CATCHMENT AREA TREATMENT AND ECO-RESTORATION OF IMPACT AREA PLAN

FOR

UPPER UDANTI BARRAGE (IRRIGATION) PROJET.

KALAHANDI INVESTIGATION DIVISION, BHAWANIPATNA, KALAHANDI

INTRODUCTION:

1.1 STATE OF ODISHA: -

Odisha (Orissa), previously known as Kalinga, an ancient state of India is renowned as Jagannath Dham. The state lies between Latitude 17^0 31' to 20^0 31' E Longitude 81°31' to 87° 30' N. Odisha shares boundaries with the states of West Bengal in the northeast, Jharkhand in the North, Andhra Pradesh in the South and Chattisgarh in the West. It has a coastline of about 480 km long on the Bay of Bengal on the East. The state of Odisha covers an area of 1,55,707 Sq. Km; where 419.74 lakh populations are residing with 979 females per thousand males with a density of 270 per Sq. Km. and literacy rate of 73% (+7 years) as per census 2011. The state is very rich in minerals like Chromite (95%), Nickel (92%), Bauxite (55%), Iron (33%), Coal (27%), and Manganese (18%) out of the total deposits of India. Besides, Graphite, China Clay, Fire Clay, Phylite, Tin, Gold, Gemstones, Rare earth minerals and other minor mineral deposits are also available for the industry. The eastern coast of Odisha, which is more than 480Km. long facilitates regular transport through ship on sea (Bay of Bengal) at three locations of the state. The state is well communicated by road through the N.H-16, 49, 55, 316,50,520 to different states/ places, The state capital-Bhubaneswar, the so-called Temple City is having an Inter National Air Port. Direct Rail links are established with Delhi, Mumbai, Chennai, Hyderabad, Howrah, Bangalore, Nagpur, Ahmadabad, Gowahati and almost with some other state capitals.

1.1.1. Geography of Odisha (Orissa): -

The area inland is made of the ancient landmass of peninsular India and covers about three-fourth of the entire state. The Middle Mountainous and Highlands Region mostly comprises the hills and mountains of the Eastern Ghats rising steeply in the East and slope gently to a dissected plateau in the west running from northeast (Mayurbhanj) to northwest (Malkangiri). These appear like scattered series of steep ridges interrupted by a number of river valleys and flood plains. The elevation varies between 300-1200m. The entire area very rich in mineral resources is mainly inhabited by tribes. The plateaus are mostly flat forming the western slopes of the Eastern Ghats with elevation varying between 305-310 m. There are two broad plateaus in Odisha: the Panposh-Keonjhar-Pallahara plateau comprising the upper Baitarani catchment's basin and the Nabrangpur-Jeypore plateau comprises the Sabari basin.

Geo-morphologically, it can be broadly divided into five major regions. The coastal plains in the East, the middle mountainous and highlands region of north and northwest, the central plateaus, the Western rolling uplands and the major flood plains. The Western Rolling Uplands are lower in elevation from 153m to 305 m and have a bed rock of hard soil with lot of flora and fauna. The Eastern Ghat in North, South & in West provides the natural beauty with springs, waterfalls and some wild life sancuaries. Abundant hydro power potential and the cultural heritage are also common in Odisha.

1.1.2. The River System:

Out of the total surface area, the coastal plains occupy only 10% and belong to the post tertiary period, which are formed by the alluvial deposits of the six major rivers. They are: - The Subarnarekha, the Budhabalanga, the Baitarani, the Brahmani, the Mahanadi, and the Rushikulya. The region stretches from the West Bengal border i.e. from the river Subarnarekha in the north to the river Rushikulya in the South. This plain slopes to-wards east with a maximum width in the middle (the Mahanadi delta), narrow in the North (Balasore plain comprising deltas of the Subarnarekha and the Budhabalanga) and narrowest in the South (Ganjam plain comprising smaller delta of the Rushikulya). The South coastal plain also comprises the lacustrine plains of Chilika Lake. The long stretch of land covers the districts of Balasore, Cuttack, Puri and a part of Ganjam with miles and miles of paddy fields constituting the 'rice bowl' of the State.

1.2.   PURPOSE OF THE PROJECT: -

Upper Udanti Barrage (Irrigation) Project is proposed to construct near village Patialpara in Nuapada District of Odisha and falls in Survey of India Topo Sheet No. 64L/4, 64L/7, 64L/8, 64L/11, 64L/12, 64L/16, & 65I/5, 65I/13. This project envisages construction of a 270 m. long and 266.50m. Height (crest level) homogeneous earthen dam besides a central spillway proposed at the centre of river gap portion. This medium irrigation project will provide irrigation to 8000ha of CCA out of 12000ha GCA with annual irrigation of 7200 ha in the drought prone areas under Sinapali & Boden Blocks. Provision for 20% U/S utilizations has been made and the net yields available at upper Udanti barrage site have been worked out.

The catchment area intercepted at the proposed barrage site is 1044sq. km, out of which 725sq.km in Chhattisgarh and 319sq.km in Odisha. This project has the Catchment Area of 319 Sq Km. & and require a Catchment Area Treatment (CAT) Plan. The CAT plan targets overall improvement in the environmental conditions of the region. All the activities are aimed at treating the degraded and potential areas of severe soil erosion. The plan provides benefits due to biological and engineering measures and its utility in maintaining the eco-tourism. It also aims to reduce fuel wood consumption at least during the interregnum till the plantations become utilizable.

A. Location:
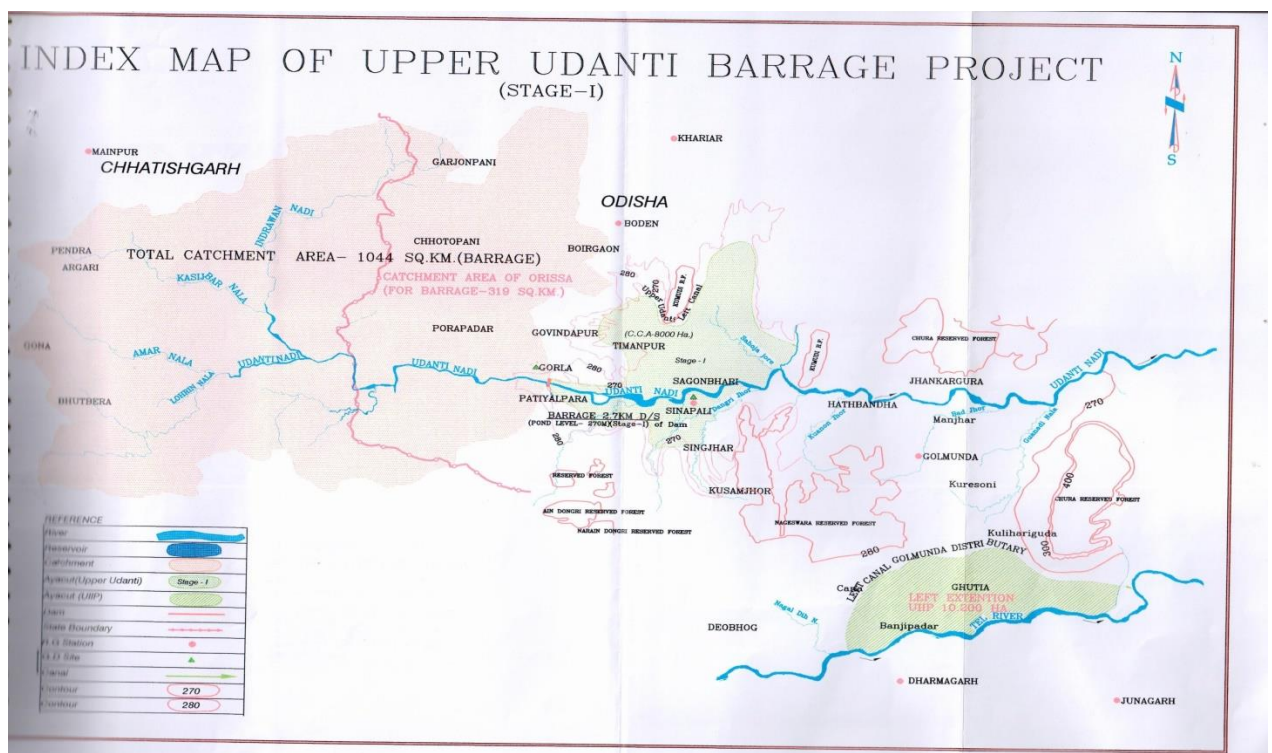|		
I.	Latitude:	: $20^0 06'20''$N
II.	Longitude:	: $82^0 32'35''$E
III.	Topo Sheet:	: 64L/4,64L/7,64L/8, 64L/11,64L/12,64L/16,65I/5&65I/13
IV.	Nearest Railway Station:	: Kantabanjhi - 81km
V.	Nearest Air Port:	: Raipur- 200km
VI.	Road new	: Khariar-Sinapalli MDR- 46km
VII.	Distance from State Capital to Project site	: 450Km
VIII.	District Headquarter	: Nuapada - 116km

