Foreword

With the growing demand for power day by day, be it for industrial growth or infrastructure development, for a sustainable growth of our country, Hydropower has a very essential role to play in the days to come. All other resources for power being exhaustible, gradually depleting and at times hazardous, the hydropower offers a wonderful alternative for which resources are inexhaustible and environment friendly. Although India has hydropower generation history of more than 100 years, it has contributed only about 25% to the total power scenario of the country tapping 26,910 MW of its total identified hydropower potential of 84,044 MW, till date. Looking at the future demand, it has become imperative to tap this vast hydropower potential. Hon'ble Prime Minister Shri A.B. Vajpayee has taken a giant step by launching "50,000 MW Hydroelectric Initiative" in May 2003, to accomplish the goal by XIth Plan and beyond. This will put the country on the faster track to progress.

NHPC feels honoured to be associated with this venture which intends to create a shelf of Pre-feasibility Reports (PFRs) of 162 projects by September, 2004 for taking up their phase-wise implementation. NHPC is entrusted with the responsibility of preparation of 43 PFRs with a likely capacity addition of 21,345 MW. The entire work of preparation of PFRs is being carried out by in-house team of experts in NHPC. After scrutiny by various departments of CEA/ CWC, Dumkhar HE Project (45 MW) prepared by us, is the first PFR located in the Indus Basin.

We are thankful to the CEA and Ministry of Power for reposing their faith on us and offering this unique opportunity to be a part of this noble initiative and we promise to put up our best effort to achieve the objective as set by our Hon'ble Prime Minister. We, also, take this opportunity to offer our sincere gratefulness to MOP, MOD and all the Departments and Organisations viz. CEA, CWC, GSI, IMD, SOI, NRSA, ZSI and various Departments of government of Jammu & Kashmir for lending their kind co-operation in completing this task.

Faridabad
15.03.2004

(Yogendra Prasad)
Chairman & Managing Director

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CHAPTER-1

EXECUTIVE SUMMARY

CHAPTER-1
EXECUTIVE SUMMARY

1. INTRODUCTION

Dumkhar HE Project is located in Leh district of Jammu and Kashmir envisages utilisation of water of river Indus for power generation. Dumkhar HE Project is a run of the river scheme comprising of Dam-Toe Power House utilising gross head of 32m.

The project with a proposed installation of 45 MW (3X15 MW) would afford an energy generation of 219.18 MU per year. Sale price of energy generated at powerhouse bus bars has been worked out as 5.30 Rs. per unit with free power to home state

The dam site is located at Latitude 34^0 28' 09'', Longitude 76^0 40' 06''. The project site is located at about 128 Km from Leh on Leh-Khalsi Batalik road. The nearest rail head is Jammu/Kiratpur and nearest airport is Leh.

2. SCOPE OF WORKS

The Dumkhar HE project envisages construction of :

- a 42 m high concrete gravity dam across river Indus with FRL 2856 m and MDDL 2853 m.

- Two nos. diversion tunnels, horse shoe shaped, 10 m dia, 450m long..

- a surface power house having an installation of 3 nos vertical shaft Kaplan turbines, each unit having generation capacity of 15 MW under rated net head of 27.83 m.

The salient features of the project are given at Annex-1.1 and layout map at Plate-III.

3. HYDROLOGY

The river Indus drains a catment area of about 61473 sq. km at proposed dam site. Water availability study has been performed at Nimoo-Bazgo (Alchi) HE Project site using the above observed discharge data at site 6.5 km downstream of Indus-Zanskar confluence (1976-2001) as obtained from Power Development Department (PDD), J&K. Since no contribution of discharge in between above two sites has been added, therefore, the same value of discharge as observed at site 6.5 km downstream of Indus-Zanskar confluence has been used for preparation of average 10-daily discharge series at Nimoo-Bazgo (Alchi) HE Project. The average 10-daily water availability series at Dumkhar H.E. Project has been estimated from Nimoo-Bazgo (Alchi) HE Project by catchment proportion method. The design flood has been assesed as 4650 cumecs.

4. POWER POTENTIAL STUDIES

The Power potential studies of Dumkhar HE Project has been made for 90% dependable year based on 10 hydrological years, from 1982-83 (June) to 1991-92 (May). An installation of 45 MW comprising of 3 generating units of 15 MW each has been proposed. Annual energy generation at 45 MW comes out to be 219.18 MU

5. POWER EVACUATION STUDIES

The Power generated from the project is proposed to be evacuated 220 KV power transmission network under planning and to be executed by PGCIL from Alistong to Leh via Kargil when the power requirement is low in this region.

6. ENVIRONMENTAL ASPECTS

The Ladakh region of Jammu & Kashmir comprises of two Districts namely Leh and Kargil. Due to high altitude and poor accessibility, the area lacks overall economic development. Based on the findings of the Environmental Impact Assessment study, Environmental Management Plans shall be formulated to mitigate the adverse impacts and to maximize the positive impacts of the project construction on the environment.

7. ESTIMATES OF THE COST

The project cost is Rs. 527.45 crores including IDC at June, 2003 price level. The preliminary estimate has been prepared as per the guidelines of CEA/ CWC. The break down of the cost estimate is given below.

Civil Works	:	Rs.354.02 Crores
Electrical Works	:	Rs.100.65 Crores
Interest During Construction	:	Rs. 65.18 Crores
Transmission work	:	Rs.7.60 Crores
Grand total (Including transmission)	:	Rs.527.45 Crores

8. FINANCIAL ASPECTS

As indicated above, the Dumkhar HE project, with an estimated cost of Rs. 527.45 Crores(Including IDC Rs. 65.18 Crores) and annual design energy 219.18 MU is proposed to be completed in 54 months. The tarrif has been worked out considering a debt equity ratio of 70:30, and 10.0% interest on loan for both estimated present cost and estimated completion cost of the project and 12% of energy as free power to Home State available after losses. The tarrif for the first year and levellised tariff have been worked out Rs. 5.30 per unit and Rs. 4.30 per unit respectively.

9. CONCLUSION

Dumkhar HE Project is envisaged to be completed in 54 months. The project would afford a design energy of 219.18 MU in a 90% depandable year. The Preliminary feasibility Report indicates that the scheme merit consideration for taking up for Survey and Investigation and preparation of DPR due to shortage of power in Ladakh region.

Annexure-1.1

Salient Features :

LOCATION

State	:	Jammu & Kashmir
District	:	Leh
River	:	Indus
Dam site	:	Near village Achingthang
Latitude		34^0 28’ 09’’
Longitude		76^0 40’ 06’’
Nearest rail head	:	Kiratpur/Jammu
Nearest airport	:	Leh

HYDROLOGY

Catchment area	:	61473sq.km
In India		34103 sq.km
In China / Tibet		26772sq.km
Location of catchment	:	
Latitude		31^0 07’ 00’’ to 34^0 28’ 00’’
Longitude		76^0 39’ 30’’ to 81^0 50’ 00’’

RESERVOIR

Full reservoir level (FRL)	:	El 2856 m
Maximum water level (MWL)	:	El 2856.0 m
Min.Draw Down Level (MDDL)	:	El 2853.0 m
Gross storage		
-at FRL	:	26.4 Mcum
-at MDDL	:	23.0 Mcum
Area under submergence at FRL	:	2.85 Sq km

DIVERSION TUNNEL

Number	:	2 Nos

Dia & Shape	:	10 m dia horse shoe
Length	:	450 m

DAM

Type	:	Concrete gravity dam
Top elevation of dam	:	El 2857.0 m
Height of dam above deepest foundation level	:	42m
Length of dam at top	:	220m

SPILLWAY

Design flood	:	4650 cumec
Type	:	Orifice type
Crest elevation	:	El 2830 m
Number & size of pillway opening	:	4 No, 8.2 m x 12 m
Energy dissipation	:	Stilling Basin
Length of spillway	:	56.8 m

INTAKE

Invert level	:	El 2841 m
Number	:	3
Size of gate opening	:	3.2 m x 4.0 m
Trash rack	:	Inclined type

PENSTOCK

Number	:	3 Nos
Size	:	4 m dia
Shape	:	Circular
Design discharge	:	67.23 cumec

POWER HOUSE

Type	:	Surface
Size		
Machine Hall	:	50 mX 19.5 m
Service Bay	:	23m X 19.5m
Installed capacity	:	3X15 MW
Number of units	:	3 Nos
Type of turbine	:	Vertical shaft Kaplan
Maximum gross head	:	32m
Rated net head	:	27.83 m

POWER GENERATED

Installed capacity	:	3X15 MW
Design energy	:	219.18 MU

CHAPTER-2

BACKGROUND INFORMATION

CHAPTER-2

BACKGROUND INFORMATION

2.1 GENERAL

The Ladakh region of Jammu & Kashmir comprising of Districts Leh and Kargil is sparsely populated. Due to high altitude, poor accessibility and non availability of adequate power, the area lacks economic development.

Ladakh region is connected to other parts of country by two road routes viz. Leh-Srinagar and Leh-Manali. Leh is situated at an altitude of 3500 M and is accessible by about 440 Km long single lane road from Srinagar. Leh-Manali is also a single lane road and is about 475 km long. Both the routes are being maintained by BRTF. These routes have few passes ranging from 3690 m to 4800 m and thus during winter months these roads are closed for vehicular traffic due to heavy snowfall and landslides. Construction of an all weather road network is under planning stage. During winter season means of communication to Leh is only by air.

2.2 BASIN SYSTEM

The Indus River originates in Tibet near Mansarovar Lake from Kailash range in western Tibet at an elevation of 5180 m and passes through mountain ranges in Northern Kashmir and Gilgit, before merging with Arabian Sea near Karachi in Pakistan. The Indus basin extends over an area of 11,65,000 $km^{2.}$. Its drainage area lying in Jammu and Kashmir is 1,93,762 km^2 .

2.3 POWER SCENARIO

2.3.1 Power System in India

The Power System in India has grown from small, isolated stations, serving limited consumers in and around large cities, into large regional

Power Grids. The generating capacity installed in the country has already grown to 107903.53 MW by March 2003.

For the purpose of system planning and operation the country has been divided into following five geopolitical regions: Northern, Western, Southern, Eastern and North-Eastern regional power grids and the transmission system are being progressively inter-connected for efficient operation of these five regional grids.

The objective of the system development is to evolve self-sufficient regional grid catering to the individual regional power demands. It is also aimed at achieving the maximum benefits from integrated operation, through a proper mix of thermal and hydro generation and ultimately to tie the five regional grids together to form a strong National Power Gird, providing even greater reliability.

The proposed Dumkhar Hydro Electric Project located in Leh district is envisaged to feed the power at the 220/66 kV nearest substation proposed to be constructed (by PGCIL) on the 220 KV Alistong (Srinagar) – Kargil – Leh transmission line.

2.3.2 Power Position in Ladakh Region

The Ladakh Region, where Dumkhar HEP is to be commissioned, in J&K has been experiencing acute power shortage till today. The main sources of generation are a few hydro stations and isolated diesel stations, with the total installed capacity in the region to be around 13.55 MW only, without considering the installed capacity of Army and Paramilitary units as they meet the demand through their own DG sets having installed capacity of 12 MW. Power deficit is a result of limitations imposed by economically unviable transportation of coal and nuclear fuel, non-amenability for power transmission from other parts of northern grid, remoteness and difficult climatic conditions of the region. Electrical energy being the basic ingredient for economic upliftment

through industrial and agricultural development, power shortage has slowed down the wheels of progress and put a curb on all development activities in the region. Also the region has power requirements for military services. Higher cost of power generation from the existing diesel plants assumes an over-riding significance in the early development of hydel power potential of Himalayas, in Ladakh region.

2.3.3 Load Demand & Power Position of Northern Grid

Table 2-1 shows the power supply position of Northern grid up to 2012. It is evident from the Table 2-1 that there shall be energy deficit in the Year 2012.

2.4 NECESSITY OF THE PROJECT

The entire population of the region is at present mostly dependent on Diesel, petrol, kerosene & firewood for their energy requirement. Due to lack of electricity in the region, restrictions are being imposed on local population for use of electricity. To mitigate the hardships being faced by the local population and also to reduce consumption of diesel, it is essential to harness the hydropower potential of river Indus. Construction of Dumkhar H.E. Project shall be a great relief to the electric power starved Ladakh region.

2.5 Studies Undertaken :

As per re-assessment studies carried out in CEA (based on desk studies) Dumkhar H. E. Project envisaged construction of a small diversion at a site having a river Bed Level at + 2870 permitting diversion of water into 7.5 km long tunnel, for utilizing a gross head of about 70 m, with installed capacity of 130 MW. During reconnaissance survey of the project area, it was observed that the construction of the diversion structure was located at just downstream of Dumkhar village on right bank and Achinthang village on left bank leading to

submergence of populated area. Further The preliminary survey with GPS revealed that the head available in the project reach was significantly low as envisaged in desk studies involving a long tunnel.

Keeping in view the above, it was considered to propose a Dam Toe Power House Structure. A Suitable site was located at about 7 km upstream of Achinthang village. The water level at the proposed dam site was about +2825.00 m and FRL was fixed keeping in view the village Skrubichan at about 8 km upstream. The other constraint was the Khalsi-Batalik Road on the right bank and agriculture land of Ledo village in between. The conceptual planning was discussed with CEA on 23.09.2003. During discussion with CEA it was decided that to obtain the optimum head, the road shall have to be rerouted and provision of cost of realignment of road and submergence of agriculture land may be kept in the cost estimate. As such the cost of realignment of road and agriculture land has been included in the estimates.

The summary record of discussions held with CEA issued vide Director (HP&I) office letter no 7/9/NHPC/2003/994 dated 23.09.2003 is placed at Appendix-4.

The X-sections at the dam axis was observed and Geological sections has been developed. The elevations mentioned are to be reaffirmed at the time of preparation of DPR after detailed survey.

The other studies undertaken were as follows :

1) Water availability studies.
2) Power Potential studies.
3) Geological appraisal based on GSI Data and Field visit.
4) Preliminary Design of structures.
5) Preparation of Drawings.
6) Environmental Studies.
7) Power Evacuation.

The details of the above studies are included in the document at relevant places.

Table 2-1

POWER SUPPLY POSITION OF NORTHERN REGION

		10th Plan					11th Plan				
Northern Region		2002-2003	2003-2004	2004-2005	2005-2006	2006-07	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012
		1	2	3	4	5	6	7	8	9	10
Installed Capacity	MW	28553	32288	33334	34250	39942	42880	43402	46602	46932	46932
Peak availability	MW	21889	24752	25554	26256	30620	32872	33273	35726	35979	35979
Peak requirement	MW	24092	25786	27598	29539	31615	33806	36149	38654	41333	44197
Peak Surplus(Deficit)	MW	-2203	-1033	-2044	-3282	-995	-934	-2876	-2928	-5354	-8218
Peak Surplus(Deficit)	%	-9.14%	-4.50%	-7.50%	-11.50%	-3.50%	-3.00%	-8.00%	-8.00%	-13.00%	-19.00%
Energy availability	MU	144218	163083	168367	172993	201743	216583	219220	235383	237050	237050
Energy requirement	MU	156610	167573	179303	191854	205284	219489	234678	250918	268281	286846
EnergySurplus(Deficit)	MU	-12392	-4489	-10936	-18861	-3540	-2906	-15458	-15535	-31232	-49797
EnergySurplus(Deficit)	%	-7.91%	-2.68%	-6.10%	-9.83%	-1.72%	-1.32%	-6.59%	-6.19%	-11.64%	-17.36%

1. All the data for the year 2002-2003 has been taken from the website **www.cea.nic.in.**
2. Energy availability for the year 2002-2003 onwards have been estimated on the basis of ratio of Energy availability to Installed capacity for the year 2002-2003.
3. Peak availability for the year 2002-2003 onwards have been estimated on the basis of ratio of Peak availability to installed capacity for the year 2002-2003.
4. Energy requirement & peak requirement for the year 2002-2003 onwards is based on the annual increments given at page -117 & 118 of "Sixteenth Electric Power Survey Of India".
5. Micro/mini projects have not been considered for the study.

Note:- This is a statistical analysis based on various publications mentioned above and are meant for study and planning purposes.

CHAPTER-3

PROJECT AREA

CHAPTER-3

PROJECT AREA

3.1 Project Location :

The proposed Dumkhar Hydroelectric Project site is located at a distance of about 128 Km from Leh on Leh-Khalsi-Batalik Road. After thorough reconnaissance survey of the area, the present site suitable for Dam Toe Power House was selected, which is 7 Km upstream of village Achinthang. The Longitude and Latitude of the project site are 76^0 40' 06'' and 34^0 28' 09'' respectively.

3.2 Climate :

The project area being located in Ladakh region has extreme climate. In summer the temperature rises to 30°C whereas in winter the mercury drops down to - 20° C. December & January are the coldest months. Precipitation in the form of rainfall and snowfall both are very less in this region.

3.3 River System :

In Ladakh region, the river Shyok, a major right hand tributary of the river Indus drains North and North-East part of Ladakh. The river Zanzskar is draining the South Central part of the area bordering Himachal Pradesh. Other tributaries of river Indus are Huza, Gilgit, Suru, Singo and Drass. The confluence of the river Indus and Zanskar is about 3 km south of village Nimoo.

3.4 Present Proposal :

This prefeasibility report envisages development of 45 MW of power by constructing a concrete gravity dam across river Indus, at about 7 km upstream of village Achinthang, a dam toe surface powerhouse and a small tail race channel. The general layout of the project is enclosed at ***Plate–III.*** The Project is planned as run of the river scheme to utilize discharge of 201.70 cumec, gross head of 32 m to generate 219.18 million units per annum.

3.5 Socio- Economic Aspects

3.5.1 Population

District Leh has the total geographical area of 82,665 sq.kms, which includes 37,555 sq. kms area under illegal occupation of China. As per the census data of the year 2001-02, total population of district Leh is 1,17,637 with the density of 3 per sq. km. This shows that the entire District is sparsely populated. The breakup of Rural and Urban population of District Leh is as under:

Persons	**Rural**	**Urban**	**Total**
Male	48420	16746	**65166**
Female	41704	10767	**52471**
Total	**90124**	**27513**	**117637**

3.5.2 Literacy

As per the census data of 2001, District Leh has the literacy rate of 62.24% (excluding child population of age group 0-6). Details of number of the literate in District Leh are as under:

Persons	Rural	Urban	Total
Male	30518	13685	44203 (71.98%)
Female	17556	6949	24505 (50.03%)
Total	48074	20634	68708 (62.24%)

3.5.3 Agriculture

Agriculture is one of the main sources of livelihood of the region. As per the census data of the year 2001, the total cropped area in 1999-2000 was 9162 ha.

The important food grains cultivated in the Leh region are Wheat, Barley, Gram, Millets etc. Wheat is generally sown during April-May and is harvested during the month of September-October. Peak marketing of wheat is done in the months of October and November. Millet is sown in the month of April-May and is harvested in the month of August-September, whereas October-November are the peak marketing months for this crop. Total area of the Leh District sown under different food grains in the year 1997-98, 1998-99 and 1999-00 was 8430 ha, 8131 ha and 8070 ha., respectively. Important vegetable crops of the region are capsicum, brinjal, cucurbits, chilli, okra, mayapple, onion, potato, carrot, raddish etc. Total area sown under vegetable cultivation in the year 1997-98, 1998-99 and 1999-00 was 207 ha, 272 ha and 211 ha, respectively.

3.5.4 Horticulture

Horticulture is playing a major role in supplementing the income of the farmers hence has assumed great importance in Leh District in recent years. Apricot and apple are the main horticulture crops of the region. Total area of Leh District brought under horticulture in the year 1997-98, 1998-99 and 1999-00 was 83 ha, 77 ha and 76 ha, respectively.

3.5.5 Irrigation

In view of prevailing desert conditions in the region, agriculture is possible only where water for irrigation is available by gravity flow. In the project area, due to topography of the terrain, no flat area for irrigation are observed. However, after the construction of the project, there will be tremendous growth in the irrigation potential by lift irrigation, where sufficient water shall be available as well as power during summers, the only suitable season for growing crops.

3.5.6 Cooperatives

Cooperative movement occupies an important place in the economic life of the people and its activities are diversified in many spheres. At present 68% of the families in the rural areas are under cooperative shield. There are 104 cooperative societies in District Leh, out of which 80 are primary agriculture credit societies. The cooperative public distribution items control 75% of consumer business of essential commodities, 100% of fertilizer distribution and 75% of marketing of agriculture produce in the district.

3.5.7 Education

In Leh district, considerable progress has been made in dispensing schooling facilities throughout the District, especially in rural areas. The enrolment in the schools has gone up considerably in recent years. As per the census data of the year 2001, 1 College, 29 High schools, 53 Middle schools, 182 Primary schools etc. have been established in the District.

3.5.8 Health and Family Welfare

Like education, health care, both curative and preventive , is being provided at considerably wide and improved scale both in rural and urban areas of the District. As per the census data of the year 2001, 1 District hospital, 1 Sub-district hospital, 7 Primary Health Centres, 8 Allopathic Dispensaries, 98 Medical Aid Centres, 53 Health Sub-Centres, 2 Family Welfare Centres etc have been established in the district to cater to the medical needs of the District.

3.5.9 Public Health

Safe drinking water is being provided to the villages on priority basis. But geographical and climatic conditions are playing havoc with water supply schemes during winters when temperature goes down to -20^0 C and water distribution lines burst due to freezing. Despite all these constraints, 100 % villages have been provided with safe drinking water.

3.5.10 Social Welfare

Social Welfare Department runs a number of centres for training for schedule castes and other backward communities. Social welfare department is also giving aid to economically weaker families on various accounts viz. tailoring etc.

3.5.11 Roads and Buildings

Most of the rural villages have been connected by the road network, constructed by the State Public Works Department. Major roads

connecting block headquarters are being maintained by HIMANK and other Central Govt. Agencies.

3.5.12 Religious and Archaeological Sites

Majority of the inhabitants of the region practice Buddhism. Leh is rich in monuments and sites of National Importance. As per the data collected from the Archaeological Survey of India, Leh has important Buddhist Monasteries at Lamayuru, Liku & Alchi, which are under the Administrative Control of Archaeological Survey of India, Srinagar Circle, Srinagar. There are several centuries old "Gumpha" having sacred "Gonpas", "Stupas" at Phyang, Tisseru, Hemis, Thiksey etc. which are still under religious use.

There is an Ancient Palace at Leh which has a royal shrine in it. Various types of antiquities including valuable manuscripts are housed in the palace. Ancient Palace at Shey is a royal palace housing a shrine built in sixteenth century A.D and has a gilt copper statue of Buddha rising to a height of three storeys.

CHAPTER-4

TPOGRAPHIC & GEO-TECHNICAL ASPECTS

CHAPTER-4
TOPOGRAPHIC AND GEOTECHNICAL ASPECTS

Introduction

The proposed Dumkhar H E Project has been identified as one of the schemes by the CEA as a part of an exercise to assess the balance hydroelectric potential in the country and rank the schemes in order of priority. As per reassessment studies carried out in CEA based on desk studies Dumkhar H.E. Project envisaged construction of a small diversion at a site having a river bed level at ±2870M., permitting diversion of the water in to about 7.5 kms. Long tunnel for utilizing a gross head of about 70m at the powerhouse to generate 51MW firm power. The location of diversion was around 3.5 kms. downstream of Takmachung H.E.Project.

After further studies NHPC proposed a scheme with dam to powerhouse at 7 km Upstream from Achinthang Village which was found in order. The river bed level at this location is around 2825m. The geological inputs have been provided by the GSI and NHPC.

Regional topographical and geotechnical features of project area

The topography of the area is rugged & general altitude is around 2500m in valleys and goes to more than 4500m on peaks. The project area is located near the boundary of two geomorphic units. One unit is defined by deep gorges of the Indus river while the other one encloses high mountain ranges with glaciers and snow covered peaks of Dosai mountains & Ladakh ranges, deeply dissected and exhibiting fine dendritic drainage pattern. The major valleys being longitudinal are aligned in WNW-ESE direction. Crests of ridges are sharp. It has transverse spur ridges. Overall appearance of mountain ranges appear to have been dictated by a regional fold having NW-SE axial trend. The ophiolites/mélanges that occur along the Indus river

typifying subduction zone along Indus suture are not distinct and are marked by the massive sedimentary pile.

In central Ladakh, where the project is located 3 distinct parallel litho tectonic belts trending in WNW-ESE have been recognized. From North to South these are:

- Ladakh granite complex
- Indus Tectonic Zone
  (a) Indus Group
  (b) Volcanics & ophiolite
- Tethyan Belts

The Granite complex separates the Tethyan belt from Himalayan Phanerozoic belts. The Granite complex forms the basement for the Indus Group sediments, which forms the basement for volcanics & ophiolites. The Granitic complex comprises a heterogeneous association of granite, gabbro, basic injection, metavolcanics and metasediments. The granitoids predominate overall the other rock types. There are a variety of basic intrusives with in Ladakh Granitic complex, belong to a period, earlier to Indus Group sedimentation.

The Indus Tectonic Zone represents one of the spectacular lineament features on the earth. It comprises two parallel, homotaxial sedimentary belts designated as Indus Group and Ophiolite. The Indus Group sediments overlie the Ladakh Granite complex along a pronounced angular unconformity.

The central Ladakh Himalaya is a well-defined tectonic belt. The tectonic sequence includes the tectonic units like Ladakh Granitic complex, Autochthon, Indus Tectonic Zone etc. which are separated from each other by unconformity & a series of thrusts namely Pashkyam, Wakha and Sanko.

The Ladakh Granitic Complex Authochthan represents tectonically the lower unit in the Ladakh Himalaya. Structurally, it represents a major anticlinorium comprising granitic & other crystalline complexes. The regional foliation in the area has southerly dips. It also appears to have WNW-ESE and N-S lineament pattern.

The Indus Group Autochthon represents a sedimentary belt forming a cover over Ladakh Granitilc Complex. It forms a complexly folded linear belt with WNW-ESE to E-W trend and preserves a large variety of fold types which include open symmetrical anticlines, synclines, isoclinal folds, reclined and chevron folds.

Topographical/Geotechnical aspects for locating component structures of the Project

The project structures will be confined in granitic rocks of Ladakh Granitic Complex exposed along the NW-SE trending Ladakh Range. The bedrock composition varies from quartz-diorite, monzodiorite, tonalite and granodiorite to granite. The structural monotony is broken by occasional faulting, severe dragging of sequence into tightly oppressed folds. At dam site the rock is essentially hornblende granite. The valley is asymmetrical having steep right bank and gentle left bank. The sluggish river flows West to East through matured valley form. The bank heights fluctuates consistently. The left bank at dam axis and upstream and downstream reach for a considerable length is covered by overburden material except for the rocky abutment rising from riverbed to approx. 15 M height. The right bank is defined by a gradually rising rocky ridge from riverbed to the observed point at El. 2855m. The enormous and extensive debris/ scree cones covering the rocky slopes are derived from weathering of rocks at higher elevation. Aeolian wind blown deposits are encountered ubiquitously in the valley. The rock is hard, massive, with 3 sets of discontinuities. The close jointing has mainly contributed to the fragmentation of the rock mass with the individual

fragments resembling cubes and rhombs(Refer geological section). The local variation in the attitude of foliation is due to the epirogenic movement caused by compression and tension. The river bed seams to has an overburden cover of the order of ±20m. The river terrace deposit is the main overburden unit in the area and consists of an assemblage of boulders, pebbles and gravels of predominantly gneissic and basic rocks with micaceous sand. The river coarse material, though of identical nature, is partly reworked. The pre existing under expense of river terrace deposit is expected concealed under the younger slope wash debris on the river flanks. Glacial morains are also observed in several lobes

The bedrock of granite will provide a suitable foundation for the dam. The powerhouse being at the toe of the dam, will be located in the same geologic and geomorphic environs.

The geological section observed at dam axis and the photograph depicts the topographical and geological condition of the site.

Seismicity

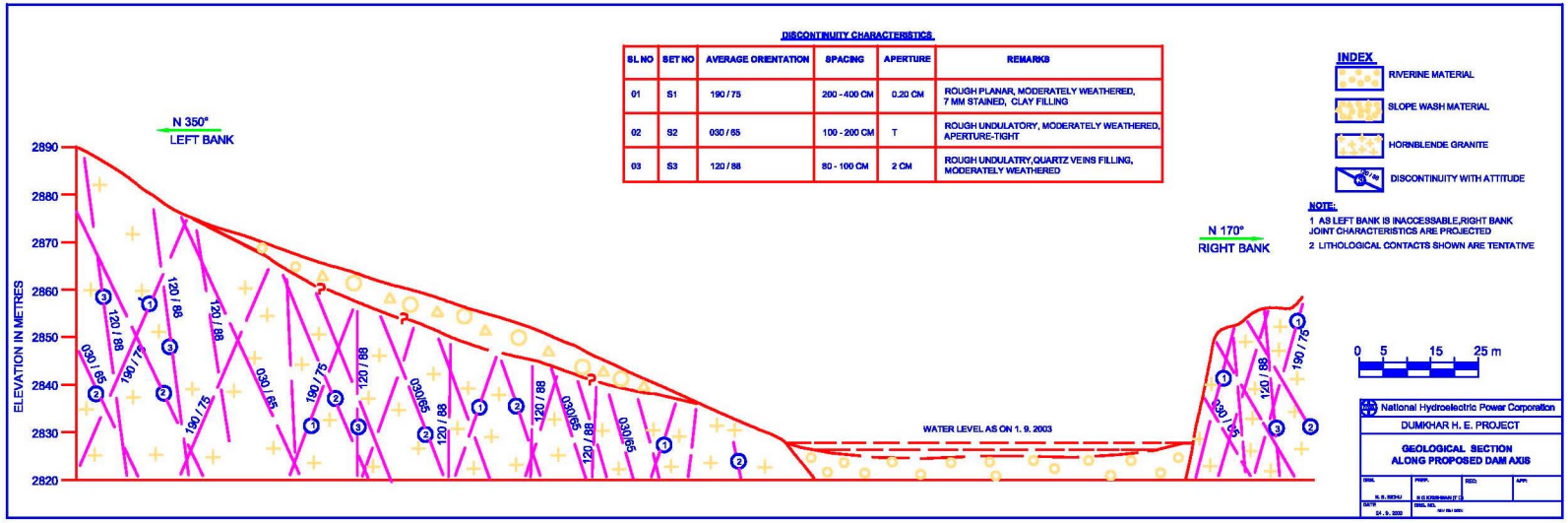
Seismotectonically, the Project is located in high Himalayan Seismic Zone in Indus Suture Zone (ISZ) in Indus valley in Central Ladakh. The northernmost tract, north of Shyok Suture Zone (SSZ) in occupied by litho assemblages of Trans-Himalayan tectogen, which continues from West. Towards south this belt is followed by tectonic assemblages comprising accretionary complex, accreted arc sediments, ophiolites & Ladakh Granitic Complex. This is bound on either side by Shyok Suture Zone & Indus Suture Zone. North of the Main Boundary Thrust (MBT) the litho units of main Himalayan belt are exposed. South of MBT, the terrain is mainly occupied by the sediments of Frontal belt. The most conspicuous mega structural element in the north is dextral strike Karakoram fault forming the eastern boundary of the Pamir syntaxes and western boundary of Tibet block. Towards south, the Shyok Suture Zone

(SSZ), separates the Karakoram Belt from Indus Shyok belt. Further South, the Indus Suture Zone marks the northern limit of the main Himalayan belt, within which, MBT & MCT are considered most regionally extensive structural discontinuities. Pashkyum, Tajurma, Wakha, Sanku and Shyok thrusts are some of the regional structural planes within this zone. Of the transverse faults, Kistwar fault is the most prominent one.

A total of 205 seismic events have been recorded in the region. Most prevalent earthquakes (48.4%) are in the magnitude range of 4 to 5. Three events with magnitude between 6 to 7 and twenty four with magnitude between 5 to 6 have been recorded in the area. With respect to spatial distribution of earthquake events, the area can be broadly divided into 3 zones. The maximum concentration of seismic events is towards SW between MCT & MBT where earthquakes are mainly with shallow focus. Towards, the Indus-Shyok as well as Tethyan belts, the area exhibits subdued seismicity. Further north, within Karakoram-Altyntagh fault block a fair concentration of seismic events is observed. In this part moderately deep focus (71-150km) events prevail. Keeping in view the seismicity, the area has been kept in Zone IV as per seismic zoning map (IS 1893 (Part-1)”2002). It is suggested that proper seismic coefficient be got determined and incorporated in designs of appurtenant structures of the project.

The Geological section along the dam axis and Photograph of the dam site are placed at Annexure 4.1 and 4.2 respectively.

The report on regional geology from GSI is placed at Appendix-6


DISCONTINUITY CHARACTERISTICS
SL NO | SET NO | AVERAGE ORIENTATION | SPACING | APERTURE | REMARKS
01 | S1 | 190 / 75 | 200 - 400 CM | 0.20 CM | ROUGH PLANAR, MODERATELY WEATHERED, 7 MM STAINED, CLAY FILLING
02 | S2 | 030 / 65 | 100 - 200 CM | T | ROUGH UNDULATORY, MODERATELY WEATHERED, APERTURE-TIGHT
03 | S3 | 120 / 88 | 80 - 100 CM | 2 CM | ROUGH UNDULATRY,QUARTZ VEINS FILLING, MODERATELY WEATHERED
INDEX
RIVERINE MATERIAL
SLOPE WASH MATERIAL
HORNBLENDE GRANITE
DISCONTINUITY WITH ATTITUDE
NOTE:
1 AS LEFT BANK IS INACCESSABLE,RIGHT BANK JOINT CHARACTERISTICS ARE PROJECTED
2 LITHOLOGICAL CONTACTS SHOWN ARE TENTATIVE
N 350°
LEFT BANK
N 170°
RIGHT BANK
ELEVATION IN METRES
2890
2880
2870
2860
2850
2840
2830
2820
WATER LEVEL AS ON 1. 9. 2003
0 5 15 25 m
National Hydroelectric Power Corporation
DUMKHAR H. E. PROJECT
GEOLOGICAL SECTION
ALONG PROPOSED DAM AXIS

Annexure 4.2


Road
Dam axis
7 Km U/S from
Achinthang village
(Dumkhar H.E.
Project)
Indus river

CHAPTER-5

HYDROLOGY

CHAPTER – 5

HYDROLOGY

GENERAL

The Dumkar H.E. Project proposed on river Indus in Leh district of Jammu & Kashmir (J&K), is a run-off the river scheme proposed to harness hydel potential of the Indus river. The project envisages construction of concrete gravity dam with a gross storage of 26.4 M.cum at FRL of El 2856.0 m. The dam is located nearly 7 km. upstream of Achinathang village. The submergence area is 2.85 sq.km at FRL.

The hydrological investigations and analysis have been carried out with a view to:

- Assess the availability of water for power generation by establishing a long-term series of average 10-daily discharges at the project site.
- Estimate the spillway design flood.
- Determine the capacity of the reservoir and the area of submergence at different levels including FRL and MDDL.

RIVER SYSTEM & BASIN CHARACTERISTICS

The Indus River originates in Tibet near the Mansarovar Lake from Kailash range in Western Tibet at an elevation of 5180 m and passes through mountain ranges in Northern Kashmir and Gilgit, before merging with Arabian Sea near Karachi in Pakistan. The Indus basin extends over an area of 11,65,000 km². Its drainage area lying in Jammu and Kashmir is 1,93,762 km².

In Ladakh region, the river Shyok, a major right hand tributary of the river Indus drains North and North-East part of Ladakh. The river Zanskar is draining the South Central part of the area, bordering Himachal Pradesh. Other tributaries of river Indus are Huza, Gilgit, Suru, Singo and Drass. The confluence of the river Indus and Zanskar is about 3 km south of village Nimoo. The riverbed slope is approximately 2m/km in the vicinity of the Project.

CATCHMENT AREA

The Indus River originates in Tibet near the Mansarovar lake from Kailash range in western Tibet at an elevation of 5180m and passes through mountain ranges in Northern Kashmir and Gilgit. The Indus basin is one of the major sub-basin of Jammu & Kashmir State. The geographical limits of the basin lie between the latitudes 31^{o}07' to 34^{o}28'09'' N and longitudes 76^{o}40'06" to 81^{o}50' E. The total area of the Indus river basin is 61,473 sq. km. at proposed Dumkar H.E.Project Dam site. The basin is highly mountainous and its elevation ranges from El 2822.087 m (Dam site river-bed level) to 5180 m above mean sea level.

The catchment area upto proposed dam site is 61,473 sq.km, out of which 26,772 sq.km lies in Tibet (China) and remaining area of about 34,701 sq.km in Indian territory. The river Indus enters into Indian Territory near the place named as Tashiganj in J&K. The dam site is situated at Longitude 76 ^{o} 40' 06" E and Latitude 34^{o}28'09'' N. The deepest river bed elevation at the proposed dam site is around EL 2822.087m. The Zanskar River is major left hand tributary of Indus River and joins about 80 km upstream of proposed Dumkar dam site. The other proposed hydro power project of NHPC namely Nimoo-Bazgo (Alchi) H.E. Project is under investigation (Feasibility report

already submitted), is situated about 62 km upstream of proposed Dumkar H.E. Project Dam site. The total catchment area at Nimoo-Bazgo (Alchi) H.E. Project dam site is 58,880 sq.km. The river length from its origin to proposed Dumkar dam site is about 750 km. out of which 404 km lies in Tibet.

The catchment area plan of river Indus has been prepared with the help of Global Positioning System (GPS) map, due to non-availability of toposheets of the catchment area lying in Tibet (China). GPS is global software developed by Microsoft Corporation, USA. The authenticity of this software has been checked by comparing the catchment area plan of river Zanskar prepared with the help of SOI toposheets (1:2,50,000 scale) and GPS map. The total catchment area of river Zanskar upto its confluence with river Indus comes out as under by these two methods:

(i)	By GPS map	=	16047 Km²
(ii)	By SOI toposheets	=	15814 Km²

which are quite comparablennnnnnn. The catchment plan marked with dam site and G&D site is shown in **Plate-1**

TEMPERATURE AND HUMIDITY

The climate in the entire Ladakh region is extreme. The daily maximum and minimum temperature records are available for the period of 20 years (1979 to 2000). The maximum temperature recorded is 38.4 ^{o} C and minimum -28.6 ^{o} C at Air Force Station, Leh. January is the coldest month. The Ladakh region has the climate more or less to the type prevailing in Tibet.

There is no recorded tornado or hurricane, which has occurred in the region. However, wind-gathering speed is more in the months of May and June. The speed of moderate tropical storms varies from 6 to 7 km./hr.

PRECIPITATION CHARACTERISTICS

Climatologically, the year for the Ladakh region can be divided as under:

i) Winter – (December, January, February and March)
ii) Spring – (April, May and June)
iii) Summer – (July, August and September)
iv) Autumn – (October and November)

Wind velocities are strong in the month of April to June and October to November while the same are moderate to light in remaining months. Leh records wind speed of 6.8 km/hr in May and Drass records 10 to 11 km/hr during July and August. The direction is generally variable but is South-Westerly to South-Easterly in spring and summer monsoon.Total annual rainfall in Ladakh valley is about 100mm. Out of this about 50% occurs during winter season.

WATER AVAILABILITY STUDY

River gauges have been established since 1976 on Indus River at 6.5 km downstream of Indus-Zanskar confluence. NHPC has established a gauge discharge site in the year 2001 at proposed Nimoo-Bazgo (Alchi) H.E. project dam site. The recording of gauge and discharge has been started since July 2001 onwards. The velocity measurement has been done by float method.

