Biodiversity Management & Wildlife Conservation Plan

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1.1 INTRODUCTION

Habitat destruction and over exploitation of natural forests are the two major contributors to the loss of biodiversity world-wide. Forests as a natural resource which furnish food, fuel-wood, fodder and other forest product for local livelihood. However, due to continued pressure on forests with increasing human population, severe change in the forest cover is reported during the last five decades. Large scale conversion of forest into agriculture land and lack of access and control on annual fires in forest affected forest to a poor condition. About 55% of the total forest cover is prone to fires annually in India (Gubbi, 2003) and there is widespread concern about loss of biodiversity, increase in concentration of greenhouse gases and effects on atmospheric chemistry due to forest fires. Forest fires are reported as a major driver of the global change in terrestrial ecosystems (Rudel et al, 2005; Reddy et al, 2017). These anthropogenic disturbances not only influence landscape and ecosystem but also the physical environment and the availability of resources (White and Pickett, 1985).

To ensure sustained availability of many products such as food, fruits, vegetables, fuel, medicines raw materials and other indirect benefits and services such as ornamentals, shading or landscaping, fencing, etc cultivation of trees in agricultural systems is one of the major practices in the tropics of South and South East Asia (Fernandes and Nair, 1986). Therefore, in view of the depleting timber and NTFP resources in the wild, such intermixing of species of agriculture and forestry is considered as a potential source of solutions of many disturbed land use systems.

1.2 BIODIVERSITY STUDY TASKS

The account of Biodiversity profile of the project study has been described based on the primary survey in the area supplemented with the Forest Working plan and records of Kurnool Forest Division. The surveys were carried out for description of vegetation in the study area of Standalone Pumped Storage component of Pinnapuram Integrated Renewable Energy Project (IREP). It describes the forest types in the study area and the documentation of flora in the project area comprised of lower and upper reservoirs area and adjoining water supply source Gorakallu reservoir within 10 km radius near Gorakallu village.

1.3 FOREST TYPES

Andhra Pradesh is reported to have 19.57 % of the geographic area under forest which includes very dense, moderately dense, and open forest (FSI, 2017). The four major forest types found in the state are Tropical Dry Deciduous, Southern Tropical Thorn,

Southern Tropical Moist Deciduous and Littoral and Swamp forests (Champion and Seth, 1966). The study area of the proposed Pinnapuram Integrated Renewable Energy with Project (IREP) has only Group 6 - Tropical Thorn Forest type and belong to Subgroup 6A/C1, 6A/DS1 and 6A/DS2. However, majority of the project area between Brahmanapalle village and Pinnapuram village is comprised of agricultural and fallow lands with surrounding vegetation of thorny trees and scrubs. Rollapadu Wildlife Sanctuary is located at a distance of about 12km from the project area.

The vegetation in fallow lands or cropped area particularly in around Brahmanapalle village and Pinnapuram Village comprises much disturbed and degraded thorn forest. Cultivation of vegetables with cotton as a main cash crop throughout the region. The forests present in the study area have been grouped into different forest types following the 'A Revised Survey of the Forest Types of India' by Champion and Seth (1968), Negi, (1989, 1996), Mudgal and Hajra (1999) and Reddy *et al* (2014). The major forest type found in this region is discussed below.

6A Southern Tropical Thorn Forests

These are open forests in which low thorny and woody species predominate. The trees usually have short boles and low branching crowns and vary in height from 6 to 9 m. There usually occurs a mixture of many species. The vegetation is comprised of small trees and large shrubs. Grass growth is thin and appears during the short-wet season. Climbers are few and show xerophytic adaptations. The forest of this sub-group may be of the following types:

6A/C1 Southern thorn forest

This is an open dry deciduous forest in which thorny trees are scattered. These forests occur in the dry tracts of central and south India. The main tree species in this type are *Acacia arabica, A. leucopholea, A. planifrons, Balanites aegyptiaca, Canthium cormandelicum, Dichrostachys cinerea, Dalbergia latifolia, D. sissoo, Gymnosporia spinosa, Grewia tenax, Prosopis juliflora*, *Tamarindus indica, Ziziphus maurtiana*, etc. Shrubs include *Catunaregam spinosa, Dodonaea viscosa, Dolichandrone falcata, Euphorbia antiquorum, Flacourtia indica, Lantana camara, Phoenix sylvestris, Senna auriculata, Tamilnadia ulginosa, Ziziphus jujuba* and *Z. xylopyrus.* This type of patchy forest is observed in Brahmanapalle, Husainpuram, Gorakallu and Pinnapuram village surrounding areas. The common grasses in the open and drier habitats are *Aristida adscensionis, Bothriochloa pertusa, Brachiaria reptans, Heteropogon contortus* and *Saccharum spontaneum*.

1.4 VEGETATION PROFILE IN THE STUDY AREA

The description of vegetation of the project area has been presented in terms of stretches which correspond to topographic/elevational class within the 10 km radius influence zone of the project. These are as follows:

i) Area between and Brahmanapalle village and Hussainapuram village

ii) Area around Kalava village and up to Pinnapuram village

iii) Area beyond Pinnapuram village and its environ.

1.4.1 Area between Brahmanapalle and Hussainapuram Village

This area predominantly has open, much disturbed and degraded southern thorn forest in the bases of forested hills bordering villages and agricultural lands in Brahmanapalle area. Because of large scale human interference especially for agriculture farming, only few tree species can be observed on the edges of fallow land and agricultural fields. Cotton cultivation is practiced throughout the region. Besides cotton crop, Paddy (*Oryza sativa*), sugar cane, ground nut and vegetables are the main crops in agricultural fields (**Plate 1.1a**).

In and around of Hussainapuram, some large tree species like Azadirachta indica, Bauhinia racemosa, Cassia fistula, Chloroxylon swietenia, Dalberbergia latifolia, Eucalyptus spp., Hardwickia binata, Tamarindus indica, etc are seen on clay and clay loam soils especially on edges of agricultural fields (Plate 1.1b), whereas on dry forest soils Acacia spp., Balanites aegyptiaca, Canthium coromandelicum, Dichrostachys cinerea, etc are found scattered. The shrubby elements are composed of decumbent and spreading species, viz., Abutilon indica, Capparis divaricata, Catunaregam spinosa, Euphorbia antiquorum, Lantana camara, Mimosa hamata, Ziziphus mauritiana, Z. xylopyrus, etc. Besides cotton crop, maize (Zea mays), sugar cane (Saccharum officinarum) and vegetables are the main crops in agriculture in this area (**Plate 1.1c**).

In and around lower reservoir, near Brahmanapalle area, a fairly dense thorn forest is found at the bases of forested high hills bordering this area. The dominant trees near this project site are *Acacia arabica, A. horrida, A. leucophloea, A. planifrons, Azadirachta indica, Bauhinia racemosa, Canthium coromandelicum, Chloroxylon swietenia, Hardwickia binata, Prosopis juliflora* and *Salvadora persica.* Shrubs include *Catunaregam spinosa, Euphorbia antiquorum, Flacourtia indica, Gardenia gummifera, Gymnosporia spinosa, Grewia tenax, Lantana camara, Tamilnadia ulginosa* and *Ziziphus maurtiana.* The ground floor is disturbed show gaps and covered with few dry grasses and herbs like *Aristida adscensionis, Bothriochloa pertusa, Cynodon dactylon, Heteropogon contortus, Paspalum vaginatum, Saccharum spontaneum, Sida cordata, S. rhombifolia,* etc.

1.4.2 Area around Kalava village and up to Pinnapuram

A low thorny and spreading patches of few tree species can be seen in hillocks and near rocky areas. Around Pinnapuram village area, the main spreading and thorny tree species are *Acacia leucophloea, A. planifrons, Balanites aegyptiaca, Canthium coromandelicum, Gymnosporia spinosa, Prosopis juliflora, Tamilandia ulginosa* and *Ziziphus mautiana*. Other deciduous and planted tree species scattered found in the area include *Albizia amara, Bauhinia racemosa, Gmelina arborea, Hardwickia binata, Holoptelea integrrifolia,* etc. Understorey is thin composed of few invading shrubs like *Calotropis gigantea, Capparis divaricata, Lantana camara, Mimosa hamata, Senna siamea, Urena lobata* and *Ziziphus xylopyrus* (Plate 1.1d). Few fruit yielding trees like Sharifa (*Annona squamosa*), mango, Guava, banana, etc can be seen planted in the small orchards and edges of agricultural fields near villages. Under thorny vegetation herbs population is thin and meagre. The common dry habitat grasses in the forest floor are *Aristida adscensionis, Bothriochloa pertusa, Cenchrus ciliaris, Eragrostis tenella, Heteropogon contortus* and *Saccharum spontaneum*. Other herb species found in the area are *Achyranthes aspera, Cleome viscosa, Datura metel, Gomphrena globosa, Parthenium hysterophorus, Saccharum spontaneum, Sida cordata* and *S. rhombifolia*.

The forests especially in upper reservoir area (near Pinnapuram village) and adjoining Hussainapuram-Kalava area are of are under heavy biotic pressure due to deforestation by burning and tree felling for preparation of agricultural fields, road construction, other developmental works, etc. These anthropogenic activities are causing an irreparable damage to the flora of the state.

1.4.3 Area beyond Pinnapuram and its environs

There are number of economically important plant species found in the surrounding area of Ghani Reserve forest. Important tree species found in the surrounding forest area include *Acacia chundra, Anogeisus latifolia, Bauhinia racemosa, Butea monosperma, Cordia dichotoma, Hardwickia binata, Helictres isora, Lannea coromandelica, Syzygium cumini, Tectona grandis, Terminalia arjuna, T. tomentosa* and *Wrightea tinctoria*. Other small trees and tall spreading shrub species occur in forest are *Anacardium occidentale, Bambusa arundinacea, Borassus flabellifer, Calycopteris floribunda, Carissa spinarum, Cleistanthus collinus, Catunaregam spinosa, Dendrocalamus strictus, Hemidesmus indicus, Holarhena pubescens,* etc.

