

KALAI POWER PRIVATE LIMITED



1200MW Kalai-II Hydroelectric Project

Comprehensive Environmental Impact Assessment Study Report

EXECUTIVE SUMMARY REPORT

July 2013



WAPCOS LIMITED

(A Government of India Undertaking)

PLOT NO. 76 - C, SECTOR 18, GURGAON -122 015, HARYANA

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EXECUTIVE SUMMARY

1. GENERAL

The river Lohit is a perennial river with its main source being snow melts of Himalayan glaciers and other small streams. During the lean season i.e. from November to March every year there is a drop in discharge. The Lohit River offers good sites for hydro power development. For the optimal use of head and water, cascade development is envisaged to harness the natural river gradient of Lohit River. The coordinates of the dam site are Lat. 27°54' 20" N and 96° 48' 16" E. The project location map is enclosed as Figure-1.

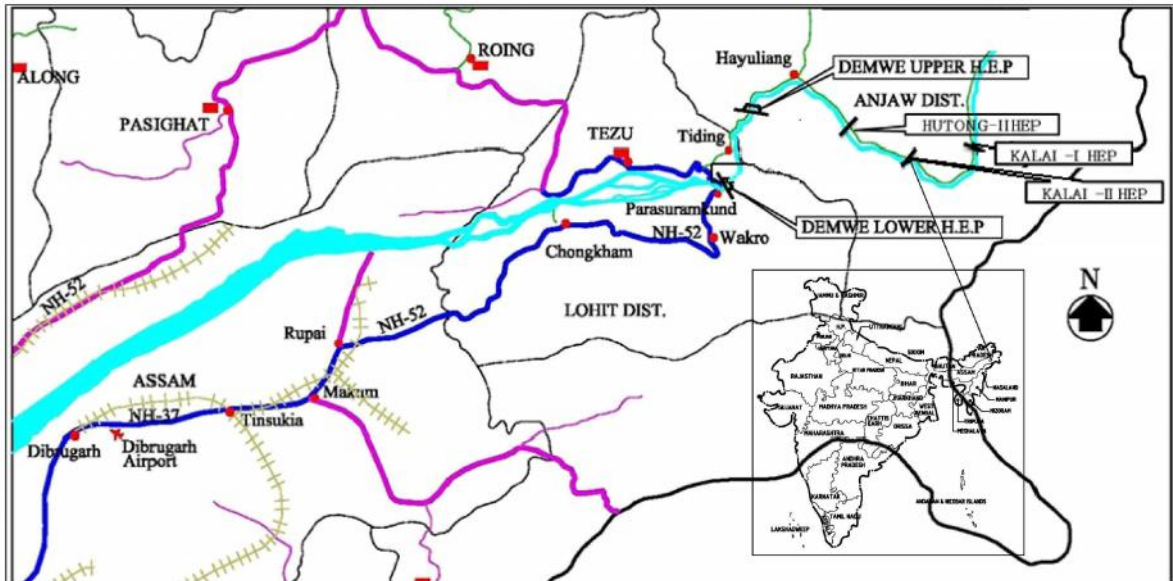


Figure-1: Project Location Map

2. PROJECT DESCRIPTION

The Gross and diurnal Storage of the Kalai-II reservoir are 318.8 M cum and 29.76 M cum with FRL at El 904.80 m and MDDL at El 900.00 m respectively. The dam on river Lohit shall be concrete dam with spillway and a separate diversion structure for diverting a regulated discharge of 1137.2 cumec through 5 nos. 7.5m dia & 1 no. 8.5m dia Head Race Tunnels. The powerhouse shall be underground with a capacity of (6 x 190 + 60) 1200 MW located on the right bank of the river.

The catchment area up to the proposed dam site including the Tibet region is estimated to be about 15,654 sq. km. The full reservoir level (FRL) is at EL 904.80m. The project involves construction of a concrete gravity dam, upstream & downstream coffer dam, diversion tunnel, intake tunnel, pressure Shafts, underground Powerhouse complex, surge chamber and Tail Race Tunnel etc. The total optimized land requirement for the project including underground structures is 1100 ha. The project layout map of Kalai-II HEP is appended as Figure-2.

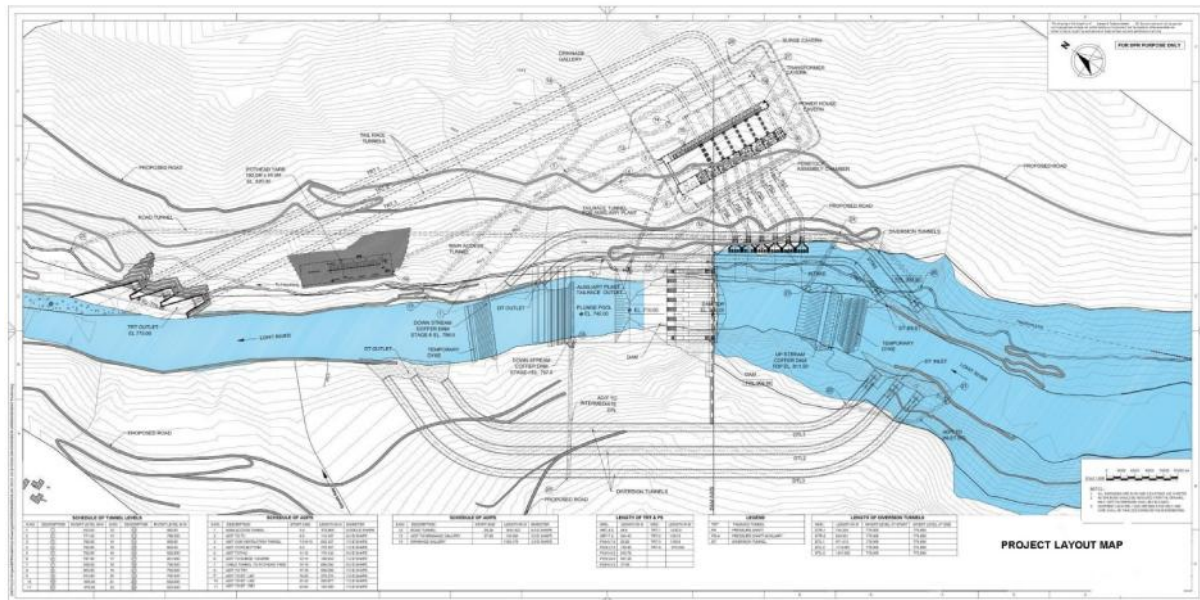


FIGURE-2

Figure-2: Project layout map of Kalai-II HEP

The total land required for the project is 1100 ha. The details of land required for various project appurtenances is given in Table-1.

TABLE-1
Land requirement for Kalai-II hydroelectric project

| S. No. | Description | Area (ha) |
|--------|---|-------------|
| 1 | Reservoir Area | 640 |
| 2 | Project Components Area | 160 |
| 3 | Muck Disposal & Quarry Area | 90 |
| 4 | Project Roads & Infrastructure | 80 |
| 5 | Road realignment | 30 |
| 6 | Infrastructure -Fabrication Yard, Steel Plates Stock Yard, Fabricated, Ferrules Stock Yard, Electrical Warehouse, stores, HM stock Area | 25 |
| 7 | Crushing Plant, Batching Plant, Aggregate stock pile area, Cement Storage & facilities | 10 |
| 8 | Contractor Camp & Owner Township | 30 |
| 9 | R&R Colony | 20 |
| 10 | Surface Area for underground works | 15 |
| | Total | 1100 |

3. STUDY AREA

The study area considered for the CEIA study is given as below:

- Submergence area
- Area within 10 km of the periphery of the submergence area
- Area to be acquired for siting of various project appurtenances.
- Area within 10 km of various project appurtenances
- Catchment area intercepted at the barrage site

The study area is enclosed as Figure-3.

