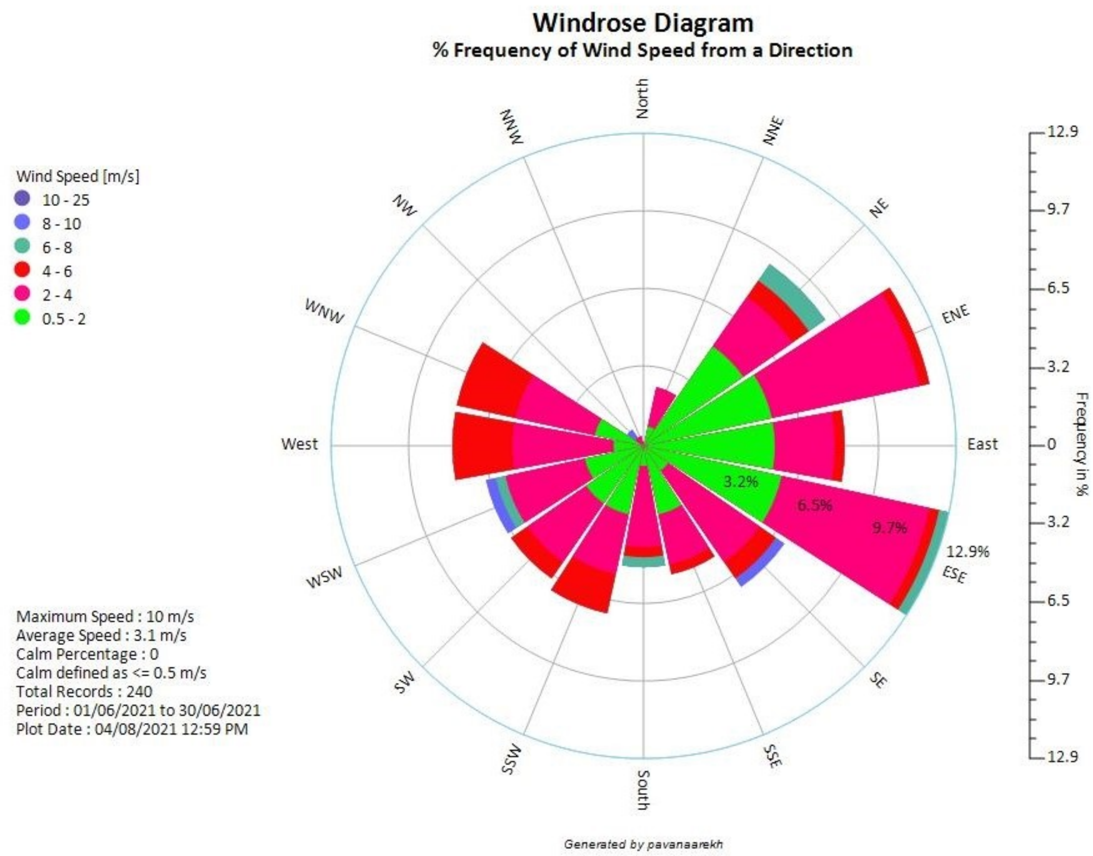
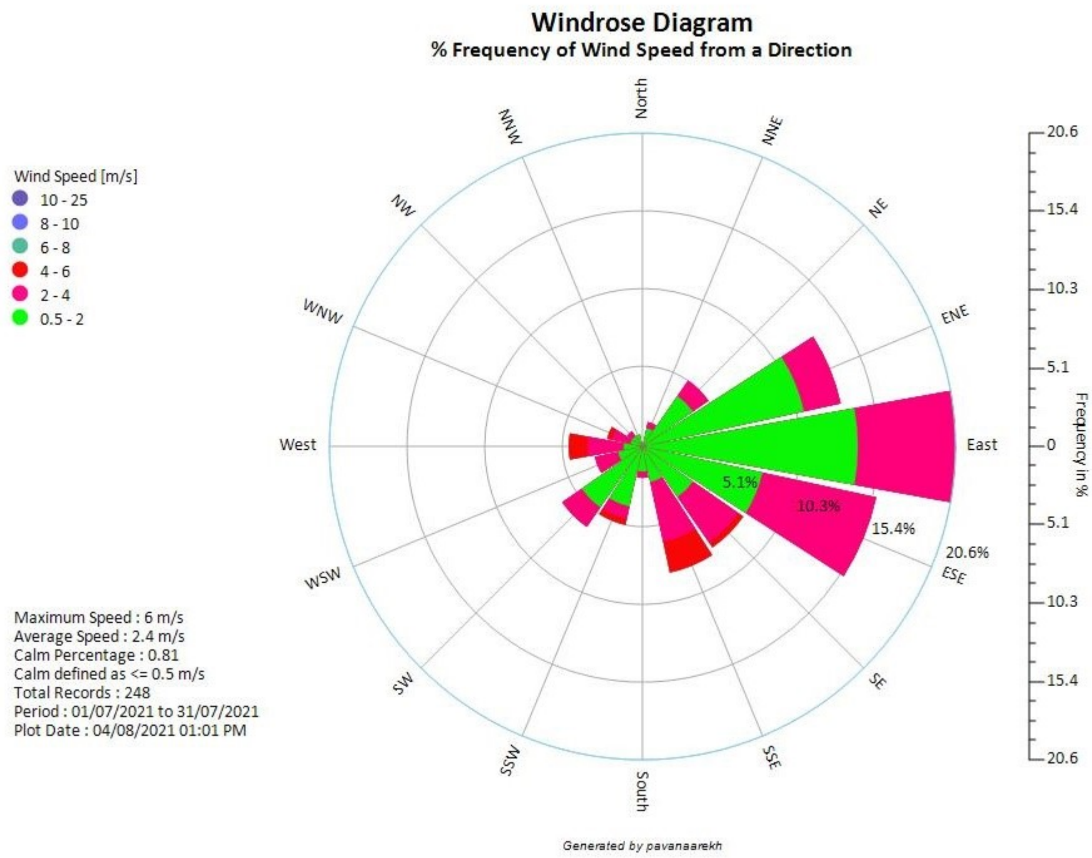
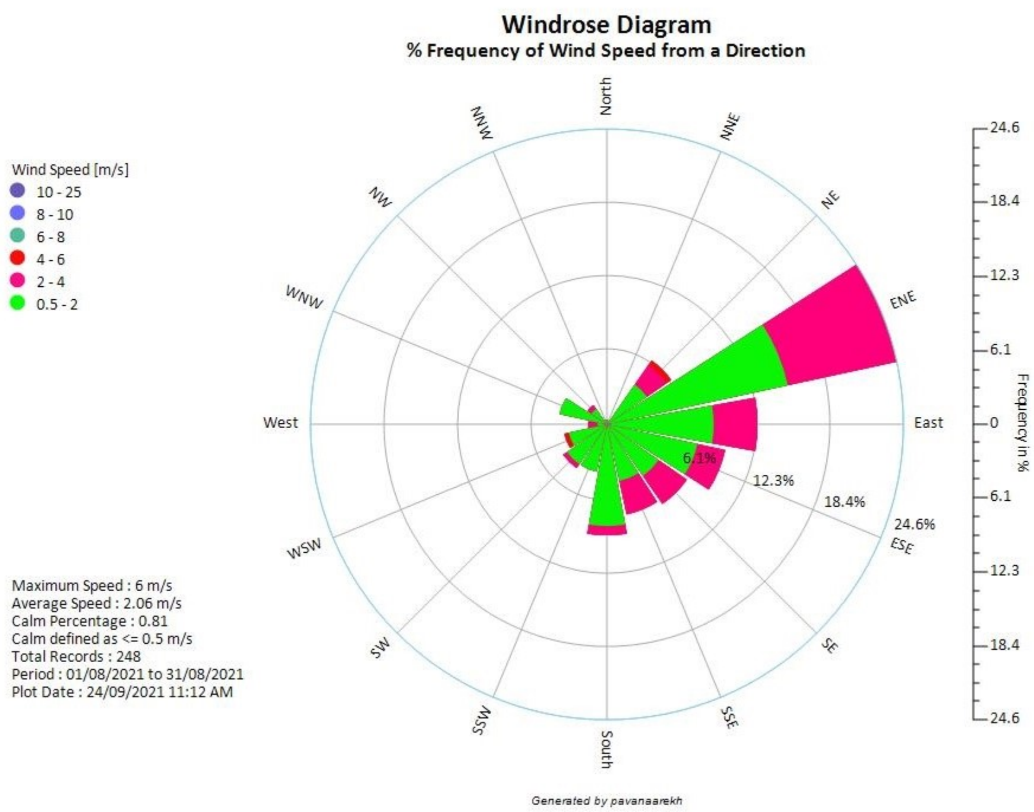


June 2021



July 2021



August 2021

Figure 3.13: Wind Rose diagram

3.2.1.8 Soil

i. Soil Taxonomic Classification

The soil map of the study area is given in **Figure 3.14** and area under different soil units is given in **Table 3.14**. Predominant soil type is Typic Udorthents (33.52%) which is found at middle slopes characterized by rock outcrops, deep well drained, mesic, loamy skeletal soils on very steep slopes with severe erosion. Typic Cryorthents second predominant soil type found near the ridge slopes and is characterized by rock outcrops, with shallow depth, excessively drained, loamy skeletal soils on very steep slopes prone to severe erosion. Valley floor is comprised of Dystric Eutrochrepts which are deep, well drained, mesic, coarse-loamy soils on gentle slopes with loamy surface and moderate erosion. Glaciated areas have Lithic Cryorthents which are Shallow, excessively drained, sandy-skeletal soils with sandy surface.

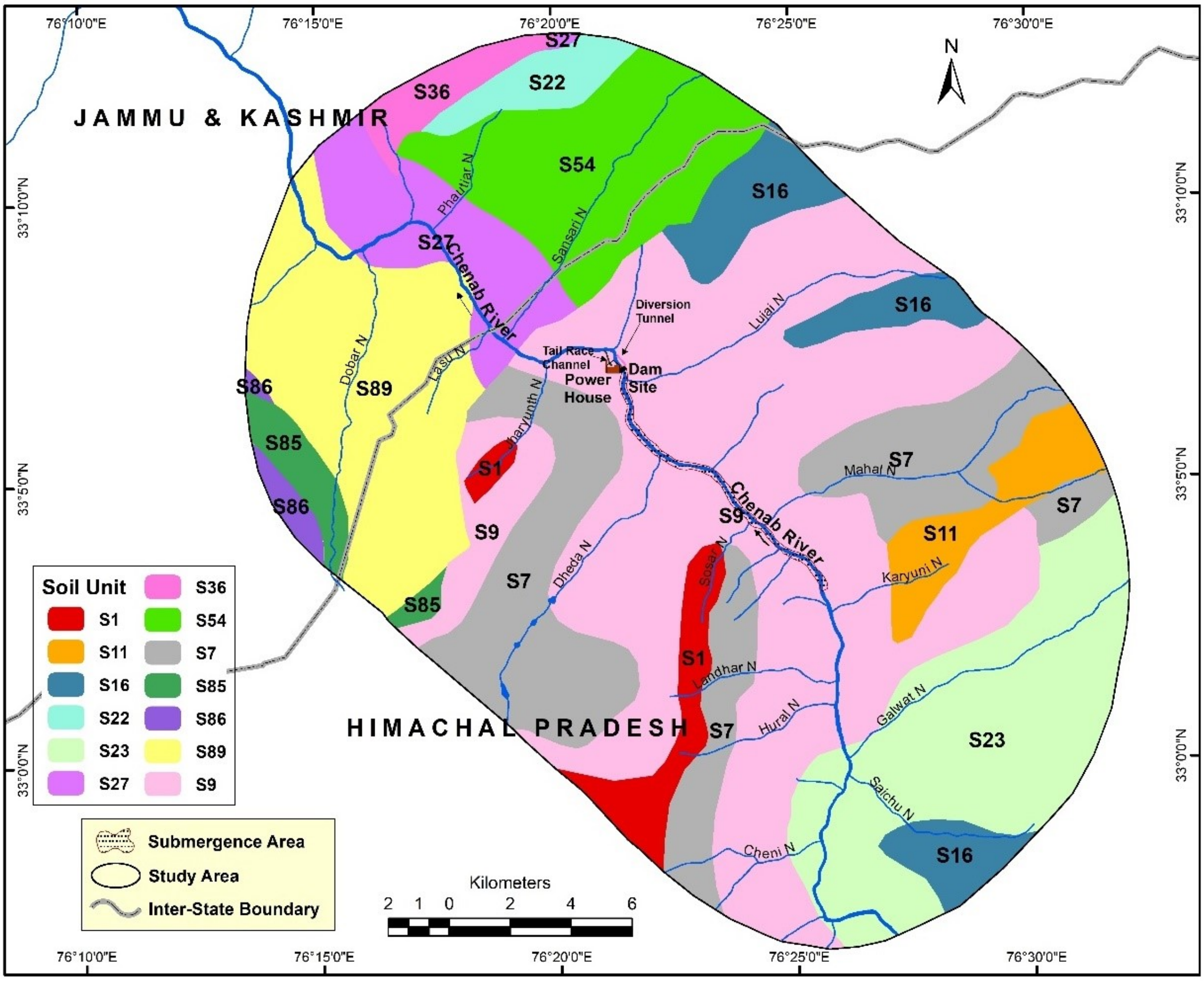


Figure 3.14: Soil map of the Study area (For Soil Unit Legend see Table 3.12)

Table 3.14: Physico-chemical characteristics of soils in the study area

Soil	Type	Area (sq km)	Area (%)
S1	Rock Outcrops covered glaciers; *associated with*: **Lithic Cryorthents** Shallow, excessively drained, sandy-skeletal soils with the sandy surface, severe erosion and strong stoniness	1465.75	2.50

Soil	Type	Area (sq km)	Area (%)
S7	Rock Outcrops *associated with*: **Typic Cryorthents** Shallow, excessively drained, loamy skeletal soils on very steep slopes with loamy surface, severe erosion and moderate stoniness	8445.60	14.41
S9	Rock Outcrops *associated with*: **Typic Udorthents** Deep, well drained, mesic, loamy skeletal soils on very steep slopes with loamy surface, severe erosion and strong stoniness	19648.59	33.52
S11	**Typic Udorthents** Shallow, well drained, mesic, coarse loamy, soils on very steep slopes with loamy surface and severe erosion; *associated with*: **Lithic Udorthents** Shallow, well drained, loamy skeletal soils with loamy surface, severe erosion and strong stoniness	1601.77	2.73
S16	Rock Outcrops *associated with*: **Typic Cryothents** Deep, excessively drained, sandy-skeletal soils with loamy surface, very severe erosion and moderate stoniness	2877.48	4.91
S22	**Typic Cryorthents** Medium deep, excessively drained, sandy-skeletal soils on moderately steep slopes with sandy surface, severe erosion and strong stoniness; *associated with*: **Typic Cryorthents** Deep, excessively drained, loamy-skeletal soils with loamy surface, severe erosion and moderate stoniness.	956.87	1.63
S23	**Dystric Eutrochrepts** Deep, well drained, mesic, coarse-loamy soils on gentle slopes with loamy surface and moderate erosion; *associated with*: **Dystric Fluventic Eutrochrepts** Deep, well drained, coarse-loamy soils with loamy surface and moderate erosion	7348.76	12.54
S27	**Typic Udorthents** Shallow, somewhat excessively drained, mesic, coarse-loamy soils on moderate slopes with loamy surface and severe erosion; *associated with*: **Dystric Eutrochrepts** Medium deep, somewhat excessively drained, fine-loamy soils with loamy surface and severe erosion	2868.66	4.89
S36	**Typic Udorthents** Shallow, excessively drained, thermic, sandy-skeletal soils on steep slopes with loamy surface, very severe erosion and strong stoniness; *associated with*: Rock Outcrops	851.49	1.45
S54	**Dystric Eutrochrepts** Medium deep to deep, well drained, thermic, fine-loamy soils on steep slopes with loamy surface and moderate erosion; *associated with*: **Typic Udorthents** Medium deep, well drained, coarse-loamy soils with loamy surface and severe erosion	4794.25	8.18
S85	**Typic Udifluvents** Deep, well drained, thermic, sandy soils on nearly level to level lands with loamy surface and slight erosion; *associated with*: **Dystric Eutrochrepts** Deep, well drained, fine-loamy soils with loamy surface and slight erosion	904.83	1.54
S86	**Typic Ustorthents** Deep, moderately well drained, hyperthermic, fine-loamy soils on moderate slopes with loamy surface and moderate erosion; *associated with*: **Typic Ustifluvents**	341.15	0.58

Soil	Type	Area (sq km)	Area (%)
	Medium deep, somewhat excessively drained, sandy soils with loamy surface, severe erosion and moderate stoniness		
S89	**Udic Ustochrepts** Deep, well drained, hyperthermic, fine-loamy soils on very gentle slopes with loamy surface and moderate erosion; *associated with*: **Udic Ustochrepts** Deep, well drained, coarse-loamy soils with loamy soils with loamy surface and moderate erosion	6515.81	11.12
	Total	**58621.00**	**100.00**

ii. Physico-chemical Properties of Soil

The location of sampling sites for the soil on the map is given in **Figure 3.15** and results of soil physico-chemical analysis are given in **Table 3.15**.

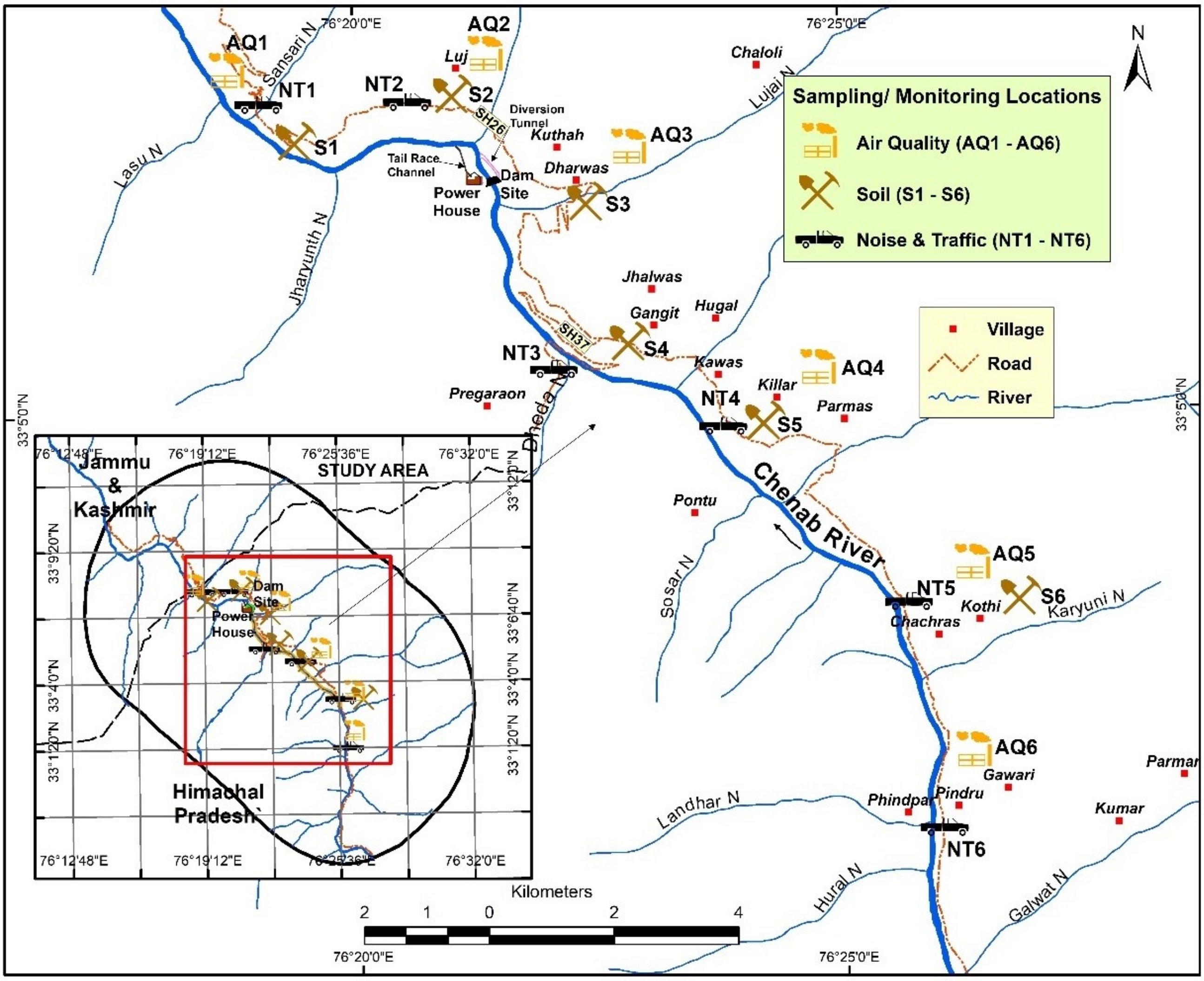


Figure 3.15: Map of study area showing the location of Soil Sampling and Air, Traffic, and Noise Monitoring sites

Bulk density reflects the soil's ability to function for structural support, water and solute movement, and soil aeration. Most of the soils in the study area are Sandy Clayey Loam. The average bulk density of soil is medium due to the presence of clay content varied from 1.25 to 1.44 (g/cc) at various locations in the study. Porosity and water holding capacity are generally low to medium in the area thereby affecting the permeability of the soil as porosity varied between 36.5% and 48.9% while water holding capacity varied between 28.0% and 47.0%. Most of the area has an almost neutral soil reaction. Electrical conductivity varied between 102 and 280 µS/cm which is a measure of soluble salts i.e., salinity. Soil with EC up to 2000 µS/cm is considered non-saline soil (see **Table 3.15**).

Table 3.15: Physico-chemical characteristics of Soil

S. No.	Parameter	Season	S1	S2	S3	S4	S5	S6
1	**Soil Texture**							
i	*Sand (% w/w)*	W	60	66	59	68	73	63
	Silt (% w/w)		10	12	9	11	8	10
	Clay (% w/w)		30	22	32	21	19	27
ii	*Sand (% w/w)*	PM	62	64	60	65	72	67
	Silt (% w/w)		9	11	8	10	8	12
	Clay (% w/w)		29	25	32	25	20	21
iii	*Sand (% w/w)*	M	62	64	60	65	72	67
	Silt (% w/w)		9	11	8	10	8	12
	Clay (% w/w)		29	25	32	25	20	21
2	Bulk Density (g/cc)	W	1.4	1.34	1.44	1.3	1.28	1.36
		PM	1.36	1.32	1.4	1.28	1.25	1.33
		M	1.39	1.33	1.42	1.27	1.27	1.32
3	Porosity (%)	W	38.5	42.1	37.8	45.4	48.9	40.1
		PM	37.5	41.2	36.5	45	47	38.9
		M	38	41.8	37.1	44.8	47.8	40.2
4	Water holding capacity (%)	W	44	38	47	35	30	42
		PM	42	36	44	33	29	40
		M	41	37	45	34	28	39
5	pH	W	7.4	7.5	7.4	7.6	7.3	7.6
		PM	7.2	7.4	7	7.2	7.1	7.4
		M	7.1	7.2	7.1	7.3	7.2	7.3
6	Electrical Conductivity (µS/cm)	W	140	220	120	110	156	172
		PM	130	240	130	102	167	180
		M	190	280	174	150	210	240
7	Total Alkalinity (mg/l)	W	180	164	180	220	210	140
		PM	175	155	177	210	202	134
		M	172	168	182	198	215	138
8	Chloride Content (mg/kg)	W	62	78	110	82	63	80
		PM	59	73	115	77	68	86
		M	56	69	98	74	66	70
9	Calcium (mg/kg)	W	2345	2545	3532	3520	2710	3950
		PM	2212	2456	3453	3567	2654	3789
		M	2434	2512	3519	3590	2787	3864
10	Magnesium (mg/kg)	W	2290	1110	3230	3264	2302	3550
		PM	2122	1023	3145	3145	2290	3433
		M	2202	1232	3231	3222	2345	3510
11	Available Nitrogen (kg/ha)	W	330	367	480	287	230	440
		PM	320	343	434	265	210	412
		M	315	355	448	261	222	428
12	Available Phosphorus (kg/ha)	W	12.1	15.4	10.2	8.9	11.1	18.9
		PM	11.1	13.4	8.7	6.5	9.7	15.4
		M	11.9	14.8	9.9	7.8	10.1	17.8
13	Available Potassium (kg/ha)	W	162	245	158	190	210	260
		PM	154	233	145	178	194	247
		M	160	241	151	182	202	245
14	Organic carbon (%)	W	0.56	1.2	0.7	1.1	0.67	1.1

S. No.	Parameter	Season	S1	S2	S3	S4	S5	S6
		PM	0.52	1.1	0.66	0.98	0.62	1.02
		M	0.5	0.98	0.64	0.87	0.58	0.99
15	Sodium (mg/kg)	W	1139	1120	1145	1165	1130	1140
		PM	1122	1052	1121	1087	1011	980
		M	1202	1190	1220	1198	1185	1130
16	Sodium Adsorption Ratio	W	4.01	4.66	3.35	3.40	3.86	3.17
		PM	4.09	4.50	3.32	3.20	3.47	2.77
		M	4.25	4.86	3.57	3.49	4.00	3.17
17	Salinity (ppt)	W	0.16	0.18	0.12	0.16	0.18	0.2
		PM	0.14	0.16	0.1	0.15	0.14	0.17
		M	0.14	0.17	0.09	0.13	0.16	0.18

W=Winter, PM=Pre-monsoon, M=Monsoon

The soil fertility status of the area was assessed based upon soil test results and based upon Soil Fertility Rating given below in the **Table 3.16**.

Table 3.16: Soil Fertility Rating as per Soil Fertility Book*

Soil Parameter	Low	Medium	High
Organic Carbon (%)	<0.5	0.5 to 0.75	>0.75
Available Nitrogen (kg/ha)	<280	280 to 560	>560
Available Phosphorus (kg/ha)	<10	10 to 25	>25
Available Potassium (kg/ha)	<108	108 to 280	>280

**Source: Department of Agriculture & Cooperation, Ministry of Agriculture, Government of India (2011)*

Organic carbon an important indicator of soil health is in the 'Medium' to 'High' range throughout the study area in different seasons (see **Table 3.17**). The soil fertility rating in terms of nitrogen was observed in the 'Low' to 'Medium' range in all seasons. Phosphorus is in the 'Low' to 'Medium' range in all the seasons and Potassium concentrations are in the 'Medium' range in all the seasons in the study area.

Table 3.17: Soil Fertility Rating in the study area

Sampling Locations	Season	Parameter/Site			
		Organic Carbon (%)	Available Nitrogen (kg/ha)	Available Phosphorus (kg/ha)	Available Potassium (kg/ha)
S1	Winter	Medium	Medium	Medium	Medium
	Pre-Monsoon	Medium	Medium	Medium	Medium
	Monsoon	Medium	Medium	Medium	Medium
S2	Winter	High	Medium	Medium	Medium
	Pre-Monsoon	High	Medium	Medium	Medium
	Monsoon	High	Medium	Medium	Medium
S3	Winter	Medium	Medium	Medium	Medium
	Pre-Monsoon	Medium	Medium	Low	Medium
	Monsoon	Medium	Medium	Low	Medium
S4	Winter	High	Low	Low	Medium
	Pre-Monsoon	High	Low	Low	Medium
	Monsoon	High	Low	Low	Medium
S5	Winter	Medium	Low	Medium	Medium
	Pre-Monsoon	Medium	Low	Low	Medium
	Monsoon	Medium	Low	Medium	Medium

Sampling Locations	Season	Parameter/Site			
		Organic Carbon (%)	Available Nitrogen (kg/ha)	Available Phosphorus (kg/ha)	Available Potassium (kg/ha)
S6	Winter	High	Medium	Medium	Medium
	Pre-Monsoon	High	Medium	Medium	Medium
	Monsoon	High	Medium	Medium	Medium

iii. Soil Nutrient Index

Based upon Soil Fertility rating overall Nutrient Index (NI) of soils in the study area vis-à-vis NPK was calculated as follows:

(Percent samples falling in Low category x 1) + (Percent samples falling in the 'Medium' category x 2) + (Percent samples falling in the 'High' category x 3)/100.

Based upon above Nutrient Index Soil Fertility is assessed as follows:

< 1.67 : Low
1.67 – 2.33 : Medium
> 2.33 : High

The soil fertility in the study area, in general, is based upon Nutrient Index in terms of NPK as above in the case of Nitrogen and Phosphorus is Low, in case of Potassium is 'High'.

Parameter	Season	Nutrient Index	Fertility Rating
Nitrogen (kg/ha)	Winter	Low	1.6
	Pre-monsoon	Low	1.6
	Monsoon	Low	1.6
Phosphorus (kg/ha)	Winter	Medium	1.8
	Pre-monsoon	Low	1.6
	Monsoon	Low	1.6
Potassium (kg/ha)	Winter	Medium	2
	Pre-monsoon	Medium	2
	Monsoon	Medium	2

iv. Conclusions

- In general, all the physical and chemical soil quality indicators reflect the good quality of the soil.
- The soil fertility based upon Nutrient Index in terms of NPK shows that Nitrogen is in the 'Low' range Potassium fertility rating 'Medium' range during Winter but in pre-monsoon and monsoon season is in the 'Low' range whereas, Phosphorus fertility status of soil in the 'Low' range.

3.2.1.9 Air Environment

The baseline status concerning ambient air quality of the study area and superimposition of potential releases of air pollutants during the project's construction and operation phase helps in impact assessment and preparation of mitigation and management measures. As the study area is mainly a rural area with no industrial establishment and little traffic movement, the ambient air in the study area is in general is free from any pollution source and is in the clean category. Ambient air quality data/ results observed during three seasons of monitoring in the study area are given in **Table 3.18**. The location of ambient air quality monitoring sites in the study area is given in **Figure 3.15**.

i. $PM_{2.5}$ levels

$PM_{2.5}$ levels were minimum at AQ3/Near Dharwas Village with 8.4 μg/m³ during the winter season, 7.0 μg/m³ during the pre-monsoon season and 5.6 μg/m³ during monsoon. Maximum levels of $PM_{2.5}$ were recorded at AQ4/Near Killar village where levels were 29.0 μg/m³, 26.7 μg/m³ and 18.2 μg/m³ during Winter, Pre-monsoon, and monsoon seasons, respectively (**Table 3.18**).

ii. PM10 levels

The maximum PM_{10} levels observed during ambient air quality monitoring were 74.2 μg/m³, 68.7 μg/m³ and 58.7 μg/m³ at monitoring site AQ4/Near Killar village in winter, pre-monsoon, and monsoon seasons, respectively. Minimum levels were recorded at monitoring site AQ3/ Near Dharwas Village with 21.2 μg/m³ in the winter season, 16.5 μg/m³ in the pre-monsoon season, and 14.5 μg/m³ in the monsoon season (**Table 3.18**).

iii. SO_2 levels and NO_2 levels

The SO_2 and NO_2 levels observed during the study were much lower than the permissible limit of 80 μg/m³ at most of the locations (see **Table 3.18**). SO_2 was maximum at AQ4/Near Killar village with 7.2 μg/m³ during the winter season, 6.6 μg/m³ during the pre-monsoon season, and 6.3 μg/m³ during monsoon.

Similarly, NO_2 was maximum at AQ4/Near Killar village with 9.0 μg/m³ during monsoon season, 7.8 μg/m³ during the pre-monsoon season, and 7.0 μg/m³ during monsoon (**Table 3.18**).

Table 3.18: Ambient Air Quality in the study area (unit: μg/m³)

Winter Season					
Monitoring Location	**Monitoring Schedule**	**Parameters (μg/m³)**			
		$PM_{2.5}$	**PM_{10}**	**SO_2**	**NO_2**
AQ1/Near Sansari Nala	1-3-2021 to 2-3-2021	12.1	32.3	5.1	6.1
	4-3-2021 to 5-3-2021	11.1	30.1	5.1	6.2
	8-3-2021 to 9-3-2021	13.2	29.4	5.1	6.3
	11-3-2021 to 12-3-2021	12.2	30.3	5.3	6.2
	15-3-2021 to 6-3-2021	12.5	32.3	5.1	6.1
	18-3-2021 to 19-3-2021	11.8	29	5.2	6.2
	22-3-2021 to 23-3-2021	11	29.9	5.2	6.2
	25-3-2021 to 26-3-2021	12.3	30	5.3	6.1
	Min	11	29	5.1	6.1
	Max	13.2	32.3	5.3	6.3
	Average	12.0	30.4	5.2	6.2
AQ2/Near Luj Village	2-3-2021 to 3-3-2021	14.5	35.6	5.2	6.2
	5-3-2021 to 6-3-2021	14.3	37.6	5.2	6.3
	9-3-2021 to 10-3-2021	13.4	38.7	5.2	6.4

Winter Season					
Monitoring Location	Monitoring Schedule	Parameters (µg/m³)			
		PM 2.5	PM 10	SO_2	NO_2
	12-3-2021 to 13-3-2021	13.9	38.7	5.4	6.3
	16-3-2021 to 17-3-2021	14.0	37.6	5.2	6.2
	19-3-2021 to 20-3-2021	14.2	35.6	5.3	6.3
	23-3-2021 to 24-3-2021	14.6	37.8	5.3	6.3
	26-3-2021 to 27-3-2021	13.7	36.1	5.4	6.2
	Min	13.4	35.6	5.2	6.2
	Max	14.6	38.7	5.4	6.4
	Average	14.1	37.2	5.3	6.3
AQ3/Near Dharwas Village	3-3-2021 to 4-3-2021	8.8	22	5.0	6.0
	6-3-2021 to7-3-2021	8.4	21.2	5.0	6.0
	10-3-2021 to 11-3-2021	8.5	22.2	5.0	6.0
	13-3-2021 to 14-3-2021	8.8	24.2	5.0	6.0
	17-3-2021 to 18-3-2021	9	21.2	5.0	6.0
	20-3-2021 to 21-3-2021	9.1	22.2	5.0	6.0
	24-3-2021 to 25-3-2021	9.8	21.2	5.0	6.0
	27-3-2021 to 28-3-2021	8.8	22.9	5.0	6.0
	Min	8.4	21.2	5	6
	Max	9.8	24.2	5	6
	Average	8.9	22.1	5.0	6.0
AQ4/Near Killar Village	1-3-2021 to 2-3-2021	28.2	70	6.9	8.8
	4-3-2021 to 5-3-2021	29	72.6	6.9	8.9
	8-3-2021 to 9-3-2021	29	68	7.0	8.7
	11-3-2021 to 12-3-2021	26.7	74	6.9	8.9
	15-3-2021 to 6-3-2021	28.7	73.2	6.8	8.0
	18-3-2021 to 19-3-2021	28.1	69	7.1	8.0
	22-3-2021 to 23-3-2021	28.7	70.8	6.9	9.0
	25-3-2021 to 26-3-2021	28	74.5	7.2	8.5
	Min	26.7	68	6.8	8
	Max	29	74.5	7.2	9
	Average	28.3	71.5	7.0	8.6
AQ5/Near Chacharwas Village	2-3-2021 to 3-3-2021	11.1	30.2	5.5	6.5
	5-3-2021 to 6-3-2021	12	31.1	5.4	6.4
	9-3-2021 to 10-3-2021	11	30.3	5.5	6.6
	12-3-2021 to 13-3-2021	12.1	32.3	5.3	6.4
	16-3-2021 to 17-3-2021	11.9	33.3	5.5	6.5
	19-3-2021 to 20-3-2021	11.2	32.1	5.6	6.6
	23-3-2021 to 24-3-2021	12.1	31.1	5.3	6.7
	26-3-2021 to 27-3-2021	11.7	33	5.6	6.8
	Min	11	30.2	5.3	6.4
	Max	12.1	33.3	5.6	6.8
	Average	11.6	31.7	5.5	6.6

Winter Season					
Monitoring Location	**Monitoring Schedule**	**Parameters (µg/m³)**			
		PM 2.5	**PM 10**	**SO_2**	**NO_2**
AQ6/Near Findru Village	3-3-2021 to 4-3-2021	20.2	58	5.9	7.1
	6-3-2021 to7-3-2021	21.2	55.5	6.0	7.0
	10-3-2021 to 11-3-2021	21.7	56.5	6.1	7.3
	13-3-2021 to 14-3-2021	22.2	58.9	6.2	7.0
	17-3-2021 to 18-3-2021	21.2	60.2	6.6	7.3
	20-3-2021 to 21-3-2021	20.4	61.2	6.5	6.9
	24-3-2021 to 25-3-2021	22.1	59.8	6.1	7.0
	27-3-2021 to 28-3-2021	21.9	58.8	6.6	7.0
	Min	20.2	55.5	5.9	6.9
	Max	22.2	61.2	6.6	7.3
	Average	21.4	58.6	6.3	7.1
Permissible Limit 24 h NAANTS 2009		**60.0**	**100.0**	**80.0**	**80.0**

Pre-Monsoon Season					
Monitoring Location	**Monitoring Schedule**	**Parameters (µg/m³)**			
		PM 2.5	**PM 10**	**SO_2**	**NO_2**
AQ1/Near Sansari Nala	2-5-2021 to 3-5-2021	10.2	25.4	5.0	5.6
	5-5-2021 to 6-5-2021	12.1	24.5	5.0	5.8
	9-5-2021 to 10-5-2021	9.8	26.7	5.0	5.6
	12-5-2021 to 13-5-2021	9.9	25.5	5.0	5.8
	16-5-2021 to 17-5-2021	11.2	27.6	5.1	5.9
	19-5-2021 to 20-5-2021	11.4	26.5	5.0	5.6
	23-5-2021 to 24-5-2021	10.6	25.6	5.0	5.7
	26-5-2021 to 27-5-2021	9.2	26	5.0	5.6
	Min	9.2	24.5	5	5.6
	Max	12.1	27.6	5.1	5.9
	Average	10.6	26.0	5.0	5.7
AQ2/Near Luj Village	3-5-2021 to 4-5-2021	13.4	30.2	5.2	5.9
	6-5-2021 to 7-5-2021	14.2	33.2	5.2	6.0
	10-5-2021 to 11-5-2021	13.3	31.3	5.1	6.0
	13-5-2021 to 14-5-2021	12.5	30.5	5.3	5.9
	17-5-2021 to 18-5-2021	13.6	29.5	5.2	5.9
	20-5-2021 to 21-5-2021	14.4	30.5	5.1	6.0
	24-5-2021 to 25-5-2021	13.4	31.1	5.2	6.1
	27-5-2021 to 28-5-2021	13.8	30.8	5.2	6.2
	Min	12.5	29.5	5.1	5.9
	Max	14.4	33.2	5.3	6.2
	Average	13.6	30.9	5.2	6.0
AQ3/Near Dharwas Village	4-5-2021 to 5-5-2021	7.8	16.5	5.0	5.7
	7-5-2021 to 8-5-2021	7.6	17.8	5.0	5.5
	11-5-2021 to 12-5-2021	7.7	18.7	5.0	5.6
	14-5-2021 to 15-5-2021	7.1	16.7	5.0	5.6

Pre-Monsoon Season					
Monitoring Location	Monitoring Schedule	Parameters (µg/m³)			
		PM 2.5	PM 10	SO_2	NO_2
	18-5-2021 to 19-5-2021	7	17.7	5.0	5.5
	21-5-2021 to 22-5-2021	7.8	17	5.0	5.6
	25-5-2021 to 26-5-2021	7.2	18.7	5.0	5.8
	28-5-2021 to 29-5-2021	8.8	17.4	5.0	5.9
	Min	7	16.5	5	5.5
	Max	8.8	18.7	5	5.9
	Average	7.6	17.6	5.0	5.7
AQ4/Near Killar Village	2-5-2021 to 3-5-2021	24.5	60.2	6.5	7.7
	5-5-2021 to 6-5-2021	25.4	64	6.5	7.0
	9-5-2021 to 10-5-2021	26.5	64.5	6.4	7.5
	12-5-2021 to 13-5-2021	24.5	59.6	6.5	7.4
	16-5-2021 to 17-5-2021	23.4	62.3	6.3	7.6
	19-5-2021 to 20-5-2021	26.7	68.7	6.6	7.7
	23-5-2021 to 24-5-2021	25.6	66.6	6.6	7.8
	26-5-2021 to 27-5-2021	26.7	67.8	6.5	7.5
	Min	23.4	59.6	6.3	7
	Max	26.7	68.7	6.6	7.8
	Average	25.4	64.2	6.5	7.5
AQ5/Near Chacharwas Village	3-5-2021 to 4-5-2021	9.9	28.4	5.2	6.1
	6-5-2021 to 7-5-2021	9.9	29.5	5.3	6.2
	10-5-2021 to 11-5-2021	9.8	30.2	5.2	6.1
	13-5-2021 to 14-5-2021	9.9	31.2	5.3	5.9
	17-5-2021 to 18-5-2021	10.1	28.9	5.2	6.1
	20-5-2021 to 21-5-2021	8.9	29.7	5.0	6.2
	24-5-2021 to 25-5-2021	9.5	28.9	5.5	6.1
	27-5-2021 to 28-5-2021	9	31.2	5.3	6.0
	Min	8.9	28.4	5	5.9
	Max	10.1	31.2	5.5	6.2
	Average	9.6	29.8	5.3	6.1
AQ6/Near Findru Village	4-5-2021 to 5-5-2021	18.2	50.5	5.5	6.8
	7-5-2021 to 8-5-2021	17.8	53	5.6	6.7
	11-5-2021 to 12-5-2021	17.6	48	5.8	6.8
	14-5-2021 to 15-5-2021	17.8	50.1	6.0	6.7
	18-5-2021 to 19-5-2021	18.7	51.7	5.6	6.9
	21-5-2021 to 22-5-2021	16.7	49.8	5.8	6.7
	25-5-2021 to 26-5-2021	18.9	53.4	5.6	6.9
	28-5-2021 to 29-5-2021	18.2	52.1	5.7	6.7
	Min	16.7	48	5.5	6.7
	Max	18.9	53.4	6	6.9
	Average	18.0	51.1	5.7	6.8
Permissible Limit 24 h NAANTS 2009		**60.0**	**100.0**	**80.0**	**80.0**

Monsoon Season					
Monitoring Location	Monitoring Schedule	Parameters (μg/m^3)			
		PM $_{2.5}$	PM $_{10}$	SO_2	NO_2
AQ1/Near Sansari Nala	15-8-2021 to 16-8-2021	8.9	20.1	5.0	5.0
	18-3-2021 to 19-3-2021	8.8	19	5.0	5.0
	22-8-2021 to 23-8-2021	7.8	18.6	5.0	5.0
	25-8-2021 to 26-8-2021	8	19.5	5.0	5.0
	29-8-2021 to 30-8-2021	7.7	19	5.0	5.0
	01-9-2021 to 02-9-2021	7.6	20.2	5.0	5.0
	05-9-2021 to 06-9-2021	7.8	21.2	5.0	5.0
	08-9-2021 to 09-9-2021	8	22	5.0	5.0
	Min	7.6	18.6	5	5
	Max	8.9	22	5	5
	Average	8.1	20.0	5.0	5.0
AQ2/Near Luj Village	16-8-2021 to 17-8-2021	10.1	25.4	5.0	5.0
	19-3-2021 to 20-3-2021	10.1	25.4	5.0	5.0
	23-8-2021 to 24-8-2021	11.1	24.2	5.0	5.0
	26-8-2021 to 27-8-2021	10.1	25.6	5.1	5.5
	30-8-2021 to 31-8-2021	9.8	26.0	5.0	5.5
	02-9-2021 to 03-9-2021	9.9	26.7	5.0	5.3
	06-9-2021 to 07-9-2021	9.7	28.9	5.0	5.4
	09-9-2021 to 10-9-2021	8.9	26.7	5.0	5.0
	Min	8.9	24.2	5.0	5.0
	Max	11.1	28.9	5.1	5.5
	Average	10.0	26.1	5.0	5.2
AQ3/Near Dharwas Village	17-8-2021 to 18-8-2021	6.6	15.6	5.0	5.0
	20-3-2021 to 21-3-2021	6.5	14.5	5.0	5.0
	24-8-2021 to 25-8-2021	5.6	16.5	5.0	5.0
	27-8-2021 to 28-8-2021	6.6	15.5	5.1	5.0
	31-8-2021 to 01-9-2021	6	14.5	5.0	5.2
	03-9-2021 to 04-9-2021	6.2	15	5.0	5.3
	07-9-2021 to 08-9-2021	6.1	15.4	5.0	5.1
	10-9-2021 to 11-9-2021	6	15.6	5.0	5.0
	Min	5.6	14.5	5	5
	Max	6.6	16.5	5.1	5.3
	Average	6.2	15.3	5.0	5.1
AQ4/Near Killar Village	15-8-2021 to 16-8-2021	18.2	55.5	6.1	7.0
	18-3-2021 to 19-3-2021	17.8	56.5	6.2	7.0
	22-8-2021 to 23-8-2021	15.6	54.5	6.2	6.9
	25-8-2021 to 26-8-2021	16.7	57.8	6.1	7.0
	29-8-2021 to 30-8-2021	17	55.5	6.3	6.8
	01-9-2021 to 02-9-2021	16.5	58.7	6.3	7.0
	05-9-2021 to 06-9-2021	16.7	52.3	6.1	6.5
	08-9-2021 to 09-9-2021	16.9	55.4	6.0	6.9
	Min	15.6	52.3	6	6.5

Monsoon Season					
Monitoring Location	Monitoring Schedule	Parameters (µg/m^3)			
		PM $_{2.5}$	PM $_{10}$	SO_2	NO_2
	Max	18.2	58.7	6.3	7
	Average	16.9	55.8	6.2	6.9
AQ5/Near Chacharwas Village	16-8-2021 to 17-8-2021	7.7	23.3	5.0	5.7
	19-3-2021 to 20-3-2021	7.8	23.4	5.0	5.6
	23-8-2021 to 24-8-2021	7.8	24	5.0	5.5
	26-8-2021 to 27-8-2021	7	24.2	5.2	5.6
	30-8-2021 to 31-8-2021	8	23.1	5.5	5.7
	02-9-2021 to 03-9-2021	8.2	23.4	5.4	6.0
	06-9-2021 to 07-9-2021	8.6	22.2	5.7	5.6
	09-9-2021 to 10-9-2021	8.3	22.5	5.3	5.4
	Min	7	22.2	5	5.4
	Max	8.6	24.2	5.7	6
	Average	7.9	23.3	5.3	5.6
AQ6/Near Findru Village	17-8-2021 to 18-8-2021	15.4	44	5.5	6.4
	20-3-2021 to 21-3-2021	14.4	44.8	5.6	6.5
	24-8-2021 to 25-8-2021	15.1	45	5.5	6.6
	27-8-2021 to 28-8-2021	14.3	44.1	5.6	6.6
	31-8-2021 to 01-9-2021	15	44.7	5.8	6.4
	03-9-2021 to 04-9-2021	15.6	45.6	5.7	6.5
	07-9-2021 to 08-9-2021	16.5	42.3	5.8	6.7
	10-9-2021 to 11-9-2021	15	46.5	5.9	6.4
	Min	14.3	42.3	5.5	6.4
	Max	16.5	46.5	5.9	6.7
	Average	15.2	44.6	5.7	6.5
Permissible Limit 24 h NAAQS 2009		**60.0**	**100.0**	**80.0**	**80.0**

The results of monitoring show that $PM_{2.5}$, PM_{10}, $SO_{2,}$ and NO_2 levels at all the sites are well within the Residential & Rural area permissible limits prescribed by National Ambient Air Quality Standard 2009 notified by CPCB. Air quality was also assessed using 24h averages of $PM_{2.5}$, PM_{10}, $SO_{2,}$ and NO_2 levels in the AQI calculator of CPCB and calculated AQI values given in the table below. All the locations fall under the 'Good' category in the different seasons in the study area except AQ4/near Killar Village and AQ6/near Findru village during winter and pre-monsoon samples fall under 'Satisfactory' category in the study area (**Table 3.19**).

Table 3.19: Air Quality Index for Different Monitoring sites

Season/ Site	AQI					
	AQ1	AQ2	AQ3	AQ 4	AQ 5	AQ 6
Winter	30	37	22	72	32	59
Pre-monsoon	26	31	18	64	30	51
Monsoon	20	26	15	56	23	45
Air Quality = Good (0-50), Satisfactory (50-100), Moderate (100-200), Poor (200-300), Very Poor (300-400) and Severe (>400).						

AQ1 -AQ6: Air Quailty Monitiring Sites

Ambient Air Quality Monitoring Locations

Luj Village (Near proposed Dam Site)

Killar (Forest Guest house)

Near Findru Village

Dharwas Village

3.2.1.10 Noise & Traffic Monitoring

a) Sound Level

The results of sound levels monitoring i.e., equivalent Noise levels (Leq dB(A) in the study area at given in **Table 3.20**. Levels were compared with the Ambient Air Quality Standard in respect of Noise, given in Schedule as part of The Noise Pollution (Regulation and Control) Rules, 2000 (amended to date). From the recorded values, day-time equivalent levels were calculated. From the data on sound pressure levels equivalent levels (Leq) for daytime, night-time, as well as day-night average, were calculated.

Table 3.20: Equivalent Noise levels (Leq dB(A) in the study area

Site Code	Monitoring location	Winter			Pre-monsoon			Monsoon			CPCB Limits	
		Leq Day dB(A)	Leq Night dB(A)	Leq Day and Night dB(A)	Leq Day dB(A)	Leq Night dB(A)	Leq Day and Night dB(A)	Leq Day dB(A)	Leq Night dB(A)	Leq Day and Night dB(A)	Day Time dB(A)	Night Time dB(A)
NT1	Near Sansari Nala	46.0	34.8	**45.6**	44.1	34.1	**44.1**	50.7	38.4	**50.0**	**55**	**45**
NT2	Near Luj Village	46.6	35.8	**46.3**	45.5	35.0	**45.3**	52.0	40.1	**51.4**	**55**	**45**
NT3	Near Dheda Nala	44.6	34.2	**44.5**	43.6	33.6	**43.6**	49.6	37.9	**49.0**	**55**	**45**
NT4	Near Killar	53.1	40.9	**52.4**	52.0	40.1	**51.4**	58.5	45.5	**57.6**	**65**	**55**
NT5	Near Chacharwas	48.1	37.5	**47.9**	47.0	36.7	**46.9**	53.4	42.0	**52.9**	**55**	**45**

Site Code	Monitoring location	Winter			Pre-monsoon			Monsoon			CPCB Limits	
		Leq Day dB(A)	Leq Night dB(A)	Leq Day and Night dB(A)	Leq Day dB(A)	Leq Night dB(A)	Leq Day and Night dB(A)	Leq Day dB(A)	Leq Night dB(A)	Leq Day and Night dB(A)	Day Time dB(A)	Night Time dB(A)
	Village											
NT6	Near Findru Village	49.1	38.2	**48.8**	47.9	37.5	**47.8**	54.1	42.2	**53.5**	**55**	**45**

As seen from **Table 3.20** equivalent sound levels during daytime as well as nighttime were within prescribed standards of CPCB. The traffic data reveals that the Average Daily Traffic was highest at Killar the only town in the study area and the tehsil headquarter of Pangi Valley and the minimum was recorded state highway near Dheda Nala, connecting the project area to the district headquarter in the study area.

During winter/lean season due to heavy snowfall in the area, the highway connecting to the Kishtwar district of Jammu and Kashmir is the only route to access the project area. However, the traffic in the route is limited only to the supply of essential goods in the area. Access for the area is through highway connecting to district headquarter Chamba and highway connecting to state capital Shimla via Lahul & Spiti district are extremely limited.

In the Pre-monsoon season, due to the Covid-19 Pandemic, some restrictions were imposed in our area, due to which the density of the vehicle has decreased. However, the traffic in the route is limited only to the supply of essential goods in the area. During the pre-monsoon season field survey (May-June), the state highway (SH37) connecting to district headquarter Chamba is not accessible.

During monsoon season, traffic density in the study area slightly increased due to relaxations in the Covid-19 restriction.

b) Traffic Volume

The data on Average Daily Traffic collected during field surveys were compiled and is given in **Table 3.21**. The traffic data reveals that the Average Daily Traffic was highest at Killar during all the seasons in the study area.

Table 3.21: Average Daily Traffic in the study area

Site Code	Monitoring Location	PCU factor	Pre-monsoon			Monsoon			Winter		
			HMV	LMV	TW	HMV	LMV	TW	HMV	LMV	TW
			3	**1.5**	**0.5**	**3**	**1.5**	**0.5**	**3**	**1.5**	**0.5**
NT1	Near Sansari Nala	No. of vehicles/day	5	3	2	0	2	2	8	12	3
		No. of PCUs/day	15	4.5	1	0	3	1	24	18	1.5
NT2	Near Luj Village	No. of vehicles/day	5	4	4	4	6	5	10	22	8
		No. of PCUs/day	15	6	2	12	9	2.5	30	33	4
NT3	Near Dheda Nala	No. of vehicles/day	2	2	1	1	2	1	9	26	5
		No. of PCUs/day	6	3	0.5	3	3	0.5	27	39	2.5
NT4	Near Killar	No. of vehicles/day	10	13	17	2	7	12	16	33	25
		No. of PCUs/day	30	19.5	8.5	6	10.5	6	48	49.5	12.5

Site Code	Monitoring Location	PCU factor	Pre-monsoon			Monsoon			Winter		
			HMV	LMV	TW	HMV	LMV	TW	HMV	LMV	TW
			3	1.5	0.5	3	1.5	0.5	3	1.5	0.5
NT5	Near Chacharwas Village	No. of vehicles/day	7	4	4	2	3	4	10	15	7
		No. of PCUs/day	21	6	2	6	4.5	2	30	22.5	3.5
NT6	Near Findru Village	No. of vehicles/day	9	5	3	2	4	5	18	28	14
		No. of PCUs/day	27	7.5	1.5	6	6	2.5	54	42	7

HMV= Heavy Motor Vehicle; LMV= Light Motor Vehicle; TW= Two Wheelers

NOISE AND TRAFFIC MONITORING IN THE STUDY AREA

Site NT1: Near Sansari Nala Bridge

Site NT2: Near Luj Village

Site NT3: SH37 Killar Chamba Road

Site NT4: Near Killar

Site NT5: SH26 Near Chacharwas Village

Site NT6: SH26 Near Findru Village

Conclusions

Based upon the ambient air quality monitoring done in the study area, it is concluded that air quality, in general, is good and within the permissible limits of CPCB standards. noise levels are also well within permissible limits as per CPCB standards. This is mainly due to the absence of major industrial establishments and a low volume of traffic in the study area.

3.2.1.11 Water Environment

a) Surface Water Quality

Analytical results of water quality at all 6 sampling locations during three seasons are given in **Table 3.22** and their location in the map is given in **Figure 3.16**. The pH varied from 7.06 to 7.3 during the monitoring. Dissolved oxygen ranged from 7.8 to 10.3 mg/l at all sampling locations. All the heavy metals were below detectable limits. Biological oxygen demand levels ranged from <2.0 mg/l at all sampling locations. Chemical oxygen demand levels ranged from <6.0 mg/l in samples collected in the study area.

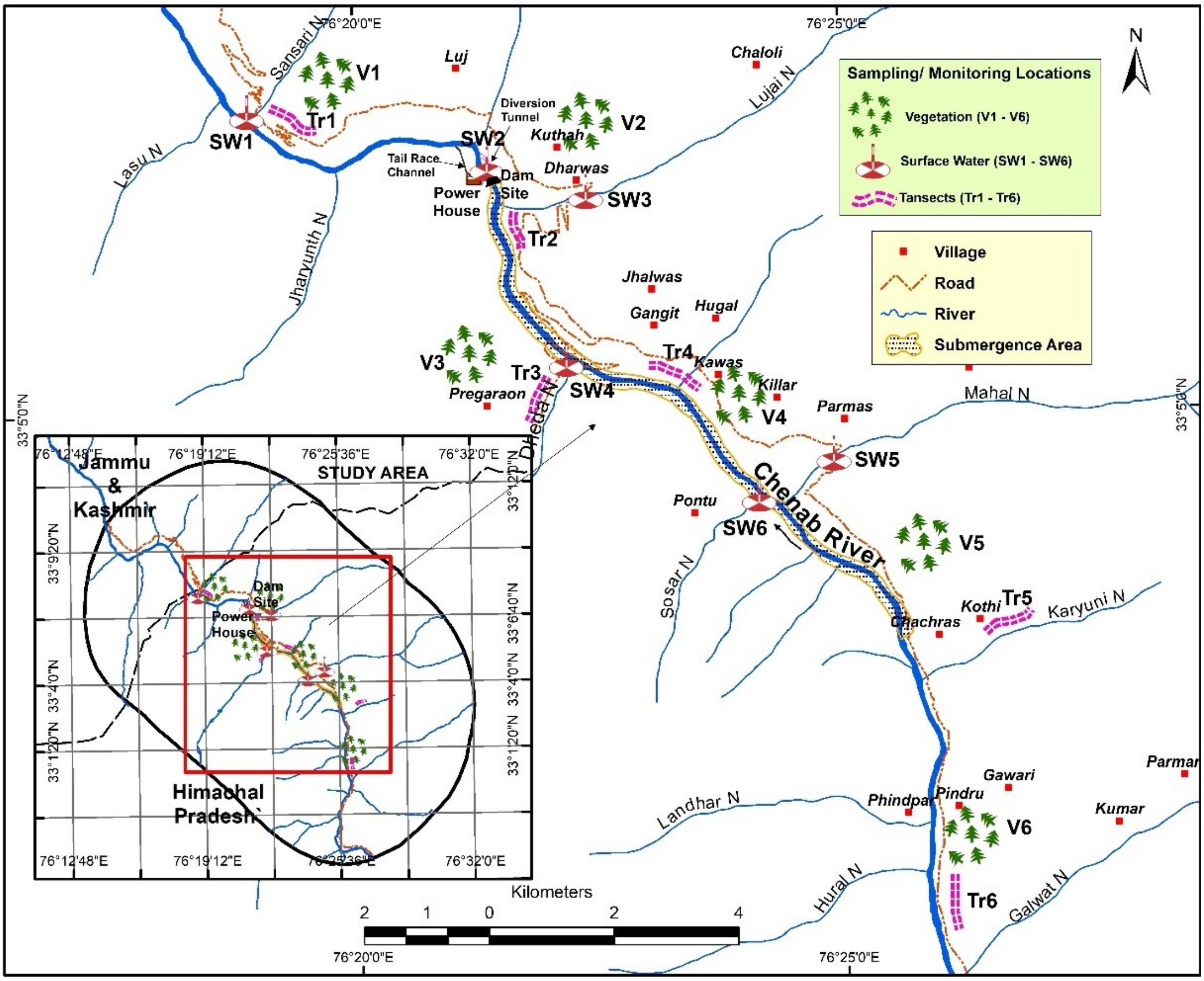


Figure 3.16: Map of study area showing location of Surface water, Vegetation and Faunalsampling sites

Table 3.22: Physico-Chemical Characteristics of Surface water at different sampling locations in different seasons

S. No.	Parameters	Season	Sampling Sites					
			SW1	SW2	SW3	SW4	SW5	SW6
1	Temperature (^{0}C)	Winter	9.2	7.8	8.4	7.7	5.9	8.2
		Pre-monsoon	10.2	8.9	9.4	8.9	7.2	9.3
		Monsoon	10	8.8	8.9	7.8	6.8	9
2	pH	Winter	7.2	7.1	7.2	7.25	7.3	7.18
		Pre-monsoon	7.1	7.08	7.12	7.18	7.2	7.2
		Monsoon	7.17	7.06	7.18	7.21	7.25	7.17
3	Dissolved Oxygen (mg/l)	Winter	8.2	8.4	7.8	7.9	8	8.3
		Pre-monsoon	8.4	9	8.4	8	8.3	8.8
		Monsoon	9.0	10.3	8.7	10.3	9.7	9.1
4	Electrical Conductivity, (µs/cm)	Winter	110	180	50	40	30	140
		Pre-monsoon	122	192	79	66	46	156
		Monsoon	180	220	140	134	98	170
5	Total Dissolved Solids, mg/L	Winter	72	117	33	26	20	91
		Pre-monsoon	79	125	51	43	30	101
		Monsoon	117	143	91	87.1	63.7	110.5
6	Turbidity (NTU)	Winter	4	5	3	2	3	4
		Pre-monsoon	15	24	21	14	12	21
		Monsoon	27	35	17	30	21	35
7	Total Suspended Solids (mg/l)	Winter	20	22	15	12	18	18
		Pre-monsoon	37.8	55.5	42	28	22	43.4
		Monsoon	54.5	69	51.2	55.6	47.8	72.1
8	Chloride (as Cl), mg/L	Winter	20.2	18	26.2	22.1	25.7	23.4
		Pre-monsoon	24.2	20.1	28.7	26.3	29.8	23.4
		Monsoon	21.2	18.7	23.4	22.2	25.6	21.9
9	Total Alkalinity (as $CaCO_3$), mg/L	Winter	16.1	15.4	11.9	16.6	20.2	12.1
		Pre-monsoon	19.8	22.2	15.6	23.2	25.6	23.6
		Monsoon	19.4	23.4	19.8	24.2	25.1	22.2
10	Total Hardness (as $CaCO_3$), mg/L	Winter	51.3	46.8	51.2	53.1	61.3	47.6
		Pre-monsoon	55.5	54.17	55.96	66.46	68.29	55.56
		Monsoon	56.25	56.84	58.79	66.73	69.62	58.56
11	Calcium (as Ca), mg/L	Winter	15.2	13.4	13.5	15.9	17.2	13.4
		Pre-monsoon	16.7	16.5	15.4	18.6	19	15.9
		Monsoon	17	17.4	16.2	19.2	19.2	16.6
12	Magnesium (as Mg), mg/L	Winter	3.2	3.2	4.2	3.2	4.4	3.4
		Pre-monsoon	3.3	3.1	4.2	4.8	5	3.8
		Monsoon	3.3	3.2	4.4	4.5	5.2	4.1
13	Sulphate (as SO_4), mg/L	Winter	12.9	9	10.3	10.6	10.7	9.2
		Pre-monsoon	14.5	10.9	12.3	13.1	13.4	10.1
		Monsoon	16.5	15.4	14.2	17.7	16.4	14.4
14	Nitrate (as NO_3), mg/L	Winter	0.45	0.6	0.4	0.3	0.4	0.34
		Pre-monsoon	0.57	0.77	0.54	0.39	0.44	0.4
		Monsoon	0.7	0.82	0.55	0.4	0.48	0.46
15	Nitrite (NO_2) (mg/l)	Winter	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
		Pre-monsoon	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
		Monsoon	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

S. No.	Parameters	Season	Sampling Sites					
			SW1	SW2	SW3	SW4	SW5	SW6
16	Phosphates (PO_4) mg/L	Winter	0.18	0.22	0.17	0.13	0.16	0.2
		Pre-monsoon	0.22	0.26	0.21	0.19	0.23	0.25
		Monsoon	0.26	0.28	0.22	0.26	0.26	0.27
17	Sodium, mg/L	Winter	4.1	2.8	4.1	3.4	4.1	3.2
		Pre-monsoon	5.4	3.2	4.4	3.9	4.3	4
		Monsoon	5.8	4.1	4.2	4.3	5	4.5
18	Potassium, mg/L	Winter	2.2	2.2	2.2	2.7	2	2.7
		Pre-monsoon	2.54	2.4	2.1	3	2.8	3.1
		Monsoon	2.4	2.3	2.1	3.1	2.9	3.2
19	Sodium Adsorption Ratio	Winter	0.25	0.18	0.25	0.2	0.23	0.2
		Pre-monsoon	0.32	0.19	0.26	0.21	0.23	0.23
		Monsoon	0.34	0.24	0.24	0.23	0.26	0.26
20	Silica (mg/l)	Winter	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
		Pre-monsoon	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
		Monsoon	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
21	Iron, mg/l	Winter	0.2	0.1	0.09	0.06	0.12	0.16
		Pre-monsoon	0.22	0.12	0.16	0.12	0.19	0.24
		Monsoon	0.24	0.2	0.19	0.15	0.23	0.26
22	Phenolic Compound, mg/L	Winter	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		Pre-monsoon	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		Monsoon	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
23	Oil and Grease, mg/L	Winter	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
		Pre-monsoon	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
		Monsoon	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
24	Cadmium (Cd), mg/l	Winter	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
		Pre-monsoon	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
		Monsoon	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
25	Arsenic (As), mg/l	Winter	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		Pre-monsoon	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		Monsoon	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
26	Mercury (Hg), mg/l	Winter	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
		Pre-monsoon	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
		Monsoon	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
27	Copper (Cu), mg/l	Winter	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
		Pre-monsoon	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
		Monsoon	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
28	Zinc (Zn), mg/l	Winter	0.4	38	0.33	0.28	0.5	0.42
		Pre-monsoon	0.45	0.43	0.42	0.33	0.56	0.5
		Monsoon	0.55	0.56	0.5	0.39	0.54	0.59
29	Total Chromium (Cr), mg/l	Winter	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		Pre-monsoon	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		Monsoon	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
30	Chromium 6 (Cr^{+6}), mg/l	Winter	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
		Pre-monsoon	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
		Monsoon	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
31	Manganese (Mn), mg/l	Winter	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
		Pre-monsoon	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

S. No.	Parameters	Season	Sampling Sites					
			SW1	SW2	SW3	SW4	SW5	SW6
		Monsoon	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
32	Lead (Pb), mg/l	Winter	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
		Pre-monsoon	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
		Monsoon	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
33	Biological Oxygen Demand (mg/l)	Winter	<2	<2	<2	<2	<2	<2
		Pre-monsoon	<2	<2	<2	<2	<2	<2
		Monsoon	<2	<2	<2	<2	<2	<2
34	Chemical Oxygen Demand (mg/l)	Winter	<6	<6	<6	<6	<6	<6
		Pre-monsoon	<6	<6	<6	<6	<6	<6
		Monsoon	<6	<6	<6	<6	<6	<6
35	Total Coliform (MPN/100 ml)	Winter	<2	<2	<2	<2	<2	<2
		Pre-monsoon	<2	<2	<2	<2	<2	<2
		Monsoon	<2	<2	<2	<2	<2	<2

The Permissible limit for Total Hardness (as $CaCO_3$) concentration as per Drinking Water Standards IS 10500: 2012 is 200 (mg/l). Based upon the Total Hardness concentration in water samples collected from different locations, the water is under the 'Soft and Moderately Hard Water' water category as per the standards given in the table below.

Total Hardness (as $CaCO_3$) (mg/l) Scale	Indication
0-60	Soft water
61-120	Moderately Hard Water
121-180	Hard water
>180	Very Hard Water

Surface water quality of Chenab and its tributaries samples collected during winter, pre-monsoon, and monsoon seasons was compared with the Water Quality Criteria of Central Pollution Control Board (http://www.cpcb.nic.in/Water_Quality_Criteria.php) fall under Class 'A' with Drinking-Water Source without conventional treatment but after disinfection, this is due to DO concentration is more than 6 mg/l, BOD is less than 2 mg/l, pH range between 6.5 and 8.5 and the Total coliform count is less than 50 MPN/100ml (T**able 3.22**).

Table 3.23: Water Quality Criteria for designated Best Use by CPCB, New Delhi

Designated-Best-Use	Class of water	Criteria
Drinking-Water Source without conventional treatment but after disinfection	A	Total Coliforms Organism MPN/100ml shall be 50 or less
		pH between 6.5 and 8.5
		Dissolved Oxygen 6mg/l or more
		Biochemical Oxygen Demand 5 days 20^0C 2mg/l or less
Outdoor bathing (Organised)	B	Total Coliforms Organism MPN/100ml shall be 500 or less, pH between 6.5 and 8.5, Dissolved Oxygen 5mg/l or more
		Biochemical Oxygen Demand 5 days 20^0C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	Total Coliforms Organism MPN/100ml shall be 5000 or less, pH between 6 and 9, Dissolved Oxygen 4mg/l or more
		Biochemical Oxygen Demand 5 days 20^0C 3mg/l or less
Propagation of Wildlife and Fisheries	D	pH between 6.5 to 8.5, Dissolved Oxygen 4mg/l or more
		Free Ammonia (as N) 1.2 mg/l or less

Designated-Best-Use	Class of water	Criteria
Irrigation, Industrial Cooling, Controlled Waste disposal	E	pH between 6.0 and 8.5
		Electrical Conductivity at 25^{0}C micromhos/cm Max.2250
		Sodium Absorption Ratio Max. 26
		Boron Max. 2mg/l
	Below-E	Not Meeting A, B, C, D & E Criteria

b) Drinking-Water Quality Index

A commonly-used water quality index (WQI) developed by the National Sanitation Foundation (NSF) in 1970 by Brown Oram (https://water-research.net/index.php/water-treatment/water-monitoring/monitoring-the-quality-of-surfacewaters) and Washington State Department of Ecology, Environmental Assessment Programme was used for assessing the surface water quality. The NSF WQI was developed to provide a standardized method for comparing the water quality of various bodies of water. The water quality index is a 100-point scale that summarizes results from a total of 9 different parameters listed below in the table.

pH	Delta Temperature Change (^{0}C)	Total Phosphates (mg/L)
Dissolved Oxygen (DO) Saturation (%)	Total Coliforms (MPN/100ml)	Nitrates (mg/L)
Turbidity (NTU)	Biochemical Oxygen Demand (BOD) (mg/L)	Total Suspended Solids (TSS) (mg/L)

The analysis of water quality, therefore, is based upon 9 parameters as defined for WQI above, and based upon the score at each sampling site water quality has been designated as Excellent, Good, Medium, etc. as per the range defined in the table below.

Water Quality Index	
Range	**Quality**
90-100	Excellent
70-90	Good
50-70	Medium
25-50	Bad
0-25	Very bad

The water quality index based upon the above parameters is given in the table below

WQI	SW1	SW2	SW3	SW4	SW5	SW6
Winter	81.07	79.58	80.49	81.62	79.91	80.97
Pre-monsoon	78.91	77.29	78.14	78.85	78.61	78.95
Monsoon	77.83	77.65	78.68	79.58	79.12	77.62

According to WQI values obtained for different seasons surface water quality, in general, is in the 'Good' category in all the sampling locations in the study area.

Therefore, based upon CPCB guidelines as well the WQI calculated above the water of Chenab River and its tributaries is safe for drinking without conventional treatment but after disinfection.

WATER SAMPLING LOCATIONS


SW1: Chenab River near the confluence of Sansari Nala


SW3: Lujai Nala


SW4: Near Chenab River near the confluence of Dheda Nala


SW5: Mahal Nala near Killar

c) Conclusion

- The water quality in the study area, in general, is good. This is primarily due to the absence of any industrial establishment and low population density in the project area.
- The water of Chenab River and its tributaries is categoriesd under Class 'A' i.e., with Drinking-Water Source without conventional treatment but after disinfection according to Water Quality Criteria of Central Pollution Control Board.
- Based upon CPCB guidelines as well the WQI calculated above the water of Chenab River and its tributaries in the study area are safe for drinking without conventional treatment but after disinfection.

3.2.2 Biological Environment

3.2.2.1 Forest Types

The details on forest types and forest cover in the study area were based on field surveys supplemented with the forest working plan of the Pangi Forest Division. The forests in the study area have been classified following the 'A Revised Survey of the Forest Types of India' by Champion and Seth (1968), under Montane Temperate Forest type and classified under Group-13 Himalayan Dry Temperate Forests. Forest Sub Types in the study area are described in paragraphs below

13/C2a *Neoza Pine Forest* (*Pinus gerardiana*)

Neoza pine forest (*Pinus gerardiana*) occurs with some deodar trees in the inner dry valleys of Chenab basin. This type of forest was observed on Dugar HEP dam site and adjoining downstream area under Luj Reserve Forest under Pangi Forest Division. Important tree associates found are *Cedrus deodara, Fraxinus xanthoxyloides,* and *Pinus wallichiana*. Shrubs are few and are represented by *Berberis aristata, Lonicera quinquelocularis*, *Indigofera heterantha, Cotoneaster microphyllus, Rubus niveus*, *Viburnum cotinifolium*, *Jasminum officinale, Rabdosia rugosa* and *Sorbaria tomentosa*. Climbers are almost absent (with a few exceptions like presence of *Clematis* spp.).

13/C2b *Dry Deodar Forest*

Dry Deodar Forest is the most predominant type found in almost all over the area along the bank of Chenab River commonly associated with *Pinus wallichiana*. This type of forest is found between 2100m and 3000m elevations. The main associate of the middle storey includes *Corylus jacquimontii, Fraxinus xanthoxyloides, Prunus cornuta, Robina pseudoacacia*, etc. Shrubs comprise *Berberis aristata*, *Desmodium heterocarpon, Lonicera angustifolia, Rabdosia rugosus, Rosa webianna, R. brunonii, Rubus lasiocarpus, Viburnum cotinifolium,* etc. The common terrestrial ferns are the species of *Adiantum, Athyrium, Dryopteris, Pteris,* etc.

13C3 West Himalayan dry temperate deciduous forest

This type is generally found on moist soils and is distributed all over the division in damp shaded areas, and tributary streams. Trees like *Aesculus indica, Corylus colurna, Acer caesium, Celtis australis, Salix* spp., *Juglans regia, Prunus cornuta* and *Fraxinus* spp. are chiefly found in areas which are characterized by comparatively moister conditions. In drier areas with lower precipitation and xerophytic conditions, generally broadleaved species like *Crataegus oxycantha* and *Fraxinus xanthoxyloides* are found. On cooler northerly aspects, pure stands of *Corylus colurna* also occur. Undergrowth is comprised of *Parrotiopsis jacquemontiana*, *Deutzia corymbosa*, *Spiraea canescens*, *Viburnum nervosum*, *Lonicera quinquelocularis* and *Salix* spp. The most commonly found herbs are the species of *Valeriana* and *Polygonum*.

13C4 West Himalayan high-level dry blue pine forest (*Pinus wallichiana*)

This type occurs in the Saichu valley. Wherever the rainfall is scanty the forest is found on melting snow beds on the gentle slopes between 2500 m and 3200 m. *Pinus wallichiana* (Kail) is the principal species in the top canopy. The most common associates of Kail are *Betula utilis, Juniperus semiglobosa, Ribes* spp., *Rhamnus prostrata,* and *Rhododendron campanulatum.* Among the herbs *Aconitum heterophylum, Picrorhiza kurroa,* and *Lonicera hypoleuca* are frequently met with.

3.2.2.2 Floristics

The vegetation of the project area is quite diverse due to varied microclimatic and ecological factors. The vegetation is generally composed of coniferous forest mainly associated with broad-leaved forest or with their corresponding undergrowth at higher elevations. The following section on Terrestrial ecology is based on data collected during field surveys conducted in three seasons during 2021 at various localities within the study area.

Objectives

The main objectives of the floristic studies are as follows:

- To prepare an inventory of plants (Angiosperms and Gymnosperms, Pteridophytes and Lichens) in the study area
- Assessment of tree, shrub, and herbs diversity in the study area
- Determination of Importance Value Index and Shannon Wiener Diversity Index for the tree, shrub, and herbs diversity in the study area.

a) Taxonomic Diversity

During the field surveys and also based upon secondary data and available information an inventory of 182 plant species in the study area has been prepared. A brief description plant species recorded in various taxonomic groups is given in **Table 3.24**.

Table 3.24: **Number of species of different plant groups reported from the study area**

S. No.	Plant Group	No. of Families	No. of Genera	No. of Species
1	**Angiosperms**			
	Trees	9	12	19
	Shrubs	13	24	31
	Herbs	25	81	89
	Grasses	2	15	16
	Climbers	5	5	5
2	**Gymnosperms**			
	Trees	2	5	6
	Shrubs	2	2	3
3	**Pteridophytes**	3	4	5

S. No.	Plant Group	No. of Families	No. of Genera	No. of Species
4	**Bryophytes**	3	3	3
5	**Lichens**	4	5	5

i. Angiosperms

As per data collected during field surveys an inventory of 160 species of plants belonging to angiosperms was compiled which includes plant species found in forested areas, scrub land, near agricultural fields and settlements, abandoned land, etc. This list includes 19 species of trees, 31 species of shrubs, 89 species of herbaceous plants, 16 species of grasses and 5 species of climbers. Dominant families in the area are Asteraceae and Rosaceae, followed by Poaceae, Lamiaceae and Fabaceae. List of angiosperms recorded from the area is given in **Annexure-IV.** The classification and nomenclature of species is based upon http://www.theplantlist.org/ accessed in September 2021.

ii. Gymnosperms

Gymnosperms in the area are represented by 9 species belonging to 3 families and 7 genera. A list of gymnosperms recorded from the study area is given in **Table 3.25**.

Table 3.25: **List of Gymnosperms recorded from the study area**

S. No.	Family	Plant species	Common name	Habit
1	Cupressaceae	*Cupressus sempervirens*		Tree
2	Cupressaceae	*Juniperus communis*	Petada, Shukpa	Shrub
3	Ephedraceae	*Ephedra gerardiana*	Somalata	Shrub
4	Ephedraceae	*Ephedra distachya*		Shrub
5	Pinaceae	*Abies spectabilis*	Tosh	Tree
6	Pinaceae	*Cedrus deodara*	Deodar	Tree
7	Pinaceae	*Pinus gerardiana*	Chilgoza pine	Tree
8	Pinaceae	*Pinus wallichiana*	Kail	Tree
9	Pinaceae	*Picea smithiana*	Spruce	Tree

iii. Pteridophytes and Bryophytes

In the study area presence of pteridophytes and bryophytes was observed along the streams and moist and wet places. The Pteridophyte group is represented by 5 species belonging to 4 genera and 3 families. *Athyrium foliolosum* and *Pteris* spp. are dominant pteridophyte species in the area. Bryophytes in the study area are represented by 3 species belonging to 3 families. *Marchantia* sp. and *Funaria* sp. are commonly found bryophytes in the study area. The list of Pteridophytes and Bryophytes recorded from the study area are list below in **Table 3.26**.

Table 3.26: **List of lower plants recorded from the study area**

S. No.	Family	Name of Species
Pteridophytes		
1	Athyriaceae	*Athyrium foliolosum*
2	Athyriaceae	*Allantodia spectabilis*
3	Equisetaceae	*Equisetum ramosissimum*
4	Pteridaceae	*Pteris cretica*

S. No.	Family	Name of Species
5	Pteridaceae	*Pteris aspericaulis*
Bryophytes		
1	Dicranaceae	*Dicranodontium* sp.
2	Funariaceae	*Funaria* sp.
3	Marchantiaceae	*Marchantia* sp.

iv. Lichens

Five species of Lichens were found in the study area belonging to 4 families. *Heterodermia* sp., *Hypogymnia* sp., and *Graphis* sp. were the most frequently occurring species found in the study area. A list of lichen species recorded from the study is given below in **Table 3.27**.

Table 3.27: **List of Lichens recorded from the study area**

S. No.	Family	Name of Species
1	Cladoniaceae	*Cladonia* sp.
2	Graphidaceae	*Graphis* sp.
3	Parmeliaceae	*Hypogymnia* sp.
4	Parmeliaceae	*Parmelia* sp.
5	Physciaceae	*Heterodermia* sp.

b) Conservation Status

Out of 182 plant species reported from the study area, only 54 species were evaluated by IUCN ver. 2021-2 (**Table 3.28**). As per the IUCN Red List of Threatened Species 2021-2, *Angelica glauca is* list under the Endangered (EN) category*, Saussurea costus* under Critically Endangered (CR), *Ephedra gerardiana* and *Ulmus wallichiana* are under the Vulnerable (VU) category, and *Abies spectabilis* and *Pinus gerardiana* under Near Threatened (NT) category. The rest of the species evaluated are either List Concern (LC) or Data Deficient (DD) category.

Table 3.28: Conservation Status as per IUCN ver. 2021-2

S. No.	Family	Name of Species	Conservation Status IUCN ver. 2021-2
1	Aceraceae	*Acer caesium*	LC
2	Apiaceae	*Angelica glauca*	EN
3	Asteraceae	*Saussurea costus*	CR
4	Berberidaceae	*Berberis aristata*	LC
5	Berberidaceae	*Berberis lycium*	LC
6	Betulaceae	*Corylus jacquemontii*	DD
7	Betulaceae	*Alnus nitida*	LC
8	Betulaceae	*Carpinus viminea*	LC
9	Betulaceae	*Betula utilis*	LC
10	Caryophyllaceae	*Silene vulgaris*	LC
11	Caryophyllaceae	*Stellaria monosperma*	LC
12	Convolvulaceae	*Cuscuta reflexa*	LC
13	Cupressaceae	*Cupressus sempervirens*	LC
14	Cupressaceae	*Juniperus communis*	LC
15	Ephedraceae	*Ephedra gerardiana*	VU

S. No.	Family	Name of Species	Conservation Status IUCN ver. 2021-2
16	Ephedraceae	*Ephedra distachya*	LC
17	Equisetaceae	*Equisetum ramosissimum*	LC
18	Fabaceae	*Robinia pseudo-acacia*	LC
19	Fabaceae	*Indigofera heterantha*	LC
20	Fabaceae	*Lespedeza juncea*	LC
21	Fabaceae	*Medicago polymorpha*	LC
22	Fabaceae	*Trifolium pratense*	LC
23	Fabaceae	*Trigonella emodi*	LC
24	Geraniaceae	*Geranium wallichianum*	LC
25	Hamamelidaceae	*Parrotiopsis jacquemontiana*	LC
26	Hippocastanaceae	*Aesculus indica*	LC
27	Juglandaceae	*Juglans regia*	LC
28	Lamiaceae	*Lamium album*	LC
29	Lamiaceae	*Mentha longifolia*	LC
30	Lamiaceae	*Prunella vulgaris*	LC
31	Oleaceae	*Fraxinus xanthoxyloides*	LC
32	Pinaceae	*Abies spectabilis*	NT
33	Pinaceae	*Cedrus deodara*	LC
34	Pinaceae	*Pinus gerardiana*	NT
35	Pinaceae	*Pinus wallichiana*	LC
36	Pinaceae	*Picea smithiana*	LC
37	Plantaginaceae	*Plantago major*	LC
38	Poaceae	*Arundo donax*	LC
39	Poaceae	*Festuca rubra*	LC
40	Poaceae	*Phleum alpinum*	LC
41	Poaceae	*Poa annua*	LC
42	Ranunculaceae	*Caltha palustris*	LC
43	Ranunculaceae	*Ranunculus sceleratus*	LC
44	Rhamnaceae	*Rhamnus virgatus*	LC
45	Rosaceae	*Prunus armeniaca*	DD
46	Rosaceae	*Prunus cornuta*	LC
47	Rosaceae	*Spiraea canescens*	LC
48	Salicaceae	*Populus ciliata*	LC
49	Salicaceae	*Salix alba*	LC
50	Salicaceae	*Salix tetrasperma*	LC
51	Saxifragaceae	*Bergenia ciliata*	LC
52	Scrophulariaceae	*Verbascum thapsus*	LC
53	Ulmaceae	*Celtis tetrandra*	LC
54	Ulmaceae	*Ulmus wallichiana*	VU

EN=Endangered; CR=Critically Endangered; VU=Vulnerable; NT=Near Threatened; DD=Data Deficient; LC=Least Concern

c) Vegetation Profile of the Study Area

The proposed Dugar HEP lies in the Pangi valley of Chamba district. Pangi valley is rich in terms of floral wealth. The catchment of Chenab River in the study area was characterized by steep slopes. The vegetation in the area in general is characterized as Himalayan Dry Temperate type (Champion and Seth, 1968). *Cedrus deodara, Pinus gerardiana, Pinus* *wallichiana, Picea smithiana*, *Abies spectabilis,* are the conifer species forming the top canopy generally observed on the steep slopes along the Chenab River and its tributaries in the study area. *Celtis australis, Corylus jacquemontii, Ulmus wallichiana, Salix tetrasperma, Salix denticulata, Fraxinus xanthoxyloides, Juglans regia, Robinia pseudo-acacia, Populus ciliata, Prunus armeniaca* and *Alnus nitida* are the associated tree species in the forest area. Shrub vegetation in the area was mostly observed on the edges of forest area, on barren rocky slopes, scrub, and fallow land represented by species like *Abelia triflora*, *Artemisia maritima*, *Berberis aristata*, *Berberis lycium*, *Cotoneaster bacillaris*, *Daphne oleoides, Clematis montana, Rabdosia rugosa*, *Ephedra gerardiana*, *Girardinia heterophylla*, *Jasminum humile*, *Olea ferruginea*, *Rosa macrophylla*, *Rosa moschata*, *Rubus foliolosus*, *Rubia cordifolia*, *Rubus niveus*, *Sambucus wightiana*, and *Sorbaria tomentosa.*

Herbaceous flora of the region varies seasonally in the area. *Polygonum molle*, *Artemisia maritima, Arenaria glanduligera, Chaerophyllum reflexum, Cirsium falconeri, Dactylis glomerata, Equisetum arvense, Eremurus himalaicus, Galium aparine*, *Gentiana coronata, Hyoscyamus niger*, *Impatiens sulcata, Muhlenbergia himalayensis, Pimpinella diversifolia, Poa annua, Rubus* sp.*, Rumex hastatus*, *Anaphalis royleana*, *Cirsium wallichii*, *Geranium nepalense*, *Impatiens glandulifera*, *Malva verticillata*, *Origanum vulgare*, *Oxalis corniculata*, *Plantago major*, *Pouzolzia zeylanica*, *Primula denticulata*, *Saussurea costus*, *Taraxacum officinale*, *Thalictrum foliolosum*, *Trifolium repens*, *Valeriana jatamansi*, *Verbascum thapsus* and *Youngia japonica*, etc. were the herb species in the catchment of Chenab River. *Carex inanis*, *Kyllinga squamulata*, *Agrostis pilosula*, *Arthraxon lancifolius*, *Bromus japonicus*, *Eragrostis pilosa*, *Poa annua*, *Stipa roylei*, etc. are the grass species in the catchment mostly grown on barren rocky steep slopes.

d) Community Structure

The community composition at different sampling locations is given in the following paragraphs.

i. Trees

Tree cover in the study area was mainly represented by conifers species observed in patches all over the study area.

Out of 19 tree species recorded from the study area, a total of 14 tree species were recorded during phytosociological sampling at different sampling locations (**Table 3.29**). *Cedrus deodara* is the dominant tree species in the area recorded from all the sampling sites, associated with *Pinus gerardiana* and *Pinus wallichiana*. Among the broad leave species*, Corylus jacquemontii*, *Fraxinus xanthoxyloides,* and *Robinia pseudo-acacia* are dominant in forest areas while, *Salix denticulata*, *Populus ciliata,* and *Prunus armeniaca* were found dominant near habitation. *Juglans regia* is the species recorded both from forest areas as well as on bunds of agriculture fields and near habitation (**Table 3.29**).

ii. Shrubs

The shrub layer in the forest is mainly restricted on the edges of the forest, forest paths, and village approach roads. A total of 15 species of shrubs were recorded during the surveys and the total number of species recorded at each site varies from 9 to 12 species at each site (see **Table 3.30**). A maximum number of shrub species were recorded from site V3 with 12 species and the minimum number of species were recorded from site V2 and V5 with 9 species at each site.

Shrubs in the area were mostly observed at the sampling area with low canopy tree cover or barren rocky outcrops with steep slopes along the river and near crop fields and habitation. *Berberis lycium, Artemisia maritima Indigofera heterantha,* and *Rhamnus virgatus* were the dominant shrub species in the area. *Berberis lycium* was found at 5 sampling sites, while *Artemisia maritima Indigofera heterantha* and *Rhamnus virgatus* were recorded from 3 sampling sites (**Table 3.30)**. *Cotoneaster bacillaris, Lonicera spinosa, Rubus niveus,* and *Sorbaria tomentosa* was the other commonly found shrub species in the study area.

iii. Herbs

At the sampling sites located in the study area, the herbaceous layer was comprised of 48 species. Species richness was found highest during monsoon and pre-monsoon season as the maximum number of species (42) were recorded during monsoon season, followed by 36 species during pre-monsoon season and a minimum number of species recorded during 22 species during winter season sampling (see **Tables 3.31**, **3.32 and 3.33**). The total number of species i.e., species richness at different sampling sites varied from 9 to 12 during the winter season, 12 to 15 during pre-monsoon, and 16 to 21 during the monsoon season survey.

The sampling area was dominated by grass species like *Arundo donax, Andropogon munroi, Carex inanis, Dianthus angulatus, Eragrostis pilosa,* and *Poa annua*.

Based upon species density across all the sampling sites during winter season sampling, the herbaceous flora in the area was dominated by species like *Anaphalis royleana, Artemisia nilagirica, Bergenia ciliata, Conyza stricta, Primula denticulata, Youngia japonica,* and *Trifolium repens* (**Table 3.31**).

During pre-monsoon season sampling *Ajuga bracteosa, Anaphalis royleana, Artemisia nilagirica, Erigeron canadensis, Geranium nepalense, Nepeta laevigata, Origanum vulgare, Oxalis corniculata, Rumex nepalensis, Thalictrum foliolosum, Thlaspi arvense,* and *Trifolium repens,* and *Trifolium repens* were the most dominant herbaceous species (**Table 3.32**).

The highest density of herb species was recorded during the monsoon season. The dominant species during monsoon season sampling were *Achyranthes aspera, Ageratum conyzoides, Arisaema concinnum, Elatostema sessile, Justicia mollissima, Mikania micrantha, Senna tora, Sida rhombifolia, Urtica dioica Phragmites karka, Saccharum spontaneum, Thysanolaena latifolia,* and *Eragrostis amabilis* (**Table 3.33**).

Table 3.29: Community Structure –Trees

S. No.	Plant Species	V1				V2				V3				V4				V5				V6			
		F	D	Ab	TBC	F	D	Ab	TBC	F	D	Ab	TBC	F	D	Ab	TBC	F	D	Ab	TBC	F	D	Ab	TBC
1	*Acer caesium*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	20	40	2.00	7.69
2	*Alnus nitida*	20	40	2.00	1.38	20	30	1.50	1.11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3	*Cedrus deodara*	70	90	1.29	126.04	30	50	1.67	69.02	40	70	1.75	117.02	20	30	1.50	98.51	50	70	1.40	118.32	30	80	2.67	137.83
4	*Celtis tetrandra*	--	--	--	--	--	--	--	--	--	--	--	--	20	30	1.50	9.37	--	--	--	--	--	--	--	--
5	*Corylus jacquemontii*	--	--	--	--	--	--	--	--	20	30	1.50	49.21	--	--	--	--	20	40	2.00	38.39	--	--	--	--
6	*Fraxinus xanthoxyloides*	30	30	1.00	0.69	20	40	2.00	0.82	30	50	1.67	0.79	--	--	--	--	--	--	--	--	20	40	2.00	0.89
7	*Juglans regia*									30	40	1.33	14.32	30	30	1.00	8.34	30	50	1.67	15.28	--	--	--	--
8	*Pinus gerardiana*	10	20	2.00	112.03	30	70	2.33	126.32	20	20	1.00	95.21	--	--	--	--	--	--	--	--	--	--	--	--
9	*Pinus wallichiana*	20	30	1.50	68.03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	30	50	1.67	98.71
10	*Populus ciliata*	--	--	--	--	--	--	--	--	--	--	--	--	30	40	1.33	1.21	40	60	1.50	3.24	--	--	--	--
11	*Prunus armeniaca*	--	--	--	--	--	--	--	--	--	--	--	--	30	40	1.33	0.89	20	40	2.00	0.76	30	30	1.00	3.02
12	*Robinia pseudo-acacia*	40	40	1.00	8.31	--	--	--	--	--	--	--	--	30	50	1.67	2.33	--	--	--	--	20	30	1.50	7.56
13	*Salix denticulata*	--	--	--	--	20	30	1.50	2.01	20	50	2.50	7.23	40	70	1.75	8.56	30	50	1.67	5.93	--	--	--	--
14	*Ulmus wallichiana*	30	30	1.00	113.0	30	50	1.67	98.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

F=Frequency (%)., D=Density (No. of Individuals/ha), Ab. =Abundance, TBC= Total Basal Cover (sq. m/ha)

Table 3.30: Community Structure –Shrubs

S. No.	Plant Species	V1			V2			V3			V4			V5			V6		
		F	D.	Ab.	F	D.	Ab.	F	D.	Ab.	F	D.	Ab.	F	D.	Ab.	F	D.	Ab.
1	*Artemisia maritima*	30	240	2.00	30	200	1.67	--	--	--	30	240	2.00	--	--	--	20	160	2.00
2	*Berberis lycium*	40	200	1.25	20	240	3.00	20	160	2.00	20	200	2.50	30	200	1.67	--	--	--
3	*Cotoneaster bacillaris*	--	--	--	--	--	--	30	120	1.00	30	160	1.33	--	--	--	--	--	--
4	*Crataegus oxyacantha*	--	--	--	--	--	--	--	--	--	--	--	--	20	120	1.50	--	--	--
5	*Deutzia staminea*	--	--	--	--	--	--	30	120	1.00	20	80	1.00	--	--	--	20	120	1.50

S. No.	Plant Species	V1			V2			V3			V4			V5			V6		
		F	D.	Ab.	F	D.	Ab.	F	D.	Ab.	F	D.	Ab.	F	D.	Ab.	F	D.	Ab.
6	*Indigofera heterantha*	30	120	1.00	30	120	1.00	20	80	1.00	--	--	--	20	160	2.00	--	--	--
7	*Lonicera spinosa*	20	160	2.00	--	--	--	--	--	--	--	--	--	--	--	--	30	120	1.00
8	*Rabdosia rugosa*	--	--	--	20	80	1.00	--	--	--	--	--	--	--	--	--	--	--	--
9	*Rhamnus virgatus*	--	--	--	--	--	--	30	160	1.33	20	160	2.00	20	160	2.00	30	240	2.00
10	*Ribes glaciale*	--	--	--	--	--	--	20	120	1.50	--	--	--	--	--	--	--	--	--
11	*Rosa macrophylla*	30	120	1.00	--	--	--	--	--	--	--	--	--	30	200	1.67	30	160	1.33
12	*Rubus foliolosus*	20	160	2.00	--	--	--	20	80	1.00	--	--	--	--	--	--	20	120	1.50
13	*Rubus niveus*	10	80	2.00	--	--	--	--	--	--	30	120	1.00	--	--	--	--	--	--
14	*Sorbaria tomentosa*	--	--	--	30	160	1.33	--	--	--	20	120	1.50	--	--	--	--	--	--
15	*Spiraea canescens*	--	--	--	--	--	--	--	--	--	--	--	--	30	120	1.00	--	--	--

F=Frequency (%)., D=Density (No. of Individuals/ha), Ab. =Abundance

Table 3.31: Community Structure –Herbs (Winter)

S. No.	Name of Species	V1			V2			V3			V4			V5			V6		
		F	D.	Ab.	F	D.	Ab.	F	D.	Ab.	F	D.	Ab.	F	D.	Ab.	F	D.	Ab.
1	*Agrostis pilosula*	--	--	--	30	2600	8.67	--	--	--	--	--	--	--	--	--	--	--	--
2	*Anaphalis royleana*	40	1600	4	40	900	2.25	--	--	--	--	--	--	--	--	--	--	--	--
3	*Andropogon munroi*	--	--	--	--	--	--	30	1700	5.67	--	--	--	--	--	--	--	--	--
4	*Artemisia nilagirica*	30	1400	4.67	30	1200	4	40	1000	2.5	50	1000	2	50	1300	2.6	50	900	1.8
5	*Arundo donax*	50	2600	5.2	--	--	--	40	1800	4.5	40	2400	6	--	--	--	--	--	--
6	*Bergenia ciliata*	--	--	--	--	--	--	50	1000	2	--	--	--	--	--	--	70	1000	1.43
7	*Caltha palustris*	--	--	--	--	--	--	--	--	--	40	800	2	40	900	2.25	--	--	--
8	*Cannabis sativa*	50	1100	2.2	--	--	--	--	--	--	--	--	--	--	--	--	30	700	2.33
9	*Carex inanis*				40	1600	4	40	1900	4.75	--	--	--	50	2300	4.6	--	--	--
10	*Conyza canadensis*	40	800	2							50	700	1.4	--	--	--	30	500	1.67
11	*Conyza stricta*							50	1100	2.2	--	--	--	--	--	--	--	--	--
12	*Dianthus angulatus*	30	2300	7.67	50	1400	2.8	--	--	--	--	--	--	--	--	--	40	1600	4
13	*Eragrostis pilosa*	30	1200	4	50	2400	4.8	--	--	--	40	1800	4.5	20	2500	12.5	40	2300	5.75

S. No.	Name of Species	V1			V2			V3			V4			V5			V6		
		F	D.	Ab.	F	D.	Ab.	F	D.	Ab.	F	D.	Ab.	F	D.	Ab.	F	D.	Ab.
14	*Inula racemosa*	--	--	--	30	500	1.67	--	--	--	--	--	--	40	1000	2.5	--	--	--
15	*Origanum vulgare*	--	--	--	--	--	--	--	--	--	50	900	1.8	70	1300	1.86	--	--	--
16	*Oxalis corniculata*	--	--	--	40	1800	4.5	30	1200	4	30	1200	4	--	--	--	60	1600	2.67
17	*Poa annua*	30	2400	8	--	--	--	60	2400	4	40	1800	4.5	--	--	--	50	2700	5.4
18	*Primula denticulata*	--	--	--	--	--	--	30	1000	3.33	60	1000	1.67	--	--	--	--	--	--
19	*Ranunculus sceleratus*	40	900	2.25	40	800	2	--	--	--	--	--	--	50	900	1.8	--	--	--
20	*Thalictrum foliolosum*	--	--	--	--	--	--	60	900	1.5	--	--	--	--	--	--	50	900	1.8
21	*Trifolium repens*	--	--	--	--	--	--	--	--	--	50	800	1.6	50	1100	2.2	--	--	--
22	*Verbascum thapsus*	--	--	--	--	--	--	--	--	--	40	900	2.25	60	1000	1.67	--	--	--

F=Frequency (%)., D=Density (No. of Individuals/ha), Ab. =Abundance

Table 3.32: Community Structure – Herbs (Pre-Monsoon)

S. No.	Plant Species	V1			V2			V3			V4			V5			V6		
		F	D.	Ab.	F	D.	Ab.	F	D.	Ab.	F	D.	Ab.	F	D.	Ab.	F	D.	Ab.
1	*Ainsliaea aptera*	40	1300	3.3	--	--	--	--	--	--	40	1800	4.5	--	--	--	70	1000	1.4
2	*Anaphalis royleana*	--	--	--	--	--	--	50	1300	2.6	--	--	--	40	1200	3.0	--	--	--
3	*Andropogon munroi*	--	--	--	--	--	--	60	2100	3.5	--	--	--	--	--	--	--	--	--
4	*Arabidopsis thaliana*	30	1400	4.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5	*Artemisia nilagirica*	50	2600	5.2	50	1000	2.0	40	1800	4.5	40	900	2.3	70	1900	2.7	50	1400	2.8
6	*Arundo donax*	70	2000	2.9	--	--	--	50	1900	3.8	50	1100	2.2	--	--	--	--	--	--
7	*Bergenia ciliata*	--	--	--	--	--	--	--	--	--	--	--	--	30	1000	3.3	--	--	--
8	*Caltha palustris*	--	--	--	--	--	--	--	--	--	50	900	1.8	--	--	--	30	1300	4.3
9	*Cannabis sativa*	--	--	--	--	--	--	30	1100	3.7	--	--	--	--	--	--	30	1200	4.0
10	*Carex inanis*	--	--	--	40	1900	4.8	60	1800	3.0	--	--	--	40	2500	6.3	--	--	--
11	*Chenopodium album*	--	--	--	--	--	--	--	--	--	40	1800	4.5	--	--	--	--	--	--
12	*Erigeron canadensis*	60	1400	2.3	50	1400	2.8	20	700	3.5	70	1300	1.9	--	--	--	--	--	--
13	*Dianthus angulatus*	30	1900	6.3	50	1100	2.2	--	--	--	--	--	--	--	--	--	50	1100	2.2
14	*Eragrostis pilosa*	--	--	--	50	2200	4.4	--	--	--	60	1000	1.7	40	2000	5.0	40	2300	5.8
15	*Erigeron multiradiatus*	40	1500	3.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

S. No.	Plant Species	V1			V2			V3			V4			V5			V6		
		F	D.	Ab.	F	D.	Ab.	F	D.	Ab.	F	D.	Ab.	F	D.	Ab.	F	D.	Ab.
16	*Euphorbia pilosa*	50	1300	2.6	--	--	--	50	1000	2.0	50	1300	2.6	--	--	--	--	--	--
17	*Fragaria vesca*	--	--	--	30	900	3.0	--	--	--	50	900	1.8	--	--	--	--	--	--
18	*Geranium nepalense*	50	2100	4.2	--	--	--	--	--	--	--	--	--	50	900	1.8	30	1200	4.0
19	*Inula racemosa*	--	--	--	40	1100	2.8	--	--	--	--	--	--	50	900	1.8	--	--	--
20	*Nepeta laevigata*	30	1200	4.0	--	--	--	60	1600	2.7	--	--	--	--	--	--	40	1100	2.8
21	*Origanum vulgare*	--	--	--	--	--	--	--	--	--	40	1200	3.0	--	--	--	--	--	--
22	*Oxalis corniculata*	40	1100	2.8	30	1000	3.3	--	--	--	--	--	--	--	--	--	60	1600	2.7
23	*Plantago depressa*	--	--	--	--	--	--	--	--	--	40	800	2.0	--	--	--	--	--	--
24	*Plantago major*	--	--	--	30	1200	4.0	--	--	--	--	--	--	--	--	--	--	--	--
25	*Poa annua*	60	2700	4.5	--	--	--	40	1600	4.0	50	700	1.4	--	--	--	50	2200	4.4
26	*Primula denticulata*	30	600	2.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
27	*Prunella vulgaris*	--	--	--	--	--	--	50	1200	2.4	--	--	--	--	--	--	--	--	--
28	*Ranunculus sceleratus*	50	1200	2.4	40	1600	4.0	--	--	--	--	--	--	40	1000	2.5	--	--	--
29	*Rumex nepalensis*	--	--	--	30	1800	6.0	--	--	--	--	--	--	--	--	--	50	1800	3.6
30	*Thalictrum foliolosum*	60	2100	3.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
31	*Thlaspi arvense*	--	--	--	50	2000	4.0	--	--	--	40	900	2.3	--	--	--	50	1600	3.2
32	*Trifolium pratense*	--	--	--	--	--	--	--	--	--	--	--	--	60	1200	2.0	--	--	--
33	*Trifolium repens*	--	--	--	40	2600	6.5	--	--	--	50	1100	2.2	--	--	--	--	--	--
34	*Verbascum thapsus*	--	--	--	--	--	--	--	--	--	50	900	1.8	--	--	--	--	--	--
35	*Viola canescens*	--	--	--	--	--	--	--	--	--	--	--	--	30	800	2.7	--	--	--
36	*Youngia japonica*	--	--	--	--	--	--	--	--	--	--	--	--	50	1200	2.4	50	1000	2.0

F=Frequency (%)., D=Density (No. of Individuals/ha), Ab. =Abundance

Table 3.33: Community Structure – Herbs (Monsoon)

S. No.	Name of Species	V1			V2			V3			V4			V5			V6		
		F.	D.	Ab.	F.	D.	Ab.	F.	D.	Ab.	F.	D.	Ab.	F.	D.	Ab.	F.	D.	Ab.
1	*Ainsliaea aptera*	30	1400	4.7	--	--	--	--	--	--	30	900	3.0	--	--	--	70	1000	1.4
2	*Allium stracheyi*	20	2200	11.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3	*Anaphalis royleana*	30	1400	4.7	--	--	--	50	1800	3.6	--	--	--	40	1200	3.0	--	--	--

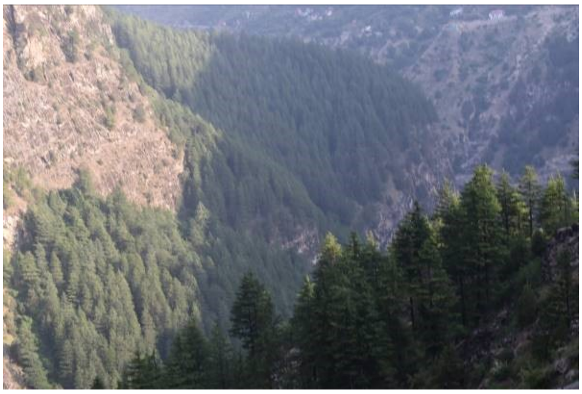
S. No.	Name of Species	V1			V2			V3			V4			V5			V6		
		F.	D.	Ab.	F.	D.	Ab.	F.	D.	Ab.	F.	D.	Ab.	F.	D.	Ab.	F.	D.	Ab.
4	*Andropogon munroi*	--	--	--	--	--	--	40	2900	7.3	--	--	--	--	--	--	--	--	--
5	*Artemisia nilagirica*	30	1900	6.3	70	2500	3.6	50	1700	3.4	50	2400	4.8	70	1900	2.7	50	1400	2.8
6	*Arundo donax*	30	2600	8.7	--	--	--	50	1900	3.8	40	2100	5.3	--	--	--	--	--	--
7	*Bergenia ciliata*	--	--	--	--	--	--	--	--	--				40	1000	2.5	--	--	--
8	*Caltha palustris*	--	--	--	--	--	--	--	--	--	50	1900	3.8	--	--	--	30	1300	4.3
9	*Cannabis sativa*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	30	1200	4.0
10	*Carex inanis*				50	2000	4.0	40	2100	5.3	--	--	--	50	2500	5.0	--	--	--
11	*Chenopodium album*	20	2700	13.5	--	--	--	40	1800	4.5	40	1800	4.5	--	--	--	50	1100	2.2
12	*Erigeron canadensis*	40	1500	3.8	40	1100	2.8	70	1500	2.1	70	1600	2.3	60	2000	3.3	40	2300	5.8
13	*Dactylis glomerata*	--	--	--	--	--	--	--	--	--	60	1000	1.7	--	--	--	--	--	--
14	*Dianthus angulatus*	--	--	--	50	1300	2.6	--	--	--	--	--	--	--	--	--	--	--	--
15	*Equisetum diffusum*	50	2300	4.6				--	--	--	--	--	--	--	--	--	30	1200	4.0
16	*Eragrostis pilosa*	--	--	--	30	2100	7.0	--	--	--	40	2300	5.8	40	2100	5.3	40	1100	2.8
17	*Erigeron multiradiatus*	20	2100	10.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
18	*Euphorbia pilosa*	20	1500	7.5	--	--	--	60	1300	2.2	50	1900	3.8	--	--	--	--	--	--
19	*Fragaria vesca*	--	--	--	50	1100	2.2				20	2100	10.5	50	1200	2.4	50	1500	3.0
20	*Gentiana kurroo*	30	2100	7.0	50	2700	3.8	50	2700	5.4	--	--	--	--	--	--	--	--	--
21	*Geranium nepalense*	30	2000	6.7	--	--	--	--	--	--	--	--	--	30	2300	7.7	40	1300	3.3
22	*Inula racemosa*	--	--	--	40	1500	6.3	--	--	--	--	--	--	40	1100	2.8	--	--	--
23	*Jurinea macrocephala*	50	1700	3.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
24	*Nepeta laevigata*	--	--	--	--	--	--	50	1900	3.8	30	1600	5.3	60	1600	2.7	50	2000	4.0
25	*Origanum vulgare*	40	1400	3.5	--	--	--	--	--	--	30	1900	6.3	--	--	--	--	--	--
26	*Oryzopsis gracilis*	--	--	--	40	2000	5.7	--	--	--	--	--	--	--	--	--	--	--	--
27	*Oxalis corniculata*	--	--	--	--	--	--	50	1600	3.2	50	1500	3.0	40	1400	3.5	40	1100	2.8

S. No.	Name of Species	V1			V2			V3			V4			V5			V6		
		F.	**D.**	**Ab.**	**F.**	**D.**	**Ab.**	**F.**	**D.**	**Ab.**	**F.**	**D.**	**Ab.**	**F.**	**D.**	**Ab.**	**F.**	**D.**	**Ab.**
28	*Persicaria capitata*	--	--	--	40	1100	4.0	--	--	--	40	1300	3.3	--	--	--	--	--	--
29	*Plantago depressa*	--	--	--	--	--	--	--	--	--	20	2100	10.5	--	--	--	--	--	--
30	*Plantago major*	--	--	--	30	1900	4.0	--	--	--	--	--	--	--	--	--	--	--	--
31	*Poa annua*	50	2300	4.6	--	--	--	50	2400	4.8	40	1900	4.8				60	2000	3.3
32	*Primula denticulata*	--	--	--	--	--	--	--	--	--	--	--	--	50	1800	3.6			
33	*Primula rosea*	--	--	--	--	--	--	60	1600	2.7	40	800	2.0	--	--	--	40	2100	5.3
34	*Prunella vulgaris*	--	--	--	--	--	--	40	1200	3.0	--	--	--	--	--	--	--	--	--
35	*Ranunculus sceleratus*	40	1300	3.3	30	1700	5.4	--	--	--	--	--	--	50	1400	2.8	--	--	--
36	*Rubia cordifolia*	--	--	--	70	1600	5.0	30	1800	6.0	--	--	--	--	--	--	--	--	--
37	*Rumex nepalensis*	--	--	--	40	1600	2.8	40	2100	5.3	50	900	1.8	50	1600	3.2	50	1200	2.4
38	*Thlaspi arvense*	--	--	--	60	2400	2.3	--	--	--	40	900	2.3	--	--	--	30	2300	7.7
39	*Trifolium repens*	--	--	--	--	--	--	--	--	--	50	1100	2.2	60	1000	1.7	--	--	--
40	*Verbascum thapsus*	--	--	--	50	1800	3.6	50	1200	2.4	50	900	1.8	60	1300	2.2	40	1300	3.3
41	*Viola canescens*	--	--	--	60	2200	3.7	--	--	--	--	--	--	30	800	2.7	--	--	--
42	*Youngia japonica*	--	--	--	--	--	--	--	--	--	--	--	--	60	1800	3.0	50	1600	3.2

F=Frequency (%)., D=Density (No. of Individuals/ha), Ab. =Abundance

Vegetation in the Study Area


Sansari Nala	Sansari Nala Confluence with Chenab River




Downstream of Dam Site


Near Proposed Dam Site


Near Dheda Nala confluence with Chenab

e) Density & Dominance

i. DENSITY

Density is one of the indicators to assess the dominance of a plant species occurring in an area. The density of trees varied from site to site depending upon elevation, land use pattern, and the extent of the area subjected to road construction in the area. The overall tree density throughout the study area ranged from a minimum of 260/ha was recorded from sampling site V3 located near the confluence of Dheda Nala with Chenab and a maximum of 310/ha at sampling site V5 located near Kothi village on the right bank of Chenab River (**Table 3.34**).

The shrub layer was quite prominent at all sampling sites and the density of the shrub layer varied from 2040 plants/ha to 2240 plants/ha, lowest density was found at the sampling site located downstream of the proposed powerhouse area near the confluence with Sansari Nala with Chenab River and highest at sampling site V3 located near the confluence of Dheda Nala with Chenab (**Table 3.34**).

Table 3.34: Density (plants per ha) of Trees

Sampling Site		V1	V2	V3	V4	V5	V6
Trees		280	270	260	260	310	270
Shrubs		2040	2120	2240	2200	2120	2160
Herbs	**Winter**	14300	13200	14000	14200	13500	12200
	Pre-Monsoon	20600	19900	19200	16600	15200	18800
	Monsoon	30400	30600	31500	32900	28000	27000

Herb density in the area varied seasonally. The lowest density for the herb species in the sampling area was recorded during the winter season varies from the lowest 12200 plants/ha at site V6 to a maximum of 14300 plants/ha.

Maximum herb density recorded during monsoon season. In monsoon season herb density was highest at sampling site V4 located near Killar is characterised by agricultural crop fields, orchards, and habitation (34400 plants/ha) and lowest at Sampling site V6 located upstream of the proposed reservoir area near Findru village (27000 plants/ha) (**Table 3.34**). During the pre-monsoon season density of herbs varied from the lowest 15200 plants/ha at sampling site V5 near Kothi village along the proposed reservoir area to the highest 20600 plants/ha at sampling site V1 near the confluence of Sansari Nala with Chenab River.

ii. DOMINANCE

The vegetation at sampling sites is of mixed types, as IVI value of all the tree species ranged between 26 and 74 (**see Table 3.35)**. *Cedrus deodara* is the most common tree species recorded from all the sampling sites, showing dominance at sampling site V1, representing area along Sansari nala, V3 (near Dheda Nala confluence with Chenab), V5 (Near Kothi village) and V6 (Near Findru Village). *Pinus gerardiana* was found dominant at site V2 located near the proposed dam site. *Salix denticulata* was dominant at sampling site and site V4, near Killar. *Fraxinus xanthoxyloides, Pinus wallichiana, Populus ciliata,* and *Ulmus wallichiana* are the other dominant species in the sampling area with IVI value more than 50.

Table 3.35: IVI of tree species at different sampling locations in the study area

S. No.	Name of Species	V1	V2	V3	V4	V5	V6
1	*Acer caesium*	--	--	--	--	--	47
2	*Alnus nitida*	44	39	--	--	--	--
3	*Cedrus deodara*	77	54	70	35	63	74
4	*Celtis tetrandra*	--	--	--	35	--	--
5	*Corylus jacquemontii*	--	--	39	--	43	--
6	*Fraxinus xanthoxyloides*	35	47	55	--	--	47
7	*Juglans regia*	--		48	35	48	--
8	*Pinus gerardiana*	32	68	30	--	--	--
9	*Pinus wallichiana*	35	--	--	--	--	54
10	*Populus ciliata*	--	--	--	42	55	--
11	*Prunus armeniaca*	--	--	--	42	43	40
12	*Robinia pseudo-acacia*	43	--	--	49	--	38
13	*Salix denticulata*	--	38	57	62	48	--
14	*Ulmus wallichiana*	34	54	--	--	--	--

f) Dispersion/Distribution

A/F Ratio is a measure of the distribution of a species over an area i.e., whether it is homogeneously distributed or has a clumped distribution. A/F ratio <0.025 indicates regular distribution, between 0.025 and 0.05 indicates random distribution while >0.05 indicates clumped or contagious distribution.