1.5 FLORISTICS OF PROJECT AREA

The present Biodiversity study in the project area of Pumped storage component of Pinnapuram IREP was undertaken with the objectives of preparing a checklist of flora in

the Lower reservoir and upper reservoir are proposed; listing of rare/endangered, economically important and medicinal plant species.

1.5.1 Vegetation around Lower Reservoir Area

The Lower reservoir is located near Brahmanapalle village, downstream of Pinnapuram village, in Kurnool District of Andhra Pradesh. Across the right and left bank of proposed lower reservoir, the vegetation is fairly rich comprised of Southern thorn forest type. The upper reaches of the bordering hills are covered with southern dry deciduous forest. The top storey of forest consists of *Acacia arabica, A. horrida, Azadirachta indica, Bauhinia racemosa, Cassia fistula, Canthium coromandelicum, Chloroxylon swietenia, Dalberbergia latifolia, Hardwickia binata* and *Tamarindus indica*. Second storey consists of few small trees like *Acacia planifrons, Balanites aegyptiaca, Feronia limonia, Holoptelea integrifolia, Morinda pubescens, Phyllanthus emblica* and *Prosopis juliflora* (**Plate 1.2a**). The shrubby elements are composed of decumbent and spreading species, viz., *Abutilon indica, Capparis divaricata, Catunaregam spinosa, Euphorbia antiquorum, Lantana camara, Mimosa hamata, Ziziphus mauritiana, Z. xylopyrus*. Forest floor is disturbed and show gaps covered with grasses, weeds and herbs (**Plate 1.2b**). A total of 70 species of angiosperms including trees, shrubs and herbs are recorded in the Lower reservoir area during primary survey (**Table 1.1**).

Table 1.1: List of flowering plant species recorded in and around the Lower Reservoir Area

Sl. No.	Botanical Name	Indian /Local Name	Family	Uses
	Trees			
1	*Acacia arabica*	Nallathumma	Mimosaceae	Medicinal
2	*A. leucophloea*	Tillatuma	Mimosaceae	Medicinal
3	*A. horrida*	Boggili	Mimosaceae	Fuel-wood
4	*A. planifrons*	Gundutumma	Mimosaceae	Fuel-wood
5	*Albizia amara*	Chigara	Mimosaceae	Ornamental
6	*Azadirachta indica*	Vepa	Meliaceae	Medicinal
7	*Balanites aeygptiaca*	Hingota	Simarubaceae	Medicinal
8	*Bauhinia racemosa*	Thati	Arecaceae	Vegetables
9	*Canthium coromandelicum*	Billudu	Rubiaceae	Fuel-wood
10	*Chloroxylon swietenia*	Rela	Meliaceae	Medicinal
11	*Cassia fistula*	Irugudu	Caesalpiniaceae	Medicinal
12	*Dalbergia paniculata*	Dobin	Papilionaceae	Timber
13	*Dichrostacys cinerea*	Jangli Jalebi	Mimosaceae	Fuel-wood
14	*Feronia limonia*	Bhenta	Rutaceae	Medicinal
15	*Hardwickia binata*	Yepi	Caesalpiniaceae	Timber
16	*Holoptelea integrifolia*	Papri	Ulmaceae	Fuel-wood
17	*Phyllanthus emblica*	Aonla	Euphorbiaceae	Medicinal
18	*Prosopis juliflora*	Kabuli Kikar	Mimosaceae	Fuel-wood
19	*Salvadora persica*	Goni	Salvadoraceae	Medicinal
20	*Tamarindus indica*	Puli	Caesalpiniaceae	Fruits edible
	Shrubs			
1	*Abutilon indicum*	Aphra	Malvaceae	Medicinal

Sl. No.	Botanical Name	Indian /Local Name	Family	Uses
2	*Calotropis gigantea*	Aankh	Asclepiadaceae	Medicinal
3	*Capparis divaricata*	-	Capparadaceae	-
4	*C. sepiaria*	Heens	Capparadaceae	-
5	*Catunaregam spinosa*	-	Rubiaceae	Medicinal
6	*Euphorbia antiquorum*	Peddajamud	Euphorbiaceae	-
7	*Flacourtia indica*	-	Flacourtiaceae	Fuel-wood
8	*Grewia tenax*	-	Tiliaceae	Fodder
9	*Gymnosporia spinosa*	Tandarsi	Celastraceae	Medicinal
10	*Helicteres isora*	Marod phali	Sterculiaceae	Medicinal
11	*Lantana camara*	Kuri	Verbenaceae	Fuel-wood
12	*Mimosa hamata*	-	Mimosaceae	Medicinal
13	*Morinda pubescens*	-	Rubiaceae	-
14	*Senna auriculata*	Tangadi	Caesalpiniaceae	Medicinal
15	*Senna siamea*	Mezali	Bignoniaceae	Medicinal
16	*Tamilnadia ulginosa*	-	Rubiaceae	Medicinal
17	*Vallaris solanacea*	Kinbot gye	Apocynaceae	Fiber
18	*Ziziphus maurtiana*	Ber	Rhamnaceae	Fruits edible
19	*Z. xylopyrus*	-	Rhamnaceae	-
	Herbs			
1	*Achyranthes aspera*	Chir chita	Amaranthaceae	Medicinal
2	*Aristida adscensionis*	-	Poaceae	-
3	*Apluda aristata*	-	Poaceae	-
4	*Blumea lacera*	-	Asteraceae	-
5	*B. densiflora*	-	Asteraceae	-
6	*Bothriochloa pertusa*	-	Poaceae	-
7	*Chloris dolichostachya*	-	Poaceae	-
8	*Cissus quadrangularis*	Hadjod	Vitaceae	Medicinal
9	*Cymbopogon martinii*	Lemon grass	Poaceae	Aromatic oil
10	*Cynodon dactylon*	Durba	Poaceae	Medicinal
11	*Cyperus irria*	-	Cyperaceae	-
12	*Dicliptera bupleuroides*	-	Acanthaceae	-
13	*Eragrostis tenella*	-	Poaceae	Medicinal
14	*Euphorbia hirta*	-	Euphorbiaceae	-
15	Gnaphalium pensylvanicum	-	Asteraceae	-
16	*Gomphrena globosa*	-	Amaranthaceae	-
17	*Heteropogon contortus*	Kuri	Poaceae	-
18	*Indigofera linifolia*	Sankhahuli	Papilionaceae	-
19	*Malvastrum coromandelianum*	Kharenti	Mimosaceae	-
20	*Mimosa pudica*	Chigara	Mimosaceae	-
21	*Paspalum vaginatum*	-	Poaceae	-
22	*Parthenium hysterophorus*	Gajar Ghass	Asteraceae	-
23	*Pavonia zeylanica*	-	Malvaceae	-
24	*Phyllanthus fraternus*	-	Euphorbiaceae	-
25	*Tephrosia purpurea*	Sar Phunkha	Papilionaceae	-
26	*Saccharum spontaneum*	Kaans	Poaceae	-
27	*Senna tora*	-	Caesalpiniaceae	Medicinal
28	*Sida cordata*	Kharenti	Malvaceae	Medicinal
29	*S. rhombifolia*	-	Malvaceae	Medicinal
30	*Tridax procumbens*	-	Asteraceae	Medicinal
31	*Vernonia cinerea*	-	Asteraceae	-

1.5.2 Vegetation around Upper Reservoir Area

The upper reservoir is proposed near Pinnapuram village area. The vegetation near project is comprised of patches of southern thorn forest interspersed with cotton fields.

The main trees species in the project area are *Acacia arabica, Albizia amara, Annona squamosa, Balanites aegyptiaca, Cassia fistula, Hardwickia binata, Mangifera indica* and *Prosopis juliflora* (**Plate 1.2c**). Understorey is also thin and composed of few patches of tall shrubs like *Abutilon indica, Capparis divaricata, Catunaregam spinosa, Calotropis gigantea, Euphorbia antiquorum, Lantana camara, Mimosa hamata, Senna auriculata, S. siamea, Urena lobata, Ziziphus xylopyrus* (**Plate 1.2d**). Ground cover consists of few herbaceous species and weeds like *Achyranthes aspera, Apluda aristata, Aristida adscensionis, Bothriochloa pertusa, Cenchrus ciliaris, Datura metel, Eragrostis tenella, Gomphrena globosa, Sida cordata, S. rhombifolia,* etc. A total of 61 species of flowering plants including trees, shrubs and herbs are recorded in the Upper reservoir area during primary survey (**Table 1.2**).

Table 1.2 List of flowering plant species recorded in and around the Upper Reservoir Area

Sl. No.	Botanical Name	Indian/Local Name	Family	Uses
	Trees			
1	*Acacia arabica*	Nallathumma	Mimosaceae	Medicinal
2	*A. leucophloea*	Tillatuma	Mimosaceae	Medicinal
3	*A. horrida*	Boggili	Mimosaceae	Fuel-wood
4	*A. planifrons*	Gundutumma	Mimosaceae	Fuel-wood
5	*Albizia amara*	Chigara	Mimosaceae	Ornamental
6	*Annona squamosa*	Sharifa	Annonaceae	Fruits edible
7	*Balanites aegyptiaca*	Hingota	Simarubaceae	Medicinal
8	*Bauhinia racemosa*	Ari	Caesalpiniaceae	Vegetables
9	*Boswelia serrata*	Anduga	Burseraceae	Medicinal
10	*Cassia fistula*	Rela	Caesalpiniaceae	Medicinal
11	*Dalbergia latifolia*	Irugudu	Papilionaceae	Timber
12	*Eucalyptus citridora*	Neelagiri	Myrtaceae	Timber
13	*Gmelina arborea*	Kumbili	Verbenaceae	Medicinal
14	*Hardwickia binata*	Yepi	Caesalpiniaceae	Timber
15	*Holoptelea integrifolia*	Papri	Ulmaceae	Fuel-wood
16	*Mangifera indica*	Aam	Anacardiaceae	Fruits edible
17	*Prosopis juliflora*	Vialayati kikar	Mimosaceae	Fuel-wood
18	*Tamarindus indica*	Puli	Caesalpiniaceae	Fruits edible
	Shrubs			
1	*Abutilon indicum*	Aphra	Malvaceae	Medicinal
2	*Caloptropis gigantea*	Aankh	Asclepiadaceae	Medicinal
3	*Capparis divaricata*	-	Capparadaceae	-
4	*Catunaregam spinosa*	-	Rubiaceae	Medicinal
5	*Corchorus olitorius*	Jute	Tiliaceae	Fiber
6	*Dodonaea viscosa*	-	Sapindaceae	Fuel-wood
7	*Euphorbia antiquorum*	-	Euphorbiaceae	Ornamental
8	*Gymnosporia spinosa*	Tandarsi	Celastraceae	Medicinal
9	*Ipomoea carnea*	-	Euphorbiaceae	Medicinal
10	*Lantana camara*	Kuri	Verbenaceae	Fuel-wood
11	*Mimosa hamata*	-	Mimosaceae	Medicinal
12	*Senna auriculata*	Tangadi	Caesalpiniaceae	Medicinal

