

GOVERNMENT OF MADHYA PRADESH WATER RESOURCE DEPARTMENT



ENVIRONMENTAL CLEARANCE FOR AULLIYA MEDIUM IRRIGATION PROJECT



EMP REPORT



ASIT INFRA TECH PLANNERS PVT.LTD.
Next Gen Engineers.....
524, 5th Floor, Tower-B3, Spaze IT Park
Sector-49, Sohna Road, Gurgaon-122018, India
Email id: asit@aiplanners.in /asit.aiplanners@gmail.com
Ph: 0124 - 246511314
Mb. No +91-9540023064, alt+91-9958836868,
www.aiplanners.in

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IRG Systems South Asia Pvt. Ltd.
B-10 & 11, Highway Tower, A - 13 / 2,3,4
Sector - 62, NOIDA-201309

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CHAPTER - 1: BIODIVERSITY CONSERVATION & MANAGEMENT PLAN

1.1 INTRODUCTION

Biodiversity is part of our daily lives and livelihood, and constitutes resources upon which families, communities, nations and future generations depend. Every organism and its variation are unique and have its own role to play in a particular ecological niche. During the last few decades, the pace of species extinction has increased dramatically as a result of human activities. Ecosystems are being fragmented or eliminated, and several species are in decline. The fragmentation, degradation, and loss of habitats pose serious threat to biological diversity. These losses are irreversible and pose a threat to our own wellbeing, considering our dependence on food crop and medicines and other biological resources.

Conservation of biodiversity is a global concern and its protection is one of the challenging tasks facing mankind today. One of the key underlying assumptions about biodiversity management is that native species and ecological processes are most likely to be maintained. To maintain and strengthen the biodiversity management recommendations are primarily aimed at managed forests. The recommendations are designed to promote long term stand level maintenance and recruitment of important structural attributes such as: wildlife, diversity of species, special or unique habitats for floral and faunal wealth, riparian areas and wetlands, coarse woody debris, horizontal and vertical structural diversity.

The main objective of Biodiversity Conservation and Management plan is sustainable use of natural resources which involves scientific management of natural wealth vis-à-vis developmental activities is likely to affect these resources. The threats to natural terrestrial and aquatic ecosystems generally arise due to by anthropogenic activities that may arise as a result of construction and associated activities of proposed Aulliya Project. Therefore, Biodiversity Conservation & Management plan has been formulated for the conservation and management of the forest ecosystems in Aulliya Project area.

1.2 MAJOR THREATS TO BIODIVERSITY

Large scale loss of biodiversity has been mainly caused by anthropogenic activities like habitat loss, degradation, fragmentation, biotic interference, grazing, demand for timber, fuel wood, pollution and introduction of exotic species etc. Some of these factors are discussed below in brief.

Habitat loss, degradation and fragmentation: Habitat loss, degradation, and fragmentation are important causes of known species-populations extinctions. The main cause of degradation and depletion of forests and wildlife are the human activity (anthropogenic pressure). Population explosion, over exploitation of forest resources, urbanization, unscientific management, encroachment of forest land, illicit felling, lack of regeneration of forests and outdated laws are major factors responsible for the degradation and depletion of forests in Madhya Pradesh. Deforestation has led to reduction of rainfall, silting of rivers and dams, increase soil erosion, dryness in the air and increase in temperature, adversely affecting not only forestry but also agriculture and horticulture, etc.

In the proposed Aulliya Medium Irrigation Project, the threat of habitat disturbance, degradation and fragmentation may not only come from the constructional activities, but also from the population of migrant labourers that will be employed by the project developers from time to time.

Biotic Interference: The collection of Minor Forest Produce (MFP) in the form of small timber, fuel wood, and fodder by the people living in the surrounding villages in the project area and areas between the village and Reserved Forests are thereby exerting intensive biotic pressures on these resources. It has often led to slope destabilization and soil erosion problems with increasing frequency of landslides. There is likelihood of increase in biotic interference with the influx of labour population during the construction of the project. This floating human population will exert serious pressure on the semi-natural ecosystems around the activity sites. The pressures may be foreseen in terms of fuel-wood collection, rearing of livestock and the grazing pressure on the surrounding forest ecosystems.

Timber Requirement: There is tremendous pressure on the forests for increasing demand for timber and is growing rapidly. The demand for timber and other wood produce is very high in the state for various activities like the construction of houses, business centers and other development activities owing to rapid population growth. The situation is similar in present project area also. Therefore, the present situation calls for exploring acceptable alternatives for fuel wood, etc. The frequency of occurrence of landslides and soil erosion is increasing with time and in the absence of appropriate measures and steps, it is likely that the construction of the proposed project may add to these problems further. Therefore, the demand of fodder, fuel wood, grass, timber and other natural resources in the project area would be addressed with creation of other alternative schemes.

Illegal Removal of NTFP: Non Wood Forest Products (NTFP) constitute an important source of livelihood for the poor and especially landless. There is abundance of medicinal plants and herbs in the project area as well as in the upper catchment. The area is rich in medicinal plants such as *Jurinea macrophylla* (Dhoop), *Aconitum lycoctonum* (Mohari), *Aconitum heterophyllum* (Patis), *Picrorhiza kurroa* (Kuru), *Morchella esculenta* (Guchhi) and *Saussurea lappa* (Kuth). These plants species are illegally and commercially exploited from the region.

All species have specific food and habitat needs. The more specific these needs and localized the habitat, the greater the vulnerability of species to loss of habitat to agricultural land, livestock, roads and cities.

Poaching: Poaching is one of the major causes for destruction of wildlife. The poaching has to be checked by regular patrolling and deployment of anti- poaching squad formed for the purpose and enforcement of the Wildlife Protection (Act) 1972.

1.3. BIODIVERSITY CONSERVATION & MANAGEMENT PLAN

Even though no rare, endangered and endemic plant or animal species are likely to be affected by project construction and submergence, the existing natural ecosystems in areas constituting upstream catchment of the proposed project need protection and further strengthening of conservation efforts. In order to facilitate State Forest & Wildlife Department's ongoing conservation efforts, policies and measures and additional mitigation measures have been formulated for the proposed project. Adequate funding support has been provided to strengthen these efforts in the area.

During the construction period various activities like road construction, excavation for dam and reservoir, quarrying, dumping of excavated material and human population pressure on land and biological resources are likely to exert pressure on the biological resources of the region.

Keeping in view of above impacts a biodiversity conservation and management plan has been proposed for Aulliya Project. The main objectives of said plan are as follows:

- (i). Maintenance of ecological balance through preservation and restoration of wherever it has been disturbed due to project developmental activities,
- (ii). Conservation and preservation of natural habitats in catchment area
- (iii). Rehabilitation of critical species (endangered, rare and threatened species), if any with provisions for in-situ or ex-situ conservation of critical/ important plant/ animal species,
- (iv). Mitigation and control of project induced biotic and/or abiotic pressures/influences that may affect the natural habitats,
- (v). Habitat enhancement in project catchment area by taking up afforestation and soil conservation measures,
- (vi). Creating all round awareness regarding conservation and ensuring people's participation in the conservation efforts and minimizing man animal conflict.

1.4. CONSERVATION ACTIVITIES & DEVELOPMENT WORKS TO BE UNDERTAKEN

1.4.1 Establishment of Botanical Garden

This region is rich repository of plants wealth. The aim of this activity will be to preserve the genetic and species diversity of the entire area. The project proponent only proposes the establishment of a botanical garden at suitable place in consultation with Forest Department.

The cost estimation for establishment and maintenance of botanical garden has been given in Table 1.1. A financial provision of **Rs. 19.00 lacs** has been made in the management plan to be implemented for at least 5 years initially for this activity and after 5 years this facility would be handed over to State Forest Department.

1.4.2 Anti-Poaching Measures

There are no ecologically sensitive areas around the project sites. Fecal material of Jackal spotted deer are seen in adjoining forest areas. However, the forest in the vicinity serve as a habitat for wildlife. Due to construction activities and increased human interferences, as a result of immigration of labour population and their family members, some adverse impacts may takes place on wildlife during construction phase; the increased human interference can have adverse impact on wildlife in an around the project area.

It is recommended that check post should be installed near major construction sites and labor camps which shall be operational during construction phase. It is proposed to develop 2 check post to implement anti-poaching measures during project construction phase. The check post shall have 3 guards to ensure that poaching does not takes place in the area. The guards will be supervised by a range officer. It is also recommended that the staff manning these check post have adequate communication equipment and other facilities. This communication link needs to be extended to Divisional Forest Officer and the local police station also.

1.4.3 Noise Mitigation and Management

The studies have indicated harmful effects of high noise levels on the behaviour of wild animals and birds in wilderness areas. Generally during the construction period, the noise levels at a distance of 7 meter vary from 100- 110 dB at a given time. Such high noise levels for prolonged periods pose a health hazard for wildlife. Therefore, during the construction period, even though forest cover would act as a potential noise absorber to some extent, it will be ensured that the noise levels do not go above 100 dB at any given time in the project area. It is proposed to adopt and implement measures like controlled and regulated blasting with strict surveillance and also to devise schedule of

implementation after due consultation with concerned wildlife officials keeping the potential impact on animal behavior and their breeding time, nesting, etc.

Some of the suggested measures for mitigation of noise impact are given below:

- i). Regular maintenance of equipment that are potential source of noise.
- ii). The equipment that needs to be placed permanently at one place like generators, etc. should be housed in enclosures consisting of noise absorbing structures.
- iii). The heavy equipment like rotating or impacting machines should be mounted on anti-vibration mountings.
- iv). Wherever combustion engines are required, they will be fitted with silencers.
- v). The traffic generated due to movement of trucks, dumpers, etc. used for the project works will be managed to produce a smooth flow instead of a noise producing stop and start flow. Necessary training/ orientation will be provided to the traffic operators/ drivers to make them aware of the environmental aspects of the traffic movement in the forest areas. Sounding of loud horns, etc. in the forested areas is to be prohibited.
- vi). During the clearing of vegetation the land for any project work, the project authorities will ensure that the working area has sufficient layers of tree cover around it. It will act as an effective noise and dust absorber. It will be ensured that bigger trees are not lopped or cut around the periphery of the site. The tree layer will act as noise buffer and likely to cut off noise by about 3-12 dB at a site depending upon the density of vegetation. These measures will be planned in advance and well before starting operation at any site.
- vii). The project authorities will monitor the noise at critical sites from time to time under the Environmental Monitoring Programme.
- viii). Noise Reduction Barriers shall be created in the project area where heavy machinery shall be installed. It will act as an acoustic barrier so that wild animals are not affected adversely by creation of noise produced by the machinery.

A provision of **Rs. 15.00 lacs** has been made in the budget for implementing these measures.

1.4.4 Habitat Improvement Programme

Habitat improvement programme is an integral part of biodiversity management. This programme consists of bringing into useful association of those condition needed by a species to reproduce and survive. The following activities have been proposed for habitat improvement programme:

- a) **Afforestation:** Area under forest and tree cover will be expanded through systematic planning and implementation of afforestation and rehabilitation programme in degraded and open forests and available non forest lands. Regeneration of felled areas will be ensured in a time bound manner and productivity of plantations will be increased through use of improved seeds and planting stock. The indigenous fruit bearing plants, vital from wildlife point of view are proposed to be planted so as to enrich the habitat & ensure the sufficient availability of food. Monoculture will be discouraged and mixed plantations of broad-leaved fodder, fuel wood and wild fruit species will be promoted. This activity will increase forest cover and will provide habitat to the animals. Afforestation programme in the degraded Forest Compartments, is proposed to be carried out on 54.60 ha of land. The cost of implementation of afforestation has been covered in CAT plan and CA plan cost
- b) **Pasture Development:** Shepherds exert tremendous impact on pasturelands of the division by way of grazing their sheep, goat and cattle. In order to improve the pasture and to make

pastures sustainable against grazing pressure the low lying areas will be taken up for pasture development. It is proposed to increase the forage availability in all the Forest Compartments by patch sowing of high yielding variety of grass such as Cocks foot (*Dactylis glomerata*), Perennial Rye grass (*Lolium perenne*), Tall Fescue (*Festuca arundinacea*), Brome grass (*Bromus inermis*), Timothy grass (*Phleum pratense*), Poa grass etc.

- c) Removal of unwanted plants (weeds) from the habitat.
- d) The human intervention will be regulated in such areas where wild animals concentration is high especially during breeding season

1.4.5 Eco-Development Works

The Eco-development Committees and Village Conservation Committees (VCCs) will be constituted for this purpose which will help State Forest Department in capacity building and microplanning of the various eco- developmental activities formulated for community development. The activities under this programme are aimed at improvement of livelihood of people living in the project area. Under this programme, number of activities have been proposed and are described in the following paragraphs.

Publicity and Awareness: Education and awareness generations programmes for garnering public support for biodiversity conservation is the need of the day. Community education and involvement is a crucial component of a biodiversity conservation strategy because the condition of the environment is reflected by the manner in which the communities treat and manage the natural resources.

Under this programme, various activities viz. trainings, publishing of research documents, pamphlets, brochures, hoardings, etc. shall be carried out during the implementation period of operations. Training should be imparted to the school teachers in the project area for introduction of environmental education among the school children and exchange to knowledge on environment and ecology between the monastic and village schools. The basic purpose of this is to create awareness among young generation and also among the local villagers so as to protect the wildlife for future generation.

Observance of Wildlife Week: Every year wildlife week in the month of March will be observed to assess the all the tasks set aside for wildlife management. Under this programme, seminars, art competitions and awareness campaigns are proposed will be held.

Nature Club: Under this activity nature clubs shall be constituted at higher secondary and high school level. The target groups shall be the students and local public. They shall be provided with audio visual aids so as to brief them about importance of wildlife conservation.

1.5 INSTITUTIONAL SUPPORT FOR IMPLEMENTATION OF BIODIVERSITY MANAGEMENT PLAN

Following institutions may be in seeking guidance and technical support during implementation of the Biodiversity Conservation & Management Plan:

- Wildlife Institute of India (WII), Dehradun for providing the technical guidance regarding the monitoring and evaluation of the faunal diversity in the area.
- Indian Institute of forest management, Bhopal for guidance and information on environment and natural resource management.

Besides these organizations/ institutes Gram Panchayats, Mahila Mangal Dals, Yuvak Mandals, Ex-servicemen's Bodies, Schools, Village Forest Development Societies, local user groups, other Community Based Organisations (CBOs) and NGOs would also be actively involved in sustainable management of biological resources.

1.6 BIODIVERSITY CONSERVATION MEASURES DURING CONSTRUCTION PHASE

The following activities and safeguards measures will be undertaken during construction phase:

- To strictly monitor and impose restrictions on the activities and movement of labourers and associated workers to avoid disturbance in the habitat of wild animals and birds.
- To monitor noise levels during construction activities that are required to be maintained wherein only restricted/essential activities will be allowed and carried out at night in areas wherever the project work and activity is undertaken in the vicinity of animal/bird habitats.
- To make provision for the supply of the free or subsidized kerosene/LPG from the depots to be set up for this purpose to minimize the pressure on forests and animal habitats.
- To keep the interference of human population to the minimum and ensure that the contractors do not set up labour colonies in the vicinity of forests and wilderness areas.
- The improvement of existing infrastructure with conservation and protection in addition to new strategies.
- To enforce mix of incentives and strict regulatory framework for protection of wildlife.
- To enforce the rules and regulations of the Wildlife Protection Act 1972 for the preservation of habitats and protection of wild animals.

1.7 MONITORING OF BIODIVERSITY CONSERVATION & MANAGEMENT PLAN

Monitoring is an important part of the Biodiversity Management Plan. All the activities of BMP will be closely and regularly monitored in terms of physical, financial progress and quality by the project proponent and officers of Forest Department.

1.8 COST ESTIMATES

It is proposed that the project authorities will provide funds to the tune of **Rs. 34.00 lacs** as outlined in Table 1.1 for the conservation works over a period of five years.

Table 1.1: Estimated cost of Biodiversity Conservation and Management Plan implementation

S. No.	Requirement	Total (Rs. lacs)
1	Establishment of Botanical Garden	
a	Collection of seeds and plant species	1.50
b	Development of garden (fencing, manure and fertilizers, chemicals and insecticides)	5.00
c	Nursery development	2.50
d	Plantation	6.00
e	Support from R&D Institution	4.00
2	Noise Mitigation & Management	15.00
	Total (Rs. in lacs)	34.00

CHAPTER - 2: CATCHMENT AREA TREATMENT PLAN

2.1 NEED FOR CATCHMENT AREA TREATMENT

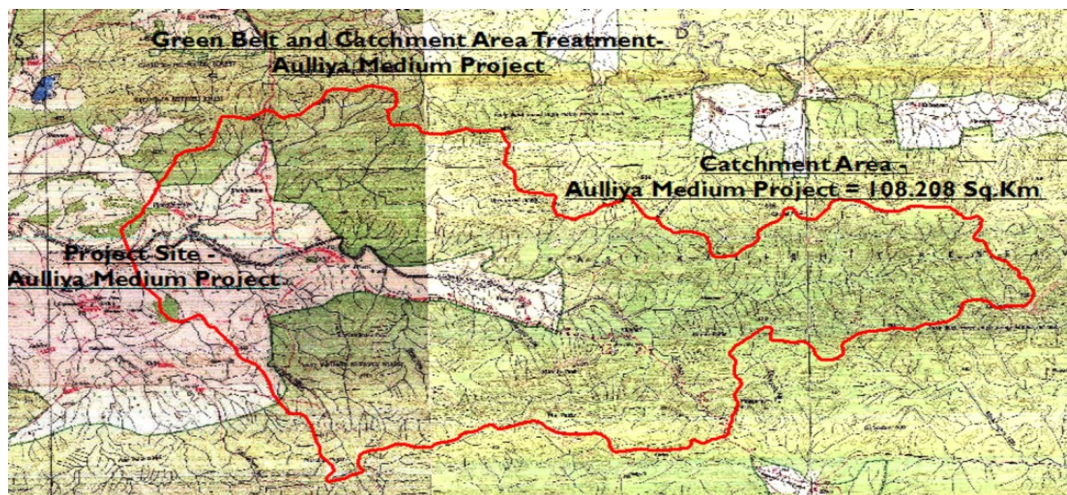
It is a well-established fact that reservoirs formed by dams on rivers are subjected to sedimentation. The process of sedimentation embodies the sequential processes of erosion, entrainment, transportation, deposition and compaction of sediment. The study of erosion and sediment yield from catchments 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 braiding of river reach. The removal of top fertile soil from 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 detachment and transportation of soil. Water is the major agent responsible for this erosion. In many locations, winds, 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 CAT Plan. Soil erosion leads to:

- loss in production potential
- reduction in infiltration rates
- reduction in water-holding capacity
- loss of nutrients
- increase in tillage operation costs
- reduction in water supply

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.

Figure – 2.1: Catchment Area for Aulliya Medium Irrigation project



CAT Plan has been formulated for free draining catchment i.e. up to the proposed Aulliya Project on Ghorapachhar River. Free draining catchment area for this CAT Plan is 108.208 sq km. The 108.208 sq.km area draining catchment of Aulliya Medium Project. The intercepted catchment area is 11.015 Sq.Km. Net Catchment area of project is 97.193 Sq.Km.

Table – 2.1: Aulliya Project Area Deatils

S. No.	Particulars	Value
1	Gross catchment Area	108.208Sq.km
2	Intercepted catchment Area	11.015 Sq.Km
2	Net catchment Area	97.193 Sq.Km
3	Designed flood (Estimated SPF)	1073.63 Cumecs
4	Net 75% dependableyield	20.870 MCM
5	Full reservoirlevel(FRL)	355.00.M
5	Tank Bundlevel(TBL)	358.00. M

Objectives:

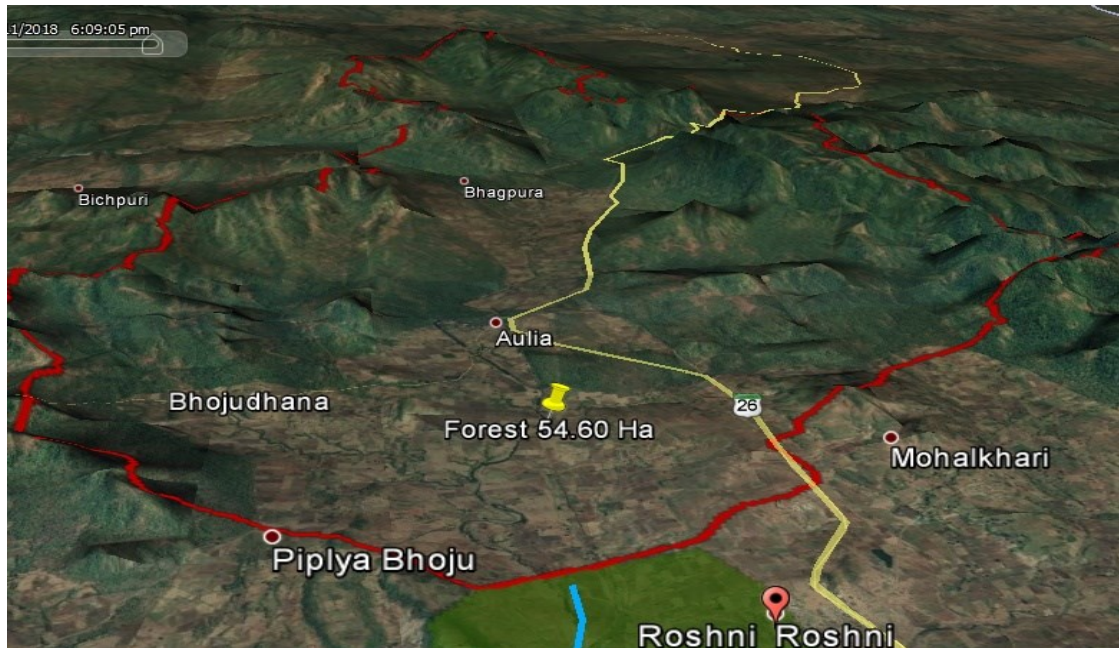
The objective is to rejuvenate various potential and degraded ecosystems in the catchment area. The action plan has been prepared for this purpose with the following objectives;

- To facilitate the hydrological functioning of the catchment and to augment the quality of water of the river and its tributaries
- Conservation of soil cover and to arrest the soil erosion, floods and siltation of the river and its tributaries and consequent reduction of siltation in the reservoir of the project
- Demarcation of the priority of sub watersheds of treatment on the basis of soil erosion intensity in the catchment area
- Rehabilitation of degraded forest through afforestation
- Mitigation of landslide landslip and rock falls
- Soil conservation through biological and engineering measures to reduce sediment load in river and tributaries, thus improving the quality of water.
- Ecosystem conservation resulting from increased vegetative cover and water retaining properties of soil.
- Employment generation through community participation and conservation.

Catchment Scenario and Drainage:

Ghorpachhar River originates at an EL 679 m and travels southwest of the Chota Tawa sub basin and in Narmada Basin. It has a length of 23.8 km before it's reaches to Aulliya Dam proposed project site at the village Roshni. Then the river Ghorapachhar travels another 30.8 Km and confluences with Chota-tawa and to the Indra Sagar Projcets.

Figure – 2.2: Catchment Drainage & Terrain Map



Soil Erosion and Forest Area Coverage:

Soil erosion in the Chota Tawa region is a not problem, as the catchment area is bounded dense forest area, which results has no loss of soil fertility and no such increased sediment load in the rivers.

Therefore, it is not required to e proper maintenance of soil functions and its health. So this project not proposing additional measures for management interventions in the relevant watershed. The slope and the satellite maps are attached for the reference of slope and soil erosion.

Figure – 2.3: Catchment Area Forest Cover Map



Slope has major influence on the loss of soil and water from the watershed and thereby influences the land use capability. The slope percentage determines the erosion susceptibility of the soil depending on its nature and class. This helps in classifying various lands suitability classes, which enables us to formulate suitable conservation measures for the prevention of soil erosion.

Figure – 2.4: Catchment Area Terrain Map

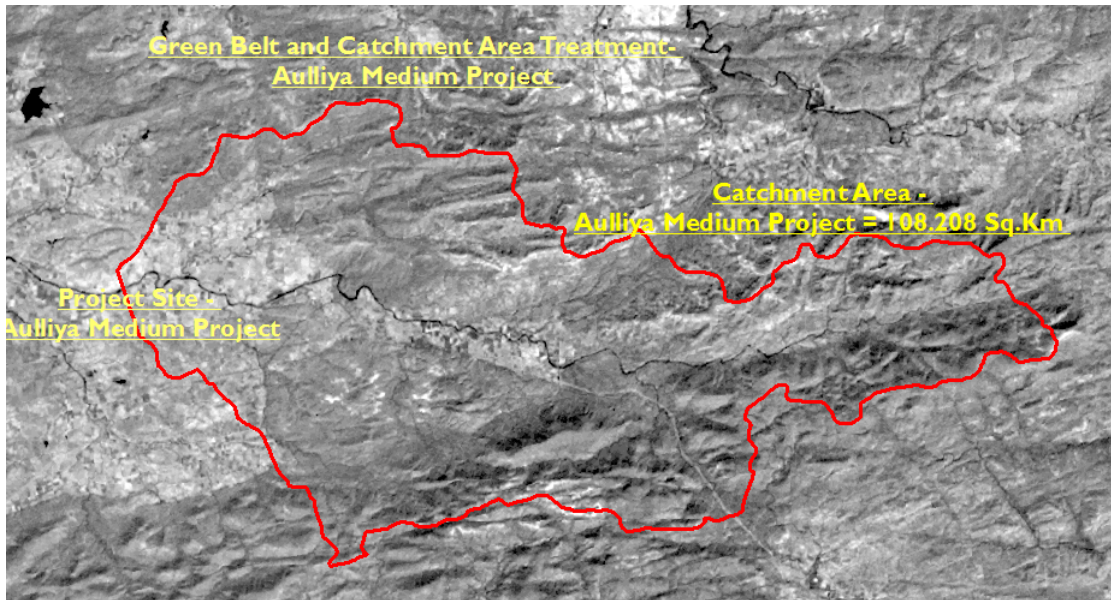
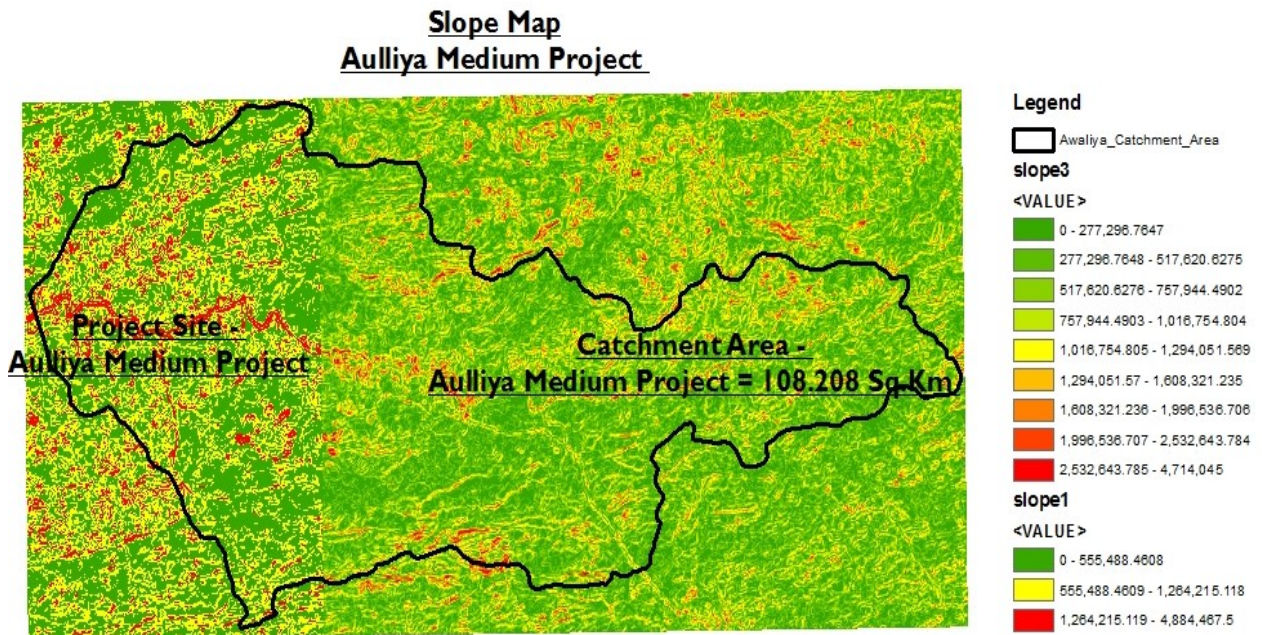


Figure – 2.5: Slope Map of Aulliya Medium Project



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 method, the terrain is subdivided into various watersheds and the erodibility is determined on relative basis. SYI provides a comparative erodibility 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.

2.2. APPROACH FOR THE STUDY

A detailed database on natural resources, terrain conditions, soil type of the catchment area, socio-economic status, etc. is a pre-requisite to prepare treatment plan keeping in view the concept of sustainable development. Various thematic maps have been used in preparation of the CAT plan. Geographic Information System (GIS) is a computerized resource data base system, which is referenced to some geographic coordinate system. In the present study, real coordinate system has been used. The GIS is a tool to store, analyze 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 analyze large amounts of data in relation to a set of established criteria. In order to ensure that latest and accurate data is used for the analysis, satellite data has been used for deriving land use data. Ground truth studies, too, have been conducted.

The various steps, covered in the study, are as follows:

- Definition of the problem
- Data acquisition and preparation
- Output presentation

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

2.2.1 Definition of the Problem

The requirements of the study were defined and the expected outputs were finalized. The various data layers of the catchment area to be used for the study are as follows:

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

2.2.2 Data Acquisition and Preparation

The data available from various sources has been 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 and brought to a common scale (real co-ordinates), so that overlay could be

performed. A computer program using standard modeling techniques 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. Ground truthing and data collection was also included in the procedure.

For the present study, IRS satellite data was used for interpretation & classification. The data has been procured in raw digital format and has been geo-referenced using Survey of India topographical sheets with the help of standard data preparation techniques in standard image processing software. The interpretation of geo-referenced satellite data has been done using standard enhancement techniques, ground checks and experiences of qualified professionals. A detailed ground truth verification exercise has been undertaken as a part of field survey to enrich the image interpretation process. The classified land use map of the free draining catchment area, considered for the study.

Derived contours from topographical maps were used for preparation of Digital Elevation Model (DEM) of the free draining 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 topographical maps were derived. 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 z - their elevation). All this information was in real world co-ordinates (latitude, longitude and height in meters above sea level).

Table 2.2: Land use classification for free draining catchment at Project Site

Land use/Land cover	Area%	Area (ha)
River/Water Bodies	0.1%	16.1
Open Areas	2.0%	220.7
Agricultural Areas	19.0%	2058.3
Dense Forest	28.9%	3123.0
Open Forest	30.1%	3252.6
Shrubs/Bushes/Grasses	19.6%	2118.6
Settlement/Exposed rocks	0.3%	31.5
Total	100.0%	10820.8

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 below in Table 2.2. The slope map is enclosed as Figure-2.3.

Table 2.3: Area falling under different slope categories

Slope category (%)	Area (%)	Area (sq km)
0-10	35.2	38.09
10-20	22.5	24.35
20-30	8.9	9.63
30-40	6.5	7.03
40-50	11.2	12.12
> 50	15.7	16.99
Total	100	108.2

2.3 ESTIMATION OF SOIL LOSS USING SILT YIELD INDEX (SYI) METHOD

In 'Silt Yield Index' (SYI), method, the terrain is subdivided into various watersheds and the erodibility is determined on relative basis. SYI provides a comparative erodibility 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.

The SYI model, considering sedimentation as product of erosivity, erodibility 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 requirements of prioritization of smaller hydrologic units within river valley project catchment areas.

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 relationship can be expressed as:

Soil erosivity = f (Climate, physiography, slope, soil parameters, land use/land cover, soil management)

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-watersheds

The prioritization of smaller hydrologic units within the vast catchments is based on the 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 for 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, physiography, 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 are required for estimating the other attributes.

The various steps involved in the application of model are:

- Preparation of a framework of sub-watersheds 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 weightage values to 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 are calculated using the following equations:

a. Silt Yield Index

To calculate SYI, the methodology developed by All India Soil & Land Use Survey (Department of Agriculture, Govt. of India) has been followed, where each erosion intensity unit is assigned a weightage value. When considered collectively, the weightage value represents approximately the relative comparative erosion intensity. 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 ratios were adjusted for each of the erosion intensity unit. The delivery ratio suggests the percentage of eroded material that finally finds entry into reservoir or river/ stream. Area of each composite unit in each sub- watershed was then estimated.

SYI was calculated using following empirical formula:

$$SYI = \frac{\sum(A_i * W_i) * D_i * 100}{A_w} ; \quad \text{where } i = 1 \text{ to } n$$

Where,

A_i	=	Area of i th unit (EIMU)
W_i	=	Weightage value of i th mapping unit
n	=	No. of mapping units
A_w	=	Total area of sub-watershed.
D_i	=	Delivery ratio

Delivery ratios are 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:

Table – 2.4: Delivery Ratio for Different Range of Streams

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

The SYI values for classification of various categories of erosion intensity rates are given in Table 2.5.

