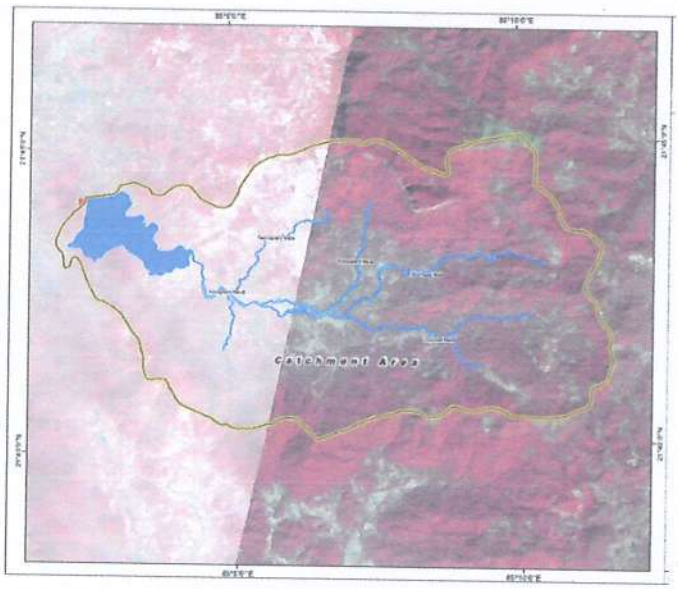
GOVERNMENT OF ODISHA
DEPARTMENT OF WATER RESOURCES

# CATCHMENT AREA TREATMENT (CAT)

# FOR

# KARAPANI IRRIGATION PROJECT




**DIST: SUNDARGARH, ODISHA**

Sundargarh
January 2019

Executive Engineer
IB Investigation Division
Sundargarh

Forest Range Officer
Kuliposh

## 1. Introduction

The Catchment Area Treatment (CAT) 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.

The CAT Plan would cover the following aspects:

- Identification of free draining catchment
- Assessment of Land Use, Soil, Slope in the catchment based on Remote Sensing (RS) /Geographic Information System (GIS) 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 higher priority erosion categories. Both Engineering measures as well as Biological treatment measures will be proposed in the CAT plan.
- The cost of the administrative set up and mitigative measures will include recommendation from State Forest Department for all forest lands and from the Soil Conservation Department for non – forest land.

## 2. Need

Reservoirs formed by dams on rivers are subject to sedimentation. The process of sedimentation embodies the sequential processes of erosion, entertainment, transportation, 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 affecting the water availability for the designated use. The eroded sediment from catchment when deposited on streambeds and banks causes threading of river reach. The removal of top fertile soil form catchment adversely affects the agricultural production. Thus, a well-designed 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

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area. Adequate preventive measures are thus needed for the treatment of catchment for its stabilization against future erosion.

Quantifying soil erosion and reservoir sedimentation is necessary for prioritizing catchments for treatment and development of a suitable treatment mix. It is, therefore, also required that the effect of various treatments on controlling soil erosion are quantitatively known. River gauging data are the best information source for undertaking the above activities. As such data are not available for this catchment, so estimation procedure is adopted. At the present level of data availability and based on the past experience, **Sedimentation (Silt) Yield Index (SYI)** appears to be an acceptable parameter for use in catchment prioritization work.

SYI is calculated using an empirical formula. Based on the numerical value of SYI, catchments are categorized into five priority classes from Very High (SYI>1300) priority to Very Low (SYI<1000) priority. The method was proposed by **All India Soil Survey and Land Use Planning (AISSLUP)** currently known as **Soil and Land Use Survey of India (SLUSI)** based on several studies. The method has been used to prioritize catchments in India totaling in area of millions of hectares. It is reported that, the SYI procedure is reliable for determining priority watersheds. The empiricism in this method is manifest in the selection of unit area (mapping unit) and assigning an appropriate value of delivery ratio to it. SYI method is widely used because of the fact that it is easy to use and lesser data requirement. Moreover, it can applied to larger areas like sub watersheds etc.

## 3. Methodology adopted

Database on natural resources, terrain conditions, soil type of the catchment area is a pre-requisite to prepare CAT plan. Various thematic maps were prepared and used in preparation of the CAT plan, in Geographic Information System (GIS) platform.

The methodology adopted for development of CAT plan for the project is as under:

- Catchment boundary delineation from Survey of India Topo sheets
- Watershed boundary form watershed Atlas of India and website of Soil and Land Use Survey of India (SLUSI) and the micro watershed boundary collected from Watershed Mission of Odisha
- Land use/Land cover map preparation from recent 5.8m resolution LISS-IV Multi Spectral Satellite image



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- Contour digitization from Survey of India OSM topo sheet and generation of slope map
- Soil map preparation from National Bureau of Soil Survey and Land Use Planning (NBSS&LUP)
- Assigning weightage value of mapping units based on slope, land use and soil texture and Delivery ratio based on distance from nearest stream
- Estimation of Soil Loss using Silt Yield Index
- Watershed Prioritization
- Selection of locations of treatment and Catchment Treatment (CAT) Plan
- Cost Estimate

Thematic data integration and erosion index modeling was done using relevant map layers in GIS.

Silt Yield Index (SYI) of various micro watersheds within the free catchment was estimated. Watershed management approach were proposed for optimal use of soil and water resources within the catchment with the broad objective of

- increasing infiltration into soil
- control excessive runoff
- manage & utilize runoff for useful purpose

## 3.1. Brief Description of Karapani Dam

This project aims at construction of a 1312 M. long and 30.50 M. high earth dam having a central ogee gated spillway of 60.50 M. length. All the alternatives of dam axis have been explored and the present one has been approved by the Engineer-in-Chief, P & D, Orissa. The total catchment area at the dam site is 121.00 Sq. Km. The total annual inflow into the reservoir is 5061.80 Ha. M, corresponding to a 75 % dependable year. The project has an average water utilization of 71.86 % considering 29 years data. The earth dam is proposed to be of homogeneous section with provisions of vertical sand chimney to drain the seepage water through the filter drains and rock-toe.

The 605 M. long central spillway shall be ogee type & gated. The crest level of the spillway is 182.50 M. fitted with 4 Nos. of radial gates of 12m X 8m size. The spillway is designed to discharge maximum flood of 1240.00 Cumecs. The project shall provide irrigation to C.C.A of 3500 Ha. The project will irrigate 3325 Ha. in kharif and 2100 Ha, in rabi by means of two main canals. The length of left main canal is 12.00 Km. (approx.) and right main canal is 4.98 Km. Minors and Sub-minors' network shall be provided as per the requirement after detailed survey is done. Besides creating above irrigation potential, 20 % of the water



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has reserved for riparian use at the downstream & upstream as per suggestion of Central Water Commission. The project is entirely in the state of Orissa and hence the question of interstate aspect does not arise. The Catchment of Karapani Irrigation project is enclosed at ***Plate-1***

## 3.2. Irrigation planning

The project comes under Lahunipara Block of Sundargarh district which is a hilly and drought prone area. The present land use practice and the traditional farming is primitive and continuing from generations. The modern methods of cultivation are yet to be practiced due to the erratic behavior of the monsoon. Paddy is the principal crop generally grown by the people of this locality. At present the area under cultivation is about 2734 Ha having very less yield. After completion of the project irrigation to an area of 3325 Ha. in Kharif and 2100 Ha. in Rabi with an annual irrigation of 5425 Ha shall be developed. Besides, the project will also provide drinking water and other riparian use at the downstream and upstream.

## 3.3. Main Canal distribution System

There are two main canals i.e. left and right of length 12 Km. and 4.98 Km. respectively. Both the canals shall be contour canals.

**Land Levelling:**

Since a large area of the ayacut is undulated, land levelling in the command area cannot be done. This activity shall be automatically undertaken by the beneficiaries of the command area after development of the irrigation facilities. Also, other beneficiary-oriented schemes can be extended by the D.R.D.A at subsidized rates.

**Cropping Pattern and crop water requirement**

Before irrigation, paddy is the main crop generally grown by the people of this locality. Due to uncertainty of rainfall in the ayacut neither any high yielding variety paddy nor any cash crops are cultivated. After creating assured irrigation high yielding paddy as well as crops like vegetables, groundnuts, maize and other oilseeds will be cultivated. State Agricultural Department provides technical know-how as well as advice for better crop yields. Crop water requirement based on statement of State Agriculture Department for different months have been calculated as per guidelines of Ministry of Agriculture.

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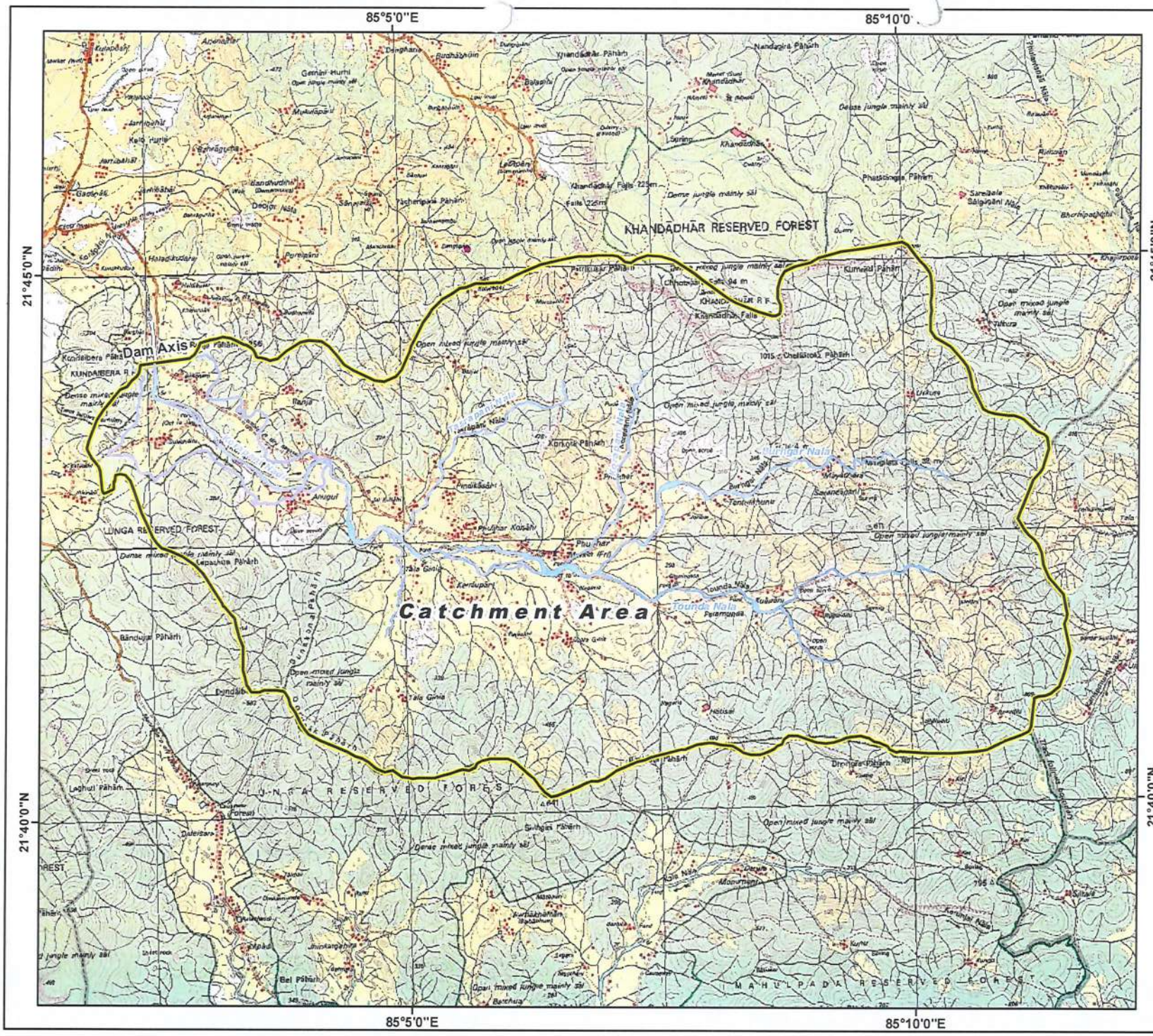
Plate-1

# Catchment Area Treatement Plan

## Korapani Irrigation Project

## Catchment Map

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## 3.4. Reservoir Stimulation Study

Period of Simulation is 1977-78 to 2005-06 (hydrological year). First of all, sediment analysis is carried out with reference to I. S. Code No. IS-5477 (part I)-1969 (Methods for fixing the capacities of Reservoirs) for 50 years and 25 years. Revised Area Capacity are computed with assumption of new zero elevation. Finally, new zero elevation with reference to 50 year's silt loads is 171.65 M. and in case of 25 year's silt load is 170.50 M. Hence D.S. L is fixed at an elevation of 174.00M. Evaporation loss data is adopted from Rukura medium irrigation project report already approved by the C.W.C. F. R.L is finalized by hit & trial at an elevation of 190.50 M. which will take care to supply the irrigation needs to an area of 3500 Ha. of C.C.A. For simulation studies, 25 years sedimented revised area capacity curves are used. Simulation studies are carried for 29 years and the percentage of success is 86.20 %. The percentage of water utilization is 71.86 %.

**Water Account Statement**

The Water Account statement reflects the percentage of utilization of water potential maximum up - to 71.86 %. The project aims at maximum utilization of water by providing irrigation up - to 95 % of C.C.A. in kharif, 60 % of C.C.A. in rabi and 155 % of C.CA. as annual irrigation.

*Table-1: Abstract of forest land involved in Dam base & Reservoir*

| Sl No. | Name of the Village | Forest Area (Ha.) | Non-Forest Area (Ha.) | Total Area (Ha.) |
|---|---|---|---|---|
| 1 | Angul | 14.504 | 44.553 | 59.057 |
| 2 | Sulavadihi | 27.867 | 116.293 | 144.160 |
| 3 | Barghat | 3.977 | 10.195 | 14.172 |
| 4 | Dhanijam | 11.218 | 65.297 | 76.515 |
| 5 | Ranja | 18.604 | 97.333 | 115.937 |
| 6 | Lunga RF | 3.626 | 0.000 | 3.626 |
| 7 | Kundeibera RF | 2.616 | 0.000 | 2.616 |
| **Total** | | **82.412** | **333.672** | **416.084** |

*Table-2: Abstract of forest land involved in Canal*

| Sl No. | Name of the Village | Forest Area (Ha.) | Non-Forest Area (Ha.) | Total Area (Ha.) |
|---|---|---|---|---|
| 1 | Barghat | 0.130 | 2.185 | 2.315 |
| 2 | Dhanijam | 0.652 | 1.222 | 1.874 |
| 3 | Haldikudar | 1.696 | 2.246 | 3.942 |
| 4 | Jadibahal | 0.275 | 6.625 | 6.900 |



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| Sl No. | Name of the Village | Forest Area (Ha.) | Non-Forest Area (Ha.) | Total Area (Ha.) |
|---|---|---|---|---|
| 5 | Kantakudar | 5.779 | 2.934 | 8.713 |
| 6 | Sadhubahal | 2.902 | 2.529 | 5.431 |
| 7 | Khajurinali | 0.000 | 2.234 | 2.234 |
| 8 | Mahuldihi | 4.508 | 10.603 | 15.111 |
| 9 | Sialikudar | 0.271 | 5.953 | 6.224 |
| 10 | Sihidiha | 2.614 | 6.775 | 9.389 |
| 11 | Kundeibera RF | 1.718 | 0.000 | 1.718 |
| | **Total** | 20.545 | 43.306 | 63.851 |

The FRL of this project has been kept at 190.50 M. MWL & FRL are the same as no difference has been allowed for flood lift. By creation of the reservoir total 400.59 Ha. of land will be submerged out of which 78.97 Ha. (approx.) is forest land.

## 4. 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) platform using satellite image, OSM SoI Topo Sheet and other secondary source data. For seamless integration of different thematic layers and interactive spatial analysis, the themes were generated UTM (Universal Transverse Mercator) projection system. 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.