Fig-1: Catchment Area of Upper Udanti Barrage (Irrigation) Project: -

Chapter-9 **(Irrigation and Hydro Electric projects, including Catchment Area Treatment (CAT PLAN)** of the Handbook deals with the requirement and necessary guidelines for the preparation of Catchment Area Treatment plan for the irrigation projects. As per the guideline 9.2,

9.2 Catchment Area Treatment (CAT PLAN): A proposal for diversion of forest land for Irrigation and Hydro-Electric projects shall invariably be accompanied by detailed CAT plan except in respect of small hydel projects (maximum up to 10MW capacity), which are either canal head or run of the river projects and don't involve impounding of water/submergence of forest land.

The cat plan is an important and essential plan for enhancing and maintaining the ecological health of the catchment area of the proposed irrigation/hydroelectric project through **site specific biological and engineering measures for conservation of & moisture and management of water regime.** Among other provisions, the measures should focus **on arresting soil erosion, improving effective drainage in the area, and rejuvenation of the degraded eco system in the catchment**. Following general principals should be kept in view while formulating CAT plans.

i.   **In the dense forest areas** major concentration should be on soil & water conservation including water harvesting for which various water harvesting structures like check dams, gully plugging, gabion dams, contour trenches and vegetative structures should be made.

ii.   **In the open forest areas** besides taking up soil and water conservation measures, plantation of local indigenous tree and shrub species, including rare/medicinal plants, should be done. In higher altitudes plantation of chir pine should be avoided.

iii.   The CAT Plan should include **a component of fodder development** on the civil soyam forest or on revenue / private lands in order to meet the requirement of fodder /small timber/fire wood for the local population with a view to reduce pressure on the forests.

iv.   The CAT Plan should have a socio-economic component including supply of CNG connections to the project affected families to be implemented through joint forest management committees (the nomenclature may vary among the states/UTs).

v.   The infrastructure component like construction of building, vehicles, salaries of staff etc. May be provided based on a careful analysis of the need for the same with detailed justification and should constitute a very small percentage (say up to 50%) of the total cost of the CAT plan.

vi.   CAT plan shall be approved by the principal CCF & HoFF or any other officer authorized by him for the purpose.

vii.   Regular monitoring is essential for effective implementation of the CAT plan. The chief project officer of the user agency must be associated in implantation as well as monitoring of the progress of CAT plan. For this, a committee with following composition may be constituted at state level for quarterly review of progress of implementation of various CAT plans and take immediate steps to ensure the same:

      1. PCCF & HoFF - Chairman
      2. Secretary (Agriculture) or his Representative - Member
      3. Secretary (Animal Husbandry) or his representative – Member
      4. Project Officer - User – Agency - Member
      5. Concerned Conservator of Forests – Member
      6. Nodal Officer (FC) @ PCCF – Member Secretary

PROJECT DETAILS

      Short narrative of the proposal and project/scheme for which the forest land is requested:

      This proposal is for diversion of 29.939 ha. of Forest land out of 644.350 Ha of total land required for Construction of Upper Udanti Barrage (Irrigation) Project. The Land required for head works (non-Forest land-94.879 Ha + Revenue Forest Land -6.491 Ha) and land required for distributary system (non-Forest land-519.532 Ha + Revenue Forest land – 23.448 Ha) = total 644.350 Ha of land involved for construction of Upper Udanti Barrage (Irrigation) Project of Kalahandi Forest Division & Kalahandi District, by the Department of Water Resources, Govt. of Odisha.

B. Salient feature of Upper Udanti Barrage (Irrigation) Catchment: -

Upper Udanti Barrage (Irrigation) Project is proposed in Udanti River on Tel sub-basin of Mahanadi basin near village Patialpara in Sinapali Block of Nuapada District, Odisha. The Udanti River is a major tributary of Tel River in Sinapali block of Nuapada District. The Udanti River originates from the hill ranges of Chhattisgarh (erstwhile Madhya Pradesh) at an altitude of 610m and flowing through Chhattisgarh and enters into Odisha and joined Tel River near village Tepra of Kalahandi district. The project intercepts a catchment area of 319 sq. km at the proposed dam site. The catchment area is fairly shaped and is bounded by hills and covered by thick forest.

A. HYDROLOGY: -

I.	Total Catchment area	: 319 sq.km (inside Odisha)
II.	Rainfall	
	(a) Average annual rainfall	: 1440.00 mm
	(b) Minimum annual rainfall	: 521.00 mm
	(c) 75% dependable year rainfall	: 1080mm
	(d) Net 75% dependable yield	: 48174 Ham
	(e) Design Flood Discharge	: 6281 Cumecs

B. Reservoir: -

I.	Length of Barrage	: 270.00m
II.	Sluice Length	: 115.00m
III.	Full Reservoir Level	: 270.00m
IV.	Maximum Water Level	: 271.00m.
V.	Maximum Height of the Crest	: 266.50m
VI.	Sill Level	: 262.185m
VII.	Number of villages submerged	: Nil
VIII.	Length of N.H to be submerged	: Nil
IX.	Length of S.H to be submerged	: Nil
X.	Forest area to be submerged	: 3.0Ha

C. Submergence: -

I.	Number of village affected	: Nil
II.	Number of village fully affected	: Nil
III.	Number of village partly affected	: Nil
IV.	Number of families affected	: Nil
V.	Cultivate land submerged	: Nil
VI.	Land required for head works	
	a) Non- Forest Land	: 94.879Ha
	b) Revenue Forest Land	: 6.491Ha

VII. Land required for Distributary system: -

a)	Non-Forest Land	: 519.532 Ha.
b)	Revenue Forest Land	: 23.448 Ha.
	Total =	**: 644.350 Ha.**

D. **Barrage: -**

    I.   Type   : Concrete barrage with sloping glacies.
   II.   Length of Earth Dam   : 2 7 0 .00 m.
  III.   Maximum Crest Height   : 266.50m.

E. **Spillway: -**

    I.   Location & Type   : Central Spillway & Ogee Crest
   II.   Length of Sluice   : 115.00 m.
  III.   Crest Level of Sluice   : RL266.50 m.
  IV.   Size of Gate   : 15.00m x 5.0 m
   V.   Numbers of gates   : 7Nos.

F. **Distribution System: -**

    I.   G.C.A   : 12000 Ha.
   II.   C.C.A   : 8000 Ha.
  III.   Area under irrigation   : 7200Ha
  IV.   Identity of irrigation during Kharif : 90%
   V.   Area to be irrigated during Kharif : 7200 Ha.
  VI.   Area to be irrigated during Rabi   : Nil.
 VII.   Annual Irrigation   : 7200 Ha.
VIII.   Annual intensity of Irrigation   : 105%
  IX.   Utilization factor   : 77.52%
   X.   Length Main Canal on Right side : 9.75 km.
  XI.   Length Main Canal on left side   : 8.815 km.
 XII.   Number of village to be benefited : 63 Nos.