Table 2.5: Criteria for erosion intensity rate

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

The erosion category of various watersheds in the catchment area as per a SYI index has been estimated. The objective of the SYI method is to prioritize sub-watershed in a catchment area for treatment. The area under very high and high erosion categories is to be treated at the project proponent's cost.

Hence, CAT plan shall be suggested for very high and high erosion categories, as a part of the EIA study, the expenses of which have to be borne by project proponents.

2.4 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 shall be suggested for the catchment area treatment depending upon the requirement and suitability:

- a. Engineering measures
 - Step drain
 - Angle iron barbed wire fencing - Stone masonry
 - Check dams
- b. Biological measures
 - Development of nurseries
 - Plantation/afforestation
 - Pasture development
 - Social forestry

The basis of site selection for different biological and engineering treatment measures under CAT are given in Table 2.6.

2.5 CATCHMENT AREA TREATMENT (CAT) PLAN

In the present report, CAT Plan as per the slope, land use pattern, soil characteristics has been suggested based on the prioritization of sub watersheds using SYI method. The CAT plan has been suggested for Sub-watersheds with very high and high erosion categories as the cost for treatment for such watersheds is to be borne by the project proponents. The objective of the SYI method is to prioritize sub-watershed in a catchment area for treatment. The area under very high and high erosion categories have to be treated by the project proponents. It is proposed that treatment measures shall be implemented over five years and shall be co-terminus with the construction of dam.

Table – 2.6: 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 protect it from grazing etc.
Step drain	To check soil erosion in small streams, steps with concrete base are prepared in sloppy area where silt erosion in the stream and bank erosion is high due to turbidity of current.
Nursery	Centrally located points for better supervision of proposed afforestation, minimize cost of transportation of seedling and ensure better Survival.

Figure – 2.6: Aulliya DEM Map

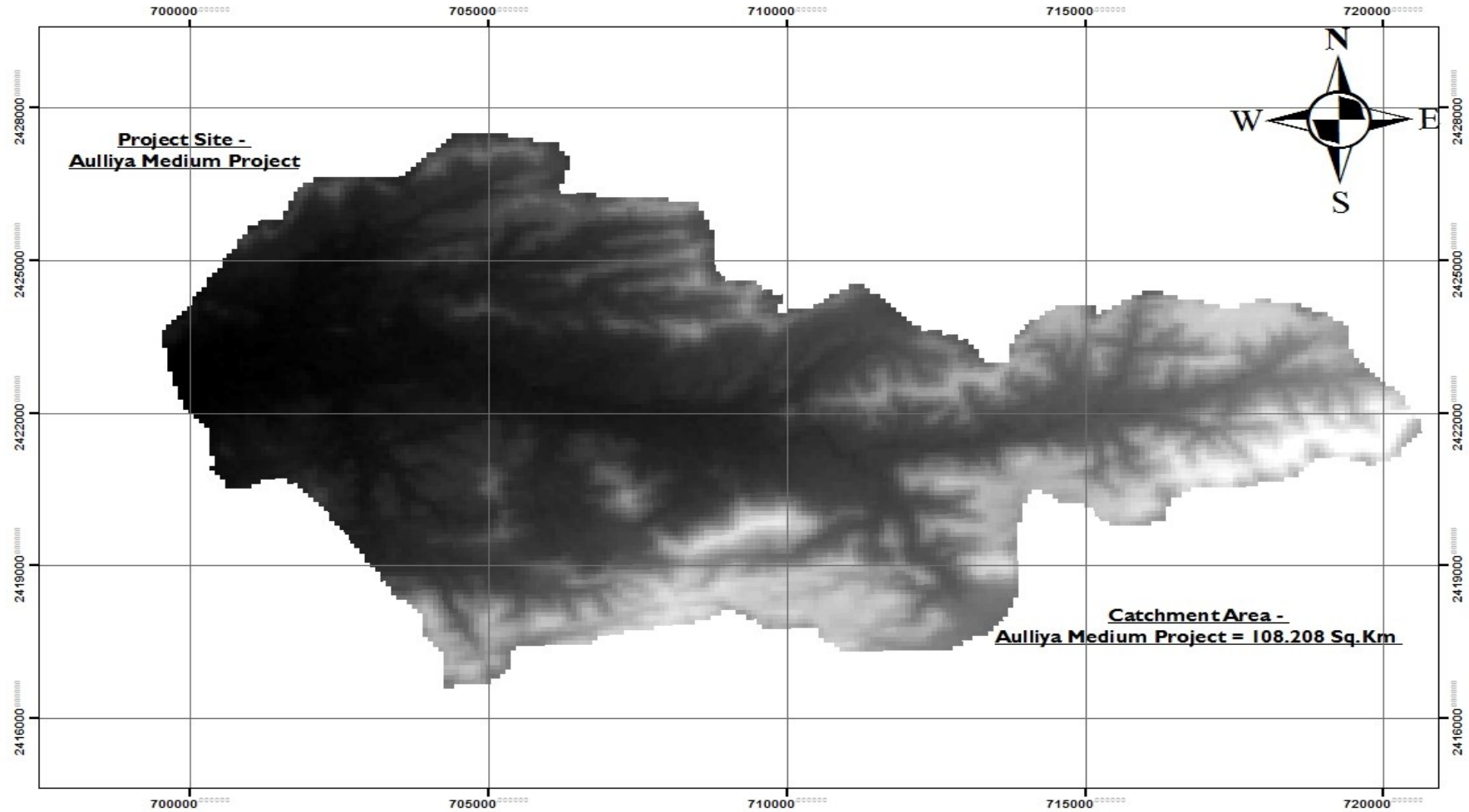


Figure – 2.7: Aulliya Land Use Map

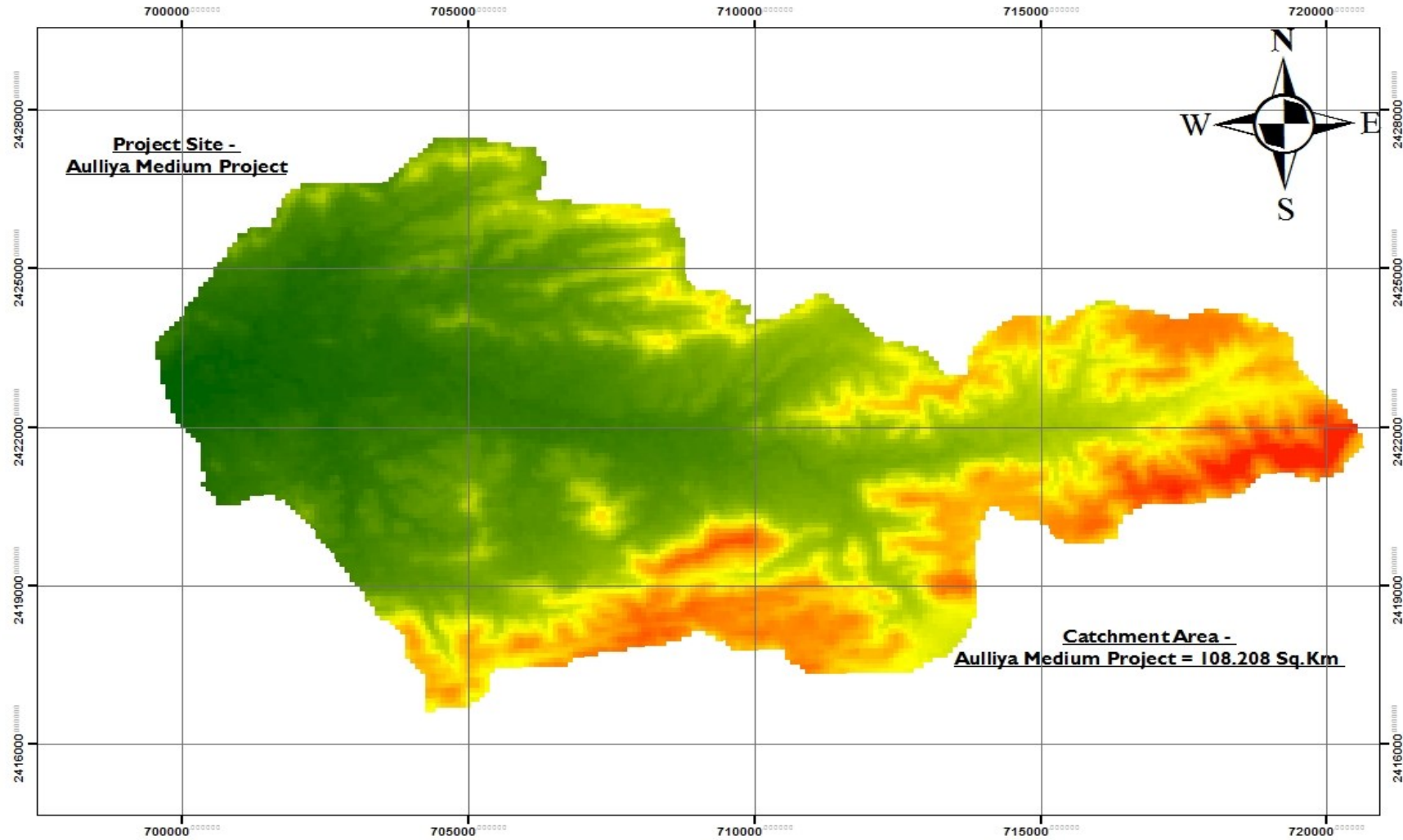


Figure – 2.8: Aulliya Flow_Acc Map

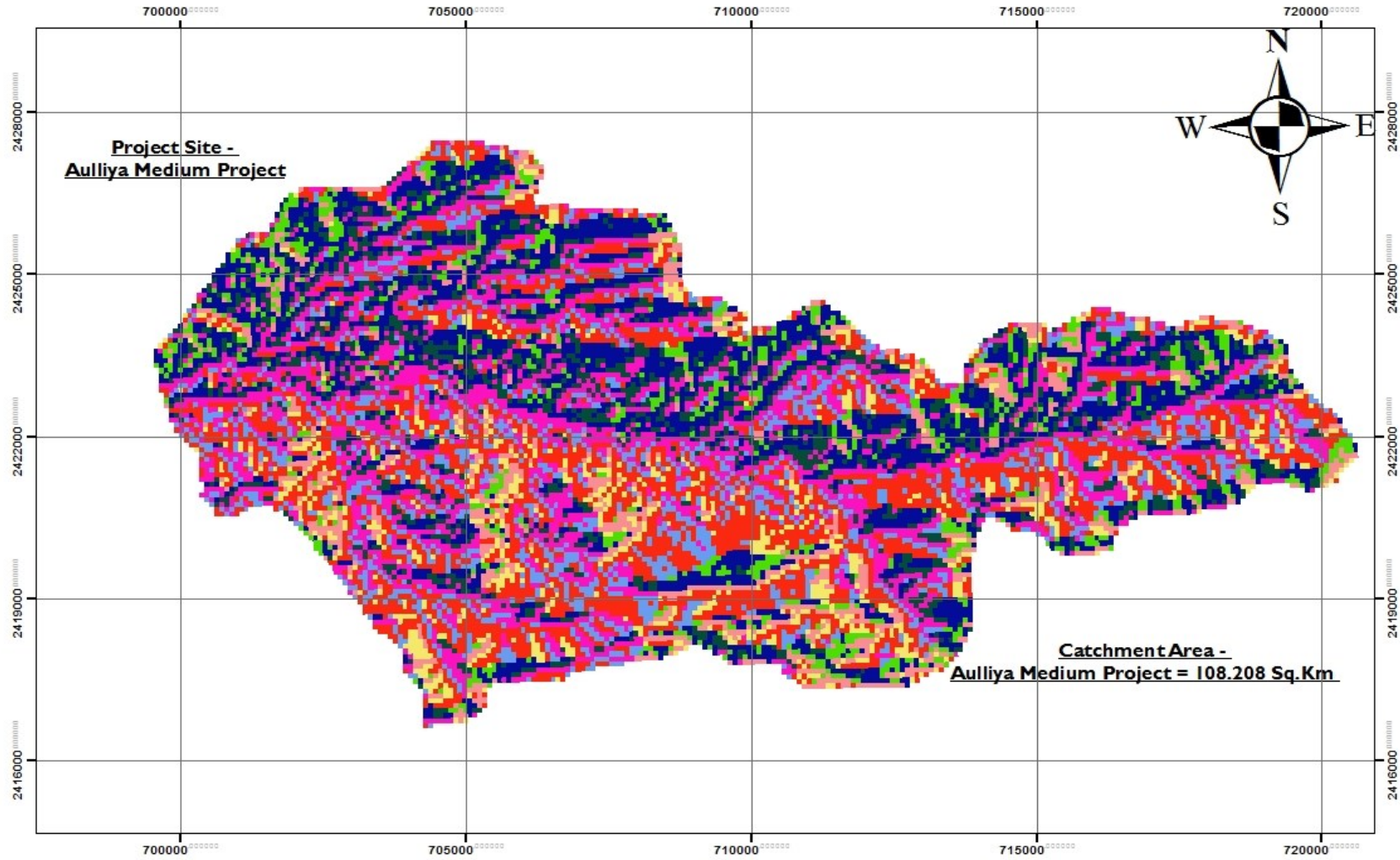


Figure – 2.9: Aulliya Stream Link Map

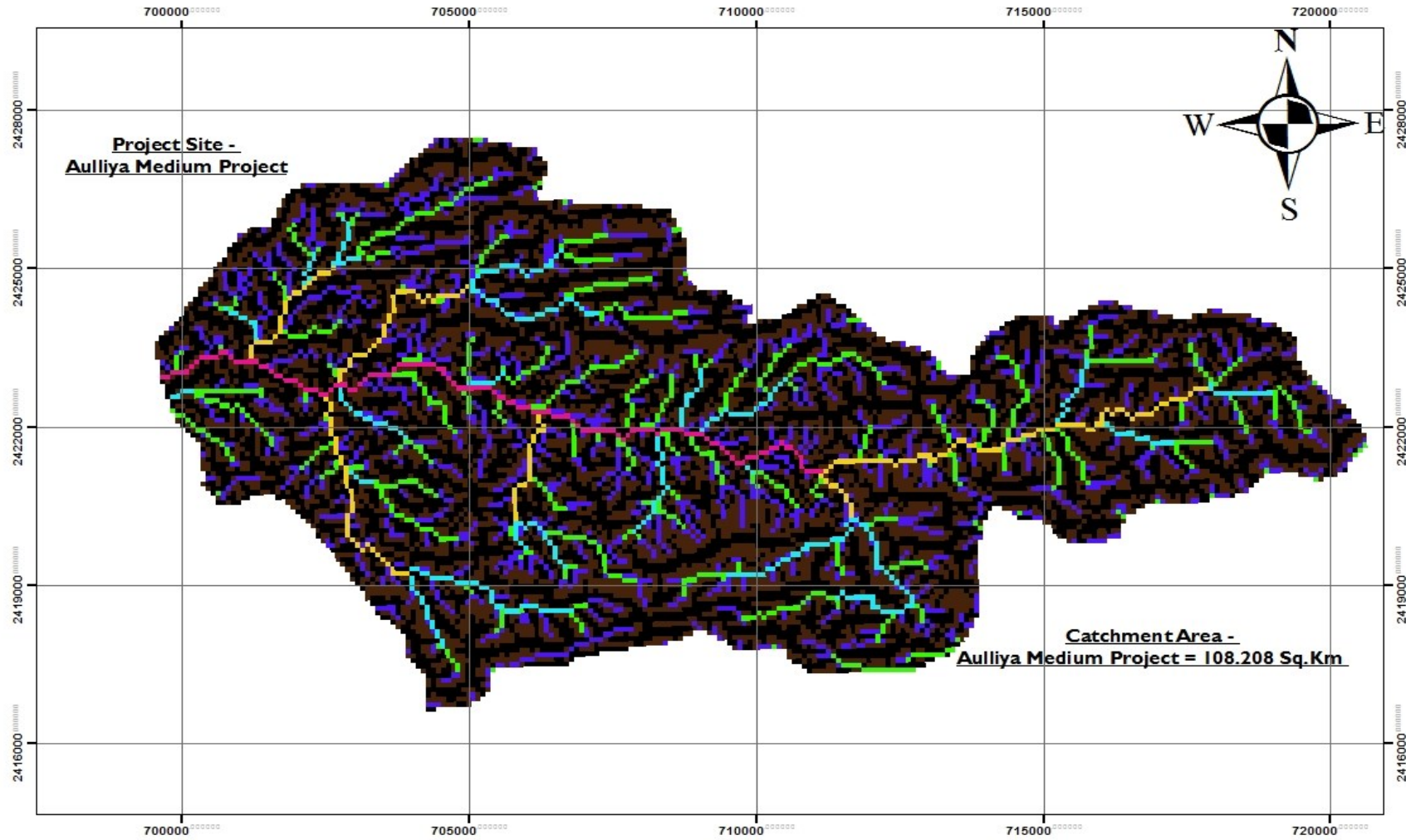


Figure – 2.10: Aulliya Watershed Treatment Map

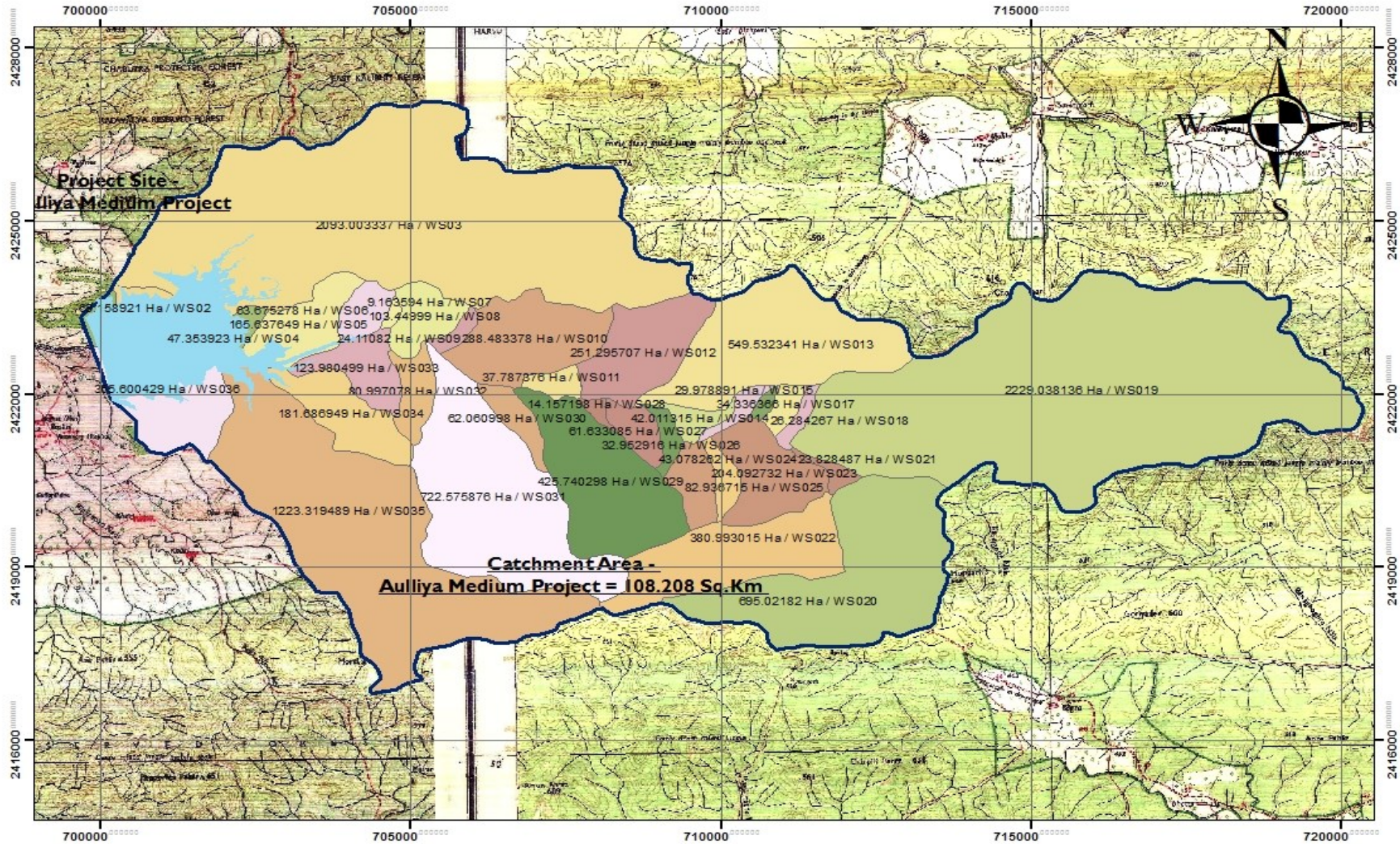


Figure – 2.11: Aulliya Watershed Area Treatment Map

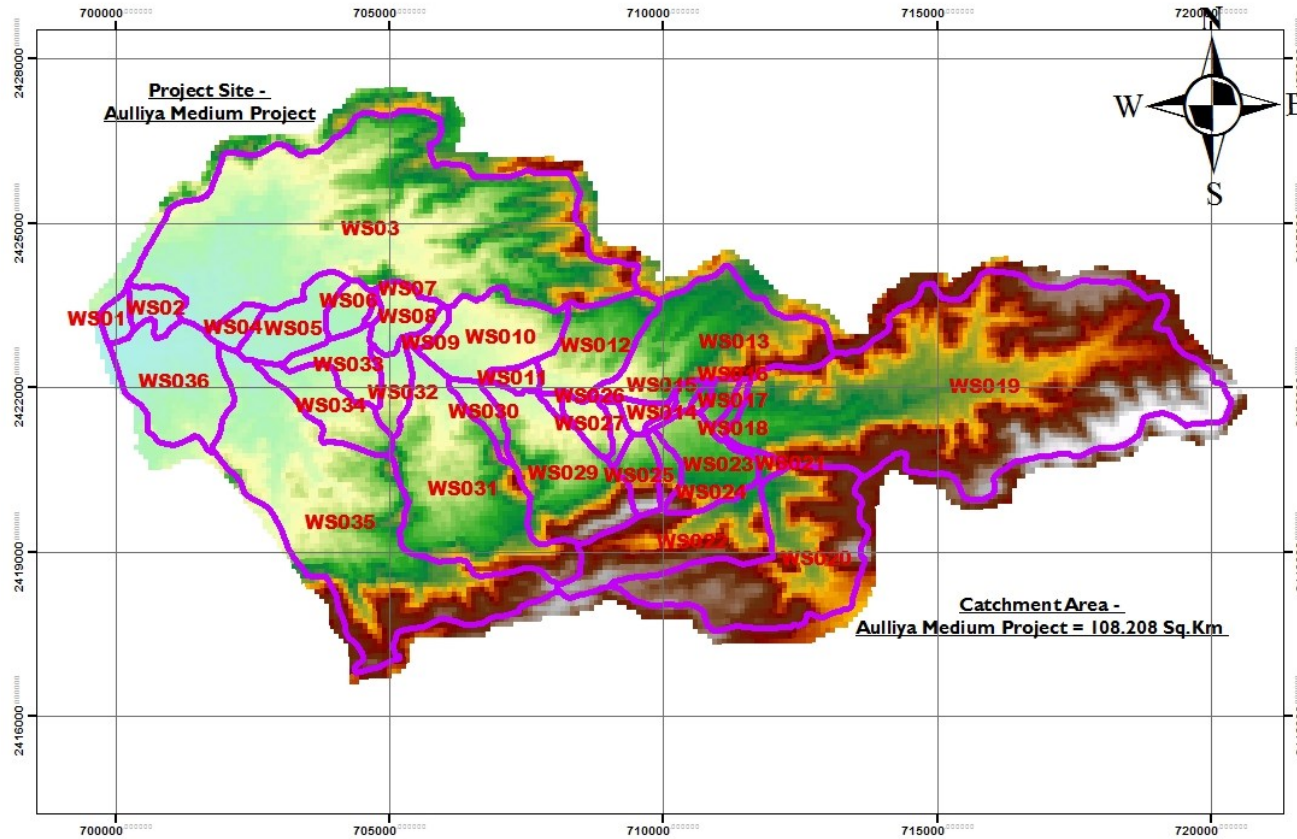


Table – 2.7: Sediment Yield Index and Priority Category

S.No.	Description	Area (SqKM)	Area (SqM)	Area in Ha	Weigthage	Area X Weightage	Delivery Ratio	Sediment Yeild	Priority Category
1	WS01	0.39	394557	39.46	5	197	0.8	158	Very Low
2	WS02	0.69	691589	69.16	12	830	0.85	705	Very Low
3	WS03	20.93	20930030	2093.00	7	14651	0.8	11721	Very High
4	WS04	0.47	473539	47.35	4	189	0.8	152	Very Low
5	WS05	1.66	1656377	165.64	9	1491	0.8	1193	Medium
6	WS06	0.64	636753	63.68	14	891	0.95	847	Very Low
7	WS07	0.09	91636	9.16	3	27	0.8	22	Very Low
8	WS08	1.03	1034500	103.45	7	724	0.8	579	Very Low
9	WS09	0.24	241108	24.11	15	362	1.0	362	Very Low
10	WS010	2.88	2884834	288.48	4	1154	0.95	1096	Low
11	WS011	0.38	377874	37.79	6	227	0.8	181	Very Low
12	WS012	2.51	2512957	251.30	4	1005	1	1005	Low
13	WS013	5.50	5495324	549.53	15	8243	1	8243	Very High
14	WS014	0.42	420113	42.01	8	336	0.8	269	Very Low
15	WS015	0.30	299789	29.98	15	450	1	450	Very Low
16	WS016	0.13	125156	12.52	2	25	0.8	20	Very Low
17	WS017	0.34	343364	34.34	15	515	1	515	Very Low
18	WS018	0.26	262843	26.28	5	131	0.8	105	Very Low
19	WS019	22.29	22290380	2229.04	12	26748	1	2675	Very High
20	WS020	6.95	6950218	695.02	14	9730	0.95	9244	Very High
21	WS021	0.24	238285	23.83	13	310	0.9	279	Very Low
22	WS022	3.81	3809930	380.99	15	5715	1	5715	Very High
23	WS023	2.04	2040927	204.09	5	1020	1	1020	Low
24	WS024	0.43	430783	43.08	14	603	0.95	573	Very Low
25	WS025	0.83	829367	82.94	15	1244	1	1305	Very High
26	WS026	0.33	329529	32.95	14	461	0.95	438	Very Low
27	WS027	0.62	616331	61.63	12	740	0.85	629	Very Low
28	WS028	0.14	141572	14.16	9	127	0.8	102	Very Low
29	WS029	4.26	4257403	425.74	15	6386	1	6386	Very High
30	WS030	0.62	620610	62.06	11	683	0.8	546	Very Low
31	WS031	7.23	7225759	722.58	9	6503	0.8	5203	Very High
32	WS032	0.81	809971	81.00	10	810	0.8	648	Very Low
33	WS033	1.24	1239805	123.98	8	992	0.8	793	Very Low
34	WS034	1.82	1816870	181.69	7	1272	0.8	1017	Low
35	WS035	12.23	12233200	1223.32	5	6117	0.8	4893	Very High
36	WS036	3.56	3556004	355.60	4	1422	0.8	1138	Medium
		108.31	108309285.65	10830.93					

Table – 2.8: Area of Very Low Sediment Index Watershed Wise

S. No.	Description	Area in Ha	Sediment Yeild	Priority Category
1	WS06	63.68	847	Very Low
2	WS033	123.98	793	Very Low
3	WS02	69.16	705	Very Low
4	WS032	81.00	648	Very Low
5	WS027	61.63	629	Very Low
6	WS08	103.45	579	Very Low
7	WS024	43.08	573	Very Low
8	WS030	62.06	546	Very Low
9	WS017	34.34	515	Very Low
10	WS015	29.98	450	Very Low
11	WS026	32.95	438	Very Low
12	WS09	24.11	362	Very Low
13	WS021	23.83	279	Very Low
14	WS014	42.01	269	Very Low
15	WS011	37.79	181	Very Low
16	WS01	39.46	158	Very Low
17	WS04	47.35	152	Very Low
18	WS018	26.28	105	Very Low
19	WS028	14.16	102	Very Low
20	WS07	9.16	22	Very Low
21	WS016	12.52	20	Very Low
		981.97		

Table – 2.9: Area of Low Sediment Yield Index Watershed Wise

S.No.	Description	Area (SqM)	Area in Ha	Sediment Yeild	Priority Category
1	WS010	2884834	288.48	1096	Low
2	WS023	2040927	204.09	1020	Low
3	WS034	1816870	181.69	1017	Low
4	WS012	2512957	251.30	1005	Low
			925.56		

Table – 2.10: Area of Medium Sediment Yield Index Watershed Wise

S.No.	Description	Area in Ha	Sediment Yeild	Priority Category
5	WS05	165.64	1193	Medium
36	WS036	355.60	1138	Medium
		521.24		

Table – 2.11: Area of Very High Sediment Yield Index Watershed Wise

S. No.	Description	Area in Ha	Sediment Yeild	Priority Category
1	WS03	2093.00	11721	Very High
2	WS020	695.02	9244	Very High
3	WS013	549.53	8243	Very High
4	WS029	425.74	6386	Very High
5	WS022	380.99	5715	Very High
6	WS031	722.58	5203	Very High
7	WS035	1223.32	4893	Very High
8	WS019	2229.04	2675	Very High
9	WS025	82.94	1305	Very High
		8402.16		

Table - 2.11: Erosion intensity rates in Free Draining Catchment

Erosion intensity categorization as per SYI values	Area Sq.KM in	Catchment Area in Ha	Catchment Area in (%)
Very High	84.02	8402.16	77.58
Medium	5.21	521.24	4.81
Low	9.26	925.56	8.55
Very Low	9.82	981.97	9.07
Total	108.31	10830.93	100.00

Table – 2.12: Sub-watershed wise proposed treatment measures

SI No	Watershed Numbers	Area of Watershed	Area in Ha(Treatment Proposed)
1	WS35	1223.00	309
2	WS31	723.00	79
3	WS29	426.00	84

SI No	Watershed Numbers	Area of Watershed	Area in Ha(Treatment Proposed)
4	WS25	83.00	29
5	WS22	381.00	302
6	WS20	695.00	560
7	WS19	2229.00	1609
8	WS13	550.00	81
9	WS03	2093.00	56
		8403.00	3109

Silt Observation points

Four silt observation locations for regular monitoring of silt load coming in tributaries of sub-watersheds falling under high and very high categories have been suggested. Monitoring would be undertaken for a period of 10 years including 5 years for CAT plan implementation period. Cost towards this should be kept in project estimates and could be taken as below:

Table – 2.13: Costing for Site

SI No	Items for One time Cost	Rs in Lakhs
1	Cost of 1 laboratories – Rs. 2,50,000/? for silt analysis per laboratory	2.50
2	One hut at each site (@ Rs. 50,000/?)	0.50
3	Cost for hiring services of persons (@ one person at each site) (one person for all the sites) (Average salary Rs. 10,000/? for next 10 years)	6.00
4	Cost for hiring services of supervisor (one person for all the sites) (Average salary Rs. 10,000/? for next 10 years)	9.00
5	Consumables for the measurement Rs. 1.00 lacs per year for next 10 years	5.00
	Total onetime cost =	23.00

2.6 COST ESTIMATE

The cost required for Catchment Area Treatment is Rs. 256.18 lacs. Provision of 10% per year to offset inflationary trends has been kept in costing. The details are given in Table 2.14.

Table 2.14: Cost estimate for Catchment Area Treatment of Aulliya Project:

S. No.	Item	Area in Ha	Rate*	Total Cost	Target for 3 Year		
			(first year)		Fin-I	Fin-II	Fin-III
Biological Measures							
1	Afforestation	3109	5,000/ha	155.45	51.82	51.82	51.82
2	Pasture Development	3109	500/ha	15.55	5.18	5.18	5.18
Engineering Measures							
3	Contour Bunding	3109	1000/ha	31.09	10.36	10.36	10.36
4	Check Dam	3109	500/ha	15.55	5.18	5.18	5.18
5	Gully Plug	3109	500/ha	15.55	5.18	5.18	5.18
	Total Cost			233.18			
Total Cost including Costing for Site =			233.18+ 23.00				256.18

CHAPTER - 3: FISHERIES CONSERVATION & MANAGEMENT PLAN

3.1 INTRODUCTION

The construction of a dam on a river blocks or delay in the upstream fish migration and contribute to the decline or even the extinction of species that depends on longitudinal movements along the stream. Fish population are highly dependent upon the characteristics of their aquatic habitat, which supports all their biological functions. Considering the migration of potamodromous fishes, whose entire life cycle is completed within the inland waters, require different environment for reproduction (Northcote, 1998). Possible fish passage / fish ladder / fish bypass to provide migratory passage have been assessed to evolve effective conservation strategies for sustainable management of aquatic biodiversity. However, these passages have been found more effective in low head barrage/ dam but for high dam's passage are not found viable due to immediate loss of habitats.

