

**ENVIRONMENTAL IMPACT ASSESSMENT
for
PARBATI MAJOR IRRIGATION PROJECT (CCA 48,000 ha)
MADHYA PRADESH, (Sector 1(c); Cat “A”)**



May, 2019

Prepared for:
WATER RESOURCES DIVISION NARSINGHGARH

Prepared by:



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QCI Certificate No. : **NABET/EIA/1619/SA 075**

Laboratory : **APEX TESTING AND RESEARCH LABORATORY**
ISO/IEC 17025:2005
(NABL Accredited Testing Laboratory)

Baseline Data : **Pre-Monsoon (May 2018)**
Monitoring Period **Monsoon (July 2018)**
Winter/ Lean (February 2018)

List '1' – Accredited EIA Consultant Organizations (ACOs) - as on May 06, 2019#

S. No.	Consultant Organization	Scope of Accreditation			
		As per NABET Scheme			Project or Activity as per Schedule of MoEFCC Notification dated September 14, 2006 and subsequent Amendments
		Sector Number	Name of Sector	Category	
1	Aadhi Boomi Mining and Enviro Tech Private Limited (formerly known as Suriya Mining Services) Address: 3/216, K.S.V.Nagar, Narasothipatti, Salem-636004 Email: suriyakumarsemban@gmail.com Tel.: 09842729655, 09443290855 <i>Conditions apply</i>	1	Mining of minerals – opencast only	A	1 (a) (i)
		3	River Valley Projects	A	1 (c)
		7	Mineral beneficiation	A	2 (b)
		9	Cement Plants	A	3 (b)
		34	Highways	B	7 (f)
		38	Building and construction projects	B	8(a)
2	Aakhivi Consultants Address: 57 C, Block E5, Shatabdi Vihar, Sector 52, Noida, UP - 201 308	1	Mining of minerals - opencast only	A**	1 (a) (i)
		4	Thermal power plants	A**	1 (d)

S. No.	Consultant Organization	Scope of Accreditation			
		As per NABET Scheme			Project or Activity as per Schedule of MoEFCC Notification dated September 14, 2006 and subsequent Amendments
		Sector Number	Name of Sector	Category	
	Address: CIFT Building, PDIL, Sindri, Dhanbad, Jharkhand-828122 E-mail: Dhn_envpdil@bsnl.in , ajay15b@gmail.com Tel.: 03262350801, 09431777483 <i>Conditions apply</i>	16	Chemical Fertilizers	A	5 (a)
		27	Oil & gas transportation pipeline (crude and refinery/ petrochemical products), passing through national parks/ sanctuaries/coral reefs /ecologically sensitive Areas including LNG terminal	A	6 (a)
		28	Isolated storage & handling of hazardous chemicals (As per threshold planning quality indicated in column 3 of schedule 2 & 3 of MSIHC Rules 1989 amended 2000)	B	6 (b)
		29	Air ports	A	7 (a)
127	R. S. Envirolinks Technologies Pvt. Ltd. Address: 402, Radisson Suites Commercial Plaza, B Block, Sushant Lok 1, Gurgaon – 122009 e. mail: ravi@rstechnologies.co.in Tel.: 0124 – 4295383 09810136853	1	Mining of minerals- opencast only	A	1 (a) (i)
		3	River Valley projects	A	1 (c)
		27	Oil & gas transportation pipeline (crude and refinery/ petrochemical products), passing through national parks/ sanctuaries/coral reefs /ecologically sensitive Areas including LNG terminal	A	6 (a)

S. No.	Consultant Organization	Scope of Accreditation			
		As per NABET Scheme			Project or Activity as per Schedule of MoEFCC Notification dated September 14, 2006 and subsequent Amendments
		Sector Number	Name of Sector	Category	
	<i>Conditions apply</i>	33	Jetties only	B	7 (e)
		34	Highways	A	7 (f)
		40 (i)	Automobile and Auto Components	-	-
128	Ramans Enviro Services Pvt. Ltd. Address: SF 23 & 24, Camps Corner, Nr. AUDA Garden, Prahladnagar, Ahmedabad – 380015 e. mail: ramans.consultancy@gmail.com samirchoksi88@yahoo.com Tel.: 079 – 26937472, 26937411 09824034495 <i>Conditions apply</i>	4	Thermal power plants	A	1 (d)
		21	Synthetic organic chemicals industry (dyes & dye intermediates; bulk drugs and intermediates excluding drug formulations; synthetic rubbers; basic organic chemicals, other synthetic organic chemicals and chemical intermediates)	A	5 (f)
		28	Isolated storage & handling of hazardous chemicals (As per threshold planning quality indicated in column 3 of schedule 2 & 3 of MSIHC Rules 1989 amended 2000)	B	6 (b)
		32	Common hazardous waste treatment, storage and disposal facilities (TSDFs)	A	7 (d)
		36	Common effluent treatment plants (CETPs)	B	7 (h)
		37	Common municipal solid waste	B	7 (i)



Quality Council of India

National Accreditation Board for
Education & Training



Certificate of Accreditation

R. S. Envirolink Technologies Pvt. Ltd., Gurgaon

402, Bestech Chamber Commercial Plaza, B Block, Sushant Lok I, Gurgaon, Haryana – 122009

Accredited as Category - A organization under the QCI-NABET Scheme for Accreditation of EIA Consultant Organizations: Version 3 for preparing EIA-EMP reports in the following Sectors:

Sl. No	Sector Description	Sector (as per)		Cat.
		NABET	MoEFCC	
1	Mining of minerals- opencast only	1	1 (a) (i)	A
2	River Valley projects	3	1 (c)	A
3	Oil & gas transportation pipeline (crude and refinery/ petrochemical products), passing through national parks/ sanctuaries/coral reefs /ecologically sensitive Areas including LNG terminal	27	6 (a)	A
4	Jetties only	33	7 (e)	B
5	Highways	34	7 (f)	A
6	Automobile and Auto Components	40 (i)	-	-

Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in SA AC minute dated June 14, 2018 posted on QCI-NABET website.

The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in QCI-NABET's letter of accreditation bearing no. QCI/NABET/ENV/ACO/18/0795 dated November 15, 2018. The accreditation needs to be renewed before the expiry date by R. S. Envirolink Technologies Pvt. Ltd., Gurgaon following due process of assessment.

Sr. Director, NABET
Dated: Nov 15, 2018

Certificate No.
NABET/EIA/1619/SA 075

Valid up to
August 15, 2019

For the updated List of Accredited EIA Consultant Organizations with approved Sectors please refer to QCI-NABET website.

Declaration by Experts contributing to the EIA Report of Parbati Major Irrigation Scheme.

I, hereby, certify that I was a part of the EIA team in the following capacity that developed the above EIA.

EIA Coordinator: Vimal Garg

Name: Vimal Garg

Signature & Date:

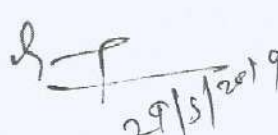
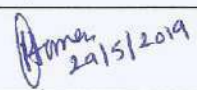
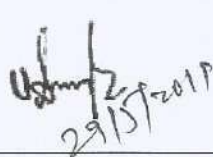
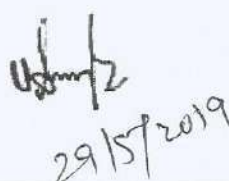
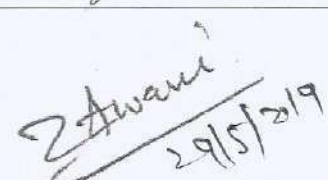
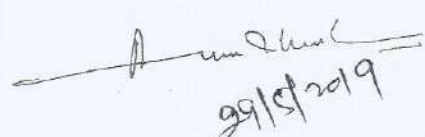
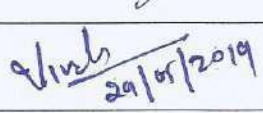
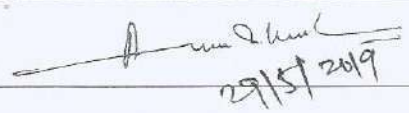

29/5/2019

Date-29/05/2019

Period of Involvement: May 2018 – May 2019

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Functional Area Experts/ Associates:

S.No.	Functional Areas	Name of the expert/s	Involvement (Period & Task)	Signature
1	AP	Vimal Garg	- Baseline Data Review and Analysis - Impact Assessment - Preparation of Air Management Plan	 29/5/2019
		Parshant Tomar	Baseline Data Collection, Analysis and Interpretation	 29/5/2019
2	WP	Ravinder P S Bhatia	- Baseline Data Review and Analysis –Water Quality - Impact Assessment and Management Plan	 29/5/2019
3	SHW	Ravinder P S Bhatia	- Impact Assessment - Preparation of Waste Management Plan - Public Health Delivery System - Muck generation analysis and Dumping Plan	 29/5/2019
4	SE	Zahoor A Wani	- Social Data Collection and Interpretation - Social Impact Assessment - Preparation of R&R Plan	 29/5/2019
5	EB	Arun Bhaskar	- Impact Assessment - Preparation of Biodiversity Management Plan - Compensatory Afforestation Plan	 29/5/2019
		Vivek Jhaladiyal	Baseline Data Collection, Analysis and Interpretation	 29/5/2019
6	SC	Arun Bhaskar	Baseline Data Review and Analysis	 29/5/2019

			• Impact Assessment	
		Vivek Jhaldiyal	• Sampling and Interpretation	<i>Vivek</i> 29/5/2019
7	AQ	Ravinder P S Bhatia	• Impact Assessment of Air and Water Environment	<i>Ushmit</i> 29/5/2019
		Parshant Tomar	• Baseline Data Collection, Analysis and Interpretation	<i>Parshant</i> 29/5/2019
8	NV	Ravinder P S Bhatia	• Baseline Data Review and Analysis – Sound levels, Impact Assessment and Mitigation Plan	<i>Ushmit</i> 29/5/2019
9	HG	Vimal Garg	• Impact Assessment	<i>Vimal</i> 29/5/2019
10	LU	Vimal Garg	• Impact Assessment • Data Review and Analysis	<i>Vimal</i> 29/5/2019
		Sanjeev Yadav	• Field Investigation and Data Collection • Sampling and Interpretation	<i>Sanjeev</i> 29/5/2019
		Dimple Razdan	• Preparation of Thematic maps	<i>Dimple</i> 29/5/2019
11	RH	Harsh Pandya	• Risk Assessment	<i>Harsh</i> 29/5/2019
12	GEO	Trilochan Singh Kaith	• Geological & Geotechnical Investigations	<i>Trilochan</i> 29/5/2019

Declaration by the Head of the Accredited Consultant Organization/ authorized person

I, Vimal Garg, hereby, confirm that the above mentioned experts prepared the EIA/EMP Report of Parbati Major Irrigation Scheme. I also confirm that the consultant organization shall be fully accountable for any mis-leading information in this statement.

Signature:

Name: Vimal Garg

Designation: Vimal Garg

Name of the EIA Consult Organization: RS Envirolink Technologies Pvt. Ltd.

NABET Certificate No. & Issue Date: NABET/EIA/1619/SA075, 15th November 2018

S.No.	Functional Areas	Complete name of the Functional Areas
1	AP	Air Pollution Prevention, Monitoring & Control
2	WP	Water Pollution Prevention, Control & Prediction of Impacts
3	SHW	Solid Waste and Hazardous Waste Management
4	SE	Socio-Economics
5	EB	Ecology and Biodiversity
6	SC	Soil Conservation
7	AQ	Meteorology, Air Quality Modeling & Prediction
8	NV	Noise/ Vibration
9	HG	Hydrology, Ground Water & Water Conservation
10	LU	Land Use
11	RH	Risk Assessment & Hazard Management

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- 2. CATCHMENT AREA TREATMENT PLAN**
- 3. FISHERIES CONVERSATION & MANAGEMENT PLAN**
- 4. COMMAND AREA DEVELOPMENT**
- 5. REHABILITATION & RESETTLEMENT PLAN**
- 6. LANSCAPING, RESTORATION & GREEN BELT DEVELOPMENT PLAN**
- 7. RESERVOIR RIM TREATMENT PLAN**

- 8. MUCK MANAGEMENT PLAN**
- 9. SOLID WASTE MANAGEMENT PLAN**
- 10. PUBLIC HEALTH DELIVERY SYSTEM**
- 11. ENERGY CONSERVATION MEASURES**
- 12. DAM BREAK MODELING & DISASTER MANAGEMENT PLAN**
- 13. CORPORATE ENVIRONMENT RESPONSIBILITY PLAN**
- 14. PUBLIC CONSULTATION ISSUES AND RESPONSE**

**Chapter
1****INTRODUCTION****1.1 PURPOSE OF THE REPORT**

Environment Impact Assessment (EIA) study of Parbati Major Irrigation Project has been carried out with a view to assess the impacts of project on the surrounding area so as to suggest mitigation and management measures to minimize such impacts. EIA study for such projects is mandatory as per EIA Notification of September 2006, which describes the environment clearance procedure.

An Environmental Impact Assessment (EIA) is a tool used to predict the environmental consequences (positive or negative) of a plan, policy, program, or project prior to the implementation decision. It proposes measures to adjust impacts to acceptable levels or to investigate new technological solutions. Although an assessment may lead to difficult economic decisions and political and social concerns, environmental impact assessments protect the environment by providing a sound basis for effective and sustainable development.

The Environment Management Plan (EMP) outlines a plan which, upon implementation, will reduce negative impacts of the project during construction and operational phase and minimize environmental degradation. This minimization may be a result of implementation of a project alternative or project modifications or environmental protection measures which simply reduces the severity or magnitude of impacts.

The purpose of the assessment is to ensure that decision makers consider the environmental impacts while deciding whether or not to proceed with a project.

1.2 PROJECT IDENTIFICATION AND PROJECT PROPONENT

The role of Water Resources Department, Madhya Pradesh is the creation and maintenance of irrigation potential through construction of water resources projects. It also looks after the construction, maintenance and regulation of Major, Medium & Minor irrigation projects, Flood Control and Drainage works.

1.3 BRIEF DESCRIPTION OF NATURE, SIZE, LOCATION OF PROJECT AND ITS IMPORTANCE

Project Components:

The Parbati Project envisages construction of an earthen dam with central spillway, three pump houses on Left bank with Rising main. The project constitutes the following:

- (i) Construction of 1050 m long Dam with a maximum height of 25.0 m and saddle 180 m long.
- (ii) The 369.65 m long Central Spillway & 10 m key wall (on both side) with 18 Nos vertical gates of size 13.80 m x 12.00 m with a maximum discharging capacity of 19853.86 cumec and foundation gallery has also been provided.
- (iii) The 680.35 m long earthen section on either side of the Dam portion.
- (iv) Storage formed by the construction of Dam will have a Gross storage 172.54 MCM live storage of 162.62 MCM with approximately 10 MCM post monsoon Flow in river; Culturable Command Area is **48,000 ha**.

Canals:

It consists of a pressurized pipe system of 48 km with micro network system to irrigate 48,000 ha. Piped canal system would irrigate 48,000 ha area of Rajgarh & Bhopal district. Total 48 km network of gravity main and rising main for GM1, GM2 and GM3 would irrigate total area.

Project Location:

River Parbati is a tributary of river Chambal, ultimate part of Yamuna Basin. The river Parbati originates in Vindhyaachal mountain near village Siddiqganj of District Sehore. The catchment area up to the proposed Dam site is 3150 sq km.

The Proposed dam site is located across river Parbati near village Fatehpur, Tehsil Narsinghgarh, District Rajgarh of Madhya Pradesh. The site is located at latitude 23°37'05" N and longitude 77°07'37" E. The site is situated about 25 km away from Narsinghgarh; Tehsil headquarter.

1.4 SCOPE OF THE STUDY

The general scope of this EIA study is as follows:

- Assessment of the existing condition of physico-chemical, ecological and socio economic aspects of environment;

- Identification of potential impacts on various environmental components due to activities envisaged during construction and operational phases of the proposed project.
- Prediction of significant impacts on major environmental components;
- Preparation of Environmental Management Plan (EMP) outlining measures to minimize adverse impacts during construction and operational phases of the proposed project. This includes components like Catchment Area Treatment Plan (CAT), Green Belt Development Plan, Fisheries development, conservation/management plan, Muck Disposal Plan, Dam Break Analysis etc;
- Formulation of Rehabilitation and Resettlement Plan as per 'The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCT_LARR)';
- Formulation of environmental monitoring plan for construction and operation phases;
- Estimation of Cost for implementation of Environmental Management Plan, Resettlement & Rehabilitation Plan, Catchment Area Treatment Plan and Environmental Monitoring Programme.