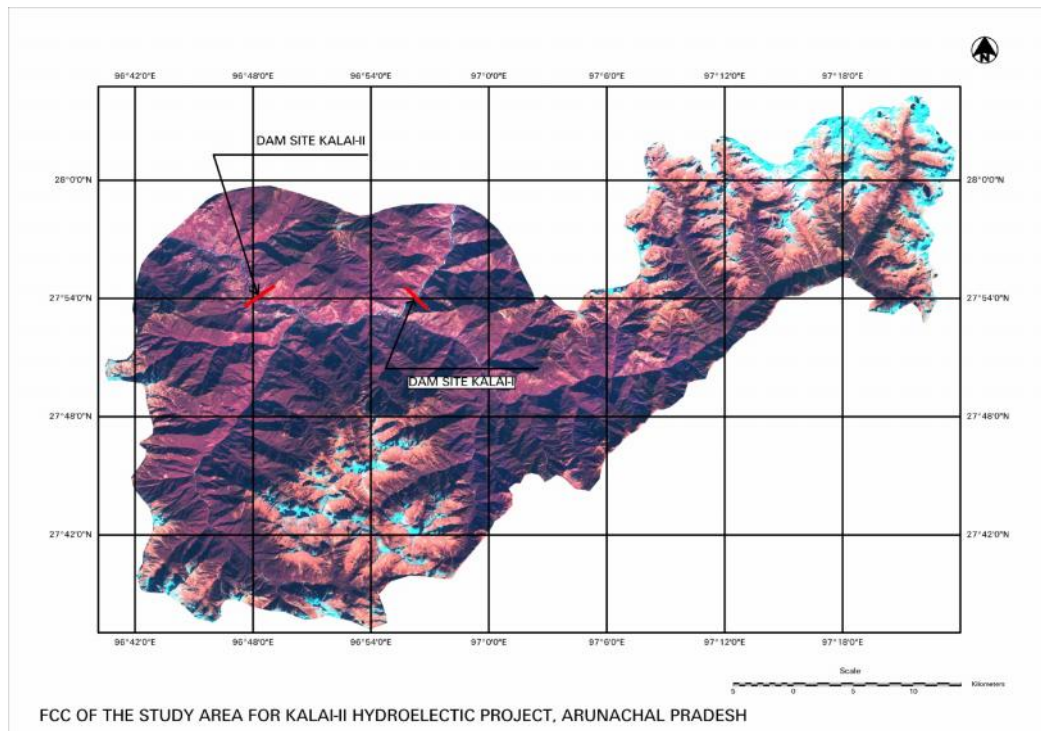


Figure-3: Satellite imagery (FCC) of the study area for Kalai-II HEP

4. FIELD STUDIES

As a part of the EIA study, primary data has been collected. for three seasons.. The details are given in Table-2.

TABLE-2
Details of field studies conducted as a part of CEIA studies

| Season | Months |
|---------|------------------------------|
| Winter | December 2010 - January 2011 |
| Summer | April - May 2011 |
| Monsoon | July- August 2011 |

5. ENVIRONMENTAL BASELINE STATUS

5.1 Physico-chemical Aspects

5.1.1 Meteorology

The climate of Lohit basin is characterized by cool and highly humid conditions at lower elevations and in the valleys and intensively cold weather at higher elevations. The winter season commences from late November and continues up to March followed by summer season from April to May. The rainfall in the basin is mainly received under the influence of south-west monsoons, which sets in by the second week of May and continues up to October. However major portion of the rainfall occurs during the period from June to August. The monsoon season is followed by a dry spell upto January. Subsequently, some rainfall is again received in the months of February and March. The average annual rainfall in the Lohit basin ranges from 2500 to 5000 mm.

5.1.2 Landuse pattern

The landuse pattern of the study area has been studied using satellite data and the details are given in Table-3.

TABLE-3
Land use pattern of the study area

| S. No. | Category | Area(ha) | Area(%) |
|--------|----------------------|---------------|---------------|
| 1 | River | 4397 | 2.53 |
| 2 | Dense Vegetation | 94225 | 54.17 |
| 3 | Open Vegetation | 31974 | 18.38 |
| 4 | Grass/Scrubs | 1742 | 1.00 |
| 6 | Snow | 10956 | 6.30 |
| 7 | Degraded/Barren Land | 30505 | 17.54 |
| 8 | Settlements | 160 | 0.09 |
| | Total | 173959 | 100.00 |

It is evident from Table-2, that major land use category in the study area is forest, which accounts for almost 72.55% of the study area. The other major category is Degraded/Barren Land accounting for about 17.54% of the study area. The Grass/Scrubs accounts for about 1.0% of the study area. Area under snow accounts for about 6.3% of the study area.

5.1.3 Soils

The soils are in neutral range. The EC levels are low. The EC levels indicate that the salt content in the soils is low. The level of various nutrients and organic matter indicates low to moderate soil productivity. In a hydroelectric project, no significant impact on soil quality is expected barring, soil pollution at local level due to disposal of construction waste. For amelioration of such impacts appropriate management measures are recommended.

5.1.4 Water Quality

The pH level in various water samples monitored the project area of Kalai-II hydroelectric project ranged from 7.2 to 7.7. The pH level indicate neutral nature of the water. The TDS level ranged from 47-50 mg/l, 40-43 mg/l and 34-40 mg/l in winter, summer and monsoon seasons respectively, which is well below the permissible limit of 500 mg/l specified for drinking water. The hardness level ranged from 25 to 37 indicating soft nature. The hardness level was well below the permissible limit of 200 mg/l specified for drinking water. The chlorides level ranged from 4 to 10 mg/l, which is well below the permissible limit specified for drinking water (200 mg/l). The sulphates was found to be well below

the permissible limit of 200 mg/l specified for drinking water purposes. The concentration of various cations was observed to be quite low which is also reflected by the low TDS level. Iron was found to be well below the permissible limit of 1 mg/l specified for drinking water purposes.

The concentration of various heavy metals was found to be well below the permissible limits. Concentration of phenolic compounds and oil & grease as expected in a hilly terrain with no major sources of water pollution from domestic or industrial sources was observed to be quite low.

The BOD and total coliform values are well within the permissible limits, which indicate the absence of organic pollution loading. The DO level ranged from 9.6 to 9.8 mg/l at various sampling locations monitored for three seasons as a part of the study. The DO levels were close to saturation limits in water, indicating the excellent quality of water in the study area.

5.1.5 Ambient Air Quality

Based on the findings of the ambient air quality survey, conducted for the summer, post-monsoon and winter seasons, it can be concluded that the ambient air quality is quite good in the area. The values of these parameters were well below the permissible limits specified for residential, rural and other areas. The absence of industries, low vehicular traffic and low population density can be attributed for good ambient air quality in the project area.

5.1.6 Ambient Noise Level

The day time equivalent noise level in post-monsoon, winter and summer seasons at various sampling were well within the permissible limit specified for residential area. The absence of industries, low vehicular traffic and low population density can be attributed for low ambient noise level in the project area.

5.2 ECOLOGICAL ASPECTS

5.2.1 Vegetation

The characteristic features and subtype of forest as per Champion and Seth (1968) for the project area are given below:

- Subgroup 1B: Northern Tropical Wet Evergreen Forests
 - C2. Upper Assam Valley tropical evergreen forests (1B/C2)
- Subgroup 8B: Northern subtropical Broadleaved Hill Forests
 - C1. East Himalayan subtropical wet hill forests (8B/C1)
- Subgroup 11B: Northern Montane Wet Temperate Forests
 - C1. East Himalayan wet temperate forests (11B/C1)

ECONOMICALLY IMPORTANT PLANTS

The list of economically important plant species in the Study Area is given in Table-4.