The reservoir invariably offer scope for inland fish production, if managed on scientific lines and for various other kinds of enhancement leading to higher productivity and income generation for the local community. They have the advantage of enabling quick enhancement of yield due to their small size and easy maneuverability of fish stock. The available technologies offer possibilities of achieving fish yield of 100 – 150 kg/ha/year. By virtue of their unmistakable role in promoting fisheries development through mass participation of local community, the small reservoir assumes special significance. The reservoir fisheries can contribute to the National Blue Revolution, which is essential to save the people from potential deficiency.

3.2 ASSESSMENT OF IMPACT ON AQUATIC ECOLOGY & MITIGATION MEASURES

The study stretch between the dam construction sites is rich in biodiversity. The aquatic ecology of this region will be affected by the dam construction activities at the dam construction site as well the surrounding areas.

3.2.1 Construction Phase

During construction the water of the river will not be stored and the natural flow of the river will be available throughout the stretch. However the area near the dam site will be affected due the construction activity.

The construction activities also involve large scale extraction of different types of construction material from the river bed including boulders, stones, gravel, sand, etc. Extraction of gravel and sand causes considerable damage to fish stocks and other aquatic life by destabilizing the sub-stratum, increasing the turbidity of water, silting of the channel bottom and modifying the flow which in turn may result in erosion of the river channel. These alterations are likely to upset the composition and balance of aquatic organisms. The material at the river sub- stratum like stones and pebbles provide anchorage and home to the invertebrates which remain attached in a fast flowing stream.

Huge quantity of debris will be generated. The debris site located close to river and may flow down the river during heavy precipitation. During fish spawning season, the fertilized eggs are laid amidst the gravel so that the eggs are not washed away in fast flowing stream. The eggs of almost all the species are sticky in nature, which provide additional safety. The turbidity in excess of 100 ppm brought by suspended solids chokes the gills of young fish. Fine solids in concentration greater than 25 mg/l, adversely affects the development of fish eggs and fish.

Temporary and permanent residential areas will be constructed to accommodate labour and staff engaged in the project. This would result in generation of domestic waste water which is likely to be discharged into the river consequently degrading the water quality.

Mitigation Measures

- The dam construction will block the route of local Nalas and tributaries of upstream of Aulliya dam may assist in supporting the population of these species in the area. Scientific management of the existing stock needs to be adopted for conservation of threatened species.
- Fish management program should be undertaken by project developer in consultation with the Fisheries Department, Government of Himachal Pradesh. In this connection Government of Madhya Pradesh published a policy/ norm for hydro power projects.

3.2.2 Operation Phase

Significant changes will occur in the riverine ecology, the river transforms from a fast-flowing water system to a quiescent lacustrine environment. Such modification will adversely affect biotic life of the river. The biotic communities, which cannot acclimatize to the changed environment, may disappear in the early years of impoundment of water due to various reasons related to feeding and reproductive characteristics.

The dam will also hinder the upward and downstream migration of the fish like catla Rohu and Mirghal and segregate the fish population. The low flow in the river will affect the habitat, which are located along the shallow banks. The flow in the downstream stretch of dam would be reduced considerably, and will leave areas dry and the river water will remain in the centre portion.

During the lean period segment of river between dam site and tail race disposal at certain places may retain some water in shallow pools subjecting the fish to prey by birds and human beings. Such situations will result in indiscriminate fishing.

Mitigation Measures

- The anthropogenic activity like extraction of sand, pebbles, gravels and stones and fishing activity in the river should be completely banned.
- It will be mandatory for the project authorities to maintain the minimum flow for the survival and propagation of invertebrates and fish.

- Ban on fishing should be enforced in the affected stretch of river during lean season and spawning season (September/October and March/April).
- Since there are series of dams in the area a detailed aquatic study is required in the Ghorpachhar River for understanding the cumulative impact on fisheries / aquatic life due to various hydro projects.

3.3 FISH CONSERVATION & MANAGEMENT PLAN

In Madhya Pradesh, Waters reservoirs, ponds and tanks are spread over 3.45 lakh hectares area in the state, from which area under waters reservoirs is 2.88 million hectares and area under rural ponds and puddle is 0.57 million hectares. Total area of 3.36 million hectares has been brought under fish culture which include 2.86 million hectares of water reservoirs and 0.50 million hectares of rural lakes and ponds.

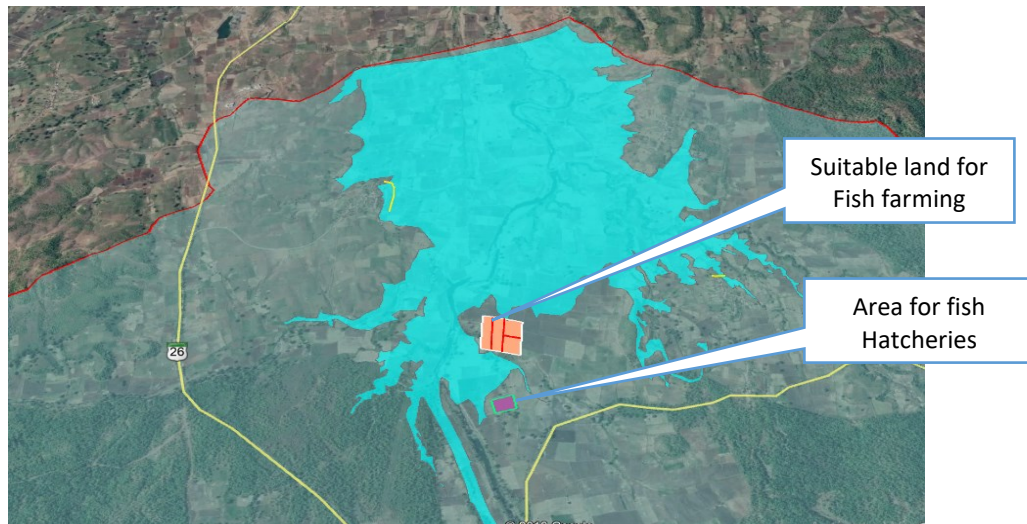
From above mentioned area, 12 water reservoirs spread over 1.71 million hectares have been transferred to Madhya Pradesh Fisheries Federation, 45 water reservoirs spread over 0.134 million hectares are subject to the department and 2575 irrigation waters reservoirs, spread over 0.89 million hectares with average of 1,000 hectares have been transferred to Panchayat Raj Institutions as per order number 1548/2008/36 dated 08.10.2008 by Department of Fisheries, State government of Bhopal. As per state policy of the fisheries, irrigation reservoirs from 100 ha to 1000 ha water spread, shall be managed by the concerned Zila Panchayat. The proposed reservoir, having a productivity water area about 487.06 ha at F.R.L, shall be managed under the aegis of Zila panchayat, Khandwa by leasing out the reservoir to the registered fishermen co-operative societies for a period of 10 years.

Small reservoirs are predominantly culture based fisheries systems and the management norms are based on the principal of stock manipulation, adjustment in fishing effort, observation of conservation measures and gear selectivity. The reservoir expected to retain water throughout the years and offers an opportunity for fisheries development to help in the increasing employment potential and provide alternate employment to poor and to produce protein rich food improve human dietary standards in rural areas and raising the net income of rural community, Fisheries are the dynamic source which when exploited replenishes the loss and hence a maximum sustainable yield from this resource is possible.

3.3.1 Management Measures

In the vicinity of Ghorpachhar River, there is little possibility of locating the fish farms and hatcheries. Therefore, reservoir fishery has been recommended for this project and also the developing of facilities of fish farm at Aulliya, Bhojudana and Barakund Village. Since the water of Ghorpachhar River here is characterized by normal temperatures and hatchery (Chinese type) is available at Sukta, Khandwa district (downstream of dam), moderate temperature water fisheries would be a suitable proposition for this reservoir.

Figure - 3.1: Land Allocation map for Fish Farming and Hatcheries



The juveniles of the fish seed such as Carps Catla (Catla), Rohu (Labeo rohita) and Migal (Cirrhinus mirgala) may be procured from the Department of Fisheries of Madhya Pradesh by the project developer which then be released in the Ghorpachhar river and other tributaries for the conservation and management of fishery in the area. The financial help to the Department of Fisheries, Madhya Pradesh for the following activities will be provided by the project developer.

a) Establishment of Hatchery

The Department of Fisheries can also utilize the Fish Farm/ hatchery, Khandwa, to meet the demand of fish seeds. The water supply facilities of the farm should be strengthened as there will be increase in water required at farm to produce fish seed. For capacity enhancement existing tanks can be renovated and if necessary new rearing/ brood tank should be constructed. Provision for other requirement like feed, medicines, net, aerator etc. should be also considered.

b) Production and Rearing of Fish Seed

Brood stock will be procured and maintained at the fish farm to produce the seed required for stocking. The hatchling will be reared at the farm up to the required stocking size. Health management and feeding of the reared stock should be taken care regularly.

c) Stocking of Fish Seed in the Streams & River

Analysis of Water Quality

Prior to seed stocking in the reservoir, detailed study of physical, chemical and biological characteristics of water and the soil of reservoir is required.

Seed Stocking

The main problem confronting the fisheries development agencies is whether the resident indigenous species would be able to establish successfully in the lacustrine system. The State Fishery Department has already introduced exotic trout in the Ravi River. Therefore, it would be worthwhile to introduce rainbow trout and brown trout and a few indigenous species on an experimental basis in the

proposed reservoir. As the hatcheries for Carps Catla (Catla), Rohu (Labeo rohita) and Mrigal (Cirrhinus mrigala) has been developed newly, no all additional facilities of fish hatcheries has to be install and create. The total reservoir area of 487.06 ha would require about 500 kg seeds for the stocking in the first year which will be increased gradually in later years, and accordingly existing seed stocking facilities would be upgraded.

For stocking of fish seed at the site necessary facilities like packaging materials, oxygenation equipment, feeder/ graders, etc. will be purchased. A vehicle will also be required for transportation of fish seed reared at the farm to the stocking site. Apart from this the vehicle will also be used to carry items required for survey and monitoring of water quality and stock assessment fortnight / monthly.

For assessment of fish stock and water/ soil quality at the site technical expertise would be required. Manpower will also be required to carry out various activities at the farm ranging from maintenance of brood, stock, rearing of fish seed, health management and transport of the stocking material to the site. For this scientific and manpower if needed will be arranged on contractual basis.

d) Organization of Fishermen

Owing to very large water spread entire reservoir of Aulliya Medium Project could be treated as a multiple beat. The reservoir would support and require an organization of about 15-25 fishermen. The Fishery Department would be advised to allow the use of fishing gears of definite types (cast nets and gill nets, etc.) and proper mesh size to prevent the young and juvenile fish from over-exploitation. Simultaneously, the authorities should initiate a training programme for operating gears at the surface and deeper waters.

e) Other Requirements

For the control of noxious weeds, harvesting of fishes (for rapid growing fishes and non-cultivable fishes) and maintenance of embankments, the Fishery Department needs some mechanical control devices, boats and chemicals. It is suggested that these equipment available at the existing facilities, could be used.

f) Institutional Mechanism

i. Setting up of Committee

The plan is proposed to be implemented through the State Fisheries Department at Khandwa, the funds for which will be released periodically by the project to the Fisheries Department. An Advisory Committee is proposed to be instituted which would monitor the implementation aspects, prioritize activities, etc. The committee would offer advice on development of marketing channels and training programmes, keeping in mind people's participation in fisheries development schemes. The committee would constitute the following members:

Chairman	:	Head, State Fisheries Department
Member	:	Local MLA
Member	:	Chief Engineer (I/c) Aulliya Medium Project
Member	:	Nominee of Fisheries Department

Member	:	Representative of Project Affected Families
Member	:	General Manager to support by Manager Environment

ii. Staffing Pattern

For smooth implementation and maintenance of fish farms, the following staffing pattern has been suggested.

S. No.	Staff	Nos.
1	Farm Manager	1
2	Farm Assistant	3
3	Fish Farm Attendant	12
4	Chowkidar	2
5	Driver	2

iii. Planning and Monitoring

A Farm Superintendent appointed full time on behalf of The Advisory Committee would coordinate and oversee the operation of the proposed Fisheries Development and Management Plan. Various teams led by Farm Managers would be constituted to look after activities such as:

- (i). land acquisition, development of fish farm facilities and office at allocated site,
- (ii). execute fish breeding activity and
- (iii). Marketing of product.

The Farm Superintendent would evaluate/monitor both financial and administrative aspects at the Farm Office. The implementation, monitoring and appraisal of the plan should be reported regularly. After five years of management and maintenance, the fish farms will be handed over to the State Fisheries Department.

The meetings of Advisory Committee would be held once every three months in order to ensure incorporation of preference of the PAFs and resolve logistic problems in plan implementation. The Farm Superintendent with team members would meet every week to ensure the implementation of project on time to time. Six monthly progress reports would be submitted to project proponent for evaluation and disbursement of finance.

g) Financial Requirements

A budgetary provision of Rs. 138.50 lacs has been kept for the setting up of fish farms infrastructure and its maintenance. The details for the creation of these facilities are given in Table 3.2. The entire cost for Fisheries management Plan will be funded by fisheries department at Roshni village Auilliya project Location near the dam line. Thus this amount will not be included in Aulliya EMP.

3.4 COST ESTIMATES

Table – 3.1: Technical Parameters

Part I. Technical Parameters Assumed		
1.	Unit Size	5 numbers of raceways of 35 m x 5 m x 2 m size
2.	StockingDensity	4000 nos. of 50 g fingerlings per raceway
3.	Mortality	10%
4.	Durationof Culture	10-12 months
5.	Harvestingsize	200-300 g (Average 250 g)
6.	FCR	1.5 : 1
7.	WaterFlow Rate	10 litters per second

Table – 3. 2: Cost Estimate for Fisheries Development plan

S. No.	ITEMS	Amount (Rs. In lacs)
A.	Capital Cost	
1	Channel construction	0.75
2	Construction of hatchery	1.25
3	Procurement of pelleted feed mill	0.50
	Total - A	2.50
B.	Working Cost	
1	Seeds @ 4000 per raceway i.e. 20,000 Nos. @ Rs. 10.00 per piece	2.00
2	Pelleted Feed @ 1200 kg/raceway i.e. 6000 kg @ Rs. 120 per kg	7.20
3	Salaries per year	17.50
4	Miscellaneous including watch and ward (L.S.)	0.50
	Total – B (for 1 year)	27.20
	Total - B (for 5 years)	136.00
	Total (A + B) for 5 years	138.50

CHAPTER - 4: SOLID WASTE MANAGEMENT PLAN

4.1. INTRODCUTION

The construction of the proposed Aulliya medium Irrigation Project will involve different categories of manpower like labour, technical, other officials and service providers. Most of these technical and non- technical workers will be temporary and will leave the region as soon as the construction phase of the project is over, which is estimated as 3 years. Some of the workers will be accompanied by their families. The total population of workers and their families has been estimated more than 100 persons. These people will be living in temporary and permanent colonies / settlements. The main sources of wastes in case of the proposed project can be divided into following categories:

- Solid wastes and wastewater from labor camps and residential area
- Bio-medical wastes from Dispensary

Solid waste generated from temporary and permanent colonies in construction as well as operation phase requires special management to dispose off as warranted under the Municipal Solid Wastes (Management and Handling) Rules 2000. For that an efficient waste management system will be required to put in place to keep the environment of the region clean and healthy.

These colonies and temporary settlements will also require adequate water supply for drinking and cleaning. The project authorities will ensure sewage treatment from the colonies of labors and workers, water supply, cleaning of the colony area and solid waste disposal. Dwellings will be provided with septic tanks and soak pits along with water supply for drinking and other daily needs for each and proper waste disposal by adopting various disposable methods.

4.2. INFLUX OF MIGRANT POPULATION

At the time of peak construction work in the project, maximum of 120 persons may be engaged, most of these will be from the local population. Around 100 nos. of the work force, which will include technical, non-technical and service class, will come from outside. In the first and fifth year 60% of the peak force will be required and in the second to fourth years 80% of the peak force will be required (see Table 4.1).

Table - 4.1: Periodic Workforce Requirement during Construction Phase

Years	Number of Labourers	Number of Technical Staff	Total
1 st	100	20	120
2 nd	90	20	110
3 rd	100	25	125

To calculate the human pressure during the peak construction of the project the following assumptions have been considered.

- i) Family size is assumed as 5; and 80% of labors and technical staff are married
- ii) Out of total workforce, 80% will be such that both husband and wife will work
- iii) 50% of technical staff will come with their families and only husband will work
- iv) 2% of total migrating population are assumed as service providers, and
- v) 50% of service providers will have families.

Based on these assumptions the peak migrant population has been calculated as 524 persons (Table 4.2). This population is expected to reside in the project area at any given time.

Table - 4.2: Calculation of Total Migrant Population (Peak time)

A.	Migrant Population of Laborers	
	Total labor force	120
	Married laborers (80% of 120)	96
	Single laborers (20% of 120)	24
	Husband and wife both working Labour (80% of 96)	77
	Number of families where both husband and wife work (96/2)	48
	Number of families where only husband work (20% of 96)	19
	Total number of laborers families (48 + 19)	67
	Total Migrant Population of Laborers (67 x 3 + 20)	227
B.	Migrant Population of Technical Staff	
	Total technical staff	25
	Married technical staff	13
	Single technical staff	12
	Total migrant population of technical staff (13 x 3 + 12)	51
	Migrant Workforce (Labor plus Technical)	278
C.	Service Providers	
	Total service providers (2% of total migrant workforce)	5
	Married service providers (50 % as assumed)	3
	Single service providers	2
	Total migrant population of service providers (2 x 3 + 2)	11
	Total Migrant Population	289

In India average solid waste generated per capita per day is considered as 210 g (dry weight). Therefore, for about 289 persons an estimated amount of about 22.15 tonnes (0.210 kg x 289 individuals x 365 days = 22152 kg) per annum of solid waste will be generated annually. This waste would not be allowed to be dumped near any surface water body or a stream. The solid waste will be collected in masonry vats of at least 10 cum capacity constructed at suitable sites near the colony area. The garbage would be transported to the landfill sites located at least 500m away from the colony area. The organic waste will be suitably processed to form compost, which can be used as manure. In addition to the above mentioned activities, proper sanitary facilities would also be provided at the labor colonies. There would be adequate facilities for drinking and cleaning water for

all the inhabitants of the colony. Septic tanks of appropriate size will be constructed. The wastewater generated from the colonies will be collected and disposed in specifically designed soak pits. The wastewater and sewage generated will not be allowed to flow into the rivers and streams of the area. The sanitary facilities at the colonies should be of standard municipal design for hill areas.

Population living in the nearby affected villages have been surveyed and it was found that the villages are electrified, have regular water supply through tube wells and wells, tube wells are also the source of drinking water and some households have toilets and some of household using open defecation.

4.3 MANAGEMENT OF SOLID WASTE

The project authority shall, within the territorial area of the project complex/ colony, be responsible for the implementation of the provision of Solid Wastes Management. Any solid waste generated in the project complex/ project colony/ labor colony, shall be managed and handled as described below.

A. Collection of Solid Wastes

The project authorities shall prohibit littering of solid wastes in the area under their control by resorting to following:

- Initiate organising house to house collection of solid waste on regular pre- informed timing and scheduling through any of the methods, like community bin collection (Central bin) and make them adopt this practice.
- Collected waste from residential areas shall be transferred to community bin by hand-driven containerised carts or other small vehicle
- Devising collection of wastes from office complexes and commercial areas
- Avoiding mixing of Bio-medical wastes with municipal solid wastes
- Horticulture and construction / demolition wastes or debris shall be separately collected and disposed off
- Wastes like dry leaves shall not be burnt
- Collection of wastes from vegetable and fruit shops and meat shops and also dry leaves collected from avenues/ parks, which are biodegradable in nature to be finally disposed off through aerobic composting in composting units of size 8 m x 2.5 m build from bricks. The compost thus obtained shall be used for development of flower beds and avenue plantation around colonies and office areas and also in biological measures to be adopted in respect of soil tips developed at muck disposal sites.

B. Segregation of Solid Wastes

The project authority shall organize awareness programme to ensure community participation in waste segregation.

C. Storage of Solid Wastes

The project authority shall establish and maintain storage facilities in such a manner as they do not create unhygienic and insanitary conditions around it. Following criteria shall be taken into account while establishing and maintaining storage facilities.

- Storage facilities of bins shall have 'easy to operate' design for handling, transfer and transportation of waste. Bins for storage of bio-degradable wastes shall be painted green, those for storage of recyclable wastes shall be painted white and those for storage of other wastes shall be painted black.
- Manual handling of waste shall be prohibited. If unavoidable due to constraints, manual handling shall be carried out under proper precaution with due care for safety of workers.

D. Transportation of Municipal Solid Wastes

- Vehicles used for transportation of wastes shall be covered. Wastes should not be visible to public, nor exposed to open environment preventing their scattering.
- Transportation vehicles shall be so designed that multiple handling of waste, prior to final disposal, is avoided.

E. Processing of Solid Wastes

The project authorities shall adopt suitable technology or combination of such technologies in coordination with local authorities to make use of wastes so as to minimize burden on landfill.

Following criteria shall be adopted: -

- The biodegradable wastes shall be processed by composting, vermicomposting or anaerobic digestion for stabilization of wastes.
- Mixed waste containing recoverable resources shall follow the route to recycling.
- Incineration can also be used for processing wastes.

F. Bio-medical Wastes

All kinds of hospital waste are considered as hazardous waste. Hospital waste is generated during the diagnosis, treatment or immunization of human beings. It may include waste like scrap, anatomical waste, culture media, discarded medicines, chemical waste, syringes, swabs, bandages, body fluids, human excreta, etc. This waste is highly infectious and can be serious threat to human health if not managed in a scientific and discriminate manner. It is expected that in Aulliya Medium Irrigation project, generation of such hazardous waste will be very less. For the purpose of management, special type of collection container and incinerator should be placed near the hospital for proper collection and disposal of hospital waste. All kind of hospital waste should be incinerated or buried at isolated, identified sites. Any kind of hospital waste should not be either recycled or reused. Incinerator is also a legal requirement for hospital waste management as such the non-biodegradable waste generated from colony as well as hospital can be scientifically disposed.

Since, the total labour force which will be used during the time of construction is very less, thus there is no requirement of installing an Incinerator at near labour colony/ camp area for reduction of total volume of non-biodegradable solid waste including bio-medical waste.

4.4. FINANCIAL REQUIREMENT

The total budget in order to manage the solid waste generated from this population, provisions for community toilets for labours and nearby villagers as well as septic tanks and soak pits, has been proposed to Rs. 36.18 lacs (Table 4.3).

Table - 4.3: Cost Estimate for Solid Waste Management Plan

Sl. No.	Description	Qty.	Unit	Rate (Rs. lacs)	Amount (Rs. lacs)
A.	Capital Expenditure				
1	Flush composite toilets for labour colony/ camps	2	sets	1.5	3
2	Community toilet with 3 seats with Effluent Treatment system	3	sets	1.75	5.25
3	Cleaning worker for 3 years (@Rs.6000/month x 12 x 3)	3	person	2.16/year	6.48
4	Door step plastic dustbin 40 litre capacity including replacement one time	12	nos.	0.25	3
5	Waste collection handcarts including one time replacement of container	5	nos.	0.08	0.4
6	Iron storage vat (3.1 m x 1.25 m x 1.25 m)	1	nos.	1	1
	Total (A)				19.13
B.	Recurring Expenditure				
7	Landfill R&M	3	years	0.5	1.5
8	Implements such spade etc. and R&M as Brooms, etc.	3	years	0.1	0.3
9	Anti-malarial and anti-insecticides equipment's & spraying material	1	nos.	1	5
10	Two covered trucks for conveyance of solid waste to landfill site (@Rs.2.50 lacs/truck/year)	1.5	trucks	2.50/truck	3.75
11	Developing simple composting unit with size 7.5 m x 2.2 m, three chambered build from brick	1	nos.	0.5	0.5
12	Contingency L.S. Rs.2.00 lacs per year	3	LS	2	6
	Total (B)				17.05
	Grand Total (A+B)				36.18

CHAPTER - 5: PUBLIC HEALTH MANAGEMENT PLAN

5.1. THE PRESENT STATUS OF MEDICAL FACILITIES

The delivery of health services is rendered through hospitals, primary health care centers and dispensaries. The district hospital serve as a referral center for complicated cases, while the primary health centers and dispensaries provide health needs primarily to the inhabitants of rural areas. The Khandwa District has one District allopathic hospitals, 28 primary health centers, 6 community health centers, 32 primary health centers and 171 health sub-centers (Madhya Pradesh Health Systems Assessment Report, a Health Financing Support Program Prepared by ACCESS Health India, <https://accessh.org/wp-content/uploads/2016/03/Madhya-Pradesh-Health-Assessment-report.compressed.pdf>). The medical facilities available to the villages in the project area are very poor. Present medical facilities is in Khalwa Block where one dispensary, one community health centre, one primary health canter, 5 primary health sub-centers and single child welfare unit. Nearest hospital is located in Harsud town at a distance of 55 km from Aulliya. The villages are sparsely populated and scattered far and wide and many of the villages are not covered by the primary health care (PHCs) units. None of the PHCs are provided with ambulance and the drugs stocked in these health centers are grossly inadequate.

5.2. THREATS TO PUBLIC HEALTH

Project construction and operation will bring about few changes in the socio-economic environment of the area including increased threats to the health of the community. Possible threats to public health are briefly discussed below along with the management measures.

5.2.1. New Diseases due to Migratory Population

During the project construction period there will be further increase in the population of this region, particularly around the project area. Around 100 nos. workers and 25 nos. of technical staff will be coming from outside for the construction work. They will be accompanied with families and children. The peak labor force during the construction period will be around 289. These migrant workers and their family members may be the potential carriers of new diseases hitherto unknown/unreported from the project area. Diseases like AIDS, VDs, malaria, gastroenteritis, etc., are some of the potential risks to human inhabitants of this area. The present available health services in the area would be insufficient to cater to such a vast influx of outside population in this area.

Therefore it would be obvious for the project authorities and their contractors to have all the labourers including their family members registered and quarantined, vaccinated against common diseases like malaria, TB, etc. The project authorities will hold screening camps for the laborers, where rapid blood tests will be conducted for diseases like AIDS, TB, malaria, etc. Only after valid certification a labor or his family members will be registered with the contractor. The project authorities would ensure that the contractors follow this strict quarantine procedure and this clause would be included in the award of the contract/works. Adequate medical facilities be provided by the

project authorities for this purpose in addition to strengthening of existing medical facilities in the area.

5.2.2. Vector-Borne Diseases

The increase in water fringe area provides suitable habitats for the growth of vectors of various diseases and they are likely to increase the incidence of water-related diseases. Malaria could be the major vector-borne disease in the area. The main breeding season of the anopheles mosquito (malaria vector) is the months of September and March. The preferred habitat is stagnant or slow moving fresh water open to sunshine or moderate shade. Malaria can be controlled by mosquito control and mosquito proofing measures. The anti-malarial operations can be coordinated by various Primary Health Centers in the nearby villages and hospital at district headquarters, in association with the project authorities. Some of suggested measures are given below:

- The site selected for habitation of workers should not be in the path of natural drainage.
- Adequate drainage system to dispose storm water from the labour colonies should be provided.
- Adequate vaccination and immunization facilities should be provided for workers at the construction site.
- The labor camps and resettlement sites should be at least 2 to 3 km away from a main water body or borrow pit areas.

5.3. MEDICAL FACILITIES

A population of more than 150-200 is likely to congregate during the construction phase. There is no medical facility in the immediate vicinity of the project area. It is recommended that the following medical facility should be provided by the developer to ensure safe and healthy operations during the entire construction phase:

- One fully equipped ambulance need to be procured to provide pre-hospital care to accident victims. The ambulance should always be stationed near major construction sites or the sites where risky operations are taking place such as blasting during tunneling. The ambulance should be equipped with lifesaving equipment, drugs along with trained manpower and communication system. Typically the ambulance should have equipments such as Fornoflex Chair/COT, Ventilator, Vacuum splint kit (Adult), Scoops Stretcher, Oxygen Cylinder with accessories, Resuscitation bag (Adult), Suction pump, Spine board, siren/beacon, Emergency light with public address system, Wireless equipments, additional battery, First Aid bag, BP instrument, stethoscope, etc.
- Two first-aid posts need to be established – one near dam site (Aulliya village) and one near power house site (Near Roshni village) to take care of basic medical needs of the workers at major construction site. The first aid posts will have essential medicines including ORS packets, dressing materials, stretcher, wheel chair, etc. The first aid post can be housed in temporarily erected structure and should be managed by one Health Assistant and assisted by one dresser/first aid attendant. A visiting doctor can attend First Aid post regularly every day at a fixed time.

- Existing medical facilities in the area are adequate, However budget provisions made for strengthening existing PHCs and PHSCs in the area will be borne by Health Department.

5.4. HEALTH EXTENSION ACTIVITIES

The health extension activities will have to be carried out in the villages situated within the study area. It is important to inculcate hygienic habits of environmental sanitation especially with respect to water pollution by domestic wastes. A medico needs to be engaged to make regular visits to these villages and organize health promotional activities with the active participation of the local village leaders, NGOs and available local health functionaries. The health functionaries would undertake the following tasks as a part of health promotional activities:

- Organize awareness programs and medical camps to make people aware about the common diseases in the region. This should include poster campaign, awareness camps, medical camps for health check-ups and vaccination/treatment, etc.
- Collect water samples to ascertain the potability of water from different sources so as to monitor regular disinfection of drinking water sources.
- Maintain close surveillance on incidence of communicable diseases in these villages.
- Maintain close liaison with the community leaders and health functionaries of different departments, so that they can be mobilized in case of an emergency.
- Close interaction to be maintained with health department functionaries of the state government.

5.5. COST ESTIMATES

Budgetary estimates for public health delivery system have been worked out as Rs. 44.00 lacs, as per the break up given at Table 5.1. Since, a well-equipped and manned PHC exist near the Location of Dam site which can meet the requirement of this project, so there is no need extra provision for Public Health Management Plan.

Table - 5.1: Budgetary estimates for developing health care facilities

Sl. No.	Particulars	Amount (Rs. lacs)
A.	Ambulance : 1 no. with all the basic medicare facilities and small DG set, etc. to cater for villages in the project area	10.0
B.	Two first aid posts including sheds, furniture and basic equipment (Dam, power house sites, etc.)	5.0
C.	Budget for strengthening existing medical facilities	12.0
D.	Budget for Health Awareness/ Vaccination Camps	4.0
E.	Budget for combating communicable diseases	5.0
F.	Budget for combating vector borne diseases	2.0
G.	Maintenance of ambulance and recurring contingent expenditure @ Rs.2.00 lac (s)/ year	6.0
Total (Rs. lacs)		44.0

CHAPTER - 6: ENERGY CONSERVATION MEASURES

6.1. INTRODUCTION

The proposed Aulliya Medium Irrigation Project on Ghorpachhar River would require construction of various project components and infrastructural facilities like residential camps/ colonies for its staff, offices, contractor's and labour camps/ colonies in addition to various access roads and other structures.

During construction phase of the project, migration of labour, road development, etc. will be carried out. It is the general tendency that the migrant labourers will use forest wood for the fuel purpose, creating biotic pressure on the nearby forest. To mitigate such impacts, feasible measures will be adopted to help minimize biotic pressure on forest.

6.2. ENERGY CONSERVATION MEASURES

The baseline social survey reveals that in most of the villages in the study area use wood, dung and kerosene as fuel and only a few villagers use LPG for cooking purpose. It is estimated that peak workforce will add a migrant population of around 289 persons in the project area. The existing facilities will become insufficient for supply of kitchen fuel for the migrant population during the construction of the project. They will require fuel for cooking and various other purposes and in the absence of adequate fuel availability they will resort to tree cutting for use of fuel wood. The project authorities would make adequate arrangements for supply of kitchen fuel. The details of the provision for kitchen fuel are provided in the following sections.

6.2.1. Provisions for Kitchen Fuel

In the villages of the project area the main source of energy is fuel wood which is one of the main causes of ecological degradation. Tree species like Pine (*Pinus wallichiana*), Deodar (*Cedrus deodara*), Rai (*Abies pindrow*) and Ban Oak (*Quercus semecarpifolia*) are commonly preferred as fuel in the area. Cutting and burning of wood will not only deplete the forest area but also is one of the sources of air pollution which emits suspended particulate matter, carbon monoxide and polycyclic hydrocarbons. Women and children are mainly affected by these pollutants. The demand for kitchen fuel will increase due to the population coming from outside for the construction and other related work of the project. Project authority should provide kitchen fuel and make arrangement for community kitchen, canteen and efficient cooking facilities, as briefly discussed below.