### 4.1.Catchment and Watershed map

The catchment boundary of Karapani dam was delineated from SoI topo sheets F45N1 & F45N2, looking at the contours and drainage. The contour and drainage map of the project is enclosed at ***Plate-2***. Since the catchment is very small, 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, website of Land Use Survey of India (SLUSI) and the micro watershed boundary collected from Watershed Mission of Odisha. The micro watershed map is enclosed at ***Plate-3***.

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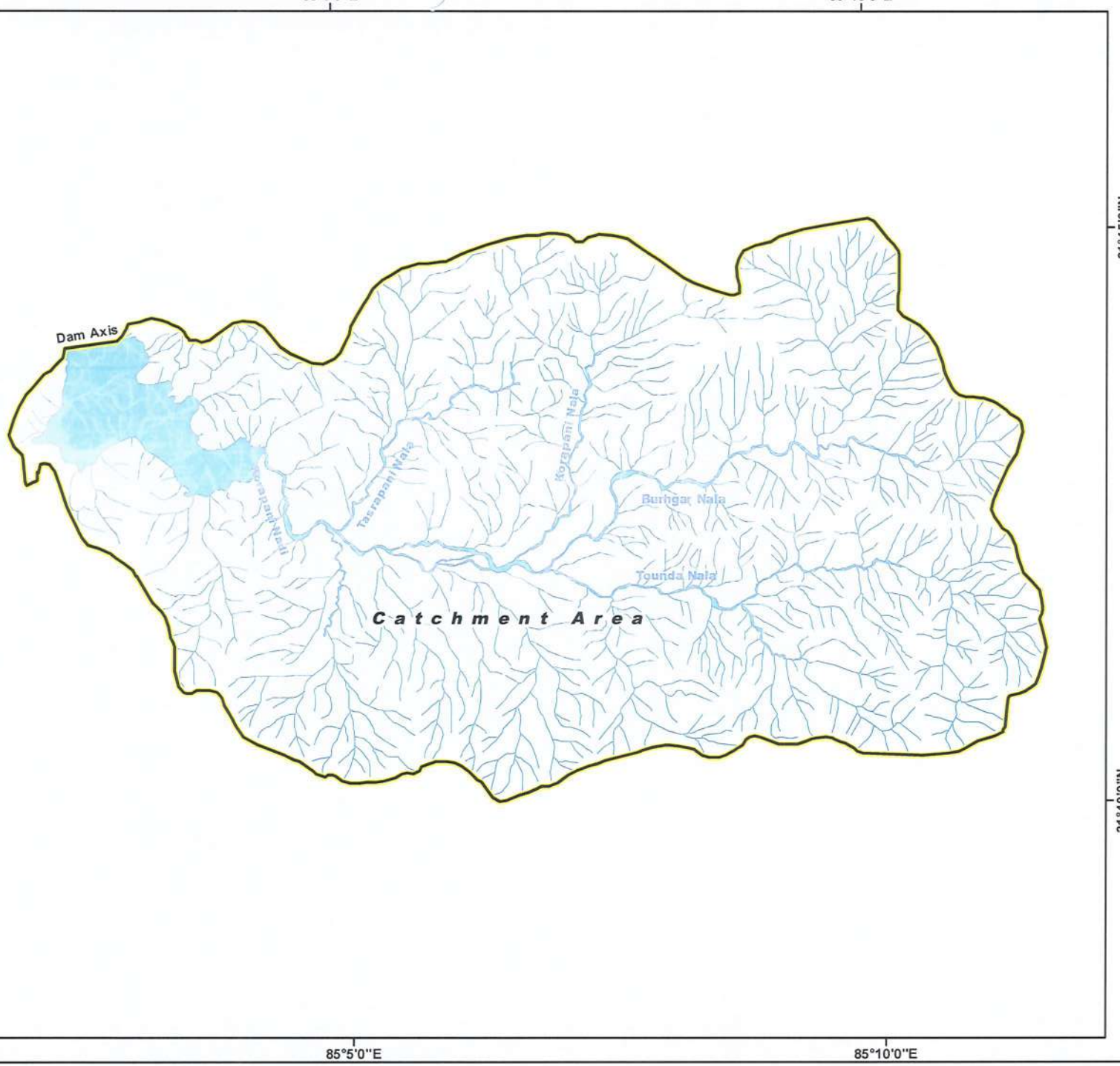
Plate-2

# Catchment Area Treatement Plan

## Korapani Irrigation Project

## Drainage Map




### Legend

- Catchment
- Drainage
- River/Waterbody

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0 0.5 1 2 3 4 Km.

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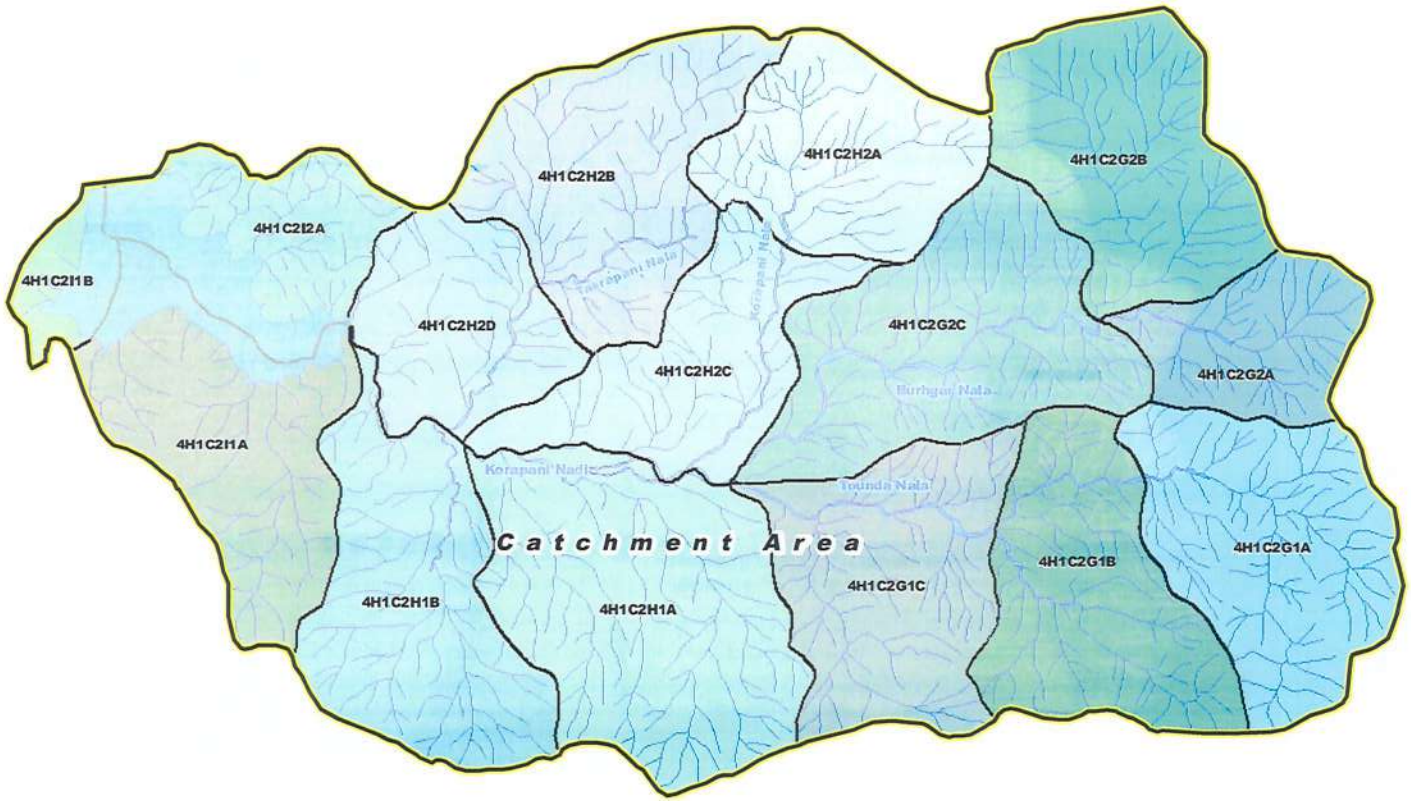
Plate-3

# Catchment Area Treatement Plan

## Korapani Irrigation Project

## Sub-Watershed Map




85°5'0"E 85°10'0"E

21°45'0"N

21°40'0"N

**Legend**

- Catchment
- Sub-Watershed

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0 0.5 1 2 3 4 Km.

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## 4.2.Slope Map

The Slope map was derived from contours shown on SoI topo sheet. After marking the catchment area, all the contours and spot heights shown on the topographical maps were mapped with 'Z' value (height above MSL in m). Since the area is mostly flat and contours are wide spaced, the spot heights collected in DGPS (differential GPS) during ground truthing of land use were also used as input.

A surface was created using the elevation values stored in the form of contours or points. 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. The areas falling under various standard slope categories have been tabulated in **Table-3** and the counter & slope map is enclosed at ***Plate-4 & 5*** respectively.

*Table-3: Area falling under different slope category*

| Slope Category | Slope (%) | Area in $Km^2$ | Area in % |
|---|---|---|---|
| Gently Slopping | 0-15 | 18.24 | 16.46 |
| Moderately sloping | 15-30 | 6.99 | 6.31 |
| Strongly sloping | 30-45 | 10.18 | 9.19 |
| Steeply sloping | 45-60 | 69.11 | 62.37 |
| Very steeply sloping | 60-75 | 6.28 | 5.67 |
| **Total** | | **110.80** | **100** |

## 4.3.Land Use/ Land Cover Map

Land Use map was prepared from recent 5.8m resolution LISS-IV Multi Spectral satellite image collected from National Data Centre of National Remote Sensing Centre (NRSC), Hyderabad. Details of Satellite Image are given bellow.

Satellite: IRS-P6

Sensor: LISS-IV MX (Multi Spectral)

Date of Pass: 1st April 2015

Path: 103

Row: 057

The image was geo-referenced using the common Ground Control Points (GCP) of Survey of India topographical sheets and satellite image with the help of feature registration techniques in standard



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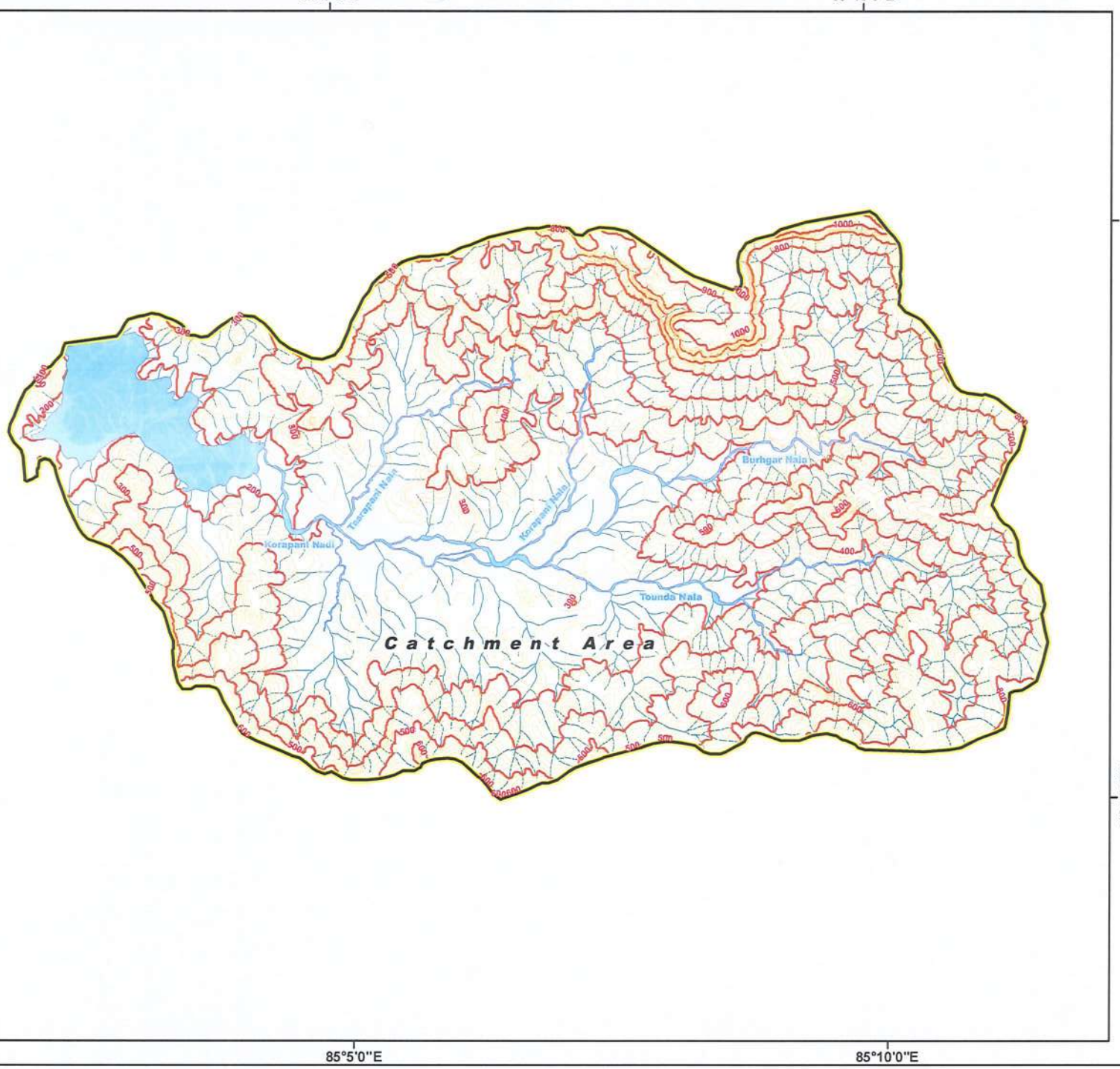
Plate-4

# Catchment Area Treatement Plan

## Korapani Irrigation Project

## Contour Map




### Legend

- Catchment
- Reservoir/River
- Contour(100m interval)
- Contour(20m interval)

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0 0.5 1 2 3 4 Km.

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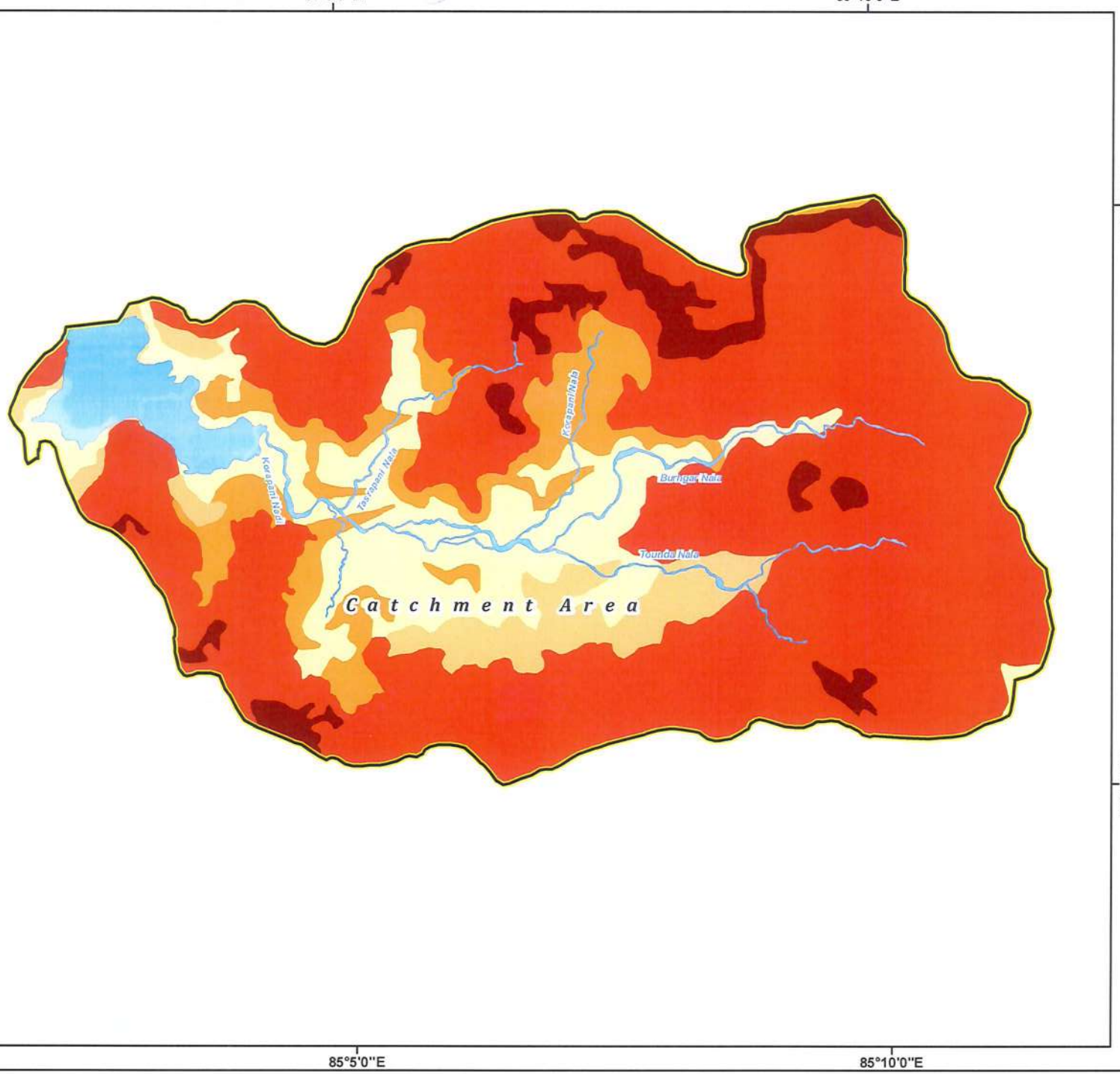
Plate-5

# Catchment Area Treatement Plan

## Korapani Irrigation Project

## Slope Map




### Legend

- Catchment Boundary
- Gently Slopping
- Moderately Slopping
- Strongly Slopping
- Steeply Slopping
- Very Steeply Slopping
- Drain/River

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0 0.5 1 2 3 4 Km.