Water availability study has been performed at Nimoo-Bazgo (Alchi) dam site using the above observed discharge data at site 6.5 km downstream of Indus-Zanskar confluence (1976-2001) as obtained from Power Development Department (PDD), J&K. Since no contribution of discharge in between above two sites has been added. Therefore, the same value of discharge as observed at site 6.5 km downstream of Indus-Zanskar confluence has been used for preparation of average 10-daily discharge series at Nomoo-Bazgo (Alchi) dam site. The average 10-daily water availability series at Dumkar H.E. Project dam site has been estimated from Nimoo-Bazgo (Alchi) average 10-daily discharge series by catchment proportion method. The average 10 daily flow series, so computed at proposed dam site has been placed as **Annexure-I** and the monthly average plot of the 10 daily flow series is shown in **Figure-I.**

RESERVOIR ELEVATION AREA CAPACITY CURVE

The reservoir elevation-area-capacity curve at proposed dam site has been prepared on the basis of 1:50000 SOI toposheets at 40 m contour interval. Area under various contours at 40 m interval has been measured from the elevation of 2822 m to 2880 m. The volume between any two elevations is calculated using the conical formula:

$$V = (A1+A2+\sqrt{A1A2})*H/3$$

Where

V = The volume between two contours

H = Contour interval

A1 = Area at level of first contour

A2 = Area at level of second contour

The incremental volumes thus obtained are added to obtain cumulative volume. The reservoir elevation-area-capacity curve at proposed dam site is given in **Figure-II.** This curve is subjected to modification after availability of reservoir cross-sections or 1:25000 scale contour maps for the reservoir area.

DESIGN FLOOD

The storage available at FRL is 26.4 M.cum but the height of dam being higher than 30 m, this requires spillway to negotiate the Probable Maximum Flood (PMF) as per CWC criterion and IS 11223-1985. Indian Meteorological Department (IMD) vide their letter no.HS-DS(NGP) 301/1 dated 07.11.2002 expressed their inability to undertake design storm study for Nimoo Bazgo HE Project which is 62 km upstream of proposed Dumkar H.E. project because of non-availability of long term rainfall data. Thus, the flood study could not be conducted by deterministic approach because of non-availability of requisite data. The design flood has been estimated using flood frequency analysis.

The Design Flood for Nimoo-Bazgo (Alchi) dam has been estimated as 4500 cumec by flood frequency analysis corresponding to 1000-year return period flood at 95% UCL. This flood of 4500 cumec at Nimoo-Bazgo (Alchi) dam site has been transferred by using Dickens formula ($Q=CA^{3/4}$) to Dumkar Dam site. The Design flood of 4500 cumec estimated at Nimoo-Bazgo (Alchi) dam site has been transferred to Dumkar dam site by conversion factor of 1.033. The computed design flood is 4649 cumec at proposed dam site. Hence Design flood of value 4650 has been adopted for Dumkar H.E. Project.

On availability of more data/information, design flood will be reviewed at feasibility stage.

SEDIMENTATION

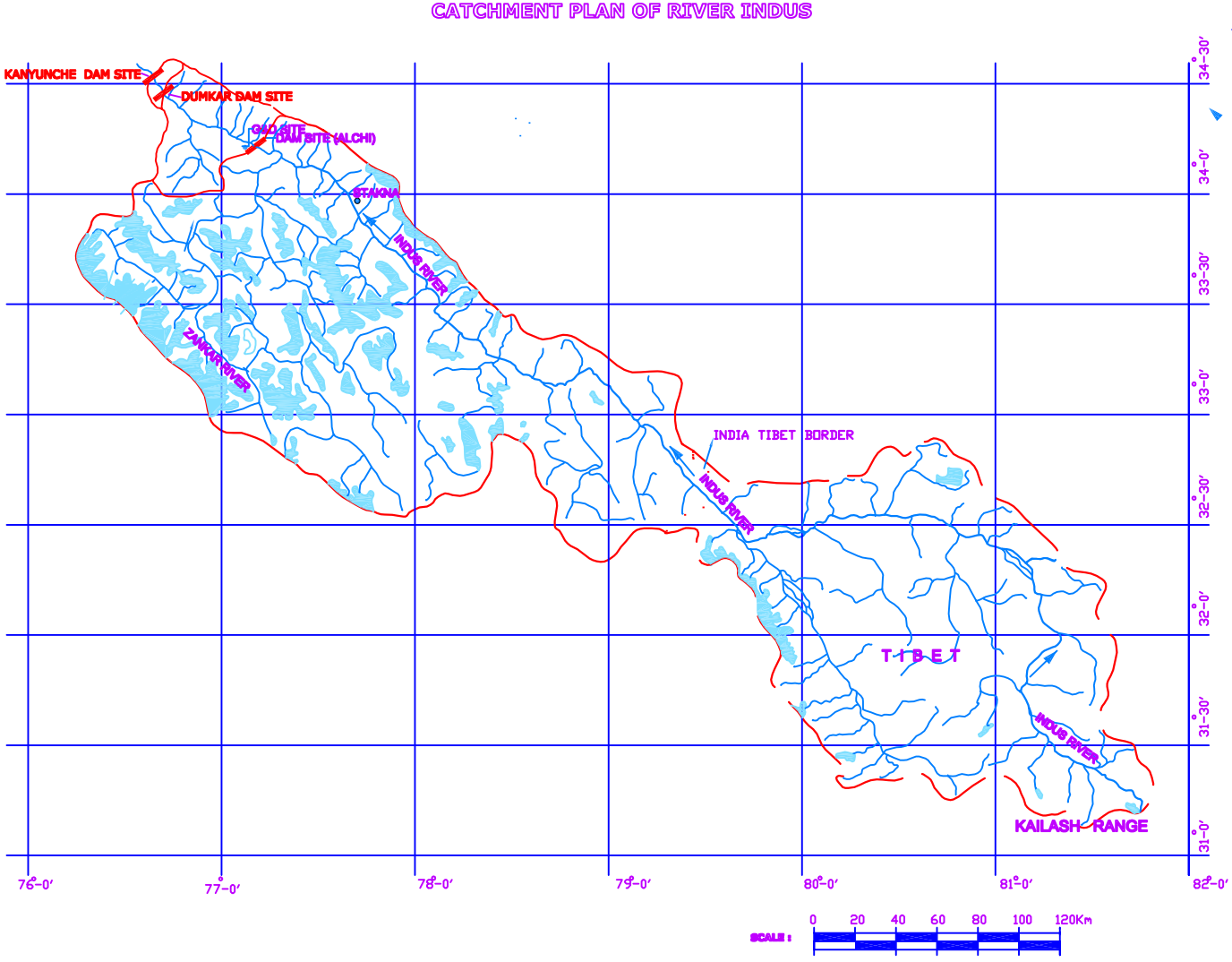
NHPC has started taking silt observations at Nimoo-Bazgo (Alchi) Dam site since Oct-2001 onwards in terms of coarse, medium and fine. The Punjab bottle type samplers are used for collections of sediment from river at a depth of 0.6 D, where D is depth of water in the river. The suspended sediment data available at dam site (Alchi) is for very short period (Oct-01 to Jun-03). The average annual suspended load is calculated as 605.17 Ham/year. Assuming 20% of the sediment load is transported as bed load, the total sediment load comes out to be 726.2 ham/year. Based on the above data the silt rate of 0.01233 ham/sq.km/year may be adopted for river Indus at the proposed Nimoo-Bazgo (Alchi) Dam site.

Detailed sedimentation study for Dumkar H.E Project will be done during feasibility stage with more observed data at the proposed site using a suitable method.

The comments received from CWC on this chapter and reply given by NHPC are placed at Appendix-7

PLATE- 1

CATCHMENT PLAN OF RIVER INDUS



Annexure-I

DUMKAR H.E. PROJECT

AVERAGE 10-DAILY WATER AVAILABILITY STATEMENT

YEAR	PERIOD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	I	50.99	53.82	52.16	56.53	60.51	145.00	853.47	853.47	477.74	115.81	80.66	61.26
1977	II	51.74	54.08	50.53	55.67	67.22	130.47	695.78	695.78	307.21	89.54	70.23	56.82
	III	49.63	53.72	60.58	61.20	92.04	357.77	753.89	753.89	153.26	86.80	70.32	55.30
	I	45.42	52.87	55.00	56.15	251.04	354.85	856.27	944.47	395.72	116.53	76.18	60.01
1978	II	47.64	51.22	51.18	67.95	204.27	343.64	663.61	1047.21	257.98	87.05	69.57	56.70
	III	49.03	50.70	56.87	84.59	260.68	856.50	759.20	602.92	202.30	80.02	63.15	56.52
	I	51.03	49.72	55.67	79.98	217.27	181.22	792.15	932.63	474.55	173.16	102.42	74.81
1979	II	47.92	49.20	51.82	107.84	256.83	254.73	590.06	765.80	235.41	164.95	84.89	68.17
	III	46.51	51.44	58.60	137.40	185.06	408.19	711.73	558.95	153.36	170.36	78.79	59.92
	I	56.01	46.24	56.00	60.28	127.16	277.08	628.05	923.73	251.77	87.27	71.19	60.18
1980	II	52.74	48.89	57.93	64.64	185.85	217.90	850.48	950.30	151.63	78.79	68.04	56.66
	III	47.34	53.09	63.01	74.42	172.69	467.76	742.29	440.31	102.49	74.60	63.78	54.21
	I	51.60	47.71	51.37	58.47	131.22	232.19	544.42	N.A.	N.A.	N.A.	73.28	57.67
1981	II	49.87	49.03	53.89	63.01	139.01	299.42	705.26	N.A.	N.A.	N.A.	67.48	55.26
	III	47.52	49.77	56.58	85.04	203.48	694.44	800.51	N.A.	N.A.	N.A.	63.45	51.48
	I	49.78	47.77	50.55	57.45	104.38	208.48	583.38	1117.30	359.51	116.15	74.86	62.26
1982	II	49.14	49.03	53.05	61.95	167.51	379.30	731.16	1090.05	201.35	87.29	71.30	58.07
	III	48.82	49.44	56.51	73.80	138.70	386.93	914.46	630.42	145.80	76.50	65.61	55.99
	I	52.69	48.44	52.49	60.84	70.94	288.76	537.35	1224.07	615.65	241.40	80.95	65.13
1983	II	50.12	51.13	54.87	62.85	92.24	282.26	671.33	937.04	499.56	141.85	76.83	59.27
	III	48.16	52.60	57.80	63.54	158.33	566.05	1154.22	734.87	340.70	94.71	70.91	53.74
	I	51.40	47.72	51.37	59.99	86.12	188.70	470.49	871.20	339.61	92.04	73.87	62.48
1984	II	49.00	48.34	53.89	64.01	99.90	372.27	355.45	888.04	207.97	82.16	69.56	57.91
	III	46.05	49.80	56.58	72.96	105.13	739.57	558.88	596.69	134.55	78.52	65.45	55.24

Annexure-I

DUMKAR H.E. PROJECT

AVERAGE 10-DAILY WATER AVAILABILITY STATEMENT

YEAR	PERIOD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	I	52.57	47.62	50.33	57.66	67.23	141.04	370.16	674.32	803.27	66.46	63.71	60.66
1985	II	50.12	48.21	52.44	61.37	71.65	207.13	427.42	817.69	347.24	65.61	63.33	58.60
	III	47.87	49.83	54.11	63.64	94.89	240.50	510.69	1051.90	105.83	63.66	63.36	55.34
	I	51.47	47.68	49.86	53.41	68.60	112.39	466.18	678.09	376.80	112.07	72.90	58.71
1986	II	48.46	47.92	50.47	56.94	70.01	326.36	558.96	436.72	345.76	88.77	67.35	54.98
	III	47.63	48.33	51.17	66.47	81.27	451.81	1080.77	381.78	238.70	70.88	63.01	52.57
	I	51.28	48.22	50.41	50.64	51.01	218.45	431.26	462.49	396.16	118.32	60.18	51.47
1987	II	50.25	48.98	50.10	50.61	49.41	181.00	454.65	404.01	348.18	66.43	59.55	51.16
	III	48.36	49.83	50.60	54.00	107.33	297.37	536.05	423.89	239.12	60.67	53.59	41.49
	I	32.16	20.90	22.23	38.84	96.82	206.80	811.91	1139.57	264.57	113.49	63.74	63.47
1988	II	26.94	20.59	21.87	48.01	131.18	275.08	755.83	907.29	264.43	87.17	63.42	61.64
	III	22.04	20.72	24.76	61.22	155.69	578.35	916.99	578.84	255.07	68.75	63.57	58.54
	I	52.94	47.75	50.05	57.06	66.96	364.49	416.24	391.54	267.09	194.68	69.04	61.83
1989	II	50.36	48.55	50.88	65.42	75.73	375.17	448.26	327.89	241.41	177.01	63.84	60.54
	III	48.49	50.06	52.45	66.70	94.51	372.33	437.02	303.46	221.73	118.34	63.22	59.09
	I	57.95	49.67	49.74	55.42	73.99	439.65	647.88	428.58	648.19	253.00	110.47	83.89
1990	II	54.16	47.71	49.94	60.62	123.38	521.39	428.76	615.00	403.56	190.62	101.50	78.60
	III	51.00	47.72	51.64	66.42	358.42	682.29	343.45	793.03	367.84	136.93	96.09	71.92
	I	57.90	49.84	48.72	55.22	68.87	145.17	348.11	570.93	277.80	110.46	74.62	62.18
1991	II	53.63	47.73	50.57	60.91	80.57	197.16	436.65	436.72	209.46	85.00	69.89	62.01
	III	51.00	47.72	52.75	67.32	113.02	253.67	532.67	381.78	152.67	78.04	65.25	60.99
	I	55.01	48.46	47.62	50.21	68.74	439.56	382.83	429.20	N.A.	N.A.	73.22	63.49
1992	II	52.41	47.64	47.76	53.16	96.60	541.23	354.54	514.34	N.A.	N.A.	67.36	61.08
	III	50.25	47.72	49.09	57.04	293.09	557.79	366.81	551.88	N.A.	N.A.	64.30	58.27

Annexure-I

DUMKAR H.E. PROJECT

AVERAGE 10-DAILY WATER AVAILABILITY STATEMENT

YEAR	PERIOD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	I	52.73	49.57	N.A.	N.A.	67.54	140.12	292.05	673.88	503.42	269.16	81.96	71.54
1993	II	50.99	47.93	N.A.	N.A.	77.80	178.69	399.52	663.07	396.53	172.57	78.26	67.80
	III	50.06	47.72	N.A.	N.A.	97.65	221.73	503.55	620.00	328.13	110.24	76.06	65.19
	I	57.16	47.69	48.57	49.96	60.72	86.17	453.17	728.65	712.11	261.37	71.55	63.28
1994	II	50.62	48.38	48.50	50.96	69.43	108.13	572.56	840.23	503.45	196.69	64.91	61.74
	III	48.43	49.92	48.51	53.97	78.51	222.09	644.75	794.21	380.18	127.36	63.60	59.42
	I	57.93	47.53	51.07	50.45	58.79	N.A.	N.A.	N.A.	N.A.	370.59	107.15	61.45
1995	II	54.19	47.55	51.84	52.32	65.72	N.A.	N.A.	N.A.	N.A.	247.04	67.31	58.35
	III	49.00	47.53	54.76	54.75	67.83	N.A.	N.A.	N.A.	N.A.	173.62	62.66	57.92
	I	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	242.56	85.06	55.91
1997	II	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	170.27	69.48	52.01
	III	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	120.20	57.82	50.53
	I	49.79	47.71	47.53	49.94	66.68	108.79	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1998	II	48.69	47.53	47.62	51.96	73.92	128.30	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	III	47.97	47.61	48.23	56.98	68.67	175.40	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	I	N.A.	N.A.	N.A.	49.75	64.01	66.47	224.35	N.A.	N.A.	N.A.	N.A.	N.A.
1999	II	N.A.	N.A.	N.A.	50.88	76.93	106.77	366.03	N.A.	N.A.	N.A.	N.A.	N.A.
	III	N.A.	N.A.	N.A.	55.18	80.37	179.99	569.66	N.A.	N.A.	N.A.	N.A.	N.A.
	I	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	166.50	67.47
2000	II	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	101.62	54.33
	III	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	79.79	48.88
	I	47.84	47.82	47.58	49.65	N.A.	N.A.	N.A.	528.33	350.30	126.97	145.31	133.10
2001	II	47.55	47.55	47.58	50.56	N.A.	N.A.	747.62	655.02	207.97	108.90	143.81	90.54
	III	47.65	47.64	48.05	52.22	N.A.	N.A.	547.53	512.48	152.21	137.39	138.80	65.15

Annexure-I

DUMKAR H.E. PROJECT

AVERAGE 10-DAILY WATER AVAILABILITY STATEMENT

YEAR	PERIOD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	I	51.65	49.87	62.78	59.92	209.64	606.35	762.94	870.84	442.94	130.42	62.53	94.38
2002	II	60.52	52.31	57.25	68.49	487.66	655.95	1120.34	944.76	340.78	83.19	61.64	71.51
	III	52.63	49.38	56.60	79.12	533.34	748.82	741.84	698.68	204.86	66.96	69.64	64.33
	I	49.55	51.45	72.44	95.42	193.91							
2003	II	49.87	67.85	86.52	143.03	375.03							
	III	47.52	75.65	95.47	122.43	429.89							
	I	**51.60**	**47.65**	**51.07**	**57.10**	**101.40**	**235.80**	**543.63**	**760.17**	**442.07**	**165.60**	**84.41**	**67.68**
AVG	II	**49.87**	**48.58**	**51.84**	**64.05**	**136.43**	**289.64**	**587.35**	**733.52**	**303.88**	**123.55**	**74.83**	**61.47**
	III	**47.52**	**49.48**	**54.76**	**70.89**	**172.63**	**450.45**	**672.71**	**600.53**	**215.49**	**99.73**	**70.53**	**57.04**

NOTE : **1- ALL DISCHARGE ARE IN CUMEC**

2- N.A. means Discharge data not available

Figure-I

DUMKAR H.E. PROJECT

PLOT OF MONTHLY AVERAGE DISCHARGE

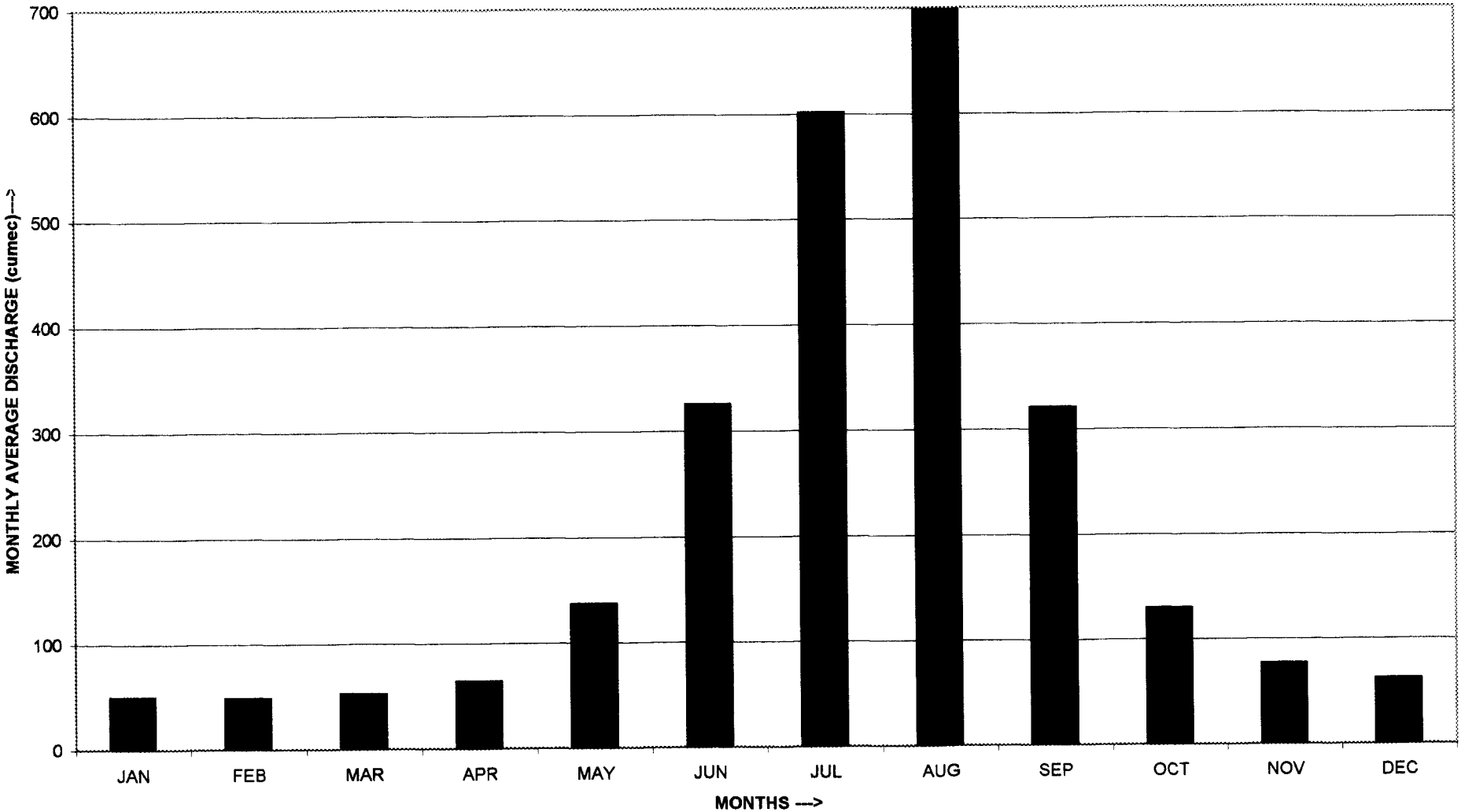
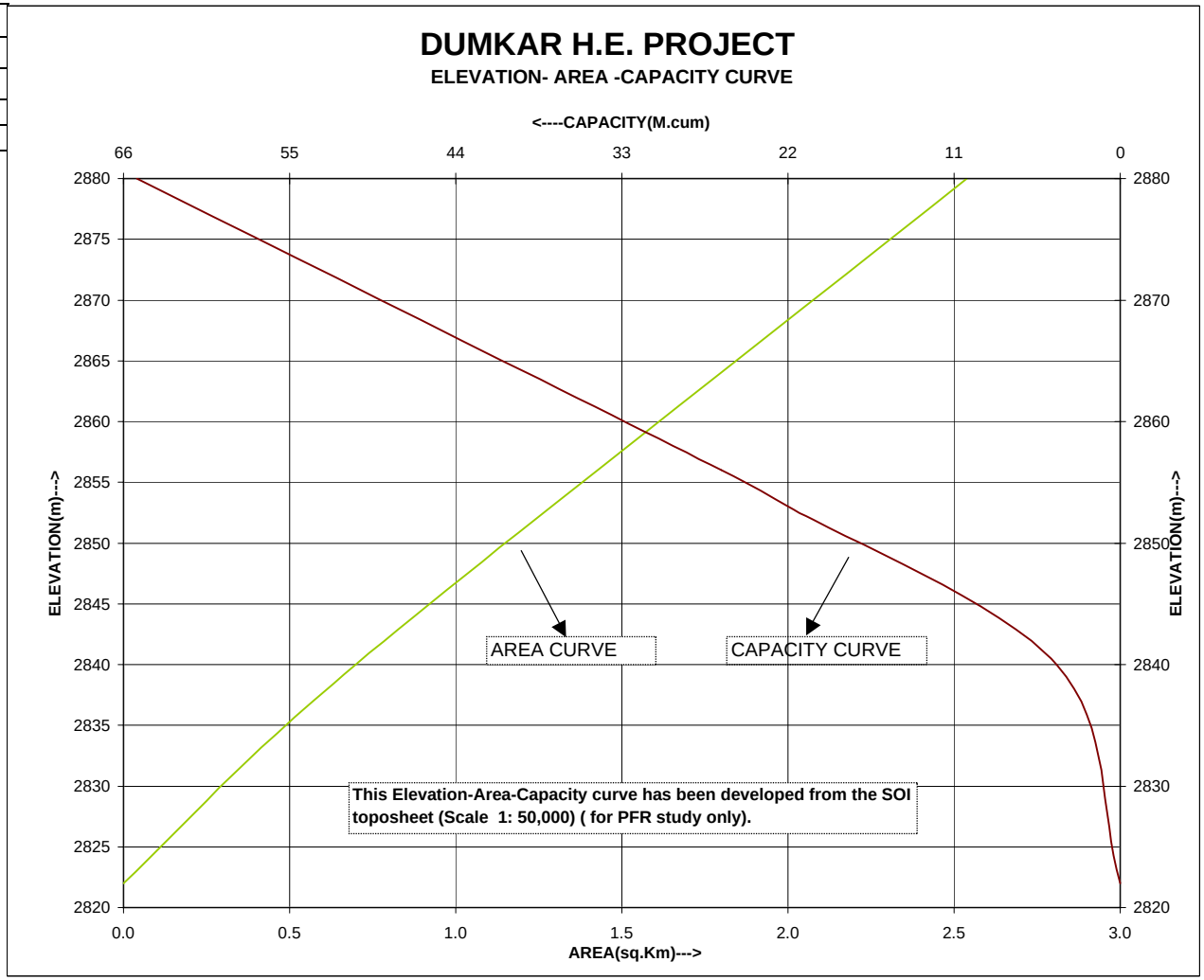


Figure-II

Elevation	Area	Capacity
(m)	(sq.k	(M.cum)
2822.0	0.00	0.00
2840.0	0.70	4.20
2880.0	2.54	65.12



Elevation	Area	Capacity
(m)	(sq.km)	(M.cum)
2822.00	0.00	0.00
2840.00	0.70	4.20
2853.00		22.00
2856.00		26.40
2880.00	2.54	65.12

CHAPTER-6

CONCEPTUAL LAYOUT AND PLANNING

CHAPTER - 6

CONCEPTUAL PLANNING AND LAYOUT

INTRODUCTION

Dumkhar H.E. Project is planned as a run of the river scheme on river Indus. The project is planned for generating 45 MW of power with design discharge of 67.23 cumec per unit utilizing a gross head of 32 m . The annual generation from this project is expected to be 219.18 million units.

The project envisages construction of 42 m high concrete gravity dam, intake structure in dam body, a dam toe surface power house and the tail water is discharged directly back into the river. The conceptual layout of the project has been finalised after disscussion with CEA. The minutes of meeting is enclosed as Annexure-I.

DIVERSION ARRANGEMENT

To facilitate construction, and considering that working season concides with high flow season of the river two nos diversion tunnel of 10.0 m dia horse shoe shape and rockfill coffer dams at upstream & downstream have been planned. The length of each diversion tunnel is about 450 m. Diversion arrangement will cater for approximately 2000 cumec discharge. Downstream Coffer dam of height 12 m and upstream coffer dam of height 27.0 m has been planned.

CONCRETE GRAVITY DAM

The concrete gravity dam is proposed near Achingthang village. This site has been selected on the basis of available Survey of India Topo Sheet no. 52 B/11 (scale 1 : 50,000) with contour interval of 40 m and longitudial and cross-sections of river taken by project.

The concrete dam is 42 m high from the expected foundation level with FRL at EL 2856.0 m and MDDL at EL 2853.0 m. The spillway is designed for PMF of 4650 cumec. The spillway is provided with 4 no. orifice type radial gates of

size 8.2 m X 12 m. To take care of silt flushing requirements orifice type spillway with crest level at EL 2830.0 m which is about 11 m below the intake level has been provided. The spillway arrangement shall be optimized with model studies at later stage. No separate provision for silt exclusion arrangement has been proposed. The concrete dam shall be founded on competent rock. Any discontinuity found in the foundation grade shall be suitably treated. Stilling basin type arrangement has been proposed for energy dissipation. The apron level of stilling basin has been proposed at EL 2808.0 m to provide sufficient conjugate depth for the formation of hydraulic Jump. End sill having EL at 2815.0 m has been proposed at the end of stilling basin. River bed downstream of stilling basin is proposed to be suitably protected with CC block. The length of stilling basin is about 100 m.

INTAKE AND WATER CONDUCTOR SYSTEM

Three nos. independent penstock intake has been proposed on the left non-overflow block of the dam. The sill level of intake is at EL 2841.0 m to allow silt free water into power house. Sufficient water seal has been provided below the MDDL level for smooth function of intake. Intake structure will be provided with service gate and stoplog gate.

The water from intake shall be led through 4.0 m diameter steel penstock to feed each machine of 15 MW.

The entire length of steel penstock is proposed to be embedded in the concrete.

POWER HOUSE COMPLEX

A surface power house is proposed to house 3 units of 15 MW each. The size of power house shall be 73 m x 19.5 m x 44 m including service bay. The discharge from the power house is directly led to the river through the Tail Pool. The draft tube gates are proposed to be operated through a gantry crane from draft tube deck. The control bay is proposed on the upstream of machine hall. The transformers shall be placed in open yard located between the intake and power house.

A cellular wall protects the power house from spillway. This wall will be raised from the rock level and provided up to the maximum downstream water level. The water from draft tube shall be led back to river through the tail pool and weir provided at the end of the tail pool.

The conceptual layout and planning has been done on the basis of limited information available at PFR stage. However, before taking up feasibility study, detail investigation in respect of topography, hydrology and geology needs to be carried out.

FURTHER STUDIES

Topographical Studies

1. Topographical contour Survey of the dam area and Power House area in 1:500 scale with 1 m contour intervals.

2. The riverbed survey comprising of longitudinal section of the river and cross sections at Dam axis and tailrace outlet to firm up the power potential of the project.

3. Reservoir Area Survey in appropriate scale.

Geological and Geo-technical investigations

1. Geological/geotechnical investigations including surface mapping and subsurface explorations like exploratory drilling and seismic profiling at the dam and powerhouse area.
2. Rock mechanic lab tests shall be required for finding out the properties of the rock material.
3. Construction material survey involving drifts, pits, and topographical surveys of the borrow/quarry areas.
4. Site-specific studies for earthquake design parameters are required to be undertaken.

Design Studies

1. Hydraulic design of various structures like spillway, power intake, stilling basin are required for firming up the dimensions.
2. Sedimentation analysis for working out the post-sedimentation storage capacity of the reservoir.
3. Stability analysis of non-overflow and overflow sections shall have to be done taking into account the approved seismic parameters .
4. Hydraulic model studies for reservoir, Dam spillway and energy dissipation structure are required for the confirmation of design parameters.
5. Optimisation of diversion arrangement.

GENERAL

Following hydro-mechanical equipments have been envisaged for Dhumkar HE Project

SPILLWAY RADIAL GATE:

Four nos. of orifice type radial gate for opening size of 8.2 m X 12.0 m shall be provided to control the discharge through the gated portion of the spillway. Each gate shall be operated by means of a set of hydraulic hoist consisting of two hydraulic cylinders of 125 T capacity each.

The inspection and maintenance of the radial gate shall be carried out by lowering one set of sliding type stoplogs on the upstream side of these gates. It is proposed to operate the stoplogs by means of a gantry crane of capacity 35 T with the help of a lifting beam. The stoplog units shall be stored in the storage vents provided in the dam area.

One trolley mounted mobile gasoline engine powered power pack capable of operating one gate at $1/4^{th}$ of the normal rated speed is also envisaged.

Suitable arrangement for heating and deicing shall be provided along side of embedded parts.

INTAKE GATE AND BULKHEAD GATE WITH HOISTS, TRASH RACK

A fixed wheel type self closing, quick acting gate for opening size of 3.2 m X 4.0 m, shall be provided for each intake. Each gate shall be operated by means of dedicated hydraulic hoist of 20 T capacity.

On upstream of the intake gates, provision has been made for one set of bulkhead gate for opening size 3.2 m X 4.0 m. It is proposed to operate the bulkhead by means of a 12 T capacity dedicated rope drum hoist.

On upstream of the bulkhead an inclined trash rack of size 7.0 m X 12.0 m covering one intake shall be provided.

Suitable arrangement for heating and deicing shall be provided along side of embedded parts.

DRAFT TUBE GATE

The draft tube emerging out from each generating unit gets divided into two bays. Each bay is provided with one gate of suitable size. The gate will have an upstream sealing (pressure / tailrace side) and upstream skin plate provided for the maintenance of machine in the powerhouse.

Each gate shall be operated by means of the traveling gantry crane of capacity 30 T.

Suitable arrangement for heating and deicing shall be provided along side of embedded parts.

DIVERSION TUNNEL GATE

For diversion of water during construction stage it is proposed to provide two nos. horseshoe shaped diversion tunnel of 10.0 m diameter. Two numbers of fixed wheel type gate of opening size of 4.15 m X 10.0 m will be provided at

inlet of each tunnel. Each gate is operated by means of electrically operated rope drum hoist of capacity of 77 T.

PENSTOCK

Three no. Penstock of dia. 4000 mm fully steel lined will take off from intake to feed the turbine placed in the powerhouse. The material of penstock including specials shall conform to ASTM 537 CL.1. The thickness shall be 14 mm.

MISCELLANEOUS

RESERVOIR MEASURING AND REMOTE CONTROL SYSTEM

One complete set of remote control system for the remote control operation of bye pass gates, along with programmable computerized automatic reservoir monitoring control system is to be provided

DIESEL GENERATING SET

A three-phase synchronous type diesel generating set of 100 KVA, 450 Volts, 50 Hz is envisaged for the emergency operations of the spillway gates at the dam site.

The comments received from CWC and replies are placed at Appendix-8.

CHAPTER-7

POWER POTENTIAL STUDIES

CHAPTER-7

POWER POTENTIAL STUDIES

7.1 General

The Power potential studies of Dumkhar HE Project has been made for 90% dependable year based on 10 hydrological years, from 1982-83 (June) to 1991-92 (May) as given in Table 7.1. The salient features of the project is as follows:

FRL (EL) =2856 m

MDDL (EL) =2853 m

TWL (EL) =2825 m

Rated net head= 27.8 m

Rated Discharge of Plant=183.80 cumecs

Proposed Plant Capacity= (3x15MW)

Design Energy =219.18 MU

7.2 Available Flow

The discharge data for the 90% dependable hydrological year is given in Table 7.3. For carrying out the power potential and optimization studies, the following statistics have been computed.

Year:

Each 10-daily period of the year represents the average of the flow recorded for the corresponding period of each year.

90% Dependable Year:

This is the lower decile of the series of the corresponding 10-daily period of the record i.e. (N+1) x 0.9^{th} year where N is the years for which continuous hydrological data are available. The 90% dependable year comes out to be 1991-92 whose calculations are shown in Tables 7.2.

7.3 Definition of Terms

Annual Energy

This is the yearly energy provided during the 90% dependable hydrological year.

Firm Power

This is the power capacity, which can be guaranteed continuously during the lean period in 90% dependable year. Here no reservoir capacity has been selected in order to have minimum environmental impact. During lean inflow period (winter season) the firm power comes out to be 11.66 MW.

7.4 Full Reservoir Level (FRL) And Minimum Draw Down Level (MDDL)

FRL has been fixed at EL 2856 m based on submergence considerations. The MDDL & TWL have been fixed at EL 2853 m & EL 2825 m respectively based on suitability of site for civil structures. This project is envisaged as a purely run of the river scheme with a small pondage based on International treaty on Indus river. The reservoir shall be connected to powerhouse through independent penstocks.

7.5 Operating Head And Head Losses

The net operating head for turbines has been derived from the following formula where head losses are taken as 2.17 m.

Net operating head = FRL-1/3 (FRL-MDDL)-TWL (all units running)-Head losses

The net operating head comes out to 27.83 m.

7.6 Installed Capacity

The computer studies for power output and annual energy generation for the 90% dependable year has been given in Tables 7.4. And incremental benefits & incremental load factors have been tabulated in table 7-4 (a). Also, incremental benefit has been plotted in graph (1), which comes out to be 2.58 for this year against plant capacity of 45 MW which is a quite reasonable value. Considering above factors the total installed capacity has been selected as 45 MW.

As there is no storage, therefore the reservoir operations are not of importance and hence have been neglected.

7.7 Size of Generating Units

Ladakh region is poorly served by power, which has put a curb on all development activities in the region. Keeping this in view it is to opt for suitable size & type of hydro units permissible within the parameters of economy, operating efficiency, ease of maintenance, optimum utilization of available water, transport limitation etc.

Considering all points 3 units with capacity each of 15 MW with vertical Kaplan turbine as prime mover have been envisaged.

7.8 Energy Generation

The energy generation in the 90% dependable year (1991-92) indicating lean inflow period and high inflow period and monthly energy generation have been shown in Table 7.5 & Table 7.6. It may be seen from this table that the total unrestricted energy generation is 341.74 MU. Also, Annual energy generation (unrestricted) have been indicated

in Table 7-7(a) to 7-7(i) for 10 hydrological years. Annual energy generation at 45 MW comes out to be 219.18 MU. Energy available at bus bar shall be 216.99 MU after allowing auxiliary losses & transformer losses of 0.5% of each.

The comments received from CEA on this chapter and replies given by NHPC are placed at Appendix-9.