1. **Community kitchen:** The project developer would make sufficient arrangement for the establishment of at least one community kitchen. This will be established near the project labour colony. The kitchen should provide food to the labour. The facility should maintain proper hygiene while preparing and supplying food, with adequate arrangement for waste collection and disposal.

2. **Kitchen fuel:** During the construction period of the project, there would be around 484 persons involved in the project work. Many families may prefer cooking on their own instead of using community kitchen. In the absence of fuel for cooking, they would resort to tree cutting and using wood as fuel. To avoid such a situation, the project authority should make LPG and/ or kerosene available to these migrant workers. The supply of LPG and kerosene can be ensured on regular basis. A local depot can be established through LPG/ kerosene suppliers for supply of the same.
3. **Efficient cooking facilities:** The proposed project is in remote area of Khandwa District of Madhya Pradesh, where supply of kitchen fuel is not easy. Project authority should also take measures for reducing the fuel consumption. The authority should provide pressure cookers and solar cookers to the families of migrant workers as well to local villagers. Accordingly budget has been allocated for the supply of cookers. This facility will also increase the work efficiency of migrant workers and they will also get proper daily diet.

6.3. COST ESTIMATES

A total grant of Rs. 4.50 lacs has been assigned towards the provision of kitchen fuel, and other facilities including establishment of community kitchen or canteens for the migrant workers (Table 6.1).

Table - 6.1: Financial Provision for Energy Conservation Measures

S. No.	Particulars	Amount (Rs. in lacs)
1	LPG and Kerosene Depot Construction	1.00
2	For supply of Gas and Cylinders	1.50
3	For supply of Kerosene Supply	0.50
4	Distribution of Pressure Cookers and Solar Cookers	0.25
5	Community Kitchen (1 Nos.)	1.00
6	Canteen (1 No.)	0.25
	Total (Rs. in lacs)	4.50

CHAPTER - 7: MUCK DISPOSAL PLAN

7.1. INTRODUCTION

For construction of different components of the project, substantial surface and underground excavation in over burden and rock for Barrage intake structure, intake tunnel, desilting chambers, silt flushing tunnel, headrace tunnel, surge shaft, pressure shaft, power house and tailrace tunnel would be generated. The excavation shall result in large quantity of excavated material i.e. muck which have to be evacuated, disposed off and roller compacted or laid on mild slopes pari-passu with the excavation work to such designated areas where the muck piles do not substantially interfere with either environment / ecology or the river flow regime and do not cause turbidity impairing the quality of water. The disposal of muck has to be scientifically planned keeping in view the economic aspects necessitating nearness to the muck generating component of work, which understandably reduce the travel time of dumpers, less interference to surface flow and ground water aquifer and disposition of habitation.

The proposed Aulliya Medium Irrigation Project is located on the Ghorpachhar River. The project envisages construction of 20.80 m high dam on Ghorpachhar River. Large quantity of material would be excavated from the Head Works, In addition the surge shaft, penstock, switch yard, etc. and the approach roads would also generate a large amount of muck.

7.2 QUANTITY OF MATERIAL TO BE EXCAVATED

The muck quantity expected to be generated from various project components is given in Table 7.1. The total quantity/volume of material (muck) to be dug out or excavated during the construction of various project components is estimated to be 513225 cubic meters including the 40% swelling factor and utilization of 25% of muck generated by the underground works. For surface works the utilization of generate muck is taken on higher side as this excavated material is found to be good for construction purpose after the laboratory tests.

7.3 DUMPING SITES

The selection of muck disposal sites was carried out considering the quantity of the muck, landscape, cost effectiveness, nearness to source of generation, absence of ground and surface water, relief and scope for afforestation works. All the dumping locations shall be well supported at base and at higher elevation by suitable retaining structures. Subsequently all the spoil tips (muck disposal sites) will be developed by taking up plantation through bio-technological methods to generate a thick forest canopy over them. Two (2) muck dumping sites have been identified matching the criteria. The details of dumping sites along with their total capacity and amount of muck to be disposed are enumerated in Table 7-1.

Table – 7.1: Details of Muck Disposal Sites

Sl. No.	Name of the Dumping Site	Location of the Dumping Site	Area in Ha.	Capacity in cum	Volume of Muck to be Dumped
1	Muck Disposal Site Zone – 1 (MDSZ – 1)	Approx. 2200 m downstream from dam axis, Right Bank	9.55	191090	461417
2	Muck Disposal Site Zone – 1 (MDSZ – 1)	Approx. 1850 m downstream from Dam axis, Left Bank	13.5	270327	

7.4. DESCRIPTION ON MUCK DISPOSAL SITES

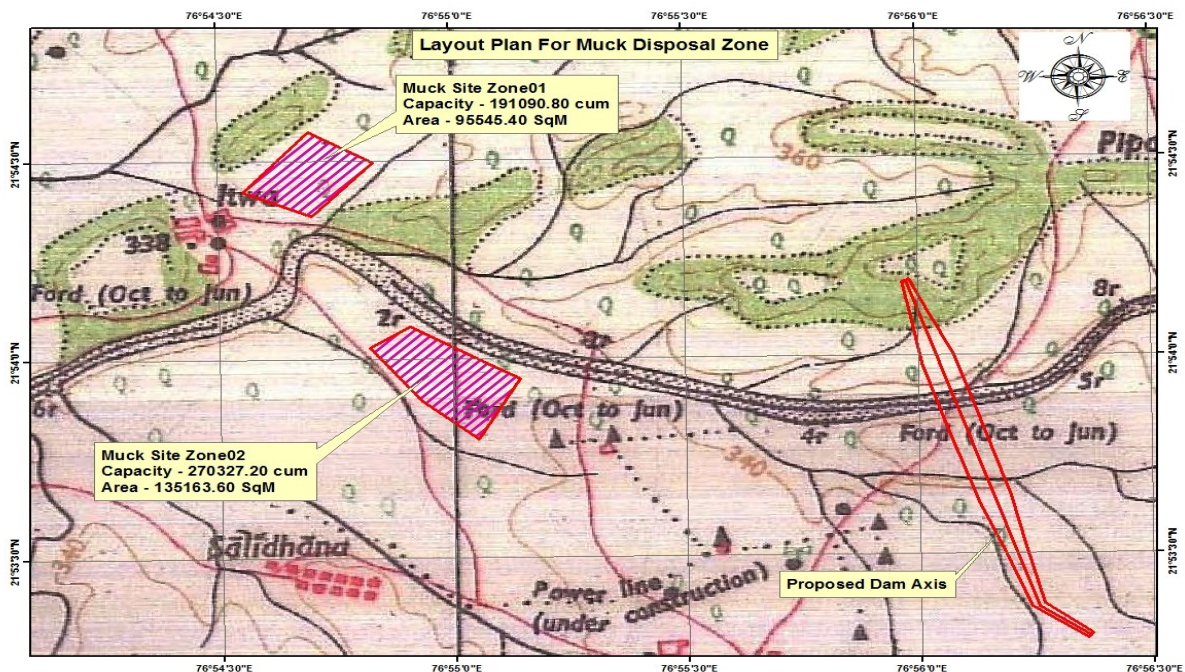
7.4.1. Muck Disposal Site Zone - 1

The proposed muck disposal site 1 is located about 2200 m approx. Towards downstream of Dam axis on Right bank of Ghorpachhar River. The site is located approx. 70 m away from the river bank at HFL of the river. The plan area of the site is 9.55 ha with a capacity of 191090 cum of muck generated due to construction.

7.4.2. Muck Disposal Site Zone -2

The proposed muck disposal site 2 is located about 1850 m upstream of dam axis on left bank of Ghorpachhar River. The site is located more than 120 m away from the river bank at HFL. The plan area of the site is 2.48 ha with a capacity of 270327 cum of muck generated due to construction.

Figure – 7.1: Muck Disposal Site Zone



In total 461417 cum of muck shall be dumped in Muck Disposal Site 1, and 2 and properly Roller compacted. After the capacity of any disposal area is exhausted, the top surface would be levelled, graded and provided a gradual slope for efficient drainage. The surface so available would be put to greenery development.

7.5. PROCESS OF DUMPING

The main objectives of process of muck dumping and restoration of these muck disposal sites are:

- To protect and control soil erosion
- To create greenery in the muck disposal areas
- To improve and develop the sites into recreational sites
- To ensure maximum utilization of muck for the construction purpose
- To develop the muck disposal sites/ dumping yards to blend with the surrounding landscape
- To minimise damages due to the spoilage of muck in the project area.

Suitable retaining walls shall be constructed prior to dumping of muck and terraces would be developed so as to support the muck on vertical slope and for optimum space utilization. Loose muck would be compacted layer-wise. The muck disposal area will be developed in a series of terraces of retention walls. In between the terraces, catch water drains will also be provided. The terraces of the muck disposal area will be ultimately covered with fertile soil and suitable plants will be planted adopting suitable bio-technological measures.

In addition, drainage measures and land levelling shall also be required to be made. The estimated cost for these engineering measures is Rs. 40.27 lacs (Table 7.).

The project authorities would ensure that the dumping yards blend with the natural landscape by developing the sites with gentle slopes, bunds, terraced and water ponds, patches of greenery in and around them. These sites can also be developed later as recreational parks and tourist spots with sufficient greenery by planting ornamental plants. The re-vegetation of dumping yards through 'Integrated Biotechnological Approach' would be undertaken. It may be necessary to inoculate the spoil dumps for development of landscape as the soils would be poor in nutrients. This can be developed through culture of microorganism or vermin-culture practices at the nurseries developed for this purpose. This task can be undertaken by National Environmental Engineering Research Institute, Nagpur or CEMDE, University of Delhi which have the required technology in the field of reclamation of derelict and degraded lands.

All the spoil areas will be developed as per the latest technology of dumping, the impact of rain, the time and angle of soil setting. In addition sprinkling of water may also be resorted to, if required to avoid or minimize dust pollution. Proper drainage system also has to be provided to ensure unobstructed flow of runoff. Planting with suitable species of trees, shrubs and other biomass will also be initiated.

7.6. IMPLEMENTATION OF ENGINEERING MEASURES AT MUCK DISPOSAL SITE

It has been observed that after disposal of muck, it creates problem as it is susceptible to scattering unless the muck disposal yards are supported with engineering measures such as gabions. All the

dumping sites need proper handling to avoid spilling of muck into the river water while dumping and in the post dumping stages. All the muck disposal sites have to be developed from the ground level either by providing stonemasonry or by gabion structure. The costing of engineering measures has been worked out based on gabion structure. In all the muck dump sites, the muck brought in dumpers shall be dumped and manually spread behind the crates and roller compacted in such a manner that rock mass is properly stacked behind the crates with minimum of voids.

7.7. IMPLEMENTATION OF BIOLOGICAL MEASURES AT MUCK DISPOSAL SITE

Biological measures, however, require special efforts as the disposed muck will be devoid of nutrients and soil contents to support vegetation. The selection of soil for spreading over such an area would require nutrient profiling of soil for different base elements. Suitable mixture of nutrients would be done before placing the soil on the top surface of muck disposal areas to have administered growth of forest canopy.

7.7.1. Plantation Technique

In view of the peculiar site conditions, particularly the soil conditions, the planting technique for all the categories of the plants has to be very site specific and suited to the stress conditions as anticipated and discussed above. The planting substrates would need to be considerably improved to support the plants in their initial stages of establishment. The moisture retention capability, availability of nutrients and soil aeration, permeability and porosity would require intervention and assistance.

Multi-level and multipurpose plantations are proposed to be raised on the muck dumping sites as also in road side strips using grasses, shrubs and bushes in the understory and trees in the upper story. Nursery raised grass slips, seedlings of shrubs & bushes and tree species would be planted in the area combined with grass sowing in patches. In addition, cuttings of bushes and shrubs can also be planted to supplement the nursery raised stock but this would substitute requirement of raising the nursery of these species. Intimate mixture of species would be avoided right at the planning stage and would be strictly followed during planting. Grasses would be mixed by groups in rows, shrubs and bushes by group again in rows.

Grass slip planting and grass seed sowing would be done in strips at 0.10 m x 0.10 m spacing in the prepared staggered patches of 1 m x 0.5 m with a depth of 0.30 m. Soil mixture would be used while filling the patches. Shrubs and bushes would be planted in elongated strips of 1.5 m x 0.5 m with a depth of 0.45m. Soil mixture would be used while filling the patches. Each patch would have two rows of planting. Planting of trees would be done in pits of 0.60 m x 0.60 m x 0.60 m size. Soil mixture would be used while filling the pits. Balance dug up soil/ muck will be stacked on downhill side of the pit for trapping the rain water and allowing it to percolate in the pit.

It is proposed to use soil mixture in the pits & patches consisting of soil imported from nearby areas mixed with compost or vermin-compost manually. The ratio for the mix would be 5 parts: Compost/manure 2 parts: Sand 2 part: and humus or vermin-compost 1 part. This will make nutrients

available for the plants in the preliminary stages and also help increase soil aeration, porosity & permeability and improved moisture available for the plants.

The stabilization sites from the time of execution of biological measures would be protected with barbed wire fencing on 2m high RCC posts and provided with inspection paths. Since the muck dumping sites are being provided with the wire crate (gabion) wall on the valley side (towards river) which is not negotiable by animal and human beings, fencing would not be required along the entire perimeter. Hence, it would be done on the vulnerable sections i.e. towards the hillside only. The plantations under biological measures would be maintained for a period of 3 years by watering the plantation during dry seasons, mortality replacement and repair of fencing & inspection paths within the area. The task of irrigation would be performed by the watchmen provided in the cost estimate. The proposed costs include raising plants, grass seedlings and also for mortality replacement. Although the sites would be either levelled or finished in a grade, yet due to rain and sliding etc., they tend to develop rills and gully. As such, while carrying out plantation; suitable soil conservation measures would also be taken.

7.7.2. Species for Plantation

Afforestation with suitable plant species of high ecological and economic value and adaptable to local conditions will be undertaken in accordance with canopy cover requirement. Some plant species have been suggested in the Table 7.2. The selection of plant species, propagation and cultivation technique would be done in coordination with the institutes like State Forest Research Institute, Itanagar; Rajiv Gandhi University, Itanagar and North-Eastern Regional Institute of Science and Technology, Nirjuli.

Table - 7.2: Suggested Species for Plantation

Sl. No.	Name of Species	Family
1	<i>Abies densa</i>	Pinaceae
2	<i>Achyranthes aspera</i>	Amaranthaceae
3	<i>Alangium alpinum</i>	Alangianaceae
4	<i>Alnus nepalensis</i>	Betulaceae
5	<i>Aristolochia griffithii</i>	Aristolochiaceae
6	<i>Berberis aristata</i>	Berberidaceae
7	<i>Betula alnoides</i>	Betulaceae
8	<i>Daphnae papyracea</i>	Thymelaeaceae
9	<i>Lyonia ovalifolia</i>	Ericaceae
10	<i>Pinus roxburghi</i>	Pinaceae
11	<i>Pinus wallichiana Pinaceae</i>	Pinaceae
12	<i>Populus sp.</i>	Salicaceae
13	<i>Rhododendron campanulatum</i>	Ericaceae
14	<i>Rhododendron cinnabarium</i>	Ericaceae
15	<i>Salix sp.</i>	Salicaceae
16	<i>Tsuga dumosa</i>	Pinaceae
17	<i>Zanthoxylum armatum</i>	Rutaceae

7.8. BUDGET FOR MUCK DISPOSAL PLAN

An estimation has been made for engineering measures of muck disposal plan including levelling and construction of drainage channels as Rs. 40.27 Lakhs whereas biological measures as Rs. 27.75 Lakhs. The cost break-up of engineering and biological measures are detailed in Table 7.3.

Table - 7.3: Cost Estimate for Engineering & Biological Measures

S. No.	Name of the work	Unit	Quantity	Rate	Amount (Rs.Lakhs)
Muck Disposal Site – 1					
1	Raising of Plantation (Creation Cost)				
	Survey/ demarcation/plantation planning/site clearance	Days	140	150	0.21
	Pit Digging /Soil working/ Manuring & Planting	Days	270	150	0.41
	Seedling cost	Number	10000	8.25	0.83
Sub-Total					1.44
2	Maintenance of Plantation Cost for 3 years				
	Seedling casualty replacement (2nd year 15% and 3rd Year 10%)	Number	2500	8.25	0.21
	Tending Operation (1st Year Operation)				
	3 weeding (1 DLS per weeding for 100 plants)	Days	300	150	0.45
	Tending Operation (2nd Year Operation)				
	2 weeding (1 DLS per weeding for 100 plants)	Days	195	150	0.29
	Tending Operation (3rd Year Operation)				
	1 weeding (1 DLS per weeding for 100 plants)	Days	100	150	0.15
Sub-Total					1.10
3	Fencing Cost				
	i) Erection of barbed wire fencing (1.2 m) cost	Meter	2500	227.85	5.70
	ii) Maintenance of barbed wire fencing @5 % of erection cost for 2nd and 3rd year				0.28
Sub-Total					5.98
4	Grass carpeting cost for ha	Ha.	9.55	30000	2.87
Total (1+2+3+4)					11.38
Contingency @ 5 %					0.57
Grand Total					11.95
Muck Disposal Site – 2					
1	Raising of Plantation (Creation Cost)				
	Survey/ demarcation/plantation planning/site clearance	Days	190	150	0.29
	Pit Digging /Soil working/ Manuring & Planting	Days	380	150	0.57
	Seedling cost	Number	140	8.25	0.01
Sub-Total					0.87
2	Maintenance of Plantation Cost for 3 years				
	Seedling casualty replacement (2nd year 15% and 3rd Year 10%)	Number	3550	8.25	0.29
	Tending Operation (1st Year Operation)				
	3 weeding (1 DLS per weeding for 100 plants)	Days	400	150	0.60
	Tending Operation (2nd Year Operation)				
	2 weeding (1 DLS per weeding for 100 plants)	Days	270	150	0.41
	Tending Operation (3rd Year Operation)				
1 weeding (1 DLS per weeding for 100 plants)	Days	135	150	0.20	

S. No.	Name of the work	Unit	Quantity	Rate	Amount (Rs.Lakhs)
				Sub-Total	1.50
	<i>Fencing Cost</i>				
3	i) Erection of barbed wire fencing (1.2 m) cost	Meter	3600	227.85	8.20
	ii) Maintenance of barbed wire fencing @5 % of erection cost for 2nd and 3rd year				0.41
					8.61
4	<i>Grass carpeting cost for ha</i>	Ha.	13.55	30000	4.07
				Total (1+2+3+4)	15.04
				Contingency @ 5 %	0.75
				Grand Total	15.80
				Total for Both the Zones	27.75

Thus, total budget for muck disposal plan has been estimated as INR Rs. 68.02 Lakhs

CHAPTER - 8: LANDSCAPING & RESTORATION PLAN

8.1. INTRODUCTION

The proposed Aulliya Medium Irrigation Project on Ghorpachhar River would require construction of various project components and infrastructural facilities like residential camps/ colonies for its staff, offices, contractor's and labour colonies in addition to various access roads and other structures.

During construction phase of the project, number of temporary construction sites and working areas will come up. In addition to this mining for construction material will also be carried out. To restore these areas to its original landscape as much as possible and retain its aesthetic values following restoration measures have been suggested. In addition avenue plantations around the colonies and working sites will be carried out.

8.2. LANDSCAPING AND RESTORATION OF CONSTRUCTION AREAS

The proposed Aulliya Medium Irrigation Project would involve construction of Dam, Power house, Adits, headrace tunnel, residential and staff colonies, roads, etc. These activities will result either in the modification or destruction of the existing landscape of the area. It is therefore imperative that after the project work and related activities are over restoration work should be carried out in these disturb areas to bring them back to their similar or near-similar pre-construction conditions and land use. Different project related activities will require acquisition of government as well as private land. The acquired land will also be used for dumping of muck and other garbage from the colony area. In addition to the habitat disturbance, project related activities will also result in the accumulation of large amounts of dumps at various construction sites, which need to be either relocated or as an alternative can be utilized for landscaping. Restoration success will, however largely depend on the topography of the area, the type of constructional activities and their detrimental effects on the terrain and the natural habitats.

There will be indirect disturbance to the area due to increase in the human population and traffic movement. It will be essential for the project authority to restore the area back to its original state.

8.2.1. Disturbed Sites & Their Restoration

Construction activities like roads, muck dumping sites, quarry sites, camps/ colonies, workshops, offices, etc. which will change the existing land use/ land cover in the region. After completion of the construction work, it is required to restore the disturbed area to its original condition. Various engineering and biological measures have been suggested for the restoration of Aulliya Medium Irrigation Project affected areas. Proposed mitigation measures will also help to arrest soil erosion in the region. Restoration of quarry sites, roads and colony area is discussed and a detailed plan is given for the landscaping of the region.

- i. Proposed Access Roads and Infra-Structure: Considering these broad aspects of existing access and infrastructure, the detailed planning for the approach roads, bridges, housing, offices, stores, construction plants and common facilities like hospitals, canteen, etc. have been done.

The requirement of access roads to the work sites from the existing road is given at Table 8.1

Table - 8.1: Details of project roads proposed to access various project components

Road No.	Description	Road Length (m)
R-1	Proposed Road from State highway to dam site	1200
R-2	Proposed Road to Muck Disposal Sites - 1	2200
R-3	Proposed Road to Muck Disposal Sites - 2	1843
R-4	Proposed Road for Labor Camps	650

Other infrastructure include construction of colonies and camp sites, construction plants viz. crushing plant, batching and mixing plant and penstock fabrication yard.

An adequate capacity batching and mixing plant will be installed near intake to cater the requirements of concrete for all inlet side works including tunnel lining. Other batching and mixing plants of requisite capacity will be provided near power house site for concreting work in power house complex, pressure shaft, head race tunnel and surge shaft.

- ii. Restoration and Landscaping of Construction sites: Setting up of infrastructure for construction including colonies for labor will lead to clearing of the vegetation and forests. The forest land at these sites will be cleared for the movement of heavy equipment's required for different project related activities which would lead to the fragmentation and destruction of the habitats at these sites. Following measures will be applied for the rehabilitation and landscaping of the construction sites:
- i). Herbaceous plants and tree seedlings, grown in nurseries or in greenhouses, will be sown in alternating rows. The growth of tree shrubs and herbaceous species will provide adequate erosion control, add vegetation variety for aesthetic values and provide the habitat for wildlife.
 - ii). The rows of herbaceous plants will be later used for the cultivation of medicinally important plant species such as *Dioscorea deltoidea*, *Origanum vulgare*, *Thymus linearis*, *Hedychium spicatum*, *Bergenia ciliata*, etc.
 - iii). The choice of the tree species for plantation will depend upon the topography of the area required to be regenerated after the constructional activities. In general, *Pinus wallichiana*, *Cedrus deodara*, *Quercus semecarpifolia*, *Alnus nepalensis* and *Populus ciliata* will be planted.

- iv). The plants which fix nitrogen like Robinia pseudo-acacia (leguminous) and Alnus nepalensis (non-leguminous) will help in increasing nitrogen levels of soil, sufficient to maintain growth of non-nitrogen fixing revegetation species. Other tree species which will constitute the hardwood mix will comprise Quercus semecarpifolia, Juglans regia, Engelhardia spicata or any other species specific to the area.
- v). Trees such as Robinia pseudoacacia and Ehretia acuminata will be planted in waste and unculturable lands of the plant areas. Robinia pseudoacacia is particularly valuable in reclamation of derelict and infertile lands.

Following measures would be adopted at for the rehabilitation and landscaping of colony areas and construction sites.

- i). Proper roads and lanes would be provided inside the colony area. The open area will be covered with the vegetation. Ornamental plants and trees will be planted in rows along the roads and lanes.
- ii). Retaining walls will be built to avoid the landslides and slips. Proper channels would be provided inside the colony to drain out the rain/ domestic water.
- iii). Parks and play grounds for children would be developed in and around the colony area.
- iv). After the project activity is over construction sites and other temporary settlements would be splattered with the top soil (separated out before construction). These leftover can support the growth of mosses and lichens which will act as ecological pioneers and would initiate the process of succession and colonization. This will provide necessary cushion and support for the growth of seeds of other plants to germinate.

8.3. LANDSCAPING & RESTORATION OF QUARRY SITES

To meet the requirement of coarse and fine aggregates for all components of the project, 1 Nos. in situ rock quarries and 1 Nos. slide material will be deposited in the vicinity of the project. The quarry sites would lead to no disturbance to forest land and but it would lead to disturb about 10 - 15 ha of private land. The details of quarry sites cost estimation are given in Table 8.2.

Table - 8.2: Details of the quarry sites in the Aulliya Medium Irrigation Project

Quarry Sites	Location of Quarry Sites	Area in ha
I	<i>In situ</i> Rock Quarry	6.50
II	Landslide Material Deposited on Ghorpachhar River Bed	4.50
	Total area to be restored	11.00

In addition to the above, the rock material expected to be available from excavation during construction of basin, sluice and spillway, etc. might also be evaluated for its suitability for use as crushed coarse aggregate and crushed sand in concrete for later use. Based on the concrete and

shotcrete quantities, total quantity of raw material for production of coarse aggregate works out to be 7.5 lacs cum.

Opening of the quarries will cause visual impacts because they remove a significant part of the hills. Other impacts will be the noise generated during aggregate acquisition through explosive and crushing, which could affect wildlife in the area, dust produced during the crushing operation to get the aggregates to the appropriate size and transport of the aggregates, and transport of materials to the nearby rivers. The quarrying for rock material in the proposed project would lead to removal of vegetation cover, top soil and leave the area barren. After the completion of mining activity, these areas will be restored to their normal habitat conditions.

Standard mitigation measures against erosion and sedimentation, noise and air pollution will be taken, in particular for the use of explosive. At the end of the exploitation, quarries will be rehabilitated. This will include re-establishment of vegetation, restoration of natural watercourses, avoidance of flooding of the excavated areas, achievement of stable slopes, and avoidance of features, which would otherwise constitute a risk to health and safety or a source of environmental pollution.

The measures adopted for landscaping of these quarry sites have been described below:

I. Measures to be adopted before quarrying

The top 6-12" of soil will be removed before starting the quarrying activity or any other surface disturbance. This top soil will be kept separate and stock piled so that it can be reused after quarrying is over for rehabilitation of sites.

II. Measures to be adopted after quarrying

- Diversion of run off: Effective drainage system will be provided to avoid the infiltration of run-off and surface waters into the ground of quarry sites.
- Filling of depressions: Removal of rocks from quarry sites for different construction works will result in the formation of depression and/or craters. These will be filled by the dumping materials consisting of boulders, rock, gravel and soil from nearby plant/working sites.
- Construction of retaining walls: Retaining walls will be constructed at the filled up depressions of quarry sites to provide necessary support particularly where there are moderately steep slopes.
- Rocks for landscaping: After the quarrying activities are over, these sites will be splattered with the leftovers of rocks and boulders. These boulders and rocks can support the growth of mosses and lichens, which will act as ecological pioneers and initiate the process of succession and colonization. The boulders of moderate size will be used to line the boundary of a path.
- Laying of the top soil: The depressions/craters filled up with rock aggregates will be covered with top soil. Fungal spores naturally present in top soil will aid plant growth and natural plant succession. The top soil will be further enriched by organic manure and Vesicular-arbuscular

mycorrhizal (VAM) fungi. This will help in the process of soil reclamation and the early establishment of juvenile seedlings.

- Revegetation: The work plan formulated for revegetation of the dumping sites through 'Integrated Biological and Biotechnological Approach' would be based upon the following parameters:
 - i). Evaluation of rock material for their physical and chemical properties to assess the nutrient status to support vegetation.
 - ii). Formulation of appropriate blends of organic waste and soil to enhance the nutrient status of rhizosphere.
 - iii). Isolation and screening of specialized strains of mycorrhizal fungi, rhizobium, azotobacter and phosphate solubilizers (bio-fertilizers inoculums) suitable for the mined out sites.
 - iv). Mass culture of plant specific biofertilizer and mycorrhizal fungi to be procured from different institutions/organisations which are engaged in the phyto-remediation activity of degraded areas.
 - v). Plantation at quarry sites/areas using identified blend and biofertilizer inoculum.

8.4. PLAN IMPLEMENTATION

The landscaping and restoration plan will be implemented with help of landscaping experts and in consultation with Madhya Pradesh Horticulture Department as well as Forest Department of Khandwa Division and the coordination and funding will be provided by the project proponent. The help of Centre for Environmental Management of Degraded Ecosystems (CEMDE) at the University of Delhi may also be sought for the requisite technical and scientific expertise for successful implementation of this plan.

8.5. COST ESTIMATES

The estimated cost for the restoration works and landscape designing would be Rs. 40.50 lacs and details of the same are given in Table 8.3.

Table - 8.3: Details Cost Estimate for Landscaping and Restoration Plan for Aulliya Project

Sl. No.	Item of Work	Amount (Rs. in lacs)
A	Pre-construction measures	
	Removal of top soil, transportation and stock piling	15.00
B	Post-construction restoration measures	
i	Diversion channels	7.50
ii	Filling of the craters	2.00
iii	Preparation of mounds	2.00
C.	Reclamation and Phytoremediation	

i)	Field works:	
	Collection of micro flora from the field	6.00
	Nursery development	4.00
	Plantation and maintenance of successfully colonized seedlings	4.00
	Total (A+B+C) (Rs. in lacs)	40.50

CHAPTER - 9: AIR & WATER MANAGEMENT PLAN

9.1. IMPACTS ON PHYSICAL ENVIRONMENT

Hydroelectric projects are generally considered cleaner source of energy as the environmental impacts are considerably lower during the project operation phase. However, the construction phases of such project, in ecologically rich areas, pose serious threats to surrounding environment. Therefore, it is important to identify and quantify such impacts and formulate mitigation measures in order to have minimum damage to project surrounding areas during construction period.

During construction phase, the activities like site preparation, approach roads, excavation, drilling, blasting, foundation, tunnelling, deployment of machinery, erection, transportation, dumping will be taken up. Tunnelling and foundation works will involve land excavation, affecting environment by noise and dust pollution. Structural work, deployment of machinery, approach roads construction and erection work will also result in dust, noise pollution and vehicular traffic. Material handling and transportation would also lead to significant increase in air and noise pollution. Muck generation, its transportation and disposal may pollute surface water due to the generation of large quantities of suspended particulate matter. Wastewater from labor camps and colonies may also pollute water bodies in the area.

The likely impacts on the physical environment during the construction phase are listed in Table 9.1. In addition, another important aspect to be taken care of during the construction phase of the project is that of "Safety". Deployment of large number of labour during the five years construction phase in difficult terrains, underground works, use of machinery and equipment, use of explosives for blasting, etc. may lead to serious accidents, if adequate safety measures are not adopted.

Table - 9.1: Impacts during Construction Phase

Construction & Operational Phase	Activity	Potential Environmental Impact
a) Site work /other facilities.	i) Cleaning and grading	Dust emission
	ii) Temporary facilities, such as sheds, approach roads, sanitary facilities	Dust emission, water pollution and solid waste generation
	iii) Earth work comprising of excavation and trenches	Soil erosion, run off, increase in traffic, dust emission
	iv) Foundation work, piling and construction of checkbarrages	Dust, visual and noise pollution, wastewater generation
	v) Construction of permanent structures like roads, colony, etc.	Dust and noise pollution and wastewater generation

Construction & Operational Phase	Activity	Potential Environmental Impact
	vi) Mechanical erection and utility systems	Dust, noise and visual impact
b) Construction of Approach roads, tunnelling works and foundations	i) Excavation	Dust, soil erosion, wastewater generation and noise
	ii) Drilling & Blasting	Dust, noise and health hazards
	iii) Dumping	Dust, noise and river pollution
	iv) Transportation	Dust, noise and visual
c) Accident	In all construction activities	Major or minor health impact

9.2. AIR ENVIRONMENT

As was observed during various field visits to the study area, the air quality in the area is pristine. In the absence of industries, the only source of air pollution in the area at present is vehicular traffic and few other anthropogenic activities like burning of fuel wood, garbage, etc. or occasional use of DG sets in the area. However, quantity of such emissions is relatively small and sources are scattered, therefore, ambient air quality is generally good for the entire area.

Construction and operation of the Aulliya Medium Irrigation Project will definitely impact the air quality of the area. Five years construction period will involve exploration activities, construction of dam, tunnels and approach roads, operation of batch mixing plants, aggregate processing plants, crushers, dumpers, cranes and other construction equipments, operation of DG sets for construction power, quarrying operations, muck generation and disposal, repair and maintenance workshops, penstock fabrication, transportation of men and material, etc. All these activities will contribute to air pollution in the area. The nature and extent of impact on air environment will vary from time to time, location to location and through different stages of development of the project. As all these activities contribute to fugitive emissions in various forms, quantification of air pollution at this stage is not possible.

9.2.1. Impacts on Ambient Air Quality

Considerable amount of air pollution will take place during different stages of construction. Suspended Particulate Matter (SPM) is the main pollutant during construction phase, released in the form of fugitive dust from various operations and activities. Additionally, SO₂ and hydrocarbons will also be released as product of fuel burning during operation of equipments.

