एसजेवीएन लिमिटेड

मिनी-रत्न शिड्यूल 'A' पीएसयू

निगमित पर्यावरण विभाग

IS/ISO 9001:2015 Certified

कार्यालय:
उप महाप्रबंधक,
निगमित पर्यावरण विभाग,
शक्ति सदन, शनान,
जिला शिमला, हिमाचल प्रदेश -171006
टेलीफोन न.: 0177-2660198
ईमेल: sjvnced@gmail.com

No. SJVN/CHQ/ENV/026- 333 Dated: 09/10/2019

Dr. S. Kerketta,
Director (IA-I) Division
Ministry of Environment, Forests & Climate Change
Vayu Wing, Indira Paryavaran Bhawan,
Jor Bagh Road,
New Delhi - 110003.

Sub: Environment Clearance of Jakhol Sankri HEP - Reply to EAC observations regarding.

Sir,

The case for Environment Clearance of Jakhol Sankri HEP in Uttarakhand was considered in the Environment Appraisal Committee meeting held on 19th July, 2019 wherein certain observations were raised.

In this regard, please find attached reply to the same for your kind information and necessary action please.

Thanking you,

Yours faithfully,

Devjani Patra

(Devjani Patra)
DGM (Environment)
Corporate Environment Department

Compliance to EAC Observations i.r.o Jakhol Sankari HEP		
S N	**Comments**	**Compliance**
1.	Details of the public hearing issues raised along with the compliance shall be submitted.	The details of Public hearing along with compliance status for each issue raised is enclosed as **Annexure-I**.
2.	PP is required to submit clarification from the StatePollution Control Board that whether Public Hearingwas conducted following the procedure mentioned in The Appendix V of EIA Notification and as amended thereof along with the justification for conducting PH distant from the project site.	Enclosed as **Annexure-II**
3.	Possibility of subsidized electricity demanded by the locals should be explored.	Each PAF shall be provided 100 units of free electricity per month for 10 years after commissioning of the project. Further, solar lights can be provided at community places as per societal need under CSR provisions.
4.	Environmental matrix during construction/operational phase needs to be submitted.	Enclosed as **Annexure-III**.
5.	Environmental Management Plan with budget break-up (Capital as well as recurring) shall be submitted.	Enclosed as **Annexure-IV**.
6.	Fund allocation for CER shall be made as per Ministry's O.M. No. 22-65/2017-IA.III dated 1st May, 2018 for various activities therein.	Complied and enclosed as part of **Annexure-V**.
7.	The details of activities with budget allocation under CER shall be submitted and incorporated in EIA/EMP report.	**Annexure-V**.
8.	Consolidated EIA/EMP report is to be submitted as per the generic structure (Appendix III) given in the EIA Notification, 2006.	Complied and EIA/EMP Report in generic format as outlined in Appendix-III of EIA Notification, 2006 is at **Annexure-XI**
9.	Content of the summary EIA be made as per the Appendix III A of EIA Notification and therefore should be submitted in the EIA Report.	Complied, **Annexure-XI**
10.	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 before grant of EC.	Enclosed as **Annexure-VI**.
11.	Fish species availability needs to be reviewed as Supin River has good number of *Rainbow trout*.	Response enclosed as **Annexure-VII**.

12.	Details of plant species of gymnosperm found in the area are to be included in plantation program.	Complied, refer **Annexure-VIII**.
13.	Criteria taken into account for selection of threatened species are to be detailed out.	**Annexure-IX**.
14.	QCI & NABET Accredited certificate of the consultant for the period during which baseline data and other EIA/EMP studies carried out.	NABET certificate attached as **Annexure-X**.

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ANNEXURE-I

PUBLIC HEARINGDETAILS

1. INTRODUCTION

The project site and its components can be reached by National Highway NH-123 from state capital Dehradun which is connected very well by rail/road/air with the other parts of the country. Sankri village which is located on the left bank of river Tons is approximately 220 km from Dehradun. Road between Dehradun to Sankri village passes through the places like Harbatpur, Barwala, Hatyari, Judoo, Nougaon, Purola, Mori and Naitwar. The Sankri village is approximately 12 Km upstream of Naitwar village. Downstream of the project site a 60 MW Naitwar Mori HEP has been proposed between the stretches of Naitwar and Mori village.

The underground powerhouse is proposed near the confluence of river Tons and Supin. The main access tunnel (MAT) to the underground powerhouse may be approached by constructing a new road from Nichla Ponva village. An existing road off taking from the road between Sankri and Jakhol leading to the Nichla Ponva village will have to be used during construction for approaching to MAT. The bridge on the river Tons will need to be strengthened for suitable class of loading. Several roads have to be constructed/ upgraded for approach to the adit to surge shaft and the adit to the Head Race Tunnel (HRT) just before the Surge Shaft and in & around powerhouse complex.

The broad gauge railhead at Dehradun / Rishikesh is about 220/260km from the powerhouse of Jakhol Sankri HEP.

2. PUBLIC HEARING

Public Hearing for Jakhol Sankri HEP was organised by Uttarakhand Environment Protection and Pollution Control Board on 01.03.2019 at Khand Vikas Adhikari Office,Mori,Uttarkashi at 11:00 am.The advertisment for Public Hearing was issued in following two leading daily newspapers on 29.01.2019 (Copy enclosed as **Appendix-I**) :

1. Hindustan Times
2. Dainik Jagran

Public Hearing was conducted on behalf of SJVN Limited (Satluj Jal Vidyut Nigam) as per the guidelines of EIA Notification 2006 and Amendment 2009.Therefore on instructions of District Magistrate Uttarkashi Public Hearing was chaired by Mr. Hemant Kumar Verma (**Additional Magistrate, Uttarkashi)**. Mr.Amit Pokhriyal (Regional Officer) and Mr. SS Chauhan (Assistant Scientist) represented Uttarakhand Environment Protection and Pollution Control Board.The Public Hearing presentation was done by Mr.S.M. Dixit (Addl.Chief Engineer) WAPCOS Limited.He explained the Environmental Impacts and other feautres of the project.The isuses raised in the Public Hearing are complied in the section below.

3. ISSUES RAISED DURING PUBLIC HEARING

Public hearing was started with the permission of the Chair, Various points raised by the public and their replies by the Project Proponent and Govt. Officers are given in Table-1.

Table-1: Issues raised and response given during Public Hearing

S. No	Name and villages	Comments	Response
1	Shri Kedar Singh Panwar, Gram Dhara	Asked the reason for venue selected for Public Hearing is 40 km away from Project Area. He also asked the reason for extraordinary Police Security due to which people are facing inconvenience in participating in public hearing. Apart from this, the issue of Forest Laws was also raised by Shri Panwar, in which he raised question about mass cutting of trees for project which will lead to ecological imbalance and environmental imbalance in the region. Moreover if locals cut even a single tree it leads to severe punishment. Shri Panwar had protested the	The venue for public hearing was decided by Uttarakhand Environment Protection and Pollution Control Board (UEPPCB)in consultation with the District Administration. Considering the remoteness of the project site, arrangements were so made to enable local persons and other stakeholder to be attend the public hearing and participate in the entire exercise. The impacts as envisaged due to tree cutting/biodiversity have been evaluated and suitable mitigation measures have been suggested in the EIA/EMP Report.

S. No	Name and villages	Comments	Response
		construction of project.	
2	Shri Surat Singh Rawat Village Sunkundi	Requested District Collector, Uttarkashi to conduct public hearing in the Jhakhol area.He further demanded Rs.10 lakh compensation for each affected family.	The venue for public hearing was decided by Uttarakhand Environment Protection and Pollution Control Board (UEPPCB) in consultation with the District Administration and considering the remoteness of the project site. The compensation shall be given as per the norms of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.
3	Shri Amrit Naagar, village Aarakot	Several Hydro projects are functioning in Sikkim, Bhutan and Himachal, which has lead to better employment opportunity and better lifestyle of the local people. Therefore he urged district administration and SJVNL to give appropriate compensation to the local people and households in the project area should be given electricity at cheap rates. He also appealed to the local people to support project construction.	We appreciate his support and compensation shall be given as per the norms of full name of Act. Apart from compensation as per LARR, Act, 2013, Local Area Development Plan or Corporate Environmental Responsibility (CER) Plan has been prepared and shall be implemented for overall development of the area.
4	Shri Kripal Singh Rana, Village Kasla	The reason for less participation of project affected area is because public hearing has not been conducted in project affected area. He further suggested that the local people should be given employment opportunity during the project construction and operation. He was of the	The venue for public hearing was decided by Uttarakhand Environment Protection and Pollution Control Board (UEPPCB) in consultation with the District Administration. During the construction and operation of project several indirect employment opportunities shall be created.

S. No	Name and villages	Comments	Response
		view that roads would get damaged due to movement of vehicles in Mori area. It was suggested by him that roads should be properly developed in the Mori area prior to start of construction activities of the project.	However, for the direct employment the applicable norms of state government shall be followed. Separate provision has been kept for repair of roads and alternative routes may be explored, if required.
5	Shri Darshan Singh Rawat, Village Sirga	Raised issue on Forest Law violation. Due to construction of said project deforestation will take place which will have adverse effect on environment. He suggested that local people should be given exemption to collect fodder for animals, wood etc. from forest.	District Administration allows the locals in Forest Area as per the Forest Right Act, 2006. Provision for development of grazing over an area of 444 ha, have been make as a part of the Catchment Area Treatment (CAT) plan.
6	Shri Durgeshwar Lal, Village Rekcha	Five other villages are coming in the project affected area, but there name are not mentioned in the list of project affected area. Therefore these villages should be given all facilities and other benefits similar to project affected area. Therefore he demanded households of the project affected area should be provided electricity at subsidized rate. He further demanded a student hostel should be constructed under project in Mori block, an ultrasound machine and Blood Testing Laboratory should be open by SJVNL	Private land is to be acquired from only four villages. These include: Dhara, Sunkundi, Paon Malla, Paon Talla.The details are enclosed in the EIA/EMP report. The R&R plan has been prepared as per the norms of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013. Apart from the provisions of R&R Plan, Improvement in infrastructure for Education and Health Facilities has been suggested as a part of Corporate Environmental Responsibility (CER) Plan. This plan shall be

S. No	Name and villages	Comments	Response
		in CHC Mori. A bypass should be constructed in Mori area to avoid traffic jam. Whether any action plan has been prepared by Project Proponent M/s SJVNL to stop land erosion?	implemented in consultation with the concerned departments of state government of Uttarakhand and district administration.
7	Shri Murti Singh Panwar, Gram Dhara	Area identified for the project is geographically sensitive area, where Govind Wild Life Sanctuary is located nearby, in which different species of birds and animals reside. During the construction of the project blasting will take place in large amount which is likely to have adverse effects on their life. He suggested that controlled blasting should be done in the construction of the project.	The barrage area of project is located in close proximity to Govind Pashu Vihar Wildlife Sanctuary. In this regard, necessary clearance from National Board of Wildlife has already been obtained. Controlled blasting method shall be used during construction of project. In addition, various other measures too have been recommended as a part of EIA/EMP Report.
8	Shri Gulbiya Lal Zingadata, village Pensar	Public Hearing should have been done in project affected area. Construction of roads should be done, employment opportunities should be given to locals and blasting should be done with proper precautions that nearby homesteads should not be affected with cracks.	The R&R benefits shall be as per norms of the Right to Fair Compensation, Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013. Apart from the provisions of the Right to the Fair Compensation, Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013. Improvement in Education and Health Facilities has been suggested as part of Local Area Development Plan and Corporate Environmental Responsibility (CER) Plan.

S. No	Name and villages	Comments	Response
			Controlled blasting method shall be done in construction of project.
9	Shri Balveer Singh Rana, village- Liwadi	Elucidated on benefits from the said project such as improvement in education level and the possibility of increasing employment. He also suggested that Local Administration and Project Proponent should speak to people who are against the project and convince them and take their consent for the project.	We appreciate the concern raised.
10	Shri Liber Singh, village Sunkundi	The land he has been residing belongs to forefather and this land was not registered in their name, if his land is acquired for project suitable action should betaken to award him fair compensation.	The R&R benefits shall be as per the Right to the Fair Compensation, Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013. District Administration is requested to update their land records prior to land acquisition.
11	Shri Prahlad Singh, Gram Dhara	Reason for cancellation of last Public Hearing was that local people were not taken in confidence for the project. Today also people are not in confidence. Therefore Project Reports should be made available in Hindi for locals to understand the advantages and disadvantages due to project.	Earlier Public Hearing was cancelled due to public protest. The procedure for conducting this Public Hearing is as per the norms of EIA, Notification, 2006 has been followed. The EIA/EMP reports have been prepared in English and Ex-summary in Hindi as per the provisions of EIA Notification 2006 and the advantages/dis-advantages of the project have been clearly

S. No	Name and villages	Comments	Response
			outlined in various section of the EIA/EMP Report.
12	Shri Harimohan Rangan, Village Gachwana	Raised the problem of Naitwar village and it was suggested that an employment should be given to the local people and a joint survey should be conducted in the respect of the cracks in walls of nearby houses and verifying it and fair compensation should be awarded to the local people according to the rules.	The R&R benefits shall be as per the norms of LARR Act, 2013. During construction and operation phases of the project several direct and indirect employment opportunities shall be created. However, for provision direct employment government norms shall have to be followed. Controlled blasting technique will be used in project construction. The compensation of cracks due the project shall be verified by the district Administration and suitable compensation shall be paid.
13	Shri Rishiram, Village Paavtalla	His Apple Orchids were affected due to the construction of the tunnel by SJVNL because of which about 500 to 600 trees have dried, which should be compensated. He was suggested that the blasting should be minimized.	This issue shall be verified by district Administration and appropriate compensation shall be paid as per the norms of the Forest Department or as suggested by the state government of Uttarakhand. if required. As suggested, control blasting technology method shall be applied during construction of project.
14	Smt. Chandi Devi, Gram Natwad	Government Inter College in Mori there are about 600 students enrolled, but there is no seating arrangement for them.Therefore she suggested that a building should be constructed	The R&R benefits shall be as per the norms of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 Apart from the provision of

S. No	Name and villages	Comments	Response
		with necessary arrangement for the same	LARR Act, 2013, improvement in Education and Health Facilities has been suggested as part of Local Area Development Plan and Corporate Environmental Responsibility (CER) Plan.
15	Shri Jayvir Singh Rawat, Village Pavntalla	The local persons should be given some exemption from Forest Rights Act so that they can protect their rights.He also suggested that the persons of the four project affected villages should be provided employment as per their qualification. Further he said the information should be imparted to the Project affected persons about the criteria decided for compensation.	District Administration allows the locals in Forest Area as per the Forest Right Act, 2006. During the construction and operation phase of project several direct and indirect employment opportunities shall be created. However, for direct employment the Government Norms shall be followed. The Land compensation shall be given as per the norms of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.
16	Smt Sarita Devi, Village- Natwad	Project affected persons were not informed about the Public Hearing because of which there is locals are outraged. She was skeptical that construction of project will lead to inconvenience to the project affected persons.	The procedure for conducting this Public Hearing, as per the EIA, Notification, 2006 has been followed.
17	Smt. Najari Devi, Gram-Natwad	We have faith in the government and government will give us justice and employment.	We appreciate the fact.
18	Shri Jaydev Singh Chauhan, Village-Panvamalla	Raised objection for conducting Public Hearing in the closed room and	The venue for public hearing was decided by Uttarakhand Environment Protection and

S. No	Name and villages	Comments	Response
		not amongst the project affected persons. He asked that the persons who are losing land are only affected persons or others residing in the area are also affected persons. He objected to Public Hearing being conducted and paper work being done in English amongst illiterate persons and signatures of villagers are being taken without their permission. He also raised question about compensation for cutting of trees.	Pollution Control Board (UEPPCB) in consultation with the District Administration. Considering the remoteness of the project site, arrangements were so made to enable the views of the concerned local persons and stakeholder in the environmental impacts of the project, to be freely expressed. The procedure for conducting this Public Hearing, as per the EIA, Notification, 2006 has been followed. For acquisition of forest land, compensable afforestation, NPV and cost of trees shall be paid as part of norms of the Forest Conservation Act (1980) and its subsequent amendments. The cutting of trees on private land, compensation shall be paid as per the norms of the state government. The Land compensation to Project Affected Families shall be given as per Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 In addition to R&R Plan, as a part of Corporate Environmental Responsibility (CER) Plan, infrastructure and

S. No	Name and villages	Comments	Response
			facilities in Educational and Health sector shall be implemented which will benefit the villagers in the project area and its surroundings.

APPENDIX-I

ADVERTISMENT FOR PUBLIC HEARING

SAVE ELECTRICITY IN THE INTEREST OF NATIONS. Use Led Bulb Save Electricity. (Toll-Free-1912) "Pay Electricity bill online 24X7 from www.upcl.org"
(For information on Electricity Theft, Informer may report to Toll Free No. 1800 180 4185/Fax No. 0135- 2760911

UP Power Transmission Corporation Limited Tender Notice against specification No ESD- 527 through E-Tendering :- E-Tenders in two parts, Part-1 & Part-II, valid for six months are invited for the supply of equipment as per details given in the following table against tender specification NO. ESD-527. Part-I of the bid shall contain earnest money deposit of Rs. 01,65,000.00 (Rs. One Lakh Sixty-Five Thousand only), tender fee against purchase of tender documents, pre qualification details, technical and Commercial terms and conditions etc. Part-II shall contain price bid only. Complete tender documents against this Bid specification can be downloaded from e-procurement website of U.P. Govt. **etender.up.nic.in** and tenderer will require to pay a non-refundable fee of Rs. 11,800/- (inclusive of 18% GST) towards cost of tender documents through RTGS/ NEFT in "UPPTCL SBI A/C No. 30231982762" (IFS Code -SBIN0003347). Tender document can be submitted only on e-procurement website **etender.up.nic.in** up to schedule date & time. Tenderer (s) are requested to get them registered with U.P. Electronics Corporation so as to obtain digital signatures for participation. **Sl. No. 1- Specn. No.-** **ESD-527- Particulars-** 250KVA, 33/0.415KV Station Transformer, **Qty. Nos.-** 64, **Earnest money (Rs)-** 165000.00, **Submission date & time-** 23.02.2019 (12:30 hrs.), **Opening date & time-** 25.02.2019 (15:30 hrs.) **Tender fee including GST (Rs)** - 11800.00, The bid of the firm without tender document fee, against the purchase of document, and without EMD will not be accepted. Tender document fee will be deposited through RTGS/NEFT in the UPPTCL account mentioned above and a proof of such deposit e.g. UTR no., Name of Account, scanned copy of pay-in slip countersigned by the tenderer should be uploaded along with etender documents. Earnest money deposit (EMD) will be deposited through RTGS/NEFT in UPPTCL account mentioned above and a proof of such deposit e.g. UTR no., Name of Account, scanned copy of pay-in slip countersigned by the tenderer, should be uploaded along with etender documents OR in the form of Bank Guarantee in favour of Superintending Engineer, Electricity Substation Design Circle-II, UPPTCL, Lucknow. If EMD is deposited in the form of Bank Guarantee, scanned copy of EMD BG alongwith a scanned copy of confirmation mail of the same from the bank issuing the BG will be uploaded with the tender document. **No tender documents including tender fee, EMD B.G. and other commercial papers are required to be submitted in hard copy or through messenger at the time of bid opening.** Part-II containing price bid shall be opened separately at a later date to be informed accordingly. Undersigned reserves the right to accept or reject any offer without assigning any reason. Please visit e-procurement website etender.up.nic in as well as our website www.upptcl.org for all amendments, corrigendum, modifications and extensions till the date of submission of tenders. **Superintending Engineer, Electricity Substation Design Circle -II U.P. Power Transmission Corporation Ltd., 13th Floor, Shakti Bhawan Extension, 14-Ashok Marg, Lucknow-226001 (Uttar Pradesh) website www.etender.up.nic.in R- 44, Dt.: 25-01-2019. "SAVE ENERGY IN THE INTEREST OF NATION**

कृषि निदेशालय, उत्तराखण्ड, नन्दा की चौकी, प्रेमनगर, देहरादून

पत्रांक-कृ0नि0/7006/एन0ई0जी0पी0ए0/18-19 दिनांक- 25.01.2019

प्रेस विज्ञप्ति

NeGP-A योजनान्तर्गत कम्प्यूटर, मल्टीफक्शन प्रिन्टेर तथा यू0पी0एस0 की क्रय/आपूर्ति करने हेतु ई-निविदा आमंत्रित की जाती है।

ई-निविदा **www.uktenders.gov.in** से अपलोड करने की अन्तिम तिथि **दि0 25.02.2019** को सांय 5.00 बजे तक हैं। समस्त अपलोड निविदाओं के तकनीकी प्रपत्र **दिनांक 26.02.2019** को सांय 4.00 बजे तथा वित्तीय निविदायें अलग तिथि निर्धारित कर खोली जायेगी, जिसकी सूचना कृषि निदेशालय, देहरादून की वेबसाईट **www.agriculture.uk.gov.in** के माध्यम से दी जायेगी। ई-निविदा के संबन्ध में समस्त सूचनायें, शर्ते एवं अन्य विस्तृत विवरण **www.uktenders.gov.in** पर उपलब्ध हैं।

नोट- 1. यह निदेशालय प्रिंटिंग की किसी त्रुटि के लिए जिम्मेदार नहीं होगा।

2. निविदा प्रपत्र डाउनलोड करने की अन्तिम तिथि **दि0 25.02.2019** को सांय 5.00 बजे तक हैं।

पत्रांक- 6707/ सू.एवं लो.सं.वि./दि. 25.01.2019 **(गौरी शंकर) कृषि निदेशक उत्तराखण्ड**

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Phone : 0135-2658086, Fax : 0135-2718092 Web : www.ueppcb.uk.gov.in

पर्यावरणीय स्वीकृति हेतु लोक सुनवाई के लिये सूचना

मै0 एस.जी.वी.एन. लि0, जखोल–सांकरी जल विद्युत परियोजना (44MW), मोरी, के द्वारा जनपद–उत्तरकाशी क्षेत्रान्तर्गत स्थित जखोल–सांकरी जल विद्युत परियोजना (44MW), मोरी हेतु पर्यावरण स्वीकृति हेतु लोक सुनवाई का प्रस्ताव उत्तराखण्ड पर्यावरण संरक्षण एवं प्रदूषण नियंत्रण बोर्ड, देहरादून के समक्ष प्रस्तुत किया गया है। परियोजना के लिये वन एवं पर्यावरण मंत्रालय, भारत सरकार के द्वारा Terms of Reference निर्धारित किये गये हैं, जिनके अन्तर्गत प्रस्तावक के द्वारा पर्यावरण प्रभाव मूल्यांकन रिपोर्ट एवं पर्यावरण प्रबन्धन योजना आदि तैयार कर प्रस्तुत की गयी है। वन एवं पर्यावरण मंत्रालय, भारत सरकार द्वारा जारी ई.आई.ए. अधिसूचना 14.09.2006 के अनुसार उक्त प्रकार की परियोजनाओं के क्रियान्वयन से पूर्व लोक सुनवाई का प्राविधान है, जिस हेतु 30 दिनों का नोटिस समाचार पत्रों के माध्यम से जन साधारण के संज्ञानार्थ दिया जाना आवश्यक है। लोक सुनवाई हेतु "पैनल" की संरचना उक्त अधिसूचना के अनुरूप निम्नवत है :–

1. जिलाधिकारी, जनपद, उत्तरकाशी या उनके द्वारा नामित प्रतिनिधि जो अपर जिलाधिकारी स्तर से कम पद का न हो, लोक सुनवाई के अध्यक्ष।
2. उत्तराखण्ड पर्यावरण संरक्षण एवं प्रदूषण नियंत्रण बोर्ड के प्रतिनिधि।

परियोजना से सम्बन्धित जमा समस्त अभिलेख क्षेत्रीय कार्यालय, पर्यावरण एवं वन मंत्रालय–देहरादून; मुख्यालय, उत्तराखण्ड पर्यावरण संरक्षण एवं प्रदूषण नियंत्रण बोर्ड देहरादून, क्षेत्रीय कार्यालय, उत्तराखण्ड पर्यावरण संरक्षण एवं प्रदूषण नियंत्रण बोर्ड, देहरादून ; कार्यालय जिलाधिकारी, उत्तरकाशी ; कार्यालय जिला पंचायत,,उत्तरकाशी ; जिला उद्योग केन्द्र, उत्तरकाशी एवं कार्यालय नगर पालिका परिषद, उत्तरकाशी में उपलब्ध है। जिनका कोई भी इच्छुक संस्था/ व्यक्ति अवलोकन कर सकता है। पर्यावरण प्रभाव मूल्यांकन रिपोर्ट के सारांश की प्रति **www.ueppcb.uk.gov.in** पर भी उपलब्ध है।

मै0 एस.जी.वी.एन. लि0, जखोल–सांकरी जल विद्युत परियोजना (44MW), मोरी, जनपद उत्तरकाशी द्वारा जखोल–सांकरी जल विद्युत परियोजना (44MW) मोरी तथा इससे सम्बन्धित प्रस्तावित लोक सुनवाई का स्थान, समय तथा दिनांक जिलाधिकारी के द्वारा निम्नानुसार सुनिश्चित् की गयी है।

प्रोजेक्ट का नाम	लोक सुनावाई हेतु प्रस्तावित स्थल	लोक सुनावाई की तिथि	समय
मै0 एस.जी.वी.एन. लि0, जखोल –सांकरी जल विद्युत परियोजना (44MW), मोरी, जनपद उत्तरकाशी	विकास खण्ड कार्यालय परिसर; मोरी, उत्तरकाशी	01.03.2019	11.00 बजे से

अतः सर्वसाधारण को सूचित किया जाता है कि अपने–अपने क्षेत्र से सम्बन्धित परियोजना के प्रस्ताव के सम्बन्ध में अपने मौखिक, लिखित, सुझाव, टीका टिप्पणियों एवं आपत्तियां इस कार्यालय अथवा बोर्ड के क्षेत्रीय कार्यालय, ई–115 नेहरू कालोनी, यू.ई.पी.पी.सी.बी., देहरादून में इस सूचना से सम्बन्धित विज्ञापन प्रकाशन की तिथि से 30 दिनों के अन्दर प्रेषित कर सकते है अथवा लोक सुनावाई के समय भी प्रस्तुत कर सकते हैं।

सदस्य सचिव

Date 29/01/2019, Hindustan Times

त्र मूल रूप में एवं छाया-प्रतियों सहित तथा नवीनतम
मेले में पंजीयन हेतु प्राप्त रसीद साथ लानी होगी। मेले
नपदों के अभ्यर्थी भी प्रतिभाग कर सकेंगे। अभ्यर्थियों
के लिए कोई भी मार्ग व्यय देय नहीं होगा। अधिक
उत्तरकाशी से सम्पर्क करें।
श्रीवास्तव) जिला सेवायोजन अधिकारी, उत्तरकाशी

फॉरेन्सिक सलाहाकार के हेतु विज्ञप्ति

एफ0 के अधीन एक साईबर फॉरेन्सिक
एक वर्ष की अवधि के लिये एक अनुभवी
कार की आवश्यकता है, जिसकी अवधि
ती है। साईबर फॉरेन्सिक सलाहाकार के
क है।
इस में साईर सिक्योरिटी एवं साईबर फ-
ी या MCA के साथ साईबर फॉरेन्सिक/
ग्री होनी आवश्यक है।
सेक्यारिटी या सिक्योरिटी ऑडिट में

क्योरिटी के क्षेत्र में प्रोफोशंनल के रूप में
ार्य है।
स्या को हल करने मे सक्षम होना चाहिये।
2019 से पुर्व वरिष्ठ पुलिस अधीक्षक,
, निकट साईबर क्राईम पुलिस स्टेशन,
ना आवेदन प्रेषित कर सकते है।
रूप में साईबर क्राईम पुलिस थाने
एवं उत्तराखण्ड पुलिस की वेबसाईट
m पर भी उपलब्ध है। उक्त के अतिरिक्त
आवश्यक जानकारी प्राप्त की जा सकती

पुलिस उप महानिरिक्षक,
एस.टी.एफ.उत्तराखण्ड देहरादून

अधिक जानकारी हेतु कृपया www.pmgsytendersuk.gov.in देखें।

मुख्य अभियन्ता,
यू.आर.आर.डी.ए., देहरादून

* निविदादाता जो पंजीकृत नहीं हैं, वे भी निविदा दे सकते हैं, किन्तु सफल निविदादाता को अनुबन्ध हस्ताक्षरित करने से पूर्व उचित श्रेणी में सक्षम प्राधिकारी से पंजीकरण करवाना अनिवार्य होगा।

नोटः टेण्डर की प्रक्रिया में मदद एवम जानकारी हेतु कृपया 0135-2675725 में प्रातः 10:00 बजे से सायं 06:00 बजे तक सम्पर्क किया जा सकता है।

उत्तराखण्ड पर्यावरण संरक्षण एवं प्रदूषण नियंत्रण बोर्ड

29/20, नेमी रोड, डालनवाला, देहरादून (उत्तराखण्ड)
Phone : 0135-2658086, Fax : 0135-2718092 Web : www.ueppcb.uk.gov.in

पर्यावरणीय स्वीकृति हेतु लोक सुनवाई के लिये सूचना

मै0 एस.जी.वी.एन. लि0, जखोल-सांकरी जल विद्युत परियोजना (44MW), मोरी, के द्वारा जनपद-उत्तरकाशी क्षेत्रान्तर्गत स्थित जखोल-सांकरी जल विद्युत परियोजना (44MW), मोरी हेतु पर्यावरण स्वीकृति हेतु लोक सुनवाई का प्रस्ताव उत्तराखण्ड पर्यावरण संरक्षण एवं प्रदूषण नियंत्रण बोर्ड, देहरादून के समक्ष प्रस्तुत किया गया है। परियोजना के लिये वन एवं पर्यावरण मंत्रालय, भारत सरकार के द्वारा Terms of Reference निर्धारित किये गये हैं, जिनके अन्तर्गत प्रस्तावक के द्वारा पर्यावरण प्रभाव मूल्यांकन रिपोर्ट एवं पर्यावरण प्रबन्धन योजना आदि तैयार कर प्रस्तुत की गयी है। वन एवं पर्यावरण मंत्रालय, भारत सरकार द्वारा जारी ई.आई.ए. अधिसूचना 14.09.2006 के अनुसार उक्त प्रकार की परियोजनाओं के क्रियान्वयन से पूर्व लोक सुनवाई का प्राविधान है, जिस हेतु 30 दिनों का नोटिस समाचार पत्रों के माध्यम से जन साधारण के संज्ञानार्थ दिया जाना आवश्यक है। लोक सुनवाई हेतु "पैनल" की संरचना उक्त अधिसूचना के अनुरूप निम्नवत है :-

1. जिलाधिकारी, जनपद, उत्तरकाशी या उनके द्वारा नामित प्रतिनिधि जो अपर जिलाधिकारी स्तर से कम पद का न हो, लोक सुनवाई के अध्यक्ष।
2. उत्तराखण्ड पर्यावरण संरक्षण एवं प्रदूषण नियंत्रण बोर्ड के प्रतिनिधि।

परियोजना से सम्बन्धित जन्मा समस्त अभिलेख क्षेत्रीय कार्यालय, पर्यावरण एवं वन मंत्रालय-देहरादून; मुख्यालय, उत्तराखण्ड पर्यावरण संरक्षण एवं प्रदूषण नियंत्रण बोर्ड देहरादून, क्षेत्रीय कार्यालय, उत्तराखण्ड पर्यावरण संरक्षण एवं प्रदूषण नियंत्रण बोर्ड, देहरादून ; कार्यालय जिलाधिकारी, उत्तरकाशी ; कार्यालय जिला पंचायत, उत्तरकाशी ; जिला उद्योग केन्द्र, उत्तरकाशी एवं कार्यालय नगर पालिका परिषद, उत्तरकाशी में उपलब्ध है। जिनका कोई भी इच्छुक संस्था / व्यक्ति अवलोकन कर सकता है। पर्यावरण प्रभाव मूल्यांकन रिपोर्ट के सारांश की प्रति **www.ueppcb.uk.gov.in** पर भी उपलब्ध है।

मै0 एस.जी.वी.एन. लि0, जखोल-सांकरी जल विद्युत परियोजना (44MW), मोरी, जनपद उत्तरकाशी द्वारा जखोल-सांकरी जल विद्युत परियोजना (44MW) मोरी तथा इससे सम्बन्धित प्रस्तावित लोक सुनवाई का स्थान, समय तथा दिनांक जिलाधिकारी के द्वारा निम्नानुसार सुनिश्चित की गयी है।

प्रोजेक्ट का नाम	लोक सुनवाई हेतु प्रस्तावित स्थल	लोक सुनवाई की तिथि	समय
मै0 एस.जी.वी.एन. लि0, जखोल-सांकरी जल विद्युत परियोजना (44MW), मोरी, जनपद उत्तरकाशी	विकास खण्ड कार्यालय परिसर, मोरी, उत्तरकाशी	01.03.2019	11.00 बजे से

अतः सर्वसाधारण को सूचित किया जाता है कि अपने-अपने क्षेत्र से सम्बन्धित परियोजना के प्रस्ताव के सम्बन्ध में अपने मौखिक, लिखित, सुझाव, टीका टिप्पणियां एवं आपत्तियां इस कार्यालय अथवा बोर्ड के क्षेत्रीय कार्यालय, ई-115 नेहरू कालोनी, यू.ई.पी.पी.सी.बी., देहरादून में इस सूचना से सम्बन्धित विज्ञापन प्रकाशन की तिथि से 30 दिनों के अन्दर प्रेषित कर सकते है अथवा लोक सुनवाई के समय भी प्रस्तुत कर सकते हैं।

सदस्य सचिव

Dainik Jagran 29/1/19

Date 29.01.2019, Dainik Jagran

Mr. Hemant Kumar Verma (Additional Magistrate, Uttarkashi)
Mr.Amit Pokhriyal (Regional Officer) &Mr. SS Chauhan (Assistant Scientist)
Uttarakhand Environment Protection and Pollution Control Board

SJVNL/WAPCOS official responding to the query raised by public

Interaction during Public Hearing

Mr.Hemant Kumar Verma (Additional Magistrate, Uttarkashi) responding to the query

ANNEXURE-II

HEAD OFFICE

UTTARAKHAND ENVIRONMENT PROTECTION & POLLUTION CONTROL BOARD
Gaura Devi Paryawaran Bhawan
46B, IT Park, Sahastradhara Road, Dehradun (Uttarakhand)

उत्तराखण्ड पर्यावरण संरक्षण एवं प्रदूषण नियंत्रण बोर्ड
गौरा देवी पर्यावरण भवन,
46बी, आई.टी. पार्क, सहस्त्रधारा रोड, देहरादून (उत्तराखण्ड)

Web: www.ueppcb.uk.gov.in, Email: msukpcb@yahoo.com

पत्रांक सं0-यूईपीपीसीबी/एच.ओ/ एन.ओ.सी.-7036/2019/ 611 दि0: 26/8/19

सेवा में,

ई0 जे0के0 महाजन,
अपर महाप्रबन्धक/परि0 प्रमुख,
एस.जे.वी.एन. लिमिटेड,
जखोल-सांकरी हाईड्रो ईलैक्ट्रिक प्रोजेक्ट,
मोरी, उत्तरकाशी, उत्तराखण्ड

विषयः- जनपद उत्तरकाशी तहसील मोरी के अन्तर्गत जखेल सांकरी जल विद्युत परियोजना (44 मे0 वा0) के पर्यावरण स्वीकृति के सम्बन्ध में।

महोदय,

उपरोक्त विषयक कृपया अपने पत्र संख्या एसजेवीएन/जसांजविपरि/पर्यावरण/19-14-15 दिनांक13.08.2019 का संदर्भ ग्रहण करने का कष्ट करें, जिसके माध्यम से आप द्वारा निम्नलिखित सूचना चाही गयी थी।

" Project Proponent is required to submit clarification from the State Pollution Control Board whether public hearing was conducted following the procedure mentioned in the appendix V of EIA Notification and as amended thereof along with the justification for conducting Public Hearing distant fom the project site."

उक्त कम में इस कार्यालय द्वारा क्षेत्रीय अधिकारी, क्षेत्रीय कार्यालय देहरादून द्वारा अवगत कराया गया है कि जिलाधिकारी उत्तरकाशी के पत्र संख्या 6148/आठ-30(2018-19) दिनांक 23.01.2019 (छायाप्रति संलग्न) के माध्यम से स्थल का चयन किया गया एवं एस.जे.वी.एन. लि0 द्वारा पर्यावरण एवं वन मंत्रालय, भारत सरकार की अधिसूचना संख्या-2006 यथा संशोधित 2009 के अनुसार लोक सुनवाई को संचालित करने के लिये प्रक्रिया के प्रस्तर 1.0 के अनुसार परियोजना क्षेत्र के निकटस्थ विकास खण्ड कार्यालय परिसर मोरी को चिन्हित किया गया है, जहां पर आधारभूत सुविधाऐं संचार व्यवस्था लॉजिस्टिक एवं पर्याप्त स्थान उपलब्ध है। उक्त बिन्दुओं को दृष्टिगत रखते हुए जिलाधिकारी, उत्तरकाशी द्वारा निर्धारित स्थप पर जल सुनवाई का आयोजन किया गया जन सुनवाई की अध्यक्षता अपर जिलाधिकारी, उत्तरकाशी द्वारा की गयी है।

उपरोक्त सूचना आपके अवलोकनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित की जा रही है।

संलग्नक- यथोपरि।

भवदीय,

(एस.पी. सुबुद्धि)
सदस्य सचिव

कार्यालय जिलाधिकारी उत्तरकाशी।

संख्या 6148/आठ–30 (2018–17)

दिनांक 23 जनवरी, 2019

सेवामें,

सदस्य सचिव,
उत्तराखण्ड पर्यावरण सुरक्षा एंव पदूषण नियंत्रण परिषद
29/20 नेमी रोड, देहरादून।

विषय – Enironment Clearance for (44 MW) Jakhol Ssnkri Hydro Electric Project (44MW) Submisson of EIA/EMP Report for conductiong Public Hearing regarding.

महोदय,

उपर्युक्त विषयक अपर महाप्रबन्धक/परियोजना प्रमुख जखोल सांकरी जल विधुत परियोजना मोरी के पत्रांक संख्या एसजेवीएन/जसांजविपरि/पर्यावरण/19–1 कैम्प उत्तरकाशी दिनांक 20.01.2019 के द्वारा अवगत कराया गया है कि जनपद उत्तरकाशी तहसील मोरी के अन्तर्गत सुपिन नदी पर प्रस्तावित जखोल–सांकरी जल विधुत परियोजना (44 मेगावाट) के लिए वन पर्यावरण एवं जलवायु परिवर्तन मंत्रालय भारत सरकार के पत्र सख्या –जे–12011/7/2016–आईए–आई (आर) दिनांक 07.06.2016 के द्वारा प्रायर इन्वायरमेन्ट क्लेरेंश कतिपय सन्दर्भित शर्तो के आधार पर प्रदान की गयी है। इन्ही शर्तो के आधार पर एस0जे0वी0एन0लि0 द्वारा पर्यावरण प्रभाव आंकलन का अध्ययन करवाकर पर्यावरण प्रबन्धन योजना तैयार की गई है। इस सम्बन्ध मे जनसुनवाई दिनांक 12.06.2018 को परियोजना क्षेत्र में आयोजित की गयी थी, जिसे स्थगित कर दिया गया था। 12.06.2019 की जनसुनवाई के स्थगन के पश्चात परियोजना प्रमुख द्वारा जनसुनवाई हेतु पुनः अनुरोध किया गया है। तथा एस0जे0वी0एन0लि0 के द्वारा पर्यावरण एंव वन मंत्रालय भारत सरकार की अधिसूचना संख्या 2002 दिनांक 1 नवम्बर 2009 के अनुसार लोक सुनवाई को संचालित करने के लिए प्रक्रिया के प्रस्तर 1.0 के अनुसार परियोजना क्षेत्र के निकटस्थ परिसर विकास खण्ड कार्यालय परिसर मोरी को चिन्हित किया गया है जहां पर आधार भूत सुविधाओं, संचार व्यवस्था, लाजिस्टिक्स एवं पर्याप्त स्थान उपलब्ध है अतः उपरोक्त स्थल पर जन सुनवाई हेतु सहमति प्रदान की जाती है।

(डॉ आशीष चौहान)
जिलाधिकारी,
उत्तरकाशी।

प्रतिलिपि – निम्नांकित को सूचनार्थ प्रेषित।

1– उपजिलाधिकारी पुरोला।
2– अपर महाप्रबन्धक/परियोजना प्रमुख जखोल सांकरी जल विधुत परियोजना मोरी।
3– खण्ड विकास अधिकारी, मोरी उत्तरकाशी।

(डॉ आशीष चौहान)
जिलाधिकारी,
उत्तरकाशी।

ANNEXURE-III

ENVIRONMENTAL MATRIX DURING CONSTRUCTION AND OPERATION PHASES

Environmental matrix during construction and operation phases, Table 1.

TABLE-1, Environmental matrix during construction and operation phases

S. N.	Parameters	Impact	Management Measures	Implementing Agency
1.	**WATER ENVIRONMENT**			
	Water Quality			
	Construction phase	• Water pollution due to disposal of sewage from labour colonies.	• Provision of community toilets and sewage treatment plant.	• SJVNL and project contractor
		• Deterioration water quality due to effluent from crusher	• Provision of settling tank	• Project contractor
	Operation phase	• Reduction in discharge in the stretch of river between Dam site and Tail Race Disperse site due to reduced flow during the lean season.	• Environmental flows will be released	• SJVNL
		• Disposal of sewage from project colony.	• Commissioning of Sewage Treatment Plant (STP) in project	• SJVNL
		• Eutrophication problem	• Eutrophication risks are minimal; hence, specific management measures are not required.	-
	Water Resources			
	Operation phase	• River stretch from barrage site to tailrace outfall will have reduced flow during lean season.	• Minimum flow will be released	• SJVNL

S. N.	Parameters	Impact	Management Measures	Implementing Agency
2.	**AIR ENVIRONMENT**			
	Construction phase	• Fugitive emissions due to crusher operation at various sites.	• Commissioning of cyclone on crushers to minimize the release of emission.	• Project contractor
		• Increased in SPM level due to vehicular movement during construction	• Provision of water sprinkler to reduce entrancement of fugitive emission.	• Project contractor
		• Emission of SO_2 due to combustion of fuel in construction equipment	• SO_2 is not expected to increase significantly. No specific mitigation measure are required.	-
3.	**NOISE ENVIRONMENT**			
	Construction phase	• Marginal increase in noise levels due to operation of various construction equipment.	• Proper maintenance of construction equipment • Provision of ear plugs. • Controlled blasting and other suitable measures will be taken to minimize disturbance in wildlife area.	• Project contractor and SJVNL
4.	**LAND ENVIRONMENT**			
	Construction Phase	• Erosion due to quarrying operation for coarse and fine aggregate	• Proper mining plan for quarrying operations shall be prepared. • Rehabilitation plan for quarry	• Project Contractor and SJVNL

S. N.	Parameters	Impact	Management Measures	Implementing Agency
			sites after extraction of construction material	• Project Contractor and SJVNL
		• Generation of muck due to underground structures and also due to other project appurtenance.	• Disposal of muck at designated muck disposal sites. • Restoration of Muck disposal sites on completion of muck disposal activities.	• Project Contractor and SJVNL
		• Erosion due to construction of road	• Cut-slope to be protected by breast walls • Provision of catch water and intercepting drains • Plantation of tree along road side.	• Project Contractor and SJVNL
		• Acquisition of about 24.317 forest and 14.771 ha private land	• Compensatory afforestation in lieu of forest land • Net Productivity Value (NPV) and cost of trees to be cut to be given to Forest Department. • R&R Plan for	• SJVNL, Forest Department and Revenue Department

S. N.	Parameters	Impact	Management Measures	Implementing Agency
			Project Affected Families (PAFs) has been prepared as per the norms of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013	
5.	**BIOLOGICAL ENVIRONMENT**			
	Terrestrial Flora			
	Construction phase	• Cutting of trees for meeting fuel wood requirements by labour.	• Provision of subsidized LPG to construction labour and technical staff.	• Project Contractor/ SJVNL
	Operation phase	• Acquisition of forest land.	• Compensatory afforestation.	• Forest Department
	Terrestrial Fauna			
	Construction phase	• Disturbance to wildlife due to operation of various construction equipment	• Surveillance through check-posts is recommended.	• Forest Department
		• Disturbance to wildlife due to increased accessibility in the area	• Surveillance through check-posts is recommended.	• Forest Department
	Operation phase	• Disturbance to wildlife in project area due to increased	• Marginal impact anticipated which could be	• Forest Department

S. N.	Parameters	Impact	Management Measures	Implementing Agency
		accessibility	minimized by implementation of strict anti-poaching law.	
	Aquatic Ecology			
	Construction phase	• Marginal decrease in aquatic productivity due to increased turbidity and lesser light penetration.	• Marginal impact, hence no specific management measures are suggested.	• Project Contractor
	Operation phase	• Obstruction in the path of migratory fishes.	• Development of hatchery for artificial seed and production. and supplementary stocking of reservoir.	• Fisheries Department
		• Drying of river stretch downstream of barrage up to tail race outfall.	• The river for a stretch of 10 km each on upstream and downstream of diversion structure site will be also be covered under supplementary stocking.	• Fisheries Department/ SJVNL
			• Release of Environmental Flows.	• SJVNL
6.	**SOCIO-ECONOMIC ENVIRONMENT**			
	Construction phase	• Increase in employment potential.	-	
		• Acquisition of private land and properties	• R&R Plan for PAFs has been suggested as	• SJVNL

S. N.	Parameters	Impact	Management Measures	Implementing Agency
	Operation phase		per the norms of the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013	
		• Increased power generation.	-	-
		• Greater employment opportunities due to mushrooming of various allied activities.	-	-

ANNEXURE-IV

BUDGET BREAKUP OF ENVIRONMENTAL MANAGEMENT PLAN

The total amount to be spent for implementation of Environmental Management Plan (EMP) would be Rs. 50.54 crore capital cost. The cost of implementing Corporate Environmental Responsibility works is Rs. 7.16 crore. The total cost works out to Rs.57.70 crore. The details of the cost are given in Table-1.

The recurring cost for implementation of Environmental Monitoring during operation phase is Rs. 18.6 lakh per year. The details are given in Table-3.

Table-1: Cost for implementing Environmental Management Plan

S. No.	Item	**Cost (Rs. Lakh)**
EMP		
1.	Biodiversity Conservation Plan	724.50
2.	Catchment Area Treatment Plan	680.0
3.	Sustenance of riverine fisheries	105.88
4.	Health Delivery System	142.30
5.	Environmental Management in Labour Camps	490.43
6.	Stabilization of Muck Disposal Sites	421.00
7.	Landscaping and Restoration of Construction Area	100.00
8.	Environmental Management in Road Construction	270.00
9.	Greenbelt Development	30.00
10.	Control of Air Pollution	66.80
11.	Control for Noise Pollution	11.00
12.	Water Pollution Control	10.00
13.	Public Awareness Program	50.00
14.	Disaster Management Plan	60.00
15.	**Resettlement and Rehabilitation Plan**	1369.13
16.	**Local Area Development Plan (LADP)**	240.0
17.	**Livelihood Plan for PAF**	192.64
18.	**Monitoring and Evaluation Aspects for social aspects**	30.0
19.	Implementation of Environmental Monitoring Programme during construction stage (Refer Table-2)	45.6
20.	Purchase of Meteorological Instruments and Noise Meter	15.0
	Total-A	**5054.28** **Say 50.54 Cr**
		Corporate Environmental Responsibility
1.	**Corporate Environmental Responsibility**	716.10
	Total-B	**Say 7.16 Cr**
	Grand Total	**57.70Cr.** **Say 58 Cr.**

COST FOR IMPLIMENTING ENVIRONMENTAL MONITORING PRORAMME

The cost required for implementation of Environmental Monitoring programme during project construction phase is Rs. 45.6 lakh. The details are given in Table-2.

Table-2: Cost for implementing Environmental Monitoring Programme during project construction phase

Item	Cost (Rs. lakh)
Effluent from labour camps	11.2
Ambient air quality monitoring	11.2
Incidence of water related diseases	23.2
Total	**45.6**

The cost for implementation of the Environmental Monitoring Programme during operation phase is the order of Rs.18.6 lakh/year. A 10% annual price increase may be considered for every year. The details are given in Table-3.

Table-3: Cost for implementing Environmental Monitoring Programme during project operation phase

Item	Cost (Rs. lakh/year)
Water quality and effluent from project colony	2.6
Ecology	5.0
Riverine fisheries	6.0
Incidence of water related diseases	5.0
Total	**18.6**

ANNEXURE-V

CORPORATE ENVIRONMENT RESPONSIBILITY

CER is being framed to extend benefits to not only the residents of the partially affected villages, but also to residents of the some villages adjoining to the project area which are also within the study area villages, so as to empower them and improve their quality & life. Five villages would be chosen for the purpose.

The following aspects have been covered:

- Educational Facilities
- Health Care and Medical Facilities
- Infrastructure Development
- Economic Development
- Social and Cultural Development.

The project cost is 477.15 crore. A budget of 1.5% (i.e Rs. 7.16 crore) of the project cost has been earmarked for implementation of Corporate Environmental Responsibility.

7.6.1 Upgradation of Educational Facilities

Following activities are proposed under Corporate Environmental Responsibility activities:

- Construction of new Hostel/community Hall
- Up-gradation of school fixtures, equipment
- Improvement in drinking water facilities
- School bus service

About 5 primary schools are proposed to be upgraded. The list of villages in which primary schools are to be upgraded is given in Table-7.9.

Table-7.9List of villages in which primary schools are to be upgraded

S. No	Village Name	Sub-district
1	Panw Malla	Mori
2	Pawn Talla	Mori
3	Sunkundi	Mori
4	Sauni	Mori
5	Saturi	Mori

A lumpsum amount of Rs. 13.0 lakh per primary school is being made for this purpose. The details are given in Table-7.10. An amount of Rs.65.0 lakh needs to be earmarked for this purpose. In addition, an amount of Rs.60 lakh has been earmarked for purchase of 2 school buses. A total amount of Rs.414.45 lakh has been earmarked for this purpose.

Table-7.10 Breakup of cost required for up-gradation of existing primary Schools.

S. No.	Particular	Amount (Rs. lakh) per school	Amount (Rs. lakh) for 5 schools
1	Construction of new Hostel/community Hall*	-	150.00
2	Furniture & fixtures and equipments	10.00	50.00
3	Improvement of drinking water facilities	3.00	15.00
	Sub-Total (A)	**13.00**	**215.00**
4	Purchase of school bus x 2 Nos.	30.00	60.00
	O&M cost of Rs. 8.75 lakh for 2 school buses (for 10 years including escalation @ 10% per annum)		139.45
	Sub-Total (B)	**30.00**	**199.45**
	Total (A + B)	**43.00**	**414.45**

Note: The above budget will be given to each of the 5 schools for up-gradation
*Land shall be provided by District Administration

7.6.2 Scholarships for Students

It is suggested to provide scholarships to 50 local students. On the one hand school going students, who are presently studying between Class–I to Class-XII, scholarships are suggested for an amount of Rs.600 per month for a period of 12 years.

On the other hand, scholarships are also suggested for students going for higher studies. Meritorious students from the above mentioned category or students who are presently pursuing higher studies will be supported for their college/ higher education. A scholarship provision of Rs. 10,000 per year for meeting their fee and study material requirement along with Rs. 5,000 per year for meeting their hostel expenses for a period of 4 years is being made for meritorious students for higher studies. About 20 students are proposed to be covered under this scheme.

A total amount of Rs.59.2 lakh may be earmarked for providing scholarships, details of which are given in Table-7.11.

Table-7.11 Details of scholarships

S. No.	Activities	Amount (Rs. lakh)
1	Scholarship for School going students (50 students x 600 per month for 12 years)	43.2
2	Scholarship for meritorious students–College/ higher education a) Fees/course material (@ Rs. 10,000/year x 20 student x 4 years)	8.0 4.0

	b) Hostel expenses (@ Rs. 5,000/years x 20 students x 4 years)	
	Total	**59.2**

7.6.3 Improvement of Public Health Facilities

It is proposed that the Primary Health Sub-Centers may be upgraded in 06 villages. The list of villages in which PHSCs are to be upgraded is given in Table-7.12.

Table-7.12 List of villages in which PHSCs are to be upgraded

S.No	Village Name	Sub District Name
1	Sankari	Mori
2	Saur	Mori
3	Jakhol	Mori
4	Dhara	Mori
5	Gangar	Mori
6	Naitwar	Mori

Upgradation of this health care facility would involve renovation of existing structure, etc. Provision of new and/or latest furniture, beds, laboratory equipment/instruments, computers wherever possible, installation of new floorings and ceilings, upgradation/ construction of new lavatories, electrification and adequate and proper lighting in rooms, facilities for cold storage of essential medicines, provision of drinking water facilities, etc

In addition, it is suggested to purchase 2 vans fitted with life saving equipments and stocked with medicines, which will function as a mobile clinics. It is further suggested to attach these mobile clinics to any of the above mentioned PHSCs from where these mobile units will operate. A total amount of Rs.242.45 lakh is being earmarked for extending health facilities under. The details are given in Table 7.13.

Table- 7.13 Budget for up-gradation of PHSCs

S. No.	Item	Cost (Rs. lakh)	Cost for 02 PHSCs (Rs. lakh)
1	Furniture, Beds and other items	8.500	17.00
2	Upgradation of Medical laboratory	15.00	30.00
3	Upgradation of operation theater (labor room)	8.00	16.00
	Sub-Total (A)	**31.50**	**63.00**
4	Purchase of 2 mobile clinic vans	40.00	40.00
	O&M cost of Rs. 8.75 lakh for 2 Vans (for 10 years including escalation @ 10% per annum)	-	139.45
	Sub-Total (B)		**179.45**
	Total (A+B)		**242.45**

An amount of **Rs.7.16 crores** has been earmarked for implementation of the Corporate Environmental Responsibility Activities. The details are shown in Table-7.14.

Table 7.14 Budget for implementation of CER

S. No.	Items	Budget (Rs. lakh)
1	Construction/ Upgradation of schools in Study Area	414.45
2	Scholarships to students in the Study Area	59.20
3	Improvement of Public Health Facility	242.45
	Total	**716.10**

ANNEXURE-VI

SJVN LIMITED

(A Joint Venture of Govt. of India & Govt. of Himachal Pradesh

JHAKOL SANKRI HYDRO ELECTRIC PROJECT(44MW)

Mori, Distt. Uttarkashi (Uttarakhand) – 249128

☎: 01373-234401, 🖷: 01373-234411/234303

Website: www.sjvn.nic.in

CIN: L40101HP1988GOI008409

TO WHOM IT MAY CONCERN

This is to certify that M/s WAPCOS limited, a Government of India Undertaking under Ministry of Jal Shakti has been entrusted for the work of Environmental Impact Assessment Study for the project of "**Jakhol Sankari Hydro-electric Project (44 MW), Uttarakhand**". It is further to certify that M/s WAPCOS Limited having its Headquarters at 76C, Sector-18, Gurgaon-122015, Haryana is a NABET Accredited Consultant and the information, data as provided in the EIA report are true and original to the best of our knowledge and have not been copied from other EIA Reports.

29/08/2019

Addl. General Manager/HOP
JS HE Project,
SJVN Ltd.
Mori, District Uttarkashi
Uttarakhand-249185

Addl. GM (HOP)
अपर महा प्रबंधक (परियोजना प्रमुख)
J.S. HEP., MORI, UTTARKASHI, U.K.
जखोल सांकरी, ज.वि.प., मोरी,
उत्तरकाशी, उत्तराखण्ड–249128

ANNEXURE-VII

FISHERIES

1. Background

Fisheries in the project area is not well developed, owing to difficult terrain, unfavorable climate. The elevation, temperature, current, velocity and natural biota are the factors governing the growth of fish in the rivers and water bodies in the area. Commercial fishing is not in practice in the Study Area.

2. Study Area and Sampling sites/ Survey locations

The complete area is divided in to three zones : a) upstream area /Submergence zone, b) barrage site to powerhouse site, and (c) downstream influence zone covering about 10 km longitudinal length of the river in line of 10km radius approach based on project appurtenances.

Fisheries survey was done for 3 seasons namely pre-monsoon, monsoon and winter seasons during the study period. The details of the study site and sampling locations to assess the aquatic fauna and flora are given in Table-1 and depicted in Figure 1. The photographs of river morphology and various sampling sites are given in Plate 1 and 2 respectively.

Table-1: Description of study sites selected on river Supin and its tributaries in the project impact zone

S. No.	Study Site	Sampling location
1	AE-1	Obra gad (u/s)
2	AE-2	Upstream Area of Barrage
3	AE-3	Barrage Site
4	AE-4	Downstream of Barrage Site near Bargad Nalla`
5	AE-5	Upstream of Power House Site
6	AE-6	Power House Site
7	AE-7	Downstream of Power House

AE= Aquatic Ecology

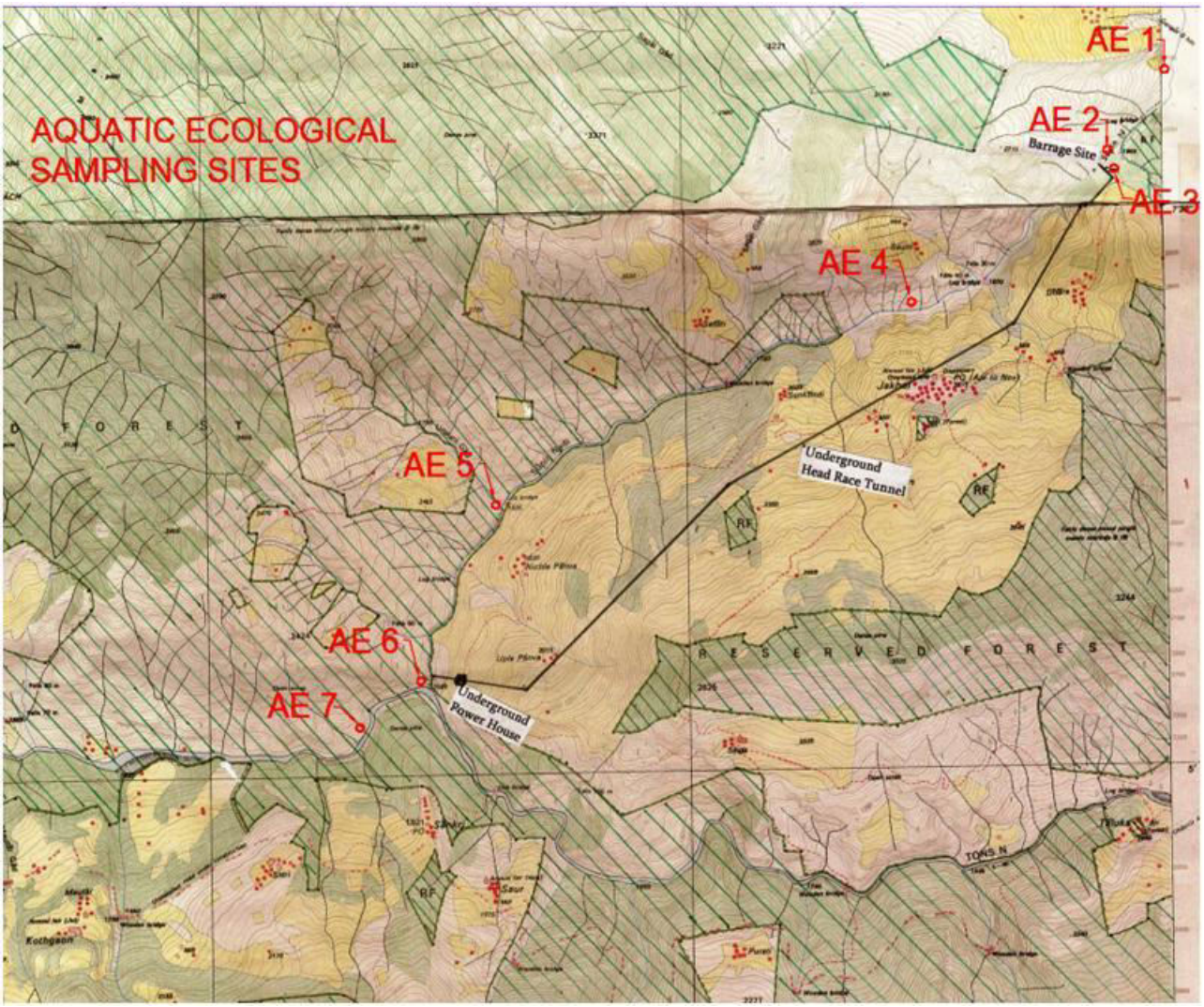


Figure-1: Aquatic Ecological Sampling Location Map

A total of 7 fish species were reported close to the confluence of Tons and Supin Rivers downstream to power house (AE-7) of Jakhol-Sankari HEP. However, no fish species were found at other sites located on river Supin with sites stretching from upstream of barrage site to upper confluence of river Tons. River Pabbar merges with the Tons River in village Tiuni. The presence of exotic or alien species like rainbow trout *(Oncorhynchus mykiss)* at sampling site (AE-VII) after confluence of river Tons with Supin could be due to the fact that the river Pabbar has its entire catchment in the neighbouring state Himachal Pradesh. The river joins the Tons on its right bank near village Tiuni (Uttrakhand), which is situated on left bank and about 54 km downstream from the proposed project site. A trout fish hatchery and fish farm is located upstream of Pabbar (~64km) at village Denwari (Rohru tehsil Himachal Pradesh) where culture of Rainbow trout is under operation since last

many years **(Plate 3)**. As discussed, no fish was found upstream to barrage area. This could be attributed to high elevation, low temperature and fast water velocity. Among the fishes found, six species are endemic in nature, eg. *Schizothorax richardsonii, Schizothorax progastus, Paraschistura montana, Barilius bendelisis, Glyptothorax penctonopterus* and *Garra gotyla gotyla*. One species commonly known as rainbow trout is *Oncorhynchus mykiss* is exotic and migratory in nature.

The list of fish species available downstream to the power house is given in Table-2.

Table-2: Fish Species Reported In Tons River Near Confluence With Supin d/s to powerhouse

S.No.	Name of the Fish	Local Name	IUCN Status	CAMP 1998
	Family:Cyprinidae			
1.	*Schizothorax richardsonii** (Gray) 1832	Maseen	VU	VU
2.	*Schizothorax progastus** (McClelland, 1839)	Chongu	LC	LRnt
3.	*Garra gotyla gotyla*(Gray, 1830)	Gondal	LC	VU
4.	*Barilius bendelisis* (Hamilton, 1807)	Fulra	LC	LRnt
	Family:Nemacheilidae			
5.	*Paraschistura montana* (McClelland, 1838)	Gadiyal-Loch	-	-
	Family: Sisoridae			
6.	*Glyptothorax pectinopterus* (McClelland, 1842)	Nau (River cat)	LC	LRnt
	Family : Salmonidae			
7.	*Oncorhynchus mykiss*[*,#] (Walbaum, 1792)	Rainbow trout	NE	-

Note- *VU-Vulnerable; LC-Least Concern; LRnt-* Lower risk-near threatened; *NE-Not Evaluated, *Trouts-migratory species; #Exotic/Alien species* (IUCN Red list version 2018-2)

The commercial fishery in the area is non-existent. The growth of the coldwater fish is also very poor due to low temperature and scarcity of food resources for fish. The river bed level at barrage axis is 1955.00 m and the river bed level at Tail Race Tunnel outfall is 1508.36 m. The Head Race Tunnel is about 6624.48 m long. There is very steep slope in the region. The slope varies from 1 in 16 to 1 in 50 in the project area. The flow velocity in the Supin river in the project area varies from 1.79 m/s to 2.32 m/s. It is very difficult for fish species to survive in such steep slope and high velocity. Therefore, present ecological survey revealed that there are no fish habitats in the project area.

Spawning and breeding

Most of the species of fish are periodic in breeding. *Schizothorax* breeds from May June to August, September depending upon the water temperature.

Fish Migration

Schizothorax is the migratory species observed in Tons river after the confluence with Supin. It is worthwhile to mention that no fish species were reported in Supin River. The migration of these species is generally related to water temperature of the river/stream. This species can survive between 2°C to 25°C. The favorable temperature of these species ranges from 10-22°C. During winter season when temperature falls below the favorable ranges these species migrate towards lower elevation. In pre-monsoon season, when river water temperature gets marginally high, they migrate back.

Proposed Barrage Site

Downstream Area of Barrage Site

Confluence of Obragad&Supin river near Baincha u/s of Barrage site

Plate-1: Aerial veiw of river /stream Morphology at proposed Barrage Site

A view of Proposed Power House Site

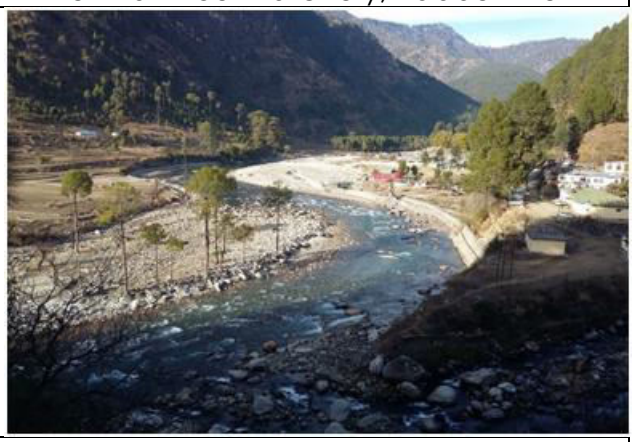
A Nalla/stream on right bank of river Supin at Upstream of PH

Plate-2: Aerial veiw of River /Stream morphology at Power House Site

Denwari Trout Hatchery (Operational)

Denwari Trout Hatchery, Pabber river

Fishing in Tons river with Cast net



Tons river at Mori block ,UK(30 km u/s tiuni)

Snow trout and Rainbow trout in Tons river

Plate-3: Trout fish hatchery at village Denwari, Pabberriver, Himachal Pradesh

ANNEXURE-VIII

List of angiosperm and gymnosperm species recommended for afforestation

Botanical Name
Trees
• *Alnus nepalensis*
• *Leucaena leucocephala*
• *Myrica esculenta*
• *Grevillea robusta*
• *Pinus roxburghii*
• *Abies pindrow*Royley
• *Cedrus deodara* (Roxb. Ex Lam) G. Don
• *Cupressus lusitenia* Mill.
• *Picea smitheana*
• *Pinus wallichiana* A.B. Jackson
Shrubs
• *Jatropha carcus*
• *Berberis asiatica*
• *Berberis lyceum*
• *Desmodium elegan*
Grasses
• *Arundinella nepalensis*
• *Agrimonia pilosa*
• *Alexandrium folium*
• *Cynodon dactylon*
• *Geranium ocellatum*
• *Solanum nigrum*

ANNEXURE-IX

Identification of Rare, Endangered and Threatened plant species

Rare and endangered species were identified referring to the Red Data Book of India, following the IUCN Red list of plants and other available literature, flora and herbarium pertaining to the rare/endangered species of state of Uttarakhand.

RET Status of Species

As per the Red Data book of Indian plants (Nayer & Sastry, 1987, 1988, 1990) and Following IUCN Red List of Threatened Species, few species fall under the rare category. R. Manikandan & S.K. Srivastava (2015) have reported some Threatened plants in Govind Wildlife Sanctuary, western Himalaya.

In the present study and with update from IUCN (Red List), only one plant species (Angelica glauca) is found to be in Endangered category. However, these species were observed at much higher elevation as compare to Barrage and power house sites. Thus, none of the species shall be affected due to the project activity. The list of threatened plant species reported in the study area is given in Table-1.

Table-1: List of threatened plant species in the study area

Botanical Name	Local Name	Habit	Status*	Status**
Acer aecium	Marik/Mapple	Tree	Vulnerable	Data Deficient
Angelica glauca Edgew	Chora	Herb	Endangered	Endangered
Asparagus adscendens Roxb.	Satawar	Shrub	Rare	Vulnerable
Berberis aristata DC.	Kashmol	Shrub	Endangered	Least Concern
Hedychium spicatum Buch.-Ham.	Van haldi	Herb	Rare	Not Evaluated
Betula alnoides Buch.-Ham. ex D. Don	Kathbhuj	Tree	Rare	Least Concern
Thalictrum foliolosum DC.	Mamri	Herb	Vulnerable	Not Evaluated

- **Status*** As per (Nayer & Sastry, 1987, 1988, 1990) and R. Manikandan & S.K. Srivastava (2015)
- **Status**** As per IUCN, 2019

Annexure-X

Quality Council of India

National Accreditation Board for Education & Training

Certificate of Accreditation

WAPCOS Limited (A Government of India Undertaking)

Plot-76-C, Sector-18, Gurgaon – 122015, Haryana

are accredited under the QCI-NABET Accreditation Scheme for EIA Consultant Organizations (Version 3) for preparing EIA/EMP reports in the following sectors:

Sl.No.	Sector Description	Sector (as per)		Cat.
		NABET	MoEFCC	
1	Mining of minerals (Open cast only)	1	1 (a) (i)	A
2	River valley projects	3	1 (c)	A
3	Thermal power plants	4	1 (d)	A
4	Ports, harbours, break waters and dredging	33	7 (e)	A

Note: Name of approved EIA Coordinators and Functional Area Experts are mentioned in SA AC minutes dated February 17, 2017 posted on QCI-NABET website.

The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in NABET's letter of accreditation bearing no. QCI/NABET/ENV/ACO/17/0300 dated 28 March 2017.The accreditation needs to be renewed before the expiry date by WAPCOS Limited, following due process of assessment.

CEO NABET	*Certificate No.*	*Issue Date*	*Expiry Date*
	NABET/EIA/1518/ SA 022	*Mar. 28, 2017*	*01.06.2018*

For the updated List of Accredited Consultants please refer QCI-NABET website.

NABET is a member of International Accreditation Forum (IAF) and Pacific Accreditation Cooperation (PAC).

Annexure-XI

SJVN Limited

(A joint venture of Govt. of India & Govt. of Himachal Pradesh)

A ' Mini Ratna' & Schedule 'A' PSU

An ISO 9001:2008 Certified Company

ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR JAKHOL SANKARI HYDRO ELECTRIC PROJECT, UTTARKASHI DISTRICT, UTTARAKHAND

Final EIA Report

वाप्कोस लिमिटेड
WAPCOS LIMITED
(भारत सरकार का उपक्रम - जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय)
(A Government of India Undertaking - Ministry of Water Resources, River Development & Ganga Rejuvenation)

WAPCOS LIMITED

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OCTOBER- 2019

ANNEXURE-VI

SJVN LIMITED

(A Joint Venture of Govt. of India & Govt. of Himachal Pradesh

JHAKOL SANKRI HYDRO ELECTRIC PROJECT(44MW)

Mori, Distt. Uttarkashi (Uttarakhand) – 249128

☎: 01373-234401, 🖷: 01373-234411/234303

Website: www.sjvn.nic.in

CIN: L40101HP1988GOI008409

TO WHOM IT MAY CONCERN

This is to certify that M/s WAPCOS limited, a Government of India Undertaking under Ministry of Jal Shakti has been entrusted for the work of Environmental Impact Assessment Study for the project of "**Jakhol Sankari Hydro-electric Project (44 MW), Uttarakhand**". It is further to certify that M/s WAPCOS Limited having its Headquarters at 76C, Sector-18, Gurgaon-122015, Haryana is a NABET Accredited Consultant and the information, data as provided in the EIA report are true and original to the best of our knowledge and have not been copied from other EIA Reports.

29/08/2019

Addl. General Manager/HOP
JS HE Project,
SJVN Ltd.
Mori, District Uttarkashi
Uttarakhand-249185

Addl. GM (HOP)
अपर महा प्रबंधक (परियोजना प्रमुख)
J.S. HEP., MORI, UTTARKASHI, U.K.
जखोल सांकरी, ज.वि.प., मोरी,
उत्तरकाशी, उत्तराखण्ड–249128

वाप्कोस लिमिटेड
WAPCOS LIMITED
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(भारत सरकार का उपक्रम)
जल संसाधन, नदी विकास व गंगा संरक्षण मंत्रालय
(A Government of India Undertaking)
Ministry of Water Resources, River Development & Ganga Rejuvenation

Date: 02.09.2019

TO WHOM IT MAY CONCERN

WAPCOS Limited, is a Government of India Undertaking, under Ministry of Jal Sakti. WAPCOS Limited, is a NABET accredited consultant for conducting EIA study in the field of River Valley & Hydroelectric Projects.

This is to certify that WAPCOS has carried out the Environmental Impact Assessment study for "CEIA study for Jakhol Sankari HEP, Uttarakhand" and declares the ownership of the contents (information and data) of the Environmental Impact Assessment study for the referred project.

Aman Sharma

(Dr. Aman Sharma)
CED (Envt., CM & Admin.)
2/9/19

डॉ. अमन शर्मा / Dr. Aman Sharma
मुख्य कार्यकारी निदेशक
(पर्यावरण, निर्माण प्रबंधन एवं प्रशासन)
Chief Executive Director
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INTRODUCTION

CHAPTER-1
INTRODUCTION

1.1 INTRODUCTION

The Satluj Jal Vidyut Nigam Ltd. (SJVNL), formerly Naptha-Jhakri Power Corporation Ltd. (NJPC) was incorporated on 24.5.1988 as a joint venture of Government of India and Govt. of Himachal Pradesh (H.P.). The 1500 MW Naptha Jhkakri H.E. Power project is the first project commissioned by the company.

India's hydropower potential is estimated at around 1,50,000 MW, out of which only 42783.42 MW (28.52%) has been tapped so far. On the other hand, the gap between demand and supply of power has been increasing at a much faster rate as the country's economic growth rate picked up in the last decade. The total power demand by 2030 is expected to cross 8,28,000 MW. Development of hydropower potential can significantly help bridge the gap between power demand and supply. In addition to meeting the power demand of the country, development of hydropower also helps in the development of water resources in general.

Uttrakhand's hydropower potential is estimated at around 20,000 MW, out of which only 3164.75 MW (about 15.82%) has been developed. There are some major projects in various stages of implementation. These are Bharon Ghati (I,II) 380 MW ,Garba Tawaghat (630 MW), Tehri Stage–II (1000 MW), Kotli Bhel (850 MW) . Various major and minor sites have been identified in the state with an aggregate estimated capacity of 15,000 MW.

The Jakhol Sankri Hydroelectric Project (JSHEP) is proposed on Supin River in Uttarkashi district of Uttrakhand State. There are several hydropower projects under different stages of development on river Tons. These are mainly 60 MW Naitwar Mori HEP, Mori Hanol HEP and Hanol Tuini HEP. In addition, Tons has about 500 MW of identified hydropower projects under development. Jakhol Sankri HEP is one of the three hydropower projects awarded to Satluj Jal Vidyut Nigam Limited (SJVN Ltd.) in the State of Uttrakhand. The other two projects are Naitwar Mori HEP on river Tons downstream of Jakhol Sankri HEP (JSHEP) and Devasari HEP on river Pindar, a major tributary of river Alaknanda, in district Chamoli.

The JSHEP envisages a run-of-the-river scheme on the river Supin. The project shall harness the hydropower potential by utilizing a maximum gross head of 445.80 m. It is worthwhile to mention here that proposed Jakhol Sankari HEP is only hydroelectric project on Supin River, which is tributary of Tons River. The JSHEP is

located about 450 Kms North East (NE) of Delhi and 225 Kms North (N) of state capital Dehradun and on the Supin River in Uttarkashi district in the state of Uttrakhand.

1.2 LOCATION OF THE PROJECT

The JSHEP is located about 450 km north-east (NE) of Delhi and 225 Kms North (N) of state capital Dehradun and on the Supin River in Uttarkashi district in the state of Uttarakhand. The potential barrage site is located some 942 m downstream (d/s) of the confluence of Supin and Devkir (Obra Gad) rivers at E.L. 1955.00 m. The potential powerhouse locations are all in the left bank of river Supin near its confluence with river Tons. The project area lies within latitudes 31°05'19" to 31°06'06"N and longitudes 78°11'10" to 78°14'07"E.

The project area can be reached by road from the nearest railhead at Dehradun which is 235 km from Delhi. The National Highway – NH 72A connects Dehradun to Musoorie and further from Musoorie to Yamnotri there is State Highway, and from Yamnotri to Naugaon, the road is classified as NH 123. Naugoan via Purola to Mori and to Sankri is connected through a district road. The project location map is enclosed as Figure-1.1.

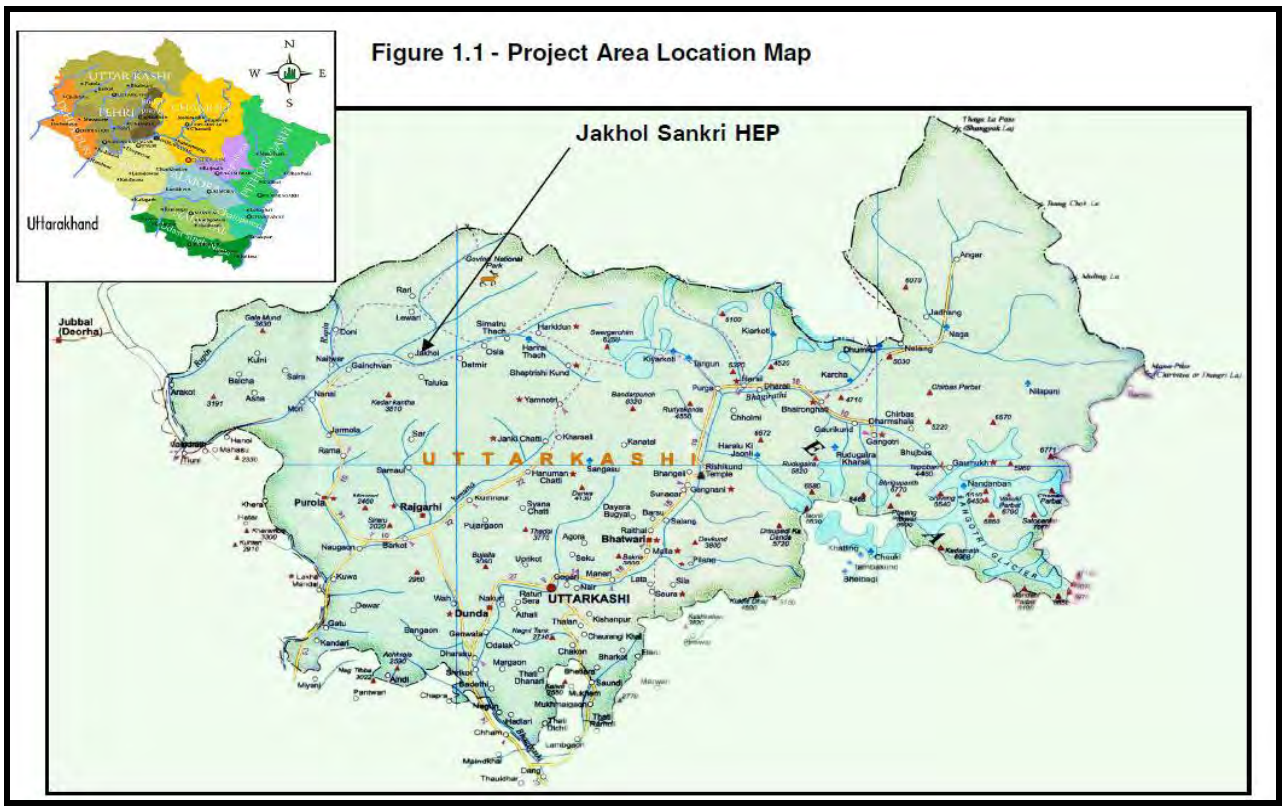

Figure-1.1: Project Location Map

1.3 NEED FOR THE PROJECT

In India, demand for electric energy is growing at an average annual compound growth rate of 7-8% per year. During the year 2010-11, the country faced an energy shortage of 73236 MU (8.5%) and a peak shortage of 12031 MW (9.8%). Presently, the total installed capacity in India is 298059.97MW (as on 31-03-2016) but as per the data available it can be seen that average demand for the year 2012-13 was 1,35,453MW against the average generation of 1,23,294 MW during the same period of which is almost 8.98% less than the requirement. To overcome this acute power shortage, Government of India has initiated a number of steps for development of new power projects. During the 12th five year Plan 1, 18,537 MW capacities shall have to be added. Out of this, hydropower is expected to account for almost 10,897 MW.

The development of hydropower in Uttarakhand will not only benefit the state but also meet the power requirements of the neighbouring states and northern region of the country. Uttrakhand is presently a net importer of electric power, but generates a seasonal surplus and plans to become a net exporter by expanding its hydropower and high voltage transmission capacity. Total capacity expansion of 10,000 megawatts (MW) is planned by the year 2018. The development of Jakhol Sankri HE Project is a step in the direction of achieving the above targets.

The alternative to hydropower could be a thermal power project based on one of a number of fuel types. However, the State of Uttarakhand has none of fuel commonly used for generating thermal power. On the other hand, the State has enormous hydropower potential yet to be tapped. Moreover, owing to a faster growth of thermal power projects in the country, the national ratio of hydropower projects has dropped from about 46% in 1951 to 14.35% in 2016. The need for an accelerated development of hydropower project is, therefore, critical for achieving an appropriate mix of thermal and hydropower.

It is obvious from the above discussion that the proposed Jakhol Sankri HEP is needed from the power demand and supply gap scenario and is the most appropriate option when compared with a thermal alternative.

1.4 INTER-STATE / INTER-NATIONAL ASPECTS

The JSHEP project is run-of-the-river project on river Supin which originates from a Kimlog glacier in Garhwal peaks. Thereafter this river flows in south-west direction to merge with the river Tons, which drains into river Yamuna at Kalsi in the northwestern part of Dehradun valley (approximately 48 km away from Dehradun). The entire course of Supin River lies within the state of Uttarakhand. There are no interstate / international implications in this scheme.

1.5 BASIN DEVELOPMENT

The Jakhol Sankri Hydroelectric Project (JSHEP) forms a part of the cascade development planned along river Supin and river Tons (after its confluence with the river Tons) in Uttarkashi district of Uttarakhand State. The Supin River is a tributary to river Tons which is one of the main tributary of the river Yamuna and located in the north Indian State of Uttarakhand (formerly Uttaranchal). This Supin River originates from the peaks of Kimlog glacier at the head of famous Har ki Doon valley in the north-north eastern part of the Tons catchment at an altitude of approximately 5000 m and after flowing a distance of 27.60 km in the south direction joins river Devkir/ Obra Gad. River Devkir originates from Devkir glacier at an altitude of 4800 m. After the confluence river Supin flows south westernly direction, meetings the Tons River near Sankri Village.

As on date, JSHEP is the only proposed project on this stream. Moreover, upstream of the diversion structure of this proposed project, area is snow covered with minimal habitation. However, on the downstream of this project there are number of hydro power projects on river Tons and river Pabbar under various stage of development. The proposed JSHEP is on River Supin. River water is diverted throughsuitable water diversion arrangement at Jakhol and is taken to the powerhouse located near village Sankri. The water from the powerhouse is drained back to the river and hence no trans-basin diversion of water is involved in the project.

The JSHEP was taken up for development under the ambitious Hydro 50,000 initiative launched in the year 2003. Therefore, the scheme very much fits into the overall basin development plan and the power potential studies assessment carried out by Central Electricity Authority (CEA) as the later formed the basis of power potential development plan for different Indian River basins.

Jakhol Sankri Hydroelectric Project (JSHEP) on Supin river, a tributary of river Tons, is presently the only hydropower project proposed under development. Since there is

no project proposed upstream of this project, there is no impact on the flow volume or the flow pattern as far as JSHEP is concerned. On the downstream of this project, there is Naitwar Mori HEP (60 MW) on river Tons with FRL at EL 1267.00 m. The free flow stretches is more than 5 km. Since the proposed JSHEP is envisaged with the TWL at EL. 1510.66 m, therefore, this project is not expected to have any impact from the downstream projects i.e. NMHEP which is run-of-the-river scheme on river Tons .

1.6 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A Comprehensive Environmental Impact Assessment (CEIA) report is a prerequisite for obtaining Environmental Clearance. SJVNL has awarded the work for Environmental Impact Assessment Study to WAPCOS Ltd., a Govt. of India Undertaking vide letter No.SJVNL/CCD/JSHEP/EIA/2016-2242-47 dated 18.11.2016. The Agreement for the implementation of the study was signed on 30th December, 2016.

The principal Environmental Regulatory Agency in India is the Ministry of Environment, Forests & Climate Change (MOEF&CC), Government of India. MOEF&CC formulates environmental policies and accords environmental clearance for the projects. The State Pollution Control Board (SPCB) accords No Objection Certificate (NOC) for Consent for Establishment and Consent for Operation for the projects.

As per the guidelines pertaining to Environmental clearance issued by MOEF&CC dated September 14, 2006, the Terms of Reference (TOR) for the EIA study is to be approved by MoEF&CC. In this connection Form-I alongwith TOR in the prescribed format was submitted to MoEF&CC. The same was received by the Environmental Appraisal Committee of River Valley Projects of MoEF&CC. The TOR for the CEIA study approved by MoEF&CC is enclosed as Annexure-I. Compliance of TOR is enclosed as Annexure-IA

1.7 SCOPE OF THE EIA STUDY

The brief scope of EIA study includes:

- Assessment of the existing status of physico-chemical, ecological and socio-economic aspects of environment
- Identification of potential impacts on various environmental components due to activities envisaged during construction and operational phases of the proposed hydro-electric project.

- Prediction of significant impacts on major environmental components using appropriate mathematical/simulation models.
- Delineation of Environmental Management Plan (EMP) outlining measures to minimize adverse impacts during construction and operational phases of the proposed project.
- Formulation of Resettlement and Rehabilitation(R&R) Plan.
- Formulation of Catchment Area Treatment (CAT) Plan.
- Formulation of environmental quality monitoring programmes for implementation during construction and operation phases.
- Estimation of Cost for implementation of Environmental Management Plan, Resettlement & Rehabilitation Plan, Catchment Area Treatment Plan and Environmental Monitoring Programme.

1.8 STAGES IN AN EIA STUDY

The purpose of this section is to enumerate the steps involved in an Environmental Impact Assessment (EIA) study, which are described in the following paragraphs.

Scoping : An exhaustive list of all likely impacts drawing information from as many sources as possible was prepared. The next step was to select a manageable number of attributes which were likely to be affected as a result of the proposed project. The various criteria applied for selection of the important impacts were follows:

- magnitude
- extent
- significance

Description of Environment: Before the start of the project, it is essential to ascertain the baseline levels of appropriate environmental parameters which could be significantly affected by the implementation of the project. The baseline status assessed as a part of CEIA through data from primary as well as secondary sources.

Prediction of Impacts: is essentially a process to forecast the future environmental conditions of the project area that might be expected to occur as a result of the construction and operation of the proposed hydroelectric project. An attempt was made to forecast future environmental conditions quantitatively to the extent possible. However, for intangible impacts, qualitative assessment has been made so that planners and decision-makers are aware of their existence as well as their possible implications.

Environmental Management Plan (EMP): the approach for formulation of an Environmental Management Plan (EMP) is to maximize the positive environmental impacts and minimize the negative ones. The steps suggested as a part of EMP include modifications of plans, engineering designs, construction schedules and techniques, as well as operational and management practices. After selection of suitable environmental mitigation measures, cost required for implementation of various management measures has also been estimated as a part of the present study.

Environmental Monitoring Programme: An Environmental Monitoring Programme for implementation during project construction and operation phases is outlined as a part of the CEIA Report to oversee the environmental safeguards, to ascertain the agreement between prediction and reality and to suggest remedial measures not foreseen during the planning stage but arising during construction and operation phases. The exercise will also generate data for future use and serve as a reference for assessment of impacts of hydropower projects in similar settings.

1.9 OUTLINE OF THE REPORT

The present document outlines the findings of the EIA study for the proposed Jakhol Sankri hydroelectric project. The contents of the document are organized as follows:

Chapter-1 The Chapter gives an overview of the need for the project. The policy, legal and administrative framework for environmental clearance has been summarized. The objectives and need for EIA study too have been covered.

Chapter-2 gives a brief description of the proposed Jakhol Sankri hydroelectric project.

Chapter-3 covers the environmental baseline conditions covering physical, ecological and socio-economic aspects of environment. The baseline study involved both field work and review of existing documents, which is necessary for identification of data which may already have been collected for other purposes.

Chapter-4 describes the anticipated positive and negative impacts as a result of the construction and operation of the proposed Jakhol Sankri hydroelectric project on physico-chemical and ecological aspects of environment. It is essentially a process to forecast the future environmental conditions of the project area that might be expected to occur as a result of the construction and operation of the proposed project. An attempt was made to forecast future environmental conditions

quantitatively to the extent possible. But for certain parameters, which cannot be quantified, approach has been to discuss such intangible impacts in qualitative terms so that planners and decision-makers are aware of their existence as well as their possible implications.

Chapter-5 describes the alternatives considered for this project.

Chapter-6: covers the Environmental Monitoring Programme for implementation during project construction and operation phases.

Chapter-7 describes various additional studies conducted during the study which included Public hearing details, Risk Assessment and DMP, Social Impact Assessment and formulation of R&R Plan for PAFs

Chapter-8: covers the Project Benefits due to implementation of the proposed Jakhol Sankri hydroelectric project

Chapter 9: Outlines the Environmental Cost Benefit analysis. (Not applicable as it was not recommended at the scoping stage)

Chapter-10: outlines the various Environmental Management Plan recommended to mitigate the negative environmental impacts.

Chapter-11: outlines the Summary and Conclusion of the project.

Chapter-12: covers the list of Experts involved in the EIA-EMP study for Jakhol Sankri hydroelectric project

CHAPTER-2
PROJECT DESCRIPTION

CHAPTER-2
PROJECT DESCRIPTION

2.1 GENERAL

The project site and its components can be reached by National Highway NH-123 from state capital Dehradun which is connected very well by rail/road/air with the other parts of the country. Sankri village which is located on the left bank of river Tons is approximately 220 km from Dehradun. Road between Dehradun to Sankri village passes through the places like Harbatpur, Barwala, Hatyari, Judoo, Nougaon, Purola, Mori and Naitwar. The Sankri village is approximately 12 Km upstream of Naitwar village. Downstream of the project site a 60 MW Naitwar Mori HEP has been proposed between the stretches of Naitwar and Mori village.

The underground powerhouse is proposed near the confluence of river Tons and Supin. The main access tunnel (MAT) to the underground powerhouse may be approached by constructing a new road from Nichla Ponva village. An existing road off taking from the road between Sankri and Jakhol leading to the Nichla Ponva village will have to be used during construction for approaching to MAT. The bridge on the river Tons will need to be strengthened for suitable class of loading. Several roads have to be constructed/ upgraded for approach to the adit to surge shaft and the adit to the Head Race Tunnel (HRT) just before the Surge Shaft and in & around powerhouse complex.

The broad gauge railhead at Dehradun / Rishikesh is about 220/260 km from the powerhouse of Jakhol Sankri HEP.

2.2 HISTORICAL BACKGROUND OF THE PROJECT

a) Earlier proposal

Government of Uttarakhand has resolved to harness the hydropower potential of the State as its central strategy for taking the State on a path of accelerated economic development. With this objective, in the year 2003 the Uttaranchal Jal Vidyut Nigam Limited embarked upon preparation of pre-feasibility reports (PFRs) of several potential hydropower projects in the state. The Jakhol Sankri HEP was identified as a potential hydropower development site by CEA as part of the Hydro 50,000 MW initiative. In November 2005, this project was allotted to Satluj Jal Vidyut Nigam Limited (SJVNL) on Built, Own, Operate and Maintain (BOOM) basis by the Government of Uttarakhand. The PFR prepared by SJVNL was submitted in

December, 2006. The estimated installed capacity of the project was 36 MW based on the preliminary study at the feasibility level.

b) Proposal in the already submitted DPR 51MW

In October 2006, SJVN Ltd. engaged a consultant for studying the project further and for getting the Feasibility Study Report (FSR), Detailed Project Report (DPR) and Bid Document. As part of this exercise, extensive survey and investigation works have been carried out to study the project in detail and identify the best project development alternative. A DPR of 51 MW was prepared and submitted to Govt. of Uttrakhand in December 2011. Environmental flows considered for DPR (51 MW) was 10% of the minimum flow during lean period.

c) Present proposal

In the present proposal there is no change in the layout of the scheme. However, due to increase in environmental releases, according to MoEF&CC guidelines for sustenance of riverine ecology. The water availability has been revised and the power potential studies carried out accordingly. Hence, the installed capacity of the scheme is reduced as 44MW.

2.3 PROJECT PROFILE

The proposed Barrage site is across river Supin near Jakhol village. The width of the river at this section is about 33 m. The right bank is rather steep while the left bank is suitable for Power Intake. The selected layout takes into consideration the constraints that protected wildlife areas are not encroached upon. The power intake, approach Tunnel, underground desilting tank; have been provided on the left bank terrace adjacent at Barrage location. A pressure tunnel (head race tunnel) connects desilting tank and surge shaft. A pressure shaft carries water from surge shaft to the powerhouse. The powerhouse is proposed on the left bank of river Supin near Sankri village. A tailrace tunnel drains the discharge from the powerhouse back to Supin river.

The Jakhol Sankri Hydroelectric project envisages the following Civil Structures:

- Barrage across river Supin near Dhara village.
- Intake, Approach Tunnel and Underground Desilting Chamber on left bank.
- Head Race Tunnel (HRT) on the left bank and terminating at Surge Shaft.
- Underground restricted orifice type Surge Shaft.
- Pressure Shaft & surface Penstock.
- Underground Power House with 2 units of vertical Pelton type turbines near village Sankri.

- Tailrace Tunnel (TRT).
- Underground Cavern for GIS

The general layout plan of the project indicating major civil structures is enclosed as Figure-2.1.

2.4 PROJECT DESCRIPTION

Barrage

The proposed Barrage site is across river Supin near Jakhol village. The width of the river at this section is about 33 m. The right bank is rather steep while the left bank is suitable for Power Intake. The selected layout takes into consideration the following points; Power Intake Approach Tunnel Underground Desilting Chamber Head Race Tunnel have been proposed on the left bank adjacent to the Barrage location.

The concrete gated Barrage structure is proposed having four vertical gates of size 5.0 m wide and 4.4 m height with upstream and downstream retaining wall both on left & right bank joining the structure. The width of Barrage across the river is 33.00 m. The bed level of the barrage structure in the upstream corresponds to the river bed level of EL 1955.00 m and the pond level has been kept at EL 1959.40 m, also the deck slab has been proposed at EL 1962.20 m.

The arrangement for river diversion during construction of Barrage has been planned by proposing two cofferdams and providing 187.405 m long 1650 mm diameter steel pipe (3 nos) at the right bank to pass 50 m3/sec of construction diversion discharge. The other key features of the barrage are:

- A Fish Ladder has been proposed adjacent to the right side of the structure to allow the aqua life flourishing.
- A Power Intake arrangement has been proposed with fixed wheel vertical lift service gate of size 6.0 m wide and 4.0 m height. There is a provision of emergency gate of equivalent size in upstream of service gate. A clear gap of 2.0 m has been kept between both tiers of service and emergency gate.
- The length of power intake structure is approximately 19.10 m. The bed level of intake structure is kept at EL 1956.00 m and the deck slab level is at EL 1962.20 m.
- A Power Intake trash rack arrangement has been proposed at extreme inlet end having size of 3.0 m wide and 3.5 m height and there are total of 4 nos. of pieces.

- Trash rack cleaning machine (TRCM) arrangement has been proposed to facilitate removal of the deposited floating debris in front of the power intake.
- An Approach Tunnel of 4.0m diameter having D-shape has been proposed to carry water from intake structure to Desilting Chamber. The water shall flow under atmospheric pressure i.e. free flow of water is maintained in the Approach Tunnel. The length of Approach tunnel is approximately 162.70 m.
- Underground Twin Chambered Hooper Type Desilting Chamber separated by 1.0 m thick RCC wall has been proposed of size 100m (L) x 12m (W) x12.27m (H) on the left bank downstream of the Approach Tunnel to remove suspended sediment size more than 0.2 mm. An upstream transition of 30.0m & downstream transition of 20.0m has been proposed with the Desilting Chamber. The flushing arrangement has been proposed from the bottom of the hooper through a connecting flushing tunnel.

Head Race Tunnel

A 6624.48 m long Modified Horse Shoe shaped Head Race Tunnel of 3.0 m diameter joins the downstream of Desilting Chamber to the Surge Shaft. The alignment of HRT has been chosen to avoid the protected wild life area and adequate rock cover has been maintained throughout the alignment in accordance with the structural requirement. Three numbers of bends have been provided in the HRT. Four Adits have been proposed in the HRT portion to facilitate excavation in HRT, Desilting Chamber & also in the Surge Shaft location.

Adits

- Adit No.1 has twin arm proposed to serve both for excavation of the Desilting Chamber as well one of its face shall cater to 624.81 m of HRT excavation. The adit is D-shaped having 4 m diameter. The total length of Adit No. 1 has been proposed approximately as 185.28 m.
- Adit No.2 has been proposed to excavate 1988.00 m of HRT. The adit is D-shaped having 4 m diameter. The total length of Adit No.2 has been proposed approximately as 392.10 m.
- Adit No.3 has been proposed to excavate 2654.00 m of HRT. The adit is D-shaped having 4 m diameter. The total length of Adit No.3 has been proposed approximately as 353.20 m.

- Adit No.4 has been proposed to excavate 66.60 m of HRT upto Surge Shaft. The adit is D-shaped having 4 m diameter. The total length of Adit No.4 has been proposed approximately as 208.13 m.

Surge Shaft

A 42.87 m high Surge Shaft of 7.5 m diameter has been proposed to withstand as well absorb the water hammer pressure in case of sudden load rejection and also sudden load acceptance. The maximum upsurge and minimum down surge level in the Surge Shaft are EL1969.75m and El 1945.00m respectively.

Pressure Shaft

A 707.34 m long underground Pressure Shaft of 1.85 m diameter carries water from the Surge Shaft to the surface Valve Chamber. A 12.0 m wide Valve Chamber is proposed with 2.0 m diameter butterfly type valve.

Penstock

A 1.85 m diameter surface Penstock is proposed from Surface Valve chamber having 166.85 m long specially to cross the Purola Thrust, which again lead into the underground Pressure Shaft after crossing the Purola thrust by a sufficient margin leading to the underground Powerhouse. The Power House has been proposed on the left bank of River Supin near Sankri village.

A 347.968 m long vertical pressure shaft of 2.0 m diameter has been proposed to meet a 192.32 m long horizontal pressure shaft of 2.0 m diameter having centerline at EL 1513.60 m and after traversing 192.32 m has been bifurcated into two unit penstock having diameter of 1.30 m. The 2.0 m diameter horizontal pressure shaft bifurcates, 25 m upstream of Power House, into two nos. of 1.3 m diameter pressure shaft feeding two nos. of Vertical Pelton Turbine of 22 MW capacity each.

Power House

An Underground Power House complex 61 m (L) x 17.39 m (W) x 34.75m (H) from centerline of Surge Shaft. The Turbine Floor level is at EL1515.20 m and center line of the Turbine is at EL1513.60 m. An Underground Transformer cavern 73.11 m (L) x 12.00m (W) x 26.78m (H) having two floors. The Transformer Floor level is at EL1523.20 m and GIS Floor is at EL1531.65 m. A 155.52 m long D-shaped Tail Race Tunnel of size 3.5m(W) X 3.75m(H) has been proposed which drains the diverted discharge from the Power House back to Supin River.

2.5 SALIENT FEATURES

The salient features of the project are given in Table-2.1.

Table-2.1Salient features of Jakhol Sankari HEP

LOCATION	
State	Uttarakhand (formerly Uttranchal)
District	Uttarkashi
Tehsil	Mori
Latitude	31°05'19"N - 31°07'06"N
Longitude	78°11' 10"E - 78°14'07"E
Nearest Rail head	Dehradun
Nearest Airport / approach	Dehradun
Name of River / Tributary	Supin (Tributary of Tons)
Name of River Basin	Yamuna River Basin
HYDROLOGY AND CLIMATE	
Catchment Area upto head works (km^2)	268.20 km^2
Snow Catchment area (km^2)	29.50 km^2 (11% of total)
Average annual Yield (Mm^3)	359.72
Maximum / Minimum Yield	667.96 - Year 1990-91/ 214.07 - Year 2000-01
Design Flood (m^3/s)	270 (in 100 year)
90% available discharge (Mm^3)	225.53 - Year 1984-85
DIVERSION STRUCTURE	
Type	Barrage
Maximum height above deepest foundation	17 m
Average River Bed Level at Barrage Axis	EL 1955.00 m
Elevation at top of Barrage	EL 1962.20m
Length of Barrage bay at top (m)	33.0 m
FRL (m)	EL 1959.4 m
MWL (m)	EL 1961.20 m
No. & size of gates	4 Nos. - 5.00m (W) x 4.4 m (H)
RIVER DIVERSION ARRANGEMENT	
Pipe Size (dia. in m), type and number	1.6 M diameter Steel Pipes, 3 No.
Pipe Length(m)	187.4 m (approximately)
DESIL TING TANK	
Type	Underground, twin chamber
Number and size - L (m) x B (m) x H (m)	Two, 100 (L) x 12.0(W) x 12.27 (H)
Particle size to be removed (mm)	0.2
Number of adit	One
HEAD RACE TUNNEL	
Length (m) and shape	6624.48m, modified Horse shoe shaped
Diameter (m)	3.0 m (finished)
Design discharge (m^3/s)	11.40
Number of adits	Four
SURGE SHAFT	
Type	Underground restricted orifice

Diameter (m)	7.5 m
Height (m)	42.87 m (EL difference between crown of Surge Shaft and sill level of Surge Shaft orifice)
Top Elevation	EL 1979.55 m (Crown of Surge Shaft)
Invert Level of Surge Shaft orifice	EL 1936.68 m
PRESSURE SHAFT / PENSTOCK	
Type	Steel Lined Partly Pressure Shaft & partly penstock
Number of Pressure shafts	One
Normal discharge through pressure shaft/penstock (m^3/s)	11.40
Internal Diameter of pressure shaft (m)	1.85
Maximum velocity (m/sec)	4.24
Length of pressure shaft (m)	707.34
Length of unit penstock (m)	50.55
Penstock Gate at Surge Shaft	1 no.
Main Inlet valve, if any (type & diameter)	2 Nos., 1.3 m (Spherical type)
UNDERGROUND POWERHOUSE	
Type	Underground
Location	Left bank of river Supin, about 200 m upstream of confluence of Supin and Tons.
Installed Capacity	2x22 MW
Efficiency of Turbine	92%
Maximum Gross Head	445.80 m
Net Design Head	436.36 m
Type of turbine	Vertical Pelton
Rated Discharge through each unit (m^3/s)	5.7 m^3/sec
For Generator/Generator motor	
- type	Synchronous, single phase
- Efficiency	98%
Size of transformer Cavern	73.11m(L)x12.00m(W)x26.78m(H) ace Conduits 02
TAILRACE CHANNEL	
Tailrace Channel	D-shaped, 3.5 m Diameter and 3.75 m (height)
Length of Tailrace channel	155.52 m
EL of the downstream crest	1508.36 m
POWER BENEFITS	
Design Energy (GWh/annum)	166.19 MU
CONSTRUCTION PERIOD	4 Years (48 Months)
COST ESTIMATES (Rs. In Crores)	**Present Day**
Civil & HM	250.23
Electrical/Mechanical	170.60
Sub-Total (Generation)	420.83
IDC	52.98

Financial charges & Front End Free	3.34
Total cost with IDC & Front End Fee	477.15
LEVELISED TARRIF	
Levelised Tariff (Rs./kWh) (with free power to home state)	7.56
First Year Tariff (Rs./kWh) (with free power to home state)	7.55
Cost per MW (with IDC & FC) – in Crore	10.84
Cost per MW (without IDC & FC) – in Crore	9.56

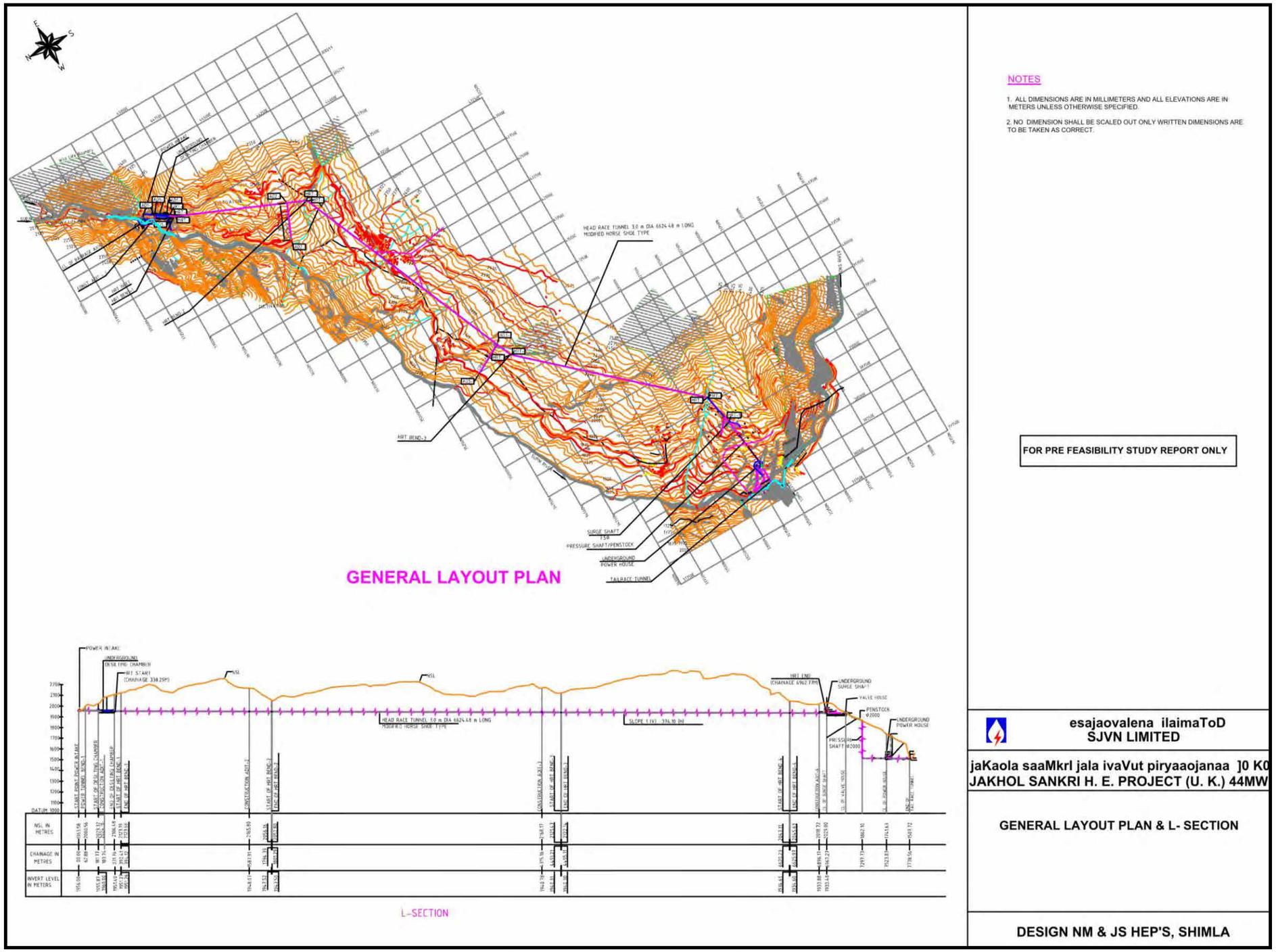

Figure-2.1: General Layout Plan

2.6 INFRASTRUCTURE FACILITIES

Proper planning and development of infrastructure is vital for timely and hassle-free construction of a project. The Jakhol Sankri HEP is located between Jakhol and Sankri village in the Mori Tehsil of Uttarkashi district. Sankri village located on the left bank of river Tons and Supin river is considered to be the entrance for the project. The approach from Sankri village towards project site will pass through the Govind Wildlife sanctuary after crossing river Tons. However, only barring some few kilometers, the road from Sankri to Jakhol is of mettled road. Nevertheless, suitable enhancement of the existing infrastructure leading to the project area and infrastructure development within the project area shall be required for smooth implementation of the project. After careful study of the project area and investigation, the following access and infrastructure facilities are proposed to be provided in the project for successful and timely completion of the project. The infrastructure facilities are shown in Figure-2.2.

2.7 ACCESS ROADS

Access roads can be divided into two categories - access to the project area and access within the project area.

Access to the Project

The major road distances along with the road width and conditions are mentioned in the Table-2.2.

Table-2.2 Major road distances along with the road width and conditions

S. No.	Description	Distance (km)	Width of Carriage-way (mm)
1.	Dehradun - Harbatpur (NH-123)	38	7.0 m with Black Top
2.	Harbatpur - Barwala (NH-123)	12	6.0 m with Black Top
3.	Barwala - Judoo via Hatyari (Project Road)	18	7.0 m with Black Top
4.	Judoo to Nougaon (NH-123)	69	5.20 m with Black Top
5.	Naugoan to Purola (ODR)	21	5.20 m with Black Top
6.	Purola to Mori (ODR)	35	5.20 m with Black Top
7.	Mori to Naitwar (ODR)	12	5.20 m with Black Top
8.	Naitwar to Sankri	12 approx.	3.50 -5.20 m with Black Top
9.	Sankri to Jakhol	19 approx.	3.50 -5.20 m with Black Top

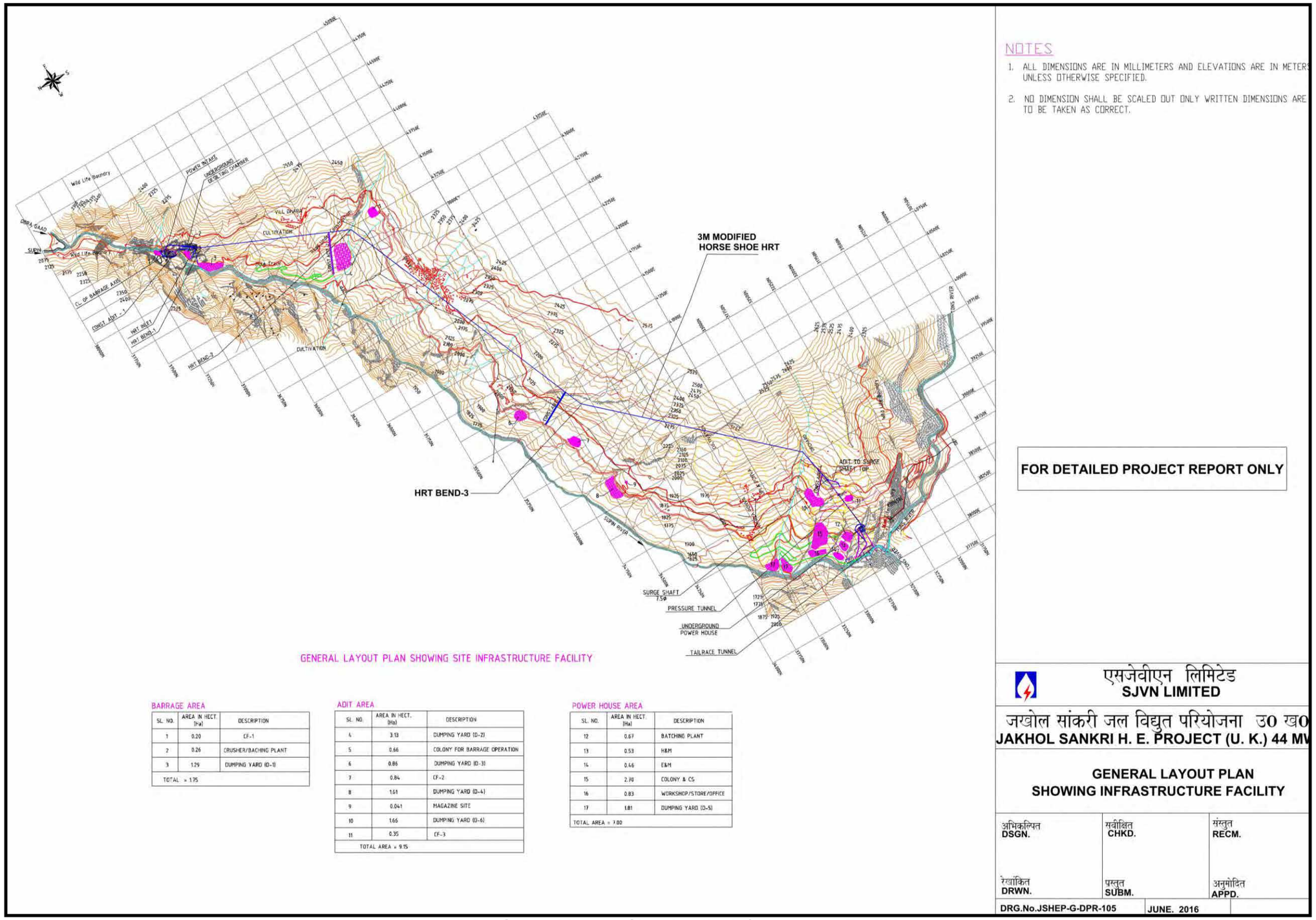

Figure-2.2 General Layout Showing the Infrastructure Facilities

An alternative road for accessing the project site may be envisaged on the right bank of river Tons in case of problem arises from transporting of heavy vehicle during construction through the road on left bank of Tons which passes some portion through the wild life area after crossing river Tons. The road on the right bank of river Tons at present exists from Naitwar village to the Supin bank a few meters upstream of confluence of river Supin and Tons and then it goes to Nichla Ponva village after crossing Supin river. The road at its present from is unsuitable for transportation of any heavy vehicle regarding its small width and steep slope.

Road & Bridge Improvement

Only 3-4 locations of the existing roads required widening on curve which is already/likely to be included by state PWD for its maintenance to fit with the project activities. A few patch of road between Sankri and Jakhol village needs urgent repair work. However, widening of these roads will be required if not taken up by state PWD, by the time project execution is in full swing. Bridges between Dehradun to Harbatpur are designed for Class A loading and Harbatpur to Mori are designed for Class loading. These are to be strengthened for IRC Class A loading as per the requirement during project construction. The steel bridge on river Tons on way to Sankri village has to be suitably upgraded/strengthened for heavy vehicles.

Access Roads within the Project Area

i) Barrage

Additional roads are yet to be built to reach the Barrage and Desilting Chamber site. Metalled road is available upto Jakhol Bend . After the Jakhol Bend about 3.50 km Road has been built by PWD which needs to be widened by extra cutting. Beyond 3.50 km of Jakhol bend the road is being constructed by PWD to approach the villages in the upstream of proposed barrage. Additional road of 0.50Km length is required to be constructed to approach left portion of barrage by widening of existing footpath/mule road, which is already available to reach these places. The widening of the existing road and footpath/mule road shall be required.

ii) Construction Adit

One construction adit (construction adit – 1) for accessing underground desilting chamber has been proposed. Three other construction adits (construction adit 2, 3 & 4) have been planned for 6624.48 m long headrace tunnel (HRT). Construction Adits 2 & 4 will be close to Desilting Basin and Surge Shaft respectively. The approaches to these Adits are to be constructed for easier access and smooth movement of

vehicle. The roads leading to these adits have been planned from the existing black top metalled road between Sankri and Jakhol village at different locations and levels. Construction Adits leading to the top of Surge Shaft and middle of vertical surge shaft have been proposed. The approaches to these Adits are also to be constructed for easier access and smooth movement of vehicle.

iii) Power House complex

The underground powerhouse is proposed near the confluence of river Tons and Supin. The main access tunnel (MAT) to the underground powerhouse may be approached by constructing a new road from Nichla Ponva village. An existing road off taking from the road between Sankri and Jakhol leading to the Nichla Ponva village will have to be used during construction for approaching to MAT.

The bridge on the river Tons will need to be strengthened for suitable class of loading. Several roads have to be constructed/ upgraded for approach to the adit to surge shaft and the adit to the Head Race Tunnel (HRT) just before the Surge Shaft and in & around powerhouse complex.

Rail Head

The broad gauge railhead at Dehradun is about 225km from the powerhouse of Jakhol Sankri HEP.

2.8 CONSTRUCTION POWER REQUIREMENT

Construction power may be drawn from the grid by, if necessary, laying a distribution line from the Mori substation. However, voltage loss due to long line and area vulnerable to landslides may hamper the construction activities of the project, the power supply from the grid may not be adequate and reliable, hence adequate back-up arrangement shall have to be made for providing construction power. The following arrangements have been considered to meet the construction power as well as power for residential and non-residential establishment for the project.

i) Barrage and Desilting Chamber Location

Barrage and Desilting chamber is situated near village Jakhol, where no direct supply line is available and therefore it is proposed to provide DG sets of 500 KVA to meet the power requirement for both the Barrage as well as Desilting Chamber. It is also required that a standby DG set of same capacity is to be mobilized to meet the power requirement in case of power failure.

ii) Adit Location

As there is no direct power supply available, it is proposed to provide DG sets of 250 KVA capacities each at different Adit locations.

iii) Power House Location

At powerhouse location, it is proposed to provide the DG set of 500 KVA capacity as there is no availability of direct power line. As total construction power at this location is to be generated by DG set, it is proposed to provide one standby DG set of same capacity to meet power requirement in case of power failure.

iv) Residential and Non – Residential Complex

For residential township and office complex, demand shall be met from the existing power network of Uttarakhand Power Corporation Limited (UPCL).

v) Power Supply Facilities

At all construction site location DG sets of specified capacities will be installed at suitable locations. For residential and non-residential locations, power requirement shall be met from the existing power network of Uttarakhand Power Corporation Limited (UPCL).

All necessary equipments and protections will be installed at each adit portal area for providing uninterrupted power supply for the construction works. Breakers/ Switchgears, Transformers, LT panels and cabling will be provided at each Adit portal for further distribution of power supply to the construction equipments inside the tunnels.

2.9 TELECOMMUNICATION FACILITIES

Internal telephone exchange compatible with Govt. owned Bharat Sanchar Nigam Limited (BSNL) would be provided at the project for communication within and outside project. For more reliable communication, installation on for VSAT is also required. In addition to this, all sites are required to be connected through wireless communication both static and moving/mounted on vehicles for efficiency of operations.

2.10 PROJECT COLONIES / BUILDINGS

It is proposed to provide main office complex at suitable topographic location near to project site. In addition, temporary site offices and camps will have to be put up during construction at different site location for ease of coordination and monitoring.

2.11 WORKSHOPS

It is proposed to provide central workshop at suitable location near to the powerhouse area, which should have suitable accessibility from all construction site locations. This workshop will be used for the maintenance of heavy earth moving equipment and transport vehicles. Moreover, separate workshop will be provided for fabrication purpose wherein all fabrication related works would be carried out.

2.12 DRINKING WATER FACILITIES

The requirement of water for drinking and construction purpose will be met from the river Tons/Supin or nearby perennial Nala by installing pumps of required capacity. Water for drinking purpose at various non-residential as well as residential complexes will be treated as per IS Specifications.

2.13 MEDICAL FACILITIES

There is not much medical facility available near the project site. The only Tehsil level Hospital is at Purola, which is about 60 km from downstream of Sankri village. Also at present there is no Hospital in the project site area. Therefore it is proposed to construct hospital for the project, which will provide the medical facilities to the project staff as well as villagers.

2.14 OTHER INFRASTRUCTURE

a) School

Govt. School facilities up to 12th standard are available at downstream Mori village.

b) Petrol Pump

It is proposed to provide petrol pump of suitable capacity for catering to requirement during project execution stage at downstream of village Naitwar.

c) Banks

Strengthening the existing branch of State Bank of India (SBI) is also required at Mori. New branches of nationalized banks should also be opened to facilitate the project activities in the vicinity of the project complex.

2.15 LAND REQUIREMENT

The land to be acquired for the project is 39.088 ha. Out of this, about 14.771 ha is private land and about 2.250 ha is forest land. The ownership status is given in Table-2.3. Based on the ownership status of land, appropriate compensatory measures of land will be suggested.

Table-2.3: Total Land proposed for Acquisition for Jakhol Sankari HEP

S.No	Type of Land	Area (ha)
1.	Govt./Civil Soyam Land (Including Notional Land)	22.067
2.	Private Land	14.771
3.	Forest Land	2.250
	Total	**39.088**

2.16 CONSTRUCTION PROGRAMME

The project is proposed to be completed within a time span of 48 months (Forty Eight Months).

CHAPTER-3
DESCRIPTION OF ENVIRONMENT

CHAPTER-3

DESCRIPCTION OF THE ENVIRONMENT

3.1 GENERAL

Before the start of any Environmental Impact Assessment study, it is necessary to identify the baseline levels of relevant environmental parameters which are likely to be affected as a result of the construction and operation of the proposed project. A similar approach has been adopted for conducting the EIA study for the proposed Jakhol Sankari hydroelectric Project. Standard methodologies of Environment Impact Assessment were followed for conducting the CEIA study for the proposed Jakhol Sankari hydroelectric project. A Scoping Matrix was formulated to identify various issues likely to be affected as a result of the proposed project. Based on the specific inputs likely to accrue in the proposed project, aspects to be covered in the EIA study were identified. The other issues as outlined in the Scoping Matrix were then discarded. Thus, planning of baseline survey commenced with the shortlisting of impacts and identification of parameters for which the data needs to be collected.

The baseline status has been divided into following three categories:

- Physico-chemical aspects
- Ecological aspects
- Socio Economic aspects

3.2 METHODOLOGY ADOPTED FOR THE CEIA STUDY

3.2.1 Study Area

The study area covered as a part of the CEIA study is as below (Refer Figure 3.1):

- Land to be acquired for various project appurtenances including reservoir submergence
- 10 km on either side from the periphery of reservoir submergence
- Area within 10 km on either side of various project appurtenances
- Catchment area intercepted at barrage site

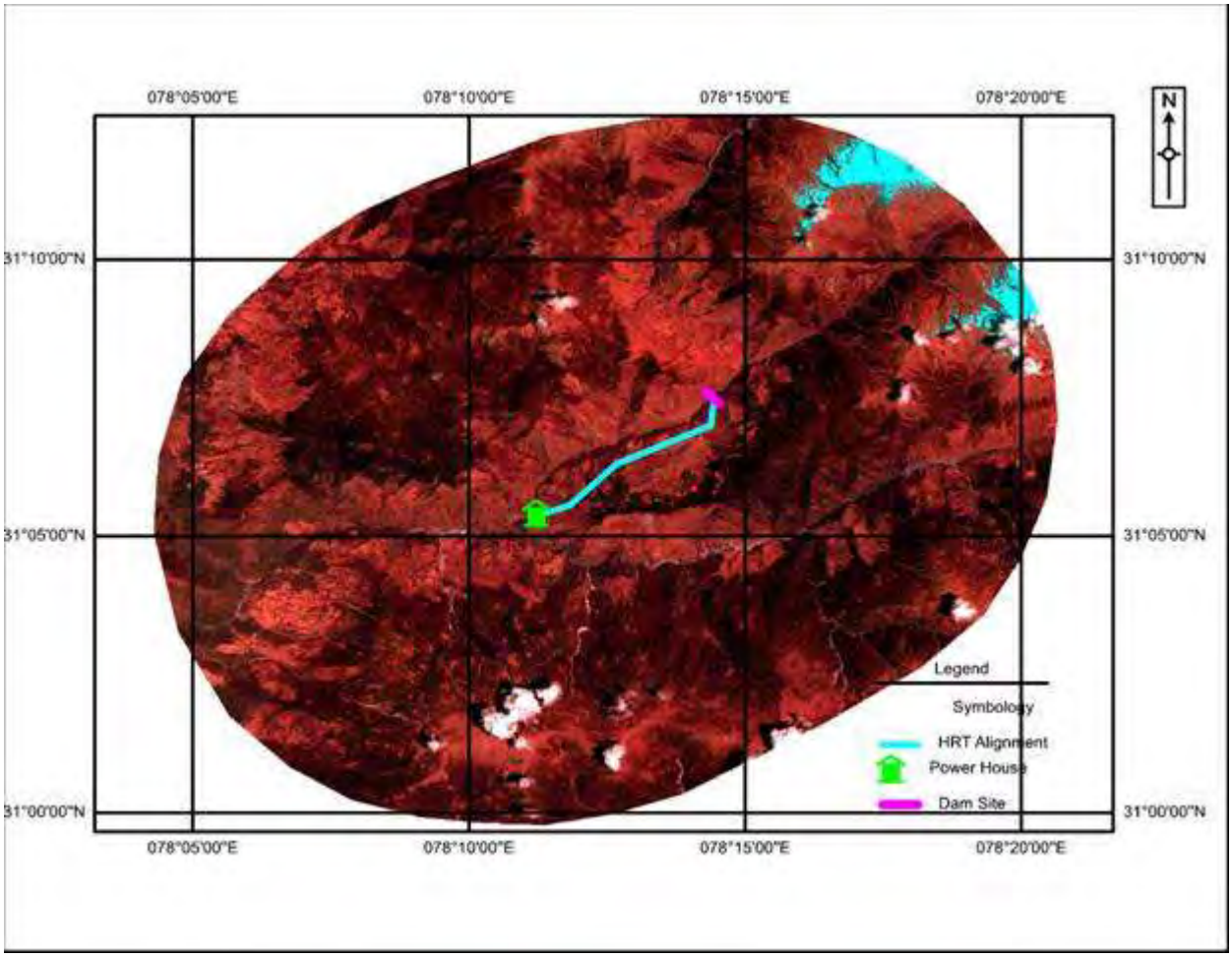

Figure-3.1: Study Area Map

3.2.2 Scoping Matrix

Scoping is a tool which gives direction for selection of impacts due to the project activities on the environment. As a part of the study, scoping exercise was conducted selecting various type of impacts which can accrue due to a hydroelectric project. Based on the project features, site conditions, various parameters to be covered as a part of the EIA study were selected. The results of scoping analysis are presented in Table-3.1.

Table-3.1 Scoping Matrix adopted for CEIA study for the proposed Jakhol Sankari hydroelectric Project

Aspects of Environment	Likely Impacts
A. Land Environment	
Construction phase	- Increase in soil erosion - Pollution by construction spoils - Acquisition of land for labour colonies - Solid waste from labour camps/ Colonies.
Operation phase	- Acquisition of land for various project appurtenances - Loss of agricultural and forest land due to submergence
B. Water resources & water quality	
Construction phase	- Increase in turbidity of nearby receiving water bodies - Degradation of water quality due to disposal of wastes from labour, colony and construction sites
Operation phase	- Modification of hydrologic regime
C. Aquatic Ecology	
Construction phase	- Increased pressure on riverine fisheries as a result of indiscriminate Fishing by the labour population. - Reduced productivity due to increase in turbidity levels as a result of disposed off effluents from Construction sites.
Operation phase	- Impacts on spawning and breeding grounds - Degradation of riverine ecology - Impacts on migratory fish species - Impact on aquatic ecology due to drying of the river stretch
D. Terrestrial Ecology	
Construction phase	- Increased pressure from labour to meet their fuel wood requirements - Adverse impacts on flora and fauna due to increased accessibility in the area and increased influx of human population - Loss of forest due to construction of road and other project appurtenances
Operation phase	- Loss of forests in the submergence area - Impacts on wildlife movement - Impacts on wildlife habitats

Aspects of Environment	Likely Impacts
E. Socio-Economic Aspects	
Construction phase	- Increased employment potential during the project construction phase - Development of allied sectors leading to greater employment - Pressure on existing infrastructure Facilities. - Cultural conflicts and law and order issues due to migration of labour population
Operation phase	- Loss of lands - Loss of private properties - Impacts on archaeological and cultural monuments, if any - Impacts on mineral reserves, if any
F. Air Pollution	
Construction Phase	- Impacts due to fuel combustion in various construction equipment - Impacts due to increased vehicular movement - Fugitive emissions from various sources - Impacts due to emissions of DG sets
G. Noise Pollution	
Construction Phase	- Noise due to operation of various construction equipment - Noise due to increased vehicular movement - Impacts due to blasting - Increased noise levels due to operation of DG sets
H. Public Health	
Construction Phase	- Increased incidence of water related diseases - Transmission of diseases by immigrant labour population
Operation phase	- Increased incidence of vector borne diseases

Based on the Scoping matrix, the environmental baseline data has been collected. The project details have been superimposed on environmental baseline conditions to understand the beneficial and deleterious impacts due to the construction and operation of the proposed project.

3.2.3 Data Collection

Primary surveys were conducted in various seasons to collect data on flora, fauna, forest types, ecological parameters, soil, ambient air quality, noise, water quality. During these surveys data and information was collected on physico-chemical, biological and socio-economic aspects of the study area. In addition, detailed surveys and studies were also conducted for understanding bio-diversity in the study area.

3.2.4 Physico-Chemical Aspects

I. Physiography

Spatial database on physiographic features were taken from various sources including Survey of India (SOI) topographic sheets, satellite data and analysed with Geographic Information System (GIS) tools. These data were collected, arranged and presented according to the EIA methods used in the study. These data were organized and presented in the form of general drainage map of the catchment and its sub-watersheds. In addition, a gradient profile indicating river profile was calculated from the origin of the river up to the barrage site. A slope model for the catchment area of intercepted at the barrage site of the proposed Jakhol Sankari hydroelectric project was digitized from the contours of Survey of India topographical sheets at 1:50,000 scale, following a 40 m contour interval. The contours were traced from the toposheets, scanned and digitized. From the digital data, a digital elevation model (DEM) for the project area as well as its sub-watersheds of the free draining catchment of the project was generated.

The area for each slope category was calculated for the entire catchment. Percent area under various slope categories namely gently sloping, moderately sloping, strongly sloping, moderately steep to steep, steep, very steep and escarpments were calculated for the entire catchment.

II. Geology

The regional geology around the project area highlighting geology, stratigraphy and structural features were based on the existing information on these aspects contained in Draft Detailed Project Report (DPR) of the project.

III. Hydrology

Hydrological data for river Supin as available in the Draft Detailed Project Report (DPR) was collected and suitably incorporated in the Comprehensive EIA study.

IV. Landuse pattern

Landuse pattern of the study area as well as the catchment area was carried out by standard methods of analysis of remotely sensed data and followed by ground truth collection and interpretation of satellite data. For this purpose digital satellite data was procured from National Remote Sensing Agency, Hyderabad, IRS-P6 LISS-IV. The data was processed through ERDAS software package available with WAPCOS.

V. Soils

The soil quality was monitored at various locations in the catchment area. The monitoring was conducted for three namely winter season (January 2017), pre-monsoon (June 2017) and monsoon (September 2017). The parameters monitored were:

- pH
- Electrical Conductivity
- Organic Matter
- Available Nitrogen
- Available Phosphorus
- Available Potassium
- Cation Exchange Capacity
- Exchangable Sodium Percentage
- Particle Size Distribution

VI. Water Quality

The existing data on water quality has been collected to evaluate river water quality on upstream and downstream of the project site. The water quality was monitored for three seasons listed as below:

- Winter season - January 2017
- Pre-monsoon season - June 2017
- Monsoon season - September 2017

The water samples were collected from the study area and analyzed for physico-chemical parameters which are listed in Table-3.2.

Table-3.2 Water quality parameters analysed as a part of field studies

pH	Potassium
Conductivity	Calcium
Total Dissolved Solids	Magnesium
Total Suspended Solids	Oil & Grease
Total Alkalinity	Iron
Total Hardness	Manganese

Carbonates	Copper
BOD	Zinc
COD	Mercury
Nitrates	Cadmium
Phosphates	Chromium
Fluorides	Lead
Dissolved Oxygen	Turbidity
Chlorides	Coliform
Sulphates	

VII. Ambient air quality

The ambient air quality was monitored at three locations in the study area. Monitoring was conducted for three seasons namely winter season (January 2017), pre-monsoon (June 2017) and monsoon (September 2017). The frequency of monitoring in each season was twice a week for four consecutive weeks. The parameters monitored were PM_{10}, $PM_{2.5}$, SO_2 and NO_2.

VIII. Ambient Noise level

As a part of the EIA study noise level was monitored at various locations in the study area. Monitoring was conducted for three seasons namely winter season (January 2017), pre-monsoon (June 2017) and monsoon (September 2017). At each station, hourly noise level was monitored during daytime, after which equivalent daytime noise level was monitored.

3.2.5 Ecological Aspects

I. Terrestrial Ecology

Flora

Data on forest type legal status and their extent in the catchment and study area has been collected from forest department. The other relevant data on bio-diversity economically important species medicinal plant. Rare and endangered species in the study area and its surroundings have been collected from secondary sources like research institute forest and wild life department. In addition field studies were conducted to collect data on various aspects in the study area. The sampling sites were selected based on topography and floristic composition. The various aspects studied were floral density frequency and abundance of species of trees, shrubs, herbs and grasses. Plant of economical species and medicinal use and endangered species were also identified as a part of the study.

The monitoring was conducted for the following three seasons:

- Winter season - January 2017
- pre-monsoon season - June 2017
- Monsoon season - September 2017

Fauna

The assessment fauna have been done on the bases secondary data collected from different government offices like forest department, wildlife department, fisheries department etc. The presence of wildlife was also confirmed from the local inhabitants depending on the animal sightings and the frequency of their visits in the catchment area. In addition review of secondary data was another source of information for studying the fauna of the area. In addition, sightings of faunal population during ecological survey and then field studies were also recorded as a part of the data collection exercise.

II. Aquatic Ecology and fisheries

Water samples from river Supin were also collected as a part of field studies. The density and diversity of periphyton and phytoplanktons, species diversity index and primary productivity, etc. were also studied. The field studies were conducted for three seasons listed as below:

- Winter season - January 2017
- pre-monsoon season - June 2017
- Monsoon season - September 2017

The data on the prevailing fish species in the river Supin was collected from Fisheries Department and through literature review as well. Fishing was done at various sites in the project area and river stretches both upstream and downstream of the barrage site to ascertain the dispersal pattern of fish species. Identification and measurements of all the fish catch was done and an inventory of the fish species was also prepared. The list of various fish species likely to be affected as a result of commissioning of the proposed project was also identified.

3.2.6 Socio-economic Aspects

The demographic and socio-economic characteristics of the submergence area as well as the study area have been studied through primary as well secondary sources. The provisions of “Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013” have been taken into

consideration, for preparation of Resettlement and Rehabilitation Plan for Project Affected Families (PAFs).

3.2.7 Summary of Data Collection

The summary of the data collected from various sources is outlined in Table-3.3.

Table-3.3 Summary of data collected from various sources

Aspect	Mode of Data collection	Parameters monitored	Frequency	Source
Meteorology	Secondary	Temperature, humidity, rainfall	-	India Meteorological Department (IMD)
Water Resources	Secondary	Flow, Design hydrograph and design flood hydrograph	-	Detailed Project Report (DPR)
Water Quality	Primary	Physico-chemical and bacteriological parameters	Three seasons	Field studies for Pre-monsoon, monsoon and Winter seasons
Ambient air quality	Primary	PM_{10}, SO_2 and NO_2	Three seasons	Field studies for Pre-monsoon, post-monsoon and Winter seasons
Noise	Primary	Hourly noise level	Three seasons	Field studies for Pre-monsoon, monsoon and Winter seasons
Landuse	Primary and secondary	Landuse pattern	-	NRSA and Ground truth Studies
Geology	Secondary	Geological characteristics of study area	-	Detailed Project Report (DPR)
Soils		Physico-chemical parameters	Three seasons	Field studies for Pre-monsoon, monsoon and Winter seasons
Terrestrial Ecology	Primary and secondary	Floral and faunal diversity	Three seasons	Field studies for Field studies for Pre-monsoon,

Aspect	Mode of Data collection	Parameters monitored	Frequency	Source
				monsoon and Winter seasons Secondary data as available with the Forest Department
Aquatic Ecology	Primary and Secondary	Presence and abundance of various species	Three seasons	Field studies for pre-monsoons, monsoon and winter seasons Secondary data as available with the Fisheries Department
Socio-economic aspects	Primary and secondary	Demographic and socio-economic, Public health	-	Data collection from Revenue Department and literature review and field studies.