It can be seen from the table below that, at sampling site V1, *Cedrus deodara* and *Robinia pseudo-acacia* show a regular distribution pattern (**Table 3.36**). *Fraxinus xanthoxyloides* and *Ulmus wallichiana* are the species having random distribution. Rest the species recorded from the site V1 show contagious distribution.

All species recorded from site V2 show contagious distribution having A/F ratio more than 0.05. At site V3, *Juglans regia* and *Pinus gerardiana* have A/F ration between 0.025 and 0.05 indicates random distribution.

Among the tree species recorded from sampling site V4, *Juglans regia, Populus ciliata, Prunus armeniaca* and *Salix denticulata* and at site V5, are the species have A/F ratio between 0.025 and 0.05 indicates random distribution. Other species recorded from site V4 have show contagious distribution

Cedrus deodara and *Populus* ciliata at sampling site V4 and *Prunus armeniaca* at site V6, are the species with random distribution. Other species at these site show contagious distribution with A/F ration more than 0.05.

Table 3.36: A/F ratio of tree species

S.No.	Name of Species	V1	V2	V3	V4	V5	V6
1	*Acer caesium*	--	--	--	--	--	0.100
2	*Alnus nitida*	0.100	0.075	--	--	--	--
3	*Cedrus deodara*	0.018	0.056	0.044	0.075	0.028	0.089
4	*Celtis tetrandra*	--	--	--	0.075	--	--
5	*Corylus jacquemontii*	--	--	0.075	--	0.100	--
6	*Fraxinus xanthoxyloides*	0.033	0.100	0.056	--	--	0.100
7	*Juglans regia*	--	--	0.044	0.033	0.056	--

S.No.	Name of Species	V1	V2	V3	V4	V5	V6
8	*Pinus gerardiana*	0.200	0.078	0.050	--	--	--
9	*Pinus wallichiana*	0.075	--	--	--	--	0.056
10	*Populus ciliata*	--	--	--	0.044	0.038	
11	*Prunus armeniaca*	--	--	--	0.044	0.100	0.033
12	*Robinia pseudo-acacia*	0.025	--	--	0.056		0.075
13	*Salix denticulata*	--	0.075	0.125	0.044	0.056	--
14	*Ulmus wallichiana*	0.033	0.056	--	--	--	--

g) Species Diversity Index (H') & Evenness Index (E)

I. Diversity

To understand species diversity, the Shannon-Wiener diversity index (H') and Evenness Indices were calculated for trees, shrubs, and herbs (see **Table 3.37**).

Among the tree species, the diversity Index was lowest at sampling site V3 located near Dheda Nala confluence with Chenab (1.69) and highest at sampling site V4 located near Killar (1.93). Among shrubs, the lowest species diversity was recorded at site V3 located near Luj village near the proposed Dam site (1.96) and lowest at site V2 located near the proposed dam site (1.54) (**Table 3.37**).

During winter season sampling herb diversity varies from the lowest 0.73 at site V3 near Dheda Nala confluence with Chenab to the highest 2.40 at site V4. Site V4 near Killar with 2.67 shows maximum diversity during the pre-monsoon season, while the lowest was recorded at site V5 near Kothi village. During Monsoon season sampling Site V3 show maximum diversity was recorded for site V3 (2.99) and at site V6 near Findru Village shows minimum diversity (2.75) pre-monsoon season sampling highest diversity of herbaceous flora was recorded from sampling site V4 (2.67), located near Killar town and lowest at site V5 located near Kothi village (2.40) (**Table 3.37**).

Table 3.37: Species Diversity Index (H')

Sampling Sites	Tree	Shrub	Herb		
			Winter	Pre-Monsoon	Monsoon
V1	1.85	1.89	1.52	2.44	2.75
V2	1.75	1.54	2.09	2.51	2.80
V3	1.69	1.96	0.73	2.52	2.80
V4	1.93	1.89	2.40	2.67	2.99
V5	1.85	1.68	0.74	2.40	2.85
V6	1.70	1.63	2.07	2.53	2.85

II. Distribution

Evenness Index (E) was calculated by using Evenness Index Formula and is indicative of distribution pattern of vegetation in any area. The evenness index ranged between 0.87 and 1.03 (**Table 10.38**). Except sampling sites V4 and V6, tree community show even distribution at other sites. The shrubs indicate regular distribution pattern at all locations, evenness index ranged ranged between 0.98 to 1.03 (**Table 10.38**).

During winter season the eveness index at all sampling location varies from 0.32 to 0.97. At site V1, V3, and V5 distribution of herb species were found irregular. While at site V2, V4 and V6, the herbs very evenely distributed in the sampling area. While during Pre-monsoon and monsoon season sampling, herbaceous flora was found evenly distributed at sampling sites, range between 0.97 to 0.98 during pre-monsoon and 0.98 to 0.99 during monsoon season sampling. The herbaceous species were also found to be evenly distributed at all the sites during seasons (**Table 3.38**).

Table 3.38: Evenness Index (E)

Sampling Site	Trees	Shrubs	Herbs		
			Winter	Pre-Monsoon	Monsoon
V1	0.94	0.98	0.75	0.98	0.99
V2	0.97	0.98	0.95	0.98	0.99
V3	0.95	1.02	0.32	0.98	0.99
V4	0.87	1.03	0.97	0.99	0.98
V5	1.03	1.01	0.32	0.97	0.98
V6	0.87	1.02	0.94	0.98	0.99

h) Economically Important and Medicinal Plant Species

i. Medicinal Plants

Local people in the area use many plants for different medicinal purposes. They use various plants for treating stomach disorders like diarrhoea, dysentery, cold, cough, fever, asthma, rheumatism, skin diseases, cuts, boil, and injuries.

Ethnobotanical uses of plants for medicinal purposes especially by tribals in this area have been studied by workers like Nath (2007), Singh *et al.* (2009), Rana *et al.* (2014), Dutt *et al.* (2014), and Singh & Kumar (2017). Although modern medical facilities are available in the area, still villagers in the area prefer using herbal plants owing to their confidence and belief in such treatment. The rural and tribal men are well-versed with the symptoms of various types of diseases and with their herbal remedies because they have carried on practice traditionally by verbal instruction. A list of commonly used medicinal plants in the area is list below in **Table 3.39.**

Table 3.39: Medicinal Plant Species in the study area

S. No.	Botanical Name	Local Name	Medicinal Value
1	*Artemisia maritima*	Safed parcha	Laxative, anthelmintic, alexiteric, cure scorpion sting, toothache, gripping, ophthalmia, gastric disorder
2	*Anthemis cotula*	Chigar weed	Piles, dysentery, swelling
3	*Ajuga bracteosa*	Neelkanthi	Inflamed or Injured skin
4	*Carduus edelbergii*	-	Gonorrhea, headache, wounds
5	*Caltha palustris*	-	Gastric troubles
6	*Berberis lycium*	Rasut	Eye and ear ailments
7	*Clinopodium umbrosum*	-	Cuts & wounds
8	*Carum carvi*	Shingu jira	Cough, asthma, headache
9	*Bergenia ciliata*	Pathafodu	Kidney pain, stone problem

S. No.	Botanical Name	Local Name	Medicinal Value
10	*Chaerophyllum reflexum*	Kashmir Chervil	Liver complaints, Jaundice
11	*Bunium persicum*	Kala zera	Reduce stomach disorder
12	*Arnebia benthami*	Ratnjot	Rheumatism, epilepsy, asthma
13	*Artemisia nilagirica*	Kunja	Stomachic disorders, aphrodisiac, laxative, anthelmintic
14	*Angelica glauca*	Taskarsh-canda	Swelling, Skin eruption, throat complaints
15	*Corylus jacquemontii*	Thangli	Fractures, joint pain
16	*Cousinia thomsonii*	Bacha Chawag	Joint pain, fracture, swelling
17	*Dactylorhiza hatagirea*	Hatajira	Syphilis, respiratory troubles, heart failure
18	*Delphinium denudatum*	Nirvisi	Rheumatism, epilepsy, asthma
19	*Duchesnea indica*	Strawberry	Joint pain, fracture, swelling
20	*Ephedra gerardiana*	Somalata	Diaphoretic, antipyretic, astringent, stimulant, jaundice, cures rheumatism
21	*Euphorbia pilosa*	-	Wheezing, piles, dysentery, swelling
22	*Viola canescens*	-	Wounds, skin disease, and fever
23	*Plantago major*	Karecha	Wounds, piles & asthma
24	*Oxytropis humifusa*	Chhuhindarm	Cures hepatitis, jaundice & stomach pain
25	*Origanum vulgare*	Banbakari	Ringworm, stomach disorder
26	*Mentha longifolia*	-	Stomachache, diarrhea, fever
27	*Inula racemosa*	Mano	Cures scorpion sting, toothache
28	*Geranium wallichianum*	-	Ophthalmia, burns, ringworm
29	*Galium aparine*	Kuri	Headache, fever, cold
30	*Fragaria vesca*	-	Female disorders, Cough, asthma
31	*Valeriana jatamansi*	Nihani	Hysteria, joint pain, and hypochondria
32	*Trigonella emodi*	-	Tuberculosis, fever
33	*Thymus linearis*	Kochi masha	Vermifuge, antiseptic
34	*Thalictrum foliolosum*	-	Catarrhal affections, body ache
35	*Tanacetum longifolium*	-	Whooping cough, pneumonia, bronchitis
36	*Selinum candollii*	-	Migraine, skin disease
37	*Saussurea costus*	Kuth	Fever, blood purifier, vermifuge, food poisoning
38	*Salix alba*	Chirand	Antiseptic, wounds
39	*Rumex nepalensis*	Shomang	Healing wounds, fractures

ii. Economical Important Plants

Agriculture and horticulture are the major occupations in the project area. Cereals are the major crops grown in the area. Rice, wheat, and maize are the major cereals. Cereals are mainly grown for self-consumption, while horticultural crops like Apple and Pear have a major contribution to the economy of the area. The people of the area use wild plants in their daily life as food, medicine, fibre, fodder, fuel wood, timber, vegetables, fruits, and various minor forest products. The list of medicinally important plant species found in the project area and their uses are given in **Table 3.40**.

Table 3.40: Economically Important Plant Species

S. No.	Name of Species	Local name	Uses
1	*Abies pindrow*	Tosh	Timber
2	*Acer caesium*	Grey Maple	Fuelwood, Fodder
3	*Aesculus indica*	Goon	Fuelwood, Timber
4	*Alnus nitida*	Piyakh	Fuel, Fodder
5	*Cannabis sativa*	Bhang	Fibre/Narcotics
6	*Cedrus deodara*	Deodar	Timber/Resin
7	*Celtis tetrandra*	Kharik	Timber, Fodder
8	*Corylus jacquemontii*	Thangli	Fodder, fuelwood
9	*Fraxinus xanthoxyloides*	Sainjal	Fuelwood
10	*Juglans regia*	Akhrot	Fruit, fuelwood
11	*Pinus gerardiana*	Chilgoza pine	Timber, Seed edible
12	*Pinus wallichiana*	Kail	Timber, Furniture
13	*Populus ciliata*	Popular	Fodder, Fuelwood
14	*Prunus armeniaca*	Chihri	Fruit edible
15	*Prunus cornuta*	Jammur	Fuel, Fodder
16	*Robinia pseudo-acacia*	-	Ornamental
17	*Rosa brunonii*	Hissar	Fencing
18	*Rubus foliolosus*	Hissar	Fruit edible
19	*Salix denticulata*	Bes	Fuel, Furniture
20	*Salix fragilis*	Bes	Timber, fuelwood
21	*Sorbus cuspidata*	-	Fuelwood
22	*Trifolium pratense*	-	Fodder
23	*Ulmus wallichiana*	Moral	Timber, Fodder, Fuel

iii. Agriculture practices including Horticulture

There are many agricultural fields are present in Lujai, Punto, and villages adjoining the Killar area in the locality. There is only one cropping season starting from April to September or early October. The area has the harsh climatic condition. The area mostly remains snow-covered for a long period from November to April. The economy of the people of the area is dependent upon cash crops mainly potatoes and peas. It is the main agricultural crop grown in the area cauliflower is fast emerging as a new cash crop alternative. Rajmash, Buckwheat, Toria, Kuth, Mandua/Koda, Makki, Ogla, Jau, and Manu are the other crops grown in this region. The details of vegetation under cultivation practices are given in below in the **Table 3.41**.

Table 3.41: Agricultural crops/ vegetables/ fruits grown in the area

Botanical name	English name	Local name
Major crops		
Hordeum vulgare	Barley	Jau
Amaranthus cruentus	Red Amaranth	Cholayi
Solanum tuberosum	Potato	Aaloo
Fagopyrum esculentum	Buckwheat	Ogla
Brassica compestris	Mustard	Sarson
Eleusine coracana	Finger millet	Mandua/Koda
Zea mays	Maize	Makki/Beldri
Setaria italica	Foxtail millet	Kauni/Chinna
Chenopodium album	Goose foot	Bethu
Phaseolus vulgaris	Kedeny been	Rajmah/Faraasbeen
Pisum sativum	Pea	Mater

Botanical name	English name	Local name
Phaseolus mungo	Blackgram	Urad/Maash
Lens esculenta	Lentils	Masoor
Cannabis sativa	Hemp	Bhang
Vegetables		
Solanum tuberosum	Potato	Aaloo
Pisum sativum	Pea	Matar
Fagopyrum tataricum	Buckwheat	Phafra
Colocacia esculenta	Cocoyam	Arabi/Gaguli
Raphanus sativus	Radish	Muli
Solanum melongena	Brinjal	Baingan/ Batasu
Cucurbita maxima	Pumpkin	Kaddu
Chenopodium album	Chenopodium	Bathuwa/Bethu
Spinacia oleracea	Spinach	Palak
Phaseolus vulgaris	Kidney bean	Farasbean
Fruits		
Pyrus communis	Pear	Nashpati
Pyrus malus	Apple	Seb
Prunus armeniaca	Apricot	Chulu/Khumbani
Juglans regia	Walnut	Akhrot
Corylus jacquemontii	Hazelnut (wild)	Hazelnut
Pinus gerardiana	Chilgoza, (wild)	Neoza

3.2.2.3 Faunal Diversity

A list of faunal elements comprising mammals, birds, and butterflies found in the study area was compiled from sightings during the field visit and supplemented by data collected from secondary sources as well as information provided by local people during field surveys. Among secondary sources, Forest Working Plan of the Pangi Forest Division was consulted. In addition, data was compiled from published literature like Prater (1998) for mammals, Daniel (2002) for reptiles, Ali & Ripley (1983), Grimmett *et al.* (1998, 2011), Inskipp *et al*. (1999) and Kazmierczak (2000) for birds and Kehimkar (2008) for butterflies. The classification and nomenclature of bird species are based upon https://avibase.bsc-eoc.org/ accessed in August 2019. The classification and nomenclature of butterfly species are based upon https://www.ifoundbutterflies.org/ (Butterflies of India).

a. Mammals

Presence of Mammals based upon Field Surveys

During field surveys only Rhesus macaque (*Macaca mulatta*), Common mongoose (*Herpestes edwardsii*), and Common langur (*Semnopithecus entellus)* are the species sighted in the study area. Rhesus macaque is the most commonly sighted species in the entire study area. Besides these, no other wild animal was sighted during field surveys.

Data on mammals based upon secondary Data

The data on mammals reported from the study area was compiled from the Forest Working Plan (implanting years 2002-03 to 2021-22) of the Pangi Forest Division after consultation with forest officials and villagers. Forest officials mention the presence of Common Leopard (*Panthera pardus*), Hanuman Langur (*Semnopitheaus entellus*), Himalayan Goral

(*Naemorhedus goral*), Indian Muntjac (*Muntiacus muntjac*), and Himalayan black bear (*Ursus thibetanus*) in the proposed study area lies under the jurisdiction of Pangi Forest Division and same was confirmed by villagers in the study area. However, no direct or indirect evidence could be recorded during the field survey about their presence in and around the project area.

These species are also mentioned in "Cumulative Environmental Impact Assessment Study of Chenab Basin in Himachal Pradesh reported the presence of *Canis aureus,* Yellow-throated Marten and Himalayan Weasel in the project area of Dugar HEP.

According to the list prepared as described above, 12 species of mammals are reportedly found in the area and the same is given in **Table 3.42**.

Table 3.42: List of Mammalian species reportedly found in the study area

S. No.	Order/ Family	Scientific Name	Common Name	Conservation Status	
				IUCN Ver. 2021-2	WPA 1972
CARNIVORA					
1	Canidae	*Canis aureus*	Jackal	LC	II
2	Canidae	*Vulpes bengalensis*	Indian Fox	LC	II
3	Felidae	*Panthera pardus*	Common Leopard	VU	I
4	Herpestidae	*Herpestes edwardsii*	Indian Grey Mongoose	LC	II
5	Mustelidae	*Martes flavigula*	Yellow-throated marten	LC	II
6	Ursidae	*Ursus thibetanus*	Himalayan black bear	VU	II
7	Viverridae	*Paguma larvata*	Himalayan Palm Civet	LC	II
CETARTIODACTYLA					
8	Bovidae	*Naemorhedus goral*	Himalayan Goral	NT	III
9	Cervidae	*Muntiacus muntjac*	Indian Muntjac	LC	III
LAGOMORPHA					
10	Ochotonidae	*Ochotona roylei*	Royle's Pika	LC	IV
PRIMATES					
11	Cercopithecidae	*Semnopitheaus entellus*	Hanuman Langur	LC	II
12	Cercopithecidae	*Macaca mulatta*	Rhesus Macaque	LC	II

IUCN- International Union for Conservation of Nature; VU – Vulnerable; NT- Near Threatened; LC - Least Concern; WPA – Wildlife (Protection) Act, 1972

b. Avifauna

During the field survey conducted between March-September 2021, 34 species of birds belonging to 8 Order and 20 families were recorded during the field survey from the study area. Most commonly found birds are Rock Pigeon, Chukar partridge, Jungle Babbler, Drongo, Plumbeous water redstart, Red-vented Bulbul, Blue Whistling Thrush, Myna House sparrow, and Crow. A large portion of avifauna species is comprised of resident birds in the project study area.

A list of bird species was compiled based upon sighting done during the field survey has been given with their conservation status in **Table 3.43**.

Table 3.43: List of avifauna recorded from the study area with their conservation status

S. No.	Order/ Family	Scientific Name	Common Name	Conservation Status	
				IUCN Ver. 2021-2	WPA 1972
	Accipitriformes				
1	Accipitridae	*Clanga hastata*	Indian Spotted Eagle	VU	-
	Bucerotiformes				
2	Upupidae	Eurasian Hoopoe	*Upupa epops*	LC	-
	Columbiformes				
3	Columbidae	*Streptopelia chinensis*	Spotted Dove	LC	IV
4	Columbidae	*Streptopelia orientalis*	Oriental Turtle dove	LC	IV
5	Columbidae	*Columba livia*	Rock Pigeon	LC	IV
	Coraciiformes				
6	Meropidae	*Merops orientalis*	Green Bee Eater	LC	IV
	Galliformes				
7	Phasianidae	*Alectoris chukar*	Chukar partridge	LC	IV
	Passeriformes				
8	Corvidae	*Corvus macrorhynchus*	Jungle Crow	LC	V
9	Corvidae	*Corvus splendens*	House Crow	LC	V
10	Corvidae	*Dendrocitta formosae*	Grey Treepie	LC	IV
11	Dicruridae	*Dicrurus macrocercus*	Black Drongo	LC	IV
12	Leiotrichidae	*Turdoides striata*	Jungle Babbler	LC	IV
13	Emberizidae	*Emberiza cia*	Rock Bunting	LC	IV
14	Fringillidae	*Chloris spinoides*	Yellow-breasted greenfinch	LC	IV
15	Motacillidae	*Motacilla maderaspatensis*	White-Browed Wagtail	LC	IV
16	Motacillidae	*Motacilla alba*	White Wagtail	LC	IV
17	Motacillidae	*Motacilla flava*	Yellow Wagtail	LC	IV
18	Motacillidae	*Phoenicurus leucocephalus*	White capped water redstart	LC	IV
19	Muscicapidae	*Chaimarrornis leucocephalus*	Plumbeous water redstart	LC	IV
20	Muscicapidae	*Copsychus saularis*	Oriental magpie-robin	LC	IV
21	Muscicapidae	*Myophonus caeruleus*	Blue Whistling Thrush	LC	IV
22	Muscicapidae	*Enicurus scouleri*	Little Forktail	LC	IV
23	Nectariniidae	*Aethopyga siparaja*	Crimson Sunbird	LC	IV
24	Paridae	*Silvyparus modestus*	Yellow-browed Tit	LC	IV
25	Paridae	*Parus rubidiventris*	Rufous-vented Tit	LC	IV
26	Passeridae	*Passer rutilans*	House sparrow	LC	IV
27	Passeridae	*Passer rutilans*	Russet Sparrow	LC	IV
28	Pycnonotidae	*Pycnonotus leucogenys*	Himalayan Bulbul	LC	IV
29	Pycnonotidae	*Pycnonotus cafer*	Red-vented Bulbul	LC	IV
30	Cinclidae	*Cinclus pallasii*	Brown Dipper	LC	IV
31	Stumidae	*Acridotheres tristis*	Common Myna	LC	IV
32	Sturnidae	*Acridotheres fuscus*	Jungle Myna	LC	IV
	Piciformes				
33	Megalaimidae	*Megalaima zeylanica*	Brown-headed Barbet	LC	IV
	Psittaciformes				
34	Psittaculidae	*Psittacula cyanocephala*	Plum-headed Parakeet	LC	IV

IUCN- International Union for Conservation of Nature; LC - Least Concern; VU: Vulnerable; WPA – Wildlife (Protection) Act, 1972.

FAUNAL SPECIES SIGHTED DURING FIELD SURVEY


Macaca mulatta


Russet Sparrow **House Sparrow**


Oriental magpie robin **Blue Whistling Thrush**


Rock Pigeon **Oriental Turtle dove**

	
White-Capped water Redstart	**Plumbeous Water Redstart**
	
Chukar Partridge	**White Wagtail**
	
White wagtail	**Yellow-breasted Greenfinch**
	
Himalayan Bulbul	**Red-vented Bulbul**

c. Herpetofauna

Visual Encounter Survey (VES) methodology was followed for recording herpetofauna wherein walks were undertaken in selected areas/ habitats for a fixed period and systematically searching for animals. During the survey, Garden lizard (*Calotes versicolor*), Kashmir Rock Agamid (*Laudakia tuberculata*), and Skinks (*Asymblepharus ladacensis)* were commonly sighted species in the area.

Table 3.44: Herpetofauna recorded from Study Area

S. No.	Family	Common name	Scientific name
Order: Squamata			
1	Agamidae	*Calotes versicolor*	Oriental garden lizard
2	Agamidae	*Laudakia tuberculata*	Kashmir Rock Agamid
3	Gekkonidae	*Hemidactylus frenatus*	Common house gecko
4	Scincidae	*Asymblepharus ladacensis*	Skinks

d. Butterflies

During the field survey, a total of 11 species of butterflies were recorded from the study area (**Table 3.45**). The butterflies belong to families Lycaenidae, Nymphalidae, Pieridae, and Papilionidae family represents maximum species of butterfly in the proposed project area. Indian cabbage white, Pearl white, and Indian Tortoiseshell were the frequently sighted species observed all along the water bodies.

Table 3.45: Butterflies recorded from Study Area

S. No.	Family	Common name	Scientific name	IUCN ver. 2021-2
1	Lycaenidae	*Lycaena phlaeas*	Small Copper	LC
2	Lycaenidae	*Celastrina argiolus*	Hill Hedge Blue	LC
3	Lycaenidae	*Polyommatus eros*	Common Meadow Blue	LC
4	Nymphalidae	*Aglais cachmirensis*	Indian Tortoiseshell	-
5	Nymphalidae	*Vanessa cardui*	Painted Lady	LC
6	Nymphaliadae	*Maniola pulchella*	Tawny meadow brown	-
7	Nymphaliadae	*Neptis hylas*	Common sailer	-
8	Pieridae	*Pieris canidia indica*	Indian Cabbage White	-
9	Pieridae	*Colias fieldii*	Clouded Yellow	-
10	Pieridae	*Euchloe daphalis*	Pearl white	-
11	Papilionidae	*Papilio machaon*	Old Swallowtail	LC

e. Conservation Status of Fauna

Common Leopard (*Panthera pardus*) and Himalayan black bear (*Ursus thibetanus*) are the species listed under the Vulnerable (VU) category of the IUCN Red List of Threatened Species Version 2021-2. Himalayan Goral (*Naemorhedus goral*) is the species listed under the Near Threatened category of IUCN (**Table 3.42**).

As per Wildlife (Protection) Act 1972, Common Leopard (*Panthera pardus*) is listed as a Schedule I species, *Canis aureus* (Jackal), while Indian Fox (*Vulpes bengalensis*), Himalayan black bear (*Ursus thibetanus*), Indian Grey Mongoose (*Herpestes edwardsii*), Yellow throated Marten (*Martes flavigula*), Himalayan Palm Civet (*Paguma larvata*), Hanuman Langur (*Semnopitheaus entellus*) and Rhesus Macaque (*Macaca mulatta*) are listed as Schedule II species. Himalayan Goral (*Naemorhedus goral*) and Indian Muntjac *Muntiacus muntjac* are species Schedule III species and Royle's Pika (*Ochotona roylei*) is the only species listed under Schedule IV of WPA, 1972 (**Table 3.43**).

Among the avifaunal species sighted from the study area only one species Indian Spotted Eagle (*Clanga hastata*) is listed as Vulnerable (VU) under IUCN 2021-2, the rest of the species fall under Least Concern (LC) category. As per WPA (1972), all the species recorded from the area are listed as Schedule IV except House crow and Jungle crow which are listed as Schedule V species (refer to **Table 3.43**).

3.2.2.4 Aquatic Ecology

a. Phytobenthos

Total 22 species of phytobenthos were recorded from Chenab River and its tributaries during field sampling conducted in three seasons in the study area. Among the recorded species, 12 species belong to class Bacillariophyceae, 6 species from class Chlorophyceae and 4 species belong to class Cyanophyceae. The maximum number of species in the study area was recorded from Lujai Nala and Mahal Nala, a tributary of Chenab River **(Table 3.46)**.

The maximum number of species of phytobenthos were recorded during the winter season, a total of 22 species recorded during sampling. The most common species recorded during winter are *Achnanthidium minutissima*, *Gomphonema intricatum*, *Phormidium autumnale*, *Scenedesmus ellipticus,* and *Synedra ulna* recorded at least from 4 sampling sites **(Table 3.46)**.

During the pre-monsoon season survey because of inaccessible terrain and the turbulent nature of the Chenab River with high water discharge, sampling for aquatic ecology isn't possible at sampling sites located on the Chenab River. Only 9 species were recorded only from Lujai Nala and Mahal Nala. While during monsoon season 15 species were recorded from the sampling sites.

The most common species recorded during pre-monsoon and monsoon season *are Achnanthidium minutissimum, Cocconeis placentula, Cymbella affinis, Cymbella ventricosa, Flagellaria pinnata, Gomphonema intricatum, Hannae arcus, Phormidium autumnale* and *Synedra ulna* **(Table 3.46)**.

Table 3.46: Phytobenthos recorded from the study area

S. No.	CLASS/Taxa	SW1	SW2	SW3	SW4	SW5	SW6
	BACILLARIOPHYCEAE						
1	*Achnanthes linearis*	W	-	W	W	-	-
		-	-	-	-	-	-
		-	M	-	-	M	-
2	*Achnanthidium minutissima*	-	W	W	-	W	W
		-	PM	-	-	PM	-
		-	M	-	-	M	-
3	*Amphora ovalis*	W	-	-	-	-	W
		-	-	-	-	-	-
		-	-	-	-	-	-
4	*Cymbella affinis*	W	W	-	-	W	-
		-	PM	-	-	PM	-
		-	M	-	-	M	M
5	*Cymbella ventricosa*	-	W	-	W	-	-
		-	PM	-	-	PM	-
			M	-	-	M	M
6	*Gomphonema intricatum*	W	-	W	-	W	W
		-	PM	-	-	-	-

S. No.	CLASS/Taxa	SW1	SW2	SW3	SW4	SW5	SW6
		-	M	-	-	M	-
7	*Gomphoneis herculeana*	-	-	-	-	-	-
		-	PM	-	-	PM	-
		-	-	-	-	-	-
8	*Synedra ulna*	W	W	-	W	W	-
		-	PM	-	-	PM	-
		M	M	-	-	M	-
9	*Flagellaria inflata*	-	-	W	-	W	W
		-	-	-	-	-	-
		-	M	M	-	M	-
10	*Flagellaria pinnata*	W	-	W	-	W	-
		-	-	PM	-	PM	-
		M	-	M	-	-	M
11	*Navicula radiosa*	-	-	W	-	W	-
		-	-	-	-	-	-
		-	-	M	-	M	-
12	*Hannaea arcus*	W	-	-	W	-	W
		-	-	-	-	-	-
		M	-	-	M	-	M
	CHLOROPHYCEAE						
13	*Chlorella vulgaris*	W	-	-	W	W	-
		-	-	-		-	-
		-	-	-	M	M	-
14	*Cladophora glomerata*	-	W	W	-	-	W
		-	-	-	-	-	-
		M	-	M	-	-	-
15	*Cocconeis placentula*	-	W	-	-	W	W
		-	PM	-	-	-	-
		-	M	-	-	M	-
16	*Scenedesmus ellipticus*	W	-	W	W	-	W
		-	-	-	-	-	-
		-	-	M	-	-	M
17	*Spirogyra porticalis*	W	-	W	-	-	W
		-	-	-	-	-	-
		-	-	M	-	-	M
18	*Zygnema himalayense*	-	W	W	-	W	-
		-	-	-	-	-	-
		-	-	M	-	M	-
	CYANOPHYCEAE						
19	*Phormidium autumnale*	W	W	-	W	-	W
		-	-	-	PM	-	-
		-	M	-	M	-	-
20	*Oscillatoria limnosa*	W	W	-	-	W	-
		-	-	-	-	-	-
		-	M	-	-	M	-
21	*Oscillatoria tinues*	W	-	W	-	-	W
		-	-	-	-	-	-
		-	-	M	-	-	M
22	*Schizothrix fasciculata*	-	W	-	W	W	-
		-	-	-	-	-	-
		-	-	M	-	M	-

W: Winter; PM: Pre-Monsoon' M: Monsoon

The density of phytobenthos (cells/cm^2) was highest during winter and was maximum at Site SW5. Density, in general, was low during pre-monsoon and monsoon season sampling at all sites. Density and Diversity at different sampling site are given in **Table 3.47.**

Table 3.47: Density and Diversity of Phytobenthos

Sampling site	SW1	SW2	SW3	SW4	SW5	SW6
WINTER						
Density (cells/ lit)	13	16	25	14	21	13
Shannon Weiner Diversity Index (H)	1.20	0.66	1.05	0.73	0.95	0.65
Evenness Index (E)	0.87	0.96	1.00	0.95	1.02	0.79
PRE-MONSOON						
Density (cells/ lit)	-	-	8	-	9	-
Shannon Weiner Diversity Index (H)	-	-	0.58	-	0.69	-
Evenness Index (E)	-	-	0.86	-	0.93	-
MONSOON						
Density (cells/ lit)	11	10	22	12	19	12
Shannon Weiner Diversity Index (H)	0.92	1.05	1.23	0.98	1.19	0.95
Evenness Index (E)	0.85	0.83	0.89	0.81	0.92	0.88

b. Phytoplankton (Periphyton)

In all total, 11 species of phytoplankton were identified in the samples collected from the proposed project study area. The phytoplankton community is comprised of 8 species of Bacillariophyceae, 1 species of Chlorophyceae, and 2 species of Cyanophyceae (**Table 3.48**).

The maximum number of species was recorded during winter and winter season sampling (11 species), and the minimum was during pre-monsoon (5 species). Bacillariophyceae is the most dominant Class and the common species observed during sampling were *Achnanthidium exilis, Cymbella affinis, Diatoma hiemale, Flagellaria spp, Gomphoneis herculeana, Gomphonema intricatum, Phormidium autumnale,* and *Reimeria sinuate* **(Table 3.48)**.

Likewise, for phytobenthos, during the monsoon season survey, sampling was not possible for phytoplankton at the site located on Chenab River due to inaccessible terrain and the turbulent nature of the Chenab River. Only 5 species were recorded during pre-monsoon season sampling from Lujai Nala and Mahal Nala. While during monsoon season 15 species were recorded from the sampling sites.

Table 3.48: Phytoplankton recorded in the study area

S. No.	CLASS/Species	SW1	SW2	SW3	SW4	SW5	SW6
	BACILLARIOPHYCEAE						
1	*Achnanthes affinis*	-	-	W	W	-	-
		-	-	PM	-	-	-
		-	-	-	-	M	-
2	*Achnanthidium exilis*	W	-	W	-	W	-
		-	-	PM	-	PM	-
		-	-	M	-	M	-
3	*Cymbella affinis*	W	-	W	W	-	W
		-	-	-	-	-	-
		-	-	-	-	-	-
4	*Diatoma hiemale*	W	-	W	W	W	-
		-	-	-	-	PM	-
		-	-	M	-	M	-
5	*Flagellaria spp*	W	-	W	W	-	-
		-	-	-	-	-	-
		-	M	M	-	M	-
6	*Gomphoneis herculeana*	W	-	W	-	W	-
		-	-	-	-	PM	-

S. No.	CLASS/Species	SW1	SW2	SW3	SW4	SW5	SW6
		-	-	M	-	M	-
7	*Gomphonema intricatum*	W	W	W	-	-	W
		-	-	-	-	-	-
		-	M	M	-	M	-
8	*Reimeria sinuata*	-	-	W	-	W	W
		-	-	PM	-	PM	-
		-	-	M	-	M	-
	CHLOROPHYCEAE						
9	*Chlorella vulgaris*	-	-	W	-	W	-
		-	-	-	-	-	-
		-	-	M	-	-	M
	CYANOPHYCEAE						
10	*Phormidium autumnale*	-	-	W	-	-	-
		-	-	-	-	-	-
		M	-	M	-	-	M
11	*Oscillatoria limnosa*	W	-	W	-	-	-
		-	-	-	-	-	-
		-	-	M	-	M	-

W: Winter; PM: Pre-Monsoon' M: Monsoon

The density of phytoplankton (cells/litre) was highest during winter and monsoon season and was found maximum at sampling site SW3 located on Lujai Nala. Density was found recorded low during pre-monsoon and sampling at all sites. Density and Diversity at different sampling site are given in **Table 3.49.**

Table 3.49: Density and Diversity of Phytoplankton

Sampling site	SW1	SW2	SW3	SW4	SW5	SW6
WINTER						
Density (cells/ lit)	13	16	25	14	21	13
Shannon Weiner Diversity Index (H)	1.20	0.66	1.05	0.73	0.95	0.65
Evenness Index (E)	0.87	0.96	1.00	0.95	1.02	0.79
PRE-MONSOON						
Density (cells/ lit)	-	-	8	-	9	-
Shannon Weiner Diversity Index (H)	-	-	0.58	-	0.69	-
Evenness Index (E)	-	-	0.86	-	0.93	-
MONSOON						
Density (cells/ lit)	11	10	22	12	19	12
Shannon Weiner Diversity Index (H)	0.92	1.05	1.23	0.98	1.19	0.95
Evenness Index (E)	0.85	0.83	0.89	0.81	0.92	0.88

c. Zooplankton

The zooplankton population is quite low in Chenab rivers owing to the fast flows of the river. Zooplankton is represented by *Vorticella* sp. of Sessilina; *Daphnia* sp. of Cladocera and *Cyclops* sp. of Copepoda Sub-orders (**Tables 3.50** to **3.52**). *Vorticella* and *Daphnia* were found at most of the sampling sites in all seasons. The density of zooplankton ranged from 23 to 43 in the winter season, 15 to 17 in the summer season, and 10 to 19 during monsoon **(Tables 3.50** to **3.52**).

Table 3.50: Zooplankton found in the study area during the winter season

S. No.	SUB-ORDER/ Name of species	SW1	SW2	SW3	SW4	SW5	SW6
	SESSILINA						
1	*Vorticella* sp.	+	+	+	+	+	+
	CLADOCERA						
2	*Daphnia* sp.	+	-	+	+	+	-
	COPEPODA						
3	*Cyclops* sp.	-	-	+	-	+	-
Total number of species		**2**	**1**	**3**	**2**	**3**	**1**
Density (Ind./lit)		**28**	**31**	**43**	**25**	**39**	**23**

Table 3.51: Zooplankton found in the study area during Pre-monsoon season

S. No.	SUB-ORDER/ Name of species	SW1	SW2	SW3	SW4	SW5	SW6
	SESSILINA						
1	*Vorticella* sp.	-	-	+	-	+	-
	CLADOCERA						
2	*Daphnia* sp.	-	-	+	-	+	-
	COPEPODA						
3	*Cyclops* sp.	-	-	-	-	+	-
Total number of species		-	-	**2**	**-**	**3**	**-**
Density (Ind./lit)		-	-	**15**	**-**	**17**	**-**

Table 3.52: Zooplankton found in the study area during monsoon season

S. No.	SUB-ORDER/ Name of species	SW1	SW2	SW3	SW4	SW5	SW6
	SESSILINA						
1	*Vorticella* sp.	-	+	-	-	+	+
	CLADOCERA						
2	*Daphnia* sp.	+	-	+	+	+	-
	COPEPODA						
3	*Cyclops* sp.	-	-	+	-	-	-
Total number of species		**1**	**1**	**2**	**1**	**2**	**1**
Density (Ind./lit)		**13**	**11**	**19**	**13**	**19**	**10**

d. Macro-invertebrates (Macro zoobenthos)

The macroinvertebrate community contributes immensely to the functioning of the stream or river ecosystem. It serves not only as a major source of food for fishes but also helps in processing relatively large amounts of organic matter. The abundance of invertebrate fauna mainly depends on the physical and chemical properties of the substratum. During pre-monsoon season, sampling for macro-invertebrate was carried out only at sites located on tributaries of Chenab River.

The macro-invertebrate fauna of the study area comprised of five orders viz. Ephemeroptera, Plecoptera, Trichoptera, Diptera, and Coleoptera during the survey. The tributaries of the Chenab River were rich in macro-invertebrates. Families Ameletidae, Perlodidae, and Chironomidae were the most dominant group at all the sampling sites during winter season sampling. Ameletidae, Baetidae Ephemerellidae and Hydroptilidae, and Chironomidae were the most common taxa of all the sampling sites studied. The percentage composition of macro-invertebrate fauna during different seasons is given in **Tables 3.53 to 3.55**.

Table 3.53: Percent composition of macro-invertebrates at different sampling locations (Winter)

TAXA	SW1	SW2	SW3	SW4	SW5	SW6
ORDER: EPHEMEROPTERA						
Family:Ameletidae						
Ameletus	31.4	27.9	30.4	33.3	32.9	32.3
Family:Baetidae						
Baetis	19.6	-	41.3	12.8	18.3	27.3
Family:Ephemerellidae						
Ephemerella	25.5	39.5	-	-	20.7	11.1
ORDER: PLECOPTERA						
Family:Perlodidae						
Isoperla	13.7	11.6	-	15.4	11.0	9.1
ORDER: TRICHOPTERA						
Family:Hydroptilidae						
Hydroptila	5.9	-	8.7	-	2.4	-
Hydropsychidae						
Hydropsyche	-	7.0	-	5.1	-	2.0
ORDER: DIPTERA						
Family:Chironomidae						
Ablabesmyia	-	14.0	19.6	30.8	14.6	17.2
ORDER: COLEOPTERA						
Family:Haliplidae						
Haliplus	3.9	-	-	2.6	-	1.0

SW1-SW6= Sampling locations

Table 3.54: Percent composition of macro-invertebrates at different sampling locations (Pre-Monsoon)

TAXA	SW1	SW2	SW3	SW4	SW5	SW6
ORDER: EPHEMEROPTERA						
Family:Ameletidae						
Ameletus	-	-	30.6	-	43.5	-
Family:Baetidae						
Baetis	-	-	13.9	-	23.9	-
Family:Ephemerellidae						
Ephemerella	-	-	22.2	-	-	-
ORDER: PLECOPTERA						
Family:Perlodidae						
Isoperla	-	-	27.8	-	13.0	-
ORDER: TRICHOPTERA						
Family:Hydroptilidae						
Hydroptila	-	-	-	-	2.2	-
Hydropsychidae						
Hydropsyche	-	-	5.6	-	-	-
ORDER: DIPTERA						
Family:Chironomidae						
Ablabesmyia	-	-	-	-	17.4	-
ORDER: COLEOPTERA						
Family:Haliplidae						
Haliplus	-	-	-	-	-	1.5

SW1-SW6= Sampling locations

Table 3.55: Percent composition of macro-invertebrates at different sampling locations (Monsoon)

TAXA	SW1	SW2	SW3	SW4	SW5	SW6
ORDER: EPHEMEROPTERA						
Family:Ameletidae						
Ameletus	-	84.6	33.3	-	-	13.6
Family:Baetidae						
Baetis	-	-	-	-	53.3	26.7
Family:Ephemerellidae						
Ephemerella	81.8	-	-	31.8	-	-
ORDER: PLECOPTERA						
Family:Perlodidae						
Isoperla	-	-	38.9	-	13.3	-
ORDER: TRICHOPTERA						
Family:Hydroptilidae						
Hydroptila	-	-	-	-	-	30.0
Hydropsychidae						
Hydropsyche	18.2	-	-	-	-	-
ORDER: DIPTERA						
Family:Chironomidae						
Ablabesmyia	-	15.4	27.8	22.7	33.4	-
ORDER: COLEOPTERA						
Family:Haliplidae						
Haliplus	-	-	-	-	-	-

SW1-SW6= Sampling locations

The higher densities of macro-invertebrates were observed during the winter season followed by the monsoon season. The density of macro-invertebrate was observed to be less during the pre-monsoon season as compared to winter and pre-monsoon and which may be due to the turbulent flow after melting of snow in the catchment of Chenab River and its tributaries (**see Table 3.56**).

Table 3.56: Density (indiv./m^2) of macro-invertebrates at different locations

Season	SW1	SW2	SW3	SW4	SW5	SW6
Winter	165	170	195	160	210	150
Pre-monsoon	-	-	55	-	65	-
Monsoon	70	75	120	60	135	80

W1-W8= Sampling locations

e. Fish Fauna

During the field survey, no fish was captured during experimental sampling. However, information was collected from villagers about the presence of fish species in the Chenab River and its tributaries. According to the villagers, Snow trout (*Schizothorax richardsonii*) is the only species occasionally sighted and captured from Chenab River in the area.

3.2.2.5 Protected Area

Sechu Tuan Wildlife Sanctuary is the nearest protected area from the proposed Dugar HEP. The location of Sechu Tuan Nala Wildlife Sanctuary with respect to project components is shown in **Figure 3.17**. All project components are outside the boundary of the Wildlife Sanctuary and its nearest boundary is about 12 km from the tail end of the proposed reservoir area and about 20 km from the proposed Dam site. No notifed wildlife corridors exist in the area.

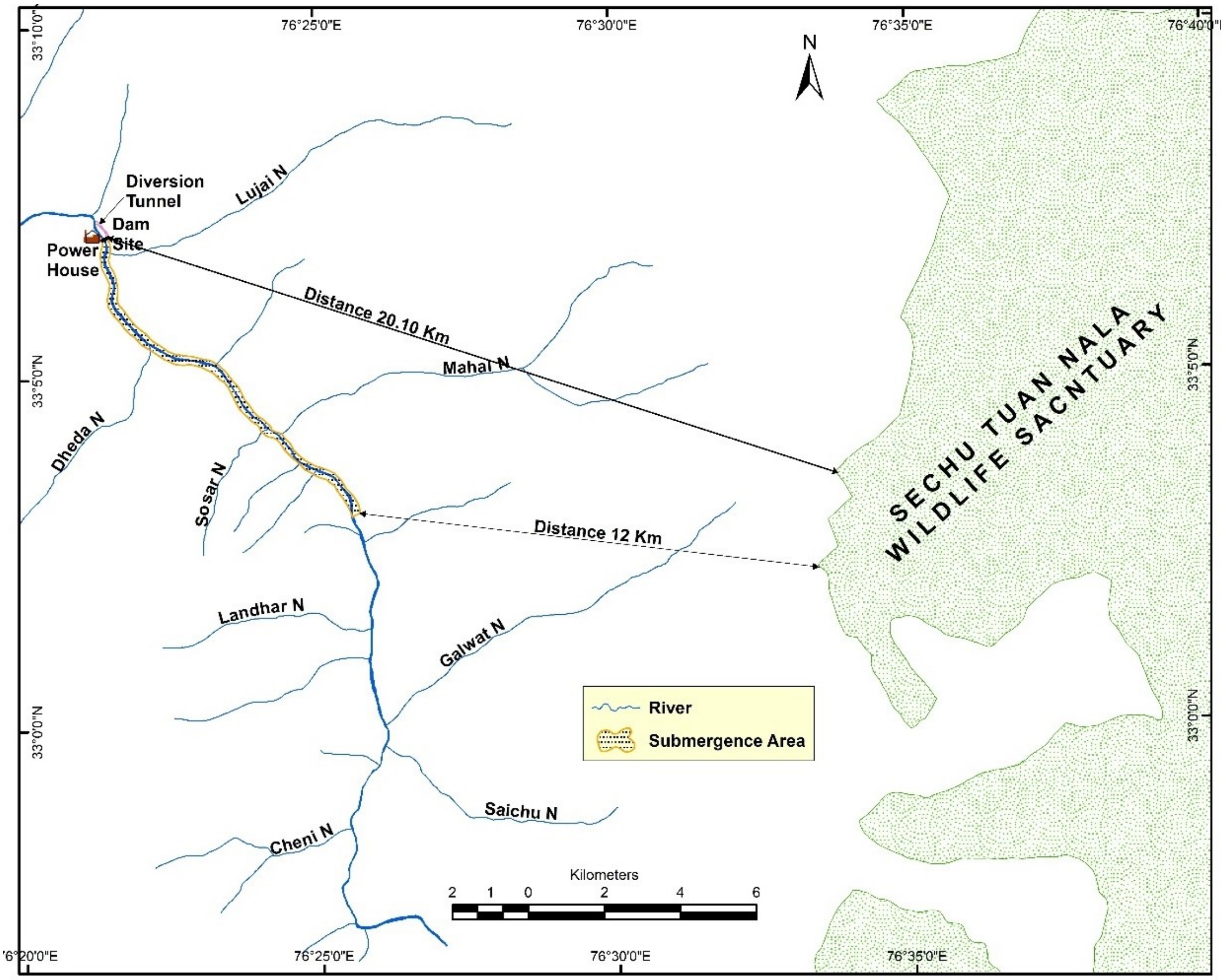


Figure 3.17: Map Showing distance of project components from Protected Area

3.2.2.6 Conclusions

i) As per landuse landcover map of the study area Evergreen/Semi-Evergreen Forest and Grass/Grazing land constitutes predominant land use in the study area (More than 50%). Scrub land and Barren Rocky each covers around 14.70% of the study area.

ii) According to 'A Revised Survey of the Forest Types of India' by Champion and Seth (1968). Forests in the study area are comprised of Group-13 Himalayan Dry Temperate Forest

iii) The most common tree species in the project area are *Cedrus deodara*, *Celtis tetrandra, Corylus jacquemontii, Fraxinus xanthoxyloides, Juglans regia, Pinus gerardiana, Pinus wallichiana, Populus ciliata, Prunus armeniaca,* and *Salix denticulata*.

iv) The project area harbours 182 plant species belonging to different plant groups like Angiosperms, Gymnosperms, Pteridophytes, Bryophytes, and Lichens.

v) Angiosperms are represented by 160 species: gymnosperms by 9 species. Eight species of pteridophytes, and bryophytes, and 5 species of lichens were recorded from the study area.

vi) A list of mammals has been prepared after consultation with forest department officials and villagers. A total of 12 species of mammals were reported from the project area. Common Leopard (*Panthera pardus*) is the Schedule I species reported from the study area.

vii) 34 species of birds were sighted during the study period. All the bird species-area list under Schedule-IV and Schedule-V.

viii) Three species of herpetofauna and 11 species of butterflies were recorded during the field survey.

ix) Sechu Tuan Wildlife Sanctuary Is the nearest protected area from the proposed project. However, no project component falls within the sanctuary. Its nearest boundary is about 12 km from the tail end of the proposed reservoir area and 20 km from the proposed Dam site.

x) Fish fauna is absent in the chenab river and its tributaries in the study area.

3.2.3 Socio-economic Environment

For sustainable development it is important to understand social and economic conditions of the community in the region, impacts of development on the community, measures to mitigate negative impacts and enhance the positive impacts. Development work depends on an effective partnership between project developer and the local community. For new development initiatives, socio economic assessment plays an important role to ensure community participation and their acceptance of the development activity and also helps in planning the activities for local area development. This section outlines baseline socio-economic scenario of the study area villages.

The majority of the project study area falls under Pangi Sub-division of Chamba district of Himachal Pradesh with small portion under Kishtwar district of Union Territory of Jammu & Kashmir **(**refer to **Figure 3.18).** However, all the proposed components of Dugar HEP, like Dam, Powerhouse and submergence area of the proposed project falls in Pangi Sub-division of Chamba district.

As per Census of India 2011, Chamba district occupies the 7th rank among the districts of Himachal Pradesh in terms of population with a total population of 5,19,080 persons. The density of population in Chamba district is 80 persons per sq km against the state average of 123 persons. There are 986 females for every thousand males in Chamba district.

3.2.3.1 Demographic Profile of the Study Area Villages

Due to pandemic COVID-19, socioeconomic survey was kept to limited villages. After permission of village heads, surveys and consultations were carried out in the villages.

Due to project, only one village i.e. Luj is directly affected by the project due to acquisition of land. A total of 8.78 ha of private land from Luj village will be acquired for proposed project.

A total of 8 revenue villages (including Luj village), in the direct proximity of project construction area have been surveyed to assess the socio-economic status of the study area villages. All the surveyed villages which fall under the jurisdiction of Pangi sub-division of Chamba District and are in the proximity of proposed project, were surveyed to (see **Table 3.57**).

Table 3.57: List of surveyed/ project Affected Villages

S. No	Name of Village	S. No	Name of Village
District: Chamba			
Sub-District/ tehsil: Pangi			
1	Chacharwas	5	Luj
2	Dharwas	6	Phindpar
3	Ghangit	7	Praghwal
4	Karel	8	Punto

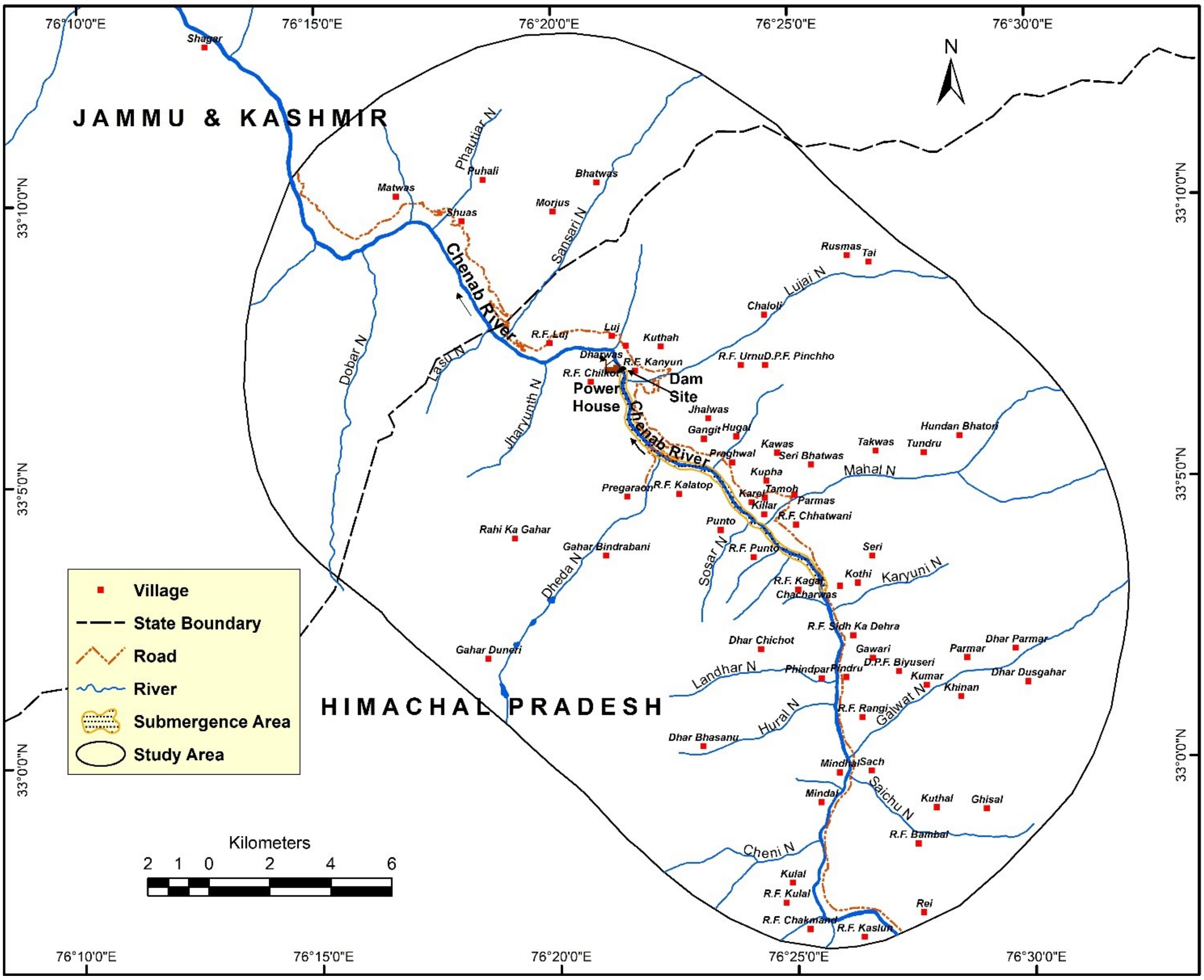


Figure 3.18: Map showing location of villages in the study area

3.2.3.2 Socio-economic Profile of the Study Area

Demographic profile of the 8 surveyed villages is given at **Tables 3.58** below. These villages comprise 622 households with a total population of 3214 of which 1592 are males 1622 are females. The sex ratio is 1019 females per thousand males.

Dharwas and Luj are the largest villages with maximum number of households with a population of 718 and 625, respectively, whereas Karel is smallest with 45 households and a population of only 201 persons.

Table 3.58: Demographic Profile of the Surveyed Villages

S. No.	Name of Village	No. of Households	Total Population	Male	Female	Sex ratio
1	Chacharwas	46	231	118	113	958
2	Dharwas	129	718	351	367	1046
3	Ghangit	60	374	185	189	1022
4	Karel	45	201	102	99	971
5	Luj	130	625	314	311	990
6	Phindpar	56	261	122	139	1139
7	Praghwal	87	471	226	245	1084
8	Punto	69	333	174	159	914
	Total	**622**	**3214**	**1592**	**1622**	**1019**

3.2.3.3 Social Category

Study area of proposed Dugar HEP lies under Pangi Sub-division of Chamba District. The Pangi Sub-division has been declared as Sechdule V area, as per the Scheduled Areas (Himachal Pradesh) Order,1975(CO 102) dated the 21st November, 1975.

About 89.0% of the total population comprises Schedule Tribe population. The Schedule Castes and General category comprise 7.0% and 4.0%, respectively of the total population. The social category of the villages is shown in **Figure 3.19** and **Table 3.59**.

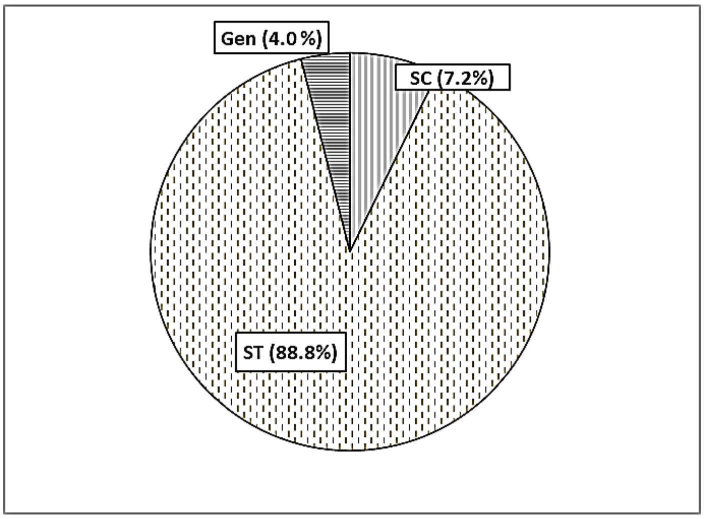


Figure 3.19: Percent composition of Social Categories in the Surveyed Villages

Table 3.59: Population structure of Surveyed Villages

S.No.	Name of village	Total Population	Scheduled Castes			Scheduled Tribes		
			Total	Male	Female	Total	Male	Female
1	Chacharwas	231	41	22	19	188	94	94
2	Dharwas	718	11	5	6	686	333	353
3	Ghangit	374	0	0	0	371	183	188
4	Karel	201	0	0	0	167	82	85
5	Luj	625	143	73	70	450	210	240
6	Phindpar	261	1	0	1	259	121	138
7	Praghwal	471	2	0	2	444	208	236
8	Punto	333	35	18	17	289	151	138
Total		**3214**	**233**	**118**	**115**	**2854**	**1382**	**1472**

3.2.3.4 Literacy

There is 70.55% literacy in the villages (see **Table 3.60**). Ghangit village has the highest literacy rate (86.92%). Inspite of the fact that primary level education is available in each village, it has been observed that male populations have achieved greater educational level than their female counterparts.

Table 3.60: Literacy Rate in Surveyed Villages

S.No	Name of Village	Total Population	Literacy (%)	Male (%)	Female (%)
1	Chacharwas	202	72.77	83.33	62.00
2	Dharwas	633	72.20	82.64	62.11
3	Ghangit	344	86.92	93.45	80.68
4	Karel	189	73.54	85.26	61.70
5	Luj	553	73.42	85.82	60.52
6	Phindpar	233	61.80	79.81	47.29
7	Praghwal	433	55.89	64.56	48.02
8	Punto	289	67.47	81.33	52.52
	Total	**2876**	**70.55**	**81.81**	**59.60**

3.2.3.5 Occupation Pattern

The data on working population shows that the about 60.8% of population fall under 'Worker' category (**Table 3.61**). Out of 'Total Worker' population, 27.74% are 'Main Workers' and 72.26% are 'Marginal Workers'. The male and female Workers population comprise 49.80% and 50.20%, respectively showing almost equal participation of male and female workers.

Table 3.61: Working population in the Surveyed Villages

S.No.	Village Name	Total Population	Total Worker			Main Worker			Marginal Worker		
			T	M	F	T	M	F	T	M	F
1	Chacharwas	231	195	97	98	12	9	3	183	88	95
2	Dharwas	718	419	213	206	110	79	31	309	134	175
3	Ghangit	374	180	94	86	48	36	12	132	58	74
4	Karel	201	136	68	68	32	24	8	104	44	60
5	Luj	625	388	202	186	105	85	20	283	117	166
6	Phindpar	261	182	80	102	128	57	71	54	23	31
7	Praghwal	471	350	164	186	58	45	13	292	119	173
8	Punto	333	104	55	49	49	28	21	55	27	28
	Total	**3214**	1954	973	981	542	363	179	1412	610	802
	Percent		60.80	49.80	50.20	27.74	66.97	33.03	72.26	43.20	56.80

Agriculture is the main occupation of the people in the area with 60.29% of the total working population engaged in agriculture and allied activities, while 5.83% is enagaged in Household industries service and about 34% in other works (**Table 3.62)**.

Table 3.62: Worker Classification in Surveyed Villages

S.No.	Village	Total Working Poulation	Cultivators	Agricultural Labour	Household Industries	Other Workers
1	Chacharwas	195	185	0	0	10
2	Dharwas	419	180	11	23	205
3	Ghangit	180	86	32	4	58
4	Karel	136	103	0	1	32
5	Luj	388	156	3	77	152

S.No.	Village	Total Working Poulation	Cultivators	Agricultural Labour	Household Industries	Other Workers
6	Phindpar	182	155	2	0	25
7	Praghwal	350	249	7	9	85
8	Punto	104	9	0	0	95
	Total	1954	1123	55	114	662
	Percent		**57.47**	**2.81**	**5.83**	**33.88**

3.2.3.6 Amenities

a. Education Facilities

Educational facilities play an important role in the overall development of an area. These facilities enhance economic growth and employment. Field survey in the villages indicate that primary education facilities are either available in the villages or located within 2-3 km from the villages. Middle schools in the area are available in three villages. Higher secondary and Senior Secondary School is available only in Dharwas village. However, Killar town is located within 5-8 km from all villages having higher secondary and senior secondary education facility.

There is only one Government Degree college which is in Killar town. The presence of educational institutions is below in **Table 3.63.**

Table 3.63: Education facilities in the in the Surveyed Villages

S.No.	Villages	Primary school		Middle School		Secondary school		Senior Secondary		College
		Govt.	Pvt.	Govt.	Pvt.	Govt.	Pvt.	Govt.	Pvt.	
1	Chacharwas	Yes	No	No	No	No	No	No	No	Killar
2	Dharwas	Yes	No	Yes	No	Yes	No	Yes	No	Killar
3	Ghangit	Yes	No	No	No	No	No	No	No	Killar
4	Karel	Yes	No	No	No	No	No	No	No	Killar
5	Luj	Yes	No	Yes	No	No	No	No	No	Killar
6	Phindpar	No	No	No	No	No	No	No	No	Killar
7	Praghwal	Yes	No	No	No	No	No	No	No	Killar
8	Punto	Yes	No	Yes	No	No	No	No	No	Killar

b. Health Care Facilities

Based upon the field survey, it was found that villages in the area do not have good medical facilities. Most of the villagers in the area prefer the traditional faith healers which use local medicinal plants available in the area for treatment of common diseases. There is one Primary Health Center is in Dharwas village, and one Civil Hospital is in Killar town which cater to the medical requirement of the villagers in Pangi valley.

c. Road Network and Transport

Most of villages in the study area are well connected to metalled roads. State Highway 26 is the main road connecting the area to state capital via Manali and Udaipur, while State Highway 37, connected the area to district headquarter Chamba. All the villages in the study area are well connected to State Highways, SH26 & SH37 through metallic road. However, during winter season (from November to March) access for the area either through state highway connecting to district headquarter Chamba or through highway connecting to state capital Shimla via Lahul Spiti district is extremely limited due to heavy snowfall in the area. The highway connecting to Kishtwar district of Jammu and Kashmir is the only route to access the project area during winter season. However, the traffic in the route also is limited only to supply of essential goods in the area.

d. Other Amenities

Basic services and amenities are not adequate in all the villages. In the area, drinking water facility is arranged through tapping water from nearby springs. In the villages, toilet facilities are available in majority of households and the practice of open defecation are rarely seen in the area.

Electricity is available in most villages, but supply is very erratic in the area. Due to uncertainty of domestic electricity supply in the study area especially during winter season, villagers depend on solar lights and solar water heaters.

Due to unavailability of communication facilities like tele-communication and internet in the area, postal services still remain the most popular option. Mobile connectivity is limited to Killar town. There are 4 post offices and Branch P.O in the area. Banking facility in the project area is available in Killar town.

Most of the households in the project villages have LPG connections for cooking but fuelwood is the main source of energy. The supply of cooking gas in the area is irregular; one LPG depot located in Killar town is not capable to cater the requirement of LPG in the area, therefore villagers in the area depend on fuel wood.

The fair price shops are located in every village panchayats. For daily needs goods, nearest market facility is in Killar.

Agriculture is the main economy of the area. Tomato, Potato, Pea, Maize, Pulses and other vegetables are main crops cultivated in the area. Among the horticulture crops Apple, Walnut and Apricot are the main commercial cultivated fruit species. Villagers also collect Hazelnuts, Chilgoza and Walnut from the forest.

3.2.3.7 Fairs and Festivals

Pangi valley is also well known for the unique culture and festivals. Phuliyath, Dekhen, Unouni, Mindhalyath, Parwath and Zukaroo are main festivals celebrated in the area. But among these, Zukaroo festival is celebrated with much pomp and enthusiasm.

In addition to these festivals, fairs in the area were organised during opening of temples after winters and at the time of closing the temple for winter season in every village.

3.2.3.8 Historical, Religious and Archaeological Importance Places

No archaeological and historical places were reported from the study area. Among the religious places there are temples in every village. Among the economical importance and tourist places the Sural Bhaturi in Dharwas village panchayat is one the important tourist place in the area. Sural Bhatori is the last village in the Sural Valley, located at an altitude more than 3000 metres and around 25 km from Killar town. As the name suggests, it is inhabited by Bhotia People (Buddhists of

Tibetan descent). It also has the most important monastery in Pangi Valley, located amidst a grove of Himalayan Birch (Bhojpatra) and meadows.

3.2.3.9 Conclusion

Finding of the social environment status of the project area is as follows:

- Proposed project area lies under Pangi Sub-division of Chamba District. Pangi Sub-division has been declared as Sechdule V area, as per the Scheduled Areas (Himachal Pradesh) Order,1975(CO 102) dated the 21st November, 1975.
- The education facilities in the area are moderate up to middle school but for secondary and senior secondary education students travel upto 5 to 8 km. There is one Government Degree college in the area at Killar.
- Medical facilities in the area are limited; there is only one PHC at Dharwas and one Civil hospital at Killar is available to cater the medical facility in the area. Villagers in the area also depend on traditional faith healers.
- Basic amenities in terms of electricity available in most of the villages. However, the supply is very erratic in the area therefore most the villagers depend on solar lights and supply of drinking water is maintained through tapping water from nearby springs/ nalas.
- The most important roads passes through the area are State Highway 26 and State Highway 37 connecting to State capital and district headquarter, respectively. Transportation facility is good in the area, all the village road are well connected to State highway through metalled roads. While the condition of State Highway's connecting the area to rest of the country is not in good condition and during winter/lean season due to heavy snowfall in the area, access for the area is through SH26 and SH37 is extremely limited. The highway connecting to Kishtwar district of Jammu and Kashmir is the only route to access the project area.
- Banking services are not adequate in the area. For banking facility villagers depend on the only bank located at Killar town. There are 4 post offices located in the area.
- The telecommunication and internet facilities are limited to Killar town. The mobile cellular network is not available in the villages or along the highways.

3.3 BASE MAPS OF ALL ENVIRONMENTAL COMPONENTS

Study area of the project covers the project area or the direct impact area within 10 km radius of the main project components like, dam, Powerhouse, reservoir, and approach road etc. Base maps based on study area for all environmental components are prepared and given in respective sections above.

Chapter 4 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

4.1 DETAILS OF INVESTIGATED ENVIRONMENTAL IMPACTS

Assessment of environmental impacts of any development activity is the key component of the EIA process. Environmental impacts are assessed based on the understanding of the project features/activities, environmental baseline setting in the area, and interaction of project activities with environment. The proposed Dugar HEP is a location-specific project and impact assessment is carried out by establishing site-specific environmental settings through baseline data collection and defining project components from detailed project information. Baseline environmental status in the project area is established through field studies in different seasons and by referring to various secondary data sources as discussed in the previous chapter. Project-related information is sourced from the Detailed Project Report (DPR) of the project to carry out the impact assessment for the project construction and operation phase.

Anticipated environmental impacts during the construction phase emanates from the activities such as drilling and blasting, excavation, concreting, dumping of muck generated from various project activities, transportation of material, material handling and storage, waste generation from labour colonies, operation of construction machinery/equipment, etc. Additionally, large-scale labour migration to the area, during the construction period, may create additional stress on the receiving environment. EIA helps in the identification and quantification of such impacts so that appropriate and adequate mitigation/management measures can be planned and implemented for mitigation and minimizing such impacts.

All the likely impacts have been considered for various aspects of the environment, including physico-chemical, ecological, and socio-economic aspects. Invariably two types of impacts occur due to construction and operation of projects viz. permanent which generally lead to loss of plant species, change of land-use, displacement of population, etc., which can only be compensated and managed; and temporary impacts which can be minimized and mitigated by implementing mitigation measures. Wherever possible, the impacts have been quantified and otherwise, qualitative assessment has been undertaken.

This chapter deals with the anticipated positive as well as negative impacts during the construction as well as operation phase of the proposed project.

Main activities during the construction as well as operation phase are as follows.

Major Activities During Construction Phase

- Site clearance
- Upstream and downstream Coffer dams
- Blasting and drilling for earthwork and excavation for adits, tunnels, and dam foundation
- Construction of a concrete dam of 128 m high
- Diversion tunnels of 11.5 m dia. and length 463m and 577m

- Intake, Pressure shaft, main underground powerhouse
- Intake, Pressure Shaft, underground Powerhouse for Auxiliary powerhouse
- Underground main powerhouse with 4 units of 103 MW each and auxiliary power house with two units of 44 MW each to tap the environmental flow during lean season and non-lean non-monsoon season in the main powerhouse cavern
- Two nos. 8.5m dia tailrace tunnels combined into a single TRT having a finished diameter of 12.1 m and length of 400 m located on the left bank of Chenab River
- Construction of new roads and upgradation of existing roads
- Project headquarter, offices and colonies
- Disposal of muck and construction wastes
- Transportation of construction material
- Operation and maintenance of construction equipment
- Civil and mechanical fabrication works for the construction of various project components.
- Operation of DG sets
- Disposal of pollutants from workshops, etc.
- Disposal of effluents and solid waste from labour camps and colonies

Operation Phase Activities

- Diversion of water from river Chenab for hydropower generation
- Equipment maintenance and restoration
- Sewage and solid waste generation from project colonies

4.1.1 Impacts on Air Quality

4.1.1.1 Construction Phase Impacts

The sources and activities that might affect air quality in the project area are vehicular traffic, dust arising from unpaved village roads, and domestic fuel burning. The air environment around the project site is free from any significant pollution source. Therefore, ambient air quality is quite good in and around the project area.

Increased vehicular movement for transportation of men and material and use of construction equipment will impact air quality at the construction site through emissions from the engines and equipment, fugitive emissions due to material handling, etc. Additionally, construction activities including operation of crushers, concrete batch plants, construction work, and movement of vehicles along the unpaved road will generate dust & gaseous emission and impact air quality. The burning of waste will also affect air quality and therefore, need to be controlled. In absence of proper fuel, construction workers at the project site may use wood for fuel burning.

a) ***Pollution due to fuel combustion in various equipment***

The operation of various construction equipment requires the combustion of fuel. Normally, diesel is used in such equipment. The major pollutant which gets emitted because of the combustion of diesel is SO_2. The particulate matter emissions are minimal due to the low ash content in diesel. Depending upon the fuel quality and quantity and rating of DG sets and other equipment, it is important to provide adequate stack height for emission to be dispersed in the atmosphere to have a minimum increase in Ground Level Concentrations (GLCs).

b) *Emissions from various crushers and other construction plants*

The operation of the crusher and other construction plants during the construction phase generates dust and fugitive emissions, which can impact plant area and surrounding area as well, depending on wind direction. Such fugitive emissions comprising mainly of particulate matter will be generated. Preventive and protective measures are required to be implemented by contractors at the site to control such emissions and further reduce their impacts on workers and locals.

c) *Fugitive Emissions from material handling and transportation*

During the construction phase, there will be increased vehicular movement. A lot of construction material like sand, fine aggregate is stored at various sites, during the project construction phase. Normally, due to the blowing of winds, especially when the environment is dry, some of the stored material can get entrained into the atmosphere. Although it is very difficult to eliminate such an impact, it is possible to reduce its intensity by implementing mitigation measures discussed in the ensuing text.

4.1.1.2 Operation Phase Impacts

In hydropower projects, air pollution occurs mainly during the project construction phase. During the operation phase, no major impacts are envisaged on the air environment.

4.1.2 Impact on Noise Environment

Sources of noise will be increased vehicular traffic due to project construction on approach roads and at construction sites. Due to construction activity in the area, noise levels will increase during the period of construction, however, they will remain limited to the work area mainly where large-scale construction activity will progress. Other sources of noise and vibration will be the use of explosives for blasting purposes for construction activities.

4.1.2.1 Construction Phase Impacts

a) Noise due to Construction Equipment

The noise levels due to the operation of the different construction equipment are given in **Table 4.1**.

Table 4.1: Equivalent Noise Levels due to Operation of Construction Equipment

Equipment	Noise level dB(A)	Equipment	Noise level dB(A)
Earth Moving		**Material Handling**	
Compactors	70-72	Concrete mixers	75-85
Front loaders	72-82	Movable cranes	82-84
Backhoes	70-92		
Tractors	76-90		
Scrappers, graders	82-90		
Truck	84-90		
Others			
Vibrators	69-81	Saws	74-81

Noise level of about 80 dB(A) at 1m from the source will reduce significantly with distance and can be calculated with the following formula at any location:

$$N2 = N1 - 20 \log_{10}(r2/r1) - A_f \quad \text{dBA}$$

Where, N2 = Sound level at any location at a distance r2 from the source
N1 = Sound level at any location at a distance r1 from the source

The decrease in sound level of 80 dB(A) (at 1m from the source) at 100m from the source is 40 dB(A) even in the absence of an external attenuation factor. Decrease in sound levels (measured at 1 m from the source) at various distances are given in **Table 4.2**. In the absence of details of attenuation factors, they have assumed zero, whereas, in actual practice attenuation factors such as vegetation, barricades, etc. will reduce the sound level significantly. Noise levels get reduced by 6 dB(A) with every doubling of distance.

Table 4.2: Decrease in Sound Levels with Distance from Source*

Distance from Source (m)	Corresponding Sound levels dB(A)
100	40.0
200	34.0
500	26.0
1000	20.0
1500	16.5
2000	14.0
2500	12.0
3000	10.5

* Source sound is 80 dB(A) at 1m

The walls of houses attenuate at least 30 dB(A) of noise. In addition, there is attenuation due to air absorption, atmospheric homogeneities, vegetal cover, etc. Thus, no increase in noise levels is anticipated beyond 100m from the source during the project construction phase. However, it can be a cause of concern from workers working in proximity to machines generating noise.

b) Noise due to increased vehicular movement

During the construction phase, there will be a significant increase in the vehicular movement for the transportation of construction material. Presently in the project area, the only sound is the noise emanating from the turbulent flow of the Chenab River and there is very little vehicular movement in the area. During the construction phase, the increase in vehicular movement is expected to be at least 5-6 trucks/hour during the peak construction period. The impact on noise level due to increased vehicular movement cannot be quantified as it will depend upon various factors such as vehicle condition, vehicle speed, road condition, idling time, traffic condition, etc.

c) Noise Generated due to Blasting

Noise generated by blasting is instantaneous. Noise generated due to blasting is site-specific and depends on the type, quantity of explosives, dimension of the drill hole, degree of compaction of explosives in the hole, and rock. Noise levels generated due to blasting at various sites recorded in other projects are given in **Table 4.3**.

Table 4.3: Noise generated due to blasting

No. of holes	Total charge (kg)	Maximum charge/delay (kg)	Distance (m)	Noise level dB(A)
15	1500	100	250	76-85
17	1700	100	250	76-86
18	1800	100	250	74-85
19	1900	100	400	70-75
20	2000	100	100	76-80

It can be observed from **Table 4.3** that noise levels due to blasting operations are expected to be of the order of 75-85 dB(A) at about 250m; which will be reduced to 35-45 dB(A) in another 100m. External attenuation factor will reduce it further. As the blasting is likely to last for 4 to 5 seconds depending on the charge, noise levels over this time would be instantaneous and short in duration. Considering attenuation due to various sources, even the instantaneous increase in noise level is not expected to be significant especially during daytime. Hence, higher noise levels generated due to blasting are not expected to cause any significant adverse impact.

e) Impacts due to Ground Vibrations

The explosive energy generated during blasting sets up a seismic wave within the surface, which may affect the structures and cause discomfort to the human population. When an explosive charge is fired in a hole, stress waves traverse in various directions, causing the rock particles to oscillate. Blasting also generates ground vibrations and instantaneous noise. Various measures have been recommended to minimize the adverse impacts due to blasting:

- Proper design of blast hole to be developed.
- Use of noiseless trunk delays to minimize the noise due to air blast.
- Use of the non-electric system of blasting for true bottom-hole initiation.
- Use of muffling mats to arrest the dust and fly rock.

f) Impacts on Labour

The effect of high noise levels on the operating personnel must be considered as this may be particularly harmful. It is known that continuous exposures to high noise levels above 90 dB(A) affect the hearing ability of the workers/operators and hence, should be avoided. To prevent these effects, it has been recommended by Occupational Safety and Health Administration (OSHA) that the exposure period of affected persons be limited as in **Table 4.4**.

Table 4.4: Maximum Exposure Periods Specified by OSHA

Maximum equivalent continuous noise level dB(A)	Unprotected exposure period per day for 8 h/day and 5 days/week
90	8
95	4
100	2
110	½
120	¼

g) Impacts on Wildlife

Noise in and around the construction site may affect the wildlife and residents in the nearby areas. It is expected that wildlife in the area will move away from the noise and eventually return to the area when the blasting is over. However, there is no major wildlife observed in and around the construction site and hence this may not be a significant issue.

4.1.2.2 Operation Phase Impacts

No major impacts are envisaged on the noise environment during the project operation phase.

4.1.3 Water Environment

Various sources of water pollution in the project area during the construction phase include disposal of effluents with high turbidity from crushers commissioned at various sites, sewage disposal from the labour camp, blasting and other land clearing activities, washing of oil, grease, and other chemicals from diesel generator sets, vehicles, and other machinery, etc.

4.1.3.1 Impacts of water pollution

Water pollution is harmful and is a serious health hazard. It has far-reaching consequences and effects on human beings and animals also. The effect can be felt not only in the surface water bodies but also in the groundwater source in the area. The effect may be of temporary or permanent nature. The major impacts of water pollution are given as under:

- The civil and hydro-mechanical work at the site will lead to stockpiling and excavation activity on-site, thereby exposing the base soil to erosion. The runoff from this site and muck disposal sites may contain a high quantity of Suspended Solids which shall add to the inorganic load of water bodies and drainages in the area. However, the impact of runoff may not be very significant except during the rainy season.
- During the construction phase, wastewater, sewage, etc. shall be generated from the labour camp and workshops. If disposed of untreated, this would substantially deteriorate the surface and groundwater quality in the area.
- The oil and grease released from the project-related activities may also change the physico-chemical characteristics of water.

4.1.3.2 Construction Phase Impacts

The major sources of water pollution during the project construction phase are as follows:

- Sewage from Construction work camps/colonies
- Discharge of waste water from Construction Plants and Workshops

a) Sewage from Construction worker Camps

The project construction will last for 98 months. About 2500 semi-skilled/unskilled, skilled, and supervisory staff are likely to work during the peak project construction phase. Most of the employees/ workers during the construction phase are likely to be employed from outside the project area. The construction phase also leads to mushrooming of various allied activities to meet the demand of immigrant construction workers in the project area. Additionally, drivers and labour associated with the transportation of material will also stay in the area temporarily.

The domestic water requirement for the construction worker and the technical staff migrating into the project area will be of the order of approx. 200 cum/day @ 70 lpcd. With 80% of this quantum to be generated as wastewater, the quantity of 160 cum/day is considered significant and requires planned disposal otherwise it will lead to water pollution, increased coliforms, and other pathogens, which can lead to incidence of water-borne diseases. Therefore, project authorities would be taking appropriate measures to check such disposal into the natural water bodies. To avoid any deterioration in water quality due to disposal of untreated wastewater from labour camps, appropriate sewage treatment facilities will be commissioned in the labour camps, and only treated wastewater will be discharged following “General Discharge Standards”.

During the project operation phase, the cause and source of water pollution will be much different. Since only a small number of O&M staff will reside in the area in a colony with facilities like a sewage treatment plant, the problem of water pollution due to disposal of sewage is not anticipated. During the operation phase, around 50 families (total population of 120) will be residing in the project colony proposed to be developed. About 37.5 m^3/day of sewage is expected to be generated resulting in a total BOD loading will be the order of 11 kg/day. It is proposed to provide a septic tank to treat the sewage generated from the project colony. It will bring down the BOD load to 3 to 4 kg/day. The quantum of sewage so generated will be so small that no major adverse impact is anticipated because of the disposal of effluents from the project colony.

b) Discharge of waste water from Construction Plants and Workshops

As discussed earlier, construction plants viz. aggregate processing and concrete mixing and workshops will be established. Water is used in these construction plants and wastewater is generated with high suspended solids. Similarly from workshops, major pollutants will be oil and grease. Discharge of untreated wastewater will adversely affect the surface and groundwater quality. To minimize the impact, such effluent needs to be treated *in-situ* before discharge to any water body or for land application.

c) Discharge of waste water from Crushers

Since local crushers are not available in the vicinity of the project two nos. of Aggregate Processing Plants (APP) at the project site of capacity 120 TPH & 240 TPH are proposed to cater to the initial requirement of works. Water is required to wash the boulders and to lower the temperature of the crushing edge. About 0.1 m^3 of water is required per ton of material crushed. The waste water from the crusher would contain high suspended solids i.e. of the order of 3000 – 4000 mg/l. About 12-24 m^3/h of wastewater is expected to be generated from each crusher. The effluent, if disposed of without treatment can lead to a marginal increase in the turbidity levels in the river. The natural slope in the area is such that, the effluents from the crushers will finally drain into the Chenab River. This amounts to a discharge of 0.0033 to 0.0042 cumec. Even the lowest 10-day minimum flow in the Chenab River is 8.7 cumec. The waste water from the crusher will have a suspended solids level of 3000-4000 mg/l. On the other hand, suspended solids as observed at various sampling locations, during water quality monitoring studies was observed to be <0.1 mg/l. The composite value of suspended solids would increase by 0.07 mg/l, which is insignificant. Therefore, no adverse impacts are anticipated due to the small quantity of waste water and a large volume of water available i.e., high discharge in Chenab River for dilution. Even then, it is proposed to treat the effluent from crushers in the settling tank before disposal to ameliorate even the marginal impacts likely to accrue on this account.

d) Disposal of Muck

The water quality may get impacted when the muck is disposed of along the water bodies and natural drainage system. The unsorted waste going into the channels/ water bodies can contribute to the turbidity of water. The high turbidity is known to reduce the photosynthetic efficiency of primary producers in the water bodies and as a result, the biological productivity will get reduced. However, muck disposal in line with the Muck Disposal Plan, as given in Environment Management Plan (Chapter 10) will avoid such impacts on water quality.

e) Impact on Aquatic Life

During the construction phase a large quantity of construction material like stones, pebbles, gravel and sand would be needed. A significant amount of material is available in the quarry and riverbed. It is proposed to extract construction material from the quarry as well as from the riverbed. The extraction of construction material may affect aquatic life due to an increase in turbidity levels. There is no fish habitat reported from the water course of Chenab river in the study area. However, the aquatic flora and fauna comprising benthos i.e., phytobenthos and zoobenthos comprising macro-invertebrates which are found attached to the stones, boulders, etc. will get dislodged and is carried away downstream by turbulent flow. In the areas from where construction material is excavated, benthic fauna gets destroyed. In the due course of time, however, the area gets recolonized, with fresh benthic fauna. The density and diversity of benthic fauna will, however, be much lower as compared with the preconstruction levels.

4.1.3.3 Operation Phase Impacts

During the operation phase, due to the absence of any large-scale construction activity, the cause and source of water pollution will be much different. Since only a small number of O&M staff will reside in the area in a well-designed colony with a sewage treatment plant and other infrastructural facilities, the problems of water pollution due to disposal of sewage are not anticipated. The treated sewage will be reused for gardening and green belt around the colony.

a) Impact of Reservoir Creation

The creation of reservoir on forest land, will lead to the availability of nutrients resulting from the decomposition of vegetation. Increased Phytoplankton productivity can supersaturate the euphotic zone with oxygen before contributing to the accommodation of organic matter in the sediments. The enrichment of reservoir water with organic and inorganic nutrients will lead to alteration in water quality with the commencement of operations. However, this phenomenon is expected to last for the first few years from the filling up of the reservoir. Therefore, it is recommended to clear the trees and other vegetation before filling up the reservoir. The proposed project is envisaged as a run of the river scheme, with significant diurnal variations in reservoir water levels. In such a scenario, significant re-aeration from the atmosphere takes place, which can maintain Dissolved Oxygen in the water body. Therefore, in the proposed project, no significant reduction in Dissolved Oxygen levels in reservoir water is anticipated.

During the operation phase, due to creation of reservoir there wil be a change from a fast-flowing lotic water system to a quiescent lacustrine environment. The alteration of the habitat would bring changes in physical, chemical, and aquatic life. Many aquatic communities unable to adapt to the altered environment might disappear with specific feeding and reproductive characteristics. The diatoms, blue-green and green algae have their habitats beneath boulders, stones, fallen logs along the river, where depth is such that light penetration can take place. But with the damming of the river, these organisms may perish because of an increase in depth and absence of substrate.

b) Risk of Eutrophication

As there are many agricultural fields on the right bank slopes of the river in the reservoir area, the problem of eutrophication occurs mainly due to the disposal of nutrient-rich effluents from the agricultural fields. The fertilizer use in the project area is negligible, the runoff at present does not contain a significant amount of nutrients. Even during the operation phase, the use of fertilizers in the project catchment area is not expected to rise significantly. As the proposed project is envisaged as a run-off-the-river scheme, with significant diurnal variations in reservoir water level, the residence time would be of the order of few days, which is too small to cause any eutrophication. Thus, in the project operation phase, problems of eutrophication, which is primarily caused by the enrichment of nutrients in the water, are not anticipated.

c) Sediments

Chenab river flows along a steep gradient and carries a significant amount of sediment load. Due to the creation of a reservoir sediments will tend to accumulate in the riverbed as the suspended load settles down due to a decrease in flow velocity. The proposed project is envisaged as a runoff river scheme, the sluice gates in the dam shall be opened to flush out the sediments. Thus, in the proposed project, the sedimentation problem is not anticipated.

4.1.4 Land Environment

4.1.4.1 Construction Phase Impacts

For the development of the Dugar HEP, the land would be acquired for construction of project components, reservoir area creation, muck dumping, quarrying operations, construction camps, and colonies, and acquisition of land.

a) ***Impact due to change in land-use***

A major impact of land acquisition is a permanent change of land use, which is unavoidable. Private land acquisition has impacts on the local population by way of loss of their agricultural land and hence livelihood. The land acquisition also leads to loss of flora and fauna by way of loss of forest land and clearing of vegetation on the acquired land. These impacts can be compnesated to a large extent by providing adequate compensation to private landowners and by compensatory afforestation *in lieu* of loss of forest land. To manage the impact of land-use change on biodiversity a ‘Biodiversity and Wildlife Conservation & Management Plan’ has been prepared discussed later in the report.

b) ***Impacts due to Muck Generation***

The construction activities would involve 3,70,880 cum of soil excavation and 9,23,970 cum of rock excavation. About 60% of rock excavation is expected to be used for producing coarse and fine aggregate for concrete production and in fillings for developing areas for construction facilities. The total quantity of excavation in common soil and balance quantity of rock excavation would have to be disposed of in designated muck disposal areas. Thus, considering swell factors 0.63 for rock and 0.80 for common soil as adopted from CWC Guidelines and redeposit compaction factor of 83%, the total muck disposal area should have a capacity of about 8,71,706 cum. The site will be fully rehabilitated and restored on completion of muck dumping. Muck, if not securely transported and dumped at a pre-designated site, can have serious environmental impacts, such as:

- Can be washed away into the natural water bodies which can cause negative impacts on surface and groundwater quality.
- In many of the sites, muck is stacked without adequate stabilisation measures. In such a scenario, the muck moves along with runoff and creates soil erosion-like situations.
- Normally muck disposal is done at low-lying areas, which get filled up due to stacking of muck. This can sometimes affect the natural drainage pattern of the area leading to accumulation of water or partial flooding of some areas which can provide ideal breeding habitat for mosquitoes.

Muck disposal needs to be carefully planned else it becomes a major impact on the construction of the project. Such a plan is prepared and included in the Environment Management Plan (Chapter 10).

c) ***Impacts Due to Waste Generation***

The construction of the proposed Dugar HEP will involve different categories of manpower like labour, technical, other officials, and service providers. Most of these technical and non-technical workers will be temporary and will leave the region as soon as the construction phase of the project is over, which is estimated as 98 months. Some of the workers will be accompanied by their families. The total migrant population of workers and their families has been estimated as 2500 persons during peak construction time. These people will be living in temporary and permanent colonies/ settlements. The main sources of waste generation can be categorized as:

- Municipal waste (includes commercial and residential wastes generated in either solid or semi-solid form excluding industrial hazardous wastes and bio-medical wastes)
- Construction and demolition debris (C&D waste)
- Bio-medical waste
- Hazardous waste (generated from construction machinery and equipment)
- e-Waste (computer parts, Printer cartridges, electronic parts, etc.).

The solid waste generated from temporary and permanent colonies in construction as well as operation phase requires special management to dispose of, as warranted under the Solid Wastes Management Rules (SWM) 2016. For that, an efficient waste management system will be required to be put in place to keep the environment of the region clean and healthy.

These colonies and temporary settlements will also require an adequate water supply for drinking and cleaning.

The project authorities will ensure sewage generated from labour colonies and site office is treated and disposed of as per the HPSPCB guidelines. It's proposed to provide adequate septic tanks with soak pits for treatment and disposal of sewage.

d) *Impacts due to Road Construction*

It has been assessed that about 13 km length of the new roads is required to be constructed to access the Dam and powerhouse complex and other project sites. The total land required for the construction of the new roads is 8.168 ha.

The major impacts likely to accrue because of the construction of the roads are:

- Loss of forest and vegetation by cutting of trees
- Geological disturbance due to blasting, excavation, etc.
- Soil erosion as the slope cutting operation disturbs the natural slope.
- Interruption of drainage and change in the drainage pattern
- Disturbance of water resources with blasting and discriminate disposal of fuel and lubricants from road construction machinery
- Siltation of water channels/ reservoirs from excavated debris
- Impact on flora and fauna
- Air pollution due to dust from debris, road construction machinery, etc.
- Noise generation due to construction activities.

e) *Impacts due to Quarrying*

In hilly terrain, quarrying is normally done by cutting the face of the hill. A permanent scar is likely to be left, once quarrying activities are over. Over time, the rock from the exposed face of the quarry under the action of wind and other erosion forces gets slowly weathered and after some time, they become a potential source of landslide. Therefore, it is necessary to implement appropriate slope stabilization measures to prevent the possibility of soil erosion and landslides in the quarry sites. The mitigation measures have been accordingly suggested in Chapter 10.

f) Impacts on Forests and Forest Land

About 211.84 ha of forest land will be diverted for the construction of the project components. This shall lead to the loss of some of the plant species used for various economic purposes. This impact is partially mitigated by the implementation of the Compensatory Afforestation Plan as well as the Biodiversity and Wildlife Conservation & Management Plan.

The mitigation measures of impacts on the land environment have been accordingly suggested in Chapter 10.

4.1.5 Flora and Fauna

4.1.5.1 Construction Phase

a) <u>Impact on Terrestrial Flora</u>

The direct impact of construction activity is generally limited in the vicinity of the construction sites only. As mentioned earlier, a large population of 2500 including technical staff, workers, and other groups of people are likely to congregate in the area during the peak project construction phase. It can be assumed that the technical staff will be of higher economic status and will live in a more urbanized habitat, and will not use wood as fuel if adequate alternate sources of fuel are provided. However, workers and other population groups residing in the area may use fuelwood, if no alternate fuel is provided. Hence, to minimize such impacts, it is proposed to provide alternate fuel for cooking e.g. LPG/kerosene to the construction workers. The other alternative is to provide community kitchens on a cooperative basis by the contractor. The details of the same have been covered in Environmental Management Plan.

Other major impacts on the flora in and around the project area would be an increased level of human interference. The workers may also cut trees to meet their requirements for the construction of houses, furniture, and space heating. Normally in such situations, a lot of indiscriminate use or wastage of wood is also observed, especially in remote or inaccessible areas. Thus, it is necessary to provide training and awareness; and implement adequate surveillance to mitigate the adverse impacts on terrestrial flora during the project construction phase.

b) <u>Impact on Terrestrial Fauna</u>

i) Disturbance to Wildlife

During the construction period, a large number of machinery and construction workers shall be mobilized, which may create disturbance to the wildlife population in the vicinity of the project area. The operation of various equipment will generate significant noise; noise and vibration will also increase during blasting which will affect the fauna of the area. The noise may scare the fauna and force them to migrate to other areas. Likewise, siting of construction plants, workshops, stores, labour camps, etc. could also lead to adverse impacts on the fauna of the area. During the construction phase, accessibility to the area will lead to an influx of workers and the people associated with the allied activities from outside will also increase. An increase in human interference will have an impact on the terrestrial ecosystem.

The impact of blasting needs to be mitigated by adopting controlled blasting and a strict surveillance regime and the same is proposed to be used in the project. This will reduce the noise level and vibrations due to blasting to a great extent.

Forest cover in the vicinity of the proposed project work sites and their immediate vicinity is comprised of coniferous forest associated with broad-leaved forest. Twelve species of mammals and 34 species of avifauna have been compiled from the study area, as discussed in the Environmental Baseline chapter. Therefore, adequate measures will be required during the construction phase not to cause any adverse impact on the terrestrial and avifaunal population.

4.1.5.2 Operation Phase Impacts

On completion of the construction of the project, the land used for construction activities will be restored. Construction workers who have resided in that area will move to another project site. By ensuring all the mitigation and management measures, as planned for this project, are implemented to minimize the impact of the construction phase, a large part of the area will go back to its original form. Operation phase impacts on flora and fauna will be positive due to green belt development, restoration of construction areas, restoration of the muck disposal area. The increase of greenery and increased moisture due to the creation of the reservoir will have a positive impact on avifauna.

Though Snow trout (*Schizothorax richardsoni*) was introduced by the State Fisheries Department, the department has not observed the presence of any fish in the river, and even during the field survey, no fishes could be observed. No spawning grounds also were observed in the river in the project area, therefore the impact of the project on fish migration is not envisaged.

4.1.6 Impacts on Socio-economic Environment

A project of this magnitude is likely to entail both positive as well as negative impacts on the socio-cultural fabric of the area.

a) Positive Impacts on Socio-Economic Environment

The following positive impacts are anticipated on the socio-economic environment of the local people of villages of project area during the project construction and operation phases:

i) Several marginal activities and jobs would be available to the locals during the construction phase.
ii) Developers bringing large-scale investment to the area will also invest in local area development and benefit will be reaped by locals. Education, medical, transportation, road network, and other infrastructure will improve.
iii) The availability of alternative resources provided by developers in the rural areas will reduce the dependence of the locals on natural resources such as a forest.

b) Negative Impacts on Socio-Economic Environment

Such projects, in addition, to the positive impact on the socio-economic environment, may also bring certain negative impacts due to the influx of outside population. The workforce will reside in that area for around 98 months and there will be an influx of drivers and other workers temporarily. This influx of people in an otherwise isolated area may lead to various social and cultural conflicts during the construction stage. Developers need to take the help of local leaders, Panchayat, and NGOs to ensure minimum impact on this count.

Increased incidence of Diseases

Large scale activity in the area due to the proposed project may become a cause of the spread of different types of diseases in the project area due to the following reasons:

- The project requires long-term input of labour from outside the area.
- The project requires that significant numbers of project employees be separated from their families for long periods.
- The project involves the creation of large, temporary construction camp(s).
- Increases mobility of people in and out of the area (job seekers, formal and informal service providers).
- Requires participation/resettlement of the local population.

4.2 MEASURES FOR MINIMIZING/OFFSETTING ADVERSE IMPACTS

Pollution generation mainly during the construction phase will be in the form of air, water, and noise pollution, which will be mitigated by adopting various mitigation measures during construction activities as discussed in a later section under the head, "Mitigation Measures".

Impacts of projects such as muck generation, worker's health, and safety, waste generation from labour colonies, impact on workers' health, the impact of tree cutting for fuel, impact on the physical environment due to material handling and operation of construction machinery, etc. will be minimized by implementing various management plans. Environmental Management Plans Viz. Catchment Area Treatment Plan, Compensatory Afforestation Plan, Muck Management Plan, Landscaping & Restoration Plan, Fisheires Management Plan, Sanitation and Solid Waste Management Plan, Green Belt Development Plan, Dam Break Modeling & Disaster Management Plan, Public Health Delivery Plan, Energy Conservation Measures and Biodiversity and Wildlife Conservation & Management Plan have been prepared to address these specific impacts to minimize adverse impacts. Detailed Management Plans are discussed in Chapter 10.

4.3 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF ENVIRONMENTAL COMPONENTS

The Dugar HEP is envisaged as a run-of-river scheme with a 500 MW installed capacity located near Luj village for utilizing the flows of Chenab River to harness the head created by constructing a 128 m high dam (from the deepest foundation) with a top length of 210.65 m; and Full Reservoir Level (FRL) and Minimum Draw Down Level (MDDL) levels at 2114.0 m and 2102.35 m., respectively. An underground powerhouse consisting of the main plant of 412MW (4 units of 103 MW) and auxiliary plant of 88 MW (2 units of 44 MW).

Irreversible environment components or resources are those, whose use limits the future use options and Irretrievable components are those whose use eliminates the future use options. Typically, in the context of infrastructure projects, Irreversible and Irretrievable commitments of environmental components are due to the use of non-renewable resources in project construction and operation.

During the construction stage of the project, raw materials will be consumed as resources, which are in abundant supply. No impact is identified on any of the flora or fauna species that will make them extinct by the project. Land required for the project will undergo a permanent change of land use. Forest land will be compensated by compensatory afforestation and private land will be compensated as per the law. No displacement of the population is involved. During the project operation, water will be the main raw material for power generation. It is a non-consumptive use of water. Only evaporation losses will be added on annual basis. Therefore, the project does not have any significant irreversible and irretrievable impacts on environmental components.

4.4 ASSESSMENT OF SIGNIFICANCE OF IMPACTS

Impacts, as discussed above, along with the mitigation measures have been summarized in the form of a matrix and subjected to categorization in the form of magnitude, significance, and duration of impact. Categorization is largely judgment-based as assessed by experts who were involved in carrying out the study. The impact assessment matrix is given in **Table 4.5**.

Table 4.5: Impact Assessment Matrix

S. No.	Environmental attribute	Potential impacts	Nature of impact	Phase	Magnitude of impacts			Significance		Long Term/Short Term	
					Low	Medium	High	Significant	Insignificant	Permanent	Temporary
A.	**Physical Resources**										
1.	Land use and Topography	Change in the surface features and present aesthetics due to the construction of the project Muck disposal	Direct/Local/ irreversible	Before construction phase		X		X		X	
B.	**Environmental Resources**										
1.	Air Quality	The project will have an impact on air quality during the construction period due to an increase in dust emission, fuel combustion in various equipment, crushers, and other construction plants & Emissions from material handling and transportation	Direct/Local/ reversible	During construction activity		X		X			X
2.	Noise	Noise due to general construction activities and equipment,	Direct/Local/ reversible	During construction activity		X		X			X

S. No.	Environmental attribute	Potential impacts	Nature of impact	Phase	Magnitude of impacts			Significance		Long Term/Short Term	
					Low	**Medium**	**High**	Significant	Insignificant	Permanent	Temporary
		increased vehicular traffic, blasting, etc.									
3.	Surface and Ground Water quality	Waste from construction labor camps, effluent from construction plants and workshops Runoff from the construction site and its disposal	Direct/Local/ reversible	During construction activity		X		X			X
		Domestic wastewater from construction sites	Direct/Local/ reversible	During construction and operation	X				X		X
4.	Soils	Soil erosion due to excavation, muck generation, construction activities, and clearing of vegetation and access roads. Muck disposal	Direct/Local/ reversible	During and after the construction activity			X	X		X	
C.	**Ecological Resources**										

S. No.	Environmental attribute	Potential impacts	Nature of impact	Phase	Magnitude of impacts			Significance		Long Term/Short Term	
					Low	**Medium**	**High**	Significant	Insignificant	Permanent	Temporary
1.	Terrestrial Flora	Loss of vegetation	Direct/Local/ irreversible	Before and during the construction phase			X	X		X	
2.	Terrestrial Fauna	Disturbance to the local fauna during construction	Direct/Local/ reversible	Before, and during the construction phase	X				X		X
3.	Aquatic Ecology	Disturbance to the aquatic fauna after construction	Direct/Local/ reversible	During construction	X				X		X
D.	**Human Environment**										
1.	Health and Safety	Increased incidence of Diseases Fires, explosions, and other accidents at construction sites	Direct/Local/ Continuous	During and after the construction phase.	X			X			x
2.	Agriculture	Impact envisaged as there is private land involved	Direct/Local/ reversible	Before the construction		X		X		X	

S. No.	**Environmental attribute**	**Potential impacts**	**Nature of impact**	**Phase**	**Magnitude of impacts**			**Significance**		**Long Term/Short Term**	
					Low	**Medium**	**High**	Significant	Insignificant	Permanent	Temporary
3.	Socio-economics	Positive and negative impacts on socio-economic environment, Job opportunities during the construction phase.	Direct/ regional/ Continuous	During operational phase		X		X			
4.	Private land acquisition	Impact envisaged as there is private land with no displacement	Direct/Local/ reversible	Before the construction		X		X			X
5.	Historical and archaeological sites	No archaeological, historical, or culturally important sites are affected by the construction.	Direct/Local/ reversible		X				X		X
6.	Traffic and Transportation	Traffic congestion due to movement of construction vehicles	Direct/Local/ reversible	During construction phase		X		X			X
7.	Solid Waste Generation	Probability of Surface and groundwater pollution	Indirect/Local/ reversible	During the construction and operation phase	X				X		X

4.5 MITIGATION MEASURES

Mitigation of construction-related impacts would be the responsibility of the project proponent (through its contractors). Air and water are two major environmental factors that are directly affected by any kind of construction activity. Transportation of material, storage, and handling of material and construction operations lead to air and noise pollution. During the construction period generation and release of effluents from the construction site, workshops, sewage disposal from labour camp, blasting and other land clearing activities, washing of oil, grease, and other chemicals from diesel generator sets, vehicles, and other machinery, etc. cause water pollution and affect the quality of surface as well groundwater.

The major air pollutants, which could be generally, released during various construction activities and vehicular movements are Particulate Matter (PM), SOx, and NO_X. In addition to these construction activities also generate noise due to the use of heavy machinery, heavy vehicles, blasting, etc. which has serious impacts on humans as well as the wildlife of the area.

4.5.1 Air Pollution

The various sources causing air pollution during the construction phase are as follows.

- **Particulate Matter (PM):** Various activities such as blasting, crushing, transportation of material in open trucks, open dumping in muck disposal sites, vehicle movements, operation of Diesel Generator Sets, etc.

- **Oxides of Sulphur (SOx):** SOx is released into the air from vehicular exhaust, Diesel Generator Sets, coal-burning *chullahs,* etc.

- **Oxides of Nitrogen (NO_x):** Motor vehicles and fuel-burning are generally responsible for the release of oxides of nitrogen into the ambient air.

4.5.2 Impacts of Air Pollution

The various impacts of air pollution associated with PM, $SO_{x,}$ and NO_x are as under:

- **Impacts of PM:** High quantities of PM in the ambient air can cause emphysema, bronchial asthma, and eye irritation which in some cases can also result in cancer. PM containing lead particles (emitted from automobiles) is considered responsible for anemia as it affects hemoglobin formation. Lead is also a proven carcinogen. Dust coating on the leaves of plants reduces photosynthesis and reduces plant growth.

- **Impacts of SOx:** The oxides of Sulphur irritate mucous membranes of the respiratory tract. Higher concentrations may cause bronchitis. Plants are particularly sensitive to high concentrations of SO_2 and suffer from chlorosis, metabolic inhibition, plasmolysis, and even death.

- **Impacts of NO_x:** Oxides of nitrogen can combine with hemoglobin to reduce the oxygen-carrying capacity of the blood. This can irritate the alveoli of the lungs and high concentrations may even cause acute bronchitis.

4.5.2.1 Control of Air Pollution

For the control of air pollution during the construction phase of the project, it is suggested that it should be made mandatory for the contractor/s engaged in the construction works to ensure the following conditions:

- The crushers should be provided with air pollution control devices as per the rules laid down by the pollution control board, to minimize the release of PM into the atmosphere.
- The chimneys of the Diesel Generator Sets should be kept at appreciable height (as per the CPCB guidelines). The DG sets should be properly maintained and with valid certificates of Type Approval and valid certificates of Conformity of Production.
- Regular water sprays at the crushing sites, dumping sites as well as on roads should be ensured. A necessary clause shall be incorporated in the contractor's agreement.
- Masks should be provided to the workers and staff.
- Proper ventilation facilities shall be provided inside the tunnel and at all the residential complexes of the staff and labour.
- Ambient Air quality shall be monitored seasonally during the construction phase at different locations with the help of a NABL accredited lab.
- Controlled blasting during construction activities will be ensured.

4.5.3 Noise Pollution

Various sources of noise pollution in the project area during the construction phase include vehicular movement, operation of heavy machinery, blasting, crushing, aggregate processing plants, diesel generator sets, etc.

4.5.4 Impacts of Noise Pollution

Noise is generally harmful and is a serious health hazard. It has far-reaching consequences and has many physical, physiological as well as psychological effects on human beings and animals. Continuous noise exposure may result in temporary or permanent shifting of the hearing threshold depending upon the level and duration of exposure. The immediate and acute effect of noise causes impairment of hearing (total deafness). The major impacts of noise pollution are given as under:

- It causes headache and increased heartbeat
- It causes anxiety, eyestrain, memory loss, and muscular strain
- It also causes fatigue, loss of sleep, and emotional disturbance
- In the case of wild animals, noise pollution has been observed to interfere with their breeding efficiencies

4.5.5 Control of Noise Pollution

Since continuous noise exposure is detrimental to health, it is essential to control noise pollution. Various measures for control of noise pollution in the project area are suggested below:

- Diesel Generator sets should have acoustic enclosures to reduce the noise as per the CPCB guidelines.

- Ear protection aids such as earplugs, earmuffs, must be provided to the workers who must continuously work in the high noise area.
- Proper and regular maintenance/lubrication of machines should be done.
- Noise-producing stationary machines (such as crushers, aggregate processing plants, etc.) should be provided with sound barriers, if close to habitation.
- Quieter machines and vehicles with high-quality silencers should be used.
- Afforestation around the residential colonies and office complexes should be done as proposed under the Green Belt Development Plan.
- Ambient noise should be monitored periodically at different locations as outlined in Environment Monitoring Program.

4.5.6 Water Pollution

Various sources of water pollution in the project area during the construction phase include disposal of effluents with high turbidity from crushers commissioned at various sites, sewage disposal from the labour camp, blasting and other land clearing activities, washing of oil, grease, and other chemicals from diesel generator sets, vehicles, and other machinery, etc.

4.5.7 Impacts of water pollution

Water pollution is harmful and is a serious health hazard. It has far-reaching consequences and effects on human beings and animals also. The effect can be felt not only in the surface water bodies but also in the groundwater source in the area. The effect may be of temporary or permanent nature. The major impacts of water pollution are given as under:

- The construction of civil and allied structures could lead to stockpiling and excavation activity on-site, thereby exposing the base soil to erosion. The runoff from this site and muck disposal sites may contain a high quantity of Suspended Solids which shall add to the inorganic load of water bodies and drainages in the area. However, the impact of runoff may not be very significant except during the rainy season.
- During the construction phase, wastewater, sewage, etc. shall be generated from the labour camp and workshops. If disposed of untreated, this would substantially deteriorate the surface and groundwater quality in the area.
- The oil and grease released from the project-related activities may also change the physico-chemical characteristics of water.

4.5.8 Control of water pollution

To avoid deterioration of water quality of the receiving water body following measures are suggested.

- During the Construction phase provision of portal STP/septic tank/ soak pit etc. of adequate capacity for labour camp so that it can function properly for the entire duration of the construction phase.
- Construction of settling tank to settle the suspended impurities from various sources i.e., Hot Mix Plant (HMP)/ crushers, labour camps, etc. before discharging into the main river channel.
- During Operation, commissioning of suitable treatment facilities to treat the sewage generated from the colony shall be done.

- Provision of sedimentation cum grease traps at the outer mouth of drains located near the workshops, fuel filling stations, diesel generator rooms, etc. to prevent the entry of contaminants to the water bodies.
- Oil interceptors shall be provided for refueling areas, vehicle parking, washing areas, etc. All spills and collected petroleum products will be disposed of following SPCB guidelines.

A lump-sum budget of **Rs. 50.00 lakh** has been proposed for the mitigation measures for control of air, noise, and water pollution during the project construction phase.

Chapter 5 ANALYSIS OF ALTERNATIVES

5.1 INTRODUCTION

During alternative study for the location of Dugar HEP, four different dam sites have been taken into consideration. Dam axis have been selected within the concession limits of Dugar HEP defined in between FRL as EL 2105.0m and normal tail water level as EL 2006.0m.

5.2 ALTERNATIVE STUDIES

The site of Alternative-I is located at km 5+510 (starting from the upstream concession limit). Alternative-II is situated approximately 1.06 km downstream of the bridge (Shukrali Bridge) of the Sach-Pass road at km 8+240 while Alternative-III is positioned at km 10+309. Alternative-IV is located after the 90° bend of the river at km 11+010. The locations of the alternatives studied are shown in **Figure 5.1**.

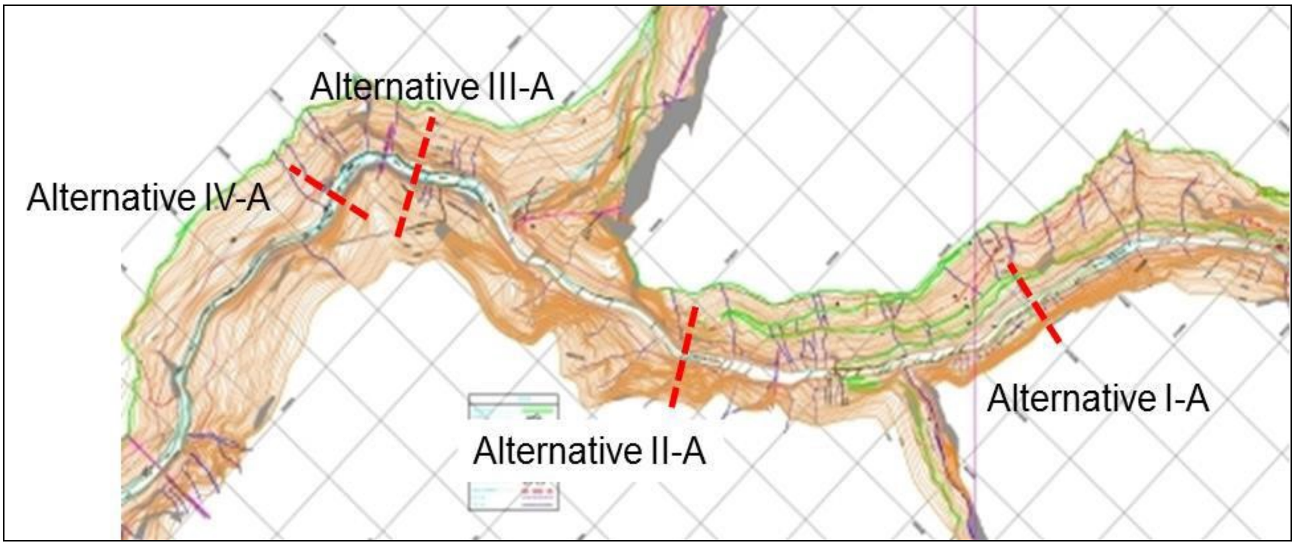


Figure 5.1: Alternative dam axis

Water conductor system is planned at left bank of Chenab River. An underground power house is planned just downstream of Alternative-III dam axis. The layout of the surge shaft, pressure shaft and pressure tunnel, the powerhouse including transformer cavern and tailrace tunnels has been kept the same for all three alternatives. Alternative-I is not considered for the further study as the total storage capacity of Alternative-I is only 5.884hm3 whereas as per IWT the required live storage is evaluated as about 15hm3. Based on the techno-economical evaluation it was found that Alternative-III is the most attractive solution. Alternative-III is further optimized for the dam height varying in between FRL from EL 2105.0m to EL 2114.0m. Keeping the gross head same (99.0m). It is concluded that most attractive solution is the dam at Alternative-III axis with increase in height by 9.0m i.e. FRL as EL 2114.0m. DHPL requested Directorate of Energy - Government of Himachal Pradesh for the change of concession limits of Dugar HEP from FRL as EL 2105.0m and normal TWL as EL 2006.0m to FRL as EL 2114.0m and normal TWL as EL 2015.0m. Keeping the gross head same as 99.0m and without affecting the upstream and downstream projects. Directorate of Energy - Government of Himachal Pradesh has given the approval for the above stated changes in the concession limits of Dugar HEP.

Considering the various alternative studies carried out by M/s DHPL and subsequent clearances provided by CWC/CEA on the layout as mentioned above, NHPC has adopted Alternative–IIIA of DHPL for updating DPR. No change in the layout of various components of civil structures is contemplated in the updated DPR, however there are minor changes in the size of the water conductor system due to change in the installed capacity (412 MW against 380 MW for main power plant and 88 MW against 69MW for auxiliary power plant as proposed by M/s DHPL) and design discharge of the main and auxiliary power plant. Accordingly, the normal tail water level of main and auxiliary power plant has been changed from 2015 m to 2015.34 m and 2017.88 m to 2018.10 m respectively.