The pollutants released during the construction activities may cause immediate effect on the construction workers who are directly exposed to them. However, the pollutant will not travel to longer distances as the project site is located in between hills. Disadvantage of such locations is that pollution generated in the valley do not get dispersed easily, hence even smaller quantities have serious impacts.

Pollution due to Fuel Combustion in Equipments

Major fuel consumption i.e. that of diesel will be in DG sets for meeting construction power requirement, which is estimated as 9 MVA. As this power requirement will be at different construction sites, it will be met through a number of DG sets installed at different construction sites, colonies and workshops. Operation of DG sets and other construction equipments requires combustion of diesel. The major pollutant which gets emitted as a result of combustion of diesel is SO₂. The SPM emissions are generally not significant; however, amount depends upon quality of fuel used.

To reduce the impact of air emissions from DG sets, it is important to have adequate stack height of these DG sets to provide for plume dispersion and reduce the impact on receptors. Minimum stack height will be worked out based on capacity of DG sets as per the following formula:

$H = h + 0.2\sqrt{KVA}$ Where,

H = Total height of stack in meter

h = Height of the building in meter where the generator set is installed

KVA = Total generator capacity of the set in KVA

These stacks form part of the DG assembly including the acoustic housing to control sound levels, hence their cost is not included in the EMP cost.

Emissions from Construction Equipment

Following major construction and repair facilities will be generated for the project which will lead to air pollution in the surrounding areas:

Repair and Maintenance Workshops: Two base workshops have been proposed for earth moving equipment, for concreting and drilling equipments near the dam and the powerhouse areas. Additionally, to cater for day to day maintenance and running repairs, small shops would be set up outside each portal of the various adits.

These plants and workshops will generate fugitive emissions comprising mainly the suspended particulate matter during loading/unloading of material and repair and maintenance activities. Major impact will be on the immediate vicinity i.e. affecting the workers involved in these operations. Provision of appropriate dust masks and other required Personal Protective Equipment at all the locations and enforcing their use by workers will help reducing emission's impact at workplace environment.

Depending on wind direction and other meteorological factor these emissions may also disperse in atmosphere and will affect the surrounding area. The impacts will remain limited to immediate surrounding and vary with wind direction. Best mitigation method is to keep the emissions under check so that they do not spread to outside the battery limits of these plants.

Fugitive Emissions from various sources

Construction activities such as tunnelling, excavation, road cuttings, etc. are associated with large amount dust generation. Additionally, quarrying operations, muck transport and dumping, transportation and storage of construction material like sand, fine aggregate, etc. generate large amount of dust. Continuous exposure to fugitive dust has serious health effects on workers and residents of nearby areas. Impacts are local and temporary, and their significance can be reduced by adopting various mitigation measures such as controlling emissions at source, water sprinkling and use of PPEs.

Emission due to Vehicular Traffic

The project construction will involve transportation of large quantities of construction material to the project site and all the transportation in the project area will be done by road. This would lead to substantial increase in heavy vehicular traffic in the area. Emissions from vehicular traffic, due to diesel burning, will lead to air pollution in the area. The impact cannot be eliminated, however, it can be reduced by enforcing on transporters that the vehicles used should have valid PUC certificate.

9.2.2. Mitigation Measures for Air Emissions

The best way of impact mitigation is to prevent the event occurring. All efforts should be made to locate the developmental activities in an area free of agricultural lands, ecologically sensitive, erosion, forests, flooding, human settlements, landslides, natural scenic beauty, water logging. However, practically, this is not possible as project design criteria govern the location of various activities. Therefore, the next step is to look at the raw materials/technologies/ processes alternatives which produce least impact i.e. adopting or using processes or technologies which are efficient and produce recyclable wastes/ minimum waste/wastes that can be easily disposed, without seriously affecting the environment. However, if the developmental activities produce the adverse impact action has to be taken to mitigate the same. Following are some of the recommendations on mitigation measures.

- I. Use of DG sets to be kept at minimum and only for captive power generation, if possible
- II. Location of DG sets and other emission generating equipment should be decided keeping in view the predominant wind direction so that emissions do not effect nearby residential areas.
- III. Stack height of DG sets to be kept in accordance with CPCB norms, which prescribes the minimum height of stack to be provided with each generator set to be calculated using the following formula:
 - $H = h + 0.2 \times \sqrt{KVA}$
 - H = Total height of stack in metre
 - h = Height of the building in metres where the generator set is installed
 - KVA = Total generator capacity of the set in KVA
- IV. Proper maintenance for efficient functioning of DG sets and other construction equipment is essential to minimize exhaust
- V. Construction equipment and vehicles will be turned off when not used for extended periods of time. Unnecessary idling of construction vehicles to be prohibited.

- VI. The entire contractor's vehicle should have valid PUC certificate and same condition may be enforced on transporters bringing in material for construction.
- VII. Effective traffic management to be undertaken to avoid significant delays in and around the project area.
- VIII. Road damage caused by sub-project activities will be promptly attended to with proper road repair and maintenance work.
- IX. Wherever practical, excavated spoils to be removed as the contractor proceeds along the length of the activity.
- X. When necessary, stockpiling of excavated material will be covered or staged offsite location with muck being delivered as needed during the course of construction.
- XI. Excessive soil on paved areas will be sprayed (wet) and/or swept and unpaved areas will be sprayed and/or mulched. The use of petroleum products or similar products for such activities will be strictly prohibited.
- XII. Contractors will be required to cover stockpiled soils and trucks hauling soil, sand, and other loose materials (or require trucks to maintain at least two feet of freeboard).
- XIII. Dust sweeping - The construction area and vicinity (access roads, and working areas) shall be swept with water sweepers on a daily basis or as necessary to ensure there is no visible dust.
- XIV. All the construction workers and other staff, who get directly exposed to dust, should necessarily be provided with dust masks.

The project authorities will work closely with representatives from the community living in the vicinity of project area to identify areas of concern and to mitigate dust-related impacts effectively (e.g., through direct meetings, utilization of construction management and inspection program, and/or through the complaint response program).

9.2.3. Noise Levels

The sound will be generated during almost all the construction activities such as tunneling, blasting, movement of vehicles, operation of construction machines and equipments, repair and maintenance work, operation of DG sets, etc. Continuous exposure of workers to high sound levels may result in annoyance, fatigue, and may cause temporary shift of threshold limit of hearing and even permanent loss of hearing. As is evident from the baseline data, in the absence of vehicular traffic, sound levels in the area are generally low. There are no industries or any other source of noise in the area.

Construction phase will generate noise at various locations in the project area and is likely to affect residents and construction workers. The simultaneous operation of some equipment may increase the noise manifolds, however, resultant increase in noise levels will depend upon location of such equipment with respect to habitation, availability of the silencers/ mufflers, condition of the equipment, losses during transmission, etc. Increase in vehicular traffic in the area will also contribute to high sound levels in the area. Construction activities such as tunneling, blasting, etc. also lead to high noise generation.

Sound attenuates with the distance and even if all the attenuation factors are removed, direct sound levels reduce by 6 dB(A) with every doubling of distance. Further, the sound level reduces substantially when the wave passes through a barrier. Therefore, if location of construction

equipment is planned keeping in view the safe distance from habitation, impact can be greatly reduced on large section of population. Workers who are directly exposed need to use Personal Protective Equipments (PPEs) to reduce the impact.

9.2.4. Mitigation Measures for Noise Impact

Impacts due to high noise levels can be greatly reduced by adopting mitigation measures, as discussed below:

- Location of the construction equipment to be decided keeping in view the safe distance from habitation.
- Contractors will be required to maintain properly functioning equipment and comply with occupational safety and health standards.
- All the construction equipment will be required to use available noise suppression devices and properly maintained mufflers.
- Staging of construction equipment and unnecessary idling of equipment within noise sensitive areas to be avoided whenever possible.
- Minimize the use of noise producing equipment during night hours to avoid the disturbance to locals and wild animals of surrounding area.
- Use of temporary sound fences or barriers to be evaluated.
- Notification will be given to residents within 300 feet of major noise generating activities. The notification will describe the noise abatement measures that will be implemented.
- Monitoring of noise levels will be conducted during the construction phase of the project. In case of exceeding of pre-determined acceptable noise levels by the machinery will require the contractor(s) to stop work and remedy the situation prior to continuing construction.
- Vehicles to be equipped with mufflers recommended by the vehicle manufacturer.

The following Noise Standards for DG sets (15-500 KVA) are recommended for the running of DG sets during the construction.

- The total sound power level, L_w , of a DG set should be less than, $94+10 \log_{10} (KVA)$, dB(A).
- Noise from the DG set should be controlled by providing an acoustic enclosure or by treating the enclosure acoustically.
- The Acoustic Enclosure should be made of CRCA sheets of appropriate thickness and structural/ sheet metal base. The walls of the enclosure should be insulated with fire retardant foam so as to comply with the 75 dBA at 1m sound levels specified by CPCB, Ministry of Environment & Forests.
- The acoustic enclosure/acoustic treatment of the room should be designed for minimum 25 dB(A) Insertion Loss or for meeting the ambient noise standards, whichever is on the higher side.
- The DG set should also be provided with proper exhaust muffler with insertion loss of minimum 25 dB(A).
- Proper efforts to be made to bring down the noise levels due to the DG set, outside its premises, within the ambient noise requirements by proper siting and control measures.

- A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacturer which would help prevent noise levels of the DG set from deteriorating with use.

9.3. WATER ENVIRONMENT

Construction work require large quantities of water to be used in various processing plants for material preparation; curing purposes, cooling water in equipments, domestic usages in colonies, etc. wastewater will be generated in various forms processing plants, workshops and residential areas. Additionally, during the construction work, muck transportation and transportation of materials; large quantities of suspended particulate matter will be generated to end up in the water body. As the construction period is long such impacts can permanently deteriorate the water quality in the area, if adequate mitigation measures are not adopted.

The following mitigation measures are suggested to be followed during the construction of the project:

- Minimize flow variation from the mean flow. Adequate river water will be secured to meet the requirements of riparian people, livestock, and wild animals and to sustain the aquatic ecosystem.
- Segregation of different types of wastes at source and avoid their mixing up in the river.
- Accumulation of oil wastes in depressions should be minimised in order to avoid possible contamination of the ground water system.
- Surface runoff from oil handling areas/devices (workshops and DG operation areas) should be treated for oil separation before discharge into the environment. If oil wastes are combined with sanitary sewage, oil separation will be necessary at the wastewater treatment facility.
- All effluents containing acid/ alkali/ organic/ toxic wastes should be processed by treatment methods. The treatment methods may include biological or chemical processes.
- The impact due to suspended solids may be minimized by controlling discharge of wastes that contain suspended solids; this includes sanitary sewage and other wastes. Also, all activity that increases erosion or contributes nutrients to water (thus stimulating algal growth) should be minimized.
- For wastes containing high TDS treatment methods include removal of liquid and disposal of residue by controlled land filling to avoid any possible leaching of the fills. All surface runoffs around quarries and excavation areas should be properly channelized and taken care of.
- The growth of aquatic weeds is to be monitored in the reservoir and excess weeds will be removed.
- Fish production in the reservoir will be monitored for any possible decrease. If any unexpected negative impact occurs, fish will be restocked. Technical support will be provided to the fish farming activities in the reservoir.
- Adequacy of the fish population will also be monitored and adequate stock of fingerlings to be maintained in the hatchery.

9.4. ACCIDENTAL RISKS

In the hydro-electric projects, the environmental risk assessment is an important aspect. Larger environmental risks such as floods, landslides, etc. have been adequately covered along with their management plan at relevant sections of Environmental Management Plan. Some of the aspects posing accidental risk during construction phase, where work force and surrounding population may get affected, have been addressed below.

9.4.1. Safety during Construction

With large scale increase in construction activity of river valley projects, the number of major accidents during construction stage has increased. Further, increased construction activity has also created construction related hazards for persons working on the projects. The degree of safety achieved in project constructions has a direct bearing on the amount of effort expended to avoid accidents by those who control the conditions and practices on the project. In order to avoid accidents it should be the overall responsibility of the project authorities to provide measures for the safety of all persons working on the projects.

The standards laid down for the safety aspects should be taken during construction work. Construction activities at the site of a hydro-electric project need to take care of safety aspect for all the activities in general and for following critical activities in particular:

- ¾ Storage, handling, transportation and operation of explosives required for blasting and tunneling activities
- ¾ Underground construction work including tunneling, excavation and other related activities
- ¾ Construction at heights
- ¾ Fire safety aspects
- ¾ Cross drainage construction work
- ¾ Storage, handling, detection and safety measures for gases, chemicals and flammable liquids
- ¾ Movement of vehicles on construction site

All persons need to be made aware of the dangerous conditions and risks involved in their activities. They should be trained to take necessary precautions for their own safety as well as that of others working at site. This should typically involve following the Safe Operating Procedure (SOP) wherever applicable, use of Personal Protective Equipment (PPE) such as helmets, gloves, gum boots, safety harness, etc., remain active and alert without any influence of alcohol or other intoxicating substances during working hours.

The safety requirement generally vary according to the type of structure, type of construction methodology, type of strata encountered and number of men and type of machinery deployed at site, therefore, it is important to develop site specific construction safety procedures. Such SOPs need to be incorporated in letter and spirit and all the staff involved need to be sensitized to the importance of safety and trained. A full time safety manager, will be appointed by the project developer with duties of monitoring and audit delegated to other staff members on safety aspects.

Apart from procuring the appropriate and adequate number of PPEs it is also important to maintain sufficient number of first aid boxes and some volunteers trained in giving first aid treatment. Further, the outsiders coming to site such as drivers, helpers, etc. also need to be made aware of safety requirement of their activity. This can be achieved by putting posters carrying safety instructions for the benefit of all and giving verbal instructions at the entry point also.

Table 9.2 gives list of BIS Standards related to safety aspects during various stages of construction, installation, erection of different components and appurtenance of river valley projects, including inspection, observation and maintenance aspects from safety consideration.

Table - 9.2: List of relevant BIS Standards

Sl. No.	IS No.	Title
1	IS 10386 (Part 1):1983	Safety code for construction, operation and maintenance of river valley projects: Part 1 General aspects
2	IS 10386 (Part 2):1982	Safety code for construction, operation and maintenance of river valley projects: Part 2 Amenities, protective clothing and equipment
3	IS 10386 (Part 3):1992	Safety code for construction, operation and maintenance of river valley projects Part 3 Plant & machinery
4	IS 10386 (Part 4):1992	Safety code for construction, operation and maintenance of river valley projects Part 4 Handling, transportation and storage of explosives
5	IS 10386 (Part 5):1992	Safety code for construction, operation and maintenance of river valley projects: Part 5 Electrical aspects
6	IS 10386 (Part 6):1983	Safety code for construction, operation and maintenance of river valley projects: Part 6 Construction
7	IS 10386 (Part 7):1993	Safety code for construction, operation and maintenance of river valley projects: Part 7 Fire safety aspects
8	IS 10386 (Part 8):1995	Safety code for construction, operation and maintenance of river valley projects Part 8 Excavation
9	IS 10386 (Part 9):1998	Safety code for construction, operation and maintenance of river valley projects Part 9 Canals and cross drainage works
10	IS 10386 (Part 10):1983	Safety code for construction, operation and maintenance of river valley projects: Part 10 Storage, handling, detection and safety measures for gases, chemicals and flammable

9.5. COST ESTIMATES

Various mitigation and management measures have been discussed above to reduce the impacts of air, noise and water pollution and implement safety measures to ensure that impacts on these counts are reduced to minimum possible during the entire construction phase. To implement such measures, it is important to prepare a budget of such measures and include in the project cost so that lack of fund should not constrain their implementation.

Some of the measures suggested have already been covered under other heads of environmental management; therefore, an estimate of only additional cost is given below in Table 9.3.

Table - 9.3: Estimated cost of implementation of mitigation and safety measures

SL. No.	Particulars	Amount (Rs. in lacs)
1	Control of Air Pollution (lump sum)	7.20
2	Control of Noise Pollution (lump sum)	0.80
3	Control of Water Pollution (lump sum)	8.00
Total		16.00

CHAPTER - 10: GREEN BELT DEVELOPMENT PLAN

10.1. INTRODUCTION

A green belt around the reservoir periphery, road side and office complex/colony area will be created to avoid erosion of soil, prevention of land slips, minimize the air pollution and noise pollution in the project area. Development of green belt not only minimizes these impacts but also improves the aesthetic environment of the region. Therefore, a "Green Belt Development Plan" has been proposed around the project area in general and along the project components in particular using the local flora.

10.2. DEVELOPMENT OF GREEN BELT

Different types of construction activities such as road network, crusher plants, camp/colony areas, office complex, dam site, reservoir rim, etc. are proposed in the Aulliya Medium Irrigation Project. The green belt is proposed to be developed within these sites. The general consideration involved while proposing the greenbelt plan are:

- Broad leaf trees growing above 10 m in height should be planted along the approach roads and camps/ colonies.
- Plantation of trees should be undertaken in appropriate encircling rows.
- Generally local/indigenous fast growing trees and shrubs should be planted.
- The trees should be protected by plantation of shrub species to avoid browsing by animals.
- Placement of Iron tree guards should be provided to save the plant saplings.

10.3. GUIDELINES & TECHNIQUES FOR GREEN BELT DEVELOPMENT

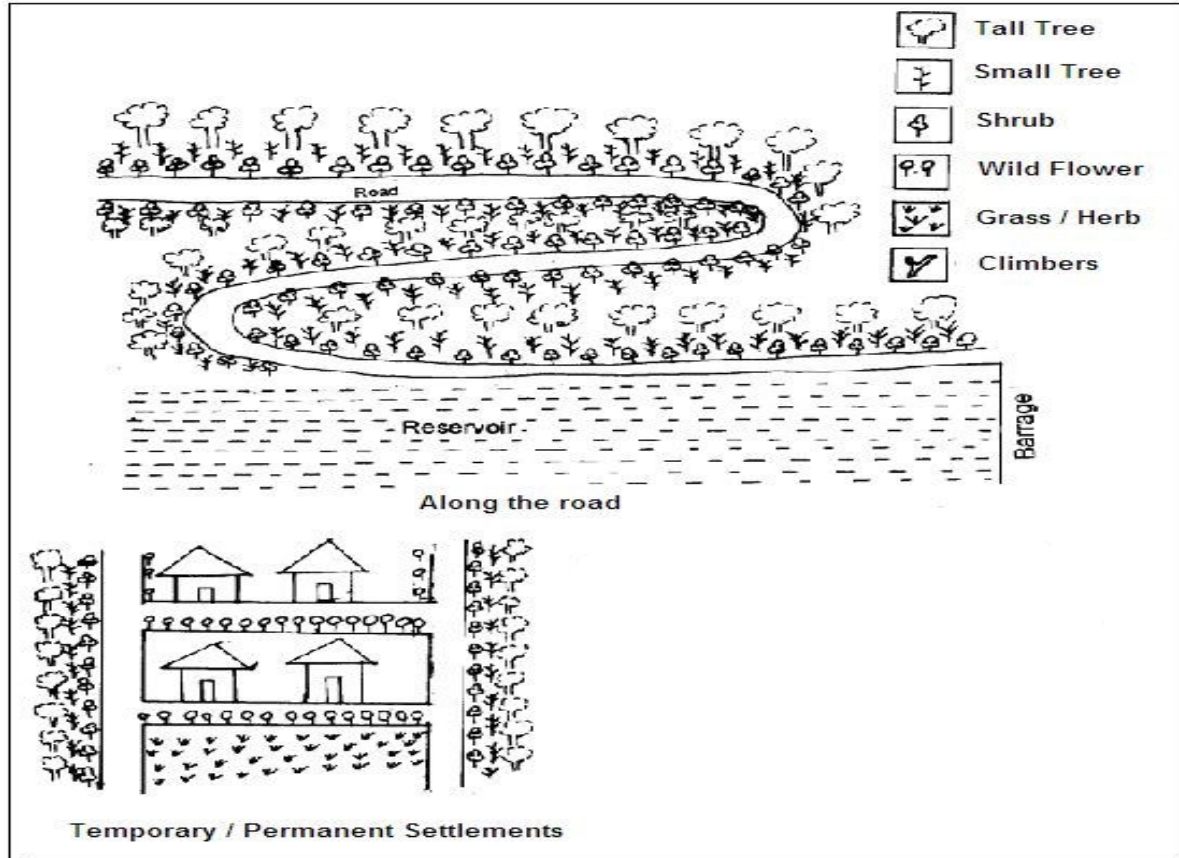
Extensive survey in the project area was undertaken to observe the structure and composition of vegetation. The soil characteristics were also kept in mind. Based on this survey and environmental conditions suitable native plants species have been proposed for green belt development plan (Table 10.1). The schematic arrangement of greenbelt plantation proposed along the reservoir rim, roads office, camps/ colony is presented in Figure 10.1.

Table - 10.1: List of plants species proposed for Green Belt development

S. No.	BOTANICAL NAME	LOCAL ANME
Trees		
1	<i>Acacia catechu</i>	<i>Khair</i>
2	<i>Acacia nilotica</i>	<i>Babul</i>
3	<i>Albizzia lebbek</i>	<i>Black siris</i>
4	<i>Albizzia procera</i>	<i>White siris</i>
5	<i>Anogeissus pendula</i>	<i>Kardhai</i>

S. No.	BOTANICAL NAME	LOCAL ANME
6	<i>Anona squamosa</i>	Sharifa
7	<i>Bombax ceiba</i>	Semal
8	<i>Azadirachta indica</i>	Neem
9	<i>Boswellia Serrata</i>	Salai, Kundur
10	<i>Butea monosperma</i>	Palas
11	<i>Embelica officinalis</i>	Amla
12	<i>Holoptelea intgrifolia</i>	Papri
13	<i>Madhuca indica</i>	Mahua
14	<i>Mangifera indica</i>	Aam
15	<i>Oroxylum indicum</i>	Jaimangal
Shrubs		
16	<i>Andrographis paniculata</i>	Kiryat
17	<i>Asparagus racemosus</i>	Satawar
18	<i>Vitex nugundo</i>	Nirgundi
Grasses		
19	<i>Cynodon dactylon</i>	Dub
20	<i>Mangifera indica</i>	Kusu
21	<i>Thysanolanca maxima</i>	Phool Bahari

Figure 10.1: Plantation techniques for green belt development at different project locations



10.4. GREEN BELT DEVELOPMENT

Green belt development will comprise plantations at various places like alongside roads, around the periphery of reservoir rim, and at different project offices and camp/ colonies.

10.4.1 Roadside plantation

It has been found that there is approach road of about 1.2 km from the nearest connecting State highway (SH-26) near the Roshni Village. It is proposed to carry out roadside plantation along the approach roads to the Dam Site. The cost of the plantation has been calculated as per the existing labour charges, material cost (plants, FYM, tree guards, etc.) and the total area of plantation. The spacing for trees is proposed 3 m while 2 m for shrubs. The pit size has been recommended as 45 cm x 45 cm x 5 cm for trees and 30 cm x 30 cm x 30 cm for shrubs. The total cost of roadside plantation works out to be Rs. 0.36 lacs (Table 10.2). Plantation along roads must take into account visibility aspects on curves so as to ensure safe driving.

Figure – 10.2: Proposed Approach Road for Dam Site



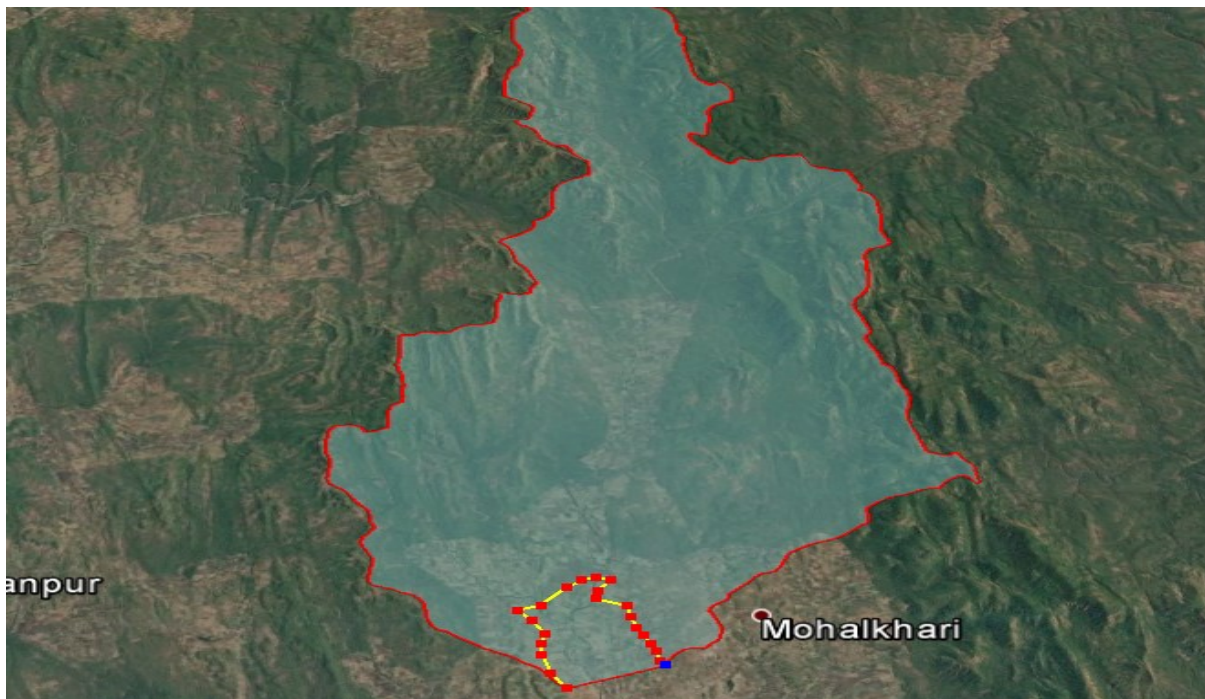
10.4.2 Green Belt Development along the Reservoir Rim

Most of the area in the vicinity of proposed reservoir of Aulliya Medium Irrigation Project is under cultivation. The creation of green belt on either side of the reservoir will ensure protection of the reservoir area from any minor slips due to fluctuation in the water level. The slopes on both the banks will be planted with suitable tree species for creation of a green belt around the reservoir rim. The green belt will start from the immediate vicinity of the reservoir rim on both the banks, where moderate slopes are available for plantation.

The average width of the green belt will be around 10 m varying depending upon the physiographic and land features. There would be at least three layers of plantation. Water loving species like *Populus* will be planted in the row nearest to the reservoir rim. The soil present at this level and the air moisture are favourable for the survival and the growth of these species. Species like *Michelia*, *Champaca* and *Terminalia myricarpa* will occupy middle portions of the green belt. These species have been observed to thrive well in this area. In the outermost layer of the green belt, *Alstonia Scholaris*, *Cadrela toona*, *Duabanga grandiflora* will be planted. The area for the green belt development around reservoir rim shall be about

In all plantations would be undertaken on an area of about 14.00 ha along the periphery of reservoir for which a provision of Rs. 12.34 lac (s) @ Rs. 88200/ha. has been earmarked.

Figure – 10.3: Reservoir Periphery



10.4.3 Green Belt at Dam site

Plantation at the dam site has been proposed for control of erosion/ siltation of the reservoir and aesthetic importance. The plants of recreational value, horticultural importance shall be planted within the complex. Developing a lawn and flower garden surrounded by this green belt may serve the purpose of beautification of the dam site area.

10.4.4 Green Belt around Camp/ Colony Area and Office Complex

Plantation around the project colony and office complexes is proposed to be done, so that, greenery is developed. Precaution should be exercised by not planting large size trees around buildings and other similar structures as during winter the sun rays are obstructed by them invariably and much wanted sunshine is impaired. Besides this, it is also proposed to develop green belt around the working areas for trapping the dust and noise. The area proposed for staff colonies and camps, is about 1.0 ha. Plantation of avenue, ornamental and fruit trees are proposed in these areas along with

the area around office complex. The ornamental, fruit plants will be procured from the horticulture department and local market while the avenue plants will be raised in the project nursery. For protection of trees from cattle iron tree guards shall be required.

10.5 INFRASTRUCTURE DEVELOPMENT FOR GREEN BELT PLAN

The creation of nursery for Green Belt Development has been included already in Landscaping and Restoration Plan and the requirement would be met from these nurseries which are located in almost the same area.

10.6. FINANCIAL REQUIREMENTS

For the creation of green belt around the reservoir sufficient financial provision has been made by the project authorities. Plantations would be carried out around reservoir, roads as well as areas in colonies and construction sites. The estimated cost of plantations as well as maintenance for 3 years will be Rs. 17.05 lacs. The plantation for this purpose will be carried out with the participation of the State Forest/ Horticulture Department(s). The cost estimate for green belt development is given in Table 10.2.

Table - 10.2: Cost estimate for Green belt development in Aulliyua Medium Irrigation Project

S. No.	Component	Amount (Rs. in Lacs)
1	Cost of plantation along road side @ Rs. 45/ tree	0.36
2	Cost of plantation around Dam site	0.15
3	Cost of avenue and ornamental plantation around Residential areas and office complex for	0.60
4	Cost of plantation & maintenance along reservoir periphery for 14 ha Rs.88,200.00/ ha	12.34
5	Iron tree guards @ 700 each	2.80
6	Contingency	0.50
7.	Maintenance of plantations other than reservoir periphery @ Rs.10,000.00 / year	0.30
	Total (Rs. in Lacs)	17.05

CHAPTER - 11: RESERVOIR RIM TREATMENT PLAN

11.1. INTRODCUTION

The impounding reservoir behind the proposed 20.80 m high dam, from deepest foundation level, top bund level 358.00 m, having FRL and LSL respectively at 355.00 m and 346.10 m, shall extend at FRL to a distance of 4.5 km in Ghorpachhar River and live storage of 22.199 MCM at FRL. The reservoir shall submerge 487.06 ha of land. Due to project sudden change shall be brought about in the existing riverine scenario to lacustrine condition. The toe of hills towering over the river bed shall be subjected to elevated water surface level, due to the reservoir. The rock mass which had not experienced the flow of river before shall be subjected to hydraulic conditions apart from many other direct and indirect factors responsible for instability of land masses. All such factors that facilitate sliding in one way or the other can be grouped into two headings i.e., internal and external factors.

The internal factors include such because which tends to reduce the shearing strength of the rocks, the water content of the rock masses, the mineralogical composition and meteorological character, structural features and the state of stress and important internal factors. External factors include mainly vibrations naturally by either and earthquake or artificial due to heavy traffic and rock blasting. Beside these, removal of support at the foot of the slope i.e. toe failure by high velocity of flow is another cause. Water charging of soil strata due to water storage reduces coefficient of friction causing landslide or slope failures. Therefore, an assessment of geological conditions and geo-technical evaluation of the reservoir are gives adequate information of the behaviour of reservoir.

In the stretch of the river where the reservoir shall be formed, it runs through wide valley, which have agriculture fields extending from the toe of the hills on either banks. The creation of green belt on either side of the reservoir will ensure protection of the reservoir rim area from any minor slips triggered due to fluctuation in the water level. The slopes on both the banks will be planted with suitable tree species. In area with moderate steep slopes indigenous, economically important, soil binding tree species, which are able to thrive well under high humidity and flood conditions, will be planted. The main objective underlining the plan is to adequately check the debris flow into the reservoir, to carry out the toe and surface treatment of the active and potential landslides besides providing protection to the foundation of the house / structures near to the FRL.

11.2. TREATMENT MEASURE FOR LAND SLIDES

The river during its course through the proposed reservoir area flows through a u-shaped valley, which has agriculture fields on either bank. In addition to this, the FRL shall be not in direct contact with the hill slopes. The project reservoir is neither prone to landslides nor any active slide is present in the project area and thus, landslide/ landslip treatment is not warranted.

11.3. TREATMENT MEASURES FOR RESERVOIR RIM

Green belt around the reservoir would be created to avoid erosion of soil and prevention of land slips from the banks surrounding the pond. Most of the area near proposed reservoir of the project is under cultivation. The green belt will start from the immediate vicinity of the reservoir rim on both the banks, where moderately sloped fields are available for plantation. The average width of the green belt will be around 10 m varying depending upon the physiographic and land features. There would be at least three layers of plantation. Water loving species like *Populus* will be planted in the row nearest to the reservoir rim. The soil present at this level and the air moisture are favourable for the survival and the growth of these species. Species like *Michelia Champaca* and *Terminalia myricarpa* will occupy middle portions of the green belt. These species have been observed to thrive well in this area. In the outermost layer of the green belt, *Alstonia Scholaris*, *Cadrela toona*, *Duabanga grandiflora* will be planted. The area for the green belt development around reservoir rim shall be about 14.00 ha along the periphery of reservoir for which a provision of Rs. 12.34 lac (s) @ Rs. 88200/ha. has been earmarked.