3.2.8 IMPACT PREDICTION

Prediction is essentially a process to forecast the future environmental conditions of the project area that might be expected to occur because of implementation of the project. Impact of project activities has been predicted using mathematical models and overlay technique (super-imposition of activity on environmental parameter). For intangible impacts qualitative assessment has been done.

The environmental impacts predicted are as follows:

A. Project construction phase

<u>Land Environment</u>

- Pollution due to large scale quarrying activities
- Degradation of land during construction activities, i.e. as a result of disposal of construction waste.
- Pollution due to increased soil erosion from the construction sites.
- Impacts due to disposal of solid waste from labour camps.

Water Environment

- Pollution due to disposal of untreated sewage from the labour colonies.
- Pollution due to disposal of runoff from construction sites.
- Impacts due to discharge of effluent from the crusher.

Ecology

- Increase in turbidity during construction phase with corresponding reduction in photosynthetic activity and primary productivity.
- Impacts on terrestrial ecology due to increased human interferences due to congregation of labour population during construction phase

Air Environment

- Impacts on ambient air quality as a result of construction activities, e.g. operation of various construction equipments, increased vehicular traffic etc.
- Impacts due to fugitive emissions.
- Impacts on ambient air quality due to source of construction power to be identified at the time of construction.

Noise Environment

- Increase in noise levels as a result of operation of various construction equipment.
- Impacts due to increased vehicular traffic.

Socio-Economic Environment

- Improvement in the employment scenario as a result of absorption of locals in the construction activities.
- Traffic congestion and traffic safety aspects due to increased traffic movement.
- Increased stress on existing infrastructure facilities due to congregation of labour population.
- Incidence of water-borne diseases in construction staff colony

B. Impacts during the operation phase

Land Environment

- Impacts on landuse pattern due to increase in cropping intensity
- Increased irrigation intensity in the command area
- Impacts on soil quality due to increased and continued use of agro-chemicals.
- Increased potential for waterlogging and soil salinization in the command area.

- Impacts due to acquisition of land for various project appurtenances including ownership status

Water Environment

- Impacts on reservoir water quality.
- Disposal of effluents containing agro-chemicals

Ecology

- Impacts on the bio-diversity as a result of introduction of irrigation in the command area.
- Impacts on flora and fauna
- Impacts on ecologically sensitive sites like national park, wildlife sanctuary, etc. if any
- Impacts on rare, endangered and threatened species.
- Impacts on medicinally important and other economically important species if any.
- Impacts on migratory routes of wildlife
- Increased potential for farm and tank fisheries in the command area.

Socio-Economic Environment

- Acquisition of private lands for construction of various project appurtenances.
- Improvement in employment potential as a result of increase in irrigation intensity.
- Improvement in quality of life as a result of higher agricultural production, and improvement in income levels.
- Impacts on livestock
- Increased incidence of vector-borne diseases.
- Improvement in public health, educational status, etc. as a result of economic development.
- Improvement in the status of livestock as a result of greater water availability and fodder from agricultural residues.
- Impetus to urbanization and industrialization as a result of improved water availability.

3.2.9 Environmental Management Plan and Cost Estimates

Based on the environmental baseline conditions and project inputs, the adverse impacts were identified and a set of measures have been suggested as a part of Environmental Management Plan (EMP) for their amelioration. The management measures have been suggested for the following aspects:

- Measures to control water pollution due to various effluents to be discharged during construction phase.
- Measures to control air pollution during construction phase.
- Measures to contain noise pollution and mitigate adverse impact on construction staff and habitat in the study area.
- Reclamation of areas disturbed during construction phase including quarry stabilization and construction waste disposal sites
- Public health management plan
- Biodiversity Conservation Plan
- Greenbelt development along periphery of reservoir, colonies, approach road, canals etc.
- Health Delivery system.
- Air Pollution Control.
- Noise Control measures
- Resettlement and Rehabilitation Plan
- Sustenance and enhancement of fisheries potential.
- Infrastructure development for agriculture.

The expenditure required for implementation of these management measures has also been estimated as a part of the EMP study.

3.2.10 Catchment Area Treatment Plan

A Catchment area Treatment Plan for the catchment area intercepted at the diversion structure of the proposed barrage site has been prepared as a part of the Comprehensive EIA study. The landuse pattern using satellite data, slope map (prepared using Survey of India toposheets), etc. has been used.

The CAT Plan comprises of delineation of watersheds in the catchment, mapping of critically degraded areas based on Integration of Remote Sensing technique, GIS methodology and Silt Yield Index method coupled with ground survey.

A Catchment Area Treatment (CAT) Plan has been be prepared for sub-watersheds with very high and high erosion intensity. The cost required for implementation of CAT plan has also been estimated as a part of the study.

3.2.11 Dam Break Analysis

A dam break analysis has been conducted to simulate hypothetical failure of dam including preparation of inundation maps. A Disaster Management Plan (DMP) including the cost estimates has been prepared for dealing with emergency situation. It includes emergency preparedness plan, surveillance plan, and evacuation plan etc including communication system.

3.2.12 Local Area Development Plan

As a part of the CEIA, a Local Area Development Plan (LADP) has been formulated for implementation in study area villages. A budget of 0.5% of the project cost has been earmarked for implementation of Local Area Development Plan (LADP). An amount of Rs.2.4 crore has been kept as a provision for LADP as a part of EMP. The district administration shall decide the plan of implementation as per the requirement of the study area after consulting local people.

3.2.13 Environmental Monitoring Programme

It is necessary to continue monitoring of certain parameters to verify the adequacy of various measures outlined in the Environmental Management Plan (EMP) and to assess the implementation of mitigative measures. An Environmental Monitoring Programme for monitoring of critical parameters has been suggested for implementation during project construction and operation phases. The staff, necessary equipment and agencies to be involved for implementation of the Environmental Monitoring Programme and costs have also been indicated.

3.2.14 Cost Estimates

The Cost Estimate covering following aspects has been prepared:

- Environment Management Plans
- Environment Monitoring Programme
- Catchment Area Treatment Plan
- Rehabilitation & Resettlement Plan
- Local Area Development Plan
- Disaster Management Plan
- Corporate Environmental Responsibility

3.3 BASELINE STATUS OF PHYSIOCHEMICAL ASPECTS

The baseline setting for physico-chemical aspects have been covered in the following section.

3.3.1 Meteorology

The climatic conditions in the project area and its surroundings vary with elevation. The variations of exposure to sunlight and to rain bearing winds produce a very intricate pattern of local climate in the project area. The climate of the project area can be divided into four seasons. The winter season lasts from December to February followed by pre-monsoon season from March to May. The monsoon season begins in June and continues upto middle of October. The period from second half of the October to November constitutes the post-monsoon season. During monsoon season, local thunderstorms are frequent, which is often accompanied by heavy hail. The monsoons or rainy season locally called *chaumas commences* from last week of June continuing upto end of September. Majority of rainfall is received during mid-July to mid-August. The sky remains generally clear in the middle of September and October. The winter season locally known as *hyund* in Garhwal himalayas, lasts from December to February. At higher reaches, snowfall is common during winter months.

I. Temperature

Temperature rises rapidly after March and the month of June is the hottest month of the year with mean daily maximum temperature going up to 24.1^{o}C. With the withdrawal of monsoons, by the end of September, there is a sharp decrease in temperatures. The months of December and January are the coolest months of the year, with mean daily minimum temperature as low as 2.5^{o}C.

II. Rainfall

The total annual rainfall is about 2176.4 mm per annum. The maximum rainfall is received in the months of July and August. About 60% of the rainfall is received under the influence of south-west monsoons during the months from July to September. On an average, there are about 88 rainy days (i.e. days with rainfall of 25 mm) in a year.

III. Humidity

The average `humidity' is about 60% Apart from the monsoon months, relative humidity ranges between 55 and 92 % throughout the year.

IV. Wind

Winds are generally light, of the order of 3 to 4 km per hour in the valleys and 5 to 8 km per hour at elevations about 2000 m above sea level. In the wake of western disturbances and in association with thunderstorms, they become quite strong.

V. Clouds

During monsoon months, i.e. from July to September, skies are generally heavily clouded. Heavy cloud cover persists in short spells during the winter months when the area is affected by the passing western disturbances.

VI. Special weather phenomenon

Thunderstorms occur throughout the year, their frequency being least in the months of November and December. Their activity is greatest during the period from May to September. During winter and the pre-monsoon months, they are accompanied by hail.

Dust storms are rare and occur, if at all, in the valleys in summer. Fog is common during monsoon months and it may also occur in association with western disturbances. Morning fog may also occur in the valley frequently in winter.

The average meteorological conditions in the project area are given in Table-3.4.

Table-3.4 Average meteorological conditions in the project area

S. No.	Month	Mean Temp. Daily (^oC)		Rainfall (mm)	No. of rainy days	Relative Humidity (%)
		Max.	Min.			
1.	January	10.6	2.5	51.8	4.5	63
2.	February	12.4	3.8	52.8	4.1	60
3.	March	16.5	7.5	57.7	4.4	55
4.	April	21.2	12.0	30.0	2.5	48
5.	May	24.1	14.7	58.4	4.1	50
6.	June	23.7	16.2	174.9	8.6	71
7.	July	20.8	15.5	662.0	21.9	91
8.	August	20.2	15.2	670.6	21.8	92
9.	September	19.9	14.0	277.5	11.1	84
10.	October	18.9	11.2	64.7	3.0	64
11.	November	15.9	7.3	14.8	0.9	58
12.	December	13.1	4.6	18.2	1.3	56
	Average	**18.1**	**10.4**	**2176.4**	**88.2**	**66**

Source: India Meteorological Department (IMD)

3.3.2 Land Use Pattern

Landuse describes how a patch of land is used (e.g. for agriculture, settlement, forest), whereas land cover describes the materials (such as vegetation, rocks or

buildings) that are present on the surface. Accurate land use and land cover identification is the key to most of the planning processes.

The land use pattern of the study area has been studied through digital satellite imagery data. RSAT-2, LISS-IV satellite data was procured from National Remote Sensing Agency (NRSA), Hyderabad. The data was processed through ERDAS software package available with WAPCOS.

Ground truth studies were conducted in the area to validate various signals in the satellite images and correlate them with different land use domains. The image obtained after the vegetation index, enhancement becomes a single band data Le. The grey set. The grey set was merged with the colored False Color Composite (FCC). This image was then classified using the prominent signatures extracted based on the past experience. However, this is only a preliminary classification which will be refined further. The FCC and the classified image of the project and its surroundings is given as Figures-3.2 and 3.3 respectively.

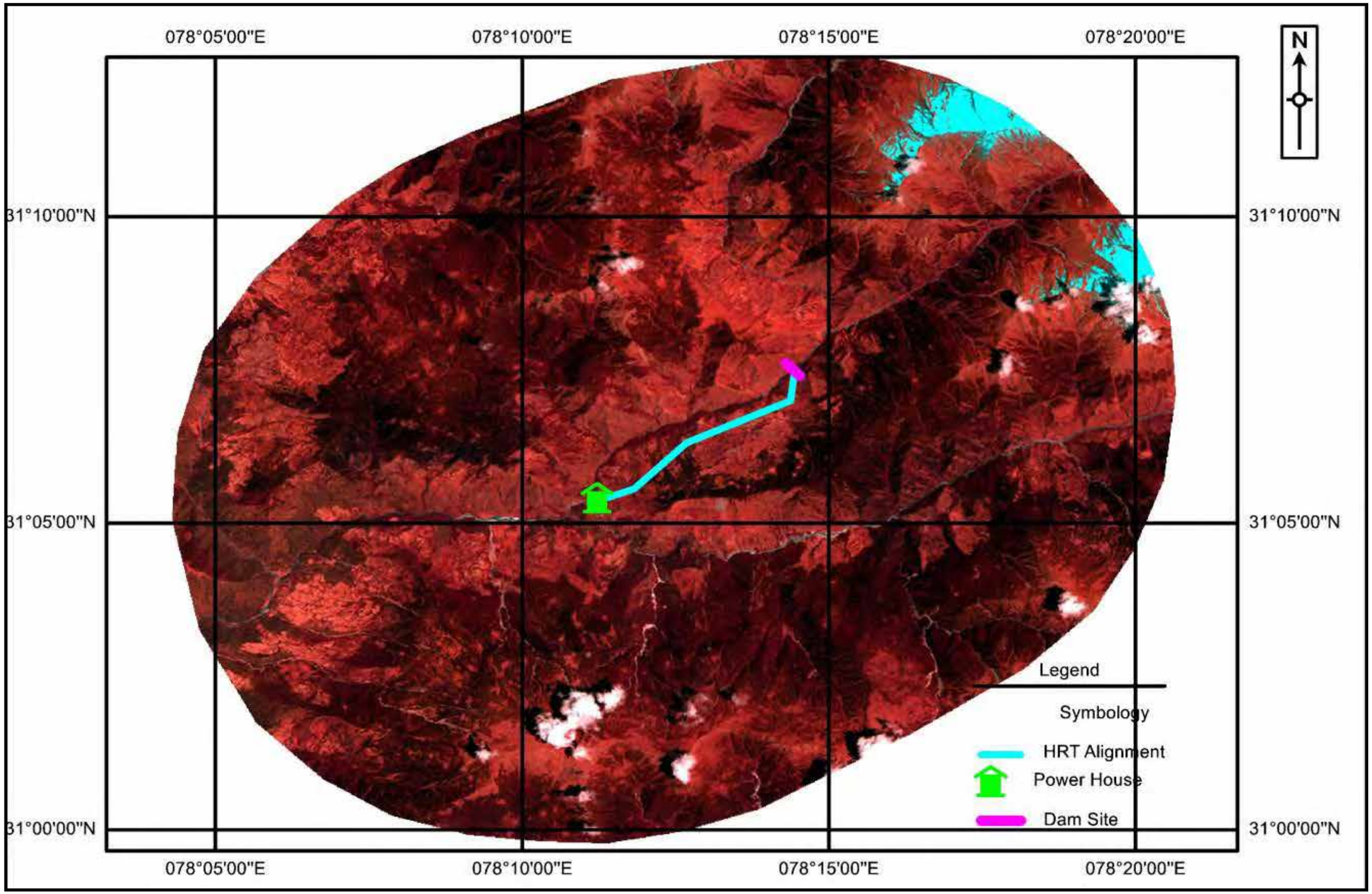

Figure-3.2: FCC image of the project and its surrounding

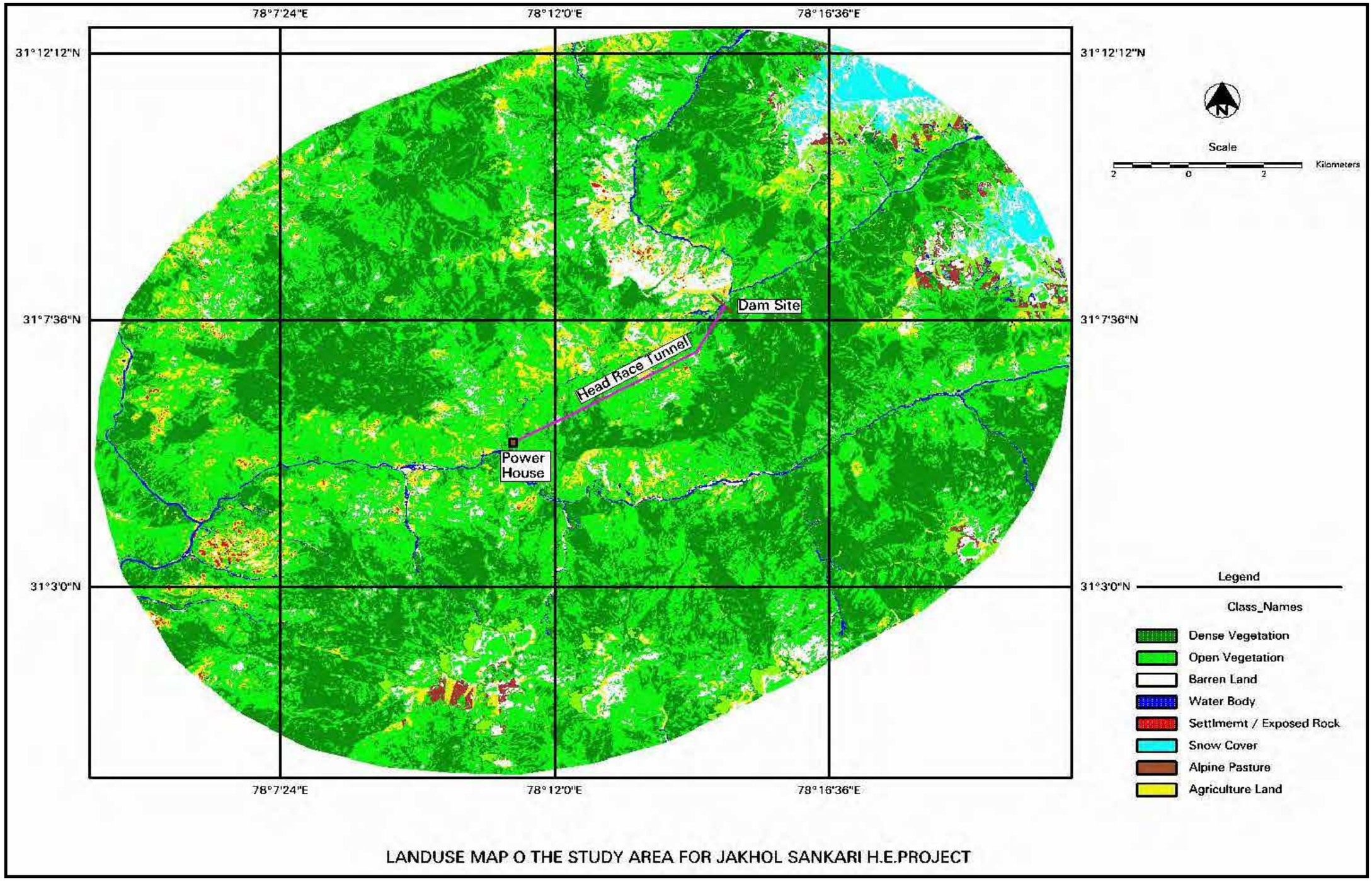

Figure 3.3: classified image of the project and its surroundings

The landuse pattern of the study area is given in Table-3.5.

Table 3.5 Land use pattern of the study area

Landuse Cover	Area (ha)	Area (%)
Dense vegetation	17140.3	36.19
Open vegetation	22877.81	48.30
Barren land	3160.42	6.7
Agricultural land	2593.65	5.48
Water body	522.34	1.10
Alpine pasture land	329.57	0.69
Snow covered area	613.43	1.3
Settlement	125.01	0.26
Total	**47362.53**	**100**

It is evident from Table-3.5, that major land use category in the study area is forest, which accounts for almost 84.49% of the study area. The other major category is barren land accounting for about 6.7% of the study area. The agriculture land accounts for about 5.48% of the study area. The area under snow and water body account for about 1.3% and 1.10% of the study area. The area under settlement is about 0.26% of the study area.

3.3.3 Soils

Soil is the product of geological, chemical and biological interactions. The soils in the region vary according to altitude and climate. The soil in the project area and study area are young like any other region of Himalayas. The vegetal cover is one of the most important influencing factors characterizing the soil types in a region. Soil on the slope above 30°, due to erosion and mass wasting processing, are generally shallow and usually have very thin surface horizons. Such soils have medium to coarse texture. Residual soils are well developed on level summits of lesser Himalayas, Sub-soil are deep and heavily textured. The soil map of the Supin river catchment is given in Figure-3.4.

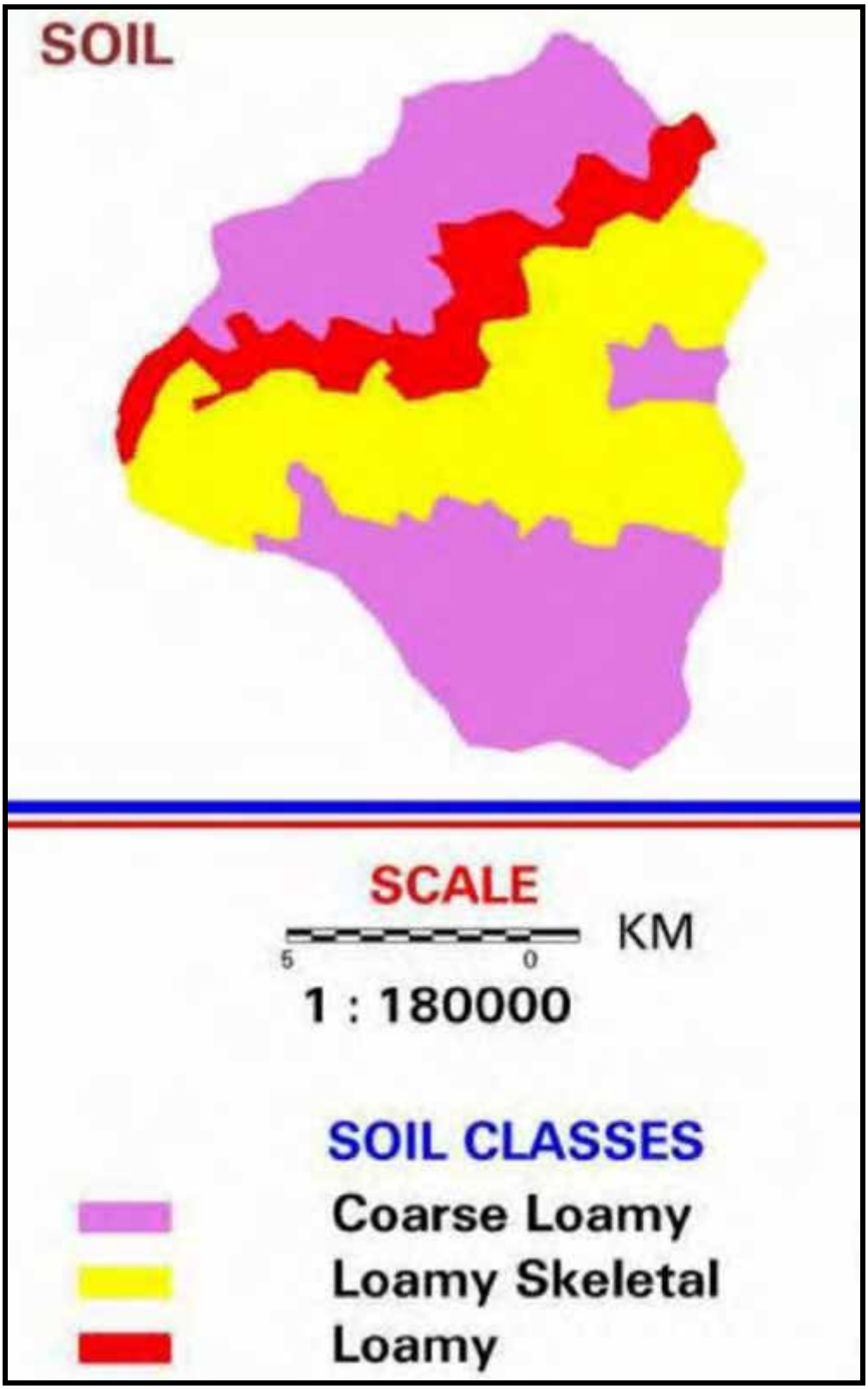

Figure-3.4: Soil Map of Supin River Catchment

As a part of field studies, soil quality was monitored at various locations in the catchment area. The monitoring was conducted for three namely winter season (January 2017), pre-monsoon (June 2017) and monsoon (September 2017).

The soil sampling stations are given in Figure -3.5.

The details of sampling stations are listed in Table-3.6. The results of the analysis of soil samples conducted for three seasons is given in Tables-3.7 to 3.9.

Table-3.6: Details of Soil Sampling Locations

Sampling Code	Location
S1	U/S or Catchment Area
S2	Barrage Site
S3	D/S of Barrage Site
S4	Adit-2 Near Jakhol Village
S5	U/S of Power House Site
S6	Power House Site
S7	D/S of Power House Site

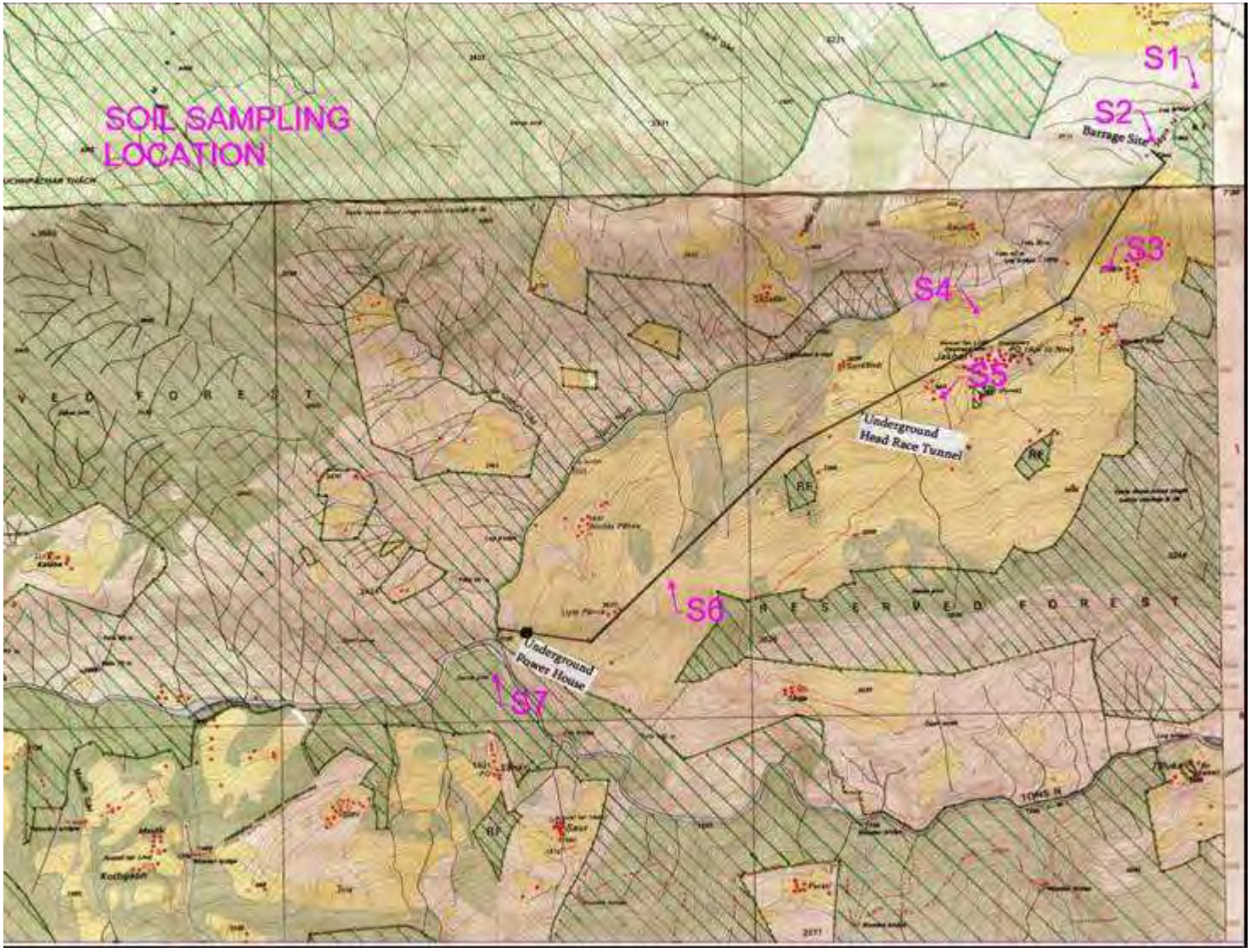

Figure-3.5: Soil Sampling Stations

Table-3.7 Results of soil sampling analysis of study area for winter season

Parameters	S1	S2	S3	S4	S5	S6	S7
pH Value	5.68	6.68	6 6.03	6.23	6.6.12	66.04	6 6.02
Conductivity, millimohs/cm	0.054	0.147	0.099	0.031	0.037	0.113	0.110
Porosity, %	63.38	65.28	66.69	66.69	59.47	65.93	65.91
Nitrogen,%	0.12	0.11	0.13	0.11	0.1	0.12	0.11
Phosphates	63.99	73.95	1.53	349.68	81.36	284.2	284.1
Organic Carbon, %	0.94	1.57	2.88	0.55	1.15	1.44	1.42
Sodium Absorption Ratio	1.98	2.23	1.67	2.68	1.31	1.46	1.41
Sodium (as Na), mg/kg	753.46	820.85	680.99	1107.09	491.79	431.26	421.16
Potassium (as K), mg/kg	5306.38	6471.15	7864.9	8077.77	9540.79	6460.09	6560.09
Calcium (as Ca), mg/kg	1853.31	3793.43	4251.3	1836.97	2538.88	215.63	215.60
Magnesium (as Mg), mg/kg	5449.22	3861.17	4999.21	6621.07	4871.83	3810.48	3210.42
Organic Matter,%	1.63	2.71	4.97	0.95	1.98	2.48	2.16
Texture	Sandy Clay Loam	Sandy Clay	Sandy Clay	Sandy Clay Loam	Sandy Clay	Sandy Clay	Sandy Clay

Table 3.8 Results of soil sampling analysis of study area for pre-monsoon season

Parameters	S1	S2	S3	S4	S5	S6	S7
pH Value	6.62	6.79	6.08	6.29	6.20	6.15	6.02
Conductivity, millimohs/cm	0.151	0.169	0.091	0.038	0.128	0.037	0.119
Porosity, %	63.12	59.21	69.62	66.61	62.01	57.41	62.93
Nitrogen,%	0.15	0.19	0.19	0.21	0.19	0.17	0.23
Phosphates	71.87	72.95	19.18	267.97	101.31	98.86	212.3
Organic Carbon, %	1.02	1.90	2.82	0.59	0.82	1.19	1.29
Sodium Absorption Ratio	2.21	2.35	1.71	2.65	1.53	1.38	1.49
Sodium (as Na), mg/kg	853.49	922.81	781.98	1107.17	312.21	490.72	532.21
Potassium (as K), mg/kg	6302.31	7125.12	7962.6	8067.72	5124.28	9542.7	7465.06
Calcium (as Ca), mg/kg	2852.38	3992.48	4758.6	2839.92	3952.21	3538.82	311.60
Magnesium (as Mg), mg/kg	4449.29	4168.19	5196.17	6519.02	5213.3	5876.80	3812.42
Organic Matter,%	2.05	3.56	3.12	0.87	1.6	1.88	2.41
Texture	Sandy Clay Loam	Sandy Clay	Sandy Clay	Sandy Clay Loam	Sandy Clay	Sandy Clay	Sandy Clay

Table-3.9 Results of soil sampling analysis of study area for monsoon season

Parameters	S1	S2	S3	S4	S5	S6	S7
pH Value	6.08	6.6	6.15	5.25	7.07	7.63	6.62
Conductivity, millimohs/cm	0.039	0.039	0.131	0.138	0.136	0.208	0.177
Porosity, %	65.61	62.91	59.62	62	50.18	62.8	56.37
Nitrogen,%	0.07	0.06	0.07	0.05	0.09	1.66	0.1
Phosphates	23.72	103.09	30.12	39.41	98.9	49.43	25.24
Organic Carbon, %	1.42	0.76	1.91	0.5	1.2	1.76	0.69
Sodium Absorption Ratio	0.22	0.29	0.44	0.36	0.35	0.38	0.31
Sodium (as Na), mg/kg	228.47	351.25	345.75	374.65	295.14	321.66	247.86
Potassium (as K), mg/kg	7362.7	3245.29	2599.3	6606.2	3196.28	2887.54	3025.68
Calcium (as Ca), mg/kg	2129.49	1643.5	1848.1	1402.9	1523.14	1836.51	1923.76
Magnesium (as Mg), mg/kg	3582.21	1833.02	1716.4	4041.5	2354.1	2116.08	1945.32
Organic Matter,%	1.42	0.76	1.91	0.5	1.2	3.03	1.19
Texture	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay	Silty Loam	Silty Loam	Silty Loam

The pH of soil at various sites lies within neutral range. The levels of NPK indicate moderate to high soil productivity. The sodium levels do not indicate any potential for soil salinization or adverse impacts on soil productivity.

In a hydroelectric project, no significant impact on soil quality is expected barring, soil pollution at local level due to disposal of construction waste. For amelioration of such impacts appropriate management measures are recommended.

3.3.4 Water Quality

There are no major sources of organic pollution loading in the basin. The Supin river basin has low population density with low cropping intensity. The low cropping intensity coupled with low agro-chemical dosing also means that the pollution load due to agro-chemicals is quite low. The absence of industries implies that there is no pollution load from this source as well. The ground water level in the study are varies from 16.25 to

22.85 mbgl as per Ground Water Year book 2014-2015 publisged by CGWB in January 2016.

As a part of the field studies, 8 water samples were collected from river Supin at various locations.

The water quality was monitored for three seasons listed as below:

- Winter season - January 2017
- Pre Monsoon season - June 2017
- Monsoon season - September 2017

As a part of the field studies, water samples from river Supin and other tributaries from various locations were collected and analysed for various physico-chemical parameters. The various sampling locations is given in Figure-3.6

The various water sampling locations is listed in Table-3.10:

Table-3.10 Details of Water Sampling Locations

Sampling Code	Location
W1	U/S of Barrage site **(surface water)**
W2	Barrage Axis site **(surface water)**
W3	D/S of Barrage **(surface water)**
W4	Bargad stream near Adit-2 **(surface water)**
W5	Power House Site **(surface water)**
W6	Near Jakhol Village **(Ground water)**
W7	Near Sunkundi village**(Ground water)**
W8	D/S of Power House site Site **(surface water)**

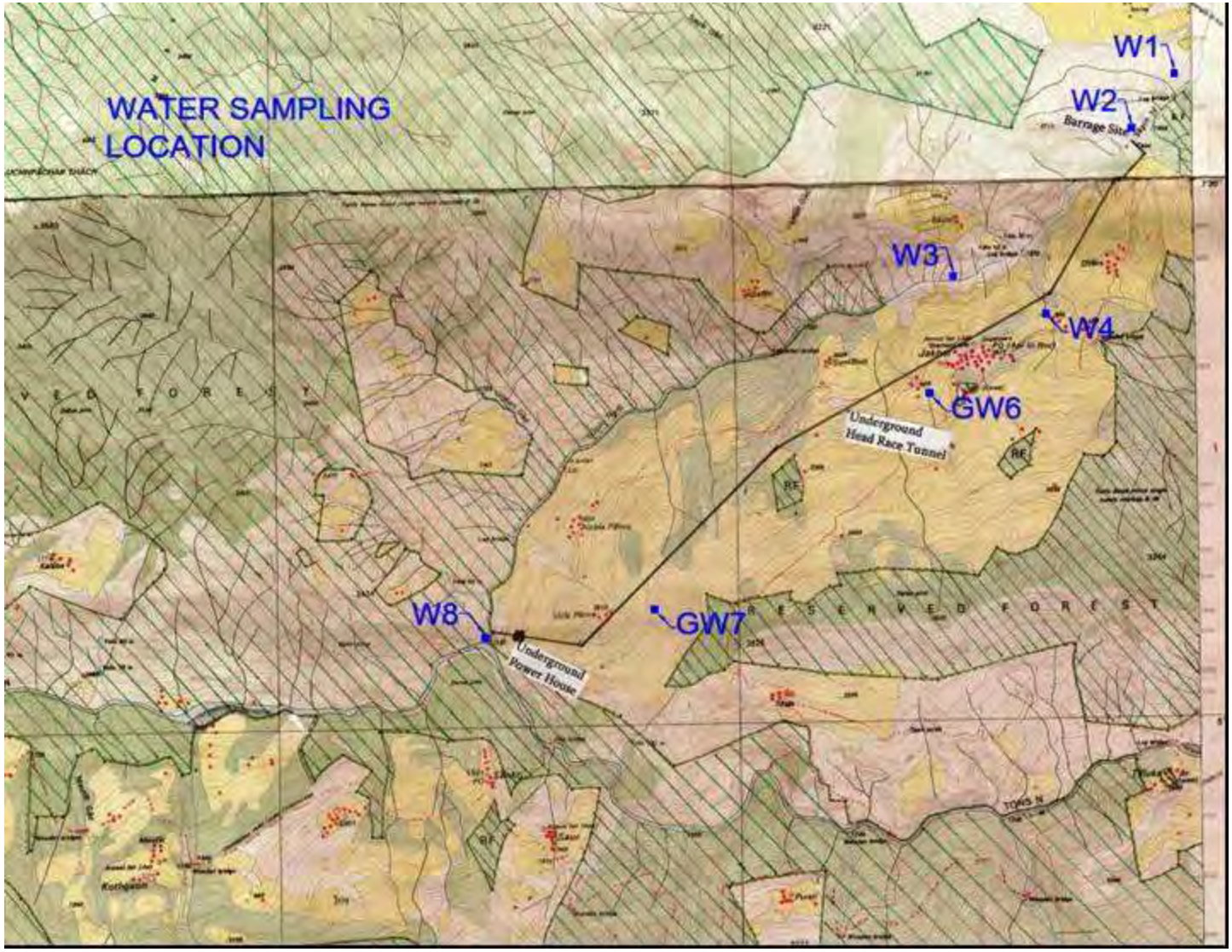

Figure-3.6: Water sampling locations

The results of water quality analysis for various seasons is given in Tables-3.11 to 3.13.

The drinking water standards are given in Table-3.14.

Table-3.11 Water quality analysis in the study area (winter season)

S. No.	Parameters	W1	W2	W3	W4	W5	W6	W7	W8
1	pH Value	7.23	7.36	7.39	6.91	7.48	7.12	7.19	7.23
2	Colour, Hazen units	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
3	Conductivity, µS/cm	57.1	63.5	66.67	76.2	60.32	73.02	61.28	64.34
4	Turbidity, NTU	<1.0	<1.0	<1.0	9.1	<1.0	<1.0	<1.0	<1.0
5	DO (mg/l)	8.5	8.1	8.2	8.4	8.9	8.3	8.3	8.3
6	B.O.D (3 days at 27°C). mg/	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
7	C.O.D mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
8	Oil & Grease, mg/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
9	Nitrate (as NO_3) mg/l	0.07	0.11	0.07	1.43	0.14	0.04	0.09	.016
10	Sulphate (as SO_4) mg/l	13.66	14.69	14.48	13.03	15.52	16.55	15.54	16.12
11	Fluoride (as F), mg/l	0.23	0.42	0.10	0.49	0.24	0.22	0.38	0.27
12	Chloride (as Cl), mg/l	1.73	3.46	1.73	1.73	1.73	1.73	1.74	1.73
13	Calcium (as Ca), mg/l	9.62	8.02	9.62	14.43	9.62	9.62	9.26	9.78
14	Magnesium (as Mg), mg/l	0.97	0.97	0.97	1.94	0.97	0.97	0.97	0.97
15	Iron (as Fe), mg/l	0.04	0.05	0.03	0.9	0.02	0.03	0.05	0.04
16	Sodium (as Na) mg/l	2.1	2.3	2.5	3.2	3.1	1.9	2.7	2.1
17	Potassium (as K). mg/l	1.8	9.6	1.9	3.7	2.1	2.2	2.3	2.7
18	Total Dissolved Solids, mg/l	36	40	42	48	38	46	44	42
19	Carbonate(asCO_3	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
20	Phenolic Compounds (as C_6H_5OH), mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001
21	Mercury (as Hg) mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001
22	Copper (as Cu) mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
23	Zinc (as Zn), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

S. No.	Parameters	W1	W2	W3	W4	W5	W6	W7	W8
24	Cadmium (as Cd), mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001
25	Chromium (as Cr) mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
26	Lead (as Pb), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
27	Arsenic(as As), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
28	Total Hardness (as $CaCO_3$),mg/l	28	24	28	44	28	28	32	30
29	Total Alkalinity (as $CaCO_3$), mg/l	14.46	14.46	19.28	28.92	14.46	19.28	14.38	14.42
30	Total Suspended Solids, mg/l	2	4	2	50	2	1	2	8
31	Residual Sodium Carbonate, mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
32	Total Silica,mg/l	1.04	0.52	0.96	1.26	0.59	0.74	0.82	0.72
33	Phosphates,mg/l	<0.01	<0.01	0.11	0.35	0.1	0.07	0.09	0.13
34	Volatile Suspended Solids, mg/l	Absent	2	Absent	12	Absent	Absent	Absent	Absent
35	Total Kjeldahl Nitrogen, mg/l	1.69	2.02	1.69	4.72	1.01	1.35	1.48	1.78
36	Ammonical Nitrogen, mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
37	Coliform Organism / 100 ml, (MPN)	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
38	Fecal Coliform , MP N/100ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent

Table-3.12: Water quality analysis in the study area (pre-monsoon season)

S. No.	Parameters	W1	W2	W3	W4	W5	W6	W7	W8
1	pH Value	7.19	7.31	7.37	6.81	7.41	7.17	7.29	7.09
2	Colour, Hazen units	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
3	Conductivity, µS/cm	56.8	62.1	65.62	75.9	60.56	71.1	66.38	60.72
4	Turbidity, NTU	<1.0	<1.0	<1.0	9.8	8.8	<1.0	<1.0	<1.0
5	DO (mg/l)	8.6	8.8	8.7	8.8	8.9	8.7	9.1	8.7
6	B.O.D (3 days at 27°C). mg/	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
7	C.O.D mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

S. No.	Parameters	W1	W2	W3	W4	W5	W6	W7	W8
8	Oil & Grease, mg/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
9	Nitrate (as NO_3) mg/l	0.06	0.13	0.08	1.39	0.16	0.02	0.17	0.32
10	Sulphate (as SO_4) mg/l	12.62	13.67	14.52	13.09	14.62	16.67	15.48	13.46
11	Fluoride (as F), mg/l	0.20	0.49	0.13	0.42	0.29	0.19	0.29	0.23
12	Chloride(as Cl), mg/l	1.70	2.46	1.75	1.86	1.67	1.54	1.59	1.72
13	Calcium(as Ca), mg/l	8.62	9.61	8.47	14.26	9.69	8.58	8.49	9.13
14	Magnesium (as Mg), mg/l	0.92	0.86	0.86	1.84	0.91	0.95	0.92	0.87
15	Iron(as Fe), mg/l	0.01	0.07	0.02	0.8	0.03	0.09	0.08	0.07
16	Sodium (as Na) mg/l	2.6	2.9	2.0	3.9	3.6	1.7	2.3	2.7
17	Potassium (as K).mg/l	1.5	9.1	1.6	3.5	2.6	3.9	4.2	4.9
18	Total Dissolved Solids, mg/l	38	45	41	38	40	36	42	47
19	Carbonate(asCO_3	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
20	Phenolic Compounds (as C_6H_5OH), mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
21	Mercury (as Hg) mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
22	Copper (as Cu) mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
23	Zinc (as Zn), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
24	Cadmium (as Cd), mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
25	Chromium (as Cr) mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
26	Lead (as Pb), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
27	Arsenic(as As),mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
28	Total Hardness(as $CaCO_3$),mg/l	26	21	29	42	24	21	26	23
29	Total Alkalinity(as $CaCO_3$),mg/l	14.32	13.29	19.31	28.86	13.22	18.28	16.72	17.38

S. No.	Parameters	W1	W2	W3	W4	W5	W6	W7	W8
30	Total Suspended Solids,mg/l	3	4	2	48	1	5	3	4
31	Residual Sodium Carbonate,mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
32	Total Silica,mg/l	1.01	0.49	0.90	1.20	0.45	0.68	0.76	0.83
33	Phosphates,mg/l	<0.01	<0.01	0.13	0.31	0.6	0.09	0.19	0.27
34	Volatile Suspended Solids, mg/l	Absent	4	Absent	14	12	Absent	11	Absent
35	Total Kjeldahl Nitrogen, mg/l	1.61	2.08	1.48	4.45	1.08	1.28	3.18	2.79
36	Ammonical Nitrogen, mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
37	Coliform Organism / 100 ml, (MPN)	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
38	Fecal Coliform , MP N/100ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent

Table-3.13: Water quality analysis in the study area (Monsoon season)

S. No.	Parameters	W1	W2	W3	W4	W5	W6	W7	W8
1	pH Value	7.1	7.28	7.44	7.05	7.75	7.62	7.13	7.05
2	Colour, Hazen units	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
3	Conductivity, µS/cm	64.9	53.7	58.1	63.6	79.4	95.2	44.2	57.1
4	Turbidity, NTU	6.2	5.8	5.1	5.2	3.0	1.0	0.6	8.3
5	DO (mg/l)	8.8	8.7	8.8	8.9	8.6	8.8	8.9	8.6
6	B.O.D (3 days at 27°C). mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
7	C.O.D mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
8	Oil & Grease, mg/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
9	Nitrate (as NO_3) mg/l	1.82	2.1	2.03	1.78	0.97	2.9	1.72	1.34
10	Sulphate (as SO_4) mg/l	14.48	14.27	16.14	15.1	3.1	8.07	1.66	10.97
11	Fluoride (as F), mg/l	0.13	<0.01	<0.01	0.56	0.6	0.8	0.32	0.52
12	Chloride(as Cl), mg/l	6.12	2.04	2.04	2.04	1.86	5.57	1.86	1.86

S. No.	Parameters	W1	W2	W3	W4	W5	W6	W7	W8
13	Calcium(as Ca), mg/l	3.85	3.85	3.85	3.21	16.03	14.43	4.81	8.02
14	Magnesium (as Mg), mg/l	3.4	3.4	3.4	2.92	<0.005	1.94	<0.005	0.97
15	Iron(as Fe), mg/l	1.2	1.8	1.3	1.2	1.1	1.6	0.8	0.61
16	Sodium (as Na) mg/l	4.8	4	3.9	2.9	0.05	3.73	3.64	2.86
17	Potassium (as K).mg/l	2.1	2.4	2.2	2.1	1.8	3.1	2.97	2.11
18	Total Dissolved Solids, mg/l	40	34	36	40	50	60	28	36
19	Carbonate(asCO_3	0	0	0	0	0	0	0	0
20	Phenolic Compounds (as C_6H_5OH), mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
21	Mercury (as Hg) mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
22	Copper (as Cu) mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
23	Zinc (as Zn), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
24	Cadmium (as Cd), mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01	<0.001
25	Chromium (as Cr) mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
26	Lead (as Pb), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
27	Arsenic(as As),mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
28	Total Hardness(as $CaCO_3$),mg/l	24	24	24	20	40	44	23	24
29	Total Alkalinity(as $CaCO_3$),mg/l	12.36	12.36	12.36	16.48	40.2	36.18	16.08	16.08
30	Total Suspended Solids,mg/l	24.5	27	33.5	20.5	7	<1.0	<1.0	21
31	Residual Sodium Carbonate,mg/l	0	0	0	0	0	0	0	0
32	Total Silica,mg/l	<0.01	<0.01	<0.01	<0.01	1.7	3.11	2.96	0.89
33	Phosphates,mg/l	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
34	Volatile Suspended Solids, mg/l	8	7	10	6	2	<1.0	0.5	0.7
35	Total Kjeldahl Nitrogen, mg/l	3.93	0.91	2.64	1.24	1.75	0.79	0.83	1.07

S. No.	Parameters	W1	W2	W3	W4	W5	W6	W7	W8
36	Ammonical Nitrogen, mg/l	1.4	<0.04	0.84	<0.04	<0.04	<0.04	<0.04	<0.04
37	Coliform Organism / 100 ml, (MPN)	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
	Fecal Coliform , MP N/100ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent

Table-3.14: Drinking water quality standards

Characteristics	*Acceptable	**Cause for Rejection
Turbidity (units on JTU scale)	2.5	10
Colour (Units on platinum cobalt scale)	5.0	25
Taste and Odour	Unobjectionable	Unobjectionable
PH	7.0 to 8.5	<6.5 or >9.2
Total Dissolved Solids (mg/l)	500	1500
Total hardness (mg/l) (as $CaCO_3$)	200	600
Chlorides as CD (mg/l)	200	1000
Sulphates (as SO_4)	200	400
Fluorides (as F) (mg/l)	1.0	1.5
Nitrates (as NO_3) (mg/l)	45	45
Calcium (as Ca) (mg/l)	75	200
Magnesium (as Mg) (mg/l) If there are 250 mg/l of sulphates, Mg content can be increased to a maximum of 125 mg/l with the reduction of sulphates at the rate of 1 unit per every 2.5 units of sulphates	30	150
Iron (as Fe) (mg/l)	0.1	1.0
Manganese (as Mn) (mg/l)	0.05	0.5
Copper (as Cu) (mg/l)	0.05	1.5
Zinc (as Zn) (mg/l)	5.0	15.0
Phenolic compounds (as phenol) (mg/l)	0.001	0.002
Anionic detergents (as MBAS) (mg/l)	0.2	1.0
Mineral Oil (mg/l)	0.01	0.3
Toxic materials		
Arsenic (as As) (mg/l)	0.05	0.05
Cadmium (as Cd) (mg/l)	0.01	0.01
Chromium (as hexaalent Cr) (mg/l)	0.05	0.05
Cyanides (as CN) (mg/l)	0.05	0.05
Lead (as Pb) (mg/l)	0.1	0.1
Selenium (as Se) (mg/l)	0.01	0.01
Mercury (total as Hg) (mg/l)	0.001	0.001
Polynuclear aromatic hydrocarbons (PAH)	0.2 μg/l	0.2 μg/l

Notes:-

*1. The figures indicated under the column `Acceptable' are the limits upto which water is generally acceptable to the consumers

**2 Figures in excess of those mentioned under `Acceptable render the water not acceptable, but still may be tolerated in the absence of alternative and better source but upto the limits indicated under column "Cause for Rejection" above which are supply will have to be rejected.

The total hardness in various water samples ranged from 24-44 mg/l and from 21-42 mg/l and from 20-44 mg/l in winter, pre-monsoon and monsoon seasons respectively. The low calcium and magnesium levels are responsible for soft nature of water. The carbonate hardness (for water with alkalinity level as observed in the study area) is equal to the alkalinity level, i.e. ranging from 14.42 to 28.92, from 12.36 to 40.2 mg/l and from 13.22 to 28.86 mg/l in winter, pre-monsoon and monsoon seasons respectively. The non-carbonate hardness accounts for the balance hardness. Normally non-carbonate hardness can be removed by boiling. However, hardness levels in the area do not need any treatment. The total hardness level in the water is well below the permissible limit of 200 mg/l.

The low EC and TDS values indicate the lower concentration of cations and anions. The concentration of TDS level ranged from 36 to 48 mg/l, from 36-47 mg/l and from 28-50 mg/l in winter, pre-monsoon and monsoon season respectively which is much lower than the permissible limit of 500 mg/l specified for domestic use. This is also reflected by the fact that the concentration of most of the cations and anions are well within the permissible limit. The fluorides level was lower than the permissible limit (1 mg/l) for drinking purposes. Use of water with such fluorides level could lead to dental curies.

The BOD values are well within the permissible limits, which indicate the absence of organic pollution loading. This is mainly due to the low population density and absence of industries in the area. The low COD values also indicate the absence of chemical pollution loading in the area. The marginal quantity of pollution load, which enters river Supin, gets diluted. In fact, even for the minimum flow, there is more than adequate water available for dilution. Level of heavy metal in the water of the project area is below

the permissible limit used for drinking purposes. Total Coliform count is nil in the study area. It can be concluded that water quality was observed to be quite good.

3.3.5 Ambient Air Quality

The ambient air quality with respect to the study area around the proposed site forms the baseline information. The study area represents rural environment. The sources of air pollution in the region are vehicular traffic, dust arising from unpaved village roads and domestic fuel burning. The prime objective of the baseline air quality study was to establish the existing ambient air quality of the area. This section describes the identification of sampling locations, methodology adopted for monitoring, and frequency of sampling.

I. Selection of Sampling Locations

The baseline status of the ambient air quality has been established through a scientifically designed ambient air quality monitoring network and is based on the following considerations:

- Meteorological conditions on synoptic scale;
- Representatives of regional background air quality for obtaining baseline status
- Representation of likely affected area.

Three Ambient Air Quality Monitoring (AAQM) locations were selected taking care of above-mentioned points. The Air and Noise sampling locations are given in Figure-3.7

II. Frequency and Parameters for Sampling

The ambient air quality was monitored at three locations in the study area. Monitoring was conducted for three seasons namely winter season (January 2017), pre-monsoon (June 2017) and monsoon (September 2017). The frequency of monitoring in each season was twice a week for four consecutive weeks. The parameters monitored were PM_{10}, $PM_{2.5}$, SO_2 and NO_2.

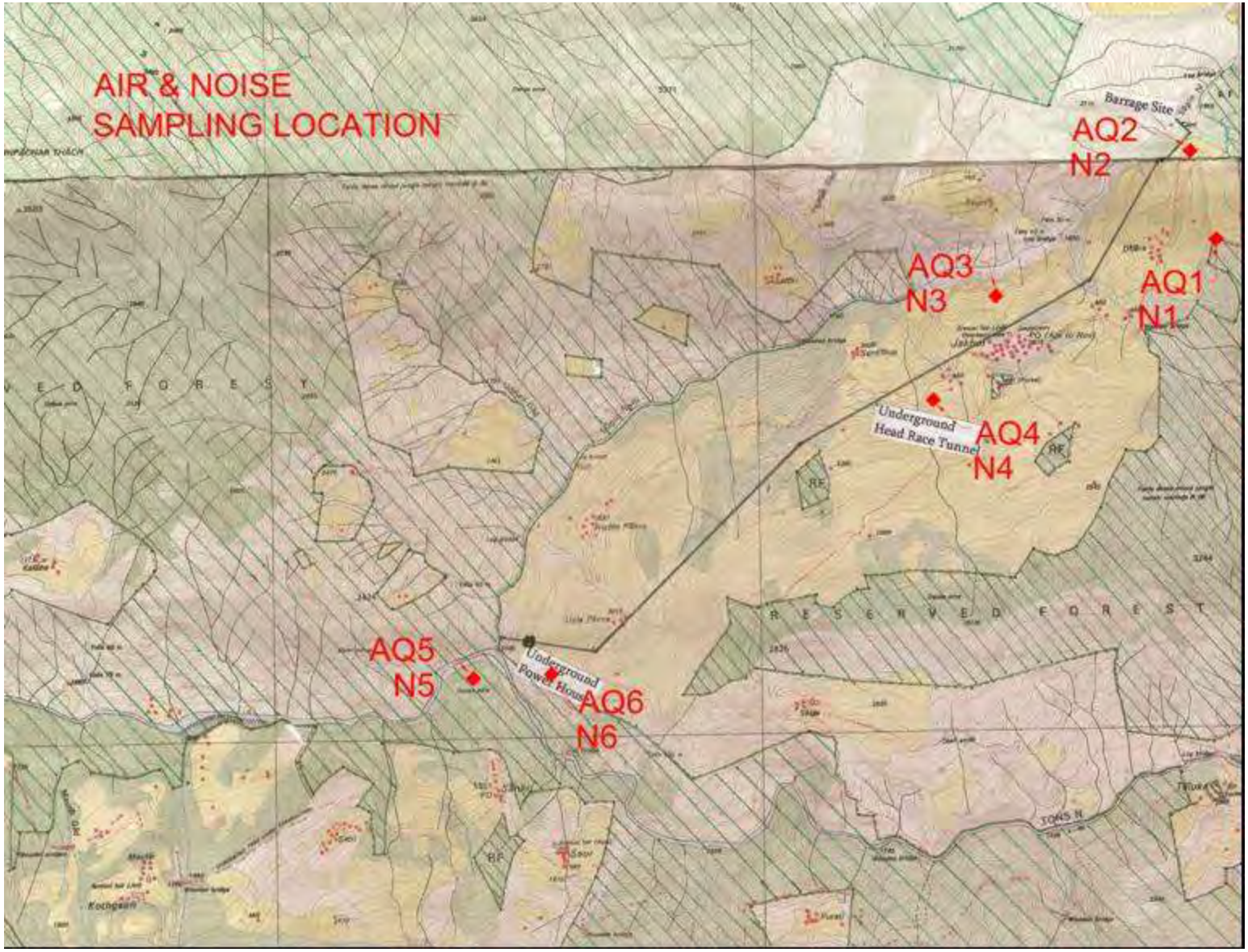

Figure- 3.7: Air and Noise sampling locations

III. Result of Ambient Air Quality Monitoring

The ambient air quality was monitored at six locations in the study area. Monitoring was conducted for three seasons namely winter season (January 2017), pre-monsoon (June 2017) and monsoon (September 2017). The Sampling locations for Air Quality sampling are given in Table-3.15. The result of ambient air quality monitoring are given in Tables-3.16 to 3.18 respectively. The ambient air quality standards are given in Table-3.19.

Table-3.15: Sampling locations for Ambient Air Quality Monitoring

AQ1	Dhara village
AQ2	Barrage site
AQ3	Sunkundi village
AQ4	Panwa village
AQ5	Moutar village
AQ6	Sankari village

Table-3.16: Results of ambient air quality monitoring in winter season (Unit: μg/m^3)

Station	PM_{10}	$PM_{2.5}$	SO_2	NO_2
AQ1	67	34	10.0	5.9
	58	30	9.6	5.4
	42	22	7.8	6.0
	45	22	10.2	5.0
	38	18	BDL	BDL
	37	20	BDL	BDL
	54	26	8.7	5.3
	50	24	10.7	6.2
AQ2	37	19	BDL	BDL
	56	29	BDL	BDL
	43	23	BDL	BDL
	62	32	BDL	BDL
	59	30	BDL	BDL
	56	29	BDL	5.1
	46	24	BDL	6.1
	43	23	BDL	BDL
AQ3	54	28	BDL	BDL
	45	22	BDL	BDL
	65	32	BDL	BDL
	64	33	BDL	BDL
	53	27	BDL	BDL
	38	20	BDL	BDL
	42	21	BDL	BDL
	51	27	BDL	BDL
	50	26	BDL	BDL
	47	25	BDL	BDL

Station	PM_{10}	$PM_{2.5}$	SO_2	NO_2
AQ4	60	31	BDL	BDL
	34	18	BDL	BDL
	52	27	BDL	BDL
	46	23	BDL	BDL
	47	24	BDL	BDL
	56	29	BDL	BDL
AQ5	53	28	BDL	BDL
	41	22	BDL	BDL
	64	33	BDL	BDL
	56	29	BDL	BDL
	45	23	BDL	BDL
	67	35	BDL	BDL
	39	19	BDL	BDL
	43	21	BDL	BDL
AQ6	40	19	BDL	BDL
	44	23	BDL	BDL
	42	21	10.7	5.1
	48	25	BDL	BDL
	53	27	BDL	BDL
	49	24	BDL	BDL
	33	20	BDL	BDL
	36	19	BDL	BDL

Table-3.17: Results of ambient air quality monitoring in pre-monsoon season (Unit: $\mu g/m^3$)

Station	PM_{10}	$PM_{2.5}$	SO_2	NO_2
AQ1	70	31	11.0	5.1
	62	24	10.1	6.0
	44	21	8.2	6.2
	47	27	10.6	5.1
	41	19	9.4	7.0
	40	19	BDL	BDL
	57	27	9.0	BDL
	52	30	11.1	5.7
AQ2	39	18	BDL	6.6
	58	20	BDL	BDL
	45	22	BDL	BDL
	64	26	BDL	BDL
	61	26	BDL	BDL
	58	29	BDL	BDL
	48	19	BDL	BDL
	45	21	BDL	5.2
AQ3	56	23	BDL	6.3
	47	20	BDL	BDL
	67	27	BDL	BDL
	66	28	BDL	BDL
	55	26	BDL	BDL
	40	18	BDL	BDL
	44	23	BDL	BDL
	53	28	BDL	BDL

Station	PM_{10}	$PM_{2.5}$	SO_2	NO_2
AQ4	52	20	BDL	BDL
	49	17	BDL	BDL
	62	30	BDL	BDL
	66	24	BDL	BDL
	54	23	BDL	BDL
	48	19	BDL	BDL
	49	25	BDL	BDL
	58	20	BDL	BDL
AQ5	53	26	9.2	5.1
	43	19	BDL	BDL
	66	30	BDL	BDL
	58	21	BDL	BDL
	47	29	BDL	BDL
	69	20	BDL	BDL
	41	17	BDL	BDL
	45	13	BDL	BDL
AQ6	42	19	11.1	5.3
	46	11	BDL	BDL
	44	15	BDL	BDL
	50	12	BDL	BDL
	55	14	BDL	BDL
	51	11	BDL	5.2
	35	22	9.1	BDL
	38	20	BDL	BDL

BDL: Below Detectable limit (5$\mu g/m^3$)

Table-3.18: Results of ambient air quality monitoring in monsoon season (Unit: $\mu g/m^3$)

Station	PM_{10}	$PM_{2.5}$	SO_2	NO_2
AQ1	65	29	10	BDL
	56	20	8.3	BDL
	40	21	7.6	6.1
	44	26	8.9	BDL
	40	16	8.6	7.0
	32	15	BDL	BDL
	56	21	6.8	BDL
	51	26	9.3	BDL
AQ2	36	16	BDL	5.9
	54	25	BDL	BDL
	41	31	BDL	BDL
	60	18	BDL	BDL
	58	27	BDL	BDL
	54	23	BDL	BDL
	42	24	BDL	BDL
	40	29	BDL	BDL
	51	19	BDL	BDL
	41	30	BDL	BDL

Station	PM_{10}	$PM_{2.5}$	SO_2	NO_2
AQ3	63	28	BDL	BDL
	52	26	BDL	BDL
	36	18	BDL	BDL
	38	23	BDL	BDL
	51	28	BDL	BDL
	52	26	BDL	BDL
AQ4	51	16	BDL	BDL
	46	25	BDL	BDL
	61	31	BDL	BDL
	60	18	BDL	BDL
	50	27	BDL	BDL
	43	26	BDL	BDL
	45	18	BDL	BDL
	54	23	BDL	BDL
AQ5	51	24	7.9	BDL
	40	16	BDL	BDL
	60	25	BDL	BDL
	54	31	BDL	BDL
	46	18	BDL	BDL
	61	27	BDL	BDL
	40	26	BDL	BDL
	40	18	BDL	BDL
AQ6	40	23	9.3	5.1
	44	13	BDL	BDL
	42	8	BDL	BDL
	48	9	BDL	BDL
	51	10	BDL	BDL
	49	10	BDL	BDL
	33	19	8.6	BDL
	31	18	BDL	BDL

BDL: Below Detectable limit (5$\mu g/m^3$)

Table-3.19: National Ambient Air Quality Standards (Unit: $\mu g/m^3$)

S. No.	Pollutants	Time Weighted Average	Concentration of Ambient Air	
			Industrial, Residential Rural and other area	Ecologically Sensitive area (notified by Central Government)
1	Sulphur Dioxide (SO_2) , $\mu g/m^3$	Annual* 24 hours **	50 80	20 80
2	Nitrogen Dioxide (NO_2), $\mu g/m^3$	Annual* 24 hours **	40 80	30 80
3	Particulate Matter (Size less than 10, µm) or PM_{10} , $\mu g/m^3$	Annual* 24 hours **	60 100	60 100
4	Particulate Matter (Size less than 2.5 µm) or $PM_{2.5}$, $\mu g/m^3$	Annual* 24 hours **	40 60	40 60

Note:
* Annual arithmetic mean of minimum 104 measurement in a year at a particular site taken twice a week 24 hourly at a uniform intervals.
** 24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceeded the limits but not on two consecutive days of monitoring.

IV. Summary of ambient air quality monitoring

The summary of results of ambient air quality monitoring is given in Table-3.20.

Table-3.20: Summary of ambient air quality monitoring in the study area

Unit: $\mu g/m^3$

Station	Average	Maximum	Minimum
Winter season			
$PM_{2.5}$			
AQ1	25	34	18
AQ2	26	32	19
AQ3	26	33	20
AQ4	25	31	18
AQ5	26	35	19
AQ6	22	27	19
PM_{10}			
AQ1	49	67	37
AQ2	50	62	37
AQ3	52	65	38
AQ4	49	60	34
AQ5	51	67	39
AQ6	43	53	33
SO_2			
AQ1	10	10.7	BDL
AQ2	BDL	BDL	BDL
AQ3	BDL	BDL	BDL
AQ4	BDL	BDL	BDL
AQ5	BDL	BDL	BDL
AQ6	10.7	10.7	BDL
NO_2			
AQ1	6	6.2	BDL
AQ2	6	6.1	BDL
AQ3	BDL	BDL	BDL
AQ4	BDL	BDL	BDL
AQ5	BDL	BDL	BDL
AQ6	5	5.1	BDL
Pre Monsoon Season			
$PM_{2.5}$			
AQ1	25	31	19
AQ2	23	29	18
AQ3	24	28	18
AQ4	22	30	17

Station	Average	Maximum	Minimum
AQ5	22	30	13
AQ6	16	22	11
PM_{10}			
AQ1	52	70	40
AQ2	52	64	39
AQ3	54	67	40
AQ4	55	66	48
AQ5	53	69	41
AQ6	45	55	35
SO_2			
AQ1	10	11.1	BDL
AQ2	BDL	BDL	BDL
AQ3	BDL	BDL	BDL
AQ4	BDL	BDL	BDL
AQ5	9	9.2	BDL
AQ6	10	11.1	BDL
NO_2			
AQ1	6	7	BDL
AQ2	6	6.6	BDL
AQ3	6	6.3	BDL
AQ4	BDL	BDL	BDL
AQ5	5	5.1	BDL
AQ6	5	5.3	BDL
Monsoon Season			
$PM_{2.5}$			
AQ1	22	29	15
AQ2	24	31	16
AQ3	25	30	18
AQ4	23	31	16
AQ5	23	31	16
AQ6	14	23	8
PM_{10}			
AQ1	48	65	32
AQ2	48	60	36
AQ3	48	63	36
AQ4	51	61	43
AQ5	49	61	40
AQ6	42	51	31
SO_2			
AQ1	9	10	BDL
AQ2	BDL	BDL	BDL
AQ3	BDL	BDL	BDL
AQ4	BDL	BDL	BDL
AQ5	7.9	7.9	BDL
AQ6	8.95	9.3	BDL

Station	Average	Maximum	Minimum
NO_2			
AQ1	5	7	BDL
AQ2	6	5.9	BDL
AQ3	BDL	BDL	BDL
AQ4	BDL	BDL	BDL
AQ5	5	BDL	BDL
AQ6	5	5.1	BDL

Source: Primary survey

Observations on ambient PM_{10} levels

The average PM_{10} levels as observed at various stations in the study area ranged from 42.0 to 55.0 µg/m^3. All the values of PM_{10} monitored during the field survey were below the permissible limit of 100 µg/m^3 for industrial, residential, rural and other areas. (Refer Table-3.20).

Observations on ambient $PM_{2.5}$ levels

The average $PM_{2.5}$ levels as observed at various stations in the study area ranged from 14.0 to 27.0 µg/m^3. All the values of $PM_{2.5}$ monitored during the field survey were below the permissible limit of 60 µg/m^3 for industrial, residential, rural and other areas (Refer Table-3.20).

Observations on NO_2 levels

The highest values of NO_2 were observed in the winter, pre-monsoon and monsoon season are 6.2, 7 and 7 µg/m^3 respectively, at station AQ1. The highest value of 7.0 µg/m^3 too was also observed at the same station. The NO_2 level observed at various sampling stations was much lower than the permissible limit of 80 µg/m^3 for industrial, residential, rural and other areas are given in Table-3.20.

Observation on ambient SO_2 levels

The maximum SO_2 level of 10.7, 11.1 and 10.0 µg/m^3 was observed at station AQ1 in the winter, pre-monsoon and monsoon season respectively. The SO_2 level observed at various stations was below detectable limit (5.0µg/m^3). The SO_2 level observed at various sampling stations was much lower than the permissible limit of 80 µg/m^3 for industrial, residential, rural and other areas are given in Table-3.20.

V. Conclusions

Based on the findings of the ambient air quality survey, conducted for the winter, pre-monsoon and monsoon season, it can be concluded that the ambient air quality in

terms of SO_2 and NO_2 is good in the area. The values of these parameters were well below the permissible limits specified for residential, rural and other areas.

3.3.6 Noise Environment

Baseline noise data has been measured using a weighted sound pressure level meter. The survey was carried out in calm surrounding. Sound Pressure Level (SPL) measurement in the outside environment was made using sound pressure level meter. Hourly noise meter readings were taken at different sites. Monitoring was conducted for three seasons, namely winter season (January 2017), pre-monsoon (June 2017) and monsoon (September 2017). The Sampling locations for Air Quality sampling are given in Table-3.21.

Table-3.21 Ambient Noise Level Sampling locations

N1	Dhara village
N2	Barrage site
N3	Sunkundi village
N4	Panwa village
N5	Moutar village
N6	Sankari village

The noise levels were monitored continuously from 6 AM to 9 PM at each location and hourly equivalent noise level was measured. Sound Pressure Level (SPL) measurement in the ambient environment was made using sound pressure level meter. The average ambient noise levels for three seasons covered as a part of the study are given in Tables-3.22 to 3.24. The noise standards for various categories is given in Table-3.25. The daytime equivalent noise levels are given in Table-3.26.

Table-3.22 Hourly equivalent noise levels in the study area in winter season (Unit: dB(A))

Time	N1	N2	N3	N4	N5	N6
6-7 AM	36	35	34	35	35	34
7-8 AM	36	36	36	36	34	35
8 -9 A.M.	36	36	36	36	36	36
9-10 A.M.	38	38	37	38	37	36
10-11 A.M.	38	38	38	38	37	37
11 am - 12 Noon	38	37	39	38	38	37
1 –2 PM	36	37	40	37	36	36
2 – 3 PM	37	36	38	37	39	37
3 – 4 PM	38	36	36	37	37	36
4 – 5 PM	40	38	36	39	39	38
5 – 6 PM	38	40	39	40	37	37
6 – 7 PM	36	37	38	40	37	37
7 – 8 PM	36	36	37	38	36	36
8 – 9 PM	37	37	35	37	36	35

Table-3.23 Hourly equivalent noise levels in the study area in pre monsoon season (Unit: dB(A))

Time	N1	N2	N3	N4	N5	N6
6-7 AM	36	35	34	35	36	34
7-8 AM	37	37	36	36	37	35
8 -9 A.M.	37	37	36	36	38	36
9-10 A.M.	38	37	37	37	37	38
10-11 A.M.	42	37	38	43	38	41
11 am - 12 Noon	41	42	40	42	38	42
12 Noon-1PM	42	41	41	40	39	45
1 –2 PM	43	46	42	37	40	41
2 – 3 PM	42	41	42	42	41	42
3 – 4 PM	42	42	41	43	42	39
4 – 5 PM	41	40	38	38	39	37
5 – 6 PM	38	37	37	37	38	36
6 – 7 PM	40	36	38	37	37	40
7 – 8 PM	37	40	39	42	37	38
8 – 9 PM	36	37	42	40	38	40

Table-3.24 Hourly equivalent noise levels in the study area in monsoon season (Unit: dB(A))

Time	N1	N2	N3	N4	N5	N6
6-7 AM	36	35	34	35	36	34
7-8 AM	37	37	38	38	37	35
8 -9 A.M.	37	37	38	39	38	36
9-10 A.M.	38	38	38	39	38	36
10-11 A.M.	36	37	38	39	39	38
11 am - 12 Noon	36	36	40	38	40	35
1 –2 PM	36	37	39	36	38	34
2 – 3 PM	37	35	38	35	39	35
3 – 4 PM	36	36	35	37	37	36
4 – 5 PM	35	36	35	40	36	38
5 – 6 PM	38	40	38	40	36	38
6 – 7 PM	36	35	38	40	37	36
7 – 8 PM	36	35	38	38	37	36
8 – 9PM	37	37	35	34	36	34

Table-3.25 Ambient Noise Standards

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

Note : 1. Day time 6 A.M. and 9 P.M.

2. Night time is 9 P.M. and 6 A.M.

3. Silence zone is defined as areas upto 100 meters around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by competent authority. Use of vehicular

horns, loudspeakers and bursting of crackers shall be banned in these zones.

4. Environment (Protection) Third Amendment Rules, 2000 Gazette notification, Government of India, date 14.2.2000.

Table-3.26 Average ambient noise levels

Location	Zone	L_{day} (dB(A))
Winter Season		
Dhara village	Residential	37.7
Barrage site	Residential	37.5
Sunkundi village	Residential	37.7
Panwa village	Residential	38.1
Motwat village	Residential	36.6
Sankari village	Residential	37.1
Pre-Monsoon Season		
Dhara village	Residential	40.1
Barrage site	Residential	40.0
Sunkundi village	Residential	38.9
Panwa village	Residential	39.6
Motwat village	Residential	38.4
Sankari village	Residential	40.3
Monsoon Season		
Dhara village	Residential	36
Barrage site	Residential	36
Sunkundi village	Residential	37
Panwa village	Residential	38
Motwat village	Residential	37
Sankari village	Residential	36

The noise level in winter and pre-monsoon seasons at various sampling stations ranged from 36.6 to 38.1 dB(A) and 38.4 to 40.3 dB(A). The day time equivalent noise level in monsoon season at various sampling stations ranged from 36 to 38 dB(A). The noise levels monitored at various locations in three seasons were well within the permissible limit specified for residential area (Refer Table-3.26).

3.3.7 REGIONAL GEOLOGY

The litho-tectonic set-up of the area is given in Table -3.27.

Table-3.27 Litho-Tectonic Set-up (Geology after GSI)

Group	Formation	Lithology
Jaunsar (undifferentiated)		Grey, Green Phyllite, Sericite Quartzite with local carboceous phyllite, schist and basic rocks
----------Purola Thrust----------		
Purola Crystalline		
		Biotite Schist, Quartz Mica Schist, Garnetiferous biotite schist, biotite gneiss, porphyroblastic gneiss, quartzite and amphibolites
----------Main Central Thrust----------		
Central Crystalline	Gangar	Intercalated sequence of grey micaceous quartzite, quartz mica schist, garnetiferous biotite schist, biotite and porphyroblastic gneiss

The Jaunsar Group is represented by snow white massive and sericitised quartzite showing pale and greenish tinge at places. It is highly fractured, jointed and is intruded by numerous basic bodies. Sericitised quartzites near Sankri show enormous thickness due to folding between Mautar in the west and Taluka in the east. It is restricted by tectonic plane, which has been locally named as Purola Thrust. This formation seems to extend southwards across high ranges to Sar area.

In the north, the Jaunsar Group is thrusted over by the Purola Crystalline Group, which is locally named as Purola Thrust. In the east, the Central Crystallines have ridden over this Formation along the Main Central Thrust (MCT). Purola Crystalline Group comprises chlorite mica schist, quartz mica schist, porphyroblastic gneiss, and pebbly/conglomeratic gneiss. It is lithologically different from the overlying rocks of Jaunsar Group. In project the barrage site is located in Central crystallines, HRT is cutting across the Main Central Thrust (MCT) 300m downstream of barrage axis. Downstream of MCT upto surge shaft HRT is located in Purola crystallines whereas pressure shaft is cutting across the Purola Thrust (PT) and power house cavern & TRT are located in Jaunsars.

The Purola crystalline Group has thrusted the Jaunsar along the Purola Thrust and is overlained by the Central Crystalline showing sharp thrusted contact. It is well exposed in and around Naitwar and Kalaba, and extends towards north up to Himri in the Rupin valley and Saluri and Fetari in the Supin Valley. In north-east, it extends toward Sirga and Jakhol, and does not continue much beyond. In southwest, the rocks of this Group have been traced up to Mori and little farther south. The chlorite mica schist of Purola Crystallines is in direct contact with the Jaunsars and extends all along Purola thrust. At Mautar, quartz biotite schist is exposed. The chlorite mica schist shows interactions of porphyroblastic gneiss (1 to 3 m) and quartzite slightly away from the contact of the Jaunsars. This sequence is wellexposed upto Nichla Panva where quartz biotite schist with porphyroblastic gneiss continues up to near Dhara village. In south-west, it extends through Saturi across Unauni gad and Yian gad to Naitwar and beyond. Besides thin intercalations, within the schistose zone, the gneisses are exposed as a separate zone above the schistose rocks. The gneisses are of two types:

- Compact gneiss
- Porphyroblastic gneiss.

The compact gneiss shows banded structure with well-developed gneissosity, which may be the outcome of the schistose rocks in the area. The porphyroblastic gneisses occur in association with other gneisses of the area. The central crystallines constitutes high grade metamorphic rocks containing kyanite –sillimanite bearing schist and gneisses, calc silicate, migmatite etc. falling within green schist to amphibolite facies of rock. The central crystallines are divided in three formations, namely Gangar, Osla and Harkidun. In project area only Gangar formation is occurring. Gangar formation comprises a thick interstratified sequence of low grade crystalline rocks forming the lower part of central crystallines. It constitutes quartz mica schist, quartzite, porphyroblastic gneisses, granitic gneisses, compact gneiss and garnetiferous mica schist. Gangar formation is thrusted upon the white quartzite rock of Jaunsar group (undifferentiated) along the MCT. The contact is marked by shearing, crushing, jointing, crumpling and mylotinisation of the rocks, which is well exposed near Taluka villge in Tons valley, near Fetari and NE of Lewari villages in Supin valley. This formation extends from Taluka to Panwani in Tons valley; from

Supin Obra gad confluence to slightly below Himri Thach in the Obra gad and NE of Pushlari Thach and SW of Mohal Thach in Supin Valley.

I. STRUCTURE AND TECTONICS

The Rupin-Supin area represents three tectonic units, namely Purola Crystallines, Jaunsar and Central Crystallines in the ascending order, from south to north. These tectonic units are independent and are separated by tectonic planes showing varied lithology.

Thrusts and Faults: At several places tectonic planes have been marked which are evidenced by shearing, crushing, truncation of litho units, association of basic bodies at the tectonic contact and presence of hot springs within the vicinity of the tectonic plane and at places, sudden change in the grade of metamorphism. The Purola Thrust is a tectonic plane occurring in the north and west of the Sankri between the Jaunsar (Undifferentiated) and the Purola crystalline Groups. It is well exposed at Mautar, where it follows a north-easterly trend, and after crossing the Tons river, swings eastwards along the northern flank of the Tons river. It finally abuts against MCT, east of Sirga. The contact is well marked by shearing, crushing, truncation of litho units, occurrence of basic body and presence of a hot spring (near Sirga). The Purola thrust continues in the south and south west. The Purola thrust is exposed opposite to Sankri Power House on the right bank of river Tons.

All the components of the Jakhol Sankri H. E. Project are located on the left bank of Supin river in the rocks of Central Crystalline, Purola crystalline and Jaunsar (Undifferentiated) Groups which consist of mainly gneisses, garnetiferrous biotite schist, biotite gneisses, quartz mica schist, biotite schist with porphyroblastic gneisses basic intrusives grey green phyllite, sericite quartzite and local carbonaceous phyllites.

II. SEISMICITY

The state of Uttarakhand is among the most seismically active parts of India. Seismologically major portion of Uttarakhand falls in zone V and Zone IV as per the seismic zoning Map of India, and thus is very susceptible to earthquakes. Many events of M5.5 or more have struck the region since 1900. Districts along the borders with Nepal and China lie in Zone V. MSK intensities in excess of IX can be expected in these districts. The rest of the state, including the city of Dehra Dun lie in Zone IV, where the maximum intensity expected could reach MSK VIII. The tectonic activities, as a result of continuous mounting pressure of Indian plate on Tibetan

plate are still going on in this part of Himalayas. These activities are quite evident by frequently occurring earthquakes in this region. On the basis of intensive study it has been concluded that earthquakes in the area result from strike slip and dip-slip movements along various faults and thrusts.

Earthquake activity in Uttarakhand have been prolific with loss of life and as a result of which over many lives have been lost and property worth millions has been destroyed or rendered unusable in the last two hundred years. The project area district comes under Seismic Zone IV of Seismic Zoning Map of India, which correspond to Zone Factors of 0.24 (effective peak ground acceleration in terms of g) of seismic intensities VIII (MSK –64 scale), (IS 1893, 2002). The Seismic Zoning Map of India is given in Figure-3.8. Largest Instrumented Earthquake in Uttarakhand observed in 19 October 1991 in - Pilang-Bhatwari area. The intensity was observed 6.8. 768 people were killed and nearly 5,000 injured in this earthquake in Uttarkashi district. Some 18,000 buildings were destroyed in the Uttarkashi-Chamoli region. Landslides and rockfalls were widespread in the Gharwal Hills.

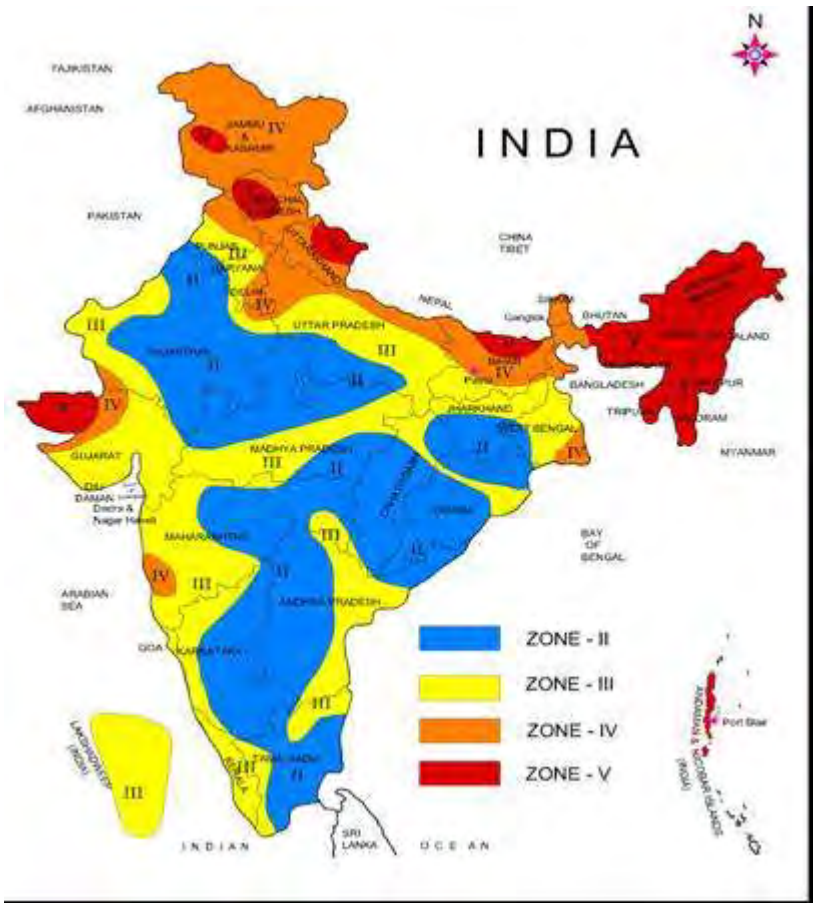

Figure-3.8: Seismic Zone Map of India

The lists of major earthquakes reported in Uttarakhand are given in Table-3.28.

TABLE-3.28 List of major earthquakes and landslides in Uttarakhand

Date of occurrence	Area	Intensity	Remarks
06 July 1505	Lo Mustang-Globo	8.2	Heavy damage in regions along the China-Nepal border. Felt strongly in many parts of north India and damage was reported from Agra, Delhi, Dholpur, Gwalior and Mathura.
01 September 1803	Kumaon-Gharwal	7.0	200 - 300 were killed in this shock and several villages were buried by landslides and rockfalls. The Badrinath temple located ~40 km north of Chamoli was severely damaged.
26 May 1816	Gangotri	6.5	Epicenter of the earthquake was located south of Gangotri, in the glaciers surrounding the Badrinath peak.
16 June 1902	Pokhra-Kainur	6.0	Epicenter of the earthquake was located south-east of Pauri in Uttarakhand.
13 June 1906	Gangotri	6.1	Epicenter of the earthquake was located near Gangotri, in the glaciers surrounding the Badrinath peak.
14 October 1911	Indo-China border	6.5	Epicenter of the earthquake was located in southern Xizang (or Tibet), China, along the international border with India
28 August 1916	Near Api Peak, Nepal	7.1	Epicenter of the earthquake was located in Far-western Nepal, to the north-east of Dharchula, Uttarakhand. The shock caused severe damage to civil structures in Dharchula
27 July 1926	Near Changabang Peak	6.5	Epicenter of the earthquake was located in the vicinity of the Changabang Peak, which lies in the vicinity of Nanda Devi National Park in Uttarakhand.
08 October 1927	Indo-China border	6.1	Epicenter of the earthquake was located north of the town of Dakar, Uttarakhand.
20 October 1937	Indo-China border	5.8	Centred along the state border with Himachal Pradesh, this earthquake caused damage in the region.
04 June 1945	Near Nanda Devi Peak	6.5	Epicenter of the earthquake was centred in the vicinity of the peak Nanda Devi (elevation: 7,817 metres).
28 December 1958	Rameshwar-Devi Dhura	6.1	This earthquake is known as the Kakpot earthquake. More than a dozen buildings collapsed Fissures and landslides were generated in an area within 150 kilometres of Kapkote.
27 June 1966	Athpali-Dhung	6.2	This earthquake was centred in Far-western Nepal, along the border with Uttarakhand.

Date of occurrence	Area	Intensity	Remarks
29 July 1980	Bajhang-Ghoghda	6.5	150 - 200 persons were killed and hundreds injured. Extensive damage to several village in western Nepal. The earthquake also caused damage in Pithoragarh area of Uttarakhand. 13 persons were killed here and 40 were injured. The shock was felt as far away as Kathmandu and New Delhi.
19 October 1991	Pilang-Bhatwari area	6.8	768 people were killed and nearly 5,000 injured in this earthquake in Uttarkashi district. Some 18,000 buildings were destroyed in the Uttarkashi-Chamoli region. Landslides and rockfalls were widespread in the Gharwal Hills
05 January 1997	Dharchula area	5.6	Felt strongly in many parts of the state then known as Uttarnchal, including Nainital, Kumaon and the Terai areas. Many people ran outdoors in panic and window panes were broken in many localities. Many houses were damaged in western Nepal and it was felt at Baitadi and Dadeldhura.
28 March 1999	Chamoli-Pipalkoti	6.4	115 people killed in the Gharwal region. The earthquake was felt very strongly in Uttar Pradesh, Chandigarh, Delhi and Haryana. In Haryana, one person was killed in the city of Ambala and 2 at Nakodar in the neighbouring state of Punjab. Minor damage to buildings in New Delhi, most significantly in Patparganj.
30 March 1999	Chamoli-Pipalkoti area	4.9	50 people were injured in this tremor, which was an aftershock of the event on 28 March 1999. Several buildings developed cracks and many damaged houses at Maithana village collapsed. At Barai in Chamoli district, 20 houses collapsed and 11 developed cracks, while at Kotiyal 4 houses collapsed and 85 developed cracks. Some damage was also reported from Rudraprayag district
31 March 1999	Chamoli-Pipalkoti	3.0	1 person was killed and several injured in a house collapsed at Hat Pipalkot in Chamoli district.
27 May 2003	Bangina region	5.0	A moderate earthquake struck the Gharwal Himalayas.
14 December	Pokhri-Gopeshwar	5.0	A moderate earthquake struck the Gharwal region of Uttarakhand, causing

Date of occurrence	Area	Intensity	Remarks
2005	region		mior damage to property in some parts of Uttarakhand. The earthquake was felt at many places in Uttarakhand as well as in Delhi.
5 August 2006	Thal area, eastern Uttarakhand	4.4	Causing damage to property in parts of eastern Uttarakhand. The earthquake was felt at many places in Uttarakhand and surprising as far as Delhi.

Source: Amateur Seismic Centre, Pune, 2007

The seismic history of the area shows that in the last 150 years about 36 earthquakes of damaging effects (Magnitude >5, Richter) have been experienced in Garhwal region and most of these occur in the 50 km wide belt following the trace of Main Central Thrust (MCT). About 11 earthquakes (in Garhwal division) of magnitude more than 5.5 are recorded between longitude 78°- 81°N and latitude 29°-31°20'E. The Uttarkashi earthquake of October 20, 1991 and Chamoli earthquake of March 29, 1999 are the recent ones. Both the earthquakes occurred in the seismological Garhwal block defined by Kaurik fault in the west, Main Central Thrust (MCT) in the north and Alaknanda fault in the south in the Main Himalayan Seismic Zone. The most damaging earthquake observed in the area is the 05 April 1905 earthquake with a magnitude of 8.0 (Richter) at Kangra which took a toll of 20,000 human lives.

The project area falls in zone IV of the seismic zoning map of India. The determination of site specific design earthquake parameters for the project has been carried out by the Department of Earthquake Engineering, Indian Institute of Technology, Roorkee for the Jakhol Sankri H. E. Project. MCE condition is estimated to be magnitude of 8.0 earthquakes occurring at MCT. The PGA value for MCE and DBE condition are estimated to be 0.38g and 0.19g respectively.

3.3.8 HYDROLOGY

Jakhol Sankri Hydroelectric Project (JSHEP) on RIVER Supin at present is the only hydropower project proposed under development. Since there is no project proposed upstream of this project, there is no impact on the flow volume or the flow pattern as far as JSHEP is concerned. Downstream of the proposed JSHEP, Naitwar Mori HEP (60 MW) on river Tons with FRL at EL 1267.00 m and TWL at EL 1170.24 m is proposed to be developed. The proposed JSHEP is envisaged with TWL at EL. 1508.95 m hence, is not expected to have any adverse impact on the Naitwar Mori

hydroelectric project.

I. DESCRIPTION OF RIVER SUPIN

The Supin river rises from the northern part of the Tons catchment near the border between Himachal Pradesh and Uttarakhand and confluences into river Tons near the mountain hamlet of village Sankri. Further downstream, river Tons meets its biggest tributary, Pabar at Tiuni. The river flows along a V shaped valley. A number of settlements have come up along Tons River such as Tiuni, Naitwar and Menus. River Supin is snow-fed and has perennial flow and large untapped power potential. The catchment area of the project on river Supin and catchment area of jakhol sankri is shown in Figures-3.9 and 3.10.

- Tones River (also known as Harikidun gad): Originating from Bandar poonch glacier at an attitude of 5400 m flowing approximately S-SW direction & length approximately 30 km up to confluence with river Supin.

- Supin River (Tributary of Tons): Originates from Kimlog glacier from Baslawa Thach area at 4100m, flows NE-SW direction, joins Tons near Sankri length 21km.
- Obra Gad (Tributary of Su- pin): Originates from Devkir glacier at an altitude of 4300m joins Supin 3km upstream to Dhara,& flows NE-SW direction length 17km

River Tons flows through Garhwal, western part of the Himalayan state of Uttarakhand, bordering Himachal Pradesh. With its source from Bandarpunchh Mountain at an elevation of 6320m, it is the biggest tributary of the Yamuna, and, in fact, carries more water than the Yamuna itself. The Tons valley lies in the Jaunsar Bawar region of Garhwal. Tons river joins Yamuna at Kalsi, approximately 48 km away from Dehradun in the north-western part of Dehradun valley.

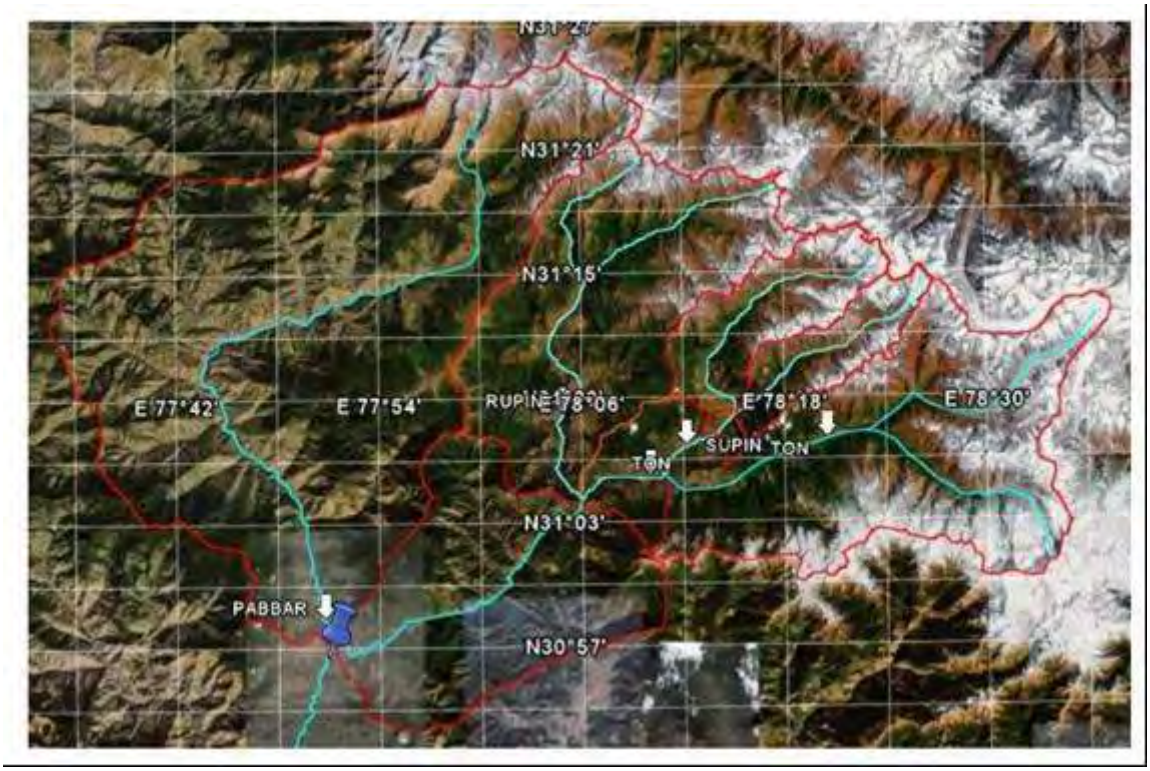

Figure-3.9: The catchment area of river Supin at jakhol

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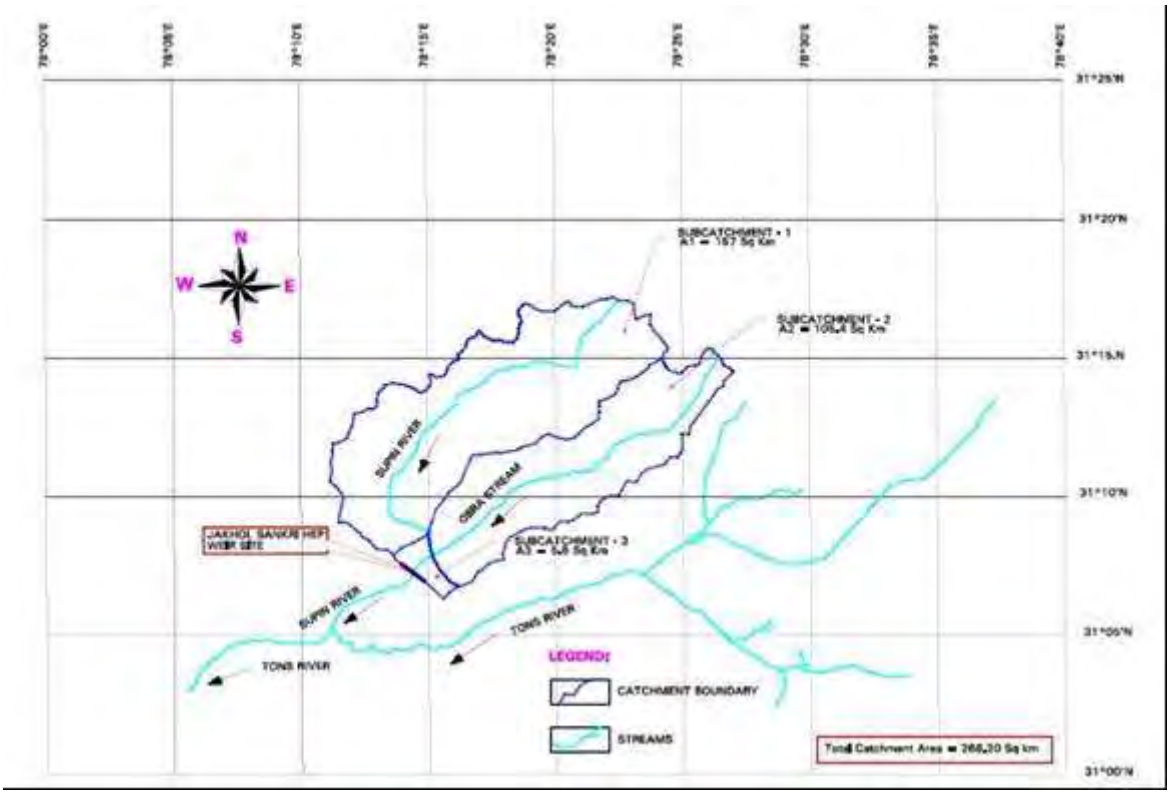


Figure-3.10: The catchment area of the jakhol Sankari HEP

The Drainage Map of Catchment Area of Jakhol Sankari HEP is shown in Figure-3.10. The catchment area intercepted upto the project site is 268.2 km^2. The altitude in the catchment area varies from EL 5800 m to EL 1515 m. The catchment exhibits mainly three types of area viz. snow covered, fairly dense forest (mainly kail, rai, morinda, deodar, kharsu, pine and fir) and open shrubs & scattered trees. Snow bound area accounts for about 86% of the catchment intercepted upto the diversion site of JSHEP.

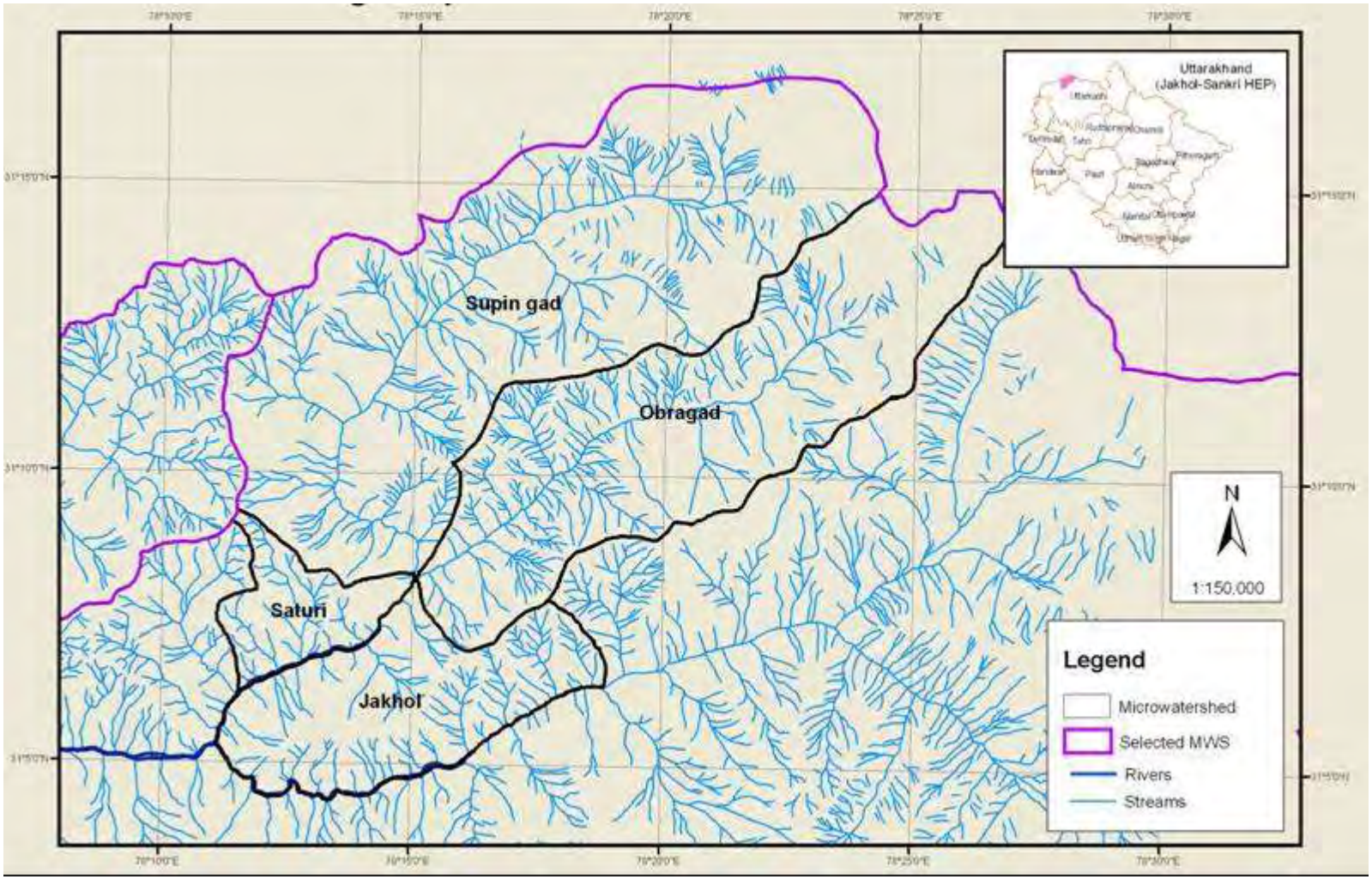


Figure-3.10: Drainage Map of Catchment Area of Jakhol Sankari HEP

II. RAINFALL DATA

The daily rainfall data has been procured for thirteen rain gauge stations in Tons river basin. All these stations are maintained by Indian Meteorological Department. Nine of these stations fall in Kinnaur and Shimla districts of Himachal Pradesh and remaining four stations are in Dehradun and Uttarkashi districts of Uttarakhand. Out of the three stations falling in Uttarkashi, no rain gauge station falls within the catchment of the JSHEP. All gauging stations are located downstream of project catchment. The details of these four stations in vicinity of the project area are presented given in Table-3.29. Even though, any of these rain gauge stations are not located in the catchment area of the project, they can help to know the climatic conditions in and around the project area.

Table-3.29: Rain gauge Stations near JSHEP Area

Station Name	District	Coordinates	Altitude	Data available for duration
Tiuni Hydro	Dehradun	30°53' N/ 77°55'E	1080	06/81 - 09/04
Purola	Uttarkashi	Not available		06/80 - 12/91
Purola Hydro	Uttarkashi	30° 52'N/ 78°E	1250	05/82- 09/05
Naitwar Hydro	Uttarkashi	31°06' N/ 78°12'E	1400	05/82- 09/05

The daily rainfall data of these above four stations was analysed and is summarized in Table 3.30.

Table-3.30 Analysis of Rainfall Data of four rain guage stations

Rainfall Statistics (in mm)	Rain gauge Stations			
	Tiuni Hydro	Purola	Purola Hydro	Naitwar hydro
Average annual	799.5	1003.3	1118.6	1016.5
Maximum annual	1170.2	1368.6	1476	1909.4
Minimum annual	415.4	508.0	491.2	250
Max. observed daily	121.8	125	127	210
Date of occurrence extreme event	27th Jun 2001	28th Aug. 1989	17th Oct. 1998	10th Feb 1986

III. GAUGE AND DISCHARGE DATA

Central Water Commission has been carrying out discharge observation on river Tons at Tiuni Gauge-Discharge (G-D) station just downstream of its confluence with Pabbar river and on river Pabbar at Tiuni, Sawra, Mandly and Rohru. These stations are near the confluence of Pabar and Tons and located downstream of JSHEP. The G-D site at Tuini on Tons is the nearest downstream site for which observed daily discharge data are available for a long period.

The following Daily Discharge data has been obtained from CWC:

Period		Location (Tiuni G&D Site)
June 1980- Dec 2007	Data available for four months (July, August, September and October) of every year	On Tons river, d/s of confluence
		On Pabbar river, u/s of confluence
Jan 2008- May 2012	Annual Daily Discharge	On Tons river, d/s of confluence
		On Pabbar river, u/s of confluence

There was no gauging site in the project catchment for which a long term daily discharge data is available. SJVNL has established a gauge and discharge station at the project site in February 2006. The observed daily discharge data at this site is available from March 2006 to March 2011.

IV. WATER AVAILABILITY

Hydrologic analysis crucial for project configuration such as water availability, power potential study etc. has been conducted on the basis of water years. The JSHEP catchment is a part of the bigger catchment of Tons at Tuini located downstream. The proportion of snow bound area is higher in case of the upper catchment (JSHEP). Some of the flow figures characterizing the flow pattern of the river at the project site are given in Table-3.31.

Table-3.31 Flow Pattern of Supin at Jakhol

Characteristic Flow	Value in Mm^3
Average annual flow	359.72
Maximum annual flow	667.96 - Year 1990-91
Minimum annual flow	214.07 - Year 2000-01
Av. monsoon flow (July-Oct.)	205.98
Av. Non-monsoon flow (Remaining months)	153.74
Maximum 10-daily discharge	65.24 m^3/s
Minimum 10-daily discharge	1.56 m^3/s

The dependable flow analysis at Jakhol Sankari hydroelectric project site is given in Table-3.32.

Table-3.32 Dependable Flow Analysis for hydroelectric project

Year	Annual Yield (MCM)	Sorted		Rank	Exceedence Probability
1977-78	479.4	1990-91	761.24	1	2.94
1978-79	524.71	1991-92	738.56	2	5.88
1979-80	345.09	1994-95	594.41	3	8.82
1980-81	402.41	1992-93	566.22	4	11.76
1981-82	374.24	1989-90	554.2	5	14.71
1982-83	374.35	1997-98	549.42	6	17.65
1983-84	389.47	1995-96	531.09	7	20.59
1984-85	255.41	1978-79	524.71	8	23.53
1985-86	367.68	1977-78	479.4	9	26.47
1986-87	357.68	2008-09	465.19	10	29.41
1987-88	309.34	1996-97	463.7	11	32.35
1988-89	388.01	1998-99	417.13	12	35.29
1989-90	554.2	1980-81	402.41	13	38.24
1990-91	761.24	1999-00	398.68	14	41.18
1991-92	738.56	1983-84	389.47	15	44.12
1992-93	566.22	1988-89	388.01	16	47.06
1993-94	368.83	1982-83	374.35	17	50.00
1994-95	594.41	1981-82	374.24	18	52.94
1995-96	531.09	1993-94	368.83	19	55.88
1996-97	463.7	1985-86	367.68	20	58.82
1997-98	549.42	1986-87	357.68	21	61.76
1998-99	417.13	1979-80	345.09	22	64.71
1999-00	398.68	2003-04	341.87	23	67.65
2000-01	242.85	1987-88	309.34	24	70.59
2001-02	246.38	2009-10	305.93	25	73.53
2002-03	258.83	2007-08	282.46	26	76.47
2003-04	341.87	2005-06	277.35	27	79.41
2004-05	270.52	2004-05	270.52	28	82.35
2005-06	277.35	2002-03	258.83	29	85.29
2006-07	256.11	2006-07	256.11	30	88.24
2007-08	282.46	1984-85	255.41	31	91.18
2008-09	465.19	2001-02	246.38	32	94.12
2009-10	305.93	2000-01	242.85	33	97.06

The annual flow series for 50 percent and 90 percent years are given in Table-3.33.

Table-3.33 Annual flow series for 50% and 90% dependable years

Month	10-daily Intervals	90% Dependable	50% Dependable
		1984-85	1982-83
June	I	8.41	12.48
	II	6.2	14.78

Month	10-daily Intervals	90% Dependable	50% Dependable
		1984-85	1982-83
	III	6.69	14.96
July	I	11.36	19.33
	II	11.61	21.51
	III	14.65	24.08
August	I	13.16	25.99
	II	17.97	27.74
	III	18.31	26.04
September	I	16.29	22.83
	II	8.74	16.26
	III	6.99	11.3
October	I	7.04	8.64
	II	6.59	6.46
	III	5.89	5.86
November	I	4.96	5.18
	II	3.98	4.71
	III	3.79	4.63
December	I	3.68	4.25
	II	3.57	3.88
	III	3.3	3.61
January	I	3.16	3.69
	II	2.55	3.39
	III	2.55	3.3
February	I	2.41	3.29
	II	2.31	3.47
	III	3.24	3.35
March	I	4.05	4.78
	II	3.11	4.75
	III	3.86	5.72
April	I	4.17	5.93
	II	5.13	4.91
	III	6.16	8.09
May	I	7.96	11.25
	II	7.4	12.77
	III	14.17	11.14

V. ESTIMATION OF DESIGN FLOOD

The barrage and intake structure should be safe against the design flood. 1 in 100 year flood has been considered for design of barrage and 1 in 500 year flood has been considered for design free board for intake structure. Design Flood for Barrage is considered as higher of the following;

- SPF obtained at Barrage using Hydro-Meteorological Approach **or**
- 100 year return period flow, calculated on the basis of yearly peaks

Derivation of design floods is based on a two-step procedure involving first a frequency analysis of annual maximum daily flood records on Tons river at Tiuni station, followed by re-scaling flood estimates from Tuini station to JSHEP site by catchment area proportionality.

Then flood values at Jakhol barrage site have been calculated on catchment proportionality basis and the estimated value by Gumbel distribution method are given in Table-3.34.

Table-3.34 Estimated values by Gumbel distribution at JSHEP site

Return Period Years	Discharge (m^3/S)
2	67.86
10	158.06
25	203.45
50	237.13
100	**270.56**
500	**347.81**
1000	381.02
10000	491.29

The estimated flood discharge values for design of various return periods are given in Table-3.35.

Table-3.35 Estimated flood discharge values

Estimated Flood	Value (cumec)
Standard Project Flood	232
50 year flood	233
100 year flood	270
500 year flood	350
Construction Diversion Flood	50

The diversion flood for construction is 50 m^3/s, which has been adopted based on the highest observed non-monsoon flood of 47.72 m^3/s witnessed in June 2008 and estimated 25 years flood of 49.48 m^3/s.

VI. SEDIMENT DATA

The sediment data at Jakhol site is available from July 2006 to Mar 2011. The silt analysis has been carried out for samples collected at Jakhol site. The silt analysis report gives information on mineralogical composition of silt sample collected from the project site. The report categorized the silt samples in Supin as varying from fine to medium grained. The summary of study on mineralogical composition of sediments is given in the Table 3.36.

Table-3.36 Summary of Average Silt Sample Analysis Report of River Supin

Mineral	Average Mineral Composition in Percentage (%)
Quartz	43
Biotite	14
Muscovite	8
Feldspar	20
Opaque	4
Iron' Oxide	3
Rock Fragment	7
% Not determinable	+1

3.4 BASELINE STUATUS FOR ECOLOGICAL ASPECTS

3.4.1 Terrestrial Ecology

Forest types in study area

Uttarakhand is reported to have 45.82 per cent of its total geographic area under forest cover, which includes very dense, moderately dense, open forest and scrub (FSI, 2013). The major forest types occurring in the state are Tropical Moist Deciduous, Tropical Dry Deciduous, Sub-tropical Pine, Himalayan Moist Temperate, Himalayan Dry Temperate, Sub-alpine and Alpine forests. The catchment area of the proposed Jakho Sankri Project covers almost of these forests. The forests in the project area fall in the Tons Forest Division. As per “Revised Survey of Indian Forest type” by Champion & Seth (1968), following forest type observed in the catchment area of the project site:

Sub-tropical chir pine forest (9/C1b): This type of forest can extends up to 1800m. It can be observed near Power house site of the project area. The forests are of pure chir pine with admixture of other species along the river and higher elevations. The associates are Banj (Quercus leucotrichophora), Anyar (Lyonia ovalifolia), Burans (Rhododendron arboretum) and near nallas Kunis (Alnus nepalensis). Shrubs are rare, chief ones being Buddleja crispa, Inula cappa, Prinsepia utilis, Rubus ellipticus, Woodfordia fruticosa, Leptodermis lanceolata etc. The under growth is usually of herbs and grasses, mainly Bergenia ciliate, Artemisia nilagirica, Eriophorum comosum, Gnaphalium luteo-album, Chrysopogon serrulatus, Heteropogon contortus, Arundo donax etc.

I. 12/C1a Banj Oak forests (Quercus leucotricophora):

This sub-type is moderately represented in the project area and is only found along the transitional belt between temperate mixed coniferous forest and sub-tropical pine

forest. This type of forest is observed left bank of Supin river near Jakhol village. Important associates of Ban oak forests are Anyar (Lyonia ovalifolia), Burans (Rhododendron arboretum), Narikh (Litsea elongata), Pyrus pashia etc. The shrubby undergrowth is scanty, fairly dense in moisture places and comprises of Sarcococca saligna, Berberis lycium, Buddleja asiatica, Daphne papyracea, Berberis aristata, Rosa brunonii, Indigofera heterantha, Plectranthus rugosus, Prinsepia utilis etc. There are a few climbers, which include Hedera nepalensis, Parthenocissus semicordata, Clematis montana, and Vitis sp. Ringal (Arundinaria falcate) is found as undergrowth with in protected shady portions.

II. Moru oak forest (Quercus floribunda):

The Moru forest forest types is found in small patches above the Ban oak forests between 1800 m to 2500m elevations and are more mesophytic than Ban oak. This type of forest found in left bank of the river. No forest cover was observed in right bank of thr river Supin. The top canopy of these forests associates with moru consists of Betula alnoides, Abies pindrow, Cedrus deodara, Acer aecium, Phoebe lanceolata, Alnus nepalensis etc. The second storey consists of Juglans regia, Pyrus pashia, Sorbus cuspidate, Rhododendron arboretum etc. The undergrowth consists of Berberis lycium, Coriaria nepalensis, Deutzia staminea, Indigofera heterantha, Rosa macrophylla, Sarcococca saligna, etc. The leaves of Moru (Quercus floribunda) are extensively used for fodder by locals hence these forests are heavily lopped.

III. 12/CIC Moist deodar forest (Cedrus deodara)

These forests grow between altitude ranges of 1,900m and 2,700m and sometimes extend up to 2800m on sunny ridges. This type of forest observed in Catchment area and completely absent in proposed project area of Jakhol Sankri. In the project area deodar zone is occupied mainly by kail (Pinus wallichiana). The second storey of scattered trees of Lyonia ovalifolia, Rhododendron arboretum, Quercus floribunda etc. is present. The ground cover consists of shrubs like Berberis aristata, Daphne papyracea, Hypericum oblongifolium, Coriaria nepalensis, Indigofera heterantha, Leea asiatica, etc. Clematis Montana, Hedera nepalensis, Parthenocissus semicordata etc. are found among climbers.

IV. 12 (C1d) Western mixed coniferous forest:

These forests are found from an altitude of 2400m. to 3000m. It is composed of four elements viz. fir, spruice, deodar and kail. In various proportions mixed with broad

leaved species. The proportion for fir (Albizia julibrissin), and spruce (Picea smithiana) is high in the coolar aspects and on easier ground while deodar has higher on steeper areas. The growth is very fine and hight upto 50m. may be attained. The lower parts have maily spruce with silver fir and some deodar. Kail is found through out in small patvhes. Ban, Moru, Burans are found in lower elevations. In the moisture areas along streame or nallas deciduous species like Acer aecium, Aesculus indica, Juglans regia Juglans regia etc. are found. Viburnum cotinifolium, Sorbaria tomentosa, Spiraea canescens, Rubus macilentus, and Salix sp are found among shrubs. The ground flora is consists of herbs, grasses and ferns.

V. 12/ 2C Moist Temperate Deciduous Forest:

This forest type is commonly found between 2500 m and 3200 m elevations in moist depressions and damp areas. The forest often grows in riparian strips along the hill streams and also on gentle slopes. The tree canopy of these forests is comprised of Ulmus wallichiana, Acer cappadocicum, Aesculus indica, Fraxinus xanthoxyloides, Rhododendron arboretum, Betula alnoides, Juglans regia, etc. The shrubby undergrowth is represented by Viburnum cotinifolium, Cotoneaster bacillaris, Sorbaria tomentosa, Rosa macrophylla, Sarcococca saligna, Spiraea canescens, etc. Climbers in the forest include Clematis montana, Hedera nepalensis, and Parthenocissus semicordata etc.

3.4.2 Field studies

As a part of the CEIA Study, a detailed ecological survey was conducted at different sites in the project area for various seasons. The seasons covered for study were:

- Winter season Jauary 2017
- Pre-monsoon season June 2017
- Monsoon season September 2017

3.4.3 Objectives

The ecological study of the surrounding area up to 10 km radius of propose project has been conducted in order to understand the ecological status of the existing flora and fauna to generate baseline information and evaluate the probable impacts on the biological environment.

The objectives of the terrestrial ecological survey were to:

- Preparation of comprehensive checklist of flora.
- Determine frequency abundance and density of different vegetation component.

- Importance value index of the dominant vegetation in the study area of proposed project.
- Estimation of ecological diversity of different plant communities
- Identification and listing of Rare Endangered species –RET.
- Identification and listing of plants of biologically, economical and medicinal importance.

3.4.4 Sampling sites

The sampling sites and location map for terrestrial ecological survey were given in Table- 3.37 and Figure-3.11.

Table-3.37 Study sites for terrestrial ecology (Floral and Faunal accounts) w.r.t. Project Appurtenances

Study sites	Sampling Locations
Site-I	Catchment Area
Site-II	Upstream (u/s) area of Barrage Axis
Site-III	Barrage Axis Site
Site-IV	Downstream (d/s) Area of Barrage
Site-V	Near Adit-2 Right bank of Bargad Nalla
Site-VI	Upstream (u/s) Area of Power House
Site-VII	Power House Site near Guinyaghati
Site-VIII	Downstream (d/s) of Power House

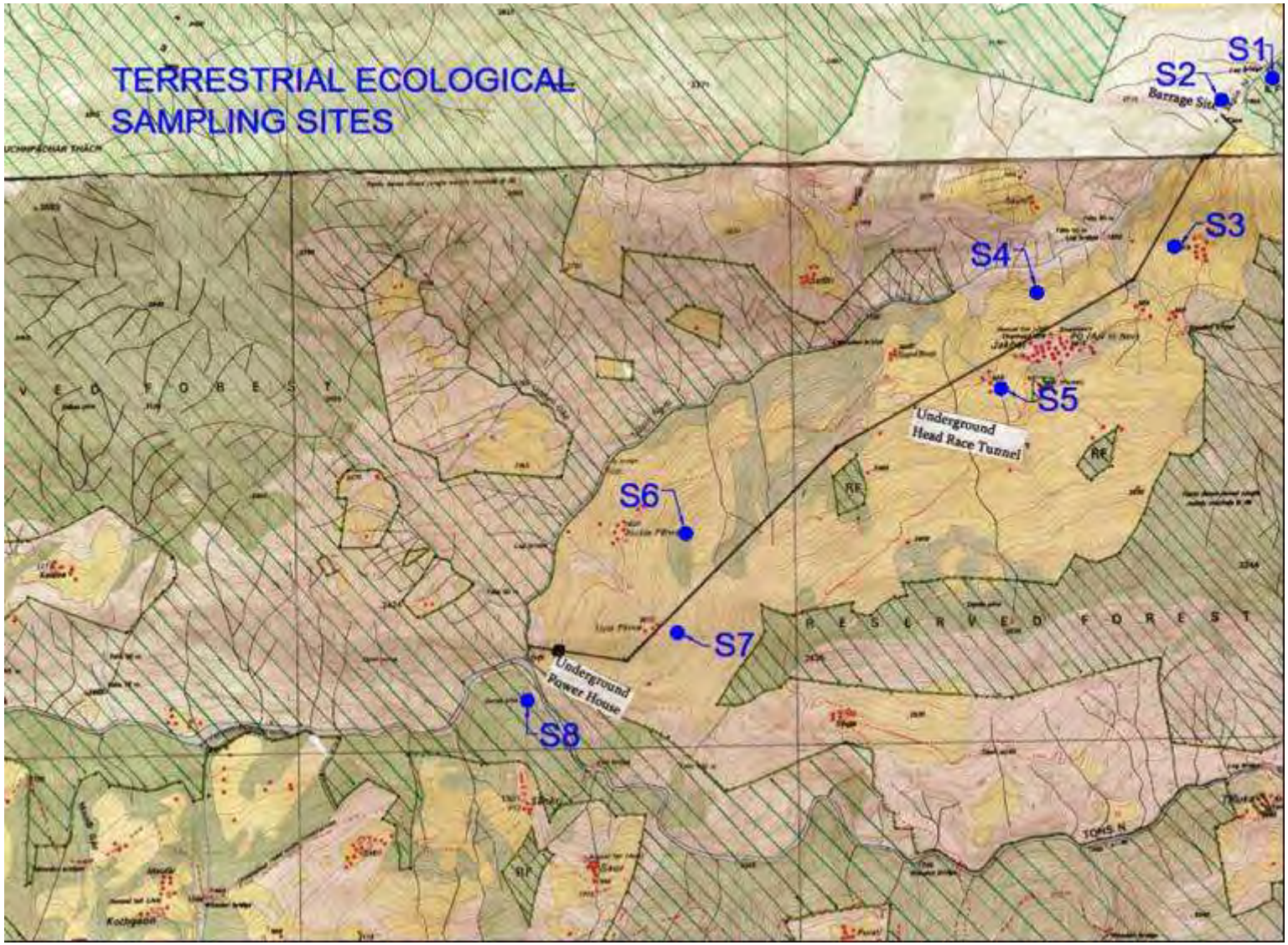


Figure-3.11: Sampling Location Map of Terrestrial Ecology

3.4.5 Methodology applied for the study

For assessing the floral diversity in the study area both floristic survey and quantitative analysis of vegetation were undertaken. Information regarding local names and locality of the plants were recorded with the help of the locals and forest staff. The quantitative analysis of vegetation was done by using quadrats as sampling units. The quadrats were laid randomly in identified sites of the project area. The vegetation analysis was undertaken by collecting numerical community data for trees, shrubs and herbs from the randomly laid quadrats. The size of vegetation patches, 20 each random quadrates of 10mX10m size were laid to study for tree, 5x5 m for shrubs and 25 random quadrat of 1 x 1 m were laid to herbaceous community. The community lavel studies of the selected sites were conducted for trees, shrubs and herbaceous vegetation. During the survey, individuals within the quadrat were identified up to the species level, and the numbers of individuals of each species in each quadrat were counted. The GBH of all trees and shrubs were measured. Vegetation composition was evaluated by analyzing the frequency, density, abundance and importance value index (IVI) according to Mishra, (1968) and Curtis and McIntosh. Based on the quadrat data, frequency, density and cover (basal area) for each species were calculated using the following formula:

Density (ha-1) = (Total number of individuals of the species in all the quadrats/total number of quadrats studied) multiplied by the factor depending on the quadrat size to express on per hectare basis for trees and shrubs, individual/m2 for herbs.

Frequency (%) = (Number of quadrats in which the species occurred/total number of quadrats studied) × 100;

Basal cover is considered as the portion of ground surface occupied by a species (Greig-Smith, 1983). Basal area = πr2 = C2/4 π Where, C = 2 πr (C = Circumference at breast height; r = Radius)

Frequency indicates the number of sampling units in which a given species occur and thus express the dispersion of various species. The density represents the numerical strength of the species in the community. Based on the quantitative characters like frequency, density, and dominance (Basal area or cover) the overall dominance of a species on the entire community is measured by analyzing the synthetic character called Importance Value Index (IVI), Philips (1959) reported that IVI expresses the abundance and ecological success of any species. The values of IVI were computed by the summation of the value of relative frequency, relative

density and relative dominance (Curtis and McIntosh 1950 and 1951; Mishra, 1968). Relative values for frequency, density and basal area were calculated by dividing the individual species value by the total value multiplied by 100. The IVI values were tabulated in the descending order. It helped in permitting the development of an abstract called community type.

Diversity indices and Evenness

The herbaceous vegetation has been studied through tiller analysis. Separate shoots appearing above the ground were counted as individual tiller. The method was selected for study because it was difficult to decide where an individual plant begins and where it ends. Grasses and sedges usually form smaller and large tufts and the number of aerial shoots (culms) varies greatly with the tufts as well as the species. Such a method provides a real picture of the actual composition of herb age of mixed grassy vegetation. To assess diversity of floral elements and structure of the plant community in different study sites, various diversity indices were analyzed.

Shannon Weinner index (H′)

It is calculated by using the following formula:

$$H' = -\sum_{i=1}^{s} p_i \ln p_i$$

where, s = the number of species

pi = the proportion of individuals or abundance of the ith species expressed as a proportion of total cover

ln = log base n.

Concentration of dominance (Cd) It is calculated as Cd= ∑ ((ni/n)2) where ni is number of individuals of taxon i. The value of D Ranges from 0 (all taxa are equally present) to 1 (one taxon dominates the community completely).

Equitability or evenness was calculated by following formula which reads:

It is calculated using the formula given by Pielou (1966, 1969),:e^H / S, where H is the Shannon's index and S represents the number of species. It indicates the relative abundance or proportion of individuals among the species.

Identification of Rare, Endangered and Threatened plant species

Rare and endangered species were identified referring to the Red Data Book of India, following the IUCN Red list of plants and other available literature, flora and herbarium pertaining to the rare/endangered species of state of Uttarakhand.

Medicinal & Economic important Plants

An Ethno botanical survey is carried out to identify the wild plants used by the local peoples for different purposes.

3.4.6 Findings of the floral diversity in the study area

During the field study for proposed JSHE project, a total of 226 plant species belonging to 183 genera and 75 families were recorded. The results of the present study reveals that herbaceous group of plant contributed highest number of species with 99 species (43.81%) followed by shrubs with 42 species (18.58%), trees with 40 species(17.70 %), grasses with 30 species (13.27%) and climbers with 11 species (6.64%). The details of number of floral species recorded at various study sites are given in Table-3.38 and shown in Figure-3.12

Table-3.38: Vegetation composition in the study area during varios seasons

Plant habit	Number of Species	% of Species
Trees	40	17.70
Shrubs	42	18.58
Herbs	99	43.81
Grasses	30	13.27
Climber	15	6.64
Total	226	100%

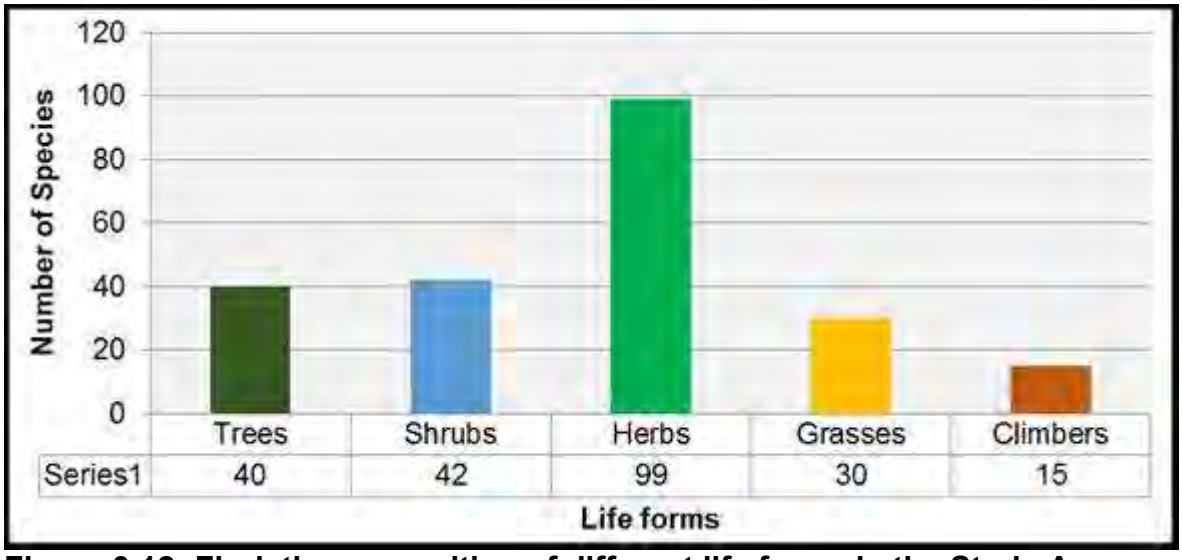


Figure-3.12: Floristic composition of different life forms in the Study Area

During floristic survey for JSHE project in winter season, a total of 136 plant species were recorded. Of these, 35 species are trees, 34 shrubs, 47 herbs, 12 grasses and 6 climbers. No epiphytic and parasites were recorded from the study area. In this season, species richness was found to be low as compared to other seasons it is because of prevailing extreme cold climatic condition. In pre monsoon season, a total of 157 plant species were recorded from the project area. Of these, 35 species are trees, 38 shrubs, 53 herbs, 20 grasses and 11 climbers. In monsoon season, a total of 209 plant species were recorded, which is the maximum number of plant diversity in the project area. It is due to fact that climatic conditions are favourable for plant growth in this particular season. Out of 209 plants, 40 species are trees, 42 shrubs, 86 herbs, 26 grasses, 15 climbers. The summary of number of floral species recorded during field studies in various seasons are given in Table-3.39 and shown in Figures-3.13.

Table-3.39 Number of plant species recorded in different seasons from the study area

Life form	Number of Species		
	Winter	Pre-Monsoon	Monsoon
Trees	35	35	40
Shrubs	34	38	42
Herbs	47	53	86
Grasses	12	20	26
Climbers	8	11	15
Total	136	157	209

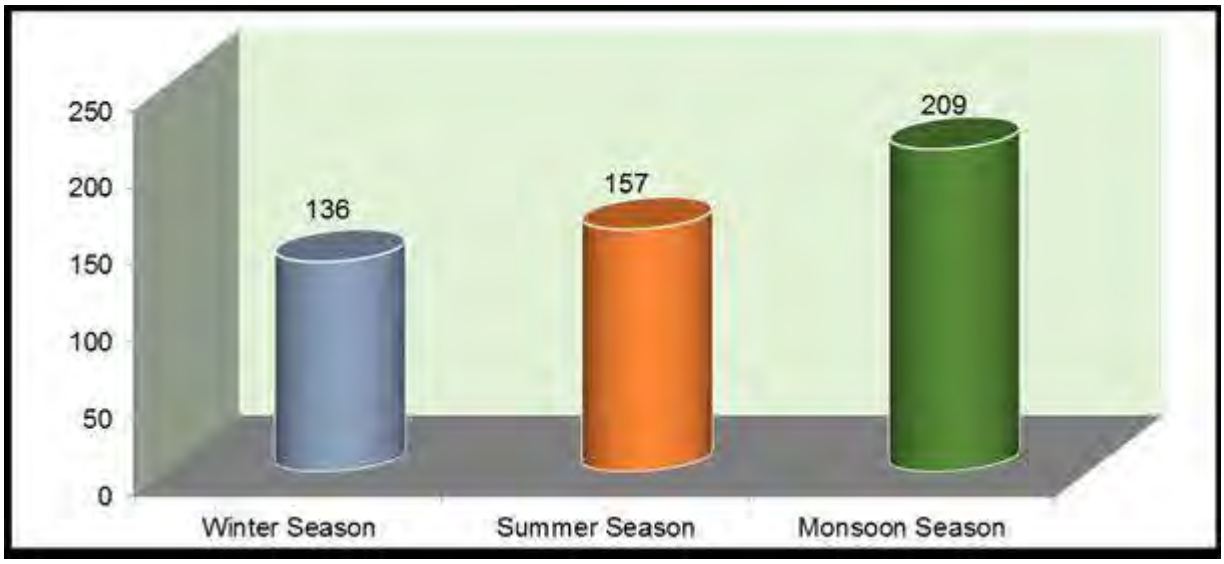


Figure-3.13: Floral diversity recorded in various seasons from the Study Area

The taxonomic group of species showed that angiosperm (monocot & dicot) was the dominant component of the flora in the study area with 220 species whereas

gymnosperm was represented by only 6 species (Refer Table-3.40). The composition of floristic elements of the study area consisted of 78.76% dicots, 18.58% monocots and 2.66% gymnosperm (Figure 3.14).