Table. 7-1 HYDROLOGICAL SERIES

		1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
JUN	I	208.48	288.76	188.70	141.04	112.39	218.45	206.80	364.49	439.65	145.17
	II	379.30	282.26	372.27	207.13	326.36	181.00	275.08	375.17	521.39	197.16
	III	386.93	566.05	739.57	240.50	451.81	297.37	578.35	372.33	682.29	253.67
JUL	I	583.38	537.35	470.49	370.16	466.18	431.26	811.91	416.24	647.88	348.11
	II	731.16	671.33	355.45	427.42	558.96	454.65	755.83	448.26	428.76	436.65
	III	914.46	1154.22	558.88	510.69	1080.77	536.05	916.99	437.02	343.45	532.67
AUG	I	1117.30	1224.07	871.20	674.32	678.09	462.49	1139.57	391.54	428.58	570.93
	II	1090.05	937.04	888.04	817.69	436.72	404.01	907.29	327.89	615.00	436.72
	III	630.42	734.87	596.69	1051.90	381.78	423.89	578.84	303.46	793.03	381.78
SEP	I	359.51	615.65	339.61	803.27	376.80	396.16	264.57	267.09	648.19	277.80
	II	201.35	499.56	207.97	347.24	345.76	348.18	264.43	241.41	403.56	209.46
	III	145.80	340.70	134.55	105.83	238.70	239.12	255.07	221.73	367.84	152.67
OCT	I	116.15	241.40	92.04	66.46	112.07	118.32	113.49	194.68	253.00	110.46
	II	87.29	141.85	82.16	65.61	88.77	66.43	87.17	177.01	190.62	85.00
	III	76.50	94.71	78.52	63.66	70.88	60.67	68.75	118.34	136.93	78.04
NOV	I	74.86	80.95	73.87	63.71	72.90	60.18	63.74	69.04	110.47	74.62
	II	71.30	76.83	69.56	63.33	67.35	59.55	63.42	63.84	101.50	69.89
	III	65.61	70.91	65.45	63.36	63.01	53.59	63.57	63.22	96.09	65.25
DEC	I	62.26	65.13	62.48	60.66	58.71	51.47	63.47	61.83	83.89	62.18
	II	58.07	59.27	57.91	58.60	54.98	51.16	61.64	60.54	78.60	62.01
	III	55.99	53.74	55.24	55.34	52.57	41.49	58.54	59.09	71.92	60.99
JAN	I	52.69	51.40	52.57	51.47	51.28	32.16	52.94	57.95	57.90	55.01
	II	50.12	49.00	50.12	48.46	50.25	26.94	50.36	54.16	53.63	52.41
	III	48.16	46.05	47.87	47.63	48.36	22.04	48.49	51.00	51.00	50.25
FEB	I	48.44	47.72	47.62	47.68	48.22	20.90	47.75	49.67	49.84	48.46
	II	51.13	48.34	48.21	47.92	48.98	20.59	48.55	47.71	47.73	47.64
	III	52.60	49.80	49.83	48.33	49.83	20.72	50.06	47.72	47.72	47.72
MAR	I	52.49	51.37	50.33	49.86	50.41	22.23	50.05	49.74	48.72	47.62
	II	54.87	53.89	52.44	50.47	50.10	21.87	50.88	49.94	50.57	47.76
	III	57.80	56.58	54.11	51.17	50.60	24.76	52.45	51.64	52.75	49.09
APR	I	60.84	59.99	57.66	53.41	50.64	38.84	57.06	55.42	55.22	50.21
	II	62.85	64.01	61.37	56.94	50.61	48.01	65.42	60.62	60.91	53.16
	III	63.54	72.96	63.64	66.47	54.00	61.22	66.70	66.42	67.32	57.04
MAY	I	70.94	86.12	67.23	68.60	51.01	96.82	66.96	73.99	68.87	68.74
	II	92.24	99.90	71.65	70.01	49.41	131.18	75.73	123.38	80.57	96.60
	III	158.33	105.13	94.89	81.27	107.33	155.69	94.51	358.42	113.02	293.09
Total discharge		**8393.24**	**9678.91**	**7230.20**	**7097.59**	**6906.60**	**5699.46**	**8476.46**	**6232.00**	**8348.41**	**5676.01**

TABLE NO. 7-2

CALCULATION FOR 90% DEPENDABLE YEAR

YEAR	UNRESTRICTED ENERGY
1982-83	503.980
1983-84	581.636
1984-85	432.996
1985-86	427.428
1986-87	415.780
1987-88	342.211
1988-89	508.177
1989-90	373.736
1990-91	499.173
1991-92	341.740

YEAR	UNRESTRICTED ENERGY ARRANGED IN DESCENDING ORDER	RANK OF THE YEAR
1983-84	581.636	1
1988-89	508.177	2
1982-83	503.980	3
1990-91	499.173	4
1984-85	432.996	5
1985-86	427.428	6
1986-87	415.780	7
1989-90	373.736	8
1987-88	342.211	9
1991-92	341.740	10

N = No. of years
P = Percentage dependability
R = Rank of the year

N =10

P =90%

R =(N+1) x P

=9.9 (For 90% dependability)

90 % Dependable year is **1991-92.**

TABLE NO. 7-3

POWER GENERATION IN 90% DEPENDABLE YEAR 1991-92

PERIOD		FLOW (CUMECS)	UNRESTRICTED ENERGY IN MU
JUNE	1-10	145.17	8.530
	11-20	197.16	11.585
	21-30	253.67	14.906
JULY	1-10	348.11	20.455
	11-20	436.65	25.658
	21-31	532.67	34.430
AUG	1-10	570.93	33.548
	11-20	436.72	25.662
	21-31	381.78	24.677
SEPT	1-10	277.80	16.324
	11-20	209.46	12.308
	21-30	152.67	8.971
OCT	1-10	110.46	6.491
	11-20	85.00	4.994
	21-31	78.04	5.044
NOV	1-10	74.62	4.384
	11-20	69.89	4.107
	21-30	65.25	3.834
DEC	1-10	62.18	3.654
	11-20	62.01	3.644
	21-31	60.99	3.942
JAN	1-10	55.01	3.232
	11-20	52.41	3.080
	21-31	50.25	3.248
FEB	1-10	48.46	2.848
	11-20	47.64	2.799
	21-29	47.72	2.523
MAR	1-10	47.62	2.798
	11-20	47.76	2.806
	21-31	49.09	3.173
APR	1-10	50.21	2.950
	11-20	53.16	3.124
	21-30	57.04	3.352
MAY	1-10	68.74	4.039
	11-20	96.60	5.677
	21-31	293.09	18.944
		TOTAL	341.740

POWER POTENTIAL STUDY (Table 7-4)
DUMKHAR HYDRO ELECTRIC PROJECT
YEAR 1991- 1992 (90 %Dependable year)

PERIOD		INFLOW	HEAD	POWER	UNRES ENERGY	ENERGY AT DIFFERENT RESTRICTED CAPACITIES														
		CUMEC	(M)	IN MW	(MU)	5MW	10MW	15MW	18MW	20MW	25MW	30MW	35MW	40MW	45MW	50MW	55MW	60MW	65MW	70MW	75MW
JUNE	I	145.17	27.8	35.543	8.530	1.140	2.280	3.420	4.104	4.560	5.700	6.840	7.980	8.530	8.530	8.530	8.530	8.530	8.530	8.530	8.530
	II	197.16	27.8	48.271	11.585	1.140	2.280	3.420	4.104	4.560	5.700	6.840	7.980	9.120	10.260	11.006	11.585	11.585	11.585	11.585	11.585
	III	253.67	27.8	62.107	14.906	1.140	2.280	3.420	4.104	4.560	5.700	6.840	7.980	9.120	10.260	11.400	12.540	13.680	14.160	14.906	14.906
JULY	I	348.11	27.8	85.230	20.455	1.140	2.280	3.420	4.104	4.560	5.700	6.840	7.980	9.120	10.260	11.400	12.540	13.680	14.820	15.960	17.100
	II	436.65	27.8	106.907	25.658	1.140	2.280	3.420	4.104	4.560	5.700	6.840	7.980	9.120	10.260	11.400	12.540	13.680	14.820	15.960	17.100
	III	532.67	27.8	130.415	34.430	1.254	2.508	3.762	4.514	5.016	6.270	7.524	8.778	10.032	11.286	12.540	13.794	15.048	16.302	17.556	18.810
AUG	I	570.93	27.8	139.782	33.548	1.140	2.280	3.420	4.104	4.560	5.700	6.840	7.980	9.120	10.260	11.400	12.540	13.680	14.820	15.960	17.100
	II	436.72	27.8	106.924	25.662	1.140	2.280	3.420	4.104	4.560	5.700	6.840	7.980	9.120	10.260	11.400	12.540	13.680	14.820	15.960	17.100
	III	381.78	27.8	93.473	24.677	1.254	2.508	3.762	4.514	5.016	6.270	7.524	8.778	10.032	11.286	12.540	13.794	15.048	16.302	17.556	18.810
SEPT	I	277.80	27.8	68.015	16.324	1.140	2.280	3.420	4.104	4.560	5.700	6.840	7.980	9.120	10.260	11.400	12.540	13.680	14.820	15.508	16.324
	II	209.46	27.8	51.282	12.308	1.140	2.280	3.420	4.104	4.560	5.700	6.840	7.980	9.120	10.260	11.400	12.308	12.308	12.308	12.308	12.308
	III	152.67	27.8	37.378	8.971	1.140	2.280	3.420	4.104	4.560	5.700	6.840	7.980	8.971	8.971	8.971	8.971	8.971	8.971	8.971	8.971
OCT	I	110.46	27.8	27.045	6.491	1.140	2.280	3.420	4.104	4.560	5.700	6.491	6.491	6.491	6.491	6.491	6.491	6.491	6.491	6.491	6.491
	II	85.00	27.8	20.810	4.994	1.140	2.280	3.420	4.104	4.560	4.994	4.994	4.994	4.994	4.994	4.994	4.994	4.994	4.994	4.994	4.994
	III	78.04	27.8	19.106	5.044	1.254	2.508	3.762	4.514	4.792	5.044	5.044	5.044	5.044	5.044	5.044	5.044	5.044	5.044	5.044	5.044
NOV	I	74.62	27.8	18.268	4.384	1.140	2.280	3.420	4.104	4.384	4.384	4.384	4.384	4.384	4.384	4.384	4.384	4.384	4.384	4.384	4.384
	II	69.89	27.8	17.111	4.107	1.140	2.280	3.420	3.901	4.107	4.107	4.107	4.107	4.107	4.107	4.107	4.107	4.107	4.107	4.107	4.107
	III	65.25	27.8	15.975	3.834	1.140	2.280	3.420	3.834	3.834	3.834	3.834	3.834	3.834	3.834	3.834	3.834	3.834	3.834	3.834	3.834
DEC	I	62.18	27.8	15.224	3.654	1.140	2.280	3.420	3.654	3.654	3.654	3.654	3.654	3.654	3.654	3.654	3.654	3.654	3.654	3.654	3.654
	II	62.01	27.8	15.183	3.644	1.140	2.280	3.420	3.644	3.644	3.644	3.644	3.644	3.644	3.644	3.644	3.644	3.644	3.644	3.644	3.644
	III	60.99	27.8	14.932	3.942	1.254	2.508	3.745	3.942	3.942	3.942	3.942	3.942	3.942	3.942	3.942	3.942	3.942	3.942	3.942	3.942
JAN	I	55.01	27.8	13.468	3.232	1.140	2.280	3.232	3.232	3.232	3.232	3.232	3.232	3.232	3.232	3.232	3.232	3.232	3.232	3.232	3.232
	II	52.41	27.8	12.832	3.080	1.140	2.280	3.080	3.080	3.080	3.080	3.080	3.080	3.080	3.080	3.080	3.080	3.080	3.080	3.080	3.080
	III	50.25	27.8	12.302	3.248	1.254	2.508	3.248	3.248	3.248	3.248	3.248	3.248	3.248	3.248	3.248	3.248	3.248	3.248	3.248	3.248
FEB	I	48.46	27.8	11.866	2.848	1.140	2.280	2.848	2.848	2.848	2.848	2.848	2.848	2.848	2.848	2.848	2.848	2.848	2.848	2.848	2.848
	II	47.64	27.8	11.664	2.799	1.140	2.280	2.799	2.799	2.799	2.799	2.799	2.799	2.799	2.799	2.799	2.799	2.799	2.799	2.799	2.799
	III	47.72	27.8	11.683	2.523	1.026	2.052	2.523	2.523	2.523	2.523	2.523	2.523	2.523	2.523	2.523	2.523	2.523	2.523	2.523	2.523
MAR	I	47.62	27.8	11.659	2.798	1.140	2.280	2.798	2.798	2.798	2.798	2.798	2.798	2.798	2.798	2.798	2.798	2.798	2.798	2.798	2.798
	II	47.76	27.8	11.694	2.806	1.140	2.280	2.806	2.806	2.806	2.806	2.806	2.806	2.806	2.806	2.806	2.806	2.806	2.806	2.806	2.806
	III	49.09	27.8	12.018	3.173	1.254	2.508	3.173	3.173	3.173	3.173	3.173	3.173	3.173	3.173	3.173	3.173	3.173	3.173	3.173	3.173
APR	I	50.21	27.8	12.293	2.950	1.140	2.280	2.950	2.950	2.950	2.950	2.950	2.950	2.950	2.950	2.950	2.950	2.950	2.950	2.950	2.950
	II	53.16	27.8	13.017	3.124	1.140	2.280	3.124	3.124	3.124	3.124	3.124	3.124	3.124	3.124	3.124	3.124	3.124	3.124	3.124	3.124
	III	57.04	27.8	13.966	3.352	1.140	2.280	3.352	3.352	3.352	3.352	3.352	3.352	3.352	3.352	3.352	3.352	3.352	3.352	3.352	3.352
MAY	I	68.74	27.8	16.829	4.039	1.140	2.280	3.420	4.039	4.039	4.039	4.039	4.039	4.039	4.039	4.039	4.039	4.039	4.039	4.039	4.039
	II	96.60	27.8	23.652	5.677	1.140	2.280	3.420	4.104	4.560	5.677	5.677	5.677	5.677	5.677	5.677	5.677	5.677	5.677	5.677	5.677
	III	293.09	27.8	71.758	18.944	1.254	2.508	3.762	4.514	5.016	6.270	7.524	8.778	10.032	11.286	12.540	13.794	15.048	16.302	17.556	17.997
ENERGY OBTAINED ON 95% M/C AVAILABILITY					**341.740**	**41.72**	**83.45**	**119.71**	**134.46**	**142.66**	**160.76**	**176.72**	**191.88**	**206.30**	**219.18**	**231.67**	**243.76**	**254.36**	**264.30**	**274.06**	**282.38**
Load Factor						**95%**	**95%**	**91%**	**85%**	**81%**	**73%**	**67%**	**61%**	**59%**	**56%**	**53%**	**51%**	**48%**	**46%**	**45%**	**43%**

Firm Power 11.659 MW

FRL= EL 2856 m
MDDL= EL 2853 m
TWL= 2825 m
LOSSES= 2.17 m
OVERALL EFFICIENCY= 0.9

Table 7-4 (a)

Incremental Load Factor for 90 % dependable Year (1991-92)

Sl. No.	Installed MW	Annual Energy MU	Load Factor %	Incremental Benefit MU/MW	Annual Load Factor for additional capacity %
1	5	41.72	95%		
2	10	83.45	95%	8.34	95%
3	15	119.71	91%	7.25	83%
4	20	142.66	81%	4.59	52%
5	25	160.76	73%	3.62	41%
6	30	176.72	67%	3.19	36%
7	35	191.88	61%	3.03	35%
8	40	206.30	59%	2.88	33%
9	45	219.18	56%	2.58	29%
10	50	231.67	53%	2.50	29%
11	55	243.76	51%	2.42	28%
12	60	254.36	48%	2.12	24%
13	65	264.30	46%	1.99	23%
14	70	274.06	45%	1.95	22%
15	75	282.38	43%	1.67	19%

TABLE: 7-5

90% DEPENDABLE YEAR 1991-1992

Period		Inflow	Unres Energy				
		CUMEC	(MU)	Power Restricted To45MW	Energy at 45 MW	Energy during High Flow Period	Energy during Lean Flow Period
JUNE	I	145.17	8.530	35.54	8.530	8.530	0.000
	II	197.16	11.585	45.00	10.260	10.260	0.000
	III	253.67	14.906	45.00	10.260	10.260	0.000
JULY	I	348.11	20.455	45.00	10.260	10.260	0.000
	II	436.65	25.658	45.00	10.260	10.260	0.000
	III	532.67	34.430	45.00	11.286	11.286	0.000
AUG	I	570.93	33.548	45.00	10.260	10.260	0.000
	II	436.72	25.662	45.00	10.260	10.260	0.000
	III	381.78	24.677	45.00	11.286	11.286	0.000
SEPT	I	277.80	16.324	45.00	10.260	10.260	0.000
	II	209.46	12.308	45.00	10.260	10.260	0.000
	III	152.67	8.971	37.38	8.971	8.971	0.000
OCT	I	110.46	6.491	27.05	6.491	0.000	6.491
	II	85.00	4.994	20.81	4.994	0.000	4.994
	III	78.04	5.044	19.11	5.044	0.000	5.044
NOV	I	74.62	4.384	18.27	4.384	0.000	4.384
	II	69.89	4.107	17.11	4.107	0.000	4.107
	III	65.25	3.834	15.98	3.834	0.000	3.834
DEC	I	62.18	3.654	15.22	3.654	0.000	3.654
	II	62.01	3.644	15.18	3.644	0.000	3.644
	III	60.99	3.942	14.93	3.942	0.000	3.942
JAN	I	55.01	3.232	13.47	3.232	0.000	3.232
	II	52.41	3.080	12.83	3.080	0.000	3.080
	III	50.25	3.248	12.30	3.248	0.000	3.248
FEB	I	48.46	2.848	11.87	2.848	0.000	2.848
	II	47.64	2.799	11.66	2.799	0.000	2.799
	III	47.72	2.523	11.68	2.523	0.000	2.523
MAR	I	47.62	2.798	11.66	2.798	0.000	2.798
	II	47.76	2.806	11.69	2.806	0.000	2.806
	III	49.09	3.173	12.02	3.173	0.000	3.173
APR	I	50.21	2.950	12.29	2.950	0.000	2.950
	II	53.16	3.124	13.02	3.124	0.000	3.124
	III	57.04	3.352	13.97	3.352	0.000	3.352
MAY	I	68.74	4.039	16.83	4.039	0.000	4.039
	II	96.60	5.677	23.65	5.677	0.000	5.677
	III	293.09	18.944	45.00	11.286	11.286	0.000
ENERGY OBTAINED ON 95% M/C AVAILABILITY					**219.18**	**133.44**	**85.74**
Load Factor					**55.60%**	**92.90%**	**34.22%**

TABLE NO. 7-6: MONTHLY ENERGY GENERATION IN 90% DEPENDABLE YEAR (1991-92)

PERIOD		90% DEPENDABLE FLOW (CUMECS)	POWER IN MW		ENERGY IN MU		MONTHLY ENERGY IN GWH
			UN RESTRICTED	RESTRICTED TO INSTALLED CAPACITY	UN RESTRICTED	RESTRICTED TO INSTALLED CAPACITY	
1		2	3	4	5	6	7
JUNE	1-10	145.17	35.543	35.54	8.530	8.530	
	11-20	197.16	48.271	45.00	11.585	10.260	29.05
	21-30	253.67	62.107	45.00	14.906	10.260	
JULY	1-10	348.11	85.230	45.00	20.455	10.260	
	11-20	436.65	106.907	45.00	25.658	10.260	31.806
	21-31	532.67	130.415	45.00	34.430	11.286	
AUG	1-10	570.93	139.782	45.00	33.548	10.260	
	11-20	436.72	106.924	45.00	25.662	10.260	31.806
	21-31	381.78	93.473	45.00	24.677	11.286	
SEPT	1-10	277.80	68.015	45.00	16.324	10.260	
	11-20	209.46	51.282	45.00	12.308	10.260	29.491
	21-30	152.67	37.378	37.38	8.971	8.971	
OCT	1-10	110.46	27.045	27.05	6.491	6.491	
	11-20	85.00	20.810	20.81	4.994	4.994	16.529
	21-31	78.04	19.106	19.11	5.044	5.044	
NOV	1-10	74.62	18.268	18.27	4.384	4.384	
	11-20	69.89	17.111	17.11	4.107	4.107	12.325
	21-30	65.25	15.975	15.98	3.834	3.834	
DEC	1-10	62.18	15.224	15.22	3.654	3.654	
	11-20	62.01	15.183	15.18	3.644	3.644	11.24
	21-31	60.99	14.932	14.93	3.942	3.942	
JAN	1-10	55.01	13.468	13.47	3.232	3.232	
	11-20	52.41	12.832	12.83	3.080	3.080	9.56
	21-31	50.25	12.302	12.30	3.248	3.248	
FEB	1-10	48.46	11.866	11.87	2.848	2.848	
	11-20	47.64	11.664	11.66	2.799	2.799	8.17
	21-29	47.72	11.683	11.68	2.523	2.523	
MAR	1-10	47.62	11.659	11.66	2.798	2.798	
	11-20	47.76	11.694	11.69	2.806	2.806	8.777
	21-31	49.09	12.018	12.02	3.173	3.173	
APR	1-10	50.21	12.293	12.29	2.950	2.950	
	11-20	53.16	13.017	13.02	3.124	3.124	9.426
	21-30	57.04	13.966	13.97	3.352	3.352	
MAY	1-10	68.74	16.829	16.83	4.039	4.039	
	11-20	96.60	23.652	23.65	5.677	5.677	21.002
	21-31	293.09	71.758	45.00	18.944	11.286	
				Total	341.740	219.18	

NOTE: The energy is calculated taking into consideration the 95% machine availability.

TABLE NO. 7-7(a)

POWER GENERATION IN YEAR 1982-83

PERIOD		FLOW (CUMECS)	UNRESTRICTED ENERGY IN MU
JUNE	1-10	208.48	12.250
	11-20	379.30	22.288
	21-30	386.93	22.736
JULY	1-10	583.38	34.279
	11-20	731.16	42.963
	21-31	914.46	59.107
AUG	1-10	1117.30	65.653
	11-20	1090.05	64.052
	21-31	630.42	40.748
SEPT	1-10	359.51	21.125
	11-20	201.35	11.832
	21-30	145.80	8.567
OCT	1-10	116.15	6.825
	11-20	87.29	5.129
	21-31	76.50	4.945
NOV	1-10	74.86	4.399
	11-20	71.30	4.189
	21-30	65.61	3.855
DEC	1-10	62.26	3.659
	11-20	58.07	3.412
	21-31	55.99	3.619
JAN	1-10	52.69	3.096
	11-20	50.12	2.945
	21-31	48.16	3.113
FEB	1-10	48.44	2.846
	11-20	51.13	3.004
	21-28	52.60	2.473
MAR	1-10	52.49	3.084
	11-20	54.87	3.224
	21-31	57.80	3.736
APR	1-10	60.84	3.575
	11-20	62.85	3.693
	21-30	63.54	3.734
MAY	1-10	70.94	4.169
	11-20	92.24	5.420
	21-31	158.33	10.234
		TOTAL	503.980

TABLE NO. 7-7(b)

POWER GENERATION IN YEAR 1983-84

PERIOD		FLOW (CUMECS)	UNRESTRICTED ENERGY IN MU
JUNE	1-10	288.76	16.968
	11-20	282.26	16.586
	21-30	566.05	33.261
JULY	1-10	537.35	31.575
	11-20	671.33	39.447
	21-31	1154.22	74.605
AUG	1-10	1224.07	71.927
	11-20	937.04	55.061
	21-31	734.87	47.499
SEPT	1-10	615.65	36.176
	11-20	499.56	29.355
	21-30	340.70	20.019
OCT	1-10	241.40	14.185
	11-20	141.85	8.335
	21-31	94.71	6.122
NOV	1-10	80.95	4.757
	11-20	76.83	4.515
	21-30	70.91	4.167
DEC	1-10	65.13	3.827
	11-20	59.27	3.483
	21-31	53.74	3.474
JAN	1-10	51.40	3.020
	11-20	49.00	2.879
	21-31	46.05	2.976
FEB	1-10	47.72	2.804
	11-20	48.34	2.841
	21-29	49.80	2.634
MAR	1-10	51.37	3.018
	11-20	53.89	3.167
	21-31	56.58	3.657
APR	1-10	59.99	3.525
	11-20	64.01	3.761
	21-30	72.96	4.287
MAY	1-10	86.12	5.060
	11-20	99.90	5.870
	21-31	105.13	6.795
		TOTAL	581.636

TABLE NO. 7-7(c)

POWER GENERATION IN YEAR 1984-85

PERIOD		FLOW (CUMECS)	UNRESTRICTED ENERGY IN MU
JUNE	1-10	188.70	11.088
	11-20	372.27	21.875
	21-30	739.57	43.457
JULY	1-10	470.49	27.646
	11-20	355.45	20.886
	21-31	558.88	36.124
AUG	1-10	871.20	51.192
	11-20	888.04	52.181
	21-31	596.69	38.568
SEPT	1-10	339.61	19.956
	11-20	207.97	12.220
	21-30	134.55	7.906
OCT	1-10	92.04	5.408
	11-20	82.16	4.828
	21-31	78.52	5.075
NOV	1-10	73.87	4.341
	11-20	69.56	4.087
	21-30	65.45	3.846
DEC	1-10	62.48	3.671
	11-20	57.91	3.403
	21-31	55.24	3.571
JAN	1-10	52.57	3.089
	11-20	50.12	2.945
	21-31	47.87	3.094
FEB	1-10	47.62	2.798
	11-20	48.21	2.833
	21-28	49.83	2.343
MAR	1-10	50.33	2.958
	11-20	52.44	3.081
	21-31	54.11	3.498
APR	1-10	57.66	3.388
	11-20	61.37	3.606
	21-30	63.64	3.739
MAY	1-10	67.23	3.950
	11-20	71.65	4.210
	21-31	94.89	6.133
		TOTAL	432.996

TABLE NO. 7-7(d)

POWER GENERATION IN YEAR 1985-86

PERIOD		FLOW (CUMECS)	UNRESTRICTED ENERGY IN MU
JUNE	1-10	141.04	8.288
	11-20	207.13	12.171
	21-30	240.50	14.132
JULY	1-10	370.16	21.751
	11-20	427.42	25.115
	21-31	510.69	33.009
AUG	1-10	674.32	39.623
	11-20	817.69	48.047
	21-31	1051.90	67.991
SEPT	1-10	803.27	47.200
	11-20	347.24	20.404
	21-30	105.83	6.218
OCT	1-10	66.46	3.905
	11-20	65.61	3.855
	21-31	63.66	4.115
NOV	1-10	63.71	3.744
	11-20	63.33	3.722
	21-30	63.36	3.723
DEC	1-10	60.66	3.565
	11-20	58.60	3.443
	21-31	55.34	3.577
JAN	1-10	51.47	3.024
	11-20	48.46	2.847
	21-31	47.63	3.079
FEB	1-10	47.68	2.802
	11-20	47.92	2.816
	21-28	48.33	2.272
MAR	1-10	49.86	2.930
	11-20	50.47	2.966
	21-31	51.17	3.307
APR	1-10	53.41	3.138
	11-20	56.94	3.346
	21-30	66.47	3.906
MAY	1-10	68.60	4.031
	11-20	70.01	4.114
	21-31	81.27	5.253
		TOTAL	427.428

TABLE NO. 7-7(e)

POWER GENERATION IN YEAR 1986-87

PERIOD		FLOW (CUMECS)	UNRESTRICTED ENERGY IN MU
JUNE	1-10	112.39	6.604
	11-20	326.36	19.177
	21-30	451.81	26.549
JULY	1-10	466.18	27.393
	11-20	558.96	32.845
	21-31	1080.77	69.857
AUG	1-10	678.09	39.845
	11-20	436.72	25.662
	21-31	381.78	24.677
SEPT	1-10	376.80	22.141
	11-20	345.76	20.317
	21-30	238.70	14.026
OCT	1-10	112.07	6.585
	11-20	88.77	5.216
	21-31	70.88	4.581
NOV	1-10	72.90	4.284
	11-20	67.35	3.957
	21-30	63.01	3.703
DEC	1-10	58.71	3.450
	11-20	54.98	3.231
	21-31	52.57	3.398
JAN	1-10	51.28	3.013
	11-20	50.25	2.953
	21-31	48.36	3.126
FEB	1-10	48.22	2.834
	11-20	48.98	2.878
	21-28	49.83	2.342
MAR	1-10	50.41	2.962
	11-20	50.10	2.944
	21-31	50.60	3.271
APR	1-10	50.64	2.975
	11-20	50.61	2.974
	21-30	54.00	3.173
MAY	1-10	51.01	2.998
	11-20	49.41	2.903
	21-31	107.33	6.938
		TOTAL	415.780

TABLE NO. 7-7(f)

POWER GENERATION IN YEAR 1987-88

PERIOD		FLOW (CUMECS)	UNRESTRICTED ENERGY IN MU
JUNE	1-10	218.45	12.836
	11-20	181.00	10.636
	21-30	297.37	17.473
JULY	1-10	431.26	25.341
	11-20	454.65	26.715
	21-31	536.05	34.648
AUG	1-10	462.49	27.176
	11-20	404.01	23.740
	21-31	423.89	27.399
SEPT	1-10	396.16	23.278
	11-20	348.18	20.459
	21-30	239.12	14.051
OCT	1-10	118.32	6.953
	11-20	66.43	3.904
	21-31	60.67	3.921
NOV	1-10	60.18	3.536
	11-20	59.55	3.499
	21-30	53.59	3.149
DEC	1-10	51.47	3.025
	11-20	51.16	3.006
	21-31	41.49	2.682
JAN	1-10	32.16	1.890
	11-20	26.94	1.583
	21-31	22.04	1.425
FEB	1-10	20.90	1.228
	11-20	20.59	1.210
	21-29	20.72	1.096
MAR	1-10	22.23	1.306
	11-20	21.87	1.285
	21-31	24.76	1.600
APR	1-10	38.84	2.282
	11-20	48.01	2.821
	21-30	61.22	3.597
MAY	1-10	96.82	5.689
	11-20	131.18	7.708
	21-31	155.69	10.063
		TOTAL	342.211

TABLE NO. 7-7(g)

POWER GENERATION IN YEAR 1988-89

PERIOD		FLOW (CUMECS)	UNRESTRICTED ENERGY IN MU
JUNE	1-10	206.80	12.152
	11-20	275.08	16.164
	21-30	578.35	33.984
JULY	1-10	811.91	47.708
	11-20	755.83	44.413
	21-31	916.99	59.271
AUG	1-10	1139.57	66.962
	11-20	907.29	53.313
	21-31	578.84	37.414
SEPT	1-10	264.57	15.546
	11-20	264.43	15.538
	21-30	255.07	14.988
OCT	1-10	113.49	6.669
	11-20	87.17	5.122
	21-31	68.75	4.444
NOV	1-10	63.74	3.745
	11-20	63.42	3.726
	21-30	63.57	3.736
DEC	1-10	63.47	3.729
	11-20	61.64	3.622
	21-31	58.54	3.784
JAN	1-10	52.94	3.111
	11-20	50.36	2.959
	21-31	48.49	3.134
FEB	1-10	47.75	2.806
	11-20	48.55	2.853
	21-28	50.06	2.353
MAR	1-10	50.05	2.941
	11-20	50.88	2.990
	21-31	52.45	3.390
APR	1-10	57.06	3.353
	11-20	65.42	3.844
	21-30	66.70	3.919
MAY	1-10	66.96	3.935
	11-20	75.73	4.450
	21-31	94.51	6.109
		TOTAL	508.177

TABLE NO. 7-7(h)

POWER GENERATION IN YEAR 1989-90

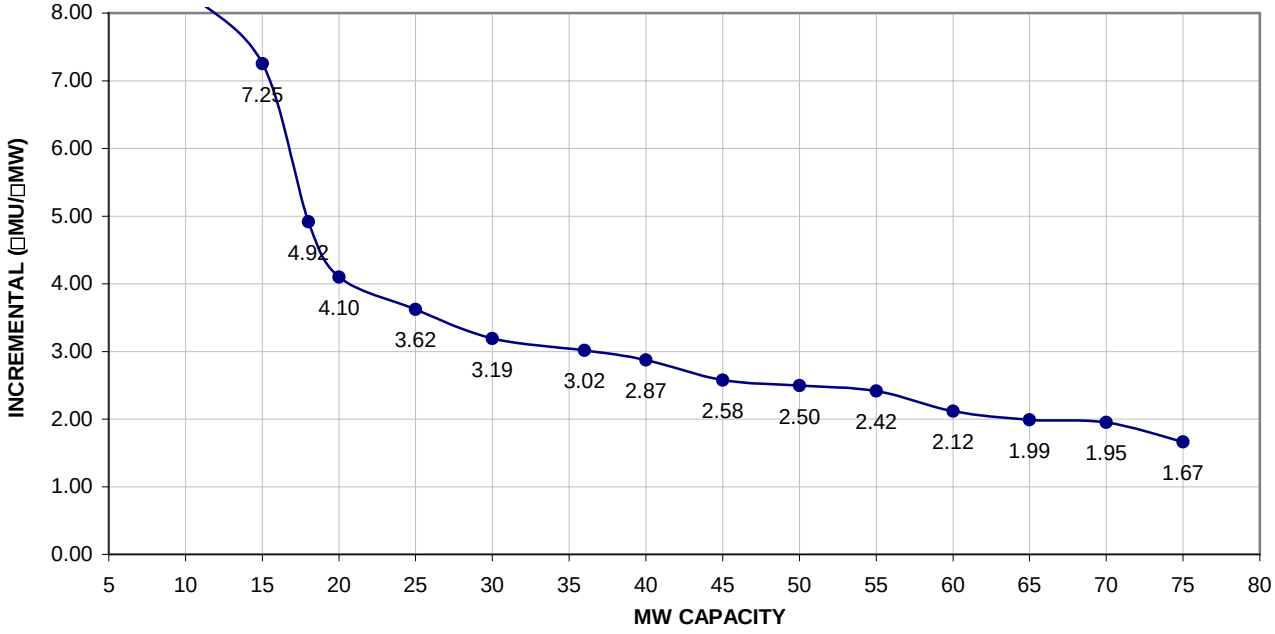
PERIOD		FLOW (CUMECS)	UNRESTRICTED ENERGY IN MU
JUNE	1-10	364.49	21.417
	11-20	375.17	22.045
	21-30	372.33	21.878
JULY	1-10	416.24	24.458
	11-20	448.26	26.340
	21-31	437.02	28.247
AUG	1-10	391.54	23.007
	11-20	327.89	19.267
	21-31	303.46	19.615
SEPT	1-10	267.09	15.694
	11-20	241.41	14.185
	21-30	221.73	13.029
OCT	1-10	194.68	11.439
	11-20	177.01	10.401
	21-31	118.34	7.649
NOV	1-10	69.04	4.057
	11-20	63.84	3.751
	21-30	63.22	3.715
DEC	1-10	61.83	3.633
	11-20	60.54	3.557
	21-31	59.09	3.819
JAN	1-10	57.95	3.405
	11-20	54.16	3.182
	21-31	51.00	3.297
FEB	1-10	49.67	2.918
	11-20	47.71	2.803
	21-28	47.72	2.243
MAR	1-10	49.74	2.923
	11-20	49.94	2.935
	21-31	51.64	3.338
APR	1-10	55.42	3.257
	11-20	60.62	3.562
	21-30	66.42	3.903
MAY	1-10	73.99	4.348
	11-20	123.38	7.250
	21-31	358.42	23.167
		TOTAL	373.736

TABLE NO. 7-7(i)

POWER GENERATION IN YEAR 1990-91

PERIOD		FLOW (CUMECS)	UNRESTRICTED ENERGY IN MU
JUNE	1-10	439.65	25.834
	11-20	521.39	30.637
	21-30	682.29	40.091
JULY	1-10	647.88	38.070
	11-20	428.76	25.194
	21-31	343.45	22.199
AUG	1-10	428.58	25.184
	11-20	615.00	36.138
	21-31	793.03	51.259
SEPT	1-10	648.19	38.088
	11-20	403.56	23.713
	21-30	367.84	21.614
OCT	1-10	253.00	14.866
	11-20	190.62	11.201
	21-31	136.93	8.851
NOV	1-10	110.47	6.491
	11-20	101.50	5.964
	21-30	96.09	5.646
DEC	1-10	83.89	4.930
	11-20	78.60	4.619
	21-31	71.92	4.649
JAN	1-10	57.90	3.402
	11-20	53.63	3.151
	21-31	51.00	3.297
FEB	1-10	49.84	2.928
	11-20	47.73	2.805
	21-28	47.72	2.243
MAR	1-10	48.72	2.863
	11-20	50.57	2.972
	21-31	52.75	3.409
APR	1-10	55.22	3.245
	11-20	60.91	3.579
	21-30	67.32	3.956
MAY	1-10	68.87	4.047
	11-20	80.57	4.735
	21-31	113.02	7.305
		TOTAL	499.173

Graph:(1) DUMKHAR HEP
INCREMENTAL BENEFIT FOR 90% DEPENDABLE YEAR (1991-92)



CHAPTER-8

POWER EVACUATION

CHAPTER-8

POWER EVACUATION

8.1 General

This chapter contains data regarding existing Power network of the Ladakh region and the power evacuation arrangement required, consequent upon power generation at the proposed Dumkhar Hydro Electric Project, as presently, the project cannot be connected to Northern grid.

8.2 Appraisal of Existing Power Evacuation Facilities

The main sources of generation in Ladakh region are a few mini-hydro stations and isolated diesel stations with local consumption of the power in pockets since the area is sparsely populated .The transmission network in this region have not been developed yet due to very difficult hilly terrain in the region. It is understood that the maximum voltage level of the distribution system in that region is 22/11 KV.

8.3 Proposed Evacuation Arrangement of the Nearest Facility

In view of the above, it can be very well understood that due to upcoming of Dumkhar (3x15MW) HE Project and also few other project of the similar capacity, the power generated shall be surplus during summer and hence required to be evacuated to the valley & other states through interconnection to Northern Grid.

Therefore, it has been assumed that the planned 220 KV power transmission network to be executed by PGCIL from Alistong to Leh via Kargil shall be used to evacuate power from Ladakh region to Northern Grid when the power requirement is low in this region. The Feasibility Report of above network submitted by PGCIL to CEA is being taken up

in coordination with up coming of this hydro project in Ladakh region. It is assumed that above transmission network will come in existence before these projects.

Provision of two no 66 KV bays has been kept in Dumkhar HE project for power evacuation. One 66 KV D/C line will connect Dumkhar HE project to 220 KV/66 KV PGCIL sub-station, which would be constructed nearest to the project.

The comments received from CEA on this chapter and replies given by NHPC are placed at Appendix-10.

CHAPTER-9

ENVIRONMENTAL ASPECTS

CHAPTER-9

ENVIRONMENTAL ASPECTS

INTRODUCTION

The Ladakh region of Jammu & Kashmir comprises of two Districts namely Leh and Kargil. Due to high altitude and poor accessibility, the area lacks overall economic development. The generation and distribution of power continues to be one of the most problematic areas of development in the district. To meet the energy demand, the region is presently dependent on diesel, petrol and kerosene. For carrying out initial environmental studies, NRSA was entrusted the study to prepare Land Use/Land Cover maps covering following Land use categories, based on Remote sensing Techniques:

- Vegetation crown, Cover (Tree canopy)
- Built up Areas/ Rocky Outcrop etc.
- Agriculture Land (Land on which agriculture is being practiced currently)
- Vegetation Density classification (Low, Medium, High)
- Water Bodies
- Barren Land
- Any other peculiar Land use category, as per local scenario
- Land Use pattern
- Vegetation cover/ density
- Approximate population density

The initial environmental study also took into consideration boundaries of National Parks, Wildlife Sanctuaries, Biosphere Reserves as any other aspect relevant to the environment in interaction with MOEF

Based on available data the various Environmental aspects are discussed as under :

LANDUSE/LANDCOVER OF THE PROJECT AREA

The land use/land cover study was entrusted to National Remote Sensing Agency, Hyderabad with an objective to acquire IRS satellite (IRS 1D) LISS-III and PAN sensor digital data of the proposed project site and to make quick analysis of these data in terms of estimation of the submergence area at proposed FRL, identification of broad land use/land cover categories, estimation of area under each categories and mapping of each categories within and in immediate surrounding of the proposed submergence area Report of NRSA has been appended as **Appendix - 11**. The details of Maps prepared are as under:

Map 1(a) shows IRS ID LISS III satellite image on 1:50,000 scale covering 7 km radius from the dam site overlaid with FRL, location of dam site and power house.

Map 1 (b) shows satellite derived land use / land cover map on 1:50,000 scale covering 7 km radius from the dam site overlaid with FRL, location of dam site and power house. Land use/ land cover map shows the following categories: Agriculture land, Open scrub, Barren and Rock Out Crop, Settlements, River Course/ Dry River Bed.

Map 1 (c) shows the land use/land cover classes and their corresponding areas statistics in hectares within the submergence area on 1:25,000 scale overlaid with FRL, location of dam site and power house.
Map 1 (d) shows the location of National Parks/Wildlife Sanctuaries vis-à-vis the location of the dam/power house and 7 km area around the dam site.

The land use / land cover categories of the submergence area and the area falling within 7 km radius of the proposed dam site are given under ***Table – 9.1*** and ***Table – 9.2*** respectively.

Table – 9.1

S.No.	Landuse / Landcover category	Area (ha.)	% of the total area
1.	High Dense forest	NIL	NIL
2.	Medium Dense forest	NIL	NIL
3.	Lowe Dense forest	NIL	NIL
4.	Open Scrub	1.9	1.31
5.	Barren/Rock Outcrop	47.8	32.99
6.	Snow	NIL	NIL
7.	Agriculture Land	5.7	3.93
8.	Human Settlement	NIL	NIL
9.	River Course including river bed	89.5	61.77
	Total	**144.9**	**100.00**

Table – 9.2

S.No.	Land use / Land cover category	Area (ha.)	% of the total area
1	High Dense forest	NIL	NIL
2	Medium Dense forest	NIL	NIL
3	Lowe Dense forest	NIL	NIL
4	Open Scrub	610	3.96
5	Barren/Rock Outcrop	14296	92.87
6	Snow	NIL	NIL

7.	Agriculture Land	284	1.85
8	Human Settlement	11	0.07
9	River Course including river bed	192	1.25
	Total	**15393**	**100**

- Total area under submergence at proposed FRL of 2858 m. (above MSL) is estimated to be 144.9 ha (Table.1).