Based on various considerations, Alternative-2 (Alternative –IIIA of DHPL) location has been chosen for the further studies and optimization of project components. For diversion structure, different dam options such as double curvature arch dam, arch gravity dam and conventional gravity dam options were studied. Taking due account of outcome of geological investigations, discontinuity interface, seismic coefficient and estimated rock mechanics parameters, conventional gravity dam and appurtenant has been proposed for detailed project report. HCD Directorate, CWC vide letter No: 7/19/2014-HCD (N&W) Dated: 20.11.2020 has issued the clearance on General Layout of the project.

The capacity of Dugar HEP is enhanced from 449 MW to 500MW. The main components of the project are:

- A 128 m high concrete gravity dam (from the deepest foundation level) located on River Chenab at Latitude 33^0 07’ 05” N and longitude 76^0 21’20.7” E.
- 2 nos. main intakes and 1 no. intake for auxiliary units located at the left bank.
- 2 nos. pressure tunnels/shafts for main units and 1 no. pressure tunnel/shaft for auxiliary units.
- Underground power house cavern housing 4 no. main units of 103 MW each and 2 nos. unit of 44.0 MW for auxiliary plant.
- Transformer cavern located u/s of power house cavern.
- 1 no. main TRT having tailrace surge chamber located downstream of power house cavern and 1 no. TRT for auxiliary units discharging just downstream of dam.
- To facilitate the construction and operation of the project components, suitable adits and access roads have been proposed.

Chapter 6 ENVIRONMENTAL MONITORING PROGRAM

6.1 TECHNICAL ASPECTS OF MONITORING THE EFFECTIVENESS OF MITIGATION MEASURES

Environmental monitoring provides feedback about the actual environmental impacts of a project. Monitoring results help judge the success of mitigation measures in protecting the environment. They are also used to ensure compliance with environmental standards and to facilitate any needed project design or operational changes.

Monitoring shall be performed during all stages of the project (namely: construction and operation) to ensure that the impacts are not greater than predicted, and to verify the impact predictions. The monitoring program will indicate where changes to procedures or operations are required, in order to reduce impacts on the environment or local population. The monitoring program for the proposed project will be undertaken to meet the following objectives:

- To monitor the environmental conditions of the project area and nearby villages;
- To check on whether mitigation and benefit enhancement measures have actually been adopted and are proving effective in practice;

To improve the future planning and execution of mitigation measures, it is necessary to provide information on the actual nature and extent of impacts due to construction of project and the effectiveness of proposed mitigation measures, implemented during and after construction period.

6.1.1 Water Quality

The water quality (surface and ground) monitoring should be carried out in seasonal intervals three times a year – Pre-monsoon (April), monsoon (July), and Lean (November). Five sampling locations for surface water–upstream of U/s Coffer dam; downstream of U/s Coffer dam; Luj nala near proposed rock quarry site; Dheda Nala confluence with Chenab River near, and at Mahal Nala near Killar town along SH26.

At each location water quality samples will be collected and analysed three times a year for entire duration of construction phase till commissioning of project. Therefore, budget has been prepared for 10 years monitoring period. After commissioning locations of monitoring and parameters will be altered, keeping in view the Consent compliances.

Parameters to be monitored for water quality - both surface water and ground water are

(i) Physical parameters (pH, temperature, electrical conductivity, TSS);
(ii) Chemical parameters (Alkalinity, Hardness, BOD, COD, NO_2, PO_4, Cl, SO_4, Na, K, Ca, Mg, Silica, Oil & Grease, phenolic compounds, residual sodium carbonate);
(iii) Bacteriological parameter (MPN, Total coliform) and
(iv) Heavy Metals (Pb, As, Hg, Cd, Cr-6, total Cr, Cu, Zn, Fe)

6.1.2 Air Quality

The ambient air quality monitoring will be carried out for the following three seasons;

- Winter (November/ March)
- Pre – monsoon (May)
- Post – monsoon (September-October)

The frequency of monitoring shall be twice a week for four consecutive weeks at each station for each season.

The parameters to be monitored are PM_{10}, $PM_{2.5}$, Sulphurdioxide (SO_2) and Nitrogen Oxides (NOx).

Every year, ambient air quality is to be monitored at three locations; two in upwind of dam construction site and one in the downwind direction at receptor locations.

Air quality will be monitored for entire duration of construction phase till commissioning of project. Budget has been prepared for 10 years monitoring period. After commissioning locations of monitoring will be altered, keeping in view the EC and Consent compliances.

6.1.3 NOISE

Sound levels will be recorded with the help of handheld sound level meter near major construction areas generating noise. First location will be close to source or area where equipment/operations are making noise and subsequent 5-6 locations will be covered by moving away from source towards habitation. Readings will be recorded with distance from source. Such monitoring exercises should be undertaken once every 3 months for entire duration of construction phase up to commissioning of project.

6.1.4 EMP Implementation Monitoring

Environment Management Plans and mitigation measures have been planned and suggested as part of EIA report for entire construction and also for operation phase with a view to minimize and eliminate the impacts. As is indicated by the impact assessment matrix, rating of all the impacts have reduced by implementing these measures. Therefore, a thorough monitoring is required to ensure that all the plans and measures suggested are implemented and their performances remain effective throughout the period of implementation. Following measures/plans will be monitored:

1) Biodiversity and Wildlife Conservation and Management Plan – All the activities suggested under the plan will be initiated with the help of forest and wildlife department and implemented. Records will be created for implementation with photographic evidence at least every six months.
2) Fisheries Conservation and Management Plan – A schedule of implementation will be prepared with the fisheries department for in situ conservation of fish species and work progress monitored with evidence of progress every 6 months.
3) R&R Plan –A monitoring mechanism has been proposed under R&R Plan and same shall be implemented to ensure the fair and transparent process of land acquisition following provisions of Himachal Pradesh Right to Fair Compensation and Transparency

in Land Acquisition, Rehabilitation and Resettlement (Compensation, Rehabilitation and Resettlement and Development Plan) Rules, 2016.

4) Green Belt Development – Green belt development has been proposed along the roads and colonies and same shall be implemented as soon as the areas are ready. Six months monitoring will be carried out for green belt development with evidence by recording the area covered, saplings, planted, survival rate, etc.
5) Reservoir Rim Treatment – to be monitored as planned and progress recorded on six monthly intervals till completion
6) Muck Disposal Plan – Muck disposal monitoring will cover the following aspects:
    a) Adequacy of retaining structures and access to sites
    b) Record of quantity of muck generated, reused and dumped
    c) Air pollution aspect at muck generation, temporary storage and transportation location.
    d) Air pollution aspect at muck dumping sites and need for control measures
    e) Closure of site and progress monitoring of restoration measures. Six monthly reports will be generated covering above aspects with evidence.
7) Restoration Plan for Quarry Areas.
8) Data Interpretation and Analysis for Water, Air and Noise monitoring and take appropriate corrective and preventive action if mitigation measures are not effective
9) Checking the Efficacy of Public Health Delivery System and take appropriate measures to fill the gap should be done every 2 months for first six months and thereafter every six month.
10) Monitoring of health and safety aspect of construction labour requires development of work instructions, training and awareness of labour, ensuring use of PPEs, preparation and implementation of emergency management plan including mock trials, etc. A officer with expertise in safety and emergency need to be engaged for this work either on contract or one full time trained person to monitor, control and implement all the safety measures.
11) Sanitation and Solid Waste Management Plan – Plan implementation including providing infrastructure, training and ensuring that instructions of waste segregation, transportation and disposal are implemented will be done on monthly basis for first six months and there after every six months.
12) Energy conservation measures – As planned these measures are implemented and monitored for effectiveness every six months.
13) Local Area Development Fund (LADF) – In line with the Government of Himachal Pradesh notification dated 05/10/2011, Revised Guidelines for Management of Local Area Development Fund, 1.5% of total project cost as per DPR will be contributed to LADF. Local Area Development Committee will be constituted as per the notification including representative of NHPC for Local Area Development Activities implementation and progress monitoring.

Environmental parameters monitoring will be carried out by an NABL accredited laboratory contracted by NHPC Ltd. Environment Management Cell of NHPC Ltd., specially created for Dugar HEP will undertake the responsibility of EMP implementation monitoring EMC will be responsible for filing six monthly monitoring report post environment clearance as per clause 10 of EIA Notification of September 2006.

6.1.5 Financial Requirement

Remuneration and other benefits to NHPC team working in EMC will not be booked under project expense and therefore not budgeted here.

A sum of **Rs. 111.50 lakh** have been allocated to implement various activities and programmes envisaged under EMP, the details are given in **Table 6.1**.

Table 6.1: Cost Estimates for Environmental Monitoring Program

S. No.	Activities	Units (samples x season x year)	Price per unit (Rs)	Cost (Rs. lakh)
1	Water quality - surface water	5x3x10	5000.00	7.50
2	Air quality	32x3x10	10000.00	96.00
3	Noise	Lumpsum for 10 years		3.00
4	Monitoring & Evaluation Documentation & Reporting- Six monthly reporting	For 10 years	0.50	5.00
	TOTAL (1-4)			**111.50**

Chapter 7 ADDITIONAL STUDIES

As per the scope of work issued by MoEF&CC, and Generic Structure of EIA Document as per Appendix III of EIA Notification, following are covered under the Additional Studies:

7.1 REHABILITATION AND RESETTLEMENT PLAN (R&R)

Rehabilitation and Resettlement Plan (R&R Plan) is proposed for the purpose of EIA Study only. For acquisition of private land, a separate process has been initiated under the provisions of Himachal Pradesh Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (Compensation, Rehabilitation and Resettlement and Development Plan) Rules, 2016.

7.2 LOCAL AREA DEVELOPMENT ACTIITIES (LADP)

It deals with the provisions being made by project proponent to benefit the local population. This plan will help improve quality of life of local population in project surrounding areas. The budget under Local Area Development Fund has been allocated following guidelines of Govt. of Himachal Ppradesh notification MPP-F(10)-24/2011 dated 5 October 2011. The budget proposed will form part of environment management plan.

7.3 PUBLIC CONSULTATION

The draft final EIA/EMP report will be submitted to Himachal Pradesh State Pollution Control Board, to initiate Public Consultation process. On completion of process and submission of minutes/report of Public Consultation process, this section will be added.

Chapter 7.1 REHABILITATION AND RESETTLEMENT

7.1.1 INTRODUCTION

The proposed Dugar HEP is located on the Chenab River in Pangi Sub- Division of Chamba District. The land requirement of Dugar HEP has been meticulously planned to minimize impact on the private land owners. Therefore, only 8.78 ha of private land would be required for the project construction without involving any displacement of families. 121 landowners have been identified as owner of the land required for the project and the process of land acquisition will be as per Himachal Pradesh Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (Compensation, Rehabilitation and Resettlement and Development Plan) Rules, 2016.

7.1.2 LAND REQUIREMENT

For the development of Dugar HEP, land would be acquired for construction of project components and submergence area. Based on the final project layout, the total land requirement for the project is **220.62 ha**, out of which **8.71 ha** is private land, **0.07 ha** community land and remaining **211.84 ha** is forest land (**Table 7.1**).

Table 7.1: Land Requirement for Dugar HEP

S. No	Component	Forest Land (ha)	Non-Forest Land (ha)	Total (ha)
1	Submergence including river area	160.45	0	160.45
2	Dam	5.83	0	5.83
3	Approach Roads	8.168	0	8.168
4	Quarry area	8.625	0	8.625
5	Borrow Areas	3.88	0	3.88
6	Muck Dumping area	8.5797	0	8.5797
7	Job facility area	7.08	0	7.08
8	Construction Facility Area	0	6.62	6.62
9	Owner's Colony	0	1.98	1.98
10	Owner's Office	0	0.18	0.18
11	Powerhouse	3.64	0	3.64
12	HRT	0.40	0	0.4
13	TRT	1.81	0	1.81
14	TRT Outfall	0.74	0	0.74
15	Diversion tunnel	1.84	0	1.84
16	MAT	0.80	0	0.80
	Total	**211.8427**	**8.78**	**220.6227**

7.1.3 PROJECT AFFECTED FAMILIES

The private land identified for the project falls in only in one village namely Luj, which falls under Pangi Sub-division of Chamba District. The private land identified for projects belongs to 121 landowners.

All the 121 families will only be losing part of their agricultural land holding and none of the families will be losing any houses i.e. there will not be any resettlement. List of identified landowners is given at **Annexure-**V.

7.1.4 APPLICABILITY OF REHABILITATION AND RESETTLEMENT RULES

With reference to the private land purchase through private negotiations and the application of the provisions relating to rehabilitation and resettlement for the Project as per the **Section 2 (3) (a)** of The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act (RFCTLARR), 2013, following provisions shall apply in case:

(a) ***a private company purchases land, equal to or more than such limits in rural areas or urban areas, as may be prescribed by the appropriate Government,*** *through private negotiations with the owner of the land in accordance with the provisions of section 46; (RFCTLARR 2013).*

With reference to the above section the relevant limits on extent of land under Section 2(3)(a) are prescribed by the Government of Himachal Pradesh under **Section 15** of The Himachal Pradesh Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (Compensation, Rehabilitation and Resettlement and Development Plan) Rules, 2016. As per the said rules:

15. Limits of extent of land under sub-section (3) of section 2—The limit of extent of land referred to in clause (a) of sub-section (3) of section 2 shall be twenty hectares in urban areas and forty hectares in rural areas.

In view of the above, it is noted that the total private land proposed to be purchased through private negotiations is about 8.78 ha. The proposed land falls in rural areas and nature of the land is non-irrigated agricultural land. As the total private land requirement (8.78 ha) does not exceed the above specified limits (40 ha for rural area) by the relevant rules notified under Himachal Pradesh Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (Compensation, Rehabilitation and Resettlement and Development Plan) Rules, 2016; private land shall be purchased by direct negotiation.

7.1.5 MONITORING AND EVALUATION GUIDELINES

Monitoring of the progress of R&R is important because of the sensitivity of these issues. The objective of monitoring is to assess the progress of resettlement activity, to identify difficulties, ascertain problem areas, and provide indication for the need of calling attention to some specific issues at an early stage. Following tasks have to be performed by the group at different stages of the project:

- Establish baseline information on individual PAFs and their pre-project standards of living, health conditions, nutritional patterns, etc. This should precede the implementation of R&R package in general after the completion of the project.

- The planning of the monitoring studies could cover disbursement of compensation and grants.

- After the completion of the project, a few sensitive indicators using 100% survey techniques should be undertaken mainly to understand how effective the R&R plan and project economic development package has been in reality.

7.1.5.1 Post-Project Monitoring

It is suggested that the monitoring be conducted by an independent agency not connected with the project. Therefore, an independent consultant having experience in R&R studies in similar areas, can be appointed for monitoring post project implication of R&R Plan implementation in the project area.

7.1.5.2 Participation of PAF's

Involvement of affected communities in planning and implementation of rehabilitation programmes according to their felt needs and socio-economic conditions is of vital importance. To obtain co-operation, participation and feedback, PAFs need to be systematically informed and consulted during preparation and implementation of R&R plan about their options and rights. In the proposed project, co-operation and participation of PAFs in this process could be ensured through their involvement in each of the following stages.

As a part of participatory planning, community meetings should be held on a routine basis to explain about the project and the benefits of the project. Direct communication with the PAFs will negate the politicization of the R&R Process. The communication with the PAFs can be through the Village Level Committee.

The Consultant/Expert Agency will review the rehabilitation and resettlement programme every year till the completion of the project. A total provision of **Rs. 100.00 lakh** has been kept in the cost estimate for this purpose.

7.1.6 R&R PLAN BUDGET

The cost of land to be paid to landowners will be finalized by District Collector after consultation with landowners. Cost of land has already been budgeted for in DPR. In addition, a budgetary provision of Rs. 1.00 crore has been kept towards monitoring and evaluation.

Chapter 7.2 LOCAL AREA DEVELOPMENT FUND

7.2.1 INTRODUCTION

Keeping in view the requirement of Local Area Development Fund, as per Govt. of Himachal pradesh notification MPP-F(10)-24/211 dated 5 October 2011, provision has been made to contribute 1.5% of the total project under Local Area Development Fund (LADF). The activities proposed under LADA will be refined after Public Consultation meeting, keeping in view the guidelines regarding Local Area Development Fund by state government and needs and requirement of local population. Activities to be implemented will be discussed with Government of District Administration and finalized by Local Area Development Committee (LADC).

7.2.2 FOCUS AREAS FOR LOCAL AREA DEVELOPMENT ACTIVITY

Based on the need assessment and local consultations in project affected villages the following focus areas covering many important components of the sustainable development such as social, economic, livelihoods and environment are identified and set of development activities proposed under each focus area for the benefit of the local people under the Project. The **Table 7.2** below presents the thrust area and the nature of activity proposed as part of the Local Area Development Plan.

Table 7.2: Focus Area and Nature of Local Area Development Activity

Focus Area	Nature of Activity
Education	• Need based infrastructure support for existing Schools • Support for basic amenities in existing Schools • Support for teaching and learning materials • Support for improving quality of education • Support for meritorious students
Health Care	• Support or general and specialized health camps • Support to existing health facility • Support through mobile health care services • Support for emergency health care services • Awareness on Health and Hygiene
Infrastructure Development	• Support for strengthening existing roads • Support for existing transportation services • Support for Drinking Water facilities • Support in garbage collection/disposal • Support for Street Lighting facilities • Support for Community Toilet facilities
Skill Development and Training	• Skill Training of local youth for Job skills • Support for Vocational Training in market trades • Support for capacity building of local Teachers
Common Interest Activity	• Support for Community Infrastructure • Promoting local culture and traditions • Support for protection of local art forms • Support for protection of local heritage

7.2.3 LADP BUDGET

Following the guidelines under the Local Area Development Fund notification of Govt. of Himachal Pradesh, the total budget allocated for implementing the various local area development acitivities has been kept as Rs. **51.00 crore**.

Chapter 8 PROJECT BENEFITS

8.1 INTRODUCTION

Hydropower is a clean renewal source of energy and relatively non-polluting and environment friendly. It provides valuable peaking power with the ability to start and stop quickly with instantaneous load acceptance/rejection making it suitable for meeting peaking power demand for enhancing system reliability and stability. The increasing energy demand of the country and requirement of peaking power can be met sustainably by having a fair share of hydropower in the grid. Hydropower projects provides additional benefits in terms of irrigation, drinking water supply, navigation, recreation, tourism, pisciculture, etc.

The northern region has been experiencing acute power shortage during the last decade due to rapid industrialization, developing irrigation network & urbanization. It is obviously not possible to meet rapidly growing power demands of industry and agriculture from the existing power stations. Electrical energy being the basic ingredient for economic upliftment through industrial and agricultural development, power shortage has slowed down the wheels of progress and put a curb on all development activities in the region. By commissioning of Dugar HEP the energy and peaking problems would be considerably improved in northern region.

It is an undoubted fact that Hydropower projects are the boon to the society. With the construction of hydroelectric project, there is a visible socio-economic development in the region. Medical / Health, education, communication and other infrastructure/civic amenities are strengthened. Such facilities of the project are extended to the locals, which directly benefits them. Work / self-employment opportunities for the locals are also generated due to emergence of markets and other commercial establishments in the area. Thus, social benefits accruing from theconstruction of a hydroelectric project in the area are manifold and lead to improvedquality of life of the local people in and around the project area/ surroundings.

8.2 BENEFITS OF DUGAR HEP (500 MW)

The proposed Dugar HEP (500 MW) of NHPC is located in Pangi Valley Sub-Division of Chamba district of Himachal Pradesh. Dugar HEP is likely to generate 1758.98 MUs in a 90% dependable year. The implementation of the proposed Dugar HEP, will contribute to meeting the power and energy demand in the Northern Region and will displace electricity that would otherwise have to be produced through the construction of fossil fuel based thermal powerplants. Power generation and supply will boost economy of the area further as myriad activities shall be taken up by the population of the area with the help of electricity.

The following positive impacts / benefits of Dugar HEP:

8.2.1 Meeting energy security and benefit to the State

Dugar HEP would benefit the State in catering to its energy demands and in providing economic advantage to the people and contribution to the national requirement of energy by tapping the immense hydroelectric potential of the State.

As per the Memorandum of Understanding (MoU), Government of Himachal Pradesh will get the Royalty Free Energy in the shape of free power @4% from 1st to 10th year, @8% from 11th to 25th year, 12% from 26th to 40th year & 25% beyond 40 years and 1% additional free Power for LADF of the deliverable energy, period starting from the date of Scheduled Commercial Operation Date / Synchronization of the first generation unit, whichever is earlier.

NHPC Limited shall be liable to deposit an equivalent amount of 100 units of electricity, per month for a period of 10 years, as per applicable subsidized tariff determined by Himachal Pradesh Electricity Regulatory Commission (HPERC) from time to time, with respective Local Area Development Committees (LADCs) of the districts and the balance amount equivalent to the quantum of subsidy with the State Government.

NHPC Limited shall contribute 1.5 % of the cost of the project towards pre-commissioning Local Area Development Fund (LADF). In addition to this, NHPC shall also run Community Development Schemes and Corporate Social Responsibility programs for the villages within / around the Project site, entwined to cater to local area development including capacity / skill development of affected population, as per the objectives and policies.

8.2.2 Increasing the Green Cover of the Region

In Dugar HEP, Catchment Area Treatment Plan has been engrafted as one of the components in the afforestation scheme to be implemented from the beginning of the construction stage, to ensure that the proposed plantation will make up for the loss of trees from the reservoir/project area. Besides, an elaborate Compensatory Afforestation scheme shall be implemented over the double degraded forest land diverted for the project. Massive plantation activities have also been proposed under Biodiversity Conservation & Management Plan, Geo-environmental management plan, landscaping and restoration of construction areas etc. This will restore the natural habitat of the region to a great extent and will help in establishing the environmental resiliency in the region.

8.2.3 Wildlife and Biodiversity Conservation

Dugar HEP does not involve any part of National Park or Wildlife Sanctuary. However, notwithstanding the fact, mitigation measures have been proposed in the Biodiversity Conservation and Management Plan for the protection of the flora and fauna. For conservation of floral species, Afforestation & Enrichment plantation and Farm Forestry for its conservation shall be established for conservation and propagation of floral species. A herbal nursery for protection of herbal drugs and medicinal plants is also proposed. Similarly, conservation of avi-fauna, installation of nest boxes in the influence zone andthe catchment area of the project had been proposed in the Biodiversity Conservation and Management Plan. For conservation of faunal species, especially Schedule – I Species i.e. Leopard (Panthera pardus), habitat improvement, biological fences, prevention of Forest fire, Veterinary care and awareness programme has been proposed. In addition to this, improved vigilance for anti-poaching, better protection, construction of control- grazing-cum-anti poaching check posts has also been proposed.

8.2.4 Enriching fish habitat and maintaining river ecology

For conservation and management of fishery in reservoir area (1.065 sq. km.) of Dugar HEP, it is proposed to explore the possibility of reservoir fisheries, for this a detailed study will be carried out by State Fisheries Department along with Directorate of Coldwater Fisheries Research, Bhimtal. Based on the outcome of the study, the introduction and management of reservoir fisheries will be carry out under supervision of State Fisheries Department. This opportunity for fishery development, help in the increasing employment potential.

For maintaining the river ecology, sufficient environmental flows shall be maintained during the lean season and non-lean non-monsoon season, two units of 44 MW each are also housed in the powerhouse main cavern.

8.2.5 Benefits to farmers

Dugar HEP shall be beneficial to farmers. Implementation of Catchment Area Treatment shall reduce soil erosion, maintain soil moisture, increase sub-surface water and fertility of fields.

8.2.6 Hydropower: A climate resilient power

Hydropower, being a renewable energy, is the main factor in the global energytransition towards mitigating anthropogenic climate change. Conventional hydroelectric power is a potentially important alternative to coal-based powerstations in the country in terms of avoided carbon emissions. In Dugar HEP, the massive afforestation activities undertaken in the project area will not only bring out visible green transition, but will also act as carbon sink and improve carbon sequestration in the region.

8.2.7 Geo-environmental Management of the area

Dugar HEP shall implement plan to protect and/or improve the reservoir zone and to provide stability to the reservoir. The plan envisages control of landslides with proper measures line rock anchoring, carving out of slopes, shot-creting, suitable engineering, bio-engineering and biological measures. These measures will not only stabilize the slope but will also check thepotential damage to land and life.

8.2.8 Socio-economic benefits for the Local people

Project is located in a very remote area. Apart from power generation benefits, such a large scale investment in the region will bring about several positive changes in the region and expected to improve the quality of life of local population. The construction of project will bring prosperity to the area. New opportunities of trade will open for the inhabitants of the area due to better connectivity. The project will help improve local infrastructure and generate direct and indirect employment and further growth opportunities for the local population.

New public services and infrastructure development, including schools, hospitals, roads, etc. come up in the area with the introduction of electricity to the rural areas, enabling better growth of the area.

Community and Social Development in and around the project area
A need-based Community and Social Development Plan (CSDP) shall also be implemented for overall socio-economic development of the project area. A budget of Rs. 51.0 crore has been proposed towards Local Area Development Plan, which will be used for the benefits of the locals. Villages in the surrounding of project area have been identified for improvement of local infrastructure such as education facilities, sanitation and healthcare facilities, solar power, etc.; In addition, budget will be utilized for skill development aimed at providing skill for self- employment and also for meeting other local needs as required by the locals. A part of profit will also go towards CSR fund and such activities can continue bringing benefits to local population for their growth and development.

8.2.9 Hydropower: An efficient Power

Hydropower projects are known to have long life. Projects constructed in the past many years are still working in an efficient manner which do not vouch the assertion that hydropower is an in-efficient power. Pertinent here to mention the fact that hydropower is a renewable source of energy and saves scarce fossil fuels. It is relatively non-polluting and hence environmentally benign source of power generation.

8.2.10 The future is Clean Ethical Energy

Enormous hydropower potential is available in Himachal Pradesh, the harnessing of which can help in overall growth in the State and country as well.Construction of Dugar HEP will not only help in tapping the unutilized vast hydro-potential of the state of Himachal Pradesh but will alsohelp in providing strategic strength to the country in Northern region. Hydropower is the demand of the hour for grid security in India. Hydroelectric Project is designed for expected extreme conditions and all the concerns are adequately addressed at every stage of project design, planning and execution.

8.3 CONCLUSION

Development, in all forms, is a gateway to economic sustainability and self-reliance. Ever increasing demands of the growing population, for meeting its basic needs, calls for greater and self-sustained economic growth. Hydropower projects have made an important and significant contribution in human development, and the benefits derived from them have been considerable. Extensive technological innovations now provide the capability to plan, design, build and operate hydropower projects with minimum undesirable environmental consequences. Government of India has taken many policy decisions to promote hydropower as a green and renewable course of power generation.

Chapter 9 ENVIRONMENTAL COST BENEFIT ANALYSIS

Environmental Cost Benefit Analysis has not been carried out, as this was not recommended at scoping stage. However, it has been separately done as part of proposal submitted for forest diversion.

Chapter 10 ENVIRONMENTAL MANAGEMENT PLAN

10.1 ENVIRONMENT MANAGEMENT PLAN

This chapter deals with the description of the administrative aspects of ensuring that mitigation measures are implemented, and their effectiveness monitored. NHPC Limited is the project proponent/implementing agency for design and execution of the work including its operation post commissioning. Institutional arrangement for planning and implementing various mitigation and management measures along with carrying out environment monitoring are given at **Table 10.1.** Once the project is accorded environment clearance by MoEF&CC, monitoring requirements as specified in the environment clearance letter will be adopted and followed for project construction and operation.

Table 10.1: EMP Implementation

S. No.	Activities	Implementing Agency	Monitoring/ Supervising/ Approving Agency
1	Catchment Area Treatment Plan	Forest Department	Forest Department
2	Compensatory Afforestation Plan	Forest Department	Forest Department/ NHPC Ltd.
3	Biodiversity Conservation and Wildlife Management Plan	Forest Department	Forest Department/ NHPC Ltd.
4	Fisheries Management Plan	Department of Fisheries	Department of Fisheries/ State Pollution Control Board
5	Muck Management Plan	Contractor/ NHPC Ltd.	NHPC Ltd./ Forest Department
6	Landscaping and Restoration of Quarry and Construction sites	Contractor/ NHPC Ltd.	NHPC Ltd./ State Pollution Control Board
7	Reservoir Rim Treatment	NHPC Ltd.	Forest Department/ NHPC Ltd.
8	Greenbelt Development Plan	Contractor/ NHPC Ltd.	Forest Department/ NHPC Ltd.
9	Sanitation and Solid Waste Management Plan	Contractor/ NHPC Ltd.	NHPC Ltd./ State Pollution Control Board
10	Public Health Delivery System	NHPC Ltd./ Contractor	NHPC Ltd./ District Administration (Health Department)
11	Energy Conservation Measures	Contractor	NHPC Ltd./ Forest Department
12	Labour Management Plan		
13	Disaster Management Plan	NHPC Ltd.	District Administration/ Govt. of Himachal Pradesh
14	Control of Air, Noise and Water Pollution*	Contractor/ NHPC Ltd.	NHPC Ltd./ State Pollution Control Board
15	Environmental Monitoring**	NHPC Ltd.	State Pollution Control Board/ MOEF&CC
16	Rehabilitation and Resettlement Plan #	NHPC Ltd.	District Administration/ Govt. of Himachal Pradesh
17	Local Area Development Fund#	NHPC Ltd.	District Administration/ Govt. of Himachal Pradesh

*Discussed in Chapter 4; **Discussed in Chapter 6; #: Discussed in Chapter 7

NHPC Ltd. is committed to ensure that all possible impacts are mitigated and shall ensure compliance to the national and state level regulatory requirements with a view to mitigate potential adverse environmental impacts resulting from the proposed project activities. The proposed EMP aims at ensuring the implementation of proposed mitigation and monitoring measures by the agency responsible for implementation.

EIA process has evaluated various impacts due to the proposed project and the proposed mitigation measures which have been suggested along with various management plans; will further reduce the severity of identified adverse impacts on environment due to the proposed activities.

The overall responsibility for implementation of the EMP measures rests with NHPC Ltd. through implementing agency and their contractors.

An Environmental Monitoring Cell (EMC) will be formed in order to assess and review the progress of the various mitigation measures suggested in the Environmental Management Plan. The project level EMC would coordinate with necessary stake holder for effective implementation of all environmental safeguard measures prescribed in the EMP. The Project Level Environmental Monitoring Cell will comprise of the following members:

1. Head of Project (HOP)
2. In-charge of Environment Division
3. Sr. Manager (Civil)
4. Manager / Dy. Manager/Asst. Manager/Env. Officer

A grievance mechanism will be established where complaints and grievances of the locals as well as of the labour force will be directly addressed by Human Resource (HR) Division. Records of all complaints will be generated along with corrective and preventive action till closure. All records will be scrutinized as planned under Monitoring.

The roles and responsibilities of NHPC Ltd. shall be:
1. Inclusion of EMP provisions in contract documents for its implementation.
2. Participate in and facilitate consultations with stakeholders.
3. Participate in project meetings and report on the issues related to environmental management and social safeguards to provide for any mid-course corrections that may be required based on situation on the ground.
4. Establish a mechanism to resolve grievances of Project Affected Persons (PAPs).
5. Coordination with district administration for implementation of R&R for land acquisition and provision of adequate compensation.
6. Develop rapport with PAFs and between PAFs and project.
7. Carry out other responsibilities as required from time to time.
8. Coordinate on the training of locals and capacity building initiatives.
9. Ensuring the implementation of all the planned mitigation and management measures
10. Review the monitoring report and assess the effectiveness of mitigation and management measures.
11. Take preventive and corrective actions as and when required.

Oversee and report implementation of EMP provisions included in the works contract.

10.2 COMPONENTS OF EMP

As per the Standard TOR, various plans need to be prepared as part of EIA study to ensure mitigation and management of identified impacts.

In addition, water, air and noise management, environment safeguards during construction activities have been covered under Chapter 4; under mitigation measures. Environment Monitoring at Chapter 6 as per generic structure of EIA. Other EMP components are discussed in ensuing sections.

Section 10.2.1 CATCHMENT AREA TREATMENT PLAN

10.2.1 CATCHMENT AREA TREATMENT PLAN

It is a well-established fact that reservoirs formed by dams on rivers are subjected to sedimentation. The process of sedimentation embodies the sequential processes of erosion, entrainment, transportation, deposition and compaction of sediment. The steady erosion and sediment in reservoir reduces its capacity, and thus affecting the water availability for the designated use. The eroded sediment from catchment when deposited on streambeds and banks causes braiding of river reach. The removal of top fertile soil from catchment adversely affects the land productivity in the area. Thus, a well-designed Catchment Area Treatment (CAT) Plan is essential to ameliorate the above mentioned adverse effects of soil erosion. Soil erosion can be defined as detachment, transportation and deposition of soil particles from one place to other by means of transporting agent like air, water or animals. Soil erosion is mainly affected by rainfall intensity and runoff, slope gradient and length, soil erodibility and vegetation cover (land use pattern). Therefore, study of erosion and sediment yield from catchments are of great importance. Soil erosion leads to:

- loss in power production
- reduction in infiltration rates
- reduction in water-holding capacity
- loss of nutrients
- increase in tillage operation costs
- reduction in water supply

To control the rate of soil erosion in the catchment, CAT is an ineluctable part. The CAT plan pertains to preparation of a management plan for treatment of erosion prone areas through adequate preventive measures. An effective CAT plan is a key factor to make the project eco-friendly and sustainable. Thus, a well-designed CAT Plan is essential to ameliorate the above mentioned adverse process of soil erosion. CAT plan essentially consist of following steps.

1. Calculation of soil erosion using Revised Universal Soil Loss Equation (RUSLE), combined with Remote Sensing (RS) and Geographic Information System (GIS) technologies.
2. Prioritizing the areas for treatment using Silt Yield Index (SYI).
3. Planning of suitable erosion control measures.
4. Cost estimation for CAT plan.

10.2.1.1 River System & Catchment Area

The Chenab is a major river of the Indus Basin originating from the Bara-Lacha pass at an elevation of 4,891 m having snow covered slopes. The river is formed by two major tributaries in the upper reaches i.e. Chandra and Bhaga. The Chandra originates from Bara-Lacha la and is further augmented by the Chandra Tal whereas the Bhaga takes off from the Suraj Tal in the vicinity of the Bara-Lacha and is further joined by the Jankar and the Milang Nala before it joins the Chandra at Tandi to form the Chandra Bhaga or Chenab. Further downstream of the confluence, it is joined by other significant tributaries namely Shansha Nala near Rashil and Thirot Nala at Thirot, Miyar Nala at Udaipur, Saichu Nala at Dawag, Mahal Nala at Killar, Dheda Nala and Lujai Nala d/s of Killar. The river in its course traverses through Lahaul & Pattan and Pangi Valley (Chamba) of Himachal Pradesh before it crosses in to Jammu & Kashmir downstream of Sansari Nala. The catchment area of the project up to the proposed dam site of Dugar HEP is 7823.00 sq km. The elevation of the catchment varies from about 6500 m to about 2017 m. Length of Chenab river up to the proposed dam site is around 250.0 km. Map showing the catchment area of the Chenab River up to the dam site of Dugar HEP is given at **Figure 10.1.**

10.2.1.2 Methodology Adopted for the Study

The present CAT plan has been prepared in line with approved Comprehensive Catchment Area Treatment Plan of Chenab River Basin (CCP CRB) in Himachal Pradesh prepared by the Himachal Pradesh Forest Department (HPFD). Also, CAT plan has been formulated in the light of guidelines issued by the Department of Forest, Himachal Pradesh, vide Notification No. FFE-B-F-(2)-72/2004-Pt-II Shimla, dated 30-09-2009. amended vide Notification No. FFB-B-F-(5)-9/2017 dated 21.11.2019. The various steps, covered in the study, are as follows:

- Defining data requirement
- Data acquisition and preparation
- Data analysis and modelling
- Output presentation
- Treatment measures

The above-mentioned steps are briefly described in the following paragraphs:

10.2.1.2.1 Defining Data Requirement

The requirements of the study were defined, and the expected outputs were finalized. The various data layers of the catchment area to be used for the study are as follows:

- Study Area Map.
- Slope Map.
- Soil Map.
- Land use Classification Map.
- Rainfall Intensity.

10.2.1.2.2 Data Acquisition and Preparation

The data available from various sources, primarily from CCR CRB were collected. Data was prepared depending on the level of accuracy required and any corrections required were made. All the layers were geo-referenced and brought to a common scale (real co-ordinates), so that overlay could be performed. A computer program using standard modeling techniques was used to estimate the soil loss. The formats of outputs from each layer were firmed up to match the formats of inputs in the program.

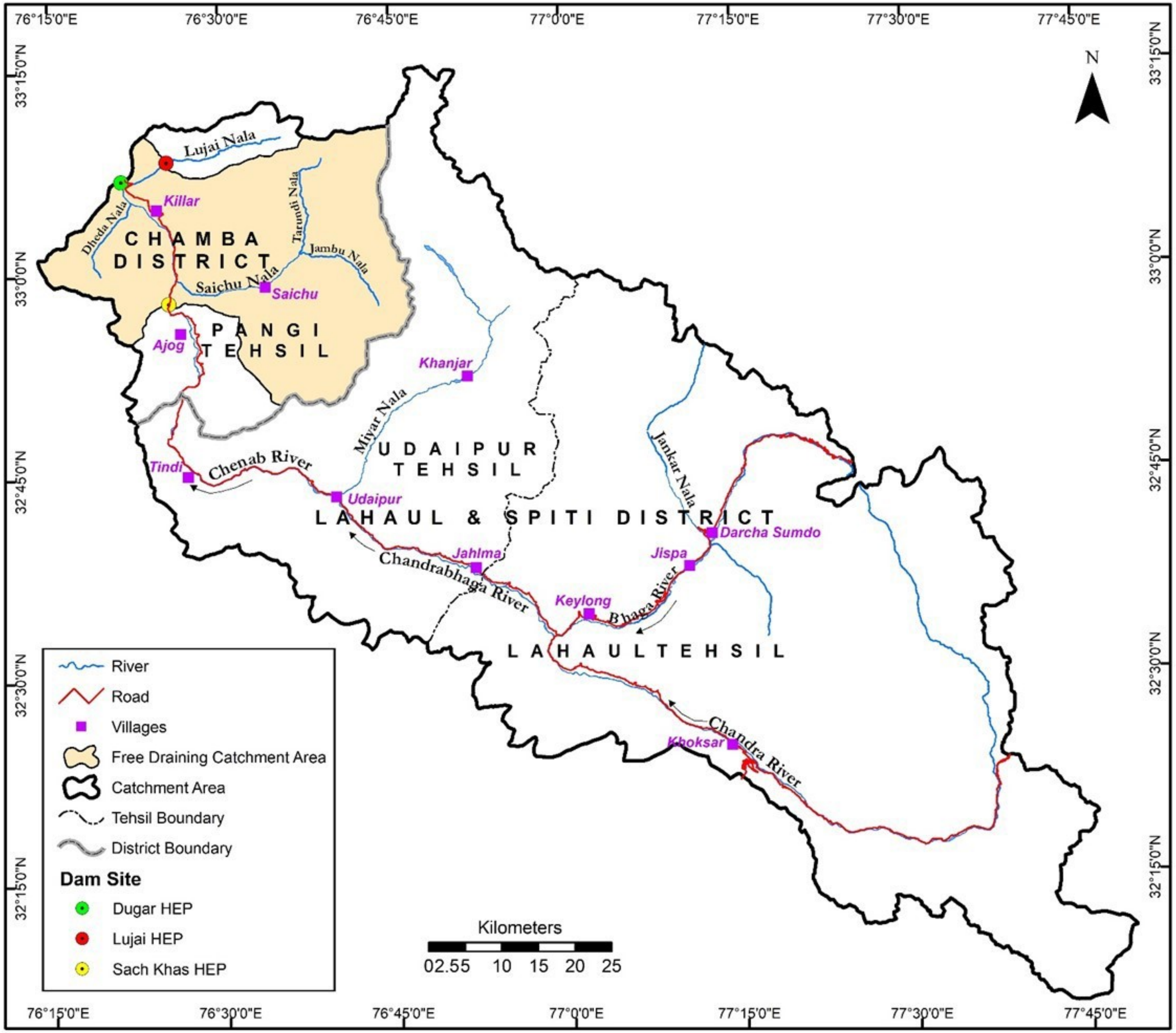


Figure 10.1: Catchment Area Map of the Dugar HEP

a. Study Area Map

Purpose of the study is preparation of CAT plan for the catchment of Dugar HEP. Upstream projects are proposed Sach Khas HEP and on river Chenab and Lujai HEP on Lujai Nala, therefore, study area to be considered for the present study is defined as free draining catchment area of Dugar HEP. Free draining catchment area has been delineated as intercepting catchment area between the dam site of upstream Sach Khas HEP on river Chenab, dam site of Lujai HEP on Lujai Nala and dam site of proposed Dugar HEP. The total area of the free draining catchment is 1131.64 sq km. **(Table 10.2 and Figure 10.1)**

In order to plan watershed management and to formulate action plans it requires watershed delineation, therefore, free draining catchment area was further delineated into macro/ micro-watersheds. As per CCP CRB, the free draining catchment area of Dugar HEP falls in 24 macro/ micro-watersheds. Out of these 24 macro/ micro-watersheds, 21 macro/ micro- watersheds fall completely within the free draining catchment area while 3 macro/ micro- watersheds viz. 1D1D5a3 (Chalkot), 1D1D5b2 (Lujai) and 1D1D7b1 (Mokna) fall partially within the free draining catchment area. The nomenclature of macro/ micro-watersheds has been assigned as follows: Indus Region (1); Chenab Basin (1D); Chenab Catchment (1D1); Sub-Catchment (1D1D); Lujai, Garotu Watershed (1D1D5) and Saichu (1D1D6) Watersheds; 8 sub-watersheds; and 24 macro/ micro-watersheds. The detail of macro/ micro-watersheds delineated for the free draining catchment area is given below (**Table 10.2 and Figure 10.2**).

Table 10.2: Names and Codes of Macro/ Micro-watersheds Delineated

S. No	Water Resource Region	Basin	Catchment	Sub-Catchment	Watershed	Sub-watershed	Macro/ Micro-watershed	Macro/ Micro-watershed Area (sq km)
1.	Indus (1)	Chenab (1D)	Chenab (1D1)	1D1D	1D1D5	1D1D5a (Dheda)	1D1D5a3 (Chalkot)	5.75
2.							1D1D5a4 (Dheda)	115.74
3.							1D1D5a5 (Sosar)	12.35
4.							1D1D5a6 (Bindi)	6.43
5.						1D1D5b (Lujai)	1D1D5b2 (Lujai)	30.97
6.						1D1D5c (Mahal)	1D1D5c1 (Manjos)	13.81
7.							1D1D5c2 (Mahal)	104.26
8.							1D1D5c3 (Karyuni)	21.14
9.							1D1D5c4 (Konsar)	7.65
10.							1D1D5c5 (Galwat)	45.25
11.						1D1D5d (Cheni)	1D1D5d1 (Landhar)	12.07

S. No	Water Resource Region	Basin	Catchment	Sub-Catchment	Watershed	Sub-watershed	Macro/ Micro-watershed	Macro/ Micro-watershed Area (sq km)
12.							1D1D5d2 (Hural)	11.67
13.							1D1D5d3 (Bonkar)	7.83
14.							1D1D5d4 (Cheni)	38.82
15.					1D1D6	1D1D6a (Sidhani)	1D1D6a1 (Bherwas)	31.05
16.							1D1D6a2 (Sidhani)	70.57
17.							1D1D6a3 (Chasag)	119.74
18.						1D1D6b (Hilu)	1D1D6b1 (Hillaur)	48.64
19.							1D1D6b2 (Hilu)	31.71
20.							1D1D6b3 (Tarundi)	185.24
21.						1D1D6c (Saichu)	1D1D6c1 (Harruin)	54.16
22.							1D1D6c2 (Saichu)	14.78
23.							1D1D6c3 (Jambu)	137.67
24.					1D1D7	1D1D7b (Shoar)	1D1D7b1 (Mokna)	4.34
	TOTAL							**1131.64**

b. Slope Map

Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model Version 3 (GDEM 003) data has been used for DEM and the same DEM has been used for the preparation of slope map. The slope was divided in classes of slope as per the slope classes and ranges recommended by Soil & Land Use Survey of India (SLUSI) erstwhile All India Soil & Land Use Survey (AIS & LUS, "Methodology of priority delineation survey", AIS & LUS technical bulletin 9.33p (1991)). The areas falling under various standard slope categories have been tabulated below in **Table 10.3.** The slope map is enclosed as **Figure 10.3.**

Table 10.3: Areas Falling Under Different Slopes Categories

Slope in Degrees	Category	Area (sq km)	Area (%)
Up to 2	Gently sloping	2.09	0.18
2-8	Moderately sloping	36.77	3.25
18-15	Strongly sloping	91.32	8.07
15-30	Moderately steep	371.08	32.79
30-45	Steep	443.95	39.23
45-60	Very steep	172.03	15.20
60-70	Extremely steep	13.75	1.21
Above 70	Escarpments	0.64	0.06
TOTAL		**1131.64**	**100.00**

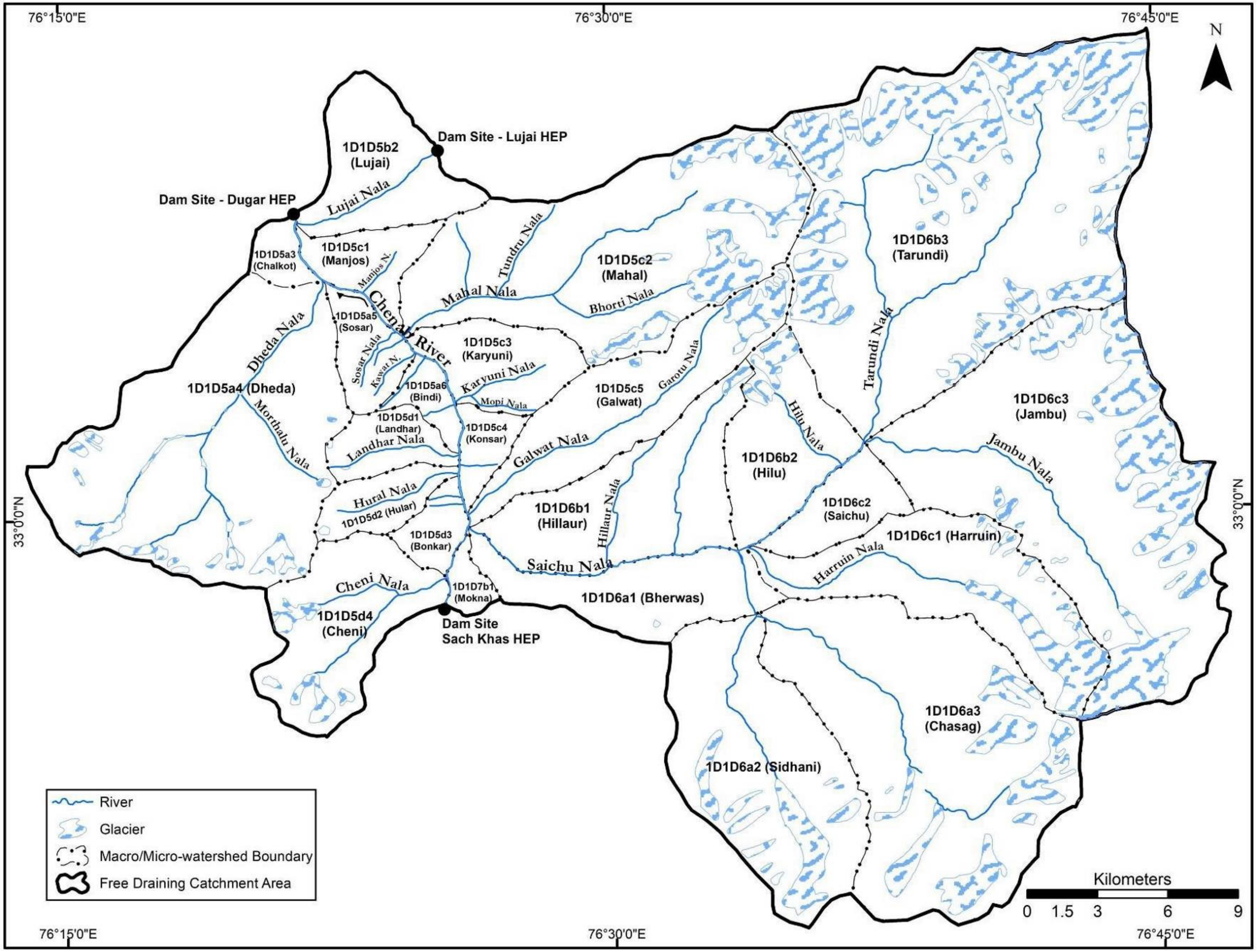


Figure 10.2: Map Showing Macro/Micro-Watershed Delineated in the Free Draining Catchment Area

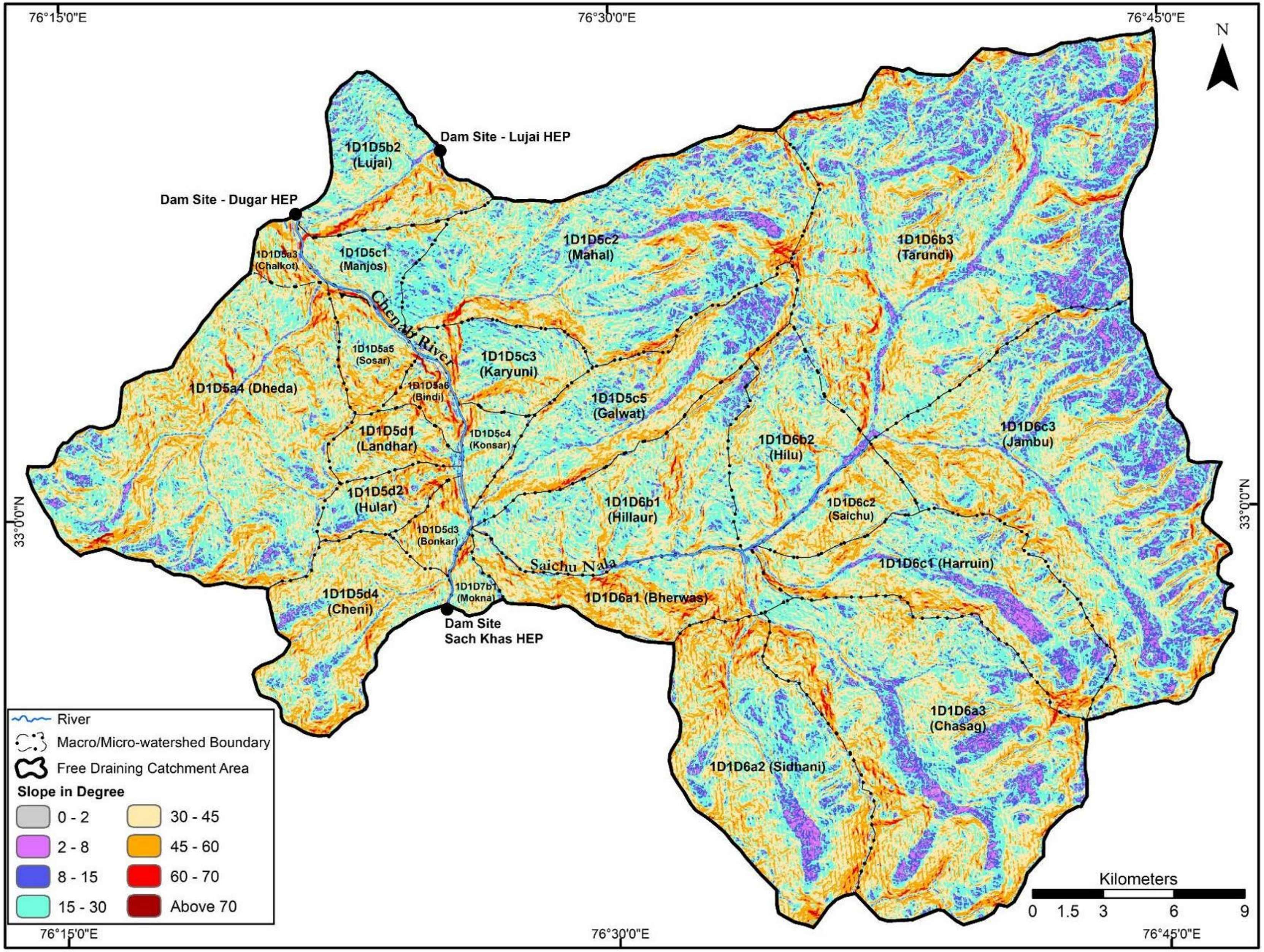


Figure 10.3: Slope Map

c. Soil Map

Soil map has been digitized and produced using soil maps collected from National Bureau of Soil Survey and Land Use Planning (NBSS&LUP) for Himachal Pradesh. Various layers, thus prepared, were used for Modeling. Soil map has been shown as Figure 10.4. The legend for soil classes has been given in **Table 10.4**.

Table 10.4: Soil Types

Soil Unit	Soil Type		Area (sq km)	Area (%)
1	Rock Outcrops covered glaciers; *associated with*: Shallow, excessively drained, sandy-skeletal soils with sandy surface, severe erosion and strong stoniness	Lithic Cryorthents	117.60	10.39
4	Rock Outcrops and Valley Glaciers; *associated with*: Shallow excessively drained, sandy-skeletal soils on very steep slopes with sandy surface, severe erosion and moderate stoniness	Lithic Cryorthents	5.39	0.48
6	Rock Outcrops *associated with*: Medium deep, excessively drained, loamy-skeletal calcareous soils on very steep slopes with loamy surface, severe erosion and moderate stoniness	Typic Cryorthents	6.80	0.60
7	Rock Outcrops *associated with*: Shallow, excessively drained, loamy skeletal soils on very steep slopes with loamy surface, severe erosion and moderate stoniness	Typic Cryorthents	317.09	28.02
8	Rock Outcrops; *associated with*: Medium deep, excessively, loamy skeletal soils on very steep slopes with loamy surface, severe erosion and strong stoniness	Typic Cryorthents	3.26	0.29
9	Rock Outcrops *associated with*: Deep, well drained, mesic, loamy skeletal soils on very steep slopes with loamy surface, severe erosion and strong stoniness	Typic Udorthents	161.24	14.25
11	Shallow, well drained, mesic , coarse loamy, soils on very steep slopes with loamy surface and severe erosion; *associated with*: Shallow, well drained, loamy skeletal soils with loamy surface, severe erosion and strong stoniness	Typic Udorthents	15.95	1.41
16	Rock Outcrops *associated with*: Deep, excessively drained, sandy-skeletal soils with loamy surface, very severe erosion and moderate stoniness	Typic Udorthents	303.54	26.82
23	Deep, well drained, mesic, coarse-loamy soils on gentle slopes with loamy surface and moderate erosion; *associated with*: Deep, well drained, coarse-loamy soils with loamy surface and moderate erosion	Dystric Eutrochrepts	196.40	17.36
39	Medium deep, well drained, thermic, coarse-loamy soils on steep slopes with loamy surface and severe erosion; *associated with*: Deep, well drained, fine loamy soils with loamy surface and moderate erosion	Typic Udorthents	4.37	0.39
	TOTAL		**1131.64**	**100.00**

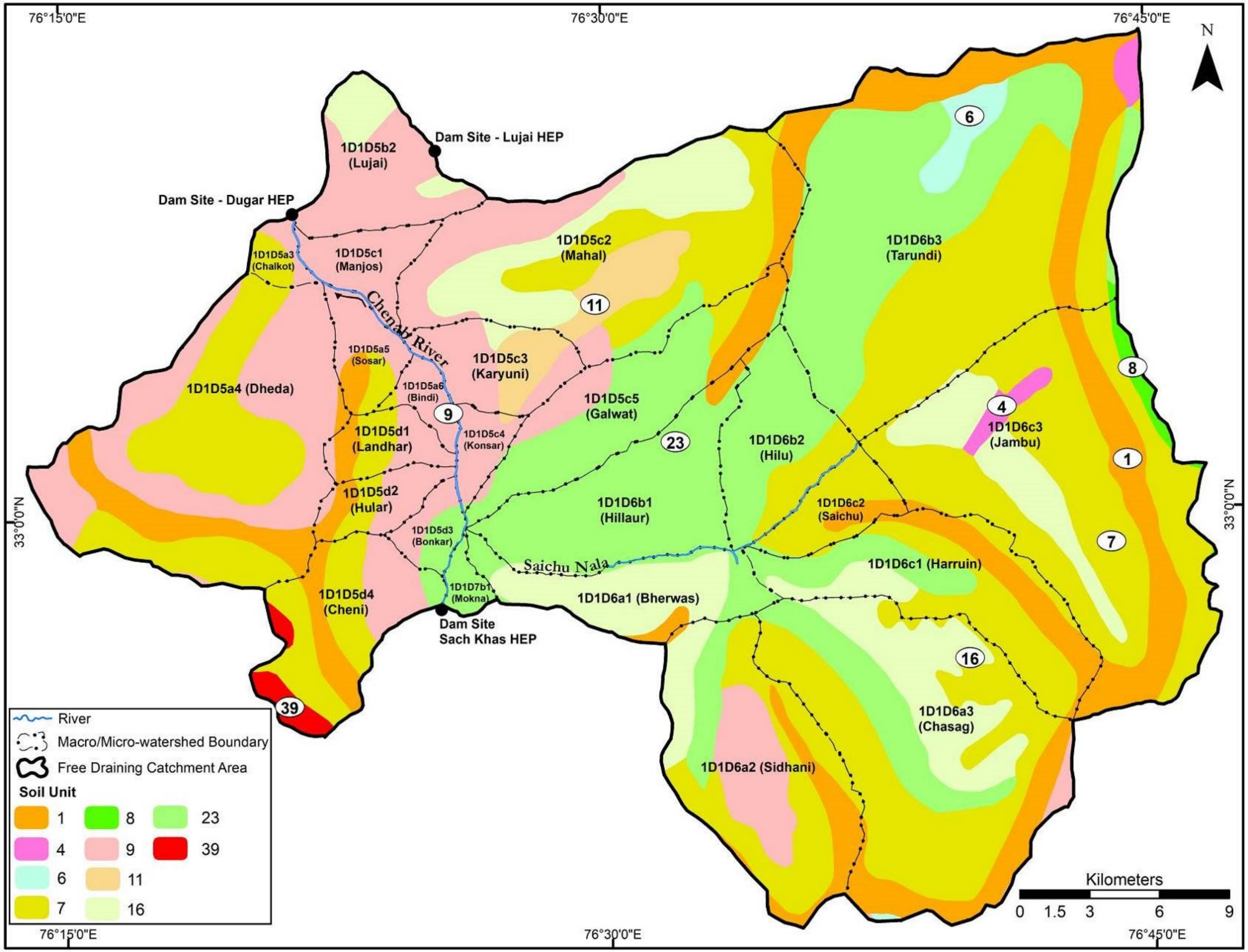


Figure 10.4: Soil Map (For Legends refer Table 10.4)

d. Land use/ Land cover Map

For the preparation of land use/ land cover map, digital data on land use/land cover thematic maps prepared by the National Remote Sensing Centre (NRSC), Indian Space Research Organisation (ISRO), Dept. of Space with Himachal Pradesh Council on Science, Technology & Environment as a partner was extracted from their web portal http://bhuvan.nrsc.gov.in/gis/thematic/index.php. The raster data was processed in the GIS environment for further refinement using information from Landsat 8 data and FCC was generated using Bands 3, 4, 5 of path 148 rows 37 dated 05.10.2020 (downloaded from https://earth explorer.usgs.gov/) and the same is given in **Figure 10.5**. The land use map thus prepared was further refined using the latest available imagery in Google Earth Pro. The interpretation was supported further by ground truth verification surveys carried out in the entire study area. The classified land use map of the free draining catchment area is shown as **Figure 10.6**. The land use pattern of the free draining catchment area is summarized in **Table 10.5**.

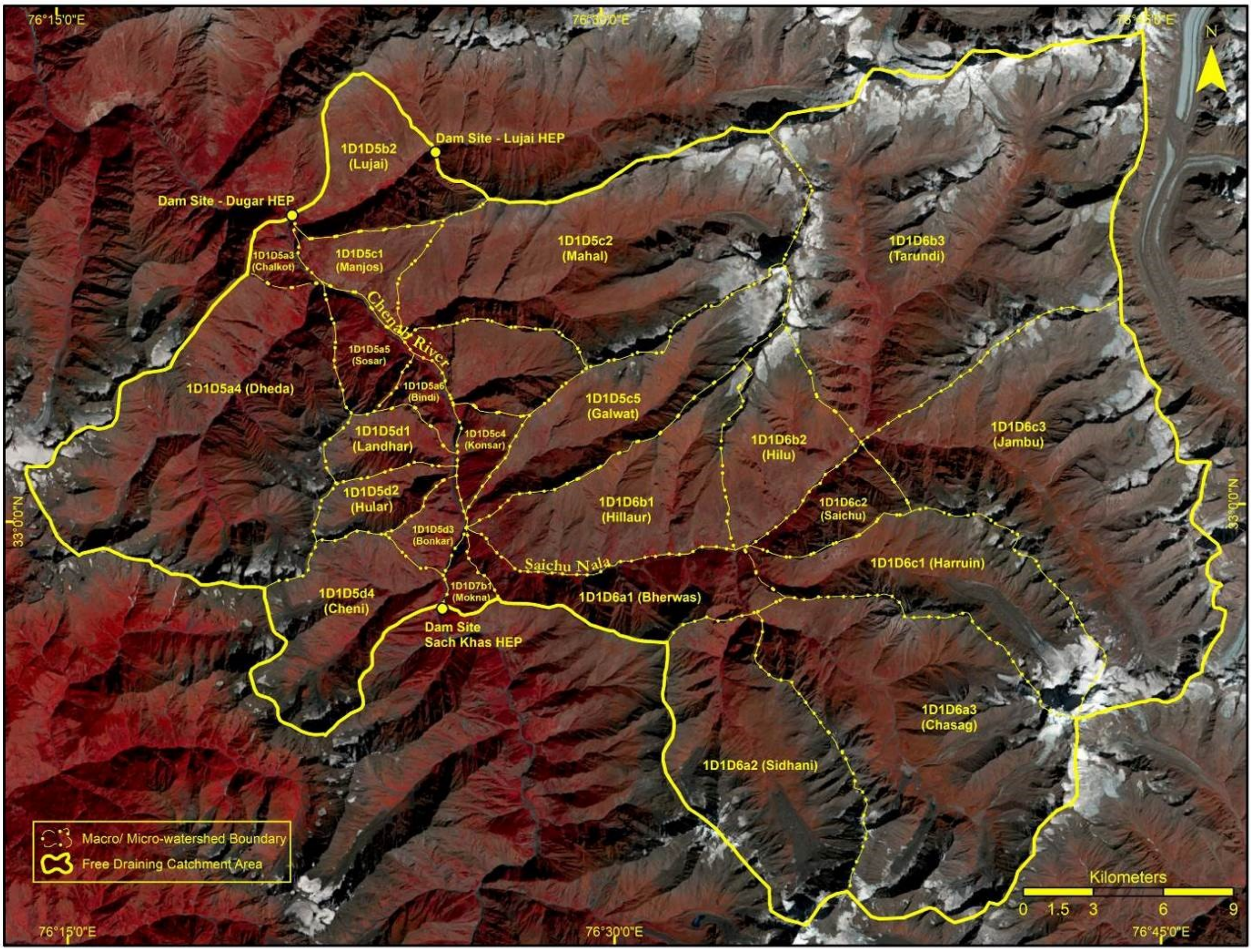


Figure 10.5: False Color Composition Map

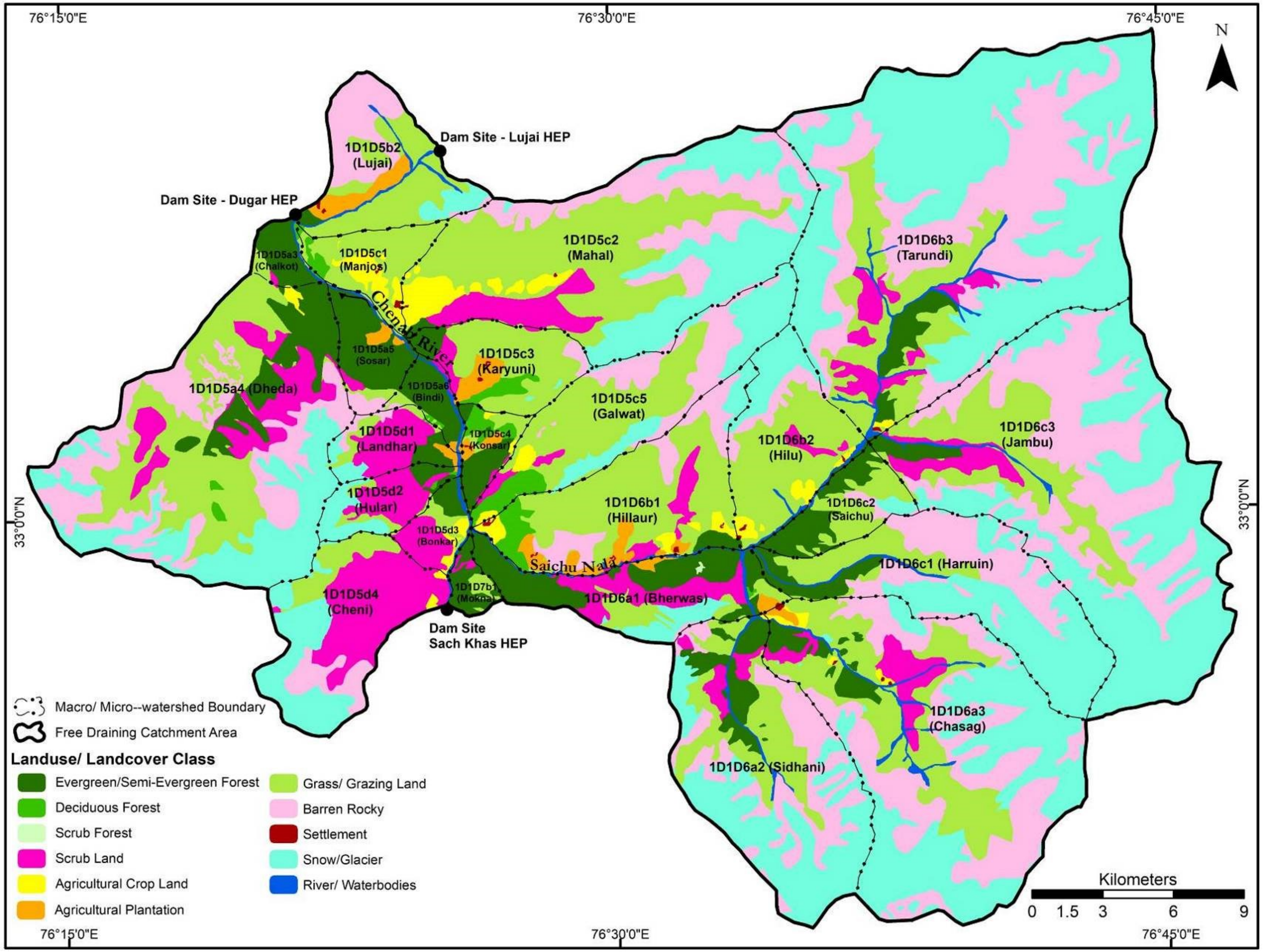


Figure 10.6: Landuse Classification Map

Table 10.5: Land Use Classification

Land use/Land cover Class	Area (Sq km)	Area (%)
Evergreen/ Semi-Evergreen Forest	86.47	7.64
Deciduous Forest	10.65	0.94
Scrub Forest	0.11	0.01
Scrub Land	89.06	7.87
Agricultural Crop Land	16.60	1.47
Agricultural Plantation	12.32	1.09
Grass/ Grazing Land	297.46	26.29
Barren Rocky	259.80	22.96
Settlement	0.88	0.08
Snow/ Glacier	344.58	30.45
River/ Waterbodies	13.71	1.21
Total	**1131.64**	**100.00**

e. Rainfall Map

For the estimation of rainfall erosivity in the free draining catchment area, average rainfall of 10 years has been taken from the Tropical Rainfall Measuring Mission (TRMM) data (**Figure 10.7**). As can be seen in the Figure 10.7, the free draining catchment area comprises of three average annual rainfall ranges i.e. <500 mm/year, 500-1000 mm/year and 1000-2000 mm/year.

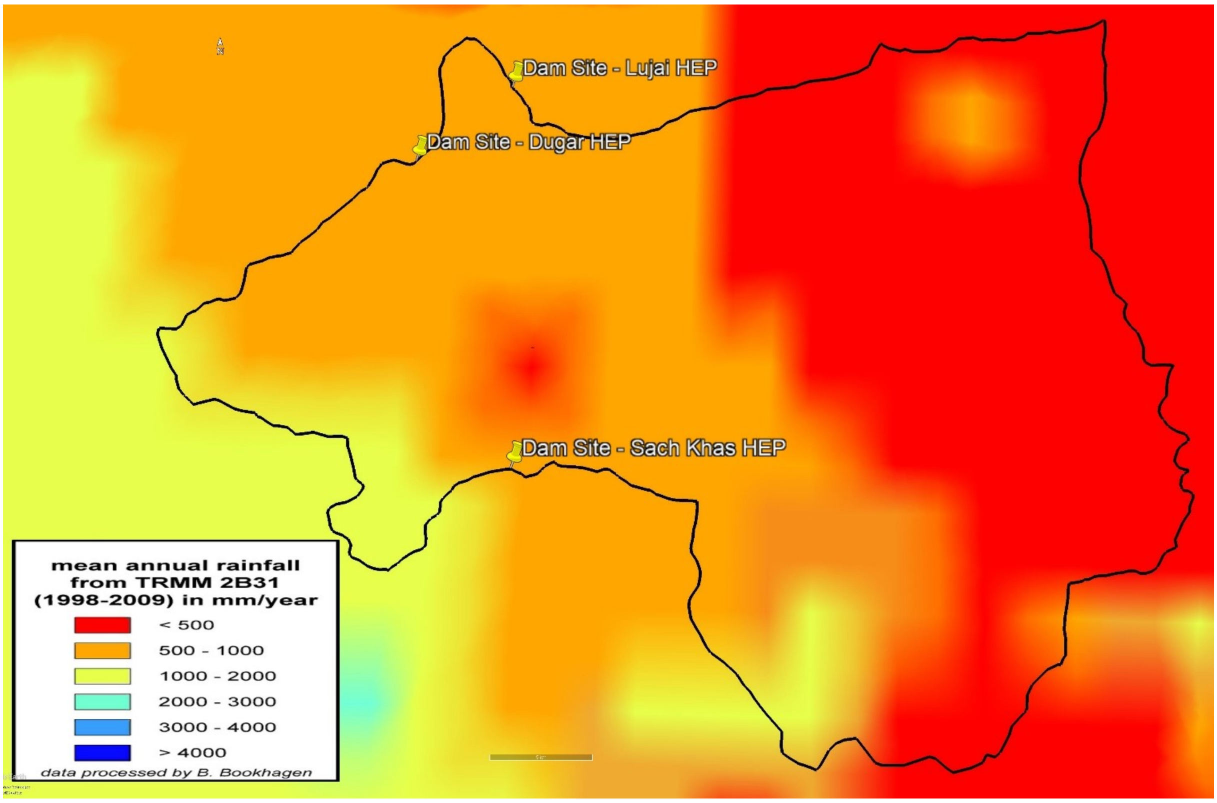


Figure 10.7: Rainfall Map

10.2.1.2.3 Data Analysis and Modelling

Soil loss has been calculated through RUSLE (Revised Universal Soil Loss Equation) model which is computed by the following equation:

Soil Loss (A) = R*K*LS*C*P

Wherein;

A = Soil loss (Tons/ha/year)
R is Rainfall & Runoff Erosivity Factor (MJ/ha/mm/year), which depends upon the annual average rainfall in mm.

K is Erodibility Factor (Tons/MJ/mm), which depends on the organic matter, texture permeability and profile structure of the soil. Also, it is a constant value for each soil type.

LS is Topographic Factor (dimensionless), which depends upon flow accumulation and steepness and length of slope in the area.

C is Vegetation Cover and Crop Management Factor (dimensionless), which is the ratio of bare soil to vegetation and non-photosynthetic material. It is a constant value for each land use category.

P is Support Practice Factor (dimensionless), which takes into account specific erosion control practices. This factor is taken as 0.5 since erosion control practices are prevailing.

10.2.1.2.4 Output Presentation

A thematic map for soil loss of the free draining catchment area has been prepared using RUSLE model mentioned in the above section. The free draining catchment area was then demarcated into different soil erosion intensity classes based upon the extent of soil loss (see **Table 10.6** & **Figure 10.8**). As can be seen from the figure and table (highlighted cells), around 56% of the free draining catchment area is prone to less than 1 tons/ha/annum soil erosion, which can be termed as negligible soil erosion intensity class. While, around 10% is prone to severe and very severe soil erosion intensity class i.e. more than 40 tons/ha/annum.

Table 10.6: Soil Loss Ranges

S. No.	Soil loss in tons/ha/annum	Area (ha)	Area (%)	Soil Erosion Intensity
1	<1	63585.83	56.19	Negligible
2	1-5	6322.22	5.59	Slight
3	5-10	8865.84	7.83	Very Low
4	10-20	11994.71	10.60	Low
5	20-40	10629.26	9.39	Moderate
6	40-80	7027.55	6.21	Severe
7	>80	4739.19	4.19	Very Severe
	Total	**113164.60**	**100**	

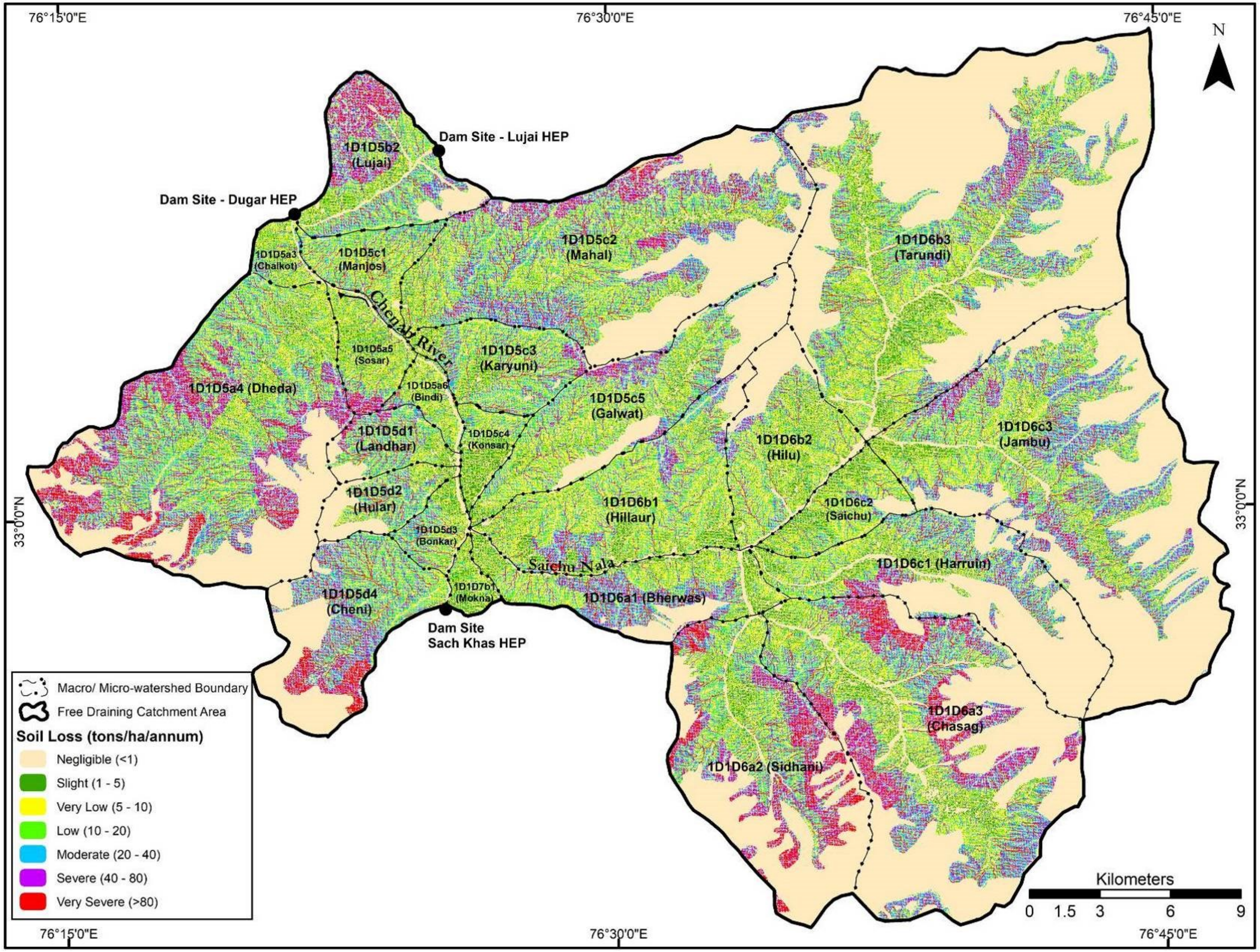


Figure 10.8: Erosion Intensity Map

10.2.1.3 Prioritization of Sub-Watersheds using Silt Yield Index (SYI) Method

`Silt Yield Index' (SYI), method has been used for prioritization of macro/micro -watersheds in the free draining catchment for treatment. SYI method has been used for prioritization of macro/micro-watersheds in the CAT Plan area for various treatment measures. The SYI is defined as the Yield per unit area and SYI value for hydrologic unit is obtained by taking the weighted arithmetic mean over the entire area of the hydrologic unit by using suitable empirical equation. The SYI considers sedimentation as product of erosivity, morphometery and delivery ratio of a particular watershed and has been used various workers in the sub- continent and has been operational since then to meet the requirements of prioritization of smaller hydrologic units within river valley project catchment areas.

To calculate silt yield index, each erosion intensity unit is assigned a weightage value. When considered collectively, the weightage value represents approximately the comparative erosion intensity. A basic factor of K = 10 was used in determining the weightage values. The value of 10 indicates a static condition of equilibrium between erosion and deposition. Any addition to the factor K (10+X) is suggestive of erosion in ascending order whereas subtraction, i.e. (10-X) is indicative of deposition possibilities.

Delivery ratios were adjusted for each of the erosion intensity unit. The delivery ratio suggests the percentage of eroded material that finally finds entry into reservoir or river/ stream. Area of each composite unit in each watershed was then estimated.

Silt yield index (SYI) was calculated using following empirical formula:

$$SYI = \frac{\Sigma (Ai * Wi) * Di * 100}{Aw}; \quad \text{where } i = 1 \text{ to } n$$

where,

Ai = Area of i^{th} unit (EIMU)
Wi = Weightage value of i^{th} mapping unit
n = No. of mapping units
Aw = Total area of watershed.
Di = Delivery ratio

Delivery ratios are assigned to all erosion intensity units depending upon their distance from the nearest stream. The criteria adopted for assigning the delivery ratio are as follows:

Nearest Stream	Delivery ratio
0 - 0.9 km	1.00
1.0 - 2.0 km	0.95
2.1 - 5.0 km	0.90
5.1 - 15.0 km	0.80
15.1 - 30.0 km	0.70

Weightage values are assigned to the erosion intensity unit depending upon the soil erosion intensity and delivery ratio in a macro/micro-watershed. Higher the soil erosion intensity and delivery ratio in the macro/micro-watershed higher is the weightage value assigned to the erosion mapping unit.

The SYI values for classification of various categories of erosion intensity rates are given below:

Priority categories	SYI Values
Very high	> 1300
High	1200-1299
Medium	1100-1199
Low	1000-1099
Very Low	<1000

Erosion Intensity Mapping Units (EIMU) are demarcated and defined as per the soil erosion intensity maps prepared as above. Various EIMU categories, such as Very Severe, Severe, Moderate, Low, Very Low, and Negligible & Slight (clubbed together), were then used to calculate macro/micro-watershed-wise SYI.

The boundary values or range of SYI values for different priority categories are arrived at by studying the frequency distribution of SYI values and locating the suitable breaking points. The micro-watersheds are subsequently rated into various categories corresponding to their respective SYI values.

The application of SYI model for prioritization of micro-watersheds in the CAT Plan area involves the evaluation of:

- Climatic factors comprising total precipitation, its frequency and intensity,
- Geomorphic factors comprising land forms, physiography, slope and drainage characteristics,
- Surface cover factors governing the flow hydraulics and Management factors.

The data on climatic factors is obtained for different locations in the free draining catchment area from the meteorological stations whereas the field investigations are required for estimating the other attributes. The various steps involved in the application of model are:

- Preparation of a framework of micro-watersheds through systematic delineation
- Rapid reconnaissance surveys on 1:50,000 scale leading to the generation of a map indicating erosion-intensity mapping units.
- Assignment of weightage values to various mapping units based on relative silt-yield potential.
- Computing Silt Yield Index for individual micro-watersheds.
- Grading of micro-watersheds into very high, high, medium, low and very low priority categories.

Prioritization of all macro/micro-watersheds falling in free draining catchment area of Dugar HEP is given in **Table 10.7** below:

Table 10.7: Prioritization of all Macro/Micro-watersheds

S. No	Macro/ Micro-watershed	Macro/ Micro-watershed Area (sq km)	Priority Category
1.	1D1D5a3 (Chalkot)	5.75	Very Low
2.	1D1D5a4 (Dheda)	115.74	Very High

S. No	Macro/ Micro-watershed	Macro/ Micro-watershed Area (sq km)	Priority Category
3.	1D1D5a5 (Sosar)	12.35	Medium
4.	1D1D5a6 (Bindi)	6.43	Very Low
5.	1D1D5b2 (Lujai)	30.97	Very High
6.	1D1D5c1 (Manjos)	13.81	Medium
7.	1D1D5c2 (Mahal)	104.26	Very High
8.	1D1D5c3 (Karyuni)	21.14	High
9.	1D1D5c4 (Konsar)	7.65	Very Low
10.	1D1D5c5 (Galwat)	45.25	Medium
11.	1D1D5d1 (Landhar)	12.07	High
12.	1D1D5d2 (Hural)	11.67	Medium
13.	1D1D5d3 (Bonkar)	7.83	Medium
14.	1D1D5d4 (Cheni)	38.82	Very High
15.	1D1D6a1 (Bherwas)	31.05	High
16.	1D1D6a2 (Sidhani)	70.57	Very Low
17.	1D1D6a3 (Chasag)	119.74	High
18.	1D1D6b1 (Hillaur)	48.64	Medium
19.	1D1D6b2 (Hilu)	31.71	Very Low
20.	1D1D6b3 (Tarundi)	185.24	Low
21.	1D1D6c1 (Harruin)	54.16	Low
22.	1D1D6c2 (Saichu)	14.78	Very Low
23.	1D1D6c3 (Jambu)	137.67	Low
24.	1D1D7b1 (Mokna)	4.34	Very Low

It can be observed from above table that 4 macro/micro-watersheds are falling in very high priority category, 4 macro/micro-watersheds are falling in high category, 6 macro/micro-watersheds are falling in medium category, 3 macro/micro-watersheds are falling in low category and the balance 7 macro/micro-watersheds are falling in very low category. In total, 25.61% area falls in very high, 16.26% area falls in high, 12.33% area falls in medium, 33.32% area falls in low and the rest of the 12.48% area falls in very low category. Area wise prioritization is given below and shown in **Figure 10.9.**

Priority	No. of Macro/ Micro-Watersheds	Area (sq km)	Area (%)
Very High	4	289.79	25.61
High	4	184.00	16.26
Medium	6	139.55	12.33
Low	3	377.07	33.32
Very Low	7	141.23	12.48
Total	**24**	**1131.64**	**100.00**

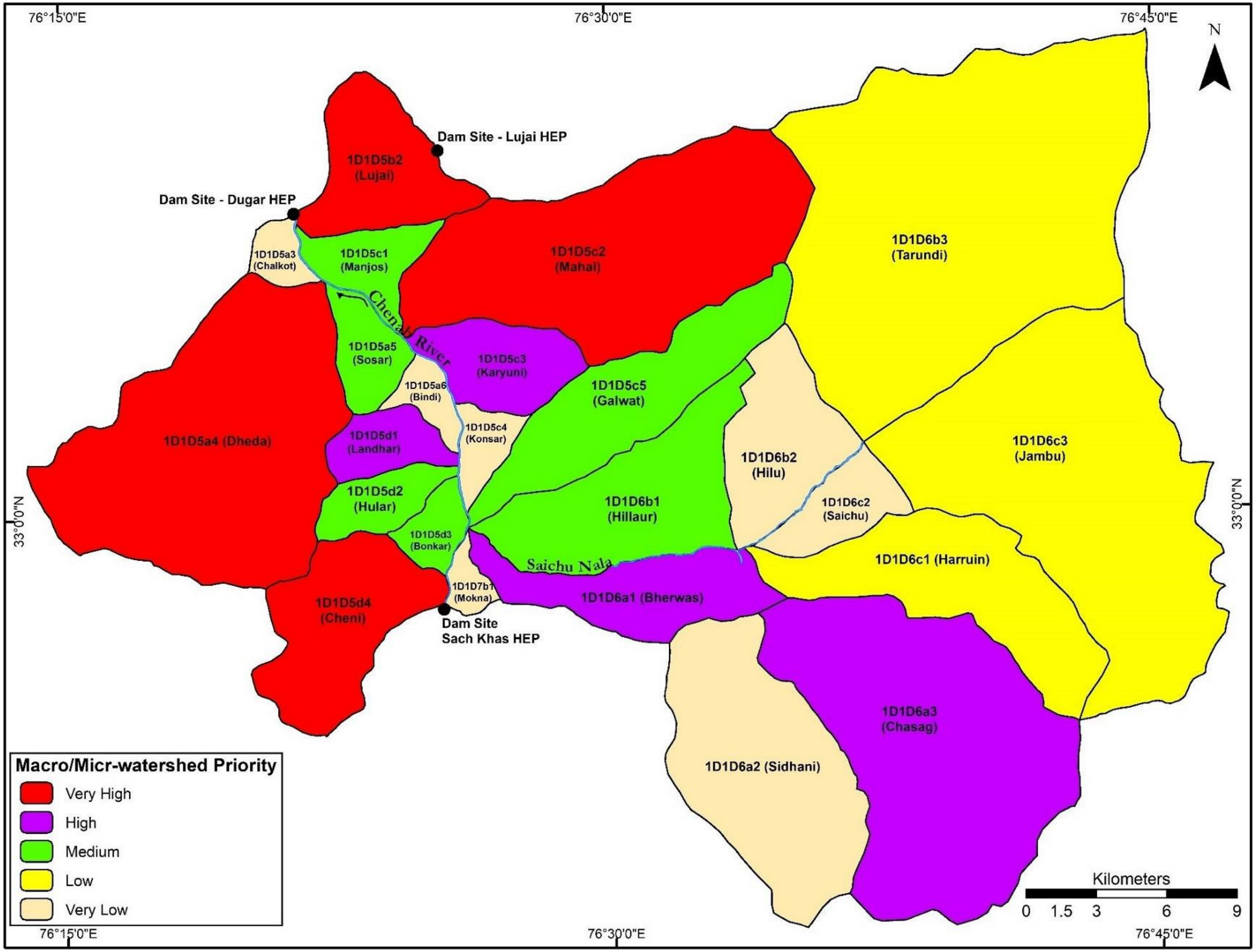


Figure 10.9: Prioritization of Macro/Micro-watersheds

10.2.1.4 Treatment Measures

Watershed management is the optimal use of soil and water resources within a given geographical area so as to enable sustainable production. It implies changes in land use, vegetative cover, and other structural and non-structural action that are taken in a watershed to achieve specific watershed management objectives. The overall objectives of watershed management programme are to:

- increase infiltration into soil;
- control excessive runoff;
- manage & utilize runoff for useful purpose.

In view of the peculiarity of the study area, in addition to biological treatment measures, emphasis has been put on engineering measures also. Following Engineering and Biological measures have been suggested for the catchment area treatment depending upon the requirement and suitability:

10.2.1.4.1 Biological Measures

The biological measures suggested are as follows (also refer **Table 10.8**):

- Afforestation
- Enrichment plantation
- Pasture development
- Assisted natural regeneration
- Raising of native medicinal shrubs and herbs

The cost norms for each of the five schemes are enclosed as **Annexure VI**. These cost norms are as per the "Norms for plantation and maintenance of old plantations for Non-Tribal and Tribal Areas for the year 2021-22" issued by the Office of HP State Compensatory Afforestation Fund Management & Planning Authority (HP State Authority), "Cost Norms for raising new Plantations and Maintenance of Old Plantations (Normal Plantations) for Non-Tribal & Tribal Areas for the year 2021-22" issued by Himachal Pradesh Forest Department and "Cost norms for raising plants (Normal and Tall plants) in nurseries for Non-Tribal & Tribal Areas for the year 2021-22" issued by Himachal Pradesh Forest Department.

a) Afforestation

A well-stocked forest plays a very important in control of soil erosion. Thus, it is proposed to increase the vegetal cover in the area. For this purpose, barren areas, devoid of tree growth have been recommended to be brought under afforestation. This will include raising of multi-tier mixed vegetation of suitable local species in steep and sensitive catchment areas of rivers/streams with the objective of keeping such areas under permanent vegetative cover. Choice of species is given in respective macro/ micro and sub-watershed. 1100 plants per ha. are to be planted. Planting will be done in pits. Earth work should be done well in advance. Plants should be healthy with strong stems. Planting should be done in June when the water supply starts. Fencing should be done with 4 strands of barbed wire with RCC fence posts, interlaced with thorny bushes at vulnerable points. Maintenance has been provided for a period of 7 years. The unit cost for afforestation including maintenance cost for seven years is estimated to be Rs. 1,67,235/- per ha consisting of Rs. 1,12,335/- for afforestation and Rs. 54,900/- for maintenance for seven years.

b) Enrichment

In areas where natural trees exist but are depleted due to excessive pressure of local population for timber, fuelwood and fodder are to be undertaken under enrichment. On an average 850 plants per ha. are planned to be planted. Choice of species is given in respective macro/ micro and sub-watershed. Planting will be done in pits. Earth work should be done well in advance. Plants should be healthy with strong stems. Planting should be done in June when the water supply starts. Fencing should be done with 4 strands of barbed wire with wooden fence posts, interlaced with thorny bushes at vulnerable points. Maintenance has been provided for a period of 7 years. The unit cost for enrichment plantation including maintenance cost for seven years is estimated to be Rs. 1,12,505/- per ha consisting of Rs. 72,065/- for plantation and Rs. 40,440/- for maintenance for seven years.

c) Pasture Development

As there are degraded patches of pasture in the area, this measure will be adopted to encourage development of new and healthy pastures for use of cattle of the area. Barren land with greater slopes has been recommended to be treated by developing pastures over them. Under this treatment, suitable species of grasses and leguminous plant species be planted in the land area earmarked for the purpose. Maintenance has been provided for a period of 7 years. The unit cost for pasture development including maintenance cost for seven years is estimated to be Rs. 63,435/- per ha consisting of Rs. 40,400/- for plantation and Rs. 23,035/- for maintenance for seven years.

d) Raising of native medicinal shrubs and herbs

Considering the local topography, soil conditions and climatic condition, at few places raising of native medicinal shrubs and herbs would be the appropriate measures instead of traditional pasture development. Propagation of medicinal plants is not only an innovative land use strategy, to address the livelihood issue of local people on sustainable basis, as it provides alternative income generating activities it also helps in un-situ conservation of medicinal plants. The unit cost for raising of native medicinal shrubs and herbs including maintenance cost for five years is estimated to be Rs. 1,52,710/- per ha consisting of Rs. 1,22,350/- for plantation and Rs. 30,360/- for maintenance for five years.

e) Assisted Natural Regeneration

It is important to enhancing the establishment of secondary forest from degraded grassland and shrub vegetation by protecting and nurturing the mother trees and their wildlings inherently present in the area. Assisted natural regeneration is proposed to accelerate, rather than replace, natural successional processes by removing or reducing barriers to natural forest regeneration such as soil degradation, competition with weedy species, and recurring disturbances (e.g., fire, grazing, and wood harvesting). Fencing should be done with 4 strands of barbed wire with wooden fence posts, interlaced with thorny bushes at vulnerable points. Maintenance has been provided for a period of 7 years. The unit cost for assisted natural regeneration including maintenance cost for seven years is estimated to be Rs. 51,025/- per ha consisting of Rs. 37,405/- for plantation and Rs. 13,620/- for maintenance for seven years.

Table 10.8: Description of Biological Treatment Measures

S. No.	Treatment Measure	Rate (Rs/ ha)
1	Normal Afforestation	1,67,235.00
2	Enrichment	1,12,505.00
3	Pasture Improvement	63,435.00
4	Raising of native medicinal shrubs and herbs	1,52,710.00
5	Assisted natural regeneration	51,025.00

10.2.1.4.2 Engineering Measures

Engineering measures are more effective in conserving soil and water when they are supplemented by vegetative methods. But in certain situations, only engineering measures can be proposed. Various engineering measures have been suggested for glaciers/ avalanches control, flood prone nalas, landslides/ landslips, treatment of nalas and soil and water conservation in private/ irrigated land in the catchment area (also refer **Table 10.9**). The engineering structures suggested are as follows:

- Check walls in wire crate with Bioengineering
- Check dams in wire crate with Bioengineering
- Bank Treatment by constructing Wire Crate spurs / Retaining walls in DRSM with Bioengineering
- DRSM stone fence wall

The cost norm for the engineering measures is enclosed as **Annexure VI**. These cost norm is as per the Schedule of Rates of Himachal Pradesh Forest Department and appropriate increase due to revision of daily wage rate.

a) Glaciers & Avalanches Control

Check walls have been suggested as retention structures which primarily consist of snow rakes and nets. As the class description implies, the driving purpose of these structures is to basically keep the snow where it sits. These structures are effective, but certainly do not beautify the landscape. They act as redistribution structures as well. These structures are used to stop, divert, confine or slow moving avalanches and glaciers.

b) Flood Control

Check walls in wire crate on both banks as well as on particular bank of Nalas and at mouth of Nalas have been proposed as flood protection measures. The purpose of these structures is to control stream bank erosion.

c) Treatment of Nalas

The rills, gullies and nalas on steeply sloping landscape are deepening and widening under the debris laden high velocity water flow. The landscape denudation and degradation are accentuating the problem of soil erosion in drainage lines. This also includes stream bank erosion in lower reaches. Check dams and a few places check walls of wire crate with bioengineering has been suggested to control the soil erosion in the nalas.

d) Soil & Water Conservation

At various locations it was noted that private/ irrigated lands have saturated soil profiles. The sub-surface flow moves down the slope and saturates the soil mass located on steep slopes below the irrigated lands. This saturation not only increases the weight of the soil mass but also reduces soil strength upon wetting. This phenomenon becomes the cause of soil erosion. Wire crate check walls have been proposed because they have the ability to provide long term stability and are efficient against the toe cutting.

The following type of check wall and check dams has been suggested in the areas prone to glaciers/ avalanches, landslides, soil erosion in private/ irrigated lands and for treatment of nalas:

- Height of wall: 1.5 m
- Base width: 1.0 m
- Top width: 0.6 m
- Length of wall: Varies from site to site
- Material: Made by locally available stones with wire mesh
- Costs: Rs 3,635/- Cum

The following type of check wall has been suggested in the flood prone nalas:

- Height of wall: 3.0 m
- Base width: 2.0 m
- Top width: 1.2 m
- Length of wall: Varies from site to site
- Material: Made by locally available stones with wire mesh
- Costs: Rs 3,635/- Cum

Table 10.9: Description of Engineering Treatment Measures

S. No.	Treatment Measure	Kind of Work	Material to be used	Length (m)	Height (m)	Width (m)		Rate (Rs/ Cum)
						Base	Top	
1	Avalanche Control	Retaining wall	Locally available stones with wire mesh	Varies from site to site	1.5	1.0	0.6	3,635
2	Flood Control	Retaining wall	Locally available stones with wire mesh	Varies from site to site	3.0	2.0	1.2	3,635
3	Treatment of Nalas	Check Dams & Retaining wall	Locally available stones with wire mesh	Varies from site to site	1.5	1.0	0.6	3,635
5	Soil Conservation	Retaining wall	Locally available stones with wire mesh	Varies from site to site	1.5	1.0	0.6	3,635

10.2.1.5 Physical and Financial Targets

Physical and financial target in respect of biological as well as engineering treatment measures are given in **Tables 10.10** and Table **10.11** respectively. The cost required for various treatment measures has been summarized in **Table 10.12**.

10.2.1.6 Silt Observation Points

Three silt observation locations for regular monitoring of silt load coming from Saichu Nala, Mahal Nala and Lujai Nala have been suggested which should be established in consultation with state forest department. This would ensure monitoring efficacy of implementation various treatments measures suggested as in CAT plan. Monitoring would be undertaken for a period of 10 years during CAT Plan implementation. Cost towards this should be kept in project estimates and could be taken as below:

- Cost of one laboratory – Rs. 6.00 lakh – Rs. 6.00 Lakh
- Cost of three huts (@ Rs 2,00,000/- per hut) – Rs. 6.00 lakh
- Cost for hiring services of three persons (Average salary- Rs 10,000/- per person per month for 10 years) = Rs. 36.00 lakh
- Consumables for the measurement Rs. 1.5 lakh per year for 10 years = Rs. 15.00 lakh

Total cost = Rs 63.00 lakh

In addition, silt monitoring has been started by various hydro developers on Main River in the basin and couple of old CWC sites have been monitoring silt data regularly. Hence, there would be sufficient data available to have a comparative analysis of silt load post implementation of various treatment measures.

10.2.1.7 Provision of Nurseries

In order to upgrade and strengthen to meet requirements for catchment area treatment plan interventions, provision have been made to upgrade 5 existing nurseries. Amount kept upgrading and strengthen these 5 nurseries is **Rs. 50.00 lakh** @ Rs. 10 lakh per nursery.

Table 10.10: Physical and Financial Targets for Biological Treatment Measures

S. No.	Name of Macro/ Micro-Watershed	Normal Afforestation		Enrichment Plantation		Pasture Development		Raising of Medicinal Herbs and Shrubs		Assisted Natural Regeneration		TOTAL	
		Phy. (ha)	Fin. (Rs.)	Phy. (ha)	Fin. (Rs.)	Phy. (ha)	Fin. (Rs.)	Phy. (ha)	Fin. (Rs.)	Phy. (ha)	Fin. (Rs.)	Phy. (ha)	Fin. (Rs.)
1	1D1D5a3 (Chalkot)	0	0	0	0	0	0	5	7,63,550	5	2,55,125	**10**	**10,18,675**
2	1D1D5a4 (Dheda)	20	33,44,700	10	11,25,050	30	19,03,050	10	15,27,100	40	20,41,000	**110**	**99,40,900**
3	1D1D5a5 (Sosar)	10	16,72,350	10	11,25,050	10	6,34,350	10	15,27,100	20	10,20,500	**60**	**59,79,350**
4	1D1D5a6 (Bindi)	0	0	0	0	0	0	0	0	5	2,55,125	**5**	**2,55,125**
5	1D1D5b2 (Lujai)	20	33,44,700	5	5,62,525	20	12,68,700	5	7,63,550	30	15,30,750	**80**	**74,70,225**
6	1D1D5c1 (Manjos)	15	25,08,525	10	11,25,050	20	12,68,700	10	15,27,100	0	0	**55**	**64,29,375**
7	1D1D5c2 (Mahal)	20	33,44,700	0	0	40	25,37,400	30	45,81,300	10	5,10,250	**100**	**1,09,73,650**
8	1D1D5c3 (Karyuni)	15	25,08,525	10	11,25,050	20	12,68,700	20	30,54,200	0	0	**65**	**79,56,475**
9	1D1D5c4 (Konsar)	5	8,36,175	0	0	0	0	0	0	5	2,55,125	**10**	**10,91,300**
10	1D1D5c5 (Galwat)	10	16,72,350	5	5,62,525	10	6,34,350	20	30,54,200	0	0	**45**	**59,23,425**
11	1D1D5d1 (Landhar)	10	16,72,350	5	5,62,525	20	12,68,700	5	7,63,550	0	0	**40**	**42,67,125**
12	1D1D5d2 (Hural)	5	8,36,175	5	5,62,525	20	12,68,700	5	7,63,550	0	0	**35**	**34,30,950**
13	1D1D5d3 (Bonkar)	10	16,72,350	5	5,62,525	10	6,34,350	5	7,63,550	10	5,10,250	**40**	**41,43,025**
14	1D1D5d4 (Cheni)	10	16,72,350	10	11,25,050	20	12,68,700	15	22,90,650	20	10,20,500	**75**	**73,77,250**
15	1D1D6a1 (Bherwas)	0	0	5	5,62,525	10	6,34,350	5	7,63,550	5	2,55,125	**25**	**22,15,550**
16	1D1D6a2 (Sidhani)	0	0	0	0	0	0	0	0	0	0	**0**	**0**
17	1D1D6a3 (Chasag)	10	16,72,350	0	0	10	6,34,350	10	15,27,100	10	5,10,250	**40**	**43,44,050**
18	1D1D6b1 (Hillaur)	10	16,72,350	10	11,25,050	20	12,68,700	10	15,27,100	0	0	**50**	**55,93,200**
19	1D1D6b2 (Hilu)	20	33,44,700	0	0	10	6,34,350	10	15,27,100	0	0	**40**	**55,06,150**
20	1D1D6b3 (Tarundi)	15	25,08,525	5	5,62,525	10	6,34,350	10	15,27,100	0	0	**40**	**52,32,500**
21	1D1D6c1 (Harruin)	10	16,72,350	0	0	20	12,68,700	10	15,27,100	0	0	**40**	**44,68,150**
22	1D1D6c2 (Saichu)	5	8,36,175	5	5,62,525	5	3,17,175	5	7,63,550	0	0	**20**	**24,79,425**
23	1D1D6c3 (Jambu)	10	16,72,350	5	5,62,525	10	6,34,350	5	7,63,550	0	0	**30**	**36,32,775**
24	1D1D7b1 (Mokna)	3	5,01,705	0	0	0	0	0	0	0	0	**3**	**5,01,705**
TOTAL		**233**	**3,89,65,755**	**105**	**1,18,13,025**	**315**	**1,99,82,025**	**205**	**3,13,05,550**	**160**	**81,64,000**	**1018**	**110230355**

Table 10.11: Physical and Financial Targets for Engineering Treatment Measures

S. No.	Name of Macro/ Micro-Watershed	Avalanche Control		Flood Control		Treatment of Nalas		Soil Conservation		TOTAL	
		Phy. (Cum)	Fin. (Rs)	Phy. (Cum)	Fin. (Rs)	Phy. (Cum)	Fin. (Rs)	Phy. (Cum)	Fin. (Rs)	Phy. (Cum)	Fin. (Rs)
1	1D1D5a3 (Chalkot)	0	0	0	0	0	0	120	4,36,200	**120**	**436200**
2	1D1D5a4 (Dheda)	800	29,08,000	0	0	300	10,90,500	180	6,54,300	**1280**	**4652800**
3	1D1D5a5 (Sosar)	250	9,08,750	0	0	60	2,18,100	240	8,72,400	**550**	**1999250**
4	1D1D5a6 (Bindi)	0	0	0	0	0	0	0	0	**0**	**0**
5	1D1D5b2 (Lujai)	800	29,08,000	0	0	0	0	0	0	**800**	**2908000**
6	1D1D5c1 (Manjos)	2,000	72,70,000	0	0	0	0	2,600	94,51,000	**4600**	**16721000**
7	1D1D5c2 (Mahal)	1,000	36,35,000	2,400	87,24,000	0	0	2,600	94,51,000	**6000**	**21810000**
8	1D1D5c3 (Karyuni)	900	32,71,500	0	0	0	0	720	26,17,200	**1620**	**5888700**
9	1D1D5c4 (Konsar)	1,500	54,52,500	0	0	0	0	300	10,90,500	**1800**	**6543000**
10	1D1D5c5 (Galwat)	400	14,54,000	2,400	87,24,000	0	0	2,100	76,33,500	**4900**	**17811500**
11	1D1D5d1 (Landhar)	400	14,54,000	0	0	0	0	240	8,72,400	**640**	**2326400**
12	1D1D5d2 (Hural)	0	0	0	0	120	4,36,200	240	8,72,400	**360**	**1308600**
13	1D1D5d3 (Bonkar)	500	18,17,500	0	0	104	3,78,040	0	0	**604**	**2195540**
14	1D1D5d4 (Cheni)	0	0	0	0	0	0	0	0	**0**	**0**
15	1D1D6a1 (Bherwas)	2,000	72,70,000	2,400	87,24,000	120	4,36,200	0	0	**4520**	**16430200**
16	1D1D6a2 (Sidhani)	0	0	0	0	0	0	0	0	**0**	**0**
17	1D1D6a3 (Chasag)	0	0	0	0	0	0	840	30,53,400	**840**	**3053400**
18	1D1D6b1 (Hillaur)	1,000	36,35,000	0	0	264	9,59,640	0	0	**1264**	**4594640**
19	1D1D6b2 (Hilu)	800	29,08,000	0	0	180	6,54,300	0	0	**980**	**3562300**
20	1D1D6b3 (Tarundi)	0	0	3,000	1,09,05,000	0	0	0	0	**3000**	**10905000**
21	1D1D6c1 (Harruin)	0	0	0	0	0	0	0	0	**0**	**0**
22	1D1D6c2 (Saichu)	0	0	0	0	0	0	0	0	**0**	**0**
23	1D1D6c3 (Jambu)	0	0	2,400	87,24,000	300	10,90,500	0	0	**2700**	**9814500**
24	1D1D7b1 (Mokna)	0	0	0	0	0	0	0	0	**0**	**0**
TOTAL		**12,350**	**4,48,92,250**	**12,600**	**4,58,01,000**	**1,448**	**52,63,480**	**10,180**	**3,70,04,300**	**36578**	**132961030**

Table 10.12: Cost of Treatment Measures

S. No.	Name of Macro/ Micro-Watershed	Cost of Treatment Measures		Total Amount (Rs.)
		Biological Measures	Engineering Measures	
1	1D1D5a3 (Chalkot)	10,18,675.00	4,36,200.00	**10,18,675.00**
2	1D1D5a4 (Dheda)	99,40,900.00	46,52,800.00	**99,40,900.00**
3	1D1D5a5 (Sosar)	59,79,350.00	19,99,250.00	**59,79,350.00**
4	1D1D5a6 (Bindi)	2,55,125.00	0.00	**2,55,125.00**
5	1D1D5b2 (Lujai)	74,70,225.00	29,08,000.00	**74,70,225.00**
6	1D1D5c1 (Manjos)	64,29,375.00	1,67,21,000.00	**64,29,375.00**
7	1D1D5c2 (Mahal)	1,09,73,650.00	2,18,10,000.00	**1,09,73,650.00**
8	1D1D5c3 (Karyuni)	79,56,475.00	58,88,700.00	**79,56,475.00**
9	1D1D5c4 (Konsar)	10,91,300.00	65,43,000.00	**10,91,300.00**
10	1D1D5c5 (Galwat)	59,23,425.00	1,78,11,500.00	**59,23,425.00**
11	1D1D5g1 (Landhar)	42,67,125.00	23,26,400.00	**42,67,125.00**
12	1D1D5g2 (Hural)	34,30,950.00	13,08,600.00	**34,30,950.00**
13	1D1D5g3 (Bonkar)	41,43,025.00	21,95,540.00	**41,43,025.00**
14	1D1D5g4 (Cheni)	73,77,250.00	0.00	**73,77,250.00**
15	1D1D6a1 (Bherwas)	22,15,550.00	1,64,30,200.00	**22,15,550.00**
16	1D1D6a2 (Sidhani)	0.00	0.00	**0.00**
17	1D1D6a3 (Chasag)	43,44,050.00	30,53,400.00	**43,44,050.00**
18	1D1D6b1 (Hillaur)	55,93,200.00	45,94,640.00	**55,93,200.00**
19	1D1D6b2 (Hilu)	55,06,150.00	35,62,300.00	**55,06,150.00**
20	1D1D6b3 (Tarundi)	52,32,500.00	1,09,05,000.00	**52,32,500.00**
21	1D1D6c1 (Harruin)	44,68,150.00	0.00	**44,68,150.00**
22	1D1D6c2 (Saichu)	24,79,425.00	0.00	**24,79,425.00**
23	1D1D6c3 (Jambu)	36,32,775.00	98,14,500.00	**36,32,775.00**
24	1D1D7b1 (Mokna)	5,01,705.00	0.00	**5,01,705.00**
TOTAL		**11,02,30,355.00**	**13,29,61,030.00**	**24,31,91,385.00**

10.2.1.8 Cost of Other Components of CAT Plan

Apart from the biological and engineering treatment measures in the catchment area there are other aspects of the CAT Plan to be addressed and their cost included in the overall cost estimate of the plan. The eco-restoration works, livelihood support works, social mobilization, documentation and publication, monitoring and evaluation and providing environmental services are some of the integral ingredients which have to be considered and included while formulating the CAT plans. The CAT plan has been formulated in the light of guidelines issued by the Department of Forest, Himachal Pradesh, vide Notification No. FFE-B-F-(2)-72/2004-Pt-II Shimla, dated 30-09-2009. amended vide Notification No. FFB-B-F-(5)-9/2017 dated 21.11.2019. Modifications have been made wherever necessary

10.2.1.8.1 Operational Support

For an efficient management of forest resources, it is essential that operational support to the Forest Department is adequately developed. Similarly, in remote localities of the division there are no places for shelter for the staff, people and trekkers. Therefore, a budget provision of **Rs. 120.00 lakh** has been kept.

10.2.1.8.2 Forest Protection

The need for rigorous watch and ward of the forest covered under the catchment area becomes more imperative in view of proposed new plantation under the CAT plan and due to increased human activity in the form of labour, who shall be engaged for forestry works. Thus, fire protection measures including construction and maintenance of fire lines, construction of check-posts, watch towers have to be undertaken. Besides these, construction / repair of forest boundary pillars and infrastructure shall also be carried out. A total provision of **Rs. 490.00 lakh** is being made under various heads for Forest Protection measures. The details are as follows:

10.2.1.8.3 Energy Saving Devices

In order to address the monitoring problem of energy scarcity and its immediate adverse fall out on the forests, the local people have to be provided energy-efficient alternatives. Under the CAT Plan, provision is being made for distribution of energy-saving devices to the BPL families & weaker section on a cost-sharing pattern. Under this component, LPG connections, Pressure Cookers, Fuel-efficient Tandoors etc. would be made available to the catchment dwellers, to reduce the pressure on the adjoining forests & to inculcate a culture of energy efficiency & environmentally friendly approaches. The total provision of **Rs. 100.00 lakh** is being made for the purpose.

10.2.1.8.4 Provision for Micro Plans

Based on the ground truth reality in each of the village forest department committee or society under different sub-watersheds, comprehensive micro plan for execution of the work has to be prepared as per norms. For this purpose, a provision of **Rs. 20.00 lakh** is being made.

10.2.1.8.5 Publicity and Awareness

Mass awareness and education programme in the project area villages is a must to reduce anthropogenic pressure. Education and awareness generation programmes for garnering public support for biodiversity conservation is the need of the day. Community education and involvement is a crucial component of a biodiversity conservation strategy because the condition of the environment is reflected by the manner in which the communities treat and manage the natural resources.

Under this programme, various activities viz. trainings, publishing of research documents, pamphlets, brochures, hoardings, etc. shall be carried out during the implementation period of CAT plan. Awareness should be imparted to the school teachers in the area for introduction of environment education among the school children and exchange of knowledge on environment and ecology between the monastic and village school. The basic purpose of this is to create awareness among young generation and also among the local villagers so as to protect the wildlife for future generation.

Biodiversity education and community awareness will therefore be strengthened in a variety of ways to reach people of all sections. Activities like opening of biodiversity register in every village and promotion of traditional farming, advertisement of hazardous effect of fire through press, sign boards and public meetings will form the important activities under this component. A provision of **Rs. 80.00 lakh** has been kept for the purpose.

10.2.1.8.6 Training to Forest Staff

The specialized training and study tours for forest officials / officers, who are executing the plan will be provided. The objective of this training component would be to provide the officers and the staff to augment their skills, professional knowledge, capacity building to be effective and efficient. The basic components of capacity building include:

- Developing human resources through training and education.
- Generate new information for better knowledge and understanding.
- Providing an adequate institutional framework and material support to enable acquired skills to be fully utilized.

Training for staff will be organized at the Forest Training Institutes of HP Forest Department, where services of resource persons from specialized institutions / organizations in the field of Soil & Water Conservation, Information Technology, Environment, Socio-economic issues etc. would be utilized for imparting practical training to the forest field staff & also communities. The provision for outlay of **Rs. 120.00** lakh has been allocated under the scheme.

10.2.1.8.7 Provision for Forestry Research

The provision for outlay of **Rs. 150.00 lakh** has been allocated under the scheme.

10.2.1.8.8 Eco-Tourism

Ecotourism has come to be regarded as a type of responsible tourism where tourists, as individuals or in small groups, venture into lesser known destinations to enjoy the nature in its pristine form along with gaining understanding of local cultures and customs in such a way as to cause minimum impact on the nature and the local culture. Since ecotourism entails understanding of local culture, it involves local communities living in their usual lifestyles and provides them a livelihood option. Subscription to ecotourism does not envisage large scale investments on the part of local communities and it remains a low cost low impact operation. As ecotourism is essentially based on Nature and managed by the local communities, it provides an incentive to the local communities to protect and sustainably manage the landscape.