Table 3.40 Percentage composition of the floristic elements in the study area

Groups	Division	Family		Genera		Species	
		No.	%	No.	%	No.	%
Angiosperms	Dicots	66	88.00	145	79.24	178	78.76
	Monocots	7	9.33	33	18.03	42	18.58
Gymnosperms		2	2.67	5	2.73	6	2.66
Total		75		183		226	

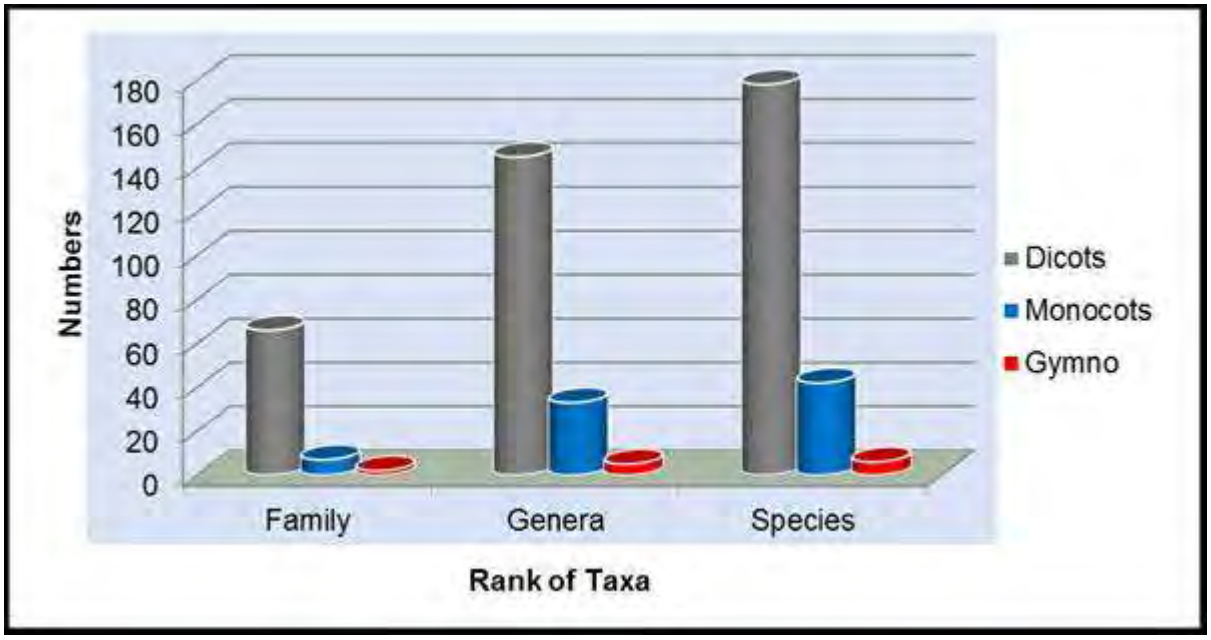


Figure-3.14: Taxa reported from the study site

The list of floral species observed at various sampling locations of project area in various seasons is given in Table 3.41

Table-3.41 List of floral species recorded from Jhakhol Sankari HE project area in various seasons

Botanical Name	Local Name	Family	Habit	Division
Abies pindrow Royley	Muronda/Fir	Pinaceae	Tree	Gymno.
Acer aecium	Marik/Mapple	Aceraceae	Tree	Dicot
Achyranthes aspera L.	Chirchita	Amaranthaceae	Herb	Dicot
Aconogonum molle (D. Don) Hara	-	Plantaginaceae	Herb	Dicot
Aerva sanguinolenta (L.) Blume	Safedfulia	Amaranthaceae	Shrub	Dicot
Aesculus indica (Colebr.ex Cambess.) Hook.	Kuner/Pangar	Hippocastanaceae	Tree	Dicot

Botanical Name	Local Name	Family	Habit	Division
Ajuga bracteosa Wallich ex Benth.	Kadwipatti	Lamiaceae	Herb	Dicot
Ajuga parviflora Benth.	Rathpathi	Lamiaceae	Herb	Dicot
Albizia odoratissimaDurazz.	Bhandir	Mimosaceae	Tree	Dicot
Alnus nepalensis D.Don	Kuinchh	Betulaceae	Tree	Dicot
Amaranthus spinosus L.	Kandyali cholai	Amaranthaceae	Herb	Dicot
Anaphalis busua (Buch.-Ham ex D.Don) DC.	-	Asteraceae	Herb	Dicot
Anaphalis contorta (D.Don) Hk. f.	Baglliya	Asteraceae	Herb	Dicot
Anemone obtusiloba D.Don	-	Ranunculaceae	Herb	Dicot
Angelica glauca Edgew	Chora	Apiaceae	Herb	Dicot
Anisomeles indica (L.) Kuntze	Gobara	Lamiaceae	Herb	Dicot
Anthemis cotula L.	Chigar weed	Asteraceae	Herb	Dicot
Apluda mutica L.	Tachula	Poaceae	Grass	Monocot
Arisaema concinnum Schott.	-	Araliaceae	Herb	Monocot
Arisaema sp	-	Araliace	Herb	Monocot
Artemisia nilagirica (Clarke) Pamp.	Chamra/Kunja	Asteraceae	Herb	Dicot
Arthraxon lancifolius (Trin.) Hochst	Kanguliya	Poaceae	Grass	Monocot
Arundinaria falcata L.	Ringal, Nirgal,	Poaceae	Grass	Monocot
Arundinella bengalensis (Sprengel) Druce	-	Poaceae	Grass	Monocot
Arundo donax L.	Fillu	Poaceae	Grass	Monocot
Asparagus adscendens Roxb.	Satawar	Liliaceae	Shrub	Monocot
Aster peduncularis Wall. ex Nees	Phyulari	Asteraceae	Herb	Dicot
Aster thomsonii Cl.	Phyulari	Asteraceae	Herb	Dicot
Barleria cristata L.	-	Acanthaceae	Herb	Dicot
Berberis aristata DC.	Kashmol	Berberidaceae	Shrub	Dicot
Berberis lycium Royle	Kashmol	Berberidaceae	Shrub	Dicot
Bergenia ciliata (Haw.) Sternberg	Pathar fodu	Saxifragaceae	Herb	Dicot
Betula alnoides Buch.-Ham. ex D. Don	Kathbhuj	Betulaceae	Tree	Dicot
Bidens biternata (laur.) merill & sherff	Kumra	Asteraceae	Herb	Dicot
Bidens pilosa L.	Kumra	Asteraceae	Herb	Dicot
Boehmeria macrophylla Hornem.	-	Urticaceae	Shrub	Dicot
Boerhavia diffusa L.	Punarva	Nyctaginaceae	Herb	Dicot
Bothriochloa pertusa (L.)	-	Poaceae	Grass	Monocot

Botanical Name	Local Name	Family	Habit	Division
A. Camus				
Brachiaria reptans (L.) Gard. & Hubb.	-	Poaceae	Grass	Monocot
Buddleja crispa Benth.	Nimbda	Buddlejaceae	Shrub	Dicot
Bunium persicum Bioss.	Kala zera	Apiaceae	Herb	Dicot
Buxus wallichiyana L.	Papri/Kanchhi	Buxaceae	Tree	Dicot
Calamagrostis pseudophragmites	-	Poaceae	Grass	Monocot
Caltha palustris L.	-	Ranunculaceae	Herb	Dicot
Cannabis sativa L.	Bang	Cannabaceae	Herb	Dicot
Capillipedium assimile (Steud.) A. Camus	-	Poaceae	Grass	Monocot
Capsella bursa-pastoris (L.) Medikus	Shephered purse	Brassicaceae	Herb	Dicot
Carex cruciata Wahlenberg	-	Cyperaceae	Herb	Monocot
Carex cruciata Wahlenberg	-	Cyperaceae	herb	Monocot
Carpesium abrotanoides L.	-	Asteraceae	Herb	Dicot
Cedrus deodara (Roxb. Ex Lam) G. Don	Deodar	Pinaceae	Tree	Gymno.
Celtis australis L.	Kharik	Ulmaceae	Tree	Dicot
Chenopodium album L.	Bathuwa	Chenopodiaceae	Herb	Dicot
Chrysopogon fulvus (Sprengel) Chiovenda	Goriyal	Poaceae	Grass	Monocot
Chrysopogon serrulatus Trin.	Golda	Poaceae	Grass	Monocot
Circium wallichii DC.	Kandaar	Asteraceae	Herb	Dicot
Cissampelos pareira L.	Parha	Menispermaceae	Climber	Dicot
Clematis grata Wallich	Karuwali	Ranunculaceae	Climber	Dicot
Clematis montana Buch. -Ham. ex DC.	Kagshi	Ranunculaceae	Climber	Dicot
Clinopodium umbrosum (M.Bieb.) C. Koch	Birchhi	Lamiaceae	Herb	Dicot
Commelina maculata Edgew.	Kunola	Commelianaceae	Herb	Monocot
Conyza japonica (Thunb.) Less. ex DC.	-	Asteraceae	Herb	Dicot
Coriaria nepalensis Wallich	Gingaaru	Coriariaceae	Shrub	Dicot
Corylus jacquemontii Decne	Kapasi/Bhotiya badam	Betulaceae	Tree	Dicot
Cotoneaster bacillaris Wallich	Reosh	Rosaceae	Shrub	Dicot
Cotoneaster microphyllus Edgew	-	Rosaceae	Shrub	Dicot
Cotoneaster obtusa	-	Rosaceae	Shrub	Dicot

Botanical Name	Local Name	Family	Habit	Division
Wall. ex Lindl.				
Cryptolepis buchananii Roemer & Schult.	-	Asclepiadaceae	Climber	Dicot
Cupressus lusitenia Mill.	Surai	Cupressaceae	Tree	Gymno.
Cyathula tomentosa (Roth) Moq.	-	Amaranthaceae	Shrub	Dicot
Cymbopogon martinii (Roxb.) Wats.	Parhu	Poaceae	Grass	Monocot
Cynodon dactylon (L.) Persoon	Doob	Poaceae	Grass	Monocot
Cynoglossum zeylanicum (Vahl ex Hornem)	-	Boraginaceae	Herb	Dicot
Daphne papyracea Wallich ex Steudel	Satpura	Thymelaeaceae	Shrub	Dicot
Debregeasia salicifolia (D.Don) Rendle	Sinyaru	Urticaceae	Shrub	Dicot
Deutzia staminea R. Br. ex Wallich	Bhatkukri	Hydrangeaceae	Shrub	Dicot
Digitaria stricta Roth. ex Roem. & Schult.	-	Poaceae	Grass	Monocot
Dioscorea belophylla (prain) J.O. Voigt ex Haines	-	Dioscoreaceae	Climber	Monocot
Dioscorea bulbifera L.	-	Dioscoreaceae	Climber	Monocot
Duchesnea indica (Andr.) Focke	Bumla	Rosaceae	Herb	Dicot
Eleusine indica (L.) Gaertner	Kodi	Poaceae	Grass	Monocot
Elsholtzia fruticosa (D.Don) Rehder	Banbangjira	Lamiaceae	Shrub	Dicot
Eragrostis nigra Nees ex Steud.	-	Poaceae	Grass	Monocot
Eragrostis tenella (L.) P.Beauv. ex Roem. & Schult.	-	Poaceae	Grass	Monocot
Erigeron karvinskianus DC.	-	Asteraceae	Herb	Dicot
Erigeron multicaulis Wall. ex DC.	-	Asteraceae	Herb	Dicot
Eriophorum comosum (Wallich) Wallich ex Nees	-	Cyperaceae	Herb	Monocot
Euphorbia hirta L.	Dudhi	Euphorbiaceae	Herb	Dicot
Euphorbia thymifolia L.	-	Euphorbiaceae	Herb	Dicot
Fagopyrum sp (D. Don) Hara	Faphriya	Polygonaceae	Herb	Dicot
Festuca gigantea (L.)	-	Poaceae	Grass	Monocot

Botanical Name	Local Name	Family	Habit	Division
Vill.				
Ficus palmata Forsk.	Fedu	Moraceae	Tree	Dicot
Ficus semicordata Buch.-Ham. ex J.E. Smith	Khanu	Moraceae	Shrub	Dicot
Fragaria vesca L,	Bhumla	Rosaceae	Herb	Dicot
Fraxinus xanthoxyloides (Wall. Ex G. Don) DC.	Ash tree	Oleaceae	Tree	Dicot
Galinsoga parviflora Cav.	Deshbon	Asteraceae	Herb	Dicot
Geranium nepalense Sweet	Sinyuli	Geraniaceae	Herb	Dicot
Gerbera gossypina Royle	Kapees	Asteraceae	Herb	Dicot
Girardinia diversifolia (Link) friis	Chharkalla	Urticaceae	Shrub	Dicot
Gloriosa superba L.	-	Liliaceae	Herb	Monocot
Gnaphalium luteo-album L.	-	Asteraceae	Herb	Dicot
Hedera nepalensis K. Koch	Mithiyari	Araliaceae	Climber	Dicot
Hedychium spicatum Buch.-Ham.	Van haldi	Zinziberaceae	Herb	Dicot
Heliotropium strigosum willd.	Safed bhangra	Boraginaceae	Herb	Dicot
Heteropogon contortus (L.) P. Beauv	Kumriya gaas	Poaceae	Grass	Monocot
Hypericum oblongifolium Choisy	-	Hypericaceae	Shrub	Dicot
Impatiens scabrida DC.	Tillua	Balsaminaceae	Herb	Dicot
Impatiens sp.	-	Balsaminaceae	Herb	Dicot
Imperata cylindrica (L.) P.Beauv.	Dapsha	Poaceae	Grass	Monocot
Indigofera heterantha Wall. ex. Brandis	-	Fabaceae	Shrub	Dicot
Inula cappa (Buch.-Ham.ex D.Don)	Bhatta/Athhula	Asteraceae	Shrub	Dicot
Inula cuspidata (DC.) C.B. Clarke	-	Asteraceae	Shrub	Dicot
Ipomoea pes-tigridis L.	-	Convolvulaceae	Climber	Dicot
Ipomoea purpurea (L.) Roth.	-	Convolvulaceae	Climber	Dicot
Juglans regia L.	Akhrot	Juglandaceae	Tree	Dicot
Kyllinga nemoralis (J.R. & G. Foster) Dandy	-	Cyperaceae	Herb	Monocot
Lecanthus wallichii Wedd.	-	Urticaceae	Herb	Dicot
Leea asiatica (L.)	-	Leeaceae	Shrub	Dicot

Botanical Name	Local Name	Family	Habit	Division
Ridsdale				
Lepidium virginicum L.	Bandarmirch	Brassicaceae	Herb	Dicot
Leptodermis lanceolata Wallich	Padera	Rubiaceae	Shrub	Dicot
Litsea elongata (Nees) Gamble	Nareekh	Lauraceae	Tree	Dicot
Lyonia ovalifolia (Wallich.) Drude	Anyar	Ericaceae	Tree	Dicot
Mallotus philippensis (Lam.) Muell.-Arg.	Rohini	Euphorbiaceae	Tree	Dicot
Mazus surculosus D.Don	Mastyar	Scrophulariaceae	Herb	Dicot
Mentha longifolia L.	Jnglipodina	Lamiaceae	Herb	Dicot
Micromeria biflora (Buch.-Ham. ex D.Don) Benth	-	Lamiaceae	Herb	Dicot
Miscanthus nepalensis	-	Poaceae	Grass	Monocot
Morus serrata Roxb.	Kimu	Moraceae	Tree	Dicot
Mucuna pruriens (L.) DC.	Jagul	Fabaceae	Climber	Dicot
Myrica esculenta Buch.-Ham.ex D.Don	Kafal	Myricaceae	Tree	Dicot
Nepata elliptica Royle ex Benth.	Upraya ghas	Lamiaceae	Herb	Dicot
Oplismenus burmannii (Retz.) P. Beauv.	-	Poaceae	Grass	Monocot
Oplismenus compositus (L.) P. Beauv.	-	Poaceae	Grass	Monocot
Origanum vulgare L	Banbakari/godila	Lamiaceae	Herb	Dicot
Ougeinia oojeinensis (Roxb.) Hochreutiner	Chhanen	Fabaceae	Tree	Dicot
Oxalis corniculata L.	Almori	Oxalidaceae	Herb	Dicot
Parthenocissus semicordata (Wall.) Planchon	Kandar	Vitaceae	Climber	Dicot
Phlomis bracteosa Royle ex Benth.	-	Lamiaceae	Herb	Dicot
Picea smitheana	Rayi/Spruce	Pinaceae	Tree	Gymno.
Pilea sriptaWedd.	Chauli	Urticaceae	Herb	Dicot
Pinus roxburghii Sargent	Chir/salli	Pinaceae	Tree	Gymno.
Pinus wallichiana A.B. Jackson	Kail	Pinaceae	Tree	Gymno.
Pistacia khinjuk Stocks	Kakad	Anacardiaceae	Tree	Dicot
Plantago depressa Willd.	-	Plantaginaceae	Herb	Dicot
Plantago major L.	Karecha	Plantaginaceae	Herb	Dicot
Plectranthus mollis (Ait.) Sprengel	-	Lamiaceae	Herb	Dicot
Plumbago zeylanica L.	Chitrak	Plumbaginaceae	Shrub	Dicot
Poa annua L.	-	Poaceae	Grass	Monocot

Botanical Name	Local Name	Family	Habit	Division
Poa supina Schrad.	-	Poaceae	Grass	Monocot
Polygala persicariifolia DC.	-	Polygalaceae	Herb	Dicot
Polygonum barbatum L.	-	Polygonaceae	Herb	Dicot
Polygonum capitatum Buch. Ham. ex D.Don	-	Polygonaceae	Herb	Dicot
Populas ciliata	Himalayan Poplor	Salicaseae	Tree	Dicot
Porana racemosa Roxb.	-	Convolvulaceae	Climber	Dicot
Pottentila sp	-	Rosaceae	Herb	Dicot
Primula denticulata Smith	-	Primulaceae	Herb	Dicot
Prinsepia utilis Royle	Baikhal	Rosaceae	Shrub	Dicot
Prunella vulgaris L.	-	Lamiaceae	Herb	Dicot
Prunus armeniaca L.	Chullu	Rosaceae	Tree	Dicot
Prunus cerasoides D.Don	Phaja/Padam	Rosaceae	Tree	Dicot
Prunus padus L.	-	Rosaceae	Tree	Dicot
Pyracantha crenulata (D.Don) M. Roemer	Ghigaru	Rosaceae	Shrub	Dicot
Pyrus pashia Buch.-Ham ex D.Don	Molu	Rosaceae	Tree	Dicot
Quercus floribunda Lindley ex Rehder	Moru	Fagaceae	Tree	Dicot
Quercus glauca Thunb.	Inni	Fagaceae	Tree	Dicot
Quercus leucotrichophora A.Camus	Bhanj	Fagaceae	Tree	Dicot
Rabdosia coetsa (Buch.-Ham. ex D.Don)	-	Lamiaceae	Shrub	Dicot
Rabdosia rugosa (Wallich ex Benth.)	Kurkha	Lamiaceae	Shrub	Dicot
Ranunculus laetus Wallich ex D.Don	-	Ranunculaceae	Herb	Dicot
Ranunculus scleratus L.	-	Ranunculaceae	Herb	Dicot
Reinwardtia indica Dumortier	phinyuli	Linaceae	Herb	Dicot
Rhamnus virgatus	-	Rhamnaceae	Shrub	Dicot
Rhododendron arboreum Smith	Buransh	Ericaceae	Tree	Dicot
Rhus cotinus	Tung	Anacardiaceae	Tree	Dicot
Rhus punjabensis J.L. Stewart	Titrai	Anacardiaceae	Tree	Dicot
Rhus wallichii Hook. f.	Akhorie	Anacardiaceae	Tree	Dicot
Rosa brunonii Lindley	Kujain	Rosaceae	Shrub	Dicot
Rosa macrophylla Lindley	Bhaunra	Rosaceae	Shrub	Dicot
Rubus ellipticus Smith	Hinsar	Rosaceae	Shrub	Dicot

Botanical Name	Local Name	Family	Habit	Division
Rubus foliolosus D.Don	Titrad	Rosaceae	Shrub	Dicot
Rubus macilentus Cambess.	Titrad	Rosaceae	Shrub	Dicot
Rubus paniculatus Smith	Hissar/Kantula	Rosaceae	Climber	Dicot
Rumex hastatus D.Don	-	Polygonaceae	Herb	Dicot
Rumex nepalensis Sprengel	Khracha	Polygonaceae	Herb	Dicot
Saccharum filifolium (Nees) A. Camus	Samghas	Poaceae	Grass	Monocot
Saccharum rufipilum Steud.	kansh/Shina	Poaceae	Grass	Monocot
Salix denticulata Anders.	Bogicha	Salicaceae	Shrub	Dicot
Salvia hians Royle ex Benth	-	Lamiaceae	Herb	Dicot
Sarcococca saligna (D.Don) Muell.-Arg.	-	Buxaceae	Shrub	Dicot
Scutellaria repens Buch.- Ham. ex D. Don.	Kashu	Lamiaceae	Herb	Dicot
Setaria glauca (L.) P. Beauv.	-	Poaceae	Grass	Monocot
Setaria verticillata (L.) P. Beauv.	-	Poaceae	Herb	Monocot
Sida cordata (Burm. F.) Borss. Waalk.	Kharenti	Malvaceae	Herb	Dicot
Sida cordifolia (Burm. F.) Borss. Waalk.	Delachi	Malvaceae	Herb	Dicot
Sida rhombifolia L.	Bhiunli	Malvaceae	Herb	Dicot
Siegesbeckia orientalis L.	Choped	Asteraceae	Herb	Dicot
Silene edgeworthi L.	Bakrolye	Caryophyllaceae	Herb	Dicot
Smilax glaucophylla Klotz.	Kukardara	Smilacaceae	Climber	Monocot
Sonchus oleraceus L.	-	Asteraceae	Herb	Dicot
Sorbaria tomentosa (Lindley) Rehder	Bhiloka	Rosaceae	Shrub	Dicot
Sorbus cuspidata (Spach.) Hedlund	Mauli	Rosaceae	Tree	Dicot
Spermadictyon sauveolens Roxb.	Padaru	Rubiaceae	Shrub	Dicot
Spiraea canescens D.Don	-	Rosaceae	Shrub	Dicot
Srobilanthes wallichi(Roth) Moq.	-	Acanthaceae	Herb	Dicot
Stellaria media (L.) Villars	Badiyara	Caryophyllaceae	Herb	Dicot
Stellaria monosperma D.Don	-	Caryophyllaceae	Herb	Dicot
Strobilanthes	-	Acanthaceae	Herb	Dicot

Botanical Name	Local Name	Family	Habit	Division
atropurpureus Nees				
Swertia alata (Royley ex D.Don) C.B.Clarke	-	Gentianaceae	Herb	Dicot
Tagetes minuta L.	Janglishuruj	Asteraceae	Herb	Dicot
Tanacetum longifolium Wall ex DC.	-	Asteraceae	Herb	Dicot
Taraxacum officinale Weber	Dhudiwa	Asteraceae	Herb	Dicot
Thalictrum foliolosum DC.	Mamri	Ranunculaceae	Herb	Dicot
Themada caudata (Nees) A. Camus	Ulakumeriya	Poaceae	Grass	Monocot
Toona serrata (Royley) M. Roem.	Darli	Meliaceae	Tree	Dicot
Trifolium repens L.	-	Fabaceae	Herb	Dicot
Trigonella emodi Benth.	-	Fabaceae	Herb	Dicot
Ulmus wallichiana Planch.	Himari	Ulmaceae	Tree	Dicot
Urena lobata L.	Buchita	Malvaceae	Shrub	Dicot
Urtica ardens Link.	Kandali	Urticaceae	Herb	Dicot
Valeriana jatamansi Jones.	Nihani	Valerianaceae	Herb	Dicot
Verbena bonariensis L.	Vanfsa	Verbenaceae	Herb	Dicot
Viburnum cotinifolium D .Don	Guinya	Caprifoliaceae	Shrub	Dicot
Viola canescens Wallich	Banatsha	Violaceae	Herb	Dicot
Vitis jacquemontii Parker	Shimonia	Vitaceae	Climber	Dicot
Woodfordia fruticosa (L.) Kurz.	Dhayi	Lythraceae	Shrub	Dicot
Zanthoxylum armatum DC.	Timru	Rutaceae	Tree	Dicot

The most dominant family of the study area as per number of genera and species was Poaceae with 30 species belonging to 24 genera. The co-dominant families were Asteraceae with 23 species and 18genera, Rosaceae with 21 species and 13 genera, Lamiaceae with 16 species and 14 genera and Ranunculaceae with 7 species and 5 genera (Figure 3.15).

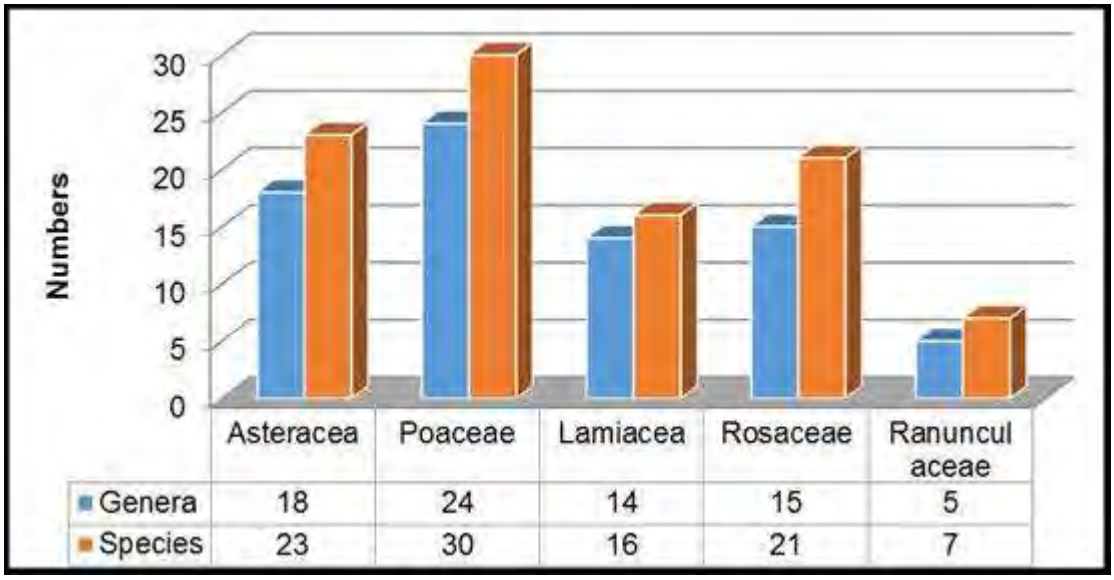


Figure 3.15: Most dominant families of the study site

3.4.7 Community characteristics at different sampling sites during various seasons

In order to understand the community structure, vegetation sampling was carried out at different locations in the project area during various seasons.

I. S-I, Catchment Area

a) Tree and shrub community

In tree community layer, a total of 13 tree species were recorded from the catchment area of proposed project during field study. The average density for this group of species was recorded to be 360 individuals /ha. The highest value of IVI (54.15) as well as density (50 individuals/ha) was recorded for Abies pindrow which was the dominant species at this site followed by Cedrus deodara (IVI, 29.25) and Lyonia ovalifolia (IVI,27.38). Frequency value ranged from 10% to 35%.

In shrub community layer, a total of 12 shrub species were recorded from the catchment area. The average density of this group of species was recorded to be 975 individuals/ ha. The highest value of IVI (48.14) as well as density (160 individuals/ha) was recorded for Viburnum cotinifolium which was dominant species of the site. Rubus macilentus (IVI, 34.27) and Cotoneaster bacillaris (IVI, 34.03) were found to be co-dominant species of this community. Frequency value ranged from 15% to 50%. The frequency, density, abundance and importance value index (IVI) of the trees and shrubs at site-I have been presented in Table-3.42.

Table-3.42 Distribution analysis for tree and shrub community at site-I

Plant species	Frequency %	Density (ha-1)	Abundance	IVI
Trees				
Abies pindrow Royley	35	50	1.43	54.15
Aesculus indica (Colebr.ex Cambess.) Hook.	10	15	1.50	17.06
Alnus nepalensis D.Don	20	30	1.50	21.87
Betula alnoides Buch.-Ham. ex D. Don	20	35	1.75	20.31
Cedrus deodara (Roxb. Ex Lam) G. Don	15	25	1.67	29.25
Fraxinus xanthoxyloides (Wall. Ex G. Don) DC.	15	15	1.00	11.30
Juglans regia L.	20	20	1.00	20.62
Litsea elongata (Nees) Gamble	25	30	1.20	22.99
Lyonia ovalifolia (Wallich.) Drude	25	35	1.40	27.38
Rhododendron arboreum Smith	15	30	2.00	18.48
Ulmus wallichiana Planch.	10	20	2.00	17.55
Salix sp	20	25	1.25	16.17
Acer aecium	15	30	2.00	22.88
Total		**360**		**300**
Shrubs				
Cotoneaster bacillaris Wallich	30	110	3.67	34.03
Daphne papyracea Wallich ex Steudel	40	55	1.38	19.96
Indigofera heterantha Wall. ex. Brandis	30	30	1.00	16.00
Prinsepia utilis Royle	20	35	1.75	10.33
Rubus macilentus Cambess.	35	145	4.14	34.27
Salix sp	40	75	1.88	26.41
Sarcococca saligna (D.Don) Muell.-Arg.	50	130	2.60	32.43
Viburnum cotinifolium D .Don	45	160	3.56	48.14
Berberis aristata DC.	35	70	2.00	28.79
Cotoneaster microphyllus Edgew	20	40	2.00	13.37
Elsholtzia fruticosa (D.Don) Rehder	15	25	1.67	8.51
Spiraea canescens D.Don	50	100	2.00	27.76
Total		**975**		**300**

b) Herbaceous Community

In herb community, a total of 21 species were recorded with an average density of 17.74 individuals /m2 during winter season. Calamagrostis pseudophragmites was found to be dominant species having maximum value of IVI (35.60) and density (2.78 individuals/m2). It was followed by Poa supina (IVI, 35.81) and P. annua (IVI, 25.79). Frequency value ranged from 4% to 36%.

In Pre monsoon season, a total of 22 herbaceous species were recorded with an average density of 33.60 individuals /m2 during the field study. In terms of IVI (31.71), Poa annua was found to be dominant herb species followed by Saccharum

filifolium (IVI, 29.37) and Rumex nepalensis (IVI, 26.49). Frequency value ranged from 8% to 52%.

In monsoon season, a total of 30 herbaceous species were recorded with an average density of 23.62 individuals /m2. The maximum value of IVI (33.68) was recorded for Rumex nepalensis which was dominant species at this site. It was followed by Calamagrostis pseudophragmites, Poa supina and Miscanthus nepalensis. The highest value of density (5.60individuals/m2) was recorded for Calamagrostis pseudophragmites. Frequency value ranged from 8% to 56%. The frequency, density, abundance and importance value index (IVI) for herbaceous layer at site-I is given in Table-3.43.

Table-3.43: Distribution analysis for herbaceous community at site-I during various seasons

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Winter Season				
Pteridium aquilinum	12	0.16	1.33	5.81
Taraxacum officinale Weber	16	0.52	3.25	11.27
Calamagrostis pseudophragmites	28	2.78	9.29	35.60
Eragrostis pilosa	24	1.36	5.67	21.15
Plantago major L.	8	0.08	1.00	3.86
Valeriana jatamansi Jones.	8	0.12	1.50	4.69
Poa supina Schrad.	32	1.80	5.63	25.81
Aconogonum molle (D. Don) Hara	12	0.16	1.33	5.81
Circium wallichii DC.	8	0.12	1.50	4.69
Fragaria vesca L,	20	0.92	4.60	16.27
Rumex nepalensis Sprengel	16	0.60	3.75	12.32
Dryopteris cochleata	8	0.08	1.00	3.86
Capillipedium assimile (Steud.) A. Camus	20	1.36	6.80	21.42
Miscanthus nepalensis	16	1.32	8.25	16.76
Setaria glauca (L.) P. Beauv.	20	1.28	6.40	20.48
Polystichum sp	4	0.08	2.00	3.96
Chrysopogon serrulatus Trin.	20	0.96	4.80	16.73
Poa annua L.	36	1.76	4.89	25.79
Saccharum rufipilum Steud.	24	1.28	5.33	20.30
Anaphalis contorta (D.Don) Hk. f.	24	0.92	3.83	16.44
Athyrium nigripes	8	0.08	1.00	3.86
Total		**17.74**		**300**
Pre monsoon Season				
Poa annua L.	52	4.88	9.38	31.71
Rumex nepalensis Sprengel	40	3.80	9.50	26.49
Athyrium sp	20	0.24	1.20	5.26
Festuca gigantea (L.) Vill.	24	2.72	11.33	22.02
Saccharum filifolium (Nees) A.	32	4.20	13.13	29.37

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Camus				
Anaphalis busua (Buch.- Ham ex D.Don) DC.	24	1.04	4.33	11.03
Angelica glauca Edgew	16	0.20	1.25	4.48
Carex cruciata Wahlenberg	24	1.52	6.33	14.17
Duchesnea indica (Andr.) Focke	36	0.76	2.11	10.41
Fagopyrum sp (D. Don) Hara	32	2.48	7.75	19.65
Geranium nepalense Sweet	20	0.32	1.60	5.84
Impatiens sp.	32	0.68	2.13	9.48
Ajuga bracteosa Wallich ex Benth.	12	0.20	1.67	4.13
Origanum vulgare L	28	1.28	4.57	12.65
Chrysopogon serrulatus Trin.	24	3.40	14.17	26.47
Aconogonum molle (D. Don) Hara	8	0.16	2.00	3.60
Capsella bursa-pastoris (L.) Medikus	20	0.68	3.40	8.46
Cynoglossum zeylanicum (Vahl ex Hornem)	24	0.48	2.00	7.37
Fragaria vesca L,	40	1.28	3.20	13.59
Taraxacum officinale Weber	28	0.92	3.29	10.48
Thalictrum foliolosum DC.	12	0.20	1.67	4.13
Arundinella bengalensis (Sprengel) Druce	20	2.16	10.80	19.20
Total		**33.6**		**300**
Monsoon Season				
Viola canescens Wallich	12	0.16	1.33	5.07
Fagopyrum sp (D. Don) Hara	16	0.52	3.25	10.32
Phlomis bracteosa Royle ex Benth.	12	0.24	2.00	6.33
Poa supina Schrad.	56	3.24	4.00	30.10
Ajuga bracteosa Wallich ex Benth.	8	0.16	2.00	4.99
Anaphalis contorta (D.Don) Hk. f.	12	0.20	1.67	5.70
Calamagrostis pseudophragmites	28	5.60	9.29	32.42
Cannabis sativa L.	24	1.40	5.83	20.33
Circium wallichii DC.	12	0.20	1.67	5.70
Anemone obtusiloba D.Don	16	0.16	1.00	5.54
Bunium persicum Bioss.	8	0.08	1.00	3.35
Capsella bursa-pastoris (L.) Medikus	16	1.48	3.00	9.79
Cynoglossum zeylanicum (Vahl ex Hornem)	12	0.12	1.00	4.45
Gerbera gossypina Royle	8	0.20	2.50	5.81
Miscanthus nepalensis	32	2.72	5.38	23.43
Origanum vulgare L	12	0.20	1.67	5.70
Primula denticulata Smith	8	0.16	2.00	4.99
Tanacetum longifolium Wall ex DC.	8	0.12	1.50	4.17
Onychium contiguum	16	0.28	1.75	7.14
Aster thomsonii Cl.	20	1.44	2.20	9.48
Impatiens sp.	12	0.16	1.33	5.07
Poa annua L.	24	0.60	2.50	11.64

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Rumex nepalensis Sprengel	16	2.28	14.25	33.68
Pteridium aquilinum	8	0.16	2.00	4.99
Dryopteris cochleata	12	0.12	1.00	4.45
Fragaria vesca L,	20	1.88	4.40	14.68
Geranium nepalense Sweet	8	0.12	1.50	4.17
Taraxacum officinale Weber	20	0.44	2.20	9.48
Valeriana jatamansi Jones.	4	0.08	2.00	3.66
Pteris cretica	8	0.08	1.00	3.35
Total		**23.62**		**300**

II. S-II, Upstream (u/s) area of Barrage axis

a) Tree and shrub community

In tree community laye, a total of 12 species were recorded with an average density of 285 individuals/ ha. In terms of IVI, the dominant tree species was Aesculus indica (IVI, 45.25) followed by Litsea elongata (IVI, 41.32) and Alnus nepalensis, (IVI, 33.70). Maximum density (50 ind/h) was recorded for Litsea elongata. Frequency value ranged from 10% to 35%.

In shrub community layer, a total of 13 species were recorded at the upstream site of proposed project during field study. The average density of this group of species was recorded to be 1075 individuals/ ha. In terms of IVI (57.27), Sarcococca saligna was found to be dominant shrub species followed by Sorbaria tomentosa (IVI, 41.67) and Debregeasia salicifolia (IVI, 37.28). The maximum frequency was observed for Sarcococca saligna and Sorbaria tomentosa each with 45% frequency. The frequency, density, abundance and importance value index (IVI) of trees and shrubs at site-II have been presented in Table-3.44.

Table-3.44 Distribution analysis for tree and shrub community at site-II

Plant species	Frequency %	Density (ha-1)	Abundance	IVI
Trees				
Pinus wallichiana A.B. Jackson	10	15	1.50	26.34
Aesculus indica (Colebr.ex Cambess.) Hook.	20	25	1.25	45.25
Rhus wallichii Hook. f.	15	20	1.33	16.38
Sorbus cuspidata (Spach.) Hedlund	20	15	0.75	16.45
Alnus nepalensis D.Don	20	30	1.50	33.70
Litsea elongata (Nees) Gamble	35	50	1.43	41.32
Rhododendron arboreum Smith	15	25	1.67	20.36
Cupressus lusitenia Mill.	15	15	1.00	17.55

Plant species	Frequency %	Density (ha-1)	Abundance	IVI
Betula alnoides Buch.-Ham. ex D. Don	20	20	1.00	18.21
Juglans regia L.	10	15	1.50	20.35
Lyonia ovalifolia (Wallich.) Drude	20	40	2.00	30.23
Acer aecium	10	15	1.50	13.86
Total		**285**		**300**
Shrubs				
Sarcococca saligna (D.Don) Muell.-Arg.	45	295	6.56	57.27
Indigofera heterantha Wall. ex. Brandis	30	75	2.50	21.46
Salix sp	25	65	2.60	17.87
Berberis aristata DC.	30	60	2.00	22.84
Boehmeria macrophylla Hornem.	25	50	2.00	13.70
Sorbaria tomentosa (Lindley) Rehder	45	115	2.56	37.28
Spiraea canescens D.Don	30	80	2.67	22.36
Cyathula tomentosa (Roth) Moq.	15	25	1.67	7.65
Daphne papyracea Wallich ex Steudel	25	60	2.40	18.83
Debregeasia salicifolia (D.Don) Rendle	40	130	3.25	41.67
Cotoneaster bacillaris Wallich	25	40	1.60	15.43
Prinsepia utilis Royle	20	45	2.25	11.67
Cotoneaster obtusa Wall. ex Lindl.	25	35	1.40	11.97
Total		**1075**		**300**

b) Herbaceous community

The vegetation of herbs on this site during winter season is characterized by the occurrence of 18 species. The average density for this group of species was recorded to be 15.12 individuals /m2. In terms of density (2.78 individuals/m2) and IVI (34.50), Setaria glauca was found to be dominant species. It was followed by Saccharum rufipilum (IVI, 31.21) and Heteropogon contortus (IVI, 29.59). Frequency value ranged from 8% to 32%.

In Pre monsoon season, a total of 25 species were recorded with an average density of 32.52 individuals /m2. In terms of importance value index (IVI), Artemisia nilagirica (IVI, 24.65) was the dominant herbaceous species followed by Saccharum filifolium (IVI, 22.03) and Fagopyrum sp (IVI, 19.95). Frequency value ranged from 12% to 36%.

In monsoon season, a total of 29 herbaceous species were recorded with an average density of 34.96 individuals /m2. The maximum value of IVI (47.56) was recorded for Calamagrostis pseudophragmites which was found to be dominant species at this site. The other associate species were Miscanthus nepalensis, Poa annua and Rumex nepalensis. Frequency value ranged from 8% to 60%. The frequency,

density, abundance and importance value index (IVI) of herbaceous layer at site-II is given in Table-3.45.

Table-3.45 Distribution analysis for herbaceous community at site-II during various seasons

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Winter Season				
Circium wallichii DC.	12	0.24	2.00	8.02
Poa annua L.	24	1.36	5.67	24.39
Anaphalis contorta (D.Don) Hk. f.	16	0.24	1.50	8.40
Chrysopogon fulvus (Sprengel) Chiovenda	12	0.28	2.33	8.79
Taraxacum officinale Weber	20	0.48	2.40	12.49
Poa supina Schrad.	32	1.72	5.38	28.60
Fragaria vesca L,	12	0.28	2.33	8.79
Miscanthus nepalensis	24	1.36	5.67	24.39
Saccharum rufipilum Steud.	20	1.80	9.00	31.21
Cynodon dactylon (L.) Persoon	32	0.60	1.88	15.90
Plantago major L.	8	0.08	1.00	4.32
Polystichum sp	12	0.16	1.33	6.49
Pteridium aquilinum	12	0.12	1.00	5.72
Calamagrostis pseudophragmites	24	1.28	5.33	23.36
Rumex nepalensis Sprengel	20	0.96	4.80	19.30
Heteropogon contortus (L.) P. Beauv	28	1.80	6.43	29.59
Valeriana jatamansi Jones.	12	0.12	1.00	5.72
Setaria glauca (L.) P. Beauv.	32	2.24	7.00	34.50
Total		**15.12**		**300**
Pre monsoon Season				
Geranium nepalense Sweet	24	0.84	3.50	9.46
Impatiens sp.	36	1.84	5.11	15.86
Lepidium virginicum L.	28	0.80	2.86	9.55
Saccharum rufipilum Steud.	32	2.24	7.00	17.82
Ajuga bracteosa Wallich ex Benth.	12	0.20	1.67	3.99
Arisaema concinnum Schott.	16	0.24	1.50	4.69
Saccharum filifolium (Nees) A. Camus	28	2.96	10.57	22.03
Cynoglossum zeylanicum (Vahl ex Hornem)	20	0.32	1.60	5.72
Arundo donax L.	24	0.84	3.50	9.46
Rumex nepalensis Sprengel	20	1.40	7.00	13.12
Origanum vulgare L	28	1.40	5.00	13.02
Circium wallichii DC.	12	0.16	1.33	3.61
Adiantum capillus- veneris	20	1.04	5.20	10.65
Poa annua L.	32	1.72	5.38	14.99
Anaphalis busua (Buch.- Ham ex D.Don) DC.	20	0.60	3.00	7.64
Fagopyrum sp (D. Don) Hara	28	2.60	9.29	19.95
Heteropogon contortus (L.) P. Beauv	24	1.40	5.83	12.94
Capsella bursa-pastoris (L.) Medikus	20	0.92	4.60	9.83

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Taraxacum officinale Weber	16	0.48	3.00	6.56
Arthraxon lancifolius (Trin.) Hochst	24	2.48	10.33	19.67
Cymbopogon martinii (Roxb.) Wats.	28	2.32	8.29	18.33
Pilea sriptaWedd.	20	1.20	6.00	11.75
Angelica glauca Edgew	12	0.24	2.00	4.36
Fragaria vesca L,	20	1.00	5.00	10.38
Artemisia nilagirica (Clarke) Pamp.	24	3.28	13.67	24.65
Total		**32.52**		**300**
Monsoon Season				
Miscanthus nepalensis	32	6.32	19.75	43.36
Poa annua L.	60	4.48	7.47	31.40
Bidens biternata (laur.) merill & sherff	12	0.16	1.33	3.76
Fagopyrum sp (D. Don) Hara	36	0.96	2.67	11.66
Taraxacum officinale Weber	32	1.92	2.88	11.03
Rumex nepalensis Sprengel	24	1.28	5.33	12.98
Aconogonum molle (D. Don) Hara	16	0.20	1.25	4.51
Polystichum sp	8	0.12	1.50	3.09
Phlomis bracteosa Royle ex Benth.	20	0.44	2.20	6.81
Origanum vulgare L	24	1.00	4.17	11.04
Geranium nepalense Sweet	12	0.16	1.33	3.76
Pteris cretica	16	0.20	1.25	4.51
Athyrium nigripes	12	0.12	1.00	3.34
Polygala persicariifolia DC.	8	0.16	2.00	3.66
Cannabis sativa L.	20	2.00	5.00	11.09
Pteridium aquilinum	16	0.60	3.75	8.01
Setaria glauca (L.) P. Beauv.	20	0.96	4.80	10.78
Capillipedium assimile (Steud.) A. Camus	16	0.88	5.50	10.45
Clinopodium umbrosum (M.Bieb.) C. Koch	20	0.52	2.60	7.42
Gerbera gossypina Royle	12	0.12	1.00	3.34
Primula denticulata Smith	16	0.16	1.00	4.16
Anisomeles indica (L.) Kuntze	8	0.12	1.50	3.09
Anthemis cotula L.	8	0.08	1.00	2.52
Anaphalis contorta (D.Don) Hk. f.	28	1.56	2.00	8.40
Impatiens sp.	12	0.20	1.67	4.19
Saccharum filifolium (Nees) A. Camus	16	1.88	5.50	10.45
Galinsoga parviflora Cav.	16	0.64	4.00	8.35
Calamagrostis pseudophragmites	40	7.48	18.70	47.56
Circium wallichii DC.	20	0.24	1.20	5.28
Total		**34.96**		**300**

III. S-III, Barrage Axis Site

a) Tree and shrub community

In tree community layer, a total of 9 species were recorded at Barrage site of proposed project during the field study. The average density of this group of species was recorded to be 210 individuals/ ha. A perusal of the data on the ecological analysis revealed that the highest value of IVI (91.99) was recorded for Buxus wallichiana which was dominant species at this site followed by Litsea elongata (IVI, 40.09) and Alnus nepalensis (IVI, 38.65). Frequency value ranged from 5% to 40% of the site.

In shrub community layer, a total of 9 species were recorded during quadrat study. The average density of this group of species was recorded to be 740 individuals/ ha. In terms of IVI (76.83) as well as density (175 individuals/ ha), Debregeasia salicifolia was recorded to be the dominant shrub species at this sampling site. Sarcococca saligna, Spiraea canescens, and Alnus nepalensis (Sapling) were the co-dominant species at this site. Frequency value ranged from 20% to 50%. The frequency, density, abundance and importance value index (IVI) of the trees and shrubs at site-III have been presented in Table-3.46.

Table-3.46 Distribution analysis for tree and shrub community at site-III

Plant species	Frequency %	Density (ha-1)	Abundance	IVI
Trees				
Rhus wallichii Hook. f.	10	10	1.00	12.99
Toona serrata (Royley) M. Roem.	5	10	2.00	9.67
Betula alnoides Buch.-Ham. ex D. Don	10	15	1.50	21.57
Ulmus wallichiana Planch.	10	10	1.00	23.31
Alnus nepalensis D.Don	20	25	1.25	38.65
Litsea elongata (Nees) Gamble	25	30	1.20	40.09
Aesculus indica (Colebr.ex Cambess.) Hook.	10	15	1.50	35.15
Lyonia ovalifolia (Wallich.) Drude	15	20	1.33	26.58
Buxus wallichiana L.	40	75	1.88	91.99
Total		**210**		**300**
Shrubs				
Spiraea canescens D.Don	30	90	3.00	32.85
Debregeasia salicifolia (D.Don) Rendle	50	175	3.50	76.83
Alnus nepalensis (Sapling)	30	110	3.67	32.43
Rubus foliolosus D.Don	20	25	1.25	15.20
Sorbaria tomentosa (Lindley) Rehder	20	30	1.50	16.81
Indigofera heterantha Wall. ex. Brandis	30	65	2.17	28.21

Plant species	Frequency %	Density (ha-1)	Abundance	IVI
Coriaria nepalensis Wallich	25	50	2.00	21.79
Berberis lycium Royle	30	50	1.67	29.93
Sarcococca saligna (D.Don) Muell.-Arg.	45	145	3.22	45.94
Total		740		300

b) Herbaceous community

In herbaceous community layer, a total of 20 species were recorded with an average density of 15.76 individuals /m2 during winter season. Poa annua was found to be dominant species having maximum value of IVI (37.76) and density (2.28 individuals/m2). It was followed by Setaria glauca (IVI, 27.51) and Miscanthus nepalensis (IVI, 26.63). Frequency value ranged from 4% to 32%.

In Pre monsoon season, a total of 24 species were recorded with an average density of 35.64 individuals /m2 during the field study. The highest value of IVI (30.64) was recorded for Arundo donax which was dominant herbaceous species at this site followed by Cymbopogon martinii (IVI, 24.29) and Heteropogon contortus (IVI, 21.93). Frequency value ranged from 12% to 36% at this sampling site.

In monsoon season, a total of 26 herbaceous species were recorded with an average density of 38.64 individuals /m2. The maximum value of IVI (41.15) and density (7.52 individuals/m2) was recorded for Calamagrostis pseudophragmites which was found to be dominant species. Species like Setaria glauca, Heteropogon contortus and Poa annua were the co-dominant species. Frequency value ranged from 8% to 44%. The frequency, density, abundance and importance value index (IVI) of herbaceous layer at site-III is given in Table-3.47.

Table-3.47 Distribution analysis of herbaceous community at site-III during various seasons

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Winter Season				
Anthemis cotula L.	20	0.96	4.80	17.86
Stellaria monosperma D.Don	28	1.28	4.57	21.74
Onychium contiguum	12	0.16	1.33	6.02
Fragaria vesca L,	32	1.28	4.00	22.05
Plantago major L.	12	0.16	1.33	6.02
Setaria glauca (L.) P. Beauv.	28	1.80	6.43	27.51
Poa annua L.	16	2.28	14.25	37.76
Miscanthus nepalensis	28	1.72	6.14	26.63
Carex cruciata Wahlenberg	20	0.88	4.40	16.82
Calamagrostis pseudophragmites	20	1.04	5.20	18.90

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Festuca gigantea (L.) Vill.	12	0.16	1.33	6.02
Cannabis sativa L.	24	0.92	3.83	17.40
Rumex nepalensis Sprengel	16	0.52	3.25	11.93
Cymbopogon martinii (Roxb.) Wats.	24	0.84	3.50	16.45
Pteridium aquilinum	8	0.12	1.50	4.91
Ajuga parviflora Benth.	12	0.16	1.33	6.02
Pteris aspericaulis	12	0.12	1.00	5.32
Aconogonum molle (D. Don) Hara	8	0.08	1.00	3.99
Saccharum rufipilum Steud.	24	1.04	4.33	18.83
Fagopyrum sp (D. Don) Hara	16	0.24	1.50	7.82
Total		**15.76**		**300**
Pre monsoon Season				
Clinopodium umbrosum (M.Bieb.) C. Koch	24	1.28	5.33	11.73
Arundo donax L.	36	5.00	13.89	30.64
Origanum vulgare L	32	0.88	2.75	10.05
Anaphalis busua (Buch.- Ham ex D.Don) DC.	16	0.24	1.50	4.56
Cymbopogon martinii (Roxb.) Wats.	24	3.40	14.17	24.29
Duchesnea indica (Andr.) Focke	32	0.96	3.00	10.46
Ajuga parviflora Benth.	12	0.20	1.67	3.88
Stellaria monosperma D.Don	20	1.04	5.20	10.26
Saccharum filifolium (Nees) A. Camus	32	2.96	9.25	20.75
Cynoglossum zeylanicum (Vahl ex Hornem)	20	0.60	3.00	7.38
Rumex nepalensis Sprengel	24	1.00	4.17	10.07
Poa annua L.	40	2.08	5.20	16.63
Taraxacum officinale Weber	20	0.24	1.20	5.02
Thalictrum foliolosum DC.	20	0.88	4.40	9.21
Chrysopogon fulvus (Sprengel) Chiovenda	24	2.64	11.00	19.79
Diplazium sp,	12	0.24	2.00	4.24
Impatiens sp.	24	0.92	3.83	9.59
Cynodon dactylon (L.) Persoon	36	2.80	7.78	19.89
Eragrostis nigra Nees ex Steud.	16	0.24	1.50	4.56
Erigeron karvinskianus DC.	24	2.28	9.50	17.65
Fagopyrum sp (D. Don) Hara	12	0.20	1.67	3.88
Geranium nepalense Sweet	20	1.44	7.20	12.88
Heteropogon contortus (L.) P. Beauv	28	3.12	11.14	21.93
Rumex hastatus D.Don	32	1.00	3.13	10.66
Total		**35.64**		**300**
Monsoon Season				
Setaria glauca (L.) P. Beauv.	24	6.68	27.83	40.36
Calamagrostis pseudophragmites	32	7.52	23.50	41.15
Fagopyrum sp (D. Don) Hara	28	0.92	3.29	9.84

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Phlomis bracteosa Royle ex Benth.	24	0.20	0.83	5.58
Pteridium aquilinum	12	0.12	1.00	3.23
Circium wallichii DC.	8	0.12	1.50	2.81
Carex cruciata Wahlenberg	40	2.72	6.80	19.09
Duchesnea indica (Andr.) Focke	32	2.16	6.75	16.11
Heteropogon contortus (L.) P. Beauv	24	5.04	21.00	31.56
Plantago major L.	12	0.20	1.67	3.88
Gerbera gossypina Royle	16	0.16	1.00	4.09
Anaphalis contorta (D.Don) Hk. f.	12	0.24	2.00	4.21
Onychium contiguum	12	0.16	1.33	3.56
Poa annua L.	44	4.00	9.09	24.69
Impatiens sp.	16	0.20	1.25	4.36
Saccharum filifolium (Nees) A. Camus	24	1.40	5.83	12.03
Aster thomsonii Cl.	8	0.08	1.00	2.38
Origanum vulgare L	16	0.44	2.75	5.98
Cynoglossum zeylanicum (Vahl ex Hornem)	12	0.12	1.00	3.23
Chrysopogon fulvus (Sprengel) Chiovenda	20	0.84	4.20	8.73
Oxalis corniculata L.	20	0.96	4.80	9.45
Thalictrum foliolosum DC.	16	0.56	3.50	6.79
Bidens biternata (laur.) merill & sherff	24	0.24	1.00	5.80
Dryopteris cochleata	16	0.40	2.50	5.71
Miscanthus nepalensis	24	2.52	10.50	18.04
Aconogonum molle (D. Don) Hara	16	0.64	4.00	7.33
Total		**38.64**		**300**

IV. S-IV, Downstream (d/s) Area of Barrage

a) Tree and shrub community

In tree community layer, a total of 9 tree species were recorded during the field study. The average density of this group of species was recorded to be 230 individuals/ ha. In terms of importance value index (IVI), Alnus nepalensis (IVI, 91.29) was the dominant tree species followed by Pinus wallichiana (IVI, 63.63) and Lyonia ovalifolia (IVI, 32.75). Frequency value ranged from 5% to 40%.

In shrub community layer, a total of 12 species were recorded at site-IV during the field study. The average density of this group of species was recorded to be 1055 individuals/ha. The highest value of IVI (81.05) was recorded for Berberis lycium which was dominant shrub species of the site followed by Rubus foliolosus (IVI, 47.86) and Sarcococca saligna (IVI, 35.58). Highest frequency of occurrence was observed for Berberis lycium with 60% frequency. The frequency, density, abundance

and importance value index (IVI) for trees and shrubs at site-IV have been presented in Table-3.48.

Table-3.48 Distribution analysis for tree and shrub community at site-IV

Plant species	Frequency %	Density (ha-1)	Abundance	IVI
Trees				
Pinus wallichiana A.B. Jackson	25	40	1.60	63.63
Aesculus indica (Colebr.ex Cambess.) Hook.	15	15	1.00	31.23
Alnus nepalensis D.Don	40	75	1.88	91.29
Lyonia ovalifolia (Wallich.) Drude	15	35	2.33	32.75
Rhododendron arboreum Smith	10	15	1.50	18.11
Toona serrata (Royley) M. Roem.	10	10	1.00	12.00
Abies pindrow Royley	5	10	2.00	12.33
Litsea elongata (Nees) Gamble	15	20	1.33	21.06
Quercus glauca Thunb.	10	10	1.00	17.59
Total		**230**		**300**
Shrubs				
Rubus foliolosus D.Don	45	215	4.78	47.86
Sarcococca saligna (D.Don) Muell.-Arg.	50	160	3.20	35.58
Prinsepia utilis Royle	30	80	2.67	19.61
Indigofera heterantha Wall. ex. Brandis	35	55	1.57	20.29
Berberis lycium Royle	60	270	4.50	81.05
Buddleja crispa Benth.	15	15	1.00	7.74
Girardinia diversifolia (Link) friis	25	40	1.60	12.98
Leptodermis lanceolata Wallich	30	60	2.00	15.63
Debregeasia salicifolia (D.Don) Rendle	35	80	2.29	31.30
Rosa brunonii Lindley	25	40	1.60	14.27
Urena lobata L.	20	25	1.25	8.77
Inula cuspidata (DC.) C.B. Clarke	10	15	1.50	4.93
Total		1055		300

b) Herbaceous community

In herb community layer, a total of 16 species were recorded durin field study in winter season. The average density for this group of species was 18.60 individuals /m2. In terms of density (3.56 individuals/m^2) and IVI (43.26), Miscanthus nepalensis was found to be dominant species. It was followed by Calamagrostis pseudophragmites (IVI, 38.73) and Heteropogon contortus (IVI, 33.01). Frequency value ranged from 8% to 40%.

In Pre monsoon season, a total of 22 species were recorded with an average density of 24.92 individuals /m2. In terms of importance value index (IVI), Rumex hastatus

(IVI, 30.13) was the dominant species followed by Chrysopogon fulvus (IVI, 26.73) and Arundinella bengalensis (IVI, 25.61). Frequency value ranged from 12% to 36% at this sampling site.

In monsoon season, a total of 34 herbaceous species were recorded with an average density of 42.00 individuals /m2. The maximum value of IVI (29.51) was recorded for Calamagrostis pseudophragmites which was found to be dominant species. It was followed by Poa annua, Heteropogon contortus and Chrysopogon serrulatus. Frequency value ranged from 8% to 48%.

The frequency, density, abundance and importance value index (IVI) for herbaceous layer at site-IV is given in Table-3.49

Table-3.49 Distribution analysis for herbaceous community at site-IV during various seasons

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Winter Season				
Rumex hastatus D.Don	16	0.56	3.50	12.54
Fagopyrum sp (D. Don) Hara	20	0.36	1.80	10.43
Stellaria monosperma D.Don	20	1.36	6.80	22.45
Poa annua L.	40	1.36	3.40	24.03
Cymbopogon martinii (Roxb.) Wats.	24	2.16	9.00	30.89
Capsella bursa-pastoris (L.) Medikus	12	0.24	2.00	7.61
Barleria cristata L.	12	0.16	1.33	6.29
Calamagrostis pseudophragmites	32	3.04	9.50	38.73
Fragaria vesca L,	16	1.28	8.00	22.39
Setaria glauca (L.) P. Beauv.	28	1.32	4.71	21.90
Miscanthus nepalensis	36	3.56	9.89	43.26
Pteridium aquilinum	8	0.12	1.50	5.08
Heteropogon contortus (L.) P. Beauv	32	2.44	7.63	33.01
Geranium nepalense Sweet	12	0.16	1.33	6.29
Artemisia nilagirica (Clarke) Pamp.	8	0.20	2.50	6.84
Adiantum venustum	12	0.28	2.33	8.27
Total		**18.6**		**300**
Pre monsoon Season				
Verbena bonariensis L.	12	0.24	2.00	5.30
Anaphalis busua (Buch.- Ham ex D.Don) DC.	20	0.52	2.60	8.64
Rumex hastatus D.Don	32	3.40	10.63	30.13
Clinopodium umbrosum (M.Bieb.) C. Koch	20	0.52	2.60	8.64
Duchesnea indica (Andr.) Focke	16	0.64	4.00	9.59
Poa annua L.	28	2.24	8.00	22.21
Cannabis sativa L.	20	0.84	4.20	11.41
Origanum vulgare L	24	0.64	2.67	10.01
Cynoglossum zeylanicum (Vahl ex	16	0.40	2.50	7.24

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Hornem)				
Cynodon dactylon (L.) Persoon	36	1.44	4.00	16.94
Geranium nepalense Sweet	24	0.48	2.00	8.74
Lepidium virginicum L.	28	0.84	3.00	11.95
Circium wallichii DC.	12	0.20	1.67	4.83
Bidens pilosa L.	20	0.64	3.20	9.68
Erigeron multicaulis Wall. ex DC.	32	1.44	4.50	16.57
Chrysopogon fulvus (Sprengel) Chiovenda	24	2.76	11.50	26.73
Saccharum rufipilum Steud.	16	1.64	10.25	19.42
Capsella bursa-pastoris (L.) Medikus	24	1.04	4.33	13.16
Arundinella bengalensis (Sprengel) Druce	20	2.48	12.40	25.61
Impatiens sp.	16	0.36	2.25	6.84
Apluda mutica L.	24	1.84	7.67	19.47
Anisomeles indica (L.) Kuntze	20	0.32	1.60	6.90
Total		**24.92**		**300**
Monsoon Season				
Rumex hastatus D.Don	20	0.92	4.60	7.78
Fagopyrum sp (D. Don) Hara	24	0.60	2.50	6.25
Circium wallichii DC.	12	0.16	1.33	2.84
Cynoglossum zeylanicum (Vahl ex Hornem)	8	0.16	2.00	2.72
Conyza japonica (Thunb.) Less. ex DC.	16	0.32	2.00	4.19
Chrysopogon serrulatus Trin.	24	2.68	11.17	16.62
Cynodon dactylon (L.) Persoon	32	1.72	5.38	11.80
Eragrostis tenella (L.) P.Beauv. ex Roem. & Schult.	16	1.04	6.50	8.71
Impatiens scabrida DC.	20	0.32	1.60	4.48
Tagetes minuta L.	16	0.24	1.50	3.68
Verbena bonariensis L.	24	0.60	2.50	6.25
Duchesnea indica (Andr.) Focke	24	1.00	4.17	8.25
Poa annua L.	40	4.92	12.30	24.84
Origanum vulgare L	24	2.16	9.00	14.03
Bidens biternata (laur.) merill & sherff	12	0.28	2.33	3.76
Ajuga bracteosa Wallich ex Benth.	12	0.24	2.00	3.45
Anaphalis busua (Buch.- Ham ex D.Don) DC.	20	0.32	1.60	4.48
Calamagrostis pseudophragmites	48	6.24	13.00	29.51
Carex cruciata Wahlenberg	24	1.40	5.83	10.24
Anaphalis contorta (D.Don) Hk. f.	28	0.56	2.00	6.39
Chrysopogon fulvus (Sprengel) Chiovenda	20	2.28	11.40	15.27
Cannabis sativa L.	24	1.28	5.33	9.64
Pteridium aquilinum	28	0.60	2.14	6.57
Impatiens sp.	12	0.28	2.33	3.76
Anisomeles indica (L.) Kuntze	12	0.20	1.67	3.15

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Capillipedium assimile (Steud.) A. Camus	28	1.80	6.43	12.11
Galinsoga parviflora Cav.	12	0.16	1.33	2.84
Plectranthus mollis (Ait.) Sprengel	16	0.32	2.00	4.19
Saccharum rufipilum Steud.	24	1.84	7.67	12.44
Sida cordifolia (Burm. F.) Borss. Waalk.	8	0.12	1.50	2.31
Trifolium repens L.	20	0.64	3.20	6.24
Cymbopogon martinii (Roxb.) Wats.	20	1.08	5.40	8.66
Setaria glauca (L.) P. Beauv.	32	2.60	8.13	15.62
Heteropogon contortus (L.) P. Beauv	36	2.92	8.11	16.91
Total		**42**		**300**

V. S-V, Near Adit-2 right bank of Bargad nalla

a) Tree and shrub community

In tree community layer, a total of 7 tree species were recorded at this site during field study. The average density of this group of species was recorded to be 270 individuals /ha. In terms of IVI (104.13) as well as density (90 individuals/ ha) with 60% frequency, Pinus wallichiana was recorded to be the dominant tree species at this sampling site. Quercus leucotrichophora, Q. floribunda and Aesculus indica were observed as the co-dominant species at this community.

In shrub community layer, a total of 13 shrub species were recorded at site-V during the field study. The average density of this group of species was recorded to be1135 individuals/ha. The maximum value of (IVI, 79.67) was recorded for Berberis lycium which was found to be dominant shrub species followed by Debregeasia salicifolia (IVI, 31.12) and Rubus foliolosus (IVI, 30.35). Highest value of occurrence was observed for Berberis lycium with 50% frequency. The frequency, density, abundance and importance value index (IVI) for trees and shrubs at site-V have been presented in Table-3.50.

Table-3.50 Distribution analysis for tree and shrub community at site-V

Plant species	Frequency %	Density	Abundance	IVI
Trees				
Aesculus indica (Colebr.ex Cambess.) Hook.	20	20	1.00	27.75
Pinus wallichiana A.B. Jackson	60	90	1.50	104.13
Quercus leucotrichophora A.Camus	35	60	1.71	72.36
Lyonia ovalifolia (Wallich.) Drude	25	30	1.20	26.77
Quercus floribunda	30	35	1.17	36.15
Juglans regia L.	10	10	1.00	11.19

Plant species	Frequency %	Density	Abundance	IVI
Rhododendron arboreum Smith	20	25	1.25	21.65
Total		**270**		**300**
Shrubs				
Rosa brunonii Lindley	15	30	2.00	8.35
Cyathula tomentosa (Roth) Moq.	20	25	1.25	8.21
Debregeasia salicifolia (D.Don) Rendle	40	125	3.13	31.12
Berberis aristata DC.	30	85	2.83	24.25
Deutzia staminea R. Br. ex Wallich	35	55	1.57	19.00
Rubus foliolosus D.Don	40	130	3.25	30.35
Indigofera heterantha Wall. ex. Brandis	30	60	2.00	17.78
Buddleja crispa Benth.	15	25	1.67	7.91
Sarcococca saligna (D.Don) Muell.-Arg.	30	105	3.50	21.67
Girardinia diversifolia (Link) friis	25	65	2.60	16.49
Leea asiatica (L.) Ridsdale	15	25	1.67	8.95
Berberis lycium Royle	50	275	5.50	79.67
Prinsepia utilis Royle	35	130	3.71	26.27
Total		**1135**		**300**

b) Herbaceous community

In herb community layer, a total of 18 herbaceous species were recorded with an average density of 19.48 individuals /m^2 during winter season. As per IVI and density, Poa annua was found to be dominant species which was followed by Carex cruciata (IVI, 33.06) and Origanum vulgare (IVI, 28.76). Frequency value ranged from 4% to 32%.

In Pre monsoon season, a total of 31 species were recorded with an average density of 52.44 individuals /m^2 during field study. The highest value of IVI (25.23) as well as density (5.80 individuals/m^2) was recorded for Heteropogon contortus which was dominant herbaceous species at this site followed by Cymbopogon martinii (IVI, 20.57) and Chrysopogon fulvus (IVI, 18.48). Frequency value ranged from 12% to 36% of the site.

In monsoon season, a total of 37 herbaceous species were recorded with an average density of 49.24 individuals /m^2. The maximum value of IVI (28.55) and density (5.72 individuals/m^2) was recorded for Heteropogon contortus which was found to be dominant species. Setaria glauca, Chrysopogon fulvus and Cymbopogon martinii were the co-dominant species at this site. Frequency value ranged from 8% to 36%. The frequency, density, abundance and importance value index (IVI) of herbaceous layer at site-V is given in Table-3.51.

Table-3.51 Distribution analysis for herbaceous community at site-V during various seasons

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Winter Season				
Rumex nepalensis Sprengel	20	0.52	2.60	11.15
Calamagrostis pseudophragmites	24	1.36	5.67	20.31
Fragaria vesca L,	12	0.24	2.00	6.86
Origanum vulgare L	28	2.24	8.00	28.76
Poa annua L.	32	3.04	9.50	35.78
Artemisia nilagirica (Clarke) Pamp.	20	0.32	1.60	8.89
Saccharum rufipilum Steud.	28	2.24	8.00	28.76
Cynodon dactylon (L.) Persoon	24	1.44	6.00	21.13
Fagopyrum sp (D. Don) Hara	28	1.76	6.29	24.18
Carex cruciata Wahlenberg	24	2.60	10.83	33.06
Pteris cretica	12	0.28	2.33	7.48
Capsella bursa-pastoris (L.) Medikus	24	0.24	1.00	8.78
Setaria glauca (L.) P. Beauv.	24	0.96	4.00	16.19
Ajuga parviflora Benth.	16	0.28	1.75	7.81
Cannabis sativa L.	20	0.96	4.80	16.13
Stellaria monosperma D.Don	12	0.24	2.00	6.86
Rumex hastatus D.Don	20	0.56	2.80	11.60
Plantago depressa Willd.	12	0.20	1.67	6.25
Total		**19.48**		**300**
Pre monsoon Season				
Saccharum filifolium (Nees) A. Camus	16	1.56	9.75	9.61
Pilea sriptaWedd.	16	1.16	7.25	7.74
Origanum vulgare L	24	1.28	5.33	8.29
Anaphalis busua (Buch.- Ham ex D.Don) DC.	20	0.60	3.00	5.38
Clinopodium umbrosum (M.Bieb.) C. Koch	20	0.60	3.00	5.38
Poa annua L.	24	3.40	14.17	16.23
Cynodon dactylon (L.) Persoon	20	2.52	12.60	13.28
Lepidium virginicum L.	20	1.52	7.60	9.16
Rumex nepalensis Sprengel	36	2.12	5.89	11.88
Cymbopogon martinii (Roxb.) Wats.	32	4.84	15.13	20.57
Ajuga bracteosa Wallich ex Benth.	16	0.84	5.25	6.25
Artemisia nilagirica (Clarke) Pamp.	36	3.40	9.44	15.89
Gnaphalium luteo-album L.	20	0.92	4.60	6.69
Oxalis corniculata L.	24	1.28	5.33	8.29
Cynoglossum zeylanicum (Vahl ex Hornem)	20	0.40	2.00	4.55
Erigeron multicaulis Wall. ex DC.	16	1.28	8.00	8.30
Chrysopogon fulvus (Sprengel) Chiovenda	24	4.00	16.67	18.48
Impatiens sp.	20	1.28	6.40	8.18
Taraxacum officinale Weber	12	0.56	4.67	4.87
Eragrostis nigra Nees ex Steud.	32	2.48	7.75	12.81

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Heteropogon contortus (L.) P. Beauv	24	5.80	24.17	25.23
Fragaria vesca L,	20	0.72	3.60	5.87
Brachiaria reptans (L.) Gard. & Hubb.	24	2.88	12.00	14.28
Bidens biternata (laur.) merill & sherff	28	0.48	1.71	5.74
Conyza japonica (Thunb.) Less. ex DC.	24	1.40	5.83	8.74
Lecanthus wallichii Wedd.	16	0.72	4.50	5.69
Duchesnea indica (Andr.) Focke	20	0.60	3.00	5.38
Cannabis sativa L.	36	1.16	3.22	8.87
Geranium nepalense Sweet	16	0.32	2.00	3.82
Rumex hastatus D.Don	20	2.08	10.40	11.47
Circium wallichii DC.	12	0.24	2.00	3.09
Total		**52.44**		**300**
Monsoon Season				
Chenopodium album L.	8	0.12	1.50	2.39
Heliotropium strigosum willd.	16	0.20	1.25	3.75
Sida rhombifolia L.	12	0.24	2.00	3.61
Fagopyrum sp (D. Don) Hara	12	0.28	2.33	3.88
Chrysopogon serrulatus Trin.	20	0.84	4.20	7.57
Bidens biternata (laur.) merill & sherff	8	0.12	1.50	2.39
Saccharum rufipilum Steud.	20	1.72	8.60	12.12
Cymbopogon martinii (Roxb.) Wats.	24	4.04	12.67	18.23
Heteropogon contortus (L.) P. Beauv	36	5.72	15.89	28.55
Plantago major L.	16	0.24	1.50	3.98
Geranium nepalense Sweet	12	0.16	1.33	3.05
Taraxacum officinale Weber	20	1.48	2.40	5.71
Impatiens scabrida DC.	12	0.24	2.00	3.61
Poa annua L.	32	3.96	9.25	17.48
Pteridium aquilinum	12	0.28	2.33	3.88
Amaranthus spinosus L.	8	0.12	1.50	2.39
Erigeron multicaulis Wall. ex DC.	12	0.24	2.00	3.61
Nepata elliptica Royle ex Benth.	12	0.24	2.00	3.61
Themada caudata (Nees) A. Camus	20	2.72	8.60	12.12
Circium wallichii DC.	12	0.20	1.67	3.33
Cynodon dactylon (L.) Persoon	16	2.88	11.75	13.56
Ajuga bracteosa Wallich ex Benth.	12	0.16	1.33	3.05
Chrysopogon fulvus (Sprengel) Chiovenda	24	4.92	16.33	22.38
Origanum vulgare L	24	0.84	3.50	7.84
Anaphalis busua (Buch.- Ham ex D.Don) DC.	28	2.76	9.86	16.67
Impatiens sp.	12	0.40	3.33	4.72
Setaria glauca (L.) P. Beauv.	28	4.84	17.29	25.82
Rumex nepalensis Sprengel	12	1.32	2.67	4.16
Fragaria vesca L,	8	0.20	2.50	3.13
Eleusine indica (L.) Gaertner	16	2.08	6.75	8.89
Oplismenus compositus (L.) P. Beauv.	16	1.28	8.00	10.06

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Artemisia nilagirica (Clarke) Pamp.	12	0.24	2.00	3.61
Rumex hastatus D.Don	12	0.20	1.67	3.33
Cannabis sativa L.	24	1.00	4.17	8.59
Cynoglossum zeylanicum (Vahl ex Hornem)	12	0.24	2.00	3.61
Anaphalis contorta (D.Don) Hk. f.	20	2.00	5.00	8.40
Trifolium repens L.	20	0.72	3.60	6.95
Total		**49.24**		**300**

VI. S-VI, Upstream (u/s) Area of Power House

a) Tree and Shrub community

In tree community layer, a total of 8 tree species were recorded at this this site during field the study. The average density for this group of species was recorded to be 265 individuals /ha. The highest value of IVI (143.76) as well as density (125 individuals/ha) was recorded for Pinus roxburghii which was the dominant species at this site followed by Quercus leucotrichophora (IVI, 50.39) and Lyonia ovalifolia (IVI, 27.63). Frequency value ranged from 5% to 45%.

In shrub community layer, a total of 13 shrub species were recorded from the site-VI. The average density of this group of species was recorded to be 895 individuals/ ha. The maximum value of IVI (55.97) as well as density (160 individuals/ha) was recorded for Debregeasia salicifolia which was dominant species of the site. Berberis lycium (IVI, 45.04) and Prinsepia utilis (IVI, 35.05) were found to be co-dominant species of this community. Frequency value ranged from 15% to 40%. The frequency, density, abundance and importance value index (IVI) for trees and shrubs at site-VI have been presented in Table-3.52.

Table-3.52 Distribution analysis for tree and shrub community at site-VI

Plant species	Frequency %	Density ha-1	Abundance	IVI
Trees				
Pinus roxburghii Sargent	45	125	2.78	143.76
Morus serrata Roxb.	10	10	1.00	12.28
Pyrus pashia Buch.-Ham ex D.Don	15	20	1.33	19.96
Quercus leucotrichophora A.Camus	25	35	1.40	50.39
Juglans regia L.	5	5	1.00	6.74
Rhododendron arboreum Smith	20	25	1.25	26.03
Lyonia ovalifolia (Wallich.) Drude	20	30	1.50	27.63
Rhus wallichii Hook. f.	10	15	1.50	13.21
Total		**265**		**300**

Plant species	Frequency %	Density ha-1	Abundance	IVI
Shrubs				
Rubus ellipticus Smith	30	65	2.17	20.82
Boehmeria macrophylla Hornem.	20	45	2.25	14.52
Aerva sanguinolenta (L.) Blume	15	40	2.67	11.19
Cyathula tomentosa (Roth) Moq.	20	25	1.25	10.43
Buddleja crispa Benth.	25	45	1.80	16.80
Berberis lycium Royle	40	115	2.88	45.04
Ficus semicordata Buch.-Ham. ex J.E. Smith	25	50	2.00	23.16
Debregeasia salicifolia (D.Don) Rendle	40	160	4.00	55.97
Deutzia staminea R. Br. ex Wallich	25	100	4.00	25.53
Prinsepia utilis Royle	35	120	3.43	35.05
Rosa brunonii Lindley	15	25	1.67	9.26
Rubus foliolosus D.Don	20	65	3.25	20.48
Leptodermis lanceolata Wallich	15	40	2.67	11.75
Total		**895**		**300**

b) Herbaceous community

In herb community, a total of 22 herbaceous species were recorded with an average density of 18.72 individuals /m2 during winter season. Heteropogon contortus was found to be dominant species having maximum value of IVI (35.29) and density (3.08 individuals/m2). The other associated species of this were Cymbopogon martinii (IVI, 29.31), Artemisia nilagirica (IVI, 21.98) and Saccharum rufipilum. Frequency value ranged from 12% to 48%.

In Pre monsoon season, a total of 27 herbaceous species were recorded with an average of 44.20 individuals /m2 during the field study. In terms of IVI (29.36), Chrysopogon serrulatus was found to be dominant herb species followed by Saccharum rufipilum (IVI, 26.13) and Heteropogon contortus (IVI, 21.71). Frequency value ranged from 12% to 40%.

In monsoon season, a total of 32 herbaceous species were recorded with an average density of 46.64 individuals /m2. The maximum value of IVI (40.46) and density (9.72 individuals/m2) was recorded for Chrysopogon serrulatus which was found to be dominant species. It was followed by Heteropogon contortus, Poa annua and Saccharum rufipilum were the co-dominant species. The frequency, density, abundance and importance value index (IVI) of herbaceous layer at site-VI is given in Table-3.53.

Table-3.53 Distribution analysis for herbaceous community at site-VI during various seasons

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Winter Season				
Stellaria monosperma D.Don	24	0.92	3.83	15.09
Carex cruciata Wahlenberg	24	1.12	4.67	17.18
Cymbopogon martinii (Roxb.) Wats.	28	2.36	8.43	29.31
Heteropogon contortus (L.) P. Beauv	48	3.08	6.42	35.29
Setaria glauca (L.) P. Beauv.	28	1.32	4.71	19.22
Taraxacum officinale Weber	16	0.48	3.00	9.89
Saccharum rufipilum Steud.	20	1.28	6.40	19.23
Cannabis sativa L.	24	0.84	3.50	14.26
Plantago depressa Willd.	12	0.20	1.67	5.85
Oxalis corniculata L.	16	0.68	4.25	12.49
Rumex nepalensis Sprengel	12	0.28	2.33	7.09
Pteridium aquilinum	16	0.20	1.25	6.26
Circium wallichii DC.	12	0.16	1.33	5.23
Polygala persicariifolia DC.	8	0.28	3.50	7.60
Fragaria vesca L,	12	0.32	2.67	7.71
Artemisia nilagirica (Clarke) Pamp.	32	1.60	5.00	21.98
Ajuga parviflora Benth.	12	0.20	1.67	5.85
Rumex hastatus D.Don	24	1.04	4.33	16.35
Calamagrostis pseudophragmites	20	0.68	3.40	12.37
Cynodon dactylon (L.) Persoon	20	1.16	5.80	17.86
Fagopyrum sp (D. Don) Hara	12	0.28	2.33	7.09
Verbena bonariensis L.	16	0.24	1.50	6.78
Total		**18.72**		**300**
Pre monsoon Season				
Heteropogon contortus (L.) P. Beauv	28	4.00	14.29	21.71
Anaphalis busua (Buch.- Ham ex D.Don) DC.	20	1.28	6.40	9.82
Poa annua L.	32	1.84	5.75	12.74
Artemisia nilagirica (Clarke) Pamp.	40	2.52	6.30	15.92
Cynoglossum zeylanicum (Vahl ex Hornem)	12	0.20	1.67	3.39
Impatiens sp.	20	0.32	1.60	4.97
Saccharum rufipilum Steud.	28	5.04	18.00	26.13
Arthraxon lancifolius (Trin.) Hochst	24	2.24	9.33	14.29
Cymbopogon martinii (Roxb.) Wats.	32	2.52	7.88	15.46
Cannabis sativa L.	20	0.88	4.40	7.80
Chrysopogon serrulatus Trin.	28	5.80	20.71	29.36
Euphorbia hirta L.	12	0.20	1.67	3.39
Tagetes minuta L.	16	0.24	1.50	4.06
Origanum vulgare L	20	0.56	2.80	6.18
Clinopodium umbrosum (M.Bieb.) C. Koch	12	0.20	1.67	3.39
Oxalis corniculata L.	20	1.16	5.80	9.21

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Chrysopogon fulvus (Sprengel) Chiovenda	24	2.52	10.50	15.58
Brachiaria reptans (L.) Gard. & Hubb.	16	2.16	13.50	15.09
Conyza japonica (Thunb.) Less. ex DC.	20	1.04	5.20	8.61
Ajuga parviflora Benth.	20	1.00	5.00	8.40
Micromeria biflora (Buch.-Ham. ex D.Don) Benth	24	1.44	6.00	10.63
Apluda mutica L.	24	2.08	8.67	13.56
Bidens biternata (laur.) merill & sherff	12	0.24	2.00	3.67
Rumex hastatus D.Don	16	0.80	5.00	7.28
Polygonum capitatum Buch. Ham. ex D.Don	24	1.00	4.17	8.61
Cynodon dactylon (L.) Persoon	32	2.60	8.13	15.78
Bidens pilosa L.	20	0.32	1.60	4.97
Total		**44.2**		**300**
Monsoon Season				
Heteropogon contortus (L.) P. Beauv	40	5.28	13.20	25.15
Ajuga parviflora Benth.	12	0.24	2.00	3.52
Bidens pilosa L.	8	0.08	1.00	1.98
Commelina sp	16	0.60	3.75	5.93
Clinopodium umbrosum (M.Bieb.) C. Koch	20	1.12	5.60	8.73
Salvia hians Royle ex Benth	12	0.16	1.33	2.96
Geranium nepalense Sweet	12	0.20	1.67	3.24
Duchesnea indica (Andr.) Focke	16	0.44	2.75	5.00
Chrysopogon serrulatus Trin.	44	9.72	22.09	40.46
Saccharum rufipilum Steud.	36	3.48	9.67	18.62
Poa annua L.	32	4.52	14.13	22.83
Fragaria vesca L,	20	0.48	2.40	5.50
Circium wallichii DC.	12	0.20	1.67	3.24
Origanum vulgare L	16	0.36	2.25	4.54
Cannabis sativa L.	36	0.92	2.56	8.98
Trifolium repens L.	20	1.40	7.00	10.15
Carex cruciata Wahlenberg	24	1.80	7.50	11.91
Oxalis corniculata L.	16	0.60	3.75	5.93
Cymbopogon martinii (Roxb.) Wats.	32	3.00	9.38	16.80
Pteridium aquilinum	12	0.20	1.67	3.24
Artemisia nilagirica (Clarke) Pamp.	16	0.32	2.00	4.31
Apluda mutica L.	24	1.84	7.67	12.09
Miscanthus nepalensis	28	1.40	5.00	10.21
Arundinella bengalensis (Sprengel) Druce	24	1.88	7.83	12.28
Cynodon dactylon (L.) Persoon	28	2.64	9.43	15.45
Polygonum capitatum Buch. Ham. ex D.Don	20	1.12	5.60	8.73
Dryopteris conjugata	12	0.20	1.67	3.24
Siegesbeckia orientalis L.	12	0.16	1.33	2.96

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Impatiens sp.	16	0.52	3.25	5.46
Erigeron multicaulis Wall. ex DC.	16	1.36	8.50	10.32
Rumex nepalensis Sprengel	12	0.24	2.00	3.52
Cynoglossum zeylanicum (Vahl ex Hornem)	8	0.16	2.00	2.74
Total		**46.64**		**300**

VII. S-VII, Power House Site

a) Tree community

In tree community layer, a total of 6 tree species were recorded from the power house site during field study. The average density of this group of species was recorded to be 250 individuals/ ha. On the basis of importance value index (IVI), Pinus roxburghii (IVI, 189.88) was the dominant tree species followed by Quercus leucotrichophora (IVI, 27.22) and Lyonia ovalifolia (IVI, 26.29). Frequency value ranged from 10% to 70%.

In shrub community layer, a total of 14 species were recorded at site-IV during the field study. The average density of this group of species was recorded to be 835 individuals/ha. The highest value of IVI (63.70) was recorded for Debregeasia salicifolia which was dominant shrub species of the site followed by Berberis lycium (IVI, 42.85) and Rubus ellipticus (IVI, 32.58). Frequency value ranged from 10% to 50%. The frequency, density, abundance and importance value index (IVI) for trees and shrubs at site-VII have been presented in Table-3.54.

Table-3.54 Distribution analysis for tree and shrub community at site-VII

Plant species	Frequency %	Density ha-1	Abundance	IVI
Trees				
Prunus cerasoides D.Don	15	25	1.67	24.52
Pinus roxburghii Sargent	70	140	2.00	189.88
Pyrus pashia Buch.-Ham ex D.Don	15	20	1.33	20.42
Quercus leucotrichophora A.Camus	20	30	1.50	27.22
Rhus punjabensis J.L. Stewart	10	10	1.00	11.66
Lyonia ovalifolia (Wallich.) Drude	20	25	1.25	26.29
Total		**250**		**300**
Shrubs				
Debregeasia salicifolia (D.Don) Rendle	50	180	3.60	63.70
Rosa brunonii Lindley	15	30	2.00	11.76
Leptodermis lanceolata Wallich	20	25	1.25	10.85
Urena lobata L.	30	45	1.50	16.14

Plant species	Frequency %	Density ha-1	Abundance	IVI
Buddleja crispa Benth.	15	20	1.33	7.91
Inula cappa (Buch.-Ham.ex D.Don)	15	30	2.00	9.02
Rubus ellipticus Smith	35	90	2.57	32.58
Cyathula tomentosa (Roth) Moq.	20	40	2.00	13.12
Deutzia staminea R. Br. ex Wallich	35	60	1.71	20.16
Hypericum oblongifolium Choisy	20	25	1.25	9.26
Pyracantha crenulata (D.Don) M. Roemer	40	80	2.00	30.53
Prinsepia utilis Royle	30	85	2.83	28.22
Berberis lycium Royle	35	115	3.29	42.85
Boehmeria macrophylla Hornem.	10	10	1.00	3.90
Total		835		300

b) Herbaceous community

In herb community layer, a total of 17 herbaceous species were recorded with an average density of 19.80 individuals /m2 during winter season. In terms of IVI and density, Heteropogon contortus was found to be dominant species followed by Chrysopogon serrulatus (IVI, 38.71) and Cymbopogon martinii (IVI, 25.77). Frequency value ranged from8% to 32%.

In Pre monsoon season, a total of 26 species were recorded during field study. The average density of this group of species was recorded to be 39.60 individuals /m2. In terms of importance value index (IVI), Chrysopogon serrulatus (IVI, 40.86) was the dominant species followed by Heteropogon contortus (IVI, 34.47) and Cynodon dactylon (IVI, 22.39). Frequency value ranged from 8% to 48% at this sampling site.

In monsoon season, a total of 31 herbaceous species were recorded with an average density of 46.64 individuals /m2. The highest value of IVI (38.00) and density (7.04 individuals/m2) was recorded for Apluda mutica which was found to be dominant species. Species like Chrysopogon serrulatus, Heteropogon contortus and Capillipedium assimile were the co-dominant species at this site. Frequency value ranged from 4% to 44%. The frequency, density, abundance and importance value index (IVI) of herbaceous layer at site-VII is given in Table-3.55.

Table-3.55 Distribution analysis for herbaceous community at site-VII during various seasons

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Winter Season				
Poa annua L.	24	1.56	6.50	23.61
Heteropogon contortus (L.) P. Beauv	32	3.92	12.25	45.65

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Polygonum capitatum Buch. Ham. ex D.Don	16	0.60	3.75	12.68
Dryopteris conjugata	12	0.20	1.67	6.79
Thalictrum foliolosum DC.	16	0.78	1.75	8.55
Sida rhombifolia L.	20	0.32	1.60	9.82
Cymbopogon martinii (Roxb.) Wats.	20	2.20	11.00	31.24
Saccharum rufipilum Steud.	20	1.72	8.60	25.77
Oxalis corniculata L.	24	0.92	3.83	16.96
Circium wallichii DC.	12	0.20	1.67	6.79
Fragaria vesca L,	16	1.08	6.25	17.85
Artemisia nilagirica (Clarke) Pamp.	16	0.82	2.00	9.07
Rumex hastatus D.Don	20	0.64	3.20	13.47
Barleria cristata L.	12	0.16	1.33	6.17
Chrysopogon serrulatus Trin.	32	3.16	9.88	38.71
Carex cruciata Wahlenberg	24	1.40	5.83	21.95
Ajuga parviflora Benth.	8	0.12	1.50	4.93
Total		**19.80**		**300**
Pre monsoon Season				
Chrysopogon fulvus (Sprengel) Chiovenda	28	3.40	12.14	22.35
Bidens biternata (laur.) merill & sherff	12	0.20	1.67	3.75
Artemisia nilagirica (Clarke) Pamp.	40	1.56	3.90	13.53
Saccharum rufipilum Steud.	24	2.16	9.00	16.20
Euphorbia hirta L.	16	0.20	1.25	4.11
Brachiaria reptans (L.) Gard. & Hubb.	24	1.80	7.50	14.17
Ajuga parviflora Benth.	12	0.16	1.33	3.40
Verbena bonariensis L.	16	0.24	1.50	4.40
Cymbopogon martinii (Roxb.) Wats.	28	2.76	9.86	19.02
Chrysopogon serrulatus Trin.	48	8.04	16.75	40.86
Oxalis corniculata L.	24	0.52	2.17	6.94
Lepidium virginicum L.	20	0.68	3.40	7.60
Gnaphalium luteo-album L.	12	0.32	2.67	4.81
Heteropogon contortus (L.) P. Beauv	40	6.32	15.80	34.47
Micromeria biflora (Buch.-Ham. ex D.Don) Benth	20	0.84	4.20	8.60
Rumex hastatus D.Don	24	0.60	2.50	7.39
Cynodon dactylon (L.) Persoon	44	3.56	8.09	22.39
Ajuga bracteosa Wallich ex Benth.	12	0.20	1.67	3.75
Eragrostis pilosa	24	1.84	7.67	14.39
Achyranthes aspera L.	20	0.20	1.00	4.59
Bidens pilosa L.	12	0.24	2.00	4.11
Duchesnea indica (Andr.) Focke	32	0.68	2.13	8.64
Salvia hians Royle ex Benth	8	0.08	1.00	2.28
Setaria glauca (L.) P. Beauv.	24	1.40	5.83	11.91
Barleria cristata L.	16	0.32	2.00	4.97
Clinopodium umbrosum (M.Bieb.) C.	20	1.28	6.40	11.36

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Koch				
Total		**39.6**		**300**
Monsoon Season				
Apluda mutica L.	44	7.04	16.00	38.00
Eleusine indica (L.) Gaertner	28	0.92	3.29	9.37
Arundo donax L.	20	0.48	2.40	6.24
Gnaphalium luteo-album L.	12	0.28	2.33	4.37
Chrysopogon serrulatus Trin.	28	4.08	14.57	26.25
Pilea sriptaWedd.	20	0.32	1.60	5.22
Circium wallichii DC.	4	0.04	1.00	1.47
Carex cruciata Wahlenberg	24	1.44	6.00	12.13
Cymbopogon martinii (Roxb.) Wats.	20	1.80	9.00	14.66
Cynodon dactylon (L.) Persoon	28	2.16	7.71	16.00
Bidens pilosa L.	12	0.16	1.33	3.32
Cynoglossum zeylanicum (Vahl ex Hornem)	12	0.24	2.00	4.02
Anaphalis busua (Buch.- Ham ex D.Don) DC.	16	0.32	2.00	4.88
Impatiens sp.	12	0.36	3.00	5.07
Themada caudata (Nees) A. Camus	32	1.08	3.38	10.52
Adiantum venustum	12	0.16	1.33	3.32
Capsella bursa-pastoris (L.) Medikus	16	0.20	1.25	4.00
Poa annua L.	36	1.88	5.22	14.70
Artemisia nilagirica (Clarke) Pamp.	12	0.20	1.67	3.67
Geranium nepalense Sweet	8	0.12	1.50	2.69
Rumex hastatus D.Don	12	0.28	2.33	4.37
Oxalis corniculata L.	16	1.00	6.25	9.83
Cannabis sativa L.	24	0.60	2.50	7.28
Heteropogon contortus (L.) P. Beauv	44	3.84	8.73	23.91
Capillipedium assimile (Steud.) A. Camus	36	2.80	7.78	19.08
Thalictrum foliolosum DC.	12	0.20	1.67	3.67
Chrysopogon fulvus (Sprengel) Chiovenda	24	1.44	6.00	12.13
Conyza japonica (Thunb.) Less. ex DC.	16	0.20	1.25	4.00
Saccharum rufipilum Steud.	16	1.04	6.50	10.12
Origanum vulgare L	12	0.28	2.33	4.37
Setaria glauca (L.) P. Beauv.	20	1.28	6.40	11.34
Total		**36.24**		**300**

VIII. S-VIII, Downstream (d/s) area of Power House

a) Tree community

In tree community layer, a total of 10 tree species were recorded at this site during field study. The average density of this group of species was recorded to be 315

individuals /ha. In terms of IVI (132.66) as well as density (105 individuals/ ha) with 65% frequency, Pinus roxburghii was recorded to be dominant tree species at this sampling site. Alnus nepalensis, Ficus palmata and Mallotus philippensis were observed as the co-dominant species at this community.

In shrub community layer, a total of 15 shrub species were recorded at d/s of PH site during the field study. The average density of this group of species was recorded to be 920 individuals/ha. The maximum value of (IVI, 54.62) was recorded for Pyracantha crenulata which was found to be dominant shrub species followed by Berberis lycium (IVI, 42.60) and Debregeasia salicifolia (IVI, 37.69). Frequency value ranged from 10% to 445%. The frequency, density, abundance and importance value index (IVI) for trees and shrubs at site-VIII have been presented in Table-3.56.

Table-3.56 Distribution analysis for tree and shrub community at site-VIII

Plant species	Frequency %	Density ha-1	Abundance	IVI
Trees				
Pinus roxburghii Sargent	65	105	1.62	132.66
Myrica esculenta Buch.-Ham.ex D.Don	10	15	1.50	11.54
Mallotus philippensis (Lam.) Muell.-Arg.	20	25	1.25	18.87
Alnus nepalensis D.Don	35	75	2.14	62.18
Ougeinia oojeinensis (Roxb.) Hochreutiner	10	10	1.00	9.06
Prunus cerasoides D.Don	10	15	1.50	10.58
Pistacia khinjuk Stocks	10	10	1.00	9.23
Pyrus pashia Buch.-Ham ex D.Don	15	15	1.00	12.63
Rhus punjabensis J.L. Stewart	10	15	1.50	10.67
Ficus palmata Forsk.	25	30	1.20	22.58
Total		**315**		**300**
Shrubs				
Rubus ellipticus Smith	35	55	1.57	22.66
Pyracantha crenulata (D.Don) M. Roemer	25	195	7.80	54.62
Berberis lycium Royle	45	120	2.67	42.60
Leptodermis lanceolata Wallich	20	25	1.25	9.22
Indigofera heterantha Wall. ex. Brandis	35	90	2.57	26.98
Leea asiatica (L.) Ridsdale	20	30	1.50	11.16
Woodfordia fruticosa (L.) Kurz.	20	30	1.50	11.70
Rosa brunonii Lindley	15	20	1.33	7.70
Buddleja crispa Benth.	15	25	1.67	9.32
Prinsepia utilis Royle	40	100	2.50	28.63
Rubus foliolosus D.Don	30	50	1.67	16.54
Plumbago zeylanica L.	10	15	1.50	5.11
Debregeasia salicifolia (D.Don) Rendle	45	110	2.44	37.69
Cyathula tomentosa (Roth) Moq.	10	15	1.50	4.92
Urena lobata L.	20	40	2.00	11.14
Total		**920**		**300**

b) Herbaceous community

In herb community layer, a total of 21 herbaceous species were recorded with an average density of 20.32 individuals /m2 during winter season. During quadrat study, Carex cruciata was found to be dominant species having maximum value of IVI (29.20) and density (2.60 individuals/m2). The other associated species of this were Heteropogon contortus (IVI, 24.35) and Chrysopogon serrulatus (IVI, 23.24). Frequency value ranged from 8% to 40%.

In Pre monsoon season, a total of 25 species were recorded with an average density of 43.24 individuals /m2 during field study. The highest value of IVI (29.54) was recorded for Chrysopogon serrulatus which was dominant herbaceous species at this site followed by Artemisia nilagirica (IVI, 28.36) and Heteropogon contortus (IVI, 26.93). Frequency value ranged from 12% to 44% of the site.

In monsoon season, a total of 35 herbaceous species were recorded with an average density of 47.06 individuals /m2. The maximum value of IVI (31.57) as well as density (5.72 individuals/m2) was recorded for Capillipedium assimile which was found to be dominant species. It was followed by Chrysopogon serrulatus, Heteropogon contortus and Apluda mutica were the co-dominant species. The frequency, density, abundance and importance value index (IVI) of herbaceous layer at site-VIII is given in Table-3.57.

Table-3.57 Distribution analysis for herbaceous community at site-VIII during Various seasons

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Winter Season				
Duchesnea indica (Andr.) Focke	20	0.96	4.80	14.73
Barleria cristata L.	12	0.20	1.67	5.61
Carex cruciata Wahlenberg	36	2.60	7.22	29.20
Gnaphalium luteo-album L.	16	0.44	2.75	8.93
Arundo donax L.	12	0.64	5.33	11.95
Cynoglossum zeylanicum (Vahl ex Hornem)	16	0.24	1.50	6.53
Stellaria media (L.) Villars	28	1.52	5.43	20.02
Eriophorum comosum (Wallich) Wallich ex Nees	24	0.88	3.67	13.96
Heteropogon contortus (L.) P. Beauv	36	2.00	5.56	24.35
Cannabis sativa L.	16	0.36	2.25	7.97
Cynodon dactylon (L.) Persoon	40	1.72	4.30	22.45
Oxalis corniculata L.	24	0.56	2.33	10.87
Rumex hastatus D.Don	12	0.24	2.00	6.19
Chrysopogon serrulatus Trin.	24	1.84	7.67	23.24

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Ajuga parviflora Benth.	8	0.12	1.50	4.12
Setaria glauca (L.) P. Beauv.	20	1.08	5.40	16.01
Clinopodium umbrosum (M.Bieb.) C. Koch	12	0.36	3.00	7.91
Cymbopogon martinii (Roxb.) Wats.	20	1.36	6.80	18.98
Capillipedium assimile (Steud.) A. Camus	24	1.60	6.67	20.92
Saccharum filifolium (Nees) A. Camus	20	1.04	5.20	15.58
Rumex nepalensis Sprengel	20	0.56	2.80	10.49
Total		**20.32**		**300**
Pre monsoon Season				
Saccharum rufipilum Steud.	20	3.48	22.40	22.44
Ajuga bracteosa Wallich ex Benth.	12	0.20	1.67	3.27
Clinopodium umbrosum (M.Bieb.) C. Koch	24	0.60	2.50	6.52
Rumex nepalensis Sprengel	12	0.32	2.67	3.96
Imperata cylindrica (L.) P.Beauv.	24	0.72	11.33	14.65
Anisomeles indica (L.) Kuntze	16	0.32	2.00	4.36
Chrysopogon serrulatus Trin.	20	6.16	30.80	29.54
Anaphalis busua (Buch.- Ham ex D.Don) DC.	16	0.32	2.00	4.36
Apluda mutica L.	24	1.60	10.83	14.19
Erigeron multicaulis Wall. ex DC.	12	0.14	5.33	5.82
Ajuga parviflora Benth.	20	1.16	10.80	12.64
Gnaphalium luteo-album L.	12	0.24	2.00	3.50
Micromeria biflora (Buch.-Ham. ex D.Don) Benth	24	0.48	6.17	9.90
Rumex hastatus D.Don	24	0.08	4.50	8.36
Eragrostis pilosa	32	1.14	5.13	11.12
Bidens biternata (laur.) merill & sherff	24	0.48	2.00	6.06
Oxalis corniculata L.	28	1.28	4.57	9.48
Cynodon dactylon (L.) Persoon	32	2.40	7.50	13.66
Barleria cristata L.	12	0.16	1.33	3.04
Impatiens sp.	24	0.80	3.33	7.29
Artemisia nilagirica (Clarke) Pamp.	44	7.00	15.91	28.36
Stellaria media (L.) Villars	24	1.44	6.00	9.74
Chrysopogon fulvus (Sprengel) Chiovenda	20	3.80	24.00	23.79
Cymbopogon martinii (Roxb.) Wats.	28	3.40	12.14	17.01
Heteropogon contortus (L.) P. Beauv	40	5.52	16.30	26.93
Total		**43.24**		**300**
Monsoon Season				
Siegesbeckia orientalis L.	12	0.24	2.00	3.77
Verbena bonariensis L.	12	0.28	2.33	4.07
Gnaphalium luteo-album L.	8	0.16	2.00	2.90
Carex cruciata Wahlenberg	24	3.12	4.67	9.62
Geranium nepalense Sweet	16	0.20	1.25	3.89

Plant species	Frequency %	Density (ind/m2)	Abundance	IVI
Cannabis sativa L.	20	1.56	2.80	6.40
Conyza japonica (Thunb.) Less. ex DC.	24	1.48	2.00	6.38
Anaphalis contorta (D.Don) Hk. f.	16	0.36	2.25	4.89
Rumex nepalensis Sprengel	16	1.56	1.75	4.39
Anisomeles indica (L.) Kuntze	12	0.20	1.67	3.47
Euphorbia hirta L.	8	0.12	1.50	2.51
Arundo donax L.	12	0.24	2.00	3.77
Cymbopogon martinii (Roxb.) Wats.	24	3.16	9.00	14.88
Capillipedium assimile (Steud.) A. Camus	28	5.72	20.43	31.57
Oplismenus compositus (L.) P. Beauv.	20	1.88	9.40	13.72
Diplazium sp,	12	0.20	1.67	3.47
Polygonum barbatum L.	12	0.24	2.00	3.77
Chrysopogon serrulatus Trin.	32	4.44	13.88	25.04
Impatiens sp.	12	0.20	1.67	3.47
Rumex hastatus D.Don	16	1.28	1.75	4.39
Clinopodium umbrosum (M.Bieb.) C. Koch	12	0.28	2.33	4.07
Sida cordifolia (Burm. F.) Borss. Waalk.	8	0.20	2.50	3.30
Erigeron karvinskianus DC.	16	0.52	3.25	5.90
Apluda mutica L.	24	4.48	14.50	21.56
Cynodon dactylon (L.) Persoon	32	2.96	6.13	13.99
Poa annua L.	20	2.60	13.00	17.71
Heteropogon contortus (L.) P. Beauv	36	4.04	11.22	23.09
Chrysopogon fulvus (Sprengel) Chiovenda	20	2.34	11.80	16.38
Origanum vulgare L	12	0.24	2.00	3.77
Plantago depressa Willd.	12	0.16	1.33	3.17
Ajuga bracteosa Wallich ex Benth.	16	0.24	1.50	4.14
Arundinella bengalensis (Sprengel) Druce	20	1.96	4.80	8.62
Pteridium aquilinum	16	0.20	1.25	3.89
Themada caudata (Nees) A. Camus	16	0.12	7.00	9.66
Anaphalis busua (Buch.- Ham ex D.Don) DC.	12	0.32	2.67	4.37
Total		**47.06**		**300**

3.4.8 Diversity indices

Species diversity index can be considered as a measure of environmental quality and indicates the well-being of any ecosystem. To assess diversity of floral elements and structure of the plant community in different study sites, various diversity indices were measured. A diversity index is a mathematical measure of species diversity in a community. They provide more information about community composition than simply species richness (i.e., the number of species present); they also take the

relative abundances of different species into account. Three species diversity indices viz., Shannon index of general diversity (H'), dominance index (D) and Pielou's evenness index (J) have been calculated.

Shannon Weinner index (H′) is an index used to measure diversity in categorical data. Value of Shannon Weinner index (H′) more than 2 is indicative higher species diversity while its value around 1 or less than 1 indicates low diversity. Diversity index (H') increases in value as the number of species increases. Thus, higher the value of (H′) the greater is the species diversity in the community. In the present study species diversity (H') ranged between 1.37 - 2.51 for tree species and 2.02 -2.42 for shrub species in all sampling sites. In case of herbs, the range of diversity was calculated for winter season (2.35 to 2.79), Pre monsoon (2.65- 3.15), whereas comparatively increased (2.52 to 3.04) in monsoon season for all the sampling sites. The maximum index for any community clearly indicates that the species richness and favourable condition for plant growth plays an important role in increasing species diversity.

Dominance diversity (Cd) is another diversity index which always ranges from 0 - 1, indicates species dominance within community gives greater weight to common species. In addition, the value of dominance closer to 1 indicates areas dominated by single or few species. The value of dominance had followed an opposite trend of diversity. From the present observations, Site-VII, power house site (tree layer) found to have maximum concentration dominance (0.365) with least diversity (1.37) whereas; site-V (herb layer) of monsoon season had the lowest dominance (0.053) with maximum species diversity (3.15). Dominance is also used for the estimation of heterogeneity of various sites.

The distribution of individuals among the species, referred to as Evenness, which compares the similarity of the population size of each of the species present. As species richness and evenness increase, so diversity increases. In the present study Pielou's evenness (J) ranged between 0.76 to 0.98 for tree species and 0.86-.0.94 for shrub species in all study sites. In case of herbs, the range of evenness (J) was calculated 0.85 to 0.92 for winter, 0.91 to 0.92 for Pre monsoon season and 0.75 to 0.86 for monsoon season in all study sites which reflected low value of evenness & indicates that there is dominance by few species and equally distributed in the study

area. The diversity indices measurements of trees, shrub and herbs at various sampling sites (communities) are given in Tables-3.58 to 3.62 respectively.

Table-3.58 Diversity indices of tree species occurring at various sampling sites

Project sampling sites	Shannon-wiener Diversity Index (H′)	Concentration of dominance (Cd)	Evenness (J)
Site-I	2.51	0.085	0.98
Site-II	2.39	0.101	0.96
Site-III	1.93	0.188	0.88
Site-IV	1.92	0.181	0.88
Site-V	1.74	0.205	0.90
Site-VI	1.65	0.272	0.79
Site-VII	1.37	0.356	0.76
Site-VIII	1.93	0.194	0.84

Table-3.59 Diversity indices of shrub species occurring at various sampling sites

Project sampling sites	Shannon-wiener Diversity Index (H′)	Concentration of dominance (Cd)	Evenness (J)
Site-I	2.33	0.108	0.94
Site-II	2.32	0.128	0.90
Site-III	2.02	0.150	0.92
Site-IV	2.12	0.151	0.86
Site-V	2.31	0.122	0.91
Site-VI	2.41	0.103	0.94
Site-VII	2.38	0.112	0.90
Site-VIII	2.42	0.110	0.89

Table 3.60 Diversity indices of herb species occurring at various sampling sites during winter season

roject sampling sites	Shannon-wiener Diversity Index (H′)	Concentration of dominance (Cd)	Evenness (J)
Site-I	2.66	0.081	0.87
Site-II	2.52	0.094	0.87
Site-III	2.65	0.082	0.89
Site-IV	2.35	0.116	0.85
Site-V	2.54	0.094	0.88
Site-VI	2.76	0.079	0.89
Site-VII	2.40	0.116	0.85
Site-VIII	2.79	0.071	0.92

Table 3.61 Diversity indices of herb species occurring at various sampling sites during Pre monsoon season

Project sampling sites	Shannon-wiener Diversity Index (H′)	Concentration of dominance (Cd)	Evenness (J)
Site-I	2.69	0.084	0.87
Site-II	2.98	0.058	0.92
Site-III	2.84	0.070	0.89
Site-IV	2.81	0.074	0.91
Site-V	3.15	0.053	0.92
Site-VI	2.94	0.065	0.89
Site-VII	2.65	0.099	0.81
Site-VIII	2.78	0.078	0.86

Table 3.62 Diversity indices of herb species occurring at various sampling sites during monsoon season

Project sampling sites	Shannon-wiener Diversity Index (H′)	Concentration of dominance (Cd)	Evenness (J)
Site-I	2.79	0.088	0.82
Site-II	2.33	0.131	0.75
Site-III	2.52	0.112	0.77
Site-IV	3.04	0.065	0.86
Site-V	2.99	0.070	0.83
Site-VI	2.83	0.088	0.82
Site-VII	2.82	0.084	0.83
Site-VIII	2.91	0.076	0.82

3.4.9 Economically Important Plant Species

The project area is blessed with high valued medicinal plants, which grow in wild as natural component of vegetation. The people of the area use wild plants in their daily life as food, medicine, fiber, fodder, fuel wood, timber, resin, oil, vegetables, fruits and various minor forest products. They use medicinal plant species for sustenance of their traditional healthcare system both logistically as well as economically. These plants are used internally for treating stomachic diarrhea, dysentery, cough, cold, fever, asthma and externally for rheumatism, skin diseases, cuts, boils, fractures and injuries. The usage of various plant species by the locals varies with the altitude and availability of resources in the surrounding areas. The list of economically and medicinally important plant species observed in the study area is enumerated in Table-3.63.

Table-3.63 List of economically important plant species recorded from the study area

Botanical Name	Local name	Economic value
Abies pindrow Royley	Muronda	Timber
Ajuga bracteosa Wallich ex Benth	Nilkanthi	Medicinal
Alnus nepalensis D.Don	Kweench/Utis	Fuel wood/Soil binder
Anemone obtusiloba D.Don	-	Medicinal
Angelica glauca Edgew	Janglijira	Medicinal
Artemisia nilagirica (Clarke) Pamp.	Kunja/chhamra	Medicinal
Arundinaria falcata L.	Ringal, Nirgal,	Mats and Baskets
Asparagus adscendens Roxb.	Satawar	Medicinal
Aster thomsonii Cl.	Phyulari	Medicinal
Barleria cristata L.	-	Medicinal
Berberis aristata DC.	Kashmol	Beverages/Fruit edible
Berberis lyceum Royle	Kashmol	Fencig/Fruit edible
Bergenia ciliata (Haw.) Sternberg	Dokphulu	Medicinal
Betula alnoides Buch.-Ham. ex D. Don	Kath-Bhuj	Medicinal
Betula alnoides Buch.-Ham. ex D. Don	Kathbhuj	Fuelwood, fodder
Cannabis sativa L.	Bhang	Seed edible/Medicinal
Cedrus deodara (Roxb. Ex Lam) G. Don	Deodar	House construction wood/Rasin/Medicinal
Celtis australis L.	Kharik	Fodder
Chenopodium album L.	jangli Bethu	Seed edible
Clinopodium umbrosum (M. Bieb.) C. Koch	Dirchi	Medicinal
Coriaria nepalensis Wallich	Gingaaru	Fruit edible
Daphne papyracea Wallich ex Steudel	Satpura	Medicinal
Debregeasia salicifolia (D.Don) Rendle	Sinyaru	Fodder
Duchesnea indica (Andr.) Focke	Bumlaa	Fruit edible
Ficus palmata Forsk.	Fedu	Fruit edible/Medicinal
Ficus semicordata Buch.-Ham. ex J.E. Smith	Khanu	Fruit edible/Fodder
Fragaria vesca L,	Bhumla	Medicinal
Geranium nepalense Sweet	Sinyuli	Medicinal
Gerbera gossypina Royle	Kapees	Medicinal
Gloriosa superba L.	Lily	Medicinal
Heteropogon contortus (L.) P. Beauv.	-	Fodder
Inula cappa (Buch.-Ham.ex D.Don)	Bhatta/Athhula	Medicinal
Juglans regia L.	Akhrot	Fruit edile/Fuelwood
Juglans regia L.	Akhrot	Fruit edible
Litsea elongata (Nees) Gamble	Nareekh	Fuelwood
Lyonia ovalifolia (Wallich.) Drude	Anyar	Fuelwood
Mentha longifolia L.	Jnglipodina	Medicinal
Morus serrata Roxb.	Kimu	Fodder

Botanical Name	Local name	Economic value
Myrica esculenta Buch.-Ham.ex D.Don	Kafal	Fruit edible
Nepata elliptica Royle ex Benth.	Upraya ghas	Medicinal
Ougeinia oojeinensis (Roxb.) Hochreutiner	Chhanen	Fodder
Phyllanthus emblica L.	Aonla	Fruit edible/Medicinal
Pinus roxburghii Sargent	Salli/Chir	Timber/Rasin
Pinus wallichiana A.B. Jackson	Kail	Timber
Pistacia khinjuk Stocks	Kaked	Fuelwood
Plantago depressa Willd.	Luhuriya	Medicinal
Pottentila sp	-	Medicinal
Primula denticulata Smith	-	Medicinal
Prinsepia utilis Royle	Bekhal	Sacred/Medicinal
Prunus armeniaca L.	Chullu	Medicinal
Prunus cerasoides D.Don	Phaja	Sacred/Fuelwood
Pyracantha crenulata (D.Don) M. Roemer	Bakeel	Fencing/Medicinal
Pyrus pashia Buch.-Ham ex D.Don	Moul	Fruit edible/Fencing
Quercus floribunda Lindley ex Rehder	Moru	Fodder/Fuelwood
Quercus glauca Thunb.	inni	Fodder
Quercus leucotrichophora A.Camus	Bhanj	Fodder/Fuelwood
Rabdosia coetsa (Buch.-Ham. ex D.Don)	-	Medicinal
Rhododendron arboreum Smith	Buransh	Flower edible/Medicinal
Rumex nepalensis Sprengel	Kharacha	Medicinal
Saccharum filifolium (Nees) A. Camus	Samghas	Fodder/Thatching
Sida cordata (Burm. F.) Borss. Waalk.	Kharenti	Medicinal
Sida cordifolia (Burm. F.) Borss. Waalk.	Delachi	Medicinal
Sorbaria tomentosa (Lindley) Rehder	-	Medicinal
Stellaria media (L.) Villars	Badiyara	Medicinal
Swertia alata (Royley ex D.Don) C.B.Clarke	-	Medicinal
Tanacetum longifolium Wall ex DC.	-	Medicinal
Thalictrum foliolosum DC.	Kirmoli	Medicinal
Toona serrata (Royley) M. Roem.	Darli	Timber
Ulmus wallichiana Planch.	Himari	Timber, fuelwood
Vitis jacquemontii Parker	Shimonia	Medicinal
Woodfordia fruticosa (L.) Kurz.	Dhayi	Fodder/Medicinal
Zanthoxylum armatum DC.	Timru	Mouthwash/Medicinal

3.4.10 Lower Floral Diversity

In the lower floral diversity, pteridophytes are important constituents of the floristic accounts in the study area. Pteridophytic (Cryptogames) eliments are mostly found in shady and moisture rich locality which makes a major contribution to the higher plants. Sandip Kumar Behera & Prem Behari Khare (2014) have reported around 55 species of ferns and fern allies from Govind Wildlife Sanctuary area. The common species of cryptogams (pteridophytes) recorded in the study area during field survey include Pteridium aquilinum, Onychium contiguum, Pteris cretica, Diplazium polypodioides, Adiantum venustum, Dryopteris wallichiana, Selaginella kraussiana etc. A good growth of moss, liverworts and hornworts were also observed in places of rocky and boulders along the river. Numerous patches of ashy blue and yellow coloured, crustose lichens were observed attached over the big boulders and rocks at the PH site. Some of non-vascular epiphytes such as lichens and variety of mosses also covered considerable space on the barks of the trees in the forest. The list of some lower plant species observed in the study area is enlisted in Table 3.64.

Table 3.64 List of lower flora recorded from the proposed project area

Botanical name	Family	Status
Adiantum Phillipense	Adiantaceae	Common
Adiantum capillus- veneris	Adiantaceae	Common
Adiantum venustum	Adiantaceae	Common
Asplenium trichomanes	Aspleniaceae	Common
Asplenium trichomanes	Aspleniaceae	Common
Athyrium nigripes	Athyriaceae	Common
Athyrium nigripes	Athyriaceae	Common
Dryopteris cochleata	Dryopteridaceae	Common
Dryopteris conjugata	Dryopteridaceae	Common
Dryopteris wallichiana	Dryopteridaceae	Common
Equisetum diffusum	Equisetaceae	Common
Lepisorus contortus	Polypodiaceae	Common
Onychium contiguum	Cryptogrammaceae	Common
Diplazium polypodioides	Dryopteridaceae	Common
Pteridium aquilinum	Pteridiaceae	Common
Pteris aspericaulis	Pteridiaceae	Common
Pteris cretica	Pteridiaceae	Common
Pteris pseudoquadriaurita	Pteridiaceae	Common
Selaginella kraussiana	Selaginellaceae	Common
BRYOPHYTES		
Anthoceros sp.	Anthocerotaceae	Common
Funaria sp.	Funariaceae	Common
Marchantia paleacea	Marchantiaceae	Common
Pellia sp.	Pelliaceae	Common
Riccia sp	Ricciaceae	Common

Botanical name	Family	Status
LICHENS		
Heterodermia sp.	Physciaceae	Common
Cladonia sp.	Cladoniaceae	Common
Parmelia sp	Parmeliaceae	Common
Usnea indica	Sphaerophoraceae	Common
FUNGI		
Aecidium sp.	Pucciniaceae	Common
Agaricus sp.	Agaricaceae	Common
Ganoderma lucidum	Ganodermataceae	Common
Laccara sp.	Hydnagiaceae	Common
Morchela esculenta	Morchellaceae	Common
Rhizopus sp.	Mucoraceae	Common
Uncinula sp.	Erysiphaceae	Common
Ganoderma lucidum	Ganodermataceae	Common

3.4.11 Red Status of Species

As per the Red Data book of Indian plants (Nayer & Sastry, 1987, 1988, 1990), few species fall under the rare category. Further, R. Manikandan & S.K. Srivastava (2015) have reported some plants under RET category in Govind Wildlife Sanctuary, Western Himalaya, which are listed in Table-3.65. In the present study and with update from IUCN (Red List), only one plant species (angelica glauca) is found to be in Endangered category. Rest are either categorized under LC/Least Concerned or are absent from the list. All these species were observed at much higher elevation of Barrage & Power house site and are not going to be affected or uprooted from the project activity.

Table-3.65 List of threatened plant species as reported by R. Manikandan & S.K. Srivastava, Indian Forester, 141 (9):966-973, 2015

Botanical Name	Local Name	Habit	Status
Acer caecium	Marik/Maple	Tree	Vulnerable
Angelica glauca Edgew	**Chora**	**Herb**	**Endangered**
Asparagus adscendens Roxb.	Satawar	Shrub	Rare
Berberis aristata DC.	Kashmol	Shrub	Endangered
Hedychium spicatum Buch.-Ham.	Van haldi	Herb	Rare
Betula alnoides Buch.-Ham. ex D. Don	Kathbhuj	Tree	Rare
Thalictrum foliolosum DC.	Mamri	Herb	Vulnerable

3.4.12 Agriculture practices including Horticulture

The habitation area also following agricultural practices in the project area. The major crops grown in the area are categorized into cereals, vegetables, pulses, and fruits. The details of vegetation under cultivation practices are given in Tables 3.66.

Table 3.66 Agriculture crops/ vegetables/ fruits grown in the area

Botanical name	English name	Local name
MAJOR CROPS		
Triticum aestivum	Wheat	Gahun
Amaranthus cruentus	Red Amaranth	Cholayi
Solanum tuberosum	Potato	Aaloo
Fagopyrum esculentum	Buckwheat	Ogla
Brassica compestris	Mustard	Sarson
Elusine 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
Phaseolus mungo	Blackgram	Urad/Maash
Lens esculenta	Lentils	Masoor
VEGETABLES		
Solanum tuberosum	Potato	Aaloo
Pisum sativum	Pea	Matar
Fgopyrum tataricum	Buckwheat	Phafra
Colocacia esculenta	Cocoyam	Arabi/Gaguli
Raphanus sativus	Radish	Muli
Solanum melongena	Bringal	Baingan/ Batasu
Cucurbita maxima	Pumpkin	Kaddu
Chinopodium album	Chinopodium	Bathuwa/Bethu
Spinacia olaracea	Spinach	Palak
Curcuma longa	Turmeric	Haldi
FRUITS		
Pyrus communis	Pear	Nashpati
Pyrus malus	Apple	Seb
Prunus persica	Peach	Aadu
Prunus armeniaca	Apricot	Chulu/Khumbani
Juglans regia	Walnut	Akhrot

3.4.13 Protected Area

The proposed project site is located close to Govind Wildlife Sanctuary and Govind National Park. The Govind Wildlife Santuary comprises of Rupin Supin ranges and erstwhile of Tons forest division, and was notified vide G.O. no. 720/14-725/1953 dated 23.03.1955 G.W.S. spread over an area of 957.97 sq. km. Later, an area of 472.06 sq.km, which was part of sanctuary notified as National Park vide G.O. No. 394/14-3-137/86 dated 26.02.1990. The entire area lies in the middle and Greater Himalayas between 1300m to 6523 m. The Protected area forms the upper catchment of the Tons river, which is the most impotant tributary of the Yamuna river.

The Sanctuary is a fairly well populated area with 42 villages some of which are located, at as high as 2800 meter altitude. The people living in these villages are very poor. The main occupation of the peoples of these villages in rearing livestock and practicing marginal agriculture. The villagers depend on the forest for many of their basic needs. Local people are largely dependent on Natural resources like fuel, fodder, timber and Minor Forest Produces (MFP) for their livelihood. These human interference heavily influence the Protected Area. The major impact is on account of grazing by livestock.

The Govind wildlife Sanctuary/NP falls in the Biotic Province 2 B (Western Himalaya) as per the Bio-geographic Classification by Rodgers & Panwar (1988). The tract harbours a rich array of habitats, vegetation types and floral and faunal communities typical of temperate–alpine regions. Depending upon the terrain, altitude, aspect, proximity to human habitation and history of anthropogenic pressures a number of vegetation types can be recognized in the area.

The major groups and subgroups as per classification by Champion and Seth (1968) are Himalayan Chir Pine Forest (9/C1b); Himalayan Moist Temperate Forests which include various sub-groups such as Banj oak (Quercus leucotrichophora) forest (12/C1a); Moru oak (Quercus dilatata) forest (12/C1b); Moist deodar (Cedrus deodara) forest (12/C1c); Western mixed (Spruce, blue pine, silver fir) conifer forest (12/C1d); Kharsu oak (Quercus semecarpifolia) forest (12/C2a); West Himalayan upper oak/fir forest (12/C2b); Moist temperate deciduous forest (12/C2c); Montane bamboo brakes (C2/DS1); Alder forest (C2/E2): West Himalayan Sub-lpine Birch/Fir (Betula/Abies) Forest (13/C2); Birch-Rhododendron Scrub Forest (15/C1); Dwarf rhododendron scrub (15/E1); Dwarf juniper scrub (15/E2) and Alpine Pastures (15/C3).

The upper catchments comprising the sub-watersheds of Harkidoon Gad and Ruinsara Gad represent mostly sub-alpine and alpine vegetation. On the other hand the lower parts especially the sub-watersheds of Rupin and Supin along with intervening areas have several categories of temperate conifer and broadleaf forests, anthropoge and secondary scrub. In the temperate belt most important category include moist temperate deciduous forest dominated by Maples (Acer spp.), Hazel nut (Corylus jacquemontii), Horse chestnut (Aesculus indica), Hornbeam (Carpinus viminea), Himalyan mulberry (Morus laevigata), Elm (Ulmus wallichiana) among others. These forests support a rich understorey vegetation. The riverine

area between Taluka and Osla supports patches of mixed conifer forests, moist deodar forests, two species of oak (Q.leucotrichophora and Q. dilatata) and Rhododendron arboreum. The stream banks and alluvial fans support riverine forests characterized by gregarious growth of alder (Alnus nepalensis), low altitude birch (Betula alnoides) and associates. The treeline vegetation is represented by patches of birch - rhododendron (Betula utilis - Rhododendron campanulatum), high altitude fir (Abies spectabilis) and brown oak (Quercus semecarpifolia). The alpine scrub and meadows within the National Park exhibit a great profusion of herbaceous plants, tussock forming grasses, sedges, and matted shrubs. The alpine meadows, frequently termed as Bugyals are rich in attractive herbs such as species of Ranunculus, Anemone, Corydalis, Cardamine, Arenaria, Potentilla, Geranium, Senecio, Silene, Primula, Gentiana, Pedicularis and Impatiens among others. In addition, the alpine zone (both scrub and meadows) harbour a large number of high value medicinal plants, notably, Gandrayan (Angelica glauca), Salam Panja (Dactylorhiza hatagirea), Kutki (Picrorhiza kurrooa), Dhoop (Jurinea macrocephala) and Atis (Aconitum heterophyllum).

The Govind Wildlife Sanctuary/NP is home of a diverse faunal assemblages typical of Western Himalaya. Rapid surveys of mammalian and avi-fauna conducted by the Wildlife Institute of India and Zoological Survey of India (Sathyakumar 1994; Kumar et al.,2004) reveals that this tract has at least 32 species of mammals and over 115 species of birds.The prominant mammalian fauna include Snow Leopard (Uncia uncia), Yellow hroated Marten (Martes flavigula), Mountain Weasel (Mustela altaica), Brown Bear (Usrus arctos), Asiatic Black Bear (Selenarctos thibetanus), Wild pig (Sus scrofa), Himalayan musk deer (Moschus chrysogaster), Sambar (Cervus unicolor), Barking deer (Muntiacus muntjak), Himalayan Tahr (Hemitragus jemlahicus), Goral (Nemorchaedus goral), Serow (N. sumatraensis), Bharal or Blue Sheep (Pseudois nayaur) and Royale's Pika (Ochotona roylei). Among avifauna Himalayan monal (Lophophorus impejanus), Koklass pheasant (Pucrasia macrolopha), Kalij pheasant (Lophura leucomelanos) and Cheer pheasant (Catreus wallichii) are prominent, albeit with low densities. The location of Govind Pashu Wildlife Sancturay/National Park alongwith the project layout is shown in Figures-3.16 and Figure-3.17 respectively.

The proposed project has recommended for Wildlife Clearance by Standing Committee of National Board for Wildlife (NBWL) and Copy of recommendation is

enclosed as Annexure-II.

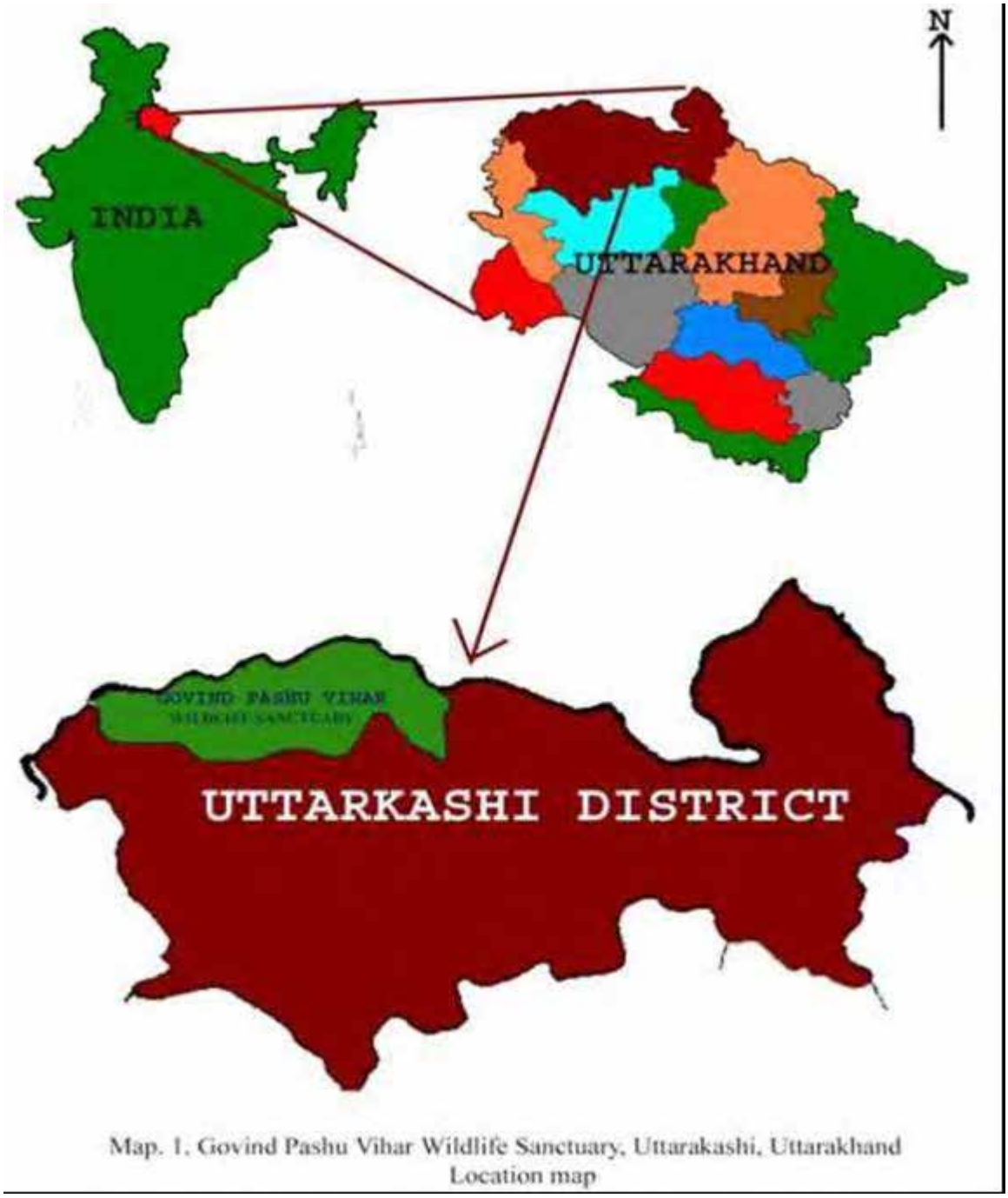


Figure-3.16: Location of Govind Pashu Vihar Wildlife Sanctuary

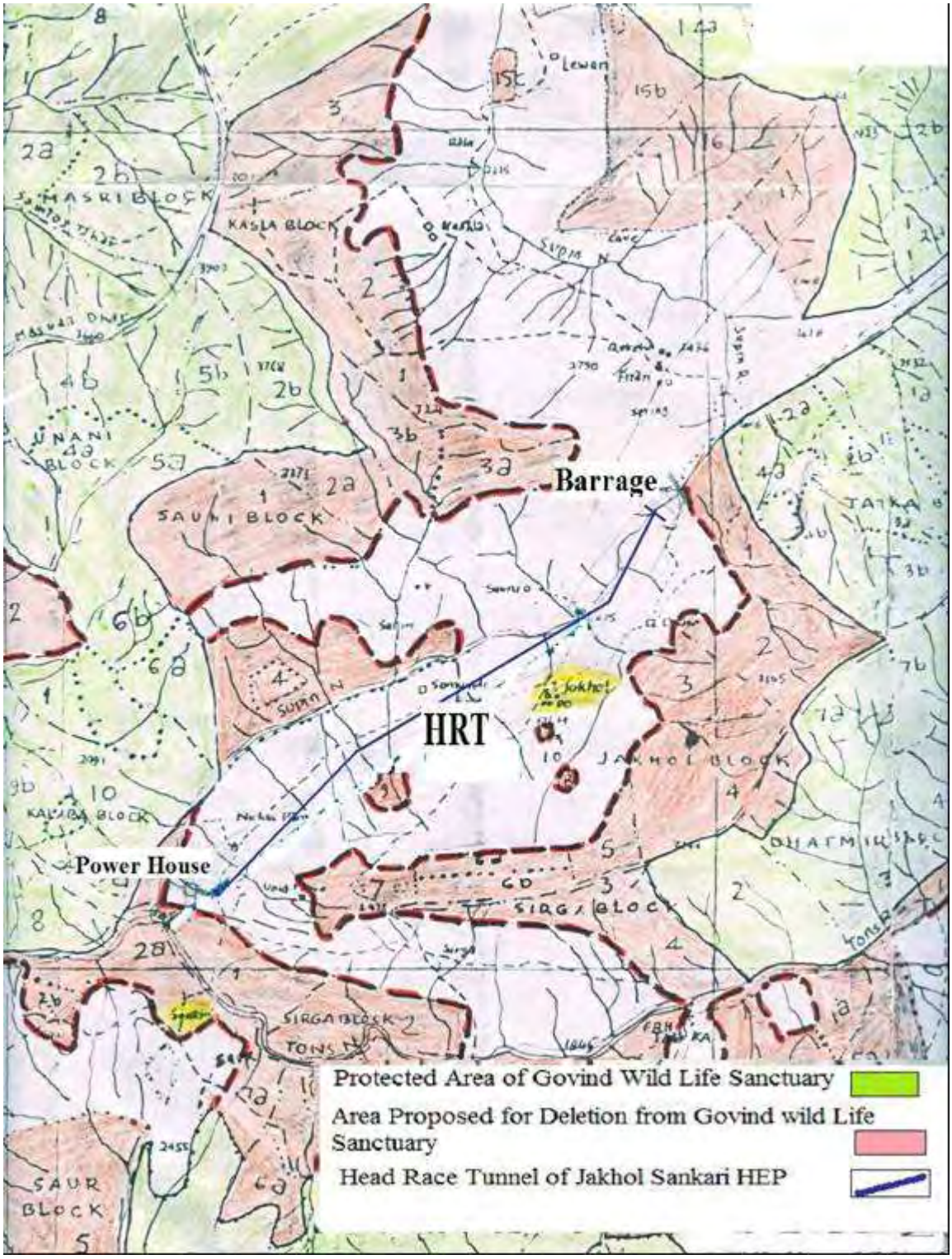


Figure-3.17: Project Layout alongwith the location of Govind Pashu Vihar Wildlife Sanctuary

3.4.14 Fauna

The fauna of the study area consists mostly of species with zoo-geographic affinities of palaearctic, Indo-Malayan and indigenous variably. However, to gain an insight in the following respects for species of carnivore, ungulates, non-human primates, mammals, birds/butterflies, reptiles and other fauna, the survey was conducted in the study area up to 10km radius from the project appurtenances in catchment-submergence zone, Barrage site, power house site and d/s power house site upto 5km river reach length. Ground surveys was carried out by trekking the impact zone for identification of faunal species inhabiting the area along the riverbanks, adjoining forest on the slopes, nallahs, hill top and agricultural fields.

I. Mammals

Ranging from area under permanent snow cover to the hot sub-tropical jungles of the foothills, the catchment area presents diverse habitats with significant levels of variation. This area is the home of a wide variety of mammals, reptiles and birds. However, due to the presence of scattered discontinuous patches of forest cover in the area of Jakhol-Sankri HEP, the wild animals would not prefer to come in the project area from the dense forest of protected area.The study of fauna takes substantial amount of time to understand the specific faunal characheristics of the area. Apart from direct sightings and primary data generated through animal call, footmark and excreta, intraction with local people and forest staff were also made to generate secondary data on distribution, species diversity and their conservation implications in the study area. On the basis of secondary data review and information collected the wild mammals are found in the upper reaches of forested area. Some of the common mammals found in the area are Wild Boar (Sus scrofa), Jackal (Canis aureus), Common Langur (Semnopithecus entellus), Rhesus Macaque (Macaca mulatta) and Yellow throated marten (Martes flavigula). Other mammals which are generally remain at higher altitude peaks and alpine pature land are Barking deer (Muntiacus muntjak), Snow Leopards (Panthera pardus), Himalayan black bear (Selenarctos thibetanus), Goral (Naemorhedus goral), Jungle Cat (Felis chaus) etc. The list of mammal species observed in the Study Area and their conservation status is given in Table-3.67.

Table-3.67 List of Mammalian species observed in project area along with their Conservation status

Common Name	Family	Scientific Name	IUCN Status	IWPA-1972
Sikkim Large Clawed Shrew	Soricidae	Soriculus nigrescens	LC	-
Greater Horse-shoe Bat	Megadermatidae	Rhinolophus ferrumequinum	LC	-
Serow	Bovidae	Capricornis sumatraensis	VU	I
Goral	Bovidae	Naemorhedus goral	NT	III
Jackal	Canidae	Canis aureus	LC	II
Common red fox	Canidae	Vulpes vulpes	LC	II
Common Langur	Cercopithecidae	Semnopithecus ente	LC	II
Rhesus Macaque	Cercopithecidae	Macaca mulatta	LC	II
Barking Deer	Cervidae	Muntiacus muntjak	LC	III
Sambar	Cervidae	Curvus unicolor	VU	III
Leopard	Felidae	Panthera pardus	NT	I
Jungle cat	Felidae	Felis chaus	LC	II
Indian Porcupine	Histricidae	Hystrix indica	LC	IV
Indian Hare	Leporidae	Lepus nigricollis	LC	IV
House Rat	Muridae	Rattus rattus	LC	V
Field Mouse	Muridae	Mus booduga	LC	V
House Mouse	Muridae	Mus musculus	LC	V
Yellow-throated Marten	Mustelidae	Martes flavigula	LC	II
Mountain weasel	Mustelidae	Mustela altaica	NT	II
Fruit Bat	Pteropidae	Rousettus leschenaulti	LC	V
Short-nosed Fruit Bat	Pteropidae	Cynopterus sphinx	LC	-
House Shrew	Soricidae	Suncus murinus	LC	-
Wild Boar	Suidae	Sus scrofa	LC	III
Himalayan Black Bear	Ursidae	Ursus thibetanus	VU	II
India Pipistrelle	Vespertilionidae	Pipistrellus babu	LC	IV

*LC = Least Concerned; VU = Vulnerable; EN = Endangered, NT=near Threatened
* Source-Govind Wildlife Sanctuary/NP wildlife status

II. Herpetofauna

As per secondary data sources, total 9 species of reptiles and 4 species of amphibians has been recorded from the area. However, during priamary survey, no such species was encountered except the rock agama and skinks.The occurrence of common species of reptiles and amphibians is enlisted in Table-3.68.

Table-3.68 List of Reptiles and Amphibians reported in the study area

Common name	Scientific name
Reptiles	
Himalayan rock skink	Asymblepharus himalayanum
West Himalayan rock agma/lizard	Agama tuberculata
Himalayan cat snake	Boiga multifasciata
Yellow-belled Mole skink	Eumees taeniolatus
Indian Gama	Boiga trigonata
Himalayan pit viper	Gloydius himalayanus
Himalayan skink	Suncella himalayanum
Mountain keelback	Amphiesma platyceps
Spiny-tailed lizard	Uromastyx hardwickii
Ambhibians	
Mountain frog	Nanorana leipigii
Common frog	Rana tigrina
Himalayan Toads	Bufo himalayanus
Common Indian Toad	Duttaphyrnus melanostrictus

* Source-Govind Wildlife Sanctuary/NP wildlife status

III. Butterflies

Insects are the most numerous, and dominant life forms on the earth. Among insects butterflies are considered as environment indicator which plays an important role in pollination. Some of the butterflies like Small copper (Lycaena phlaeas), Common Sailor (Neptis sp), Common leopard (Phalantha Phalentha), Common marmom (Papilio polytes romulus), Pale clouded yellow (Colias erate) and Indian cabbage white (Pieris canidia indica) were common and found throughout the study area. The list of butterflies reported from the study area is given in Table-3.69.