TABLE-4
Economically important plant species in the Study Area

| S. No | Botanical Name | Vernacular Name | Status | Economic Importance |
|---------------------------------|---|-----------------|--------|----------------------|
| Angiosperms/ Gymnosperms | | | | |
| TREES | | | | |
| 1 | <i>Abroma angusta</i> L. | | Common | Timber, fuel wood |
| 2 | <i>Actinodaphne obovata</i> | | Common | Timber, fuel wood |
| 3 | <i>Albizia odoratissima</i> (L.f.) Benth. | | Common | Timber, fuel wood |
| 4 | <i>Alnus nepalensis</i> D.Don. | | Common | Timber, fuel wood |
| 5 | <i>Altingia excelsa</i> | Jutuli | Common | Timber, fuel wood |
| 6 | <i>Arnogeissus sericea</i> Brandes | | Common | Fodder, fuel wood |
| 7 | <i>Artocarpus lakucha</i> Buch.Ham. | Kathal | Common | Timber, fuel wood |
| 8 | <i>Bauhinia purpurea</i> L. | Kanchan | Common | Flower bud edible |
| 9 | <i>Bischofia javonica</i> Bl. | Urium | Common | Fodder |
| 10 | <i>Bombex ceiba</i> L. | Simul | Common | Flower bud edible |
| 11 | <i>Cedrella toona</i> Roxb. | | Common | Timber, fuel wood |
| 12 | <i>Celtis tetrandra</i> Roxb. | | Common | Timber, fuel wood |
| 13 | <i>Croton oblongifolium</i> Roxb. | Changpephum | Common | Timber, fuel wood |
| 14 | <i>Dalbergia latifolia</i> Roxb. | | Common | Timber, fuel wood |
| 15 | <i>Dendrocalamus hamiltonii</i> Nees | | Common | household work |
| 16 | <i>Elaeocarpus floribundus</i> Bl. | | Common | Timber, fuel wood |
| 17 | <i>Erythriana stricta</i> Roxb. | Modar | Common | Timber, fuel wood |
| 18 | <i>Eugenia jambolana</i> Lamik | | Common | Timber, fruit edible |
| 19 | <i>Ficus auriculata</i> Lour. | | Common | Fruit edible |
| 20 | <i>F. oligodon</i> Miq | | Common | Timber, fuel wood |
| 21 | <i>F.semichordata</i> Buch-Ham ex Smith | | Common | Fruit edible |
| 22 | <i>Grewia microcos</i> L. | | Common | Timber, fuel wood |
| 23 | <i>Juglans regia</i> L. | | Common | Timber, fuel wood |
| 24 | <i>Kydia calycina</i> Roxb. | Pichola | Common | Timber, fuel wood |
| 25 | <i>Lagestromia speciosa</i> (L.) Persoon | | Common | Timber, fuel wood |
| 26 | <i>Mallotus nepelensis</i> | | Common | Timber, fuel wood |
| 27 | <i>Musa balbisiana</i> Colla | | Common | Flower bud edible |
| 28 | <i>Mussaenda roxburghii</i> L. | | Common | Timber, fuel wood |
| 29 | <i>Padamus nepalensis</i> St. John | | Common | Timber, fuel wood |
| 30 | <i>Terminalia myriocarpa</i> Heurek | Holok | Common | Timber, fuel wood |
| 31 | <i>Trema orientalis</i> Bl. | | Common | Fodder, fuel wood |
| SHRUBS | | | | |
| 1 | <i>Abroma angusta</i> L. | Bon kopahi | Common | Fuel wood |
| 2 | <i>Acacia torta</i> (Roxb.) | | Common | Fuel wood |

| S. No | Botanical Name | Vernacular Name | Status | Economic Importance |
|--------------|--|-----------------|--------|--------------------------|
| 3. | <i>Artemesia japonica</i> Thumb. | | Common | Fuel wood |
| 4 | <i>Artemesia nelegerica</i> C.B.Clarke | Sangaisaik | Common | Fuel wood |
| 5 | <i>Arundo donex</i> L. | | Common | Fuel wood |
| 6 | <i>Boehmeria macrophylla</i> D.Don. | | Common | Fodder |
| 7 | <i>Boehmeria regulosa</i> Wedd. | | Common | Fodder |
| 8 | <i>Calamus tenuis</i> Roxb. | | Common | Household work (sticks) |
| 9 | <i>Callicarpa macrophylla</i> Vahl. | | Common | Fuel wood |
| 10 | <i>Caryopteris odorata</i> | | Common | Fuel wood |
| 11 | <i>Cythea spinulosa</i> Wall. ex.Hook | | Common | Fuel wood |
| 12 | <i>Debregeasia velutina</i> Gaudich | | Common | Fodder |
| 13 | <i>Girardiana diversifolia</i> (Link.) Friss. | | Common | Leaf edible, fibre |
| 14 | <i>Imperata cylindrica</i> (L.) P. Beauv. | | Common | Fuel wood |
| 15 | <i>Lantana camara</i> L. | Phutkilap | Common | Fuel wood |
| 16 | <i>Leea asiatica</i> (L.) Richsdale | Dubjal-Aychnes | Common | Fuel wood |
| 17 | <i>Mimosa himalayana</i> Gamble | | Common | Fuel wood |
| 18 | <i>Perilla frutescens</i> (L.) Britt. | | Common | Seeds edible |
| 19 | <i>Randia cochinchinensis</i> Merr. | | Common | Fuel wood |
| 20 | <i>Rhus ellipticus</i> | | Common | Fruit edible |
| 21 | <i>Rhus semialata</i> Murray | Boisang | Common | Fuel wood |
| 22 | <i>Rubus ellipticus</i> Smith | | Common | Fruit edible |
| 23 | <i>Sterculia roxburghii</i> Wall. | | Common | Timber work |
| HERBS | | | | |
| 1 | <i>Alocasia spp</i> | | Common | Edible |
| 2 | <i>Chenopodium album</i> L. | | Common | Edible |
| 3 | <i>Colocasia fallax</i> Schott. | | Common | Edible |
| 4 | <i>Rubia manjit</i> Roxb. ex. Fleming | | Common | Dye |
| 5 | <i>Rumex dentatus</i> L. | | Common | Edible |
| 6 | <i>Urena lobata</i> L. | | Common | Fibre |

MEDICINAL PLANTS

This region harbours a wide range of medicinal plants which are used in Ayurvedic, Homoeopathic and Unani medicines or used by the local people. Some of the medicinal plants like *Abroma angusta*, *Achyranthes aspera*, *Artemisia nilagirica*, *Buddleja asiatica*, *Eleusine indica*, *Gynocardia odorata*, *Holarrhena pubescens*, *Oroxylum indicum*, *Phyllanthus emblica*, *Sapindus mukorossi*, *Spondias pinnata* and *Syzygium cumini* are quite common in the tropical parts of the proposed project. *Castanopsis hystrix*, *Dioscorea deltoidea*, *Fagopyrum cymosum*, *Hedychium spicatum*, *Rubia cordifolia*, *Saurauia*

roxburghii, *Zanthoxylum acanthopodium*, etc. are important medicinal plants of the sub-tropical areas. These plants are used internally for treating stomachic diarrhoea, dysentery, cough, cold, fever, asthma and externally for rheumatism, skin diseases, cuts, boils and injuries.

THREATENED STATUS OF PLANTS

During the study in various seasons in Kalai-II HE project area, following IUCN Red List of threatened plant, *Lagerstroemia minucarpa* falls under endangered category. Rest of the species are common in Arunachal Pradesh. However, this species though observed in the study area but not found in the land to be acquired for the project.

5.2.2. Fauna

The list of mammals, avi-fauna, amphibians, reptiles, and butterflies species reported in the Study Area is given in tables 5 to 9 respectively.

