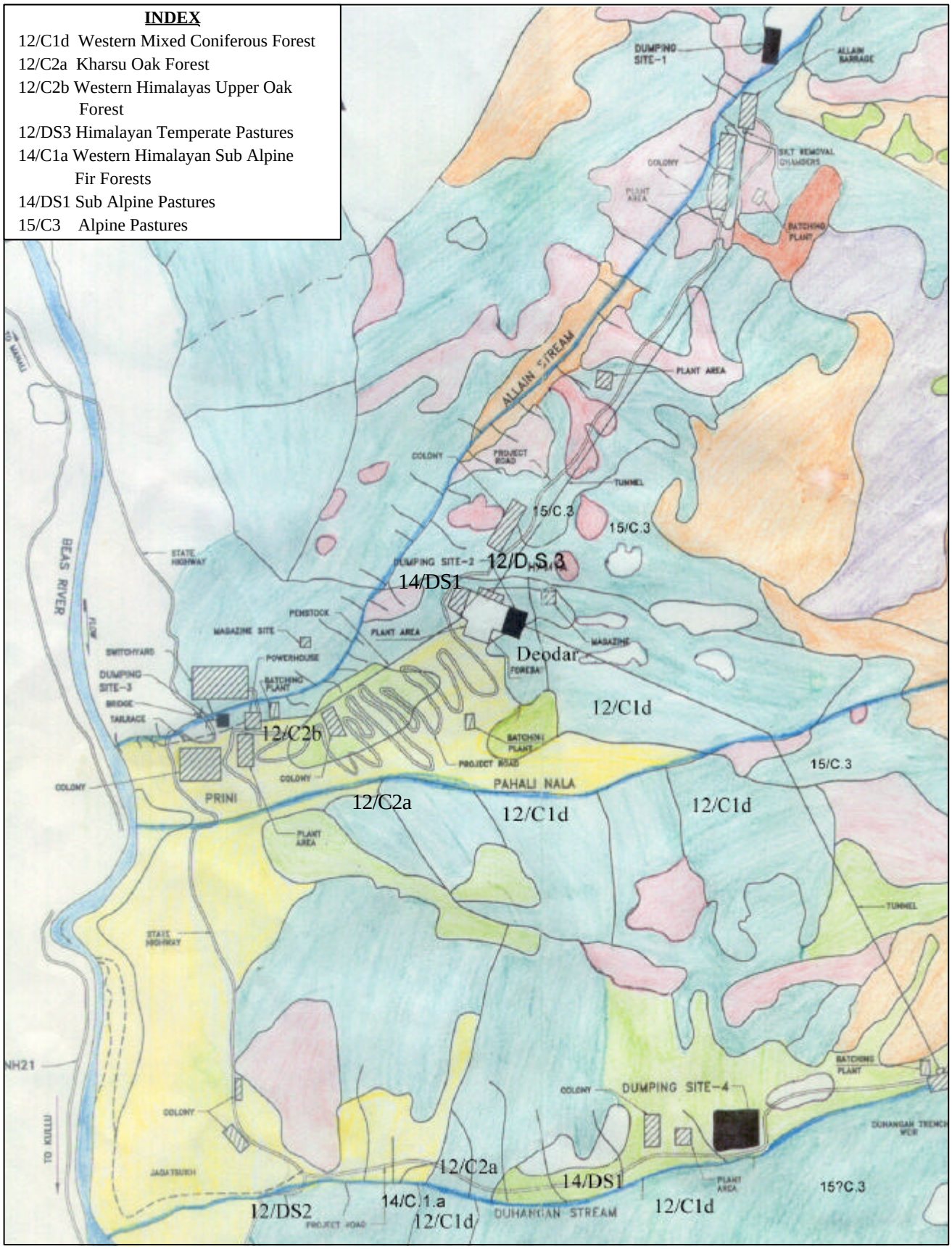


Figure 1.8: Forest types within the Project Catchment Area

The following Table describes tree species to be affected due to Allain and Duhangan project with details on respective forest compartment.

Table 1.4 *Tree species, forest compartment numbers and numbers of individuals recorded at Allain and Duhangan sites*

Compartment Number	Tree species	Number of individuals	Timber Volume (cu m)
2/17 C III C	*Quercus dialtata*	232	296.78
2/17 C III C + 2/17 C I A	*Acer sp*	88	195.10
J III	*Kosh*	1	2.75
J III	*Mohran*	1	1.30
2/17 C II C	*Juglans nigra*	10	47.50
2/17 C III C + 2/17 C II C	*Black Cherry*	48	52.60
J III + 2/18 C III	*Quercus semicarpifolia*	270	609.68
2/18 C III	*Aesculus indica*	3	19.35
J III and 1/17	*Cedrus deodara*	78	354.37
J III + 1/7 + 2/17 C-I-A	*Pinus wallichiana*	133	302.10
J III +1/17 + 2/17 C-I-A + C II C + C II B	*Rai*	195	985.48
2/18 C III	*Tosh*	268	1837.09
15 C/III	*Willow*	3	8.75
15 C/III	*Bhoj Patra*	8	23.32
15 C/III	*Khanur*	1	2.92
15 C/III	*Rekhel*	6	17.49
15 C/III	*Hemari*	7	20.41
Total		1352	4776.98

At Allain site, a total of 882 trees are going to be affected while at Duhangan site these would be 470.

1.1.1 Habitat Types and Ecological features

Besides these forest types reported from the study area, a number of habitat types are also found. Some of the prominent of these are:

- River bed
- Rocky habitat on mountain slopes
- Rocky habitat near streams
- Boulders
- Steep grassy slopes
- Mountain cliffs and cut slopes
- Glaciers and glacial moraines
- Sheltered valleys
- Small streams on mountain slopes
- Sub alpine pastures
- Marshy patches near pastures

The detailed ecological observations, including the habitat types, recorded during ecological survey are presented below in *Table 4.28*. The ecological description of each of the line transect 1 to 4 is also the ecological description of the project catchment area.

Table 1.5: Description of physical and ecological features of transects

Transect	Physical Description	Ecological Features
Transect 1 Region encompassing the area covered along the Upstream of Duhangan stream. (LHS, RHS have been described w.r.t movement upstream of Duhangan from the east bank of Beas river)	• The line transect started from about 100 m from the road towards the upstream of Duhangan stream. • As one faces Duhangan from the road, the line transect was on the northern side of the stream. • The transect gained altitude gradually. • The maximum width of the stream, as observed from the line transect varied from 5 to 15 m. • The stream was strewn and littered with boulders ranging from small to medium size. • The northern side of Duhangan stream has rocky outcrops of varying sizes. These rocky outcrops continued for almost the entire length of the line transect. • The gradient of the stream was moderate to steep and the flow rate was fast. • The stream has contributed to the formation of a characteristic 'V' shaped valley, which at places narrows down, imparting a gorge like appearance. However, such narrowing of the Duhangan valley is rare.	• The northern side slopes of the Duhangan valley, rises gradually and is dominated by typical Western Mixed Coniferous Forests (12/C.1.d). • These forests are typically rich in *Abies* and *Picea*. At lower altitudes, some incursions by Pinus were also observed. At very high elevation, presence of Cedrus was encountered. • At lower elevation of the streams, Western Himalayan Sub-Alpine Fir Forests (12/D.S.2) were seen. As the name suggests, these forests are dominated by Fir (*Abies*). • A number of apple orchards were found on the northern side of Duhangan. These orchards have some *Prunus* trees as well. • Further up and after the apple orchards, a distinct patch of *Quercus semicarpifolia* (oak) forest was encountered. This is classified as Kharsu Oak Forest (12/C.2.a). Besides oaks, some Barberry bushes and a few young pine trees along with grassy patches were observed in this forest. • A small rivulet/stream was flowing down to Duhangan stream from the left side slope, immediately after the end of private land. This stream flow was observed in a small sheltered valley within the slope and this area was more species rich than other area of the open slope. Birds were also noted on this high-diversity patch of mixed vegetation. The small sheltered valley was devoid of large trees and had good herbaceous vegetation with a few shrubs. • There were a few of such narrow sheltered valleys with high diversity. • The moderate to steep slopes culminates into hilltops, which were mostly dominated by large trees with little or sparse ground flora at this time of the year. Some dry grasses and small herbs were also seen. • The hilltops were composed of

Transect	Physical Description	Ecological Features
		Abies and Picea mixed forests and are representatives of the Western Mixed Coniferous Forests (12/C.1.d). • Further upstream (about 2.5 km from road) the transect entered into spruce forest (Picea) on a very steep slope. Along with large spruce trees some scattered bushes and dry grasses could be seen interspersed between small rocks. • At the confluence of Duhangan and Kala nalla and in the stream were small to medium-sized boulders, which were contributing to the abrupt change in the speed of flow. • In this area, there is a typical sub-alpine pasture (locally called as thatch). This region is classified as Sub Alpine pastures (14/D.S.1). • The thatch showed good diversity with respect to herbs and shrubs. • Further up from this point, snow was encountered and steep slopes rising to the hilltops were observed. The hilltops appeared to be again dominated by Fir and Spruce trees.
Transect 2 Region encompassing the area covered along the route from Prini to Sainthal village, via Hamta village, Forebay Reservoir	• The transect started after the Prini village, which is at about 1 km from road. • The transect passed through moderate to steep slopes almost up to its entire length and terminated at the hilltop, below which is the site for forebay reservoir. • The steep slope uphill was spread with rock pieces and small to medium sized boulders. • Large number of rock pieces were also observed en-route.	• The transect, at lower elevations, had good growth of *Pinus wallichiana* forest, which gradually followed other forest type. • Western Mixed Coniferous Forests (12/C.1.d) was encountered further up to the hilltop. This forest patch was again dominated by Spruce and Fir forests, which are characteristic of this region. • About half-way to Hamta village, a rich deodar forest was observed. This region was dominated by large trees of *Cedrus deodara*, which were present on steep slope. This forest is Class I forest and rich in commercial timber. • Besides deodar, the slopes were full of grass patches along with other herbaceous vegetation, such as members of Leguminosae and Labiatae families of flowering plants. • Soil erosion from the steep slopes was also observed. The soil on most steep slopes in the Western Himalayan ranges is skeletal and mixed with rock crust.