Table-3.69 List of butterflies reported from the Study Area

Common name	Scientific name
Common peacock	Papilio polyctor polyctor
Common marmom	Papilio polytes romulus
Indian cabbage white	Pieris canidia indica
Large Cabbage whitw	Pier brassicae nepalensis
Lemon emigrant	Catopsilia pomona
Spotless yellow	Eurema sp
Pale clouded yellow	Colias erate
Himalayan blackvein	Aporia sp
Common Tiger	Danous genutia genutia
Common forester	Lethe insana insana
Common punch	Dodona durga
Common beak	Libythia lepita
Common Sailor	Neptis hylas astola
Chocolate pancsy	Presis iphita siccata
Common silver stripe	Fabriciana kamala
Orange Oakleaf	Kalima inachus

Common name	Scientific name
Common leopard	Phalantha phalentha
Hedge blue	Celastrina sp
Pale grass blue	Zizeeria maha maha
Common copper	Lycaena phlaes

Source: Forest Department

IV. Avi-fauna

The commonly observed bird species include White-cheeked Bulbul, Indian Myna, Hoopoe, Spotted Forktail, Black Partridge, Spotted Turtle Dove, Jungle Babbler, Grey Wagtail, Red-billed Magpie, Slaty-Blue Flycatcher etc. Most of the species of birds are protected as their respective families have been listed under Schedule IV of Indian Wildlife (Protection) Act 1972. During present studies the species observed are illustrated in the Table 3.70.

Table-3.70 Avi-faunal species observed from the study area

Family/Common Name	Scientific Name	Habit	IUCN status	IWPA 1972
Indian Myna	Acridotheres tristis	R	LC	IV
Mrs Gould Sunbird	Aethopyga gouldiae	r	LC	IV
Crimson Sunbird	Aethopyga siparaja	r	LC	IV
Himalayan Tree Creeper	Certhia himalayana	r	LC	IV
Himalayan Pied Kingfisher	Ceryle lugubris	r	LC	IV
White-capped Redstart	Chaimarrornis leucocephalus	r	LC	IV
Himalayan Brown Dipper	Cinculus pallasii	r	LC	IV
Pallid harrier	Circus macrourus	P	NT	IV
Blue Rock Pigeon	Columba livia	R	LC	IV
Indian Magpie Robin	Copsychus saularis	r	LC	IV
Jungle Crow	Corvus macrorhynchos	R	LC	IV
Himalayan Tree Pie	Dendrocitta formosae	R	LC	IV
Northern Tree Pie	Dendrocitta vagabunda	r	LC	IV
Ashy Drongo	Dicrurus leucophaeus	r	LC	IV
Black Drongo	Dicrurus macrocercus	R	LC	IV
Golden-backed Woodpecker	Dinopium benghalensis	R	LC	IV
Spotted Forktail	Enicurus maculates	R	LC	IV
Slaty-Blue Flycatcher	Ficedula tricolor	r	LC	IV
Black Partridge	Francolinus francolinus	R	LC	IV
White-throated Laughing Thrush	Garrulax albogularis	r	LC	IV
White-crested Laughingthrush	Garrulax leucolophus	R	LC	IV
Streaked Laughing Thrush	Garrulax lineatus	R	LC	IV
White-breasted Kingfisher	Halcyon smyrnensis	R	LC	IV
Black bulbul	Hypsipetes	R	LC	IV

Family/Common Name	Scientific Name	Habit	IUCN status	IWPA 1972
	leucocephalus			
Rufous-backed Shrike	Lanius schach	R	LC	IV
White Crested Kaleej Pheasant	Lophura leucomelana	R	-	IV
Himalayan black-lored Tit	Machlolophus xanthogenys	r	-	-
Great Barbet	Megalaima virens	R	LC	IV
Chestnut-headed Bee-eater	Merops leschenaulti	p	LC	IV
Small Green Bee Eater	Merops orientalis	R	LC	IV
Black Kite	Milvus migrans	r	LC	IV
White Wagtail	Motacilla alba	wm	LC	IV
Grey Wagtail	Motacilla caspica	r	LC	IV
White-browed wagtail	Motacilla maderaspatensis	R	LC	IV
Small Niltava	Muscicapa macgrigorie	r	LC	IV
Verditer Flycatcher	Muscicapa thalassina	r	LC	IV
Blue Whistling Thrush	Myiophonus caeruleus		LC	IV
Purple sunbird	Nectarinia asiaticus	R	LC	IV
Egyptian Vulture	Neophron percnopterus	r	EN	IV
Blue-bearded Bee-eater	Nyctyornis athertoni	r	LC	IV
Cinereous Tit	Parus cinereus	r	-	IV
Grey Tit	Parus major	R	LC	IV
Yellow-cheeked Tit	Parus xanthogenys	r	LC	IV
House Sparrow	Passer domesticus	R	LC	IV
Long-tailed Minivet	Pericrocotus ethologus	r	LC	IV
Hume's Warbler	Phylloscopus humei	r	LC	IV
Blythy Leaf Warbler	Phylloscopus reguloides	r	LC	IV
Greenish Leaf Warbler	Phylloscopus trochiloides	r	LC	IV
Garhwal Pied Woodpecker	Picoides himalayensis	r	LC	IV
Brown-capped Pygmy Woodpecker	Picoides nanus	r	LC	IV
Scalbellied Woodpecker	Picus squamates	r	LC	IV
Coppersmith Barbet	Psilopogon haemacephalus	R	LC	IV
Grey-headed Parakeet	Psittacula finschii	R	NT	IV
Slaty-headed Parakeet	Psittacula himalayana	R		IV
Red-vented Bulbul	Pycnonotus cafer	r	LC	IV
White-cheeked Bulbul	Pycnonotus leucogenys	R	LC	IV
White-throated Fantail Flycatcher	Rhipidura albicollis	R	LC	IV
Plumbeous Redstart	Rhyacornis fulginosus	r	LC	IV

Family/Common Name	Scientific Name	Habit	IUCN status	IWPA 1972
Pied Bush Chat	Saxicola caprata	r	LC	IV
Grey-headed Warbler	Seicercus xanthoschistos	r	LC	IV
Velvet-fronted Nuthatch	Sitta frontalis	r	LC	IV
Crested Serpent Eagle	Spilornis cheela	r	LC	IV
Spotted Turtle Dove	Streptopelia chinensis	R	LC	IV
Ring Dove	Streptopelia decaocta	R	LC	IV
Jungle Babbler	Turdoides striatus	r	LC	IV
Grey-winged Black Bird	Turdus boulboul	r	LC	IV
Hoopoe	Upupa epops	R	LC	IV
Red-billed Magpie	Urocissa erythrorhyncha	r	LC	IV

R = resident, r = local/sparse resident, P = Migratory, p = local migratory, wm = winter migrant, LC = least concerned

3.4.15 Aquatic Ecology

I. Methodology

Plankton samples were collected using a tericot ring net of a 20 µm net to make. For enumeration of phytoplankton population, 100 l composite water samples were collected from the river surface up to60 cm depth and were filtered through a 20 µm net to make 1 l of bulk sample. The bulk samples so collected were preserved in 2% formalin solution and were brought to the laboratory for analysis. Ten replicate water samples each of 15 ml were made out of the preserved 1 l bulk sample and were centrifuged at 1500 rpm for 10 minutes. After centrifuging, the volume of aliquot concentrate was measured. 0.1 ml of aliquot concentrate was used for enumeration of phytoplankton population in each replicate. A plankton chamber of 0.1 ml capacity was used for counting of plankton under a light microscope. Periphyton-Epilithic phytobenthos were obtained by scrapping the surface of rocks and boulders (4 x 4 cm2) with the help of a hard brush and preserved in 3% formalin solution for further analyses.

For the quantification of zooplankton and phytoplankton 100 liters of water for each community was filtered at each site by using plankton net made up of fine silk cloth (mesh size 25 µm). The filtrate collected for the study of phytoplankton was preserved in Lugol's solution, while a part of the unpreserved samples for the study of zooplankton was brought to the laboratory.

Benthic macro-invertebrates were collected from the pebbles, cobbles and gravels form the surface collected up to 15 cm sediment depth at different elevations with the help of sieve of a mesh size of 100 µm.

All collected specimens –organisms of planktons, periphytons, benthoses etc were preserved in 3 % formalin solution or 70 % alcohol and were identified by using keys formulated by different workers such as Pennak (1953), Edmondson (1959), Ward and Whipple (1959), Needham and Needham (1962), Trivedy and Goel (1984), Sarod and Kamat (1984), Hustedt and Jensen (1985), Battish (1992), Edington and Holdren (1995) and APHA (1992, 1998). The density of the plankton and benthic samples was estimated by using drop count method (Bhatt et al., 2005) and standards methods of APHA (1992, 1998).

Fishes occurrence were determined by visual method and by collecting samples using different fishing gears like cast net, scoop net, hand net, hook-line, pot and open local devices methods. Fishes were identified up to the species level with the help of keys of Jayaram (1981), Menon (1987) and Talwar and Jhingran (1997). IUCN Red Data List (2008) was compared to assess threatened, endangered and vulnerable species in the study area. Conservation Assessment Management Plan of Biodiversity Conservation Prioritization Project Workshop (CAMP-BCPP, 1997) was followed to understand the threats and conservation status of Indian fish species.

The total number of planktons present in a litre of water sample was calculated using the following formula:

$$N = (n \times v \times 100) / V$$

Where, N= Number of plankton per litre

n = average number of plankton cells in 0.1 ml of aliquot concentrate

v = volume of plankton concentrate (aliquot)

V= volume of water from bulk sample centrifuged

The species diversity index was calculated using Shannon's species diversity index (H) formula taking the density values of each species into consideration.

Shannon index of general diversity (H): $- \Sigma Pi \log Pi$

Where ni = density value for each species

N = total density value

Pi = density probability for each species = ni /N

II. Study Area & Sampling sites/ Survey locations

The complete area is divided in to three zones of having and holistic view of river ecology i.e. upstream area /Submergence zone, Barrage site to powerhouse site,

and downstream influence zone covering about 20 km longitudinal length of the river in line of 10km radius approach based on project appurtenances. Samples were made during Pre monsoon season during the study period. The details of the study site and sampling locations to assess the aquatic fauna and flora are given in Table-3.71 and Figure 3.18

Table-3.71 Description of study sites selected on river Supin and its tributaries in the project impact zone

S. No.	Study Site	Sampling location
1	AE-1	Obra gad (u/s)
2	AE-2	Upstream Area of Barrage
3	AE-3	Barrage Site
4	AE-4	Downstream of Barrage Site near Bargad Nalla`
5	AE-5	Upstream of Power House Site
6	AE-6	Power House Site
7	AE-7	Downstream of Power House

AE= Aquatic Ecology

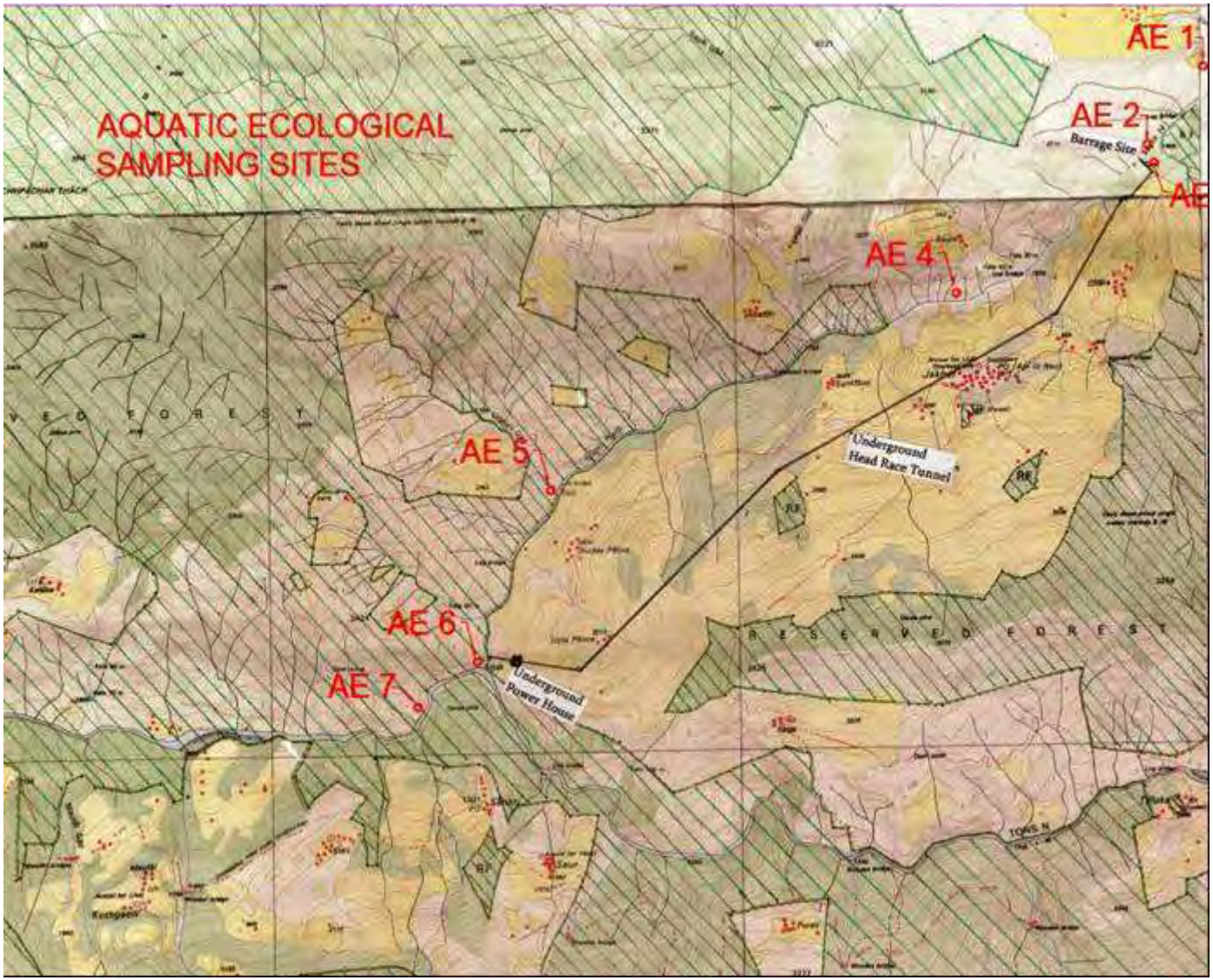


Figure-3.18: Aquatic Ecological Sampling Location Map

III. Biotic Resources (Biological Characteristics)

Biotic resources study involved the assessment of status of phytoplankton, zooplankton, phytobenthos, benthos and macro-invertebrates, macrophytes, fishes and other aquatic fauna. Biotic resources are divided into two groups i.e. autotrophs and heterotrophs. Autotroph constitutes the aquatic flora whereas heterotrophs constitutes of aquatic fauna. Aquatic flora comprises of algae in suspended form (plankton) and benthic form (phyto-benthos). Micro flora is comprised of Phytoplankton and Phytobenthos. Aquatic fauna includes zooplankton, micro-invertebrates and fish & fisheries. Aquatic flora includes microflora as phytoplankton, phytobenthos, and periphytons and macroflora consist of aquatic plants. The quantitative and qualitative descriptions of these components of Supin river and its tributaries are given below and illustrated in the Tables-3.72-3.76.

IV. Phytoplanktons

This community is represented by Chlorophyceae (green algae), Cynophyceae (blue green algae) and Bacillarionphyceae (ditoms). The poor occurrence of phytoplankton in this study can also be attributed to the high turbidity in river due to surface runoff caused by snow melt waters and precipitation /rain at higher peaks results very sedimentation load and torrent flow that inhibit the photosynthetic process, thus affect the community acutely.

A total 23 taxa were recored from the study sites during field study in various seasons. The number of taxa /species was recorded higher in side streams /tributaries than in the main river course. The stream being a freshwater body, the presence of Chlorophyceae was more prominent. Chlorophyceae included Spirogyra, Zygnema and Cladophora as filamentous algae forming sheets on the river / streams edges. Other green algae found predominate are chlorella and scenedesmus with other flagellates. Blue green algae are represented by Oscillatoria, and Schizothrix taxon. After diatoms (Bacillariophyceae), green algae are found in abundance. At most of the sampling sites Synedra, Achnanthes, Cocconeis, Fragilaria and Gomphonema taxon were the most common species in river Supin and its tributaries recorded during study period. The trend of aquatic flora is reflecting the local climatic conditions and oligotrophic in nature. However, the occurrence was quite low that may be attributed to the glacial melt water of oligotropic nature. Thus, the variation in occurrence of phytoplankton taxa is the

reflection of prevailing the water quality, channel morphology, elevation, geomorphology that occur in the project site in river Supin and its tributaries. The occurrence of various taxon in the study sites in varios seasons are given in Table-3.72 & 3.74 respectively. The diversity indices calculated for phytoplankton community for understanding the seasonal variation has been illustrated in Table 3.73 Shannon weiner diversity varies from 0.920 to 1.359 and found lowest in monsoon season. However, overall diversity remain low in the glacial fed streams/river. Similarly species richness varies from 9 to 22 and found maximum in winter and pre monsoons and lowest in monsoon season. However, density of phytoplankton was found minimum in monsoon and maximum in winters followed by summer and monsoon season i.e. 15-321 counts ind.per litre.

Table-3.72 Phytoplankton community in Supin river at different sampling sites during various seasons

Phytoplankton Taxon (cells/l)	**AE-1**	**AE-2**	**AE-3**	**AE-4**	**AE-5**	**AE-6**	**AE-7**
Blue green algae (Cyanophyceae)							
Winter Season							
Schizothrix fasciculata	12	11	12	0	15	12	17
O. limnosa	0	11	12	14	15	13	15
Oscillatoria tinues	0	12	13	14	16	15	16
Green Algae (Chlorophyceae)							
Cladophora glomerata	11	12	14	11	13	15	0
Chlorella vulgaris	12	0	11	11	13	16	15
Spirogyra porticalis	0	12	15	17	13	12	14
Scenedesmus sp	11	13	11	15	15	12	18
Zygnema himalayense	12	13	11	0	12	0	13
Diatoms (Bacillariophyceae)							
Gomphoneis herculeana	0	13	12	14	16	12	11
Cymbella affinis	11	13	0	12	14	11	14
Navicula radiosa	14	0	11	12	12	14	14
Amphora ovalis	11	0	13	13	16	12	11
Achnanthidium exilis	12	0	12	0	11	15	13
Navicula dicephala	0	12	12	11	13	13	13
Flagellaria sp	12	11	14	15	12	0	11
Flagellaria sp	0	11	14	12	12	13	15
Synedra mediocontracta	12	14	11	12	13	16	12
Cocconeis placentula	12	13	17	14	16	17	16
Flagellaria pinnata	14	13	17	14	14	14	13
Fragilaria alpestris	14	13	0	0	11	16	16
Cymbella ventricosa	13	0	0	15	15	14	17
Gomphonema	12	12	14	15	14	17	18

Phytoplankton Taxon (cells/l)	AE-1	AE-2	AE-3	AE-4	AE-5	AE-6	AE-7
olivaceoides							
Synedra ulna	11	0	13	13	13	0	19
Pre Monsoon season							
Blue green algae (Cyanophyceae)							
Oscillatoria tinues	0	3	4	2	5	3	7
O. limnosa	1	2	3	3	3	5	3
Schizothrix fasciculata	3	0	4	2	7	2	5
Green Algae (Chlorophyceae)							
Chlorella vulgaris	3	2	2	0	4	7	4
Spirogyra porticalis	0	4	4	3	2	6	2
Cladophora glomerata	0	0	2	2	4	8	6
Scenedesmus sp	2	2	0	6	8	5	4
Zygnema himalayense	3	1	0	2	3	3	6
Diatoms (Bacillariophyceae)							
Flagellaria sp	2	2	3	0	4	0	6
Fragilaria alpestris	3	5	2	1	3	5	3
Navicula radiosa	0	2	3	2	3	2	9
Synedra ulna	0	0	4	6	5	1	6
Achnanthidium exilis	3	2	5	0	2	5	4
Gomphoneis herculeana	0	5	3	0	3	7	3
Flagellaria sp	3	2	2	3	0	3	5
Cocconeis placentula	2	4	10	2	8	2	4
Flagellaria pinnata	4	3	7	4	4	4	3
Amphora ovalis	0	2	2	4	3	2	0
Cymbella ventricosa	0	1	0	3	2	6	5
Cymbella affinis	3	6	3	3	0	2	6
Gomphonema olivaceoides	6	4	2	8	7	5	4
Navicula dicephala	2	0	1	3	2	3	7
Synedra mediocontracta	0	2	3	0	4	8	5
Monsoon Season							
Blue green algae (Cyanophyceae)							
O. limnosa	0	1	0	0	2	2	1
Schizothrix fasciculata	1	0	2	1	2	0	3
Oscillatoria tinues	0	0	1	2	3	1	2
Green Algae (Chlorophyceae)							
Cladophora glomerata	0	0	1	0	2	5	4
Zygnema himalayense	2	0	2	0	2	3	4
Scenedesmus sp	2	1	0	1	3	4	6
Spirogyra porticalis	0	2	2	1	2	5	3
Chlorella vulgaris	1	0	2	1	3	2	0
Diatoms							

Phytoplankton Taxon (cells/l)	AE-1	AE-2	AE-3	AE-4	AE-5	AE-6	AE-7
(Bacillariophyceae)							
Navicula dicephala	1	0	1	2	0	1	3
Cymbella affinis	0	2	1	4	1	0	2
Navicula radiosa	2	0	1	2	2	0	6
Achnanthidium exilis	0	0	2	1	1	3	1
Cymbella ventricosa	3	0	0	1	0	3	4
Flagellaria pinnata	2	0	0	2	0	2	0
Gomphoneis herculeana	0	3	0	0	2	3	5
Flagellaria sp	1	0	2	1	2	0	2
Cocconeis placentula	0	0	4	6	3	4	8
Amphora ovalis	0	1	0	2	1	1	2
Fragilaria alpestris	0	2	1	0	2	3	2
Gomphonema olivaceoides	2	0	0	4	2	1	0
Synedra ulna	1	2	2	0	2	0	4
Flagellaria sp	2	1	2	1	0	2	6
Synedra mediocontracta	0	0	1	0	2	5	2

Table-3.73 Diversity Indices of Phytoplankton community present in the study area

Phytoplankton Taxon Index	AE-1	AE-2	AE-3	AE-4	AE-5	AE-6	AE-7
Winter Season							
Shannon H'	1.229	1.229	1.297	1.276	1.359	1.297	1.337
Shannon Hmax	1.230	1.230	1.301	1.279	1.362	1.301	1.342
Shannon J' (Eveness)	0.999	0.999	0.997	0.997	0.998	0.997	0.996
Species Richness(N)	17	17	20	19	23	20	22
Total Individuals (Density ind/l)	206	209	259	254	314	279	321
Pre monsoon season							
Shannon H'	1.114	1.229	1.241	1.202	1.280	1.290	1.318
Shannon Hmax	1.146	1.279	1.301	1.255	1.322	1.342	1.342
Shannon J' (Eveness)	0.972	0.961	0.954	0.957	0.968	0.961	0.982
Species Richness(N)	14	19	20	18	21	22	22
Total Individuals(Density ind/l)	40	54	69	59	86	94	107
Monsoon Season							
Shannon H'	1.049	0.920	1.164	1.115	1.259	1.202	1.241
Shannon Hmax	1.079	0.954	1.204	1.204	1.279	1.255	1.301
Shannon J' (Eveness)	0.972	0.964	0.966	0.926	0.985	0.957	0.954
Species Richness(N)	12	9	16	16	19	18	20
Total Individuals(Density ind/l)	20	15	27	32	39	50	70

V. Periphyton Community (Phytobenthos)

The occurrence of various taxon in the study sites in varios seasons are given in Table-3.74, respectively. The diversity indices calculated for phytobenthos community for understanding the seasonal variation has been illustrated in Table-3.75, Shannon weiner diversity varies from 0.872 to 1.076 and found lowest in monsoon season. However, overall diversity remain low in the glacial fed streams/river. Similarly, species richness varies from 8 to 12 and found maximum in winter and pre monsoons and lowest in monsoon season. However, density of phytobenthos was found minimum in monsoon and maximum in winters followed by pre monsoon and monsoon season i.e. 14-180 counts ind.per sq cm.

Table-3.74 Periphyton community in tributaries of Supin river during various seasons

Periphytons (ind./sq cm)	AE-1	AE-2	AE-3	AE-4	AE-5	AE-6	AE-7
Winter Season							
Flagellaria spp	0	12	15	18	13	16	15
Cymbella affinis	12	14	0	11	16	15	18
Flagellaria vaucherae	0	12	14	11	0	12	14
Achnanthidium Hauckiana	0	12	16	12	13	15	16
Achnanthes affinis	12	11	12	15	17	15	13
Achnanthidium exilis	11	14	13	17	14	18	12
Gomphonema parvulum	12	15	13	11	17	14	17
Diatoma hiemale	11	14	0	11	13	12	15
Achnanthidium microcephala	13	15	17	0	15	13	12
Gomphoneis herculeana	14	12	15	13	12	16	14
Reimeria sinuata	12	0	12	17	13	17	14
Gomphonema intricatum	11	12	0	16	13	17	15
Pre monsoon Season							
Achnanthes affinis	4	4	0	6	4	8	6
Flagellaria vaucherae	3	0	6	3	2	4	3
Gomphoneis herculeana	6	3	4	5	3	8	2
Diatoma hiemale	2	6	2	2	4	0	6
Achnanthidium Hauckiana	0	3	5	1	7	9	11
Cymbella affinis	3	4	1	3	4	10	5
Achnanthidium microcephala	2	9	3	2	9	7	4
Reimeria sinuata	5	3	7	5	5	5	5
Achnanthidium exilis	3	2	5	8	6	3	9
Flagellaria spp	2	5	8	3	4	5	7
Gomphonema intricatum	0	3	3	4	7	7	4
Gomphonema parvulum	2	3	4	9	5	3	8
Monsoon Season							
Flagellaria vaucherae	0	2	3	1	2	2	1
Achnanthidium Hauckiana	1	0	2	0	1	2	6

Periphytons (ind./sq cm)	AE-1	AE-2	AE-3	AE-4	AE-5	AE-6	AE-7
Achnanthidium microcephala	1	3	6	3	2	5	0
Achnanthes affinis	2	3	1	2	0	5	3
Gomphoneis herculeana	3	4	1	2	5	3	5
Cymbella affinis	0	1	3	5	2	8	9
Achnanthidium exilis	0	0	2	5	2	1	5
Gomphonema intricatum	2	1	0	2	4	1	2
Reimeria sinuata	2	1	3	2	0	2	3
Flagellaria spp	1	2	5	7	2	8	3
Gomphonema parvulum	0	2	1	5	0	0	5
Diatoma hiemale	2	4	0	0	2	1	5

Table-3.75 Diversity Indices of Periphyton community present in the study area

Periphyton Index	AE-1	AE-2	AE-3	AE-4	AE-5	AE-6	AE-7
Winter Season							
Shannon H'	0.953	1.039	0.951	1.033	1.038	1.076	1.076
Shannon Hmax	0.954	1.041	0.954	1.041	1.041	1.079	1.079
Shannon J' (Eveness)	0.999	0.998	0.997	0.992	0.997	0.997	0.997
Species Richness (N)	9	11	9	11	11	12	12
Total Individuals (D. ind/sq cm)	108	143	127	152	156	180	175
Pre monsoon Season							
Shannon H'	0.965	1.001	0.992	1.014	1.049	1.011	1.040
Shannon Hmax	1.000	1.041	1.041	1.079	1.079	1.041	1.079
Shannon J' (Eveness)	0.965	0.962	0.953	0.939	0.972	0.971	0.964
Species Richness (N)	10	11	11	12	12	11	12
Total Individuals (D. ind/sq cm)	32	45	48	51	60	69	70
Monsoon Season							
Shannon H'	0.872	0.949	0.925	0.936	0.910	0.930	0.988
Shannon Hmax	0.903	1.000	1.000	1.000	0.954	1.041	1.041
Shannon J' (Eveness)	0.965	0.949	0.925	0.936	0.954	0.893	0.949
Species Richness (N)	8	10	10	10	9	11	11
Total Individuals (D. ind/sq cm)	14	23	27	34	22	38	47

VI. Macroflora/ Macrophytes

No growth of macrophytes seen in the area that may be due to rapid currents and fall habitat which has river wash affects. However, macrophytes that remain attached to the rocks, boulders; stones, etc. belong to various genera of bryophytes (mosses). These mosses grow on stone and boulders that protrude a few centimeters above the surface of water sometimes growth reaches in the flowing water edges stones.

VII. Zooplanktons

Microfauna: Zooplanktons are represented by protozoa, rotifer and crustaceans (Table-3.76). Among protozoans Arcella, Peridinium, and Ceratium taxon are commonly observed. Rotifers are represented by Keratella, Brachionus and Philodina taxon. Copepod consists of Cyclopes species whereas cladocerans are represented by Daphnia and Bosmina sp. The occurrence are mainly from the edge pools of side stream and river banks, however, the group in totality is poorly represented due to climate conditions followed by long winters and torrential flow. The low occurrence is also linked to rapid habitat and rocky substratum in the deep gorge narrow valley. The occurrence of various taxon in the study sites in varios seasons are given in Table-3.76. The diversity indices calculated for zooplankton community for depicting the seasonal variation has been illustrated in Table 3.77. Shannon weiner diversity varies from 0.527 to 1.114 and found lowest in monsoon season. However, overall diversity remains low in the glacial fed streams/river. Similarly, species richness varies from 4 to 13 and found maximum in winter and pre monsoons and lowest in monsoon season. However, density of zooplankton was found minimum in monsoon and maximum in winters followed by pre monsoon and monsoon season i.e. 15-130 counts ind.per litre.

Table-3.76 Community composition of Zooplanktons in Supin river during various seasons

Zooplanktons (Cells/L)	AE-1	AE-2	AE-3	AE-4	AE-5	AE-6	AE-7
Winter Season							
Protozoan							
Pteridinium sp	6	8	0	6	6	5	12
Ceratium furca	12	13	8	6	9	7	9
Arcella crenulata	6	11	12	9	13	11	6
Rotifers							
Brachionus bidenta	16	18	15	12	19	21	24
Keratella quadrata	14	0	11	0	18	14	15
Polyarthra vulgaris	0	4	9	4	3	7	9
Trichocerca sp	8	4	0	5	6	8	8
Asplanchna priodonta	6	6	4	7	8	10	12
Philodena roseola	2	4	4	6	4	8	8
Cladoceran							
Bosmina longirostris	5	4	6	4	6	8	10
Daphnia pulax	7	6	8	5	11	6	6
Copepods							
Cyclops scutifer	4	8	6	5	2	5	2
Cyclops glacialis	8	12	7	9	11	14	9

Zooplanktons (Cells/L)	AE-1	AE-2	AE-3	AE-4	AE-5	AE-6	AE-7
Pre Monsoon Season							
Protozoan							
Ceratium furca	3	9	5	7	6	9	7
Pteridinium sp	0	7	3	5	3	6	4
Arcella crenulata	7	3	8	3	9	3	3
Rotifers			6	5	13	8	16
Brachionus bidenta	6	2	12	7	8	11	4
Polyarthra vulgaris	3	6	4	0	9	4	9
Philodena roseola	8	10	8	6	5	5	5
Trichocerca sp	2	5	6	3	4	3	11
Keratella quadrata	7	0	9	0	14	8	5
Asplanchna priodonta	5	7	2	5	7	6	7
Cladoceran							
Daphnia pulax	11	9	6	7	12	8	5
Bosmina longirostris	8	6	3	4	7	15	11
Copepods							
Cyclops glacialis	9	11	8	8	9	13	18
Cyclops scutifer	5	6	4	4	5	7	3
Monsoon Season							
Protozoan							
Ceratium furca	0	0	0	1	2	3	5
Pteridinium sp	0	0	0	0	1	3	2
Arcella crenulata	1	0	3	4	5	0	4
Rotifers							
Asplanchna priodonta	2	3	0	2	3	0	2
Trichocerca sp	0	0	3	0	3	3	6
Polyarthra vulgaris	0	0	0	0	2	0	4
Keratella quadrata	2	0	0	3	5	2	0
Philodena roseola	2	5	2	5	0	3	5
Brachionus bidenta	3	1	5	4	2	2	5
Cladoceran							
Bosmina longirostris	0	0	0	2	2	7	4
Daphnia pulax	3	0	2	0	5	0	3
Copepods							
Cyclops scutifer	0	0	0	0	5	4	2
Cyclops glacialis	2	7	3	6	0	4	5

Table- 3.77 Diversity Indices of Zooplankton community present in the study area

Zooplanktons Index	AE-1	AE-2	AE-3	AE-4	AE-5	AE-6	AE-7
Winter Season							
Shannon H' - Diversity	1.025	1.023	1.008	1.054	1.043	1.073	1.061
Shannon Hmax	1.079	1.079	1.041	1.079	1.114	1.114	1.114
Shannon J' (Eveness)	0.950	0.948	0.968	0.977	0.936	0.964	0.953
Species Richness (N)	12	12	11	12	13	13	13
Total Individuals(Density	94	98	90	78	116	124	130

Zooplanktons Index	AE-1	AE-2	AE-3	AE-4	AE-5	AE-6	AE-7
ind/l)							
Pre-Monsoon Season							
Shannon H' - Diversity	1.039	1.044	1.067	1.020	1.080	1.066	1.050
Shannon Hmax	1.079	1.079	1.114	1.041	1.114	1.114	1.114
Shannon J' (Eveness)	0.963	0.968	0.958	0.979	0.969	0.957	0.942
Species Richness (N)	12	12	13	11	13	13	13
Total Individuals(Density ind/l)	74	81	78	59	98	98	92
Monsoon Season							
Shannon H' - Diversity	0.825	0.527	0.756	0.853	0.994	0.922	1.053
Shannon Hmax	0.845	0.602	0.778	0.903	1.041	0.954	1.079
Shannon J' (Eveness)	0.976	0.874	0.971	0.945	0.955	0.966	0.975
Species Richness (N)	7	4	6	8	11	9	12
Total Individuals(Density ind/l)	15	16	18	27	35	31	47

VIII. Macro-invertebrates (Zoo benthos)

Macro-invertebrate fauna of river Supin are comprised by Heptageniidae, Baetidae, Ephemerellidae, Perlidae, Hydropsychidae, Hydroptilidae, Chironomidae, Simulidae, Elmiade, Blepharoceridae and Amphizoidae families (Table-3.78). Species of genera Stenonema, Epeorus, Baetis, Ephemeralla, Ochrotrichia and Chironimds are observed in the region. The distribution and occurrence is directly related to the habitat structure and substratum of Supin river and its tributaries. The poor occurrence of benthos during study period could be due to low water temperature, high turbidity, torrent flow and rocky substratum in river and its tributaries. The diversity indices calculated for macro-benthos community for depicting the seasonal variation has been illustrated in Table 3.69. Shannon weiner diversity varies from 0.642 to 1.118 and found lowest in monsoon season. However, overall diversity remains low in the glacial fed streams/river. Similarly, species richness varies from 5 to 14 and found maximum in winter and pre monsoons and lowest in monsoon season. However, density of phytoplankton was found minimum in monsoon and maximum in winters followed by pre monsoon and monsoon season i.e. 13-136 counts ind.per sq m.

Table-3.78 Macro-invertebrate (Zoo benthos) species composition in project area during various seasons

Invertebrates Taxon (ind./m2)	AE-1	AE-2	AE-3	AE-4	AE-5	AE-6	AE-7
Winter Season							
Heptageniidae							
Ameletus sp	12	6	8	6	8	15	6
Hydropsychidae							
Rhyacophila fuscula	5	7	3	8	8	6	12
Blepharoceridae							
Bibiocephalle sp	4	4	0	3	9	12	9
Elmidae							
Narpus sp larvae	3	7	1	8	0	3	17
Diptera -Simulidae							
Simulium pictipus	6	8	2	0	6	7	5
Athericidae							
Atherix sp (Snipe fly larvae)	5	3	8	10	5	8	9
Ephemerellidae							
Ephemeralla major	6	18	17	15	5	14	7
Stenonema sp	4	8	2	7	6	15	12
Baetidae							
Baetis chandra	9	3	6	13	8	11	6
Baetis himalayana	6	9	11	4	3	9	8
Perlidae							
Isoperla montana	5	3	0	11	4	6	8
Perla sp	9	4	7	0	6	3	11
Hydroptilidae							
Ochrotrichia susanae	2	0	7	5	2	7	9
Chironomidae							
Chironemous sp	0	5	8	7	11	16	17
Pre Monsoon Season							
Heptageniidae							
Ameletus sp	6	7	3	6	9	12	5
Hydropsychidae							
Rhyacophila fuscula	3	4	5	4	6	8	14
Blepharoceridae							
Bibiocephalle sp	8	0	4	7	13	3	6
Elmidae							
Narpus sp larvae	0	3	2	0	7	7	10
Diptera -Simulidae							
Simulium pictipus	7	6	0	4	3	9	6
Athericidae							
Atherix sp (Snipe fly larvae)	4	9	5	13	10	4	8
Ephemerellidae							
Ephemeralla major	3	11	7	11	9	0	3
Stenonema sp	5	6	9	5	12	8	6

Invertebrates Taxon (ind./m2)	AE-1	AE-2	AE-3	AE-4	AE-5	AE-6	AE-7
Baetidae							4
Baetis chandra	6	8	10	8	5	4	8
Baetis himalayana	3	5	5	0	8	9	11
Perlidae							
Isoperla montana	3	6	2	11	4	6	8
Perla sp	4	4	6	3	0	6	4
Hydroptilidae							
Ochrotrichia susanae	5	3	7	9	4	4	9
Chironomidae							
Chironemous sp	3	0	5	6	10	6	12
Monsoon Season							
Heptageniidae							
Ameletus sp	3	0	0	4	3	5	0
Hydropsychidae							
Rhyacophila fuscula	2	2	3	2	0	2	7
Blepharoceridae							
Bibiocephalle sp	3	0	0	0	5	2	4
Elmidae							
Narpus sp larvae	0	0	0	2	5	2	5
Diptera -Simulidae							
Simulium pictipus	3	5	0	2	0	4	2
Athericidae							
Atherix sp (Snipe fly larvae)	2	0	1	4	2	0	4
Ephemerellidae							
Ephemeralla major	0	3	0	5	3	0	0
Stenonema sp	3	0	2	0	6	3	6
Baetidae							4
Baetis chandra	3	1	5	2	5	3	3
Baetis himalayana	0	0	2	0	1	5	5
Perlidae							
Isoperla montana	1	2	0	4	3	2	1
Perla sp	0	0	0	0	0	2	0
Hydroptilidae							
Ochrotrichia susanae	2	0	0	2	4	3	5
Chironomidae							
Chironemous sp	0	0	3	5	6	8	8

Table–3.79 Diversity Indices of Benthic Innvertebrates community present in the study area

Zoobenthos Index	AE-1	AE-2	AE-3	AE-4	AE-5	AE-6	AE-7
Winter Season							
Shannon H' - Diversity	1.072	1.050	0.988	1.040	1.079	1.099	1.118
Shannon Hmax	1.114	1.114	1.079	1.079	1.114	1.146	1.146
Shannon J' (Eveness)	0.962	0.943	0.916	0.963	0.969	0.959	0.975
Species Richness (N)	13	13	12	12	13	14	14

Zoobenthos Index	AE-1	AE-2	AE-3	AE-4	AE-5	AE-6	AE-7
Total Individuals(D. ind/sq m)	76	85	80	97	81	132	136
Pre monsoon Season							
Shannon H' - Diversity	1.087	1.047	1.072	1.041	1.078	1.084	1.114
Shannon Hmax	1.114	1.079	1.114	1.079	1.114	1.114	1.146
Shannon J' (Eveness)	0.976	0.97	0.962	0.964	0.968	0.973	0.972
Species Richness (N)	13	12	13	12	13	13	14
Total Individuals(D. ind/sq m)	60	72	70	87	100	86	110
Monsoon Season							
Shannon H' - Diversity	0.935	0.642	0.732	0.967	1.003	1.029	0.996
Shannon Hmax	0.954	0.699	0.778	1	1.041	1.079	1.041
Shannon J' (Eveness)	0.98	0.919	0.94	0.967	0.963	0.954	0.957
Species Richness (N)	9	5	6	10	11	12	11
Total Individuals(D. ind/sq m)	22	13	16	32	43	41	50

3.4.16 Fisheries

Background

Fisheries in the project area is not well developed, owing to difficult terrain, unfavorable climate. The elevation, temperature, current, velocity and natural biota are the factors governing the growth of fish in the rivers and water bodies in the area. Commercial fishing is not in practice in the Study Area.

Study Area and Sampling sites/ Survey locations

The complete area is divided in to three zones : a) upstream area /Submergence zone, b) barrage site to powerhouse site, and (c) downstream influence zone covering about 10 km longitudinal length of the river in line of 10km radius approach based on project appurtenances.

Fisheries survey was done for 3 seasons namely pre-monsoon, monsoon and winter seasons during the study period. The details of the study site and sampling locations to assess the aquatic fauna and flora are given in Table-1 and depicted in Figure 18. The photographs of river morphology and various sampling sites are given in Plate 1 and 2 respectively.

Table-1: Description of study sites selected on river Supin and its tributaries in the project impact zone

S. No.	Study Site	Sampling location
1	AE-1	Obra gad (u/s)
2	AE-2	Upstream Area of Barrage
3	AE-3	Barrage Site

S. No.	Study Site	Sampling location
4	AE-4	Downstream of Barrage Site near Bargad Nalla`
5	AE-5	Upstream of Power House Site
6	AE-6	Power House Site
7	AE-7	Downstream of Power House

AE= Aquatic Ecology

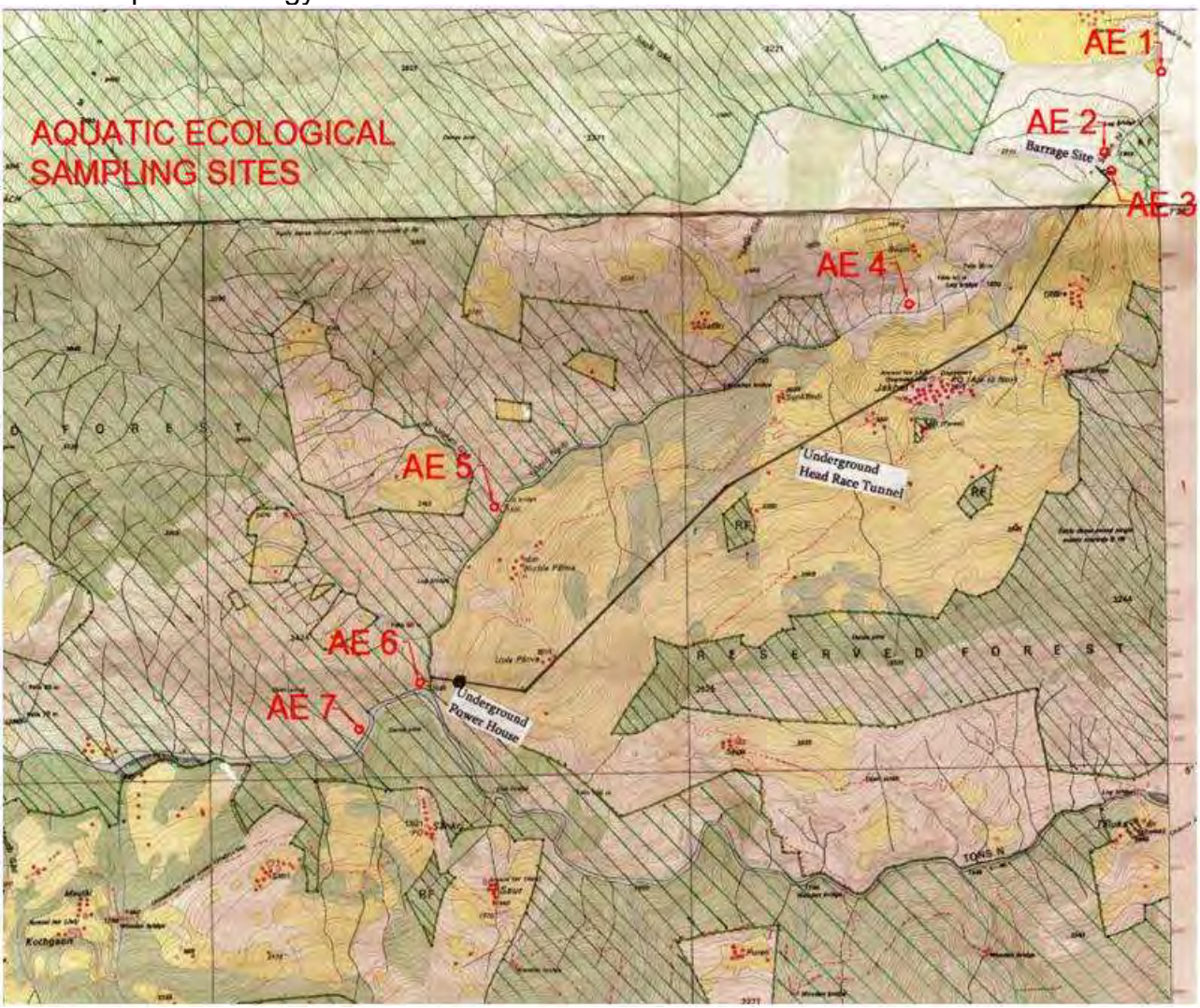


Figure-18: Aquatic Ecological Sampling Location Map

A total of 7 fish species were reported close to the confluence of Tons and Supin Rivers downstream to power house (AE-7) of Jakhol-Sankari HEP. However, no fish species were found at other sites located on river Supin with sites stretching from upstream of barrage site to upper confluence of river Tons. River Pabbar merges with the Tons River in village Tiuni. The presence of exotic or alien species like rainbow trout *(Oncorhynchus mykiss)* at sampling site (AE-VII) after confluence of river Tons with Supin could be due to the fact that the river Pabbar has its entire catchment in the neighbouring state Himachal Pradesh. The river joins the Tons on

its right bank near village Tiuni (Uttrakhand), which is situated on left bank and about 54 km downstream from the proposed project site. A trout fish hatchery and fish farm is located upstream of Pabbar (~64km) at village Denwari (Rohru tehsil Himachal Pradesh) where culture of Rainbow trout is under operation since last many years **(Plate 3)**. As discussed, no fish was found upstream to barrage area. This could be attributed to high elevation, low temperature and fast water velocity. Among the fishes found, six species are endemic in nature, eg. *Schizothorax richardsonii, Schizothorax progastus, Paraschistura montana, Barilius bendelisis, Glyptothorax penctonopterus* and *Garra gotyla gotyla*. One species commonly known as rainbow trout is *Oncorhynchus mykiss* is exotic and migratory in nature.

The list of fish species available downstream to the power house is given in Table-2.

Table-2: Fish Species Reported in Tons River near Confluence with Supin d/s to powerhouse

S.No.	Name of the Fish	Local Name	IUCN Status	CAMP 1998
	Family:Cyprinidae			
1.	*Schizothorax richardsonii** (Gray) 1832	Maseen	VU	VU
2.	*Schizothorax progastus** (McClelland, 1839)	Chongu	LC	LRnt
3.	*Garra gotyla gotyla*(Gray, 1830)	Gondal	LC	VU
4.	*Barilius bendelisis* (Hamilton, 1807)	Fulra	LC	LRnt
	Family:Nemacheilidae			
5.	*Paraschistura montana* (McClelland, 1838)	Gadiyal-Loch	-	-
	Family: Sisoridae			
6.	*Glyptothorax pectinopterus* (McClelland, 1842)	Nau (River cat)	LC	LRnt
	Family : Salmonidae			
7.	*Oncorhynchus mykiss*[*,#] (Walbaum, 1792)	Rainbow trout	NE	-

Note- *VU-Vulnerable; LC-Least Concern; LRnt-* Lower risk-near threatened; *NE-Not Evaluated, *Trouts-migratory species;* [#]*Exotic/Alien species* (IUCN Red list version 2018-2)

The commercial fishery in the area is non-existent. The growth of the coldwater fish is also very poor due to low temperature and scarcity of food resources for fish. The river bed level at barrage axis is 1955.00 m and the river bed level at Tail Race Tunnel outfall is 1508.36 m. The Head Race Tunnel is about 6624.48 m long. There is very steep slope in the region. The slope varies from 1 in 16 to 1 in 50 in the project area. The flow velocity in the Supin river in the project area varies from 1.79 m/s to 2.32 m/s. It is very difficult for fish species to survive in such steep slope and

high velocity. Therefore, present ecological survey revealed that there are no fish habitats in the project area.

Spawning and breeding

Most of the species of fish are periodic in breeding. *Schizothorax* breeds from May June to August, September depending upon the water temperature.

Fish Migration

Schizothorax is the migratory species observed in Tons river after the confluence with Supin. It is worthwhile to mention that no fish species were reported in Supin River. The migration of these species is generally related to water temperature of the river/stream. This species can survive between 2°C to 25°C. The favorable temperature of these species ranges from 10-22°C. During winter season when temperature falls below the favorable ranges these species migrate towards lower elevation. In pre-monsoon season, when river water temperature gets marginally high, they migrate back.

Proposed Barrage Site

Downstream Area of Barrage Site

Confluence of Obragad&Supin river near Baincha u/s of Barrage site

Plate-1: Aerial veiw of river /stream Morphology at proposed Barrage Site

A view of Proposed Power House Site

A Nalla/stream on right bank of river Supin at Upstream of PH

Plate-2: Aerial veiw of River /Stream morphology at Power House Site

Denwari Trout Hatchery (Operational)

Denwari Trout Hatchery, Pabber river

Fishing in Tons river with Cast net

Tons river at Mori block ,UK(30 km u/s tiuni)

Snow trout and Rainbow trout in Tons river

Plate-3: Trout fish hatchery at village Denwari, Pabberriver, Himachal Pradesh

Sarcococca saligna

Rosa brunonii

Elsholtzia fruticosa

Berberis sp

Rubus foliolosus

Inula cuspidata

Plate : Common shrub species found in the study area

Aconogonum molle

Lepidium virginicum

Fagopyrum sp

Erigeron multicaulis

Origanum vulgare

Anaphalis sp

	
Miscanthus nepalensis	Arisaema sp
	
Calamagrostis pseudophragmites	Impatiens sp.
	
Taraxacum officinale	Artemisia nilagirica

Plate- Herbaceous plant diversity in the study area

Selaginella kraussiana

Onychium contiguum

Plate-: Pteridophytic plants recorded at u/s of barrage axis

3.5 BASELINE STATUS-SOCIO-ECONOMIC ASPECTS

3.5.1 Study Area Village Profile

I. Demographic Profile

The total 33 villages in Mori Tehsil, Uttarkashi district are coming under the study area. As per 2011 Census the total population of the area is about 17243.The male and female population in the villages is 50.92% and 49.08% respectively and population below 6 years of age accounts for 18.92% of the total population. The

number of females per 1000 males is 964 and average family (persons per family) size is 6. The demographic details of are given in Table–3.81 and depicted in Figure-3.19.

Table- 3.81 Demographic Profile of Study Area villages

S. No	Village Name	Total Households	Total Population	Total Male	Total Female	Population<6 years	Average Family Size	Sex Ratio
1	Masari	119	783	410	373	111	7	910
2	Satta	105	596	298	298	120	6	1000
3	Bhitri	176	1140	604	536	258	6	887
4	Khanyasani	117	725	385	340	161	6	883
5	Kotgaon	195	975	480	495	139	5	1031
6	Sidri	119	664	313	351	130	6	1121
7	Sankari	77	270	153	117	42	4	765
8	Saur	85	494	242	252	96	6	1041
9	Sirga	72	410	215	195	82	6	907
10	Panw Malla	45	247	120	127	60	5	1058
11	Panw Talla	39	235	129	106	39	6	822
12	Saturi	38	260	140	120	58	7	857
13	Sunkundi	38	297	155	142	68	8	916
14	Jakhol	295	1601	816	785	286	5	962
15	Sauni	22	152	81	71	36	7	877
16	Dhara	62	466	229	237	101	8	1035
17	Fitari	134	890	444	446	185	7	1005
18	Regcha	61	392	197	195	100	6	990
19	Kasla	67	460	245	215	69	7	878
20	Rala	20	132	70	62	23	7	886
21	Liwari	135	918	467	451	217	7	966
22	Gangar	108	535	273	262	91	5	960
23	Dhatmeer	192	809	366	443	153	4	1210
24	Pawani	35	239	111	128	44	7	1153
25	Kalap	96	469	238	231	80	5	971
26	Naitwar	66	319	162	157	62	5	969
27	Gainchwan Gaon	192	783	432	351	95	4	813
28	Dewara	99	443	216	227	80	4	1051
29	Suchan Gaon	28	170	84	86	30	6	1024
30	Dargar Gaon	191	1025	512	513	177	5	1002
31	Haltari	52	307	168	139	68	6	827
32	Sankari Range	7	7	7	0	0	1	0

S. No	Village Name	Total Households	Total Population	Total Male	Total Female	Population<6 years	Average Family Size	Sex Ratio
33	Supin Range	11	30	18	12	1	3	667
	Total	**3098**	**17243**	**8780**	**8463**	**3262**	**6**	**964**

Source: 2011 Census

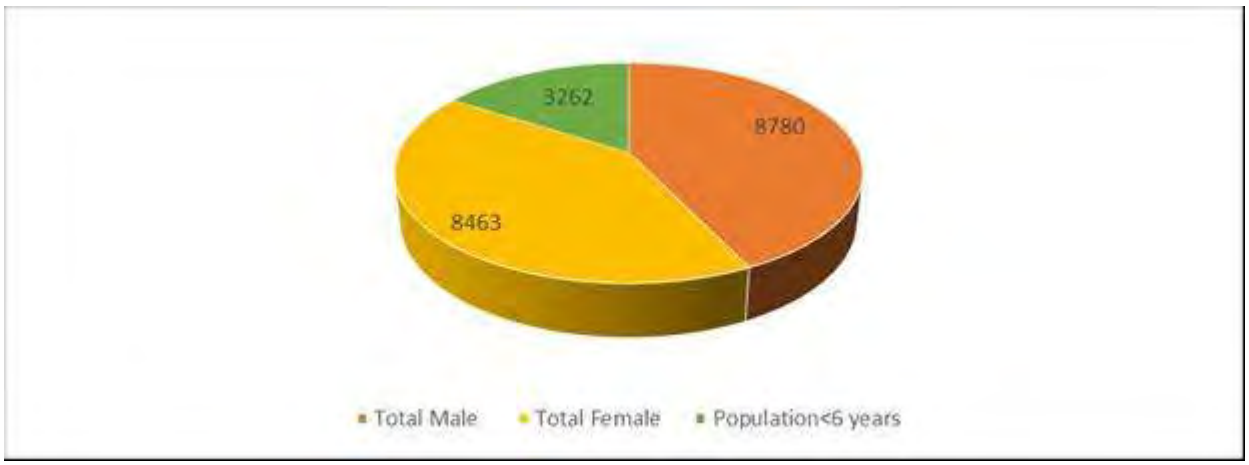


Figure-3.19 Demographic profile of Study Area Villages

II. Caste Profile

According to Census 2011 data that the General Caste population accounts for 70.21% of the total population in the Study area villages followed by Schedule Caste accounting for 29.57% and Schedule Tribe accounting for the 0.21% of total population. The village wise caste profile of the area is given in the Table-3.82 and depicted in Figure-3.20.

Table-3.82- Caste Profile of the Study Area Villages

S. No	Village Name	Total Population	Population Schedule Caste	Schedule Tribe	General Caste
1	Masari	783	331	0	452
2	Satta	596	319	0	277
3	Bhitri	1140	389	0	751
4	Khanyasani	725	256	0	469
5	Kotgaon	975	179	0	796
6	Sidri	664	236	0	428
7	Sankari	270	41	3	226
8	Saur	494	82	0	412
9	Sirga	410	106	0	304
10	Panw Malla	247	101	0	146

S. No	Village Name	Total Population	Population Schedule Caste	Schedule Tribe	General Caste
11	Panw Talla	235	53	0	182
12	Saturi	260	121	0	139
13	Sunkundi	297	18	0	279
14	Jakhol	1601	656	0	945
15	Sauni	152	17	0	135
16	Dhara	466	96	0	370
17	Fitari	890	236	0	654
18	Regcha	392	67	0	325
19	Kasla	460	93	3	364
20	Rala	132	30	0	102
21	Liwari	918	161	0	757
22	Gangar	535	132	0	403
23	Dhatmeer	809	220	0	589
24	Pawani	239	52	0	187
25	Kalap	469	94	0	375
26	Naitwar	319	57	0	262
27	Gainchwan Gaon	783	189	10	584
28	Dewara	443	263	0	180
29	Suchan Gaon	170	66	0	104
30	Dargar Gaon	1025	352	20	653
31	Haltari	307	69	0	238
32	Sankari Range	7	4	0	3
33	Supin Range	30	13	1	16
	Total	**17243**	**5099**	**37**	**12107**

Source: 2011 Census

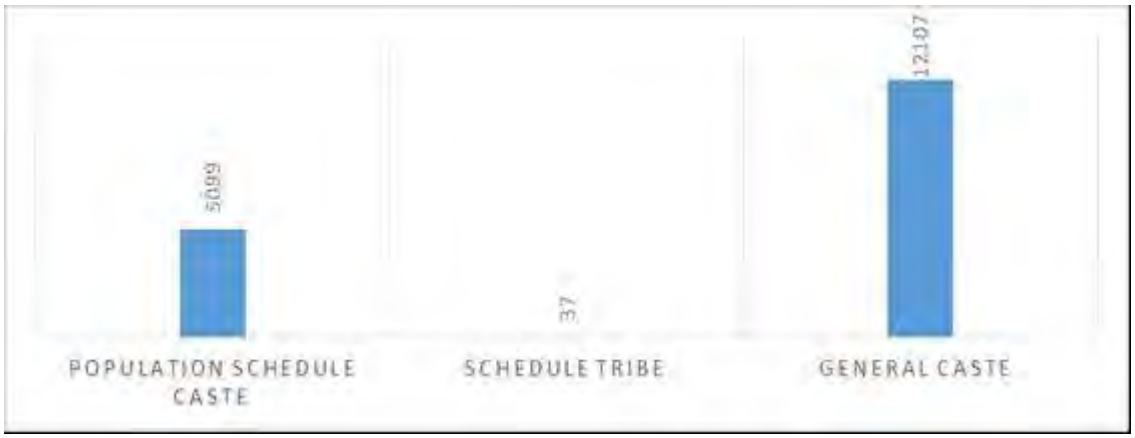


Figure-3.20: Caste profile of Study Area Villages

III. Literacy rate

The total literate population in villages is of the order of 46.0% (as per 2011 census data). The overall illiterate population in the villages is 54.0%. The male and female literacy rate in the villages is 57.76% and 33.81% respectively. The details of literacy rate in command area villages are given in Table -3.83 and depicted in Figure-3.21.

Table-3.83- Literacy Profile of Command Area Villages

S. No	Village Name	Total Population	Population Literate	Male Literate	Female Literate	Population Illiterate	Male Illiterate	Female Illiterate
1	Masari	783	225	164	61	558	246	312
2	Satta	596	235	142	93	361	156	205
3	Bhitri	1140	319	213	106	821	391	430
4	Khanyasani	725	428	298	130	297	87	210
5	Kotgaon	975	483	302	181	492	178	314
6	Sidri	664	273	157	116	391	156	235
7	Sankari	270	156	106	50	114	47	67
8	Saur	494	273	159	114	221	83	138
9	Sirga	410	176	113	63	234	102	132
10	Panw Malla	247	164	87	77	83	33	50
11	Panw Talla	235	129	91	38	106	38	68
12	Saturi	260	74	48	26	186	92	94
13	Sunkundi	297	148	93	55	149	62	87
14	Jakhol	1601	874	573	301	727	243	484
15	Sauni	152	61	38	23	91	43	48
16	Dhara	466	209	128	81	257	101	156
17	Fitari	890	387	253	134	503	191	312
18	Regcha	392	148	88	60	244	109	135
19	Kasla	460	205	130	75	255	115	140
20	Rala	132	69	45	24	63	25	38
21	Liwari	918	409	283	126	509	184	325
22	Gangar	535	217	139	78	318	134	184
23	Dhatmeer	809	363	220	143	446	146	300
24	Pawani	239	103	64	39	136	47	89
25	Kalap	469	159	98	61	310	140	170
26	Naitwar	319	158	97	61	161	65	96
27	Gainchwan Gaon	783	500	332	168	283	100	183
28	Dewara	443	254	155	99	189	61	128
29	Suchan Gaon	170	53	32	21	117	52	65
30	Dargar Gaon	1025	492	288	204	533	224	309
31	Haltari	307	156	110	46	151	58	93
32	Sankari Range	7	6	6	0	1	1	0
33	Supin Range	30	24	17	7	6	1	5
	Total	**17243**	**7930**	**5069**	**2861**	**9313**	**3711**	**5602**

Source: 2011 Census

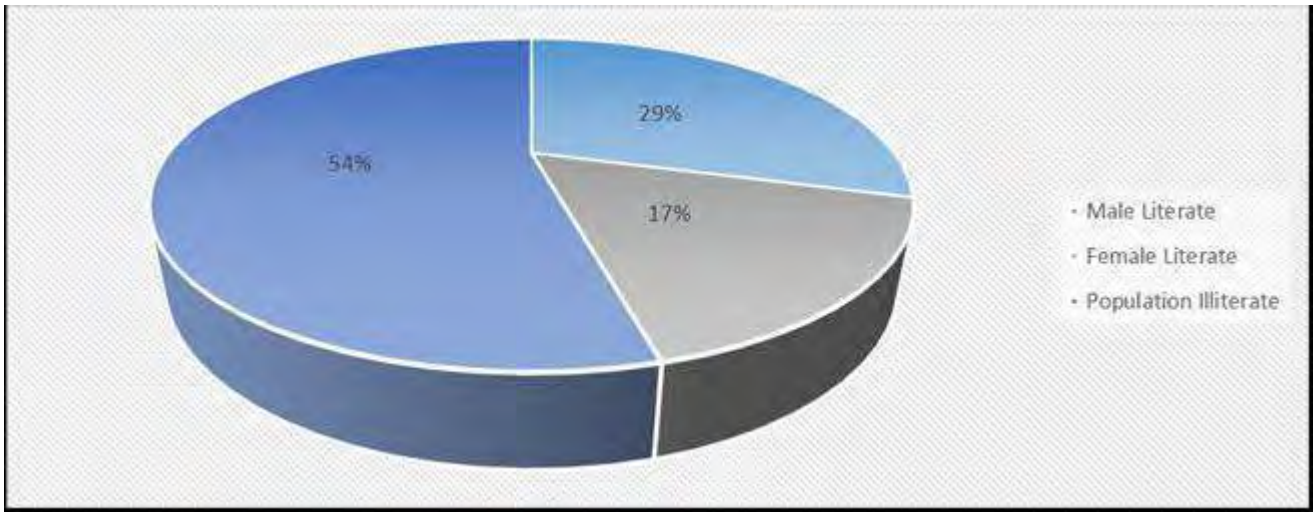


Figure-3.21: Literacy Profile of Study Area Villages

IV. Occupational Profile

The total working population in the area constitutes for 52.17% and dependent population or non-workers in the villages are 47.83% of the total population. It is further observed that 90.56% of the total population falls under main worker category. The marginal workers account for about 9.44% of the total population. The occupational profile of the sub-districts is given in Table-3.84. The Occupational Profile of Command Area Villages is depicted in Figure-3.22.

Table-3.84-Occupational profile of Study Area Villages

S. No	Village Name	Total Population	Total Working Population	Main Workers	Marginal Workers	Non-Workers
1	Masari	783	415	289	126	368
2	Satta	596	314	138	176	282
3	Bhitri	1140	562	554	8	578
4	Khanyasani	725	344	341	3	381
5	Kotgaon	975	491	481	10	484
6	Sidri	664	342	267	75	322
7	Sankari	270	94	93	1	176
8	Saur	494	118	117	1	376
9	Sirga	410	218	218	0	192
10	Panw Malla	247	120	120	0	127
11	Panw Talla	235	129	129	0	106
12	Saturi	260	126	125	1	134

S. No	Village Name	Total Population	Total Working Population	Main Workers	Marginal Workers	Non-Workers
13	Sunkundi	297	146	146	0	151
14	Jakhol	1601	832	830	2	769
15	Sauni	152	63	63	0	89
16	Dhara	466	217	215	2	249
17	Fitari	890	525	499	26	365
18	Regcha	392	190	148	42	202
19	Kasla	460	401	366	35	59
20	Rala	132	113	112	1	19
21	Liwari	918	638	542	96	280
22	Gangar	535	250	250	0	285
23	Dhatmeer	809	451	429	22	358
24	Pawani	239	143	143	0	96
25	Kalap	469	252	250	2	217
26	Naitwar	319	158	144	14	161
27	Gainchwan Gaon	783	362	177	185	421
28	Dewara	443	239	231	8	204
29	Suchan Gaon	170	78	77	1	92
30	Dargar Gaon	1025	476	471	5	549
31	Haltari	307	167	166	1	140
32	Sankari Range	7	7	7	0	0
33	Supin Range	30	15	9	6	15
	Total	**17243**	**8996**	**8147**	**849**	**8247**

Source: 2011 Census

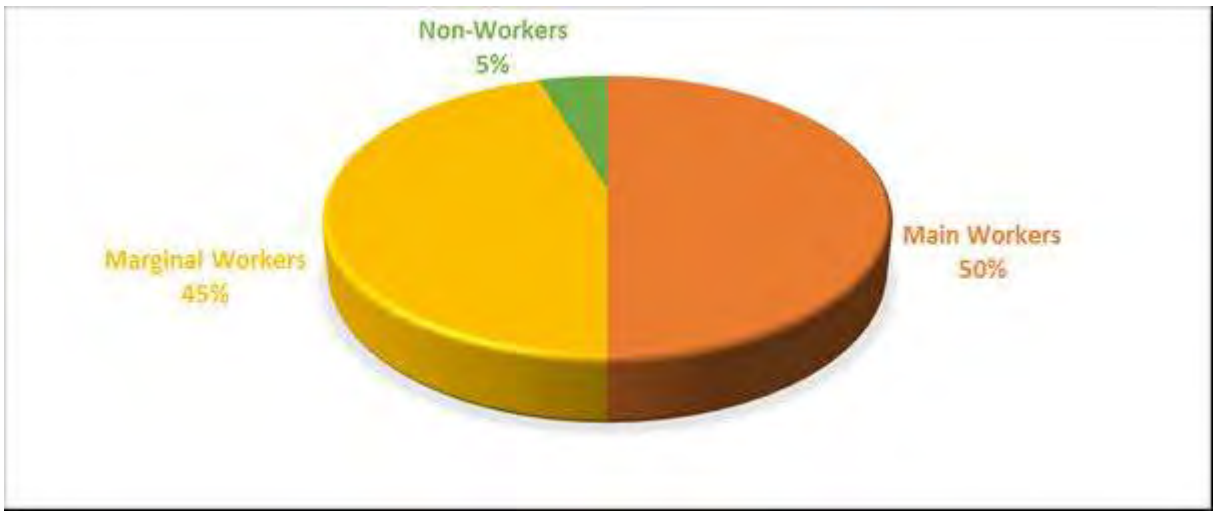


Figure-3.22 Occupational profile of main workers in Command Area Villages

3.5.2 Amenities and Infrastructure Facility

A) General Description

The details of the General Description is given in Table-3.85. It following section describes the number of CD Block in all 33 villages along with the other details like District Headquarter of every village distance to the district Headquarter etc.

Table-3.85-General Description of the Area

S. No	Village Name	CD Block Name	Gram Panchayat Name	Sub District Head Quarter (Name)	Sub District Head Quarter (Distance in km)	District Head Quarter (Distance in km)	Nearest Statutory Town (Name)	Nearest Statutory Town (Distance in km)	Within the State/UT (Name)	Within the State/UT (Distance in km)	Total Geographical Area (in Hectares)
1	Masari	Mori	Masari	Mori	34	195	Barkot	98	Dehradun	234	510.39
2	Satta	Mori	Satta	Mori	29	179	Barkot	94	Dehradun	209	247.22
3	Bhitri	Mori	Bhitri	Mori	30	215	Barkot	82	Dehradun	230	608.92
4	Khanyasani	Mori	Khanyasani	Mori	28	189	Barkot	79	Dehradun	228	413.3
5	Kotgaon	Mori	Kotgaon	Mori	22	191	Barkot	81	Dehradun	202	342.61
6	Sidri	Mori	Sidri	Mori	24	193	Barkot	84	Dehradun	204	313.96
7	Sankari	Mori	Saur	Mori	25	195	Barkot	86	Dehradun	225	40.01
8	Saur	Mori	Saur	Mori	25	195	Barkot	87	Dehradun	225	210.84
9	Sirga	Mori	Sirga	Mori	35	200	Barkot	100	Dehradun	235	573.05
10	Panw Malla	Mori	Panw malla	Mori	38	197	Barkot	94	Dehradun	213	431.68
11	Panw Talla	Mori	Panw talla	Mori	36	197	Barkot	94	Dehradun	213	113.1
12	Saturi	Mori	Saturi	Mori	36	200	Barkot	102	Dehradun	296	352.22
13	Sunkundi	Mori	Pawn talla	Mori	33	197	Barkot	96	Dehradun	213	261.4
14	Jakhol	Mori	Jakhol	Mori	36	190	Barkot	97	Dehradun	296	251.87
15	Sauni	Mori	Saturi	Mori	40	204	Barkot	104	Dehradun	300	323.96
16	Dhara	Mori	Dhara	Mori	42	202	Barkot	99	Dehradun	202	233.72
17	Fitari	Mori	Fitari	Mori	60	220	Barkot	105	Dehradun	250	271.31
18	Regcha	Mori	Regcha	Mori	60	220	Barkot	106	Dehradun	250	453.89
19	Kasla	Mori	Kasla	Mori	65	220	Barkot	117	Dehradun	236	245.3
20	Rala	Mori	Kasala	Mori	48	195	Barkot	114	Dehradun	230	212.93
21	Liwari	Mori	Liwari	Mori	101	295	Barkot	115	Dehradun	232	467.96
22	Gangar	Mori	Gangar	Mori	55	205	Barkot	110	Dehradun	250	440.95

S. No	Village Name	CD Block Name	Gram Panchayat Name	Sub District Head Quarter (Name)	Sub District Head Quarter (Distance in km)	District Head Quarter (Distance in km)	Nearest Statutory Town (Name)	Nearest Statutory Town (Distance in km)	Within the State/UT (Name)	Within the State/UT (Distance in km)	Total Geographical Area (in Hectares)
23	Dhatmeer	Mori	Dhatmeer	Mori	42	175	Barkot	105	Dehradun	195	269.17
24	Pawani	Mori	Pawani	Mori	57	192	Barkot	113	Dehradun	195	198.32
25	Kalap	Mori	Kalap	Mori	28	178	Barkot	87	Dehradun	209	507.7
26	Naitwar	Mori	Naitwar	Mori	15	176	Barkot	76	Dehradun	200	66.51
27	Gainchwan Gaon	Mori	Devra	Mori	10	168	Barkot	77	Dehradun	211	137.96
28	Dewara	Mori	Dewara	Mori	15	176	Barkot	78	Dehradun	211	44.18
29	Suchan Gaon	Mori	Haltwari	Mori	12	170	Barkot	82	Dehradun	213	47.09
30	Dargar Gaon	Mori	Dargar gaon	Mori	16	180	Barkot	82	Dehradun	200	300.95
31	Haltari	Mori	Haltari	Mori	20	176	Barkot	82	Dehradun	200	113.46
32	Sankari Range	Forest CD Block Uttarkashi		Mori	72	182	Barkot	92	Dehradun	250	49984.39
33	Supin Range	Forest CD Block Uttarkashi		Mori	68	170	Barkot	76	Dehradun	195	31166.5

B) Educational Facility

It is observed from the VDA 2011 data that there are only four study area villages namely Bhitri, Kotgaon, Sidri, Pawani and Kalap that have the facility of Private preprimary schools out of all 33 study area villages. Whereas there are 33 study area villages that have Government Primary school out of which there are six such villages that have the 2 each government primary schools in the villages the other villages have 1 each school. Private Primary School are available in Kotagaon, Saturi and Kalap villages only. Facility of the Government Middle School is available in 18 study area villages.

Villages namely Kotgaon, Saturi, Pawani and Kalap have one each Government Secondary School. Students of other Study area villages have to cover varying distance of <5km,5-10 km and >10 km to avail the facility of the secondary school. Whereas Saturi, Pawani and Kalap are the only three Study area villages that have one each Senior Secondary Government School within the village children of other Study area villages have to cover varying distance of 5km,5-10 km and >10 km to avail the facility.

Since there are no options of higher education students of all the Study area villages have to go to the nearest town. Students who wish to pursue Arts & Science and Vocational training Institute the students have to travel upto Puraula since it has Government Art &Science College. Government Polytechnic is situated in Uttarkashi town. Whereas Institute for Non-Formal Education, Institute for Disabled and other Institutes are based at Dehradun.

C) Medical Facility

There are no Community Health Centre and Primary Health Centre in all the study area villages. Whereas two villages namely Gainchwan Gaon, Sucha Gaon. Maternity and Child Welfare Centre. Both these villages have one each Para Medical Staff. Allopathic Hospitals are available in Liwanri, Ganjar and Naitwar villages each village have 3,2,1 each villages respectively. Whereas Doctors in position in these villages are 2,1,1 respectively in all the three villages. All the above mentioned villages have 4 each paramedical staff. Hospitals of Alternative Medicine Centre are available in Sauni, Jakhol and Fitari village all these centres have one each doctors and 3 each Para medical staff. Whereas facility of Dispensary is available in Masari and Gainchwan Gaon both the villages have one each doctor and 4,3 respectively

para medical staff. Family Welafre Centre is available in Gainchwan Gaon with one para medical staff and no doctor.

Jhakol is the only Study area village that has Non-Government Outpatient /Non Gov.in and outpatient and Non-Government Medical Charitable Facilty.

There are non-government Medical Practiner available in Gainchaw Gaon and Suchan Gaon with MBBS degree. Doctors with other degree are also available in these villages. Traditional Faith Healers and Medicine Shop also present in these villages.

D) Power Supply

It is observed from the source data that Power supply for domestic use is available in all the Study area villages but time of supply in each village varies between minimum 7 hours to maximum 20 hours. Whereas Bhitri,Jakhol and DAGAR Gaon are the only three villages that have power supply for the agriculture purpose for 12 to 14 hours daily in winters and 12 hours daily in summers.

E) Drinking Water

Table- 3.86 elucidates the details of drinking water facility in all the Study area villages. There are 19 villages that have the facility of Treated Tap Water whereas there are 13 such villages which have tap water supply but it is not treated. Uncovered wells are available in 4 study villages and 5 villages have Handpump facility.10 study villages have supply of drinking water through springs. River /Canal give drinking water to about 8 Study area villages. Whereas 3 Study area villages get drinking water from Tank/Pond /Lakes.

Table-3.86: Drinking Water facility in the Study area villages

S. No	Village Name	Tap Water-Treated	Tap Water-Treated Functioning All round the year	Tap Water-Treated Functioning in Summer months (April-September) (	Tap Water Untreated	Tap Water Untreated Functioning All round the year	Tap Water Untreated Functioning in Summer months (April-September)	Uncovered Well	Uncovered Well Functioning All round the year	Uncovered Well Functioning in Summer months (April-September)	Hand Pump	Hand Pump Functioning All round the year	Hand Pump Functioning in Summer months (April-September)	Spring	Spring Functioning All round the year (	Spring Functioning in Summer months (April-September)	River/Canal	River/Canal Functioning All round the year (	River/Canal Functioning in Summer months (April-September)	Tank/Pond/Lake	Tank/Pond/Lake Functioning All round the year	Tank/Pond/Lake Functioning in Summer months (April-September)	Others	Others Functioning All round the year (	Others Functioning in Summer months (April-September
1	Masari	A	A	A	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	2	0	0	N.A	0	0
2	Satta	N.A	N.A	N.A	A	A	A	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	A	A	A	N.A	0	0
3	Bhitri	N.A	N.A	N.A	A	A	A	A	A	A	N.A	0	0	N.A	0	0	N.A	0	0	2	0	0	N.A	0	0
4	Khanyasani	A	A	A	N.A	0	0	A	A	A	N.A	0	0	N.A	0	0	N.A	0	0	2	0	0	N.A	0	0
5	Kotgaon	A	A	A	N.A	0	0	N.A	0	0	A	A	A	N.A	0	0	A	A	A	2	0	0	N.A	0	0
6	Sidri	A	A	A	A	A	A	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	2	0	0	N.A	0	0
7	Sankari	A	A	A	A	A	A	N.A	0	0	N.A	0	0	A	A	A	A	A	A	2	0	0	N.A	0	0
8	Saur	A	A	A	A	A	A	N.A	0	0	N.A	0	0	A	A	A	A	A	A	2	0	0	N.A	0	0
9	Sirga	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	A	A	A	N.A	0	0	2	0	0	N.A	0	0
1	Panw	N.A	N.	N.A	A	A	A	N.A	0	0	N.	0	0	N.A	0	0	N.A	0	0	2	0	0	A	A	A

S.No	Village Name	Tap Water-Treated	Tap Water-Treated Functioning All round the year	Tap Water-Treated Functioning in Summer months (April-September) (	Tap Water Untreated	Tap Water Untreated Functioning All round the year	Tap Water Untreated Functioning in Summer months (April-September)	Uncovered Well	Uncovered Well Functioning All round the year	Uncovered Well Functioning in Summer months (April-September)	Hand Pump	Hand Pump Functioning All round the year	Hand Pump Functioning in Summer months (April-September)	Spring	Spring Functioning All round the year (	Spring Functioning in Summer months (April-September)	River/Canal	River/Canal Functioning All round the year (	River/Canal Functioning in Summer months (April-September)	Tank/Pond/Lake	Tank/Pond/Lake Functioning All round the year	Tank/Pond/Lake Functioning in Summer months (April-September)	Others	Others Functioning All round the year (	Others Functioning in Summer months (April-September
0	Malla		A								A														
11	Panw Talla	N.A	N.A	N.A	A	A	A	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	2	0	0	A	A	A
12	Saturi	N.A	N.A	N.A	A	A	A	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	2	0	0	N.A	0	0
13	Sunkundi	N.A	N.A	N.A	A	A	A	N.A	0	0	A	A	A	N.A	0	0	N.A	0	0	2	0	0	N.A	0	0
14	Jakhol	A	A	A	N.A	0	0	N.A	0	0	A	N.A	A	A	A	A	N.A	0	0	2	0	0	N.A	0	0
15	Sauni	N.A	N.A	N.A	A	A	A	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	2	0	0	N.A	0	0
16	Dhara	A	A	A	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	2	0	0	N.A	0	0
17	Fitari	A	A	A	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	2	0	0	N.A	0	0
18	Regcha	A	A	A	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	2	0	0	N.A	0	0
19	Kasla	A	A	A	N.A	0	0	N.A	0	0	N.A	0	0	A	A	A	N.A	0	0	2	0	0	N.A	0	0
2	Rala	N.A	N.	N.A	A	A	A	N.A	0	0	N.	0	0	A	A	A	N.A	0	0	2	0	0	N.	0	0

S.No	Village Name	Tap Water-Treated	Tap Water-Treated Functioning All round the year	Tap Water-Treated Functioning in Summer months (April-September) (	Tap Water Untreated	Tap Water Untreated Functioning All round the year	Tap Water Untreated Functioning in Summer months (April-September)	Uncovered Well	Uncovered Well Functioning All round the year	Uncovered Well Functioning in Summer months (April-September)	Hand Pump	Hand Pump Functioning All round the year	Hand Pump Functioning in Summer months (April-September)	Spring	Spring Functioning All round the year (	Spring Functioning in Summer months (April-September)	River/Canal	River/Canal Functioning All round the year (	River/Canal Functioning in Summer months (April-September)	Tank/Pond/Lake	Tank/Pond/Lake Functioning All round the year	Tank/Pond/Lake Functioning in Summer months (April-September)	Others	Others Functioning All round the year (	Others Functioning in Summer months (April-September
0			A								A												A		
21	Liwari	N.A			N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	2	0	0	A	A	A
22	Gangar	N.A			N.A	0	0	A	A	A	N.A	0	0	A	A	A	A	A	A	A	A	A	N.A	0	0
23	Dhatmeer	A	A	A	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	A	A	A	2	0	0	N.A	0	0
24	Pawani	N.A			N.A	0	0	N.A	0	0	N.A	0	0	A	A	A	N.A	0	0	2	0	0	N.A	0	0
25	Kalap	N.A	N.A	N.A	A	A	A	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	2	0	0	N.A	0	0
26	Naitwar	A	A	A	N.A	0	0	N.A	0	0	A	A	A	N.A	0	0	A	A	A	2	0	0	N.A	0	0
27	Gainchwan Gaon	A	A	A	N.A	0	0	N.A	0	0	A	A	A	N.A	0	0	N.A	0	0	2	0	0	N.A	0	0
28	Dewara	A	A	A	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	2	0	0	A	A	A
29	Suchan Gaon	A	A	A	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	2	0	0	N.A	0	0

S. No	Village Name	Tap Water-Treated	Tap Water-Treated Functioning All round the year	Tap Water-Treated Functioning in Summer months (April-September) (	Tap Water Untreated	Tap Water Untreated Functioning All round the year	Tap Water Untreated Functioning in Summer months (April-September)	Uncovered Well	Uncovered Well Functioning All round the year	Uncovered Well Functioning in Summer months (April-September)	Hand Pump	Hand Pump Functioning All round the year	Hand Pump Functioning in Summer months (April-September)	Spring	Spring Functioning All round the year (	Spring Functioning in Summer months (April-September)	River/Canal	River/Canal Functioning All round the year (	River/Canal Functioning in Summer months (April-September)	Tank/Pond/Lake	Tank/Pond/Lake Functioning All round the year	Tank/Pond/Lake Functioning in Summer months (April-September)	Others	Others Functioning All round the year (	Others Functioning in Summer months (April-September
30	Dargar Gaon	N.A	N.A	N.A	A	A	A	A	A	A	N.A	0	0	A	A	A	N.A	0	0	A	N.A	A	N.A	0	0
31	Haltari	A	A	A	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	2	0	0	A	A	A
32	Sankari Range	A	A	A	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	A	A	A	2	0	0	N.A	0	0
33	Supin Range	A	A	A	N.A	0	0	N.A	0	0	N.A	0	0	N.A	0	0	A	A	A	2	0	0	N.A	0	0

3.5.3 Historical, Religious Aspects

As per the analysis of the primary data it has been observed that Govind Wildlife Sanctuary is the only nearest ecological sensitive area around the project. However there are no other major historical or religious place around the project area. There are Temples in project area villages.

3.5.4 Agriculture Pattern

The major crops grown in the project area villages are Wheat, Rajma, Potato, Mandva and Chaulai and Kuttu.Wheat is sowed in the months of June and July. Whereas Potato, Kuttu and Chaulai are sowed in the months of September and October. Mandva is sowed in the month of October and November. Rainfall is the major source of irrigation. The cropping is done on the poorly constructed terrace land.

Horticulture is also practiced by the villagers. Apple, Apricot and Peach are the major fruits grown in the area.

3.5.5 Occupational Profile

Primary data collection elucidates that agriculture and horticulture are the major occupations adopted by the persons residing in the study area villages. It is observed that most of the persons are agriculture/non-agriculture labours followed by farmers. There are few persons engaged Govt./Pvt Job. Minuscule number of persons are Traders and Farmers as well.

3.5.6 Livestock Rearing

Cow, Goat and Sheep are the major livestock reared by the persons of the study area villages. Most of the households have separate cattle shed for the livestocks.

3.5.9 Forest Produce

The persons in the area are dependent on the forest for firewood, medicinal plants and fodder. Since most of the homestead in the area are wooden based forest serve as source of Timber for the construction of the households.

CHAPTER-4
PREDICTION OF IMPACTS AND MITIGATION MEASURES

CHAPTER-4
PREDICTION OF IMPACTS

4.1 GENERAL

Based on the project details and the baseline environmental status, potential impacts as a result of the construction and operation of the proposed Jakhol Sankari hydroelectric project have been identified. This Chapter addresses the basic concepts and methodological approach for conducting a scientifically based analysis of the potential impacts likely to accrue as a result of the proposed project. The Environmental Impact Assessment (EIA) for quite a few disciplines is subjective in nature and cannot be quantified. 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 due to construction and operation of the proposed project. The construction and operation phase comprises of various activities each of which is likely to have an impact on environment. Thus, it is important to understand and analyze each activity so as to assess its impact on environment. The key activities have been categorized for construction and operation phases.

Construction Phase Activities

- Site preparation including removal of trees
- Earthwork and excavation including controlled blasting and drilling
- diversion structure across river Supin near Jakhol villages
- Power intake; approach tunnel and desilting tank on left bank
- Head Race tunnel on the left bank and terminating at the surge tank
- Open surge tank
- Pressure shaft/penstock
- Underground power house
- Tail Race tunnel
- GIS underground switchyard
- Project headquarter, offices and colonies (labour and staff)
- Disposal of muck and construction wastes
- Transportation of construction material
- Operation and maintenance of construction equipment
- Civil and mechanical fabrication works for 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 Supin for hydropower generation
- Equipment maintenance and equipment restoration
- Sewage and solid waste generation from project colonies

The various project activities and associated potential environmental impacts on various environmental parameters have been identified and summarized in a matrix and the same is outlined in Table- 4.1.

Table-4.1 Matrix for various project activities and associated potential Environmental Impact on various Environmental Parameters

S. No.	Project Activities	Soil & Land	Geology	Hydrology	Water quality	Air quality	Noise	Flora/ Fauna	Employment	Socio-culture
A.	**Construction Phase**									
1.	Site preparation including tree cutting	√				√	√		√	
2.	Earthwork and excavation including blasting and drilling	√	√	√	√	√	√	√	√	
3.	Construction of barrage across river Supin	√		√		√		√	√	
4.	Construction of head race tunnel	√	√						√	
5.	Construction of underground surge shaft	√	√						√	
6.	Construction of underground power house	√	√						√	
7.	Widening of approach roads	√				√	√	√	√	
8.	Disposal of muck and construction wastes	√	√		√	√		√		
9.	Transportation of construction materials					√	√	√	√	
10.	Operation and maintenance of construction equipment				√	√	√		√	
11.	Disposal of sewage and solid waste from labour camps	√			√					
12.	Acquisition of private land	√								√

S. No.	Project Activities	Soil & Land	Geology	Hydrology	Water quality	Air quality	Noise	Flora/ Fauna	Employment	Socio-culture
13.	Acquisition of forest land	√						√		√
14.	Immigration of labour population	√			√	√	√	√	√	√
B.	**Operation Phase Activities**									
1.	Diversion of water for hydropower generation			√	√			√		
2.	Equipment maintenance				√	√	√		√	
3.	Disposal of sewage and solid waste from project colony	√			√					
4.	Mushrooming of allied activities	√			√	√	√		√	√

The impacts which have been covered in the present Chapter are categorized as below:

- Impacts on Water Environment
- Impacts on Air Environment
- Impacts on Noise Environment
- Impacts on Land Environment
- Impacts on Biological Environment
- Impacts on Socio-Economic Environment

4.2 IMPACTS ON WATER ENVIRONMENT

The various aspects covered under water environment are:

- Water quality
- Sediments
- Water resources and downstream users

4.2.1 Water Quality

a) **Construction phase**

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

- Sewage from labour camps/colonies.
- Effluent from crushers.
- Effluents from other sources

i) Sewage from labour camps

The project construction is likely to last for a period of 4 years. The peak labour strength likely to be employed during project construction phase is about 800 workers and 200 technical staff. The employment opportunities in the area are limited. Thus, during the project construction phase, some of the locals may get employment. It has been observed during construction phase of many of the projects; the major works are contracted out, who bring their own skilled labour. However, it is only in the unskilled category, that locals get employment.

The construction phase, also leads to mushrooming of various allied activities to meet the demands of the immigrant labour population in the project area.

The following assumptions have been made for assessing the emigrating population in the area:

- 80% of workers and technical staff emigrating into the area are married.
- In 80% of the family of workers both the husband and wife will work.
- In 100% of the family of technical staff, only husband will work.
- 2% of total migrating population has been assumed as service providers.

- 50% of service providers will have families.
- Family size has been assumed as 5.

Based on experience of similar projects and above referred assumptions, the increase in the population as a result of migration of labour population during construction phase is expected to be of the order of 3200.

The domestic water requirement has been estimated as 70 lpcd. Thus, total water requirements work out to 0.22 mld. It is assumed that about 80% of the water supplied will be generated as sewage. Thus, total quantum of sewage generated is expected to be of the order of 0.18 mld. The BOD load contributed by domestic sources will be about 144 kg/day. It is assumed that the sewage is discharged without any treatment for which, the minimum flow required for dilution of sewage is about 2 cumec.

Detailed DO modelling was done using Streeter Phelp's model. The D.O. level was estimated using the following equation:

$$D_t = \frac{K_1 L_A [10^{-K1t} - 10^{-K2t}]}{K_2 - K_1} + D_A \, 10^{-K2t}$$

D_t = D.O. deficit downstream at time t.

K_1 = Deoxygenation rate

K_2 = Reaeration rate

L_A = Ultimate upstream BOD

D_A = D.O. deficit upstream

t = Time of stream flow upstream to point at which D.O. level is to be estimated

The D.O. level in the river was taken as 8.0 mg/l. The ten day minimum flow in the river Supin was taken as 2.86 cumec. The results of D.O. model are summarized in Table-4.2.

Table-4.2 Results of D.O. Modelling due to disposal of sewage from labour camps in river Supin

Distance from outfall (km)	D.O. (mg/l)
0.1	8.00
0.2	8.00
0.3	8.00
0.4	8.00
0.5	8.00
1.0	8.00

It can be observed from Table-4.2, that no impact is anticipated on river water quality, as a result of disposal of sewage from labour camps. Even though no impact is envisaged on water quality of river Supin, as a result of disposal of untreated sewage, it is recommended to commission units for treatment of sewage generated from labour camps. During construction phase, normally large scale secondary treatment facilities are not commissioned, because they are likely to remain unutilized, once the construction activities are over.

ii) Effluent from crushers

During construction phase, at least one crusher will be commissioned at the quarry site by the contractor involved in construction activities. It is proposed only crushed material would be brought at construction site. The total capacities of the two crushers are likely to be of the order of 120-150 tph. 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 tonne of material crushed. The effluent from the crusher would contain high-suspended solids. About 12-15 m^3/hr of wastewater is expected to be generated from each crusher. The effluent, if disposed without treatment can lead to marginal increase in the turbidity levels in the receiving water bodies. The natural slope in the area is such that, the effluent from the crushers will ultimately find its way in river Supin. This amounts to a discharge of 0.0033 to 0.0042 cumec. Even the lowest 10 day minimum flow in river Supin is 2.31 cumec. The effluent from crusher will have 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 0.25 mg/l, which is insignificant. Thus, no adverse impacts, are anticipated due to small quantity of effluent and large volume of water available in river Supin for dilution. Even then, it is proposed to treat the effluent before disposal so to ameliorate even the marginal impacts likely to accrue on this account.

iii) Effluent from other sources

Substantial quantities of water would be used in the construction activities. With regard to water quality, waste water from construction activities and runoff from construction site would mostly contain suspended impurities. Adequate care should be taken so that excess suspended solids in the wastewater are removed before discharge into water body. The effluent is proposed to be treated by collecting the

waste water and runoff from construction sites and treating the same in settling tanks.

b) Operation phase

The major sources of water pollution during project operation phase include:

- Effluent from project colony.
- Impacts on reservoir water quality.

i) Effluent from project colony

During project operation phase, due to 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 sewage treatment plant and other infrastructure facilities, the problems of water pollution due to disposal of sewage are not anticipated.

In the operation phase, about 100 families (total population of 500) will be residing in the project colony. About 0.23 to 0.27 mld of sewage will be generated. The total BOD loading will be order of 68 to 81 kg/day. It is proposed to provide biological treatment facilities including secondary treatment units for sewage so generated from the BOD load after treatment will reduce to 10 to 12 kg/day. It shall be ensured that sewage from the project colony be treated in a sewage treatment plant so as to meet the disposal standards for effluent. Thus, with commissioning of facilities for sewage treatment, no impact on receiving water body is anticipated. Thus, no impacts are anticipated as a result of disposal of effluents from the project colony.

ii) Impacts on reservoir water quality

The flooding of previously forest and agricultural land in the submergence area will increase the availability of nutrients resulting from decomposition of vegetative matter. In the proposed project a barrage is proposed to be constructed.

The proposed project is envisaged as a runoff the river scheme, with significant diurnal variations in water level. In such a scenario, significant re-aeration from natural atmosphere takes place, which maintains Dissolved Oxygen in the water body. Thus, in the proposed project, no significant reduction in D.O. level in reservoir water is anticipated.

4.2.2 Sediments

When a river flows along a steep gradient, it could carry a significant amount of sediment load, depending on the degradation status of the catchment. When a

hydraulic structure is built across the river, it creates a reservoir, which tends to accumulate the sediment, as the suspended load settles down due to decrease in flow velocity. The proposed project is envisaged as a runoff the river scheme. At regular intervals, flushing will be done to clear out the sediments. Thus, in the proposed project, sedimentation problems are not anticipated.

4.2.3 Water Resources and Downstream Users

The proposed project is a run of the river scheme. The river flow will be diverted through a barrage and no major storage is envisaged in the project. Water will be diverted through a tunnel for power generation and the tail race discharge outfall in Supin river about 7 km downstream from the diversion site. The river stretch downstream of the diversion site upto the confluence point of tailrace discharge (about 7 km) will have reduced flow. The flow will be augmented by contribution of flow by release of adequate quantum of Environmental Flows for sustenance of riverine ecology.

The reduction in flow or drying of the river in the intervening stretch is not likely to have any adverse impact on the downstream users. This is mainly because of the fact that settlements/ villages within this dry stretch are not dependent on the water of river Supin, as the villagers use water of small streams or nallahs flowing adjacent to their habitation.

Mitigation Measures

- Sewage from toilets of dredgers will be transferred to the existing sewage handling facilities at project site.
- No additional waste water discharge or solid waste generation during the implementation phase is envisaged.
- Confinement of construction and concreting works within designated areas of key project components to avoid downstream river contamination
- The contractor has to confirm to all the maritime laws and pollution related legalities so as to seek approvals.
- The effluent generated from crushers, batching plants and tunneling sites would be treated in settling tank before disposal
- Muck disposal would be done in accordance with muck disposal plan outlined in environmental management plant to avoid any negative impacts on water quality
- Set up of sewage treatment plant for treatment of sewage generated from labour camps, prior to disposal

4.3 IMPACTS ON AIR ENVIRONMENT

In a water resources project, air pollution occurs mainly during project construction phase. The major sources of air pollution during construction phase are:

- Pollution due to fuel combustion in various equipment
- Emission from various crushers
- Fugitive emissions from various sources.
- Blasting Operations
- Pollution due to increased vehicular movement
- Dust emission from muck disposal

Pollution due to fuel combustion in various equipment

The operation of various construction equipment requires combustion of fuel. Normally, diesel is used in such equipment. The major pollutant which gets emitted as a result of combustion of diesel is SO_2. The SPM emissions are minimal due to low ash content in diesel. The short-term increase in SO_2, even assuming that all the equipment are operating at a common point, is quite low, i.e. of the order of less than 1μg/m^3. Hence, no major impact is anticipated on this account on ambient air quality.

Emissions from crushers

The operation of the crusher during the construction phase is likely to generate fugitive emissions, which can move even up to 1 km in predominant wind direction. During construction phase, one crusher each is likely to be commissioned near proposed barrage and proposed power house sites. During crushing operations, fugitive emissions comprising mainly the suspended particulate will be generated. Since, there are no major settlements close to the barrage and power house, hence, no major adverse impacts on this account are anticipated. However, during the layout design, care should be taken to ensure that the labour camps, colonies, etc. are located on the leeward side and outside the impact zone (say about 2 km on the wind direction) of the crushers.

Fugitive Emissions from various sources

During construction phase, there will be increased vehicular movement. Lot of construction material like sand, fine aggregate are stored at various sites, during the project construction phase. Normally, due to blowing of winds, especially when the environment is dry, some of the stored material can get entrained in the atmosphere. However, such impacts are visible only in and around the storage sites. The impacts on

this account are generally, insignificant in nature.

Blasting Operations

Blasting will result in vibration, which shall propagate through the rocks to various degrees and may cause loosening of rocks/boulders. The overall impact due to blasting operations will be restricted well below the surface and no major impacts are envisaged at the ground level.

During tunneling operations, dust will be generated during blasting. ID blowers will be provided with dust handling system to capture and generated dust. The dust will settle on vegetation, in the predominant down wind direction. Appropriate control measures have been recommended to minimize the adverse impacts on this account.

Pollution due to increased vehicular movement

During construction phase, there will be increased vehicular movement for transportation of various construction materials to the project site. Similarly, these will be increased traffic movement on account of disposal of muck or construction waste at the dumping site. The maximum increase in vehicle is expected to 50 vehicles per hour. Large quantity of dust is likely to be entrained due to the movement of trucks and other heavy vehicles. Similarly, marginal increase in Hydrocarbons, SO_2 and NOx levels are anticipated for a short duration. Modelling studies for hydrocarbon emissions were conducted and the results are given in Table-4.3.

Table-4.3 Increase in hydrocarbon concentration due to vehicular movement

Distance (m)	Increase in HC concentration (µg/m^3)
10	5
20	2.50
30	1.67
40	1.25
50	1.00
60	0.83
70	0.71
80	0.63
90	0.56
100	0.50

The increase in vehicular density is not expected to significant. In addition, these ground level emissions do not travel for long distances. Thus, no major adverse impacts are anticipated on this account.

Dust emission from muck disposal

The loading and unloading of muck is one of the source of dust generation. Since, muck will be mainly in form of small rock pieces, stone, etc., with very little dust particles. Significant amount of dust is not expected to be generated on this account. Thus, adverse impacts due to dust generation during muck disposal are not expected.

Mitigation Measures

a) Control of Emissions

Minor air quality impacts will be caused by emissions from construction vehicles, equipment and DG sets, and emissions from transportation traffic. Frequent truck trips will be required during the construction period for removal of excavated material and delivery of select concrete and other equipment and materials. The following measures are recommended to control air pollution:

- The contractor will be responsible for maintaining properly functioning construction equipment to minimize exhaust.
- Construction equipment and vehicles will be turned off when not used for extended periods of time.
- Unnecessary idling of construction vehicles to be prohibited.
- Effective traffic management to be undertaken to avoid significant delays in and around the project area.
- Road damage caused by sub-project activities will be promptly attended to with proper road repair and maintenance work.

An amount of Rs. 30.0 lakh is earmarked for this purpose.

`

b) Air Pollution control due to DG sets

The Central Pollution Control Board (CPCB) has issued emission limits for generators upto 800 KW. The same are outlined in Table-4.4, and are recommended to be followed.

Table-4.4 Emission limits for DG sets prescribed by CPCB

Parameter	Emission limits (gm/kwhr)
NOx	9.2
HC	1.3
CO	2.5
PM	0.3
Smoke limit*	0.7

Note : * Light absorption coefficient at full load (m^{-1})

The above standards need to be followed by the contractor operating the DG sets.

c) Dust Control

The project authorities will work closely with representatives from the community living in the vicinity of project area to identify areas of concern and to mitigate dust-related impacts effectively (e.g., through direct meetings, utilization of construction management and inspection program, and/or through the complaint response program). To minimize issues related to the generation of dust during the construction phase of the project, the following measures have been identified:

- Identification of construction limits (minimal area required for construction activities).
- When practical, excavated spoils will be removed as the contractor proceeds along the length of the activity.
- When necessary, stockpiling of excavated material will be covered or staged offsite location with muck being delivered as needed during the course of construction.
- Excessive soil on paved areas will be sprayed (wet) and/or swept and unpaved areas will be sprayed and/or mulched. The use of petroleum products or similar products for such activities will be strictly prohibited.
- Contractors will be required to cover stockpiled soils and trucks hauling soil, sand, and other loose materials (or require trucks to maintain at least two feet of freeboard).
- Contractor shall ensure that there is effective traffic management at site. The number of trucks/vehicles to move at various construction sites to be fixed. Three personnel will be earmarked for this purpose.
- Dust sweeping - The construction area and vicinity (access roads, and working areas) shall be swept with water sweepers on a daily basis or as necessary to ensure there is no visible dust. Five sweepers will be earmarked for this purpose

4.4 IMPACTS ON NOISE ENVIRONMENT

a) Construction phase

In a water resource projects, the impacts on ambient noise levels are expected only during the project construction phase, due to earth moving machinery, etc. Likewise, noise due to quarrying, blasting, vehicular movement will have some adverse impacts on the ambient noise levels in the area.

i) Impacts due to operation of construction equipment

The noise level due to operation of various construction equipment is given in Table-4.5

Table-4.5 Noise level due to operation of various construction equipment

Equipment	Noise level dB(A)
Earth moving	
Compactors	70-72

Equipment	Noise level dB(A)
Loaders and Excavator	72-82
Dumper	72-92
Tractors	76-92
Scrappers, graders	82-92
Pavers	86-88
Truck	84-94
Material handling	
Concrete mixers	75-85
Movable cranes	82-84
Stationary	
Pumps	68-70
Generators	72-82
Compressors	75-85
Others	
Vibrators	69-81
Saws	74-81

Under the worst-case scenario, considered for prediction of noise levels during construction phase, it has been assumed that all these equipment generate noise from a common point. The increase in noise levels due to operation of various construction equipment is given in Table-4.6.

Table-4.6 Increase in noise levels due to operation of various construction Equipment

Distance (m)	Ambient noise levels dB(A)	Increase in noise level due to construction activities dB(A)	Increased noise level due to construction activities dB(A)	Increase in ambient noise level due to construction activities dB(A)
100	36	45	45	34
200	36	39	39	29
500	36	31	31	25
1000	36	25	25	25
1500	36	21	21	24
2000	36	19	19	24
2500	36	17	17	24
3000	36	15	15	24

It would be worthwhile to mention here that in absence of the data on actual location of various construction equipment, all the equipment have been assumed to operate at a common point. This assumption leads to over-estimation of the increase in noise levels. Also, it is a known fact that there is a reduction in noise level as the sound wave passes through a barrier. The transmission loss values for common construction materials are

given in Table-4.7.

Table-4.7 Transmission loss for common construction materials

Material	Thickness of construction material (inches)	Decrease in noise level dB(A)
Light concrete	4	38
	6	39
Dense concrete	4	40
Concrete block	4	32
	6	36
Brick	4	33
Granite	4	40

Thus, the walls of various houses will attenuate at least 30 dB(A) of noise. In addition there are attenuation due to the following factors.

- Air absorption
- Rain
- Atmospheric inhomogeneties.
- Vegetal cover

Thus, no increase in noise levels is anticipated as a result of various activities, during the project construction phase. The noise generated due to blasting is not likely to have any effect on habitations. However, blasting can have adverse impact on wildlife, especially along the alignment of the tunnel portion. It would be worthwhile to mention that no major wildlife is observed in and around the project site. Hence, no significant impact is expected on this account.

Impacts due to increased vehicular movement

During construction phase, there will be significant increase in vehicular movement for transportation of construction material. At present, there is no vehicular movement near the barrage site. During construction phase, the increase in vehicular movement is expected to increase upto a maximum of 5 to 6 trucks/hour.

As a part of EIA study, impact on noise level due to increased vehicular movement was studied using Federal Highway Administration model. The results of modelling are outlined in Table-4.8.

Table-4.8 increase in noise levels due to increased vehicular movement

Distance (m)	Ambient noise level dB(A)	Increase in noise level due to increased vehicular movement dB(A)	Noise levels due to increased vehicular movement dB(A)	Increase in ambient noise level due to increased vehicular movement dB(A)
10	36	72	72	36
20	36	67	67	31
50	36	61	61	25
100	36	57	57	21
200	36	52	52	16
500	36	46	47	11
1000	36	42	44	8

As mentioned earlier, there will be significant attenuation due to various factors, e.g. absorption by construction material, air absorption, atmospheric inhomogeneties, and vegetal cover. Thus, no significant impact on this account is anticipated. Appropriate measures have been suggested as a part of Environmental Management Plan (EMP) report to minimize impacts on wildlife.

Impacts on labour

The effect of high noise levels on the operating personnel, has to be considered as this may be particularly harmful. It is known that continuous exposures to high noise levels above 90 dB(A) affects the hearing acuity 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 per the maximum exposure period specified in Table-4.9.

Table-4.9 Maximum Exposure Periods specified by OSHA

Maximum equivalent continuous Noise level dB(A)	Unprotected exposure period per day for 8 hrs/day and 5 days/week
90	8
95	4
100	2
105	1
110	½
115	¼
120	No exposure permitted at or above this level

Noise generated due to drilling

The noise levels monitored at a 10 m distance from the source and operator's cabin is given in Table-4.10.

Table-4.10 Noise generated due to drilling

Equipment	Noise level at source dB(A)
Standing idle (inside cabin)	70-72
Standing idle (10 m radius)	72-74
On load (inside cabin)	78-80
On load (10 m radius)	82-84

The noise levels during various construction activities have been compared to various standards prescribed by Occupational Safety and Health Administration (OSHA), which are being implemented in our country through rules framed under Factories Act. It can be observed (Refer Table-4.8) that for an 8 hour duration, equivalent noise level exposure should be less than 90 dB(A).

The Director General of Mines Safety in its circular no. DG(Tech)/18 of 1975, has prescribed the noise level in mining operations for workers in 8 hour shift period with unprotected ear as 90 dB(A) or less. Similar norms can be considered for construction phase of the proposed project as well. The workers who are expected to be exposed to noise levels greater than 90 dB(A), should not work in these areas beyond 6 to 8 hours. In addition, they also need to be provided with ear plugs. Thus, increased noise levels due to drilling are not expected to adversely affect the workers operating the drill or involved in other mining activities closely.

Noise generated due to blasting

Noise generated by blasting is instantaneous, site specific and depends on type, quantity of explosives, dimension of drill hole, degree of compaction of explosives in the hole and rock. Noise levels generated due to blasting have been monitored at various sites and the results have been summarized in Table-4.11.

Table-4.11 Noise generation 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-4.10, that noise level due to blasting operations are expected to be of the order of 75-86 dB(A). Since, the nearest settlement are about 0.8 to 1.0 km away, the incremental noise due to blasting is expected to be 50-60 dB(A). 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 60 dB(A). Hence, noise level due to blasting is not expected to cause any significant adverse impact.

Mitigation Measures

- The contractors will be required to maintain properly functioning equipment and comply with occupational safety and health standards. The construction equipment will be required to use available noise suppression devices and properly maintained mufflers.
    - Vehicles to be equipped with mufflers recommended by the vehicle manufacturer.
    - Staging of construction equipment and unnecessary idling of equipment within noise sensitive areas to be avoided whenever possible.
    - Use of temporary sound fences or barriers to be evaluated.
    - Notification will be given to residents within 300 feet (about 90 m) of major noise generating activities. The notification will describe the noise abatement measures that will be implemented.
    - Monitoring of noise levels will be conducted during the construction phase of the project. In case of exceeding of pre-determined acceptable noise levels by the machinery will require the contractor(s) to stop work and remedy the situation prior to continuing construction.
- Provision with ear muffs or plugs for the workers, so as to attenuate the noise level near the crusher by atleast 15 dB(A).
- Working hours of the laborers working on dredgers will decided considering the guidelines of Occupational Safety and Health Administration (OSHA)
- To prevent other psychological and physiological impacts as mentioned in literature, the exposure period of affected persons be limited as recommended by OSHA limits in the Table- 4.9

- The following Noise Standards for DG sets are recommended for the running of DG sets during the construction:
  - The maximum permissible sound pressure level for new diesel generator sets with rated capacity upto 1000 KVA shall be 75 dB(A) at 1 m from the enclosure surface.
  - Noise from the DG set should be controlled by providing an acoustic enclosure or by treating the enclosure acoustically.
  - The Acoustic Enclosure should be made of CRCA sheets of appropriate thickness and structural/ sheet metal base. The walls of the enclosure should be insulated with fire retardant foam so as to comply with the 75 dB(A) at 1m sound levels specified by CPCB, Ministry of Environment & Forests. An amount of Rs. 5.0 lakh is earmarked for this purpose.
  - The acoustic enclosure/acoustic treatment of the room should be designed for minimum 25 dB(A) Insertion Loss or for meeting the ambient noise standards, whichever is on the higher side.
  - The DG set should also be provided with proper exhaust muffler with insertion loss of minimum 25 dB(A).
  - Proper efforts to be made to bring down the noise levels due to the DG set, outside its premises, within the ambient noise requirements by proper siting and control measures.
  - A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacturer which would help prevent noise levels of the DG set from deteriorating with use. An amount of Rs. 6.0 lakh is earmarked for this purpose.

4.5 IMPACTS ON LAND ENVIRONMENT

a) Construction phase

The major impacts anticipated on land environment during construction are as follows:

- Quarrying operations
- Operation of construction equipment
- Soil erosion
- Muck disposal
- Acquisition of land

i. Quarrying operations

A project of this magnitude would require significant amount of construction material. The cement will be transported from Haridwar or from Dehradun. The steel transported from Haridwar by road. A part of the concrete can be met by using the muck generated during excavation of the tunnel, powerhouse and other project appurtenances, by crushing it into the required size. The quantum of muck utilization as construction material would depend on the engineering properties of the muck and its suitability for construction.

The quarrying operations are semi-mechanized in nature. Normally, in a hilly terrain like Uttarakhand, quarrying is normally done by cutting a face of the hill. A permanent scar is likely to be left, once quarrying activities are over. With the passage of time, the rock from the exposed face of the quarry under the action of wind and other erosion forces, get slowly weathered and after some time, they become a potential source of landslide. Thus it is necessary to implement appropriate slope stabilization measures to prevent the possibility of soil erosion and landslides in the quarry sites.

Similarly, the proposed project would require significant amount of fine material, which can be met either by crushing the aggregates or by excavation from borrow areas. In the proposed project, large quantity of fines shall be required, which would entail excavation from borrow pits. Normally, such sites are left untreated after excavation of the construction material. The pit so created impedes the natural drainage, increases the potential for soil erosion and stores rain water and runoff. These pools of water can serve as habitats for proliferation of mosquitoes, which can lead to increased incidence of vector-borne diseases.

ii. Operation of construction equipment

During construction phase, various types of equipment will be brought to the site. These include crushers, batching plant, drillers, earth movers, rock bolters, etc. The siting of this construction equipment would require significant amount of space. Similarly, space will be required for storing of various other construction equipment. In addition, land will also be temporarily acquired, i.e. for the duration of project construction for storage of quarried material before crushing, crushed material, cement, rubble, etc. Efforts must be made for proper siting of these facilities. The various criteria for selection of these sites would be:

- Proximity to the site of use
- Sensitivity of forests in the nearby areas
- Proximity from habitations
- Proximity to drinking water source

Efforts must be made to site the contractor's working space in such a way that the adverse impacts on environment are minimal, i.e. to locate the construction equipment, so that impacts on human and faunal population is minimal.

iii. Soil erosion

The runoff from the construction sites will have a natural tendency to flow towards river Supin or its tributaries. For some distance downstream of major construction sites, such as barrage, power house, etc. there is a possibility of increased sediment levels which will lead to reduction in light penetration, which in turn could reduces the photosynthetic activity to some extent of the aquatic plants as it depends directly on sunlight. This change is likely to have an adverse impact on the primary biological productivity of the affected stretch of river Supin. Since, river Supin has sufficient flow even in the lean season, hence, adverse impacts on this account are not expected to be significant. However, runoff from construction sites, entering small streams would have significant adverse impact on their water quality. The runoff would increase the turbidity levels with corresponding adverse impacts on photosynthetic action and biological productivity. The impacts on these streams and rivulets thus, would be significant. Adequate measures need to be implemented as a part of EMP to ameliorate this adverse impact to the extent possible.

iv. Muck disposal

A large quantity of muck is expected to be generated as a result of tunneling operations, construction of roads, etc. Based on the geological nature of the rocks and engineering properties of the soil, a part of the muck generated can be used as construction material. The balance needs to be suitably disposed. Normally, muck is disposed in low-lying areas or depressions. Trees, if any, are cut before muck disposal, however, shrubs, grass or other types of undergrowth in the muck disposal at sites perish. The muck disposal sites will be suitably stabilized on completion of the muck disposal. The details of stabilization of muck disposal sites are covered in Environmental Management Plan covered in Volume-III of this Report.

v. Construction of roads

The project construction would entail significant vehicular movement for transportation of large construction material, heavy construction equipment. New access roads would have to be constructed. Some of the existing roads in the project area, would require widening. The details are given in Table-4.12.

Table-4.12 Details of roads to be constructed

S. No.	Description	Distance (km)	Width of Carriage-way (mm)
1.	Dehradun - Harbatpur (NH-123)	38	7.0 m with Black Top
2.	Harbatpur - Barwala (NH-123)	12	6.0 m with Black Top
3.	Barwala - Judoo via Hatyari (Project Road)	18	7.0 m with Black Top
4.	Judoo to Nougaon (NH-123)	69	5.20 m with Black Top
5.	Naugoan to Purola (ODR)	21	5.20 m with Black Top
6.	Purola to Mori (ODR)	35	5.20 m with Black Top
7.	Mori to Naitwar (ODR)	12	5.20 m with Black Top
8.	Naitwar to Sankri	12 approx.	3.50 -5.20 m with Black Top
9.	Sankri to Jakhol	19 approx.	3.50 -5.20 m with Black Top

An alternative road for accessing the project site may be envisaged on the right bank of river Tons in case of problem arises from transporting of heavy vehicle during construction through the road on left bank of Tons which passes some portion through the wild life area after crossing river Tons. The road on the right bank of river Tons at present exists from Naitwar village to the Supin bank a few meters upstream of confluence of river Supin and Tons and then it goes to Nichla Ponva village after crossing Supin river. The road at its present from is unsuitable for transportation of any heavy vehicle regarding its small width and steep slope.

The construction of roads can lead to the following impacts:

- The topography of the project area has steep slopes, which descends rapidly into narrow valleys. The conditions can give rise to erosion hazards due to net downhill movement of soil aggregates.
- Removal of trees on slopes and re-working of the slopes in the immediate vicinity of roads can encourage landslides, erosion gullies, etc. With the removal of vegetal cover, erosive action of water gets pronounced and accelerates the process of soil erosion and formation of deep gullies. Consequently, the hill faces are bared of soil vegetative cover and enormous quantities of soil and rock can move down the rivers, and in some cases, the road itself may get washed out.

- Construction of new roads increases the accessibility of a hitherto undisturbed areas resulting in greater human interferences and subsequent adverse impacts on the ecosystem.
- Increased air pollution during construction phase.

Various management measures have been recommended for control of adverse impacts due to construction of roads. The details are covered in Environmental Management Plan covered in Volume-III of this Report.

vi. Acquisition of land

The land to be acquired for the project is 39.088 ha. The ownership status is given in Table-4.13. The component wise details are given in Tables-4.13 and 4.14. Based on the ownership status of land, appropriate compensatory measures of land will be suggested.

Table 4.13 Total Land proposed for Acquisition for Jakhol Sankari HEP

S. No	Type of Land	Area (ha)
1.	Govt./Civil Soyam Land (Including Notional Land)	22.067
2.	Private Land	14.771
3.	Forest Land	2.250
	Total	**39.088**

Table-4.14 Component wise Details of Land to be acquired

S. No	Component	Forest & Civil Soyam Land(ha.)	Private Land (ha.)
1	Quarry site area	2.25	
2	Barrage site and left bank upstream	0.204	
3	Left bank down stream Barrage site including contractor facility& Dumping yard D-1	2.626	
4	Right Bank barrage site & Contractor facility area	0.495	
5	Road from dhara bend to Dumping yard D-1 (road widening)	0.75	
6	Dumping yard D-2 & Approch road to adit-2	0.266	4.772
7	Approach road & Adit portal at adit-2	0.602	0
8	Office cum field hostel	0	0
9	Dumping yard D-3	0.531	0.298
10	Road widening near Adit-3	0.27	
11	Contractor facility near Adit-3	0.809	0.21
12	Explosive megazine site and approach road	0.659	0.851
13	Dumping yard D-4	1.874	0
14	Approach road to surge shaft & dumping yard D-6	0.988	0.495
15	Road to MAT portal & contractor facility	0.115	2.312

S. No	Component	Forest & Civil Soyam Land(ha.)	Private Land (ha.)
16	Dumping yard D-6near surge shaft	0.219	
17	Dumping yard D-5	0.082	1.095
18	TRT Outfall & approach	0.37	
19	EM workshop & approach	2.377	
20	Switchyard & MAT portal	1.509	
21	Project Colony	0	1.663
22	Surface pressure shaft	2.068	3.075
23	Adits (Notional Land)	0.38	
24	HRT (Notional Land)	3.3	
25	TRT(Notional Land)	0.07	
26	Ventilation, Cable,Construction Tunnel (Notional Land)	0.17	
27	Main Access Tunnel (Notional Land)	0.1	
28	Surge shaft & access tunnel to surge shaft (Notional land)	0.12	
29	Pressure Shaft & Penstock (Notional land)	0.075	
30	Desilting Chamber & access tunnel to desilting chamber (Notional land)	0.2	
31	Silt flushing tunnel (Notional Land)	0.05	
32	Power intake (Notional land)	0.07	
33	U/S & D/S Transition (Notional land)	0.05	
34	Power house & bus duct (Notional land)	0.12	
35	Transformer hall & its access tunnel (Notional Land)	0.07	
36	Nitches @ 10% of total notional land	0.4775	
	Total	**24.317**	**14.771**

Table 4.15 Village wise Details of Civil Soyam Land to be acquired

S. No	Village	Civil Soyam Land (ha.)	Private land
1	Dhara	3.846	4.772
2	Jakhol	0.602	-
3	Sunkundi	4.133	1.359
4	Paon Malla	1.363	0.673
5	Sawani	0.495	-
6	Paon Talla	6.365	7.967
7.	Notional Land	5.263	-
	Total	**22.067**	**14.771**

Mitigation Measures

- Afforestation of the degraded forest patches and as per Forest Conservation Act (1980), double the amount of forest land that is being acquired for the project.
- Regeneration of felled areas will be ensured in a time bound manner and productivity of plantations will be increased through use of improved seeds and planting stock.
- Muck generated would be properly disposed off as outlined in the Muck disposal plan of Chapter- 10 Environmental Management Plan.
- To check soil erosion in small streams, steps with concrete base are prepared in sloppy area where silt erosion in the stream and bank erosion is high due to turbidity of current. Catchment area treatment plan would be implemented as outlined in Environment Management Plan covered in Volume-III of this Report. which involves all the management techniques to prevent soil erosion in the catchment area of a water resource project.

4.6 IMPACTS ON BIOLOGICAL ENVIRONMENT

a) Construction phase

4.6.1 Impacts on Terrestrial Flora

i) Increased human interferences

The direct impact of construction activity of any water resource project in a Himalayan terrain is generally limited in the vicinity of the construction sites only. As mentioned earlier, a large population (3,200) including technical staff, workers and other group of people are likely to congregate in the area during the 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 fuel wood, if no alternate fuel is provided for whom alternate fuel could be provided. There will be an increase in population by about 3200 of which about 2400 are likely to use fuel wood. On an average, the fuel wood requirements will be of the order of ($1.0 \times 365 \times 2400 \times 10^{-3}$) 879 m^3. The wood generated by cutting tree is about 2 to 3 m^3. Thus every year fuel wood equivalent to bout 400-500 trees will be cut, which means every year on an

average about 1-2 ha of forest area will be cleared for meeting fuel wood requirements, if no alternate sources of fuel are provided. Hence to minimize impacts, community kitchens have been recommended. These community kitchens shall use LPG or diesel as fuel. The details are covered in Environmental Management Plan covered in Volume-III of this Report.

The other major impact on the flora in and around the project area would be due to increased level of human interferences. The workers may also cut trees to meet their requirements for construction of houses and other needs. Thus, if proper measures are not undertaken, adverse impacts on terrestrial flora is anticipated. Since, labour camps are proposed to be constructed by the contractor along with necessary facilities, such impacts are not envisaged.

Acquisition of forest land

During project construction phase, land will be required for location of construction equipment, storage of construction material, muck disposal, widening of existing roads and construction of new project roads. The total forest land to be acquired for the project shall be 24.126 ha including Civil Soyam land. The forest in the area has already been degraded due to a large-scale human interference. Though the project area is located in an ecologically sensitive area, the forests in and around the project area are quite degraded. The tree density in the submergence area and power house area is about 344 and 352 trees/ha. Normally in a dense forest, tree density is of the order of 1000-1200 trees/ha. Thus, in land to be acquired for the project, the tree density is low to moderate.

4.6.2 Impacts on Terrestrial Fauna

i) Disturbance to wildlife

During construction phase, large number of machinery and construction labour will have to be mobilized. The operation of various construction equipment, and blasting is likely to generate noise. These activities can lead to some disturbance to wildlife population. Likewise, siting of construction equipment, godowns, stores, labour camps, etc. can lead to adverse impacts on fauna in the area.

It is proposed that during construction phase, strict surveillance measures be adopted to minimize adverse impacts due to increased human interferences. Stray animals, however, may some times drift to the construction site. It should be ensured through stringent anti-poaching surveillance that the stray animals are not killed.

Detailed measures for the same have been suggested in Environmental Management Plan covered in Volume-III of this Report.

b) Operation phase

i) Increased accessibility

During the project operation phase, the accessibility to the area will improve due to construction of roads, which in turn may increase human interferences leading to marginal adverse impacts on the terrestrial ecosystem. The details of measures to improve the terrestrial ecology of the area are covered in volume-III of this Report.

4.6.3 Aquatic Flora

a) Construction phase

During construction phase wastewater mostly from domestic source will be discharged mostly from various camps of workers actively engaged in the project area. Around 0.22 mld of water is required for the workers during the peak construction phase out of which 80% (i.e. about 0.18 mld) will be discharged back to the river as wastes, more or less as a point sources from various congregation sites where workers will reside. Sufficient water for dilution will be available in Supin to keep the DO of the river to significantly high levels.

b) Operation phase

The completion of Jakhol Sankari hydroelectric Project would bring about significant changes in the riverine ecology, as the river transforms from a fast-flowing water system to a quiescent lacustrine environment. Such an alteration of the habitat would bring changes in physical, chemical and biotic life. Among the biotic communities, certain species can survive the transitional phase and can adapt to the changed riverine habitat. There are other species amongst the biotic communities, which, however, for varied reasons related to feeding and reproductive characteristics cannot acclimatize to the changed environment, and may disappear in the early years of impoundment of water. The micro-biotic organisms especially diatoms, blue-green and green algae before the operation of project, 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 river, these organisms may perish as a result of increase in depth.

4.6.4 Impacts on Aquatic Fauna

a) Construction phase

The construction of the proposed Jakhol Sankari hydroelectric would involve large-scale extraction of different types of construction material from the riverbed including boulders, stones, gravel, sand, etc. Extraction of gravel and sand causes considerable damage to fish stocks and other aquatic life by destabilizing the sub-stratum, increasing the turbidity of water, silting of the channel bottom and modifying the flow, which in turn may result in erosion of the river channel. These alterations upset the composition and balance of aquatic organisms. The material at the river sub-stratum like stones and pebbles often provide anchorage and home to the invertebrates that remain attached in a fast flowing stream. During fish spawning season, the fertilized eggs are laid amidst the gravel, where it is made sure, that eggs are not washed away in fast flowing stream. The eggs of almost all species are sticky in nature, which provide additional safety. The turbidity in excess of 100 ppm brought by suspended solids chokes the gills of young fish. Fine solids in concentration greater than 25 mg/l, adversely affects the development of fish eggs and fish.

b) Operation phase

Among the aquatic animals, it is the fish life, which would be most affected. The migratory fish species, e.g. snow trouts are likely to be adversely affected due to obstruction created by the proposed barrage.

With the completion of barrage, flow in the downstream stretch of the river would be reduced considerably more so during the lean period. The most important changes, which can be expected, are:

- Reduced flow rate
- Increase in water temperature
- Reduction in availability of steno-thermal aquatic animals
- Increase in population of euro-thermal species.

Unless the desired flow is maintained downstream of the barrage, aquatic ecology in general and fisheries in particular would be affected. The mitigative measures for minimizing these impacts have been covered in Volume-III of this Report.

Mitigation Measures

- Use of good dredging equipment that can considerably reduce the turbidity and nutrient/contaminant addition to the water for the benefit of aquatic life.

- Adopting controlled blasting and strict surveillance regime to reduce noise level and vibrations from blasting to great extent.
- contractor/s to made responsible to provide subsidized kerosene/LPG to their workers which will in turn discourage them from illegal tree felling and removal of fuel wood and timber from the adjoining forests
- Appropriate sewage treatment measures to be taken for the discharge of wastewater so as to avoid adverse impacts on riverine ecology.
- the wildlife protection force to be adequately equipped with watch towers, wildlife personnel and other necessary equipment be deployed to prevent poaching in the area.
- installation of artificial nest boxes in the influence zone and catchment area of the project after consultation with the forest department as well as local NGOs
- Compensatory afforestation of the forest area utilized for the construction purpose.
- Compensatory plantation is to be established on degraded forest lands, which must be twice the forest area affected or lost.
- Fodder and wild fruit plantation for wild animals and for roosting, breeding and hiding cover for migratory birds etc.

4.7 INCREASED INCIDENCE OF WATER-RELATED DISEASES

4.7.1 Increased incidence of water-related diseases

The construction of a barrage would convert riverine ecosystem into a lacustrine ecosystem. The vectors of various diseases may breed in shallow parts of the impounded water. The magnitude of breeding sites for mosquitoes and other vectors in the impounded water is in direct proportion to the length of the shoreline. Since, this is a run-of river project in a mountainous region, increase in water spread area will be marginal and it would remain mostly confined in the gorge of the river, the increase in the incidence of water borne disease is not expected. Further, mosquitoes are normally observed upto a maximum elevation of about 1950-1960 m above sea level. The proposed project is located just above this elevation. Hence, increase in incidence of mosquitoes is not expected at the barrage site. The power house is located at an elevation of about 1400-1500 m above men sea level. Thus at this site and at the location of other project appurtenances, which are at a lower elevation could face increased incidence of malaria as a result of various factors like aggregation of labour,

formation of stagnant pools near labour camps, colonies, etc. may lead to the increased incidence of such diseases around the project area.

Labour camps located at lower elevations, especially close to the power house site could be vulnerable to increased incidence of water-borne diseases, if adequate measures are not undertaken.

4.7.2 Aggregation of labour

The labourers and technical staff will congregate in the project area during peak construction phase. Most of the labour would come from various parts of the country. The labourer would live in dormitories provided by the Contractor. Proper sanitary facilities are generally provided.

4.7.3 Excavations

The excavation of earth from borrow pits etc. is one of the major factor for the increase in prevalence of malaria. After excavation of construction material, the depressions are generally left without treatment where water gets collected. These pools of water, then serves as breeding grounds for mosquitoes. However, in the present case, the borrow areas are within the river bed, which in any case remain under water. Thus, no additional habitat for mosquito breeding is created due to excavation. The flight of mosquito is generally limited up to 1 to 2 km from the breeding sites. Since, no residential areas are located within 1 km from the reservoir, periphery, increased incidences of malaria are not anticipated. However, labour camps, etc. could be vulnerable to increased incidence of malaria, if proper control measures are not undertaken.

4.7.4 Inadequate facilities in labour camps

Improperly planned labour camps generally tend to become slums, with inadequate facilities for potable water supply and sewage treatment and disposal. This could lead to outbreak of epidemics of water-borne diseases.

Mitigation Measures

- Measures to be taken for provision of adequate drinking and sanitation facilities for the labors and their families.
- Borrow areas for excavation material would be under river bed, hence it would prevent formation of mosquitoes breeding ground.
- Adequate measures for supply of potable water and sewage treatment have been recommended as a part of Environmental Management Plan outlined in Volume-III of this Report.

- A proper surveillance, immunization schedule and medical facilities would be provided for the labour population migrating into the project area.

4.8 IMPACTS ON SOCIAL ENVIRONMENT

4.8.1 Impacts during construction phase

It is expected that a lot of labour force will be deployed at the project site during the construction phase and the total increase in population during peak construction has been estimated to the tune of 3200. Together with the work force many business establishment will take place which will attract people from other places. Influx of labour population might lead to number of social, cultural, economic and security related problems. However, it is evident that the local residents will have an upper hand in the establishments of any business ventures.

Land acquisition and population displacement/involuntary resettlement. The important adverse impact during construction phase will be that, pertaining to land acquisition. About 15.681 ha of land is to be acquired for the proposed Jakhol Sankri HE project. A part of this could be private, forest or government land. The acquisition of private land would lead to PAFs losing land in varying proportions. A suitable Rehabilitation Plan has been formulated for compensation of families in lieu of acquisition of land.

1. Local employment opportunities

The construction phase will last for about 4 years. The total number of persons inhabiting the area including the service population will be about 3200. The construction phase of any project is rather an unsettled stage characterized by uncertainties and often disorders. The basic problem relates to management of large population, which migrates to the project area or near major construction sites, in search of jobs. The construction of the proposed project would invariably create a number of direct employment opportunities. However, indirect employment opportunities would also be generated which would provide great impetus to the economy of the local area. Various types of businesses, such as shops, food-stalls, tea stalls, restaurants, workshops, etc. would invariably come-up, which would be run by the more entrepreneurial local residents. Besides, a variety of suppliers, traders, transporters, service providers, etc., are also likely to concentrate here and likely to benefit immensely, as demand for almost all types of goods and services will increase significantly. The business community as a whole would be benefited. The

locals would also avail these opportunities arising from the project and increase their income levels.

The construction phase of the proposed project will provide an impetus to the industrialization and urbanization in the area. Many of the agricultural lands or barren lands in the vicinity of the project area are likely to be put to non-agricultural uses. The project would require lot of ancillary developments like shops, restaurant, workshops, etc. which will have a significant impact on the existing land use of the area. Job opportunities will drastically improve in this area. At present most of the population sustains on agriculture and allied activities. There are no major industries or other avenues of occupation in the area. The project will open a large number of jobs to the local population during project construction phase.

2. Business opportunities

Apart from direct employment, opportunities for indirect employment will also be generated which would provide great impetus to the economy of the local area. Various types of business like shops, food-stall, tea stalls, etc. besides a variety of suppliers, traders, transporters will concentrate here and benefit immensely as demand will increase significantly for almost all types of goods and services. The business community as a whole will be benefited. The locals will avail these opportunities arising from the project and increase their income levels. With the increase in the income levels, there will be an improvement in the infrastructure facilities in the area.

3. Impacts due to blasting on people and structures

The construction of the project would require blasting for various operations due to tunneling, cutting of roads, quarrying, etc. This could affect the nearby structures. Normally blasting is done in with proper safety measures and major impacts are not anticipated. However, if such impacts do take place, suitable compensation shall be paid for mitigation of adverse impacts in this account.

4. Construction workforce related influence on social services (Educational, Health, Communication, Water Supply, Consumer Goods, and Sanitation etc.)

During construction phase a large labour force, including skilled, semi-skilled and un-skilled labour force, is expected to immigrate into the project area. Some of the locals would also be employed to work in the project. The labour force would stay near to the project construction sites. Education will receive a shot in the arm. The advantages of education to secure jobs will quickly percolate through all sections of

the population and will induce people to get their children educated. A sizeable amount of surplus generated through labour will be spent on education.

The labour force that would work in the construction phase would settle around the project site. They would temporarily reside there. This may lead to pollution, due to generation of domestic wastewater, human waste, municipal solid waste etc. Besides, other deleterious impacts are likely to emerge due to inter-mixing of the local communities with the labour force. Differences in social, cultural and economic conditions among the locals and labour force could also lead to friction between the migrant labour population and the local population.

5. Improved access facilities in the project area

Development of the proposed Jhakol Sankari HEP project will have multifold beneficial impacts. The immediate beneficial impacts from the project will be improved connectivity by the road. The improved road access will bring an improvement of food security situation and overall economic and social stability. The improved access road will also provide cheap, safe and fast transport of goods and services from rural areas to urban centers and vice versa. This will contribute significantly to improve the overall socio-economic condition of the people.

6. Impacts on public health due to migrant population

About 1000 labourers, technical staff and service providers will congregate in the project area during peak construction phase. The total increase in population is expected to be of the order of 3200. Most of the labour would come from various parts of the country. The labourer would live in dormitories provided by the Contractor. Proper sanitation facilities are generally provided. Hence, a proper surveillance and immunization schedule needs to be developed for the labour population migrating into the project area.

7. Increased incidence of vector-borne diseases due to excavations

The excavation of earth from borrow pits etc. is one of the major factor for the increase in prevalence of malaria. After excavation of construction material, the depressions are generally left without treatment where water gets collected. These pools of water, then serves as breeding grounds for mosquitoes. However, in the present case, the borrow areas are within the river bed, which in any case remain under water. Thus, no additional habitat for mosquito breeding is created due to excavation.

The quarry areas after excavation shall from stagnant pools of water during monsoons, which can serve as breeding sites for mosquitoes. The flight of mosquito is generally limited up to 1 to 2 km from the breeding sites. The residential areas is located within 1 km from the reservoir periphery, or stagnant pool of water will be vulnerable to increased incidence of malaria. Similarly, labour camps, etc. could be vulnerable to increased incidence of malaria, if proper measures for siting drainage and mosquito control are not undertaken.

4.8.2 Impacts during Operation Phase

Although there are a number of positive impacts of the proposed project, certain negative impacts will also be there, which are described in the following paragraphs.

1. Improved Access to social services (education, health, market etc)

Once the construction of the project starts, significant and visible impacts will be felt in the project area. It can be assumed that economic activities will boom in settlements close to the project facility sites. During construction phase, education centers, health post, market etc. will be improved. After construction phase, there will be withdrawal of economic activities which flourished during construction phase since most of the construction related workforce will leave the project area. However, it is likely that some economic activities will continue or be further promoted in these areas because of the relatively good accessibility to cities and urban areas.

2. Community health improvement

After the project construction, there will be better accessibility condition to and around the project area. At the same time, project will establish one health care units at the dam site area. Improvement the project area people will have easy access to the district hospital as well as project health care units. The better electrification (with the implementation of rural electrification program) will further enhance the facilities available at the centers.

During project construction phase, the proponent will establish two health care units (one at dam site and other at powerhouse area) with adequate number of health workers and logistic supports primarily to provide health support services to the workers and project staff. The health facility will also be made available to local people and visitors as well.

3. Local employment opportunities

The operation of the project will provide an impetus to the industrialization and urbanization in the area. Many of the agricultural lands or barren lands in the vicinity

of the project area are likely to be put to non-agricultural uses. The project would require lot of ancillary developments like shops, restaurant, workshops, etc. which will have a significant impact on the existing land use of the area. Job opportunities will drastically improve in this area. At present most of the population sustains on agriculture and allied activities. There are no major industries or other avenues of occupation in the area. The project will open a large number of jobs to the local population during project operation phase.