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image processing software. The satellite image map is enclosed at ***Plate-6***. As the catchment area is very small, visual interpretation of the geo-referenced satellite data was done by qualified professionals using standard enhancement techniques followed by detail ground truthing to enhance the quality of image interpretation. The classified land use map of the catchment area is depicted in ***Table-4*** and the map is enclosed at ***Plate-7***.

*Table-4: Area falling under different Land Use*

| Description | Area in $Km^2$ | Area in % |
|---|---|---|
| Open Forest | 83.97 | 75.785 |
| Wasteland with scrub | 9.05 | 8.168 |
| Cultivation | 17.69 | 15.966 |
| Plantation | 0.09 | 0.081 |
| **Total** | **110.80** | **100.00** |

## 4.4.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. The soil map is depicted at ***Plate-8*** and catchment area coming under different soil category is depicted in ***Table-5***.

*Table-5: Area falling under different soil category*

| *Code* | *Description* | *Texture* | *Area in $km^2$* | *Area in %* |
|---|---|---|---|---|
| 1 | Deep, well drained, fine-loamy soils with loamy surface, moderate erosion and moderate stoniness | Loamy | 18.25 | 16.47 |
| 2 | Moderately deep, well drained fine loamy soils with loamy surface and moderate erosion | Loamy | 3.48 | 3.14 |
| 3 | Moderately deep, well drained, gravelly loamy soils with loamy surface and severe erosion | Loamy | 8.14 | 7.35 |
| 4 | Moderately shallow, well drained, gravelly loamy soils with loamy surface and moderate erosion | Loamy | 80.93 | 73.04 |
| | **Total** | | **110.8** | **100.00** |

# 5. 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 arial 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.



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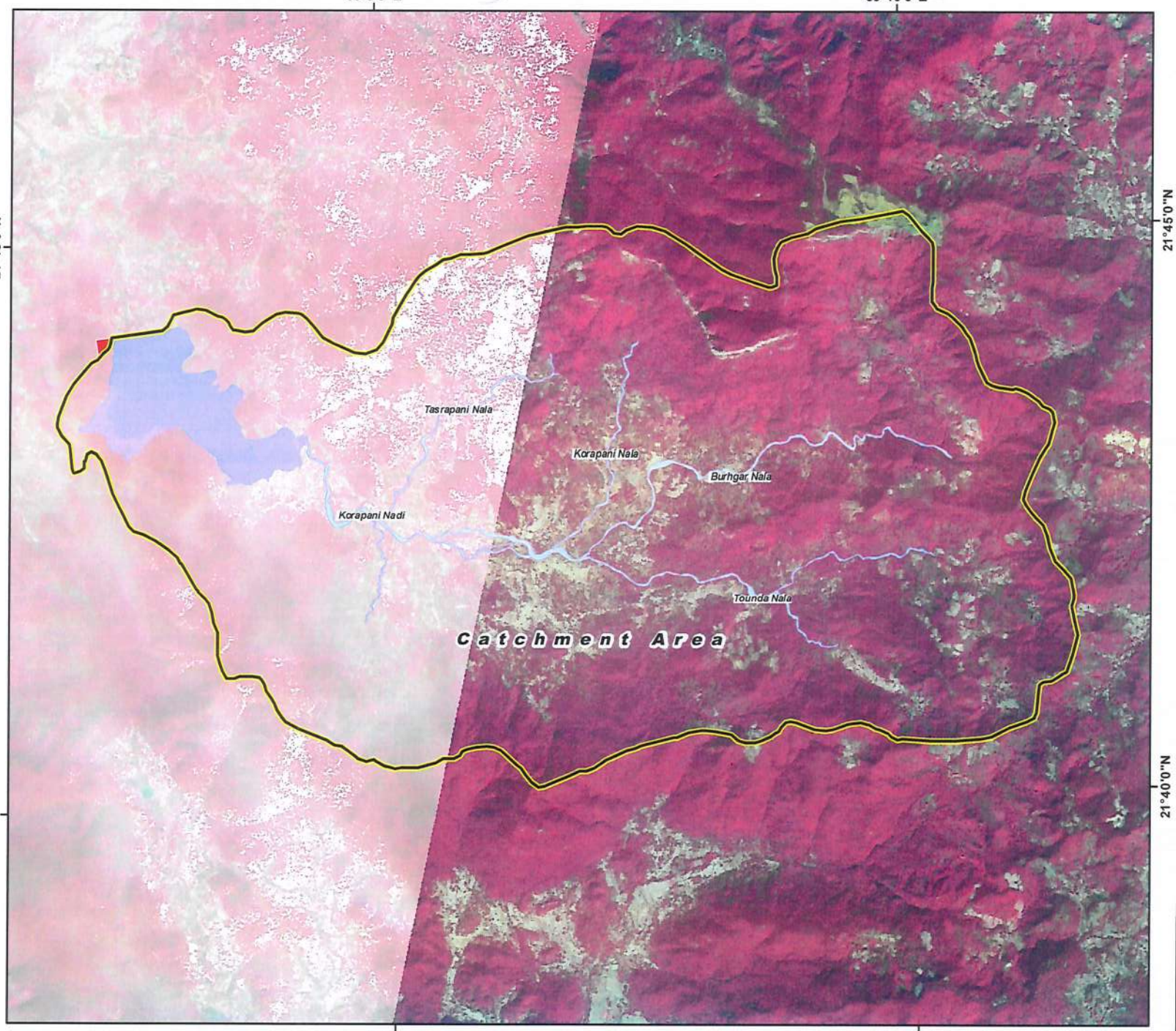
Plate-6

# Catchment Area Treatement Plan

## Korapani Irrigation Project

## LISS-IV Multi Spectral, Satellite Image




### Legend

- Catchment Boundary
- River
- Pondage

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0 0.5 1 2 3 4 Km.

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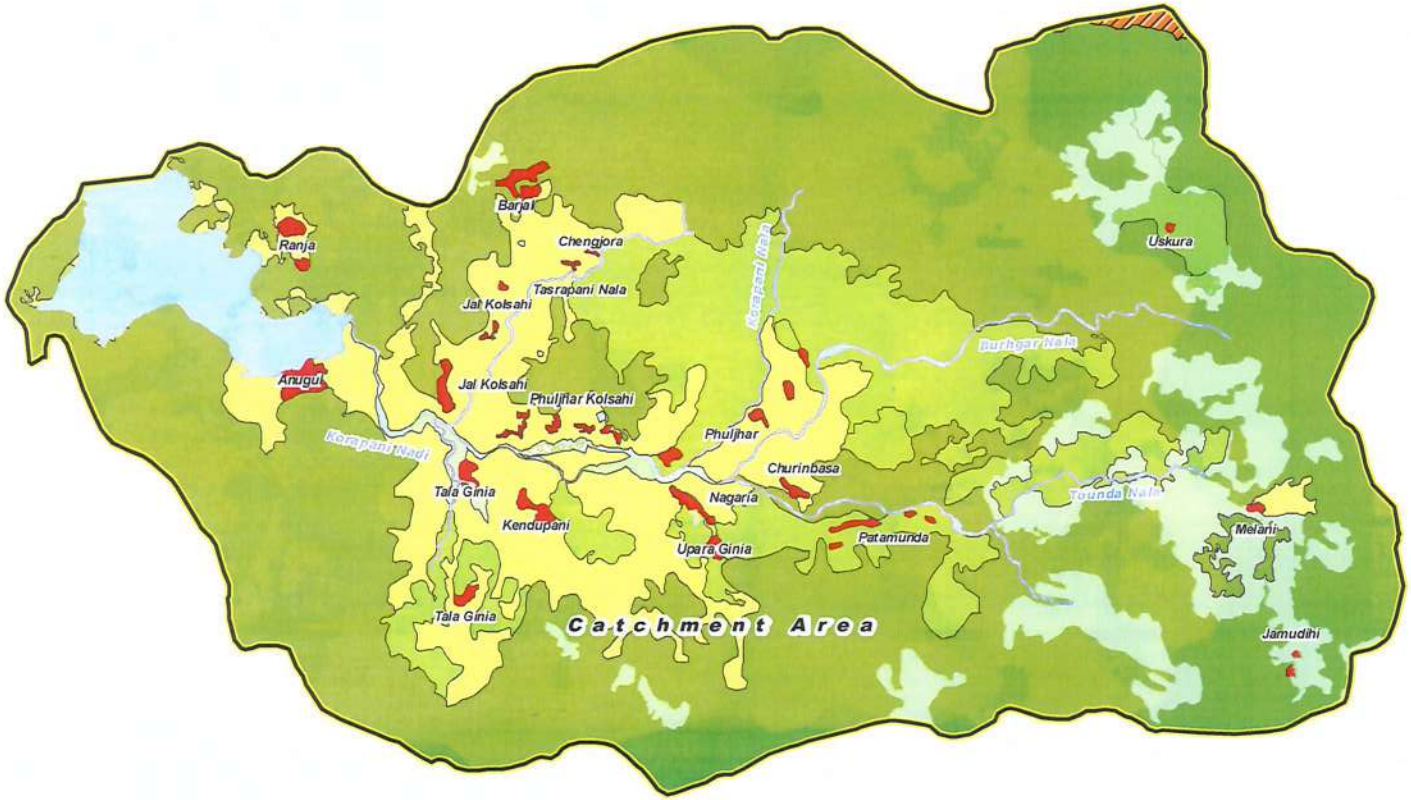
Plate-7

# Catchment Area Treatement Plan

## Korapani Irrigation Project

## Landuse Map




## Legend

- Catchment Boundary

### Landuse

- Dense Forest
- Open Forest
- Plantation; Grooves & Orchards
- Scrubs
- Cultivation
- Settlement
- River/ Waterbody

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0 0.5 1 2 3 4 Km.

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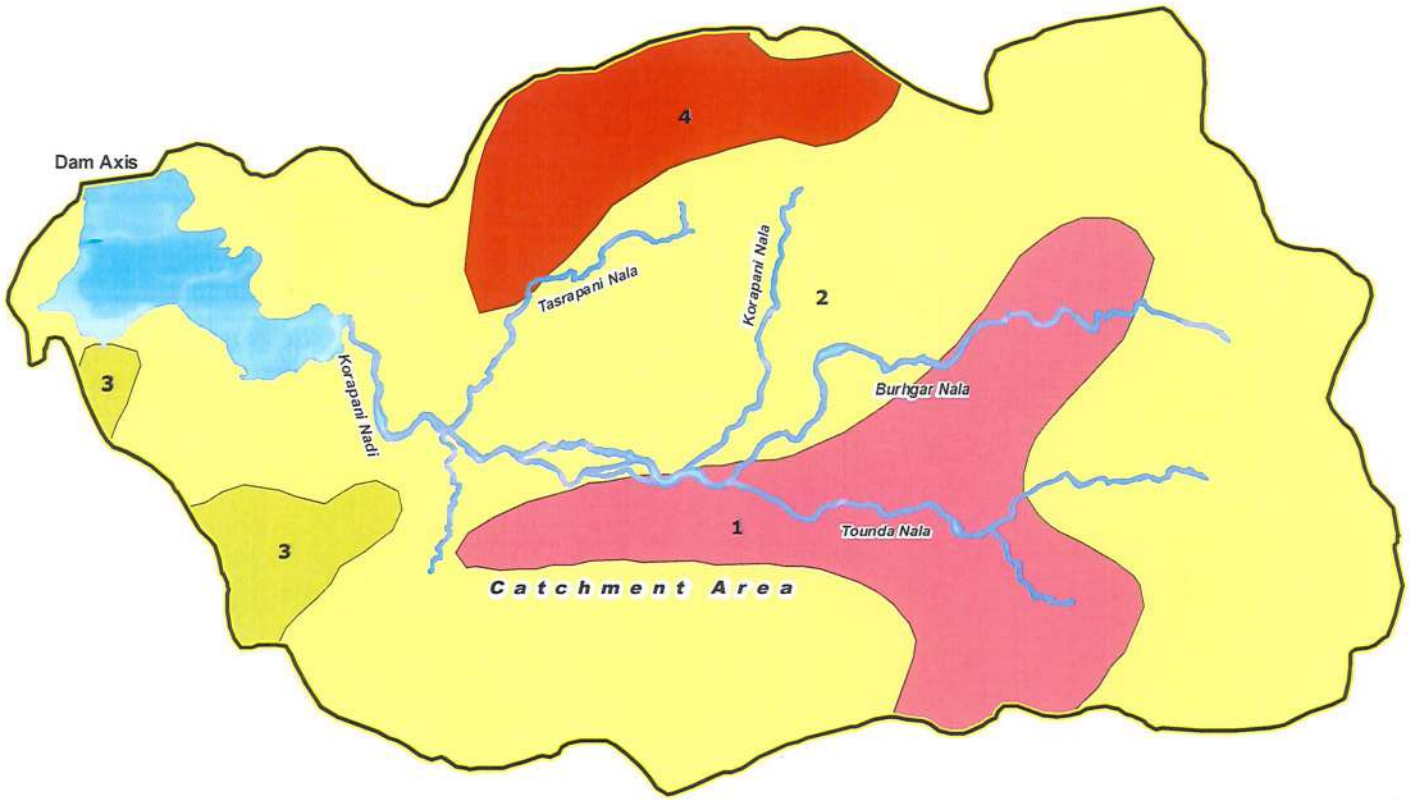
Plate-8

# Catchment Area Treatement Plan

## Korapani Irrigation Project

## Soil Map




| | Code | Descripton | Texture |
|---|---|---|---|
| | 1 | Deep, well drained, fine- loamy soils with loamy surface, moderate erosion and moderate stoniness | Fine-loamy |
| | 2 | Moderately shallow, well drained, gravelly loamy soils with loamy surface and moderate erosion | Loamy-skeltal |
| | 3 | Moderately deep, well drained fine loamy soils with loamy surface and moderate erosion | Fine |
| | 4 | Moderately deep, well drained, gravelly loamy soils with loamy surface and severe erosion | Loamy-skeltal |

**Legend**

- Catchment Boundary
- Reservoir/River

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0 0.5 1 2 3 4 Km.