Transect	Physical Description	Ecological Features
		• In and around village Hamta, apple orchards were observed. • A few trees of Juglans were also found in Hamta. • The forest on the left side of Hamta is typical Western Mixed Coniferous Forests (12/C.1.d) dominated by Spruce and Fir trees. The forest in this area is luxuriant. • From Hamta to the hilltop is a steep slope, which had snowmelt running down at places. • During the survey period, there was heavy snow at the top. • These steep slopes are typical sub-alpine pastures and support a good diversity of small flowering herbs. • The hilltop was flat and land use of this area has been observed to be terrace farming. • A number of potato fields were observed, which during the survey period were full of snow and were giving an appearance of snowfields. • Gradual to moderate slopes were observed beyond the hilltop site, where the line transect ended. • These forests were of good quality Western Mixed Coniferous Forests (12/C.1.d) dominated by Spruce and Fir trees.
Transect 3 Region encompassing the area covered along the Pahali stream, upto Prini Village from Forebay reservoir. (LHS, RHS have been described w.r.t movement upstream of Pahali stream from the east bank of Beas river)	• The transect started from a little distance from the road to upstream of Pahali stream. • The flow of water was observed to be fast during the survey period. • The gradient of the stream was also moderate to steep at some places during its course up to the river Beas. • The left-hand side of the stream is a moderate to steep slope with a large number of rocky outcrops. • The stream could be seen emanating from a glacier, snow covered from recent snowfall. • Downstream of Pahali stream was more narrower and gorge like than the upstream area of the stream.	• On the left-hand side of the stream and close to the road there are a number of apple orchards. Some of the apple orchards have a few Prunus trees. • Just below the orchards and close to the stream, a grass-dominated patch was observed. • This patch had a number of small boulders with only a few medium-sized boulders in between. • The right-hand side of the stream is a moderate slope dominated by grasses and leads to a patch of Kharsu trees (*Quercus semicarpifolia*). • Beyond this patch of oaks, the typical Western Mixed Coniferous Forests (12/C.1.d) with spruce and fir trees starts. No deodar were observed in this slope. • The right-hand side of the stream

Transect	Physical Description	Ecological Features
	• There are a number of boulders, mostly small in the stream up to the river Beas.	is dominated by Western Mixed Coniferous Forests (12/C.1.d) with typical and majestic spruce and fir forests. • The steep slopes are dominated by pine trees (*Pinus wallichiana*). • Some patches of the pine forest showed mix of Fir trees and gradually with increasing altitude, the pine forests followed the Western Mixed Coniferous Forests (12/C.1.d). • The steep slopes had good diversity with respect to herbs. • Only a few shrubs were observed on the slopes and these shrubs were similar to the ones observed in Transect 2. • The slopes were mostly barren with a few fir trees. • On top of the barren slopes there was a plum orchard and a few planted apple trees. • Further downstream there were steep grassy slopes. • On the right-hand side of the slope a few houses were found on the slopes.
Transect 4 Region encompassing the area covered along the Allain stream, and adjoining areas where the proposed switchyard, magazine site (near powerhouse) would come-up (LHS, RHS have been described w.r.t movement upstream of Allain stream from the east bank of Beas river)	• The transect started from a little distance from the road to upstream of Allain nalla. • Further upstream of Allain, the slopes are less steep. • The flow of the stream is fast and the gradient quite steep. • The streambed is strewn with small to medium sized boulders. Only a few moderate sized boulders were found towards the upstream of Allain nalla. • The left-hand side slopes of the stream are moderate to steep in gradient. • These slopes have a large number of rocky outcrops and scattered boulders of varying sizes. • These slopes rise steeply and gradually merge into the area close to the Drift Tunnel. • The area of the drift tunnel is quite rocky. At this point the upstream of Allain is quite steep with the streambed full of	• The right-hand side slopes of the stream are largely barren with exposed rock outcrops with little or no vegetation cover. • Slopes are still largely barren but show occasional tree cover in the form of Moru (*Quercus dialatata*). • The Moru oak forest represents the Western Himalayan Upper Oak Forest (12/C.2.b). • The vegetation of these slopes show variation with a few trees, but mostly grasses covering the slopes. • Some shrubby species as also herbaceous vegetation is common on the right-hand side slopes. • Upstream of Allain lies the area for the proposed powerhouse and downstream, close to the road is the site for discharge of tailrace. • Through the Moru oak forest, the route, a small trail, reaches the drift tunnel. • At this point the rock face over the drift tunnel shows regeneration forest of blue pines (*Pinus wallichiana*). • On way to this area also, vegetation gradually changes with

Transect	Physical Description	Ecological Features
	moderately sized boulders.	vegetation gradually changes with the presence of some pine trees. • Further upstream, there were forests of spruce and fir constituting the characteristic Western Mixed Coniferous Forests (12/C.1.d). • The habitat is quite patchy and rocky and support increased herb and grass diversity. • Downstream of Allain, there was a small patchy forest of Spruce and Fir trees. The rest of the area was largely barren with a few grasses present in the slopes.

1.3.5 Biodiversity Aspects of Floral and Faunal Species in Project Catchment

Phytosociological and Biodiversity Aspects of Flora

During the ecological assessment of the study area, a number of species were recorded from the quadrants. These details are presented for all the species found in the quadrants for the entire study area in *Table 1.6*, which also give the other biodiversity aspects of the species found. The phyto-socioogical details are also provided for each of the Transect sampled individually in *Table 1.7* and *Table 1.8* gives the biodiversity aspects of the plant species found within the study area. Due to the time of survey many of the herbs have not been found as area was snow bound. Due to this the observed bird diversity is also low and some of the animals known to be found in the study area could not be sighted.

A wide variation was observed with respect to the phytosociological parameters of frequency, density and abundance. Some of the species show good variation among Transects, whereas certain other species follow a similar trend across all the Transects. Variation is also observed from the values at individual Transects when the phytosociological parameters of a specific species are pooled together for determining the pattern of distribution for the entire project catchment.

With respect to the phytosociological parameters, *Bromus*, a grass is found to be the most frequent in the study area, with a frequency of 50%. The other grass that is in the list of top ten floral species in terms of frequency is *Cynadon dactylon* with 22.5% frequency. This is followed by *Abies*, which has a frequency of 42.5%. This is quite evident from the composition of the forests and the presence of Western Mixed Coniferous Forests, which are chiefly composed of majestic fir trees. Similarly, *Picea* also show a relatively high frequency in trees at 32.5%. These two trees, fir and spruce, are the major tree species in the study area. Although pure stands of deodar, blue pine and oaks have been found in the study area, based on the ecological survey, fir and spruce are the most common and dominant trees in the entire study area.

Amongst herbs, *Rumex* is the most frequently encountered species with 37.5% frequency followed by *Stellaria* with 26.25%. For shrubs, *Berberis*, is the most commonly found one with a frequency of 30%.

The pure deodar forest patches in the study area are mostly confined to one or two locations and thus the frequency of this otherwise common tree of western Himalayas has a low frequency of 8.75%. However, this tree is of great commercial value for which, it is often felled.

With respect to the phytosociological parameter of density, again *Bromus* clearly stands out at a density of 2.54. This is followed by *Rumex* at 1.86. *Stellaria*, which also figured as one of the species with high frequency is the third most dense species within the sampled area (quadrants) at a density of 1.61. Other dominant tree species, such as *Abies* and *Picea* have density values of 0.89 and 0.69 respectively. This means that although fir and spruce trees are very frequently sighted, they do not have large number of individuals within the actual area sampled (quadrants). This is true due to their large size.

