

# GOVERNMENT OF MADHYA PRADESH



## CAT - PLAN OF MANDLIYA GHAT MINOR IRRIGATION PROJECT

TEHSIL :- BAJNA

DISTRICT :- RATLAM

ESTIMATED COST : RS. 5.83 LAKHS

PROPOSED IRRIGATION : RS. 814 HACT.

**Executive Engineer**  
Water Resources Division  
Ratlam  
District Ratlam (M.P.)

# **MANDLIYA GHAT MINOR TANK PROJECT**

Teh. BAJNA

Dist. RATLAM

## **CATCHMENT AREA TREATMENT PLAN FOR FOREST AREA**

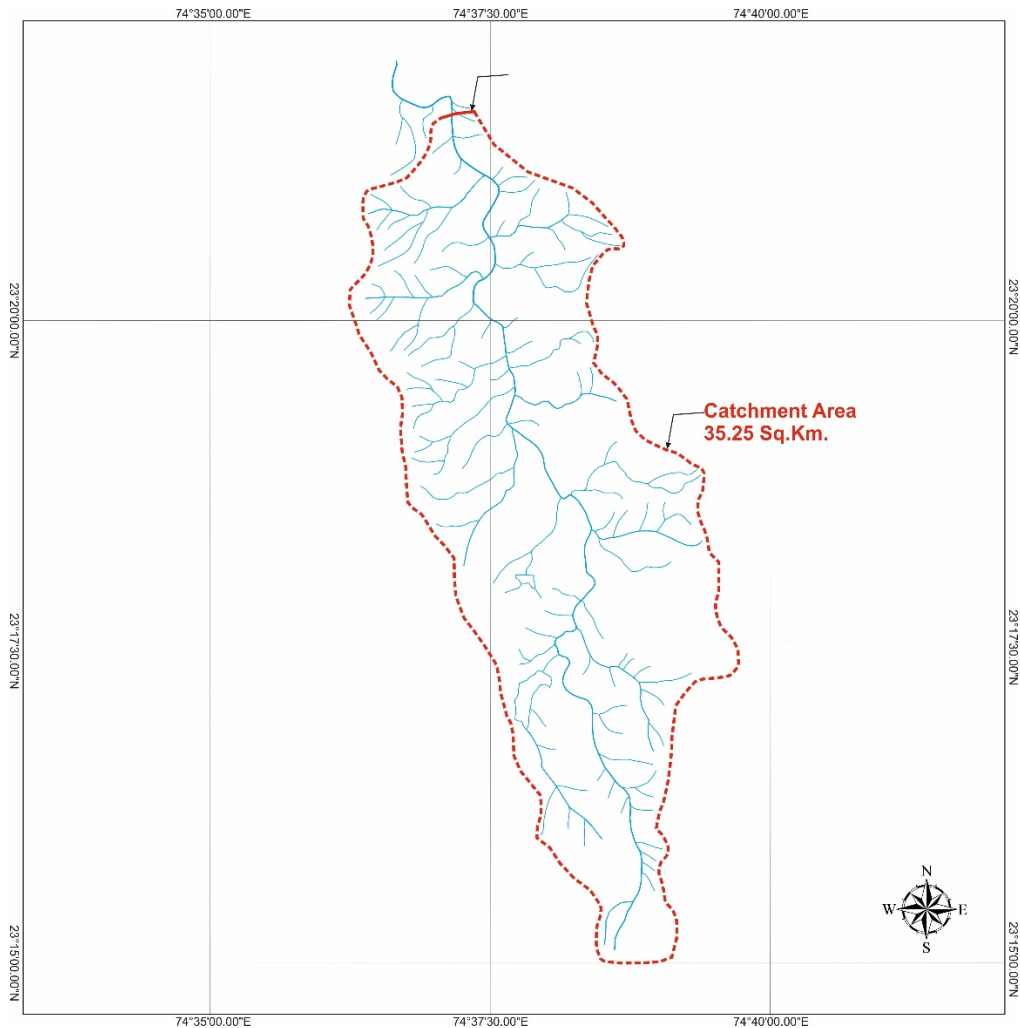
### **1.1 NEED FOR CATCHMENT AREA TREATMENT**