1.4.1 Policy, Legal and Administrative Framework

In the emerging scenario of rapid economic growth, sustainability of existing resources for the present and future generations requires an integrated approach so that, the existing resources are optimally utilized without causing undue damage to the environment. To achieve this objective, the Ministry of Environment, Forests & Climate Change (MoEF&CC), Government of India has enacted Acts, Legislations, Guidelines and Standards to ensure sustainable development and conserve the environment. These are required to be compiled by the Project proponents while executing the development of Project. The Project proponent thus prepares the EIA report, incorporating management plans to mitigate the adverse impacts (if any) for perusal of the MoEF&CC. The MoEF&CC in turn evaluates the proposal and suggests stipulations for mitigation of adverse impacts while granting the clearance for execution of the Project. The important Environmental legislations laid down for conservation of environment are presented in **Table 1.1**.

Table 1.1: Key Environmental Legislations in India

Name	Scope and Objective	Key Areas	Operational Agencies/ Key Players
Water (Prevention and Control of Pollution) Act, 1974, Amendment 1988	To provide for the prevention and control of water pollution and enhancing the quality of water	Controls sewage and industrial effluent discharges	Central and State Pollution Control Boards

Name	Scope and Objective	Key Areas	Operational Agencies/ Key Players
Air (Prevention and Control of Pollution) Act 1981 Amendment 1987	To provide for the prevention and control of air pollution	Controls emissions of air pollutants	Central and State Pollution Control Boards
Forest (Conservation) Act, 1980 Amendment 1988	To consolidate acquisition of common property such as forests; halt India's rapid deforestation and resulting Environmental degradation	Regulates access to natural resources, state has a monopoly right over land; Restriction on de-reservation and using forest for non-forest purpose	State Government and Central Government
Wildlife (Protection) Act, 1972, Amendment 1993	To protect wildlife	Creates protected areas (National parks/ sanctuaries) categories of wildlife which are protected	Wildlife Advisory Boards; Central Zoo Authorities
Environment (Protection) Act, 1986	To provide for the protection and improvement of Environment	An umbrella legislation; supplements pollution laws	Central Government nodal agency MoEF, can delegate powers to state departments of Environments
The Right to Fair Compensation & Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013	Resettlement and Rehabilitation of Project affected people and Social Impact Assessment	Social issues	Central Government
EIA Notification 2006 with subsequent amendment	Environmental Impact Assessment	Environmental Protection	Project Developer, State and Central government

(Source: Government of India Publications)

Like many other developmental activities, the proposed Project could also lead to a variety of adverse environmental impacts. However, by proper planning at the inception stage and by incorporating appropriate mitigation measures in the planning, design, construction and operation phases, the adverse impacts can be minimized to a large extent, whereas the beneficial impacts could be maximized. The main objective of the EIA study is to assess the positive and negative impacts likely to accrue as a result of the construction and operation of the proposed Project and to suggest suitable Environmental Management Plans (EMP) to ameliorate the adverse impacts, if any. A well-designed environmental monitoring programme covering various critical parameters to be covered in the Project construction and operation phase would also be required. The present

EIA for Parbati (Rinsi) Major Irrigation Project has been prepared based on the analysis of baseline data and accordingly Environment Management Plan has been prepared for seeking Environment Clearance.

The principal Environmental Regulatory Agency in India is the Ministry of Environment, Forests and Climate Change (MoEF&CC). MoEF&CC formulates environmental policies and accords environmental and Forest clearance for the projects. The State Pollution Control Board (SPCB) conducts Public hearing and accords Consent to Establish and Consent to Operate for the project.

The project would need the following clearances before starting construction:

- Prior Environmental Clearance from the MoEF&CC;
- Forest Clearance from MoEF&CC;
- Consent to Establish from the Madhya Pradesh State Pollution Control Board;

1.4.2 EC under EIA Notification, 2006

EC process is laid down in EIA notification of 14th September 2006 and subsequent amendments; issued by Ministry of Environment Forest & Climate Change in exercise of the powers conferred by Environment Protection Act. As per the notification, environment clearance is a three stage process viz. Scoping, Public Consultation and Appraisal. Project Categories are defined by culturable command area in an irrigation project or the generation capacity for hydro-electric projects in EIA notification.

As per Schedule enclosed with the EIA notification of Sept 2006 and subsequent amendments, irrigation projects are listed at item 1(c); major projects greater than or equal to 50,000 ha CCA are category A projects, major projects greater than or equal to 10,000 ha and less than 50,000 ha CCA are category B1 projects and medium projects greater than 2,000 ha and less than 10,000 ha CCA are category B2 projects (as per amendment to EIA Notification dated August 14, 2018).

Scoping: This would require submission of an application to SEIAA (for Category B Projects)/MOEF&CC (for Category A Projects) for issuance of Terms of Reference (TOR) to undertake EIA study. The application consists of Project Report and duly filled in Form 1 with proposed TOR. On completion and submission of application for approval of TOR to SEIAA/ MOEF&CC, a technical presentation before the State Expert Appraisal Committee (SEAC) or EAC of MoEF&CC for Scoping Clearance is made; as the case may be.

In present case, EAC in its 11th meeting, dated January 30th, 2018, recommended grant of scoping clearance for the Parbati (Rinsi) Major Irrigation Project (48,663 ha CCA). Based upon recommendation of EAC, Scoping clearance of Parbati (Rinsi) Major Irrigation Project (48,663 ha CCA) was accorded by MoEF&CC, Govt. of India vide letter no. **J-12011/01/2018-IA-I (R) dated February 26th, 2018**. EAC noted during discussion in 11th meeting that Narsingharh Wildlife Sanctuary is in close proximity and a small portion of submergence area will fall within the sanctuary. **To avoid project component falling within protected area, dam site has been shifted upstream by about 2 km; requiring amendment of TOR.** The case was considered by EAC in its 19th Meeting held on 26.10.2018 and based upon recommendation of EAC amendment in TOR was accorded by MoEF&CC, Govt. of India vide letter no. **J-12011/01/2018-IA-I (R) dated February 22nd, 2019**.

As per amendment to EIA notification dated August 14, 2018; CCA of up to 50,000 ha projects are considered at state as Category B1 projects; however, as per General Conditions, projects within 5 km of protected area are considered at Centre as Category A project. Therefore, Parbati Major Irrigation Project, with CCA of 48000 ha will be appraised at Centre due to its proximity (within 5 Km) to Narsingharh WLS.

*Scoping Clearance giving Terms of Reference (TOR) and Compliance to TOR, giving details of coverage of TOR in EIA study are enclosed as **Annexure I & II** respectively.*

Environment Impact Assessment (EIA) study of the Project has been carried out with a view to assess the impacts of project on the surrounding area so as to suggest mitigation and management measures to minimize such impacts. EIA study for such projects is mandatory as per EIA Notification of September 2006, which describes the environment clearance procedure.

Public Consultation: On completion of draft EIA/EMP reports and its executive summary, public consultation is conducted through public consultation process coordinated by State Pollution Control Board, as stipulated in EIA notification. Project proponent takes lead in submitting requisite fee and application to State Pollution Control Board.

On successful completion of Public Consultation Process, EIA/EMP reports are updated if required, incorporating any suggestions/observation made during Public Consultation process and revised reports are submitted by project proponent to SEIAA/ MOEF&CC for Appraisal. Video and text of Public

Consultation is submitted by State Pollution Control Board to SEIAA/ MOEF&CC directly.

Appraisal: A detailed presentation is made before SEAC/EAC during final appraisal and after successful completion; SEAC/EAC recommends the case to SEIAA/ MOEF&CC and EC letter is issued by SEIAA/ MOEF&CC.

1.4.3 Forest Clearance

Forest Clearance under the Forest (Conservation) Act 1980 from Ministry of Environment, Forests & Climate Change, Government of India is one of major step in project development. Initially, forest area of 49.75 ha has been identified as part of the land requirement for the project and application for diversion of forest land has been submitted online on 19th February 2018. However, due to change of project location, with a view to keep it outside the protected area, dam site has been shifted to a suitable location about 2 Km upstream; this has not only kept the project outside the protected area but also eliminated the need for diversion of forest land. The matter was discussed and recorded in the EAC meeting dated October 26, 2019.