With respect to the phytosociological parameter of Abundance, *Trifolium repens* and *T. tomentosum* both show a high abundance value of 7 and 6.17 respectively. Another herb, *Fragaria numbicola* also has a high abundance value of 6.2. It is interesting to note that although, spruce and fir trees have high frequency and relatively higher densities, their abundance values are quite low at 2.12 and 2.09 respectively. This means that even though they are most frequent, that is there are more chances of encountering them their numbers in a given plot of forest are not many. This is because of the fact that these are large trees attaining a height of up to 50 m with large canopies and occupy large area in a given plot of forest. Each tree takes up a large area and this results in a lower abundance value.

At each individual Transect surveyed, *Abies* is most frequent at Transect 1 (Duhangan) followed by at Transect 3 (Pahali). This is also confirmed by our field observations, as both these streams have large tracts of Western Mixed Coniferous Forests on the north facing slopes, which are chiefly composed of fir and spruce trees. Same is true for *Picea* also. Other phytosociological traits of density and abundance also reflect the same trend.

The grass species, *Bromus*, is most frequent at Transect 1, followed by at Transect 3 where its values for density and abundance are even higher than those for Transect 1. This indicates that although it is present in more quadrants in Transect 1, its distribution within the quadrants is more even in Transect 3 where perhaps, more individuals represent it.

Table 1.6: Phytosociological aspects of plant species encountered in the four Transects sampled in the project catchment area

(F – Frequency; D – Density; A – Abundance)

S. No.	Species	Transect 1 – Duhangan Total Quadrantes – 25			Transect 2 – Hamta Total Quadrantes – 25			Transect 3 – Pahali Total Quadrantes – 15			Transect 4 – Allain Total Quadrantes – 15		
		F (%)	D	A	F (%)	D	A	F (%)	D	A	F (%)	D	A
1.	*Abies pindrow*	72	1.56	2.17	36	0.6	1.67	40	1.07	2.67	7	0.7	1
2.	*Acer caesium*	8	0.08	1	8	0.12	1.5	-	-	-	-	-	-
3.	*Aesculus indica*	8	0.08	1	12	0.12	1	-	-	-	-	-	-
4.	*Ageratum housbuianum*	20	0.64	3.2	12	0.36	3	33	1.0	3	27	0.93	3.5
5.	*Alnus nitida*	4	0.04	1	-	-	-	-	-	-	-	-	-
6.	*Artemisia sp*	8	0.2	2.5	24	0.8	3.33	27	0.87	3.25	20	0.73	3.6
7.	*Berberis asiatica*	36	0.96	2.67	24	0.72	3	33	1.07	3.2	27	0.93	3.5
8.	*Berginia ciliata*	4	0.12	3	8	0.28	3.5	-	-	-	7	0.13	2
9.	*Boehmeria sp*	12	0.44	3.67	8	0.28	3.5	7	0.27	4	27	1.33	5
10.	*Brassica sp*	-	-	-	8	0.24	3	-	-	-	-	-	-
11.	*Bromus sp*	56	2.8	5	48	2.48	5.17	53	3.4	6.38	40	1.33	3.33
12.	*Campanula cashmeriana*	4	0.28	7	4	0.12	3	-	-	-	7	0.27	4
13.	*Caryopteris odorata*	4	0.08	2	-	-	-	-	-	-	-	-	-
14.	*Cedrus deodara*	8	0.12	1.5	20	0.64	3.2	-	-	-	-	-	-
15.	*Corydalis rutifolia*	4	0.24	6	8	0.44	5.5	-	-	-	20	0.8	4
16.	*Cuscuta reflexa*	-	-	-	8	0.16	2	-	-	-	13	0.33	2.5
17.	*Cyanadon dactylis*	16	0.84	5.25	28	1.52	5.43	27	1.33	5	20	1.07	5.33
18.	*Equisetum sp*	-	-	-	4	0.12	3	-	-	-	-	-	-
19.	*Fragaria nubicola*	24	1.6	6.67	16	1.28	8	20	0.93	4.67	13	0.47	3.5
20.	*Gagea elegans*	8	0.24	3	8	0.28	3.5	-	-	-	7	0.2	3
21.	*Gentiana sp*	12	0.86	5.67	16	0.84	5.25	-	-	-	-	-	-
22.	*Hedera nepalensis*	4	0.16	4	8	0.12	1.5	7	0.2	3	-	-	-
23.	*Iris kumaonensis*	4	0.2	5	8	0.24	3	-	-	-	20	0.67	3.33
24.	*Juglans nigrum*	-	-	-	4	0.08	2	-	-	-	-	-	-
25.	*Leucas sp*	12	0.44	3.67	20	0.48	0.4	13	0.4	3	13	0.2	1.5
26.	*Majus*	16	0.84	5.25	16	0.96	6	27	1.2	4.5	20	0.93	4.66
27.	*Malus malus*	8	0.28	3.5	4	0.16	4	-	-	-	-	-	-
28.	*Melilotus indica*	16	0.84	5.25	16	0.96	6	13	0.73	5.5	13	0.53	4
29.	*Penisetum lanatum*	-	-	-	8	0.28	3.5	-	-	-	-	-	-
30.	*Phlomis rotata*	8	0.28	3.5	12	0.44	3.67	7	0.33	5	7	0.27	4
31.	*Picea*	48	1.0	2.08	28	0.6	2.14	40	0.73	1.83	7	0.27	4
32.	*Pinus wallichiana*	8	0.2	2.5	12	0.36	3	-	-	-	7	0.27	4
33.	*Populus ciliata*	4	0.04	1	-	-	-	-	-	-	-	-	-

S. No.	Species	Transect 1 – Duhangan Total Quadrantes – 25			Transect 2 – Hamta Total Quadrantes – 25			Transect 3 – Pahali Total Quadrantes – 15			Transect 4 – Allain Total Quadrantes – 15		
		F (%)	D	A	F (%)	D	A	F (%)	D	A	F (%)	D	A
34.	*Primula sp*	8	0.36	4.5	8	0.28	3.5	-	-	-	7	0.2	3
35.	*Princepia utilis*	8	0.2	2.5	-	-	-	-	-	-	-	-	-
36.	*Prunus cerasoides*	4	0.08	2	4	0.04	1	-	-	-	-	-	-
37.	*Q. dialatata*	6	0.12	1.5	-	-	-	13	0.4	3	-	-	-
38.	*Quercus semicarpifolia*	-	-	-	-	-	-	-	-	-	27	0.8	3
39.	*Ranunculus scleratus*	8	0.32	4	12	0.48	4	7	0.2	3	13	0.6	4.5
40.	*Rhus cotinus*	-	-	-	4	0.08	2	-	-	-	-	-	-
41.	*Rubia cordifolia*	-	-	-	4	0.04	1	-	-	-	7	0.07	1
42.	*Rubus ellipticus*	8	0.2	2.5	8	0.02	2.5	7	0.07	1	13	0.2	1.5
43.	*Rubus nepalensis*	4	0.12	3	-	-	-	-	-	-	-	-	-
44.	*Rumex sp*	28	1.2	4.29	36	1.76	4.87	53	2.6	4.88	40	2.4	6
45.	*Saccharum sp*	-	-	-	8	0.24	3	-	-	-	7	0.13	2
46.	*Salix tetrasperma*	24	0.72	3	16	0.4	2.5	13	0.2	1.5	7	0.2	3
47.	*Sarcococea pruniformis*	4	0.12	3	4	0.04	1	-	-	-	-	-	-
48.	*Sassuria sp*	8	0.16	2	8	0.12	1.5	-	-	-	-	-	-
49.	*Scurulla sp*	-	-	-	-	-	-	-	-	-	7	0.33	5
50.	*Sonchus asper*	12	0.36	3	4	0.16	4	7	0.13	2	13	0.47	3.5
51.	*Stellaria media*	32	1.6	5	24	1.44	6	27	1.87	7	20	1.67	8.3
52.	*Tagetus minutus*	4	0.16	4	-	-	-	-	-	-	-	-	-
53.	*Thaspi griffithianum*	-	-	-	4	0.2	5	-	-	-	-	-	-
54.	*Trifolium repens*	20	1.6	8	28	2.12	7.57	13	1.13	8.5	27	1.07	4
55.	*Trifolium tomentosum*	8	0.44	5.5	12	0.84	7	-	-	-	7	0.33	5
56.	*Urtica sp*	20	0.52	2.6	20	0.6	3	20	0.4	2	20	0.53	2.66
57.	*Veronica agrestis*	4	0.16	4	4	0.12	3	-	-	-	7	0.13	2
58.	*Vicia perigriua*	8	0.44	5.5	4	0.24	6	-	-	-	7	0.2	3
59.	*Viola sp*	8	0.36	4.5	12	0.76	6.33	7	0.33	5	13	0.6	4.5
60.	*Viscum album*	-	-	-	-	-	-	7	0.27	4	20	0.47	2.33

Table 1.7 : Phytosociological and Biodiversity aspects of plant species encountered during ecological survey in the entire project catchment area

(RLF – Raunkiers Life Form; T – Tree; S – Shrub; H – Herb; C – Climber; G – Grass)