4. Impoverishment risk assessment (IRA)

One of the most important and negative impact due to the commissioning of the project would be that a number of families could be displaced from their lands, and economic activity. As per the assessment, a total of 216 landholders/ land titleholders would be losing land in varying proportions. In project feasibility and preparation studies, the ira performs two basic functions. Foremost, it serves as a diagnostic and predictive tool, to anticipate risks in resettlement and to assess their nature and their expected intensity. Secondly, IRA is also used as a problem resolution and planning function, to guide the incorporation of measures matching each main risk, either for prevention or mitigation. The IRA identifies impoverishment not only in terms of income, but also in terms of employment opportunities, health care, nutrition, food security, common assets, education, shelter or social capital. The ira framework has been synthesized from the knowledge of past experiences, which saves considerable time and effort in feasibility work by not demanding general risk analysis to start afresh in each project, but rather by *ex-ante* offering a well-tested starting point. The matrix of eight basic risks in light of historical experience, predictable in most resettlement situations: landlessness, joblessness, homelessness, marginalization, increased morbidity and mortality, food insecurity, loss of access to common property, and social (community) disarticulation. Each of these risks is briefly discussed below in Table-4.16.

Table-4.16: Impoverishment Risk Assessment

S. No.	Risks involved	Description of risks involved	Details
1.	Landlessness	Expropriation of land removes the main foundation on which people build productive systems, commercial	As per our assessment, there are about 216 PAFs who are likely to lose their lands in varying proportions due to the process of land acquisition.

S. No.	Risks involved	Description of risks involved	Details
		activities, and livelihoods. Often land is lost forever, sometimes it is partially replaced, and seldom is it fully replaced or fully compensated. This is the principal form of de-capitalization and pauperization of displaced people, as they lose both natural and man-made capital.	The villagers depend on their lands for their livelihood. In addition, there are a number of families that are dependent on these lands for their livelihood, who work as agricultural labour work force. Acquisition of lands would invariably affect their means of livelihood and sustenance.
2.	Joblessness	Loss of wage employment occurs on account of acquisition of agriculture land, Yet creation of new jobs is difficult and requires substantial investment. Resulting unemployment or underemployment among resettlers endures long after physical relocation has been completed.	There are a number of PAFs who are dependent on Agricultural land. As This would adversely affect the job opportunities in the area.
4.	Marginalization	Marginalization occurs when families lose economic power and slide on a downward mobility path middle-income farm - households do not become landless, they become small land holders, small shopkeepers' and craftsmen downsize and slip below poverty thresholds. Relative marginalization often begins long before actual displacement; for instance when lands are condemned for future flooding they are implicitly devalued as new public and private infrastructure investment	This aspect needs to be carefully and sensitively assessed, as the main source of sustenance, i.e. land would be acquired and thus the main source of income and livelihood is gone; the possibility of many of the PAFs would become marginalized. As mentioned there are 216 land titleholders that would lose land due to the process of land acquisition. It is felt that only a few families/ individuals that would be able to bear the brunt of land acquisition. For the remaining the possibility of sliding on a downward mobility path would be inevitable unless alternative sources of livelihood are not provided.

S. No.	Risks involved	Description of risks involved	Details
		are prohibited and the expansion of social service is undercut.	

4.8.3 Skill Mapping

The land to be acquired for the project is 39.008 ha. Out of this, about 14.771 ha is private land and about 2.250 ha is forest land. There are no families losing homesteads & 216 families losing land only due to the proposed project.

There are 6 project affected villages in Tehsil Mori of District Uttarakashi namely Dhara, Jakhol, Sunkundi, Pawn Malla, Pawn Talla and Sawani. Whereas the private land is to be acquired in four villages in village Jakhol & Sawani entire land to be acquired is Government Land.

Agriculture is the main occupation in the PAVs. The total working population in the area constitutes for 52.2% and dependent population or non-workers in the villages are 47.8% of the total population. It is further observed that 90.6% of the working population are main worker. The marginal workers account for about 9.4% of the working population. Apart from cultivation, farmers and other PAFs rear cattle for milk, meat, eggs and labour.

The conclusion of Skill Mapping are given as below:

- Skill levels are quite low amongst PAFs.
- PAFs have skills related to Agriculture and Livestock
- Even in Agriculture and livestock, PAFs are not trained in modern practices.

As a part of skill development, it is suggested to impart training for the following aspects:

- Wool knitting
- Stitching
- Electrician

CHAPTER -5
ANALYSIS OF ALTERNATIVES

CHAPTER -5
ANALYSIS OF ALTERNATIVES

5.1 INTRODUCTION

The project alternatives were identified in terms of location, type and alignment of different components. Restrictions on planning layout of development alternatives are imposed by the Govind Wildlife Sanctuary and/or the Reserved Forest. The projects should have no adverse impact on the wildlife sanctuary. No construction activities are allowed within the boundaries. Significant impounding of forest areas has also to be avoided. The boundaries of the wildlife area limit the planning at the powerhouse location, which is just upstream of the confluence of Supin and Tons rivers on the left bank. The actual boundary runs along a ridge which separates the lower catchments of Tons right bank and Supins left bank. After the confluence it extends on both banks of Tons river. Therefore, no access roads can be planned on the downstream side of the proposed powerhouse.

The subsequent sections describe the approach followed to identify the most recommendable hydropower development for the Jakhol Sankri HEP scheme.

5.2 ALTERNATIVES IN TERMS OF RIVER BANKS

As mentioned in the previous section, different options were explored in terms of type, location and alignment of different project components. This section presents analysis that went into deciding whether the project would be planned as a left bank or a right bank development.

Topographically, the right river bank near all potential diversion work locations is quite steep and has very little space on the surface for locating/aligning any structure. While the left bank also more or less has similar topographic features, it has better accessibility and still provides some space for locating intake (or a surface desilting, in some cases). Therefore, it was decided to go ahead with the left bank option.

5.3 ALTERNATIVES CONSIDERED FOR TYPE AND LOCATION OF DIVERSION STRUCTURE

As mentioned earlier, in terms of comprehensive development alternatives, four options viz; Alternative 1L, 2L, 3L and 4L were identified and explored. Among these, the first three were primarily in terms of type and location of diversion structure. The

powerhouse location is just upstream of confluence of Tons and Supin rivers and is common to all the first three alternatives.

5.3.1 Alternatives -1L

In this alternative the barrage is located upstream of Jakhol village, some 25 m upstream of the suspension bridge and at immediate upstream of confluence of Bar Gad and Supin. Some 6 km long HRT runs along the left bank. FRL is in the order of 1886 msl. Setting of turbines is taken as 1510 msl, thus providing 376 m of gross head. As mentioned earlier in this chapter, for locating a diversion structure, the entire stretch from barrage location up to the wild life boundary, around 1600 m upstream of barrage is available for consideration. So, by having a barrage at this location we are not utilizing the full potential of the river stretch which can be achieved in two ways; either by constructing a dam at the same location and raising water level by impounding or by moving upstream. Therefore, Alternative-1L was rejected and the dam based option was first explored.

5.3.2 Alternatives -2L

A narrow gorge some 50 m downstream of the barrage site, or 25 m downstream of the suspension bridge is a site which has excellent topography for an arch dam. Dam heights considered range up to 80 m with the highest FRL at 1932 msl which still stays clear of the wildlife area boundary. The slightly shorter but still nearly 6 km long waterway is located underground in the left bank and ends in the same powerhouse cavern (or open air powerhouse) as the other alternatives. Maximum gross head is 422 m.

The arch dam alternative was rejected on account of the following considerations:

In case of an arch dam, much of the load is transferred to the abutments. Now, unless detailed geological investigation is carried out to confirm availability of good rock mass for a considerable depth on both the abutments, an arch dam is generally avoided in Himalayan region.

The dam location is at immediate downstream of the confluence of Supin River and Bar Gad which brings lot of debri/material with it. This river borne material will get deposited in the reservoir created by the arch dam thus resulting in reduction of its capacity.

As both these options were rejected, the only logical alternative left is moving the diversion structure location upstream; as close to the wild life boundary as possible so that maximum can be gained in terms of head.

5.3.3 Alternatives -3L

This alternative comprises an Barrage at around 1600 m upstream of 1L barrage location, an underground desilting tank, some 6.6 km long HRT on the left bank and an underground powerhouse.

The weir/barrage based option (Alternative-3L) was preferred on account of the following considerations:

Upstream of barrage location, the river gradient is quite steep. Therefore, by moving the diversion location further upstream, considerable increase in head is achieved which also compensates for the loss of head that could be achieved by a gated barrage. On the other hand, as both the banks along this river stretch are quite steep, there is hardly any loss of discharge.

The increase in length in HRT is again offset by the increase in energy generation and savings in cost of construction of weir over barrage.

5.3.4 Alternatives -4L

This alternative mooted with Powerhouse is to be located upstream of the Purola Thrust and consequently cross the Thrust with Tailrace Tunnel (TRT).

5.4 HEADWORK OPTIONS CONSIDERED WITHIN ALTERNATIVE-3L

Once the type and location of the headwork was decided, the following types of diversion structures were considered for diversion of design discharge:

An ungated weir – rejected due to presence of lot of boulders and other river borne materials which can potentially block the flow.

A gated weir – rejected due to space constraint

A Coanda weir – this special type of trench weir developed by USBR rejected as coanda screens are patented items and not presently available in india.

A trench weir – a trench weir with an elevated profile to minimize drop in water level was selected and prescribed in the FSR.

A gated Barrage - Apprehensions have been raised on the performance of the trench weir prescribed in the FSR in light of the boulder pebbles mixed debrises flowing in the river eventually shall settle and clog the trench. Any disruption in the periodical cleaning of the trench shall have a direct impact on the running of the

power house. After careful examination of the alternatives for headworks, a gated Barrage with four bays of 5.0m(W) X 4.40m(H) has been finalized and being prescribed in the DPR. Trash Rack Cleaning Machine (TRCM) arrangement has been provided to facilitate mechanical cleaning of the floating debrises approaching infront of the power intake.

A fish ladder has also been provided on right side of the barrage structure to facilitate environmental release of water for maintaining aquatic life.

5.5 ALTERNATIVES CONSIDERED FOR DESILTING

Both the possibilities of a surface and an underground disilting were explored. Finally, the underground option was selected as there was not enough space for a surface desilting as indicated in the FSR. The situation remains unchanged in the DPR.

5.6 ALTERNATIVES CONSIDERED FOR WATER CONDUCTOR SYSTEM

The wild life area restricted the HRT alignment to steer clear of its boundary and it has been maintained throughout the alignment of HRT. The minimum bare bends and kinks in HRT and other part of the water conductor system has been provided to meet the requirements for fixing the alignment,

5.7 ALTERNATIVES CONSIDERED FOR POWERHOUSE

The type of power house has been dictated by the topography of the area under consideration and it was concluded that the underground powerhouse considered in the PFR and subsequently in the FSR shall be the best option. Location of the powerhouse must fulfil the constraints imposed by the protected wildlife area along Tons river in the vicinity of its confluence with Supin river and the Purola Thrust running across the general area selected for the powerhouse. Since all the project components must stay clear of the protected wildlife areas, the powerhouse must be located upstream of it and the tail race tunnel must drain into Supin river, not Tons river.

5.8 CONCLUSIONS & RECOMMENDATIONS

With regard to the Purola Thrust, there are two major options available;

Cross the Thrust with HRT/ Pressure Shaft and, therefore, site the powerhouse downstream of the Thrust.

The alternative development configurations studied for the Jakhol Sankri hydropower project as part of the Feasibility Study considered different feasible locations of the

components and its alignments before arriving at final project layout. The constraints imposed by backwater from the downstream Hydroelectric Project, location of potential thrust/fault zones, patches of protected wildlife area and terms of allotment of the project by the Uttarakhand Government etc. have been considered in the alternative studies. The wild life area restricted the HRT alignment to steer clear of its boundary and it has been maintained throughout the alignment of HRT/Pressure Shaft/ Penstock. A surface Penstock has been provided to cross the Purola thrust so that in case of any eventuality, this project component is accessible for inspection and any remedial measure thereupon. The alternative, which is techno-economically the best development plan and which also fulfils the aforementioned constraints has been finally chosen for further study in DPR preparation.

Powerhouse is to be located upstream of the Purola Thrust and consequently cross the Thrust with Tailrace Tunnel (TRT). (Alternative 4L)

It is noted from the geological and seismotectonic study reports that Purola Thrust is not seismically active feature. Although there is increased possibility of movement along the thrust line, the magnitude of the movement may or may not be significant. Therefore, until detail geological/geotechnical investigations have been carried out, the Purola Thrust is considered as a region of potentially poor geology. Crossing the region of Purola Thrust by a TRT will allow easy inspection, particularly because the project is envisaged as a high head scheme with Pelton Turbines. However, Alternative 4L leads to a long TRT and the powerhouse location with difficult and longer access tunnels.

Considering the above, it had been considered most appropriate for study at FSR stage to cross the Purola Thrust with pressure shaft starting from the underground surge shaft.

After careful examination it has been decided to avoid the purola thrust lying between Surge Shaft and Power House cavern, the Pressure Shaft has been proposed to be taken out to the surface and continuously laid along the surface as a penstock till it crosses the purola thrust by a sufficient margin. The reason for this changed layout is to avoid any type of uncertainties while traversing/crossing the underground thrust.

Thus the recommended options i.e., the 3L option with underground powerhouse has been considered.

CHAPTER-6
ENVIRONMENTAL MONITORING PROGRAMME

CHAPTER-6
ENVIRONMENTAL MONITORING PROGRAMME

6.1 THE NEED

Monitoring is an essential component for sustainability of any water resources project. It is an integral part of any environmental assessment process. Any water resources development project introduces complex inter-relationships in the project area between people, various natural resources, biota and the many developing forces. Thus, a new environment is created. It is very difficult to predict with complete certainty the exact post-project environmental scenario. Hence, monitoring of critical parameters is essential in the project operation phase.

Monitoring of environmental indicators signal potential problems and facilitate timely prompt implementation of effective remedial measures. It will also allow for validation of the assumption and assessments made in the present study.

Monitoring becomes essential to ensure that the mitigation measures planned for environmental protection function effectively during the entire period of project operation. The data so generated can also serve as a data bank for prediction of post-project scenarios in similar projects as well.

6.2 AREAS OF CONCERN

From the monitoring point of view, the important parameters are water quality, erosion and siltation, landuse, afforestation, etc. An attempt is made to establish early warning of indicators of stress on the environment. Suggested monitoring details are outlined in the following sections.

6.3 WATER QUALITY

Construction Phase

It is proposed to monitor the effluent before and after treatment from septic tanks. The frequency of monitoring could be once per month. Since, 4 septic tanks have been proposed for labour camps, a total of 96 samples need to be analysed. The parameters to be monitored include pH, Bio-chemical Oxygen Demand, Total Suspended Solids and Total Dissolved Solids. The cost of treatment of one sample is expected to be Rs.2,500. Thus, total cost for analysis of 96 samples is expected to be Rs.2.4 lakh/year. Considering the construction phase to last for a period of 4 years and an escalation cost of 10% every year, the total cost over the entire

construction phase works out to Rs.11.2 lakh. The analysis work can be done by any laboratory recognized by Uttarakhand Pollution Control Board.

Operation phase

The surface water quality of the proposed reservoir and Supin river can be monitored thrice a year (winter, pre-monsoon and post-monsoon seasons). The proposed parameters to be monitored include; pH, temperature, electrical conductivity, turbidity, total dissolved solids, calcium, magnesium, total hardness, chlorides, sulphates, nitrates, DO, COD, BOD, Iron, Zinc and Manganese.

The sampling sites shall be:

- 1 km upstream of the reservoir.
- Submergence area.
- 1, 3 and 5 km downstream of the dam.

The total cost of analysis will be Rs.0.5 lakh per year. This analysis shall be done throughout the life of the project. The analysis work can be conducted by a reputed external agency recognized by the Uttarakhand Pollution Control Board.

During project operation phase, a sewage treatment plant (STP) is proposed to be set up to treat the effluent from the project colony. Once every week, it is envisaged to analyse a sample each before and after treatment from the STP. The parameters to be analysed include pH, Biochemical Oxygen Demand, Chemical Oxygen Demand, Total Suspended Solids and Total Dissolved Solids. The cost of analysis of 104 samples @ Rs.2000/sample works out to Rs.2.1 lakh/year. Thus, total cost for analysis in project operation works out to (0.5 + 2.1) Rs. 2.6 lakh/year.

6.4 AIR QUALITY AND METEOROLOGY

Construction Phase

The ambient air quality monitoring during construction phase can be carried out by an external agency, approved by State Pollution Control Board at two stations. Every year monitoring is to be done for three seasons namely, winter, pre-monsoon and Post-monsoon.

The frequency of monitoring could be twice a week for four consecutive weeks at each station for each season. The parameters to be monitored are PM_{10}, $PM_{2.5}$, SO_2 and NO_2.

Every year, ambient air quality is to be monitored for (2 stations*twice a week* four weeks*three seasons) 48 days. A total cost of Rs. 2.4 lakh @ Rs.5000/day can be earmarked for this purpose. Considering the construction phase to last for a period of

4 years and an escalation cost of 10% every year, the total cost over the entire construction phase works out to Rs.11.2 lakh.

A meteorological laboratory can be set up at one of the ambient air quality monitoring stations. Automatic recorders for temperature, wind speed and direction, humidity, rainfall needs to be commissioned at the site. An amount of Rs.5.0 lakh can be earmarked for this purpose.

6.5 NOISE

Construction Phase

Noise emissions from vehicular movement, operation of various construction equipment may be monitored during construction phase at major construction sites. The frequency of monitoring could be once every three months. For monitoring of noise level, an integrating Sound Level Meter will be required. An amount of Rs.10.0 lakh can be earmarked for this purpose.

6.6 ECOLOGY

Project Operation Phase

Status of afforestation programmes, changes in migration patterns of the aquatic and terrestrial fauna species should be studied. The study could be undertaken twice every year till the entire design life of the dam. The monitoring can be done for two seasons in a year namely pre-monsoon and post-monsoon. A provision of Rs. 5 lakh/year can be earmarked for this purpose. The study can be conducted by an external agency having an experience to conduct such studies.

6.7 AQUATIC ECOLOGY AND FISHERIES

Project Construction Phase

No monitoring programme has been suggested for the project construction phase.

Project Operation Phase

Monitoring of fisheries in the reservoir will be essential to achieve sustainable yield of fish. Some of the parameters to be monitored are phytoplanktons, zooplanktons, benthic life and fish composition, etc. Based on human resources and facilities available, monthly observations in time and space need to be made.

The monitoring can be conducted by a reputed external agency. An amount of Rs.6.0 lakh/year can be earmarked for this purpose.

6.8 INCIDENCE OF WATER-RELATED DISEASES

Project Construction Phase

During project construction phase, the incidence of various water-related diseases can be monitored. The various parameters to be covered include various diseases cause and control measures. The monitoring can be conducted by the medical staff posted at the dispensary near construction site. A provision of Rs.5.0 lakh/yr has been earmarked for this purpose. The total cost for entire construction phase of 4 years works out to Rs.23.2 lakh.

Project Operation Phase

Various parameters to be covered included various disease cause and control measure. The monitoring can be conducted by Environmental Cell. A provision of Rs.5.0 lakh per year can be embarked for the same.

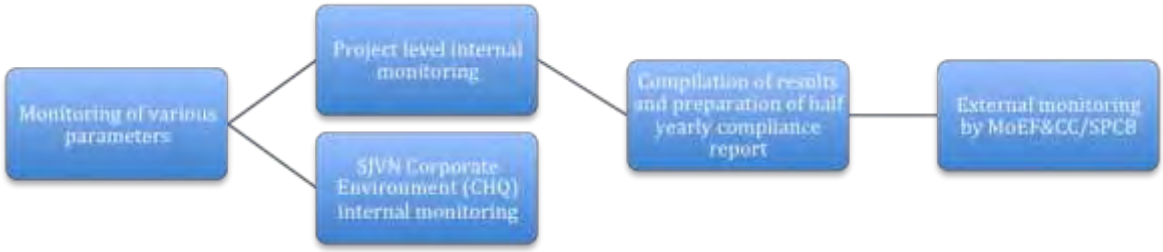
6.9 ADMINSITRATIVE/ORGANISATION SETUP

The magnitude of the project and various proposed environmental plan indicate that the project would require manpower to look after all issues of EMP report especially Biodiversity Management Plan, CAT Plan, Relocation and Rehabilitation of Muck, Creation of Green Belt, R&R, etc. In order to implement these plans in environmentally sound manner a dedicated Project Environment Deptt. and R&R Deptt. is to be constituted at site having 2 no. Environment Officers and 1 no. R&R Officer with necessary support staff. These officers shall also undertake internal monitoring/assessment of EMP activities and also assist during external monitoring by MoEF&CC/SPCB.

<u>Compliance to Conditions Laid Down by the State and Central Government:</u>

While granting statutory clearances, the State Government and regulators as well as Central Government will impose certain conditions on the project authorities, which are required to be complied with. As soon as these conditions are imposed, the Project Environment Deptt. and R&R Deptt. will undertake all necessary steps to achieve 100% compliance of these stipulations. A half yearly compliance report along with monitoring results will be made available to these statutory/regulatory agencies for effective monitoring.

The reporting mechanism will be as under:



6.10 SUMMARY OF ENVIRONMENTAL MONITORING PROGRAMME

The summary of Environmental Monitoring Programmes to be implemented in project construction and operation phases is given in Tables 6.1 and 6.2 respectively.

Table-6.1: Summary of Environmental Monitoring Programme during Project Construction Phase

S. No.	Item	Parameters	Frequency	Location
1.	Effluent from septic tanks	pH, BOD, COD, TSS, TDS	Once every month	Before and after treatment from STP
2.	Water-related diseases	Identification of water related diseases, adequacy of local vector control and curative measure, etc.	Three times a year	Labour camps and colonies
3.	Air quality	PM_{10}, $PM_{2.5}$, SO_2 and NO_2	Once every season	At major construction sites
4.	Noise	Equivalent noise level (L_{eq})	Once in three months	At major construction sites
5.	Meteorological aspects	Wind direction & velocity temperature humidity, rain	Once every season	At two of the ambient air quality sampling sites

Table-6.2: Summary of Environmental Monitoring Programme during Project Operation Phase

S. No.	Items	Parameters	Frequency	Location
1.	Water	pH, Temperature, EC, Turbidity, Total Dissolved Solids, Calcium,	Thrice a year	• 1 km upstream of reservoir • Reservoir area • 1, 3 and 5 km

S. No.	Items	Parameters	Frequency	Location
		Magnesium, Total Hardness, Chlorides, Sulphates, Nitrates, DO, COD, BOD, Iron, Zinc, Manganese		downstream of dam site
2.	Effluent from Aerated Lagoon	pH, BOD, COD, TSS, TDS	Once every week	• Before and after treatment from STP
3.	Water related diseases	Identification of water related diseases, sites, adequacy of local vector control measures, etc.	Three times in a year	• Villages adjacent to project sites
4.	Terrestrial Ecology	Status of afforestation programme of green belt development	Once in a year	-
5.	Aquatic ecology	Phytoplanktons, zooplanktons, benthic life, fish composition	Three time in a year	• 1 km upstream of reservoir • Reservoir area • 1, 3 and 5 km downstream of dam site

6.11 COST FOR IMPLIMENTING ENVIRONMENTAL MONITORING PRORAMME

The cost required for implementation of Environmental Monitoring programme during project construction phase is Rs. 45.6 lakh. The details are given in Table-6.3.

Table-6.3 Cost for implementing Environmental Monitoring Programme during project construction phase

Item	Cost (Rs. lakh)
Effluent from labour camps	11.2
Ambient air quality monitoring	11.2
Incidence of water related diseases	23.2
Total	45.6

The cost required for implementation of the Environmental Monitoring Programme during operation phase is the order of Rs.18.6 lakh/year. A 10% annual price increase may be considered for every year. The details are given in Table-6.4.

Table-6.4 Cost for implementing Environmental Monitoring Programme during project operation phase

Item	Cost (Rs. lakh/year)
Water quality and effluent from project colony	2.6
Ecology	5.0
Riverine fisheries	6.0
Incidence of water related diseases	5.0
Total	18.6

CHAPTER-7
ADDITIONAL STUDIES

CHAPTER-7
ADDITIONAL STUDIES

7.0 INTRODUCTION

The present chapter shall discuss about the public hearing details, dam break analysis, disaster management and social impact assessment study for the proposed Jakhol Sankri Hydro-electric Project, Uttarakhand. The various issues raised and remarks given by project proponent during public hearing meeting have been described in the section of public hearing details. The Dam Break Analysis for Jakhol Sankri hydro-electric project has been carried out to ascertain the impact of uncontrolled release of water in the downstream, in the hypothetical condition of failure of dam for which Disaster Management plan has been made, to highlight the measures to be taken during the state of emergency. The section discusses about the emergency action plan, special preparedness measures, efficient communication system, and management after receding of Flood Water as the preventive plan during flood conditions. The most important negative impact due to the commissioning of the project would be that a number of families would be displaced from their lands, homesteads and economic activity. Besides, certain impacts are likely to emerge due to inter-mixing of the native population with the expatriate labour force. Hence, the social impacts of the project affected families have been discussed with the rehabilitation and resettlement operations taken.

7.1 PUBLIC HEARING

Public Hearing forJakhol Sankri HEP was organised by Uttarakhand Environment Protection and Pollution Control Board on 01.03.2019 at Khand Vikas Adhikari Office,Mori,Uttarkashi at 11:00 am.The advertisment for Public Hearing was issued in following two leading daily newspapers on 29.01.2019 (Copy enclosed as **Annexure-III**):

1. Hindustan Times
2. DainikJagran

Public Hearing was conducted on behalf of SJVN Limited (SatlujJalVidyut Nigam) as per the guidelines of EIA Notification 2006 and Amendment 2009.Therefore on instructions of District Magistrate Uttarkashi Public Hearing was chaired by Mr.Hemant Kumar Verma (Additional Magistrate, Uttarkashi).Mr.Amit Pokhriyal (Regional Officer) and Mr. SS Chauhan (Assistant Scientist) represented

Uttarakhand Environment Protection and Pollution Control Board.The Public Hearing presentation was done by Mr. S.M. Dixit (Addl.Chief Engineer) WAPCOS Limited.He explained the Environmental Impacts and other feautres of the project.The minutes of meeting are enclosed as Annexure-IV.

The isuses raised in the Public Hearing are complied in the section below.

7.1.1 Issues Raised During Public Hearing

Public hearing was started with the permission of the Chair, Various points raised by the public and their replies by the Project Proponent and Govt. Officers are given in Table-7.0.

Table-7.0 Issues raised and response given during Public Hearing

S. No	Name and villages	Comments	Response
1	ShriKedar Singh Panwar, Gram Dhara	Asked the reason for venue selected for Public Hearing is 40 km away from Project Area. He also asked the reason for extraordinary Police Security due to which people are facing inconvenience in participating in public hearing. Apart from this, the issue of Forest Laws was also raised by ShriPanwar,in which he raised question about mass cutting of trees for project which will lead to ecological imbalance and environmental imbalance in the region. Moreover if locals cut even a single tree it leads to severe punishment. Shri Panwar had protested the construction of project.	The venue for public hearing was decided by Uttarakhand Environment Protection and Pollution Control Board (UEPPCB) in consultation with the District Administration and considering the remoteness of the project site. The arrangements were so made to enable the views of the concerned local persons and others who have plausible stake in the environmental impacts of the project, to be freely expressed. The impacts as envisaged due to tree cutting/biodiversity already been evaluated and suitable mitigation measures

S. No	Name and villages	Comments	Response
			suggested in the report.
2	ShriSurat Singh Rawat Village Sunkundi	Requested District Collector, Uttarkashi to conduct public hearing in the Jhakhol area. He further demanded Rs.10 lakh compensation for each affected family.	The venue for public hearing was decided by Uttarakhand Environment Protection and Pollution Control Board (UEPPCB) in consultation with the District Administration and considering the remoteness of the project site. The compensation shall be given as per LARR Act, 2013.
3	ShriAmritNaagar, village Aarakot	Several Hydro projects are functioning in Sikkim, Bhutan and Himachal, which has lead to better employment opportunity and better lifestyle of the local people. Therefore he urged district administration and SJVNL to give appropriate compensation to the local people and households in the project area should be given electricity at cheap rates. He also appealed to the local people to support project construction.	We appreciate his support and compensation shall be given as per LARR, Act, 2013. Apart from compensation as per LARR, Act, 2013 the Local Area Development Plan is also prepared.
4	ShriKripal Singh Rana, Village Kasla	The reason for less participation of project affected area is because public hearing has not been conducted in project affected area. He further suggested that the local people should be given	The venue for public hearing was decided by Uttarakhand Environment Protection and Pollution Control Board (UEPPCB) in

S. No	Name and villages	Comments	Response
		employment opportunity during the project construction and operation. He was of the view that roads would get damaged due to movement of vehicles in Mori area. It was suggested by him that roads should be properly developed in the Mori area prior to start of construction activities of the project.	consultation with the District Administration and considering the remoteness of the project site. During the construction and operation of project several indirect employment opportunities shall be created. However, for the direct employment the Government Norms shall have to be followed. Separate provision has been kept for repair of roads and alternative routes may be explored, if required.
5	ShriDarshan Singh Rawat, Village Sirga	Raised issue on Forest Law violation. Due to construction of said project deforestation will take place which will have adverse effect on environment. He suggested that local people should be given exemption to collect fodder for animals, wood etc. from forest.	District Administration allows the locals in Forest Area as per the Forest Right Act, 2006. Provision for development of grazing land has been made in the CAT Plan which will be developed over an area of 444 ha.
6	ShriDurgeshwarLal, Village Rekcha	Five other villages are coming in the project affected area, but there name are not mentioned in the list of project affected	There are only four project villages from which private land will be acquired namely Dhara,

S. No	Name and villages	Comments	Response
		area. Therefore these villages should be given all facilities and other benefits similar to project affected area. Therefore he demanded households of the project affected area should be provided electricity at subsidized rate. He further demanded a student hostel should be constructed under project in Mori block, an ultrasound machine and Blood Testing Laboratory should be open by SJVNL in CHC Mori. A bypass should be constructed in Mori area to avoid traffic jam. Whether any action plan has been prepared by Project Proponent M/s SJVNL to stop land erosion?	Sunkundi, PaonMalla, PaonTalla the details of which have been enclosed in the EIA/EMP report and also shared during public hearing. The R&R benefits shall be as per LARR Act, 2013. Apart from the provision of LARR Act, 2013 Improvement in Education and Health Facilities has been suggested as part of Local Area Development Plan. Action Plan shall be prepared as and when required during the construction period in consultation with concern departments.
7	ShriMurti Singh Panwar, Gram Dhara	Area identified for the project is geographically sensitive area, where Govind Wild Life Sanctuary is located nearby, in which different species of birds and animals reside. During the construction of the project blasting will take place in large amount which is likely to have adverse effects on their life. He suggested that	The barrage area of project is located in close proximity to GovindPashuVihar Wildlife Sanctuary. In this regard, the necessary clearance from National Board of Wildlife has already been obtained. Control blasting

S. No	Name and villages	Comments	Response
		controlled blasting should be done in the construction of the project.	method shall be done during construction of project.
8	Shri Gulbiya Lal Zingadata, village Pensar	Public Hearing should have been done in project affected area. Construction of roads should be done, employment opportunities should be given to locals and blasting should be done with proper precautions that nearby homesteads should not be affected with cracks.	The R&R benefits shall be as per LARR Act, 2013. Apart from the provision of LARR Act, 2013 Improvement in Education and Health Facilities has been suggested as part of Local Area Development Plan. Control blasting method shall be done in construction of project.
9	ShriBalveer Singh Rana, village- Liwadi	Elucidated on benefits from the said project such as improvement in education level and the possibility of increasing employment. He also suggested that Local Administration and Project Proponent should speak to people who are against the project and convince them and take their consent for the project.	We appreciate the concern raised.
10	Shri Liber Singh, village Sunkundi	The land he has been residing belongs to forefather and this land was not registered in their name, if his land is acquired for project suitable action should be taken to award him fair compensation.	The R&R benefits shall be as per LARR Act, 2013. District Administration suggested the local to update their land records prior to land acquisition.

S. No	Name and villages	Comments	Response
11	Shri Prahlad Singh, Gram Dhara	Reason for cancellation of last Public Hearing was that local people were not taken in confidence for the project. Today also people are not in confidence. Therefore Project Reports should be made available in Hindi for locals to understand the advantages and disadvantages due to project.	Earlier Public Hearing was cancelled due to public protest before taking any issues. The procedure for conducting this Public Hearing, as per the EIA, Notification, 2006 has been followed. The EIA/EMP reports have been prepared in English and ex-summary in Hindi as per provisions of EIA Notification 2006 and the advantages/dis-advantages of the project were also shared during public hearing.
12	Shri Harimohan Rangan, Village Gachwana	Raised the problem of Naitwar village and it was suggested that an employment should be given to the local people and a joint survey should be conducted in the respect of the cracks in walls of nearby houses and verifying it and fair compensation should be awarded to the local people according to the rules.	The R&R benefits shall be as per LARR Act, 2013. During the construction and operation of project several indirect employment opportunities shall be created. However, for the direct employment the Government Norms shall have to be followed. Controlled blasting will be used in

S. No	Name and villages	Comments	Response
			project construction. However, compensation in case of cracks due to project shall be verified by district Administration and paid accordingly.
13	Shri Rishiram, Village Paavtalla	His Apple Orchids were affected due to the construction of the tunnel by SJVNL because of which about 055 to 055 trees have dried, which should be compensated. He was suggested that the blasting should be minimized.	This issue shall be verified by district Administration and appropriate compensation may be paid, if required. As suggested, control blasting method shall be done during construction of project.
14	Smt. Chandi Devi, Gram Natwad	Government Inter College in Mori there are about 600 students enrolled, but there is no seating arrangement for them. Therefore she suggested that a building should be constructed with necessary arrangement for the same	The R&R benefits shall be as per LARR Act, 2013. Apart from the provision of LARR Act, 2013 Improvement in Education and Health Facilities has been suggested as part of Local Area Development Plan.
15	Shri Jayvir Singh Rawat, Village Pavntalla	The local persons should be given some exemption from Forest Rights Act so that they can protect their rights. He also suggested that the persons of the four project affected villages should be provided employment as per their qualification. Further he said the information should	District Administration allows the locals in Forest Area as per the Forest Right Act, 2006. During the construction and operation of project several indirect

S. No	Name and villages	Comments	Response
		be imparted to the Project affected persons about the criteria decided for compensation.	employment opportunities shall be created. However, for the direct employment the Government Norms shall have to be followed. The Land compensation shall be given as per LARR Act, 2013.
16	Smt Sarita Devi, Village- Natwad	Project affected persons were not informed about the Public Hearing because of which there is locals are outraged. She was skeptical that construction of project will lead to inconvenience to the project affected persons.	The procedure for conducting this Public Hearing, as per the EIA, Notification, 2006 has been followed.
17	Smt. Najari Devi, Gram-Natwad	We have faith in the government and government will give us justice and employment.	We appreciate the fact.
18	Shri Jaydev Singh Chauhan, Village-Panvamalla	Raised objection for conducting Public Hearing in the closed room and not amongst the project affected persons. He asked that the persons who are losing land are only affected persons or others residing in the area are also affected persons. He objected to Public Hearing being conducted and paper work being done in English amongst illiterate persons and signatures of villagers are being taken without their permission. He also raised question about compensation for cutting of	The venue for public hearing was decided by Uttarakhand Environment Protection and Pollution Control Board (UEPPCB) in consultation with the District Administration and considering the remoteness of the project site. The arrangements were so made to enable the views of the concerned local persons and others

S. No	Name and villages	Comments	Response
		trees.	who have plausible stake in the environmental impacts of the project, to be freely expressed. The procedure for conducting this Public Hearing, as per the EIA, Notification, 2006 has been followed. Regarding cutting of trees, provision has been made as a part Environmental Management Plan. The Land compensation to Project Affected Families shall be given as per LARR Act, 2013. However, as a part of Local Area Development Plan the nearby villages/ villagers shall be benefited.

7.2 SOCIAL IMPACT ASSESSMENT

7.2.1 INTRODUCTION

A project of this magnitude is likely to entail both positive as well as negative impacts on the socio-cultural fabric of the project area and its surroundings. At present, most of the population is engaged in agriculture and related activities. During construction and operation phases, a lot of allied activities will mushroom in the project area. It is felt that most of the labour force would come from various parts of the country. However, some of the locals would also be employed to work in the project. The labour force would stay close to the project construction sites. Apart from direct

employment, opportunities for indirect employment will also be generated which would provide great impetus to the economy of the local area. Various types of business like shops, food-stall, tea stalls, etc. besides a variety of suppliers, traders, transporters will concentrate here and benefit immensely as demand will increase significantly for almost all types of goods and services. The business community as a whole will be benefitted. The locals will avail these opportunities arising from the project and increase their income levels. With the increase in income levels, there will be an improvement in the infrastructure facilities in the area. The educational, health, social services, communication, etc. are some of the sectors which will improve greatly as a result of the upcoming project. The quality of life of the locals including women will improve as a result of the project.

7.2.2 IMPACTS DURING CONSTRUCTION PHASE

It is expected that a lot of labour force will be deployed at the project site during the construction phase and the total increase in population during peak construction has been estimated to the tune of 3200. Together with the work force many business establishment will take place which will attract people from other places. Influx of labour population might lead to number of social, cultural, economic and security related problems. However, it is evident that the local residents will have an upper hand in the establishments of any business ventures.

7.2.2.1 Land acquisition and population displacement/involuntary resettlement

The important adverse impact during construction phase will be that, pertaining to land acquisition. About 15.681 ha of land is to be acquired for the proposed Jakhol Sankri HE project. A part of this could be private, forest or government land. The acquisition of private land would lead to PAFs losing land in varying proportions. A suitable Rehabilitation Plan has been formulated for compensation of families in lieu of acquisition of land.

7.2.2.2 Local employment opportunities

The construction phase will last for about 4 years. The total number of persons inhabiting the area including the service population will be about 3200. The construction phase of any project is rather an unsettled stage characterized by uncertainties and often disorders. The basic problem relates to management of large population, which migrates to the project area or near major construction sites, in search of jobs.

The construction of the proposed project would invariably create a number of direct employment opportunities. However, indirect employment opportunities would also be generated which would provide great impetus to the economy of the local area. Various types of businesses, such as shops, food-stalls, tea stalls, restaurants, workshops, etc. would invariably come-up, which would be run by the more entrepreneurial local residents. Besides, a variety of suppliers, traders, transporters, service providers, etc., are also likely to concentrate here and likely to benefit immensely, as demand for almost all types of goods and services will increase significantly. The business community as a whole would be benefited. The locals would also avail these opportunities arising from the project and increase their income levels.

The construction phase of the proposed project will provide an impetus to the industrialization and urbanization in the area. Many of the agricultural lands or barren lands in the vicinity of the project area are likely to be put to non-agricultural uses. The project would require lot of ancillary developments like shops, restaurant, workshops, etc. which will have a significant impact on the existing land use of the area. Job opportunities will drastically improve in this area. At present most of the population sustains on agriculture and allied activities. There are no major industries or other avenues of occupation in the area. The project will open a large number of jobs to the local population during project construction phase.

7.2.2.4 Business opportunities

Apart from direct employment, opportunities for indirect employment will also be generated which would provide great impetus to the economy of the local area. Various types of business like shops, food-stall, tea stalls, etc. besides a variety of suppliers, traders, transporters will concentrate here and benefit immensely as demand will increase significantly for almost all types of goods and services. The business community as a whole will be benefited. The locals will avail these opportunities arising from the project and increase their income levels. With the increase in the income levels, there will be an improvement in the infrastructure facilities in the area.

7.2.2.5 Impacts due to blasting on people and structures

The construction of the project would require blasting for various operations due to tunneling, cutting of roads, quarrying, etc. This could affect the nearby structures.

Normally blasting is done in with proper safety measures and major impacts are not anticipated. However, if such impacts do take place, suitable compensation shall be paid for mitigation of adverse impacts in this account.

7.2.2.6 Construction workforce related influence on social services (Educational, Health, Communication, Water Supply, Consumer Goods, and Sanitation etc.)

During construction phase a large labour force, including skilled, semi-skilled and un-skilled labour force, is expected to immigrate into the project area. Some of the locals would also be employed to work in the project. The labour force would stay near to the project construction sites. Education will receive a shot in the arm. The advantages of education to secure jobs will quickly percolate through all sections of the population and will induce people to get their children educated. A sizeable amount of surplus generated through labour will be spent on education.

The labour force that would work in the construction phase would settle around the project site. They would temporarily reside there. This may lead to pollution, due to generation of domestic wastewater, human waste, municipal solid waste etc. Besides, other deleterious impacts are likely to emerge due to inter-mixing of the local communities with the labour force. Differences in social, cultural and economic conditions among the locals and labour force could also lead to friction between the migrant labour population and the local population.

7.2.2.7 Improved access facilities in the project area

Development of the proposed Jhakol Sankari HEP project will have multifold beneficial impacts. The immediate beneficial impacts from the project will be improved connectivity by the road. The improved road access will bring an improvement of food security situation and overall economic and social stability. The improved access road will also provide cheap, safe and fast transport of goods and services from rural areas to urban centers and vice versa. This will contribute significantly to improve the overall socio-economic condition of the people.

7.2.2.8 Impacts on public health due to migrant population

About 1000 labourers, technical staff and service providers will congregate in the project area during peak construction phase. The total increase in population is expected to be of the order of 3200. Most of the labour would come from various parts of the country. The labourer would live in dormitories provided by the Contractor. Proper sanitation facilities are generally provided. Hence, a proper

surveillance and immunization schedule needs to be developed for the labour population migrating into the project area.

7.2.2.9 Increased incidence of vector-borne diseases due to excavations

The excavation of earth from borrow pits etc. is one of the major factor for the increase in prevalence of malaria. After excavation of construction material, the depressions are generally left without treatment where water gets collected. These pools of water, then serves as breeding grounds for mosquitoes. However, in the present case, the borrow areas are within the river bed, which in any case remain under water. Thus, no additional habitat for mosquito breeding is created due to excavation.

The quarry areas after excavation shall from stagnant pools of water during monsoons, which can serve as breeding sites for mosquitoes. The flight of mosquito is generally limited up to 1 to 2 km from the breeding sites. The residential areas is located within 1 km from the reservoir periphery, or stagnant pool of water will be vulnerable to increased incidence of malaria. Similarly, labour camps, etc. could be vulnerable to increased incidence of malaria, if proper measures for siting drainage and mosquito control are not undertaken.

7.2.3 IMPACTS DURING OPERATION PHASE

Although there are a number of positive impacts of the proposed project, certain negative impacts will also be there, which are described in the following paragraphs.

7.2.3.1 Improved Access to social services (education, health, market etc)

Once the construction of the project starts, significant and visible impacts will be felt in the project area. It can be assumed that economic activities will boom in settlements close to the project facility sites. During construction phase, education centers, health post, market etc. will be improved. After construction phase, there will be withdrawal of economic activities which flourished during construction phase since most of the construction related workforce will leave the project area. However, it is likely that some economic activities will continue or be further promoted in these areas because of the relatively good accessibility to cities and urban areas.

7.2.3.2 Community health improvement

After the project construction, there will be better accessibility condition to and around the project area. At the same time, project will establish one health care units

at the dam site area. Improvement the project area people will have easy access to the district hospital as well as project health care units. The better electrification (with the implementation of rural electrification program) will further enhance the facilities available at the centers.

During project construction phase, the proponent will establish two health care units (one at dam site and other at powerhouse area) with adequate number of health workers and logistic supports primarily to provide health support services to the workers and project staff. The health facility will also be made available to local people and visitors as well.

7.2.3.3 Local employment opportunities

The operation of the project will provide an impetus to the industrialization and urbanization in the area. Many of the agricultural lands or barren lands in the vicinity of the project area are likely to be put to non-agricultural uses. The project would require lot of ancillary developments like shops, restaurant, workshops, etc. which will have a significant impact on the existing land use of the area. Job opportunities will drastically improve in this area. At present most of the population sustains on agriculture and allied activities. There are no major industries or other avenues of occupation in the area. The project will open a large number of jobs to the local population during project operation phase.

7.2.3.4 Impoverishment Risk Assessment (IRA)

One of the most important and negative impact due to the commissioning of the project would be that a number of families could be displaced from their lands, and economic activity. As per the assessment, a total of 216 landholders/ land titleholders would be losing land in varying proportions. In project feasibility and preparation studies, the IRA performs two basic functions. Foremost, it serves as a diagnostic and predictive tool, to anticipate risks in resettlement and to assess their nature and their expected intensity. Secondly, IRA is also used as a problem resolution and planning function, to guide the incorporation of measures matching each main risk, either for prevention or mitigation. The IRA identifies impoverishment not only in terms of income, but also in terms of employment opportunities, health care, nutrition, food security, common assets, education, shelter or social capital. The IRA framework has been synthesized from the knowledge of past experiences, which saves considerable time and effort in feasibility work by not demanding general risk analysis to start afresh in each project, but rather by *ex-ante* offering a

well-tested starting point. The matrix of eight basic risks in light of historical experience, predictable in most resettlement situations: landlessness, joblessness, homelessness, marginalization, increased morbidity and mortality, food insecurity, loss of access to common property, and social (community) disarticulation. Each of these risks is briefly discussed below in Table-7.1.

Table-7.1-Impoverishment Risk Assessment

S. No.	Risks involved	Description of risks involved	Details
1.	Landlessness	Expropriation of land removes the main foundation on which people build productive systems, commercial activities, and livelihoods. Often land is lost forever, sometimes it is partially replaced, and seldom is it fully replaced or fully compensated. This is the principal form of de-capitalization and pauperization of displaced people, as they lose both natural and man-made capital.	As per our assessment, there are about 216 PAFs who are likely to lose their lands in varying proportions due to the process of land acquisition. The villagers depend on their lands for their livelihood. In addition, there are a number of families that are dependent on these lands for their livelihood, who work as agricultural labour work force. Acquisition of lands would invariably affect their means of livelihood and sustenance.
2.	Joblessness	Loss of wage employment occurs on account of acquisition of agriculture land, Yet creation of new jobs is difficult and requires substantial investment. Resulting unemployment or underemployment among resettlers endures long after physical relocation has been completed.	There are a number of PAFs who are dependent on Agricultural land. As This would adversely affect the job opportunities in the area.
4.	Marginalization	Marginalization occurs when families lose	This aspect needs to be carefully and sensitively

S. No.	Risks involved	Description of risks involved	Details
		economic power and slide on a downward mobility path middle-income farm - households do not become landless, they become small land holders, small shopkeepers" and craftsmen downsize and slip below poverty thresholds. Relative marginalization often begins long before actual displacement; for instance when lands are condemned for future flooding they are implicitly devalued as new public and private infrastructure investment are prohibited and the expansion of social service is undercut.	assessed, as the main source of sustenance, i.e. land would be acquired and thus the main source of income and livelihood is gone; the possibility of many of the PAFs would become marginalized. As mentioned there are 216 land titleholders that would lose land due to the process of land acquisition. It is felt that only a few families/ individuals that would be able to bear the brunt of land acquisition. For the remaining the possibility of sliding on a downward mobility path would be inevitable unless alternative sources of livelihood are not provided.

7.2.4 SKILL MAPPING

The land to be acquired for the project is 39.008 ha. Out of this, about 14.771 ha is private land and about 2.250 ha is forest land. There are no families losing homesteads & 216 families losing land only due to the proposed project.

There are 6 project affected villages in Tehsil Mori of District Uttarakashi namely Dhara, Jakhol, Sunkundi, Pawn Malla, Pawn Talla and Sawani. Whereas the private land is to be acquired in four villages in village Jakhol & Sawani entire land to be acquired is Government Land.

Agriculture is the main occupation in the PAVs. The total working population in the area constitutes for 52.2% and dependent population or non-workers in the villages are 47.8% of the total population. It is further observed that 90.6% of the working

population are main worker. The marginal workers account for about 9.4% of the working population. Apart from cultivation, farmers and other PAFs rear cattle for milk, meat, eggs and labour.

The conclusion of Skill Mapping are given as below:

- Skill levels are quite low amongst PAFs.
- PAFs have skills related to Agriculture and Livestock
- Even in Agriculture and livestock, PAFs are not trained in modern practices.

As a part of skill development, it is suggested to impart training for the following aspects:

- Wool knitting
- Stitching
- Electrician

7.3 RESETTLEMENT AND REHABILITATION PLAN

7.3.1 Land Details

The land to be acquired for the project is 39.008 ha. Out of this, about 14.771 ha is private land and about 2.250 ha is forest land. The ownership status is given in Table-4.1. Based on the ownership status of land, appropriate compensatory measures of land will be suggested. Village wise bifurcation of the private land being acquired is given in Table-7.2.

Table-7.2 Total Land proposed for Acquisition for Jakhol Sankari HEP

S.No	Type of Land	Area (ha)
1.	Govt./Civil Soyam Land (Including Notional Land)	22.067
2.	Private Land	14.771
3.	Forest Land	2.250
	Total	**39.088**

Table-7.3Village wise acquired private land

S.No	Name of the Village	Area (ha.)
1.	Dhara	4.772
2.	Sunkhundi	1.359
3.	PaonMalla	0.673
4.	PaonTalla	7.967
	Total	**14.771**

7.3.2 Details of PAFS

A total of 216 PAFs are losing land. These affected families will be losing homestead as well as the land shall be compensated on the terms of the "Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013".

7.3.3 Measures for Rehabilitation

In the proposed project, majority of the population depends on land for their livelihood. Privately owned land is also expected to be acquired. The rehabilitation plan would be formulated in line with the norms of "Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013". The cost estimate for implementation of Rehabilitation measures is given in Table-7.4 and 7.5.

Table-7.4Market value of the private land acquired in various villages

S. No	Village Name	Land Acquired (Ha.)	Total Value of Land (Rs.)	Factors to be multiplied in rural area B=(A*2) (Rs.)	Solatium (C) (Rs.)	Final Award (B+C) (Rs.)
1	Dhara	4.772	19.37	38.7486	38.7486	77.4973
2	Sunkundi	1.359	5.52	11.0351	11.0351	22.0702
3	PaonMalla	0.673	2.62	5.2494	5.2494	10.4988
4	PaonTalla	7.967	32.35	64.692	64.692	129.384
	Total	**14.771**	**59.86**	**119.7251**	**119.7251**	**239.45**

Table-7.5Provisions for Rehabilitation Plan for families losing land as per the "SECOND SCHEDULE"

S. No	Description	Unit	Assumed Provision#	Cost (Rs. lakh)
1.	**Total Market Value of the Project affected villages (Refer Table-4.3)**	ha	14.771	**239.45**
2.	**Rural artisans / Self-employed**			
	One-time financial assistance of a minimum of Rs. 25,000/- to each affected family of an artisan, small trader or self-employed person or an affected family which owned non-agricultural land or commercial, industrial or institutional structure in the affected area, and which has been involuntarily displaced from the affected area due to land acquisition	216	216 PAFs x Rs.25000/ PAF	54.00
3.	**Choice of Annuity or Employment**			

S. No	Description	Unit	Assumed Provision#	Cost (Rs. lakh)
	a) At least one member per affected family will be provided job (either in the project or arrange for a job in such other project), after providing suitable training and skill development in the required field Or **b)** Onetime payment of Rs. 500,000 per affected family Or **c)** Annuity policies that shall pay not less than Rs. 2000 per month per family for 20 years, with appropriate indexation to the Consumer Price Index for Agricultural Labourers	216	216 PAFs x Rs.2000/month x 20 years x 12 months for each PAF	Livelihood plan been prepared for each PAF losing land 1036.80
4.	Training of the affected persons, so as to enable such persons to take on suitable jobs	216	216 PAFs x Rs.500/month x 6 months for each PAF	6.48
5.	Scholarships and other skill development opportunities to the eligible persons from the affected families as per the criteria as may be fixed by the appropriate Government	216	216PAFs x Rs.500/month x 12 months for each PAF	12.96
6.	Skill development opportunities to the eligible persons from the affected families as per the criteria as may be fixed by the appropriate Government	216	216PAFs x Rs.500/month x 6 months for each PAF	6.48
7.	Affected persons shall be offered the necessary training facilities for development of entrepreneurship, technical and professional skills for self-employment	216	216 PAFs x Rs.1000/month x 6 months for each PAF	12.96
Total				**1369.13**

7.3.4 Budget

The total budget for implementation of the Rehabilitation Plan is **Rs.1369.13** lakh or say Rs.13.69 crore. The details are given in Table-7.6.

Table-7.6Budget for implementation of the Rehabilitation Plan

S. No.	Components of Rehabilitation Plan	Cost (Rs. lakh)
1.	Compensation for Land	239.45
2.	Grant to Rural Artisans	54.00
3.	Annuity payment	1036.80
4.	Training to take on suitable jobs	6.48
5.	Scholarships	12.96
6.	Other Skill Development	6.48
7.	Training facilities for development of entrepreneurship, technical and professional skills for self-employment	12.96
	Total	**1369.13**

7.4 LIVELIHOOD PLAN

The livelihood Plan shall be given to those PAFs who are likely to be loose major proportion of their land holdings. The families loosing land under reservoir submergence shall be covered under Livelihood Plan. A total 216 PAFs are likely to lose land under reservoir submergence. As part of Income generating activities, following activities are proposed.

- Livestock rearing
- Horticulture
- Bee Keeping
- Eco-tourism
- Training for skill development

7.4.1 Livestock Rearing

Livestock requiring is quite common in the project affected families. It is proposed that for about 216 PAFs, 2 Goats/Sheep shall be given to each family. Thus, about 432 Goats/Sheep shall be purchased. The cost of a Goats/Sheep has been taken as Rs.12,000/-. Thus, total amount spent on each PAFs shall be Rs.24000/-. In addition, an amount of Rs.15000/-can be given to each PAFs for construction of cattle shed and initial inputs. It is proposed to conduct following training programmes:

- Fodder Demonstration
- Demonstrations of use of mineral mixture in daily diet of milch animals
- Artificial Insemination and natural Breeding in Goat and Sheep
- Training and Exposure of PAFs
- Technical Training of Veterinarians instrumental in implementation of various activities.

Fodder plays a vital role in livestock production. The health and productivity is directly proportional to quality and balance feeding. The main purpose of this activity is to educate the farmers about the need of feeding green fodder to cattle. There are two ways of fodder production i.e. overlapping cropping and Relay cropping. In overlapping cropping a fodder is introduced in the field before the other crop completes its life-cycle. In relay cropping, the fodder crops are grown in succession, i.e. one after another, the gap between the two crops being very small. Both practices can be taken at field level.

The deficit of green fodder and lack of pasture land has great impact on increase in number of infertility amongst milch animals. Mineral deficient cow and buffalo not only shows reduction in wet period but also having poor health and reduced auto immune system to fight with adverse environment condition. The demonstration of use of mineral mixture has been envisaged to educate the farmers for adoption and continuity in daily diet of milch animals.

It is proposed to develop a quality breeding service through commissioning of Artificial Insemination Centres in project area. It is proposed to select and trainee 100 unemployed educated youth for door to door artificial insemination and other related activities. Besides this natural breeding center shall also be established.

To promote better Livestock management practices in the project area, it is important to provide skill up-gradation training to the PAFs. For imparting modern techniques of the livestock management, it is necessary to equip the department staff with such techniques. Thus, it is proposed to further upgrade the existing skills in the Department of Animal Husbandry through various trainings on modern livestock management.

An amount of **Rs.181.84 lakh** has been earmarked for livestock development amongst PAFs. The details are given in Table-7.7.

Table-7.7Budget earmarked for livestock development amongst PAFs

S. No.	Activity	No.	Unit Cost (Rs.)	Budget (Rs.lakh)
1	Purchase of Goats/Sheep	216 PAFs	24000/PAF	51.84
2	Training of youth in artificial insemination	100PAFs	50,000/PAF	50.0
3	Grant for establishment of	Lumpsum		30.0

S. No.	Activity	No.	Unit Cost (Rs.)	Budget (Rs.lakh)
	Natural Breeding centre			
4	Demonstration for use of fodder, use of mineral mixture in daily diet of milch animals	100 demonstrations	Rs.50,000/ demonstration	50.0
	Total			**181.84**

7.4.2 Training for Skill Development

One member of each family shall give training for skill development. This could be either male or female member of family. This will be in addition to the income generating activities mentioned in this plan. The training that can be imparted are sewing sweaters, stitching and technical training for Electrician. This will empower women and will help them to generate their own livelihood .One women from each PAF shall be trained for sweater knitting and stitching. A sum of Rs.5000/ PAF shall be allocated for the same. An amount of **Rs.10.8 lakh** has been earmarked for the training for skill development for better livelihood of the PAFs.

7.4.3 Budget for Livelihood Plan for PAFs

An amount of **Rs.192.64 lakh** has been earmarked for implementation of plan for income generating activities, which is in addition to the cost earmarked for implementation of Resettlement and Rehabilitation Plan. The details are given in Table-7.8. Although there are various livelihood development plans along with health programmes run by the SJVNL like technical/non–technical skill development programmes, Health programmes and Educational programmes.

Table-7.8Budget earmarked for implementation of plan for income generating activities

S. No.	Activity	Budget (Rs. lakh)
1	Livestock Rearing(Refer Table-5.1)	181.84
2	Training for Skill Development	10.8
	Total	**192.64**

7.5 CORPORATE ENVIRONMENTAL RESPOSIBILITY

CER is being framed to extend benefits to not only the residents of the partially affected villages, but also to residents of the some villages adjoining to project area

which are also within the study area villages, so as to empower them and improve their quality & life. Five villages would be chosen for the purpose.

The following aspects have been covered for this purpose:

- Educational Facilities
- Health Care and Medical Facilities
- Infrastructure Development
- Economic Development
- Social and Cultural Development.

The project cost is 477.15 crore. A budget of 1.5% (Rs. 7.16 crore) of the project cost has been earmarked for implementation of Corporate Environmental Responsibility).

7.5.1 Upgradation of Educational Facilities

Following activities are proposed under Corporate Environmental Responsibility activities:

- Construction of new Hostel/community Hall
- Up-gradation of school fixtures, equipment
- Improvement of drinking water facilities
- School bus service

About 5 primary schools are proposed to be upgraded. The list of villages in which primary schools are to be upgraded is given in Table-7.9.

Table-7.9List of villages in which primary schools are to be upgraded

S. No	Village Name	Sub-district
1	PanwMalla	Mori
2	Pawn Talla	Mori
3	Sunkundi	Mori
4	Sauni	Mori
5	Saturi	Mori

A lumpsum amount of Rs. 13.0 lakh per primary school is being made for this purpose. The details are given in Table-7.10. An amount of Rs.65.0 lakh needs to be earmarked for this purpose. In addition, an amount of Rs.60 lakh has been earmarked for purchase of 2 school buses. Thus, a total amount of Rs.414.45 lakh needs to be earmarked for this purpose.

Table-7.10Breakup of cost required for up-gradation of existing primary Schools.

S. No.	Particular	Amount (Rs. lakh) per school	Amount (Rs. lakh) for 5 schools
1	Construction of new Hostel/community Hall*	-	150.00
2	Furniture & fixtures and equipments	10.00	50.00
3	Improvement of drinking water facilities	3.00	15.00
	Sub-Total (A)	**13.00**	**215.00**
4	Purchase of school bus x 2 Nos.	30.00	60.00
	O&M cost of Rs. 8.75 lakh for 2 school buses (for 10 years including escalation @ 10% per annum)		139.45
	Sub-Total (B)	**30.00**	**199.45**
	Total (A + B)	**43.00**	**414.45**

Note: The above budget will be given to each of the 5 schools for up-gradation
*Land shall be provided by District Administration

7.5.2 Scholarships for Students

It is suggested to provide scholarships to 50 local students. On the one hand school going students, who are presently studying between Class–I to Class-XII, scholarships are suggested for an amount of Rs.600 per month for a period of 12 years.

On the other hand, scholarships are also suggested for students going for higher studies. Meritorious students from the above mentioned category or students who are presently pursuing higher studies will be supported for their college/ higher education. A scholarship provision of Rs. 10,000 per year for meeting their fee and study material requirement along with Rs. 5,000 per year for meeting their hostel expenses for a period of 4 years is being made for meritorious students for higher studies. About 20 students are proposed to be covered under this scheme.

A total amount of Rs.59.2 lakh may be earmarked for providing scholarships, details of which are given in Table-7.11.

Table-7.11 Details of scholarships

S. No.	Activities	Amount (Rs. lakh)
1	Scholarship for School going students (50 students x 600 per month for 12 years)	43.2
2	Scholarship for meritorious students–College/ higher	

	education a) Fees/course material (@ Rs. 10,000/year x 20 student x 4 years) b) Hostel expenses (@ Rs. 5,000/years x 20 students x 4 years)	8.0 4.0
	Total	**59.2**

7.5.3 Improvement of Public Health Facilities

It is proposed that the Primary Health Sub-Centers may be upgraded in 06 villages. The list of villages in which PHSCs are to be upgraded is given in Table-7.12.

Table-7.12 List of villages in which PHSCs are to be upgraded

S.No	Village Name	Sub District Name
1	Sankari	Mori
2	Saur	Mori
3	Jakhol	Mori
4	Dhara	Mori
5	Gangar	Mori
6	Naitwar	Mori

Upgradation of this health care facility would involve renovation of existing structure, etc. Provision of new and/or latest furniture, beds, laboratory equipment/instruments, computers wherever possible, installation of new floorings and ceilings, upgradation/ construction of new lavatories, electrification and adequate and proper lighting in rooms, facilities for cold storage of essential medicines, provision of drinking water facilities, etc

In addition, it is suggested to purchase 2 vans fitted with life saving equipment and stocked with medicines, which will function as a mobile clinics. It is further suggested to attach these mobile clinics to any of the above mentioned PHSCs from where these mobile units will operate. A total amount of Rs.242.45 lakh is being earmarked for extending health facilities under. The details are given in Table 7.13.

Table- 7.13 Budget for up-gradation of PHSCs

S. No.	Item	Cost (Rs. lakh)	Cost for 02 PHSCs (Rs. lakh)
1	Furniture, Beds and other items	8.500	17.00
2	Upgradation of Medical laboratory	15.00	30.00
3	Upgradation of operation theater (labor room)	8.00	16.00
	Sub-Total (A)	**31.50**	**63.00**
4	Purchase of 2 mobile clinic vans	40.00	40.00
	O&M cost of Rs. 8.75 lakh for 2 Vans (for 10 years including escalation @ 10% per	-	139.45

S. No.	Item	Cost (Rs. lakh)	Cost for 02 PHSCs (Rs. lakh)
	annum)		
	Sub-Total (B)		**179.45**
	Total (A+B)		**242.45**

An amount of **Rs.7.16 crores** has been earmarked for implementation of the Corporate Environmental Responsibility Activities. The details are shown in Table-7.14.

Table 7.14 Budget for implementation of CER

S. No.	Items	Budget (Rs. lakh)
1	Construction/ Upgradation of schools in Study Area	414.45
2	Scholarships to students in the Study Area	59.20
3	Improvement of Public Health Facility	242.45
	Total	**716.10 (Say 716)**

7.6 LOCAL AREA DEVELOPMENT PLAN (LADP)

While developing hydropower projects, there is an impact on the environment, existing infrastructure, individual and community resources, etc. This needs to be addressed by making appropriate and adequate provisions in the Project design and cost. Provision for mitigating these adverse consequences is provided for in schemes like Environment Management Plan (EMP).Thus, LADP is being framed to extend benefits to not only the residents of the partially affected villages, but also to residents of the villages adjoining to project area which are also within the study area villages

A budget of 0.5% of the project cost has been earmarked for implementation of Local Area Development Plan (LADP). An amount of Rs.2.4 crore has been kept as a provision for LADP as a part of EMP. The district administration shall decide the plan of implementation as per the requirement of the study area after consulting local people.

7.7 MONITORING AND EVALUATION IMPLEMENTATION OF R&R PLAN

7.7.1 Institutional/Administrative Arrangement for Implementation of R&R Measures

I. Appointment of administrator at state level

- State Government of Uttarakhand shall appoint an officer not below the rank of Joint Collector or Additional Collector or Deputy Collector or equivalent official of Revenue Department, who will be responsible for R&R Plan at the State Level.
- Administrator shall, with a view to enable him to function efficiently and to meet the special time-frame, be provided with such powers, duties and responsibilities as may be prescribed by the appropriate Government and provided with office infrastructure and be assisted by such officers and employees who shall be subordinate to him as the appropriate Government may decide.
- Subject to the superintendence, directions and control of the appropriate Government and the Commissioner for Rehabilitation and Resettlement, the formulation, execution and monitoring of the Rehabilitation and Resettlement Scheme shall vest in the Administrator.

II. Commissioner for rehabilitation and Resettlement

- The State Government shall appoint an officer of the rank of Commissioner or Secretary of that Government for rehabilitation and resettlement of affected families under this Act, to be called the Commissioner for Rehabilitation and Resettlement.
- The Commissioner shall be responsible for supervising the formulation of rehabilitation and resettlement schemes or plans and proper implementation of each schemes or plans.
- The Commissioner shall be responsible for the post implementation social audit in consultation with the Gram Sabha in rural areas and municipality in the urban areas.

III. Rehabilitation and Resettlement Committee at Project Level

- Where land proposed to be acquired is equal to or more than one hundred acres, the appropriate Government shall constitute a Committee under the chairmanship of the Collector to be called the Rehabilitation and Resettlement Committee, to monitor and review the progress of implementation of the Rehabilitation and Resettlement scheme and to carry out post-implementation social audits in consultation with the Gram Sabha in rural areas and municipality in urban areas.

- The Rehabilitation and settlement Committee shall include, apart from officers of the appropriate Government, the following members, namely:-
  - representative of women residing in the affected area;
  - a representative of each schedule caste and schedule tribe residing in the affected area
  - a representative of a voluntary organization working in the area
  - a representative of a nationalized bank the land acquisition officer of the project
  - the chairperson of the panchayats or municipalities located in the affected area or their nominees
  - the chairperson of the district planning committee or his nominee
  - the Member of Parliament and Member of Legislative assembly of the concerned area or nominees
  - a representative of the requiring body
  - Administrator for Rehabilitation and Resettlement as the member Convener.
- The procedure regulating the discharge of the process given in this section and other matters connected thereto of the Rehabilitation and Resettlement Committee shall be such as may be prescribed by the appropriate Government.

7.7.2 Monitoring and Evaluation

Monitoring and Evaluation (M&E) must be simultaneous with the implementation of Rehabilitation Plan. It requires specialized skill for application of general project monitoring procedures to the process of land acquisition and rehabilitation. Conventional monitoring, normally carried out by the Government machinery, often misses focus on certain vital aspects and does not identify certain shortcomings, which may otherwise prove very important. While the conventional government monitoring will continue, an external M&E agency will also be engaged to help in proper monitoring of land acquisition and rehabilitation programs. The main purpose of involving such an agency is to bring the problems and difficulties faced by the PAFs to the notice of Administrator R&R on a regular basis for their redressal as well as to help in formulating and undertaking corrective measures. The external Monitoring and Evaluation (M&E) agency can submit half yearly reports on the

progress of implementing Rehabilitation Master Plan (RMP) along with suggestions and corrective measures required for improvement in the implementation of Rehabilitation Plan.

For Land Acquisition and rehabilitation program, M&E system will consist of:

i) Administrative monitoring;

ii) Socio-economic performance, and

iii) Impact evaluation.

Administrative monitoring will be conventionally carried out by SLAO, project authorities, Resettlement Commissioner and other concerned government agencies/departments. The focus will be on physical (like number of land holders affected and land based resettlement, area identified for allotment to Village Level Committee, etc.) and financial (like compensation paid, payment to M&E agency, office establishment cost, etc.) parameters.

The socio-economic monitoring which will be carried out concurrently is the crux of M&E exercise to provide interim measures based on the field level situations. This along-with impact evaluation at the end of plan period will be carried out by the M&E agency. While covering the affected community, monitoring will focus on the vulnerable groups like women, physically handicapped, etc. The household information collected through the socio-economic survey will form the benchmarks for comparison. However, these benchmarks will be supplemented in order to create new reference points against performance, effects and objectives.

I. 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 resettlement in general by a year.
- The planning of the resettlement monitoring studies could cover disbursement of compensation and grants.

- Monitoring of resettlement sites regarding, preparation of land, construction activities, water and other facilities required before the actual resettling of PAFs.
- The resettlement monitoring system could cover transport of people, belongings and allocation of replacement assets. Their report should also include information on performance of field staff and concerned official"s participation of the PAFs and host community reactions.
- After resettlement, a few sensitive indicators using sample survey techniques should be measured, mainly to understand how effective the R&R plan has been in reality.
- The monitoring and evaluation can continue for several years after actual relocation. The frequency of monitoring can be reduced after the completion of R&R work. The monitoring reports need to be submitted periodically to assess progress of resettlement and its effects compared with established policy and specific timetables and benchmarks at each phase.

II. Post-Project Monitoring

Status of availability of alternative homestead for project affected persons, development of infrastructural facilities such as schools, sewer networks, roads, etc. are some of the aspects which could be considered for monitoring and modifications may be suggested if required. It needs to be appreciated that R&R issues are politically and socially sensitive issues and need timely attention. For such reasons, it is suggested that the monitoring be conducted by an independent agency not connected with the project. Therefore, an independent Consultant having experience in monitoring & evaluation of implementation of Resettlement & Rehabilitation Plans in similar areas and not connected with the project, can be appointed for monitoring the project. The Consultant will review the rehabilitation and resettlement programme after 2nd, 4th and 6th year from the completion of the R&R activity.

III. Participation of PAFs

Involvement of affected communities in planning and implementation of rehabilitation programs 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

resettlement plan about their options and rights. In the proposed project, co-operation and participation of PAFs in the resettlement process could be ensured through their involvement in each of the following stages.

- Involvement in preparation of Rehabilitation Master Plan

As a part of participatory planning, community meetings should be held on a routine basis to explain about the project and the R&R policy 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.

- Involvement of PAFs in implementation process

The Village Level Committee can be involved in the implementation of Rehabilitation Plan particularly during the identification of forest land to be allotted to Village Level Committee. They shall also be consulted in finding out alternative economic opportunities to supplement their household income. However, some NGO groups can also be associated which can interact directly with the project authorities and the affected population.

IV. Parameters for Monitoring and Evaluation of R&R Plan

Once the R&R Plan is implemented, affected families should not be forgotten. Their progress should be monitored, evaluated and recorded. This would greatly help the government or other organizations for further improving the Rehabilitation and Resettlement guidelines. It would form a basis of evaluating whether the resettlement has been a success or not. If the resettlement has not been successful, the answers would come out at this stage and the same mistakes can be avoided for other resettlement schemes.

Priorities that would have to be monitored and evaluated are; is the family's income more or less in their new location? Do they inter-mingle with the host population? If not, why? Has their standard of living increased or decreased? Are health and education facilities more accessible to them? Have new opportunities come their way or have they stagnated? etc. Such questions would prove invaluable in assessing the success of the resettlement scheme. Progress report of their resettlers should be maintained. The progress report format should include among others the following:

Total household covered under the R&R plan:

(1) No of families

(2) Population

Birth and Death information:

(1) No. of children born

(2) No. of deaths

Income and expenditure (monthly) pattern of the resettlers

(1) Average monthly income (with its break up)

(2) Average monthly expenditure (with its break-up)

House constructions:

(1) No. of constructions under progress

(2) Constructions completed

(3) Materials used

(4) Size of construction

Credit facilities availed:

(1) No. of resettled families that have availed of credit

(2) Purpose for credit availed

(3) Sizes of credit availed

Loan Recovery:

(1) Excellent (100%)

(2) Good (over 50%)

(3) Bad (below 20%)

Agricultural inputs;

(1) Seeds (kg)

(2) Fertilizers (kg)

(3) Pesticides (kg)

Agricultural Production:

(1) Annual cereal productions (kg)

(2) Cash crop productions (kg)

(3) Other farm produce (kg)

Education facilities:

(1) Primary School

(2) Community School

(3) Junior High School

(4) Others

(5) No. of students enrolled

Medical facilities:

(1) BHU (Basic Health Unit)

(2) Dispensaries

(3) Others

Communication:

(1) Distance from motorable road

(2) Distance from telephone

(3) Distance from Post office

(4) Distance from Bus stop

Drinking water:

(1) Piped water

(2) Natural stream water

(3) Other sources of water

Rural electrification:

(1) No. of houses covered

If such a format was included the progress of the resettled families can be easily monitored and evaluated. However, such a formatted progress report would have to be up dated annually for a minimum of two years in order to get an accurate picture.

An amount of Rs.30.0 lakh has been earmarked for conducting Monitoring & Evaluation Studies and Social Awareness Programme for implementation of Resettlement and Rehabilitation Plan.

7.8 DAM BREAK AND DISASTER MANAGEMENT PLAN

Any hydro project if not designed on the sound principles of design after detail investigations in respect of hydrology, geology, seismicity etc., could spell a large scale calamity. Thus these are inherent risk to the project like improper investigation, planning, designing and construction which ultimately lead to human catastrophe. Though through detailed field investigations it has been ensured that the barrage is founded on firm foundation, designed for suitable seismic design parameters, yet in view of that uncertain element of “Force Mejure” the eventuality of a disaster cannot be ignored but a rescue plan has to be devised for confronting such an exigency without being caught in the vast realm of unpreparedness.

A disaster is an unwarranted, untoward and emergent situation that culminates into heavy toll of life and property and is a calamity sometimes caused by “force mejure” and also by human error. The identification of all types of disaster in any proposed

project scenario involves the critical review of the project vis-à-vis the study of historical past incidents/disasters in the similar situations. The evolution of disaster management plan dwells on various aspects such as provision of evacuation paths, setting up of alarms and warning systems, establishing communicating system besides delineating an Emergency Response Organization with an Effective Response System. Keeping in view the grievous affects a disaster can cause on human or animal population, loss of property and environment in and around the areas of impact. Therefore it is essential to assess the possibility of such failures in context to the present project and formulate a contingent plan.

The JakholSankri Hydroelectric project envisages the following Civil Structures:

- Barrage across river Supin near Jakhol villagehaving 33 meter length and 17 meter height & having elevation at Top of barrage 1962.20 m.
- 4 number of vertical gates.(Size 5.0 meter width and 4.4 meter Height)
- Design Flood 270 Cumecs.
- Intake, Approach Tunnel and Underground Desilting Chamber on left bank.
- Head Race Tunnel (HRT) on the left bank and terminating at Surge Shaft.
- Underground restricted orifice type Surge Shaft.
- Pressure Shaft & surface Penstock.
- Underground Power House with 2 units of vertical Pelton type turbines near village Sankri.
- Tailrace Tunnel (TRT)&Underground Cavern for GIS

7.8.1 Dam Break Inundation Analysis

The outflow flood hydrograph from a dam/Barrage failure is dependent upon many factors such as physical characteristics of the Barrage, volume of reservoir and the mode of failure. The parameters which control the magnitude of the peak discharge and the shape of outflow hydrograph include: the breach dimensions, the manner and length of time for the breach to develop, the depth and volume of water stored in the reservoir, and the inflow to the reservoir at the time of failure. The shape and size of the breach and the elapsed time of development of the breach are in turn dependent upon the geometry of the dam, construction materials and the causal agent for failure.

For reasons of simplicity, generally, wide applicability and the uncertainty in the actual mechanism, the BOSS DAMBRK model has been used. The model uses failure time interval, terminal size and shape of the breach as the inputs. The possible shapes of the breach that can be accomplished by the model are rectangular, triangular and trapezoidal. The model is capable of adopting either storage routing or dynamic routing methods for routing floods through reservoirs depending on the nature of flood wave movement in reservoirs at the time failure.

The dynamic routing method based on the complete equations of unsteady flow is the appropriate technique to route the flood hydrograph through the downstream valley. The method is derived from the original equations developed by St. Venant. The model uses St. Venant‟s equations for routing dam break floods in channels.

7.8.2 Methodology

The National Weather Service‟s DAMBRK model developed by Dr. L. Fread has been used in the study. This model simulates the failure of dam, computes the resultant outflow hydrograph and also simulates movement of the dam break flood wave through the downstream river valley. The model is built around three major capabilities, which are reservoir routing, breach simulation and river routing. However, it does no rainfall-runoff analysis and storm inflow hydrographs to the upstream of reservoir must be developed external to the model. A brief description of the capabilities of the model is described in the following paragraphs.

I. Reservoir Routing

The storage routing is based on the law of conservation given as:

$$I - Q = dS/dt \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

In which, I is reservoir inflow. Q is the total reservoir outflow which includes the flow spillway, breach, overtopping flow and head independent discharge, and rate of change of reservoir storage volume. Equation (1) can be expressed in finite difference form as :

$$(1 + I‟) 2 - (Q + Q‟)/2 = \Delta S/\Delta t \text{ -.-----(2)}$$

In which the prime („) superscript denotes the values at the time t - Δt and the notation approximates the differential. The term ΔS may be expressed as:

$\Delta S = (As + A''s)(h - h'')/2$ ……(3)

In which, As is the reservoir surface area coincidental with the elevation (h) and is a function of h. The discharge Q which is to be evaluated from equation (2) is a function of h and this known h is evaluated using Newton–Raphson iteration technique and thus the estimation of discharge corresponding to h.

II. Dynamic Routing

The hydrologic storage routing technique, expressed by equation (2) implies that the water surface elevation within the reservoir is horizontal. This assumption is quite adequate for gradually occurring breaches with no substantial reservoir inflow hydrographs. However, when the breach is specified to form almost instantaneously so as to produce a negative wave within the reservoir, and/or the reservoir inflow hydrograph is significant enough to produce a positive wave progressing through the reservoir, a routing option which simulates the negative and /or positive wave occurring within the reservoir may be used in DAMBRK model. Such a technique is referred to as dynamic routing. The routing principle is same as dynamic routing in river reaches and it is performed using St. Venant"s equation. The movement of the dam break flood wave through the downstream river channel is simulated using the complete unsteady flow equations for one dimensional open channel flow, alternatively known as St. Venant"s equations. These equations consist of the continuity equation

$$\frac{\partial Q}{\partial t} + \frac{\partial (A + A0)}{\partial t} = q \quad \text{……(4)}$$

and the conservation of momentum equation :

$$\frac{\partial Q}{\partial t} + \frac{\partial (A2/ + A)}{\partial t} + g A \left(\frac{\partial h}{\partial t} + Sf + S e \right) + Lc = 0 \quad \text{……(5)}$$

where,

A = active cross – sectional flow area

A0 = inactive (off-channel storage) cross – sectional area

X = distance the channel

q = lateral inflow or outflow per unit distance along the channel

g = acceleration due to gravity

Q = discharge

H = water surface elevation

Ss = friction slope

Se = expansion – contraction loss slope

Lc = lateral inflow/outflow momentum effect due to assumed flow path of inflow being perpendicular to the main flow.

The friction slope and expansion – contraction loss slope are evaluated by the following equation

$$Sf = \frac{n^3 Q^2}{2.21 A^2 R^{3/4}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(6)$$

and,

$$Se = \frac{K\Delta(Q/A)^2}{2g \Delta X} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(7)$$

where,

n = Manning"s roughness coefficient

R = A/B where B is the top width of the active portion of the channel

K = Expansion – contraction coefficient varying from 0.1 to 0.3 for contraction and 0.5 to – 1.0 expansion

$\Delta(Q/A)^2$ = Difference in $(Q/A)^2$ for cross sections at their end of a reach

The non-linear partial differential equations (4) and (5) are represented by a corresponding set of non-linear finite difference algebraic equations and they are solved by the Newton-Raphson method using weighted four point implicit scheme to evaluate Q and h. The initial conditions are given by known steady discharge at the dam, for which steady state non-uniform boundary flow equation are used. The outflow hydrograph from the reservoir is the upstream boundary condition for the channel routing and the model is capable of dealing with fully supercritical flow or fully supercritical flow in the reach or the upstream reach having supercritical flow and downstream reach having subs critical flow. There is a choice of downstream boundary conditions such as internally calculated loop rating curve, user provided single valued rating curve, user provided time dependent water surface elevation, critical depth and dam/barrage which may pass flow via spillways, overtopping and/or breaching.

III. Statement of the problem

The computation of flood wave resulting from a dam breach basically involves two scenarios which can be considered jointly or separately: (1) the outflow hydrograph from the pond (2) the routing of the flood wave downstream from the breached dam along the river valley and the flood plain. If breach outflow is independent of downstream conditions, or if their effect can be neglected, the reservoir outflow hydrograph is referred to as the free outflow hydrograph. In this case, the computation of the flood characteristics is divided into two distinct phases: (a) the determination of outflow hydrograph with or without the routing of the negative wave the reservoir, and (b) the routing of flood wave downstream from the breached dam. In this study the problem of simulating the failure of "Dam" and computing the free outflow hydrograph from the breached section using storage routing technique" with the aim of reproducing the maximum water level marks reached during the passage of flood wave is considered. The information regarding inflow hydrograph into the pond due to the storm at the time of failure, the structural and the hydraulic characteristics details of the dam, the time of failure, the channel cross sections details, the maximum water level marks reached in the reservoir at the time of failure and those observed in the downstream reach of the dam to the passage of flood wave etc. are available for the study.

IV. Availability of Data

The input data required can be categorized into two groups. The first data group pertains to the dam and inflow hydrograph into the reservoir and the second group pertains to the routing of the outflow hydrograph through the downstream valley. These are described in the following paragraphs.

- **First Data Group**

With reference to the data group pertaining to the dam, the information on reservoir elevation-volume relationship, spillway details, elevation of bottom and top of dam, elevation of water surface in the pond at the beginning of analysis and at the time of failure, breach description data are required.

- **Second Data Group**

The second group of data pertaining to the routing of the outflow hydrograph through the downstream valley consists of a description of cross-sections, hydraulic resistance coefficients of the reach, steady state flow in the river at the beginning of

the simulation and downstream boundary condition. The cross section is specified by location mileage, and tables of top width and corresponding elevation.

7.8.3 Result and Conclusions

A rectangular breach at an El 1962.20 masl with side slope 1:0 and breach formation time as 15 minutes.have been considered in the study for Barrage break analysis of SJHEP. After the breach, immediately below the Barrage, the maximum flow will occur immediately after the start of breach. The magnitude of the simulated outflow hydrograph will be 927.62 cumec corresponding to maximum stage elevation 1962.50 masl, at Km. 2.50 is attenuated to 850.32 cumecs corresponding to maximum stage elevation of 1815.12 masl and at km. 9.32. Further reduced to 394.25 cumecs. The maximum flow and time to maximum stage at various distances d/s of the dam is given in Table-7.15. The Inundation Map is enclosed as Figure-7.1.

Figure 7.1: Inundation Map

Table-7.15Summary of Wave Profile In The Event Of Dam Break

Distance from Dam (km)	Max Elevation, (masl)	Maximum Flow (cumec)	Time to Maximum Stage, (hrs)	Maximum velocity, m/s
0.0	1962.50	927.62	0.060	10.65
2.25	1844.32	856.30	0.090	10.10
2.50	1815.12	850.32	0.093	9.98
2.75	1796.4	842.87	0.101	9.81
3.00	1788.10	835.50	0.121	9.60
6.25	1582.45	510.11	0.230	6.50
6.50	1566.22	488.96	0.250	6.36
6.75	1552.07	484.23	0.280	6.31
7.00	1539.74	467.83	0.310	6.22
9.30	1499.7	394.25	0.35	5.10

The following conclusions could be drawn from Table-7.15:

- Failure of Barrage like the proposed JSHEP, which is designed to the present technical standards and built with adequate quality control, is a very remote possibility.
- The monoliths having the least resistance to withstand the unforeseen loading combinations may give way, which in turn provides a relief and prevents failure of other monoliths. Under such as situation, the discharge and the water depth will be much lesser than those determined from the study.

7.8.4 Disaster Management Plan

The emergency planning for Barrage break scenario is devised on the basis of results of dam break analysis mainly the travel time of flood wave to various locations in the downstream stretch of the river. It is inferred from the analysis that in case of main Barrage failure the flood peak discharge as it prorogates through valley shall inundate downstream stretch of 9.3 km and the flood wave peak in 0.35 hour implying that a little reaction time for executing any rescue plan. The inundation map is presented in Figure-7.1. The plan is, therefore, based on such measures, which are purely preventive in nature. However in present case no village will be affected.

The degree of alertness has to enhance during high stage of river manifested with sharp increase in discharge. Though there cannot be very sharp edge demarcation between different levels of emergency yet the following flood conditions have been contemplated and the preventive measures suggested against each as given in Table-7.16.

Table-7.16 Status of Emergency

S. No.	Status of emergency	Water Level	Preventive measures
1.	Normal Flood	Normal Flood	Below FRL i.e. EL 1959.40 masl and flood discharge below 270 cumecs..
2.	Level –1 Emergency	Level –1 Emergency	Rises above FRL 1959.40 masl but below 1961.20masl.
3.	Level –2 Emergency	Level –2 Emergency	Above MWL i.e. EL 1961.20 masl but below top of Barrage
4.	Level –3 Emergency	Level –3 Emergency	Top of Barrage i.e 1962.20masl
5.	Disaster	Disaster	Rising above top of Barrage and the breach appears in any form

I. Barrage Safety and Maintenance Manual

Based on standard recommended guidelines for the safety inspection of Barrage a manual should be prepared by the project proponents in respect of dam safety surveillance and monitoring aspects. This should be updated with the availability of instrumentation data and observation data with periodical review. The need for greater vigil has to be emphasized during first reservoir impoundment and first few years of operation. The manual should also delve on the routine maintenance schedule of all hydro-mechanical and electrical instruments. It should be eloquent in respect of quantum of specific construction material needed for emergency repair along with delineation of the suitable locations for its stocking and also identify the much needed machinery and equipment for executing emergency repair work and for accomplishing the evacuation plan.

II. Emergency Action Plan (EAP)

Barrage safety programme as indicated above includes the formation of an Emergency Action Plan for the barrage. An emergency is defined as a condition of serious nature which develops unexpectedly and endangers downstream property and human life and required immediate attention. Emergency Action Plan should include all potential indicators of likely failure of the dam/barrage, since the primary concern is for timely and reliable identification and evaluation of existing of potential emergency.

This EAP presents warning and notification procedures to follow during the monsoon season in case of failure or potential failure of the dam/barrage. The objective is to provide timely warning to nearby residents and alert key personnel responsible for taking action in case of emergency.

III. Administration and Procedural Aspects

The administrative and procedural aspects of the Emergency Action Plan consist of flow chart depicting the names and addresses of the responsible personnel of project proponent and the Dist. Administration. In order of hierarchy, the following system will usually be appropriate. In the event that the failure is imminent or the failure has occurred or a potential emergency conditions is developing, the observer at the site is required to report it to the Junior Engineer who will report to the Executive Engineer / Superintending Engineer for their reporting to the Chief Engineer through a wireless system or by any available fastest communication system. The Engineer-

in-Charge is usually responsible for making cognizant with the developing situation to the Civil Administration. Each personnel are to acknowledge his/her responsibilities under the EAP in an appropriate format at a priority.

The technical aspects of the EAP consist of preventive action to be taken with regards to the structural safety of the barrage. The EAP is drawn at a priority for the regular inspection of the barrage. For this purpose, providing an adequate and easy access to the barrage site is a necessity. The dam/barrage, its sluices, overflows and non-overflow sections should be properly illuminated for effective operations during night time. Whenever sinkholes, boils, increased leakages, movement of masonry rock, gate failure, rapid rise or fall of the level in the reservoir, rise in the level of reservoir beyond the maximum working level, or wave overrun of the dam/barrage crest are observed, the personnel on patrol is required to inform immediately to the Junior Engineer (JE) / Assistant Engineer (AE) for initiation of the execution of EAP. They are required to inform the Engineer-in-Charge and the local administrative authorities. It is desirable if the downstream inhabitants are warned using siren, if available, so as to make them aware the likely imminent danger.

The other preventive measures may include availability of sufficient number of sandbags at several selected downstream locations and logs (for holding sandbags) and at the barrage site, one tractor, two motor boats, gas lanterns, Manila ropes and life jackets. Areas from where the labour can be mobilized should be chalked out at a priority. In addition to these, public participation in the process of execution of the EAP may further help in amelioration of the adverse impacts of the likely disaster. For this, it is necessary that the public should be made aware of its responsibilities.

IV. Preventive Action

Once the likelihood of an emergency situation is suspected, action has to be initiated to prevent a failure. The point at which each situation reaches an emergency status shall be specified and at that stage the vigilance and surveillance shall be upgraded both in respect of time and level. At this stage a thorough inspection of the dam/barrage should be carried out to locate any visible sign(s) of distress.

Engineers responsible for preventive action should identify sources of equipment needed for repair, materials, labour and expertise for use during an emergency. The amount and type of material required for emergency repairs should be determined

for dam/barrage, depending upon its characteristics, design, construction history and past behavior. It is desirable to stockpile suitable construction materials at appropriate sites. The anticipated need of equipment should be evaluated and if these are not available at the dam/barrage site, the exact location and availability of these equipments should be determined and specified. The sources/agencies must have necessary instructions for assistance during emergency. Due to the inherent uncertainties about their effectiveness, preventive actions should usually be carried out simultaneously with the appropriate notification on alert situation or a warning situation.

V. Communication System

An effective communication system and a downstream warning system are absolutely essential for the success of an emergency preparedness plan. The difference between a high flood and dam-break situation must be made clear to the downstream population.

VI. Evacuations Plans

Emergency Action Plan includes evacuation plans and procedures for implementation based on local needs. These could be:

- Demarcation / prioritization of areas to be evacuated.
- Notification procedures and evacuation instructions.
- Safe routes, transport and traffic control.
- Safe areas/shelters.
- Functions and responsibilities of members of evacuation team.

Any precarious situation during floods will be communicated either by an alert situation or by an alert situation followed by a warning situation. An alert situation would indicate that although failure of flooding is not imminent, a more serious situation could occur unless conditions improve. A warning situation would indicate that flooding is imminent as a result of an impending failure of the dam/barrage. It would normally include an order for evacuation of delineated inundation areas.

VII. Evacuation Team

It will comprise of following official / Representative:

- District Magistrate (D. M.)/ His Nominated officer (To peacefully relocate the people to places at higher elevation with state administration).

- Engineer in charge of the project (Team Leader)
- Superintendent of Police (S. P.) / Nominated Police Officer (To maintain law and order)
- Chief Medical Officer (C. M. O.), (To tackle morbidity of affected people)
- Head of affected village to execute the resettlement operation with the aid of state machinery and project proponents.
- Sub committees at village level

The Engineer-in-Charge will be responsible for the entire operation including prompt determination of the flood situation time to time. Once the red alert is declared the whole state machinery will come into swing and will start evacuating people in the inundation areas delineated in the inundation maps. For successful execution, annually demo exercise will be done. The D.M. is to monitor the entire operation.

VIII. Public Awareness for Disaster Mitigation

In addition, guidelines that have to be followed by the inhabitants of flood prone areas, in the event of flood resulting from dam/barrage failure, which form part of public awareness for disaster mitigation may also include following:

- Listen to the radio for advance information and advice.
- Disconnect all electrical appliances and move all valuable personal and household goods beyond the reach of floodwater, if one is warned or if one suspects that flood waters may enter the house.
- Move vehicles, farm animals and movables goods to the higher place nearby.
- Keep sources of water pollution i.e. insecticides out of the reach of water.
- Turn off electricity and LPG gas before one has to leave the house.
- Lock all outside doors and windows if one has to leave the house.
- Do not enter floodwaters.
- Never wander around a flood area.

IX. Notifications

Notification procedures are an integral part of any emergency action plan. Separate procedures should be established for slowly and rapidly developing situations and failure. Notifications would include communication of either an alert situation or an alert situation followed by a warning situation. An alert situation would indicate that although failure or flooding is not imminent, a more serious situation could occur unless conditions improve. A warning situation would indicate that flooding is

imminent as a result of an impending failure of the dam/barrage. It would normally include an order for evacuation of delineated inundation areas.

X. Notification Procedures

Copies of the EAP that also include the above described inundation map are displayed at prominent locations, in the rooms and locations of the personnel named in the notification chart. For a regular watch on the flood level situation, it is necessary that the flood cells be manned by two or more people so that an alternative person is always available for notification round the clock. For speedy and unhindered communication, a wireless system is a preferable mode of communication. Telephones may be kept for back up, wherever available. It is also preferred that the entire flood cells, if more that one, are tuned in the same wireless channel. It will ensure communication from the dam/barrage site to the control rooms. The communication can be established by messenger service in the absence of such modes of communication.

XI. Management after receding of Flood Water

It is to be accepted that in the even of dam/barrage break, even with maximum efforts, the loss of human lives, livestock and property would be inevitable. Under such a scenario, a massive effort would be used by various government agencies to provide various relief measures to the evacuees. Formulation of a plan delineating such measures is beyond the scope of work of this document. However, some of the measures which need to be implemented are listed as below:

- Provision of various food items and shelter to the evacuees.
- Provision of fuel for various evacuees.
- Provision of adequate fodder supply.
- Arrangements for potable water supply.
- Commissioning of low cost sewage treatment and sanitation facilities, and disposal of treatment sewage.
- Expeditious disposal of dead bodies human and livestock.
- Immunization programmes for prevention of outbreak of epidemics of various water related diseases.
- Adequate stocks of medicines of various diseases, especially water-related diseases.

XII. Reservoir Induced Seismicity

The incidence of reservoir induced seismicity (RIS) or some time referred as reservoir triggered seismicity (RTS) is usually confined in both time and space. It has

been observed that in some reservoirs seismicity begins immediately after the first filling while at others it is not observed until several years of filling cycles. The differential behavior in spatial and temporal pattern of RIS is attributed to two fundamental mechanisms – one related to rapid increase in the elastic stress due to loading of the reservoir and the other to the more gradual diffusion of water from the reservoir to hypo central depths. Until recently it was surmised that RIS was triggered by the loading of the reservoir and/or by the effect of pore pressure (Pp) in lowering the strength of rocks at hypo central depths. The analysis of case histories accumulated suggest that the latter i.e. pore-pressure is the prime factor and a small perturbation in the *in situ* stress field due to Pp changes triggers the RIS. Pore pressure can play a twofold roles in the seismic process, the first, as mechanical effect as pore pressure, and second, a chemical effect in reducing the co-efficient of friction between the clays in the pre-existing fractures and the rocks that enclose these fractures. This underlines need for routine monitoring of seismic data on dense and local networks. The seismic data so collected shall help to study the mechanism of RIS in particular and the physics of the earthquake process in general. For mitigation of the seismic hazard, the only option available is to upgrade our knowledge on the co-dynamics of earthquakes and to utilize the state-of-the-art technology to constraint the motion characteristics. This would help in seismic designing of the components of the project. The reservoir induced seismic concerns, however, requires a special emphasis for judging the effect of impoundment of the reservoir on seismic status of the area. With this background, it is proposed that a seismic observatory may be made compatible with IMD National Grid for recording and analyzing the nation-wide seismic activity. This would not only help the project authorities to plan the disaster management scheme related to the project but will also be helpful for the other projects in the area.

The budget for different activities required to be carried out for mitigation and prevention of dam/barrage break hazard exclusively from the barrage is Rs 60.00 lakh as per details given in Table-7.17.

Table-7.17 Budget earmarked for implementation of Disaster Management Plan

S. No.	Particular	Cost (Rs. lakh)
1.	Installation of alert system in control room	10.0
2	Setting up of communication between various projects on river Supin /Tons	10.0
3	Setting up of communication system between	15.0

S. No.	Particular	Cost (Rs. lakh)
	barrage and d/s settlements	
4	Public information system	15.0
5	Training and miscellaneous expenses	10.0
	Total	**60.0**

CHAPTER-8
PROJECT BENEFITS

CHAPTER-8
PROJECT BENEFITS

8.1 GENERAL

The development of Jakhol Sankri HE Project in yamuna basin, Uttarakhand will not only benefits the state but will meet the power requirements of the neighbouring states and northern region of the country. Uttarakhand is currently a net importer of electric power, but generates a seasonal surplus and plans to become a net exporter of power by expanding its hydropower and high voltage transmission capacity. The project would add a peak power of 44 MW to the northern grid.

The project would also promote social and economical uplifment of people in the remote location of Tehsil Mori, District Uttarkashi by providing ample oppurtunities of employment, development and improvement of road connectivitiy through CSR works and implementation of R&R plan and community development plan.

8.2 BENEFITS DURING CONSTRUCTION PHASE

i) Local employment opportunities

The construction phase will last for about 4 years. The construction of the proposed project would invariably create a number of direct employment opportunities. Generation of several indirect employment opportunities would provide great impetus to the economy of the local area. Various types of businesses, such as shops, food-stalls, tea stalls, restaurants, workshops, etc. would invariably come-up, which would be run by the more entrepreneurial local residents. Besides, a variety of suppliers, traders, transporters, service providers, etc., are also likely to concentrate here and likely to benefit immensely, as demand for almost all types of goods and services will increase significantly.

At present most of the population sustains on agriculture and allied activities. There are no major industries or other avenues of occupation in the area. The project will open a large number of jobs for the local population during project construction phase.

ii) Business opportunities

Various types of business like shops, food-stall, tea stalls, etc. besides a variety of suppliers, traders, transporters will operate from the project area and benefit immensely as demand will increase significantly for almost all types of goods and services. The business community as a whole will be benefited.

iii) Improved access facilities in the project area

Development of the proposed Jhakol Sankari HEP project will have multifold beneficial impacts. The immediate beneficial impacts from the project will be improved connectivity by the road. The improved road access will bring an improvement of food security situation and overall economic and social stability.

8.3 BENEFITS DURING OPERATION PHASE

Although there are a number of positive impacts of the proposed project, certain negative impacts will also be there, which are described in the following paragraphs.

i) Improved Access to social services (education, health, market etc)

Improvement in the education centers, health post, market etc will take place during construction phase. After construction phase, there will be withdrawal of economic activities which flourished during construction phase since most of the construction related workforce will leave the project area. However, it is likely that some economic activities will continue or be further promoted in these areas because of the relatively good accessibility to cities and urban areas.

ii) Community health improvement

It is expected there will be better accessibility condition to and around the project area. At the same time, project will establish one health care units at the dam site area. Improvement the project area people will have easy access to the district hospital as well as project health care units. The improvement in electrification programme (with the implementation of rural electrification program) will further enhance the facilities available at the centers.

During project construction phase, the proponent will establish two health care units (one at dam site and other at powerhouse area) with adequate number of health workers and logistic supports primarily to provide health support services to the workers and project staff. The health facility will also be made available to locals and visitors as well.

iii) Local employment opportunities

The operation of the project will provide an impetus to the industrialization and urbanization in the area. Job opportunities will drastically improve in this area. At present most of the population sustains on agriculture and allied activities. There are no major industries or other avenues of occupation in the area. The project will open a large number of jobs to the local population during project operation phase.

8.4 CSR ACTIVITIES CONDUCTED BY THE SJVNL

Under the Corporate Social Responsibility performed by SJVN the following activities shall be performed:

- SJVN will supply 12% of free power from the project to Government of Uttarakhand.
- 1% of the cost of the revenue generated by the project shall be spent on Infrastructure development of the project area.
- Distribution of the free medicines to the PAFs and local residents at their door step through the Mobile Health Van (MHV) of SJVN. This van shall be accompanied by the doctors and para-medical staff visits on weekly basis in the project affected villages.
- Initiative of Entrepreneurship Training Programme will also be conducted by the project proponent in which women are imparted training on stitching, sewing, fruit preservation etc.,
- Male members are imparted ITI training in technical trade like Computer Application, Electrician, Fitter etc. is also imparted.

CHAPTER-9
ENVIRONMENTAL COST BENEFIT ANALYSIS

CHAPTER - 9

ENVIRONMENTAL COST BENEFIT ANALYSIS

This chapter is not applicable as it was not recommended at the scoping stage

CHAPTER-10
ENVIRONMENTAL MANAGEMENT PLAN

CHAPTER-10
ENVIRONMENT MANAGEMENT PLAN

10.1 INTRODUCTION

Environmental Management Plan is a plan that seeks to achieve a required end state and describes how activities that have or could have an adverse impact on the environment, will be mitigated, controlled, and monitored.

The EMP will address the environmental impacts during design, construction and operation phases of a project. Due regard must be given to environmental protection during the entire project. In order to achieve this, number of environmental specifications/ recommendations has been made. These are aimed at ensuring that the proponent/contractor maintains adequate control over the project in order to minimize the extent of impact during construction, ensuring appropriate restoration of areas affected by construction, and preventing long term environmental degradation.

Environmental impacts arising due to development activities are the key aspects on EIA study. An equally essential element of this process is to develop measures to eliminate, offset, or reduce adverse impacts to acceptable levels and enhance the beneficial ones during implementation and operation of the projects. The integration of the project planning has been done by clearly defining the environment requirements within an Environment Management Plan (EMP). The Management Action Plan aims at controlling pollution at the source of generation itself to the maximum possible extent with the available and affordable technology followed by treatment measures before they are discharged.

Formulating Environmental Management Plan, which specify mitigation, monitoring activities and indicators to be attached to Annual and periodic activity plans for project implementation.

10.2 COMPENSATORY AFFORESTATION AND BIODIVERSITY CONSERVATION PLAN

10.2.1 Impacts on Forests

The forest land to be required for the proposed Jakhol Sankari hydroelectric project shall be estimated as a part of DPR preparation. The project construction, clearing of vegetation, widening of road, vehicular movement for transportation of construction

material and equipment stocking of construction materials, erection of temporary labour sheds and excavation disturb vegetation and forest area.

During reservoir filling the river and associated wetland become inundated and the vegetation in the submergence area is adversely affected. The species density and diversity in the proposed submergence area is not significant. Based on the findings of the ecological survey conducted as a part of CEIA study, it can be concluded that the tree density in the project area to be acquired shows has medium density forest. The forest in and around the project area are quite degraded. No rare or endangered species are reported in the area to be acquired for the project.

10.2.2 Acquisition of Forest Land

The land to be acquired for the project is 39.088 ha. Out of this, about 14.771 ha is private land and about 2.250 ha is forest land and 22.067 ha is Civil Soyam Land. The ownership status is given in Table-10.1. The component wise detail of land to be acquired is given in Table-10.2. Based on the ownership status of land, appropriate compensatory measures of land will be suggested.

Table-10.1Total Land proposed for Acquisition for JakholSankari HEP

S.No	Type of Land	Area (ha)
1.	Govt./Civil Soyam Land (Including Notional Land)	22.067
2.	Private Land	14.771
3.	Forest Land	2.250
	Total	**39.088**

Table-10.2Component wise Details of Land to be acquired

S. No	Component	Forest & Civil Soyam Land(ha.)	Private Land (ha.)
1	Quarry site area	2.25	
2	Barrage site and left bank upstream	0.204	
3	Left bank downstream Barrage site including contractor facility& Dumping yard D-1	2.626	
4	Right Bank barrage site & Contractor facility area	0.495	
5	Road from dhara bend to Dumping yard D-1 (road widening)	0.75	
6	Dumping yard D-2 &Approch road to adit-2	0.266	4.772
7	Approach road &Adit portal at adit-2	0.602	0
8	Office cum field hostel	0	0
9	Dumping yard D-3	0.531	0.298
10	Road widening near Adit-3	0.27	

S. No	Component	Forest & Civil Soyam Land(ha.)	Private Land (ha.)
11	Contractor facility near Adit-3	0.809	0.21
12	Explosive magazine site and approach road	0.659	0.851
13	Dumping yard D-4	1.874	0
14	Approach road to surge shaft & dumping yard D-6	0.988	0.495
15	Road to MAT portal & contractor facility	0.115	2.312
16	Dumping yard D-6near surge shaft	0.219	
17	Dumping yard D-5	0.082	1.095
18	TRT Outfall & approach	0.37	
19	EM workshop & approach	2.377	
20	Switchyard & MAT portal	1.509	
21	Project Colony	0	1.663
22	Surface pressure shaft	2.068	3.075
23	Adits (Notional Land)	0.38	
24	HRT (Notional Land)	3.3	
25	TRT(Notional Land)	0.07	
26	Ventilation, Cable, Construction Tunnel (Notional Land)	0.17	
27	Main Access Tunnel (Notional Land)	0.1	
28	Surge shaft & access tunnel to surge shaft (Notional land)	0.12	
29	Pressure Shaft & Penstock (Notional land)	0.075	
30	Desilting Chamber & access tunnel to desilting chamber (Notional land)	0.2	
31	Silt flushing tunnel (Notional Land)	0.05	
32	Power intake (Notional land)	0.07	
33	U/S & D/S Transition (Notional land)	0.05	
34	Power house & bus duct (Notional land)	0.12	
35	Transformer hall & its access tunnel (Notional Land)	0.07	
36	Nitches @ 10% of total notional land	0.4775	
	Total	**24.317**	**14.771**

The division wise details of Forest and Civil land to be acquired is given in Table-10.3. Likewise, the village wise details of Civil Soyam Land to be acquired is given in Table-10.4.

Table-10.3Division wise Details of Forest and Civil land to be acquired for JakholSankari HEP

S.No	Division Name	Forest Land (ha.)	Remarks
1.	GovindPashuVihar,Purola	22.067	Govt./Civil Soyam Land (Including Notional Land
2.	Tons,Purola	2.25	Forest Land
Total		**24.317**	

Table-10.4Village wise Details of Civil Soyam Land to be acquired

S.No	Village	Civil SoyamLand (ha.)
1	Dhara	3.846
2	Jakhol	0.602
3	Sunkundi	4.133
4	PaonMalla	1.363
5	Sawani	0.495
6	PaonTalla	6.365
7.	Notional Land	5.263
	Total	**22.067**

10.2.3 Compensatory Afforestation

The Indian Forest Conservation Act (1980) stipulates:

- If, non-forest land is not available, compensatory plantations are to be established on degraded forest lands, which must be twice the forest area affected or lost, and
- If, non-forest land is available, compensatory forest are to be raised over an area equivalent to the forest area affected or lost.

The total land to be acquired for the project shall be estimated. Compensatory afforestation is proposed in lieu of acquisition of this land. It is proposed to afforest the degraded forest patches and as per Forest Conservation Act (1980), double the amount of forest land that is being acquired for the project.

It is proposed to afforest double the amount of entire land being acquired for the project including private land. Thus, a total of (24.317x2= 48.634) ha of land needs to be afforested. The afforestation work is to be done by the Forest Department.

The total expenditure required for afforestation of 48.634 ha of area (@ of Rs. 2.20 lkah/ha) will be **Rs.106.99 lakh.** In addition to above the project proponent will pay NPV and cost of trees to the Forest Department, which shall be estimated by the Forest Department. The NPV is calculated @ of Rs. 9.50 lakh/ha based on the present level of information and an amount of Rs. 231.0 lakh. The details of villagewise value of trees are given in Table-10.5.

Table-10.5Details of village wise value of trees

S. No	Village	Civil Soyam/ForestLand (ha.)	Total no. Trees	Total Cost (Rs.)
1	Dhara	3.846	107	51612
2	Jakhol	0.602	85	36390
3	Sunkundi	4.133	210	205716
4	PaonMalla	1.363	160	141783

S. No	Village	Civil Soyam/ForestLand (ha.)	Total no. Trees	Total Cost (Rs.)
5	Sawani	0.495	8	3798
6	PaonTalla	6.365	631	482496
7.	Notional Land	5.263	329	462903
8.	Tons Forest Division	2.25	0	0
	Total	**24.317**	**1530**	**13,84,698 say Rs. 13.85 lakh**

The total expenditure for forest land acquisition is Rs. 351.84 lakh. The details is given in Table-10.6. The Majority of tree Species recorded in the Forest Land Area are of *AlnusNepalenis, UlmusWallichiana, Rhododendron arboretum* and*Quercusteucotricophora*, etc.

Table-10.6Total expenditure for forest land acquisition

S. No	Component	Total Cost (Rs. lakh)
1	Afforestation	106.99
2	NPV	231.0
3	Cost of Trees	13.85
	Total	**351.84**

10.2.4 Biodiversity Conservation

As a part of Biodiversity Conservation Plan, the following measures are proposed:

- Afforestation
- Soil stabilization measures & improving water regime,
- Sustenance of Livelihoods
- Establishment of botanical gardens for conservation and propagation of RET species.
- Anti-poaching measures

I. Habitat Improvement Programme

Habitat improvement programme is an integral part of biodiversity management. This programme consists of bringing into useful association of those condition needed by a species to reproduce and survive. The following activities have been proposed for habitat improvement programme:

II. Afforestation

Area under forest and tree cover will be expanded through systematic planning and implementation of afforestation and rehabilitation programme in degraded and open forests and available non forest lands.

Regeneration of felled areas will be ensured in a time bound manner and productivity of plantations will be increased through use of improved seeds and planting stock. The indigenous fruit bearing plants, vital from wildlife point of view are proposed to be planted so as to enrich the habitat & ensure the sufficient availability of food. Monoculture will be discouraged and mixed plantations of broad-leaved fodder, fuel wood and wild fruit species will be promoted.This activity will increase forest cover and will provide habitat to the animals. Afforestation programme in the degraded Forest Compartments, is proposed to be carried out and species for this shall be finalized by the Forest Department. An amount of Rs.10.0 lakh can be earmarked for this purpose.

III. Avi-fauna

Forests are vital for the survival, foraging, breeding and nesting of avifauna. Natural forests provide a variety of food materials to the birds not only in the form of nectar of flowers, fruits, seeds etc. in the trees, shrubs, herbs and grasses but they also contain a large number of insects eaten by birds. In the forests, food is always available for the faunal component. Although most floral species flower during spring through summer but fruit maturation and seed ripening takes place in them throughout the year. Therefore, first strategy of improvement of habitat for birds is avoiding nest predation or brood parasitism through maintenance of large contiguous forest tract. These areas have the ability to support the largest number of forest interior birds and will also be more likely to provide habitat for area sensitive species. It is more practicable to protect the existing forest area rather than creating new forest area.

Another measure for habitat improvement for avifauna is to be installation of artificial nest boxes in the influence zone and catchment area of the project after consultation with the forest department as well as local NGOs. These nest boxes has been found to be quite beneficial for attracting hole nester birds. The size and capacity of boxes vary from one species to another.

Feature of a Nest Box:

The characteristic features of nest box are listed below and shown in Figure 10.1.

- Untreated wood (Jamun, mango, pine, cedar or fir)
- Thick walls (at least ¾ inches)
- Extended, sloped roof
- Rough or grooved interior walls
- Recessed floor, coated with primer and paint
- Drainage holes
- Ventilation holes
- Easy access for monitoring and cleaning
- Sturdy construction
- No outside perches

The entrance hole should have a 2-inch diameter and 6 inch depth from entrance hole. Nest boxes are placed on trees at height from 10-12 ft. Such nest boxes designs have been used with success.

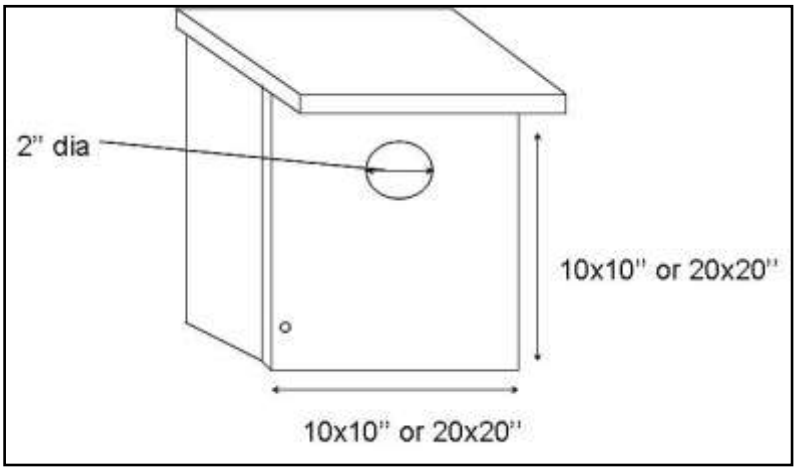


Figure 10.1: Nest Box

It is proposed that one qualified person be hired for a period of five years. An amount of Rs.32 lakh can be earmarked for habitat improvement of avai-fauna in the study area. The details are given in Table-10.7.

Table-10.7 Cost of habitat improvement for avi-fauna in the study area

S. No.	Particulars	Amount (Rs. lakh)
A	**Non-recurring Cost**	
1	Cost of nests of different sizes (10”x10” to 20”x20”; average cost Rs. 1000 per wooden box) and installation in the area along with the green belt (1000)	10.0
2	Repair and maintenance of the nests	2.0
B	**Recurring Cost (for 5 years)**	

S. No.	Particulars	Amount (Rs. lakh)
1	Salary for one skilled person @ Rs. 15,000 per month for implementation and data collection including 10% escalation	15.0
2	Contingencies (including avifaunal biodiversity awareness programme for the local inhabitants)	5.0
Total Cost (A+B)		**32.0**

Eco-Development Works

The Eco-development Committees and Village Conservation Committees (VCCs) can be constituted for this purpose which will help State Forest Department in capacity building and microplanning of the various eco-developmental activities formulated for community development. The activities under this programme are aimed at improvement of livelihood of people living in the project area. Under this programme, number of activities have been proposed and are described in the following paragraphs.

Compensation: *Ex-gratia* payment to the victims of crop damage, cattle lifting and human life loss/injury:

Ex-gratia payment to the victims of crop damage, cattle lifting and human life loss/injury is also a management tool for conserving the wild animals. The compensation to the owners for loss of their crop / livestock by wildlife, if any, is proposed under this scheme on humanitarian grounds. An amount of Rs. 20.0 lakh is proposed for victims of the legal heirs.

Publicity and Awareness

- Under this programme, the following activities are proposed:
- Training should be imparted to the school teachers in the project area for introduction of environmental education among the school children and exchange to knowledge on environment and ecology between the monastic and village schools.
- Publishing of research documents, pamphlets, brochures, hoardings
- Opening of biodiversity register in every village
- Advertisement of hazardous effect of fire through press, sign boards and public meetings will form the important activities under this component.

An amount of Rs. 10.0 lakh is earmarked for this purpose.

Establishment of Botanical Gardens

For conservation & propagation of local species, development of Botanical and Herbal garden shall be done at suitable place in consultation with State Forest Department. These gardens would function as repositories and would catalyze the biodiversity conservation, scientific research, education and environmental awareness in the area.

It is proposed to develop nursery at appropriate location preferably in the Gram Panchayat. Self-help groups formed by women shall be involved for the promotion of herbal drugs from the kitchen stock and rare medicinal plants.

An amount of Rs. 75.00 lakh has been earmarked for the botanical gardens including development of nurseries, collection of seeds and plant species in consultation with the state forest department.

10.2.5 Wildlife Protection Plan

For the improvement of vigilance and measures to check poaching, number of measures described below would be undertaken.

During construction phase in and around the main construction areas, i.e. the barrage site, powerhouse site, etc. where construction workers congregate, some disturbance to the wildlife population may occur. The terrain is hilly & difficult, therefore, the wildlife protection force adequately equipped with watch towers, wildlife personnel and other necessary equipment be deployed to prevent poaching in the area. The measures proposed for wildlife protection are outlined in the following paragraphs.

Purchase of anti-poaching kits: To capture and translocate wild animals out of human habitations or agricultural lands, various trapping equipment‟s pertaining to anti-poaching activities are needed. For this an amount of Rs. 25.0 lakh has been earmarked.

Infrastructure Development: This includes anti-poaching huts, rock shelters development and residential quarters for forest guards. For effective monitoring, one watch tower is also proposed to be established at an identified place having high pressure of biotic interference. The basic amenities for the field staff shall be provided to enable them to do effective patrolling in the areas. For watch tower and accommodation an amount of Rs. 75.0 lakh has been earmarked.

Purchase of Survey equipment and Vehicles: In order to improve network and vigilance it is required to procure communication equipment like walkie talkie, IT infrastructure to document and develop a database, altimeters, G.P.S., binoculars, video as well as digital still cameras are essential. Purchase of field vehicle will help in increased vigilance. For better communication and purchase of survey equipment, an amount of Rs. 75.0 lakh has been earmarked.

Construction of Check posts: To improve vigilance for illegal logging/loping, anti-poaching, better protection, enforcement for control grazing practices, control-grazing-cum-anti poaching check posts are proposed to be constructed. An amount of Rs. 25.0 lakh has been earmarked for this purpose.

Total 8 no. of Guards shall be hired at monthly remuneration of Rs. 8000 for 4 year; hence total expenditure shall be incurred (assuming 10 % escalation per year) Rs. 35.65 lakh.

The cost for implementation of Wildlife Protection Plan is Rs. 235.65 lakh and details are given in Table-10.8.

Table-10.8Measures for implementation of Wildlife Protection Plan

S. No.	Particulars	Amount(Rs. lakh)
	Non-recurring	
1	Anti-Poaching Kits	25.0
2	Infrastructure	75.0
3	Survey equipment & vehicle	75.0
4	Check posts	25.0
5	Salary for wildlife protection force	35.65
	Total	**235.65**

10.2.6 Monitoring of Biodiversity Conservation & Management Plan

Monitoring is an important part of the Biodiversity Management Plan. All the activities of BMP will be closely and regularly monitored in terms of physical, financial progress and quality by the project proponent and officers of Forest Department.

The State Government shall set up a Biodiversity Conservation Committee (BCC) under the chairmanship of the Principal Chief Conservator of Forests, Govt. of Uttarakhand. The committee shall review and oversee the conservation work to be undertaken.

A total provision of Rs. 724.50 lakh has been earmarked for biodiversity conservation. The details are given in Table-10.9.

Table-10.9Estimated cost of Biodiversity Conservation and ManagementPlan implementation

Particulars	**Cost (Rs. lakh)**
Compensatory Afforestation including the NPV & cost of trees	351.84
Habitat improvement for avi-fauna	32.0
Eco-Development Works - Compensation	20.0
Eco-Development Works - Publicity & Awareness	10.0
Establishment of Botanical Gardens	75.0
Wildlife Protection Plan	235.65
Total	**724.49 say Rs. 724.50 lakh**

10.3 CATCHMENT AREA TREATMENT PLAN

10.3.1 The Need

It is a well-established fact that reservoirs formed by dams, weirs or barrages on rivers are subjected to sedimentation. The process of sedimentation embodies the sequential processes of erosion, entrainment, transportation, deposition and compaction of sediment. The study of erosion and sediment yield from catchments is of utmost importance as the deposition of 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 agricultural production. Thus, a well-designed Catchment Area Treatment (CAT) Plan is essential to ameliorate the above-mentioned adverse process of soil erosion.

Soil erosion may be defined as the detachment and transportation of soil. Water is the major agent responsible for this erosion. In many locations, winds, glaciers, etc. also cause soil erosion. In a hilly catchment area as in the present case erosion due to water is a common phenomenon and the same has been studied as a part of the Catchment Area Treatment (CAT) 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. The total catchment considered for treatment

under the present project i.e. JakholSankari hydroelectric project. The sub-watersheds in the catchment area considered for the present study is given in Figure-10.2.

The catchment area treatment involves

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

In the present study `Silt Yield Index" (SYI), method has been used. In this method, the terrain is subdivided into various watersheds and the erodibility is determined on relative basis. SYI provides a comparative erodibility criteria of catchment (low, moderate, high, etc.) and do not provide the absolute silt yield. SYI method is widely used mainly because of the fact that it is easy to use and has lesser data requirement. Moreover, it can be applied to larger areas like sub-watersheds, etc.

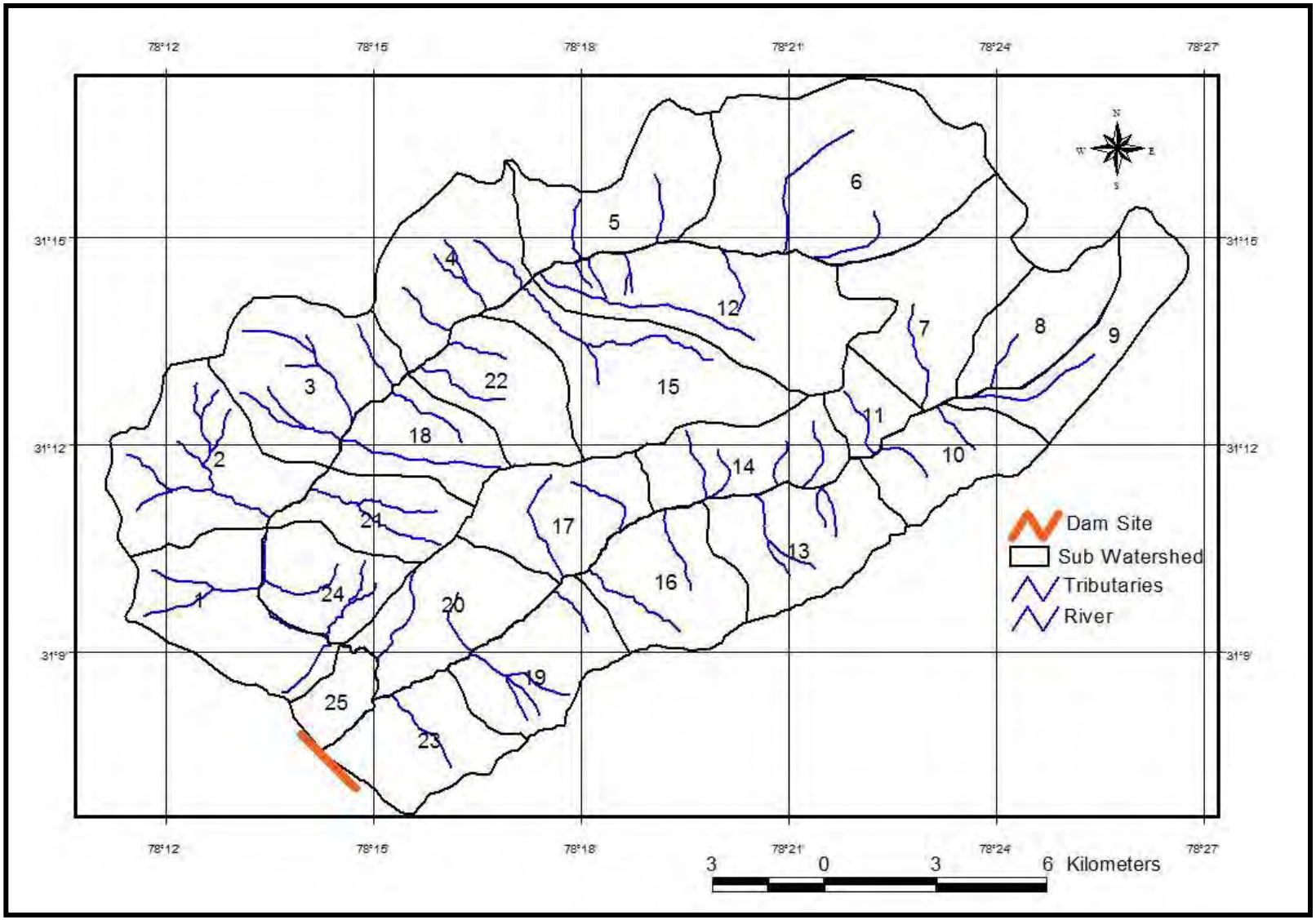


Figure-10.2: Sub-watersheds in the catchment area

10.3.2 Approach for the Study

A detailed database on natural resources, terrain conditions, soil type of the catchment area, socio-economic status, etc. is a pre-requisite to prepare treatment plan keeping in view the concept of sustainable development. Various thematic maps have been used in preparation of the CAT plan. Due to the spatial variability of site parameters such as soils, topography, land use and rainfall, not all areas contribute equally to the erosion problem. Several techniques like manual overlay of spatially index-mapped data have been used to estimate soil erosion in complex landscapes.

Geographic Information System (GIS) is a computerized resource data base system, which is referenced to some geographic coordinate system. In the present study, real coordinate system has been used. The GIS is a tool to store, analyze and display various spatial data. In addition, GIS because of its special hardware and software characteristics, has a capacity to perform numerous functions and operations on the various spatial data layers residing in the database. GIS provides the capability to analyze large amounts of data in relation to a set of established criteria.

In order to ensure that latest and accurate data is used for the analysis, satellite data has been used for deriving land use data and ground truth studies too have been conducted.

The various steps covered in the study are as follows:

- Data acquisition
- Data preparation
- Output presentation

The above mentioned steps are briefly described in the following paragraphs.

I. Data Acquisition

The requirement of the study was first defined and the outputs expected were noted. The various data layers of the catchment area used for the study are as follows:

- Slope Map
- Soil Map
- Land use Classification Map
- Current Management Practices
- Catchment Area Map.

II. Data Preparation

The data available from various sources was collected. The ground maps, contour information, etc. were scanned, digitized and registered as per the requirement. 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 coordinates), so that overlay could be performed. A computer programme 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. The grid size to be used was also decided to match the level of accuracy required, the data availability and the software and time limitations. The format of output was finalized. Ground truthing and data collection was also included in the procedure.

For the present study IRS 1C-LISS III digital satellite data was used for interpretation & classification. The classified land use map of the catchment area considered for the study is shown as Figure-10.3. The land use pattern of the catchment interrupted at weir site is summarized in Table-10.10.

Table-10.10Landuse pattern of the catchment area

Category	Area (ha)	Percentage of Catchment area (%)
Dense vegetation	5405	20
Open vegetation	2121	8
Agricultural land	137	1
Alpine pasture	5609	21
Barren land	2941	11
Water body	3311	12
Snow Cover	7273	27
Total	**26800**	**12**

Digitized contours from toposheets were used for preparation of Digital Elevation Model (DEM) of the catchment area and to prepare a slope map. The first step in generation of slope map is to create surface using the elevation values stored in the form of contours or points. After marking the catchment area, all the contours on the toposheet were digitised (100 m interval). The output of the digitisation procedure was the contours as well as points contours in form of x, y & z points. (x, y location and their elevation). All this information was in real world coordinates (latitude, longitude and height in meters above sea level).

A Digital Terrain Model (DTM) of the area was then prepared, which was used to derive a slope map. The slope was divided in classes of slope percentages. The slope map is enclosed as Figure-10.4. Various layers thus prepared were used for Modeling. Software was prepared to calculate the soil loss using input from all the layers.

III. Output Presentation

The result of the modeling was interpreted in pictorial form to identify the areas with high soil erosion rates. The primary and secondary data collected as a part of the field studies were used as an input for the model.

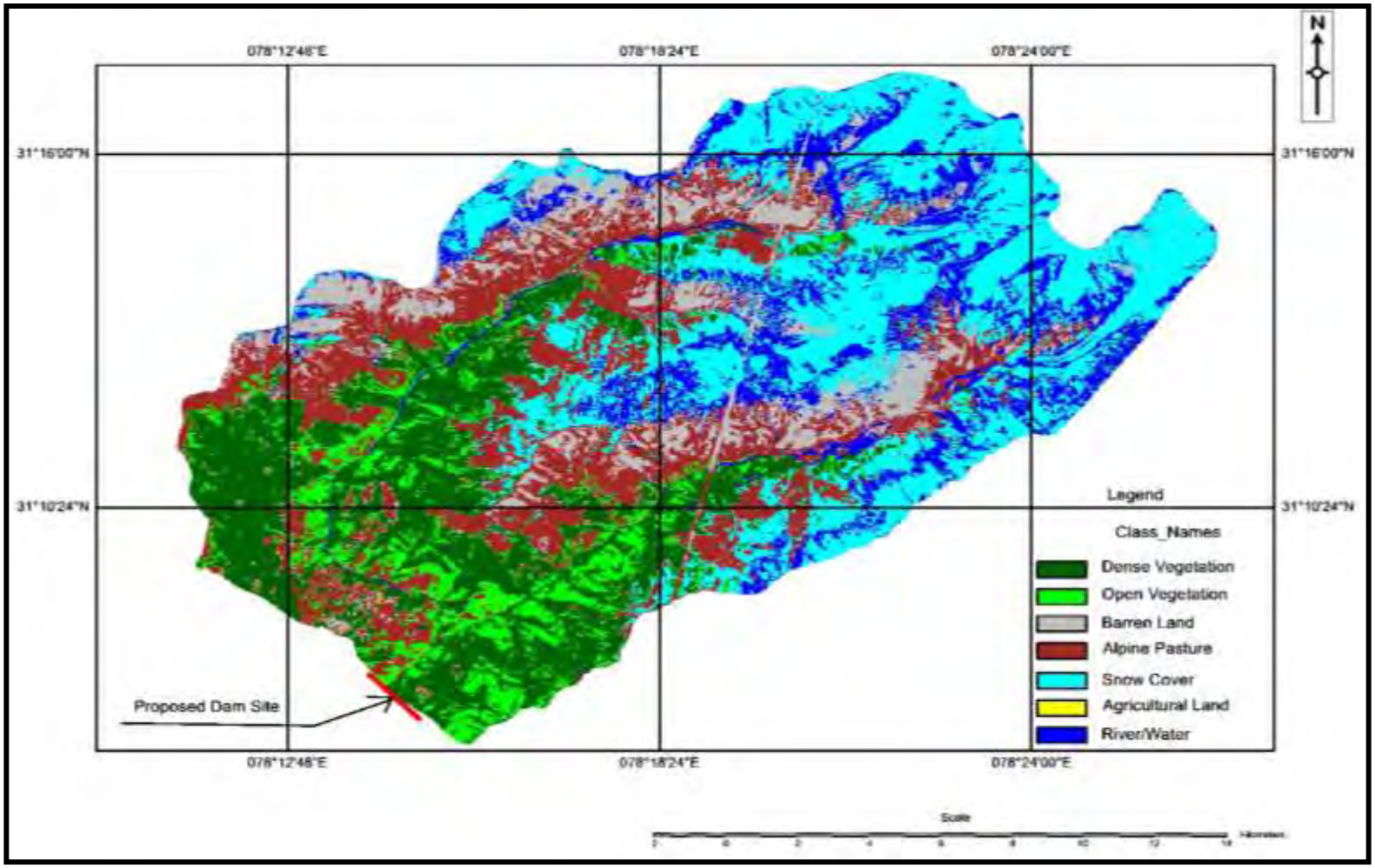


Figure-10.3: Classified imagery of the catchment area

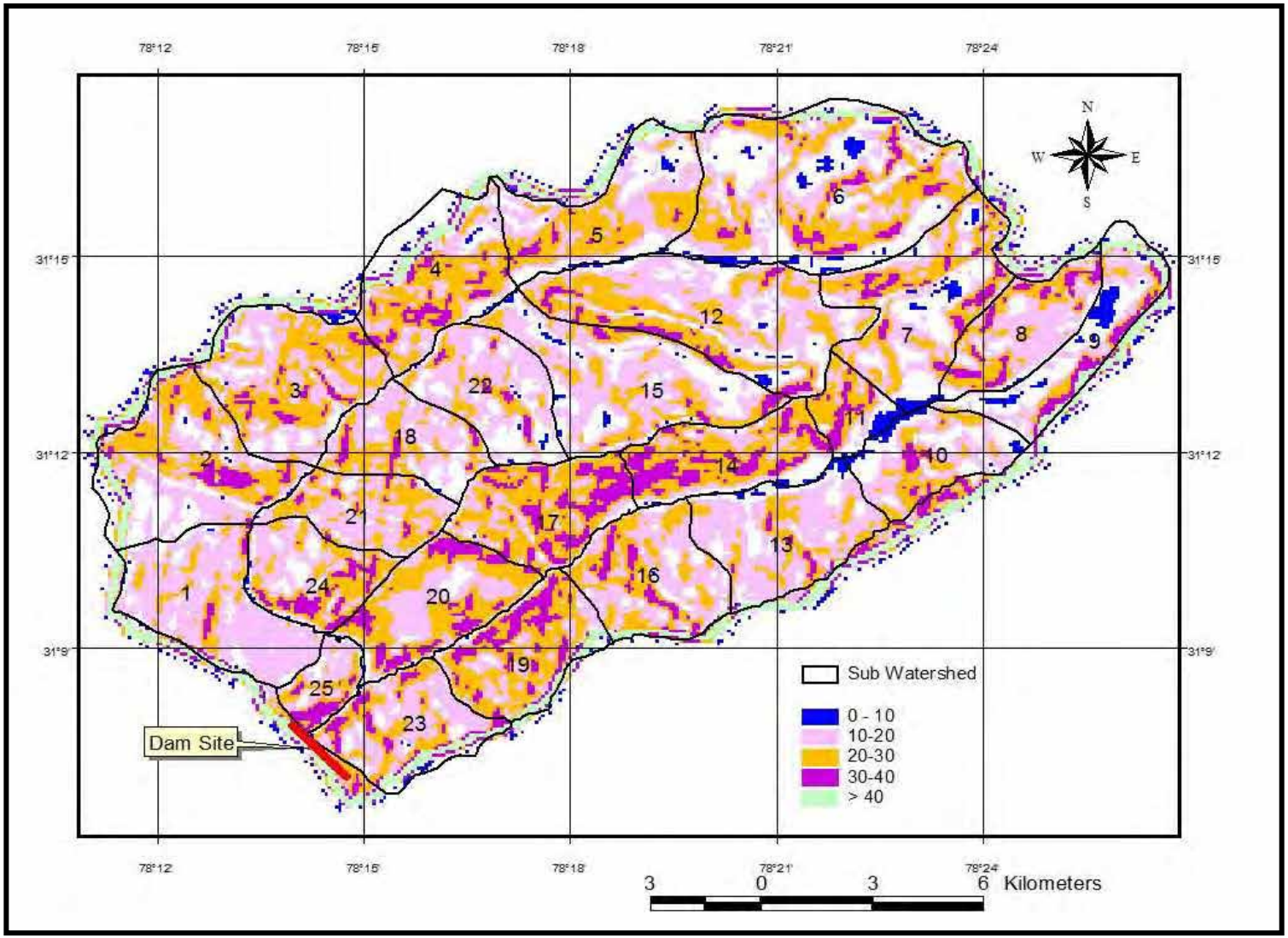


Figure-10.4: Slope Map of the catchment area

10.3.3 Estimation of Soil Loss Using Silt Yield Index (Syi) Method

The Silt Yield Index Model (SYI), considering sedimentation as product of erosivity, erodibility and arial extent was conceptualized in the All India Soil and Land Use Survey (AISLUS) as early as 1969 and has been in operational use since then to meet the requirements of prioritization of smaller hydrologic units.

The erosivity determinants are the climatic factors and soil and land attributes that have direct or reciprocal bearing on the unit of the detached soil material. The relationship can be expressed as:

Soil erosivity = f (Climate, physiography, slope, soil parameters, land use/land cover, soil management)

Silt Yield Index

The Silt Yield Index (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.

Prioritization of Watersheds/Sub-watersheds

The prioritization of smaller hydrologic units within the vast catchments are based on the Silt Yield Indices (SYI) of the smaller units. 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 watersheds/ sub-watersheds are subsequently rated into various categories corresponding to their respective SYI values.

The application of SYI model for prioritization of subwatersheds in the catchment areas involves the evaluation of:

a) Climatic factors comprising total precipitation, its frequency and intensity,
b) Geomorphic factors comprising land forms, physiography, slope and drainage characteristics,
c) Surface cover factors governing the flow hydraulics and
d) Management factors.

The data on climatic factors can be obtained for different locations in the 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 sub-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 watersheds/sub watersheds.
- Grading of watersheds/sub watersheds into very high, high medium, low and very low priority categories.

The area of each of the mapping units is computed and silt yield indices of individual sub watersheds are calculated using the following equations:

a. Silt Yield Index

$$SYI = \frac{\Sigma (Ai \times Wi) \times 100}{Aw}; \quad \text{where } i = 1 \text{ to } n$$

where

Ai = Area of ith unit (EIMU)
Wi = Weightage value of ith mapping unit
n = No. of mapping units
Aw = Total area of sub-watershed.

The SYI values for classification of various categories of erosion intensity rates are given in Table-10.11.

Table-10.11 Criteria for erosion intensity rate

Priority categories	SYI Values
Very high	> 1300
High	1200-1299
Medium	1100-1199
Low	1000-1099
Very Low	<1000

10.3.4 Watershed Management – Available Techniques

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 and utilize runoff for useful purpose.