Chapter 2

PROJECT DESCRIPTION

2.1 INTRODUCTION

The Parbati Major Irrigation Project envisages construction of an earthen dam with central spillway, three pump houses on left bank with rising main. The project constitutes the following:

- (i) Construction of 1050 M long Dam with a maximum height of 25.0 m and saddle 180 m long.
- (ii) The 369.65 m long Central Spillway & 10 m key wall (on both side) with 18 Nos vertical gates of size 13.80 m x 12.00 m with a maximum discharging capacity of 19853.86 cumec and foundation gallery
- (iii) The 680.35 m long earthen section on either side of the dam portion.
- (iv) Storage formed by the construction of dam will have a gross storage 172.54 MCM live storage of 162.62 MCM with approximately 10 MCM post monsoon flow in river; Culturable Command Area is **48,000 ha**.

Canals:

It consists of a pressurized pipe system of 48 km with micro network system to irrigate 48,000 ha. Piped canal system would irrigate 48,000 ha area of Rajgarh & Bhopal district. Total 48 km network of gravity main and rising main for GM1, GM2 and GM3 would irrigate total area.

The Proposed dam site is located across river Parbati near village Fatehpur, Tehsil Narsinghgarh, District Rajgarh of Madhya Pradesh. The site is located at latitude 23°37'05" N and longitude 77°07'37" E. The site is situated about 25 km away from Narsinghgarh; Tehsil headquarter.

River Parbati is a tributary of river Chambal, ultimate part of Yamuna Basin. The river Parbati originates in Vindhyachal mountain near village Siddiqganj of District Sehore. The catchment area up to the proposed Dam site is 3150 sq km.

Salient features of the project are given in **Table 2.1**.

Table 2.1: Salient Features

I	Location	
	State	Madhya Pradesh
	District	Rajgarh
	Tehsil / Block	Narsinghgarh
	Toposheet No	55E/2, E/3
	Latitude	23°37'05"

	Longitude	77°07'37"
	River	Parbati
	River Sub Basin	Chambal
	River Basin	Yamuna
	Tribal/ Non Tribal	Non Tribal
	Distance From	25 km From Narsinghgarh
		85 km From Rajgarh
	Probable Estimated Cost	1815.54 Crore
	Irrigation Proposed	48000 ha
	Cost Per Hectare	3.78 Lakh
II	Hydrology	
	Catchment Area	3150 Sq.km
	Maximum Flood Discharge (PMF)	19853.86 Cumec
	75% Dependable Yield	726 MCM
	Proposed Design Flood	As per Norms
III	Reservoir Data	
	Gross Storage	172.54 MCM
	Live storage	162.62 MCM
	Dead Storage	9.92 MCM
	Gross Area of Submergence at F.R.L	3494.64 ha
	Private Land	2290.57 ha
	Government Land	1204.07 ha.
	Forest Land	0.0 ha
	No. of Village Submerged	4 Full
		14 Partial
		18 Total
	Families Affected	1125
IV	Barrage Data	
	Type of Barrage	Concrete
	Total length including earthen bund Saddle	1050 m 180 m
	Length of Spillway	369.65 m
	Height	25.0 m
	No. of openings	18
	Size of Gates	13.80 M X 12 m
	Crest Level	433.45 m
	Thickness of Piers	3.25 m
V	Control Level	
	Top Level of Dam	449.50 m
	Top Level of Dam Gates	445.45 m
	Crest Level	433.45 m
VI	Canal	
	Length of Rising Main (Left)	5 km
	Length of Rising Main (Right)	1 km
	Dia of Rising Main (Right)	1.50 m
	Dia of Rising Main (Left)	2.80 m
	Lift (Left)	59.5 m
	Lift (Right)	39 m
	Power Required	16.00 MW
VII	Area Proposed Under Irrigation	48,000 ha.
	Crops proposed for irrigation	H.Y.V Wheat, O.L.V Wheat, Gram & Oil Seeds
	Total GCA	70,000 ha.

	CCA (Left)	42,000 ha.
	CCA (Right)	6,000 ha.
	Total CCA	48,000 ha.
	Annual Irrigation	
	Crop Kharif	0
	Crop Rabi	48,000 ha.
	Crop Perennial	0
	Total	48,000 ha.
VIII	Financial Aspects (Estimated Cost)	
	Unit -I Head Works	859.96Crore
	Unit -II Canal	955.58Crore
	Total	1815.54Crore

2.2 LOCATION AND CONNECTIVITY

The Parbati Major Irrigation Project is located in Fatehpur village of Narsinghgarh tehsil of Rajgarh district in Madhya Pradesh on river Parbati having Latitude as 23°37'05" N and Longitude as 77°07'37" E. The site is situated about 25 km away from Narsinghgarh Tehsil headquarter. Dam site is approachable either from Fatehpur village of Narsinghgarh tehsil (25 km) by NH- 12 tar road and then on forest road or via Gava Village of Shyampur tehsil (27 km). Nearest railway station Biaora is 60 km from site.

The location of the project is shown in **Figure 2.1**.

2.3 LAND REQUIREMENT

Total land required for the different components of project is 3537.19 ha., out of which 1246.62 ha is revenue land and 2290.57 ha is private land. Out of the total land requirement, 3494.64 ha of land will be required for construction and dam and resulting submergence area itself. Of the total land required for dam and submergence, 2290.57ha (65.44%) is private land and 1204.07ha (33.3%) is revenue land. The details of land requirement for the project are given in **Table 2.2**.

Table 2.2: Details of Land Requirement

S. No.	Project Component	Revenue Land (ha)	Forest Land (ha)	Private Land (ha)	Total (ha)
1.	Dam & Reservoir	1204.07	0	2290.57	3494.64
2.	Canal Network		0		
3.	Colony & Approach Road and other project components	10.00	0	-	10.00
4.	Resettlement and Rehabilitation	32.55	0	-	32.55
	Total	1246.62	0	2290.57	3537.19