Sl. No.	Botanical Name	Indian/Local Name	Family	Uses
13	*Senna siamea*	Mezali	Caesalpiniaceae	Medicinal
14	*Urena lobata*	-	Malvaceae	Medicinal
15	*Tamilnadia ulginosa*	-	Rubiaceae	Medicinal
16	*Ziziphus xylopyrus*	-	Rhamnaceae	-
	Herbs			-
1	*Aristida adscensionis*	-	Poaceae	-
2	*Apluda aristata*	-	Poaceae	-
3	*Blumea lacera*	-	Asteraceae	-
4	*B. densiflora*	-	Asteraceae	-
5	*Bothriochloa pertusa*	-	Poaceae	-
6	*Cenchrus ciliaris*	-	Poaceae	-
7	*Cissus quadrangularis*	Hadjod	Vitaceae	Medicinal
8	*Cynodon dactylon*	Durba	Poaceae	Medicinal
9	*Cleome viscosa*	Hulhul	Capparadaceae	Medicinal
10	*Cyperus niveus*	-	Cyperaceae	-
10	*Datura metel*	Dhatura	Solanaceae	-
11	*Dicliptera bupleuroides*	-	Acanthaceae	-
12	*Eragrostis tenella*	-	Poaceae	-
13	*Euphorbia hirta*	Dudhi	Euphorbiaceae	-
14	*Gomphrena globosa*	-	Amaranthaceae	-
15	*Heteropogon contortus*	Kuri	Poaceae	-
16	*Malvastrum coromandalica*	-	Malvaceae	-
17	*Musa paradisiaca*	Kela	Musaceae	Fruits edible
18	*Parthenium hysterophorus*	Gajar Ghas	Asteraceae	-
19	*Paspalum vaginatum*	-	Poaceae	-
20	*Phyllanthus fraternus*	-	Euphorbiaceae	-
21	*Rungia pectinata*	-	Acanthaceae	-
22	*Tephrosia purpurea*	-	Papilionaceae	-
23	*Saccharum spontaneum*	-	Poaceae	-
24	*Senna tora*	-	Caesalpiniaceae	-
25	*Sida cordata*	kharenti	Malvaceae	Medicinal
26	*S. rhombifolia*	-	Malvaceae	Medicinal
27	*Tridax procumbens*	Pather chatta	Asteraceae	Medicinal

1.6 RET SPECIES

The project area is largely a degraded ecosystem due to high human pressure, large scale removal of fodder and timber species for preparation of agricultural fields, construction of road, etc. As per Red Data Book of India, no rare and endangered species are reported from the project area (Nayar and Sastry, 1987, 1988 & 1990). Since most of forest pockets or forest stands are already converted for agricultural practices in the Pinnapuram area, there is no possibility of these threatened species to be found in the dry and degraded areas of the proposed project.

During the present primary survey in the project area we came across four plant species which have been reported threatened in IUCN Red List of Threatened species. *Chloroxylon swietenia* and *Dalbergia latifolia* are listed in Vulnerable category, while

Azadirachta indica and *Senna siamea* are listed in Least Concern category from the project as well influence area of this project (**Plate 1.3a & b**).

1.7 ECONOMICALLY IMPORTANT PLANT SPECIES

Though most of the natural forest cover in Pinnapuram and adjoining (Hussainapuram-Brahamanapalle village) area has been cleared for agriculture, road construction, developmental works, etc., but few patches of Southern thorn forest and southern dry mixed deciduous forest can be observed in Lower reservoir area (near Brahamanapalle village) especially adjoining to Ghani Reserve Forest area of Kurnool District of Andhra Pradesh. Vegetation is varied in the forest area depending upon land use, climate and edaphic factors. The remnant forest in the project area is rich resource for many edible plants, medicinal plants, fibre and pulp industry, etc. Comprehensive account of these plant resources is given below**:**

i) Medicinal Plants

This state harbours a wide range of medicinal and aromatic plants used in Ayurvedic, Homoeopathic, Sidha medicines or used by the local people. Many local people or tribal population inhabited in the various adjoining pockets of the forest areas, use these plants for curing their common diseases. Recent floristic diversity study in Ghani Reserve forest, identifies about 111 medicinally important plants used by the people for the treatment of common diseases in Nerramalais forest area (Khaleel and Niaz Parveen, 2013). Different parts of medicinal plant species were used by local people as medicine (Mudgal and Hajra, 1999). Some of the important medicinal and aromatic plants of the project area are given in **Table 1.3** (**Plate 1.4 a, b & C**).

Table 1.3 Some of the medicinal plants recorded in the Standalone component of Pinnapuram IREP

Botanical Name	Indian/Local Name	Family	Part used
Abutilon indicum	Aphra	Malvaceae	Roots
Acacia arabica	Nallathumma	Mimosaceae	Pods
Azadirachta indica	Vepa	Meliaceae	Leaves, Twigs
Balanites aeygptiaca	Hingota	Simarubaceae	Fruits
Caloptropis gigantea	Aankh	Asclepiadaceae	Roots
Cassia fistula	Irugudu	Caesalpiniaceae	Pods
Catunaregam spinosa	-	Rubiaceae	Fruits
Cissus quadrangularis	Hadjod	Vitaceae	stem
Datura metel	Dhatura	Solanaceae	Fruits
Dicliptera bupleuroides	-	Acanthaceae	Roots
Feronia limonia	Bhenta	Rutaceae	Leaves
Gmelina arborea	Kumbili	Verbenaceae	Fruits
Gymnosporia spinosa	Tandarsi	Celastraceae	Leaves
Ipomoea carnea	-	Euphorbiaceae	Roots
Mimosa hamata	-	Mimosaceae	Fruits
Phyllanthus fraternus	-	Euphorbiaceae	Leaves

Senna auriculata	Tangadi	Caesalpiniaceae	Leaves
Senna siamea	Mezali	Bignoniaceae	Leaves
Sida cordata	kharenti	Malvaceae	Leaves
S. rhombifolia	-	Malvaceae	Roots
Urena lobata	Vilayti San	Malvaceae	Roots

ii) Food Plants

A variety of wild edible plants occur in the project and influence area. These includes leaves and buds of *Senna auriculata, S. siamea, Chenopodium album, Bauhinia racemosa*; fruits of *Annona squamosa, Canthium coromandelicum, Grewia tiliiifolia, Musa paradisiaca, Ziziphus jujuba, Z. maurtiana*; Seeds of *Cassia fistula, Cleome viscosa, Helicteres isora*, etc. (**Plate 1.5 a & b**).

iii) Fibre yielding species

Some fiber yielding plant species include *Abutilon indicum, Grewia tiliiifolia, Helicteres isora, Sida rhombifolia,* etc. in the project as well as influence area.

iv) Plywood and Paper pulp Industry

Some important plywood and pulp yielding species in the project influence area are *Eucalyptus* spp., *Dalbergia sissoo* (Shisham) and *Mangifera indica* (Aam).

Plate 1.1a View of land use near Brahmanpalle Village

Plate 1.2b: View of forest with tall grasses in Lower Reservoir Area

Plate 1.1a View of forest vegetation in Husainpurum Village

Plate 1.2d: View understorey vegetation in Upper Reservoir Area

Plate 1.2a View of forest vegetation in Lower Reservoir Area

View of thorny forest vegetation in Upper Reservoir area

Plate 1.3a: *Chloroxylon swietenia* (Vulnerable species in IUCN) from influence area

Plate 1.3b: *Senna siamea* (Least concern in IUCN) form Upper Reservoir Area

Plate 1.4a: *Cissus quadrangularis* (Hadjod) in Upper reservoir area

Plate 1.4b: Hadjod and *Feronia limonia* in Lower Reservoir Area

Plate 1.4c: *Balanites aegyptiaca* (Hingot) from Pinnapurum village

Plate 1.5a: Fruit edible (*Canthium coromandelicum*) in Lower Reservoir Area

Plate1.5b: *Musa paradisiaca* (Cultivation in Pinnapurum village)

2
Fauna

2.1 INTRODUCTION

Present study area is covered under the Deccan Plateau biogeographic province of India. The area comes under the jurisdiction of Kurnool district of Andhra Pradesh, a part of a distinct topographic region 'Rayalaseema'. Major area of Kurnool district is covered with agricultural land (about 65%) while designated forest area is nearly 19% (as per revenue record).

The natural floral and faunal composition of a region largely depends on the climatic conditions, relief, topography and land use/land cover. Zoo-geographically the area classified under the Indo-Malayan region. Major part of the study area is under rainfed fallow land, rainfed mixed crop land and rangeland land use, the small forest patches are in fragmented condition and the region is highly prone to drought (Anitha, 2016). The land use/land cover patterns and diversified climatic conditions reflect in the faunal composition of the region.

The present study was undertaken in the light of proposed Pumped Storage component of Pinnapuram IREP, the construction activities of the proposed projects are anticipated to lead adverse impacts on the flora and fauna of surroundings environ. The baseline data on different faunal elements would be helpful in the prediction of likely impacts of the project and in formulating a sound plan for mitigation measures.