Following Engineering and Biological measures have been suggested for the catchment area treatment.

1. Engineering measures

- Step drain
- Angle iron barbed wire fencing
- Stone masonry
- Check dams

2. Biological measures

- Development of nurseries
- Plantation/afforestation
- Pasture development
- Social forestry

The basis of site selection for different biological and engineering treatment measures under CAT are given in Table-10.12.

Table-10.12 Basis for selection of catchment area treatment measures

Treatment measure	Basis for selection
Social forestry, fuel wood and fodder grass development	Near settlements to control tree felling
Contour Bunding	Control of soil erosion from agricultural fields.
Pasture Development	Open canopy, barren land, degraded surface
Afforestation	Open canopy, degraded surface, high soil erosion, gentle to moderate slope
Barbed wire fencing	In the vicinity of afforestation work to protect it from grazing etc.
Step drain	To check soil erosion in small streams, steps with concrete base are prepared in sloppy area where silt erosion in the stream and bank erosion is high due to turbidity of current.
1:4:8 Stone masonry	Steep slopes, sliding surfaces, less vegetative cover and silt erosion is high
Nursery	Centrally located points for better supervision of proposed afforestation, minimize cost of transportation of seedling and ensure better survival.

10.3.5 Catchment Area Treatment Measures

The total catchment area is 26800ha. The erosion category of various watershed in the catchment area as per a SYI index are given in Tables-10.13 and 10.14. The details are shown in Figure- 10.5. The CAT measures have been shown in Figure-10.6.

Table-10.13Erosion category of various watersheds

Watershed number	Area (ha)	SYI values	Category
W1	1225	1240	High
W2	1461	1253	High
W3	1341	1125	Medium
W4	1194	1036	Low
W5	1165	1047	Low
W6	2497	1036	Low
W7	738	1137	Medium
W8	709	1170	Medium
W9	771	1153	Medium
W10	932	1153	Medium
W11	1519	1038	Low
W12	1799	1039	Low
W13	563	1058	Low
W14	322	1143	Medium
W15	1027	1236	High
W16	985	1170	Medium
W17	907	1151	Medium
W18	1193	1147	Medium
W19	905	1148	Medium
W20	952	1256	High
W21	1035	1017	Low
W22	1129	1054	Low
W23	775	1027	Low
W24	859	1054	Low
W25	797	1043	Low
Total	**26800**		

Table-10.14Area under various erosion categories

S. No.	Category	Area (ha)
1.	Low	13332 (49.7)
2.	Medium	8803 (32.8)
3.	High	4665 (17.4)
	Total	26800 (100)

Note: Figure in brackets indicates percentage.

The objective of the SYI method is to prioritize sub-watershed in a catchment area for treatment. The area under very high and high erosion categories is to be treated at project cost. Hence, CAT plan has been suggested for area under high erosion category, as a part of the present CEIA study, the expenses of which have to be borne by project proponents. No area under very high erosion category is observed in the proposed project. The area under high erosion categories is 4665 ha.

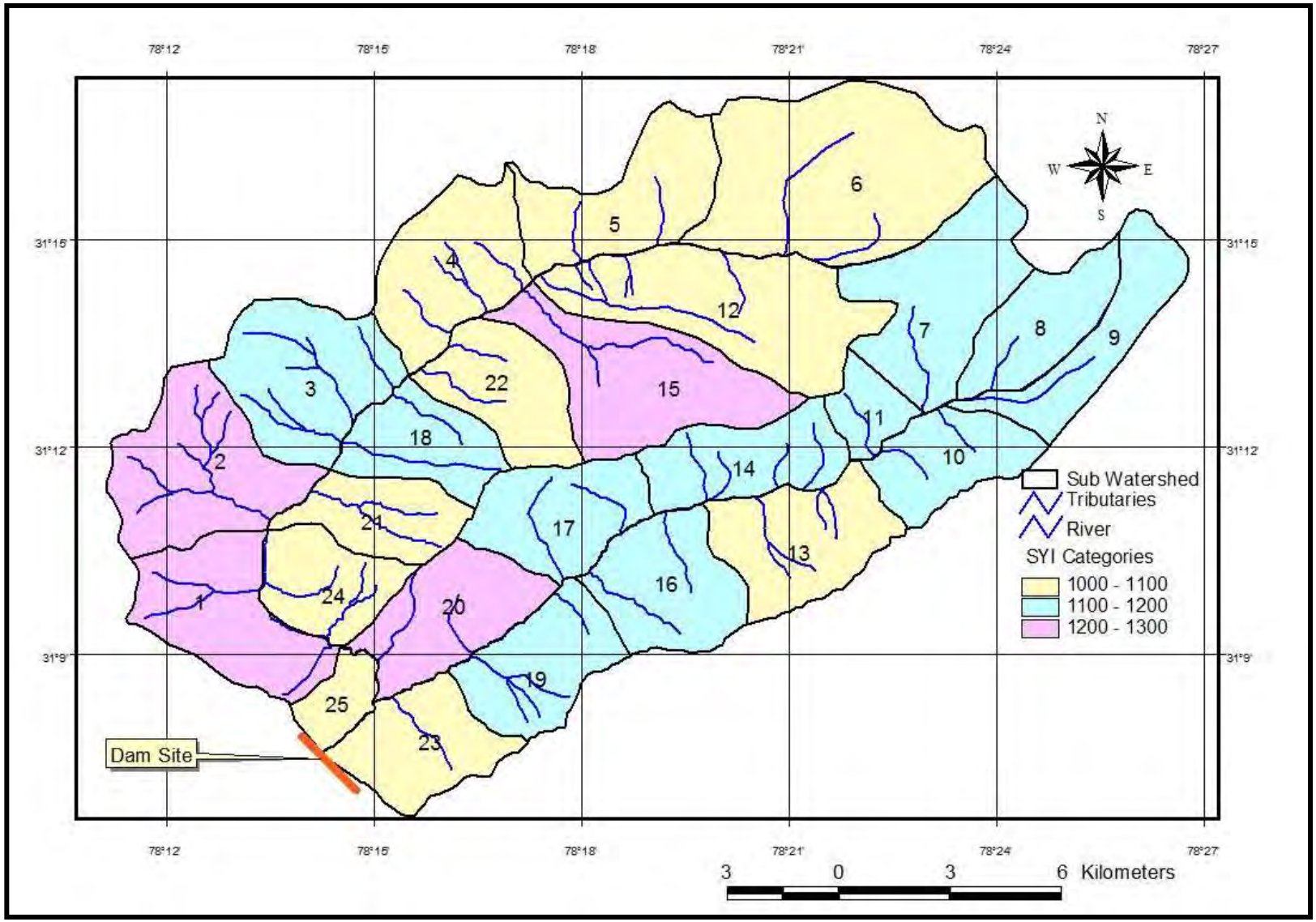


Figure 10.5-: Prioritization Map of the catchment area

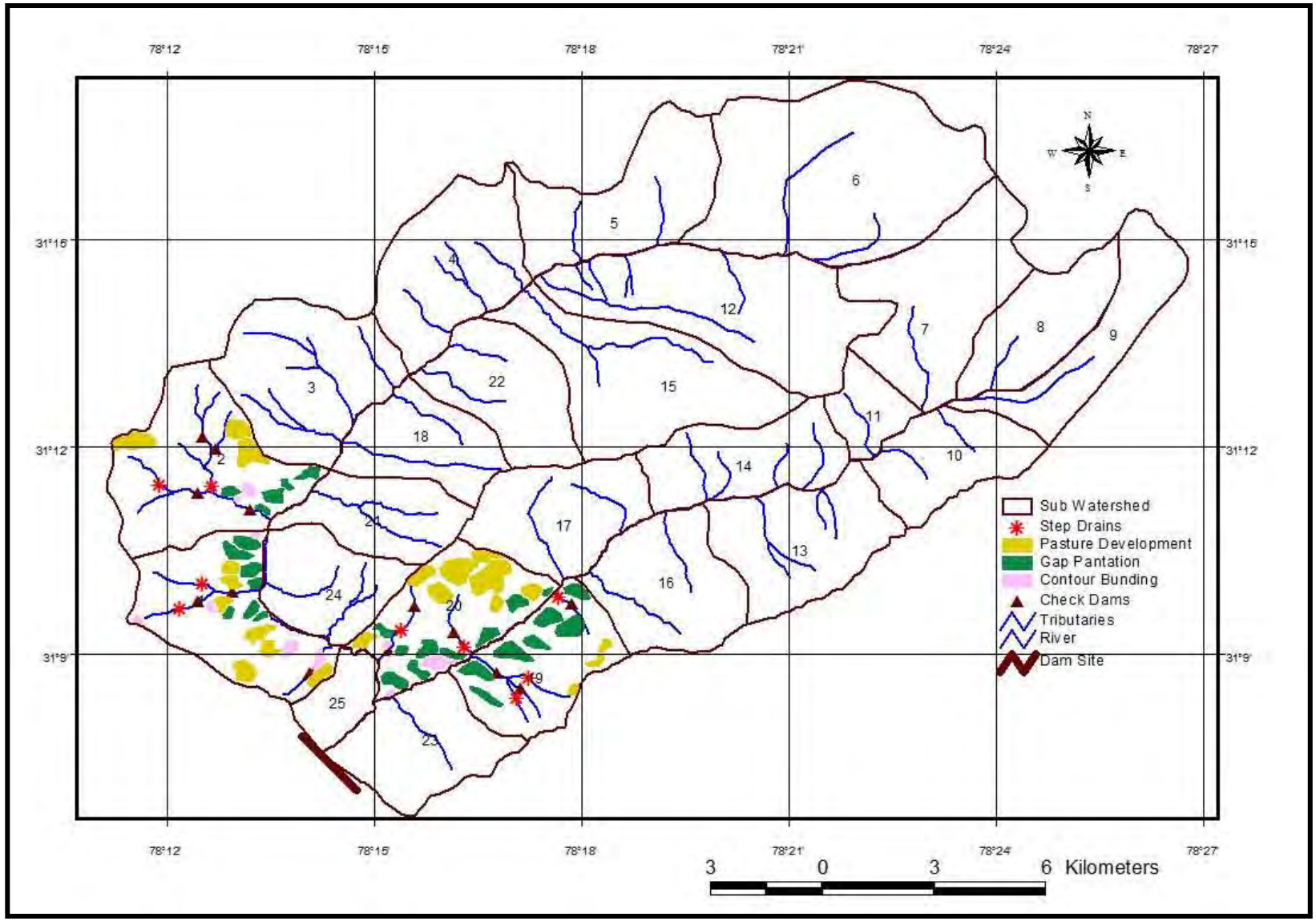


Figure-10.6: Catchment Area Treatment Measures recommended for Jakhol Catchment

I. Biological Treatment Measures

An amount of Rs. 361.2 lakh has been earmarked for various afforestation measures. The details are given in Table-10.15.

Table-10.15Cost estimate for implementation of Afforestation measures as a part of CAT Plan

S. No.	Item	Unit Rate (Rs.)	Unit	Target	
				Physical	Financial (Rs. lakh)
1.	Enrichment Plantation	30,000/ha	ha	428	128.4
2.	Pasture development	10,000/ha	ha	444 ha	44.4
3.	Nursery development	5,00,000/ no.	no.	5	25.0
4.	Barbed wire fencing	1,00,000/km	km	5	5.0
5.	Watch and ward for 5 years for 8 persons	8000/-	Man-months	480	38.4
6.	Rim Plantation	Lumpsum			70.0
7.	Social Forestry	Lumpsum			50.0
	Total				**361.2**

II. Soil & Water Conservation Works

An amount of Rs. 126.3 lakh has been earmarked for various Soil & Water Conservation measures. The details are given in Table-10.16.

Table-10.16Cost estimate for implementation of Soil & Water Conservation measures as a part of CAT Plan

S. No.	Item	Unit Rate (Rs.)	Unit	Target	
				Physical	Financial (Rs. lakh)
1.	Contour Bunding	25,000/ha	ha	85	21.3
2.	Step drains	1,00,000	Nos.	9	9.0
3.	Check Dams	2,00,000	Nos.	13	26.0
4.	Landslide Control Measures				70.0
	Total				**126.3**

III. Research Training and Capacity Building

An amount of Rs. 60 lakh has been earmarked for Training & Capacity building of forest staff as well as local community through State Forest Training Institutes and reputed non-governmental organizations.

IV. Forest Protection

An amount of Rs. 52.5 lakh has been earmarked for implementation of various Forest Protection measures.The details are given in Table 10.17.

Table-10.17Cost summary for Forest Protection measures

S. No.	Component/Item	No.	Unit Rate (Rs. lakh)	Total Cost (Rs. lakh)
1	Fire protection measures			27.5
2	Distribution of Non-conventional Energy and Fuel Saving Devices in catchment area on a cost-sharing basis, such as, LPG, Tandoors, Pressure cookers and Solar devices	-	Lumpsum	25.0
	Total			**52.5**

V. Wildlife Management

It is recommended to fund various components of wildlife management plan through CAT Plans that have a direct bearing on the reduction of silt load. The activities proposed for wildlife related

interventions will be restricted to the project catchment area only. An amount of **Rs. 80.0 lakh** has been earmarked for implementation of various wildlife management measures.

The cost required for implementation of various measures is Rs. 680.0 lakh. The details are given in Table 10.18.

Table-10.18Cost earmarked for implementation of CAT plan

S.No.	Activity	Amount (Rs. lakh)
1	Biological Treatment Measures	361.2
2	Soil & Water Conservation Works	126.3
3	Research Training and Capacity Building	60.0
4	Forest Protection	52.5
5	Wildlife Management	80.0
	Total	**680.0**

10.3.6 Schedule for Implementation of Cat Plan

It is proposed to implement the CAT Plan in 5 years. The year wise implementation of physical and financial targets is given in Table-10.19

Table-10.19Yearwise implementation schedule for CAT Plan

S. No.	Activity	Year											
		Year I		Year II		Year III		Year IV		Year V		Total	
		Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)
A.	**Biological Treatment Measures**												
iii)	Enrichment Plantation	150 ha	45.0	100 ha	30.0	100 ha	30.0	78.0 ha	23.4	-	-	428 ha	128.4
iv)	Pasture Development	200 ha	20.0	150 ha.	15.0	94 ha	9.4	-	-	-	-	444 ha	44.4
v)	Nursery Development	3 No.	15.0	2 No.	10.0	-	-	-	-	-	-	5 No.	25.00
vi)	Barbed wire fencing	3 km	3.0	2 km	2.0	-	-	-	-	-	-	5 km	5.0
vii)	Watch and ward	96 man - months	7.68	96 man-months	7.68	96 man-months	7.68	96 man-months	7.68	96 man-months	7.68	480 man-months	38.4
viii)	Rim Plantation	-	40.0	-	30.0	-		-	-	-	-	-	70.00
ix)	Social Forestry	-	30.0	-	20.0	-	-	-	-	-	-	-	50.00
	Sub-Total (A)		**160.68**		**114.68**		**47.08**		**31.08**		**7.68**		**361.2**

S. No.	Activity	Year											
		Year I		Year II		Year III		Year IV		Year V		Total	
		Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)
B.	**Soil & Water Conservation Works**												
i)	Contour Bunding	50 ha	12.5	35 ha	8.75	-	-	-	-	-	-	85 ha	21.3
ii)	Step Drains	6	6.0	3	3.0	-	-	-	-	-	-		9.0
iii)	Check Dams	7	14.0	6	12.0	-	-	-	-	-	-		26.0
iv)	Landslide Control Measures	-	50.0	-	20.0	-	-	-	-	-	-	-	70.0
	Sub-Total (B)		**82.5**		**43.75**	**-**	-	-	-	-	-	**-**	**126.3**
C.	Research, Training & Capacity Building	-	12.0	-	12.0	-	12.0	-	12.0	-	12.0	-	60.0
	Sub-Total (C)	**-**	**12.0**	**-**	**12.0**	**-**	**12.0**	**-**	**12.0**	**-**	**12.0**	**-**	**60.0**
D	**Forest Protection Measures**												
i)	Fire Protection Measures	-	20.0	-	7.5	-	-	-	-	-	-	-	27.5

S. No.	Activity	Year											
		Year I		Year II		Year III		Year IV		Year V		Total	
		Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)
ii)	Distribution of Non-conventional Energy and Fund Saving Devices	-	15.0	-	10.0	-	-	-	-	-	-	-	25.0
	Sub-Total (D)		**35.0**	**-**	**17.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**52.5**
E	Wildlife Management	-	40.0	-	40.0	-	-	-	-	-	-	-	80.00
	Sub-Total (E)	**-**	**40.0**	**-**	**40.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**80.00**
	Grand Total	**-**	**330.18**		**227.93**		**59.08**		**43.08**		**19.68**		**680**

10.4 FISHERIES MANAGEMENT PLAN

10.4.1 Fisheries Status

The fisheries in the project area are poorly developed since the potential has remained unexploited owing to difficult terrain, unfavorable climate and poor infrastructure facilities. The elevation, temperature, current, velocity and natural biota are the factors governing the growth of fish in the rivers and water bodies in the area. Most of the streams, rivers, and village ponds and other aquatic body in the upper reaches maintains fairly low temperature, which results into low primary productivity. Hence, small sized fish may be available in the streams. Commercial fishing is not in practices in the study area.

This may be due to high elevation, low temperature and fast water velocity. The list of fish species available downstream the power house is given in Table-10.20. The commercial fisheries in the area are non- existent. The growth of the coldwater fish is also very poor due to low temperature and scarcity of food resources for fish. There is no specific spawning and breeding reserves in the Supin River in the project area. Therefore, present ecological survey revealed that there is no substantive loss of fish habitat due to the construction of Jakhol-Sankari HEP

Table-10.20 Fish species reported in the Tons river near confluence with Supin d/s of PH

S.No.	Name of the Fish	Local Name	IUCN Status	CAMP 1998
	Family:Cyprinidae			
1.	*Schizothorax richardsonii** (Gray) 1832	Maseen	VU	VU
2.	*Schizothorax progastus** (McClelland, 1839)	Chongu	LC	LRnt
3.	*Garra gotyla gotyla*(Gray, 1830)	Gondal	LC	VU
4.	*Barilius bendelisis* (Hamilton, 1807)	Fulra	LC	LRnt
	Family:Nemacheilidae			
5.	*Paraschistura montana* (McClelland, 1838)	Gadiyal-Loch	-	-
	Family: Sisoridae			
6.	*Glyptothorax pectinopterus* (McClelland, 1842)	Nau (River cat)	LC	LRnt
	Family : Salmonidae			
7.	*Oncorhynchus mykiss*,#* (Walbaum, 1792)	Rainbow trout	NE	-

*Note- VU-Vulnerable; LC-Least Concern; LRnt- Lower risk-near threatened; NE-Not Evaluated, *Trouts-migratory species; #Exotic/Alien species (IUCN Red list version 2018-2)*

I. Fish catch composition

The fishery survey was conducted for three seasons form January 2017 to September 2017 with the help of local fishermen using cast net having mesh size 1 cm in the study area, in pools and rapids wherever possible in the river Supin. There is no fish was observed near proposed barrage and power house site.

Total seven species *Schizothorax richardsonii*, *Schizothorax progastus*, Paraschistura *montana*, *Barilius bendelisis*, *Glyptothorax pectinopterus*, *Garra gotyla gotyla and Oncorhynchus mykiss* were reported during the study period at the downstream site of confluence Supin & Tons Rivers.

II. Spawning and breeding

Most of the species of fish are periodic in breeding. *Schizothorax* breeds from May June to August, September depending upon the water temperature.

III. Fish Migration

Schizothorax is the migratory species observed in Tons river after the confluence with Supin. It is worthwhile to mention that no fish species were reported in Supin River. The migration of these species is generally related to water temperature of the river/stream. This species can survive between 2°C to 25°C. The favorable temperature of these species ranges from 10-22°C. During winter season when temperature falls below the favorable ranges these species migrate towards lower elevation. In pre-monsoon season, when river water temperature gets marginally high, they migrate back.

10.4.2 Impacts on Fisheries

I. Construction phase

Impacts due to excavation of construction material from river bed

During the construction phase a large quantity of construction material like stones, pebbles, gravel and sand would be needed. Significant amount of material is available in the river bed. It is proposed to extract construction material from borrow areas in the river bed. The extraction of construction material may affects the river water quality due to 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 river bed.
- 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 is 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 increase in the turbidity levels. If the depth of cut is too high, there is possibility of slope collapse, which releases a sediment cloud. This will further move outside the suction radius of dredged head. In order to avoid this typical situation, the depth of cut be restricted to:

$$\gamma H/C < 5.5$$

where,

γ - unit weight of the soil
H - depth of soil
C - Cohesive strength of soil

The dredging and deposition of dredged material may affect the survival and propagation of benthic organisms. The macro-benthic life which remains attached to the stones, boulders etc. gets dislodged and is carried away downstream by turbulent flow. The areas from where construction material is excavated, benthic fauna gets destroyed. In due course of time, however, the area gets recolonized, with fresh benthic fauna. The density and diversity of benthic fauna, will however, be less as compared with the pre-dredging levels.

The second important impact is on the spawning areas of fishes. Almost all the cold water fish breed in the flowing waters. The spawning areas of these fish species are found amongst pebbles, gravel, sand etc. The eggs are sticky in nature and remain embedded in the gravel and subsequently hatch. Any disturbance of stream bottom will result in adverse impacts on fish eggs. Even increase in fine solids beyond 25 ppm will result in deposition of silt over the eggs, which would result in asphyxiation of developing embryo and also choking of gills of young newly emerged fry. Thus, if adequate precautions during dredging operations are not undertaken, then significant adverse impacts on aquatic ecology are anticipated.

Impacts due to discharge of sewage from labour camp/colony

The proposed hydro-power project would envisage the construction of temporary and permanent residential colonies to accommodate labour and staff engaged in the project. This would result in emergence of domestic waste water which is usually

discharged into the river. However, it is proposed to commission adequate number of septic tanks for treatment of domestic sewage before its disposal in to the river. Due to perennial nature of river supin, it maintains sufficient flow throughout the year which is sufficient to dilute the treated sewage from residential colonies. Therefore, as mentioned earlier, no adverse impacts on water quality are anticipated due to discharge of sewage from labour camp/colony.

Impacts due to human activities

Accumulation of labour force in the project area might results in enhancement in indiscriminate fishing including use of explosives. The use of explosive material to kill fishes in the river in the project area would result in complete loss of fishes and other aquatic life making a river stretch completely barren. Indiscriminate fishing will reduce fish stock availability for commercial and sport fishermen.

II. Operation Phase

Impacts due to damming of river

The damming of river supin will lead to formation of a reservoir 0.24 ha. The barrage site change the fast flowing river to a quiscent lacustrine environment. The creation of a pond will bring about a number of alterations in physical, abiotic and biotic parameters both in upstream and downstream directions of the proposed barrage site. The micro and macro benthic biota is likely to be most severely affected as a result of the proposed project.

The positive impact of the project will be the formation of a water body which can be used for fish stocks on commercial basis to meet the protein requirement of region. The commercial fishing in the proposed reservoir would be successful and other undesirable objects are removed before submergence.

The reduction in flow rate of river Supin especially during lean period is likely to increase turbidity levels downstream of the barrage. Further reduction in rate of flow may even create condition of semi-dessication in certain stretches of the river. This would result in loss of fish life by poaching. Hence, it is essential to maintain minimum flow required for well being of fish life till the disposal point of the tail race discharge.

Impacts on migratory fish species

It is proposed that the artificial propagation in hatchery may be adopted which can be stocked in the river stretches downstream and upstream of the proposed barrage site.

The *Schizothorax* species are steno-thermal. During winter months, they migrate from upper reaches to near flood plains in search of suitable temperature, feeding and breeding grounds. The spatio-temporal characteristic of river Supin both on upstream and downstream of the proposed diversion site found supportive for macro-benthic life that gave 5 units/sq.m. of fry of *Schizothorax* species. This observation further strengthens the fact that *Schizothorax* species migrate during winter months. With the onset of summer season, these species migrates upstream. These species from henceforth would congregate in the reservoir. It is expected that in due course of time these species will adapt themselves to the changed habitat.

10.4.3 Management Measures

I. Provision of minimum flow

The construction of the proposed project will lead to reduction in flow, especially during dry months, in the intervening stretch between the diversion site and the tail race disposal point. Such a situation will adversely affect the benthic communities and fish.

The dry segment of river between diversion site and tail race at certain places may retain some water in shallow pools subjecting the fish to prey by birds and other animals. Such a condition will also enable the poachers to catch fish indiscriminately. It is therefore, very essential for the project authorities to maintain the minimum flow for the survival and propagation of invertebrates and fish. In order to avoid possible loss of aquatic life, a minimum flow will always be released.

The proposed project is a run of the river scheme. The river flow will be diverted through a small-gated barrage and no major storage is envisaged in the project. Water will be diverted through a tunnel for power generation and the tail race discharge outfall in supin river about 7 km downstream from the barrage site. The river stretch downstream of the barrage site upto the confluence point of tailrace discharge (about 7 km) will have reduced flow. The flow will be augmented by release of adequate quantity of Environmental Flows for sustenance of riverine ecology. In addition, various streams will also be contributing flow in the intervening stretch. The reduction in flow or drying of the river in the intervening stretch is not likely to have any adverse impact on the downstream users. This is mainly because of the fact that settlements/ villages within this dry stretch are not dependent on the water of river Supin, as the villagers use water of small streams or nallahs flowing adjacent to their habitation.

II. Sustenance of fisheries

The stocking program shall comprise of the following:

- Acclimatization stocking (a new fish species is introduced in a water course)
- Supplementary stocking (a species already living in a water body)
- Transfer stocking (transportation of mature fish from one water body to another)
- Repetitive stocking (species which do not propagate in natural conditions).

To carry out the stocking programme on annual basis, suitable aquaculture facilities have to be created in river supin to meet the requirements of fingerlings. The endemic stocks in supin river are the Trout. The proposed aquaculture facilities have to meet the requirements of fingerlings of the Trout. The proposed aquaculture facilities have to be in flow through system facility for Trout species.

Commercial fishing is not in vogue in the project area. The diversion site on river Supin to be developed as a part of the project will act as a barrier to the free movement of fish species. Since, *Schizothorax richardsonii - Snow trout* is categorized as vulnerable species amongst the threatened fishes of India, scientific management of the existing stock needs to be adopted. It is proposed to implement supplementary stocking programmes for the project area. In addition to reservoir area, it is proposed to stock river Supin for a length of 10 km each on the upstream and the downstream side of the diversion site. The rate of stocking is proposed as 100 fingerlings of about 30 mm size per km. For reservoir area, the rate of stocking could be 200 fingerlings of about 30 mm size per ha. The stocking can be done annually by the Fisheries Department, State Government of Uttarakhand and due consultation of the Directorate of Coldwater Fisheries Nainital (ICAR). Directorate of Coldwater Fisheries has successfully artificially propagated *Schizothorax richardsonii and S. progastus* in nature. A brief description of artificial propagation is mentioned below as per information retrieved from the literature and Directorate of coldwater fisheries. Snow trout, ***Schizothorax richardsonii*** (Gray) is an important indigenous cold water fish species, endemic to the Himalayas and found in streams and lakes which receive snow melt water from the hills. Artificial propagation and seed production in captivity is required for species diversification in cold water aquaculture. Technology for artificial fecundation of snow trout and rearing of young ones in controlled condition has been developed at DCFR. Spawning can be done by dry stripping method and eggs are incubated in the flow through hatchery. This is

a farm based eco friendly and location specific technique. Maturity of the brooder depends on the favorable temperature range *i.e* 14-18°C. Fertilized eggs remain bright orange in colour at the time of stripping. The average fecundity is 10560-22120 eggs/kg. Incubation period depends on the water temperature in the range of 110-270 hours. Good recovery of the fry can be achieved by proper nutritional care of brooder prior to the breeding season.

Therefore, to achieve this objective, facilities to produce seed of trout need to be developed at suitable sites. The cost required for developing of hatcheries shall be Rs. 25.2 lakh. The dimension of the hatching nurseries and rearing unit and their approximate cost is given in Table-10.21. The recurring expenditure for hatchery will be 17.55 lakh/year. The total recurring expenditure for 4 years including 10% escalation will be Rs. 80.68 lakh. The detail of recurring expenditure are given in Table-10.22.

Table-10.21 Cost required for development of hatcheries

Farm Component	Area (m)	Number	Rate of flow (lpm)	Cost (Rs. Lakh)
Hatchery building	15x 6 x 5	1	-	3.0
Hatching trough each with 4 trays each	2.0x0.5x 0.4	20	3.0-5.0	2.0
Nursery ponds (Cement lined)	3.0 x 0.75 x 0.5	9	25-50	2.7
Rearing tanks (cement lined)	10.0x 1.5 x 1.0	9	75-100	4.5
Stock raceways (cement lined)	30.0 x 6.0x 1.5	2	150-200	3.0
Storage – cum – Silting tank	4.0 x 4.0	1	-	1.0
Office store & laboratory room	8.0 x 6.0	3	-	6.0
Watchmen hut	4. 4.0	1	-	2.0
Other items like Dragnet, wide mouth earthen pots miniature happa bucket bamboo patches etc.	Lumpsum			1.0
Total				**25.2**

Table-10.22Recurring expenditure for hatchery

S. No.	Particular	Number	Rate	Amount (Rs. Lakh)
1.	Salaries			
i)	Farm Manager	1	25000/month	3.0
ii)	Farm Assistants	1	15000/ month	1.8
iii)	Farm Attendants	1	10000/	1.2

S. No.	Particular	Number	Rate	Amount (Rs. Lakh)
			month	
iv)	Chowkidars	1	10000/ month	1.2
2.	Fish food	Lumpsum		0.10
3.	Brooders	200 kg	150	3.0
4.	Ponds manuring			
i)	Cow dung	20 tons	200/tons	0.0
ii)	Urea	100 kg	10/kg	0.0
iii)	Potash, phosphate	100 kg	100/kg	1.0
5.	Lime	300 kg	10/kg	0.3
6.	Training and Research	Lumpsum		0.10
7.	Chemical	Lumpsum		0.10
8.	Maintenance	Lumpsum		0.10
9.	Travel	Lumpsum		0.10
10	Miscellaneous	Lumpsum		0.10
	Sub-total for one year **Total recurring expenditure for four years including 10% escalation (B)**			17.6 **80.68**

Thus total cost for fish seed farm will be Rs. 105.88 lakh (Rs. 25.2 + 80.68 lakh). The above facility can be developed and implemented by Fisheries Department, State Government of Uttarakhand at an appropriate site. Seeds can be transported from this hatchery. The supply of seeds can also be augmented by collecting them from natural sources. Production, transportation and stocking of fish material is a highly technical subject for which project proponent may not have the required expertise. Thus, implementation of this proposal may be done by the Fisheries Department. The funding can be done by Project Proponents.

10.5 PUBLIC HEALTH DELIVERY SYSTEM

10.5.1 Impacts on Public Health

The construction of a reservoir replaces the riverine ecosystem by a lacustrine ecosystem. The vectors of various diseases breed in shallow water areas not very far from the reservoir margins. The magnitude of breeding sites for mosquitoes and other vectors in the impounded water is in direct proportion to the length of the shoreline. The construction of the reservoir would marginally increase the shoreline as compared to the pre-project shoreline of river Supin under submergence. Thus, the construction of the proposed reservoir is not expected to increase the potential

breeding sites for various diseases vectors. Thus, no major impact on public health is anticipated.

10.5.2 Public Health Delivery System

Development of medical facilities

I. Proposed Health Facilities at Construction sites

A first aid post is to be provided at major construction sites, so that workers are immediately attended to in case of an injury or accident.

This first-aid post will have at least the following facilities:

- First aid box with essential medicines including ORS packets
- First aid appliances-splints and dressing materials
- Stretcher, wheel chair, 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. Doctors from the dispensary can attend First Aid post regularly every day at a fixed time. Communication link between the dispensary and then first-aid post shall be established, so as to enable doctors from dispensary to reach the work site in case of an emergency. The first aid post shall have facilities such as fire fighting equipment, telephone connection, one vehicle or ambulance van for effective functioning.

II. 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 habits of environmental sanitation specially with respect to water pollution by domestic wastes. There would be possibility of the transmission of communicable diseases due to migration of labour population from other areas at the construction site.

The doctors from the dispensary will 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:

- 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 these 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.

The costs estimated as follows are approximate and indicate the order of expenditure likely to accrue.

A. Expenditure on salaries

Recurring

Dispensary

Post	*Number*	*Monthly* **Emoluments (Rs.)**	*Annual* **expenditure (Rs.)**
Doctors	2	25,000	600,000
Nurse	4	8000	384,000
Male Multi-purpose Health Workers	**2**	**6,000**	**144,000**
Attendants	2	4,000	96,000
Drivers	2	3,000	36,000
Total			**1,266,000**

First Aid Posts

Health Assistants	2	5,000	120,000
Dressers	2	3,000	72,000
Total			**192,000**

Total Expenditure (A) = Rs.14,52,000

B. Expenditure on Material and Supplies

Dispensary

Non-recurring

i)	2 Vehicles (Closed Jeep) and	Rs. 1,500,000
ii)	Furniture, etc.	Rs. 200,000
iii)	Miscellaneous item	Rs. 1800,000
Total		**Rs.35,00,000**

Recurring

i)	Drugs and Medicine,	Rs. 300,000/yr
ii)	Contingencies	Rs. 50,000/yr
iii)	2 First-Aid Posts at construction sites	Rs. 36,000/yr

Total	**Rs. 3,86,000/yr**

C. Infrastructure

Non-recurring

Dispensary: Considering the number of rooms, staff quarters and open space etc., it is estimated that 5000 sq.feet (i.e. 465 sq.meter) of plot will be required for dispensary, out of which about 4000 sq.feet (375 sq.meter) will be the built-up land which includes dispensary building staff quarters, etc. The construction cost for RCC structure will be Rs.400/sq.feet excluding land cost. The cost of construction of dispensary will be Rs.16.0 lakh. The land can be purchased by the project proponents from the State Government of Uttarkhand. An amount of Rs.3.0 lakh can be earmarked for this purpose.

First-Aid Posts: These are of temporary nature and will be constructed with MS/GI sheets, bamboo, etc. It will cost @ Rs.150,000/First- Aid Post. The total cost for constructing two First -Aid Posts will be of the order of Rs.3.0 lakh.

The total cost for developing the infrastructure will be (Rs.16.0 lakh + Rs.3.0 lakh + Rs.3.0 lakh) Rs.22.0 lakh.

The total expenditure for implementation of various public health measures shall be about Rs.142.3 lakh. The details are given as below:

A.	**Recurring Expenditure**		
*	Expenditure on salaries	:	Rs. 1452,000/yr
*	Expenditure on materials & supplies		Rs. 386,000/yr
	Sub-Total		**Rs. 1838,000/yr**
Total expenditure for 4 years (A) (considering 10% escalation per year period)		:	Rs. 85.3 lakh
B.	**Non-Recurring Expenditure**		
*	Infrastructure (Construction of Dispensary & 2 First aid posts)	:	Rs. 22.0 lakh
*	Expenditure on materials & supplies	:	Rs. 35.0 lakh
Total (B)			**Rs. 57.0** lakh
	Total A + B		**Rs.142.3** lakh

10.6 ENVIRONMENTAL MANAGEMENT IN LABOUR CAMPS

10.6.1 Provision of Heating

The contractor can make a block of two large rooms in which about 30-40 workers can stay. It is proposed to provide a central heating system which shall provide hot water to workers throughout the year. The project is located at an elevation of about 1900 to 1950 m, where hot water will be required throughout the year. If hot water facilities are not provided, then, workers will be forced to cut trees to meet the fuel requirements to heat the water required for various uses.

10.6.2 Provision of Water Supply

The project construction is likely to last for a period of 4.0 years. The peak labour strength likely to be employed during project construction phase is about 800 workers and 200 technical staff. The major works shall be given on contract, who bring their own skilled labour. The following assumptions have been made for assessing the emigrating population in the area:

- 80% of workers and technical staff emigrating into the area are married.
- In 80% of the family of workers both the husband and wife will work.
- In 100% of the family of technical staff, only husband will work.
- 2% of total migrating population has been assumed as service providers.
- 50% of service providers will have families.
- Family size has been assumed as 5.

Based on experience of similar projects and above referred assumptions, the increase in the population as a result of migration of labour population during construction phase is expected to be of the order of 3200. The domestic water requirement has been estimated as 70 lpcd. Thus, total water requirements work out to 0.22 mld.

The water for drinking purpose is collected from the rivers or streams flowing upstream of the labour camps. The water is stored in tanks and supplied for use. Considering the environmental setting of the water quality is expected to be quite good and does not require any elaborate treatment. However, it is proposed to disinfect the water prior to distribution. The settlements/ labour camps shall be placed far from the drinking water sources.

It is recommended that, water quality of the river or stream to be tapped shall be monitored on a monthly basis.

10.6.3 Solid Waste Management

The labour colonies will generate substantial amount of municipal wastes. In view of the condition that might exist in the labour camps, most likely the solid wastes will contain majority of vegetable matter followed by paper cans and glasses. About

3,200 persons are likely to congregate during the construction phases resulting in generation of about 0.67 tonnes of solid waste/day. Adequate facilities for collection conveyance and disposal of municipal waste generated from labour camps should be developed. For solid waste collection, masonry storage vats, each of 2 m^3 capacity at convenient dumping points in the labour camp will be constructed. Each vat will have a storage capacity of 150 kg (dry weight) of garbage, which will be emptied at regular intervals and will be transported to the landfill site. One covered truck to collect the solid waste from the common collection point and transfer it to the disposal site needs to be put to service.

Various aspects of solid waste management include:

- Reuse/Recycling
- Refuse storage
- Collection and Transportation
- Disposal

Reuse/Recycling

In order to reduce quantum of waste generated, project will reuse significant quantity of Muck (generated due to excavations) for backfilling, form work (in civil work) wherever possible and will also reuse the packing materials received with packages etc.

Project proponent will explore opportunity to recycle the waste generated at the project site. In this context project will identify authorized vendors and send used batteries, used oil, and used oil filters for recycling.

Bio- degradable waste will be disposed by composting and the manure generated will be given to local community for cultivating vegetables and flowers.

Refuse storage

In the proposed project, labour camps are proposed to be located near Hawai. The labour colony shall have provisions to separately store the degradable and non-degradable solid waste.

Two different coloured bins shall be supplied to each labour family, who will segregate the waste generated by their family. Green and Biodegradable waste is to be deposited in one container and non-biodegradable waste in another container. In case of canteens, kitchens also, two different coloured dust-bins suitable to deposit the Biodegradable and non-biodegradable waste generated in their unit shall be

provided. A sustained awareness programme will be conducted to educate workers about the segregation of degradable and bio-degradable wastes.

Collection of Household Waste

Every day the trolleys will collect the waste at the door of each unit of labour camp and colonies. The trolleys will be provided with two compartments for depositing segregated waste separately. Each worker will be allotted at a fixed area. The collection will be on regular pre-informed timings and the arrival will be informed through blowing a whistle/horn. The solid waste so collected shall be disposed at a common storage point. Two trucks will be commissioned to collect the solid waste and dispose the same at sites designated for disposal of solid waste.

Segregation of waste

The awareness programmes shall be organized for waste segregation. Residents of labour camps shall be apprised of the benefits of waste segregation. Regular meeting shall be conducted with representative of residents of colonies where good upkeep shall be recognized & rewarded.

Disposal

Degradable component

The degradable portion of the solid waste would be disposed off by composting. The degradable portion is taken as about 38.9%. Thus, (0.389*0.67) about 0.26 t/day of degradable portion of solid waste will be generated. In composting the process takes around 60 days to mature. Keeping, a margin of 30 days total capacity of pits has been provided as (0.44x90 = 39.6 m^3). Thus the total capacity of pits required would be 40 cu m.

A pit of 2m x 1.5m x 1.3m deep (0.3 m freeboard) size can take 3.0 cu m of compostable waste. Thus the no. of pits required shall be about 14. The total area will be almost three times the pit area as some area in between pits will be required for transportation and stacking of waste. Hence, total area required will be 126 m^2. The pits will be covered with GI sheets. Additional 63 sq.m shall be kept for storage for compost plus screening and other activities.

The pits to be constructed will have around 25 cm of bottom lining consisting of about 5 cm thick stone grit over which 15 cm thick coarse sand followed by 15 cm thick earth lining will be done. The refuse along with animal dung will have to be laid in layers of 5 to 10 cm thickness. The pit will be then watered on alternate days.

Thereafter waste is laid in 5 to 10 cm thick layers twice in a week till the whole pit is filled up. Every week the waste will need to be turned up and water will have to be sprinkled every day to keep adequate moisture. The process will take around 60 days where after the composted waste from the pit is taken out and after drying it is screened with screens having 2 mm dia holes. The screened compost would be filled in plastic bags and used as good manure especially for cultivation of vegetables and flowers.

Non-Degradable component

The non- degradable portion such as plastic bottles, cans, etc. shall be segregated and disposed of at separate sites identified by the district administration.

A suitable landfill site can be identified and designed to contain the municipal waste from all the project township, labour colonies, etc. A total provision of Rs.39.0 lakh needs to be earmarked for this purpose. The details are given in Table-10.23.

Table-10.23Details of Expenditure required for solid waste management

Item	Cost (Rs. lakh)
• One covered truck for conveyance of solid waste up to landfill site.	15.0
• Manpower cost for 6 persons @ Rs.5000/month for 4 years including 10% escalation/year.	16.7
• Waste collection hand carts 9 @ Rs.25,000/unit	2.3
• Preparation of landfill site	5.0
Total	**39.0**

A provision of 15% of the total area, for accommodating infrastructure facilities will be included while working out requirement of space. The liner system will comprise of the following layers below the waste:

- 0.30 m thick drainage layer comprising of coarse sand or gravel (stone dust with no fines)
- 0.2m thick protective layer of sandy silt
- 1.50mm thick HDPE geo-membrane
- 1.0 m thick clay layer/amended soil layer, amended soil layer comprising of local soil + bentonite is to be provided).

Generally, from sanitary landfill, there is little risk from methane, generated due to the decay of vegetable matters, as it slowly diffuses at low concentration through the covering material. The most serious risk from sanitary landfill is that of pollution from

leachates. Thus, the bed of the disposal sites shall be covered with an impervious material so as to ensure that leachate does not lead to soil and water pollution.

The essential components of a landfill site are:

- A liner system at the base and sides of the land fills which prevents migration of leachate or gas to the surrounding soil.
- A leachate collection and control facility which collects and extracts leachate from within and from the base of the landfill and then treats the leachate.
- A. final cover system at the top of the landfill which enhances surface drainage, prevents infiltrating water and supports surface vegetation.
- A surface water drainage system which collects and removes all surface runoff from the landfill site.
- An environmental monitoring system. which periodically collects and analyses air, surface water, soil-gas and ground water samples around the landfill site.
- A closure and post-closure plan which lists the steps that must be taken to close and secure a landfill site once the filling operation has been completed and the activities for long-term monitoring, operation and maintenance of the completed land

CRITERIA FOR SELECTION OF LANDFILL SITES

Location

Following criteria may be adopted for locating site for a municipal solid waste landfill:

- **Lake or Pond**- No landfill should be constructed within 200 m of any lake or pond.
- **River** No landfill should be constructed within 100 m of a navigable river or stream. The distance may be reduced in some instances for non-meandering rivers but a minimum of 30 m should be maintained in all cases.
- **Flood Plain**: No landfill should be constructed within a 100 year flood plain.
- **Highway**- No landfill should be constructed within 200m of the right of way or any state or national highway. A landfill may be built within the restricted distance, but not closer than 50 m if trees and berms are used to screen the landfill site.
- **Habitation**. A landfill site should be at least 500 m from a notified habitation area. A zone of 500 m around a landfill boundary should be declared a non-development Buffer Zone after the landfill location is finalized.

- **Public parks** No landfill should be constructed within 300 m of a public park.
- **Critical Habitat Area**No landfill should be constructed within critical habitat areas. A critical habitat area is defined as the area in which one or more endangered species live.
- **Wetlands**. No landfill should be constructed within wetlands. If there is any doubt, then the regulatory agency should be contacted.
- **Water Supply Well**: No landfill should be constructed within 500 m of any water supply well.
- **Unstable Zone**: A landfill should not be located in a tentatively unstable zones such as landslide prone areas, fault zone etc.
- **Buffer Zone**: A landfill should have a buffer zone around it, up to a distance prescribed by regulatory agencies.
- **Other criteria** as may be decided by any statutory authorities like the State Pollution Control Board, or the Planning authorities etc.

10.6.4 Provision of Water Supply

The water for drinking purpose is collected from the rivers or streams flowing upstream of the labour camps. The water is stored in tanks and supplied for use. The water quality in general is good and does not require any elaborate treatment. However, if some problems are anticipated as a result of bacteriological contamination, then suitable treatment units can be installed at a later date. The settlement of the population likely to migrate in the area to provide various allied activities shall be placed far from the drinking water sources.

10.6.5 Sanitation Facilities

One community latrine shall be provided per 20 persons. The sewage from the community latrines shall be treated in mobile sewage treatment plant. For each 500 persons, one mobile sewage treatment plant shall be provided. The effluent from mobile sewage treatment plant shall be disposed off through absorption trenches. As mentioned earlier, the drinking water facilities and waste disposal sites will be located away from each other.

The total construction time for the project is about 4 years. At peak construction phase, there will be an increase in population by 2000. To ensure that the sewage from the labour camps do not pollute the river water it has been estimated that about

160 community latrines and sewage treatment plants need to be constructed. The total cost required will be Rs.95.0 lakh (refer Table-10.24).

Table- 10.24Cost Estimate for sanitary facilities for labour camps

Unit	Rate (Rs./unit)	Number	Total cost (Rs. lakh)
Community latrines	40,000	160	64.0
Mobile sewage treatment plant			31.0
Total			**95.0**

10.6.6 Provision for free Fuel Distribution

It is proposed to establish a gas agency at appropriate site, which shall provide LPG for cooking purpose for the technical staff &labour employed in project construction activities. The increase in the population as a result of migration of labour population during construction phase is expected to be of the order of 3200. For every 5 persons, 1 LPG Cylinder shall be taken per month. Considering the cost of each LPG Cylinder as Rs. 1000 and taking 10% escalation in cost every year, the total cost for provision of fuel works out to Rs. 356.43 lakh. The details are given in Table-10.25.

Table-10.25Cost estimate for LPG distribution

Year	Population to be served	Annual requirement @1cylinder per 5 persons per month (No. of cylinders)	Total Cost @Rs.1000 /cylinder (Rs. lakh)	Cost after escalation @ 10%/ year (Rs. lakh)
I	3200	7680	76.80	76.80
II	3200	7680	76.80	84.48
III	3200	7680	76.80	92.93
Iv	3200	7680	76.80	102.22
Total				**356.43**

A total provision ofRs. 490.43 lakh has been earmarked for implementation of various measures in labour camps. The details are given in Table-10.26.

Table-10.26Cost estimate for implementation of various measures in labour camps

S. No.	Fuel	Cost (Rs. lakh)
1.	Solid waste management in labour camps	39.0
2.	Sanitation facilities for labour camps	95.0
3.	Fuel distribution in labour camps	356.43
	Total	490.43

10.6.7 Implementing Agency

Various measures recommended in this chapter shall be included in the contract document of the contractor involved in construction activities. The implementation of these measures shall be monitored by the project proponents. However, the site for disposal of solid waste shall be identified in consultation with district administration.

10.7 MUCK MANAGEMENT PLAN

10.7.1 Muck Generation

Based on the geological nature of the rocks and engineering properties of the soil, a part of the muck generated can be used as construction material. The balance needs to be suitably disposed. Normally, muck is disposed in low-lying areas or depressions. Trees, if any, are cut before muck disposal, however, shrubs, grass or other types of undergrowth in the muck disposal at sites perish. The muck disposal sites will be suitably stabilized on completion of the muck disposal.

- Muck disposal can lead to impacts on various aspects of environment. Normally, the land is cleared before muck disposal. During clearing operation trees are cut, but undergrowth perishes as a result of muck disposal.
- In many of the sites, muck is stacked without adequate stabilization measures. In such a scenario, the muck moves along with runoff and creates landslide like situations. Many a times, boulders/large stone pieces enter the river/water body, affecting the benthic fauna, fisheries and other components of aquatic biota.
- The increased vehicular movement near muck disposal sites lead to adverse impacts on ambient air quality as well. However, increase in vehicular traffic is not significant to cause major impact on ambient air quality.
- Normally muck disposal is done at low lying areas, which gets 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 area which can provide ideal breeding habitat for mosquitoes.

Thus, it is necessary to develop a proper muck disposal plan for amelioration of above referred impacts.

10.7.2 Muck Disposal Sites

The total excavation quantity likely to be generated at the project will be around 2.56 lakh cum. Approximately 30% of generated muck will be used as construction

material and remaining 2.50 lakh cum (including 40% swelling factor and over break) will be disposed off at six muck disposal sites. However, the capacity of the six dumping sites is 4.09 lakh cum. The details of Muck generation from various project components are given in Table-10.27. Likewise, the details of muck disposal sites are given in Table-10.28.

Table-10.27Muck Generation from Project Components of JSHEP

S. No.	Project Component	Total Muck (m^3)
1	Excavation of Coffer Dam & Pipe alignment	4498
2	Barrage Excavation	7949
3	Power intake Excavation	930
4	Adit-1(to desilting tank) Excavation	3868
5	Excavation of Desilting Basin (Underground)	26917
6	Intake Tunnel Excavation	3081
7	Adit-2 (to Head Race Tunnel) Excavation	6460
8	Adit-3 (to Head Race Tunnel) Excavation	5970
9	Adit-4 (to Head Race Tunnel & surge shaft) Excavation	3525
10	Face-1 (from Desilting Side) Excavation	7670
11	Face-2 (Construction Adit-2 Upstream) Excavation	7670
12	Face-3 (Construction Adit-2 Downstream) Excavation	16725
13	Face-4 (Construction Adit-3 Upstream) Excavation	16725
14	Face-5 (Construction Adit-3 Downstream) Excavation	15830
15	Face-6 (Construction Adit-4 Upstream) Excavation	15830
16	Face-7 (Construction Adit-4 Downstream) Excavation	817
17	Surge Shaft Excavation	2773
18	Pressure shaft & Penstock Excavation	6344
19	Valve House Excavation	1000
20	Power House Cavern Excavation	46009
21	Main Access Tunnel Excavation	12500
22	Ventilation Tunnel Excavation	7328
23	Cable Tunnel Excavation	1656
24	Tail Race Tunnel Excavation	4863
25	Pothead Yard Excavation	29172
Total Muck generation		**256110**
Swelling factor @ 40%		**358554**
Muck to be utilized@ 30%		**107566**
Muck to be dumped		**250988**

Table-10.28Details of Muck Disposal Sites

S. No.	Dumping Sites	Location	Area (ha)	Capacity (m^3)	Muck to be dumped (m^3)	Distance from HFL (m)
1	D-1	Near D/s of Barrage Site on the Left Bank of Supin River	0.4182	65646	33110	30
2	D-2	Adjacent to Dhara Village i.e. Near	2.598	129734	50944	200

S. No.	Dumping Sites	Location	Area (ha)	Capacity (m^3)	Muck to be dumped (m^3)	Distance from HFL (m)
		Adit-2				
3	D-3	Near Adit-3	0.829	22857	21364	240
4	D-4	Near Junction of Main Road and PowanMalla Road	1.874	64187	19107	250
5	D-5	Between colony location and MAT portal	1.178	107857	65500	85
6	D-6	Near Surge Shaft and Adit-4	0.746	18769	60963	520
Total			**7.6432**	**409050**	**250988**	

The cross-sections & topographical contour map of various dumping sites are given in Figure-10.7 to 10.18 respectively. The cross section of retaining wall is shown in Figure-10.19.

10.7.3 Management Measures

As mentioned earlier, a large quantum of muck is expected to be generated. 30% of muck is proposed to be utilized as a construction material for various project appurtenances. The balance is proposed to be disposed at the designated site.

Muck generated from excavation of any project component is required to be disposed in a planned manner so that it takes a least possible space and is not hazardous to the environment. In the hilly area, dumping is done after creating terraces thus usable terraces are developed. The overall idea is to enhance/maintain aesthetic view in the surrounding area of the project in post-construction period and avoid contamination of any land or water resource due to muck disposal.

Suitable retaining walls shall be constructed to develop terraces so as to support the muck on 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 of boulder crate wall and masonry wall to protect the area/muck from flood water during monsoons. In-between the terraces, catch water drain will be provided.

The terraces of the muck disposal area will be ultimately covered with fertile soil and suitable plants will be planted adopting suitable bio-technological measures.

The basic aim and objectives of the muck management plan are to:

- protect these areas from soil erosion
- develop these areas by afforestation

- develop them into parks, gardens etc.
- utilize the maximum quantity of muck for development of infrastructure of the project
- develop these areas in harmony with the landscape of the project area.

Various activities proposed as a part of the management plan are given as below:

- Land acquisition for muck dumping sites
- Civil works (construction of retaining walls, boulder crate walls etc.)
- Dumping of muck
- Levelling of the area, terracing and implementation of various engineering control measures e.g., boulder, crate wall, masonry wall, catchwater drain.
- Spreading of soil
- Application of fertilizers to facilitate vegetation growth over disposal sites.

For stabilization of muck dumping areas following measures of engineering and biological measures have been proposed

Engineering Measures

- Wire crate wall
- Boulder crate wall
- R.C.C
- Catch water Drain

Biological Measures

- Plantation of suitable tree species and soil binding species
- Plantation of ornamental plants
- Barbed wire fencing

Muck generally lacks nutrients and therefore, are difficult to re-vegetate. However, if no attempts to vegetate the slopes are made, the muck could slide lower down during rain and may eventually wash off the check dams also. Since, top soils are not available in large quantities in Himalayas, it may not be possible to apply a thin layer of soil over the muck. Bio-fertiliser technique developed by National Environmental Engineering Research Institute (NEERI) can be adopted in the proposed project. NHPC has successfully used this technique in Uri hydroelectric project. Similar approach can be utilized in the proposed project as well. In this process, the unused excavated material is piled and stacked with proper slopes at the designated muck disposal sites. The slopes are broken up by creating benches across them. This is done to provide stability to the slopes and also to provide ample space for planting of trees that would further help in holding and consolidating biotechnological approach. The traditional methods of afforestation of these areas would be supplemented with the use of fungus, i.e. Vesicular ArbuscularMycorrizae

(VAM) and nitrogen fixing bacteria that form partnership with plant roots. These grow on plant roots and provide water and nutrition especially phosphorus to plants at faster rate. The seeding of plants would be inoculated with VAM and nitrogen fixing bacteria before planting. It has been found that plants inoculated with bio-fertilizers grow at faster rate especially in the medium where the soil/rock is devoid of nutrients.

The afforestation with suitable plant species shall be done. About 1000-1200 trees/ha shall be planted. The tentative list of plant species suggested for afforestation is as follows:

Botanical Name

Trees

- *Alnusnepalensis*
- *Leucaenaleucocephala*
- *Myricaesculenta*
- *Grevillearobusta*
- *Pinusroxburghii*

Shrubs

- *Jatrophacarcus*
- *Berberisasiatica*
- *Berberis lyceum*
- *Desmodiumelegan*

Grasses

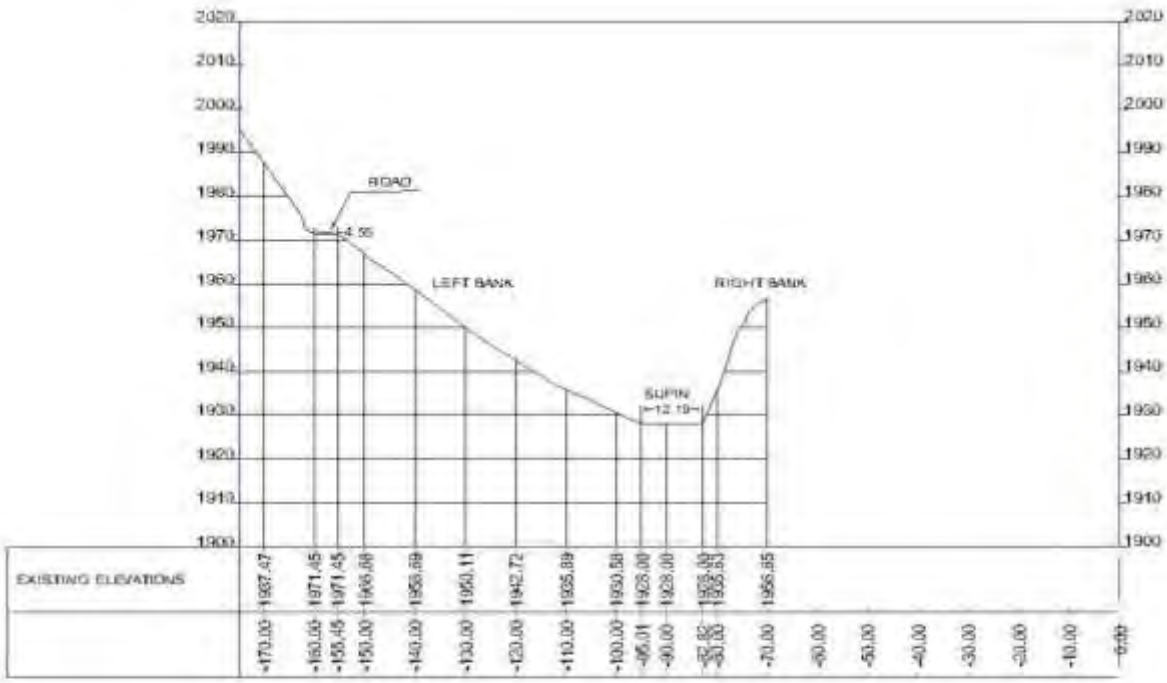
- *Arundinellanepalensis*
- *Agrimoniapilosa*
- *Alexandrium folium*
- *Cynodondactylon*
- *Geranium ocellatum*
- *Solanumnigrum*

A provision of Rs.42.1 million has been earmarked for stabilization and restoration of muck disposal site. The details are given in Table-10.29.

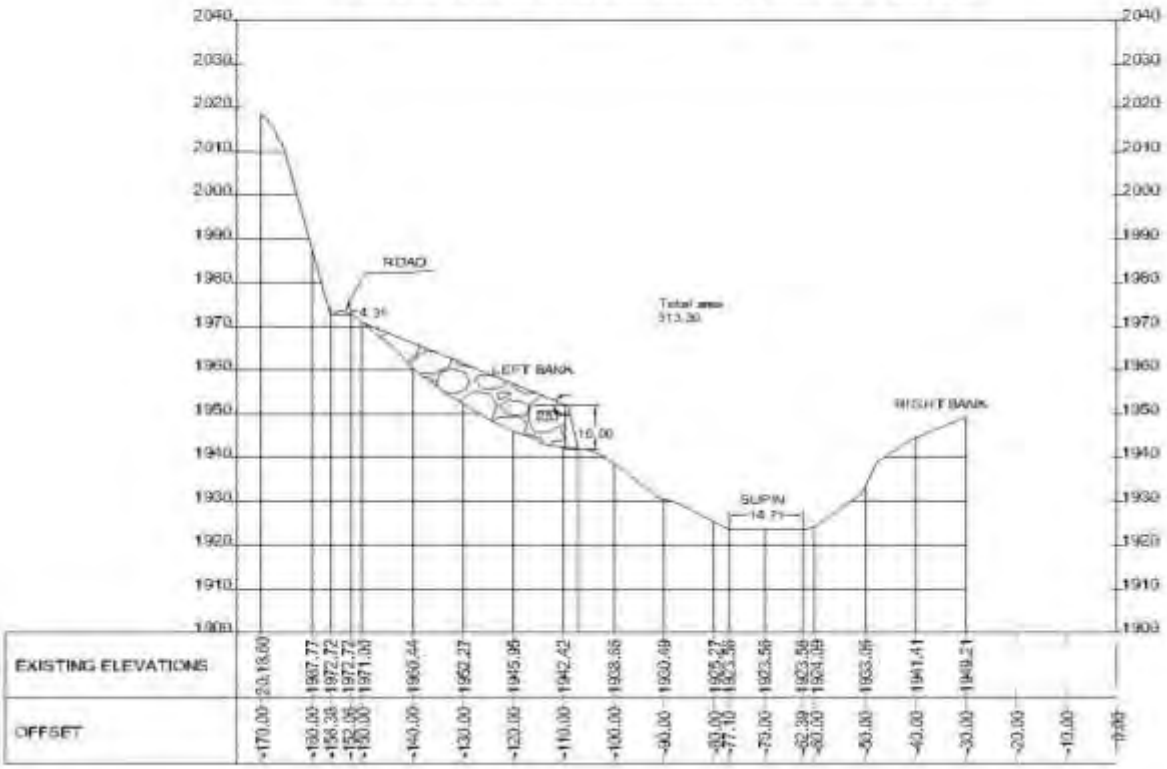
Table-10.29Cost estimate for stabilization of muck disposal sites

S. No.	Works	Quantity	Unit	Rate (Rs.)	Cost (Rs.million)
A. Engineering Measures					
1.	Boulder Crate Wall	8000	m^3	1000	8.0
2.	Masonry Wall	3000	m^3	4000	12.0
3.	Catch Water Drain	2000	m^3	4000	8.0
4.	Levelling including spreading of soil		LS		1.0
	Sub-Total (A)				**29.0**
B. Biological Measures					
1.	Plant sapling			LS	0.1

S. No.	Works	Quantity	Unit	Rate (Rs.)	Cost (Rs.million)
	procurement				
2.	Plantation			LS	4.0
3.	Fencing			LS	4.0
4.	Biological fertilizer procurement			LS	2.0
5.	Watch and ward				3.0
	Sub Total (B)				**13.1**
	Total (A+B)				**42.1**



X-SECTION AT CHAINAGE 00M FOR DUMPING SITE- 1 (JSHEP)



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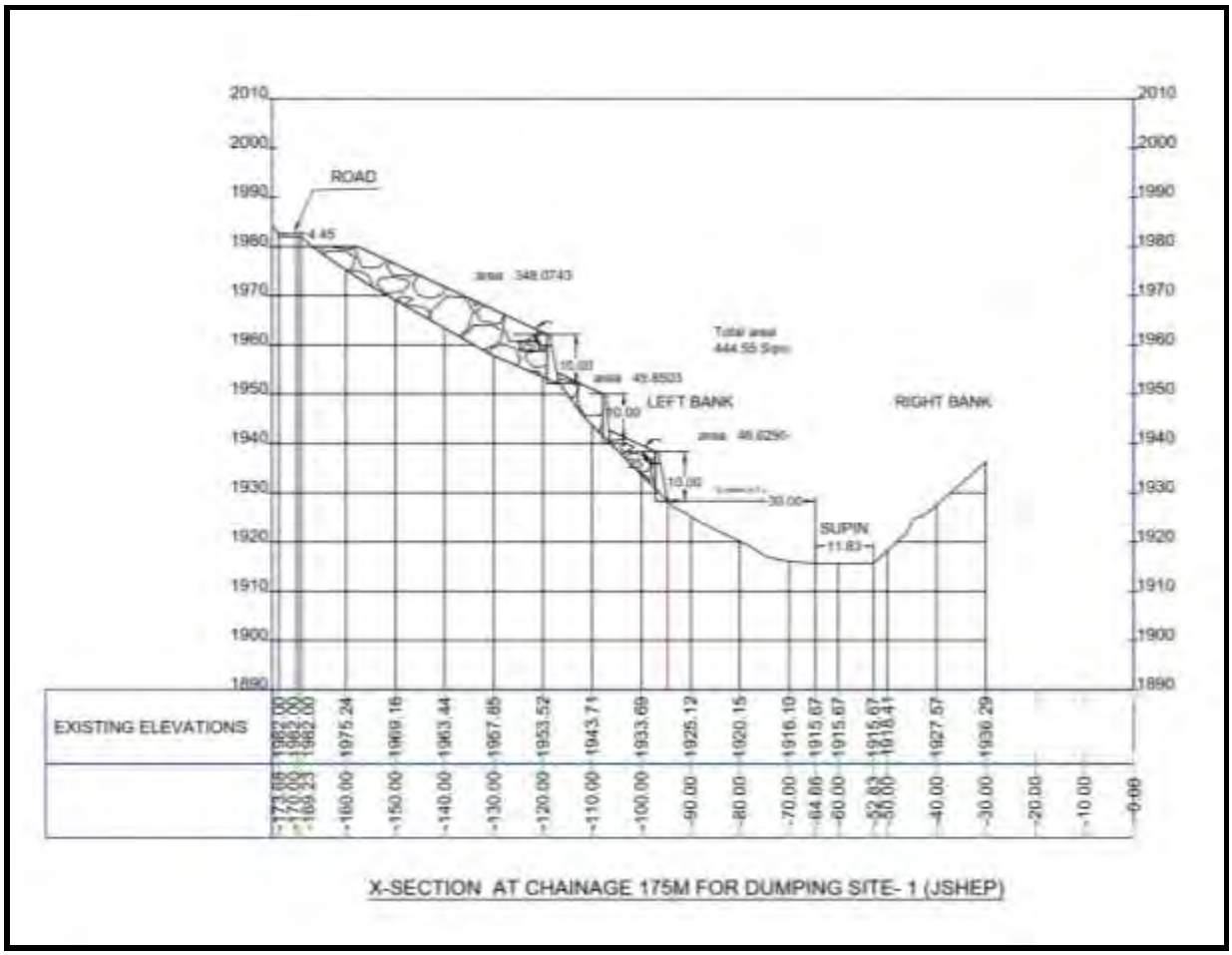


Figure-10.7 Cross-sections of Dumping site-1

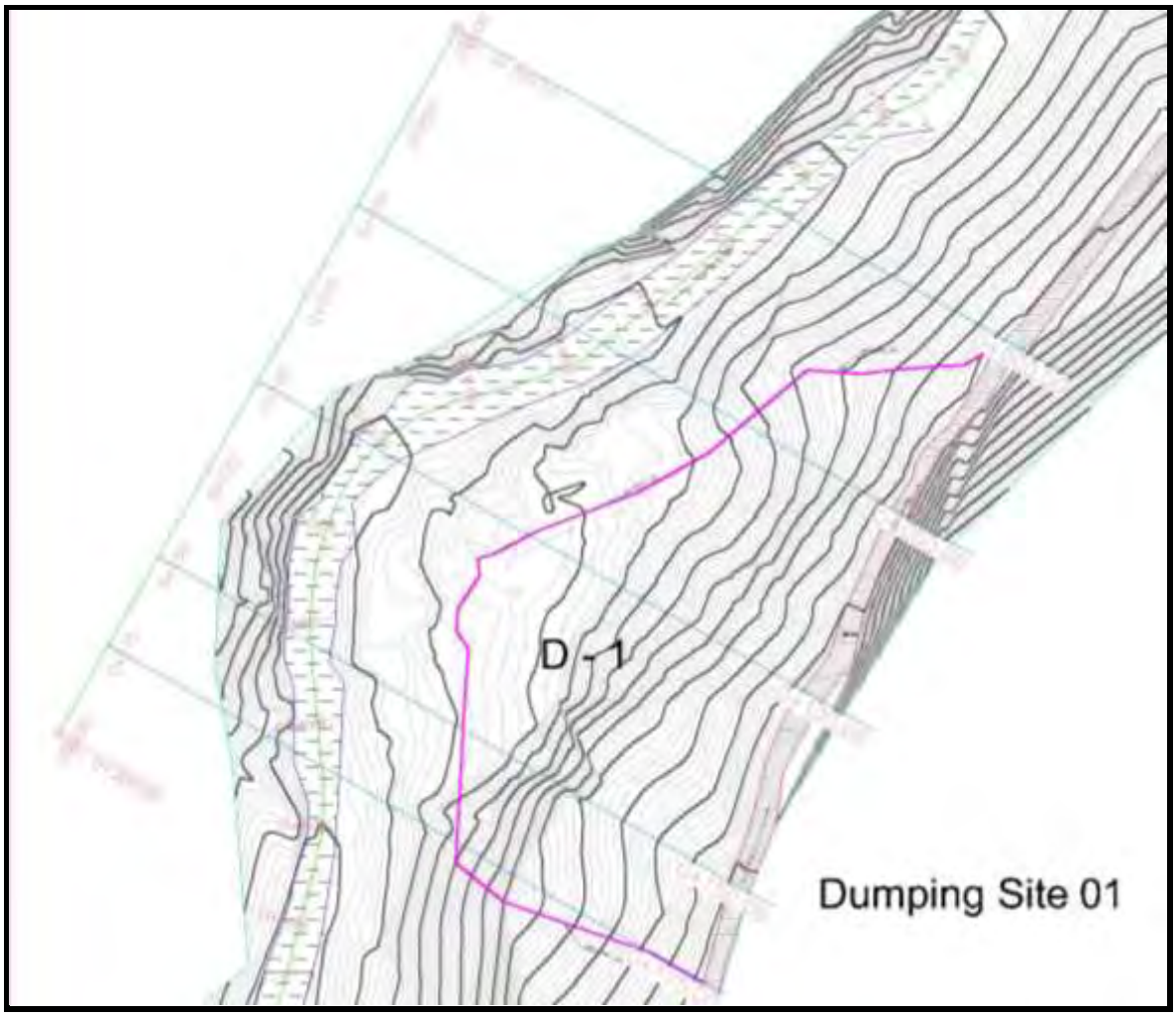
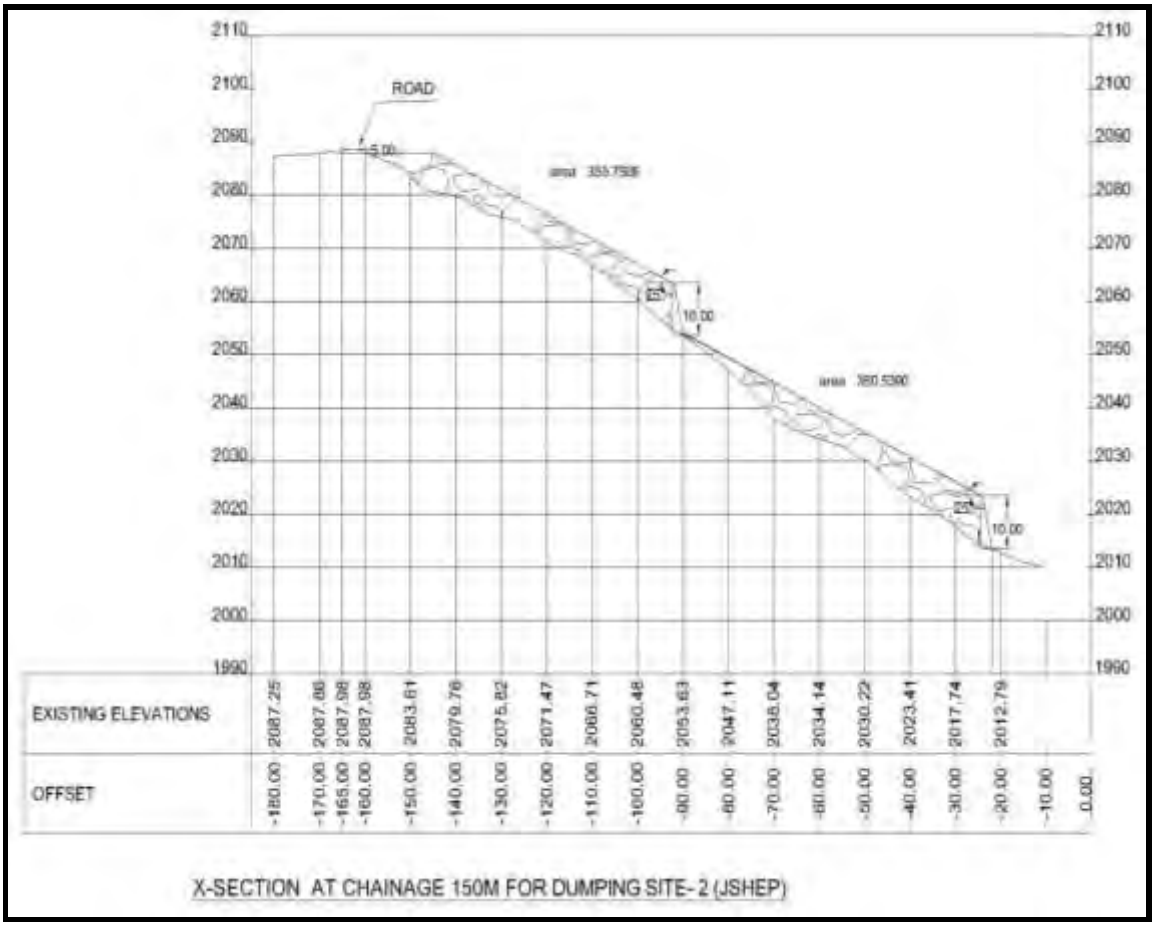


Figure-10.8: Topographical Contour Map of Dumping Site-1



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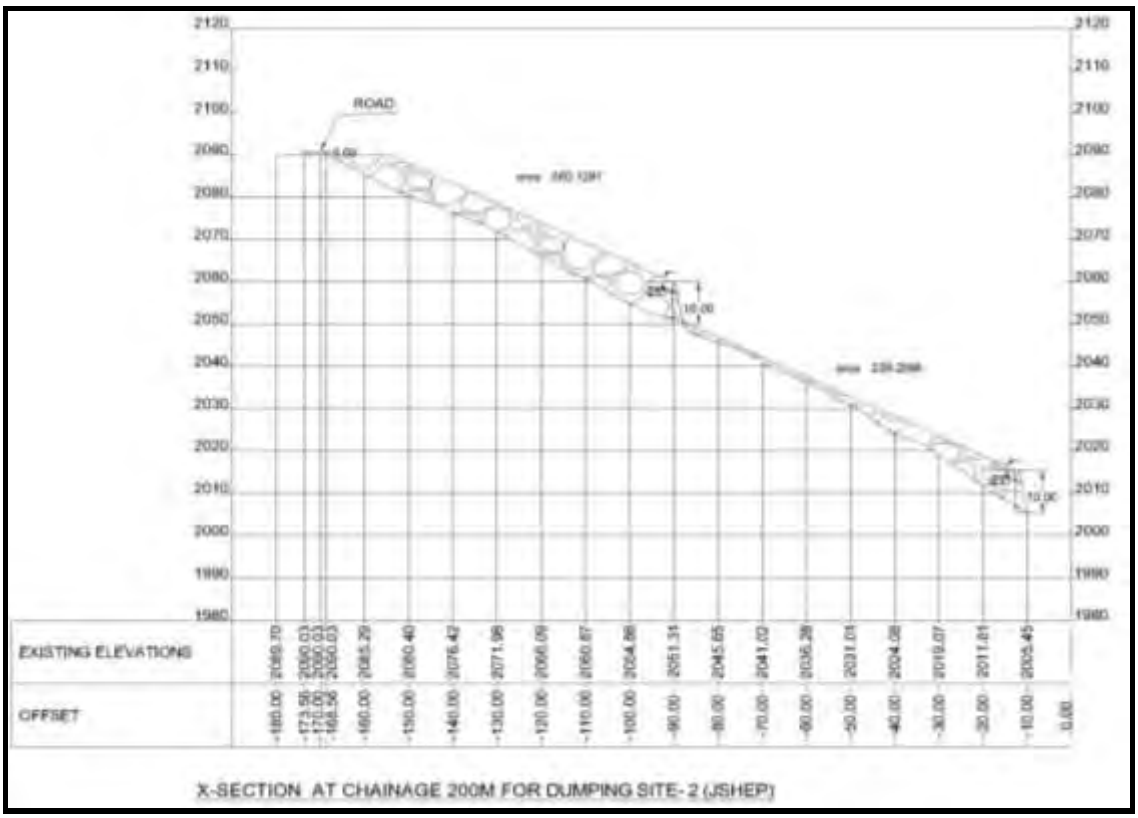

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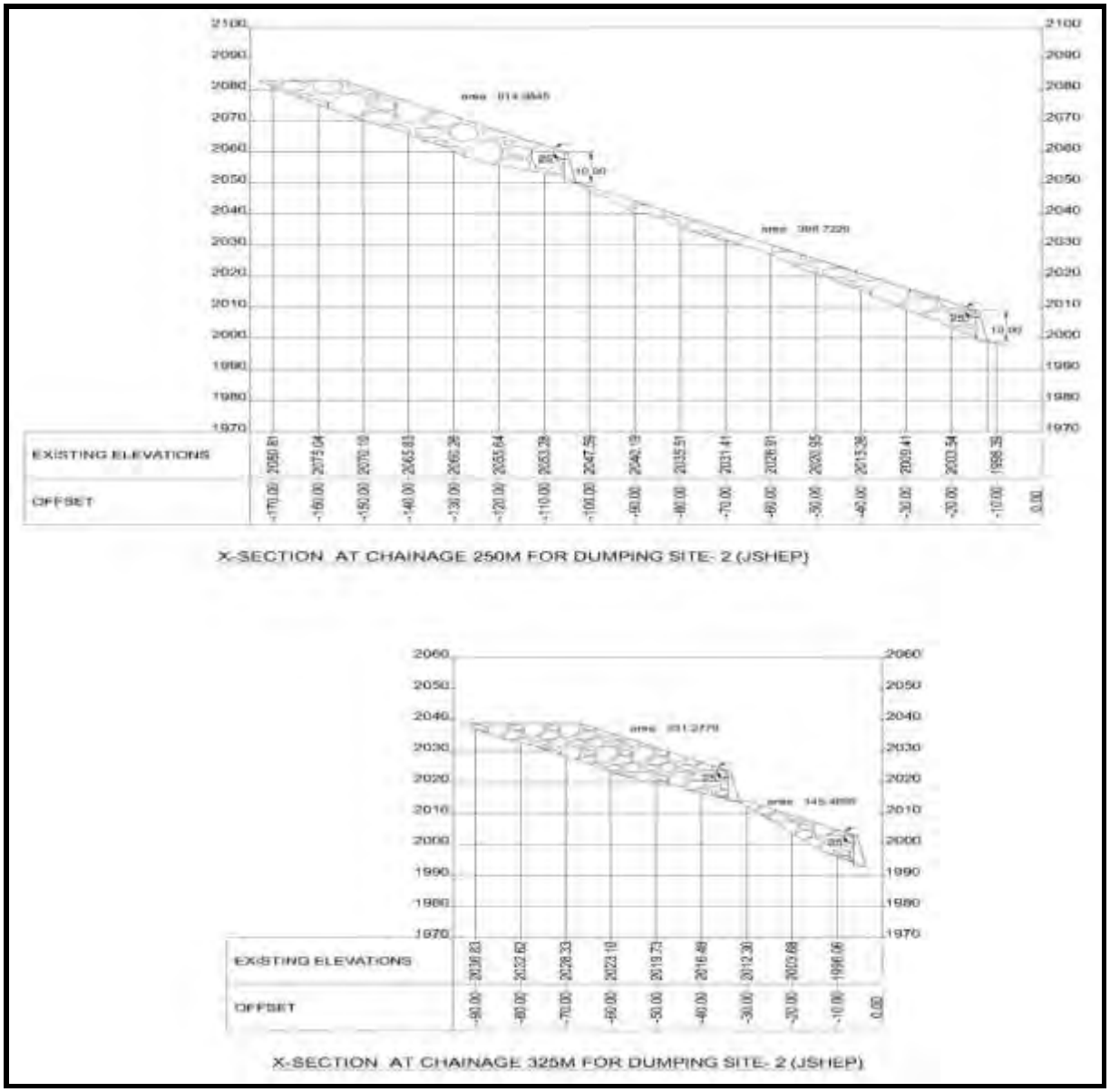


Figure-10.9 Cross-sections of Dumping site-2

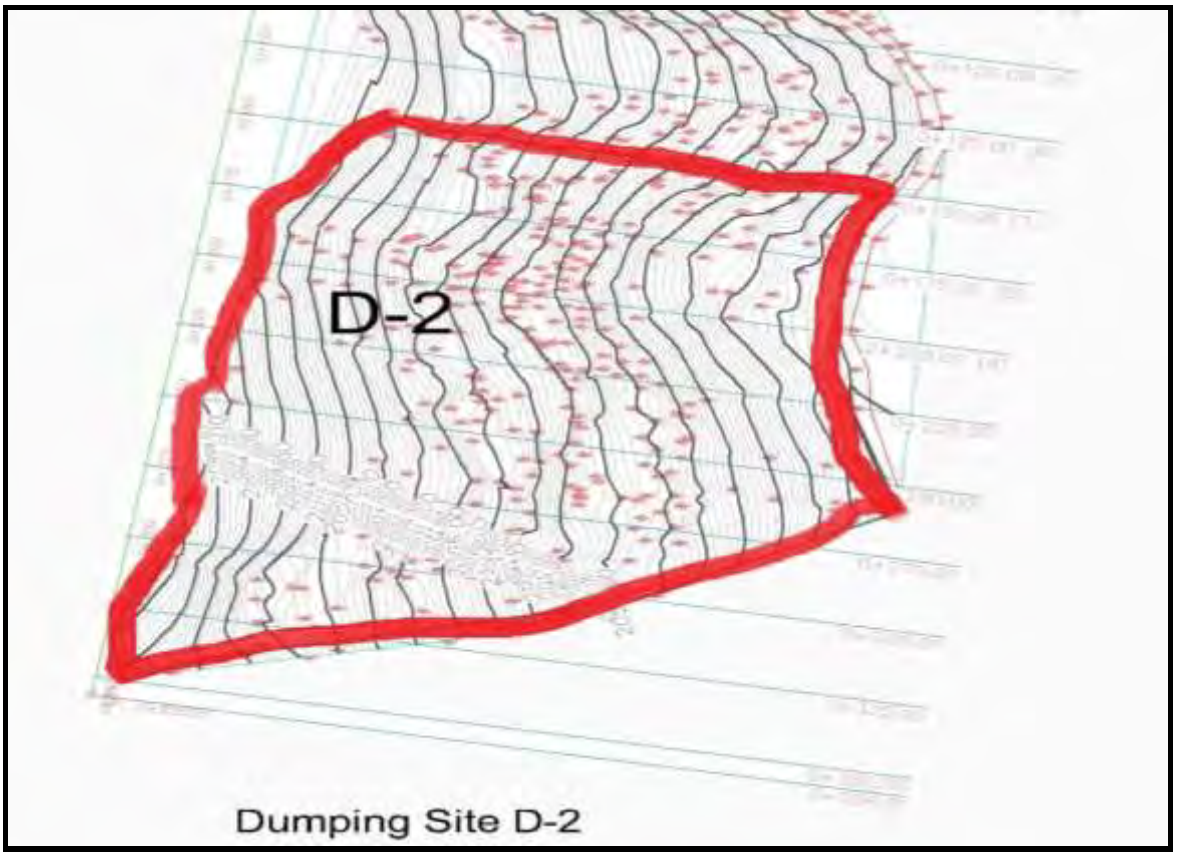
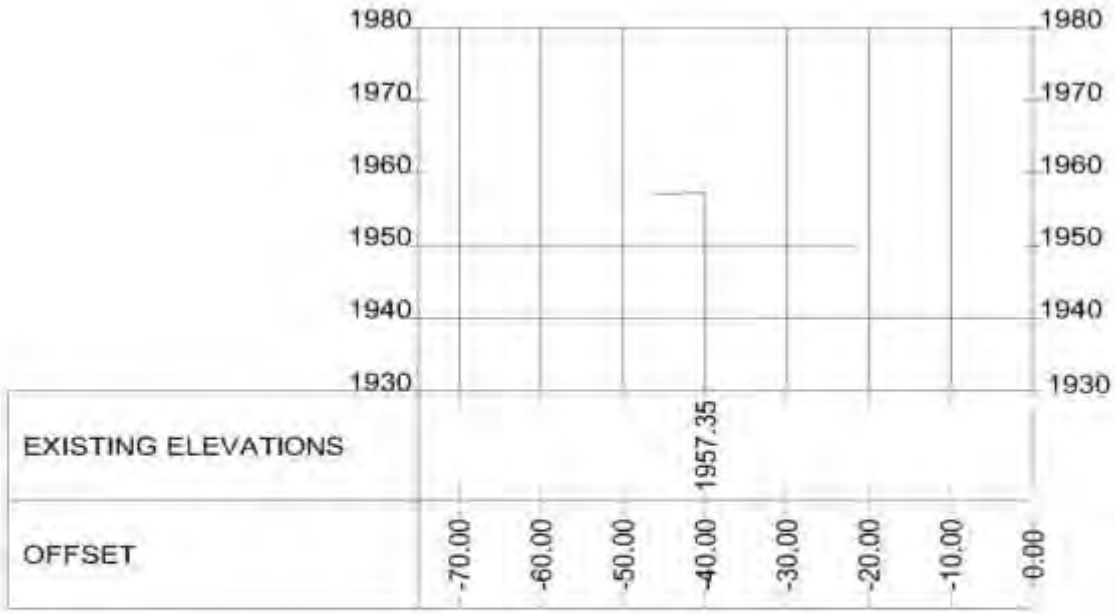


Figure-10.10 Topographical Contour Map of Dumping Site-2 (D-2)



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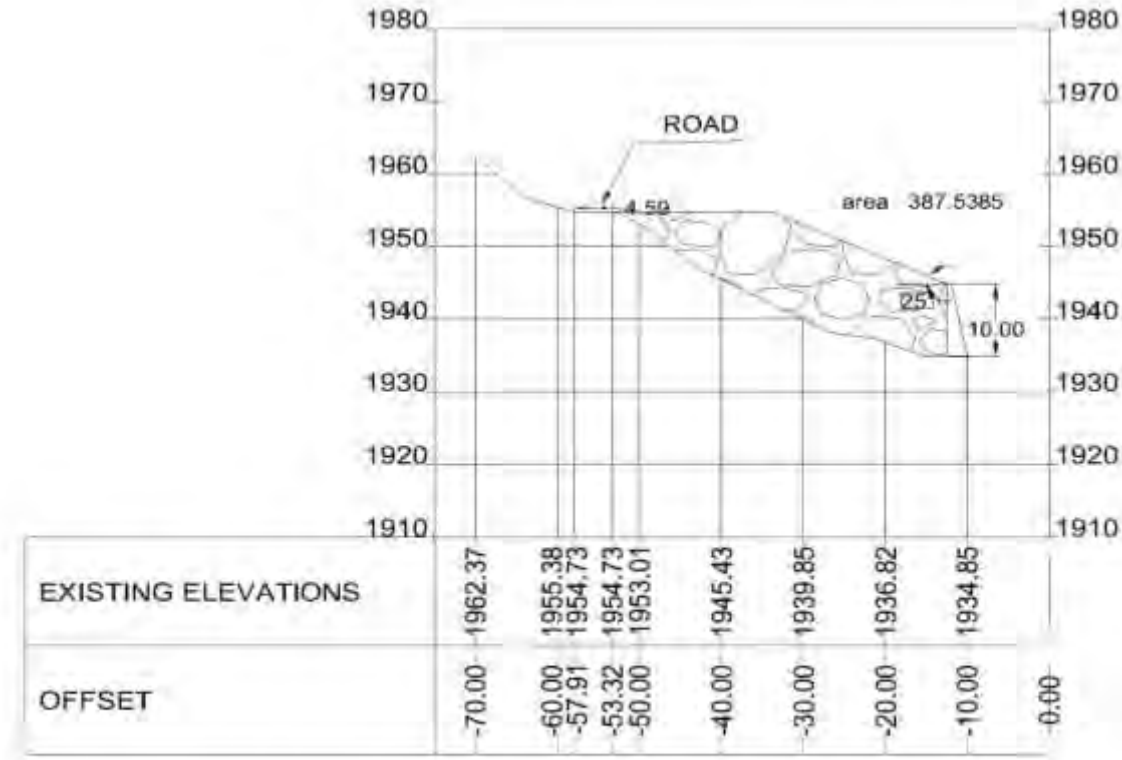

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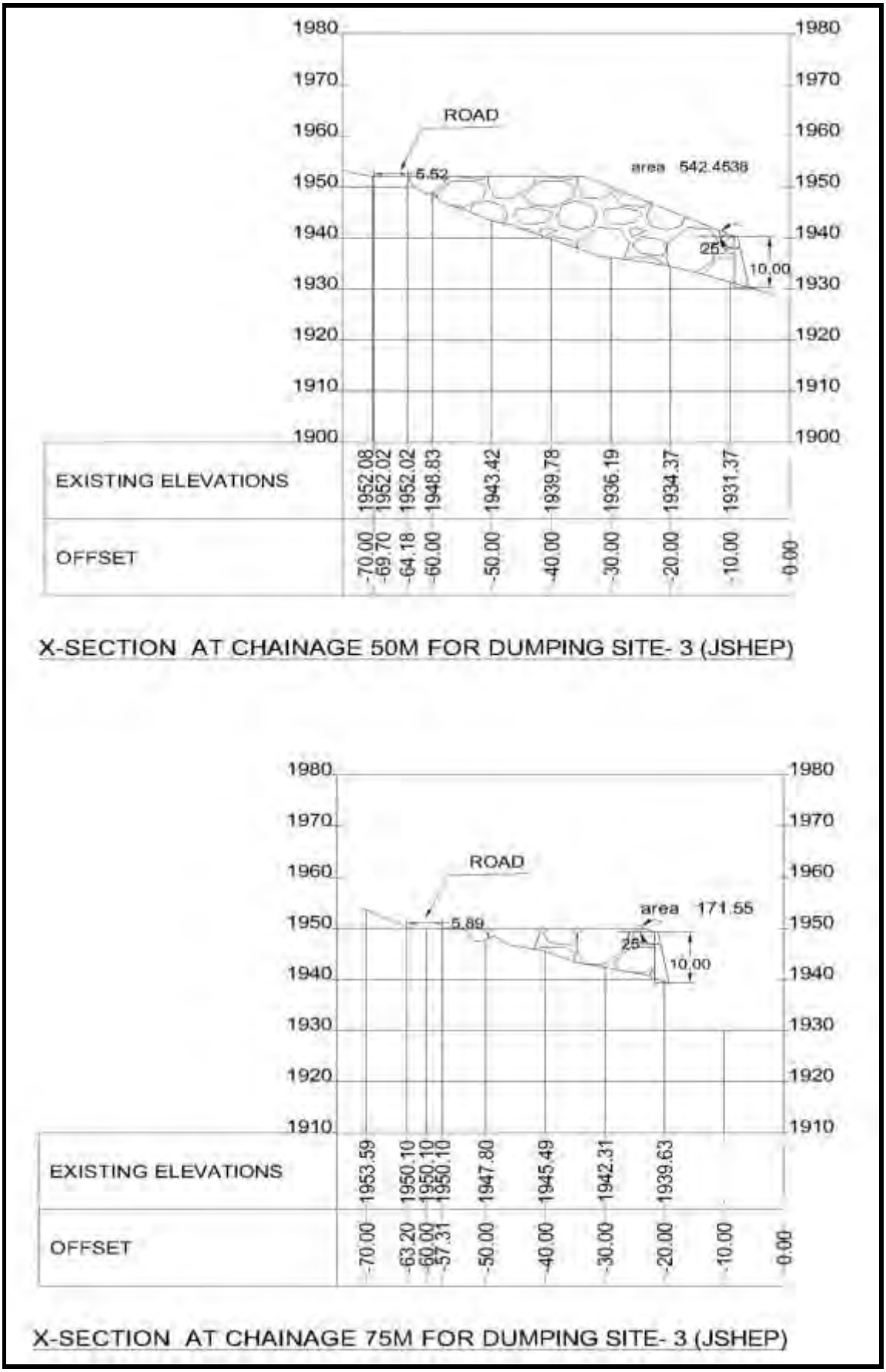


Figure-10.11 Cross-sections of Dumping site-3

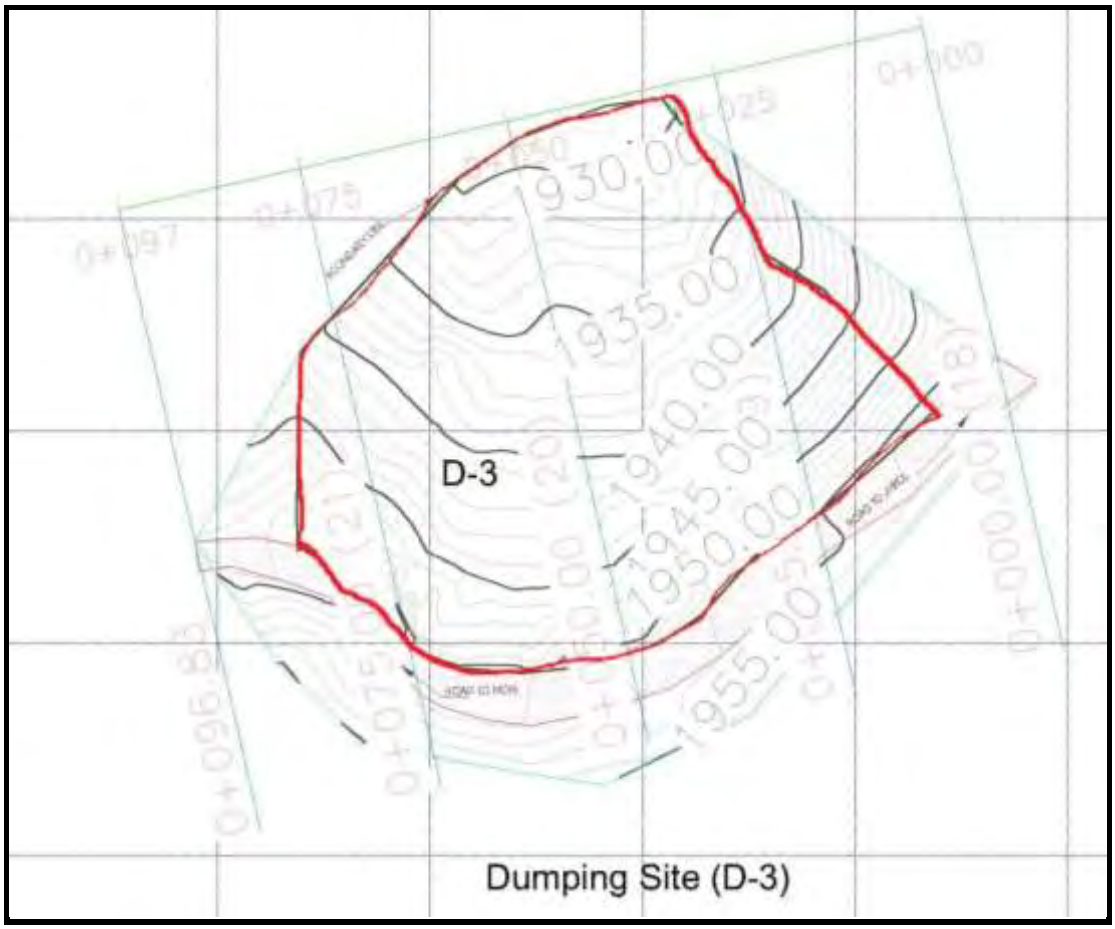
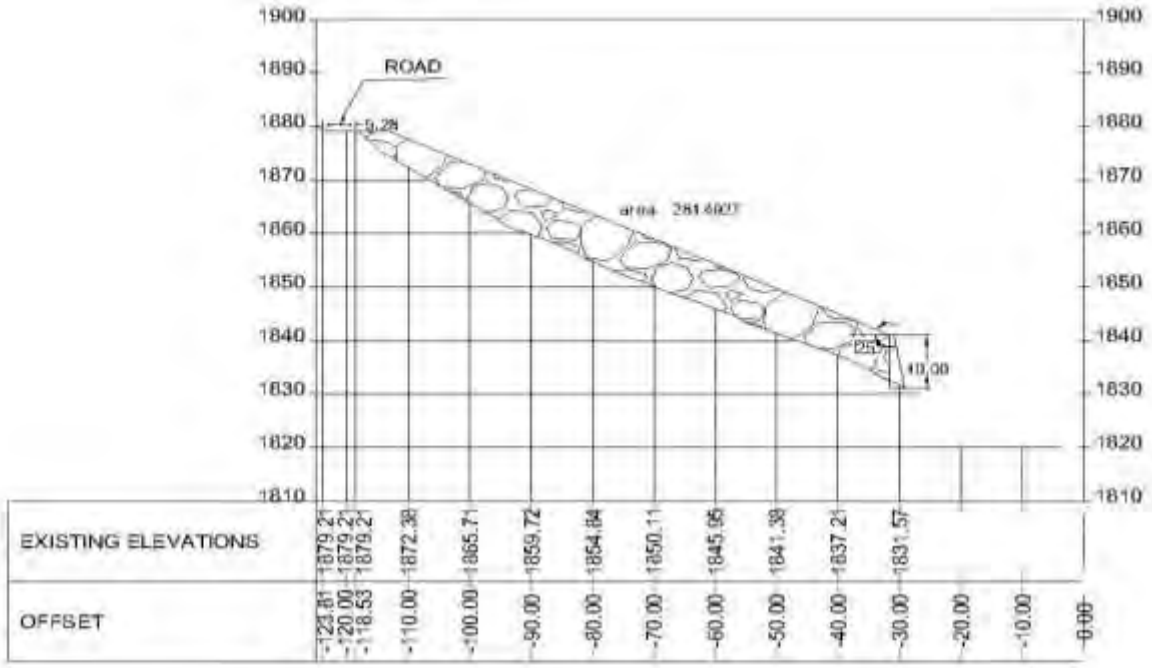
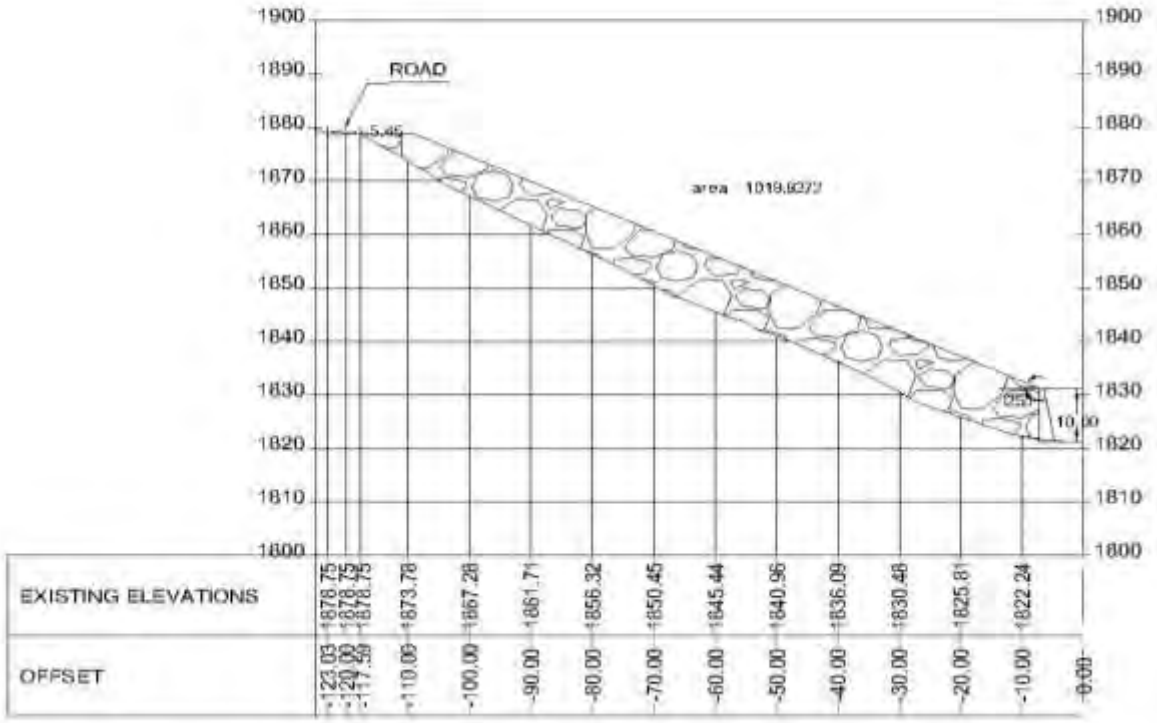


Figure-10.12: Topographical Contour Map of Dumping Site-3 (D-3)



SECTION AT CHAINAGE 00M FOR DUMPING SITE- 4 (JSHEP)



X-SECTION AT CHAINAGE 50M FOR DUMPING SITE- 4 (JSHEP)

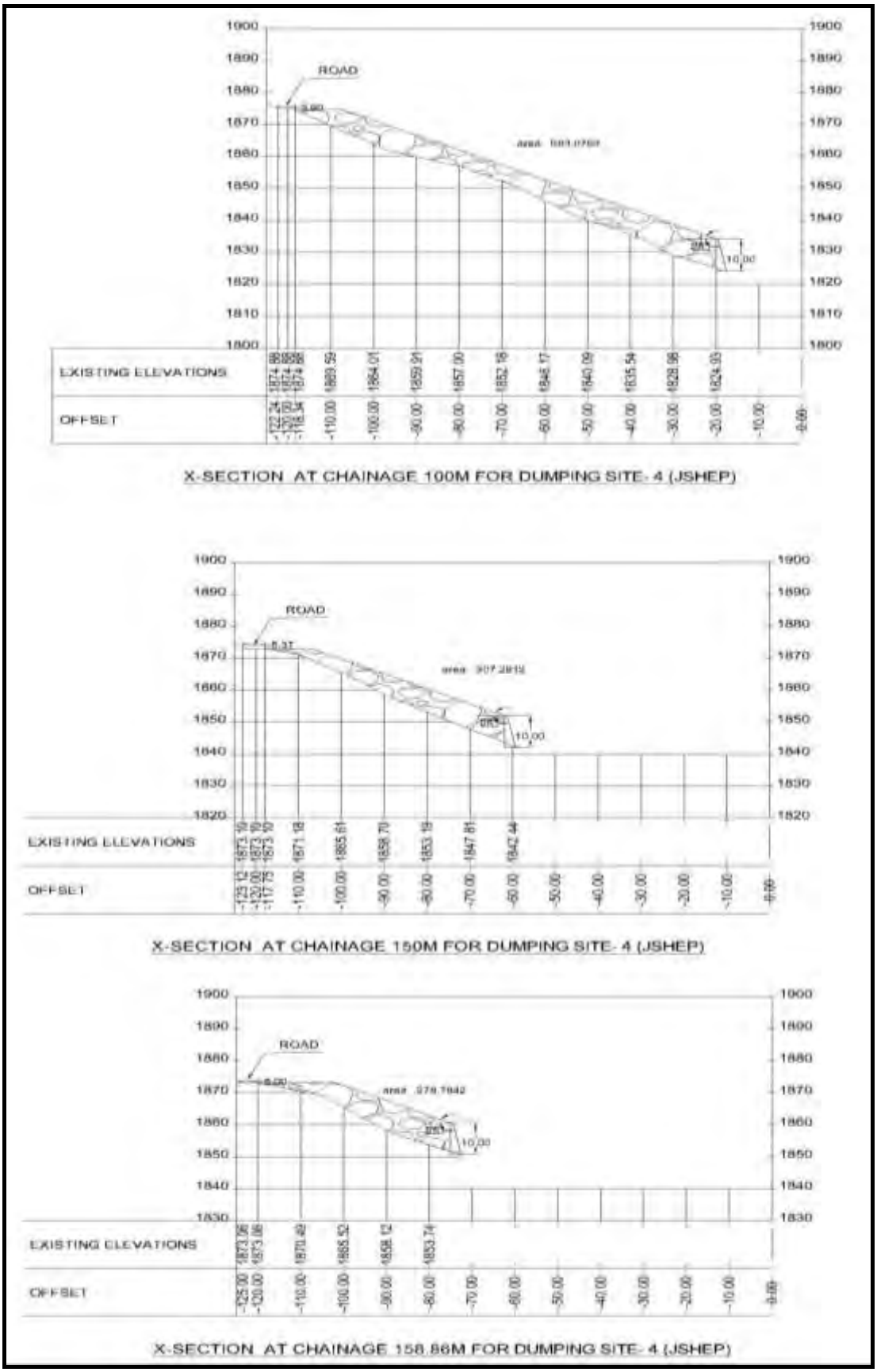


Figure-10.13 Cross-sections of Dumping site-4

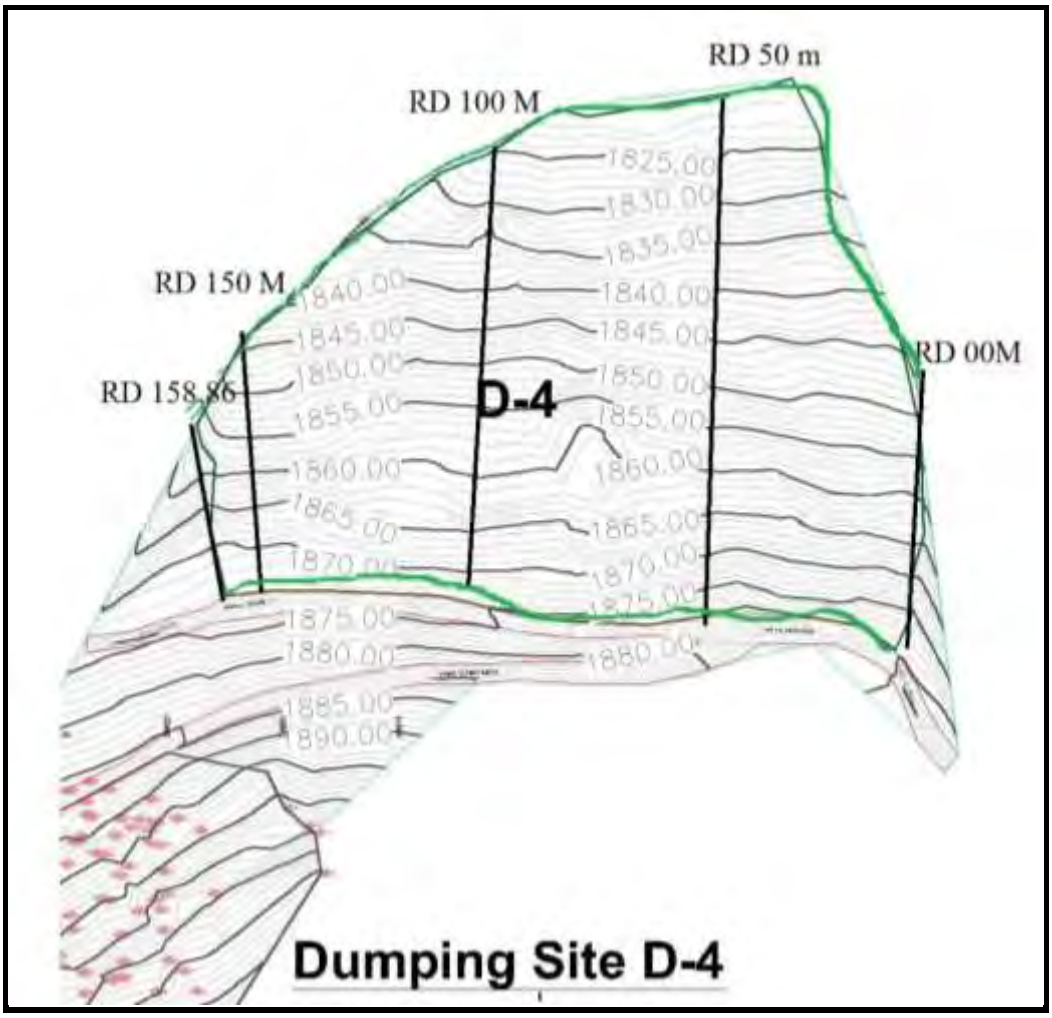
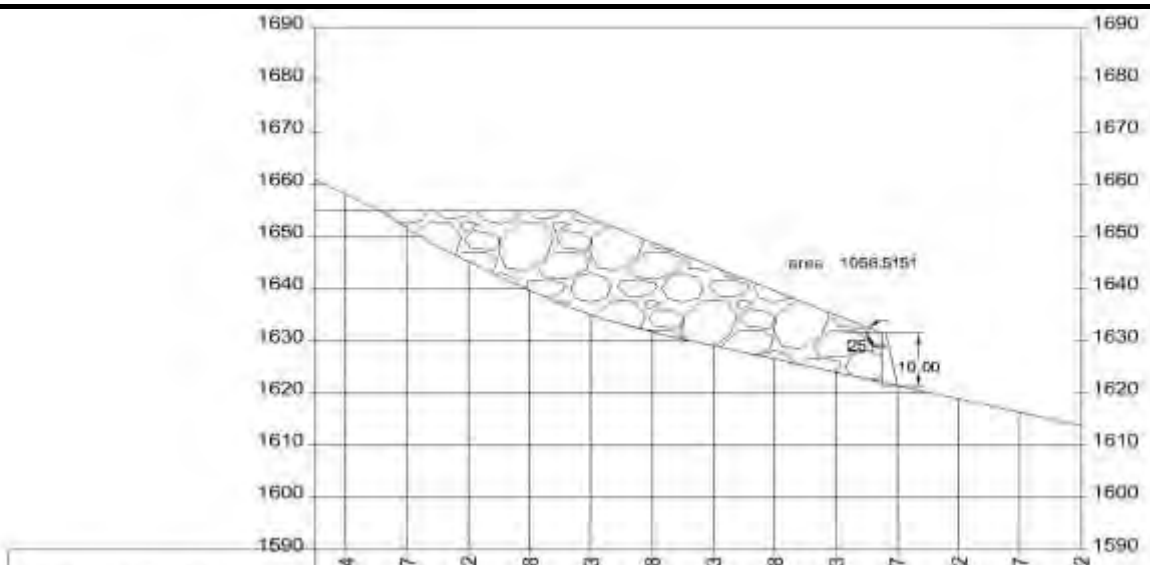
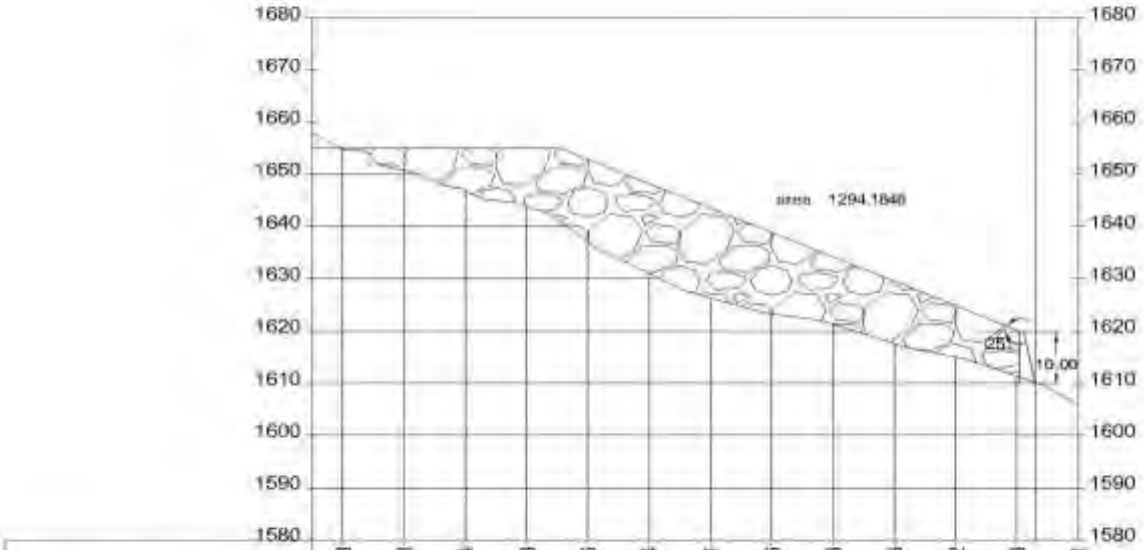


Figure-10.14: Topographical Contour Map of Dumping Site-4 (D-4)



EXISTING ELEVATIONS	1658.04	1651.67	1645.22	1639.68	1634.93	1631.68	1629.03	1626.48	1623.93	1621.37	1618.82	1616.27	1613.72
OFFSET	-120.00	-110.00	-100.00	-90.00	-80.00	-70.00	-60.00	-50.00	-40.00	-30.00	-20.00	-10.00	0.00

X-SECTION AT CHAINAGE 00M FOR DUMPING SITE- 5 (JSHEP)



EXISTING ELEVATIONS	1654.88	1650.83	1646.94	1643.78	1637.16	1631.04	1626.31	1623.26	1621.33	1617.63	1615.02	1611.33	1605.91
OFFSET	-120.00	-110.00	-100.00	-90.00	-80.00	-70.00	-60.00	-50.00	-40.00	-30.00	-20.00	-10.00	0.00

X-SECTION AT CHAINAGE 50M FOR DUMPING SITE- 5 (JSHEP)

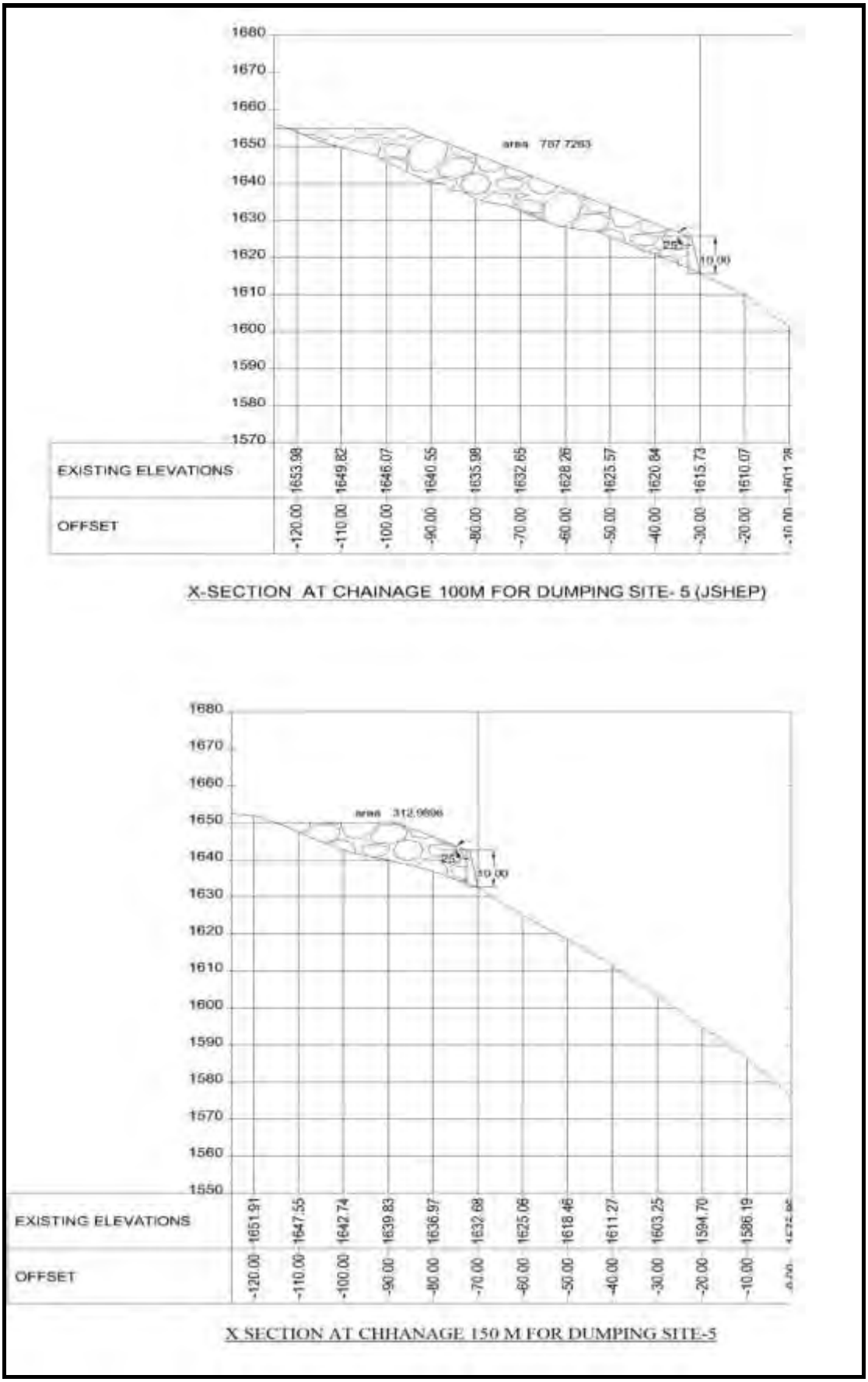


Figure-10.15 Cross-sections of Dumping site-5

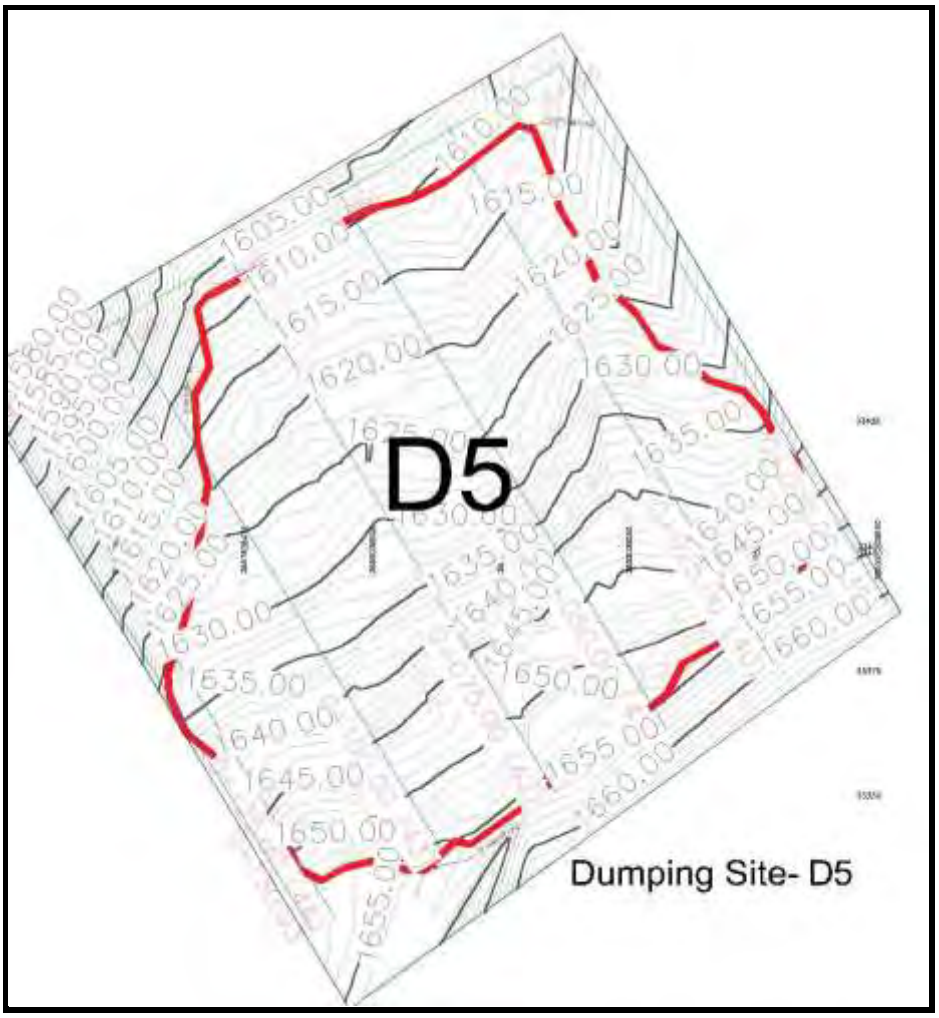
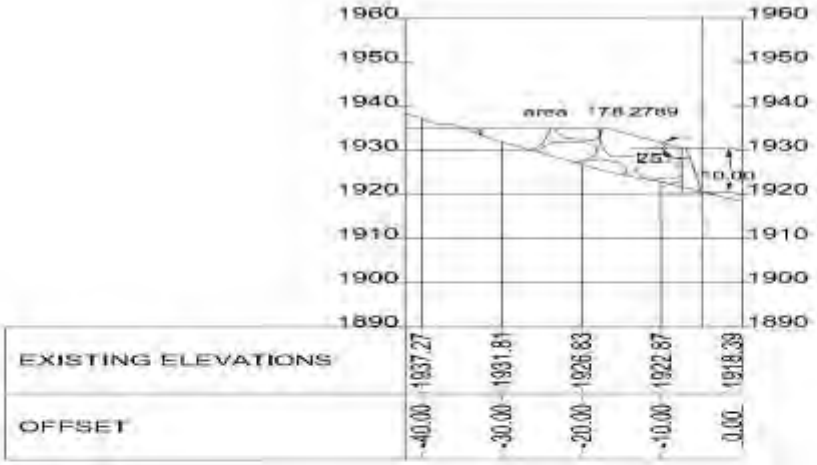
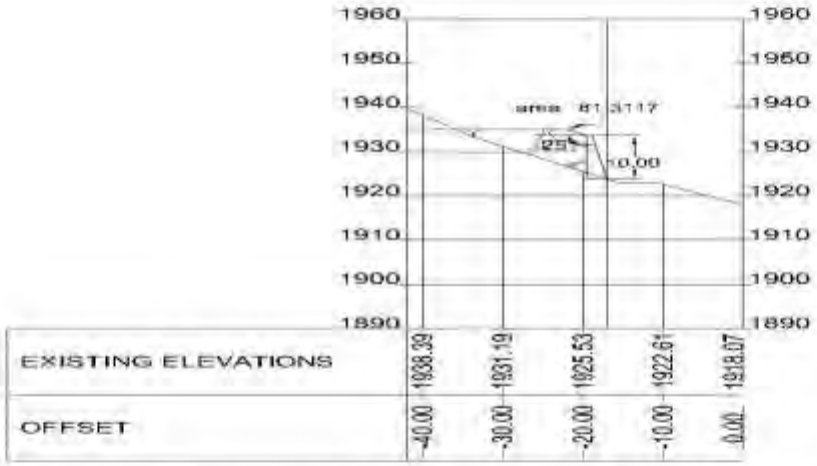


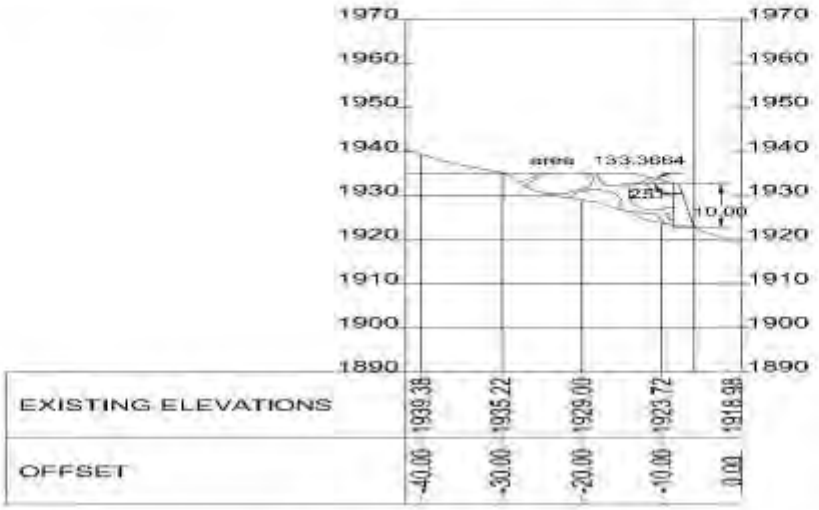
Figure-10.16: Topographical Contour Map of Dumping Site-5 (D-5)



X-SECTION AT CHAINAGE 05M FOR DUMPING SITE- 6 (JSHEP)



X-SECTION AT CHAINAGE 50M FOR DUMPING SITE- 6 (JSHEP)



X-SECTION AT CHAINAGE 100M FOR DUMPING SITE- 6 (JSHEP)

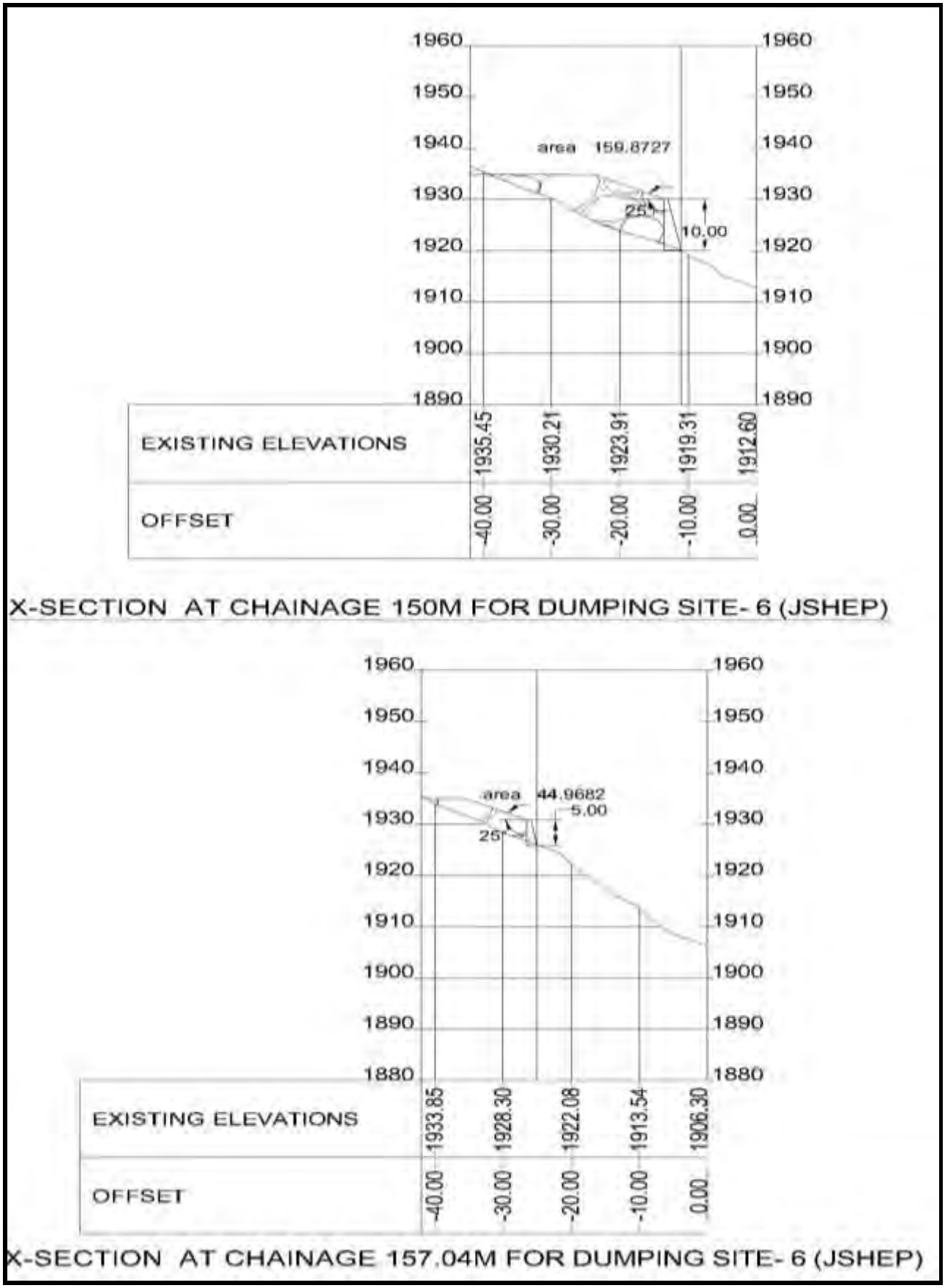


Figure-10.17 Cross-sections of Dumping site-6

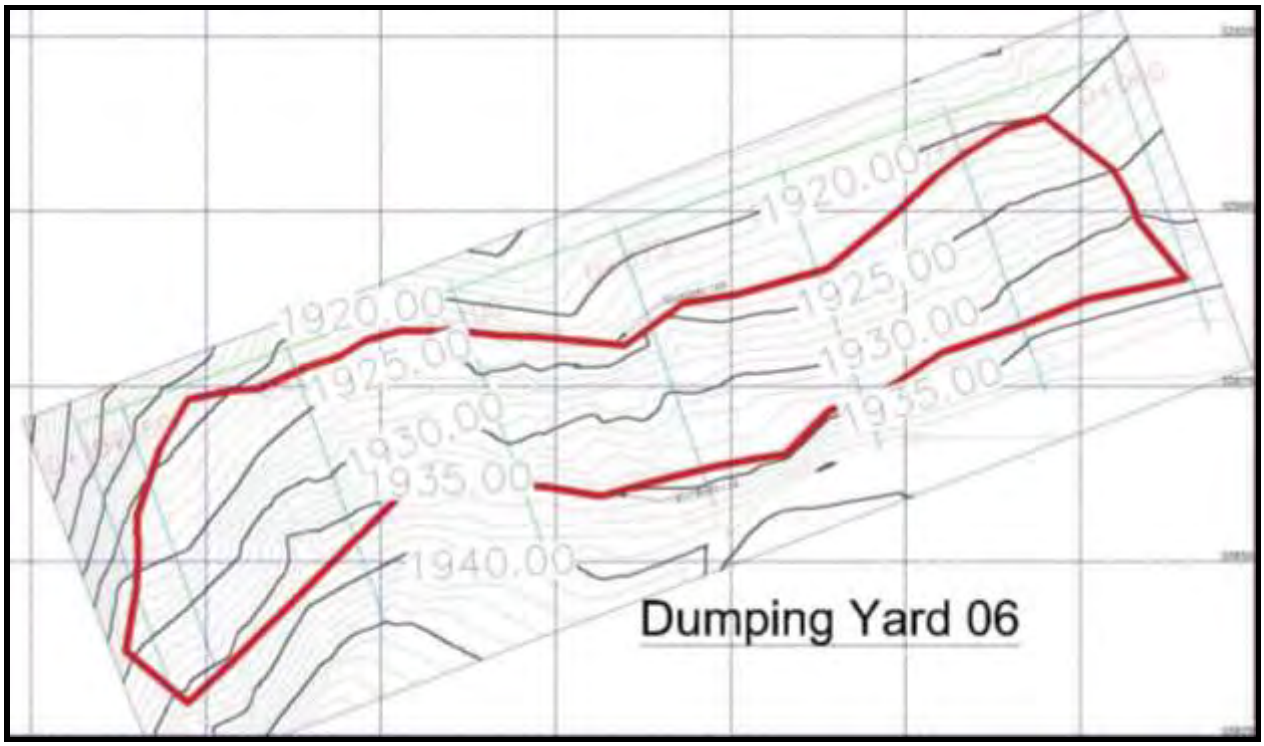


Figure-10.18: Topographical Contour Map of Dumping Site-6 (D-6)

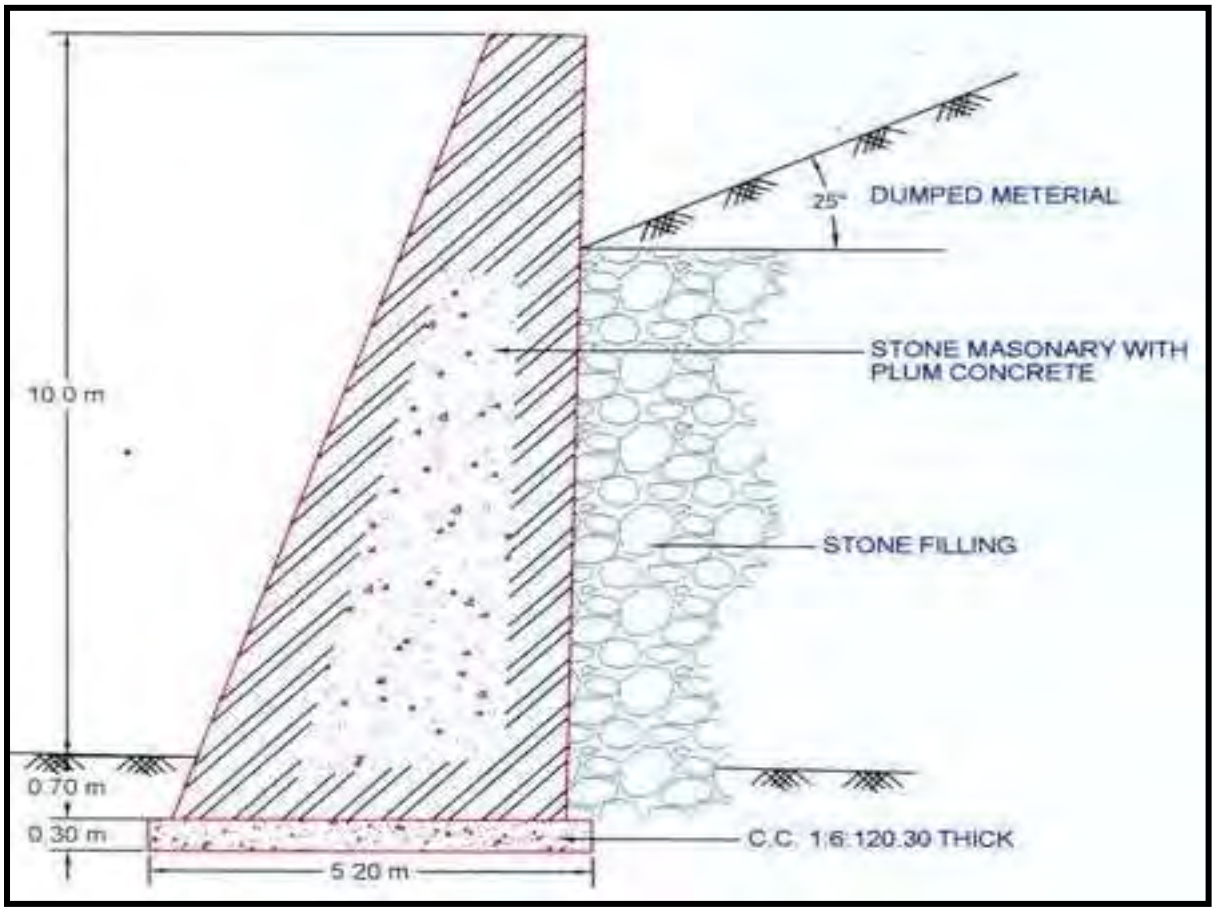


Figure-10.19: Cross section of Retaining Wall

10.8 RESTORATION AND LANDSCAPING OF CONSTRUCTION SITES

10.8.1 Quarrying Operations

It is envisaged that river bed material shall be utilized for the proposed project. Generally, these sites are located in the bank of the river from past experience it is seen that these area get filled up with silt and sand during subsequent monsoon season. Therefore, no restoration measures are necessary for these sites.

10.8.2 Landscaping and Restoration of Construction Areas

i. Area for landscaping

The working area of dam site, power house complex colony area have been selected for beautification of the project area after construction is over. The reservoir created due to the construction of dam may be a local point of tourist attraction. This could be used for sport fishing, so there is a need to construct benches for sitting, development of resting sheds and footpath. The beautification would be carried out by developing flowering beds for plantation ornamental plant and flower garden.

There would be sufficient open space in power house complex and colony area. Forested area in the power house complex would provide aesthetic view and add to natural seismic beauty. The beautification in the colony area would be carried out by development of flowering beds for plantation of ornamental plant, creepers, flower garden and a small park, construction of benches for sitting, resting sheds, walk way and fountain.

The construction of the project is expected to lead to certain changes in the area, as the construction of the proposed requires excavations. Also approach roads have been proposed to excess these construction areas. Although, no major alteration of the area is expected, still measures have been recommended for landscaping and restoration of construction sites is recommended.

The measures are given in the following paragraphs:

ii. Garden Complex :

A garden with local ornamentation plants and trees will be created near dam site in areas left after the construction activities. All plants will be properly labeled with scientific and/or common names.

iii. Creation of viewpoints :

Two view points will be created one near the power house and other at suitable place along the periphery of the reservoir.

A total amount of Rs.100.0 lakh can be earmarked for implementation of various works related to landscaping and restoration of construction sites.

A total provision of Rs.100.0 lakh has been earmarked for reclamation of construction sites landscaping and beautification.

