CATCHMENT TREATMENT PLAN FOR SONG DAM DRINKING WATER PROJECT (As per guidelines mentioned in order no PO-50 Dt. 02 Aug 2014 of Uttarakhand Forest Department)

Submitted by
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Glossary

Abbreviations	Description
AGB	Above ground biomass
AoI	Area of Influence
AoIC	Area of Influence towards the city
BGB	Below ground biomass
BIA	Biodiversity Impact Assessment
CA	Compensatory Afforestation
CAT	Catchment Area Treatment
DIZ	Direct Impact Zone
EIA	Environmental Impact Assessment
GBH	Girth at breast height
GIS	Geographical Information System
IUCN	International Union for Conservation of Nature
IGA	Income Generating Activities
IVI	Important Value Index
MoEF&CC	Ministry of Environment, Forest & Climate Change
PMC	Project Monitoring and Control
RCC	Roller-compacted concrete
REET	Rare, Endemic, Endangered and Threatened
SLUSI	Soil and Land Use Survey of India
SP	Sampling Point
SZ	Submergence Zone
TCS	Total Carbon Stock
UKID	Uttarakhand Irrigation Department

1. INTRODUCTION

1.1 Background of the project

Dehradun is the capital city in the State of Uttarakhand and is on the Tourist map of the Country. The population of the city is 5,74,840 (2011) within the Municipal Corporation boundaries and it is continuously increasing. The tourists who visit Mussoorie and the pilgrims who visit the Shrines of Badrinath, Kedarnath, Gangotri and Yamunotri - halt at Dehradun. This has put a tremendous pressure for necessary amenities to be provided to the Public. Dehradun is already facing shortage of water supply and the situation becomes more grave during summers when the discharge at the sources of water supply reduces. There is a demand for Song storage reservoir to meet the drinking water requirement and ground/subsurface water source augmentation in the vicinity of Dehradun.

It is anticipated that this shortfall will go up continuously over the coming years. Keeping this in view, it is proposed to store surplus water during monsoon by constructing a dam across river song to solve the problem of domestic water requirement for the city of Dehradun and adjoining suburban areas.

Irrigation department, Uttarakhand has proposed a dam on River Song, to cater the domestic water demand of Dehradun city and its suburban areas. The project envisages construction of a dam 131.6 meters height. A part of stored water shall be released into the existing Kalanga Canal. The share for drinking water shall be released to proposed treatment plant near pacific Golf (Sahastradhara road) thereafter to distribution system. The project will be helpful in supplying the water through gravity and so the huge expenditure involved in pumping the water will be saved. By construction of the dam some of the water will seep into the ground and will supplement the ground water table which, in turn, will enhance the output of tube wells in the vicinity and Storage of water will help in recharging the ground water and augmentation of natural water sources in downstream. Rivers like Rispana, Bindal and other small streams may get recharged and ground water level in vicinity of Dehradun will also be increased. Tourism and Fisheries may also be developed.

1.2 Location & Approach

The Song River is a major river in Dehradun district draining the central and eastern part of the Doon Valley, in the state of Uttarakhand, India. It is a tributary of Sooswa river, which in turn is a tributary of the Ganges. It originates as spring-fed stream in the southern slopes of the Mussoorie ridge of the Himalayan range and runs from Dhanaulti towards Narendranagar. Song is one of the largest rivers that drain the Doon Valley, and its tributaries includes, Kali Gad, Shahastradhara, Assan River and Rispana River.

The proposed site is located at the boundary of district Dehradun and Tehri Garhwal near village Sondhana at a distance of about 25 kilometers from Dehradun Railway Station. The coordinates of the dam site is as follows.

Longitude : 78°11’30”E, Latitude :30°18’08”N, Bearing of Dam : N 300 W

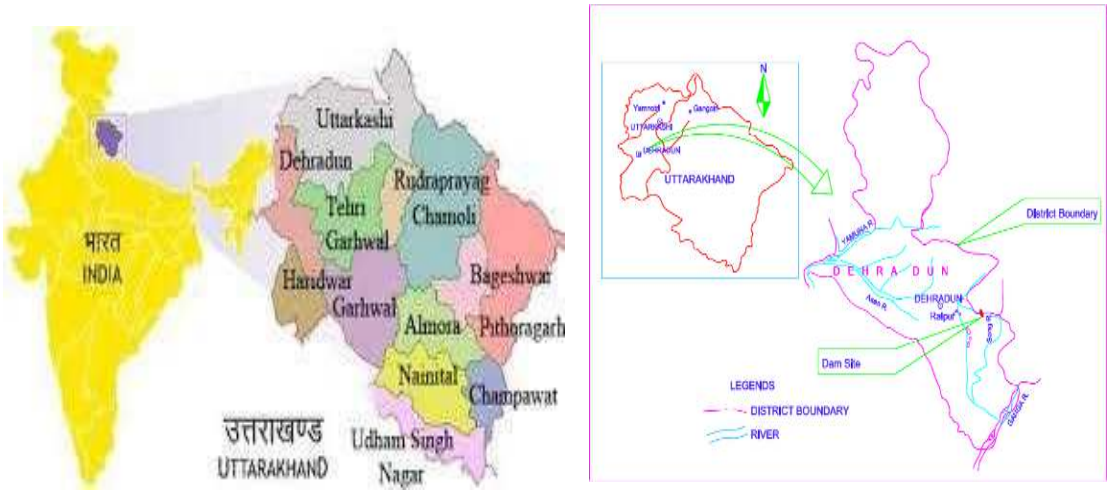


Figure 1: Location of Song Dam Site

1.3 Access to the project site

Dehradun City is located at a distance of around 236km from national capital of New Delhi and can be easily accessed from major cities of India via all means of railways, airways as well as roadways.

Jolly Grant Airport is the nearest airport from Dehradun City- approximately 25 kms. Accessed through motorable roads. The city is well connected by rail and road routes as well. It lies on NH 72 easing the access to the city.

The proposed site is located at the boundary of district Dehradun and Tehri Garhwal near village Sondhana at a distance of about 25 kilometers from Dehradun Railway Station.

1.4 General Climatic Conditions

Dehradun's climate is a "humid subtropical" type being moderately hot in summers and very cold in winters. The temperature can soar up to 44° during summers (May-June) and dip between 1° to 20° during winter months. The Monsoon rainfall usually starts in late June and ends till September. The average annual and monsoon season rainfall is about 2247 mm and 1942 mm, respectively July and August being the rainiest months of the season.

1.5 International Aspect/ Inter State Issues

The project is proposed on River Song – a tributary of River Ganga basin. Streams namely Song, Rispana, Bindal, Suswa etc. flow in the Doon valley and form a part of Ganga basin in the upstream reach.

Figure 4-1 shows schematically the various rivers flowing in the Doon Valley

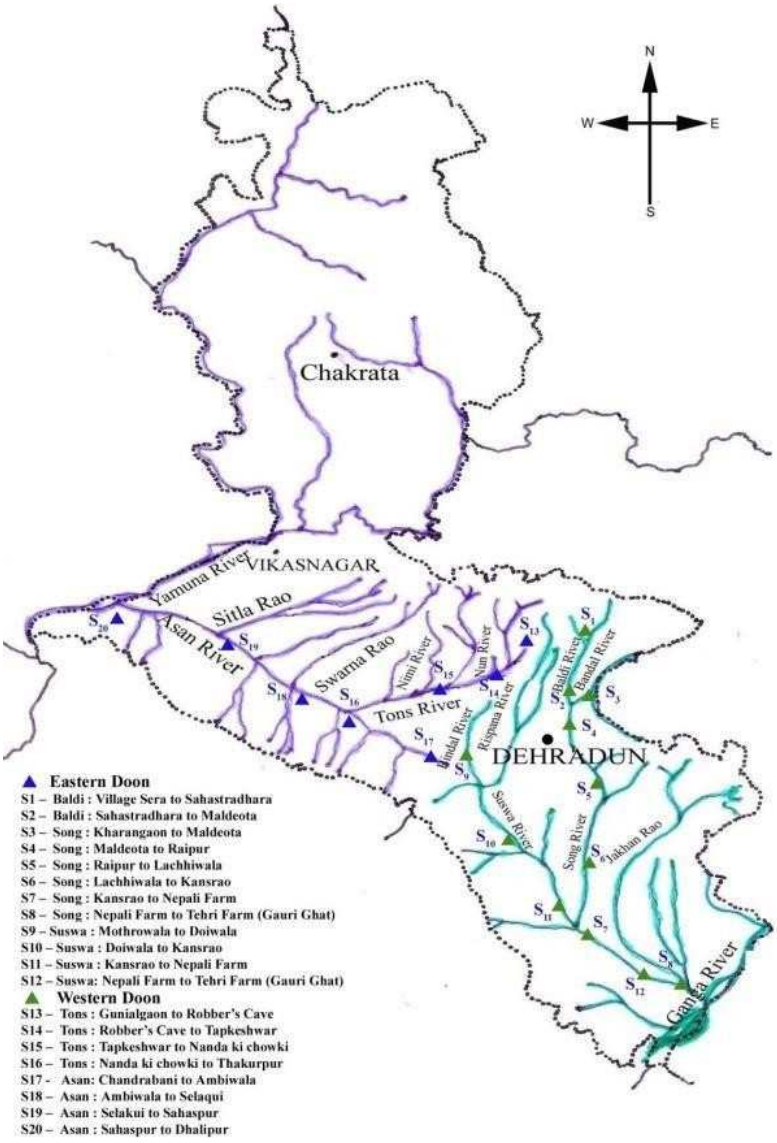


Figure 2:Shows schematically the various rivers flowing in the Doon Valley

The site covers very small catchment area of 85 sq. km (around 0.36 % of catchment area at Haridwar) with a very small proportion of available water in river Ganga in plain).

As per water treaties for sharing of water amongst the Stakeholder states i.e. Uttarakhand and Uttar Pradesh, there should not be any obstruction in planning of the project – particularly for drinking water scheme for Dehradun City.

Hence there are no interstate / international implications in this scheme.

1.6 Proximity to Wildlife Sanctuary/National Parks

It may be noted from the map (figure-3) below that there is no any that there are no National Park or Wildlife Sanctuaries or Biosphere Reserves or other ecologically sensitive areas within the study area. The nearest boundary of Rajaji National Park has found to be approx. 18km (8.1 km from the 10km buffer zone) from the project site in the south. The proposed activities shall have no impact on the National park. The location of Rajaji National Park in relation to the Song Drinking Water Project is shown below.

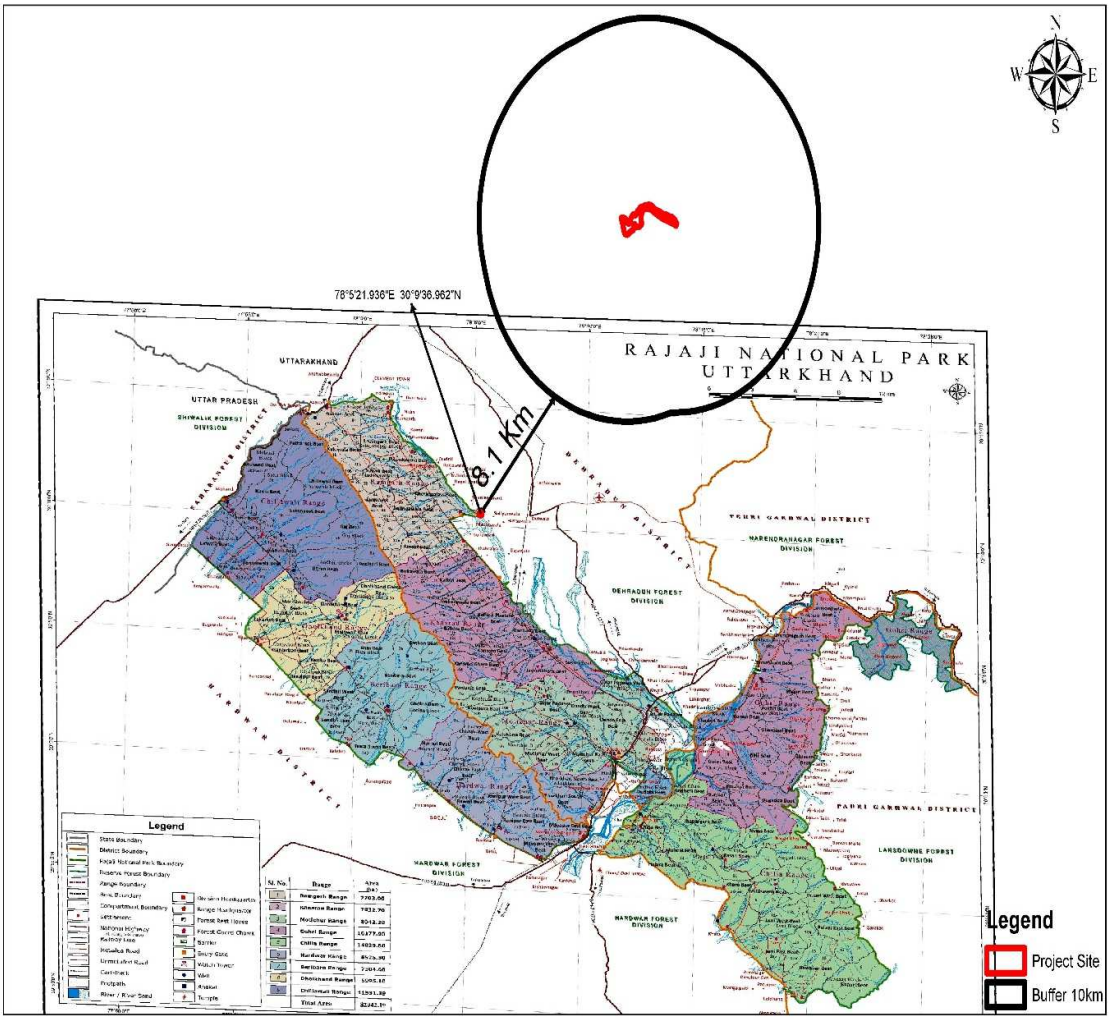


Figure 3: Aerial distance from Wildlife Sanctuary/National Park

2. SONG DAM DRINKING WATER PROJECT

2.1 Salient Features of the project

Table 1:Salient Features of the project

A. LOCATION	
State	Uttarakhand
District	Dehradun
River	Song
Location of Dam	Location near village Sondhana
Nearest Airport & Railhead	Dehradun
Latitude	30°17' to 30°21' N
Longitude	78° 05' to 78°17' E
B. HYDROLOGY	
Catchment area	85 sq.km
Annual average rainfall in the catchment	1250-2800 mm
Design flood	1493 Cumecs
Diversion flood (Maximum observed flood)	26 m^3/s – Non monsoon
C. DAM	
Type	RCC type
Maximum height above deepest foundation	131.60 m
Maximum height above River Bed	109 .00 m
Top of Dam	EL 983.0 m
River bed level at dam site	EL 874.0 m
Expected deepest foundation level	EL 851.6 m
Top road width	12.5 m
Top length	225.0 m
Upstream slope	0.2 (H): 1 (V)
Downstream slope	0.8 (H): 1 (V)
D. SPILLWAYS	