G. **Cost: -**

    I.   Cost of Head Works   : 10595.40 Lakhs
   II.   Cost of Distribution System   : 8807.73 Lakhs
  III.   Total Cost of the Project   : 19403.13 Lakhs
  IV.   Cost per hector of annual irrigation : 2.695 Lakhs
   V.   B.C. Ratio (10% rate of interest rate) : 1.524

E. Need for Catchment Area Treatment Plan: -

The objective is to prepare CAT Plan of various projects for Forest Clearance / Environmental Clearance purposes to comply the following points:

   I. Reducing soil erosion and land degradation by taking up adequate and effective soil conservation measures in erosion prone area.
  II. Rehabilitation of degraded forest areas through afforestation, treatment of pastureland and facilitating natural regeneration.
 III. Reduction and control of cultivation practices in the catchment area through suitable and appropriate alternatives acceptable to local residents.
 IV. Demonstration of good practices in agriculture and horticulture land treatment.
  V. Saving and conservation of forest-based fuel.
 VI. Conservation and rehabilitation of riverine flora particularly in the river stretches between barrage and tailrace outlet.

It is well-established fact that reservoirs formed by dams on rivers are subjected to sedimentation. The process of sedimentation embodies the sequential process of erosion,

transportation, deposition and compaction of sediment. The study of erosion and sediment yield from catchment is of utmost importance as the deposition of sediment in reservoir reduces its capacity, and thus affecting the water availability for the designated use. The eroded sediment from catchment when deposited on streambeds and banks causes braiding of river reach.

The removal of top fertile soil from catchment, adversely affects the agricultural production. Thus, a well-designated catchment area treatment plan is essential to ameliorate the above-mentioned adverse process of soil erosion.

The CAT plan highlights the management techniques to control erosion in the catchment area of a water resource project. The life span of a reservoir is greatly reduced due to erosion in the catchment area. Adequate preventive measures are thus needed for the treatment of catchment for its stabilization against future erosion. The catchment area treatment involves understanding of the erosion characteristics of the terrain and suggesting remedial measures to reduce the erosion rate.

In the present study **Silt Yield Index (SYI)** method has been used. In this process, the terrain is subdivided into various watersheds with the erodibility criteria of catchment (low, moderate, high etc.) and so; do not provide the absolute silt yield. SYI method is widely used because of the fact that it is easy to use and lesser data requirement. Moreover, it can be applied to larger areas like sub-watersheds etc.

F. The CAT Plan would cover the following aspects: -

- ❖ Identification of directly / free draining catchment to be done basing on remote sensing and validation through field survey.
- ❖ Erosion levels the watershed and prioritization of water sheds will be done by appropriate methods.
- ❖ As per the requirement of Ministry of Environment & Forests and Climate Change (MoEF & CC), Government of India, the treatment measures will be proposed for the area falling under very severe erosion categories. Both Engineering as well as biological treatment measures will be proposed in the CAT plan.
- ❖ The cost of the administrative set up and mitigate measures will include recommendation from State Forest Department for all forest land and from the Soil Conservation Department for non-forest land.
- ❖ The CAT plan also includes a socio - economic component including supply of CNG connections to the project affected families to be implemented through VAN Surakhya Samities (VSSs).
- ❖ The infrastructure component like construction of building, vehicles, salaries of staff etc. may be provided based on a careful analysis of the need for the same with detailed justification and should constitute a very small percentage (say up to 50%) of the total cost of the CAT plan.

G. Scope of Work: -

The detailed Scope of work for development of CAT plan for U p p e r U d a n t i B a r r a g e (Irrigation) Project is as under:

H. Data Collection: -
   i. Survey of India (SOI) Topo Sheets.
   ii. Project Map / Catchment Area Map from concerned Project Authorities.
   iii. Satellite imagery acquisition (LISS-IV) from National Remote Sensing Agency, Hyderabad.
   iv. Soil map from All India Soil and Land Use Survey.

Data Generation: -

i. Drainage & Hydrology.
ii. Contour.
iii. Land Use: The land used classification and coverage in the Project Catchment Area.
iv. Physiography / Soil: Project area will have a variety of soils, mainly dependent on the lithology, topography, altitude, climate and vegetation cover. This shall be derived from map prepared by All India Soil and Land Use Surveys.
v. Micro Watershed.
vi. Data Elevation Model (DEM): Derived contours from topographical maps will be used for preparation of DEM of the free draining catchment area and to prepare a slope-oriented map.
vii. Slope: Generation of Slope from SOI Topo sheets.

Data Analysis / Modeling: -

i. 25m X 25m grid with Land Use, Soil, Slope values.
ii. Watershed prioritization.

Plan for Watershed Management: -

i. Treatment measures / options.
ii. Sub watershed wise afforestation plan.
iii. Slit observation locations.

CATCHMENT AREA TREATMENT PLAN AND ECO-RESTORATION OF IMPACT AREA PLAN: -

NEED FOR CATCHMENT AREA TREATMENT PLAN: -

As per the Environment Impact Assessment report of the Irrigation project the Catchment Area Treatment Plan has been prepared.
The details are: -

It is well-establishment fact that reservoirs formed by dams on rivers area subjected to sedimentation. The process of sedimentation embodies the sequential processes of erosion, entrainment, deposition and compaction of sediment. The study of erosion and sediment yield from catchments is of utmost importance as the deposition of sediment in reservoir reduces its capacity, and thus affected the water availability for the designated use. The eroded sediment from catchment when deposited of streambeds and banks causes braiding of river reach. The removal of top fertile soil form catchment adversely affects the agricultural production. Thus, a well- designed Catchment Area Treatment (CAT) Plan is essential to ameliorate the above- mentioned adverse process of soil erosion.

Soil erosion may be defined as the catchment and transportation of soil. Water is the major agent responsible for this erosion. In many locations, winds also cause soil erosion. In the present case erosion due to water is a common phenomenon and the same has been studied as a part of the Catchment Area Treatment (CAT) Plan.

The Catchment Area Treatment (CAT) Plan highlights the management techniques for to control erosion in the catchment area of a water resources project. The life span of a reservoir is greatly reduced due to erosion in the catchment area. Adequate preventive measures are thus needed for the treatment of catchment for its stabilization against future erosion. The directly draining catchment area has been considered for treatment under the present project i.e. Upper Udanti Barrage (Irrigation) Project.

NEED FOR ECO-RESTORATION PLAN OF IMPACT AREA: -

Area draining into reservoir through natural drainage within the Impact area mainly responsible for soil erosion. It disturbs the eco-logical balance by destroying the vegetated cover, dislocating wild life and removing precious topsoil, modification of stream morphology. Consequently, natural vegetation is removed on either side of river bank. Soil gets disturbed and is easily removed during periods of heavy down pour, leading to accelerated erosion of soil cover. This causes silt/sediment flow into streams below. Siltation of stream beds reduces the capacity of stream channel and reservoir.

The study of erosion and sediment yield from catchments is of utmost importance as the deposition of sediment in reservoir reduces its capacity, thus affecting the water availability for the designated use. The eroded sediment from catchments when deposited on streambeds and banks causes braiding of river beach. The removal of top fertile soil from catchments also adversely affects the agricultural production. Another important factor that adds to the sediment load, and which contributes to soil degradation is grazing pressure. A large number of cattle, sheep's, and goats graze the pastures during summer season continuously for about six months. Due to this pressure, the productivity of these pastures is also declining further. The lack of proper vegetal cover is a factor to cause degradation and thereby results in severe run off/soil erosion, and subsequently premature siltation of the reservoir. Thus, a well-designed **Eco-Restoration Plan of Impact Area (hereafter referred as Eco- Restoration Plan, ERP)** is essential to ameliorate the above-mentioned adverse causes and process of soil erosion. The ERP involves understanding of the erosion characteristics of the terrain and suggesting remedial measures to reduce the erosion rate. For this reason, the catchments of the directly draining rivers, streams, tributaries, etc. are treated and the treatment plan has been included in the project.

THEMATIC MAP GENERATION: -

As mentioned in the methodology, various thematic layers like catchment, watershed, drainage, contour, slope, land use, soil were prepared in Geographic Information System (GIS) plat form. For seamless integration of different thematic layers and interactive spatial analysis, the themes were generated in a real world coordinate system, i.e. UTM (Universal Transverse Mercator). This projection system is used in the recent publication Open Series Map (OSM) of SOI and is also suggested in National Map Policy. Datum used for the projection is WGS 1984 and Zone is UTM 44 North.