10.9 ENVIRONMENTAL MANAGEMENT IN ROAD CONSTRUCTION

10.9.1 Impacts due to Construction of Roads

The construction of roads can lead to the following impacts:

- The topography of the project area has steep slope, which descends rapidly into narrow valleys. The conditions can give rise to erosion hazards due to net downhill movement of soil aggregates.
- Removal of trees on slopes and re-working of the slopes in the immediate vicinity of roads can encourage landslides, erosion gullies, etc. With the removal of vegetal cover, erosive action of water gets pronounced and accelerates the process of soil erosion and formation of deep gullies. Consequently, the hill faces are bared of soil vegetative cover and enormous quantities of soil and rock can move down the rivers, and in some cases, the road itself may get washed out.
- Construction of new roads increases the accessibility of a hitherto undisturbed areas resulting in greater human interferences and subsequent adverse impacts on the ecosystem.
- Increased air pollution during construction phase.

10.9.2 Management Measures

The approach roads will have to be constructed as a part of the access to the construction site. In a hilly environment, construction of roads sometime disturbs the scenic beauty of the area. In addition, landslides are often triggered due to road construction because of the loosening of rocks by water trickling from various streams.

Steeply sloping banks are liable to landslides, which can largely be controlled by provision of suitable 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 a steeply sloping terrain, 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. The cost required for implementation of various measures has already been incorporated in the overall budget earmarked for construction of roads.

In hilly terrain, road construction often generates 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 material finally flow down to the valleys and ultimately finds its 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 disposal operation is complete at the dump site, the dump yard should be contoured and vegetated.

The various aspects to be considered while making the project roads are briefly described in the following paragraphs.

I. Construction

- The clearing area shall be properly demarcated to save desirable trees and shrubs and to keep tree cutting to the minimum.
- Where erosion is likely to be a problem, clearing operations shall be so scheduled and performed that grading operations and permanent erosion control of features can follow immediately thereafter, if the project conditions permit; otherwise temporary erosion control measures shall be provided between successive construction stages. Under no circumstances, however, should very large surface area of erodible earth material be exposed at any one time by clearing and grubbing.
- The method of balanced cut and fill formation shall be adopted to avoid large difference in cut and fill quantities.
- The cut slopes shall be suitably protected by breast walls, provision of flat stable slopes, construction of catch water and intercepting drains, treatment of slopes and unstable areas above and underneath the road, etc.
- Where rock blasting is involved, controlled blasting techniques shall be adopted to avoid over-shattering of hill faces.

- Excavated material shall be dumped after duly dressing up the same in a suitable form at appropriate places where it cannot get easily washed away by rain, and such spoil deposits may be duly trapped or provided with some vegetative cover.

II. Drainage

- All artificial drains shall be linked with the existing natural drainage system.
- Surface drains shall have gentle slopes. Where falls in levels are to be negotiated, check dams with silting basins shall be constructed and that soil is not eroded and carried away by high velocity flows.
- Location and alignment of culverts should also be so chosen as to avoid severe erosion at outlets and siltation at inlets.

III. Grassing and Planting

- Tree felling for road construction/works should be kept bare minimum and strict control must be exercised in consultation with the Forest Department. Equivalent amount of new trees should be planted as integral part of the project within the available land and if necessary, separate additional land may be acquired for this purpose.
- Depending on the availability of land and other resources, afforestation of roadside land should be carried out to a sufficient distance on either side of the road.

An amount of Rs. 270.0 lakh has been earmarked for implementation of measures to mitigate adverse impacts due to construction of roads. The details are given in Table-10.30.

Table-10.30Details of expenditure for implementation of measures for management of Impacts due to construction of roads

S. No.	Item	Cost (Rs. lakh)
1.	Clearing and grubbing	40.0
2.	Provision of breast walls, construction of catch water and interceptor drains	150.0
3.	Provision of drainage system along roads	50.0
4.	Roadside plantation, Jute matting etc.	30.0
	Total	**270.0**

10.10 GREENBELT DEVELOPMENT PLAN

10.10.1 Need for Greenbelt Development Plan

Although the forest loss due to reservoir submergence and other project appurtenances have been compensated as a part of compensatory afforestation. However in addition to above, it is proposed to develop greenbelt around the perimeter of various project appurtenances, selected stretches along reservoir periphery, etc. The general consideration involved while developing the greenbelt are:

- Trees growing up to 10 m or above in height with perennial foliage should be planted around various appurtenances of the proposed project.
- Planting of trees should be undertaken in appropriate encircling rows around the project site.
- Generally fast growing trees should be planted
- Since, the tree trunk area is normally devoid of foliage upto a height of 3 m, it may be useful to have shrubbery in front of the trees so as to give coverage to this portion.

The details of Greenbelt development are given as below:

- Plantation will be done along the boundaries of project colony
- The inter-connecting/approach roads of various project components, within the colonies, working sites, etc. shall be covered with avenue plantation.
- Available space within the colonies will be brought under Greenbelt for plantation of fruit, ornamental and shade trees along with shrubs, climbers etc. Fruit trees can be protected with angle iron guards.
- During the initial phase of plantation and summer seasons, watering of plants can be done. In addition if required farm yard manure and agro-chemicals can also be applied.
- Along the road sides, 2 to 3 rows of ornamental trees can be planted.
- At the construction site and colony sites, the width of Greenbelt development can be increased depending on the quantum of land available.
- Thickness of greenbelt along reservoir periphery can be about 4 – 6 m.
- The saplings for Greenbelt can be processed from nearby nurseries of the Forest Department.

The cost of plantation per hectare is estimated at Rs.1,00,000. It is proposed to afforest about 30 ha of land as a part of Greenbelt Development Plan. The total cost works out to Rs.30.0 lakh. The plantation for this purpose will be carried out by Forest Department, state government of Uttarakhand.

10.11 CONTROL OF AIR POLLTION

10.11.1 Impacts on Air Quality

In a water resources project, air pollution occurs mainly during project construction phase. The major sources of air pollution during construction phase are:

- Fuel combustion in various construction equipment, e.g. crushers, drillers, rock bolters, diesel generating vehicles, etc.
- Fugitive emissions from crusher
- Impacts due to vehicular movement

i. Pollution due to fuel combustion in various equipment

The operation of various construction equipment requires of combustion of fuel. Normally, diesel is used in such equipment. The major pollutant, which gets emitted as a result of diesel combustion, is SO_2. The SPM emissions are minimal due to low ash content. Based on past experience in similar projects, SPM and SO_2 are not expected to increase significantly. Thus, in the proposed project, no significant impact on ambient air quality is expected as a result of operation of various construction equipment.

ii. Emissions from crusher

The operation of the crusher during the construction phase is likely to generate fugitive emissions, which can move even up to 1 km in predominant wind direction. During construction phase, one crusher of 60 tph capacity is likely to be commissioned. During crushing operations, fugitive emissions comprising of the suspended particulate will be generated. There could be marginal impacts to settlements close to the sites at which crusher is commissioned. However, based on past experience, adverse impacts on this account are not anticipated. However, during finalizing the project layout, it should be ensured that the labour camps, colonies, etc. are located on the leeward side and outside the impact zone (about 1.5 to 2 km) of the crushers.

iii. Impacts due to vehicular movement

During construction phase, there will be increased vehicular movement for transportation of various construction materials to the project site. Large quantity of

dust is likely to be entrained due to the movement of trucks and other heavy vehicles. However, such ground level emissions do not travel for long distances. Thus, no major adverse impacts are anticipated on this account.

An amount of Rs. 66.8 lakh is earmarked for air pollution control. The details are given in Table-10.32.

Table-10.32Cost estimate for implementation of air pollution control measures

S. No.	Activity	Cost (Rs. lakh)
1.	Repair of roads during construction phase	30.0
2.	3 Traffic managers @ Rs. 12,000 per month for 4 years including 10% escalation per year	20.1
3.	5 sweepers @ Rs. 6,000 per month for 4 years including 10% escalation per year	16.7
	Total	**66.8**

10.11.2 Implementing Agency

The above referred management measures shall be implemented by the Contractor involved in construction phase. The same shall be monitored on a regular basis by the project proponents.

10.12 MEASURES FOR NOISE CONTROL

10.12.1 Impacts on Noise Levels

In a water resource projects, the impacts on ambient noise levels are expected only during the project construction phase, due to earth moving machinery, etc. Likewise, noise due to quarrying, blasting, vehicular movement will have some adverse impacts on the ambient noise levels in the area.

Noise due to crushers

Based on literature review, noise generated by crushers is in the range of 79-80 dB(A) at a distance of 250 ft or 80 m from the crusher. Thus, noise level at a distance of 2 m from the crusher shall be of the order of 110 dB(A). The exposure to labour operating in such high noise areas shall be restricted upto 30 minutes on a daily basis. Alternatively the workers need to be provided with ear muffs or plugs, so as to attenuate the noise level near the crusher by atleast 15 dB(A). The exposure to noise level in such a scenario is limited upto 4 hours per day.

It is known that continuous exposure to noise levels above 90 dB(A) affects the hearing of the workers/operators and hence has to be avoided. Other physiological and psychological effects have also been reported in literature, but the effect on hearing acuity has been specially stressed. To prevent these effects, it has

been recommended by international specialist organizations that the exposure period of affected persons be limited as specified in Table-10.33.

Table-10.33Maximum Exposure Periods specified by OSHA

Maximum equivalent continuous noise level dB(A)	Unprotected exposure period per day for 8 hrs/day and 5 days/week
90	8
95	4
100	2
105	1
110	½
115	¼
120	No exposure permitted at or above this level

An amount of Rs. 11.0 lakh has been earmarked for implementation of various measures. The details are given in Table-10.34.

Table-10.34 Cost estimate for implementation of various noise control measures

S. No.	Activity	Cost (Rs. lakh)
1.	Construction of acoustic enclosure for DG sets	5.0
2.	Maintenance of DG sets	6.0
	Total	**11.0**

10.12.2 Implementing Agency

The above referred management measures shall be implemented by the Contractor involved in construction phase. The same shall be monitored on a regular basis by the project proponents.

10.13 WATER POLLUTION CONTROL

10.13.1 Impacts on Water Quality

a) Construction phase

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

- Sewage from labour camps/colonies
- Effluent from crushers

Sewage from labour camps

The project construction is likely to last for a period of 4 years. As mentioned earlier in Section-5.3, about 800 workers and 200 technical staff are likely to work during project construction phase. However, most of the employees/workers during

construction phase are likely to be employed from outside the project area. But, the construction phase, also leads to mushrooming of various allied activities to meet the demand of immigrant labour population in the project area. Therefore, the maximum increase in the population during construction phase is expected to be of the order of 3,200. The domestic water requirements of the immigrant population are expected to be of the order of 0.22 mld @ 70 lpcd. It is assumed that about 80% of the water supplied will be generated as sewage. Thus, the total quantum of sewage generated is expected to be of the order of 0.18 mld. The BOD load contributed by domestic sources will be about 90 kg/day. Even if, the sewage is discharged without treatment, in river supin then the flow required for dilution is of the order of 0.6 cumec. The minimum flow in river Supin is much higher, higher than this flow. Thus, no major adverse impacts are anticipated as a result of disposal of even untreated sewage from labour camp.

Normally, during project construction, the labour population is concentrated at 2 locations. Thus, the sewage/BOD loading would outfall into river Supin at 2 locations. The sewage is proposed to be treated before disposal to avoid deterioration of water quality of the receiving water body. It is proposed to treat the sewage in sewage treatment plants prior to disposal.

Effluent from crushers

During construction phase, at least two crusher each will be commissioned at the dam site and the power house site. The total capacity of the crusher is likely to be of the order of 120-150 tph. 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 tonne of material crushed. The effluent from the crusher would contain high suspended solids. The quantum of effluent generated is of the order of 12-15 m^3/hr or 0.0033 to 0.0042 m^3/sec. The natural slope in the area is such that, the effluent from the crushers will ultimately find its way in river supin through natural drains. However, no major adverse impacts, are anticipated due to small quantity of effluent and large volume water available for dilution in river Supin. However, turbidity levels in small tributaries, especially, in lean season may increase marginally. To minimise the impact, it is proposed to treat the effluent before disposal to ameliorate even the marginal impacts likely to accrue on this account.

b) Operation phase

The various aspects covered as a part of impact on water quality during project operation phase are:

- Effluent from project colony.
- Impacts on reservoir quality.

Effluent from project colony

During the operation phase, due to 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 sewage treatment plant and other infrastructural facilities, the problems of water pollution due to disposal of sewage are not anticipated. In the operation phase, about 50 families (total population of 250) will be residing in the area. About 0.04 mld of sewage will be generated. The total BOD loading will be of the order of 12 kg/day. It is proposed to provide biological treatment facilities including secondary treatment for the sewage so generated. Thus, no impacts are anticipated as a result of disposal of effluents from the project colony.

Impacts on reservoir water quality

The flooding of previously forest and agricultural land in the submergence area will increase the availability of nutrients resulting from decomposition of vegetative matter. In the proposed project a trench weir is proposed to be constructed. The submergence shall lie within the river bed only. Thus, no adverse impact on account of flooding of forest or agricultural land and subsequent degradation of organic material is anticipated.

The proposed project is envisaged as a runoff the river scheme, with significant diurnal variations in water level. In such a scenario, significant re-aeration from natural atmosphere takes place, which maintains Dissolved Oxygen in the water body. Thus, in the proposed project, no significant reduction in D.O. level in reservoir water is anticipated.

10.13.2Control of Water Pollution during Construction Phase

Sanitation facilities in labour camps

One community latrine shall be provided per 20 persons. The sewage from the community latrines shall be treated in septic tanks. For each 500 persons, one septic tank shall be provided. The effluent from these septic tanks shall be disposed

offthrough absorption trenches. As mentioned earlier, the drinking water facilities and waste disposal sites will be located away from each other.

The total construction time for the project is about 4 years. At peak construction phase, there will be an increase in population by 2000. To ensure that the sewage from the labour camps do not pollute the river water it has been estimated that about 160 community latrines and sewage treatment plants need to be constructed. The total cost required will be Rs.95.0 lakh (refer Table-10.35).

Table- 10.35Cost Estimate for sanitary facilities for labour camps

Unit	Rate (Rs./unit)	Number	Total cost(Rs. lakh)
Community latrines	50,000	160	80.0
Septic Tanks			15.0
Total			**95.0**

The cost required for commissioning of sanitation facilities in labour camps is already included in the Environmental Management of labour camps (Chapter-5).

Treatment of effluents from construction sites

The construction activities would require a crusher to crush large lumps of rocks into the requisite size for coarse as well as fine aggregates. During construction phase of the proposed project, 1 crusher is likely to operate at near dump/power house site. About 0.1 m^3 of water is required in the crusher to crush 1 tonne of aggregates. The effluent so generated will have high suspended solids i.e. of the order of 4,000 mg/l. The effluent needs to be treated before disposal. It is proposed to provide settling tanks for treatment of effluent from various crushers.

During tunneling work ground water flows into the tunnel along with construction water which is used for various works like drilling, shortcreting, etc. The effluent thus generated in the tunnel contains high suspended solids. It is proposed to construct a settling tank for removal of the suspended impurities. As mentioned above, settling tanks may be required for treatment of effluents from crushers. A provision of Rs.10.0 lakh has been earmarked for this purpose.

The sludge from the settling tanks which comprises mainly of grit and sand can be collected once in 15 days and disposed at the site designed for disposal of municipal solid wastes from the labour camps. The sludge after drying could also be used as cover material of the municipal wastes.

10.13.3 Control of Water Pollution during Operation Phase

In the project operation phase, a plant colony with 50 quarters is likely to be set up. It is recommended to provide a suitable Sewage Treatment Plant (STP) to treat the sewage generated from the colony. The cost required for construction of sewage STP in the project colony has already been covered in the budget earmarked for construction of the project colony. Hence, the cost for the same has not been included in the cost for implementing EMP.

The total cost required for implementing various measures for water pollution control is estimated as Rs. 10.0 lakh.

10.14 PUBLIC AWARENESS PROGRAMME

10.14.1 Objective of Awareness Programme

The main objective is to slow down the spread of HIV/AIDS infection through creation of awareness and aiming at behavioral change. The awareness programme has the following components:

- Ensuring Blood Safety
- Control of sexually transmitted diseases
- Public awareness and community support.

i.Ensuring blood safety

The training programe for the doctors and the blood bank staffs in consultation National or State AIDS Control Organization which includes the diagnosis of AIDS cases, mandatory licensing of blood banks and promotion of voluntary blood donation.

ii.Control of Sexually Transmitted Diseases

The main strategy for prevention and control of HIV/AIDS is to control of sexually transmitted diseases in the labour camp by the suggested measures of National or State AIDS Control Organization

iii.Public awareness and community support

A wide campaign using various media to spread awareness about the HIV/AIDS in the project area shall be taken up as Environmental management programme. This includes the use of radio, print media and folk theatre by the contractor and project proponent.

The counseling centre shall be set up in government Hospital at Tharali, which have the following objectives:

i. To provide pre-test, post-test, follow-up, general and family counselling to general public, workers and technical staff coming to the hospital.
ii. To provide support services and after care services for HIV positive clients.
iii. To disseminate information regarding STD, HIV/AIDS and measures suggested by National or State AIDS Control Organization.

iv. Measures for AIDS Control

The following measures are recommended for AIDS control :

- Prevention
- Anti retroviral treatment
- Primary health care

The above referred approaches for implementation in the project area are described briefly in the following paragraphs :

Prevention

- Awareness programme educating people to enable to make life saving need to be implemented.
- Intravenous drug users to be informed about the perils of sharing of needles.
- Use of various modes of media to educate people on AIDS, its nature, transmission and prevention.
- People in high risk groups to be refrained from donating blood, body organ, etc.
- All blood to be screened before transfusion.
- Strict sterilization practiced to be ensured in hospitals and dispensaries.
- Pre-sterlized or disposable syringes to be used as far as possible.

v. Anti-retroviral treatment

At present there is no vaccine or cure for treatment of HIV infection/AIDS. However, drugs that suppress the HIV infection rather than its complications can be used for prolonging the life of terminally ill patients.

vi. Primary health care

AIDS touches all aspects of primary health care, including mother and child, family planning and education. Thus, it is recommended that the AIDS control programme integrates various related issues into country‟s primary health care system. The AIDS control and awareness programs, developed by National Aids Control Society (NACO) need to be strictly implemented in the project area as well. In addition to

primary health care, it is also recommended that the workers should be made aware not to hurt the traditional cultural and regions customs and practices.

An amount of Rs. 50.0 lakh has been earmarked for public awareness programme among the workers and technical labours about the HIV/AIDS in the project area.

10.15 ASSESSMENT OF ENVIRONMENTAL FLOWS

10.15.1 Environment Flows

Environmental Flows (EF) are the flows of water in rivers that are necessary to maintain aquatic ecosystems. In other words, a flow regime in the river, capable of sustaining a complex set of aquatic habitats and ecosystem processes are referred to as environmental flow. The EF is designed to maintain or upgrade a river in desired, agreed or pre-determined status referred to as an “environmental management class” ranging from A (Negligible modification from natural condition) to F (Critically modified ecosystem).

The process for determining or estimating EF is termed as Environmental Flow Assessment (EFA) and there are more than 200 techniques suggested in literature for the same. EFA techniques determine the volume and temporal distribution of EF. The difficulty of estimation EF values lies in the lack of understanding the relationship between river flow and the multiple components of river ecology and the scarcity of data concerned to these relationships. For example, required river flow conditions are available only for a target fish species in a given river basin and this information is very specific and not applicable under different circumstances. Different types of flows with different amount of discharge are spread through dry and wet seasons. This fact plays a very important issue in the interaction of river flow with the surrounded ecosystem. According, to flow, regime of a river can be divided into:

- ***Low flows*** (Base flow): this occurs through out the year and is more in the wet season than in the dry season and defines if river flow through out the year. The delayed flow that reaches a stream essentially as groundwater flow is also called base flow. In the annual hydrograph of a perennial stream the base flow is easily recognized as the slowly decreasing flow of the stream in rainless periods.
- ***Small floods***: they are small in size, (as compared with high floods) a few number per year and they have a small period of time (days or weeks)

- ***Large floods***: they are infrequently and the timing is very short (hours or days) (Refer Figure-10.20).

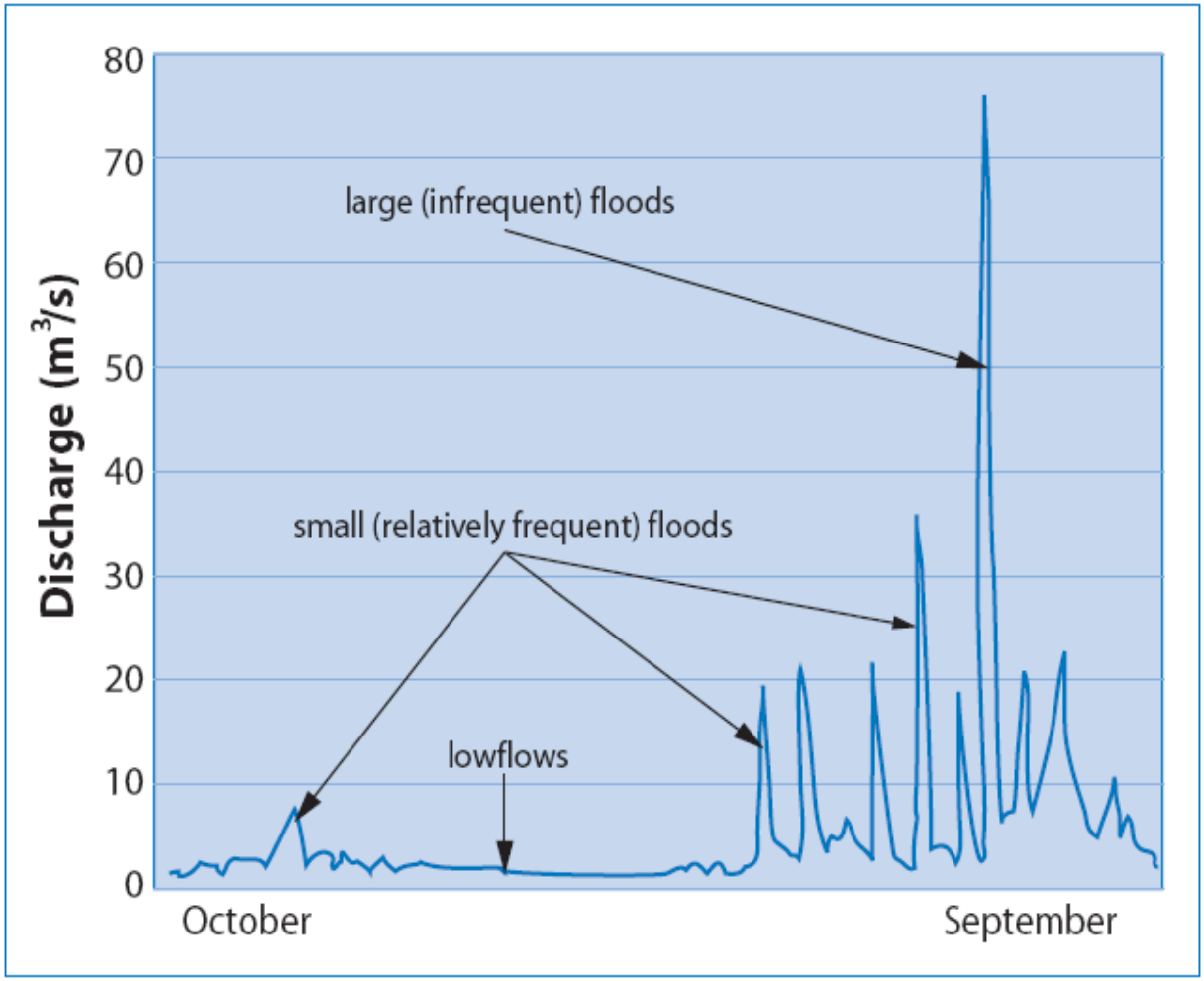


Figure-10.20: Typical Annual Hydrograph of daily flows in a river

Identification of these flow components and the understanding the ecosystem consequences of their loss or modification are one of the main objectives of Environmental Flow Assessment (EFA).

Further, flows in most of the river are being modified through impoundments such as dams and weirs, abstractions for agriculture, industrial and domestic supply, hydropower, drainage return flows and through structures for flood control. These interventions have had significant impacts, reducing the total flow of many rivers and affecting both; the seasonality of flows and the size and frequency of floods. In many cases, these modifications have adversely affected the river ecosystem, including the people living near the river banks. The river ecosystem includes both the

channel and the floodplain. Regulations of river flows reduce or eliminate the linkage between the river and its floodplain margins.

With this background, it is important to recognize the importance of different flows in the river ecosystem. According to Brown (2003), flow in rivers is generally needed for various purposes such as to:

- maintain river flow conditions like flow velocity, water depth and acceptable turbidity levels, making it possible for the river purify itself (dilution of effluents and waste water).
- maintain low flow which support livelihood of the people (people who use the river for drinking, washing, bathing, fishing, recreation and tourism, etc).
- sustain both terrestrial and aquatic ecosystem. For example, low flow provides water to wild animals, maintain soil-moisture in the banks, etc. Small floods stimulate spawning in fish and allow passage for migratory fish and germination of seeds on river banks. Large floods deposits nutrients on the banks and distribute seeds.
- recharge groundwater and aquifers by large floods, which maintain the perennial nature of rivers acting as source of water during dry season. Further, large floods flush sediments and natural obstructions in the river course and maintain a sufficient deep channel for navigation.
- preserve estuarine conditions: low flows maintain the required salt-freshwater balance and prevented the incursion of salinity. Large floods maintain links with the by scouring estuaries.

In general, flows enabling the river to play its role in the cultural and spiritual live of the people. This is very important in Indian context as some religious festivals reduce the quality and quantity of flow.

10.15.2 Environmental Flow Assessment Techniques

In a recent review of international environmental flows assessment, Tharme (2003) recorded 207 different methods within 44 countries. Broadly, these can be divided into four categories:

- **Hydrological Index Methods** (or rule of thumb, threshold, or standard setting, desktop methods, or flow duration curve methods)
- **Habitat Discharge Methods** (hydraulic rating or habitant rating methods)
- **Habitat Simulation Methods**
- **Holistic Approaches**

In the present study, a combination of Building block methodology and Hydraulic Rating Method has been adopted.

10.15.3Environmental Flows

The diversion of water for hydropower generation in the proposed hydroelectric projects will lead to drying or reduction of flow river stretch of upto tailrace disposal. The effect will be more pronounced in the lean season. There are no major users of water in the intervening stretches, as river flows through a gorge and requires pumping for use at point of consumption. As a result, there are no major users of water of river Supin in the intervening stretch. Thus, no major adverse impacts are anticipated on downstream water users. However, there will be significant adverse impacts on riverine ecology, which needs to be ameliorated through the release of Environmental Flows.

The requirements of Environmental flows considered are:

- Irrigation water requirements
- Drinking water requirements
- Flow required to maintain water quality
- Flow required to sustain riverine ecology including fisheries

Irrigation and drinking water requirements

The proposed project is located in an area with low population density with no major sources of pollution. The major source of water for meeting irrigation and drinking requirements in the project area are rivers or nallahs which flow adjacent to the habitations. The water is conveyed to the point of consumption. Thus, no water is abstracted from river Supin or its tributaries.

Flow required maintaining water quality

There are no sources of pollution in the area; hence, no flows are required to maintain water quality.

Flow required sustaining riverine ecology including fisheries

The river Supin and its tributaries are typically hilly river, which has a fast water current with rich dissolved Oxygen.

The project is located in an area with elevation close to 2000m above, with steep slopes. Such elevation and steep slopes, riverine fisheries are not observed. The riverine fisheries is observed in downstream of the project site, after the confluence of river Supin and Tons. Amongst the migratory fish species, Snow Trout is observed in this stretch. However, river Tons is used for migration and river Supin is not

observed. As a part of fisheries Management Plan, it is recommended to stock the reservoir and the river stretch upstream and downstream of barrage site. The tail race tunnel with discharge water after hydropower generation at a distance of 7 km downstream of diversion site. The river will remains dry for a stretch of 7 km. To sustain, the stocked fisheries, downstream of Barrage site, it is proposed to release Environmental Flows.

Criteria for Sustenance of Snow Trout

The minimum depth requirements are for Snow Trout are given in Table-10.36.

Table-10.36Minimum Depth Requirements

S.No.	Season	Depth Requirement (m) for Trout
1.	Monsoon season	1.0
2.	Lean Season	0.4
3.	Non-monsoon Non-lean season	0.65 – 0.70

Source: Literature Review

Snow Trout has been considered, as the target species, which mean that if environmental flow is sufficient for their sustenance, other riverine fishes would also sustain.

Reduction in water depth and flow width should not be more than 50% of pre-project levels. Pre-project water depth and water width are assessed by reviewing the results of 100% release scenario.

Season I: This season is considered as high flow season influenced by monsoon. It covers the months from June to September. The minimum flow during this period is assumed as 30% of average flow (10 daily or monthly).

Season II: This season is considered as average flow period. It covers the month of October to November in which the proposed minimum flow is taken as 25% of average flow. This period is a transitional period between the wet and dry period.

Season III: This season is considered as low or lean or dry flow season. It covers the months from December to March. The proposed minimum flow is taken as 20% of average flow during this period.

Season IV: This season is considered as average flow period and is same as that of season II. It covers the month of April and May in which the proposed minimum flow is taken as 25% of average flow. This period is a transitional period between the dry and wet period.

HYDROLOGICAL MODELLING

Methodology

1-D mathematical model has been developed for assessing the changes in hydraulic parameters corresponding to design flood. The model is based on the solution of St. Venant‟s equation of continuity and momentum. US Army Corps of Engineers, Hydrologic Engineering Centre software HECRAS, which is in public domain, has been used to carry out the studies.

The HEC-RAS system contains three one-dimensional hydraulic components for:

- Steady flow surface profile computations
- Quasi-unsteady flow simulation
- Unsteady flow simulation

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The L-section of the river stretch in the study area shall be developed based on available data. The available data on river cross-sections were used.

Out of the full year flow series (90% Dependability), three average values shall be calculated:

- Average of four leanest months
- Average of four monsoon months
- Average of remaining four months(NMNL-1 & NMNL-2)

Fish assemblages often include a range of species and reflect the integrated effects of environmental changes. Their presence is used to infer the presence of other aquatic organisms, since the adult fish occupy the top of the food chain in most aquatic systems. They also pass through most trophic levels above the primary producer stage during their development from larvae to adults. Fish can thus be regarded as reflecting the integrated environmental health of a river (Karr et al., 1986). Fish species in river can guide to prepare specification of the flows necessary to meet their needs, and be useful in the monitoring and management of those flows. It is often surmised that if management of flows for fish maintenance is successful, then flow requirements for aquatic invertebrates will also be satisfied. This is because of the larger scale of fish habitat.

Boundary Conditions

Steady Flow Simulation has been done with normal depth at the downstream section as boundary condition.

Manning's 'N' Value

Bed of main channel at the study area is granular sand and that of flood plains are consisted of silt mixed with sand. Value of Manning"s „n" has been adopted as 0.04.

Model Studies

Steady state simulation runs have been carried out with the 1-D mathematical model with Environmental flows proposed to be released in various seasons. The results of steady simulation runs for average flow in various seasons at various cross sections for 90% dependable year are given in Table-10.37.

Table-10.37Depth of flow for the proposed Minimum Flow on the basis of average flow during 90% dependable year for JakholSankari HEP

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
At axis	M(100%)	11.7	1956.1	1957.2	1.1	5.05	9.43
	M(30%)	3.51	1956.1	1956.78	0.68	1.9	5.62
	M(29%)	3.39	1956.1	1956.77	0.67	1.84	5.53
	M(28%)	3.28	1956.1	1956.76	0.66	1.8	5.47
	M(27%)	3.16	1956.1	1956.75	0.65	1.75	5.38
	M(26%)	3.04	1956.1	1956.74	0.64	1.69	5.3
	M(25%)	2.92	1956.1	1956.73	0.63	1.64	5.22
	M(24%)	2.81	1956.1	1956.72	0.62	1.59	5.13
	M(23%)	2.69	1956.1	1956.71	0.61	1.55	5.07
	M(22%)	2.57	1956.1	1956.7	0.6	1.48	4.96
	M(21%)	2.46	1956.1	1956.69	0.59	1.43	4.87
	M(20%)	2.34	1956.1	1956.68	0.58	1.38	4.78
	L(100%)	3.15	1956.1	1956.75	0.65	1.76	5.4
	L(20%)	0.63	1956.1	1956.44	0.34	0.48	2.83
	L(19%)	0.6	1956.1	1956.43	0.33	0.46	2.76
	L(18%)	0.57	1956.1	1956.43	0.33	0.45	2.72
	L(17%)	0.54	1956.1	1956.42	0.32	0.43	2.66
	L(16%)	0.5	1956.1	1956.41	0.31	0.4	2.58
	L(15%)	0.47	1956.1	1956.41	0.31	0.38	2.52
	NMNL1(100%)	7.5	1956.1	1957.02	0.92	3.52	7.65
	NMNL1(25%)	1.87	1956.1	1956.63	0.53	1.14	4.36
	NMNL1(24%)	1.8	1956.1	1956.62	0.52	1.12	4.3
	NMNL1(23%)	1.72	1956.1	1956.61	0.51	1.07	4.22
	NMNL1(22%)	1.65	1956.1	1956.6	0.5	1.04	4.16
	NMNL1(21%)	1.57	1956.1	1956.59	0.49	1	4.08
	NMNL1(20%)	1.5	1956.1	1956.58	0.48	0.97	4.01
	NMNL2(100%)	5.38	1956.1	1956.9	0.8	2.67	6.66
	NMNL2(25%)	1.34	1956.1	1956.56	0.46	0.88	3.83
	NMNL2(24%)	1.29	1956.1	1956.56	0.46	0.86	3.77
	NMNL2(23%)	1.24	1956.1	1956.55	0.45	0.83	3.71
	NMNL2(22%)	1.18	1956.1	1956.54	0.44	0.79	3.63

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	NMNL2(21%)	1.13	1956.1	1956.53	0.43	0.77	3.56
	NMNL2(20%)	1.08	1956.1	1956.53	0.43	0.75	3.52
250 m d/s of axis	M(100%)	11.7	1933.82	1934.79	0.97	5.47	12.02
	M(30%)	3.51	1933.82	1934.42	0.6	2.02	6.84
	M(29%)	3.39	1933.82	1934.41	0.59	1.97	6.75
	M(28%)	3.28	1933.82	1934.4	0.58	1.92	6.65
	M(27%)	3.16	1933.82	1934.39	0.57	1.87	6.57
	M(26%)	3.04	1933.82	1934.39	0.57	1.82	6.48
	M(25%)	2.92	1933.82	1934.38	0.56	1.75	6.36
	M(24%)	2.81	1933.82	1934.37	0.55	1.69	6.26
	M(23%)	2.69	1933.82	1934.36	0.54	1.65	6.17
	M(22%)	2.57	1933.82	1934.35	0.53	1.58	6.05
	M(21%)	2.46	1933.82	1934.34	0.52	1.53	5.95
	M(20%)	2.34	1933.82	1934.33	0.51	1.47	5.84
	L(100%)	3.15	1933.82	1934.39	0.57	1.86	6.55
	L(20%)	0.63	1933.82	1934.12	0.3	0.52	3.45
	L(19%)	0.6	1933.82	1934.12	0.3	0.49	3.38
	L(18%)	0.57	1933.82	1934.11	0.29	0.47	3.3
	L(17%)	0.54	1933.82	1934.1	0.28	0.45	3.24
	L(16%)	0.5	1933.82	1934.1	0.28	0.43	3.15
	L(15%)	0.47	1933.82	1934.09	0.27	0.4	3.06
	NMNL1(100%)	7.5	1933.82	1934.63	0.81	3.78	9.48
	NMNL1(25%)	1.87	1933.82	1934.29	0.47	1.23	5.33
	NMNL1(24%)	1.8	1933.82	1934.28	0.46	1.19	5.25
	NMNL1(23%)	1.72	1933.82	1934.27	0.45	1.15	5.15
	NMNL1(22%)	1.65	1933.82	1934.26	0.44	1.11	5.06
	NMNL1(21%)	1.57	1933.82	1934.26	0.44	1.08	4.99
	NMNL1(20%)	1.5	1933.82	1934.25	0.43	1.03	4.88
	NMNL2(100%)	5.38	1933.82	1934.53	0.71	2.87	8.21
	NMNL2(25%)	1.34	1933.82	1934.23	0.41	0.94	4.67
	NMNL2(24%)	1.29	1933.82	1934.22	0.4	0.91	4.59
	NMNL2(23%)	1.24	1933.82	1934.22	0.4	0.88	4.52
	NMNL2(22%)	1.18	1933.82	1934.21	0.39	0.84	4.42
	NMNL2(21%)	1.13	1933.82	1934.2	0.38	0.82	4.36
	NMNL2(20%)	1.08	1933.82	1934.19	0.37	0.79	4.28
500 m d/s of axis	M(100%)	11.7	1917.27	1917.93	0.66	5.85	14.6
	M(30%)	3.51	1917.27	1917.65	0.38	2.32	10.26
	M(29%)	3.39	1917.27	1917.65	0.38	2.28	10.2
	M(28%)	3.28	1917.27	1917.64	0.37	2.21	10.1
	M(27%)	3.16	1917.27	1917.63	0.36	2.14	9.99
	M(26%)	3.04	1917.27	1917.63	0.36	2.09	9.92
	M(25%)	2.92	1917.27	1917.62	0.35	2.02	9.81

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	M(24%)	2.81	1917.27	1917.61	0.34	1.96	9.71
	M(23%)	2.69	1917.27	1917.61	0.34	1.91	9.63
	M(22%)	2.57	1917.27	1917.6	0.33	1.83	9.5
	M(21%)	2.46	1917.27	1917.6	0.33	1.79	9.44
	M(20%)	2.34	1917.27	1917.59	0.32	1.73	9.35
	L(100%)	3.15	1917.27	1917.63	0.36	2.14	9.98
	L(20%)	0.63	1917.27	1917.46	0.19	0.64	6.75
	L(19%)	0.6	1917.27	1917.46	0.19	0.63	6.7
	L(18%)	0.57	1917.27	1917.45	0.18	0.6	6.56
	L(17%)	0.54	1917.27	1917.45	0.18	0.57	6.38
	L(16%)	0.5	1917.27	1917.44	0.17	0.54	6.21
	L(15%)	0.47	1917.27	1917.44	0.17	0.51	6.06
	NMNL1(100%)	7.5	1917.27	1917.81	0.54	4.16	12.71
	NMNL1(25%)	1.87	1917.27	1917.56	0.29	1.46	8.89
	NMNL1(24%)	1.8	1917.27	1917.55	0.28	1.4	8.79
	NMNL1(23%)	1.72	1917.27	1917.55	0.28	1.37	8.73
	NMNL1(22%)	1.65	1917.27	1917.55	0.28	1.33	8.67
	NMNL1(21%)	1.57	1917.27	1917.54	0.27	1.28	8.57
	NMNL1(20%)	1.5	1917.27	1917.53	0.26	1.23	8.48
	NMNL2(100%)	5.38	1917.27	1917.73	0.46	3.23	11.54
	NMNL2(25%)	1.34	1917.27	1917.52	0.25	1.14	8.32
	NMNL2(24%)	1.29	1917.27	1917.52	0.25	1.11	8.26
	NMNL2(23%)	1.24	1917.27	1917.52	0.25	1.08	8.21
	NMNL2(22%)	1.18	1917.27	1917.51	0.24	1.04	8.13
	NMNL2(21%)	1.13	1917.27	1917.51	0.24	0.99	8.05
	NMNL2(20%)	1.08	1917.27	1917.5	0.23	0.97	8.01
750 m d/s of axis	M(100%)	11.7	1901.53	1902.13	0.6	6.35	18.89
	M(30%)	3.51	1901.53	1901.89	0.36	2.55	13.64
	M(29%)	3.39	1901.53	1901.89	0.36	2.49	13.55
	M(28%)	3.28	1901.53	1901.88	0.35	2.4	13.41
	M(27%)	3.16	1901.53	1901.88	0.35	2.36	13.33
	M(26%)	3.04	1901.53	1901.88	0.35	2.31	13.26
	M(25%)	2.92	1901.53	1901.87	0.34	2.23	13.11
	M(24%)	2.81	1901.53	1901.87	0.34	2.19	13.04
	M(23%)	2.69	1901.53	1901.86	0.33	2.09	12.81
	M(22%)	2.57	1901.53	1901.85	0.32	2.01	12.55
	M(21%)	2.46	1901.53	1901.85	0.32	1.96	12.39
	M(20%)	2.34	1901.53	1901.84	0.31	1.89	12.19
	L(100%)	3.15	1901.53	1901.88	0.35	2.36	13.34
	L(20%)	0.63	1901.53	1901.72	0.19	0.65	7.16
	L(19%)	0.6	1901.53	1901.71	0.18	0.64	7.06
	L(18%)	0.57	1901.53	1901.71	0.18	0.61	6.94
	L(17%)	0.54	1901.53	1901.71	0.18	0.58	6.75

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	L(16%)	0.5	1901.53	1901.7	0.17	0.55	6.59
	L(15%)	0.47	1901.53	1901.7	0.17	0.52	6.4
	NMNL1(100%)	7.5	1901.53	1902.02	0.49	4.51	16.57
	NMNL1(25%)	1.87	1901.53	1901.82	0.29	1.56	11.05
	NMNL1(24%)	1.8	1901.53	1901.81	0.28	1.52	10.93
	NMNL1(23%)	1.72	1901.53	1901.81	0.28	1.45	10.67
	NMNL1(22%)	1.65	1901.53	1901.8	0.27	1.42	10.55
	NMNL1(21%)	1.57	1901.53	1901.8	0.27	1.38	10.38
	NMNL1(20%)	1.5	1901.53	1901.79	0.26	1.32	10.17
	NMNL2(100%)	5.38	1901.53	1901.96	0.43	3.52	15.16
	NMNL2(25%)	1.34	1901.53	1901.78	0.25	1.2	9.7
	NMNL2(24%)	1.29	1901.53	1901.78	0.25	1.17	9.58
	NMNL2(23%)	1.24	1901.53	1901.77	0.24	1.14	9.44
	NMNL2(22%)	1.18	1901.53	1901.77	0.24	1.08	9.19
	NMNL2(21%)	1.13	1901.53	1901.77	0.24	1.06	9.11
	NMNL2(20%)	1.08	1901.53	1901.76	0.23	1.01	8.91
1000 m d/s of axis	M(100%)	11.7	1884.89	1885.61	0.72	5.97	15.56
	M(30%)	3.51	1884.89	1885.33	0.44	2.33	10.26
	M(29%)	3.39	1884.89	1885.32	0.43	2.27	10.17
	M(28%)	3.28	1884.89	1885.32	0.43	2.21	10.06
	M(27%)	3.16	1884.89	1885.31	0.42	2.15	9.94
	M(26%)	3.04	1884.89	1885.3	0.41	2.08	9.79
	M(25%)	2.92	1884.89	1885.3	0.41	2.02	9.68
	M(24%)	2.81	1884.89	1885.29	0.4	1.96	9.56
	M(23%)	2.69	1884.89	1885.28	0.39	1.88	9.41
	M(22%)	2.57	1884.89	1885.28	0.39	1.83	9.31
	M(21%)	2.46	1884.89	1885.27	0.38	1.79	9.22
	M(20%)	2.34	1884.89	1885.26	0.37	1.7	9.05
	L(100%)	3.15	1884.89	1885.31	0.42	2.13	9.89
	L(20%)	0.63	1884.89	1885.11	0.22	0.6	5.36
	L(19%)	0.6	1884.89	1885.11	0.22	0.58	5.26
	L(18%)	0.57	1884.89	1885.1	0.21	0.54	5.12
	L(17%)	0.54	1884.89	1885.1	0.21	0.53	5.05
	L(16%)	0.5	1884.89	1885.09	0.2	0.49	4.86
	L(15%)	0.47	1884.89	1885.09	0.2	0.47	4.78
	NMNL1(100%)	7.5	1884.89	1885.49	0.6	4.19	13.24
	NMNL1(25%)	1.87	1884.89	1885.23	0.34	1.42	8.26
	NMNL1(24%)	1.8	1884.89	1885.22	0.33	1.38	8.15
	NMNL1(23%)	1.72	1884.89	1885.22	0.33	1.33	8.01
	NMNL1(22%)	1.65	1884.89	1885.21	0.32	1.28	7.86
	NMNL1(21%)	1.57	1884.89	1885.21	0.32	1.24	7.71
	NMNL1(20%)	1.5	1884.89	1885.2	0.31	1.19	7.57
	NMNL2(100%)	5.38	1884.89	1885.41	0.52	3.25	11.83

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	NMNL2(25%)	1.34	1884.89	1885.19	0.3	1.09	7.26
	NMNL2(24%)	1.29	1884.89	1885.18	0.29	1.06	7.13
	NMNL2(23%)	1.24	1884.89	1885.18	0.29	1.02	7.01
	NMNL2(22%)	1.18	1884.89	1885.17	0.28	0.99	6.9
	NMNL2(21%)	1.13	1884.89	1885.17	0.28	0.95	6.77
	NMNL2(20%)	1.08	1884.89	1885.16	0.27	0.91	6.63
1250 m d/s of axis	M(100%)	11.7	1871.25	1872.1	0.85	5.93	15.22
	M(30%)	3.51	1871.25	1871.77	0.52	2.14	8.21
	M(29%)	3.39	1871.25	1871.77	0.52	2.09	8.11
	M(28%)	3.28	1871.25	1871.76	0.51	2.04	8.02
	M(27%)	3.16	1871.25	1871.75	0.5	1.98	7.89
	M(26%)	3.04	1871.25	1871.75	0.5	1.93	7.79
	M(25%)	2.92	1871.25	1871.74	0.49	1.86	7.64
	M(24%)	2.81	1871.25	1871.73	0.48	1.82	7.56
	M(23%)	2.69	1871.25	1871.72	0.47	1.75	7.41
	M(22%)	2.57	1871.25	1871.71	0.46	1.69	7.28
	M(21%)	2.46	1871.25	1871.71	0.46	1.62	7.14
	M(20%)	2.34	1871.25	1871.7	0.45	1.56	7.01
	L(100%)	3.15	1871.25	1871.75	0.5	1.98	7.89
	L(20%)	0.63	1871.25	1871.52	0.27	0.55	4.15
	L(19%)	0.6	1871.25	1871.51	0.26	0.53	4.07
	L(18%)	0.57	1871.25	1871.51	0.26	0.5	3.98
	L(17%)	0.54	1871.25	1871.5	0.25	0.49	3.91
	L(16%)	0.5	1871.25	1871.49	0.24	0.46	3.8
	L(15%)	0.47	1871.25	1871.49	0.24	0.43	3.7
	NMNL1(100%)	7.5	1871.25	1871.97	0.72	4.07	12.08
	NMNL1(25%)	1.87	1871.25	1871.66	0.41	1.3	6.4
	NMNL1(24%)	1.8	1871.25	1871.65	0.4	1.26	6.3
	NMNL1(23%)	1.72	1871.25	1871.65	0.4	1.22	6.2
	NMNL1(22%)	1.65	1871.25	1871.64	0.39	1.18	6.09
	NMNL1(21%)	1.57	1871.25	1871.63	0.38	1.13	5.97
	NMNL1(20%)	1.5	1871.25	1871.62	0.37	1.09	5.86
	NMNL2(100%)	5.38	1871.25	1871.88	0.63	3.07	10
	NMNL2(25%)	1.34	1871.25	1871.61	0.36	1	5.6
	NMNL2(24%)	1.29	1871.25	1871.6	0.35	0.97	5.53
	NMNL2(23%)	1.24	1871.25	1871.6	0.35	0.93	5.41
	NMNL2(22%)	1.18	1871.25	1871.59	0.34	0.91	5.35
	NMNL2(21%)	1.13	1871.25	1871.58	0.33	0.87	5.24
	NMNL2(20%)	1.08	1871.25	1871.58	0.33	0.84	5.15
1500 m d/s of axis	M(100%)	11.7	1855.56	1856.26	0.7	6.6	21.69
	M(30%)	3.51	1855.56	1856.04	0.48	2.46	12.03
	M(29%)	3.39	1855.56	1856.04	0.48	2.39	11.79

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	M(28%)	3.28	1855.56	1856.03	0.47	2.29	11.4
	M(27%)	3.16	1855.56	1856.02	0.46	2.24	11.21
	M(26%)	3.04	1855.56	1856.02	0.46	2.16	10.92
	M(25%)	2.92	1855.56	1856.01	0.45	2.08	10.58
	M(24%)	2.81	1855.56	1856	0.44	2	10.23
	M(23%)	2.69	1855.56	1856	0.44	1.95	10.01
	M(22%)	2.57	1855.56	1855.99	0.43	1.85	9.57
	M(21%)	2.46	1855.56	1855.98	0.42	1.77	9.2
	M(20%)	2.34	1855.56	1855.97	0.41	1.7	8.85
	L(100%)	3.15	1855.56	1856.02	0.46	2.22	11.16
	L(20%)	0.63	1855.56	1855.8	0.24	0.57	4.77
	L(19%)	0.6	1855.56	1855.8	0.24	0.56	4.71
	L(18%)	0.57	1855.56	1855.79	0.23	0.52	4.57
	L(17%)	0.54	1855.56	1855.78	0.22	0.51	4.49
	L(16%)	0.5	1855.56	1855.78	0.22	0.48	4.38
	L(15%)	0.47	1855.56	1855.77	0.21	0.46	4.26
	NMNL1(100%)	7.5	1855.56	1856.18	0.62	4.92	20.76
	NMNL1(25%)	1.87	1855.56	1855.93	0.37	1.38	7.41
	NMNL1(24%)	1.8	1855.56	1855.92	0.36	1.32	7.26
	NMNL1(23%)	1.72	1855.56	1855.92	0.36	1.28	7.14
	NMNL1(22%)	1.65	1855.56	1855.91	0.35	1.23	7
	NMNL1(21%)	1.57	1855.56	1855.9	0.34	1.19	6.88
	NMNL1(20%)	1.5	1855.56	1855.9	0.34	1.15	6.76
	NMNL2(100%)	5.38	1855.56	1856.13	0.57	3.89	20.12
	NMNL2(25%)	1.34	1855.56	1855.88	0.32	1.05	6.45
	NMNL2(24%)	1.29	1855.56	1855.88	0.32	1.03	6.39
	NMNL2(23%)	1.24	1855.56	1855.87	0.31	0.99	6.27
	NMNL2(22%)	1.18	1855.56	1855.87	0.31	0.95	6.15
	NMNL2(21%)	1.13	1855.56	1855.86	0.3	0.92	6.05
	NMNL2(20%)	1.08	1855.56	1855.86	0.3	0.88	5.93
1750 m d/s of axis	M(100%)	11.7	1840.13	1841.31	1.18	4.83	8.22
	M(30%)	3.51	1840.13	1840.86	0.73	1.83	5.03
	M(29%)	3.39	1840.13	1840.85	0.72	1.78	4.96
	M(28%)	3.28	1840.13	1840.84	0.71	1.73	4.89
	M(27%)	3.16	1840.13	1840.83	0.7	1.68	4.82
	M(26%)	3.04	1840.13	1840.82	0.69	1.63	4.75
	M(25%)	2.92	1840.13	1840.81	0.68	1.58	4.67
	M(24%)	2.81	1840.13	1840.8	0.67	1.53	4.6
	M(23%)	2.69	1840.13	1840.78	0.65	1.48	4.52
	M(22%)	2.57	1840.13	1840.77	0.64	1.43	4.44
	M(21%)	2.46	1840.13	1840.76	0.63	1.38	4.37
	M(20%)	2.34	1840.13	1840.75	0.62	1.32	4.28
	L(100%)	3.15	1840.13	1840.83	0.7	1.7	4.84

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	L(20%)	0.63	1840.13	1840.5	0.37	0.47	2.54
	L(19%)	0.6	1840.13	1840.49	0.36	0.44	2.48
	L(18%)	0.57	1840.13	1840.48	0.35	0.43	2.43
	L(17%)	0.54	1840.13	1840.47	0.34	0.41	2.38
	L(16%)	0.5	1840.13	1840.46	0.33	0.39	2.31
	L(15%)	0.47	1840.13	1840.46	0.33	0.37	2.25
	NMNL1(100%)	7.5	1840.13	1841.12	0.99	3.38	6.83
	NMNL1(25%)	1.87	1840.13	1840.69	0.56	1.1	3.9
	NMNL1(24%)	1.8	1840.13	1840.69	0.56	1.07	3.85
	NMNL1(23%)	1.72	1840.13	1840.68	0.55	1.04	3.78
	NMNL1(22%)	1.65	1840.13	1840.67	0.54	1	3.72
	NMNL1(21%)	1.57	1840.13	1840.66	0.53	0.96	3.64
	NMNL1(20%)	1.5	1840.13	1840.65	0.52	0.93	3.58
	NMNL2(100%)	5.38	1840.13	1840.99	0.86	2.58	5.97
	NMNL2(25%)	1.34	1840.13	1840.63	0.5	0.85	3.43
	NMNL2(24%)	1.29	1840.13	1840.62	0.49	0.83	3.38
	NMNL2(23%)	1.24	1840.13	1840.61	0.48	0.8	3.32
	NMNL2(22%)	1.18	1840.13	1840.6	0.47	0.77	3.25
	NMNL2(21%)	1.13	1840.13	1840.59	0.46	0.74	3.2
	NMNL2(20%)	1.08	1840.13	1840.58	0.45	0.71	3.13
2000 m d/s of axis	M(100%)	11.7	1827.41	1828.14	0.73	5.37	11.29
	M(30%)	3.51	1827.41	1827.8	0.39	2.13	7.71
	M(29%)	3.39	1827.41	1827.79	0.38	2.07	7.63
	M(28%)	3.28	1827.41	1827.79	0.38	2.02	7.57
	M(27%)	3.16	1827.41	1827.78	0.37	1.96	7.48
	M(26%)	3.04	1827.41	1827.77	0.36	1.9	7.4
	M(25%)	2.92	1827.41	1827.76	0.35	1.85	7.33
	M(24%)	2.81	1827.41	1827.76	0.35	1.8	7.25
	M(23%)	2.69	1827.41	1827.75	0.34	1.73	7.16
	M(22%)	2.57	1827.41	1827.74	0.33	1.67	7.07
	M(21%)	2.46	1827.41	1827.73	0.32	1.62	6.99
	M(20%)	2.34	1827.41	1827.72	0.31	1.57	6.91
	L(100%)	3.15	1827.41	1827.78	0.37	1.95	7.47
	L(20%)	0.63	1827.41	1827.56	0.15	0.59	5.23
	L(19%)	0.6	1827.41	1827.56	0.15	0.58	5.19
	L(18%)	0.57	1827.41	1827.56	0.15	0.56	5.15
	L(17%)	0.54	1827.41	1827.55	0.14	0.53	5.1
	L(16%)	0.5	1827.41	1827.55	0.14	0.51	5.05
	L(15%)	0.47	1827.41	1827.54	0.13	0.48	5
	NMNL1(100%)	7.5	1827.41	1827.99	0.58	3.81	9.74
	NMNL1(25%)	1.87	1827.41	1827.69	0.28	1.33	6.54
	NMNL1(24%)	1.8	1827.41	1827.68	0.27	1.29	6.47
	NMNL1(23%)	1.72	1827.41	1827.67	0.26	1.23	6.38

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	NMNL1(22%)	1.65	1827.41	1827.67	0.26	1.21	6.35
	NMNL1(21%)	1.57	1827.41	1827.66	0.25	1.16	6.26
	NMNL1(20%)	1.5	1827.41	1827.66	0.25	1.12	6.2
	NMNL2(100%)	5.38	1827.41	1827.9	0.49	2.95	8.76
	NMNL2(25%)	1.34	1827.41	1827.64	0.23	1.03	6.05
	NMNL2(24%)	1.29	1827.41	1827.64	0.23	1	6
	NMNL2(23%)	1.24	1827.41	1827.63	0.22	0.97	5.94
	NMNL2(22%)	1.18	1827.41	1827.63	0.22	0.94	5.88
	NMNL2(21%)	1.13	1827.41	1827.62	0.21	0.91	5.83
	NMNL2(20%)	1.08	1827.41	1827.62	0.21	0.88	5.78
2250 m d/s of axis	M(100%)	11.7	1812.3	1813.3	1	5.23	10.5
	M(30%)	3.51	1812.3	1812.92	0.62	1.99	6.44
	M(29%)	3.39	1812.3	1812.91	0.61	1.93	6.34
	M(28%)	3.28	1812.3	1812.9	0.6	1.87	6.25
	M(27%)	3.16	1812.3	1812.89	0.59	1.82	6.16
	M(26%)	3.04	1812.3	1812.88	0.58	1.77	6.07
	M(25%)	2.92	1812.3	1812.88	0.58	1.73	6
	M(24%)	2.81	1812.3	1812.87	0.57	1.67	5.9
	M(23%)	2.69	1812.3	1812.86	0.56	1.61	5.78
	M(22%)	2.57	1812.3	1812.85	0.55	1.55	5.68
	M(21%)	2.46	1812.3	1812.84	0.54	1.49	5.58
	M(20%)	2.34	1812.3	1812.83	0.53	1.44	5.47
	L(100%)	3.15	1812.3	1812.89	0.59	1.82	6.16
	L(20%)	0.63	1812.3	1812.61	0.31	0.5	3.23
	L(19%)	0.6	1812.3	1812.61	0.31	0.48	3.17
	L(18%)	0.57	1812.3	1812.6	0.3	0.46	3.1
	L(17%)	0.54	1812.3	1812.6	0.3	0.45	3.07
	L(16%)	0.5	1812.3	1812.59	0.29	0.42	2.97
	L(15%)	0.47	1812.3	1812.58	0.28	0.4	2.88
	NMNL1(100%)	7.5	1812.3	1813.14	0.84	3.69	8.76
	NMNL1(25%)	1.87	1812.3	1812.78	0.48	1.2	5
	NMNL1(24%)	1.8	1812.3	1812.77	0.47	1.16	4.92
	NMNL1(23%)	1.72	1812.3	1812.77	0.47	1.12	4.83
	NMNL1(22%)	1.65	1812.3	1812.76	0.46	1.09	4.77
	NMNL1(21%)	1.57	1812.3	1812.75	0.45	1.05	4.67
	NMNL1(20%)	1.5	1812.3	1812.74	0.44	1	4.57
	NMNL2(100%)	5.38	1812.3	1813.04	0.74	2.82	7.67
	NMNL2(25%)	1.34	1812.3	1812.72	0.42	0.92	4.38
	NMNL2(24%)	1.29	1812.3	1812.72	0.42	0.89	4.3
	NMNL2(23%)	1.24	1812.3	1812.71	0.41	0.87	4.25
	NMNL2(22%)	1.18	1812.3	1812.7	0.4	0.83	4.15
	NMNL2(21%)	1.13	1812.3	1812.7	0.4	0.81	4.1
	NMNL2(20%)	1.08	1812.3	1812.69	0.39	0.77	4.02

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
2500 m d/s of axis	M(100%)	11.7	1785.83	1786.67	0.84	5.32	11.03
	M(30%)	3.51	1785.83	1786.33	0.5	2.1	7.58
	M(29%)	3.39	1785.83	1786.33	0.5	2.04	7.49
	M(28%)	3.28	1785.83	1786.32	0.49	1.99	7.4
	M(27%)	3.16	1785.83	1786.31	0.48	1.94	7.33
	M(26%)	3.04	1785.83	1786.3	0.47	1.88	7.23
	M(25%)	2.92	1785.83	1786.29	0.46	1.82	7.13
	M(24%)	2.81	1785.83	1786.29	0.46	1.77	7.05
	M(23%)	2.69	1785.83	1786.28	0.45	1.71	6.95
	M(22%)	2.57	1785.83	1786.27	0.44	1.64	6.84
	M(21%)	2.46	1785.83	1786.26	0.43	1.6	6.76
	M(20%)	2.34	1785.83	1786.25	0.42	1.53	6.65
	L(100%)	3.15	1785.83	1786.31	0.48	1.93	7.31
	L(20%)	0.63	1785.83	1786.08	0.25	0.56	4.42
	L(19%)	0.6	1785.83	1786.07	0.24	0.54	4.31
	L(18%)	0.57	1785.83	1786.07	0.24	0.52	4.24
	L(17%)	0.54	1785.83	1786.06	0.23	0.49	4.12
	L(16%)	0.5	1785.83	1786.06	0.23	0.47	4.03
	L(15%)	0.47	1785.83	1786.05	0.22	0.45	3.93
	NMNL1(100%)	7.5	1785.83	1786.53	0.7	3.79	9.83
	NMNL1(25%)	1.87	1785.83	1786.21	0.38	1.29	6.21
	NMNL1(24%)	1.8	1785.83	1786.21	0.38	1.26	6.15
	NMNL1(23%)	1.72	1785.83	1786.2	0.37	1.21	6.05
	NMNL1(22%)	1.65	1785.83	1786.2	0.37	1.17	5.98
	NMNL1(21%)	1.57	1785.83	1786.19	0.36	1.13	5.9
	NMNL1(20%)	1.5	1785.83	1786.18	0.35	1.09	5.83
	NMNL2(100%)	5.38	1785.83	1786.44	0.61	2.95	8.77
	NMNL2(25%)	1.34	1785.83	1786.17	0.34	1.01	5.67
	NMNL2(24%)	1.29	1785.83	1786.16	0.33	0.98	5.6
	NMNL2(23%)	1.24	1785.83	1786.16	0.33	0.95	5.54
	NMNL2(22%)	1.18	1785.83	1786.15	0.32	0.91	5.45
	NMNL2(21%)	1.13	1785.83	1786.14	0.31	0.88	5.39
	NMNL2(20%)	1.08	1785.83	1786.14	0.31	0.85	5.33
2750 m d/s of axis	M(100%)	11.7	1768.18	1769.27	1.09	5.05	9.35
	M(30%)	3.51	1768.18	1768.85	0.67	1.91	5.68
	M(29%)	3.39	1768.18	1768.84	0.66	1.85	5.6
	M(28%)	3.28	1768.18	1768.83	0.65	1.8	5.53
	M(27%)	3.16	1768.18	1768.82	0.64	1.75	5.45
	M(26%)	3.04	1768.18	1768.81	0.63	1.7	5.37
	M(25%)	2.92	1768.18	1768.8	0.62	1.65	5.29
	M(24%)	2.81	1768.18	1768.79	0.61	1.6	5.2
	M(23%)	2.69	1768.18	1768.78	0.6	1.54	5.1

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	M(22%)	2.57	1768.18	1768.77	0.59	1.49	5.02
	M(21%)	2.46	1768.18	1768.76	0.58	1.43	4.93
	M(20%)	2.34	1768.18	1768.75	0.57	1.38	4.83
	L(100%)	3.15	1768.18	1768.82	0.64	1.75	5.44
	L(20%)	0.63	1768.18	1768.53	0.35	0.54	3.02
	L(19%)	0.6	1768.18	1768.52	0.34	0.52	2.96
	L(18%)	0.57	1768.18	1768.52	0.34	0.5	2.91
	L(17%)	0.54	1768.18	1768.51	0.33	0.48	2.85
	L(16%)	0.5	1768.18	1768.5	0.32	0.46	2.78
	L(15%)	0.47	1768.18	1768.5	0.32	0.43	2.71
	NMNL1(100%)	7.5	1768.18	1769.09	0.91	3.52	7.72
	NMNL1(25%)	1.87	1768.18	1768.7	0.52	1.16	4.43
	NMNL1(24%)	1.8	1768.18	1768.69	0.51	1.12	4.35
	NMNL1(23%)	1.72	1768.18	1768.68	0.5	1.08	4.29
	NMNL1(22%)	1.65	1768.18	1768.67	0.49	1.05	4.21
	NMNL1(21%)	1.57	1768.18	1768.67	0.49	1.02	4.15
	NMNL1(20%)	1.5	1768.18	1768.66	0.48	0.98	4.08
	NMNL2(100%)	5.38	1768.18	1768.97	0.79	2.69	6.75
	NMNL2(25%)	1.34	1768.18	1768.64	0.46	0.91	3.93
	NMNL2(24%)	1.29	1768.18	1768.63	0.45	0.88	3.86
	NMNL2(23%)	1.24	1768.18	1768.63	0.45	0.86	3.82
	NMNL2(22%)	1.18	1768.18	1768.62	0.44	0.82	3.74
	NMNL2(21%)	1.13	1768.18	1768.61	0.43	0.81	3.7
	NMNL2(20%)	1.08	1768.18	1768.6	0.42	0.78	3.64
3000 m d/s of axis	M(100%)	11.7	1761.73	1762.43	0.7	5.78	14.06
	M(30%)	3.51	1761.73	1762.15	0.42	2.33	10.25
	M(29%)	3.39	1761.73	1762.14	0.41	2.27	10.13
	M(28%)	3.28	1761.73	1762.13	0.4	2.2	9.99
	M(27%)	3.16	1761.73	1762.13	0.4	2.13	9.85
	M(26%)	3.04	1761.73	1762.12	0.39	2.08	9.76
	M(25%)	2.92	1761.73	1762.12	0.39	2.03	9.66
	M(24%)	2.81	1761.73	1762.11	0.38	1.97	9.52
	M(23%)	2.69	1761.73	1762.1	0.37	1.9	9.37
	M(22%)	2.57	1761.73	1762.1	0.37	1.82	9.2
	M(21%)	2.46	1761.73	1762.09	0.36	1.76	9.07
	M(20%)	2.34	1761.73	1762.08	0.35	1.69	8.91
	L(100%)	3.15	1761.73	1762.13	0.4	2.14	9.88
	L(20%)	0.63	1761.73	1761.94	0.21	0.62	5.83
	L(19%)	0.6	1761.73	1761.93	0.2	0.58	5.66
	L(18%)	0.57	1761.73	1761.93	0.2	0.57	5.61
	L(17%)	0.54	1761.73	1761.92	0.19	0.54	5.48
	L(16%)	0.5	1761.73	1761.92	0.19	0.51	5.3
	L(15%)	0.47	1761.73	1761.91	0.18	0.48	5.15

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	NMNL1(100%)	7.5	1761.73	1762.3	0.57	4.13	12.64
	NMNL1(25%)	1.87	1761.73	1762.05	0.32	1.42	8.3
	NMNL1(24%)	1.8	1761.73	1762.04	0.31	1.38	8.19
	NMNL1(23%)	1.72	1761.73	1762.04	0.31	1.33	8.08
	NMNL1(22%)	1.65	1761.73	1762.03	0.3	1.29	7.98
	NMNL1(21%)	1.57	1761.73	1762.03	0.3	1.25	7.86
	NMNL1(20%)	1.5	1761.73	1762.02	0.29	1.2	7.75
	NMNL2(100%)	5.38	1761.73	1762.23	0.5	3.21	11.6
	NMNL2(25%)	1.34	1761.73	1762.01	0.28	1.1	7.49
	NMNL2(24%)	1.29	1761.73	1762	0.27	1.06	7.38
	NMNL2(23%)	1.24	1761.73	1762	0.27	1.04	7.32
	NMNL2(22%)	1.18	1761.73	1762	0.27	1.01	7.22
	NMNL2(21%)	1.13	1761.73	1761.99	0.26	0.97	7.13
	NMNL2(20%)	1.08	1761.73	1761.99	0.26	0.94	7.03
3250 m d/s of axis	M(100%)	11.7	1747.67	1748.58	0.91	5.53	12.4
	M(30%)	3.51	1747.67	1748.23	0.56	2.09	7.42
	M(29%)	3.39	1747.67	1748.22	0.55	2.04	7.32
	M(28%)	3.28	1747.67	1748.22	0.55	1.99	7.23
	M(27%)	3.16	1747.67	1748.21	0.54	1.92	7.1
	M(26%)	3.04	1747.67	1748.2	0.53	1.86	6.99
	M(25%)	2.92	1747.67	1748.19	0.52	1.79	6.86
	M(24%)	2.81	1747.67	1748.18	0.51	1.75	6.78
	M(23%)	2.69	1747.67	1748.17	0.5	1.69	6.67
	M(22%)	2.57	1747.67	1748.16	0.49	1.63	6.54
	M(21%)	2.46	1747.67	1748.16	0.49	1.58	6.44
	M(20%)	2.34	1747.67	1748.15	0.48	1.51	6.31
	L(100%)	3.15	1747.67	1748.2	0.53	1.9	7.08
	L(20%)	0.63	1747.67	1747.95	0.28	0.53	3.73
	L(19%)	0.6	1747.67	1747.95	0.28	0.51	3.68
	L(18%)	0.57	1747.67	1747.94	0.27	0.48	3.56
	L(17%)	0.54	1747.67	1747.93	0.26	0.46	3.48
	L(16%)	0.5	1747.67	1747.92	0.25	0.44	3.39
	L(15%)	0.47	1747.67	1747.92	0.25	0.42	3.31
	NMNL1(100%)	7.5	1747.67	1748.43	0.76	3.86	10.08
	NMNL1(25%)	1.87	1747.67	1748.1	0.43	1.25	5.74
	NMNL1(24%)	1.8	1747.67	1748.1	0.43	1.22	5.65
	NMNL1(23%)	1.72	1747.67	1748.09	0.42	1.18	5.57
	NMNL1(22%)	1.65	1747.67	1748.08	0.41	1.14	5.47
	NMNL1(21%)	1.57	1747.67	1748.08	0.41	1.1	5.38
	NMNL1(20%)	1.5	1747.67	1748.07	0.4	1.06	5.27
	NMNL2(100%)	5.38	1747.67	1748.33	0.66	2.94	8.79
	NMNL2(25%)	1.34	1747.67	1748.05	0.38	0.96	5.03
	NMNL2(24%)	1.29	1747.67	1748.04	0.37	0.94	4.96

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	NMNL2(23%)	1.24	1747.67	1748.04	0.37	0.91	4.9
	NMNL2(22%)	1.18	1747.67	1748.03	0.36	0.87	4.79
	NMNL2(21%)	1.13	1747.67	1748.02	0.35	0.85	4.71
	NMNL2(20%)	1.08	1747.67	1748.02	0.35	0.81	4.61
3500 m d/s of axis	M(100%)	11.7	1731.43	1732.32	0.89	5.44	11.6
	M(30%)	3.51	1731.43	1731.98	0.55	2.1	7.62
	M(29%)	3.39	1731.43	1731.97	0.54	2.05	7.53
	M(28%)	3.28	1731.43	1731.97	0.54	1.99	7.43
	M(27%)	3.16	1731.43	1731.96	0.53	1.93	7.31
	M(26%)	3.04	1731.43	1731.95	0.52	1.88	7.21
	M(25%)	2.92	1731.43	1731.94	0.51	1.82	7.11
	M(24%)	2.81	1731.43	1731.93	0.5	1.77	7.01
	M(23%)	2.69	1731.43	1731.92	0.49	1.7	6.87
	M(22%)	2.57	1731.43	1731.92	0.49	1.64	6.74
	M(21%)	2.46	1731.43	1731.91	0.48	1.58	6.62
	M(20%)	2.34	1731.43	1731.9	0.47	1.53	6.5
	L(100%)	3.15	1731.43	1731.96	0.53	1.94	7.32
	L(20%)	0.63	1731.43	1731.71	0.28	0.53	3.85
	L(19%)	0.6	1731.43	1731.7	0.27	0.51	3.77
	L(18%)	0.57	1731.43	1731.7	0.27	0.5	3.71
	L(17%)	0.54	1731.43	1731.69	0.26	0.47	3.61
	L(16%)	0.5	1731.43	1731.68	0.25	0.45	3.52
	L(15%)	0.47	1731.43	1731.68	0.25	0.42	3.42
	NMNL1(100%)	7.5	1731.43	1732.17	0.74	3.84	10.13
	NMNL1(25%)	1.87	1731.43	1731.86	0.43	1.28	5.96
	NMNL1(24%)	1.8	1731.43	1731.85	0.42	1.24	5.85
	NMNL1(23%)	1.72	1731.43	1731.84	0.41	1.19	5.74
	NMNL1(22%)	1.65	1731.43	1731.84	0.41	1.15	5.65
	NMNL1(21%)	1.57	1731.43	1731.83	0.4	1.11	5.53
	NMNL1(20%)	1.5	1731.43	1731.82	0.39	1.07	5.44
	NMNL2(100%)	5.38	1731.43	1732.08	0.65	2.96	9.06
	NMNL2(25%)	1.34	1731.43	1731.81	0.38	0.98	5.22
	NMNL2(24%)	1.29	1731.43	1731.8	0.37	0.95	5.13
	NMNL2(23%)	1.24	1731.43	1731.79	0.36	0.91	5.03
	NMNL2(22%)	1.18	1731.43	1731.78	0.35	0.88	4.93
	NMNL2(21%)	1.13	1731.43	1731.78	0.35	0.84	4.83
	NMNL2(20%)	1.08	1731.43	1731.77	0.34	0.82	4.76
3750 m d/s of axis	M(100%)	11.7	1718.25	1719.22	0.97	5.21	10.24
	M(30%)	3.51	1718.25	1718.85	0.6	2.02	6.74
	M(29%)	3.39	1718.25	1718.84	0.59	1.96	6.65
	M(28%)	3.28	1718.25	1718.83	0.58	1.9	6.54
	M(27%)	3.16	1718.25	1718.82	0.57	1.85	6.46

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	M(26%)	3.04	1718.25	1718.81	0.56	1.79	6.35
	M(25%)	2.92	1718.25	1718.8	0.55	1.75	6.27
	M(24%)	2.81	1718.25	1718.8	0.55	1.7	6.17
	M(23%)	2.69	1718.25	1718.79	0.54	1.63	6.06
	M(22%)	2.57	1718.25	1718.78	0.53	1.57	5.94
	M(21%)	2.46	1718.25	1718.77	0.52	1.52	5.85
	M(20%)	2.34	1718.25	1718.76	0.51	1.46	5.73
	L(100%)	3.15	1718.25	1718.82	0.57	1.84	6.43
	L(20%)	0.63	1718.25	1718.55	0.3	0.51	3.39
	L(19%)	0.6	1718.25	1718.54	0.29	0.49	3.31
	L(18%)	0.57	1718.25	1718.54	0.29	0.47	3.24
	L(17%)	0.54	1718.25	1718.53	0.28	0.45	3.2
	L(16%)	0.5	1718.25	1718.52	0.27	0.43	3.1
	L(15%)	0.47	1718.25	1718.52	0.27	0.41	3.02
	NMNL1(100%)	7.5	1718.25	1719.05	0.8	3.65	8.78
	NMNL1(25%)	1.87	1718.25	1718.71	0.46	1.22	5.25
	NMNL1(24%)	1.8	1718.25	1718.71	0.46	1.19	5.16
	NMNL1(23%)	1.72	1718.25	1718.7	0.45	1.14	5.06
	NMNL1(22%)	1.65	1718.25	1718.69	0.44	1.11	4.99
	NMNL1(21%)	1.57	1718.25	1718.68	0.43	1.06	4.89
	NMNL1(20%)	1.5	1718.25	1718.67	0.42	1.03	4.81
	NMNL2(100%)	5.38	1718.25	1718.96	0.71	2.83	7.9
	NMNL2(25%)	1.34	1718.25	1718.66	0.41	0.94	4.6
	NMNL2(24%)	1.29	1718.25	1718.65	0.4	0.91	4.52
	NMNL2(23%)	1.24	1718.25	1718.64	0.39	0.88	4.44
	NMNL2(22%)	1.18	1718.25	1718.63	0.38	0.85	4.36
	NMNL2(21%)	1.13	1718.25	1718.63	0.38	0.82	4.28
	NMNL2(20%)	1.08	1718.25	1718.62	0.37	0.78	4.2
4000 m d/s of axis	M(100%)	11.7	1702.66	1703.52	0.86	5.5	12
	M(30%)	3.51	1702.66	1703.18	0.52	2.13	7.79
	M(29%)	3.39	1702.66	1703.17	0.51	2.06	7.67
	M(28%)	3.28	1702.66	1703.16	0.5	2	7.59
	M(27%)	3.16	1702.66	1703.15	0.49	1.95	7.49
	M(26%)	3.04	1702.66	1703.15	0.49	1.9	7.42
	M(25%)	2.92	1702.66	1703.14	0.48	1.85	7.32
	M(24%)	2.81	1702.66	1703.13	0.47	1.78	7.21
	M(23%)	2.69	1702.66	1703.12	0.46	1.72	7.11
	M(22%)	2.57	1702.66	1703.11	0.45	1.65	6.99
	M(21%)	2.46	1702.66	1703.11	0.45	1.61	6.91
	M(20%)	2.34	1702.66	1703.1	0.44	1.55	6.8
	L(100%)	3.15	1702.66	1703.15	0.49	1.95	7.49
	L(20%)	0.63	1702.66	1702.92	0.26	0.56	4.27
	L(19%)	0.6	1702.66	1702.92	0.26	0.53	4.16

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	L(18%)	0.57	1702.66	1702.91	0.25	0.51	4.07
	L(17%)	0.54	1702.66	1702.91	0.25	0.49	4.01
	L(16%)	0.5	1702.66	1702.9	0.24	0.46	3.86
	L(15%)	0.47	1702.66	1702.89	0.23	0.44	3.78
	NMNL1(100%)	7.5	1702.66	1703.37	0.71	3.85	10.16
	NMNL1(25%)	1.87	1702.66	1703.06	0.4	1.29	6.32
	NMNL1(24%)	1.8	1702.66	1703.06	0.4	1.27	6.27
	NMNL1(23%)	1.72	1702.66	1703.05	0.39	1.22	6.17
	NMNL1(22%)	1.65	1702.66	1703.04	0.38	1.18	6.09
	NMNL1(21%)	1.57	1702.66	1703.03	0.37	1.13	5.99
	NMNL1(20%)	1.5	1702.66	1703.03	0.37	1.09	5.9
	NMNL2(100%)	5.38	1702.66	1703.28	0.62	2.96	9.01
	NMNL2(25%)	1.34	1702.66	1703.01	0.35	1.01	5.74
	NMNL2(24%)	1.29	1702.66	1703.01	0.35	0.98	5.66
	NMNL2(23%)	1.24	1702.66	1703	0.34	0.94	5.55
	NMNL2(22%)	1.18	1702.66	1703	0.34	0.91	5.46
	NMNL2(21%)	1.13	1702.66	1702.99	0.33	0.88	5.34
	NMNL2(20%)	1.08	1702.66	1702.98	0.32	0.85	5.25
4250 m d/s of axis	M(100%)	11.7	1683.05	1684.28	1.23	4.78	7.83
	M(30%)	3.51	1683.05	1683.8	0.75	1.81	4.79
	M(29%)	3.39	1683.05	1683.79	0.74	1.75	4.72
	M(28%)	3.28	1683.05	1683.78	0.73	1.71	4.66
	M(27%)	3.16	1683.05	1683.77	0.72	1.65	4.58
	M(26%)	3.04	1683.05	1683.76	0.71	1.61	4.51
	M(25%)	2.92	1683.05	1683.75	0.7	1.56	4.44
	M(24%)	2.81	1683.05	1683.74	0.69	1.51	4.37
	M(23%)	2.69	1683.05	1683.73	0.68	1.45	4.29
	M(22%)	2.57	1683.05	1683.71	0.66	1.4	4.22
	M(21%)	2.46	1683.05	1683.7	0.65	1.36	4.15
	M(20%)	2.34	1683.05	1683.69	0.64	1.31	4.08
	L(100%)	3.15	1683.05	1683.77	0.72	1.67	4.6
	L(20%)	0.63	1683.05	1683.43	0.38	0.45	2.4
	L(19%)	0.6	1683.05	1683.42	0.37	0.44	2.36
	L(18%)	0.57	1683.05	1683.41	0.36	0.42	2.31
	L(17%)	0.54	1683.05	1683.4	0.35	0.4	2.26
	L(16%)	0.5	1683.05	1683.39	0.34	0.38	2.19
	L(15%)	0.47	1683.05	1683.39	0.34	0.36	2.14
	NMNL1(100%)	7.5	1683.05	1684.07	1.02	3.31	6.48
	NMNL1(25%)	1.87	1683.05	1683.64	0.59	1.09	3.72
	NMNL1(24%)	1.8	1683.05	1683.63	0.58	1.06	3.66
	NMNL1(23%)	1.72	1683.05	1683.62	0.57	1.02	3.59
	NMNL1(22%)	1.65	1683.05	1683.61	0.56	0.98	3.53
	NMNL1(21%)	1.57	1683.05	1683.59	0.54	0.94	3.46

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	NMNL1(20%)	1.5	1683.05	1683.58	0.53	0.91	3.4
	NMNL2(100%)	5.38	1683.05	1683.94	0.89	2.53	5.67
	NMNL2(25%)	1.34	1683.05	1683.56	0.51	0.84	3.26
	NMNL2(24%)	1.29	1683.05	1683.55	0.5	0.81	3.21
	NMNL2(23%)	1.24	1683.05	1683.55	0.5	0.79	3.16
	NMNL2(22%)	1.18	1683.05	1683.54	0.49	0.75	3.09
	NMNL2(21%)	1.13	1683.05	1683.53	0.48	0.73	3.04
	NMNL2(20%)	1.08	1683.05	1683.52	0.47	0.7	2.99
4500 m d/s of axis	M(100%)	11.7	1666.06	1667.01	0.95	5.25	10.65
	M(30%)	3.51	1666.06	1666.64	0.58	2.02	6.8
	M(29%)	3.39	1666.06	1666.64	0.58	1.99	6.75
	M(28%)	3.28	1666.06	1666.63	0.57	1.92	6.64
	M(27%)	3.16	1666.06	1666.62	0.56	1.86	6.55
	M(26%)	3.04	1666.06	1666.61	0.55	1.8	6.46
	M(25%)	2.92	1666.06	1666.6	0.54	1.76	6.38
	M(24%)	2.81	1666.06	1666.59	0.53	1.7	6.29
	M(23%)	2.69	1666.06	1666.58	0.52	1.65	6.2
	M(22%)	2.57	1666.06	1666.57	0.51	1.59	6.1
	M(21%)	2.46	1666.06	1666.56	0.5	1.53	6
	M(20%)	2.34	1666.06	1666.55	0.49	1.47	5.89
	L(100%)	3.15	1666.06	1666.62	0.56	1.86	6.54
	L(20%)	0.63	1666.06	1666.35	0.29	0.52	3.5
	L(19%)	0.6	1666.06	1666.35	0.29	0.5	3.44
	L(18%)	0.57	1666.06	1666.34	0.28	0.48	3.36
	L(17%)	0.54	1666.06	1666.33	0.27	0.46	3.29
	L(16%)	0.5	1666.06	1666.33	0.27	0.43	3.19
	L(15%)	0.47	1666.06	1666.32	0.26	0.41	3.12
	NMNL1(100%)	7.5	1666.06	1666.85	0.79	3.69	9
	NMNL1(25%)	1.87	1666.06	1666.51	0.45	1.23	5.4
	NMNL1(24%)	1.8	1666.06	1666.5	0.44	1.19	5.32
	NMNL1(23%)	1.72	1666.06	1666.5	0.44	1.15	5.22
	NMNL1(22%)	1.65	1666.06	1666.49	0.43	1.11	5.13
	NMNL1(21%)	1.57	1666.06	1666.48	0.42	1.07	5.04
	NMNL1(20%)	1.5	1666.06	1666.47	0.41	1.03	4.93
	NMNL2(100%)	5.38	1666.06	1666.75	0.69	2.84	7.95
	NMNL2(25%)	1.34	1666.06	1666.46	0.4	0.95	4.73
	NMNL2(24%)	1.29	1666.06	1666.45	0.39	0.92	4.67
	NMNL2(23%)	1.24	1666.06	1666.44	0.38	0.89	4.58
	NMNL2(22%)	1.18	1666.06	1666.43	0.37	0.85	4.48
	NMNL2(21%)	1.13	1666.06	1666.43	0.37	0.83	4.42
	NMNL2(20%)	1.08	1666.06	1666.42	0.36	0.79	4.33

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
4750 m d/s of axis	M(100%)	11.7	1650.16	1651.13	0.97	5.26	10.71
	M(30%)	3.51	1650.16	1650.76	0.6	2.01	6.66
	M(29%)	3.39	1650.16	1650.75	0.59	1.95	6.55
	M(28%)	3.28	1650.16	1650.74	0.58	1.9	6.47
	M(27%)	3.16	1650.16	1650.74	0.58	1.86	6.39
	M(26%)	3.04	1650.16	1650.73	0.57	1.79	6.28
	M(25%)	2.92	1650.16	1650.72	0.56	1.75	6.21
	M(24%)	2.81	1650.16	1650.71	0.55	1.69	6.1
	M(23%)	2.69	1650.16	1650.7	0.54	1.63	6
	M(22%)	2.57	1650.16	1650.69	0.53	1.57	5.89
	M(21%)	2.46	1650.16	1650.68	0.52	1.51	5.76
	M(20%)	2.34	1650.16	1650.67	0.51	1.45	5.66
	L(100%)	3.15	1650.16	1650.73	0.57	1.84	6.37
	L(20%)	0.63	1650.16	1650.46	0.3	0.51	3.34
	L(19%)	0.6	1650.16	1650.45	0.29	0.49	3.27
	L(18%)	0.57	1650.16	1650.45	0.29	0.47	3.22
	L(17%)	0.54	1650.16	1650.44	0.28	0.45	3.16
	L(16%)	0.5	1650.16	1650.43	0.27	0.42	3.05
	L(15%)	0.47	1650.16	1650.43	0.27	0.41	2.99
	NMNL1(100%)	7.5	1650.16	1650.98	0.82	3.7	9.02
	NMNL1(25%)	1.87	1650.16	1650.63	0.47	1.22	5.18
	NMNL1(24%)	1.8	1650.16	1650.62	0.46	1.18	5.11
	NMNL1(23%)	1.72	1650.16	1650.61	0.45	1.14	5.01
	NMNL1(22%)	1.65	1650.16	1650.6	0.44	1.1	4.93
	NMNL1(21%)	1.57	1650.16	1650.59	0.43	1.06	4.82
	NMNL1(20%)	1.5	1650.16	1650.59	0.43	1.02	4.75
	NMNL2(100%)	5.38	1650.16	1650.87	0.71	2.83	7.89
	NMNL2(25%)	1.34	1650.16	1650.57	0.41	0.93	4.52
	NMNL2(24%)	1.29	1650.16	1650.56	0.4	0.9	4.45
	NMNL2(23%)	1.24	1650.16	1650.56	0.4	0.88	4.4
	NMNL2(22%)	1.18	1650.16	1650.55	0.39	0.84	4.3
	NMNL2(21%)	1.13	1650.16	1650.54	0.38	0.81	4.23
	NMNL2(20%)	1.08	1650.16	1650.53	0.37	0.79	4.16
5000 m d/s of axis	M(100%)	11.7	1633.11	1634.07	0.96	5.67	13.11
	M(30%)	3.51	1633.11	1633.7	0.59	2.04	6.95
	M(29%)	3.39	1633.11	1633.69	0.58	1.98	6.85
	M(28%)	3.28	1633.11	1633.68	0.57	1.93	6.76
	M(27%)	3.16	1633.11	1633.67	0.56	1.87	6.66
	M(26%)	3.04	1633.11	1633.67	0.56	1.83	6.58
	M(25%)	2.92	1633.11	1633.66	0.55	1.77	6.46
	M(24%)	2.81	1633.11	1633.65	0.54	1.71	6.36
	M(23%)	2.69	1633.11	1633.64	0.53	1.65	6.25
	M(22%)	2.57	1633.11	1633.63	0.52	1.6	6.15

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	M(21%)	2.46	1633.11	1633.62	0.51	1.54	6.04
	M(20%)	2.34	1633.11	1633.61	0.5	1.47	5.91
	L(100%)	3.15	1633.11	1633.67	0.56	1.87	6.66
	L(20%)	0.63	1633.11	1633.41	0.3	0.52	3.51
	L(19%)	0.6	1633.11	1633.4	0.29	0.5	3.44
	L(18%)	0.57	1633.11	1633.39	0.28	0.48	3.36
	L(17%)	0.54	1633.11	1633.39	0.28	0.46	3.29
	L(16%)	0.5	1633.11	1633.38	0.27	0.43	3.19
	L(15%)	0.47	1633.11	1633.37	0.26	0.41	3.12
	NMNL1(100%)	7.5	1633.11	1633.91	0.8	3.82	9.98
	NMNL1(25%)	1.87	1633.11	1633.57	0.46	1.24	5.41
	NMNL1(24%)	1.8	1633.11	1633.56	0.45	1.19	5.31
	NMNL1(23%)	1.72	1633.11	1633.55	0.44	1.16	5.24
	NMNL1(22%)	1.65	1633.11	1633.55	0.44	1.12	5.16
	NMNL1(21%)	1.57	1633.11	1633.54	0.43	1.07	5.03
	NMNL1(20%)	1.5	1633.11	1633.53	0.42	1.03	4.94
	NMNL2(100%)	5.38	1633.11	1633.81	0.7	2.9	8.28
	NMNL2(25%)	1.34	1633.11	1633.51	0.4	0.95	4.74
	NMNL2(24%)	1.29	1633.11	1633.5	0.39	0.92	4.66
	NMNL2(23%)	1.24	1633.11	1633.5	0.39	0.9	4.61
	NMNL2(22%)	1.18	1633.11	1633.49	0.38	0.85	4.48
	NMNL2(21%)	1.13	1633.11	1633.48	0.37	0.82	4.4
	NMNL2(20%)	1.08	1633.11	1633.48	0.37	0.8	4.34
5250 m d/s of axis	M(100%)	11.7	1619.06	1620.18	1.12	5.01	9.05
	M(30%)	3.51	1619.06	1619.75	0.69	1.89	5.49
	M(29%)	3.39	1619.06	1619.74	0.68	1.84	5.41
	M(28%)	3.28	1619.06	1619.73	0.67	1.79	5.34
	M(27%)	3.16	1619.06	1619.72	0.66	1.73	5.26
	M(26%)	3.04	1619.06	1619.71	0.65	1.68	5.18
	M(25%)	2.92	1619.06	1619.7	0.64	1.62	5.09
	M(24%)	2.81	1619.06	1619.69	0.63	1.58	5.01
	M(23%)	2.69	1619.06	1619.68	0.62	1.52	4.92
	M(22%)	2.57	1619.06	1619.66	0.6	1.46	4.83
	M(21%)	2.46	1619.06	1619.66	0.6	1.42	4.76
	M(20%)	2.34	1619.06	1619.64	0.58	1.37	4.67
	L(100%)	3.15	1619.06	1619.72	0.66	1.73	5.25
	L(20%)	0.63	1619.06	1619.4	0.34	0.48	2.76
	L(19%)	0.6	1619.06	1619.4	0.34	0.46	2.71
	L(18%)	0.57	1619.06	1619.39	0.33	0.44	2.65
	L(17%)	0.54	1619.06	1619.38	0.32	0.42	2.6
	L(16%)	0.5	1619.06	1619.37	0.31	0.4	2.52
	L(15%)	0.47	1619.06	1619.37	0.31	0.38	2.46
	NMNL1(100%)	7.5	1619.06	1619.99	0.93	3.49	7.46

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	NMNL1(25%)	1.87	1619.06	1619.59	0.53	1.14	4.26
	NMNL1(24%)	1.8	1619.06	1619.58	0.52	1.11	4.2
	NMNL1(23%)	1.72	1619.06	1619.58	0.52	1.07	4.13
	NMNL1(22%)	1.65	1619.06	1619.57	0.51	1.04	4.07
	NMNL1(21%)	1.57	1619.06	1619.56	0.5	0.99	3.98
	NMNL1(20%)	1.5	1619.06	1619.55	0.49	0.96	3.9
	NMNL2(100%)	5.38	1619.06	1619.87	0.81	2.66	6.51
	NMNL2(25%)	1.34	1619.06	1619.53	0.47	0.87	3.74
	NMNL2(24%)	1.29	1619.06	1619.52	0.46	0.84	3.67
	NMNL2(23%)	1.24	1619.06	1619.51	0.45	0.82	3.61
	NMNL2(22%)	1.18	1619.06	1619.5	0.44	0.79	3.55
	NMNL2(21%)	1.13	1619.06	1619.5	0.44	0.76	3.49
	NMNL2(20%)	1.08	1619.06	1619.49	0.43	0.73	3.42
5500 m d/s of axis	M(100%)	11.7	1607.97	1608.74	0.77	5.44	11.76
	M(30%)	3.51	1607.97	1608.43	0.46	2.25	9.34
	M(29%)	3.39	1607.97	1608.43	0.46	2.19	9.29
	M(28%)	3.28	1607.97	1608.42	0.45	2.14	9.21
	M(27%)	3.16	1607.97	1608.42	0.45	2.1	9.14
	M(26%)	3.04	1607.97	1608.41	0.44	2.03	9.03
	M(25%)	2.92	1607.97	1608.4	0.43	1.97	8.93
	M(24%)	2.81	1607.97	1608.4	0.43	1.91	8.82
	M(23%)	2.69	1607.97	1608.39	0.42	1.84	8.7
	M(22%)	2.57	1607.97	1608.38	0.41	1.77	8.55
	M(21%)	2.46	1607.97	1608.37	0.4	1.72	8.42
	M(20%)	2.34	1607.97	1608.37	0.4	1.66	8.29
	L(100%)	3.15	1607.97	1608.42	0.45	2.09	9.13
	L(20%)	0.63	1607.97	1608.2	0.23	0.58	4.89
	L(19%)	0.6	1607.97	1608.2	0.23	0.56	4.81
	L(18%)	0.57	1607.97	1608.19	0.22	0.54	4.71
	L(17%)	0.54	1607.97	1608.19	0.22	0.52	4.62
	L(16%)	0.5	1607.97	1608.18	0.21	0.48	4.47
	L(15%)	0.47	1607.97	1608.17	0.2	0.45	4.32
	NMNL1(100%)	7.5	1607.97	1608.6	0.63	3.94	10.69
	NMNL1(25%)	1.87	1607.97	1608.33	0.36	1.38	7.54
	NMNL1(24%)	1.8	1607.97	1608.33	0.36	1.34	7.44
	NMNL1(23%)	1.72	1607.97	1608.32	0.35	1.3	7.32
	NMNL1(22%)	1.65	1607.97	1608.31	0.34	1.25	7.19
	NMNL1(21%)	1.57	1607.97	1608.31	0.34	1.2	7.03
	NMNL1(20%)	1.5	1607.97	1608.3	0.33	1.16	6.93
	NMNL2(100%)	5.38	1607.97	1608.52	0.55	3.06	10.01
	NMNL2(25%)	1.34	1607.97	1608.29	0.32	1.06	6.61
	NMNL2(24%)	1.29	1607.97	1608.28	0.31	1.03	6.51
	NMNL2(23%)	1.24	1607.97	1608.28	0.31	0.99	6.4

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	NMNL2(22%)	1.18	1607.97	1608.27	0.3	0.95	6.25
	NMNL2(21%)	1.13	1607.97	1608.26	0.29	0.92	6.15
	NMNL2(20%)	1.08	1607.97	1608.26	0.29	0.89	6.05
5750 m d/s of axis	M(100%)	11.7	1597.85	1598.7	0.85	5.04	9.36
	M(30%)	3.51	1597.85	1598.37	0.52	2.14	7.54
	M(29%)	3.39	1597.85	1598.36	0.51	2.09	7.48
	M(28%)	3.28	1597.85	1598.35	0.5	2.04	7.43
	M(27%)	3.16	1597.85	1598.35	0.5	1.99	7.37
	M(26%)	3.04	1597.85	1598.34	0.49	1.94	7.31
	M(25%)	2.92	1597.85	1598.33	0.48	1.89	7.25
	M(24%)	2.81	1597.85	1598.32	0.47	1.83	7.19
	M(23%)	2.69	1597.85	1598.32	0.47	1.78	7.12
	M(22%)	2.57	1597.85	1598.31	0.46	1.72	7.05
	M(21%)	2.46	1597.85	1598.3	0.45	1.68	7
	M(20%)	2.34	1597.85	1598.3	0.45	1.63	6.94
	L(100%)	3.15	1597.85	1598.35	0.5	1.99	7.37
	L(20%)	0.63	1597.85	1598.13	0.28	0.66	4.62
	L(19%)	0.6	1597.85	1598.13	0.28	0.64	4.55
	L(18%)	0.57	1597.85	1598.12	0.27	0.6	4.43
	L(17%)	0.54	1597.85	1598.11	0.26	0.58	4.35
	L(16%)	0.5	1597.85	1598.11	0.26	0.54	4.2
	L(15%)	0.47	1597.85	1598.1	0.25	0.54	4.18
	NMNL1(100%)	7.5	1597.85	1598.55	0.7	3.64	8.67
	NMNL1(25%)	1.87	1597.85	1598.26	0.41	1.41	6.67
	NMNL1(24%)	1.8	1597.85	1598.26	0.41	1.38	6.63
	NMNL1(23%)	1.72	1597.85	1598.25	0.4	1.34	6.58
	NMNL1(22%)	1.65	1597.85	1598.25	0.4	1.29	6.48
	NMNL1(21%)	1.57	1597.85	1598.24	0.39	1.26	6.39
	NMNL1(20%)	1.5	1597.85	1598.23	0.38	1.22	6.29
	NMNL2(100%)	5.38	1597.85	1598.46	0.61	2.86	8.26
	NMNL2(25%)	1.34	1597.85	1598.22	0.37	1.12	6.04
	NMNL2(24%)	1.29	1597.85	1598.21	0.36	1.09	5.96
	NMNL2(23%)	1.24	1597.85	1598.21	0.36	1.06	5.87
	NMNL2(22%)	1.18	1597.85	1598.2	0.35	1.02	5.77
	NMNL2(21%)	1.13	1597.85	1598.2	0.35	0.99	5.67
	NMNL2(20%)	1.08	1597.85	1598.19	0.34	0.96	5.59
6000 m d/s of axis	M(100%)	11.7	1591.71	1592.59	0.88	4.87	8.47
	M(30%)	3.51	1591.71	1592.18	0.47	1.96	6.04
	M(29%)	3.39	1591.71	1592.17	0.46	1.9	5.98
	M(28%)	3.28	1591.71	1592.17	0.46	1.87	5.94
	M(27%)	3.16	1591.71	1592.16	0.45	1.8	5.87
	M(26%)	3.04	1591.71	1592.15	0.44	1.76	5.83

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	M(25%)	2.92	1591.71	1592.14	0.43	1.7	5.77
	M(24%)	2.81	1591.71	1592.13	0.42	1.65	5.71
	M(23%)	2.69	1591.71	1592.12	0.41	1.6	5.66
	M(22%)	2.57	1591.71	1592.11	0.4	1.55	5.61
	M(21%)	2.46	1591.71	1592.1	0.39	1.5	5.55
	M(20%)	2.34	1591.71	1592.09	0.38	1.44	5.49
	L(100%)	3.15	1591.71	1592.16	0.45	1.8	5.87
	L(20%)	0.63	1591.71	1591.92	0.21	0.56	4.41
	L(19%)	0.6	1591.71	1591.91	0.2	0.54	4.38
	L(18%)	0.57	1591.71	1591.91	0.2	0.53	4.37
	L(17%)	0.54	1591.71	1591.9	0.19	0.51	4.34
	L(16%)	0.5	1591.71	1591.9	0.19	0.49	4.32
	L(15%)	0.47	1591.71	1591.89	0.18	0.45	4.26
	NMNL1(100%)	7.5	1591.71	1592.41	0.7	3.46	7.39
	NMNL1(25%)	1.87	1591.71	1592.05	0.34	1.22	5.24
	NMNL1(24%)	1.8	1591.71	1592.05	0.34	1.19	5.21
	NMNL1(23%)	1.72	1591.71	1592.04	0.33	1.15	5.16
	NMNL1(22%)	1.65	1591.71	1592.03	0.32	1.13	5.13
	NMNL1(21%)	1.57	1591.71	1592.02	0.31	1.08	5.07
	NMNL1(20%)	1.5	1591.71	1592.02	0.31	1.04	5.03
	NMNL2(100%)	5.38	1591.71	1592.3	0.59	2.7	6.73
	NMNL2(25%)	1.34	1591.71	1592	0.29	0.96	4.93
	NMNL2(24%)	1.29	1591.71	1592	0.29	0.93	4.89
	NMNL2(23%)	1.24	1591.71	1591.99	0.28	0.91	4.86
	NMNL2(22%)	1.18	1591.71	1591.98	0.27	0.88	4.83
	NMNL2(21%)	1.13	1591.71	1591.98	0.27	0.85	4.79
	NMNL2(20%)	1.08	1591.71	1591.97	0.26	0.82	4.76
6250 m d/s of axis	M(100%)	11.7	1570.37	1571.15	0.78	5.52	12.13
	M(30%)	3.51	1570.37	1570.82	0.45	2.15	8.15
	M(29%)	3.39	1570.37	1570.81	0.44	2.11	8.08
	M(28%)	3.28	1570.37	1570.8	0.43	2.06	8.01
	M(27%)	3.16	1570.37	1570.79	0.42	1.98	7.89
	M(26%)	3.04	1570.37	1570.79	0.42	1.93	7.81
	M(25%)	2.92	1570.37	1570.78	0.41	1.87	7.71
	M(24%)	2.81	1570.37	1570.77	0.4	1.82	7.64
	M(23%)	2.69	1570.37	1570.76	0.39	1.76	7.53
	M(22%)	2.57	1570.37	1570.76	0.39	1.7	7.44
	M(21%)	2.46	1570.37	1570.75	0.38	1.65	7.36
	M(20%)	2.34	1570.37	1570.74	0.37	1.58	7.24
	L(100%)	3.15	1570.37	1570.79	0.42	1.98	7.88
	L(20%)	0.63	1570.37	1570.59	0.22	0.6	5.34
	L(19%)	0.6	1570.37	1570.58	0.21	0.57	5.27
	L(18%)	0.57	1570.37	1570.58	0.21	0.55	5.23

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	L(17%)	0.54	1570.37	1570.57	0.2	0.53	5.18
	L(16%)	0.5	1570.37	1570.57	0.2	0.51	5.12
	L(15%)	0.47	1570.37	1570.56	0.19	0.48	5.02
	NMNL1(100%)	7.5	1570.37	1571	0.63	3.89	10.44
	NMNL1(25%)	1.87	1570.37	1570.71	0.34	1.33	6.81
	NMNL1(24%)	1.8	1570.37	1570.7	0.33	1.3	6.75
	NMNL1(23%)	1.72	1570.37	1570.69	0.32	1.26	6.67
	NMNL1(22%)	1.65	1570.37	1570.69	0.32	1.21	6.59
	NMNL1(21%)	1.57	1570.37	1570.68	0.31	1.17	6.51
	NMNL1(20%)	1.5	1570.37	1570.68	0.31	1.13	6.44
	NMNL2(100%)	5.38	1570.37	1570.91	0.54	3	9.33
	NMNL2(25%)	1.34	1570.37	1570.66	0.29	1.05	6.28
	NMNL2(24%)	1.29	1570.37	1570.66	0.29	1.02	6.22
	NMNL2(23%)	1.24	1570.37	1570.65	0.28	0.98	6.16
	NMNL2(22%)	1.18	1570.37	1570.65	0.28	0.95	6.09
	NMNL2(21%)	1.13	1570.37	1570.64	0.27	0.92	6.02
	NMNL2(20%)	1.08	1570.37	1570.64	0.27	0.89	5.97
6500 m d/s of axis	M(100%)	11.7	1555.18	1555.9	0.72	5.28	10.72
	M(30%)	3.51	1555.18	1555.56	0.38	2.12	7.74
	M(29%)	3.39	1555.18	1555.55	0.37	2.06	7.66
	M(28%)	3.28	1555.18	1555.54	0.36	2.02	7.62
	M(27%)	3.16	1555.18	1555.54	0.36	1.97	7.56
	M(26%)	3.04	1555.18	1555.53	0.35	1.91	7.49
	M(25%)	2.92	1555.18	1555.52	0.34	1.85	7.43
	M(24%)	2.81	1555.18	1555.51	0.33	1.8	7.36
	M(23%)	2.69	1555.18	1555.51	0.33	1.75	7.3
	M(22%)	2.57	1555.18	1555.5	0.32	1.68	7.23
	M(21%)	2.46	1555.18	1555.49	0.31	1.62	7.15
	M(20%)	2.34	1555.18	1555.48	0.3	1.58	7.1
	L(100%)	3.15	1555.18	1555.53	0.35	1.96	7.55
	L(20%)	0.63	1555.18	1555.33	0.15	0.6	5.78
	L(19%)	0.6	1555.18	1555.33	0.15	0.6	5.77
	L(18%)	0.57	1555.18	1555.33	0.15	0.57	5.73
	L(17%)	0.54	1555.18	1555.32	0.14	0.55	5.69
	L(16%)	0.5	1555.18	1555.32	0.14	0.52	5.65
	L(15%)	0.47	1555.18	1555.31	0.13	0.5	5.62
	NMNL1(100%)	7.5	1555.18	1555.75	0.57	3.76	9.4
	NMNL1(25%)	1.87	1555.18	1555.45	0.27	1.32	6.78
	NMNL1(24%)	1.8	1555.18	1555.44	0.26	1.29	6.73
	NMNL1(23%)	1.72	1555.18	1555.44	0.26	1.26	6.7
	NMNL1(22%)	1.65	1555.18	1555.43	0.25	1.24	6.66
	NMNL1(21%)	1.57	1555.18	1555.42	0.24	1.18	6.59
	NMNL1(20%)	1.5	1555.18	1555.42	0.24	1.14	6.54

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	NMNL2(100%)	5.38	1555.18	1555.65	0.47	2.93	8.6
	NMNL2(25%)	1.34	1555.18	1555.4	0.22	1.05	6.41
	NMNL2(24%)	1.29	1555.18	1555.4	0.22	1.03	6.38
	NMNL2(23%)	1.24	1555.18	1555.4	0.22	0.99	6.34
	NMNL2(22%)	1.18	1555.18	1555.39	0.21	0.95	6.28
	NMNL2(21%)	1.13	1555.18	1555.39	0.21	0.93	6.25
	NMNL2(20%)	1.08	1555.18	1555.38	0.2	0.9	6.21
6750 m d/s of axis	M(100%)	11.7	1542.18	1542.93	0.75	5.12	9.7
	M(30%)	3.51	1542.18	1542.56	0.38	2.06	7.06
	M(29%)	3.39	1542.18	1542.56	0.38	2.01	7.01
	M(28%)	3.28	1542.18	1542.55	0.37	1.96	6.97
	M(27%)	3.16	1542.18	1542.54	0.36	1.9	6.9
	M(26%)	3.04	1542.18	1542.54	0.36	1.86	6.86
	M(25%)	2.92	1542.18	1542.53	0.35	1.8	6.8
	M(24%)	2.81	1542.18	1542.52	0.34	1.74	6.74
	M(23%)	2.69	1542.18	1542.51	0.33	1.7	6.69
	M(22%)	2.57	1542.18	1542.5	0.32	1.64	6.62
	M(21%)	2.46	1542.18	1542.49	0.31	1.58	6.55
	M(20%)	2.34	1542.18	1542.49	0.31	1.53	6.5
	L(100%)	3.15	1542.18	1542.54	0.36	1.91	6.91
	L(20%)	0.63	1542.18	1542.33	0.15	0.6	5.37
	L(19%)	0.6	1542.18	1542.33	0.15	0.58	5.35
	L(18%)	0.57	1542.18	1542.32	0.14	0.56	5.32
	L(17%)	0.54	1542.18	1542.32	0.14	0.53	5.27
	L(16%)	0.5	1542.18	1542.31	0.13	0.51	5.25
	L(15%)	0.47	1542.18	1542.31	0.13	0.49	5.22
	NMNL1(100%)	7.5	1542.18	1542.77	0.59	3.64	8.52
	NMNL1(25%)	1.87	1542.18	1542.45	0.27	1.3	6.25
	NMNL1(24%)	1.8	1542.18	1542.44	0.26	1.27	6.21
	NMNL1(23%)	1.72	1542.18	1542.44	0.26	1.22	6.15
	NMNL1(22%)	1.65	1542.18	1542.43	0.25	1.18	6.1
	NMNL1(21%)	1.57	1542.18	1542.42	0.24	1.14	6.05
	NMNL1(20%)	1.5	1542.18	1542.42	0.24	1.11	6.01
	NMNL2(100%)	5.38	1542.18	1542.67	0.49	2.83	7.82
	NMNL2(25%)	1.34	1542.18	1542.41	0.23	1.03	5.92
	NMNL2(24%)	1.29	1542.18	1542.4	0.22	0.99	5.88
	NMNL2(23%)	1.24	1542.18	1542.39	0.21	0.97	5.84
	NMNL2(22%)	1.18	1542.18	1542.39	0.21	0.94	5.81
	NMNL2(21%)	1.13	1542.18	1542.39	0.21	0.91	5.78
	NMNL2(20%)	1.08	1542.18	1542.38	0.2	0.88	5.73
7000 m d/s of	M(100%)	11.7	1529.86	1530.86	1	5.26	10.67
	M(30%)	3.51	1529.86	1530.48	0.62	1.99	6.46

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
axis	M(29%)	3.39	1529.86	1530.47	0.61	1.93	6.36
	M(28%)	3.28	1529.86	1530.46	0.6	1.89	6.29
	M(27%)	3.16	1529.86	1530.45	0.59	1.84	6.2
	M(26%)	3.04	1529.86	1530.44	0.58	1.77	6.1
	M(25%)	2.92	1529.86	1530.44	0.58	1.73	6.01
	M(24%)	2.81	1529.86	1530.43	0.57	1.67	5.92
	M(23%)	2.69	1529.86	1530.42	0.56	1.61	5.8
	M(22%)	2.57	1529.86	1530.41	0.55	1.55	5.7
	M(21%)	2.46	1529.86	1530.4	0.54	1.5	5.61
	M(20%)	2.34	1529.86	1530.39	0.53	1.44	5.49
	L(100%)	3.15	1529.86	1530.45	0.59	1.83	6.18
	L(20%)	0.63	1529.86	1530.18	0.32	0.51	3.28
	L(19%)	0.6	1529.86	1530.17	0.31	0.5	3.23
	L(18%)	0.57	1529.86	1530.16	0.3	0.48	3.15
	L(17%)	0.54	1529.86	1530.16	0.3	0.46	3.1
	L(16%)	0.5	1529.86	1530.15	0.29	0.43	3.01
	L(15%)	0.47	1529.86	1530.14	0.28	0.42	2.95
	NMNL1(100%)	7.5	1529.86	1530.7	0.84	3.68	8.89
	NMNL1(25%)	1.87	1529.86	1530.34	0.48	1.2	5.01
	NMNL1(24%)	1.8	1529.86	1530.33	0.47	1.17	4.95
	NMNL1(23%)	1.72	1529.86	1530.33	0.47	1.12	4.85
	NMNL1(22%)	1.65	1529.86	1530.32	0.46	1.09	4.77
	NMNL1(21%)	1.57	1529.86	1530.31	0.45	1.05	4.68
	NMNL1(20%)	1.5	1529.86	1530.3	0.44	1.01	4.59
	NMNL2(100%)	5.38	1529.86	1530.6	0.74	2.84	7.78
	NMNL2(25%)	1.34	1529.86	1530.28	0.42	0.92	4.38
	NMNL2(24%)	1.29	1529.86	1530.28	0.42	0.9	4.34
	NMNL2(23%)	1.24	1529.86	1530.27	0.41	0.87	4.27
	NMNL2(22%)	1.18	1529.86	1530.26	0.4	0.83	4.17
	NMNL2(21%)	1.13	1529.86	1530.26	0.4	0.81	4.12
	NMNL2(20%)	1.08	1529.86	1530.25	0.39	0.77	4.02
7250 m d/s of axis	M(100%)	11.7	1522.29	1523.56	1.27	4.68	7.39
	M(30%)	3.51	1522.29	1523.07	0.78	1.78	4.57
	M(29%)	3.39	1522.29	1523.06	0.77	1.72	4.49
	M(28%)	3.28	1522.29	1523.05	0.76	1.68	4.43
	M(27%)	3.16	1522.29	1523.04	0.75	1.63	4.36
	M(26%)	3.04	1522.29	1523.03	0.74	1.58	4.31
	M(25%)	2.92	1522.29	1523.02	0.73	1.54	4.24
	M(24%)	2.81	1522.29	1523.01	0.72	1.49	4.18
	M(23%)	2.69	1522.29	1522.99	0.7	1.44	4.1
	M(22%)	2.57	1522.29	1522.98	0.69	1.38	4.02
	M(21%)	2.46	1522.29	1522.97	0.68	1.33	3.95
	M(20%)	2.34	1522.29	1522.95	0.66	1.28	3.87

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	L(100%)	3.15	1522.29	1523.04	0.75	1.62	4.36
	L(20%)	0.63	1522.29	1522.68	0.39	0.45	2.29
	L(19%)	0.6	1522.29	1522.68	0.39	0.43	2.25
	L(18%)	0.57	1522.29	1522.67	0.38	0.41	2.2
	L(17%)	0.54	1522.29	1522.66	0.37	0.4	2.17
	L(16%)	0.5	1522.29	1522.65	0.36	0.37	2.1
	L(15%)	0.47	1522.29	1522.64	0.35	0.35	2.04
	NMNL1(100%)	7.5	1522.29	1523.35	1.06	3.26	6.14
	NMNL1(25%)	1.87	1522.29	1522.9	0.61	1.07	3.54
	NMNL1(24%)	1.8	1522.29	1522.89	0.6	1.04	3.49
	NMNL1(23%)	1.72	1522.29	1522.88	0.59	1.01	3.44
	NMNL1(22%)	1.65	1522.29	1522.87	0.58	0.97	3.37
	NMNL1(21%)	1.57	1522.29	1522.86	0.57	0.93	3.3
	NMNL1(20%)	1.5	1522.29	1522.85	0.56	0.9	3.24
	NMNL2(100%)	5.38	1522.29	1523.22	0.93	2.52	5.43
	NMNL2(25%)	1.34	1522.29	1522.82	0.53	0.82	3.1
	NMNL2(24%)	1.29	1522.29	1522.81	0.52	0.8	3.05
	NMNL2(23%)	1.24	1522.29	1522.81	0.52	0.77	3
	NMNL2(22%)	1.18	1522.29	1522.8	0.51	0.74	2.94
	NMNL2(21%)	1.13	1522.29	1522.78	0.49	0.71	2.89
	NMNL2(20%)	1.08	1522.29	1522.78	0.49	0.69	2.84
7500 m d/s of axis	M(100%)	11.7	1502.1	1504.09	1.99	5.18	5.27
	M(30%)	3.51	1502.1	1503.34	1.24	2.04	3.19
	M(29%)	3.39	1502.1	1503.32	1.22	1.99	3.16
	M(28%)	3.28	1502.1	1503.3	1.2	1.94	3.13
	M(27%)	3.16	1502.1	1503.29	1.19	1.89	3.09
	M(26%)	3.04	1502.1	1503.27	1.17	1.83	3.06
	M(25%)	2.92	1502.1	1503.25	1.15	1.78	3.02
	M(24%)	2.81	1502.1	1503.24	1.14	1.73	2.98
	M(23%)	2.69	1502.1	1503.22	1.12	1.67	2.94
	M(22%)	2.57	1502.1	1503.2	1.1	1.61	2.9
	M(21%)	2.46	1502.1	1503.18	1.08	1.56	2.87
	M(20%)	2.34	1502.1	1503.16	1.06	1.5	2.82
	L(100%)	3.15	1502.1	1503.29	1.19	1.88	3.09
	L(20%)	0.63	1502.1	1502.73	0.63	0.54	1.7
	L(19%)	0.6	1502.1	1502.72	0.62	0.52	1.67
	L(18%)	0.57	1502.1	1502.71	0.61	0.5	1.64
	L(17%)	0.54	1502.1	1502.7	0.6	0.48	1.6
	L(16%)	0.5	1502.1	1502.68	0.58	0.45	1.55
	L(15%)	0.47	1502.1	1502.66	0.56	0.43	1.52
	NMNL1(100%)	7.5	1502.1	1503.77	1.67	3.62	4.28
	NMNL1(25%)	1.87	1502.1	1503.07	0.97	1.27	2.6
	NMNL1(24%)	1.8	1502.1	1503.06	0.96	1.23	2.56

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	NMNL1(23%)	1.72	1502.1	1503.04	0.94	1.19	2.52
	NMNL1(22%)	1.65	1502.1	1503.03	0.93	1.15	2.48
	NMNL1(21%)	1.57	1502.1	1503.01	0.91	1.11	2.43
	NMNL1(20%)	1.5	1502.1	1502.99	0.89	1.07	2.39
	NMNL2(100%)	5.38	1502.1	1503.56	1.46	2.79	3.65
	NMNL2(25%)	1.34	1502.1	1502.95	0.85	0.98	2.29
	NMNL2(24%)	1.29	1502.1	1502.94	0.84	0.95	2.25
	NMNL2(23%)	1.24	1502.1	1502.93	0.83	0.92	2.22
	NMNL2(22%)	1.18	1502.1	1502.91	0.81	0.89	2.18
	NMNL2(21%)	1.13	1502.1	1502.9	0.8	0.86	2.14
	NMNL2(20%)	1.08	1502.1	1502.89	0.79	0.83	2.1
At TRT	M(100%)	11.7	1501.16	1502.66	1.5	3.95	4.42
	M(30%)	3.51	1501.16	1502.07	0.91	1.62	3.5
	M(29%)	3.39	1501.16	1502.06	0.9	1.58	3.49
	M(28%)	3.28	1501.16	1502.05	0.89	1.55	3.47
	M(27%)	3.16	1501.16	1502.04	0.88	1.51	3.44
	M(26%)	3.04	1501.16	1502.03	0.87	1.47	3.39
	M(25%)	2.92	1501.16	1502.02	0.86	1.42	3.34
	M(24%)	2.81	1501.16	1502	0.84	1.38	3.29
	M(23%)	2.69	1501.16	1501.99	0.83	1.32	3.22
	M(22%)	2.57	1501.16	1501.97	0.81	1.28	3.16
	M(21%)	2.46	1501.16	1501.96	0.8	1.23	3.11
	M(20%)	2.34	1501.16	1501.94	0.78	1.19	3.05
	L(100%)	3.15	1501.16	1502.04	0.88	1.5	3.43
	L(20%)	0.63	1501.16	1501.62	0.46	0.41	1.8
	L(19%)	0.6	1501.16	1501.61	0.45	0.4	1.76
	L(18%)	0.57	1501.16	1501.61	0.45	0.38	1.73
	L(17%)	0.54	1501.16	1501.6	0.44	0.37	1.69
	L(16%)	0.5	1501.16	1501.58	0.42	0.35	1.65
	L(15%)	0.47	1501.16	1501.57	0.41	0.33	1.6
	NMNL1(100%)	7.5	1501.16	1502.39	1.23	2.82	4
	NMNL1(25%)	1.87	1501.16	1501.87	0.71	0.99	2.78
	NMNL1(24%)	1.8	1501.16	1501.86	0.7	0.96	2.74
	NMNL1(23%)	1.72	1501.16	1501.85	0.69	0.93	2.69
	NMNL1(22%)	1.65	1501.16	1501.84	0.68	0.9	2.65
	NMNL1(21%)	1.57	1501.16	1501.83	0.67	0.86	2.6
	NMNL1(20%)	1.5	1501.16	1501.82	0.66	0.83	2.55
	NMNL2(100%)	5.38	1501.16	1502.24	1.08	2.21	3.76
	NMNL2(25%)	1.34	1501.16	1501.79	0.63	0.76	2.44
	NMNL2(24%)	1.29	1501.16	1501.78	0.62	0.74	2.41
	NMNL2(23%)	1.24	1501.16	1501.77	0.61	0.71	2.36
	NMNL2(22%)	1.18	1501.16	1501.76	0.6	0.68	2.32
	NMNL2(21%)	1.13	1501.16	1501.75	0.59	0.66	2.28

Location	Profile	Q Total	Deepest Bed Level	Water surface Elevation	Depth of Flow	Flow Area	Top Width
		(m^3/s)	(m)	(m)	(m)	(m^2)	(m)
	NMNL2(20%)	1.08	1501.16	1501.74	0.58	0.64	2.24

Note:
M – Monsoon Season
NMNL1 – Non Monsoon Non Lean Season (October & November)
L – Lean Season
NMNL2 – Non Monsoon Non Lean Season (April & May)

The depth of flow for snow trout in various seasons is given in Table-10.38. The minimum depth for various seasons is not available even with 100% flow. Hence, in such projects, the criteria of top width & depth has been considered for assessment of Environmental Flows.

Reduction in water depth and flow width should not be more than 50% of pre-project levels. Pre-project water depth and water width are assessed by reviewing the results of 100% release scenario.

The summary of Environmental Flows for JakholSankari HEP is given in Table-10.38.

Table-10.38Summary of Environmental Flows for JakholSankari HEP

S. No.	Season	Percentage of Environmental Flows	Average Environmental Flows(m^3/s)
1	Monsoon *(June to September)*	25%	2.92
2	Non-monsoon Non Lean Season *(October to November*	22%	1.18
3	Non-monsoon Non Lean Season *(April to May)*	22%	1.65
4	Lean Season *(December to March)*	20%	0.63

10.16 COST ESTIMATE

10.16.1 Cost for Implementing Environmental Management Plan

The total amount to be spent for implementation of Environmental Management Plan (EMP) would be Rs. 50.54 crore. The cost of Corporate Environmental Responsibility is 7.16 crore. The details of the cost are given in Table-10.39.

Table-10.39 Cost for implementing Environmental Management Plan

S. No.	Item	Cost (Rs. Lakh)
EMP		
1.	Biodiversity Conservation Plan	724.50
2.	Catchment Area Treatment Plan	680.0
3.	Sustenance of riverine fisheries	105.88
4.	Health Delivery System	142.30
5.	Environmental Management in Labour Camps	490.43
6.	Stabilization of Muck Disposal Sites	421.00
7.	Landscaping and Restoration of Construction Area	100.00
8.	Environmental Management in Road Construction	270.00
9.	Greenbelt Development	30.00
10.	Control of Air Pollution	66.80
11.	Control for Noise Pollution	11.00
12.	Water Pollution Control	10.00
13.	Public Awareness Program	50.00
14.	Disaster Management Plan	60.00
15.	Resettlement and Rehabilitation Plan	1369.13
16.	Local Area Development Plan (LADP)	240.0
17.	Livelihood Plan for PAF	192.64
18.	Monitoring and Evaluation Aspects for social aspects	30.0
19.	Implementation of Environmental Monitoring Programme during construction stage (Refer Table-10.40)	45.6
20.	Purchase of Meteorological Instruments and Noise Meter	15.0
	Total-A	**5054.28 Say 50.54 Cr**
	Corporate Environmental Responsibility	
1.	Corporate Environmental Responsibility	716.10
	Total-B	**Say 7.16 Cr**
	Grand Total	**57.70Cr. Say 58 Cr.**

10.16.2 Cost for Implementing Environmental Monitoring Proramme During Construction Phase

The cost required for implementation of Environmental Monitoring programme during project construction phase is Rs. 45.6 lakh. The details are given in Table-10.40.

Table-10.40 : Cost for implementing Environmental Monitoring Programme during project construction phase

Item	Cost (Rs. lakh)
Effluent from labour camps	11.2
Ambient air quality monitoring	11.2
Incidence of water related diseases	23.2
Total	**45.6**

10.16.3 Cost for Implementing Environmental Monitoring Proramme During Operation Phase

The cost required for implementation of the Environmental Monitoring Programme during operation phase is the order of Rs.18.6 lakh/year. A 10% annual price increase may be considered for every year. The details are given in below Table-10.41.

Table-10.41: Cost for implementing Environmental Monitoring Programme during project operation phase

Item	Cost (Rs. lakh/year)
Water quality and effluent from project colony	2.6
Ecology	5.0
Riverine fisheries	6.0
Incidence of water related diseases	5.0
Total	**18.6**

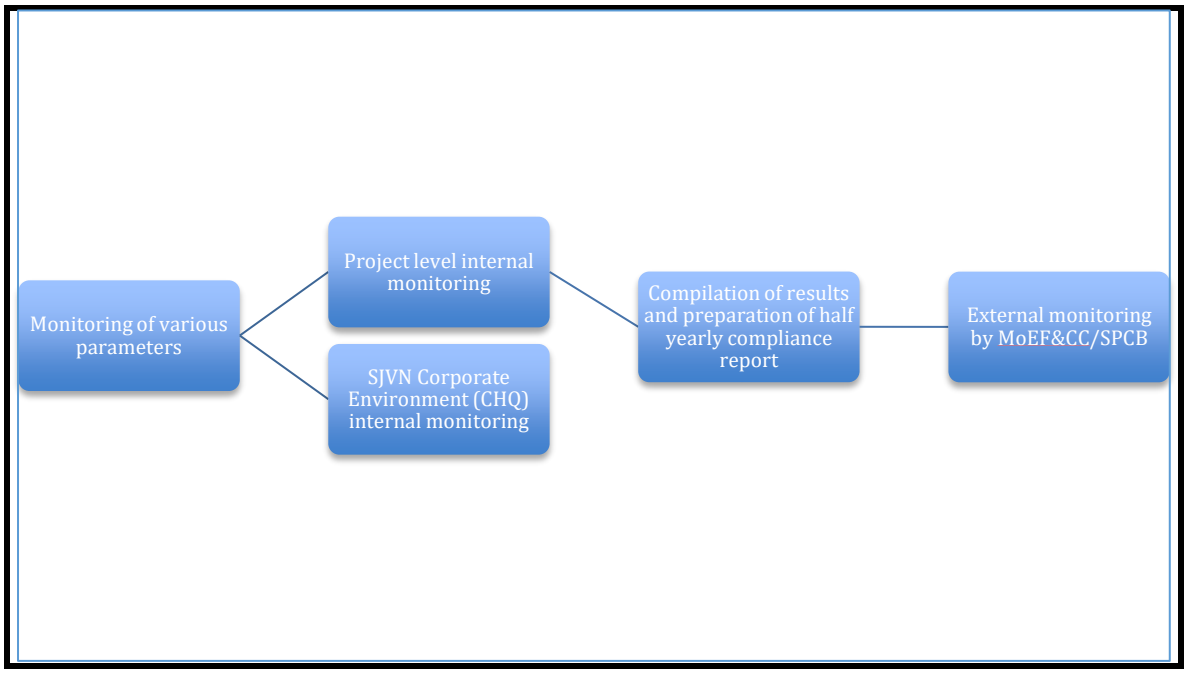
10.16.4 ADMINSITRATIVE/ORGANISATION SETUP

The magnitude of the project and various proposed environmental plan indicate that the project would require manpower to look after all issues of EMP report especially Biodiversity Management Plan, CAT Plan, Relocation and Rehabilitation of Muck, Creation of Green Belt, R&R, etc. In order to implement these plans in environmentally sound manner a dedicated Project Environment Deptt. and R&R Deptt. is to be constituted at site having 2 no. Environment Officers and 1 no. R&R Officer with necessary support staff. These officers shall also undertake internal monitoring/assessment of EMP activities and also assist during external monitoring by MoEF&CC/SPCB.

Compliance to Conditions Laid Down by the State and Central Government:

While granting statutory clearances, the State Government and regulators as well as Central Government will impose certain conditions on the project authorities, which are required to be complied with. As soon as these conditions are imposed, the Project Environment Deptt. and R&R Deptt. will undertake all necessary steps to achieve 100% compliance of these stipulations. A half yearly compliance report along with monitoring results will be made available to these statutory/regulatory agencies for effective monitoring.

The reporting mechanism will be as under:



CHAPTER-11
SUMMARY AND CONCLUSIONS

CHAPTER-11

SUMMARY AND CONCLUSIONS

11.1 GENERAL

The Satluj Jal Vidyut Nigam Ltd. (SJVNL), formerly Naptha-Jhakri Power Corporation Ltd. (NJPC) was incorporated on 24.5.1988 as a joint venture of Government of India and Govt. of Himachal Pradesh (H.P.). The 1500 MW Naptha Jhkakri H.E. Power project is the first project commissioned by the company.

The Jakhol Sankri Hydroelectric Project (JSHEP) is proposed on Supin River in Uttarkashi district of Uttrakhand State. There are several hydropower projects under different stages of development on river Tons. These are mainly 60 MW Naitwar Mori HEP, Mori Hanol HEP and Hanol Tuini HEP. In addition, Tons has about 500 MW of identified hydropower projects under development. Jakhol Sankri HEP is one of the three hydropower projects awarded to Satluj Jal Vidyut Nigam Limited (SJVN Ltd.) in the State of Uttrakhand. The other two projects are Naitwar Mori HEP on river Tons downstream of Jakhol Sankri HEP (JSHEP) and Devasari HEP on river Pindar, a major tributary of river Alaknanda, in district Chamoli.

11.2 PROJECT DESCRIPTION

The project site and its components can be reached by National Highway NH-123 from state capital Dehradun which is connected very well by rail/road/air with the other parts of the country. Jakhol village which is located on the left bank of river Supin is approximately 220 km from Dehradun. Road between Dehradun Jakhol village passes through the places like Harbatpur, Barwala, Hatyari, Judoo, Nougaon, Purola, Mori and Naitwar. The Jakhol village is approximately 12 Km upstream of Naitwar village. Downstream of the project site a 60 MW Naitwar Mori HEP has been proposed between the stretches of Naitwar and Mori village.

The proposed Barrage site is across river Supin near Dhara village. The width of the river at this section is about 33 m. The right bank is rather steep while the left bank is suitable for Power Intake. The selected layout takes into consideration the constraints that protected wildlife areas are not affected upon. The power intake, approach Tunnel, underground desilting tank; have been provided on the left bank terrace adjacent at Barrage location.. A pressure shaft carries water from surge shaft to the powerhouse. The powerhouse is proposed on the left bank of river Supin near Sankri village. A tailrace tunnel drains the discharge from the powerhouse back to

Supin river. The salient features are given in Table-11.1

Table-11.1: Salient features of Jakhol Sankari HEP

LOCATION	
State	Uttarakhand (formerly Uttranchal)
District	Uttarkashi
Tehsil	Mori
Latitude	31°05'19"N - 31°07'06"N
Longitude	78°11' 10"E - 78°14'07"E
Nearest Rail head	Dehradun
Nearest Airport / approach	Dehradun
Name of River / Tributary	Supin (Tributary of Tons)
Name of River Basin	Yamuna River Basin
HYDROLOGY AND CLIMATE	
Catchment Area upto head works (km^2)	268.20 km^2
Snow Catchment area (km^2)	29.50 km^2 (11% of total)
Average annual Yield (Mm^3)	359.72
Maximum / Minimum Yield	667.96 - Year 1990-91/ 214.07 - Year 2000-01
Design Flood (m^3/s)	270 (in 100 year)
90% available discharge (Mm^3)	225.53 - Year 1984-85
DIVERSION STRUCTURE	
Type	Barrage
Maximum height above deepest foundation	17 m
Average River Bed Level at Barrage Axis	EL 1955.00 m
Elevation at top of Barrage	EL 1962.20m
Length of Barrage bay at top (m)	33.0 m
FRL (m)	EL 1959.4 m
MWL (m)	EL 1961.20 m
No. & size of gates	4 Nos. - 5.00m (W) x 4.4 m (H)
RIVER DIVERSION ARRANGEMENT	
Pipe Size (dia. in m), type and number	1.6 M diameter Steel Pipes, 3 No.
Pipe Length(m)	187.4 m (approximately)
DESIL TING TANK	
Type	Underground, twin chamber
Number and size - L (m) x B (m) x H (m)	Two, 100 (L) x 12.0(W) x 12.27 (H)
Particle size to be removed (mm)	0.2
Number of adit	One
HEAD RACE TUNNEL	
Length (m) and shape	6624.48m, modified Horse shoe shaped
Diameter (m)	3.0 m (finished)
Design discharge (m^3/s)	11.40
Number of adits	Four
SURGE SHAFT	
Type	Underground restricted orifice
Diameter (m)	7.5 m
Height (m)	42.87 m (EL difference between

	crown of Surge Shaft and sill level of Surge Shaft orifice)
Top Elevation	EL 1979.55 m (Crown of Surge Shaft)
Invert Level of Surge Shaft orifice	EL 1936.68 m
PRESSURE SHAFT / PENSTOCK	
Type	Steel Lined Partly Pressure Shaft & partly penstock
Number of Pressure shafts	One
Normal discharge through pressure shaft/penstock (m^3/s)	11.40
Internal Diameter of pressure shaft (m)	1.85
Maximum velocity (m/sec)	4.24
Length of pressure shaft (m)	707.34
Length of unit penstock (m)	50.55
Penstock Gate at Surge Shaft	1 no.
Main Inlet valve, if any (type & diameter)	2 Nos., 1.3 m (Spherical type)
UNDERGROUND POWERHOUSE	
Type	Underground
Location	Left bank of river Supin, about 200 m upstream of confluence of Supin and Tons.
Installed Capacity	2x22 MW
Efficiency of Turbine	92%
Maximum Gross Head	445.80 m
Net Design Head	436.36 m
Type of turbine	Vertical Pelton
Rated Discharge through each unit (m^3/s)	5.7 m^3/sec
For Generator/Generator motor	
- type	Synchronous, single phase
- Efficiency	98%
Size of transformer Cavern	73.11m(L)x12.00m(W)x26.78m(H) ace Conduits 02
TAILRACE CHANNEL	
Tailrace Channel	D-shaped, 3.5 m Diameter and 3.75 m (height)
Length of Tailrace channel	155.52 m
EL of the downstream crest	1508.36 m
POWER BENEFITS	
Design Energy (GWh/annum)	166.19 MU
CONSTRUCTION PERIOD	4 Years (48 Months)
COST ESTIMATES (Rs. In Crores)	Present Day
Civil & HM	250.23
Electrical/Mechanical	170.60
Sub-Total (Generation)	420.83
IDC	52.98
Financial charges & Front End Free	3.34
Total cost with IDC & Front End Fee	477.15

LEVELISED TARRIF	
Levelised Tariff (Rs./kWh) (with free power to home state)	7.56
First Year Tariff (Rs./kWh) (with free power to home state)	7.55
Cost per MW (with IDC & FC) – in Crore	10.84
Cost per MW (without IDC & FC) – in Crore	9.56

The land to be acquired for the project is 39.998 ha. Out of this, about 15.681 ha is private land and about 2.250 ha is forest land. The ownership status is given in Table-11.2.

Table-11.2: Total Land proposed for Acquisition for Jakhol Sankari HEP

S. No	Type of Land	Area (ha)
1.	Govt./Civil Soyam Land (Including Notional Land)	22.067
2.	Private Land	15.681
3.	Forest Land	2.250
	Total	**39.998**

11.3 STUDY AREA

The study area covered as a part of the CEIA study is as below

- Land to be acquired for various project appurtenances including reservoir submergence.
- 10 km on either side from the periphery of reservoir submergence.
- Area within 10 km on either side of various project appurtenances.
- Catchment area intercepted at barrage site.

The FCC of the Study Area is enclosed as Figure-11.1.