Type of Spillway	Over Flow Type Spillway
No. & size of openings	3 Nos. of 9.0 m x 10.0 m
Crest elevation	970.0 m
Design flood	1500.00 Cumecs
Energy dissipation	Trajectory Bucket type with plunge pool
E. RESERVOIR	
Reservoir Level (FRL/MWL)	EL. 980.00 m
Minimum Draw Down Level (MDDL)	EL. 925.0.00 m
Gross Storage at FRL/MWL	26.3 MCM
Dead Storage at MDDL	4.55 MCM
Reservoir Area at FRL/MWL	64.829Hectare
Live Storage	26.4 MCM
F. INTAKE	
Location	Block No 4
Intake type	Bell mouth
Invert level	EL. 918.0 m
Trash racks	Inclined
G. Water Conductor System	
Total Length	14.7 km
Start Location	Dam Block No. 04
End Location	WTP at KulhanManSingh
Diameter of the Pipeline	1.5m
Length along Song River	10.5 km
Length Along Baldi River	4.2 km
Saddle Supports/ Piers	335 Nos. / 190 Nos.
Anchor Blocks	69 Nos
River crossings	02 Nos
Thickness of Pipeline	15mm & 20mm

2.2 Layout Plan of the Song Drinking Water Project

Based on the study carried out by UKID for topographical, geological and hydrological features of the catchment of river Song and adjoining area, the layout of the proposed drinking water project comprises of following components:

(i) 130 m high Storage dam.

(ii) Diversion Tunnel with Upstream & Downstream coffer Dam

(iii) Spillway

(iv) Water Conveyance system of length 15 km from dam to proposed water treatment plant. Near Pacific Golf Dehradun

(v) Piers saddles & Surge shaft for Water Conveyance system

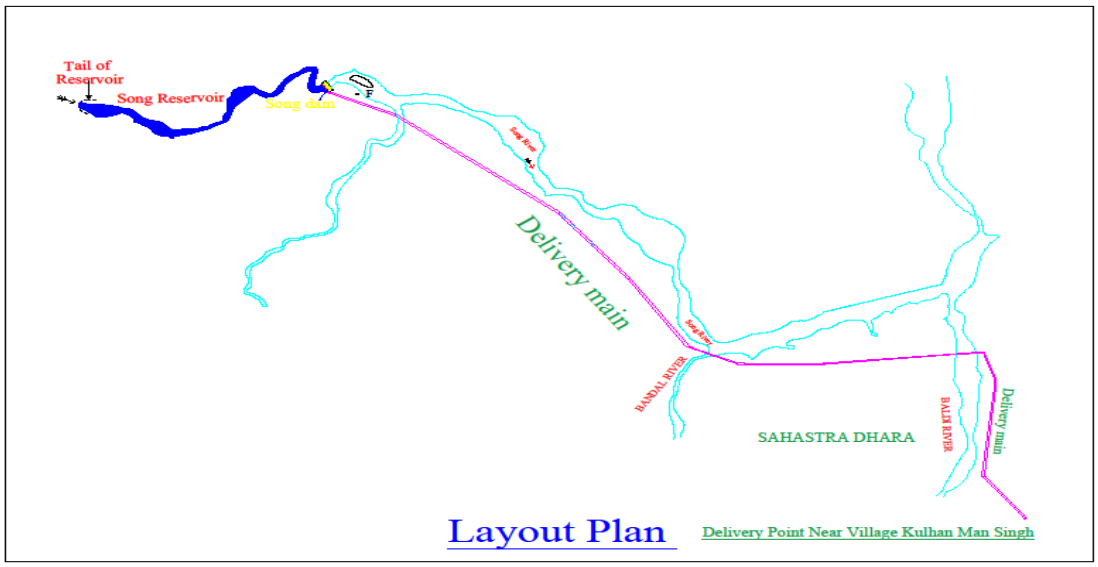


Figure 4: Layout Plan of the Song Drinking Water Project

2.3 Size and Attributes of Land Acquisition under the project

2.3.1 District-level

Table 2: District-level land acquisition details

S.no	District Name	Forest Land(ha.)	Non-Forest Land(ha.)
1.	Dehradun	72.6105	2.061
2.	Tehri Garhwal	55.0607	8.58
Total		**127.6712**	**10.641**

2.3.2 Village-wise breakup

Table 3: Village-wise land acquisition details

S.no	Village	Forest Land(ha.)	Non-Forest Land(ha.)
1	Rangargaon	5.1914	0.446
2	Ghurshalgaon	18.1867	4.316
3	Plad	9.917	2.061
4	Sondana	4.2668	3.818
5	Bharwakatal	0.504	0
6	Shripur	0.433	0
7	Thaiwa	0.056	0
8	Rainiwala	0.42	0
9	Khairimansingh	1.48	0
10	Pustadi	0.8	0
11	Kulhanmansingh	0.62	0
12	Marotha	0.161	0
13	Raipur Rang Mussoorie Forest Division	49.2699	0
14	Mussoorie Range Mussoorie Forest Division	1.762	0
15	Thano Rang Dehradun Forest Division	34.6034	0
Total		**127.6712**	**10.641**

2.3.3 Project component-wise breakup

Table 4: Project Component-wise breakup

S.no	Component	Forest Land(ha.)	Non-Forest Land(ha.)
1	Submergence	68.821	4.762
2	Control Room	0.5	0
3	stock Piles	14.2827	0
4	Muck Dumping	4.6965	3.7544
5	Colony	2.5576	2.061
6	Motor road New approach	7.0275	0
7	Motor Road Upgrade	6.33	0
8	Quarry	4.6143	0
9	Batching Plant	3.9716	0.0636
10	Pipe Line	14.87	0
Total		**127.6712**	**10.641**

2.4 Public Purpose and Need for the Project

2.4.1 General Description

The project area encompasses source i.e from Song Dam situated on river song with is 25 km from Dehradun City. The water will be transmitted through cross country pipeline from Dam up to city limit.

The clear water transmission main of 15 km (approx.) run from Song dam up to proposed water reservoir at Khulan Mansingh. A water treatment plant will be situated at Khulan Mansingh and potable water will be supplied mainly by gravity to Dehradun city and adjoining suburban areas which is termed as service area of the project.

The project covers service area, which is Dehradun Municipal Corporation (DMC) area with its 6 wards, and peripheral areas limited by Dehradun Master Plan 2025. DMC area along with peripheral area has been considered for population projection and demand estimation.

Areas between Sahastradhara road and Rajpur road and sub urban areas such as Balawala and Nathuawala Jogiwala, Mothrowala, Jakhan etc. will be fed with supply of drinking water through this project.

2.4.2 Summary Water Demand, Supply Gaps and need for the Song Dam

Table 5:Summary Water Demand, Supply Gaps and need for the Song Dam

S. No	Description	Year 2011	Year 2018	Year 2021	Year 2031	Year 2041	Year 2051	Year 2061	Year 2071
I	**Population**								
1	Urban Area	706,124	789,262	829,552	984,045	1,169,601	1,386,221	1,633,904	1,912,652
2	Floating population	70,613	78,927	82,956	98,405	116,961	138,623	163,391	191,266
3	Rural Population	257,100	284,478	296,212	335,323	374,435	413,546	452,658	491,769
	Total Projected Population	**1,033,837**	**1,152,667**	**1,208,720**	**1,417,773**	**1,660,996**	**1,938,390**	**2,249,953**	**2,595,687**
II	**Water Computation**								
1	Water demand for Urban Area(inMLD) @ 135LPCD	95.33	106.55	111.99	132.85	157.90	187.14	220.58	258.21
2	Water demand for floating population (in MLD) @ 45 LPCD	3.18	3.55	3.73	4.43	5.26	6.24	7.35	8.61
3	Water demand for Rural Area (in MLD)	25.71	28.45	29.62	33.53	44.00	52.21	61.11	66.39
4	Bulk Industrial Requirement in MLD	25.00	25.00	25.00	30.00	30.00	40.00	40.00	45.00

	Net Water demand in MLD	149.21	163.55	170.34	200.81	237.16	285.59	329.04	378.20
	Total Water Requirement in MLD @ 15% water loss	**175.55**	**192.41**	**200.40**	**236.24**	**279.01**	**335.99**	**387.10**	**444.95**
	Total water requirement in Cumec	2.03	2.23	2.32	2.73	3.23	3.89	4.48	5.15
	Total water requirement in MCM	64.07	70.23	3.15	86.23	101.84	122.63	141.29	162.41
III	**Water Supply**								
S. No	**Description**	Year 2011	Year 2018	Year 2021	Year 2031	Year 2041	Year 2051	Year 2061	Year 2071
A	**Surface Sources**								
1	**Massi fall (Shahensai Ashram WTP)**	10.00	10.00	12.00	12.00	12.00	12.00	12.00	12.00
2	**Bandal river (Dilram Bazar WTP)**	8.00	8.00	10.00	10.00	10.00	10.00	10.00	10.00
3	**Bijapur canal (Dilram Bazar WTP)**	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
4	**Kolhu Khet**	-	-	-	-	-	-	-	-
5	**Khalanga Canal**	-	-	-	-	-	-	-	-
6	**Galogi (Purukul Gram WTP)**	-	-	10.00	10.00	10.00	10.00	10.00	10.00
	Total Surface Water available for existing Source in MLD (A)	28.00	28.00	42.00	42.00	42.00	42.00	42.00	42.00
	Water losses @ 15%	4.20	4.20	6.30	6.30	6.30	6.30	6.30	6.30
	Net Surface Water Available from existing Source in MLD	23.80	23.80	35.70	35.70	35.70	35.70	35.70	35.70
B	**Song Dam**								
	Total water supply from song dam in cumec	-	-	1.74	1.74	1.74	1.74	1.74	1.74
	Total water supply in MCM	-	-	54.87	54.87	54.87	54.87	54.87	54.87
	Total water supply in MLD (B)	-	-	150.34	150.34	150.34	150.34	150.34	150.34
	Water Distribution losses @ 15%	-	-	22.55	22.55	22.55	22.55	22.55	22.55
	Net Water supply from Song Dam in MLD	-	-	127.79	127.79	127.79	127.79	127.79	127.79

	Total available surface water in MLD (A+B)	28.00	28.00	192.34	192.34	192.34	192.34	192.34	192.34
C	**Ground Water Sources**								
	Total available ground water in MLD	150.00	165.00	150.00	150.00	150.00	150.00	150.00	150.00
	Water Distribution losses @ 15%	22.50	24.75	22.50	22.50	22.50	22.50	22.50	22.50
S. No	**Description**	Year 2011	Year 2018	Year 2021	Year 2031	Year 2041	Year 2051	Year 2061	Year 2071
	Net water supply from Tube Wells in MLD	127.50	140.25	127.50	127.50	127.50	127.50	127.50	127.50
	Total water available to be supplied from surface and ground water	178.00	193.00	342.34	342.34	342.34	342.34	342.34	342.34
	Surplus / Deficit water demand in MLD	2.45	0.59	141.93	106.09	63.33	6.35	(44.77)	(102.61)

A detailed assessment of existing situation and future projection is carried out, which concludes that the available water resources including song dam is surplus to cater the increasing demand of Dehradun. The ground water source is restricted at a sustainable rate of 150 MLD up to year 2071. After restricting the ground water at 150 MLD, a combined shortfall of 102 MLD (8.4% of total demand) is expected after 50 years. Alternate source is proposed to be explored to supply the additional requirement at year 2071.

The water supply from available source will be a combination of surface and ground water depending on the location, treatment capacity, distribution network and cost economics. It is recommended to give priority to song dam and other available surface sources over ground water. The tube well will have higher operation and maintenance cost as compared to song dam. The water supply from song dam will be by gravity resulting is huge saving in power and O&M cost.

2.5 Project Impacts

2.5.1 Ground water rejuvenation

Existing sources of surface and sub-surface water are being depleted at a higher rate. The tube wells provide 80% of water supply of Dehradun town and its adjoining areas and 20% is from various surface resources.

Presently, ground water being a major source of water in and around Dehradun City- with increase in demand and in absence of any alternate source, the ground water table is depleting at an alarming rate indicating over exploitation of sub surface source at rate higher than the annual average recharge capacity.Storage of water in the reservoir thereafter shall help in recharging of sub surface sources-i.e. ground water.

2.5.2 Rejuvenation of dying Ripsana River

The rejuvenation of Rispana river is also a burning issue these day. A provision has been made to fed Rispana River through song dam. The surplus water will be diverted to Rispana river near proposed WTP site. As the demand increases, the water will be completely utilized for potable use only. River Rispana is almost dried up presently as can be seen in Figure 5.

Figure 5: Present Condition of Ripsana River

Alternate sustainable measure should be taken to rejuvenate the river. In case of water shortage from Dam, treated sewage water can be viewed as a potential source. Restoring the river flow with treated sewage can be worked out in future as a separate project. The sewage treatment plant should be based on the state to art technology complying with pollution board norms. Water can also be retained in the river by using gates / weir at strategic locations. The water stored in the weir and gates will increase groundwater level and overall the river will look alive. The continuous flow of treated water will maintain the quality and quantity in the river.