Himachal Pradesh, a paradise of scenic beauty with very hospitable local communities, forms an ideal ecotourism destination. As the word is spreading, more and more eco-tourists are thronging the State to enjoy Himalayan landscape and the variety of local cuisine and folk dances. The Forest Department of Himachal Pradesh, realizing the potential of ecotourism in the State, has enunciated a Policy on Development of Eco-tourism in Himachal Pradesh (2005), Re-Revised in the year 2017, wherein blueprint for development of ecotourism in the State has been provided. The policy is based on the understanding that involvement of local communities in eco-tourism would support their livelihood needs and consequently create a stake for them in the conservation of local culture, ecology and environment.

Strategy for Developing Ecotourism

In the first two years of the project a study would be conducted to access the Eco tourism potential & requirements of the area & to suggest a modus operandi for operationalizing Eco-tourism. The study on Eco-tourism would form part of the study being proposed under the PES component, though the implementation of the Action Plan on Eco-Tourism, emerging out of the PES study, would be done from the **Rs. 160.00 lakh** earmarked under this head.

10.2.1.8.9 Payment for Eco Services

Payment for Environmental Services (PES) is a tool to incentivize the local communities for sustainable and environmentally friendly use of the Catchment. The PES mechanisms suitable for the Dugar HEP Catchment Area would be identified by conducting a study on the issue, to identify the most appropriate routes and activities under PES. This study should be carried out in the first year of the Project and shall be approved by the Forest Department, before implementation. Hence, a small part of the PES funds is being allocated in the initial year of the implementation of the CAT Plan for getting this study conducted.

The actual implementation of the PES mechanisms, so identified by the approved study, shall begin then from the 2nd year of implementation of the CAT Plan. The interventions under the Eco-tourism head would also be defined through the PES study, though provisions for its implementation have been made separately under Eco-tourism head. A total provision of **Rs. 440.00 lakh** has been earmarked under PES.

10.2.1.8.10 Wildlife Protection, Management and Conflict Resolution

This area has been a subject of focused wildlife management. But as such specific problems associated with wildlife of the area have not been that well documented. This CAT Plan, therefore, provides a unique opportunity to document the wildlife of the area and initiate programs for management of wildlife habitats.

The Himalayan region is witnessing a very high and increasing biotic pressure causing degradation and fragmentation of its fragile habitats and putting the survival of many a plant and animal species under threat. Whereas much of this biotic pressure is on account of increased incidence of grazing, both local and migratory, fuel and fodder removals, and extraction of herbs; developmental projects like construction of roads, hydroelectric projects and transmission lines are also making significant contribution to this habitat degradation.

The developmental projects also bring in an influx of outside labour that is generally not concerned about the local environmental customs and traditions, causing damage to the local ecology through various acts of omission and commission including removal of biomass from forests and poaching. The wild animals become especially susceptible to poaching during winters when water sources tend to freeze at upper reaches, and they descend to lower slopes in search of water and food.

The areas hitherto inaccessible used to provide safe heavens to a variety of Himalayan fauna.

However, as more and more remote areas are getting connected with road network, even the remote habitats are coming under increased activity, causing threat to the populations of usually shy Himalayan fauna. It would need creating general awareness about conservation imperatives to ensure the long-term survival of Himalayan wildlife.

Detailed CAT plan interventions have been suggested in the areas. In addition, under the provision of other components of CAT plan, a provision of **Rs. 280.00 lakh** has been made for implementation of the Wildlife related activity for which the break-up is as follows:

Strategies

The following strategies are suggested under wildlife activities for the area:

1. Planning of wildlife component including formation of self help groups and formulation of CAT plan
2. Implementation of these measures
   a. Implementation of income generating programs/activities, awareness and energy saving measures
   b. Helping resolve man-animal conflict especially for farmers, including herd insurance schemes etc.
   c. Wildlife habitat management
3. Training
4. Research & Monitoring

The above shall also include providing for water holes, saltlicks, watch towers, growing of wild fruits, grazing control etc.

10.2.1.8.11 Monitoring & Evaluation

Monitoring and evaluation will be developed as in-built part of the project management. Thus, a process of self-evaluation at specified intervals of time will ensure the field worthiness and efficacy of the CAT Plan. The emphasis would be on Monitoring and impact studies of the works done under the plan.

A sum of **Rs. 160.00 lakh** has been provided for monitoring and evaluation. Under this component, independent consultants or third party evaluation will be done to make Base Line Survey, Mid-term Survey and end of project survey/evaluation to find out effectiveness of CAT Plan activities in the catchment area.

NOTE - Depending on the site specific requirements, changes in activities, within and across components, can be made by the field agencies with prior approval of the Principal Chief Conservator of Forests, Himachal Pradesh.

10.2.1.8.12 Eco Battalion

Eco Task Forces (ETF) are being raised under the aegis of Ministry of Environment and Forests and Ministry of Defense in conjunction with states on priority tasks for challenging assignments in the ecologically fragile and sensitive areas. The objective behind starting ETFs was to solve the twin problems of eco-regeneration and rehabilitation of ex- servicemen. Experimenting with deploying ex-servicemen for increasing the states green cover were attempted in 2010, when an Eco Task Force was constituted for carrying out a plantation drive in Satluj river basin. The eco-battalion was instrumental for launching a plantation drive in 2010 and about 1 lakh saplings supplied by the forest department had been planted over 200 hectares of grassland around Tattapani. Himachal Pradesh Government had drawn up plans of basing one eco-battalion in Ravi, Beas and Satluj river basin for increasing green cover, protecting flora and fauna and checking soil erosion. One such eco-battalion is proposed for free draining catchment area also. Based on the present evaluation on the eco-restoration work done by the ETFs the following recommendations have been made:

- Regular monitoring of the projects at every step by the Forest Department should be done so that the problem could be addressed on the spot.

- Mid and end term (immediately after the project) evaluations should become a regular feature of ETF projects. Midterm evaluation has greater significance over end-term because any shortcoming if found during the mid-term evaluation would be immediately taken care of during the project period itself.

- Timely supply of materials ensures timely completion of project activities with the desired results. There should be mutual trust between the defense and Forest Department for supply of material.

- The Village Forest Committee (VFC) should be formed by the forest department to ensure the sustainability of the plantations, after that the plantation should be handed over to the department. ETFs may also try to form Village Forest Project Management Committees (VFPMCs) from the very first year in collaboration with the Forest Department for effective protection of the area and start giving them benefits of grass and fuel from the area. The ETFs should continue their watch and ward till effective VFCs are formed. They may claim additional expenditure for maintenance after 3 years. As long as ETFs are protecting the area, the success standard is high. After handing over the raised plantation may get a setback if VFCs do not cooperate fully.

- In order to make the work of ETF sustainable, it is important that VFCs are constituted either before or during the deployment of ETF in the area. For this certain percentage of the cost may be allowed as Entry Point Activities (EPAs) for rapport building. ETF personal should also ensure the participation of local community in selection of species for plantation, implementation and more important in protection also.

- Officers and Jawans of ETF have felt the need of training on technical aspects of forestry. Such trainings should be conducted on a regular basis through short training courses by the Forest Department. This would greatly enhance the competence level of the personnel in the field and result in quality work. It would be more beneficial if the department groom some personal of ETF and nurture them as a “Master Trainer”. The same will be cost effective and more purposeful.

- An important aspect of the Eco-restoration work by ETF is the benefits accruing to the local communities in the form of fuel, fodder and timber. No doubt the project has been successful to an extent in meeting the above mentioned needs of the people but nothing can be said without quantification of benefits reaching up to the people. This is because there is no data on the quantity supplied, collected or consumed by the communities. Therefore, it is suggested that to have an estimate of the quantum of direct benefits reaching to the people, the collection and consumption of usufructs be recorded/ quantified by the ETF till the time of handed over of area to the Forest Department. There should be clear cut resolutions for usufruct sharing mechanism.

- It would certainly be of immense help to record changes in the micro climate of the area to know the exact status of ecological restoration. This can be done in collaboration with the meteorological office of the area concerned and collection of climatic data and increased flow in lower streams, increased agriculture and dairy production in nearby villages for which data needs to be collected, regularly both by ETFs and the Forest Department.

- The establishment cost also included in plantation cost in assessing the cost per hectare of plantation carried out by the ETF. Whereas in case of Forest Department no establishment cost taken into consideration at the time of assessing per hectare cost of plantation. Therefore, the per hectare cost of ETF plantation come higher than forest department. It would be better, if MOEF&CC suggest them to maintain two separate records one for planting operation and one for establishment. The same will also be helpful in assessing the actual per hectare funds spent by the ETF as well as Forest Department

- Record Maintenance is one of the areas, which require immediate attention. Maintenance of information in the form of organized records, makes retrieval of data for reference, analysis etc., easy. A systematic report also ensures smooth flow of information in an organization and forms the basis of an efficient Management Information System (MIS). It was found that it has already been mentioned earlier that records of afforestation and pasture development like plantation journals, numbers of different species planted under different components, etc. have not been maintained properly. Even the financial detail of the money spent on the material support to ETF for which the State Forest Department is responsible is available only for few years. Therefore, periodic maintenance of records is a must.

- It was found that on an average an officer is stationed at the headquarters for a period of two to three years when the project period is of more than 5 years duration. Moreover, when an officer joins the unit, he is usually ignorant to the concepts of forestry and gradually acquaints himself in subsequent years. However, by the time he gets well versed and starts delivering results he is transferred and a new officer with little or no knowledge of forestry takes charge. In this way, the new officer starts working from scratch. This has been the usual administrative practice and has been affecting work to a great extent. There should be an average of five year tenure posting of officers in such areas.

- According to Territorial Army norms, it is not possible to have the same officer for the whole duration of the project, but the service tenure of an officer can and should be increased to four to five years so that he is able to deliver the desired results.

- The ETFs may consider employing retired Forest Rangers, Foresters and Forest Guards in equivalent grades of the ETF for strengthening technical knowhow of their people and better control in the work.

A provision of **Rs. 200.00 lakh** has been kept under this component.

10.2.1.8.13 Contingencies

A provision of **Rs. 255.00 lakh** has been kept under this component for some leeway to adjust any unforeseen expenditure.

10.2.1.9 Cost Estimate

The cost required for Catchment Area Treatment is **Rs. 50.90 Crore**. The details are given in **Table 10.13**. The year wise physical and financial targets are given in **Annexure VII**.

Table 10.13: Cost Estimate of CAT Plan

Treatment Measures	Physical	Financial (Rs)
Biological Measures (ha)		
Afforestation	233	3,89,65,755.00
Enrichment Planting	105	1,18,13,025.00
Pasture Development	315	1,99,82,025.00
Raising of Medicinal Herbs	205	3,13,05,550.00
Assisted Natural Regeneration	160	81,64,000.00
Upgradation of existing nurseries (nos.)	5	50,00,000.00
TOTAL (I)		**11,52,30,355.00**
Engineering Measures (cum)		
Avalanche Control	12,350	4,48,92,250.00
Flood Control	12,600	4,58,01,000.00
Treatment of Nalas	1,448	52,63,480.00
Soil & Water Conservation	10,180	3,70,04,300.00
Silt Observing Points (nos.)	3	63,00,000.00
TOTAL (II)		**13,92,61,030.00**
OTHER COMPONENTS OF CAT PLAN		
Operational Support		1,20,00,000.00
Forest Protection Plan		4,90,00,000.00
Energy Saving Devices		1,00,00,000.00
Provisions for Micro Plans		20,00,000.00
Publicity and Awareness		80,00,000.00
Training of Forest Staff		1,20,00,000.00

Treatment Measures	Physical	Financial (Rs)
Provision for Forestry Research		1,20,00,000.00
Eco Tourism		1,60,00,000.00
Payment for Eco Services		4,40,00,000.00
Wildlife Protection, Management and Conflict Resolution		2,80,00,000.00
Monitoring & Evaluation		1,60,00,000.00
Eco Batallion		2,00,00,000.00
Contingencies		2,55,00,000.00
TOTAL (III)		**25,45,00,000.00**
TOTAL CAT PLAN COST (Rs) (I+II+III)		**50,89,91,385.00**
OR SAY		**50,90,00,000.00**

Section 10.2.2 COMPENSATORY AFFORESTATION PROGRAMME

10.2.2 COMPENSATORY AFFORESTATION PLAN

The Duagr HEP is being constructed in the jurisdiction of Pangi Forest Division in Chamba district, Himachal Pradesh. The total land required for the construction of proposed project activities is approximately **220.62 ha** with **211.2487 ha** of forestland and **8.78 ha** of private land (**Table 10.14**).

Table 10.14: Details of the Land to be acquired for Dugar HEP

S. No	Land Type	Area (ha)
1	Forest Land	211.84
2	Private land	8.78
Total		**220.62**

Source: DPR Dugar HEP

10.2.2.1 Compensatory Afforestation Programme

The objective of the compensatory afforestation programme will be to develop natural areas in which ecological functions could be maintained on sustainable basis. Therefore, planting of indigenous species would be undertaken. The compensatory afforestation is proposed to be done mainly in those forest blocks where degraded land and forest blanks are available for planting.

The Forest Conservation Act, 1980 stipulates strict forest protection measures and procedures (Guide Line 1/08-1 (ii)) for compensatory afforestation on acceptance of diversion of forestland for non-forestry purposes.

i. If non-forest land is not available, compensatory plantation is to be raised on degraded forest land to the extent of twice the affected or lost forest area, and
ii. If non-forest land is available, the extent of compensatory plantation will be equivalent of the affected or lost forest area.

As per the above guidelines compensatory Afforestation has been proposed on degraded forest land to the extent of twice the proposed forest land for diversion. This works out to 423.684 ha **[211.842 ha x 2 = 423.684 ha]**. Thus, compensatory afforestation is to be taken up on **423.684 ha** of land in the denuded or degraded forest areas.

The estimated cost of Compensatory Afforestation programme including maintenance for 7 years is **Rs. 6,20,58,797 lakh**.

Table 10.15: Cost Estimates of Compensatory Afforestation Plan*

	Particulars	Area (ha)	Rate/ ha for plantation (Rs.)	Total Amount (Rs.)
A	Plantation	423.684	98785/-	4,18,53,624/-
B	Maintenance for Seven Years	423.684		2,02,05,173/-
	Total			**6,20,58,797/-**

10.2.2.2 NET PRESENT VALUE (NPV)

The Hon'ble Supreme Court of India has made it mandatory vide its order dated 28.03.2008 for the user agency to compensate for the diversion of forest land for non-forest use for developmental activities on the recommendations of Central Empowered Committee (CEC) to make payment of Net Present Value (NPV) of such diverted land so as to utilize this for getting back in the long run which are lost by such diversion.

For this purpose CEC has classified the forest taking in view the ecological role and value of the forest and the purpose of the report, 16 major forest types have been further grouped into 6 ecological classes depending upon their ecological functions (refer. Revision of rates of NPV applicable for different class/category of forests 2014).

1	**Eco-Class I**	Consisting of Tropical Wet Evergreen Forests, Tropical Semi Evergreen Forests and Tropical Moist Deciduous Forests
2	**Eco-Class II**	Consisting of Littoral and Swamp Forests
3	**Eco-Class III**	Consisting of Tropical Dry Deciduous Forests
4	**Eco-Class IV**	Consisting of Tropical Thorn Forests and Tropical Dry Evergreen Forests
5	**Eco-Class V**	Consisting of Sub-tropical Board Leaved Hill Forests, Sub-Tropical Pine Forests and Sub Tropical Dry Evergreen Forests
6	**Eco-Class VI**	Consisting of Montane Wet Temperate Forests, Himalayan Moist Temperate Forests, Himalayan Dry Temperate Forests, Sub Alpine Forest, Moist Alpine Scrub and Dry Alpine Scrub

The net present value per hectare of forest has been fixed based on this data.

Based on this, the NPV was fixed and the following recommendations have been made:
For non-forestry use/diversion of forest land, the NPV may be directed to be deposited in the Compensatory Afforestation Fund as per the rates given below **(in Rs.).**

Eco-Value class	Very Dense Forest	Dense Forest	Open Forest
Class I	10,43,000	9,39,000	7,30,000
Class II	10,43,000	9,39,000	7,30,000
Class III	8,87,000	8,03,000	6,26,000
Class IV	6,26,000	5,63,000	4,38,000
Class V	9,39,000	8,45,000	6,57,000
Class VI	9,91,000	8,97,000	6,99,000

Total forest land requirement for diversion for non-forest use i.e. for the construction of Dugar HEP activities is **221 ha** (**Refer Table 10.16**). As the forest in the project area fall in the **Eco Class VI** as being of type Himalayan Dry Temperate Forests therefore NPV @ Rs. 9.91 lakh/ha would be required to be deposited in the Compensatory Afforestation Fund. The total cost of NPV has been computed as under. Himalayan Dry Temperate Forests.

Table 10.16: Cost Estimates of NPV

Forest Land (Area in ha)	Eco Class	Rate (Rs.)	NPV to be deposited (Rs.)
200.542	VI (Very Dense Forest)	9.91 lakh per ha	19,87,37,122/-
110.30	VI (Open Forest)	6.99 lakh per ha	78,98,700/-
Total NPV to be deposited			**20,66,35,822/-**

10.2.2.3 ABSTRACT OF COST

The total cost of the compensatory afforestation plan, NPV, compensation of trees and cost of damage to fence and infrastructure is Rs**. 2686.95 lakh**. The details are given in **Table 10.17.**

Table 10.17: Total Cost

Sl. No.	Particulars	Amount (Rs. in lakh)
1	Compensatory Afforestation	6,20,58,797/-
2	Net Present Value (NPV)	20,66,35,822/-
Total		**26,86,94,619/-**

Section 10.2.3 BIODIVERSITY AND WILDLFIE CONSERVATION AND MANAGEMENT PLAN

10.2.3 BIODIVERSITY AND WILDLIFE CONSERVATION & MANAGEMENT PLAN

The main objective of the Biodiversity Conservation and Wildlife Management plan is the sustainable use of natural resources which involves scientific management of natural wealth vis-à-vis developmental activities that are likely to affect these resources. The threats to biodiversity generally arise due to anthropogenic activities that may arise as a result of the development activities of the Dugar HEP. Therefore, Biodiversity Conservation & Wildlife Management plan has been formulated for the conservation and management of the forest ecosystems in the vicinity of proposed project.

Keeping in view of the anticipated impacts of proposed project on the biodiversity of area, the main objectives of biodiversity conservation and wildlife management plan are as follows:

i. Conservation and preservation of natural habitats in and around project area
ii. Mitigation and control of project induced biotic and/or abiotic pressures/ influences that may affect the natural habitats,
iii. Creating all round awareness regarding conservation and ensuring people's participation in the conservation efforts and minimizing man-animal conflict.
iv. Habitat Conservation and Management of Schedule-I species reported from the project area

Following are the measures suggested for the said plan:

i. Wildlife Habitat Preservation & Improvement
ii. Establishment of Eco Park
iii. Biological fencing
iv. Prevention and Control of Forest Fire
v. Development of Grazing land/ Pastures
vi. Awareness promotion
vii. Strengthening of Infrastructural Facilities of Forest Department
viii. Biodiversity Management Committee (BMC)

Detail biodiversity conservation plan along with conservation plan for Schedule-I species is enclosed as **Annexure VIII.**

The estimated cost of implementation of various activities envisaged in the Biodiversity Conservation and Management Plan would be **Rs. Rs. 173.36 lakh** (**Table 10.18)**

Table 10.18: Break-up for Wildlife Management and Conservation Plan for Schedule I Species

S.No.	Activity	Fund Allocated (Rs in Lakh)
A	Biodiversity Conservation and Management Plan	138.36
B	Conservation Plan for Schedule-I Species	25.00
C	Monitoring and Evaluation	10.00
	Total	**173.36**

Section 10.2.4 FISHERIES DEVELOPMENT PLAN

10.2.4 FISHERIES DEVELOPMENT PLAN

In a publication by ZSI (2010-2011) and Cumulative Environmental Impact Assessment Study of Chenab Basin in Himachal Pradesh, reported that there are no records of fishes even from Pangi valley. During the present surveys also no fish species could be recorded from any of the stretch of Chenab River. Catchment of Chenab River is bestowed with rich water resources in the form of rivers and rivulets, but high potential of water bodies does not reflect any Ichthiyofauna. Absence of fish can be attributed to harsh climatic conditions like extremely low temperatures and turbulent nature of the Chenab River with high water discharge.

i. Strategy for Introduction and Management of Fishery Resources

The reservoir is expected to retain water throughout the year and offers an opportunity for fishery development to help in the increasing employment potential. Reservoir area of proposed Dugar HEP will spread over an area of 1.065 sq.km. Thus, there is an opportunity of introduction and development of reservoir fisheries in the area.

To explore the possibility of reservoir fisheries in Chenab River and its tributaries, it is proposed that detailed study will be carried out by State Fisheries Department along with Directorate of Coldwater Fisheries Research, Bhimtal. The introduction and management of reservoir fisheries will carry out under supervision of State Fisheries Department.

Budgetary provision of **Rs. 40.00 lakh** was proposed to explore the possibility of reservoir fisheries in the proposed reservoir of Dugar HEP.

Section 10.2.5 MUCK MANAGEMNT PLAN

10.2.5 MUCK MANAGEMENT PLAN

The construction would involve about 3,70,880 cum of soil excavation and 9,23,970 cum of rock excavation. About 60% of rock excavation is expected to be used for producing coarse and fine aggregate for concrete production and in fillings for developing areas for construction facilities. The total quantity of excavation in common soil and balance quantity of rock excavation would have to be disposed of in designated muck disposal areas. Thus, considering swell factors 0.63 for rock and 0.80 for common soil as adopted from CWC Guidelines and redeposit compaction factor of 83%, the total muck disposal to be disposed of is **716676 Cum** (see **Table 10.19**).

Table 10.19: Total quantity of muck to be disposed off

S. No.	Particulars	Soil	Rock
1	Total Excavation (Cum)	370880	923270
2	Less Used in Production of Aggregates (Cum)		553962
3	Balance To be Deposited (Cum)	378412	369308
4	Swell Factor, S	0.80	0.63
5	Re Deposition Factor, R	0.83	0.83
6	Quantity of Re deposits of Muck, (Q / S) x R, (Cum)	392602	486549
7	**Balance Muck for Disposal at Muck Disposal Sites, cum**	**392602**	**324074**
	Total muck to be disposed of (Cum)	**716676**	

Muck dumping plan involves careful selection of muck disposal site/s based upon environmentally sustainable guidelines, adopting suitable dumping methodology right from loading and transportation of muck from the excavation sites through 20T Rear Dumpers, management of dumping sites, and monitoring of muck disposal process to ensure minimum spillage during transportation, dumping, and compaction, and then finally rehabilitation of dumping sites through revegetation.

10.2.5.1 Criteria for Selection of Dumping Site

The following points were considered and followed for finalization of the area to be used as a dumping site:

- The dumping site was selected as close as possible to the project area to avoid long-distance transport of muck.
- Standard distance between each dumping site and from the High Flood Level is maintained as per condition of Statndard ToR, issued by MoEF&CC for Hydro Electric projects.
- The site is free from active landslides or creep and care has been taken that the site does not have a possibility of toe erosion and slope instability.

- The dumping site is either at a higher level than the flood level or is away from the river course so that the possibility of muck falling into the river is avoided.
- No active channel or stream is flowing through the dumping site.
- The site is far away from human settlement areas.

Keeping the above requirement, one muck disposal site has been identified downstream of the proposed powerhouse with a total area of 8.58 ha and capacity has been worked as 8,75,000 cum which is much more than the total quantity of muck to be disposed of (refer to **Figure 10.9**).

The area identified for dumping is planned on the banks of the nearest drainage and away from river HFL. The identified area is mostly gradually sloping near the riverbank. The drainage side bank of the area will be properly protected and stabilized with Gabions/ Retaining Walls of suitably designed sections (refer to **Figure 10.10**).

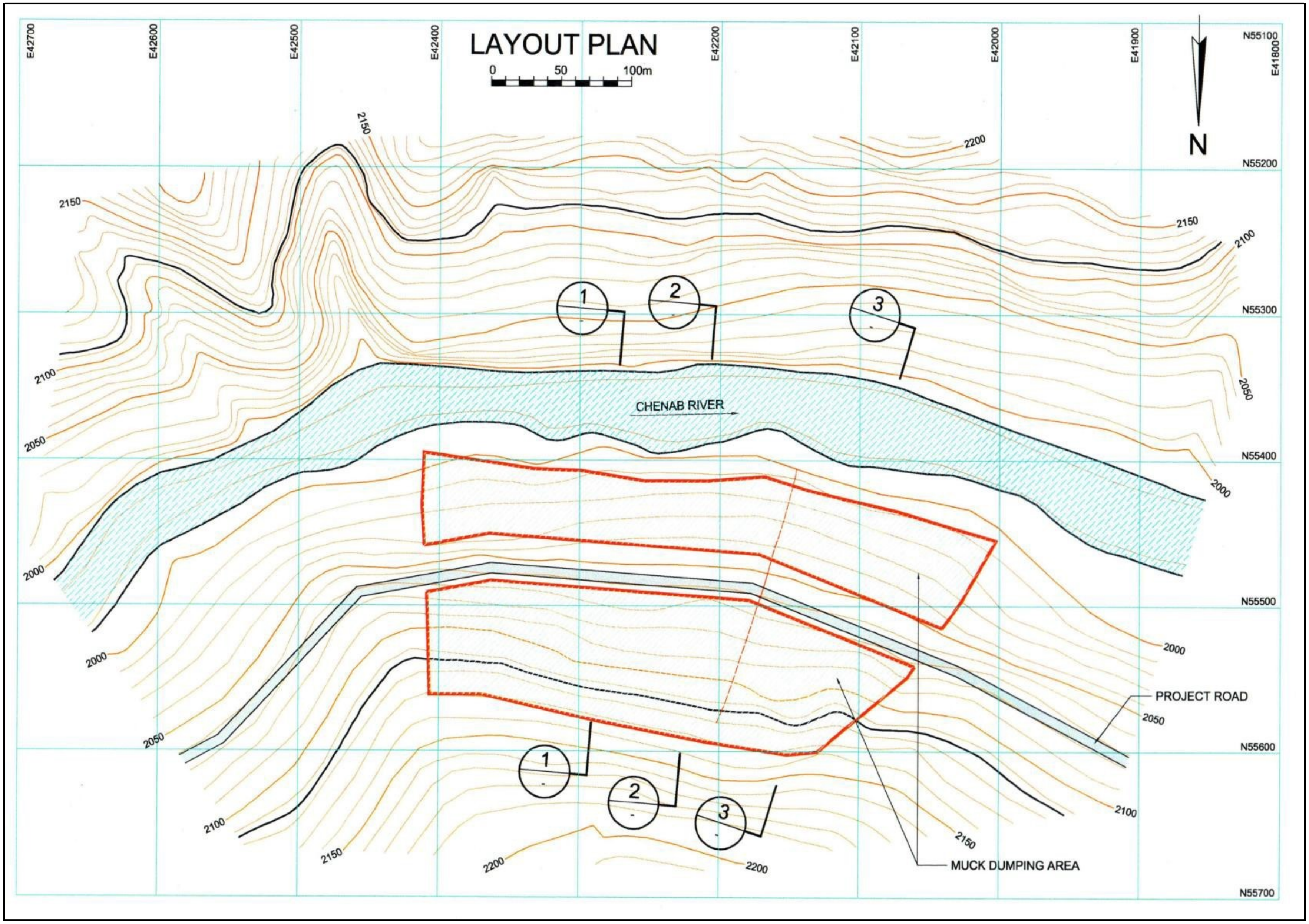


Figure 10.10: Layout of Muck Disposal area

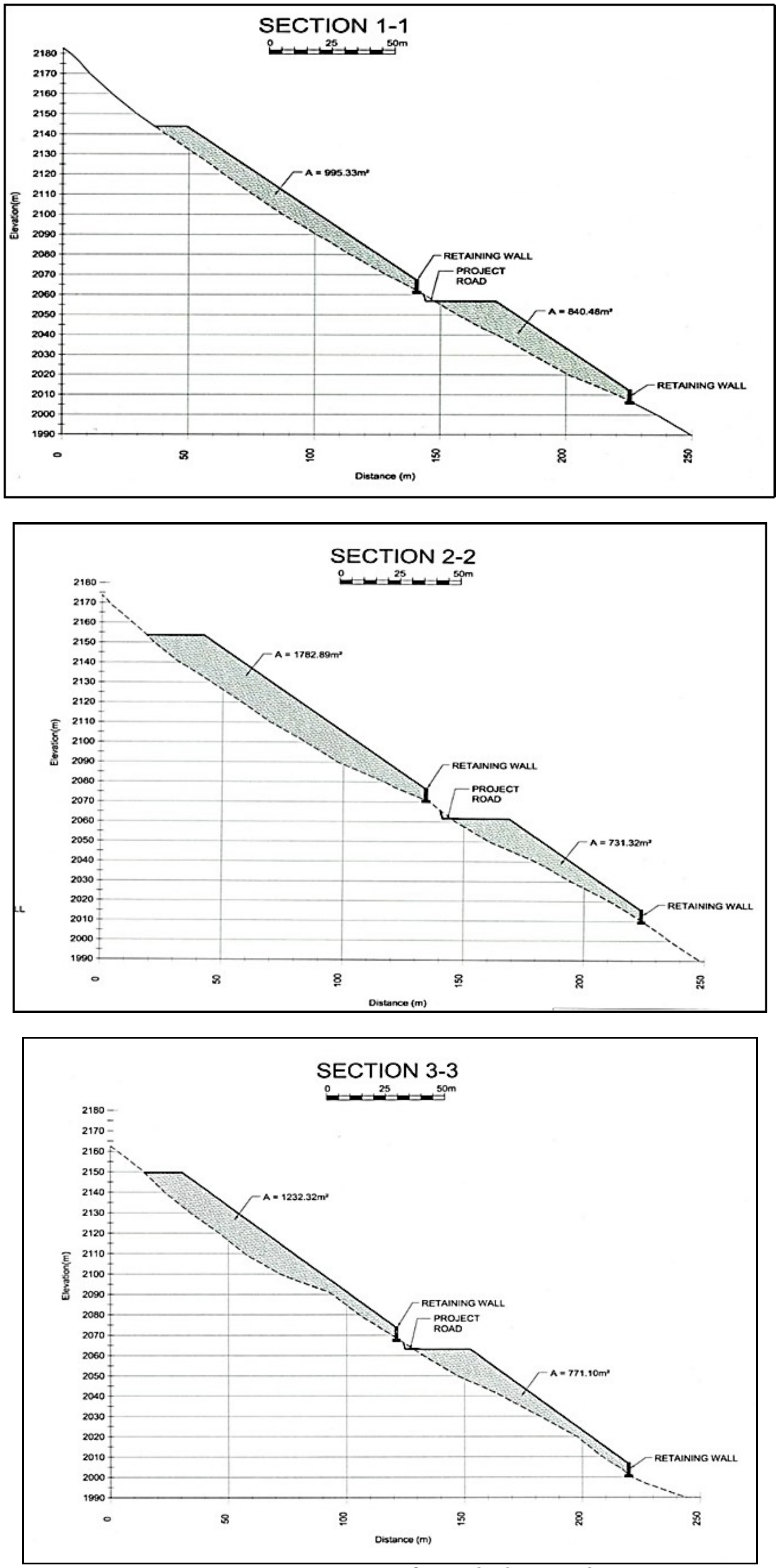


Figure 10.11: Sections of muck disposal area

10.2.5.2 Preparation of Muck Dumping Site

The muck that needs disposal would be piled at Ø (angle of repose) between 30° and 36° at the proposed dumping sites. For this, the slopes would be broken up by creating benches across the slope. This will be done to provide stability to the slopes and to provide ample space for planting trees, which would further help in holding and consolidating the material stacked at different sites. The description regarding the stabilization of the stacked material along the proposed roads has been discussed in the following paragraphs.

The dumping of muck shall be done in stages by allowing it to consolidate/settle through the monsoon, compacting the dumped muck with Bulldozer movement. The zoning of the dump will be done judiciously to ensure the stability of the 30° slope under all superimposed conditions.

10.2.5.3 Methodology of Dumping

The main objectives of the process of muck dumping and restoration of the muck disposal site are:

- to protect and control soil erosion.
- to create greenery in and around the muck disposal area.
- to improve and develop the site into a recreational site, if feasible.
- to ensure maximum utilization of muck for construction purposes.
- to develop the muck disposal sites/ dumping yards to blend with the surrounding landscape; and
- to minimise damages due to the spoilage of muck in the project area.

10.2.5.3.1 Transportation of Muck

The generated muck will be carried in dumper trucks covered with heavy-duty tarpaulin properly tied to the vehicle in line with international best practices. All precautionary measures will be followed during the dumping of muck. All dumpers will be well maintained to avoid any chances of loose material/soil falling during the transportation. All routes will be periodically wetted with the help of sprinklers before the movement of dump trucks. Dumping would be avoided during the high-speed wind, so that suspended particulate matter (PM_{10} and $PM_{2.5}$) levels could be kept under check. For this SPM levels need to be monitored during transportation. Further, dumping will be avoided if there is heavy traffic in the area. After the dumping, the surface of dumps will be sprayed with water with the help of sprinklers and then compacted.

The cycle time of 20T Rear Dumpers for loading and transportation of muck is given below.

Cycle time of 20 T Rear Dumper is as follows:

Activity	**Time taken (min.)**
Spotting time	1.0
Loading time	6.7
Transportation @ 20 kmph for 3.5 km	10.5
Unloading	1.0
Return @ 25 kmph	8.4
Total	27.6

Based upon the varying cycle time of 20T Rear Dumpers at different excavation sites and their distance from the disposal site appropriate pollution management will be devised. The Standard practices of pollution abatement and control will be enforced through the contractor.

For **716676** m^3 of muck, about 72000 truck trips will be required for muck transportation from point of generation to disposal site. This will be done over a period of 4 years; therefore for 300 working days per annum, about 60 trips per day will be required for disposal of muck.

10.2.5.3.2 Retaining Walls/ Stone Filled Wire Crates

Suitable retaining walls shall be constructed prior to dumping of muck, and terraces would be developed to support the muck on a vertical slope and for optimum space utilization. Loose muck would be compacted layer-wise. The muck disposal area will be developed in a series of terraces with retention walls. The terraces of the muck disposal area will be ultimately covered with fertile soil, and suitable plant species will be planted adopting suitable biotechnological measures.

For stacking of dumped material, concrete reinforced retaining walls are proposed to be built before dumping any material onto the sites (refer to **Figure 10.10**). In addition, leveling would also be done after dumping the material on every cycle and simultaneously improving the drainage of the disposal site.

All the approach roads from various project excavation sites to the dumping site will be constructed by employing the methodology recommended by Border Roads with minimal environmental damage. The methodology consists in developing the formation width is half cutting and half-filling, so that the materials obtained from cutting are utilised in filling. The excavation on the hillside will be done to get a stable slope for the materials encountered. At places breast wall, gabion walls shall be done in natural slope to retain filled material, particularly where there is the problem of retaining the hill slope.

A retaining wall and gabion structure shall be constructed to retain filled material. To minimize the environmental damage, construction materials like stones, sand, etc., required for the construction of the road will be obtained mostly from the excavated material. In the streams, box culverts will be provided to prevent the erosion of the Nala bed. In addition, stone/concrete work on the downstream area will also be provided at vulnerable places to minimize erosion.

The total area for the dumping of muck is **8.58 ha** which can accommodate more than **8.75 lakh** cum though the estimated muck to be disposed of is **7.17** lakh cum. At least two retaining walls are required to be built to accommodate the muck as a road traverse through the middle of the proposed dumping site. These retaining walls are proposed to be located at about 30.0m distance from the highest flood level. The total length of retaining walls proposed to be constructed along the river would be more than 1000 running meters. The height of these retaining walls including MSE wall panels will be approximately 10 m.

The retaining wall shall comprise 100 m thick PCC M10 base, RR Masonry blocks embedded in cement concrete (M10), and pressure relief holes at an angle of 50 for 1000 cc of discharge/drain holes of 50 cm provided for drainage.

10.2.5.3.3 Compaction

Compaction is an engineering measure, which would reduce bulk density of the muck thereby optimising the use of muck disposal area and would make it suitable for the plantation and other biological measures. The top surface would be leveled and graded to make the alternative use. The muck will be spread in layers of 500-700 mm thick layers. The top surface would be leveled and graded to make the alternative use. On top, a layer of soil would be spread to make the land suitable for plantation. The total cost for the process of compaction is **Rs. 50.00 lakh**.

The total financial outlay for the retaining walls and compaction is **Rs.605.27** lakh, and the breakup is given in **Table 10.20**.

Table 10.20: Estimated Cost of retaining walls construction

S. No.	Particular	Volume (cum)	Rate in Rs. per cum	Amount (Rs. in lakh)
1	Earthwork for foundation	20000	712	142.40
2	Cement concrete for retaining wall (M15)	2000	5332	106.64
3	R.R. Masonry (1:6)	4400	4529	199.27
4	Stone filled wire crates	4000	2674	109.96
5	Compacting and land leveling, etc.	Lumpsum	--	50.00
	Total			**605.27**

10.2.5.3.4 Fencing

After rehabilitation of muck, the dumping areas need protection for some time from disturbing by human and domestic animals. For this reason, fencing over the muck deposits is required. Barbed wire strands with two diagonal strands, clamped to wooden/ concrete posts placed at a 3m distance are proposed around the dumping piles. Project authorities will establish temporary wind barriers around 3 sides of dumps in nearby settlement areas.

10.2.5.3.5 Biological Measures

Vegetation cover controls the hydrological and mechanical effects on soils and slopes. Therefore, biological measures to stabilize the loose slope are essential. Top surfaces and slopes of all dumping areas would be left with a total area of about 8.58 ha. These areas will be treated for plantation. To implement the biological measures in dumping areas the following activities would be considered. The biological measures include the following:

i) Soil treatment

Muck dumped at the site is not nutrient-rich as it is excavated from tunnels and other structures. To make it suitable for the plantation it will be enriched through bio-treatment. The work plan will be formulated for the re-vegetation of the dumping sites through an Integrated Biotechnological Approach.

ii) Plantation

The selected species will be planted after their nurseries have been developed for catchment treatment plan implementation. Nearly 1-2 years old saplings would be used for the plantation. The plantation can be carried out in lines across the slopes. Grass and herb species would be used in the interspace of tree species. It will help in providing the continuous chain of support in retaining debris, reinforcing soil, and increasing the infiltration capacity of the area.

After the process of compaction total area of about 8.58 ha will be available for the plantation and the same shall be used for Plantation/ Greenbelt Development. About 8,500 saplings will be planted at the dumping site. The afforestation with suitable plant species of high ecological and economic value which can adapt to local habitat will be undertaken with 800-850 plants per ha depending upon the canopy cover required after consultation with the state Forest Department. However, a list of plant species has been given later in the chapter from which species recommended by the Forest Department can be selected. The estimated cost of biological measures is given in **Table 10.21**.

Table 10.21: Estimated Cost of biological measures

S. No.	Particulars	Quantity	Rate (in Rs.)	Amount (Rs. in lakh)
1	Rolling of Muck	Lump-sum		40.00
2	Pitting (size: 0.45 m x 0.45 m x 0.45 m)	8,500 pits	35.00/pit	2.98
3	Manure and soil filling in pits	8,500 pits	5.00/pit	0.42
4	Raising of plants (including nursery cost, manure, transport, etc.)	8,500 pits	25.00/plant	2.13
5	Fencing, maintenance, watering, transport, etc.	Lump-sum		20.00
	Total			**65.53**

10.2.5.4 Financial Outlay

The estimated cost of the muck management plan is **Rs. 670.80 lakh** (see **Table 10.22**).

Table 10.22: Financial outlay for the muck management plan

S. No.	Particulars	Amount (Rs. in lakh)
1	Engineering measures	605.27
2	Biological measures	65.53
	Total	**670.80**

Section 10.2.6 **LANDSCAPING AND RESTORATION PLAN**

10.2.6 LANDSCAPING AND RESTORATION PLAN

The proposed Dugar HEP on Chenab River would entail construction of various project components like the dam, diversion tunnel, coffer dams, etc. which would require a large quantity of construction material, the construction of infrastructural facilities like residential colonies for its staff, office, contractors, and labour colonies in addition to various access roads and other structures. During the construction phase of the project several temporary construction sites, storage, and working areas will come up. For construction, material mining will also be carried out. All these activities will require restoration and rehabilitation of such sites and areas after the construction is over.

10.2.6.1 Construction Material Requirement

The construction of a 128m high concrete gravity dam, two 11.5m dia. diversion tunnels, cofferdams, intake portal, twin pressure tunnel and underground powerhouse complex, and other project structures require a large amount of construction material, and the estimated requirement is given in **Table 10.23**.

Table 10.23: Estimated requirements of aggregates for construction

S. No.	Construction Material	Required Quantity (Lakh cum)	Required Quantity including 38% production loss (Lakh cum)
1	**Coarse Aggregate** (i) Wearing surface (ii) Non-Wearing surface	 1.17 7.04	 1.61 9.72
2	**Fine Aggregate**	4.94	6.82
3	**Rock Fill Material & Rip Rap**	0.11	0.15
Total		**13.26**	**18.3**

10.2.6.1.1 Rock Quarries

Approximately 8.2 lakh cum of coarse aggregate and 4.9 lakh cum of fine aggregate is required for concrete production for the construction of the Dugar HEP. Three rock quarry sites i.e., Dugar Rock Quarries (DRQ) have been identified and marked as DRQ-01, 02 & 06 on the map for use as coarse and fine aggregates like crushed stone. The details of these rock quarries are given in **Table 10.24** and their respective locations regarding the project are given in the index plan in the map (see **Figures 10.11 & 10.12**).

Table 10.24: Details of Rock Quarry Identified

S. No.	Quarry ID/Location	Distance from batching plant (km)	Area (ha)	Quantity (In Lakh Cum)
1	DRQ-01, upstream of Hasku Bridge	17.5	2.981	7.7
2	DRQ-02, downstream of Hasku Bridge	17.0	0.590	1.2
3	DRQ-06, Along Dharwas Road	6.0	1.605	4.3
	Total		**5.176**	**13.274**

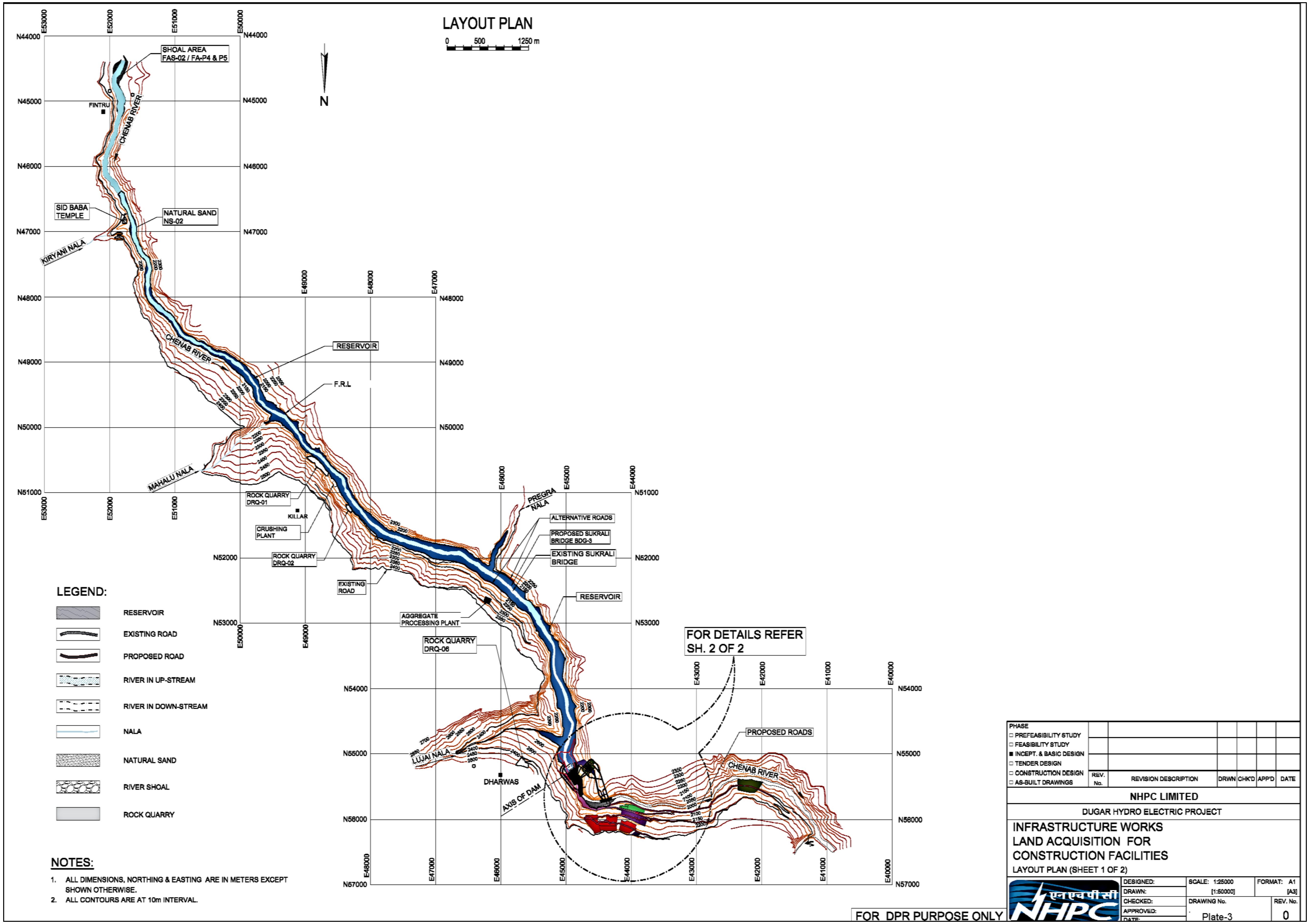


Figure 10.12: Index map of Dugar HEP showing construction areas

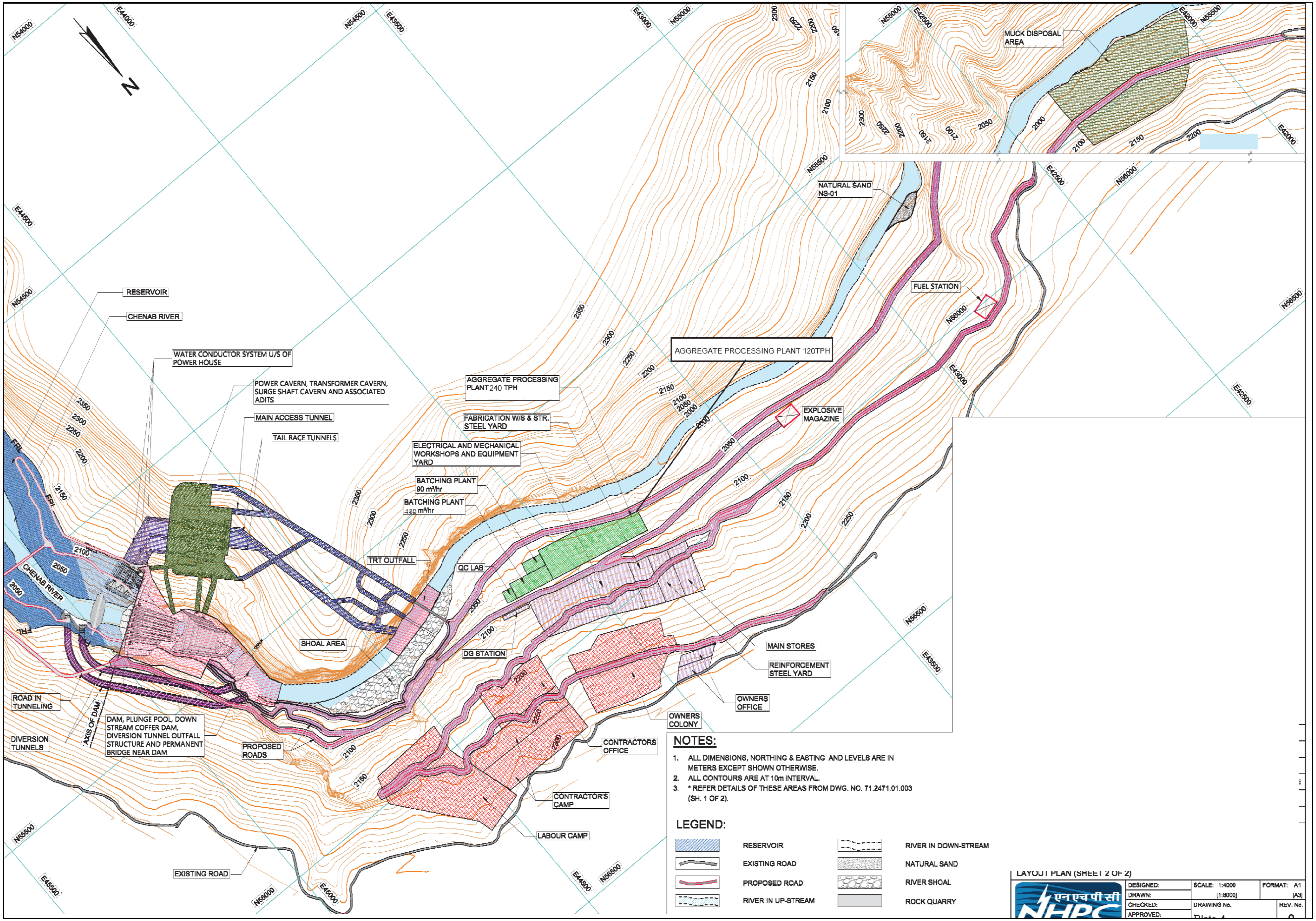


Figure 10.13: Details of inset in Figure 10.11

10.2.6.1.2 DRQ-01, Upstream of Hasku bridge

This quarry is located 17.5 km upstream from the dam site along the right side of Chenab River and presently approach road is available for this rock quarry (refer to **Figure 10.13**). The main rock unit is micaceous quartzite with minor bands of pegmatite and schist. A total of 2.981 ha of slope face with an average width of 65m and a length of about 450m shall be disturbed due to blasting for material at this quarry.

Figure 10.14: Rock Quarry-DRQ-01 (Source: DPR by NHPC)

10.2.6.1.3 DRQ-02, downstream of Hasku Bridge

This quarry is an extension of the DRQ-01, located further downstream, approximately 17.0 km upstream from the dam site along the right side of Chenab River and presently approach road is available for this rock quarry (Refer to **Figure 10.14**). Total 0.590 ha of steep slope face with an average width of 50m and a length of about 115m shall be disturbed due to quarrying.

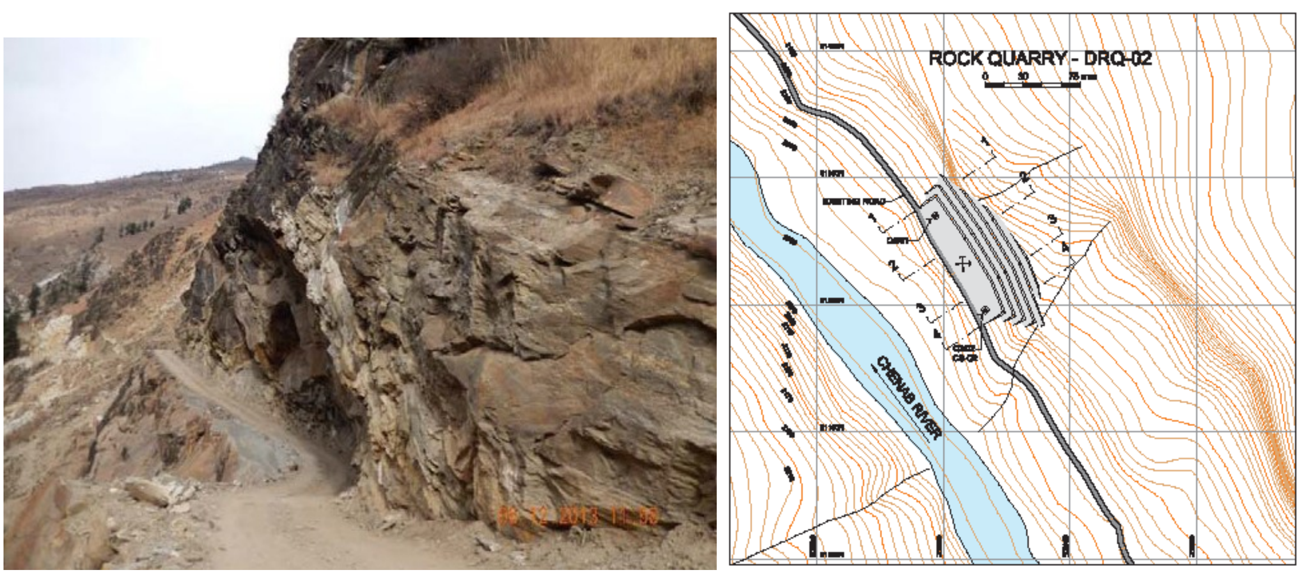


Figure 10.15: Section of Rock Quarry-DRQ-02 (Source: DPR by NHPC)

10.2.6.1.4 DRQ-06, along Dharwas road

This quarry is located 6 km from the aggregate processing location, along the right side of Chenab River and presently approach road is available for this rock quarry (refer to **Figure 10.15**). A total of 1.605 ha of slope face with an average width of 115m and a length of about 145m shall be disturbed due to quarrying.

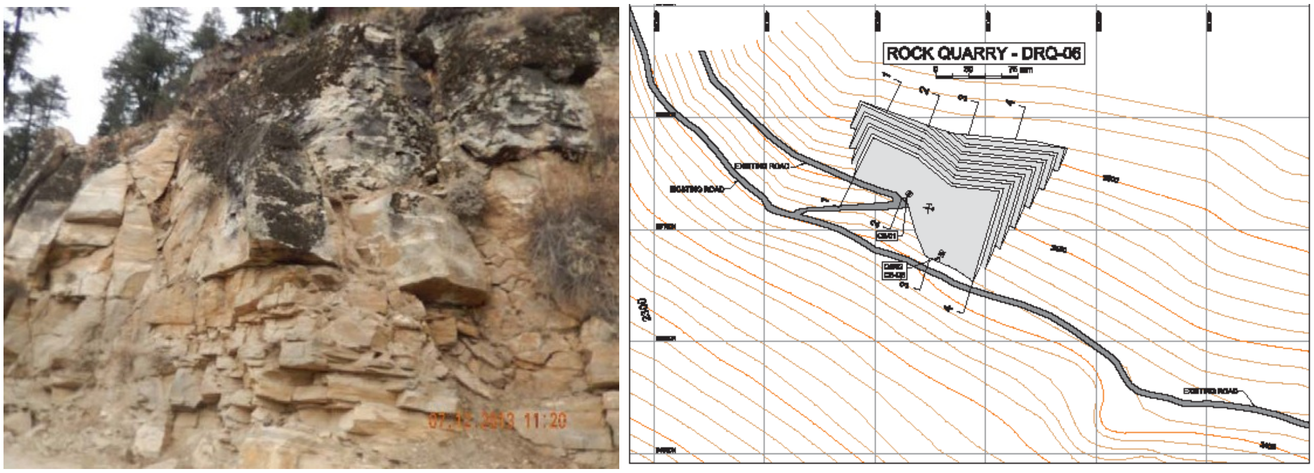


Figure 10.16: Rock Quarry-DRQ-06 (Source: DPR by NHPC)

10.2.6.1.5 Excavated muck from DT, Dam, and PH

The excavated material from Diversion Tunnel, left and right abutment of the dam, and powerhouse is not suitable for use as a coarse aggregate however it may be utilized as fine aggregate in concrete. Excavated material of DT can be utilized for the construction of upstream and downstream cofferdams (being temporary structures).

10.2.6.1.6 River Shoal Deposits

The rock quarries are suitable for non-wearing surface concrete and not for wearing surface aggregate, therefore, to meet the total requirement of wearing concrete requirement approximately 1.17 lakh cum for project two river shoal / fluvial terrace deposits (Fine Aggregate Sand-FAS) have been identified and their details are given in **Table 10.25**.

Table 10.25: Details of shoal area and natural sand deposits proposed for fine aggregates

S. No.	Location	Distance from APP (km)	Area (ha)	Available quantity (In lakh cum)
1	FAS-01, Near TRT outfall area	0.5	2.170	3.261
2	FAS-02, Near Findru village	28.0	6.242	9.543
3	Natural Sand deposits, NS-01	21.0	0.236	0.313
4	Natural Sand deposits, NS-02	1.5	0.326	0.309
	Total		**8.974**	**13.426**

The project proponent shall have to adhere to the mandatory provision of the EIA notification/office memorandum and follow the ‘Enforcement & Monitoring Guidelines for Sand Mining’, guidelines issued by MoEF&CC, GoI in January 2020 and have the District Survey Report

(DSR) and Mining Plan approved by the authorized agency of the concerned state government as a mandatory requirement.

10.2.6.1.7 FAS-01, Near TRT Outfall

FAS-01, river shoal is located just downstream of the dam site, near the proposed TRT outfall area. A total of 2.17 ha area will be available during lean season and which will provide 3.26 lakh cum of aggregates (refer to **Figure 10.16**).

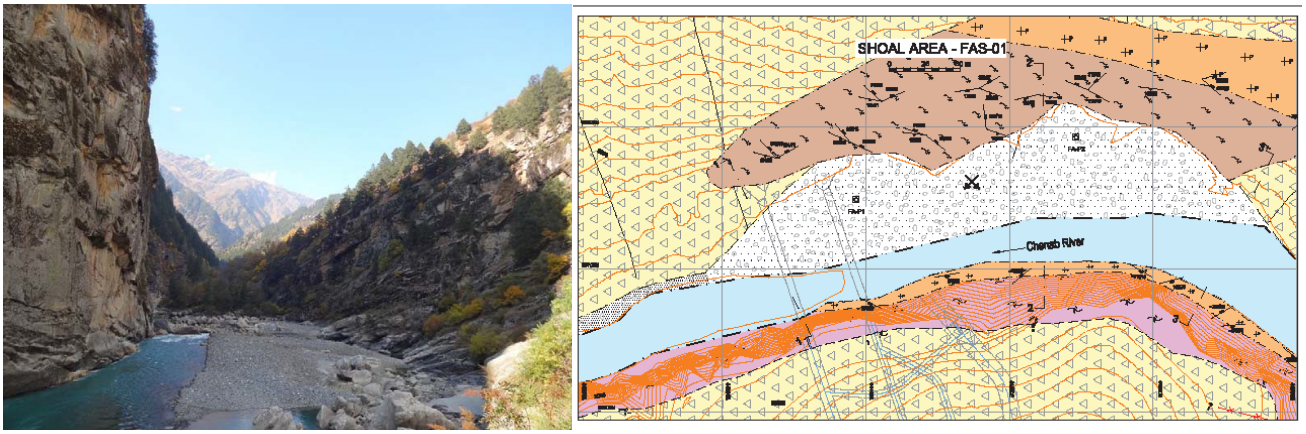


Figure 10.17: Shoal area, downstream of dam site (FAS-01)

10.2.6.1.8 FAS-02, Near Findru village

FAS-02, the river shoal is located at the tail end of the reservoir, approximately 28km (road distance) from the dam site. A total of 6.242 ha area will be available during lean season and which will provide 9.5 lakh cum of aggregates (refer to **Figure 10.17**).

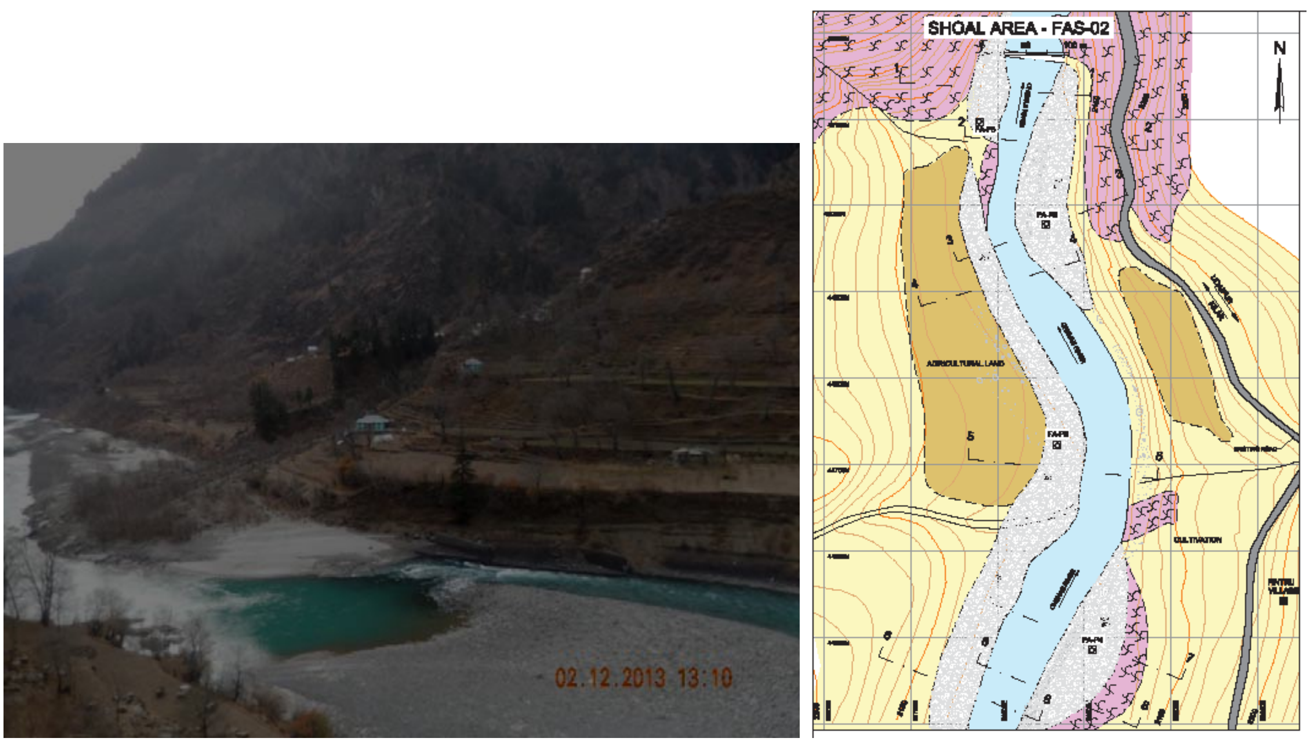


Figure 10.18: Shoal area, at Findru, tail end of the reservoir (FAS-02)

10.2.6.1.9 NS-01 & NS-02, Natural Sand

Two small pockets of sand deposits have been identified which can provide the natural sand requirement for concrete production. NS-01, located at the far end of the reservoir on the right bank of Chenab River, near Sid Baba Temple, and are extended in a 0.2 ha area, which may provide 0.3 lakh cum of natural sand (refer to **Figure 10.18**).

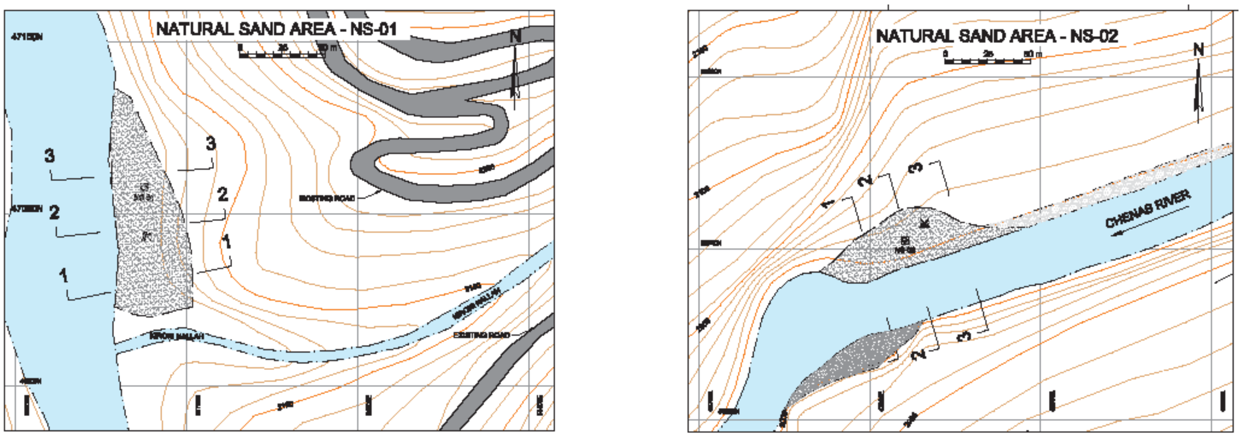


Figure 10.19: Natural Sand areas: NS-01 and NS-02

10.2.6.1.10 Rockfill Material

The upstream cofferdam will be constructed using colloidal concrete; therefore, the requirement of rockfill material will be limited to only construction of downstream cofferdam which is about 13 m high, and the estimated requirement of random fill material will be about 0.11 Lakh cum. The material will be sourced from excavated muck from 2 nos. of 11.5 m diversion tunnels and portals.

10.2.6.1.11 Rockfill and Riprap

The excavated material from DT may be used as rock fill for the proposed d/s cofferdam. About 0.15 lakh cum coarse aggregate is available from excavated material of diversion tunnel, against the requirement of 0.10 lakh cum. Boulders available at Dam site along either bank of the river may be used as riprap for the proposed d/s cofferdam.

10.2.6.1.12 Impervious Soil

A sufficient quantity of suitable impervious material is available in five borrow areas in the project vicinity to be used as impervious core (if required) in cofferdams. Since the cofferdams are proposed to be constructed with concrete, therefore clay may not be required.

10.2.6.2 Landscaping & Restoration Plan for Quarry and Borrow areas

The environmental impacts of excavation of construction material depend on the excavation process, local hydrological conditions, rock types, size and type of methodology adopted, and topography. Opening of rock quarries will cause visual impact because of the removal of a significant part of the hill face. Other impacts that are likely to be generated are the noise generated during aggregate acquisition through explosive and crushing (which could affect wildlife in the area), dust produced during the crushing operation to get the aggregates to the appropriate size and transport of the aggregates, and transport of materials to the nearby drainage channels. The quarrying for rock material in the proposed project would lead to the removal of vegetation cover, topsoil and leave the area barren. After the completion of mining activity, these areas will be restored to their normal habitat conditions.

Similarly, excavation and transportation of fine aggregates from the riverbed will cause visual impact because of the removal of a significant part of the riverbed. The extraction of construction material from riverbeds may also affect the river water quality due to an increase in the turbidity levels. This is mainly because the dredged material gets released during one or all the operations mentioned below:

- Excavation of material from the riverbed
- Loss of material during transport to the surface
- Overflow from the dredger while loading
- Loss of material from the dredger during transportation

The cumulative impact of all the above operations will lead to an increase in turbidity levels. Good dredging practices can, however, minimize turbidity. It has also been observed that slope collapse is the major factor responsible for the increase in turbidity levels. If the depth of cut is too high, there is the possibility of slope collapse, which releases a sediment cloud. This will further move outside the suction radius of the dredged head.

10.2.6.2.1 Mitigation and Restoration Measures

Quarrying for construction materials will require **12.505 ha** area (see Table below). Frequent trips for blasting, excavation will also disturb the adjoining forests in the proposed quarry and borrow areas.

S. No.	Facility	Area (ha)
1	Quarry area	8.625
2	Borrow Areas	3.880
	Total	**12.505**

As seen from **Figures 10.13, 10.14, and 10.15,** the exposed face of three proposed rock quarries viz. DRQ-01, DRQ-01, and DRQ-06 are characterized by steep gradients/slopes varying between 35% and 70% at certain places. The main rock is quartzite schist with pegmatite and schist at DRQ-10 and DRQ-02 while at DRQ-06 it is gneiss with bands of pegmatite and schist.

The general plan to minimize the degradation of the area due to mining for construction material would be as follows:

- Photographically record quarry faces before excavation.
- Building of garland drains around quarry site to capture the runoff and divert the same to the nearest natural drain.
- Construction of concrete guards to check the soil erosion of the area.
- The pit formed after excavation be filled with small rocks, sand, and farmyard manure.

- Grass slabs to be placed to stabilized and to check the surface runoff of water and loose material.

The traditional measures adopted for landscaping of the quarry sites after quarrying are:

a. Filling of depressions

Removal of rocks from quarry sites for different construction works will result in the formation of depression and/or craters. The depressions are to be filled by the dumping materials consisting of boulders, rock, gravel, and soil from nearby plant/working sites, followed by compaction to prevent subsidence, porosity, and permeability, and to increase the capacity of fill on site. Compacted inert waste material helps retarding percolation to the quarry base and the adjacent watercourse.

b. Laying of the topsoil

The depressions/craters filled up with rock aggregates will be covered with topsoil. The topsoil is then covered with geo-textiles like coir, jute, or other locally available bio-degradable material.

c. Construction of breast walls

Breast walls are generally constructed at the base of filled-up depressions of quarry sites to provide the necessary support, particularly where there are moderately steep slopes.
At the top of the fill, cast concrete strip foundation and erect a random dry-stone rubble wall along the established and/or designed location of field boundaries; place the subsoil simultaneously on the lower sides of the terraces.

d. Diversion of runoff

Provision of an effective drainage system to avoid the infiltration of run-off and surface waters into the ground of quarry sites.

Though the above described are broadly recommended for rehabilitation of quarries after the mining operation of over at the site, however, it is recommended that the project proponent undertake detailed site surveys and formulate appropriate engineering measured after ascertaining the steepness of the slope and extent of depression formed after the excavation.

However, during quarrying operations, standard mitigation measures against erosion and sedimentation, noise, and air pollution will be taken, especially for the use of explosives. The most important mitigation measure during blasting and excavation will be to keep noise and dust levels under control by installing noise dampeners, use of sprinklers, and controlled blasting. At the end of the exploitation, quarries will be rehabilitated.

Generally, rehabilitation includes re-establishment of vegetation, restoration of natural watercourses, avoidance of flooding of the excavated areas, achievement of stable slopes, and avoidance of features, which would otherwise constitute a risk to health and safety or a source of environmental pollution. However, revegetation of bare slopes does not seem feasible in these quarries owing to steep slope face and almost complete absence of any soil cover which is a prerequisite for the establishment of any vegetation cover.

After the quarrying activity is over, the site will be splattered with the leftovers of rocks and boulders. These boulders and rocks can support the growth of mosses and lichens, which will act as ecological pioneers and initiate the process of succession and colonization. The boulders of moderate size will be used to line the boundary of a path.

As the tentative cost of landscaping and restoration of quarry sites covering a total area of 5.176 ha (with an average total width of 235m and length of 710m) cannot be estimated till a detailed engineering plan to stabilize the disturbed area of three quarries is formulated by the project proponent to be prepared during pre-construction activities a lumpsum amount of **Rs.50.00 lakh** have been earmarked for the same**.**

10.2.6.3 Construction Areas & Project Colonies

The proposed Dugar HEP would involve the construction of the dam, powerhouse, adits, diversion tunnel, residential and staff colonies, roads, batching plants, etc. These activities will result either in the modification or destruction of the existing landscape of the area. It is therefore imperative that after the project work and related activities are over restoration work should be carried out in these disturbed areas to bring them back to their similar or near-similar pre-construction conditions and land use. Around **8.78** ha will be disturbed due to the acquisition of land for the construction of colony area, office colony, and construction facility area.

10.2.6.3.1 Aggregate Processing and Batching & Mixing (BM) Plant

To meet the total requirement of aggregate to produce the concrete for the project 2 nos. of Aggregate Processing Plants (APP) of capacity 120 TPH & 240 TPH for crushing, screening, and washing of coarse and fine aggregate have been proposed. Considering the total quantum of concrete about 11.3 lakh cum including shotcrete two batching & mixing plants, one of 90 cum/h capacity for Powerhouse, TRT areas, etc. and other of 180 cum/h are proposed to be used for catering the concrete production requirement of Dam, Plunge pool, etc. of the project. The Aggregate Processing Plant (APP) and Batching & Mixing (BM) Plants have been proposed to be located on the right bank on the d/s of Dam area as shown in **Figures 10.11 & 10.12**.

10.2.6.3.2 Workshops

Several workshops for construction-related activities have been proposed on the right bank of Chenab River downstream of the dam and their location on the map is shown in **Figure 10.12**.

i. HEM workshop

Since servicing and repairing facilities are not available near the project area, a fully equipped self-sufficient Heavy Equipment Maintenance (HEM) workshop shall be established to provide quick repairs and maintenance of heavy construction equipment so that availability of equipment is maintained, and the work does not suffer for repairs and maintenance of equipment.

A provision of 20m x 10m i.e., about 200sqm has been proposed for the HEM workshop.

ii. Light Vehicle Workshop

One light vehicle repairing facility shall also be maintained at the project site to provide regular services and repairs to the project vehicles.

A provision of 15m x 10m i.e., about 150sqm has been proposed for the LV workshop.

iii. Electrical Workshop

An electrical workshop shall be established at the Project site to provide services to electrical installations and equipment such as power systems, DG sets, transformers, pumps, etc., and lighting of the Project and camp. This will also ensure an uninterrupted power supply for construction works.

A provision of 15m x 10m i.e., about 150sqm has been proposed for the Electrical workshop.

iv. Ferrule Fabrication Workshop

As approaches to the Project are difficult, it is proposed to establish a small ferrule fabrication workshop at the project site itself. Ferrule fabrication workshop shall include a facility for cutting, rolling, welding, and testing of steel plates and fabricating ferrules of required dimensions and plate thickness. A dye penetration test, UT test, radiography, and hydrostatic tests, etc. shall be performed on welded joints in the workshop.

A temporary provision of 25m x 10m i.e., about 250 sqm has been proposed for the Ferrule Fabrication workshop.

v. Explosive magazine

Explosive is mainly required for open and underground rock excavation. Explosive magazines of 60 MT capacity shall be provided at a suitable location selected at the site keeping sufficiently away from the human habitat. The explosive magazine complex extending over an area of 400 sqm has been planned to keep the distance traveled by the explosive van to a minimum. All safety codes and regulations prescribed by the central and state government in this respect will be followed and magazines will be suitably guarded round the clock. As laid down in the Explosive Rules, 2008, safe distance will be maintained from public roads, etc.

vi. Quality Control Laboratory

To assure and maintain quality standards of the construction material and construction works, arrangements will be made to facilitate field laboratory tests as per the applicable standards. For this purpose, a fully equipped laboratory shall be installed for carrying out the prescribed tests on site.

One centralized Quality Control laboratory shall be established with an area of 200 sqm near the main batching and mixing plant for undertaking various tests and concrete mix design studies etc.

Experienced senior engineers/technicians, well versed in various aspects of quality assurance will manage quality assurance and quality control programs strictly following prescribed standards and ensure that the specified tests are carried out and the results interpreted in the manner stipulated in the prescribed project Quality Assurance Manual and standards.
A provision of 20m x 10m i.e., about 200m^2 has been proposed for quality control laboratory. This laboratory shall be established near batching plant area.

The working areas near the dam site, powerhouse complex colony area would be selected for beautification of the project area after construction is over. The beautification would be carried out by developing flowering beds for plantation ornamental plants and flower gardens.

10.2.6.4 Mitigation and Restoration Measures

The most important mitigation measure during the construction phase will be to keep noise and dust levels under control by installing noise dampeners, use of sprinklers, and periodic equipment maintenance. The sprinklers shall be used for stockpiles of aggregate and the washing of the aggregate shall be first allowed to settle in the settling tanks before being disposed into the river. For keeping dust emissions under control, dust shields of Galvanized Iron Corrugated (G.C.) sheets of adequate height shall be erected.

The following measures would be adopted for the rehabilitation and landscaping of colony areas.

- Proper roads and lanes would be provided inside the colony area. The open areas will be covered with vegetation. Ornamental plants and trees will be planted in rows along the roads and lanes.
- Retaining walls will be built to avoid landslides and slips. Proper channels would be provided inside the colony to drain out the rain/ domestic water.
- Parks and playgrounds for children would be developed in the colony area, near villages, and in schools of the project area.

After the project activity is over construction sites and other temporary settlements would be splattered with the topsoil (separated before construction). These leftovers can support the growth of mosses and lichens which will act as ecological pioneers and would initiate the process of succession and colonization. This will provide the necessary cushion and support for the growth of seeds of other plants to germinate. The estimated cost for restoration of construction sites is given below in **Table 10.26.**

Table 10.26: Estimated cost for restoration of Construction sites of Dugar HEP

S. No.	Item of work	Quantity	Rate/ unit (in Rs.)	Amount Rs. (in lakh)
1	Leveling and development of the area around construction and storage sites after construction is over	4 ha	200000/ha	8.00
2	Covering the slopes with geo-textiles like coir, etc.	4000 sqm	100/sqm	4.00
3	Retaining walls to prevent spillage of material	Lumpsum		3.00
4	Construction of diversion channels in construction sites	Lumpsum		35.00
5	Erection of GC sheets near working sites	Lumpsum		10.00
6	A periodic sprinkling of water to check dust emissions	Lumpsum	500000/Year	20.00
Total				**80.00**

The creation of the Green Belt in and around project construction areas and colonies is also being planned and discussed later in the chapter under **section 10.9**.

10.2.6.5 Project Roads

10.2.6.5.1 Roads to the Project Components

The project site is located near Luj village which is well connected through SH-26 Tandi- Kisthwar road via Udaipur. SH-26 is along the right bank of Chenab River near the project site. On the left bank of the Chenab River, there is no access to the project area. The road from Ghangit to Chamba crosses the river Chenab and reaches to left bank through a bridge called Shukrali Bridge, about 3.5 km upstream of the Project area. A possibility of constructing a road on the left bank may be considered for approaching the Project area on the left bank, however, this is not considered now.

The existing Tandi-Kishtwar Road near Luj village on the right bank is available at an elevation of about 2,260m near the Project area. However, going a little downstream the off-take point (R1) of the main Project Road is taken at an elevation of about 2220m. An approach road has been planned from this to reach project area to elevation about 1988m i.e., the bottom of Dam. Considering a gradient of 1:15 (6.6%) a length of about 3.5 km would be required. From this road various permanent and temporary project roads and bridges are proposed for communication requirements in the project vicinity during the construction stage and that of during the Operation and Maintenance stage. A road would be required to reach the top of the Diversion Tunnel inlet at elevation 2079m and bridge upstream of the dam proposed at El. 2080m from the top of Dam to reach these areas even after completion of Dam. Since a very steep rock face exists in this area, a 7m dia D-shaped road tunnel is proposed to access these areas. The proposed roads and bridges in the project area are summarized in **Tables 10.27 and 10.28 and shown in Figure 10.19,** respectively.

Table 10.27: Proposed Roads in Project Area of Dugar HEP

S. No.	Description	Type	Road length (m)
A	**Right Bank Roads**		
1	Road from existing Tandi-Kishtwar Road (offtake point R0) to Junction R2 of Road to Bottom of Dam and DT inlet and Outlet.	Permanent	1140
2	Road from R1 to Junction R2 of Road to Explosive Magazine	Permanent	415
3	Road from R2 to Explosive Magazine	Temporary	563
4	Road from R2 to Junction R3 of Road to MAT Bridge BDG-1	Permanent	563
5	Road from R3 to Junction R4 of Road to Bottom of Dam and DT inlet and Outlet.	Temporary	189
6	Road from Junction R4 to R5 Right Abutment of Bridge-BDG1	Permanent	531
7	Road from MAT Bridge Junction R5 to existing Tandi-Kishtwar Road (offtake point R11 near U Bends) passing through Muck Disposal Area.	Permanent	2695
8	Road from Junction R3 to Junction R6 Dam top on right bank	Permanent	623
9	Road from Junction R6 to Toad Tunnel Portal T1	Temporary	33
10	Road from Tunnel Portal T2 to Bridge BDG-2	Permanent	35
11	Road from Tunnel Portal T2 to top of DT Inlet Structure R7	Permanent	197
12	Road from Junction R4 to DT Outlet Portals R12	Temporary	104
13	Road from Junction R4 to Junction R13 of road to d/s Cofferdam	Temporary	263
14	Road from Junction R13 to D/s Cofferdam	Temporary	78
15	Road from Junction R13 to DT Inlet Portals R14 through Dam and U/s Coffer Dam Area	Temporary	314
16	Road from existing Tandi-Kishtwar Road (offtake point R10) to Junction R1 through camp and construction facility area	Permanent	2540
B	**Left Bank Roads**		
1	Road from Junction B2L on left abutment of Bridge BDG-2 to Power Intake R8.	Temporary	254
2	Road from Junction B2L on left abutment of Bridge BDG-2 to Pothead Yard, Cable Tunnel Portal and Dam Top	Temporary	710
3	Road to dam Bottom extended from Power Intake Bottom	Temporary	900

Table 10.28: Proposed Bridges in Project Area of Dugar HEP

S. No.	Description	Type	Deck Level (m asl)	Span (m), approx.
1	Bridge - BDG1: Access Bridge to MAT	Permanent	2036	110
2	Bridge - BDG2: Upstream Dam	Temporary	2080	116
3	Bridge - BDG3: New Sukhrali Bridge	Permanent	2118	202
4	Approach Bridge to MAT-TRT Adit	Temporary	2025	100

10.2.6.5.2 Realignment of Roads & Bridges under Submergence

The existing Sukhrali Bridge which is a communication connection between Killar and Chamba is going under submergence of Dugar HEP reservoir along with a portion of approach road to the right abutment of this will need realignment. Thus, construction of this alternative approach arrangement i.e., alternative bridge to the existing Sukhrali bridge and with approach roads of about 1000 m to abutments of this bridge is planned to be completed before initial filling of Dugar HEP reservoir.

All project road sections shall be provided with a carriageway width of 7m, and the total right-of-way shall be 15m. All the bridges shall also be of 7m carriageway width. Appropriate cambers, super elevations, turning radius and additional widths at bends shall be provided wherever required. In addition to the above road width, additional width of about 3.50m shall be provided for parking lanes for emergency and breakdown parking. Parking lanes shall be of a minimum length of 30m and shall be spaced at about 300m along the road. Parking lanes can be provided on either side of the road wherever convenient.

In the Dugar HEP area construction of more than 13.00 km of new roads are proposed (refer to **Tables 10.27**).

Major impacts due to the construction of roads are as follows:

- The project area is characterized by the topography of steep slopes and narrow valleys. Such topography is prone to erosion hazards due to the net downhill movement of soil aggregates.
- The removal of trees on steep slopes and re-working of the slopes near roads can encourage landslides, landslips, etc. as erosive action of water gets pronounced accelerating the process of soil erosion and formation of gullies. The hill faces are bereft of vegetative cover facilitating the movement of enormous quantities of soil and rock down into the river, and occasionally washing away of the road itself.
- Increased air pollution during the construction phase.

The steep slopes are always liable to gravity movement of materials which can to a large extent can be controlled by providing appropriate drainage. The basic principle is to intercept and divert as much water as possible before it arrives at a point, where it becomes a nuisance. The other erosion hazard is that of surface erosion of the bank, which is best controlled by vegetation. However, in steeply sloping terrain, the difficulty lies in growing vegetation on steeply sloping banks. Engineering solutions such as surface drainage, sub-surface drainage, toe protection, and rock bolting can be used. Landslides can be stabilized by several methods-engineering or bioengineering measures alone or a combination of these. In hilly terrain, road construction often generates a significant quantity of wastes (muck) due to the stripping of the rocks to make way for the roads. The stripped muck is generally cleared by dumping the material along the slopes. These dumped materials finally flow down to the valleys and ultimately find their way to the river. However, it is recommended to adopt a more systematic approach. The stripped material should be collected and dumped in the designated muck disposal area, which will have check dams to prevent the muck to flow down into the river. After the disposal operation is complete at the dumpsite, the dump yard should be contoured and vegetated.

i. Mitigation Measures to be adopted during Construction

The following mitigations measures are recommended during the construction of roads. Keep an area for clearing and grubbing to a minimum subject to the technical requirements of the road.

- Properly demarcate area to be cleared to save as many trees as well as shrubs possible. Tree felling for road construction/works would be kept bare minimum and strict control must be exercised in consultation with the Forest Department.
- In erosion-prone areas clearing and grubbing operations, formulate a schedule so that grading operations and permanent erosion control of features follow immediately thereafter, depending upon logistics; otherwise plan temporary erosion control measures between successive construction stages. Enforce that exposure of a very large surface area of erodible earth material should not be exposed at any one time by clearing and grubbing under no circumstances.
- Employ the methodology of balanced cut and fill formation to avoid large differences in cut and fill quantities.
- Protect cut slopes by providing breast walls, construction of catch water and intercepting drains, treatment of slopes and unstable areas above and underneath the road, etc.
- Undertake controlled blasting techniques where blasting is required to avoid over-shattering of hill faces.
- Do not dump or throw excavated material haphazardly but dump in a duly dressed up in a suitable format at appropriate places to prevent from easily washed away by rain, and such spoil deposits may be duly trapped or provided with some sort of protective mesh cover. Link all artificial drains built for drainage near the working area with the existing natural drainage system. Ensure these drains have gentle slopes. However, on steep slopes provide check dams so that soil is not eroded and carried away by high-velocity flows.
- Chose the siting and alignment of culverts to avoid severe erosion at outlets and siltation at inlets.

The estimated cost of implementing mitigation measures discussed above during road construction is given in **Table 10.29**.

Table 10.29: Details of cost estimates for implementing measures during road construction

S. No.	Item	Rate	Amount (Rs. lakh)
1.	Site Clearance of vegetation from 8.168 ha	Rs. 25000/- per ha	1.63
2.	Provision of retaining/ breast walls, construction of catch water, and interceptor drains (1881.80 RM)	Rs.7530/- per cum	141.70
3.	Provision of the drainage system along roads for 2 x 13.147 km	Rs.500/- per rmt	131.47
	Total		**274.80**

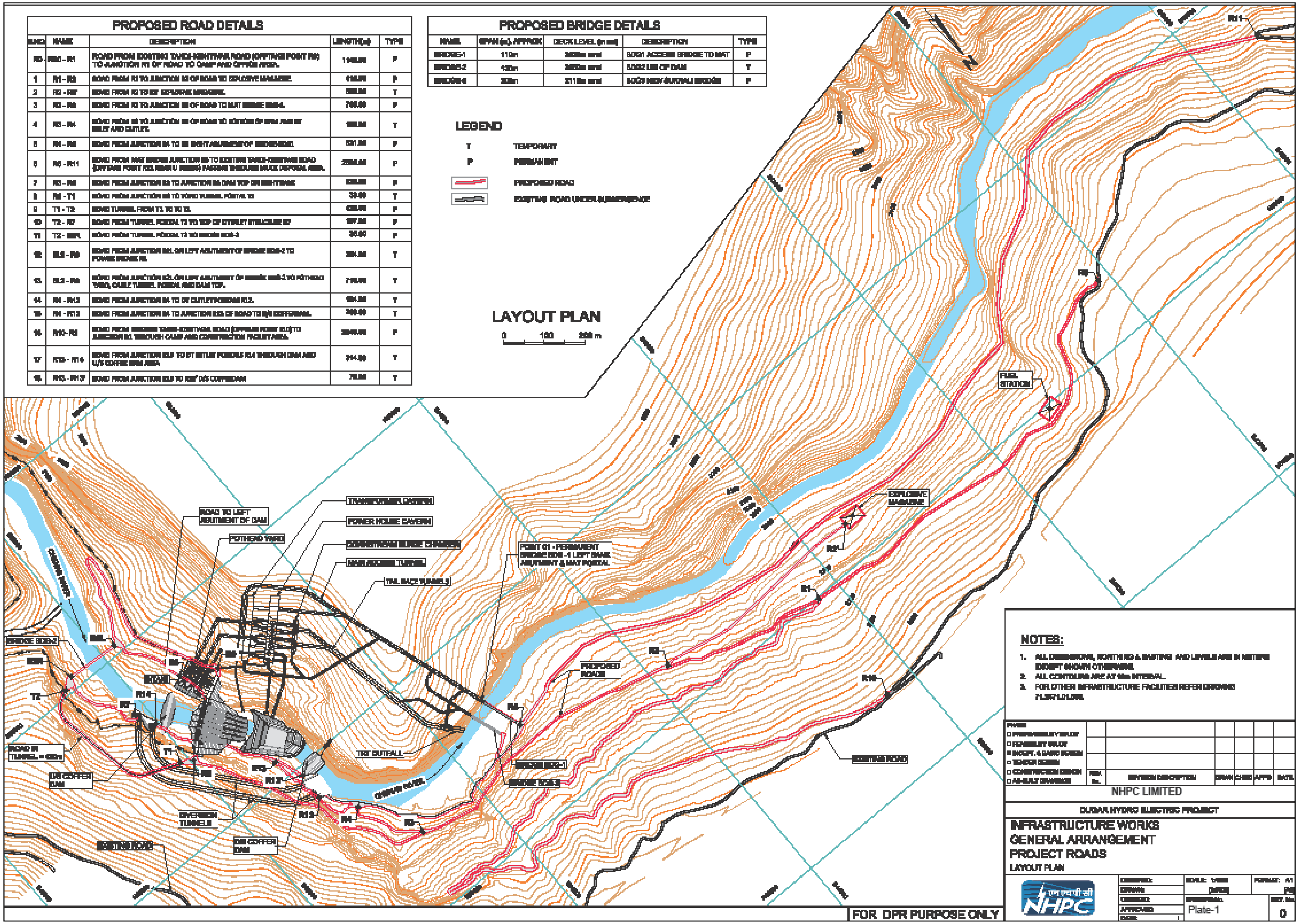


Figure 10.20: Index map of Dugar HEP showing proposed roads and bridges

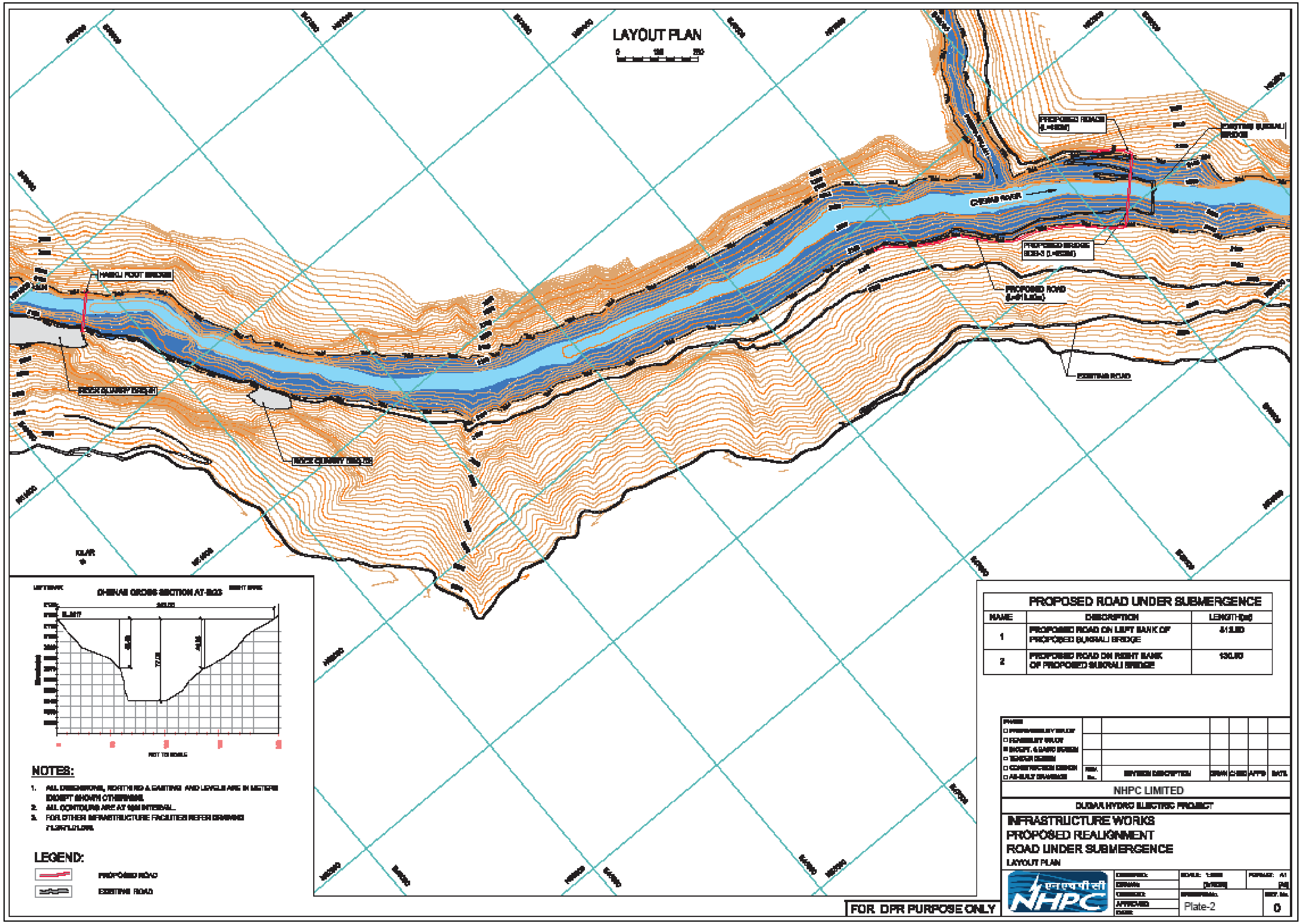


Figure 10.21: Index map of Dugar HEP showing roads under submergence

It is proposed to carry out roadside plantation and the details of same are discussed in **Section 10.11**.

10.2.6.6 Plan Implementation

The landscaping and restoration plan will be implemented with help of landscaping experts and in consultation with Uttarakhand Horticulture Department as well as Pithoragarh Forest Division and the coordination and funding will be provided by the project proponent for successful implementation of this plan.

10.2.6.7 Cost Estimates

The estimated cost for the restoration works, landscaping of quarry areas, roadside plantations, and creation of green belt around reservoir and colonies and working sites would be **Rs. 404.80 lakh.**

Table 10.30: Summary of Cost estimates

S. No.	Item	Amount (Rs. in lakhs)
1	Reclamation of quarry areas	**50.0**
2	Restoration of construction areas, colonies, and residential areas	**80.0**
3	Resroration measures during road construction	**274.80**
	Total	**404.80**

Section 10.2.7 RESERVOIR RIM TREATMENT PLAN

10.2.7 RESERVOIR RIM TREATMENT

The 128m high concrete gravity dam would create a reservoir extending ±11 km along river Chenab submerging 160.45 ha of land. The maximum width of the reservoir at FRL of 2114m is expected to be about 200m. The Reservoir rim area is sparsely vegetated and mostly inaccessible. The upper reaches of the reservoir rim can be approached via Killar, Chamba, and Punto roads.

10.2.7.1 Geology of Reservoir Area

Based upon the description given in DPR of Dugar HEP, Chenab River in the reservoir area, flows generally in SE-NW direction through a V-shaped valley with gentle curves in a generally high relief terrain (refer to **Figure 10.21**). The slopes are dissected by cross drainages that join the river perpendicularly indicating a structurally controlled drainage pattern. The right bank possesses a few deep nalas within the reservoir area. These are Kiryani Nala (near Sidh Baba Temple), Mahal Nala (Killar), Phargawal Nala (Pharagwal village), and Lujai Nala u/s of the dam site, whereas left bank possesses Bindi Nala, Kawat Nala (Dugar Village), and Dedha Nala in u/s to d/s order. Surface geological mapping has been carried out along the entire stretch of reservoir area with objectives of delineating the vulnerable slopes, rock types, and overburden. Lithologically, the reservoir is located in massive crystalline rocks of gneisses, micaceous quartzite, and schist. In the reservoir area, the left bank is characterized by steep rocky cliffs all along the length of the reservoir and forest-covered slopes in the higher reaches. The left bank is relatively unaffected by human activity (i.e., agricultural land use), except Punto/Dugar village. The rock types of left bank slope are gneisses (banded, granitic & augen), micaceous quartzite, mica schist, and pegmatite with no major unstable slopes recorded in this stretch. The right bank of the reservoir area has a gentle to moderate slope covered by slope wash and thick overburden deposits at a higher level with exposures of gneisses, micaceous quartzite, mica schist, and pegmatite. At places, the right bank slopes exhibit generally a uniform slope directly down to the river. The upper slopes are less steep and are seen to be terraced.

10.2.7.2 Landslides

In general, the reservoir rim appears to be stable. In the entire mapped area, only one small landslide has been found along the Killar road, located on the left bank of Mahal Nala, and restricted to its side slope at El. 2250m i.e., about 136 m above FRL (El. 2114m). This landslide at present is fairly stable and otherwise also has no implication of any kind whatsoever on the competency of the proposed reservoir.

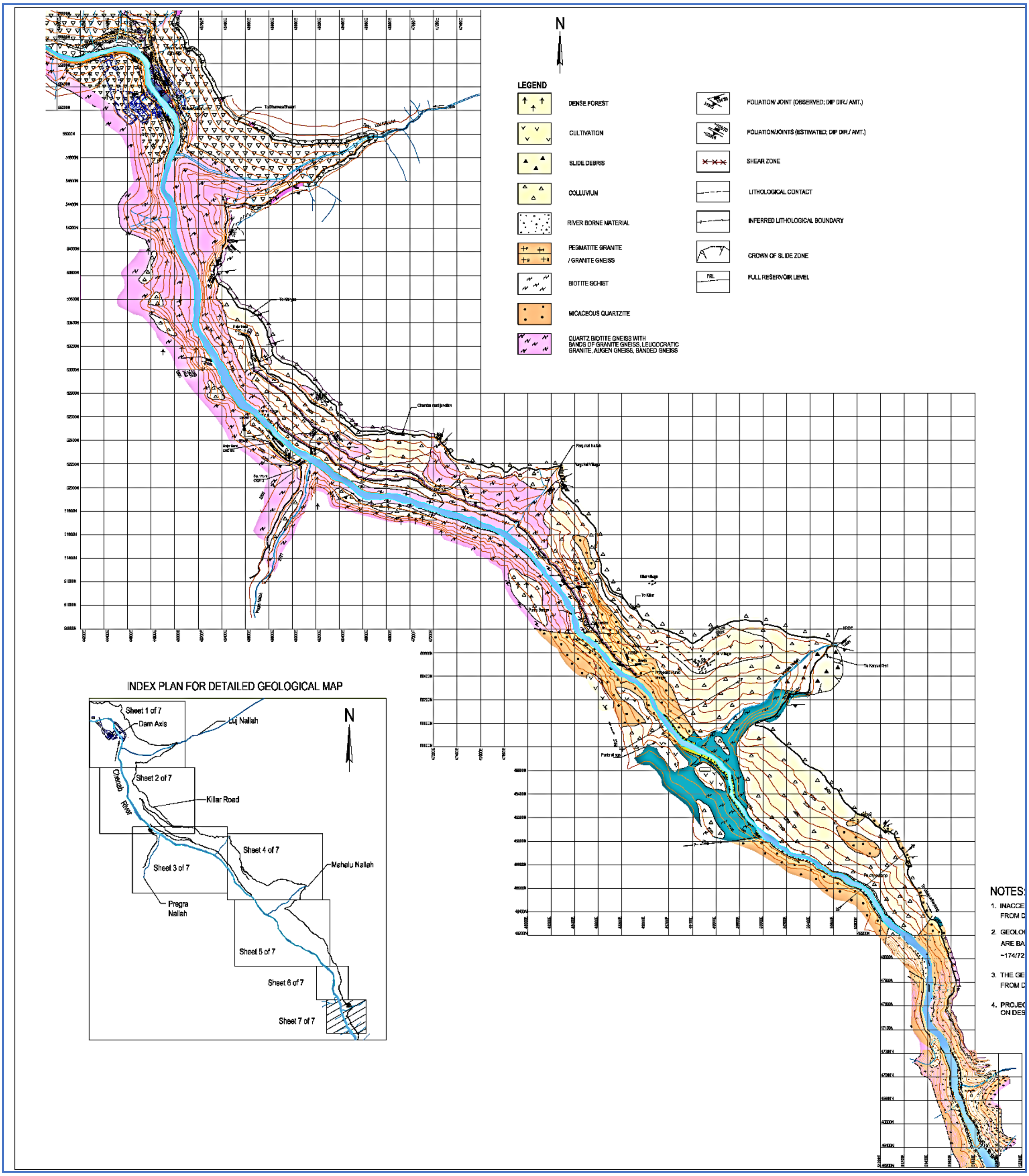


Figure 10.22: Geological map of Dugar HEP reservoir area (Source: DPR)

10.2.7.3 Treatment Measures

During the operation of the project, the reservoir level will fluctuate from the FRL of El. 2114m to MDDL of El. 2102.35m depending upon the power generation requirement and water availability. Therefore, the reservoir elevation will vary by about 12m. The river flows through a V-shaped valley in the submergence area and as seen from the geological map of the reservoir area crystalline rocks of gneisses, micaceous quartzite and schist are dominant with no major unstable slopes recorded in this stretch. The left bank is characterized by steep bare rocky cliffs all along the length of the reservoir. The right bank of the reservoir area has a gentle to moderate slope covered by slope wash and thick overburden deposits at a higher level with exposures of gneisses, micaceous quartzite, mica schist, and pegmatite. There is one small landslide is seen on the left bank which is in stable condition.

Though no major active landslide or slope instability is present in the reservoir area, however in order to take care and treat any slope instability / slide in future during construction / operation stage a lumpsum amount of **Rs. 40 lakh** has been kept.

Section 10.2.8 GREEN BELT DEVELIOPMNT PLAN

10.2.8 GREEN BELT DEVELOPMENT

Green belt development will comprise plantations at various places like alongside roads, around the periphery of reservoir rim, construction areas, and at different project offices and colonies.

10.2.8.1 Roadside/Avenue Plantation

In the Dugar HEP area construction of more than 13.00 km of new roads are proposed. However, the proposed roads will traverse through steep slopes and rocky terrain with very little or no vegetation cover. There is very little feasibility to undertake roadside plantation along the roads as only engineering measures can be undertaken which have been discussed in **section 10.9.6.2** and an appropriate budget has been allocated.

10.2.8.2 Green Belt Development along the Reservoir Rim

As already discussed in **section 10.10** on Reservoir Rim Treatment the creation of a green belt around the reservoir rim is not feasible owing to its geological makeup and steep slopes.

10.2.8.3 Green Belt at Dam Site and Powerhouse site

The forest land at the construction sites will be cleared for the movement of heavy equipment required for different project-related activities which would lead to the fragmentation and destruction of the habitats at these sites. The following measures will be undertaken for the rehabilitation/ restoration and landscaping of the construction sites:

- Herbaceous plants and tree seedlings, grown in nurseries or greenhouses, will be sown in alternating rows. The growth of tree shrubs and herbaceous species will provide adequate erosion control, add vegetation variety for aesthetic values and provide the habitat for wildlife.
- The rows of herbaceous plants will be later used for the cultivation of medicinally important plant species.
- The choice of the tree species for plantation will depend upon the topography of the area required to be regenerated after the construction activities.
- The species which fix nitrogen like *Albizia lebbek* (leguminous) will help in increasing nitrogen levels of soil, enough to maintain the growth of non-nitrogen fixing species.

Plantation at the dam site and powerhouse has been proposed for control of erosion/ siltation of the reservoir and aesthetic importance. The plants of recreational value, horticultural importance shall be planted within the complex. Developing a lawn and flower garden surrounded by this green belt may serve the purpose of beautification of the dam site.

10.2.8.4 Green belt around crusher plants

For mitigating the impact of dust and noise, which will rise from the crusher plant, plantation must be done around the crusher plant area.

10.2.8.5 Green Belt around Colony area and Office Complex

Plantation around the project colony and office complexes is proposed to be done, so that, greenery is developed. Precaution should be exercised by not planting large size trees around buildings to avoid accidents. Besides this, it is also proposed to develop a green belt around the working areas for trapping the dust and noise. Plantation of avenue, ornamental, and fruit trees are proposed in these areas along with the area around the office complex. The ornamental and fruit plants will be procured from the horticulture department and local market while plants for avenue plantation will be procured from the forest department nursery. For the protection of trees from cattle, iron tree guards shall be required.

10.2.8.6 Choice of Species

The plantations have been suggested for restoration and reclamation of quarry areas, working sites, and plantations in and around the residential colonies, green belt local native species of trees, shrubs, and herbs have been suggested and a list of these species is given in **Table 10.31**.

Table 10.31: Plant species suggested for landscaping and restoration work

S. No.	Family	Scientific Name
Trees		
1	Cupressaceae	*Juniperus recurva*
2	Fabaceae	*Robinia pseudo-acacia*
3	Juglandaceae	*Juglans regia*
4	Oleaceae	*Fraxinus xanthoxyloides*
5	Pinaceae	*Cedrus deodara*
6	Pinaceae	*Pinus wallichiana*
7	Pinaceae	*Pinus gerardiana*
8	Pinaceae	*Picea smithiana*
9	Rosaceae	*Prunus armeniaca*
10	Rosaceae	*Malus domestica*
11	Salicaceae	*Salix denticulata*
12	Salicaceae	*Salix alba*
13	Salicaceae	*Salix fragilis*
14	Salicaceae	*Populus ciliata*
	Sapindaceae	*Aesculus indica*
Shrubs		
1	Berberidaceae	*Berberis aristata*
2	Berberidaceae	*Berberis lycium*
3	Cupressaceae	*Juniperus communis*
4	Elaeagnaceae	*Hippophae salicifolia*
5	Ephedraceae	*Ephedra gerardiana*
6	Grossulariaceae	*Ribies orientale*
7	Rosaceae	*Rosa moschata*

S. No.	Family	Scientific Name
8	Rosaceae	*Rosa webbiana*
9	Rosaceae	*Sorbaria tomentosa*
10	Rosaceae	*Prunus armeniaca* L.
11	Rosaceae	*Prunus padus* L.

10.2.8.7 Cost Estimates

The estimated cost for the creation of green belt around reservoir, roadside and colonies and working sites would be **Rs. 397.80 lakh.** A summary of the same are given at **Table 10.32.**

Table 10.32: Cost estimates for biological & engineering measures

S. No.	Item of work	Quantity	Rate/ unit in Rs.	Amount (Rs. in lakh)
A. Construction areas & Colonies				
	Engineering Measures			
1	a) Retaining walls	200 cum	7500	15.00
2	b) Leveling of the area	13 ha	85000	11.05
	Bio-engineering measures			
3	a) Covering the slopes with geo-textiles like coir, etc.	300000 sq m	100	300.00
4	b) Grass seeding	13 ha	13200	1.72
	Biological measures			
5	a) Planting of trees and shrubs	13 ha	33220/ha	4.32
6	b) Planting of flowering plants and other herbs	5000 nos.	50/plant	2.50
	c) Maintenance for 5 years			1.71
	Total - A			**336.30**
B. Roads				
	Engineering Measures			
7	a) Retaining walls	500 cum	7500	37.50
	Biological measures			
9	Planting of trees along the roadsides	26 km	100000	24.00
	Total Roads - B			**61.50**
				397.80

Section 10.2.9 SANITATION AND SOLID WASTE MANAGEMENT PLAN

10.2.9 SANITATION AND SOLID WASTE MANAGEMENT

The solid waste generated from temporary and permanent colonies in construction as well as operation phase requires special management to dispose of as warranted under the Solid Wastes Management Rules (SWM) 2016. For that, an efficient waste management system will be required to put in place to keep the environment of the region clean and healthy. These colonies and temporary settlements will also require an adequate water supply for drinking and cleaning.

The project authorities will ensure sewage generated from labour colonies and site office is treated and disposed of as per the SPCB guidelines. It's proposed to provide adequate septic tanks with soak pits for treatment and disposal of sewage.

The waste generation rate in Indian cities ranges between 200-870 grams/capita/day, depending upon the region's lifestyle and the size of the city. The per capita waste generation is increasing by about 1.3% per year in India (Annepu, 2012). State-wise data show that Himachal Pradesh average is about 300 gm/capita/day, however, the project area being small-town/rural is expected to generate lower than that of the state average. It is assumed for the estimation of quantum of waste generation, for preparation of solid waste management plan, that migrant labour population will follow the local pattern. Therefore, when the project will go for construction, about 300 grams/capita/day is expected to be generated.

Further, the peak worker population is estimated to be 2500 persons (2200 labours + 300 technical staff). It is also expected that locals in the proximity will also use solid waste management facilities; keeping this in view, the plan is prepared for about 2500 persons.

For 2500 persons an estimated amount of about 750 Kg/day (0.30 kg x 2500 individuals) of solid waste will be generated. This waste will be collected, segregated, and disposed of in line with the provisions laid down in Solid Waste Management Rules, 2016.

10.2.9.1 Management of Solid Waste

The project authority shall, within the territorial area of the project complex/ colony, be responsible for the implementation of the provision of Solid Wastes Management. Adequate facilities for the collection, transportation, and disposal of solid waste will be developed. Any solid waste generated in the project complex/ project colony/ labour colony, shall be managed and handled appropriately. Various aspects of solid waste management include:

- Reuse/Recycling
- Storage/Segregation
- Collection and Transportation
- Disposal

10.2.9.1.1 Reuse/Recycling

The project proponent/contractor will explore the opportunity to recycle the waste generated at the project site, in this context project will identify authorized vendors for recycling or disposal of used batteries, used oil, and used oil filters (as these are a hazardous waste). Bio-degradable waste will be treated in Organic Waste Composter (OWC) and the manure generated will be distributed to local villagers.

10.2.9.1.2 Storage and Segregation

In the labour colony, provisions shall be made to separately store the degradable and non-degradable solid waste. Two different coloured bins will be supplied to each labour family, who will segregate the waste generated in their household. Green and Biodegradable waste are to be deposited in one container and non-biodegradable waste in another container. In the case of canteens and community kitchens also, two different coloured dust bins will be used for separately storing the biodegradable and non-biodegradable waste generated. A sustained awareness programme will be conducted to educate workers about the segregation of degradable and biodegradable wastes.

10.2.9.1.3 Collection and Transportation

The project authorities shall prohibit littering of solid wastes in the area under their control by resorting to the following collection practices:

- Organizing house-to-house collection of solid waste on regular pre-informed timing by using mini trucks.
- Collected waste from residential areas shall be transferred to community bin by suitable vehicle
- Collection of wastes from office complexes and commercial areas
- Construction/demolition wastes, or debris shall be separately collected and disposed of
- Wastes from vegetable and fruit shops and meat shops shall be separately collected

Solid waste collected shall be disposed of at a common storage point. Three mini-trucks will be commissioned to collect the solid waste and dispose of the same at sites designated for the disposal of solid waste.

10.2.9.1.4 Disposal

The solid waste will be transported for disposal at the designated landfill sites. The landfill shall have impervious clay at the bottom-most layers. The second layer shall be impervious liner (Geomembrane), the third layer will be of sand, after that well-compacted solid waste is to be put over the sand, then again, a layer of clay, finally a layer of soil. Vegetation shall be grown on the topmost layers. It will give a good aesthetic view of the landfill.

i) Degradable component

The bio-degradable portion of the solid waste would be disposed of by composting. The degradable portion is expected to be about 50% i.e., about 136.88 kg/day of the degradable portion of solid waste will be generated.

For treatment of bio-degradable solid waste, provision of Solid Waste Treatment Plant has been proposed established in the project area. The capacity of treatment plant is about 5 ton/day. Proposed Solid Waste Treatment Plant not only manage the solid waste generated inside the project area, but also cater the management of Solid Waste of Killar town and surrounding villages. Composting process takes around 45-60 days to mature. The screened compost would be used as good manure especially for the cultivation of vegetables and for fruit orchard in the area. The treated waste is further utilized as manure at plantation sites, gardens, and herbal park.

ii) Non-Degradable component

The non-degradable portion (about 137 ton/annum) shall be segregated and transported to disposed at designated sites to be finalized with local authorities. No land fill site will be developed on the hill slopes. A transfer station at a suitable location shall be set up to collect residual and inert waste. A suitable landfill site shall be identified in consultation with local authorities in the plain area within 25 km for setting up sanitary landfill. In case on non-availability of land, in consultation with local authority, waste can be disposed off at regional landfill site.

The details of land fill site are given as below:

Waste Generation:	375 kg/day
Design Life:	10 years (construction phase)
Total Waste Generation in 10 Years:	1369 tons
Volume of waste:	1610 m^3 (assumed density =0.85 tonnes/m^3)
Provision of daily cover, liner, etc:	322 m^3 (20% approx.)
Total Volume:	1932 m^3
Pits of Size (LxWxD):	55m x 20m x 2m (effective depth 1.7 m)

A provision of an additional 50% of the total area, for accommodating infrastructure facilities will be included while working out the requirement of space. The liner system will comprise of the following layers below the waste:

- 0.30m thick drainage layer comprising of coarse sand or gravel
- 0.2m thick protective layer of sandy silt
- 1.50mm thick HDPE geo-membrane
- 1m thick clay layer/amended soil layer, comprising of local soil

iii) Bio-medical Wastes

Biomedical waste is generated during the diagnosis, treatment or immunization of human beings. It may include waste like scrap, anatomical waste, culture media, discarded medicines, chemical waste, syringes, swabs, bandages, body fluids, human excreta, etc. This waste is highly infectious and can be serious threat to human health if not managed in a scientific and discriminate manner. In Dugar HEP, biomedical waste will be generated from first aid posts and other medical establishments in the area. As the quantity of biomedical waste generated is not expected to be very significant requiring separate incineration at project site, it is proposed to have a tie up with Govt. Civil hospital at Killar to treat/ dispose-off biomedical waste generated from project activities in their facility.

At present handling of biomedical waste generated from such facilities will also be included as part of upgrading component as the existing facilities are not in place. Provision of financial aid is proposed for to procure and establishment of Incinerator for biomedical waste at Govt. Civil hospital at Killar.

iv) Sewage Treatment

For disposal and treatment of sewage generated from the project area (labour colony and staff quarters), provision of Sewage Treatment and Disposal Plant of capacity is about 15 kiloliters has been proposed. The sewage from the community toilet will be treated in a septic tank.