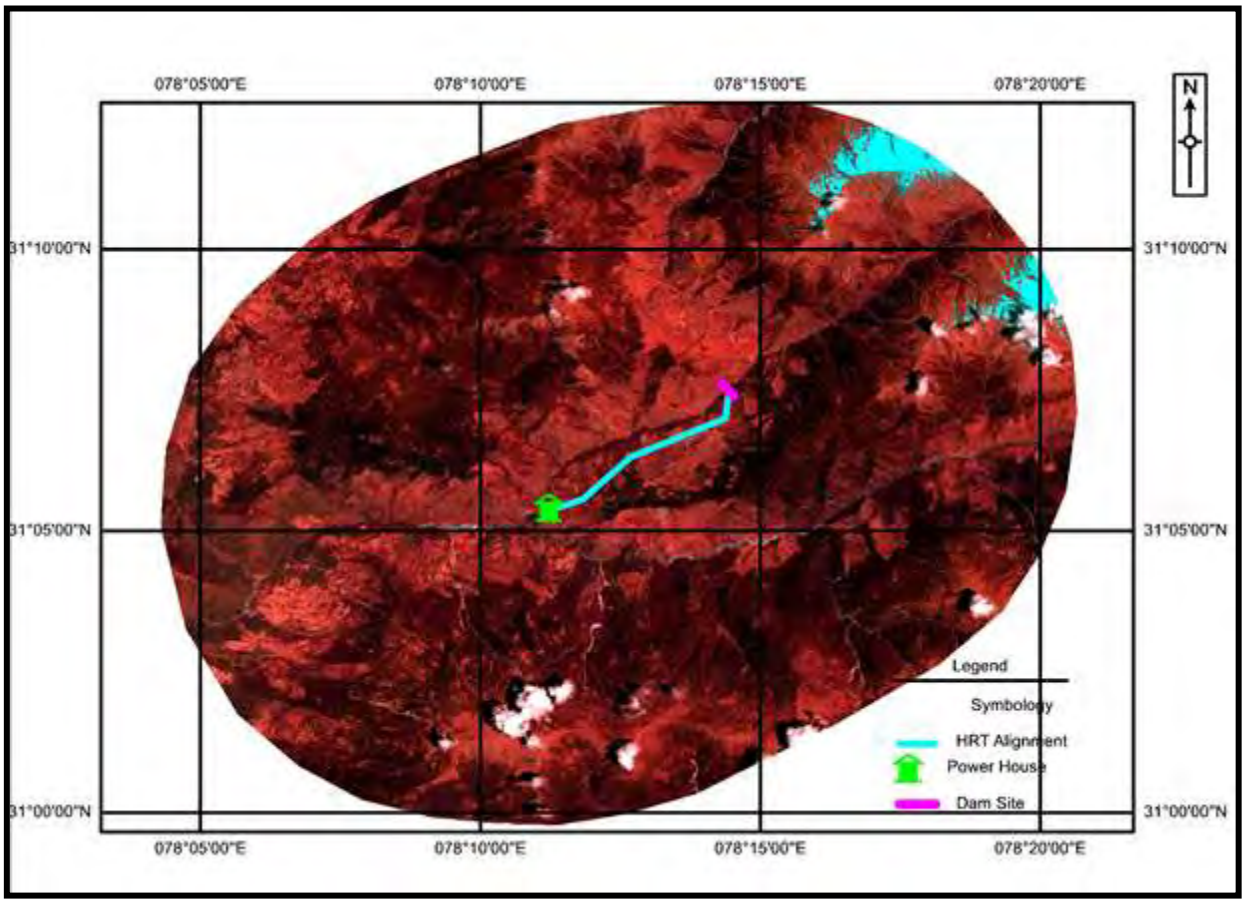


Figure-11.1: Study Area Map

11.4 ENVIRONMENTAL BASELINE STATUS

The baseline status for the above referred categories has been described in the following sections.

11.4.1 Physcio-Chemical Aspects

11.4.1.1 Meteorology

The climatic conditions in the project area and its surroundings vary with elevation. The average meteorological conditions in the project area are given in Table-11.3.

Table-11.3: Average meteorological conditions in the project area

Month	Temperature (°C)		Rainfall (mm)	No. of rainy days	Relative humidity (%)
	Maximum	Minimum			
January	10.6	2.5	51.8	4.5	63
February	12.4	3.8	52.8	4.1	60
March	16.5	7.5	57.7	4.4	55
April	21.2	12.0	30.0	2.5	48

Month	Temperature (°C)		Rainfall (mm)	No. of rainy days	Relative humidity (%)
	Maximum	Minimum			
May	24.1	14.7	58.4	4.1	50
June	23.7	16.2	174.9	8.6	71
July	20.8	15.5	662.0	21.9	91
August	20.2	15.2	670.6	21.8	92
September	19.9	14.0	277.5	11.1	84
October	18.9	11.2	64.7	3.0	64
November	15.9	7.3	14.8	0.9	58
December	13.1	4.6	18.2	1.3	56
Average	**18.1**	**10.4**	**2176.4**	**88.2**	**66**

Source: India Meteorological Department (IMD)

11.4.1.2 Soils

The pH in soils of the command area lies within neutral range, i.e. 5.25 to 7.63. The Electrical Conductivity indicates that salt content is low in the soils. The sodium levels do not indicate any potential for soil salinization or adverse impacts on soil productivity. The concentration of Available Potassium, Available Calcium and Available Magnesium ranged from 2887.54 to 9542 mg/kg, 215.6 to 4758.mg/kg, and 1716.4 to 6621.07 mg/kg. The organic carbon in various samples indicates low to moderate productivity. The porosity ranged from 50.18 to 69.62%.

11.4.1.3 Surface Water Quality

The total hardness in various water samples ranged from 24-44 mg/l and from 21-42 mg/l and from 20-44 mg/l in winter, pre-monsoon and monsoon seasons respectively. The low calcium and magnesium levels are responsible for soft nature of water. The carbonate hardness (for water with alkalinity level as observed in the study area) is equal to the alkalinity level, i.e. ranging from 14.42 to 28.92, from 12.36 to 40.2 mg/l and from 13.22 to 28.86 mg/l in winter, pre-monsoon and monsoon seasons respectively. The non-carbonate hardness accounts for the balance hardness. Normally non-carbonate hardness can be removed by boiling. However, hardness levels in the area do not need any treatment. The total hardness level in the water is well below the permissible limit of 200 mg/l.

The low EC and TDS values indicate the lower concentration of cations and anions. The concentration of TDS level ranged from 36 to 48 mg/l, from 36-47 mg/l and from 28-50 mg/l in winter, pre-monsoon and monsoon season respectively which is much lower than the permissible limit of 500 mg/l specified for domestic use. This is also reflected by the fact that the concentration of most of the cations and anions are well

within the permissible limit. The fluorides level was lower than the permissible limit (1 mg/l) for drinking purposes. Use of water with such fluorides level could lead to dental curies.

The BOD values are well within the permissible limits, which indicate the absence of organic pollution loading. This is mainly due to the low population density and absence of industries in the area. The low COD values also indicate the absence of chemical pollution loading in the area. The marginal quantity of pollution load, which enters river Supin, gets diluted. In fact, even for the minimum flow, there is more than adequate water available for dilution. Level of heavy metal in the water of the project area is below the permissible limit used for drinking purposes. Total Coliform count is nil in the study area. It can be concluded that water quality was observed to be quite good.

11.4.1.4 Ambient Air Quality

The average PM_{10} levels as observed at various stations in the study area ranged from 42.0 to 55.0 µg/m^3. All the values of PM_{10} monitored during the field survey were below the permissible limit of 100 µg/m^3 for industrial, residential, rural and other areas. The average $PM_{2.5}$ levels as observed at various stations in the study area ranged from 14.0 to 27.0 µg/m^3. All the values of $PM_{2.5}$ monitored during the field survey were below the permissible limit of 60 µg/m^3 for industrial, residential, rural and other areas. The highest values of NO_2 were observed in the winter, pre-monsoon and monsoon season are 6.2, 7 and 7 µg/m^3 respectively, at station AQ1. The highest value of 7.0 µg/m^3 too was also observed at the same station. The NO_2 level observed at various sampling stations was much lower than the permissible limit of 80 µg/m^3 for industrial, residential, rural and other areas. The maximum SO_2 level of 10.7, 11.1 and 10.0 µg/m^3 was observed at station AQ1 in the winter, pre-monsoon and monsoon season respectively. The SO_2 level observed at various stations was below detectable limit (5.0µg/m^3). The SO_2 level observed at various sampling stations was much lower than the permissible limit of 80 µg/m^3 for industrial, residential, rural and other areas

11.4.1.5 Noise Environment

The day time equivalent noise level in post monsoon season at various sampling stations ranged from 36 to 38 dB(A). The noise level in winter and summer seasons at various sampling stations ranged from 37.5 to 38.1 dB(A) and 38.9 to 40.3

dB(A).The noise level monitored at various locations in three seasons were well within the permissible limit specified for residential area.

11.4.1.6 Land use pattern

The land use pattern of the study area is given in Table-11.4.

Table-11.4: Land use pattern of the study area

Land use Cover	Area (ha)	Area (%)
Dense vegetation	17140.3	36.19
Open vegetation	22877.81	48.30
Barren land	3160.42	6.7
Agricultural land	2593.65	5.48
Water body	522.34	1.10
Alpine pasture land	329.57	0.69
Snow covered area	613.43	1.3
Settlement	125.01	0.26
Total	**47362.53**	**100**

The major land use category in the study area is forest, which accounts for almost 84.49% of the study area. The other major category is barren land accounting for about 6.7% of the study area. The agriculture land accounts for about 5.48% of the study area. The area under snow and water body account for about 1.3% and 1.10% of the study area. The area under settlement is about 0.26% of the study area.

11.4.2 Ecological Aspects

11.4.2.1 Flora

Uttarakhand is reported to have 45.82 per cent of its total geographic area under forest cover, which includes very dense, moderately dense, open forest and scrub (FSI, 2013). The major forest types occurring in the state are Tropical Moist Deciduous, Tropical Dry Deciduous, Sub-tropical Pine, Himalayan Moist Temperate, Himalayan Dry Temperate, Sub-alpine and Alpine forests. The catchment area of the proposed Jakhol Sankri Project covers almost of these forests. The forests in the project area fall in the Tons Forest Division.

The major forest types found in this catchment are described below.

Sub-tropical chir pine forest (9/C1b): This type of forest can extends up to 1800m. It can be observed near Power house site of the project area. The forests are of pure chir pine with admixture of other species along the river and higher elevations. The associates are Banj *(Quercus leucotrichophora*), *Anyar* (*Lyonia ovalifolia),* Burans (*Rhododendron arboretum)* and near nallas Kunis (*Alnus nepalensis).* Shrubs are rare, chief ones being *Buddleja crispa, Inula cappa, Prinsepia utilis, Rubus ellipticus,*

Woodfordia fruticosa, Leptodermis lanceolata etc. The under growth is usually of herbs and grasses, mainly *Bergenia ciliate, Artemisia nilagirica, Eriophorum comosum, Gnaphalium luteo-album, Chrysopogon serrulatus, Heteropogon contortus, Arundo donax* etc.

12/C1a Banj Oak forests (*Quercus leucotricophora*): This sub-type is moderately represented in the project area and is only found along the transitional belt between temperate mixed coniferous forest and sub-tropical pine forest. This type of forest is observed left bank of Supin river near Jakhol village. Important associates of Ban oak forests are *Anyar* (*Lyonia ovalifolia),* Burans (*Rhododendron arboretum), Narikh* (*Litsea elongata*), *Pyrus pashia* etc. The shrubby undergrowth is scanty, fairly dense in moisture places and comprises of *Sarcococca saligna*, *Berberis lycium, Buddleja asiatica, Daphne papyracea, Berberis aristata*, *Rosa brunonii, Indigofera heterantha, Plectranthus rugosus, Prinsepia utilis* etc. There are a few climbers, which include *Hedera nepalensis, Parthenocissus semicordata, Clematis montana,* and *Vitis* sp. *Ringal (Arundinaria falcate)* is found as undergrowth with in protected shady portions.

Moru oak forest (*Quercus floribunda*)*:* The Moru forest forest types is found in small patches above the Ban oak forests between 1800 m to 2500m elevations and are more mesophytic than Ban oak. This type of forest found in left bank of the river. No forest cover was observed in right bank of thr river Supin. The top canopy of these forests associates with moru consists of *Betula alnoides, Abies pindrow, Cedrus deodara, Acer aecium, Phoebe lanceolata, Alnus nepalensis* etc. The second storey consists of *Juglans regia, Pyrus pashia, Sorbus cuspidate, Rhododendron arboretum* etc. The undergrowth consists of *Berberis lycium, Coriaria nepalensis, Deutzia staminea, Indigofera heterantha, Rosa macrophylla, Sarcococca saligna*, etc. The leaves of Moru (*Quercus floribunda*) are extensively used for fodder by locals hence these forests are heavily lopped.

2/CIC Moist deodar forest *(Cedrus deodara)*

These forests grow between altitude ranges of 1,900m and 2,700m and sometimes extend up to 2800m on sunny ridges. This type of forest observed in Catchment area and completely absent in proposed project area of Jakhol Sankri. In the project area deodar zone is occupied mainly by kail (*Pinus wallichiana*). The second storey of scattered trees of *Lyonia ovalifolia, Rhododendron arboretum, Quercus floribunda* etc. is present. The ground cover consists of shrubs like *Berberis aristata, Daphne*

papyracea, Hypericum oblongifolium, Coriaria nepalensis, Indigofera heterantha, Leea asiatica, etc. *Clematis Montana, Hedera nepalensis, Parthenocissus semicordata* etc. are found among climbers.

12 (C1d) Western mixed coniferous forest: These forests are found from an altitude of 2400m. to 3000m. It is composed of four elements viz. fir, spruice, deodar and kail. In various proportions mixed with broad leaved species. The proportion for fir (*Albizia julibrissin*), and spruce (*Picea smithiana*) is high in the coolar aspects and on easier ground while deodar has higher on steeper areas. The growth is very fine and hight upto 50m. may be attained. The lower parts have maily spruce with silver fir and some deodar. Kail is found through out in small patvhes. Ban, Moru, Burans are found in lower elevations. In the moisture areas along streame or nallas deciduous species like *Acer aecium, Aesculus indica, Juglans regia Juglans regia* etc. are found. *Viburnum cotinifolium, Sorbaria tomentosa, Spiraea canescens, Rubus macilentus,* and *Salix* sp are found among shrubs. The ground flora is consists of herbs, grasses and ferns.

12/ 2C Moist Temperate Deciduous Forest: This forest type is commonly found between 2500 m and 3200 m elevations in moist depressions and damp areas. The forest often grows in riparian strips along the hill streams and also on gentle slopes. The tree canopy of these forests is comprised of *Ulmus wallichiana, Acer cappadocicum, Aesculus indica, Fraxinus xanthoxyloides, Rhododendron arboretum*, *Betula alnoides, Juglans regia,* etc. The shrubby undergrowth is represented by *Viburnum cotinifolium, Cotoneaster bacillaris, Sorbaria tomentosa, Rosa macrophylla, Sarcococca saligna, Spiraea canescens,* etc. Climbers in the forest include *Clematis montana, Hedera nepalensis,* and *Parthenocissus semicordata* etc.

Floristic

During the field study for proposed JSHE project, a total of 226 plant species belonging to 183 genera and 75 families were recorded. The results of the present study reveals that herbaceous group of plant contributed highest number of species with 99 species (43.81%) followed by shrubs with 42 species (18.58%), trees with 40 species(17.70 %), grasses with 30 species (13.27%) and climbers with 11 species (6.64%). The details of number of floral species recorded at various study sites are given in Table-11.5.

Table-11.5: Vegetation composition of the study area in various seasons

Plant habit	Number of Species	% of Species
Trees	40	17.70
Shrubs	42	18.58
Herbs	99	43.81
Grasses	30	13.27
Climber	15	6.64
Total	**226**	**100%**

11.4.2.2 Fauna

The fauna of the study area consists mostly of species with zoo-geographic affinities of palaearctic, Indo-Malayan and indigenous variably. However, to gain an insight in the following respects for species of carnivore, ungulates, non-human primates, mammals, birds/butterflies, reptiles and other fauna, the survey was conducted in the study area up to 10km radius from the project appurtenances in catchment-submergence zone, Barrage site, power house site and d/s power house site upto 5km river reach length. Ground surveys was carried out by trekking the impact zone for identification of faunal species inhabiting the area along the riverbanks, adjoining forest on the slopes, nallahs, hill top and agricultural fields.

11.4.2.2.1 Biodiversity

Mammals

Ranging from area under permanent snow cover to the hot sub-tropical jungles of the foothills, the catchment area presents diverse habitats with significant levels of variation. This area is the home of a wide variety of mammals, reptiles and birds. However, due to the presence of scattered discontinuous patches of forest cover in the area of Jakhol-Sankri HEP, the wild animals would not prefer to come in the project area from the dense forest of protected area.The study of fauna takes substantial amount of time to understand the specific faunal characheristics of the area. Apart from direct sightings and primary data generated through animal call, footmark and excreta, intraction with local people and forest staff were also made to generate secondary data on distribution, species diversity and their conservation implications in the study area. On the basis of secondary data review and information collected the wild mammals are found in the upper reaches of forested area. Some of the common mammals found in the area are Wild Boar (*Sus scrofa*), Jackal (*Canis aureus*), Common Langur (*Semnopithecus entellus*), Rhesus Macaque (*Macaca mulatta*) and Yellow throated marten (*Martes flavigula*). Other mammals

which are generally remain at higher altitude peaks and alpine pature land are Barking deer (*Muntiacus muntjak*), Snow Leopards (*Panthera pardus*), Himalayan black bear (*Selenarctos thibetanus*), Goral (*Naemorhedus goral*), Jungle Cat (*Felis chaus*) etc.

Avifauna

The commonly observed bird species include White-cheeked Bulbul, Indian Myna, Hoopoe, Spotted Forktail, Black Partridge, Spotted Turtle Dove, Jungle Babbler, Grey Wagtail, Red-billed Magpie, Slaty-Blue Flycatcher etc. Most of the species of birds are protected as their respective families have been listed under Schedule IV of Indian Wildlife (Protection) Act 1972.

Butterflies

Insects are the most numerous, and dominant life forms on the earth. Among insects butterflies are considered as environment indicator which plays an important role in pollination. Some of the butterflies like Small copper (*Lycaena phlaeas*), Common Sailor (*Neptis* sp), Common leopard (*Phalantha Phalentha*), Common marmom (*Papilio polytes romulus*), Pale clouded yellow (*Colias erate*) and Indian cabbage white (*Pieris canidia indica*) were common and found throughout the study area.

Herpetofauna

As per secondary data sources, total 9 species of reptiles and 4 species of amphibians has been recorded from the area. However, during priamary survey, no such species was encountered except the rock agama and skinks.

11.4.2.3 Aquatic Ecology

11.4.2.3.1 Biotic Resources (Biological Characteristics)

Biotic resources study involved the assessment of status of phytoplankton, zooplankton, phytobenthos, benthos and macro-invertebrates, macrophytes, fishes and other aquatic fauna. Biotic resources are divided into two groups i.e. autotrophs and heterotrophs. Autotroph constitutes the aquatic flora whereas heterotrophs constitutes of aquatic fauna. Aquatic flora comprises of algae in suspended form (plankton) and benthic form (phyto-benthos). Micro flora is comprised of Phytoplankton and Phytobenthos. Aquatic fauna includes zooplankton, micro-invertebrates and fish & fisheries. Aquatic flora includes microflora as phytoplankton, phytobenthos, and periphytons and macroflora consist of aquatic plants.

11.4.2.3.2 Phytoplanktons

A total 23 taxa were recorded from the study sites during field study in various seasons. The number of taxa /species was recorded higher in side streams /tributaries than in the main river course. The stream being a freshwater body, the presence of Chlorophyceae was more prominent. Chlorophyceae included *Spirogyra*, *Zygnema* and *Cladophora* as filamentous algae forming sheets on the river / streams edges. Other green algae found predominate are chlorella and scenedesmus with other flagellates. Blue green algae are represented by *Oscillatoria,* and *Schizothrix taxon*. After *diatoms* (Bacillariophyceae), green algae are found in abundance. At most of the sampling sites *Synedra, Achnanthes, Cocconeis, Fragilaria* and *Gomphonema taxon* were the most common species in river Supin and its tributaries recorded during study period.

11.4.2.3.3 Macroflora/ Macrophytes

No growth of macrophytes seen in the area that may be due to rapid currents and fall habitat which has river wash affects. However, macrophytes that remain attached to the rocks, boulders; stones, etc. belong to various genera of bryophytes (mosses). These mosses grow on stone and boulders that protrude a few centimeters above the surface of water sometimes growth reaches in the flowing water edges stones.

11.4.2.3.4 Zooplanktons

Microfauna: Zooplanktons are represented by protozoa, rotifer and crustaceans. Among protozoans *Arcella, Peridinium,* and *Ceratium* taxon are commonly observed. Rotifers are represented by *Keratella, Brachionus* and *Philodina* taxon. Copepod consists of Cyclopes species whereas *cladocerans* are represented by *Daphnia* and *Bosmina* sp. The occurrence are mainly from the edge pools of side stream and river banks, however, the group in totality is poorly represented due to climate conditions followed by long winters and torrential flow. The low occurrence is also linked to rapid habitat and rocky substratum in the deep gorge narrow valley.

11.4.2.3.5 Macro-invertebrates (Zoo benthos)

Macro-invertebrate fauna of river Supin are comprised by Heptageniidae, Baetidae, Ephemerellidae, Perlidae, Hydropsychidae, Hydroptilidae, Chironomidae, Simulidae, Elmiade, Blepharoceridae and Amphizoidae families. Species of genera *Stenonema, Epeorus, Baetis, Ephemeralla, Ochrotrichia* and *Chironimds* are observed in the region. The distribution and occurrence is directly related to the habitat structure and substratum of Supin river and its tributaries. The poor occurrence of benthos during

study period could be due to low water temperature, high turbidity, torrent flow and rocky substratum in river and its tributaries.

11.4.2.4 Fisheries

The fisheries in the project area are poorly developed since the potential has remained unexploited owing to difficult terrain, unfavorable climate and poor infrastructure facilities. The elevation, temperature, current, velocity and natural biota are the factors governing the growth of fish in the rivers and water bodies in the area. Commercial fishing is not in practices in the study area. A total of 6 species were found close to the confluence of Tons and Supin River at downstream site of power house (AE-VII) under the area of Jakhol-Sankari HEP however, no fish was found at other sites. This may be due to high elevation, low temperature and fast water velocity. The commercial fisheries in the area are non- existent. The growth of the coldwater fish is also very poor due to low temperature and scarcity of food resources for fish. Therefore, present ecological survey revealed that there is no substantive loss of fish habitat due to the construction of Jakhol-Sankari HEP.

11.4.3 Socio-Economic Aspects

11.4.3.1 Demographic profile

11.4.3.1.1 Population

As per 2011 Census the total population of the area is about 17243.The male and female population in the villages is 50.92% and 49.08% respectively and population below 6 years of age accounts for 18.92% of the total population. The number of females per 1000 males is 964 and average family (persons per family) size is 6.

11.4.3.1.2 Caste Profile

According to Census 2011 data that the General Caste population accounts for 70.21% of the total population in the Study area villages followed by Schedule Caste accounting for 29.57% and Schedule Tribe accounting for the 0.21% of total population.

11.4.3.1.3 Literacy rate

The total literate population in villages is of the order of 46.0% (as per 2011 census data). The overall illiterate population in the villages is 54.0%. The male and female literacy rate in the villages is 57.76% and 33.81% respectively.

11.4.3.1.4 Occupational Profile

The total working population in the area constitutes for 52.17% and dependent population or non-workers in the villages are 47.83% of the total population. It is

further observed that 90.56% of the total population falls under main worker category. The marginal workers account for about 9.44% of the total population.

11.4.3.2 Property Survey

A total of 320 PAFs are losing land. These affected families will be losing homestead as well as the land shall be compensated on the terms of the "Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013". The land to be acquired for the project is 39.998 ha. Out of this, about 15.681 ha is private land and about 2.250 ha is forest land (Refer Table-11.2)

11.5 PREDICTION OF IMPACTS

The impacts on various aspects of environment are briefly described in the following sections.

11.5.1 Impacts on Water Environment

a) Construction Phase

Sewage from labour camps

The increase in the population as a result of migration of labour population during construction phase is expected to be of the order of 3200.Total quantum of sewage generated is expected to be of the order of 0.18 mld. The BOD load contributed by domestic sources will be about 144 kg/day. It is assumed that the sewage is discharged without any treatment for which, the minimum flow required for dilution of sewage is about 2 cumec. No impact is anticipated on river water quality, as a result of disposal of sewage from labour camps. Even though no impact is envisaged on water quality of river Supin, as a result of disposal of untreated sewage, it is recommended to treat the sewage generated from labour camps.

Effluent from crushers

The natural slope in the area is such that, the effluent from the crushers will ultimately find its way in river Supin. This amounts to a discharge of 0.0033 to 0.0042 cumec. Even the lowest 10 day minimum flow in river Supin is 2.31 cumec. The effluent from crusher will have 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 0.25 mg/l, which is insignificant. Thus, no adverse impacts, are anticipated due to small quantity of effluent and large volume of water available in river Supin for dilution.

Effluent from other sources

Substantial quantities of water would be used in the construction activities. With regard to water quality, waste water from construction activities and runoff from construction site would mostly contain suspended impurities. Adequate care should be taken so that excess suspended solids in the wastewater are removed before discharge into water body. The effluent is proposed to be treated by collecting the waste water and runoff from construction sites and treating the same in settling tanks.

b) Operation phase

Effluent from project colony

In the operation phase, about 100 families (total population of 500) will be residing in the project colony. About 0.23 to 0.27 mld of sewage will be generated. The total BOD loading will be order of 68 to 81 kg/day. It is proposed to provide biological treatment facilities including secondary treatment units for sewage so generated from the BOD load after treatment will reduce to 10 to 12 kg/day. It shall be ensured that sewage from the project colony be treated in a sewage treatment plant so as to meet the disposal standards for effluent. Thus, with commissioning of facilities for sewage treatment, no impact on receiving water body is anticipated. Thus, no impacts are anticipated as a result of disposal of effluents from the project colony.

Impacts on reservoir water quality

The flooding of previously forest and agricultural land in the submergence area will increase the availability of nutrients resulting from decomposition of vegetative matter. In the proposed project a barrage is proposed to be constructed.

The proposed project is envisaged as a runoff the river scheme, with significant diurnal variations in water level. In such a scenario, significant re-aeration from natural atmosphere takes place, which maintains Dissolved Oxygen in the water body. Thus, in the proposed project, no significant reduction in D.O. level in reservoir water is anticipated.

11.5.2 Impacts on Air Environment

Pollution due to fuel combustion in various equipment

The major pollutant which gets emitted as a result of combustion of diesel is SO_2. The SPM emissions are minimal due to low ash content in diesel. The short-term increase in SO_2, even assuming that all the equipment are operating at a common

point, is quite low, i.e. of the order of less than 1$\mu g/m^3$. Hence, no major impact is anticipated on this account on ambient air quality.

Emissions from crushers

The operation of the crusher during the construction phase is likely to generate fugitive emissions, which can move even up to 1 km in predominant wind direction. During construction phase, one crusher each is likely to be commissioned near proposed barrage and proposed power house sites. During crushing operations, fugitive emissions comprising mainly the suspended particulate will be generated. Since, there are no major settlements close to the barrage and power house, hence, no major adverse impacts on this account are anticipated.

Fugitive Emissions from various sources

During construction phase, there will be increased vehicular movement. Lot of construction material like sand, fine aggregate are stored at various sites, during the project construction phase. Normally, due to blowing of winds, especially when the environment is dry, some of the stored material can get entrained in the atmosphere. However, such impacts are visible only in and around the storage sites. The impacts on this account are generally, insignificant in nature.

Blasting Operations

During tunneling operations, dust will be generated during blasting. ID blowers will be provided with dust handling system to capture and generated dust. The dust will settle on vegetation, in the predominant down wind direction. Appropriate control measures have been recommended to minimize the adverse impacts on this account.

Pollution due to increased vehicular movement

The increase in vehicular density is not expected to significant. In addition, these ground level emissions do not travel for long distances. Thus, no major adverse impacts are anticipated on this account.

Dust emission from muck disposal

The loading and unloading of muck is one of the source of dust generation. Since, muck will be mainly in form of small rock pieces, stone, etc., with very little dust particles. Significant amount of dust is not expected to be generated on this account. Thus, adverse impacts due to dust generation during muck disposal are not expected.

11.5.3 Impacts on Noise Environment

a) Construction phase

Impacts due to operation of construction equipment

No increase in noise levels is anticipated as a result of various activities, during the project construction phase. The noise generated due to blasting is not likely to have any effect on habitations. However, blasting can have adverse impact on wildlife, especially along the alignment of the tunnel portion. It would be worthwhile to mention that no major wildlife is observed in and around the project site. Hence, no significant impact is expected on this account.

Impacts due to increased vehicular movement

During construction phase, there will be significant increase in vehicular movement for transportation of construction material. At present, there is no vehicular movement near the barrage site. During construction phase, the increase in vehicular movement is expected to increase upto a maximum of 5 to 6 trucks/hour.

Impacts on labour

The effect of high noise levels on the operating personnel, has to be considered as this may be particularly harmful. It is known that continuous exposures to high noise levels above 90 dB(A) affects the hearing acuity 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 per the maximum exposure period specified in Table-11.6

Table-11.6: Maximum Exposure Periods specified by OSHA

Maximum equivalent continuous Noise level dB(A)	Unprotected exposure period per day for 8 hrs/day and 5 days/week
90	8
95	4
100	2
105	1
110	½
115	¼
120	No exposure permitted at or above this level

Noise generated due to drilling

The Director General of Mines Safety in its circular no. DG(Tech)/18 of 1975, has prescribed the noise level in mining operations for workers in 8 hour shift period with unprotected ear as 90 dB(A) or less. Similar norms can be considered for

construction phase of the proposed project as well. The workers who are expected to be exposed to noise levels greater than 90 dB(A), should not work in these areas beyond 6 to 8 hours. In addition, they also need to be provided with ear plugs. Thus, increased noise levels due to drilling are not expected to adversely affect the workers operating the drill or involved in other mining activities closely.

Noise generated due to blasting

That noise level due to blasting operations are expected to be of the order of 75-86 dB(A). Since, the nearest settlement are about 0.8 to 1.0 km away, the incremental noise due to blasting is expected to be 50-60 dB(A). 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 60 dB(A). Hence, noise level due to blasting is not expected to cause any significant adverse impact.

11.5.4 Impacts on Land Environment

a) Construction phase

Quarrying operations

The quarrying operations are semi-mechanized in nature.

In JSHEP the construction material is excavated from river bed. From past experience it is seen that these area get filled up with silt and sand during subsequent monsoon season. Therefore, no restoration measures are necessary for these sites.

Operation of construction equipment

During construction phase, various types of equipment will be brought to the site. These include crushers, batching plant, drillers, earth movers, rock bolters, etc. The siting of this construction equipment would require significant amount of space. Similarly, space will be required for storing of various other construction equipment. In addition, land will also be temporarily acquired, i.e. for the duration of project construction for storage of quarried material before crushing, crushed material, cement, rubble, etc.

Efforts must be made to site the contractor’s working space in such a way that the adverse impacts on environment are minimal, i.e. to locate the construction equipment, so that impacts on human and faunal population is minimal.

Muck disposal

The muck disposal sites will be suitably stabilized on completion of the muck disposal. The details of stabilization of muck disposal sites are covered in Environmental Management Plan

Construction of roads

The project construction would entail significant vehicular movement for transportation of large construction material, heavy construction equipment. New access roads would have to be constructed. Some of the existing roads in the project area, would require widening.

Acquisition of land

The land to be acquired for the project is 39.998 ha. Based on the ownership status of land, appropriate compensatory measures of land will be suggested.

11.5.5 Impacts on Biological Environment

a) Construction phase

11.5.5.1 Impacts on Terrestrial flora

Increased human interferences

There will be an increase in population by about 3200 of which about 2400 are likely to use fuel wood. On an average, the fuel wood requirements will be of the order of (1.0 x 365 x 2400 x 10^{-3}) 879 m^3. The wood generated by cutting tree is about 2 to 3 m^3. Thus every year fuel wood equivalent to about 400-500 trees will be cut, which means every year on an average about 1-2 ha of forest area will be cleared for meeting fuel wood requirements, if no alternate sources of fuel are provided. Hence to minimize impacts, community kitchens have been recommended. These community kitchens shall use LPG or diesel as fuel. The details are covered in Environmental Management Plan

Acquisition of forest land

The total forest land to be acquired for the project shall be 24.126 ha including Civil Soyam land. The forest in the area has already been degraded due to a large-scale human interference. Though the project area is located in an ecologically sensitive area, the forests in and around the project area are quite degraded. The tree density in the submergence area and power house area is about 344 and 352 trees/ha. Normally in a dense forest, tree density is of the order of 1000-1200 trees/ha. Thus, in land to be acquired for the project, the tree density is low to moderate.

11.5.5.2 Impacts on Terrestrial fauna

Disturbance to wildlife

During construction phase, large number of machinery and construction labour will have to be mobilized. The operation of various construction equipment, and blasting is likely to generate noise. These activities can lead to some disturbance to wildlife population. Likewise, siting of construction equipment, godowns, stores, labour camps, etc. can lead to adverse impacts on fauna in the area.

It is proposed that during construction phase, strict surveillance measures be adopted to minimize adverse impacts due to increased human interferences.

b) Operation phase

Increased accessibility

During the project operation phase, the accessibility to the area will improve due to construction of roads, which in turn may increase human interferences leading to marginal adverse impacts on the terrestrial ecosystem. The increased accessibility to the area can lead to increased human interferences in the form of illegal logging, lopping of trees, collection of non-timber forest produce, etc. Since significant wildlife population is not found in the region, adverse impacts of such interferences are likely to be marginal. The details of measures to improve the terrestrial ecology of the area are covered in volume-III of this Report.

11.5.5.3 Aquatic Flora

a) Construction phase

During construction phase wastewater mostly from domestic source will be discharged mostly from various camps of workers actively engaged in the project area. Around 0.22 mld of water is required for the workers during the peak construction phase out of which 80% (i.e. about 0.18 mld) will be discharged back to the river as wastes, more or less as a point sources from various congregation sites where workers will reside. Sufficient water for dilution will be available in Supin to keep the DO of the river to significantly high levels.

b) Operation phase

The completion of Jakhol Sankari hydroelectric Project would bring about significant changes in the riverine ecology, as the river transforms from a fast-flowing water system to a quiescent lacustrine environment. Such an alteration of the habitat would bring changes in physical, chemical and biotic life. Among the biotic communities, certain species can survive the transitional phase and can adapt to the changed

riverine habitat. There are other species amongst the biotic communities, which, however, for varied reasons related to feeding and reproductive characteristics cannot acclimatize to the changed environment, and may disappear in the early years of impoundment of water. The micro-biotic organisms especially diatoms, blue-green and green algae before the operation of project, 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 river, these organisms may perish as a result of increase in depth.

11.5.5.4 Impacts on Aquatic Fauna

a) Construction phase

Extraction of gravel and sand causes considerable damage to fish stocks and other aquatic life by destabilizing the sub-stratum, increasing the turbidity of water, silting of the channel bottom and modifying the flow, which in turn may result in erosion of the river channel. These alterations upset the composition and balance of aquatic organisms. The material at the river sub-stratum like stones and pebbles often provide anchorage and home to the invertebrates that remain attached in a fast flowing stream. During fish spawning season, the fertilized eggs are laid amidst the gravel, where it is made sure, that eggs are not washed away in fast flowing stream. The eggs of almost all species are sticky in nature, which provide additional safety. The turbidity in excess of 100 ppm brought by suspended solids chokes the gills of young fish. Fine solids in concentration greater than 25 mg/l, adversely affects the development of fish eggs and fish.

b) Operation phase

Among the aquatic animals, it is the fish life, which would be most affected. The migratory fish species, e.g. snow trouts are likely to be adversely affected due to obstruction created by the proposed barrage.

With the completion of barrage, flow in the downstream stretch of the river would be reduced considerably more so during the lean period. The most important changes, which can be expected, are:

- Reduced flow rate
- Increase in water temperature
- Reduction in availability of stano-thermal aquatic animals
- Increase in population of euro-thermal species.

Unless the desired flow is maintained downstream of the barrage, aquatic ecology in general and fisheries in particular would be affected.

11.5.6 Increased Incidence of Water-Related Diseases

Increased incidence of water-related diseases

This is a run-of river project in a mountainous region, increase in water spread area will be marginal and it would remain mostly confined in the gorge of the river, the increase in the incidence of water borne disease is not expected. Further, mosquitoes are normally observed upto a maximum elevation of about 1950-1960 m above sea level. The power house is located at an elevation of about 1400-1500 m above men sea level. Thus at this site and at the location of other project appurtenances, which are at a lower elevation could face increased incidence of malaria as a result of various factors like aggregation of labour, formation of stagnant pools near labour camps, colonies, etc. may lead to the increased incidence of such diseases around the project area.

Labour camps located at lower elevations, especially close to the power house site could be vulnerable to increased incidence of water-borne diseases, if adequate measures are not undertaken.

Aggregation of labour

The labourers and technical staff will congregate in the project area during peak construction phase. Most of the labour would come from various parts of the country. The labourer would live in dormitories provided by the Contractor. Proper sanitary facilities are generally provided. Hence, a proper surveillance and immunization schedule needs to be developed for the labour population migrating into the project area.

Excavations

in the present case, the borrow areas are within the river bed, which in any case remain under water. Thus, no additional habitat for mosquito breeding is created due to excavation. The flight of mosquito is generally limited up to 1 to 2 km from the breeding sites. Since, no residential areas are located within 1 km from the reservoir, periphery, increased incidences of malaria are not anticipated. However, labour camps, etc. could be vulnerable to increased incidence of malaria, if proper control measures are not undertaken.

Inadequate facilities in labour camps

Improperly planned labour camps generally tend to become slums, with inadequate facilities for potable water supply and sewage treatment and disposal. This could lead

to outbreak of epidemics of water-borne diseases. Adequate measures for supply of potable water and sewage treatment have been recommended as a part of Environmental Management Plan outlined in Volume-III of this Report.

11.6 ENVIRONMENTAL MANAGEMENT PLAN

11.6.1 Environmental Measures During Construction Phase

Facilities in Labour Camps

It is proposed that it should be made mandatory for the contractor involved in the construction activities to provide adequate facilities for water supply and sanitation. The contractor can make a block of two large rooms in which about 30-40 workers can stay. It is proposed to provide a central heating system which shall provide hot water to workers throughout the year. The project is located at an elevation of about 1900 to 1950 m, where hot water will be required throughout the year.

Total provision of Rs. 426.8 lakh has been earmarked for implementation of various measures in labour camps. The details are given in Table-11.7

Table-11.7: Cost estimate for implementation of various measures in labour camps

S. No.	Fuel	Cost (Rs. lakh)
1.	Solid waste management in labour camps	39.0
2.	Sanitation facilities for labour camps	95.0
3.	Fuel distribution in labour camps	292.8
	Total	**426.8**

Water supply

The water for drinking purpose is collected from the rivers or streams flowing upstream of the labour camps. The water is stored in tanks and supplied for use. The water quality in general is good and does not require any elaborate treatment. However, it is proposed to disinfect the water prior to distribution. The settlements/ labour camps shall be located at a distance from the drinking water sources, so that the sewage generated from these labour camps, does not affect the water quality.

Sanitation facilities

One community latrine shall be provided per 20 persons. The sewage from the community latrines shall be treated in septic tanks. For each 500 persons, one septic tank shall be provided. The effluent from these septic tanks shall be disposed off

through absorption trenches. As mentioned earlier, the drinking water facilities and waste disposal sites will be located away from each other.

Provision of community kitchen and Free Fuel

A community kitchen could be provided where workers have their meals. The fuel used in such community kitchens could be LPG or diesel. The project contractor in association shall make necessary arrangements for supply of fuel to labour population for which provision shall be kept in the cost estimate.

Solid waste management

About 3,200 persons are likely to congregate during the construction phases resulting in generation of about 0.67 tonnes of solid waste/day. Adequate facilities for collection conveyance and disposal of municipal waste generated from labour camps should be developed. For solid waste collection, masonry storage vats, each of 2 m^3 capacity at convenient dumping points in the labour camp will be constructed. Each vat will have a storage capacity of 150 kg (dry weight) of garbage, which will be emptied at regular intervals and will be transported to the landfill site. One covered truck to collect the solid waste from the common collection point and transfer it to the disposal site needs to be put to service. A suitable landfill site can be identified and designed to contain the municipal waste from all the project township, labour colonies, etc. A total provision of Rs.39.0 lakh needs to be earmarked for this purpose. The details are given in Table-11.8

Table-11.8: Details of Expenditure required for solid waste management

Item	Cost (Rs. lakh)
• One covered truck for conveyance of solid waste up to landfill site.	15.0
• Manpower cost for 6 persons @ Rs.5000/month for 4 years including 10% escalation/year.	16.7
• Waste collection hand carts 9 @ Rs.25,000/unit	2.3
• Preparation of landfill site	5.0
Total	**39.0**

Restoration of construction sites

Normally construction sites are left unclaimed, with construction waste being left without being properly disposed. In the proposed project, it is proposed to collect the construction waste from various construction sites, and disposed off at sites

identified in consultation with the district administration. The various construction sites would be properly levelled. The levelling or reclamation of various construction sites, should be made mandatory for the contractor, hence, no additional cost has been earmarked as a part of the cost to be earmarked for implementation of EMP.

11.6.2 Maintenance of Water Quality

In the project operation phase, a colony is likely to be set up. It is proposed to provide sewage treatment plant in the project colony, cost of which shall be included in the contract for constructing the project colony.

11.6.3 Health Delivery System

The various measures for control of Public Health are listed as below:

- The site selected for habitation of workers should not be in the path of natural drainage.
- Adequate drainage system to dispose storm water drainage from the labour colonies should be provided.
- Adequate vaccination and immunization facilities should be provided for workers at various construction sites.
- The labour camps should be at least 2 to 3 km away from quarry areas.

It is proposed to develop one dispensary if the proposed project area. The staffing details are given in Table-11.9

Table-11.9: Details of staff in the dispensary

Para medical staff	Numbers
Doctors	2
Nurse	4
Health Workers	2
Attendants	**2**
Drivers	**2**

A first aid post shall be provided at the major construction sites. These posts will have the following facilities:

- First aid box with essential medicines including ORS packets
- First aid appliances-splints and dressing materials
- Stretcher, wheel chair, etc.

11.6.4 Sustenance & Enhancement of Fisheries Potential

A river valley project may have adverse or beneficial effects on the fish fauna, depending upon the particular situation and the fish fauna inhabiting the concerned river. Similarly it has various impacts on the people, the livelihood of whom depends

on the fish. The construction of the dam leads the fragmentation of habitat, modification in hydrologic regime and may have adverse effects on indigenous and migratory fish. On the other hand pondage provides a large volume of water, which is beneficial with respect to fish culture and can play an important role in the upliftment of economic growth.

11.6.5 Control of Air Pollution

The following measures are recommended:

- The contractor will be responsible for maintaining properly functioning construction equipment to minimize exhaust.
- Construction equipment and vehicles will be turned off when not used for extended periods of time.
- Unnecessary idling of construction vehicles to be prohibited.
- Effective traffic management to be undertaken to avoid significant delays in and around the project area.
- Road damage caused by sub-project activities will be promptly attended to with p Identification of construction limits (minimal area required for construction activities).
- When practical, excavated spoils will be removed as the contractor proceeds along the length of the activity.
- When necessary, stockpiling of excavated material will be covered or staged offsite location with muck being delivered as needed during the course of construction.
- Excessive soil on paved areas will be sprayed (wet) and/or swept and unpaved areas will be sprayed and/or mulched. The use of petroleum products or similar products for such activities will be strictly prohibited.
- Contractors will be required to cover stockpiled soils and trucks hauling soil, sand, and other loose materials (or require trucks to maintain at least two feet of freeboard).
- Contractor shall ensure that there is effective traffic management at site. The number of trucks/vehicles to move at various construction sites to be fixed. Three personnel will be earmarked for this purpose.
- Dust sweeping - The construction area and vicinity (access roads, and working areas) shall be swept with water sweepers on a daily basis or as

necessary to ensure there is no visible dust. Five sweepers will be earmarked for this purpose

- Roper road repair and maintenance work.

11.6.6 Noise Control Measures

The contractors will be required to maintain properly functioning equipment and comply with occupational safety and health standards. The construction equipment will be required to use available noise suppression devices and properly maintained mufflers.

- Vehicles to be equipped with mufflers recommended by the vehicle manufacturer.
- Staging of construction equipment and unnecessary idling of equipment within noise sensitive areas to be avoided whenever possible.
- use of temporary sound fences or barriers to be evaluated.
- Notification will be given to residents within 300 feet (about 90 m) of major noise generating activities. The notification will describe the noise abatement measures that will be implemented.
- Monitoring of noise levels will be conducted during the construction phase of the project. In case of exceeding of pre-determined acceptable noise levels by the machinery will require the contractor(s) to stop work and remedy the situation prior to continuing construction.

The following Noise Standards for DG sets are recommended for the running of DG sets during the construction:

- The maximum permissible sound pressure level for new diesel generator sets with rated capacity upto 1000 KVA shall be 75 dB(A) at 1 m from the enclosure surface.
- Noise from the DG set should be controlled by providing an acoustic enclosure or by treating the enclosure acoustically.
- The Acoustic Enclosure should be made of CRCA sheets of appropriate thickness and structural/ sheet metal base. The walls of the enclosure should be insulated with fire retardant foam so as to comply with the 75 dB(A) at 1m sound levels specified by CPCB, Ministry of Environment & Forests. An amount of Rs. 5.0 lakh is earmarked for this purpose.

- The acoustic enclosure/acoustic treatment of the room should be designed for minimum 25 dB(A) Insertion Loss or for meeting the ambient noise standards, whichever is on the higher side.
- The DG set should also be provided with proper exhaust muffler with insertion loss of minimum 25 dB(A).
- Proper efforts to be made to bring down the noise levels due to the DG set, outside its premises, within the ambient noise requirements by proper siting and control measures.
- A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacturer which would help prevent noise levels of the DG set from deteriorating with use. An amount of Rs. 6.0 lakh is earmarked for this purpose.

11.6.7 Management Measures

The basic aim and objectives of the muck management plan are to:

- protect these areas from soil erosion
- develop these areas by afforestation
- develop them into parks, gardens etc.
- utilize the maximum quantity of muck for development of infrastructure of the project
- develop these areas in harmony with the landscape of the project area.

Various activities proposed as a part of the management plan are given as below:

- Land acquisition for muck dumping sites
- Civil works (construction of retaining walls, boulder crate walls etc.)
- Dumping of muck
- Levelling of the area, terracing and implementation of various engineering control measures e.g., boulder, crate wall, masonry wall, catch water drain.
- Spreading of soil
- Application of fertilizers to facilitate vegetation growth over disposal sites.

For stabilization of muck dumping areas following measures of engineering and biological measures have been proposed

Engineering Measures

- Wire crate wall
- Boulder crate wall

- R.C.C
- Catch water Drain

Biological Measures

- Plantation of suitable tree species and soil binding species
- Plantation of ornamental plants
- Barbed wire fencing

11.6.8 Road Construction

- The clearing area shall be properly demarcated to save desirable trees and shrubs and to keep tree cutting to the minimum.
- Where erosion is likely to be a problem, clearing operations shall be so scheduled and performed that grading operations and permanent erosion control of features can follow immediately thereafter, if the project conditions permit; otherwise temporary erosion control measures shall be provided between successive construction stages. Under no circumstances, however, should very large surface area of erodible earth material be exposed at any one time by clearing and grubbing.
- The method of balanced cut and fill formation shall be adopted to avoid large difference in cut and fill quantities.
- The cut slopes shall be suitably protected by breast walls, provision of flat stable slopes, construction of catch water and intercepting drains, treatment of slopes and unstable areas above and underneath the road, etc.
- Where rock blasting is involved, controlled blasting techniques shall be adopted to avoid over-shattering of hill faces.

Excavated material shall be dumped after duly dressing up the same in a suitable form at appropriate places where it cannot get easily washed away by rain, and such spoil deposits may be duly trapped or provided with some vegetative cover

11.6.9 Public Awareness Programme

The main objective is to slow down the spread of HIV/AIDS infection through creation of awareness and aiming at behavioral change. The awareness programme has the following components:

- Ensuring Blood Safety
- Control of sexually transmitted diseases
- Public awareness and community support.

- **Ensuring blood safety**

The training programe for the doctors and the blood bank staffs in consultation National or State AIDS Control Organization which includes the diagnosis of AIDS cases, mandatory licensing of blood banks and promotion of voluntary blood donation.

- **Control of Sexually Transmitted Diseases**

The main strategy for prevention and control of HIV/AIDS is to control of sexually transmitted diseases in the labour camp by the suggested measures of National or State AIDS Control Organization

- **Public awareness and community support**

A wide campaign using various media to spread awareness about the HIV/AIDS in the project area shall be taken up as Environmental management programme. This includes the use of radio, print media and folk theatre by the contractor and project proponent.

The counseling centre shall be set up in government Hospital at Mori, which have the following objectives:

- To provide pre-test, post-test, follow-up, general and family counselling to general public, workers and technical staff coming to the hospital.
- To provide support services and after care services for HIV positive clients.
- To disseminate information regarding STD, HIV/AIDS and measures suggested by National or State AIDS Control Organization.

11.6.10 Greenbelt Development Plan

Although the forest loss due to reservoir submergence and other project appurtenances have been compensated as a part of compensatory afforestation. However in addition to above, it is proposed to develop greenbelt around the perimeter of various project appurtenances, selected stretches along reservoir periphery, etc. The general consideration involved while developing the greenbelt are:

- Trees growing up to 10 m or above in height with perennial foliage should be planted around various appurtenances of the proposed project.
- Planting of trees should be undertaken in appropriate encircling rows around the project site.

- Generally fast growing trees should be planted
- Since, the tree trunk area is normally devoid of foliage upto a height of 3 m, it may be useful to have shrubbery in front of the trees so as to give coverage to this portion.

The details of Greenbelt development are given as below:

- Plantation will be done along the boundaries of project colony
- The inter-connecting/approach roads of various project components, within the colonies, working sites, etc. shall be covered with avenue plantation.
- Available space within the colonies will be brought under Greenbelt for plantation of fruit, ornamental and shade trees along with shrubs, climbers etc. Fruit trees can be protected with angle iron guards.
- During the initial phase of plantation and summer seasons, watering of plants can be done. In addition if required farm yard manure and agro-chemicals can also be applied.
- Along the road sides, 2 to 3 rows of ornamental trees can be planted.
- At the construction site and colony sites, the width of Greenbelt development can be increased depending on the quantum of land available.
- Thickness of greenbelt along reservoir periphery can be about 4 – 6 m.
- The saplings for Greenbelt can be processed from nearby nurseries of the Forest Department.

11.7 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. The total catchment considered for treatment under the present project i.e. Jakhol Sankari hydroelectric project.

The catchment area treatment involves

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

Following Engineering and Biological measures have been suggested for the catchment area treatment.

1. **Engineering measures**
   - Step drain
   - Angle iron barbed wire fencing
   - Stone masonry
   - Check dams
2. **Biological measures**
   - Development of nurseries
   - Plantation/afforestation
   - Pasture development
   - Social forestry

11.8 RESETTLEMENT AND REHABILITATION PLAN

The R&R plan has been devised using the norms and guidelines of the "Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013". There are no families losing homesteads hence there is no Resettlement Plan needs to be prepared. As per the data there are 320 families that are affected due to the proposed project. The Rehabilitation Plan is prepared for the 320 families that will be losing land only.

11.8.1 Measures for Rehabilitation

In the proposed project, majority of the population depends on land for their livelihood. Privately owned land is also expected to be acquired. The rehabilitation plan would be formulated in line with the norms of "Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013". The market value of private land to be acquired in various villages is given in Table-11.10. The cost estimate for implementation of Rehabilitation measures is given in Table-11.11

Table-11.10: Market value of the private land acquired in various villages

S.No	Village Name	Land Acquired (Ha.)	Total Value of Land (Rs.)	Factors to be multiplied in rural area B=(A*2) (Rs.)	Solatium (C) (Rs.)	Final Award (B+C) (Rs.)
1	Dhara	4.772	19.37	38.7486	38.7486	77.4973
2	Jhakol	0.91	3.69	7.3892	7.3892	14.7784
3	Sunkundi	1.359	5.52	11.0351	11.0351	22.0702
4	Paon	0.673	2.62	5.2494	5.2494	10.4988

S.No	Village Name	Land Acquired (Ha.)	Total Value of Land (Rs.)	Factors to be multiplied in rural area B=(A*2) (Rs.)	Solatium (C) (Rs.)	Final Award (B+C) (Rs.)
	Malla					
5	Paon Talla	7.967	32.35	64.692	64.692	129.384
	Total	**15.681**	**63.56**	**127.11**	**127.11**	**254.23**

Table-11.11: Provisions for Rehabilitation Plan for families losing land as per the "SECOND SCHEDULE"

S. No	Description	Unit	Assumed Provision#	Cost (Rs. lakh)
1.	**Total Market Value of the Project affected villages (Refer Table-4.3)**	ha	15.681	**254.23**
2.	**Rural artisans / Self-employed**			
	One-time financial assistance of a minimum of Rs. 25,000/- to each affected family of an artisan, small trader or self-employed person or an affected family which owned non-agricultural land or commercial, industrial or institutional structure in the affected area, and which has been involuntarily displaced from the affected area due to land acquisition	320	320 PAFs x Rs.25000/PAF	80.00
3.	**Choice of Annuity or Employment**			
	a) At least one member per affected family will be provided job (either in the project or arrange for a job in such other project), after providing suitable training and skill development in the required field Or **b)** Onetime payment of Rs. 500,000 per affected family Or **c)** Annuity policies that shall pay not less than Rs. 2000 per month per family for 20 years, with appropriate indexation to the Consumer Price Index for Agricultural Labourers	320	320 PAFs x Rs.2000/month x 20 years x 12 months for each PAF	Livelihood plan been prepared for each PAF losing land 1536.0
4.	Training of the affected persons, so as to enable such persons to take on suitable jobs	320	320PAFs x Rs.500/month x 6 months for each PAF	9.6
5.	Scholarships and other skill development opportunities to the eligible persons from	320	320PAFs x Rs.500/mont	19.20

S. No	Description	Unit	Assumed Provision#	Cost (Rs. lakh)
	the affected families as per the criteria as may be fixed by the appropriate Government		h x 12 months for each PAF	
6.	Skill development opportunities to the eligible persons from the affected families as per the criteria as may be fixed by the appropriate Government	320	320PAFs x Rs.500/month x 6 months for each PAF	9.6
7.	Affected persons shall be offered the necessary training facilities for development of entrepreneurship, technical and professional skills for self-employment	320	320 PAFs x Rs.1000/month x 6 months for each PAF	19.20
Total				**1927.83**

11.8.2 Budget

The total budget for implementation of the Rehabilitation Plan is **Rs.1927.83** lakh or say Rs.19.27 crore. The details are given in Table-11.12

Table-12: Budget for implementation of the Rehabilitation Plan

S. No.	Components of Rehabilitation Plan	Cost (Rs. lakh)
1.	Compensation for Land	254.23
2.	Grant to Rural Artisans	80.00
3.	Annuity payment	1536.00
4.	Training to take on suitable jobs	9.6
5.	Scholarships	19.20
6.	Other Skill Development	9.6
7.	Training facilities for development of entrepreneurship, technical and professional skills for self-employment	19.20
	Total	**1927.83**

11.9 CORPORATE ENVIRONMENTAL RESPOSIBILITY

The following aspects have been covered under the Local Area Development Plan:

- Educational Facilities
- Health Care and Medical Facilities
- Infrastructure Development
- Economic Development
- Social and Cultural Development

An amount of Rs.238.0lakh is being made for implementation of the LADP Activities. The details are shown in Table-11.13.

Table-11.13: Budget for implementation of Corporate Environmental Responsibility

S. No.	Items	Budget (Rs. lakh)
1	Construction/ Upgradation schools in Study Area	414.45
2	Scholarships to students in the Study Area	59.2
3	Improvement of Public Health Facility	242.45
	Total	**716**

11.10 LOCAL AREA DEVELOPMENT PLAN (LADP)

A budget of 0.5% of the project cost has been earmarked for implementation of Local Area Development Plan (LADP). An amount of Rs.2.4 crore has been kept as a provision for LADP as a part of EMP. The district administration shall decide the plan of implementation as per the requirement of the study area after consulting local people.

11.11 DISASTER MANAGEMENT PLAN

The following measures have been suggested as a part of the Disaster Management Plan:

- Dam Safety and Maintenance Manual
- Emergency Action Plan (EAP)
- Administration and Procedural Aspects
- Preventive Action
- Communication System
- Notifications
- Evacuations Plans and Evacuation Team
- Public Awareness for Disaster Mitigation
- Management after receding of Flood Water

The budget for different activities required to be carried out for mitigation and prevention of dam/barrage break hazard exclusively from the barrage is Rs 60.00 lakh as per details given in Table-11.14.

Table-11.14: Budget earmarked for implementation of Disaster Management Plan

S. No.	Particular	Cost (Rs. lakh)
1.	Installation of alert system in control room	10.0
2	Setting up of communication between various projects on river Supin /Tons	10.0
3	Setting up of communication system between barrage and d/s settlements	15.0
4	Public information system	15.0
5	Training and miscellaneous expenses	10.0
	Total	**60.0**

11.12 ENVIRONMENTAL MONITORING PROGRAMME

An Environmental Monitoring Programme should be undertaken during construction and operation phase of the project. The details of environmental monitoring programme are given in Tables-11.15 and 11.16 respectively.

Table-11.15: Environmental Monitoring Programme during Construction Phase

S. No.	Item	Parameters	Frequency	Location
1.	Effluent from septic tanks	pH, BOD, COD, TSS, TDS	Once every month	Before and after treatment from STP
2.	Water-related diseases	Identification of water related diseases, adequacy of local vector control and curative measure, etc.	Three times a year	Labour camps and colonies
3.	Air quality	PM_{10}, $PM_{2.5}$, SO_2 and NO_2	Once every season	At major construction sites
4.	Noise	Equivalent noise level (L_{eq})	Once in three months	At major construction sites
5.	Meteorological aspects	Wind direction & velocity temperature humidity, rain	Once every season	At two of the ambient air quality sampling sites

Table-11.16: Summary of Environmental Monitoring Programme during Project Operation Phase

S. No.	Items	Parameters	Frequency	Location
1.	Water	pH, Temperature, EC, Turbidity, Total Dissolved Solids, Calcium, Magnesium, Total Hardness, Chlorides, Sulphates, Nitrates, DO, COD, BOD, Iron, Zinc, Manganese	Thrice a year	• 1 km upstream of reservoir • Reservoir area • 1, 3 and 5 km downstream of dam site
2.	Effluent from Aerated Lagoon	pH, BOD, COD, TSS, TDS	Once every week	• Before and after treatment from STP
3.	Water related diseases	Identification of water related diseases, sites, adequacy of local vector control measures, etc.	Three times in a year	• Villages adjacent to project sites
4.	Terrestrial Ecology	Status of afforestation programme of green belt development	Once in a year	-
5.	Aquatic ecology	Phytoplanktons, zooplanktons, benthic life, fish composition	Three time in a year	• 1 km upstream of reservoir • Reservoir area • 1, 3 and 5 km downstream of dam site

11.13 FOR IMPLEMENTING ENVIRONMENTAL MANAGEMENT PLAN

11.13.1 Cost for Implementing Environmental Management Plan

The total amount to be spent for implementation of Environmental Management Plan (EMP) would be Rs. 55.93 crore. The details of the cost are given in Table-11.17.

Table-17: Cost for implementing Environmental Management Plan

S. No.	Item	Cost (Rs. Lakh)
EMP		
1.	Biodiversity Conservation Plan	724.50
2.	Catchment Area Treatment Plan	680.0
3.	Sustenance of riverine fisheries	105.88
4.	Health Delivery System	142.30

S. No.	Item	Cost (Rs. Lakh)
5.	Environmental Management in Labour Camps	490.43
6.	Stabilization of Muck Disposal Sites	421.00
7.	Landscaping and Restoration of Construction Area	100.00
8.	Environmental Management in Road Construction	270.00
9.	Greenbelt Development	30.00
10.	Control of Air Pollution	66.80
11.	Control for Noise Pollution	11.00
12.	Water Pollution Control	10.00
13.	Public Awareness Program	50.00
14.	Disaster Management Plan	60.00
15.	Resettlement and Rehabilitation Plan	1369.13
16.	Local Area Development Plan (LADP)	240.0
17.	Livelihood Plan for PAF	192.64
18.	Monitoring and Evaluation Aspects for social aspects	30.0
19.	Implementation of Environmental Monitoring Programme during construction stage (Refer Table-11.18)	45.6
20.	Purchase of Meteorological Instruments and Noise Meter	15.0
	Total-A	**5054.28 Say 50.54 Cr**
		Corporate Environmental Responsibility
1.	Corporate Environmental Responsibility	716.10
	Total-B	**Say 7.16 Cr**
	Grand Total	**57.70Cr. Say 58 Cr.**

11.13.2 Cost for Implementing Environmental Monitoring Proramme During Construction Phase

The cost required for implementation of Environmental Monitoring programme during project construction phase is Rs. 45.6 lakh. The details are given in Table-11.18.

Table-11.18: Cost for implementing Environmental Monitoring Programme during project construction phase

Item	Cost (Rs. lakh)
Effluent from labour camps	11.2
Ambient air quality monitoring	11.2
Incidence of water related diseases	23.2
Total	**45.6**

11.13.3 Cost for Implementing Environmental Monitoring Proramme During Operation Phase

The cost required for implementation of the Environmental Monitoring Programme during operation phase is the order of Rs.18.6 lakh/year. A 10% annual price increase may be considered for every year. The details are given in below Table-11.19.

Table-11.19: Cost for implementing Environmental Monitoring Programme during project operation phase

Item	**Cost (Rs. lakh/year)**
Water quality and effluent from project colony	2.6
Ecology	5.0
Riverine fisheries	6.0
Incidence of water related diseases	5.0
Total	**18.6**

CHAPTER-12
DISCLOSURE OF CONSULTANTS INVOLVED IN THE CEIA STUDY

CHAPTER-12

DISCLOSURE OF CONSULTANTS INVOLVED IN THE CEIA STUDY

The CEIA study has been conducted by WAPCOS Ltd., a government of India Undertaking under Ministry of Water Resources. The company has a full-fledged Centre for Environment who has conducted the above referred study. The list of the Experts involved in the CEIA study is given in Table-12.1.

Table-12.1: List of Experts involved in the CIEA study

S. No.	Name	Expertise	Signature
1.	Dr. Aman Sharma	EIA Coordinator • Air Pollution Expert • Water Pollution Expert • Solid Waste Management Expert • Hydrologist & Ground Water Expert	
2.	Dr. A. K. Sharma	Ecology and Bio-diversity Expert	
3.	Mr. R.V. Ramana	Noise Expert	
4.	Dr. K.K. Gaur	Social Expert	
5.	Mr. S.M. Dixit	Air Quality Expert	
6.	Mrs. Moumita Mondal Ghosh	Landuse Expert	
7.	Mr. Sanjeev Sharma	Noise & Vibration Expert	
8.	Dr. H S Rumana	Ecology and Bio-diversity Expert	
9.	Mr. B M Sinha	Geologist	
10.	Dr. Santosh K Sati	Geologist	

ANNEXURES

No.J-12011/7/2016-IA-I (R)
Ministry of Environment, Forest & Climate Change
Government of India
(IA-I Division)

Indira Paryavan Bhavan
5th Floor, Vayu Wing
Jor Bagh Road
New Delhi – 110 003

Date: 7 June 2016

To
Er. O.P. Gupta
Additional General Manager
Corporate Environment Department
Corp. H.Q. Himfed Building, New Shinla-171009

Subject: Jakhol Sankri Hydro Electric Project (44 MW), Uttarakhand submitted by M/s. SJVN Ltd-for consideration of ToR.

Sir,

This is with reference to your letter No. CC/Env./26/16-723-724 dated 08.3.2016 on the above mentioned subject.

2. The said proposal was appraised by the Environment Appraisal Committee (EAC) for River Valley and Hydroelectric Power Projects (RV&HEP) in its 92nd meeting held on 28-29 March, 2016. The comments and observations of EAC may be seen in the Minutes of the meeting are available on the Ministry's web-site.

3. It is noted that the proposed development is located in Uttarkasi District of Uttarakhand State envisages utilisation of the water of river Supin for power generation on a run of the river type development harnessing a maximum gross head of about 445.80 m. The Supin River is the right bank tributary of the Tons River and Tons River is right bank tributary of Yamuna river located in Northern India. The project envisages construction of 7.20 m high Barrage (from average river bed level at barrage axis) for diversion of water through a 6.6 km long HRT having a dia of 3 m to an underground power house for generation of about 166 MU of design energy. The tentative land requirement is about 39.817 ha., out of which 24.126 ha. is forest land and 15.691 ha is private land. The submergence are of 0.24 ha is in forest land. The total project cost is about Rs. 442.31 Crores and project proposed to be completed within 48 months.

4. Based on recommendations of the EAC, the Ministry of Environment & Forests hereby accords a fresh clearance for pre-construction activities at the proposed site as per the provisions of the Environmental Impact Assessment Notification, 2006 and subsequent amendment, 2009 along with the following Terms of Reference (TOR) for preparation of EIA/EMP report. The EIA/EMP report should contain the information in accordance with provisions & stipulations as given in the **Annexure-I**. While preparing the EIA/EMP report prevailing norms should be followed with respect to environmental flows and muck disposal sites.

5. 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. This is a pre-requisite.

6. Consultants 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.

7. The draft EIA/EMP report prepared as per the above Terms of References should be submitted to the State Pollution Control Board/Committee concerned for conducting Public Hearing / Consultation as per the provisions stipulated in EIA Notification of 2006. The draft EIA/EMP report is to be submitted to SPCB etc sufficiently 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 submitted to MoEFCC before expiry of validity.

8. All issues discussed in the Public Hearing/Consultations should be addressed and incorporated in the EIA/EMP Report. 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.

9. The ToR will remain valid for a period of 4 years from the date of issue of this letter for submission of EIA/EMP report along with public consultation. The ToR will stand lapsed on completion of 4 years time in case final EIA/EMP is not submitted and the validity is not renewed.

10. In case of any change in the Scope of the Project such as capacity enhancement, shifting of dam site/powerhouse and change in submergence etc., fresh scoping clearance has to be obtained by the project proponent.

11. Information pertaining to Corporate Environmental Responsibility and Environmental Policy shall be provided in the EIA/EMP Report as per this Ministry's OM No.J-11013/25/2014-IA-I dated 11.8.2014.

12. 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.

13. The scoping/TOR clearance is being considered by MoEF & CC subject to the outcome of the court order and the project proponent shall bound by the decision of the MoEFCC arising out of such outcome of court order.

14. Recommended of additional measures contained in EB report dated 19.10.2015 on 6 HEBs of Uttarakhand may also be examined and necessary safeguard measures included in the EMP.

15. In case the validity is to be extended, necessary application is to be submitted at least 3 months before expiry of validity of TOR.

16. This has approval of the Competent Authority.

Yours faithfully,

(Manoj Kumar Gangeya)
Director

Copy to:

1. The Secretary, Ministry of Power, Shram Shakti Bhawan, Rafi Marg, New Delhi -1
2. The Secretary, Ministry of Water Resources, RD & GR, Shram Shakti Bhawan, Rafi Marg, New Delhi -.
3. The Addl. Chief Secretary, Department of Forest & Environment, Government of Uttarakhand., Uttarakhand Secretariat, 4, Subhash Road, Dehradun – 248001. UK.
4. The Principal Secretary, Department of Energy, Government of Uttarakhand, Uttarakhand Secretariat, 4, Subhash Road, Dehradun – 248001. UK
5. The Chief Engineer, Project Appraisal Directorate, Central Electricity Authority, Sewa Bhawan, R. K. Puram, New Delh-110066.
6. The Addl. PCCF (C), Regional Office, Ministry of Environment, Forests & Climate Change, GOI, FRI Campus, Pearson Road, P.O. New Forest, Dehradun – 248006. UK.
7. Member Secretary, Uttarakhand Environment Protection & Pollution Control Board, Government of Uttarakhand, 29/20, Nemi Road, Dehradun-248001. UK.
8. EI-Division, Ministry of Environment & Forests, New Delhi-110003.
9. PS to JS (GB)/Manoj Kumar Gangeya (Director)
10. NIC Cell – for uploading in MoEFCC's website.
11. Guard File.

(Manoj Kumar Gangeya)
Director

Annexure-1

TERMS OF REFERENCE FOR CONDUCTING ENVIRONMENT IMPACT ASSESSMENT STUDY FOR 'A' CATEGORY HYDRO POWER PROJECTS AND INFORMATION TO BE INCLUDED IN EIA/EMP REPORT

(1) Scope of EIA Studies

The EIA Report should identify the relevant environmental concerns and focus on potential impacts that may change due to the construction of proposed project. Based on the baseline data collected for three (3) seasons (Pre-monsoon, Monsoon and Winter seasons), the status of the existing environment in the area and capacity to bear the impact on this should be analysed. Based on this analysis, the mitigation measures for minimizing the impact shall be suggested in the EIA/EMP study.

(2) Details of the Project and Site

- General introduction about the proposed project.
- Details of project and site giving L-sections of all U/S and D/S projects of River with all relevant maps and figures. Connect such information as to establish the total length of interference of Natural River, the total length of tunneling of the river and the committed unrestricted release from the site of diversion into the main river.
- A map of boundary of the project site giving details of protected areas in the vicinity of project location.
- Location details on a map of the project area with contours indicating main project features. The project layout shall be superimposed on a contour map of ground elevation showing main project features (viz. location of dam, Head works, main canal, branch canals, quarrying etc.) shall be depicted in a scaled map.
- Layout details and map of the project along with contours with project components clearly marked with proper scale maps of at least a 1:50,000 scale and printed at least on A3 scale for clarity.
- Existence of National Park, Sanctuary, Biosphere Reserve etc. in the study area, if any, should be detailed and presented on a map with distinct distances from the project components.
- Drainage pattern and map of the river catchment up to the proposed project site.
- Delineation of critically degraded areas in the directly draining catchment on the basis of silt Yield Index as per the methodology of All India Soil and Land Use Survey of India.
- Soil characteristics and map of the project area.
- Geological and seismo-tectonic details and maps of the area surrounding the proposed project site showing location of dam site and powerhouse site.
- Remote Sensing studies, interpretation of satellite imagery, topographic sheets along with ground verification shall be used to develop the land use/land cover pattern of the study using overlaying mapping techniques viz. Geographic Information System (GIS), False Color composite (FCC) generated from satellite data of project area.
- Land details including forests, private and other land.
- Demarcation of snow fed and rain fed areas for a realistic estimate of the water availability.
- Different riverine habitats like rapids, pools, side pools and variations in the river substratum – bedrocks, rocks, boulders, sand/silt or clay etc. need to be covered under the study.

(3) Description of Environment and Baseline Data

To know the present status of 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. should be collected with 10 km radius of the main components of the project/site i.e. dam site and power house site. The air quality and noise are to be monitored at such locations which are environmentally & ecologically more sensitive in the study area. The baseline studies should be collected for 3 seasons (Pre-Monsoon, Monsoon and Post Monsoon seasons). The study area should comprise of the following:

- 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 upto the point where Tail Race Tunnel (TRT) meets the river.
- Downstream upto 10 km from tip of Tail Race Tunnel (TRT).

(4) Details of the Methodology

The methodology followed for collection of base line data along with details of number of samples and their locations in the map should be included. Study area should be demarcated properly on the appropriate scale map. Sampling sites should be depicted on map for each parameter with proper legends. For forest classification, Champion and Seth (1968) classification should be followed.

(5) Methodology for collection of Biodiversity Data

- The number of sampling locations should be adequate to get a reasonable idea of the diversity and other attributes of flora and fauna. The guiding principles should be the size of the study area (larger area should have larger number of sampling locations) and inherent diversity at the location, as known from secondary sources (e.g. eastern Himalayan and low altitude sites should have a larger number of sampling locations owing to higher diversity).

- The entire area should be divided in grids of 5km X 5km preferably on a GIS domain. There after 25% of the grids should be randomly selected for sampling of which half should be in the directly affected area (grids including project components such as reservoir, dam, powerhouse, tunnel, canal etc.) and the remaining in the rest of the area (areas of influence in 10 km radius form project components). At such chosen location, the size and number of sampling units (e.g. quadrats in case of flora/transects in case of fauna) must be decided by species area curves and the details of the same (graphs and cumulative number of species in a tabulated form) should be provided in the EIA report. Some of the grids on the edges may not be completely overlapping with the study area boundaries. However these should be counted and considered for selecting 25% of the grids. The number of grids to be surveyed may come out as a decimal number (i.e. it has an integral and a fractional part) which should be rounded to the next whole number.

- The conventional sampling is likely to miss the presence of rare, endangered and threatened (R.E.T.) species since they often occur in low densities and in case of faunal species are usually secretive in behaviour. Reaching the conclusion about the absence of such species in the study area based on such methodology is misleading.

It is very important to document the status of such species owing to their high conservation value. Hence likely presence of such species should be ascertained from secondary sources by a proper literature survey for the said area including referring to field guides which are now available for many taxonomic groups in India. Even literature from studies/surveys in the larger landscapes which include the study area for the concerned project must be referred to since most species from adjoining catchments is likely to be present in the catchments in question. In fact such literature form the entire state can be referred to. Once a listing of possible R.E.T. species form the said area is developed, species specific methodologies should be adopted to ascertain their presence in the study area which would be far more conclusive as compared to the conventional sampling. If the need be, modern methods like camera trapping can be resorted to, particularly for areas in the eastern Himalayas and for secretive/nocturnal species. A detailed listing of the literature referred to, for developing lists of R.E.T. species should be provided in the EIA reports.

- The R.E.T. species referred to in this point should include species listed in Schedule I and II of Wildlife (Protection) Act, 1972 and those listed in the red data books (BSI, ZSI and IUCN).

(6) <u>Components of the EIA Study</u>

Various aspects to be studied and provided in the EIA/EMP report are as follows:

A. Physical and Chemical Environment

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 the 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).
- Impact of project on geological environment.

Meteorology, Air and Noise:

- Meteorology (viz. Temperature, Relative humidity, wind speed/direction etc.) to be collected from nearest IMD station.
- Ambient Air Quality with parameters viz. Suspended Particulate Matter (SPM), Respirable Suspended Particulate Matter (RSPM) i.e. suspended particulate materials <10 microns, Sulphur Dioxide (SO_2) and Oxides of Nitrogen (NOx) in the study area at 6 locations.
- Existing noise levels and traffic density in the study area at 6 locations.

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).

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.

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, 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 locations).
- 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.

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 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 characteristics
- 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.
- Information on the 10-daily flow basis for the 90 per cent dependable year the flow intercepted at the dam, the flow diverted to the power house and the spill comprising the environmental flow and additional flow towards downstream of the dam for the project may be given.
- The minimum environmental flow shall be 20% of the flow of four consecutive lean months of 90% dependable year, 30% of the average monsoon flow. The flow for remaining months shall be in between 20-30%, depending on the site specific requirements. A site specific study shall be carried out by an expert organization.

- 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.
- Sedimentation data available with CWC may be used to find out the loss in storage over the years.
- A minimum of 1 km distance from the tip of the reservoir to the tail race tunnel should be maintained between upstream and downstream projects.

C Biological Environment

Besides primary studies, review of secondary data/literature published for project area on flora & fauna including RET species shall be reported in EIA/EMP report.

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, Pteriodophytes, Bryophytes (all groups).
- General vegetation profile and floral diversity covering all groups of flora including lichens and orchids. 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 Horticultural Practices in the study area.
- Biodiversity study shall be carried out by associating a reputed organisation as per the list of such institutes is available on MoEFCC website.

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 analysed.
- 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 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.

D Aquatic Ecology

- Documentation of aquatic fauna like macro-invertebrates, zooplankton, phytoplantktons, benthos etc.
- Fish and fisheries, their migration and breeding grounds.
- Fish diversity composition and maximum length & weight of the measured populations to be studies for estimation of environmental flow.
- Conservation status of aquatic fauna.
- Sampling for aquatic ecology and fisheries and fisheries must be conducted during three seasons – Pre-monsoon (summer), monsoon and winter. Sizes (length & weight) of important fish species need to be collected and breeding and feeding grounds should also be identified along the project site or in vicinity.

E Socio-Economic

- 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.
- Documentation of demographic, Ethnographic, Economic Structure and development profile of the area.
- Information on Agricultural Practices, Cultural and aesthetic sites, Infrastructure facilities etc.
- Information on the dependence of the local people on minor forest produce and their cattle grazing rights in the forest land.
- List of all the Project Affected Families with their name, age, educational qualification, family size, sex, religion, caste, sources 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, any other property, possession of cattle, type of house etc.
- Special attention has to be given to vulnerable groups like women, aged persons etc. and to any ethnic/indigenous groups that are getting affected by the project.

(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.

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 equipments and vehicles
- Fugitive emissions from various sources

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 labour colonies/ camps and washing equipment.

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.

Biological Environment

- Impact on forests, flora, fauna including wildlife, migratory avi-fauna, rare and endangered species, medicinal plants etc.
- 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.

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 / vector 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 population will be studies. 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.

(8) Environmental Management Plans

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, Deptt. 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.

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 plants for afforestation should include native and RET species, if any. This will be a part of the forest clearance proposal.

3. **Biodiversity and Wildlife Conservation and Management Plan** for the conservation and preservation of rare, endangered or endemic floral/faunal species or some National Park/Sanctuary/ Biosphere Reserve or other protected area is going to get affected directly or indirectly by construction of the project, then suitable conservation measures should be prepared in consultation with the State Forest Department and with the physical and financial details. Suitable conservation techniques (in-situ/ex-situ) will be proposed under the plan and the areas where such conservation is proposed will be marked on a project layout map.

4. **Fisheries Conservation and Management Plan** – a specific fisheries management measures should be prepared for river and reservoir. If the construction of fish ladder/ fish-way etc. is not feasible then measures for reservoir fisheries will be proposed. The plan will detail out the number of hatcheries, nurseries, rearing ponds etc. proposed under the plan with proper drawings. If any migratory fish species is getting affected then the migratory routes, time/season of upstream and downstream migration, spawning grounds etc will be discussed in details.

5. **Resettlement and Rehabilitation 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. Resettlements site should be identified. The plan will also incorporate community development strategies.

R&R Plan is to be formulated as per new Act, 2013 which came into force w.e.f. 1.1.2014. Plan will also incorporate community development strategies.

Project Proponent will perform skill mapping for the services required for construction, operation & maintenance of the project based on the estimated workforce. In order to employ local population, the eligible persons amongst the local population should be trained to acquire skills required during the investigation, construction, operation & maintenance of the project and such an empowerment project for local populations should be part of and included in R&R Plan.

Suitable Provisions for health care services should be incorporated in R&R Plan.

6. **Green Belt Development Plan** along the periphery of the reservoir, approach roads around the colonies and other project components, local plant species must be suggested with physical and financial details. A layout map showing the proposed sites for developing the green belt should be prepared.

7. **Reservoir Rim Treatment Plan** for stabilization of land slide / land slip zones, if any, around the reservoir periphery is to be prepared based on detailed survey of geology of the reservoir rim area. Suitable engineering and biological measures for treatment of identified slip zones to be suggested with physical and financial schedule. Layout map showing the landslide/landslip zones shall be prepared and appended in the chapter.

8. **Muck Disposal Plan s**uitable sites for dumping of excavated materials should be identified in consultation with State Pollution Control Board and State Forest Department. All muck disposal sites should be minimum 30 m away from the HFL of river. The quantity of muck to be generated and the quantity of muck proposed to be utilized shall be calculated in consultation with the project authorities. Details of each dumping site viz. area, capacity, total quantity of muck that can be dumped etc. should be worked out and discussed in the plan. Plan for rehabilitation of muck disposal sites should also be given. The L-section / cross section of muck disposal sites and approach roads should be given. The plan shall have physical and financial details of the measures proposed. Layout map showing the dumping sites vis-à-vis other project components will be prepared and appended in the chapter.

9. **Restoration Plan for Quarry Sites and landscaping** of colony areas, working areas, roads etc. Details of the coarse/fine aggregate/clay etc. required for construction of the project and the rock/clay quarries/river shoal sites identified for the project should be discussed along-with the Engineering and Biological measures proposed for their restoration with physical and financial details. Layout map showing quarry sites vis-à-vis other project components, should be prepared.

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.

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. To identify inundation areas, population and structures likely to be affected due to catastrophic floods in the event of dam failure. DMP will be prepared with the help of Dam Break Analysis. Maximum water level that would be attained at various points on the downstream in case of dam break will be marked on a detailed contour map of the downstream area, to

show the extent of inundation. The action plan will include Emergency Action and Management plan including measures like preventive action notification, warning procedure and action plan for co-ordination with various authorities.

12. **Water, Air and Noise Management Plans** to be implemented during construction and post-construction periods.

13. **Public Health Delivery Plan** including the provisions of drinking water supply for local population shall be in the EIA/EMP Report. Status of the existing medical facilities in the project area shall be discussed. Possibilities of strengthening of existing medical facilities, construction of new medical infrastructure etc. will be explored after assessing the need of the labour force and local populace.

14. **Labour Management Plan** for their Health and Safety.

15. **Sanitation and Solid waste management plan** for domestic waste from colonies and labour camps etc.

16. **Local Area Development Plan** to be formulated in consultation with the Revenue Officials and Village Pancahayats. Appropriate schemes shall be prepared under EMP for the Local Area Development Plan with sufficient financial provisions.

    Environmental safeguards during construction activities including Road Construction.

17. **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 of the natural resource (wood) for the domestic and commercial use is curbed.

18. **Environmental Monitoring Programme** to monitor the mitigatory 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.

19. **A summary of Cost Estimates** for all the plans, cost for implementing all the Environmental Management Plans.

Additional Information:

The following additional information/study shall be required to be undertaken by the Project Proponent.

i. The outcome of Cumulative Impact Assessment Study of Yamuna river Basin, as applicable, would be implemented by the project.

ii. Biodiversity study shall be carried out by associating a reputed organization as per the list of institutes available on MoEFCC website.

iii. Camera trapping to be used for assessment of presence of wildlife in the project area.

iv. Skill mapping of project affected families shall be carried out and suitable provisions shall be made in R&R plan.

v. Efforts to be made to the extent possible, so that no PAF loses their entire land holding on account of acquisition of land for the project.

vi. Possibility of providing fish ladder/passage in barrage shall be explored for sustenance of fisheries.

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Annexure-Ia

TOR Compliance Matrix for Jakhol Sankri HEP

S. No.	TOR Points	Compliance
1	**Scope of the EIA Studies**	
	The EIA Report should identify the relevant environmental concerns and focus on potential impacts that may change due to the construction of proposed project. Based on the baseline data collected for three (3) seasons (Pre-monsoon, Monsoon and Winter seasons), the status of the existing environment in the area and capacity to bear the impact on this should be analysed. Based on this analysis, the mitigation measures for minimizing the impact shall be suggested in the EIA/EMP study.	This aspect has been covered in section 3.2 of Chapter-3 of EIA report. The detailed study of environment impacts with their mitigation measures for minimizing the impact has been done in Chapter-4
2	**Details of the Project and Site**	
	• General introduction about the proposed project.	This aspect has been covered in section 1.1 of chapter-1 of EIA report
	• Details of project and site giving L-sections of all U/S and D/S projects of River with all relevant maps and figures. Connect such information as to establish the total length of interference of Natural River, the total length of tunnelling of the river and the committed unrestricted release from the site of diversion into the main river.	This aspect has been covered in section 10.15, sub-section 10.15.3 of chapter-10.
	• A map of boundary of the project site giving details of protected areas in the vicinity of project location.	The map has been shown as Figure 3.14 section 3.4 of chapter-3.
	• Location details on a map of the project area with contours indicating main project features. The project layout shall be superimposed on a contour map of ground elevation showing main project features (viz. location of dam, Head works, main canal, branch canals, quarrying etc.) shall be depicted in a scaled map.	Location details on a map of the project with contours indicating main project features has been shown in Figure 2.1 of chapter-2
	• Layout details and map of the project along with contours with project components clearly marked with proper scale maps of at least a 1 :50,000 scale and printed at least on A3 scale for clarity.	Location details on a map of the project with contours indicating main project features has been shown in Figure 3.2 and 3.3 in section 3.3 of chapter-3
	• Existence of National Park, Sanctuary, Biosphere Reserve etc. in the study area, if any, should be detailed and presented on a map with distinct distances from the project components.	The aspect has been covered in section 3.4, subsection 3.4.13 of chapter-3. The maps showing the location of wildlife sanctuary has been shown in Figure 3.13 and 3.14
	• Drainage pattern and map of the river catchment up to the proposed project site.	The aspect has been covered in section 3.38 of chapter-3.
	• Delineation of critically degraded areas in the directly draining catchment on the basis of silt Yield	The aspect has been covered in section 10.3 of chapter-10

S. No.	TOR Points	Compliance
	Index as per the methodology of All India Soil and Land Use Survey of India.	
	• Soil characteristics and map of the project area	The aspect has been covered in section 3.3, subsection 3.3.3 of chapter-3.
	• Geological and Seismo-tectonic details and maps of the area surrounding the proposed project site showing location of dam site and powerhouse site.	The aspect has been covered in section 3.3.7 of the chapter-3.
	• Remote Sensing studies, interpretation of satellite imagery, topographic sheets along with ground verification shall be used to develop the land use/land cover pattern of the study using overlaying mapping techniques viz. Geographic Information System {GIS), False Color Composite (FCC) generated from satellite data of project area.	This aspects has been covered in Figure 3.2 and Figure 3.3 of section 3.3 of Chapter-3
	• Land details including forests, private and other land.	This aspect has been covered in section 2.15 of chapter-2
	• Demarcation of snow fed and rain fed areas for a realistic estimate of the water availability.	This aspect has been covered in section 3.3 of chapter-3
	• Different riverine habitats like rapids, pools, side pools and variations in the river substratum-bedrocks, rocks, boulders, sand/silt or clay etc. need to be covered under the study.	The aspect has been covered in section 3.4, sub-section 3.4.15 of chapter-3.
3	**Description of Environment and Baseline Data**	
	To know the present status of 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. Should be collected with 10 km radius of the main components of the project site i.e. Dam site and power house site. The air quality and noise are to be monitored at such locations which are environmentally & ecologically more sensitive in the study area. The baseline studies should be collected for 3 seasons (Pre-Monsoon, Monsoon and Post Monsoon seasons). The study area should comprise of the following: • Catchment area up-to the dam site • Submergence Area Project area or the direct impact area should comprise of area falling within 1 O km radius from the periphery of reservoir, land coming under submergence and area downstream of dam upto the point where Tail Race Tunnel (TRT) meets the river. • Downstream upto 10 km from tip of Tail Race Tunnel (TRT).	The baseline data of the various aspects has been covered in section 3.3, 3.4 and 3.5 of chapter-3
4	**Details of the Methodology**	
	The methodology followed for collection of base line data along with details of number of samples and their locations in the map should	The methodology for collecting the baseline data has been outlined in section 3.2 of Chapter-

S. No.	TOR Points	Compliance
	be included. Study area should be demarcated properly'. On the appropriate scale map. Sampling sites should be depicted on map for each parameter with proper legends. For forest classification, Champion and Seth (1968) classification should be followed	3
5	**Methodology for collection of Biodiversity Data**	
	• The number of sampling locations should be adequate to get a reasonable idea of the diversity and other attributes of flora and fauna. The guiding principles should be the size of the study area (larger area should have larger number of sampling locations) and inherent diversity at the location, as known from secondary sources (e.g. eastern Himalayan and low altitude sites should have a larger number of sampling locations owing to higher diversity).	This aspect has been covered in section 3.4 of chapter-3.
	• The entire area should be divided in grids of 5km X 5km preferably on a GIS domain. There after 25% of the grids should be randomly selected for sampling of which half should be in the directly affected area (grids including project components such as reservoir, dam, powerhouse, tunnel, canal etc.) and the remaining in the rest of the area (areas of influence in 10 km radius for project components). At such chosen location, the size and number of sampling units (e.g. quadrats in case of flora/transectsin case of fauna) must be decided by species area curves and the details of the same (graphs and cumulative number of species in a tabulated form) should be provided in the EIA report. Some of the grids on the edges may not be completely overlapping with the study area boundaries. However these should be counted and considered for selecting 25% of the grids. The number of grids to be surveyed may come out as a decimal number (i.e. it has an integral and a fractional part) which should be rounded to the next whole number.	This aspect has been covered in section 3.4, sub-section 3.4.5 of chapter-3.
	• The conventional sampling is likely to miss the presence of rare, endangered and threatened (R.E.T.) species since they often occur in low densities and in case of faunal species are usually secretive in behaviour. Reaching the conclusion about the absence of such species in the study area based on such methodology is misleading.	This aspect has been covered in section 3.4, sub-section 3.4.5 of chapter-3.
	• It is very important to document the status of such species owing to their high conservation value. Hence presence of such species should be ascertained from secondary sources	This aspect has been covered in section 3.4, sub-section 3.4.11 of the chapter-3

S. No.	TOR Points	Compliance
	by a proper literature survey for the said area including referring to field guides which are now available for many taxonomic groups in India. Even literature from studies/surveys in the larger landscapes which include the study area for the concerned project must be referred to since most species from adjoining catchments is likely to be present in the catchments in question. In fact such literature form the entire state can be referred to. Once a listing of possible R.E.T. species form the said area is developed, species specific methodologies should be adopted to ascertain their presence in the study area which would be far more conclusive as compared to the conventional sampling. If the need be, modern methods like camera trapping can be resorted to, particularly for areas in the eastern Himalayas and for secretive/nocturnal species. A detailed listing of the literature referred to, for developing lists of R.E.T. Species should be provided in the EIA reports.	
	• The R.E.T. species referred to in this point should include species listed in Schedule I and II of Wildlife (Protection) Act, 1972 and those listed in the red data books (BSI, ZSI and IUCN).	This aspect has been covered in section 3.4, sub-section 3.4.11 of the chapter-3
6	**Components of the EIA Study**	
	Various aspects to be studied and provided in the EINEMP report are as follows:	
	A. Physical and Chemical Environment Geological & Geophysical Aspects and Seismo - Tectonics	
	• Physical geography, Topography, Regional Geological aspects and structure of the Catchment	This aspects has been covered in section 3.2 of chapter-3.
	• Tectonics, seismicity and history of past earthquakes in the area. A site specific study of the 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.	The aspect has been covered in section 3.3, sub-section 3.3.7 of chapter-3.
	• Landslide zone or area prone to landslide existing in the study area should be examined.	The aspect has been covered in section 3.3, sub-section 3.3.7 and Table-3.28 of chapter-3.
	• Presence of important economic mineral deposit, if any.	The aspect has been covered in section 3.3, sub-section 3.3.8 of chapter-3.
	• Justification for location & execution of the project in relation to structural components (dam height).	The aspect has been covered section 2.3, 2.4 and 2.5 of chapter 2
	• Impact of project on geological environment	This aspect has been covered in

S. No.	TOR Points	Compliance
		table 4.1 of chapter-4.
	Meteorology, Air and Noise:	
	• Meteorology (viz. Temperature, Relative humidity, wind speed/direction etc.) to be collected from nearest IMO station.	The aspect has been covered in Table 3.4 of chapter-3.
	• Ambient Air Quality with parameters viz. Suspended Particulate Matter (SPM), Respirable Suspended Particulate Matter (RSPM) i.e. suspended particulate materials <10 microns, Sulphur Dioxide (SO_2) and Oxides of Nitrogen (NOx) in the study area at 6 locations.	This aspect has been covered in section 3.3, sub-section 3.3.5 of chapter-3
	• Existing noise levels and traffic density in the study area at 6 locations.	This aspect has been covered in section 3.3, sub-section 3.3.6 of chapter-3
	Soil Characteristic:	
	• 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).	The aspect has been covered in section 3.3, subsection 3.3.3 of chapter-3.
	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	The slope map is shown as Figure 10.4 The land use map is shown as Figure 3.2 and 3.3 The drainage map is shown as Figure 3.10 The soil map is shown as Figure 3.4 The soil erosion intensity map is shown as 10.5
	Water Quality:	
	• History of the ground water table fluctuation in the study area	The aspect has been covered in section 3.3, sub-section 3.3.4 of chapter-3.
	• 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, N02, P04, Cl, S04, 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 locations).	The aspect has been covered in section 3.3, sub-section 3.3.4 of chapter-3.
	• Delineation of sub and micro-watersheds, their locations and extent based on the All India	The aspect has been covered in section 10.3 of chapter-10

S. No.	TOR Points	Compliance
	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.	
	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 established along-with real time telemetry and data acquisition system for inflows monitoring.	The aspect has been covered in section 3.3, sub-section 3.3.1 and 3.3.8 of chapter-3.
	• Run off, discharge, water availability for the project, sedimentation rate, etc.	The aspect has been covered in section 3.3.8 of chapter-3
	• Basin characteristics	
	• Catastrophic events like cloud bursts and flash floods, if any, should be documented.	The aspect has been covered in sub-section 3.3.8 of chapter-3
	• 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.	The aspect has been covered in sub-section 3.3.8 of chapter-3
	• Set up a G&D monitoring station and a few rain gauge stations in the catchment area for collecting data during the investigation.	The aspect has been covered in sub-section 3.3.8 of chapter-3
	• Flow series, 10 daily with 90% 75% and 50% dependable years discharges.	The aspect has been covered in sub-section 3.3.8 of chapter-3
	• Information on the 10-daily flow basis for the 90 per cent dependable year the flow intercepted at the dam, the flow diverted to the power house and the spill comprising the environmental flow and additional flow towards downstream of the dam for the project may be given	The aspect has been covered in sub-section 3.3.8 of chapter-3
	• The minimum environmental flow shall be 20% of the flow of four consecutive lean months of 90% dependable year, 30% of the average monsoon flow. The flow for remaining months shall be in between 20-30%, depending on the site specific requirements. A site specific study shall be carried out by an expert organization.	The aspect has been covered in section 10.15 of chapter-10.
	• Hydrological studies/data as approved by CWC shall be utilized in the preparation of EINEMP report. Actual hydrological annual yield may also be given in the report.	The aspect has been covered in sub-section 3.3.8 of chapter-3
	• Sedimentation data available with ewe may be used to find out the loss in storage over the years.	The aspect has been covered in sub-section 3.3.8 of chapter-3
	• A minimum of 1 km distance from the tip of	

S. No.	TOR Points	Compliance
	the reservoir to the tail race tunnel should be maintained between upstream and downstream projects.	
	C Biological Environment	
	Besides primary studies, review of secondary data/literature published for project area on flora & fauna including RET species shall be reported in EINEMP report	
	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.	The aspect has been covered in section 3.4, sub-section 3.4.1 of the chapter-3.
	• Documentation of all plant species i.e. Angiosperm, Gymnosperm, Pteriodophytes Bryophytes (all groups).	The aspect has been covered in table 3.30 and table 3.31 of the chapter-3.
	• General vegetation profile and floral diversity covering all groups of flora including lichens and orchids. 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.	The aspect has been covered in in section 3.4, sub-section 3.4.5 of the chapter-3
	• Existence of National park, Sanctuary, Biosphere Reserve etc. in the study area, if any, should be detailed	The aspect has been covered in section 3.4, sub-section 3.4.13 of chapter-3.
	• Economically important species like medicinal plants, timber, fuel wood etc.	The aspect has been covered in section 3.4, sub-section 3.4.9 of chapter-3.
	• 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.	The aspect has been covered in section 3.4, sub-section 3.4.11 of the chapter-3.
	• Cropping pattern and Horticultural Practices in the study area	The aspect has been covered in section 3.5, sub-section 3.5.6 of the chapter-3.
	• Biodiversity study shall be carried out by associating a reputed organisation as per the list of such institutes is available on MoEFCC website.	Biodiversity study was carried out by CISHME, which is an organisation of repute and recognised by MOEF&CC

S. No.	TOR Points	Compliance
	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.	The aspect has been covered in section 3.4, sub-section 3.4.14 of chapter-3.
	• Documentation of fauna plankton (phyto and zooplankton), periphyton, benthos and fish should be done and analysed.	The aspect has been covered in section 3.4, sub-section 3.4.15 of chapter-3.
	• Information (authenticated) on Avi-fauna and wildlife in the study area	The aspect has been covered in section 3.4, sub-section 3.4.14 of chapter-3.
	• Status of avifauna their resident/ migratory/ passage migrants etc.	The status of avifauna has been discussed in table 3.60 of chapter-3
	• Documentation of butterflies, if any, found in the area.	The aspect has been covered in section 3.4, sub-section 3.4.14 of chapter-3
	• Details of endemic species found in the project area.	
	• RET species-voucher specimens should be collected along-with GPS readings to facilitate rehabilitation. RET faunal species to be classified as per IUCN Red Data list and as per different schedule of Indian Wildlife (Protection) Act, 1972.	The aspect has been covered in section 3.4, sub-section 3.4.14 of chapter-3
	• Existence of barriers and corridors, if any, for wild animals.	No
	• 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.	The aspect has been covered in section 10.2 of chapter-10.
	• Collection of primary data on agricultural activity, crop and their productivity and irrigation facilities components.	The aspect has been covered in section 3.5 of chapter-3.
	D. Aquatic Ecology	
	• Documentation of aquatic fauna like macro-invertebrates, zooplankton, phytoplantktons, benthos etc.	The aspect has been covered in section 3.4, section 3.4.15 of chapter-3.
	• Fish and fisheries, their migration and breeding grounds.	The aspect has been covered in section 3.4.16 of chapter-3.
	• Fish diversity composition and maximum length & weight of the measured populations to be studies for estimation of environmental flow.	The aspect has been covered in section 3.4.16 of chapter-3
	• Conservation status of aquatic fauna.	The aspect has been covered in section 3.4, section 3.4.15 of chapter-3.
	• Sampling for aquatic ecology and fisheries and fisheries must be conducted during three seasons - Pre-monsoon (summer), monsoon and winter. Sizes (length & weight) of important fish species need to be collected and breeding	The aspect has been covered in section 3.2, sub-section 3.2.5 of the chapter-3.

S. No.	TOR Points	Compliance
	and feeding grounds should also be identified along the project site or in vicinity.	
	E Socio-Economic	
	• 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	The aspect has been covered in section 3.5 of chapter-3.
	• 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	The aspect has been in section 3.5, sub-section 3.5.2 of chapter-3.
	• Collection of information on sensitive habitat of historical, cultural and religious and ecological importance	The aspect has been covered in section 3.5, sub-section 3.5.5 of chapter-3.
	• 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.	The aspect has been covered in section 3.5 of chapter-3.
	• Documentation of demographic, Ethnographic, Economic Structure and development profile of the area	The aspect has been covered in section 3.5 of chapter-3.
	• Information on Agricultural Practices, Cultural and aesthetic sites, Infrastructure facilities etc.	The aspect has been covered in section 3.5 of chapter-3.
	• Information on the dependence of the local people on minor forest produce and their cattle grazing rights in the forest land	The aspect has been covered in section 3.5 sub-section 3.5.8 and 3.5.9 of chapter-3.
	• List of all the Project Affected Families with their name, age, educational qualification, family size, sex, religion, caste, sources 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, any other property, possession of cattle, type of house etc.	The aspect has been covered in section 3.5 of chapter-3.
	• Special attention has to be given to vulnerable groups like women, aged persons etc. and to any ethnic/indigenous groups that are getting affected by the project.	The aspect has been covered in section 3.5 of chapter-3.
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.	
	Air Environment:	
	• Changes in ambient and ground level	The aspect has been covered in

S. No.	TOR Points	Compliance
	concentrations due to total emissions from point, line and area sources.	section 4.3 of chapter 4.
	• Effect on soil, material, vegetation and human health.	The aspect has been covered in section 4.3 of chapter 4.
	• Impact of emissions from DG set used for power during the construction, if any, on air environment.	The aspect has been covered in section 4.3 of chapter 4.
	• Pollution due to fuel combustion in equipment and vehicles.	The aspect has been covered in section 4.3 of chapter 4.
	• Fugitive emissions from various sources.	The aspect has been covered in section 4.3 of chapter 4.
	Water Environment:	
	• Changes in surface and ground water quality	The aspect has been covered in section 4.2 of chapter 4.
	• Steps to develop pisci-culture and recreational facilities.	The aspect has been covered in section 4.2 of chapter 4.
	• Changes in hydraulic regime and downstream flow	The aspect has been covered in section 4.2 of chapter 4.
	• Water pollution due to disposal of sewage.	The aspect has been covered in section 4.2 of chapter 4.
	• Water pollution from labour colonies/ camps and washing equipment.	The aspect has been covered in section 4.2 of chapter 4.
	Land Environment:	
	• Adverse impact on land stability, catchment of soil erosion, reservoir sedimentation and spring flow (if any) (a) due to considerable road construction l widening activity (b) interference of reservoir with the inflowing stream (c) blasting for commissioning of HRT, TRT and some other structures.	The aspect has been covered in section 4.5 of chapter 4
	• Changes in land use / land cover and drainage pattern.	The aspect has been covered in section 4.5 of chapter 4
	• Immigration of labour population.	The aspect has been covered in section 4.5 of chapter 4
	• Quarrying operation and muck disposal.	The aspect has been covered in section 4.5 of chapter 4
	• Changes in land quality including effects of waste disposal.	The aspect has been covered in section 4.5 of chapter 4
	• River bank and their stability.	The aspect has been covered in section 4.5 of chapter 4
	• Impact due to submergence.	The aspect has been covered in section 4.5 of chapter 4
	Biological Environment:	
	• Impact on forests, flora, fauna including wildlife, migratory avi-fauna, rare and endangered species, medicinal plants etc.	The aspect has been covered in section 4.6 of chapter 4
	• Pressure on existing natural resources.	The aspect has been covered in section 4.6 of chapter 4
	• Deforestation and disturbance to wildlife, habitat fragmentation and wild animal's	The aspect has been covered in section 4.6 of chapter 4

S. No.	TOR Points	Compliance
	migratory corridors.	
	• Compensatory afforestation-identification of suitable native tree species for compensatory afforestation and green belt	The aspect has been covered in section 4.6 of chapter 4
	• Impact on fish migration and habitat degradation due to decreased flow of water.	The aspect has been covered in section 4.6 of chapter 4
	• Impact on breeding and nesting grounds of animals and fish.	The aspect has been covered in section 4.6 of chapter 4
	Socio-Economic Aspects:	
	• Impact on local community including demographic profile	The aspect has been covered in section 4.8 of chapter-4.
	• Impact on socio-economic status.	The aspect has been covered in section 4.8 of chapter-4.
	• Impact on economic status.	The aspect has been covered in section 4.8 of chapter-4.
	• Impact on human health due to water/ vector borne disease.	The aspect has been covered in section 4.8 of chapter-4.
	• Impact on increase traffic.	
	• Impact on Holy Places and Tourism	There are no major historical or religious place around the project area. There is only Govind Wildlife Sanctuary.
	• 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 population will be studies. Proper record shall be maintained of the baseline information in the post project period.	The aspect has been covered in section 4.8 of chapter-4.
	• Positive and negative impacts likely to be accrued due to the project are listed.	The aspect has been covered in section 4.8 of chapter-4.
8	**Environmental Management Plans:**	
	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, Deptt. 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.	The aspect has been covered in section 10.3 of chapter-10
	2. Compensatory Afforestation shall be	The aspect has been covered in

S. No.	TOR Points	Compliance
	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 plants for afforestation should include native and RET species, if any. This will be a part of the forest clearance proposal.	section 10.2 of chapter-10.
	3. Biodiversity and Wildlife Conservation and Management Plan for the conservation and preservation of rare, endangered or endemic floral/faunal species or some National Park/Sanctuary/ Biosphere Reserve or other protected area is going . to get affected directly or indirectly by construction of the project, then suitable conservation measures should be prepared in consultation with the State ForestDepartment and with the physical and financial details. Suitable conservation techniques (in-situ/ex-situ) will be proposed under the plan and the areas where such conservation is proposed will be marked on a project layout map.	The aspect has been covered in section 10.2 of chapter-10
	4. Fisheries Conservation and Management Plan - a specific fisheries management measures should be prepared for river and reservoir. If the construction of fish ladder/ fish-way etc. is not feasible then measures for reservoir fisheries will be proposed. The plan will detail out the number of hatcheries, nurseries, rearing ponds etc. proposed under the plan with proper drawings. If any migratory fish species is getting affected then the migratory routes, time/season of upstream and downstream migration, spawning grounds etc. will be discussed in details.	The aspect has been covered in section 10.4 of chapter-10
	5. Resettlement and Rehabilitation 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. Resettlements site should be identified. The plan will also incorporate community development strategies. R&R Plan is to be formulated as per new Act, 2013 which came into force w.e.t 1.1.2014. Plan will also incorporate community development strategies. Project Proponent will perform skill mapping for the services required 'for construction, operation & maintenance of the project based on the estimated workforce. In order to employ local population, the eligible persons amongst the	The aspect has been covered in section 7.3 of chapter-7.

S. No.	TOR Points	Compliance
	local population should be trained to acquire skills required during the investigation, construction, operation & maintenance of the project and such an empowerment project for local populations should be part of and included in R&R Plan. Suitable Provisions for health care services should be incorporated in R&R Plan	
	6. Green Belt Development Plan along the periphery of the reservoir, approach roads around the colonies and other project components, local plant species must be suggested with physical and financial details. A layout map showing the proposed sites for developing the green belt should be prepared.	The aspect has been covered in section 10.10 of chapter-10.
	7. Reservoir Rim Treatment Plan for stabilization of land slide/land slip zones, if any, around the reservoir periphery is to be prepared based on detailed survey of geology of the reservoir rim area. Suitable engineering and biological measures for treatment of identified slip zones to be suggested with physical and financial schedule. Layout map showing the landslide/landslip zones shall be prepared and appended in the chapter.	The aspect has been covered in section 10.9, sub-section 10.9.2 and 10.3, sub-section 10.3.5 of chapter-10.
	8. Muck Disposal Plan suitable sites for dumping of excavated materials should be identified in consultation with State Pollution Control Board and State Forest Department. All muck disposal sites should be minimum 30 m away from the HFL of river. The quantity of muck to be generated and the quantity of muck proposed to be utilized shall be calculated in consultation with the project authorities. Details of each dumping site viz. area, capacity, total quantity of muck that can be dumped etc. should be worked out and discussed in the plan. Plan for rehabilitation of muck disposal sites should also be given. The• L-section/cross section of muck disposal sites and approach roads should be given. The plan shall have physical and financial details of the measures proposed. Layout map showing the dumping sites vis-a-vis other project components will be prepared and appended in the chapter.	The aspect has been covered in section 10.7 of chapter-10.
	9. Restoration Plan for Quarry Sites and landscaping of colony areas, working areas, roads etc. Details of the coarse/fine aggregate/clay etc. required for construction of the project and the rock/clay quarries/river shoal sites identified for the project should be discussed along-with the Engineering and Biological measures proposed for their restoration with physical and financial details. Layout map showing quarry sites vis-a-vis other project components, should be prepared.	The aspect has been covered in section 10.8 of chapter-10.

S. No.	TOR Points	Compliance
	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.	The aspect has been covered in section 7.7, sub-section 7.7.4 of chapter-7.
	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. To identify inundation areas, population and structures likely to be affected due to catastrophic floods in the event of dam failure. DMP will be prepared with the help of Dam Break Analysis. Maximum water level that would be attained at various points on the downstream in case of dam break will be marked on a detailed contour map of the downstream area, to show the extent of inundation. The action plan will include Emergency Action and Management plan including measures like preventive action notification, warning procedure and action plan for co-ordination with various authorities.	The aspect has been covered in section 7.7 of chapter-7
	12. Water, Air and Noise Management Plans to be implemented during construction and post-construction periods.	The aspect has been covere in section 10.11, 10.12 and 10.13 of chapter-10.
	13. Public Health Delivery Plan including the provisions of drinking water supply for local population shall be in the EIA/EMP Report. Status of the existing medical facilities in the project area shall be discussed. Possibilities of strengthening of existing medical facilities, construction of new medical infrastructure etc. will be explored after assessing the need of the labour force and local populace.	The aspect has been covered in section 10.5 of chapter-10.
	14. Labour Management Plan for their Health and Safety	The aspect has been covered in section 10.6 of chapter-10.
	15. Sanitation and Solid waste management plan for domestic waste from colonies and labour camps etc.	The aspect has been covered in section 10.6 of chapter-10.
	16. Local Area Development Plan to be formulated in consultation with the Revenue Officials and Village Pancahayats. Appropriate schemes shall be prepared under EMP for the Local Area Development Plan with sufficient financial provisions. Environmental safeguards during construction activities including Road Construction.	The aspect has been covered in section 7.5 of chapter-7.
	17. Energy Conservation Measures for the work force during construction with physical and financial details. Alternatives will be proposed for the	The aspect has been covered in section 10.6 of chapter-10.

S. No.	TOR Points	Compliance
	labour force so that the exploitation of the natural resource (wood) for the domestic and commercial use is curbed.	
	18. 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.	The aspect has been widely discussed in chapter-10.
	19. A summary of Cost Estimates for all the plans, cost for implementing all the Environmental Management Plans.	The aspect has been covered in section 10.16 of chapter-10.
	Additional Information:	
	The following additional information/study shall be required to be undertaken by the Project Proponent**.**	
	i. The outcome of Cumulative Impact Assessment Study of Yamuna river Basin, as applicable, would be implemented by the project	
	ii. Biodiversity study shall be carried out by associating a reputed organization as per the list of institutes available on MoEF&CC website	The aspect has been covered in section 10.2, of chapter-10.
	iii. Camera trapping to be used for assessment of presence of wildlife in the project area.	Camera trapping method has been used for assessment of presence of wildlife in the project area
	iv. Skill mapping of project affected families shall be carried out and suitable provision shall be made in R&R plan	The aspect has been covered in section 4.8 of chapter-4.
	v. Efforts to be made to the extent possible, so that no PAF loses their entire land holding on account of acquisition of land for the project.	The aspect has been covered in section 7.4 of chapter-7.
	vi. Possibility of providing fish ladder/passage in barrage shall be explored for sustenance of fisheries.	The aspect has been covered in section 10.4, sub-section 10.4.3 of chapter-10.

ANNEXURE-II

F.No.6-109/2016 WL (39th Meeting)
Government of India
Ministry of Environment, Forest & Climate Change
Wildlife Division
***

Indira Paryavaran Bhawan
Jor Bag Road, Aliganj
New Delhi-110003
Dated:21.09.2016.

To

The Principal Secretary (Forests)
Department of Forests
Government of Uttarakhand
87, Sachivalaya, Rajpur Road
Dehradun-600006.

Sub: Minutes of the 39th Meeting of Standing Committee of NBWL.

Sir,

The 39th Meeting of the Standing Committee of National Board for Wildlife (SC-NBWL) was held on 23rd August 2016 under the chairmanship of Hon'ble Minister of State (Independent Charge) for Environment, Forest and Climate Change. The following proposals pertaining to your State were considered. The relevant portion of the decision taken in respect of the proposals is reproduced below:

"1. ***Construction of Singoli-Bhatwari Hydroelectric Project 99 MW by M/s L&T Uttaranchal Hydropower Limited. The proposed site falls within 10 kms from the boundary of Kedarnath Wildlife Sanctuary.***

2. ***Construction of 171 MW Lata Tapovan Hydro Power Project of NTPC Ltd, Uttarakhand.***

3. ***Construction of 520 MW (4x130) Tapovan Vishnugad Hydroelectric Project of NTPC Ltd, Uttarakhand. The proposed site falls outside Nanda Devi National Park at a distance of 7.5 km.***

The Member Secretary briefed the Committee on the proposals. He mentioned that the proposals were deferred due to non-submission of ESZ proposals of Uttarakhand by State. He added that ESZ proposals have been received from the state.

The Chair opined that comments of Ministry of Water Resources & Ganga Rejuvenation (MoWRGJ) on the project should be obtained to see if the project is in conformity with the policy of that Ministry. Consequently, the proposal was deferred pending receipt of comments from MoWRGJ.

4. ***Diversion of 1.610 ha Forest (Civil Land) for construction of Hapla-Guram-Nail motor road (5 km), Uttarakhand. The proposed site falls within 10 km aerial distance from the Kedarnath Musk Deer Wildlife Sanctuary.***

The Member Secretary briefed the Committee on the proposal. He mentioned that the proposal was deferred due to non-submission of ESZ proposals by state. The state has now

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submitted ESZ proposals. The proposal involves construction of 5 km length of motorable road within 10km default ESZ of Kedarnath Musk Deer Wildlife Sanctuary, and is for rural connectivity, which is a critical requirement of the people living in remote areas of the hill state.

After discussions, considering the public utility of the project, the Standing Committee decided to recommend the proposal along with conditions prescribed by State Chief Wildlife Warden and SBWL.

5. *Proposal for Jakhol Sankri Hydroelectric project (51 MW), Uttarakhand by M/s Satluj Jal Vidhut Nigam Ltd. Within 10km of Govind Wildlife Sanctuary /National Park.*

The Member Secretary briefed the Committee on the proposal and stated that the proposal was deferred due to non-submission of ESZ proposals of Uttarakhand by State. The ESZ proposals have been submitted by the state.

The Chair enquired if comments of the Ministry of Water Resources & Ganga Rejuvenation (MoWRGJ) on the project need be obtained to see if the project is in conformity with the Ganga rejuvenation plan. DGF & SS sought clarification from the state if the project was part of Ganga basin. Chief Wildlife Warden clarified that the project is on Tons river, which is a tributary of Yamuna and not Ganga. He clarified that the project has no linkage with Ganga related action plan of MoWRGJ.

After discussion, the Committee decided to recommend the project with conditions imposed by the State Government.

6. *Proposal for investigation and survey for diversion of 0.2883 ha of Reserved Forest Land from Gangotri National Park for construction of Sumla Check post 12th BN ITBP, Uttarakhand.*

The Member Secretary briefed the Committee on the proposal. The Chief Wildlife Warden of Uttarakhand appraised that the proposal involves investigation, survey and construction of Sumla Check Post by ITBP on an area of 0.29 ha in a strategic location identified within the National Park.

After discussions, considering the strategic importance of the project, the Standing Committee decided to recommend the proposal along with conditions prescribed by State Chief Wildlife Warden.

7. *Proposal for Hot Mix Plant inside Gangotri National Park for surfacing work for ITBP roads Sonam-PDA, PDA-Mendi & PDA-Sumla, Uttarakhand.*

The Member Secretary briefed the Committee on the proposal. He mentioned that proposal involves establishment of Hot Mix Plant on a temporary basis for resurfacing work of ITBP roads. It was confirmed by the Chief Wild Life Warden that the plant will be dismantled after completion of the work.

Contd.../3

After discussions, the Standing Committee decided to recommend the proposal along with the condition that the location of the plant after dismantling it will be restored adequately by the user agency, and other conditions prescribed by State Chief Wildlife Warden.

8. *Proposal for development of facilities for running of 18 coaches train between Haridwar to Dehradun, Uttarakhand.*

The Member Secretary briefed the Committee on the proposal and stated that proposal involves extension of Motichur railway station to accommodate 18 Coach Trains within the land owned by Railways. Chief Wildlife Warden confirmed that the activity is to be undertaken within the land already available with the railways and no extra forest land is needed by railways for this purpose.

After discussions, the Standing Committee decided to recommend the proposal along with conditions prescribed by State Chief Wildlife Warden.

9. *Diversion of 0.25 ha of forest land from Gangotri National Park for installation of Wind Mast study of wind data at Nelong (near forward post of I.T.B.P.), Uttarakhand.*

The Member Secretary briefed the Committee on the proposal and mentioned that proposal involves installation of weather data facilities, on an area of 0.25 ha, for studying the feasibility of wind power generation for ITBP check post located at a place where conventional power cannot be provided due to remoteness.

After discussions, considering the importance of the project for ITBP and no negative impact involved, the Standing Committee decided to recommend the proposal along with the conditions prescribed by Chief Wildlife Warden.

10. *Permission for installation of stone crusher at km 4.400 (Priority-I) on road Naga-Nilapani/km 2.100 (priority-II) on road Nelong-NAGA for completion of surfacing works under construction road Bhaironghati-Nelong, Nelong-Naga, Naga-Sonam, Naga-Nilapani and Naga-Jadung, Uttarakhand.*

The Member Secretary briefed the Committee on the proposal and stated that the proposal involves installation of stone crusher at km 4.400 (Priority-I) on road Naga-Nilapani/km 2.100 (priority-II) on road Nelong-NAGA for carrying out the surfacing works of border roads. It was clarified that no new diversion of forest is involved. Permission for temporary installation of stone crusher is needed to use the stones from the road construction work in the surfacing work.

After discussions, considering the strategic importance of border roads and no need of additional diversion apart from the proposal for reuse of the stones generation from the road work itself, the Standing Committee decided to recommend the proposal along with conditions prescribed by State Chief Wildlife Warden.

Contd.../4

11. Proposal for re-alignment and height extension of 220 KV Jhajhra-Rishikesh (earlier 220 KV Khodri-Rishikesh Line) and 132 KV Majra-Rishikesh Line at various locations at Dehradun-Haridwar road (NH-72), Uttarakhand.

The Member Secretary briefed the Committee on the proposal and mentioned that the proposal involves realignment and height extension of existing electric power transmission lines, 220 KV Jhajhra-Rishikesh and 132 KV Majra-Rishikesh Line at various locations on Dehradun-Haridwar road (NH-72). Chief Wildlife Warden informed that as a part of road development, the old existing transmission line is being replaced by new modern design masts with more height because of the flyover resulting in higher level of the road to facilitate connectivity of habitat underneath, and there is no additional land involved.

After discussions, considering the inevitability of the need, the Standing Committee decided to recommend the proposal along with condition of provision of installation of reflectors and bird deflectors and looking into possibility of using insulated wires, and those prescribed by State Chief Wildlife Warden.

12. Diversion of 0.50 ha (PDA 0.25 ha and Tirpani 0.25 ha) of forest land from Gangotri National Park for construction of Army Static Communication Network (ASCON PH-IV), Uttarakhand.

The Member Secretary briefed the Committee on the proposal and stated that the proposal involves construction of strategic installation (ASCON PH-IV) in an area of 0.50 ha (PDA 0.25 ha and Tirpani 0.25 ha) inside Gangotri National Park.

After discussions, considering the strategic importance of the communication network, the Standing Committee decided to recommend the proposal along with the conditions prescribed by Chief Wildlife Warden.

13. Diversion of 0.63 ha of forestland from Kedarnath Musk Deer Wildlife Sanctuary for construction of Mansoona-Gadbu Motor Road from Km.3.500 to 4.200 under P.M.G.S.Y in District Rudraprayag, Uttarakhand.

The Member Secretary briefed the Committee on the proposal and mentioned that the proposal involves construction of 700 m of Mansoona-Gadbu road under PMGSY and would need 0.63 ha of forest land from Kedarnath Musk Deer WLS for diversion. CWLW informed that the road connects remote village and is being aligned along the existing paths with appropriate levelling, to provide last mile connectivity of road, causing minimum disturbance to the sanctuary environment.

After discussions, considering the public utility of the project, the Standing Committee decided to recommend the proposal along with the conditions prescribed by State Chief Wildlife Warden.

Contd.../5

18. Diversion of 0.42 ha of forest land from Mussoorie Wildlife Sanctuary for construction of 600 meters motor road of Masrana- Kimoi proposed motor road, Uttarakhand.

The Member Secretary briefed the Standing Committee on the proposal that only 600 meters of the proposed road is passing through Mussoorie Wildlife Sanctuary involving 0.42 ha of land diversion and felling of trees. The total length 8.0 km (total 5.865 ha) of motor road involves 3.78 ha forest land, 1.10 ha civil land & 0.38 ha private land. The proposed road will provide connectivity to 5 villages in the remote hilly area. He added that State Wildlife Board has recommended the proposal. He clarified that the portion involving the area of Mussoorie Wildlife Sanctuary is adjacent to eastern fringe of the WL range, and is unavoidable because of the alignment reasons in the hilly area.

After discussions, considering that connectivity to the remote hilly villages is very important for provisioning of the basic amenities, limited traffic can hardly be a barrier in wildlife conservation in such remote areas and that in the region, villages are interspersed and are part of the forest landscape, the Standing Committee agreed to recommend the proposal along with the prescribed conditions of Chief Wildlife Warden.

1. *The proponent will take all necessary steps to avoid unscientific hill cutting.*
2. *The proposed work within the sanctuary area should be completed within a time frame mutually agreed with the Wild Life Warden.*
3. *No explosives will be utilized for the construction work within and in immediate vicinity of the sanctuary.*

The proponent will deposit the construction cost of a double storey forest chauki at Masrana with the Wildlife Warden, at prevalent P.W.D. rates".

The above recommendation(s) are subject to the existing directives of Hon'ble Supreme Court and provisions of Forests (Conservation) Act, 1980.

Yours faithfully

(Rajasekhar Ratti)
Scientist 'C'/Deputy Director (WL)

Copy to:

1. The Chief Wildlife Warden, Government of Uttarakhand, 5, Chandravani, Mohabawala, Dehradun-248 001.
2. The Addl.Pr. Chief Conservator of Forests, Ministry of Environment & Forests, Regional Office(CZ), Kendriya Bhandar, 5th Floor, Sector-H, Aliganj, Lucknow-226020, U.P.
3. The Joint Secretary, I.A. Division, MoEF & CC.
4. The Inspector General of Forests, FC Division, MoEF & CC.

(Rajasekhar Ratti)
Scientist 'C'/Deputy Director (WL)

ANNEXURE-III

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UP Power Transmission Corporation Limited Tender Notice against specification No ESD- 527 through E-Tendering :- E-Tenders in two parts, Part-1 & Part-II, valid for six months are invited for the supply of equipment as per details given in the following table against tender specification NO. ESD-527. Part-I of the bid shall contain earnest money deposit of Rs. 01,65,000.00 (Rs. One Lakh Sixty-Five Thousand only), tender fee against purchase of tender documents, pre qualification details, technical and Commercial terms and conditions etc. Part-II shall contain price bid only. Complete tender documents against this Bid specification can be downloaded from e-procurement website of U.P. Govt. **etender.up.nic.in** and tenderer will require to pay a non-refundable fee of Rs. 11,800/- (inclusive of 18% GST) towards cost of tender documents through RTGS/ NEFT in "UPPTCL SBI A/C No. 30231982762" (IFS Code -SBIN0003347). Tender document can be submitted only on e-procurement website **etender.up.nic.in** up to schedule date & time. Tenderer (s) are requested to get them registered with U.P. Electronics Corporation so as to obtain digital signatures for participation. **Sl. No. 1- Specn. No.-** **ESD-527- Particulars-** 250KVA, 33/0.415KV Station Transformer, **Qty. Nos.-** 64, **Earnest money (Rs)-** 165000.00, **Submission date & time-** 23.02.2019 (12:30 hrs.), **Opening date & time-** 25.02.2019 (15:30 hrs.) **Tender fee including GST (Rs)** - 11800.00, The bid of the firm without tender document fee, against the purchase of document, and without EMD will not be accepted. Tender document fee will be deposited through RTGS/NEFT in the UPPTCL account mentioned above and a proof of such deposit e.g. UTR no., Name of Account, scanned copy of pay-in slip countersigned by the tenderer should be uploaded along with etender documents. Earnest money deposit (EMD) will be deposited through RTGS/NEFT in UPPTCL account mentioned above and a proof of such deposit e.g. UTR no., Name of Account, scanned copy of pay-in slip countersigned by the tenderer, should be uploaded along with etender documents OR in the form of Bank Guarantee in favour of Superintending Engineer, Electricity Substation Design Circle-II, UPPTCL, Lucknow. If EMD is deposited in the form of Bank Guarantee, scanned copy of EMD BG alongwith a scanned copy of confirmation mail of the same from the bank Issuing the BG will be uploaded with the tender document. **No tender documents including tender fee, EMD B.G. and other commercial papers are required to be submitted in hard copy or through messenger at the time of bid opening.** Part-II containing price bid shall be opened separately at a later date to be informed accordingly. Undersigned reserves the right to accept or reject any offer without assigning any reason. Please visit e-procurement website etender.up.nic in as well as our website www.upptcl.org for all amendments, corrigendum, modifications and extensions till the date of submission of tenders. **Superintending Engineer, Electricity Substation Design Circle -II U.P. Power Transmission Corporation Ltd., 13th Floor, Shakti Bhawan Extension, 14-Ashok Marg, Lucknow-226001 (Uttar Pradesh) website www.etender.up.nic.in R- 44, Dt.: 25-01-2019.**
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पत्रांक-कृ०नि०/7006/एन०ई०जी०पी०ए०/18-19 दिनांक- 25.01.2019

प्रैस विज्ञप्ति

NeGP-A योजनान्तर्गत कम्प्यूटर, मल्टीफंक्शन प्रिन्टर तथा यू०पी०एस० की क्रय/आपूर्ति करने हेतु ई-निविदा आमंत्रित की जाती है।

ई-निविदा **www.uktenders.gov.in** से अपलोड करने की अन्तिम तिथि **दि0 25.02.2019** को सांय 5.00 बजे तक हैं। समस्त अपलोड निविदाओं के तकनीकी प्रपत्र **दिनांक 26.02.2019** को सांय 4.00 बजे तथा वित्तीय निविदायें अलग तिथि निर्धारित कर खोली जायेगी, जिसकी सूचना कृषि निदेशालय, देहरादून की वेबसाईट **www.agriculture.uk.gov.in** के माध्यम से दी जायेगी। ई-निविदा के संबन्ध में समस्त सूचनायें, शर्तें एवं अन्य विस्तृत विवरण **www.uktenders.gov.in** पर उपलब्ध हैं।

नोट- 1. यह निदेशालय प्रिंटिंग की किसी त्रुटि के लिए जिम्मेदार नहीं होगा।

2. निविदा प्रपत्र डाउनलोड करने की अन्तिम तिथि **दि0 25.02.2019** को सांय 5.00 बजे तक हैं।

पत्रांक- 6707/ सू.एवं लो.सं.वि./दि. 25.01.2019

(गौरी शंकर) कृषि निदेशक उत्तराखण्ड

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पर्यावरणीय स्वीकृति हेतु लोक सुनवाई के लिये सूचना

मै0 एस.जी.वी.एन. लि0, जखोल–सांकरी जल विद्युत परियोजना (44MW), मोरी, के द्वारा जनपद–उत्तरकाशी क्षेत्रान्तर्गत स्थित जखोल–सांकरी जल विद्युत परियोजना (44MW), मोरी हेतु पर्यावरण स्वीकृति हेतु लोक सुनवाई का प्रस्ताव उत्तराखण्ड पर्यावरण संरक्षण एवं प्रदूषण नियंत्रण बोर्ड, देहरादून के समक्ष प्रस्तुत किया गया है। परियोजना के लिये वन एवं पर्यावरण मंत्रालय, भारत सरकार के द्वारा Terms of Reference निर्धारित किये गये हैं, जिनके अन्तर्गत प्रस्तावक के द्वारा पर्यावरण प्रभाव मूल्यांकन रिपोर्ट एवं पर्यावरण प्रबन्धन योजना आदि तैयार कर प्रस्तुत की गयी है। वन एवं पर्यावरण मंत्रालय, भारत सरकार द्वारा जारी ई.आई.ए. अधिसूचना 14.09.2006 के अनुसार उक्त प्रकार की परियोजनाओं के क्रियान्वयन से पूर्व लोक सुनवाई का प्राविधान है, जिस हेतु 30 दिनों का नोटिस समाचार पत्रों के माध्यम से जन साधारण के संज्ञानार्थ दिया जाना आवश्यक है। लोक सुनवाई हेतु "पैनल" की संरचना उक्त अधिसूचना के अनुरूप निम्नवत है :–

1. जिलाधिकारी, जनपद, उत्तरकाशी या उनके द्वारा नामित प्रतिनिधि जो अपर जिलाधिकारी स्तर से कम पद का न हो, लोक सुनवाई के अध्यक्ष।
2. उत्तराखण्ड पर्यावरण संरक्षण एवं प्रदूषण नियंत्रण बोर्ड के प्रतिनिधि।

परियोजना से सम्बन्धित जमा समस्त अभिलेख क्षेत्रीय कार्यालय, पर्यावरण एवं वन मंत्रालय–देहरादून; मुख्यालय, उत्तराखण्ड पर्यावरण संरक्षण एवं प्रदूषण नियंत्रण बोर्ड देहरादून, क्षेत्रीय कार्यालय, उत्तराखण्ड पर्यावरण संरक्षण एवं प्रदूषण नियंत्रण बोर्ड, देहरादून ; कार्यालय जिलाधिकारी, उत्तरकाशी ; कार्यालय जिला पंचायत,,उत्तरकाशी ; जिला उद्योग केन्द्र, उत्तरकाशी एवं कार्यालय नगर पालिका परिषद, उत्तरकाशी में उपलब्ध है। जिनका कोई भी इच्छुक संस्था/ व्यक्ति अवलोकन कर सकता है। पर्यावरण प्रभाव मूल्यांकन रिपोर्ट के सारांश की प्रति **www.ueppcb.uk.gov.in** पर भी उपलब्ध है।

मै0 एस.जी.वी.एन. लि0, जखोल–सांकरी जल विद्युत परियोजना (44MW), मोरी, जनपद उत्तरकाशी द्वारा जखोल–सांकरी जल विद्युत परियोजना (44MW) मोरी तथा इससे सम्बन्धित प्रस्तावित लोक सुनवाई का स्थान, समय तथा दिनांक जिलाधिकारी के द्वारा निम्नानुसार सुनिश्चित् की गयी है।

प्रोजेक्ट का नाम	लोक सुनावाई हेतु प्रस्तावित स्थल	लोक सुनावाई की तिथि	समय
मै0 एस.जी.वी.एन. लि0, जखोल –सांकरी जल विद्युत परियोजना (44MW), मोरी, जनपद उत्तरकाशी	विकास खण्ड कार्यालय परिसर; मोरी, उत्तरकाशी	01.03.2019	11.00 बजे से

अतः सर्वसाधारण को सूचित किया जाता है कि अपने–अपने क्षेत्र से सम्बन्धित परियोजना के प्रस्ताव के सम्बन्ध में अपने मौखिक, लिखित, सुझाव, टीका टिप्पणियों एवं आपत्तियां इस कार्यालय अथवा बोर्ड के क्षेत्रीय कार्यालय, ई–115 नेहरू कालोनी, यू.ई.पी.पी.सी.बी., देहरादून में इस सूचना से सम्बन्धित विज्ञापन प्रकाशन की तिथि से 30 दिनों के अन्दर प्रेषित कर सकते है अथवा लोक सुनावाई के समय भी प्रस्तुत कर सकते हैं।

सदस्य सचिव

Hindustan Times

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नपदों के अभ्यर्थी भी प्रतिभाग कर सकेंगे। अभ्यर्थियों
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* निविदादाता जो पंजीकृत नहीं हैं, वे भी निविदा दे सकते हैं, किन्तु सफल निविदादाता को अनुबन्ध हस्ताक्षरित करने से पूर्व उचित श्रेणी में सक्षम प्राधिकारी से पंजीकरण करवाना अनिवार्य होगा।

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29/20, नेमी रोड, डालनवाला, देहरादून (उत्तराखण्ड)
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पर्यावरणीय स्वीकृति हेतु लोक सुनवाई के लिये सूचना

मै0 एस.जी.वी.एन. लि0, जखोल-सांकरी जल विद्युत परियोजना (44MW), मोरी, के द्वारा जनपद-उत्तरकाशी क्षेत्रान्तर्गत स्थित जखोल-सांकरी जल विद्युत परियोजना (44MW), मोरी हेतु पर्यावरण स्वीकृति हेतु लोक सुनवाई का प्रस्ताव उत्तराखण्ड पर्यावरण संरक्षण एवं प्रदूषण नियंत्रण बोर्ड, देहरादून के समक्ष प्रस्तुत किया गया है। परियोजना के लिये वन एवं पर्यावरण मंत्रालय, भारत सरकार के द्वारा Terms of Reference निर्धारित किये गये हैं, जिनके अन्तर्गत प्रस्तावक के द्वारा पर्यावरण प्रभाव मूल्यांकन रिपोर्ट एवं पर्यावरण प्रबन्धन योजना आदि तैयार कर प्रस्तुत की गयी है। वन एवं पर्यावरण मंत्रालय, भारत सरकार द्वारा जारी ई.आई.ए. अधिसूचना 14.09.2006 के अनुसार उक्त प्रकार की परियोजनाओं के क्रियान्वयन से पूर्व लोक सुनवाई का प्राविधान है, जिस हेतु 30 दिनों का नोटिस समाचार पत्रों के माध्यम से जन साधारण के संज्ञानार्थ दिया जाना आवश्यक है। लोक सुनवाई हेतु "पैनल" की संरचना उक्त अधिसूचना के अनुरूप निम्नवत है :-

1. जिलाधिकारी, जनपद, उत्तरकाशी या उनके द्वारा नामित प्रतिनिधि जो अपर जिलाधिकारी स्तर से कम पद का न हो, लोक सुनवाई के अध्यक्ष।
2. उत्तराखण्ड पर्यावरण संरक्षण एवं प्रदूषण नियंत्रण बोर्ड के प्रतिनिधि।

परियोजना से सम्बन्धित जमा समस्त अभिलेख क्षेत्रीय कार्यालय, पर्यावरण एवं वन मंत्रालय-देहरादून; मुख्यालय, उत्तराखण्ड पर्यावरण संरक्षण एवं प्रदूषण नियंत्रण बोर्ड देहरादून, क्षेत्रीय कार्यालय, उत्तराखण्ड पर्यावरण संरक्षण एवं प्रदूषण नियंत्रण बोर्ड, देहरादून ; कार्यालय जिलाधिकारी, उत्तरकाशी ; कार्यालय जिला पंचायत, उत्तरकाशी ; जिला उद्योग केन्द्र, उत्तरकाशी एवं कार्यालय नगर पालिका परिषद, उत्तरकाशी में उपलब्ध है। जिनका कोई भी इच्छुक संस्था / व्यक्ति अवलोकन कर सकता है। पर्यावरण प्रभाव मूल्यांकन रिपोर्ट के सारांश की प्रति **www.ueppcb.uk.gov.in** पर भी उपलब्ध है।

मै0 एस.जी.वी.एन. लि0, जखोल-सांकरी जल विद्युत परियोजना (44MW), मोरी, जनपद उत्तरकाशी द्वारा जखोल-सांकरी जल विद्युत परियोजना (44MW) मोरी तथा इससे सम्बन्धित प्रस्तावित लोक सुनवाई का स्थान, समय तथा दिनांक जिलाधिकारी के द्वारा निम्नानुसार सुनिश्चित की गयी है।

प्रोजेक्ट का नाम	लोक सुनवाई हेतु प्रस्तावित स्थल	लोक सुनवाई की तिथि	समय
मै0 एस.जी.वी.एन. लि0, जखोल-सांकरी जल विद्युत परियोजना (44MW), मोरी, जनपद उत्तरकाशी	विकास खण्ड कार्यालय परिसर, मोरी, उत्तरकाशी	01.03.2019	11.00 बजे से

अतः सर्वसाधारण को सूचित किया जाता है कि अपने-अपने क्षेत्र से सम्बन्धित परियोजना के प्रस्ताव के सम्बन्ध में अपने मौखिक, लिखित, सुझाव, टीका टिप्पणियों एवं आपत्तियां इस कार्यालय अथवा बोर्ड के क्षेत्रीय कार्यालय, ई-115 नेहरू कालोनी, यू.ई.पी.पी.सी.बी., देहरादून में इस सूचना से सम्बन्धित विज्ञापन प्रकाशन की तिथि से 30 दिनों के अन्दर प्रेषित कर सकते है अथवा लोक सुनवाई के समय भी प्रस्तुत कर सकते हैं।

सदस्य सचिव

Dainik Jagran. 29/1/19

Dainik Jagran

ANNEXURE IV PHOTOGRAPHS OF PUBLIC MEETING

वाप्कोस लिमिटेड
WAPCOS LIMITED
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