2.5.3 Scope of Fisheries-Economic Boost

The project upon completion shall boost Fisheries in the area- thus creating some revenue. People in adjoin areas/ villages can explore it as a sustainable source of income

2.5.4 Tourism Boost

The project will create a lake extending in a length of about 4 kms and will be a big attraction for the tourists. The submergence will involve about 72.20 hectares of forest and Benaap land and 11.73 hectare of agricultural land. The number of trees in submergence area is also very less and so the project is ideal with respect of environmental aspect.This reservoir can act as artificial lake and can be used to promote tourism in adjoin area.

2.5.5 Summary of impacts

The project shall serve as a multipurpose project for water supply, irrigation, tourism development, recharge of surface and sub surface sources of water, economic development (boost in Fisheries) etc.

It is seen that upon completion, it shall be highly beneficial to Dehradun and adjoining areas in various aspects. It is found to be environment friendly as well.

3. CATCHMENT AREA DETAILS

3.1 General Details

ThestudyareaisSongRivercatchmentuptoDamSite.SongRiverisoneofthelarge riversthatdrainstheDoonvalleyandisaleftbanktributaryofGangaRiver.Themajor tributariesofSongRiverareKaliGad,Sahastradhara,AssanRiverandRispanaRiver. The river Song originates from Surkanda Devi temple in District Tehri- Garhwal at an elevation of about 2700 m above msl. It joins River Ganga at near Raiwala between Haridwar and Rishikesh at an elevation of about 315 m. The project area lies in the Survey of India (SoI) Toposheet No 53J/3. The catchment area up to Dam site has mountainous physical geography and dominantly covered with forest and green vegetation. The climate of the area is moderately hot in summers and very cold in winters. During the summer months (May & June), the temperature ranges between 36◦C and 16.7◦C. The winter months are colder with the maximum and minimum temperatures touching 23.4°C and 5.2°C, respectively. The Monsoon rainfall starts in lateJunetoandendstillSeptember.Theaverageannualandmonsoonseasonrainfall is about 2247 mm and 1942 mm, respectively July and August being the rainiest months of theseason.

Uttrakhand Irrigation Department has proposed a roller compacted concrete (RCC) gravitydamofamaximumheightof131.6metresfromdeepestfoundationlevelacross theriversongnearvillageSondhana,P.O.Maldeota,Distt.Dehraduntomeetthewater demand of Dehradun city. The project is situated in the district of Dehradunlocated about 9 km U/S of Maldeota village. Proposed Dam Site on River Song is located at Latitude 30°18'08" North and Longitude 78°11'30" East about 9 km U/S of Maldeota village.

The total catchment area of Song River up to the dam site is about 85.225 sq km consisting mainly of hilly terrain with about 90% of the area falling in a slope range of 20-100%. The catchment is dominated by forests (80%). The range lands and agricultural lands occupy nearly 10% and 8% of the catchment respectively. The soils inthecatchmentareaarechieflyloamysoils.ThemapofSongRiverdrainagenetwork andthecatchmentDigitalElevationModeluptodamsiteisshownin**Figure 6.1**. The major part of the catchment area (about 85%) is covered by excessivelydrained,loamyandloamy-skeletalsoilswithmoderatelyshallowto very shallow soil-depth. The loamy surface on steep slopes have erosion problem. Moderately deep, well drained, coarse loamy soils mixed with fine loamy soils on moderate slopes have slighterosion.

3.2 Details of Catchment, Watersheds, Sub watersheds and MWS

The Land Survey Directorate (LSD), a wing of Uttarakhand Forest Deptt. has, hydrologically, divided Uttarakhand broadly into 8 Catchments, these catchments have further been divided into 26 watersheds, 110 SWS and finally into 1110 MWS. Details of these hydrological units given in the table below:

Table 6: Details of Catchment, Watersheds, Sub watersheds and MWS in Uttarakhand

Sl. No	Catchment	Watershed	No. of Sub watersheds	No. of MWS	Total Area (ha.)
1	Alknanda	Alaknanda	7	86	6,69,643
		Lower Alaknanda	5	32	95,475
		Mandakini	5	33	1,68,049
		Pindar	5	56	1,87,800
		Total	22	207	11,20,967
2	Bhagirathi	Bhagirathi	14	120	5,77,523
		Bhilangana	4	39	1,49,660
		Total	18	159	7,27,183
3	Ganga-A	Song	5	56	1,76,597
4	Ganga-B	Hiyunl/mal	6	28	1,00,683
		Nayar	6	59	2,08,612
		Total	12	87	3,09,295
5	Kali	Kali	5	82	5,49,682
		Lower Kali	3	34	1,17,760
		Saryu	8	123	4,45,494
		Total	16	239	11,12,936
6	Kosi	Bhakra	3	9	1,64,746
		Gola	3	20	1,65,988
		Kosi	4	71	2,10,075
		Nandhaur Left	3	17	1,23,618
		Total	13	117	6,64,427
7	Ramganga	Dhela Nadi	1	2	45,393
		Khoh	2	8	48,723
		Ramganga	8	75	3,33,926
		Total	11	85	4,28,042
8	Yamuna	Aglar	2	7	25,698
		Asan	3	18	82,088
		Lower Tons	3	19	45,265
		Tons	4	36	1,67,926
		Yamuna	7	80	2,29,185
		Total	19	160	**5,50,162**
		Grand Total	116	1110	**50,89,610**
				+ Haridwar	**2,33,506**
				Total	**53,20,291**

3.3 Song Dam Project Region

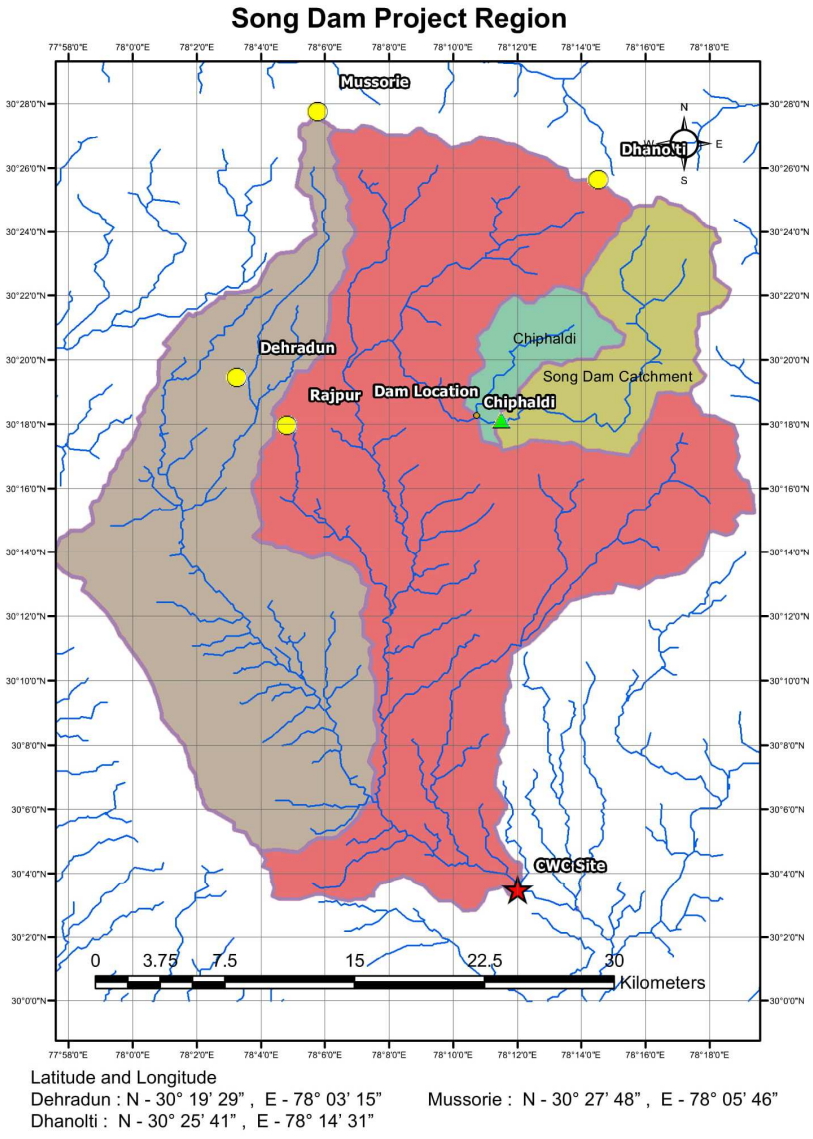


Figure 6: song Dam Project Region

3.4 Topography, Physiography & Geology of the project area

Adequate topographical surveys have been carried out by Irrigation Department, Dehradun, Uttarakhand to establish the selection and design of the most techno- economically viable alternative for the Song Dam Drinking Water Project. The scope and extent of the survey and investigations were finalized after extensive field reconnaissance of the project area by engineers and geologists.

Topographical survey of the left bank has been done up to a contour level of 1060 m while the right bank was surveyed up to a contour level of 1074 m.

The following topographical survey data has been used for preparing the DPR:

- Survey of India Toposheet (Scale 1:50,000)

Survey of India Toposheet no. 53-J/3 which covers all the components of the project area. The dam site has a longitude of 78°11'18.63"E and latitude of 30°18'8.29"N.

- Topographical Maps 1:3,000

Topographical survey covering the entire Dam Area, Reservoir area and approx. 1km downstream of the dam axis area on both the banks has been carried out at the scale of 1:3,000 with a contour interval of 2.0 m. The survey has been conducted up to 50m above the dam top level.

- Cross-Sections of Song river

100 nos. of river cross sections at every 50.0m distance from the dam axis to 5035m in the upstream direction has been prepared.

Similarly, 30 nos. of river cross sections at every 50.0m distance from the dam axis to 1500m in the downstream direction has been prepared

Geology & Physiography

The Song river system is composed of a good number of tributaries of which the main are Bandal Nala, Chiphaldi nadi and some small streams from the south as well as north faces. Most of the streams are perennial and spring fed because there are no glaciers or snow covered mountains either at the source of the Song river or any of its tributaries. Most of the rain water goes as run off but some percentage gets in-filtered into the joints and crevases and comes out in the form of spring which form the bulk water of this river.

A large number of springs on the south hills of this river are located in the phyllite quartzite silt stone association of rocks which have been equated to Chandpur. Various lineaments / fractures in this formation which underlie the massive, hard, highly metamorphosed quartzite have mostly given rise to spring formation. Considerate amount of water is contributed to Song river from the northern hill slope having large number of tributaries with the water sources mainly from springs. The Song drainage basin at dam site has a total area of 85 sq.km. approximately. The width of the water bearing stream in the Song river is approximately 6.0 – 10.0 m wide with an average water depth of 0.6 m.

A series of ridge-lines intervened by valleys make up the landscape. The north facing slopes which also form the dip slopes are gentler and luxuriantly vegetated. Landslips and landslides occur mostly due to unstable slope conditions and old mining works in a few places. Numerous scarps, at times semi-amphitheatrical in shape, are present on both the banks of the Song. This region marks the youthful stage of the river. Cases of occasional braiding in the Song river also occur, forming channel bars which comprise of sand, gravel and boulders. In the upper reaches of Song, boulders are strewn all over.

3.5 Watershed Details

As per the Soil and Land Use Survey of India (SLUSI), the concerned watershed of the of the project area is as follows:

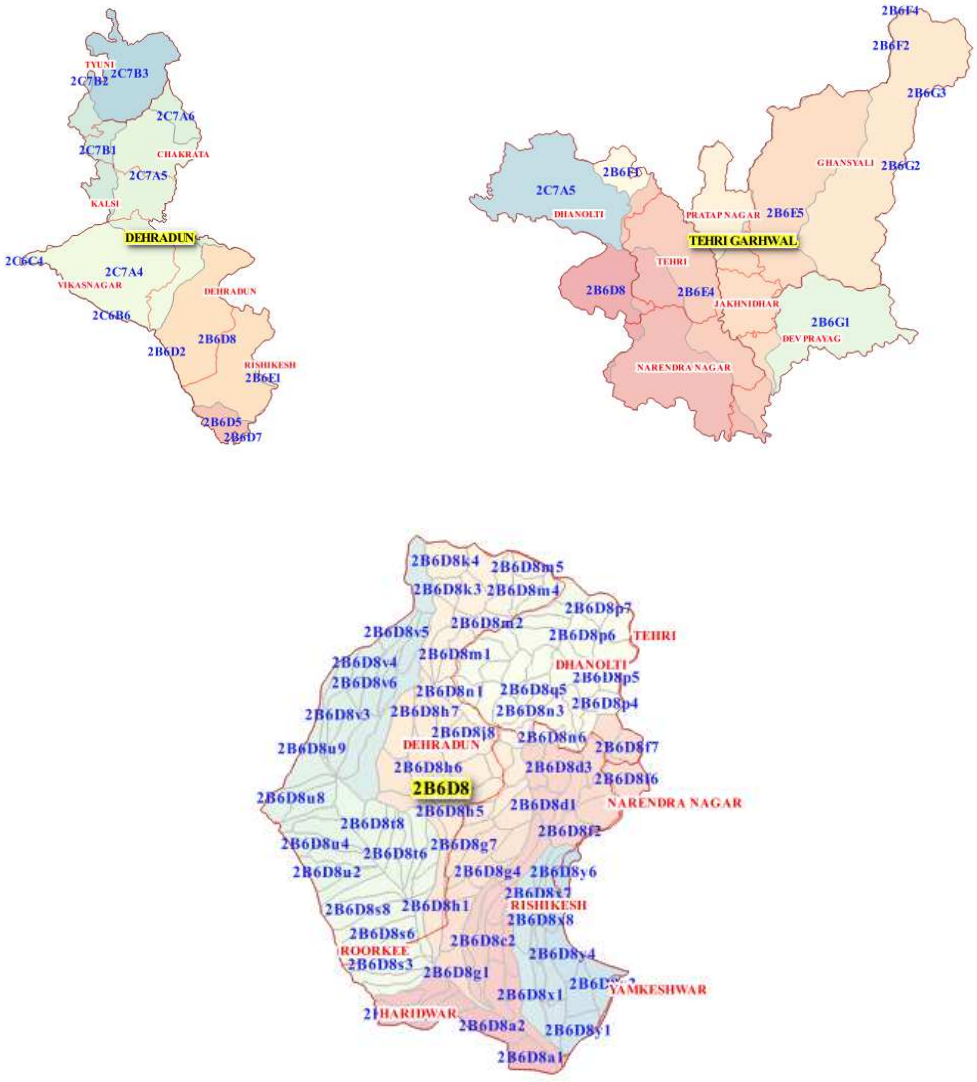


Figure 7: Watershed Map of the Project Area

3.6 Socio-Economic Profile

3.6.1 Demographic Profile of the Project-Affected Families

The total number of project affected families has been shown in table below. There are 50 project affected families identified during the field surveys and the total population of the affected families is recorded as 486. This population includes persons below 18 years of age and married female child. The beneficiaries of R&R is all persons above 18 years of age within the project affected area.