10.2.9.2 Financial Requirement

The total budget to manage the solid waste generated from this population has been proposed as **Rs. 316.40 lakh** (**Table 10.33**).

Table 10.33: Cost Estimate for Solid Waste Management Plan*

S. No.	Item	Cost (Rs. lakh)
1	Solid Waste Treatment Plant (including organic waste composter)	20.0
2	Operation and maintenance of Soild Waste Treatment Plant @ Rs. 1.0 Lakh/year for 10 years	10.0
3	Construction at composting site and land fill site - digging of pits, construction of pits, boundary wall, drainage, lining, etc.	25.0
4	Reclamation and stabilization of land fill and composting site	15.0
5	Sewage Treatment Plant (1 Nos)	50.0
6	Septic Tanks at Labour colony**	0.0
7	Two covered mini-trucks for the conveyance of solid waste to landfill site @ Rs. 15.00 lakh per truck	30.0
8	Running, operation and maintenance of trucks including driver's salaries @ Rs. 25000 per vehicle per month for 2 vehicles for 10 years	60.0
9	Manpower cost for 6 persons @ Rs. 12000 per person per month for 10 years	86.4
10	Awareness Programme/ Periodical Training for control and management of waste generation (Rs. 1 Lakh/ year)	10.0
11	Tools & implements	10.0
Total Cost (Rs. lakh)		**316.40**

***** Cost of land is taken in DPR

****** Cost for construction of septic tank is taken in DPR under construction cost of colonies

Section 10.2.10 PUBLIC HEALTH DELIVERY SYSTEM

10.2.10 PUBLIC HEALTH DELIVERY SYSTEM

10.2.10.1 Existing Medical Facilities

Medical services at secondary level play a vital and complimentary role to the tertiary and primary health care systems and together form a comprehensive district-based health care system.

There is only one Sub-divisional Civil Hospital at Killar in the study area, which caters to the medical needs of the people and is located at about 20 km from the main project construction area. In addition, there is one Primary Health Center at Dharwas village and some private clinic at Killar, which provide basic health services.

10.2.10.2 Objective of Public Health Delivery System

- Provide medical facility at the construction sites during construction Phase.
- To improve efficiency in the allocation and use of health resources in the project area.
- To improve the performance of the health care system in the project area through improvements in the quality, effectiveness and coverage of health services at the first referral level and selective coverage at the primary level, to improve the health infrastructure.

10.2.10.3 Threats to Public Health

Project construction and operation will bring about several changes in the socio-economic environment of the area including increased threats to health of the community. Possible threats to public health are briefly discussed below along with the management measures.

i. New Diseases due to Migratory Population

During the project construction period, there will be increase in the population of this region, particularly around the project area. These migrant workers and their family members may be the potential carriers of new diseases hitherto unknown/unreported from the project area. Diseases like VDs, gastroenteritis, etc. are some of the potential risks to human inhabitants of this area. The present available health services in the area would be insufficient to cater to such a vast influx of outside population in this area. Therefore, the project authorities and their contractors will have to register all the labourers including their family members, quarantine and vaccinate them against common diseases like malaria, etc. The project authorities will hold screening camps for the labourers, where rapid blood tests will be conducted for diseases like, TB, etc. and health card will be issued. Only after valid certification a labour or his family members will be registered with the contractor. The project authorities would ensure that the contractors follow this strict quarantine procedure, and this clause would be included in the award of the contract/works. Adequate medical facilities will be provided by the project authorities for this purpose in addition to providing medical facilities to workers.

ii. **Chances of increase in water borne diseases are high** if there is a stagnant water body in the vicinity. Stagnation of water and multiplication of mosquitoes and other vectors is not anticipated as long as adequate hygiene and sanitation standards are maintained, however, monitoring and preventive measures are recommended to prevent outbreak of water-borne diseases.

iii. **Chances of increase in respiratory troubles due to increase in suspended particles during the construction phase.** Mainly a cause of concern for construction workers who are likely to be exposed to dust for long hours. PPEs, such as dust masks, are recommended to mitigate such impacts.

iv. **Chances of occurrence of gastroenteritis, cholera and typhoid in the labour camps.** The project should make proper arrangements for maintaining high hygienic conditions in the colonies and labour camps, by providing good sanitation and drinking water facilities. Medicines would be distributed to the labour during construction period as and when required.

10.2.10.4 Medical Facilities

A migratory population of labour force of about 2500 persons is expected to be present during construction phase, spread along construction sites in labour colonies. One part of impact is on local population due to migrant population and second part is medical needs of migrant population putting stress on existing limited medical resources in the area. Another dimension which needs to be kept in mind while planning medical services from project side is the risk of accidents during project construction and emergency medical services to respond to such incidents. Working at heights, underground operations, blasting using explosives, use of heavy machinery and equipment with moving parts, movement of large number of vehicles carrying men and material, etc. increase the risk of accidents at workplace. Despite training and use of safety gears, possibilities of accidents at workplace cannot be ruled out and require preparedness.

It is recommended that the developer would provide the following medical facility, directly or through contractor, to ensure safe and healthy operations during the entire construction phase. This also helps in minimizing dependence of labour population on the existing medical facility.

- Two fully equipped ambulance needs to be procured to provide pre-hospital care to accident victims. The ambulances should always be stationed near major construction sites or the sites where risky operations are taking place. Typically, the ambulance should have equipment such as Fornoflex Chair/COT, Ventilator, Vacuum Splint Kit (Adult), Scoops Stretcher, Oxygen Cylinder with accessories, Resuscitation Bag (Adult), Suction Pump, Spine Board, siren/beacon, Emergency Light with public address system, Wireless equipment, additional battery, First Aid bag, BP instrument, stethoscope, etc and with trained manpower.
- Two first-aid posts need to be established - near proposed construction sites and colony areas to take care of basic medical needs of the workers at major construction site. The

first aid posts will have essential medicines including dressing materials, stretcher, wheel chair, ORS packets, etc. The first aid post can be housed in temporarily erected structure and should be managed by one Health Assistant and assisted by one dresser/first aid attendant. Visiting doctors can attend First Aid post regularly every day at a fixed time.

- As the existing medical facilities in the area are not adequate, budget provisions have been made for strengthening existing facilities in the project area.

10.2.10.5 Health Extension Activities

The health extension activities will have to be carried out in the villages situated within the study area. It is important to inculcate hygienic sanitary habits especially with respect to water pollution by domestic wastes.

A medico needs to be engaged to make regular visits to these villages and organize health promotional activities with the active participation of the local village leaders, NGOs and available local health functionaries. The health functionaries would undertake the following tasks as a part of health promotional activities:

- Organize awareness programs and medical camps to make people aware about the common diseases in the region. This should include poster campaign, awareness camps, medical camps for health check-ups and vaccination/ treatment, etc.
- Collect water samples to ascertain the potability of water from different sources so as to monitor regular disinfection of drinking water sources.
- Maintain close surveillance on incidence of communicable diseases in villages.
- Maintain close liaison with the community leaders and health functionaries of different departments, so that they can be mobilized in case of an emergency.
- Close interaction to be maintained with health department functionaries of the state government.

10.2.10.6 COVID Consideration

Keeping in view the Covid19 pandemic all around the world all projects need to make provisions to avoid risk of spread of highly infectious diseases like Covid19. At present, the spread of Covid19 in India is at alarming level and all construction sites have to follow specific protocols and government advisories. Therefore, it is important that as part of EMP, the project should made provisions to ensure taking adequate measures to control the spread of disease among workforce. The plan should be updated, keeping in view the prevailing situation at the time of start of work.

At the time of labour engagement and start of work or anytime during the execution of work, any directives issued by government with respect to labour, movement, labour stay at site, social distancing or any other restriction put in place to contain the spread of infectious disease such as Covid19 should be strictly adhered to.

Project proponent will monitor and ensure that contractor will follow any restriction on movement or advise on distancing as issued by government due to Covid19 or any other infectious disease during the period of construction.

Project proponent will request the details from the Contractor about the measures being taken to address the risks. This may include the following aspects as relevant:

- Conducting pre-employment testing for Covid19
- Controlling entry and exit from site/workplace
- General hygiene
- Cleaning and waste disposal
- Reviewing accommodation arrangements, to see if they are adequate and designed to reduce contact with the community
- Control the frequency of workers entering/exiting the site
- Providing appropriate forms of personal protective equipment (PPE) such as masks
- Putting in place alternatives to direct contact, like tele-medicine appointments and live stream of instructions.
- Keep a tab on symptoms and instances of spread of virus to quickly isolate the infected
- Training and communication with workers
- Communication and contact with community
- Request the Contractor to convene regular meetings with the project health and safety specialists and medical staff (and where appropriate the local health authorities), and to take their advice in designing and implementing the agreed measures.
- Create one or more Covid focal point(s) among workforce, who can monitor the situation and workers and interact with them for any symptoms/requirement

A lumpsum budgetary provision of **Rs. 20.00 lakh** has been kept on this count to ensure required, testing, training and awareness, masks, etc. as per the requirement at the time of implementation.

10.2.10.7 Cost Estimates

Budgetary estimates for public health delivery system have been worked out as **Rs. 335.00 lakh**, as per the breakup given at **Table 10.34**.

Table 10.34: Budgetary estimates for developing health care facilities

S. No.	Particulars	Amount (Rs. lakh)
1	Ambulance: 2 no. with all the basic Medicare facilities and small DG set, etc. in the project area	30.00
2	Budget for running the ambulances including driver, fuel and maintenance for 10 years @ 3 lakh per ambulance per annum for two ambulances	60.00
3	Two first aid posts including sheds, furniture and basic equipment	15.00

S. No.	Particulars	Amount (Rs. lakh)
4	Budget for running two first aid posts @ Rs. 8 lakh per post per annum including cost of medico, para-medico/Nurses and attendant, consumables, etc. for 10 years	160.00
5	Budget for strengthening existing medical facilities at Killar Civil Hospital	30.00
6	Measures to control COVID19 in the project area	20.00
7	Budget for Health Awareness/ Vaccination Camps @ Rs. 2.00 lakh per annum for 10 years	20.00
	Total (Rs. lakh)	**335.00**

Section 10.2.11 ENERGY CONSERVATION MESURES

10.2.11 ENERGY CONSERVATION MEASURES

As discussed previously, the proposed project would remain under construction for about 10 years, and it is estimated that migrant population during peak construction phase will be of the order of 2500 workers (labour and staff). It is the general tendency of the migrant laborers to use forest wood for the fuel and other domestic uses, especially when it is easily available. This would create serious biotic pressure on the nearby forest. To mitigate such impacts, various management measures need to be put in place and strictly implemented.

Energy Conservation Measure (ECM) are to be planned and implemented during construction phase either directly by developer or through contractor to reduce the pressure on natural resources in the project area and minimize impacts on this count. These measures can affect a variety of resources mainly forest, from negative impact of fuel wood collection by stakeholders as well as by labours during construction period. To mitigate such impacts, feasible measures will be adopted to help minimize pressure on forest. These are briefly discussed in the ensuing text.

10.2.11.1 Conservation Measures

Renewable natural resources like Forests should be protected/ cared to enhance quality of life and can also be used and replenished for future use. In study area, supply of cooking gas and kerosene is available in all villages, but fuel wood is the dominant source of energy due to its easy availability; therefore, there is need to reduce the pressure on natural forests for wood. With an estimated migrant population of 2500 persons in the area, the existing facilities will become insufficient for supply of kitchen fuel for the migrant population during the construction of the project. Fuel for cooking is an essential requirement and in the absence of adequate fuel availability they will resort to tree cutting for use of fuel wood. The project authorities would need to make adequate arrangements for supply of fuel for domestic use.

10.2.11.2 Provisions for Kitchen Fuel

The demand for kitchen fuel will increase due to the population coming from outside for the construction and other related work of the project. Project authority through contractor/ working agencies should provide kitchen fuel and make arrangement for community kitchen, canteen and efficient cooking facilities, as briefly discussed below.

Community kitchen: The project developer through contractor/ working agencies would make sufficient arrangement for the establishment of at least two community kitchens. These will be established near the project colonies. The kitchen should provide food to the labour at subsidized rates. The facility should maintain proper hygiene while preparing and supplying food, with adequate arrangement for waste collection and disposal. In addition, canteens are also proposed for labour near major construction sites to provide tea/snacks at subsidized rates.

Kitchen fuel: During the construction period of the project, many families may prefer cooking on their own instead of using community kitchen. In absence of fuel for cooking, they would resort to tree cutting and using wood as fuel. To avoid such situations, the project authority through contractor/ working agencies should make LPG available to these migrant workers. The supply of LPG can be ensured on regular basis at subsidized rates.

It is estimated that about 50% of married labour families and all the technical and supervisory staff would prefer doing their own cooking. Additional connections would be needed for community kitchens, and married labour families. Based on this, it is estimated that a total of 600 LPG connections would be needed for locals, labour and community kitchen. Therefore, developer through contractor/ working agencies will coordinate with the LPG supplier to set up a storage depot in the area to ensure regular supply of LPG cylinders in the project area during construction period.

Efficient cooking facilities: Project authority should also take measures for reducing the fuel consumption. The authority should provide solar cookers and pressure cookers through contractor/ working agencies to the families of migrant workers. Accordingly, budget has been allocated for the supply of cookers. This facility will also increase work efficiency of migrant workers and they will also get proper daily diet.

Solar Cookers and Lantern: Provision of solar lantern has also been made in the project budget and these will be distributed among the workers.

Awareness Programmes on Energy Conservation: Special awareness programmes against tree cutting should be held, which should concentrate on the awareness of labor families and villagers on environment conservation and sustainable development for the future generations. Thus, issues like saving trees, electricity and water should be covered in such programmes.

10.2.11.3 Cost Estimates

A total budget of **Rs. 300.00 lakh** have been proposed towards the provision of kitchen fuel, and other facilities including establishment of community kitchen or canteens for the migrant workers (**Table 10.35**).

Table 10.35: Financial Provision for Energy Conservation Measures

S. No.	Particulars	Amount (Rs. In lakh)
1	Financial assistance for strengthening of LPG Depot at Killar	20.00
2	Connection cost of 500 connections @ Rs. 5000.00 per connection	25.00
3	Community Kitchen (2 No.) – capital cost (Rs. 5.00 lakh per kitchen)	10.00
4	Community Kitchen (2 No.) –running cost for 10 years @ Rs. 8 lakh per kitchen per annum	160.00
5	Canteen (2 No.) – capital cost (Rs. 2.50 lakh per canteen)	5.00
6	Canteen (2 No.) – running cost @ Rs. 5.0 lakh per canteen per annum for 10 years	50.00
7	Distribution of Solar Cooker and Pressure Solar Lantern to project staff and labours	25.00
8	Community Awareness Programme @ Rs. 0.50/ annum for 10 years	5.00
	Total (Rs. lakh)	**300.00**

Section 10.2.12 LABOUR MANAGEMNT PLAN

10.2.12 LABOUR MANAGEMENT PLAN FOR THEIR HEALTH AND SAFETY

About 2500 labour and technical staff would be engaged temporarily during the peak construction period, which is planned to be completed in 98 months. Construction work has many associated risks and health impacts for the workers who are directly exposed to such health and safety risks. Direct exposure to heat, noise and dust can cause long term health impacts. On the other hand, risky operations if carried out by untrained workers can cause serious accidents at sites not only affecting to those working at site but also in surrounding areas. Natural accidents such as flooding, landslide, earthquake also pose risk to life of workers on the project site. Therefore, there is a need to prepare complete health and safety documents for workers either by project proponent/contractor and proponent shall ensure its implementation. The document should cover the following:

1. Identification of risks – fire and explosion, collapse of shed/structure, fall from working at height, collapse of lifting appliances, hit by fallen objects, landslides, failure during underground work, drowning, etc. All the potential risk and high hazard areas/activities need to be identified and listed. It should also cover high pollution area such as working in high noise or high dust areas.
2. Steps to Minimize Accident/Emergency – Documents should list all the Do's and Don'ts to avoid/minimize emergencies. It should also identify the activities and areas requiring use of specific PPEs. Prepare SOPs for risk operations.
3. Resource Planning – Document should identify the resources required to minimize accidents/emergency as well as those which would be required to manage emergency, if it happens and budge thereof.
4. Preparation of Site Emergency Plan – a site specific emergency plan needs to be prepared covering all the accident/emergency situations listing control and command structure and roles and responsibilities.
5. Training and Awareness – regular training and awareness of workers will be needed to ensure they understand and follow all the safety instructions and use appropriate PPEs.

A detailed plan will be prepared covering the above activities before start of construction work. A tentative budget for labour management is given in **Table 10.36**.

Table 10.36: Budget for Labour Management Plan

S. No.	Activity	Budget (Rs. In lakh)
1	Identification of risks, risky operations and areas and preparation of onsite emergency plan	25.00
2	Provision of PPEs @ Rs. 25.00 lakh as capital expenditure and Rs. 5 lakh every year for next 10 years for replenishment	75.00

S. No.	Activity	Budget (Rs. In lakh)
3	Safety Training and Awareness Programs for Workers @ Rs. 2.00 lakh per annum for 10 years	20.00
4	Regular Safety Audits @ Rs. 2 lakh/annum	20.00
Total		**140.00**

Table 10.37 gives list of BIS Standards related to safety aspects during various stages of construction, installation, erection of different components and appurtenance of river valley projects, including inspection, observation and maintenance aspects from safety consideration. Relevant codes should be used to ensure safety of workers at sites.

Table 10.37: List of relevant BIS Standards

S.No.	IS No.	Title
1	IS 10386 (Part 1):1983	Safety code for construction, operation and maintenance of river valley projects: Part 1 General aspects
2	IS 10386 (Part 2):1982	Safety code for construction, operation and maintenance of river valley projects: Part 2 Amenities, protective clothing and equipment
3	IS 10386 (Part 3):1992	Safety code for construction, operation and maintenance of river valley projects Part 3 Plant & machinery
4	IS 10386 (Part 4):1992	Safety code for construction, operation and maintenance of river valley projects Part 4 Handling, transportation and storage of explosives
5	IS 10386 (Part 5):1992	Safety code for construction, operation and maintenance of river valley projects: Part 5 Electrical aspects
6	IS 10386 (Part 6):1983	Safety code for construction, operation and maintenance of river valley projects: Part 6 Construction
7	IS 10386 (Part 7):1993	Safety code for construction, operation and maintenance of river valley projects: Part 7 Fire safety aspects
8	IS 10386 (Part 8):1995	Safety code for construction, operation and maintenance of river valley projects Part 8 Excavation
9	IS 10386 (Part 9):1998	Safety code for construction, operation and maintenance of river valley projects Part 9 Canals and cross drainage works
10	IS 10386 (Part 10):1983	Safety code for construction, operation and maintenance of river valley projects: Part 10 Storage, handling, detection and safety measures for gases, chemicals and flammable liquids

Section 10.2.13 DAM BREAK MODELING AND DISASTER MANAGEMENT PLAN

10.2.13 DAM BREAK MODELING AND DISASTER MANAGEMENT PLAN

10.2.13.1 Dam Break Phenomenon

Dam break may be summarized as the partial or catastrophic failure of a dam leading to the uncontrolled release of water. Such an event can have a major impact on the land and communities downstream of the breached structure. A dam break may result in a flood wave up to tens of meters high, travelling along a valley at quite high speeds. The impact of such a wave on developed areas can be sufficient to completely destroy infrastructure. With such destructive force comes an inevitable loss of life, if advance warning and evacuation was not possible.

10.2.13.2 Need for Dam Break Modelling

The extreme nature of dam break floods means that flow conditions will far exceed the magnitude of most natural flood events. Under these conditions, flow will behave differently to conditions assumed for Normal River flow modelling and areas will be inundated, that are not normally considered. This makes dam break modelling a separate study for the risk management and emergency action plan.

The objective of dam break modelling or flood routing is to simulate the movement of a dam break flood wave along a valley or indeed any area downstream that would flood as a result of dam failure. The key information required at any point of interest within this flood zone is generally:

- Travel time of flood water
- Peak water level – extent of inundation
- Peak discharge
- Duration of flooding

The nature, accuracy and format of information produced from a dam break analysis will be influenced by the end application of the data.

Emergency Planning

To reasonably prepare an emergency plan, it will be necessary for the dam break analysis to provide:

- Inundation maps at a scale sufficient to determine the extent of and duration of flooding
- Timing of the arrival and peak of the flood wave

Development Control

Development control will focus mainly on the extent of possible inundation resulting from different failure scenarios. Consideration may also be given to the characteristics of the population at risk.

10.2.13.3 Present Dam Break Modeling Study

The present study for Dugar HEP comprises of the following hydrodynamic simulations due to occurrence of:

- Design flood with Dam break with initial reservoir level at FRL of the dam
- Design flood without dam in place (virgin condition)

The study comprises of:
1. Prediction of outflow hydrograph due to dam breach
2. Routing of dam breach flood hydrograph through the downstream valley to get the maximum water level and discharge along with time of travel at different locations of the river downstream of the dam
3. Channel routing the design flood hydrograph through the downstream valley in the virgin condition of River i.e. without Dam to get the maximum discharge and water level at different locations of the river downstream of the dam

10.2.13.4 Introduction to Dam Break Modeling

Generally, dam break modeling can be carried out by either i) scaled physical hydraulic models, or ii) mathematical simulation using computer. A modern tool to deal with this problem is the mathematical model, which is most cost effective and reasonably solves the governing flow equations of continuity and momentum by computer simulation.

Mathematical modeling of dam breach floods can be carried out by either one dimensional analysis or two-dimensional analysis. In one dimensional analysis, the information about the magnitude of flood, i.e., discharge and water levels, variation of these with time and velocity of flow through breach can be had in the direction of flow. In the case of two-dimensional analysis, the additional information about the inundated area, variation of surface elevation and velocities in two dimensions can also be assessed.

One dimensional analysis is generally accepted, when valley is long and narrow and the flood wave characteristics over a large distance from the dam are of main interest. On the other hand, when the valley widens considerably downstream of dam and large area is likely to be flooded, two-dimensional analysis is necessary. In the instant case, as these valleys are long and the flood wave characteristics over a large distance from the dam are of main interest, one dimensional modeling was adopted.

10.2.13.5 Hydrodynamic Modeling

The essence of dam break modeling is hydrodynamic modeling, which involves finding solution of two partial differential equations originally derived by Barre De Saint Venant in 1871. The equations are:

i. **Conservation of mass (continuity) equation**

$(\partial Q/\partial X) + \partial(A + A_0) / \partial t - q = 0$

ii. **Conservation of momentum equation**

$(\partial Q/\partial t) + \{ \partial(Q^2/A)/\partial X \} + g A ((\partial h/\partial X) + S_f + S_c) = 0$

where, Q = discharge;

A = active flow area;
A_0 = inactive storage area;
h = water surface elevation;
q= lateral outflow;
x = distance along waterway;
t = time;
S_f = friction slope;
S_c = expansion contraction slope and
g = gravitational acceleration.

10.2.13.6 Selection of Model

Selection of an appropriate model to undertake dam break flood routing is essential to ensure the right balance between modeling accuracy and cost (both in terms of software cost and time spent in developing & running the model). In the instant case, MIKE 11 model developed by Danish Hydraulic Institute has been selected for the present study because of its wide acceptability in India and abroad.

10.2.13.7 Mike 11 Model

The core of the MIKE 11 system consists of the HD (hydrodynamic) module, which is capable of simulating unsteady flows in a network of open channels. The results of a HD simulation consist of time series of water levels and discharges. MIKE 11 hydrodynamic module is an implicit, finite difference model for unsteady flow computation. The model can describe sub-critical as well as supercritical flow conditions through a numerical description, which is altered according to the local flow conditions in time and space.

Advanced computational modules are included for description of flow over hydraulic structures, including possibilities to describe structure operation. The formulations can be applied for looped networks and quasi two-dimensional flow simulation on flood plains. The computational scheme is applicable for vertically homogeneous flow conditions extending from steep river flows to tidal influenced tributaries.

The following three approaches simulate branches as well as looped systems.

i) **Kinematic wave approach**: The flow is calculated from the assumption of balance between the friction and gravity forces. The simplification implies that the Kinematic wave approach cannot simulate backwater effects.
ii) **Diffusive wave approach**: In addition to the friction and gravity forces, the hydrostatic gradient is included in this description. This allows the user to take downstream boundaries into account, and thus, simulate backwater effects.
iii) **Dynamic wave approach**: Using the full momentum equation, including acceleration forces, the user is able to simulate fast transients, tidal flows, etc., in the system.

Depending on the type of problem, the appropriate description can be chosen. The dynamic and diffusive wave descriptions differ from kinematic wave description by being capable of calculating backwater effects. The solution algorithm for the different flow descriptions is identical in the inner programme structure, implying that the user does not have to distinguish between the different computational levels, when running the program. In the instant case, dynamic wave approach was adopted for a better simulation.

Hydrodynamic module utilizes a space staggered grid consisting of alternating **h** and **Q** points, i.e., points where water levels (**h**) and discharges (**Q**) are computed sequentially. Topographic data are entered at the **h** points, and discharge relations are evaluated at **Q** points. During simulations, the complete non-linear equations of open channel flow are solved numerically at the grid points at specified time intervals for the given boundary conditions.

10.2.13.8 Mike 11 Model Set-Up

The Dam Break Module in MIKE 11 simulates the outflow hydrograph resulting from the failure of a dam. The model set-up consists of a single or several channels, reservoirs, dam break structures and other auxiliary dam structures such as spillways, bottom outlets etc. As the flood propagation due to the dam break will be of highly unsteady nature, the river course needs to be described accurately through the use of as many cross-sections as possible, particularly where the cross-section is changing rapidly. Further, the cross-sections should extend as far as possible to cover the highest modelled water level, which normally will be in excess of the highest recorded flood level. If the modelled water level exceeds the highest level in the cross-section for a particular location, MIKE 11 will extrapolate the processed Data as a vertical wall, and this will give conservative results.

10.2.13.8.1 River channel set-up

The river channel set-up for dam break modelling is the same as for the HD model except that the dam break structure is located in a separate reservoir branch, which contains 3 calculation points, i.e., two h-points and one Q-point. If a spillway is added to the dam, it can be described as a separate branch with 3 calculation points. The dam and spillways are located at a Q-point. The river set-up with a dam and, with dam and spillway are shown in **Figure 10.22** and **Figure 10.23** respectively.

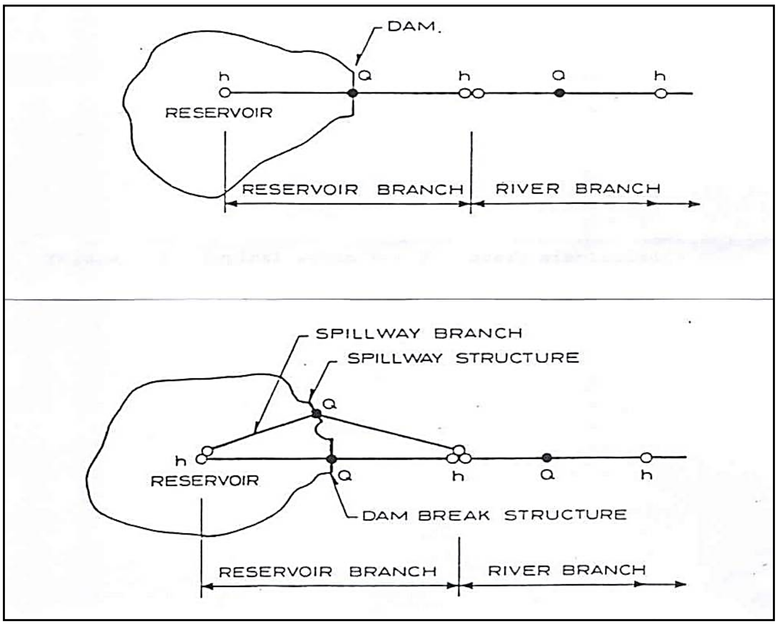


Figure 10.23 & 10.24: River set up with dam and spillway

10.2.13.8.2 Description of reservoir and appurtenant structures

Reservoir

To obtain an accurate description of the reservoir storage characteristics, the reservoir is normally modelled as a single **h**-point in the model. This will usually correspond to the upstream boundary of the model, where also the inflow hydrograph is also specified.

The description of the reservoir storage is entered in the processed data. The surface storage area of the dam is described as a function of the water level and it is entered as additional flooded area. The lowest water level given for the reservoir should be somewhere below the final breach elevation of the dam.

The cross-sectional area is set to a large finite value and is used only for calculating the inflow head loss into the breach. The inflow head loss can be calculated as:

$$\Delta H = (V_s^2/2g)\, C_i\, [1-(A_s / A_{res})]$$

Where,	V_s	= Velocity through the breach
	C_i	= Inflow head loss coefficient
	A_s	= Flow area through the breach, and
	A_{res}	= Cross-sectional area of the reservoir

In order to obtain a reasonable head loss description, it is only necessary that $A_{res} >> A_s$ so that $[1-(A_s/A_{res})] = 1$. The hydraulic radius is set to any non-zero value.

The total surface area of the reservoir is calculated as:

$$A_{total} = b.2\Delta x + \text{Additional flooded area}$$

Since the total surface area is already described by the additional flooded area, the first term should be equal to zero. Therefore, the width b should be set to zero.

Dam

At the **Q** point, where the dam break structure is located, the momentum equation is replaced by an equation which describes the flow through the structure. As the momentum equation is not used at the **Q** point, the Δx – step is of no relevance. The maximum Δx for the river branch, where the dam is to be placed, should therefore be greater than the distance between two cross-sections in the reservoir branch. So, no cross-section is interpolated between the actual cross-sections.

Spillways and other structures

At the node, where two branches meet the surface flooded area is taken as the sum of the individual flooded areas specified at the **h**-points. Therefore, if the reservoir storage has already been specified at the reservoir **h**-point, the spillway **h**-point should not contain any flooded areas. Both the width b, and the "additional flooded area" should be set to zero and other parameters such as the cross-sectional area and hydraulic radius should be the same as for the reservoir.

10.2.13.8.3 Boundary conditions for dam break modeling

The boundary conditions must be specified at both upstream and downstream limits of the model. The upstream boundary will generally be an inflow into the reservoir at the first reservoir **h**-point. The downstream boundary will generally be a stage-discharge relationship at the last cross section of the set up.

10.2.13.9 Salient Features of the project

The salient features of the Project are given below:

I. Hydrology

i) Total catchment area 7,823 sq km

ii) Design flood 9,425 cumec

II. Reservoir

i) FRL El. 2114 m

ii) MWL El. 2114 m

iii) Water spread area at FRL 169.87 ha

iv) Total storage 61.58 M Cum

v) Live Storage 16.57 M Cum

III. Dam

i) Type of dam Concrete gravity

ii) Length at dam 210.65 m

ii) Top of dam El. 2116 m

iii) Average riverbed level El. 2017 m

IV. Spillway

i) Type of spill way Combination (free overflow & sluice spillways)

ii) No. and Size opening of sluice spillway 5 bays of 8.2 m width x 10.65 m height each

iii) Crest Elevation of sluice spillway 2052.5 m

iv) No. and Size opening of free overflow spillway 1 bay of 8.2 m width x 11.7 m height each

v) Crest Elevation of free overflow spillway 2102.3 m

V. Power house

i) Type Underground

ii) Installed capacity 4 units of 103 MW each

iii) Type of turbine Francis

iv) Design discharge 126 cumec per unit

10.2.13.10 Input Data Requirement

Dam break flood analysis requires a range of data to depict accurately to the extent possible the topography and hydraulic conditions of the river course and dam break phenomenon. The important data required are;

(i) Cross sections of the river from dam site and up to location downstream of the dam to which the study is required

(ii) Elevation-surface area relationship of the reservoir
(iii) Rating curve of spillway and sluices
(iv) Salient features of the all hydraulic structures at the dam site and also in the study reach of the river
(v) Design flood hydrograph
(vi) Stage-discharge relationship at the last river cross section of the study area
(vii) Manning's roughness coefficient for different reaches of the river under study
(viii) Rating curve of all the hydraulic structures in the study reach of the river

For the present study, the following data supplied has been used;

10.2.13.10.1 River cross sections

For dam break studies of Dugar HEP, the River for a length of about 58,160 m downstream of the dam site (up to Kiru dam site) have been represented in the model by numerous cross sections taken at a suitable interval. In the case of extreme floods the flood water spreads beyond the normal course of the river, where the resistance to flow will be high due to presence of bushes, vegetation etc. Considering the above the Manning's roughness coefficient for the entire study reach of the river has been taken as 0.040.

10.2.13.10.2 Reservoir and dam

The reservoir has been represented in the model by a separate reservoir branch and its elevation-surface area relation, which has been specified at Chainage "0" km of the reservoir branch, is given below. The dam has been placed at Chainage 500 m of the reservoir branch and dam breach parameters specified therein.

Elevation-Area relationship of the reservoir

Elevation (m)	Area (Ha)	Capacity (MCM)
2017.50	0.00	0.00
2023.50	1.38	0.02
2033.50	11.25	0.58
2043.50	24.95	2.34
2053.50	36.14	5.38
2063.50	52.12	9.77
2073.50	74.50	16.06
2083.50	91.37	24.34
2093.50	109.69	34.38
2103.50	130.60	46.38
2105.00	133.92	48.37
2108.00	140.40	52.48
2111.00	147.00	56.79
2113.50	168.43	60.73
2114.00	**169.87**	**61.58**
2123.50	216.21	79.87

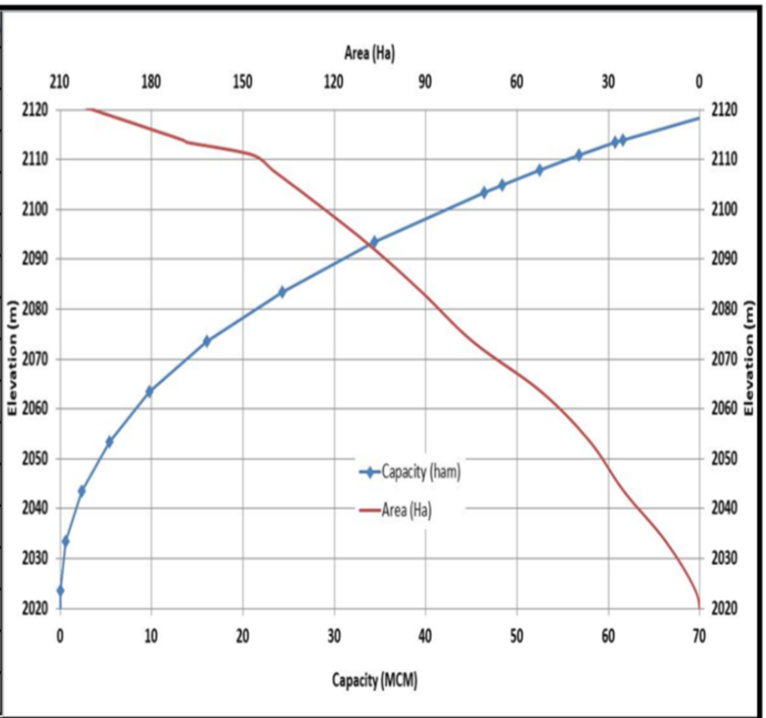


Figure 10.25: Elevation-Area relationship of the reservoir

10.2.13.10.3 Spillway

The spillway has been represented in the model by number and size of spillway gates. The same has been specified at Chainage 500 m of the spillway branch. All gates have been considered as fully open at the time of impingement of design flood hydrograph.

Design Flood Hydrograph

The design flood hydrograph for the present case has been used as for the upstream boundary of the dam break model set up. The same applied at chainage "0" km of the reservoir branch in the model set up, is given in **Table 10.38 and Figure 10.26**.

Table 10.38: Design Flood Hydrograph

TIME (hr)	**TOTAL Q** (cumec)	**TIME** (hr)	**TOTAL Q** (cumec)	**TIME** (hr)	**TOTAL Q** (cumec)
0	325	15	2648	30	4521
1	325	16	2076	31	3377
2	326	17	1677	32	2328
3	329	18	1541	33	1388
4	335	19	1730	34	836
5	350	20	2414	35	602
6	385	21	3563	36	490
7	452	22	4791	37	422
8	580	23	6125	38	382
9	803	24	7632	39	358
10	1151	25	9103	40	344
11	1637	**26**	**9425**	41	335
12	2230	27	8548	42	330
13	2821	28	6986	43	327
14	2970	29	5652	44	325

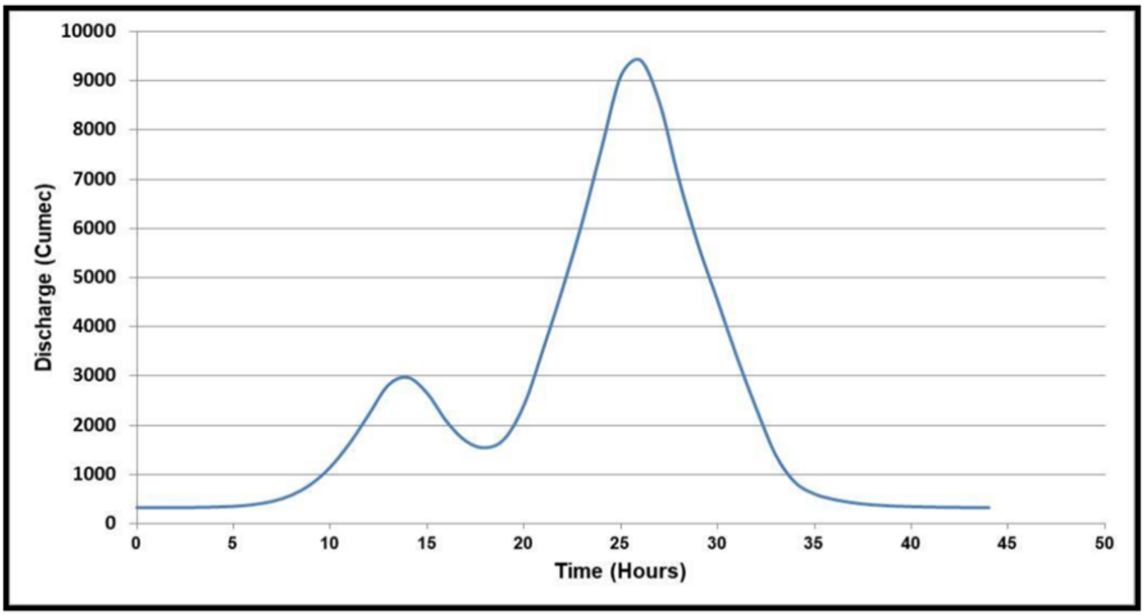


Figure 10.26: Flood Hydrograph

10.2.13.10.4 Downstream boundary

In order to avoid its influence in the study reach normally the downstream boundary should be applied at a distant location from the last river cross section of study reach. The same has been worked out using Manning's equation and applied at a location 14,270 m downstream for dam site, as given in **Table 10.39**.

Table 10.39: Stage-discharge relationship - downstream boundary of MIKE11 model set up

Stage (m)	Discharge (cumec)		Stage (m)	Discharge (cumec)		Stage (m)	Discharge (cumec)
1392.56	0.00		1419.50	25016.54		1485.27	428956.38
1395.56	35.36		1423.15	33072.66		1492.58	507388.49
1396.21	61.57		1426.81	42590.49		1499.89	591985.69
1396.56	83.63		1430.46	53709.16		1507.20	682738.57
1396.61	87.48		1434.12	66482.60		1514.51	779639.28
1397.96	289.60		1437.77	80957.33		1521.81	882687.99
1398.06	310.54		1441.42	97153.70		1529.12	991817.25
1399.46	710.77		1445.08	115113.35		1536.43	1107404.50
1399.56	746.35		1448.73	134891.40		1536.64	1110819.14
1404.30	3562.74		1456.04	179770.25		1546.97	1285420.38
1409.03	8270.39		1459.69	204830.24		1557.30	1473156.38
1413.77	14763.81		1463.35	231671.73		1567.63	1674303.29
1418.50	23042.33		1477.97	356691.57		1577.96	1888467.21

10.2.13.10.5 Upstream Elevation View

Upstream Elevation view of the dam has been shown below respectively:

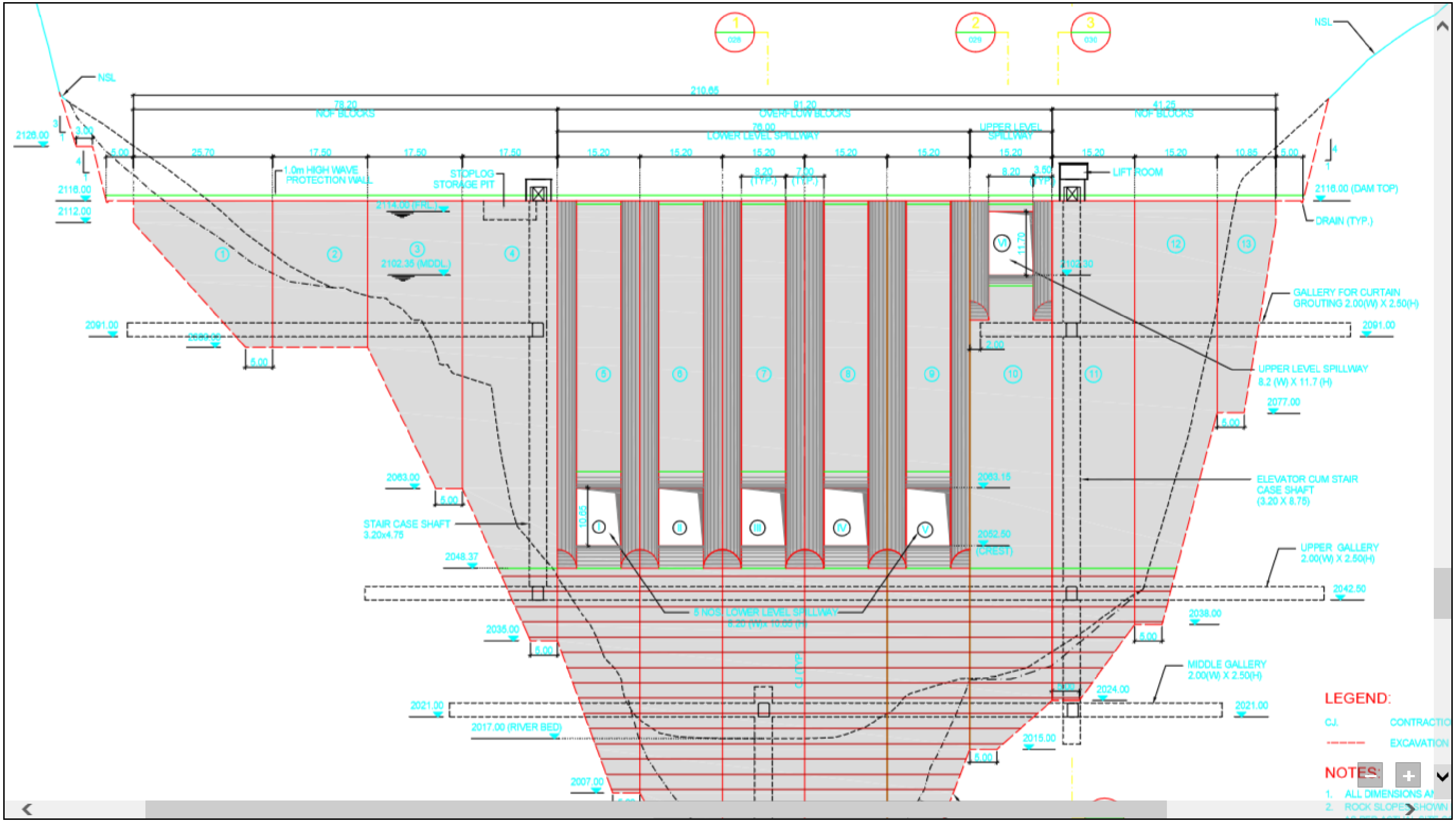


Figure 10.27: Upstream Elevation view of the Dam

10.2.13.11 Selection of Dam Breach Parameters

Estimation of the dam break flood will depend on time of failure, extent of overtopping before failure, size, shape and time of the breach formation, etc., which are called dam breach parameters. The breach characteristics that are needed as input to the existing dam break models are i) Initial and final breach width; ii) Shape of the breach; iii) Time duration of breach development, and iv) Reservoir level at time of start of breach. The predominant mechanism of breach formation is, to a large extent, dependent on the type of dam and the cause due to which the dam failed.

A study of the different dam failures indicates that concrete arch and gravity dams breach by sudden collapse, overturning or sliding away of the structure due to inadequate design or excessive forces that may result from overtopping, earthquakes and deterioration of the abutment or foundation material.

As per the *UK Dam Break Guidelines and U.S. Federal Energy Regulatory Commission (FERC) Guidelines*, *in the case of concrete dams, the breach width should be taken 0.2-0.5 times the crest length of the dam*. *The breach development time for concrete dam should be about 0.3 to 0.4 hour. The breach depth can be taken corresponding to the relatively weaker locations in the dam such as galleries etc or the zero storage elevation of the reservoir.*

Accordingly, the breach parameters given in **Table 10.40** has been selected for the dam break study.

Table 10.40: Breach parameters

Breach Level (m)		Breach Width (m)	Breach Slope	Breach Development Time (Minute)	Remarks
Initial	Final				
2116	2042	52.5 m (3 blocks of 17.5 m each)	0	30	The final breach level at El 2042 m has been taken at upper gallery level of three left blocks (adjacent to sluice spillway)

10.2.13.12 Critical Conditions for Dam Break Study

The critical condition for a Dam break study is when the reservoir is at FRL and design flood hydrograph is impinged. In the present case, it has been assumed that the maximum water level reached in the reservoir shall occur at 26 hr after the application of design flood. Hence for the hypothetical case of Dam break simulation and also to get the maximum Dam breach flood peak it would be appropriate to assume the starting of the breach, when the reservoir level is at FRL.

10.2.13.13 Dam Break Simulation

Taking the above breach parameter and critical condition of above para, the dam break condition has been simulated. In the simulation the dam has been assumed to breach 26 hour after the impingement of the design flood, when the water level in the reservoir is at EL 2114 m after the impingement of the design flood. The dam breach flood hydrograph just downstream of the dam is given in **Figure 10.24**.

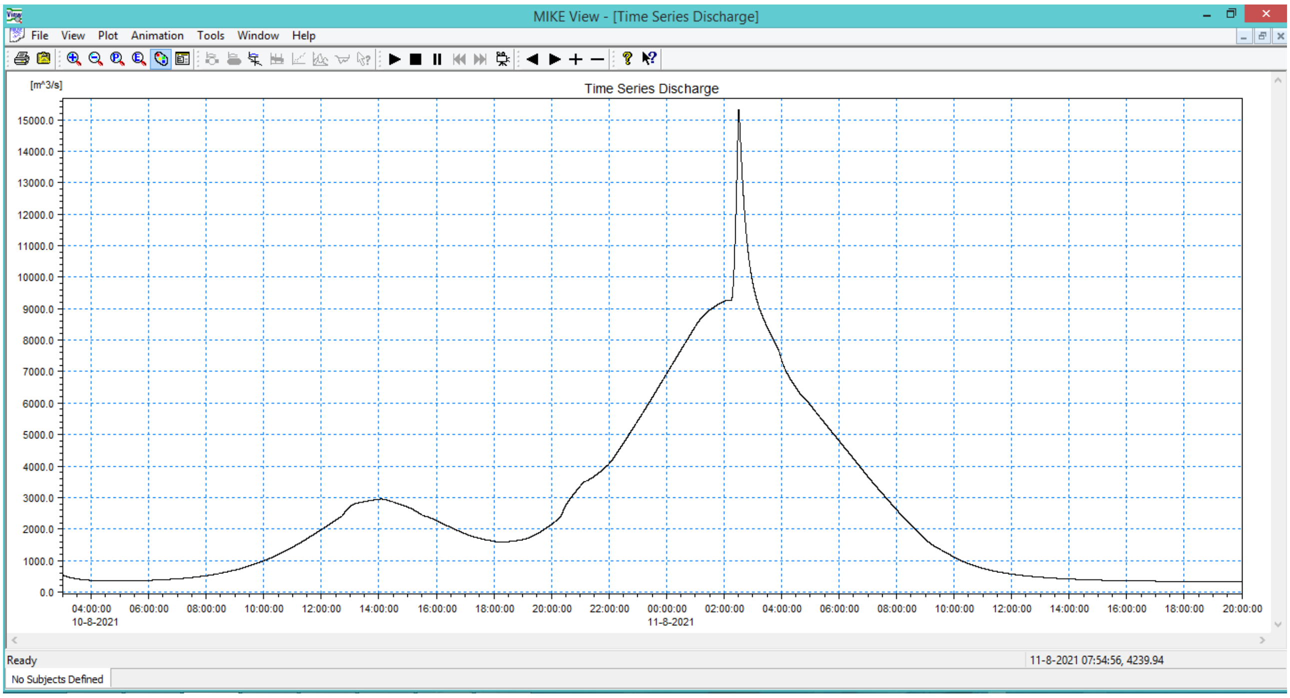


Figure 10.28: The dam breach flood hydrograph

Note: The dates shown on the time axis of the plot are relative dates as used in MIKE11 model

The peak of the dam breach flood just downstream of the dam is 15,320 cumec which includes about 9,425 cumec due to design flood itself. Hence the contribution of reservoir storage in the dam breach flood peak is 5,895 cumec. The maximum discharge, water level and their time of occurrence at different locations of the River downstream of the dams are given in **Table 10.41 and 10.42** respectively.

Table 10.41: Maximum discharge due to dam breach flood

The breach has been assumed to start on 11-08-2021 02:00:00 hours		
Chainage (m) d/s of dam	**Maximum discharge (cumec)**	**Time of occurrence (Date:hour:Minute:Second)**
CHENAB 80.00	15321	11-08-2021 02:30:55
CHENAB 660.00	15298	11-08-2021 02:31:15
CHENAB 1660.00	15229	11-08-2021 02:31:59
CHENAB 2660.00	15205	11-08-2021 02:32:35
CHENAB 3660.00	15146	11-08-2021 02:33:10
CHENAB 4660.00	14956	11-08-2021 02:34:19
CHENAB 5660.00	14715	11-08-2021 02:35:09
CHENAB 6660.00	14606	11-08-2021 02:36:09
CHENAB 7660.00	14506	11-08-2021 02:37:09
CHENAB 8660.00	14443	11-08-2021 02:38:20
CHENAB 9660.00	14402	11-08-2021 02:39:10
CHENAB 10660.00	14359	11-08-2021 02:39:59
CHENAB 11660.00	14285	11-08-2021 02:40:54
CHENAB 12660.00	14160	11-08-2021 02:42:14
CHENAB 13660.00	14089	11-08-2021 02:43:19
CHENAB 14660.00	14048	11-08-2021 02:44:09
CHENAB 15660.00	13955	11-08-2021 02:45:09

The breach has been assumed to start on 11-08-2021 02:00:00 hours		
Chainage (m) d/s of dam	**Maximum discharge (cumec)**	**Time of occurrence (Date:hour:Minute:Second)**
CHENAB 16660.00	13875	11-08-2021 02:46:29
CHENAB 17660.00	13846	11-08-2021 02:47:35
CHENAB 18660.00	13836	11-08-2021 02:48:15
CHENAB 19660.00	13831	11-08-2021 02:48:45
CHENAB 20660.00	13824	11-08-2021 02:49:24
CHENAB 21660.00	13813	11-08-2021 02:50:00
CHENAB 22660.00	13787	11-08-2021 02:51:00
CHENAB 23660.00	13768	11-08-2021 02:51:55
CHENAB 24660.00	13754	11-08-2021 02:52:39
CHENAB 25660.00	13728	11-08-2021 02:53:29
CHENAB 26660.00	13683	11-08-2021 02:54:29
CHENAB 27660.00	13649	11-08-2021 02:55:35
CHENAB 28660.00	13628	11-08-2021 02:56:30
CHENAB 29660.00	13596	11-08-2021 02:57:30
CHENAB 30660.00	13514	11-08-2021 02:58:55
CHENAB 31660.00	13376	11-08-2021 03:00:29
CHENAB 32660.00	13179	11-08-2021 03:02:59
CHENAB 33660.00	13118	11-08-2021 03:04:44
CHENAB 34660.00	13097	11-08-2021 03:05:55
CHENAB 35660.00	13078	11-08-2021 03:07:00
CHENAB 36660.00	13046	11-08-2021 03:08:29
CHENAB 37660.00	13032	11-08-2021 03:09:29
CHENAB 38660.00	13019	11-08-2021 03:10:29
CHENAB 39660.00	12998	11-08-2021 03:11:30
CHENAB 40660.00	12965	11-08-2021 03:12:49
CHENAB 41660.00	12948	11-08-2021 03:13:55
CHENAB 42660.00	12941	11-08-2021 03:14:44
CHENAB 43660.00	12935	11-08-2021 03:15:34
CHENAB 44660.00	12930	11-08-2021 03:16:20
CHENAB 45660.00	12924	11-08-2021 03:16:59
CHENAB 46660.00	12916	11-08-2021 03:17:54
CHENAB 47660.00	12910	11-08-2021 03:18:40
CHENAB 48660.00	12906	11-08-2021 03:19:14
CHENAB 49660.00	12904	11-08-2021 03:19:49
CHENAB 50660.00	12901	11-08-2021 03:20:30
CHENAB 51660.00	12898	11-08-2021 03:20:55
CHENAB 52660.00	12890	11-08-2021 03:21:50
CHENAB 53660.00	12883	11-08-2021 03:22:39
CHENAB 54660.00	12877	11-08-2021 03:23:29
CHENAB 55660.00	12873	11-08-2021 03:23:59
CHENAB 56660.00	12860	11-08-2021 03:24:59
CHENAB 57660.00	12853	11-08-2021 03:25:49

Table 10.42: Maximum water level due to dam breach flood breach

The breach has been assumed to start on 11-08-2020 02:00:00 hours			
Chainage (m) d/s of dam	***Bed Level (m)***	***Maximum water level (m)***	***Time of occurrence (Date:hour:Minute:Second)***
CHENAB 0.00	2017.00	2032.92	11-08-2021 02:30:59
CHENAB 160.00	2017.00	2031.68	11-08-2021 02:31:15
CHENAB 1160.00	*	2020.30	11-08-2021 02:31:54
CHENAB 2160.00	1991.00	2007.56	11-08-2021 02:32:24
CHENAB 3160.00	*	1987.62	11-08-2021 02:33:15
CHENAB 4160.00	1962.52	1977.45	11-08-2021 02:34:30
CHENAB 5160.00	*	1974.52	11-08-2021 02:36:30
CHENAB 6160.00	1952.04	1972.39	11-08-2021 02:36:30
CHENAB 7160.00	*	1966.81	11-08-2021 02:37:34
CHENAB 8160.00	1943.73	1960.80	11-08-2021 02:38:20
CHENAB 9160.00	*	1952.64	11-08-2021 02:39:10
CHENAB 10160.00	1929.01	1943.96	11-08-2021 02:40:05
CHENAB 11160.00	*	1934.98	11-08-2021 02:41:19
CHENAB 12160.00	1908.70	1927.80	11-08-2021 02:42:49
CHENAB 13160.00	*	1923.44	11-08-2021 02:43:39
CHENAB 14160.00	1898.52	1918.82	11-08-2021 02:44:30
CHENAB 15160.00	*	1911.59	11-08-2021 02:46:15
CHENAB 16160.00	1892.00	1908.35	11-08-2021 02:46:54
CHENAB 17160.00	*	1903.63	11-08-2021 02:47:35
CHENAB 18160.00	1883.05	1896.50	11-08-2021 02:48:10
CHENAB 19160.00	*	1879.67	11-08-2021 02:48:45
CHENAB 20160.00	1849.53	1868.72	11-08-2021 02:49:14
CHENAB 21160.00	*	1852.55	11-08-2021 02:50:00
CHENAB 22160.00	1832.00	1844.12	11-08-2021 02:51:00
CHENAB 23160.00	*	1832.83	11-08-2021 02:51:50
CHENAB 24160.00	1801.69	1820.13	11-08-2021 02:52:34
CHENAB 25160.00	*	1805.32	11-08-2021 02:53:39
CHENAB 26160.00	1775.02	1794.62	11-08-2021 02:54:54
CHENAB 27160.00	*	1790.37	11-08-2021 02:55:45
CHENAB 28160.00	1771.00	1785.13	11-08-2021 02:56:30
CHENAB 29160.00	*	1775.49	11-08-2021 02:57:44
CHENAB 30160.00	1754.00	1767.13	11-08-2021 02:59:30
CHENAB 31160.00	*	1763.93	11-08-2021 03:01:59
CHENAB 32160.00	1749.00	1761.92	11-08-2021 03:04:14
CHENAB 33160.00	*	1759.27	11-08-2021 03:05:05
CHENAB 34160.00	1742.30	1755.17	11-08-2021 03:05:55
CHENAB 35160.00	*	1747.02	11-08-2021 03:07:04
CHENAB 36160.00	1728.00	1738.43	11-08-2021 03:08:29
CHENAB 37160.00	*	1728.11	11-08-2021 03:09:29
CHENAB 38160.00	1708.00	1717.41	11-08-2021 03:10:29
CHENAB 39160.00	*	1704.30	11-08-2021 03:11:40
CHENAB 40160.00	1677.84	1693.81	11-08-2021 03:13:09
CHENAB 41160.00	*	1689.26	11-08-2021 03:13:55
CHENAB 42160.00	1669.00	1684.06	11-08-2021 03:14:34
CHENAB 43160.00	*	1673.03	11-08-2021 03:15:20
CHENAB 44160.00	1648.59	1658.87	11-08-2021 03:16:09
CHENAB 45160.00	*	1618.89	11-08-2021 03:16:54
CHENAB 46160.00	1570.04	1586.91	11-08-2021 03:17:49
CHENAB 47160.00	*	1577.38	11-08-2021 03:18:29
CHENAB 48160.00	1549.65	1566.45	11-08-2021 03:19:05
CHENAB 49160.00	*	1548.53	11-08-2021 03:19:40

The breach has been assumed to start on 11-08-2020 02:00:00 hours			
Chainage (m) d/s of dam	***Bed Level (m)***	***Maximum water level (m)***	***Time of occurrence (Date:hour:Minute:Second)***
CHENAB 50160.00	1516.02	1531.22	11-08-2021 03:20:14
CHENAB 51160.00	*	1509.22	11-08-2021 03:20:49
CHENAB 52160.00	1479.13	1494.23	11-08-2021 03:21:44
CHENAB 53160.00	*	1484.12	11-08-2021 03:22:30
CHENAB 54160.00	1463.88	1472.10	11-08-2021 03:23:20
CHENAB 55160.00	*	1449.82	11-08-2021 03:23:59
CHENAB 56160.00	1413.04	1429.69	11-08-2021 03:24:59
CHENAB 57160.00	*	1421.45	11-08-2021 03:25:45
CHENAB 58160.00	1392.56	1412.37	11-08-2021 03:26:15

** cross sections interpolated by MIKE11*

From the **Table 10.42,** it can be seen that the rise in water level along the reach of the river is about 8.22 m to 20.35 m with average rise of 15.35 m.

10.2.13.14 Maximum Water Level in the Virgin Condition of the River due to occurrence of design flood

To know the maximum discharge and water level due to occurrence of design flood in the virgin condition of the River (assuming no dam) the necessary simulation has been run. In this case, the design flood has been impinged at chainage "0" of the River (just d/s of dam site) without considering the dam. The maximum discharge and water level obtained at the different locations along the river reach is given in **Table 10.43** and **10.44** respectively.

Table 10.43: Maximum discharge due to occurrence of DESIGN FLOOD in virgin river condition (no Dam)

Design flood has been impinged at chainage "0" of River on 10-08-2021 at 00:00:00 hr		
Chainage (m) d/s of dam	***Maximum discharge (cumec)***	***Time of occurrence (Date:hour:Minute:Second)***
CHENAB 80.00	9425	11-08-2021 02:00:04
CHENAB 660.00	9423	11-08-2021 02:00:20
CHENAB 1660.00	9421	11-08-2021 02:00:50
CHENAB 2660.00	9420	11-08-2021 02:01:20
CHENAB 3660.00	9419	11-08-2021 02:01:50
CHENAB 4660.00	9416	11-08-2021 02:02:49
CHENAB 5660.00	9412	11-08-2021 02:03:29
CHENAB 6660.00	9410	11-08-2021 02:04:19
CHENAB 7660.00	9407	11-08-2021 02:05:14
CHENAB 8660.00	9406	11-08-2021 02:06:05
CHENAB 9660.00	9405	11-08-2021 02:06:55
CHENAB 10660.00	9403	11-08-2021 02:07:50
CHENAB 11660.00	9401	11-08-2021 02:08:50
CHENAB 12660.00	9399	11-08-2021 02:10:05
CHENAB 13660.00	9397	11-08-2021 02:11:05
CHENAB 14660.00	9396	11-08-2021 02:11:54
CHENAB 15660.00	9395	11-08-2021 02:12:44
CHENAB 16660.00	9393	11-08-2021 02:14:00
CHENAB 17660.00	9392	11-08-2021 02:15:00
CHENAB 18660.00	9392	11-08-2021 02:15:50
CHENAB 19660.00	9392	11-08-2021 02:16:20

Design flood has been impinged at chainage "0" of River on 10-08-2021 at 00:00:00 hr		
Chainage (m) d/s of dam	***Maximum discharge (cumec)***	***Time of occurrence (Date:hour:Minute:Second)***
CHENAB 20660.00	9391	11-08-2021 02:16:59
CHENAB 21660.00	9391	11-08-2021 02:17:35
CHENAB 22660.00	9391	11-08-2021 02:18:29
CHENAB 23660.00	9390	11-08-2021 02:19:19
CHENAB 24660.00	9390	11-08-2021 02:20:05
CHENAB 25660.00	9389	11-08-2021 02:20:55
CHENAB 26660.00	9388	11-08-2021 02:21:55
CHENAB 27660.00	9387	11-08-2021 02:22:59
CHENAB 28660.00	9387	11-08-2021 02:23:54
CHENAB 29660.00	9386	11-08-2021 02:24:54
CHENAB 30660.00	9384	11-08-2021 02:26:19
CHENAB 31660.00	9381	11-08-2021 02:27:49
CHENAB 32660.00	9377	11-08-2021 02:29:55
CHENAB 33660.00	9376	11-08-2021 02:31:20
CHENAB 34660.00	9375	11-08-2021 02:32:29
CHENAB 35660.00	9374	11-08-2021 02:33:35
CHENAB 36660.00	9374	11-08-2021 02:34:49
CHENAB 37660.00	9373	11-08-2021 02:35:49
CHENAB 38660.00	9373	11-08-2021 02:36:50
CHENAB 39660.00	9372	11-08-2021 02:37:55
CHENAB 40660.00	9371	11-08-2021 02:39:15
CHENAB 41660.00	9370	11-08-2021 02:40:19
CHENAB 42660.00	9370	11-08-2021 02:41:10
CHENAB 43660.00	9370	11-08-2021 02:42:00
CHENAB 44660.00	9370	11-08-2021 02:42:44
CHENAB 45660.00	9369	11-08-2021 02:43:39
CHENAB 46660.00	9369	11-08-2021 02:44:39
CHENAB 47660.00	9368	11-08-2021 02:45:34
CHENAB 48660.00	9368	11-08-2021 02:46:20
CHENAB 49660.00	9368	11-08-2021 02:46:59
CHENAB 50660.00	9368	11-08-2021 02:47:35
CHENAB 51660.00	9368	11-08-2021 02:48:05
CHENAB 52660.00	9368	11-08-2021 02:49:00
CHENAB 53660.00	9367	11-08-2021 02:49:44
CHENAB 54660.00	9367	11-08-2021 02:50:35
CHENAB 55660.00	9367	11-08-2021 02:51:09
CHENAB 56660.00	9367	11-08-2021 02:52:04
CHENAB 57660.00	9367	11-08-2021 02:52:59

Table 10.44: Maximum water level due to occurrence of DESIGN FLOOD in virgin river condition (no Dam)

Design flood has been impinged at chainage "0" of River on 10-08-2021 at 00:00:00 hr			
Chainage (m) d/s of dam	***Bed Level (m)***	***Maximum water level (m)***	***Time of occurrence (Date:hours:Minutes:Seconds)***
CHENAB 0.00	2017.00	2029.55	11-08-2021 02:00:00
CHENAB 160.00	2017.00	2028.36	11-08-2021 02:00:09
CHENAB 1160.00	*	2016.89	11-08-2021 02:00:34
CHENAB 2160.00	1991.00	2004.40	11-08-2021 02:01:09
CHENAB 3160.00	*	1985.24	11-08-2021 02:01:40
CHENAB 4160.00	1962.52	1974.39	11-08-2021 02:02:29
CHENAB 5160.00	*	1971.19	11-08-2021 02:03:45
CHENAB 6160.00	1952.04	1968.77	11-08-2021 02:04:19
CHENAB 7160.00	*	1963.36	11-08-2021 02:05:05

Design flood has been impinged at chainage "0" of River on 10-08-2021 at 00:00:00 hr			
Chainage (m) d/s of dam	***Bed Level (m)***	***Maximum water level (m)***	***Time of occurrence (Date:hours:Minutes:Seconds)***
CHENAB 8160.00	1943.73	1957.10	11-08-2021 02:05:49
CHENAB 9160.00	*	1949.29	11-08-2021 02:06:50
CHENAB 10160.00	1929.01	1941.05	11-08-2021 02:07:39
CHENAB 11160.00	*	1931.94	11-08-2021 02:08:54
CHENAB 12160.00	1908.70	1924.71	11-08-2021 02:09:59
CHENAB 13160.00	*	1920.33	11-08-2021 02:11:10
CHENAB 14160.00	1898.52	1915.73	11-08-2021 02:11:44
CHENAB 15160.00	*	1908.96	11-08-2021 02:13:05
CHENAB 16160.00	1892.00	1905.77	11-08-2021 02:13:50
CHENAB 17160.00	*	1901.02	11-08-2021 02:14:39
CHENAB 18160.00	1883.05	1894.22	11-08-2021 02:15:20
CHENAB 19160.00	*	1877.26	11-08-2021 02:16:04
CHENAB 20160.00	1849.53	1865.84	11-08-2021 02:16:40
CHENAB 21160.00	*	1850.46	11-08-2021 02:17:10
CHENAB 22160.00	1832.00	1841.94	11-08-2021 02:18:19
CHENAB 23160.00	*	1830.40	11-08-2021 02:19:00
CHENAB 24160.00	1801.69	1817.49	11-08-2021 02:19:40
CHENAB 25160.00	*	1802.49	11-08-2021 02:20:49
CHENAB 26160.00	1775.02	1791.56	11-08-2021 02:21:44
CHENAB 27160.00	*	1787.64	11-08-2021 02:22:55
CHENAB 28160.00	1771.00	1782.81	11-08-2021 02:23:34
CHENAB 29160.00	*	1773.38	11-08-2021 02:24:34
CHENAB 30160.00	1754.00	1765.19	11-08-2021 02:26:19
CHENAB 31160.00	*	1762.09	11-08-2021 02:28:00
CHENAB 32160.00	1749.00	1760.03	11-08-2021 02:30:20
CHENAB 33160.00	*	1757.42	11-08-2021 02:31:24
CHENAB 34160.00	1742.30	1753.36	11-08-2021 02:32:04
CHENAB 35160.00	*	1745.28	11-08-2021 02:33:10
CHENAB 36160.00	1728.00	1737.04	11-08-2021 02:34:35
CHENAB 37160.00	*	1726.40	11-08-2021 02:35:25
CHENAB 38160.00	1708.00	1715.85	11-08-2021 02:36:30
CHENAB 39160.00	*	1702.49	11-08-2021 02:37:34
CHENAB 40160.00	1677.84	1691.51	11-08-2021 02:39:04
CHENAB 41160.00	*	1687.02	11-08-2021 02:39:59
CHENAB 42160.00	1669.00	1682.04	11-08-2021 02:40:54
CHENAB 43160.00	*	1671.35	11-08-2021 02:41:15
CHENAB 44160.00	1648.59	1657.95	11-08-2021 02:41:44
CHENAB 45160.00	*	1617.54	11-08-2021 02:43:19
CHENAB 46160.00	1570.04	1584.55	11-08-2021 02:44:30
CHENAB 47160.00	*	1575.09	11-08-2021 02:45:00
CHENAB 48160.00	1549.65	1564.23	11-08-2021 02:45:50
CHENAB 49160.00	*	1546.29	11-08-2021 02:46:20
CHENAB 50160.00	1516.02	1529.28	11-08-2021 02:46:50
CHENAB 51160.00	*	1507.57	11-08-2021 02:47:59
CHENAB 52160.00	1479.13	1492.27	11-08-2021 02:48:40
CHENAB 53160.00	*	1482.47	11-08-2021 02:49:00
CHENAB 54160.00	1463.88	1470.82	11-08-2021 02:49:54
CHENAB 55160.00	*	1448.22	11-08-2021 02:51:05
CHENAB 56160.00	1413.04	1427.43	11-08-2021 02:51:39
CHENAB 57160.00	*	1418.98	11-08-2021 02:52:20
CHENAB 58160.00	1392.56	1409.83	11-08-2021 02:52:50

** cross sections interpolated by MIKE11*

The rise in water level along the reach of the river downstream of the dam is about 6.94 m to 17.27 m with an average rise of 12.91 m.

10.2.13.15 Comparison of Maximum Discharge and Water Level

For the different hydrodynamic scenario simulated so far, the maximum discharge and water level occurring at different locations of River downstream of dam have been compared in **Table 10.45** and **10.46** respectively.

Table 10.45: Comparison of maximum discharge obtained in different cases

Chainage (m) d/s of dam	Maximum discharge (cumec)	
	Design flood and dam breach	Design flood in virgin condition
	(Table 10.41)	(Table 10.42)
CHENAB 80.00	15321	9425
CHENAB 660.00	15298	9423
CHENAB 1660.00	15229	9421
CHENAB 2660.00	15205	9420
CHENAB 3660.00	15146	9419
CHENAB 4660.00	14956	9416
CHENAB 5660.00	14715	9412
CHENAB 6660.00	14606	9410
CHENAB 7660.00	14506	9407
CHENAB 8660.00	14443	9406
CHENAB 9660.00	14402	9405
CHENAB 10660.00	14359	9403
CHENAB 11660.00	14285	9401
CHENAB 12660.00	14160	9399
CHENAB 13660.00	14089	9397
CHENAB 14660.00	14048	9396
CHENAB 15660.00	13955	9395
CHENAB 16660.00	13875	9393
CHENAB 17660.00	13846	9392
CHENAB 18660.00	13836	9392
CHENAB 19660.00	13831	9392
CHENAB 20660.00	13824	9391
CHENAB 21660.00	13813	9391
CHENAB 22660.00	13787	9391
CHENAB 23660.00	13768	9390
CHENAB 24660.00	13754	9390
CHENAB 25660.00	13728	9389
CHENAB 26660.00	13683	9388
CHENAB 27660.00	13649	9387
CHENAB 28660.00	13628	9387
CHENAB 29660.00	13596	9386
CHENAB 30660.00	13514	9384

Chainage (m) d/s of dam	Maximum discharge (cumec)	
	Design flood and dam breach	Design flood in virgin condition
	(Table 10.41)	(Table 10.42)
CHENAB 31660.00	13376	9381
CHENAB 32660.00	13179	9377
CHENAB 33660.00	13118	9376
CHENAB 34660.00	13097	9375
CHENAB 35660.00	13078	9374
CHENAB 36660.00	13046	9374
CHENAB 37660.00	13032	9373
CHENAB 38660.00	13019	9373
CHENAB 39660.00	12998	9372
CHENAB 40660.00	12965	9371
CHENAB 41660.00	12948	9370
CHENAB 42660.00	12941	9370
CHENAB 43660.00	12935	9370
CHENAB 44660.00	12930	9370
CHENAB 45660.00	12924	9369
CHENAB 46660.00	12916	9369
CHENAB 47660.00	12910	9368
CHENAB 48660.00	12906	9368
CHENAB 49660.00	12904	9368
CHENAB 50660.00	12901	9368
CHENAB 51660.00	12898	9368
CHENAB 52660.00	12890	9368
CHENAB 53660.00	12883	9367
CHENAB 54660.00	12877	9367
CHENAB 55660.00	12873	9367
CHENAB 56660.00	12860	9367
CHENAB 57660.00	12853	9367

Table 10.46: Comparison of maximum water level obtained in different cases

Chainage (m) d/s of dam	Bed Level (m)	Maximum discharge (cumec)	
		Design flood and dam breach	Design flood in virgin condition
		(Table 10.41)	(Table 10.42)
CHENAB 0.00	2017.00	2032.92	2029.55
CHENAB 160.00	2017.00	2031.68	2028.36
CHENAB 1160.00	*	2020.30	2016.89
CHENAB 2160.00	1991.00	2007.56	2004.40
CHENAB 3160.00	*	1987.62	1985.24
CHENAB 4160.00	1962.52	1977.45	1974.39
CHENAB 5160.00	*	1974.52	1971.19
CHENAB 6160.00	1952.04	1972.39	1968.77
CHENAB 7160.00	*	1966.81	1963.36

Chainage (m) d/s of dam	Bed Level (m)	Maximum discharge (cumec)	
		Design flood and dam breach	Design flood in virgin condition
		(Table 10.41)	(Table 10.42)
CHENAB 8160.00	1943.73	1960.80	1957.10
CHENAB 9160.00	*	1952.64	1949.29
CHENAB 10160.00	1929.01	1943.96	1941.05
CHENAB 11160.00	*	1934.98	1931.94
CHENAB 12160.00	1908.70	1927.80	1924.71
CHENAB 13160.00	*	1923.44	1920.33
CHENAB 14160.00	1898.52	1918.82	1915.73
CHENAB 15160.00	*	1911.59	1908.96
CHENAB 16160.00	1892.00	1908.35	1905.77
CHENAB 17160.00	*	1903.63	1901.02
CHENAB 18160.00	1883.05	1896.50	1894.22
CHENAB 19160.00	*	1879.67	1877.26
CHENAB 20160.00	1849.53	1868.72	1865.84
CHENAB 21160.00	*	1852.55	1850.46
CHENAB 22160.00	1832.00	1844.12	1841.94
CHENAB 23160.00	*	1832.83	1830.40
CHENAB 24160.00	1801.69	1820.13	1817.49
CHENAB 25160.00	*	1805.32	1802.49
CHENAB 26160.00	1775.02	1794.62	1791.56
CHENAB 27160.00	*	1790.37	1787.64
CHENAB 28160.00	1771.00	1785.13	1782.81
CHENAB 29160.00	*	1775.49	1773.38
CHENAB 30160.00	1754.00	1767.13	1765.19
CHENAB 31160.00	*	1763.93	1762.09
CHENAB 32160.00	1749.00	1761.92	1760.03
CHENAB 33160.00	*	1759.27	1757.42
CHENAB 34160.00	1742.30	1755.17	1753.36
CHENAB 35160.00	*	1747.02	1745.28
CHENAB 36160.00	1728.00	1738.43	1737.04
CHENAB 37160.00	*	1728.11	1726.40
CHENAB 38160.00	1708.00	1717.41	1715.85
CHENAB 39160.00	*	1704.30	1702.49
CHENAB 40160.00	1677.84	1693.81	1691.51
CHENAB 41160.00	*	1689.26	1687.02
CHENAB 42160.00	1669.00	1684.06	1682.04
CHENAB 43160.00	*	1673.03	1671.35
CHENAB 44160.00	1648.59	1658.87	1657.95
CHENAB 45160.00	*	1618.89	1617.54
CHENAB 46160.00	1570.04	1586.91	1584.55
CHENAB 47160.00	*	1577.38	1575.09
CHENAB 48160.00	1549.65	1566.45	1564.23
CHENAB 49160.00	*	1548.53	1546.29
CHENAB 50160.00	1516.02	1531.22	1529.28

Chainage (m) d/s of dam	Bed Level (m)	Maximum discharge (cumec)	
		Design flood and dam breach	Design flood in virgin condition
		(Table 10.41)	(Table 10.42)
CHENAB 51160.00	*	1509.22	1507.57
CHENAB 52160.00	1479.13	1494.23	1492.27
CHENAB 53160.00	*	1484.12	1482.47
CHENAB 54160.00	1463.88	1472.10	1470.82
CHENAB 55160.00	*	1449.82	1448.22
CHENAB 56160.00	1413.04	1429.69	1427.43
CHENAB 57160.00	*	1421.45	1418.98
CHENAB 58160.00	1392.56	1412.37	1409.83

** cross sections interpolated by MIKE11*

From the **Table 10.45**, it can be concluded that the rise in water level along the river reach in dam breach condition is about 0.92 m to 3.7 m with an average of 2.44 m more in comparison to non-dam breach condition (col. 3 &4)

The water levels given in **Table 10.45** can be used for the preparation of inundation map. The tables of few cross sections of the River used have been given in **Table 10.46**. The maximum water level at these cross sections due to dam breach flood has also been superimposed over them.

10.2.13.16 Dam Breach Flood Hydrograph

The dam breach flood hydrograph of **Figure 10.24** has been reproduced in the tabular form and the same are given in **Table 10.47**. The peak of the hydrograph is 15,320 cumec.

Table 10.47: Dam breach Flood hydrograph just d/s of dam

Time (Date: hours: minutes: seconds)	Discharge (cumec)
10-08-2021 03:00:00	245
10-08-2021 04:00:00	267
10-08-2021 05:00:00	348
10-08-2021 06:00:00	368
10-08-2021 07:00:00	417
10-08-2021 08:00:00	515
10-08-2021 09:00:00	694
10-08-2021 10:00:00	990
10-08-2021 11:00:00	1423
10-08-2021 12:00:00	1979
10-08-2021 13:00:00	2709
10-08-2021 14:00:00	2946
10-08-2021 15:00:00	2698
10-08-2021 16:00:00	2266
10-08-2021 17:00:00	1848
10-08-2021 18:00:00	1610
10-08-2021 19:00:00	1661

Time (Date: hours: minutes: seconds)	Discharge (cumec)
10-08-2021 20:00:00	2143
10-08-2021 21:00:00	3360
10-08-2021 22:00:00	4067
10-08-2021 23:00:00	5431
11-08-2021 00:00:00	6923
11-08-2021 01:00:00	8429
11-08-2021 02:00:00	9229
11-08-2021 02:30:55	**15321**
11-08-2021 03:00:00	9816
11-08-2021 04:00:00	7376
11-08-2021 05:00:00	5942
11-08-2021 06:00:00	4802
11-08-2021 07:00:00	3668
11-08-2021 08:00:00	2611
11-08-2021 09:00:00	1679
11-08-2021 10:00:00	1106
11-08-2021 11:00:00	749
11-08-2021 12:00:00	567
11-08-2021 13:00:00	468
11-08-2021 14:00:00	410
11-08-2021 15:00:00	375
11-08-2021 16:00:00	355
11-08-2021 17:00:00	342
11-08-2021 18:00:00	334
11-08-2021 19:00:00	329
11-08-2021 20:00:00	326

10.2.13.17 Preparation of Inundation Map

An inundation map (**Figure 10.25**) is a map depicting the d/s areas vulnerable to inundation by the Dam break flood. The MIKE11 model computes maximum flood elevation at each original or interpolated cross-section. In present case, the cross-sections are available for a length of about 58,160 m downstream of the dam site (upto Kiru dam site). From this profile, at locations below the Dam & their subsequent markings on the topographic maps, it can be seen which areas are likely to be submerged in case of Dam break.

It is clear from the inundation map that in case of Dam break, following villages are likely to be affected.

1. Paridaun
2. Chaund
3. Khuma
4. Gulab garh
5. Arthal
6. Hugai
7. Totaun
8. Lal

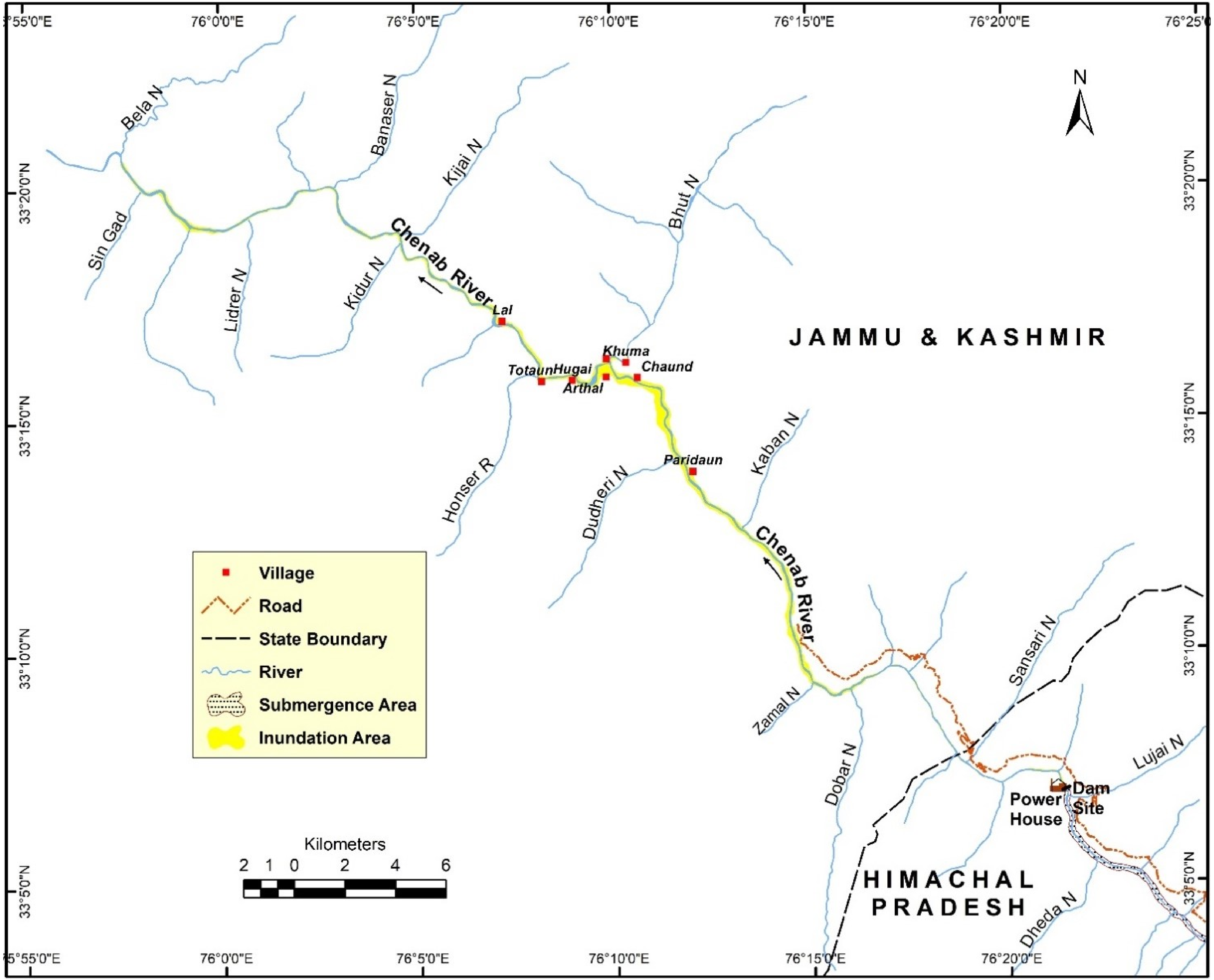


Figure 10.29: Inundation Map

10.2.13.18 Disaster Management Plan

Emergency action plan: Emergency identification and evaluation during construction stage

The emergency action plan includes emergency identification and evaluation matrix containing following items:

i. Listing of the conditions or events which could lead to or indicate an existing or potential emergency during construction stage of the project;

ii. Brief description of the means by which potential emergencies identified, including the data and information collection system, monitoring arrangements; and

iii. Designation of persons responsible for identifying and evaluating emergency.

Accordingly, emergency identification and response level matrix would need to be prepared for the construction stage of the project and be included in disaster management plan as proposed subsequently.

10.2.13.8.1 Vulnerability Assessment

From the result of Dam Break Modeling it is evident that up to about 58,160 m d/s of the Dam, time required in reaching the flood wave elevation to the maximum is about one and a half hour due to high slopes. Since the time available is very short, the Disaster Management Plan should concentrate on preventive actions. Also as evident from the inundation map, that in case of design flood plus Dam break scenario, eight villages are likely to be affected, Disaster Management Plan is more of a precautionary measure.

10.2.13.8.2 Surveillance & Monitoring

The surveillance and monitoring programs are required to be implemented during design and investigation, construction, early operation period and operation and maintenance phases of the life cycle of the Dam. An effective flood forecasting system is required by establishing hourly gauge reading at suitable upstream locations with real time communication at the top. An effective Dam safety surveillance, monitoring and observation along with periodic inspection, safety reviews and evaluation must be put in place. These programs will be implemented in five phases in the life cycle of Dam/embankment *viz*.,

i) Design and investigation phase,
ii) Construction phase,
iii) First reservoir filling,
iv) Early operation period, and
v) Operation and maintenance phase.

Surveillance and monitoring programmes are required to be implemented during design and investigation, construction, first reservoir filling, early operation period and operation & maintenance phases of the life cycle of Dam/embankment.

10.2.13.8.3 Disaster Management Plan (DMP) for Project

A Disaster Management Plan essentially consists of Disaster Response Plan, Contingency Plans and Standard Operating Procedures (SOPs). A well-coordinated Disaster Response Plan, which makes best use of the organisation's combined expertise and resources, is essential for efficient and successful disaster response. During an actual emergency, rapid and effective action is required. For this to happen, disaster response and contingency plans must be in place before a disaster strikes along with the necessary resources. If appropriate action is not taken or if the response is delayed, lives may be needlessly lost.

A detailed comprehensive Disaster Management Plan including emergency action plan for construction stage would need to be prepared which would need to be dove tailed with the state disaster management plan for which adequate provision has been kept in cost estimates. In addition to components of emergency action plan during construction stage, broadly it should consist of following:

- Disaster Response Plan
- Contingency Plan
- Awareness and Emergency Preparedness
- Emergency Action Plan (EAP)
- Communication System
- Emergency Alert System
- Emergency Warning and Control System
- Health & Medical Response System
- Training
- Mock Drills & Exercises
- Public Information System
- Information Dissemination and Safety Procedures & Plan
- Safety Procedures & Plan
- Evacuation Plans
- Notifications

10.2.13.8.4 Cost Estimates for Disaster Management

The estimated total cost of execution of disaster management plan including the equipment would be **Rs. 155.00 lakh** and the breakup of the same is given at **Table 10.48**.

Table 10.48: Estimated cost disaster management plan

S. No.	Particulars	Amount Rs. in Lakh
1	Preparation of compressive Disaster Management Plan	75.00
2	Setting up of communication system	40.00
3	Public Information System	20.00
4	Training & Miscellaneous	20.00
	Grand Total A+B	**155.00**

Chapter 11 SUMMARY AND CONCLUSION

11.1 PROJECT DESCRIPTION

Dugar HEP is proposed on Chenab River to harness the hydropower potential of river Chenab. The project proponent is NHPC Ltd., (erstwhile National Hydroelectric Power Corporation) is an Indian government hydropower board under the ownership of the Ministry of Power, Govt. of India. The construction of the dam and underground powerhouse for the Dugar HEP (500 MW) is proposed near Luj village in Pangi Tehsil of Chamba district of Himachal Pradesh.

Dugar HEP envisages the construction of a 128m high dam from the deepest foundation level. The reservoir storage is 61.58 MCM at Full Reservoir Level EL. 2114m and the live storage capacity is 16.57 MCM. The powerhouse will accommodate four units of 103 MW each for the main plant and two units of 44 MW each for the auxiliary plant (4 x 103 MW + 2 x 44 MW). Two nos. 8.5m dia tailrace tunnels combined into a single TRT having a finished diameter of 12.1 m and length of 400 m located on the left bank of Chenab River, about 780 m downstream of the dam axis.

11.2 DESCRIPTION OF THE ENVIRONMENT

Data on the existing environmental parameters in the study area delineated as per the approved Terms of Reference (TOR) for EIA studies by Ministry of Environment, Forests & Climate Chang (MoEF&CC), Government of India was collected to understand the present setting of the environment at the project site. The base line status is described briefly in the following sections:

11.2.1 Land Use/ Land Cover

The land use/ land cover pattern of the study area was interpreted from the latest satellite data and out of the classified land use/ land cover categories, Evergreen/Semi-Evergreen Forest and Grass/Grazing land constitutes predominant land use in the study area (More than 50%). Scrub land and Barren Rocky each covers around 14.70% of the study area. Snow/Glacier is comprised of 8%. Waterbody covers around 1.38% of the study area. Each of the other class covers less than 5% of the study area.

11.2.2 Physiography

The study area of the proposed project lies between 1908 m and 5386 m elevation. More than three-fourth of the project study area lies in 500 to 2500 m elevation band (refer **Figure 3.2** and **Table 3.8** of Chapter 3) and about 37% of project components are restricted to 3200 to 4000m elevation band. Nearly 42% of the study area is characterised by steep slopes and about 30% area by moderately steep slopes (refer **Figure 3.3** and **Table 3.9** of Chapter 3).

11.2.3 Geology

Geologically the project is located within the Central Crystalline represented by the Vaikrita Group of rocks. The project area is dominated by a variety of gneissic rocks. Regionally, the area around the project comprises a litho-stratigraphic sequence from the Proterozoic age to the Quaternary period including Salkhala Group and Chamba, Manjir, Katarigali, Bhaderwah, and Dul Formations.

11.2.4 Meteorology

The study area of the proposed project lies in Pangi valley of Chamba District of Himachal Pradesh. The average maximum temperature of 40^0C was recorded during the month of June and minimum temperature of 7.4^0C during the month of January. The area receives maximum rainfall during south-west monsoon i.e. between June and September. The Humidity is generally low throughout the year, except during monsoon months, humidity in the study area is close to 66% in the month of August. The average maximum wind speed of 4.17 m/s is observed during May.

11.2.5 Soil

Soils in the project area in general are predominantly Entisols and Inceptisols i.e. they have weakly developed soil profiles. These are Typic Udorthents (33.52%) which is found at middle slopes characterized by rock outcrops, deep well drained, mesic, loamy skeletal soils on very steep slopes with severe erosion. Typic Cryorthents second predominant soil type found near the ridge slopes and is characterized by rock outcrops, with shallow depth, excessively drained, loamy skeletal soils on very steep slopes prone to severe erosion.

The soil fertility based upon Nutrient Index in terms of NPK shows that Nitrogen is in the 'Low' range Potassium fertility rating 'Medium' range during Winter but in pre-monsoon and monsoon season is in the 'Low' range whereas, Phosphorus fertility status of soil in the 'Low' range.

11.2.6 Ambient Air and Noise Quality

The Ambient Air Quality monitoring was carried out conforming to the National Ambient Air Quality Standards for Industrial Residential, Rural & Other Areas and Ecologically Sensitive Areas. The concentrations of $PM_{2.5}$, PM_{10}, SO_2, and NO_2 at all the sites were well within the Residential & Rural area permissible limits prescribed by National Ambient Air Quality Standard 2009 notified by CPCB.

Air quality was also assessed using 24h averages of $PM_{2.5}$, PM_{10}, SO_2, and NO_2 levels in the AQI calculator of CPCB and calculated AQI values given in the table below. All the locations fall under the 'Good' category during different seasons in the study area except AQ4/near Killar Village and AQ6/near Findru village during winter and pre-monsoon seasons respectively, which fall under 'Satisfactory' category in the study area.

11.2.7 Water Quality

The data on water quality has been collected to evaluate surface water quality in study area. Ground water sources are not available in the study area. The water quality in the study area, in general, is good. This is primarily due to the absence of any industrial establishment and low population density in the project area.

Surface water quality of Chenab and its tributaries samples collected during winter, pre-monsoon, and monsoon seasons was compared with the Water Quality Criteria of Central Pollution Control Board (http://www.cpcb.nic.in/Water_Quality_Criteria.php) fall under Class 'A' with Drinking-Water Source without conventional treatment but after disinfection.

11.2.8 Floristic Diversity

Forest is dominant land use dominant land use pattern in the study area as more than 50% of the study area is under good forest cover. These forests are comprised primarily of Northern Dry Mixed Deciduous Forest classified according to 'A Revised Survey of the Forest Types of India' by Champion and Seth (1968).

Among the tree species *Cedrus deodara, Pinus gerardiana, Pinus wallichiana, Picea smithiana*, *Abies spectabilis,* are the conifer species forming the top canopy. *Celtis australis, Juglans regia*, *Salix tetrasperma, Salix denticulata, Populus ciliata, Corylus jacquemontii, Ulmus wallichiana, Fraxinus xanthoxyloides, Robinia pseudo-acacia* and *Alnus nitida* are the associated tree species in the forest area.

Shrub vegetation in the area was represented by *Abelia triflora*, *Artemisia maritima*, *Berberis aristata*, *Berberis lycium*, *Cotoneaster bacillaris*, *Daphne oleoides, Clematis montana, Rabdosia rugosa*, *Ephedra gerardiana*, *Jasminum humile*, *Olea ferruginea*, *Rosa macrophylla*, *Rosa moschata*, *Rubus foliolosus*, *Rubia cordifolia*, *Rubus niveus*, *Sambucus wightiana*, and *Sorbaria tomentosa. Carex inanis*, *Kyllinga squamulata*, *Agrostis pilosula*, *Arthraxon lancifolius*, *Bromus japonicus*, *Eragrostis pilosa*, *Poa annua*, *Stipa roylei*, etc. are the grass species in the catchment, mostly grown on barren rocky steep slopes.

The project area harbors 182 plant species belonging to different plant groups like Angiosperms (160 species), Gymnosperms (9 species), Pteridophytes (5 species),, Bryophytes (3 species), and Lichen (4 species).

As per the IUCN Red List of Threatened Species 2021-2, *Angelica glauca is* list under the Endangered (EN) category*, Saussurea costus* under Critically Endangered (CR), *Ephedra gerardiana* and *Ulmus wallichiana* are under the Vulnerable (VU) category, and *Abies spectabilis* and *Pinus gerardiana* under Near Threatened (NT) category. The rest of the species evaluated are either List Concern (LC) or Data Deficient (DD) category.

11.2.9 Faunal Diversity

Mammals: During field surveys only Rhesus macaque (*Macaca mulatta*), Common mongoose (*Herpestes edwardsii*), and Common langur (*Semnopithecus entellus)* are the species sighted in the study area.

Presence of Common Leopard (*Panthera pardus*), Hanuman Langur (*Semnopitheaus entellus*), Himalayan Goral (*Naemorhedus goral*), Indian Muntjac (*Muntiacus muntjac*), and Himalayan black bear (*Ursus thibetanus*) was confirmed by forest officials and villagers in the project area.

Avifauna: A total of 34 species of bird species 8 Order and 20 families were recorded during the field survey from the study area. Most commonly found birds are Rock Pigeon, Chukar partridge, Jungle Babbler, Drongo, Plumbeous water redstart, Red-vented Bulbul, Blue Whistling Thrush, Myna House sparrow, and Crow. A large portion of avifauna species is comprised of resident birds in the project study area.

Herpetofauna: During the survey, Garden lizard (*Calotes versicolor*), Kashmir Rock Agamid (*Laudakia tuberculata*), and Skinks (*Asymblepharus ladacensis)* are the species sighted in the area.

Butterflies: 11 species of butterflies were recorded during the field survey. Indian cabbage white, Pearl white, and Indian Tortoiseshell were the frequently sighted species observed all along the water bodies.

Aquatic Ecology: Among the aquatic organisms, 22 species of phytobenthos and 11 species of phytoplaktons were recorded from river Chenab and its tributaries. During sampling 3 species of zooplankton and 8 genera of macro-invertebrates (MI) were recorded from various sampling site.

Fish fauna: During the experimental fishing no fish was captured during experimental sampling. According to published literature, no fish species was reported from the area. According to the villagers, Snow trout (*Schizothorax richardsonii*) is the only species occasionally sighted and captured from Chenab River in the area

Conservation Status

As per the IUCN Red List of Threatened Species Version 2021-2, Common Leopard (*Panthera pardus*) and Himalayan black bear (*Ursus thibetanus*) are the species listed under the Vulnerable (VU) category. Himalayan Goral (*Naemorhedus goral*) is the species listed under the Near Threatened category of IUCN. As per Wildlife (Protection) Act (1972), Common Leopard (*Panthera pardus*) is listed as a Schedule I species.

Among the avifaunal species sighted from the study area only one species Indian Spotted Eagle (*Clanga hastata*) is listed as Vulnerable (VU) under IUCN 2021-2, the rest of the species fall under Least Concern (LC) category. As per WPA (1972), all the species recorded from the area are listed as Schedule IV except House crow and Jungle crow which are listed as Schedule V species.

11.2.10 Proximity to Protected Area

Sechu Tuan Wildlife Sanctuary is the nearest protected area from the proposed Dugar Hydro Electric project. All project components are outside the boundary of the Wildlife Sanctuary and its nearest boundary is about 12 km from the tail end of the proposed reservoir area and about 20 km from the proposed Dam site.

11.2.11 Social Environment

The majority of the project study area falls under Pangi Sub-division of Chamba district of Himachal Pradesh with small portion under Kishtwar district of Union Territory of Jammu & Kashmir. However, all the proposed components of Dugar HEP, like Dam, Powerhouse and submergence area of the proposed project falls in Pangi Sub-division of Chamba district.

The Pangi Sub-division has been declared as Schedule V area as per the Scheduled Areas (Himachal Pradesh) Order,1975(CO 102) dated the 21st November, 1975.

Only one village i.e. Luj is directly affected by the project due to proposed acquisition of land. A total of 8.78 ha of private land from Luj village will be acquired for proposed project. After permission of village head, survey and consultation was carried out in the project surrounding villages. A total of 8 revenue villages (including Luj village), in the direct proximity of project construction area has been surveyed to access the socio-economic status of the study area villages.

These villages comprise 622 households with a total population of 3214 persons of which 1592 are males 1622 are females. The sex ratio is 1019 females per thousand males. About 89.0% of the total population comprises Schedule tribe population. The Schedule Castes and general category comprise 7.0% and 4.0% respectively. There is 70.55% literacy in the surveyed villages. Agriculture is the main occupation of the people in the area with 60.29% of the total working population engaged in agriculture and allied activities.

The education facilities in the area are moderate up to middle school but for secondary and senior secondary education students travel up to 5 to 8 km. There is one Govt. Degree college in the area, which is located at Killar. Medical facilities in the area are limited, there is only one PHC at Dharwas and one Civil hospital at Killar to cater to the medical needs of the locals. Road & transportation facility in the area is good. The important roads in the area are SH26 and SH37 connecting to State capital and district headquarter. The telecommunication and internet facilities are limited to Killar town. The mobile cellular network is not available in the villages or along the highways.

11.3 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

11.3.1 Ambient Air Quality

Construction Phase Impacts: The air environment around project site is free from any significant pollution source at present. The sources and activities that might affect air quality in the project area during construction phase are vehicular traffic, material handling and storage, dust arising from unpaved village roads, construction activities including operation of construction plant and machinery and domestic fuel burning.

Additionally, construction activities including operation of crushers, concrete batch plants, construction work and movement of vehicles along unpaved road will generate dust & gaseous emission and impact air quality. The burning of waste will also affect air quality. In absence of proper fuel, construction workers at the project site may use wood for fuel burning and space heating. This will also impact air quality.

Operation Phase Impacts: In hydropower project, air pollution occurs mainly during project construction phase. During operation phase, no impacts are envisaged on air environment.

11.3.2 Noise Environment

Construction Phase Impacts: Noise in and around the construction site may affect the wildlife and residents in the nearby areas. Sources of noise will be increased vehicular traffic due to project construction on approach roads and at construction sites. Due to construction activity in the area, noise levels will increase during the period of construction, however, they will remain limited to the work area mainly where large-scale construction activity will progress. Other sources of noise and vibration will be the use of explosives for blasting purposes for construction activities.

Operation Phase Impacts: No major impacts are envisaged on noise environment during project operation phase.

11.3.3 Water Environment

Construction Phase Impacts: Water is used in construction activities leading to wastewater generation with high suspended solids. Similarly, effluents due to washing from truck or equipment etc. would have high concentration of oil and grease. Assessment of quantum of wastewater from such activities is difficult however, they can impact the nearby water bodies if surface run off with high suspended solid is washed into them. Domestic wastewater will be generated from worker's colony to be set up during construction phase, which if finds its way to river/ground water without any treatment will become significant impact on water environment.

Operation Phase Impacts: Construction of dam to regulate water for power generation will lead to permanent change in flow regime of the river – both upstream as well downstream. Chenab river flows along a steep gradient and carries a significant amount of sediment load. Due to the creation of a reservoir sediments will tend to accumulate in the riverbed as the suspended load settles down due to a decrease in flow velocity.

11.3.4 Land Environment

Construction Phase: The following impacts are anticipated on Land environment during construction phase

- **Impact due to Land Requirement and change in land-use:** Major impact of land acquisition is permanent change of land use, which is irreversible impact. These impacts cannot be mitigated; however, compensation in terms of implementation of Compensatory Afforestation Plan, Biodiversity Conservation Plan, Green Belt Development Plan will help in managing and reducing the magnitude of such impacts.
- **Impact Due to Muck Generation:** Muck generation, transportation and disposal can significantly impact the land environment, if not managed properly.
- **Impact due to Waste Generation**: The main sources of waste generation can be categorized as:
  i. Municipal waste (includes commercial and residential wastes generated in either solid or semi-solid form excluding industrial hazardous wastes and bio-medical wastes)
  ii. Construction and demolition debris (C&D waste)
  iii. Bio-medical waste

iv. Hazardous waste (generated from construction machinery and equipment)

- **Impacts due to Road Construction:** The major impacts likely to accrue because of the construction of the roads are loss of vegetation and geological.
- **Impacts due to Quarrying**: Quarrying is normally done by cutting the face of the hill. The rock from the exposed face of the quarry under the action of wind and other erosion forces gets slowly weathered and they become a potential source of landslide.

11.3.5 Impacts on Forests and Forest Land

211.84 ha of forest land will be diverted for the construction of the project components. This shall lead to loss of some of the plant species used for various economic purposes. This impact is partially mitigated by implementation of Compensatory Afforestation Plan as well as Biodiversity Conservation and Wildlife Management Plan.

11.3.6 Flora and Fauna

Construction Phase

Impact on Terrestrial Flora: Increase in human interference could have an impact on terrestrial ecosystem. The workers may also cut trees to meet their requirements for fuelwood, construction of houses, furniture. Thus, it is necessary to provide training and awareness, maintain cooking fuel supply and implement adequate surveillance to mitigate the adverse impacts on terrestrial flora during project construction phase.

Impact on Terrestrial Fauna: During the construction period, large number of machinery and construction workers shall be mobilized, which may create disturbance to wildlife population in the vicinity of project area. The operation of various equipment will generate significant noise; noise and vibration will also increase during blasting which will have adverse impact on fauna of the area.

Operation Phase

On completion of the construction of the project, the land used for construction activities will be restored. Construction workers who have resided in that area will move to another project site. Operation phase impacts on flora and fauna will be positive due to green belt development, and restoration of construction areas. Increase of greenery in the area and creation of reservoir, will have positive impact on avifauna.

11.3.7 Socio-Economic Environment

a) Positive Impacts on Socio-Economic Environment

The following positive impacts are anticipated on the socio-economic environment of the local people of villages of project area during the project construction and operation phases:

i) A number of marginal activities and jobs would be available to the locals during construction phase.

ii) Developer bringing large scale investment to the area will also invest in local area development and benefit will be reaped by locals. Education, medical, transportation, road network and other infrastructure will improve.

iii) The availability of alternative resources provided by developer in the rural areas will reduce the dependence of the locals on natural resources such as forest.

b) Negative Impacts on Socio-Economic Environment

i) Loss of agriculture land

ii) Impact due to influx of outside population may lead to various social and cultural conflicts during the construction stage.

iii) Increased incidence of Diseases

11.3.8 Mitigation Measures for Air, Water and Noise Pollution

Proposed project involves construction of dam, powerhouse, reservoir, roads and other associated infrastructure, and construction period is planned for 98 months. Major construction activities have serious potential of pollution generation and impacts all components of environment as discussed above. Impacts arising out of construction activities can be mitigated significantly by taking appropriate mitigation measures, as discussed below.

Control of Air Pollution: For the control of air pollution during construction phase of the project, it is suggested that it should be made mandatory for the contractor/s engaged in the construction works to ensure the implementation of pollution control measures as per CPCB guidelines with regular monitoring of ambient air quality in the project area.

Control of Noise Pollution:

- Diesel Generator sets are to be placed in acoustic enclosures to reduce the noise.
- Proper and regular maintenance/lubrication of machines should be done.
- Noise producing machines (such as crushers, aggregate processing plants, etc.) should be provided with sound barriers.
- Quieter machines and vehicles with high quality silencers should be used.
- Ambient noise should be monitored periodically at different locations.

Control of Water Pollution:

- Provision of septic tank/ soak pit of adequate capacity for labour camp.
- Commission of suitable treatment facilities to treat the sewage generated from the colony
- Oil interceptors shall be provided and residue of petroleum products will be disposed off in accordance with PCB guidelines.
- Provision of sedimentation cum grease traps to prevent entry of contaminants to the water bodies.

A lump sum budget of **Rs. 50 lakh** per annum has been proposed for the mitigation measures for control of air, noise and water pollution during project construction phase.

11.4 ENVIRONMENTAL MONITORING PROGRAMME

Environmental Monitoring shall be performed during all stages of the project (namely: construction and operation) to ensure that the impacts are no greater than predicted, and to verify the impact predictions.

The monitoring will be carried out by an NABL accredited laboratory for a period of 10 years during the project construction phase or extended if the project construction period gets extended. The monitoring program for the proposed project will be undertaken to meet the following objectives:

- To monitor the environmental conditions of the project area and nearby villages;
- To check on whether mitigation and benefit enhancement measures have actually been adopted and are proving effective in practice;

A total of **Rs. 111.50 lakh** have been allocated to implement various activities envisaged under Environmental Monitoring Programme.

11.5 ADDITIONAL STUDIES

11.5.1 Resettlement & Rehabilitation Plan

For the development of Dugar Hydro Elelctric Project, land requirement has been worked out as 220.6227 ha. Out of which 211.8427 ha is forest land, 8.71 ha is private land and 0.07 ha is community land.

The entire private land identified for the project falls in one revenue village - Luj, tehsil Pangi, District Chamba. The private land proposed for procurement belongs to a total of 121 land owners. All the 121 families will be losing part of their agricultural land and none of the families will be losing any house or any other assets. Private land identified for the project will be acquired as per Himachal Pradesh Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (Compensation, Rehabilitation and Resettlement and Development Plan) Rules, 2016.

With reference to the above the relevant limits on extent of land under Section 2(3)(a) are prescribed by the Government of Himachal Pradesh under **Section 15** of The Himachal Pradesh Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (Compensation, Rehabilitation and Resettlement and Development Plan) Rules, 2016. As per the said rules:

15. Limits of extent of land under sub-section (3) of section 2.—The limit of extent of land referred to in clause (a) of sub-section (3) of section 2 shall be twenty hectares in urban areas and forty hectares in rural areas.

In view of the above, it is noted that the total private land proposed to be purchased through private negotiations for the above Project is about 8.78 ha. The cost of land and final award will be declared by District Collector. A budget of rs. 1.00 crore is made towards monitoring and implementation.

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11.5.2 Local Area Development Fund

The aim of Local Area Development Activities is focused sustainable development to improve the quality of life of neighborhood communities through equitable and proactive smart initiatives in spheres of education, health, rural development, environment and livelihoods resulting in improvement of the overall local social, economic and environmental conditions.

As per Govt. of Himachal pradesh notification MPP-F(10)-24/211 dated 5 October 2011, provision has been made to contribute 1.5% of the total project for Local Area Development Fund. Therefore,the total fund allocated for implementing the various local area development acitivities in affected area around the project has been kept as Rs. 51**.00 crore**.

The activities proposed under Local Area Development Activities will be refined after Public Consultation meeting, keeping in view the needs and requirement of local population following the guidelines under the Local Area Development Fund notification of Govt. of Himachal Pradesh. Activities to be implemented will be discussed with Government of District Administration and finalized by LADC.

11.6 PROJECT BENEFITS

Dugar Hydro Electric Project will help in harnessing potential of river Chenab for generating electricity to the tune of 1758.98 MUs in a 90% dependable year annually and bring benefits of renewable energy to state of and country. In addition to this other benefits form the projects are;

a. As per the Memorandum of Understanding (MoU), Government of Himachal Pradesh, NHPC Limited shall be liable to deposit an equivalent amount of 100 units of electricity, per month for a period of 10 years.
b. NHPC Limited shall contribute 1.5 % of the cost of the project towards pre-commissioning Local Area Development Fund (LADF).
c. Increase in green cover of the region
d. Conservation of Biodiversity and Wildlife through implementation of Biodiversity and Wildlife Conservation and Management Plan.
e. Large scale investment in the region will bring about several positive changes in the region and expected to improve the quality of life of local population. The project will help improve local infrastructure and employment generation for local during construction and operation phase.
f. There will be secondary employment opportunities for locals in terms of catering to the daily need of migratory labour and floating population of transporters and material suppliers to the site.

11.7 ENVIRONMENT MANAGEMENT PLAN (EMP)

Pollution generation mainly during construction phase will be in the form of air, water and noise pollution; which will be mitigated by adopting various mitigation measures and implementation of environment management plans.

The project level Environment Monitoring Cell (EMC) would coordinate with necessary stake holder for effective implementation of all environmental safeguard measures prescribed in the EMP.

11.7.1 Catchment Area Treatment Plan

The Catchment Area Treatment (CAT) plan highlights the management techniques to control erosion in the catchment area of a water resource project. The life span of a reservoir is greatly reduced due to erosion in the catchment area. Adequate preventive measures are thus needed for the treatment of catchment for its stabilization against future erosion.

In the present study, CAT Plan has been formulated for the free draining catchment till the proposed dam site on Chenab river. The total area of the free draining catchment is **1131.64 sq km**.

The catchment area treatment involves

- Understanding of the erosion characteristics of the terrain and,
- Suggesting remedial measures to reduce the erosion rate.

The estimated cost of implementation of CAT plan including monitoring and evaluation is **Rs. 5090.00 lakh**.

11.7.2 Compensatory Afforestation Plan

The Dugar Hydro Electric Project is being constructed in the jurisdiction of Pangi Forest Division. The total land required for the construction of proposed project activities is approximately **220.62 ha** with **211.842 ha** of forest land.

As per the guidelines of Forest Conservation Act, 1980 block plantation is to be taken up two times of the above ground component of forest land diversion **[221.842 ha x 2 = 423.684 ha]**. So the compensatory afforestation to be taken up on **423.684 ha** on forestland over degraded forest areas, it is also proposed to have avenue plantation along the proposed roads with iron guard fencing work around the new plantation with angle iron in the diverted land to maintain the ecological balance of the areas.

The estimated cost of Compensatory Afforestation programme is **Rs. 6,20,58,797/-.** In addition, the total cost under Net Present Value (NPV) is **Rs. 20,66,35,822/-.**

The total cost of the compensatory afforestation plan and Net present Value is **Rs. 26,86,94,619/-**.

11.7.3 Fisheries Management Plan

In a publication by ZSI (2010-2011) and Cumulative Environmental Impact Assessment Study of Chenab Basin in Himachal Pradesh, reported that there are no records of fishes from Pangi valley.

Reservoir area of proposed Dugar HEP will spread over an area of 1.605 sq.km. The reservoir of proposed project is expected to retain water throughout the year and offers an opportunity for fishery development. Therefore, to explore the possibility of reservoir fisheries in Chenab River and its tributaries, it is proposed that detailed study will be carried out by State Fisheries Department along with Directorate of Coldwater Fisheries Research, Bhimtal.

Budgetary provision of **Rs. 40.00 lakh** has been proposed to explore the possibility of reservoir fisheries in the proposed reservoir of Dugar Hydro Electric Project.

11.7.4 Muck Management Plan

The construction would involve about 3,70,880 cum of soil excavation and 9,23,970 cum of rock excavation. About 60% of rock excavation is expected to be used for producing coarse and fine aggregate for concrete production and in fillings for developing areas for construction facilities. The total area for the dumping of muck is **8.58 ha** which can accommodate more than **8.75 lakh** cum though the estimated muck to be disposed of is **7.17** lakh cum.

The estimated cost of the relocation and rehabilitation of excavated material will be **Rs. 670.80 lakh.**

11.7.5 Landscaping and Restoration of Construction Sites

Landscaping and restoration of construction sites will focus restoration of sites like, Quarry & Borrow sites, job facility area, colony area, and project roads, After the completion of mining activity, these areas will be restored to their normal habitat conditions.

These activities will result either in the modification or destruction of the existing landscape of the area. It is therefore imperative that after the project work and related activities are over restoration work should be carried out in these disturbed areas. Various engineering and biological measures will be implemented for the restoration of proposed project affected areas. The landscaping and restoration plan will be implemented with help of landscaping experts and in consultation with Pangi Forest Division and the coordination and funding will be provided by the project proponent.

The estimated cost for the landscaping and restoration works of quarry and borrow area, job facility area, colony area, and project roads areas, would be **Rs. 404.80 lakh**.

11.7.6 Reservoir RIM Treatment Plan

The construction of the Dugar Hydro Electric Project will create a reservoir upstream of the proposed dam in the Chenab River. An area of 160.45 ha upto 2114 m elevation will be submerged in the submergence. The objective of the Reservoir Rim Treatment plan is to check sedimentation in the reservoirs, and to mitigate the effects of debris flow and landslides along the reservoir rim especially during the drawdown period of the reservoir. The Reservoir rim area is sparsely vegetated and mostly inaccessible. The upper reaches of the reservoir rim can be approached via Killar, Chamba, and Punto roads.

