LANCO GREEN POWER PRIVATE LTD.

Catchment Area Treatment Plan

of

BUDHIL HYDRO-ELECTRIC PROJECT (70MW) BHARMOUR

CHAMBA-HIMACHAL PRADESH

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PREFACE

The document in hand is the Catchment Area Treatment Plan of the Budhil Hydro Electric Project 70 M.W. The Programme includes, afforestration over 270 ha. of Degraded Forest land at a cost of Rs.146.68 lacs, Enrichment Plantation over existing areas having less density Forest to the tune of 150 ha. at a total cost of Rs.63.67 lacs, Pasture Development at a cost of Rs.49.80 lacs, stabilization of land slips costing Rs.10 lacs, stream banks stabilization at a cost of Rs.5 lacs, Development of medicinal plants Rs.10 lacs, Development of wild life costing Rs.20 lacs, soil and water conservation at a total cost of Rs.20 lacs and Rs.30 lacs have been provided for infrastructural development for programme implementation, thus total cost of CAT Plan shall be Rs.495.40 lacs. In addition the price of wooden fence posts required under afforestration, enrichment plantation, pasture development and Development of medicinal plants numbering 1,07,850 amounting to Rs.140.205 lacs shall be paid by the Project Proponents to the Forest Deptt. as and when demanded.

In addition compensatory plantation covering 56 ha. costing Rs.35.75 lacs shall be undertaken by Forest Department. Similarly present net environment value of land to be transferred to Forest Department amounting to Rs.170.35 lacs and Price of trees to be transferred to promoter agency amounting to Rs.11.8 lacs shall also be paid by the Project Proponents.

In addition the programme of EMP and LADA shall also be implemented by various concerned departments for which money as provided shall be placed at the disposal of the respective departments.

It is hoped that these proposals shall take full care of preservation and development of catchment area including environment preservation and local area development.

Dated: December, 2005

Place: Chamba

Conservator Forest Chamba	**D.F.O. Bharmour**	**General Manager, Project Proponent (Lanco Green)**	**Managing Director Dhiman Enviro-Forestry Consultant**

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Ravi river is one of the major rivers of Indus basin. It originates at an elevation of 4229 m above mean sea level from mid Himalayas in Bara Bhangal situated in Kangra District of Himachal Pradesh. After traversing for some distance in Bara Bhangal, it enters Trehta valley of Bharmaur Tehsil in Chamba district upstream of Chulan-Pandban forests. The river runs for about 100 km in Chamba district, HP and then flows through Punjab on the left bank and Jammu & Kashmir on the right bank where after it enters Pakistan downstream of Madhopur-Kathua (J&K).

1.2 PERSPECTIVE PLAN

A major plan for harnessing hydel potential of Ravi river within Himachal Pradesh State territory has been drawn by Himachal Pradesh State Electricity Board and schemes with total installed capacity of 2338 MW have been identified. Some of these are now completed and are under operation, some under execution and some under investigation. Table-1 below indicates the present status of stage of harnessing of the identified hydel potential in Ravi basin.

TABLE 1.1 STATUS OF IDENTIFIED HYDEL POTENTIAL IN RAVI BASIN

Sl. No.	Description/ Name of Scheme	River Nallah	Installed Capacity (MW)	Remarks / Agency
A. Under Operation				
1	Baira Suil	Baira Suil and Bhaled	198	NHPC
2	Chamera Stage-I	Ravi	540	NHPC
3	Gharola	Gharola N.	0.05	HPSEB
4	Bhuri Singh	Sal N.	0.45	-do-
5	Bharmaur Micro	Bharmaur N	0.02	-do-
6	Sal Stage II	Sal N	2	-do-
7	Chamera Stage II	Ravi	300	NHPC
		Total	**1040.52**	
B. Under Execution				
1	Holi	Holi N	3	HPSEB
2	Chamera Stage III	Ravi	231	NHPC
		Total	**234**	
C. Investigation				
1	Sal I	Sal N	6.50	MOU signed
2	Budhil	Budhil N	70	MOU signed
3	Kutehr	Ravi	260	
4	Suil	Suil N	13	
5	Bharmaur	Budhil	45	
		Total	**394.50**	
D. Under Investigation				
1	Bajoli-Holi	Ravi	180	HPSEB
2	Sai-Kothi	Baira N	17	
3	Harsar	Budhil N	60	
4	Kugti	Budhil N	45	
5	Chamba	Ravi	125	HPSEB
		Total	**427**	
E. Investigation to be taken up				
1.	Bara-Banghal	Ravi	170	
2.	Chanju-I	Chanju N	40	
3.	Chanju-II	Chanju N	17	
4.	Baira-Bihali	Baira N	15	
		Total	**242**	
		Grand Total	**2338.02**	

1.3 BUDHIL HYDEL PROJECT (70 MW)

Budhil hydel project (70 MW) is envisaged on Budhil Nallah, a right bank tributary of Ravi river joining the river near village Kharamukh. The access to proposed dam site is 7 km by road taking off from 59 km on Chamba-Bharmaur road. The dam site on Budhil nallah is 500 m upstream of suspension bridge near village Thalla and underground power house is on the right bank of Ravi river near village Kainduta at about 51 km upstream of Kharamukh on Chamba-Holi road. The project envisages utilization of water of Budhil nallah with a gross head of 252 m for generation of 70 MW of power. The project comprises of a 58 m high concrete gravity dam above deepest foundation level, an underground desilting arrangement with two parallel chambers 137.00m x 11.55m x 9.00m in size, a 6028m long, 4 m diameter modified horseshoe shaped head race tunnel, a 53 m high circular surge shaft of 10 m dia, a 284m long underground pressure shaft with main and branch pipes diameter as 3m and 2.05m respectively to lead water into two units of 35 MW capacity each, housed in an underground power house 17 m wide x 51 m long x 32 m high and a 610 m long, 4 m diameter modified horseshoe shaped tail race tunnel discharging the water into river Ravi.

The project will generate 313.33 GWh in 90% dependable year. The power generated will be fed into the Northern Regional Grid.

The location and vicinity of the project is shown in Map-I on page 7.

1.4 FOREST CONSERVATION ACT, 1980

Rules and guidelines (Revised on October 25, 1992) framed under Forest Conservation Act, 1980 issued by government of India, Ministry of Environment and Forests, New Delhi lay down that discussion of forest area of more than 20 hectares shall require clearance from Environment Wing of the MOEF from environment angle and from Forest Wingh of MDEF for diversion of land. This case will be refered through application on the prescribed form. (Form for seeking prior approval under section 2 of the proposals by the state government and other authorities (Rule 4). This has to be accompanied by Compensatory afforestration scheme and detailed catchment area treatment plan (CAT Plan) scheme have been submitted separately. The present document presents the detailed Catchment Area Plan.

1.5 SCOPE OF THE REPORT

The present report deals with the existing parameters of the catchment like geology, climatic aspects, soils, Discharge measurements and sediments rates have been studied from records of various Government Departments and Agencies. Landuse and vegetative cover status etc. have been arrived at through Remote Sensing techniques by the experts of the Department of Science and Technology, Government of Himachal Pradesh. Results of rapid reconnaissance survey for delineation of priority sub-watersheds for integrated watershed management in the cat catchment of Ravi River Valley Project above Thin Dam, Punjab, J&K and Himachal Pradesh conducted by All India Soil and Land use Survey Organisation Department oif Agriculture & Cooperation, Ministry of Agriculture, Govt. of India have been made use of.

Field surveys were carried out for the confirmation of ground truth of landuses and their present status, erosion conditions and the status of flora and fauna (including Kugti Sanctuary status). Socio-economic parameters were studied and investigated in the field to study people, their food habits, professions. literacy, economic status, food crops being raised, livestock rearing and present development programmes. Based on these studies, extensive field trips and interaction with local people and civil and technical departments experienced functionaries, a detailed catchment Area Tretment Plan has been formulated.

1.6 OUTLINE OF THE PRESENT REPORT

The report is arranged in following chapters:

Chapter 1: Introduction

Gives the general background of the Project and scope of the report.

Chapter 2: Project Description

Project description and salient features of the project are brought out in details.

Chapter 3: General description of the Catchment area. The chapter deals with catchment area details physiography, geology, seismicity, soils, climate

rainfall, water resource, sedimentation, landuses status of land uses, Flora & Fauna, minor forest product.

Chapter 4: Status of Erosion

Decisions status of erosion in different landuses.

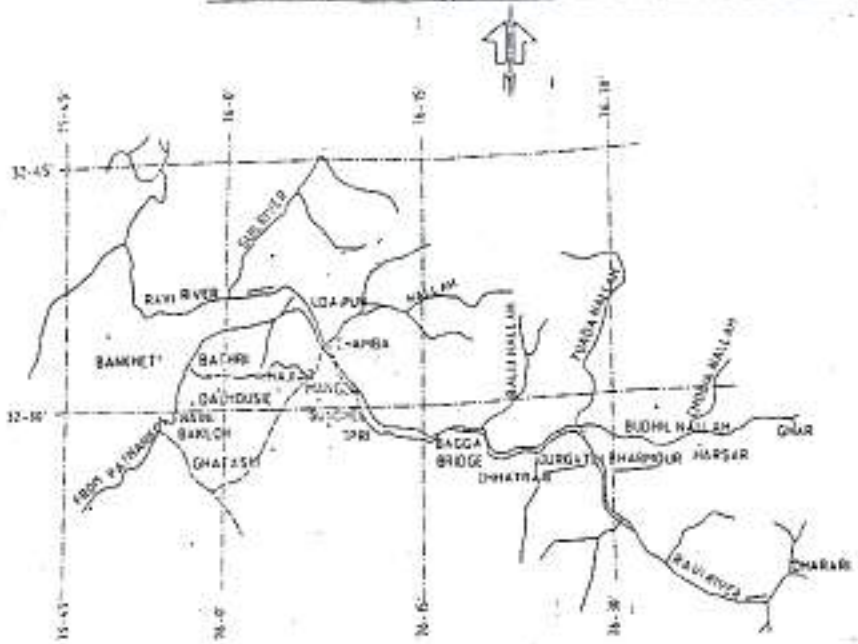
Chapter 5: Catchment area treatment Plan (CAT Plan)

Gives objects, preventive and remedial measures, afforestration, enrichment plantation, pasture development, stabilization of landslips, stabilization of stream banks, prioritization and watersheds and programme implementation.

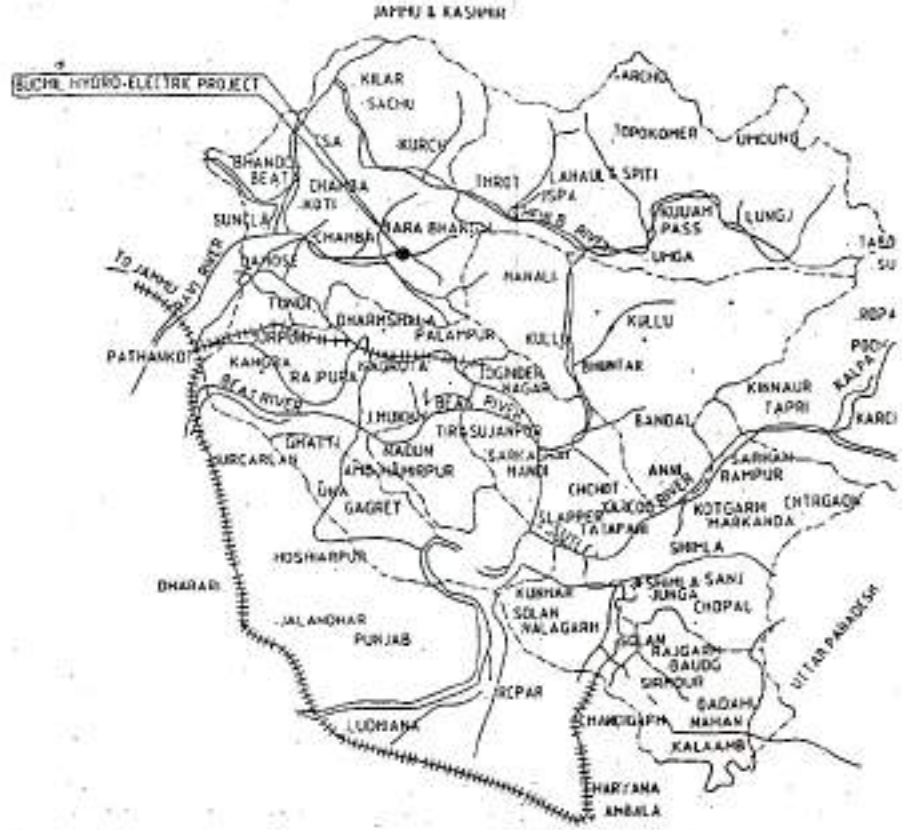
Chapter 6: Cost Estimate

Detailed programme wise estimates of expenditure.

LOCATION AND VICINITY MAP OF BUDHIL HYDROELECTRIC PROJECT BHARMOUR



VICINITY MAP



LOCATION MAP

MAP OF INDIA

S NO	DESCRIPTION	SYMBOL
1.	BOUNDRY STATE	
2.	- DO- DISTRICT	
3.	CAPITAL OF STATE	
4.	DISTRICT HEAD QUARTER	
5.	OTHER TOWNS	
6.	RAILWAY LINE DOUBLE LINE	
7.	ROADS	
8.	RIVERS	

NOTES :-

VICINITY MAP HAS BEEN TRACED FROM S.O.I SHEET. 52F

SCALE :-

LOCATION MAP :- 0 5 10 15 20 Km.

VICINITY MAP :- 0 2 4 6 8 Miles

LOCATION & VICINITY MAP

CHAPTER 2

PROJECT DESCRIPTION

2.1 THE PROJECT

Budhil Hydroelectric Project will develop the hydro-electrical potential of Budhil nallah in its lowest reach just upstream of its confluence with river Ravi, lying in Bharmaur Tehsil, Chamba District, Himachal Pradesh. It is almost a run of the river scheme and the diversion dam will be located about 500 m upstream of suspension bridge near village Thalla. The underground water conductors will be on the left bank. They will feed a two unit 70 MW underground powerhouse, located on the right bank of Ravi river near village Kainduta. The gross head amounts to about 252 m. The components of the project are shown in Map-II on page 13.

2.2 SALIENT FEATURES

Location

State	Himachal Pradesh
District	Chamba
Tehsil	Bharmaur
Nallah/River	Budhil nallah, a tributary of Ravi river.
Dam	500 m upstream of suspension bridge near village Thalla
Power House	Right bank of the Ravi river near village Kainduta (upstream of Khandamukh bridge on river Ravi)
Access (Road/Rail)	Chamba town is connected by 120 km long highway from Pathankot Rail head. Powerhouse is 51 km from Chamba on Chamba-Holi Road. Dam site near village Thalla is connected by State road 7 km from 59th km point on Chamba-Bharmaur State highway.

Hydrology

Catchment area at Dam site	524 sq km
Snow catchment (By Remote Sensing)	155.65 sq km
Snow catchment above EL 4000 m	262 sq. km
Mean annual rainfall	812 mm
Maximum observed average	

10-daily discharge	78.26 cumec
Design flood	3400 cumec
Firm discharge for 90% availability	6.06 cumec
Firm discharge for 50% availability	6.28 cumec
Availability corresponding to design discharge of 34 cumec	27.94%

Climatic Data

Maximum summer temperature	25° C
Minimum winter temperature	-10° C

Dam

Type	Concrete Gravity
Length	64.00 m
Maximum height above deepest foundation	58.00 m

Reservoir

Full reservoir level (FRL)	1647.00 m
Maximum draw down level	1636.60 m
Gross storage upto FRL Level	43.80 Ha m
Top of the dam	1650.00 m

Spilway

Design flood	3400.00 cumec
Gates	3 Nos, Radial
Size	7.00 m x 12.00 m

Feeder Tunnel

Shape	Circular, Concrete lined
Length	264.0 m
Diameter	4.00 m
Design discharge	40.80 cumec

Desilting Tank

Type	Underground
Size	137.00 m x 11.55 m x 9.00 m
No. of chambers	Two, Central gutter type
Size of particle to be removed	0.2 mm and above

Head Race Tunnel

Type	Modified horseshoe, concrete lined
Length	6028 m
Size	4.0 m, finished
Design discharge	34.00 cumec
Flow velocity	3.14 m/s

Surge Shaft

Type	Restricted, Orifice, Underground
Size and shape	10.00 m dia, circular
Height	68.6 m
Orifice area	2.27 sq m

Pressure Shaft

(i)	Main	
	Diameter	3.00 m Circular
	Length	284.0 m
	Plate thickness	12.0 mm to 22.0 mm (ASTM-517)
(ii)	Branch	
	Diameter	2.05 m Circular
	Length	68 m
	Plate thickness	16.00 mm (ASTM-517)

Power House

Type	Underground
Machine Hall gallery	17 m wide x 51 m long x 32 m high
Transformer gallery size	17 m wide x 36 m long x 13 m high
Gross Head	252.00 m
Net Head	237.50 m
Type of turbine	Francis, Vertical Axis
No. & capacity	2 units of 35 MW each

Tail Race

Type	Modified Horseshoe, concrete lined
Size	4 m finished
Length	610 m

Transmission of System

Transmission system	One No.18 km long 220 kV Single Circuit line to proposed Chamera III Sub-Station
Terminating station	440 kV Chamera III sub-station

Power Benefits

Energy generation in 90% dependable year	313.33 GWh
Load factor	0.51

Cost Estimate (Feb. 2005 price level):

Capital cost of the project	Rs. 41,880 lacs

Financial Aspects

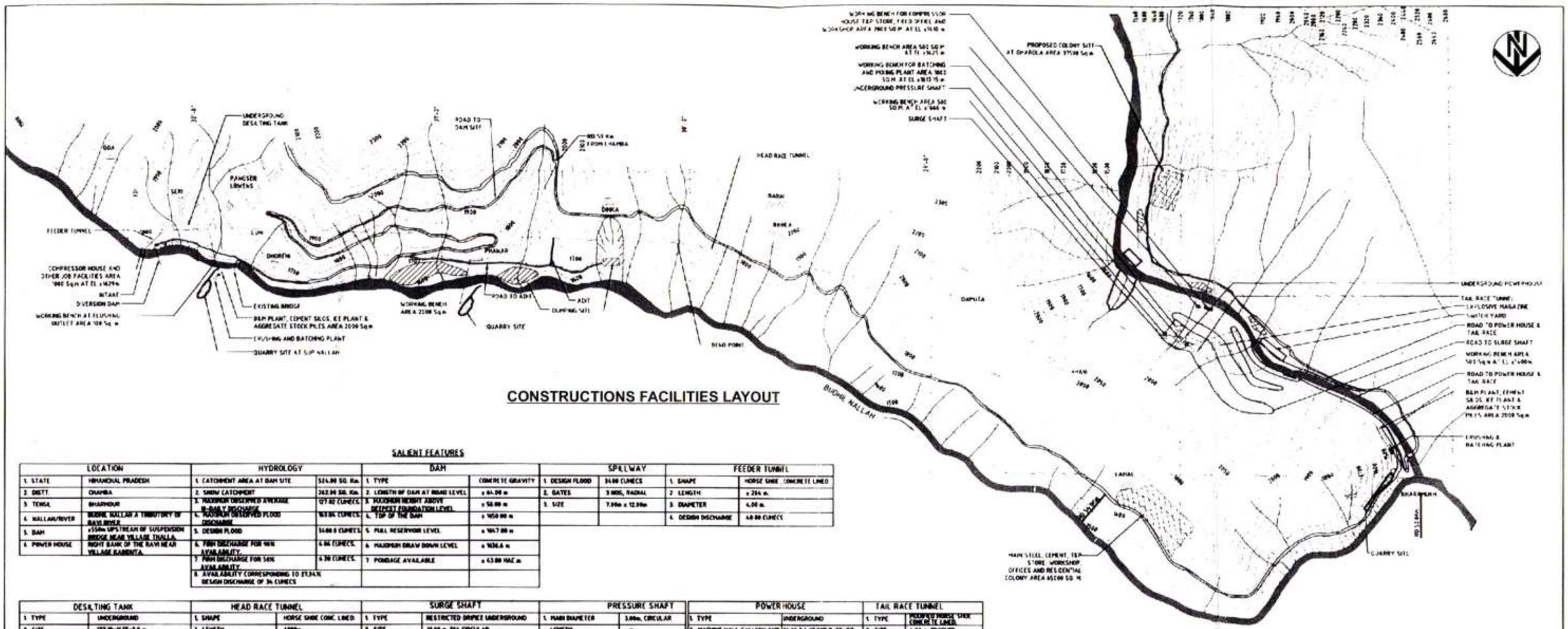
Levelised tariff at Power House bars in 90% of dependable year	Rs. 2.08
Energy as available for sale in 90% dependable year (excluding Auxiliary consumption @ 0.40% and 0.50% Transformation losses)	310.51 MU

Construction Period **42 months**

Components of the Project are shown in Map-II, page 12

BUDHIL HYDRO-ELECTRIC PROJECT-COMPONENTS MAP

MAP NO.II



CONSTRUCTIONS FACILITIES LAYOUT

SALIENT FEATURES

LOCATION		HYDROLOGY		DAM		SPILLWAY		FEEDER TUNNEL	
1. STATE	HIMANCHAL PRADESH	1. CATCHMENT AREA AT DAM SITE	524.00 SQ. Km.	1. TYPE	CONCRETE GRAVITY	1. DESIGN FLOOD	34.00 CUMECS	1. SHAPE	HORSE SHOE CONCRETE LINED
2. DISTT.	CHAMBA	2. SNOW CATCHMENT	262.00 SQ. Km.	2. LENGTH OF DAM AT ROAD LEVEL	± 64.00 m	2. GATES	3 NOS. RADIAL	2. LENGTH	± 396 m.
3. TEHSIL	BHARMOUR	3. MAXIMUM OBSERVED AVERAGE 15-DAY DISCHARGE	127.82 CUMECS	3. MAXIMUM HEIGHT ABOVE DEEPEST FOUNDATION LEVEL	± 58.00 m	3. SIZE	7.00m x 12.00m	3. DIAMETER	4.00 m.
4. NALLAH/RIVER	BUDHIL NALLAH A TRIBUTARY OF RAVI RIVER	4. MAXIMUM OBSERVED FLOOD DISCHARGE	163.84 CUMECS	4. TOP OF THE DAM	± 1650.00 m			4. DESIGN DISCHARGE	4.0.00 CUMECS
5. DAM	±554m UPSTREAM OF SUSPENSION BRIDGE NEAR VILLAGE THALLA	5. DESIGN FLOOD	34.00 CUMECS	5. FULL RESERVOIR LEVEL	± 1647.00 m				
6. POWER HOUSE	RIGHT BANK OF THE RAVI NEAR VILLAGE KANDATA	6. FDC DISCHARGE FOR 90% AVAILABILITY	6.66 CUMECS.	6. MAXIMUM DRAW DOWN LEVEL	± 1636.6 m				
		7. FDC DISCHARGE FOR 50% AVAILABILITY	4.38 CUMECS.	7. POINDAGE AVAILABLE	± 43.00 HAC m				
		8. AVAILABILITY CORRESPONDING TO 17.34% DESIGN DISCHARGE OF 34 CUMECS							