Figure 8: Public Consultations

Table 7: Demographic Profile of the Project-Affected Families

District	GP	Village	Houses	Total Population		
				Population	Male	Female
Tehri	Ragadgaon	Ragad gaon	1	4	2	2
Tehri	Ghudsalgaon	Ghudsalgaon	24	155	100	55
Tehri	Tolia Katal	Sondhana (Tehri)	17	274	205	69
Dehradun	Akhundwali Bhilang	Sondhana (Dehradun)	8	53	41	12

3.6.2 Literacy Profile

The details of literacy rate of affected families in various command area is given in Table-8. The overall literacy rate of families in Ragad Gaon is 75%. Literacy rate in Ghursal Gaon is 81.5%. Literacy rate of Sondhana Tehri is 69% and the literacy rate of Sondhana Dehradun is 71%. The literacy rate as observed is quite low, and is an indicator of socio - economic backwardness of the area. Apart from this it is observed that female literates are very less as compared to male literate.

Table 8:Literacy Profile

District	Village	Total Population of affected houses	Population literate		Population illiterate	
			M	F	M	F
Tehri	Ragad Gaon	4	2	1	0	1
Tehri	Ghudsal Gaon	155	76	55	3	6
Tehri	Sondhana (Tehri)	274	124	89	7	36
Dehradun	Sondhana	53	26	16	2	6

3.6.3 Caste Profile

The total population in the submergence area villages is 486. The classification of the population on the basis of the Caste is given in Table 15. It is observed that the maximum amount of population belongs to the Other Backward classes comprising of 51.3 % of the total population followed by General Category population which comprises of 42.3% of the total population in the submergence area. Only 6.2% population belongs to Schedule Caste category of the total submergence area population.

Table 9: Caste Profile

Name of village	Total Affected Houses	Caste Details (Family-wise)			
		Gen	OBC	SC	ST
Ragad gaon	1	-	1	-	-
Ghudsal gaon	24	18	2	4	-
Sondhana (Tehri)	17	1	15	1	-
Sondhana (Dehradun)	8	7	1	-	-

3.6.4 Occupation Profile

In economic development of the region its geographical location, natural resources, business and employment, industries and manpower play vital role. The occupational profile of command area tehsils is given in Table 9.

Table 10: Occupation Profile

Occupation	Ragadgaon	Ghudsalgaon	Sondhana (Tehri)	Sondhana (Dehradun)	Total
Labour	0	20	3	2	25
Main Cultivators	4	95	120	30	245
Private Service	0	9	3	2	14

It is observed that total main cultivators in the project affected area are 245 accounting for about 48% of the total population. Labour workers account for about 5% of the total population. 2.7% are into private sector jobs. The remaining (44.3%) is the dependent population. Occupation profile is extremely poor, more than 44% population are non-workers. The dominant occupation is agriculture and there is no other source of income in this area.

Apart from this worker belonging to different gender category reported. The gender composition among the workers in the submergence area indicates that most of the workers are male and very few workers belong to female category.

3.6.5 Agriculture

The major agriculture crops grown in the submergence area are Vegetables in Kharif and wheat in Rabi, which account for about 45% and 40 % of the total cropped area respectively. After those others crops (6%) grown in Kharif and Peas & Beans (9 %) in Rabi. Most of the irrigation is done through River water and some rely on the rainfed water. The details of cropping pattern of the command area are given in Table 17. It was observed that hat Vegetables in Kharif and wheat in Rabi dominates in the area. Under rainfed condition crop yields are small and varying.

Table 11: Agriculture

Crop	Dehradun District	Tehri Gharwal District		
	Sondhana (Dehradun)	Sondhana (Tehri)	Ragadgaon	Ghudsalgaon
Maize	Yes	Yes	Yes	Yes
Green Chilly	Yes	Yes	Yes	Yes
Turmeric	Yes	Yes	Yes	Yes
Wheat	Yes	Yes	Yes	Yes
Peas	Yes	Yes	Yes	Yes
Beans	Yes	Yes	Yes	Yes

The villagers follow a crop pattern where they cultivate more vegetables than agricultural crops. Also, the farming is organic in nature due to the influence of an NGO who had taken majority of the farmers to an exposure visit organized in Nainital. Most of the agriculture is

subsistence in nature and the much of the produced vegetables are sold in nearby Raipur Mandi.

3.6.6 Education Profile

Educational facilities are available in all the submergence area villages till Anganwadi and primary school (education from 1st- 5th standard), Secondary schools or Intercollege (education from 6- 12th standard) is situated in Ragadgaon. Higher education facilities are extremely poor in the submergence area villages. The residents are traveling long distances to get the better education facilities either to Maldevta Degree College or Dehradun. Details of education facilities in submergence area villages are given in below Table below.

Table 12: Education Profile

Name of Village	Aanganwadi	Primary School	Inter-college	College	Adult Literacy Centre
Hillancevalli	1	1	0	0	0
Sondhana (Tehri)	1	1	0	0	0
Sondhana (Dehradun)	0	0	0	0	0
Ragadgaon	1	1	1	0	0
Gurshalgaon	1	1	0	0	0

3.6.7 Medical Facilities

Table 13: Medical Facilties

Name of Village	Aanganwadi	Allopathic Hospitals	Maternity child welfare center	Primary health center
Hillanceveli	1	0	0	0

Sondhana (Tehri)	1	0	0	0
Sondhana (Dehradun)	0	0	0	0
Ragadgaon	1	0	0	0
Gurshalgaon	1	0	0	0

3.6.8 Demographic profile of villages within 10 km of the project area

Table 14: Demographic profile of villages within 10 km of the project area

Name of Block	Name of Village	Total area of village (in hectares)	Total Population (2011 Census)	No of Households (2011 Census)
Raipur	Akhandwali Bhilang	348.8	527	93
	Dwara	1104.7	1500	274
	Thewa	142.2	801	164
	Playd	296	139	27
Jaunpur	Sera goan	51.1	225	34
	Kund	175.3	309	46
	Danda Gaon	42.3	58	9
	Chiphalti Lagga Gawali Danda	87.5	109	17
	Toliya Katal	61.4	95	17
	Airal Gaon	97.3	116	19

3.6.9 Education Facilities within 10 km of the project area

Table 15:Education Facilities within 10 km of the project area

Name of Block	Name of Village	No. of educational amenities available (If not available within the village, the distance range code viz; (a) for < 5 Kms, (b)for 5-10 Kms and (c) for 10+ kms of nearest place where facility is available is given).						
		Pre-Primary school (PP)	Primary school (P)	Middle school (M)	Secondary School (S)	Senior Secondary school (SS)	Non-formal training center (NFTC)	Special school for disabled (SSD)
Raipur	Akhandwali Bhilang	a	1	1	A	a	C	c
	Dwara	a	1	1	1	a	C	c
	Thewa	1	1	1	1	1	C	c
	Playd	c	1	C	B	b	C	c
Jaunpur	Sera goan	c	1	A	A	c	C	c
	Kund	c	1	B	b	c	C	c
	Danda Gaon	b	1	B	c	c	C	c
	Chiphalti Lagga Gawali Danda	b	1	B	b	c	C	c
	Toliya Katal	a	a	A	b	c	C	c
	Airal Gaon	c	1	B	b	c	C	c

3.6.10 Availability of drinking water within 10 km of the project area

Table 16:Availability of drinking water within 10 km of the project area

Name of Village	Tap water (Treated/ Untreated)	Well water (Covered / Uncovered well)	Hand Pump	Tube wells / Bore well	Spring	River / Canal	Tank / Pond / Lake

Akhandwali Bhilang	Yes	No	No	No	No	Yes	No
Dwara	Yes	Yes	Yes	No	No	Yes	No
Thewa	Yes	No	No	No	No	Yes	No
Playd	Yes	No	No	No	No	No	No
Sera goan	No	No	Yes	No	No	Yes	No
Kund	Yes	No	Yes	No	No	No	No
Danda Gaon	Yes	No	Yes	No	No	No	No
Chiphalti Lagga Gawali Danda	Yes	No	Yes	No	No	No	No
Toliya Katal	Yes	No	Yes	No	No	Yes	No
Airal Gaon	Yes	No	Yes	No	No	No	No

3.7 Forest Types, Flora and Fauna

3.7.1 Forest and Forest types

The forest present in study area belong to Tropical Dry Deciduous Forests (Group 5), Subtropical Pine Forests (Group 9), and Degraded Forest as per the classification of Champion & Seth (1964). Some of the forest types observed in the study area are as follows:

Tropical Dry Deciduous Forests (Group 5)

a. Dry Siwalik Sal Forests (5B/Cla)
b. North Dry Mixed Deciduous Forests (5B/C2)

Subtropical Pine Forests (Group 9)

c. Subtropical Chir Pine Forests

Degraded Forest

d. Himalayan Sub-Tropical Scrubs (9/Clb/DSI)
e. Sub-tropical Euphorbia Scrubs (9/Clb/DS2)
f. Secondary Scrubs (12/CI/DS2)

Figure 9: Forest in the catchment area

A total of 26 trees, 13 shrubs, and 17 herbs, 55 species of avi- fauna, 4 species of fish and 3 species of reptiles and fauna were recorded during the field survey. Among other terrestrial animals, 14 reptiles and mammals were recorded through secondary literature review and interactions with local villagers The details of Flora and Fauna has been given in the separate BIA Report and suitable efforts shall be made so as to avoid and damage to it during the construction of the project. If however during the execution of the project works. There may

be any damage of Flora and Fauna suitable measures shall been taken as per the guidelines of the Forest Act 1980 and instructions of Uttarakhand Forest Department.

3.7.2 Status of recorded Tree Species

Table 17: REET Status of tree species

Species	**IUCN Status**
Bombax ceiba	Not evaluated
Albizia procera	Not evaluated
Acacia Catechu	Not evaluated
Falconeria insignis	Not evaluated
Jacaranda mimosifolia	Vulnerable1
Leucaena leucocephala	Not evaluated
Euphorbea royleana	Not evaluated
Zizyphus mauritiana	Not evaluated
Mallotus phillipensis	Not evaluated
Pinus roxburghii	Least concern
Sizygium cuminii	Not evaluated
Alstonia scholaris	Least concern
Butea monosperma	Data deficient
Pterospermum acerifolium	Not evaluated
Carica papaya	Data deficient
Mangifera indica	Data deficient
Pyrus communis	Least concern
Prunus persica	Least concern
Juglans regia	Least concern
Psydium guajava	Least concern
Emblica officianalis	Not evaluated

3.7.3Status of recorded Shrub Species

Table 18:REET Status of shrub species

Species	IUCN Status
Murraya koengii	Not evaluated
Ricinus communis	Not evaluated
Carissa opaca	Not evaluated
Lantana camarra	Not evaluated
Ageratum conizoides	Not evaluated
Colebrookia oppositifolia	Not evaluated
Opuntia sp.	Not evaluated
Adhathoda vesical	Not evaluated
Debregeasia longifolia	Not evaluated
Solanum chrysotrichum	Not evaluated
Rumex hastatus	Not evaluated
Reinwardtia indica	Not evaluated
Berberis lyceum	Not evaluated

3.7.4Status of recorded Herb Species

Table 19: REET status of recorded herb species

Species	IUCN Status
Urticaria dioica	Least concern
Oxalis corniculate	Not evaluated
Ageratina adenophora	Not evaluated
Cirsium spp.	Not evaluated
Agave spp	Not evaluated
Asparagus adscendens	Not evaluated
Dicliptera paniculate	Not evaluated
Cissampelos perriera	Not evaluated
Smilax spinosa	Not evaluated
Alternanthera sessilis	Least concern
Abrus Pulchellus	Not evaluated
Parthenium hysterophorus	Not evaluated
Gallium aparine	Not evaluated
Holmskioldia sanguinea	Not evaluated
Mentha arvensis	Not evaluated

3.7.5Status of recorded fauna

During the study, the direct sightings of was only for Langoors and Rhesus macaque only. Secondary information was collected from literature review and interactions with nearby villagers (see below list of some of the stakeholders interacted during the study).