S. No.	Species	Frequency (%)	Density	Abundance	RLF	Conservation Status	Whether listed in Red Data Book	Whether endemic to the region or project catchment
1.	*Abies pindrow*	42.5	0.89	2.09	T	Common	No	No
2.	*Acer caesium*	5	0.06	1.25	T	Common	No	No
3.	*Aesculus indica*	6.25	0.06	1	T	Common	No	No
4.	*Ageratum housbuianum*	21.25	0.68	3.18	H	Common	No	No
5.	*Alnus nitida*	1.25	0.01	1	T	Common	-	No
6.	*Artemisia sp*	18.75	0.61	3.27	H	Common	No	No
7.	*Berberis asiatica*	30	0.9	3	S	Rare	Yes	No
8.	*Berginia ciliata*	5	0.15	3	H	Common	No	No
9.	*Boehmeria sp*	12.5	0.53	4.2	H	Common	No	No
10.	*Brassica sp*	2.5	0.08	3	H	Common	No	No
11.	*Bromus sp*	50	2.54	5.08	G	Common	No	No
12.	*Campanula cashmeriana*	3.75	0.18	4.67	H	Common	No	No
13.	*Caryopteris odorata*	1.25	0.03	2	H	Common	-	No
14.	*Cedrus deodara*	8.75	0.24	2.71	T	Common	No	No
15.	*Corydalis rutifolia*	7.5	0.36	4.83	H	Common	No	No
16.	*Cuscuta reflexa*	5	0.11	2.25	C	Common	No	No
17.	*Cyanadon dactylis*	22.5	1.19	5.28	G	Common	No	No
18.	*Equisetum sp*	1.25	0.04	3	H	Rare	Yes	No
19.	*Fragaria nubicola*	18.75	1.16	6.2	H	Common	No	No
20.	*Gagea elegans*	6.25	0.2	3.2	H	Common	No	No
21.	*Gentiana sp*	8.75	0.48	5.43	H	Common	No	No
22.	*Hedera nepalensis*	5	0.13	2.5	H	Common	No	No
23.	*Iris kumaonensis*	7.5	0.26	3.5	H	Common	No	No
24.	*Juglans nigrum*	1.25	0.03	2	T	Common	No	No
25.	*Leucas sp*	15	0.4	2.67	S	Common	No	No
26.	*Majus*	18.75	0.96	5.13	H	Common	No	No
27.	*Malus malus*	3.75	0.14	3.67	T	Common	No	No
28.	*Melilotus indica*	15	0.8	5.33	H	Common	No	No
29.	*Penisetum lanatum*	2.5	0.09	3.5	G	Common	No	No
30.	*Phlomis rotata*	8.75	0.34	3.86	H	Common	No	No
31.	*Picea*	32.5	0.69	2.12	T	Common	No	No
32.	*Pinus wallichiana*	7.5	0.23	3	T	Common	No	No

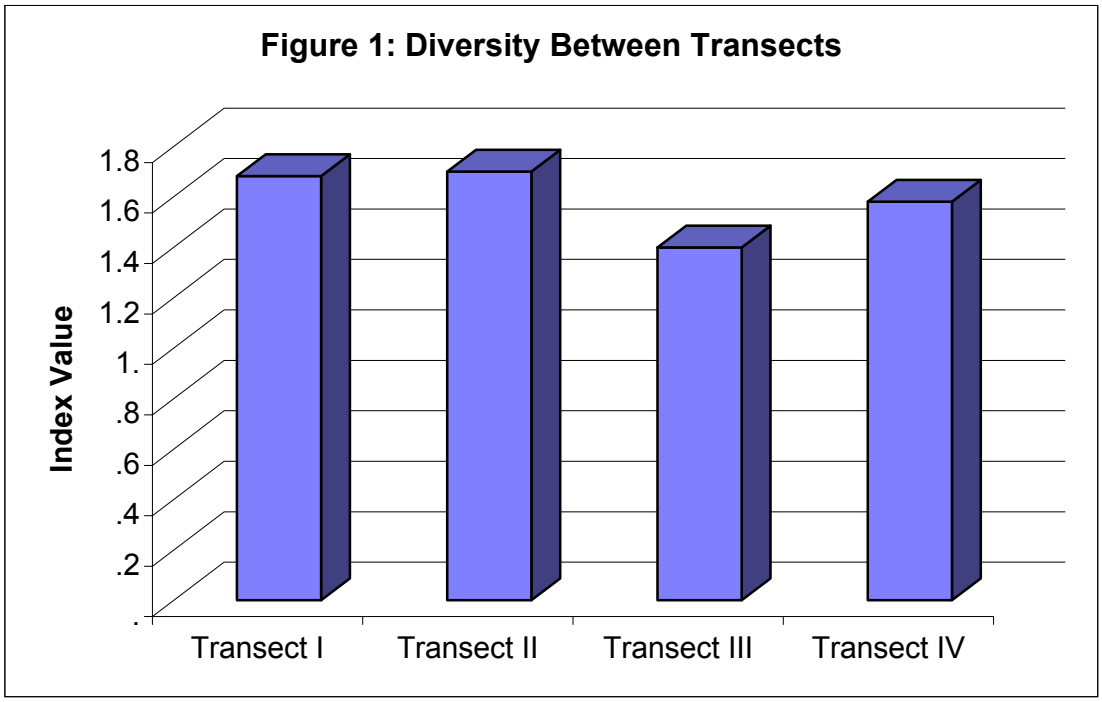
S. No.	Species	Frequency (%)	Density	Abundance	RLF	Conservation Status	Whether listed in Red Data Book	Whether endemic to the region or project catchment
33.	*Populus ciliata*	1.25	0.01	1	T	Common	No	No
34.	*Primula sp*	6.25	0.24	3.8	H	Common	No	No
35.	*Princepia utilis*	2.5	0.06	2.5	S	Common	No	No
36.	*Prunus cerasoides*	2.5	0.04	1.5	T	Common	No	No
37.	*Quercus dialatata*	5	0.11	2.25	T	Common	No	No
38.	*Quercus semicarpifolia*	5	0.15	3	T	Common	No	No
39.	*Ranunculus scleratus*	10	0.4	4	H	Common	No	No
40.	*Rhus cotinus*	1.25	0.03	2	H	Common	No	No
41.	*Rubia cordifolia*	2.5	0.03	1	H	Common	No	No
42.	*Rubus ellipticus*	8.75	0.18	2	S	Common	No	No
43.	*Rubus nepalensis*	1.25	0.04	3	S	Common	No	No
44.	*Rumex sp*	37.5	1.86	4.97	H	Common	No	No
45.	*Saccharum sp*	3.75	0.1	2.67	G	Common	No	No
46.	*Salix tetrasperma*	16.25	0.43	2.62	S	Common	No	No
47.	*Sarcococea pruniformis*	2.5	0.05	2	H	Common	No	No
48.	*Sassuria sp*	5	0.09	1.75	H	Rare	Yes	No
49.	*Scurulla sp*	1.25	0.06	5	H	Common	No	No
50.	*Sonchus asper*	8.75	0.28	3.14	H	Common	No	No
51.	*Stellaria media*	26.25	1.61	6.14	H	Common	No	No
52.	*Tagetus minutus*	1.25	0.05	4	H	Common	No	No
53.	*Thaspi griffithianum*	1.25	0.06	5	H	Common	No	No
54.	*Trifolium repens*	22.5	1.58	7	H	Common	No	No
55.	*Trifolium tomentosum*	7.5	0.46	6.17	H	Common	No	No
56.	*Urtica sp*	20	0.53	2.63	H	Common	No	No
57.	*Veronica agrestis*	3.75	0.11	3	H	Common	No	No
58.	*Vicia perigriua*	5	0.25	5	H	Common	No	No
59.	*Viola sp*	10	0.53	5.25	H	Common	No	No
60.	*Viscum album*	5	0.14	2.75	H	Common	No	No

Diversity Index – Flora

All the four Transects sampled were compared to bring out the extent of diversity within each of them and between them. The Shannon-Weiner Diversity Index was used to highlight the extent of diversity. The results are presented below in *Table 1.8* and graphically shown in *Figure 1*.

Table 1.8: Shannon Diversity Index Results for the four sampled Transects

Index	Transect 1	Transect 2	Transect 3	Transect 4
Shannon H' Log Base 10	1.484	1.513	1.241	1.446
Shannon Hmax Log Base 10	1.681	1.699	1.398	1.58



As is clear from the results of the Shannon Diversity Index, Transect 1 and 2 are most diverse with Transect 2 displaying the highest diversity for the two types of Shannon Diversity Indices.

Transect 2 is the route to Hamta village and beyond up to the hill tops and it passes through varied types of habitats, which include Spruce-Fir dominated forests, Deodar forests, steep to moderate slopes, grasslands and sub alpine pastures etc. Therefore, the high diversity in habitat types is able to support the high biodiversity encountered in this Transect, as is confirmed by the Diversity Index.

For Transect 1, which is the upstream area of Duhangan, the diversity is also quite high, as it is very close to the values for Transect 1. This fact is also supported by our field observations, as Duhangan upstream also has a varied range of habitats in the form of slopes, pastures, rocky patches etc. Further,

during our field visit, we also noted small sheltered valleys within the south facing slopes and these sheltered valleys support high diversity.