2.2 STUDY AREA AND METHODOLOGY

The proposed project is located in Pinnapuram village of Panyam sub-division of Kurnool district. Major structure of the project envisages the creation of two reservoirs, a head race tunnel, powerhouse and embankment. The water of lower reservoir will be pumped up and stored in upper reservoir (Pinnapuram reservoir) and will be utilized for power generation. The Geographical coordinates of the proposed Pinnapuram reservoir are at longitude 78° 18' 29.17" E. and latitude 15° 35' 38.57" N.

The study essentially covered an area of 10 km radius of said structures (**Figure 2.1**). Faunal elements comprised of mammals, avifauna, herpetofauna, butterflies and other invertebrates. The data was gathered with the help of primary surveys, carried out for three seasons and secondary literature. Primary surveys included direct sightings, presence of pellets, calls and interaction with local people. To gather the data from secondary literature, Forest Working Plan of concerned Forest division was consulted. In addition, literature available from the adjoining areas was also consulted. Literature included Kurup (1992), Rao *et al*. (2005, 2007), Manakadan (2014), Harinath *et al* (2014)

and anonymous sources. All the species reported in secondary literature mentioned above were not included in the inventory list randomly. Only those species were included in this contribution whose presence in the study area was confirmed by local people and other sources. After preparation of inventory of species, each species was subjected to the assessment for its conservation status using criteria of IUCN (2018-1) and IWPA (1972).

2.3 SPECIES DIVERSITY AND DISTRIBUTION

2.3.1 Mammals

Major part of the study area is dominated with farm practices and scrub forests. The species inhabit this area are well adapted to scrub forests and grasslands. During the study, presence of a total of 31 species could be confirmed to inhabit this area from primary and secondary sources. All species are grouped under 21 families (Table 2.1). Primates are represented by three species, of which Bonnet Macaque is most common and widely distributed in the area. Striped Hyena and Civet Cat of families Hyaenidae and Viverridae, respectively are rarely reported in the study area. Hyaena occupies open grassland while Civet Cat is found in the inner part of forest areas. The species of Herpestidae (Mongoose) are very common species of the region. They inhabit all types of habitats like forests, scrubs, settlements and agricultural fields. Indian Porcupine (Hystricidae) is generally reported from small forest patches.

Ungulates comprise three species (Wild Boar, Cheetal and Black Buck). All these species inhabit grasslands and agricultural fields. In this area they are found to raid crops, therefore, man – wildlife conflicts due to these species are common in this area. Hedge Hog (Erinaceida) and Common Indian Hare (Leporidae) are commonly found in this region. Common Indian Hare is also reported from agricultural fields and is found to damage the crops. It is widely distributed species and occupies scrubs and grasses. Chiroptera (Bats) include about 7 species, all species are common in the area. Rodents comprise 7 species, of which 6 are mice and rats while one species is squirrel. A few more species of rodents and bats are anticipated to occur in the study area.

Table 2.1: Mammal species composition in the influence zone of Pumped storage component of Pinnapuram IRE Project

S. No.	Family	Scientific Name	Common Name	Conservation Status	
				IWPA 1972	IUCN 2018-1
1	Cercopithecidae	*Macaca mulatta*	Rhesus macaque	II	LC
2	Cercopithecidae	*Macaca radiata*	Bonnet Macaque	II	LC

S. No.	Family	Scientific Name	Common Name	Conservation Status	
				IWPA 1972	IUCN 2018-1
3	Cercopithecidae	*Semnopithecus entellus*	Grey Langur	II	LC
4	Canidae	*Canis aureus*	Asiatic Jackal	II	LC
5	Felidae	*Felis chaus*	Jungle cat	II	LC
6	Hyaenidae	*Hyaena hyaena*	Striped Hyena	III	NT
7	Viverridae	*Paradoxurus hermaphroditus*	Civet Cat	II	LC
8	Herpestidae	*Herpestes edwardsii*	Indian Grey Mongoose	II	LC
9	Herpestidae	*Herpestes auropunctatus*	Small Indian Mongoose	V	LC
10	Hystricidae	*Hystrix indica*	Indian Porcupine	IV	LC
11	Suidae	*Sus scrofa*	Wild Boar	III	LC
12	Bovidae	*Antilope cervicapra*	Black Buck	I	LC
13	Cervidae	*Axis axis*	Cheetal	III	LC
14	Erinaceidae	*Paraechinus micropus*	Indian Hedge Hog	IV	LC
15	Leporidae	*Lepus nigricollis*	Common Hare	IV	LC
16	Megadermatidae	*Megaderma lyra*	Indian False Vampire	V	LC
17	Vespertilionidae	*Pipistrellus coromandra*	Indian Pipistrelle	V	LC
18	Pteropodidae	*Pteropus giganteus*	Indian Flying Fox	V	LC
19	Pteropodidae	*Cynopterus sphinx*	Short-nosed Fruit Bat	V	LC
20	Pteropodidae	*Eonycteris spelaea*	Cave Fruit Bat	V	LC
21	Rhinopomatidae	*Rhinopoma hardwickei*	Lesser Rat-tailed Bat	V	LC
22	Emballonuridae	*Taphozous longimanus*	Long-armed Sheath-tailed Bat	V	LC
23	Tupaiidae	*Anathana ellioti*	Madras Tree Shrew	V	LC
24	Soricidae	*Suncus murinus*	House Shrew	V	LC
25	Muridae	*Tatera indica*	Indian Gerbil	V	LC
26	Muridae	*Rattus rattus*	House Rat	V	LC
27	Muridae	*Mus booduga*	Field Mouse	V	LC
28	Muridae	*Mus musculus*	House Mouse	V	LC
29	Muridae	*Mus saxicola*	Elliot's Brown Spiny Mouse	V	LC
30	Muridae	*Bandicota indica*	Large Bandicoot Rat	V	LC
31	Sciuridae	*Funambulus palmarum*	Indian Palm Squirrel	IV	LC

LC – Least Concern, NT = Near Threatened

Conservation Profile: Most of the species of mammals are common and widely distributed in Deccan region. Majority of the species are under 'Least Concern' under the assessment of IUCN redlist (2018-1). Following the criterion of IWPA (1972), Black Buck is listed under Schedule I.

2.3.2 Avifauna

A total of 71 species of birds were recorded from the study area, which are grouped under 41 families. The families like Ardeidae, Accipitridae and Alaudidae were relatively diverse (**Table 2.2**). Out of 71 species, 27 species of birds were directly sighted and/or confirmed from the study area. The common and relatively abundant species recorded during the survey were *Bubulcus ibis*, *Egretta garzetta*, *Vanellus indicus*, *Phalacrocorax niger*, *Pavo*

cristatus, *Streptopelia senegalensis*, *Streptopelia decaocto*, *Ceryle rudis*, *Hirundo rustica* and *Corvus splendens*. In addition, local inhabitants revealed the presence of Great Indian Bustard and Lesser Florican in the surroundings of agricultural lands and grass lands. Their small populations are surviving is Rollapadu Wildlife Sanctuary (nearest protected area of project). It is located at an aerial distance of about 12 km from the nearest project component. Rollapadu Wildlife Sanctuary is very small protected area; therefore, populations of these species are also found outside of protected area. Primarily they are grassland dwellers, but they lay their eggs in and around the agricultural fields and reportedly damage agricultural crops. These species are also sufferers of man-animal conflicts in the area.

Nearly 80% of the total avifaunal species in the study area are widespread breeding resident while about 14% species are winter migrants. Seasonal migrants comprise *Himantopus himantopus* (Black-winged Stilt), *Sypheotides indicus* (Lesser Florican), *Coturnix coromandelica* Rain Quail), *Coturnix coturnix* (Common Quail) and *Dicrurus macrocercus* (Black Drongo).

Table 2.2: Avifaunal composition in the influence zone of Pumped storage component of Pinnapuram IRE Project

S. No.	Family	Scientific Name	Common Name	Conservation Status		Habit
				IUCN 2018-1	IWPA 1972	
1	Ardeidae	*Ardea cinerea**	Grey Heron	LC	IV	R
2	Ardeidae	*Ardeola grayii*	Indian Pond Heron	LC	IV	R
3	Ardeidae	*Butorides striatus*	Little Green Heron	LC	IV	R
4	Ardeidae	*Bubulcus ibis**	Cattle Egret	LC	IV	R
5	Ardeidae	*Egretta garzetta**	Little Egret	LC	IV	R
6	Podicipedidae	*Tachybaptus ruficollis*	Little Grebe	LC	IV	R
7	Anatidae	*Sarkidiornis melanotos*	Comb Duck	LC	IV	WM
8	Recurvirostridae	*Himantopus himantopus**	Black-winged stilt	LC	IV	SM
9	Charadriidae	*Charadrius hiaticula*	Common Ringed Plover	LC	IV	WM
10	Charadriidae	*Vanellus indicus**	Red Wattled Lapwing	LC	IV	R
11	Charadriidae	*Vanellus malarbaricus*	Yellow-wattled Lapwing	LC	IV	R
12	Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked Stork	NT	IV	R
13	Phalacrocoracidae	*Phalacrocorax niger**	Little Cormorant	LC	IV	R
14	Otididae	*Ardeotis nigriceps*	Great Indian Bustard	CR	I	R
15	Otididae	*Sypheotides indicus*	Lesser Florican	EN	I	SM
16	Glareolidae	*Cursorius coromandelicus*	Indian Courser	LC	IV	R
17	Pterocidae	*Pterocles exustus*	Chestnut-bellied Sandgrouse	LC	IV	R