TABLE-5
List of mammals reported in the Study Area

| Common name | Scientific name | Schedule as per Wildlife Protection Act, 1972 |
|--------------------------------|-----------------------------------|---|
| Family: Cercopithacidae | | |
| Common langur | <i>Semnopithecus entellus</i> | II |
| Assamese macaque | <i>Macaca assamensis</i> | II |
| Rhesus macaque | <i>Macaca mulatta</i> | II |
| Family: Felidae | | |
| Jungle cat | <i>Felis chaus</i> | II |
| Family: Canidae | | |
| Indian fox | <i>Vulpes bengalensis</i> | II |
| Wild dog | <i>Cuon alpinus</i> | |
| Family: Viverridae | | |
| Large Indian Civet | <i>Viverra zibetha</i> | |
| Common palm civet | <i>Paradoxurus hermaphroditus</i> | |
| Small Indian Civet | <i>Viverricula indica</i> | |
| Family: Herpestidae | | |
| Common Mongoose | <i>Herpestes edwardsii</i> | IV |
| Family Bovidae | | |
| Mithun | <i>Bos frontalis</i> | |
| Goral | <i>Nemorhaedus goral</i> | III |
| Takin | <i>Budorcas taxicolor</i> | I |
| Family: Cervidae | | |
| Barking Deer | <i>Muntiacus muntjak</i> | III |
| Hog deer | <i>Axis porcinus</i> | III |
| Family: Suidae | | |
| Wild boar | <i>Sus scrofa</i> | III |
| Family: Leporidae | | |
| Indian Hare | <i>Lepus nigricollis</i> | IV |

| Common name | Scientific name | Schedule as per Wildlife Protection Act, 1972 |
|---------------------------------|--------------------------------|---|
| Family: Manidae | | |
| Indian Pangolin | <i>Manis crassicaudata</i> | |
| Family : Sciuridae | | |
| Himalayan Stripped Squirrel | <i>Tamiops macclellandi</i> | |
| Hodgson's flying Squirrel | <i>Petaurista magnificus</i> | |
| Particolored Flying Squirrel. | <i>Hylopetes alboniger</i> | |
| Family: Muridae | | |
| Large Bandicoot-Rat | <i>Bandicota indica</i> | V |
| House Rat | <i>Rattus rattus</i> | V |
| Family: Vespertilionidae | | |
| Indian Pipistrelle | <i>Pipistrellus coromandra</i> | V |
| Indian Pygmy Bat | <i>Pipistrellus tenuis</i> | V |

TABLE-6
List of avi-fauna species reported in the Study Area

| Family/Common Name | Scientific name | Distribution Habit | Conservation Status WPA(1972) |
|--------------------------|-------------------------------|--------------------|-------------------------------|
| Rallidae | | | |
| White-breasted water hen | <i>Amaurornis phoenicurus</i> | R | IV |
| Moorhen | <i>Gallinula chloropus</i> | R | IV |
| Jacanidae | | | |
| Bronze winged jacana | <i>Metopidius indicus</i> | R | IV |
| Phasianidae | | | |
| Redjungle fowl | <i>Gallus gallus</i> | R | - |
| Picidae | | | |
| Grey-headed woodpecker | <i>Picus canus</i> | R | IV |
| Megalaimidae | | | |
| Great hill barbet | <i>Megalaima virens</i> | R | IV |
| Upupidae | | | |
| Common hoopoe | <i>Upupa epops</i> | RW | IV |
| Columbidae | | | |
| Rock pigeon | <i>Columba livia</i> | R | IV |
| Ashy wood pigeon | <i>C. pulchricollis</i> | r | IV |
| Speckled wood pigeon | <i>C. hodgsonii</i> | r | IV |
| Pintail green pigeon | <i>Treron apicauda</i> | r | IV |
| Green imperial pigeon | <i>Ducula aenea</i> | r | IV |
| Mountain imperial pigeon | <i>D. badia</i> | | |
| Spotted dove | <i>Streptopelia chinensis</i> | R | IV |
| Emerald dove | <i>Chalcophaps indica</i> | R | IV |
| Cuculidae | | | |
| Common hawk cuckoo | <i>Hierococcyx varius</i> | r | IV |
| Pied crested cuckoo | <i>Clamator jacobinus</i> | rs | IV |
| Common koel | <i>Eudynamys scolopacea</i> | R | IV |
| Centropodidae | | | |

| Family/Common Name | Scientific name | Distribution Habit | Conservation Status WPA(1972) |
|--|-------------------------------|--------------------|-------------------------------|
| Lesser coucal | <i>Centropus bengalensis</i> | r | IV |
| Greater coucal | <i>C. sinensis</i> | R | IV |
| Aegithalidae | | | |
| Green backed tit | <i>Parus monticolus</i> | R | IV |
| Brown crested tit | <i>P. dichrous</i> | R | IV |
| Sittidae | | | |
| Wall creeper | <i>Tichodroma muraria</i> | rw | IV |
| Sturniidae | | | |
| Common myna | <i>Acridotheres tristis</i> | R | IV |
| Hill myna | <i>Gracula religiosa</i> | r | IV |
| Pycnonotidae | | | |
| Red vented bulbul | <i>Pycnonotus cafer</i> | R | IV |
| Striated green bulbul | <i>P. striatus</i> | r | IV |
| Mountain bulbul <i>Hypsipetes mcclllandii</i> | r | IV | |
| Black bulbul | <i>H. leucocephalus</i> | R | IV |
| Laniidae | | | |
| Rufous backed shrike | <i>Lanius schach</i> | R | IV |
| Muscicapidae | | | |
| Blue whistling thrush | <i>Myophonus caeruleus</i> | R | IV |
| Grey winged black bird | <i>Turdus bouboul</i> | r | IV |
| Plumbeous redstart | <i>Rhyacornis fuliginosus</i> | r | IV |
| Paradise flycatcher | <i>Terpsiphone paradisi</i> | R | IV |
| Carvidae | | | |
| Large billed crow | <i>Corvus macrorhynchos</i> | R | V |
| Himalayan treepie | <i>Dendrocitta formosae</i> | R | IV |
| Maroon oriole | <i>Oriolus traillii</i> | r | IV |
| Black headed oriole | <i>O. xanthornus</i> | r | IV |
| Scarlet minivet | <i>Pericrocotus flammeus</i> | R | IV |
| Sylviidae | | | |
| Striated laughing thrush | <i>Garrulax striatus</i> | r | IV |
| Greater laughing thrush | <i>G. pectoralis</i> | r | IV |
| Grey hooded warbler | <i>Seicercus poliogenys</i> | r | IV |
| Passeridae | | | |
| Russet sparrow | <i>Passer rutilans</i> | R | IV |
| Tree sparrow | <i>P. montanus</i> | R | IV |
| White wagtail | <i>Motacilla alba</i> | rW | IV |

R - Common Resident; W - Widespread; r - resident; s - sparse

TABLE-7
List of Amphibians reported in the Study Area

| Family/Common Name | Scientific Name |
|--------------------|---------------------------|
| Bufonidae | |
| Common toad | <i>Bufo melanostictus</i> |
| Himalayan toad | <i>Bufo himalayana</i> |

| | |
|------------------------------|--------------------------------|
| Ranidae | |
| Meghalaya stream frog | <i>Amolops afghanus</i> |
| Daniel's Oriental Streamfrog | <i>Rana danieli</i> |
| Yembung Sucker Frog | <i>Rana gerbillus</i> |
| Taipei frog | <i>Rana taipehensis</i> |
| Rhacophoridae | |
| Pied theloderma | <i>Philautus annandalii</i> |
| Twin-spotted Flying Frog | <i>Rhacophorus bipunctatus</i> |

TABLE-8
List of reptiles reported in the Study Area

| Family/Common Name | Scientific Name |
|------------------------|-------------------------------------|
| Scincidae | |
| Sikkim sunskink | <i>Scinella sikimmensis</i> |
| Large Forest-skink | <i>Sphenomorphus indicum</i> |
| Writhing skinks | <i>Lygosoma sp</i> |
| Gekkoniade | |
| Khasi lizard | <i>Cyrtodactylus khasiensis</i> |
| Brook's House Gecko | <i>Hemidactylus brookii</i> |
| House geckos, | <i>H. frenatus</i> |
| Laceridae | |
| Asian grass lizard | <i>Takydromus sexlineatus</i> |
| Elapidae | |
| Common krait | <i>Bungarus niger</i> |
| Banded krait | <i>B. fasciatus</i> |
| Cobra | <i>Naja naja</i> |
| Viperidae | |
| Bamboo pit viper | <i>Trimeresurus spp</i> |
| Brown-spotted pitviper | <i>Protobothrops mucrosquamatus</i> |
| Mountain pitviper | <i>Ovophis monticola</i> |
| Colubridae | |
| Green keelback | <i>Macropisthodon plumbicolor</i> |
| Common worm snake | <i>Typlina branmina</i> |
| Common wolf snake | <i>Lycodon aulicus</i> |