Transects 1 and 2 are followed by Transect 4 in terms of high diversity. This result is also in line with our observations. Transect 4, the Allain upstream and the region near the drift tunnel had barren slopes thereby depriving the Transect of some species that are characteristic of this region and found on other Transects. Further, some areas of Transect 4 were almost pure stands of Oak forests and Blue Pine forests. Being almost monoculture stands the extent of diversity is generally low in such areas.

According to the results, Transect 3 has the lowest diversity. Transect 3 is more or less homogenous with Spruce-Fir forests dominating large tracts of the slopes. Our observations from the field are in line with the results of the Diversity Index.

Besides the species encountered during ecological survey (species that were present in the quadrants), a number of other species were also observed, which did not fall within the quadrants. These species are listed below, which also include a few species that are reported from the study area and were not seen. This happened primarily because the ecological survey was conducted quite early in the summer season. Most of the species not falling in the quadrants are herbs, as they have just started emerging after snowmelt started. Later in the season many of the flowering plants are more established and widespread. Also, during summer months the high altitude forests are also accessible, as at this time they were snow bound. These species are listed below in *Table 1.9*.

Table 1.9: Species observed during ecological survey of project catchment but not encountered in the quadrants

S. No.	Species	RLF	Conservation Status	Whether listed in Red Data Book	Whether endemic to the region or project catchment
1.	*Corylus colurna*	T	Common	No	No
2.	*Taxus baccata*	T	Endangered	Yes	No
3.	*Betula utilis*	T	Common	No	No
4.	*Rhododendron arboretum*	H	Common	No	No
5.	*Carpinus*	T	Common	No	No
6.	*Ulmus wallichiana*	H	Common	No	No
7.	*Populus ciliata*	S	Common	No	No
8.	*Juniperous*	T	Common	No	No
9.	*Viburnum*	H	Common	No	No
10.	*Cotoneaster*	H	Common	No	No
11.	*Indigofera sp*	S	Common	No	No
12.	*Desmodium*	H	Common	No	No
13.	*Ilex dipyrena*	H	Common	No	No
14.	*Lonicera*	H	Common	No	No
15.	*Deutzia*	H	Common	No	No
	Strobilanthus	H	Common	No	No
16.	*Impatiens*	H	Common	No	No
17.	*Rosa*	S	Common	No	No
18.	*Polygonatum*	H	Common	No	No
19.	*Valeriana*	H	Common	No	No
20.	*Anemone*	H	Common	No	No

S. No.	Species	RLF	Conservation Status	Whether listed in Red Data Book	Whether endemic to the region or project catchment
21.	*Potentilla*	H	Common	No	No
22.	*Delphinium*	H	Common	No	No
23.	*Balsam*	H	Common	No	No
24.	*Anaphalis*	H	Common	No	No
25.	*Festuca*	G	Common	No	No
26.	*Agrostis*	G	Common	No	No
27.	*Danthonia*	G	Common	No	No
28.	*Brachipodium*	G	Common	No	No
29.	*Aconitum*	H	Rare	No	No
30.	*Podophyllum*	H	Common	No	No
31.	*Jurinea*	H	Common	No	No

Some mosses and a number of both fruticose and crustose lichens were found on tree bark and rock respectively. Ferns were also observed in some locations in Transect 1, 2 and 4.

Biodiversity Aspects of Fuana

Due to the time period of the ecological assessment, many faunal species could not be observed. The population sizes of the species observed were also limited in number and most often only a few individuals were seen. However, faunal species were visually observed and their individuals were counted and recorded. Porcupine was not sighted but its quill was found, which was taken as an indirect measure of the presence of the species in the project catchment area.

Table 1.12 gives the biodiversity aspects of faunal species (Mammals, Birds, Reptiles, Amphibians, Mollusks and Fishes). Amongst the terrestrial faunal species, reptiles, such as, snakes were not observed. Only a few lizards were seen. In the category of aquatic faunal species, only a few fingerlings of '*desi*' carp fish were found, besides a few tadpoles. No frogs were seen, although, a few tree frog species are reported from the project catchment area. No mollusks were found during the ecological survey.

Since both Allain and Duhangan streams are cold streams fed by snowmelt from higher reaches. Only cold water fish are expected to withstand such temperature range and habitat conditions. A special type of fish with adaptation to stick to rocks through modified gill as suckers can also survive. However, attempts to catch such fish by using dragnets failed to yield any catch.

Both the streams, Allain and Duhangan were found devoid of any fish species. Only near the confluence of Duhangan and Beas, fingerlings of Desi carp were caught in the nets. Some species of fishes are reported from Beas and are mentioned in *Table 1.12*. The upward migration of fishes from Beas to Allain and Duhangan is season specific and is mostly post-monsoon when the water in Beas swells up. It is likely that at that time fishes migrates upwards in search of food and spawning sites.

To ascertain the fish biodiversity, a visit was made to the fisheries department at Patli Kulah and Kullu. No records of fish biodiversity could be found from the

fisheries department. At Patli Kulah, some fishermen were found to be angling. After enquiry the only fish catch recorded from them was Desi carp – a local fish. No other fishes were found. Pictorial guidebooks were shown to the fishermen, who reported some fishes are available in Beas only in the post monsoon period. According to the local fishermen, sometimes Mahaseer and Rainbow Trout are also found in Beas.

Fish catch were also evaluated at Kullu market. The fishes were brought by local fishermen caught through angling in river Beas. Again only Desi carp fish catch was found.

Table 1.10: Biodiversity Aspects of Faunal Species (Mammal, Bird, Reptile, Amphibian, Mollusk and Fish Species in the Project Catchment Area)

S. No.	Species	Endangered	Threatened	Vulnerable	Rare	Common	Whether listed in Schedule 1of Wildlife Protection Act
Mammals							
1.	Fox				✔		No
2.	Porcupine				✔		No
3.	Common Langur					✔	No
4.	Ibex*	✔					Yes
5.	Blue Sheep (Bharal)*	✔					Yes
6.	Black Bear*		✔				No
7.	Brown Bear*	✔					Yes
8.	Musk Deer*	✔					Yes
9.	Ghoral*	✔					Yes
Reptiles							
10.	Cobra*					✔	No
11.	Krait*					✔	No
12.	Pit Viper				✔		No
13.	House Gecko					✔	No
14.	Garden Lizard					✔	No
15.	Rock Lizard					✔	No
Amphibians							
16.	Bull frog*					✔	No
Mollusks							
17.	Fresh Water Snail*					✔	No
* Species reported to be present in the study area but not sighted during ecological survey							
Birds							
18.	Passer domesticus (Sparrow)					✔	No
19.	Streptopelia chinensis (Spotted dove)					✔	No
20.	Urocissa erythrorhycha (Red billed blue Magpie)					✔	No
21.	Corvus macrorhynchos (Large-billed crow)					✔	No

S. No.	Species	Endangered	Threatened	Vulnerable	Rare	Common	Whether listed in Schedule 1of Wildlife Protection Act
22.	Chaimarrornis leucocephalus (White capped water redstart)					✔	No
23.	Arborophila torqueola (Hill partridge)				✔		No
24.	Coutrnix couternix (Common quail)					✔	No
25.	Lophophorus impejanus (Monal)	✔					Yes
26.	Gyps fulvus (Eurasian griffon)				✔		No
27.	Neophron percnopterus (Egyptian vulture)					✔	No
28.	Acridotheres ginginianus (Bank Myna)					✔	No
29.	Acridotheres tristis (Common Myna)					✔	No
30.	Sternus pagodarum (Brahminy Myna)					✔	No
31.	Accipiter badius (Shikra)					✔	No
32.	Megalaima haemacephala (Coppersmith barbet)					✔	No
33.	Coloumba livia (Rock pigeon)					✔	No
34.	Streptopelia decaocto (Ringed dove)					✔	No
35.	Cercomela fusca (Common Rock Chat)					✔	No
36.	Carpodacus erythrinus (Rose finch)					✔	No
37.	Motachilla alba (White wagtail)					✔	No
38.	Woodpecker					✔	No
Fishes							
39.	Salma gairdnerii gairdnerii# (Rainbow Trout)					✔	No

S. No.	Species	Endangered	Threatened	Vulnerable	Rare	Common	Whether listed in Schedule 1of Wildlife Protection Act
40.	Salma truffa fario# (Brown Trout)					✔	No
41.	Tor Pitutora# (Mahaseer)					✔	No
42.	Catla catla#					✔	No
43.	Lebio rohita#					✔	No
44.	Lebio batu#					✔	No
45.	Desi Carp					✔	No
46.	Lebio dero#					✔	No
47.	Lebio dyochelus#					✔	No
48.	Cirrhina mrigala#					✔	No
49.	Notopterus chitala#					✔	No
50.	Wallgo attu#					✔	No
51.	Nemachilus botio#					✔	No
52.	Pontius ticto#					✔	No
53.	Pontius sarana#					✔	No
54.	Silver Carp#					✔	No
55.	Mastacimballus armatus#					✔	No