S. No.	Family	Scientific Name	Common Name	Conservation Status		Habit
				IUCN 2018-1	IWPA 1972	
18	Accipitridae	*Accipiter badius*	Shikra	LC	I	R
19	Accipitridae	*Elanus caeruleus**	Black-shouldered Kite	LC	I	R
20	Accipitridae	*Butastur teesa*	White-eyed Buzzard	LC	IV	R
21	Accipitridae	*Circus macrourus*	Pallid Harrier	NT	IV	WM
22	Accipitridae	*Circus pygargus*	Montagu's Harrier	LC	IV	WM
23	Falconidae	*Falco tinnunculus*	Common Kestrel	LC	IV	WM
24	Apodidae	*Apus affinis**	Little Swift	LC		R
25	Rallidae	*Gallinula chloropus*	Common Moorhen	LC	IV	R
26	Phasianidae	*Pavo cristatus**	Indian Peafowl	LC	I	R
27	Phasianidae	*Francolinus pondicerianus**	Grey Francolin	LC	IV	R
28	Phasianidae	*Coturnix coromandelica*	Rain Quail	LC	IV	SM
29	Phasianidae	*Coturnix coturnix*	Common Quail	LC	IV	SM
30	Columbidae	*Streptopelia decaocto**	Eurasian Collared-dove	LC	IV	R
31	Columbidae	*Streptopelia senegalensis**	Little Brown Dove	LC	IV	R
32	Meropidae	*Merops leschenaulti*	Chestnut-headed Bee-eater	LC	IV	R
33	Meropidae	*Merops orientalis**	Small Green Bee-eater	LC	IV	R
34	Meropidae	*Merops philippinus*	Blue-tailed Bee-eater	LC	IV	R
35	Coraciidae	*Coracias benghalensis*	Indian Roller	LC	IV	R
36	Alcedinidae	*Ceryle rudis**	Pied Kingfisher	LC	IV	R
37	Alcedinidae	*Halcyon smyrnensis*	White-breasted Kingfisher	LC	IV	R
38	Cuculidae	*Centropus sinensis*	Greater Coucal	LC	IV	R
39	Cuculidae	*Cuculus micropterus**	Indian Cuckoo	LC	IV	R
40	Cuculidae	*Eudynamys scolopacea*	Asian Koel	LC	IV	R
41	Psittacidae	*Psittacula krameri**	Rose-ringed Parakeet	LC	IV	R
42	Tytonidae	*Tyto alba*	Common Barn-owl	LC	IV	R
43	Hirundinidae	*Hirundo rustica**	Common Swallow	LC	IV	WM
44	Hirundinidae	*Hirundo daurica*	Red-rumped Swallow	LC	IV	WM
45	Artamidae	*Artamus fuscus*	Ashy Woodswallow	LC	IV	WM
46	Sturnidae	*Acridotheres tristis**	Common Myna	LC	IV	R
47	Nectariniidae	Nectarinia asiatica*	Purple Sunbird	LC	IV	R
48	Corvidae	*Corvus macrorhynchos**	Indian Jungle Crow	LC	IV	R
49	Corvidae	*Corvus splendens**	House Crow	LC	V	R
50	Lanidae	*Lanius meridionalis*	Southern Grey Shrike			R
51	Dicruridae	*Dicrurus macrocercus**	Black Drongo	LC	IV	SM
52	Pittidae	*Pitta brachyura*	Indian Pitta	LC	IV	R
53	Ploceinae	*Ploceus philippinus*	Baya Weaver	LC	IV	R
54	Pycnonotidae	*Pycnonotus cafer**	Red-vented Bulbul	LC	IV	R
55	Turdinae	*Saxicoloides fulicatus*	Indian Black Robin	LC	IV	R
56	Sturnidae	*Sturnus agodarum*	Brahminy Starling	LC	IV	R
57	Timaliinae	*Turdoides caudatus**	Common Babbler	LC	IV	R

S. No.	Family	Scientific Name	Common Name	Conservation Status		Habit
				IUCN 2018-1	IWPA 1972	
58	Timaliinae	*Turdoides striatus**	Jungle Babbler	LC	IV	R
59	Turdinae	*Copsychus saularis*	Oriental Magpie-robin	LC	IV	R
60	Cisticolidae	*Cisticola juncidis*	Zitting Cisticola	LC	IV	R
61		*Prinia inornata*	Plain Prinia	LC	IV	R
62	Passeridae	*Passer domesticus**	House Sparrow	LC	IV	R
63	Motacillidae	*Anthus campestris*	Tawny Pipit	LC	IV	R
64	Motacillidae	*Anthus rufulus*	Paddyfield Pipit	LC	IV	WM
65	Alaudidae	*Eremopterix grisea*	Ashy Crowned Sparrow Lark	LC	IV	R
66	Alaudidae	*Mirafra erythroptera*	Red-winged Bushlark	LC	IV	R
67	Alaudidae	*Ammomanes phoenicurus*	Rufous-tailed Finch-Lark	LC	IV	R
68	Alaudidae	*Galerida deva*	Sykes's Crested Lark	LC	IV	R
69	Alaudidae	*Alauda gulgula*	Oriental Skylark	LC	IV	R
70	Alaudidae	*Calandrella brachydactyla**	Greater Short-toed Lark	LC	IV	WM
71	Estrildidae	*Euodice malabarica*	Indian Silverbill	LC	IV	R

LC = Least Concern; NT = Near Threatened; EN = endangered; CR = critically endangered; R = resident; WM = winter migrant; SM = seasonal migrant

Conservation Profile: Majority of the species found in the influence zone has been included under 'least concern' category of IUCN redlist. *Ardeotis nigriceps* (Great Indian Bustard), and *Sypheotides indicus* (Lesser Florican) have been assessed as 'Critically Endangered' and 'endangered' species, respectively. Both species are found in the Rollapadu Wildlife Sanctuary. In addition, *Ephippiorhynchus asiaticus* (Black-necked Stork) and *Circus macrourus* (Pallid Harrier) are 'Near Threatened' species. A total of five species including Great Indian Bustard, Lesser Florican and Shikra have been listed under Schedule I of IWAP (1972).

2.3.3 Herpetofauna

Herpetofauna of study area comprises 28 species, of which 9 species are grouped under the class Amphibia and remaining 19 species under Reptilia (**Table 2.3**). In the amphibian fauna, *Duttaphrynus melanostictus* (Common Indian Toad) and *Hoplobatrachus tigerinus* (Indian Bull Frog) were common species in the area. They are spotted frequently by local people. In reptilian fauna, *Hemidactylus brooki* (Brook's Gecko), *Hemidactylus flaviviridis* (Northern House Gecko), and *Calotes versicolor* (Garden Lizard) were recorded during the survey while the presence of *Varanus bengalensis* (Indian Monitor Lizard). *Naja kaouthia* (Indian Cobra) and *Bungarus caeruleus* (Common Indian Krait) were confirmed with help of indirect evidences.

Table 2.3: Herpetofauna species composition in the surrounding area of Pumped storage component of Pinnapuram IRE Project

S.N.	Family	Scientific Name	Common Name	Conservation Status	
	Amphibia			**IUCN 2017**	**IWPA 1972**
1	Bufonidae	*Duttaphrynus melanostictus*	Common Indian Toad	LC	-
2	Bufonidae	*Duttaphrynus stomaticus*	Marbled Toad	LC	-
3	Microhylidae	*Microhyla ornata*	Ornate microhylis	LC	-
4	Microhylidae	*Microhyla rubra*		LC	-
5	Microhylidae	*Uperodon systoma*	Marbled Ballon Frog	LC	-
6	Ranidae	*Hoplobatrachus tigerinus*	Indian Bull Frog	LC	IV
7	Ranidae	*Fejervarya limnocharis*	Indian Cricket Frog	LC	IV
8	Ranidae	*Sphaerotheca breviceps*	Indian Burrowing Frog	LC	IV
9	Rhacophoridae	*Polypedates maculatus*	Common Tree Frog	LC	-
	Reptilia				-
10	Gekkonidae	*Hemidactylus brooki*	Brook's Gecko	NE	-
11	Gekkonidae	*Hemidactylus flaviviridis*	Northern House Gecko	NE	-
12	Gekkonidae	*Hemidactylus leschenaultii*	Bark Gecko	NE	-
13	Agamidae	*Calotes versicolor*	Garden Lizard	NE	-
14	Agamidae	*Sitana ponticeriana*	Fan-throated Lizard	LC	-
15	Scincidae	*Eutropis carinata*	Common Skink	LC	-
16	Varanidae	*Varanus bengalensis*	Indian Monitor Lizard	LC	II
17	Boidae	*Gongylophis conicus*	Russell's Earth Boa	NE	IV
18	Elapiddae	*Bungarus caeruleus*	Common Indian Krait	NE	IV
19	Elapiddae	*Naja kaouthia*	Indian Cobra	LC	II
20	Colubridae	*Amphiesma stolata*	Buffstriped Keelback	NE	IV
21	Colubridae	*Coelognathus helena helana*	Trinket Snake	NE	IV
22	Colubridae	*Dendrelaphis tristis*	Indian Bronze Back	NE	IV
23	Colubridae	*Lycodon striatus*	Barred Wolf Snake	NE	IV
24	Colubridae	*Lycodon travancoricus*	Travancore Wolf Snake	LC	IV
25	Colubridae	*Oligodon arnensis*	Banded Kukri Snake	NE	IV
26	Colubridae	*Ptyas mucosa*	Indian Rat Snake	NE	II
27	Viperidae	*Daboia russelii*	Russel's Viper	LC	II
28	Viperidae	*Echis carinatus*	Green Pit Viper	NE	IV

NE = Not evaluated, LC = least concern

Conservation Profile: Under the assessment of IUCN redlist, most of the species are not evaluated for their conservation profile while all evaluated species are categorised as 'least concern'. Similarly, in the schedule list of IWPA (1972), none of the herpetofaunal species is listed under Schedule I. A total of four species namely, *Varanus bengalensis* (Indian Monitor Lizard), *Naja kaouthia* (Indian Cobra), *Ptyas mucosa* (Indian Rat Snake) and *Daboia russelii* (Russel's Viper) are listed under Schedule II. It can be inferred that the region is moderately rich in herpetofauna diversity but is relatively less vulnerable from the conservation point of view.

2.3.4 Butterflies

During the primary survey, very low number of butterfly species was recorded from the study area. It indicates that the area is poor in butterfly richness. However, much data on the butterfly fauna from the present study area in particular is not available, therefore, data of adjacent areas as baseline was used for this study. To make data to study area, only very common species were included in the present inventory (see Harinath *et al*., 2014). A total of 31 species of 5 families are reportedly found in the area (**Table 2.4**).