- The agricultural area present in the submergence area is very less (5.7 ha. which is 3.93 percent of the submergence area) which is a positive indicator of insignificant environmental cost, should the proposed hydro-power project is developed at this site.
- It is observed that the land use – land cover is mostly dominated by barren / rock outcrop which is 47.80 ha (33 % of the submergence area). Open scrub land, which is present to the extent of 1.9 ha. (1.31 % of the submergence area).

- There are no surface water bodies other than the river course. The area under river course including dry river bed is estimated to be 89.5 ha constituting 61.77 % of the submergence area, indicating the FRL is mostly confined within the river course (Gorge section) indicating a near ideal location to develop the proposed hydro power site.

- It is observed that settlements within the submergence appear to be nil hence no rehabilitation issues to be addressed in developing this hydro power site. This is a positive indicator

so far as socio-economic and demographic factor is concerned with respect to the proposed hydro-power development project.

- It is observed that there is no permanent snow in the submergence area.

- It is observed that the road runs along the Indus river and the proposed FRL is very close to this road. Though enough care is taken to avoid submergence of this road by keeping the elevation difference between the road and the proposed FRL, it appears that at few small stretches (at the bends) the road is likely to be affected by the proposed HE scheme. Therefore it requires a close look on the ground.

TERRESTRIAL ECOLOGY

As per the available Forest Statistic Data of the year 2000-01, total forest area in Leh District is 13047 sq. km. Due to its altitude above tree line, the region presents a look of a cold desert. Inspite of such a great natural constraint, Forest Division, Leh is trying its best to bring more and more areas under green cover. The main objective is to bridge the gap between demand and supply of timber and firewood in the region and protect the forest resources.

As per the preliminary survey conducted by the project and no forest area is falling either in the project area or under submergence.

Flora

The ladakh region is above the tree line. Inspite of that, the region harbours both endemic and exotic plant species, some of which have medicinal

importance. Important medicinal plant species reported in Ladakh Region are detailed out as below:

Botanical Name	Local Name
Physochlaina praealta	Langtang
Peganum harmala	Sepan
Juniperus macropoda	Shukpa
Cicer microphyllum	Sari
Artemisia brevifolia	Burtse
Urtica hyperborea	Zatsot
Clematis tibetica	Bisho
Latium latifolium	Shangshow
Rheum tibeticum	Lachu
Stachys tibetica	Yagzes
Allium loratum	Skotsey
Nepeta flocosa	-
Coridalis adiantifolia	-
Caparis spinosa	Capra
Ehinops cornigerus	Nagtser
Acontholimon spp.	Longze
Potetilla spp.	Toma
Hippophae rhemnoide	Tsermang
Delphenium brunonianum	Laddar
Ephedra gerardiana	Tsepath

Exotic floral species reported in the Ladakh region are *Populus nigera* (Yulat), *Populus candican* (Yarpa), *Salix elegans* (Sho), *Arnebea euchroma* (Demok) etc. Plants like *Populus nigera, Salix alba, Salix elegans* are being planted by the Forest Department under various afforestation programmes, on a very

large scale. The survival rate of these species is very good inspite of the harsh climatic conditions.

For propagation of endangered species and conservation of gene pool, gene banks have been established by the Forest Department in Numa block and Nubra valley of Distt. Leh, which harbours about 50 endangered plant species of medicinal and aromatic importance.

Flora of the Project / Catchment Area

Broadly two types of vegetation are found in these area i.e. (Skurbuchan Lado & Achinathang) these are as under :

a) Riverian Vegetation, It is divided as :-

i) Natural Riverian Vegetation :- It mainly comprises of broad leaved, such as, Hippophae rhamnoides, Myricariggarmanica, clamatias, botana Caragana pygmoa, Rosa webbiana, Ephedra geraidiana, Lonicera spp's.

ii) Artificial Vegetaion :- It Comprises of Salix spp's, Popular spp's Juglans regia (Walnut), Prunus armanica (Apricot) etc. Plantation on the fringes of crop fields or occurs in the patches in the close vicinity of the habitation.

Fauna

Since the entire Leh region has sparse forest cover having thin vegetation, diverse faunal species are not reported in the region. Fauna reported in the region are Wild Yak, Zo, Zomes, Wolf, Fox, Ibex (Wild Goat), Marmot, Antelope, Horse, Mule, Kyang etc.

Ladakh has varied diversity of Avi-fauna. A few of the reported species of the region are Rose Finch, Black Headed Gull, Bar Headed Geese, Hill Pigeon,

Rock Bunting, Desert Weather Hawk, Snow Finch, Horned Lark, Gray Backed Gull, Great Crested Grebe, Lesser Plyover, Sand Piper, Hoopoe, Brahmani Duck, Black Necked Crane, Black Red Start, Red Shank and Snow Finch.

Fauna of the project area

Zoological Name	Common Name	Local Name
Copra ibex sibirica	Ibex	Skyin
Ovis Orientalis	Ladakh Urial	Shapo
Unica unica	Snow leopard	Shan
Felis mannal	Pallas's Cat	
Canis lupus	Wolf	Shanku
Vulpes vulpes	Red Fox	Watse
Cuon alpinis	Wilddog or Dhole	Phara
Ochotona roylei	Himalayan mouse hare	
Lepus nigricrllis	Indian hare	Khargosh
Mustela Nivalis	Himalayan Weasel	Lakhemo

AQUATIC ECOLOGY

Fisheries

As per the details provided by the Fisheries Department, Leh, main fish species reported in the river Indus are the cold water fishes like *Schizothorax spp*. which are the main commercial fishes of the river. *Schizothorax ecocinus* is the most commonly found fish of the river. It is commonly called as Snow Trout and is one of the favourite game fishes of the world, after the English Trout. Other fishes found in the river are *Schizothorax longipinnis, Ptychobarbus conirostris* and many species of *Noemacheilus*, of which

N.gracilis and *N.stoliczkae* are most commonly found in the Indus and its tributaries.

Schizothorax spp. migrate hundreds of kilometers for spawning to the upstream of the river where they spawn in shallow waters with pebbles and sandy beds. This fish breeds in the spring, starting from April and May and entire brood population migrates upstream to the head waters of the river and after spawning in the shallow portion of the river, migrates downwards.

The species wise details of the fish available in the river are as follows:

1.	*Schizothorax esocinus*	:	Migratory, moves upstream for breeding purposes. Feeds on Algae and Mosses.
2.	*Schizothorax longipinnis*	:	Migratory, moves upstream for spawning
3.	*Phychobarbus conirostris*	:	Migratory in short distance for spawning, feeds on Algae and mosses.
4.	*Barilius tileo*	:	Small fish, not of commercial importance
5.	*B. vagra vagra*	:	Fish not of commercial importance
6.	*Noemacheilus gracilis*	:	Fish not of commercial importance, indigenous and does not migrate for breeding purposes.
7.	*N. stoliczkae*	:	Fish not of commercial importance.

Besides the above, there are many species of *Naemacheilus* available in the river that are of no commercial importance. Trout like *Salmo trutta fario* has also been introduced but this fish does not migrate for spawning.

Water Quality

Quality of water of river Indus near village Alchi. Physico-chemical parameters viz. Temperature, pH, Conductivity, Total Dissolve Solids, Dissolve Oxygen,

Salinity, Turbidity, Total Alkalinity, Ca-Hardness, Mg-Hardness, Total Hardness, Chloride, Iron, Nitrate-N, Nitrate (NO_3), Phosphorous & Chemical Oxygen Demand (COD) were tested for both the sites to ascertain the quality of water. The results are as under

Sl.No.	Parameters	Unit	S1	S2
	(A) Physical			
1	Temperature	^oC	4.6	4.6
2	p H	-	7.50	7.10
3	Conductivity	uS/cm	308.00	136.90
4	T.D.S.	mg/l	142.00	62.00
5	D.O	mg/l	12.55	11.99
6	Salinity	percent	0.1	0.1
7	Turbidity	FTU	0.00	0.00
	(B) Chemical			
8	T. Alkalinity	mg/l	68.00	80.00
9	Ca-Hardness	mg/l	96.00	116.00
10	Mg-Hardness	mg/l	42.00	30.00
11	Total Hardness	mg/l	138.00	146.00
12	Chloride	mg/l	8.20	6.40
13	Iron	mg/l	0.03	0.07
14	Nitrate-N	mg/l	1.80	1.70
15	Nitrate-NO_3	mg/l	7.92	7.48
16	Phosphorous	mg/l	0.01	0.01
17	C.O.D	mg/l	0.00	0.00

All the parameters are within the permissible limits prescribed by the Bureau of Indian Standards for Drinking Water. Hence it can be ascertained that the river water is free from pollution and is of good quality.

PREDICTION OF IMPACTS

Construction activities of the project have certain impacts on the ecosystem, if proper care is not taken during the construction phase of the project.

Although impacts during the construction phase are temporary and could last only till the construction activities are under progress, the repercussions of

certain activities like road construction, quarrying, land clearing for construction of project appurtenances etc. could cause environmental degradation if the steps towards restoration of the environment are not taken well in time. Secondly, the congregation of labourers and project staff may also pose certain threat to the water and land environment if the waste generated from the camps/colonies is not dumped/managed properly. Major impacts anticipated from the project construction and operation may be summarized as under:

Impacts on Land Environment

Project will submerge about 145 Ha of Land. About 5.7 Ha Agriculture land is getting affected due to submergence. No homestead land is getting affected due to subergence. Other landcover categories of submergence area include: Open Scrub (1.9 Ha), Barren/Rock Outcrop (47.8Ha), Snow and Human Settlement etc. The exact Land getting affected due to Project construction, including submergence could only be ascertained after detailed Environmental Impact Assessment Studies of the project.

During construction phase, activities like construction of roads, project colonies, quarrying, muck generation etc. may cause degradation of the environment, if the activities are not carried out judiciously.

During the construction phase there will be congregation of large number of labourers and other project staff. Solid waste and sewage generated from the project colonies/labour camps may pollute the land resources if proper measures for waste management are not adopted.

Quarrying for generation of coarse and fine aggregate may leave a scar on the quarried land, if the land is not restored properly.

Muck generated during excavation of the project components are to be disposed off properly and the dumping sites restored aesthetically.

Project area falls in the cold desert region of the country, having hostile climatic conditions, which are not conducive for supporting any kind of vegetation. The little vegetation that is present in the region is either due to the efforts of the local people or due to various afforestation schemes that are being implemented by the Forest Department.

The project construction would also involve significant vehicular movement for transportation of large construction material, heavy equipment etc. For this, most of the roads in the project area would require widening and many new roads would have to be constructed. If the construction activities are carried out in an unplanned manner, there may be increased incidences of soil erosion, in the area which is already devoid of vegetation.

Project is not involving any National Park/ Sanctuary Biosphere etc. The nearest National Park is Kanji located at about 31.5 KM (Arial distance) from the proposed dam site.

R&R ASPECTS

No family is getting displaced either due to submergence of land or due to construction of the project components. However a small area of private agriculture land may be acquired for the construction of project components.

Impacts On Water Environment (Aquatic Ecology)

Construction of various project components will emanate sufficient quantity of debris, which if not meticulously disposed off, is likely to enter the river and block a part of the river channel downstream of the proposed dam. Identification of dumping sites and implementation of proper restoration plan for the same will be required to address the issue.

The project would also envisage construction of temporary and permanent residential areas to accommodate labour and staff engaged. This would result in the production of domestic waste, human excreta, which if discharged into the river directly could affect the quality of river water. Proper waste management plan (solid and liquid) would therefore be framed and implemented to mitigate adverse effect of waste on aquatic environment.

Similarly, the impact due to formation of reservoir on the migratory routes of the fishes and the impact due to impoundment of water on other aquatic fauna should be studied and necessary management plans/ mitigatory measures should be framed to address the problem.

ENVIRONMENTAL MANAGEMENT PLANS

Based on the findings of the Environmental Impact Assessment study, following Environmental Management Plans shall be formulated to mitigate the adverse impacts and to maximize the positive impacts of the project construction on the environment:

- Afforestation
- Green Belt Development
- Restoration of query sites/dumping areas
- Conservation plan for Flora
- Fish Management Plan
- Health Management plan
- Solid Waste Management Plan

CHAPTER-10

INFRASTRUCTURE

CHAPTER - 10

INFRASTRUCTURE FACILITIES

Dumkhar HE Project is located in Distt Leh in the state of J & K. The project Site is near about 7 KM upstream of village Achinthang on Khalsi Batalik Road. The Project site is situated at about 128 Km from Leh. Leh is located at a distance of 440 Km from Srinagar and 740 Kms from Jammu. The other route to Leh is via Manali and is at a distance of 475 Kms from Manali. Both the routes get closed during winter season. Jammu/Kiratpur is the nearest railhead. Leh is also connected by Air throughout the year.

Roads

The Project is located at Khalsi –Batalik Road which shall have to be rerouted due to submergence before talking up the project. This is an alternative route to Kargil other than Khalsi-Kargil Road.

Project Headquarters

Project Headquarters is proposed to be established near Project site. Residential and Non-residential buildings are proposed on right bank of the river. All other facilities such as field hostel, Guest house, recreation center, Shopping center, hospital and school are proposed to be established in project colony. This will also cater the requirement of O& M stage. Construction facilities like store, workshop, explosive magazine and POL station are also proposed to be established near project site.

Project being remotely located, needs to be provided a reliable communication system. V-Sat, LDST. Phones shall be established in addition to P & T Phones. Other facilities like Internet shall also be provided, in addition to this, project shall also have EPABX system in the project Area.

CONSTRAINTS :

At present there are restrictions on the load carrying capacity of 6 MT of vehicles transporting the material via Manali- Leh road or Srinagar-Kargil-Leh road. The heavier parts shall have to be lifted by air and help of army shall have to be taken which have got aircrafts with load carrying capacity of 25 MT.

Before taking up the Project, The Khalsi-Batalik road shall have to be rerouted as some portion of the road shall come into submergence area in case the proposed power potential to be utilised.

CHAPTER-11

CONSTRUCTION PLANNING AND SCHEDULE

CHAPTER-11

CONSTRUCTION PLANNING & SCHEDULE

Introduction

The equipment planning & construction methodology of Dumkhar H.E. Project(3x15MW) in Indus Basin, J&K has been developed on following considerations:-

1. The project construction period has been considered as four & half years.
2. Available Geological Data at PFR stage.
3. Requirement of Construction Equipment has been planned to handle the quantities worked out on the basis of preliminary layout.
4. Three months (from December to February) winter period has been considered while doing the equipment planning and no work will be done during during this period.

1. Construction Methodology:

1.1 Infrastructure Works:

The main infrastructure development is proposed to be carried out in period of 12 months. During infrastructure period Land Acquisition, construction of approach roads, bridges& culverts, arrangement of construction power will be undertaken. The main works will be started from 7th month. Platform to accommodate batching plant, stores for construction material, site workshop, offices and other buildings (residential/ non residential) colonies will also be developed in infrastructure period. Crawler Dozer, Loader cum Excavator, Motor Grader, Air compressor, Road Roller, Snow Blower etc. are proposed for deployment during infrastructure stage.

1.2 Diversion of River

The construction of 2 nos. 10.0m finished diameter, Horse shoe shaped 450m long each diversion tunnel would be carried out by heading & benching method. Excavation of Diversion Tunnel will be carried out with 2 Boom drill jumbo, jack hammer, 2.5 Cum side dump loader and 25T L.P. Dumpers. Diversion tunnel excavation & concreting would be completed in 13 months. Concreting requirement would be catered by 120 cum/hr Batching & Mixing plant and 250 TPH aggregate Processing Plant being proposed at Dam, Concrete pump, Transit mixer, Shotcrete m/c, Grout pump and shutters. U/s & D/s Coffer dam would be constructed immediately after construction of diversion tunnel within a period of one month to divert the river .

1.3 Concrete Dam, Spillway and Stilling Basin

After construction of coffer dam and river diversion, the excavation of river bed will be taken up. The excavation of river bed would be carried out in 5 months. Excavated material will be handled by 1.0/ 2.0 cum Hyd. Excavator and 25T Rear Dumpers. Concreting of Dam & HM work would be carried out in further 12 working months .Excavation of spillway and Stilling Basin would be carried out by 2.0 cum Hyd. Excavator and 25 T dumper. Excavation and Concreting of spillway and Stilling Basin would be completed in 14 working months. Concreting of dam, spillways and Stilling Basin would be done by 2 Nos. Tower crane (6.9T at 60m radius) with 2.0/3.0 cum bucket capacity, Concrete pump with Placer Boom, 120 cum/hr Batching & Mixing plant and 250TPH Aggregate Processing plant. Necessary arrangement for hot water to meet the required temperature will be made.

1.4 Power House

3 X 15 MW (45 MW) surface power house (73 m X 19.5 m) would be excavated in 10 months. For excavation of Power House, benches of suitable

height will be developed by cutting hill slopes. The equipment to be deployed for excavation are jack hammers, wagon drills, air compressors, loader, 2.0 cum Hyd. excavators, 25 T Reardumpers, etc. Concreting of Power house ,cellular wall , laying of Pen stock and associated concreting would be completed in 18 months. Concreting of Power house, would be done by 1 no. Tower crane 6.9 T at 60 m radius , concrete pump, 80 cum/hr. Batching and Mixing Plant and 150 cum/hr. aggregate Processing Plant. Installation & Testing of Machine would be undertaken in such a manner that Project gets commissioned in 54th month from the start of Project construction.

The excavation of the small **Tail pool** will be carried out along with the excavation of Powerhouse.

Dumkhar HE Project J&K.

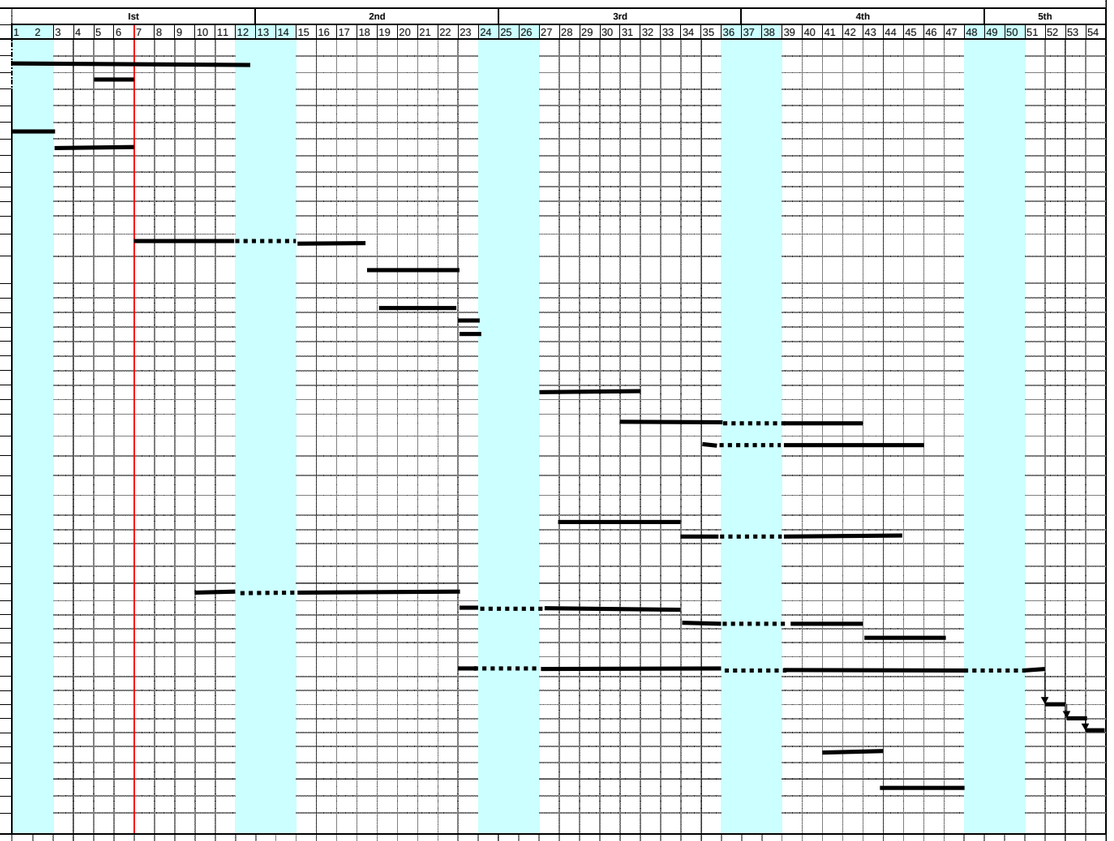
Q-Spl T&P for Infrastructure Development

Sl.No.	Description of equipment	Quantity (Nos.)	Rate (Rs in Lacs)	Amount (Rs in Lacs)
1	Loader cum Excavator, 1.0/0.25 cum.	1	19.80	19.80
2	Crawler Dozer, 100 FHP	2	55.00	110.00
3	Wheel Dozer, 130 FHP	1	58.00	58.00
4	Wheel loader, 2 Cum	1	33.00	33.00
5	Diamond Core Drill (Mechanical)	1	16.50	16.50
6	Diamond Core Drill (Hyd)	1	66.00	66.00
7	Air Track/Wagon Drill	2	16.50	33.00
8	Jack Hammer/Pavement Breaker	5	0.39	1.95
9	Compressed Air(cfm)	2000	0.0138	27.60
10	Mobile Crane, 10 t Pick & Carry	1	11.00	11.00
11	Mobile Crane, 20 t	1	77.00	77.00
12	Road Roller, 8/10 t	1	11.00	11.00
13	Snow Cutter	1	55.00	55.00
14	Dewatering Pump	L.S	11.00	11.00
15	Tipper 4.5/6.0 cum.	6	10.45	62.70
16	Truck, 10 t	6	8.25	49.50
17	Concrete Mixer, 14/10 cft	1	1.65	1.65
18	Explosive Van, 5 t	1	11.00	11.00
19	Water Tanker/Sprinkler, 10 KL	2	13.20	26.40
20	Petrol/Diesel Tanker, 10 KL	2	13.20	26.40
21	Bus/Mini Bus	4	8.80	35.20
22	Car/MUV	2	4.40	8.80
23	Jeep (Petrol/Diesel)	15	4.40	66.00
24	Ambulance	2	8.80	17.60
25	Workshop Equipt.	L.S	27.50	27.50
26	Fire Tender	1	16.50	16.50
27	Recovery Van	1	5.50	5.50
28	Pick up Van/L.C.V	2	5.50	11.00
			Total	**896.60**

CONSTRUCTION SCHEDULE

DAMKHAR HE PROJECT (3 x 15 MW) (J & K)

DETAIL OF WORK	Qty.	UNIT	Month
INFRASTRUCTURE WORKS			
Land Acquisition,Roads,Blds & Communication etc.			
Construction Power			
AWARD OF WORK & MOB.			
Award of main works			
Mobilisation by Contractors			
MAIN WORKS			
DIVERSION WORKS			
DIVERSION TUNNELS (2 Nos.) (parallel activities)			
Excavation	450 (each)	m	**8.5**
Concreting	450(each)	m	**4.5**
COFFER DAMS			
Transportation of material for Coffer dams	319500	Cum	4
Excavation	5000	Cum	1
Const.of Coffer dams	319500	Cum	1
CONCRETE DAM (INCLUDING INTAKE)			
EXCAVATION			
Excavation	57000	Cum	**5**
CONCRETING & HM WORKS			
Concreting	68500	Cum	**9**
Erection of gates & other HM items	Job		**8**
SPILLWAY & STILLING BASIN			
EXCAVATION			
Excavation	181000	Cum	**6**
Concreting	126000	Cum	**8**
POWER HOUSE (INCLUDING CELLULAR WALL)			
P/H			
Excavation	250000	Cum	**10**
Concreting	100000	Cum	**8**
Laying of penstock & associated concreting	Job	-	**8**
Cellular wall concreting			**4**
SUPPLY & ERECTION OF MACHINES			**20**
TESTING & COMMISSIONING			
Unit-1	Job	-	**1**
Unit-2	Job	-	**1**
Unit-3	Job	-	**1**
TAILPOOL WORKS	Job	-	**3**
SWITCHYARD WORKS	Job	-	**4**



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CHAPTER-12

COST ESTIMATES

CHAPTER –12
COST ESTIMATE

12.0 Cost Estimate

12.1 PRELIMINARY COST ESTIMATE FOR CIVIL, HYDRO-MECHANICAL, ELECTRO-MECHANICAL WORKS: -

The estimate has been prepared to arrive at the Capital Cost of Dumkhar H. E. Project and is of Pre-feasibility level of accuracy. The base date of the estimate is June 2003 and the Cost is expressed in Indian Rupees. The Cost Estimate is divided into Civil, Electrical and Transmission Works. For Civil Works, the sub heads are as under: -

12.1.1 I-WORKS

Under this head, provision has been made for various components of the Project as detailed hereunder:-

12.1.2 A-PRELIMINARY

Under A-Preliminary, provision has been made for all surveys and investigations to be conducted to arrive at the optimum of the Project Components.

12.1.3 B-LAND

This covers the provision for acquisition of land for construction of the Project, colonies, offices and stores and compensation for trees and standing crops etc.

12.1.4 C-WORKS

This covers the cost of River Diversion Works, Coffer dam, Concrete Dam and Spillway & Stilling Basin along with associated Hydro-mechanical equipment.

12.1.5 J-POWER PLANT CIVIL WORKS

This covers the cost of project components viz. Power House and other Appurtenant Works along with associated Hydro-mechanical equipment.

The quantities indicated in the estimates for C - Works & J-Power Plant Civil Works (Civil & HM) are calculated from the preliminary Engineering drawings and as per experience of other on-going or commissioned projects.

The unit rates for various items are taken as per the Guidelines issued by CEA for preparation of PFRs. The additional factors like additional cost of transportation, higher labour cost, low efficiency of machinery and labour due to high altitude, availability of construction power etc. shall have to be taken into account at the time of preparation of DPR. It has been assumed that the quarry is available at a distance of 10 Kms from the work site.

12.1.6 K-BUILDINGS

Buildings, both residential and non-residential have been provided under this head. Under the permanent category only those structures have been included which shall be subsequently utilized during the operation and maintenance of the project. The costs are worked out on plinth area basis prevalent in the area for the type of construction involved.

12.1.7 O-MISCELLANEOUS

Provision under this head has been taken as 4% of I -Works to cover the cost of the following miscellaneous works.

a) Capital cost of electrification, water supply, sewage disposal, fire fighting equipments etc.

b) Repair and maintenance of electrification, water supply, sewage disposal, medical assistance, recreation, post office, telephone

and telegraph office, security arrangements, fire fighting, inspection vehicles, schools, transport of labour etc.

c) Other services such as laboratory testing, R&M of Guest House and transit camps, Community center, retrenchment compensation, photographic instruments as well as R&M charges etc.

12.1.8 P-MAINTENANCE DURING CONSTRUCTION AND Y-LOSSES ON STOCK

A provision of 1% and 0.25% of C-Civil works, J-Power Plants, K-Buildings & R-Communications has been made for maintenance of works during construction period and losses on stock respectively.

12.1.9 Q-SPECIAL TOOLS AND PLANT

It is assumed that the work will be carried out through Contracts and not through departmental construction. Accordingly, provision for general purpose equipment and inspection vehicle only has been made as per CWC guidelines.

12.1.10 R-COMMUNICATION

Provision under this head covers the cost of new roads, widening/improvement of roads and strengthening of bridges. The costs of roads and bridges are based on the rate structure prevalent in the area of the Project, for the type of construction involved.

12.1.11 X-ENVIRONMENT AND ECOLOGY

Provision under this head has been taken as 2% of I -Works towards bio-diversity Conservation, creation of Green Belt, Restoration of Construction Area, Catchment Area Treatment, Compensatory Afforestation etc

12.1.12 II-ESTABLISHMENT

Provision for establishment has been made at 8% of I-works minus B-Land for civil works.

12.1.13 III-TOOLS AND PLANTS

This provision is distinct from that under Q-Special T&P and is meant to cover cost of survey instruments, camp equipment and other small tools and plants. The outlay is provided at 1% of cost of I-works.

12.1.14 IV-SUSPENSE

No provision has been made under this head as all the outstanding suspense are expected to be cleared by adjustment to appropriate heads at completion of the project.

12.1.15 V-RECEIPTS AND RECOVERIES

Under this head, provision has been made for estimated recoveries by way of resale or transfer of equipment used in infrastructure works, DG set and Temporary buildings.

12.1.16 ELECTRICAL WORKS AND GENERATING PLANT

The cost of Generating Plant and Equipment is based on indigenous sources. The prices of auxiliary equipment and services are based on prevailing market prices/costs incurred at other ongoing or commissioned projects.

CHAPTER-13

ECONOMIC EVALUATION

CHAPTER - 13
ECONOMIC EVALUATION

13.0 ECONOMIC EVALUATION

The Project has been contemplated as a run-off the river scheme on river Indus. The project is estimated to cost Rs. 462.27 crores excluding IDC at June 2003 Price Level. Sale price of energy generated at powerhouse bus bars has been worked out as 5.30 Rs. per unit with free power to home state **(Table 13.2)** & Rs. 4.66 per unit without free power to home state **(Table 13.2-A).**

13.1 ECONOMIC JUSTIFICATION:

The energy generation of the project with an installed capacity of 3 X 15 MW has been estimated at 219.18 MU in a 90% dependable year.

13.2 COST ESTIMATES AND PHASING OF EXPENDITURES

The cost of construction of the project has been estimated at June 2003 price level with a construction schedule of 6 years including 1.5 years for Infrastructure works.

The estimated Present Day Cost of the project is Rs. 462.27 Crores without IDC at June 2003 Price level.

13.3 PHASING OF EXPENDITURE

The phasing of expenditure has been worked out on the basis of anticipated construction programme.

The phasing of expenditure without IDC for the present cost is shown as below:

Year	Estimated Cost at June 2003 P.L. (Rs. in Crores)
1st	46.23
2nd	64.72
3rd	92.45
4th	129.43
5th	69.34
6th	60.09
Net Cost	**462.27**

INTEREST DURING CONSTRUCTION (IDC)

Based upon above phasing of expenditure the interest during construction (IDC) have been calculated with 70:30 debt equity ratio and 10.0% interest on loan. **(Table 13.1)**

The estimated IDC with estimated present cost is Rs 65.18 Crores

COST OF ENERGY GENERATION

The cost of energy generation has been calculated for the annual energy generation in a 90% dependable year based upon following assumptions.

1.	Debt-equity ratio	70 : 30
2.	Annual interest rate on loan	10.0%
3.	Return on equity	16%
4.	Annual interest rate on working capital	10.0%
5.	O&M Charges	1.5% of Project Cost
6.	Free power to Home State	12% of the energy available after losses
7.	Depreciation considered	1/12th of loan amount during loan repayment period.

The levellised tariff of the Project at present day cost works out to be Rs. 4.30 Per Unit with free power to home state **(Table 13.3)** & Rs 3.78 per unit without free power to home state **(Table 13.3-A).**

TABLE-13.1

STATEMENT SHOWING IDC CALCULATION AT PRESENT DAY COST (JUNE 2003 LEVEL)

PRESENT DAY COST	**462.27**	**Crs.**				
Civil Works	**354.02**	**Crs.**	**Electrical Works**	**100.65**	**Crs.**	
INTEREST RATE PER ANNUM		**10%**	**Transmission cost**	**7.60**	**Crs.**	

(Rs. in Crs.)

Year	Present Day Cost	Amount Equity	Receivable Loan	I.D.C	Loan Outstanding at the end of year	Amount Equity	Receivable Loan (for the year)
1	2	3	4	5	6	7	8
1	46.23	46.23	0.00	0.00	0.00	46.23	0.00
2	64.72	64.72	0.00	0.00	0.00	64.72	0.00
3	92.45	47.29	45.16	1.10	46.27	47.29	46.27
4	129.43		129.43	11.10	186.80	0.00	140.53
5	69.34		69.34	22.15	278.29	0.00	91.49
6	60.09		60.09	30.83	369.21	0.00	90.93
Total	462.27	158.23	304.03	65.18		158.23	369.21

IDC	**65.18**	**Crs.**	**Equity**	**158.23**	**Crs.**
Net cost of the project	**527.45**	**Crs.**	**Loan**	**369.21**	**Crs.**

TABLE-13.2

UNIT COST OF ENERGY AT BUS BAR AT CURRENT PRICE LEVEL

(June 2003 P.L.)

(Based on 16% return on equity & 10% interest on loan, 10% interest on working capital)

1	Installed capacity			45	MW
2	Cost of the Project (Net)		Rs.	462.27	Crores
3	Interest During Construction		Rs.	65.18	Crores
4	Total Cost of Project (Including IDC)		Rs.	527.45	Crores
	a) Equity	30%	Rs.	158.23	Crores
	b) Loan	70%	Rs.	369.21	Crores
5	Annual Energy Generatior			219.18	MU
6	0.5% As Auxiliary Consumption of No. 5		0.50%	1.10	MU
7	Energy Available After Auxiliary Consumptio			218.08	MU
8	0.5% As Transformer Loss of No. 7		0.50%	1.09	MU
9	Energy Available After Transformer Loss			216.99	MU
10	Free Power to Home State		12%	26.04	MU
11	Energy Available After Allowing Free Powe			190.95	MU
12	Fixed and Running Charges				
A)	Capacity Charges				
a)	Interest on Loan		10.00%	35.38	Crores
b)	Depreciation Charges (Limited to 1/12 th of Loan Amount)			30.77	Crores
		SUB-TOTAL		66.15	Crores
B)	Energy Charges				
a)	O&M Charges		1.50%	7.91	Crores
b)	Return on Equity		16.00%	25.32	Crores
		SUB-TOTAL		33.23	Crores
c)	Interest on Working Capital		10.00%	1.75	Crores
I)	O&M Charges for 1 month		0.66		
II)	2 Months Average Billing		16.86		
	TOTAL		Rs.	101.13	Crores
13	Sale Price at Bus Bar/Unit			5.30	Rs.
14	Cost of Generation at Bus Bar/Unit (Without Allowing Free Power to Home State and Return on Equity)			3.49	Rs.

Note : This unit rate is excluding water cess, income tax incentive, penalties etc

TABLE-13.2 A

UNIT COST OF ENERGY AT BUS BAR AT CURRENT PRICE LEVEL (June 2003 P.L.) WITHOUT FREE POWER TO HOME STATE

(Based on 16% return on equity & 10% interest on loan, 10% interest on working capital)

1	Installed capacity			45	MW
2	Cost of the Project (Net)		Rs.	462.27	Crores
3	Interest During Construction		Rs.	65.18	Crores
4	Total Cost of Project (Including IDC)		Rs.	527.45	Crores
	a) Equity	30%	Rs.	158.23	Crores
	b) Loan	70%	Rs.	369.21	Crores
5	Annual Energy Generation			219.18	MU
6	0.5% As Auxiliary Consumption of No. 5		0.50%	1.10	MU
7	Energy Available After Auxiliary Consumptio			218.08	MU
8	0.5% As Transformer Loss of No. 7		0.50%	1.09	MU
9	Energy Available After Transformer Loss			216.99	MU
10	Free Power to Home State		0%	0.00	MU
11	Energy Available After Allowing Free Powe			216.99	MU
12	Fixed and Running Charges				
A)	Capacity Charges				
a)	Interest on Loan		10.00%	35.38	Crores
b)	Depreciation Charges (Limited to 1/12 th of Loan Amount)			30.77	Crores
	SUB-TOTAL			66.15	Crores
B)	Energy Charges				
a)	O&M Charges		1.50%	7.91	Crores
b)	Return on Equity		16.00%	25.32	Crores
	SUB-TOTAL			33.23	Crores
c)	Interest on Working Capital		10.00%	1.75	Crores
I)	O&M Charges for 1 month		0.66		
II)	2 Months Average Billing		16.86		
	TOTAL		Rs.	101.13	Crores
13	Sale Price at Bus Bar/Unit			4.66	Rs.
14	Cost of Generation at Bus Bar/Unit (Without Allowing Free Power to Home State and Return on Equity)			3.49	Rs.