DESILTING TANK		HEAD RACE TUNNEL		SURGE SHAFT		PRESSURE SHAFT		POWER HOUSE		TAIL RACE TUNNEL	
1. TYPE	UNDERGROUND	1. SHAPE	HORSE SHOE CONC. LINED	1. TYPE	RESTRICTED ORIFICE UNDERGROUND	1. MAIN DIAMETER	3.00m. CIRCULAR	1. TYPE	UNDERGROUND	1. TYPE	PRESSURE HORSE SHOE CONCRETE LINED
2. SIZE	137.10x11.55x8.0 m.	2. LENGTH	6400m	2. SIZE	16.00 m. DIA CIRCULAR	LENGTH	. m.	2. MACHINE HALL GALLERY SIZE	26.00 [illegible]	2. SIZE	4.00 m. FINISHED
3. NO. OF CHAMBERS	TWO NOS.	3. SIZE	4.0. FINISHED	3. HEIGHT	± 53.00 m.	PLATE THICKNESS	[illegible]	3. TRANSFORMER GALLERY SIZE	26.00 [illegible]	3. LENGTH	± 610.00 m.
4. SIZE OF PARTICLE TO BE REMOVED	0.2 mm & ABOVE	4. DESIGN DISCHARGE	34.00 CUMECS	4. ORIFICE AREA	2.23 m.	2. BRANCH DIAMETER	2.85 m. CIRCULAR	4. SERVICE BAY	[illegible]		
		5. VELOCITY	2.54m/SEC			LENGTH	± 90.00m	5. CONTROL BLOCK	[illegible]		
						PLATE THICKNESS	16.00mm (ASTM-517)	6. GROSS HEAD	752.00 m.		
								7. NET HEAD	732.50 m.		
								8. TYPE OF TURBINE	VERTICAL AXIS, FRANCIS		
								9. NO. & CAPACITY	2 UNITS OF 35 MW EACH		

LEAD CHART OF ROADS

SL. NO.	FROM	TO	TYPE OF ROAD	DISTANCE IN Kms.
1.	PATHANKOT	CHAMBA	INTER STATE HIGHWAY	120.00
2.	CHAMBA	BUDHIL P/H SITE	DISTRICT ROAD	12.00
3.	CHAMBA	LAHAL COLONY SITE	DISTRICT ROAD	55.00
4.	CHAMBA	KHARAMUKH	DISTRICT ROAD	58.00
5.	CHAMBA	GHAROLA COLONY SITE	DISTRICT ROAD	53.00
6.	LAHAL	ADIT	PROJECT ROAD	11.00
7.	LAHAL	BUDHIL DAM SITE	PROJECT ROAD	11.50
8.	KHARAMUKH	GHAROLA COLONY SITE	DISTRICT ROAD	5.00
9.	KHARAMUKH	DIVERSION POINT ALONG KHARAMUKH BHARMOUR ROAD	PROJECT ROAD	0.50
10.	KHARAMUKH BRIDGE	P/H APPROACH TUNNEL AT EL ±1414	PROJECT ROAD	2.00
11.	LAHAL	SURGE SHAFT BOTTOM ADIT AT EL ±1600.00	PROJECT ROAD	5.50
12.	LAHAL	SURGE SHAFT TOP ADIT AT EL ± 1666	PROJECT ROAD	4.50

DETAIL OF HAUL/COLONY ROADS

SL. NO.	DESCRIPTION	LENGTH IN Kms.
1.	5/3 M. WIDE ROAD FROM EXISTING ROAD TO DAM SITE	0.00
2.	5/3 M. WIDE ROAD FROM DAM TOP TO DIVERSION WORKS	0.00
3.	7/10 M. WIDE ROAD FROM OLD BRIDGE TO FLUSHING OUTLET AT THALA	0.50
4.	5/3 M. WIDE ROAD TO HRT ADIT	1.50
5.	7/10 M. WIDE ROAD TO SURGE SHAFT & S/S ADIT PORTAL	5.50
6.	5/3 M. WIDE ROAD FROM DIVERSION POINT TO P/H ADIT & TO TRT OUTFALL	2.50
7.	5/3 M. WIDE ROAD FROM CHAMBA HAULT ROAD TO PROPOSED COLONY	3.00
8.	7/10 M. WIDE ROAD TO CRUSHING & BATCH MIXING PLANT	0.25
9.	5/3 M. WIDE ROAD FROM CHAMBA ROAD TO RESIDENTIAL COLONY AT LAHAL	2.00
10.	5/3 M. WIDE ROAD FROM OLD BRIDGE TO QUARRY SITE	1.00

SYMBOLS

SL. NO.	DESCRIPTION	SYMBOLS
1.	SPACE REQUIRED FOR JOB FACILITIES	
2.	SPACE FOR MAIN STORE WORKSHOP, RESIDENTIAL AND NON-RESIDENTIAL COLONY	
3.	QUARRY SITE	
4.	BRIDGES	
5.	EXISTING ROADS	
6.	PROPOSED ROADS	
7.	CRUSHING AND PROCESSING PLANT	O
8.	DUMPING SITE	

NOTES :-
1. ALL DIMENSIONS ARE IN mm AND ELEVATIONS IN m UNLESS OTHERWISE SPECIFIED.
2. CONTOUR PLAN HAS BEEN TRACED FROM SURVEY OF INDIA SHEETS NO. 15 J/ 2 OF BUDHIL HYDEL PROJECT
3. THIS DRAWING IS MEANT FOR PROJECT REPORT AND ESTIMATION ONLY AS SUCH NOT TO BE USED FOR CONSTRUCTION
4. DIMENSIONS SHALL NOT BE SCALED FROM THE DRAWING, ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED

ISSUE	DESCRIPTION	DATE	APPROVED
	ISSUE/AMENDMENT		

SCALES 1:2500

TITLE	NAME	DATE
DRAWN	S.S.	
DRAFTING CHECK	R.K.M	
DESIGNER	A.B.	
DESIGN CHECK	V.K.I.	
ACAD FILE No.	SMEC-1059-01-CV-002	

DESIGN CONSULTANT
SMEC

EIA & CAT PLAN CONSULTANTS
DEFC
DHIMAN ENVIRO FORESTRY CONSULTANTS PVT. LTD.

CLIENT
LANCO
LANCO GREEN POWER PVT. LIMITED

BUDHIL 70 MW HYDRO-ELECTRIC PROJECT

CONSTRUCTION FACILITIES HAUL ROAD, QUARRY SITES & COLONIES ETC.

DRAWING STATUS	DRAWING No.	REVISION NUMBER
DRAFT	SMEC-1059-01-CV-002	0

CHAPTER - 3

GENERAL DESCRIPTION OF THE CATCHMENT AREA

3.1 CATCHMENT AREA

Budhil nallah, a right bank tributary of river Ravi originates from Malhas Jot situated at an altitude of 6108 m in mid Himalayas and flows in north-west direction through Hadsar and Bharmaur valley to join Ravi at Khadamukh at an elevation of 1380 m about 50 km upstream of Chamba town on Chamba-Holi State highway.

The catchment area of Budhil nallah above the proposed dam site at Thalla lies between longitude of 76°39'E to 76°50'E and latitude of 32°28'N to 32°27'N and covers an area of 524 sq. km out of which 154 sq.km is considered to be snow covered and glacial area on the basis of estimates of this category of land as 154 sq km by Remote Sensing technique and 154.75 sq km by All India Soil and Land Use Survey Organization, Govt. of India through Priority Surveys of Thein dam Catchment area conducted by them. The area administratively falls in Bharmaur Tehsil, Chamba district Himachal Pradesh, The Divisional Forest Officer, Bharmaur Forest Division, Bharmaur manages the forest areas, within his divisional jurisdiction including Bharmaur Forest Range covering Budhil catchment. The outline of the catchment area above Thalla dam site is shown in Map-III, page 14

3.2 PHYSIOGRAPHY

The catchment area is bounded by mid Himalayas in the north and Manimahesh dhar emanating from mid-Himalayas in north-west, Dhog dhar in the east and Mani Mahesh dhar in the South and a spur from this emanating from Grimma down Bharmaur-Kharia to dam site.

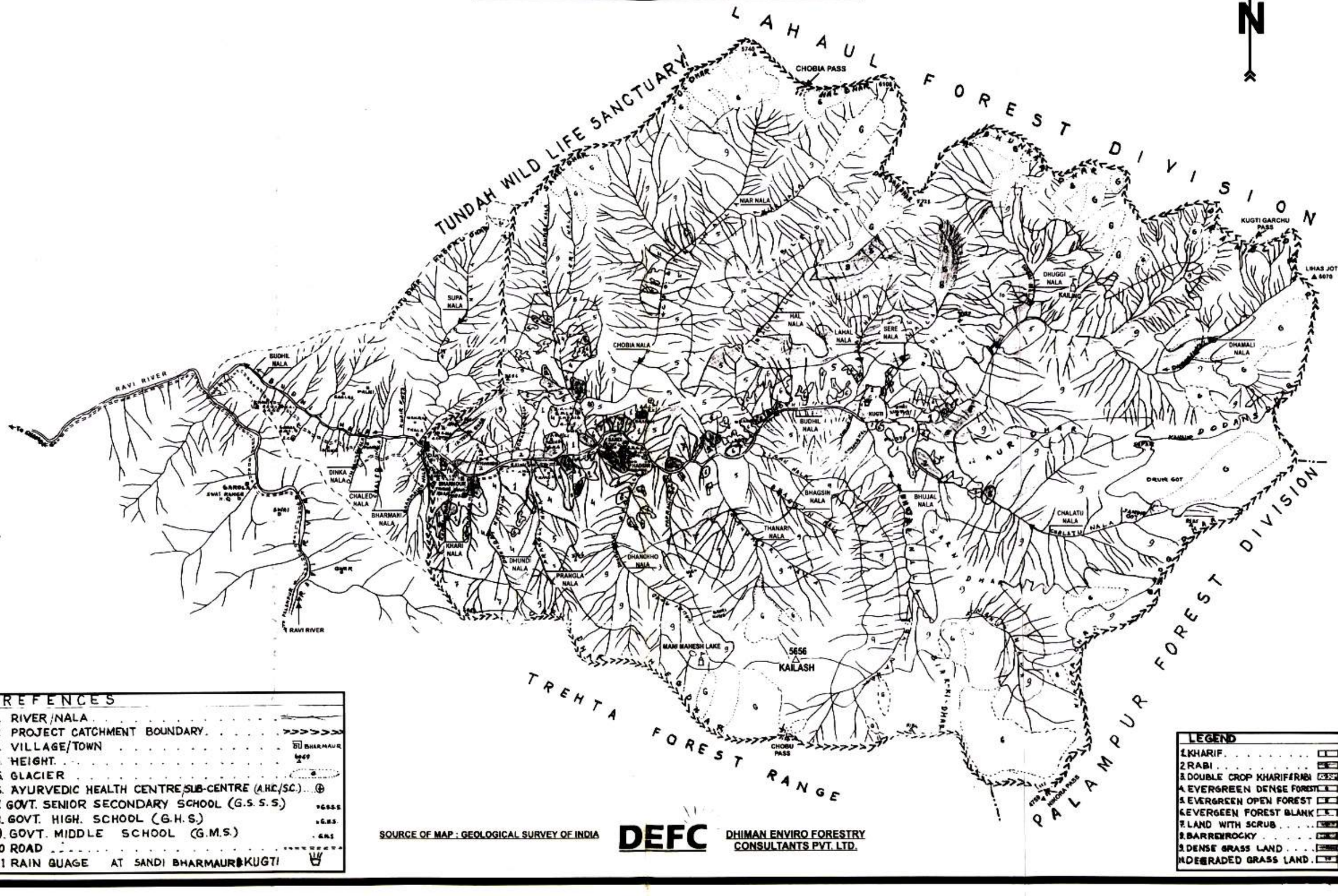
The lowest altitude is 1380 m at Power House site along river Ravi just above Khadamukh. The higher altitudes lie along mid-Himalayas.

The catchment area is narrow and linear in shape about 40 kms in length. The parts of the catchment area above about 2500m altitudes are steep to very steep and sometimes rocky. The ruling slopes right from river to upper portions vary from 20% to 35%. There are practically no plain areas.

BUDHIL HYDRO-ELECTRIC PROJECT

CATCHMENT AREA MAP

MAP NO. III



REFENCES

1. RIVER/NALA
2. PROJECT CATCHMENT BOUNDARY
3. VILLAGE/TOWN — BHARMAUR
4. HEIGHT — 4969
5. GLACIER
6. AYURVEDIC HEALTH CENTRE/SUB-CENTRE (A.H.C./S.C.) ⊕
7. GOVT. SENIOR SECONDARY SCHOOL (G.S.S.S.) — G.S.S.S.
8. GOVT. HIGH SCHOOL (G.H.S.) — G.H.S.
9. GOVT. MIDDLE SCHOOL (G.M.S.) — G.M.S.
10. ROAD
11. RAIN GUAGE AT SANDI BHARMAUR & KUGTI

SOURCE OF MAP : GEOLOGICAL SURVEY OF INDIA

DEFC

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LEGEND

1. KHARIF
2. RABI
3. DOUBLE CROP KHARIF&RABI
4. EVERGREEN DENSE FOREST
5. EVERGREEN OPEN FOREST
6. EVERGREEN FOREST BLANK
7. LAND WITH SCRUB
8. BARREN/ROCKY
9. DENSE GRASS LAND
10. DEGRADED GRASS LAND

3.3 GEOLOGY

Regional geological Map of part of Chamba District showing the layout of the proposed Hibra (now Chamera III) Kutehr and Budhil Hydel projects is given in Map IV, page 16

Almost all the hill ranges of the Himalayas follow a definite pattern of strata. They usually lie in the east-west direction with some variation. The strata dip to the north barring some variations due to orogenic movements and local disturbances. These mountains are composed of granite mass comprising of fine to coarse-grained granite and gneisses, the granite consists mostly of quartz, felspar and biotile. Schists occur in different forms such as shales, slates, gneisses, argillaceous clay etc.

3.4 SEISMICITY

The Project area falls within Himalayan seismic belt and lies in seismic Zone V of the "India Seismic-Zoning Map" which corresponds to the highest seismically active area in India.

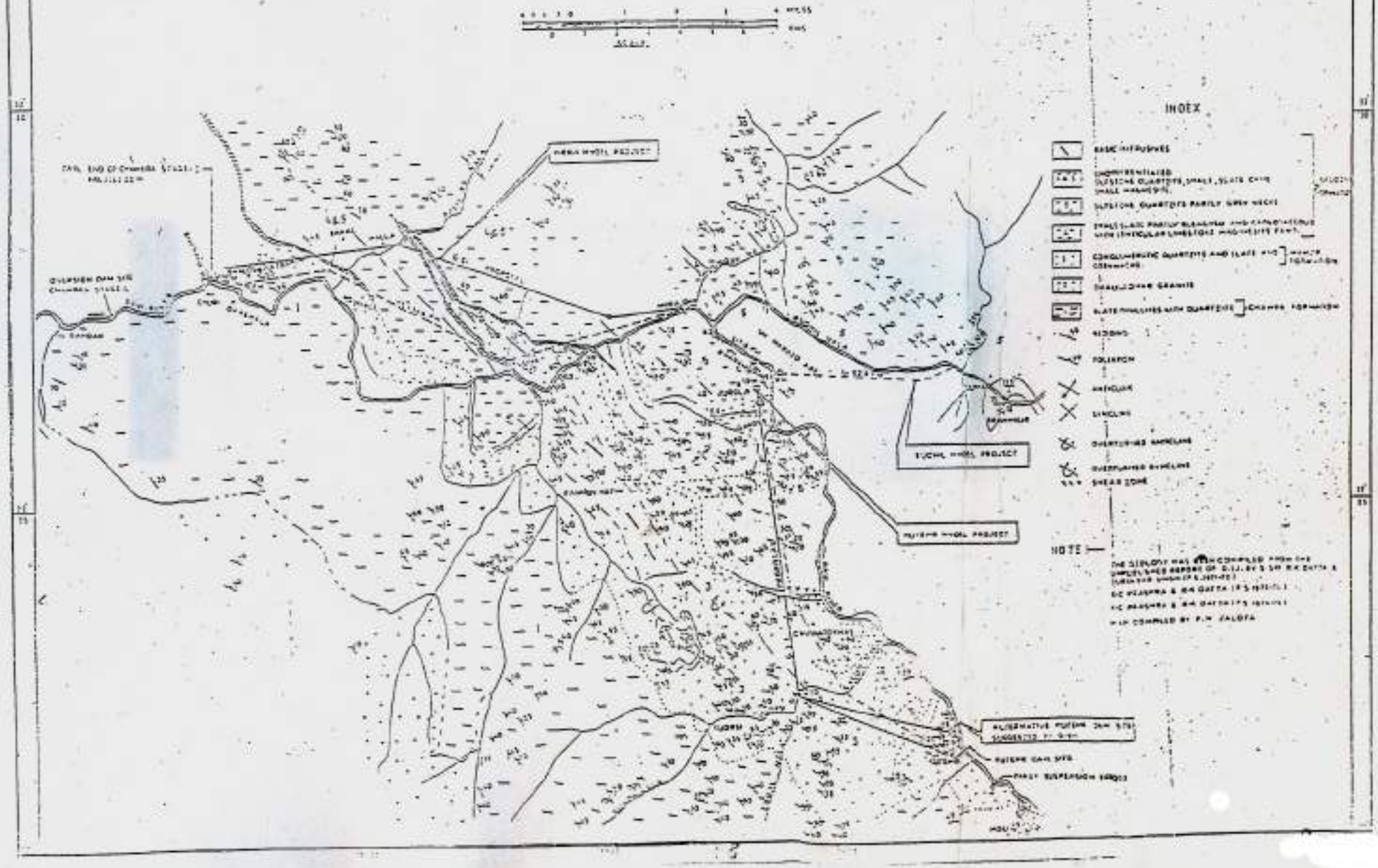
The area has experienced the Kangra earthquake of 1905 having epicenter located about 20 km south of the project area and having magnitude of 8.6 on Richter scale. The other important earthquake of 1947 having magnitude of 6 on Richter scale was located about 50 km north of the project area. The area had experienced the micro earthquake activity in the Dharmshala earthquake of 1978 and 1986 having magnitudes of 5 & 5.70 respectively.

The epicenters of a number of earthquakes of different magnitudes are shown on the seismotectonic Map of Himachal Himalaya and attached as Map V, page 21

The Chamera H.E. Project Stage II, about 30 kms downstream of the proposed Budhil H.E. Project falls in the same seismotectonic zone. This project was investigated seismotectonically during investigation and pre construction stage and the design earthquake parameters (seismic co-efficient) based on magnitude, distance and acceleration are 0.17 g, 0.2 g and 0.22 g respectively. These co-efficients are based on the parameters for earthquake resistant structures decided by the Committee of the Central Water Commission.

MAP No. IV

REGIONAL GEOLOGICAL MAP OF PART OF CHAMBA DISTT. SHOWING THE LAYOUT OF THE PROPOSED HIBRA, KUTEHR AND BUDHIL HYDEL PROJECTS IN H.P



For a seismic design of structures the large magnitude earthquake with long recurrence interval located 15 kms below the site would be considered as the MCE. The PGA value with very conservative assumption of about 12 km as the shortest distance would be 0.49 g. For OBE the transverse and the BTF related seismic source with maximum of 7 magnitudes earthquakes potential and epicentral distance of 10 to 15 km may be considered which could be expected during the lift span of the Project. The approximate value of PGA for these sources would be of the order of 0.24 g.

3.5 SOILS

Soils are shallow except in areas covered by vegetation especially trees where leaf litter is in plenty. There is deep soil only in case of bowls formed by nature due to scree deposition. At the lower elevations, the rock system is very unstable, weak and friable in nature and as such is readily prone to disintegration. The terrain in such parts is highly susceptible to landslides, land slips and erosion. The sub-soil is fairly hard generally argillaceous shale which often fissures and easily subject to disintegration near the surface when exposed. The soil depth is inversely proportional to the slopes. On ridges and spurs and precipitous arid and southern aspects, the soil is shallow and dry with numerous outcrops of bare rocks.

3.6 CLIMATE

3.6.1 General

The climate is markedly temperate and varies with the altitude. Since most of the tract lies on higher elevations and on northern aspects, therefore, cool weather prevails during most part of the year. The proximity to snowy heights and glaciers of mid-Himalayas, cold weather is intensely cold. Spring season is cool, bright and free of haze. April to June are warmer and so considered as summer months. Monsoons generally set in July and last upto end of August. The tract being surrounded all around by lofty mountains rainfall is not very heavy. In fact, the tract can be said to be semi-dry. However, there are occasional heavy intensity showers that bring in devastating flash floods in the streams and nallahs as also frequent occurrence of landslides and land slips along the road cuttings. September and October are cool, bright, free of haze and dust and pleasantly sunny. Snowfall is a regular feature from December to middle of March. It accumulates as much as 9 m at 2700 m elevation and above and does not stay for longer period below 1800 m of elevation and southern aspects.

3.6.2 Rainfall

There are only three stations, namely Bharmaur (2212 m) Sandi (2212m) and Kugti (2250m) in Budhil catchment where rain gauges and snow gauges are located. As mentioned earlier, Budhil has a linear catchment area running east to west. The location of these gauges is shown in Map III on page 1५ Details of average monthly rainfall and snowfall for these three stations for the last 10 years are given in Table 2 below:

TABLE 2 AVERAGE OF LAST 10 YEARS MONTHLY RAINFALL AND SNOW FALL

	Rainfall (mm)			Snowfall (cm)		
Month	**Bharmaur**	**Sandi**	**Kugti**	**Bharmaur**	**Sandi**	**Kugti**
January	20.37	-	12.40	41.47	2.58	81.28
February	41.62	7.29	22.62	61.93	30.37	102.79
March	135.39	22.87	43.15	15.97	5.87	58.35
April	88.69	45.62	52.55	0.046	0.090	10.90
May	92.64	16.14	89.25	-	-	1.00
June	39.57	4.30	50.06	-	-	-
July	145.45	27.69	83.78	-	-	-
August	102.16	29.41	91.35	-		-
September	89.62	15.20	29.90	-	-	-
October	30.76	11.25	16.09	0.82	-	3.00
November	12.73	5.03	6.74	2.09	3.46	11.40
December	12.95	5.14	9.24	40.83	17.71	61.90
Total	**811.95**	**189.97**	**507.13**	**163.16**	**60.08**	**330.62**

It may be noticed from above rainfall data that this is almost a semi-dry zone. Therefore, vegetation cannot be luxuriant and lot of efforts will be needed to make a success of new plantations. Due to rocky & shallow soils, selection of sites for raising plantations will need greater attention.

3.7 WATER RESOURCE

Budhil nalla is a tributary of the river Ravi. It is almost a snowfed stream. It is longitudinal in form running from East to West. Dhomali nallah and Duggi nallahs join to form Budhil nallah. Lal nallah, Hal nallah, Chobia nalla and Seri nalla join Budhilnalla on its right bank and Chalatu nalla, Bhujal nalla, Thansari nalla, Dhancho nalla, Paranghala nalla, Bharmani Nalla & Khani nallah join it from its left bank. Some of these are not perennial but only alive during the snow-melt and short rainy season.

It is of interest to record that the Sup nallah which has perennial flow of water joins Budhil nallah on its right bank just below the diversion dam and as such Budhil nallah will not remain dry or devoid of water during any time of the year.

3.8 SEDIMENTATION

Budhil nallah has been gauged for stream flows only for some period at following gauge stations:

(a) At Harsar from December 1972 to March, 1982.

(b) Budhil nallah at Bharmaur from August, 1972 to July, 1983 and September, 1984 to June, 1990.

(c) Budhil nallah at Lahal from July, 1970 to March, 1982 and July, 1990 onwards.

Estimation of water resources have been based on Durgathi site ((G& D site) on Ravi for Chamera II and Chamera III hydroelectric Projects. No silt gauging seems to have been done for Budhil nallah on any of the discharge sites. Based on last 14 years study of suspended sediment inflow in Ravi at Durgathi site (2205 sq. km catchment area), the annual suspended sediment flow has been estimated for Chamera HE Project (III) as 1.98 million tonnes. This gives 898 tonnes per Sq. Km. of the catchment area annually. Although Budhil catchment area is comparatively less eroded than Ravi catchment and nearly 30% of the area is under permanent snows and glaciers, but without any other guide 898 tonnes per Sq.Km. of the catchment area may be taken as annual suspended silt load in Budhil at dam site as well.