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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 weightage value. When considered collectively, the weightage 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:

$$SYI = \frac{\sum (Ai \times Wi \times Di) \times 100}{Aw}$$

[ where i = 1 to n (n is the No. of EIU)]

Ai = Area of $i^{th}$ unit (EIU)
Wi = Weightage value of the $i^{th}$ unit EIU
Di = Delivery Ratio of the $i^{th}$ 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 was 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. The criteria adopted for assigning the delivery ratio are as follows:

| Nearest Stream | Delivery Ratio |
|---|---|
| 0 - 0.9 km | 1.00 |
| 1.0 - 2.0 km | 0.95 |
| 2.1 - 5.0 km | 0.90 |
| 5.1 - 15.0 km | 0.80 |
| 15.1 - 30.0 km | 0.70 |



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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.

Prioritization of Micro Watershed based on SYI findings

The objective of the SYI method is to prioritize micro watershed in a catchment area for treatment. For prioritizing the micro watersheds, these are to be divided in to different categories based on their SYI. The SYI values for classification of various categories of erosion intensity rates are depicted below

| Priority categories | SYI Values |
|---|---|
| Very high | > 1300 |
| High | 1200-1299 |
| Medium | 1100-1199 |
| Low | 1000-1099 |
| Very Low | <1000 |

The micro watershed wise SYI and category of erosion is depicted in ***Table-6***.

### *Table-6: Soil Erosion Priority Category of Micro Watersheds*

| SL | MWS Code | SYI | Priority |
|---|---|---|---|
| 1 | 4H1C2G1C | 1148 | Medium |
| 2 | 4H1C2H1A | 1215 | High |
| 3 | 4H1C2I1B | 1216 | High |
| 4 | 4H1C2G2C | 1258 | High |
| 5 | 4H1C2H1B | 1265 | High |
| 6 | 4H1C2I2A | 1266 | High |
| 7 | 4H1C2I1A | 1267 | High |
| 8 | 4H1C2G2B | 1292 | High |
| 9 | 4H1C2G1B | 1295 | High |
| 10 | 4H1C2H2C | 1315 | Very High |
| 11 | 4H1C2G1A | 1332 | Very High |
| 12 | 4H1C2H2D | 1354 | Very High |
| 13 | 4H1C2H2A | 1358 | Very High |
| 14 | 4H1C2G2A | 1375 | Very High |
| 15 | 4H1C2H2B | 1376 | Very High |

Area under very high categories is proposed to be treated at the project. A base map showing land use, reserve forest boundary, slope, major drains and priority watershed is enclosed at ***Plate-9*** for micro planning of the catchment area treatment plan as the step areas are more prone to soil erosion, looking at the land use and topography **4H1C2H2A, 4H1C2H2B, 4H1C2H2C and 4H1C2H2D** micro watersheds finally selected for treatment which is directly draining to the Karapani river. The detail map for preparation of treatment plan is enclosed at ***Plate-10***. The topographic map, drainage



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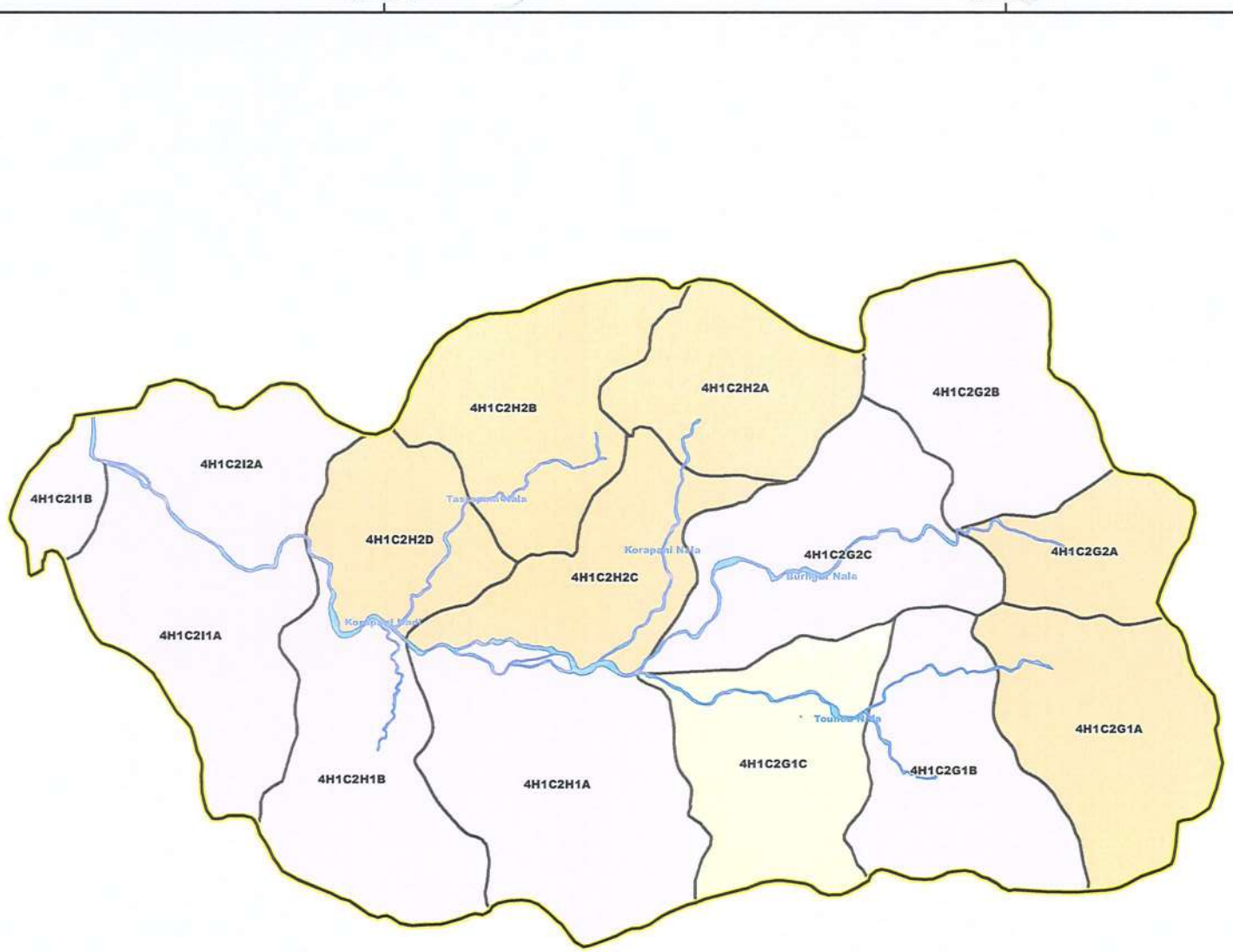
Plate-9

# Catchment Area Treatement Plan

## Karapani Irrigation Project

### Prioratisation of

### Micro Watershed based on SYI




## Legend

- Catchment Boundary
- Micro-Watershed

### Silt Yield Index

- Very High
- High
- Medium
- Low

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0 0.5 1 2 3 4 Km.

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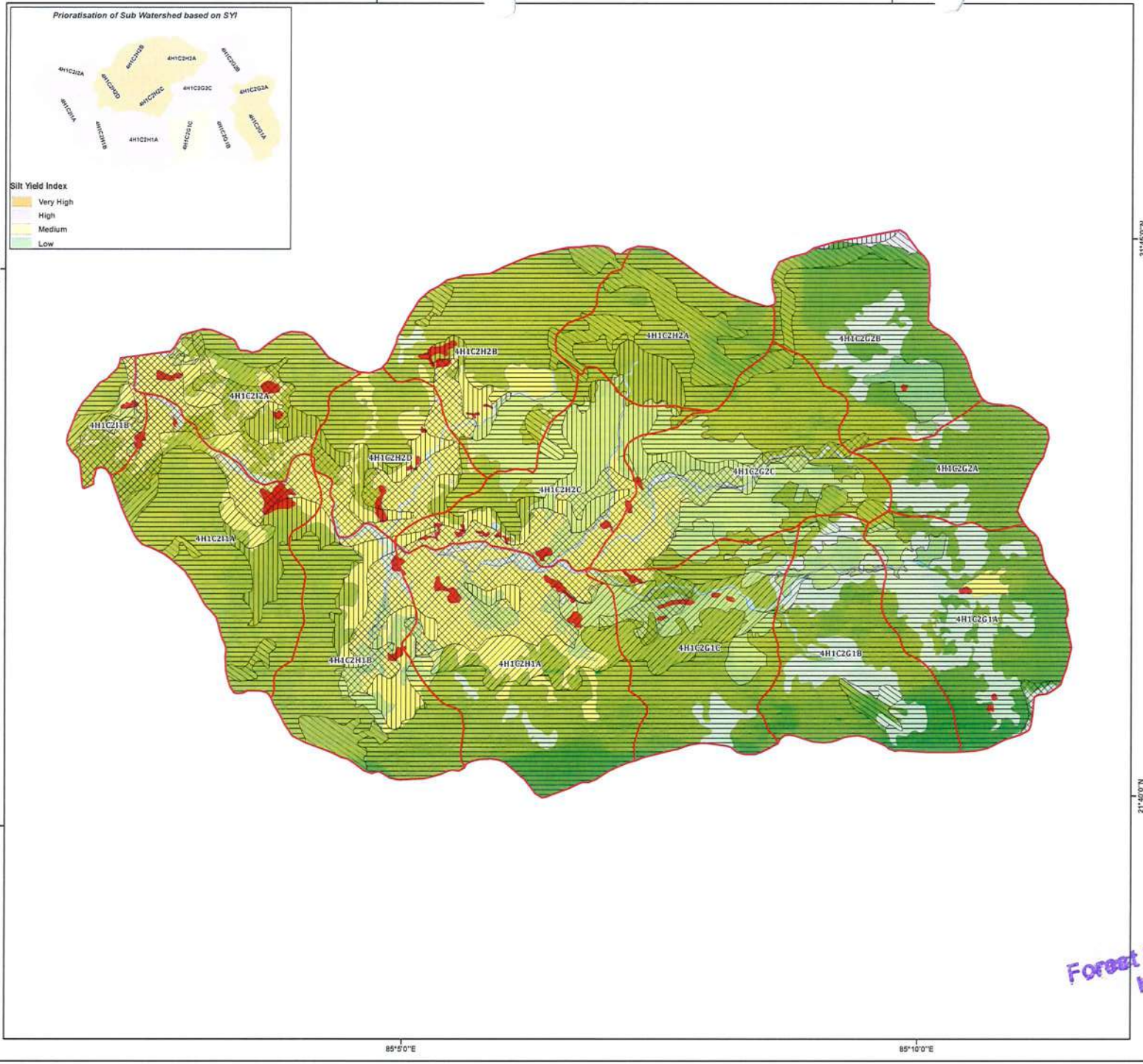
Plate-10

# Catchment Area Treatement Plan
## Karapani Irrigation Project
## Detail Map for Preparation of Treatment Plan




## Legend

- Catchment Boundary
- Sub-Watershed Boundary
- Forest

### Slope

- Gently Slopping
- Moderately Slopping
- Strongly Slopping
- Steeply Slopping
- Very Steeply Slopping

### Landuse

- Moderate Dense Forest
- Open Forest
- Plantation; Grooves & Orchards
- Scrubs
- Forest Blank
- Cultivation
- Settlement
- River/ Waterbody
- Others

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0 0.5 1 2 3 4 Km.

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and contour map and land use and slope map of the sub watershed is enclosed at ***Plate-11, 11b*** *and* ***11c*** respectively.

## 7. Demography of the watershed

The village map of the sub watersheds is enclosed at ***Plate-12***. The demography of the villages of Micro Watershed **4H1C2H2A, 4H1C2H2B, 4H1C2H2C and 4H1C2H2D** as per Census 2011 are depicted below.

*Table-7: Demography of Watersheds as per Census 2011*

***All areas in Hectore***

| Name of the village | Population | Male | Female | SC | ST | Literate | Worker |
|---|---|---|---|---|---|---|---|
| Badjal | 699 | 359 | 340 | 3 | 673 | 192 | 388 |
| Fuljhar | 2052 | 1108 | 944 | 80 | 172 | 726 | 716 |
| Uskuda | 649 | 325 | 324 | 0 | 558 | 154 | 375 |
| Ranja | 270 | 137 | 133 | 0 | 270 | 91 | 145 |
| Talaginia | 610 | 306 | 304 | 0 | 590 | 162 | 281 |

## 8. Catchment Area Treatment (CAT) Plan

Following Engineering and Biological measures are planned for the catchment area treatment depending upon the requirement and suitability:

a. Biological measures
- Assisted Natural Regeneration
- Block Plantation/Afforestation
- Fodder land development

b. Engineering measures (Water Harvesting Structures)
- Loose boulder wall-gully plugging in small hilly streams
- Stone masonry check dams – in major drains

c. Others
- Awareness campaign for farm management, control grazing etc.
- Drinking Water facilities to Villagers

As most of the area is agricultural land (81.92%), awareness campaign will be done for farm management (negatives of burning farm residuals, adoption of proper cropping pattern etc.), digging of farm pond, controlled grazing in graze land, etc.

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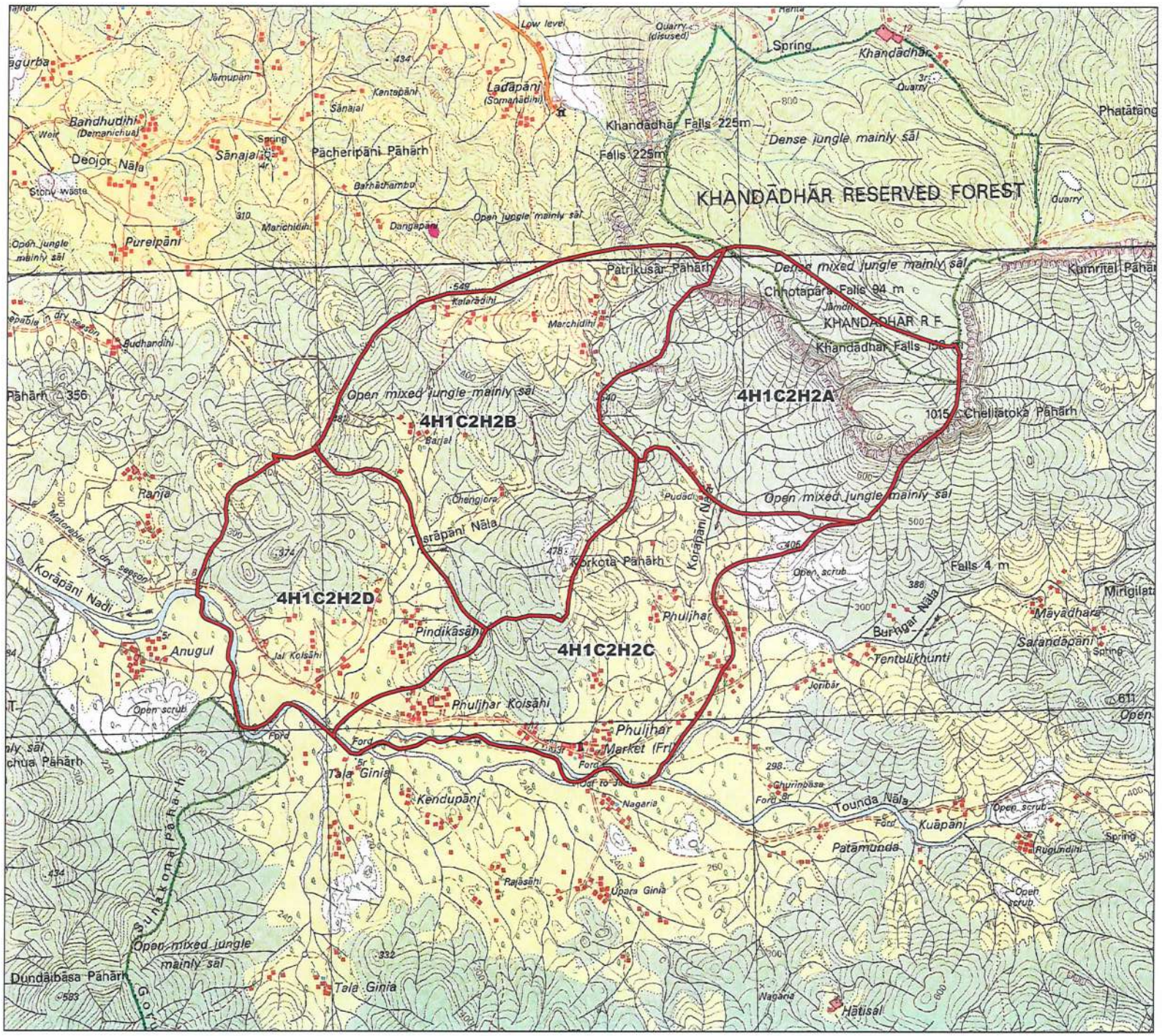
Plate-11.a

*Catchment Area Treatement Plan*

*Karapani Irrigation Project*

## *Topographic Map of the Priority Watershed*




**Legend**

Sub-Watershed Boundary

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0 0.5 1 2 3 Km.