Note : This unit rate is excluding water cess, income tax incentive, penalties etc

TABLE-13.3

DUMKER H. E. PROJECT,J&K, (3 X 15 MW)
CALCULATION OF ENERGY RATE WITH PRESENT COST (JUNE 2003 PRICE LEVEL) AS PER TARIFF NOTIFICATION

Annual Generation in a 90% dependable year			219.18 MU	O&M Charges	1.50%
Annual Generation after allowing losses & free				Rate of increase of O&M Charges after 1st Year (Compounded)	6%
power to home state in a 90% dependable year			190.95 MU	Interest rate on Loan	10.0%
Total cost including IDC		Rs.	527.45 Crores	Interest rate on Working Capital	10.00%
	Equity 30%	Rs.	158.23 Crores	Return on Equity	16%
	Loan 70%	Rs.	369.21 Crores	Discounting rate	12%

YEAR	CAPACITY CHARGES (Rs.in Cr.)				(Rs.in Cr.)						CHARGES PER UNIT (Rs. per Unit)			Discounting Factor	Discounted Tariff (Paisa per Unit)
	Out-standing Loan (Rs.in Cr.)	Interest on loan	Depre-ciation	Total	Return on equity	O&M Charges	Interest on Working Capital: O&M for 1 month	Interest on Working Capital: 2 months Average Billing	Interest on Working Capital: Interest	Total	Capacity charges	Energy charges	Total		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	369.21	35.38	30.77	66.15	25.32	7.91	0.66	16.86	1.75	34.98	3.46	1.83	5.30	1.0000	5.30
2	338.45	32.31	30.77	63.07	25.32	8.39	0.70	16.41	1.71	35.42	3.30	1.85	5.16	0.8929	4.61
3	307.68	29.23	30.77	60.00	25.32	8.89	0.74	15.98	1.67	35.88	3.14	1.88	5.02	0.7972	4.00
4	276.91	26.15	30.77	56.92	25.32	9.42	0.79	15.55	1.63	36.37	2.98	1.90	4.89	0.7118	3.48
5	246.14	23.08	30.77	53.84	25.32	9.99	0.83	15.12	1.60	36.90	2.82	1.93	4.75	0.6355	3.02
6	215.37	20.00	30.77	50.77	25.32	10.59	0.88	14.71	1.56	37.46	2.66	1.96	4.62	0.5674	2.62
7	184.61	16.92	30.77	47.69	25.32	11.22	0.94	14.29	1.52	38.06	2.50	1.99	4.49	0.5066	2.28
8	153.84	13.85	30.77	44.61	25.32	11.90	0.99	13.89	1.49	38.70	2.34	2.03	4.36	0.4523	1.97
9	123.07	10.77	30.77	41.54	25.32	12.61	1.05	13.49	1.45	39.38	2.18	2.06	4.24	0.4039	1.71
10	92.30	7.69	30.77	38.46	25.32	13.37	1.11	13.09	1.42	40.10	2.01	2.10	4.11	0.3606	1.48
11	61.54	4.62	30.77	35.38	25.32	14.17	1.18	12.71	1.39	40.88	1.85	2.14	3.99	0.3220	1.29
12	30.77	1.54	30.77	32.31	25.32	15.02	1.25	12.33	1.36	41.69	1.69	2.18	3.88	0.2875	1.11
13	0.00	0.00	4.59	4.59	25.32	15.92	1.33	7.79	0.91	42.15	0.24	2.21	2.45	0.2567	0.63
14		0.00	4.59	4.59	25.32	16.88	1.41	7.95	0.94	43.13	0.24	2.26	2.50	0.2292	0.57
15			4.59	4.59	25.32	17.89	1.49	8.13	0.96	44.17	0.24	2.31	2.55	0.2046	0.52
16			4.59	4.59	25.32	18.96	1.58	8.31	0.99	45.27	0.24	2.37	2.61	0.1827	0.48
17			4.59	4.59	25.32	20.10	1.67	8.50	1.02	46.43	0.24	2.43	2.67	0.1631	0.44
18			4.59	4.59	25.32	21.30	1.78	8.71	1.05	47.67	0.24	2.50	2.74	0.1456	0.40
19			4.59	4.59	25.32	22.58	1.88	8.93	1.08	48.98	0.24	2.57	2.81	0.1300	0.36
20			4.59	4.59	25.32	23.94	1.99	9.16	1.12	50.37	0.24	2.64	2.88	0.1161	0.33
21			4.59	4.59	25.32	25.37	2.11	9.40	1.15	51.84	0.24	2.71	2.96	0.1037	0.31
22			4.59	4.59	25.32	26.90	2.24	9.67	1.19	53.40	0.24	2.80	3.04	0.0926	0.28
23			4.59	4.59	25.32	28.51	2.38	9.94	1.23	55.06	0.24	2.88	3.12	0.0826	0.26
24			4.59	4.59	25.32	30.22	2.52	10.23	1.28	56.81	0.24	2.98	3.22	0.0738	0.24
25			4.59	4.59	25.32	32.03	2.67	10.54	1.32	58.67	0.24	3.07	3.31	0.0659	0.22
26			4.59	4.59	25.32	33.96	2.83	10.87	1.37	60.64	0.24	3.18	3.42	0.0588	0.20
27			4.59	4.59	25.32	35.99	3.00	11.22	1.42	62.73	0.24	3.29	3.53	0.0525	0.19
28			4.59	4.59	25.32	38.15	3.18	11.59	1.48	64.95	0.24	3.40	3.64	0.0469	0.17
29			4.59	4.59	25.32	40.44	3.37	11.98	1.54	67.29	0.24	3.52	3.76	0.0419	0.16
30			4.59	4.59	25.32	42.87	3.57	12.39	1.60	69.78	0.24	3.65	3.89	0.0374	0.15
31			4.59	4.59	25.32	45.44	3.79	12.83	1.66	72.42	0.24	3.79	4.03	0.0334	0.13
32			4.59	4.59	25.32	48.17	4.01	13.30	1.73	75.22	0.24	3.94	4.18	0.0298	0.12
33			4.59	4.59	25.32	51.06	4.25	13.79	1.80	78.18	0.24	4.09	4.33	0.0266	0.12
34			4.59	4.59	25.32	54.12	4.51	14.32	1.88	81.32	0.24	4.26	4.50	0.0238	0.11
35			4.59	4.59	25.32	57.37	4.78	14.87	1.97	84.65	0.24	4.43	4.67	0.0212	0.10
												TOTAL		9.1566	39.34
														(A)	(B)

Note: The charges per unit is exclusive of water cess, spares, incentive & Income Tax etc.

Levellised Tariff =(B)/(A) 4.30

TABLE-13.3 A

DUMKER H. E. PROJECT,J&K, (3 X 15 MW)
CALCULATION OF ENERGY RATE WITH PRESENT COST (JUNE 2003 PRICE LEVEL) AS PER TARIFF NOTIFICATION
WITHOUT FREE POWER TO HOME STATE

Annual Generation in a 90% dependable year			219.18 MU	O&M Charges	1.50%
Annual Generation after allowing losses				Rate of increase of O&M Charges after 1st Year (Compounded)	6%
in a 90% dependable year			216.99 MU	Interest rate on Loan	10.0%
Total cost including IDC		Rs.	527.45 Crores	Interest rate on Working Capital	10.00%
	Equity 30%	Rs.	158.23 Crores	Return on Equity	16%
	Loan 70%	Rs.	369.21 Crores	Discounting rate	12%

YEAR	CAPACITY CHARGES (Rs.in Cr.)				(Rs.in Cr.)						CHARGES PER UNIT (Rs. per Unit)			Discounting Factor	Discounted Tariff (Paisa per Unit)
	Out-standing Loan (Rs.in Cr.)	Interest on loan	Depre-ciation	Total	Return on equity	O&M Charges	Interest on Working Capital: O&M for 1 month	Interest on Working Capital: 2 months Average Billing	Interest on Working Capital: Interest	Total	Capacity charges	Energy charges	Total		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	369.21	35.38	30.77	66.15	25.32	7.91	0.66	16.86	1.75	34.98	3.05	1.61	4.66	1.0000	4.66
2	338.45	32.31	30.77	63.07	25.32	8.39	0.70	16.41	1.71	35.42	2.91	1.63	4.54	0.8929	4.05
3	307.68	29.23	30.77	60.00	25.32	8.89	0.74	15.98	1.67	35.88	2.76	1.65	4.42	0.7972	3.52
4	276.91	26.15	30.77	56.92	25.32	9.42	0.79	15.55	1.63	36.37	2.62	1.68	4.30	0.7118	3.06
5	246.14	23.08	30.77	53.84	25.32	9.99	0.83	15.12	1.60	36.90	2.48	1.70	4.18	0.6355	2.66
6	215.37	20.00	30.77	50.77	25.32	10.59	0.88	14.71	1.56	37.46	2.34	1.73	4.07	0.5674	2.31
7	184.61	16.92	30.77	47.69	25.32	11.22	0.94	14.29	1.52	38.06	2.20	1.75	3.95	0.5066	2.00
8	153.84	13.85	30.77	44.61	25.32	11.90	0.99	13.89	1.49	38.70	2.06	1.78	3.84	0.4523	1.74
9	123.07	10.77	30.77	41.54	25.32	12.61	1.05	13.49	1.45	39.38	1.91	1.81	3.73	0.4039	1.51
10	92.30	7.69	30.77	38.46	25.32	13.37	1.11	13.09	1.42	40.10	1.77	1.85	3.62	0.3606	1.31
11	61.54	4.62	30.77	35.38	25.32	14.17	1.18	12.71	1.39	40.88	1.63	1.88	3.51	0.3220	1.13
12	30.77	1.54	30.77	32.31	25.32	15.02	1.25	12.33	1.36	41.69	1.49	1.92	3.41	0.2875	0.98
13	0.00	0.00	4.59	4.59	25.32	15.92	1.33	7.79	0.91	42.15	0.21	1.94	2.15	0.2567	0.55
14	0.00	0.00	4.59	4.59	25.32	16.88	1.41	7.95	0.94	43.13	0.21	1.99	2.20	0.2292	0.50
15	0.00	0.00	4.59	4.59	25.32	17.89	1.49	8.13	0.96	44.17	0.21	2.04	2.25	0.2046	0.46
16	0.00	0.00	4.59	4.59	25.32	18.96	1.58	8.31	0.99	45.27	0.21	2.09	2.30	0.1827	0.42
17	0.00	0.00	4.59	4.59	25.32	20.10	1.67	8.50	1.02	46.43	0.21	2.14	2.35	0.1631	0.38
18	0.00	0.00	4.59	4.59	25.32	21.30	1.78	8.71	1.05	47.67	0.21	2.20	2.41	0.1456	0.35
19	0.00	0.00	4.59	4.59	25.32	22.58	1.88	8.93	1.08	48.98	0.21	2.26	2.47	0.1300	0.32
20	0.00	0.00	4.59	4.59	25.32	23.94	1.99	9.16	1.12	50.37	0.21	2.32	2.53	0.1161	0.29
21	0.00	0.00	4.59	4.59	25.32	25.37	2.11	9.40	1.15	51.84	0.21	2.39	2.60	0.1037	0.27
22	0.00	0.00	4.59	4.59	25.32	26.90	2.24	9.67	1.19	53.40	0.21	2.46	2.67	0.0926	0.25
23	0.00	0.00	4.59	4.59	25.32	28.51	2.38	9.94	1.23	55.06	0.21	2.54	2.75	0.0826	0.23
24	0.00	0.00	4.59	4.59	25.32	30.22	2.52	10.23	1.28	56.81	0.21	2.62	2.83	0.0738	0.21
25	0.00	0.00	4.59	4.59	25.32	32.03	2.67	10.54	1.32	58.67	0.21	2.70	2.92	0.0659	0.19
26	0.00	0.00	4.59	4.59	25.32	33.96	2.83	10.87	1.37	60.64	0.21	2.79	3.01	0.0588	0.18
27	0.00	0.00	4.59	4.59	25.32	35.99	3.00	11.22	1.42	62.73	0.21	2.89	3.10	0.0525	0.16
28	0.00	0.00	4.59	4.59	25.32	38.15	3.18	11.59	1.48	64.95	0.21	2.99	3.20	0.0469	0.15
29	0.00	0.00	4.59	4.59	25.32	40.44	3.37	11.98	1.54	67.29	0.21	3.10	3.31	0.0419	0.14
30	0.00	0.00	4.59	4.59	25.32	42.87	3.57	12.39	1.60	69.78	0.21	3.22	3.43	0.0374	0.13
31	0.00	0.00	4.59	4.59	25.32	45.44	3.79	12.83	1.66	72.42	0.21	3.34	3.55	0.0334	0.12
32	0.00	0.00	4.59	4.59	25.32	48.17	4.01	13.30	1.73	75.22	0.21	3.47	3.68	0.0298	0.11
33	0.00	0.00	4.59	4.59	25.32	51.06	4.25	13.79	1.80	78.18	0.21	3.60	3.81	0.0266	0.10
34	0.00	0.00	4.59	4.59	25.32	54.12	4.51	14.32	1.88	81.32	0.21	3.75	3.96	0.0238	0.09
35	0.00	0.00	4.59	4.59	25.32	57.37	4.78	14.87	1.97	84.65	0.21	3.90	4.11	0.0212	0.09
												TOTAL		9.1566	34.62
														(A)	(B)

Note: The charges per unit is exclusive of water cess, spares, incentive & Income Tax etc.

Levellised Tariff =(B)/(A) 3.78

APPENDIX-1

A - PRELIMINARY

Sl. No.	DESCRIPTION	UNIT	QTY	RATE (Rs.)	AMOUNT (Rs. in lacs)
	Expenditure incurred for Preparation of PFR				14.00
1	Topographical surveys				15.00
2	Hydrological and meteorological survey				10.00
3	Drilling				10.00
4	Drifting				6.00
5	Geological and Geophysical investigation				4.00
6	Construction material survey				10.00
7	Investigation for foundation and rock testing				20.00
8	Hydraulic model studies				80.00
9	Preperation and Printing of project report				3.00
10	Computer & telecommunication facilities				20.00
11	Instrument and equipment for S & I works				25.00
12	Inspection vehicles				20.00
13	Camping Equipments				2.00
14	Preliminary soil test and soil test labs				5.00
15	Cosutancy for perliminary design				150.00
16	Training of Engineers during investigation				3.00
17	Seismological observation @ 2.5 lacs/year for 4 years				10.00
18	Ground water studies				5.00
19	Environment & Ecological studies				25.00
				Grand total	**437.00**

B - LAND

S. No.	Name of Project Component	Quantity	Unit	Rate in Rs. (lacs)	Amount (Rs. In Lakhs)
A.	**Land Acquisition:**				
1.	Dam submergence area, Colony and Construction facilities etc.				
	Government Land Leased	380.0	Ha	3.20	1216.00
(b)	Agriculture land	6.0	Ha	4.0	24.00
				Total	**1240.00**
C	Cost of Establishment for land acquisition and Compensation @ 6.25% of Item A & B				77.50
D	Solatium charges @ 30% of the cost of Private Land				7.20
E	Interest charges on amount of award for the period between taking over possession of land and date of award @ 12% per annum on 25% of cost of total compensation for 2 years				74.40
F	Legal charges @ 1% of total compensation				12.40
G	Labour and material required for measurement & demarcation of land/Properties @ 1% of cost of land Acquisition				12.40
				Total	**1423.90**

ABSTRACT OF COST OF C - WORKS

S. N.	Description	Amount (Rs. In Lakhs)		
		CIVIL	**HM**	**TOTAL**
1.	Diversion Tunnel	4051.95	279.30	4331.25
2.	Coffer Dam	1272.96		1272.96
3.	Concrete Dam	2624.98	213.41	2838.39
4.	Spillway	6801.81	1316.18	8117.99
	TOTAL	14751.70	1808.89	16560.59
	ADD FOR WORKS TAX @4.2%	619.57	75.97	695.54
	GRAND TOTAL	**15371.27**	**1884.86**	**17256.13**

DIVERSION TUNNEL

S. No.	Description	Unit	Qty.	Rate	Amount (Rs. in Lakhs)
1	**Surface Excavation**				
1.1	Common excavation	Cum	7,000	125	8.75
1.2	Rock excavation	Cum	26,000	300	78.00
2	**Underground excavation**	Cum	105,000	1000	1050.00
3	**Rock Support System**				
3.1	Rockbolts	M	40,000	400	160.00
3.2	Steel Rib Supports	MT	310	42000	130.20
3.3	Shotcrete	Cum	3,200	4000	128.00
4	**Concrete**				
4.1	Concrete lining M-20	Cum	31,300	4000	1252.00
4.2	M-15	Cum	3,000	2930	87.90
4.3	M-20	Cum	2,000	3390	67.80
4.4	M-25	Cum	9,000	3610	324.90
5	**Reinforcement**	MT	750	27000	202.50
				Sub total A	**3490.05**
6	Miscellaneous and ancillary works @ 7.5% of sub-total A		7.50%		261.75
				Sub total B	**3751.80**
7	Instrumentation @ 1% of sub-total B		1.00%		37.52
8	Dewatering @ 2% of sub total B		2.00%		75.04
9	Contingency @ 3% of sub-total B		3.00%		112.55
10	Work Charged establishment @ 2% of Sub-total B		2.00%		75.04
	Total civil works				**4051.95**

COFFER DAM

S. No.	Description	Unit	Qty.	Rate	Amount (In Lakhs)
1	**Surface Excavation**				
1.1	Common excavation	Cum	5,000	125	6.25
2	**Embankment Construction**				
2.1	Earth/ Rockfill	Cum	265,000	342	906.30
2.2	Impervious Core	Cum	45,000	354	159.30
2.3	Filter	Cum	9,500	901	85.60
3	**Concrete**				
3.1	M-10	Cum	600	2560	15.36
				Sub Total(A)	**1172.81**
4	Miscellaneous and ancillary works @ 0.50% of sub-total A		0.50%		5.86
				Sub Total(B)	**1178.67**
5	Dewatering @ 3% of sub total-B		3.00%		35.36
6	Contingency @ 3% of sub-total-B		3.00%		35.36
7	Work Charged establishment @ 2% of Sub-total-B		2.00%		23.57
				Total civil works	**1272.96**

CONCRETE DAM

S. No.	Description	Unit	Quantity	Rate	Amount (Rs. in Lakhs)
1	**Surface Excavation**				
1.1	Common excavation	Cum	47,000	125	58.75
1.2	Rock excavation	Cum	10,000	300	30.00
2	**Rock Support system**				
2.1	Rock bolts	M	300	400	1.20
3	**Concrete**				
3.1	M-15	cum	60,500	2930	1772.65
3.2	M-20	cum	2,000	3390	67.80
3.3	M-25	cum	6,000	3610	216.60
4	Reinforcement steel	MT	750	27000	202.50
				Sub Total(A)	**2349.50**
5	Miscellaneous and ancillary works @ 2.5% of sub-total A		2.5%		58.74
				Sub-Total(B)	**2408.24**
6	Instrumentation @ 1% of sub-total B		1%		24.08
7	Dewatering @ 3% of sub total B		3%		72.25
8	Contingency @ 3% of sub-total B		3%		72.25
9	Work Charged establishment @ 2% of Sub-total B		2%		48.16
	Total civil works				**2624.98**

SPILLWAYS &STILLING BASIN

S. No.	Description	Unit	Quantity	Rate	Amount (Rs. in Lakhs)
1	**Surface Excavation**				
1.1	Common excavation	Cum	96,000	125	120.00
1.2	Rock excavation	Cum	85,000	300	255.00
2	**Concrete**				
2.1	M-15	Cum	54,500	2930	1596.85
2.2	M-20	Cum	22,000	3390	745.80
2.2	M-25	Cum	49,500	3610	1786.95
3	**Reinforcement steel**	MT	6,250	27000	1687.50
	Rock Support System				
4	Rock Bolts	M	3,200	400	12.80
				Sub Total (A)	**6204.90**
5	Various Miscellaneous works like wire mesh/steel fibre reinforcement, drilling & grouting, PVC pipes, water stops, other steel works, slope protection works, road works, architectural works for dam etc @ 2.5% of sub-total A		1.5%		93.07
				Sub-Total (B)	**6297.97**
6	Instrumentation @ 1% of sub-total B		1%		62.98
7	Dewatering @ 3% of sub total B		2%		125.96
8	Contingency @ 3% of sub-total B		3%		188.94
9	Work Charged establishment @ 2% of Sub-total except of lump-sum items B		2%		125.96
				Total civil works	**6801.81**

J -POWER PLANT APPURTENANCES (CIVIL WORKS)

S. No.	Description	Amount (Rs. in Lakhs) CIVIL	HM	TOTAL
1	Power House Complex	6650.84	442.58	7093.41
	Total	**6650.84**	**442.58**	**7093.41**
	Add For Works Tax @ 4.2%	279.34	18.59	297.92
	GRAND TOTAL	**6930.18**	**461.16**	**7391.34**

POWER HOUSE COMPLEX
(INCLUDING CELLULAR WALL)

S. No.	Description	Unit	Quantity	Rate	Amount (Rs. in Lakhs)
1	**Under ground excavation**				
1.1	Comman excavation	Cum	70,000	125	87.50
1.2	Rock excavation	Cum	180,000	300	540.00
2	**Supports System**				
2.1	Rockbolts	m	3,000	400	12.00
2.2	Shotcrete	Cum	500	4000	20.00
3	**Concrete**				
3.1	M15	Cum	35,000	2930	1025.50
3.2	M25	Cum	65,000	3610	2346.50
4	**Reinforcement Steel**	MT	6,400	27000	1728.00
5	**Structural Steel for roof trusses etc.**	MT	175	42000	73.50
6	**Stone/Brick Masonry**	Cum	3,000	2000	60.00
				Sub Total(A)	**5893.00**
7	Miscellaneous and ancillary works @4.5% of sub-total A		4.5%		265.2
				Sub Total(B)	**6158.19**
8	Instrumentation @ 1% of sub-total B		1%		61.58
9	Dewatering @ 2% of sub total B		2%		123.16
10	Contingency @ 3% of sub-total B		3%		184.75
11	Work Charged establishment @ 2% of Sub-total B		2%		123.16
				Total Civil Cost	**6650.84**

DHUMKAR HE PROJECT

SR. NO.		WEIGHT(T)	NOS/SET	Qty	Rate in Rs.	Amount in Lacs
1	**SPILLWAY RADIAL GATE**					
a	RADIAL GATE	86	4	344	100000	344.00
b	EMBEDDED PARTS	52	4	208	50000	104.00
c	HYDRAULIC HOISTCAPACITY (2X125T)	L.S.	4	LS	10000000	400.00
d	POWERPACK	L.S.	4	LS	1800000	72.00
e	GASOLINE OPERATED POWER PACK	L.S.	1	LS	7500000	75.00
f	STOPLOGS	80	1	80	60000	48.00
g	EMBEDDED PARTS INCLUDING HATCH COVERS	20	4	80	50000	40.00
h	STORAGE VENT WITH COVER	5	1	5	50000	2.50
i	GANTRY CRANE (35 T CAPACITY)	L.S.	1	LS	3500000	35.00
j	LIFTING BEAM	6	1	6	50000	3.00
k	ARMAC & COMPUTER CONTROL INSTRUMENTATION	L.S.	1	LS	10000000	100.00
l	DG SET (225KVA)	L.S.	1	LS	1500000	15.00
m	ARRANGEMENT FOR DEICING	L.S.	1	LS	1500000	15.00
2	**INTAKE**					
a	FIXED WHEEL GATE	10	3	30	60000	18.00
b	FIXED WHEEL GATE EMBEDDED PARTS	5	3	15	100000	15.00
c	HYDRAULIC HOISTCAPACITY 20 T	L.S.	3	LS	600000	33.00
d	POWER PACK	L.S.	3	LS	500000	
e	TRASHRACK	30	3	90	50000	45.00
f	EMBEDDED PARTS	16	3	48	50000	24.00
g	BONNET COVER	7.5	3	22.5	50000	11.25
h	ARRANGEMENT FOR DEICING	L.S.	1	LS	600000	6.00
i	BULKHEAD GATE	10	3	30	60000	18.00
j	EMBEDDED PARTS	4	3	12	50000	6.00
k	ROPE DRUM HOISTCAPACITY 12 T	6	3	18	100000	18.00
l	HOIST SUPPORTING STRUCTURE	4	3	12	50000	6.00
m	ARRANGEMENT FOR DEICING	L.S.	1	LS	300000	3.00
3	**PENSTOCK (ASTM A537 CL.1)**	150	3	450	70000	315.00

SR. NO.		WEIGHT(T)	NOS/SET	Qty	Rate in Rs.	Amount in Lacs
1	**SPILLWAY RADIAL GATE**					
4	**DRAFT TUBE GATE**					
a	SLIDE TYPE GATE	15	6	90	60000	54.00
b	EMBEDDED PARTS	4.5	6	27	50000	13.50
c	GANTRY CRANE(30 T CAPACITY)	L.S.	1	LS	3000000	30.00
d	LIFTING BEAM	6	1	6	50000	3.00
e	ARRANGEMENT FOR DEICING	L.S.	1	LS	600000	6.00
5	**DIVERSION TUNNEL**					
a	DIVERSION TUNNELGATE	35	4	140	60000	84.00
b	EMBEDDED PARTS	15	4	60	50000	30.00
c	ROPE DRUM HOISTCAPACITY 77 T	27	4	108	100000	108.00
d	HOIST SUPPORTING STRUCTURE	22	4	88	50000	44.00
					Total	2144.25
	Add 5% for spares, contingencies and valves					107.2125
					Total	2251.46
	Add Works tax @ 4.2%					94.56143
					Grand total	**2346.02**

DUMKHAR HE PROJECT
COST ESTIMATE OF E&M WORKS

Generator, Turbine and Accessories

S.No.	Item Particulars	Qty	Unit	Rate	Amount	Excise Duty*		Total
					(Rs Lcs)	Rate	Amount	(Rs Lcs)
1	2	3	3(a)	4	5	6	7	5+7
1	(a) Generating units and Bus Ducts 3 X 15 MW, 214.28 rpm, Head 27.83meters	3	no.	12000 Rs/KW	5400.00	16	864.00	6264.00
2	Step up transformer 11/66 KV, 6.11 MVA, single phase	10	no.	350 Rs/KVA	213.85	16	34.216	248.066
3	Step Down transformer 66/11 KV, 5MVA, three phase	1	no.	350 Rs/KVA	17.5	16	2.8	20.30
4	Auxiliary Electrical Equipment for Power Stations (Except Transformer) (5% of item 1)				270	16	43.2	313.20
5	Auxiliary Equipment & Services for Power stations (5% of Item 1)				270	16	43.2	313.20
6	Switchyard (66KV)	7	bays	50 lacs/bay	350.00	16	56.00	406.00
7	Spares (5% of item 1 and 3% of item 2 to 6)				303.64	16	48.58	352.22
8	**Subtotal(1-7)**							**7916.99**
9	Central Sales tax** 4% of item 8							316.68
10	Transportation & Insurance 6% of item 8							475.02
11	Erection & commissioning 8% of item 7 except spares							605.18
12	**Subtotal (8-11)**							**9313.87**
13	Establishment, Contingency, other charges 11% of Item 12 Excluding taxes & duties							750.75
	GRAND TOTAL (In Lacs)							**10064.62**

DUMKHAR HE PROJECT
COST ESTIMATE OF E&M WORKS
Power Evacuation system

S.No.	Item Particulars	Qty		Rate	Amount	Excise Duty*		Total
				(Rs Lcs)	(Rs Lcs)	Rate	Amount	(Rs Lcs)
1	2	3		4	5	6	7	5+7
1	1 nos. 66 kV Double circuit line of approx. 50 kms	50	km	10 lacs/km	500.00	16	80.00	580.00
2	Spares (3% of 1)				15	16	2.4	17.40
3	**Subtotal(1)**							**597.40**
4	Central Sales tax 4% of item 3							23.90
5	Transportation & Insurance 6% of item 3							35.84
7	Erection & commissioning 8% of item 3 except spares							46.40
8	**Subtotal(2)**							**703.54**
9	Establishment, Contingency, other charges 11% of Item 3 excluding duties							56.65
	GRAND TOTAL (In Lacs)							**760.19**

K - BUILDINGS

S. No.	Description	Unit	Plinth Area (Sqm.)	Rate (Rs.)	Amount (Rs. Lacs)
1	**Residential Buildings**				
i	C/o Permanent residential building	Sqm	6000	10000	600.00
ii	Charges for providing services of above @			31.0%	186.00
I	C/o Temporary residential building	Sqm.	3500	9000	315.00
II	Charges for providing services of above @			27.0%	85.05
	Total Residential Buildings				**1186.05**
2	**Non-Residential Buildings**				
i	C/o Permanent non-residential building	Sqm.	6000	9500	570.00
ii	Charges for providing services of above @			22.5%	128.25
I	C/o Temporary non-residential building	Sqm.	4000	8500	340.00
II	Charges for providing services of above @			20.5%	69.70
	Total Non-residential Buildings				**1107.95**
	Total (Residential + Non-Residential)				**2294.00**
	Works Tax and Surcharge @			4.20%	96.35
				Grand Total	**2390.35**

R - COMMUNICATION

S. No.	Description	Unit	Length	Rate	Amount
				(Rs. in lacs)	
1.	Road to colony	Km	10	60.00	600.00
2.	Bridge on Indus river	m	100	2.00	200.00
3	Road submergence and rerouting of Khalsi batalic Road	Km	2.5	60.00	150.00
				Total	**950.00**
	Add works tax @ 4.2%	#####			39.90
				Grand Total	**989.90**

DISTRIBUTION OF COST UNDER HEAD Q - SPECIAL T & P AND V - RECEIPT & RECOVERIES

	Cost (Rs. In lakhs)	Q	R&R
Cost of equipments excluding inspection vehicles	752.50	188.13	141.09
Cost of inspection vehicles	144.10	144.10	28.82
Provision under head Q - Spl. T&P		332.23	
	896.60		
Recoveries to be shown under V- Receipt and Recoveries			169.91

Q-Spl T&P for Infrastructure Development

Sl.No.	Description of equipment	Quantity (Nos.)	Rate (Rs in Lacs)	Amount (Rs in Lacs)
1	Loader cum Excavator, 1.0/0.25 cum.	1	19.80	19.80
2	Crawler Dozer, 100 FHP	2	55.00	110.00
3	Wheel Dozer, 130 FHP	1	58.00	58.00
4	Wheel loader, 2 Cum	1	33.00	33.00
5	Diamond Core Drill (Mechanical)	1	16.50	16.50
6	Diamond Core Drill (Hyd)	1	66.00	66.00
7	Air Track/Wagon Drill	2	16.50	33.00
8	Jack Hammer/Pavement Breaker	5	0.39	1.95
9	Compressed Air(cfm)	2000	0.0138	27.60
10	Mobile Crane, 10 t Pick & Carry	1	11.00	11.00
11	Mobile Crane, 20 t	1	77.00	77.00
12	Road Roller, 8/10 t	1	11.00	11.00
13	Snow Cutter	1	55.00	55.00
14	Dewatering Pump	L.S	11.00	11.00
15	Tipper 4.5/6.0 cum.	6	10.45	62.70
16	Truck, 10 t	6	8.25	49.50
17	Concrete Mixer, 14/10 cft	1	1.65	1.65
18	Explosive Van, 5 t	1	11.00	11.00
19	Water Tanker/Sprinkler, 10 KL	2	13.20	26.40
20	Petrol/Diesel Tanker, 10 KL	2	13.20	26.40
21	Bus/Mini Bus	4	8.80	35.20
22	Car/MUV	2	4.40	8.80
23	Jeep (Petrol/Diesel)	15	4.40	66.00
24	Ambulance	2	8.80	17.60
25	Workshop Equipt.	L.S	27.50	27.50
26	Fire Tender	1	16.50	16.50
27	Recovery Van	1	5.50	5.50
28	Pick up Van/L.C.V	2	5.50	11.00
			Total	**896.60**

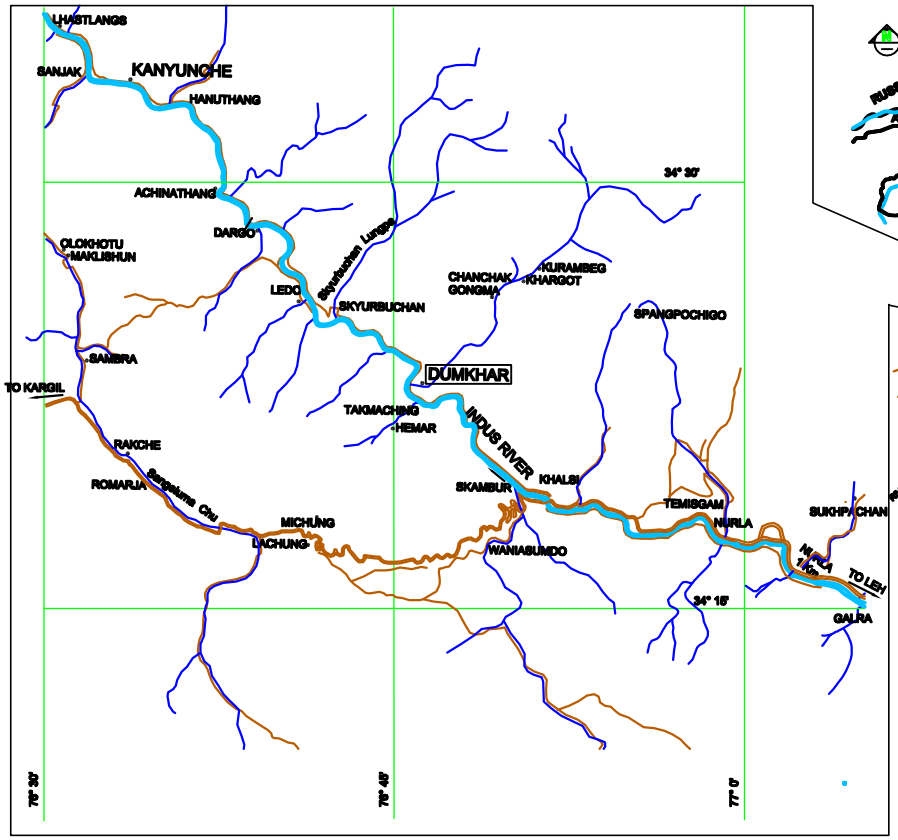
DISTRIBUTION OF COST UNDER HEAD Q - SPECIAL T & P AND V - RECEIPT & RECOVERIES

	Cost (Rs. In lakhs)	Q	R&R
Cost of equipments excluding inspection vehicles	752.50	188.13	141.09
Cost of inspection vehicles	144.10	144.10	28.82
Provision under head Q - Spl. T&P		332.23	
	896.60		
Recoveries to be shown under V- Receipt and Recoveries			169.91

V - RECEIPT & RECOVERIES

S. No.	Item	Amount (Rs. In Lakhs)
1.	Recovery from the Sale of Equipments	169.91
3.	Recovery from Temporary Building	121.46
	Total	**291.38**

APPENDIX-2

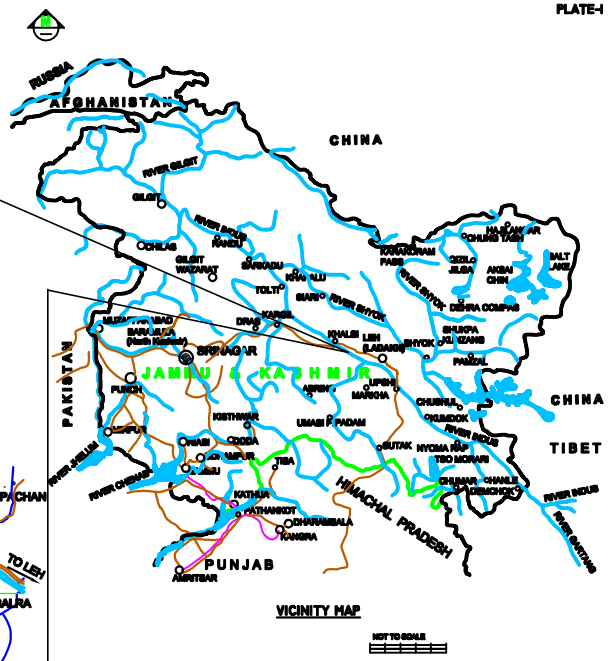


PROJECT LOCATION MAP

LEGEND
RIVER
METALLED ROADS
NALA

SCALE:-
0 2.5 7.5 KM.

PLATE-I



VICINITY MAP

NOT TO SCALE

LEGEND

1. INTERNATIONAL BOUNDARY.
2. STATE BOUNDARY
3. RIVER
4. ROAD
5. STATE HEADQUARTER
6. DISTRICT
7. OTHER TOWNS
8. RAILWAY LINE

नैशनल हाइड्रोइलेक्ट्रिक पावर कारपोरेशन
NATIONAL HYDROELECTRIC POWER CORPORATION LTD.

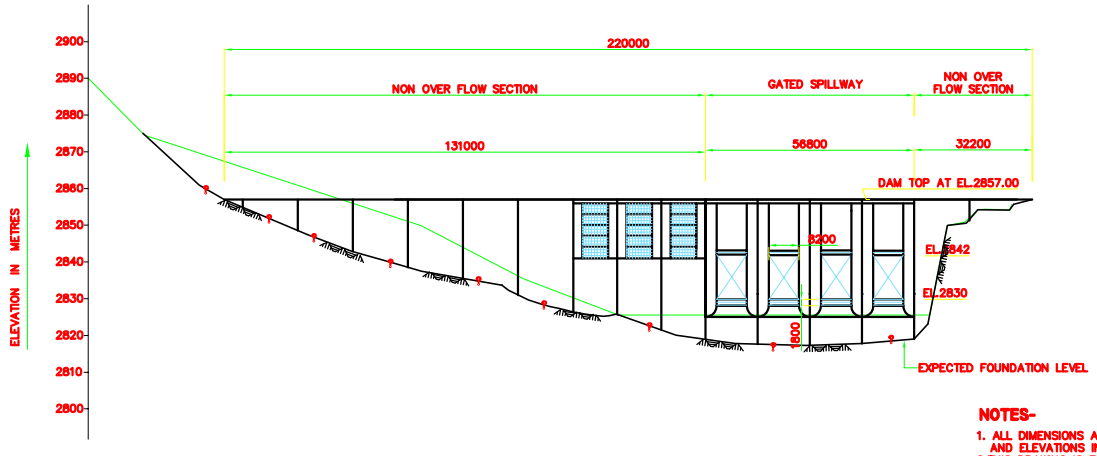
डमखार जलविद्युत परियोजना
DUMKHAR HYDROELECTRIC PROJECT

VICINITY MAP

	00	PRE FEASIBILITY REPORT STG.				
DATE		REVISION OR ISSUED	BY	CH.	APP.	DATE

DRG. NO.

PLATE–II



NOTES-

1. ALL DIMENSIONS ARE IN MILIMETRES AND ELEVATIONS IN METRE.
2. THIS DRAWING IS FOR PRE FEASIBILTY REPORT ONLY.

NOT TO SCALE

NATIONAL HYDROELECTRIC POWER CORPORATION LTD.

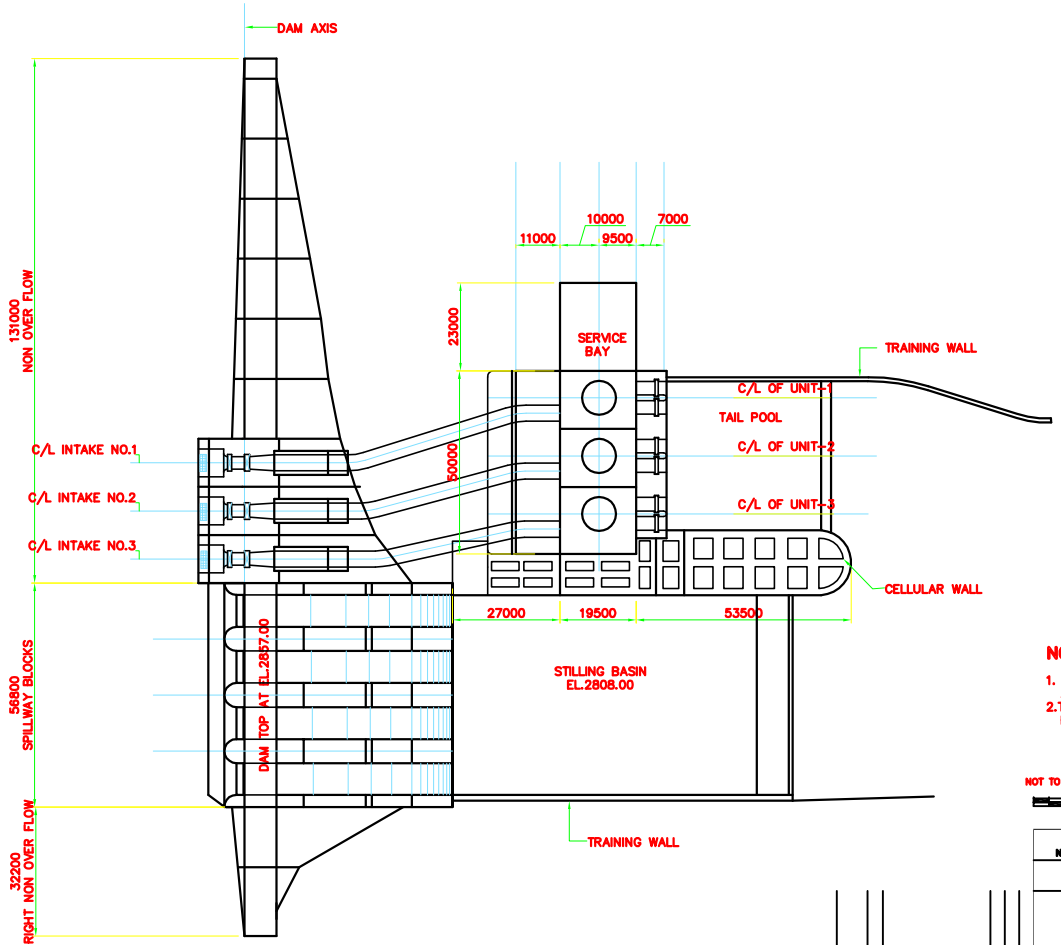
DUMKHAR HYDROELECTRIC PROJECT

DAM
UPSTREAM ELEVATION

NO.	DATE	REVISION OR ISSUED	BY	CHKD.
00				

Dwg. NO.

