TERMS OF REFERENCE FOR CONDUCTING COMPREHENSIVE EIA STUDY FOR SIANG UPPER HYDRO POWER PROJECT (3750 MW), STAGE-II, ARUNACHAL PRADESH

The major thrust of the study is to assess the impacts of the proposed Siang Upper Hydro Power Project (3750 MW), Stage-II on various facets of environment during construction and operation phases. The present study shall cover the impacts on water quality, noise, air quality, forestry, wildlife, aquatic ecology including fisheries and muck disposal and borrow areas, etc. The study will cover collection of baseline data, prediction of impacts due to various activities and formulation of Environmental Management Plan (EMP) for amelioration of adverse impacts. The objectives of the CEIA study are as follows:

(a) Establish appropriate study area(s) to identify and assess physical, biological and social effects on the proposed project.

(b) Develop a comprehensive and environmentally relevant project description

(c) Prepare a description of the environment of the potentially affected/study area that includes the present relevant baseline information on the most important physical, biological, socio-cultural aspects of the project/study area.

(d) Describe and apply appropriate methodologies to identify project environment. Cause/effect relationships, predict and evaluate environment and socio-cultural effects, perform a rigorous assessment of the significance of bio-physical, socio-cultural and cumulative effects of the project.

(e) Identify, describe and cost, feasible, specific environmental mitigation measures for each significant impact

(f) Develop, describe and cost an Environmental Management Programme including the mitigatory measures.

(g) Develop, Describe and cost an Environmental Monitoring Programme for implementation during project construction and operation phases.

(h) Stipulations of Ministry of Environment & Forests (MOEF) in its Model TOR for Hydropower Projects including provisions for North Eastern states.

2. The Ministry of Environment and Forests (MoEF), Government of India (GoI) has issued a notification called EIA Notification 2006 on Sept. 14, 2006. As per this notification the proposed project falls under Category `A'. The project requires Environmental Clearance from Ministry of Environment and Forests (MoEF). A Comprehensive EIA study is a pre-requisite for obtaining Environmental Clearance.
3. The terms of reference for preparation of Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) reports for the proposed Siang Upper Hydro Power Project (3750 MW), Stage-II, Arunachal Pradesh would conform to the model TOR prepared by MOEF for North-East. The baseline studies shall consist of three season field data i.e. Pre-Monsoon, Monsoon and winter (lean) season covering one calendar year.
4. The EIA report would cover the following aspects

(a) General introduction giving details of the salient features of the proposed project

- Layout map of the project to be given along with contours with project components clearly marked with a proper scale
- Study area to be demarcated properly on the appropriate scale map
- Sampling sites to be depicted on map for each parameter with proper legends

(b) The study area would comprise of the following:

- Catchment area up to the dam site
- Submergence area
- Project area or the direct impact area would comprise of area within 10 km radius of the main project components like dam, power house, etc. and also area within 10 km upstream of reservoir tail & 10 km distance from the reservoir rim along both the river banks.

(c) The sampling will be done at following locations:

- Catchment area up to the dam site
- Submergence area
- Project area or the direct impact area would comprise of area within 10 km radius of the main project components like dam, power house, stretch between Dam and powerhouse, area within 10 km upstream of reservoir tail, 10 km distance from the reservoir rim along both the river banks, and area 10 km downstream of power house

(d) Detailed methodology followed for the analysis of various parameters required for EIA.

(e) Various details regarding the project layout etc., would be depicted in proper scale maps at least at 1:15,000 like:

- Location map of proposed HE project
- Location map of the project area with contours indicating main project features,
- Drainage map of the river catchment up to the proposed project site,
- Soil map of the project area.
- Geological and Seismo-tectonic maps of the area surrounding the proposed project site showing location of dam site, powerhouse site and tunnel alignment.
- False Color Composite (FCC) generated from satellite data of project area and land-use / land-cover prepared from these images.

Scoping and Assessment of Alternatives

Scoping is a tool which gives direction for selection of impacts due to the project activities on the environment. As a part of the study, scoping exercise will be conducted selecting various type of impacts which can accrue due to a hydroelectric project. Based on the project features, site conditions, various parameters to be covered as a part of the EIA study were selected. The results of scoping analysis are presented in Table-1.