TABLE-9
List of butterflies reported in the Study Area

| Family/Common Name | Scientific Name |
|----------------------|--------------------------------|
| Papilionidae | |
| Blue Peacock | <i>Priceps arcturus</i> |
| The redbreasted | <i>P. aclmentor</i> |
| Common mormon | <i>Papilio polytes</i> |
| Pieridae | |
| Pale wanderer | <i>Pareronia avatar</i> |
| Yellow orange tip | <i>Ixias pyrene familiaris</i> |
| Indian cabbage white | <i>Pieris canidia</i> |
| Lycaenida | |

| Family/Common Name | Scientific Name |
|-----------------------|-------------------------------------|
| Longbanded silverline | <i>Spindasis lohita himalayanus</i> |
| Metallic cerulean | <i>Jamides alecto euryasces</i> |
| Punchinello | <i>Zemeros flegyas indicus</i> |
| Nymphalidae | |
| Yellow owl | <i>Neorina hilda</i> |
| Nigger | <i>Orsotrioena medus medus</i> |
| Himalayan fivering | <i>Ypthima sacra sacra</i> |
| Common fourring | <i>Y. hubenri hubenri</i> |
| Large yeoman | <i>Cirrochroa aoris aoris</i> |
| Indian fritillary | <i>Argyreus hyperbius hyperbius</i> |
| Veriegated Sailer | <i>Neptis antilope</i> |
| Orange staff sergeant | <i>Parathyma cama</i> |
| Blackvein sergeant | <i>P. ranga ranga</i> |
| Stripped blue crow | <i>Euploea mulciber</i> |

Amongst mammals, two species Wild dog and Indian fox are reported in the area. Indian fox is included under Schedule-II as per Wildlife Protection Act (1972). Mithun and Goral are included under Schedule-III as per Wildlife Protection Act (1972). Takin is included under Schedule-I as per Wildlife Protection Act (1972). Takin is reported at higher elevations of the catchment, i.e., at elevation range between 2100 -3000 m and is not reported in the project area. The species of Muridae family includes rats, and are placed under the Schedule V of Indian Wildlife Protection Act, 1972. The species of Scuridae family includes Himalayan Stripped Squirrel, Hodgson's flying Squirrel and Particolored Flying Squirrel. These species are not listed as per the schedules of Wildlife Protection Act (1972). All bat species belonging to Vespertilionidae family are reported from the Study Area. They are restricted to the lower reaches. They are nocturnal and invade citrus orchards in the region. They have been placed under the Schedule V as per Indian Wildlife Protection Act (1972). Among Avi-fauna most of the species are listed under under Schedule-IV or are not listed in any category as per Wildlife Protection Act (1972).

A total of 7 species of amphibians were reported from the study area. The amphibians comprise of toads and frogs. *Rana* spp. and *Bufo melanostictus* are very common in the study area. None of the frog and toad species in the study areas is 'threatened' and endemic to Arunachal Pradesh. Reptilian fauna comprises of 15 species belonging to 6 families. Forest skink, Khasi lizard, house lizard, common krait, Indian monitor, pit viper are the commonly observed reptilian species within the study area. 19 species belonging to various families are reported. None of the species recorded from the project areas is 'globally threatened' (IUCN, 2008). These species are either listed under Schedule-IV or are not listed in any category as per Wildlife Protection Act (1972).

5.2.3 Aquatic Ecology

The population of phytoplankton was sparse (103 -109 ind. l⁻¹) at all the sampling sites. The diversity index ranged from 2.438 to 2.494 in the stretch of the Lohit river under the area of Kalai II HEP.

Zooplankton is represented by the taxa of Cladocera (01), Rotifera (03) and Copepoda (02). Density of zooplankton was present in the range of 70-91 ind. l⁻¹. The diversity index ranged between 2.123 - 2.750 at all the sites.

Some of the aquatic macrophytes were recorded along the bank of the Kalai II River. These macrophytes were identified as *Equisetum spp.*, *Adiantum* and *Selaginella spp.* Aquatic macrophytes were present in the wet area of riparian zone of Kalai II River, where there is some anthropogenic activities.

5.2.4 Fisheries

The Lohit River is typically a hill stream, which has a fast water current with rich dissolved Oxygen. Most of the fishes inhabiting the river are well adapted to hill streams. A total of 6 species represented by three families has been reported from the Lohit river. A total of two species (*Tor tor* and *Tor putitora*;) has been categorized as endangered (EN) species (Table-10). However, *Schizothorax richardsonii* has been categorized as vulnerable (Vu). However, these species are not restricted to the Lohit River. In spite of this, there is an urgent need to protect these endangered fish species dwelling the Lohit river. The dam construction activities will also create a problem for migratory fish species (*Tor tor* and *Tor putitora*). These migratory fish species may move into the small tributaries of Lohit River.

TABLE-10
Fish diversity in Study Area of Kalai II HEP

| Species | Local Name | Status |
|---------------------------------------|------------|---------------------------|
| Family: Cyprinidae | | |
| <i>Schizothorax richardsonii</i> Gray | Kadang | Vulnerable |
| <i>Tor putitora</i> Hamilton | Ngauch | Endangered |
| <i>Tor tor</i> Hamilton | Ngorika | Endangered |
| <i>Acrossocheilus hexagonolepis</i> | | |
| Family Sisoridae | | |
| <i>Glyptothorax pectinopterus</i> | Ngapang | Low Risk- near threatened |
| Family Cobitidae | | |
| <i>Botia dario</i> | | |

6. PREDCTION OF IMPACTS

6.1 Water quality

a) Construction phase

Effluent from labour colony

The peak migrant population is likely to be of the order of 3000. The quantum of sewage generated due to this population is expected to be of the order of 0.33 mld. The BOD load contributed by domestic sources will be about 135 kg/day. The sewage from labour camps shall be treated in sewage treatment plant prior to disposal.

Effluent from crushers

The effluent from the crusher would contain high suspended solids. It is proposed to treat the effluents from crusher in settling tanks.

Effluent from other sources

Substantial quantities of water would be used in the construction activities. With regard to water quality, waste water from construction activities and runoff from construction site

would mostly contain suspended impurities. Adequate care shall be taken so that excess suspended solids in the wastewater are removed prior to disposal.

b) Operation phase

Effluent from project colony

During operation phase, only a small number of O&M staff will reside in the colony. The sewage generated would be provided biological treatment prior to disposal.

Impacts on reservoir water quality

In the proposed project, most of the land coming under reservoir submergence is barren, with few patches of trees. These trees too are likely to be cleared before filling up of the reservoir. The proposed project is envisaged as a runoff the river scheme, with significant diurnal variations in reservoir water level. In such a scenario, significant re-aeration from natural atmosphere takes place, which maintains Dissolved Oxygen in the water body. Thus, in the proposed project, no significant reduction in D.O. level in reservoir water is anticipated.

Eutrophication risks

Fertilizer use in the project area is negligible, hence, the runoff at present does not contain significant amount of nutrients. Even in the post-project phase, use of fertilizers in the project catchment area is not expected to rise significantly. Another factor to be considered that the proposed project is envisaged as a run off the river scheme, with significant diurnal variations in reservoir water level. Thus, in project operation phase, problems of eutrophication, are not anticipated.

Water resources and downstream users

The proposed Kalai-II hydroelectric project would require filling up reservoir up to its live storage capacity, which would then be used for peaking power. The filling up of reservoir for peaking power operations can lead to drying up of river downstream of dam site, especially in non-monsoon seasons. The impact is most severe in lean season. This can lead to significant adverse impacts on downstream riverine ecology. To mitigate the adverse impacts, Environmental flows shall be released

As per the present norms of MoEF, the Environmental Flows shall be released as below;

- **Monsoon Season- May to September** - 30% of the average flows during 90 % dependable year.
- **Non-monsoon Non lean Season- October & April** - 20% to 30% of the average flows during 90% dependable year.
- **Lean Season- November to March** - 20% of the average flows during 90% dependable year.