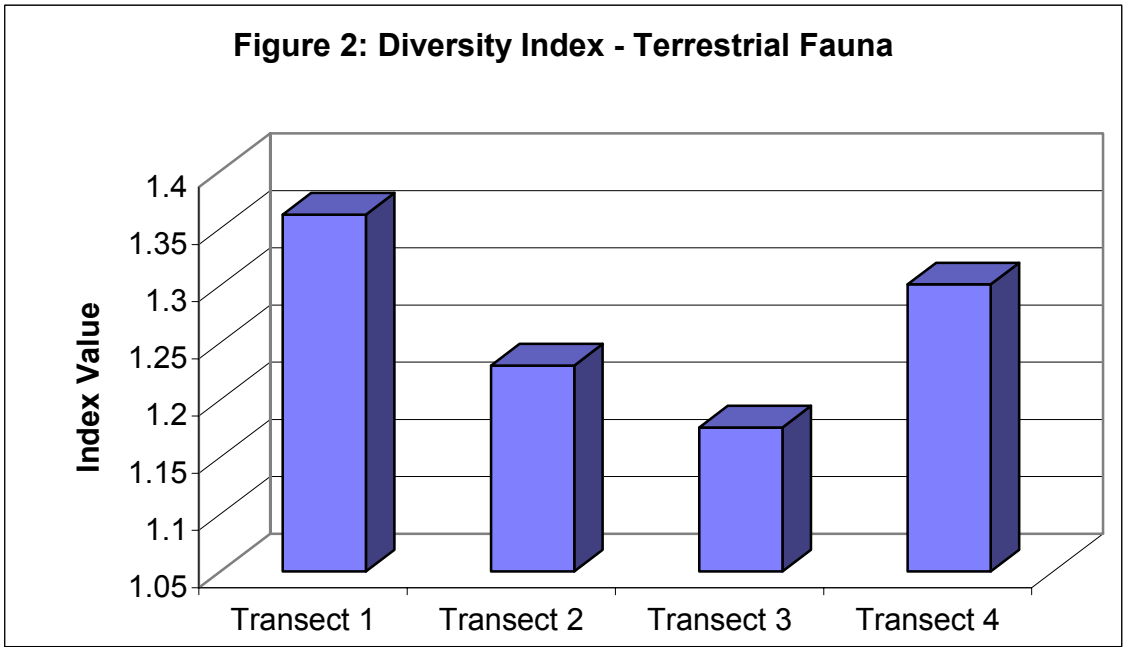
Fish species reported to be present in river Beas but not caught during ecological survey

Diversity Index – Fauna

Based on the data collected from the field Shannon diversity index was calculated. The results are given in *Table 1.11* and graphically represented in *Figure 2.*

Table 1.11: Shannon Diversity Index Results for fauna in the project catchment area

Index	Transect 1	Transect 2	Transect 3	Transect 4
Shannon H' Log Base 10	1.202	1.099	1.102	1.215
Shannon Hmax Log Base 10	1.362	1.23	1.176	1.301



As is clear from the Shannon diversity index above, Transect 1 is the most species rich in the project catchement, followed by Transect 4. Transect 1 (Duhangan stream) is a pristine area with little or no disturbances. Thus a number of faunal species, including birds were observed here. Even some endangered species, like the Ibex and Musk Deer are reported from upstream Duhangan catchment area. Transect 4 was also rich in faunal diversity, particularly bird diversity. This transect supports a number of habitat types, which display a somewhat patchy distribution in the landscape and thus provide shelter, food and breeding sites for many species. Consequently, the Transect 4 stood at second position, as per the Shannon Diversity Index. Transect 2 was low in species richness, as this area of the project catchment had three villages, namely, Prini, Hamta and Sethan. Of these Prini is a large village and is located close to the road (State Highway). Clearing of land for apple orchards and extraction of firewood by village inhabitants causes disturbances to wild animals. The upper reaches of Transect 4, near the site for forebay reservoir and up to the site of barrage on Allain, were snow bound. Similarly,

large tracts of Transect 3 (Pahali stream) were also snow bound, as a result of which the Shannon index for this transect is the lowest.

1.4 SALIENT FINDINGS OF THE ECOLOGICAL ASSESSMENT

- Parallel slopes of the mountain ranges, i.e. south facing slopes of Allain, Pahali and Duhangan streams are quite similar with respect to vegetation and other ecological features.
- Similarly, the north facing slopes of these streams are closely related with respect to vegetation and other ecological features.
- This indicates that geo-climatic forces are shaping evolution of vegetation types and the resulting forest types are governed largely by photoperiod, precipitation and soil types.
- The soil across the project catchment is relatively loose and is mixed variously with rock crust. At most locations, and particularly on steep to moderate slope, the soil is skeletal. The soil is a fine gravel and loam, usually sandy loam to clayey loam.
- Fir (*Abies pindrow*) and Spruce (*Picea*) are the most frequent tree species in the entire study area.
- The three rare species identified in the survey viz. *Berberis, Equisetum and Scurulla* do not lie in the project component area, and shall not be affected adversely by the project.
- None of the species were found to possess endemic nature; and
- None of the Biosensitive areas identified by the Forest Department lie in the project area.

1.4.1 *Estimation of land and forest loss in project catchment area*

One of the major sources of ecological impact would be loss of land, and more specifically loss of forestland. Tree felling and loss of forestland is likely to have long-term impacts as are discussed in the next section of Ecological Concerns Matrix. It is estimated that about 77.272 ha of land will be lost due to various project activities, like barrage and reservoir, silt removal chamber, roads, plant area, switch yard and tail race, colony and office, dumping area, powerhouse and magazine storage. *Table 1.12* gives the estimates of loss of forestland due to project activities.

Table 1.12 : Estimated loss of forestland due to project activities

Project Activity	Loss of Forestland Area (ha)
Barrage/weir/ Forebay and Intermediate Reservoir	9.84
Silt removal chamber	0.187
Project roads	12.00
Plant area	2.00
Switch yard/tail race	5.14
Colonies	1.00
Powerhouse	1.00
Magazines	1.00
Total	32.167

With all the various activities and ensuing loss of forestland, the loss of forest trees and volume of timber has also been estimated and also expressed in terms of loss of potential revenue in *Table 1.13*.

Table 1.13 : Loss of trees, volume and amount in rupees

Species	Dam/Reservoir		Approach Road		Total No. of Trees	Total Volume (cu m)	Rate (Rs/cu m)	Amount (million Rs)
	No. of Trees	Volume (cu m)	No. of Trees	Volume (cu m)				
Kail	97	268.2	106	283.6	203	551.8	8,750	4.83
Devidyar	45	92.7	19	39.4	64	132.1	4,711	0.62
Deodar	11	48.0	11	52.6	22	100.6	9,862	0.99
Moors	6	10.8	-	-	6	10.8	2,115	0.02
Horse Chest Nut	4	7.2	-	-	4	7.2	5,514	0.04
Kosh	6	45.6	-	-	6	45.6	2.073	0.01
Popular	28	34.7	-	-	28	34.7	2,073	0.07
Chir	-	-	6	9.6	6	9.6	2,875	0.03
Total	197	507.2	142	385.2	331	892.4	-	6.69

Due to loss of trees and forestland, it is estimated that compensatory afforestation will need to be carried out in about 64.334 ha of land.

1.5 ECOLOGICAL CONCERNS MATRIX

The ecological assessment has highlighted certain concerns regarding the developmental phase of the project that may have an adverse implication on the ecology of the project catchment and surrounding area. Since the rare species identified in the Red Data Book do not lie in the project area, the impact on these species has not been mentioned. Also, no biosensitive location in the project component area. These are presented below in *Table 1.14*.

Table 1.14: Ecological concerns along with their sources of threats and affected ecological parameters

Ecological concern	**Whether Impact is Negative & Timescale**	**Source of threat**	**Affected Ecological Parameters**
Deforestation	Yes; Long-term	Road building	Loss of habitats Loss of soil Loss of species Impact on animal movement Variation in local climate
		Submergence	Permanent loss of trees Changes in hydrological patterns
Soil erosion	Yes; Long- term	Road building	Loss of soil microbes and invertebrates Reduced soil fertility
		Tunneling	Damage to habitats through dumping of waste material Sedimentation in streams

Ecological concern	Whether Impact is Negative & Timescale	Source of threat	Affected Ecological Parameters
Habitat destruction	Yes; Long-term	Road building	Loss of species Reduced ecosystem productivity Reduced ecosystem resilience Biological invasions and introduction of exotics
Threat to wildlife	Yes; Long-term	Colonization	Teasing of wild animals Incidences of poaching and illegal trade Restricted movement of wild animals
Firewood extraction	Yes; medium-term	Labourers and workers' colony	reduced ecosystem productivity. Rampant firewood extraction or lopping could permanently damage some trees and reduce their regeneration potential. Wood cutting during flowering and fruiting will result in reduced number of propagules for regeneration.

1.6 IMPACTS ON THE ECOLOGY OF THE PROJECT WATERSHED AREA

As mentioned in the above section, the following are the broad ecological concerns:

- Deforestation.
- Soil erosion.
- Habitat destruction.
- Threat to wildlife.
- Firewood extraction.