TABLE-1
Scoping Matrix adopted for CEIA study for the proposed
Siang Upper Hydro Power Project (3750 MW), Stage-II, Arunachal Pradesh

Aspects of Environment	Likely Impacts
A. Land Environment	
Construction phase	- Increase in soil erosion - Pollution by construction spoils - Acquisition of land for labour colonies - Solid waste from labour camps/colonies
Operation phase	- Acquisition of land for various project appurtenances - Loss of agricultural and forest land due to submergence
B. Water resources & water quality	
Construction phase	- Increase in turbidity of nearby receiving water bodies - Degradation of water quality due to disposal of wastes from labour, colony and construction sites
Operation phase	- Modification of hydrologic regime
C. Aquatic Ecology	
Construction phase	- Increased pressure on riverine fisheries as a result of indiscriminate fishing by the labour population. - Reduced productivity due to increase in turbidity levels as a result of disposed off effluents from construction sites.
Operation phase	- Impacts on spawning and breeding grounds - Degradation of riverine ecology - Impacts on migratory fish species - Impact on aquatic ecology due to drying of the river stretch
D. Terrestrial Ecology	
Construction phase	- Increased pressure from labour to meet their fuel wood requirements - Adverse impacts on flora and fauna due to increased accessibility in the area and increased influx of human population - Loss of forest due to construction of road and other project appurtenances
Operation phase	- Loss of forests in the submergence area - Impacts on wildlife movement - Impacts on wildlife habitats
E. Socio-Economic Aspects	
Construction phase	- Increased employment potential during the project construction phase - Development of allied sectors leading to greater employment - Pressure on existing infrastructure facilities. - Cultural conflicts and law and order issues due to migration of labour population
Operation phase	- Loss of lands - Loss of private properties - Impacts on archaeological and and cultural monuments, if any - Impacts on mineral reserves, if any
F. Air Pollution	

Aspects of Environment	Likely Impacts
Construction Phase	- Impacts due to fuel combustion in various construction equipment - Impacts due to increased vehicular movement - Fugitive emissions from various sources - Impacts due to emissions of DG sets
G. Noise Pollution	
Construction Phase	- Noise due to operation of various construction equipment - Noise due to increased vehicular movement - Impacts due to blasting - Increased noise levels due to operation of DG sets
H. Public Health	
Construction Phase	- Increased incidence of water related diseases - Transmission of diseases by immigrant labour population
Operation phase	- Increased incidence of vector borne diseases

BASELINE STUDIES

The baseline studies shall consist of three season field data i.e. Pre-Monsoon, Monsoon and winter (lean) Season covering one calendar year. The report would also include Salient Features of the project

(f) Physical-Chemical Environment

- Physical geography, Topography, Stratigraphy, Regional Geology of the catchment area. Landslide zone or areas prone to landslide existing in the study area especially along the periphery of the reservoir would be examined.
- Tectonics and seismicity of the study area.
- Presence of important economic mineral deposit if any.
- Meteorology of the study area (viz. precipitation, temperature, relative humidity, wind speed/direction etc.)
- Ambient air quality with parameters, viz. Particulate Matter (RPM) i.e. suspended particulate materials < 10 microns, sulphur dioxide (SO2) and oxides of nitrogen (NOx) in the study area.
- Existing noise levels and traffic density in the area.
- Soil classification, physical parameters (viz. texture, porosity, bulk density and water holding capacity) and chemical characteristics (viz. pH, electrical conductivity, sodium, potassium, calcium, magnesium, nitrogen, total nitrogen, exchangeable sodium percentage (ESP), organic matter, phosphorus, etc.) for the study area.
- Identification of free draining catchment area
- Remote Sensing & GIS Studies: Generation of thematic maps viz. slope map, drainage map, soil map, land use land cover map, etc. Based on these, thematic maps, an erosion Intensity map would be prepared.
- Delineation of sub and micro watershed, their location and extent based on Soil and Land Use Survey of India (AISLUS), Deptt. of Agriculture, Govt. of India. Erosion levels in each micro-watershed and prioritization of micro-watersheds through Silt Yield Index (SYI) method of AISLUS.

- Physical, Chemical and Bacteriological parameters of surface water quality. Physical parameters include temperature, pH, electrical conductivity, total dissolved solids (TDS), DO, turbidity. Chemical parameters are salinity, alkalinity, Ca, Mg and total hardness, chlorides, nitrogen (organic, ammonia, nitrite and nitrate), phosphate, and total coliform
- Downstream water use and its impact. Disposal of sewage, if any in the downstream needs to be reported.