It is a well-established fact that reservoirs formed by dams on rivers are subjected to sedimentation. The process of sedimentation embodies the sequential processes of erosion. Entrainment, transportation, deposition and compaction of sediment. The study of erosion and sediment yield from catchment is of almost 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 growth of plants 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 detachment and transportation of soil. Water is the major agent responsible for this erosion in many locations, winds; glaciers, etc. also cause soil erosion. In a hilly catchment area as 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 to control erosion in the catchment area life span of a reservoir in case of a seasonal storage dam is greatly reduced due to erosion in the catchment area. The catchment area considered for treatment of MANDLIYAGHAT Minor Irrigation project is 35.25 Sq.km. The sub watersheds in the catchment area of considered for the present study is given in Figure -A

In the present study Silt Yield Index' (SYI) method has been used. In this method, the terrain is subdivided into various watersheds and the credibility is determined on relative basis. SYI provides a comparative credibility criteria of catchment (low, moderate, high, etc.) and do not provide the absolute silt yield. SYI method is widely used mainly because of the fact that it is easy to use and has lesser data requirement. Moreover, it can be applied to larger areas like sub watersheds, etc.



**Figure 1.1 Drainage Map for MANDLIYA GHAT Tank**

## 1.2 APPROACHES FOR THE STUDY

Various thematic maps have been used in preparation of the CAT plan. Due to the spatial variability of site parameters such as soils, topography, land use, and rainfall, not all areas contribute equally to the erosion problem. Several techniques like manual overlay of spatially index-mapped data have been used to estimate soil erosion in complex landscapes.

Geographic Information System (GIS) is a computerized resource data base system, which is referenced to some geographic coordinate system. In the present study, a real coordinate system has been used. The GIS is a tool to store, analyse, and display various spatial data. In addition, GIS, because of its special hardware and software characteristics, has a capacity to perform numerous functions and operations on the various spatial data layers residing in the database. GIS provides the capability to analyse large amounts of data in relation to a set of established criteria. In order to ensure that the latest and accurate data is used for the analysis, satellite data has been used for deriving land use data, and ground truth studies have also been conducted.

The various steps covered in the study are as follows:

- Data acquisition
- Data preparation
- Output presentation

The above mentioned steps are briefly described in the following paragraphs,

### 1.2.1 DATA ACQUISITION

The requirement of the study was first defined and the outputs expected were noted.

The various data layers of the catchment area used for the study are as follows:

- Slope Map
- Soil Map
- Land use Classification Map
- Current Management Practices
- Catchment Area Map.

### 1.2.2 DATA PREPARATION

The data available from various sources was collected. The ground maps, contour information etc. were scanned, digitized and registered as per the requirement. Data was prepared depending on the level of. Accuracy required and any corrections required were made. All the layers were geo-referenced brought to a common scale (real coordinates) so that overlay could be performed. A computer programmed was used to estimate the soil loss. The formats of outputs from each layer were firmed up to match the formats of inputs in the program. The grid size to be used was also decided to match the level of accuracy required the data availability and the software and time limitations. The format of output was finalized. Ground frothing and data collection was also included in the procedure.

For the present study IRS IC-LISS III digital satellite data was used for interpretation & classification the classified land use map of the catchment area of various dams considered for the study are shown in Figure-B. The land use pattern of the catchment area is summarized in Table-13.1.

**TABLE- 1.1:- LAND USE PATTERN OF THE CATCHMENT AREA**

Category	Area (ha)	Area %)
Vegetation	390	11.06
Scrubs/ Grass and	215	6.10
Agricultural Land	2226	63.15
Barren Land	425	12.06
River	54	1.53
Settlements	215	6.10
<b>Total</b>	<b>3525</b>	<b>100</b>

Digitized contours from toposheets were used for preparation of Digital Elevation Model (DEM) of the catchment area and to prepare a slope map. The first step in generation of slope map is to create surface using the elevation values stored in the form of contours or points. After marking the catchment area, all the contours on the toposheets were digitized (100 m interval). The output of the digitization procedure was the contours as well as points contours in form of x, y & z points (x,y location and their elevation) All this information was in real world coordinates (latitude, longitude and height in meters above sea level.)

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

Various layers thus prepared were used for modelling Software was prepared to calculate the soil loss using input from all the layers.

### **1.2.3 OUTPUT PRESENTATION**

The result of the modelling was interpreted in pictorial form to identify the areas with high soil erosion rates. The primary and secondary data collected as a part of the field studies were used as an input for the model.



### 1.3 ESTIMATION OF SOIL LOSS USING SILT YIELD INDEX (SYI) METHOD.

The Silt Yield Index Model (SYI), considering sedimentation as product of erosivity, credibility and arial extent was conceptualized in the All India Soil and Land Use Survey (AISLUS) as early as 1969 and has been in operational use since then to meet the requirement of prioritization of smaller hydrologic units.