CATCHMENT AND WATERSHED MAP: -

The catchment boundary of Udanti barrage was delineated from SOI Topo sheets No. 64L/4, 64L/7, 64L/8, 64L/11, 64L/12, 64L/16, & 65I/5, 65I/13 looking at the contours and drainage. The Index Map of the project is enclosed as plate-I. The total catchment area is 319 Sq. Km, inside Odisha, it was decided to prepare the CAT plan at Micro Watershed level instead of Watershed level. The micro watersheds are prepared using the information available in Watershed Atlas of India and website and Land Use Survey of India (SLUSI) and the micro watershed boundary collected from Watershed Mission of Odisha. The Catchment Area Map of Upper Udanti Barrage Project is enclosed as plate-II.
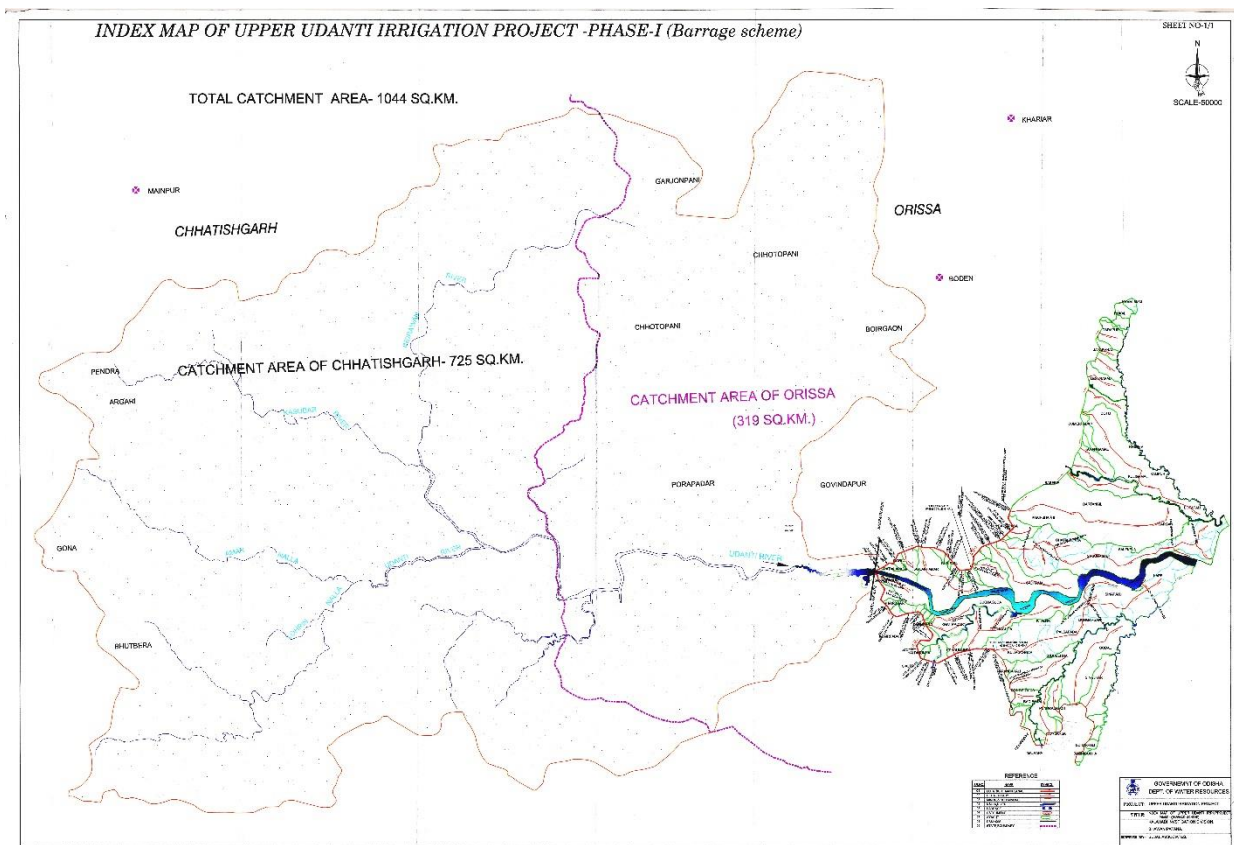
SLOPE MAP: -

The Slope was prepared using the derived contours from SOI Topo sheet. These contours were used for preparation of Digital Elevation Model (DEM) of the catchment area before preparation of the slope map. A surface was created using the elevation values stored in the form of contours or points. After marking the catchment area, all the contours on the topographical maps were derived. The output of the digitization procedure was the contours with 'Z' value (height as well as spot above heights in form of X, Y & Z points. (X

Longitude, Y Latitude and Z Elevation above MSL). As the area is mostly flat and there are wide horizontal gaps between contours, the spot heights collected in DGPS (differential GPS) during ground trotting of land use are also used as an input.

A Digital Terrain Model (DTM) of the area was then prepared, which was used to derive a slope map. The slope was divided in classes of slope percentages.

Land Use/ Land Cover Map: -

Land Use map was prepared from recent LISS-IV Multi Spectral Satellite Image collected from National Data Centre of National Remote Sensing Agency (NRSA).

Satellite:	
Sensor:	
Date of Pass	
Path:	
Row:	

The image was geo-referenced using common Ground Control Points (GCP) of Survey of India Topo sheets and satellite image with the help of standard data preparation techniques in standard image processing software. As the catchment area is very small, visual interpretation of the geo-referenced data was done by qualified professionals using standard enhancement techniques followed by detail ground trotting to enhance the quality of image interpretation.

SOIL MAP: -

Soil map was prepared by digitizing the soil map collected from National Bureau of Soil Survey and Land Use Planning (NBSS & LUP) for Odisha and undivided Madhya Pradesh.

Estimate of Soil Loss Intensity using Silt Yield Index (SYI) Method: -

The Sedimentation (Silt) Yield Index Model (SYI), considering sedimentation as product of erosivity, erodibility and areal extent was conceptualized in the AISLUS, as early as 1969 and has been in operational use since then to meet the requirements of prioritization of smaller hydrologic units. The erosivity determinants are the climatic factors and soil and land attributes that have direct or reciprocal bearing on the unit of the detached soil material.

The Silt Yield Index (SYI) is defined as the Yield per unit area and SYI value for hydrologic unit is obtained by taking the weighted arithmetic mean over the entire area of the hydrologic unit by using suitable empirical equation.

In SYI methodology, each Erosion Intensity Unit (EIU) is assigned a weight age value. When considered collectively, the weight age value represents approximately the relative comparative erosion intensity. The slope, soil and land use theme of the catchment were combined using union tool in GIS and EIU were formed using different combination of soil, slope and land use categories.

SYI was calculated using following empirical formula: -

SYI =	$\dfrac{\Sigma(Ai \times Wi) \times Di \times 100}{Aw}$	[where i = 1 to n (n is the No. of EIU)]
Ai = Area of ith unit (EIU)		Wi = Weightage value of the ith unit EIU
Di = Delivery Ratio of the ith unit EIU		Aw = Total area of Micro-watershed

Weightage Value (W): -

Weightage Value is a combination of two factors K and X, A basic factor of K = 10 were used in determining the weightage values. The value of 10 indicates a static condition of equilibrium between erosion and deposition. Any addition to the factor K (10+X) is suggestive of erosion in ascending order whereas subtraction, i.e. (10-X) is indicative of deposition possibilities.

Delivery Ratio (D): -

Delivery ratios were assigned for each of the erosion intensity unit. The delivery ratio suggests the percentage of eroded material that finally finds entry into reservoir. Area of each EIU in each micro watershed was then estimated.

Delivery ratios were assigned to all erosion intensity units depending upon their distance from the nearest stream. 1.0 km, 2.0 km, 5.0 km, 15.0 km and 30.0 km buffers were created around the main stream and reservoir using GIS. EIUs falling in different buffer zone were assigned the Delivery ratio of the respective buffer zone.

The area under medium erosion categories is to be treated: -

Hence, CAT plan is planned for medium erosion categories, as a part of the EIA study, the expenses of which have to be borne by project proponents.

CATCHMENT AREA TREATMENT (CAT) PLAN: -

Following Engineering and Biological measures shall be suggested for the catchment area treatment depending upon the requirement and suitability.