Table 2.4: Butterfly species composition in the influence zone of Pumped storage component of Pinnapuram IRE Project

S. No.	Family	Scientific Name	Common Name	Conservation Status	
				IUCN 2018-1	IWPA 1972
1	Nymphalidae	*Danaus chrysippus chrysippus*	Plain Tiger	NE	-
2	Nymphalidae	*Danaus limniace leopardus*	Blue Tiger	NE	-
3	Nymphalidae	*Euploea core core*	Common Crow	LC	IV
4	Nymphalidae	*Melanitis leda ismene*	Common Evening	NE	-
5	Nymphalidae	*Ariadne merione merione*	Common Castor	NE	-
6	Nymphalidae	*Euthalia nais*	The Baronet	NE	-
7	Nymphalidae	*Hypolimnas bolina*	Great Egg Fly	NE	-
8	Nymphalidae	*Junonia almana*	Peacock Pansy	LC	-
9	Nymphalidae	*Junonia lemonias*	Lemon Pansy	NE	-
10	Nymphalidae	*Phalanta phalantha*	Common Leopard	NE	-
11	Nymphalidae	*Mimacraea terpsicore*	Tawny Coster	NE	-
12	Lycaenidae	*Euchrysops cnejus*	Gram Blue	NE	-
13	Lycaenidae	*Everes lacturnus syntala*	Indian cupid	NE	-
14	Lycaenidae	*Spindasis vulcanus vulcanus*	The Silverline	NE	-
15	Lycaenidae	*Rathinda amor*	Monkey Puzzle	NE	-
16	Lycaenidae	*Spindasis ictis*	Common Short Silver Line	NE	-
17	Lycaenidae	*Spindasis nipalicus*	Silver Gray Silver Line		II
18	Papilionidae	*Graphium agamemnon*	Tailed Jay	NE	-
19	Papilionidae	*Pachliopta aristolochiae*	Common Rose	NE	
20	Papilionidae	*Papilio demoleus*	Lime Butterfly	NE	-
21	Pieridae	*Belenois aurota*	The Pioneer	NE	-
22	Pieridae	*Catopsilia pyranthe*	Molted Emigrant	NE	-
23	Pieridae	*Colotis danae danae*	Crimson Tip	NE	-
24	Pieridae	*Colotis eucharis eucharis*	Plain Orange Tip	NE	-
25	Pieridae	*Colotis fausta*	Large Salmon Arab	NE	-
26	Pieridae	*Cepora nerissa nerissa*	Common Gull	NE	-
27	Pieridae	*Eurema hecabe simulate*	Common Grass Yellow	NE	-
28	Pieridae	*Eurema brigitta*	Small Grass Yellow	LC	-
29	Hesperiidae	*Borbo cinnara*	Rice Swift	NE	-
30	Hesperiidae	*Pelopidas mathias mathias*	Small Branded Swift	NE	-
31	Hesperiidae	*Spialia galba*	Indian Skipper	NE	-

NE = not evaluated; LC = least concern

Conservation Profile: Majority of the species listed in **Table 2.4** has not been evaluated for their conservation assessment under IUCN red list (2018-1). Only three species namely *Euploea core*, *Junonia almanac* and *Eurema brigitta* have been included under 'Least Concern' category. Also, in the IWPA's schedule list most of the species are in Schedule IV.

2.3.5 Other Invertebrates

Other invertebrate fauna of the region comprises molluscs, insects, earthworm, etc. Most common mollusc species which are common in the Nallamalai hill ranges and anticipated to inhabit the study area are *Stagnicola tungabhadraensis*, *Succinea gravelyi deccallensis*, *Bellamya bengalensis, Bellanlya crassa, Gabbia stenothyroides*, etc. Insect fauna includes dragon flies, beetles, diptera, bugs, moth etc. Common dragon flies are *Ischnura delicata, Ischnura senegalensis, Anax guttatus, Copera marginipes,* etc. Common Orthoptera are represented by *Cyrtocanthacris ranacea*, *Sathrophyllia* sp, and *Gerris* sp. Hemiptera comprises *Dysdercus cingulatus*¸*Acanthaspis maculata*, *Homoeocerus signatus*, etc. Coleoptera (Beetles) are widely distributed and commonly represented by *Acanthophorus serraticornis*, *Prionomma atratum*, *Plocaederus* spp., *Heliocopris bucephalus*, *Oxyoetonia versicolor*. Common moth (Lepidoptera) species are *Nyctipao heiroglyphica*, *Othreis fullonica*, *Spodoptera mauritia*, *Eumeta crameri*, *Daphnis nerii*, *Marumba dyras,* etc. Common annelid species of this area is *Octochaetona albida*.

2.4 CONCLUSION

The faunal species mentioned under various groups are widely distributed in Indian sub-continent especially in Deccan Plateau. Except a few butterfly species, none of the species is endemic to this region and Deccan biogeographic region. However, a few threatened and Schedule I species especially mammals and birds are found in the study area.

Rollapadu Wildlife Sanctuary is nearest protected area of influence area of the proposed project, located beyond 10 km radius of the project. It is small sanctuary and harbours a good population of Great Indian Bustard, Lesser Florican and many mammal species like Jackal, Jungle Cat, etc. To conserve the biodiversity of the region, an effective and sound biodiversity management plan is warranted, which needs to address the concerns of local people, likely impacts of the project and involvement of local communities in the conservation strategies.

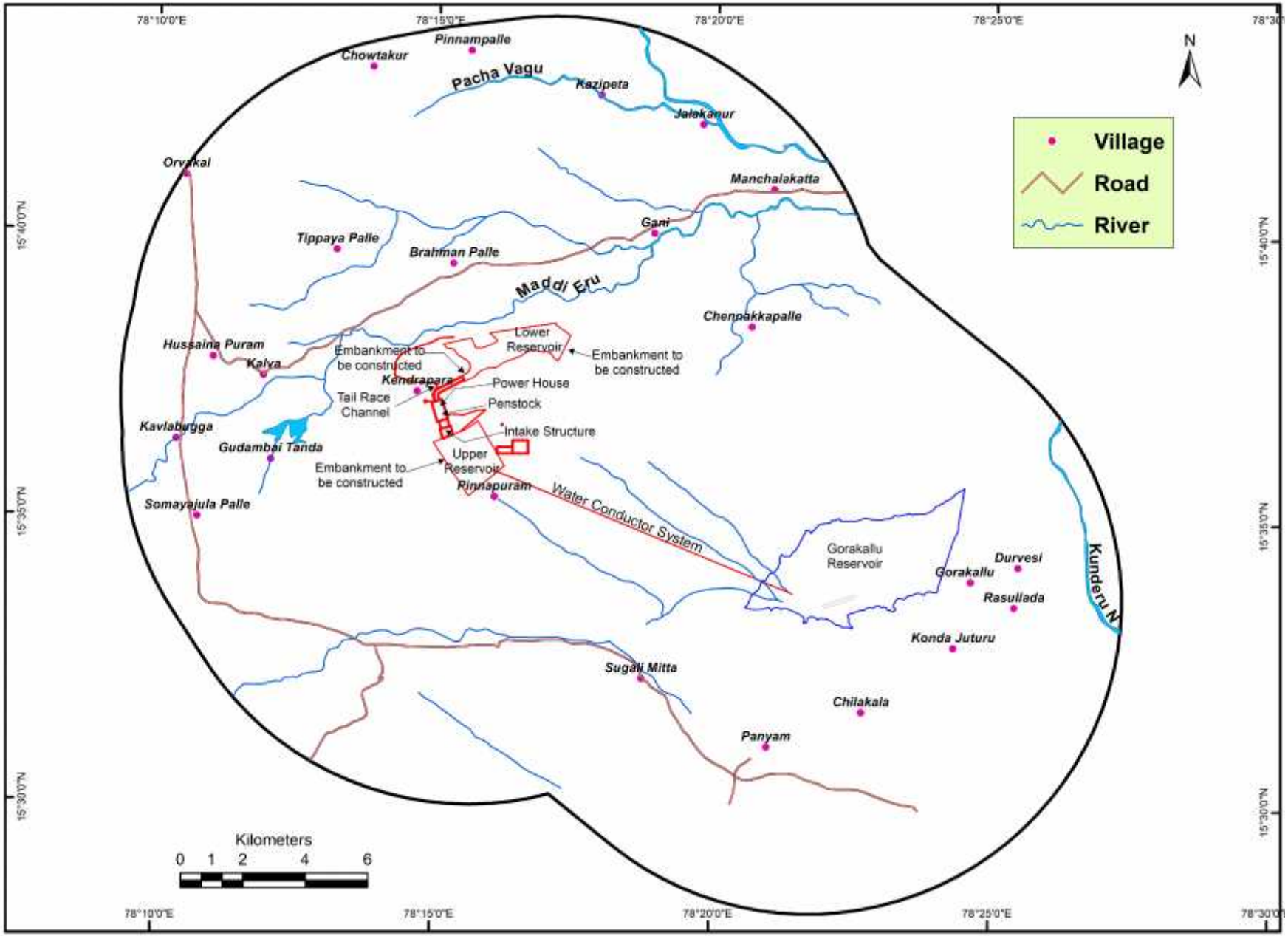

Figure 2.1: Area demarcated for the biodiversity studies

3

Biodiversity Management & Wildlife Conservation Plan

3.1 BACKGROUND

Habitat degradation, land use /land cover changes, hunting and poaching, invasiveness of exotic species are main threats to native biodiversity and wildlife. Most of these phenomena are related to man induced activities like population growth, increasing agricultural practices, urbanization, road construction and other developmental activities. In recent years, the pace in the developmental activities has led to additional pressures on biodiversity, as a result, not only the wildlife is under severe threats but there are increasing incidences of man – wildlife conflicts in many areas of India. The biodiversity conservation practices face many challenges, one of the challenges is socio-economic constraints of local population as their livelihood depends on the forests and forest resources.