6.2 IMPACTS ON AIR ENVIRONMENT

Ambient Air Quality

Pollution due to operation of construction equipment

The major construction equipment would be operated through electricity. Therefore, fossil fuel combustion would be minimal. Diesel would be used only in contingency. Thus, no significant impact on ambient air quality is expected as a result of operation of various construction equipment.

Emissions from various crushers

During crushing operations, there would be emissions of dust particles. These emissions would be controlled through cyclone. Further, the labour camps would be located on the leeward side at appropriate location.

Blasting Operations

Blasting will result in vibration, which shall propagate through the rocks to various degrees and may cause loosening of rocks/boulders. The overall impact due to blasting operations will be restricted well below the surface and no major impacts are envisaged at the ground level.

During tunneling operations, dust will be generated during blasting. Ventilation system will be provided with dust handling system to capture and generated dust. The dust will settle on vegetation, in the predominant down wind direction. Appropriate control measures have been recommended to minimize the adverse impacts on this account.

Impacts due to vehicular Movement

The vehicular movement is likely to lead to entrainment of dust. However such ground level emissions do not travel for long distances. Thus, no major adverse impacts are anticipated on this account.

6.3 IMPACTS ON NOISE ENVIRONMENT

The operation of construction equipment is likely to have insignificant impact on the ambient noise level. The effect of high noise levels on the operating personnel, has to be considered as this may be particularly harmful. It is known that continuous exposures to high noise levels above 90 dB(A) affects the hearing acuity of the workers/operators and hence, should be avoided. To prevent these effects, it is recommended that exposure period of affected persons be limited as per the maximum exposure period specified by Occupational Safety and Health Administration (OSHA).

6.4 IMPACTS ON LAND ENVIRONMENT**6.4.1 Quarrying operations**

For the construction purpose, river bed materials from quarries listed in Table-11 shall be estimated.

TABLE-11
Details of river bed quarries

| Quarry | Quantity Available (lakh Cum) |
|----------------------------|-------------------------------|
| River Bed Material (RBM) 1 | 3.3 |
| River Bed Material (RBM) 2 | 2.5 |
| River Bed Material (RBM) 3 | 3.3 |

Stone quarries

The rock quarries identified for extraction of construction material is given in Table-12.

TABLE-12
Details of rock quarries

| Quarry | Quantity Available (lakh Cum) |
|-----------------|-------------------------------|
| Rock Quarry RQ1 | 25 |
| Rock Quarry RQ2 | 3 |
| Rock Quarry RQ3 | 30 |

Quarrying operations are semi-mechanized in nature. Normally, in a hilly terrain like Arunachal Pradesh, quarrying is normally done by cutting a face of the hill. A permanent scar is likely to be left, once quarrying activities are over. With the passage of time, the rock from the exposed face of the quarry under the action of wind and other erosion forces, get slowly weathered and after some time, they become a potential source of landslide. Thus it is necessary to implement appropriate slope stabilization measures to prevent the possibility of soil erosion and landslides in the quarry sites.

Operation of construction equipment

The siting of this construction equipment would require significant amount of space. In addition, land will also be temporarily acquired, i.e. for the duration of project construction for storage of quarried material before crushing, crushed material, cement, rubble, etc. Efforts must be made for proper siting of these facilities. The various criteria for selection of these sites would be:

- Proximity to the site of use
- Sensitivity of forests in the nearby areas
- Proximity from habitations
- Proximity to drinking water source

Muck Disposal

The total quantity of muck expected to be generated has been estimated to be of the order of 117.45 lacm³. The total requirement of coarse and fine aggregate for production of concrete to be used for construction will be met from the quarries / borrow areas which have been identified for the purpose and the useful ingredient from excavated material in open as well as underground structures. The total requirement of aggregates, both coarse and fine for concrete production has been estimated to be around 42 lakh cum. In addition to this 2 lac cum of rock fill materials are also required for coffer dams. The total excavated material in rock likely to be generated from open as well as underground excavation at the project will be approximately 55 lac cum, out of which about 10% suitable material i.e. 5.5 lac cum will be used for production of aggregates.

Acquisition of land

The total land required for the project is 1100 ha. The entire land to be acquired for the project is considered as forest land. On certain portions of land, community/private settlements are private/community properties. For such categories of land, compensation on account of forest land acquisition will be paid. The community land has been considered as the forest land for the purpose of preparation of Environmental Management Plan. Appropriate plan for compensation of forest and private land to be acquired for the project has been formulated.

6.5 TERRESTRIAL ECOLOGY

a) Construction phase

Increased human interferences

A large population (3,000) is likely to congregate in the area during the project construction phase. This population residing in the area may use fuel wood (if no alternate fuel is provided). Therefore, alternate fuel shall be provided to such population. Further, community kitchens should be provided using LPG.

Acquisition of forest land

The total land required for the project is 1100 ha of which about 640 ha comes under submergence, (including river bed). It would be worthwhile to mention here that most of the submergence lies within the gorge portion. Thus, creation of a reservoir due to the proposed project is not expected to cause any significant adverse impact on wildlife movement. The project area and its surroundings are not reported to serve as habitat for wildlife nor do they lie on any known migratory route. Thus, no impacts are anticipated on this account.

Impacts on avi-fauna

In the proposed project area and its surroundings due to terrain conditions, water flow is swift, which does not provide suitable habitat for the growth of water birds. With the damming of the river, a reservoir of an area of about 640 ha will be created, with quiescent/tranquil conditions. The reservoir banks will have wet environment throughout the year which can lead to proliferation of vegetation e.g. grass, etc. along the reservoir banks. Such conditions are generally ideal for various kinds of birds, especially, water birds. This is expected to increase the avi-faunal population of the area.

b) Operation phase

Impacts due to increased accessibility

During project operation phase, the accessibility to the area will improve due to construction of roads, which in turn may increase human interferences leading to marginal adverse impacts on the terrestrial ecosystem. However, during construction phase, there is an increased probability of poaching and other impacts due to aggregation of labour population. Thus, it is necessary to implement adequate surveillance in the area to ameliorate adverse impacts.

6.6 AQUATIC ECOLOGY

a) Construction phase

During construction phase wastewater mostly from domestic source will be discharged mostly from various camps of workers actively engaged in the project area. Around 0.41 mld of water is required for the workers during the peak construction phase out of which 80% (i.e. about 0.33 mld) will be discharged back to the river as wastes, more or less as a point sources from various congregation sites where workers will reside. The Sewage will be treated prior to disposal.

b) Operation phase

The dam of proposed Kalai-II HEP Will lead to formation of reservoir of 640 ha. The dam will change the fast flowing river to a quiescent lacustrine environment. The creation of a

pond will bring about a number of alterations in physical, abiotic and biotic parameters both in upstream and downstream directions of the proposed dam site. The micro and macro benthic biota is likely to be most severely affected as a result of the proposed project.

6.7 IMPACTS ON SOCIO-ECONOMIC ENVIRONMENT

Immigration of labour population

The peak labour force and technical staff required is estimated at about 3,000. Job opportunities will improve in this area. At present most of the population sustains by agriculture and allied activities. The project will open a large number of jobs to the local population both during project construction and operation phases.

7. ENVIRONMENTAL MANAGEMENT PLAN

7.1 Control of pollution from labour camps during construction phase

The aggregation of large labour population and technical staff during construction phase is likely to put significant stress on various facets of environment. The various issues covered in environmental management during construction phases are described in this section.

Facilities in labour camps

It is recommended that project authorities can compulsorily ask the contractor to make semi-permanent structures for their workers. These structures could be tin sheds. These sheds can have internal compartments allotted to each worker family. The sheds will have electricity and ventilation system, water supply and community latrines.

The water for meeting domestic requirements may be collected from the rivers or streams flowing upstream of the labour camps. The water quality in general is good and can be used after chlorination.

Sanitation facilities

One community latrine can be provided per 20 persons. The sewage from the community latrines can be treated in sewage treatment plants prior to disposal.