Catchment area treatment measures will certainly contribute towards reduction in silt yield (in suspension) but there is also an inbuilt mechanism in the design of the

project as well so that neither the inflow of water in headrace tunnel is effected nor turbines in the power house are damaged. In case of Budhil catchment hardly 3.55% of is agriculture land and that too one cropped whereas 29.70% of catchment area constitutes snow/glacial area. 17.40% is under evergreen dense forests and 41.91% under dense grasslands and with semi wet zone, there is practically no reason for Budhil to have heavy silt loads.

3.9 LAND USES

Status and extent of landuses has been derived from Revenue and Forest Department records as also through Remote Sensing. The distribution, location, extent and composition of vegetation have been derived from satellite imagery followed by intensive field survey.

Land Use / Land Cover By Remote Sensing

Land uses/land cover as derived from Remote Sensing are also marked on the Map V on page 22-A. Details are given in the Table 3 below.

TABLE 3 LAND USE / LAND COVER THROUGH REMOTE SENSING

Sl. No.	Land Use	Area (sq km)	Proportion (%)
1	Agriculture – Kharif Agriculture – Rabi Agriculture – Double Crop	13.34 5.24 0.03	3.55
2.	Fruit crop	7.00	1.33
3.	Evergreen Dense Forest	29.61	5.65
4	Evergreen open forests	61.58	11.75
5	Evergreen Forest Blank	7.41	1.42
6	Land with scrub	8.26	1.58
7	Barren Rocky area	7.99	1.20
8	Dense grasslands	219.63	41.62
9	Degraded grasslands	9.91	1.89
10	Snow/glacial area	154.00	30.01
	Total	**524.00**	**100.00**

MAP NO. V

LANDUSE/COVER MAP OF BUDHIL HYDRO-ELECTRIC PROJECT CATCHEMENT AREA

BHARMOUR, DISTRICT CHAMBA

DEFC

DHIMAN ENVIRO FORESTRY CONSULTANTS PVT. LTD.

GIS HP REMOTE SENSING CENTRE SHIMLA

3.10 STATUS OF LANDUSES

3.10.1 Crop Lands

1861 ha are classified as agriculture land which forms about 3.55 % of the total catchment area. Out of this, 1334 ha are under kharif, 524 ha under Rabi and only 3 ha are under double crop. Due to high altitude and prolonged wintry conditions, a variety of crops are raised in kharif season. Some land is kept fallow to grow Rabi crops. Maize, Sarson, Rajmash, Mash & Potato are the major kharif crops whereas wheat and Barley are gown in Rabi season. Cultivation is on imperfectly terraced lands except in bowls formed due to depressions where soil depth is adequate and fields relatively more plain.

Those who have surplus land are also switching over to raising peas as a cash crop.

Productivity Of Crops

Productivity is quite low and this is mostly due to short growing season on account of inclement weather conditions, poor quality of seeds and deficient attention by the owners on this activity. Productivity of main crops in kg/ha is estimated as under:

S.No.	Name of crop	Yield per ha (kg)
1.	Wheat	1507
2.	Maize	375
3.	Barley	2124
4.	Sarson	1125
5.	Rajmash	40
6.	Mash	125
7.	Potato	2240

Rajmash and Mash are generally grown on the field boundaries.

3.10.2 Fruit Plants

Fruit orchards are not separately classified and recorded as such, therefore, it is estimated that 700 ha are under fruit plants out of the cultivated area. Mainly apple and scattered thin-shelled walnuts are grown as fruit plants. Because of semi-dry climatic conditions, the quality of fruit is very good and brings higher rates in the market as compared to apples from wet zone. People, therefore, devote more attention, care & look after this crop. In fact, farmers are gradually converting their unproductive agricultural lands into apple orchards mainly due to better economic returns and shortage of labour in winter on account of migration of major percentage of local population to lower zones of Chamba and mainly Kangra.

3.10.3 Forests

All areas except lands assessed to land revenue and legally constituted as Reserve Forests and Demarcated Protected Forests have been brought under Chapter IV of Indian Forest Act, 1927 and thus stand declared as Protected Forests by the Himachal Pradesh Government vide notification No. Ft. 29-241/49 dated 25th February, 1952. Some of these lands were earmarked and delimited on the ground, rights settled and notified as Demarcated Protected Forests under the Indian Forest Act, 1927 but these were not entered in revenue records as such under orders of the Government and thus these areas still remain as just Protected Forests, Grazing lands, grass lands, alpine pastures owned by Government have been declared as N.DPFs (newly demarcated protected forests) under Indian Forest Act but boundary pillars do not exist on the ground and also not been so far recorded as such in revenue records. The Budhil catchment area forms part of Bharmaur Forest Range and is covered under the territorial jurisdiction of Bharmaur Forest Division. The latest forest Working Plan for Bharmaur Forest Division by an experienced Officer, Mr. Avtar Singh, IFS for the period 2002-2003 to 2016-17 has been approved by Government of India vide their No 13-7(30)/2002-ROC/906 dated 29.3.2004. All the Reserve forests, Demarcated Protected Forests and most of the newly Protected Forests are covered by the Working Plan and managed according to the prescriptions.

3.10.4 Grazing land

These are situated mostly around villages and are classified as "Charagah bila drakhtan" (grazing lands without trees) or "Charagah drakhtan" (grazing lands with

trees) in revenue records but recognised as Protected Forests under the Indian Forest Act. Grazing lands nearer the villages are now almost devoid of the trees whereas proportion of trees over these grazing lands goes on increasing as these areas recede from populations. The scattered trees are Ban Oak and Kahu which are heavily lopped for fodder especially during winter.

3.10.5 Alpine Pastures

Alpine pastures known as "Dhars" in common parlance are legally covered by the general term of Protected Forests under the control of Forest Department. They generally, are situated above the tree limit between the altitude of 3500 m to 3800 m. In practice, they are comparable to Reserve forests in so far as they are free of rights. In these areas, local inhabitants known as Gaddis are allowed grazing on payment of prescribed fees. This, however, does not confer on them any title to the right of grazing in these areas.

The flora is herbaceous and alpine grasses existing in the area are hardy annuals. Local people rear large number of sheep and goat for wool and meat due to necessity because of intense and prolonged wintry conditions. Because of the location of these pastures in snowy zone, grazing is possible only for about 3-4 months i.e. from June to September after which these flocks are on the move for grazing in lower hills, scrub lands in Himachal Pradesh and adjoining foothills in Punjab.

These pastures remain under snow or in dormancy period for nearly 8 months. These pastures serve as corridors for the movement of thousands of flocks from Kangra and lower Chamba areas to Lahaul & Spiti for grazing and their return journey during which lot of damage to vegetation is done.

3.11 Flora

The catchment area is a typical coniferous zone with occupation of various species according to altitudinal zonation. Herbaceous alpine pastures occupy the top most zone generally above 3800 m altitude. Between 2700 m and 3800 m altitudes Fir, Spruce exist in pure form or associated with Deodar, Kail and Kharshu Oak. From 2400 m to 2700 m elevation, pure formations of Deodar or with varying percentage of mixture of Kail are prevalent. Below 2400 m elevation, cultivation and thin cover

grasslands with or without sporadic trees of Kail, Kahu and Ban Oak are in existence. Forest classification and flora present are given in Annexure I.

3.11.1 FAUNA

Animals

Due to altitudinal variation within the area from 1350 m to about 4500 m, there is a variety of fauna. Commonly found species of fauna in the area are given in Table 4.

TABLE 4 FAUNA OF THE TRACT

Sl. No.	Hindi name	English name	Scientific name
1.	Ghoral	Hill goat	*Nemorhaedus ghoral*
2.	Kakkar	Barking deer	*Muntiacus muntijak*
3.	Kastura	Musk deer	*Moschus mochiferus*
4.	Baghera	Leopard	*Panthera pardus*
5.	Kala Bhalu	Himalayan Black Bear	*Selenarctos thibetanus*
6.	Lal Bhalu Gorthu	Himalayan Brown Bear	*Ursus arctos*
7.	Sehal	Himalayan line Martin	*Martes flavigula*
8.	Ean	Indian Porcupine	*Hystrix indica*
9.	Bharal	Flying squirrel	*Hytopetes*
10.		Wild sheep	*Ovis nahura*
Birds			
1.	Monal	Monal	*Lophophorus impeyanus*
2.	Chukor	Partridge	*Alectoris graeca*
3.	Jungli Murga	Red Jungle Fowl	*Gallus gallus*
4.	Kalesha	White Crested Kaleej Pheasant	*Genuocus albicratatus* *Caterus wallichi*
5.	Cheer pheasant		*Pucrasia macrolopha*
6.	Koklas pheasant		*Francolinus grancolinus*
7.	Black Partridge		

3.11.2 WILDLIFE SANCTUARY

There is no Natinal Park or Nature/ Biosphere Reserve in the project area. However, Kugti Wildlife Sanctuary, named after Kugti village located around the headwaters of the Project catchment was originally notified vide No. Ft.43-51/50-VI dated 19.9.62, further revised vide No.5-11/70-59 dated 27.3.1974. The final notification (Section 26 of Wildlife (Proection) Act, 1972) of establishment was issued vide Notification No.FFE-B-F (6)-2/99 dated 23.10.99. The sanctuary covers an area of 32,390.01 ha. split up as under:

Forested area	=	3,398.73 ha.
Alpine pastures including Permanent snow	=	28,841.73 ha.
Land under cultivation	=	149.55 ha.
Total	=	32,390.01 ha.

Although census figures are not available but reported fauna comprises of Ghoral, Urial, Barking deer, Pine Martin, Serow, Chozal, Thar, Musk deer, Porcupine, Black bear, Brown bear and leopard. Birds reported are Kalij pheasant, Western Horned pheasant, Monal, Khakhrola, Chakor, Snow pigeon and Snow cock.

There is a management plan of Kugti wildlife Sanctuary (1995-96 to 2003-04) by T.D. Sharma, IFS. Although this plan expired in 2003-04 but its prescriptions and valid even now. Forests are to be protected. Some wildlife protection and development works as also construction of paths and trails for eco-tourism are yet to be accomplished for lack of funds. However, this has not resulted either in deterioration of environment or the flourishing wildlife.

3.11.3 WILDLIFE MANAGEMENT

A complete moratorium on commercial felling and complete ban on hunting have been imposed but never-the-less there are regulations and system to administer Wildlife Preservation Act and rules made thereunder:

3.11.4 Fish

Fingerling size fish have been observed in Budhil nallah. The Fisheries Department confirms the existence of indigenous fish namely Schzotherase species, Gasso *lamata* as well as the exotic fish Rainbow trout (Sa/mo *gairdneri)* in Budhil

nallah. Budhil nallah has two perennial stream joining just downstream of proposed dam site. These are Sup nallah and Bharrmani nallah. These are perennial in nature and therefore Budhil nallah will not remain dry for any time of the year even during the lean season.

3.11.5 SOCIO- ECONOMIC PROFILE

3.11.5.1 Administrative Offices

Bharmaur is a Civil Sub-Division as well as Tehsil also. The offices of officers i.e. SDO Civil Project Officer Tribal Area, Divisional Forest Officer, XEN PWD, XEN Electricity Board, Block Medical Officer, Block Primary Education Officer & Agriculture Development Officer and Tehsildar are located here.

3.11.5.2 The People

The people of the catchment area are physically well built, active, generous, hospitable and highly religious. They lead a hard life. People living in this tract are from all castes, i.e. Scheduled caste, Khatris, Rajputs, Brahmins etc. but collectively are called "Gaddis" which means professional graziers. Gaddis have been recognised as a Schedule Tribe under the constitution and the entire Bharmaur sub-division has been declared as a Tribal area. Therefore, all people irrespective of caste who have been living in the area from generation to generation are recognized as schedule tribes. This has given great boost to their economy in the sense that all doors to all services are open to them under tribal reservation in addition to other overall relatively greater stress on all round development in communications, health, education, agriculture etc. Due to severe and prolonged winters, agriculture season is far too short to give chance to raise two crops. For want of funds in the erstwhile Chamba State of which this area was a part remained almost cut off from main streams of life because of lack of proper communication with distant urban areas. The people needed wool for woolen clothes and meat to keep them healthy and strong so they reared large number of sheep & goats. Since grazing could not be available throughout the year, they remained migratory. They took their flocks to alpine pastures in their tract during summer and to foothills of southern slopes of Dhauladhar in adjoining Kangra District in Scrub forests and private or community lands. There were practically no schools, no hospitals, or dispensaries, no roads or telephones and hence they remained

backwards in every human sphere. The only improvement in their perception was in some financially sound families who started purchasing lands in Kangra District. Their children would get elementary education in Kangra District and gradually perception also improved. With the integration of princely hill states into Himachal Pradesh and constitution of this Country into a Republic, the inhabitants got recognition as "Gaddis- a scheduled tribe" with all the special benefits in preference to all other citizens that flow to schedule tribes under the constitution of the Republic. There are reservation in educational and professional/technical institution as well as in services. This has greatly improved their educational and financial capabilities. Such enlightened members of the tribes continue shifting to urban areas like State capital, district headquarters or industrial centres. It is on account of this reason we find from census figures that nearly 62% of the villages in the tract are un-inhabited. Resultantly, the area has now only such population who could not afford to migrate or who have dual residences and land in this area for summer and fertile foothills of Dhauladhar in Kangra District for winter.

There are 73 villages in the catchment area, out of which 44 are un-inhabited. Total population of the catchment area is estimated as 10,790 giving density of population / sq km area as 20.60 of which 81% are schedule tribes, 13% of schedule castes and thus only 6% are others. Sex ratio (number of females per '000 males) is 934. There are about 4316 workers out of which 3064 are cultivators, and others are agricultural labourers or partly engaged to household industries, service and repairs etc. The religion of the inhabitants is Hinduism. Houses are generally two storied. Except for proper Bharmaur, houses are invariably built of stones and wood. Large quantity of wood is required to construct a house and it is mainly extracted form the forests at concessional rates, as local right holders.

3.11.5.3 Food Habits

The staple diet of the people consists of maize roti, rice, somewhat wheat and mash and rajmash grown locally. Food grains are supplied by the State Govt. at subsidized rates to certain sections of inhabitants through Co-operative Societies stores and rarely through Govt. designated shops where Cooperative Society shops are non-existent. Almost all the people here relish meat of goat.

3.11.5.4 Drinking Water and Electrification

All the households are electrified and linked with piped potable drinking water supply.

3.11.5.5 Telecommunication

In the entire tribal area of Bharmaur Sub-Division/Tehsil, there are 26 Post offices/sub- post offices/branch offices, 2 Telegraph offices/P&T Wireless Stations, 6 Telephone Exchanges and 1213 Telephone connections.

3.11.5.6 Roads

In the entire tribal area of Bharmaur Sub-Division, there are 7-32 km of double lane, 219.68 km of single lane, 89 km jeepable and 206 km of road and tracks. Road density / 100 sq km of area is 12.5 km and per '000 of population is 6.10 sq km. Almost all villages are connected by roads or tracks.

3.11.5.7 REST HOUSES

There are in all 15 rest houses under difference administrative departments as under:

(a)	Public Works Department	=	3
(b)	Irrigation & Public Health	=	6
(c)	Forest Department	=	4
(d)	H.P. State Electricity Board	=	2

3.11.5.8 Education

There are 2 Govt. Senior Secondary Schools, 3 Govt. High Secondary Schools, 4 Govt. Middle Schools, and 27 Govt. Primary Schools providing ediucation to the inhabitants. Those who want to study further after Senior Secondary Education join a college either at Chamba or Dharmshala.

3.11.5.9 Health Delivery System

The health needs of the inhabitants of the project area are met by two C.H.C. at Bharmaur with 18 sub-centres at surrounding villages and one Ayurvedic hospital with 18 Ayurvedic dispensaries There are also 8 Veterinary hospitals and 18 Veterinary dispensaries in Bharmaur Sub-Division..

3.11.5.10 Live Stock

There are 8 Veterinary hospitals and 18 Veterinary Dispensaries in Bharmour Sub-Division.

Total livestock population in 1999-2000 is estimated at 40,550 of which 32,050 are sheep and goat . Each household generally keeps a cow, a pair of bullocks and a flock of sheep and goat. A herd of sheep and goat for migration to alpine pastures during summer and to foothill plains during winter is formed by pooling sheep and goat of many households so that it becomes a sizeable herd. The life of shepherds attending to migratory herds is very hard and uncomfortable. This practice had to be adopted by virtue of necessity inspite of the fact that heavy and continuous grazing damaged the alpine pastures and winter grazing grounds beside discomfort. Now the extensive education facilities available around their living areas and people availing of the same as also reservations in professional institutions and services is increasing financial security and wider perception of local people . These factors are leading to diversion from the profession of keeping and herding of large number of flocks of sheep and goats and subjecting people engaged in this profession to avoidable hardship, discomfort and even devoid of perceptive financial gain. So in course of time this profession of keeping and grazing large herd of sheep and goat is bound to substantially decrease if not altogether cease.

3.11.5.11 FODDER

The animals are dependent on grazing in forest areas during summer and rainy season. During winter cattle are required to be stall fed due to snowfalls and that is why number of cattle reared is bare minimum. The field studies indicated that about 70 percent of the requirements are met with from forest fodder trees and remaining 30% from their own grass lands and fodder trees sporadically grown in their grasslands as also boundaries of agriculture lands.

3.11.5.12 RIGHTS FOR TREES FROM GOVT. FORESTS

Local people have the rights admitted in forest settlements/ Wajib-ul-Arz for grant of trees from Government forests at nominal rates for construction/repairs of their living houses and cowsheds etc. The rates at which trees are granted since past many years are nominal as compared to market rates.

3.11.5.13 FUEL WOOD

Due to severe and prolonged winter the people of the area required large quantity of wood and need to be stored for 2-3 months before snowfall. During the field surveys annual consumption of fuel-wood per household of five people has been assessed as 6 to 7 tonnes. Local inhabitants admitted meeting about 90% of their requirements from dry fallen trees in Government forests for which they have the right to collect for domestic use free of any charge and remaining 10% is met with from the remnants of woody fodder as also crop residues. Alnus and willow grow along nalla banks and Parotia as undergrowth in forest areas which also supplement the fuel requirements. With the availability of cooking gas and convenience of its use, people are gradually switching over to use of gas rather than incurring the trouble of collecting fuel wood from distant and scanty forest areas nearby. Moreover this area is, every year, attracting religious tourists to Bharmour and local people converting their houses into hotels and guest houses, use of LPG gas for cooking is on the increase.

3.11.5.14 Minor Forest Produce (Non-Timber Forest Produce)

The region is rich in herbal flora especially the medicinal plants and other valuable aromatic and edible herbs (their fruits, roots etc). A list of commonly extracted medicinal plants and herbs occurring naturally is given in Table-5.

TABLE 5 COMMON MEDICINAL PLANTS AND HERBS

Sr. No.	Botanical name	Common name	Habit	Habit height (in Mtrs)	Part used
1	Aconitum heterophyllum	Patis	Herb	Sub-alpine region	Root
2	Asparagus racemosus	Satawar	Herb	Upto 1800	Root
3	Atropa belladona	Shafoo	Shrub	Upto 2400	Leaves
4	Berberis aristata	Kasmal	Shrub	1800-2600	Whole plant
5	Cinnamomum tamala	Tejpat	Shrub	Upto 2000	Leaves
6	Digitalis purpurea	--	Herb	Above 1700	Leaves
7	Jurinea marocephalla	Dhoop	Herb	Sub-alpine region	Root
8	Picrorhiza kurroora	Kaur	Herb	Above 3000	Root
9	Podophyllum emboddi	Bankakru	Herb	---	Root & rhizome
10	Saxifraga ligulata	Pathar-tor	Herb	-----	Leaves (edible) roots as medicine
11	Saussurea lappa	Kuth	Shrub	1500-3000	Whole plant
12	Swertia chirata	Chirata	Herb	2000-3000	Whole plant
13	Taxus baccata	Barmi	Tree	2400-3000	Whole plant
14	Viola serpens	Banafsa	Herb	1000-3000	Flower

Extraction and sale of these herbs is regulated under Chamba Minor Forest Product Act,2003 and Chamba Minor Forest Product Manufacture of Drugs and Export Rules, 1947. Local right holders get a seasonal permit for extraction of herbs at a nominal fee and then sell it to local purchasers (who have the license to purchase) who export out of Chamba after payment of export fee fixed by the Forest Department and sell these out mainly at Amritsar which is the major market for this purpose in the north. Since this sale by farmers to the business men is unorganized, farmers do not get proper price for these herbs. However, this is also a source of income without any financial investment.

CHAPTER - 4

STATUS OF EROSION

4.1 GENERAL

According to sum total of sub-watershed area falling within Budhil catchment as arrived at by All India Soil and Landuse Survey Organisation (AISLUS) of Government of India amounts to 527 sq.km. as comared to 524 sq.km. by remote sensing since area calculated by AISLUS is based on topographical major, this figure has been taken for prioritization purpose. Out of this total area of 52700 hectares, 17675 hectares are covered by snow and glaciers permanently 14665 hq. Are situated above 4000 mtrs. (13000 ft.) Altitude, Thus in this total area of 32,340 hq. (17675 + 14665) the only type of erosion is geological erosion. No control, either preventive or remedial, is available to stop, mitigation or even reclaim the eroded area in site in respect of natural/ geological erosion. Out of the remaining 20,360 hectares, the following categories of land are least susceptible to erosion:

S.No.	Type of Landuse	Area as per remote sensing (ha)	Area estimated below 4000 mtrs (hectares)	Remarks
1.	Agriculture	1858	1858	
2.	Fruit Crop	700	700	
3.	Evergreen dense forests	2961	2961	
4.	Barren rocky area	799	599	About 200 ha. are estimated to be above 4000 mtrs altitude
5.	Dense grasslands	21963	11963	10000 ha. are estimated to be above 4000 mtrs. altitude
	Total	28281	18081	

The remaining about 2280 ha. comprising of Evergreen open forests, evergreen forest blank, land with scrub and degraded grasslands is susceptible to different types of erosion.

Nature and type of erosion observed over these landuses is stated in the paragraphs that follow:

4.2

4.3 AGRICULTURE:

Agriculture over bowls where soil is formed from repeated snow screes in the part is on plain lands. Agricultural fields over higher slopes are imperfectly terraced. Cultivation is relatively less intensive as these lands are under one crop i.e. Kharif. There is sheet erosion from over the imperfectly terraced fields during the light monsoon these areas receive. Terracing is highly expensive and unremunerative, time consuming as most of the cultivation migrate during winter to lower hills of Kangra & Chamba.

4.3 Forests

30% of the catchment area is under dense forests and evergreen alpine scrub with about 741 hectares only forming evergreen forest blank which in fact is devoid of tree growth but covered by grasses and herbs. Open forest area is gradually recouping because all green trees fellings are banned in the State since last over 10 years. At places open forest areas need to be helped also. Where bushy formations exist, natural regenerating is coming up because of non-interference of felling and part of its being gradually planted up by the Forest Department. However, through afforestation under the Catchment Area Treatment and Compensatory planting, this project will also extend the needed appropriate tree coverage.

4.4 A Grasslands

Out of 45% of catchment area under grasslands, nearly 42% is under dense grasslands and only 3% are degraded grasslands . These are mostly in alpine pastures and to some extent around habitations in temperate zone which bear the brunt of heavy grazing, lopping of saplings and grass cutting for feeding domestic cattle during winter. There is less of erosion but more of degradation of vegetation in these areas. Therefore, protection and raising of medicinal plants and aromatic herbs/shrubs in alpine zone and afforestation supported by soil conservation will need to be practised in temperate grazing lands.