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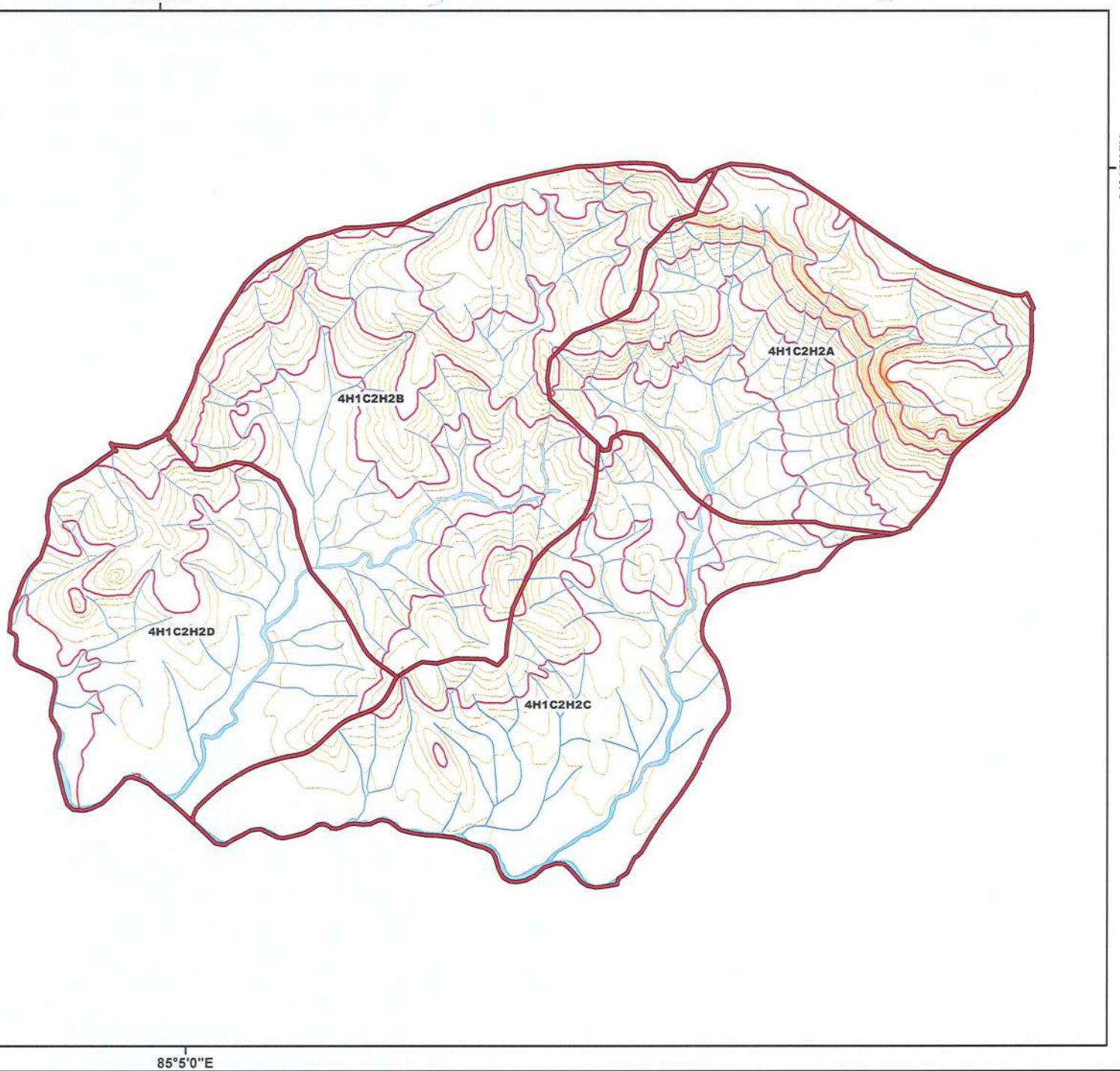
Plate-11.b

# Catchment Area Treatement Plan

## Karapani Irrigation Project

## Drainage & Contour Map of the Priority Watershed




### Legend

- Sub-Watershed Boundary
- River/Drainage
- Contour(100m interval)
- Contour(20m interval)

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0 0.25 0.5 1 1.5 Km.

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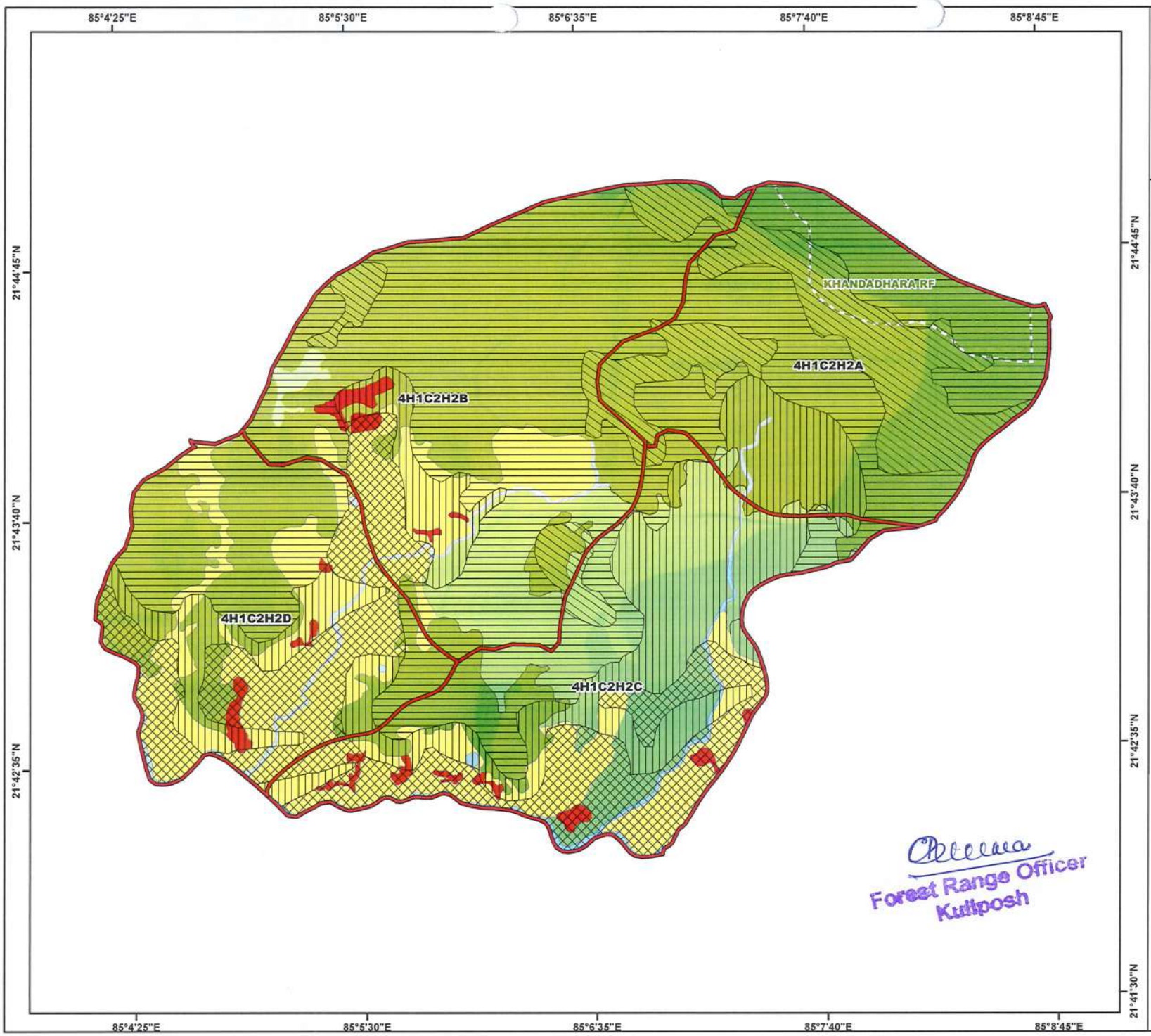
Plate-11.c

# Catchment Area Treatement Plan
## Karapani Irrigation Project
## Land Use & Slope Map of the Priority Watershed




**Legend**

- Catchment Area
- Sub-Watershed Boundary
- Reserve Forest

**Slope**

- Gently Slopping
- Moderately Slopping
- Strongly Slopping
- Steeply Slopping
- Very Steeply Slopping

**Landuse**

- Moderate Dense Forest
- Open Forest
- Plantation; Grooves & Orchards
- Scrubs
- Forest Blank
- Cultivation
- Settlement
- River/ Waterbody
- Others

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0 0.5 1 2

## 8.1 Assisted Natural Regeneration

Assisted Natural regeneration is suggested in 50ha in open forests available within the watersheds. The sites to be treated are depicted in ***Plate-13***. The detail estimate is depicted at ***Annexure-1.***

## 8.2 Block Plantation/Afforestation

The village wise revenue forest and govt. land is depicted in the below.

*Table-8: Availability of Govt. and forest land*

***All areas in Ac.***

| Name of the village | Govt Land | Forest Land | Gochar Land |
|---|---|---|---|
| Badjal | 239.49 | 36.2 | 11.4 |
| Fuljhar | 3491.78 | 207.36 | 76.14 |
| Uskuda | 4892.3 | 0 | 0 |
| Ranja | 1044.55 | 257.57 | 30 |
| Talaginia | 1566.79 | 260.02 | 89.92 |

As 260.02 ha of forest land is available in Talaginia villages, but there is no forest growth, it is proposed to block plantation of 75 hectors in the village. The detailed estimate is enclosed at **Annexure-2**.

## 8.3 Fodder land development

To minimize the pressure on forest for grazing, it is suggested to develop fodder land in the watershed.

*Table-9: Availability of Gochar land*

| Name of the village | Population | Gochar land |
|---|---|---|
| Badjal | 699 | 11.4 |
| Fuljhar | 2052 | 76.14 |
| Uskuda | 649 | 0 |
| Ranja | 270 | 30 |
| Talaginia | 610 | 89.92 |

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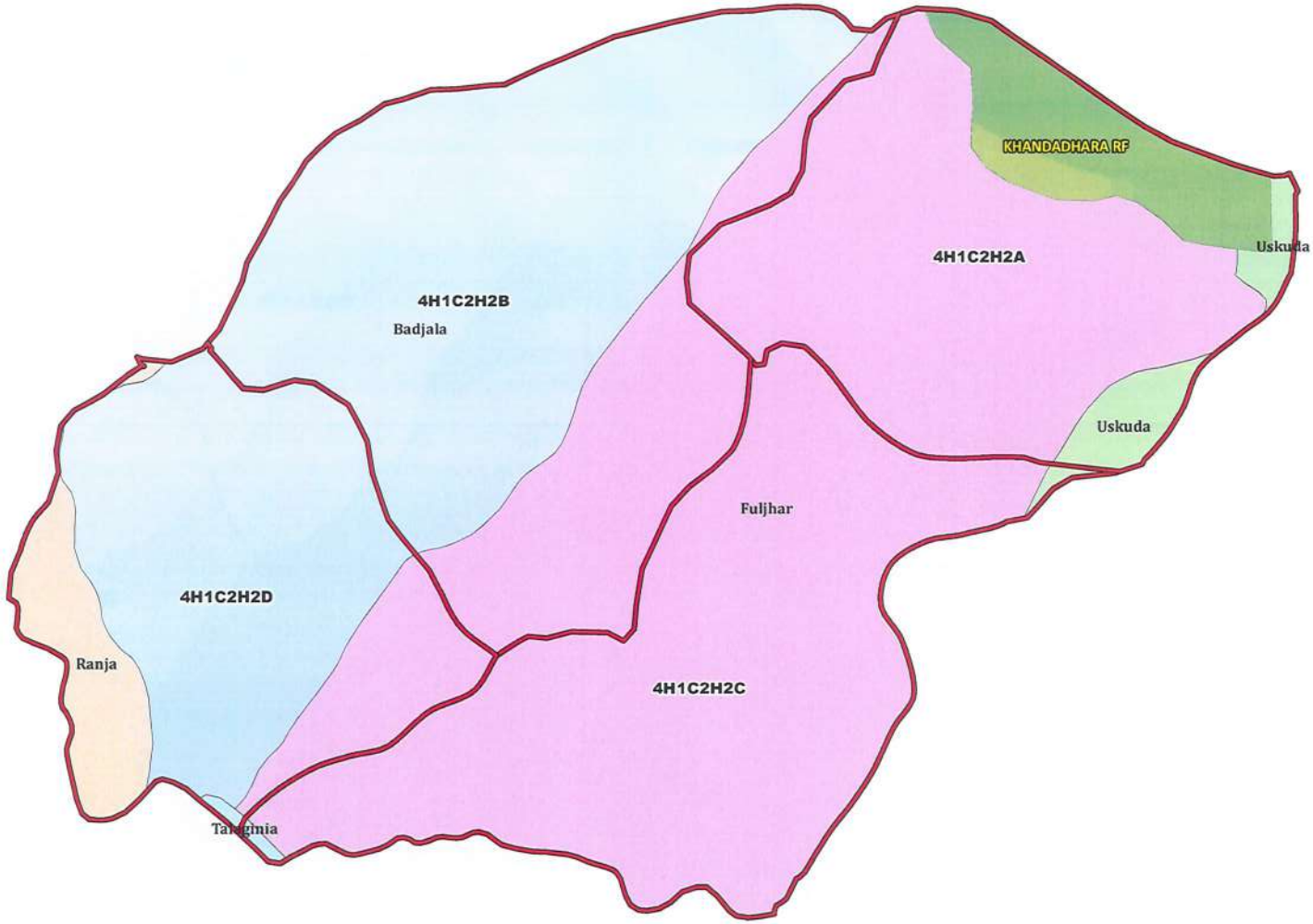
Plate-12

# Catchment Area Treatement Plan

## Karapani Irrigation Project

## Village Map of the Priority Watershed




**Legend**

- Watershed Boundary
- River/Waterbody
- Drainage
- RF

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0 0.5 1 2

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Looking at the availability of Gochar land and population, it is proposed to develop 4 blocks (of 10 ha each) of fodder land development in each villages of watersheds except Fuljhar & Talaginia. The detail estimate is given at ***Annexure-3***.

## 8.4 Loose boulder wall-gully plugging in small hilly streams

**Gully erosion**, including ephemeral gully erosion, refers to the cutting of narrow channels resulting from concentration of sheet and rill flow of runoff water. Ephemeral gullies are small channels of approximately 3 to 12 inches deep. Gullies may be one to several feet deep. Gully erosion occurs when rill erosion is neglected. The tiny grooves develop into wider and deeper channels, which may assume a huge size. This state is called 'gully 'erosion. Gullies are the most spectacular evidence of the destruction of soil. The gullies usually deepen and widen with every heavy rainfall. They cut up large fields into small fragments and, in course of time, make them out of shape for cultivation.