Deforestation

The potential impacts due to project activities on deforestation:

- During road building, a number of trees are likely to be cut.
- Of all the various plant communities found in the study area, two are particularly threatened due to road building. These are – the deodar community on the way to Hamta village and the alpine pasture & marshy habitat near confluence of Duhangan and Kala stream.
- Reservoir and submergence would lead to permanent loss of trees.

Soil Erosion

The potential impacts due to project activities on soil erosion:

- In the absence of tree cover, a number of ecological factors contribute to soil erosion. There are no deep penetrating root system to bind the rock particles and soil. Water from snowmelt and precipitation flows easily creating rills and gullies that increase the loss of topsoil.
- Incidences of landslides increase with lack of tree cover. The road construction in this area may also result in incidences of landslides, therefore, further damaging the habitats. Since the soil on the slopes near

Hamta village is loose and slippery, it may also lead to loss of topsoil along with increased incidences of landslides.

- Chances of soil erosion due to project activities in the footpath to Chandrathal and Sathan; as well as along Jabri, Allain, Duhangan and Hamta nallah were found to be of concern during field observations.

Habitat destruction

- Upstream Duhangan and Allain are pristine areas with luxuriant forests and road building in these areas will contribute to the damage of these pristine habitats. This would be primarily due to fragmentation of habitat and damage during road construction
- Road up to the reservoir site and upstream Allain may in future be extended by public pressure and vote bank politics to link up with Spiti, which is highly inaccessible at present. This would further lead to habitat destruction.
- Construction of colony would lead to change in land use pattern. Forest habitats would be converted into urban and semi-urban areas. Gradually, more and more construction will start happening due to developmental needs of the society. Thus, loss of pristine habitats would gradually increase.
- Tunnelling might lead to deposition of waste material and increased sedimentation of the stream. Unplanned dumping of waste material has the potential to destroy natural habitats.

Threat to wildlife

- Road construction would have adverse impact on the wildlife as well. Upstream Duhangan and areas above the reservoir site are known to have musk deer populations. Road building will damage their habitats and will restrict their movements. Roads will also make these areas easily accessible and the chances of poaching incidences may also increase.
- Colonization will make the virgin forest of the area quite porous and accessible to poachers and hunters. With musk deer, ibex, brown bear etc poaching may become lucrative in the region.
- Colonization will also permanently disturb movement of wild animals in the region. A detailed study, spanning over different seasons would be required to confirm whether the proposed sites fall on animal migration routes.

1.7 MITIGATION MEASURES FOR THE ECOLOGICAL IMPACTS IDENTIFIED

1. Protection of sheltered valleys on the slopes of Duhangan would require special consideration. This is more so, as these valleys, or spots of increased biodiversity, fall on the proposed route for road construction. Since the width of these sheltered valleys are not much, options to avoid habitat destruction should be explored.
2. Special precautions would need to be taken while road construction in the mountain harbouring Hamta village. This would be important, as the soil in this region is loose and the incidences of landslides may dramatically

increase due to the activity of road building. Constructed road would need to be supported while construction itself. Check dams, culverts, stonewalls and other necessary and frequently used techniques would be employed while undertaking this activity.

3. The moderate to steep slope on way to Hamta is quite prone to landslide and associated soil erosion. This problem has been compounded due to tree felling in pockets on way to Hamta village. Rills and gullies are formed rapidly following precipitation through which soil erosion increases. Measures, such as, loose boulder check dams, gulley plugging and bioengineering would be implemented for preventing excess loss of soil.
4. The proposed site for discharge of water from the powerhouse is on Allain stream. At this site, the north facing slopes of Allain stream are barren steep slope. With increased water into the stream, it is likely that the water level in the stream may rise and the flow may also increase due to the steep gradient of the flow. This could cut the slopes along Allain stream leading to landslides. Therefore, slope stabilization measures would be taken on Allain after release of discharges water. These would be in the form of biological measures by planting grasses and climbers along with other soil binding plants or through measures, such as the use of wire mesh or stonewall. Many slope stabilization methods are available and these would need to be undertaken at this site.
5. Due to loss of forestland in the project catchment, compensatory afforestation would be carried out. Due to non-availability of non-forest land, 64 land, approximately, will be afforested near the project catchment. Some of this afforestation activity would also be taken up on the slopes on way to Hamta. Indigenous species would be used for afforestation. Use of blue pine, which is one of the regeneration species, will be useful and effective. Efforts would also be made to plant deodar trees. Other sites, where afforestation may be undertaken are villages Prini, Sethan and Jagatsukh. Upstream reservoir area would also be a good site for afforestation.
6. Compensatory afforestation would commence from the first year of project start.
7. Some of the sites identified suitable for afforestation activities are 2/16 Upper rahni (whole), 2/17 Hamtagarh C-III, 2/17 Hamtagarh C-Ic,Id,IIa,IIc and 2/19 Bansai-da-dug.
8. Some of the species, which are likely to lose a large number of its individual trees would be taken up for compensatory afforestation. *Quercus dialata, Quercus semicarpifolia, Cedrus deodara, Acer sp*, Rai and Tosh should be considered. These species should be planted in forest gaps, which are often termed as culturable blanks falling in the tree zone.
9. Besides compensatory afforestation, efforts would also be made to develop pasturelands. Since roads, construction of barrage etc in the high altitude regions of the project catchment will impact rich pastures (temperate, sub alpine and alpine), pasture development would be useful for maintaining the ecological continuity of habitats across the altitudinal gradients. Some of the endangered species, for example, Ibex, Musk Deer, Bharal etc also graze on alpine pastures. By developing alternate pasturelands, there will be no reduction in the availability of grazing grounds for wild animals.

10. Since Fir and Spruce trees are the most frequent trees in the entire study area landscape, efforts would be made to maintain this landscape feature, as this will help in maintaining the biogeochemical cycles and will help the ecosystem function in discharging ecological services. Thus, a special focus would be required during afforestation activities to plant native fir and spruce trees.
11. Since a large number of labourers and other workers are likely to be working during the project construction phase and after, it is likely that there would be an additional pressure on the neighbouring forests for firewood both for cooking purposes and for warming the shelters during winter months. The project authorities would take appropriate measures to reduce the firewood extraction from nearby pristine forests.

1.8 ECOLOGICAL MANAGEMENT PLAN

1.8.1 Catchment Area Treatment Plan

Catchment Area Treatment Plan extends from the Phimi Village near the proposed underground Power House upto and beyond the Allain Barrage Site and from Jagatsukh Village upto and beyond the Duhangan Weir Site. Details of various types of plantations, spurs, check walls, check dams, and compensatory afforestations which will be provided are also given below.

The Catchment Area Treatment has been suggested considering the landuse pattern, soil cover and topography. The areas where afforesation is to be carried out are as follows:

Table 1.15: Proposed Afforestation in Catchment Area

Sl. No.	Afforestation Location	Area (ha)
1	Prini	140
2	Hamta	120
3	Saithan	60
4	Jagatsukh	160
5	Chikka Springs	120
6	Jabri Nallah	100
7	Upstream Storage Reservoir	100
	Total	**800**

About 800 ha area will be afforested from project funds. The cost of plantation, which has been provided, will be Rs 2,36,12,000/- (800 ha x Rs 29515).

Table 1.16: Pasture Development in Catchment Area

Sl. No.	Afforestation Location	Area (ha)
1	Saithan	30
2	Pahali Stream	20
3	Hamta Garh	30
4	Tangra/Chikka Springs	30
5	Upstream Storage Reservoir	90
	Total	**200**

The Pastures to be developed in 200 ha within the catchment area.

The total cost worked out will be Rs 19,00,000/- at the rate of Rs 9,500/ha. The engineering structures will be provided at various sites as detailed below. The total cost of civil works for soil conservation measures will be Rs 45,30,000/-.

Table 1.17 Details of Catchment Area Treatment Works

S No.	Item	Check wall with boulders & stones with/without wire mesh	Check dam with boulders & stones	Spur	Total
1	Jabri Nallah	10	10	-	20
2	Footpath to Chandratal	15	-	1	16
3	Footpath to Sathan	19	-	4	23
4	Allain Nallah	15	25	2	42
5	Duhangan Nallah	11	16	1	28
6	Hamta Nallah	7	14	1	22
	Total	77	65	9	151

Among a variety of trees to be planted under the afforestation scheme, the following species of trees, which are already observed in the area and which have been identified for plantation are:

1. Kail (*Pinus wallichina*)
2. Deodar (*Cedrus deodara*)
3. Devidyar (*Cupressus torulosa*)
4. Mulberry tree (*Morus alba*)
5. Horse Chest Nut (*Aesculus indica*)
6. Kosh (*Alnus nitida*) and
7. Populus (*Acupressus torulosa*) etc. etc.