4.5 Land Slips

Eight (8) landslips have been identified in the field after intensive field survey. They have generally been triggered through geological disturbances or road construction in preliminary stages.

4.6 Streambank Erosion

The 2.5 km. Budhil nallah lands between the junction of Sia nallah and Lal nallah with Budhil are erosion prone. This portion has width of about 240 mtrs. Due to bank erosion. There are thick deodar forests on both sides of these nallahs. Which are getting damaged due to stream bank erosion.

CHAPTER - 5

CATCHMENT AREA TREATMENT PLAN

5.1 OBJECTS OF THE CAT PLAN

(i) To check further degradation of the catchment area.

(ii) To rehabilitate already degraded areas under different land uses.

(iii) To control soil erosion so as to reduce silt contents of water in streams and nallahs.

(iv) To improve the vegetation cover in the area.

(v) To improve degraded pastures and grazing lands.

(vi) To increase production of biomes.

It appropriate action is taken to achieve above objectives the usual aesthetics of area will improve and degradation of ecosystem will be checked.

5.2 Approach and Treatment:

There have to be two pronged approach to achieve the objective the preventive and remedial measures.

5.2.1 Preventive measures include control on felling of tress, control. Catchment are treatment measures are essential not only for conservation of soil for maintaining and even enhancing productivity but also for reduction of sediment load flowing through Budhil nallah. Apart from accelerated siltation of storage behind the dams, the increased silt loads in rivers have adversely affected the turbines through corrosive action of silt particles as experienced in hydroelectric projects on Sutlej river and its tributaries. Therefore, special attention has been focused on this aspect in the present report.

5.2.2 Remedial Measures:

A series of biological measures like afforestration, enrichment plantations, pasture development, development of medicinal plants, agriculture and horticulture as well as engineering measures like gully plugging, landslip stabilization and construction of silt detention dam have been provided as part of catchment Area Treatment (CAT Plan).

5.3.1 AFFORESTATION

(i) General

Since this is mountainous tract with moderate to steep slopes, gully formation due to water/snow flows in the depression are bound to occur. Therefore, all afforestation works will have to be supported by anti-erosion measures like gully plugging, check dams etc. in varying extent. The following types of areas are proposed for afforestation aided by varying types and degrees of soil conservation measures and check dams:

(i) Evergreen forest blanks detected through Remote Sensing

(ii) Heavily grazed areas around habitations

(iii) Blank area fit for bringing in vegetation and draining directly in the vicinity of diversion dam storage.

In the background of above criteria, limitation of extent of area which can be closed with the consent of local people (right-holders) and in consultation with local field forest officers, it is proposed to afforest 270 hectares in a period of 3 years as detailed in Table 6 below.

TABLE 6 AREAS SUGGESTED FOR AFFORESTATION

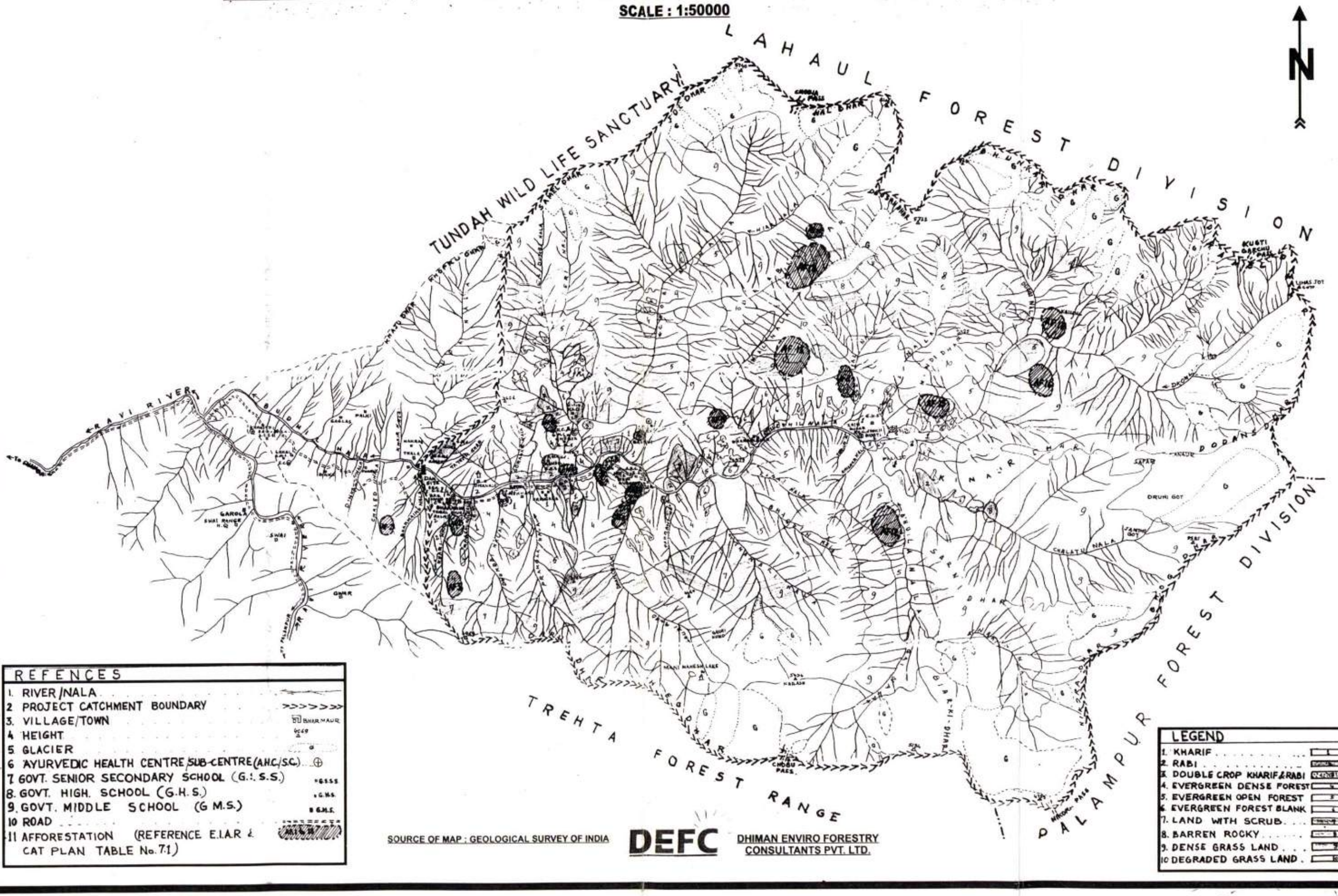
Year	S.N	No. of DPF	Forest	Area (Ha)
Ist year	1	55	Goha DPF	10.00
	2	59	Dadma DPF	5.00
	3	56	Simra DPF	20.00
	4	49	Sathli DPF -II	5.00
	5	39	Ghoie DPF	10.00
	6	43	Sandi DPF	10.00
	7	38	Hadsar DPF	10.00
	8	31	Chobia DPF-I	15.00
	9	19	Mandho DPF	15.00
Total				100.00
IInd year	10	141	Dharoul RF	15.00
	11	69	Thantha DPF	10.00
	12	62	Kangru DPF	30.00
	13	71	Deosah DPF	20.00
	14	64	Dharoul DPF	5.00
	15	65	Buhar DPF	10.00
				90.00
IIIrd year	16	66	Sappar-Kinour DPF-I	10.00
	17	67	Kailung DPF	15.00
	18	74	Haldar DPF	35.00
	19	-	Arki DPF II	20.00
				80.00
			Grand Total	**270.00**

BUDHIL HYDRO-ELECTRIC PROJECT

MAP NO.- VI

CATCHMENT AREA TREATMENT-AFFORESTATION MAP

SCALE : 1:50000



REFENCES

1. RIVER/NALA	
2 PROJECT CATCHMENT BOUNDARY	>>>>>>>
3. VILLAGE/TOWN	BHARMAUR
4 HEIGHT	4669
5 GLACIER	G
6 AYURVEDIC HEALTH CENTRE/SUB-CENTRE (A.H.C./S.C.)	⊕
7 GOVT. SENIOR SECONDARY SCHOOL (G.S.S.S.)	G.S.S.S
8. GOVT. HIGH. SCHOOL (G.H.S.)	G.H.S.
9. GOVT. MIDDLE SCHOOL (G.M.S.)	G.M.S.
10 ROAD	
11 AFFORESTATION (REFERENCE E.I.A.R & CAT PLAN TABLE No. 7.1)	

LEGEND

1. KHARIF	
2. RABI	
3. DOUBLE CROP KHARIF & RABI	
4. EVERGREEN DENSE FOREST	
5. EVERGREEN OPEN FOREST	
6. EVERGREEN FOREST BLANK	
7. LAND WITH SCRUB	
8. BARREN ROCKY	
9. DENSE GRASS LAND	
10 DEGRADED GRASS LAND	

SOURCE OF MAP : GEOLOGICAL SURVEY OF INDIA

DEFC

DHIMAN ENVIRO FORESTRY CONSULTANTS PVT. LTD.

Total creation plus maintenance = Rs. 54,325.00 (per ha)

The total expenditure on afforestation will be:

Creation	= Rs. 85,38,750
Maintenance for 7 years	= Rs. 61,29,000
Total	**= Rs. 146,67,750 lakhs**
Or Say	**= Rs.146.68 lakhs**

Additional price of 56700 wooden fence posts for creation & maintenance of 270 ha. (per ha. having 210 including creation and maintenance) @Rs.130/- per posts amounting to Rs.73.71 lacs which amount shall be deposited by the Project proponents with the Forest Deptt. as and when demanded.

(i) Afforsation and maintenance cost of 270 ha. @ 54,325/ha	= Rs.146.68lacs
(ii) Cost of 56700 F.Posts for aff. + Maint. @ Rs. 130/ F.P.	= Rs. 73.71 lacs
Grand Total of the afforestration including fence posts	**= Rs.220.39 lacs**

Yearwise phasing of physical and financial projection for each component of proposals aregiven in Annexure VI.

5.4 ENRICHMENT PLANTATIONS

5.4.1 Works

There are some forests in the catchment area where in patches density of crop is poor and devoid of overhead shade where planting could be done. In such areas planting of 800 seedlings per hectare is expected to result in full density forests. Extent of such areas is estimated to be 150 hectares which will be planted in 5 years.Areas suggested for enrichment plantations, in consultation with local forest officers, are given in Table 8 below:

TABLE 8 AREAS SUGGESTED FOR ENRICHMENT PLANTATIONS

Year	S.N.	No. of DPF	Name of the forest	Area (Ha)
1st year	1	58	Bharmani DPF C-I	10
	2	57	Bharmani DPFC-II	20
	3	62	Moru DPF	10
	4	45	Pranghala DPF	20
				60
IInd year	5	51	Paldho DPF	5
	6	52	Rajaur DPF	5
	7	144	Kugti RF-C IIIa	10

	8	144	Kugri RF CIII b	10
	9	50	Galu DPF	5
	10	47	Khund DPF	10
	11	41	Dunda DPF-I	5
				50
IIIrd year	12	54	Drati DPF	10
	13	72	Bhiyanu DPF	10
	14	76	Gharoie Dhar DPF	20
				40
			Grand Total	**150**

Plantations over these 150 hectares are proposed to be completed in 3 years and maintenance is to be continued for 7 years after planting. Sequence of forests for planting given in the Table above is merely suggestive and not binding. Due to any administrative exigencies, Divisional Forest Officer, Bharmaur may make any adjustments in the yearly sequence. Specifications and guidelines for works will be the same as for afforestation and are appended as Annexure III. Location of areas to be taken up for Enrichment Plantations are shown on Map VII, page 45.

5.4.2 Expenditure

The item wise details of expenditure per hectare for new enrichment plantation works and maintenance supported by soil conservation measures are given in Annexures VA to VE. However an abstract of norms of expenditure is given in Table 9

TABLE 9 ABSTRACT OF NORMS FOR EXPENDITURE ON ENRICHMENT PLANTATIONS

Creation = Number of plants per ha = 800

Maintenance = For 7 years

1. Creation Rs. 24,550.00

2. Maintenance (Per ha)

1st year	Rs. 4,300.00
IInd year	Rs. 4,100.00
IIIrd year	Rs. 3,300.00
IVth year	Rs. 1,550.00
Vth year	Rs. 1,550.00
VIth year	Rs. 1,550.00
VII year	Rs. 1,550.00
Sub-Total	**Rs. 17,900.00**

Total creation plus maintenance = Rs. 42,450 (per ha)

The Sequence of forests in this table is suggestive only and not binding. Divisional Forest Officer, Bharmaur may make changes/adjustments in the sequence of areas depending upon administrative exigencies.

Necessary techniques of some important species are suggested in Annexure-II.

Specifications and suggestive guidelines for afforestation and soil conservation works are detailed in Annexure III. It is proposed to complete this work in 3 years. In view of rigors of climate and short growing and working season, maintenance of planted areas has been provided for 7 years to aim for complete success. Location of areas taken up for afforestation are shown on Map VI, page 38 These areas are designated as N-DPF because these have been demarcated on Maps, rights recorded and notified but have not been entered in revenue records as such under Govt. orders because local people were dissatisfied for constitution of these areas into Demarcated Protected Forests. So we can rehabilitate these areas to the extent local people are agreeable to close for grazing.

5.3.2 Expenditure

Taking into consideration the likely annual increase in wages and material costs, the expenditure per hectare for new works and maintenance of afforestation supported by minor soil conservation works like gully plugging and small check dams prepared in consultation with Forest Department are given in Annexure IV A to IV E. However, an abstract of norms of expenditure is given in Table 7

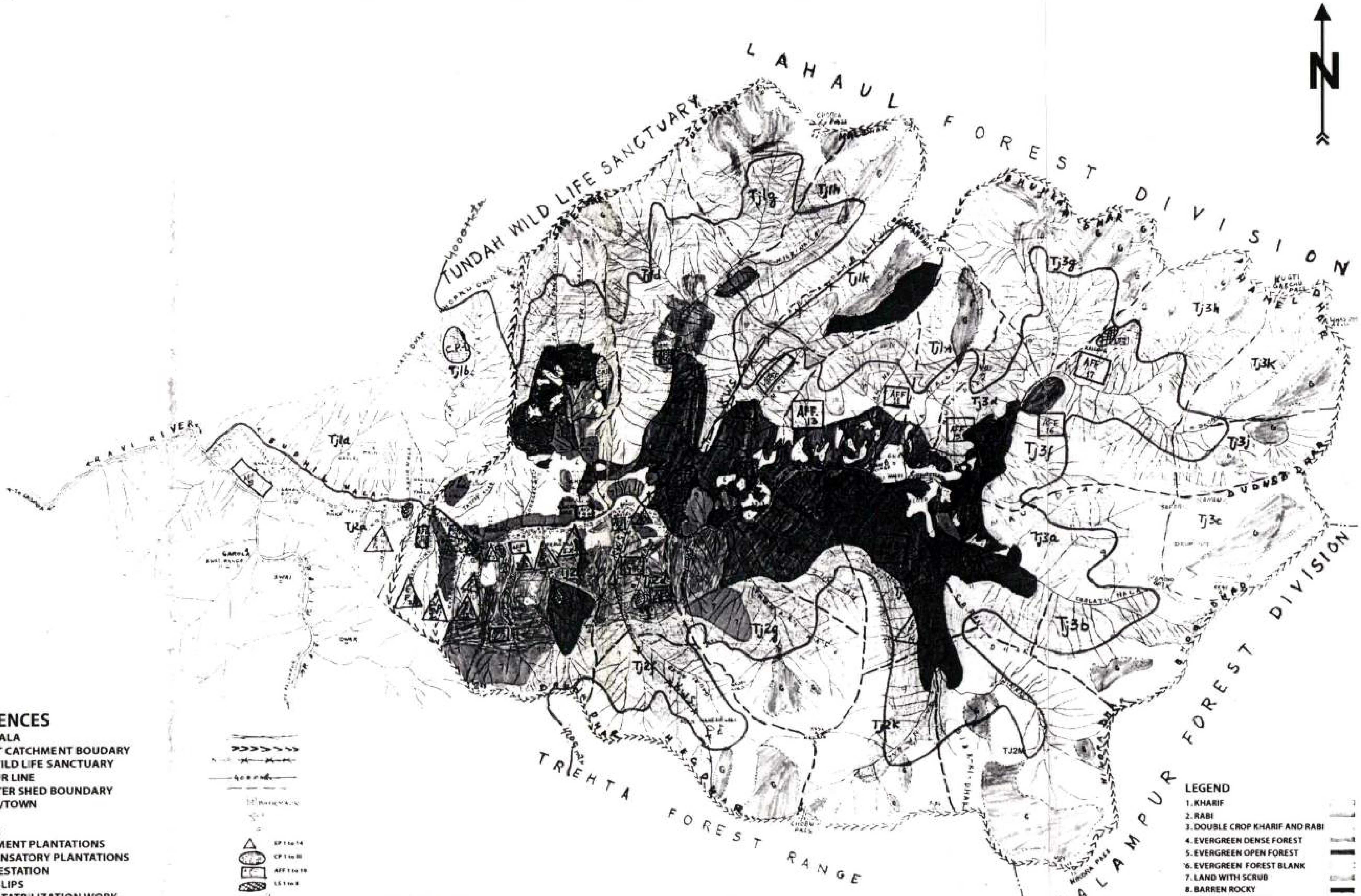
TABLE 7 ABSTRACT OF NORMS FOR EXPENDITURE ON AFFORESTATION

Creation	=	Number of plants per ha=1100
Maintenance	=	For 7 years
1. Creation		Rs. 31, 625.00
2.Maintenance (Per ha)		
1st year	Rs.	5,750.00
IInd year	Rs.	4,650.00
IIIrd year	Rs.	4,300.00
IVth year	Rs.	2,000.00
Vth year	Rs.	2,000.00
VIth year	Rs.	2,000.00
VII year	Rs.	2,000.00
Sub-Total	**Rs.**	**22,700.00**

SUB WATERSHEDS OF BUDHIL CATCHMENT INTEGRATED LAND USE AND TREATMENT

MAP NO. VII

MAP SHOWING LOCATIONS OF ENVIRONMENT MANAGEMENT AND CAT PLAN AREAS PROPOSED FOR TREATMENT



REFERENCES

1. RIVER/NALA
2. PROJECT CATCHMENT BOUDARY
3. KUGTI WILD LIFE SANCTUARY
4. CONTOUR LINE
5. SUB WATER SHED BOUNDARY
6. VILLAGE/TOWN
7. HEIGHT
8. GLACIER
9. ENRICHMENT PLANTATIONS
10. COMPENSATORY PLANTATIONS
11. AFFORESTATION
12. LAND SLIPS
13. BANK STATBILIZATION WORK
14. ROADS

LEGEND

1. KHARIF
2. RABI
3. DOUBLE CROP KHARIF AND RABI
4. EVERGREEN DENSE FOREST
5. EVERGREEN OPEN FOREST
6. EVERGREEN FOREST BLANK
7. LAND WITH SCRUB
8. BARREN ROCKY
9. DENSE GRASS LAND
10. DEGRADED GRASS LAND

Map Not to a Scale

SOURCE OF MAP : SURVEY OF INDIA

DEFC DHIMAN ENVIRO FORESTRY CONSULTANTS PVT. LTD.

The total expenditure on Enrichment Plantations will be:

Creation	=	Rs. 36.825 lacs
Maintenance for 7 years	=	Rs. 26.850 lacs
Total	=	**Rs. 63.675 lacs**

Additional price of 24750 wooden fence posts for creation & maintenance of 150 ha. (per ha. having 165 including creation and maintenance) @Rs.130/- per posts amounting to Rs.32.17 lacs which amount shall be deposited by the Project proponents with the Forest Deptt. as and when demanded.

Cost of creation & maint. 150 ha. @ 42,450/- per ha. = Rs.63.675 lacs

Cost of 24,750 F. Posts for creation and maint. @ 130/-F.P. = Rs.32.175 lacks

(165 F.Posts per ha x 150 ha. = 26250 F.P.)

Grand Total enrichment plantation including fence posts = Rs.95.85 lacs

Yearwise phasing of physical and financial projection are given in Annexure VI.

5.5 PASTURE DEVELOPMENT

5.5.1 General

There are two types of pastures. One type constitutes depleted forest areas around habitations in the lower altitudinal zone which are grazed by domestic animals all the time. Trees, generally of Ban oak and Kahu, existing in these areas which are heavily lopped inspite of proper lopping rules. Overgrazed over longer periods without any rest, these areas are now merely exercising grounds for cattle as these areas are now, practically devoid of even grass. These areas need rest and replenishment. The second type constitutes alpine and sub-alpine pastures mainly grazed by migratory sheep and goat. Due to altitudinal variations, these pastures are vegetationally differently placed and need different approach for improvement.

5.5.2 Lower Altitudinal Grazing lands

As mentioned earlier, these are not grasslands not even grazing lands but merely exercising grounds for domestic cattle. Such lands extend over nearly 1500 hectares rising above the banks of Budhil nallah situated in lower portions of the watersheds of small tributaries of Budhil upstream of dam. This is because heavy grazing in this zone is almost all through the year.

The areas need protection and rest but due to non-availability of alternate grazing lands, it will not be possible to treat the entire area. Parts of such areas have been proposed for regular afforestation. However, it is proposed to treat 120 ha. of these lands in a period of 3 years taking 2 blocks of 20 ha. each per year for closure and improvement every year under this scheme as well.. Closure for longer periods is bound to cause resentment amongst the surrounding villagers and the area being in the interior, local people may not let these areas remain effectively closed for longer periods if the extent is large.

The selection of area to be taken up annually will be done by the Divisional Forest Officer, Bharmaur out of the areas prescribed in the latest Working Plan for Bharmaur Forest Division under Pasture Improvement (Over-lapping) Working Circle.

5.5.3 Works

The improvement works will comprise of closure of the area to grazing, fencing, removal of unpalatable thorny bushes, minor soil conservation measures, gully plugging and check damming where necessary, seeding of improved grass species of local varieties and planting of about 50 trees per ha. of fodder species may be planted to provide leaf fodder also (Ban, Kahu and hill-mulberry etc.)

One check dam/water pond in each block of 20 ha shall be constructed to provide drinking water for the cattle.

Since the establishment period for grasses is not long, it is proposed to provide funds for maintenance for 5 years only after the first year in which new works are completed.

5.5.4 Expenditure

The norms of expenditure for original works and maintenance are proposed as under:-

Creation of grasslands and planting of tree species	Rs. 18000 per ha
Soil Conservation works within closed area	Rs. 2,000 per ha
Water pond/check dams (one in each of closed block)	Rs. 2,00,000 each

Maintenance of all works (Per ha)

1st year	=	Rs. 3000.00
IInd Year	=	Rs. 2500.00
IIIrd year	=	Rs. 2000.00
IVth year	=	Rs. 2000.00
Vth year	=	Rs. 2000.00

Total creation plus maintenance = Rs. 41,500.00 (per ha)

Annual and total Expenditure are given in Table 10 below

TABLE 10 ANNUAL AND TOTAL EXPENDITURE ON PASTURE DEVELOPMENT

New works (Rs. in lakhs) **(40 Ha annually)**

S.N	Item	Istyr	IInd yr	IIIyr	Total
1	Sowing grasses / planting trees	7.2	7.2	7.2	21.6
2	Soil conservation measures	0.8	0.8	0.8	2.4
3	Water Ponds/ check dams	4.0	4.0	4.0	12.0
	Total	12.0	12.0	12.0	36.0

Maintenance from first year after initial works

Year	Rs. in lakhs
1st year	1.20
IInd year	2.20
IIIrd year	3.00
IVth year	2.60
Vth year	2.40
VIth year	1.60
VIIth year	0.80
Total	**13.80**

The total expenditure on development of lower altitudinal grazing lands will be:

Creation, Soil Conservation and check dam (120 Ha.) = Rs. 36.0 lakhs

Maintenance (120 ha.) = Rs. 13.8 lakhs

Total = Rs. 49.8 lakhs

Additional price of 19800 wooden fence posts for creation & maintenance of 120 ha. (per ha. having 165 including creation and maintenance) @Rs.130/- per posts amounting to Rs.25.74 lacs which amount shall be deposited by the Project proponents with the Forest Deptt. as and when demanded.