Table 20: Status of recorded fauna

Species	**IUCN Status**
Rhesus Macaque (Macaca mulatta)	Least Concern
Wild Boar (Sus scrofa)	Least Concern
Indian crested porcupine (Hystrix indica)	Least Concern
Barking Deer (Muntiacus muntjac)	Least Concern
Golden Jackal (Canis aureus)	Least Concern
Leopard cat (Prionailurus bengalensis)	Least Concern
Monitor Lizard (Varanus bengalensis)	Least Concern
Mongoose (Herpestes edwardsii)	Least Concern
Indian Hare (Lepus nigricollis)	Least Concern
Yellow Throated Marten (Martes flavigula)	Least Concern

3.7.6 Status of recorded avi-fauna

Table 21: Status of recorded avi-fauna

Common Name	Scientific Name	IUCN Status
Long tailed minivet	Pericrocotus ethologus	LC
Black Kite	Milvus migrans	LC
Crested Kingfisher	Megaceryle lugubris	LC
Pied Kingfisher	Ceryle rudis	LC
Stork-Billed Kingfisher	Pelargopsis capensis	LC
Common Kingfisher	Alcedo atthis	LC
White throated Kingfisher	Halcyon smyrnensis	LC
White-capped Redstart	Chaimarrornis leucocephalus	LC
Plumbeous Water Redstart	Rhyacornis fuliginosa	LC

Yellow Wagtail	Motacilla flava	LC
White Wagtail	Motacilla alba	LC
Blue Whistling Thrush	Myophonus caeruleus	LC
Red-Billed Leiothrix	Leiothrix lutea	LC
Jungle Babbler	Turdoides striata	LC
Jungle Crow	Corvus culminates	LC
House Crow	Corvus splendens	LC
Emerald Dove	Chalcophaps indica	LC
Himalayan Bulbul	Pycnonotus leucogenys	LC
Red vented Bulbul	Pycnonotus cafer	LC
Spotted Forktail	Enicurus maculatus	LC
Little Forktail	Enicurus scouleri	LC
White Browed Shrike Babbler	Pteruthius aeralatus	LC
Bronzed Drongo	Dicrurus aeneus	LC
Slaty Headed Parakeet	Psittacula himalayana	LC
Grey Bushchat	Saxicola ferreus	LC
Common Stonechat	Saxicola torquatus	LC
Red-Wattled Lapwing	Vanellus indicus	LC
Crested Serpent Eagle	Spilornis cheela	LC
Grey-Breasted Prinia	Prinia hodgsonii	LC
Brown Dipper	Cinclus palasii	LC
Nepal House Martin	Delichon nipalense	LC
Grey Treepie	Dendrocitta formosae	LC
Red-Billed Blue Magpie	Urocissa erythrorhyncha	LC
Black-lored Tit	Parus xanthogenys	LC
Chestnut-bellied Nuthatch	Sitta(castanea) cinnamoventris	LC

Grey-capped Pygmy Woodpecker	Dendrocopus canicapillus	LC
Wallcreeper	Tichodroma muraria	LC
Black Bulbul	Hypsipetes leucocephalus	LC
Streaked Laughingthrush	Garrulax lineatus	LC
House Sparrow	Passer domesticus	LC
Common Pigeon	Columba livia	LC
Great Tit	Parus major	LC
Oriental Skylark	Alauda gulgula	LC
Indian Peafowl	Pavo cristatus	LC
White-breasted Waterhen	Amaurornis phoenicurus	LC
White-browed Wagtail	Motacilla maderaspatensis	LC
White-crested Laughingthrush	Garrulax leucolophus	LC
Grey-hooded Warbler	Phylloscopus xanthoschistos	LC
Rusty-tailed Flycatcher	Muscicapa ruficauda	LC
Green Crowned Warbler	Seicercus burkii	LC
Common Myna	Acridotheres tristis	LC

3.7.7 Status of recorded aquatic species

Table 22: Status of recorded aquatic species

Common Name	Scientific Name	IUCN Status
Asla	Schizothorax richardsonii	VU1
-	Bairilius benedelisis	LC
-	Garra gotyla	LC
Rosy Barb	Pethia conchonius	LC

[1] IUCN Red List of Threatened Species 2010: e.T166525A135873256

3.8 Catchment Delineation and Estimation of Catchment Characteristics

The Digital Elevation Model of the study area is developed from the Cartosatdata. Arc Hydro Tool has been used for basin delineation in ArcGIS. The DEM is filled to remove any local sink and then used to derive the flow direction and flow accumulation grids which are further used for defining and segmenting the streams and the catchment grid. Once drainage point is defined, the drainage network and catchment boundary is masked as a separate project. The drainage point is selected on the stream grid near to the point of interest. The delineated catchment area and various catchment characteristics are shown in Figure 6.14. The estimated value of catchment characteristics is given in Table 6.18.

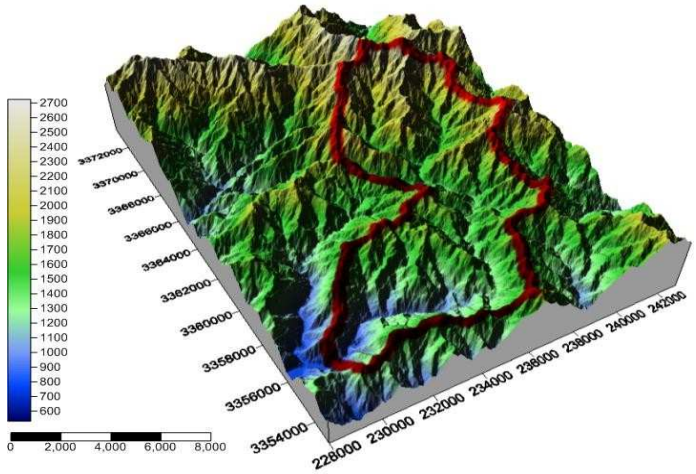
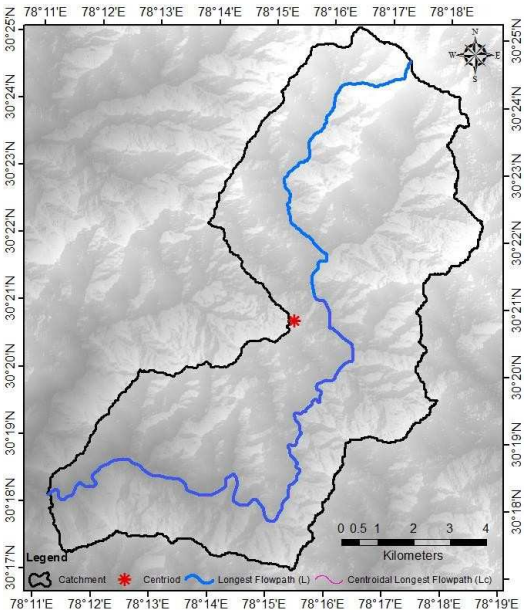


Figure 10:Digital Elevation map of the study area

3.9 Catchment Characteristics

Characteristics	Value
A: Area of the catchment (km2)	85.225
L : Length of the main stream (km)	28.28
Lc: Centroid longest flow path (km)	18.21
S : Equivalent stream slope (m/km)	46.04

3.10 Delineated catchment with catchment characteristics



3.11 Landuse Pattern of the catchment area

The land use map is required for estimating the cover and management factor of the USLE. Land use/cover classification was carried out using LISS III satellite data by supervised classification method. Six land use classes viz., forest, agricultural land, range land, settlement, barren outcropand swampy land were identified in the catchment as shown in Figure 6.20. The area under each land use category is presented in Table 6.35.

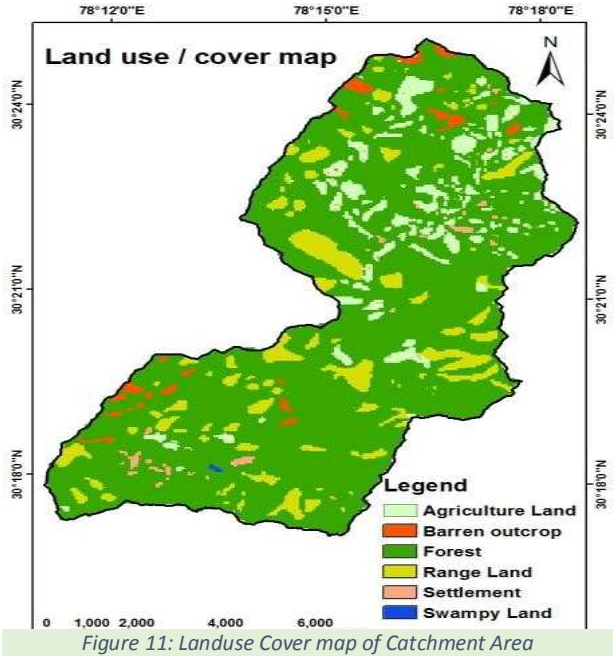


Figure 11: Landuse Cover map of Catchment Area

Table 23:Details of land use/land cover in the Song reservoir catchment

S. No.	Land use/land cover	Area (Km2)	% of total area
1	Forests	68.163	79.981
2	Agricultural land	6.610	7.756
3	Range land	8.238	9.666
4	Settlement	0.728	0.854
5	Barren outcrop	1.445	1.695
6	Swampy land	0.041	0.048
Total		85.225	100.000

3.12 Estimation of USLEfactors

3.12.1 R-factor

R factor: The rainfall erosivity factor, R, accounts for the potential of falling rain drops and flowing water in a particular area to produce erosion. In India, research has shown that R factor can be computed using the following relation (Singh et al., 1981).

$$R = 79 + 0.363*X \qquad (6.2)$$

Where, X is the average annual rainfall in mm.

The average annual rainfall data of two rain gauge stations namely, Dhanolti (1320 mm) and Song dam site (2136 mm) were used and a Thiessen polygon map of the rainfall was prepared for the study area. The Thiessen polygon map was converted to raster format using a grid cell size of 30 m. The R factor map (Figure 6.21) was then computed from the rainfall map using Eq. 6.2.

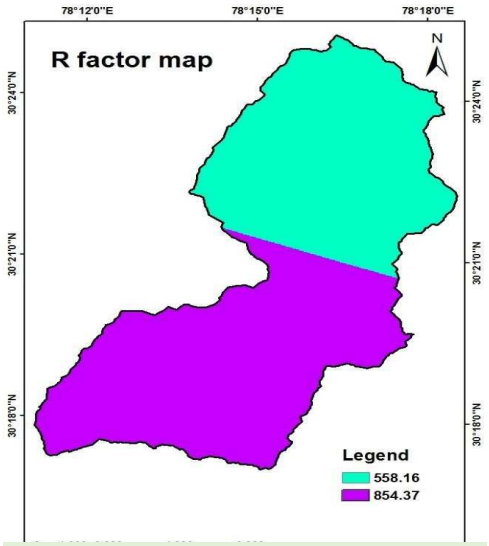


Figure 12: R factor Map

3.12.2 K-factor

K Factor: The soil erodibility factor, K, considers soil properties that influence both detachment and transport of soil materials. These include soil organic matter content, texture, structure, size, shape, and stability of aggregates, and the permeability of the soil to water. Soil erodibility tends to increase with greater silt content and decrease with greater sand and clay contents. Organic matter binds individual particles together thus increasing aggregate strength, hence the resistance to detachment. Soil structure, in terms of its size, shape, and aggregate stability, influences the infiltration rate. Erosion will not occur if the infiltration rate is greater than the rainfall rate. Permeability of the soil to water affects erosion because rainfall must enter and move through the soil if runoff is to be minimal.

Based on the description of soil mapping units given in Table 6.34, appropriate K values for each soil polygon were assigned in the soil map. The gridded spatial distribution of K values was then prepared in the form of a K factor map as shown in Figure 6.22

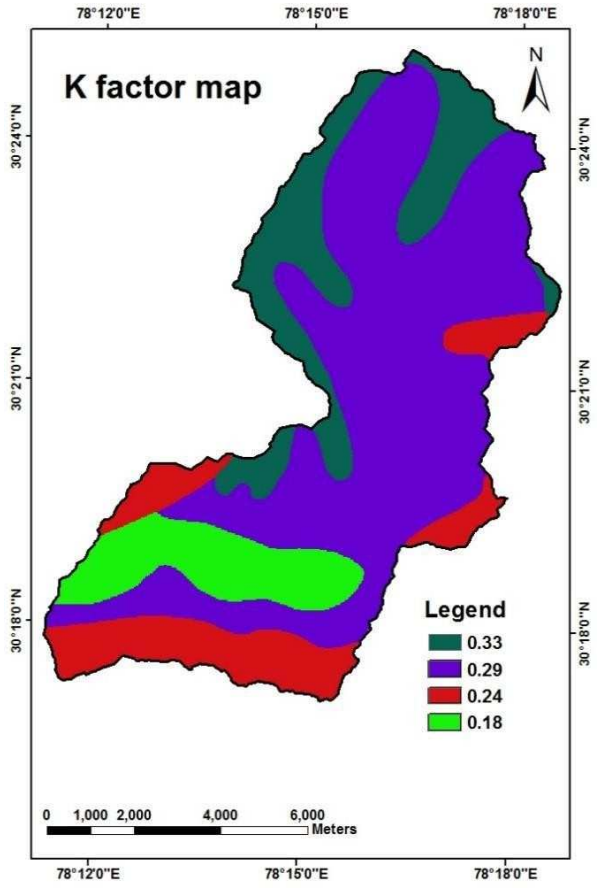


Figure 13: K-factor Map

3.12.3 LS-factor

LS factor: Soil erosion by water is affected by slope length, L, and slope steepness, S, which jointly determine the amount and velocity of runoff.

As L factor is the ratio of field soil loss to the corresponding soil loss from 22.13 m slope length, its value is computed using Eq. 6.2 (Wischmeier and Smith, 1978).

$L = (\lambda/22.13)^m$ (6.3)

Where λ is the field slope length and m assumes the value of 0.2 to 0.5. Wischmeier and Smith (1978) gave varying values of 'm' for different slopes as given in Table 6.36

A map showing the distribution of m values was created using the slope map as input. The L factor map was then computed by taking the field slope length as 30 m (grid size) using Eq.6.3. The S factor map was computed using Eq.6.3 (McCool et al., 1987; Liu et al., 1994).

$S = 10.80 \sin\theta + 0.03 \quad \theta < 5.14°$ (or 9%)

$S = 16.80 \sin\theta - 0.50 \quad \theta \geq 5.14°$ (or 9%) (6.4)

Where, θ is the slope gradient in degrees. The combined LS factor map was calculated by multiplying the L and S factor maps. The combined LS factor map is shown in Figure 6.23.

Table 6-36: Values of 'm' for different slope classes.

Table 24:Values of 'm' for different slope classes

Slope gradient	Value of 'm'
< 1%	0.2
1 - 3%	0.3
3 - 4.5%	0.4
above 4.5%	0.5

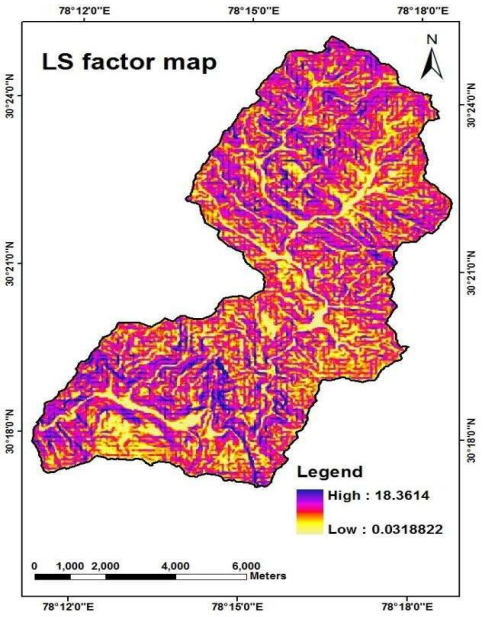


Figure 14: LS Map

3.12.4 C-factor

The vegetation cover has a big impact on the erosion. The land cover intercepts the rainfall, increases the infiltration and reduces the rainfall energy. The values of C factor (Table 6.37) for different land uses were taken from the land use attribute data and assigned to each classification. The gridded maps showing the spatial distribution of C factor for the study area is presented in Figure. 6.24.