    A. **Engineering measures: -**
        i. Gully control
        ii. Stream bank protection
        iii. Contour staggered trenches
        iv. Catch water drains.
    B. **Biological measures: -**
        i. Restoration of degraded area.
        ii. Afforestation.
        iii. Timber plantation.
        iv. Fodder plantation.
        v. Plantation of Horticulture and Agriculture land development.
        vi. Publicity and Awareness.
        vii. Monitoring & Evaluation.

The Udanti River is a tributary of river tel sub-basin of Mahanadi Basin. This river originates from the hill ranges of Chhattisgarh at an altitude of 610 meter and enters into Odisha & joins river Tel near Tepra of Kalahandi district. The project intercepts a catchment area of 319 sqkm at the proposed dam site. The catchment area is fairly shaped and is bounded by hills and covered by thick forest.

The catchment of this river includes part of Adipata, Gurudonger, Koilakhala, Nimna, Patdhara forest blocks in Khariar, Komna, & Sinapali Forest Ranges of Khariar Forest Division and also under Nuapada district. The total area of above forest blocks is 59140.99 ha, which has been allotted to (i) Improvement Working

Circle (ii) Rehabilitation Working Circle (iii) Plantation Working Circle (iv) Bamboo Overlapping Working Circle and (v) Protection Working Circle considering the elevation of 270 mt, and canopy density 0.3. The forests of these forest blocks has been allotted to (i) Southern Tropical Dry Deciduous Forest (5A/C1), (ii) Northern Dry Mixed Deciduous Forest (5B/C2), (iii) Dry Peninsular Sal Forest (5B/C/C).

This Forest Blocks are located in Western side of Nuapada. Here Q. ll type Sal finds occurrence in the valleys and low lying areas having deep loamy soil, while hill slopes are mostly covered with Q. iii Sal. The associates of Sal are Asan (Terminalia alta), Dhaura (Anogeissus latifolia), Jamun (Syzygium cuminii) etc. The regeneration condition of Sal is poor due to biotic interferences like encroachment, shifting cultivation, grazing, smuggling etc and fire hazard. Due to depletion of vegetation the soil has been exposed to weathering condition and suffers from soil erosion. This has led to formation of rills and gullies. During rains development of gullies leads to heavy soil erosion.

In view of the above, the catchment area of this Irrigation Project, which includes the forest blocks, needs to be treated properly under Catchment Area Treatment Plan in order to increase the longevity of the project for achieving assured irrigation to the ayacut area in the Scheduled period.

Down below (towards east) there exist good fertile ayacut area. The catchment need to be treated properly not only to maintain the life of the irrigation project but also to prevent deposit of the eroded soil in the paddy field located in the ayacut.

Catchment Area Treatment plan is an essential document as its portrait the ecological of the catchment area and various soil and moisture conservation and watershed management program required to arrest soil erosion, to improve free drainage in the area and to regenerate the degraded ecosystem in the catchment. Sedimentation of the reservoir is a function of soil erosion rate of the river catchment area. It reduces the water storage capacity of the reservoir and availability of water for its designated use.

Keeping the above in back-ground, the catchment of these forest blocks has been categorized in three stages.

   i.   The moderately dense forest area on the higher hills where major concentration will be gully plugging, staggered contour trenches and Percolation Pits.
   ii. In the permanent gaps (compact area of 4 Ha) on the middle hill slope plantation of indigenous species is to be done.
   iii. On the foot hill of forest blocks a number of villages / hamlets have come up and the habitants rear domestic cattle. The regular practice is to let loose the cattle in the morning to the forest area for grazing.

Such practice exerts a lot of pressure and their trampling affect also accelerates erosion and less survival of natural re-generation of dominant species like Sal (Shorea robusta), Asan (Terminalia alata), Dhura (Anogeissus latifolia), Jamun (Syzygium cuminii) Piasal (Ptrocarpus marsupium), Bandhan (Ougeinia oogeinenesis), Moi (Lannea coromandelica), etc.

Upper hill slopes in this zone suitable soil conservation measures like Gully plugging, Staggered Contour trenches and Percolation pits will be under taken. The gully plugging will be done especially where gullies have been formed, by erecting loose boulder Check Dams over 200.0 ha, which costs Rs.922/- per cum. (Estimate enclosed as **Annexure–I**.) Rs**.** 922.00 x 400 Cum. Thus, the total cost will come to Rs.3,68,800.00/-.

Areas where moderate erosion has taken place and if not protected may lead to gullies, Staggered Contour Trenches will be done of size 2.5m length, 0.5mt width and 0.5m depth. Horizontal gap between trenches will be 4.5 mt and vertical distance between contour lines will be 5 to 7 mtrs. At least 200 such trenches will be excavated per ha. Such treatment will be provided to 200.0 ha. Cost of each such trench will cost Rs.58500.00 x 200.0 ha = Rs. 1,17,00,000.00 **(Annexure–II).**

In the gentle slopes percolation pits will be excavated over 200.0 ha. The size of Percolation pits will be 1.0 mt length x 1.0 mt width and 1.0 mt depth. = 1cum. 200 such pits will be excavated per ha with a cost of Rs. 58500.00. The total cost comes to Rs. 58500.00 x 200 ha = Rs. 1,17,00,000.00 **(Annexure-III).**

Development of Gullies

Construction of Loose Boulder Structure

MIDDLE HILL SLOPES – 300 HA

In this zone there is a good depth of soil and vegetation under sub-climax stage exists which need to be supplemented by Aided Natural Regeneration (ANR). In such Plantation 500 plants will be planted in gaps at irregular intervals according to availability of gaps. The species to be preferred for plantation are as stated below: -

Piasal	-	Pterocarpus marsupium
Kururm	-	Adina cordifolia
Moi	-	Lannea coromandelica
Amla	-	Emblica officinalis
Mahul	-	Madhuca indica
Bel	-	Aegle marmelos
Ashok	-	Saraca indica
Karanj	-	Pongamia glabra
Kususm	-	Schleichera oleosa

The cost norm for such plantation is Rs. 1,57,554.00/- (for the year 2024-2025) per Ha, with 10 years maintenance with the Wage Rate of Rs.450/- **(Annexure– IV).** Thus, the total cost comes to Rs. 1,57,554.00X 300 ha = **Rs.4,72,66,200.00**

Others

I. It is proposed to make provisions of socio-economic component including supply of CNG connections to the project affected families to be implemented through VSS. 100 number of families X Rs. 10,000.00 = Rs. 10, 00, 000.00

II. it is proposed for infrastructure component like construction of buildings, vehicles, salaries of staff etc

      a. Construction Building to be used as office   = Rs. 12, 00, 000.00

      b. Engagement of two persons including one data entry operator to supervise the work for 10 years @Rs. 15,000.00/- Month X 2 = 30, 000.00

            Rs. 30, 000.00 X 120 Months = Rs. 36, 00, 000.00

      c. One Two-wheeler vehicle to be purchased for use of supervising staff Rs. 1, 00, 000

      d. Fuel for the Two-wheeler for 10 years Rs. 2, 40, 000.00

      e. Contingency, Computer, Printer etc. Rs. 5, 00, 000.00

Others Total cost = Rs. 66,40,000.00

TOTAL COST OF THE CATCHMENT AREA TREATMENT PLAN

Sl. No.	Type of Work	Extent	Cost Norm	Total Cost	Annexure No.
01	Gully Plugging	200 Ha (400 cum)	Rs. 922/-	3,68,800.00	I
02	Staggered Contour Trenches	200 Ha	Rs. 58,500.00	1,17,00,000.00	II
03	Percolation Pits	200 Ha	Rs. 58,500.00/-	1,17,00,000.00	III
04	Total (1+2+3)			2,37,68,800.00	
05	20% Escalation			47,53,760.00	
06	Total (4+5)			2,85,22,560.00	
07	Assisted Natural Regeneration-ANR (500 Plants/Ha) with 10years maintenance.	300 Ha	Rs.1,57,554/-	4,72,66,200.00	IV
08	Other cost (Construction Building, Engagement of two persons including one data entry operator, One Two-wheeler vehicle, Fuel for the Two-wheeler & Contingency, Computer, Printer)			66,40,000.00	
	Grand total (6+7+8)			8,24,28,760.00	

(Rupees Eight Core Twenty-four Lakh Tweety eight Thousand Seven Hundred Sixty only)

Note: - DoWR has to deposit the cost of Catchment Area Treatment Plantation with
D.F.O. Khariar Forest Division for execution