(g) Hydrology of the basin

- Hydro-meteorology, drainage systems
- Catastrophic events like cloud bursts and flash floods, if any would be documented
- A Gauge & Discharge station would be established at a suitable location to record the inflow as well as the sediment concentration of the river water during the 3 seasons of observations particularly during the lean season and during the monsoon season
- Recording of data at G-D-S stations will continue during the life of the project.
- Graph of 10-daily discharges before and after the project at the Dam site immediately below the Dam shall be provided in the CEIA study.
- For estimation of Sedimentation rate direct sampling of river flow shall be done during EIA to get actual silt flow rate (expressed in ha m/ Km2/year). The one year of EIA study shall be incorporated in the CEIA report.
- Water availability for the project, minimum & maximum flows and the aquatic fauna
- Design discharge and its recurrence interval

(h) Biological Environment

Flora

- Characterization of forest types in the study area as per the data available in the Forest Working Plan.
- General vegetation pattern and floral diversity viz. trees, shrubs, grasses, herbs, significant micro-flora, etc. Vegetation shal cover all groups of plants including lichens and orchids.
- Species frequency, density, abundance to be detailed. Biodiversity index (Shannon–Wiener Diversity index) and Importance Value Index (IVI) of the species to be provided. Methodology used for calculating the various diversity indices along with details of locations of quadrats, size of quadrats, etc. to be reported.
- Economically important species viz. medicinal, timber, fuel wood etc.
- Flora under Rare, Endangered and Threatened (RET) categories would be documented using International Union for the Conservation of Nature and Natural Resources (IUCN) criteria and Botanical Survey of India's Red Data list along with economic significance.
- Cropping and Horticulture pattern and practices in the study area.

Faunal Elements

- Inventorisation of terrestrial wildlife including reptiles and herpetofauna, their present status in the project area
- Zoogeographic distribution/affinities, Endemic, threatened and endangered species.
- Avifauna - Status, Resident/Migratory/Passage migrants, Impact of project on threatened/endangered taxa, if any, Butterflies, if any found in the area
- For RET species, voucher specimens will be collected along with GPS readings to facilitate rehabilitation. RET faunal species are to be classified in two ways viz. as per IUCN Red Data list or as per different schedule of Indian Wilde Life Protection Act, 1972.
- To document the existence of barriers and corridors (if any) for wild animals, the habitat fragmentation and destruction of wild animals due to project.
- Effect on fish migration and habitat degradation due to project.
- Existence of National Park, Sanctuary, Biosphere, Reserve Forest etc. in the study area if any, would be detailed.

(i) Aquatic Biology

- Aqua- fauna like macro-invertebrates, zooplankton, phytoplanktons, benthos, etc.
- Conservation Status
- Fish and Fisheries
- Fish migrations, if any
- Breeding grounds
- Impact of Dam building on fish migration and habitat degradation
- Impact on aquatic ecology at least 10 km downstream of the Dam

(j) Socio-economic Environment

- Land details*
- Demographic profile
- Ethnographic profile
- Economic structure
- Development profile
- Agricultural practices
- Cultural and aesthetic sites
- Infrastructure facilities: education, health and hygiene, communication network, etc.
- Impact on socio-cultural and ethnographic aspects due to Dam building

*Report would include list of all the Project Affected Families with their names, education, land holdings, other properties, occupation, source of income, land and other properties to be acquired, etc.

In addition to Socio-economic aspects of the study area, a separate chapter on socio-cultural aspects based upon study on Ethnography of the area.

The summary of primary data to be collected are given in Table-2.

TABLE-2
Summary of primary data to be collected

Description	No. of locations	Frequency of Sampling
AIR Ambient air quality monitoring (24 hourly samples), twice a week for 4 weeks at two major construction sites **Parameters :** PM_{10}, SO_2, NO_2	4	Three seasons (Pre-monsoon, Monsoon, Post-monsoon)
WATER Samples to be collected from various representative locations in the study area **Parameters :** Temperature, pH, Electrical Conductivity, Total Dissolved Solids, Salinity, Alkalinity, Total Hardness, Chlorides, Sulphates, Fluorides, Phosphates, Calcium, Magnesium, Sodium, Potassium, Iron, Chromium, Lead, Cadmium, Mercury, Zinc, DO, BOD, COD, Total Coliform, Faecal Coliform	5	Three seasons (Pre-monsoon, Monsoon, Post-monsoon)
SOILS Sampling in the catchment area **Parameters :** pH, N,P,K, organic mater soil texture	10	Three seasons (Pre-monsoon, Monsoon, Post-monsoon)
NOISE Hourly readings taken for 24 hours (Leq.)	5	Three seasons (Pre-monsoon, Monsoon, Post-monsoon)
TERRESTRIAL ECOLOGY **Parameters** : Density, Diversity and abundance of various floral species. Presence of various faunal species as observed during the ecological survey shall also be recorded and studied	10	Three seasons (Pre-monsoon, Monsoon, Post-monsoon)
FISHERIES **Parameters :** Presence and occurrence of various fish species and migratory routes	5	Three seasons (Pre-monsoon, Monsoon, Post-monsoon)
AQUATIC ECOLOGY **Parameters:** Density, diversity and abundance of various periphytons, phytoplanktons, zooplanktons, macro-invertebartes, primary productivity.	5	Three seasons (Pre-monsoon, Monsoon, Post-monsoon)