11.4. PROTECTION OF HOUSES/ FIELDS

The human settlements and agricultural fields at four villages are coming under partial submergence to FRL of reservoir, in which two villages habitation are very close to reservoir periphery. Therefore, those two villages if need protection for their land and houses after detailed study for which it is proposed to construct concrete retaining wall along the stretch of reservoir at potentially vulnerable places having a combined length of about 1.200 km as depicted in Table 11.1. The cost of protection wall (R.R. Stone masonry in C.M 1:5) of 3 m height has been assessed as Rs. 21.62 lac(s) and is shown in Table 11.2

Table – 11.1: Village wise length of RCC wall Protection

Sl. No.	Name of Village	Length (in Km)
1	Barakund	0.55
2	Bhojudhna	0.40
Total		0.95

Figure – 11.1: Map for Village Protection Wall

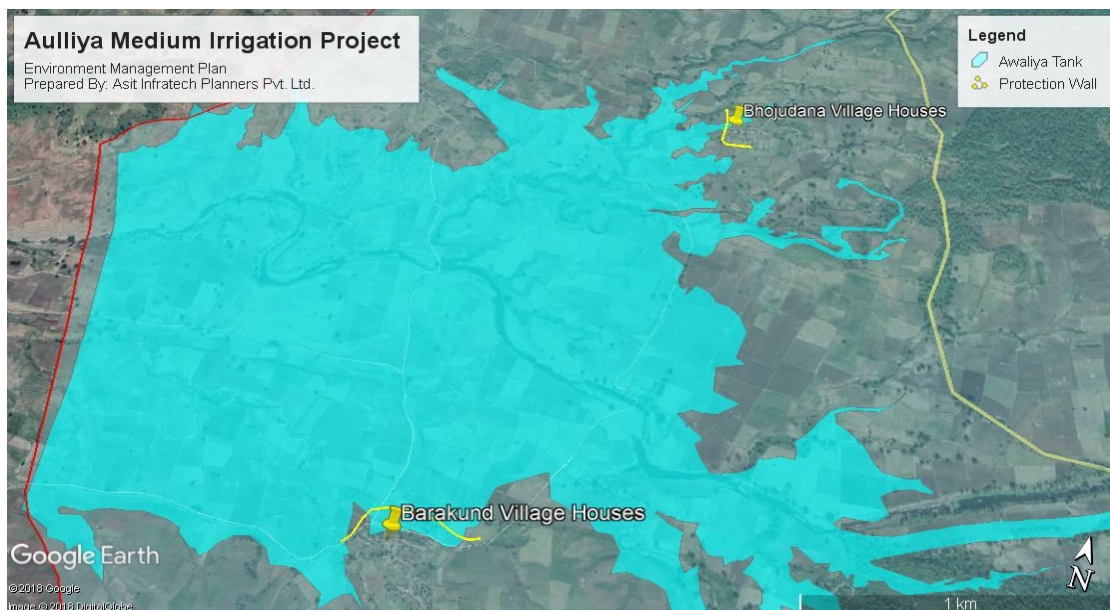


Table – 11.2: Cost of Protection Walls

Sl. No.	Particulars	Quantity	Unit	Rate	Amount (Rs lakh)
1	R.R Stone Masonary in Cement Mortar 1:5 with 0.3 m thick M-10 grade c.c. in foundation CC M-10 grade (1200 x 2 x 0.3)	600	Cum	2712	16.27
2	R.R Stone Masonary in Cement Mortar 1:5 (1200 x 0.5 (0.6 + 1.6) x 3	2800	Cum	1200	33.60
Total					49.87

11.5. TREATMENT AT THE MOUTH OF STREAMS JOINING RESERVOIR

The hill torrents/ rivulet has steep gradient and during rains very high discharge flow in them with high velocity. Wherever these torrents meet main rivers there is a large difference in their bed levels. Such torrents are also potential carrier of highly sediment concentrated flows resulting from high velocities attained by them during flash floods which some time becomes as high as 10 m/sec. Loose deposits or shoal are therefore often witnessed just upstream of confluence point of such streams with main river. The mouth of these streams have a tendency of sliding and widening because of following reasons:

- These are subjected to change in hydraulic conditions depending upon the fluctuation of water level of the main river during different period of the year and abrupt water level changes brought about during monsoon. The change gradient of ground water affects the pore water pressure of the soil mass of banks at the mouthing and reduces the shear strength of the rock-mass which disintegrates.
- The sediment load carried by the hill streams get deposited at the mouth and thus obstruct the high flow during monsoon there by increasing the flow velocity near banks which cause te-erosion.
- Due to the changes in flow conditions at the mouth of the streams, from super critical to sub critical the energy dissipation takes place and the bank material face the onslaught.
- The FRL of the reservoir has to vary between 355.00 m and 346.10 m i.e. 8.90 m though the variation is to take effect over a considerable long period/ duration, there are no chances of sudden draw down of water in the reservoir, yet due to looseness of strata at the mouth sliding cannot be ruled out.
- The mouth of the streams is generally constituted of riverine material usually shingle, pebbles, boulder and fine sediments like clay, silt and sand which have lower shear strength. Swelling caused due to hydration of clay is the main cause of mass movement.

Therefore, the mouth of the streams directly into reservoir need to be protected against toe-erosion at the level of FRL of reservoir by gabion retaining wall. The sediment load transported by the streams can be minimized by making check dam size 10 m x 1.5 m x 3.0 m, in Nadi/ Nala meeting the reservoir. The cost of these works has been assessed as Rs. 7.65 lac (s).

Table – 11.3: Cost Estimate of Mouth Treatment of Stream

Sl. No.	Measures	Qty.	Unit	Rate	Amount (Rs. In lakh)
1	Gabion Wall approx. 75.00 m length (=75 x 2 x 1.5)	225	m ³	1000.00	2.25
2	Check dams 10 nos. od Size (=10 x 1.5 x 3)	450	m ³	1200.00	5.40
Total					7.65

11.6. OVERALL COST OF RESERVOIR RIM TREATMENT

The summed-up cost of various activities involved in the comprehensive reservoir rim treatment plan is Rs. 57.52 lac(s) as enumerated in Table 11.4

Table – 11.4: Total Cost of Reservoir Rim Treatment

Sl. No.	Measures to be Adopted	Amount (Rs. In Lakh)
1	Protection of Houses/ Fields	49.87
2	Treatment of the mouth of the major streams/ khad joining reservoir directly	7.65
Total		57.52

CHAPTER - 12: COMPENSATORY AFFORESTATION PLAN

12.1. INTRODUCTION

Deforestation and forest degradation result in adverse ecological and livelihood consequences, leading to reduced well-being of the present and future generations. The depletion of forest resources as a result of developmental projects has a wide-ranging impact on ecological balance. The encroachment in the forest areas generally takes place in a variety of ways:

- Fragmentation of households and trend towards nuclear families as a household is considered to be the basic unit by the government rather than the number of families.
- Encroachment in and around the forest area for building and construction activities has been a major menace. It makes very difficult to monitor the extent of encroachment due to lack of resources, manpower and technology.
- In rural areas, the encroachers are cultivators who are ignorant of the laws relating to the protection of forestlands, or people whose holdings are attached to the boundaries of forestland. In urban areas, encroachment generally does not take place in forestland because people are conversant with the law.
- The steady deforestation is also attributed to growing energy needs, land diversion for development activities, commercial activities, forest fires and natural calamities.

Regeneration of forests becomes essential as more and more forest areas become degraded due to increase in open and scrub forests because of social and economic causes and other natural phenomenon. Area under forest and tree cover will be expanded through systematic planning and implementation of afforestation and rehabilitation programme in degraded and open forests and available non forest lands. Regeneration of felled areas will be ensured in a time bound manner and productivity of plantations will be increased through use of improved seeds and planting stock. There will be mixed plantations of broad-leaved fodder, fuel wood and wild fruit species will be promoted. The equation between forest degradation and forest regeneration should be maintained to ensure that the forest cover does not get depleted.

12.2. ENERGY NEEDS

The traditional sources of energy in study area are firewood, animal dung, and crop residues. These are still the only or major energy sources for the majority of the people. Biomass has been a vital part of the state energy scenario. Environmental degradation arises out of persistent over dependence on the biomass and adverse health effects of biomass combustion, particularly in confined spaces. Fuel wood continues to be the main source of energy, accounting for major part of the total energy consumption. In the study area, forest wood continues to be the predominant source of fuel for cooking. Diverse plant species are facing threats from various human activities. Plant species such as Cedrus deodara, Pinus wallichiana, Abies pindrow, Betula alnoides, Alnus sp., Quercus semecarpifolia, etc. are declining constantly due to over exploitation for fuel wood and timber.

12.3. COMPENSATORY AFFORESTATION STRATEGY FOR THE PROPOSED PROJECT

- Need-based and time-bound programme of afforestation and tree planting is to be launched with main emphasis on production of fuel wood and fodder on degraded and denuded lands, both forest and non-forest. Afforestation being a time specific activity, the government will ensure technical, administrative and financial approval well in advance for all afforestation projects to ensure the success of these programmes and improve the quality of works.
- These degraded lands are to be developed by planting fodder and fuel wood trees. Suitable fodder grasses would be planted to augment the availability of fodder. Grazing to be allowed only up to the carrying capacity of the lands. Stall-feeding to be encouraged. The status of these lands would be regularly monitored to avoid over-exploitation of these lands.
- The alignment of the road and transport system for the project would be planned with minimum use of cultivated lands and good forest areas. The construction of roads would have in built provision for waterways to supplement the natural drainage system, treatment of landslides prone and fragile areas, compensation for crop / forest / land property, etc. likely to be damaged/ destroyed and having provision for compensatory afforestation for greater stability of the slopes.
- The construction of dams and reservoirs for power generation which are consistent with the needs for conservation of trees and forest, which involve such diversion of forest land, shall provide in their budget, funds for regeneration/ compensatory afforestation and compensation for damage caused to the forest crop both on government and private lands.

12.4. DIVERSION OF FOREST LAND FOR AULLIYA MEDIUM IRRIGATION PROJECT

The area in the scope of this study falls in the Khandwa District of Madhya Pradesh. The total land affected in project is 487.06 ha in which Forest land is about 54.60 ha, Culturable land is about 352.26 ha, Unculturable land is about 32.182 ha. and Revenue land- 48.018 ha. The Forest Conservation Act 1980 stipulates strict forest protection measures and procedures (Guide Line 1/08-1 (ii) for compensatory afforestation on acceptance of diversion of forestland for non-forestry purposes.

- If non forestland is not available, compensatory plantation is to be raised on degraded forest land to the extent of twice the affected or lost forest area, and
- If non forest land is available, the extent of compensatory plantation will be equivalent of the affected or lost forest area.

The upstream areas of the proposed project are covered with mixed forest. There is no negative impact on the flora of both the submergence area is predicted either by way of loss of populations or species during the construction and running of the proposed project. The location would be selected during the joint survey of land by the Divisional Forest Officer, Khandwa Forest Division, Government of Madhya Pradesh and Developer.

12.5. COMPENSATORY AFFORESTATION PROGRAMME

The Aulliya Medium Irrigation Project is being constructed in the jurisdiction of Khandwa Forest Division. The Department of Forests, Govt. of Madhya Pradesh is responsible for the conservation and management of forests in the project area. The total forest area covered under project is 54.60 ha which is divided into two compartments in which one is under SCI felling series Kandviliya compartment no. 513A of about area 19.87 ha and forest village compartment no. 513 B of about area 34.72 ha. As per the site inspection report by the CCF there will be 416 tree will be affected. Most of the area is part of forest village Aulliya. No significant availability of wild life is seen in the area.

The objective of the afforestation programme will be to develop natural areas in which ecological functions could be maintained on sustainable basis. Therefore planting of economic important indigenous species would be undertaken. The compensatory afforestation is proposed to be done mainly in those forest blocks where degraded land and forest blanks are available for planting. The plantations in the above forests will be restricted to the areas which lie close to reservoir site. Suitable sites, depressions and sites along streams will be planted up with appropriate species. Under the afforestation programme different types of plantations would be undertaken. The species for plantation are selected after considering altitude, aspect, biotic pressure, soil depth, moisture etc. following species have been selected for plantation under the scheme:

Table - 12.1: Species suggested for Compensatory Afforestation

Tree Species		
<i>Alnus nepalensis</i>	<i>Salix denticulata</i>	<i>Lyonia ovalifolia</i>
<i>Aesculus indica</i>	<i>Ficus palmata</i>	<i>Salix karelinii</i>
<i>Populus ciliata</i>	<i>Ulmus wallichiana</i>	<i>Melia azadirach</i>
<i>Cedrus deodara</i>	<i>Picea smithiana</i>	<i>Morus alba</i>
<i>Quercus leucotrichophora</i>	<i>Bauhinia variegata</i>	<i>Celtis australis</i>
<i>Quercus semecarpifolia</i>	<i>Bombax ceiba</i>	<i>Pyrus pashia</i>
<i>Betula utilis</i>	<i>Pinus wallichiana</i>	<i>Malus domestica</i>
<i>Acer caesium</i>	<i>Abies pindrow</i>	<i>Juglans regia</i>
<i>Acer oblongum</i>	<i>Cupressus torulosa</i>	
Shrubs species		
<i>Agave americana</i>	<i>Debregeasia longifolia</i>	<i>Rhamnus virgatus</i>
<i>Artemisia roxburghiana</i>	<i>Desmodium elegans</i>	<i>Rhus spp.</i>
<i>Astragalus chlorostachys</i>	<i>Desmodium multiflorum</i>	<i>Rosa brunoni</i>
<i>Barleria cristata</i>	<i>Elaeagnus parvifolia</i>	<i>Rubus ellipticus</i>
<i>Berberis angulosa</i>	<i>Grewia vestita</i>	<i>Rubus niveus</i>
<i>Berberis asiatica</i>	<i>Hypericum perforatum</i>	<i>Sarcococca saligna</i>
<i>Colebrookia oppositifolia</i>	<i>Indigofera heterantha</i>	<i>Sorbaria tomentosa</i>
<i>Coriaria nepalensis</i>	<i>Jasminum humile</i>	<i>Spiraea canescens</i>
<i>Cotoneaster bacillaris</i>	<i>Prinsepia utilis</i>	<i>Woodfordia fruticosa</i>
<i>Cotoneaster microphyllus</i>	<i>Pyracantha crenulata</i>	<i>Zanthoxylum armatum</i>
<i>Daphne oleoides</i>	<i>Rabdosia rugosa</i>	<i>Indigofera heterantha</i>
<i>Datura stramonium</i>	<i>Rhamnus purpureus</i>	<i>Jasminum humile</i>

Contour planting conserves soil and enhances moisture regime and adverse effect of surface run off of rainwater is reduced considerably. Trenches, pits and plants along the contour reduce velocity of water, increase soil moisture and facilitate seepage of water in soil and reduce soil loss, which will result in better growth of plants. Therefore plantation to replenish the loss number of trees will be stringently undertaken in the project. In the afforestation areas, the digging of trenches and pits would be along the contour. About 20 to 30m long contour trenches would be dug leaving a space of 50 cm (septa) between the two consecutive trenches. Soil would be dug on the lower side of the trench after removing pebbles and weeds. For digging 1000 pits per ha pits would be dug 15 cm uphill side from the contour trenches. The spacing of pits along contour trench will not be closer than 1.25m. In afforestation areas soil working would be started in October-November and to be completed by March. It is important that filling of pits and half filling of trenches to be completed before the onset of monsoon, otherwise dug soil will be washed away by rains leaving only stones and pebbles near the pit. Extreme care would be taken in transporting the plants from nurseries to the plantation site to avoid any damage. Planting would be completed before the monsoon period is over.

12.5.1 Fuel Wood & Fodder Plants

With a view to conserve not only soil and water but also for fuel wood production, it is important to raise the vegetative barrier of hedge plants. When the water of surface run off reaches the line of ridges its speed is checked and the hedge plants stop silt and only percolated water passes down slowly. Hedges spread and grow well in the silt left behind and form a natural terrace. The work on raising of nursery will start right from first year. A new nursery site will be developed at the project cost.

12.5.2 Fencing

RCC poles of 2.5 m high with 2.5 m interval will be placed and 4 strand barbed wire fencing would be erected during first year along with soil working. The cooperation of local villagers would be sought for the success of the plantation programme.

12.5.3 Watch & Ward/ Fire Protection

Protection of plantation is the greatest challenge in hills as villagers and their livestock damage the plantation before it is established. Hence the protection of plantation particularly in the juvenile stage is of paramount importance and watchmen/ chowkidars would be engaged from the nearby villages for the required job. Besides the above, other appropriate measures would be adopted to ward off these potential threats.

12.5.4 Sites & Cost of Compensatory Afforestation

The compensatory afforestation is proposed to be undertaken on tropical dry deciduous forest and mixed forest land identified in consultation with the state forest department. Plant species have been identified based on soil and climatic conditions of the proposed compensatory afforestation area. The estimated cost of Compensatory Afforestation programme is Rs.218.40 lacs (Table 12.2), however the same needs to be ratified by the State Forest Department.

12.6. NET PRESENT VALUE (NPV)

The Hon'ble Supreme Court of India has made it mandatory vide its order dated 28.03.2008 for the user agency to compensate for the diversion of forest land for non-forest use for developmental activities on the recommendations of Central Empowered Committee (CEC) to make payment of Net Present Value (NPV) of such diverted land so as to utilize this for getting back in the long run which are lost by such diversion (Refer Annexure I).

For this purpose CEC has classified the forest taking in view the ecological role and value of the forest and the purpose of the report, 16 major forest types have been further grouped into 6 ecological classes depending upon their ecological functions.

1. Eco-Class I- Consisting of Tropical Wet Evergreen Forests, Tropical Semi Evergreen Forests and Tropical Moist Deciduous Forests
2. Eco-Class II –Consisting of Littoral and Swamp Forests
3. Eco-Class III – Consisting of Tropical Dry Deciduous Forests
4. Eco-Class IV- Consisting of Tropical Thorn Forests and Tropical Dry Evergreen Forests
5. Eco-Class V – Consisting of Sub-tropical Broad Leaved Hill Forests, Sub- Tropical Pine Forests and Sub Tropical Dry Evergreen Forests
6. Eco-Class VI - Consisting of Montane Wet Temperate Forests, Himalayan Moist Temperate Forests, Himalayan Dry Temperate Forests, Sub Alpine Forest, Moist Alpine Scrub and Dry Alpine Scrub.

The net present value per hectare of forest has been fixed based on this data. For calculating the average net present value per hectare of forest in India, the following monetary value of goods and services provided by the forest have been considered:

- a. Value of timber and fuel
- b. Value of Non Timber Forest Products (NTFP)
- c. Value of fodder
- d. Value of Eco-tourism
- e. Value of bio-prospecting
- f. Value of Ecological services of forest
- g. Value of Flagship Species
- h. Carbon Sequestration Value

Based on this, the NPV was fixed and the recommendations have been made. Total forest land requirement for diversion for non-forest use i.e. for the construction of Aulliya medium irrigation Project activities is 54.60 ha including the horticulture land. As the forest in the project area fall in the Eco Class III, therefore NPV will be calculated @ Rs.8.03 lacs/ha for compartment 513 A and NPV @ Rs. 6.26 lacs/ha for compartment 513 B and that would be required to be deposited in the Compensatory Afforestation Fund. In addition as per the cost benefit guideline an amount of 10% of the NPV of the entire area is to be added for loss of animal husbandry productivity including cost of fodder and an amount of 30% of the NPV for the possession value of forest land diverted.

Table - 12.2: Cost estimates of Compensatory Afforestation Plan

S. No.	Particulars	Amount (in Lacs)
1	Compensatory afforestation and soil moisture conservation cost (@ Rs. 3.30 lacs/ha)	180.18
2	15% of Soil Moisture	27.03
3	NPV @ 8.03 lacs/ha for 54.60 ha.	438.43
	Total cost (Rs. lacs)	645.64

CHAPTER - 13: DAM BREAK ANALYSIS & DISASTER MANAGEMENT PLAN

13.1. INTRODUCTION

Building a dam ensures a large number of potential benefits, but it also creates a structure with potential hazards, which may result from its failure. When a dam fails, the huge volume of water stored transforms into a flood wave, which may cause severe damages to the lives and properties situated downstream. The effect of such a flood disaster can be mitigated to a great extent, if the resultant magnitude of flood peak and its time of arrival at different locations downstream of the dam can be estimated, facilitating planning of the emergency action measures. This warrants dam break analysis, which assesses the flood hydrograph of discharge from the dam breach and maximum water level at different locations of the river downstream of the dam due to propagation of flood waves along with their time of occurrence.

Dam break may be summarized as the partial or catastrophic failure of a dam leading to the uncontrolled release of water. Such an event can have a major impact on the land and communities downstream of the failed structure. A dam break may result in a flood wave up to tens of meters deep traveling along a valley at quite high speeds. The impact of such a wave on developed areas can be sufficient to completely destroy infrastructure, such as, roads, railways and bridges, and to demolish buildings. With such destructive force comes an inevitable loss of life, if advance warning and evacuation was not possible. Additional features of such extreme flooding include movement of large amounts of sediment (mud) and debris along with the risk of distributing pollutants from any sources, such as, chemical works or mines in the flood risk area.

13.2 NEED FOR DAM BREAK MODELING

In India, Risk assessment and disaster management plan has been made a mandatory requirement while submitting application for environmental clearance in respect of river valley projects. Preparation of Emergency Action Plan after detailed dam break study has become a major component of dam safety programme of India. The extreme nature of dam break floods means that flow conditions will far exceed the magnitude of most natural flood events. Under these conditions, flow will behave differently to conditions assumed for normal river flow modeling and areas will be inundated, that are not normally considered. This makes dam break modeling a separate study for the risk management and emergency action plan.

The objective of dam break modeling or flood routing is to simulate the movement of a dam break flood wave along a valley or indeed any area 'downstream' that would flood as a result of dam failure. The key information required at any point of interest within this flood zone is generally:

- ¾ Time of first arrival of flood water
- ¾ Peak water level – extent of inundation
- ¾ Time of peak water level

¾Depth and velocity of flood water (allowing estimation of damage potential)

¾Duration of flooding

The nature, accuracy and format of information produced from a dam break analysis will be influenced by the end application of the data.

13.2.1 Emergency Planning

To reasonably prepare an emergency plan, it will be necessary for the dam break analysis to provide:

¾Inundation maps at a scale sufficient to determine the extent of flooding in relation to people at risk, properties and access routes

¾ Identification of structures (bridges etc.) likely to be destroyed

¾Indication of main flow areas (damage potential of flow)

¾Timing of the arrival and peak of the flood wave

¾Identification of features likely to affect mobility / evacuation during and after the event including impact on infrastructure and the deposition and scour of debris and sediment.

13.2.2 Development Control

Development control will focus mainly on the extent of possible inundation resulting from different failure scenarios. Consideration may also be given to the characteristics of the population at risk.

13.2.3 Insurance Companies

The aim of insurance companies will be to determine their exposure to risk through identifying both the probability of failure and the financial impact of flooding. Modeling and mapping will, therefore, need to be at accuracy sufficient to determine impact on properties. An assessment of damage potential will also assist in impact assessment.

Therefore, it is the responsibility of the organizations involved with the safety of the dams, to plan preventive measures so that in the eventuality of dam failure, the loss can be minimized to the extent possible. The dam failure study involves the following component steps:

- Development or identification of the inflow hydrograph to the reservoir at the time of failure.
- Routing this hydrograph through the reservoirs,
- Calculating the outflow hydrograph from the failed structure, and
- Modeling the movement of the flood wave downstream to determine travel time, maximum water level reached, inundated areas etc.

13.3 DAM BREAK MODEL

The National Weather Service's DAMBRK model developed by D.L. Fread has been used in the present study. DAMBRK is used to develop the outflow hydrograph from a dam and hydraulically route the flood through the downstream valley. The governing equations are complete one dimensional Saint Venant equations of unsteady flow coupled with internal boundary equations, representing rapidly

varied flow through structures (which may develop time dependent breach) and utilizes external boundary equations at the u/s and d/s ends of the routing reach. The system of equations is solved by a non-linear weighted 4-point implicit finite difference method. The flow may be sub-critical or super-critical or combination of these each varying in space and time from one to the other. Outflow hydrograph to be routed is developed by the model using specified breach parameters. High water profiles along the valley, Flood arrival times and hydrographs at user specified locations are standard output.

The model consists of two conceptual parts:

- 1) Description of the dam failure mode i.e. temporal and geometrical description of breach.
- 2) A hydraulic computation algorithm for determining the time history of the outflow through the breach as affected by the breach description, reservoir inflow, reservoir storage characteristics, spillway outflows and d/s tail water elevation for routing of the outflow hydrograph through the d/s valley. The model also determines the resulting water surface elevations and flood wave travel times.

13.4 METHODOLOGY

DAMBRK model includes reservoir storage routing (level pool) to compute outflow hydrograph from reservoir with sub-critical dynamic routing of outflow hydrograph through entire length of d/s valley, tail water depth computed by Manning's equation applied to tail water section. In other words, this model simulates the failure of a dam, computes the resultant outflow hydrograph and also simulates movement of the dam break flood wave through the downstream river valley. The model is built around three major capabilities, which are reservoir routing, breach simulation and river routing. After computing the hydrograph of the reservoir outflow, the time of occurrence of flooding in the downstream valley is determined by routing the outflow hydrograph through the valley. The dynamic wave method based on the complete equations of unsteady flow is the appropriate technique to route the dam break flood hydrograph through the downstream valley.

13.5 STATEMENT OF THE PROBLEM

The computation of flood wave resulting from a dam breach basically involves solving following problems:

- 1) The outflow hydrograph from the reservoir.
- 2) The routing of the flood wave downstream from the breached dam along the river channel and the flow plain
- 3) The flood hydrograph and water level at desired downstream location and its lag with respect to inflow/ breach hydrograph at dam site.

In this case, the computation of the flood characteristics is divided into two distinct phases: (a) the determination of outflow hydrograph (b) the routing of flood wave downstream from the dam breach.

In this study, the problem of simulating the failure of Aulliya. Project is considered, by computing the outflow hydrograph from the breached dam and routing this hydrograph along the downstream

channel using dynamic routing technique to obtain the maximum water level marks reached during the passage of flood wave. The information regarding inflow hydrograph into the reservoir due to the storm at the time of failure, the structural and the hydraulic characteristics details of the dam, the channel cross sectional details, the maximum water level marks reached in the reservoir at the time of failure and those observed in the downstream reach of the dam due to the passage of flood wave etc. are available for the study.

13.6 DAM BREAK MODELING PROCESS

Generally, dam break modeling can be carried out by either i) scaled physical hydraulic models, or ii) mathematical simulation using computer. A modern tool to deal with this problem is the mathematical model, which is most cost effective and reasonably solves the governing flow equations of continuity and momentum by computer simulation.

Mathematical modeling of dam breach floods can be carried out by either one dimensional analysis or two dimensional analyses. In one dimensional analysis, the information about the magnitude of flood, i.e., discharge and water levels, variation of these with time and velocity of flow through breach can be had in the direction of flow. In the case of two dimensional analysis, the additional information about the inundated area, variation of surface elevation and velocities in two dimension can also be assessed.

One dimensional analysis is generally accepted, when valley is long and narrow and the flood wave characteristics over a large distance from the dam are of main interest. On the other hand, when the valley widens considerably downstream of dam and large area is likely to be flooded, two dimensional analysis is necessary. In the instant case, narrow and the flood wave characteristics over a distance from the dam are of main interest, one dimensional modeling was adopted.

13.6.1 Hydrodynamic Modeling

The essence of dam break modeling is hydrodynamic modeling, which involves finding solution of two partial differential equations originally derived by Barre De Saint Venant in 1871. The equations are:

- i. Conservation of mass (continuity) equation $(\partial Q/\partial X) + \partial (A + A_0) / \partial t - q = 0$
- ii. Conservation of momentum equation

$(\partial Q/\partial t) + \{ \partial(Q^2/A)/\partial X \} + g A ((\partial h/\partial X) + Sf + Sc) = 0$ where, Q = discharge;

- A = active flow area;
- A₀ = inactive storage area;
- h = water surface elevation;
- q = lateral outflow;
- x = distance along waterway;
- t = time;
- S_f = friction slope;
- S_c = expansion contraction slope and

g = gravitational acceleration.

The following three approaches simulate branches as well as looped systems.

- (i). Kinematic wave approach: The flow is calculated from the assumption of balance between the friction and gravity forces. The simplification implies that the Kinematic wave approach cannot simulate backwater effects.
- (ii). Diffusive wave approach: In addition to the friction and gravity forces, the hydrostatic gradient is included in this description. This allows the user to take downstream boundaries into account, and thus, simulate backwater effects.
- (iii). Dynamic wave approach: Using the full momentum equation, including acceleration forces, the user is able to simulate fast transients, tidal flows, etc., in the system.

Depending on the type of problem, the appropriate description can be generally, model boundaries should be chosen at points, where either water level or discharge measurements are available so that the model is used for predictive purposes. It is important that the selected boundary locations lie outside the range of influences of any anticipated changes in the hydraulic system.

13.6.2 Description of Reservoir and Appurtenant Structures

Reservoir

To obtain an accurate description of the reservoir storage characteristics, the reservoir is normally modelled as a single h-point in the model. This will usually correspond to the upstream boundary of the model, where also the inflow hydrograph is specified.

The description of the reservoir storage is entered in the processed data. The surface storage area of the dam is described as a function of the water level and it is entered as additional flooded area. The lowest water level given for the reservoir should be somewhere below the final breach elevation of the dam.

The cross-sectional area is set to a large finite value and is used only for calculating the inflow head loss into the breach. The inflow head loss can be calculated as:

$$\Delta H = (V_s^2 / 2g) C_i [1 - (A_s / A_{res})]$$

Where,

V_s = Velocity through the breach

C_i = Inflow head loss coefficient

A_s = Flow area through the breach, and

A_{res} = Cross-sectional area of the reservoir

In order to obtain a reasonable head loss description it is only necessary that $A_{res} \gg A_s$ so that $[1 - (A_s / A_{res})] = 1$. The hydraulic radius is set to any non-zero value.

The total surface area of the reservoir is calculated as:

$A_{total} = b \cdot \Delta x + \text{Additional flooded area}$

Since the total surface area is already described by the additional flooded area, the first term should be equal to zero. Therefore, the width b should be set to zero.

Dam

At the Q point, where the dam break structure is located, the momentum equation is replaced by an equation, which describes the flow through the structure. As the momentum equation is not used at the Q point, the Δx – step is of no relevance. The maximum Δx for the river branch, where the dam is to be placed should, therefore, be greater than the distance between two cross-sections in the reservoir branch, so that no cross-section is interpolated between the actual cross-sections.

13.6.3 Boundary Conditions for Dam Break Modeling

The boundary conditions must be specified at both upstream and downstream limits of the model. The upstream boundary will generally be an inflow into the reservoir at the first reservoir. The downstream boundary will generally be a stage-discharge relationship at the last cross section of the set up.

13.6.4 Specifications of Dam Break Structures

The following information relating to dam break structures need to be specified:

- (i). Geometrical specifications
- (ii). Breach characteristics
- (iii). Failure moment, and
- (iv). Failure mode

13.6.5 Geometrical Specifications

The geometrical specifications for the dam break structure are taken from the longitudinal and cross-sections of the dam.

13.6.6 Breach Characteristics

Breach characteristics, such as, breach development period, breach section profile, etc. are very vital for dam break modeling, but at the same time very difficult to predict. Past experiences provide clue for reasonable assessment of breach characteristics. Concrete dams breaches in a very short period, say 10– 15 minutes. But, Earth and Rockfill dams usually do not collapse instantaneously, but they develop breaches, which increase gradually. The breach development period may vary between a few

minutes up to a few hours, depending on amongst other, the dam geometry and the construction material. The development of the breach determines the breach outflow hydrograph, and an accurate description of the breach development is, therefore, required in “near field” dam breach studies. In the “far-field” studies, an accurate flood routing procedure is of more importance, because the outflow variation is rapidly damped out as the flood propagates downstream.

13.6.7 Failure Moment

Like breach characteristics, prediction of failure moment is also very difficult. The time of occurrence of failure depends on stress concentration due to structural inconsistency, material properties, water level in the reservoir, etc. Since, no information is generally available about stress concentration, it is quite reasonable to assume that failure of the dam will get initiated when water level in the reservoir is at maximum.

13.7 OVERVIEW OF THE PROJECT

The project consists of 20.8 m high (above river bed level) concrete dam on Ravi River.