Gully plugging work is required for reduction of runoff velocities within permissible limits and for controlling gully erosion of micro-watersheds. Appropriate gully plugging works would be selected from brush wood check dams, palisading works, gabion structures, sunken pits, etc. A provision is kept for **40** gullies plugging in the streams. The typical Estimate of Gully Plugging is depicted at ***Annexure-4.***

## 8.5 Earthen Check Dam with concrete core Wall – in major drains

Check dams' range in size, shape and cost. It is possible to build them out of easily available materials and even at a very little cost. Decision of building such a dam depends on its location. Essentially a check dam has an earthen dam and masonry spillway.

It cuts the velocity and reduces erosive activity, the stored water improves soil moisture of the adjoining area and allows percolation to recharge the aquifers Spacing between the check dams should be such that water spread of one should be beyond the water spread of the other Height depends on the bank height, varies from 1m to 3m and length varies from less than 3m to 10m. A provision is kept for **20** Masonry Check in the streams. The typical Estimate of earthen check dam with concrete core is depicted at ***Annexure-5***

The locations of proposals for all treatments other than ANR activities are depicted in ***Plate-14***. The detail year wise cash flow estimate is depicted at ***Annexure-6.***



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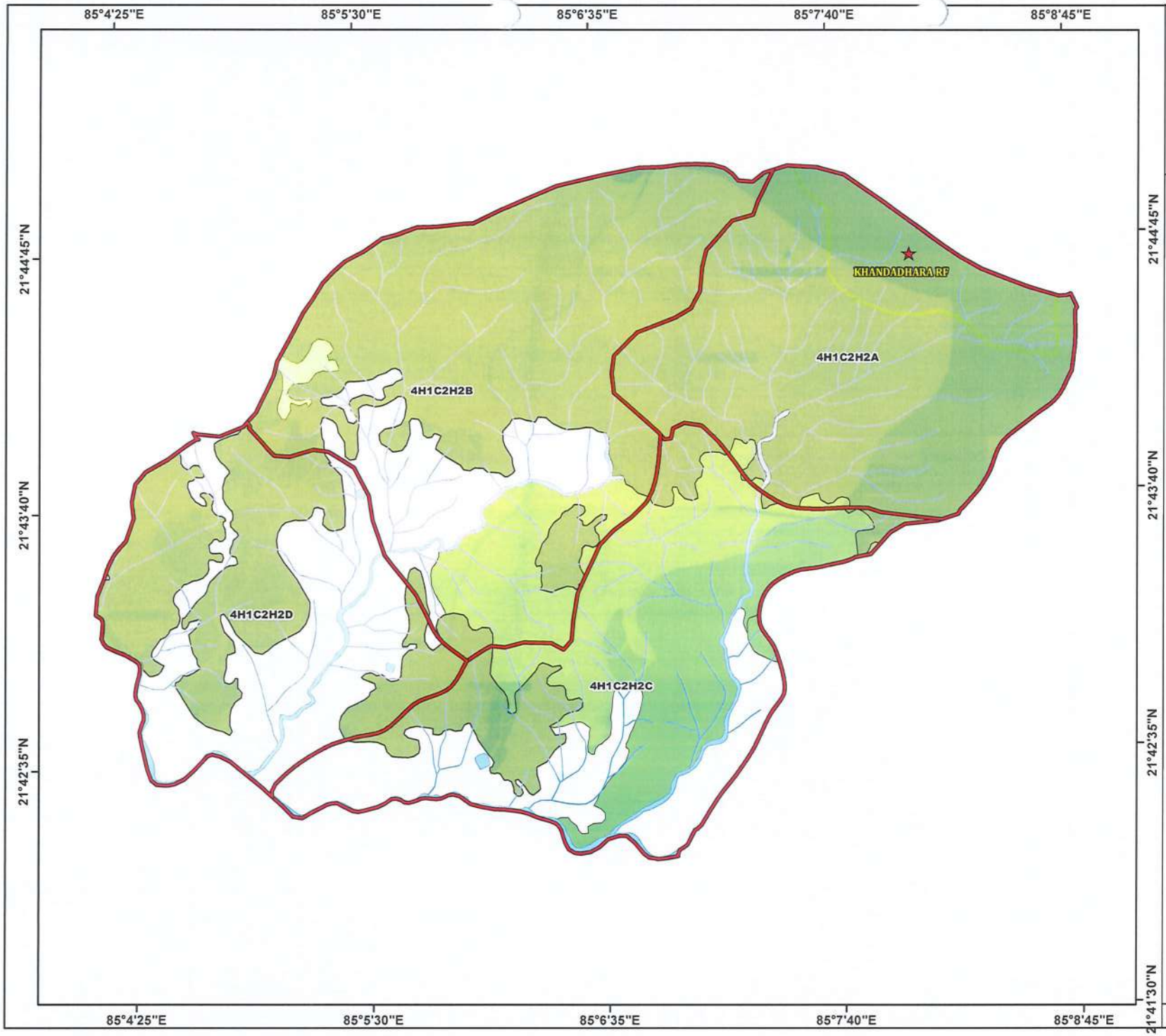
Plate-13

# Catchment Area Treatement Plan

## Karapani Irrigation Project

## Map Showing Proposed Assisted Natural Regeneration Activity




**Legend**

- ANR Plantation
- Watershed Boundary
- River
- Drainage
- Reserve Forest
- Open Forest
- Scrub

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0 0.25 0.5 1 1.5 Km.

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## 9. Cost Estimate

| SL | Item | Rate in Rs. | Unit | Physical | Financial (Rs, in Lakh) |
|---|---|---|---|---|---|
| Biological Measure | | | | | |
| 1 | Enrichment of Plantation/Re-densification (ANR with gap plantation @600 plants) | 70,485.24 | Ha | 50 | 35.24 |
| 2 | Afforestation including maintenance (Block Plantation @ 1600 plants/ha (6 months seedlings) | 1,73,871.39 | Ha | 75 | 130.40 |
| 3 | Grass land (Fodder land) development including grass reserves over 40.0ha (10 ha one unit) | 13,00,000 | Ha | 40 | 52.00 |
| Engineering Measure | | | | | |
| 4 | Loose Boulder wall gully plugging | 4771.53 | No | 40 | 1.91 |
| 5 | Earthen Check Dam with Concrete Core | 2,47,253 | No | 20 | 49.45 |
| Others | | | | | |
| 6 | Awareness campaign for farm management, control grazing etc. | - | - | - | 5.00 |
| 7 | Drinking Water facilities and socio-economic development to Villagers | - | - | - | 10.00 |
| | **Total** | | | | **284.00** |

Total cost of Biological, Engineering & other measure a silt observation at site **Rs. 284.00 lakh**

Administrative Expenditure/ Monitoring & Supervision @10% Rs. 28.4 Lakh

**Total** **Rs. 312.40 Lakh**

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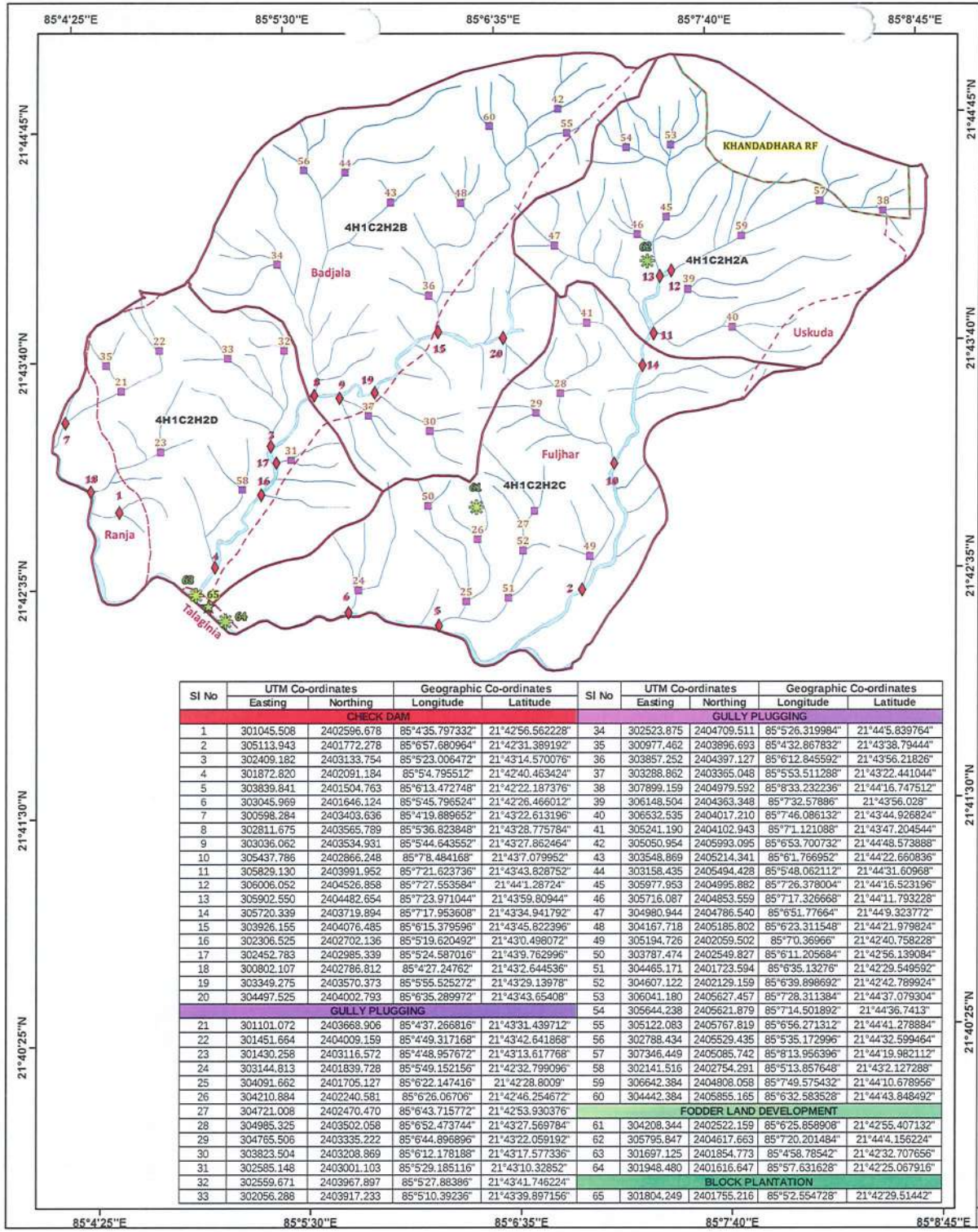
Plate-14

# Catchment Area Treatement Plan
## Karapani Irrigation Project
### Map Showing Catchment Area Treatment Activities other than ANR




## Legend

- Watershed Boundary
- River/Drainage
- Village Boundary
- Reserve Forest

## Type of Treatement

- Block Plantation
- Fodder Land Developement
- Gully Plugging
- Check Dam

| Sl No | UTM Co-ordinates | | Geographic Co-ordinates | | Sl No | UTM Co-ordinates | | Geographic Co-ordinates | |
|---|---|---|---|---|---|---|---|---|---|
| | Easting | Northing | Longitude | Latitude | | Easting | Northing | Longitude | Latitude |
| CHECK DAM | | | | | GULLY PLUGGING | | | | |
| 1 | 301045.508 | 2402596.678 | 85°4'35.797332" | 21°42'56.562228" | 34 | 302523.875 | 2404709.511 | 85°5'26.319984" | 21°44'5.839764" |
| 2 | 305113.943 | 2401772.278 | 85°6'57.680964" | 21°42'31.389192" | 35 | 300977.462 | 2403896.693 | 85°4'32.867832" | 21°43'38.79444" |
| 3 | 302409.182 | 2403133.754 | 85°5'23.006472" | 21°43'14.570076" | 36 | 303857.252 | 2404397.127 | 85°6'12.845592" | 21°43'56.21826" |
| 4 | 301872.820 | 2402091.184 | 85°5'4.795512" | 21°42'40.463424" | 37 | 303288.862 | 2403365.048 | 85°5'53.511288" | 21°43'22.441044" |
| 5 | 303839.841 | 2401504.763 | 85°6'13.472748" | 21°42'22.187376" | 38 | 307899.159 | 2404979.592 | 85°8'33.232236" | 21°44'16.747512" |
| 6 | 303045.969 | 2401646.124 | 85°5'45.796524" | 21°42'26.466012" | 39 | 306148.504 | 2404363.348 | 85°7'32.57886" | 21°43'56.028" |
| 7 | 300598.284 | 2403403.636 | 85°4'19.889652" | 21°43'22.613196" | 40 | 306532.535 | 2404017.210 | 85°7'46.086132" | 21°43'44.926824" |
| 8 | 302811.675 | 2403565.789 | 85°5'36.823848" | 21°43'28.775784" | 41 | 305241.190 | 2404102.943 | 85°7'1.121088" | 21°43'47.204544" |
| 9 | 303036.062 | 2403534.931 | 85°5'44.643552" | 21°43'27.862464" | 42 | 305050.954 | 2405993.095 | 85°6'53.700732" | 21°44'48.573888" |
| 10 | 305437.786 | 2402866.248 | 85°7'8.484168" | 21°43'7.079952" | 43 | 303548.869 | 2405214.341 | 85°6'1.766952" | 21°44'22.660836" |
| 11 | 305829.130 | 2403991.952 | 85°7'21.623736" | 21°43'43.828752" | 44 | 303158.435 | 2405494.428 | 85°5'48.062112" | 21°44'31.60968" |
| 12 | 306006.052 | 2404526.858 | 85°7'27.553584" | 21°44'1.28724" | 45 | 305977.953 | 2404995.882 | 85°7'26.378004" | 21°44'16.523196" |
| 13 | 305902.550 | 2404482.654 | 85°7'23.971044" | 21°43'59.80944" | 46 | 305716.087 | 2404853.559 | 85°7'17.326668" | 21°44'11.793228" |
| 14 | 305720.339 | 2403719.894 | 85°7'17.953608" | 21°43'34.941792" | 47 | 304980.944 | 2404786.540 | 85°6'51.77664" | 21°44'9.323772" |
| 15 | 303926.155 | 2404076.485 | 85°6'15.379596" | 21°43'45.822396" | 48 | 304167.718 | 2405185.802 | 85°6'23.311548" | 21°44'21.979824" |
| 16 | 302306.525 | 2402702.136 | 85°5'19.620492" | 21°43'0.498072" | 49 | 305194.726 | 2402059.502 | 85°7'0.36966" | 21°42'40.758228" |
| 17 | 302452.783 | 2402985.339 | 85°5'24.587016" | 21°43'9.762996" | 50 | 303787.474 | 2402549.827 | 85°6'11.205684" | 21°42'56.139084" |
| 18 | 300802.107 | 2402786.812 | 85°4'27.24762" | 21°43'2.644536" | 51 | 304465.171 | 2401723.594 | 85°6'35.13276" | 21°42'29.549592" |
| 19 | 303349.275 | 2403570.373 | 85°5'55.525272" | 21°43'29.13978" | 52 | 304607.122 | 2402129.159 | 85°6'39.898692" | 21°42'42.789924" |
| 20 | 304497.525 | 2404002.793 | 85°6'35.289972" | 21°43'43.65408" | 53 | 306041.180 | 2405627.457 | 85°7'28.311384" | 21°44'37.079304" |
| GULLY PLUGGING | | | | | 54 | 305644.238 | 2405621.879 | 85°7'14.501892" | 21°44'36.7413" |
| 21 | 301101.072 | 2403668.906 | 85°4'37.266816" | 21°43'31.439712" | 55 | 305122.083 | 2405767.819 | 85°6'56.271312" | 21°44'41.278884" |
| 22 | 301451.664 | 2404009.159 | 85°4'49.317168" | 21°43'42.641868" | 56 | 302788.434 | 2405529.435 | 85°5'35.172996" | 21°44'32.599464" |
| 23 | 301430.258 | 2403116.572 | 85°4'48.957672" | 21°43'13.617768" | 57 | 307346.449 | 2405085.742 | 85°8'13.956396" | 21°44'19.982112" |
| 24 | 303144.813 | 2401839.728 | 85°5'49.152156" | 21°42'32.799096" | 58 | 302141.516 | 2402754.291 | 85°5'13.857648" | 21°43'2.127288" |
| 25 | 304091.662 | 2401705.127 | 85°6'22.147416" | 21°42'28.8009" | 59 | 306642.384 | 2404808.058 | 85°7'49.575432" | 21°44'10.678956" |
| 26 | 304210.884 | 2402240.581 | 85°6'26.06706" | 21°42'46.254672" | 60 | 304442.384 | 2405855.165 | 85°6'32.583528" | 21°44'43.848492" |
| 27 | 304721.008 | 2402470.470 | 85°6'43.715772" | 21°42'53.930376" | FODDER LAND DEVELOPMENT | | | | |
| 28 | 304985.325 | 2403502.058 | 85°6'52.473744" | 21°43'27.569784" | 61 | 304208.344 | 2402522.159 | 85°6'25.858908" | 21°42'55.407132" |
| 29 | 304765.506 | 2403335.222 | 85°6'44.896896" | 21°43'22.059192" | 62 | 305795.847 | 2404617.663 | 85°7'20.201484" | 21°44'4.156224" |
| 30 | 303823.504 | 2403208.869 | 85°6'12.178188" | 21°43'17.577336" | 63 | 301697.125 | 2401854.773 | 85°4'58.78542" | 21°42'32.707656" |
| 31 | 302585.148 | 2403001.103 | 85°5'29.185116" | 21°43'10.32852" | 64 | 301948.480 | 2401616.647 | 85°5'7.631628" | 21°42'25.067916" |
| 32 | 302559.671 | 2403967.897 | 85°5'27.88386" | 21°43'41.746224" | BLOCK PLANTATION | | | | |
| 33 | 302056.288 | 2403917.233 | 85°5'10.39236" | 21°43'39.897156" | 65 | 301804.249 | 2401755.216 | 85°5'2.554728" | 21°42'29.51442" |

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Sundargarh

0 0.5 1 2 Km.