PLATE–III



NOTES-

1. ALL DIMENSIONS ARE IN MILIMETRES AND ELEVATIONS IN METRE.
2. THIS DRAWING IS FOR PRE FEASIBILTY REPORT ONLY.

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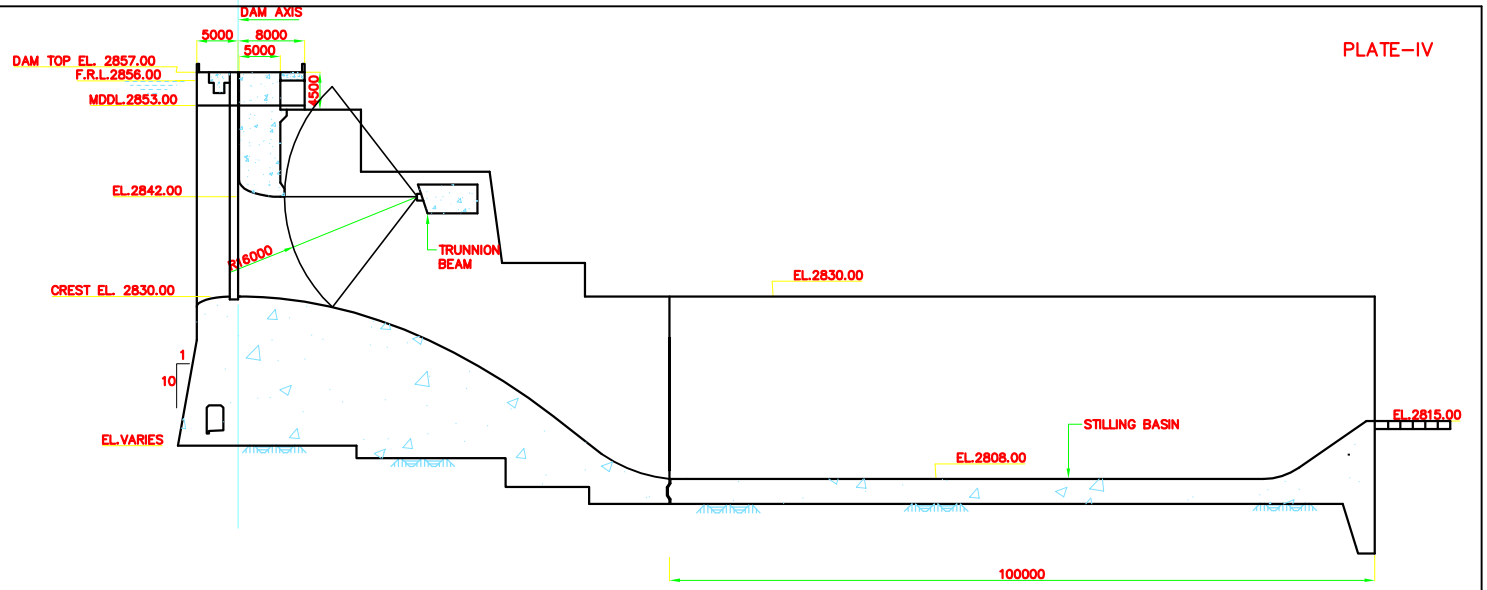
NATIONAL HYDROELECTRIC POWER CORPORATION LTD.

DUMKHAR HYDROELECTRIC PROJECT

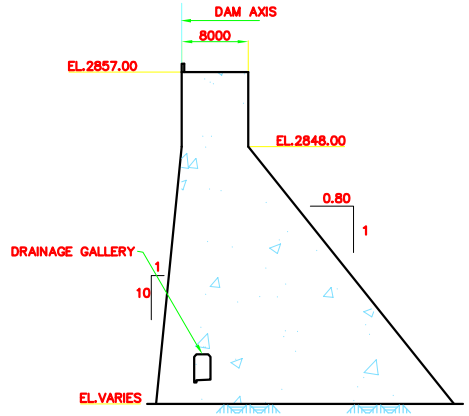
LAYOUT PLAN

DRG. NO.

PLATE–IV



OVER FLOW SECTION(TYP.)



NON OVER FLOW SECTION(TYP.)

NOTES-

1. ALL DIMENSIONS ARE IN MILIMETRES AND ELEVATIONS IN METRE.
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NATIONAL HYDROELECTRIC POWER CORPORATION LTD.

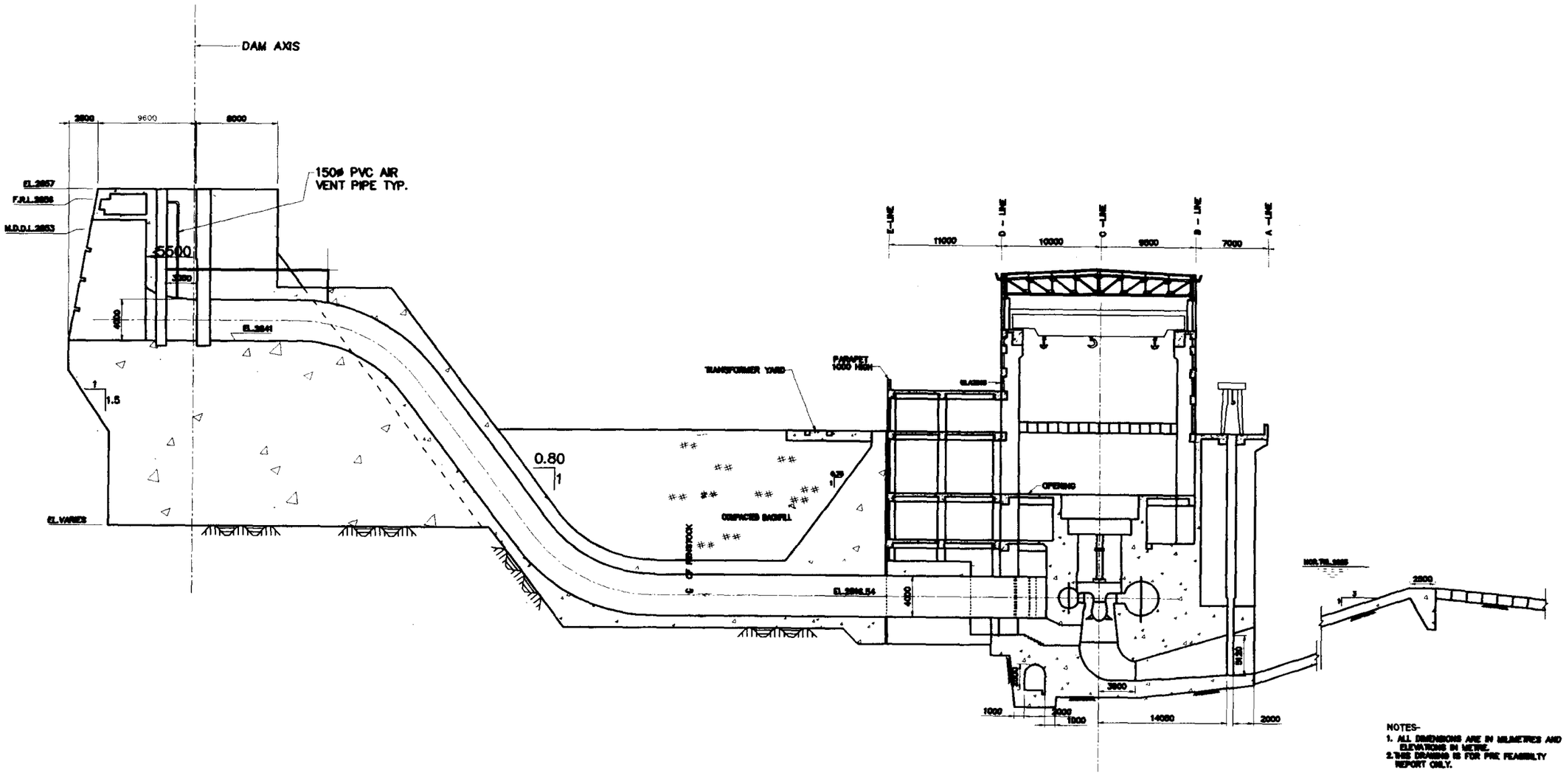
DUMKHAR HYDROELECTRIC PROJECT

DAM SECTIONS

NO.	DATE	REVISION OR ISSUED	BY	CHK'D	APP'D
00					

DRWG. NO.

PLATE–V



NOTES-
1. ALL DIMENSIONS ARE IN MILIMETRES AND ELEVATIONS IN METRE.
2. THIS DRAWING IS FOR PRE FEASIBILITY REPORT ONLY.

NOT TO SCALE

नैशनल हाइड्रोइलैक्ट्रिक पावर कारपोरेशन लि॰
NATIONAL HYDROELECTRIC POWER CORPORATION LTD.

दुमखार जलविद्युत परियोजना
DUMKHAR HYDROELECTRIC PROJECT

INTAKE AND POWER HOUSE CROSS SECTION

NO	ISSUED FOR CONSTRUCTION				DRAWN	SUBMITTED	RECOMMENDED	APPROVED
DATE	REVISION OR ISSUES	BY	CH.	APP.	DATE	DRG. NO.		

APPENDIX-3

Dumkhar Hydro Electric Scheme

Again about 35 kms downstream of Takmachung hydro electric scheme, the river Indus appears suitable for diversion of water with a small diversion weir at a site with river bed level as +2870 m. The waters diverted from the weir may be led into a 7.5 kms long tunnel to a power house enabling utilisation of a gross head of 70 m. The scheme may have an optimum generating capacity of about 130 MW affording a firm power of about 51 MW. An annual generation in 90% and 50% flow years may be of the order of 656 GWH and 721 GWH respectively.

APPENDIX-4

Central Electricity Authority
HP & I Division
403, Sewa Bhawan, RK Puram
New Delhi – 110066
****

No. 7/9/(NHPC)/2003/914 Dated 11-9-2003

To

Shri Bal Mukand,
Executive Director (Planning)
NHPC
Sector 33, Faridabad.

Sub : Summary Record of Discussions of meeting taken by CE (HP&I), CEA with NHPC on 11.9.2003 regarding PFRs of Hydro-electric projects in Indus basin.

****

Sir,

Please find enclosed herewith Summary Record of discussions of meeting taken by CE (HP&I), CEA with NHPC on 11.9.2003 regarding PFRs of Hydro-electric projects in Indus basin.

(TANMOY DAS)
Director

Copy to :

Shri Y.R. Pahuja, Chief Engineer, Nimoo Bazgo H.E. Project, Fort Road, Leh ,Ladakh.

Summary Record of discussions of meeting taken by Chief Engineer (HP&I), CEA with NHPC Officers on 11.9.2003 regarding PFR of Kanyunche & Dumkhar HE Projects in Indus Basin.

List of participants is enclosed.

Conceptual planning and general layout of two hydro electric projects viz., Kanyunche & Dumkhar HE projects located in Indus Basin was discussed in detail and summarized as under :

Kanyunche HE Project :

As per re-assessment studies carried out in CEA (based on desk studies) Kanyunche HE project envisaged construction of a diversion structure, 6 km long channel, a power house with installed capacity of 105MW. River bed level at dam site was +2720 m and tail race level was +2666m. NHPC officer stated that they have carried out reconnaissance survey of the site and it was observed that construction of channel is not feasible in the left bank as considered in earlier CEA studies because of steep hill slopes and scree material and would be desirable to have a dam toe power house alternative. NHPC have located suitable site for construction of dam at about 3 km upstream of village Hanuthang village. River bed level at dam site would be about 2766m. NHPC may proceed further with preparation of PFR as per their proposal. Cost of diversion of Khalsi – Batalik road may be included in the cost estimates.

2. **Dumkhar HE Project :**

As per re-assessment studies carried out in CEA (based on desk studies) Dumkhar project envisaged construction of a diversion structure, 7.5 km long tunnel, a power house with installed capacity of 130MW. River bed level at dam site was +2870 m and tail race level was +2800m. NHPC officer stated that it would be better to consider a dam to power house. NHPC have located suitable site for construction of dam at about 7 km upstream of village Achinthang village. River bed level at dam site would be about 2825m. NHPC may proceed further with preparation of PFR as per their proposal. Cost of diversion of Khalsi – Batalik road, agricultural land may be included in the cost estimates.

3. Hydro power development between Khalsi and Kanyunche sites were discussed in general. Chief Engineer (HP&I) mentioned that effort should be make to utilize the head available between these two sites as far as possible. Constraints, if any, may be discussed in the PFR in detail.

4. Recommendation for further studies at FR/DPR stage may also be listed in the PFR.

5. Regarding site visit, Chief Engineer (HP&I) mentioned that the same could be undertaken after development of design parameters/features of the project.

List of participants
S/Shri
Central Electricity Authority
S.M. Dhiman., Chief Engineer (HP&I)
Tanmoy Das, Director(HP&I)
K. Ravindranathan ,Dy Director (HP&I)

NHPC
Y.R. Pahuja,Chief Engineer

APPENDIX-5

Central Electricity Authority
HP & I Division
403, Sewa Bhawan, RK Puram
New Delhi – 110066
****

No. 7/9/(NHPC)/2003/994 Dated 23.9.03

To

Shri Bal Mukand,
Executive Director (Planning)
NHPC
Sector 33, Faridabad.

Sub : Summary Record of Discussions of meeting taken by CE (HP&I), CEA with NHPC on 23.09.2003 regarding power potential studies of PFRs of Dumkhar & Kanyunche HE projects in Indus Basin.

****

Sir,

Please find enclosed herewith Summary Record of Discussions of meeting taken by CE (HP&I), CEA with NHPC on 23.09.2003 regarding power potential studies of PFRs of Dumkhar & Kanyunche HE projects in Indus Basin.

ED(DEM)360
24/9/03

Tanmoy 23.9.2003
(TANMOY DAS)
Director.

Copy to

1. ✓ Shri Y.R. Pahuja, Chief Engineer, Ninoo Bazgo HE project, Leh, Ladak.

Summary Record of Discussions of meeting taken by CE (HP&I), CEA with NHPC on 23.09.2003 regarding power potential studies of PFRs of Dumkhar & Kanyunche HE projects in Indus Basin.

List of Participants is enclosed.

Power potential studies of two hydro electric projects in Indus Basin were discussed in detail and summarized as under :

1. Dumkhar HE Project

NHPC has carried out power potential studies for 10 years inflow series (1982-83 to 1991-92). NHPC has proposed installed capacity of the project as 3 units of 15MW each (Kaplan type turbine). Rated head has been indicated as 27.83 m Design energy has been calculated as 219.18 Gwh. The power potential studies carried out by NHPC are generally in order subject to approval of hydrology by CWC. NHPC may proceed with preparation of chapters on power potential study of Dumkhar HE project. NHPC has been advised to prepare a summary table indicating yearly inflow, annual energy generation, load factor of operation during high inflow and low inflow period.

2. Kanyunche HE Project

NHPC has carried out power potential studies for 10 years inflow series (1982-83 to 1991-92). NHPC has proposed installed capacity of the project as 3 units of 15MW each (Kaplan type turbine). Rated head has been indicated as 28.76 m. Design energy has been calculated as 223.02 Gwh. The power potential studies carried out by NHPC are generally in order subject to approval of hydrology by CWC. NHPC may proceed with preparation of chapters on power potential study of Dumkhar HE project. NHPC has been advised to prepare a summary table indicating yearly inflow, annual energy generation, load factor of operation during high inflow and low inflow period.

List of Participants :

(S/Shri)

CEA

1. S.M. Dhiman, Chief Engineer (HP&I)
2. Tanmoy Das, Director (HP&I)
3. K. Ravindranath, Dy. Director (HP&I)

NHPC

1. Y.R. Pahuja, Chief Engineer
2. Lakhmichand, Assistant Manager

APPENDIX-6

RESTRICTED

GEOLOGICAL SURVEY OF INDIA

GEOLOGY OF THE AREA AROUND THE PROPOSED DUMKHAR HYDROELECTRIC PROJECT, LADAKH REGION, JAMMU AND KASHMIR

(Preliminary Appraisal for Pre Feasibility Report)

OCTOBER 2003

DETAILED PROJECT REPORT UNIT
NEW DELHI

GEOLOGY OF THE AREA AROUND PROPOSED DUMKHAR HYDROELECTRIC PROJECT, LADAKH REGION, JAMMU AND KASHMIR

INTRODUCTION

The proposed Dumkhar Hydroelectric Project located in Indus Basin in Ladakh Region of Jammu & Kashmir has been identified as one of the hydroelectoic schemes in first phase as a result of an exercise to assess the balance hydroelectric potential in the country after ranking studies carried out by the CEA based on various parameters. The proposed Dumkhar Hydroelectric Project located near Dumkhar in Ladakh Region of Jammu & Kashmir is a run of river scheme. The project envisages construction of a diversion dam/weir ($34^{O}28'00"$ N: $76^{O}39'30"$ E; 52 B/11) across the river Indus and a powerhouse with probable installed capacity of 130 MW at the toe of the dam .

The area around the proposed project lies on the southern or southwestern edge of Indus-Shyok Belt north of Main Himalaya Belt. The topography of the area is rugged and general altitude is around 2500 m in valleys and goes to more than 4500 m on peaks. The area of Dumkhar is located near the boundary of Geomorphic Units S 1b and S 1c as per classification of geomorphic units of Ghosh et al (1989). The Unit S 1b encloses high mountain ranges with glaciers and snow covered peaks of Dosai Mountains and Ladakh Ranges. Its northern boundary is well defined by Indus-Shyok lineament system and its southern boundary with Unit S Ic is defined by deep gorges of the Indus River where the project is located. The mountain ranges of this unit are deeply dissected and exhibit fine dendritic drainage pattern. The major river valleys being longitudinal are aligned in WNW-ESE direction. Crests of ridges are sharp. It has transverse spur ridges. The geomorphic unit S Ic occupies mainly Zanskar mountain ranges of Indus and Zanskar Valleys. It is moderately dissected. Its northern contact with the Unit SI b is well marked by Indus River gorge (Indus Suture) but its southern boundary is not well defined except with some minor stream knick points. This has strike parallel ridges and drainage. This unit is developed mainly over Tethyan sediments. Its NW boundary appears to indicate closure of a fold which is probably affected by a N-S (NNE-SSW) fault along which the Zanskar River along with its northerly flowing tributaries takes a sharp turn to join the Indus River. However, overall appearance of these mountain ranges appears to have been dictated by a regional fold having NW-SE axial trend. The Ophiolites/melanges that occur along the Indus River typifying subduction zone along Indus Suture are not distinct and are marked by the massive sedimentary pile of this geomorphic unit.

REGIONAL GEOLOGY

In central Ladakh, where this project is located, three distinct litho-tectonic belts have been recognized. From north to south these are: -

1. Ladakh Granitic Complex.
2. Indus Tectonic Zone.
    i) Indus Group.
    ii) Sangeleuma Group - Volcanics and Ophiolite.
3. The Spiti-Zanskar and Tethyan Belts.

These three belts trend WNW-ESE and are parallel to each other. The great batholith of Ladakh Granitic Complex broadly separates the Karakoram Tethyan belt from the Himalayan Phanerozoic Belts. Ladakh Granitic Complex forms the basement for the Indus Group sediments and the latter serve as the tectonic base for Sangeleuma Group. The Indus and Sangeleuma Group together constitute the Indus Tectonic Zone which is bound on the south by the Spiti-Zanskar and Kashmir Phanerozoic Belts and in the north by the Ladakh Granitic Complex.

Ladakh Granitic Complex comprises a heterogeneous association of granite, gabbro, basic injection, metavolcanics and metasediments. The granitoids predominate over all the other rock types. This crystalline group represents gigantic complex which extends from Nanga Parbat region in the NW to Hanle and intermittently to Kailas Mountain in SE. The older metamorphic rocks intruded by granite have been designated as Kharbu Group (Srikantia and Razdan, 1980).

The group comprises garnetiferous marble, slate, phyllite, metavolcanics, amphibolite, migmatite and gneiss. The granitoids of the complex include hornblende and biotite granite, porphyritic granite, quartz feldspar granite, biotite granite, granodiorite, diorite, hornblendite, tonalite, pegmatite and aplite. In the inner zone of the granitic complex there is a persistent band of a strongly foliated flaser gneiss. There are a variety of basic intrusives within Ladakh Granitic Complex. Some of the mafic dykes in the complex vary in width from 1 m to more than 15 m and trend in N40 E direction. According to Srikantia and Razdan (1980), the basic igneous activity in the Ladakh Granitic Complex .is earlier to Indus Group sedimentation.

The Indus Tectonic Zone represents one of the spectacular lineament features on the earth. It extends from Nanga Parbat in the NW to Namcha Barwa in the SE. It is sandwiched between the Ladakh Granitic Complex in the north and Phanerozoic sedimentary belts in the south. It comprises two separate parallel almost homotaxial and independent sedimentary belts designated as Indus Group in the north and Sangeleuma Group in the south. The Indus Group

represents a non-ophiolitic sedimentary belt occurring unconformably over the Ladakh Granitic Complex, whereas Sangeleuma Group represents an ophiolitic sedimentary belt with a tectonic base and structurally overlying the Indus Belt along a pronounced tectonic discontinuity in the Indus Tectonic Zone. The ophiolite is confined only to Sangeleuma Group. The Indus Group was earlier given a formational status. De Terra (1935) has earlier described it as Indus Flysch and Tewari (1964) as Ladakh Molasse. It is traceable from Kargil in the west to Khalsi in the east and beyond it extends to Hemis, Upshi, Mahe, Nyoma and Hanle. It has maximum width of 10 km in the section between Sangeleum Chu and Kuksho nala. Litho stratigraphically, Indus Group is divisible into four formations (Srikantia and Razdan, 1980). These are: -

Formation	Lithology
	Purple, grey and green diamictite, sandstone and siltstone.
Karit	Purple, grey cross bedded sandstone, siltstone and minor shale alteration.
Maklishum	Grey siltstone with dark grey splintery shale, olive green and carbonaceous shale, coarse sandstone, grit and diamictite.
Kuksho	Grey to greyish brown fine grained sandstone, siltstone, subordinate silty shale and sporadic diamictite showing turbiditic structures
Skinding	Mainly diamictite with local sandstone and shale.

---------- -----Unconformity----------

Ladakh Granite Complex of diorite, granodiorite and granite

Kharbu Crystalline Group.

The Indus Group sediments overlie the Ladakh Granite Complex along a pronounced angular unconformity.

Skinding Formation forms basal part of Indus Group and is not persistent as it pinches out at several places. It comprises dominantly diamictite with subordinate grit and sandstone and local lenses of limestone. The diamictite has 60:40 clast to matrix ratio. The clasts are generally rounded to subrounded and rarely angular. Among these the granitic clasts form the dominant proportion followed by basic rocks, quartzite, cherty rocks and rarely purple chert.

Kuksho Formation normally succeeds the Skinding Formation and where Skinding is not developed, it directly overlies Ladakh Granitic Complex with a thrust contact. It is characterised by a sequence of alternating beds of siltstone, shale and fine grained sandstone with minor gritstone and local diamictite. These sediments repeat in rhythmic pattern. It has been assigned Ecoene age on the basis of its rich fossil assemblage.

Moklishun Formation which succeeds the Kuksho Formation is characterised by an association of black carbonaceous shale, grey sandstone, grit and diamictite in varying proportions. On the basis of the fact that the underlying Kuksho is considered Ecoene and in overlying formation there are clasts of nummulite bearing limestone, Makishun Formation has been considered to be Oligocene age by Srikantia & Razdan (1980)

Karit Formation succeeds the Moklishun and the contact at places is gradational. It comprises dominantly of purple shale, grey sandstone and gritstone and locally green gritstone and diamictite. It has been traced from the area east of Khalsi to Pashkyum near Kargil. According to Srikanta & Razdan (1980) this formation forming upper part of the Indus Group directly overlaps the Ladakh Granitic Complex at places due to transgressive phase. It is divisible into Narula and Hegnis Members. The Narula Member comprises an alteration of purple shale, siltstone and diamictite with interbeds of grey sandstone. The upper Hegnis Member comprises dominantly purple diamictite with subordinate gritty sandstone and siltstone. The Indus Group largely represents a sedimentary sequence deposited in a basin on a continental crust. The total absence of ophiolite and general lack of marine elements distinguishes Indus Group from Sangeleuma Group.

The Sangeleuma Group includes a sequence of sediments and lava flows with ophiolitic emplacement in the southern part of the Indus Tectonic Zone. It broadly includes Dras Complex of Raiverman & Mishra (1975), and the Dras Formation of Shah et al, (1976). The belt of Sangeleuma Group is bound by Indus Group in NNE up to Kargil and beyond and by Ladakh Granitic Complex in NW with which it has tectonic relationship. In the south it is bound by Spiti Zanskar and Kashmir Pre-Cambrian and Phanerpzoic Belts having tectonic overlap. It is exposed as a linear belt trending WNW-ESE between Khalsi and Naktul south east of Kargil, from NNE-SSW to NE-SW between Kargil and Sanko and WNW-ESE to E-W towards Dras.

According to Srikanta and Razdan (op. cit.) and Geological Survey of India, the Sangeleuma Group is divisible in to four formations viz. Khalsi, Dras volcanics, Nindam and Shargol on the basis of fossil evidences. The formational contacts at many places have been found to be tectonic. Base of Sangeleume Group is generally tectonic. Along this contact, the Sangeleume Group is thrust over the Indus Group. Lithostratigraphic classification of Sangeleume Group is as follows:-

FORMATION	LITHOLOGY
Shergol	Dark grey shale, purple and green cherty siltstone, quartzite, sandstone with Nummulites, purple conglomerate and metavolcanics with serpentinite-dolerite-harzburgite (ophiolite)
Nindam	Sandstone, siltstone, shale and greywacke with turbidite structure, local diamictite and chert beds.
Shilkong Ophiolite	Volcanogenic sediments and silt, serpentinite, dunite and harzburgite.
Dras Volcanics	Greenish to purple coloured vesicular basalt, andesite, agglomerate and chert with diopsidite, dunite and serpentinite bodies.
Khalsi	Volcanogenic slate, shale, quartzite, arenite with Belemnite and Orbitolina bearing limestone with diabase-serpentinite, emplacement (ophiolite)

---------- ---- -- Tectonic Base ----------

Khalsi Formation is characterised by association of Oribitolina limestone, greyish white limestone, dark grey splintery shale, sporadic lenticular diamictite, volcanogenic sediments, tuffaceous shale minor quartz arenite with serpentinite and diabase. This Formation extends from Khalsi to the west of Sangeleuma valley beyond which it is cut along a thrust. The basal part of this formation comprises Orbitolina limestone bands which are particularly exposed in Khalsi area. These bands at many places, particularly in Khalsi-Narula section and Hagnis, occur as tectonic slices within Karit Formation of Indus Group. Black shale associated with thin lenticular bands of diamictite and resinous looking quartzite arenite limestone interbeds form dominant lithology of this formation. The Khalsi Formation is characterised by serpentine, diabase and gabbro

occurring as pods and lenticels. The ultra mafics are represented by slickensided and polished serepentinites.

Dras Volcanic Formation succeeds the Khalsi Formation and normally underlies the Nindam Formation. It is represented by a sequence of lava flows, chert beds, pyroclastics and agglomerates with lenses of limestone. In lower part there is preponderance of basalt and andesite with minor chert and agglomerate and in the upper part it is characterised by dominant chert beds and subordinate basalt – andesite. It was earlier believed that Dras Volcanics were directly related to ultra basic emplacement. However, according to Srikantia and Razdan (1980), all the ophiolite bodies found in this area are tectonic emplacements. Tectonic slices of snow-white marble are noticed within Dras Volcanic Formation.

Nindam Formation generally succeeds Dras Volcanics and comprises a thick sequence of olive green and purple shale, siltstone, greywacke, sandstone, quartzite, arenite and subordinate, pale purple limestone and diamictite. These rock types show graded bedding.

The Nindam Formation is succeeded by a complex sequence of sediments with ophiolite association belonging to Shergol Formation. This is represented by an association of slate-phyllite, purple to green diamictite, greyish to grey blue oolitic limestone, grey to pink quartz arenite, purple jespery chert, pyroclastics, agglomerate and ophiolite. At places mafic and pyroclastics predominate over other rocks. The sedimentation of Sangeleuma Group has broad geosynclinal framework of its own and ophiolite emplacement is independent of Sangeleuma sedimentation.

STRUCTURE AND TECTONICS

The Central Ladakh Himalayas is a well defined tectonic belt. The tectonic sequence includes the tectonic units like Ladakh Granitic Complex Autochthon, Indus Tectonic Zone comprising Indus Group Autochthon and Sangeleuma Group Parautochthonous belt and Spiti-Zanskar Phanerozoic-Proterozoic Parautochthon. These tectonic units are separated from each other by unconformity, Pashkyam Thrust, Wakha Thrust and Sanko Thrust, respectively.

The Ladakh Granitic Complex-Kharbu Group Autochthon represents tectonically the lowest unit in the Ladakh Himalayas. Structurally it represents a major anticlinorium comprising granitic and other crystalline complexes. The regional foliation in the area has southerly dip. It also appears to have WNW-ESE and NS lineament pattern.

The Indus Group Autochthon represents a sedimentary belt forming a cover over Ladakh Granitic Complex. It forms a complexly folded linear belt with WNW-ESE to E-W trend and preserves a large variety of fold types which include

open symmetrical anticlines, synclines, isoclinal folds, reclined and chevron folds. The autochthonous belts of the Ladakh Granitic Complex and Indus Group are thrust over by the Sangeleuma Group along the Pashkyum Thrust.

The Sangeleuma Parautochthonous belt is defined by two major tectonic planes viz. Pashkyum Thrust along the base and the Wakha-Sanko Thrust along its top contact. The Sangeleuma belt, in turn, is thrust over by Spiti-Zanskar Parautochthon. This belt has broadly WNW-ESE trend and regionally the formation is south dipping. It has undergone intense deformation and tectonic attenuation. The Pashkyum Thrust defines the contact between the Indus Group and Dras Volcanic Formation near Pashkyum and has been extended to define the regional tectonic contact between the Sangeleuma Group and Indus Group-Ladakh Granitic Complex autochthonous. It behaves like a low angle thrust or high angled reverse fault with dip of tectonic plane ranging from 30^0 to 70^0 in southerly direction. This thrust trends along WNW-ESE direction.

The Dras Volcanics Formation is also highly deformed. The Nindam Formation displays a remarkable sequence of folds with symmetrical to asymmetrical anticlines and synclines with limbs dipping 20^O to 70^O. The fold overturnings support a south to north movement. Its contact with Shargol is tectonised at many places. The Shergol Formation is considerably tectonised and has resulted in boudinisation of bands particularly of Ultramafics, limestone and chert.

Spiti-Zanskar Parautochthon represents a major unit in the area south of Indus tectonic zone. It represents a synclinorium with closure along the area connecting Rusi La-Sapi La. It has WNW-ESE trend with ESE regional plunge. It has thrust over the Indus tectonic zone with a NNE directed movement.

SEISMOTECTONICS AND SEISMICITY

Seismotectonically, the project is located in High Himalayan Seismic Zone in Indus Suture Zone (ISZ) in Indus Valley in Central Ladakh (Narula et al., 2000). The northernmost tract, north of Shyok Suture Zone (SSZ), is occupied by litho assemblages of Trans Himalayan Tectogen which continues from west. Towards south this belt is followed by tectonic assemblages comprising accretionary complex, accreted arc sediments, ophiolites and Ladakh Granitic Complex. This is bound on either side by Shyok Suture Zone & Indus Suture Zone. North of the Main Boundary Thrust (MBT) the litho units of Main Himalayan Belt are exposed. South of MBT, the terrain is mainly occupied by the sediments of Frontal Belt. The most conspicuous mega structural element in the north is dextral strike Karakoram Fault forming the eastern boundary of the Pamir Syntaxes and western boundary of Tibet Block. Towards south, the Shyok Suture Zone (SSZ) separates the Karakoram Belt from Indus-Syhok belt. Further south, the Indus Suture Zone marks the northern limit of the Main Himalaya Belt within which MCT and MBT are considered most regionally extensive structural

discontinuities. Pashkyum Thrust, Tajurma Thrust, Wakha Thrust, Sanku Thrust and Shyok Thrust are some of the regional structural planes within this zone. Of the transverse faults, Kishtwar Fault is the most prominent one.

A total of 205 events have been recorded/interpreted to have occurred in the region. Most prevalent earthquakes (48.4 %) are in the magnitude range of $\geq 4 \leq 5$. Three events with magnitude between 6.0 and 7.0 and 24 with magnitude 5.0 and 6.0 have been recorded in and around the area. With respect to spatial distribution of earthquake events, the area can be broadly divided into three zones. The maximum concentration of seismic events is towards SW between MCT and MBT where earthquakes are mainly with shallow focus. Towards, the Indus-Shyok as well as Tethyan Belt, the area exhibits subdued seismicity. Further north, within Karakoram – Altyn Tagh Fault Block a fair concentration of seismic events is observed. In this part moderately deep focus (71-150 km) events prevail. Keeping in view the seismo-tectonic set up and seismicity, the area has been kept in Zone-IV as per Map of India showing Seismic Zones [IS-1893 (Part –1) : 2002). It is suggested that proper seismic coefficient be got determined and incorporated in designs of appurtenant structures of the projects.

GEOTECHNICAL APPRAISAL

The proposed Dumkhar Hydroelectric project, a run of the river scheme would be located on the boundary of Indus Group and Ladakh Granitic complex within the Indus tectonic Zone which are separated by an unconformity. The site of the proposed diversion dam/weir site exposes rocks of Indus Group comprising purple grey green conglomerate, sandstone and siltstone with Nummulitic clasts belonging to Karit Formation of Indus Group. The rocks are inherently soft and deformed due to presence of thrust. Therefore, the presence of local faults, shears and highly weathered zones can not be ruled out. The area also indicates the presence of thick debris zones and talus cones. Stabilization of slopes in thick over burden zones and zones with Quaternary deposits will have to be ensured. It appears that the dam site selected will have rocks belonging to two different tectonic units on either sides i.e. Ladakh Granite Complex on right abutment and rocks of Indus Group belonging to Indus Tectonic Zone on the left abutment. It therefore, appears that the dam axis will be aligned across the unconformity i.e. plane separating these two major tectonic units. Besides neotectonism, rockmass properties on either abutment will be grossly different. The presence of a weak pane separating two contrasting lithologies could pose problems of leakage as well as stability and will need careful geotechnical evaluation. Also, proximity of Pashkyum Thrust has to be kept in view while finalizing the site as well as the design. The powerhouse would be located in the same geological and geomorphic environs. It is suggested that sites of appurtenant structures may be finalized after detailed inspection of sites so that some of the problems are minimized. This geotechnical appraisal is based on the regional geological set up without field visit.

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Geology of the area around the proposed Dumkhar Hydroelectric project district Ladakh, Jammu & Kashmir

Restricted

(Scale: 1: 253,440)

INDEX

- Conglomerate
- Variegated shale, limestone etc.
- Dras volcanic, Indus Flysch
- Limestone
- Lamayuru Formation
- Ladakh Granite
- Bedding
- Foliation
- Joint
- Thrust

76° 30′

76°45′

34° 30′

34° 30′

Kanyunche

Dargo

Dam site/Power House

Skyurbuchan

Dumkhar

Khalsi

APPENDIX-7

Annex

Central Electricity Authority
HP&I Div
403, Sewa Bhawan,
R.K.Puram, New Delhi

No: 7/9/(NHPC)/2003/ 1236 Dated: 1-10-03

To
Shri Bal Mukund
ED(P &C)
National Hydroelectric Power Corporation (NHPC)
Office Complex
Sector 33 FARIDABAD
Fax: 95129-3378693 / 95129

Sir,

Sub: Preparation of Preliminary Feasibility Report(PFRs): Comments of CWC on Hydrological aspects Kanyunche & Dumkhar HE Project in J&K.

****

The comments of CWC on the Hydrological aspects recd vide letter no. 1/J&K/9/2003/Hyd(N)/257 & 258dt 1st Oct , 03 is enclosed for necessary action at your end please

Encls: As above

(Tanmoy Das)
Director(HP&I)

केन्द्रीय जल आयोग
जल विज्ञान (उ) निदेशालय

कमरा नं. ५०७ए, सेवा भवन,
आर. के. पुरम, नई दिल्ली।

विषय : पी. एच. आर. दुम्कर जल विघुत परियोजना (लेह,जम्मू एंव कश मीर)

संदर्भ : अप्र का पत्राक ७/९(NHPC)/०३/HP&I/९९० दिनांक २३/९/०३

उपर्युक्त संदर्भित पत्र का कृपया अवलोकन करें, जिसमें इस निदेशा नय से उपरोक्त परियोजना संबंधी प्रीफिसिबिलिटी रिपोर्ट की जांच का अनुरोध किया गया है ।

इस संबंध में इस निदेशालय द्वारा उपरोक्त परियोजना रिपोर्ट की जांच की गई है और इसकी टिप्पणी उचित कार्यवाही हेतु प्रेषित की जा रही है । कृपया आप अपने स्तर से सभी सलाहकारों (consultants) को परियोजना की प्रीफिजिबिलिटी प्रतिवेदन में व्यवृहत आकडों की Excel mode में साफट कापी (Floppy या CD) भी प्रेषित करने के लिये निंदेश देने की कृपा करें ।

यह मुख्य अभियन्ता द्वारा अनुमोदित है

संलग्न : यथावत

(के. के. सिंह)
निदेशक

निदेशक, जल विघुत आयोजन एंव अन्वेषण प्रभाग, केन्द्रीय विघुत प्राधिकरण

अ. शा. पत्र सं. 1/384/10/2003/WP&A(30)/257 दिनांक 1.10.03

Sep-2003

CENTRAL WATER COMMISSION
HYDROLOGY NORTH DIRECTORATE
ROOM NO. 507(A), SEWA BHAWAN, R. K. PURAM, NEW DELHI-110066

SUBJECT : PFR Dumkar H.E. Project (Leh, J&K)

1.0 Introduction

The Dumkar HE Project (CA: 61473 sq.m.) proposed on river Indus in Leh district of Jammu & Kashmir (J&K) , is a run-off the river scheme proposed to harness hydel potential of the Indus river. The project envisages construction of concrete gravity dam with a gross storage of 26.4 M.cum at FRL of El 2856.0 m. The dam is located nearly 7 km upstream of Achinathang village. The submergence area is 2.85 sq.km. at FRL.

The catchment area upto proposed dam site is 61,473 sq.km. out of which 26,772 sq.km. lies in Tibet (China) and remaining area of about 34,701 sq.km in Indian territory. The dam site is proposed to be located at Longitude 76 ^{0} 39'30" E and 34 ^{0} 28' N. The Zanskar River is major left bank tributary of Indus River and joins about 80 km upstream of proposed Dumkar dam site, a hydro power project of NHPC namely Nimoo-Bazgo (Alchi) H.E. Project is under investigation and situated about 62 km upstream of proposed Dumkar H.E. Project Dam site.

2.0 COMMENTS (Water availability, design flood and sedimentation)

The PFR of this project is similar to the PFR of Kanyunche HE project, which is locatedjust 11 Km d/s of the project. The comments of this project regarding water availability, design flood and sedimentation are therefore similar to the comments offered for the Kanyunche HE(Leh, J&K) Project by this Dte. Hence the same may be complied to, for this project also.