5. **IMPACT PREDICTION**

The following impacts of the project should be assessed

(a) Air

- Changes in ambient levels and ground level concentrations due to total emissions from point, line and area sources

- Effects on soils, material, vegetation, and human health
- Impact of emissions DG sets used for construction power if any, on air environment.

(b) Noise

- Changes in ambient levels due to noise generated from equipment, blasting operations and movement of vehicles
- Effect on fauna and human health

(c) Water

- Changes in quality
- Sedimentation of reservoir
- Impact on fish fauna
- Impact of sewage disposal

(d) Land

- Changes in land use and drainage pattern
- Changes in land quality including effects of waste disposal
- Riverbank and their stability
- Impact due to submergence

(e) Biological

- Deforestation and shrinkage of animal habitat
- Impact on fauna and flora (including aquatic species if any) due to decreased flow of water
- Impact on rare and endangered species, endemic species, and migratory path/route of animals, if any
- Impact on breeding and nesting grounds, if any
- Impact on animal distribution, migration routes (if any), habitat fragmentation and destruction due to Dam building activity

(f) Socio-economic Aspects

- Impact on the local community including demographic changes
- Impact on economic status
- Impact on human health
- Impact on increased traffic
- Impact on Holy Places and Tourism

(g) Downstream impact on water, land & human environment due to drying up of the river at least 10 km downstream of the Dam.

(h) Positive as well as negative impacts likely to be accrued due to the project are to be listed.

(i) Positive impacts like benefits from carbon trading.

ENVIRONMENTAL MANAGEMENT PLAN

6. **Resettlement and Rehabilitation (R&R)** plan will be prepared with due consultation with Project Affected Families (PAFs). It shall include community development strategies and a list containing name of PAFs, age, educational qualification, family size, sex, religion, caste, source of income, house with type and amount of land holding, house/land to be acquired, any other property, possession of cattle, etc. The provision of the prepared R&R plan would be according to the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013. Detailed budgetary estimates would be provided. In addition to Socio-economic aspects of the study area, a separate chapter on socio-cultural aspects based upon study on Ethnography of the area will be included.

7. **Muck Disposal Plan** - Suitable sites for dumping of excavated material would be identified in consultation with the State Pollution Control Board and Forest Department. Cross-sections of muck disposal sites would be given.
8. **Catchment Area Treatment Plan** shall be prepared micro-watershed wise. Areas/watersheds falling under 'very severe' and 'severe' erosion categories are required to be treated. Delineation of micro-watersheds in the entire river catchment intercepted at the Dam site and mapping of critically degraded areas requiring various biological and engineering treatment measures. Identification of area for treatment based upon Remote Sensing & GIS methodology and Silt Yield Index (SYI) method of AISLUS coupled with ground survey. The steps to be followed are listed as below:
    (a) Catchment Area Treatment Plan to be prepared using Silt Yield Index method.
    (b) Delineation of sub watersheds in the catchment area.
    (c) Land use pattern using satellite data with ground truth verification will be prepared
    (d) Slope map of the catchment shall be prepared using Survey of India topo-sheets
    (e) Mapping of critically degraded areas based on Integration of Remote Sensing technique, GIS methodology and Silt Yield Index method.
    (f) Preparation of phase wise Catchment Area Treatment (CAT) Plan using biological and engineering measures for sub-watersheds with very high and high erosion intensity.
    (g) Estimation of cost required for implementation of CAT plan.
    (h) Spatial Information in each micro watershed shall be earmarked on maps in the scale of 1:50,000. The CAT plan shall be prepared with year-wise Physical and financial details.
    (i) Layout map showing land slide/land slip zones if any, around the reservoir periphery needs to be prepared. Suitable engineering and biological measures for the identified land slip zones treatment must be provided with physical and financial schedule.
9. **Public Health Management Plan** including the provisions for drinking water facility for the local community.
10. **Compensatory Afforestation** in lieu of the forest land required for the project will be proposed. Choice of plants will be made in consultation with State Forest Department.
11. **Forest Protection Plan**
12. **Reservoir Rim Treatment Plan**
13. **Creation of Green Belt Plan** - Suitable species of plants for the proposed green belt along periphery of reservoir (Reservoir Rim Treatment Plan), colonies, approach road, canals etc. must be suggested. Complete plan with physical and financial details and layout of the proposed sites of green belt development will be included.
14. **Biodiversity Conservation and Wild life Management Plan -** Suitable Biodiversity conservation plan in consultation with State Forest Department will be included.
15. **Wild Life Conservation Plan**