Table 25:C factor values for different land uses in the study area

Land use	C
Forests	0.004
Agricultural land	0.28
Range land	0.01
Settlement	0.18
Barren outcrop	0.15
Swampy land	0.002

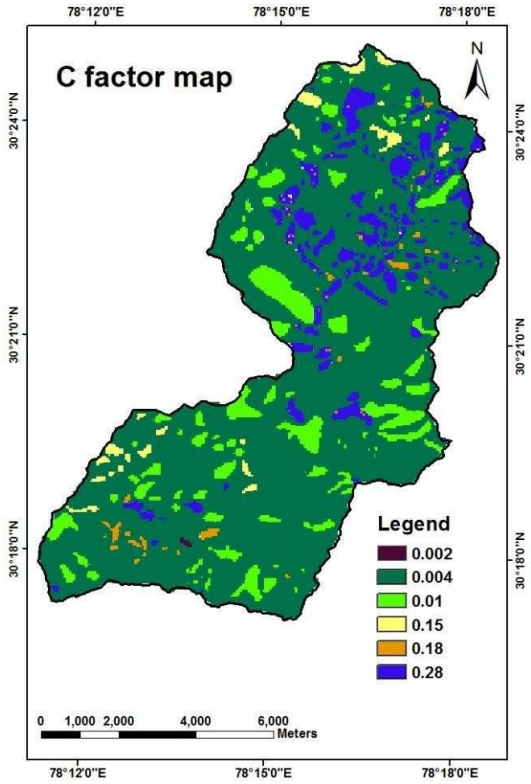


Figure 15: C-factor Map

3.12.5 P-factor

P factor: In the study area no major supporting conservation practices are followed except that the agricultural plots under cultivation are bunded. Therefore, agricultural land was

assigned P-factor of 0.30 and other land uses were assigned P factor of 1. The P factor map is shown in Figure 6.25.

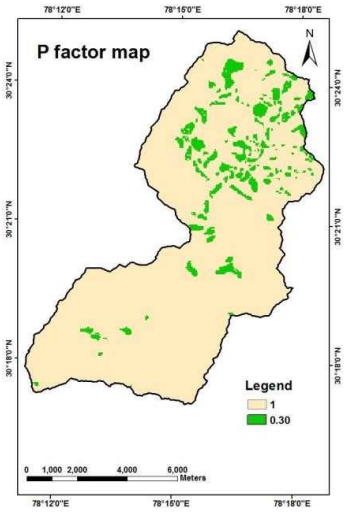


Figure 16:P factor map of Song reservoir catchment

3.13 Estimation of soil erosion

All the factor maps of R, K, LS, C and P, generated in the form of raster maps, were multiplied in GIS to produce the final map of soil erosion intensities. The soil erosion intensities were classified into various erosion classes as per the severity of the erosion. The areas computed under each erosion class are presented in Table 6.38. The soil erosion map showing the spatial distribution of erosion intensity classes is shown in Figure. 6.26.

As can be seen from Table 6.38, about 73% of the catchment of the proposed song reservoir has soil erosion up to 10 t/ha /year and the soil erosion classes of high, very high, severe and very severe erosion (>10 t/ha/year) cover an area of about 27% only. The generally accepted maximum limit of soil erosion (tolerance limit) is 11.2 t/ha/year (Wischmeier and smith, 1978), while Rubio (1986) considered a tolerance limit of 20 t/ha/year. Sudhishri et al. (2014) found that the tolerance limit in North-western Himalayas of India varies from 5 to 12.5 t/ha/year. Considering these tolerance limits, the soil erosion rate in about 73% of the catchment is within safe limits. However, some site-specific soil conservation measures may be planned and implemented in the remaining areas having higher soil erosion. The mean rate of gross soil erosion in the study catchment is computed as 22.16 t/ha/year.

Erosion class	Rate of soil loss (tons/ha/year)	Area (sq km)	% of total area
Slight	<5	18.527	21.740
Moderate	5-10	43.305	50.811
High	10-20	11.795	13.839
Very high	20-50	3.480	4.084
Severe	50-100	2.242	2.631

Very severe	>100	5.876	6.895
Total		85.225	100.000

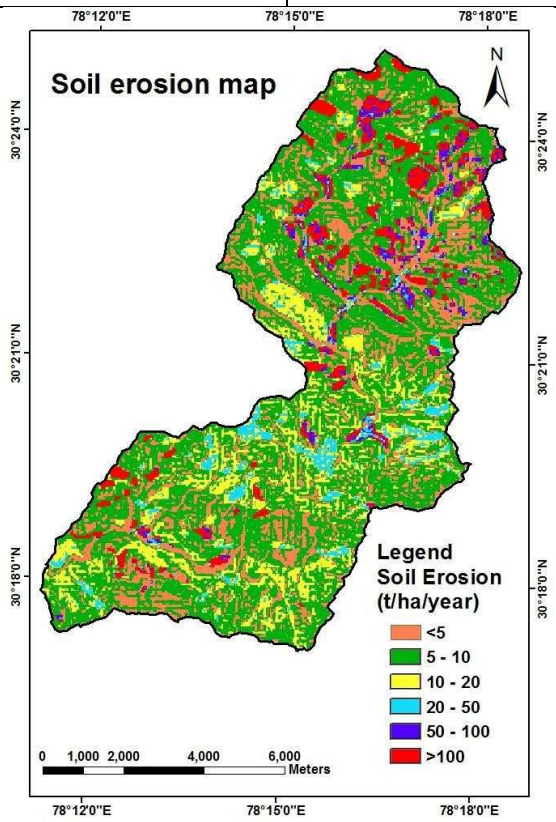


Figure 17: Soil Erosion Map

3.14 Assessment of Sediment Yield at Song reservoir

While the USLE computes gross sheet and rill erosion, it does not directly predict downstreamsedimentyield.Alltheerodedsedimentsfromthecontributingareadonot enterthestreamnetworkandapartofthesedimentloadinthesurfacerunoffmayget depositedintheareaitselfdependingontransportcapacityoftheoverlandflow,which is primarily a function of the depth and velocity of the overland flow and the sediment load in the overland flow. If the transport capacity of the overland flow is less than the sediment load being transported, the excess sediment load is deposited in the watershed.

The sediment delivery ratio (SDR) is commonly used to compute the sediment yield from gross soil erosion. The sediment yield can be estimated by multiplying the gross erosion by the SDR, if it is known or can be approximated for the watershed. The sedimentdeliveryratioformanywatershedshasbeenestimatedat25percent,plusor minus15percent,dependingmoreonsizeofthewatershedthananyotherfactor.The SDR is generally higher for smaller watersheds and it decreases with increase in the size of the watershed. The USDA-SCS (1983) developed a SDR model based on the data from the few catchments. A power function was derived between SDR and the catchment area(Eq.6.5):

$$SDR = 0.417762A^{-0.134958} \qquad (6.5)$$

where A = drainage area in sq. miles.

Vanoni (1975) used the data from 300 watersheds throughout the world to develop a model by the power function. This model is considered a more generalized one to estimate SDR and is given by Eq. 6.5 as:

$SDR = 0.42\ A^{-0.125}$ (6.6)

The SDR for the Song reservoir catchment (area = 85.225 sq km or 32.90 sq miles) is computed as 0.260 and 0.271 using Eq. 5.5 and Eq. 5.6 respectively. In this study, higher of the two values of SDR i.e. 0.271 is taken for computation of sediment yield.

3.14.1 Suspended Sediment Load

The mean rate of gross soil erosion in the study catchment using USLE is computed as 22.16 t/ha/year. With the computed mean rate of soil erosion of 22.16 t/ha/year, the gross soil erosion from the entire catchment (area=85.225 sq km) works out to 0.189 Million tonnes/year. Using the SDR of 0.271, the sediment yield from the catchment is computed as 0.0512 Million tonnes/year.

The low sediment yield from the catchment can be justified in view of its land use pattern. About 80% of the catchment is covered under thick forest which produces very low soil erosion. Also, the range lands accounting for about 10% of the catchment contribute low sediment load. Remaining about 10% of the area which mainly comprises of agricultural and barren lands has high potential for sediment production.

The computed sediment yield was compared with the observed sediment yield. The daily discharges and sediment concentration were measured at the proposed dam site by the Department of Irrigation, Govt. of Uttarakhand during monsoon seasons (mostly 15th June to 15th October) of the years 2002 to 2005. The sediment yield at the dam site during four months of monsoon season was found to vary from 0.00363 to 0.0205 Million tonnes per year. Considering that the major sediment load would reach the reservoir during monsoon months only with little sediment load during lean season, the computed sediment yield of 0.0513 Million tonnes/year in the present study is quite safe for adoption in the design of the proposed dam for estimating the dead storage allowance in the reservoir.

3.14.2 Bed Load

The bed load in rivers moves in sliding, rolling or jumping modes along the bed and will not affect the turbidity of water. The bed load is thus in frequent contact with the channel bed. Bed load may vary from 10-20% of the suspended load in general (Simons and Sentürk, 1977; Holland, 1978; Summerfield and Hulton, 1994; Hay, 1998; Basumallick and Mukherjee, 1999; Galy and France-Lanord, 2001; Lavé and Avouac, 2001) and sometimes 20-40% for Mountain Rivers (Dadson et al., 2003; Turowski et al., 2007, 2008). Yang (1996) stated that in most natural rivers, sediments are mainly transported as suspended load, and generally, the bed load to suspension load ratio is about 5- 25%. The Himachal Pradesh Electricity Board (HPSEB) regularly calculates the bed- load of Himalayan Rivers as 15-20% of the suspended load.

Measured data of the bed-load for the Song River in the study area was not available. Therefore, the bed load at the dam site is computed by taking a conservative value of 25% of the suspended sediment load as given below.

1. Computed suspended sediment load = 0.0512 Million tonne/year

2. Bed load (@25% of suspended load) = 0.0128 Million tonne/year.

3.14.3 Summary of results

The soil erosion study in the catchment area of proposed Song reservoir shows wide range of soil erosion rates. High soil erosion rates are present in the regions of steep slopes covered mostly under agriculture and barren lands. The areas covered under forests and range lands mostly show slight to moderate erosion rates. The weighted mean rate of soil erosion in the catchment is computed as 22.16 tonnes/ha/year. The sediment delivery ratio (SDR) for the Song reservoir catchment is computed as 0.271. Using the concept of SDR and the USLE computed gross soil erosion, the sediment yield at Song reservoir is computed as 0.0512 Million tonne/year. The bed load is assumed as 25% of the suspended load amounting to 0.0128 Million tonne/year. The total sediment load, taken as the sum of the suspended load and the bed load, is computed as 0.0640 Million tonne/year. Considering the trap efficiency of the reservoir as 96% and the bulk density of sediment deposits in the reservoir as 1.35 tonne/m3, the average rate of sedimentation in reservoir has been computed as 0.0455 MCM per year or 4.55 ha-m per year. If this uniform sedimentation rate is assumed for next 100 years, the loss of live storage would be around 4.55 MCM or 455 ha-m.

4. CATCHMENT AREA TREATMENT PLAN

4.1 Area to be taken up for treatment

The total catchment area of Song River up to the dam site is about 85.225 Sq. Km. (8522.50 Ha) consisting mainly of hilly terrain with about 90% of the area falling in a slope range of 20-100%. The catchment is dominated by forests (80%). The range lands and agricultural lands occupy nearly 10% and 8% of the catchment respectively. The soils in the catchment area are chiefly loamy soils. The major part of the catchment area (about 85%) is covered by excessively drained, loamy and loamy-skeletal soils with moderately shallow to very shallow soil-depth. The loamy surface on steep slopes have erosion problem. Moderately deep, well drained, coarse loamy soils mixed with fine loamy soils on moderate slopes have slight erosion.However, considering these tolerance limits discussed in section 3.10, the soil erosion rate in about 73% of the catchment is within safe limits. Some site-specific soil conservation measures may be planned and implemented in the remaining areas having higher soil erosion.

4.2 Objectives of the CAT Plan

The prime objective of this CAT plan is the eco-restoration of the project area and participation of the local people for their livelihood support system. Efforts will be made to incorporate all the key factors which are important part of modern system of catchment and impact area treatment plan.

The main aim of CAT plan is to control the quantity of silt in the Catchment area along with soil water conservation and eco-restoration so that to concept of construction of small hydro power project can be realized. The main aim of CAT plan is to control the quantity of silt in the Catchment area along with soil water conservation and eco-restoration so that to concept of construction of Song Dam Drinking Water Project can be realized.

Subsidiary Objectives:-

1. Water conservation, increase infiltration, surface flow/run-off reduction to minimise siltation and flood losses.
2. Facilitate the hydrological functioning of the catchment and to augment the quality of the water of the river and its tributaries.
3. Reverse the degradation process and restore the bio-diversity of eco-impact zone affected by the Song Dam Drinking Water Project.
4. Improving vegetal cover and thus conserving ecosystem resulting from increased and water retaining properties of soil.
5. To improve availabilities of fuel, fodder and timber in the area outside forest.
6. To explore the potential of Eco-tourism in the area.
7. To improve rural livelihood support system and to create additional avenues for socio-economic condition of locals for sustainable development of the area.
8. Encouraging participatory approach, emphasis on upliftment of women/under-privileged and use of Non-Conventional Energy Devices.
9. To preserve the ecosystem in the project area.

4.3 Treatment Measures

The proposed treatment measures include activities in various sectors that will focus on environmental sustainability of the catchment area along with supporting the population of the area with integrated development of the villages falling in the catchment area of the dam. The interventions proposed will be in line with directions of the Uttarakhand Forest Department.