Solid waste management from labour camps

For solid waste collection, suitable number of masonry storage vats, each of 2 m³ capacity should be constructed at appropriate locations in various labour camps. These vats should be emptied at regular intervals and should be disposed at identified landfill sites. Suitable solid waste collection and disposal arrangement shall be provided. A suitable landfill site should be identified and designed to contain municipal waste from various project township, labour colonies, etc.

Provision of free fuel

Project proponents in association with the state government should make necessary arrangements for distribution of LPG. These fuel would be supplied at subsidized rates to the local/contract laborers for which provision has been kept in the cost estimate.

7.2 ENVIRONMENTAL MANAGEMENT IN ROAD CONSTRUCTION

The approach roads will have to be constructed as a part of the proposed project. Steeply sloping banks are liable to landslides, which can largely be controlled by provision of suitable drainage. Landslides is proposed to be stabilized by several methods i.e. engineering or bio-engineering measures alone or a combination of these. Engineering solutions such as surface drainage, sub-surface drainage, toe protection and rock bolting can be used.

7.3 MANAGEMENT OF MUCK DISPOSAL SITES

In the hilly area, dumping is done after creating terraces; thus usable terraces are developed. The overall idea is to enhance/maintain aesthetic view in the surrounding area of the project in post construction period & avoid contamination of any land or water resource due to muck disposal. Suitable retaining walls shall be constructed to develop terraces so as to support the muck on vertical slope and for optimum space utilization. The muck disposal sites should be reclaimed with vegetation.

7.4 RESTORATION AND LANDSCAPING OF PROJECT SITES

The beautification would be carried out by developing flowering beds for plantation ornamental plant and flower garden. The beautification in the colony area would be carried out by development of flowering beds for plantation of ornamental plant, creepers, flower garden and a small park, construction of benches for sitting, resting sheds, walk way and fountain.

7.5 GREENBELT DEVELOPMENT

It is proposed to develop greenbelt around the perimeter of various project appurtenances, selected stretches along reservoir periphery, etc. This will be carried out in consultation with the State Forest Department.

7.6 PUBLIC HEALTH DELIVERY SYSTEM

A population of about 3000 is likely to congregate during the construction phase. The labour population will be concentrated at two or three sites. There is no medical facility in the immediate vicinity of the project area. It is recommended that necessary medical facilities be developed at the project site. It is recommended that the dispensary should be developed during project construction phase itself, so that it can serve the labour population migrating in the area as well as the local population.

A first-aid post is to be provided at each of the major construction sites, so that workers are immediately attended to in case of an injury or accident.

This first-aid post will have at least the following facilities:

- First aid box with essential medicines including ORS packets
- First aid appliances-splints and dressing materials
- Stretcher, wheel chair, etc.

7.7 COMPENSATORY AFFORESTATION

The total land required for the project is 1100 ha. The entire land to be acquired for the project is considered as forest land. The afforestation work is to be done by the Forest Department.

In addition, following measures are also recommended:

- Afforestation
- Soil stabilization measures & improving water regime,
- Promote use of non-conventional energy so as to reduce pressure on natural resources,
- Sustenance of Livelihoods
- Establishment of botanical gardens for conservation and propagation of RET species.
- Forest & Wildlife protection -Control of grazing & implementation of anti poaching measures etc.
- Peoples participation in the biodiversity conservation programmes
- Community development initiatives
- Training & Publicity Programmes

7.8 CONTROL OF AIR POLLUTION

The air pollution is basically generated due to primary crushing and fugitive dust from the heap of crushed material. The various crushers need to be provided with cyclones to control the dust generated while primary crushing the stone aggregates. It should be mandatory for the contractor involved in crushing activities to install cyclone in the crusher.

7.9 CONTROL OF WATER POLLUTION

Construction phase

During construction phase of the proposed project, crushers are likely to operate at major construction sites. The effluent generated from crushers will have high suspended solids. It is proposed to provide settling tanks for treatment of effluent from various crushers.

During tunneling work, the ground water flows into the tunnel along with construction water which is used for various works like drilling, shotcreting etc. The effluent thus generated in the tunnel contains high suspended solids. It is proposed to construct a settling tank to settle the suspended impurities.

Operation phase

In the project operation phase, a project colony of 50 quarters will be established. The colony will have a Septic Tank to treat the sewage generated from the colony

7.10 FISH MANAGEMENT

a) Release of minimum flow

The approved 10 daily flow series for the 90% dependable year and Environmental Flows for Kalai-II HEP are given in Table-13.

TABLE-13
Environmental Flows for Kalai-II HEP

| Month | 10 Daily | 10 daily Discharge in 90% Year (Cumeecs) | Season | Av. Flow during the season in 90% year (cumecc) | Env. Flow during the season (cumecc) | Env Flow as a %age of 90% average |
|-----------|----------|--|----------------------|---|--------------------------------------|-----------------------------------|
| May | I | 550 | Monsoon | 794 | 238 | 30% |
| | II | 766 | | | | |
| | III | 786 | | | | |
| June | I | 710 | | | | |
| | II | 798 | | | | |
| | III | 784 | | | | |
| July | I | 841 | | | | |
| | II | 1124 | | | | |
| | III | 1189 | | | | |
| August | I | 861 | | | | |
| | II | 863 | | | | |
| | III | 619 | | | | |
| September | I | 539 | | | | |
| | II | 506 | | | | |
| | III | 975 | | | | |
| October | I | 758 | Non Monsoon Non Lean | 567 | 142 | 25% |
| | II | 487 | | | | |
| | III | 457 | | | | |
| November | I | 358 | Lean | 278 | 56 | 20% |
| | II | 333 | | | | |
| | III | 307 | | | | |
| December | I | 294 | | | | |
| | II | 283 | | | | |
| | III | 270 | | | | |
| January | I | 258 | | | | |
| | II | 239 | | | | |
| | III | 251 | | | | |
| February | I | 255 | | | | |
| | II | 257 | | | | |
| | III | 258 | | | | |

| Month | 10 Daily | 10 daily Discharge in 90% Year (Cumeecs) | Season | Av. Flow during the season in 90% year (cumecc) | Env. Flow during the season (cumecc) | Env Flow as a %age of 90% average |
|-------|----------|--|----------------------|---|--------------------------------------|-----------------------------------|
| March | I | 251 | | | | |
| | II | 285 | | | | |
| | III | 276 | | | | |
| April | I | 322 | Non Monsoon Non Lean | 335 | 115 | 34% |
| | II | 337 | | | | |
| | III | 347 | | | | |

The power station is proposed to comprise of 6 units of 190 MW each and 1 unit of 60 MW. One unit each of 60MW and 190MW i.e. 250 MW is envisaged to utilize the mandatory environmental releases. The plant shall be run so as to meet the requirement of the environmental flows into the river just downstream of the dam

b) Sustenance of Endemic Fisheries

It is proposed to stock the reservoir and river Lohit for a length of 16 km upstream and 2 km on the downstream of the dam. The rate of stocking is proposed as 100 fingerlings of about 30 mm size per km. For reservoir area, stocking shall be 1000 fingerlings/ha of 30 mm size. The migratory fish species namely, mahaseer and snow trout can be stocked. The stocking can be done annually by the Fisheries Department, State Government of Arunachal Pradesh. To achieve this objective, facilities to produce seeds of mahaseer and snow trout would have to be created at suitable sites. The site would be identified in consultation with Fisheries Department, State Government of Arunachal Pradesh

7.11 NOISE CONTROL MEASURES

Workers operating in high noise should be provided with effective personal protective measures such as ear muffs or ear plugs to be worn during periods of exposure. The other measures to control noise could be as follows:

- Equipment and machineries should be maintained regularly to keep the noise generation at the design level;
- Silencers and mufflers of the individual machineries to be regularly checked;
- Exposure of workers to high noise areas, should be limited as per maximum exposure periods specified by OSHA.

8. CATCHMENT AREA TREATMENT (CAT) PLAN

Silt Yield Index (SYI) method has been used to prioritize sub-watershed in a catchment area for treatment. The area under high erosion category has to be treated by the project proponents, which accounts for about 48.84% of the total free draining catchment area. The details are given in Table-14.