= Rs.49.80 lacs

= Rs.25.74 lacs

Grand Total of the afforestration including fence posts **= Rs.75.54 lacs**

Yearwise phasing of physical and financial projections for each component of proposals are given in Annexure VI.

5.6 Alpine Pastures

These are high lying areas situated in sub-alpine and alpine zone. The flora is herbaceous and the pastures have the potential to support regulated grazing. Herds of sheep and goat of migratory graziers graze in these pasture for about two months and spend some time while on way to Lahaul and back. Thus these herds graze in these areas for about 2-3 months during summer. These areas remain under snow from late October to late February. Therefore, they get automatic rest for about 6 to 8 months in a year. Droppings of sheep and goat act as fertilizer. Alpine pastures, locally known as "dhars" are very good grazing grounds but due to continuous heavy grazing year after year leads to reduction in their productive capacity. Given rest and regulated grazing, the herbaceous flora has the capacity to recuperate and regenerate itself. Suggestions for improvement of these pastures in the Pasture Improvement (over-lapping) Working Circle under latest Working Plan for Bharmaur Forest Division (2002-03 to 2016-17) briefly state, the prescriptions as under should be followed:

(i) Carrying capacity of these alpine pastures has been determined and fixed in para 14.4.4 of the Working Plan. Grazing should be limited to the number of units worked out for each pasture.

(ii) Graziers should be registered. This is a measure which should be effectively used to check the graziers so that pastures are not grazed beyond the carrying capacity.

(iii) Routes for movement of flocks should be fixed.

Closures of even parts of alpine pastures is practically difficult to implement. It is, therefore, left to the discretion of the Divisional Forest Officer, Bharmaur to plan a closure scheme for these areas as far as possible.

5.7 STABILIZATION OF LAND SLIPS

Relatively weak geological structure of the terrain and its disturbance through road and other on-land construction programme disturb the strata and many a time results in landslips. Left unattended some of these get naturally stabilized whereas others aggravate to such an extent that special efforts are needed to stabilize these.

Landslides seen in the catchment area which can be stabilized with engineering and vegetative measures as mentioned in Annexure III as also through cross walls and estimated expenditure to reclaim these are given in Table 11 below.

TABLE 11 LIST OF LANDSLIPS AND ESTIMATED RECLAMATION COST

S.N	Year	Name of landslip	Estimated Area (Ha)	Estimated expenditure (Rs. in lacs)
1	1st year	Ghoie landslip	5	1.0
2		Kailing landslip	5	1.0
3		Pranghalla	5	1.0
4		Thalla landslip	5	1.0
5	IInd year	Paldha landslip	5	1.0
6		Drati	5	1.0
7		Buhar landslip	10	2.0
8	IIIrd year	Kangon landslip	10	2.0
		Total	**50**	**10.00**

Therefore, Rs. 10.00 lacs are proposed for stabilization of land slips. The location of these landslips is shown on Map VII, page 4 .

5.8 STABILIZATION OF STREAM BANKS

The 2.5 km. Budhil nallah banks between the junction of Sia nallah and Lal nllah with Budhil are erosion prone. This portion has a width of about 250 meters due to bank erosion. There are thick deodar forests on both sides of the steak which are getting damaged due to stream bank erosion.

In the identified stretch it is necessary to provide cratewire structure on both banks to save the banks and simultaneously provide spurs so as to train the flow of water in a specified course. Ten structures are estimated to be needed along the banks and also spurs. These are shown on Map VII, page 42. Each such structure is estimated to cost Rs. 50,000. These structures may be constructed every year and work completed in 2 years at an estimated expenditure of Rs.5lakhs. There may be need for some odd bank protection structure or a spur here and there, which can also be adjusted within these funds.

5.9 DEVELOPMENT OF MEDICINAL PLANTS

5.9.1 Medicinal Plants

The catchment area comprises mainly of alpine and sub-alpine zone. In fact dense alpine and sub alpine grasslands constitute about 42% of the total land area. This is also the area that has the preponderance of medicinal herbs which are exploited by local right holders year after year without any rest or replenishment by any agency. Patches within these grasslands are more suitable for propagation of some important herbs and their marketing in an organized way.

A list of commonly used or economically extracted medicinal plants and herbs occurring naturally are given below.

COMMONLY USED AND EXTRACTED MEDICINAL PLANTS AND HERBS

S.N	Botinical name	Common name	Habit	Habit height (m)	Part used
1	*Aconitum heterophyllum*	Patis	Herb	Sub-alpine region	Root
2	*Asparagus racemosus*	Satawar	Herb	Upto 1800	Root
3	*Atropa belladona*	Shafoo	Shrub	Upto 2400	Leaves
4	*Berberis aristuta*	Kasmal	Shrub	1800-2600	Whole plant
5	*Cinnamomum tamal*	Tejpat	Shrub	Upto 2000	Leaves
6	*Digitalis pupurea*	--	Herb	Above 1700	Leaves
7	*Jurinea macrocephalla*	Dhoop	Herb	Sub-alpine region	Root
8	*Picrorhiza kurroora*	Kaur	Herb	Above 3000	Root
9	*Podophyllum embodii*	Bankakru	Herb	--	Root & rhizome
10	*Saxifraga ligulata*	Pathar-tor	Herb	Above 1800	Leaves edible roots as medicine
11	*Saussurea lappa*	Kuth	Shrub	1500-3000	Whole plant
12	*Swertia chirata*	Chirata	Herb	2000-3000	Whole plant
13	*Taxus baccata*	Barmi	Tree	2400-3000	Leaves
14	*Viola serpens*	Banafsa	Herb	1000-3000	Flower

Aconitum heterophllum (Mithi Patish), Dioscoria deltoidea (kins) Jurinia macrocephala (dhoop) and Saussuria lappa(kuth) are the plants which can be easily propagated and readily marketed and hence their propagation is recommended.

5.9.2 Cultivation Technology

Cultivation technology of the recommended four species is as under:

(i) Aconitum heterophulum

It is a non-poisonous Aconite used as a valuable tonic to combat debility after fevers. It is used in a number of other pharmaceutical products.

Method of cultivation

No standard techniques for cultivation of this herb have been evolved but some experiments were conducted by the Forest Department in Chamba and Kullu in sixties as also in Ayurvedic Research Centre, Jogindernagar. On the basis of that data it has been found that the plant can be raised from seeds and tuber division. Method of tuber division is perhaps better as it avoids cross fertilization and failure of germination due to sterile seed. Crop raised by tuber planting will be ready one year advance.

Seeds are sown late in spring or in March-April depending upon the melting of snow, in nursery beds. The soil should be well sieved and mixed with leaf mould. Seeds are mixed 10 to 20 times of their volume with fine sand before sowing to ensure even distribution. Sowing is done in lines about 5 cm, apart and seeds are then covered with about 2 mm thick layer of fine soil. The seed germinates in 15-20 days. The seedlings are ready in about a month for transplanting.

The seedlings are pricked out in well prepared and mannured beds in rows at 30 cmx15 cms spacing.

Propagation of tubers is usually done by planting small tubers of few years growth in well prepared field usually late in autumn before snow fall. The plant requires irrigation in hot summer months.

The plants flower in July-August of next year

Harvesting

The crop raised through seed will be ready for harvest in 3 years and the one raised by tubers in two years. Harvesting is done by digging out the tubers in autumn when the aerial shoots start drying. The larger tubers are cleaned, washed and dried for marketing and smaller ones are collected and preserved in soil for next planting.

Yield and Economics

No yield data is available. However, on an ocular estimate, yield of 250 kg per ha. may be available.

(ii) Dioscoria deltoidea

Cultivation

The rhizomes of dioscoria are collected and cut into pieces having at least 2-3 eyebuds. These rhizomes cuttings are planted in March-April or June-July at 0.5mx1 meter spacing. The sprouting of vines start within 40-60 days. Stakes are provided to the climbers so that the growth is allowed to take place fully.

From seed

Seeds which ripe in October-November can also be used for propagation. Seed is sown in March-April in pre-prepared patches spaces at one meter apart.

Irrigation, weeding and hoeing

If plants can be provided with irrigation in summer and dry part of winter in October, November, the growth is accelerated. Weeding and hoeing also keep the plant to grow vigorously and increase the quantity of rhizome.

Harvesting

Under cultivated and proper cultivation/operational conditions the tubers of crop raised from rhizome cuttings are expected to be ready for harvest after 4-5 years. The digging out of rhizome should be done in the months of October-November. The rhizomes after being properly cleaned off the mud/soil and washed, are dried in the sun. It is hoped that the dioscoria sown under forest plantation conditions shall be ready by about 7-8 years without incurring much of expenditure.

Yield

The crop raised under proper cultivation condition will be ready for harvest after 4-5 years and per ha. yield is expected to be of the order of about 10 qtls. dry.

Economics

The total expenditure cost per ha. including maintenance cost upto 4 years will not be more than Rs. 4000/- to 5000/-. A total return of about Rs. 10,000/- per ha. is expected. Thus a net saving of Rs. 5000/- per ha. can be expected from one ha. of the harvest.

(iii) Jurinea macro-cephala (Dhoop)

Cultivation

Some experiments of cultivation of Dhoop were conducted at Kalatop Nursery (Altitude 2750 m) in Chamba Forest Division by the Forest Department in early sixtees. The experiments have indicated that dhup can be raised by seed as well as by roots.

It is suggested that some areas one to 2 ha. in extent, may be closed and protected from grazing. The seed collected from existing Dhup areas may be broadcast before snow fall or dibbling of seed in small patches may be done. The seed germinates on melting of snow and establishes itself. Weeding may be done during rainy season itself. The plants will be available for commercial exploitation at the age of about 3-4 years.

Yield

No yield date or information or economics of cultivation is available but in higher zone where no other sources are available and areas are lying unused, it will be worth-while to undertake small plantation projects of 1-2 ha. area in Kugti sanctuary area.

(iii) Saussuria lappa (Kuth)

Cultivation

Kuth needs deep rich porous soil. The area where the sheep and goats have been halting during their migration can safely be taken up for the purpose.

Kuth can be raised both by seed as well as by root cuttings but seeds are economical. Seeds are sown in nurseries and seedling transplanted to planting site after a year at the spacing of 90 cm. X 90 cms. Sowing of seed either in nurseries or directly in plantation areas can be done in October-November which will start sprouting in April to June. Seeds can also be sown in March/April if the weather conditions permit.

Harvesting

The crop is ready for harvesting after 3 years. Roots are harvested in the month of October and are dried after cutting into small pieces of about 10 cms. Length. The drying can be done in sun and after drying for some time partially, direct roots can be taken down to lower altitude for drying.

Yield

The yield under favourable conditions per ha. is 2.00 to 2.5 tonnes of dry roots. It is reported that Kuth roots can be sold in Amritsar market at Rs. 40/- a kg.

Economics

Taking 2,000 kg of dried roots as produce of one ha. an amount of Rs. 16,000/-can be earned even if the sale rate is taken to be at Rs. 8/- per kg. Thus an average annual income of more than Rs. 5,000/- per ha. is indicated.

Kuth is cultivated in Lahaul on an extensive scale. The sale rate is organised through Lahaul Kuth Growers Society Manali.

5.9.3 Experimental Cultivation of Medicinal Plants

It is proposed to cover 40 hectares in 3 years, i.e. 20 ha. in 1st year and 10 ha. each in 2nd and 3rd year. The area seems to be small but since this will be a pioneering effort the work should be more on experimental basis and to acquire field knowledge and experience by field officials Selection of area & Species to be raised is left to the concerned Range Forest Officers Bharmaur Range. It may be in one block or different situations every year. Since harvesting takes place generally after 3 years, the plantation have to be regularly maintained for 3 years. Expenditure for creation of plantation including maintenance for 3 years is estimated to cost Rs.25,000.00 per ha. The expenditure norm has been kept slightly higher so that these can be effectively protected as also greater attention be given in the field. Proper records need to be maintained so that this experience becomes a good guide for future. Therefore, provision of (Rs. 10+8.58) = Rs.18.58 lacs including price of wooden fence posts numbering 165 posts for this work has been made. State medicinal plant board should be associated in planning and execution of this scheme.

5.10 DEVELOPMENT OF WILD LIFE

Kugti Wild Life sanctuary covering 32.391-41 ha. forms the head water of Budhil Catchment. A management plan of this Wild Life Sanctuary was formulated for the period 1994-95 to 2003-04 by the Forest Department but it could not be implemented completely for lack of funds. Therefore Rs.20.00 lakhas are earmarked for implementation of the following useful activities deserving priority consideration:

1.	Provision of salt lies	1.00
2.	Study programmes on various aspects through Wild life institute and Universities.	=Rs.5.00 lakh
3.	Raising fruit trees &fodder grasses preferred by Wild life.	=Rs.5.00 lakh
4.	Provision of drinking water ponds for wild life	=Rs. 1.50 lakh
5.	Infrastructure facilities	= Rs.2.50 lakh
6.	Construction of watch towers	= Rs.2.00 lakh
7.	Wild Life Watcher (Part time)	= Rs.3.00 lakh
	Total	**= Rs.20.00 lakh**

5.11 SOIL AND WATER CONSERVATION

(i) Government Lands:

Soil conservation works without closure can not succeed. Entire government lands cannot be closed to grazing. Therefore those areas which are closed for planting under afforestration compensatory plantation and enrichment plantations need to be supplemented by soil and water conservation measures. For this purpose while working out the norms for expenditure under plantations, as give in Annexure IV and V, Rs.6325/- ha. for under compensatory plantation and afforestration plans and Rs.4912.05 per ha. Under enrichment plantation schemes have been provided for soil and water conservation measures. However it is suggested that one silt detention dam, one each in, Tj3d, Tj1m, Tj2c, Tj1c & Tj2b sub water sheds may be constructed at an expenditure of

Rs.4.00 lacs each. Therefore for this work Rs.20.00 lacs are being earmarked. However the site of the S.D.D. can be changed by the D.F.O. Bharmour depending upon suitability and priority. The work will be completed in three years.

5.12 PRIORITIZATION OF WATERSHEDS/ SUB WATERSHEDS

5.12.1 Silt Yield Index

The silt yield Index (SYI) considering sedimentation as product of credibility was conceptualized by the All India Soil and Land Use Survey (SISLUS) Organisation as early as 1969 and has been in operational use since then to meet the requirements of prioritization of smaller hydrological units within river valley project catchment areas.

The silt yield indeed is defined as the yield per unit area and SYI value of hydrologic unit is obtained by taking the weighted arithmetic mand over the entire area of the hydrologic unit.

5.12.2 Prioritization:

The prioritization of smaller hydrologic units within the vast catchment are based on the SYI of the smaller units. The boundary values or range of SYI values for different priority categories are arrived at by studying the frequency distribution of SYI values and locating the suitable breaking points. The watersheds/sub watersheds are subsequently rated into various categories corresponding to their respective SYI values.

The application of SYI model for prioritization of subwatersheds in the catchment areas involves the evaluation of:

a) Climatic factors comprising total precipitation, its frequency and intensity
b) Geomorphic factors comprising land forms, physiography, slope and drainage characteristics.
c) Surface cover factors governing the flow hydraulics and
d) Management factors

The data on climatic factors can be obtained for different locations in the catchment area from the meteorological stations whereas the field investigations are required for estimating the other attributes.

The various steps involved in the application of model are:

- Preparation of a framework of sub-watersheds through systematic delineation
- Rapid reconnaissance surveys on 1:50,000 scales followed by detailed surveys leading to the generation of a map indicating erosion-intensity mapping units.
- Assignment of weightage values to various mapping units based on relative silt-yield potential.
- Computing Silt Yield Index for individual watersheds/sub watersheds.
- Grading of watersheds/sub watersheds into very high, high medium, low and very low priority categories.

The area of each of the mapping units is computed and silt yield indices of individual subwater sheds are calculated

The SYI values for classification of various categories of erosion intensity rates are given in Table 12

Table 12 Criteria for Erosion Intensity Rate:

Sr. No.	Priority Category	SYI Values
1.	Very High	1400 and Above
2.	High	1200 – 1399
3.	Medium	1000 – 1199
4.	Low	Less than 1000

All India Soil and Land Use Survey Organization, Department of Agriculture and Cooperation, Ministry of Agriculture Govt. of India conducted **rapid reconnaissance survey** on delineation of priority sub water sheds for integrated water shed management in the catchment of the Ravi River Valley Project above Thein Dam Punjab, J&K and Himachal Pradesh from May to July 1986. The survey is quite old and only a rapid reconnaissance survey but nevertheless it may be appropriate here to discuss the results of that survey.

Catchment area of Budhil nallah, a right bank tributary of Ravi river in Bharmour Tehsil, Distt. Chamba was included in this survey. Budhil catchment lies along the head waters of mid-Himalayan Range. The catchment area above Thalla dam site on Budhil nallah, divided in 28 sub-water sheds.

Sub water shed wise mapping units, their area and silt yield index and relative priority in Budhil catchment area are indicated below in Table No. 13:

PRIORITIZATION TABLE

TABLE 13
Priority I: VERY HIGH
(SYI Value: 1400 and above arranged in descending order of SYI)

Sr. No.	Sub-Watershed Code	SYI	Area in Hectares				Extent of areas taken up for bringing under vegetation (Ha.)				
			Snow & Glacial area	Area above 4000 mtr. altitude	Area below 4000m altitude	Total	Compensatory Plantation	Afforestation	Enrichment Plantation	Total	Remarks
1.	TJ1d	1440	-	1000	1500	2500	16	-	-	16	
2.	TJ1f	1440	-	475	950	1425	20	20	-	40	
3.	TJ1g	1440	-	1275	600	1875	-	20	-	20	
4.	TJ1h	1440	1875	-	-	1875	-	-	-	-	Snow & glaciers
5.	TJ1k	1440	2150	-	-	2150	-	-	-	-	-do-
6.	TJ2f	1440	-	1000	625	1625	-	-	-	-	
7.	TJ2g	1440	-	1250	1200	2450	-	30	-	30	
8.	TJ2k	1440	1825	-	-	1825	-	-	-	-	Snow & glaciers
9.	TJ2m	1440	2675	-	-	2675	-	-	-	-	-do-
10.	TJ3f	1440	-	1325	250	1575	-	20	-	20	
11.	TJ3h	1440	-	1600	25	1625	-	15	-	15	
12.	TJ1n	1438	1375	-	-	1375	-	-	-	-	Snow & glaciers
13.	TJ2j	1437	-	1600	400	2000	-	35	30	65	
14.	TJ3b	1435	-	1825	425	2250	-	-	-	-	
15.	TJ3d	1433	-	300	1000	1300	-	20	-	20	

16.	TJ2h	1430	-	450	925	1375	-	-	10	10	
17.	TJ1m	1423	-	150	1600	1750	-	25	-	25	
18.	TJ3a	1415	-	900	950	1850	-	-	10	10	
19.	TJ2c	1414	-	-	1450	1450	-	20	25	45	
20.	TJ2d	1414	-	-	1300	1300	-	20	5	25	
21.	TJ1c	1408	-	900	1800	2700	-	15	-	15	
22.	TJ2b	1400	-	-	2025	2025	-	20	60	80	
23.	TJ3c	-	1450	-	-	1450	-	-	-	-	Snow & glaciers
24.	TJ3g	-	2750	-	-	2750	-	-	-	-	-do-
25.	TJ3j	-	2325	-	-	2325	-	-	-	-	-do-
26.	TJ3k	-	1250	-	-	1250	-	-	-	-	-do-
	Total		**17675**	**14050**	**17025**	**48750**	**36**	**245**	**140**	**421**	

Priority II: HIGH
(SYI Vlaue-1200-1399 arranged in descending order of SYI)

1	TJ1b	1351	-	615	2460	3075	20	10	-	30	
2.	TJ1j	1281	-	-	875	875		10	-	10	
	Total		**-**	**615**	**3335**	**3950**	**56**	**265**	**140**	**461**	

	Below Dam Site		-	-	-	-	-	5	10	15	Within the project components
	TJ2a	**Grand Total**	**17,675**	**14,665**	**20,360**	**52,700**	**56**	**270**	**150**	**476**	

ABSTRACT

Sr.No.	Priority of sub-water shed	Snow &Glacial area (ha.)	Area above 4000 mtrs. Altitude (ha.)	Area below 4000 mtrs. Altitude (ha.)	Total (ha.)
1.	I	17675	14050	17025	48750
2.	II	-	615	3335	3950
		17675	**14665**	**20360**	**52700**

According to this abstract 20360 ha. Lie below 4000 meters altitude. All the priority I & II areas above 4000 meters altitude and under snow & glaciers constituting 32340 ha. are free from my biotic factors and are subject to natural/ geological erosion. So far no method seems to have been evolved to stop or even mitigate geological erosion and hence nothing can be done over 32,340 ha. Out of the remaining 20,360 ha., following categories of land and practically, no attention from soil conservation/ afforestation point of view:

Sr. No.	Type of Land use	Area as per remote sensing (ha.)	Area estimated below 4000 mtrs. From remote sensing map (ha.)	Remarks
1.	Agriculture	1858	1858	
2.	Fruit Crops	700	700	
3.	Ever green dense forests	2961	2961	
4.	Barren rocky areas	799	599	About 200 hac. Estimated be above 4000 mts. altitude
5.	Dense grass lands	21963	11963	10000 has estimated to be above 4000 meter altitude.
	Total	**28281**	**18081**	

Therefore nearly 2279 ha. Are left which lie around populated areas like spots on leopard skin, are burdened with rights of grazing, fodder and trees for housing repairs and making agricultural implements by the local people. It is difficult to close areas in this tract & even more difficult to enforce closures against grazing. It is also accepted that no more than one third of the area maybe closed at a time and that too with the consent of the local people / Panchayat. It is in this background that 836 ha. are suggested for plantation related activities.

The following extent of areas are proposed to be covered under different items:

(i)	Compensatory Plantation	=	56 ha
(ii)	Development of medicinal plants	=	40 ha
(iii)	Horticulture	=	70 ha
(iv)	Afforestation	=	270 ha
(v)	Enrichment Plantation	=	150 ha
(vi)	Pasture Development	=	120 ha
(vii)	Area coverage under landslips	=	50 ha
	Total	=	**756 ha.**

Besides these area coverage works, construction 5 silt detention dams in Govt. lands, (5 priority sub water sheds) have been provided. Intensive coverage of this much area maybe deemed to be sufficient to contribute to the amelioration of environmental conditions in this tract.

5.12 PROGRAMME IMPLEMENTATION INCLUDING INFRASTRUCTURE

Varying degrees of physical and financial targets have been suggested in different fields. In some cases amounts are to be spent on infrastructure and in some cases workload is ,not very heavy.

(i) **Organisation** Since major component of physical and financial targets are to be achieved by the Forest Department, it is proposed to place Rs. 15.0 lakhs at their disposal to engage requisite staff to match the targets as they deem fit.

(ii) **Buildings** Several forest buildings already exist but some of them are not in good condition without repairs for want of funds. Therefore, renovation of following buildings is suggested.