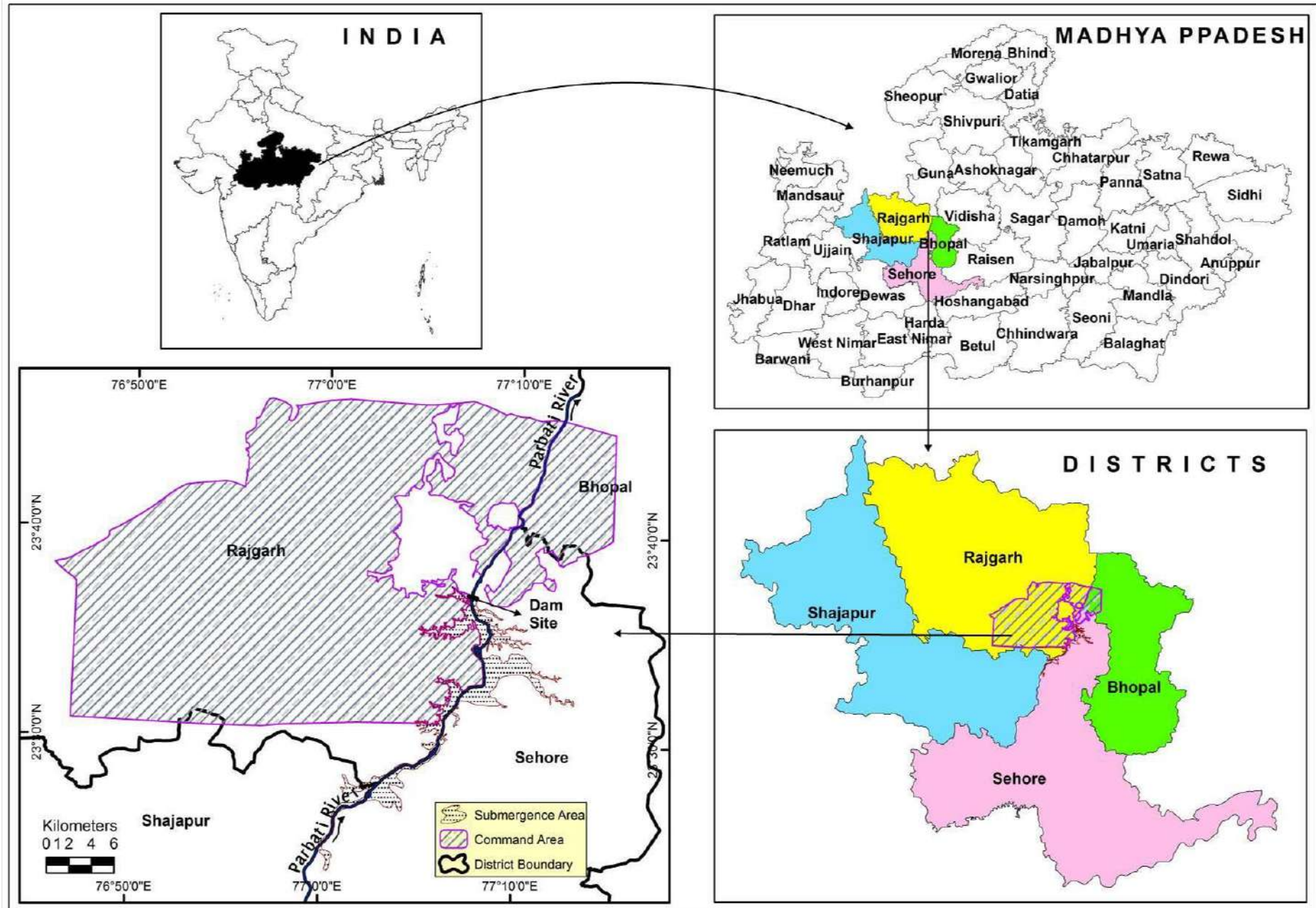


Figure 2.1: Location Map of Parbati Major Irrigation Project

2.4 CATCHMENT AREA OF PROJECT

River Parbati is a tributary of river Chambal which itself is a tributary of river Yamuna. It is also known as the Western Parbati as distinguished from river Parbati, a tributary of Sindh river. This river originates from Siddiqganj village in Sehore district of Madhya Pradesh. After flowing about 234 km in Madhya Pradesh, the river forms the boundary between Rajasthan and Madhya Pradesh for a length of about 80 km. After running for a further distance of about 96 km in Rajasthan, it again forms the boundary between Rajasthan and Madhya Pradesh for about 64 km and joins the Chambal river about 32 km south east of Sawai Madhopur city in Rajasthan.

The elevation of the catchment varies from about El. 426.0 m to about El. 610.0 m. Length of Parbati river up to the proposed dam site is around 130.0 km. The catchment area map is shown in **Figure 2.2**.

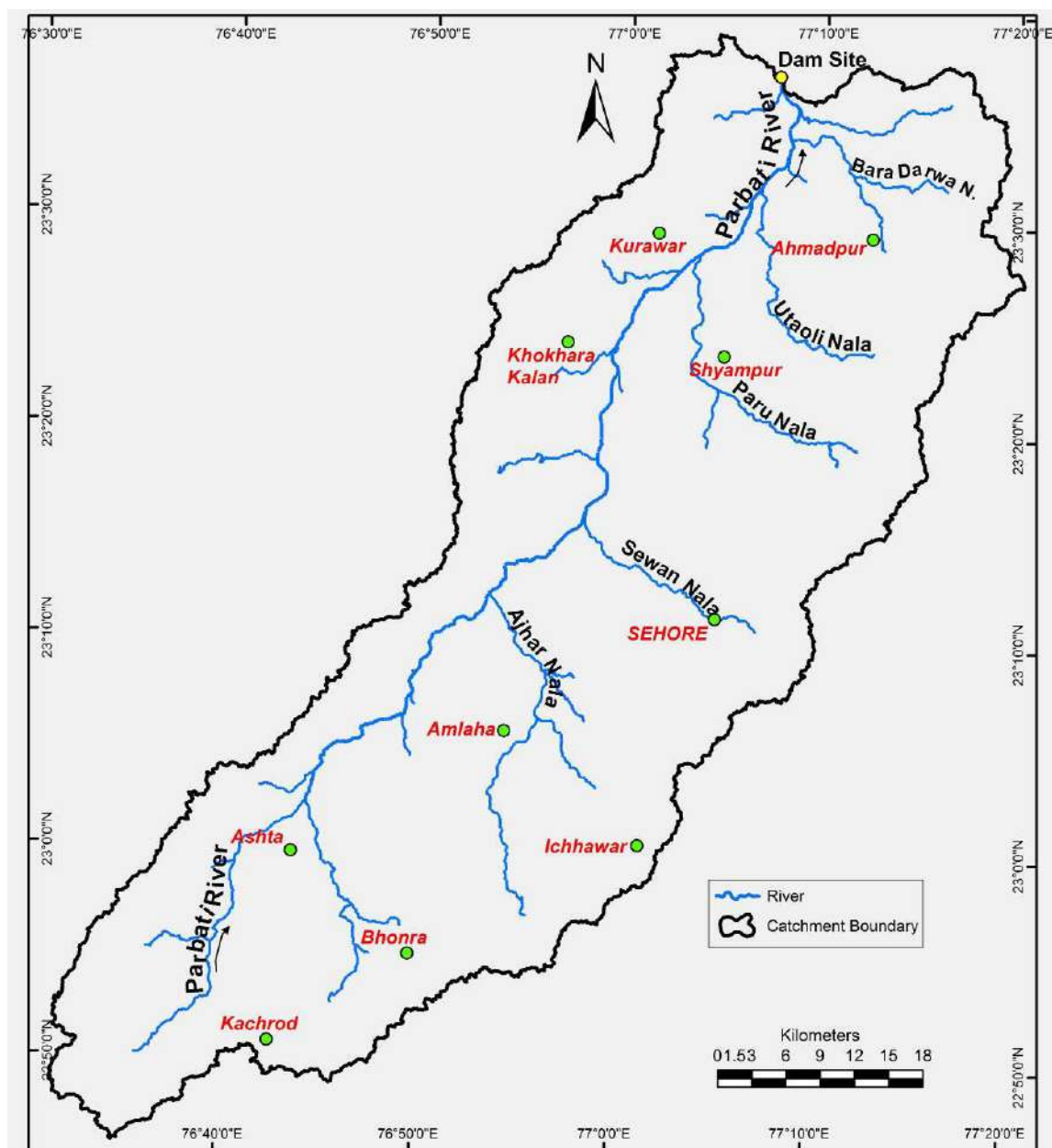


Figure 2.2: Catchment Area Map of Parbati Major Irrigation Project

2.5 COMMAND AREA OF PROJECT

The 132 villages under the command are as follows:

S No	Piped Canal System	GCA (ha)	CCA (ha)	Name of Villages
1	Main Pipe	70,000	48,000	Rajgarh Distt. – 121 Nos Amlyahat, Barkhedi, Kharetiya Kalan, Motipura, Agar, Lodipura, Amdor, Bhanwas, Tumdia, Karondiya, Kishorepura, Mandawar, Berasia, Bhojpuria, Mundla Bajrang, Amba Pura, Khanpura, Pipliya Dhakad, Moi, Palasi, Banjari, Sonkatch, Achalpura, Andalheda, Kadia Mitrasen, Kolu Khedi, Padaliya Bana, Kadia Chandrawat, Chainpura Kalan, Dhamdhore, Pipliya Bag, Bhawanipura, Madora, Madori, Mundli, Gadia, Charpura, Bandi, Manpuradeo, Mittanpur, Shankarpura, Panjra, Panjri, Pura Baraitha, Badodia Jagir, Lakdia, Lachhmanpura, Sanwasi, Hedapura, Gandhigram, Pachhtalai, Baodiya, Muwalia Khedar, Hinoti, Ilahipura, Doongapura, Neenore, Barkheda Bir, Baraytha, Ramgarh, Charpura, Chainpura Khurd, Bihar, Beejwa, Ganlyari, Dharmya Khedi, Jamonia Ganesh, Badbeli Bihar, Barkheda Amardas, Onkarpura, Nandgaon, Mawasa, Lasoodlya Pata, Nipanya Garhi, Gagar, Sendri, Gathla, Guradiya, Jhad Pipliya, Bakani, Hinotiya, Khaleli, Jasapura, Jhumka, Pakhari, Padalaya Khedi, Barkheda Dor, Bisarti, Anwali, Pipliya Jiya, Mengla Deep, Sukalya, Hikmi, Kotdi Kalan, Kandara Kotdi, Pipliya Biram, Mugal Khedi, Kalali, Bijori, Kalyanpura, Chhapri Khurd, Chhapri Kalan, Jhadla, Badlya, Manpichudi, Jamoniya Gov Chauhan, Palkhedi, Bilwa Bhat, Lasudliya Haji, Kankaria Meena, Mana, Tuti, Khajuri, Bamora Sukha, Baksi, Kacchipura, Rukmanpura, Golyapura, Moya Chappar. Bhopal Distt. – 11 Nos Itkhedi, Neem Khedi, Bandikhedi, Mengra, Bijawan Kalan, Ankia, Mangalgarh, Dhoot Khedi, Bhaupura, Bagsi, Manikhedi.