Table – 13.1: Salient features of the Aulliya Project

(A) Location		
1	State	MadhyaPradesh
2	District	Khandwa
4	Latitude	Lat.21°-53'-57"
5	Longitude	Long.76°-56'-03".
6	River	GhorapachharRiver
7	Situation	NearRoshni Village
(B) Hydrology		
1	Catchment Area	108.2 Sq. Km.
2	Maximum Annual Rain	2081.90 mm.
3	Minimum Annual Rain Fall	578.00mm.
4	AverageAnnual RainFall	941.64mm.
5	DesignFlood (PMF) as per Flood Hydrograph	1073.63 Cumecs
	75%Dependable Yield	20.87 MCM
(c) ReservoirData		
1	T.B.L.	358.00 m
2	M. W.L	355.00m
3	F.R.L.	355.0 m.
	M.D.D.L	347.45 m
4	Dead StorageLevel	346.10m.
5	New Zero Elevation RL	346.10m
6	LSLKeptat RL	347.45 m
7	River BedLevel	337.50 m.
8	Gross Storage atFRL	26.246 MCM
9	Live Storage	22.199 MCM

10	Capacity at MDDL	4.047MCM
11	Tehsils in Which SubmergenceAreaLies	Khalwa
12	No. ofVillages Affected	4
13	No. ofFamilies Affected	30
14	No. ofPersons Affected	150
15	WaterSpread Areaat FRL	487.06Ha.
16	RevenueSubmergenceArea	48.02 Ha
17	Forest SubmergenceArea	54.60 Ha.
18	private land Submergence	384.44 Ha
(D) Earth Dam		
1.	TotalLength of Dam	1782.00 m.
2.	Top Width of Dam	5.00 m.
3.	Top ofDam (R.L.)	358.00 m.
4.	Maximum height AboveG.L.	20.80 m.
(a) OverflowDam		
1	Crest level of Weir (R.L)	350 m.
2	Length of Weir	72.50m.
3	No. ofGates	6 NOS
	Size of Gates	10 m X 5 m
	Estimated SPF	1073.63 Cumec
	Discharge Ccapacity of Spillway	1168.10 Cumec
(E) Canal System(Irrigation)		
1	Typeof Canal	Main gravitypipe canal
	RBC	20 Km
	LBC	20 Km
2	G.C.A. Available	7500Ha.
3	C.C.A. Available	5000 Ha.
4	proposed irrigation	
	a) Rabi	5000 Ha.
	wheat (Olv) 36%	1800 Ha
	Wheat 3 MV 20%	1000 Ha
	Gram S2 RA 44%	2200 Ha
	Total 100%	5000 Ha.
5	Annual	5000 Ha.
	Intensityof Irrigation	100%
6	Cost	
	Estimated Cost	Rs. 165. 08Crore

13.8 INPUT DATA AND MODEL SET-UP

13.8.1 Input Data Requirement

Dam break flood analysis requires a range of data to depict accurately to the extent possible the topography and hydraulic conditions of the river course and dam break phenomenon. The important data required are:

- (i). Cross sections of the river from dam site and up to location downstream of the dam to which the study is required
- (ii). Elevation-Volume relationship of the reservoir
- (iii). Rating curve of spillway and sluices
- (iv). Salient features of the all hydraulic structures at the dam site and also in the study reach of the river
- (v). Design flood hydrograph
- (vi). Stage-discharge relationship at the last river cross section of the study area
- (vii). Manning's roughness coefficient for different reaches of the river under study
- (viii). Rating curve of all the hydraulic structures in the study reach of the river

Where the dam break analysis includes an assessment of potential impact and is combined with the development of an emergency action plan, then additional data relating to the social and economic development of the area will also be required.

Area Capacity of Aulliya Dam Project

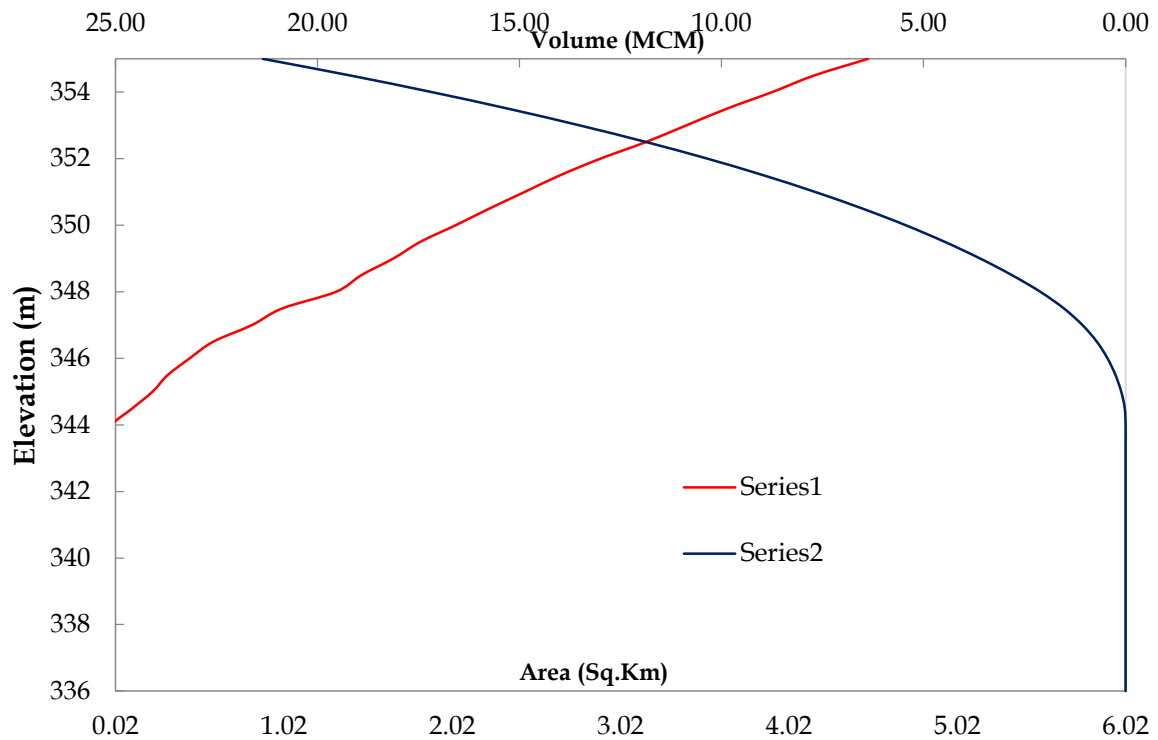
The Area Capacity of Aulliya Dam Project curve shows the storage and quantum of water at particular height of the Dam.

Table – 13.2: Area Capacity Calculation

Sr. No.	Contour RL (m)	Contour Interval (m)	Contour Area in sqm	Contour Area (Sq Km)	Sum Area of the Individual Contour(A1+A2)	Root Area Sqrt(A1*A2)	Capacity in Cum (2.5/3)*(col 5+col 6)	Cumalative Capacity in cum	Cumalative MCM
1	2	3	4	4	5	6	7	8	5
1	336	0	0	0	0	0	0	0	0
2	336.5	0.5	0	0	0	0	0	0	0
3	337	0.5	0	0	0	0	0	0	0
4	337.5	0.5	0	0	0	0	0	0	0
5	338	0.5	0	0	0	0	0	0	0
6	338.5	0.5	0	0	0	0	0	0	0
7	339	0.5	0	0	0	0	0	0	0
8	339.5	0.5	0	0	0	0	0	0	0
9	340	0.5	0	0	0	0	0	0	0
10	340.5	0.5	0	0	0	0	0	0	0
11	341	0.5	0	0	0	0	0	0	0
12	341.5	0.5	0	0	0	0	0	0	0
13	342	0.5	0	0	0	0	0	0	0
14	342.5	0.5	0	0	0	0	0	0	0
15	343	0.5	0	0	0	0	0	0	0
16	343.5	0.5	0	0	0	0	0	0	0
17	344	0.5	0	0	0	0	0	0	0
18	344.5	0.5	120000	0.12	120000	0	20000	20000	0.02
19	345	0.5	240000	0.24	360000	169705.63	88284.27	108284.27	0.11
20	345.5	0.5	330000	0.33	570000	281424.95	141904.16	250188.43	0.25
21	346	0.5	460000	0.46	790000	389615.19	196602.53	446790.96	0.45
22	346.5	0.5	600000	0.6	1060000	525357.02	264226.17	711017.13	0.71
23	347	0.5	830000	0.83	1430000	705691.15	355948.53	1066965.66	1.07
24	347.5	0.5	1010000	1.01	1840000	915587.24	459264.54	1526230.2	1.53
25	348	0.5	1330000	1.33	2340000	1159008.2	583168.03	2109398.23	2.11

Sr. No.	Contour RL (m)	Contour Interval (m)	Contour Area in sqm	Contour Area (Sq Km)	Sum Area of the Individual Contour(A1+A2)	Root Area Sqrt(A1*A2)	Capacity in Cum (2.5/3)*(col 5+col 6)	Cumulative Capacity in cum	Cumulative MCM
26	348.5	0.5	1480000	1.48	2810000	1402996.79	702166.13	2811564.36	2.81
27	349	0.5	1670000	1.67	3150000	1572132.31	787022.05	3598586.41	3.6
28	349.5	0.5	1830000	1.83	3500000	1748170.47	874695.08	4473281.49	4.47
29	350	0.5	2040000	2.04	3870000	1932149.06	967024.84	5440306.34	5.44
30	350.5	0.5	2240000	2.24	4280000	2137662.27	1069610.38	6509916.72	6.51
31	351	0.5	2450000	2.45	4690000	2342648.07	1172108.01	7682024.73	7.68
32	351.5	0.5	2660000	2.66	5110000	2552841.55	1277140.26	8959164.99	8.96
33	352	0.5	2900000	2.9	5560000	2777408.86	1389568.14	10348733.13	10.35
34	352.5	0.5	3170000	3.17	6070000	3031996.04	1516999.34	11865732.47	11.87
35	353	0.5	3410000	3.41	6580000	3287810.82	1644635.14	13510367.61	13.51
36	353.5	0.5	3650000	3.65	7060000	3527959.75	1764659.96	15275027.57	15.28
37	354	0.5	3920000	3.92	7570000	3782591.7	1892098.62	17167126.18	17.17
38	354.5	0.5	4170000	4.17	8090000	4043068.14	2022178.02	19189304.21	19.19
39	355	0.5	4490000	4.49	8660000	4327042.87	2164507.15	21353811.35	21.35

Area Capacity Curve of Aulliya Project



Spillway:

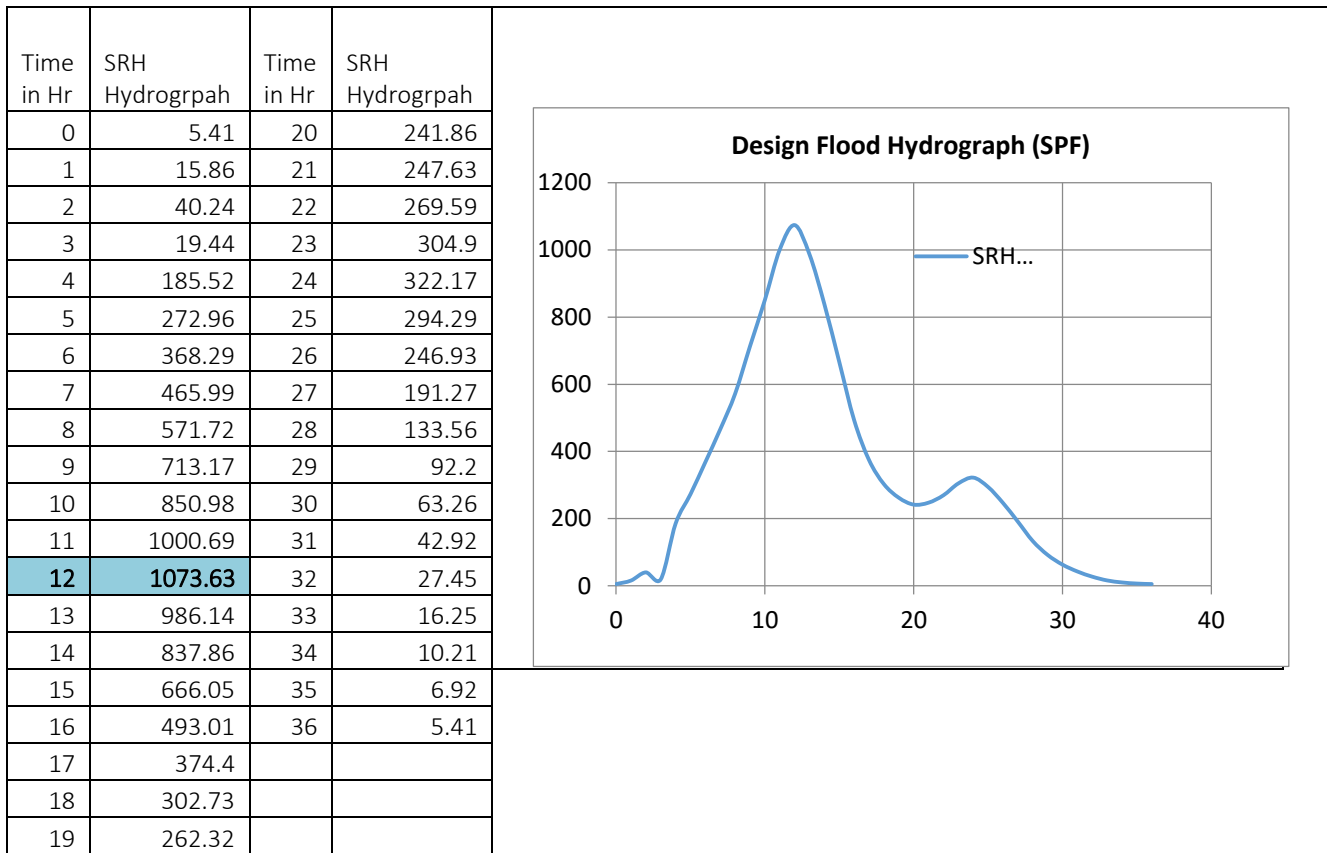
Spillway is given in Table 13.1 while for gated spillway, dimensions and crest elevation have been given above and in model.

Table - 13.3: Elevation-Volume relationship of the reservoir

Full Reservoir Level	:	355
Crest Level of Spillway	:	350
Gate heights	:	5
Number of Gates	:	6
Width of Gates	:	10
Width of Piers	:	2.5
Overall Length of Spillway	:	72.5

Reservoir Level (m)	Storage (Mm ³)	S/T (Cumeecs)	Head on Crest, H (m)	Outflow (Cumeecs)	Outflow / 2 (Cumeecs)	ST + O/2 (Cumeecs)
350.00	8.92	2476.55	0.00	0	0	2476.55
350.50	10.13	2815.16	0.50	31.45	15.73	2830.89
351.00	11.45	3180.24	1.00	91.39	45.69	3225.93
351.50	12.87	3574.46	1.50	171.33	85.67	3660.13
352.00	14.41	4002.24	2.00	270.56	135.28	4137.52
352.50	16.07	4463.36	2.50	385.42	192.71	4656.07
353.00	17.84	4956.5	3.00	513.45	256.72	5213.22
353.50	19.74	5483.88	3.50	655.52	327.76	5811.64
354.00	21.77	6046.38	4.00	811.22	405.61	6451.99
354.50	23.93	6647.84	4.50	975.21	487.61	7135.45
355.00	26.25	7290.64	5.00	1168.1	584.04	7874.68
355.50	28.7	7972.55	5.50	1370.62	685.31	8657.86
Modified Puls Method						
Time (Hr)	Inflow (Cumeecs)	Mean Flow in Cumeecs	ST - O/2 (Cumeecs)	ST + O/2 (Cumeecs)	Outflow (Cumeecs)	Reservoir Level (m)
12	1073.63			7512.63	1073.63	354.755

Table - 13.4: Design Flood Hydrograph (SPF):



13.9 DAM BREAK SIMULATION

13.9.1 Selection of Dam Breach Parameters

Prediction of the dam breach parameters and timing of the breach are very important for any dam break study, but they are extremely difficult to predict. However, assuming the dam fails, the important aspects to deal with are, time of failure, extent of overtopping before failure, size, shape and time of the breach formation. Estimation of the dam break flood will depend on these parameters.

The breach characteristics that are needed as input to the existing dam break models are

- i). Initial and final breach width and level;
- ii). Shape of the breach;
- iii). Time duration of breach development, and iv) Reservoir level at time of start of breach. The predominant mechanism of breach formation is, to a large extent, dependent on the type of dam and the cause due to which the dam failed.

13.9.2 Critical Condition for Dam Break Study

The critical condition for a dam break study is when the reservoir is full and design flood hydrograph (SPF) is impinged. Accordingly, in the present study keeping the reservoir at full level of 355 m, the

SPF has been impinged keeping all the spillway gates fully open. The maximum water level reached in the reservoir is 355 m, after the application of SPF. It is reasonable to assume that the dam will breach when the water level in the reservoir is at this maximum level.

The following parameters have been considered for breach:

Critical Condition for Dam Break Study

Breach parameters considered

Reservoir level at time when breach occurs	: 358 m (top of dam)
Estimated SPF	: 1073.63 Cumecs
Time to failure –	: 0.20 hr as this is concrete Sections of spillway where failure occurs instantaneously
Quantum Flood to be evacuated instantaneously:	773013.6 M ³
Crest Level of Spillway	
River Bed Level	; 350
Height at Flood to be evacuated instantaneously	: 337.5 =Crest Level - River Bed Level
Area of the Breach in m ²	: 12.5 M : 61841.088 M ²
Breach width –	
Bottom of breach	: 792.8 m
Slope of breach	: 1 in 110 m
Model reach	: up to confluence of D/S Nalla (about 9.2 km from proposed dam site)

13.10 ASSUMPTIONS

As in the case of any other modeling process, dam break modeling has inherent approximations through assumptions. The foremost assumptions are in the hydrodynamic equations (Saint Venant equations), which are further derived on the basis of the following assumptions:

- 1) The water is incompressible and homogeneous i.e. without significant variation in density.
- 2) The bottom slope is small.
- 3) The wave lengths are large compared to the water depth. This ensures that the flow everywhere can be regarded as having a direction parallel to the bottom, i.e., vertical accelerations can be neglected and a hydrostatic pressure variation along the vertical can be assumed.
- 4) The flow is super-critical in upper reach and sub-critical in lower most.

The other assumptions are associated with the breach parameters, especially, breach width and breach depth, which has great impact on flood peak and arrival times. Further, the high velocity flows associated with dam break floods can cause significant scour of channels due to bed as well as bank erosion. This enlargement in channel cross sections is neglected due to limitations in modeling such a complicated physical process. Moreover, this limitation has an effect on the conservative side only.

Dam break floods create a large amount of transported debris. This may accumulate at constricted cross sections, where it acts as a temporary dam and partially or completely restricts the flow, resulting variation in water level at the downstream locations. This aspect has also been neglected due to limitations in modeling of such a complicated physical process. This limitation also has an effect on the conservative side only.

Even with the assumptions outlined above, dam break modelling serves very useful purpose, as it provides reasonable extent of inundation under different situations enabling preparation of Emergency Action Plan / Disaster Management Plan.

13.11 PREPARATION OF INUNDATION MAP

An inundation map is a map depicting the d/s areas vulnerable to inundation by the dam break flood. The DAMBRK model computes maximum flood elevation at each original or interpolated cross-section. In present case, the cross-sections are available up to 9.2 km d/s of dam i.e D/S Nalla with Ranhai. From this profile, at locations below the dam & their subsequent markings on the topographic maps, it can be seen which areas are likely to be submerged in case of dam break. It is clear from the Figure 13.6 that in case of dam break, though there would be inundation of lower areas however no settlement will be affected. The floods generated, however, may lead to a number of river section erosion and slips downstream of dam causing damage to roads, etc. and also blocking of river itself endangering the life or property.

13.12 DISASTER MANAGEMENT PLAN

From the result it is evident that up to about 9.2 km d/s of the Aulliya, time required in reaching the flood wave elevation to the maximum is of the order of 0.4 - 0.5 hr. It hardly leaves any possibility of any rescue or evacuation. Since the time available is very short, the Disaster Management Plan should concentrate on preventive actions.

Surveillance and monitoring programmes are required to be implemented during design and investigation, construction, first reservoir filling, early operation period and operation & maintenance phases of the life cycle of dam. It is desirable that all gates, electricity, public announcement system, power generator backups etc are thoroughly checked before arrival of the monsoon. As it is clear from the results that u/s water level has significant effect on the dam break flood, the following flood conditions may be considered for different level of alertness:

- 1) If u/s water level reaches at top of the dam, it may be considered as an emergency. At this point only a few minutes are available for taking any action. All the staff from the dam site should be alerted to move to a safe place. The district administration and the corporation's head office shall be informed about the possibility of dam failure.
- 2) If u/s water level rises above the dam top and dam begins to fail, it may be considered as a disaster condition. At this stage, nothing can be done. Information in this regard should be given to the head office and district administration.
 - i). If upstream water level is at or below FRL and flood is of the order of 20% to 30% of SPF, it may be considered as normal flood condition and normal routine may be maintained.
 - ii). If upstream water level is rising above FRL, it may be considered as Level-1 emergency. In this condition at least four gates must be kept fully operational. All concerned officials should be alerted so that they may reach at the dam site to take suitable actions. Preventive actions may be carried out simultaneously. A suitable warning and notification procedure may be laid. The local officials should be informed about the situation.
 - iii). If upstream water level reaches above MWL and still rising, it may be considered as Level-2 emergency. It is seen from the results that around 1 hour is available to carry out suitable action at this condition. All communication systems and safety measures should be operational now. Public announcement system or centralized siren system may be used. A flood warning may be issued to the public downstream so that they may reach a higher and safe place.