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Kalahandi Investigation Division
Bhawanipatna

Divisional Forest officer
Khariar Forest Division,
Khariar

Wage Rate Rs.450/-

Loose Boulder Check Dams

(A). Size – 10' x 10' x 5'

(i) Requirement of boulder In- Situ (Picked up and broken)

½ (10'+4') X 10' X 5' =350 cft or 9.90 cum @ Rs.185/- per cum= **Rs. 1831.50/-**

(ii) Labour for construction of LBCD for 1 cum

Mulia-	1.04 nos @ 450.00	= 468.00
Mason special-	0.17 nos. @ 550.00	= 93.50
Stone packer-	0.35 nos. @ 500.00	=175.00
	Total = 736.50	
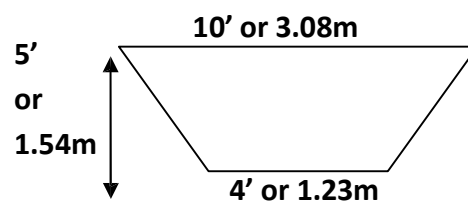
For 9.90 cum =9.90X736.50 = Rs. 7291.35

Total 1831.50 + 7291.35 = Rs. 9122.85 (or round) 9123.00)

For 1 cum Rs. 922 /cum

Rs.922/- x 400 cum = **Rs.3,68,800/-** (**Rupees Three Lakhs Sixty-Eight Thousand Eighty Hundred only).**

10' or 3.08m

5' or 1.54m

4' or 1.23m

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Bhawanipatna   **Khariar**

STAGGERED CONTOUR TRENCH

Specification: -
Length – 2.5 mt
Width- 0.5 mt
Depth- 0.5 mt
Cross Section- (0.5 mt x 0.5 mt) = 0.25 sq mt
Earth Work- (2.5 mt x 0.25 sq mt) = 0.625 cum
Gap between Trenches (Horizontal) = 4-5 mt
Distance between contour lines (Vertical) = 5-7 mt

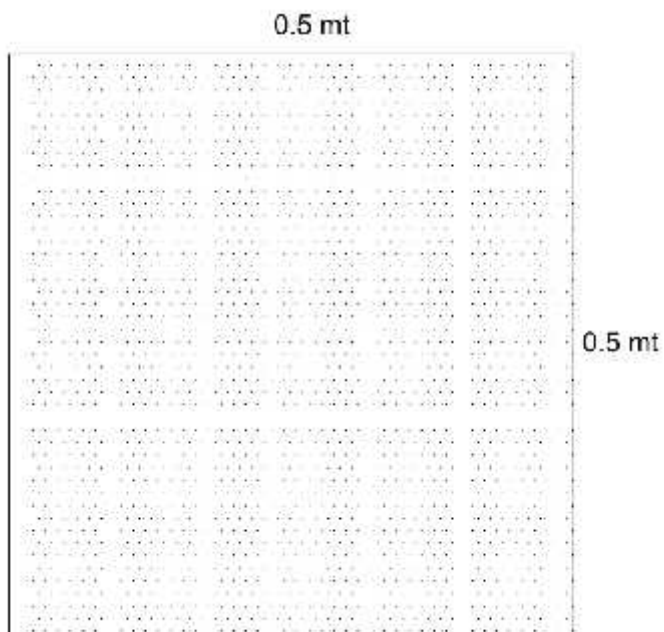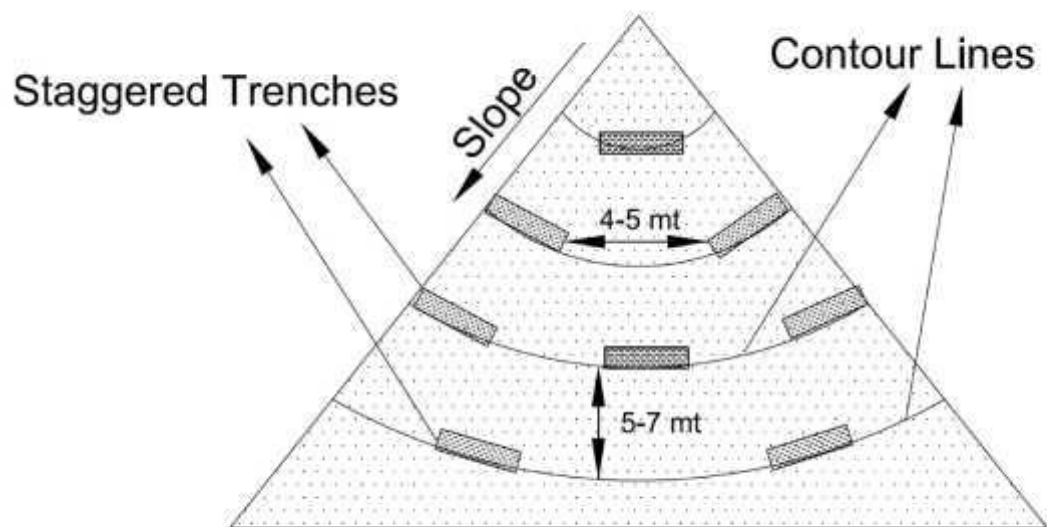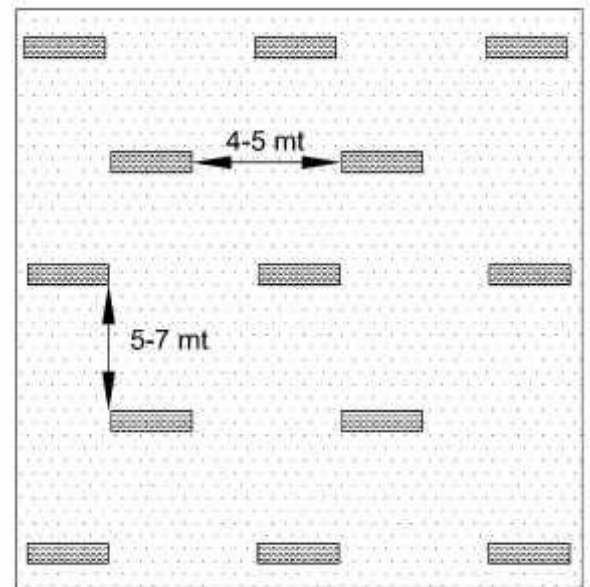Cross Section of each staggered trench
Plains

Staggered Trenches Design in

Explanation: -

As per the PWD schedule of Rate 2018, it envisages adopting Analysis of Rate 2006 mutatis-mutandis. Accordingly, the Earth work is calculated as follows.

1. (a) Earth work in ordinary soil per 100 cum as follows:
   i) Labour

   Male Mulia - 16 Nos @ 450.00/ MD = 7200.00

   Female Mulia- 16 Nos @ 450.00/ MD = 7200.00

   ii) Overhead Charges @ 10 % on (i)   = 1440.00

   iii) 2% Sundries and T & P etc on (i)   = 288.00

   Total (i+ii+iii)   = 16,128.00

For 300 number of Staggered contour trenches: 300x0.625 cum =187.50

For 100 cum Earth work required   = Rs. 16,128.00

For 187.5 cum Earth required   =Rs.30,240

Examples:
1. Under state plan scheme & State CAMPA- Bald hill plantations, the cost norm provided for Soil and Water Conservation measures is 130 man-days to dig up 300 Staggered contour trenches per ha with specification of 2.5 mt. x 0.5 mt x0.5mt. so the total earth work involved is worked out to be 187.50 cum per ha. Accordingly, the financial outlay calculated as follows:

   130 MD @ Rs.450.00/MD = Rs 58500.00

2. Under MGNREGA guidelines, works permitted under the scheme related to watershed works has given cost norms as follows:

   Unit cost of a contour trench of dimension 0.5 mtx0.5mt in staggered design comes to around Rs. 11,000.00 per ha. in terms of running length, the cost comes to Rs 17 per running meter. The unskilled labour cost is 100% of the total cost.

   As per the PWD schedule of Rate 2018, it envisages adopting Analysis of Rate 2006 mutatis-mutandis. Accordingly, the Earth work has been calculated as follows.