(i) Gross Command Area	70,000 ha.
(ii) Irrigable Command Area	48,000 ha.
(iii) Proposed Rabi Area	48,000 ha.
(iv) Proposed Kharif Area	Nil
(v) Annual Irrigation	48,000 ha.

2.6 HYDROLOGY

- i. The proposed Dam site is located on Parbati river near the village Fatehpur in the tehsil of Narsinghgarh of Rajgarh district of Madhya Pradesh. The total catchment area up to Parbati Dam site is 3150 sq km. There is observed gauge-discharge data from Pilukhedi G.D. site available U/s of at the proposed Dam site. Hence efforts have been made to derive Rainfall-Runoff relationship using the rain gauge data of nearby existing R.G. station applying the same R-R Equation at the proposed Parbati Dam site.
- ii. The expected yield (virgin) at the site at 75% dependability on the basis of current data's has been worked out to 924.09 MCM by NIH and after deducting upstream utilization of 198.09 MCM the net yield comes out to 726 MCM. This gives a yield factor of 0.22 MCM/sq km. The top level of Dam is kept at RL 447.95, with top of gates being at RL 449.50 m, crest of the Dam at 433.45 m to restrict submergence of 3494.64 ha of land at RL 445.45 m. The submergence created on the back of Dam will require about 2290.57 ha of private land, 1204.07 ha of Govt. Land and no forest land. The benefitted area of the project lies in the zone of Lower & Medium part of lower Chambal sub basin. In this part of basin, the existing projects are mostly of medium and minor type. There is no major project constructed on Pārbbati river neither upstream nor downstream in Madhya Pradesh to the proposed site.

2.6.1 Flood Control and Damage

The structure being Dam, no flood cushion has been provided in the proposed project with storage mainly allowed up to banks only and the waterway area has been kept wide enough to pass a PMF of 19853.86 cumec. Since topography of area is having mild slopes, drainage problem is not expected.

2.6.1.1 Reservoir & Power

The gross storage capacity and principal levels of Parbati Dam is as summarized below:

Gross capacity:	172.54 MCM.
Live capacity:	162.62 MCM.
Dead Capacity:	9.92 MCM.
Top level of Dam:	449.50 m.
Top level of gates of Dam:	445.45 m
Crest level of Dam:	433.45 m.
River bed level:	426.10 m.

Total water available at Parbati Dam for Utilization:

$$\begin{aligned}
 &= \text{Live capacity} + \text{Non - Monsoon inflows (Regeneration \& Recharge)} \\
 &= 162.62 + 10 = 172.62 \text{ MCM}
 \end{aligned}$$

2.6.2 Power Requirement for the Project

Total area irrigated by pressurized pipe canal system is 48,000 ha. which requires 3 pump houses and thus requires total power of 16.00 MW.

2.7 BRIEF DESCRIPTION OF MAIN COMPONENTS OF PROJECT

The project comprises of four main components namely Head works (Dam with central spillway & appurtenant works) Pump House, Distribution chamber and Pressurized Canal works (**Refer Figure 2.3**).

2.7.1 Physical Features

The physical features include:

Dam:

The Parbati Project envisages construction of an Earthen dam with Central Spillway. Three Pump houses on Left bank with Rising main. The project constitutes the following:

- (i) Construction of 1050 m long Dam with a maximum height of 25.0 m and saddle 180 m long.
- (ii) The 369.65 m long Central Spillway & 10m key wall (on both side) with 18 Nos vertical gates of size 13.80 m x 12.00 m with a maximum discharging capacity of 19853.86 Cumec and foundation gallery has also been provided.
- (iii) The 680.35 m long earthen section on either side of the Dam portion.
- (iv) Storage formed by the construction of Dam will have a Gross storage 172.54 MCM live storage of 162.62 MCM with approximately 10 MCM post monsoon Flow in river, it irrigates 48,000 ha.
- (v) Rehabilitation and Resettlement in 18 villages being submerged (11 villages of Tehsil -Narsingharh and 7 villages of Tehsil -Shyampur) as the FTL of project is marked at RL 445.45 m. Totally 4 villages would be fully submerged and 14 villages would be partially submerged. On the other hand, total private land under submergence is 2290.57 ha., Government land 1204.07 ha. and no forest land involved.

2.7.2 Canals

It consists of a pressurized pipe system of 48 km with micro network system to irrigate 48,000 ha. Left and right Piped canal systemd irrigate 42,000 ha

and 6,000 ha area respectively of Rajgarh & Bhopal districts. Total 48 km network of gravity main and rising main for GM1, GM2 and GM3 would irrigate area of 18000 ha, 24000 ha and 6000 ha respectively.

a. Desilting and Anti-corrosion measures in Pipelines

For desilting and anti-corrosion, provision of drain valve at an interval of every 200 m has been made. In addition, pipes are with polyurethane lining, as anti-corrosion measure.

b. Measures for Leakage and Bursting of Pipelines

Provision of M.S. Pipe having bursting strength of 10 times from head in case of water logging has been made for Rising Main and Gravity Main. These pipes are not anti-burst and will burst in case of more than 10 times of pressure only. The joints of M.S. Pipe are with 3 stages of welding and will be laid down 2 m from ground surface. Hence, there won't be leakage problem in this pipe.

2.8 IRRIGATION PLANNING AND CROPPING PATTERN

The scheme will irrigate the area of the Wheat H.Y.V – 15,000 ha, Wheat OLV – 8,000 ha, Gram – 20,000 ha and Oil Seeds – 5,000 ha. Total Rabi of 48,000 ha and so Annual Irrigation as 48,000 ha.

S No.	Type of Crop	Name of Crop	Area (Ha)	Intensity of Irrigation (% of CCA)	Method of Irrigation
1	Rabi	Wheat HYV	15000	31.25%	By Gravity Pressure/ Sprinkler
2	Rabi	Wheat OLV	8000	16.67%	By Gravity Pressure/ Sprinkler
3	Rabi	Gram	20000	41.66%	By Gravity Pressure/ Sprinkler
4	Rabi	Oil Seeds	5000	10.42%	By Gravity Pressure/ Sprinkler
	Total Rabi		48000	100%	
	Annual Irrigation		48000	100%	

1. IRRIGATION & COMMAND AREA DEVELOPMENT: -

The proposed command of this Dam is situated on the left and right bank of river Parbati. On left flank, the command area covers the area of Tehsil Narsingharh, Pachore, Biaora of Rajgarh district covering area of 121 villages, whereas, on right flank command area covers the area of Tehsil Berasia of Bhopal district covering area of 11 villages. Thus, total area to be irrigated is 48,000 ha. covering 132 villages.

The irrigation to the proposed command involves providing micro irrigation down to 0.60 ha to 1.20 ha in 48,000 ha by lifting the water and providing water in a pressurized irrigation network through pumping.