(i)	Forest Rest House Sandi	Rs. 1.50 lacks
(ii)	Block Officers quarter Kugti	Rs. 1.25 lacks
(iii)	Forest Guard hut lower Kugti	Rs. 1.00 lacs
(iv)	Forest Guard hut upper Kugti	Rs. 1.00 lacs
	Total	**Rs. 4.75 lacks**

(iii) For mobility of the field staff, a vehicle is needed. Therefore Rs. 7.25 lacs are provided for purchase of vehicle considered necessary by the Forest Department and engagement of a driver. Also, motorcycles will be used by the junior field staff for which Rs 2 lakhs has been budgeted for 3 motorcycles. Also, Rs 1 lac will be provided for a computer and printer / copier / scanner. Thus in all Rs. 30.0 lacs will be placed at the disposal of Forest Department for following itesm:

(a)	Organizations	Rs. 15.00 lacs
(b)	Buildings	Rs. 4.75 lacs
(c)	Vehicle with driver	Rs. 7.25 lacs
(d)	Motorcycles	Rs 2.0 lacs
(e)	Office Equipment	Rs 1.0 lacs
	Total	**Rs. 30.00 lacs**

CHAPTER 6

COST ESTIMATES

TABLE

Sr.	Item	Para	Cost of Creation & Maintenance		Price of Wooden Fence Post			Grand Total in Lacs
			Area (ha.)	Cost in lacs	No. /ha.	Total No.of Fence Post	Cost	
1.	Afforestration	5.3.2	270	146.68	210	56700	73.71	220.39
2.	Enrichment Plantation	5.4.2	150	63.675	165	24750	32.175	95.85
3.	Pasture Development	5.5.4	120	49.80	165	19800	25.74	75.54
4.	Stabilization of Landslips	5.7	-	10.00	-	-	-	10.00
5.	Stream bank stabilization	5.8	-	5.00	-	-	-	5.00
6.	Development of medicinal plants	5.9.3	40	10.00	165	6600	8.58	18.58
7.	Development of Wild Life	5.10	-	20.00	-	-	-	20.00
8.	Soil & Water conservation	5.11	-	20.00	-	-	-	20.00
9.	Programme Implementation	5.13	-	30.00	-	-	-	30.00
	Total	**Rs.**	**580**	**355.155**		**107850**	**140.205**	**495.36**
							Say	**495.40**

Compensatory Plantation scheme has been separately submitted to the Forest Department H.P. The schemes covers 56 ha. of land for afforestration for which Rs.75.75 lakhs is to be provided by the promoters. The above amount of Rs.495.40 lakhs are to be placed at the disposal of Forest Department H.P. for Catchment Area Treatment. It may be mentioned that no financial units can be imposed on technical programmes included in CAT plan. Physical targets have to be need based and the corresponding financial requirements have to be worked out. Physical programmes have to be tailored to administrative and socio-economic requirements of the area.

ANNEXURE I **FOREST CLASSIFICATION AND FLORA PRESENT**

Based on classification by Champion and Seth (the Revised Survey of Forest Types of India) the main forest types met within the catchment area are:

12/C1-Lower Western Himalayan Temperate Forests Sub-Groups

1. Type 12/C1a : Ban Oak Forests (*Quercus leucotrichophora*)
2. Type 12/C1b : Moru Oak Forests(*Quercus dilatata*)
3. Type 12/C1c : Moist Deodar Forest
4. Type 12/C1d : Western mixed coniferous forests (Spruce, Blue Pine, Silver Fir)
5. Type 12/C1e : Moist Temperate deciduous forests

12/C2 -Upper Western Himalayan Temperate Forests Sub-Groups

6. Type 12/C2 a: Kharsu Oak Forests (*Quercus semicarpifolia*)
7. Type 12/1S1 : Alder Forests
8. Type 12/2S1 : Low Level Blue Pine Forests

15: Moist Alpine Scrub

9. Type 15/C1 : Birch/Rhododendron Scrub Forests
10. Type 15/C2 : Deciduous Alpine Scrub
11. Type 15/C3 : Alpine Pastures

Type 12/C1a: Ban, Oak Forests (*Quercus leucotrichophora*)

These forests are generally found between the elevation of 1500 m to 2000 m and Ban Oak is the principal species. Oak forests of poor quality are found in Bharmaur Range on the terrain sloping to the left bank of Budhil nalla below Ghararu. The annual precipitation in these forests may vary from 1250 to 2250 mm. The snowfall during winter is a regular feature. The chief species is Ban (*Quercus leucotrichophora*). The other associates are *Litsea umbrosa*, *Mactulus* species, *Pyrus pashia* and groups of *Ilex dipyrena*. The shrub under-growth consists of *Viburnum cotilifoluim*, *Rubus niveus*, *Desmodium tiliaefolium*, *Indigofera* species, *Deutzia corymbosa*, *Lonicera-quinquelocularis*, *Berberis* Species. Climbers like *Vitis* species, and *Rosa moschata* are commonest.

Ban Oak forests particularly those bordering agricultural lands have been mercilessly lopped and felled for fodder and agricultural implements. Natural regeneration in these forests is almost absent.

Type 12/C1b: Moru Oak Forests (*Quercus dilata*)

Moru Oak is found mixed with Ban Oak at the lower limits and Kharsu Oak at the upper extremity. The floristic composition is the same as of the Ban forests. In addition Deodar and Kail are found mixed with the Moru Oak. It is more mesophytic than Ban, Oak and, therefore, occupies cooler and damper places.

Type 12/C1c: Moist Deodar Forests

This is an important formation containing valuable forests of Deodar. It covers generally the altitudinal range of 1700 - 2800 m. Annual rainfall varies from 1250 to 2250 mm and most of the precipitation is in the form of snow during winter. The forests are irregular more or less of all ages except those that have been regenerated during the last 50 years or so which are of uniform age. In the regenerated areas, the growing stock consists of saplings and poles with some over-wood. By and large the growing stock in the forests is mainly of II and III class trees. The average density of these forests is about 0.6 on ocular estimates. Natural regeneration is deficient.

Deodar forests are pure in the middle altitudinal limits, but lower down are found mixed with Ban. Kail intrudes into Deodar forests where ever conditions are suitable for its growth. Deodar is found mixed with Spruce and some Fir also. The deciduous associates found especially in depressions are Ban, Litzea *umbrosa*, *Celtis australis*, *Cedrella serrata*, *Populus ciliata*, *Carpinus viminea*, *Ulmus villesa*, *Cornus macrophylla*, *Prunus pedus*, etc. and in the damp declivities *Ulmus wallichiana*, *Juglans regia* and *Aesculus indica*, etc. The undergrowth mainly consists of *Parrotia jacquemontiana*, *Viburnum cotinifolium*, *Indigofera* species, *Desmodium tiliaefolium*, *Rubus ellipticus*, *Fragaria vesica*, *Lonicera qvinquelocularis*, *Berberis lycium*, *Viola canescens*, *Artemisia vulgaris*, *Veleriana* species, *Rosa moschata* and *Hedra helix*, etc.

Type 12/C1d: Western Mixed Coniferous Forests (Kail, Spruce,Fir)

These are mixed coniferous forest of Kail (*Pinus wallichiana*), Spruce (*Picea smithiana*) and Silver Fir (*Abies pindrow*). These occur between the altitudinal zones of 2000 m to 3500 m. Annual rainfall is 1250 to 2250 mm, which is equally received as rain and snowfall. Kail is of 1st quality. Fir and Spruce forests did not receive the treatment as was available to Deodar and Kail forests in the past and hence generally there is dominance of mature classes. Younger age classes are deficient and most of the over mature trees are putting on negative increment. Humus accumulation is heavy, which is detrimental to natural regeneration, which is absent all over. Spruce is dominant along the lower altitudinal limits, whereas some Deodar and Fir are found scattered in sunny and moist situations respectively. The middle zone carries a mixture of Kail, Spruce and Fir, while in the upper belts Fir is almost pure. Kail is found on the well drained and exposed situations. It comes up spontaneously along land slips and exposed portions to the exclusions of the other species, and extends right upto the zone of Betula and Rhododendron. Deodar is found on the well drained sunny aspects in the lower belt. On the cooler northern aspects Taxus baccata forms the under storey. The deciduous associates interspersed in these forests are *Aesculus indica*, *Juglans regia*, *Acer* species. *Celtis australis*, *Prunus padus*, *Ulmus wallichiana*, *Fraxinus floribunda*, *Morus serrata*, *Machilus* species and *Litsea* species. The undergrowth and herbaceous flora are fairly thick and consists of Berberis, Lonicera, Artemisia, Viburnum, Deutzia, Potentilla, Anemone, Viola, Valeriana, Fragaria etc. At places bracken fern occurs in thick colonies taking complete possession of the ground and thus hampering the natural regeneration. On the southern and steeper grounds Salvia, Verbascum, Senecio species and some grasses also appear.

Type 12/C1e: Moist Temperate Deciduous forests

This type is found from an elevation of 1800 m to 2750 m on hollows and depressions. The canopy is generally complete. Due to extremely moist conditions the conifers retreat from such places and these are colonized by deciduous species, but on comparatively better drained sites, Silver Fir in the upper and Kail in the lower zone come up. The predominant species are *Aescules indica*, *Corylus colurna*, *Acer pictum*, *Acer caesium*, *Juglans regia*, *Prunus cornata*, *Abies pindrow*, *Picea smithiana*, *Taxus baccata*, etc.

Type 12/C2a: Kharsu Oak (*Quercus semicarpifolia*)

This type occurs above the Spruce and Silver Fir forests between 2500 to 3200 m altitude. *Quercus semicarpifolia* is the dominant species. The trees are mainly stunted due to heavy winter snowfalls and the lashing winds that prevail there. Groups of poor quality Fir, Spruce and *Quercus dilatata* are found in the sheltered localities. The undergrowth consists of Viburnum, Strobilanthus, Sarcococa, Rosa etc. Along the upper reaches these species are replaced by *Betula utilis*, *Rhododendron campanulatum* and *Juniperus recurva*. These latter species find themselves in a state of perpetual strife with snow, with further rise in elevation, some black patches of *Juniperus recurva* are the only vestiges of arborescent vegetation.

Type 12/1s1: Alder Forests

Alder (Alnus nitida) occurs in pure patches especially on the banks of streams and nallahs from about 1000 m to 3000 m altitude. Under growth is generally absent. This formation is found on the banks of Budhil. However, alder is limited to the sites with permanent water supply. The other associates, though rare are *Poplus ciliata, Celtis australis*, etc.

Type 12/2 s1: Low Level Blue Pine (Kail) Forests

This type generally occurs from an elevation of 1500 to 2000 meters, though on the spurs it extends to much higher limits. Kail is the main species, which occurs in pure and dense forests. The crops are generally young to middle aged. Regeneration is spontaneous and profuse almost anywhere and everywhere. Higher up Kail is dwarfish in stature and the canopy is almost complete and there is heavy congestion at a number of places. Undergrowth is generally absent.

Type 15/C1: Birch/Rhododendron Scrub Forests (Sub-alpine Forests)

This type forms a low evergreen forests of Rhododendron and Birch. The formation is rather dense. Mosses or fern cover the ground with varying amount of alpine shrubs. At places, birch occurs in pure stands. Rhododendron is well adapted to stand snow pressure and even sliding snow. This type is found in the upper portion of the mountain ranges.

Type 15/C2: Deciduous alpine Forests

Essentially this formation is not a tree type, and it lies between the sub-alpine forests and alpine pastures. It is characterized by low deciduous shrubs usually about one meter high. Patches of dwarf Rhododendron, Junipers, Betula etc. are the only representatives of tree growth. Grass glades are interspersed here and there very frequently. This type is again found in the upper portions of the mountain ranges.

Type 15/C3: Alpine Pastures

Above the tree limit, lie the vast and extensive grass lands and pastures, which are much prized by the Gaddis for grazing their flocks of sheep and goat. These grass lands are the abodes of a number of important medicinal plants and herbs. The more significant of these plants are *Jurinea macrophylla* (Dhoop), *Aconitum nepellus* (Mohari), *Aconitum heterophyllum* (Patis), *Picrorhiza Kurroora* (Karu) and *Sassurea lappa* (Kuth) occurs rarely. *Viola odorata* (Banafsa), *Podophyllum emodi* (Bankakru), *Velerina wallichii* (Muskbala), *Salvia moorcrafitiana* (Thuth) are found growing gregariously in the Deodar and Fir zones. These grasslands receive very heavy snowfall during winter.

TREES, SHRUBS AND HERBS FOUND IN BUDHIL HYDROELECTRIC PROJECT CATCHMENT AREA, BHARMOUR FOREST DIVISION & FAUNA OF THE TRACT.

Scientific	Local Name	English Name
A-TREES		
Abies pindrow	Rai	Silver Fir
Abies spectabilis	--	Himalayan Silver Fir
Acer acuminatum	Mandar	Maple
Acer caesium	Mandar	Maple
Aesculus indica	Goon	Horse Chestnut
Alnus nepalensis	Piak	Alder
Alnus nitida	Piak	Alder
Bauhinia purpurea	Kachnar	-
Benthamidia capitata	-	Dog wood
Betutla alnoides	Kathbhoj	-
Betula utilis	Bhojpatra	Birch
Buxus wallichiana	-	Box wood
Cedrus deodara	Diyar	Deodar
Celtis australis	Khirak	Nettle Tree
Corylus colurna	Thangi	Hazlnut
Cupressus torulosa	Devidiyar	Cyprus
Euonymus tingens	-	-

Ficus bengalensis	Bar	-
Ficus religiosa	Pipal	-
Fraxinus excelsior	Sanooh	Ash
Fraxinus floribunda	Sanooh	Ash
Grewia vestita	Dhaman	-
Ibex dipyrena	-	Holly
Juglans regia	Akhrot	Walnut
Lannea grandis	Jhingan	-
Litsea glutinosa	Chirindi	-
Machilus odoratissima	-do-	-
Morus alba	Karun	Mulberry
Morus serrata	-do-	-do-
Myrica nagi	Kaphal	-
Neolitsaea umbrosa	Chirindi	-
Olea cuspidate	Kahu	Wild Olive
Picea smithiana	Tosh	Spruce
Pinus gerardiana	Neoza	Chilgoza Pine
Pinus roxburghii	Chir,Chil	Chil Pine
Pinus wallichiana	Kail	Blue Pine
Populus alba	Pahari Pipal	Poplar
Populus ciliata	Chaloon	-do-
Punica granatum	Daru	Wild Pomegranate
Pyrus communis	Nakh	Pear
Pyrus malus	Seo	Apple
Quercus dilatata	Moru	Green Oak (Middle Zone)
Quercus leucotrichophora	Ban	White Oak (Low level)
Quercus semicarpifolia	Kharsu	Brown Oak (High level)
Rhododendron arboreum	Cheo	Red Rhododendron
Robinia pseudoacacia	--	--
Salix alba	Badha	Willow
Salix babylonica	Badhu (Majnu)	-do-
Taxus baccata	Barmi	Yew
Toona ciliata	Tun	-
Toona serrata	Dhauri	-

B.HERBS AND SHRUBS

Agave americana	Ramban	Century Plant
Ainslea aptera	Mukh Nihani	Airon's Rod
Berberis aristata	Kemal/Kasmla	--
Berberis lycium	Kemal/Kasmal	--
Chenopodium album	Bathu	--
Cotinus coggygria	Tung	--
Cotoneaster acuminatus	Rheuns	--
Cotoneaster bacillaris	-do-	--
Cotoneaster microphyllus	-do-	--
Cotoneaster vulgaris	-do-	--
Daphne payracea	Niggi	--
Dendrocalamus strictus	Bans	--
Desmodium tiliaefolium	Pre	Wild Syringe
Deutzia compacta	Batti	--
Deutzia staminea	Batti	--
Duchesnia indica	Strawberry	Strawberry
Eulaliopsis binata	--	--

Euphorbia royleana	--	--
Fragaria vesca	Strawberry	Strawberry
Galium asperifolium	--	--
Galium rotundifolia	--	--
Girardinia diversifolia	Ain/bichhu buti	--
Ibex dipyrena	Kanderu	The Holly
Indigofera hirsuta	Kathi	--
Indigofera heterantha	Kathi	--
Juniperus communis	Bither	Cedar
Juniperus recurva	-do-	-do-
Lonicera angustifolia	Kantias	Honeysuckle
Lonicera quinquilocularis	Bakhru	-do-
Mimosa rubicaulis	--	--
Oxalis corniculata	Malori	--
Parrotia jacquemontiana	Killar	Wych hazel
Plantago lanceolata	Isabgol	--
Plantago tibetica	--	--
Plectranthus rugosus	Kuthal	--
Potentilla Spp.	--	--
Primulla Spp.	--	--
Prinsepia utilis	Kangora	--
Pteris aquiline	Lingar	--
Rhamnus purpurea	Luhish	--
Rhododendron anthopogon	Talshi	--
Rhododendron campanulatum	Kashmiri patta	--
Rhododendron lepidotum	Talshi	--
Rhus parviflora	Tungla	--
Ribes glaciale	--	Gooseberry/purple current
Rosa macrophylla	Karer, Bangulab	--
Rosa moschata	--	--
Rosa sericea	--	--
Rubus biflorus	Akhre	Raspberry orange-red
Rubus ellipticus	-do-	Raspberry yellow
Rubus niveus	-do-	--
Sarcococca saligna	Diun	--
Sinarundinaria falcata	Naghal	--
Spermadictyon suaveolens	Padara	--
Staphylea emodi	Nagdaun,Chitra	Snake wood
Strobilanthus dalhousianus	--	--
Thanmocalamus spathiflorus	Naghal	--
Trifolium repens	--	Clover white
Viburnum continifolium	Talanj	--
Viburnum grandiflorum	-do-	--
Viburnum mullaha	do-	--
Vitex negundo	Bannah	--
Woodfordia fruticosa	Dhawa	--

C.CLIMBERS

Ampelocissus latifolia	Panibel	The Virginian Creeper
Hedera helix	Kural	Ivy
Parthenocissus semicordata	Panibel	The Virginian Creeper
Smilex parviflora	--	--

D.MEDICINAL PLANTS

Aconitum chasmanthum	Mohri	Medicinal herb
Aconitum heterophyllum	Patis	-do-
Arisaema flavum	Samp-ki-makki	--
Arisaema jacquemontii	Ki-kukri	Cobra Plan
Arisaema tortuosum	-do-	-do-
Asparagus racemosus	Satawar	--
Atropa acuminata	Shafoo	Belladona
Berginia ciliata	Pathartor	--
Berginia stracheyi	Pathartor	--
Centella asiatica	Brahmi-Buti	--
Cinnamomum tamala	Tejpat	--
Digitalis purpurea	--	--
Dioscrorea bulbifera	Khildri	--
Dioscorea deltoidea	-do-	--
Jurinea macrocephala	Dhup	--
Mentha acquatica	Pudina	Mint
Ocimum species	--	--
Onosma bracteatum	Rarra (Rattanjot)	--
Picrorhiza kurrooa	Kaur	Medicinal Plant
Podophyllum hexandrum	Ban Kakru	--
Rumex nepalensis	Ammlora	--
Salvia nubicola	Makhiar	Dog Flower
Saussurea costus	Kuth	--
Taraxacum officinale	Dudhali	--
Thalictrum foliolosum	Machhar Mar	--
Valeriana hardwickii	Nakhnihani	--
Valeriana jatamansii	Smak, Nihani	--
Verbascum thapsus	Giddar Tamaku	--
Viola pilosa	Banafsa	--
Withania somnifera	Ashawgandha	--

ANNEXURE II

NURSERY TECHNIQUES FOR IMPORTANT SPECIES

1. TOONA CILIATA

Artificial Propagation - The ripe fruits are collected from the trees before opening. The fruits should be collected when they start turning yellow and a few of them commence to open. These are dried, rubbed and winnowed to get the clean seed.

Sowing is done in June-July and August. The seed is sown in raised nursery beds in lines about 20 cms. Aprt and should be only lightly covered by the fine soil or sand and should in no case be sown deep. The beds should be covered by a thin layer of dry grass to prevent the washing away of the seed. The germination commence in about a week and continues for another week. The grass is removed after germination starts. The nursery beds are shaded to protect the young seedlings from the heat of the sun. Water logging has also to be avoided. About 5-8 cm. Tall seedlings are transplanted in nursery beds at a spacing of about 20x15 cms. Regular weeding is necessary. Watering should also be regularly done after the monsoon rains cease. The seedlings are planted out either during winter when they are leafless or during the following July-August.

2. POPLAR (Populus ciliata)

Poplar is best raised by using nusery-raised plants from cuttings. The plants should have two-year root and one year shoot.

Nursery should be located in planting zone. Southern aspect, at low elevation and northern at higher elevation be avoided. Exposed windy ridges too be avoided. The nursery should be located a sheltered place but not forest hole. It should have adequate irrigation facility to ensure floor irrigation. But it should not have water logging conditions and adequate drainage is desirable. The soil should be sandy loam. Sandy/clayey soil should be avoided. As far as possible, the nursery should be near planting site because the planting stock is very bulky and may weigh about half a ton for 1000 plants making manual carriage difficult and expensive. In case, plants are to be transported then nursery be located near road head to facilitate vehicular transportation. Width of nursery beds should be in multiple of 45 cms.

For making cuttings for preparation of planting stock, stool beds be maintained in the nursery. Here cuttings from new branches of young/middle aged trees be used.

The time for making cuttings is during December or March when trees are leafless. In case these are prepared during March. These should be prepared before sprouting. The trees and branches from which cuttings are prepared should be young and disease/pest free. The cuttings are cut to size of about 20 to 25 cms. Length. The thickness should be 10 to 25 mm. Cutting with a thickness lesser than 10 mm. At thinner end be avoided. The cutting should be horizontally cut with a sharp instrument so as to make one clean cut in one stroke. Cuttings are then inserted in sunken beds having well pulverized sieved soil to depth of minimum 30 cms. For insertion, hole be made with dibbler. The width of hole should be slightly more than that of cutting. Cutting be inserted in it leaving about 2 cm.. Above ground. Care be taken that upper side of cutting is not inserted down. Then soil be well packed firmly around it. The test for firm packing is that the cutting should not be pulled out easily by using thumb and one finger. Spacing of cuttings be kept 45x45 cms.

The beds be watered immediately after and regularly afterwards. Watering by flooding and once in a week is sufficient. No watering is required during rains. Weeding too is necessary with weeding, light hoeing so as not to disturb the roots of plant is also necessary.

The shoot from these stool beds are used to make cuttings for planting stock year after year.

Many shoots are developed from a cutting and, therefore,, singing offshoots is done. For it lower and inferior ones are cut with a sharp spectator carefully retaining only one best-grown straight shoot. This is done when shoots are of about 15 cm. When shoots become one year old during winter(December or March) these are cut back to a height of 15 cm. From ground and used to make cuttings for planting stock year after year.

Cuttings are made as earlier, cut with a sharp instrument in one fine cut in one stroke, length of cuttings should be 20-25 cm. And dia 10-25 mm. Cuttings with thinner and lesser than 10 mm . be rejected.

These cuttings be inserted in other beds(Planting beds) in the same manner as above at spacing of 45x45 cm. And maintained as regards weeding/hoeing/watering/singling as above. The beds be manured also. For manuring sufficient quantity of well decomposed FYM be added to beds every year. This be done in case of stool beds as well as planting beds. This is so because raising of poplar in a nursery for 3-4 years reduces mineral deficiency of soil. So well decomposed FYM 50-70 tones/hectares be added to beds every year. If this not possible then nursery be shifted after a few years say 2 years or at the most 4 years.

The root portion of the plants in planting beds be retained. It again sprouts during spring and the shoots when about 15 cms are singled with sharp secateur as done in earlier case. By the end of the year i.e. by December by shoots are above 2 m. high. These plants with two year root and one year shoot are used for planting in the field. Those with a height less than 2 meters and basal diameter less than 20 mm. Be rejected and not planted in the field.