The erosivity determinants are the climatic have direct or reciprocal bearing on the relationship can be expressed as factors and soil and land attributes that unit of the detached soil material. The relationship can be expressed as :

Soil erosivity = 1(Climate, physiographic, Slope, soil parameters, land use / land cover, soil management)

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.

Prioritization of Watersheds / Sub water heads:

The prioritization of smaller hydrologic units within the vast catchments are based on the Silt Yield Indices (SYI) of the smaller units, the boundary values or range of SYI values for different priority categories are arrived at by studying the frequency distribution of SYI values and locating the suitable breaking points. The watersheds/ Sub-watersheds are subsequently rated into various categories corresponding to their respective SYI values.

The application of SYI model of prioritization of sub watersheds in the catchment areas involves the evaluation of :

- a) Climatic factors comprising total precipitation, its frequency and intensity.
- b) Geomorphic, factors comprising land forms, physiographic, slope and drainage characteristics.
- c) Surface cover factors governing the flow hydraulics and
- d) Management factors.

The data on climatic factors can be obtained for different locations in the catchment area from the meteorological stations whereas the field investigations area required for estimating the other attributes.

The various steps involved in the application of model are :

- Preparation of a framework of sub-watershed through systematic delineation.
- Rapid reconnaissance surveys on 1:50,000 scale leading to the generation of a map indicating erosion - intensity mapping units'

- Assignment of weight age value of various mapping units based on relative silt yield potential.
- Computing Silt Yield index for individual watersheds / Sub watersheds.
- Grading of watersheds/ sub watersheds into very high, high medium. low and very low priority categories.

The area of each of the mapping units is computed and silt yield indices of individual sub watersheds area calculated using the following equations.

a Silt Yield Index

$$SYI = \frac{\sum (A_i \times W_i)}{A_w} \times 100 \text{ where } i=L \text{ to } n$$

$A_i$  = Area of ith unit (EIMU)

$W_i$  = Weightage Value of ith mapping

unitn = No. of mapping units

$A_w$  = Total area of sub watershed.

The SYI values for classification of various categories of erosion intensity rates are given in.

**TABLE - 1.2 CRITERIA FOR EROSION INTENSITY RATE**

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

#### 1.4 WATERSHED MANAGEMENT - AVAILABLE TECHNIQUES

Watershed management is the optimal use of soil and water resources within a given geographical area so as to enable sustainable production. It implies changes in land use, vegetative cover, and other structural and non-structural action that are taken in a watershed to achieve specific watershed management objectives. The overall objectives of watershed management programme are to:

- increase infiltration into soil
- Control excessive runoff;
- Manage & utilize runoff for useful purpose

Following Engineering and Biological measures have been suggested for the catchment areatreatment .

### 1. Engineering measures

- Nallah Bunding
- Contour Bunding
- Angle iron barbed wire fencing

### 2. Biological measures

- Development of nurseries
- Plantation / afforestation
- Pasture development
- Social forestry

The basis of site selection for different biological and engineering treatment measures underCAT are given in Table-13.3.

**TABLE - 1.3: BASIS FOR SELECTION OF CATCHMENT AREA TREATMENT MEASURES**

Treatment measure	Basis for selection
Social forestry, fuel wood and fodder grass development	Near settlements to control tree felling
Contour Bunding	Control of soil erosion from agricultural fields.
Pasture Development	Open canopy, barren land, degraded surface
Afforestation	Open canopy, degraded surface, high soil erosion, gentle to moderate slope
Barbed wire fencing	In the vicinity of afforestation work to protectis from grazing etc.
Nallah Bunding	Nalla bonding work consists of constructing bunds of suitable dimensions across thenalla or gullies to hold the maximum runoffwater to create flooding of the upstream areatemporarily for some days or weeks, withSurplusing arrangements at suitable intervals to drain the water.
Nursery	Centrally located points for better supervision of proposed afforestation minimize cost of transportation of seedling and ensure better survival.

## 1.5 CATCHMENT AREA TREATMENT METASURES

The erosion category of sub-watersheds in the catchment area as per a SYI index is given in Table-13.4. The details are shown in Figure-C. The area under different erosion categories is given in Table-13.5.