The left bank is characterized by steep bare rocky cliffs all along the length of the reservoir. The right bank of the reservoir area has a gentle to moderate slope covered by slope wash and thick overburden deposits at a higher level. There is one small landslide is seen on the left bank which is in stable condition.

Though no major active landslide or slope instability is present in the reservoir area, however in order to take care and treat any slope instability / slide in future during construction / operation stage a lumpsum amount of **Rs. 40 lakh** has been kept.

11.7.7 Green Belt Development Plan

Green belt development will comprise plantations at various places like alongside roads, around the construction areas, and at different project offices and colonies.

During plantation for development of green belt, precaution should be exercised by not planting large size trees around buildings to avoid accidents. Besides this, it is also proposed to develop a green belt around the working areas for trapping the dust and noise, which will rise from the crusher plant, plantation must be done around the crusher plant area. Plantation of avenue, ornamental, and fruit trees are proposed in these areas along with the area around the office complex. The plants of recreational value, horticultural importance shall be planted within the colony area. The ornamental and fruit plants will be procured from the horticulture department and local market while plants for avenue plantation will be procured from the forest department nursery. For the protection of trees from cattle, iron tree guards shall be required.

A budgetary provision of **Rs. 397.80 lakh** has been kept for the development of Green Belt in and around the project area.

11.7.8 Sanitation and Solid Waste Management

Solid waste generated from temporary and permanent colonies in construction as well as operation phase requires special management for disposal. The project authorities will ensure sewage generated from labour colonies and site office is treated and disposed as per the SPCB guidelines. Various aspects of solid waste management include:

- Reuse/Recycling
- Storage/Segregation
- Collection and Transportation
- Disposal

The waste generated from the project area will be collected, segregated and disposed off in line with the provisions laid down in Solid Waste Management Rules, 2016. The total budget in order to manage the solid waste generated from this population, has been proposed as **Rs. 316.40 lakh.**

11.7.9 Public Health Delivery System

Project construction and operation will bring about several changes in the socio-economic environment of the area including increased threats to health of the community.

i. New Diseases due to Migratory Population
ii. Chances of increase in water borne diseases as malaria, and dengue are high
iii. Chances of increase in respiratory troubles due to increase in suspended particles during the construction phase.
iv. Chances of occurrence of gastroenteritis, cholera and typhoid in the labour camps.

Medical services at secondary level play a vital and complimentary role to the tertiary and primary health care systems and together form a comprehensive district-based health care system. Following activities are proposed:

- Ambulance: 2 no. with all the basic Medicare facilities to cater for villages in the project area.
- Budget for running the ambulances including driver, fuel and maintenance for 10 years.
- Two first aid posts including sheds, furniture and basic equipment.
- Budget for running the first aid posts for 10 years.
- Budget for strengthening existing medical facilities.
- Measures to control COVID19 in the project area
- Budget for Health Awareness/ Vaccination Camps for 10 years.

Budgetary estimates for public health delivery system to be implemented have been worked out as **Rs. 335.00 lakh.**

11.7.10 Energy Conservation Measures

The existing facilities will become insufficient for supply of kitchen fuel for the migrant population during the construction of the project. Therefore, the project authorities would make adequate arrangements such as Community kitchen, Supply of Kitchen fuel, efficient cooking facilities and solar lantern either directly by developer or through contractor to reduce the pressure on natural resources in the project area and minimize impacts on this count. A total budget of **Rs. 300.00 lakh** have been proposed under Energy Conservation Plan.

11.7.11 Labour Management Plan for their Health and Safety

Construction work has many associated risks and health impacts for the workers who are directly exposed to such health and safety risks. Therefore, there is a need to prepare complete health and safety documents for workers either by project proponent/contractor and proponent shall ensure its implementation. A detailed plan will be prepared covering the above activities before start of construction work. A tentative budget of **Rs. 140.00 lakh** for labour management have been proposed under EMP.

11.7.12 Disaster Management Plan

In order to visualize the worst-case scenario Dam Break Modeling exercise was undertaken and an inundation map was prepared. Based upon the outputs generated from this modeling, a Disaster Management Plan has been formulated. This plan presents warning and notification procedures to be followed in case of failure or potential failure of the dam. The purpose is to provide timely warning to the population likely to be affected and alert key people who have to take respective actions in case of an emergency. The estimated total cost of execution of disaster management plan including the equipment would be **Rs. 155.00 lakh.**

11.7.13 Biodiversity Conservation & Wildlife Management Plan

Keeping in view of the anticipated impacts of proposed project on the biodiversity of area, the mitigation measures suggested for biodiversity conservation and wildlife management plan and conservation of Schedule-I species are as follows:

i. Wildlife Habitat Preservation & Improvement
ii. Establishment of Eco Park
iii. Biological fencing
iv. Prevention and Control of Forest Fire
v. Development of Grazing land/ Pastures
vi. Awareness promotion
vii. Strengthening of Infrastructural Facilities of Forest Department
viii. Biodiversity Management Committee (BMC)

The estimated cost of implementation of various activities envisaged in the Biodiversity Conservation and Management Plan would be **Rs. Rs. 173.36 lakh**.

11.8 SUMMARY OF COST

The costs involved for implementation of Environmental Management Plan for Dugar Hydro Electric are summarized in the table given below.

Table 11.1: Cost for Implementing Environmental Management Plan

Sl. No	Component of EMP	Capital Cost (Rs. In lakh	Recurring Cost (Rs. In lakh)										Total Cost (Rs. In lakh)
			Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	
1	Catchment Area Treatment Plan	5090.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5090.00
2	Compensatory Afforestation Plan	2686.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2686.95
3	Biodiversity Conservation & Wildlife Management Plan	173.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	173.36
4	Fisheries Conservation and Management Plan	40.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.00
5	Muck Dumping and Management Plan	0.00	50.00	80.50	80.50	80.50	80.50	80.00	70.00	50.30	50.50	48.00	670.80
6	Landscaping, Restoration of Quarry and Construction Sites	0.00	1.63	0.00	0.00	0.00	10.00	10.00	333.17	20.00	20.00	10.00	404.80
7	Reservoir Rim Treatment Plan	40.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.00
8	Green Belt Development Plan	0.00	0.00	40.00	50.00	55.00	70.85	60.85	45.60	30.50	25.00	20.00	397.80
9	Sanitation and Solid Waste Management Plan	110.00	20.64	20.64	20.64	20.64	20.64	20.64	20.64	20.64	20.64	20.64	316.40
10	Public Health Delivery System	75.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	335.00
11	Energy Conservation Measures	60.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	300.00
12	Labour Management Plan	50.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	140.00
13	Disaster Management Plan	135.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	155.00
14	Control of Air, Noise and Water Pollution	0.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	50.00
15	Environmental Monitoring Programme	0.50	11.10	11.10	11.10	11.10	11.10	11.10	11.10	11.10	11.10	11.10	111.50
16	Rehabilitation and Resettlement Plan*	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
17	LADF @ 1.5% of Rs.3393.21 crore (project cost)	5100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5100.00
Total		**13660.81**	**149.37**	**218.24**	**228.24**	**233.24**	**259.09**	**248.59**	**546.51**	**198.54**	**193.24**	**175.74**	**16111.61**

*Final award for purchasing of private land will be finalized by district administration.

Chapter 12 DISCLOSURE BY THE CONSULTANT

12.1 DISCLOSURE BY THE CONSULTANT

Final EIA report of Dugar Hydro Electric Project has been prepared by M/s R S Envirolink Technologies Pvt. Ltd., (RSET) Gurgaon which is a QCI-NABET accredited company to undertake River Valley, Hydroelectric, Drainage and Irrigation Projects (Category 'A') according to the TOR approved by MoEF&CC. Certification and contact details are:

Certificate No	: NABET/EIA/1922/RA 0152
Validity	: August 14, 2022
Contact Person	: Mr. Ravinder Bhatia
Name of Sector	: River Valley and Hydroelectric Projects
Category	: A
MoEF Schedule	: I(C)
Address	: 403, Bestech Chambers, Block-B, Sushant Lok Phase I, Sector 43, Gurugram, Haryana - 122009.
E-mail	: ravi@rstechnologies.co.in
Land Line	: (0124) 4295383
Cellular	: (+91) 9810136853

A copy of the Accreditation certificate along with the list of experts involved is appended at the beginning of the report.

R S Envirolink Technologies Pvt. Ltd (RSET) is a multi-disciplinary environmental consulting company with special focus on River Valley, Hydel, Drainage and Irrigation projects. RSET was established in 2007 as a specialized consulting Service Company, focused to provide entire gamut of environmental services for water resource development projects. We have in-house expertise and have a compact team of consulting professionals providing comprehensive, responsive and high-quality services primarily in the field of natural resources management, environment, environmental audits and due diligence, environmental impact assessment, environmental management plan, environmental modeling, environmental monitoring and compliance status evaluation, hydrology, geology, Remote Sensing & GIS and modeling using these latest tools, techniques and technologies with projects extending across the Himalaya and hilly and mountainous regions of India. Various studies, we undertake, include:

- Environmental Impact Assessment
- Environmental Management Planning and Implementation
- River Basin/Carrying Capacity Studies
- Ecological Studies including Aquatic Ecology
- Biodiversity Conservation and Management Planning
- Assessment of Ecological Flow Requirement
- Glacial Lake Outburst Flood (GLOF) Modeling
- Dam Break Modeling and Disaster Management Plan; Hydrological and Hydro-dynamic modelling

- Catchment Area Treatment (CAT) Plan, Watershed modelling, Watershed Analysis, Rehabilitation, Inventories and Management Planning
- Remote Sensing and GIS: All aspects related to applications of Remote Sensing and GIS especially in the field of natural resources management.
- Socio-economic studies
- Surface Water Hydrology, Water Quality, and Erosion Control
- Environmental Monitoring

RSET is on the list of Consultants who are permitted to appear before Expert Appraisal Committee (EAC) and State Expert Appraisal Committee (SEAC) and can certify various documents including Environment Impact Assessment (EIA)/ Environment Management Plan (EMP) reports under the accreditation scheme for EIA consultants with Quality Council of India (QCI)/National Accreditation Board for Education and Training (NABET). Environment Impact Assessment (EIA) Consultant Accreditation Scheme has been developed which has been adapted as minimum requirement by Ministry of Environment, Forest & Climate Change (MoEF&CC), Government of India.

We would like to mention that RSET has significant experience of working on environmental impact assessment studies. We have successfully completed and got environmental clearances from MoEF&CC/SEIAA for 42 River Valley, Hydel, Drainage and Irrigation projects. Presently we are involved with around 10 similar studies which are at various stages of progress.

RSET’s core competence includes **Environment & Social Impact Assessment (ESIA)** of hydro power, solar power, drinking water supply and transmission & distribution projects according to **World Bank, IFC’s performance standards, NDB and Equator principles**.

Annexure-Ia

No. J-12011/08/2020-IA-I
Government of India
Ministry of Environment, Forest & Climate Change
(IA.I Division)

Indira Paryavaran Bhawan
3rd Floor, Vayu Wing
Jor Bagh Road
New Delhi-110 003

Dated: 05th August, 2020

To

The Executive Director (EDM)
NHPC LIMITED
NHPC OFFICE COMPLEX,
SECTOR-33, FARIDABAD,
HARYANA-121003

Sub: Dugar Hydroelectric Project (449 MW) in Chamba District of Himachal Pradesh, NHPC Ltd – **Terms of Reference-regarding**

Sir,

This has reference to your online Proposal No. IA/HP/RIV/155974/2020 and letter no S. NH/Paryavaran&/215/8108 Dated 02.06.2020 submitted to the Ministry for ToR to the project cited in the subject.

2. The above referred proposal was considered by the Expert Appraisal Committee (EAC) for River Valley & Hydroelectric projects in its 33rd meeting held on 24.06.2020 under Schedule 1 (c) of the EIA Notification 2006 and as amended thereof. The comments and observations of EAC on the project may be seen in the Minutes of the meeting which are available on the web-site of this Ministry.

3. Project Proponent (PP) informed that in 2011, Government of Himachal Pradesh had allotted the Dugar HEP to M/S Dugar Hydropower Limited (a JV of Tata Power & SN Power). In 2012, MOEF&CC had accorded TOR to M/S DHPL for conducting EIA&EMP. In 2017, the validity of TOR was extended for the 5th year, which has expired on 31.12.2017. Draft EIA & EMP Report was prepared by M/s DHPL but Public hearing could not be conducted. In Sept 2017, Govt. of H.P cancelled the allotment of Project. NHPC entered into an MoU with Govt. of HP on 25/09/2019 to execute Dugar HEP. NHPC has taken over the DPR and other investigation data from M/S Dugar HPL (a JV of Tata Power & SN Power). As the earlier TOR has expired, a fresh TOR is requested in the name of NHPC Limited.

SK

4. PP submitted that Dugar HEP is located on Chenab River near Killar village in Chamba district of Himachal Pradesh. The latitude and longitude of project site are N 33°07'05" and E 76°21' 20.7" respectively. The Dugar Hydro Electric Project (449 MW) is envisaged as a run-of-river scheme for utilizing the flows of Chenab River to harness the head created by constructing a 128 m high (from deepest foundation) dam and Length of Dam at Top is 210.65 m near Luj village with Full Reservoir Level (FRL) and Minimum Draw Down Level (MDDL) as 2114.00 m a.s.l. and 2102.35 m a.s.l., respectively.

5. The main components of the project are: A 128 m high concrete gravity dam (from the deepest foundation level); 2 nos. main intakes and 1 no. intake for auxiliary units located at the left bank; 2 nos. pressure tunnels/shafts and 1 no. pressure tunnel/shaft for auxiliary units; Underground Power house cavern housing 4 no. main units of 95 MW each and 2 nos. unit of 34.5 MW for auxiliary plant; 1 no. main TRT having tailrace surge chamber located downstream of power house cavern and 1 no. TRT for auxiliary units. The tail race tunnel, located on the left bank of the Chenab River, is discharging back into Chenab River at a distance of about 780 m downstream of dam axis with normal tail water level as 2015.00 m a.s.l. (under normal operating condition).

6. Total capacity of plant shall be 449 MW (380 + 69 MW). The catchment area of Project at Dam site: 7823 km^2. The total land requirement for Dugar HEP is estimated as 223.63 ha. Out of which 11.79 ha is private land and remaining 211.84 ha is forest land. The submergence area will cover 160.45 ha which is completely forest land. CIA study of Chenab basin was recommended by EAC during July 2016 and approved by MoEF&CC in March 2018. All the recommendation w.r.t. to Dugar HEP, including that on environment flow, will be adopted in Project design.

7. PP informed that total forest land required for the project is 211.842 ha, application for diversion of forest land was submitted on 31/12/2014. State Secretary, HP has recommended the case on 16/11/2016. Due to cancellation of the project, forest diversion proposal got stalled and shall be reinitiated shortly. As the project is located on Chenab River, this shall be governed by the relevant provisions of the Indus Water Treaty (IWT).

8. EAC in the 33rd meeting deliberated on the information submitted (Form 1, PFR, kml file, etc.) and as presented in the meeting and observed that project is located on Chenab River near Killar village in Chamba district of Himachal Pradesh and shall be governed by the relevant provisions of the Indus Water Treaty (IWT). EAC also observed that as per DSS analysis of kml file, the instant project is not located within 10 km distance from any wildlife sanctuary, national park.

9. EAC further observed that the earlier developer had projected cost of the project as Rs. 3390.74 Cr. at completion level in the DPR submitted in Central Electricity Authority (CEA) which was considered for concurrence in 341stmeeting of the Authority held on 20.12.2016, while NHPC has projected project cost of as Rs 5415.60 Cr at present day price level. Reasons for such drastic increase in the cost may be justified in the proposal of final EC. EAC after detailed deliberation on the information submitted and as presented, **recommended** for grant of Standard ToR to the proposed project with some Additional ToRs.

10. Based on recommendations of the EAC, the Ministry of Environment Forest & Climate Change hereby accords a fresh Terms of Reference (TOR) as per the Standard ToR (Hydro projects) for activities at the proposed site as per the provisions of the Environmental Impact Assessment Notification, 2006 and as amended time to time along with the following additional ToR for preparation of EIA/EMP report:

Standard ToR

The EIA/EMP report should contain the information in accordance with provisions & stipulations as given in the **Standard ToR for hydro projects (***Please visit the following link to download the Standard ToR:*

http://environmentclearance.nic.in/writereaddata/standardtorreference.pdf.

Additional ToR

i. Land acquired for the project shall be suitably compensated in accordance with the law of the land with the prevailing guidelines. Private land shall be acquired as per provisions of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.

ii. The project involves diversion of about 211.842 ha of forestland. Forest clearance shall be obtained as per the prevailing norms of Forest (Conservation) Act, 1980.

iii. Application to obtain prior approval of Central Government under the Forest (Conservation) Act, 1980 for diversion of forest land required should be submitted as soon as the actual extent of forest land required for the project is known, and in any case, within six months of issuance of this letter.

iv. Funds allocation for Corporate Environment Responsibility (CER) shall be made as per O.M. No. 22-65/2017-IA.III dated 01.05.2018 for various activities therein.

v. The details of funds allocation and activities for CER shall be incorporated in EIA/EMP report.

vi. Consolidated EIA/EMP report is to be submitted as per the generic structure (Appendix III & IIIA) given in the EIA Notification, 2006.

vii. The EIA report should clearly mention activity wise EMP and CER cost details and should earmarked clear break-up of the capital and recurring cost along with the timeline for incurring the capital cost.

viii. Conservation plan for the Scheduled I species, if any, in the project study area shall be prepared and submitted to the Competent Authority for approval.

SK

ix. Pre-DPR Chapters viz., Hydrology and Layout Map and Power Potential Studies duly approved by CWC/CEA shall be submitted.

x. Dam break analysis, Disaster Management Plan and Fisheries Management Plan be prepared and submitted in the EIA/EMP report.

xi. Environmental matrix during construction and operational phase needs to be submitted.

xii. Both capital and recurring expenditure under EMP shall be submitted.

xiii. Impact of developmental activity/project on the wildlife habitat, if any, within 10 km of the project boundary shall be studied.

xiv. NOC from the earlier project proponent i.e. Dugar Hydroelectric Project Ltd. be obtained and submitted during appraisal of EIA/EMP

xv. The consultant engaged for preparation of EIA/EMP report has to be registered with Quality Council of India (QCI/ NABET) under the scheme of Accreditation & Registration of MoEF& CC. This is a pre-requisite.

xvi. Consultant shall include a "Certificate" in EIA/EMP report regarding portion of EIA/EMP prepared by them and data provided by other organization(s)/ laboratories including status of approval of such laboratories. Declaration by the Consultant that information submitted in the EIA/EMP is factually correct and shall be submitted along with EIA/EMP reports.

xvii. An undertaking as part of the EIA report from Project proponent, owning the contents (information and data) of the EIA report with the declaration about the contents of the EIA report pertaining to a project have not been copied from other EIA reports.

xviii. The draft EIA/EMP report prepared as per the Generic Structure (Appendix III of EIA Notification, 2006) incorporating information as per the Standard ToR, should be submitted to the State Pollution Control Board concerned for conducting Public Consultation, district wise, as per the provisions stipulated in EIA Notification, 2006. Public Hearing, which is a part of Public Consultation, shall be held district wise at the site or in its close proximity as prescribed in Appendix (IV) of EIA Notification, 2006. The draft EIA/EMP report is to be submitted to SPCB sufficient before the expiry of the ToR validity so that necessary amendments in EIA/EMP can be undertaken based on public hearing and the same is to be submitted to MoEF&CC before expiry of validity.

xix. All the tasks including conducting public hearing shall be done as per the provisions of EIA Notification, 2006 and as amended from time to time. Public hearing issues raised and compliance of the same shall be incorporated in the EIA/EMP report in the relevant chapter. Final EIA/EMP report should be submitted to the Ministry for Environmental Clearance only after incorporating these issues, before the expiry of validity of ToR.

xx. As per Ministry's Notification 17.02.2020, the ToR will remain valid for a period of 5 years from the date of issue of this letter for submission of EIA/EMP report along with public consultation. The ToR will stand lapsed after completion of 5 years in case final EIA/EMP is not submitted.

xxi. Baseline data and public consultation shall not be older than 3 years, at the time of submission of the proposal, for grant of Environmental Clearance.

xxii. In case of any change in the scope of the project such as capacity enhancement, change in submergence, etc., fresh scoping clearance has to be obtained.

xxiii. Details of the name and number of posts to be engaged by the project proponent for implementation and monitoring of environmental parameters be specified in the EIA report.

xxiv. The EIA/ EMP report must contain an Index showing details of compliance of all ToR conditions. The Index will comprise of page No. etc., vide which compliance of a specific ToR is available. It may be noted that without this index, EIA/ EMP report will not be accepted.

xxv. Appropriate Biodiversity Conservation and Management plan for the Native, Rare & Endangered floral and faunal species getting affected due to the project shall be prepared.

xxvi. The PP should complete all the tasks as per the provisions of EIA Notification, 2006 and as amended time to time) and submit the application for final clearance within the stipulated time.

This has approval of the Competent Authority.

Yours faithfully,

Kerketta

(Dr. S. Kerketta)
Director
Telefax: 011-24695314

Copy to:

1. The Secretary, Ministry of Power, Sharm Shakti Bhawan, Rafi Marg, New Delhi-110001
2. The Secretary, Ministry of Water Resources, RD & GR, Sharm Shakti Bhawan, Rafi Marg, New Delhi-110003.
3. The Special Secretary (Power), Department of Power, Govt. of Himachal Pradesh

4. The Secretary, Department of Environment, Govt. Of Himachal Pradesh, Forest Secretariat, Shimla.
5. The Chief Engineer, Project Appraisal Directorate, Central Electricity Authority, Sewa Bhawan R.K. Puram, New Delhi-110066.
6. The DDG, Regional Office, Ministry of Environment, Forest & Climate Change, Bays No 24-25, Sector-31 A, Dakshin Marg, Chandigarh-162022.
7. The Member Secretary, Himachal Pradesh Pollution Control Board, Phase-III, Him Parivesh, New Shimla-171009.
8. NIC Cell - uploading in MoEFCC's website.
9. PPS to JS (GM)
10. Guard File

(Director)

Annexure- Ib

F. No. J-12011/08/2020-IA.I
Government of India
Ministry of Environment, Forests and Climate Change
(IA Division)

सत्यमेव जयते

2nd Floor, Vayu Block,
Indira Paryavaran Bhawan,
Jor Bagh Road, Aliganj,
New Delhi-110 003.

Dated: 08th February, 2021

To,

The Executive Director (EDM)
NHPC Ltd.
NHPC Office Complex, Sector-33,
Faridabad – 121 003, Haryana

Sub: Dugar Hydroelectric Project in Chamba District of Himachal Pradesh – Amendment of ToR - reg.

Sir,

This is with reference to your Proposal No. IA/HP/RIV/184065/2020 & letter No. NHPC/ Env.&EDM/2015/8260 dated 11.11.2020 on the above mentioned subject.

2. The said proposal was appraised by the Environment Appraisal Committee (EAC) for River Valley and Hydro Electric Power Projects (RV&HEP) in its 4th meeting held on 02.12.2020. The comments and observations of EAC may be seen in the minutes of the meeting, available on the Ministry's website.

3. Project proponent (PP) informed that Dugar Hydro Electric Project is located in Pangi valley of Chamba district of Himachal Pradesh is s a run-of-river scheme for utilizing the flow of Chenab River to harness the head created by constructing a 128 m high (from deepest foundation) concrete gravity dam near Luj village with FRL of EL 2114.00 m a.s.l. To harness the environmental flow during lean season, non-lean non-monsoon season and monsoon season, auxiliary plant of total 88 MW are housed in the power house cavern. Therefore, the total capacity of plant shall be 500MW (Main plant 412 MW + Aux. Plant 88 MW). The catchment and submergence area at Dam site are 7823 km2 and 160.45 ha, respectively. The updated DPR of Project has been submitted by NHPC to CEA on 25.11.2020.

4. Project Proponent informed that earlier, the project was accorded ToR vide dated 05.08.2020 with 449 MW installed capacity. During examination of the revised DPR Chapter on Power Potential Studies, the installed capacity has changed from earlier vetted 449 MW (main plant 380 MW + Aux. Plant 69 MW) to 500 MW (Main Plant 412, Aux. Plant 88MW). There is no change in other important project parameters like Dam height, FRL, Submergence area, total land requirement etc. Therefore, Project Proponent requested for an amendment in ToR granted vide Ministry letter dated 05.08.2020.

5. The comparative statement with reference to earlier proposal and revised proposal is as under:

Sl No	Details	Original	Revised
1.	Proposal for fresh TOR to Dugar Hydroelectric Project in Himachal Pradesh submitted by NHPC Limited.	**449MW(Main Plant 380 MW +69 MW)**	**500MW (Main Plant 412 MW + Aux. Plant 88 MW)**
2.	There is no change in other important project parameters like Dam Height, FRL, Submergence area etc.		

6. Project Proponent made the detailed presentation before the EAC in its 4th meeting held on 02.12.2020 for ToR amendment proposal. EAC after detailed deliberations on the information submitted and as presented, **recommended the proposal for an amendment** in the granted ToR i.e. change in the installation capacity from earlier vetted 449 MW (main plant 380MW + Aux. Plant 69 MW) to 500MW (Main Plant 412, Aux. Plant 88MW).

7. Above proposal was again referred to EAC in its 6th meeting held on 20.01.2021 for deliberation in terms of recommendation of the Chenab River basin study. EAC recommended the proposal for amendment (change in installation capacity from 449 MW to 500 MW only) however, the EIA study should be undertaken in accordance with recommendations of the Chenab river basin study and the project parameters/salient features of the project such as Dam height, FRL, Submergence area, total land requirement, e-flow etc. as discussed/deliberated during the Chenab river basin study should remain unchanged.

8. Based on the recommendation of the EAC, Ministry of Environment, Forest and Climate Change, hereby accords an amendment in the Terms of Reference (ToR) to the proposed revised proposal for Dugar Hydroelectric Project (500 MW) in Chamba, Himachal Pradesh.

9. Also, you are advised to prepare the EIA/EMP report following Terms of Reference granted vide Ministry letter dated 5.08.2020 and shall be submitted to the Ministry within the ToR validity period. *"The EIA study should be undertaken in accordance with recommendations of the Chenab river basin study and the project parameters/ salient features of the project such as Dam height, FRL, Submergence area, total land requirement, e-flow etc. as discussed/ deliberated during the Chenab river basin study should remain unchanged".*

10. Further, Ministry in suppression of OM dated 1st May 2018 regarding CER has issued an another OM dated 30.09.2020 (enclosed). In this regard, it is advised that issues raised during Public hearing and activities proposed to address such issues shall be made part of EMP.

11. This issue with the approval of the Competent Authority.

Yours faithfully,

8.2.2021

(Yogendra Pal Singh)
Scientist 'E' Email:
- yogendra78@nic.in
Telefax: - 011-24695365

Copy to:

1. The Secretary, Ministry of Power, Shram Shakti Bhawan, Rafi Marg, New Delhi - 110 001.
2. The Secretary, Ministry of Water Resources, RD & GR, Shram Shakti Bhawan, Rafi Marg, New Delhi – 110 001.
3. The Special Secretary, (Power) Department of Power, Government of Himachal Pradesh.
4. The Secretary, Department of Environment, Government of Himachal Pradesh, Forest Secretariat, Shimla.
5. The Chief Engineer, Project Appraisal Directorate, Central Electricity Authority, Sewa Bhawan, R. K. Puram, New Delhi – 110 066.
6. The DDG, Regional office, Ministry of Environment, Forests & Climate Change, Bays No.- 24-25, Sect-31A, Dakshin Marg, Chandigarh - 162 022.
7. The Member Secretary, Himachal Pradesh Pollution Control Board, Phase-III, Him Parivesh, New Shimla – 171 009.
8. Guard File/NIC Cell - uploading in MoEF&CC's website.

01.2.2021

(Yogendra Pal Singh)
Scientist 'E'

ANNEXURE - II

ToR Compliance – Dugar Hydro Electric Project

S. No	Clause in Standard ToR	Compliance
1	**Scope of EIA study**	Chapter 1: Introduction, Section 1.4
2	**Details of the Project and site**	
	• General introduction about the proposed project.	Chapter 1: Introduction, Section 1.3; Page 1.2
	• Details of project (exiting and proposed) and site L-sections of all U/S and D/S projects of river with relevant maps and figures.	Chapter 1: Introduction; Section 1.3.6; Figure 1.1, Page 1.3
	• A map of boundary of the project site.	Chapter 2: Project Description, Figure 2.2; Page 2.5
	• Location details on a map of the project area	Chapter 2: Project Description, Section 2.3, Figure 2.1; Page 2.2
	• Layout details and map of the project	Chapter 2: Project Description, Section 2.4, Figure 2.2; Page 2.5
	• Existence of National Park, Sanctuary, Biosphere Reserve etc. in the study area	Chapter 3: Description of The Environment: Section 3.2.2.5; Page 3.86; Figure 3.17
	• Drainage pattern and map of the river catchment up to the proposed project site.	Chapter 3: Description of The Environment: Section 3.2.1.5; Figure 3.7; Page 3.17
	• Delineation of critically degraded areas in the directly draining catchment on the basis of silt yield	Chapter 10: Environmental Management Plan: Section 10.2.1; Page 10.4
	• Soil characteristic and map of the project area.	Chapter 3: Description of The Environment: Section 3.2.1.8; Figure 3.14; Page 3.33
	• Geological and Seismo-tectonic details and maps of the area surrounding the proposed project	Chapter 3: Description of The Environment: Section 3.2.1.4; Page 3.17 Chapter 10 Environmental Management Plan: Section 10.2.7; Figure 10.21; Page 10.72
	• Remote sensing studies, interpretation of satellite imagery, topographic sheets	Chapter 3: Baseline Environment: Section 3.2; Figure 3.2, 3.3, 3.4, 3.5, 3.6 and 3.7: Page 3.12 and 3.18; Chapter 10 Environmental Management Plan: Section 10.2.1; Page 10.4
	• Land details including forests, private and other land.	Chapter 2: Project Description: Section 2.4.18; Table 2.3; Page 2.12
3	**Description of Environment and Baseline data**	
	To know the present status off environment in the area, baseline data with respect to environmental components air, water, noise, soil, land and biology & biodiversity (flora & fauna), wildlife, socio-economic status etc. the study area should comprise off the following:	Chapter 3: Description of The Environment Section 3.1.1 Figure 3.1

	• Catchment area up to the dam site • Submergence area • Project area or the direct impact area should comprise of area falling within 10 km radius from the periphery of reservoir, land coming under submergence and area downstream of dam up to the point where tail race Tunnel (TRT) meets the river. • Downstream up to 10km from the tip off the reservoir.	
4	**Details of the Methodology**	Chapter 3 Description of The Environment Section 3.1.4; Page 3.4
5	**Methodology for collection of Biodiversity data**	
	• The number of sampling locations should be adequate to get a reasonable idea off the diversity and other attributes of flora and fauna. • The entire area should be divided in grids. • The R.E.T. species referred should include species listed in schedule I and II of Wildlife (protection) Act, 1972.	Chapter 3: Description of The Environment Section 3.1.4.2; Page 3.7; Figure 3.16; Page 3.48 Chapter 3: Description of The Environment Figure 3.15; Page 3.35; Figure 3.16; Page 3.48; Chapter 3: Description of The Environment Section 3.2.2.2 (b) Page 3.58 and 3.2.2.3 (e) Page 3.79
6	**Components of the EIA study**	
A	**Physical and Chemical Environment**	
i	**Geological & Geophysical Aspects and Seismo-Tectonics**	
	• Physical Geography, Topography, Regional Geological aspects and structure of the catchment. • Tectonics, Seismicity and History of past earthquakes in the area. A site-specific study of earthquake parameters will be done. The results of the site-specific earthquake design shall be sent for approval of the NCSDP (National Committee of Seismic design parameters, Central Water Commission, New Delhi for large dams. • Landslide zone or area prone to landslide existing in the study area should be examined. • Presence of important economic mineral deposit, if any. • Justification for location & execution of the project in relation to structural components (dam height).	Chapter 3: Description of The Environment Section 3.2; Page 3.12 Chapter 3: Description of The Environment Section 3.2.1.4; Page 3.16. Chapter 10 Environmental Management Plan: Section 10.2.7; Figure 10.21; Page 10.72 Not Applicable Chapter 5: Analysis of Alternatives
ii	**Meteorology, Air and Noise**	
	• Meteorology (viz., Temperature, Relative Humidity, wind speed/direction etc.) to be collected from nearest IMD station.	Chapter 3: Description of The Environment Section 3.2.1.7; Page 3.24

	• Ambient Air Quality with parameters viz., Suspended Particulate Matter (SPM), Repairable Suspended Particulate Matter (RSPM) i.e., suspended particulate materials <10-microns, Sulphur Dioxide (SO_2), Oxides of Nitrogen (NOx), in the study area at 6 locations. • Existing noise levels and traffic density in the study area at 6 locations.	Chapter 3: Description of The Environment Section 3.2.1.9; Page 3.38 Chapter 3: Description of The Environment Section 3.2.1.10; Page 3.45
iii	**Soil Characteristics**	
	• Soil classification, physical parameters (viz., texture, porosity, bulk density and water holding capacity) and chemical parameters (viz. pH, electrical conductivity, Magnesium, calcium, total alkalinity, chlorides, sodium, potassium, organic carbon, available potassium, available phosphorus, SAR, nitrogen and salinity, etc.,) (6 locations).	Chapter 3: Description of The Environment Section 3.2.1.8; Page 3.33; Table 3.15; Page 3.36
iv	**Remote sensing and GIS Studies**	
	• Generation of thematic maps viz., slope map, drainage map, soil map, land use and land cover map, etc. Based on these, thematic maps, an erosion intensity map should be prepared. • New Configuration map to be given in EIA report	Chapter 3: Description of The Environment Figure 3.2, Figure 3.3, Figure 3.4; Page 3.12,3.13, 3.14 Chapter 10: Environmental Management Plan: Section 10.2.1; Page 3.4 Chapter 3: Description of The Environment Section 3.94
V	**Water Quality**	
	• History of the ground water table fluctuation in the study area. • Water quality for both surface water and ground water for (i)Physical parameters'(pH, temperature, electrical conductivity, TSS); (ii)Chemical parameters (Alkalinity, Hardness, BOD, COD, NO_2, PO_4, CI, SO_4, Na, K, Ca Mg, Silica, Oil & Grease, phenolic compounds, residual sodium carbonate); (iii)Bacteriological parameters (MPN, Total coliforms) and (iv) Heavy Metals (Pb, As, Hg, cd, cr-6, total Cr, Cu, Zn, Fe). • Delineation of sub and micro-watersheds, their locations and extent based on the All India Soil and Land Use Survey of India (AISLUS), Department of Agriculture, Government of India. Erosion levels in each micro-watershed and prioritization of micro-watershed through silt yield index (SYI) method of AISLUS.	NA Chapter 3: Description of The Environment; Section 3.2.1.11: Water Environment; Page 3.48 Table 3.23; Page 3.49 Chapter 10: Environmental Management Plan: Section 10.2.1; Page 3.4
B	**Water Environment & Hydrology**	
	• Hydro-Meteorology of the project viz. precipitation (snowfall, rainfall), temperature, relative humidity, etc. Hydro-meteorological studies in the catchment area should be	Chapter 3: Description of The Environment Section 3.2.1.5; Page 3.17

	established along-with real time telemetry and data acquisition system for inflows monitoring. • Run-off, discharge, water availability for the project, sedimentation rate, etc. • Basin characteristic's • Catastrophic events like cloud bursts and flash floods, if any, should be documented. • For estimation of Sedimentation Rate, direct sampling of river flow is to be done during the EIA study. The study should be conducted for minimum one year. Actual silt flow rate to be expressed in ha-m km^2 year^{-1}. • Set-up a G&D monitoring station and a few rain-gauge stations in the catchment area for collecting data during the investigation. • Flow series, 10 daily with 90%, 75% and 50% dependable years discharges. • A table of 10-daily water discharges corresponding to 90% dependable year showing the intercepted discharge at the barrage, the environmental flow to be released and the other flow releases downstream of the barrage and spills to be provided in hydrology section of EIA. • Norms for release of Environmental flow i.e. 30% in monsoon, 20% in lean season and 25% in non-monsoon & non-lean season to be followed corresponding to 90% dependable year. A site-specific study on minimum environmental flow should be carried out. • Hydrological studies/data as approved by CWC shall be utilized in the preparation of EIA/ EMP report. Actual hydrological annual yield may also be given in the report. • A minimum of 1 km distance from the top of the reservoir to the tail race tunnel should be maintained between upstream and downstream projects.	 Chapter 3: Description of The Environment Section 3.2.1.5; Page 3.17 Chapter 3: Description of The Environment Section 3.2.1.5; Page 3.17 Chapter 3: Description of The Environment Section 3.2.1.6; Page 3.23 Chapter 3: Description of The Environment Section 3.2.1.5 (f); Page 3.23. Chapter 3: Description of The Environment Section 3.2.1.5 (C); Page 3.19 Chapter 3: Description of The Environment Section 3.2.1.5 (c); Page 3.19 Chapter 3: Description of The Environment Section 3.2.1.5 (c); Page 3.19 Chapter 2: Project Description; Section 2.4.10; Page 2.4. Chapter 3: Description of The Environment Section 3.2.1.5 (C); Page 3.19 Chapter 1 Introduction; Section 1.3.6; Page 1.3
C	**Biological Environment**	
	Flora: • Characterization of forest types (as per Champion and Seth method) in the study area and extent of each forest type as per the Forest Working Plan. • Documentation of all plant species i.e. Angiosperm, Gymnosperm, Pteridophytes, Bryophytes (all groups).	 Chapter 3: Description of The Environment Section 3.2.2.1; Page 3.54 Chapter 3: Description of The Environment Section 3.2.3.1 (a); Page 3.55

	• General vegetation profile and floral diversity covering all groups of flora including. A species wise list may be provided. • Assessment of plant species with respect to dominance, density, frequency, abundance, diversity index, similarity index, importance value index (IVI, Shannon Weiner index etc. of the species to be provided. Methodology used for calculating various diversity indices along with details of locations of quadrates, size of quadrates etc. to be reported within the study area in different ecosystems. • Existence of National park, Sanctuary, Biosphere Reserve etc. in the study area, if, any, should be detailed. • Economically important species like medicinal plants, timber, fuel wood etc. • Details of endemic species found in the project area. • Flora under RET categories should be documented using International Union for the Conservation of Nature and Natural Resources (IUCN) criteria and Botanical Survey of India's Red Data list along-with economic significance. Species diversity curve for RET species should be given. • Cropping pattern and Horticulture Practices in the study area. **Fauna:** • Fauna study and inventorisation should be carried out for all groups of animals in the study area. Their present status along with Schedule of the species. • Documentation of fauna plankton (phyto and zooplankton), periphyton, benthos and fish should be done and analyzed. • Information (authenticated) on Avi-fauna and wildlife in the study area. • Status of avifauna their resident/ migratory/ passage migrants etc. • Documentation of butterflies, if any, found in the area. • Details of endemic species found in the project area. • RET species-voucher specimens should be collected along with GPS readings to facilitate	Chapter 3: Description of The Environment Section 3.2.3.1 (c); Page 3.58 Annexure-IV Chapter 3: Description of The Environment Section 3.2.3.1 (d), (e), (f),and (g); Page 3.58 Chapter 3: Description of The Environment Section 3.2.3.5; Page 3.68 Chapter 3: Description of The Environment Section 3.2.3.1 (h); Page 3.71 Chapter 3: Description of The Environment Section 3.2.3.1 (b); Page 3.57 Chapter 3: Description of The Environment Section 3.2.3.1 (b); Page 3.57 Chapter 3: Description of The Environment Section 3.2.3.2 (g-III); Page 3.73 Chapter 3: Description of The Environment Section 3.2.2.3; Page 3.74; Table 3.42,3.43, 3.45 Chapter 3: Description of The Environment Section 3.2.2.4; Page 3.80-3.86 Chapter 3: Description of The Environment Section 3.2.2.3; Page 3.74; Table 3.43, Chapter 3: Description of The Environment Section 3.2.2.3; Page 3.74; Table 3.43, Chapter 3: Description of The Environment Section 3.2.2.3; Page 3.74; Table 3.45, Chapter 3: Description of The Environment Section 3.2.2.3 (e); Page 3.79 Chapter 3: Description of The Environment Section 3.2.2.3 (e); Page 3.79

	rehabilitation. RET faunal species to be classified as per IUCN Red Data list and as per different schedule of Indian Wildlife (Protection) Act, 1972. • Existence of barriers and corridors, if any, for wild animals. • Compensatory afforestation to compensate the green belt area that will be removed, if any, as part of the proposed project development and loss of biodiversity. • Collection of primary data on agricultural activity, crop and their productivity and irrigation facilities components. • For categorization of sub-catchment into classes and for the consequent CAT plan, the entire catchment (Indian Portion) is to be considered and not only the directly the draining catchment.	Chapter 3: Description of The Environment Section 3.2.2.5; Page 3.87 Chapter 10: Environmental Management Plan Section 10.2.2; Page 10.38 Chapter 3: Description of The Environment Section 3.2.3.2 (g-III); Page 3.73 Chapter 10: Environmental Management Plan Section 10.2.1; Page 10.4
D	**Aquatic Biology**	
	• Documentation of aquatic fauna like macro-invertebrates, zooplankton, phytoplankton benthos etc. • Fish and fisheries, their migration and breeding grounds. • Fish diversity composition and maximum length & weight of the measured populations to be studied for estimation of environmental flow. • Conservation status of aquatic fauna. • Sampling for aquatic ecology and fisheries must be conducted during three seasons Pre-monsoon (summer) and monsoon. Sizes (length & weight) off important fish species need to be collected and breeding and feeding grounds should also be identified along the project site or in vicinity.	Chapter 3: Description of The Environment Section 3.2.2.4; Page 3.80-3.86 Chapter 3: Description of The Environment Section 3.2.2.4 (e); Page 3.86 Chapter 3: Description of The Environment Section 3.2.2.4 (e); Page 3.86 Chapter 3: Description of The Environment Section 3.2.2.4 (e); Page 3.86
E	**Socio-economic Environment**	
	• Collection of baseline data on human settlements, health status of the community and existing infrastructure facilities for social welfare including sources of livelihood, job opportunities and safety and security of workers and surroundings population. • Collection of information with respect to social awareness about the developmental activity in the area and social welfare measures existing and proposed by project proponent. • Collection of information on sensitive habitat of historical, cultural and religious and ecological importance. • The socio-economic survey/ profile within 10 km of the study area for demographic profile; Economic Structure; Developmental Profile; Agricultural Practices; Infrastructure, education facilities; health and sanitation facilities; available communication network etc.	Chapter 3: Description of The Environment Section 3.2.3 Page 3.88 Chapter 3: Description of The Environment Section 3.2.3 Page 3.88 Chapter 3: Description of The Environment; Section 3.2.3.8; Page 3.93 Chapter 3: Description of The Environment Section 3.2.3 Page 3.88

	• List of all the Project Affected Families with their names, age, education qualification, family size, religion, caste, source of income, land & house holdings, other properties, occupation, source of income, house/land to be acquired for the project and house/land left with the family, and other property, possession of cattle, type off houses etc.	Chapter 7 Additional Studies Section 7.1 Rehabilitation & Resettlement Plan Annexure-V
7	**Impact Prediction and Mitigation Measures**	
	The adverse impact due to the proposed project should be assessed and effective mitigation steps to abate these impacts should be described.	Chapter 4: Anticipated Impact and Mitigation Measures
i	**Air Environment**	
	• Changes in ambient and ground level concentrations due to total emissions from point, line and area sources. • Effect on soil, material, vegetation and human health. • Impact of emissions from DG set used for power during the construction, if any, on air environment. • Pollution due to fuel combustion in equipment and vehicles • Fugitive emissions from various sources.	Chapter 4: Anticipated Impact and Mitigation Measures Section 4.1.1 Page 4.2
ii	**Water Environment**	
	• Changes in surface and ground water quality. • Steps to develop pisci-culture and recreational facilities • Changes in hydraulic regime and downstream flow. • Water pollution due to disposal of sewage • Water pollution from labor colonies/ camps and washing equipment.	Chapter 4 Anticipated Impact and Mitigation Measures Section 4.1.3 Page 4.6
3	**Land Environment**	
	• Adverse impact on land stability, catchment of soil erosion, reservoir sedimentation and spring flow (if any) (a) due to considerable road construction/widening activity (b) interference of reservoir with the inflowing stream (c) blasting for commissioning of HRT, TRT and some other structures. • Changes in land use / land cover and drainage pattern • Immigration of labour population • Quarrying operation and muck disposal • Changes in land quality including effects of waste disposal. • River bank and their stability • Impact due to submergence.	Chapter 4: Anticipated Impact and Mitigation Measures Section 4.1.4 Page 4.9
4	**Biological Environment**	
	• Impact on forests, flora, fauna including wildlife, migratory avi-fauna rare and endangered species, medicinal plants etc.	Chapter 4: Anticipated Impact and Mitigation Measures Section 4.1.5 Page 4.11

	• Pressure on existing natural resources. • Deforestation and disturbance to wildlife, habitat fragmentation and wild animal's migratory corridors. • Compensatory afforestation-identification of suitable native tree species for compensatory afforestation and green belt. • Impact on fish migration and habitat degradation due to decreased flow of water. • Impact on breeding and nesting grounds of animals and fish.	Chapter 4: Anticipated Impact and Mitigation Measures Section 4.1.5 Page 4.11 Chapter 4: Anticipated Impact and Mitigation Measures Section 4.1.5 Page 4.11 Chapter 10: Environment Management Plan Section 10.2.2; Page 10.38 Section 10.8.6; Table 10.31, Page 10.75 Chapter 4 Anticipated Impact and Mitigation Measures; Section 4.1.3.2 (e), Page 4.8 Chapter 4: Anticipated Impact and Mitigation Measures Section 4.1.5 Page 4.11
5	**Socio – Economic Aspects**	
	• Impact on local community including demographic profile. • Impact on socio-economic status. • Impact on economic status. • Impact on human health due to water / water borne disease • Impact on increase traffic. • Impact on Holy Places and Tourism. • Impacts of blasting activity during project construction which generally destabilize the land mass and leads to landslides, damage to properties and drying-up of natural springs and cause noise pollution will be studied. Proper record shall be maintained of the baseline information in the post project period. • Positive and negative impacts likely to be accrued due to the project are listed.	Chapter 4: Anticipated Impact and Mitigation Measures Section 4.1.6; Page 4.13
8	**Environmental Management Plan (EMP)**	
1	Catchment Area Treatment (CAT) Plan should be prepared micro-watershed wise. Identification of free draining/ directly draining catchment based upon Remote Sensing and Geographical Information System (GIS) methodology and Sediment Yield Index (SYI) Method of AISLUS, Dept. of Agriculture, Govt. of India coupled with ground survey. Areas or watersheds falling under 'very severe' and 'severe' erosion categories should be provided and required to be treated. Both biological as well as engineering measures should be proposed in consultation with State Forest Department for areas requiring treatment. Year-wise schedule of work and monetary allocation should be provided. Mitigation measures to check shifting cultivation in the catchment area with provision for alternative and better agricultural practices should be included.	Chapter 10: Environment Management Plan Section 10.2.1; Page 10.4
2	Compensatory Afforestation shall be prepared by the state forest department in lieu of the forest land proposed to be diverted for construction of the project as per the Forest (Conservation) Act, 1980. Choice of plant for afforestation should include native	Chapter 10: Environment Management Plan Section 10.2.2; Page 10.38

	and RET species, if any. This will be a part of the forest clearance proposal.	
3	Biodiversity and Wildlife Conservation & Management Plan for conservation and preservation of endemic, rare and endangered species of flora and fauna to be prepared in consultation with State Forest Department	Chapter 10: Environment Management Plan Section 10.2.3; Page 10.41
4	Fisheries Conservation & Management Plan-Fish fauna inhabiting the affected stretch of river, a specific fisheries management plan should be prepared for river and reservoir.	Chapter 10: Environment Management Plan Section 10.2.4; Page 10.43
5	Resettlement and Rehabilitation (R&R) Plan needed to be prepared on the basis of findings of the socio-economic survey coupled with the outcome of public consultation held. The R&R package shall be prepared after consultation with the representatives of the project affected families and the State Government. Detailed budgetary estimates are to be provided. Resettlement site should be identified. The plan will also incorporate community development strategies. R&R Plan is to be formulated as per land Acquisition, Resettlement and Rehabilitation Act, 2013 which came into force w.e.f. 1.1.2014	Chapter 7: Additional Studies; Section 7.1: Resettlement and Rehabilitation Plan
6	Green Belt Development Plan along the periphery of reservoir, colonies, approach road, canals etc. Local plant species must be suggested with physical and financial details. Local plant species suitable for greenbelt development should be selected	Chapter 10 Environmental Management Plan Section 10.2.8; Page 10.74
7	Reservoir Rim Treatment Plan for stabilization of land slide/land slip zones if any, around the reservoir periphery to be prepared. Suitable engineering and biological measures for treatment of the identified slip zones to be provided with physical and financial schedule.	Chapter 10: Environment Management Plan Section 10.2.7; Page 10.71
8	Muck Disposal Plan- suitable sites for dumping of excavated material should be identified in consultation with the State Pollution Control Board and Forest Department. All Muck disposal sites should be minimum 30 m away from the HFL of river. Plan for rehabilitation of muck disposal sites should also be given. The L- section/ cross section of muck disposal sites and approach roads to be given. The plan shall have physical and financial details of the measures proposed.	Chapter 10: Environment Management Plan Section 10.2.5; Page 10.44
9	Plan for Restoration of quarry sites and landscaping of colony areas, working areas, roads, etc.	Chapter 10: Environment Management Plan Section 10.2.6; Page 10.52
10	Study of Design Earthquake Parameters: A site specific study of earthquake parameters should be done. Results of the site-specific earthquake design parameters should be approved by National Committee of Seismic Design Parameters, Central Water Commission (NCSDP) New Delhi.	Chapter 3: Description of The Environment; Section 3.2.1.4 (c); Page 3.17

11	Dam Break Analysis and Disaster Management Plan: The outputs of Dam Break Model should be illustrated with appropriate graphs and maps clearly bringing out the impact of Dam break scenario. Provision for early warning systems should be provided.	Chapter 10 Environmental Management Plan Section 10.2.13; Page 10.90
12	Water, Air and Noise Management Plans to be implemented during construction and post construction periods.	Chapter 6 Environmental Monitoring Programme
13	Public Health Delivery Plan including for local community. Existing medical facilities	Chapter 10 Environmental Management Plan Section 10.2.10; Page 10.81
14	Labour Management Plan for their Health and Safety.	Chapter 10 Environmental Management Plan Section 10.2.12; Page 10.88
15	Sanitation and Solid-waste management plan for domestic waste from colonies and labour camps etc.	Chapter 10 Environmental Management Plan Section 10.2.9; Page 10.77
16	Local Area Development Plan to be formulated in consultation with the Revenue Officials and Village Panchayats. Local skill development schemes should be given. Details of various activities to be undertaken along with its financial out lay should be provided.	Chapter 7: Additional Studies; Section 7.2 Local Area Development Fund
17	Environmental safeguards during construction activities including road construction.	Chapter 4 Assessment of Impact Section 4.5; Page 4.19 EIA Chapter 6 Environment Monitoring Programme
18	Energy conservation measures for the work force during construction with physical and financial details. Alternatives will be proposed for the labour force so that the exploitation off the natural resource (wood) for the domestic and commercial use is curbed.	Chapter 10 Environmental Management Plan Section 10.2.11; Page 10.86
19	Environmental Monitoring Programme to monitor the migratory measures implemented at the project site is required will be prepared. Provision for Environment Management Cell should be made. The plan will spell out the aspects required to be monitored, monitoring indicators/parameters with respect to each aspect and the agency responsible for the monitoring of that particular aspect throughout the project implementation.	Chapter 10: Environmental Monitoring Plan Section 10.1, Page 10.1
20	A summary off cost Estimates for all the plans, cost for implementing all the Environmental Management Plans.	Chapter 11: Summary and Conclusion, Section 11.8; Page 11.15; Table 11.1; Page 11.16

Additional Condition as per Scoping clearance issued by MoEF&CC vide letter no. J-12011/08/20120-IA-I dated 5th August 2020 for 449 MW installed capacity and letter no. J-12011/08/2020-IA-I dated February 08, 2021 (refer to **Annexure Ia &Ib**).

S. No	ADDITIONAL CONDTIONS	COMPLIANCE
1	Land acquired for the project shall be suitably compensated in accordance with the law of the land with the prevailing guidelines. Private land shall be acquired as per provisions of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.	Chapter 7: Additional Studies Section 7.1: Resettlement and Rehabilitation Plan.
2	The project involves the diversion of about 211.842 ha of forest land. Forest clearance shall be obtained as per prevailing norms of the Forest (Conservation) Act, 1980.	For diversion of 211.842 ha of forest land, an online application has been submitted to MoEF&CC vide proposal No.: FP/HP/HYD/ 123533/2021 (http://forestsclearance.nic.in/viewreport.aspx?pid=FP/HP/HYD/123533/2021).
3	Application to obtain prior approval of Central Government under the Forest (Conservation) Act, 1980 for diversion of forest land required, if not submitted, should be submitted as soon as the actual extent of forest land required for the project is known, and in any case, within six months of issuance of this letter.	For diversion of 211.842 ha of forest land, an online application has been submitted to MoEF&CC vide proposal No.: FP/HP/HYD/ 123533/2021 (http://forestsclearance.nic.in/viewreport.aspx?pid=FP/HP/HYD/123533/2021).
4	Fund allocation for Corporate Environment Responsibility (CER) shall be made as per O.M. No. 22-65/2017-IA.III dated 01.05.2018 for various activities therein.	Not Applicable as per OM dated 30.10.2020. EIA Chapter 7: Additional Studies Section 7.3 Local Area development Fund
5	The details of fund allocation and activities for CER shall be incorporated in EIA/EMP report	Not Applicable as per OM dated 30.10.2020 EIA Chapter 7: Additional Studies Section 7.3 Local Area development Fund
6	Consolidated EIA/EMP report is to be submitted as per the generic structure (Appendix III & IIIA) given in the EIA Notification, 2006	Draft Final EIA/ EMP Report; Dugar HEP (500MW)
7	The EIA report should clearly mentioned activity wise EMP and CER cost details and should earmarked clear break-up of the capital and recurring cost along with the time line for incurring the capital cost	Chapter 11: Summary and Conclusion, Section 11.8; Page 11.15 Table 11.1; Page 11.16
8	Conservation Plan for Schedule-I species shall be prepared and submitted to the competent authority for approval.	EIA Chapter 10: Environmental management Plan; Section 102.3. Biodiversity and Wildlife Conservation & Management Plan; Page 10.41; Annexure VIII

9	Dam Break Analysis, Disaster Management Plan, and Fisheries Management Plan be prepared and submitted in the EIA/EMP report.	EIA Chapter 10 Environmental Management Plan Section 10.2.13; Page 10.90
10	Environmental Matrix during construction and operational phase needs to be submitted	EIA Chapter 4: Anticipated Impact and Mitigation Measures; Section 4.4; Page 4.14; Table 4.5; Page 4.15
11	Both Capital and Recurring expenditure under EMP shall be submitted	EIA Chapter 11: Summary and Conclusion, Section 11.8; Table 11.1; Page 11.16
12	Impact of development activity/ project on the wildlife habitat within 10 km of the project boundary shall be studied	EIA Chapter 4: Anticipated Impact and Mitigation Measures Section 4.1.5 Page 4.11
13	The consultant engaged for preparation of EIA/ EMP report has to be registered with Quality Council of India (QCI/ NABET) under the scheme of Accreditation & Registration of MoEF&CC. This is a pre-requisite.	EIA Chapter 12: Disclosure by the consultant
14	Consultant shall include a "Certificate" in EIA/EMP report regarding portion of EIA/EMP prepared by them and data provided by the other organisition(s)/ laboratories including status of approval of such laboratories. Declaration by the consultant that information submitted in the EIA/EMP is factually correct and shall be submitted along with EIA EMP report.	EIA Chapter 12: Disclosure by the consultant
15	An undertaking as part of the EIA/EMP report from Project proponent, owing the contents (information and data) of the EIA report with the declaration about the contents of the EIA report pertaining to a project have not been copied from other EIA reports.	EIA Chapter 12: Disclosure by the consultant
16	Baseline Data and Public Consultation shall not be older than 3 years at the time of submission of the proposal, for grant of Environmental Clearance.	EIA Chapter 03: Description of The Environment; Section 3.1.2 Page 3.1
17	In case of any change in the scope of the project such as capacity enhancement, changes in submergence, etc., fresh scoping clearance has to be obtained.	EIA Chapter 01: Introduction; Section 1.3; Page 1.3
18	Details of the name and number of posts to be engaged by the project proponent for implementation and monitoring of environmental parameters be specified in the EIA report.	EIA Chapter 10: Environment Management Plan; Section 10.1; Page 10.1

19	The EIA/EMP Report must contain an Index showing details of compliance of all ToR conditions. The Index will comprise of Page No.	EIA: Annexure II
20	Appropriate Biodiversity Conservation and Management Plan for the Native, Rare and Endangered floral and faunal species getting affected due to the project shall be prepared.	EIA Chapter 10: Environmental management Plan; Section 102.3. Biodiversity and Wildlife Conservation & Management Plan; Page 10.41; Annexure VIII
21	The EIA study should be undertaken in accordance with recommendations of the Chenab River basin study and the project parameters/ salient features of the project such as Dam height, FRL, Submergence area, total land requirement, e-flow, etc. as discussed/deliberated during the Chenab basin study should remain unchanged.	EIA Chapter 02: Project Description
22	Further the ministry in suppression of OM dated 1st May 2018 regarding CER has issued an another OM dated 30.09.2020. In this regard, it is advises that issues raised during Public Hearing and activities proposed to address the such issues shall be made part of EMP.	Chapter 7: Additional Studies; Section 7.2 Local Area Development Fund

ANNEXURE-IIIa

METEOROLOGY DATA

Table 1: Mean monthly Maximum and Minimum Temperature (°C) (Reference years 2011-2020) Killar Town.

Month	2011		2012		2013		2014		2015		2016		2017		2018		2019		2020	
	Temperature (°C)		Temperature (°C)		Temperature (°C)		Temperature (°C)		Temperature (°C)		Temperature (°C)		Temperature (°C)		Temperature (°C)		Temperature (°C)		Temperature (°C)	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
January	18	4	17	5	19	6	18	6	19	7	21	8	19	9	22	11	19	9	16	9
February	20	8	19	6	20	8	20	6	23	11	25	11	24	11	25	13	20	10	22	12
March	28	11	26	10	28	13	25	11	25	14	28	16	28	14	30	16	25	13	25	15
April	33	14	31	16	33	17	32	15	32	19	34	20	36	21	35	20	35	21	32	21
May	39	21	37	20	39	22	36	21	39	24	38	25	38	25	39	25	38	24	38	26
June	38	24	41	24	40	25	41	25	39	26	40	28	38	26	40	28	41	27	42	30
July	35	23	39	24	37	24	38	24	36	26	36	27	36	27	36	26	36	26	41	30
August	32	22	33	21	33	21	36	22	35	25	35	25	36	25	34	24	33	24	35	27
September	31	19	33	20	34	20	33	19	34	22	35	23	36	23	33	22	33	23	35	26
October	30	15	31	16	31	16	31	15	32	20	33	20	34	20	31	18	30	19	34	21
November	26	11	26	11	26	11	26	11	27	15	28	15	28	15	27	15	26	16	26	15
December	22	8	21	9	20	8	19	7	22	10	25	10	24	13	22	11	19	11	21	13

Table 2: Mean annual average Rainfall (mm) and Numbers of Rainy Days (Reference years 2011-2020) Killar Town.

Months	2011		2012		2013		2014		2015		2016		2017		2018		2019		2020	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
January	46.1	5	62.72	10	84.7	4	42.4	5	47.2	5	15.4	4	77.67	9	0.3	1	59.5	7	167.8	16
February	198.2	15	88.9	12	238.1	12	136.6	14	85.2	11	17.5	4	68.7	7	48.2	5	299.4	14	11.7	4
March	66.44	10	62.4	7	94.7	11	154.79	18	172.36	16	128.9	12	34.3	6	11.6	8	49.9	8	167	12
April	67.16	11	90.9	16	17.3	5	74.11	9	77.68	15	27.68	12	90.2	7	32.61	8	58.3	6	29.4	13
May	40.3	11	16	6	16.9	5	61.1	10	16.2	3	38.67	15	28.1	8	41.3	8	54.4	12	56.9	15
June	45.47	13	1	1.6	87.9	8	23.1	5	48.43	13	73.33	16	242.6	27	164.6	13	26	3	39.3	12
July	187.14	21	88.41	13	300.6	20	200.06	15	185.14	23	159.99	26	155.5	15	284.6	22	382.4	26	111.9	24

Months	2011		2012		2013		2014		2015		2016		2017		2018		2019		2020	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
August	410.69	26	349.83	27	755.63	30	133.91	16	300	23	171.8	20	25.1	2	253.7	27	377.5	25	458.8	29
September	313.7	18	192.3	15	59.7	12	317.96	12	127.49	9	23.1	9	0	0	209.07	14	175.2	23	32.1	5
October	16.7	5	5.4	4	56.2	11	25.1	4	8.2	2	0	0	6.3	2	2.5	0	12.8	6	0	0
November	4.9	1	6.9	2	9.5	2	2.05	3	9	3	1.3	1	76	3	21.9	4	100.2	12	22.1	3
December	3.9	1	49.7	5	53.3	4	4.97	2	19.8	4	0	0	1	0.3	4.8	3	144.5	5	61.1	7

Note:- A-Rainfall (mm); B-No. of Rainy days

Table 3: Mean Monthly Average Maximum Wind speed (m/s) (Reference years 2011-2020) Killar Town.

Months	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
January	2.9	2.5	2.6	2.4	2.8	2.5	3.2	3	3.1	2.5	**2.75**
February	3.4	2.8	3.3	3	3.4	3.5	3.2	3.2	3.6	2.7	**3.21**
March	3.9	3.4	3.4	3.6	3.5	3.7	3.8	3.8	3.4	3.4	**3.59**
April	4	4.1	3.7	3.7	3.9	4	4.5	3.9	4.4	4	**4.02**
May	3.9	3.4	4.4	3.6	4	4	3.9	4.5	4.6	5.4	**4.17**
June	3.2	3.9	3.3	3.6	4.1	3.1	3.1	3.8	5.2	4.6	**3.79**
July	2.5	3.7	2.9	3.1	3.3	2.7	2.9	3.2	3.7	3.6	**3.16**
August	2.8	2.8	2.9	2.5	3	2.5	2.6	2.9	2.6	2.8	**2.74**
September	2.8	2.6	2.3	2.7	2.9	2.6	3	2.8	2.3	2.5	**2.65**
October	2.4	2.6	2.4	2.4	2.7	3	3.5	3.2	2.5	2.9	**2.76**
November	2.6	2.6	2.6	2.7	3	2.8	2.9	2.9	2.8	3.2	**2.81**
December	2.5	2.6	2.3	2.5	2.7	2.6	2.6	2.7	1.9	2.7	**2.51**

Table 4: Mean Monthly Average Humidity (%) (Reference years 2011-2020) Killar Town.

Months	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
January	50	51	44	38	43	38	45	28	41	62	**44**
February	57	56	57	49	45	34	42	33	58	54	**49**
March	45	40	43	54	44	37	33	25	45	56	**42**
April	36	38	29	47	34	26	26	24	28	36	**32**
May	29	24	20	31	21	27	27	18	22	27	**25**
June	41	22	37	28	29	34	36	33	23	27	**31**

Months	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
July	60	49	54	26	55	56	56	55	56	41	**51**
August	78	72	74	50	64	59	56	68	71	67	**66**
September	73	62	55	57	45	49	40	58	68	51	**56**
October	47	34	50	65	33	25	21	30	47	24	**38**
November	37	30	29	41	29	21	22	29	46	28	**31**
December	34	39	38	27	31	31	26	27	50	37	**34**

ANNEXURE-IIIb

Wind Rose Data

Table 1: Wind Rose data September 2020

S.No.	YYYY	MM	DD	HH	W_dir	W_Sp
1	2020	9	1	00:00	67.5	2
2	2020	9	1	03:00	90	2
3	2020	9	1	06:00	90	2
4	2020	9	1	09:00	135	2
8	2020	9	1	12:00	157.5	2
6	2020	9	1	15:00	225	2
7	2020	9	1	18:00	225	1
8	2020	9	1	21:00	67.5	1
9	2020	9	2	00:00	67.5	2
10	2020	9	2	03:00	67.5	1
11	2020	9	2	06:00	67.5	1
12	2020	9	2	09:00	135	2
13	2020	9	2	12:00	180	2
14	2020	9	2	15:00	157.5	2
18	2020	9	2	18:00	90	2
16	2020	9	2	21:00	90	2
17	2020	9	3	00:00	67.5	2
18	2020	9	3	03:00	67.5	2
19	2020	9	3	06:00	67.5	2
20	2020	9	3	09:00	112.5	2
21	2020	9	3	12:00	135	2
22	2020	9	3	15:00	135	2
23	2020	9	3	18:00	157.5	2
24	2020	9	3	21:00	202.5	2
28	2020	9	4	00:00	90	2
26	2020	9	4	03:00	112.5	1
27	2020	9	4	06:00	67.5	2
28	2020	9	4	09:00	135	1
29	2020	9	4	12:00	315	2
30	2020	9	4	15:00	202.5	1
31	2020	9	4	18:00	67.5	1
32	2020	9	4	21:00	22.5	1
33	2020	9	8	00:00	67.5	1
34	2020	9	8	03:00	67.5	2
38	2020	9	8	06:00	90	1
36	2020	9	8	09:00	135	2
37	2020	9	8	12:00	225	1
38	2020	9	8	15:00	292.5	2
39	2020	9	8	18:00	315	2
40	2020	9	8	21:00	247.5	1
41	2020	9	6	00:00	67.5	2
42	2020	9	6	03:00	67.5	1

S.No.	YYYY	MM	DD	HH	W_dir	W_Sp
43	2020	9	6	06:00	67.5	1
44	2020	9	6	09:00	112.5	1
48	2020	9	6	12:00	225	1
46	2020	9	6	15:00	270	1
47	2020	9	6	18:00	247.5	1
48	2020	9	6	21:00	45	2
49	2020	9	7	00:00	67.5	2
80	2020	9	7	03:00	67.5	1
81	2020	9	7	06:00	67.5	1
82	2020	9	7	09:00	157.5	1
83	2020	9	7	12:00	292.5	2
84	2020	9	7	15:00	315	2
88	2020	9	7	18:00	225	2
86	2020	9	7	21:00	67.5	1
87	2020	9	8	00:00	67.5	2
88	2020	9	8	03:00	67.5	2
89	2020	9	8	06:00	67.5	2
60	2020	9	8	09:00	135	1
61	2020	9	8	12:00	292.5	2
62	2020	9	8	15:00	315	3
63	2020	9	8	18:00	225	2
64	2020	9	8	21:00	45	2
68	2020	9	9	00:00	67.5	2
66	2020	9	9	03:00	67.5	1
67	2020	9	9	06:00	45	2
68	2020	9	9	09:00	67.5	1
69	2020	9	9	12:00	180	1
70	2020	9	9	15:00	315	2
71	2020	9	9	18:00	247.5	2
72	2020	9	9	21:00	45	2
73	2020	9	10	00:00	67.5	2
74	2020	9	10	03:00	90	1
78	2020	9	10	06:00	90	1
76	2020	9	10	09:00	90	1
77	2020	9	10	12:00	202.5	1
78	2020	9	10	15:00	202.5	2
79	2020	9	10	18:00	22.5	2
80	2020	9	10	21:00	67.5	2
81	2020	9	11	00:00	67.5	2
82	2020	9	11	03:00	67.5	1
83	2020	9	11	06:00	67.5	2
84	2020	9	11	09:00	90	1

S.No.	YYYY	MM	DD	HH	W_dir	W_Sp
88	2020	9	11	12:00	202.5	1
86	2020	9	11	15:00	315	2
87	2020	9	11	18:00	247.5	2
88	2020	9	11	21:00	45	2
89	2020	9	12	00:00	67.5	2
90	2020	9	12	03:00	67.5	1
91	2020	9	12	06:00	45	1
92	2020	9	12	09:00	112.5	2
93	2020	9	12	12:00	225	2
94	2020	9	12	15:00	315	3
98	2020	9	12	18:00	247.5	2
96	2020	9	12	21:00	45	2
97	2020	9	13	00:00	67.5	2
98	2020	9	13	03:00	67.5	2
99	2020	9	13	06:00	90	1
100	2020	9	13	09:00	135	1
101	2020	9	13	12:00	247.5	1
102	2020	9	13	15:00	202.5	2
103	2020	9	13	18:00	22.5	2
104	2020	9	13	21:00	67.5	2
108	2020	9	14	00:00	67.5	2
106	2020	9	14	03:00	67.5	1
107	2020	9	14	06:00	67.5	1
108	2020	9	14	09:00	112.5	2
109	2020	9	14	12:00	225	2
110	2020	9	14	15:00	202.5	2
111	2020	9	14	18:00	22.5	2
112	2020	9	14	21:00	67.5	2
113	2020	9	18	00:00	67.5	2
114	2020	9	18	03:00	67.5	1
118	2020	9	18	06:00	67.5	1
116	2020	9	18	09:00	112.5	2
117	2020	9	18	12:00	202.5	1
118	2020	9	18	15:00	202.5	2
119	2020	9	18	18:00	22.5	2
120	2020	9	18	21:00	45	2
121	2020	9	16	00:00	90	2
122	2020	9	16	03:00	112.5	2
123	2020	9	16	06:00	67.5	2
124	2020	9	16	09:00	112.5	1
128	2020	9	16	12:00	225	2
126	2020	9	16	15:00	202.5	2
127	2020	9	16	18:00	22.5	2

S.No.	YYYY	MM	DD	HH	W_dir	W_Sp
128	2020	9	16	21:00	45	2
129	2020	9	17	00:00	90	2
130	2020	9	17	03:00	112.5	1
131	2020	9	17	06:00	67.5	2
132	2020	9	17	09:00	112.5	1
133	2020	9	17	12:00	225	1
134	2020	9	17	15:00	202.5	2
138	2020	9	17	18:00	22.5	2
136	2020	9	17	21:00	45	2
137	2020	9	18	00:00	67.5	2
138	2020	9	18	03:00	67.5	2
139	2020	9	18	06:00	67.5	2
140	2020	9	18	09:00	135	1
141	2020	9	18	12:00	292.5	1
142	2020	9	18	15:00	315	3
143	2020	9	18	18:00	247.5	2
144	2020	9	18	21:00	45	2
148	2020	9	19	00:00	67.5	3
146	2020	9	19	03:00	67.5	2
147	2020	9	19	06:00	67.5	2
148	2020	9	19	09:00	90	2
149	2020	9	19	12:00	135	2
180	2020	9	19	15:00	337.5	2
181	2020	9	19	18:00	247.5	2
182	2020	9	19	21:00	67.5	2
183	2020	9	20	00:00	67.5	2
184	2020	9	20	03:00	67.5	2
188	2020	9	20	06:00	67.5	1
186	2020	9	20	09:00	112.5	1
187	2020	9	20	12:00	112.5	2
188	2020	9	20	15:00	225	3
189	2020	9	20	18:00	315	2
160	2020	9	20	21:00	225	2
161	2020	9	21	00:00	67.5	2
162	2020	9	21	03:00	67.5	2
163	2020	9	21	06:00	67.5	2
164	2020	9	21	09:00	135	1
168	2020	9	21	12:00	202.5	1
166	2020	9	21	15:00	202.5	2
167	2020	9	21	18:00	22.5	2
168	2020	9	21	21:00	45	2
169	2020	9	22	00:00	67.5	2
170	2020	9	22	03:00	67.5	2

S.No.	YYYY	MM	DD	HH	W_dir	W_Sp
171	2020	9	22	06:00	67.5	1
172	2020	9	22	09:00	135	1
173	2020	9	22	12:00	202.5	1
174	2020	9	22	15:00	225	1
178	2020	9	22	18:00	22.5	2
176	2020	9	22	21:00	67.5	2
177	2020	9	23	00:00	67.5	2
178	2020	9	23	03:00	67.5	2
179	2020	9	23	06:00	90	1
180	2020	9	23	09:00	135	2
181	2020	9	23	12:00	202.5	2
182	2020	9	23	15:00	225	2
183	2020	9	23	18:00	45	3
184	2020	9	23	21:00	67.5	2
188	2020	9	24	00:00	67.5	2
186	2020	9	24	03:00	67.5	2
187	2020	9	24	06:00	90	2
188	2020	9	24	09:00	135	2
189	2020	9	24	12:00	247.5	2
190	2020	9	24	15:00	225	3
191	2020	9	24	18:00	22.5	2
192	2020	9	24	21:00	67.5	2
193	2020	9	28	00:00	67.5	2
194	2020	9	28	03:00	90	2
198	2020	9	28	06:00	135	1
196	2020	9	28	09:00	135	2
197	2020	9	28	12:00	247.5	2
198	2020	9	28	15:00	202.5	2
199	2020	9	28	18:00	45	3
200	2020	9	28	21:00	67.5	4
201	2020	9	26	00:00	90	3
202	2020	9	26	03:00	135	1
203	2020	9	26	06:00	67.5	2
204	2020	9	26	09:00	112.5	3
208	2020	9	26	12:00	157.5	3

S.No.	YYYY	MM	DD	HH	W_dir	W_Sp
206	2020	9	26	15:00	135	2
207	2020	9	26	18:00	90	2
208	2020	9	26	21:00	112.5	3
209	2020	9	27	00:00	67.5	3
210	2020	9	27	03:00	67.5	2
211	2020	9	27	06:00	67.5	3
212	2020	9	27	09:00	112.5	2
213	2020	9	27	12:00	202.5	2
214	2020	9	27	15:00	292.5	2
218	2020	9	27	18:00	247.5	3
216	2020	9	27	21:00	45	3
217	2020	9	28	00:00	67.5	3
218	2020	9	28	03:00	90	2
219	2020	9	28	06:00	67.5	2
220	2020	9	28	09:00	112.5	2
221	2020	9	28	12:00	202.5	2
222	2020	9	28	15:00	315	2
223	2020	9	28	18:00	247.5	2
224	2020	9	28	21:00	45	3
228	2020	9	29	00:00	67.5	2
226	2020	9	29	03:00	67.5	1
227	2020	9	29	06:00	67.5	2
228	2020	9	29	09:00	135	1
229	2020	9	29	12:00	270	2
230	2020	9	29	15:00	337.5	3
231	2020	9	29	18:00	247.5	3
232	2020	9	29	21:00	45	3
233	2020	9	30	00:00	67.5	2
234	2020	9	30	03:00	67.5	2
238	2020	9	30	06:00	67.5	1
236	2020	9	30	09:00	135	1
237	2020	9	30	12:00	270	2
238	2020	9	30	15:00	315	4
239	2020	9	30	18:00	247.5	3
240	2020	9	30	21:00	45	3

YYYY-Year; MM-Month; DD-Date; HH-Hour; W_dir-Wind Direction (Degree); W_Sp-Wind Speed (m/s).

Table 2: Frequency Distribution (Period 01/09/2020 to 30/09/2020)

S. No.	Directions	0-0.5	0.5-2	2-4	4-6	6-8	8-10	10-25	Total
1	North	0	0	0	0	0	0	0	0

S. No.	Directions	0-0.5	0.5-2	2-4	4-6	6-8	8-10	10-25	Total
2	NNE	0	4.17	0	0	0	0	0	4.17
3	NE	0	5	2.5	0	0	0	0	7.5
4	ENE	0	31.67	2.08	0	0	0	0	33.75
5	East	0	7.92	0.42	0	0	0	0	8.34
6	ESE	0	5.83	0.83	0	0	0	0	6.66
7	SE	0	8.33	0	0	0	0	0	8.33
8	SSE	0	1.67	0.42	0	0	0	0	2.09
9	South	0	0.83	0	0	0	0	0	0.83
10	SSW	0	7.5	0	0	0	0	0	7.5
11	SW	0	5.42	0.83	0	0	0	0	6.25
12	WSW	0	4.58	1.25	0	0	0	0	5.83
13	West	0	1.25	0	0	0	0	0	1.25
14	WNW	0	2.08	0	0	0	0	0	2.08
15	NW	0	2.92	1.67	0	0	0	0	4.59
16	NNW	0	0.42	0.42	0	0	0	0	0.84
Total		**0**	**89.59**	**10.42**	**0**	**0**	**0**	**0**	**100**

Table 3: Wind Rose data October 2020

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
1	2020	10	1	00:00	67.5	3
2	2020	10	1	03:00	67.5	2
3	2020	10	1	06:00	67.5	1
4	2020	10	1	09:00	112.5	1
8	2020	10	1	12:00	247.5	3
6	2020	10	1	15:00	225	2
7	2020	10	1	18:00	45	2
8	2020	10	1	21:00	45	3
9	2020	10	2	00:00	67.5	3
10	2020	10	2	03:00	67.5	2
11	2020	10	2	06:00	67.5	2
12	2020	10	2	09:00	112.5	2
13	2020	10	2	12:00	225	2
14	2020	10	2	15:00	202.5	2
18	2020	10	2	18:00	22.5	3
16	2020	10	2	21:00	45	3
17	2020	10	3	00:00	45	2
18	2020	10	3	03:00	45	2
19	2020	10	3	06:00	67.5	2
20	2020	10	3	09:00	135	1
21	2020	10	3	12:00	247.5	2
22	2020	10	3	15:00	202.5	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
23	2020	10	3	18:00	22.5	2
24	2020	10	3	21:00	45	2
28	2020	10	4	00:00	45	2
26	2020	10	4	03:00	45	2
27	2020	10	4	06:00	67.5	2
28	2020	10	4	09:00	135	1
29	2020	10	4	12:00	247.5	2
30	2020	10	4	15:00	315	3
31	2020	10	4	18:00	247.5	2
32	2020	10	4	21:00	45	2
33	2020	10	8	00:00	45	2
34	2020	10	8	03:00	67.5	2
38	2020	10	8	06:00	67.5	2
36	2020	10	8	09:00	135	2
37	2020	10	8	12:00	247.5	2
38	2020	10	8	15:00	315	3
39	2020	10	8	18:00	247.5	2
40	2020	10	8	21:00	45	2
41	2020	10	6	00:00	67.5	2
42	2020	10	6	03:00	67.5	2
43	2020	10	6	06:00	67.5	2
44	2020	10	6	09:00	112.5	1

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
48	2020	10	6	12:00	225	2
46	2020	10	6	15:00	315	2
47	2020	10	6	18:00	247.5	3
48	2020	10	6	21:00	45	2
49	2020	10	7	00:00	67.5	2
80	2020	10	7	03:00	67.5	2
81	2020	10	7	06:00	67.5	2
82	2020	10	7	09:00	112.5	1
83	2020	10	7	12:00	225	2
84	2020	10	7	15:00	202.5	2
88	2020	10	7	18:00	22.5	3
86	2020	10	7	21:00	45	2
87	2020	10	8	00:00	67.5	2
88	2020	10	8	03:00	67.5	2
89	2020	10	8	06:00	90	1
60	2020	10	8	09:00	135	2
61	2020	10	8	12:00	202.5	2
62	2020	10	8	15:00	180	2
63	2020	10	8	18:00	22.5	3
64	2020	10	8	21:00	45	3
68	2020	10	9	00:00	67.5	2
66	2020	10	9	03:00	67.5	2
67	2020	10	9	06:00	90	1
68	2020	10	9	09:00	135	2
69	2020	10	9	12:00	225	2
70	2020	10	9	15:00	202.5	2
71	2020	10	9	18:00	22.5	3
72	2020	10	9	21:00	45	2
73	2020	10	10	00:00	45	2
74	2020	10	10	03:00	67.5	2
78	2020	10	10	06:00	90	1
76	2020	10	10	09:00	135	1
77	2020	10	10	12:00	247.5	2
78	2020	10	10	15:00	315	3
79	2020	10	10	18:00	247.5	2
80	2020	10	10	21:00	45	2
81	2020	10	11	00:00	67.5	2
82	2020	10	11	03:00	67.5	2
83	2020	10	11	06:00	90	2
84	2020	10	11	09:00	135	2
88	2020	10	11	12:00	225	2
86	2020	10	11	15:00	315	2
87	2020	10	11	18:00	247.5	3

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
88	2020	10	11	21:00	45	3
89	2020	10	12	00:00	67.5	2
90	2020	10	12	03:00	67.5	2
91	2020	10	12	06:00	90	1
92	2020	10	12	09:00	112.5	1
93	2020	10	12	12:00	202.5	2
94	2020	10	12	15:00	180	2
98	2020	10	12	18:00	22.5	2
96	2020	10	12	21:00	67.5	3
97	2020	10	13	00:00	67.5	2
98	2020	10	13	03:00	67.5	2
99	2020	10	13	06:00	90	2
100	2020	10	13	09:00	112.5	1
101	2020	10	13	12:00	225	2
102	2020	10	13	15:00	315	2
103	2020	10	13	18:00	247.5	2
104	2020	10	13	21:00	45	2
108	2020	10	14	00:00	45	2
106	2020	10	14	03:00	67.5	2
107	2020	10	14	06:00	90	1
108	2020	10	14	09:00	157.5	2
109	2020	10	14	12:00	247.5	4
110	2020	10	14	15:00	315	4
111	2020	10	14	18:00	337.5	2
112	2020	10	14	21:00	247.5	2
113	2020	10	18	00:00	45	3
114	2020	10	18	03:00	67.5	3
118	2020	10	18	06:00	67.5	2
116	2020	10	18	09:00	112.5	5
117	2020	10	18	12:00	225	7
118	2020	10	18	15:00	90	8
119	2020	10	18	18:00	45	7
120	2020	10	18	21:00	157.5	3
121	2020	10	16	00:00	225	2
122	2020	10	16	03:00	45	1
123	2020	10	16	06:00	67.5	1
124	2020	10	16	09:00	180	2
128	2020	10	16	12:00	247.5	3
126	2020	10	16	15:00	247.5	3
127	2020	10	16	18:00	292.5	3
128	2020	10	16	21:00	337.5	2
129	2020	10	17	00:00	225	2
130	2020	10	17	03:00	45	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
131	2020	10	17	06:00	67.5	2
132	2020	10	17	09:00	180	2
133	2020	10	17	12:00	270	2
134	2020	10	17	15:00	270	3
138	2020	10	17	18:00	202.5	3
136	2020	10	17	21:00	22.5	3
137	2020	10	18	00:00	45	1
138	2020	10	18	03:00	67.5	1
139	2020	10	18	06:00	67.5	2
140	2020	10	18	09:00	112.5	3
141	2020	10	18	12:00	247.5	3
142	2020	10	18	15:00	292.5	4
143	2020	10	18	18:00	202.5	5
144	2020	10	18	21:00	45	5
148	2020	10	19	00:00	45	5
146	2020	10	19	03:00	45	4
147	2020	10	19	06:00	45	3
148	2020	10	19	09:00	112.5	3
149	2020	10	19	12:00	225	2
180	2020	10	19	15:00	180	4
181	2020	10	19	18:00	45	6
182	2020	10	19	21:00	45	5
183	2020	10	20	00:00	45	4
184	2020	10	20	03:00	45	3
188	2020	10	20	06:00	22.5	2
186	2020	10	20	09:00	112.5	2
187	2020	10	20	12:00	270	3
188	2020	10	20	15:00	270	3
189	2020	10	20	18:00	292.5	3
160	2020	10	20	21:00	202.5	2
161	2020	10	21	00:00	247.5	2
162	2020	10	21	03:00	67.5	2
163	2020	10	21	06:00	67.5	2
164	2020	10	21	09:00	135	2
168	2020	10	21	12:00	270	3
166	2020	10	21	15:00	292.5	4
167	2020	10	21	18:00	315	4
168	2020	10	21	21:00	247.5	2
169	2020	10	22	00:00	45	3
170	2020	10	22	03:00	67.5	3
171	2020	10	22	06:00	67.5	2
172	2020	10	22	09:00	135	2
173	2020	10	22	12:00	270	4

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
174	2020	10	22	15:00	292.5	5
178	2020	10	22	18:00	225	4
176	2020	10	22	21:00	45	3
177	2020	10	23	00:00	45	4
178	2020	10	23	03:00	45	4
179	2020	10	23	06:00	67.5	4
180	2020	10	23	09:00	90	4
181	2020	10	23	12:00	157.5	5
182	2020	10	23	15:00	180	5
183	2020	10	23	18:00	135	4
184	2020	10	23	21:00	45	6
188	2020	10	24	00:00	45	5
186	2020	10	24	03:00	45	3
187	2020	10	24	06:00	45	3
188	2020	10	24	09:00	135	3
189	2020	10	24	12:00	270	3
190	2020	10	24	15:00	292.5	5
191	2020	10	24	18:00	225	5
192	2020	10	24	21:00	45	5
193	2020	10	28	00:00	67.5	3
194	2020	10	28	03:00	67.5	2
198	2020	10	28	06:00	90	2
196	2020	10	28	09:00	135	2
197	2020	10	28	12:00	247.5	3
198	2020	10	28	15:00	292.5	4
199	2020	10	28	18:00	225	3
200	2020	10	28	21:00	45	3
201	2020	10	26	00:00	67.5	3
202	2020	10	26	03:00	45	3
203	2020	10	26	06:00	45	2
204	2020	10	26	09:00	112.5	2
208	2020	10	26	12:00	270	3
206	2020	10	26	15:00	292.5	4
207	2020	10	26	18:00	202.5	3
208	2020	10	26	21:00	22.5	2
209	2020	10	27	00:00	67.5	2
210	2020	10	27	03:00	67.5	2
211	2020	10	27	06:00	67.5	2
212	2020	10	27	09:00	112.5	2
213	2020	10	27	12:00	247.5	3
214	2020	10	27	15:00	270	3
218	2020	10	27	18:00	225	2
216	2020	10	27	21:00	67.5	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
217	2020	10	28	00:00	45	2
218	2020	10	28	03:00	67.5	2
219	2020	10	28	06:00	67.5	2
220	2020	10	28	09:00	135	2
221	2020	10	28	12:00	247.5	2
222	2020	10	28	15:00	292.5	3
223	2020	10	28	18:00	225	2
224	2020	10	28	21:00	45	2
228	2020	10	29	00:00	67.5	3
226	2020	10	29	03:00	67.5	2
227	2020	10	29	06:00	67.5	2
228	2020	10	29	09:00	135	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
229	2020	10	29	12:00	225	3
230	2020	10	29	15:00	292.5	3
231	2020	10	29	18:00	225	2
232	2020	10	29	21:00	45	3
233	2020	10	30	00:00	45	3
234	2020	10	30	03:00	67.5	2
238	2020	10	30	06:00	45	2
236	2020	10	30	09:00	112.5	1
237	2020	10	30	12:00	270	3
238	2020	10	30	15:00	292.5	4
239	2020	10	30	18:00	180	2
240	2020	10	30	21:00	22.5	2

YYYY-Year; MM-Month; DD-Date; HH-Hour; W_dir-Wind Direction (Degree); W_Sp-Wind Speed (m/s).

Table 4: Frequency Distribution (Period 01/10/2020 to 30/10/2020)

S. No.	Directions	0	0	0	0	0	0	0	0
1	North	0	2.42	2.02	0	0	0	0	4.44
2	NNE	0	10.48	7.66	2.82	0.4	0	0	21.36
3	NE	0	17.74	3.63	0	0	0	0	21.37
4	ENE	0	3.23	0.4	0	0.4	0	0	4.03
5	East	0	4.03	0.81	0.4	0	0	0	5.24
6	ESE	0	5.24	0.81	0	0	0	0	6.05
7	SE	0	0.4	0.4	0.4	0	0	0	1.2
8	SSE	0	2.02	0.4	0.4	0	0	0	2.82
9	South	0	3.23	0.81	0.4	0	0	0	4.44
10	SSW	0	5.24	1.21	0.4	0.4	0	0	7.25
11	SW	0	4.84	3.63	0	0	0	0	8.47
12	WSW	0	0.4	4.44	0	0	0	0	4.84
13	West	0	0	3.63	0.81	0	0	0	4.44
14	WNW	0	1.21	2.02	0	0	0	0	3.23
15	NW	0	0.81	0	0	0	0	0	0.81
16	NNW	0	0	0	0	0	0	0	0
Total		**0**	**61.29**	**31.87**	**5.63**	**1.2**	**0**	**0**	**100**

Table 5: Wind Rose data November 2020

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
1	2020	11	1	00:00	67.5	2
2	2020	11	1	03:00	67.5	2
3	2020	11	1	06:00	67.5	1
4	2020	11	1	09:00	180	1
5	2020	11	1	12:00	270	3

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
6	2020	11	1	15:00	292.5	3
7	2020	11	1	18:00	202.5	2
8	2020	11	1	21:00	45	2
9	2020	11	2	00:00	67.5	2
10	2020	11	2	03:00	67.5	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
11	2020	11	2	06:00	67.5	1
12	2020	11	2	09:00	135	1
13	2020	11	2	12:00	247.5	3
14	2020	11	2	15:00	270	3
15	2020	11	2	18:00	202.5	2
16	2020	11	2	21:00	45	2
17	2020	11	3	00:00	67.5	2
18	2020	11	3	03:00	67.5	2
19	2020	11	3	06:00	67.5	1
20	2020	11	3	09:00	157.5	2
21	2020	11	3	12:00	247.5	3
22	2020	11	3	15:00	292.5	3
23	2020	11	3	18:00	202.5	2
24	2020	11	3	21:00	45	2
25	2020	11	4	00:00	67.5	2
26	2020	11	4	03:00	67.5	2
27	2020	11	4	06:00	67.5	1
28	2020	11	4	09:00	135	2
29	2020	11	4	12:00	225	3
30	2020	11	4	15:00	270	3
31	2020	11	4	18:00	202.5	2
32	2020	11	4	21:00	45	2
33	2020	11	8	00:00	90	2
34	2020	11	8	03:00	67.5	2
35	2020	11	8	06:00	90	1
36	2020	11	8	09:00	135	2
37	2020	11	8	12:00	225	3
38	2020	11	8	15:00	270	3
39	2020	11	8	18:00	202.5	2
40	2020	11	8	21:00	45	2
41	2020	11	6	00:00	67.5	2
42	2020	11	6	03:00	67.5	2
43	2020	11	6	06:00	67.5	1
44	2020	11	6	09:00	112.5	2
45	2020	11	6	12:00	247.5	2
46	2020	11	6	15:00	270	3
47	2020	11	6	18:00	202.5	2
48	2020	11	6	21:00	45	2
49	2020	11	7	00:00	67.5	2
50	2020	11	7	03:00	67.5	2
51	2020	11	7	06:00	67.5	1
52	2020	11	7	09:00	135	1
53	2020	11	7	12:00	247.5	3
54	2020	11	7	15:00	270	3
55	2020	11	7	18:00	202.5	1
56	2020	11	7	21:00	45	2
57	2020	11	8	00:00	67.5	2
58	2020	11	8	03:00	67.5	2
59	2020	11	8	06:00	67.5	1
60	2020	11	8	09:00	135	2
61	2020	11	8	12:00	225	3
62	2020	11	8	15:00	270	3
63	2020	11	8	18:00	202.5	2
64	2020	11	8	21:00	45	2
65	2020	11	9	00:00	67.5	2
66	2020	11	9	03:00	67.5	2
67	2020	11	9	06:00	67.5	2
68	2020	11	9	09:00	135	2
69	2020	11	9	12:00	247.5	3
70	2020	11	9	15:00	292.5	3
71	2020	11	9	18:00	225	2
72	2020	11	9	21:00	45	2
73	2020	11	10	00:00	67.5	2
74	2020	11	10	03:00	67.5	2
75	2020	11	10	06:00	67.5	1
76	2020	11	10	09:00	135	1
77	2020	11	10	12:00	225	2
78	2020	11	10	15:00	270	2
79	2020	11	10	18:00	202.5	2
80	2020	11	10	21:00	45	2
81	2020	11	11	00:00	67.5	2
82	2020	11	11	03:00	67.5	2
83	2020	11	11	06:00	67.5	1
84	2020	11	11	09:00	135	2
85	2020	11	11	12:00	225	3
86	2020	11	11	15:00	270	3
87	2020	11	11	18:00	225	2
88	2020	11	11	21:00	45	2
89	2020	11	12	00:00	67.5	2
90	2020	11	12	03:00	67.5	2
91	2020	11	12	06:00	67.5	1
92	2020	11	12	09:00	135	2
93	2020	11	12	12:00	247.5	3
94	2020	11	12	15:00	270	3
95	2020	11	12	18:00	202.5	2
96	2020	11	12	21:00	45	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
97	2020	11	13	00:00	67.5	1
98	2020	11	13	03:00	67.5	2
99	2020	11	13	06:00	67.5	1
100	2020	11	13	09:00	135	2
101	2020	11	13	12:00	270	3
102	2020	11	13	15:00	270	3
103	2020	11	13	18:00	202.5	2
104	2020	11	13	21:00	45	2
105	2020	11	14	00:00	67.5	2
106	2020	11	14	03:00	67.5	2
107	2020	11	14	06:00	112.5	1
108	2020	11	14	09:00	180	1
109	2020	11	14	12:00	225	2
110	2020	11	14	15:00	292.5	2
111	2020	11	14	18:00	270	2
112	2020	11	14	21:00	67.5	2
113	2020	11	18	00:00	67.5	2
114	2020	11	18	03:00	45	2
115	2020	11	18	06:00	45	1
116	2020	11	18	09:00	22.5	1
117	2020	11	18	12:00	90	2
118	2020	11	18	15:00	225	2
119	2020	11	18	18:00	225	3
120	2020	11	18	21:00	67.5	8
121	2020	11	16	00:00	45	8
122	2020	11	16	03:00	45	4
123	2020	11	16	06:00	135	2
124	2020	11	16	09:00	337.5	1
125	2020	11	16	12:00	315	2
126	2020	11	16	15:00	292.5	2
127	2020	11	16	18:00	202.5	2
128	2020	11	16	21:00	22.5	2
129	2020	11	17	00:00	22.5	2
130	2020	11	17	03:00	45	1
131	2020	11	17	06:00	45	1
132	2020	11	17	09:00	112.5	2
133	2020	11	17	12:00	225	2
134	2020	11	17	15:00	225	1
135	2020	11	17	18:00	157.5	1
136	2020	11	17	21:00	22.5	1
137	2020	11	18	00:00	45	1
138	2020	11	18	03:00	67.5	1
139	2020	11	18	06:00	67.5	1
140	2020	11	18	09:00	135	1
141	2020	11	18	12:00	247.5	2
142	2020	11	18	15:00	270	2
143	2020	11	18	18:00	202.5	1
144	2020	11	18	21:00	45	1
145	2020	11	19	00:00	67.5	2
146	2020	11	19	03:00	45	2
147	2020	11	19	06:00	45	1
148	2020	11	19	09:00	135	2
149	2020	11	19	12:00	270	2
150	2020	11	19	15:00	270	2
151	2020	11	19	18:00	202.5	2
152	2020	11	19	21:00	22.5	3
153	2020	11	20	00:00	45	2
154	2020	11	20	03:00	45	2
155	2020	11	20	06:00	22.5	1
156	2020	11	20	09:00	112.5	2
157	2020	11	20	12:00	270	3
158	2020	11	20	15:00	270	2
159	2020	11	20	18:00	292.5	2
160	2020	11	20	21:00	247.5	1
161	2020	11	21	00:00	22.5	1
162	2020	11	21	03:00	45	1
163	2020	11	21	06:00	135	1
164	2020	11	21	09:00	135	1
165	2020	11	21	12:00	247.5	2
166	2020	11	21	15:00	247.5	2
167	2020	11	21	18:00	247.5	1
168	2020	11	21	21:00	180	1
169	2020	11	22	00:00	45	1
170	2020	11	22	03:00	67.5	2
171	2020	11	22	06:00	45	1
172	2020	11	22	09:00	112.5	1
173	2020	11	22	12:00	247.5	2
174	2020	11	22	15:00	270	2
175	2020	11	22	18:00	202.5	1
176	2020	11	22	21:00	22.5	2
177	2020	11	23	00:00	22.5	2
178	2020	11	23	03:00	45	4
179	2020	11	23	06:00	45	3
180	2020	11	23	09:00	135	2
181	2020	11	23	12:00	292.5	1
182	2020	11	23	15:00	135	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
183	2020	11	23	18:00	90	3
184	2020	11	23	21:00	45	5
185	2020	11	24	00:00	22.5	6
186	2020	11	24	03:00	22.5	6
187	2020	11	24	06:00	22.5	5
188	2020	11	24	09:00	135	4
189	2020	11	24	12:00	247.5	4
190	2020	11	24	15:00	45	3
191	2020	11	24	18:00	45	4
192	2020	11	24	21:00	22.5	2
193	2020	11	28	00:00	45	1
194	2020	11	28	03:00	67.5	1
195	2020	11	28	06:00	157.5	1
196	2020	11	28	09:00	270	1
197	2020	11	28	12:00	292.5	2
198	2020	11	28	15:00	360	2
199	2020	11	28	18:00	247.5	3
200	2020	11	28	21:00	45	3
201	2020	11	26	00:00	45	4
202	2020	11	26	03:00	45	3
203	2020	11	26	06:00	45	2
204	2020	11	26	09:00	135	2
205	2020	11	26	12:00	337.5	3
206	2020	11	26	15:00	315	3
207	2020	11	26	18:00	315	3
208	2020	11	26	21:00	337.5	2
209	2020	11	27	00:00	22.5	2
210	2020	11	27	03:00	22.5	2
211	2020	11	27	06:00	45	1

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
212	2020	11	27	09:00	112.5	1
213	2020	11	27	12:00	247.5	2
214	2020	11	27	15:00	270	3
215	2020	11	27	18:00	315	2
216	2020	11	27	21:00	247.5	1
217	2020	11	28	00:00	45	1
218	2020	11	28	03:00	45	1
219	2020	11	28	06:00	45	1
220	2020	11	28	09:00	90	1
221	2020	11	28	12:00	247.5	2
222	2020	11	28	15:00	270	2
223	2020	11	28	18:00	202.5	1
224	2020	11	28	21:00	45	1
225	2020	11	29	00:00	90	1
226	2020	11	29	03:00	90	1
227	2020	11	29	06:00	112.5	1
228	2020	11	29	09:00	157.5	1
229	2020	11	29	12:00	202.5	2
230	2020	11	29	15:00	247.5	2
231	2020	11	29	18:00	180	1
232	2020	11	29	21:00	67.5	1
233	2020	11	30	00:00	45	1
234	2020	11	30	03:00	67.5	1
235	2020	11	30	06:00	90	1
236	2020	11	30	09:00	135	1
237	2020	11	30	12:00	247.5	2
238	2020	11	30	15:00	270	2
239	2020	11	30	18:00	180	1
240	2020	11	30	21:00	45	1

YYYY-Year; MM-Month; DD-Date; HH-Hour; W_dir-Wind Direction (Degree); W_Sp-Wind Speed (m/s).

Table 6: Frequency Distribution (Period 01/11/2020 to 30/11/2020)

S. No.	Directions	0-0.5	0.5-2	2-4	4-6	6-8	8-10	10-25	Total
1	North	0	0.42	0	0	0	0	0	0.42
2	NNE	0	4.58	0.42	1.25	0	0	0	6.25
3	NE	0	14.58	3.33	0.42	0.42	0	0	18.75
4	ENE	0	20	0	0	0.42	0	0	20.42
5	East	0	2.92	0.42	0	0	0	0	3.34
6	ESE	0	2.92	0	0	0	0	0	2.92
7	SE	0	7.92	0.42	0	0	0	0	8.34
8	SSE	0	1.67	0	0	0	0	0	1.67
9	South	0	2.08	0	0	0	0	0	2.08

S. No.	Directions	0-0.5	0.5-2	2-4	4-6	6-8	8-10	10-25	Total
10	SSW	0	7.08	0	0	0	0	0	7.08
11	SW	0	2.92	2.08	0	0	0	0	5
12	WSW	0	5	2.92	0	0	0	0	7.92
13	West	0	4.17	5.42	0	0	0	0	9.59
14	WNW	0	2.08	1.25	0	0	0	0	3.33
15	NW	0	0.83	0.83	0	0	0	0	1.66
16	NNW	0	0.83	0.42	0	0	0	0	1.25
Total		**0**	**80**	**17.51**	**1.67**	**0.84**	**0**	**0**	**100**

Table 7: Wind Rose data December 2020

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
1	2020	12	1	00:00	67.5	1
2	2020	12	1	03:00	90	1
3	2020	12	1	06:00	90	1
4	2020	12	1	09:00	157.5	1
5	2020	12	1	12:00	247.5	2
6	2020	12	1	15:00	270	2
7	2020	12	1	18:00	202.5	1
8	2020	12	1	21:00	45	1
9	2020	12	2	00:00	45	1
10	2020	12	2	03:00	67.5	1
11	2020	12	2	06:00	67.5	1
12	2020	12	2	09:00	135	1
13	2020	12	2	12:00	247.5	3
14	2020	12	2	15:00	270	2
15	2020	12	2	18:00	180	1
16	2020	12	2	21:00	45	1
17	2020	12	3	00:00	67.5	2
18	2020	12	3	03:00	90	1
19	2020	12	3	06:00	90	1
20	2020	12	3	09:00	112.5	2
21	2020	12	3	12:00	202.5	3
22	2020	12	3	15:00	225	2
23	2020	12	3	18:00	180	1
24	2020	12	3	21:00	67.5	2
25	2020	12	4	00:00	67.5	2
26	2020	12	4	03:00	67.5	2
27	2020	12	4	06:00	67.5	1
28	2020	12	4	09:00	112.5	2
29	2020	12	4	12:00	225	2
30	2020	12	4	15:00	225	2
31	2020	12	4	18:00	180	2
32	2020	12	4	21:00	67.5	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
33	2020	12	8	00:00	67.5	2
34	2020	12	8	03:00	67.5	2
35	2020	12	8	06:00	90	1
36	2020	12	8	09:00	112.5	2
37	2020	12	8	12:00	202.5	2
38	2020	12	8	15:00	247.5	2
39	2020	12	8	18:00	202.5	1
40	2020	12	8	21:00	67.5	2
41	2020	12	6	00:00	67.5	2
42	2020	12	6	03:00	45	2
43	2020	12	6	06:00	67.5	1
44	2020	12	6	09:00	135	1
45	2020	12	6	12:00	247.5	2
46	2020	12	6	15:00	270	3
47	2020	12	6	18:00	180	2
48	2020	12	6	21:00	22.5	1
49	2020	12	7	00:00	67.5	1
50	2020	12	7	03:00	67.5	1
51	2020	12	7	06:00	135	1
52	2020	12	7	09:00	292.5	1
53	2020	12	7	12:00	292.5	2
54	2020	12	7	15:00	292.5	3
55	2020	12	7	18:00	292.5	2
56	2020	12	7	21:00	247.5	1
57	2020	12	8	00:00	67.5	1
58	2020	12	8	03:00	67.5	1
59	2020	12	8	06:00	67.5	1
60	2020	12	8	09:00	135	2
61	2020	12	8	12:00	292.5	3
62	2020	12	8	15:00	315	3
63	2020	12	8	18:00	225	3
64	2020	12	8	21:00	22.5	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
65	2020	12	9	00:00	22.5	2
66	2020	12	9	03:00	22.5	2
67	2020	12	9	06:00	135	2
68	2020	12	9	09:00	292.5	1
69	2020	12	9	12:00	292.5	2
70	2020	12	9	15:00	292.5	3
71	2020	12	9	18:00	270	3
72	2020	12	9	21:00	202.5	4
73	2020	12	10	00:00	22.5	4
74	2020	12	10	03:00	45	2
75	2020	12	10	06:00	45	2
76	2020	12	10	09:00	90	3
77	2020	12	10	12:00	225	2
78	2020	12	10	15:00	247.5	3
79	2020	12	10	18:00	180	1
80	2020	12	10	21:00	22.5	1
81	2020	12	11	00:00	22.5	2
82	2020	12	11	03:00	22.5	2
83	2020	12	11	06:00	112.5	1
84	2020	12	11	09:00	202.5	1
85	2020	12	11	12:00	247.5	2
86	2020	12	11	15:00	315	2
87	2020	12	11	18:00	315	2
88	2020	12	11	21:00	247.5	2
89	2020	12	12	00:00	225	2
90	2020	12	12	03:00	67.5	1
91	2020	12	12	06:00	112.5	1
92	2020	12	12	09:00	292.5	2
93	2020	12	12	12:00	180	4
94	2020	12	12	15:00	157.5	3
95	2020	12	12	18:00	22.5	2
96	2020	12	12	21:00	22.5	1
97	2020	12	13	00:00	45	1
98	2020	12	13	03:00	45	2
99	2020	12	13	06:00	22.5	2
100	2020	12	13	09:00	112.5	2
101	2020	12	13	12:00	270	2
102	2020	12	13	15:00	292.5	3
103	2020	12	13	18:00	315	2
104	2020	12	13	21:00	247.5	2
105	2020	12	14	00:00	247.5	1
106	2020	12	14	03:00	45	1
107	2020	12	14	06:00	45	1

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
108	2020	12	14	09:00	135	1
109	2020	12	14	12:00	270	2
110	2020	12	14	15:00	292.5	3
111	2020	12	14	18:00	315	2
112	2020	12	14	21:00	225	2
113	2020	12	18	00:00	22.5	1
114	2020	12	18	03:00	45	1
115	2020	12	18	06:00	67.5	1
116	2020	12	18	09:00	135	2
117	2020	12	18	12:00	292.5	3
118	2020	12	18	15:00	292.5	3
119	2020	12	18	18:00	315	2
120	2020	12	18	21:00	225	1
121	2020	12	16	00:00	247.5	1
122	2020	12	16	03:00	45	1
123	2020	12	16	06:00	45	1
124	2020	12	16	09:00	135	2
125	2020	12	16	12:00	270	3
126	2020	12	16	15:00	270	3
127	2020	12	16	18:00	292.5	2
128	2020	12	16	21:00	337.5	1
129	2020	12	17	00:00	247.5	1
130	2020	12	17	03:00	45	1
131	2020	12	17	06:00	67.5	0
132	2020	12	17	09:00	135	1
133	2020	12	17	12:00	270	2
134	2020	12	17	15:00	292.5	2
135	2020	12	17	18:00	315	1
136	2020	12	17	21:00	247.5	1
137	2020	12	18	00:00	45	1
138	2020	12	18	03:00	67.5	1
139	2020	12	18	06:00	67.5	0
140	2020	12	18	09:00	135	1
141	2020	12	18	12:00	247.5	2
142	2020	12	18	15:00	292.5	2
143	2020	12	18	18:00	202.5	1
144	2020	12	18	21:00	22.5	1
145	2020	12	19	00:00	45	1
146	2020	12	19	03:00	67.5	1
147	2020	12	19	06:00	90	1
148	2020	12	19	09:00	135	1
149	2020	12	19	12:00	270	2
150	2020	12	19	15:00	270	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
151	2020	12	19	18:00	202.5	1
152	2020	12	19	21:00	22.5	1
153	2020	12	20	00:00	90	0
154	2020	12	20	03:00	90	1
155	2020	12	20	06:00	112.5	0
156	2020	12	20	09:00	135	1
157	2020	12	20	12:00	270	2
158	2020	12	20	15:00	292.5	2
159	2020	12	20	18:00	202.5	1
160	2020	12	20	21:00	22.5	1
161	2020	12	21	00:00	9090	0
162	2020	12	21	03:00	112.5	0
163	2020	12	21	06:00	135	1
164	2020	12	21	09:00	270	2
165	2020	12	21	12:00	292.5	1
166	2020	12	21	15:00	202.5	2
167	2020	12	21	18:00	22.5	1
168	2020	12	21	21:00	22.5	1
169	2020	12	22	00:00	67.5	1
170	2020	12	22	03:00	67.5	1
171	2020	12	22	06:00	67.5	1
172	2020	12	22	09:00	112.5	1
173	2020	12	22	12:00	225	2
174	2020	12	22	15:00	270	2
175	2020	12	22	18:00	225	1
176	2020	12	22	21:00	45	1
177	2020	12	23	00:00	67.5	2
178	2020	12	23	03:00	67.5	2
179	2020	12	23	06:00	67.5	1
180	2020	12	23	09:00	67.5	1
181	2020	12	23	12:00	135	2
182	2020	12	23	15:00	270	2
183	2020	12	23	18:00	270	2
184	2020	12	23	21:00	202.5	1
185	2020	12	24	00:00	67.5	1
186	2020	12	24	03:00	67.5	1
187	2020	12	24	06:00	67.5	1
188	2020	12	24	09:00	135	1
189	2020	12	24	12:00	270	2
190	2020	12	24	15:00	270	2
191	2020	12	24	18:00	180	1
192	2020	12	24	21:00	22.5	1
193	2020	12	28	00:00	67.5	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
194	2020	12	28	03:00	157.5	1
195	2020	12	28	06:00	247.5	1
196	2020	12	28	09:00	112.5	1
197	2020	12	28	12:00	270	2
198	2020	12	28	15:00	292.5	2
199	2020	12	28	18:00	315	1
200	2020	12	28	21:00	247.5	1
201	2020	12	26	00:00	45	1
202	2020	12	26	03:00	45	0
203	2020	12	26	06:00	67.5	1
204	2020	12	26	09:00	135	1
205	2020	12	26	12:00	247.5	2
206	2020	12	26	15:00	270	2
207	2020	12	26	18:00	225	1
208	2020	12	26	21:00	45	1
209	2020	12	27	00:00	67.5	2
210	2020	12	27	03:00	67.5	2
211	2020	12	27	06:00	67.5	2
212	2020	12	27	09:00	112.5	2
213	2020	12	27	12:00	157.5	3
214	2020	12	27	15:00	180	2
215	2020	12	27	18:00	225	2
216	2020	12	27	21:00	247.5	5
217	2020	12	28	00:00	67.5	6
218	2020	12	28	03:00	45	7
219	2020	12	28	06:00	45	6
220	2020	12	28	09:00	67.5	6
221	2020	12	28	12:00	67.5	5
222	2020	12	28	15:00	67.5	4
223	2020	12	28	18:00	45	3
224	2020	12	28	21:00	45	1
225	2020	12	29	00:00	67.5	1
226	2020	12	29	03:00	360	1
227	2020	12	29	06:00	135	0
228	2020	12	29	09:00	270	1
229	2020	12	29	12:00	225	1
230	2020	12	29	15:00	270	2
231	2020	12	29	18:00	292.5	2
232	2020	12	29	21:00	247.5	1
233	2020	12	30	00:00	45	1
234	2020	12	30	03:00	67.5	2
235	2020	12	30	06:00	45	2
236	2020	12	30	09:00	90	1

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
237	2020	12	30	12:00	225	1
238	2020	12	30	15:00	292.5	2
239	2020	12	30	18:00	202.5	2
240	2020	12	31	21:00	22.5	1
241	2020	12	31	00:00	45	1
242	2020	12	31	03:00	67.5	1

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
243	2020	12	31	06:00	67.5	1
244	2020	12	31	09:00	112.5	1
245	2020	12	31	12:00	247.5	1
246	2020	12	31	15:00	270	2
247	2020	12	31	18:00	292.5	1
248	2020	12	31	21:00	315	0

YYYY-Year; MM-Month; DD-Date; HH-Hour; W_dir-Wind Direction (Degree); W_Sp-Wind Speed (m/s).