Central Electricity Authority
HP&I Div
403, Sewa Bhawan,
R.K.Puram, New Delhi

No: 7/9/(NHPC)/2003/ HP&I/ 1256 **Dated:** 6.11.03

To
Shri Bal Mukund
ED(P &C)
National Hydroelectric Power Corporation (NHPC)
Office Complex
Sector 33 FARIDABAD (Fax: 95129-2278005/2277941)

GMC Consultancy Services
CE(C-I)

Sub: Preparation of Preliminary Feasibility Report(PFRs): Further Hydrology comments of CWC on replies of NHPC on Dumkhar & Kanyunche HE Project

Please find enclosed herewith further comments of CWC on the Hydrological aspects received vide letter no1/J&K/9/2003/296 dt 3.11.03

(Tanmoy Das)
HP&I Div

Encls: As above

केन्द्रीय जल आयोग
जल विज्ञान (उ) निदेशालय

कमरा नं. [illegible], सेवा भवन,
आर. के. पुरम, नई दिल्ली।

विषय : [illegible] आर. दुमकर तथा कल्पनी जल विद्युत परियोजना

संदर्भ : पत्रांक 7/7/NHPC/03/HPE-I/1158 दिनांक 23/10/03

उपर्युक्त संदर्भित पत्र का कृपया अवलोकन करें, जिसमें इस निदेशालय से उपरोक्त परियोजना संबंधी हाइड्रोलॉजी रिपोर्ट की जांच का अनुरोध किया गया है।

इस संदर्भ में इस निदेशालय द्वारा उपरोक्त परियोजना रिपोर्ट तथा परियोजना के अभियन्ताओं द्वारा भेजे गये उत्तर की जांच की गई है और अगली टिप्पणी उचित कार्यवाही हेतु प्रेषित की जा रही है।

[illegible] (H) यह मुख्य अभियन्ता द्वारा अनुमोदित है

संलग्न : यथोक्त

[signature] 3/10
(के. के. सिंह)
निदेशक

निदेशक, जल विद्युत आयोजना एवं अन्वेषण प्रभाग, केन्द्रीय विद्युत प्राधिकरण

अ. शा. प. सं. 1/[illegible]/1/2003/[illegible] दिनांक 3.11.03

Sh. Rawat –
Pl. [illegible] [illegible]
[illegible] letter to NHPC.
[initials]

CENTRAL WATER COMMISSION
HYDROLOGY NORTH DIRECTORATE
ROOM NO. 507, SEWA BHAWAN, R. K. PURAM, NEW DELHI-110066

Subject : PFR of Kanyuncheu HE Project and Dumkher HE Project

Replies of the comments of this Dte. by NHPC regarding above mentioned projects have been examined and the further comments of this Dte. are as under

Comments :

1. As stated by the consultants that the consistency of the flow data used for the water availability could not be checked due to non availability of flow data at near by location on river Indus. On examination of the flow data from 1977-94 , the annual availability has shown a falling trend, which appears to be on conservative side. Keeping in view the remote location and scanty data available in the basin , the observed flow data of PDD, J&K on Indus River at 9.5 km downstream of Indus-Zanskar confluence ~~and~~ may be utilized for PFR purpose for above two projects. Consistency of the flow series however needs to be established before it is to be used for DPR purpose.

2. As already suggested, 10000 yr return period flood may be considered close to the design flood and same may be computed from flood frequency analysis by relevant method, taking in to account all the statistical parameters. The consultant has not enclosed the annual peak flow series and detail statistical output of flood frequency analysis to judge the fitness of distribution. As referred , the feasibility report of 'Nimoo Bazgo (Alchi) HEP has not been made available. The above information needs to be furnished in PFR for vetting.

3. The project has small storage, it is likely to be silted up in short period to function as run of the river project. The consultant has sated in page 5-6 of PFR to carry out the detail sedimentation study during feasibility stage with more observed data at proposed site. An approximate sediment studies may however be carried out to decide sill level of permanent outlet and the live storage available for peaking purpose.

Central Electricity Authority
HP&I Div
403, Sewa Bhawan,
R.K.Puram, New Delhi 1100066

No. 7/9/(NHPC)/2003/HP&I/ 1120 **Dated** 30 **Oct., 2003**

To
Shri Bal Mukund
ED(R &C)
National Hydroelectric Power Corporation (NHPC)
Office Complex
Sector 33 FARIDABAD (Fax: 95129-2278005/2277941)

Sir,

Subject : Preparation of PFRs – comments on draft PFRs (8 Nos.) submitted by NHPC.

*****

Reference is invited to your letters vide which copies of draft PFRs in respect of the following HE projects were received.

i.	Dikchu	3x35 MW
ii.	Agoline	3x125 MW
iii.	Kurung	3x110 MW
iv.	Emini	4x125 MW
v.	Dumkhar	3x15 MW
vi.	Kanyunche	3x15 MW
vii.	Naying	4x250 MW
viii.	Basania	3x30 MW

Copies of draft PFRs have been forwarded to Central Water Commission. The comments of CWC on hydrological, layout planning aspects on some of the Draft PFRs have already been forwarded and other comments for draft PFR would be forwarded as soon as they are recieved. In continuation to above the comments of Hydrology division, CWC on Draft PFR of Dumkhar & Kanyunche , Naying HE Project are enclosed at **Annex-I**

In continuation to comments of SP&PA Division, CEA on power evacuation aspects of some of the draft PFR already sent, the comments on draft PFR of Naying & Agoline HE project is enclosed as **Annex-II** . Other comments would be forwarded as soon as they are received.

Our comments on power potential studies draft PFR for the above 8 projects are given at **Annex – III**

C:/krn/nhpc

It is requested that the same may be taken into account while finalizing the PFRs.

Encl : As above

(TANMOY DAS)
Director (HP&I)

Copy to : (for information -without enclosure)

i. Chief Engineer, SP&PA Division, CEA
ii. Chief Engineer, Design (E&NE)
iii. Chief Engineer, Hydrology, CWC

Director(HP&I)

C:/krn/nhpc

केन्द्रीय जल आयोग
जल विज्ञान (उ) निदेशालय

विषय : पी. एफ. आर. दुम्कर जल विघुत परियोजना तथा कन्युन्चे जल विघुत [illegible]
।

उपर्युक्त संदर्भित पत्र का कृपया अवलोकन करें, जिसमें इस निदेशालय स [illegible] प्रीफ़िसिविलिटी रिपोर्ट की जांच का अनुरोध किया गया है ।

इस संबंध में इस निदेशालय द्वारा उपरोक्त परियोजना रिपोर्ट की जांच की गई है और इसकी टिप्पणी उचित कार्यवाही हेतु प्रेषित की जा रही है ।

यह मुख्य अभियन्ता द्वारा अनुमोदित है

सलग्न : यथावत

27/10/03
(के. के. सिंह)
निदेशक

निदेशक, जल विघुत आयोजन एंव अन्वेषण प्रभाग, केन्द्रीय विघुत प्राधिकरण

अ. शा. पत्र सं. 1/JLK/9/2003/Hyd/286 दिनांक 27/10/03

CENTRAL WATER COMMISSION
HYDROLOGY NORTH DIRECTORATE
ROOM NO. 507(A), SEWA BHAWAN, R. K. PURAM, NEW DELHI-110066

Subject : PFR of Kanyunche HE Project and Dumkher HE Project

The hydrology chapter in PFR in respect of above two projects are same as received earlier in this dte. No new data has been appended/ included.

Hence comments of this dte. sent earlier vide this Dte letter no.1 J&K 2003 HYD-N/ 257-58 dated 1/10/2003 will stand as it is.

नैशनल हाइड्रोइलैक्ट्रिक पावर कारपोरेशन लिमिटेड
(भारत सरकार का उद्यम)
आई एस ओ-९००१ और १४००१ प्रमाणित कम्पनी
National Hydroelectric Power Corporation Ltd.
(A GOVT. OF INDIA ENTERPRISE)
ISO-9001 & 14001 Certified Company

NH/CON-229/ /690

फोन/TEL. 11.11.2003

संदर्भ सं./Ref. No._____

फरीदाबाद/Faridabad_____

The Chief Engineer (HP & I),
403/N, Central Electricity Authority,
Sewa Bhawan,
R. K. Puram,
New Delhi – 110066
Fax No.: 9511-26103332

Sub: Preparation of PFR of Dhumkar (3 X 15 MW) & Kanyunche (3 X 15 MW) HE Projects – Reply of Comments of CWC.

Sir,

Kindly refer to CEA letter no. 7/9(NHPC)/2003/ HP&I/1256 dated 4.11.2003 on the subject cited above vide which comments of CWC on the hydrology aspects of Dhumkar (3 X 15 MW) & Kanyunche (3 X 15 MW) HE Projects has been forwarded.

Point wise reply of comments is enclosed.

Thanking you,

Yours faithfully,

(R.S.Mina)
General Manager (Consultancy Services)

Encl: As above.

NOO:

Copy to:

1. **ED (Region –I)**
2. **CE (Nimoo Bazgo)**

DESIGN DIVISION
(Hydrology Unit)

NH/DD/HYD/IND -4173 **10.11.2003**

Sub: Indus Basin Projects – Reply to comments of CWC.

Ref: I) NH/CON-229/1635 dated 03.11.2003
ii) 7/9/(NHPC)/2003/HP&I/1120 dated 30.10.2003 of CEA.
ii) 7/9/(NHPC)/2003/HP&I/1256 dated 04.11.2003 of CEA.

Kindly find enclosed herewith the replies of comments of CWC received vide letter no 1/J&K/9/2003/HYD-N/286 dated 27.10.2003 and letter no. 1/J&K/9/2003/296 dated 03.11.2003 in respect of Kanyunche and Dumkar H.E. Projects.

This may please be forwarded to CEA for further necessary action.

10.11.03
(S. D. Shukla)
Engineer (C)

Shankhadhar 10/11

Chief Engineer (Hydrology)

General Manager (D-II)

General Manager (Consultancy)

CE (C-I)
11/11

ISO-9001 Company

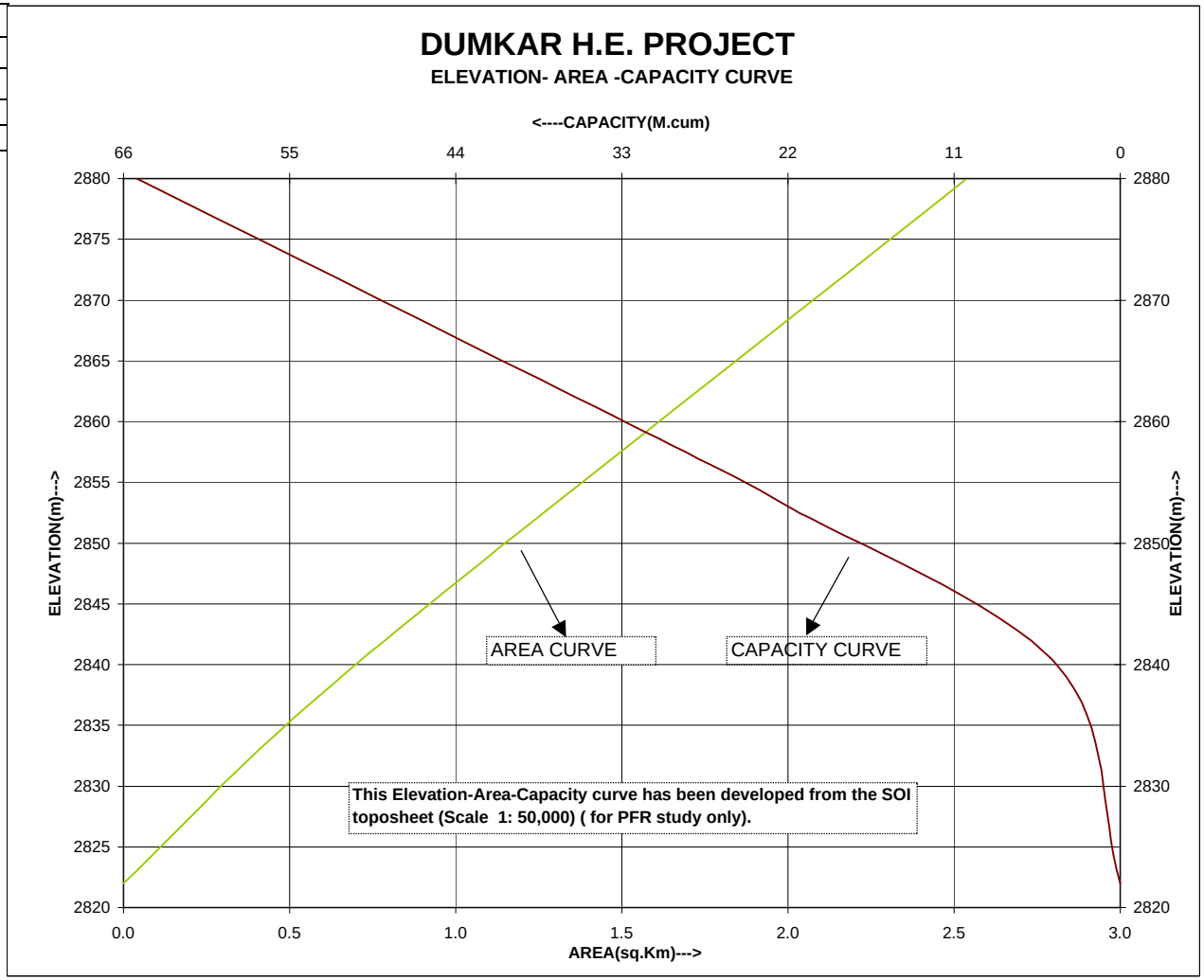
Dumkar H.E. Project

Point wise reply to CWC Observations

S.No.	CWC Observations	Reply of NHPC
ii) Reservoir Sedimentation Study	Vide Page 5-6 the rate of siltation has been indicated as 0.01233 ha.m./sq.km./year which appears to be on lower side and needs to be reviewed. The "Compendium on Silting of reservoir in India" published by CWC in Jan'2001 indicates median value of rate of siltation as 0.211 ha.m./sq.km./year in respect of Himalayan region (Indus, Ganga and Brahmputra basins).	The rate of siltation indicated as 0.01233 ha.m./sq.km./year is based on actual observed suspended sediment data at Nimoo-Bazgo (Alchi) H.E. Project proposed dam site. Emphasis has been given on available site-specific data (Nimoo-Bazgo is near to the proposed project on the same river). Since the project is proposed to be run off the river scheme, detailed sedimentation studies as per prevailing practice is not required at PFR stage. The same will be detailed in the Feasibility Report/DPR.
iii) Elevation Area Capacity Curve	**1-**Vide Figure-II, Chapter 5, the elevation area capacity curve indicates capacity at El 2828 m to be less than the capacity at El 2824 m. Capacity at a higher elevation can not be less than that at lower elevation. The elevation area capacity curve may therefore be correctly reviewed.	The elevation area capacity curve of Dumkar H.E. Project has been prepared from SOI toposheet scale 1:50,000 due to non-availability of larger scale of reservoir map. Only three points are available to plot the curve hence the curve seems to be distorted from its shape although the elevation area capacity readings supplied are correct. The distorted elevation area capacity curve has been smoothened and the same is enclosed along with this letter.

Figure-II

Elevation	Area	Capacity
(m)	(sq.k	(M.cum)
2822.0	0.00	0.00
2840.0	0.70	4.20
2880.0	2.54	65.12



Elevation	Area	Capacity
(m)	(sq.km)	(M.cum)
2822.00	0.00	0.00
2840.00	0.70	4.20
2853.00		22.00
2856.00		26.40
2880.00	2.54	65.12

Kanyunche and Dumkar H.E. Project

Point wise reply to CWC Observation

S.No.	CWC Observations	Reply of NHPC
1.) Water Availability study	As stated by the consultants that the consistency of the flow data used for the water availability could not be checked due to non availability of flow data at near by location on river Indus. On examination the flow data from 1977-94, the annual availability has shown a falling trend, which appears to be on conservative side. Keeping in view the remote location and scanty data available in the basin, the observed data of PDD, J&K on Indus river at 6.5 km downstream of Indus-Zanskar confluence may be utilized for PFR purpose for above two projects. Consistency of the flow series however needs to be established before it is to be used for DPR purpose.	The suggestion of further study for DPR is accepted.
2.) Design Flood Study	As already suggested, 10000 year return period flood may be considered close to the design flood and the same may be computed from flood frequency analysis by relevant method, taking in to account all the statistical parameters. The consultant has not enclosed the annual peak flow series and detail statistical output of flood frequency analysis to judge the fitness of the distribution. As referred, the feasibility report of Nimoo-Bazgo (Alchi) HEP is not made available. The above information needs to be furnished in PFR for vetting.	The annual flood series of Nimoo-Bazgo (Alchi) H.E. project along with the results of flood frequency analysis is attached for ready reference as desired. On the basis of this, the Design flood of 4650 cumec has been estimated and recommended for Kanyunche and Dumkar H.E. Projects.

3.) Reservoir Sedimentation Study	The project has small storage, it is likely to be silted up in short period to function as run of the river project. The consultant has stated in page 5-6 of PFR to carry out detail sedimentation study during feasibility stage with more observed data at proposed site. An approximate sediment studies may however be carried out to decide sill level of permanent outlet and the live storage available for peaking purpose.	The sedimentation studies could not be conducted at this stage as the reservoir X-sections are not available. However as stated earlier the same will be detailed at feasibility level with more information's and relevant data.

NIMOO-BAZGO(ALCHI) H.E. PROJECT

ANNUAL PEAK DISCHARGE(cumecs) OF RIVER INDUS AT ALCHI DAM SITE

S.No.	Year	Peak Discharge (cumec)	Date	Instanteneous Peak(115%)
1	1977	983.7	13-Jul	1131.3
2	1978	1421.6	11-Aug	1634.8
3	1979	1163.3	3-Aug	1337.8
4	1980	1030.3	16-Aug	1184.8
5	1981	823.6	25-Jul	947.1
6	1982	1421.6	13-Aug	1634.8
7	1983	1421.6	31-Jul	1634.8
8	1984	997.1	16-Aug	1146.7
9	1985	1048.0	29-Aug	1205.2
10	1986	1421.6	29-Jul	1634.8
11	1987	596.6	30-Jul	686.1
12	1988	1257.6	7-Aug	1446.2
13	1989	488.5	10-Aug	561.8
14	1990	823.6	30-Aug	947.1
15	1991	596.6	31-Jul	686.1
16	1992	627.3	24-Aug	721.4
17	1993	716.9	8-Aug	824.4
18	1994	841.1	28-Aug	967.3
19	1996	708.9	1-Sep	815.2
20	1999	1017.4	31-Jul	1170.0
21	2001	740.6	21-Aug	851.7
22	2002	1605.7	17-Jul	1846.6

Annexure-V

NIMOO-BAZGO (ALCHI) H.E. PROJECT

RESULT OF FLOOD FREQUENCY ANALYSIS AT DAM SITE (ALCHI) WITH 15% ENHANCED PEAKS

RETURN PD.(Year)	GUMBLE EV- I						3-PARAMETER LOGNORMAL			LOGPEARSON TYPE- III		
	MOM			MML			MOM			MOM		
	Xt	St	95% UCL	Xt	St	95% UCL	Xt	St	95% UCL	Xt	St	95% UCL
2	1081	73	1224	1073	77	1223	1117	86	1285	1090	85	1256
5	1473	136	1739	1420	118	1651	1442	100	1637	1435	114	1658
10	1733	189	2103	1650	151	1946	1623	124	1866	1646	148	1936
20	1982	242	2456	1871	185	2233	1779	159	2090	1838	199	2228
25	2061	259	2568	1941	196	2324	1826	172	2162	1897	219	2326
30	2125	273	2660	1997	205	2398	1859	182	2215	1939	235	2399
50	2305	312	2915	2156	230	2606	1962	216	2386	2074	292	2645
100	2546	365	3261	2370	264	2887	2088	266	2609	2243	379	2986
200	2787	418	3606	2583	298	3168	2207	318	2831	2407	479	3346
500	3105	488	4061	2864	344	3538	2355	393	3124	2617	631	3853
1000	3345	541	4406	3076	379	3819	2462	452	3347	2771	760	4260
2000	3585	595	4750	3289	414	4100	2564	512	3569	2924	900	4687
5000	3902	665	5206	3570	460	4471	2693	594	3857	3117	1098	5270
10000	4142	719	5551	3782	495	4752	2792	661	4087	3269	1269	5757

नैशनल हाइड्रोइलैक्ट्रिक पावर कारपोरेशन लिमिटेड
(भारत सरकार का उद्यम)
आई एस ओ-९००१ और १४००१ प्रमाणित कम्पनी
National Hydroelectric Power Corporation Ltd.
(A GOVT. OF INDIA ENTERPRISE)
ISO-9001 & 14001 Certified Company

सदर्भ स./Ref. No. **एनएच/ कॉन /229 /1504**

फोन/TEL.
फरीदाबाद/Faridabad **दिनांक 9.10.2003**

मुख्य अभियंता, (एच पी एंड आई)
403/एन,
केंद्रीय विद्युत प्राधिकरण
सेवा भवन, राम कृष्ण पुरम,
नई दिल्ली -110066

विषय : कॉनयुनचे और धुमकर जल विद्युत परियोजनाओं के - जल उपलब्धता अध्ययन की वैंटिग .

महाशय,

आपके पत्रांक 7/9(एनएचपीसी)/2003/एचपी एंड आइ /1036 दिनांक 1.10.03 के माध्यम से भेजे गए केंद्रीय जल आयोग की टिप्पणी पर विचार किया गया है ।

इस संबंध में आवश्यक उत्तर केंद्रीय जल आयोग को शीघ्र वैंटिग के लिए भेज दें ताकि पी एफ आर तयशुदा समय पर जमा की जा सके ।

धन्यवाद,

आपका विश्वासी,

सुरेश 9/10/03

(एस के दुबे)
मुख्य अभियंता (परामर्श सेवाएं)

संलग्न: उपरोक्त अनुसार

प्रतिलिपि
मुख्य अभियंता (हाइड्रोलॉजी) - को नोट नं एनएच/डीडी/आईएंडडी-3622 दिनांक 8.10.2003 के संदर्भ में सूचनार्थ

Point wise reply to CWC Observations

S.No.	CWC Observations	Reply of NHPC
2.0 Water Availability Study	**1-**Consistency check of basic data used for developing 10-Daily series has not been carried out which may be done at least by comparing the same with corresponding observed discharge at nearby G&D sites on Indus or with the discharge data of neighboring basin having similar catchment characteristics.	The consistency check of the daily discharge series at G&D site located 6.5 km d/s of river Indus-Zanskar confluence has been thought of with the available daily discharge of river Indus at Stakna. The Stakna G&D site is located on river Indus about 40 km u/s of Indus-Zanskar confluence. Since the discharge data available at Stakna G&D site are random i.e. only a few days of each month's data are available, hence the study could not be done. However on examination, it is found that the discharges at Stakna G&D site are always less than the discharge at 6.5 km d/s of Indus-Zanskar confluence site. As per the available information's with us, the similar hydro meteorological conditions does not prevail in the neighboring basin so not attempted as suggested by you.
	2- The basic data of site maintained by PDD & NHPC used for derivation for flow series also need to be appended.	As per the general practice the average 10-daily discharge series is only annexed in the reports. The basic data may be produced if desired so. Presently the G&D site at 6.5 km d/s of Indus-Zanskar confluence maintained by PDD of J&K had been discontinued w.e.f. April 2001.
	3- The missing 10-Daily discharge data between years 1977 to 1994 in Annexure-I may be filled up with the regression analysis or any acceptable method to develop complete flow series or otherwise the year with discontinuous flow data may be deleted.	As stated earlier also, since the discharge data available at Stakna G&D site is not continuous and scanty. So a logical and reliable relationship could not be established between discharges at these two sites in question.

3.1 Design Flood	**1-** Annual instantaneous flood peak series of G&D site 6.5 km d/s of Indus Zanskar confluence may be appended in the report. The series may be adopted for frequency analysis after conducting necessary statistical checks for outliers, Jump & trend etc	The annual instantaneous flood peak series of G&D site 6.5 km d/s of Indus Zanskar confluence is available in the Feasibility Report of Nimoo Bazgo (Alchi) H.E. Project. The details of frequency analysis as available in the above mentioned report may kindly be referred. As advised, the series has been analyzed for outliers. All the points of the series are well within the upper and lower limits of 2045.0 cumec and 229 5 cumec respectively. The instantaneous peak series has a mean value of 1137.1 cumec while first half and second half of the series have means of 1288.9 cumec and 985.3 cumec respectively. The linear trend line shows decrease in mean value for second half series however the variance is higher for the same.
	2- PMF for proposed Dam site has been computed as 1000 year return year flood in absence of information required for hydro meteorological approach, 1000-years return period flood appears to be lower side to consider as PMF. As experienced in case of projects in its neighboring basin of having similar characteristics, generally 10000-year return period flood may be considered close to PMF. Selection of fittest distribution in frequency analysis may be discussed and details appended in the report.	The observed annual maximum flood series at G&D site 6.5 km d/s of Indus Zanskar confluence have been enhanced by 15% to make it instantaneous. The three distributions Gumble EV-1. 3-Parameter Log Normal and Log Pearson Type-II have been tried for estimating the design flood for Nimoo-Bazgo H.E. Project. The results by various methods were quite comparable. For detail kindly refer Annexure VI of Hydrology Chapter in the Feasibility Report of Nimoo-Bazgo (Alchi) H E. Project. The calculated flood corresponding to 1000-year return period at 95% UCL was 4406 cumec while mean line flood corresponding to 10000-year return period is 4142 cumec in case of Gumbl EV-1 (MOM). Keeping in view the above facts the Design Flood of 4500 cumec for Nimoo-Bazgo H.E. Project has been arrived. The Design Flood of Kanyunche H.E. Project has been derived from the Design Flood of Nimoo-Bazgo H.E. Project using Dicken's Formula.

APPENDIX-8

Central Electricity Authority
HP&I Div
403, Sewa Bhawan,
R.K.Puram, New Delhi

No: 7/9/(NHPC)/2003/ HPI/ 1854 **Dated:** 23-10-03

To
Shri Bal Mukund
ED(P &C)
National Hydroelectric Power Corporation (NHPC)
Office Complex
Sector 33 FARIDABAD
Fax: 95129-2278005/2277941

Sir,

Sub: Preparation of Preliminary Feasibility Report(PFRs):
****

The comments of CWC / CEA on following are enclosed herewith. is enclosed for necessary action at your end please.

1 CWC Comments on Hydrology chapters on following HEProjects (Recd vide letter no 4/330/2003/Hyd. NE/336-37 dt 21.10.03)

i) Kurung St-I &II
ii) Mithudon
iii) Emini
iv) Agoline

2 Comments of SP&PA division, CEA (Recd. Vide letter No. 9/14-/a/2003/SP&PA/ dated 16.10.2003)

i) Dumkhar HEP
ii) Kanyunche HEP

C:/km/wapcos

3. Comments of CWC, HCD (N&W) Directorate (Recd. Vide No. 2/33/2003-HCD(N&W)/637 & Lr. 642, dated 21.10.2003).

i) Dumkhar HEP
ii) Kanyunche HEP

Encls: As above

(Tanmoy Das)
Director(HP&I)

Copy for information to

1 Chief Engineer (Hydrology), CWC
2 Chief Engineer (SP&PA), CEA
3 Director HCD (N&W), CWC

C:\ktn\wapcos

Central Water Commission
HCD (N&W) Directorate

603(S) Sewa Bhawan
R.K. Puram, N. Delhi

Sub: **Preparation of PFR: Draft PFR - Dumkhar H.E. Project (J&K) (3 x 15 MW) – comments in respect of Hydel Civil Design aspects**

Ref: CEA U.O. No. 7/9(NHPC)/03/HP&I/1042 dated 3/10/2003 addressed to Chief Engineer, Designs (E&NE), CWC

The Preliminary Feasibility Report of Dumkhar H.E. Project (J&K) (3 x 15 MW) has been examined in this Directorate in respect of Hydel civil Design Aspects as envisaged in the "50,000 MW Hydroelectric Initiative" document of Ministry of Power. The examination has been restricted to vetting of preliminary lay out of the project. The comments in respect of hydel civil design aspects are as under :

i) Vide Chapter 4, Page 4-1, levels have been indicated as ' ± ' whereas it should be '+' only

ii) Vide Page 5-6, the rate of siltation has been indicated as 0.01233 ha.m./sq.km./year which appears to be on lower side and needs to be reviewed. The "Compendium on Silting of Reservoirs in India" published by CWC in Jan'2001 indicate median values of rate of siltation as 0.211 ha.m./sq.km./year in respect of Himalayar region (Indus, Ganga and Bramhaputra basins)

iii) Vide figure-II, Chapter 5, the elevation area capacity curve indicates capacity at EL 2828 m to be less than the capacity at EL 2824 m. Capacity at a higher elevation cannot be less than that at lower elevation. The elevation area capacity curve may therefore be correctly reviewed.

iv) The lay out plan in Plate-III of Appendix-2 indicates compound bend in the penstock at exit from the downstream face of the dam which should be avoided. Dam block and power house lay out should be so aligned as to eliminate compound bend in the penstock as far as feasible. Further, the L-section along water conductor system should also be incorporated in the Preliminary Feasibility Report.

v) The entire length of steel penstock has been proposed to be embedded in the concrete which may be a costly alternative. Instead, it is suggested that penstock be backfilled with compacted sand and excavated material after covering the penstock with insulation material (say asbestos sheets) in accordance with the established practices for the burried penstock.

vi) Vide Plate-V, Annexure-2 the upslope of tail race channel has been proposed as 3 to 1. This is too steep and should be restricted to a

maximum of 5 to 1 in accordance with USBR Design Standard No. 6 'Turbines and Pumps'.

j) The cost aspects of the project have not been examined by this Dte. It may however be brought out that the proportion of cost of civil and electrical works i.e. Rs. 456.96 crore (civil) & Rs. 105.09 (electrical) appears to be on higher side. This aspect may have to be got reviewed from Cost Appraisal Dte. (HWF), CWC.

This issues with the approval of Chief Engineer, Designs (N&W), CWC.

21/10/03

(M.K. Sinha)
Director

Chief Engineer (HP&I), CEA, Sewa Bhawan, R.K. Puram, New Delhi
U.O. No. 2/33/2003-HCD(N&W)/ 837 Dated: 21st Oct.2003

Copy for information to :

1 Chief Engineer, Designs (E&NE), CWC

2 Director, Cost Appraisal (HWF), CWC, Room No. 904 (N), Sewa Bhawan, R.K. Puram, New Delhi

1. ED (R-II)
2. CE (HIMAN-BAZGO)
3. CE (Civil Design) Sh Deshmukh

केन्दीय विधुत प्राधिकरण
जल विधुत आयोजन तथा अन्वेषण प्रभाग

***

सं. 7/9(NHPC)/एच.पी. एवं आई/ 2003/1351

दिनांक: 19.11.2003.

सेवा में,

[illegible]

ED (Consultancy)

विषय: Project Planning: CWC Comments on Himachal, Kangra (J&K) on Draft PFR

महोदय,

उपर्युक्त विषय पर हमारा/आपका पत्र सं. CWC [illegible] NO 512, ID No 3/143/2003/CMDD(NEW)/399 & 402 dt 18-11-03.

दिनांक 18.11.2003 आवश्यक कार्यवाही हेतु संलग्न है

CE(C-I)

संलग्नक : यथोपरि

भवदीय

प्रतिलिपि : Chief Engineer, Design (E&NE) CWC.

(सूचनार्थ अग्रेषित)

(तन्मय दास)

निदेशक (एच.पी. एवं आई)

ED (Pl. & Con.)
Dy. No. 2561
Date 3/12/3

ED Consultancy
Dy No 46
Dt 3/12/03

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1567
3/12/03

Central Water Commission
CMDD(N&W) Directorate

Sub : Pre-feasibility Report of Dumkhar Hydroelectric Project (3 x 15 MW), Distt. Leh (J&K)

Ref : 1. CEA U.O. No. 7/9(NHPC)/03/HP&I/1042, dated 06-10-2003 addressed to Chief Engineer, Designs(E&NE), CWC
2. CWC U.O. No. 2/33/2003-HCD(N&W)/641, dated 21-10-2003

The following are the observations of this Directorate on the layout of the Concrete Dam & Spillway of Dumkhar H.E. Project :

1. At page 5-6 (Chapter-5) of the report it is indicated that the design flood (4650 cumecs) for the project is calculated on the basis of frequency analysis. No hydrograph is enclosed.

   The design flood to be adopted should be as per guidelines laid down in IS:11223-1985. Adequacy of the value / hydrograph adopted for the same may be got examined from Hydrology Directorate of CWC.

2. At the detailed design stage flood routing studies may be carried out and the no. and size of radial gates be optimized. The free board allowances may be checked at that stage as per relevant BIS codes.

3. The spillway has been provided with breast wall type of arrangement. Stilling basin has been proposed for energy dissipation. However the tail water rating curve is not enclosed. This is necessary for verifying the proposed parameters of the EDA tentatively at this stage.

   The hydraulic performance of both the spillway and the stilling basin may be checked in a hydraulic model at the time of detailed designs.

Contd.....2/-

4. The results of stability analysis of dam and spillway are not enclosed in the report. The same may be enclosed. The seismic coefficient adopted may also be indicated.

Further, the seismic parameters adopted will need to be got approved by the National Committee on Seismic Design Parameters (NCSDP) before taking up detailed designs.

7. As the project is located in Leh district, adequate precautions with regard to construction of concrete dam in cold weather may need to be taken as per IS:7861-1978(Part-II) – Recommended practice for cold weather concreting.

8. It is seen that very elaborate river diversion arrangements are proposed viz.

- Diversion discharge : 2000 cumecs (monsoon period)
- Diversion tunnels : 2 nos., 10m dia., horseshoe, 450m long each
- U/S coffer dam : 27m high
- D/S coffer dam : 12m high

The type of coffer dam proposed is not indicated in the PFR.

Work is not proposed to be done in winter months (i.e. December to February) as per page 11-1 of the report and the diversion is planned for the monsoon months, viz. June, July, August, September.

Normally river diversion arrangements for concrete dams are designed for non-monsoon flows.

It is recommended that the following alternatives be also studied & the river diversion arrangements be finalized based on techno-economic considerations.

Contd.....3/-

i) Considering 5-6 working months per year as concreting period for dam with river diversion arrangements for non-monsoon flows (Non working months are Dec. to Feb. – winter months & June to Sept. – monsoon months)

ii) Considering 8 working months per year as construction period inclusive of the winter months but excluding monsoon months considering all cold weather precautions for dam concreting (refer our comment at 5 above).

This issues with the approval of Chief Engineer, Designs(N&W), CWC.

C.S Mathur

(C.S. MATHUR)
DIRECTOR

Chief Engineer (HP&I), CEA, Sewa Bhawan, R.K. Puram, New Delhi
CWC I.D. No. 3/ 143/ 2003-CMDD(N&W)/ 397 , Dt. 18 November, 2003

Copy to :

i) Chief Engineer, Designs(E&NE), CWC.
ii) Director, Hydrology(N) Dte., CWC.
iii) Director, HCD(N&W) Dte., CWC.
iv) Director, Gates(N&W) Dte., CWC alongwith PFR for vetting / comments .

नैशनल हाइड्रोइलैक्ट्रिक पावर कारपोरेशन लिमिटेड
(भारत सरकार का उद्यम)
आई एस ओ-९००१ और १४००१ प्रमाणित कम्पनी
National Hydroelectric Power Corporation Ltd.
(A GOVT. OF INDIA ENTERPRISE)
ISO-9001 & 14001 Certified Company

NH/CON-229/ 1633

फोन/TEL.

03.11.2003

संदर्भ सं./Ref. No._____

फरीदाबाद/Faridabad_____

The Chief Engineer (HP & I),
403/N, Central Electricity Authority,
Sewa Bhawan,
R. K. Puram,
New Delhi – 110066
Fax No.: 9511-26103332

Sub: Preparation of PFR of Dhumkar (3 X 15 MW) & Kanyunche (3 X 15 MW) HE Projects – Reply of Comments of CWC.

Sir,

Kindly refer to your letter no. 7/9(NHPC)/2003/ HP&I/1154 dated 23.10.2003 on the subject cited above vide which comments of CWC on the Hydel Design aspects of Dhumkar (3 X 15 MW) & Kanyunche (3 X 15 MW) HE Projects has been forwarded.

Point wise reply of comments is enclosed.

Thanking you,

Yours faithfully,

31 X1 03

(S. K. Dubey)
Chief Engineer (Consultancy Services)

Encl: As above.

NOO:

Copy to:

1. **ED (Region –I)**
2. **CE (Nimoo Bazgo)**

Design Division

NH/DD/D-IV/Indus/2003/994 *Date :* 31.10.2003

Sub: **Preparation of PFR- Draft PFR in respect of Dumkhar HE Project, J&K (3 x 15 MW)**

Ref : **Consultancy Division Note No. NH/CON-229/1589 dated 24.10.2003**

This has reference to above note vide which comments of Hydel Civil Design (CWC) has been forwarded to Design Division. The reply of the Para's pertaining to Design (Civil) are as below :

Para-IV : In the preliminary feasibility report, the intake block has been proposed just adjacent to spillway block to minimise entry of silt. Accordingly, the layout of powerhouse & penstock has been made. However, the layout proposed in PFR shall be further optimised in the feasibility report & DPR.

As per the scope of the PFR, approximate 4 nos. drawings were to be added. Accordingly, we have appended 5 nos. drawings for the PFR.

Para-V : After making provision for anchor blocks at the bends, practically small length of the penstock will be left uncovered with the concrete. Further, considering the extreme temperature variation in the region, the entire length of the penstock have been proposed to be embedded in the concrete.

Para-VI : The construction of divide wall between powerhouse & river (cellular wall) will be time consuming as well as costly and therefore to keep its length, minimum, slope of 3H:1V has been proposed in tail pool. However, the performance of tail pool will be verified on model studies during construction stage.

(Anuj Kumar Jha)
Engineer (Civil)

ISO-9001 & 14001 Company

CE (Design)

GM (Design- IV)

GM (Consultancy)

ED(I) CE(D-IV)

Based on above, we may inform CEA vide copy to CWC / CSO

ED (D-I) / CE (Mumbai)

Design Division

NH/DD/D-IV/Indus/2003/ 1095 *Date :* 08.12.2003

Sub: **Preliminary Feasibility Report of Dumkhar and Kanyunche HE Projects – Replies of Comments of CWC (CMDD)**

Ref : **Consultancy Division Letter No. NH/CON-229/1852 dated 04.12.2003**

This has reference to CEA letter no. 7/9 (NHPC)/HP&I/2003/1359 dt. 19.11.2003 vide which observations of CWC (CMDD) have been forwarded to Design Division. The replies of the Paras pertaining to Design (Civil) are as below :

Point No.-3 : No tail water rating curve has been developed at pre-feasibility stage. The parameters of energy dissipation arrangement have been proposed as per experience of NHPC on similar type of projects. However, this aspect has been included in the further studies in Chapter-VI of Conceptual Layout & Planning.

Point No.-4 : The stability analysis is not in the scope of work of pre-feasibility report. The dam section has been proposed as per experience of NHPC on similar type of projects. However, this aspect has been included in the further studies in Chapter-VI of Conceptual Layout & Planning.

Point No.-5 : We agree that adequate provision as per IS 7861-1978 (Part-II) of Recommended practice for cold weather concreting, has to be included at construction stage.

Point No.-6 : At the PFR stage, concreting has been proposed in the fair weather i.e. March to October. Accordingly, the diversion has been proposed for these months. However, optimisation of flood diversion arrangement shall be done at feasibility stage/DPR stage. This aspect has been included in the further studies to be done in the Chapter-VI. Further, the type of coffer dam proposed is Rockfill type.

Submitted please.