TABLE-14
Area under different erosion categories

| Category | Area (ha) | Area (Percentage) |
|--------------|---------------|-------------------|
| Low | 13789 | 9.28 |
| Medium | 62240 | 41.88 |
| High | 72571 | 48.84 |
| Total | 148600 | 100.00 |

A CAT Plan comprising of following measures is proposed:

- Gap Plantation
- Afforestation
- Nursery development and maintenance of nursery
- Vegetative fencing
- Check Dams

9. LOCAL AREA DEVELOPMENT PLAN

It is proposed to upgrade the infrastructure in various schools in the project area and its vicinity. The following activities are proposed under LADP activities:

- Up-gradation of school buildings, furniture & fixtures and equipments
- Improvement of drinking water and sanitation facilities
- School bus service
- Scholarship to students

Improvement of Public Health Facilities

- Upgradation of Hospital building
- Furniture, Beds and other items
- Up-gradation of Pathological laboratory
- Up-gradation of operation theater
- Purchase of Mobile clinic vans

Improvement of infrastructure and living standards

Construction of training/educational institute

An amount of Rs. 5910.0 lakh is being made for implementation of the LADP Activities. The details are shown in Table-15.

TABLE-15
Budget for implementation of Local Area Development Plan

| S. No. | Items | Budget (Rs. Lakh) |
|--------|--|-------------------|
| 1 | Upgradation of Educational facilities | 455.0 |
| 2 | Scholarship to students | 360.0 |
| 3 | Expenditure on Health care facilities | 675.0 |
| 4 | Improvement of Infrastructure & living standards | 3220.0 |
| 5 | Expenditure on Training / Educational Institute | 1200.0 |
| | Total | 5910.0 |

10. DISASTER MANAGEMENT PLAN

The following measures have been suggested as a part of the Disaster Management Plan:

- Dam Safety and Maintenance Manual
- Emergency Action Plan (EAP)
- Administration and Procedural Aspects
- Preventive Action
- Communication System
- Notifications
- Evacuations Plans and Evacuation Team
- Public Awareness for Disaster Mitigation
- Management after receding of Flood Water

11. SUMMARY OF ENVIRONMENTAL MONITORING PROGRAMME

An Environmental Monitoring Programme should be undertaken during construction and operation phase of the project. The details of environmental monitoring programme are given in Tables - 16 and 17 respectively.

TABLE-16
Summary of Environmental Monitoring Programme during
Project Construction Phase

| S. No. | Item | Parameters | Frequency | Location |
|--------|------------------------|---|----------------------|--|
| 1. | Effluent from STP | pH, BOD, COD, TSS, TDS | Once every month | Before and after treatment from STP |
| 2. | Water-related diseases | Identification of water related diseases, adequacy of local vector control and curative measure, etc. | Three times a year | Labour camps and colonies |
| 3. | Noise | Equivalent noise level (L_{eq}) | Once in three months | At major construction sites. |
| 4. | Air quality | PM_{10} , SO_2 and NO_2 | Once every season | At major construction sites |
| 5. | Meteorological aspects | Wind direction & velocity temperature humidity, rain | Once every season | At one of the ambient air quality sampling sites |

TABLE-17
Summary of Environmental Monitoring Programme during
Project Operation Phase

| S. No. | Items | Parameters | Frequency | Location |
|--------|--|---|--------------------|--|
| 1. | WATER | pH, Temperature, EC, Turbidity, Total Dissolved Solids, Calcium, Magnesium, Total Hardness, Chlorides, Sulphates, Nitrates, DO. COD, BOD, Iron, Zinc, Manganese | Thrice a year | <ul style="list-style-type: none"> • 1 km upstream of dam site • Water spread area • 1, 3 and 5 km downstream of dam site |
| 2. | Effluent from Sewage Treatment Plant (STP) | pH, BOD, COD, TSS, TDS | Once every week | <ul style="list-style-type: none"> • Before and after treatment from Sewage Treatment Plant (STP) |
| 3. | Erosion & Siltation | Soil erosion rates, stability of bank embankment, etc. | Once a year | Catchment Area, Muck disposal sites |
| 4. | Ecology | Status of afforestation programmess of green belt development | Once in a year | - |
| 5. | Water-related diseases | Identification of water-related diseases, sites, adequacy of local vector control measures, etc. | Three times a year | <ul style="list-style-type: none"> • Villages adjacent to project sites |
| 6. | Aquatic ecology | Phytoplanktons, zooplanktons, benthic life, fish composition | Once a year | <ul style="list-style-type: none"> • 1 km upstream of dam site • Water spread area • 1, 3 and 5 km downstream of dam site |
| 7. | Landuse | Landuse pattern using satellite data | Once in a year | Catchment area |
| 8. | Soil | pH, EC, texture, organic matter | Once in a year | Catchment area |

12. COST ESTIMATES

12.1 COST FOR IMPLEMENTING ENVIRONMENTAL MANAGEMENT PLAN

The total amount to be spent for implementation of Environmental Management Plan (EMP) is Rs.40,660 lakh. The details are given in Table-18.

TABLE-18
Cost for Implementing Environmental Management Plan

| S.No. | Item | Cost (Rs. lakh) |
|-------|--|--|
| 1. | Compensatory Afforestation, and Bio-diversity conservation | 5416.75 |
| 2. | Catchment Area Treatment | 3195.39 |
| 3. | Fisheries Management | 516.80 |
| 4. | Public health delivery system | 678.12 |
| 5. | Environmental Management in labour camp | 1044.33 |
| 6. | Muck management | 1470.28 |
| 7. | Restoration and Landscaping of construction sites | 325.00 |
| 8. | Environmental management in road construction | 520.00 |
| 9. | Greenbelt development | 97.50 |
| 10. | Air Pollution Control | 400.40 |
| 11. | Water pollution control | 200.00 |
| 12. | Local Area Development Plan | 5910.00 |
| 13. | Resettlement and Rehabilitation Plan | 15087.60 |
| 14. | Energy Conservation measures | 100.00 |
| 15. | Fire Protection Plan | 40.00 |
| 16. | Landslide Treatment Plan | 2839.19 |
| 17. | Disaster Management Plan | 2622.80 |
| 18. | Environmental Monitoring during construction phase (Refer Table-19) | 194.73 |
| 19. | Purchase of meteorological instruments | 0.70 |
| 20. | Purchase of noise meter | 0.10 |
| | Total | 40659.69 Say 40660 lakh |

12.2 COST FOR IMPLEMENTING ENVIRONMENTAL MONITORING PROGRAMME

The cost required for implementation of the Environmental Monitoring Programme is of the order of Rs. 194.73 lakh @ Rs.19.72 lakh/year. A 10% annual price increase may be considered for every year. The construction period for estimation of cost for implementation of Environmental Monitoring programme during construction phase has been taken as 7 years. The details are given in Table-19. The cost required for implementation of the Environmental Monitoring Programme at operation phase is of the order of Rs.18.7 lakh/year. The details are given in Table-20.

TABLE-19
Cost for Implementing Environmental Monitoring Programme during construction phase

| S. No | Item | Cost (Rs. million/year) | Total cost for construction period of 7 years with 10% escalation per year (Rs. million) |
|-------|-------------------------------------|-------------------------|--|
| 1 | Water quality | 0.72 | 6.83 |
| 2 | Air quality | 5.00 | 55.0 |
| 3 | Ecology | 12.00 | 113.9 |
| 4 | Incidence of water related diseases | 2.00 | 19.0 |
| | Total | 19.72 | 194.73 |

TABLE-20

**Cost for Implementing Environmental Monitoring Programme
during operation phase**

| S. No | Item | Cost (Rs. lakh/year) |
|--------------|-------------------------------------|-----------------------------|
| 1 | Water quality | 6.2 |
| 2 | Soil quality | 1.5 |
| 3 | Ecology | 5.0 |
| 4 | Incidence of water related diseases | 3.0 |
| | Land use pattern | 3.0 |
| | Total | 18.7 |