The outline of biodiversity management plan relies on many factors related to the area of implementation. Understanding of diversity and distribution of floral and faunal species, identification of existing threats to biodiversity, concerns of local inhabitants and impacts of developmental activities on animal and plant species play an important role in preparation of sound management plan.

3.2 PROJECT ACTIVITIES AND LIKELY IMPACTS

Project activities are anticipated to lead additional stresses on the plant and animal species. The magnitudes of the impacts of the projects would rely on the size of project activities. The major activities involved in the proposed project are embankments, construction of new roads, dumping of muck, construction of tail race tunnel, project colonies, etc. Embankments are rock fill type having an average height of average height of around 12m to 14m with maximum of 33 m height in lower reservoir and 35 m in upper reservoir for very short reach for creation of Pinnapuram IRE Project upper and lower reservoir with 1.20 TMC live storage capacity. A 70 m wide concrete lined Tail race channel with FSD of 6.00m and 1300 m long connecting Tail race channel to the lower reservoir is proposed for the project. Total land required for various activities, viz. reservoir area, muck dumping, quarrying, construction camps and colony, etc. is 713.65 ha. In addition, ancillary activities like transportation of much, high level of noises, high concentration of particulate matter, vehicular movement, and influx of migrant labourers are associated with the project activities. All these activities are anticipated to lead to adverse impacts on the biodiversity of the project and its influence area.

3.3 BIODIVERSITY IMPORTANCE OF THE AREA

As per biogeographic classification of India, the study area is covered under Deccan Plateau biogeographic region. In terms of species richness, this region is not considered as rich as Western Ghats and Himalayan biogeographic regions. Majority of the species inhabiting this region are widely distributed in Indian sub-continent, however, many threatened species, especially faunal species are found in this zone including present study area. The important species included under IUCN red-list or/and Schedule I list of IWPA are *Antilope cervicapra* (Black Buck) among mammals, *Ephippiorhynchus asiaticus* (Black-necked Stork), *Ardeotis nigriceps* (Great Indian Bustard), *Sypheotides indicus (*Lesser Florican), *Pavo cristatus* (Indian Peafowl) among birds. In addition, there are a few plant species like *Dalbergia latifolia*, *Chloroxylon swietinia*, *Azadirachta indica* (Tree), *Gymnosporia spinosa*, *Senna auriculata*, *Justicia adhatoda* (Shrub), *Senna simea*, *Cissus quadrangularis*, *Alternanthera sissilis*, which are either included under IUCN red-list or having medicinal importance or are under threats. The proposed biodiversity and conservation plan would be focused mainly on these species.

3.4 CONCERNS OF LOCAL INHABITANTS

Usually the livelihood of villagers is associated to forests and forest resources. However, animal hunting and poaching for food, games and trophies is not reported from the zone of influence of proposed project. It would be worthy to mention that a few species like Black Buck, Wild Boar, Indian Hare, Great Indian Bustard and Lesser Florican are reported to raid agricultural land and reportedly damage the crops, which results in the man – wildlife conflicts. To control such conflicts, this issue is also needed to address in biodiversity management plan.

3.5 PLAN OF ACTION

The management and conservation strategies may affect the traditional rights of local people. Taking these concerns into account, the involvement of local people in formulation of effective management plan would be helpful in its implementation. Considering all factors related to local people, biodiversity of the region, size of the project and magnitude of the impacts, the present biodiversity management plan is proposed for Pinnapuram Pumped Storage project.

3.5.1 Awareness Programme

An effective wildlife conservation plan is a participatory management, involving the local communities in the conservation strategies. This approach requires a comprehensive awareness programme on the significance, benefits and sustainable utilization of biodiversity and forest resources. The awareness programme would focus on the fact that the protection of grassland dwelling species like Great Indian Bustard, Lesser Florican, and

small mammalian species can be achieved by the protection of grasslands, which would be beneficial to local people also (Rahmani, 2003). Local people can play a significant role in the implementation of this plan. The awareness programme would take certain issues like prevention of forest fire, to avoid the man-wildlife conflicts, not to damage the eggs/nets of bird species like Bustard and Florican, into account etc. These species wander in search of food and to lay eggs and raid agricultural fields, where they are encountered with local people. Awareness programme can be implemented by organising the public meetings with the help of NGOs and Forest Department, distributing pamphlets, posters and hoardings, etc. Total budget estimated for awareness programme is **Rs. 10,00,000** only.

3.5.2 Development of Grasslands

Black Buck, Jackal, Peacock, Common Indian Hare, Great Indian Bustard, Lesser Florican, etc. are grassland dwellers and forage around the cultivated lands. Black Buck, Common Indian Hare, Great Indian Bustard and Lesser Florican reportedly invade cultivated fields and damage the standing crops of local peoples. To prevent the crops from these animals, to control the animal raids, and to avoid the man-animal conflicts and to protect these species, there would be needs of more grasslands in the area. The development of grassland can be achieved by joint forest management mechanism by involving local people. Such grassland can be developed on the government and community lands. The development of new grasslands would be beneficial to local people and would control the animal raids on private agricultural lands. This programme would be implemented by Forest Department having a sound Joint Forest Management mechanism. The detailed plan of action for this plan would be formulated by forest department. Total financial outlay for this plan is **Rs. 50,00,000** only.

3.5.3 Fire Protection Measures

Grasslands are high prone to fire; forest fire is one of the concerns in this area. Forest fire damages not only palatable grasses, seedlings and other plants but damages the nests and eggs of birds and reptiles and increases the growth of a few non-palatable grasses to wild animal like *Heteropogon contortus* in this area. Thus, fire protection is an important component of management. A detailed programme on the identification of forests and grassland patches, which are habitats of Great Indian Bustard, Florican, Black Buck, etc. and are prone to forest fire, is proposed in the peripheral areas of the project. These patches would be provided with proper fire lines. State Forest Department shall implement this plan. Total financial outlay under this head is **Rs. 20,00,000**.

3.5.4 Infrastructure Development & Strengthening of Patrolling

To protect the biodiversity of the zone of influence, improvement in infrastructure facilities is warranted. In this plan project authorities would assist State Forest Department in strengthening the infrastructures, so that State Forest Department can contribute to the biodiversity protection of this area. This plan will be implemented in the zone of influence of proposed project. Project authorities would provide one-time grant to State Forest Department to improve the infrastructure for the conservation of biodiversity. In order to improve the vigilance, to monitor the wildlife movement, and to check the poaching, State Forest Department shall be provided with grant to build necessary facilities like watch towers, check posts and patrolling paths and also grant for purchase of equipment like, cameras, binoculars, sleeping bags, search lights, health kits etc. Patrolling parties need to be equipped with Wireless communication system for more efficient system. Project authorities would provide funds to State Forest Department. Total financial outlay under this head would be **Rs. 50,00,000** only.

3.5.5 Conservation Measures for RET species

As already discussed, one Schedule-I mammal species Black buck is found in the project area. In addition, 5 Schedule I bird species are also found in and around the project area. Therefore, a conservation plan has been suggested for them.

I. Blackbuck (*Antelope cervica*pra)

Blackbuck is a species which thrives in open plains, scrub land, and agricultural fields and moves in herds of about 50. They are primarily grazers and avoid forested areas. They are common in the project area as well as Rollapadu Wildlife sanctuary where its increasing numbers are disturbing the habitat of Great Indian Bustard. They are known to move long distances in search of water and forage in summers (Rahmani, 2001). Despite their adaptability, Blackbuck are subject to increasing pressure from human population growth, increasing numbers of domestic livestock, and economic development.

Conservation Measures

- Ban on removal of bushes, creepers and closed canopy and thick undergrowth near tall grassland areas where these animals are found as they prefer closed canopy and thick undergrowth for resting and nursing young ones but may use open or scrub forest for foraging purpose.
- Development of some fruit trees or flower plants with seeds and pods near the areas of its habitat. Augmentation of its habitat with some shrub species with soft stems or creepers or climbers and small trees with thick leaves should be developed as they prefer leaflets of shrubs, trees and creepers.

- Fire protection - will save fodder from burning, also their breeding and littering sites.

II. Great Indian Bustard (*Ardeotis nigriceps*)

This species is listed as Critically Endangered because it has an extremely small population that has undergone an extremely rapid decline owing to a multitude of threats including habitat loss and degradation, hunting and direct disturbance. It prefers semi-arid grasslands with scattered short scrub, bushes and low intensity cultivation in flat or gently undulating terrain. There are no suitable habitats of semiarid and grass-land ecosystem in and around study area as the study area habitat is dominated by agroecosystem. The main threat to its habitat is agricultural expansion. Though it was not sighted in the study area during the surveys, following conservation measures have been suggested.

Conservation Measures

- They avoid foraging inside the sanctuary and are seen in open grasslands adjoining the sanctuary (Rao & Javed, 2005). The breeding season is between April and December. Blackbuck is of major concern in the area. Villagers tend to shoo them away from raiding their crops and they are known to enter from the Sanctuary. Therefore, biotic interference near the sanctuary should be monitored and disturbance to be checked.
- Creation of awareness among local people as well as staff and contractors about the importance of protecting the habitat and foraging grounds outside the sanctuary.
- Creation of Environmental Cell to monitor any probable movement of Bustard in and around the project area.

III. Lesser Florican (*Sypheotides indica*)

It has listed as Endangered because its population rapidly due to pressure on remaining grasslands intensifies, and areas of its habitat are lost and degraded. It was not sighted during the surveys as it is found in general in Rollapadu Wildlife sanctuary. It occurs in productive dry grasslands, in lowland areas particularly dominated by *Sehima nervosum* and *Chrysopogon fulvus*, with scattered bushes and scrub; with breeding areas coinciding with areas of black cotton soil (Yahya, 2016).

Conservation Measures

- As hunting is one of the major causes of its declining populations, it should therefore be checked in consultation with forest department officials and severe penalties to be levied on anyone indulging in hunting in the project area.
- Grasslands in and around the project area should be protected and should not be allowed to be converted into agricultural fields.
- Project need to employ biodiversity specialist to monitor the movement of Blackbuck, Great Indian Bustard and Lesser Florican.