**TABLE-1.4: EROSION INTENSITY CATEGORIZATION AS PER SYI CLASSIFICATION**

SWS	Area (ha)	SYI	Erosion Category
W1	323	1230	High
W2	360	1150	Medium
W3	241	1160	Medium
W4	277	1180	High
W5	241	1150	Medium
W6	355	1210	High
W7	382	1230	High
W8	192	1150	Medium
W9	328	1160	Medium
W10	294	1180	High
W11	216	1150	Medium
W12	316	1210	High
Total -	<b>3525</b>		

**TABLE - 1.5 : AREA UNDER DIFFERENT EROSION CATEGORIES**

Category	Area (ha)	Percentage
Very low	-	-
Low	-	-
Medium	1578	44.76
High	1947	55.24
Very High	-	-
Total :-	<b>3525</b>	<b>100.00</b>

The objective of the SYI method is to prioritize sub-watersheds in a catchment area for treatment. The total area under high erosion category in various dams is to be treated as a part of the project cost. The various measures suggested for catchment area treatment are depicted in Figure -D.

## 1.6 COST ESTIMATE FOR CAT PLAN

The cost required for Catchment Area Treatment is Rs. 0.5835 million. The details are given in Tables - 13.6 and 13.7

**TABLE. 1.5: COST ESTIMATE FOR CATCHMENT AREA TREATMENT OF MANDLIYA GHAT DAM . BIOLOGICAL MEASURES**

S.No.	Item	Rate/Unit (Rs.) (including maintenance cost)	Target	
			Physical	Financial (Rs. millions)
1	Gap Plantation	186800/ha	1.00 ha	0.1868
2	Pasture Development	97500/ ha	1.00 ha	0.0975
3	Social forestry	70000/ha	0.50 ha	0.0350
4	Nursery development	30000 /No.	1.00 No.	0.0300
5	Maintenance of nursery	27000/ No.	1.00 No.	0.0270
6	Barbed wire fencing	100000/km	0.500	0.050
7	Watch and ward for 3years for 2 persons	75000/ man- month	6 man- month	0.045
<b>Total (A)</b>				<b>0.471</b>

**TABLE = 1.7 : COST ESTIMATE FOR CATCHMENT AREA TREATMENT OF MANDLIYA GHAT DAM - ENGINEERING MEASURES**

S.No.	Item	Rate (Rs.)	Unit	Target	
				Physical	Financial (Rs. millions)
1	Contour Bunding	15000/ha	Ha.	1.50 Ha.	0.0225
2	Nallah Bunding	10,000	No.	1.00 No.	0.010
<b>Total :-</b>					<b>0.0325</b>

Total cost for Biological and Engineering measures = Rs. 0.5035 million (A) administrative expenditure.

-	Government Expenditure 3% of A (including O&M)	Rs. 0.015 million
-	Establishment cost 8% of A	Rs. 0.040 million
-	Contingency 5% of A	Rs. 0.025 million
<b>Total :-</b>		<b>Rs. 0.08 million</b>

### 1.5 (B) COST ESTTMATES OF CAT PLAN FOR FOREST AREA

The Total Catchment Area of **MANDLIYA GHAT TANK** is **3525.00 I-hectares** out of this **486.00 Hectares ForestLand**. The cost required for Catchment Area treatment of Forest is Rs. 0.5835 million. The details are given in Tables-7 and 8.

**TABLE-7 : COST ESTIMATE FOR TREATMENT OF CATCHMENT AREA IN FOREST AREA OF MANDLIYA DAM.BIOLOGICAL MEASURES**

S.No.	Item	Rate/Unit (Rs.) (including maintenance cost)	Target	
			Physical	Financial (Rs. millions)
1	Gap Plantation	186800/ha	1.00 ha	0.1868
2	Pasture Development	97500/ ha	1.00 ha	0.0975
3	Social forestry	70000/ha	0.50 ha	0.0350
4	Nursery development	30000 /No.	1.00 No.	0.0300
5	Maintenance of nursery	27000/ No.	1.00 No.	0.0270
6	Barbed wire fencing	100000/km	0.500	0.050
7	Watch and ward for 3 years for 2 persons	75000/ man- month	6 man- month	0.045
	<b>Total (A)</b>			<b>0.471</b>

**TABLE.8 : COST ESTIMATE FOR TREATMENT OF CATCHMENT AREA IN FOREST AREA OF MANDLIYA GHAT DAM ENGTNEERING MEASURES**

S. No.	Item	Rate (Rs.)	Unit	Target	
				Physical	Financial (Rs. millions)
1	Contour Bunding	15000/ha	Ha.	1.50 Ha.	0.0225
2	Nallah Bunding	10,000	No.	1.00 No.	0.010
	Total :-				<b>0.0325</b>

Total cost for Biological and Engineering measures = Rs. 0.5035 million (A) administrative expenditure.