Table 8: Frequency Distribution (Period 01/12/2020 to 31/12/2020)

S. No.	Directions	0-0.5	0.5-2	2-4	4-6	6-8	8-10	10-25	Total
1	North	0	0.4	0	0	0	0	0	0.4
2	NNE	0	7.29	0.4	0	0	0	0	7.69
3	NE	0.4	9.31	0.4	0.4	0.4	0	0	10.91
4	ENE	0.81	17	0.4	1.21	0	0	0	19.42
5	East	0.4	3.24	0.4	0	0	0	0	4.04
6	ESE	0.81	4.05	0	0	0	0	0	4.86
7	SE	0.4	6.48	0	0	0	0	0	6.88
8	SSE	0	0.81	0.81	0	0	0	0	1.62
9	South	0	2.83	0.4	0	0	0	0	3.23
10	SSW	0	4.05	0.81	0	0	0	0	4.86
11	SW	0	5.26	0.4	0	0	0	0	5.66
12	WSW	0	6.88	0.81	0.4	0	0	0	8.09
13	West	0	7.69	1.62	0	0	0	0	9.31
14	WNW	0	6.07	2.83	0	0	0	0	8.9
15	NW	0.4	2.83	0.4	0	0	0	0	3.63
16	NNW	0	0.4	0	0	0	0	0	0.4
Total		**3.22**	**84.59**	**9.68**	**2.01**	**0.4**	**0**	**0**	**100**

Table 9: Wind Rose data January 2021

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
1	2021	01	1	00:00	67.5	1
2	2021	01	1	03:00	67.5	1
3	2021	01	1	06:00	135	1
4	2021	01	1	09:00	112.5	1
5	2021	01	1	12:00	135	2
6	2021	01	1	15:00	225	1
7	2021	01	1	18:00	180	1
8	2021	01	1	21:00	67.5	1
9	2021	01	2	00:00	67.5	1
10	2021	01	2	03:00	67.5	2
11	2021	01	2	06:00	45	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
12	2021	01	2	09:00	112.5	1
13	2021	01	2	12:00	292.5	1
14	2021	01	2	15:00	292.5	2
15	2021	01	2	18:00	225	2
16	2021	01	2	21:00	45	1
17	2021	01	3	00:00	45	2
18	2021	01	3	03:00	45	2
19	2021	01	3	06:00	45	1
20	2021	01	3	09:00	67.5	2
21	2021	01	3	12:00	225	2
22	2021	01	3	15:00	292.5	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
23	2021	01	3	18:00	180	2
24	2021	01	3	21:00	22.5	1
25	2021	01	4	00:00	67.5	3
26	2021	01	4	03:00	67.5	3
27	2021	01	4	06:00	45	3
28	2021	01	4	09:00	45	3
29	2021	01	4	12:00	67.5	2
30	2021	01	4	15:00	45	2
31	2021	01	4	18:00	90	1
32	2021	01	4	21:00	135	1
33	2021	01	8	00:00	67.5	3
34	2021	01	8	03:00	45	2
35	2021	01	8	06:00	67.5	2
36	2021	01	8	09:00	90	2
37	2021	01	8	12:00	67.5	3
38	2021	01	8	15:00	45	3
39	2021	01	8	18:00	67.5	2
40	2021	01	8	21:00	90	1
41	2021	01	6	00:00	67.5	4
42	2021	01	6	03:00	45	5
43	2021	01	6	06:00	45	3
44	2021	01	6	09:00	67.5	3
45	2021	01	6	12:00	135	3
46	2021	01	6	15:00	202.5	1
47	2021	01	6	18:00	247.5	1
48	2021	01	6	21:00	45	1
49	2021	01	7	00:00	22.5	2
50	2021	01	7	03:00	45	2
51	2021	01	7	06:00	45	2
52	2021	01	7	09:00	90	2
53	2021	01	7	12:00	202.5	1
54	2021	01	7	15:00	270	1
55	2021	01	7	18:00	225	1
56	2021	01	7	21:00	90	1
57	2021	01	8	00:00	67.5	1
58	2021	01	8	03:00	67.5	1
59	2021	01	8	06:00	67.5	1
60	2021	01	8	09:00	112.5	1
61	2021	01	8	12:00	202.5	1
62	2021	01	8	15:00	225	2
63	2021	01	8	18:00	292.5	1
64	2021	01	8	21:00	225	1
65	2021	01	9	00:00	22.5	1

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
66	2021	01	9	03:00	135	1
67	2021	01	9	06:00	247.5	1
68	2021	01	9	09:00	67.5	0
69	2021	01	9	12:00	225	1
70	2021	01	9	15:00	270	2
71	2021	01	9	18:00	292.5	2
72	2021	01	9	21:00	315	1
73	2021	01	10	00:00	337.5	1
74	2021	01	10	03:00	337.5	1
75	2021	01	10	06:00	247.5	0
76	2021	01	10	09:00	90	1
77	2021	01	10	12:00	225	1
78	2021	01	10	15:00	292.5	2
79	2021	01	10	18:00	292.5	2
80	2021	01	10	21:00	315	1
81	2021	01	11	00:00	247.5	0
82	2021	01	11	03:00	112.5	0
83	2021	01	11	06:00	135	0
84	2021	01	11	09:00	157.5	1
85	2021	01	11	12:00	247.5	2
86	2021	01	11	15:00	270	2
87	2021	01	11	18:00	292.5	2
88	2021	01	11	21:00	225	1
89	2021	01	12	00:00	67.5	0
90	2021	01	12	03:00	157.5	0
91	2021	01	12	06:00	135	1
92	2021	01	12	09:00	157.5	1
93	2021	01	12	12:00	247.5	1
94	2021	01	12	15:00	270	2
95	2021	01	12	18:00	292.5	1
96	2021	01	12	21:00	337.5	1
97	2021	01	13	00:00	22.5	0
98	2021	01	13	03:00	67.5	0
99	2021	01	13	06:00	157.5	1
100	2021	01	13	09:00	180	1
101	2021	01	13	12:00	247.5	1
102	2021	01	13	15:00	270	2
103	2021	01	13	18:00	292.5	1
104	2021	01	13	21:00	247.5	1
105	2021	01	14	00:00	135	0
106	2021	01	14	03:00	90	0
107	2021	01	14	06:00	112.5	1
108	2021	01	14	09:00	135	1

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
109	2021	01	14	12:00	202.5	2
110	2021	01	14	15:00	247.5	1
111	2021	01	14	18:00	202.5	1
112	2021	01	14	21:00	67.5	1
113	2021	01	18	00:00	112.5	1
114	2021	01	18	03:00	135	1
115	2021	01	18	06:00	180	1
116	2021	01	18	09:00	135	1
117	2021	01	18	12:00	202.5	2
118	2021	01	18	15:00	247.5	2
119	2021	01	18	18:00	180	1
120	2021	01	18	21:00	45	1
121	2021	01	16	00:00	45	1
122	2021	01	16	03:00	45	1
123	2021	01	16	06:00	112.5	0
124	2021	01	16	09:00	270	1
125	2021	01	16	12:00	270	2
126	2021	01	16	15:00	292.5	2
127	2021	01	16	18:00	180	1
128	2021	01	16	21:00	22.5	1
129	2021	01	17	00:00	90	0
130	2021	01	17	03:00	112.5	1
131	2021	01	17	06:00	112.5	1
132	2021	01	17	09:00	135	2
133	2021	01	17	12:00	180	2
134	2021	01	17	15:00	202.5	2
135	2021	01	17	18:00	157.5	2
136	2021	01	17	21:00	67.5	2
137	2021	01	18	00:00	67.5	2
138	2021	01	18	03:00	67.5	2
139	2021	01	18	06:00	67.5	2
140	2021	01	18	09:00	112.5	1
141	2021	01	18	12:00	247.5	1
142	2021	01	18	15:00	247.5	2
143	2021	01	18	18:00	315	1
144	2021	01	18	21:00	247.5	1
145	2021	01	19	00:00	135	1
146	2021	01	19	03:00	247.5	1
147	2021	01	19	06:00	67.5	1
148	2021	01	19	09:00	157.5	1
149	2021	01	19	12:00	292.5	2
150	2021	01	19	15:00	292.5	3
151	2021	01	19	18:00	292.5	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
152	2021	01	19	21:00	247.5	1
153	2021	01	20	00:00	270	0
154	2021	01	20	03:00	90	0
155	2021	01	20	06:00	135	0
156	2021	01	20	09:00	247.5	1
157	2021	01	20	12:00	270	2
158	2021	01	20	15:00	202.5	3
159	2021	01	20	18:00	22.5	2
160	2021	01	20	21:00	22.5	1
161	2021	01	21	00:00	67.5	1
162	2021	01	21	03:00	90	1
163	2021	01	21	06:00	90	0
164	2021	01	21	09:00	135	0
165	2021	01	21	12:00	270	1
166	2021	01	21	15:00	270	2
167	2021	01	21	18:00	180	1
168	2021	01	21	21:00	45	1
169	2021	01	22	00:00	90	1
170	2021	01	22	03:00	90	1
171	2021	01	22	06:00	112.5	1
172	2021	01	22	09:00	135	1
173	2021	01	22	12:00	180	2
174	2021	01	22	15:00	180	1
175	2021	01	22	18:00	135	1
176	2021	01	22	21:00	90	2
177	2021	01	23	00:00	67.5	3
178	2021	01	23	03:00	67.5	3
179	2021	01	23	06:00	90	2
180	2021	01	23	09:00	112.5	3
181	2021	01	23	12:00	180	6
182	2021	01	23	15:00	157.5	5
183	2021	01	23	18:00	67.5	3
184	2021	01	23	21:00	67.5	4
185	2021	01	24	00:00	67.5	5
186	2021	01	24	03:00	67.5	2
187	2021	01	24	06:00	67.5	2
188	2021	01	24	09:00	112.5	1
189	2021	01	24	12:00	247.5	1
190	2021	01	24	15:00	247.5	2
191	2021	01	24	18:00	202.5	1
192	2021	01	24	21:00	45	1
193	2021	01	28	00:00	45	1
194	2021	01	28	03:00	45	1

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
195	2021	01	28	06:00	45	1
196	2021	01	28	09:00	90	1
197	2021	01	28	12:00	225	1
198	2021	01	28	15:00	292.5	2
199	2021	01	28	18:00	315	1
200	2021	01	28	21:00	247.5	1
201	2021	01	26	00:00	22.5	1
202	2021	01	26	03:00	67.5	1
203	2021	01	26	06:00	67.5	1
204	2021	01	26	09:00	112.5	1
205	2021	01	26	12:00	270	2
206	2021	01	26	15:00	292.5	1
207	2021	01	26	18:00	315	1
208	2021	01	26	21:00	247.5	1
209	2021	01	27	00:00	22.5	1
210	2021	01	27	03:00	45	1
211	2021	01	27	06:00	45	1
212	2021	01	27	09:00	112.5	1
213	2021	01	27	12:00	270	2
214	2021	01	27	15:00	292.5	2
215	2021	01	27	18:00	180	1
216	2021	01	27	21:00	22.5	1
217	2021	01	28	00:00	67.5	1
218	2021	01	28	03:00	45	1
219	2021	01	28	06:00	45	1
220	2021	01	28	09:00	112.5	1
221	2021	01	28	12:00	225	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
222	2021	01	28	15:00	270	2
223	2021	01	28	18:00	225	1
224	2021	01	28	21:00	67.5	1
225	2021	01	29	00:00	45	1
226	2021	01	29	03:00	67.5	1
227	2021	01	29	06:00	67.5	1
228	2021	01	29	09:00	112.5	1
229	2021	01	29	12:00	247.5	2
230	2021	01	29	15:00	270	3
231	2021	01	29	18:00	292.5	2
232	2021	01	29	21:00	247.5	1
233	2021	01	30	00:00	67.5	1
234	2021	01	30	03:00	67.5	1
235	2021	01	30	06:00	67.5	1
236	2021	01	30	09:00	112.5	1
237	2021	01	30	12:00	247.5	2
238	2021	01	30	15:00	270	2
239	2021	01	30	18:00	247.5	1
240	2021	01	30	21:00	22.5	1
241	2021	01	30	00:00	67.5	1
242	2021	01	30	03:00	45	1
243	2021	01	31	06:00	67.5	1
244	2021	01	31	09:00	112.5	1
245	2021	01	31	12:00	247.5	2
246	2021	01	31	15:00	292.5	2
247	2021	01	31	18:00	202.5	1
248	2021	01	31	21:00	22.5	1

YYYY-Year; MM-Month; DD-Date; HH-Hour; W_dir-Wind Direction (Degree); W_Sp-Wind Speed (m/s).

Table 10: Frequency Distribution (Period 01/01/2021 to 31/01/2021)

S. No.	Directions	0-0.5	0.5-2	2-4	4-6	6-8	8-10	10-25	Total
1	North	0	0	0	0	0	0	0	0
2	NNE	0.4	4.44	0	0	0	0	0	4.84
3	NE	0	9.68	1.61	0.4	0	0	0	11.69
4	ENE	1.21	12.9	4.03	0.4	0	0	0	18.54
5	East	1.61	4.84	0	0	0	0	0	6.45
6	ESE	0.81	6.45	0.4	0	0	0	0	7.66
7	SE	1.61	4.84	0.4	0	0	0	0	6.85
8	SSE	0.4	2.02	0	0.4	0	0	0	2.82
9	South	0	4.44	0	0.4	0	0	0	4.84
10	SSW	0	3.63	0.4	0	0	0	0	4.03

S. No.	Directions	0-0.5	0.5-2	2-4	4-6	6-8	8-10	10-25	Total
11	SW	0	4.84	0	0	0	0	0	4.84
12	WSW	0.81	9.27	0	0	0	0	0	10.08
13	West	0.4	5.65	0.4	0	0	0	0	6.45
14	WNW	0	7.26	0.4	0	0	0	0	7.66
15	NW	0	2.02	0	0	0	0	0	2.02
16	NNW	0	1.21	0	0	0	0	0	1.21
Total		**7.25**	**83.49**	**7.64**	**1.6**	**0**	**0**	**0**	**100**

able 11: Wind Rose data February 2021

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
1	2021	02	1	00:00	45	1
2	2021	02	1	03:00	45	1
3	2021	02	1	06:00	90	1
4	2021	02	1	09:00	157.5	1
5	2021	02	1	12:00	270	2
6	2021	02	1	15:00	292.5	3
7	2021	02	1	18:00	202.5	2
8	2021	02	1	21:00	45	1
9	2021	02	2	00:00	45	1
10	2021	02	2	03:00	67.5	1
11	2021	02	2	06:00	67.5	1
12	2021	02	2	09:00	112.5	2
13	2021	02	2	12:00	247.5	2
14	2021	02	2	15:00	270	2
15	2021	02	2	18:00	180	2
16	2021	02	2	21:00	22.5	3
17	2021	02	3	00:00	45	5
18	2021	02	3	03:00	45	6
19	2021	02	3	06:00	45	5
20	2021	02	3	09:00	67.5	3
21	2021	02	3	12:00	157.5	2
22	2021	02	3	15:00	292.5	2
23	2021	02	3	18:00	247.5	2
24	2021	02	3	21:00	45	2
25	2021	02	4	00:00	22.5	3
26	2021	02	4	03:00	45	6
27	2021	02	4	06:00	45	5
28	2021	02	4	09:00	45	5
29	2021	02	4	12:00	67.5	6
30	2021	02	4	15:00	135	4
31	2021	02	4	18:00	135	3
32	2021	02	4	21:00	90	1
33	2021	02	8	00:00	45	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
34	2021	02	8	03:00	135	1
35	2021	02	8	06:00	337.5	1
36	2021	02	8	09:00	315	1
37	2021	02	8	12:00	270	2
38	2021	02	8	15:00	270	3
39	2021	02	8	18:00	292.5	2
40	2021	02	8	21:00	247.5	1
41	2021	02	6	00:00	22.5	1
42	2021	02	6	03:00	67.5	1
43	2021	02	6	06:00	67.5	1
44	2021	02	6	09:00	112.5	1
45	2021	02	6	12:00	225	2
46	2021	02	6	15:00	292.5	2
47	2021	02	6	18:00	202.5	2
48	2021	02	6	21:00	22.5	1
49	2021	02	7	00:00	45	1
50	2021	02	7	03:00	45	1
51	2021	02	7	06:00	45	1
52	2021	02	7	09:00	135	1
53	2021	02	7	12:00	247.5	2
54	2021	02	7	15:00	292.5	2
55	2021	02	7	18:00	202.5	2
56	2021	02	7	21:00	45	1
57	2021	02	8	00:00	45	1
58	2021	02	8	03:00	22.5	1
59	2021	02	8	06:00	45	1
60	2021	02	8	09:00	180	1
61	2021	02	8	12:00	270	2
62	2021	02	8	15:00	292.5	3
63	2021	02	8	18:00	202.5	2
64	2021	02	8	21:00	45	1
65	2021	02	9	00:00	45	1
66	2021	02	9	03:00	67.5	1

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
67	2021	02	9	06:00	67.5	1
68	2021	02	9	09:00	135	1
69	2021	02	9	12:00	270	2
70	2021	02	9	15:00	270	2
71	2021	02	9	18:00	180	1
72	2021	02	9	21:00	45	2
73	2021	02	10	00:00	67.5	2
74	2021	02	10	03:00	45	1
75	2021	02	10	06:00	22.5	1
76	2021	02	10	09:00	112.5	1
77	2021	02	10	12:00	247.5	2
78	2021	02	10	15:00	270	3
79	2021	02	10	18:00	202.5	2
80	2021	02	10	21:00	22.5	1
81	2021	02	11	00:00	67.5	1
82	2021	02	11	03:00	67.5	2
83	2021	02	11	06:00	67.5	1
84	2021	02	11	09:00	112.5	1
85	2021	02	11	12:00	247.5	2
86	2021	02	11	15:00	292.5	2
87	2021	02	11	18:00	202.5	2
88	2021	02	11	21:00	22.5	1
89	2021	02	12	00:00	45	2
90	2021	02	12	03:00	67.5	2
91	2021	02	12	06:00	45	1
92	2021	02	12	09:00	112.5	1
93	2021	02	12	12:00	247.5	2
94	2021	02	12	15:00	270	2
95	2021	02	12	18:00	180	1
96	2021	02	12	21:00	22.5	1
97	2021	02	13	00:00	67.5	1
98	2021	02	13	03:00	67.5	1
99	2021	02	13	06:00	90	1
100	2021	02	13	09:00	157.5	1
101	2021	02	13	12:00	225	2
102	2021	02	13	15:00	292.5	2
103	2021	02	13	18:00	225	1
104	2021	02	13	21:00	45	1
105	2021	02	14	00:00	45	2
106	2021	02	14	03:00	67.5	2
107	2021	02	14	06:00	45	1
108	2021	02	14	09:00	135	1
109	2021	02	14	12:00	247.5	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
110	2021	02	14	15:00	292.5	2
111	2021	02	14	18:00	202.5	2
112	2021	02	14	21:00	22.5	2
113	2021	02	18	00:00	67.5	2
114	2021	02	18	03:00	67.5	2
115	2021	02	18	06:00	67.5	1
116	2021	02	18	09:00	112.5	1
117	2021	02	18	12:00	247.5	2
118	2021	02	18	15:00	292.5	2
119	2021	02	18	18:00	202.5	2
120	2021	02	18	21:00	22.5	2
121	2021	02	16	00:00	45	2
122	2021	02	16	03:00	45	2
123	2021	02	16	06:00	45	1
124	2021	02	16	09:00	90	1
125	2021	02	16	12:00	247.5	1
126	2021	02	16	15:00	292.5	2
127	2021	02	16	18:00	202.5	2
128	2021	02	16	21:00	22.5	2
129	2021	02	17	00:00	45	2
130	2021	02	17	03:00	45	2
131	2021	02	17	06:00	45	2
132	2021	02	17	09:00	90	1
133	2021	02	17	12:00	135	2
134	2021	02	17	15:00	270	2
135	2021	02	17	18:00	202.5	2
136	2021	02	17	21:00	22.5	2
137	2021	02	18	00:00	67.5	2
138	2021	02	18	03:00	67.5	2
139	2021	02	18	06:00	67.5	2
140	2021	02	18	09:00	112.5	1
141	2021	02	18	12:00	247.5	2
142	2021	02	18	15:00	292.5	2
143	2021	02	18	18:00	202.5	2
144	2021	02	18	21:00	22.5	2
145	2021	02	19	00:00	45	2
146	2021	02	19	03:00	67.5	2
147	2021	02	19	06:00	45	2
148	2021	02	19	09:00	90	1
149	2021	02	19	12:00	225	2
150	2021	02	19	15:00	270	2
151	2021	02	19	18:00	202.5	2
152	2021	02	19	21:00	22.5	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
153	2021	02	20	00:00	45	2
154	2021	02	20	03:00	45	1
155	2021	02	20	06:00	135	1
156	2021	02	20	09:00	315	1
157	2021	02	20	12:00	270	3
158	2021	02	20	15:00	292.5	3
159	2021	02	20	18:00	180	2
160	2021	02	20	21:00	22.5	1
161	2021	02	21	00:00	67.5	2
162	2021	02	21	03:00	67.5	1
163	2021	02	21	06:00	112.5	1
164	2021	02	21	09:00	157.5	1
165	2021	02	21	12:00	270	2
166	2021	02	21	15:00	292.5	3
167	2021	02	21	18:00	202.5	2
168	2021	02	21	21:00	45	2
169	2021	02	22	00:00	67.5	2
170	2021	02	22	03:00	67.5	2
171	2021	02	22	06:00	112.5	0
172	2021	02	22	09:00	180	1
173	2021	02	22	12:00	247.5	2
174	2021	02	22	15:00	292.5	3
175	2021	02	22	18:00	202.5	2
176	2021	02	22	21:00	22.5	2
177	2021	02	23	00:00	45	3
178	2021	02	23	03:00	67.5	2
179	2021	02	23	06:00	90	1
180	2021	02	23	09:00	90	2
181	2021	02	23	12:00	157.5	2
182	2021	02	23	15:00	180	2
183	2021	02	23	18:00	67.5	1
184	2021	02	23	21:00	67.5	3
185	2021	02	24	00:00	67.5	4
186	2021	02	24	03:00	45	2
187	2021	02	24	06:00	45	3
188	2021	02	24	09:00	135	3

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
189	2021	02	24	12:00	292.5	3
190	2021	02	24	15:00	225	5
191	2021	02	24	18:00	22.5	4
192	2021	02	24	21:00	45	5
193	2021	02	28	00:00	45	4
194	2021	02	28	03:00	22.5	3
195	2021	02	28	06:00	22.5	4
196	2021	02	28	09:00	135	4
197	2021	02	28	12:00	315	4
198	2021	02	28	15:00	292.5	5
199	2021	02	28	18:00	202.5	3
200	2021	02	28	21:00	45	3
201	2021	02	26	00:00	45	4
202	2021	02	26	03:00	22.5	3
203	2021	02	26	06:00	22.5	4
204	2021	02	26	09:00	135	4
205	2021	02	26	12:00	315	4
206	2021	02	26	15:00	292.5	5
207	2021	02	26	18:00	202.5	3
208	2021	02	26	21:00	45	3
209	2021	02	27	00:00	67.5	4
210	2021	02	27	03:00	67.5	3
211	2021	02	27	06:00	67.5	1
212	2021	02	27	09:00	112.5	3
213	2021	02	27	12:00	180	7
214	2021	02	27	15:00	202.5	5
215	2021	02	27	18:00	135	2
216	2021	02	27	21:00	22.5	1
217	2021	02	28	00:00	67.5	3
218	2021	02	28	03:00	67.5	3
219	2021	02	28	06:00	45	2
220	2021	02	28	09:00	67.5	1
221	2021	02	28	12:00	180	3
222	2021	02	28	15:00	202.5	4
223	2021	02	28	18:00	157.5	3
224	2021	02	28	21:00	67.5	3

YYYY-Year; MM-Month; DD-Date; HH-Hour; W_dir-Wind Direction (Degree); W_Sp-Wind Speed (m/s).

Table 12: Frequency Distribution (Period 01/02/2021 to 28/02/2021)

S. No.	Directions	0-0.5	0.5-2	2-4	4-6	6-8	8-10	10-25	Total
1	North	0	0	0	0	0	0	0	0
2	NNE	0	7.14	3.12	0	0	0	0	10.26

S. No.	Directions	0-0.5	0.5-2	2-4	4-6	6-8	8-10	10-25	Total
3	NE	0	15.18	2.68	3.12	0	0	0	20.98
4	ENE	0	12.95	3.57	0.45	0	0	0	16.97
5	East	0	3.57	0	0	0	0	0	3.57
6	ESE	0.45	3.57	0.45	0	0	0	0	4.47
7	SE	0	3.12	2.23	0	0	0	0	5.35
8	SSE	0	2.23	0.45	0	0	0	0	2.68
9	South	0	3.12	0.45	0	0.45	0	0	4.02
10	SSW	0	6.25	1.34	0.45	0	0	0	8.04
11	SW	0	1.79	0	0.45	0	0	0	2.24
12	WSW	0	5.36	0	0	0	0	0	5.36
13	West	0	4.46	1.34	0	0	0	0	5.8
14	WNW	0	4.46	2.68	0.89	0	0	0	8.03
15	NW	0	0.89	0.89	0	0	0	0	1.78
16	NNW	0	0.45	0	0	0	0	0	0.45
Total		**0.45**	**74.54**	**19.2**	**5.36**	**0.45**	**0**	**0**	**100**

Table 13: Wind Rose data March 2021

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp	S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
1	2021	03	1	00:00	45	2	25	2021	03	4	00:00	67.5	3
2	2021	03	1	03:00	22.5	2	26	2021	03	4	03:00	45	2
3	2021	03	1	06:00	22.5	2	27	2021	03	4	06:00	45	2
4	2021	03	1	09:00	112.5	2	28	2021	03	4	09:00	90	2
5	2021	03	1	12:00	270	3	29	2021	03	4	12:00	180	1
6	2021	03	1	15:00	292.5	3	30	2021	03	4	15:00	202.5	1
7	2021	03	1	18:00	202.5	3	31	2021	03	4	18:00	22.5	3
8	2021	03	1	21:00	360	2	32	2021	03	4	21:00	22.5	4
9	2021	03	2	00:00	45	1	33	2021	03	8	00:00	22.5	3
10	2021	03	2	03:00	67.5	2	34	2021	03	8	03:00	22.5	2
11	2021	03	2	06:00	157.5	1	35	2021	03	8	06:00	45	2
12	2021	03	2	09:00	315	1	36	2021	03	8	09:00	112.5	2
13	2021	03	2	12:00	270	3	37	2021	03	8	12:00	292.5	4
14	2021	03	2	15:00	292.5	4	38	2021	03	8	15:00	292.5	4
15	2021	03	2	18:00	315	2	39	2021	03	8	18:00	315	3
16	2021	03	2	21:00	247.5	2	40	2021	03	8	21:00	247.5	2
17	2021	03	3	00:00	45	2	41	2021	03	6	00:00	67.5	2
18	2021	03	3	03:00	67.5	1	42	2021	03	6	03:00	67.5	2
19	2021	03	3	06:00	67.5	1	43	2021	03	6	06:00	67.5	2
20	2021	03	3	09:00	157.5	1	44	2021	03	6	09:00	135	1
21	2021	03	3	12:00	270	2	45	2021	03	6	12:00	247.5	2
22	2021	03	3	15:00	292.5	3	46	2021	03	6	15:00	292.5	2
23	2021	03	3	18:00	225	3	47	2021	03	6	18:00	202.5	1
24	2021	03	3	21:00	45	4	48	2021	03	6	21:00	22.5	3

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
49	2021	03	7	00:00	22.5	9
50	2021	03	7	03:00	45	10
51	2021	03	7	06:00	67.5	6
52	2021	03	7	09:00	67.5	4
53	2021	03	7	12:00	112.5	5
54	2021	03	7	15:00	135	7
55	2021	03	7	18:00	112.5	7
56	2021	03	7	21:00	67.5	6
57	2021	03	8	00:00	45	3
58	2021	03	8	03:00	67.5	3
59	2021	03	8	06:00	67.5	3
60	2021	03	8	09:00	112.5	3
61	2021	03	8	12:00	157.5	4
62	2021	03	8	15:00	112.5	3
63	2021	03	8	18:00	22.5	3
64	2021	03	8	21:00	45	4
65	2021	03	9	00:00	45	6
66	2021	03	9	03:00	67.5	3
67	2021	03	9	06:00	67.5	2
68	2021	03	9	09:00	90	3
69	2021	03	9	12:00	180	2
70	2021	03	9	15:00	180	2
71	2021	03	9	18:00	135	2
72	2021	03	9	21:00	45	3
73	2021	03	10	00:00	45	4
74	2021	03	10	03:00	45	4
75	2021	03	10	06:00	45	3
76	2021	03	10	09:00	135	2
77	2021	03	10	12:00	315	2
78	2021	03	10	15:00	292.5	3
79	2021	03	10	18:00	225	3
80	2021	03	10	21:00	45	4
81	2021	03	11	00:00	45	4
82	2021	03	11	03:00	67.5	4
83	2021	03	11	06:00	67.5	3
84	2021	03	11	09:00	90	3
85	2021	03	11	12:00	135	3
86	2021	03	11	15:00	157.5	2
87	2021	03	11	18:00	112.5	3
88	2021	03	11	21:00	67.5	6
89	2021	03	12	00:00	45	5
90	2021	03	12	03:00	45	4
91	2021	03	12	06:00	45	3

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
92	2021	03	12	09:00	67.5	3
93	2021	03	12	12:00	112.5	4
94	2021	03	12	15:00	202.5	5
95	2021	03	12	18:00	225	4
96	2021	03	12	21:00	90	5
97	2021	03	13	00:00	45	2
98	2021	03	13	03:00	22.5	2
99	2021	03	13	06:00	135	1
100	2021	03	13	09:00	292.5	2
101	2021	03	13	12:00	292.5	3
102	2021	03	13	15:00	225	3
103	2021	03	13	18:00	225	3
104	2021	03	13	21:00	45	2
105	2021	03	14	00:00	22.5	1
106	2021	03	14	03:00	22.5	2
107	2021	03	14	06:00	67.5	2
108	2021	03	14	09:00	67.5	3
109	2021	03	14	12:00	112.5	5
110	2021	03	14	15:00	292.5	3
111	2021	03	14	18:00	292.5	3
112	2021	03	14	21:00	315	3
113	2021	03	18	00:00	45	2
114	2021	03	18	03:00	45	2
115	2021	03	18	06:00	45	2
116	2021	03	18	09:00	135	2
117	2021	03	18	12:00	292.5	4
118	2021	03	18	15:00	315	4
119	2021	03	18	18:00	202.5	3
120	2021	03	18	21:00	22.5	3
121	2021	03	16	00:00	45	3
122	2021	03	16	03:00	45	2
123	2021	03	16	06:00	45	2
124	2021	03	16	09:00	135	2
125	2021	03	16	12:00	292.5	3
126	2021	03	16	15:00	315	4
127	2021	03	16	18:00	247.5	4
128	2021	03	16	21:00	45	4
129	2021	03	17	00:00	45	3
130	2021	03	17	03:00	45	2
131	2021	03	17	06:00	45	1
132	2021	03	17	09:00	135	2
133	2021	03	17	12:00	270	3
134	2021	03	17	15:00	292.5	4

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
135	2021	03	17	18:00	225	3
136	2021	03	17	21:00	45	3
137	2021	03	18	00:00	67.5	2
138	2021	03	18	03:00	45	2
139	2021	03	18	06:00	45	2
140	2021	03	18	09:00	135	2
141	2021	03	18	12:00	292.5	2
142	2021	03	18	15:00	315	4
143	2021	03	18	18:00	225	4
144	2021	03	18	21:00	45	4
145	2021	03	19	00:00	45	4
146	2021	03	19	03:00	45	3
147	2021	03	19	06:00	22.5	2
148	2021	03	19	09:00	112.5	4
149	2021	03	19	12:00	292.5	5
150	2021	03	19	15:00	315	4
151	2021	03	19	18:00	225	4
152	2021	03	19	21:00	22.5	2
153	2021	03	20	00:00	45	2
154	2021	03	20	03:00	67.5	2
155	2021	03	20	06:00	67.5	2
156	2021	03	20	09:00	90	1
157	2021	03	20	12:00	247.5	2
158	2021	03	20	15:00	292.5	4
159	2021	03	20	18:00	225	3
160	2021	03	20	21:00	45	2
161	2021	03	21	00:00	45	2
162	2021	03	21	03:00	157.5	2
163	2021	03	21	06:00	315	1
164	2021	03	21	09:00	247.5	1
165	2021	03	21	12:00	225	3
166	2021	03	21	15:00	337.5	4
167	2021	03	21	18:00	225	5
168	2021	03	21	21:00	45	5
169	2021	03	22	00:00	225	4
170	2021	03	22	03:00	22.5	5
171	2021	03	22	06:00	45	8
172	2021	03	22	09:00	67.5	5
173	2021	03	22	12:00	112.5	7
174	2021	03	22	15:00	157.5	10
175	2021	03	22	18:00	180	7
176	2021	03	22	21:00	45	6
177	2021	03	23	00:00	67.5	4

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
178	2021	03	23	03:00	67.5	3
179	2021	03	23	06:00	67.5	4
180	2021	03	23	09:00	67.5	10
181	2021	03	23	12:00	67.5	8
182	2021	03	23	15:00	112.5	6
183	2021	03	23	18:00	45	5
184	2021	03	23	21:00	22.5	3
185	2021	03	24	00:00	112.5	2
186	2021	03	24	03:00	67.5	3
187	2021	03	24	06:00	45	2
188	2021	03	24	09:00	67.5	2
189	2021	03	24	12:00	180	3
190	2021	03	24	15:00	270	3
191	2021	03	24	18:00	315	2
192	2021	03	24	21:00	247.5	2
193	2021	03	28	00:00	22.5	2
194	2021	03	28	03:00	45	3
195	2021	03	28	06:00	45	2
196	2021	03	28	09:00	112.5	2
197	2021	03	28	12:00	292.5	1
198	2021	03	28	15:00	270	2
199	2021	03	28	18:00	202.5	2
200	2021	03	28	21:00	360	2
201	2021	03	26	00:00	22.5	2
202	2021	03	26	03:00	45	2
203	2021	03	26	06:00	67.5	2
204	2021	03	26	09:00	112.5	1
205	2021	03	26	12:00	247.5	2
206	2021	03	26	15:00	292.5	2
207	2021	03	26	18:00	225	2
208	2021	03	26	21:00	45	2
209	2021	03	27	00:00	45	2
210	2021	03	27	03:00	45	2
211	2021	03	27	06:00	67.5	1
212	2021	03	27	09:00	135	2
213	2021	03	27	12:00	292.5	2
214	2021	03	27	15:00	315	2
215	2021	03	27	18:00	225	2
216	2021	03	27	21:00	22.5	2
217	2021	03	28	00:00	45	2
218	2021	03	28	03:00	45	2
219	2021	03	28	06:00	67.5	1
220	2021	03	28	09:00	135	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
221	2021	03	28	12:00	292.5	2
222	2021	03	28	15:00	315	2
223	2021	03	28	18:00	225	2
224	2021	03	28	21:00	22.5	2
225	2021	03	29	00:00	67.5	4
226	2021	03	29	03:00	67.5	4
227	2021	03	29	06:00	90	4
228	2021	03	29	09:00	157.5	6
229	2021	03	29	12:00	180	7
230	2021	03	29	15:00	225	5
231	2021	03	29	18:00	180	5
232	2021	03	29	21:00	22.5	3
233	2021	03	30	00:00	45	4
234	2021	03	30	03:00	45	3

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
235	2021	03	30	06:00	112.5	1
236	2021	03	30	09:00	315	2
237	2021	03	30	12:00	270	4
238	2021	03	30	15:00	270	5
239	2021	03	30	18:00	292.5	6
240	2021	03	30	21:00	315	3
241	2021	03	30	00:00	247.5	1
242	2021	03	30	03:00	112.5	1
243	2021	03	31	06:00	157.5	1
244	2021	03	31	09:00	180	3
245	2021	03	31	12:00	225	4
246	2021	03	31	15:00	270	4
247	2021	03	31	18:00	292.5	4
248	2021	03	31	21:00	247.5	2

YYYY-Year; MM-Month; DD-Date; HH-Hour; W_dir-Wind Direction (Degree); W_Sp-Wind Speed (m/s).

Table 14: Frequency Distribution (Period 01/03/2021 to 31/03/2021)

S. No.	Directions	0-0.5	0.5-2	2-4	4-6	6-8	8-10	10-25	Total
1	North	0	0.81	0	0	0	0	0	0.81
2	NNE	0	4.84	3.23	0.4	0	0.4	0	8.87
3	NE	0	11.29	8.47	2.02	0.4	0.4	0	22.58
4	ENE	0	6.05	6.05	1.61	0.4	0.4	0	14.51
5	East	0	0.81	1.21	0.4	0	0	0	2.42
6	ESE	0	2.82	2.02	1.21	0.81	0	0	6.86
7	SE	0	4.03	0.4	0	0.4	0	0	4.83
8	SSE	0	2.02	0.4	0.4	0	0.4	0	3.22
9	South	0	1.21	0.81	0.4	0.81	0	0	3.23
10	SSW	0	1.21	0.81	0.4	0	0	0	2.42
11	SW	0	1.21	4.84	0.81	0	0	0	6.86
12	WSW	0	3.63	0.4	0	0	0	0	4.03
13	West	0	0.81	2.42	0.4	0	0	0	3.63
14	WNW	0	2.82	5.65	0.81	0	0	0	9.28
15	NW	0	3.23	2.82	0	0	0	0	6.05
16	NNW	0	0	0.4	0	0	0	0	0.4
Total		**0**	**46.79**	**39.93**	**8.86**	**2.82**	**1.6**	**0**	**100**

Table 15: Wind Rose data April 2021

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
1	2021	04	1	00:00	67.5	1
2	2021	04	1	03:00	67.5	1
3	2021	04	1	06:00	90	1

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
4	2021	04	1	09:00	157.5	2
5	2021	04	1	12:00	247.5	4
6	2021	04	1	15:00	270	5

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
7	2021	04	1	18:00	270	5
8	2021	04	1	21:00	225	2
9	2021	04	2	00:00	90	2
10	2021	04	2	03:00	112.5	2
11	2021	04	2	06:00	135	3
12	2021	04	2	09:00	157.5	4
13	2021	04	2	12:00	202.5	5
14	2021	04	2	15:00	247.5	4
15	2021	04	2	18:00	292.5	2
16	2021	04	2	21:00	270	2
17	2021	04	3	00:00	45	3
18	2021	04	3	03:00	45	3
19	2021	04	3	06:00	67.5	2
20	2021	04	3	09:00	90	2
21	2021	04	3	12:00	202.5	3
22	2021	04	3	15:00	247.5	3
23	2021	04	3	18:00	202.5	3
24	2021	04	3	21:00	22.5	3
25	2021	04	4	00:00	45	3
26	2021	04	4	03:00	45	3
27	2021	04	4	06:00	67.5	2
28	2021	04	4	09:00	135	2
29	2021	04	4	12:00	270	3
30	2021	04	4	15:00	315	3
31	2021	04	4	18:00	247.5	2
32	2021	04	4	21:00	45	2
33	2021	04	8	00:00	45	3
34	2021	04	8	03:00	67.5	3
35	2021	04	8	06:00	45	3
36	2021	04	8	09:00	22.5	4
37	2021	04	8	12:00	135	5
38	2021	04	8	15:00	315	5
39	2021	04	8	18:00	202.5	4
40	2021	04	8	21:00	22.5	3
41	2021	04	6	00:00	22.5	4
42	2021	04	6	03:00	22.5	5
43	2021	04	6	06:00	45	5
44	2021	04	6	09:00	112.5	4
45	2021	04	6	12:00	247.5	3
46	2021	04	6	15:00	247.5	5
47	2021	04	6	18:00	157.5	4
48	2021	04	6	21:00	90	4
49	2021	04	7	00:00	22.5	4

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
50	2021	04	7	03:00	90	2
51	2021	04	7	06:00	90	3
52	2021	04	7	09:00	90	5
53	2021	04	7	12:00	112.5	6
54	2021	04	7	15:00	67.5	6
55	2021	04	7	18:00	135	6
56	2021	04	7	21:00	247.5	3
57	2021	04	8	00:00	45	3
58	2021	04	8	03:00	45	3
59	2021	04	8	06:00	45	2
60	2021	04	8	09:00	90	2
61	2021	04	8	12:00	270	3
62	2021	04	8	15:00	270	5
63	2021	04	8	18:00	292.5	5
64	2021	04	8	21:00	247.5	3
65	2021	04	9	00:00	45	3
66	2021	04	9	03:00	45	3
67	2021	04	9	06:00	45	3
68	2021	04	9	09:00	112.5	2
69	2021	04	9	12:00	270	3
70	2021	04	9	15:00	292.5	5
71	2021	04	9	18:00	315	5
72	2021	04	9	21:00	247.5	4
73	2021	04	10	00:00	45	4
74	2021	04	10	03:00	45	4
75	2021	04	10	06:00	45	4
76	2021	04	10	09:00	135	4
77	2021	04	10	12:00	292.5	5
78	2021	04	10	15:00	292.5	5
79	2021	04	10	18:00	202.5	5
80	2021	04	10	21:00	22.5	4
81	2021	04	11	00:00	45	4
82	2021	04	11	03:00	45	4
83	2021	04	11	06:00	67.5	4
84	2021	04	11	09:00	112.5	4
85	2021	04	11	12:00	247.5	2
86	2021	04	11	15:00	202.5	4
87	2021	04	11	18:00	67.5	5
88	2021	04	11	21:00	67.5	4
89	2021	04	12	00:00	45	3
90	2021	04	12	03:00	45	1
91	2021	04	12	06:00	67.5	5
92	2021	04	12	09:00	157.5	6

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
93	2021	04	12	12:00	247.5	4
94	2021	04	12	15:00	22.5	5
95	2021	04	12	18:00	45	5
96	2021	04	12	21:00	45	5
97	2021	04	13	00:00	45	4
98	2021	04	13	03:00	22.5	3
99	2021	04	13	06:00	45	3
100	2021	04	13	09:00	135	3
101	2021	04	13	12:00	270	4
102	2021	04	13	15:00	292.5	6
103	2021	04	13	18:00	315	5
104	2021	04	13	21:00	247.5	3
105	2021	04	14	00:00	45	4
106	2021	04	14	03:00	45	3
107	2021	04	14	06:00	22.5	3
108	2021	04	14	09:00	135	4
109	2021	04	14	12:00	292.5	4
110	2021	04	14	15:00	315	7
111	2021	04	14	18:00	247.5	10
112	2021	04	14	21:00	45	7
113	2021	04	18	00:00	45	4
114	2021	04	18	03:00	45	3
115	2021	04	18	06:00	45	3
116	2021	04	18	09:00	157.5	3
117	2021	04	18	12:00	315	2
118	2021	04	18	15:00	292.5	3
119	2021	04	18	18:00	315	4
120	2021	04	18	21:00	247.5	3
121	2021	04	16	00:00	45	5
122	2021	04	16	03:00	67.5	3
123	2021	04	16	06:00	67.5	2
124	2021	04	16	09:00	135	3
125	2021	04	16	12:00	180	4
126	2021	04	16	15:00	157.5	5
127	2021	04	16	18:00	135	5
128	2021	04	16	21:00	90	4
129	2021	04	17	00:00	247.5	1
130	2021	04	17	03:00	45	2
131	2021	04	17	06:00	22.5	2
132	2021	04	17	09:00	45	3
133	2021	04	17	12:00	90	6
134	2021	04	17	15:00	67.5	5
135	2021	04	17	18:00	67.5	4
136	2021	04	17	21:00	90	2
137	2021	04	18	00:00	67.5	2
138	2021	04	18	03:00	45	2
139	2021	04	18	06:00	45	2
140	2021	04	18	09:00	22.5	3
141	2021	04	18	12:00	67.5	4
142	2021	04	18	15:00	67.5	5
143	2021	04	18	18:00	180	4
144	2021	04	18	21:00	247.5	4
145	2021	04	19	00:00	45	8
146	2021	04	19	03:00	45	7
147	2021	04	19	06:00	157.5	3
148	2021	04	19	09:00	337.5	2
149	2021	04	19	12:00	270	3
150	2021	04	19	15:00	270	4
151	2021	04	19	18:00	292.5	4
152	2021	04	19	21:00	247.5	3
153	2021	04	20	00:00	45	3
154	2021	04	20	03:00	45	3
155	2021	04	20	06:00	67.5	3
156	2021	04	20	09:00	112.5	2
157	2021	04	20	12:00	157.5	1
158	2021	04	20	15:00	22.5	4
159	2021	04	20	18:00	22.5	7
160	2021	04	20	21:00	45	4
161	2021	04	21	00:00	67.5	4
162	2021	04	21	03:00	45	4
163	2021	04	21	06:00	90	3
164	2021	04	21	09:00	135	4
165	2021	04	21	12:00	180	6
166	2021	04	21	15:00	202.5	5
167	2021	04	21	18:00	270	4
168	2021	04	21	21:00	247.5	3
169	2021	04	22	00:00	67.5	1
170	2021	04	22	03:00	45	1
171	2021	04	22	06:00	90	2
172	2021	04	22	09:00	135	3
173	2021	04	22	12:00	202.5	3
174	2021	04	22	15:00	315	3
175	2021	04	22	18:00	247.5	4
176	2021	04	22	21:00	45	4
177	2021	04	23	00:00	45	4
178	2021	04	23	03:00	67.5	3

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
179	2021	04	23	06:00	67.5	4
180	2021	04	23	09:00	22.5	9
181	2021	04	23	12:00	45	7
182	2021	04	23	15:00	135	5
183	2021	04	23	18:00	247.5	5
184	2021	04	23	21:00	90	1
185	2021	04	24	00:00	45	4
186	2021	04	24	03:00	67.5	3
187	2021	04	24	06:00	67.5	4
188	2021	04	24	09:00	22.5	9
189	2021	04	24	12:00	45	7
190	2021	04	24	15:00	135	5
191	2021	04	24	18:00	247.5	5
192	2021	04	24	21:00	90	1
193	2021	04	28	00:00	67.5	3
194	2021	04	28	03:00	45	3
195	2021	04	28	06:00	45	3
196	2021	04	28	09:00	112.5	2
197	2021	04	28	12:00	292.5	3
198	2021	04	28	15:00	270	3
199	2021	04	28	18:00	292.5	2
200	2021	04	28	21:00	247.5	2
201	2021	04	26	00:00	45	3
202	2021	04	26	03:00	45	3
203	2021	04	26	06:00	67.5	2
204	2021	04	26	09:00	135	2
205	2021	04	26	12:00	270	2
206	2021	04	26	15:00	315	1
207	2021	04	26	18:00	247.5	1
208	2021	04	26	21:00	45	3
209	2021	04	27	00:00	45	3

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
210	2021	04	27	03:00	45	3
211	2021	04	27	06:00	45	2
212	2021	04	27	09:00	135	3
213	2021	04	27	12:00	270	3
214	2021	04	27	15:00	292.5	4
215	2021	04	27	18:00	225	3
216	2021	04	27	21:00	45	3
217	2021	04	28	00:00	45	5
218	2021	04	28	03:00	45	3
219	2021	04	28	06:00	45	3
220	2021	04	28	09:00	112.5	2
221	2021	04	28	12:00	225	2
222	2021	04	28	15:00	292.5	4
223	2021	04	28	18:00	225	4
224	2021	04	28	21:00	45	5
225	2021	04	29	00:00	45	4
226	2021	04	29	03:00	45	2
227	2021	04	29	06:00	45	2
228	2021	04	29	09:00	157.5	3
229	2021	04	29	12:00	315	5
230	2021	04	29	15:00	202.5	5
231	2021	04	29	18:00	45	7
232	2021	04	29	21:00	135	5
233	2021	04	30	00:00	45	4
234	2021	04	30	03:00	45	2
235	2021	04	30	06:00	45	2
236	2021	04	30	09:00	67.5	2
237	2021	04	30	12:00	135	2
238	2021	04	30	15:00	180	6
239	2021	04	30	18:00	45	10
240	2021	04	30	21:00	45	6

YYYY-Year; MM-Month; DD-Date; HH-Hour; W_dir-Wind Direction (Degree); W_Sp-Wind Speed (m/s).

Table 16: Frequency Distribution (Period 01/04/2021 to 30/04/2021)

S. No.	Directions	0-0.5	0.5-2	2-4	4-6	6-8	8-10	10-25	Total
1	North	0	0	0	0	0	0	0	0
2	NNE	0	0.42	4.17	0.83	0.42	0.83	0	6.67
3	NE	0	5	18.33	2.92	2.5	0.42	0	29.17
4	ENE	0	3.75	5.42	2.08	0	0	0	11.25
5	East	0	3.75	1.67	0.83	0	0	0	6.25
6	ESE	0	2.08	0.83	0.42	0	0	0	3.33
7	SE	0	1.25	3.33	2.5	0	0	0	7.08

S. No.	Directions	0-0.5	0.5-2	2-4	4-6	6-8	8-10	10-25	Total
8	SSE	0	0.83	2.08	0.83	0	0	0	3.74
9	South	0	0	0.83	0.83	0	0	0	1.66
10	SSW	0	0	2.08	1.67	0	0	0	3.75
11	SW	0	0.83	0.83	0	0	0	0	1.66
12	WSW	0	2.08	5.83	1.25	0	0.42	0	9.58
13	West	0	0.83	3.75	1.25	0	0	0	5.83
14	WNW	0	0.83	2.5	2.08	0	0	0	5.41
15	NW	0	0.83	1.25	1.67	0.42	0	0	4.17
16	NNW	0	0.42	0	0	0	0	0	0.42
Total		**0**	**22.9**	**52.9**	**19.16**	**3.34**	**1.67**	**0**	**100**

Table 17: Wind Rose data May 2021

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
1	2021	05	1	00:00	202.5	3
2	2021	05	1	03:00	45	3
3	2021	05	1	06:00	67.5	2
4	2021	05	1	09:00	112.5	3
5	2021	05	1	12:00	247.5	3
6	2021	05	1	15:00	202.5	4
7	2021	05	1	18:00	22.5	4
8	2021	05	1	21:00	67.5	4
9	2021	05	2	00:00	67.5	3
10	2021	05	2	03:00	90	3
11	2021	05	2	06:00	90	3
12	2021	05	2	09:00	135	3
13	2021	05	2	12:00	157.5	4
14	2021	05	2	15:00	180	3
15	2021	05	2	18:00	135	2
16	2021	05	2	21:00	45	3
17	2021	05	3	00:00	90	3
18	2021	05	3	03:00	90	2
19	2021	05	3	06:00	90	2
20	2021	05	3	09:00	135	2
21	2021	05	3	12:00	247.5	3
22	2021	05	3	15:00	292.5	4
23	2021	05	3	18:00	292.5	4
24	2021	05	3	21:00	135	4
25	2021	05	4	00:00	45	3
26	2021	05	4	03:00	67.5	2
27	2021	05	4	06:00	90	3
28	2021	05	4	09:00	157.5	3
29	2021	05	4	12:00	202.5	3

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
30	2021	05	4	15:00	292.5	3
31	2021	05	4	18:00	225	4
32	2021	05	4	21:00	67.5	4
33	2021	05	8	00:00	45	3
34	2021	05	8	03:00	22.5	2
35	2021	05	8	06:00	90	3
36	2021	05	8	09:00	157.5	2
37	2021	05	8	12:00	225	2
38	2021	05	8	15:00	292.5	3
39	2021	05	8	18:00	247.5	4
40	2021	05	8	21:00	67.5	3
41	2021	05	6	00:00	67.5	2
42	2021	05	6	03:00	45	2
43	2021	05	6	06:00	67.5	2
44	2021	05	6	09:00	135	3
45	2021	05	6	12:00	157.5	4
46	2021	05	6	15:00	135	3
47	2021	05	6	18:00	45	3
48	2021	05	6	21:00	45	4
49	2021	05	7	00:00	45	6
50	2021	05	7	03:00	67.5	3
51	2021	05	7	06:00	67.5	1
52	2021	05	7	09:00	67.5	3
53	2021	05	7	12:00	67.5	3
54	2021	05	7	15:00	112.5	4
55	2021	05	7	18:00	247.5	4
56	2021	05	7	21:00	157.5	3
57	2021	05	8	00:00	45	2
58	2021	05	8	03:00	67.5	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
59	2021	05	8	06:00	112.5	2
60	2021	05	8	09:00	180	2
61	2021	05	8	12:00	225	2
62	2021	05	8	15:00	270	1
63	2021	05	8	18:00	202.5	4
64	2021	05	8	21:00	112.5	6
65	2021	05	9	00:00	67.5	3
66	2021	05	9	03:00	67.5	2
67	2021	05	9	06:00	45	2
68	2021	05	9	09:00	112.5	2
69	2021	05	9	12:00	202.5	3
70	2021	05	9	15:00	202.5	5
71	2021	05	9	18:00	45	6
72	2021	05	9	21:00	45	4
73	2021	05	10	00:00	45	3
74	2021	05	10	03:00	45	3
75	2021	05	10	06:00	112.5	3
76	2021	05	10	09:00	225	2
77	2021	05	10	12:00	270	2
78	2021	05	10	15:00	270	3
79	2021	05	10	18:00	202.5	3
80	2021	05	10	21:00	45	4
81	2021	05	11	00:00	45	3
82	2021	05	11	03:00	67.5	3
83	2021	05	11	06:00	67.5	3
84	2021	05	11	09:00	112.5	3
85	2021	05	11	12:00	202.5	3
86	2021	05	11	15:00	180	6
87	2021	05	11	18:00	45	9
88	2021	05	11	21:00	157.5	7
89	2021	05	12	00:00	67.5	4
90	2021	05	12	03:00	45	4
91	2021	05	12	06:00	90	2
92	2021	05	12	09:00	135	3
93	2021	05	12	12:00	202.5	5
94	2021	05	12	15:00	157.5	6
95	2021	05	12	18:00	45	5
96	2021	05	12	21:00	67.5	2
97	2021	05	13	00:00	67.5	3
98	2021	05	13	03:00	45	3
99	2021	05	13	06:00	67.5	2
100	2021	05	13	09:00	67.5	4
101	2021	05	13	12:00	67.5	5

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
102	2021	05	13	15:00	90	5
103	2021	05	13	18:00	90	4
104	2021	05	13	21:00	45	2
105	2021	05	14	00:00	67.5	2
106	2021	05	14	03:00	112.5	2
107	2021	05	14	06:00	90	2
108	2021	05	14	09:00	135	2
109	2021	05	14	12:00	180	3
110	2021	05	14	15:00	225	3
111	2021	05	14	18:00	270	3
112	2021	05	14	21:00	247.5	2
113	2021	05	18	00:00	45	3
114	2021	05	18	03:00	135	3
115	2021	05	18	06:00	225	3
116	2021	05	18	09:00	135	3
117	2021	05	18	12:00	292.5	1
118	2021	05	18	15:00	225	1
119	2021	05	18	18:00	67.5	2
120	2021	05	18	21:00	45	3
121	2021	05	16	00:00	22.5	2
122	2021	05	16	03:00	22.5	3
123	2021	05	16	06:00	45	2
124	2021	05	16	09:00	67.5	1
125	2021	05	16	12:00	135	2
126	2021	05	16	15:00	315	3
127	2021	05	16	18:00	292.5	4
128	2021	05	16	21:00	202.5	3
129	2021	05	17	00:00	22.5	2
130	2021	05	17	03:00	45	2
131	2021	05	17	06:00	45	2
132	2021	05	17	09:00	112.5	2
133	2021	05	17	12:00	270	4
134	2021	05	17	15:00	270	6
135	2021	05	17	18:00	292.5	5
136	2021	05	17	21:00	225	3
137	2021	05	18	00:00	45	2
138	2021	05	18	03:00	45	2
139	2021	05	18	06:00	67.5	2
140	2021	05	18	09:00	112.5	3
141	2021	05	18	12:00	202.5	4
142	2021	05	18	15:00	225	4
143	2021	05	18	18:00	202.5	4
144	2021	05	18	21:00	112.5	3

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
145	2021	05	19	00:00	45	3
146	2021	05	19	03:00	45	2
147	2021	05	19	06:00	135	2
148	2021	05	19	09:00	292.5	2
149	2021	05	19	12:00	247.5	3
150	2021	05	19	15:00	202.5	3
151	2021	05	19	18:00	112.5	4
152	2021	05	19	21:00	22.5	5
153	2021	05	20	00:00	67.5	3
154	2021	05	20	03:00	112.5	2
155	2021	05	20	06:00	112.5	1
156	2021	05	20	09:00	112.5	2
157	2021	05	20	12:00	157.5	3
158	2021	05	20	15:00	157.5	3
159	2021	05	20	18:00	135	3
160	2021	05	20	21:00	112.5	3
161	2021	05	21	00:00	90	2
162	2021	05	21	03:00	67.5	2
163	2021	05	21	06:00	135	3
164	2021	05	21	09:00	202.5	7
165	2021	05	21	12:00	45	5
166	2021	05	21	15:00	135	2
167	2021	05	21	18:00	180	2
168	2021	05	21	21:00	22.5	3
169	2021	05	22	00:00	67.5	7
170	2021	05	22	03:00	157.5	3
171	2021	05	22	06:00	337.5	2
172	2021	05	22	09:00	315	2
173	2021	05	22	12:00	270	3
174	2021	05	22	15:00	247.5	4
175	2021	05	22	18:00	292.5	3
176	2021	05	22	21:00	247.5	2
177	2021	05	23	00:00	135	2
178	2021	05	23	03:00	360	1
179	2021	05	23	06:00	270	2
180	2021	05	23	09:00	157.5	4
181	2021	05	23	12:00	292.5	5
182	2021	05	23	15:00	292.5	5
183	2021	05	23	18:00	292.5	3
184	2021	05	23	21:00	315	2
185	2021	05	24	00:00	225	2
186	2021	05	24	03:00	135	1
187	2021	05	24	06:00	315	1
188	2021	05	24	09:00	270	2
189	2021	05	24	12:00	270	6
190	2021	05	24	15:00	270	6
191	2021	05	24	18:00	292.5	5
192	2021	05	24	21:00	202.5	3
193	2021	05	28	00:00	45	3
194	2021	05	28	03:00	67.5	3
195	2021	05	28	06:00	67.5	2
196	2021	05	28	09:00	135	2
197	2021	05	28	12:00	292.5	3
198	2021	05	28	15:00	270	6
199	2021	05	28	18:00	292.5	5
200	2021	05	28	21:00	202.5	2
201	2021	05	26	00:00	45	2
202	2021	05	26	03:00	67.5	3
203	2021	05	26	06:00	67.5	2
204	2021	05	26	09:00	112.5	3
205	2021	05	26	12:00	247.5	3
206	2021	05	26	15:00	270	3
207	2021	05	26	18:00	292.5	3
208	2021	05	26	21:00	225	2
209	2021	05	27	00:00	67.5	3
210	2021	05	27	03:00	67.5	3
211	2021	05	27	06:00	90	4
212	2021	05	27	09:00	157.5	4
213	2021	05	27	12:00	202.5	3
214	2021	05	27	15:00	270	4
215	2021	05	27	18:00	292.5	3
216	2021	05	27	21:00	225	2
217	2021	05	28	00:00	67.5	3
218	2021	05	28	03:00	90	3
219	2021	05	28	06:00	112.5	4
220	2021	05	28	09:00	157.5	5
221	2021	05	28	12:00	180	4
222	2021	05	28	15:00	247.5	4
223	2021	05	28	18:00	202.5	3
224	2021	05	28	21:00	90	3
225	2021	05	29	00:00	90	4
226	2021	05	29	03:00	135	5
227	2021	05	29	06:00	112.5	4
228	2021	05	29	09:00	157.5	4
229	2021	05	29	12:00	180	4
230	2021	05	29	15:00	225	4

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
231	2021	05	29	18:00	202.5	3
232	2021	05	29	21:00	90	2
233	2021	05	30	00:00	67.5	3
234	2021	05	30	03:00	90	2
235	2021	05	30	06:00	112.5	2
236	2021	05	30	09:00	135	4
237	2021	05	30	12:00	180	3
238	2021	05	30	15:00	270	3
239	2021	05	30	18:00	247.5	6

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
240	2021	05	30	21:00	67.5	7
241	2021	05	31	00:00	67.5	4
242	2021	05	31	03:00	67.5	3
243	2021	05	31	06:00	112.5	2
244	2021	05	31	09:00	157.5	3
245	2021	05	31	12:00	225	3
246	2021	05	31	15:00	225	4
247	2021	05	31	18:00	135	5
248	2021	05	31	21:00	157.5	5

YYYY-Year; MM-Month; DD-Date; HH-Hour; W_dir-Wind Direction (Degree); W_Sp-Wind Speed (m/s).

Table 18: Frequency Distribution (Period 01/05/2021 to 31/05/2021)

S. No.	Directions	0-0.5	0.5-2	2-4	4-6	6-8	8-10	10-25	Total
1	North	0	0.4	0	0	0	0	0	0.4
2	NNE	0	1.21	1.21	0.4	0	0	0	2.82
3	NE	0	4.44	6.85	1.61	0	0.4	0	13.3
4	ENE	0	6.45	8.87	0.4	0.81	0	0	16.53
5	East	0	2.82	4.03	0.4	0	0	0	7.25
6	ESE	0	3.63	4.44	0.4	0	0	0	8.47
7	SE	0	3.63	4.03	0.81	0	0	0	8.47
8	SSE	0	0.4	4.44	1.21	0.4	0	0	6.45
9	South	0	0.81	2.02	0.4	0	0	0	3.23
10	SSW	0	0.4	6.05	0.81	0.4	0	0	7.66
11	SW	0	2.82	3.23	0	0	0	0	6.05
12	WSW	0	0.81	3.23	0.4	0	0	0	4.44
13	West	0	1.61	2.82	1.61	0	0	0	6.04
14	WNW	0	0.81	4.03	2.02	0	0	0	6.86
15	NW	0	1.21	0.4	0	0	0	0	1.61
16	NNW	0	0.4	0	0	0	0	0	0.4
Total		**0**	**31.85**	**55.65**	**10.47**	**1.61**	**0.4**	**0**	**100**

Table 19: Wind Rose data June 2021

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
1	2021	06	1	00:00	292.5	3
2	2021	06	1	03:00	112.5	2
3	2021	06	1	06:00	112.5	2
4	2021	06	1	09:00	157.5	3
5	2021	06	1	12:00	225	4
6	2021	06	1	15:00	180	6
7	2021	06	1	18:00	112.5	8

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
8	2021	06	1	21:00	112.5	4
9	2021	06	2	00:00	135	3
10	2021	06	2	03:00	67.5	3
11	2021	06	2	06:00	67.5	3
12	2021	06	2	09:00	135	5
13	2021	06	2	12:00	135	4
14	2021	06	2	15:00	90	3

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
15	2021	06	2	18:00	90	3
16	2021	06	2	21:00	180	4
17	2021	06	3	00:00	67.5	3
18	2021	06	3	03:00	67.5	3
19	2021	06	3	06:00	90	3
20	2021	06	3	09:00	202.5	2
21	2021	06	3	12:00	247.5	2
22	2021	06	3	15:00	292.5	2
23	2021	06	3	18:00	202.5	2
24	2021	06	3	21:00	22.5	3
25	2021	06	4	00:00	67.5	3
26	2021	06	4	03:00	67.5	3
27	2021	06	4	06:00	67.5	2
28	2021	06	4	09:00	135	2
29	2021	06	4	12:00	225	2
30	2021	06	4	15:00	292.5	3
31	2021	06	4	18:00	337.5	3
32	2021	06	4	21:00	270	3
33	2021	06	8	00:00	67.5	2
34	2021	06	8	03:00	67.5	2
35	2021	06	8	06:00	67.5	2
36	2021	06	8	09:00	112.5	2
37	2021	06	8	12:00	112.5	3
38	2021	06	8	15:00	225	5
39	2021	06	8	18:00	180	7
40	2021	06	8	21:00	45	3
41	2021	06	6	00:00	45	3
42	2021	06	6	03:00	45	2
43	2021	06	6	06:00	90	2
44	2021	06	6	09:00	180	2
45	2021	06	6	12:00	270	3
46	2021	06	6	15:00	292.5	4
47	2021	06	6	18:00	202.5	5
48	2021	06	6	21:00	45	7
49	2021	06	7	00:00	67.5	3
50	2021	06	7	03:00	67.5	2
51	2021	06	7	06:00	90	2
52	2021	06	7	09:00	135	3
53	2021	06	7	12:00	225	3
54	2021	06	7	15:00	292.5	3
55	2021	06	7	18:00	225	3
56	2021	06	7	21:00	135	3

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
57	2021	06	8	00:00	45	3
58	2021	06	8	03:00	67.5	3
59	2021	06	8	06:00	112.5	3
60	2021	06	8	09:00	135	3
61	2021	06	8	12:00	202.5	3
62	2021	06	8	15:00	270	4
63	2021	06	8	18:00	315	3
64	2021	06	8	21:00	247.5	2
65	2021	06	9	00:00	45	3
66	2021	06	9	03:00	90	2
67	2021	06	9	06:00	112.5	3
68	2021	06	9	09:00	180	3
69	2021	06	9	12:00	247.5	3
70	2021	06	9	15:00	292.5	5
71	2021	06	9	18:00	292.5	3
72	2021	06	9	21:00	292.5	2
73	2021	06	10	00:00	22.5	1
74	2021	06	10	03:00	90	2
75	2021	06	10	06:00	112.5	3
76	2021	06	10	09:00	202.5	3
77	2021	06	10	12:00	270	2
78	2021	06	10	15:00	292.5	5
79	2021	06	10	18:00	270	5
80	2021	06	10	21:00	202.5	4
81	2021	06	11	00:00	45	3
82	2021	06	11	03:00	67.5	2
83	2021	06	11	06:00	112.5	3
84	2021	06	11	09:00	202.5	2
85	2021	06	11	12:00	292.5	3
86	2021	06	11	15:00	292.5	5
87	2021	06	11	18:00	202.5	6
88	2021	06	11	21:00	22.5	4
89	2021	06	12	00:00	225	6
90	2021	06	12	03:00	67.5	4
91	2021	06	12	06:00	112.5	4
92	2021	06	12	09:00	135	5
93	2021	06	12	12:00	157.5	4
94	2021	06	12	15:00	202.5	2
95	2021	06	12	18:00	247.5	4
96	2021	06	12	21:00	90	6
97	2021	06	13	00:00	67.5	4
98	2021	06	13	03:00	112.5	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
99	2021	06	13	06:00	112.5	2
100	2021	06	13	09:00	135	3
101	2021	06	13	12:00	180	3
102	2021	06	13	15:00	225	3
103	2021	06	13	18:00	247.5	4
104	2021	06	13	21:00	225	2
105	2021	06	14	00:00	67.5	3
106	2021	06	14	03:00	112.5	1
107	2021	06	14	06:00	157.5	2
108	2021	06	14	09:00	112.5	4
109	2021	06	14	12:00	135	3
110	2021	06	14	15:00	112.5	2
111	2021	06	14	18:00	112.5	2
112	2021	06	14	21:00	112.5	4
113	2021	06	18	00:00	67.5	2
114	2021	06	18	03:00	67.5	3
115	2021	06	18	06:00	112.5	2
116	2021	06	18	09:00	112.5	4
117	2021	06	18	12:00	202.5	6
118	2021	06	18	15:00	315	9
119	2021	06	18	18:00	247.5	7
120	2021	06	18	21:00	67.5	6
121	2021	06	16	00:00	135	3
122	2021	06	16	03:00	247.5	2
123	2021	06	16	06:00	22.5	3
124	2021	06	16	09:00	45	6
125	2021	06	16	12:00	45	8
126	2021	06	16	15:00	45	5
127	2021	06	16	18:00	135	2
128	2021	06	16	21:00	225	2
129	2021	06	17	00:00	45	2
130	2021	06	17	03:00	45	2
131	2021	06	17	06:00	45	2
132	2021	06	17	09:00	112.5	2
133	2021	06	17	12:00	270	2
134	2021	06	17	15:00	247.5	2
135	2021	06	17	18:00	157.5	1
136	2021	06	17	21:00	22.5	1
137	2021	06	18	00:00	45	2
138	2021	06	18	03:00	67.5	2
139	2021	06	18	06:00	90	2
140	2021	06	18	09:00	135	3

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
141	2021	06	18	12:00	225	3
142	2021	06	18	15:00	157.5	3
143	2021	06	18	18:00	22.5	3
144	2021	06	18	21:00	67.5	3
145	2021	06	19	00:00	112.5	4
146	2021	06	19	03:00	112.5	2
147	2021	06	19	06:00	112.5	2
148	2021	06	19	09:00	157.5	3
149	2021	06	19	12:00	180	3
150	2021	06	19	15:00	157.5	5
151	2021	06	19	18:00	45	3
152	2021	06	19	21:00	67.5	3
153	2021	06	20	00:00	90	3
154	2021	06	20	03:00	135	3
155	2021	06	20	06:00	112.5	3
156	2021	06	20	09:00	135	4
157	2021	06	20	12:00	202.5	3
158	2021	06	20	15:00	180	3
159	2021	06	20	18:00	67.5	3
160	2021	06	20	21:00	90	1
161	2021	06	21	00:00	112.5	4
162	2021	06	21	03:00	90	3
163	2021	06	21	06:00	90	2
164	2021	06	21	09:00	135	2
165	2021	06	21	12:00	202.5	3
166	2021	06	21	15:00	292.5	2
167	2021	06	21	18:00	292.5	2
168	2021	06	21	21:00	157.5	1
169	2021	06	22	00:00	67.5	1
170	2021	06	22	03:00	67.5	1
171	2021	06	22	06:00	112.5	2
172	2021	06	22	09:00	180	3
173	2021	06	22	12:00	247.5	3
174	2021	06	22	15:00	270	4
175	2021	06	22	18:00	270	3
176	2021	06	22	21:00	225	2
177	2021	06	23	00:00	67.5	2
178	2021	06	23	03:00	90	2
179	2021	06	23	06:00	112.5	3
180	2021	06	23	09:00	247.5	2
181	2021	06	23	12:00	225	3
182	2021	06	23	15:00	202.5	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
183	2021	06	23	18:00	157.5	2
184	2021	06	23	21:00	157.5	2
185	2021	06	24	00:00	157.5	2
186	2021	06	24	03:00	67.5	2
187	2021	06	24	06:00	90	2
188	2021	06	24	09:00	157.5	2
189	2021	06	24	12:00	247.5	3
190	2021	06	24	15:00	270	5
191	2021	06	24	18:00	292.5	5
192	2021	06	24	21:00	270	3
193	2021	06	28	00:00	45	2
194	2021	06	28	03:00	45	1
195	2021	06	28	06:00	90	2
196	2021	06	28	09:00	180	2
197	2021	06	28	12:00	270	2
198	2021	06	28	15:00	202.5	6
199	2021	06	28	18:00	135	10
200	2021	06	28	21:00	247.5	10
201	2021	06	26	00:00	112.5	5
202	2021	06	26	03:00	202.5	1
203	2021	06	26	06:00	90	2
204	2021	06	26	09:00	270	3
205	2021	06	26	12:00	292.5	4
206	2021	06	26	15:00	292.5	6
207	2021	06	26	18:00	292.5	5
208	2021	06	26	21:00	202.5	1
209	2021	06	27	00:00	292.5	1
210	2021	06	27	03:00	225	2
211	2021	06	27	06:00	112.5	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
212	2021	06	27	09:00	202.5	3
213	2021	06	27	12:00	247.5	4
214	2021	06	27	15:00	270	4
215	2021	06	27	18:00	225	3
216	2021	06	27	21:00	45	2
217	2021	06	28	00:00	45	1
218	2021	06	28	03:00	45	2
219	2021	06	28	06:00	90	2
220	2021	06	28	09:00	157.5	3
221	2021	06	28	12:00	247.5	4
222	2021	06	28	15:00	270	5
223	2021	06	28	18:00	270	5
224	2021	06	28	21:00	225	2
225	2021	06	29	00:00	45	2
226	2021	06	29	03:00	67.5	2
227	2021	06	29	06:00	90	2
228	2021	06	29	09:00	180	3
229	2021	06	29	12:00	247.5	4
230	2021	06	29	15:00	270	5
231	2021	06	29	18:00	270	4
232	2021	06	29	21:00	225	2
233	2021	06	30	00:00	45	2
234	2021	06	30	03:00	90	3
235	2021	06	30	06:00	112.5	3
236	2021	06	30	09:00	180	3
237	2021	06	30	12:00	270	4
238	2021	06	30	15:00	270	5
239	2021	06	30	18:00	292.5	3
240	2021	06	30	21:00	247.5	1

YYYY-Year; MM-Month; DD-Date; HH-Hour; W_dir-Wind Direction (Degree); W_Sp-Wind Speed (m/s).

Table 20: Frequency Distribution (Period 01/06/2021 to 30/06/2021)

S. No.	Directions	0-0.5	0.5-2	2-4	4-6	6-8	8-10	10-25	Total
1	North	0	0	0	0	0	0	0	0
2	NNE	0	0.83	1.67	0	0	0	0	2.5
3	NE	0	5	2.5	0.83	0.83	0	0	9.16
4	ENE	0	5.42	6.25	0.42	0	0	0	12.09
5	East	0	5.42	2.5	0.42	0	0	0	8.34
6	ESE	0	5.83	6.25	0.42	0.42	0	0	12.92
7	SE	0	1.25	4.58	0.83	0	0.42	0	7.08
8	SSE	0	2.92	2.08	0.42	0	0	0	5.42

S. No.	Directions	0-0.5	0.5-2	2-4	4-6	6-8	8-10	10-25	Total
9	South	0	0.83	3.33	0.42	0.42	0	0	5
10	SSW	0	2.92	2.5	1.67	0	0	0	7.09
11	SW	0	2.92	2.92	0.83	0	0	0	6.67
12	WSW	0	2.5	3.33	0	0.42	0.42	0	6.67
13	West	0	1.25	4.17	2.5	0	0	0	7.92
14	WNW	0	2.08	3.33	2.5	0	0	0	7.91
15	NW	0	0	0.42	0	0	0.42	0	0.84
16	NNW	0	0	0.42	0	0	0	0	0.42
Total		**0**	**39.17**	**46.25**	**11.26**	**2.09**	**1.26**	**0**	**100**

Table 21: Wind Rose data July 2021

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
1	2021	07	1	00:00	67.5	3
2	2021	07	1	03:00	67.5	3
3	2021	07	1	06:00	112.5	3
4	2021	07	1	09:00	135	4
5	2021	07	1	12:00	135	3
6	2021	07	1	15:00	225	3
7	2021	07	1	18:00	225	3
8	2021	07	1	21:00	112.5	2
9	2021	07	2	00:00	247.5	2
10	2021	07	2	03:00	90	3
11	2021	07	2	06:00	112.5	3
12	2021	07	2	09:00	157.5	3
13	2021	07	2	12:00	202.5	2
14	2021	07	2	15:00	247.5	3
15	2021	07	2	18:00	202.5	2
16	2021	07	2	21:00	112.5	2
17	2021	07	3	00:00	67.5	4
18	2021	07	3	03:00	45	3
19	2021	07	3	06:00	45	1
20	2021	07	3	09:00	90	2
21	2021	07	3	12:00	247.5	4
22	2021	07	3	15:00	247.5	4
23	2021	07	3	18:00	225	3
24	2021	07	3	21:00	67.5	4
25	2021	07	4	00:00	112.5	2
26	2021	07	4	03:00	90	3
27	2021	07	4	06:00	90	3
28	2021	07	4	09:00	157.5	3
29	2021	07	4	12:00	247.5	4
30	2021	07	4	15:00	270	4

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
31	2021	07	4	18:00	202.5	5
32	2021	07	4	21:00	45	4
33	2021	07	8	00:00	90	2
34	2021	07	8	03:00	112.5	2
35	2021	07	8	06:00	112.5	2
36	2021	07	8	09:00	157.5	2
37	2021	07	8	12:00	270	4
38	2021	07	8	15:00	292.5	4
39	2021	07	8	18:00	225	2
40	2021	07	8	21:00	90	1
41	2021	07	6	00:00	67.5	2
42	2021	07	6	03:00	67.5	2
43	2021	07	6	06:00	90	2
44	2021	07	6	09:00	180	2
45	2021	07	6	12:00	270	3
46	2021	07	6	15:00	270	5
47	2021	07	6	18:00	292.5	4
48	2021	07	6	21:00	247.5	2
49	2021	07	7	00:00	45	3
50	2021	07	7	03:00	67.5	2
51	2021	07	7	06:00	90	2
52	2021	07	7	09:00	202.5	2
53	2021	07	7	12:00	270	5
54	2021	07	7	15:00	292.5	6
55	2021	07	7	18:00	202.5	4
56	2021	07	7	21:00	22.5	2
57	2021	07	8	00:00	247.5	2
58	2021	07	8	03:00	90	2
59	2021	07	8	06:00	180	3
60	2021	07	8	09:00	270	3

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
61	2021	07	8	12:00	270	4
62	2021	07	8	15:00	270	5
63	2021	07	8	18:00	270	4
64	2021	07	8	21:00	157.5	3
65	2021	07	9	00:00	90	1
66	2021	07	9	03:00	90	2
67	2021	07	9	06:00	135	3
68	2021	07	9	09:00	157.5	4
69	2021	07	9	12:00	202.5	3
70	2021	07	9	15:00	292.5	3
71	2021	07	9	18:00	225	3
72	2021	07	9	21:00	90	3
73	2021	07	10	00:00	90	3
74	2021	07	10	03:00	112.5	3
75	2021	07	10	06:00	112.5	4
76	2021	07	10	09:00	157.5	5
77	2021	07	10	12:00	157.5	3
78	2021	07	10	15:00	135	2
79	2021	07	10	18:00	157.5	4
80	2021	07	10	21:00	112.5	3
81	2021	07	11	00:00	90	3
82	2021	07	11	03:00	90	3
83	2021	07	11	06:00	112.5	3
84	2021	07	11	09:00	157.5	5
85	2021	07	11	12:00	157.5	5
86	2021	07	11	15:00	135	4
87	2021	07	11	18:00	90	4
88	2021	07	11	21:00	112.5	3
89	2021	07	12	00:00	112.5	4
90	2021	07	12	03:00	135	3
91	2021	07	12	06:00	112.5	3
92	2021	07	12	09:00	157.5	5
93	2021	07	12	12:00	157.5	6
94	2021	07	12	15:00	112.5	4
95	2021	07	12	18:00	67.5	4
96	2021	07	12	21:00	90	3
97	2021	07	13	00:00	22.5	2
98	2021	07	13	03:00	45	2
99	2021	07	13	06:00	67.5	2
100	2021	07	13	09:00	112.5	3
101	2021	07	13	12:00	157.5	3
102	2021	07	13	15:00	157.5	2
103	2021	07	13	18:00	112.5	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
104	2021	07	13	21:00	67.5	2
105	2021	07	14	00:00	67.5	2
106	2021	07	14	03:00	67.5	3
107	2021	07	14	06:00	90	2
108	2021	07	14	09:00	180	1
109	2021	07	14	12:00	337.5	1
110	2021	07	14	15:00	337.5	2
111	2021	07	14	18:00	315	1
112	2021	07	14	21:00	247.5	1
113	2021	07	18	00:00	67.5	2
114	2021	07	18	03:00	67.5	2
115	2021	07	18	06:00	90	2
116	2021	07	18	09:00	157.5	2
117	2021	07	18	12:00	270	1
118	2021	07	18	15:00	315	3
119	2021	07	18	18:00	315	2
120	2021	07	18	21:00	225	2
121	2021	07	16	00:00	67.5	2
122	2021	07	16	03:00	90	2
123	2021	07	16	06:00	112.5	3
124	2021	07	16	09:00	135	4
125	2021	07	16	12:00	180	2
126	2021	07	16	15:00	292.5	1
127	2021	07	16	18:00	225	2
128	2021	07	16	21:00	67.5	2
129	2021	07	17	00:00	90	2
130	2021	07	17	03:00	67.5	2
131	2021	07	17	06:00	67.5	2
132	2021	07	17	09:00	135	1
133	2021	07	17	12:00	225	1
134	2021	07	17	15:00	202.5	2
135	2021	07	17	18:00	45	2
136	2021	07	17	21:00	67.5	2
137	2021	07	18	00:00	90	2
138	2021	07	18	03:00	67.5	2
139	2021	07	18	06:00	90	2
140	2021	07	18	09:00	157.5	3
141	2021	07	18	12:00	157.5	3
142	2021	07	18	15:00	112.5	2
143	2021	07	18	18:00	90	3
144	2021	07	18	21:00	112.5	4
145	2021	07	19	00:00	135	5
146	2021	07	19	03:00	112.5	4

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
147	2021	07	19	06:00	112.5	4
148	2021	07	19	09:00	135	4
149	2021	07	19	12:00	112.5	3
150	2021	07	19	15:00	112.5	3
151	2021	07	19	18:00	90	2
152	2021	07	19	21:00	67.5	2
153	2021	07	20	00:00	90	1
154	2021	07	20	03:00	112.5	2
155	2021	07	20	06:00	135	1
156	2021	07	20	09:00	67.5	2
157	2021	07	20	12:00	22.5	3
158	2021	07	20	15:00	90	2
159	2021	07	20	18:00	90	1
160	2021	07	20	21:00	67.5	1
161	2021	07	21	00:00	67.5	2
162	2021	07	21	03:00	45	1
163	2021	07	21	06:00	112.5	1
164	2021	07	21	09:00	270	1
165	2021	07	21	12:00	225	2
166	2021	07	21	15:00	292.5	2
167	2021	07	21	18:00	225	1
168	2021	07	21	21:00	67.5	1
169	2021	07	22	00:00	67.5	2
170	2021	07	22	03:00	45	2
171	2021	07	22	06:00	67.5	2
172	2021	07	22	09:00	135	2
173	2021	07	22	12:00	225	1
174	2021	07	22	15:00	270	1
175	2021	07	22	18:00	157.5	1
176	2021	07	22	21:00	90	2
177	2021	07	23	00:00	67.5	2
178	2021	07	23	03:00	90	2
179	2021	07	23	06:00	90	2
180	2021	07	23	09:00	45	1
181	2021	07	23	12:00	135	0
182	2021	07	23	15:00	225	1
183	2021	07	23	18:00	157.5	1
184	2021	07	23	21:00	90	1
185	2021	07	24	00:00	90	2
186	2021	07	24	03:00	90	2
187	2021	07	24	06:00	90	2
188	2021	07	24	09:00	135	2
189	2021	07	24	12:00	202.5	2
190	2021	07	24	15:00	225	1
191	2021	07	24	18:00	202.5	1
192	2021	07	24	21:00	45	1
193	2021	07	28	00:00	67.5	2
194	2021	07	28	03:00	67.5	2
195	2021	07	28	06:00	90	2
196	2021	07	28	09:00	112.5	2
197	2021	07	28	12:00	180	2
198	2021	07	28	15:00	225	2
199	2021	07	28	18:00	202.5	1
200	2021	07	28	21:00	112.5	2
201	2021	07	26	00:00	90	2
202	2021	07	26	03:00	67.5	2
203	2021	07	26	06:00	90	3
204	2021	07	26	09:00	112.5	3
205	2021	07	26	12:00	157.5	4
206	2021	07	26	15:00	135	4
207	2021	07	26	18:00	112.5	3
208	2021	07	26	21:00	90	2
209	2021	07	27	00:00	112.5	2
210	2021	07	27	03:00	135	2
211	2021	07	27	06:00	90	3
212	2021	07	27	09:00	90	2
213	2021	07	27	12:00	112.5	2
214	2021	07	27	15:00	112.5	1
215	2021	07	27	18:00	112.5	2
216	2021	07	27	21:00	135	2
217	2021	07	28	00:00	112.5	2
218	2021	07	28	03:00	90	1
219	2021	07	28	06:00	135	1
220	2021	07	28	09:00	112.5	2
221	2021	07	28	12:00	112.5	2
222	2021	07	28	15:00	135	3
223	2021	07	28	18:00	112.5	2
224	2021	07	28	21:00	90	1
225	2021	07	29	00:00	90	3
226	2021	07	29	03:00	90	3
227	2021	07	29	06:00	90	3
228	2021	07	29	09:00	90	3
229	2021	07	29	12:00	67.5	2
230	2021	07	29	15:00	22.5	1
231	2021	07	29	18:00	112.5	1
232	2021	07	29	21:00	225	1

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
233	2021	07	30	00:00	157.5	1
234	2021	07	30	03:00	90	1
235	2021	07	30	06:00	90	1
236	2021	07	30	09:00	135	1
237	2021	07	30	12:00	202.5	2
238	2021	07	30	15:00	202.5	2
239	2021	07	30	18:00	225	1
240	2021	07	30	21:00	157.5	0

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
241	2021	07	31	00:00	90	2
242	2021	07	31	03:00	67.5	2
243	2021	07	31	06:00	45	2
244	2021	07	31	09:00	135	1
245	2021	07	31	12:00	202.5	1
246	2021	07	31	15:00	45	2
247	2021	07	31	18:00	90	2
248	2021	07	31	21:00	45	1

YYYY-Year; MM-Month; DD-Date; HH-Hour; W_dir-Wind Direction (Degree); W_Sp-Wind Speed (m/s).

Table 22: Frequency Distribution (Period 01/07/2021 to 31/07/2021)

S. No.	Directions	0-0.5	0.5-2	2-4	4-6	6-8	8-10	10-25	Total
1	North	0	0	0	0	0	0	0	0
2	NNE	0	1.21	0.4	0	0	0	0	1.61
3	NE	0	4.03	1.21	0	0	0	0	5.24
4	ENE	0	10.89	2.42	0	0	0	0	13.31
5	East	0	14.11	6.45	0	0	0	0	20.56
6	ESE	0	8.06	7.66	0	0	0	0	15.72
7	SE	0.4	4.03	3.63	0.4	0	0	0	8.46
8	SSE	0.4	2.42	4.03	2.02	0	0	0	8.87
9	South	0	1.61	0.4	0	0	0	0	2.01
10	SSW	0	4.03	0.81	0.4	0	0	0	5.24
11	SW	0	4.84	1.61	0	0	0	0	6.45
12	WSW	0	1.61	1.61	0	0	0	0	3.22
13	West	0	1.21	2.42	1.21	0	0	0	4.84
14	WNW	0	0.81	1.21	0.4	0	0	0	2.42
15	NW	0	0.81	0.4	0	0	0	0	1.21
16	NNW	0	0.81	0	0	0	0	0	0.81
Total		**0.8**	**60.48**	**34.26**	**4.43**	**0**	**0**	**0**	**100**

Table 23: Wind Rose data August 2021

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
1	2021	08	1	00:00	90	2
2	2021	08	1	03:00	67.5	2
3	2021	08	1	06:00	67.5	1
4	2021	08	1	09:00	157.5	2
5	2021	08	1	12:00	180	3
6	2021	08	1	15:00	180	2
7	2021	08	1	18:00	135	2
8	2021	08	1	21:00	112.5	3

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
9	2021	08	2	00:00	90	2
10	2021	08	2	03:00	67.5	1
11	2021	08	2	06:00	90	1
12	2021	08	2	09:00	135	2
13	2021	08	2	12:00	157.5	2
14	2021	08	2	15:00	135	1
15	2021	08	2	18:00	45	2
16	2021	08	2	21:00	45	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
17	2021	08	3	00:00	67.5	2
18	2021	08	3	03:00	112.5	1
19	2021	08	3	06:00	135	1
20	2021	08	3	09:00	157.5	2
21	2021	08	3	12:00	180	2
22	2021	08	3	15:00	202.5	1
23	2021	08	3	18:00	180	1
24	2021	08	3	21:00	67.5	2
25	2021	08	4	00:00	90	2
26	2021	08	4	03:00	67.5	2
27	2021	08	4	06:00	45	2
28	2021	08	4	09:00	67.5	1
29	2021	08	4	12:00	202.5	2
30	2021	08	4	15:00	270	2
31	2021	08	4	18:00	202.5	2
32	2021	08	4	21:00	67.5	2
33	2021	08	8	00:00	90	2
34	2021	08	8	03:00	90	2
35	2021	08	8	06:00	157.5	3
36	2021	08	8	09:00	225	3
37	2021	08	8	12:00	157.5	3
38	2021	08	8	15:00	202.5	2
39	2021	08	8	18:00	180	1
40	2021	08	8	21:00	90	2
41	2021	08	6	00:00	67.5	2
42	2021	08	6	03:00	67.5	2
43	2021	08	6	06:00	112.5	2
44	2021	08	6	09:00	157.5	2
45	2021	08	6	12:00	180	2
46	2021	08	6	15:00	247.5	2
47	2021	08	6	18:00	225	2
48	2021	08	6	21:00	90	2
49	2021	08	7	00:00	67.5	2
50	2021	08	7	03:00	67.5	2
51	2021	08	7	06:00	67.5	2
52	2021	08	7	09:00	135	2
53	2021	08	7	12:00	180	2
54	2021	08	7	15:00	202.5	2
55	2021	08	7	18:00	180	1
56	2021	08	7	21:00	90	2
57	2021	08	8	00:00	90	2
58	2021	08	8	03:00	112.5	2
59	2021	08	8	06:00	90	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
60	2021	08	8	09:00	135	3
61	2021	08	8	12:00	180	2
62	2021	08	8	15:00	157.5	2
63	2021	08	8	18:00	67.5	3
64	2021	08	8	21:00	67.5	2
65	2021	08	9	00:00	135	1
66	2021	08	9	03:00	67.5	2
67	2021	08	9	06:00	90	2
68	2021	08	9	09:00	157.5	2
69	2021	08	9	12:00	202.5	2
70	2021	08	9	15:00	247.5	1
71	2021	08	9	18:00	180	1
72	2021	08	9	21:00	67.5	2
73	2021	08	10	00:00	67.5	2
74	2021	08	10	03:00	67.5	2
75	2021	08	10	06:00	67.5	2
76	2021	08	10	09:00	135	2
77	2021	08	10	12:00	202.5	2
78	2021	08	10	15:00	270	1
79	2021	08	10	18:00	202.5	1
80	2021	08	10	21:00	67.5	2
81	2021	08	11	00:00	67.5	2
82	2021	08	11	03:00	45	3
83	2021	08	11	06:00	67.5	2
84	2021	08	11	09:00	112.5	1
85	2021	08	11	12:00	225	1
86	2021	08	11	15:00	247.5	1
87	2021	08	11	18:00	180	2
88	2021	08	11	21:00	67.5	3
89	2021	08	12	00:00	67.5	3
90	2021	08	12	03:00	67.5	3
91	2021	08	12	06:00	67.5	3
92	2021	08	12	09:00	112.5	3
93	2021	08	12	12:00	157.5	4
94	2021	08	12	15:00	135	2
95	2021	08	12	18:00	112.5	2
96	2021	08	12	21:00	67.5	3
97	2021	08	13	00:00	67.5	3
98	2021	08	13	03:00	45	3
99	2021	08	13	06:00	45	2
100	2021	08	13	09:00	112.5	2
101	2021	08	13	12:00	180	2
102	2021	08	13	15:00	225	2

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
103	2021	08	13	18:00	180	2
104	2021	08	13	21:00	67.5	3
105	2021	08	14	00:00	67.5	3
106	2021	08	14	03:00	67.5	3
107	2021	08	14	06:00	67.5	2
108	2021	08	14	09:00	112.5	2
109	2021	08	14	12:00	180	2
110	2021	08	14	15:00	225	1
111	2021	08	14	18:00	180	1
112	2021	08	14	21:00	67.5	2
113	2021	08	18	00:00	45	6
114	2021	08	18	03:00	45	4
115	2021	08	18	06:00	157.5	4
116	2021	08	18	09:00	315	4
117	2021	08	18	12:00	247.5	5
118	2021	08	18	15:00	112.5	4
119	2021	08	18	18:00	292.5	2
120	2021	08	18	21:00	247.5	2
121	2021	08	16	00:00	45	2
122	2021	08	16	03:00	45	2
123	2021	08	16	06:00	67.5	2
124	2021	08	16	09:00	157.5	1
125	2021	08	16	12:00	337.5	1
126	2021	08	16	15:00	315	2
127	2021	08	16	18:00	225	1
128	2021	08	16	21:00	67.5	3
129	2021	08	17	00:00	67.5	2
130	2021	08	17	03:00	45	2
131	2021	08	17	06:00	45	2
132	2021	08	17	09:00	112.5	1
133	2021	08	17	12:00	225	1
134	2021	08	17	15:00	202.5	1
135	2021	08	17	18:00	360	1
136	2021	08	17	21:00	67.5	2
137	2021	08	18	00:00	67.5	2
138	2021	08	18	03:00	67.5	2
139	2021	08	18	06:00	67.5	2
140	2021	08	18	09:00	112.5	2
141	2021	08	18	12:00	180	2
142	2021	08	18	15:00	247.5	1
143	2021	08	18	18:00	247.5	1
144	2021	08	18	21:00	67.5	2
145	2021	08	19	00:00	67.5	3
146	2021	08	19	03:00	90	2
147	2021	08	19	06:00	90	2
148	2021	08	19	09:00	112.5	3
149	2021	08	19	12:00	157.5	2
150	2021	08	19	15:00	112.5	2
151	2021	08	19	18:00	67.5	3
152	2021	08	19	21:00	90	3
153	2021	08	20	00:00	90	3
154	2021	08	20	03:00	90	3
155	2021	08	20	06:00	90	3
156	2021	08	20	09:00	135	3
157	2021	08	20	12:00	135	4
158	2021	08	20	15:00	135	4
159	2021	08	20	18:00	112.5	3
160	2021	08	20	21:00	67.5	1
161	2021	08	21	00:00	90	1
162	2021	08	21	03:00	135	1
163	2021	08	21	06:00	292.5	2
164	2021	08	21	09:00	247.5	2
165	2021	08	21	12:00	135	3
166	2021	08	21	15:00	45	2
167	2021	08	21	18:00	112.5	2
168	2021	08	21	21:00	247.5	2
169	2021	08	22	00:00	112.5	0
170	2021	08	22	03:00	292.5	1
171	2021	08	22	06:00	292.5	1
172	2021	08	22	09:00	315	2
173	2021	08	22	12:00	270	3
174	2021	08	22	15:00	292.5	2
175	2021	08	22	18:00	292.5	1
176	2021	08	22	21:00	180	1
177	2021	08	23	00:00	112.5	0
178	2021	08	23	03:00	292.5	1
179	2021	08	23	06:00	292.5	1
180	2021	08	23	09:00	315	2
181	2021	08	23	12:00	270	3
182	2021	08	23	15:00	292.5	2
183	2021	08	23	18:00	292.5	1
184	2021	08	23	21:00	180	1
185	2021	08	24	00:00	90	1
186	2021	08	24	03:00	90	1
187	2021	08	24	06:00	112.5	1
188	2021	08	24	09:00	157.5	1

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
189	2021	08	24	12:00	225	1
190	2021	08	24	15:00	180	1
191	2021	08	24	18:00	112.5	2
192	2021	08	24	21:00	90	3
193	2021	08	28	00:00	112.5	2
194	2021	08	28	03:00	67.5	2
195	2021	08	28	06:00	67.5	2
196	2021	08	28	09:00	112.5	2
197	2021	08	28	12:00	157.5	2
198	2021	08	28	15:00	202.5	1
199	2021	08	28	18:00	180	1
200	2021	08	28	21:00	67.5	2
201	2021	08	26	00:00	135	1
202	2021	08	26	03:00	67.5	3
203	2021	08	26	06:00	90	1
204	2021	08	26	09:00	135	2
205	2021	08	26	12:00	180	2
206	2021	08	26	15:00	225	2
207	2021	08	26	18:00	90	1
208	2021	08	26	21:00	67.5	3
209	2021	08	27	00:00	67.5	3
210	2021	08	27	03:00	90	3
211	2021	08	27	06:00	90	2
212	2021	08	27	09:00	157.5	3
213	2021	08	27	12:00	135	4
214	2021	08	27	15:00	112.5	3
215	2021	08	27	18:00	67.5	3
216	2021	08	27	21:00	90	3
217	2021	08	28	00:00	67.5	3
218	2021	08	28	03:00	67.5	3

S. No.	YYYY	MM	DD	HH	W_dir	W_Sp
219	2021	08	28	06:00	90	3
220	2021	08	28	09:00	135	3
221	2021	08	28	12:00	157.5	3
222	2021	08	28	15:00	135	2
223	2021	08	28	18:00	67.5	3
224	2021	08	28	21:00	67.5	3
225	2021	08	29	00:00	67.5	3
226	2021	08	29	03:00	135	1
227	2021	08	29	06:00	90	2
228	2021	08	29	09:00	112.5	2
229	2021	08	29	12:00	157.5	2
230	2021	08	29	15:00	315	1
231	2021	08	29	18:00	45	2
232	2021	08	29	21:00	45	3
233	2021	08	30	00:00	67.5	3
234	2021	08	30	03:00	45	3
235	2021	08	30	06:00	67.5	2
236	2021	08	30	09:00	157.5	3
237	2021	08	30	12:00	180	1
238	2021	08	30	15:00	225	1
239	2021	08	30	18:00	90	1
240	2021	08	30	21:00	90	3
241	2021	08	31	00:00	67.5	2
242	2021	08	31	03:00	225	1
243	2021	08	31	06:00	67.5	2
244	2021	08	31	09:00	112.5	2
245	2021	08	31	12:00	180	3
246	2021	08	31	15:00	157.5	1
247	2021	08	31	18:00	112.5	2
248	2021	08	31	21:00	112.5	2

YYYY-Year; MM-Month; DD-Date; HH-Hour; W_dir-Wind Direction (Degree); W_Sp-Wind Speed (m/s).

Table 24: Frequency Distribution (Period 01/07/2021 to 31/07/2021)

S. No.	Directions	0-0.5	0.5-2	2-4	4-6	6-8	8-10	10-25	Total
1	North	0	0.4	0	0	0	0	0.4	0
2	NNE	0	0	0	0	0	0	0	0
3	NE	0	4.03	2.02	0.4	0	0	6.45	0
4	ENE	0	15.32	9.27	0	0	0	24.59	0
5	East	0	8.87	3.63	0	0	0	12.5	0
6	ESE	0.81	7.66	2.42	0	0	0	10.89	0.81
7	SE	0	5.24	2.82	0	0	0	8.06	0
8	SSE	0	4.84	2.82	0	0	0	7.66	0

S. No.	Directions	0-0.5	0.5-2	2-4	4-6	6-8	8-10	10-25	Total
9	South	0	8.47	0.81	0	0	0	9.28	0
10	SSW	0	4.03	0	0	0	0	4.03	0
11	SW	0	4.03	0.4	0	0	0	4.43	0
12	WSW	0	3.23	0	0.4	0	0	3.63	0
13	West	0	0.81	0.81	0	0	0	1.62	0
14	WNW	0	4.03	0	0	0	0	4.03	0
15	NW	0	1.61	0.4	0	0	0	2.01	0
16	NNW	0	0.4	0	0	0	0	0.4	0
Total		**0.81**	**72.97**	**25.4**	**0.8**	**0**	**0**	**100**	**0.81**

Annexure IV

List of Angiosperms

S. No.	Family	Name of Species
1	Aceraceae	*Acer caesium*
2	Amaranthaceae	*Chenopodium album*
3	Apiaceae	*Angelica glauca*
4	Apiaceae	*Bunium persicum*
5	Apiaceae	*Carum carvi*
6	Apiaceae	*Chaerophyllum reflexum*
7	Apiaceae	*Chaerophyllum villosum*
8	Apiaceae	*Heracleum lanatum*
9	Asteraceae	*Ainsliaea aptera*
10	Asteraceae	*Anaphalis busua*
11	Asteraceae	*Anaphalis royleana*
12	Asteraceae	*Anthemis cotula*
13	Asteraceae	*Artemisia maritima*
14	Asteraceae	*Artemisia nilagirica*
15	Asteraceae	*Artemisia scoparia*
16	Asteraceae	*Aster thomsonii*
17	Asteraceae	*Carduus edelbergii*
18	Asteraceae	*Cichorium intybus*
19	Asteraceae	*Cirsium wallichii*
20	Asteraceae	*Conyza canadensis*
21	Asteraceae	*Conyza stricta*
22	Asteraceae	*Cousinia thomsonii*
23	Asteraceae	*Crepis multicaulis*
24	Asteraceae	*Dichrocephala integrifolia*
25	Asteraceae	*Erigeron multiradiatus*
26	Asteraceae	*Galinsoga parviflora*
27	Asteraceae	*Inula racemosa*
28	Asteraceae	*Lactuca disecta*
29	Asteraceae	*Onopordon acanthium*
30	Asteraceae	*Saussurea costus*
31	Asteraceae	*Senecio laetus*
32	Asteraceae	*Tanacetum longifolium*
33	Asteraceae	*Taraxacum officinale*
34	Asteraceae	*Youngia japonica*
35	Balsaminaceae	*Impatiens glandulifera*
36	Berberidaceae	*Berberis aristata*
37	Berberidaceae	*Berberis lycium*
38	Betulaceae	*Alnus nitida*
39	Betulaceae	*Betula utilis*
40	Betulaceae	*Carpinus viminea*
41	Betulaceae	*Corylus jacquemontii*
42	Boraginaceae	*Arnebia benthami*
43	Boraginaceae	*Cynoglossum lanceolatum*
44	Boraginaceae	*Cynoglossum zeylanicum*
45	Brassicaceae	*Arabidopsis thaliana*
46	Brassicaceae	*Capsella bursa-pastoris*
47	Brassicaceae	*Roripa apetala*
48	Brassicaceae	*Thlaspi arvense*
49	Cannabaceae	*Cannabis sativa*
50	Caprifoliaceae	*Lonicera angustifolia*
51	Caprifoliaceae	*Sambucus wightiana*

S. No.	Family	Name of Species
52	Caprifoliaceae	*Viburnum cotinifolium*
53	Caprifoliaceae	*Abelia triflora*
54	Caryophyllaceae	*Arenaria sepyllifolia*
55	Caryophyllaceae	*Silene vulgaris*
56	Caryophyllaceae	*Stellaria monosperma*
57	Cuscutaceae	*Cuscuta reflexa*
58	Cyperaceae	*Carex inanis*
59	Cyperaceae	*Carex nubigena*
60	Cyperaceae	*Kyllinga squamulata*
61	Datiscaceae	*Datisca cannabina*
62	Dioscoreaceae	*Dioscorea deltoidea*
63	Euphorbiaceae	*Euphorbia pilosa*
64	Fabaceae	*Astragalus candolleanus*
65	Fabaceae	*Indigofera heterantha*
66	Fabaceae	*Lespedeza juncea*
67	Fabaceae	*Medicago polymorpha*
68	Fabaceae	*Oxytropis humifusa*
69	Fabaceae	*Robinia pseudo-acacia*
70	Fabaceae	*Trifolium pratense*
71	Fabaceae	*Trifolium repens*
72	Fabaceae	*Trigonella emodi*
73	Geraniaceae	*Geranium nepalense*
74	Geraniaceae	*Geranium wallichianum*
75	Geraniaceae	*Swertia cordata*
76	Grossulariaceae	*Ribes glaciale*
77	Hamamelidaceae	*Parrotiopsis jacquemontiana*
78	Hippocastanaceae	*Aesculus indica*
79	Hydrangeaceae	*Deutzia staminea*
80	Hypericaceae	*Hypreicum oblongifolium*
81	Juglandaceae	*Juglans regia*
82	Lamiaceae	*Ajuga bracteosa*
83	Lamiaceae	*Clinopodium umbrosum*
84	Lamiaceae	*Elsholtzia ciliata*
85	Lamiaceae	*Isodon rugosus*
86	Lamiaceae	*Lamium album*
87	Lamiaceae	*Mentha longifolia*
88	Lamiaceae	*Nepeta laevigata*
89	Lamiaceae	*Origanum vulgare*
90	Lamiaceae	*Phlomoides bracteosa*
91	Lamiaceae	*Prunella vulgaris*
92	Lamiaceae	*Thymus linearis*
93	Malvaceae	*Malva verticillata*
94	Oleaceae	*Fraxinus xanthoxyloides*
95	Oleaceae	*Jasminum humile*
96	Oleaceae	*Olea ferruginea*
97	Orchidaceae	*Dactylorhiza hatagirea*
98	Orchidaceae	*Eulophia dabia*
99	Oxalidaceae	*Oxalis corniculata*
100	Plantaginaceae	*Plantago depressa*
101	Plantaginaceae	*Plantago major*
102	Poaceae	*Agrostis pilosula*
103	Poaceae	*Alopecurus arundinaceus*
104	Poaceae	*Andropogon munroi*

S. No.	Family	Name of Species
105	Poaceae	*Arthraxon lancifolius*
106	Poaceae	*Arundo donax*
107	Poaceae	*Bromus japonicus*
108	Poaceae	*Dactylis glomerata*
109	Poaceae	*Dianthus angulatus*
110	Poaceae	*Eragrostis pilosa*
111	Poaceae	*Festuca rubra*
112	Poaceae	*Phleum alpinum*
113	Poaceae	*Poa annua*
114	Poaceae	*Stipa roylei*
115	Polygonaceae	*Fagopyrum dibotrys*
116	Polygonaceae	*Oxyria digyna*
117	Polygonaceae	*Persicaria polystachya*
118	Polygonaceae	*Polygonum molle*
119	Polygonaceae	*Rumex nepalensis*
120	Primulaceae	*Primula denticulata*
121	Ranunculaceae	*Caltha palustris*
122	Ranunculaceae	*Clematis montana*
123	Ranunculaceae	*Delphinium denudatum*
124	Ranunculaceae	*Ranunculus sceleratus*
125	Ranunculaceae	*Thalictrum foliolosum*
126	Rhamnaceae	*Rhamnus virgatus*
127	Rosaceae	*Cotoneaster bacillaris*
128	Rosaceae	*Cotoneaster ellipticus*
129	Rosaceae	*Cotoneaster microphyllus*
130	Rosaceae	*Crataegus oxyacantha*
131	Rosaceae	*Duchesnea indica*
132	Rosaceae	*Fragaria vesca*
133	Rosaceae	*Malus domestica*
134	Rosaceae	*Prunus armeniaca*
135	Rosaceae	*Prunus cornuta*
136	Rosaceae	*Pyracantha crenulata*
137	Rosaceae	*Rosa brunonii*
138	Rosaceae	*Rosa macrophylla*
139	Rosaceae	*Rosa moschata*
140	Rosaceae	*Rosa webbiana*
141	Rosaceae	*Rubus foliolosus*
142	Rosaceae	*Rubus macilentus*
143	Rosaceae	*Rubus niveus*
144	Rosaceae	*Sorbaria tomentosa*
145	Rosaceae	*Spiraea canescens*
146	Rubiaceae	*Leptodermis lanceolata*
147	Rubiaceae	*Rubia cordifolia*
148	Salicaceae	*Populus ciliata*
149	Salicaceae	*Salix alba*
150	Salicaceae	*Salix denticulata*
151	Salicaceae	*Salix disperma*
152	Salicaceae	*Salix tetrasperma*
153	Saxifragaceae	*Bergenia ciliata*
154	Scrophulariaceae	*Verbascum thapsus*
155	Ulmaceae	*Celtis tetrandra*
156	Ulmaceae	*Ulmus wallichiana*
157	Urticaceae	*Girardinia diversifolia*

S. No.	Family	Name of Species
158	Urticaceae	*Pouzolzia zeylanica*
159	Valerianaceae	*Valeriana jatamansi*
160	Violaceae	*Viola canescens*

Annexure V

List of Project Affected Families (PAFs) with area to be acquired

S. No.	Village Name	Name of Landowner	Name of Father/ Mother/Husband
1	Luj	Smt. Prabh Dei	W/o Moti Chand
2	Luj	Shri. Jadish Kumar	S/o Veer Chand
3	Luj	Shri. Dhayan Singh	S/o Veer Chand
4	Luj	Smt. Sato Devi	W/o Veer Chand
5	Luj	Smt. Kamlo Devi	D/o Veer Chand
6	Luj	Smt. Lalo	W/o Veer Chand
7	Luj	Smt. Noor Dei	D/o Pratap Chand
8	Luj	Smt. Gurdei	D/o Pratap Chand
9	Luj	Shri. Indra Singh	S/o Amar Chand
10	Luj	Shri. Ravi Kumar	S/o Shri. Mahendra Singh
11	Luj	Smt. Bela daru	W/o Shri. Mahendra Singh
12	Luj	Shri. Indra SIngh	S/o Shri. Buddhi Chand
13	Luj	Shri. Mahendra Singh	S/o Shri. Buddhi Chand
14	Luj	Shri. Hosiyar Singh	S/o Shri. Buddhi Chand
15	Luj	Shri. Neeraj Kumar	S/o Shri. Hosiyar Singh
16	Luj	Shri. Krishan Singh	S/o Shri. Pani Lal
17	Luj	Shri. Chatar Singh	S/o Shri. Pani Lal
18	Luj	Shri. Rakesh Kumar	S/o Shri. Gyan Singh
19	Luj	Shri. Harnaam Singh	S/o Shri. Mahendra Singh
20	Luj	Shri. Bhupendra Singh	S/o Shri. Mahendra Singh
21	Luj	Shri. Ram Chandrara	S/o Shri. Moti Chand
22	Luj	Shri. Ravi Kumar	S/o Shri. Gyan Singh
23	Luj	Smt. Sukhi	W/o Shri. Gyan Singh
24	Luj	Shri. Krishan Kumar	S/o Shri. Banshi Lal
25	Luj	Smt. Devi Dei	W/o Shri. Banshi Lal
26	Luj	Shri. Ram Singh	S/o Shri. Mahesh Chand
27	Luj	Shri. Jai Singh	S/o Shri. Mahesh Chand
28	Luj	Shri. Bhagat Singh	S/o Shri. Mahesh Chand
29	Luj	Shri. Sahil	S/o Shri. Sanjay Kumar
30	Luj	Shri. Aman	S/o Shri. Sanjay Kumar
31	Luj	Shri. Hukum Chand	S/o Shri. Kunj Lal
32	Luj	Shri. Mahesh Chand	S/o Shri. Kunj Lal
33	Luj	Shri. Dhram Singh	S/o Shri. Hukum Chand
34	Luj	Shri. Madan Lal	S/o Shri. Hukum Chand
35	Luj	Shri. Nageen Chand	S/o Shri. Kunj Lal
36	Luj	Shri. Hari Singh	S/o Shri. Daleep Chand
37	Luj	Shri. Chaman Singh	S/o Shri. Daleep Chand
38	Luj	Shri. Sandeep Kumar	S/o Shri. Daleep Chand
39	Luj	Smt. Meena	D/o Shri. Daleep Chand
40	Luj	Shri. Shiv Nath	S/o Shri. Vijay Sain
41	Luj	Shri. Amar Chand	S/o Shri. Aami Ram Alias Aagya Ram
42	Luj	Shri. Wazir Chand	S/o Shri. Aami Ram Alias Aagya Ram
43	Luj	Shri. Hakam Singh	S/o Shri. Trilok Chand
44	Luj	Shri. Daleep Chand	S/o Shri. Trilok Chand
45	Luj	Shri. Dheeraj Narayana Singh	S/o Shri. Kehar Singh
46	Luj	Shri. Sunder Singh	S/o Shri. Kehar Singh
47	Luj	Shri. Balbeer Singh	S/o Shri. Kehar Singh
48	Luj	Shri. Bhupendra Singh	S/o Shri. Hari Nath
49	Luj	Shri. Devendra Kumar	S/o Shri. Hari Nath
50	Luj	Smt. Maheshi	W/o Shri. Hari Nath
51	Luj	Shri. Sher Singh	S/o Shri. Hari Nath
52	Luj	Shri. Amit Kumar	S/o Shri. Hari Nath

S. No.	Village Name	Name of Landowner	Name of Father/ Mother/Husband
53	Luj	Shri. Hari Singh	S/o Shri. Brijlal Lal
54	Luj	Shri. Pyare lal	S/o Smt. Jaiyavanti
55	Luj	Shri. Surjeer Singh	S/o Smt. Jaiyavanti
56	Luj	Shri. Dhyan Singh	S/o Smt. Jaiyavanti
57	Luj	Smt. Shakuntala	S/o Smt. Jaiyavanti
58	Luj	Smt. Sunita	D/o Smt. Jaiyavanti
59	Luj	Shri. Jai Krishan	S/o Shri. Mani Das
60	Luj	Shri. Shankar Dass	S/o Shri. Mani Da
61	Luj	Shri. Lal Chandra	S/o Shri. Mani Das
62	Luj	Shri. Naresh Kumar	S/o Shri. Mani Das
63	Luj	Smt. Har Dei	D/o Shri. Mani Das
64	Luj	Smt. Bhag Dei	D/o Shri. Mani Das
65	Luj	Smt. Ghuti Devi	D/o Shri. Mani Das
66	Luj	Shri. Prem Chandra	S/o Shri. Basant Ram
67	Luj	Shri. Jai Singh	S/o Shri. Basant Ram
68	Luj	Shri. Prem Chandra	S/o Shri. Basant Ram
69	Luj	Shri. Devi Singh	S/o Shri. Prem Singh
70	Luj	Shri. Ajeet Kumar	S/o Shri. Prem Singh
71	Luj	Shri. Kehar Singh	S/o Shri. Basant Ram
72	Luj	Shri. Des Raj	S/o Shri. Ram Nath
73	Luj	Shri. Charu Chand	S/o Shri. Lakheu
74	Luj	Shri. Pani Lal	S/o Shri. Sadh Ram
75	Luj	Smt. Lachao	D/o Shri. Sadh Ram
76	Luj	Smt. Meena	D/o Shri. Sadh Ram
77	Luj	Smt. Bego	D/o Shri. Sadh Ram
78	Luj	Shri. Amar Chand	S/o Shri. Mahesh Chandra
79	Luj	Shri. Hansh Raj	S/o Shri. Mahesh Chandra
80	Luj	Shri. Som Raj	S/o Shri. Mahesh Chandra
81	Luj	Smt. Kamla Kumari	D/o Shri. Mahesh Chandra
82	Luj	Smt. Om Dei	W/o Shri. Mahesh Chandra
83	Luj	Shri. Thakur Chandra	S/o Shri. Charu Chandra
84	Luj	Shri. Hosiyar Singh	S/o Shri. Charu Chandra
85	Luj	Smt. Naro	W/o Shri. Charu Chandra
86	Luj	Shri. Dhyan Singh	S/o Shri. Lakheu
87	Luj	Smt. Parju	W/o Shri. Lakheu
88	Luj	Shri. Biku Kumar	S/o Shri. Tika Ram
89	Luj	Smt. Poonam Kumari	D/o Shri. Tika Ram
90	Luj	Smt. Sur Dei	W/o Shri. Tika Ram
91	Luj	Shri. Duni Chandra	S/o Shri. Chani Ram
92	Luj	Smt. Hansh Dei	D/o Shri. Chani Ram
93	Luj	Shri. Chatar Singh	S/o Shri. Shiv Nath
94	Luj	Shri. Surendra Singh	S/o Shiv Nath
95	Luj	Shri. Jagat Ram	S/o Shri. Madho Ram
96	Luj	Shri. Dhyan Singh	S/o Shri. Suram Chandra
97	Luj	Shri. Rajkumar	S/o Shri. Dhayan Chandra
98	Luj	Shri. Pratap Chandra	S/o Shri. Suram Chandra
99	Luj	Shri. Ram Chandra	S/o Shri. Sass Ram
100	Luj	Shri. Des Raj	S/o Shri. Sass Ram
101	Luj	Smt. Indro Devi	D/o Shri. Sass Ram
102	Luj	Smt. Rup Dei	D/o Shri. Sass Ram
103	Luj	Smt. Chandraro	D/o Shri. Sass Ram
104	Luj	Shri. Mansa Ram	S/o Shri. Moti Chand
105	Luj	Smt. Prem Dei	W/o Shri. Moti Chand
106	Luj	Shri. Rajindra Kumar	S/o Shri. Prem Chand
107	Luj	Shri. Ajay Kumar	S/o Shri. Prem Chand
108	Luj	Shri. Sanjay Kumar	S/o Shri. Prem Chand