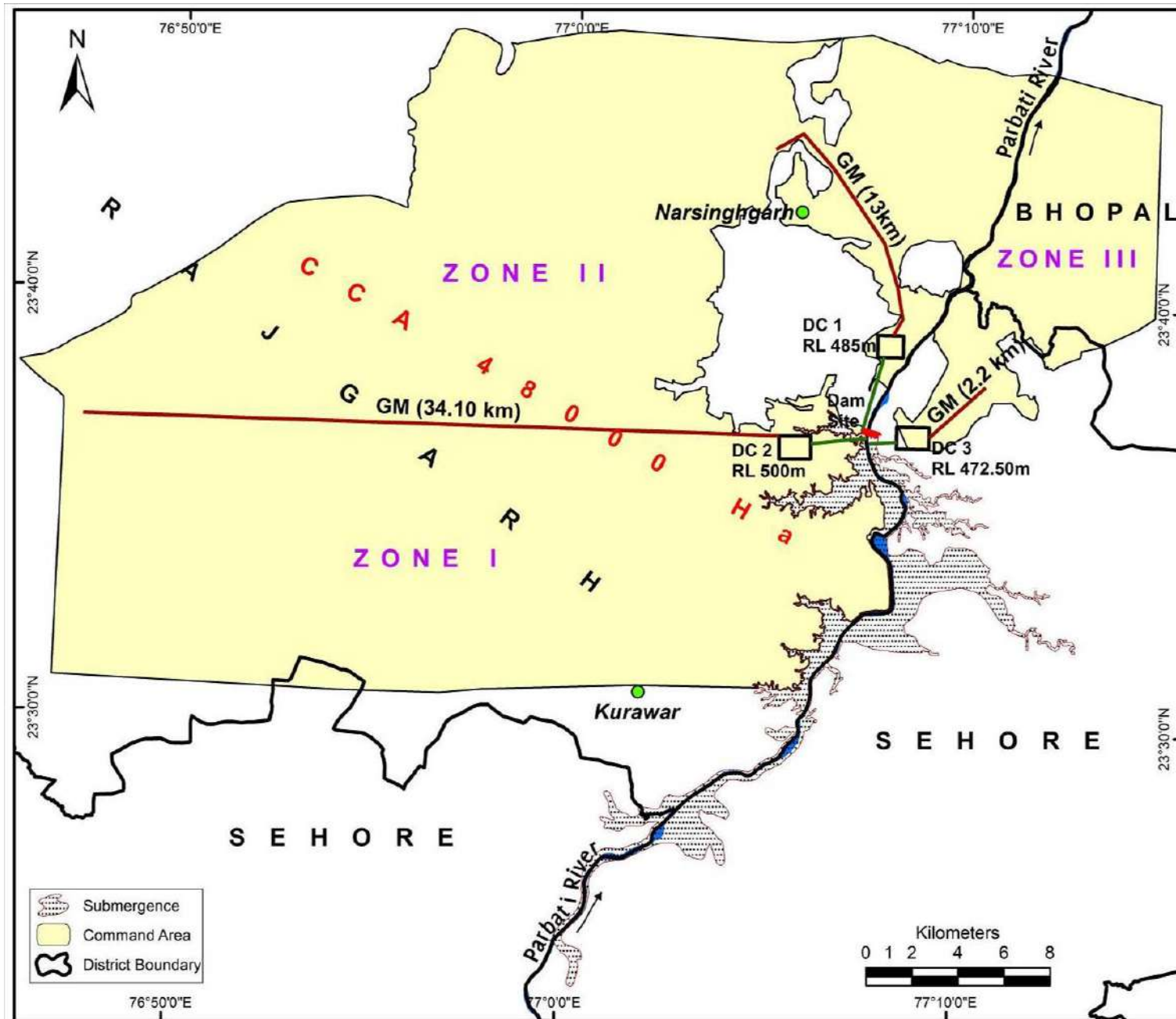


Figure 2.3: Project Layout Map of Parbati Major Irrigation Project

To have a maximum coverage of irrigation with limited water quantity available, micro irrigation system has been proposed for whole of command area down to 0.60 to 1.20 ha where water for irrigation will be provided through pressurized irrigation pipe line network system with available residual pressure head of about 15 - 20 m i.e. a pressure of 1.5 - 2 kg/ cm² for running of sprinkler system.

As per the availability of water, a total of 48,000 ha area will be irrigated by utilizing 162.62 Mcum water together satisfying other water needs also. The cropping pattern in the proposed command area of has been adopted as per the suggestion of Madhya Pradesh Agriculture Department in nearby located project. Major crops of the command areas of the Project are Wheat (Ordinary and HYV) and Gram and Oil Seeds. The details of CCA under Parbati Dam, annual irrigation and utilization are furnished below:

CCA (ha)	Utilization (MCM) For irrigation
48,000	162.62

2. PRE-PAID CONTROL AND METER SYSTEM (Optional) :-

A prepaid smart farmer card system is proposed for the Parbati Dam. The prepaid system is based on providing every farmer with a user card with a photo ID and user number. The cards are loaded with credit and are inserted into a slot in the prepaid meter and water pumps automatically with the charge levied against the credit on the card. The smart cards are topped up by a vendor who would collect payments from users (farmers) and deposit the collected funds into the bank account of the system operator. The vendor would be paid, typically on a commission basis, according to the amount of water sold. The process uses technology and management similar to cell phones. The benefits of the prepaid system include:

- Water use efficiency increase as farmers use the water more carefully,
- Flexible on-demand irrigation supply to farmers.
- 100% financial cost recovery from users (farmers) according to amount of water each used.
- Elimination of any “rent seeking” from pump owners and operators or corruption or loss of funds.
- The system is completely transparent with checks and balances to counter fraud.

A pre-paid smart card control system has been considered which is comprising a smart card controlled volumetric water meter and valve which would be installed at the head of buried pipe system downstream of the header tank.

The smart card with a volumetric water meter can be used if there is a diesel pump.

2.9 OPERATION AND MAINTENANCE

After commissioning of the project, operation & maintenance shall be carried out of all components of the project including associated works in accordance with prudent utility practice. O&M manual shall be prepared and following activities shall be covered during O&M.

- i) Whole pipe line system including its structures and maintenance of all pumps and electro-mechanical components.
- ii) Services necessary to maintain the project efficiently maximize the availability of the water & optimize the useful life of the project.
- iii) Providing requisite numbers of qualified personnel to perform the services.
- iv) Carrying out maintenance of the total pipe line system and carry out repair and preventive maintenance in accordance with the requirements.
- v) Maintenance or repairs or rectification work in case of any problem or emergency that may arise while the system is in-operation.
- vi) Providing technical and other assistance in solving operational and maintenance problems.
- vii) Maintenance of all roads, yards, walkways, the colony, housekeeping and security of the project.
- viii) Suggestions for improvement in the operation and maintenance schedule for better performance.
- ix) Preparation of Annual Operation Plan.

2.10 PROTECTED AREAS (PA) IN VICINITY

Earlier a small portion of submergence area was falling within the Narsinghgarh Wildlife Sanctuary. **To avoid project component falling within protected area, dam site was shifted upstream by about 2 km.** The location of Narsinghgarh Wildlife Sanctuary with respect to project components is shown as **Figure 2.4**.

All project components including the submergence area now falls outside the boundary of Narsinghgarh WLS. A certificate has also been issued by DFO in this regard. Copy enclosed as **Annexure III**.

Eco-sensitive Zone notification of Narsinghgarh WLS has been issued 27th July 2018 declaring the area ranging from 100m to 2Km around Narsinghgarh WLS as ESZ. Small portion of submergence will fall in ESZ.