Integrated Approach of Watershed Management approach will be usedfor the treatment of any Catchment. This model of treatment targets for the holistic treatment and development of the MWS under consideration and includes the following activities:

i. Forestry management
ii. Drainage Line Treatment works (Soil & Moisture Conservation works)
iii. Agriculture Improvement
iv. Horticulture
v. Eco-Tourism
vi. Animal husbandry
vii. Energy conservation
viii. Water Harvesting & Conservation
ix. Training support
x. Income Generation Activities (IGA) as per PRA micro planning.

4.4 Proposed CAT Plan Treatment Measures

The CAT Plan treatment measures is broadly divided into three categories viz.- Biological measures, Engineering Measures and Other Measures of CAT Plan.

4.4.1 Biological Measures

Afforestation

A well-stocked forest plays a very important in control of soil erosion. It is suggested to undertake plantation of shrubs as well as native tree species, wherever the slopes have been prone to erosion in the catchment area. The preference would be given to planting of only local shrubs and trees with a judicious mixture of rapid colonizers as well as fruit trees.

Non Timber Forest Produce

Considering the local topography, soil conditions and climatic condition, at few places non-timber forest produce in form of medicinal plants, shrubs and herbs would be the appropriate measures instead of traditional pasture development. Propagation of medicinal plants, shrubs and herbs is not only an innovative land use strategy it also helps in un-situ conservation of plants.

Pasture Development

As there are degraded patches in the area, this measure will be adopted to encourage development of new and healthy pastures for use of cattle of the area. Scrub land with greater slopes has been recommended to be treated by developing pastures over them. Under this treatment, suitable species of grasses and leguminous plant species may be planted.

Assisted Natural Regeneration

It is important to enhancing the establishment of secondary forest from degraded grassland and shrub vegetation by protecting and nurturing the mother trees and their wildlings inherently present in the area. Assisted natural regeneration is proposed to accelerate, rather than replace, natural successional processes by removing or reducing barriers to natural forest regeneration such as soil degradation, competition with weedy species, and recurring disturbances (e.g., fire, grazing, and wood harvesting).

4.4.2 Engineering Measures

The engineering treatment measures require less time to be put in place and can provide quick solutions. These would comprise mainly of Brushwood check dams, Dry stone masonry check dams, Contour bunding and Bench terracing.

Brush Wood Check Dams

Gullies having depth ranging between 1.2 m to 2.1 meters, brush wood check dams are made by making 2 rows of shrubs and posts. In this method four sufficiently long wooden posts are fixed vertically on the ground across the direction of gully. These posts are inserted 60 cm inside the earth. The brush wood is thereafter spread on the surface of the gully in such a way that the stumps of the bushes are in opposite direction of the flow of water. The brush woods are tied together and are also tied with the wooden posts. The posts should be made of those species which are good coppices. Brush wood check dam with two rows can also be used for the gullies which have depth of 2.1 meters to 3 meters and width of nearly 6m.

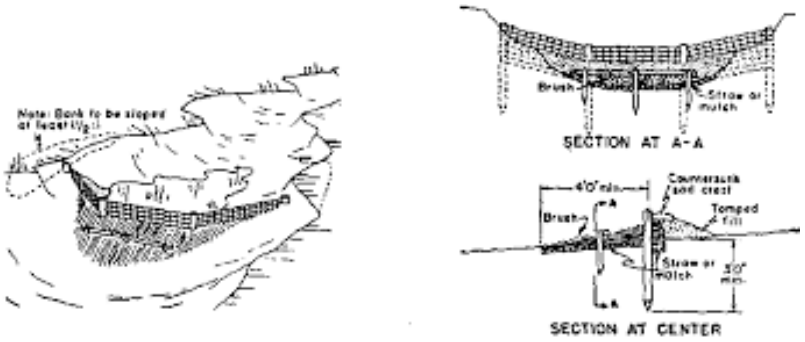


Figure 18: Brush Wood Check Dams

Dry Check Dams

Where adequate stones and boulders are available dry check dams are made across the gullies. These are made nearly 0.73 meter deep and 1.25 meters wide (Figure below).

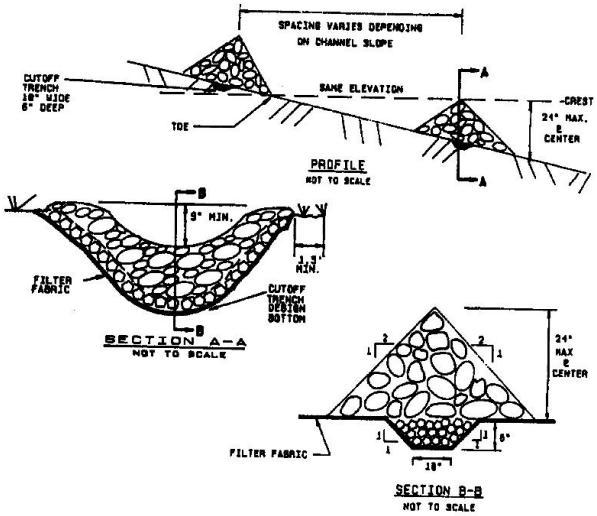


Figure 19: Dry Check Dams

Gabion Structure/Crate Wire Check Dams

Gabion structures have multifarious application in erosion control works, Generally these are used for reducing slopes or river and nalas and also for various other purposes as mentioned in other paragraphs of this chapter. Gabion boxes are made of galvanised iron wire preferably with No-8 gauge but not less than 10 gauges. Hexagonal or square triple twisted mesh varying in size between 7.5 cm to 15 cm is commonly used. The wire mesh may be made by labours after short training. One gabion structure is known as gabion unit and bigger structures are made of these gabion units. For construction of these structures in the field first wire mesh is prepared and thereafter if available locally. In case of stones of various sizes being available the larger one should be placed on sides and smaller ones are used for filling in the centers.

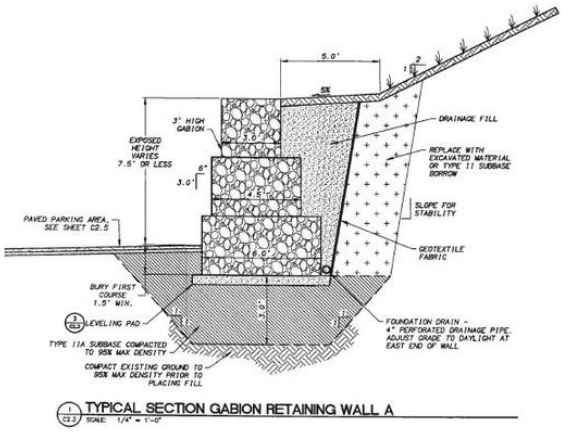


Figure 20: Gabion Structure

Peerul checkdam

Checkdams constructed from Peerul/pine leaves give an alternate use of pine leaves. Pine leaves are very sensitive to forest fire and their use in the form of checkdams may reduce the possibility of forest fire and enhance soil & moisture conditions. For constructing the peerul checkdams the following items are required.

1- 30-35 kg dry pine leaves for 3 meter long checkdam.
2- Net formed from coconut rope, standard size 10cmx10cm.

For checkdam of 3 meter long and 50 cm diameter, a 3 mx3m sized net is required. According the nature of site the size of net may be changed. Streams of shrubs or iron may be used as supporting pillars to the peerul checkdams. For making the checkdams from peerul the net is spread and peerul leaves are wrapped with in it in the form of roles. After that this net is tied with rope tightly.

These roles are placed such that no space is left on both the sites and there is no other way for water passes except checkdam. If the role is smaller as compared to the size of Gadhera, then the number of roles may be increased and placed in such a way that the whole Gadhera is covered completely. After that for supporting the roles the supporting sticks or iron hooks (in case of hard rock) may be used. In case of deep Gadheras the roles may be placed one above the other. In small Gadheras series of checkdams may be constructed in such a way that level of lower side of the upper checkdam and upper side of the lower checkdam is samel. There is no need to leave any spill way in this case.

Stabilization of Land Slips/Slides

Landslides are common phenomenon in hilly areas and these are basically because of the effect of changes in the earth and also because of the effect of weather on the earth surface. When landslides/landslip takes place a lot of vegetation or public property is destroyed. Landslide areas requires treatment for their rehabilitation and to check accelerated soil erosion in the area.

Following are the main methods used for stabilization of land slide affected areas:

a. Retaining Wall/Breast/Side Wall

Retaining wall is constructed for protecting land and soil on steep slopes. This is made of either dry masonry work or cement masonry work. The wire mesh or gabion blocks are also used depending on the intensity of erosion. The ratio of width and depth of the foundation should be kept as such that it can withstand the weight/pressure of the retaining wall. The breadth of the retaining wall should be 2/3 of the height of the retaining wall. The width of the retaining wall should decrease gradually when ascending towards upper end and it should be nearly 1 meter on the top. Normally width of the base is kept in the multiple of meter so that one meter size gabion blocks can be used for this purpose. The reduction in the width of the retaining wall is such that 1/3 part of measurement of gabion block is reduced.

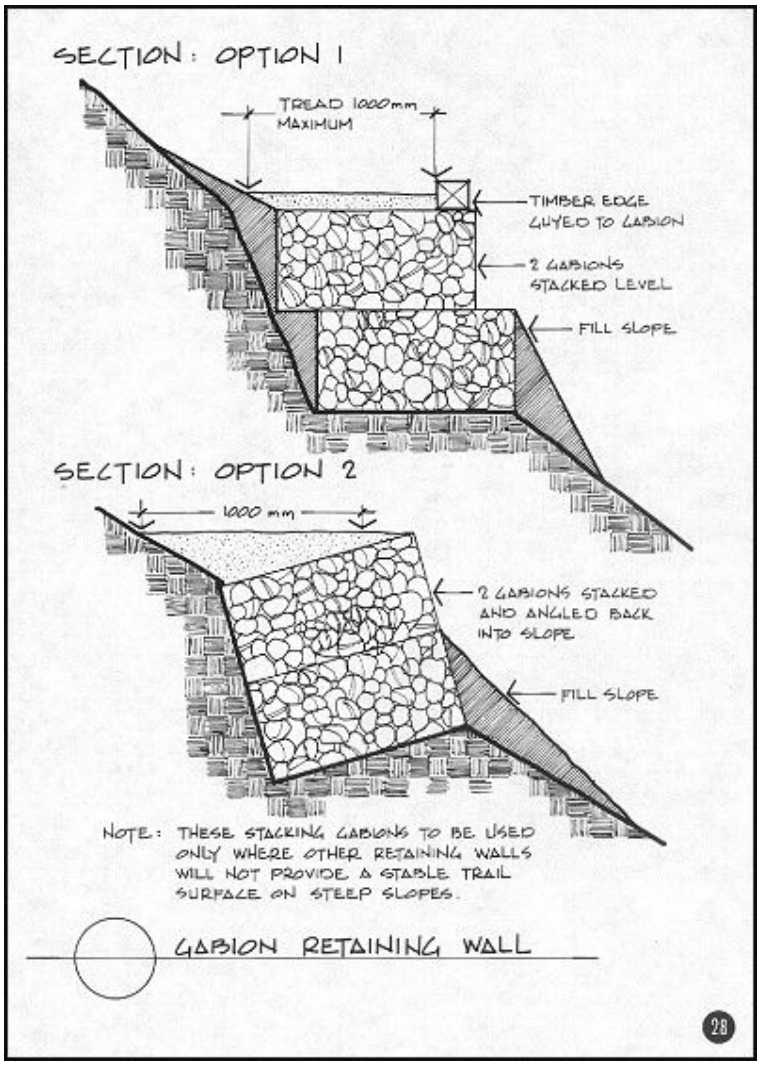


Figure 21: Retention Wall

Use of concrete in constructed of retaining wall in every 6 cm of retaining/breast wall concrete lintel is given and rest of the height is covered by dry masonry work. After every 2 meter gap 100 sqcm size weep holes are made stones are filled between the horizontal wall and the sloping wall.

"T" wall is made with cement concrete at the base of the retaining wall. It should be 60 cm deep and should be in appropriate ratio of the height. A suitable apron should also be made.

b. Vegetative Gully plug, construction of checkdam by pine needles (Peerul)

To reinforce the protective function of the above soil conservation structures the proposed works will necessarily be strengthened by suitable vegetative measures. The treated area will be supplemented with the plantation of soil binding shrubs and grass species such *as Napier grass, Vitex negundo, lannea grandious, lannea, coromandelica, erthrina, suberosa, ipomoea, cormea etc.*

4.4.3 Water Harvesting and Conservation

Most of the agriculture in the area is rain fed some of which can be put under irrigation if natural water resources are properly utilized. Keeping this in mind following minor irrigation structures have been proposed under this component-

i. Water harvesting tank
ii. Irrigation tank
iii. Contour trenching
iv. Repair of Naula/Chal- Khal
v. Repair of irrigation channel
vi. Construction /Strengthening of minor irrigation channels.
vii. Construction/repairing the natural water sources in the form of Bauries, that could be used mainly for drinking. They can hold water for a long time because of almost negligible water evaporation.

4.4.4 Wildlife Habitat Management

Habitat improvement is an integral part of wildlife management. This consists of bringing into useful association of those conditions needed by a species to reproduce and survive. Even creation of small openings is of great value and importance. Such openings are essential for herbaceous cover and insect production on which ground-living animals such as pheasants predominately feed during the first few weeks after birth, control of cover is also important. Any change in vegetation can affect many of the animals do not recognize the boundaries and barriers.

The following main faunal species are found in the area-

Rhesus Macaque (Macaca mulatta), Wild Boar (Sus scrofa), Indian crested porcupine (Hystrix indica), Barking Deer (Muntiacus muntjac), Golden Jackal (Canis aureus), Indian Hare (Lepus nigricollis), Monitor Lizard (Varanus bengalensis), Leopard cat (Prionailurus bengalensis), Mongoose (Herpestes edwardsii).