Figure 13.2: Catchment Area map of Aulliya Project

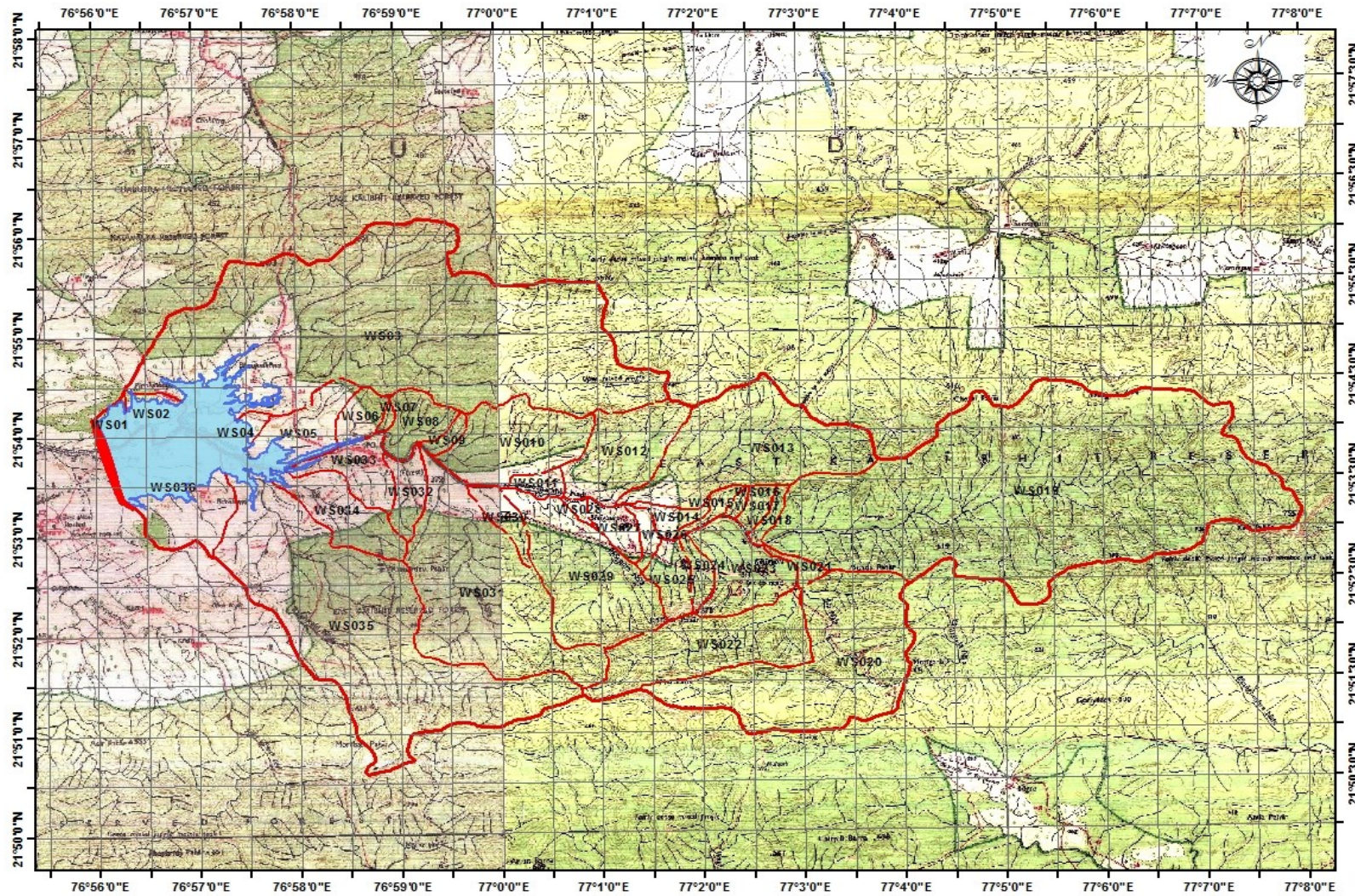


Figure – 13.3: Submergence at FRL – 355 m, Map of Aulliya Project

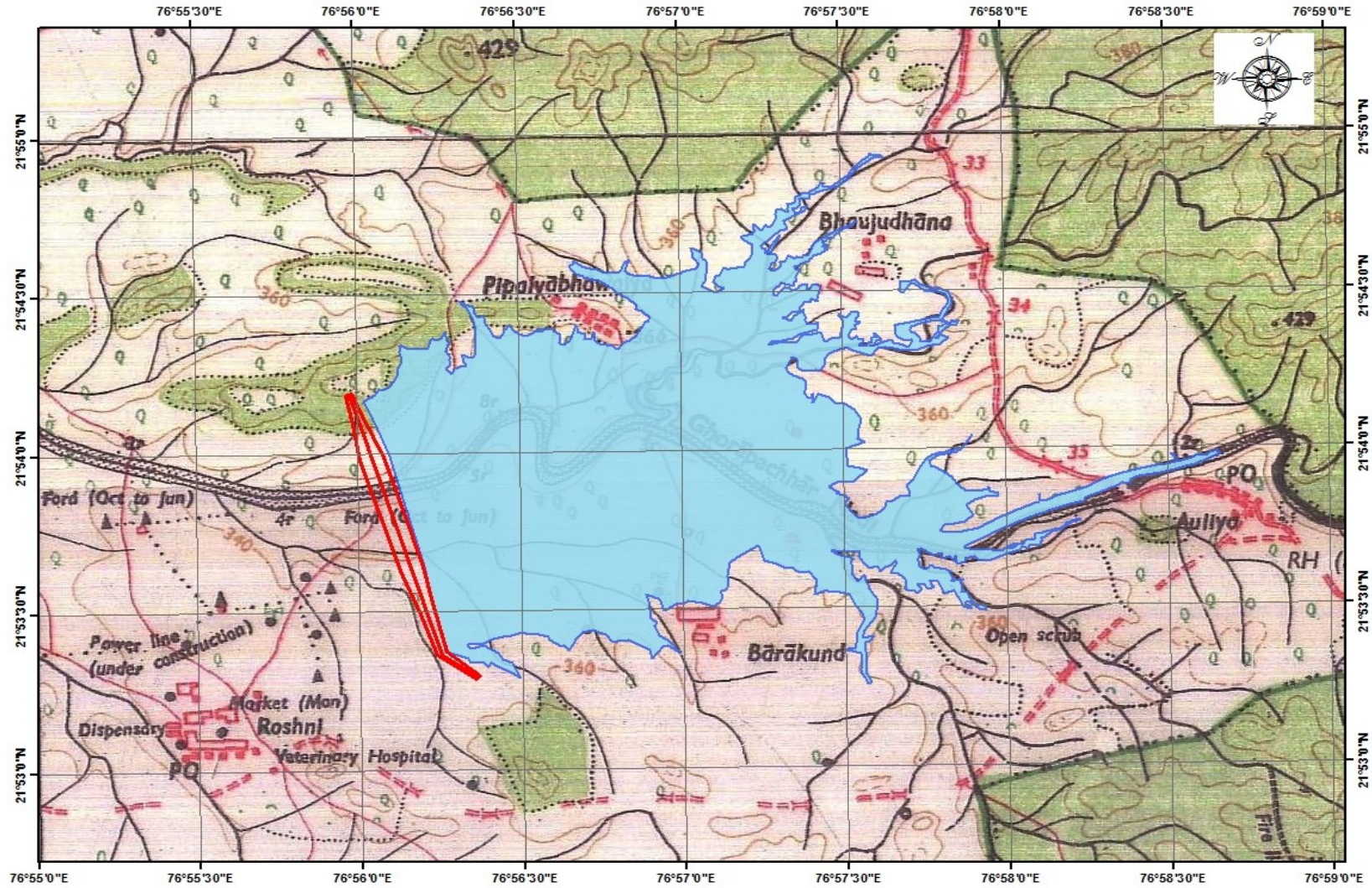


Figure – 13.4: Submergence at FRL – above 1 m, Map of Aulliya Project

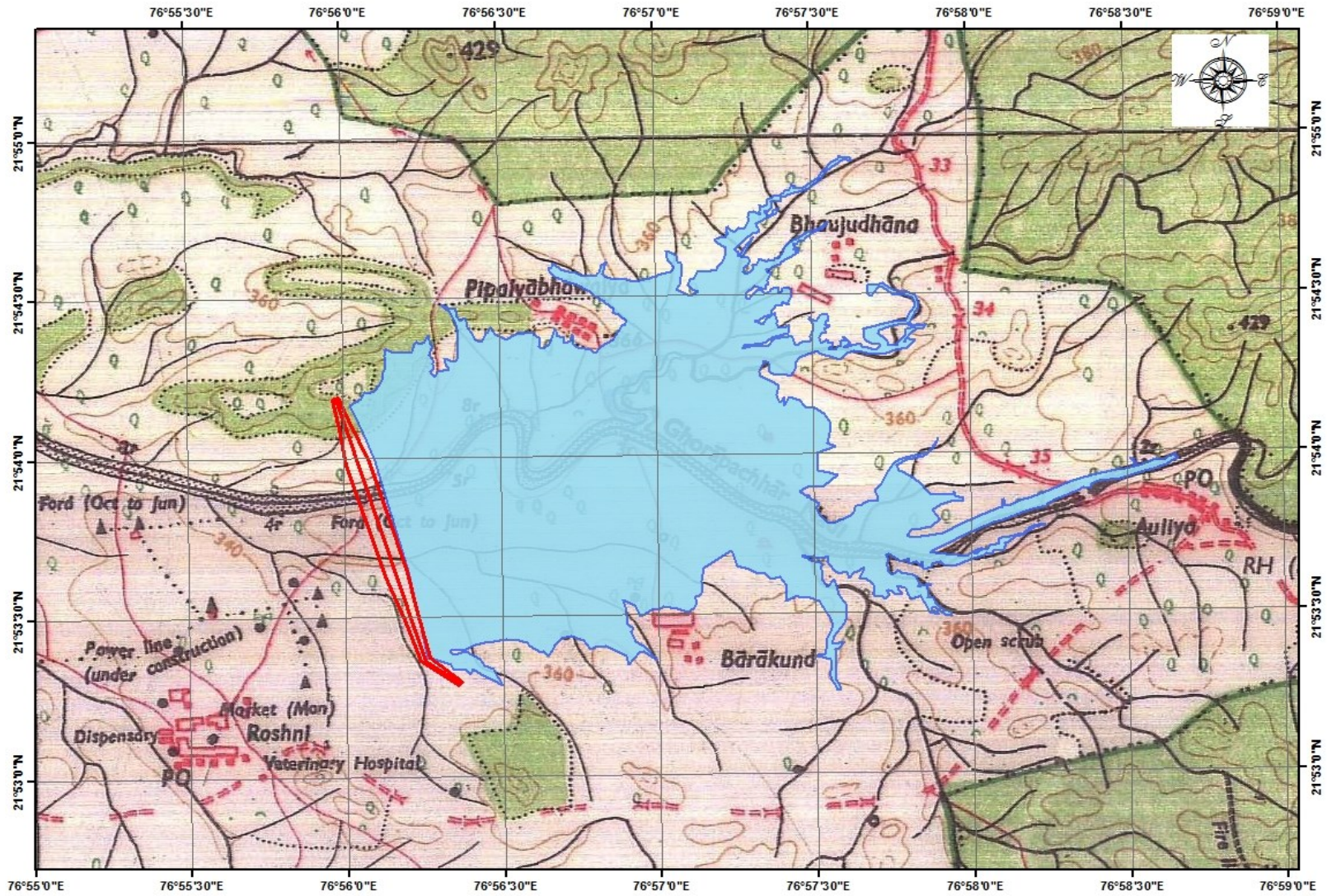


Figure – 13.5: Submergence at FRL – Below 1 m, map of Aulliya Project

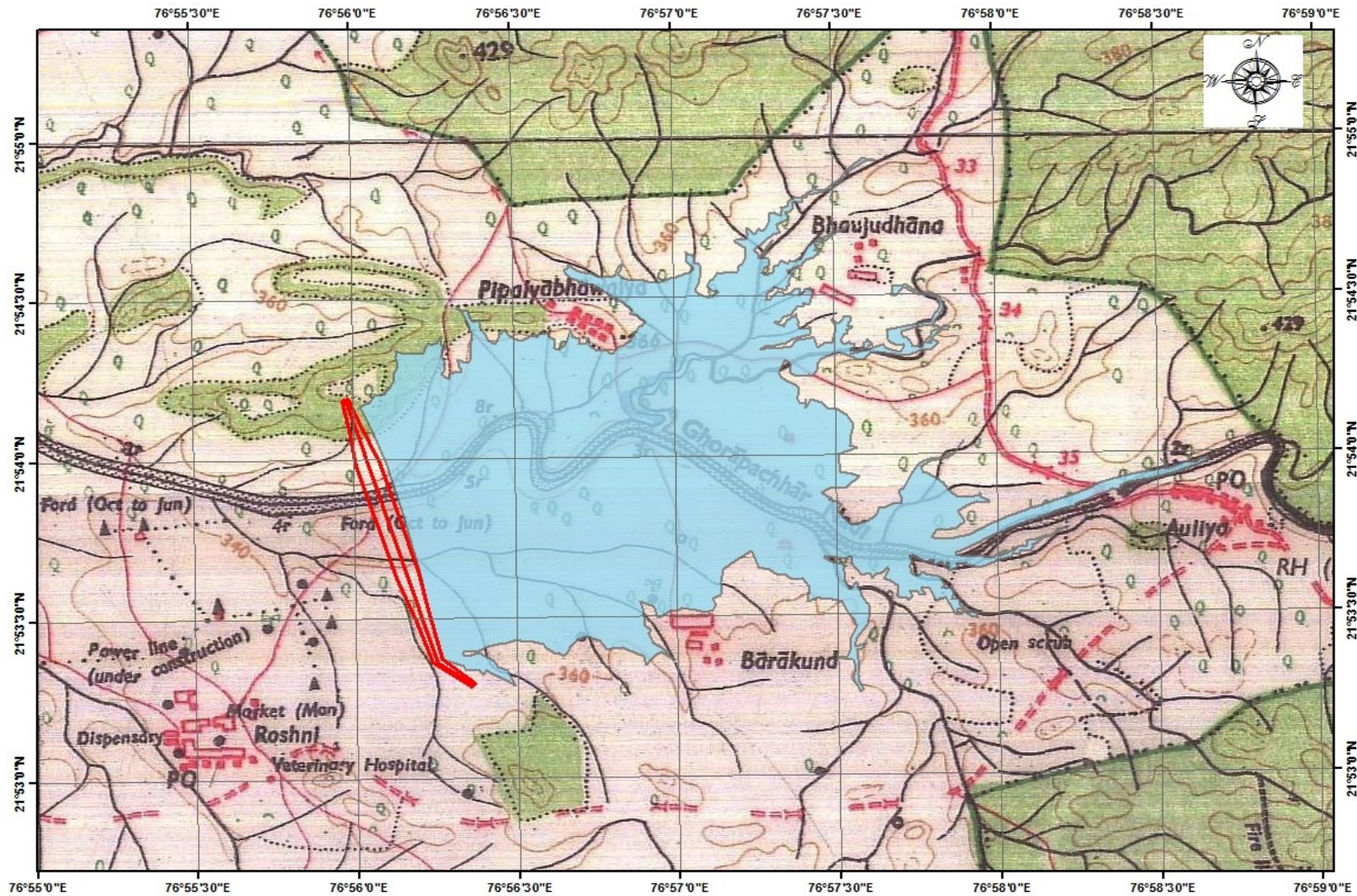
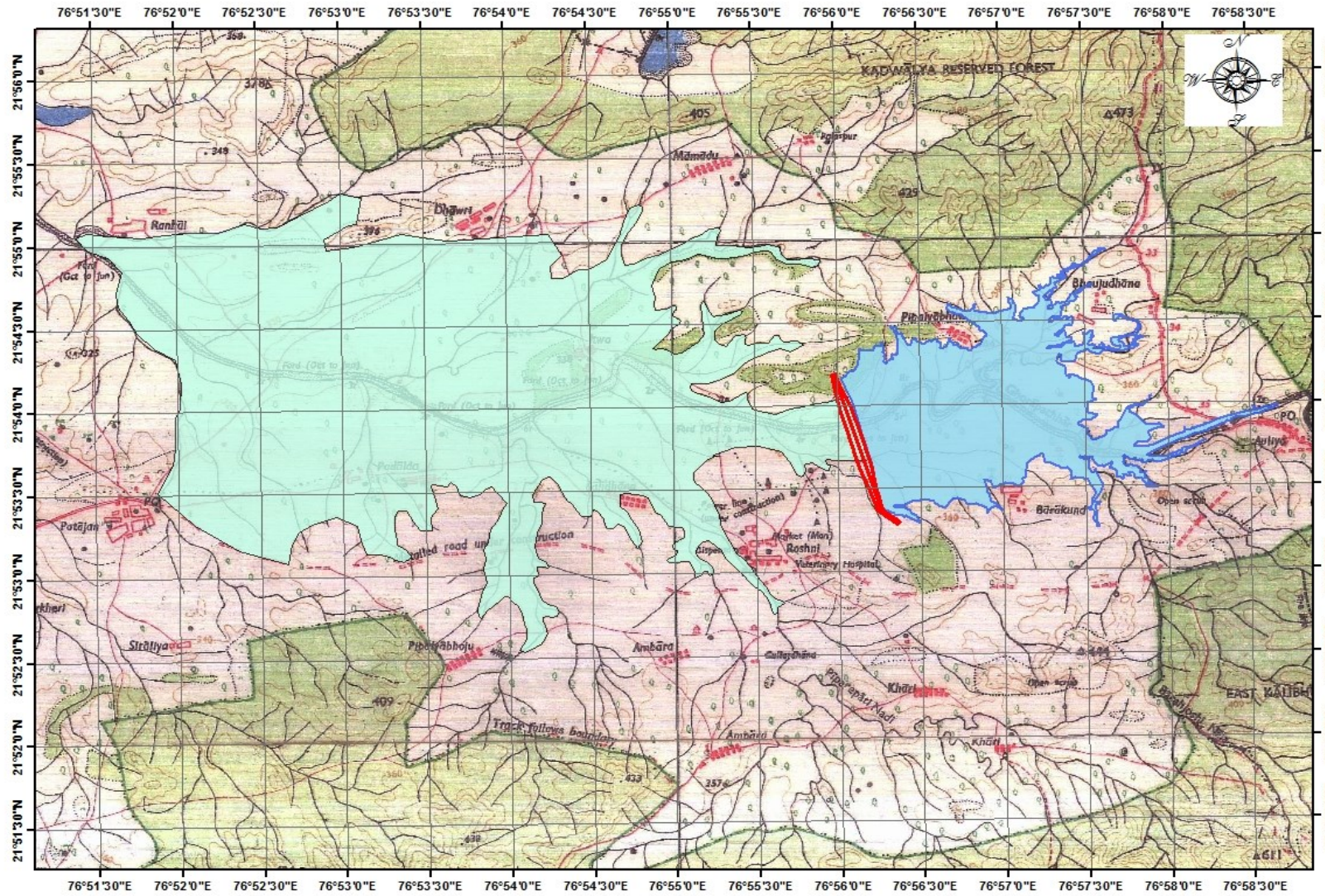


Figure – 13.6: Inundation Map In case of Dam Break, Aulliya Project



- iv). If upstream water level reaches at the top of the dam, it may be considered as Level-3 emergency. At this point only a few minutes are available for taking any action. All the staff from the dam site should be alerted to move to a safe place. The district level office and the corporation's head office should be informed about the possibility of dam failure.
- v). If upstream water level is rising above the dam top and dam has started to fail. It may be considered as a disaster condition. Any information in this regard should be immediately provided to civil administration for necessary rescue operations.

The following measures can be taken to avoid the loss of lives and property:

- To establish an effective Dam Safety Surveillance and monitoring program including rapid analysis and interpretation of instrumentation and observation data; periodic inspection and safety reviews/evaluation by an independent panel of experts.
- To formulate and implement an Emergency Action Plan to minimize to the maximum extent possible, the probable loss of life and damage to property in the event of failure of dam.

13.12.1 Surveillance

The surveillance and monitoring programs are required to be implemented during design and investigation, construction, early operation period and operation and maintenance phases of the life cycle of the dam. An affective flood forecasting system is required by establishing hourly gauge reading at suitable upstream locations with real time communication at the top. An effective dam safety surveillance, monitoring and observation along with periodic inspection, safety reviews and evaluation must be put in place. These programs will be implemented in five phases in the life cycle of a dam viz.,

- i). Design and investigation phase,
- ii). Construction phase,
- iii). First reservoir filling,
- iv). Early operation period, and
- v). Operation and maintenance phase.

13.12.2 Emergency Action Plan

An emergency is defined as a condition of serious nature which develops unexpectedly and endangers downstream property and human life and requires immediate attention. Emergency Action Plan shall include all potential indicators of likely failure of the dam, since the primary concern is for timely and reliable identification and evaluation of potential emergency.

This plan presents warning and notification procedures to be followed in case of potential failure of the dam. The purpose is to provide timely warning to nearby residents and alert key personnel responsible for taking action in case of an emergency.

13.12.3 Administrative and Procedural Aspects

The Administrative and Procedural Aspects of Emergency Action Plan consists of a flow chart depicting the names, addresses and telephone numbers of the responsible officials. In order of hierarchy, the following system will usually be appropriate. In the event of potential emergency, the observer at the site is required to report it to the Engineer-in-charge through a wireless system, if available, or by the fastest communication system available. The Engineer-in- charge shall be

responsible for contacting the Civil Administration, viz. Deputy Commissioner. In order to oversee all the operations required to tackle the emergency situations.

13.12.4 Preventive Action

Once the likelihood of an emergency situation is suspected, action has to be initiated to prevent a failure. The point at which each situation reaches an emergency status shall be specified and at that stage the vigilance and surveillance shall be upgraded. At this stage, a thorough inspection of the dam shall be carried out to locate any visible signs of distress.

The anticipated need of equipment shall be evaluated and if these are not available at the dam site, the exact locations and availability of these equipments shall be identified. A plan shall be drawn on priority for inspection of the dam. The dam, its sluices and non-overflow sections will be properly illuminated.

13.12.5 Communication System

An efficient communication system and a downstream warning system is absolutely essential for the success of an emergency plan especially in the present case because of inadequacy of time. The difference between a high flood and a dam break situation shall be made clear to the downstream people. All of the villages falling under the flooding zone or on margins are required to be connected through wireless system backed by stand-by telephone lines.

13.12.6 Evacuation Plans

Emergency Action Plan includes evacuation plans and procedures for implementation based on local needs. These are:

- Demarcation/prioritization of areas to be evacuated.
- Notification procedures and evacuation instructions.
- Safe routes, transport and traffic control.
- Shelter areas
- Functions and responsibilities of members of evacuation team.

The flood prone zone in the event of break of dam shall be marked properly at the village locations with adequate factor of safety. As the flood wave takes sufficient time in reaching these villages, its populace shall be informed well in time through wireless and sirens etc. so that people may climb on hills or to some elevated place beyond the flood zone which has been marked.

The Evacuation Team would comprise of:

- i). D.M./ his Nominated Officer (To peacefully relocate the people to places at higher elevation with state administration)
- ii). Engineer-in-Charge of the Project (Team Leader)
- iii). S.P./Nominated Police Officer (To maintain law and order)
- iv). C.M.O. of the area (To tackle morbidity of affected people)
- v). Sarpanch/ Affected Village Representative to execute the resettlement operation with the aid of state machinery and project proponents
- vi). Sub-committees at village level

The Engineer-in-Charge will be responsible for the entire operation including prompt determination of the flood situation from time to time. Once the red alert is declared the whole state machinery will come into swing and will start evacuating people in the inundation areas delineated in the inundation map. For successful execution, annually Demo exercise will be done. DM is to monitor the entire operation.

13.12.7 Notifications

Notification procedures are an integral part of any emergency action plan. Separate procedures shall be established for slowly and rapidly developed situations and failure. Notifications will include communications of either an alert situation or an alert situation followed by a warning situation. An alert situation will indicate that although failure or flooding is not imminent, a more serious situation can occur unless conditions improve. A warning situation will indicate that flooding is imminent as a result of an impending failure of the dam. It will normally include an order for evacuation of delineated inundation areas. For a regular watch on the flood level situation, it is necessary that two or more people man the flood cell so that an alternative person is available for notification round the clock.

In addition, a few guidelines to be generally followed by the inhabitants of flood prone areas, which form part of public awareness for disaster mitigation include:

- Listen to the radio for advance information and advice.
- Disconnect all electrical appliances and move all valuable personal and household goods and all clothing out of reach of flood water.
- Move vehicles, farm animals and movable goods to the highest ground nearby.
- Move all dangerous pollutants and insecticides out of reach of water.
- Do not enter flood waters on foot, if it can be avoided.

13.12.8 Cost Estimates for Disaster Management

The estimated total cost of execution of disaster management plan including the equipment would be Rs. 42.57 lacs and it is given in Table 13.5.

Table - 13.5: Estimated cost of setting up of a Flood warning monitoring

Sl. No.	Product	Amount (Rs. in lacs)
1	Setting up of Warning Chamber at Dam site for Flood Observation Book and Data Keeping	15.00
2	Generators 1 Nos. (2 KVA)	1.00
3	Computer for keeping U/S Catchment Information, Flood Data, Everyday Record of Catchment runoff during peak Monsoon Period	0.50
4	UPS 1 Nos	0.20
5	Installation and maintenance of system, maintenance and	22.00
6	running cost of UPS, generators, etc. @ 10% of the total cost for 5 years	3.87
	Total (A+B+C) (Rs. in lacs)	42.57

CHAPTER - 14: REHABILITATION & RESETTLEMENT PLAN

14.1 INTRODUCTION

The proposed scheme envisages storage of water by constructing a dam across Ghorapachhar River near Roshni village of Khandwa District and providing Irrigation facility for 5000 ha CCA lands. The gross storage is 26.246 MCM, and average annual utilization of 20.15 MCM. This reservoir is to irrigate the area coming under Khalwa tehsil of Khandwa District. The Gross & Culturable Command Area under this project respectively 7500 Ha. and 5000 Ha. The main components of the Aulliya Medium Irrigation Project are Earthen Dam, central spillway, sluice and canal distribution system.

The Aulliya Medium Project Dam is on tributary to Chhota Tawa River in Narmada Basin at Lat.21°-53'-57" and long. 76°-56'-03". The project site can be approached by Rail Connectivity – Chhanera (40 Km.), NH Accessibility – NH 59A 100 km, and Airport facility – Indore (200 Km.).

Aulliya project is designed at Top of Bund Level 358.00 M, M W L 355.00 M, Full Reservoir Level 355.00 M and Dead Storage Level 346.10 M. Top width of the dam is 5 m. Total area affected in the project: 487.06 Ha, whereas, Forest in submergence- 54.60 Ha, Culturable land in submergence- : 384.44 Ha and Revenue land in submergence- : 48.02 Ha.

14.2 RESETTLEMENT & REHABILITATION PRINCIPLES

The R&R package has been prepared keeping the local socio-economic setting in mind which ultimately depends upon the following.

14.2.1 Types of Displacement

Development projects invariably affect a large numbers of people. Displacement usually occurs at two levels. However, the impacts of displacement are not easy to quantify or compensate. The population that is displaced usually is disturbed at two levels: Economic displacement and Social displacement. Economic displacement occurs in the following situations:

- Displaced from land partially or fully; and
- Displacement of other groups of population who are not dependent on land.

“Displacement from Land”, partially or fully leads to reorganizing one’s family economy in a new way, with or without cash compensation. When ‘land for land’ option cannot be enforced and only cash compensation is provided, some farmers invest compensation in purchasing another piece of land and continue with their cultivation. This means minor readjustments in organizing the family labour. If cash compensation involves investment in an occupation other than agriculture, it means that at least one of the adult males in the house will have to take up a new job. However, the cash may also be spent on non-sustainable or secondary items instead of purchase of new land, e.g. marriage,

repayment of loans, purchase of consumer goods, construction of house, etc. the farmer often ends up in debt for consumption, having no future land to support his family.

“Economic Dislocation”, Land is the basic capital for a farmer. Due to land acquisition, the traditional source of earning gets severely hampered for the affected population. Apart from those persons whose land has been acquired, others without directly being affected by the project face some kind of economic displacement at a wider level of economic interaction and participation. This means that changes come about sometimes creating completely alien sub-groups for the traditional network.

On the other hand displacement also shatters the social hierarchic set-up of the society that is being displaced. Displaced social hierarchy, resulting in new inter-relationships of community participation, not only forces the displaced population to move to new relocation sites but also these people have to re-establish their social interactions and relationships afresh. However, this may not be very easily accomplished, as it is difficult to predict how the host village would react to these populations who would now depend on their resources.

The first two levels affect the micro-level family relations, which is equally important, while the last one occurs at the macro-level. Displacement brings about vigorous interaction between the internal and external cultural settings, through commerce, business, job shifting, educational opportunities, etc. It increases competition that was not there so much, resulting in more conflicts. It can be said that the two levels do not occur in a sequential order, but come more or less simultaneously, either as a manifestation of displacement or in a latent form. A clear comprehension of the above aspects would make the project authorities much more competent.

14.2.2 Objectives of Resettlement and Rehabilitation Plan

The main objectives of the Resettlement and Rehabilitation Plan are to:

- To minimize displacement and to promote as far as possible, non-displacing and least displacing alternatives. Involuntary resettlement should be avoided where feasible.
- To provide better standard of life and to assist in each PAFs in regaining their economic status and sustain it for life long.
- To compensate the families affected adversely by construction of the project
- To improve the quality of life of the PAFs and the surrounding project affected area by developing infrastructure facilities and also to provide trainings and skill development activities for their better living
- To ensure that special care is taken for protecting the rights of the weaker sections especially the Scheduled Tribes and also care is to be taken not to disturb much the cultural and ethnicity of the area.
- To provide adequate compensation to PAFs whose land is acquired and who are being displaced.
- To create good rapport with the local people for long-term relationship and mutual benefits.

14.3 LAND REQUIREMENT

For the development of Aulliya. Project land would be acquired for the construction of various project components like dam, reservoir, sluice, and spillway, Office and labour colonies, quarrying, magazine, batching plants, muck dumping sites, etc. For this purpose land is likely to be acquired on permanent as well as on temporary lease basis. Major part of the land under submergence is in the project: 487.06 Ha, whereas Forest in submergence- 54.60 Ha, Culturable land in submergence- : 384.44 Ha and Revenue land in submergence- : 48.02 Ha.

Table - 14.1: Land Requirement for Aulliya. Project

DETAILS OF SUBMERGENCE AREA	In Ha
Total area affected in the project :	487.06
Forest in submergence- :	54.6
Culturable land in submergence- :	384.44
Revenue land in submergence- :	48.02

Project benefits:

The irrigation will increase the general standard of living of the people in the project area and following benefits are envisaged;

1. Land and property value will appreciably increase.
2. Reservoir will provide an excellent opportunity for development of fisheries which will ultimately leads to financial upliftment of people of command area.
3. Reservoir site will provide excellent site for picnic spot resulting in addition of the economic wealth of the people of the area.
4. Project will provide employment to the thousands of people and will help in improving the financial condition of the people of the area.
5. Water table in the area will rise; the wells in the area will be useful for a longer period.
6. There shall be cattle rearing, and other linkage animal husbandry activities in the command area.
7. The benefited population of command area will try to improve their sanitation condition, due to improvement of the socio economic condition and better purchase power parity.
8. The mindset of the benefited farmers will have better perception for girl child education and there shall be a sea of changes in their social spheres of life.

14.4 RESETTLEMENT AND REHABILITATION PLAN

For the purpose of this project, the R&R plan has been devised using the norms and guideline of the “Right to Fair Compensation and Transparency in land Acquisition, Rehabilitation and Resettlement Act, 2013”. The Consultant based on past experiences in similar project, in the area have suggested/specified/augmented/enhanced the R&R provisions. The objective of the R&R plan is to enable project planners to take appropriate measures to devise suitable compensation as a part of resettlement and rehabilitation package for the PAFs. However Govt. of MP As issued special package vide to order no. 22(A)/349/39/18SPS/31/1315 Bhopal dated 27.07.2018. Accordingly the compensation will be paid to PAFs after getting their consent.

14.4.1 Measures for Compensation of Loss of Private Properties

Compensation for Land:

Of the total land coming under submergence area, private irrigated land accounts for 384.4 Ha. About 30 Families are likely to lose land due to the project. The other hand, compensation for the acquisition of private land would be paid to the respective land owners/ land titleholders as per the provisions of “Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013”. However Govt. of MP As issued special package vide to order no. 22(A)/349/39/18SPS/31/1315 Bhopal dated 27.07.2018. Accordingly the compensation will be paid to PAFs after getting their consent.

Compensation for Homesteads

It is envisaged that this proposed project is also likely to evict a number of families from their homesteads as well. As per assessment, 30 homestead structures are likely to get affected as a result of land acquisition.

Compensation of Other Properties

Other properties such as tree, wells, ponds, temples, cremation ground, public utility buildings and spaces, electric and telephone poles and cables, etc., would be assessed, valued and compensation rates would be fixed as per the prevalent guidelines/ norms. The compensation amount shall be disbursed to the concerned department, agency, individual etc. However Govt. of MP As issued special package.

Table – 14.2: Cost of Land in various villages coming under Dam submergence

Sl No	Name of the Village	Total Area Submerged in (Ha)	Irrigated Land in (Ha)	Non Irrigated Land (Ha)	Number of Land Holders	Number of Lands	Cost of Irrigated Land per Ha (As per the Guideline Madhya Pradesh 2017-18) in Lakh	Cost of Non Irrigated Land per Ha (As per the Guideline Madhya Pradesh 2017-18) in Lakh	Total Cost of Irrigated Land in Lakh	Total Cost of Non Irrigated Land in Lakh	
1	Pipliyabhoju	81.511	71.045	10.466	57	70	3.20	1.88	227.344	19.67608	
2	Roshni	8.454	7.642	0.812	12	15	9.35	5.50	71.4527	4.466	
3	Barakund	194.733	176.394	18.339	166	256	3.20	1.88	564.4608	34.47732	
4	Bhojudhana	99.744	97.179	2.565	68	109	3.20	1.88	310.9728	4.8222	
Total		384.442	352.26	32.182	303	450			1174.23	63.4416	
									Total Cost of Land		1237.672

However Govt. of MP As issued special package vide to order no. 22(A)/349/39/18SPS/31/1315 Bhopal dated 27.07.2018. Accordingly the compensation will be paid to PAFs after getting their consent. Total budget required for 384.44 ha. land at the rate of Rs. 10 lac(s)/Ha. is 3844.42

14.5 COST ESTIMATE FOR REHABILITATION

The total Budget for implementation of the Rehabilitation and Resettlement Plan is Rs. 4244.42 lac(s). The details are given in Table 14.3.

Table – 14.3: Cost Estimate for Rehabilitation and Resettlement Plan

Sl. No	PARTICULAR	Cost (Rs.Lakh)
1	Compensation approximately at 5 lacs/ house (30*5)	150.00
2	Extra Grant for Nuclear family (50 * 5 lakhs)	250.00
	Total (A)	400.00
3	Cost of Land	3844.42
	Total (B)	3844.42
	GRAND TOTAL (A+B)	4244.42

CHAPTER - 15: ENVIRONMENT MONITORING PROGRAMME

15.1. INTRODUCTION

Environmental Monitoring is an essential tool in relation to environmental management as it provides the basis for rational management decisions regarding impact control. Monitoring shall be performed during all stages of the project (namely: construction, and operation) to ensure that the impacts are no greater than predicted, and to verify the impact predictions. The monitoring program will indicate where changes to procedures or operations are required, in order to reduce impacts on the environment or local population. The monitoring program for the Aulliya Medium Irrigation Project will be undertaken to meet the following objectives:

- To monitor the environmental conditions of the Ghorpachhar river and the reservoir as impacted by the Aulliya Medium Irrigation Project;
- To check on whether mitigation and benefit enhancement measures have actually been adopted, and are proving effective in practice;
- To provide information on the actual nature and extent of key impacts and the effectiveness of mitigation and benefit enhancement measures which, through a feedback mechanism, can improve the planning and execution of future, similar projects.

Monitoring of three basic items of air, water and noise suffices for monitoring the environmental changes at the local level. Accordingly, it is imperative to monitor air quality, water quality, and noise levels during the construction and operation phases.

15.2. WATER QUALITY

Construction Phase

The water quality monitoring should be carried out on regular basis. Frequency of monitoring will vary from site to time and as we progress during the construction phase and shall be decided on yearly basis with the help of MPPCB. The sampling sites shall typically be colony and camp area (sewage effluent from colony and camps), Dam site; downstream of Dam site, etc and alsosome ground water samples from suitable locations. During the construction phase, if any other stream etc. needs to be monitored, it will also be covered. The monitoring is proposed to be done for entire period of construction i.e. 3 years.

Operation phase

The surface water quality of the proposed reservoir and river Ghorpachharand ground water can be monitored thrice a year (summer, pre and post-monsoon seasons). The proposed parameters to be monitored include; pH, total suspended solids, DO and conductivity. The sampling sites are 1 to 2 km upstream of dam, near dam site, downstream of dam (Roshni village).

15.3. AIR QUALITY

Construction Phase

The ambient air quality monitoring during construction phase will be carried out through State Pollution Control Board or any agency approved by them. Every year monitoring is to be done for the following three seasons:

- Summer
- Pre - monsoon
- Post - monsoon

The frequency of monitoring could be twice a week for four consecutive weeks at each station for each season. The parameters to be monitored are Suspended Particulate Matter (SPM), Sulphurdioxide (SO₂) and Nitrogen Oxides (NO_x). Every year, ambient air quality is to be monitored for (3 stations x 2 days/week x 4 weeks x 3 seasons) 96 days.

Operation Phase

Similarly air quality will be monitored regularly during operation phase also for parameters – SPM, SO₂ and NO_x for first 2 years.

15.4. NOISE

Construction Phase

Noise emissions from vehicular movement, operation of various construction equipments may be monitored during construction phase at major construction sites. The frequency of monitoring could be once in months. For monitoring of noise generators, an Integrating Sound Level Meter will be used to record sound levels.

Operation Phase

Noise monitoring will continue during operation phase also for first 2 years.

15.5. MUCK/ DEBRIS DUMPING AND DISPOSAL

Construction Phase

In addition to the air quality, water quality and noise quality during the construction phase, management of construction debris and muck arising out of the earth work involved in the hydro projects is also a major environmental issue. Adopting appropriate and well designed engineering structures for retaining the construction debris and muck is very crucial and this needs to be monitored regularly both for stability of the dump sites and their vulnerability to stress failures due to various factors such as erodability, strong water currents and earth pressures. Regular monitoring of the muck dumping will be carried out by MPPCB.

15.6. MINIMUM ENVIRONMENTAL FLOW

Operation Phase

Similarly during operation phase of the project, most crucial environmental aspect is the monitoring of flow released from the hydel project to ensure that minimum flow is maintained at all times

especially during lean season. Therefore, monitoring mechanism will be established as per the requirement of MPPCB to monitor river flow immediately downstream of the diversion structure.

15.7. FINANCIAL REQUIREMENT

A sum of Rs. 95.80 lacs has been allocated to implement various activities and programme envisaged under EMP and the details are given in Table 15.1. The detailed matrix of EMP listing all the activities to be monitored and implementing agency has been given in Table 15.2.

Table - 15.1: Cost estimates for Environmental Monitoring Programme

Sl. No.	Items to be Monitored	Parameters	Monitoring Agency	Budget (Rs. In lakhs)
CONSTRUCTION PHASE				
1	Ambient Air Quality	SO ₂ , NO _x , SPM	SPCB	7.12
2	Ambient Sound Levels	Sound Levels	SPCB	
3	Surface Water Quality	pH, TSS, DO and Conductivity	SPCB	
4	Ground Water Quality	BOD, COD, DO, pH	SPCB	
5	Muck/Debris Dumping and Disposal	Muck Quantity, Dumping process, Engineering and Biological Measures implementation	SPCB	
OPERATION PHASE				
1	Ambient Air Quality	SO ₂ , NO _x , SPM	SPCB	7.12
2	Ambient Sound Levels	Sound Levels	SPCB	
3	Surface Water Quality	pH, TSS, DO and conductivity	SPCB	
4	Ground Water Quality	BOD, COD, DO, pH	SPCB	
5	Release of Minimum Flow	Inflow and release in river at diversion structure	SPCB	
TOTAL (In Rs Lacs)				14.24

Table - 15.2: Matrix of Environmental Monitoring Plan

Sl. No.	Aspect	Source of Impact	Monitoring Methods & Parameters
1.0 Construction Phase			
1.1	Local manpower absorption	Construction works	Contractor's report No. of people working in the project
1.2	Erosion and landslides	Excavation, disposal, cut & fill and land clearing activities for access roads, disposal	Survey & observation Extent and degree of landslides and erosion
1.3	Biodiversity	Land clearing activities fauna in the project area for access roads, colonies	Composition of flora and fauna
1.4	Re-vegetation & Afforestation	Land clearing, disposal works	Survey & observation Density of vegetation Survival rate of species planted
1.5	Soil erosion control measures	Excavation, landslides, cut & fill for road construction	Status/ Survival rate of bio-engineering and engineering structures for controlling soil erosion
1.6	Water Quality	Excavation, disposal, sewage disposal, land clearing activities and other chemical parameters	Surveys & sample collection and field measurements Turbidity, pH, T.D.S., D.O., Total Coliform and E. coli
1.7	Air Quality	Operation of DG sets, transportation of muck, road construction, mobilization of material, running of crushers	Survey & observation Levels of SPM, SO _x , NO _x
1.8	Public Health	Dust, noise, influx to labour	Regular medical checkups and camps
1.9	Health Delivery System	Influx of labour	Status of water and vector borne diseases, improvement observed, if any, status of women and child health
1.10	Fish Management	Construction Activities	Impact of project construction on fish, and aquatic life, if any Status of infrastructure developed for fish management like hatcheries
1.11	Restoration of Muck Disposal sites, construction areas	Muck generation, transportation and dumping	Status of protection measures at the dumping sites. Whether dumping is done so as to avoid spillage of muck into the river, especially during rains Leveling and slope stabilization works at dumping sites. Status

Sl. No.	Aspect	Source of Impact	Monitoring Methods & Parameters
			ofafforestation/ turfingworks on the dumping sites
2.0 Operation Phase			
2.1	Water Quality and Quantity (for irrigation & domestic use)	Reservoir water regulation Diversionof water for power generation	Surveys, sample collection & field measurement Waterdischarge d/s of dam Water quality (turbidity,coliformbacteria and others
2.2	Air Quality	Increased activities in the areaincluding movement of vehicles, airpollution from colony, etc.	Survey & observation Levels of SPM, SOx, NOx
2.3	Noise Levels	Noise due to operational activities including that from housing colony	Sound Levels using sound level meter
2.4	Fish production	Reservoir regulation	Survey & observation
2.5	Aquatic weeds		Surveys & sample collection Kinds of species
2.6	Catchment conditions	Deforestation	Survey & observation of Barren areas for Afforestation
2.7	Accidents	Sudden discharge of water for power generation	Surveillance
2.8	Disaster	Heavy rainfall, flash flood situation	Surveillance and disaster management exercises, Regularinformation to people

CHAPTER - 16: COST ESTIMATES

An amount of Rs. 5659.32 lacs has been allocated for the implementation of different environmental management plans. The summary of total cost estimates for the execution of different plans is given in Table 16.1 below.

Table – 16.1: Summary of Cost for EMP Implementation

Sl. No.	Management Plan	Amount (in lacs)
1	Biodiversity Conservation & Management Plan	34.00
2	Catchment Area Treatment Plan	256.18
3	Fisheries Conservation Management Plan	138.50
4	Solid Waste Management Plan	36.18
5	Public Health Management Plan	44.00
6	Energy Conservation Measures	4.50
7	Muck Disposal Plan	68.02
8	Landscaping & Restoration Plan	40.50
9	Air & Water Management Plan	16.00
10	Green Belt Development Plan	17.05
11	Reservoir Rim Treatment Plan	57.52
12	Compensatory Afforestation Plan	645.64
13	Dam Break Analysis & Disaster Management Plan	42.57
14	Rehabilitation & Resettlement Plan	4244.42
15	Environment Monitoring Programme	14.24
	Total Cost for EMP	5659.32

*****Note:**

- i). *The entire cost for Fisheries management Plan will be funded by Fisheries Department, GoMP at Roshni village Auilliya project Location near the dam site.*
- ii). *A well-equipped and manned PHC exist near the Location of Dam site which can meet the requirement of this project, so there is no need extra provision for Public Health Management Plan.*