   It is proposed that the SMC works are being executed departmental mode & the O.H Charges (10%) and 2% Sundries and T& P etc may not be taken into account for cost norm analysis.

   i) Labour

   Male Mulia- 16 nos @ 450.00/MD = 7200.00

   Female Mulia- 16 nos @ 450.00/MD = 7200.00

   Total   = 14400.00/100 cum

   For 300 Number of staggered contour trenches:

   300 staggered Trenches x 0.625 cum   = 187.50 cum

   For 100 cum Earth work required   =Rs. 144000.00

   For 187.5 cum Earth work required   = Rs. 27000.00

Committee Recommendation: -

For digging up of 300 number Staggered Trenches per ha in plain lands@ wage rate Rs.450.00/MD, it is required 60 Man-Day's or Rs. 27000.00/Ha. In case of bald hills & sloppy lands, the approved norm of 130 MD/ha with financial outlay of **Rs 58,500.00/Ha** may be adopted. The cost norms/ha may be fixed accordingly.

Rs. 58,500.00 x 200Ha = Rs.1, 17, 00,000.00

(Rupees One Core Seventeen Lakh Only)

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Bhawanipatna   **Khariar**

PERCOLATION PIT

Specification: -

Length   -   1.0mt
Width   1.0mt
Depth   -   1.0mt
Cross Section- (1.0 mt x 1.0 mt) = 1.0sq mt
Earth Work – (1.0 mt x 1.0 sq mt) = 1.0 cum
Spacing in a staggered manner =   10 mt x 10 mt

As per the PWD schedule of Rate 2018, it envisages adopting Analysis of Rate 2006 mutatis-mutandis. Accordingly, the Earth work has been calculated as follows:

Cross Section of each percolation pit   **Percolation pits Design**
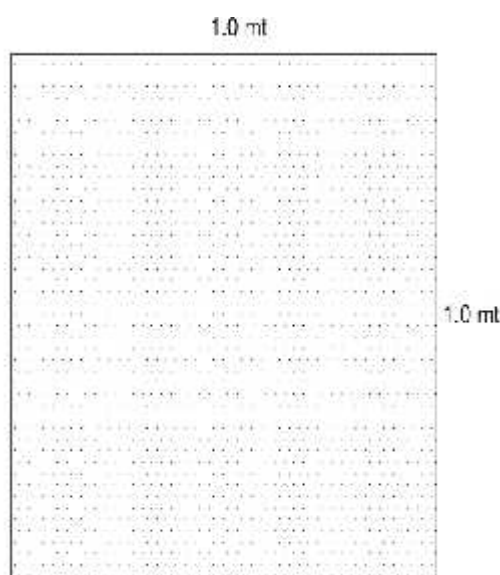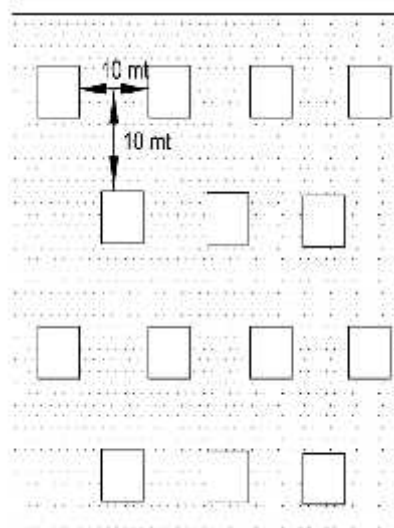
Explanation: -

Under State plan scheme & state CAMPA – Bald hill plantations, the cost norms provided for Soil and Water Conservation measures is 130 man-days' (40 X3.25=130) to dig up staggered contour trench @ 300 per ha (2.5mt x 0.5 mt x0.5mt); gully plugging and Drainage line treatment, digging of percolation pits @600 per ha. in lieu of staggered trenches, half-moon trench on the uphill side of each planting pit. So, the total earth work involved is worked out to 187.50 cum per Ha. Accordingly, the financial outlay calculated as follows:

130 MD @ Rs. 450.00/MD = 58,500.00

In the Bald Hills & Sloppy lands, the quantum of earth work involved in digging up of 600 percolation pits worked out to be 600 cum which is very high to complete within the prescribed Man-day's. So, it is proposed to prescribe 150 percolation pits (Dimensions of 1.0 mt x 1.0 mt X1.0 mt = 1.0 cum) along with half-moon trench on the uphill side of each planting pit. The cost requirement remains same to take up these SMC measures.

As far as plain land is concern, it is proposed that the SMC works are being executed departmental mode & the O.H. Charges (10%) and 2 % Sundries and T & P etc may not be taken into account for cost norm analysis.

I) Labour

Male Mulia – 16 nos @ 450.00/ MD   = 7200.00
Female Mulia – 16 nos. @ 450.00/ MD   = 7200.00
                     Total   **=14400.00/100 cum**

For 200 Number of Percolation pits in plains:
200 Percolation pits x 1.0 cum = 200.00 cum
For 100 cum. Earth work required = Rs. 14400.00
For 200.00 cum Earth work required = **Rs. 28,800.00**

Committee Recommendation: -

In plain lands for digging up of 200 number percolation pits per ha @ wage rate Rs.450.00/MD, it is required 64 Man-day's or Rs. 2 8 8 0 0 .00/Ha. The cost norm/ha may be fixed accordingly.

In case of bald hills & sloppy lands, the approved norm under Bald hill plantation i.e. 130 MD/ha with financial outlay of **Rs. 58,500.00/Ha** may be adopted with a slight modification i.e 150 percolation pits in place of 600 numbers along with half-moon trench on the uphill side of each planting pit (1600/ha).
Rs. 58,500.00 X 200 Ha. = Rs. 1,17,00, 000.00

(Rupees One core Seventeen Lakhs Only)

                Executive Engineer   **Divisional Forest officer**
        Kalahandi Investigation Division   **Khariar Forest Division,**
                    Bhawanipatna   **Khariar**

Sl. No.	Item of Work	Preferable Period of Execution	No of Mandays	Labour cost (In Rs.)	Material cost (In Rs.)	Total cost (In Rs.)
	BASE COST NORM FOR COMPENSATORY AFFORESTATION THROUGH AIDED NATURAL REGENERATION (ANR) @ 500 SEEDLINGS/ HECTARE (18 months old seedling)					
	Wage Rate Rs.311/- PER MANDAY					
1	**2**	**3**	**4**	**5**	**6**	**7**
	0th Year (Advance Work) Pre-Planting Operation					
1.	Survey, Demarcation and Pillar Posting	Nov-Dec	2	622.00	0.00	622.00
2.	Preparation of Treatment Map (Digital Map)	Nov-Dec	1	311.00	100.00	411.00
3.	Site preparation	Nov-Dec	2	622.00	0.00	622.00
4.	Silvicultural operation including clearance of weed, cutting of climber, High stump cutting, singling of shoots & removal of cut out after drying from the field to blank space	Jan-Feb	15	4665.00	0.00	4665.00
5.	Alignment and stacking for digging of pits	Feb-Mar	1	311.00	0.00	311.00
6.	Digging of pits (45 cm x 45 cm x 45 cm) in hard and gravelly soil	Feb-Mar	20	6220.00	0.00	6220.00
	Sub Total =		**41**	**12751.00**	**100.00**	**12851.00**
	1st Year/Planting Year					
1.	Refilling of pits by altering the dugout soil of the pits, application of organic compounds /CDM/FYM & Mixing the same perfectly.	Jun-Jul	4	1244.00	2500.00	3744.00
2.	Transportation of 18 months old polythene bag seedlings in hired truck/tractor from the Permanent/Mega nursery to planting site including loading & unloading. (Average lead of 10 Rkm) & stacking the seedling @ Rs.6/- per Seedling. (550nos.)	Jul-Aug	0	0.00	3300.00	3300.00
3.	Watering polythene bag seedlings at stacking site of plantation	Jul-Aug	1	311.00	0.00	311.00
4.	Conveyance of polythene bag seedlings on head load from the stacking site to individual dugout pits within the planting site, applying insecticide, fertilizers & planting after scooping the soil with other applied materials & pressing the soil perfectly around the planted seedlings.	Jul-Aug	11	3421.00	0.00	3421.00
5.	Cost of Fertilizer & Insecticide a. NPK/Bio-fertilizer @ 50 gms/plant as basal dose = 25kg @ Rs.30/- per kg = Rs.750.00 b. Urea/Vermi compost /Mo Khata/any other fertilizer @ Rs.375.00 c. Insecticide/Bio-pescticide @ 5 gms/plant = 2.5kg @ Rs.150/- per kg = Rs.375.00	Jul-Aug	0	0.00	1500.00	1500.00
6.	Casualty Replacement@ 10% (50 nos.)	Jul-Aug	1.5	466.50	0.00	466.50
7.	1st weeding & Manuring	Aug-Sept	5	1555.00	0.00	1555.00
8.	2nd Weeding, Soil working (1mt. diameter around the plants) & Manuring	Oct-Nov	8	2488.00	0.00	2488.00
9.	Fire line Tracing & inspection path	Feb-Mar	3	933.00	0.00	933.00
10.	Watch & ward including watering as per requirement	Aug-Mar	8	2488.00	0.00	2488.00
	Sub Total =		**41.50**	**12906.50**	**7300.00**	**20206.50**
	2nd Year Maintenance					
1.	Transportation of 50 seedlings from Nursery to plantation site including loading, unloading & conveyance by	Jul	0	0.00	300.00	300.00