The abstract of provisions made towards the cost for catchment area treatment plan including the provision of 32.5% i.e. Rs. 97,63,650 for maintenance at the rate of 5% per year towards catchment area treatment plan is given below:

Table 1.18 Cost estimates for Catchment Area Treatment

S.No.	Activity	Rs.
1	Afforestation 800 ha	23612000.00
2	Pasture development 200 ha	1900000.00
3	Engineering measures such as check wall, check dam, spur farm, pond	4530000.00
4	Maintenance @ 5% per year for 6.5 years	9763650.00
	Total	**39805650.00**

The year-wise plan in detail for the catchment area treatment (pasture development and afforestation) have been shown in *Table 1.17* and *Table 1.18*

Table 1.19: Yearwise Physical and Financial Plan for Catchment Area Treatment – Activity - Afforestation

Location	Year															
	1		II		III		IV		V		VI		VII		Total	
	Physical Ha	Financial Rs.	Physical Ha	Financial Rs.	Physical Ha	Financial Rs.	Physical Ha	Financial Rs.	Physical Ha	Financial Rs.	Physical Ha	Financial Rs.	Physical Ha	Financial Rs.	Physical Ha	Financial Rs.
Phirni	-	-	20	590300	20	590300	40	1180600	40	1180600	10	295150	-	-	140	4132100
Hamta	10	295150	10	295150	10	295150	20	590300	20	590300	20	590300	30	885450	120	3541800
Sathan	10	295150	10	295150	10	295150	10	295150	10	295150	10	295150	-	-	60	1770900
Jagat Sukh	10	295150	20	295150	20	295150	40	1180600	40	1180600	30	885450	-	-	160	4722400
Tangra/Chikka Springs	10	295150	10	295150	10	295150	20	590300	20	590300	20	590300	30	885450	120	3541800
Jabri Nallah	10	295150	10	295150	10	295150	10	295150	10	295150	20	590300	30	885450	100	2951500
Upstream Storage Reservoir	10	295150	20	590300	20	590300	10	295150	20	590300	20	590300	10	295150	100	2951500
Total	60	1770900	100	2951500	100	2951500	150	4427250	160	4722400	130	3836950	100	2951500	800	23612000

Provision for Afforestation - Rs. 23612000
Add 32.5% for maintenance @ 5% per year - Rs. 7673900

Total Provision Rs. 31285900

Table 1.20: Yearwise Physical and Financial Plan for Catchment Area Treatment – Activity – Pasture Development II

Location	Year															
	1		II		III		IV		V		VI		VII		Total	
	Physical Ha	Financial Rs.	Physical Ha	Financial Rs.	Physical Ha	Financial Rs.	Physical Ha	Financial Rs.	Physical Ha	Financial Rs.	Physical Ha	Financial Rs.	Physical Ha	Financial Rs.	Physical Ha	Financial Rs.
Sathan	-	-	10	95000	10	95000	10	95000	-	-	-	-	-	-	30	285000
Pahali Nallah	-	-	-	-	5	47500	5	47500	5	47500	5	47500	-	-	20	190000
Hamta Garh	10	95000	10	95000	5	47500	5	47500	-	-	-	-	-	-	30	285000
Tangra/ Chikka Springs	5	47500	5	47500	5	47500	5	47500	5	47500	5	47500	-	-	30	285000
Upstream Storage Reservoir	20	190000	20	190000	10	95000	10	95000	10	95000	10	95000	10	95000	90	855000
Total	35	332500	45	427500	35	332500		332500	20	190000	20	190000	10	95000	200	1900000

Provision for Pasture Development - Rs. 1900000
Add 32.5% for maintenance @ 5% per year - Rs. 617500

Total Provision Rs2517500

1.8.2 Compensatory Afforestation

The Allain Dhuhanga Hydro Electric project is being constructed in the jurisdiction of Kullu Forest Division by Rajasthan Spinning and Weaving Mills Ltd. The department of Forests, Govt. of Himachal Pradesh is responsible for the conservation and managements of forests in the project area. The Forest Conservation Act 1980 stipulates strict forest projection measures and procedures (Guide Line 1/08-1 (ii) for compensatory afforestation on acceptance of diversion of forest land for non-forestry purposes. If non forest land is not available, compensatory plantation is to be raised on degraded forest land to the extent of twice the affected or lost forest area and if non forest land is available, the extent of compensatory plantation will be equivalent of the affected or lost forest area.

According to the scheme of this project , 32.167 ha. of forest land will lost due to the project. Since no, non-forest land is available for raising compensatory afforestation, double the area of lost forest land would be planted up i.e. 64.334 ha. of plantations will be raised in degraded forest land available hereby. In addition to this, efforts will be made to plant trees at appropriate places on completion of the works, alone the road.

The objective of the afforestation programme will be to develop natural areas in which ecological functions could be maintained on sustainable basis. Therefore planting of miscellaneous indigenous species would be undertaken.

The compensatory afforestation is proposed to be done mainly in the 2/17 Hamta area, and also in 2/18 Jamari Dhar and 2/19 Bansai Da- Dugh forests where degraded land and many forest banks are available for planting.

The plantations in the above forests will be restricted to the areas which lie below the weir sites of the project. As all these above forests are situated beyond 7500 elevation, the main species for plantation will be fir only. Suitable sites, depressions and sites alone Nallas will planted up with appropriate Broad leave species like Maple, Horse chest nut, walput and poplar etc.

Total 70770 plants will be planted in 64.334 ha. area of compensatory afforestation at the norm of 1100 plant per ha. The ratio of fir and broad-leafed plants will be 75% Fir and 25 % suitable broad-leafed species. The work on raising of nursery will start right from current year i.e. 2000-2001. A new nursery site will be developed at the approximate expenditure of 4.5 lac. The detailed cost analysis of expenditure on raising of Fir seedling, broad-leafed species and that of afforestation has been worked out. As the gestation period of main species i.e. fir is more than 4 years main planting thrust will be in the year 2004.

An year wise phasing of Expenditure has been planned as shown in earlier table. Provision for maintenance of plantations for three years has been kept. Total expenditure on the compensatory afforestation scheme will be Rs. 29 lakhs.

1.8.3 Monitoring and Implementation of Environmental Safeguards for CAT

As per the advise of the Ministry of Environment & Forest, the Government of Himachal Pradesh has constituted Committees for monitoring and implementing the environmental safeguards in respect of all state/private/joint sector hydroelectric projects in Himachal Pradesh vide notification no. FFE-B-(F)-2-25196 dated April 7, 1997. The High Level Committees are represented as under:

Table 1.21: Agencies to be involved in monitoring and implementation of CAT Plan

S No.	Committee Members	Designation
State Level		
1	F.C.-cum-Secretary (Fts)	Chairman
2	Chairman/Member (Projects) BPSEB	Member
3	Principal Chief Conservator of Forests	Member
4	Conservator of Forests (Planning)	Member Secretary
Project Level		
1	Pr. Chief Conservator of Forests	Chairman
2	General Manager of project concerned	Member
3	Conservator of Forests concerned	Member
4	Superintending Engineer concerned	Member
5	Divisional. Forest Officer concerned	Member Secretary

The above committees will be monitoring the progress achieved on catchment area treatment plans etc as approved by the Ministry of Environment & Forests, Government of India, both in terms of funding by the project authorities and implementation in the field by the State Government Forest Department. In addition to the aforesaid, participation of local people in the implementation of environmental mitigation measures will also be ensured.

In addition to the. above, through the same Notification, the Govt. of Himachal Pradesh has also appointed the Forest Department of the Govt. of Himachal Pradesh to act as 'Nodal Agency' for implementation and monitoring of the function of the above Committees.

The Govt. of Himachal Pradesh has therefore taken necessary action to ensure that the commitments, made by the implementing Agency to the Ministry of Environment & Forests, are implemented at site and in view of the above it is submitted that the Area identified for providing Catchment Area Treatment Plan may kindly be approved.

1.8.4 Role of Local Communities

The involvement of local communities to collaborate with the Forest Department in the monitoring of the project implementation and project performance cannot be ensured directly. However, Himachal Pradesh Government promotes role of local communities in joint forest management for better protection and management of forests. The 25% of the revenue generated from the jointly managed forests go to the local communities for development purposes.

1.9 LIST OF DOCUMENTS REFERRED

1. Flora of Himcahal Pradesh, Volume 1
2. Flora of Himcahal Pradesh, Volume 2
3. Flora of Himcahal Pradesh, Volume 3
4. Forest Types of India (Champion and Seth)
5. Red Data Book (BSI), Volume 1
6. Red Data Book (BSI), Volume 2
7. Red Data Book (BSI), Volume 3

1.10 LIST OF PEOPLE MET DURING ECOLOGICAL SURVEY

1. Range Forest Officer, Manali
2. Forester, Manali
3. Forest Guard, Manali
4. Incharge – Manali Interpretation Center
5. Jai, Local Fisherman
6. Bhan Singh, Local Fisherman
7. Chauhan, Local Fisherman
8. Vikas Kumar, resident of Hamta village
9. Gheru Ram, resident of Hamta village
10. Manoj, Resident of Prini
11. Lata, Resident of Prini
12. Tea stall owner, Jagat Sukh Village
13. Raj Kumar, Fish trader, Kullu
14. Local fish buyer, Kullu