Similar conservation measures should be adopted for Schedule I species like Black shouldered kite and Shikra though they have been listed under Least Concern category in IUCN Redlist 2018-1.

For the Peafowl, an Eco-park has been proposed for their protection in the following section. In addition, hunting of Peafowl especially should be checked with the help of forest department.

3.5.6 Establishment of Eco-Park

For the preservation and conservation of biodiversity and wildlife in the area an Eco-Park (short for Ecological park) housing a Nature Interpretation Centre (NIC) may be developed. Eco-Park is setup generally as an entertainment cum education park without hampering its natural environment so that the biodiversity remains unaffected there. Generally, a particular area of a forest/Natural heritage/landscape is set aside or demarcated and brought under intensive management for this purpose.

The Nature Interpretation Centre (NIC) is a kind of museum, often associated with visitor centres or eco-museums, and built and located in areas to preserve biodiversity and cultural diversity. Interpretation centres use different means of communication to enhance the understanding of natural heritage. Environmental interpretation is usually carried out in areas which facilitate knowledge about nature and the relationship between society and nature in a specific location or region. The creation Eco-Park including Interpretation Centre will have trails and walks for use by the visitors as an important support mechanism for the environmental education process and complementing the educational possibilities in more innovative ways. NIC shall have an auditorium to showcase documentaries and movies of the ecosystem, a photography exhibition centre, a walkthrough of wildlife, an open museum with replicas of wild animals, a craft shop for souvenirs, an office block for management. The centre shall also host 'Teach the Mentor' programmes, where school and college teachers from neighbouring areas can experience

and learn more about the region's biodiversity first-hand. That way, they can educate the next generation about the importance of conserving the ecosystem, too.

The establishment of an Eco-park cum NIC would play an important role as creation of vegetation belt and cover in otherwise degraded landscape in the study area and act as a check against possible dust and noise pollution in the area and in creating awareness among the people. The rehabilitated muck disposal area can be utilised for the development of eco-park. The eco-park can be used for walks, jogging, and other activities. Most importantly avenue plantation to be done at the boundaries of park can act as a natural barrier and the park area can become roosting places for peafowl. The important plant species which are suggested to be planted in the proposed park are *Dalbergia sissoo*, *Azadirachta indica*, *Terminalia arjuna,* and *Senna auriculata* because of their height. The height of first branches of *Dalbergia sissoo* and *Azadirachta indica* can offer better protection to Peafowl from predators like stray dogs and humans. Peafowl can then watch the approaching predators as a safety measure as they would be able to hide behind the foliage of bigger trees. The budget heads include development of a nursery, collection of seeds and plant species, small laboratory and staff. For the landscaping of such park a professional landscape architect may be engaged along with the help of Forest Department, Government of Andhra Pradesh. Total budget allocated for the establishment of the ECO Park cum NIC is **Rs. 120,00,000** only.

3.5.7 Good Practices

Project authorities would follow a few precautionary and good practices in the project areas. Such types of practices are not expensive but play a vital role in protecting the biodiversity. The important safeguard measures as good practices are given below:

i. Project authorities shall organise a training programme for the workers. All project workers must be aware of importance of biodiversity and all such types of activities related to endangering the wildlife including plants and animals. All project workers must be aware of presence of a few threatened and Schedule species in the area and legal consequences of hunting, poaching of animals and harvesting of forest produces.
ii. Each project worker shall be provided with an identity card and would not be allowed to enter in the village, forest, grassland and protected areas without a valid permission.
iii. Project authorities will be bound by rules and regulation of Wildlife (Protection) Act, 1972 of India and any others rule and guidelines, stipulated by the state Government.

iv. Project workers will be discouraged to plant any alien and/or invasive species in the camp and colony areas, which may spread in the forest areas. State Forest Department can provide the list of such plant species. Project authorities would ensure to uproot all existing alien/invasive species from the colony and other working areas. Restriction shall be imposed on the disposal of any types of pesticide, poison and other toxic material in the forest areas.

v. Project authorities are suggested to follow the mechanism of control blasting especially in the breeding season of a threatened species wandering in the close vicinity of the project. This activity is to be restricted during nights, early mornings and late afternoons, which are the feeding times of most of the fauna. Total budget allocated for the implementation of good practices is **Rs. 5,00,000** only.

3.6 SETTING UP OF BIODIVERSITY MANAGEMENT COMMITTEE

In order to monitor the implementation of proposed Biodiversity Management and Wildlife Conservation plan, a biodiversity management committee (BMC) would be constituted for the project. The committee shall follow the guidelines of National Biodiversity Authority, State Biodiversity Board and State Forest Department. The Biodiversity Management Committee for Standalone Pumped Storage component of Pinnapuram IRE project comprises the following members:

Chief Wildlife Warden/his/her representative	Chairman
Project Director /his/her representative	Member Secretary
Divisional Forest Officer	Member
Chief (Environment), Project	Member
Renowned wildlife expert (1 or 2 Nos)	Member(s)
Local Body's Representatives from at least 3 villages	Member(s)
Representative of a well-known local NGO	Member

Chairman will have right to assign different tasks to different members for proper functioning of plan. Also, the number of members of committee mentioned above may be increased or decreased or changed as per need. Project authorities would provide funds and facilities for the functioning of committee. Total financial outlay for the functioning of BMC is **Rs. 5,00,000** (Five lakhs) only.

3.7 BUDGETARY ESTIMATES

Total budget allocated for the Biodiversity Management and Wildlife Conservation Plan for Pinnapuram IRE Project would be **Rs**. **310,00,000** (Rs. Three hundred Ten lakhs) only. Break-up of the budget is given in Table 3.1.

Table 3.1: Break-up of the Biodiversity Management and Wildlife Conservation Plan

S. No.	Particulars	Total Budget (in Lakh)
1	Awareness Programme	10.00
2	Development of Grasslands	50.00
3	Fire Protection Measures	200.00
4	Infrastructure Development	50.00
5	Monitoring of populations of Schedule I species in and around project area, Checking and monitoring of hunting	50.00
6	Establishment of Eco Park	120.00
7	Good Practices	5.00
8	Biodiversity Management Committee	5.00
	Total Budget	**310.00**

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No. J-11011/1/2013-IA-I
Government of India
Ministry of Environment & Forests
IA-I Division

Paryavaran Bhawan,
CGO Complex, New Delhi

Dated: 3rd December, 2013

Office Memorandum

Sub:- Streamlining of process of Environment Clearance (EC) and Forest Clearance (FC) cases by Expert Appraisal Committee (EAC) & Forest Advisory Committee (FAC) respectively for Hydropower and River Valley Projects (HEP&RVP)-Names of Institutes capable for conducting studies.

This Ministry had reviewed the issues which are normally considered by both the EAC and FAC while examining the EC and FC cases respectively in respect of hydropower and river valley projects (HEPs & RVPs) with a view to streamlining the processes and avoiding duplication of efforts by the two Committees. Accordingly, an OM of even number dated 28.5.2013 was issued on the captioned subject.

2. Vide Para 3(ii) of the above OM, a list of Institutes for conducting Bio-diversity studies by the Project Proponents under EIA of HEP &RVP was required to be published.

3. ICFRE and WII, Dehradun have provided names of the potential Institutes in this regard, which is enclosed for information and further necessary action.

(B. B. Barman)
Director
Telefax: 24362434

To,

1. PS to Minister (E&F)
2. PPS to Secretary (E&F)/DG(Forests)/ JS (AT)/JS(MS)/IG(F)
3. Chief Secretaries of all States
4. Additional Secretary, Ministry of Power, Shram Shakti Bhawan, New Delhi. Fax 23350780
5. Environment & Forest Secretaries/Principal Secretaries of all States
6. Joint Secretary, Ministry of Power, Shram Shakti Bhawan, New Delhi. Fax 23350780
7. All the Officers of IA Division
8. Chairpersons / Member Secretaries of all the SEIAAs/SEACs
9. Chairman, CPCB
10. Chairpersons / Member Secretaries of all SPCBs/UTPCC
11. Website of the MoEF through NIC
12. Guard File

13. Indian Council of Forestry Research and Education (ICFRE)
P.O. New Forest
Dehradun 248006

14. Zoological Survey of India
M Block, New Alipore
Kolkata 700 053
Telefax: 033 24008595
Email: zsikolkata@gmail.com

15. Botanical Survey of India,
P-8, Brabourne Road,
Calcutta – West Bengal

16. Salim Ali Center for Ornithology and Natural History (SACON)
Anaikatty P.O.,
Coimbatore 641 108 (Tamil Nadu)

17. National Institute of Oceanography (NIO)
Dona Paula-Goa, 403 004

18. National Environmental Engineering Research Institute (NEERI)
Nehru Marg,
Nagpur 440020

19. Centre for Ecological Science
Indian Institute of Science
Bangalore 560 012

20. Central Arid Zone Research Institute (CAZRI)
Near Industrial Training Institute (ITI)
Light Industrial Area
Jodhpur - 342 003 (Rajasthan)

21. Indian Institute of Forest Management (IIFM)
Nehru Nagar, PO Box # 3577
Bhopal 462 003

22 Indian Institute of Remote Sensing (IIRS),
4, Kalidas Road,
Dehradun.

23 G.B. Pant Institute of Himalayan Environment and
Development (GBPIHED)
Kosi-Katarmal, Almora-263 643

24 North Eastern Regional Institute of Science and Technology (NERIST)
Nirjuli (Itanagar) - 791109
Arunachal Pradesh

25 Environment Protection Training and Research Institute (EPTRI)
91/4, Gachibowli, Hyderabad - 500 032
Andhra Pradesh

Universities

26 University of Delhi,
Delhi 110 007

27 H.N.B.Garhwal University
Srinagar –
Dist.Pauri Garhwal
Uttarakhand – 246174

28 Bharati Vidyapeeth Institute of Environment Education & Research
(Bhartiya Vidyapeeth Deemed University)
Katraj-Dhankawadi,
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29 Manipal University
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30 Anna University
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