Planting is done during December-January when plants are leafless in low lying areas and during March- April before sprouting in higher elevation areas. Plants are safely taken out from nursery. The roots should in no case be splitted. In this process the lateral roots and sinkers are cut with sharp edged. Tool to avoid splitting. Cut be make finely with one stroke. Roots should be cut in such a manner that lateral roots about 15 cm. Long and sinkers about 40 cm are retained. The planting is done in 45 cm sized pits or in case areas is affected with raw humus, 60 cm. Sized pits. Branches should be pruned to have the lower half of stem free of branches. Excessive pruning should be avoided. There should be minimum time gap between lifting of plants from nursery and planting in the field. Distance of plants is kept 4x4 meters.

3. ROBINIA PSEUDOACACIA

Artificial Propagation - Black locus can be propagated by planting outeither nursry raised seedlings or root suckers.

Seed Collection and Storage - The pods are collected from October to December. These are dried in the sun , trashed and winnowed to obtain clean seed.

Nursery Technique - The seed requires pre-sowing treatment, which may consist of immersion in sulphuric acid or dipping in hot water or soaking in cold water. Hot waster treatment, which is normally adopted, consists in soaking the seed in cooling boiled water for 2 to 5 minutes and allowed to soak at room temperature for 8 to 10 hours. Sowing is done in ht nursery beds in lines about 20 cms aparat.

Planting Technique - The plants from March sowing become fit for planting the following December-January when they attain height of about 1 to 2 meters.Planting out is done in pits of 45-cm3 dug in advance. Spacing adopted is generally 3.5x3.5 meters for compact block planting. Naked root plants are planted out. In case of large root system the taproot is cut and the lateral root are pruned so as to accommodate the root system of plants in 45 cm3 pits. The plant is bundled and the roots wrapped in gunny bags during transport.

4. AKHROT (JUGLANS REGIA)

Seeds are collected during October-November and sown in nursery beds either during December before snow fall or during March Just after snow melting. Spacing is kept 10 cm from seed to seed and 20cm from line to line. Seeds germinate after snow melting and germination completes within a month. Regular watering is done to beds. Weeding too is necessary but care be taken not to disturb the plant. Plants are planted naked root in field during next winter when these are about twenty-one months old. In case plants develop long tap root, then the tap root portion is cut to size so as to accommodate it in 45 cm3 sized pit. Planting should not be done during monsoon rains.

5. DEODAR (CEDRUS DEODARA)

Preparation of Nursery - The nursery should be located in low elevation in Deodar zone. Natural blanks, forest holes, badly drained pockets and exposed ridges should be avoided, soil should be deep fertile and well drained. Loamy soil be performed, regular water supply is very essential particularly drier months.

Seed Collection and Storage - Seed be collected from healthy, middle aged, self-pruned trees of good form and equally. It is desirable to select good quality forests and to manage them as seed stands. Cones are collected during October-November and dried in sun after these have opened; the seed is separated by winnowing.

Sufficient quantity of seed be collected and stored for meeting requirements in poor seed years. Seed should be stored in sealed tins in cool/dry place.

Sowing in Nursery - Sowing is done in raised nursery beds in lines 7-8 cm apart. Seed be sown about 25 mm deep and covered lightly with soil. Before sowing a thin layer if debris is kept on beds and given a burnt. The ash thus obtained be mixed in the nursery soil. These germinate in March-April after snow melting. Weeding is necessary but care be taken not to disturb the roots of seedlings. Light watering with rose can during drier months is necessary.

Transplanting - During July when seedlings are about 4 months old, these are transplanted in nursery at spacing of 10x15 cms in raised beds. Line being 15 cms aparat and plants in line 10 mm apart. For transplanting , holes be made with dibblers. Regular weeding is necessary. Light watering be done in drier months. These are gain transplanted in nursery beds in following monsoon when about 1 ¼ year old at a spacing of 20x15 cms i.e. lines being 20 cms and plants 15 cms is there.

Planting - Planting is done in monsoons when plants are about 2¼ years old. The planting may also be done during winter before snowfall. The pits for this be dug in advance i.e. at the end of September. The plants for winter planted are about 2 ¾ years old. The plants can be planted during the next year in monsoon/winter when they are 3¼ or 3¾ year old. Naked root planting is done and plants are taken out from nursery, with care as to avoid injury to roots. Plants less than 30 cms height be culled out in the nursery.

6. SPRUCE (PICEA SMITHIANA)

Preparation of Nursery - The nursery should be located in low elevation in the Spruce zone. Natural blanks, frost holes, badly drained pockets and exposed riedges should be avoided. Soil should be deep, fertile and well drained. Regular water supply for irrigation is very essential. It is estimated that for 1000 plants about 80M² nursery is required 32 M² for germination beds).

Seed Collection and Storage - Seed should be collected from the healthy, middle aged trees of good form. It is desirable to select good quality spruce forest to manage them

as seed stand and to procure seeds from such forests. The seed should be stored in airtight containers and kept in air dry and cool place. Spruce does not produce seed every year and efforts, therefore, should be aimed at collection of sufficient quantity of seed in good seed year for use in the subsequent bad seed year too. Cones should be collected during the first fortnight of October. The cones should be dried in sun and after these have opened the seed should be separated by winnowing.

Control Against Damping Off - Damping off takes a very heavy toll of the nursery seedlings. To avoid this the seeds be sown in spring when snow melts after giving formalin treatment to the soil. For formalin treatment, the beds are dug out and prepared to the desired size. Formalin treatment is given 15 days before sowing 250n ml. Of formalin in about 4 litres of water per M2 of the bed area is applied. The quantity of the water should be sufficient to soak the soil up to at least 15 cms of depth. The beds are immediately covered with polythene sheet. The sheet is removed after three days of the formalin application and the soil is raked to allow the fumes to escape. While raking soil, it should be ensured that the untreated soil does not mixed up with the treated top soil. The beds are kept as such for about ten days before sowing to avoid toxic effect of the formalin on the seeds. After the germination of the seeds, the beds are drenched with 0.2% solution of Blitox every fortnight for three months.

Sowing in Nursery - Sowing is done in the raised beds of 1 meter width. It is done in spring after snow melting and formalin treatment against damping off. Seeds soaked in water for 24 hours before sowing. The seeds, which float being non-viable are to be rejected. Remaining seeds are down. The sowing in 4 cms wide strips spaced 10 cms apart from the centre-to-centre give better germination. Depth of sowing is 10 mm 40 grams of seed with 80% germination is sown per square meter of nursery area. Seeds are covered with humus or good textured soil. Watering/seeding is done regularly.

Shading - Shading of germination beds against high temperature is essential. Shades made of wooden battens of 125x2x0.3 dimensions provide suitable shading material. The wooden battens are fastened together with the help of Nylon thread or steel wire. The gap between the two consecutive battens is kept approximately 0.7 cms. This

permits 30-40% of direct sunlight on the beds, the shading to the germination beds be given for 3-4 months in the initial stage.

Weeding - The germination starts in about two weeks and is complete within a period of about four weeks. The weeding is done till the germination is complete.

Transplanting - Transplanting is done in the first fortnight of August when the plants are about sixteen months old. It is done in deep holes about 18 cms deep made with a dibbler at a spacing of 15x8 cm the spruce seedlings of height less than 10 cms should not be transplanted. The shading of the transplanted bed is done during the first year.

Lifting of seedling from nursery - The plants are vulnerable to the damage by drying out while they are being lifted and transported to the planting sites. The more the fine roots are retained at the time of lifting the better are the chances of survival after planting. Care during the lifting should be aimed at to retain the maximum number of the short fibrous roots, avoiding damage to the bark and breaking of the roots. The time gap between the lifting of the plants from the nursery and their planting in the field should the shortest possible. Only that number of the plants should be taken out of the nursery beds which can be planted the same day. After lifting, the sorting of the plants is done by culling the sub standard plants. In case the plants are to be transported to the long distances, the roots should be wrapped in the moss and hessian cloth and kept moist.

Planting - The plants are ready for planting in the field after the two years of the transplanting when these about three and half years old. Naked root planting is done . The planting should be done preferably during the rains. The height of the plants at the time of planting should be 25 to 30 cms. The plants of less than 25 cms in height should not be planted and rather be culled in the nursery.

7 SILVER FIR (ABIES PINDROW)

The techniques involved are the same as are in the case of the Spruce except that the nursery should located on the low elevation in the Fir Zone and :-

i) The seeds are sown 155mm deep.

ii) 40-50 grams of seed with 60% germination is required for 1 M^2 of the nursery bed area.

iii) Transplanting is done in holes of about 13 cms depth which equals to the length of the root at the time of transplanting. The seedlings having collar diameter less than 1.5 mm should not be transplanted.

iv) The plants are ready for the planting in the field after three years of the transplanting as against two years in case of Spruce i.e. when they are 4½ year old.

v) Sowing are done before snowfall i.e. December.

v) Planting is done during monsoon.

8. SANOOH (FRAXINUS FLORIBUNDA)

Sanooh can be raised successfully by nursery raise transplants. Nursery be made in the planting zone . The seeds ripen during October/November and are sown in sunken nursery beds in lines 15 cms apart. The distances from seed to seed be kept 5-7 cms . Seed has a dormancy of about 16-18 months and remain un germinated in nursery till next season . Germination starts in next April/May. The plants are watered regularly by rose can. Plants are then transplanted (Pricked) in beds at spacing of about 22x15 cms during winter ie.e December/January when leafless. They are maintained in for another two seasons. Regular weeding/watering is done. These are planted naked roots in the field in winter when these are about 30 months old. Care be taken to ensure that roots are not damaged during taking out from nursery. Planting is done preferably in 45 cms pits, Planting should be done during monsoons.

Due to dormancy of the seed it is also suggested that seeds collected during the year be dried well and stored in a cool/dry place in sealed tins for a year and then sown in December in the following years. It be tried whether the seed so stored for a year germinates in April/ May i.e. after about 4-5 months of sowing. In case this

method meets success then one-year seed be sown in future. This will save unnecessary occupation of nursery beds by seed for one year.

9. SWEET CHESTNUT (CASTANEA SATIVA)

The tree is not natural to the tract. But can be tried on a small scale. The seeds can be imported from Kullu Forest Division.

The species grows up to an elevation of 1800 meters. On Northern aspects it succeeds well on low elevation 1000-1500 meters. It requires moderate dry region and sandy/sandy loam but fertile soil. It dislikes clayey soil.

The seeds ripen during August/September and should be sown immediately in nursery in lines 22 cms apart. Regular watering is done. These are picked out in next winter when about 15 months old at a spacing of 22x15 cms and planted in next winter when about 27 months old. Naked root planted is done.

ANNEXURE III

SPECIFICATIONS FOR AFFORESTRATION AND SOIL CONSERVATION WORKS

Afforestation

Regular afforestation is to be carried out in blank and deteriorated forest areas and grasslands. Generally this activity will be limited to such areas situated within the catchment area of Budhil Hydro Electric project. If the area under planting is gullied and cut up with natural drainage channels, the planting has to be supplemented with soil conservation works like engineering/vegetative measures like gulley plugging and check dams to make the area a success.

The planting area should be closed to grazing, lopping, quarrying etc through a proper legal notification. For effective protection, it is necessary that the area is fenced and fence maintained properly. It has generally been seen that after a couple of years of fencing, these plants get grazed and damaged leading to failures. Plants must be protected till these attain a height which is above grazing level.

Prior to planting bush cuttings should be done and area cleared of all obnoxious vegetation. On steep slopes it is preferable to clear strips where planting is to be done so that entire area is not bared of all vegetation.

Pits to be dug should be of 30 cmx30cmx30cm or 45 cm x 45 cm x 45 cms size depending upon the species and type of land for planting.

In case of afforestation and compensatory plantations, there should be 1100 plants per ha and in case of Enrichment Plantations, it should be 800 plants per ha.

Hoeing, weeding and mulching should be attended to regularly.

Preference should be given to fuel and fodder species like Ban oak, Alnus, Robinia, Ulmus, Walnut, Khanor and Morus serrata.

Maintenance of plantations will be needed for atleast 7 years as these areas are refractory and grazing pressure is very heavy.

2.1 STABILIZATION OF UNSTABLE SLOPES

Such slopes will be in land slips, slides and along roadsides caused by cutting of roads and disturbance of strata during construction. In stabilizing these slopes there is generally the choice between vegetative measures and solid structures of stone and concrete or a combination of both. Vegetative measures are :

- widely applicable and adaptable
- economical
- effective
- easy to repair
- in harmony with the natural environment

However, purely biological measures have their limitations on very steep slopes where only solid structures may provide the desired protection and stability.

In fragile Himalayan slopes where soil is shallow, blasting and earth cutting on steep slopes for ever expanding road construction programmes are in progress aided by overgrazing, it is generally the combination of both vegetative and engineering works that is likely to succeed in stabilization of slopes especially in case of landslips.

2.2 VEGETATIVE Methods of slope stabilization have their limitations on slopes over 50%. In steeper, bouldery slopes with very shallow and stony soil formations, solid retaining walls are needed. However, because of their high costs, these should be limited to places where their construction is justified by their function. In many situations loose masonry check walls and gabions can be equally strong and useful. Generally at the foot of the slip a strong gabion structure is necessary. Thereafter, a series of loose masonry check walls, depending upon the length, width and slope of the slip, need to be constructed and vegetation induced in the intervening spaces through planting and or wattling. Where the size of slip is small, soil is hospitable and slopes have formed the angle of repose, purely wattling can be successful and very useful.

2.3 Where one has to cope with high quantities of run-off due to size, length of slope & quantity of rainfall, diversion channel at the head of the slip has to be provided to prevent surface run-off from entering the area to be stabilized and to divert it into stable waterways without creating new gullies/slips. If there are no stable natural water ways, one has to dig a trench and stabilize it with cement lining, old barrels cut in

halves, stone riprap or the like. These channels should have a trapezoidal cross-section with sides sloping 1:1.

2.4 The design, plan and specification of retaining & check walls will vary from location to location and are well understood by field officers. However, it needs to be kept in mind that :

For increased stability against pressure from the slopes, the front must be slightly inclined while the back is vertical. For different types of retaining walls, the following inclination is recommended.

Dry stone wall	1=1/3 to 1=1/4
Masonry	1=1/4 to 1=1/5

The thickness of the wall on top depends on the material and the height of the wall. The following suggestions apply to retaining walls 1 meter high.

Dry stone wall	=	0.50 meters
Masonry	=	0.40 meters

The foundation must be deep enough to avoid sinking. As a rule of thumb, foundation of dry stone walls should have a width of about two thirds of height.

2.5 GABIONS

These are rectangular wire crates that are filled with stones and employed in erosion control. These have some significant advantage over solid structures:

- **Flexibility :** Gabions bend without breaking and in contrast to concrete or masonry with mortar do not crack. This can be an important aspect with regard to unevenly sinking foundations and the pressure in slopes.

- **Permeability :** Gabions structures are permeable and do not need an extra drainage system.

- **Economics :** Usually they are cheaper to construct than other solid engineering structures. They may become expensive only where stones are not available in sufficient quantity.

14.	Interlacing of thorny buses with B/wire 240 RM		1.65 Rmt	396.00
			Total	12139.79
	Add 16.66% increase on schedule rate on a/c of wage hike from 60/- to Rs.70/- per day			2022.49
	Add 25% increase for special Tribal area			3540.57
15	Cost of raising seedlings in nursery 1100 Nos @ 4.50/- each			4950.00
	Total labour cost			22652.85
B.	Cost of material			
1.	Cost of Barbed wire approximate	80 kgs	@29.50 kgs	2360.00
2.	Cost of U-Nails	2 kgs	@30/-	60.00
3.	Cost of Black Japan	1 ltrs	@ 50/ kgs	50.00
4.	Carriage of B/wire/u-nails from range store to work site		@L/S	230.00
	Total cost of material			2700.00
	Total A+B			25352.85
	Or say			25300.00
	C. Minor Soil & Water conservation measures i.e. 25% of the total cost of afforestation			6325.00
	G. Total per Hectare B+C			31625.00

Gabions can be used in flowing water and for land reclamation along banks, for retaining walls, gully stabilization. The toe wall/retaining wall at the base of the slip using gabions can be very satisfactory. It is possible to stabilize the base of a slope with only one row of gabion or to arrange them in terrace formation as shown in attached figure.1. Especially the first type of structure should always have a slight inclination towards the slope.

2.6 WATTLINGS

Wattling consists of interwoven fences of brushwood in shallow trenches approximately 30 cm deep, pegs are driven 90 to 120 cm apart, between which whipy rods of sprouting species like Salix, Alnus and Poplars etc. are planted The rods must be interwoven in a way that the butt ends are bent down into the soil and their upper portion exposed. It is also possible to insert cuttings in the wattling structure.

Finally, the trenches are refilled with excavated soil leaving the upper part of the wattling structure exposed. Wattling can be constructed in continuous lines or intermittently along the contour. The distance between wattlings depends upon the slope and stability of the soil The intervening space between successive, wattling structures can be planted with seedlings or cuttings of suitable species like Alnus, Robinia and Poplar. Where slope has an angle of repose and the soil is not shallow and stony, it may be desirable to stabilize the slip entirely through wattling only without any recourse to engineering (masonry) structures. Wattling is very useful on uphill side slopes of roadsides.

3. STABILIZATION OF GULLIES AND NALLAHS

3.1 Gully erosion : Due to irregularities of the soil surface the water is often forced to concentrate in small and shallow canals, which is where rill erosion starts. The flowing water loosens the soil particles, lifts them up and transports them away. Gully is similar to rill and can be considered its advanced stage. Gullies are formed when many rills join, which will increase the volume and the erosive power of the water flow. Gullies can have different shapes. U shaped gullies are formed where the sub-soil erodes as easily as the top soil V-shaped gullies are formed in soils with a very resistant layer below the surface. In that case, the gully has a rather trapezoidal shape, because the water erodes more along the banks.

A classification of gullies according to their size is given by BENNET (1955) as under :

Rills	Less that 0.3 meters deep (1 foot)
Small gullies	Less than 1 meter deep (3 feet)
Medium gullies	1 meter to 4.5 meters deep (3 to 15 feet)
Large gullies	4.5 meters to 9.1 meters deep (15 to 30 feet)
Ravines	More than 9.1 meter deep (30 feet)

In Himalayan zone and its foothills, the terrain and soils are such that gullies when approach the upper limits of depth, medium gullies convert themselves into natural drainage systems, i.e. nallas.

3.2 STABILIZATION

3.2.1 Gullied Area: In totally degraded land, gullies can make up for a large part of the area. The objective of reclaiming these gullies is to prevent further erosion and utilize the land again for protective and productive use. Effective closures and afforestation will promote vegetational growth and retard further growth of gullies. However, to increase sedimentation to fill up the gulley gradually, check dams may have to be constructed where even seasonal water flow is still expected. Typical measures for reclamation of small gullies include brushwood plugs and loose stones. Their function is to reduce the velocity of the flood and 'comb out' the sediments so that gulley is gradually silted up.

3.2.1.1 Brushwood plugs -

At first trenches which should follow the contour are dug 40 to 60 cm deep across the gulley bed and the banks. Seen from above the layour will be more or less V-shaped. The brushwood which must be of sprouting species, is placed upright and tightly together on the downstream side of the trench. Afterwards the trench is refilled and tamped.

3.2.1.2. Loose stone plugs -

Smaller gullies of less than one meter in depth can often be stablized by plugging them with loose stones. which may be simply heaped in the gully. It can be in combination with bushy brushwood which may not even be of sprouting species.

3.2.2.1 Nalas

Large gullies and nallas have to be treated to prevent further deepening and widening. This is done mainly by various types of check dams.

The purpose of check dam is to reduce the gradient and break the velocity of the flow. Through check dams the water is conducted safely from a higher to a lower point without causing erosion at the gulley/nalla bed and banks. The water pools behind the dams promote the percolation of water into the soil. Check dams still serve their purpose even when they are completely silted up by reducing the gradient inside the gulley/nalla. Longer life-span should be aimed in case of check dams to be constructed in nallas. They should be constructed in places where the bed is narrow and the banks are firm. Curves or sites within or just below gulley/nalla junctions must be avoided.

In an ideal case, check dams should be spaced in such a way that the bottom of the upper check dam is in level with the top of the next lower one. In steep area as in the Himalayan region, this is difficult to achieve because too many check dams will be required. If the section between two successive check dams cannot be made level, the gradient should at least not exceed 5 percent for greater success.

The height of the dams influences their spacing. There is the alternative of constructing a few high or many low dams on a certain gradient. High check dams have to resist a greater pressure than the low ones and, therefore, are more liable to damages. While concrete or masonry dams can be built to any height, dry stone or brushwood dams should be low.

Check dams must be well anchored in the ground and particularly in the banks to prevent under-scouring and scouring between the dam and the banks. The flow is directed through a water spill or notch in the center of the dam. Below the dam where the water hits the bed, a protective apron must be constructed. For additional strength the check dam is filled up to the notch with soil on the upstream side.

Types of check dams are distinguished according to the material used.

3.2.2.2 **Dry Masonry check dam** - These are generally constructed in upper reaches of eroding nalas to reduce the bed slope, stabilize the grade and check the bed scouring and retain silt, sand and pebbles.

Depending upon the size of the dam depth of foundations may vary from 30cm to 60 cm. Foundation should be dug across the nalla width extending well into the banks. The soil is piled up-stream to be used later for the refill. The largest stones are placed in the bottom layers. Larger check dams with steps in front are stronger, safer and more useful. In every layer of stones a step of 15 to 20 cm is left on the down stream side, so that width is reduced from base to top. The advantage is that the flow is gradually conducted down to the apron. Two wing walls with appropriate foundation are often constructed at the upper side to force the flow into the water spill or notch and to prevent it from damaging the banks. The wing walls should form an angle of about 30° with the banks.

In the center of the "crown" a notch of concave shape is to be provided which must be wide enough to cope with the peak run-off. Generally a length of half the span of the dam and depth of 20 to 30 cm are considered appropriate.

Below the dam an apron has to be constructed with stones. On the up-stream side the dam has to get an earth fill for greater strength. Finally, the structure is supplemented by planting seedlings and cuttings of suitable species along the banks on the upstream side. Alnus & willows, form good species for this purpose. Refer to Figure 2 attached. Such check dams are provided in areas closed for afforestation.

3.2.2.3 **Solid check dams** - In bouldery nallas, with or without some water flow, check dams may be constructed of gabions, masonry with mortar or concrete. Each situation will have to be looked into for the type of dam that needs to be constructed.

3.2.2.4 **Brushwood check dams** - These are only temporary and should be preferred where stones are not available and water discharge is not substantial.

At first a foundation extending well into the banks is dug. The brushwood, preferably sprouting type, is placed between two rows of pegs driven in 40 cm apart across the gulley bed. The distance between the rows should be 0.80 to 1 meter for gullies/nalas upto 5 meters in width. The brushwood is packed firmly and the two rows of pegs are

tied together. On the top, a notch of about half the span of the dam is kept for stream flow. Refer to attached figure 3.

4. STREAM BANK TRAINING

Perennial or seasonal streams crossing through the steep slopes, bring lot of debris in them during rains and spread the same over even cultivated lands beside washing away the land on the banks.

In all these situations the remedy lies in construction of spurs and embankments of stone, masonry, gabion or vegetative or a combination of both depending upon the local situations.

4.1 Spurs

These are required to protect the structures and agricultural lands on the banks by diverting the stream flow away. Generally a single spur may serve the purpose in view. However, in certain situations a series of spurs may be needed. In some rare cases, construction of spurs on both the banks may become necessary. A large spacing can be adopted for convex bank and smaller one for concave bank. A spacing of 2 to 2.5 times the length of the spur is the general practice.

Generally attractive type spurs, i.e. pointing downwards are used in the presently described situations. These are around 30° inclination with the bank facing downstream flow. These can be of dressed masonry or gabbiness. Construction of spurs should be supplemented with vegetation inducement so as to aim permanency in the achievement of objective.

Alnus, Robinia, Poplar, Ulmus and Salix could be planted, depending upon locality factors in space in between spurs.