16. **Fishery Management Plan** including base line data on catch composition, fish density, fish standing crop, fish population dynamics in and around project area, presence of migratory/endangered fish if any will be checked and mitigation measures would include monitoring the impact of the proposed construction on the fish resources.

17. **Fisheries Conservation Plan** for conservation/management of fishes. Probability of having fish ladder or fish pass is will be examined in case there is any migratory fish species in the area.

18. **Dam Break Analysis and Disaster Management Plan**. The outputs of Dam Break Model would be illustrated with appropriate graphs and maps clearly bringing out the impact of Dam break scenario. Dam break study shall be conducted covering the following steps
    (a) Development or identification of the inflow hydrograph to the reservoir at the time of failure
    (b) Routing of the hydrograph through the reservoir
    (c) Estimation of the outflow hydrograph from the failed structure
    (d) Modeling the movement of the flood wave downstream to determine travel time, maximum water level reached, inundated areas, etc.
    (e) Formulation of Disaster Management Plan

19. **Study of Design Earthquake Parameters**: A site specific study of earth quake parameters will be done. The results of the site specific earth quake design parameters will be sent for approval of the NCSDP (National Committee of Seismic Design Parameters, Central Water Commission, New Delhi for large Dams.

20. **Management during the Road Construction**

21. **Sanitation & Solid Waste Management Plan** for domestic waste from colonies and labour camps, etc.

22. **Energy Conservation Measures.**

23. **Restoration and landscaping of working Areas**: reclamation of borrow pits (quarry sites), muck disposal and construction areas.

24. **Water and Air Quality & Noise Environment Management** during construction and post-construction period.

25. **Local Area Development Plan** to be formulated in consultation with the Revenue Officials and Village Panchayats. An amount of 0.5% of the project cost will be earmarked for this purpose.

26. **Tribal area development plan** as the area is predominantly tribal inhabited.

27. Mitigation measures to check Jhum (shifting) cultivation at any in the catchment area with provision for alternative and better agricultural practices. CAT Plan shall cover impact of shifting cultivation.

28. Construction Methodology and Equipment Planning including the tunnel driving operations, machinery and charge density, etc.

29. A scientific study shall be done to assess the downstream requirement of water to decide minimum assured release of water (Environmental Flows) for maintaining the aquatic ecology and water quality of river.

30. ENVIRONMENTAL MONITORING PROGRAMME

The Environmental Impact Assessment is basically an evaluation of future events. It is necessary to continue monitoring certain parameters identified as critical by relevant authorities under an Environmental Monitoring Programme. This would anticipate any environmental problem so as to take effective mitigation measures. An Environmental Monitoring Programme will be formulated for implementation during project construction and operation phases. The cost estimates and equipment necessary for the implementation of this programme shall also be covered as a part of the Comprehensive EIA study.

31. Additional Studies

- Disaster vulnerability of the area on various aspects like landslides, earthquakes and floods.
- Downstream social and environmental Impact Assessment.
- Impacts due to peaking Power Operations with special reference to downstream areas and communities
- Impacts of Tunneling and Blasting
- Impacts of Mining of materials for the project
- Impacts of Backwater Effects of the reservoir in flood season
- Impact of peaking operation of the project on
- A table of 10 daily water discharges in 90% dependable year showing the intercepted discharge at the dam, the environmental and other flow releases downstream of the dam and spills to be included in the EIA report
- To include observed flow at G&D site, rainfall data and intermediate catchment mapping along with its contribution in EIA report
- Impacts due to DG set operation during construction phase.