	Tractor @ Rs.6/- per seedling				
2.	Casualty replacement	Jul	1.5	466.50	0.00	466.50

3.	Cost of Fertilizer & Insecticide
	  a. Cost of Insecticide/Bio-pesticide (Themet/Forate) @ 5 gms/plant = 0.25 kg @ Rs. 150/- per kg = Rs. 37.50/-
	  b. Urea/NPK/Bio-fertilizer/Vermicompost/Mo Khata/any other fertilizer @ Rs.1400/-
		Jul-Aug	0	0.00	1437.50	1437.50

4.	Weeding (Complete weeding), Manuring & Soil working, (1mt, diameter around the plants)	Sep-Oct	8	2488.00	0.00	2488.00
5.	Fire line tracing (2m. wide fire line) & inspection path	Feb-Mar	3	933.00	0.00	933.00
6.	Watch & Ward including watering as per requirement	Apr-Mar	12	3732.00	0.00	3732.00
	Sub Total =		**24.5**	**7619.50**	**1737.50**	**9357.00**
	3rd Year Maintenance					
1.	Cost of Fertilizer (Urea/NPK/Bio-fertilizer/Vermi compost/Mo Khata/any other fertilizer =Rs.1400/-	Jul-Aug	0	0.00	1400.00	1400.00
2.	Weeding (Complete weeding), Manuring & Soil working, (1mt, diameter around the plants)	Sep-Oct	8	2488.00	0.00	2488.00
3.	Fire line tracing (2m. wide fire line) & inspection path	Feb-Mar	3	933.00	0.00	933.00
4.	Watch & ward including watering as per requirement	Apr-Mar	12	3732.00	0.00	3732.00
	Sub Total =		**23**	**7153.00**	**1400.00**	**8553.00**
	4th Year Maintenance					
1.	Fire line tracing (2m. wide fire line) inspection path	Feb-Mar	3	933.00	0.00	933.00
2.	Watch & ward including watering as per requirement	Apr-Mar	12	3732.00	0.00	3732.00
	Sub Total =		**15**	**4665.00**	**0.00**	**4665.00**
	5th Year Maintenance					
1.	Fire line tracing (2m. wide fire line over 400 m length)	Feb-Mar	3	933.00	0.00	933.00
2.	Watch & ward including watering as per requirement	Apr-Mar	12	3732.00	0.00	3732.00
	Sub Total =		**15**	**4665.00**	**0.00**	**4665.00**
	6th Year Maintenance					
1.	Fire line tracing (2m. wide fire line over 400 m length)	Feb-Mar	3	933.00	0.00	933.00
2.	Watch & ward including watering as per requirement	Apr-Mar	12	3732.00	0.00	3732.00
	Sub Total =		**15**	**4665.00**	**0.00**	**4665.00**
	7th Year Maintenance					
1.	Fire line tracing (2m. wide fire line over 400 m length)	Feb-Mar	3	933.00	0.00	933.00
2.	Watch & ward including watering as per requirement	Apr-Mar	12	3732.00	0.00	3732.00
	Sub Total =		**15**	**4665.00**	**0.00**	**4665.00**
	8th Year Maintenance					
1.	Fire line tracing (2m. wide fire line over 400 m length) & cultural operation	Feb-Mar	3	933.00	0.00	933.00
2.	Watch & ward including watering as per requirement	Apr-Mar	12	3732.00	0.00	3732.00
	Sub Total =		**15**	**4665.00**	**0.00**	**4665.00**
	9th Year Maintenance					
1.	Fire line tracing (2m. wide fire line over 400 m length)	Feb-Mar	3	933.00	0.00	933.00

2.	Watch & ward including watering as per requirement	Apr-Mar	12	3732.00	0.00	3732.00
	Sub Total =		**15**	**4665.00**	**0.00**	**4665.00**
	10th Year Maintenance					
1.	Fire line tracing (2m. wide fire line over 400 m length)	Feb-Mar	3	933.00	0.00	933.00
2.	Watch & ward including watering as per requirement	Apr-Mar	12	3732.00	0.00	3732.00
	Sub Total =		**15**	**4665.00**	**0.00**	**4665.00**

ABSTRACT

Sl. No.	Year	No. of Mandays	Labour cost (In Rs.)	Material cost (In Rs.)	Monitoring, Evaluation, Learning, Documentation & other Contingency 5% of (4+5)	Cost of Seedlings @ Rs.50.31 per seedlings	Total Cost (In Rs.)
1	2	3	4	5	6	7	8
1.	0th Year	41	12751.00	100.00	549.00	0.00	13400.00
2.	1st Year	41.5	12906.50	7300.00	993.50	27671.00	48871.00
3.	2nd Year	24.5	7619.50	1737.50	443.00	2516.00	12316.00
4.	3rd Year	23	7153.00	1400.00	347.00	0.00	8900.00
5.	4th Year	15	4665.00	0.00	135.00	0.00	4800.00
6.	5th Year	15	4665.00	0.00	135.00	0.00	4800.00
7.	6th Year	15	4665.00	0.00	135.00	0.00	4800.00
8.	7th Year	15	4665.00	0.00	135.00	0.00	4800.00
9.	8th Year	15	4665.00	0.00	135.00	0.00	4800.00
10.	9th Year	15	4665.00	0.00	135.00	0.00	4800.00
11.	10th Year	15	4665.00	0.00	135.00	0.00	4800.00
	Total =	**235**	**73085.00**	**10537.50**	**3277.50**	**30187.00**	**117087.00**

Rs. 1,57,554×300 Ha. =4,72,66,200/-

Executive Engineer   **Divisional Forest Officer**

Kalahandi Investigation Division   **Khariar Forest Division**

Bhawanipatna   **Khariar**

Matrix for ANR Plantation for Compensatory Afforestation @ 500 Seedlings/ Ha. with 10 year maintenance

Sl. No.	Commencement Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	Total Cost (10 Yrs)
	Base Norm	13400	48871	12316	8900	4800	4800	4800	4800	4800	4800	4800											
01	2021-22	13400	51315	13577	10003	5834	6126	6432	6754	7092	7446	7819											136098
02	2022-23		14070	53881	14256	10818	6126	6432	6754	7092	7447	7819	8210										142904
03	2023-24			14774	56575	14969	11359	6432	6754	7092	7447	7819	8210	8621									150061
04	2024-25				15513	59404	15717	11927	6754	7092	7447	7819	8210	8621	9052								157554
05	2025-26					16289	62374	16503	12523	7092	7447	7819	8210	8621	9052	9505							165433
06	2026-27						17103	65493	17328	13149	7447	7819	8210	8621	9052	9505	9980						173705
07	2027-28							17958	68768	18194	13806	7819	8210	8621	9052	9505	9980	10479					182390
08	2028-29								18856	72206	19104	14496	8210	8621	9052	9505	9980	10479	11003				191510
09	2029-30									19799	75816	20059	15221	8621	9052	9505	9980	10479	11003	11553			201086
10	2030-31										20789	79607	21062	15982	9052	9505	9980	10479	11003	11551	12131		211141