4.2 Embankments

These are strong walls along the banks for bank protection. These can be of stones, gabions, or vegetation. If soils along the bank are hospitable, vegetative embankments supported by strip planting along the bank can be cheaper and more lasting. In bouldery terrain, use of gabions is more appropriate.

EXPENDITURE NORMS FOR AFFORESTRATION

Per Ha. Cost for raising Plantation (Afforestation) 1100 plants per ha. (Based on labour rate Rs. 70 per day)

S. N	Item of works	Qty	Rate	Amount
A.	**Labour Cost**			
1.	Survey and demarcation of plantation area	1 h	40.85/ha	40.85
2.	Bush cutting and clearance per head load of 30 kgs	50 HL	3.40 each	170.00
3.	Construction of I/Path, 60 cm wide	250 RM	4/30/RMT	1075.00
4.	Digging of pits 30x30x30cm 45x45x45 cm	550 Nos 550 Nos	190.90% No 381.75 Nos	1049.95 299.62
5.	Filling of pits 30x30x30 cm 45x45x45 cm	550 Nos 550 Nos	76.30% Nos 109.10 % Nos	419.65 600.05
6.	Planting of plants in 30 cms 3 pits In 45cms3 pits	550 Nos 550 Nos	87.30 Nos 73.60%	480.15 404.80
7.	Carriage of plants from nursery to work site over and average of 4 km @ 87.20 and 14.10	1100 Nos	50.65	2228.60
8.	Cutting and preparation of Fence posts	80 Nos	518.10	414.40
9.	Coal tarring of Fence posts	80 Nos	111.75	89.40
10.	Carriage of Fence posts from forest to work site average distance 4 km by Manual labour (50% uphill & 50% down hill)	80 Nos	318/% Nos	1017.60
11.	Digging of hole 45 cm deep and 20-30 cm dia	80 Nos	363.70/% Nos	290.16
12.	Fixing of wooden posts i/c strutting	80 Nos	278.45% Nos	222.76
13	Stretching of B/wire in 600 RM	4 strands	1.90/Rmts	1140.00

Cost Norms 1st year Maintenance (Afforestation) Area per ha.

1	Weeding & hoeing of plants in planting area 770 Nos @ 32.70 per %	251.79
2.	Cutting & preparation of fence posts 30 Nos @ 518.10 per%	155.43
3.	Carriage of fence posts from forest to work site at least 4 km 30 Nos @ Rs. 318 per%	381.60
4.	Coal tarring of fence posts 30 Nos @ 111.75 per%	33.52
5.	Digging of holes for fence posts 30 Nos @ 362.70%	108.81
6.	Fixing of fence posts 30 Nos @ 278.45 per%	83.53
7.	Repair of B/wire fence in 4 strands=360 Rm @ 0.65 P/Rmt	234.00
8.	Re-digging of failed pits 30x30x30cm=150 Nos @ 95.45 per% 45x45x45cm=180 Nos @ 190.90%	143.17 343.12
9.	Refilling of pits & planting of plants in 30 cm 3 pits=150 Nos @ 163.60% in 45xm3pits=180 Nos @ 182.70 %	245.40 328.86
10	Interlacing of thorny bushes with B/wire 100 RM @ 1.65/Rmt	165.00
11	Carriage of plants from nursery to work site over an average of 4 km uphill (87.20 and 14.10) i.e. 30 Nos @ 50.65%	668.58
	Total	3143.31
	Add increase of 16.66% on schedule rate (on a/c of hike in wage rate from Rs. 60/- to Rs. 70/-)	523.67
	Total	3666.98
	Add 25% special increase for tribal area	916.74
	Total	4583.72
12	Cost of raising seedlings in the nursery 330 Nos @ 4.50/- each	1155.00
13	Cost of U-Nails=1 kgs	30.00
	Grand Total	5758.00
	Or Say Rs.	5750.00

Cost Norms 2nd year Maintenance (Afforestation) Area per ha.

1	Weeding & hoeing of plants in planting area 830 Nos @ 32.70 per %	271.41
2.	Cutting & preparation of fence posts 20 Nos @ 518.10 per%	103.62
3.	Carriage of fence posts from forest to work site at least 4 km 20 Nos @ Rs. 318 per%	254.40
4.	Coal tarring of fence posts 20 Nos @ 111.75 per%	22.35
5.	Digging of holes for fence posts 20 Nos @ 362.70%	72.54
6.	Fixing of fence posts 20 Nos @ 278.45 per%	57.79
7.	Repair of B/wire fence in 4 strands=240 Rm @ 0.65 P/Rmt	156.00
8.	Re-digging of failed pits 30x30x30cm=135 Nos @ 95.45 per% 45x45x45cm=135 Nos @ 190.90%	128.85 257.71
9.	Refilling of pits & planting of plants in 30 cm 3 pits=135 Nos @ 163.60% in 45xm3pits=135 Nos @ 182.70 %	 220.86 246.64
11	Carriage of plants from nursery to work site over an average of 4 km uphill (87.20 and 14.10) i.e. 270 Nos @ 50.65%	547.02
	Total	2338.99
	Add increase of 16.66% on schedule rate (on a/c of hike in wage rate from Rs. 60/- to Rs. 70/-)	389.67
	Total	2728.66
	Add 25% special increase for tribal area	682.16
	Total	3410.82
12	Cost of raising seedlings in the nursery 270 Nos @ 4.50/- each	1215.00
13	Cost of U-Nails=1 kgs	30.00
	Grand Total	4655.00
	Or Say Rs.	4650.00

Cost Norms 3rd year Maintenance (Afforestation) Area per ha.

1	Weeding & hoeing of plants in planting area 880 Nos @ 32.70 per %	287.76
2.	Cutting & preparation of fence posts 20 Nos @ 518.10 per%	103.62
3.	Carriage of fence posts from forest to work site at least 4 km 20 Nos @ Rs. 318 per%	254.40
4.	Coal tarring of fence posts 20 Nos @ 111.75 per%	22.35
5.	Digging of holes for fence posts 20 Nos @ 362.70%	72.54
6.	Fixing of fence posts 20 Nos @ 278.45 per%	57.79
7.	Repair of B/wire fence in 4 strands=480 Rm @ 0.65 P/Rmt	312.00
8.	Re-digging of failed pits 30x30x30cm=110 Nos @ 95.45 per% 45x45x45cm=110 Nos @ 190.90%	105.00 210.00
9.	Refilling of pits and planting of plants in in 30 cm 3 pits = 110 Nos @ 76.30% in 45xm3pits=110 Nos @ 109.10 %	 83.93 120.01
10	Planting of plants in in 30 cm 3 pits = 110 Nos @ 87.30% in 45xm3pits=110 Nos @ 73.60 %	 96.00 80.96
11	Carriage of plants from nursery to work site over an average of 4 km uphill (87.20 and 14.10) i.e. 2200 Nos @ 50.65%	445.72
	Total	2251.91
	Add increase of 16.66% on schedule rate (on a/c of hike in wage rate from Rs. 60/- to Rs. 70/-)	375.16
	Total	2627.07
	Add, 25% special increase for tribal area	656.76
	Total	3283.83
12	Cost of raising seedlings in the nursery 220 Nos @ 4.50/- each	990.00
13	Cost of U-Nails=1 kgs	5.00
	Grand Total	4278.83
	Or Say Rs.	4300.00

Annexure IV-E

Cost Norms 4th 5th, 6th and 7th year Maintenance (Afforestation) Area per ha.

1	Weeding & hoeing of plants in planting area 550 Nos @ 32.70 per %	179.85
2.	Cutting & preparation of fence posts 15 Nos @ 518.10 per%	77.71
3.	Carriage of fence posts from forest to work site at least 4 km by Manual labour 50% 50% uphill & 50% down hill 15 Nos @ Rs. 318 per%	190.80
4.	Digging of holes for fence posts 15 Nos @ 362.70%	54.40
5.	Fixing of fence posts 15 Nos @ 278.45 per%	43.12
6.	Repair of B/wire fence in 4 strands=360 Rm @ 0.65 P/Rmt	234.00
7	Interlacing of thorny bushes with B/wire 360 RM @ Rs. 1.65 per RM	594.00
	Total	1373.88
	Add increase of 16.66% on scheduled rate (on account of hike in wage rate from Rs. 60/- to Rs. 70/-)	228.88
	Total	1602.76
	Add 25% special increase for tribal area	400.69
	Total	2003.45
	Or say Rs.	2000.00

ANNEXURE V-A

EXPENDITURE NORMS FOR ENRICHMENT PLANTATION

Per Ha. Cost for raising Plantation (Afforestation)
1100 plants per ha. (Based on labour rate Rs. 70 per day)

S.N	Item of works	Qty	Rate	Amount
1.	Survey and demarcation of plantation area	1 h	40.85/ha	40.85
2.	Bush cutting and clearance per head load of 30 kgs	140 hld	3.40 each	476.00
3.	Construction of I/Path, 60 cm wide	250 RM	4/30/RMT	1075.00
4.	Cutting and preparation of Fence posts	60 Nos	518.10	310.86
5.	Coal tarring of Fence posts	60 Nos	111.75	67.05
6	Carriage of Fence posts from forest to work site average distance 2 km manual uphill	60 Nos	362.70/% per km	436.08
7.	Digging of hole 45 cm deep and 20-30 cm dia	60 Nos	362.70/% Nos	217.62
8..	Fixing of wooden posts including strutting carriage of barbed wire 75 kg, u-nail 2 kg, blackjapan 93 kg, 2 km uphill	60 Nos	278.45% Nos	167.07
9	3 kg, 2 km uphill	80 kg	68.15 per ha.	68.15
10	Stretching of B/wire	560 RM	1.90/Rmts	1064
11	Interlacing of thorny buses with B/wire	186 Rm	1.65 Rmt	306.9
12	Lay out of pits	1 ha	68.15 per ha	68.15
13	Digging of pits 30x30x30cm 45x45x45 cm	480 Nos 320 Nos	190.90% No 381.75 Nos	916.32 1221.6
14	Filling of pits 30x30x30 cm 45x45x45 cm	480 Nos 320 Nos	76.30% Nos 109.10 % Nos	366.24 349.12

15	Carriage of p. bags plants from nursery to work site over and average of 2 kms	510 Nos	87.20 % per km	889.44
16	Carriage of naked roots plants 2 kms uphill (BL and conifer)	290 Nos	14.10% per km	81.78
17	Planting of plants in polythene bags Named roots plants	510 Nos 290 Nos	87.30 Nos 73.60%	445.23 213.44
18	Cost of raising seedlings in nursery	800 Nos	3.66	2928
	Total			11749.79
	Add 16.66% increase on schedule rate on a/c of wage hike from 60/- to Rs.70/- per day			1957.51
	Add 25% increase for special Tribal area			3426.82
	Total labour cost			17134.12
B.	Cost of material			
1.	Cost of Barbed wire approximate	75 kg	30 per kgs	2250
2.	Cost of U-Nails	2 kgs	@30/-	60.00
3.	Cost of Black Japan	3 ltrs	@ 50/ kgs	150.00
4.	Carriage of B/wire/u-nails from range store to work site		@L/S	50.00
	Total cost of material			2510.00
	Total A+B			19644.12
	Or say			19650
	C. Minor Soil & Water conservation measures i.e. 25% of the total cost of afforestation			4912.5
	G. Total per Hectare B+C			24562.5
	Grand Total or say			24550

ANNEXURE V-B

1st year Maintenance Per Ha Cost Model for Enrichment Plantation

S.N	Item of works	Qty	Rate	Amount
	Mortality 25%			
1.	Bush cutting and clearance per head load of 30 kgs	50 hld	3.40 each	170.00
2.	Repair of I/Path, 60 cm wide	250 RM	L/S	275.00
3.	Cutting and preparation of Fence posts	15 Nos	518.10	77.71
4.	Coal tarring of Fence posts	15 Nos	111.75	16.76
5	Carriage of Fence posts from forest to work site average distance 2 km manual uphill	15 Nos	363.40/% per km	54.51
6.	Digging of hole 45 cm deep and 20-30 cm dia	15 Nos	362.70/% Nos	54.40
7.	Fixing of wooden posts including strutting	15 Nos	278.45% Nos	41.76
8	Repair of barbed wire fence	180 Rm	0.65/Rm	117.00
9	Interlacing of thorny buses with B/wire	60 Rm	1.65 Rmt	99.00
10	Redigging of pits 30x30x30cm 45x45x45 cm	120 Nos 80 Nos	95.45% 190.90 %	114.54 152.75
11	Filling of pits 30x30x30cm 45x45x45 cm	120 Nos 80 Nos	76.30% No 109.10 Nos	91.56 87.28
11	Carriage of p. bags plants from nursery to work site average lead 2 kms uphill	125 Nos	87.20 % per km	218.00
12	Carriage of naked roots plants 2 kms uphill (BL and conifer)	75 Nos	14.10% per km	21.15
13	Planting of plants in polythene bags Naked root plants	125 Nos 75 Nos	87.30 Nos 73.60%	109.12 55.20
14	Cost of raising seedlings in nursery	200 Nos	3.66	732.00
15	Repair of soil & moist cons. works	0	L/S	366.00
	Total			2853.74

	Add 16.66% increase on schedule rate on a/c of wage hike from 60/- to Rs.70/- per day			475.43
	Total			3329.17
	Add 25% increase for special Tribal area			832.29
	Total			4161.46
	Total labour cost			4160.00
B.	Cost of material			
1.	Cost of Barbed wire approximate	0.750 kg	30 per kgs	22.50
2.	Cost of U-Nails	0.750 kg	@50/-	37.50
3.	Cost of Black Japan	3 ltrs	@ 50/ kgs	150.00
4.	Carriage of B/wire/u-nails from range store to work site	0	@L/S	50.00
	Total cost of material			110.00
	Total cost (Labor and material)			4270.00
	Cost of maintenance per Ha, Or say			4300.00

ANNEXURE V-C

1st year Maintenance Per Ha Cost Model for Enrichment Plantation

S.N	Item of works	Qty	Rate	Amount
.	Mortality 20%			
1.	Bush cutting and clearance per head load of 30 kgs	50 hld	3.40 each	170.00
2.	Repair of I/Path, 60 cm wide	250 RM	L/S	275.00
3.	Cutting and preparation of Fence posts	15 Nos	518.10	77.71
4.	Coal tarring of Fence posts	15 Nos	111.75	16.76
5	Carriage of Fence posts from forest to work site average distance 2 km manual uphill	15 Nos	363.40/% per km	54.51
6.	Digging of hole 45 cm deep and 20-30 cm dia	15 Nos	362.70/% Nos	54.40
7.	Fixing of wooden posts including strutting	15 Nos	278.45% Nos	41.76
8	Repair of barbed wire fence	180 Rm	0.65/Rm	117.00
9	Interlacing of thorny buses with B/wire	60 Rm	1.65 Rmt	99.00
10	Redigging of pits 30x30x30cm 45x45x45 cm	96 Nos 64 Nos	95.45% 190.90 %	91.63 122.17
11	Filling of pits 30x30x30cm 45x45x45 cm	96 Nos 64 Nos	76.30% No 109.10 Nos	69.82 87.28
11	Carriage of p. bags plants from nursery to work site average lead 2 kms uphill	102 Nos	87.20 % per km	177.89
12	Carriage of naked roots plants 2 kms uphill (BL and conifer)	58 Nos	14.10% per km	216.35
13	Planting of plants in polythene bags Naked root plants	102 Nos 58 Nos	87.30 Nos 73.60%	89.04 42.69

14	Cost of raising seedlings in nursery	160 Nos	3.66	585.60
15	Repair of soil & moist cons. works	0	L/S	366.00
	Total			2370.58
	Add 16.66% increase on schedule rate on a/c of wage hike from 60/- to Rs.70/- per day			454.91
	Total			3185.49
	Add 25% increase for special Tribal area			796.37
	Total			3981.86
	Total labour cost			3980.00
B.	Cost of material			
1.	Cost of U-Nails	0.750 kg	30 per kgs	22.50
2.	Cost of Black Japan	0.750 kg	@50/-	37.50
3.	Cost of empty tins and bamboo basket	0	L/S	30.00
	Total cost of material			90.00
	Total cost (Labor and material)			4070.00
	Cost of maintenance per Ha, Or say			4100.00

ANNEXURE V-D

3rd year Maintenance Per Ha Cost Model for Enrichment Plantation

S.N	Item of works	Qty	Rate	Amount
	Mortality 15%			
1.	Bush cutting and clearance per head load of 30 kgs	50 hld	3.40 each	170.00
2.	Repair of I/Path, 60 cm wide	250 RM	L/S	275.00
3.	Cutting and preparation of fence posts	15 Nos	518.10	77.71
4.	Coal tarring of Fence posts	15 Nos	111.75	16.76
5	Carriage of Fence posts from forest to work site average distance 2 km manual uphill	15 Nos	363.40/% per km	54.51
6.	Digging of hole 45 cm deep and 20-30 cm dia	15 Nos	362.70/% Nos	54.40
7..	Fixing of wooden posts including strutting	15 Nos	278.45% Nos	41.76
8	Repair of barbed wire fence	180 Rm	0.65/Rm	117.00
9	Interlacing of thorny buses with B/wire	60 Rm	1.65 Rmt	99.00
10	Redigging of pits 30x30x30cm 45x45x45 cm	72 Nos 48 Nos	95.45% 190.90 %	68.72 91.63
11	Filling of pits 30x30x30cm 45x45x45 cm	72 Nos 48 Nos	76.30% No 109.10 Nos	54.94 49.09
11	Carriage of p. bags plants from nursery to work site average lead 2 kms uphill	76 Nos	87.20 % per km	132.54
12	Carriage of naked roots plants 2 kms uphill (BL and conifer)	44 Nos	14.10% per km	12.40
13	Planting of plants in polythene bags Naked root plants	76 Nos 44Nos	87.30 Nos 73.60%	66.35 32.38

14	Cost of raising seedlings in nursery	120 Nos	3.66	439.20
15	Repair of soil & moist cons. works	0	L/S	366.00
	Total			2219.39
	Add 16.66% increase on schedule rate on a/c of wage hike from 60/- to Rs.70/- per day			369.75
	Total			2589.14
	Add 25% increase for special Tribal area			647.28
	Total			3236.42
.	Total labour cost			3240.00
B.	Cost of material			
1.	Cost of U-Nails	0.750 kg	30 per kgs	22.50
2.	Cost of Black Japan	0.750 kg	@50/-	37.50
3.	Cost of empty tins and bamboo basket	0	L/S	30.00
	Total cost of material			90.00
	Total cost (Labour and material)			3330.00
	Cost of maintenance per Ha, Or say			3300.00

ANNEXURE V-E

4th, 5th, 6th & 7th year Maintenance Per Ha Cost Model for Enrichment Plantation

S.N	Item of works	Qty	Rate	Amount
	Mortality 20%			
1.	Bush cutting and clearance per head load of 30 kgs	50 hld	3.40 each	170.00
2.	Repair of I/Path, 60 cm wide	250 RM	L/S	185.00
3.	Cutting and preparation of Fence posts	15 Nos	518.10	77.71
4.	Coal tarring of Fence posts	15 Nos	111.75	16.76
5	Carriage of Fence posts from forest to work site average distance 2 km manual uphill	15 Nos	363.40/% per km	54.51
6.	Digging of hole 45 cm deep and 20-30 cm dia	15 Nos	362.70/% Nos	54.40
7..	Fixing of wooden posts including strutting	15 Nos	278.45% Nos	41.76
8	Repair of barbed wire fence	180 Rm	0.65/Rm	117.00
9	Interlacing of thorny buses with B/wire	60 Rm	1.65 Rmt	99.00
15	Repair of soil & moist cons. works	L/S	L/S	185.00
	Total			1001.14
	Add 16.66% increase on schedule rate on a/c of wage hike from 60/- to Rs.70/- per day			166.79
	Total			1167.93
	Add 25% increase for special Tribal area			291.98
	Total			1459.91
	Total labour cost			1460.00
B.	Cost of material			
1.	Cost of U-Nails	0.750 kg	30 per kgs	22.50
2.	Cost of Black Japan	0.750 kg	@50/-	37.50
3.	Cost of empty tins and bamboo basket	0	L/S	30.00
	Total cost of material			90.00
	Total cost (Labor and material)			1550.00
	Cost of maintenance per Ha, Or say			1550.00

ANNEXURE VI: YEAR WISE PHASING OF PHISICAL TARGETS & FINANCIAL PROJECTS FOR VARIOUS PROGRAMME COMPONENTS

Sr.	Activity	1Year		IIYear		IIIYear		IVYear		V Year		VIYear		VIIYear		VIIIYear		IXYear		XYear		TOTAL	
		Ph	Fin	Ph	Fin	Ph	Fin	Ph	Fin	Ph	Fin	Ph	Fin	Ph	Fin	Ph	Fin	Ph	Fin	Ph	Fin	Ph	Fin
I	**Afforsation**																						
	(a) Creation	100	31.63	90	28.46	80	25.3	-														270	85.39
	(b) Maintenance	-	-	100	5.75	190	9.82	270	13.09	270	9.59	270	7.24	270	5.4	270	5.4	170	3.4	80	1.6	-	61.29
	Total	100	31.63	190	34.21	270	35.12	270	13.09	270	9.59	270	7.24	270	5.4	270	5.4	170	3.4	80	1.6	-	146.68
	Price of wooden fence Posts																					-	73.71
	Grand Total																					-	**220.39**
II	**Enrichment Plantation**																					-	-
	(a) Creation	60	14.73	50	12.27	40	9.825															150	36.825
	(b) Maintenance			60	2.58	110	4.61	150	5.75	150	4.22	150	3.03	150	2.33	150	2.33	90	1.4	40	0.6	-	26.85
	Total	60	14.73	110	14.85	150	14.44	150	5.75	150	4.22	150	3.03	150	2.33	150	2.33	90	1.4	40	0.6	-	63.675
	Price of wooden fence Posts																					-	32.17
	Grand Total																					-	**95.85**
III	**Pasture Development**																					-	-
	(a) Creation	40	12.00	40	12.00	40	12.00															120	36.00
	(b) Maintenance			40	1.20	80	2.2	120	3	120	2.6	120	2.4	80	1.6	40	0.8					-	13.80
	Total	40	12.00	80	13.20	120	14	120	3	120	3	120	2	80	2	40	1	-	-	-	-	-	49.80
	Price of wooden fence Posts																					-	25.74
	Grand Total																					-	**75.54**
IV	**Stabilization of land slips (No. of Slips(PH.)**	4	4.00	3	4.00	1	2															8	**10.00**
V	**Stabilization of Stream banks (No. of Structures) (Ph.)**	6	3.00	4	2.00																	10	**5.00**
VI	Development of medicinal Plants	8	2.00	8	2.00	8	2	8	2	8	2											40	10.00
	Price of wooden fence Posts																					-	8.58
	Grand Total																					-	**18.58**
VII	Development of Wild Life		5.00		5.00		5		5													-	**20.00**
VIII	Soil and water Conservation																					-	
	Silt detention Dams	2	8.00	2	8.00	1	4.00															5	**20.00**
XI	**Programme Implementation**		30.00																			-	**30.00**
	Total (Financial)		**110.36**		**83.26**		**76.76**		**28.84**		**18.41**		**12.67**		**9.33**		**8.53**		**4.80**		**2.20**		**495.36**
	Or Say																						**495.40**

168.72 145.58 140.31 50.68 35.28 24.94 19.06 16.96 9.60 4.40

UNDERTAKING

Name of the Project: **Budhil Hydro-Electric Project 70 MW**

We undertake to pay the increased cost of material and wages at the time of execution for the implementation Catchment Area Treatment Plan and Compensatory Afforsation in respect of Budhil Hydro-Electric Project 70 MW at Bharmour, Distt. Chamba, H. P.

For Lanco Green Power Pvt. Ltd.

General Manager, Projects

Lanco Green Power Pvt. Ltd.

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