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| COST NORM FOR AIDED NATURAL REGENERATION (ANR) @ 600 PLANTS PER HECTARE Wage rate 298.00/Day. | | | | | | |
|---|---|---|---|---|---|---|
| **Sl no.** | **Items of work** | **Preferable Period of** Execution | **Labour in** Mandays | **Labour** cost | **Material** cost | **Total cost** in RS |
| | **0TH YEAR** | | | | | |
| 1 | Survey, Demarcation and Pillar Posting, GPS Reading with mapping | Nov/Dec | 2 | 596 | 0 | 596 |
| 2 | Site Preparation | Nov/Dec | 2 | 596 | 0 | 596 |
| 3 | Silvicultural Operation including clearance of weed, climber cutting, high stump cutting, singling of shoots etc. | Jan/Feb | 5 | 1490 | 0 | 1490 |
| 4 | Nursery cost (6 months old seedling) part @ Rs.12.43/-seedling (Rs.8.67 in 0th year + Rs.3.76 in 1st year) for 660 seedlings (600+60) | Jan-Mar | 16.5 | 4917 | 1102 | 6019 |
| 5 | Contingency and Unforeseen Expenditures | | | 0 | 198 | 198 |
| | **SUB TOTAL** | | **25.5** | **7599** | **1300** | **8899** |
| **6** | Monitoring & Supervision charge 5 % of the total cost | | | | | **444.95** |
| | **GRAND TOTAL** | | 25.5 | 7599 | 1300 | 9343.95 |
| | **1ST YEAR** | | | | | |
| 1 | Nursery cost (6 months old seedling) balance @ Rs.3.76 for 660 seedlings | Apr-June | 8 | 2384 | 241.5 | 2625.5 |
| 2 | Pitting 30 cm cube size | Feb/Mar | 18 | 5364 | 0 | 5364 |
| 3 | Carriage and planting including casualty replacement | Jul/Aug | 15 | 4470 | 0 | 4470 |
| 4 | Complete weeding, Soil working, Manuring | Aug/Sep | 18 | 5364 | 0 | 5364 |
| 5 | Cost of Vermi compost @ 200 gms/plant @ Rs.20/-per kg =Rs.2400.00 and Granúlar Insecticide 5 gms/plant @ Rs.80/- per kg= Rs.240.00 | Aug/Sep | 0 | 0 | 2640 | 2640 |
| 6 | Cost of Chemical fertiliser<br>(a) Urea 70 gms/plant in two subsequent doses@ Rs.6/-per kg Rs.252.00<br>(b) NPK 50 gms/plant @ Rs.24/- per kg= Rs.720.00 as basal dose | Jul/Aug | 0 | 0 | 972 | 972 |
| 7 | Fireline Tracing and Inspection Path | Feb/Mar | 3 | 894 | 0 | 894 |

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Ib Investigation Division
Sundargarh

Forest Range Officer
Kuliposh

| | | | | | | |
|---|---|---|---|---|---|---|
| 8 | silvicultural Operation involving clearance of weeds, cutting of climbers, singling of shoots etc | Sep/Oct | 15 | 4470 | 0 | 4470 |
| 9 | Soil Conservation Measures (Staggered trenches of dimension 2 m X 0.5 m X0.5 m @ 60 nos per ha) or its equivalent | Sep/Oct | 20 | 5960 | 0 | 5960 |
| 10 | Watch & ward | Aug-Mar | 7 | 2086 | 0 | 2086 |
| 11 | Contingency and Unforeseen Expenditures | | 0 | 0 | 353 | 353 |
| | | **SUB TOTAL** | **104** | **30992** | **4207** | **35199** |
| 12 | Monitoring & Supervision charge 5 % of the total cost | | | | | **1759.5** |
| | | **GRAND TOTAL** | **104** | **30992** | **4207** | **36958.5** |
| | | **2ND YEAR** | | | | |
| 1 | Casualty Replacement including cost of seedling, carriage and planting | Jul/Aug | 3 | 894 | 745.8 | 1639.8 |
| 2 | Complete weeding and cultural operations | Sep/Oct | 6 | 1788 | 0 | 1788 |
| 3 | Soil working and manuring | Sep/Oct | 6 | 1788 | 0 | 1788 |
| 4 | Cost of Fertiliserand insecticide<br>(a) Vermicompost 200gms/plant Rs.20/- per kg=Rs.2400.00<br>(b) Granular Insecticides 5 gms/plant for 60 plants 300 gms@ Rs.80/-per kg=Rs.24.00 | Sep/Oct | 0 | 0 | 2424 | 2424 |
| 5 | Fireline Tracing and Inspection Path | Feb/Mar | 1 | 298 | 0 | 298 |
| 6 | Soil Conservation Measures (Renovation of staggered trenches etc.) | Sep/Oct | 8 | 2384 | 0 | 2384 |
| 7 | Watch & ward (whole year) | Apr-Mar | 7 | 2086 | 0 | 2086 |
| 8 | Contingency and Unforeseen Expenditures | | 0 | 0 | 193 | 193 |
| | | **SUB TOTAL** | **31** | **9238** | **3362.8** | **12600.8** |
| 9 | Monitoring & Supervision charge 5 % of the total cost | | | | | 630.04 |
| | | **GRAND TOTAL** | **31** | **9238** | **3362.8** | **13230.84** |
| | | **3RD YEAR** | | | | |
| 1 | Complete weeding and cultural operations | Aug/Sep | 3 | 894 | 0 | 894 |
| 2 | Soil working | Aug/Sep | 3 | 894 | 0 | 894 |
| 3 | Fireline Tracing and Inspection Path | Feb/Mar | 1 | 298 | 0 | 298 |
| 4 | Watch & ward (whole year) | Apr-Mar | 7 | 2086 | 0 | 2086 |
| | | **SUB TOTAL** | **14** | **4172** | **0** | **4172** |
| 5 | Monitoring & Supervision charge 5 % of the total cost | | | | | 208.6 |
| | | **GRAND TOTAL** | **14** | **4172** | **0** | **4380.6** |

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Ib Investigation Division
Sundargarh

Forest Range Officer
Kuliposh

| | | | | | | |
|---|---|---|---|---|---|---|
| | **4TH YEAR** | | | | | |
| 1 | Fireline Tracing and Inspection Path | Feb/Mar | 1 | 298 | 0 | 298 |
| 2 | Watch & ward and cultural operations | Apr-Mar | 2 | 596 | 0 | 596 |
| | SUB TOTAL | | 3 | 894 | 0 | 894 |
| 3 | Monitoring & Supervision charge 5 % of the total cost | | | | | 44.7 |
| | GRAND TOTAL | | 3 | 894 | 0 | 938.7 |
| | **5TH YEAR** | | | | | |
| 1 | Fireline Tracing and Inspection Path | Feb/Mar | 1 | 298 | 0 | 298 |
| 2 | Watch & ward and cultural operations | Apr-Mar | 2 | 596 | 0 | 596 |
| | **SUB TOTAL** | | **3** | **894** | **0** | **894** |
| 3 | Monitoring & Supervision charge 5 % of the total cost | | | | | 44.7 |
| | **GRAND TOTAL** | | **3** | **894** | **0** | **938.7** |
| | **6TH YEAR** | | | | | |
| 1 | Fireline Tracing and Inspection Path | Feb/Mar | 1 | 298 | 0 | 298 |
| 2 | Watch & ward and cultural operations | Apr-Mar | 2 | 596 | 0 | 596 |
| | **SUB TOTAL** | | **3** | **894** | **0** | **894** |
| 3 | Monitoring & Supervision charge 5 % of the total cost | | | | | 44.7 |
| | **GRAND TOTAL** | | **3** | **894** | **0** | **938.7** |
| | 7TH YEAR | | | | | |
| 1 | Fireline Tracing and Inspection Path | Feb/Mar | 1 | 298 | 0 | 298 |
| 2 | Watch & ward and cultural operations | Apr-Mar | 2 | 596 | 0 | 596 |
| | **SUB TOTAL** | | **3** | **894** | **0** | **894** |
| 3 | Monitoring & Supervision charge 5 % of the total cost | | | | | 44.7 |
| | **GRAND TOTAL** | | **3** | **894** | **0** | **938.7** |
| | **8TH YEAR** | | | | | |
| 1 | Fireline Tracing and Inspection Path | Feb/Mar | 1 | 298 | 0 | 298 |
| 2 | Watch & ward and cultural operations | Apr-Mar | 2 | 596 | 0 | 596 |
| | **SUB TOTAL** | | **3** | **894** | **0** | **894** |
| 3 | Monitoring & Supervision charge 5 % of the total cost | | | | | 44.7 |
| | **GRAND TOTAL** | | **3** | **894** | **0** | **938.7** |
| | **9TH YEAR** | | | | | |
| 1 | Fireline Tracing and Inspection Path | Feb/Mar | 1 | 298 | 0 | 298 |
| 2 | Watch & ward and cultural operations | Apr-Mar | 2 | 596 | 0 | 596 |
| | **SUB TOTAL** | | **3** | **894** | **0** | **894** |
| 3 | Monitoring & Supervision charge 5 % of | | | | | 44.7 |

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Sundargarh

Forest Range Officer
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| | | | | | | |
|---|---|---|---|---|---|---|
| | the total cost | | | | | |
| | GRAND TOTAL | | 3 | 894 | 0 | 938.7 |
| | | **10TH YEAR** | | | | |
| 1 | Fireline Tracing and Inspection Path | Feb/Mar | 1 | 298 | 0 | 298 |
| 2 | Watch & ward and cultural operations | Apr-Mar | 2 | 596 | 0 | 596 |
| | | SUB TOTAL | 3 | 894 | 0 | 894 |
| 3 | Monitoring & Supervision charge 5 % of the total cost | | | | | 44.7 |
| | | **GRAND TOTAL** | **3** | **894** | **0** | **938.7** |

**ABSTRACT**

| Sl. | Year | No. Person Day | Labour cost @298.00/- per day | Material cost | Monitoring & Supervision charge 5 % of the total cost | Total cost in (Rs) |
|---|---|---|---|---|---|---|
| 1 | 0th year | 25.5 | 7599 | 1300 | 444.95 | 9343.95 |
| 2 | 1st year | 104 | 30992 | 4207 | 1759.95 | **36958.95** |
| 3 | 2nd year | 31 | 9238 | 3362.8 | 630.04 | **13230.84** |
| 4 | 3rd year | 14 | 4172 | 0 | 208.6 | **4380.6** |
| 5 | 4th year | 3 | 894 | 0 | 44.7 | **938.7** |
| 6 | 5th year | 3 | 894 | 0 | 44.7 | 938.7 |
| 7 | 6th year | 3 | 894 | 0 | 44.7 | 938.7 |
| 8 | 7th year | 3 | 894 | 0 | 44.7 | 938.7 |
| 9 | 8th year | 3 | 894 | 0 | 44.7 | **938.7** |
| 10 | 9th year | 3 | 894 | 0 | 44.7 | **938.7** |
| 11 | 10th year | 3 | 894 | 0 | 44.7 | **938.7** |
| | **Total** | **195.5** | **58259** | **8869.8** | **3356.44** | **70485.24** |

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ANNEXURE-2

**COST NORM FOR BLOCK PLANTATION @1600 PLANTA PER HECTARE ( 6 month old seedling) Wage Rate @ R.s. 298/- per day**

| Sl. No | Items of work | Preferable period of execution | Labour in Mandays | Labour cost (Rs) | Material cost (Rs) | Total cost (Rs) |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | **0TH YEAR (ADVANCE WORK) PRE-PLANTING OPERATION** | | | | | |
| 1 | Survey,demarcation and pillar posting | Nov/Dec | 2 | 596 | 0 | 596 |
| 2 | Site preparation | Nov/Dec | 12 | 3576 | 0 | 3576 |
| 3 | Alignment and stacking of pits | Jan/Feb | 2 | 596 | 0 | 596 |
| 4 | Digging of pits (30 cm cube) | Feb/March | 40 | 11920 | 0 | 11920 |
| 5 | Nursery cost (6 months old seedling ) part @Rs. 12.43/- seedling (RS.8.67 in $0^{th}$ year + Rs.3.76 in $1^{st}$ year) for 1760 seedlings (1600+160) | Jan-March | 44 | 13112 | 2939 | 16051 |
| | **Total** | | **100** | **29800** | **2939** | **32739** |
| 6 | Monitoring & Supervision charge 5% of the total cost | | | | | 1636.95 |
| | **Grand Total** | | **100** | **29800** | **2939** | **34375.95** |
| | **1ST YEAR/PLANTING YEAR** | | | | | |
| 7 | Nursery cost (6 months old seedling ) balance @Rs.3.76/- for 1760 seedlings | Apr-June | 21.5 | 6407 | 593 | 7000 |
| 8 | Fencing For an average of 250 meters/ha @Rs.76.80/- per meter for bamboo twigs and bamboo thorn fencing | May/June | 38 | 11324 | 8560 | 19884 |
| 9 | Carriage & planting, Casualty Replacement and application of insecticides, manure etc. | Jul/Aug | 21 | 6258 | 0 | 6258 |
| 10 | Cost of insecticide and fertilizer (a)NPK @50 gms/plant as basal dose = 80kg @ Rs.24 / -per kg =Rs.1920.00 (b) Urea @ 70 gms/plant in two subsequent doeses @ Rs.6/-per kg= Rs.672.00 (c) Granular insecticide(Themet, Forate etc.) @5 gms/plant@Rs.80-/per kg= Rs.640.00 | Jul/Aug | | 0 | 3232 | 3232 |
| 11 | 1st weeding (complete weeding) | Aug/Sep | 7 | 2086 | 0 | 2086 |
| 12 | Manuring Urea 35 gm | Aug/Sep | 5 | 1490 | 0 | 1490 |
| 13 | 2nd Weeding (complete weeding) | Sep/Oct | 5 | 1490 | 0 | 1490 |
| 14 | Soil working (50 cms. Radius around plants) & manuring Urea 358ms per plant | Sep/Oct | 7 | 2086 | 0 | 2086 |
| 15 | Soil conservation measures in the form of straggerd trenches of size 2 mx0.5 m x0.5 m@ 30 nos per ha | Sep/Oct | 10 | 2980 | 0 | 2980 |
| 16 | Fire line tracing & inspection path | Feb/March | 3 | 894 | 0 | 894 |
| 17 | Watch&Ward | Aug/March | 7 | 2086 | 0 | 2086 |
| | **Total** | | **124.5** | **37101** | **12385** | **49486** |
| 18 | Monitoring & Supervision charge 5% of the total cost | | | | | 2474.3 |
| | **Grand Total** | | **124.5** | **37101** | **12385** | **51960.3** |
| | **2ND YEAR MAINTENANCE** | | | | | |
| 19 | Casualty replacement ( 10 % ) with Nursery cost | Jul/Aug | 4 | 1192 | 1988.8 | 3180.8 |
| 20 | Weeding (complete weeding) | Sep/Oct | 6 | 1788 | 0 | 1788 |
| 21 | Cost of fertilizer (NPK @70 gms/plant) ( Rs.24/-per kg & Insecticide @5 gms/plant for 160 plants 800 Gms @ Rs.80/ per kg) | Sep/Oct | | 0 | 2752 | 2752 |