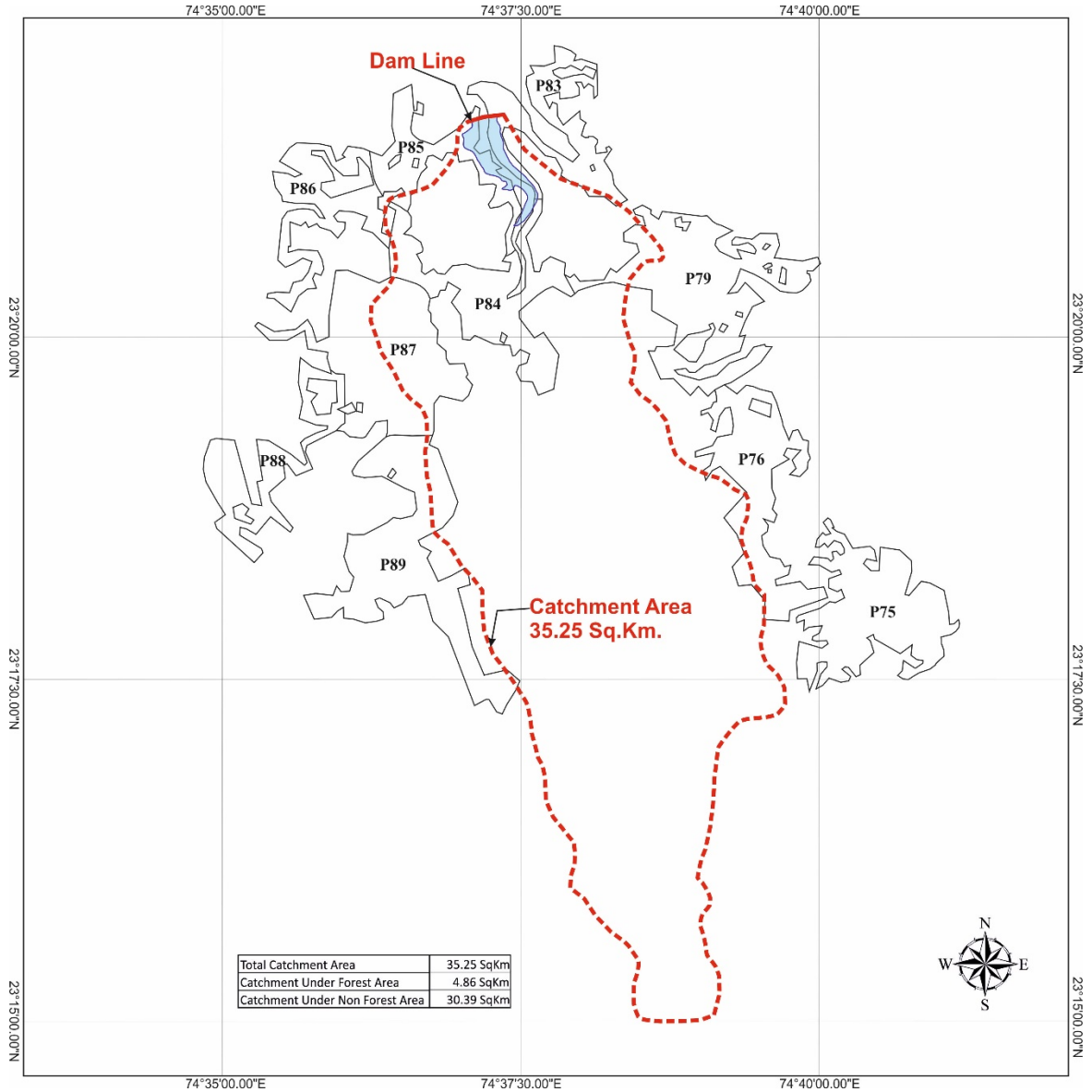
- Government Expenditure 3% of A (including O&M)      Rs. 0.015 million
- Establishment cost 8% of A      Rs. 0.040 million
- Contingency 5% of A      Rs. 0.025 million

---

**Total :-      Rs. 0.08 million**

---

**Total Cost for Catchment Area Treatment for Forest Area of MANDLIYA GHAT Dam = 0.5835 million.**



Sub Divisional Officer  
Dholawad H/W Sub Division  
Vasindra

Executive Engineer  
Water Resources Division  
Ratlam