S. No.	Village Name	Name of Landowner	Name of Father/ Mother/Husband
109	Luj	Smt. Kunto Kumari	D/o Shri. Prem Chand
110	Luj	Smt. Rajani	D/o Shri. Prem Chand
111	Luj	Smt. Naino Devi	W/o Shri. Prem Chand
112	Luj	Smt. Sum Dei	D/o Shri. Bhag Chand
113	Luj	Shri. Krishan Chandra	S/o Shri. Param Chand
114	Luj	Shri. Baldev Ram	S/o Shri. Param Chand
115	Luj	Shri. Ram SIngh	S/o Shri. Param Chand
116	Luj	Shri. Ram Nath	S/o Shri. Param Chand
117	Luj	Smt. Ram Dei	D/o Shri. Param Chand
118	Luj	Smt. Krishni Devi	D/o Shri. Param Chand
119	Luj	Smt. Paan Dei	D/o Shri. Param Chand
120	Luj	Smt. Amar Dei	D/o Shri. Param Chand
121	Luj	Smt. Lambho Kumari	W/o Shri. Param Chand

Source: Based on Revenue department records

ANNEXURE VI

COST NORMS (at the wage rate of Rs. 375/-)

1. Normal Afforestation

S. No.	Particulars of Works	Unit	Qty.	Mandays involved	Amount at the wage rate of Rs. 375/- for Tribal Areas
A	**SURVEY, DEMARCATION & FENCING:-**				
1	Survey & Demarcation of Plantation Area	ha.	1	0.67	251.25
2	Preparation/ Purchase of RCC Fence Post	No.	50	0.00	18750.00
3	Carriage of RCC Fence Post upto 165 cm long over a distance of 2 km uphill/ downhill	KM/ No.	50	22.33	8373.75
4	Preparation /Digging of Holes of 20x30x50 cm size	No.	50	3.02	1132.50
5	Fixing of RCC Fence Post i/c Strutting	No.	50	2.39	896.25
6	Carriage of B/Wire over a distance of 2 Kms uphill/ downhill	KM/ Qtl.	0.75	0.74	277.50
7	Stretching & Fixing of Barbed Wire in 4 Strands	Rmt.	600	19.20	7200.00
8	Interlacing of Thorny Bushes along the Fence	Rmt.	150	4.09	1533.75
9	Cost of Barbed Wire	Qtl.	0.75	0.00	4882.00
Total -A/Survey, Demarcation & Fencing:					**43297.00**
Or Say					**43300.00**
B.	**PLANTING:-**				
1	Bush Cutting in Strips (3m x 3m)	ha.	1	7.95	2981.25
2	Digging of Pits of 45x45x45 cm Size	No.	550	34.98	13117.50
3	Digging of Pits of 30x30x30 cm Size	No.	550	17.49	6558.75
4	Filling of Pits of 45x45x45 cm size	No.	550	9.97	3738.75
5	Filling of Pits of 30x30x30 cm size	No.	550	7.00	2625.00
6	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	KM/ No.	550	13.93	5223.75
7	Carriage of naked root Plants over a distance 2 Km uphill/downhill	KM/ No.	550	1.91	716.25
8	Planting of Plants Raised in P/Bags	No.	550	7.99	2996.25
9	Planting of Plants with naked roots	No.	550	6.71	2516.25
10	Nursery Cost of Plants	No.	1100	23.06	25366.00
11	Construction of Inspection Path	Rmt.	100	7.33	2748.75
12	Cost of Sign Board, Carriage & Fixing	No.	0	0.00	450.00
Total -B/Planting:					**69038.50**
Or Say					**69035.00**
Grand Total (A+B):					**112335.00**
1st YEAR MAINTENANCE (30 % BEATING UP):					
1	Re-digging of Pits 45x45x45 cm	No.	165	5.25	1968.75
2	Re-digging of Pits 30x30x30 cm	No.	165	2.62	982.50
3	Filling of Pits 45x45x45 cm	No.	165	2.99	1121.25
4	Filling of Pits 30x30x30 cm	No.	165	2.10	787.50
5	Planting of Plants raised in P/Bags	No.	165	2.40	900.00
6	Planting of Plants with naked roots	No.	165	2.01	753.75
7	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	KM/ No.	165	4.18	1567.50
8	Carriage of naked root plants over a distance 2 Km uphill/downhill	KM/ No.	165	0.57	213.75
9	Nursery Cost of Plants	No.	330	23.06	7609.80
10	Repair of Fencing	Rmt	60	0.72	270.00
Total/Ist Year Maintenance:					**16174.80**

S. No.	Particulars of Works	Unit	Qty.	Mandays involved	Amount at the wage rate of Rs. 375/- for Tribal Areas
Or Say					**16175.00**
2nd YEAR MAINTENANCE (20 % BEATING UP):					
1	Re-digging of Pits 45x45x45 cm	No.	110	3.50	1312.50
2	Re-digging of Pits 30x30x30 cm	No.	110	1.75	656.25
3	Filling of Pits 45x45x45 cm	No.	110	1.99	746.25
4	Filling of Pits 30x30x30 cm	No.	110	1.40	525.00
5	Planting of Plants raised in P/Bags	No.	110	1.60	600.00
6	Planting of Plants with naked roots	No.	110	1.34	502.50
7	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	No.	110	2.79	1046.25
8	Carriage of naked root plants over a distance 2 Km uphill/downhill	No.	110	0.38	142.50
9	Nursery Cost of Plants	No.	220	23.06	5073.20
10	Repair of Fencing	Rmt	60	0.72	270.00
Total/2nd Year Maintenance:					**10874.45**
Or Say					**10875.00**
3rd YEAR MAINTENANCE (10 % BEATING UP):					
1	Re-digging of Pits 45x45x45 cm	No.	55	1.75	656.25
2	Re-digging of Pits 30x30x30 cm	No.	55	0.87	326.25
3	Filling of Pits 45x45x45 cm	No.	55	1.00	375.00
4	Filling of Pits 30x30x30 cm	No.	55	0.70	262.50
5	Planting of Plants raised in P/Bags	No.	55	0.80	300.00
6	Planting of Plants with naked roots	No.	55	0.67	251.25
7	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	No.	55	1.39	521.25
8	Carriage of naked root plants over a distance 2 Km uphill/downhill	No.	55	0.19	71.25
9	Nursery Cost of Plants	No.	110	23.06	2536.60
10	Repair of Fencing	Rmt	60	0.72	270.00
Total/3rd Year Maintenance:					**5570.35**
Or Say					**5570.00**
4th YEAR MAINTENANCE (10 % BEATING UP):					
1	Re-digging of Pits 45x45x45 cm	No.	55	1.75	656.25
2	Re-digging of Pits 30x30x30 cm	No.	55	0.87	326.25
3	Filling of Pits 45x45x45 cm	No.	55	1.00	375.00
4	Filling of Pits 30x30x30 cm	No.	55	0.70	262.50
5	Planting of Plants raised in P/Bags	No.	55	0.80	300.00
6	Planting of Plants with naked roots	No.	55	0.67	251.25
7	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	No.	55	1.39	521.25
8	Carriage of naked root plants over a distance 2 Km uphill/downhill	No.	55	0.19	71.25
9	Nursery Cost of Plants	No.	110	23.06	2536.60
10	Repair of Fencing	Rmt	60	0.72	270.00
Total/4th Year Maintenance:					**5570.35**
Or Say					**5570.00**
5th YEAR MAINTENANCE (10 % BEATING UP):					
1	Re-digging of Pits 45x45x45 cm	No.	55	1.75	656.25
2	Re-digging of Pits 30x30x30 cm	No.	55	0.87	326.25
3	Filling of Pits 45x45x45 cm	No.	55	1.00	375.00
4	Filling of Pits 30x30x30 cm	No.	55	0.70	262.50
5	Planting of Plants raised in P/Bags	No.	55	0.80	300.00
6	Planting of Plants with naked roots	No.	55	0.67	251.25

S. No.	Particulars of Works	Unit	Qty.	Mandays involved	Amount at the wage rate of Rs. 375/- for Tribal Areas
7	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	No.	55	1.39	521.25
8	Carriage of naked root plants over a distance 2 Km uphill/downhill	No.	55	0.19	71.25
9	Nursery Cost of Plants	No.	110	23.06	2536.60
10	Repair of Fencing	Rmt	60	0.72	270.00
Total/5th Year Maintenance:					**5570.35**
Or Say					**5570.00**
6th YEAR MAINTENANCE (10 % BEATING UP):					
1	Re-digging of Pits 45x45x45 cm	No.	55	1.75	656.25
2	Re-digging of Pits 30x30x30 cm	No.	55	0.87	326.25
3	Filling of Pits 45x45x45 cm	No.	55	1.00	375.00
4	Filling of Pits 30x30x30 cm	No.	55	0.70	262.50
5	Planting of Plants raised in P/Bags	No.	55	0.80	300.00
6	Planting of Plants with naked roots	No.	55	0.67	251.25
7	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	No.	55	1.39	521.25
8	Carriage of naked root plants over a distance 2 Km uphill/downhill	No.	55	0.19	71.25
9	Nursery Cost of Plants	No.	110	23.06	2536.60
10	Repair of Fencing	Rmt	60	0.72	270.00
Total/6th Year Maintenance:					**5570.35**
Or Say					**5570.00**
7th YEAR MAINTENANCE (10 % BEATING UP):					
1	Re-digging of Pits 45x45x45 cm	No.	55	1.75	656.25
2	Re-digging of Pits 30x30x30 cm	No.	55	0.87	326.25
3	Filling of Pits 45x45x45 cm	No.	55	1.00	375.00
4	Filling of Pits 30x30x30 cm	No.	55	0.70	262.50
5	Planting of Plants raised in P/Bags	No.	55	0.80	300.00
6	Planting of Plants with naked roots	No.	55	0.67	251.25
7	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	No.	55	1.39	521.25
8	Carriage of naked root plants over a distance 2 Km uphill/downhill	No.	55	0.19	71.25
9	Nursery Cost of Plants	No.	110	23.06	2536.60
10	Repair of Fencing	Rmt	60	0.72	270.00
Total/7th Year Maintenance:					**5570.35**
Or Say					**5570.00**
Grand Total					**167235.00**

2. Enrichment Plantation

S. No.	Particulars of Works	Unit	Qty.	Mandays involved	Amount at the wage rate of Rs. 375/- for Tribal Areas
A	**SURVEY, DEMARCATION & FENCING:-**				
1	Survey & Demarcation of Plantation Area	ha.	1	0.67	252.50
2	Cutting and preparation of wooden fence posts 1.85 mt long and 8 to 10 cm dia including debarking and fashioning the top 1.5 cms in conical shape	No.	50	4.32	1618.75

S. No.	Particulars of Works	Unit	Qty.	Mandays involved	Amount at the wage rate of Rs. 375/- for Tribal Areas
3	Carriage of wooden Fence Post over a distance of 2 km	KM/ No.	50	4.55	1705.00
4	Charring and coaltaring of ends of fence posts up to 45 at bottom and 15 cms at conical end	No.	50	0.93	350.00
5	Preparation /Digging of Holes of 20 to 30 cm dia and 45 cm deep	No.	50	3.02	1132.50
6	Fixing of wooden Fence Post i/c Strutting	No.	50	2.39	895.00
7	Carriage of B/Wire over a distance of 2 Kms	KM/ Qtl.	0.75	0.74	276.19
8	Stretching & Fixing of Barbed Wire in 4 Strands	Rmt.	600	19.20	7200.00
9	Interlacing of Thorny Bushes along the Fence	Rmt.	150	4.09	1533.75
10	Cost of Barbed Wire	Qtl.	0.75	0.00	4882.50
11	Cost of U-Nails	Qtl.	0.05		320.00
Total -A/Survey, Demarcation & Fencing:					**20166.19**
Or Say					**20165.00**
B.	**PLANTING:-**				
1	Bush Cutting in Strips (3m x 3m)	ha.	1	7.95	2982.00
2	Digging of Pits of 45x45x45 cm Size	No.	400	25.44	9540.00
3	Digging of Pits of 30x30x30 cm Size	No.	400	12.72	4770.00
4	Filling of Pits of 45x45x45 cm size	No.	400	7.25	2720.00
5	Filling of Pits of 30x30x30 cm size	No.	400	5.09	1910.00
6	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	KM/ No.	400	10.13	3800.00
7	Carriage of naked root Plants over a distance 2 Km uphill/downhill	KM/ No.	400	1.39	520.00
8	Planting of Plants Raised in P/Bags	No.	400	5.81	2180.00
9	Planting of Plants with naked roots	No.	400	4.88	1830.00
10	Nursery Cost of Plants	No.	800	23.06	18448.00
11	Construction of Inspection Path	Rmt.	100	7.33	2750.00
12	Cost of Sign Board, Carriage & Fixing	No.	0	0.00	450.00
Total -B/Planting:					**51900.00**
Or Say					**51900.00**
Grand Total (A+B):					**72065.00**
1st YEAR MAINTENANCE (30 % BEATING UP):					
1	Re-digging of Pits 45x45x45 cm	No.	120	3.82	1431.00
2	Re-digging of Pits 30x30x30 cm	No.	120	1.90	714.00
3	Filling of Pits 45x45x45 cm	No.	120	2.18	816.00
4	Filling of Pits 30x30x30 cm	No.	120	1.53	573.00
5	Planting of Plants raised in P/Bags	No.	120	1.74	654.00
6	Planting of Plants with naked roots	No.	120	1.46	549.00
7	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	KM/ No.	120	3.04	1140.00
8	Carriage of naked root plants over a distance 2 Km uphill/downhill	KM/ No.	120	0.42	156.00
9	Nursery Cost of Plants	No.	240	23.06	5534.40
10	Repair of Fencing	Rmt	60	0.72	270.00
Total/Ist Year Maintenance:					**11837.40**
Or Say					**11835.00**
2nd YEAR MAINTENANCE (20 % BEATING UP):					
1	Re-digging of Pits 45x45x45 cm	No.	80	2.54	954.00
2	Re-digging of Pits 30x30x30 cm	No.	80	1.27	476.00
3	Filling of Pits 45x45x45 cm	No.	80	1.45	544.00
4	Filling of Pits 30x30x30 cm	No.	80	1.02	382.00

S. No.	Particulars of Works	Unit	Qty.	Mandays involved	Amount at the wage rate of Rs. 375/- for Tribal Areas
5	Planting of Plants raised in P/Bags	No.	80	1.16	436.00
6	Planting of Plants with naked roots	No.	80	0.98	366.00
7	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	No.	80	2.03	760.00
8	Carriage of naked root plants over a distance 2 Km uphill/downhill	No.	80	0.28	104.00
9	Nursery Cost of Plants	No.	160	23.06	3689.60
10	Repair of Fencing	Rmt	60	0.72	270.00
Total/2nd Year Maintenance:					**7981.60**
Or Say					**7980.00**
3rd YEAR MAINTENANCE (10% BEATING UP):					
1	Re-digging of Pits 45x45x45 cm	No.	40	1.27	477.00
2	Re-digging of Pits 30x30x30 cm	No.	40	0.63	238.00
3	Filling of Pits 45x45x45 cm	No.	40	0.73	272.00
4	Filling of Pits 30x30x30 cm	No.	40	0.51	191.00
5	Planting of Plants raised in P/Bags	No.	40	0.58	218.00
6	Planting of Plants with naked roots	No.	40	0.49	183.00
7	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	No.	40	1.01	380.00
8	Carriage of naked root plants over a distance 2 Km uphill/downhill	No.	40	0.14	52.00
9	Nursery Cost of Plants	No.	80	23.06	1844.80
10	Repair of Fencing	Rmt	60	0.72	270.00
Total/3rd Year Maintenance:					**4125.80**
Or Say					**4125.00**
4th YEAR MAINTENANCE (10 % BEATING UP):					
1	Re-digging of Pits 45x45x45 cm	No.	40	1.27	477.00
2	Re-digging of Pits 30x30x30 cm	No.	40	0.63	238.00
3	Filling of Pits 45x45x45 cm	No.	40	0.73	272.00
4	Filling of Pits 30x30x30 cm	No.	40	0.51	191.00
5	Planting of Plants raised in P/Bags	No.	40	0.58	218.00
6	Planting of Plants with naked roots	No.	40	0.49	183.00
7	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	No.	40	1.01	380.00
8	Carriage of naked root plants over a distance 2 Km uphill/downhill	No.	40	0.14	52.00
9	Nursery Cost of Plants	No.	80	23.06	1844.80
10	Repair of Fencing	Rmt	60	0.72	270.00
Total/4th Year Maintenance:					**4125.80**
Or Say					**4125.00**
5th YEAR MAINTENANCE (10 % BEATING UP):					
1	Re-digging of Pits 45x45x45 cm	No.	40	1.27	477.00
2	Re-digging of Pits 30x30x30 cm	No.	40	0.63	238.00
3	Filling of Pits 45x45x45 cm	No.	40	0.73	272.00
4	Filling of Pits 30x30x30 cm	No.	40	0.51	191.00
5	Planting of Plants raised in P/Bags	No.	40	0.58	218.00
6	Planting of Plants with naked roots	No.	40	0.49	183.00
7	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	No.	40	1.01	380.00
8	Carriage of naked root plants over a distance 2 Km uphill/downhill	No.	40	0.14	52.00
9	Nursery Cost of Plants	No.	80	23.06	1844.80
10	Repair of Fencing	Rmt	60	0.72	270.00

S. No.	Particulars of Works	Unit	Qty.	Mandays involved	Amount at the wage rate of Rs. 375/- for Tribal Areas
Total/5th Year Maintenance:					**4125.80**
Or Say					**4125.00**
6th YEAR MAINTENANCE (10 % BEATING UP):					
1	Re-digging of Pits 45x45x45 cm	No.	40	1.27	477.00
2	Re-digging of Pits 30x30x30 cm	No.	40	0.63	238.00
3	Filling of Pits 45x45x45 cm	No.	40	0.73	272.00
4	Filling of Pits 30x30x30 cm	No.	40	0.51	191.00
5	Planting of Plants raised in P/Bags	No.	40	0.58	218.00
6	Planting of Plants with naked roots	No.	40	0.49	183.00
7	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	No.	40	1.01	380.00
8	Carriage of naked root plants over a distance 2 Km uphill/downhill	No.	40	0.14	52.00
9	Nursery Cost of Plants	No.	80	23.06	1844.80
10	Repair of Fencing	Rmt	60	0.72	270.00
Total/6th Year Maintenance:					**4125.80**
Or Say					**4125.00**
7th YEAR MAINTENANCE (10 % BEATING UP):					
1	Re-digging of Pits 45x45x45 cm	No.	40	1.27	477.00
2	Re-digging of Pits 30x30x30 cm	No.	40	0.63	238.00
3	Filling of Pits 45x45x45 cm	No.	40	0.73	272.00
4	Filling of Pits 30x30x30 cm	No.	40	0.51	191.00
5	Planting of Plants raised in P/Bags	No.	40	0.58	218.00
6	Planting of Plants with naked roots	No.	40	0.49	183.00
7	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	No.	40	1.01	380.00
8	Carriage of naked root plants over a distance 2 Km uphill/downhill	No.	40	0.14	52.00
9	Nursery Cost of Plants	No.	80	23.06	1844.80
10	Repair of Fencing	Rmt	60	0.72	270.00
Total/7th Year Maintenance:					**4125.80**
Or Say					**4125.00**
Grand Total					**112505.00**

3. Assisted Natural Regeneration

S. No.	Particulars of Works	Unit	Qty.	Mandays involved	Amount at the wage rate of Rs. 375/- for Tribal Areas
A	**SURVEY, DEMARCATION & FENCING:-**				
1	Survey & Demarcation of Plantation Area	ha.	1	0.67	251.25
2	Cutting and preparation of wooden fence posts 1.85 mt long and 8 to 10 cm dia including debarking and fashioning the top 1.5 cms in conical shape	No.	50	4.32	1620.00
3	Carriage of wooden Fence Post over a distance of 2 km	KM/ No.	50	4.55	1706.25
4	Charring and coaltaring of ends of fence posts up to 45 at bottom and 15 cms at conical end	No.	50	0.93	348.75
5	Preparation /Digging of Holes of 20 to 30 cm dia and 45 cm deep	No.	50	3.02	1132.50

S. No.	Particulars of Works	Unit	Qty.	Mandays involved	Amount at the wage rate of Rs. 375/- for Tribal Areas
6	Fixing of wooden Fence Post i/c Strutting	No.	50	2.39	896.25
7	Carriage of B/Wire over a distance of 2 Kms	KM/ Qtl.	0.75	0.74	277.50
8	Stretching & Fixing of Barbed Wire in 4 Strands	Rmt.	600	19.20	7200.00
9	Interlacing of Thorny Bushes along the Fence	Rmt.	150	4.00	1500.00
10	Cost of Barbed Wire	Qtl.	0.75	0.00	4882.50
11	Cost of U-Nails	Qtl.	0.05	0.00	320.00
Total -A/Survey, Demarcation & Fencing:					**20135.00**
Or Say					**20135.00**
B.	**PLANTING:-**				
1	Bush Cutting/ cultural operation	ha.	1	7.95	2981.25
2	Digging of Pits of 45x45x45 cm Size	No.	125	7.95	2981.25
3	Digging of Pits of 30x30x30 cm Size	No.	125	3.98	1492.50
4	Filling of Pits of 45x45x45 cm size	No.	125	2.27	851.25
5	Filling of Pits of 30x30x30 cm size	No.	125	1.59	596.25
6	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	KM/ No.	125	3.17	1188.75
7	Carriage of naked root Plants over a distance 2 Km uphill/downhill	KM/ No.	125	0.43	161.25
8	Planting of Plants Raised in P/Bags	No.	125	1.82	682.50
9	Planting of Plants with naked roots	No.	125	1.53	573.75
10	Nursery Cost of Plants	No.	250	23.06	5765.00
Total -B/Planting:					**17273.75**
Or Say					**17270.00**
Grand Total (A+B):					**37405.00**
1st YEAR MAINTENANCE (30 % BEATING UP):					
1	Re-digging of Pits 45x45x45 cm	No.	37	1.18	442.50
2	Re-digging of Pits 30x30x30 cm	No.	37	0.59	221.25
3	Filling of Pits 45x45x45 cm	No.	37	0.67	251.25
4	Filling of Pits 30x30x30 cm	No.	37	0.47	176.25
5	Planting of Plants raised in P/Bags	No.	37	0.54	202.50
6	Planting of Plants with naked roots	No.	37	0.45	168.75
7	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	KM/ No.	37	0.94	352.50
8	Carriage of naked root plants over a distance 2 Km uphill/downhill	KM/ No.	37	0.13	48.75
9	Nursery Cost of Plants	No.	74	23.06	1706.44
10	Repair of Fencing	Rmt	60	0.72	270.00
Total/Ist Year Maintenance:					**3840.19**
Or Say					**3840.00**
2nd YEAR MAINTENANCE (20 % BEATING UP):					
1	Re-digging of Pits 45x45x45 cm	No.	25	0.80	300.00
2	Re-digging of Pits30x30x30cm	No.	25	0.40	150.00
3	Filling of Pits 45x45x45 cm	No.	25	0.45	168.75
4	Filling of Pits 30x30x30 cm	No.	25	0.32	120.00
5	Planting of Plants raised in P/Bags	No.	25	0.36	135.00
6	Planting of Plants with naked roots	No.	25	0.31	116.25
7	Carriage of Plants in P. Bags over a distance of 2 Km uphill/downhill	No.	25	0.63	236.25
8	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	No.	25	0.09	33.75
9	Nursery Cost of Plants	No.	50	23.06	1153.00
10	Repair of Fencing	Rmt	60	0.72	270.00

S. No.	Particulars of Works	Unit	Qty.	Mandays involved	Amount at the wage rate of Rs. 375/- for Tribal Areas
Total/2nd Year Maintenance:					**2683.00**
Or Say					**2680.00**
3rd YEAR MAINTENANCE (10% BEATING UP):					
1	Re-digging of Pits 45x45x45 cm	No.	12	0.38	142.50
2	Re-digging of Pits 30x30x30 cm	No.	12	0.19	71.25
3	Filling of Pits 45x45x45 cm	No.	12	0.22	82.50
4	Filling of Pits 30x30x30 cm	No.	12	0.15	56.25
5	Planting of Plants raised in P/Bags	No.	12	0.17	63.75
6	Planting of Plants with naked roots	No.	12	0.15	56.25
7	Carriage of Plants in P. Bags over a distance 2 Km uphill/downhill	No.	12	0.30	112.50
8	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	No.	12	0.04	15.00
9	Nursery Cost of Plants	No.	24	23.06	553.44
10	Repair of Fencing	Rmt	60	0.72	270.00
Total/3rd Year Maintenance:					**1423.44**
Or Say					**1420.00**
4th YEAR MAINTENANCE (10 % BEATING UP):					
1	Re-digging of Pits 45x45x45 cm	No.	12	0.38	142.50
2	Re-digging of Pits 30x30x30 cm	No.	12	0.19	71.25
3	Filling of Pits 45x45x45 cm	No.	12	0.22	82.50
4	Filling of Pits 30x30x30 cm	No.	12	0.15	56.25
5	Planting of Plants raised in P/Bags	No.	12	0.17	63.75
6	Planting of Plants with naked roots	No.	12	0.15	56.25
7	Carriage of Plants in P. Bags over a distance 2 Km uphill/downhill	No.	12	0.30	112.50
8	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	No.	12	0.04	15.00
9	Nursery Cost of Plants	No.	24	23.06	553.44
10	Repair of Fencing	Rmt	60	0.72	270.00
Total/4th Year Maintenance:					**1423.44**
Or Say					**1420.00**
5th YEAR MAINTENANCE (10 % BEATING UP):					
1	Re-digging of Pits 45x45x45 cm	No.	12	0.38	142.50
2	Re-digging of Pits 30x30x30 cm	No.	12	0.19	71.25
3	Filling of Pits 45x45x45 cm	No.	12	0.22	82.50
4	Filling of Pits 30x30x30 cm	No.	12	0.15	56.25
5	Planting of Plants raised in P/Bags	No.	12	0.17	63.75
6	Planting of Plants with naked roots	No.	12	0.15	56.25
7	Carriage of Plants in P. Bags over a distance 2 Km uphill/downhill	No.	12	0.30	112.50
8	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	No.	12	0.04	15.00
9	Nursery Cost of Plants	No.	24	23.06	553.44
10	Repair of Fencing	Rmt	60	0.72	270.00
Total/5th Year Maintenance:					**1423.44**
Or Say					**1420.00**
6th YEAR MAINTENANCE (10 % BEATING UP):					
1	Re-digging of Pits 45x45x45 cm	No.	12	0.38	142.50
2	Re-digging of Pits 30x30x30 cm	No.	12	0.19	71.25
3	Filling of Pits 45x45x45 cm	No.	12	0.22	82.50
4	Filling of Pits 30x30x30 cm	No.	12	0.15	56.25
5	Planting of Plants raised in P/Bags	No.	12	0.17	63.75

S. No.	Particulars of Works	Unit	Qty.	Mandays involved	Amount at the wage rate of Rs. 375/- for Tribal Areas
6	Planting of Plants with naked roots	No.	12	0.15	56.25
7	Carriage of Plants in P. Bags over a distance 2 Km uphill/downhill	No.	12	0.30	112.50
8	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	No.	12	0.04	15.00
9	Nursery Cost of Plants	No.	24	23.06	553.44
10	Repair of Fencing	Rmt	60	0.72	270.00
Total/6th Year Maintenance:					**1423.44**
Or Say					**1420.00**
7th YEAR MAINTENANCE (10 % BEATING UP):					
1	Re-digging of Pits 45x45x45 cm	No.	12	0.38	142.50
2	Re-digging of Pits 30x30x30 cm	No.	12	0.19	71.25
3	Filling of Pits 45x45x45 cm	No.	12	0.22	82.50
4	Filling of Pits 30x30x30 cm	No.	12	0.15	56.25
5	Planting of Plants raised in P/Bags	No.	12	0.17	63.75
6	Planting of Plants with naked roots	No.	12	0.15	56.25
7	Carriage of Plants in P. Bags over a distance 2 Km uphill/downhill	No.	12	0.30	112.50
8	Carriage of Plants in P. Bags over distance 2 Km uphill/downhill	No.	12	0.04	15.00
9	Nursery Cost of Plants	No.	24	23.06	553.44
10	Repair of Fencing	Rmt	60	0.72	270.00
Total/7th Year Maintenance:					**1423.44**
Or Say					**1420.00**

51025.00

4. Pasture Development

S. No.	Component	Amount (Rs.)
1	Fencing cost (wage component)	16049.02
2	Fencing material	5671.33
3	Removal of weeds	
4	Sowing of grass seeds/ tufts in trenches/ patches of size 2mx1m (400-500/ha)	
5	Moisture retention interventions gully plugging, water ponds etc.	18717.14
	Total	**40437.49**
	Or Say	**40400.00**
	1st Year Maintenance	6465.00
	2nd Year Maintenance	4445.00
	3rd Year Maintenance	2425.00
	4th Year Maintenance	2425.00
	5th Year Maintenance	2425.00
	6th Year Maintenance	2425.00
	7th Year Maintenance	2425.00
	Maintenance Total	**23035.00**
	GRAND TOTAL	**63435.00**

5. Raising Of Native Medicinal Shrubs and Herbs

Particulars of Works	Unit	Qty.	Rate	Amount (Rs.)
Bush cutting in strips/ patches	LS	LS		2284.09
Preparation of trenches/ patches including digging & stacking of soil along berms (1.00x0.50x0.15 m3)	No.	1100	2600 per 100	28600.00
Planting of plants in patches	No.	13200	735 per 1200	8085.00
Cost of carriage of Plants (L/S)	LS	LS	LS	5625.23
Total			0.00	**44594.32**
Or Say				**44600.00**
Nursery Cost of Plants	No.	13200	5.89	77748.00
Or Say				**77750.00**
Total				**122350.00**
1st YEAR MAINTENANCE (5% BEATING UP):				8520.00
2nd YEAR MAINTENANCE (3% BEATING UP):				6720.00
3rd YEAR MAINTENANCE (2% BEATING UP):				5040.00
4th YEAR MAINTENANCE (2% BEATING UP):				5040.00
5th YEAR MAINTENANCE (2% BEATING UP):				5040.00
Maintenance Total				**30360.00**
GRAND TOTAL				**152710.00**

6. Engineering Measures

S. No.	Description	Unit	Rate (Rs)
1	Weaving of wire netting for wire crate with G.I. wire 4mm/ 5mm or SWG No. 6/8 i/c binding sides & portions to make crate of 7.5 cm x 7.5 cm mesh	Sqm	33.15
2	Carriage of soling stone and stone for filling crates	Cum	400.50
3	Boulder stone filing into crates and dry hand packing	Cum	125.60
4	Tipping wire crates including equipments	Cum	85.80
5	Spreading of wire crates over pitching connecting with side protection walls, inclusive of wire etc.	Sqm	25.55
6	Dumping of Stones	Cum	62.40
7	Stone pitching	Cum	265.40
8	Fixing of vegetative spurs (double)	Rmt	50.60
9	Construction of puddle core wall for percolation dams	Cum	142.10
10	Filling up stone or Spawls (for use as Graded filter)	Cum	70.20
	TOTAL		**1261.30**
	Add 130.77% increase on account of revision of daily wage rates		**1649.40**
	TOTAL		**2910.70**
	Add 25% increase for Tribal area		727.68
	GRAND TOTAL		**3638.38**
	OR SAY		**3635.00**

ANNEXURE VII

YEAR WISE TARGET (PHYSICAL AND FINANCIAL) FOR CATCHMENT AREA TREATMENT PLAN

S. No.	Treatment Measures	Year - 1		Year - 2		Year - 3		Year - 4		Year - 5		Year - 6		Year - 7		Year - 8		Year - 9		Year - 10		Total	
		Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)
I	**Biological Measures**																						
1	**Afforestation**	105	1,17,95,175	95	1,06,71,825	33	37,07,055															233	**2,61,74,055**
	1st Year maintenance			105	16,98,375	95	15,36,625	33	5,33,775													233	**37,68,775**
	2nd Year maintenance					105	11,41,875	95	10,33,125	33	3,58,875											233	**25,33,875**
	3rd Year maintenance							105	5,84,850	95	5,29,150	33	1,83,810									233	**12,97,810**
	4th Year maintenance									105	5,84,850	95	5,29,150	33	1,83,810							233	**12,97,810**
	5th Year maintenance											105	5,84,850	95	5,29,150	33	1,83,810					233	**12,97,810**
	6th Year maintenance													105	5,84,850	95	5,29,150	33	1,83,810			233	**12,97,810**
	7th Year maintenance															105	5,84,850	95	5,29,150	33	1,83,810	233	**12,97,810**
2	**Enrichment**	45	32,42,925	55	39,63,575	5	3,60,325															105	**75,66,825**
	1st Year maintenance			45	5,32,575	55	6,50,925	5	59,175													105	**12,42,675**
	2nd Year maintenance					45	3,59,100	55	4,38,900	5	39,900											105	**8,37,900**
	3rd Year maintenance							45	1,85,625	55	2,26,875	5	20,625									105	**4,33,125**
	4th Year maintenance									45	1,85,625	55	2,26,875	5	20,625							105	**4,33,125**
	5th Year maintenance											45	1,85,625	55	2,26,875	5	20,625					105	**4,33,125**
	6th Year maintenance													45	1,85,625	55	2,26,875	5	20,625			105	**4,33,125**
	7th Year maintenance															45	1,85,625	55	2,26,875	5	20,625	105	**4,33,125**
3	**Pasture Development**	170	68,68,000	130	52,52,000	15	6,06,000															315	**1,27,26,000**
	1st Year maintenance			170	10,99,050	130	8,40,450	15	96,975													315	**20,36,475**
	2nd Year maintenance					170	7,55,650	130	5,77,850	15	66,675											315	**14,00,175**
	3rd Year maintenance							170	4,12,250	130	3,15,250	15	36,375									315	**7,63,875**
	4th Year maintenance									170	4,12,250	130	3,15,250	15	36,375							315	**7,63,875**
	5th Year maintenance											170	4,12,250	130	3,15,250	15	36,375					315	**7,63,875**
	6th Year maintenance													170	4,12,250	130	3,15,250	15	36,375			315	**7,63,875**
	7th Year maintenance															170	4,12,250	130	3,15,250	15	36,375	315	**7,63,875**
4	**Raising of Medicinal Herbs & Shrubs**					100	1,22,35,000	85	1,03,99,750	20	24,47,000											205	**2,50,81,750**
	1st Year							100	8,52,000	85	7,24,200	20	1,70,400									205	**17,46,600**

S. No.	Treatment Measures	Year - 1		Year - 2		Year - 3		Year - 4		Year - 5		Year - 6		Year - 7		Year - 8		Year - 9		Year - 10		Total	
		Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)
	maintenance																						
	2nd Year maintenance									100	6,72,000	85	5,71,200	20	1,34,400							205	**13,77,600**
	3rd Year maintenance											100	5,04,000	85	4,28,400	20	1,00,800					205	**10,33,200**
	4th Year maintenance													100	5,04,000	85	4,28,400	20	1,00,800			205	**10,33,200**
	5th Year maintenance															100	5,04,000	85	4,28,400	20	1,00,800	205	**10,33,200**
5	**Assisted Natural Regeneration**	115	43,01,575	30	11,22,150	15	5,61,075															160	**59,84,800**
	1st Year maintenance			115	4,41,600	30	1,15,200	15	57,600													160	**6,14,400**
	2nd Year maintenance					115	3,08,200	30	80,400	15	40,200											160	**4,28,800**
	3rd Year maintenance							115	1,63,300	30	42,600	15	21,300									160	**2,27,200**
	4th Year maintenance									115	1,63,300	30	42,600	15	21,300							160	**2,27,200**
	5th Year maintenance											115	1,63,300	30	42,600	15	21,300					160	**2,27,200**
	6th Year maintenance													115	1,63,300	30	42,600	15	21,300			160	**2,27,200**
	7th Year maintenance															115	1,63,300	30	42,600	15	21,300	160	**2,27,200**
6	**Upgradation of existing nurseries**		**50,00,000**																				**50,00,000**
	Sub Total	**435**	**3,12,07,675**	**745**	**2,47,81,150**	**913**	**2,31,77,480**	**998**	**1,54,75,575**	**1,018**	**68,08,750**	**1,018**	**39,67,610**	**1,018**	**37,88,810**	**1,018**	**37,55,210**	**483**	**19,05,185**	**88**	**3,62,910**		**11,52,30,355**
II	**Engineering Measures**																						
7	Avalanche Control	5,900	2,14,46,500	4,150	1,50,85,250	2,300	83,60,500															12,350	**4,48,92,250**
8	Flood Control	4,800	1,74,48,000	7,800	2,83,53,000	0	0															12,600	**4,58,01,000**
9	Treatment of Nalas	420	15,26,700	848	30,82,480	180	6,54,300															1,448	**52,63,480**
10	Soil & Water Conservation	4,580	1,66,48,300	5,180	1,88,29,300	420	15,26,700															10,180	**3,70,04,300**
11	Silt Observation Points		17,10,000		5,10,000		5,10,000		5,10,000		5,10,000		5,10,000		5,10,000		5,10,000		5,10,000		5,10,000		**63,00,000**
	Sub Total	**15,700**	**5,87,79,500**	**17,978**	**6,58,60,030**	**2,900**	**1,10,51,500**		**5,10,000**		**5,10,000**		**5,10,000**		**5,10,000**		**5,10,000**		**5,10,000**		**5,10,000**	**36,578**	**13,92,61,030**
A	**Total (I and II)**		**8,99,87,175**		**9,06,41,180**		**3,42,28,980**		**1,59,85,575**		**73,18,750**		**44,77,610**		**42,98,810**		**42,65,210**		**24,15,185**		**8,72,910**		**25,44,91,385**
III	**Other Components of CAT Plan**																						
14	Machinery & Equipment		18,00,000		18,00,000		18,00,000		18,00,000		18,00,000		18,00,000		12,00,000								**1,20,00,000**
15	Forest Protection Plan		98,00,000		49,00,000		49,00,000		98,00,000		49,00,000		98,00,000		49,00,000								**4,90,00,000**
16	Energy saving devices		15,00,000		15,00,000		15,00,000		15,00,000		15,00,000		15,00,000		10,00,000								**1,00,00,000**
17	Provisions for Micro Plans		20,00,000																				**20,00,000**
18	Publicity and Awareness		12,00,000		12,00,000		12,00,000		12,00,000		12,00,000		12,00,000		8,00,000								**80,00,000**
19	Training of		24,00,000		12,00,000		12,00,000		24,00,000		12,00,000		24,00,000		12,00,000								**1,20,00,000**

S. No.	Treatment Measures	Year - 1		Year - 2		Year - 3		Year - 4		Year - 5		Year - 6		Year - 7		Year - 8		Year - 9		Year - 10		Total	
		Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)
	Forest Staff																						
20	Provision for Forestry Research		18,00,000		18,00,000		18,00,000		18,00,000		18,00,000		18,00,000		12,00,000								**1,20,00,000**
21	Eco Tourism		24,00,000		24,00,000		24,00,000		24,00,000		24,00,000		24,00,000		16,00,000								**1,60,00,000**
22	Payment for Eco Services		44,00,000		88,00,000		88,00,000		88,00,000		44,00,000		44,00,000		44,00,000								**4,40,00,000**
23	Wildlife protection, management and conflict resolution		28,00,000		28,00,000		28,00,000		28,00,000		28,00,000		28,00,000		28,00,000		28,00,000		28,00,000		28,00,000		**2,80,00,000**
24	Monitoring & Evaluation		16,00,000		16,00,000		16,00,000		16,00,000		16,00,000		16,00,000		16,00,000		16,00,000		16,00,000		16,00,000		**1,60,00,000**
25	Eco Batallion		30,00,000		30,00,000		30,00,000		30,00,000		30,00,000		30,00,000		20,00,000								**2,00,00,000**
26	Contingencies		25,50,000		25,50,000		25,50,000		25,50,000		25,50,000		25,50,000		25,50,000		25,50,000		25,50,000		25,50,000		**2,55,00,000**
B	**Total (III)**		**3,72,50,000**		**3,35,50,000**		**3,35,50,000**		**3,96,50,000**		**2,91,50,000**		**3,52,50,000**		**2,52,50,000**		**69,50,000**		**69,50,000**		**69,50,000**		**25,45,00,000**
	Total (A and B)		**12,72,37,175**		**12,41,91,180**		**6,77,78,980**		**5,56,35,575**		**3,64,68,750**		**3,97,27,610**		**2,95,48,810**		**1,12,15,210**		**93,65,185**		**78,22,910**		**50,89,91,385**

ANNEXURE- VIII

BIODIVERSITY CONSERVATION AND WILDLIFE MANAGEMENT PLAN
&
CONSERVATION PLAN FOR SCHEDULE-I SPECIES

BIODIVERSITY CONSERVATION AND WILDLIFE MANAGEMENT PLAN

&

CONSERVATION PLAN FOR SCHEDULE-I SPECIES

Leopard (*Panthera pardus*)

Prepared for:

Dugar Hydro Electric Project

NHPC. Ltd.

Prepared by:

RSET
Environmental Consulting

R. S. Envirolink Technologies Pvt. Ltd.
402, Bestech Chambers Commercial Plaza,
B-Block, Sushant Lok-I, Gurugram
Phone: +91-124-4295383: www.rstechnologies.co.in

1. Introduction

The main objective of the Biodiversity Conservation and Wildlife Management plan is the sustainable use of natural resources which involves scientific management of natural wealth vis-à-vis developmental activities that are likely to affect these resources. The threats to biodiversity generally arise due to anthropogenic activities that may arise as a result of the development activities of the Dugar HEP. Therefore, Biodiversity Conservation & Wildlife Management plan has been formulated for the conservation and management of the forest ecosystems in the vicinity of proposed project.

2. Project Location

Dugar Hydro Electric Project is located in Chenab River in district Chamba, Himachal Pradesh, and is being developed by NHPC Ltd. The construction of the dam and underground powerhouse for the Dugar Hydro Electric Project (500 MW) is proposed near Luj village in Pangi Tehsil of Chamba district of Himachal Pradesh. The proposed dam site is located at latitude $30^0$31’03” N and longitude $77^0$56’58” E.

3. Project Description

The Dugar HEP is envisaged as a run-of-river scheme with a 500 MW installed capacity located near Luj village for utilizing the flows of Chenab River to harness the head created by constructing a 128 m high dam (from the deepest foundation) with a top length of 210.65 m; and Full Reservoir Level (FRL) and Minimum Draw Down Level (MDDL) levels at 2114.0 m and 2102.35 m., respectively. An underground powerhouse consisting of the main plant of 412MW (4 units of 103 MW) and auxiliary plant of 88 MW (2 units of 44 MW).

4. Propose of Report

In reference to additional conditions of Term of Reference (ToR) issued by Ministry of Environment, Forest and Climate Change (MoEF&CC) vide letter F. No. J-12011/08/20120-IA-I dated 5th August 2020 (**Annexure-I**), directed to submit Conservation plan for the Scheduled I species reported from the study area. In pursuant to the condition of ToR, a Conservation Plan for Schedule-I species has been prepared.

5. DESCRIPTION OF FLORA AND FAUNA OF THE PROJECT AREA

5.1 Forest Types in the Study Area

The details on forest types and forest cover in the study area were based on field surveys supplemented with the forest working plan of the Pangi Forest Division. The forests in the study area have been classified following the ‘A Revised Survey of the Forest Types of India’ by Champion and Seth (1968) fall under Montane Temperate Forest type and classified under Group-13 Himalayan Dry Temperate Forests. Forest Sub Types in the study area are described in paragraphs below

13/C2a *Neoza Pine Forest* (*Pinus gerardiana*)

Neoza pine forest (*Pinus gerardiana*) occurs with some deodar trees in the inner dry valleys of Chenab basin. This type of forest was observed on Dugar dam site and adjoining downstream area under Luj Reserve Forest under Pangi Forest Division. Important tree associates found are *Cedrus deodara, Fraxinus xanthoxyloides,* and *Pinus wallichiana*. Shrubs are few and are represented by *Berberis aristata, Lonicera quinquelocularis*, *Indigofera heterantha, Cotoneaster microphyllus, Rubus niveus*, *Viburnum cotinifolium*, *Jasminum officinale, Rabdosia rugosa* and *Sorbaria tomentosa*. Climbers are almost absent (with a few exceptions like presence of *Clematis* spp.).

13/C2b *Dry Deodar Forest*

Dry Deodar Forest is the most predominant type found in almost all over the area along the bank of Chenab River commonly associated with *Pinus wallichiana*. This type of forest is found between 2100m and 3000m elevations. The main associate of the middle storey includes *Corylus jacquimontii, Fraxinus xanthoxyloides, Prunus cornuta, Robina pseudoacacia*, etc. Shrubs comprise *Berberis aristata*, *Desmodium heterocarpon, Lonicera angustifolia, Rabdosia rugosus, Rosa webianna, R. brunonii, Rubus lasiocarpus, Viburnum cotinifolium,* etc. The common terrestrial ferns are the species of *Adiantum, Athyrium, Dryopteris, Pteris,* etc.

13C3 West Himalayan dry temperate deciduous forest

This type is generally found on moist soils and is distributed all over the division in damp shaded areas, and tributary streams. Trees like *Aesculus indica, Corylus colurna, Acer caesium, Celtis australis, Salix* spp*., Juglans regia, Prunus cornuta* and *Fraxinus* spp. are chiefly found in areas which are characterized by comparatively moister conditions. In drier areas with lower precipitation and xerophytic conditions, generally broadleaved species like *Crataegus oxycantha* and *Fraxinus xanthoxyloides* are found. On cooler northerly aspects, pure stands of *Corylus colurna* also occur. Undergrowth is comprised of *Parrotiopsis jacquemontiana*, *Deutzia corymbosa*, *Spiraea canescens*, *Viburnum nervosum*, *Lonicera quinquelocularis* and *Salix* spp. The most commonly found herbs are the species of *Valeriana* and *Polygonum*.

13C4 West Himalayan high-level dry blue pine forest (*Pinus wallichiana*)

This type occurs in the Saichu valley. Wherever the rainfall is scanty the forest is found on melting snow beds on the gentle slopes between 2500 m and 3200 m. *Pinus wallichiana* (Kail) is the principal species in the top canopy. The most common associates of Kail are *Betula utilis, Juniperus semiglobosa, Ribes* spp*., Rhamnus prostrata,* and *Rhododendron campanulatum.* Among the herbs *Aconitum heterophylum, Picrorhiza kurroa,* and *Lonicera hypoleuca* are frequently met with.

5.2 Description Of Flora of The Project Area

A. Vegetation Profile of the Project Area

The proposed Dugar Project lies in the Pangi valley of Chamba district. Pangi is rich in terms of floral wealth. The catchment of Chenab River in the study area was characterized by steep slopes. The vegetation in the area in general is characterized as Himalayan temperate type. *Cedrus deodara, Pinus gerardiana, Pinus wallichiana, Picea smithiana*, *Abies spectabilis,* are the conifer species forming the top canopy generally observed on the steep slopes along the Chenab River and its tributaries in the study area. *Celtis australis, Corylus jacquemontii, Ulmus wallichiana, Salix tetrasperma, Salix denticulata, Fraxinus xanthoxyloides, Juglans regia, Robinia pseudo-acacia, Populus ciliata, Prunus armeniaca* and *Alnus nitida* are the associated tree species in the forest area. Shrub vegetation in the area was mostly observed on the edges of forest area, on barren rocky slopes, scrub, and fallow land represented by species like *Abelia triflora*, *Artemisia maritima*, *Berberis aristata*, *Berberis lycium*, *Cotoneaster bacillaris*, *Daphne oleoides, Clematis montana, Rabdosia rugosa*, *Ephedra gerardiana*, *Girardinia heterophylla*, *Jasminum humile*, *Olea ferruginea*, *Rosa macrophylla*, *Rosa moschata*, *Rubus foliolosus*, *Rubia cordifolia*, *Rubus niveus*, *Sambucus wightiana*, and *Sorbaria tomentosa.*

Herbaceous flora of the region varies seasonally in the area. *Polygonum molle*, *Artemisia maritima, Arenaria glanduligera, Chaerophyllum reflexum, Cirsium falconeri, Dactylis glomerata, Equisetum arvense, Eremurus himalaicus, Galium aparine*, *Gentiana coronata, Hyoscyamus niger*, *Impatiens sulcata, Muhlenbergia himalayensis, Pimpinella diversifolia, Poa annua, Rubus* sp.*,* *Rumex hastatus*, *Anaphalis royleana*, *Cirsium wallichii*, *Geranium nepalense*, *Impatiens glandulifera*, *Malva verticillata*, *Origanum vulgare*, *Oxalis corniculata*, *Plantago major*, *Pouzolzia zeylanica*, *Primula denticulata*, *Saussurea costus*, *Taraxacum officinale*, *Thalictrum foliolosum*, *Trifolium repens*, *Valeriana jatamansi*, *Verbascum thapsus* and *Youngia japonica*, etc. were the herb species in the catchment of Chenab River. *Carex inanis*, *Kyllinga squamulata*, *Agrostis pilosula*, *Arthraxon lancifolius*, *Bromus japonicus*, *Eragrostis pilosa*, *Poa annua*, *Stipa roylei*, etc. are the grass species in the catchment mostly grown on barren rocky steep slopes.

B. Taxonomic Diversity

During the field surveys and also based upon secondary data and available information an inventory of 182 plant species in the study area has been prepared. A brief description of number of plant species recorded in various taxonomic groups is given in **Table 2**.

Table 1: Number of species of different plant groups reported from the study area

S. No.	Habit	No. of Families	No. of Genera	No. of Species
1	**Angiosperms**			
	Trees	9	12	19
	Shrubs	13	24	31
	Herbs	25	81	89
	Grasses	2	15	16
	Climbers	5	5	5
2	**Gymnosperms**			
	Trees	2	5	6
	Shrubs	2	2	3
3	**Pteridophytes**	3	4	5
4	**Bryophytes**	3	3	3
5	**Lichens**	4	5	5

i. Angiosperms

As per data collected during field surveys an inventory of 160 species of plants belonging to angiosperms was compiled which includes plant species found in forested areas, scrub land, near agricultural fields and settlements, abandoned land, etc. This list includes 19 species of trees, 31 species of shrubs, 89 species of herbaceous plants, 16 species of grasses and 5 species of climbers. Dominant families in the area are Asteraceae and Rosaceae, followed by Poaceae, Lamiaceae and Fabaceae. List of angiosperms recorded from the area is given in **Annexure-I.** The classification and nomenclature of species is based upon http://www.theplantlist.org/ accessed in September 2021.

ii. Gymnosperms

Gymnosperms in the area were represented by 9 species belonging to 3 families and 7 genera. List of gymnosperms recorded from study area is given in **Table 3**.

Table 2: List of Gymnosperms recorded from the study area

S. No.	Family	Plant species	Common name	Habit
1	Cupressaceae	*Cupressus sempervirens*		Tree
2	Cupressaceae	*Juniperus communis*	Petada, Shukpa	Shrub
3	Ephedraceae	*Ephedra gerardiana*	Somalata	Shrub
4	Ephedraceae	*Ephedra distachya*		Shrub
5	Pinaceae	*Abies spectabilis*	Tosh	Tree
6	Pinaceae	*Cedrus deodara*	Deodar	Tree
7	Pinaceae	*Pinus gerardiana*	Chilgoza pine	Tree
8	Pinaceae	*Pinus wallichiana*	Kail	Tree
9	Pinaceae	*Picea smithiana*	Spruce	Tree

iii. Lower Plants (Pteridophytes and Bryophytes)

In the study area presence of pteridophytes and bryophytes was observed along the streams and moist and wet places. The Pteridophyte group is represented by 5 species belonging to 4 genera and 3 families. *Athyrium foliolosum* and *Pteris* spp. are dominant pteridophyte species in the area. Bryophytes in the study area are represented by 3 species belonging to 3 families. *Marchantia* sp. and *Funaria* sp. are commonly found bryophytes in the study area. The list of Pteridophytes and Bryophytes recorded from the study area are list below in **Table 4**.

Table 3: List of lower plants recorded from the study area

S. No.	Family	Name of Species
Pteridophytes		
1	Athyriaceae	*Athyrium foliolosum*
2	Athyriaceae	*Allantodia spectabilis*
3	Equisetaceae	*Equisetum ramosissimum*
4	Pteridaceae	*Pteris cretica*
5	Pteridaceae	*Pteris aspericaulis*
Bryophytes		
1	Dicranaceae	*Dicranodontium* sp.
2	Funariaceae	*Funaria* sp.
3	Marchantiaceae	*Marchantia* sp.

iv. Lichens

Five species of Lichens were found in the study area belonging to 4 families. Heterodermia, *Hypogymnia sp.* and *Graphis sp.* were the most frequently occurring species found in the study area. List of lichen species recorded from the study are given below in **Table 5**.

Table 4: **List of Liches recorded from the study area**

S. No.	Family	Name of Species
1	Cladoniaceae	*Cladonia* sp.
2	Graphidaceae	*Graphis* sp.
3	Parmeliaceae	*Hypogymnia* sp.
4	Parmeliaceae	*Parmelia* sp.
5	Physciaceae	*Heterodermia* sp.

C. Conservation Status of Floral species

Out of 182 plant species reported from the study area, only 54 species were evaluated by IUCN ver. 2021-2. As per IUCN Red List of Threatened Species 2021-2, *Angelica glauca is* list under Endangered (EN) category*, Saussurea costus* under Critically Endangered (CE), *Ephedra* gerardiana & *Ulmus wallichiana* are under Vulnerable (VU) category and *Abies spectabili* & *Pinus gerardiana* under Near Threatened (NT) category. Rest of the species evaluated are either List Concern (LC) or Data Deficient (DD) category (**Table 6**).

Table 5: Conservation Status of Plant Species

S.No.	Family	Name of Species	Conservation Status IUCN 2021-2
1	Aceraceae	*Acer caesium*	LC
2	Apiaceae	*Angelica glauca*	EN
3	Asteraceae	*Saussurea costus*	CR
4	Berberidaceae	*Berberis aristata*	LC
5	Berberidaceae	*Berberis lycium*	LC
6	Betulaceae	*Corylus jacquemontii*	DD
7	Betulaceae	*Alnus nitida*	LC
8	Betulaceae	*Carpinus viminea*	LC
9	Betulaceae	*Betula utilis*	LC
10	Caryophyllaceae	*Silene vulgaris*	LC
11	Caryophyllaceae	*Stellaria monosperma*	LC
12	Convolvulaceae	*Cuscuta reflexa*	LC
13	Cupressaceae	*Cupressus sempervirens*	LC
14	Cupressaceae	*Juniperus communis*	LC
15	Ephedraceae	*Ephedra gerardiana*	VU
16	Ephedraceae	*Ephedra distachya*	LC
17	Equisetaceae	*Equisetum ramosissimum*	LC
18	Fabaceae	*Robinia pseudo-acacia*	LC
19	Fabaceae	*Indigofera heterantha*	LC
20	Fabaceae	*Lespedeza juncea*	LC
21	Fabaceae	*Medicago polymorpha*	LC
22	Fabaceae	*Trifolium pratense*	LC
23	Fabaceae	*Trigonella emodi*	LC
24	Geraniaceae	*Geranium wallichianum*	LC
25	Hamamelidaceae	*Parrotiopsis jacquemontiana*	LC
26	Hippocastanaceae	*Aesculus indica*	LC
27	Juglandaceae	*Juglans regia*	LC
28	Lamiaceae	*Lamium album*	LC
29	Lamiaceae	*Mentha longifolia*	LC
30	Lamiaceae	*Prunella vulgaris*	LC
31	Oleaceae	*Fraxinus xanthoxyloides*	LC
32	Pinaceae	*Abies spectabilis*	NT

S.No.	Family	Name of Species	Conservation Status IUCN 2021-2
33	Pinaceae	*Cedrus deodara*	LC
34	Pinaceae	*Pinus gerardiana*	NT
35	Pinaceae	*Pinus wallichiana*	LC
36	Pinaceae	*Picea smithiana*	LC
37	Plantaginaceae	*Plantago major*	LC
38	Poaceae	*Arundo donax*	LC
39	Poaceae	*Festuca rubra*	LC
40	Poaceae	*Phleum alpinum*	LC
41	Poaceae	*Poa annua*	LC
42	Ranunculaceae	*Caltha palustris*	LC
43	Ranunculaceae	*Ranunculus sceleratus*	LC
44	Rhamnaceae	*Rhamnus virgatus*	LC
45	Rosaceae	*Prunus armeniaca*	DD
46	Rosaceae	*Prunus padus*	LC
47	Rosaceae	*Spiraea canescens*	LC
48	Salicaceae	*Populus ciliata*	LC
49	Salicaceae	*Salix alba*	LC
50	Salicaceae	*Salix tetrasperma*	LC
51	Saxifragaceae	*Bergenia ciliata*	LC
52	Scrophulariaceae	*Verbascum thapsus*	LC
53	Ulmaceae	*Celtis tetrandra*	LC
54	Ulmaceae	*Ulmus wallichiana*	VU

EN=Endangered; CR=Critically Endangered; VU=Vulnerable; NT=Near Threatened; DD=Data Deficient; LC=Least Concern

5.3 Faunal Elements

List of faunal elements comprising mammals, birds and butterflies found in the study area was compiled from sightings during field visit and supplemented by data collected from secondary sources as well as information provided by local people during field surveys. Among secondary source Forest Working Plan of Pangi Forest Division were consulted. Birds were identified using the field guide of birds by Ali & Ripley (1983), Grimmett *et al.* (1998, 2011), Inskipp *et al.* (1999) and Kazmierczak (2000). The classification and nomenclature of bird species is based upon https://avibase.bsc-eoc.org/ accessed in September 2021. The classification and nomenclature of butterfly species is based upon https://www.ifoundbutterflies.org/ (Butterflies of India).

A. Mammals

The data on mammals reported from the study area was compiled from the Forest Working Plan (implanting years 2002-03 to 2021-22) of the Pangi Forest Division after consultation with forest officials and villagers. Forest officials mention the presence of Common Leopard (*Panthera pardus*), Hanuman Langur (*Semnopitheaus entellus*), Himalayan Goral (*Naemorhedus goral*), Indian Muntjac (*Muntiacus muntjac*), and Himalayan black bear (*Ursus thibetanus*) in the proposed study area lies under the jurisdiction of Pangi Forest Division and same was confirmed by villagers in the study area. However, no direct or indirect evidence could be recorded during the field survey about their presence in and around the project area.

These species are also mentioned in “Cumulative Environmental Impact Assessment Study of Chenab Basin in Himachal Pradesh reported the presence of *Canis aureus,* Yellow-throated Marten and Himalayan Weasel in the project area of Dugar HEP.

According to the list prepared as described above, 12 species of mammals are reportedly found in the area and the same is given in **Table 7**.

Table 6: List of Mammalian species reportedly found in the study area

S. No.	Order/ Family	Scientific Name	Common Name	Conservation Status	
				IUCN 2021-2	WPA 1972
CARNIVORA					
1	Canidae	*Canis aureus*	Jackal	LC	II
2	Canidae	*Vulpes bengalensis*	Indian Fox	LC	II
3	Felidae	*Panthera pardus*	Common Leopard	VU	I
4	Herpestidae	*Herpestes edwardsii*	Indian Grey Mongoose	LC	II
5	Mustelidae	*Martes flavigula*	Yellow throated marten	LC	II
6	Ursidae	*Ursus thibetanus*	Himalayan black bear	VU	II
7	Viverridae	*Paguma larvata*	Himalayan Palm Civet	LC	II
CETARTIODACTYLA					
8	Bovidae	*Naemorhedus goral*	Himalayan Goral	NT	III
9	Cervidae	*Muntiacus muntjac*	Indian Muntjac	LC	III
LAGOMORPHA					
10	Ochotonidae	*Ochotona roylei*	Royle's Pika	LC	IV
PRIMATES					
11	Cercopithecidae	*Semnopitheaus entellus*	Hanuman Langur	LC	II
12	Cercopithecidae	*Macaca mulatta*	Rhesus Macaque	LC	II

IUCN- International Union for Conservation of Nature; VU – Vulnerable; NT- Near Threatened; LC - Least oncern; WPA – Wildlife (Protection) Act, 1972

B. Avifauna

The survey for birds was carried out on fixed width trails wherever the terrain permitted. Birds were identified as per the field guide of birds by Ali & Ripley (1983), Grimmett *et al.* (1998, 2011), Inskipp *et al.* (1999) and Kazmierczak (2000).

During the field survey conducted between March-September 2021, 34 species of birds belonging to 8 Order and 20 families were recorded during the field survey from the study area. Most commonly found birds are Rock Pigeon, Chukar partridge, Jungle Babbler, Drongo, Plumbeous water redstart, Red-vented Bulbul, Blue Whistling Thrush, Myna House sparrow, and Crow. A large portion of avifauna species is comprised of resident birds in the project study area.

A list of bird species was compiled based upon sighting done during the field survey has been given with their conservation status in **Table 8**.

Table 7: List of avifauna recorded from the study area with their conservation status

S. No.	Order/ Family	Scientific Name	Common Name	Conservation Status	
				IUCN 2021-2	WPA 1972
	Accipitriformes				
1	Accipitridae	*Clanga hastata*	Indian Spotted Eagle	VU	-
	Bucerotiformes				
2	Upupidae	Eurasian Hoopoe	*Upupa epops*	LC	-
	Columbiformes				
3	Columbidae	*Streptopelia chinensis*	Spotted Dove	LC	IV
4	Columbidae	*Streptopelia orientalis*	Oriental Turtle dove	LC	IV
5	Columbidae	*Columba livia*	Rock Pigeon	LC	IV

S. No.	Order/ Family	Scientific Name	Common Name	Conservation Status	
				IUCN 2021-2	WPA 1972
	Coraciiformes				
6	Meropidae	*Merops orientalis*	Green Bee Eater	LC	IV
	Galliformes				
7	Phasianidae	*Alectoris chukar*	Chukar partridge	LC	IV
	Passeriformes				
8	Corvidae	*Corvus macrorhynchus*	Jungle Crow	LC	V
9	Corvidae	*Corvus splendens*	House Crow	LC	V
10	Corvidae	*Dendrocitta formosae*	Grey Treepie	LC	IV
11	Dicruridae	*Dicrurus macrocercus*	Black Drongo	LC	IV
12	Leiotrichidae	*Turdoides striata*	Jungle Babbler	LC	IV
13	Emberizidae	*Emberiza cia*	Rock Bunting	LC	IV
14	Fringillidae	*Chloris spinoides*	Yellow-breasted greenfinch	LC	IV
15	Motacillidae	*Motacilla maderaspatensis*	White-Browed Wagtail	LC	IV
16	Motacillidae	*Motacilla alba*	White Wagtail	LC	IV
17	Motacillidae	*Motacilla flava*	Yellow Wagtail	LC	IV
18	Motacillidae	*Phoenicurus leucocephalus*	White capped water redstart	LC	IV
19	Muscicapidae	*Chaimarrornis leucocephalus*	Plumbeous water redstart	LC	IV
20	Muscicapidae	*Copsychus saularis*	Oriental magpie-robin	LC	IV
21	Muscicapidae	*Myophonus caeruleus*	Blue Whistling Thrush	LC	IV
22	Muscicapidae	*Enicurus scouleri*	Little Forktail	LC	IV
23	Nectariniidae	*Aethopyga siparaja*	Crimson Sunbird	LC	IV
24	Paridae	*Silvyparus modestus*	Yellow-browed Tit	LC	IV
25	Paridae	*Parus rubidiventris*	Rufous-vented Tit	LC	IV
26	Passeridae	*Passer rutilans*	House sparrow	LC	IV
27	Passeridae	*Passer rutilans*	Russet Sparrow	LC	IV
28	Pycnonotidae	*Pycnonotus leucogenys*	Himalayan Bulbul	LC	IV
29	Pycnonotidae	*Pycnonotus cafer*	Red-vented Bulbul	LC	IV
30	Cinclidae	*Cinclus pallasii*	Brown Dipper	LC	IV
31	Stumidae	*Acridotheres tristis*	Common Myna	LC	IV
32	Sturnidae	*Acridotheres fuscus*	Jungle Myna	LC	IV
	Piciformes				
33	Megalaimidae	*Megalaima zeylanica*	Brown-headed Barbet	LC	IV
	Psittaciformes				
34	Psittaculidae	*Psittacula cyanocephala*	Plum-headed Parakeet	LC	IV

IUCN- International Union for Conservation of Nature; LC - Least Concern; VU: Vulnerable; WPA – Wildlife (Protection) Act, 1972.

FAUNAL SPECIES SIGHTED DURING FIELD SURVEY

Macaca mulatta

	
Russet Sparrow	**House Sparrow**
	
Oriental magpie robin	**Blue Whistling Thrush**
	
Rock Pigeon	**Oriental Turtle dove**
	
White-Capped water Redstart	**Plumbeous Water Redstart**
	
Chukar Partridge	**White Wagtail**

	
White wagtail	**Yellow-breasted Greenfinch**
	
Himalayan Bulbul	**Red-vented Bulbul**

C. Butterflies

During field survey, a total of 11 species of butterflies belonging to 4 families were recorded from the surrounding of proposed project area (**Table 9**). Nymphalidae family was represented by 4 species followed by Lycaenidae and Pieridae with 3 species and Papilionidae was represented by one species. Indian cabbage white, Pearl white and Indian Tortoiseshell were the frequently sighted species observed all along the water bodies.

Table 8: Butterflies recorded from Study Area

S.No.	Family	Common name	Scientific name	IUCN 2021-2
1	Lycaenidae	*Lycaena phlaeas*	Small Copper	LC
2	Lycaenidae	*Celastrina argiolus*	Hill Hedge Blue	LC
3	Lycaenidae	*Polyommatus eros*	Common Meadow Blue	LC
4	Nymphalidae	*Aglais cachmirensis*	Indian Tortoiseshell	-
5	Nymphalidae	*Vanessa cardui*	Painted Lady	LC
6	Nymphalidae	*Maniola pulchella*	Tawny meadow brown	-
7	Nymphalidae	*Neptis hylas*	Common sailer	-
8	Pieridae	*Pieris canidia indica*	Indian Cabbage White	-
9	Pieridae	*Colias fieldii*	Clouded Yellow	-
10	Pieridae	*Euchloe daphalis*	Pearl white	-
11	Papilionidae	*Papilio machaon*	Old Swallowtail	LC

D. Herpetofauna

Visual Encounter Survey (VES) methodology was followed for recording herpetofauna (amphibians and reptiles). VES is a method in which field personnel walk through an area or habitat for a given time period systematically searching for animals. During the survey, Garden lizard (*Calotes versicolor*), Kashmir Rock Agamid (*Laudakia tuberculata*), and Skinks (*Asymblepharus ladacensis)* were commonly sighted species in the area.

Table 9: Herpetofauna recorded from Study Area

S.No.	Family	Common name	Scientific name
Order: Squamata			

1	Agamidae	*Calotes versicolor*	Oriental garden lizard
2	Agamidae	*Laudakia tuberculata*	Kashmir Rock Agamid
3	Gekkonidae	*Hemidactylus frenatus*	Common house gecko
4	Scincidae	*Asymblepharus ladacensis*	Skinks

E. Conservation Status of Fauna

Leopard (*Panthera pardus*) and Himalayan black bear (*Ursus thibetanus*) are the species listed under Vulnerable (VU) category of IUCN Red list of Threatened Species Version 2021-2. Himalayan Goral (*Naemorhedus goral*) is the species listed under Near Threatened category of IUCN.

As per Indian Wildlife Protection Act (IWP Act) Leopard (*Panthera pardus*) is listed as Schedule I species, *Canis aureus* (Jackal), while Indian Fox (*Vulpes bengalensis*), Himalayan black bear (*Ursus thibetanus*), Indian Grey Mongoose (*Herpestes edwardsii*), Yellow throated Marten (*Martes flavigula*), Himalayan Palm Civet (*Paguma larvata*), Hanuman Langur (*Semnopitheaus entellus*) and Rhesus Macaque (*Macaca mulatta*) are listed as Schedule II species. Himalayan Goral (*Naemorhedus goral*) and Indian Muntjac *Muntiacus muntjac* are species Schedule III species and Royle's Pika (*Ochotona roylei*) is the only species listed under Schedule IV of IWPA (**Table 7**).

Among the avifaunal species sighted from the study area only one species Indian Spotted Eagle (*Clanga hastata*) is listed as Vulnerable (VU) under IUCN 2021-2, rest of the species fall under Least Concern (LC) category. As per WPA (1972) all the species recorded from the area are listed as Schedule IV except House crow and Jungle crow which are listed as Schedule V species (**refer Table 8**).

5.4 Proximity To Protected Area

Sechu Tuan Wildlife Sanctuary is the nearst protected area from proposed Dugar HEP. The location of Sechu Tuan Nala Wildlife Sanctuary with respect to project components is shown in **Figure 2**. All project components are outside the boundary of the Wildlife Sanctuary and its nearest boundary is about 12 km from tailend of proposed reservoir area and about 20 km from proposed Dam site.

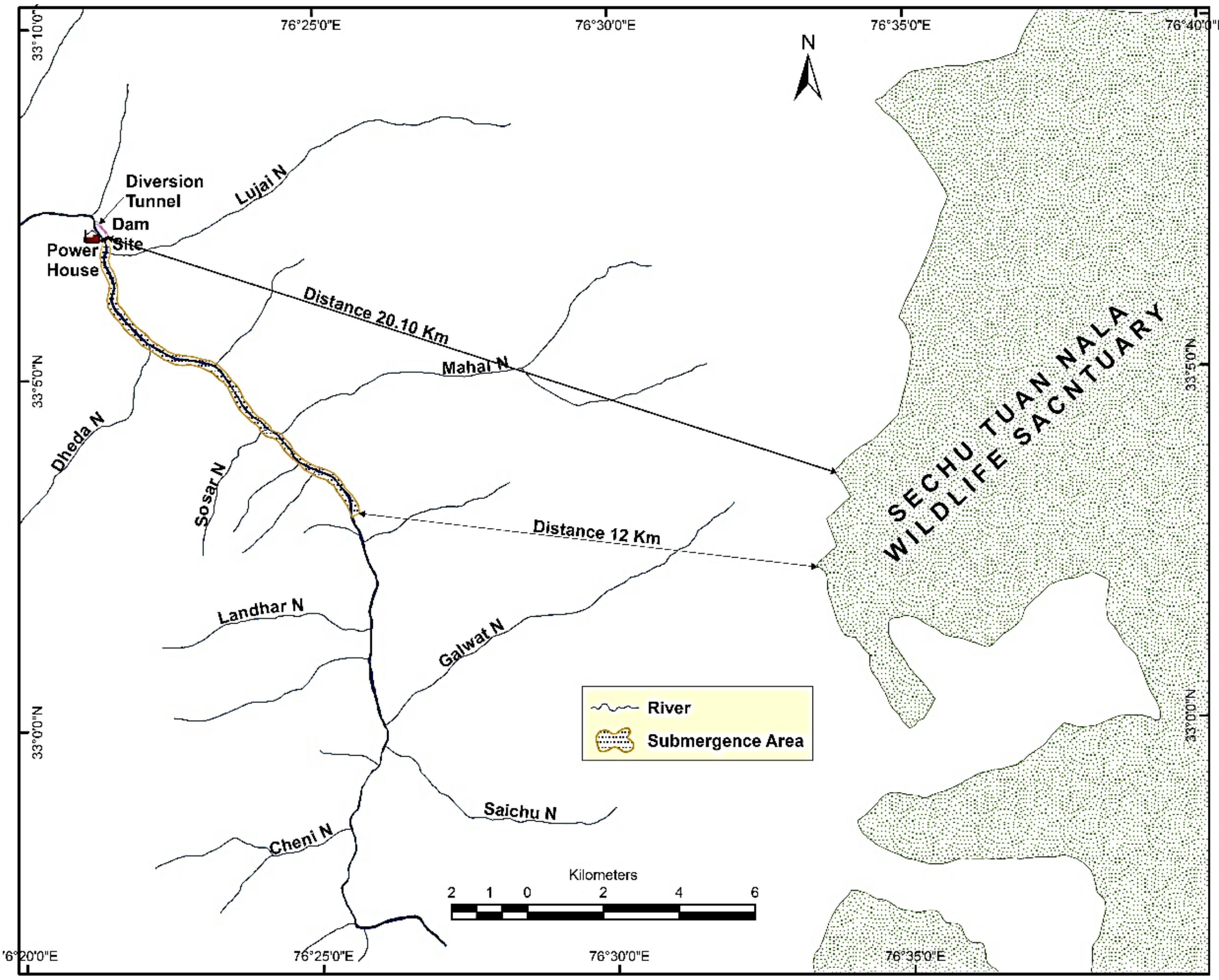

Figure 1: Map showing distance of Sechu Tuan Nala Wildlife Sanctuary from components of Dugar HEP

5.5 Threats to Biodiversity & Wildlife

The fragmentation of forested landscape in the area is happening due to degradation activities like encroachment into forest land, clear felling for timber, man-animal conflict, introduction of exotic species and uncoordinated infrastructural development. Population explosion, over exploitation of forest resources, urbanization, unscientific management, encroachment of forest land, illicit felling, lack of regeneration of forests are major factors responsible for the degradation and depletion of forests in area. Therefore, major threats to biodiversity and wildlife in the project area are as follows.

- Encroachment of Forest land:
- Hunting and poaching:
- Human Elephant Conflict
- Illegal cutting of trees:
- Grazing pressure:

The results of above-mentioned activities and impact of implementation of the proposed Dugar HEP will result in:

i. Loss of plant biodiversity due to conversion forest land for non-forestry use for development of project;

ii. Shrinkage of potential wildlife habitat due to forest degradation;
iii. Particulate pollution due to increase in traffic density and transportation of equipment by road during construction phase of proposed project;
iv. Civil construction and structural installation;
v. Disturbance due to noise pollution and vibration during use of explosive for construction work;
vi. Large work force and increase in demand for biomass; and
vii. Unauthorized stone quarries for construction materials.

5.6 Objectives Of Management

Keeping in view of the anticipated impacts, the management objectives can be described as:

i. Maintenance of ecological balance through preservation and restoration, wherever it has been disturbed due to project developmental activities,
ii. Conservation and preservation of natural habitats in project surrounding
iii. Mitigation and control of project induced biotic and/or abiotic pressures/ influences that may affect the natural habitats,
iv. Habitat enhancement in project area by taking up afforestation and soil conservation measures,
v. Creating all round awareness regarding conservation and ensuring people's participation in the conservation efforts and minimizing human wildlife conflict.

5.7 Mitigation Measures

The above discussed objectives shall be mitigated by implementation of following mitigation measures. Proposed mitigation measures shall be implemented in project area as well as in impact area.

5.7.1 Measures Implemented By Project Authorities

The mitigation measure listed below will be implemented by project proponent within the project area. The cost of proposed measures implemented by project proponent is part of Environmental management Plan.

i. Green Belt Development in the surrounding of Project Area
ii. Energy Conservation Measure to maintain the supply of kitchen fuel
iii. Muck Management Plan
iv. Sanitation and Solid Waste Management
v. Landscaping and Restoration of Construction sites
vi. Control of Air, Noise and Water Pollution in the project area
vii. Safeguard during Construction.
viii. Awareness regarding conservation and ensuring people's participation in the conservation efforts

Implantation of all the above-mentioned management activities and mitigation measures will be monitored by State Pollution Control Board, State Forest Department and District

Administration. Project proponent will submit the compliance of the proposed activities to Regional Office of Ministry of Environment, Forest and Climate Change.

Proposed Plan period

Construction of Dugar HEP is planned to be completed in a period of about 10 years including pre-construction works, creation of infrastructure facilities viz. additional investigations, improvement of road network and colonies. The mitigation measures implemented during construction period by project proponent are therefore proposed for 10 years.

5.7.2 Measures Implemented Under Biodiversity Conservation and Wildlife *Management Plan*

The following management strategies including shall be implemented by forest department in the impact area proposed project.

i. Habitat Improvement of Schedule-I species through conservation and preservation of natural habitats in project surrounding
ii. Infra-structure development
iii. Anti-Poaching measures
iv. Training Programme for Techniques of faunal species Rescue
v. Prevention of Forest Fire
vi. Creating all round awareness regarding conservation and ensuring people's participation in the conservation efforts and minimizing human wildlife conflict.

6. Biodiversity Management & Wildlife Conservation Plan

The most effective way of biodiversity conservation in the area are joint forest management, natural resource management and awareness programme involving local peoples.

Wildlife management consists of habitat evaluation and assessment, periodic monitoring of vegetation cover and animal population status, identification of habitat factors favourable to growth and which act against the population. Welfare factors are promoted, adverse factors are arrested and limiting factors mitigated so that habitat carrying capacity is optimized and populations attain the equilibrium point intrinsic to the species. Participation and support of local public is enlisted to make the conservation plan work and outcome becomes sustainable.

6.1 Wildlife Habitat Preservation & Improvement

i. Afforestation and Enrichment plantation

Afforestation and enrichment plantation will be carried out in the area. Area under forest and tree cover will be expanded through systematic planning and implementation of afforestation and rehabilitation programme in available community lands. Afforestation programme in the degraded Forest Compartments around the project area is also proposed to be carried out in the surrounding to the project area. The sites and species to be planted will be finalized by the state Forest Department as the program will be implemented by them.

Plantation site will be trench fenced and brushwood fence, for the protected from cattle grazing. With the improvement in habitat of wildlife the incidences of human wildlife conflict will accordingly reduce. The estimate cost for plantation over about 10 ha area has been worked @ Rs. 1,12,505/- per ha including maintenance for seven years for Enrichment plantation. The enrichment plantation will be carried along the periphery of upper reservoir in the adjoining forest area. As such, no additional forest land will be diverted for this purpose.

A budgetary estimate has been made @ Rs. 22,50,100/- under this head.

ii. Farm Forestry

The project area harbours number of economically important plants like *Pinus gerardiana*, *Juglans regia*, *Corylus jacquemontii, etc*. These valuable resources will be directly useful to the people of the area which can form the basis of economic upliftment.

With a view to reduce dependence on the natural forests for biomass and other Non-timber forest products (NTFPs) or minor forest products (MFPs) alternate resources need to be building up. NTFPs/MFPs plantations will be carried out on the community land, degraded land, fallow lands which help in sustainable land management and also a tool for reclamation. Abandoned agricultural land with an area of about 10.0 ha will be developed under farm forestry programme.

Decentralized nurseries will be created with the help of forest department. Species to be raised are primarily to cater to fuel, fodder and small timber needs. Seedlings will be distributed every year to villagers on a nominal rate. The distribution will be facilitated through Forest Range office in the area. Forest department may take up prior survey with the help of local administrative bodies/panchayats to assess the requirement plants.

A budgetary provision of Rs. 10,00,000/- (@ Rs. 1,00,000 per ha) has been kept under this head.

6.2 Fencing

It is proposed to develop vegetative barrier along the village boundary adjacent to forest area. These areas are prone to infiltrate by wild animals to hunt livestock's. The seedlings and saplings of hedges like *Salix spp., Rosa webbiana, Juniperus communis, Berberis spp.,* etc. will be sown on the area identified after consultation with forest department. The fence not only check the infiltration of wild predators but also stop the preys from crop raiding.

Along the biological fencing, physical structure by means of stone wall and barbed wire fencing would be erected on the area were biological fencing is not feasible.

A total cost of Rs. 10,00,000/- has been made for creation of fencing along the edges of forest adjacent to villages.

6.3 Development of Grazing lands/ Pasture lands

As there are degraded patches of pasture in the area, this measure will be adopted to encourage development of new and healthy pastures for use of wild animals in the area. Barren land with greater slopes has been recommended to be treated by developing pastures over them. Under this treatment, protection from domestic cattals, and introduction of suitable species of grasses and leguminous plant species be planted in the land area earmarked for the purpose. Designated area for development of grassland will be identified by forest department. Financial provision for development of grassland has been kept for an area of 25 ha with estimated cost of Rs. to be Rs. 15,85,875/- @ Rs. 63,435/- per ha.

6.4 Development of Eco Park

The Nature Interpretation Centre (NIC) is a kind of museum, often associated with visitor centres or eco-museums, and built and located in areas to preserve biodiversity and cultural diversity. Interpretation centres use different means of communication to enhance the understanding of natural heritage. Environmental interpretation is usually carried out in areas which facilitate knowledge about nature and the relationship between society and nature in a specific location or region. The creation Eco-Park including Interpretation Center will have trails and walks for use by the visitors as an important support mechanism for the environmental education process and complementing the educational possibilities in more innovative ways. The centre shall also host 'Teach the Mentor' programmes, where, tourists, villagers, school and college students and teachers from neighbouring areas can share their knowledge & experience and learn more about the region’s biodiversity first-hand. That way, they can educate the next generation about the importance of conserving the ecosystem, too.

At present forest department working on development of an Eco- Park at Sural Bhatori with the financial and technical assistance of Global Environment Facility (GEF), UNDP. At the area of Avenue plantation of native tree, shrub and herb species of aesthetic, economical and medicinal importance plant species to be done in the park. The Park will be managed by local youth societies under supervision of forest department.

For the landscaping of such park a professional landscape architect may be engaged along with the help of Forest and Horticulture Departments and other experts.

A financial aid allocated for the establishment development and management of Eco-Park of is **Rs. 20,00,000** only.

6.5 Prevention and Control of Forest Fire

Forest fire is caused both naturally as well as by the human beings. Wild animals trapped and killed due to forest fire. Forest fire not only destroy the habitat but also disrupt the food chain. Due to habitat loss and decrease of prey in natural habitat tempted to prey on domestic livestock and cause human wildlife conflict. The following measures are therefore proposed to be taken to prevent forest fire:

i. **Clearing of Fire Line:** Fireline will be cleared in vulnerable areas and maintained annually. A budgetary provision of Rs. 10,00,000/- @ Rs. 1.0 lakh per year has been kept for clearing of fire lines in the forest area vulnerable to forest fire.

ii. **Fire Fighting Equipment’s:** Fire watchers will be equipped with certain Fire Fighting Equipment’s such as Fire resistance dress, Water bottle, Axe, Shoes etc. to attend to emergencies. A provision of Rs. 5,00,000/- has been made for fire-fighting equipment's.

iii. **Training**: Provision of training has been made for volunteers and staff of forest department to early detection and control of forest fire.

The total budget of **Rs. 15,00,000/-** has been proposed for control and prevention of forest fire.

6.6 Awareness Programme

The success of any conservation plan of this magnitude is entirely hinged on the active support and wholehearted co-operation of all stakeholders with the members of public playing a major role. For this purpose, meetings and workshops will be organized from village to village on regular basis. Functions like Van Mahotsav, Wildlife Week, World Forestry Day, and World Environment Day will be organized in a befitting manner to which village heads, members of public representatives' system at Gram Panchayat level, local leaders and members of NGO will be involved. The topics should include deterioration of biodiversity, habitat loss, control of Blue Bull and Wild Boar damages and other human wildlife conflicts, fire damage control and how best the vegetation can be revamped etc. Members of public will be encouraged to speak. Student community should also be sensitized on various conservation issues.

Considering that the wildlife populations will be impacted by project construction activities and also due to influx of migrant labour force, mitigation measures should also be taken for the larger area. The following measures are proposed:

- Control on poaching.
- Awareness campaigns aimed at creating awareness towards respecting the habitat protection in general and the protection of wildlife species in particular.

Under this programme, various activities viz. training, publishing of pamphlets, brochures, hoardings, etc. shall be carried out during the construction phase of the project.

The following activities are planned under this programme:

Observance of Wildlife Week: The wildlife week will be celebrated every year in the month of March to assess all the tasks set aside for wildlife management. Under this programme, seminars, art competitions and awareness campaigns will be held.

Nature Club: Nature clubs will be introduced at Higher secondary and High school level in the project area. They will be imparted education by means of audio-visual aids so as to sensitize them about importance of wildlife conservation.

Involvement of Village Panchayats and NGOs: The Panchayats of affected villages and active NGOs in the project area would be involved to disseminate the knowledge about the benefits of the proposed project and ensuring greater participation in the conservation efforts and safeguard the environment of the area.

For implementation of awareness programme an amount of **Rs. 1.00 lakh/year** has been budgeted.

6.7 Strengthening of Infrastructural Facilities of Forest Department

Under this plan Project authority would assist the State Forest Department in strengthening the infrastructure facilities, which are poorly developed in the area. Various activities which are necessary for the forest protection plan are described in the following paragraphs.

i) For improvement of vigilance and measures to check poaching, check posts and watch towers will be needed. In order to strengthen the working capacity, the workforce of the State Forest/Wildlife Department they must be provided with necessary equipment such as a camera, wireless, binoculars GPS, search lights, health kits, etc. that would increase their capability and efficiency of monitoring.

ii) The construction of inspection paths and watch towers for more effective and meaningful patrolling by the department.

iv) Creation of veterinary facilities and rescue camps for healthcare of wild animals and for disease control. For this purpose, it is essential to maintain a stock of medicines in addition to setting up of a *mobile-rescue-cum-publicity-van*.

Project authorities would provide funds to State Forest Department. Total financial outlay under this head would be **Rs. 30.00 lakh**.

6.8 Safeguard during construction

The important mitigation and safeguard measures to be followed are given below:

i. Project authorities shall organize a training programme for the workers to ensure that workers are aware of the importance of biodiversity conservation and not to do activities leading to endangering the plants and animals. All project workers shall be aware of the legal consequences of hunting, poaching of animals, and harvesting of forest produce.
ii. To ensure above-mentioned measures are implemented, movement of workers will be controlled especially entry into the r forested landscapes, and protected areas without valid permit.
iii. Cutting and collection of fuelwoods by the construction workers from the forest should be strictly prohibited.
iv. No person shall carry on any activity that is harmful to habitat of birds including their eggs, nests, and habitat
v. The project proponent would impose restrictions on the disposal of any type of pesticide, poison, and other toxic material in the forest areas.
vi. No person shall carry any firearm or any hunting appliance in the project area.
vii. All the areas should be declared as plastic-free, smoking free and silence zone and signboards for the purpose should be displayed at the work site and workers should be made aware of it by training.
viii. Project authorities shall follow the mechanism of control blasting especially during the breeding season of a faunal species in consultation with the wildlife department. This activity is to be restricted during nights, early mornings, and late afternoons, which are the feeding times of most of the fauna.

6.9 Budget

Total budget for the Biodiversity Management & Wildlife Conservation Plan would be **Rs. 138.36 lakh**. The breakup of the budget is given at **Table 17** below.

Table 10: Budget for Biodiversity Management & Wildlife Conservation Plan

S. No.	Particulars	Total Amount (Rs. in lakh)
1	Afforestation Enrichment Plantation	22,50,100.00
2	Farm forestry for fruit, fodder, and fuelwood species	10,00,000.00
3	Fencing along edges of forest	15,00,000.00
3	Development of Grassland	15,85,875.00
4	Development of Eco-Park	20,00,000.00
5	Control and Prevention of Forest Fire	15,00,000.00
6	Awareness Program @ Rs. 1 lakh/year for 10 years	10,00,000.00
7	Strengthening of Infrastructural Facilities of Forest Department	30,00,000.00
	Total	**1,38,35,975**

7. CONSERVATION AND MANAGEMENT OF SCHEDULE-I SPECIES

In reference to additional conditions of Term of Reference (ToR) issued by Ministry of Environment, Forest and Climate Change (MoEF&CC) via letter No. F. No. J-12011/22/2019-IA-I dated 28th February 2020 (**Annexure-I**), directed to submit Conservation plan for the Scheduled I species reported from the study area. Therefore, the proposed mitigation measures suggested in this chapter are focused on habitat management and conservation of Schedule-I species reported from the study area.

The data on mammals reported from the study area was compiled from Forest Working Plan of Pangi Forest Division after consultation with forest officials and villagers. In the project area Forest officials mention presence of Leopard (*Panthera pardus*), and same was confirmed by villagers in the study area. However, no direct or indirect evidence could be recorded during the field survey. As per IWPA 1972, Leopard (*Panthera pardus*) is a Schedule I species.

7.1 Leopard (Panthera pardus)

The Indian leopard (*Panthera pardus*) is one of the five big cats found in India, apart from the Asiatic lion, Bengal tiger, Snow leopard, and Clouded leopard. The Indian leopard (*Panthera pardus*) is widely distributed in the Indian subcontinent.

7.1.1.1 Habitat

The species has a wide geographical range. On the Indian subcontinent, topographical barriers to the dispersal of this species are the Indus River in the west and the Himalayas in the north. In the east, the lower course of the Brahmaputra and the Ganges Delta form natural barriers to the distribution of the Indochinese leopard. Indian leopards are distributed all over India, in Nepal, Bhutan, Bangladesh, and parts of Pakistan. They inhabit tropical rain forests, Dry deciduous forests, Temperate forests, and Northern coniferous forests. Its range stretches from the Indus River in the west, the Himalayas in the north and all the way to the lower course of the Brahmaputra in the east.

In Pangi Forest Division Leopard was found elevation of 2500m (Forest Working Plan, Pangi Forest Division). It resides in isolated rocky hills, where leopard found suitable habitat and cover for depredation on wild as well domestic animals.

7.1.1.2 Conservation Status

As per Indian Wildlife Protection Act (1972) Leopard is listed under Schedule-I species. The leopard is classified as Vulnerable (VU) on the IUCN Red List of Threatened Species Ver. 2020-1 (https://www.iucnredlist.org/species/15954/163991139). *Panthera pardus* is listed in CITES Appendix I.

7.1.1.3 Threats

a. **Habitat Threats**: Loss of natural habitat is a major threat to leopards. Habitat fragmentation reduced prey base and conflict with livestock and game farming has reduced Leopard populations throughout most of their range (https://www.Iucnredlist.org/species/15954/163991139). Habitat degradation caused by overgrazing, overharvest of forest products, expansion of agricultural areas, and mining of minerals also possess threats to the habitat of species.

b. **Human - Leopard Conflicts**: Human leopard conflict is a well-known problem in and around protected as well as unprotected areas in India (Chauksey *et. al*., 2017). Many wildlife biologists have studied the human leopard conflict in India like Athreya *et. al.* (2007), Chellam (2010), Aggarwal *et. al*. (2011), Mathur (2014), Chauksey *et. al*. (2017), Kshettry *et. al*. (2017), Naha *et. al.* (2018), and Athreya *et. al.* (2020). These studies have listed several factors responsible for these conflicts. Some of them are the expansion of agriculturally used land, encroachment of humans and their livestock into protected areas are main factors contributing to habitat loss and decrease of wild prey. As a result, leopards approach human settlements, where they are tempted to prey on domestic livestock like cattle, dogs, and goats, which constitutes an important part of their diet if they live on the periphery of human habitations. In retaliation for attacks on livestock, leopards are shot, and trapped in brutal snares. Leopard-human conflict is a serious problem in India and the subcontinent and is another cause of significant mortality of Leopards. India's Forest Department is entitled to set up traps only in cases of a leopard having attacked humans.

c. **Poaching**: A significant immediate threat to wild leopard populations is the illegal trade in poached skins and body parts. Illegal trade in Leopard body parts (skin, bones, and claws) continues to threaten the survival of the species in the wild.

d. **Forest Fire:** Forest fire is caused both naturally as well as by the human beings. Wild animals trapped and killed due to forest fire. Forest fire not only destroy the habitat but also disrupt the food chain. Due to habitat loss and decrease of prey in natural habitat Leopard tempted to prey on domestic livestock and cause human wildlife conflict.

e. Activities like road construction and other anthropogenic interference lead to the disturbance of wildlife habitat.

7.1.1.4 Management and Conservation Measures

Athreya and Belsare (2007) have listed ten commandments of wildlife interventions for human leopard conflict management guidelines. Chauksey et. al. (2017) also have suggested a number of management measures to reduce human leopard conflict.

Therefore, based upon these studies the following measures are suggested for this project.

a. **Habitat improvement**: Leopards live in a variety of dry and wet forests, and in some grasslands, where boulders and scattered shrubs and trees provide shelter. The leopard has the widest habitat tolerance than any big cat in India. The habitat of the species will be improved by planting suitable species in surrounding areas. The prey species preferred by the leopard will be conserved to ensure sufficient prey availability, which will also reduce the conflict with humans.

b. **Biological Fences:** Conflicts generally arise when leopard enters in croplands and human settlements, which indirectly reflect the condition of adjacent forested areas, i.e., its ability to support leopard. Protective Fencing to Protect Livestock: Biological fences will be used to protect the livestock from a leopard attack. Financial provision for fencing has been kept under **Section 10.15.9.2** (**refer Table 10**)

c. **Prevention of Forest Fire**

The Conservation Plan also emphasis on prevention of forest fire. The following measures are therefore proposed to be taken to prevent forest fire:

i. **Clearing of Fire Line:** Fireline will be cleared in vulnerable areas and maintained annually.
ii. **Fire Fighting Equipments: Fire watchers will be equipped with certain Fire Fighting** Equipments such as Fire resistance dress, Water bottle, Axe, Shoes etc. to attend to emergencies.
iii. **Training:** Provision of training has been made for volunteers and staff of forest department to early detection and control of forest fire.

To control and prevention of forest fire in the project area, provision of cost is kept under **Section 10.15.9.5 (refer Table 10)**

iv. **Strict Protection Measures**: The Wildlife (Protection) Act of 1972 provides us with the statutory framework for wildlife conservation, and Poaching is a crime against wildlife. During interviews and discussions with local people, it was noted that the study area is not prone to poaching or any other wildlife violence related to leopards. But precaution will be always taken while dealing with wildlife. The contact information of the concerned wildlife and forest department will be provided to every worker or at the field office. If any kind of poaching or other offense is noticed; it will be immediately brought to the notice of the concerned Forest and Wildlife Officials. More importantly, workers will be made aware of wildlife crime and subsequent penalties and punishment.

v. **Veterinary care**: Strengthening of veterinary care and provision of ambulance with cages for injured or sick animals will be carried out with the help of experts of forest department and local veterinary facilities available in the area.

vi. **Public Awareness Programme**: Involvement of local people in conservation activities will be ensured by organizing meetings and seminars from village to village on regular basis to carry the people along with implementation. Moreover, workers will be trained and educated about the importance of leopards for ecology and ultimately for humans; an internal attraction towards the species will be tried to develop.

The support of village heads and other members of gram panchayat, local leaders, and members of regional NGOs would be solicited to execute the proposed awareness and habitat improvement programmes. Functions like Wildlife Week, World Forestry Day, *Van Mahotsav,* and World Environment Day will be organized. The discussions would r evolve around habitat loss, human-wildlife conflicts, and how best the vegetation cover can be increased, etc.

Moreover, a training workshop for all workers shall be conducted in starting of any project. It will include formal training on the importance of biodiversity and to make available the information of the flora and fauna of high conservation value present in the area. Information on Wildlife policies and Government regulations and penalties will be provided to workers. Similar kinds of activities will be done from time to time to enhance the interest of project workers in conservation.

7.1.1.5 Locations of Proposed Intervention & Implementing Agency

Proposed intervention shall be implemented by State Forest department. Hence the selection of site for implementation of proposed measures will be finalized by state forest department.

7.1.1.6 Budgetary Provisions

The total budget allocated focusing on Conservation plan for Schedule -I species is **Rs 25.00 lakh**. The Break-up of the budget is given in **Table 11**.

Table 11: Budget for Conservation Plan for Schedule I Species

S. No.	Conservation Activities	Expenditure (Rs. in Lakh)
A	Habitat Conservation	5.00
B	Biological Fencing*	0.00
C	Prevention of Forest Fire*	0.00
D	Veterinary care	15.00
E	Awareness Programme	5.00
	TOTAL	**25.00**

* financial provision made under Biodiversity conservation Plan (refer table 10)

8. Monitoring and Evaluation

The monitoring and evaluation of Biodiversity Conservation and Wildlife Management Plan of Dugar Hydro Electric Project will be carried out by a Biodiversity Management Committee (BMC). The committee will follow the guidelines of National Biodiversity Authority, State Biodiversity Conservation Strategy Action Plans (SBCSAP) and State Forest Department to implement, monitor and evaluate the Biodiversity Conservation and Wildlife Management Plan of the proposed Project. The activities of BMC shall be under the direct administrative control of the Chief Wildlife Warden/Principal Chief Conservator of Forests, Himachal Pradesh. The BMC will comprise of the following members:

Chief Wildlife Warden/Principal Chief Conservator of Forests, Dimachal Pradesh	Chairman
Manager (Environment) NHPC Ltd.	Member Secretary
Divisional Forest Officer of the concerned Division	Member
Experts form State University and Active NGO's	Member
Local Body's Representatives from the villages	Member

The Chairman of the committee will have the right to assign various activities to various members for proper functioning and result-oriented tasks. The committee will monitor the progress of the proposed plan. Total financial outlay for the BMC would be **Rs. 10.00 lakh** only.

9. Budgetary Provisions

The total estimate of Biodiversity Conservation and Wildlife Management Plan is therefore (Rs. 138.36 lakh + 25.00 lakh+ 10.00 lakh) = **Rs. 173.36 lakhs**. State Forest Department is the executing agency for the implementation of proposed mitigation measure under Biodiversity Conservation and Wildlife Management Plan, therefore, a total amount of **Rs. 173.36 lakh** will be deposited with the D.F.O/ Forest Department for taking up different activities within the area.

The Break-up of the budget is given in **Table 18**.

Table 12: Break-up for Wildlife Management and Conservation Plan for Schedule I Species

S.No.	Activity	Fund Allocated (Rs in Lakhs)
A	Biodiversity Conservation and Management Plan	138.36
B	Conservation Plan for Schedule-I Species	25.00
C	Monitoring and Evaluation	10.00
	Total	**173.36**

Annexure-IX

CROSS SECTIONS FOR DAM BREAK MODELING

Dam Site		160m		2160m		4160m		6160m		8160m		10160m	
Distance (m)	**Elevation (m)**	**Distance (m)**	**Elevation (m)**	**Distance (m)**	**Elevation (m)**	**Distance (m)**	**Elevation (m)**	**Distance (m)**	**Elevation (m)**	**Distance (m)**	**Elevation (m)**	**Distance (m)**	**Elevation (m)**
0.00	2182.22	0.00	2241.44	0.00	2189.27	0.00	2127.69	0.00	2187.48	0.00	2293.82	0.00	2166.62
27.96	2170.55	27.72	2197.35	26.99	2187.22	27.68	2106.17	27.50	2168.45	27.75	2263.03	27.63	2145.76
55.91	2154.57	55.44	2169.20	53.98	2178.17	55.35	2082.42	55.00	2126.52	55.50	2210.01	55.27	2121.17
83.87	2135.40	83.15	2154.44	80.96	2159.45	83.03	2058.38	82.49	2074.86	83.25	2163.48	82.90	2098.61
111.83	2116.91	110.87	2135.37	107.95	2130.41	110.70	2053.71	109.99	2040.98	111.00	2113.62	110.54	2063.18
139.79	2084.34	138.59	2117.22	134.94	2095.08	138.38	2015.32	137.49	2019.97	138.75	2039.23	138.17	2020.06
167.74	2042.96	166.31	2089.44	161.93	2062.74	166.05	1982.81	164.99	2002.73	166.50	1990.50	165.81	1986.69
195.70	2019.41	194.02	2061.38	188.91	2031.86	193.73	1968.33	192.49	1985.56	194.26	1960.84	193.44	1952.98
223.66	2017.05	221.74	2038.22	215.90	2006.77	221.40	1964.04	219.98	1965.50	222.01	1945.22	221.07	1930.20
251.61	2017.00	249.46	2017.95	242.89	1991.00	249.08	1962.52	247.48	1952.04	249.76	1943.73	248.71	1929.01
279.57	2030.73	277.18	2017.00	269.88	1993.86	276.75	1963.47	274.98	1953.13	277.51	1952.45	276.34	1929.51
307.53	2057.85	304.90	2017.00	296.86	2024.83	304.43	1967.58	302.48	1975.16	305.26	1972.83	303.98	1951.12
335.49	2078.79	332.61	2056.25	323.85	2046.49	332.10	1982.02	329.98	2001.97	333.01	2013.29	331.61	1980.86
363.44	2101.35	360.33	2094.45	350.84	2062.54	359.78	2007.40	357.47	2024.12	360.76	2074.41	359.25	1999.79
391.40	2130.90	388.05	2124.50	377.83	2082.92	387.45	2027.77	384.97	2043.27	388.51	2120.50	386.88	2001.26
419.36	2150.20	415.77	2143.96	404.81	2085.14	415.13	2047.59	412.47	2064.34	416.26	2154.01	414.51	2016.10
447.31	2171.71	443.49	2163.72	431.80	2096.65	442.80	2072.20	439.97	2083.04	444.01	2218.63	442.15	2033.94
475.27	2197.35	471.20	2184.87	458.79	2111.01	470.48	2092.55	467.47	2100.40	471.76	2271.92	469.78	2076.53
		498.92	2206.56	485.78	2130.65	498.15	2104.51	494.96	2113.34	499.51	2313.31	497.42	2140.53

12160m		14160m		16160m		18160m		20160m		22160m		24160m	
Distance (m)	**Elevation (m)**	**Distance (m)**	**Elevation (m)**	**Distance (m)**	**Elevation (m)**	**Distance (m)**	**Elevation (m)**	**Distance (m)**	**Elevation (m)**	**Distance (m)**	**Elevation (m)**	**Distance (m)**	**Elevation (m)**
0.00	2088.69	0.00	2110.38	0.00	1968.14	0.00	2093.95	0.00	2005.76	0.00	1992.30	0.00	1975.72
27.71	2069.84	27.49	2083.59	27.61	1953.26	27.34	2050.74	27.60	1984.27	27.66	1966.08	27.68	1954.81
55.42	2042.49	54.97	2056.87	55.21	1936.02	54.68	1998.02	55.20	1974.74	55.32	1949.88	55.35	1938.43

12160m		14160m		16160m		18160m		20160m		22160m		24160m	
Distance (m)	Elevation (m)	Distance (m)	Elevation (m)	Distance (m)	Elevation (m)	Distance (m)	Elevation (m)	Distance (m)	Elevation (m)	Distance (m)	Elevation (m)	Distance (m)	Elevation (m)
83.12	2007.81	82.46	2021.77	82.82	1926.46	82.02	1971.86	82.79	1960.50	82.98	1932.05	83.03	1917.90
110.83	1976.46	109.94	2002.58	110.42	1916.17	109.36	1944.80	110.39	1944.96	110.64	1910.10	110.70	1891.80
138.54	1948.72	137.43	1980.20	138.03	1910.09	136.70	1933.03	137.99	1928.37	138.31	1886.01	138.38	1859.49
166.25	1926.74	164.91	1962.93	165.64	1901.18	164.04	1920.92	165.59	1906.48	165.97	1870.24	166.05	1836.86
193.96	1917.61	192.40	1937.27	193.24	1895.30	191.38	1895.66	193.19	1891.14	193.63	1860.05	193.73	1826.12
221.66	1913.33	219.88	1907.10	220.85	1892.00	218.72	1885.92	220.78	1867.40	221.29	1844.51	221.40	1809.26
249.37	1908.70	247.37	1898.52	248.45	1892.00	246.06	1883.05	248.38	1849.53	248.95	1833.18	249.08	1801.69
277.08	1915.09	274.85	1907.54	276.06	1905.14	273.40	1885.82	275.98	1858.24	276.61	1832.00	276.75	1816.64
304.79	1945.85	302.34	1939.63	303.67	1939.94	300.74	1940.09	303.58	1914.36	304.27	1833.02	304.43	1863.34
332.49	2003.11	329.82	1958.27	331.27	1989.45	328.08	1978.58	331.18	1991.99	331.93	1835.51	332.10	1909.69
360.20	2060.76	357.31	1972.07	358.88	2011.36	355.42	2007.75	358.77	2052.32	359.59	1863.78	359.78	1921.66
387.91	2105.36	384.79	1984.98	386.48	2034.91	382.76	2053.50	386.37	2084.45	387.26	1895.73	387.45	1938.39
415.62	2152.86	412.28	1999.03	414.09	2055.08	410.10	2113.43	413.97	2108.39	414.92	1925.44	415.13	1955.24
443.33	2194.37	439.76	2012.25	441.70	2066.68	437.45	2144.48	441.57	2129.69	442.58	1942.63	442.80	1964.95
471.03	2223.60	467.25	2029.55	469.30	2091.07	464.79	2168.54	469.17	2148.90	470.24	1974.46	470.48	1966.47
498.74	2226.78	494.73	2052.65	496.91	2120.10	492.13	2193.59	496.77	2167.68	497.90	2002.59	498.15	1961.61

26160m		28160m		30160m		32160m		34160m		36160m		38160m	
Distance (m)	Elevation (m)	Distance (m)	Elevation (m)	Distance (m)	Elevation (m)	Distance (m)	Elevation (m)	Distance (m)	Elevation (m)	Distance (m)	Elevation (m)	Distance (m)	Elevation (m)
0.00	1942.52	0.00	1945.83	0.00	1834.35	0.00	1788.80	0.00	1857.67	0.00	1777.21	0.00	1816.76
27.59	1929.09	27.64	1926.27	27.78	1814.05	27.86	1786.81	28.01	1850.94	27.50	1775.03	27.69	1797.77
55.19	1915.98	55.28	1913.73	55.56	1791.69	55.71	1783.28	56.01	1845.19	55.01	1767.69	55.39	1783.02
82.78	1899.50	82.92	1897.05	83.34	1774.37	83.57	1776.01	84.02	1833.60	82.51	1763.01	83.08	1766.09
110.37	1880.87	110.56	1868.28	111.13	1764.95	111.42	1768.81	112.02	1813.94	110.01	1759.51	110.77	1749.36
137.96	1855.21	138.20	1831.70	138.91	1757.89	139.28	1766.32	140.03	1790.23	137.52	1756.07	138.47	1732.84
165.56	1830.37	165.85	1799.99	166.69	1756.14	167.13	1763.62	168.04	1768.51	165.02	1750.51	166.16	1719.84
193.15	1795.45	193.49	1774.67	194.47	1754.59	194.99	1756.25	196.04	1752.39	192.52	1740.23	193.85	1708.00
220.74	1775.88	221.13	1771.34	222.25	1754.00	222.85	1749.92	224.05	1745.99	220.02	1730.57	221.54	1708.00
248.33	1775.02	248.77	1771.00	250.03	1754.00	250.70	1749.00	252.05	1743.79	247.53	1728.06	249.24	1708.00

26160m		28160m		30160m		32160m		34160m		36160m		38160m	
Distance (m)	**Elevation (m)**	**Distance (m)**	**Elevation (m)**	**Distance (m)**	**Elevation (m)**	**Distance (m)**	**Elevation (m)**	**Distance (m)**	**Elevation (m)**	**Distance (m)**	**Elevation (m)**	**Distance (m)**	**Elevation (m)**
275.93	1779.75	276.41	1780.18	277.81	1759.01	278.56	1749.12	280.06	1742.30	275.03	1728.00	276.93	1708.00
303.52	1843.60	304.05	1795.28	305.59	1772.07	306.41	1750.60	308.07	1745.39	302.53	1730.64	304.62	1713.52
331.11	1849.03	331.69	1809.42	333.38	1786.18	334.27	1751.35	336.07	1755.03	330.04	1732.64	332.32	1735.55
358.70	1894.59	359.33	1822.19	361.16	1788.84	362.12	1752.11	364.08	1762.75	357.54	1734.55	360.01	1747.63
386.30	1943.12	386.97	1846.55	388.94	1789.89	389.98	1752.00	392.08	1764.85	385.04	1735.80	387.70	1749.00
413.89	1991.26	414.61	1887.78	416.72	1792.27	417.84	1752.01	420.09	1770.37	412.55	1737.40	415.40	1751.77
441.48	2024.83	442.25	1923.69	444.50	1793.97	445.69	1757.72	448.10	1773.99	440.05	1739.13	443.09	1757.72
469.08	2040.80	469.90	1946.78	472.28	1795.04	473.55	1765.46	476.10	1777.63	467.55	1745.59	470.78	1760.83
496.67	2063.16	497.54	1964.60	500.06	1795.04	501.40	1767.79	504.11	1780.36	495.05	1750.51	498.48	1763.54
										522.56	1753.39		
										550.06	1758.78		
										577.56	1786.67		
										605.07	1827.92		
										632.57	1859.05		

40160m		42160m		44160m		46160m		48160m		50160m		52160m	
Distance (m)	**Elevation (m)**	**Distance (m)**	**Elevation (m)**	**Distance (m)**	**Elevation (m)**	**Distance (m)**	**Elevation (m)**	**Distance (m)**	**Elevation (m)**	**Distance (m)**	**Elevation (m)**	**Distance (m)**	**Elevation (m)**
0.00	1816.07	0.00	1776.08	0.00	1749.31	0.00	1748.22	0.00	1810.21	0.00	1743.41	0.00	1635.11
27.69	1784.13	27.65	1756.30	27.63	1763.19	27.65	1731.90	27.77	1776.98	27.61	1717.98	27.87	1605.88
55.38	1765.97	55.30	1707.56	55.25	1754.83	55.29	1711.75	55.54	1746.85	55.22	1688.85	55.75	1578.75
83.07	1755.37	82.94	1723.08	82.88	1730.09	82.94	1689.86	83.32	1724.66	82.83	1658.02	83.62	1563.51
110.75	1726.29	110.59	1744.53	110.51	1695.00	110.59	1670.64	111.09	1696.60	110.44	1621.06	111.49	1556.76
138.44	1704.41	138.24	1730.59	138.13	1664.72	138.24	1647.60	138.86	1651.64	138.05	1589.37	139.37	1540.55
166.13	1688.97	165.89	1716.55	165.76	1653.92	165.88	1614.40	166.63	1620.41	165.66	1581.09	167.24	1526.17
193.82	1680.43	193.53	1701.74	193.39	1648.59	193.53	1593.16	194.41	1586.65	193.26	1544.52	195.11	1507.25
221.51	1677.84	221.18	1676.71	221.01	1653.08	221.18	1577.26	222.18	1559.78	220.87	1521.66	222.99	1490.01
249.20	1677.99	248.83	1669.00	248.64	1656.04	248.83	1570.04	249.95	1549.65	248.48	1516.02	250.86	1479.25
276.88	1688.85	276.48	1669.68	276.27	1656.00	276.47	1574.17	277.72	1557.95	276.09	1527.53	278.73	1479.13
304.57	1727.00	304.12	1684.53	303.90	1656.00	304.12	1592.29	305.50	1590.64	303.70	1551.94	306.61	1490.40

40160m			42160m			44160m			46160m			48160m			50160m			52160m	
Distance (m)	Elevation (m)		Distance (m)	Elevation (m)		Distance (m)	Elevation (m)		Distance (m)	Elevation (m)		Distance (m)	Elevation (m)		Distance (m)	Elevation (m)		Distance (m)	Elevation (m)
332.26	1728.02		331.77	1724.51		331.52	1657.81		331.77	1631.55		333.27	1620.15		331.31	1593.43		334.48	1504.35
359.95	1764.79		359.42	1758.32		359.15	1670.59		359.42	1670.15		361.04	1654.29		358.92	1669.66		362.35	1536.84
387.64	1802.53		387.07	1797.89		386.78	1687.06		387.06	1704.61		388.81	1690.02		386.53	1719.57		390.23	1587.70
415.33	1847.59		414.71	1843.60		414.40	1725.37		414.71	1732.73		416.58	1723.94		414.14	1732.44		418.10	1651.00
443.02	1886.68		442.36	1887.74		442.03	1744.66		442.36	1787.27		444.36	1747.46		441.75	1753.41		445.97	1699.62
470.70	1928.31		470.01	1915.05		469.66	1767.26		470.01	1812.34		472.13	1742.69		469.36	1777.15		473.85	1731.84
498.39	1935.85		497.66	1926.47		497.28	1790.91		497.65	1836.87		499.90	1754.31		496.97	1814.49		501.72	1750.32

54160m			56160m			58160m (Kiru Dam Site)	
Distance (m)	Elevation (m)		Distance (m)	Elevation (m)		Distance (m)	Elevation (m)
0.00	1550.89		0.00	1797.59		0.00	1577.96
27.57	1541.57		27.75	1774.75		3.27	1574.26
55.15	1528.80		55.50	1729.04		7.10	1568.52
82.72	1510.81		83.25	1682.79		24.04	1515.72
110.30	1489.80		111.00	1639.97		35.40	1482.50
137.87	1471.99		138.75	1555.62		38.95	1441.47
165.44	1464.54		166.50	1521.10		60.49	1403.95
193.02	1464.00		194.25	1475.36		62.92	1399.56
220.59	1464.00		222.00	1437.28		65.00	1392.56
248.16	1463.88		249.75	1415.37		70.00	1395.56
275.74	1470.37		277.50	1413.04		75.00	1396.06
303.31	1500.21		305.25	1419.91		80.00	1396.56
330.89	1547.26		333.00	1433.97		85.00	1396.56
358.46	1597.70		360.75	1452.52		90.00	1396.21
386.03	1648.15		388.50	1474.76		95.00	1397.96
413.61	1686.05		416.25	1497.87		100.00	1398.06
441.18	1719.57		444.00	1527.06		105.00	1399.46
468.75	1751.64		471.75	1552.61		110.01	1399.56
496.33	1787.31		499.50	1576.34		112.19	1403.95

54160m			56160m			58160m (Kiru Dam Site)	
Distance (m)	**Elevation (m)**		**Distance (m)**	**Elevation (m)**		**Distance (m)**	**Elevation (m)**
						119.50	1418.50
						125.26	1419.50
						129.20	1421.50
						139.34	1425.53
						150.35	1432.46
						160.43	1441.47
						164.50	1443.25
						170.98	1449.79
						173.11	1453.02
						176.11	1455.92
						185.34	1463.77
						186.13	1524.00
						189.75	1527.10
						192.92	1467.98
						194.20	1536.43
						195.52	1536.64
						198.37	1549.76
						200.21	1550.55