Proposed Activities

✓ Control of invasive weeds and ecological restoration
✓ Water Springs/Water Holes
✓ Man-Animal Conflict Training & Capacity Building

4.4.5 Payment of ecosystem services to local communities and institution

Table 26: Payment of ecosystem services to local communities and institution

Sl. No	PROPOSED ACTIVITIES	PROPOSED EXPENDITURE (Rs. In Lakhs)
1.	Reward and recognitation to the local communities/institution, biodiversity conservation, fire protection measures bio production system water harvesting etc.	46.08
	Total	46.08

4.4.6 Provision of Alternate Energy resources/Energy Conservation

The nearby village population is dependent on forest and forest produce e.g. food, fodder & fuel for their livelihood which ultimately result into deterioration and degradation of forest wealth. So the measures have to be taken in to account which can help reduce the demand of such necessities by providing them other alternative suggested as under:

1) Encouraging use of Bio-Gas/LPG/Street Solar lights. For bio-mass saving efficiency improvement and better life style.
2) Encouraging use of individual toilets & Bathrooms-dovetailing with Swajal Yojna & other
3) Bio bracketing for income generating.
4) Encouraging use of induction cookers/plates

4.4.7 Agriculture based development activities

Nearly 8% of the catchment area is under agriculture. The most of agriculture is rain fed, only small portion is irrigated. The farmers still stick to conventional agriculture practices. Agriculture output is low yield per hectare which is only sufficient for substance barely for 3-4 months, and to fulfil their other day to day requirement the villagers migrate to nearby town and cities. Keeping all these facts into consideration the following measures have been proposed under agriculture components.

- ✓ **Field demonstration and Promotion of productive agri-systems**- The main agriculture of crops-wheat and paddy will be exhibited on the field, so that the farmers may be motivated and encouraged for use of improved variety seed and farming techniques.
- ✓ **Repairing of terraces**- The terrain in the catchment area is not suited for good agriculture yield, so the leveling of terracing will be carried out to better the production. The farmers will also be encouraged for scientific mulching practices.
- ✓ **Promotion of use of bio/vermi compost**- The use of chemical fertilizers bring many hazards to public health and organic/biofertilizers are suffer from this view point, simultaneously the productivity is also maintained. Vermi compost is a preferred nutrient sources for organic farming. It is eco-friendly non toxic, consumes low energy input for composting is a recycled biological product, so the bio/vermin compost will be advertised for larger use.
- ✓ **Promotion of use of improved agriculture implements**-the conventional implements take a lot of time and are expensive in energy consumption and also results in low productivity, the use of improved agriculture implements will be encouraged to save the time and energy and increase the productivity.
- ✓ **Establishment of Mahila Nursery**- To involve the local villagers, specially women there is a proposal to establish women nurseries with byback guarantee. Such nurseries will be managed by local Mahila SHG (Self Help Group). The financial support will be extended through CAT Plan and the groups will be properly trained. The technical knowhow and support will also be provided by local forest officers and horticulture experts.
- ✓ **Multiple cropping**- Growing more than one crop of the same pieces of land in one year is called multiple cropping. The system can take various forms including intercropping, relay cropping. Apart from increasing crop production all forms can be

beneficial to erosion control because they add an earlier protective cover to the ground compared to mono cropping.

- ✓ **Contour Cultivation and closed planning**- Contour cultivation means filling & planning at right angles to the natural slope of the land. For erosion control, contour cultivation is better than the up and down slope tillage method. Besides this close planting followed by triangle design on the contour will yield better results to control runoff erosion.
- ✓ **Strip cropping**- Is a system where farms crops are planted in relatively narrow strips across the slope of the land and so arranged that the living strips act as erosion resistant crops.
- ✓ **Mulching** – is a cover on the soil that is quite effect for erosion control because it protects at ground level, forming a cover against erosion. It is also protects the soil from extreme temperature. Materials used for mulching can be crop reduces, straw, green leaves and stems, wood chips, old paper as available to farmers

4.4.8 Horticulture

As yield from agriculture is not sufficient even for subsistence the villagers are unwilling to continue with agriculture and most of the fields are fallow. This is the area which can be put under horticulture. Also spaces are available in the back yard of the houses where vegetables can be grown to fulfil day to day requirement of the villagers. Keeping this in mind following activities under horticulture component have been proposed.

- ✓ Encouraging use of HYV fruit species.
- ✓ Encouraging cultivation of medicinal and aromatic plants.
- ✓ Strengthening of storage capacity building for grading and packaging techniques etc.
- ✓ Encouraging use of quality seed and planting materials.
- ✓ Encouraging the use of organic manures.
- ✓ Fruit processing and value addition.

4.4.9 Animal Husbandry

After agriculture animal husbandry is the second important occupation and source of income for the villages. The animals are of local breed and milk production per cattle is very nominal. The number of the cattle, specially goats and sheep per household is quite large. These animals are left free to graze in the forests. To improve and develop management of livestock in the village following activities have been proposed under animal husbandry component-

- ✓ Establishment of NBC/Buffalo (Murra) – goats – for breed improvement.
- ✓ Vaccination – for health improvement through regular visits of resource persons.
- ✓ Chari construction/Nand (troughs) – for better stall feeding.
- ✓ Encouraging use of fodder seeds, (Jai-barseem etc.)- for better nutrition. This will also reduce the fodder wastage and women labour.
- ✓ Strengthening of co-operative milk societies for better marketing. The existing co-operative milk societies will be strengthened and new co-operatives will be

initiated in the areas where they don't exceed to give a strong marketing setup to the community.

4.4.10 Training for income Generating Activities (IGA)/support

As the opportunities of various incomes generating activities are very bleak, so the inhabitant of the project area faced the mounting problem of unemployment and this is also an inducting factor for the migration of youths. Keeping this factor in view a large number of employment generating activities will have to be developed to make the villagers self sufficient. The training for skill up gradation and other income oriented activities have been taken care of in this plan.

Following activities are being included this purpose-

- ✓ Capacity building training and exposure visit of VP, SHGs and staff.
- ✓ Process building workshop and catchment awareness programme.

As the opportunities of various income generating activities are very less, so the inhabitant of the project area faces the mounting problem un-employment and this is also an inducting factor for the migration of youths. Keeping this factor in view a large number of employment generating activities will have to be developed to make the villagers self sufficient. The training for skill up gradation and other income oriented activities have been taken care of in this plan. Following activities are being included for this purpose:-

- Backyard poultry.
- Training and support for local artisans, blacksmith, carpenter (wooden items) and support for handicraft centers.
- Training and support of small IGA activities.
- Bio/vermin composting
- Orchard development

4.4.11 Infrastructure and Communication

To carry out plan smoothly and successfully, the strengthening of essential infrastructure and communication such as setting up building like field huts/stores, maintenance of old staff quarters/ minor civil works and out sourcing of vehicles is an urgent need. The modern technology can be used as good tool for arriving at better results and healthy operation of the management units. To improvise the effectiveness, incentives to personnel and structured Monitoring and Evaluation process will make the plan objective meaningful and its results.

4.4.12 Micro-planning

The activities proposed in this CAT Plan is indicative only to be finalised by the Uttrakhand Forest Department before implementation. A detailed CAT Planwill be prepared for the physical targets, treatment requirement and annual action plan will be prepared after preparing micro-plans, using PRA as a tool, for the entire Catchment area of the proposed Song Dam Drinking Water Project.

Table 27: Micro-Planning for CAT Plan

Sl. No.	PROPOSED ACTIVITIES	PHYSICAL TARGET No	TOTAL COST (Rs. In Lakhs)
1	Preparation of DPR & Microplans	LS	23.04

2	Research and studies	LS	23.04
	Total		**46.08**

5. CAT PLAN DURATION, ACTIVITIES & FINANCIAL OUTLAY

The CAT plan period is 7 years, first 4 years will be utilized for management and the rest period is withdrawal phase. Component wise and subcomponent wise financial targets are being shown in the table below:

Table 10: CAT Plan Duration, Activities & Financial Outlay

Sl. No.	Code No.	Component and Activities	Proposed amount (in lacs)	% of total CAT Plan Outlay
1	**1**	**Project Management**		**12%**
	1.1	Administration Cost (Project Management Cell)		10%
	1.1.1	Investment Cost		
	1.1.1.1	Equipment and supplies and setting up building like field huts/store	34.56	1.5%
	1.1.1.2	Outsourcing of vehicles (Four & two wheelers)	34.56	1.5%
	1.1.2	Recurrent Costs		
	1.1.2.1	Salaries/service charges of contractual staff (Sector heads), village motivator, senior co-ordinator, Regional co-ordinator and staff on deputation	69.12	3%
	1.1.2.2	Project allowance/ honorarium to forest staff	23.04	1%
	1.1.2.3	POL of vehicle maintenance, repair and hiring of vehicles	23.04	1%
	1.1.2.4	Communication and conveyance allowance to total Project staff & Motivators	23.04	1%
	1.1.2.5	Office expenses	23.04	1%
		Sub Total	**230.4**	**10%**
	1.2	Monitoring and Evaluation-Proposed		
	1.2.1	Management Information System(MIS)/GIS	11.52	0.5%
	1.2.2	Concurrent Monitoring & Evaluation	11.52	0.5%
	1.2.3	Study(Baseline/mid-term/end term)	11.52	0.5%
	1.2.4	Control Systems & Financial	11.52	0.5%

		review-Audit(Internal+ External)		
		Sub Total	**46.08**	**2%**
		Total (1)	**276.48**	**12%**
2	**2**	**Preparatory Phase-Proposed**		**10%**
	2.1	Development of institutional system		
	2.1.1	Institutional Development and Support	23.04	1%
	2.1.2	Entry Point Activities (EPA) Minor repairing of community (water tap, Drinking water etc.)	69.12	3%
		Sub Total	**96.16**	**4%**
	2.2	Capacity Building and Publication awareness and extension		
	2.2.1	Capacity building training and exposure visit of vp villagers and staff	69.12	3%
	2.2.2	Publicity and extension of project and its documentation	23.04	1%
		Sub Total	**96.16**	**4%**
	2.3	Preparation of DPR & Micro-plans	23.04	1%
	2.4	Research and study	23.04	1%
		Sub Total	**46.08**	**2%**
		Total(2)	**23.69**	**10%**
3	**3**	**Catchment area treatment Phase**		**75%**
	3.1	**Catchment area treatment activities**		**63%**
	3.1.1	A forestation works in Reserve Forests		
	3.1.1.1	Afforestation works	691.2	30%
	3.1.1.2	Assisted Natural Regeneration works		
	3.1.1.3	Miscellaneous activities-Pasture development, Catchment Treatment Work		
	3.1.2	**Soil & moisture conservation work**		27%
	3.1.2.1	Construction of vegetative CheckDams/ gully plug	63.97	
	3.1.2.2	Stone Check Dams		
	3.1.2.3	Pirul Check Dams		
	3.1.2.4	Construction of R.R. Dry Check		

		Dam		
	3.1.2.5	Construction of Gabion Structure Crate wire checkdam, Retaining walls, Breast wall, Side wall, Defective Spurs		
	3.1.2.6	Construction of water conservation tanks (Kacha) Small size		
	3.1.2.7	Construction of spurs with in gabion structure (with filling of hard packed stone)		
	3.1.2.8	Digging of contour trenches (3.0x0.30x0.30) seed sowing of suitable grasses and shrub species)		
	3.1.2.9	Construction of Chal-khal		
	3.1.3	Payment of eco-system services to the local communities/ institutions, bio-diversity conservation, fire protection measures to adopt bio production system water harvesting etc.	46.08	2%
	3.1.4	Wildlife Management (Mitigation of Man-animal conflict, habitat improvement by eradication of noxious weeds., Creation of water holes)	46.08	2%
	3.1.5	Provision of alternative energy resources (by installation of solar energy panel and supply of solar lantern)	46.08	2%
		Sub Total	**149.27**	**63%**
	3.2	Conservation oriented livelihood activities		
	3.2.1	Agricultural based development activities	96.16	4%
	3.2.1.1	Development of agro-forestry (plantation of fuel, fodder and domestic use species.		
	3.2.2	**Horticulture**	**69.12**	3%
	3.2.2.1	Development of horticulture activities (Planting of high yield and latest variety horticultural species creation of infrastructure for storage of food and vegetable		

	3.2.3	**Animal husbandry**		
	3.2.3.1	Chari construction/Nand (troughs)- for better stall feeding		3%
	3.2.3.2	Vaccination –for health improvement		
	3.2.3.3	Cattle immunization (Twice in a year through animal husbandry doctor)		
	3.2.3.4	Promoting artificial insemination in cattle		
	3.2.4	**Support for income generation activities in non-farm sector (Nature guide/eco-tourism and development of local embroidery)**		
	3.2.4.1	Training for related to different income generating activities.	23.04	1%
	3.2.5	Organization of health camp	23.04	1%
		Sub Total	**276.48**	**12%**
		Total (3)	**1728**	**75%**
4	4	Consolidation phase		
	4.1	Execution of withdrawal of Plan	6.912	0.30%
	4.2	Documentation of project work consolidation and completion	16.128	0.70%
		Total (4)	**23.04**	**1%**
5	5	Contingency Charges		
		Total (5)	**46.08**	**2%**
		Total (1+2+3+4+5)	**2304**	**100%**

The component wise and sub component wise financial allocation is based on the guide lines issued by PCCF, Uttarakhand.

The activity proposed under each measure component of the five components (Project Management, Preparatory Phase , Watershed Work Phase, Livelihood Activities for poorest/ marginal farmers and consolidation phase) are indicative and may slightly differ depending on the site specific condition/requirement as per micro-planning.

The total cost of the proposed CAT Plan is 2304 Lakhs which is 2% of the total project cost.

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Executive Engineer
Investigation & Planning Division
Dehradun.

Asstt. Assistant Engineer

सहायक अभियन्ता-प्रथम
अनुसंधान एवं नियोजन खण्ड देहरादून

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6. REFERENCES

- DETAILED PROJECT REPORT FOR SONG DAM DRINKING WATER PROJECT
- SOIL AND LAND USE SURVEY OF INDIA (SLUSI)
- CAT PLAN TANKUL SMALL HYDRO- ELECTRIC PROJECT
- IUCN WEBSITE FOR IUCN STATUS
- WII ENVIS WEBSITE FOR SCHEDULE SPECIES INFORMATION
- DISTRICT HANDBOOK CENSUS 2011 FOR DEHRAUDN DISTRICT AND TEHRI GHARWAL DISTRICT
- UTTARAKHAND FOREST DEPARTMENT WEBSITE