Executive Engineer
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Sundargarh

Forest Range Officer
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| | | | | | | |
|---|---|---|---|---|---|---|
| 22 | Repair and maintenance of Bamboo fence including material cost | May/June | 20 | 5960 | 5080 | 11040 |
| 23 | Sol working (50 cms. Radlus around plants) | Oct/Nov | 7 | 2086 | 0 | 2086 |
| 24 | Application of fertilizer & insecticide | Sep/Oct | 4 | 1192 | 0 | 1192 |
| 25 | Fire line tracing (2 m wide fire line over 400 m long) | Feb/March | 3 | 894 | 0 | 894 |
| 26 | Watch & Ward | Apr-March | 15 | 4470 | 0 | 4470 |
| | **Total** | | **59** | **17582** | **9820.8** | **27402.8** |
| 27 | Monitoring & Supervision charge 5% of the total cost | | | | | 1370.14 |
| | **Grand Total** | | **59** | **17582** | **9820.8** | **28772.94** |
| | 3RD YEAR MAINTENANCE | | | | | |
| 28 | Weeding and application of fertilizer | Aug/Sep | 7 | 2086 | 0 | 2086 |
| 29 | Cost of fertilizer (NPK @ s0 gms/plant) 1960 Rs.24/-per kg | | | 0 | 1920 | 1920 |
| 30 | Repair and maintenance of Bamboo fence including material cost | May/June | 20 | 5960 | 1000 | 6960 |
| 31 | Soil working (50 cms. Radius around plants) & applicaton of fertilizer | Oct/Nov | 7 | 2086 | 0 | 2086 |
| 32 | Fire line tracing (2 m. wide fire line over 400 m length)& cultural operation | Feb/March | 3 | 894 | 0 | 894 |
| 33 | Watch& Ward | Apr-March | 15 | 4470 | 0 | 4470 |
| | **Total** | | **52** | **15496** | **2920** | **18416** |
| 34 | Monitoring & Supervision charge 5% of the total cost | | | | | 920.8 |
| | **Grand Total** | | **52** | **15496** | **2920** | **19336.8** |
| | **4TH YEAR MAINTENANCE** | | | | | |
| 35 | Fire line tracing (2 m. wide fire line over 400 m length)& cultural operation | Feb/March | 3 | 894 | 0 | 894 |
| 36 | Watch& Ward | Apr-March | 15 | 4470 | 0 | 4470 |
| | **Total** | | **18** | **5364** | **0** | **5364** |
| 37 | Monitoring & Supervision charge 5% of the total cost | | | | | 268.2 |
| | **Grand Total** | | **18** | **5364** | **0** | **5632.2** |
| | 5TH YEAR MAINTENANCE | | | | | |
| 38 | Fire line tracing (2 m. wide fire line over 400 m length)& cultural operation | Feb/March | 3 | 894 | 0 | 894 |
| 39 | Watch& Ward | Apr-March | 15 | 4470 | 0 | 4470 |
| | **Total** | | **18** | **5364** | **0** | **5364** |
| 40 | Monitoring & Supervision charge 5% of the total cost | | | | | 268.2 |
| | **Grand Total** | | **18** | **5364** | **0** | **5632.2** |
| | **6TH YEAR MAINTENANCE** | | | | | |
| 41 | Fire line tracing (2 m. wide fire line over 400 m length)& cultural operation | Feb/March | 3 | 894 | 0 | 894 |
| 42 | Watch& Ward | Apr-March | 15 | 4470 | 0 | 4470 |
| | **Total** | | **18** | **5364** | **0** | **5364** |
| 43 | Monitoring & Supervision charge 5% of the total cost | | | | | 268.2 |
| | **Grand Total** | | **18** | **5364** | **0** | **5632.2** |
| | **7TH YEAR MAINTENANCE** | | | | | |
| 44 | Fire line tracing (2 m. wide fire line over 400 m length)& cultural operation | Feb/March | 3 | 894 | 0 | 894 |
| 45 | Watch& Ward | Apr-March | 15 | 4470 | 0 | 4470 |
| | **Total** | | **18** | **5364** | **0** | **5364** |
| 46 | Monitoring & Supervision charge 5% of the total cost | | | | | 268.2 |
| | **Grand Total** | | **18** | **5364** | **0** | **5632.2** |
| | **8TH YEAR MAINTENANCE** | | | | | |

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Sundargarh

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| | | | | | | |
|---|---|---|---|---|---|---|
| 47 | Fire line tracing (2 m. wide fire line over 400 m length)& cultural operation | Feb/March | 3 | 894 | 0 | 894 |
| 48 | Watch& Ward | Apr-March | 15 | 4470 | 0 | 4470 |
| | **Total** | | **18** | **5364** | **0** | **5364** |
| 49 | Monitoring & Supervision charge 5% of the total cost | | | | | 268.2 |
| | **Grand Total** | | **18** | **5364** | **0** | **5632.2** |
| | **9TH YEAR MAINTENANCE** | | | | | |
| 50 | Fire line tracing (2 m. wide fire line over 400 m length)& cultural operation | Feb/March | 3 | 894 | 0 | 894 |
| 51 | Watch& Ward | Apr-March | 15 | 4470 | 0 | 4470 |
| | **Total** | | **18** | **5364** | **0** | **5364** |
| 52 | Monitoring & Supervision charge 5% of the total cost | | | | | 268.2 |
| | **Grand Total** | | **18** | **5364** | **0** | **5632.2** |
| | **10TH YEAR MAINTENANCE** | | | | | |
| 53 | Fire line tracing (2 m. wide fire line over 400 m length)& cultural operation | Feb/March | 3 | 894 | 0 | 894 |
| 54 | Watch& Ward | Apr-March | 15 | 4470 | 0 | 4470 |
| | **Total** | | **18** | **5364** | **0** | **5364** |
| 55 | Monitoring & Supervision charge 5% of the total cost | | | | | 268.2 |
| | **Grand Total** | | **18** | **5364** | **0** | **5632.2** |

**ABSTRACT**

| Sl. No | YEAR | No. Person Day | Labour cost @ Rs.298/- per day | Material cost (Rs) | Monitoring & Supervision charge 5% of the total cost | Total cost (Rs) |
|---|---|---|---|---|---|---|
| 1 | 0th year | 100 | 29800 | 2939 | 1636.95 | 34375.95 |
| 2 | 1st year | 124.5 | 37101 | 12385 | 2474.3 | 51960.3 |
| 3 | 2nd year | 59 | 17582 | 9820.8 | 1370.14 | 28772.94 |
| 4 | 3rd year | 52 | 15496 | 2920 | 920.8 | 19336.8 |
| 5 | 4th year | 18 | 5364 | 0 | 268.2 | 5632.2 |
| 6 | 5th year | 18 | 5364 | 0 | 268.2 | 5632.2 |
| 7 | 6th year | 18 | 5364 | 0 | 268.2 | 5632.2 |
| 8 | 7th year | 18 | 5364 | 0 | 268.2 | 5632.2 |
| 9 | 8th year | 18 | 5364 | 0 | 268.2 | 5632.2 |
| 10 | 9th year | 18 | 5364 | 0 | 268.2 | 5632.2 |
| 11 | 10th year | 18 | 5364 | 0 | 268.2 | 5632.2 |
| **Total :** | | **461.5** | **137527** | **28065** | **8279.59** | **173871.39** |

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***Annexure-3***

**Cost estimates of Grassland Development Including Grass Reserves for one unit (10 Ha.)**

*Rupees in Lakh*

As per Guideline of Dept. of Animal Husbandry and Dairying & Fisheries, GoI (2016)

| ***SL*** | ***Item*** | ***CPR, Gochar land / community land / waste land which need treatment of soil*** |
|---|---|---|
| **1. Capital Investment** | | |
| A | Demarcation of boundary, fencing/ (trench / brushwood / barbed wire) | 0.75 |
| B | Land Development (10 hectares) @10 lakhs per ha. (including soil treatment and weeding) | 1.00 |
| C | Farm sheds – for equipment, seed, manure, and office | 1.50 |
| D | Purchase of agricultural implements | 0.50 |
| E | Creation of irrigation facilities: wells, pumps, power line, water tank, pump room, pipelines etc. | 3.75 |
| | **Sub- Total** | **7.50** |
| **2. Recurring Expenditure** | | |
| A | Wages of supervisory staff | 0.20 |
| B | Seeds, fertilizer/ manure, insecticides | 0.40 |
| C | Cultivation charges | 1.00 |
| D | Irrigation electricity / fuel charges | 0.30 |
| E | Maintenance of Store/dead stock | 0.30 |
| F | Maintenance of Store/dead stock | 0.30 |
| | **Sub-Total** | **2.50** |
| | **Grand Total** | **10.00** |
| | **Add for inflation of 3 years @10% per annum = 10.00x 3 x 10% =** | **3.00** |
| | **Total** | **13.00** |

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Sundargarh

Forest Range Officer
Kuliposh

***Annexure-4***

***Gully with 1.3 m width, 0.6 m bottom width and depth 0.6 m***

***(As per Manual of Land and Water Management)***

| Sl. No | Details of work | Man days | Rate | Amount in Rs. |
|---|---|---|---|---|
| 1 | Survey, alignment, demarcation | 1 | 298 | 298 |
| 2 | Earth work excavation in stony earth mixed with gravel within initial lead and lift<br>Edging out of gully 2x0.5x0.85x2.25x0.6 = 1.15<br>Foundation for stone packing1x2.3x1.8x0.3 = 1.24<br>D/S guard wall 1x1.3x0.5x0.6 = 0.39<br>Side wall 2x2.13x0.5x0.3 =0.64<br>Total **= 3.42** | 1.74 | 298 | 518.52 |
| 3 | **a. Dry stone packing in the foundation of structure**<br>U/S dumping (deflected by 45 deg.)<br>1x{(1.3+2.2)/2}x 0.45x0.3 = 0.24 Head wall and D/S dumping 1x1.3x0.9x0.3 = 0.35 Apron<br>1x1.3x0.9x0.3 = 0.35 Side walls<br>2x3.95x0.5x0.33=1.19 D/S guard wall<br>1x1.3x0.5x0.6 = 0.39 $m^3$<br>**b. Dry stone packing in super structure**<br>U/S dumping 1x{(3.2+2.3)/2x0.45 (0.45+0)/2=0.27 D/S dumping 1x2.3x0.45x(0.45+0.2)/2 = 0.33 Head wall<br>1x2.3x0.45x0.45 = 0.47 Apron 1x0.9x1.3x0.15 =0.18 Side walls 2x3.95x0.5x0.3 =1.30<br>Total (a+b) = 5.07$m^3$ | 2.6 MD<br><br>Material 5.07 $m^3$ | 298<br><br>488.40 | 774.8<br><br>2476.19 |
| 4 | Earth work in hard soil for side bund of 10m length in both side of structure 2x10x {(1.05+ 0.45) /2}x0.3 =4.5-3.42 = 1.08 i.e excavated earth in the foundation will be adjusted for the side bund | 0.6 MD | 298 | 178.8 |
| 5 | Fine dressing and turfing locally available grass within initial lead and lift both side slopes 2x10x0.42 = 8.40 Top 1x10x0.45 = 4.50 For 2 no. bunds 2x12.90 = 25.80 sq m | 0.8 MD | 298 | 238.4 |
| 6 | Vetiver plantation with locally collected vetiver sleeves in D/S of the structure with Spacing (0.23x 0.23) sq m over 1.3 mt span and 1.0mt width of 3 rows including foliar spraying with Urea. No. of sleeves required = (2.3/0.23)x3 =30 nos. | 0.2 MD | 298 | 59.6 |
| | **Sub Total** | | | **4544.31** |
| 7 | Contingencies and unforeseen charges (5%) | | | 227.22 |
| | **Total** | | | **4771.53** |

Note: Labor rate as per the letter no 11688/LC, Bhubaneswar, dated 07.11.2019 of Labour Commissioner, Odisha, Bhubaneswar and material & conveyance cost as per schedule of rates (Works Dept. GoO)

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Sundergarh

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Kuliposh

***Annexure-5***

***Earthen Check dam with 10m Concrete Core wall***
***(As per Manual of Land and Water Management)***

| | | | |
|---|---|---|---|
| *Labor cost* | | | |
| *Ordinary Labour* | *310 man-days* | *298/-* | *92,383.00/-* |
| *Skilled Labour (Mason etc.)* | *15 man-days* | *388/-* | 5820.00/- |
| ***Total*** | | | *98203.00/-* |
| ***Material Cost*** | | | |
| *Cement* | *230 bags* | *305.00/-* | 70,150/- |
| *Sand* | *15 truck* | *1370.00/-* | *20,550/-* |
| *Brick* | *2500 Nos.* | *7.50/-* | 18,750/- |
| *Aggregate (40 mm)* | *5 truck* | *6000* | 30,000/- |
| *Bamboo* | *60 nos.* | *160/-* | 9,600/- |
| ***Total*** | | | ***1,49,050/-*** |

***Total Cost: 98203.00 + 1,49,050.00=Rs.2,47,253.00/-***

Note: Labor rate as per the letter no 11688/LC, Bhubaneswar, dated 07.11.2019 of Labour Commissioner, Odisha, Bhubaneswar and material & conveyance cost as per schedule of rates (Works Dept. GoO)

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Sundargarh

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## Year wise cash Flow

**Annexure-6**

| Sl | Item | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Enrichment of Plantation/Re-densification (Aided Natural Regeneration) 600/ha | 4.67 | 18.48 | 6.61 | 2.19 | 0.47 | 0.47 | 0.47 | 0.47 | 0.47 | 0.47 | 0.47 | 35.24 |
| | Afforestation including maintenance (Block Plantation @ 1600 plants/ha (6 months seedlings) | 25.78 | 38.98 | 21.58 | 14.51 | 4.23 | 4.22 | 4.22 | 4.22 | 4.22 | 4.22 | 4.22 | 130.40 |
| 2 | Fodder land Development per 10ha | 13.00 | 13.00 | 13.00 | 13.00 | | | | | | | | 52.00 |
| 3 | Loose Boulder Wall gully plugging | 0.00 | 0.00 | 1.91 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.91 |
| 4 | Earthen Check Dam with Concrete Core | 0.00 | 0.00 | 49.45 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 49.45 |
| 5 | Awareness campaign for farm management, Control grazing etc. | 0.00 | 0.00 | 2.50 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.00 |
| 6 | Drinking Water facilities and socio-economic development to Villagers | 0.00 | 0.00 | 5.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.00 |
| 7 | **Total cost of Biological & Engineering measure** | **43.45** | **70.46** | **100.05** | 37.20 | **4.70** | **4.69** | **4.69** | **4.69** | **4.69** | 4.69 | **4.69** | **284.00** |
| 11 | Administrative Expenditure/Monitoring & Supervision @ 10% | 4.35 | 7.05 | 10.01 | 3.72 | 0.47 | 0.47 | 0.47 | 0.47 | 0.47 | 0.47 | 0.47 | 28.40 |
| | **Total** | **47.80** | **77.51** | **110.06** | 40.92 | **5.17** | **5.16** | **5.16** | **5.16** | **5.16** | 5.16 | **5.16** | **312.40** |

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