(Rajat Gupta)
Manager (Design-IV)

CE (Design) 8/12/03

GM (Design- IV) 3/12/03

GM (Consultancy) 9/12

cc : ED(R-I)
Sh Sh Y. Paliwja - CE (Nimoo-Bazgo)

ISO-9001 & 14001 Company

APPENDIX-9

Central Electricity Authority
HP&I Div
403, Sewa Bhawan,
R.K.Puram, New Delhi 1100066

No. 7/9/(NHPC)/2003/HP&I/ 1120 **Dated** 30 **Oct., 2003**

To
Shri Bal Mukund
ED(R&C)
National Hydroelectric Power Corporation (NHPC)
Office Complex
Sector 33 FARIDABAD (Fax: 95129-2278005/2277941)
Sir,

Subject : Preparation of PFRs – comments on draft PFRs (8 Nos.) submitted by NHPC.

*****

Reference is invited to your letters vide which copies of draft PFRs in respect of the following HE projects were received.

i.	Dikchu	3x35 MW
ii.	Agoline	3x125 MW
iii.	Kurung	3x110 MW
iv.	Emini	4x125 MW
v.	Dumkhar	3x15 MW
vi.	Kanyunche	3x15 MW
vii.	Naying	4x250 MW
viii.	Basania	3x30 MW

Copies of draft PFRs have been forwarded to Central Water Commission. The comments of CWC on hydrological, layout planning aspects on some of the Draft PFRs have already been forwarded and other comments for draft PFR would be forwarded as soon as they are recieved. In continuation to above the comments of Hydrology division, CWC on Draft PFR of Dumkhar & Kanyunche , Naying HE Project are enclosed at **Annex-I**

In continuation to comments of SP&PA Division, CEA on power evacuation aspects of some of the draft PFR already sent, the comments on draft PFR of Naying & Agoline HE project is enclosed as **Annex-II** . Other comments would be forwarded as soon as they are received.

Our comments on power potential studies draft PFR for the above 8 projects are given at **Annex – III**

C:/krn/nhpc

It is requested that the same may be taken into account while finalizing the PFRs.

Encl : As above

(TANMOY DAS)
Director (HP&I)

Copy to : (for information -without enclosure)

i. Chief Engineer, SP&PA Division, CEA
ii. Chief Engineer, Design (E&NE)
iii. Chief Engineer, Hydrology, CWC

Director(HP&I)

C:/krn/nhpc

HP&I Division, CEA Comments on draft PFRs :

A- General comments on 8 Nos Draft PFRs

1. An Executive Summary may also be incorporated in the PFR as per format given at **Annex – IV.**
2. It may be ensured that the Initial Environmental studies incorporated in the PFR are as per scope of work for PFR .
3. The Financial Parameters may be taken as per guidelines sent vide our Lr. No. 7/9/HPI-2003/1118-1123, dated 21st October, 2003.
4. The Cost Estimates may be prepared taking into account the Guidelines sent vide our Lr. No. 7/9/HP&I/2003/1163-1172, dated 24.10.2003.
5. NHPC may indicate recommendations for further studies required wherever necessary in the relevant chapters of PFRs for consideration during Feasibility Report/DPR stage.
6. It is presumed that geological inputs of the area are as per information supplied by GSI. The report of GSI may also be included in the PFR.
7. It may be ensured that the Installed Capacities & assessment of power benefits takes into account various comments and advise given in this regard.
8. It may be ensured that the water availability adopted for power potential studies is approved by CWC.
9. The power evacuation arrangements considered in the PFR should take into account views and suggestions of SP&PA Division of CEA.

B-Power potential studies :

i. **Dumkhar :** In the yearwise summary table, the load factor of operation during monsoon and lean flow period may be indicated for all the years.

ii. **Kanyunche :** In the yearwise summary table, the load factor of operation during monsoon and lean flow period may be indicated for all the years.

iii. **Kurung :** Reasons for keeping the reservoir at MDDL between 1st May to 20th July, which was pointed out by us in our earlier communication dated 24.4.2003 has not been given in the draft PFR. This may be explained in the PFR.

C:/krn/nhpc

iv. **Basania :** It was pointed out by us in earlier comments dated 21.09.2003 that the hydrological year is to be considered from June to May instead of July to June and evaporation losses have to be taken in to account in the power potential studies. This has not been done in the draft PFR and may be taken in to account while finalizing the PFRs.

v. **Dikchu:** In the yearwise summary table, the load factor of operation during monsoon and lean flow period may be indicated for all the years.

vi. **Emini :** In the yearwise summary table, the load factor of operation during monsoon and lean flow period may be indicated for all the years.

vii. **Agoline :** In the yearwise summary table, the load factor of operation during monsoon and lean flow period may be indicated for all the years.

viii. **Naying:** It may be ensured that all our previous comments sent vide letter dated 09.10.2003 are taken into account.

C:/krn/nhpc

DESIGN (E&M) DIVISION

NH/DEM/DLM-KAN //02/4182 Date: 24.11.03

SUB: Reply to Observations of CEA on PFR Projects-Dumkhar & Kanyunche HE Projects

Ref: Note no. NH/CON/229/1635 dated 03.11.03

With reference to above cited letter the reply of the CEA observations in respect of Dumkhar and Kanyunche HE Projects pertaining to this Division is as under.

i) **Dumkhar: In the Year-wise summary table, the load factor of operation during monsoon & lean flow period may be indicated for all the years.**

The Summary Table indicating load factor for monsoon & lean periods have been enclosed.

ii) **Kanyunche: In the Year-wise summary table, the load factor of operation during monsoon & lean flow period may be indicated for all the years.**

The Summary Table indicating load factor for monsoon & lean periods have been enclosed.

Submitted please.

(Lakhmi Chand)
Asstt. Mgr. (Elect)

C.E. (DEM-IV)

GM (DEM-IV) 24/11/03

ED (DEM) 24/11

ED (Consultancy) 24/11

ISO-9001 & 14001 Company

DUMKHAR HE PROJECT (3X15 MW)

SUMMARY TABLE FOR LOAD FACTOR FOR HIGH & LEAN INFLOW PERIOD

Year	Load Factor	
	High inflow	Lean inflow
1982-83	93.53%	36.35%
1983-84	93.93%	37.01%
1984-85	95.00%	36.99%
1985-86	93.60%	33.92%
1986-87	95.00%	35.28%
1987-88	94.38%	28.09%
1988-89	95.00%	35.73%
1989-90	94.97%	35.90%
1990-91	95.00%	40.80%
1991-92	92.90%	34.22%

APPENDIX-10

Final Report

Satellite Remote Sensing Based Inputs for Initial Environmental Study in respect of 5 Proposed Hydro-Power Sites in Indus Basin in Jammu & Kashmir

Name of the Hydro-Power Site : DUMKAR

Prepared for

National Hydroelectric Power Corporation Ltd.
NHPC Office Complex, Sector - 33
Faridabad – 121003

Water Resource Division
Water Resource & Oceanography Group
Remote Sensing & GIS Applications Area
National Remote Sensing Agency
Dept. of Space, Govt. of India
Balanagar, Hyderabad- 500037

February, 2004

Central Electricity Authority
HP&I Div
403, Sewa Bhawan,
R.K.Puram, New Delhi

No: 7/9/(NHPC)/2003/ HPI/ 1454 **Dated:** 23-10-03

To
Shri Bal Mukund
ED(P &C)
National Hydroelectric Power Corporation (NHPC)
Office Complex
Sector 33 FARIDABAD
Fax: 95129-2278005/2277941

Sir,

Sub: Preparation of Preliminary Feasibility Report(PFRs):
****

The comments of CWC / CEA on following are enclosed herewith. is enclosed for necessary action at your end please.

1. CWC Comments on Hydrology chapters on following HEPtojects (Recd vide letter no 4/330/2003/Hyd. NE/336-37 dt 21.10.03)

   i) Kurung St-I &II
   ii) Mithudon
   iii) Emini
   iv) Agoline

2. Comments of SP&PA division, CEA (Recd. Vide letter No. 9/14-/a/2003/SP&PA/ dated 16.10.2003)

   i) Dumkhar HEP
   ii) Kanyunche HEP

C:\km\wapcos

3 Comments of CWC, HCD (N&W) Directorate (Recd. Vide No. 2/33/2003-HCD(N&W)/637 & Lr. 642, dated 21.10.2003).

i) Dumkhar HEP
ii) Kanyunche HEP

Encls: As above

(Tanmoy Das)
Director(HP&I)

Copy for information to

1. Chief Engineer (Hydrology), CWC
2. Chief Engineer (SP&PA), CEA
3. Director HCD (N&W), CWC

C:\km\wapcos

Central Electricity Authority
SP&PA Division

Sub - PFR in respect of Dumkhar HEP (3x15MW) and Kanyunche HEP (3x15MW) in Leh district of J&K

Chief Engineer (HP&I) vide U.O. no. 7/9 (NHPC)/03/(HP&I)/1043 dt. 06.10.03 have enclosed copy of preliminary feasibility report on Dumkhar HEP (3x15MW) and Kanyunche HEP (3x15MW) in Leh district of J&K for examination and comments of SP&PA division on the power evacuation aspects.

The Project report has been examined and our observation/comments on the same are enclosed.

This issues with the approval of Chief Engineer (SP&PA).

Encl - As above

(A.K. Asthana)
Director (SP&PA)

Chief Engineer (HP&I)

No. 9 14-A/2003/SP&PA/ Dated: 16.10.03

Power evacuation aspects: -

A **Dumkhar HEP (3x15 MW) in Leh district of J&K**

The pre-feasibility report on Dumkhar HEP submitted to CEA indicates that the project would be located in Leh district of J&K with 3x15 MW generating unit. It is mentioned that the power from the project would be evacuated through 2 nos. of 66 kV D/C line to the nearby 220 kV S/S to be constructed by POWERGRID. It is further mentioned that during low inflow period (winter season) the firm power availability from the project would be 11.66 MW.

The details of generation voltage as well as step up voltage are not indicated in the project report, and the single line drawing of the generation switchyard is also not furnished.

B **Kanyunche HEP (3x15 MW) in Leh district of J&K**

The pre-feasibility report on Kanyunche HEP submitted to CEA indicates that the project would be located in Leh district of J&K with 3x15 MW generating unit. It is mentioned that the power from the project would be evacuated through 2 nos. of 66 kV D/C line to the nearby 220 kV S/S to be constructed by POWERGRID. It is further mentioned that during low inflow period (winter season) the firm power availability from the project would be 12.09 MW.

The details of generation voltage as well as step up voltage are not indicated in the project report, and the single line drawing of the generation switchyard is also not furnished.

Recently POWERGRID had furnished a proposal for linking the Leh region with Srinagar valley through a 220 kV D/C line. The matter was discussed in detail in a meeting taken by Secretary, Power on 22.09.03, wherein, it was proposed that besides the 220 kV S/S at Alistang (to be constructed by PDD, J&K) four new S/Ss ie, Drass, Kargil, Khalsi and Leh would be constructed by POWERGRID enroute the proposed line

NHPC though have intimated that 66 kV line from both these project would be taken to the nearest 220 kV S/S of POWERGRID. However the distance of the projects from the nearest proposed 220 kV S/S of POWERGRID is not indicated. In absence of the same it is difficult to examine the project from Tecno-economic angle. The Project authorities may, therefore, intimate the following:-

(i) Proposed generation voltage of the project.
(ii) Distance of the project from the nearest 220 kV S/S to be created by POWERGRID.
(iii) No. of line bays that would be made available for evacuation of power
(iv) Tentative time frame of the project

नैशनल हाइड्रोइलैक्ट्रिक पावर कारपोरेशन लिमिटेड
(भारत सरकार का उद्यम)
आई एस ओ-९००१ और १४००१ प्रमाणित कम्पनी
National Hydroelectric Power Corporation Ltd.
(A GOVT. OF INDIA ENTERPRISE)
ISO-9001 & 14001 Certified Company

NH/CON-229/ 1611

फोन/TEL.

30.10.2003

संदर्भ सं./Ref. No.

फरीदाबाद/Faridabad

The Chief Engineer (HP & I),
403/N, Central Electricity Authority,
Sewa Bhawan,
R. K. Puram,
New Delhi – 110066

Fax No.: 9511-26103332

Sub: Preparation of PFR of Dhumkar (3 X 15 MW) & Kanyunche (3 X 15 MW) HE Projects – Reply of Comments on Power evacuation studies.

Sir,

Kindly refer to your letter no. 7/9(NHPC)/2003/ HP&I/1154 dated 23.10.2003 on the subject cited above vide which comments of Director (SP & PA) has been forwarded.

The parawise reply is as under:

(i) "Proposed generation voltage of the project"

Generation voltage has been envisaged as 11 kV for both the projects

(ii) "Distance of the project from the nearest 220 kV sub-station to be created by POWERGRID"

POWERGRID has submitted the FR for 220 kV S/C Transmission line from Alistong to Leh via Kargil where provision for two nos. of substations has been envisaged one at Kargil and another at Leh. However, J&K PDD has suggested for two more substations en-route at Dras in Kargil and Khalsti in Leh District. At present aforesaid proposals is in planning stage. In view of this, line length of 50 km has been taken for both the projects for estimation of cost considering Khalsti sub station would be coming up in near future.

(iii) "No. of line bays that would be made available for evacuation of power".

Two nos. of 66 kV line bays have been envisaged for evacuation of 45 MW power from each power station.

(iv) "Tentative time frame of the project"

The construction period would normally be 48 to 54 months from the date of Government approval.

Further Power evacuation aspects can be considered at DPR Stage.

Thanking you,

Yours faithfully,

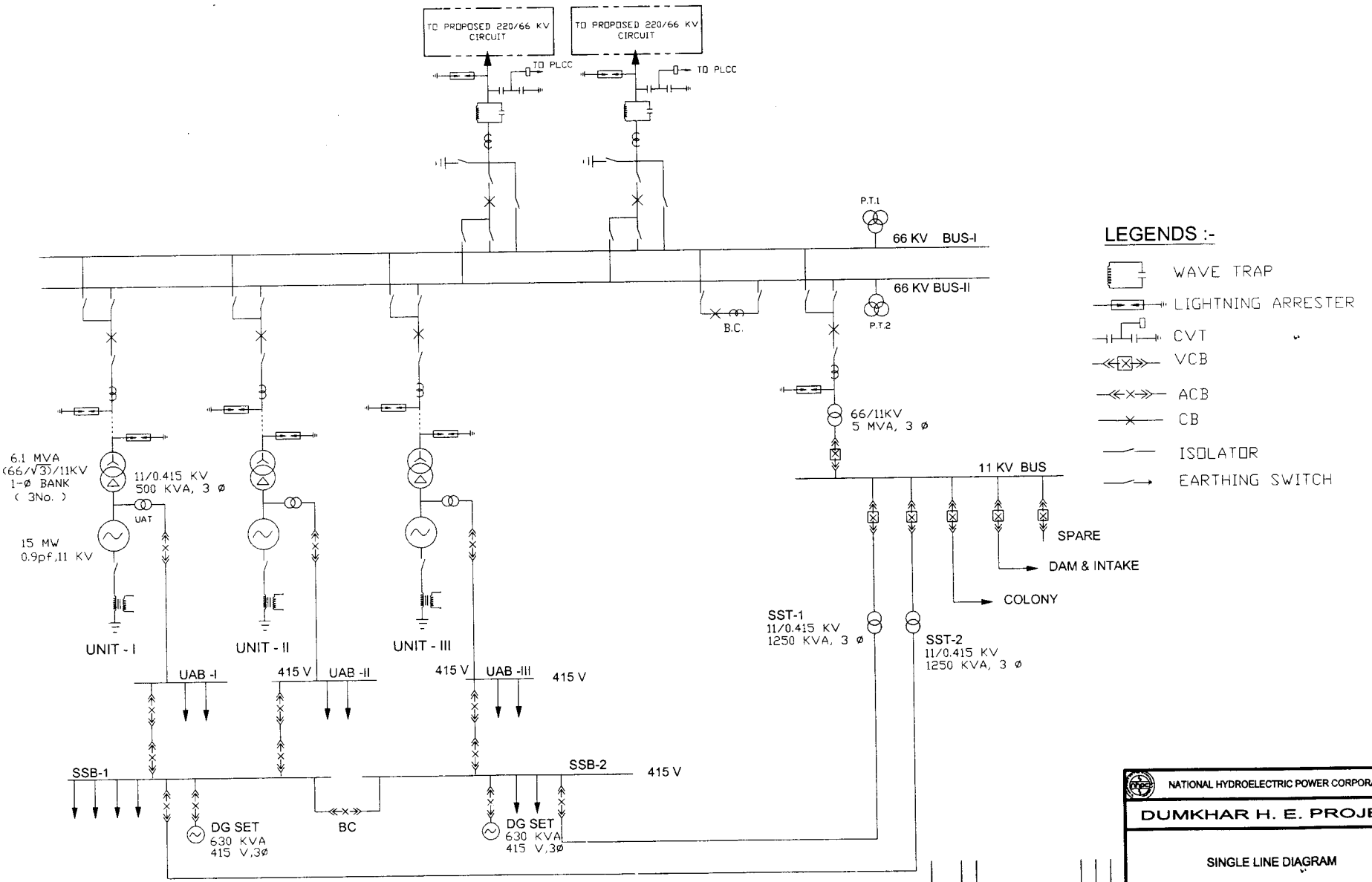
30/10

(S. K. Dubey)
Chief Engineer (Consultancy Services)

NOO:

Copy to:

1. **ED (Region –I)**
2. **GM (DEM – IV)** w.r.t. note no. NH/DEM/DUM-KAN/02/3861 dated 28.10.2003.
3. **CE (Nimoo Bazgo)**



NATIONAL HYDROELECTRIC POWER CORPORATION LTD.

DUMKHAR H. E. PROJECT

SINGLE LINE DIAGRAM

DRAWN	SUBMITTED	RECOMMENDED	APPROVED
VED PAL			

DATE	DRG. NO.	REV
SEP. 2003	NH/DEM/DUM/SLD-01	0

DATE	NO.	REVISION OR ISSUES	BY	CH.	APP.

APPENDIX-11

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List of Maps

List of Tables

1. Study Background

Central Electricity Authority (CEA) under Ministry of Power, Govt. of India has earlier identified 399 potential hydroelectric sites in the country with an installed capacity of 1,07,000 Megawatt (MW). With a view to preparing an action plan to develop this hydroelectric potential and prioritizing the implementation of hydro-electric projects, a Ranking Study was taken up by the CEA in 2001. This Ranking Study identified 162 most potential sites with a total installed capacity of 50,560 MW for development.

Preparation of Pre-Feasibility Reports (PFR) of these 162 sites has been initiated by the CEA in 2002 with works entrusted to a number of Consultants, namely, National Hydroelectric Power Corporation (NHPC), North Eastern Electric Power Corporation (NEEPCO), Water And Power Consultancy Services India Limited (WAPCOS), Satluj Jal Vidut Nigam Limited (SVJNL) , Himachal Pradesh State Electricity Board (HPSEB), Uttaranchal Jal Vidut Nigam Limited (UJVNL) and Kerala Power Corporation Limited (KPCL) with time target of completion of the whole exercise by September 2003. To oversee the progress of the PFRs preparation in time and with full cooperation of the Central Government agencies, a Central Coordination Committee consisting of Central Electricity Authority (CEA), Central Water Commission (CWC), India Meteorological Department (IMD), Ministry of Environment & Forest, Survey of India, Geological Survey of India (GSI) and National Remote Sensing Agency (NRSA) was constituted by the CEA with Member (Hydro-power) as its Chairman. The Committee is sitting periodically in presence of the representatives of the Consultants to take stock of the completion of the studies. One of the mandates of PFR preparation is “Initial Environmental Study” with respect to each of the 162 proposed sites using satellite remote sensing data.

As is well known in India and elsewhere in the world, space technology plays a very important role in terrain mapping and scientific assessment of the ground condition at speed, and is ideally suitable for inaccessible mountainous regions where majority of these hydroelectric dam/diversion sites are located. Computer processing of satellite digital data of the dam / diversion sites and their immediate environ provides wealth of information for preparation of the Pre-Feasibility Reports. The Potential of this technology was amply demonstrated in the preliminary ranking study of the 81 proposed hydro-electric sites in Indus Basin completed by NRSA in October 2001 on behalf of CEA. In view of this, NRSA has been approached by a number of consultants, namely, NHPC and HPSEB to take up Initial Environmental Studies in respect of 37 proposed hydro-power sites located in the States of Arunachal Pradesh, Himachal Pradesh, Jammu & Kashmir and Madhya Pradesh using most recent satellite remote sensing data.

Regional Office of NHPC, Faridabad at with responsibility of survey and investigation in Indus basin in Jammu & Kashmir, has approached NRSA for satellite remote sensing based inputs for initial environmental study of 6 hydro-power sites of which 5 sites are located in Indus basin, Jammu & Kashmir and one site in Narnada river basin, Madhya Pradesh.

This Report deals with Dumkar hydro-power site.

2. Objective

Principal objective of the satellite based study is to acquire Indian Remote Sensing satellites (IRS 1C/1D) LISS-III and PAN sensor digital data of the hydro-power sites and to make quick analysis of these data in terms of estimation of the

submergence area at proposed Full Reservoir Level (FRL) and mapping of land use - land cover information within and in immediate surrounding of the proposed submergence area as inputs for Initial Environmental Study (IES) of the Pre-Feasibility Report.

The **specific objectives and scope of the study** are:

- To estimate the area of submergence at proposed FRL of the proposed hydro-power sites

- To analyse the satellite data for identifying broad landuse - landcover categories like agricultural land, forest land, barren land, scrub land, water bodies, settlements, infrastructural features (roads and bridges) and to estimate the area under each of the categories within and in immediate surrounding of the proposed submergence area at FRL.

- To prepare land use - land cover map at 1:50,000 scale and/or 1:25,000 scale of the submergence area and its immediate surrounding for each hydro-power site.

3. Salient Features of the Dumkar Hydro-Power Site

Proposed hydro-power site viz. Dumkar Hydropower Project in Indus Basin in Jammu & Kashmir is falling in Survey of India topo sheet No.52B/15. The proposed project scheme at Dumkar envisages construction of a Dam on on Indus river, and a power house with a installed capacity of 130 MW. FRL is proposed to be 2858 metre above MSL. The river water will be stored in the reservoir which will be diverted through the Head-Race Tunnel to the Power House for hydro-

power generation and subsequent power evacuation to areas in Jammu & Kashmir and other areas.

The geographic location of Dam and Power House for this hydro-power site is given below :

	Dam	**Power House**
Latitude :	34° 28' 09" N	Located at the toe of the Dam
Longitude:	76° 40' 06" E	

4. Satellite data Used

Indian Remote Sensing Satellite, IRS-ID LISS III and PAN sensors data of 4th October, 2002 covering the study site were procured from the NRSA Data Centre (NDC) after intensive browsing of the available satellite data for cloud-free and radiometric suitability. IRS-1D covers the study site by satellite geo-reference number Path 94 and Row 46. These data are geometrically and radiometrically corrected digital data products which can be used readily in Window based image analysis platform.

5. Brief Methodology of Satellite Data Analysis

Image processing and analysis was done using ERDAS Imagine image analysis software in Windows platform. Satellite data of IRS 1D LISS III sensor provides 23.5 m spatial resolution and PAN sensor provides 5.8m spatial resolution. The two sensor data were geocoded and digitally merged using IHS transformation technique . Baseline information layers (like rivers/ streams) and infrastructural features (like roads and bridges), settlements / villages were initially interpreted on the digital image scene. Subsequently, image

classification technique was performed to obtain the land use-land cover categories of the study area.

Output maps were composed in the image processing system which provide the landuse / landcover information along with other interpreted information such as roads, settlements etc., within the 7 Km radius from the dam site. The Full Reservoir Level (FRL) boundary, provided by the NHPC, Regional Office at Farodabad, was superimposed on the satellite data as well as on the land use - land cover map. Area statistics of different landuse-landcover categories were generated within the submergence area at FRL and within the 7 km radius circle from the dam site.

6. Outputs provided

Based on the analysis of the satellite data and other available ancillary information, the following outputs were generated :

- **Map 1 (a)** Shows IRS 1D LISS III satellite image of 4th October, 2002 on 1:50,000 scale covering 7 km radius from the dam site overlaid with FRL , location of dam site and power house.

- **Map 1(b)** Shows satellite derived landuse-landcover map on 1:50,000 scale covering 7 km radius from the dam site overlaid with FRL , location of dam site and power house. Land use /land cover map shows the following categories : Agricultural Land, Open Scrub, Barren and Rock Outcrop, Settlements, River Course/ Dry River Bed.

- **Map 1(c)** Shows the landuse- landcover classes and their corresponding area statistics in hectares within the submergence area on

1:25000 scale overlaid with FRL, location of dam site and power house.

- **Map 1 (d)** Shows the location of the National parks / Wildlife Sanctuaries vis-à-vis the location of the dam/ Power House and 7 km radius area around the dam site.

- **Table.1 Landuse-landcover Information within the Submergence Area**

S.No	Landuse-landcover Category	Area under submergence (Ha)	% of the total submergence area
1	High Dense Forest	Nil	Nil
2.	Medium Dense Forest	Nil	Nil
3.	Low Dense Forest	Nil	Nil
4.	Open Scrub	1.9	1.31
5.	Barren / Rock Outcrop	47.8	32.99
6.	Snow	Nil	Nil
7.	Agricultural Land	5.7	3.93
8.	Human Settlement	Nil	Nil
9.	River Course including dry river bed	89.5	61.77
	Total	**144.9**	**100.00**

- **Table.2 Landuse-landcover Information within the 7 Km Radius from the Dam site at Dumkar**

S.No	Landuse-landcover Category	Total Area (ha)	% of the total area
1	High Dense Forest	Nil	Nil
2.	Medium Dense Forest	Nil	Nil
3.	Low Dense Forest	Nil	Nil
4.	Open Scrub	610	3.96
5.	Barren / Rock Outcrop	14296	92.87
6.	Snow	Nil	Nil
7.	Agricultural Land	284	1.85
8.	Human Settlement	11	0.07
9.	River Course including dry river bed	192	1.25
	Total area	**15393**	**100.00**

7. Critical Analysis of Satellite based Initial Environmental Study

- Total area under submergence at proposed FRL of 2858 m. (above MSL) is estimated to be 144.9 ha (Table.1).

- The agricultural area present in the submergence area is very less (5.7 ha. which is 3.93 percent of the submergence area) which is a positive indicator of insignificant environmental cost, should the proposed hydro-power project is developed at this site.

- It is observed that the land use – land cover is mostly dominated by barren / rock outcrop which is 47.80 ha (33 % of the submergence area). Open scrub land, which is present to the extent of 1.9 ha. (1.31 % of the submergence area).

- There are no surface water bodies other than the river course. The area under river course including dry river bed is estimated to be 89.5 ha constituting 61.77 % of the submergence area, indicating the FRL is mostly confined within the river course (Gorge section) indicating a near ideal location to develop the proposed hydro power site.

- It is observed that settlements within the submergence appear to be nil hence no rehabilitation issues to be addressed in developing this hydro power site. This is a positive indicator so far as socio-economic and demographic factor is concerned with respect to the proposed hydro-power development project.

- It is observed that there is no permanent snow in the submergence area.

- It is observed that the road runs along the Indus river and the proposed FRL is very close to this road. Though enough care is taken to avoid submergence of this road by keeping the elevation difference between the road and the proposed FRL, it appears that at few small stretches (at the bends) the road is likely to be affected by the proposed HE scheme. Therefore it requires a close look on the ground.

- The immediate environs of the proposed hydropower project indicates similar land use land cover pattern as that of the submergence are, dominated by barren / rock outcrop land use, followed by open scrub area and agricultural land (Table 2).

- In the absence of available information from other sources about the existence and spatial extent of national parks and wildlife sanctuaries, best efforts were made to collect information from the Internet. The information available in website of United Nations Environment programme World Conservation Monitoring Center (http://www.unep-wcmc.org), regarding Jammu & Kashmir State and its National Parks / Wild Sanctuaries, were browsed through. The information at hand is made use in preparing map 1(d) which depicts the latitude and longitude of dam site and the sanctuaries/national parks. 7 km radius circle around the dam is plotted and the radial distance to the various national park/ sanctuary were estimated around the nearest national park/ sanctuary which are of significant only are measured on the map 1(d). The following points are observed from the map 1(d).

- The nearest National park is Kanji which is about 31.5 Km from the dam site. The nearest sanctuary is Hemis which are about at distance of 103.8 Km. So it is observed that the dam site is more than 31.5 Km away from the National park and sanctuaries.

- Since 7 Km radius around the dam site was considered as the area of study, efforts were made to check whether the geo-coordinates of this Wildlife Sanctuary is falling within the area of study. The map No. 1(d) explains the location of the sanctuary vis-à-vis the dam site and the power house.

8. Conclusion & Recommendation

1. Satellite based study has provided insight into the landuse-landcover pattern and their spatial extent within the submergence area at FRL and within the 7 Km radius vicinity of the proposed dam site. Such detail information on a scale of 1:25,000 are not available from any other sources at present.
2. It is observed that, there are no settlements present within the submergence area. This is a positive indicator of this hydropower site. Within the 7 km radius of the dam site, there are small pockets of human settlements (11 ha.). However, socio-economic and demographic data of this and others not identified need to be verified on the ground.

3. The extent of agricultural land is insignificant (5.7 ha., within submergence area. The environmental cost on this score therefore is very less and can easily be relocated.

4. The FRL mostly confining to the river course, indicating a nearly ideal location of the proposed hydropower site.

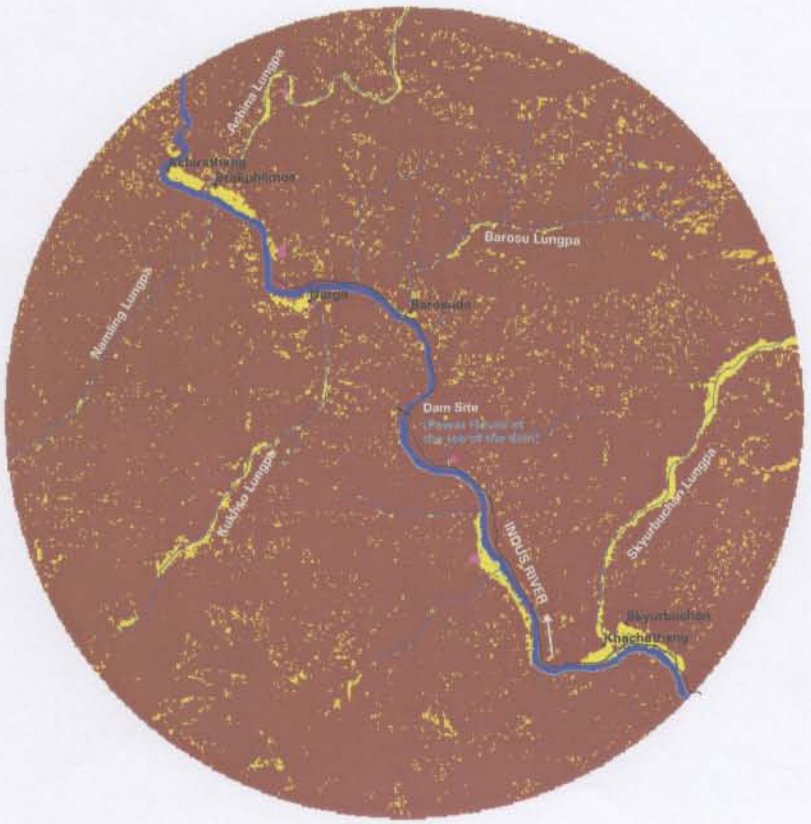
5. The nearest National park is Kanji which is about 31.5 Km from the dam site. The nearest sanctuary is Hemis which are about at distance of 103.8 Km. So it is observed that the dam site is more than 31.5 Km away from the National park and sanctuaries according to the information collected from several websites. The location and wildlife of this sanctuary will in no way be affected by the hydro-electric project, since the fetch distance of the reservoir submergence will be around 8.659 Km only.

Satellite Remote Sensing based Inputs for Initial Environmental Study

PROPOSED HYDRO - POWER SITE DUMKAR, JAMMU & KASHMIR

1 (a) IRS 1D LISS III satellite image of 4th October 2002

Satellite Remote Sensing based Inputs for Initial Environmental Study
PROPOSED HYDRO - POWER SITE DUMKAR, JAMMU & KASHMIR



Scale =1 : 50000

1 0 1 2 Km

Legend

	Area* (ha)
Barren / Rock outcrop	14296
Agricultural/Fallow Area	284
Open Scrub	610
Settlements	11
Road	
River course with dry river bed	192
Dam	
Submergence area	

* Area estimates of land use - land cover within this area

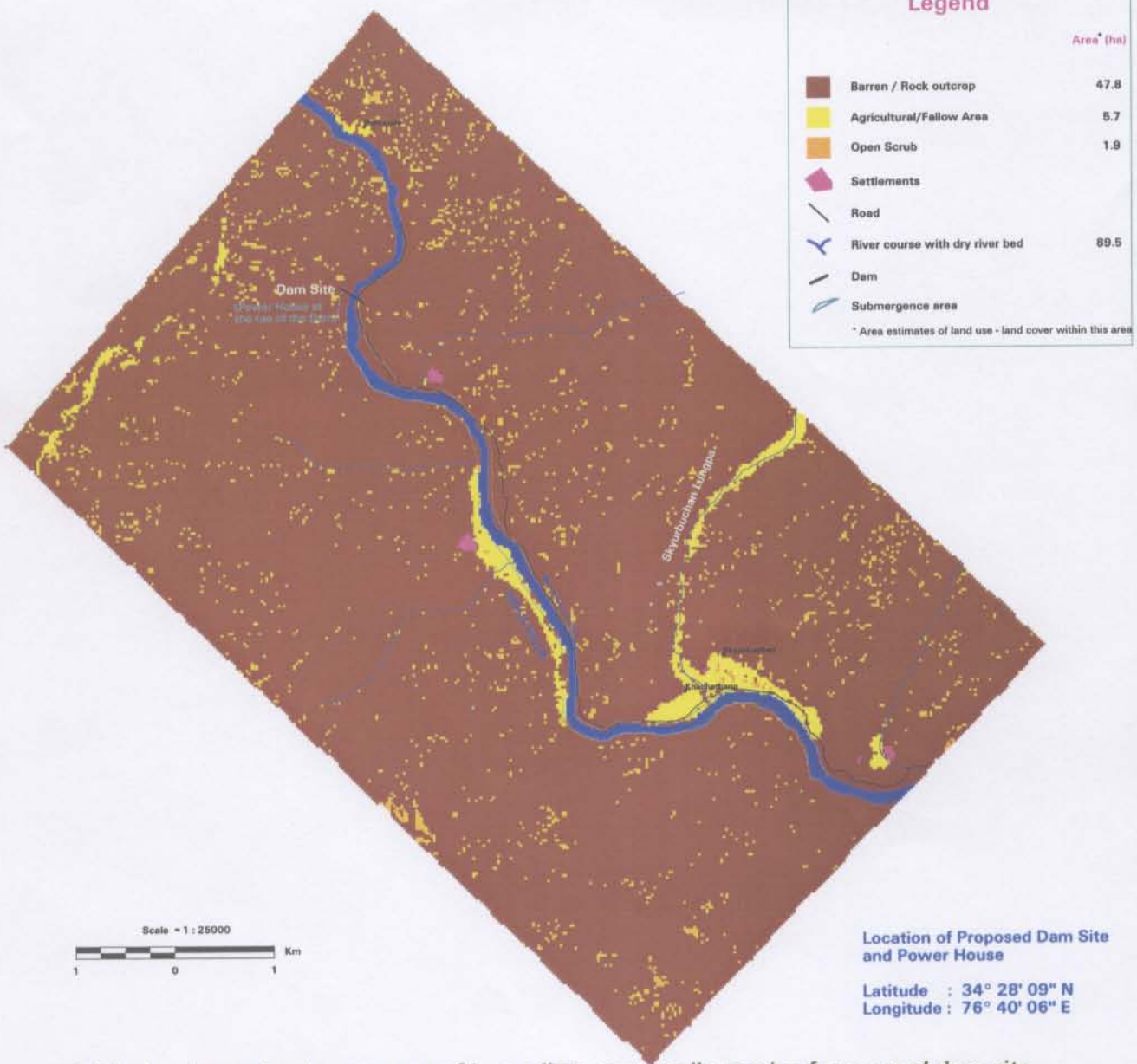
Location of Proposed Dam Site and Power House

Latitude : 34° 28' 09" N
Longitude : 76° 40' 06" E

1 (b) Satellite derived land use - land cover map of surroundings of Dumkar, Jammu & Kashmir

Satellite Remote Sensing based Inputs for Initial Environmental Study

PROPOSED HYDRO - POWER SITE DUMKAR, JAMMU & KASHMIR



1 (c) Land use - land cover map of immediate surroundings u/s of proposed dam site at Dumkar, including submergence area

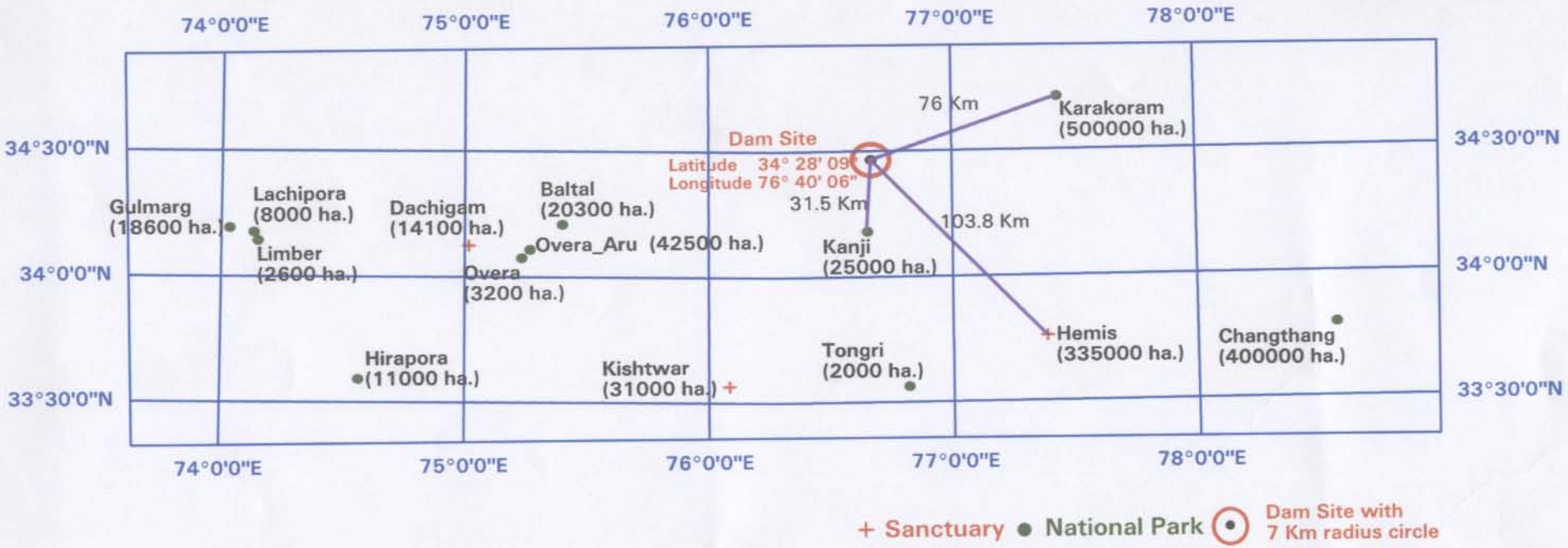


Fig 1d Map of National Parks / Sanctuaries and the location of Dumkar hydropower site and 7 km radius circle from the dam site