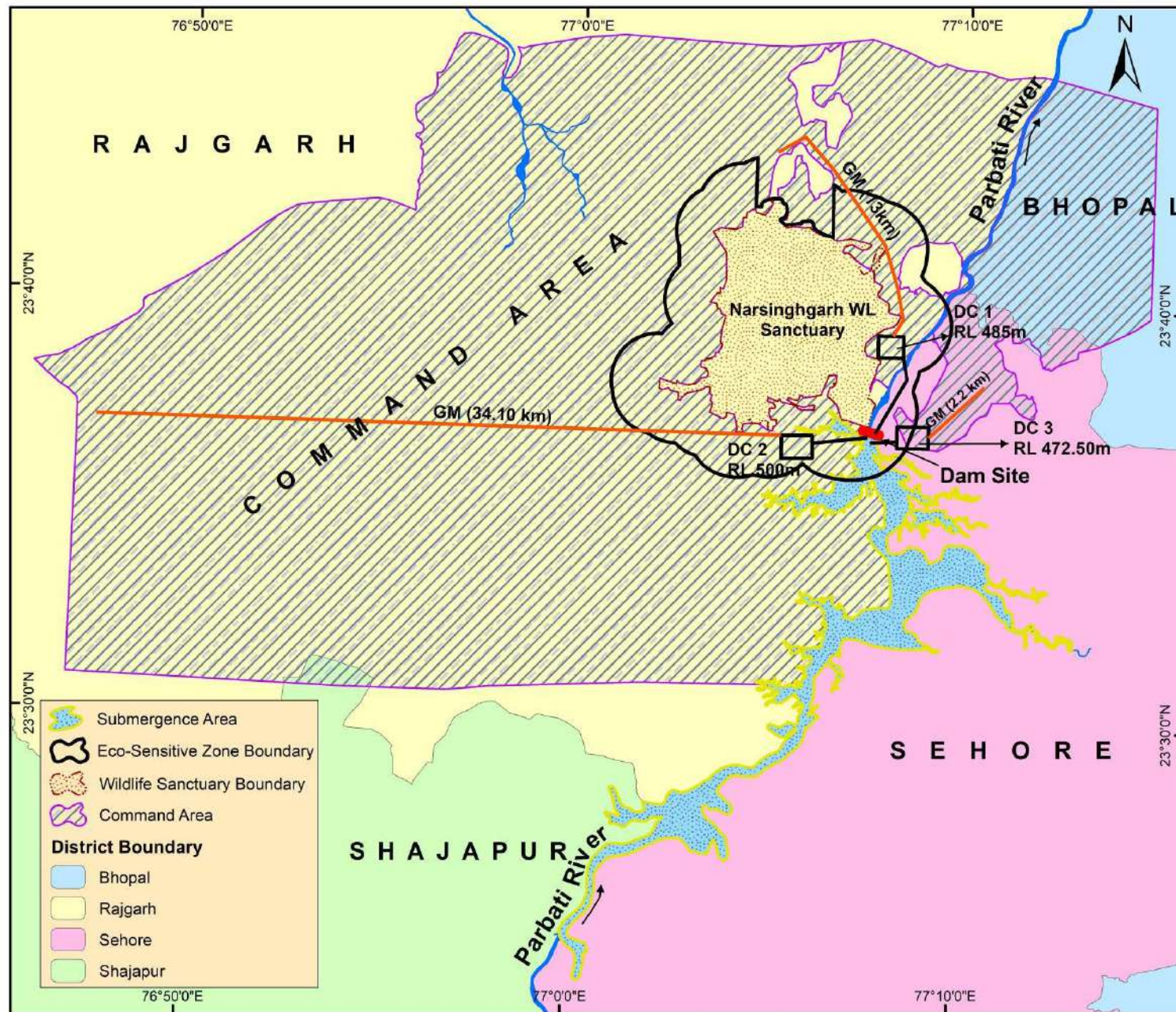


Figure 2.4: Map Showing Protected Area in the Vicinity of Parbati Major Irrigation Project

**Chapter
3****DESCRIPTION OF ENVIRONMENT****3.1 GENERAL**

Environmental Impact Assessment define and assess the potential physical, biological, and socio-economic impact of the proposed project in a manner that allows for a logical and rational decision to be made about the proposed action. This chapter covers the baseline status of physical and biological environment in the study area of proposed Parbati Major Irrigation Project covering the description of study area, study period, methodology of baseline data collection leading to establishment of baseline for valued environmental components, as identified in the scope.

Base maps of all environmental components are included at appropriate sections. The study area has been defined as per the Terms of Reference (TOR) issued by EAC, MoEF&CC as part of scoping clearance.

It is necessary to determine the baseline status of key environmental parameters which are likely to be affected due to construction and operation of the proposed project. The baseline data collected during the studies has been divided into the following three main categories.

- Physico-chemical aspects
- Biological aspects
- Socio-economic and Demography profile of command area

This chapter describes baseline status of physico-chemical and biological environment. The description is based upon primary data collected during field studies which was supplemented with data/information gathered during interaction with personnel of various government departments and available literature and reports published by various institutions and organizations. The description of Socio-economic environment is given at Chapter 4.

3.2 STUDY AREA

The data on environmental parameters was collected from the study marked for EIA study. The Study Area for assessment of environmental baseline status was delineated as follows:

- The area within 10 km radius of the main project components like proposed reservoir area and dam site

- Area within 2.5 km buffer on either side of pipeline (water conductor system) in proposed command area

Water Conductor System – In this dam is proposed to be constructed which will supply water by canal network and later distribute in the command area.

Command Area - The gross command area of Parbati Major Irrigation Project is 70000 ha to irrigate 48000 ha of command area by drip/sprinkler system. Some of the command area falls outside the study area.

A map of the study area prepared based upon the above criteria is given at **Figure 3.1**.

3.2.1 Terrain Characteristics of the Study area

To understand the topography of the study area, Digital Elevation Map, Relief map, and slope map were prepared from Digital Elevation Model (DEM) of Advanced Space borne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model (GDEM) Version 2 data was downloaded from <https://earthexplorer.usgs.gov/> from which mask of the study was extracted to prepare above mentioned thematic maps. These maps are given at **Figures 3.2, 3.3 & 3.4**.

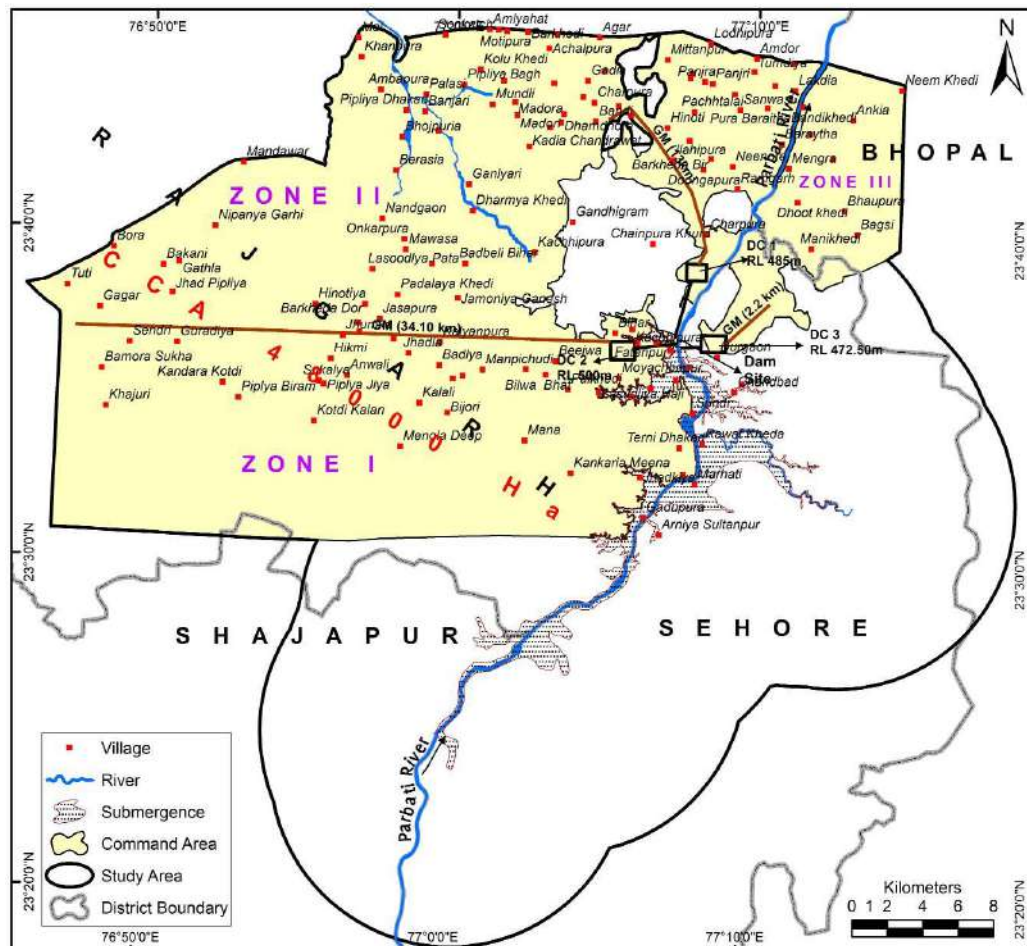


Figure 3.1: Map showing Study Area of Parbati Major Irrigation Project

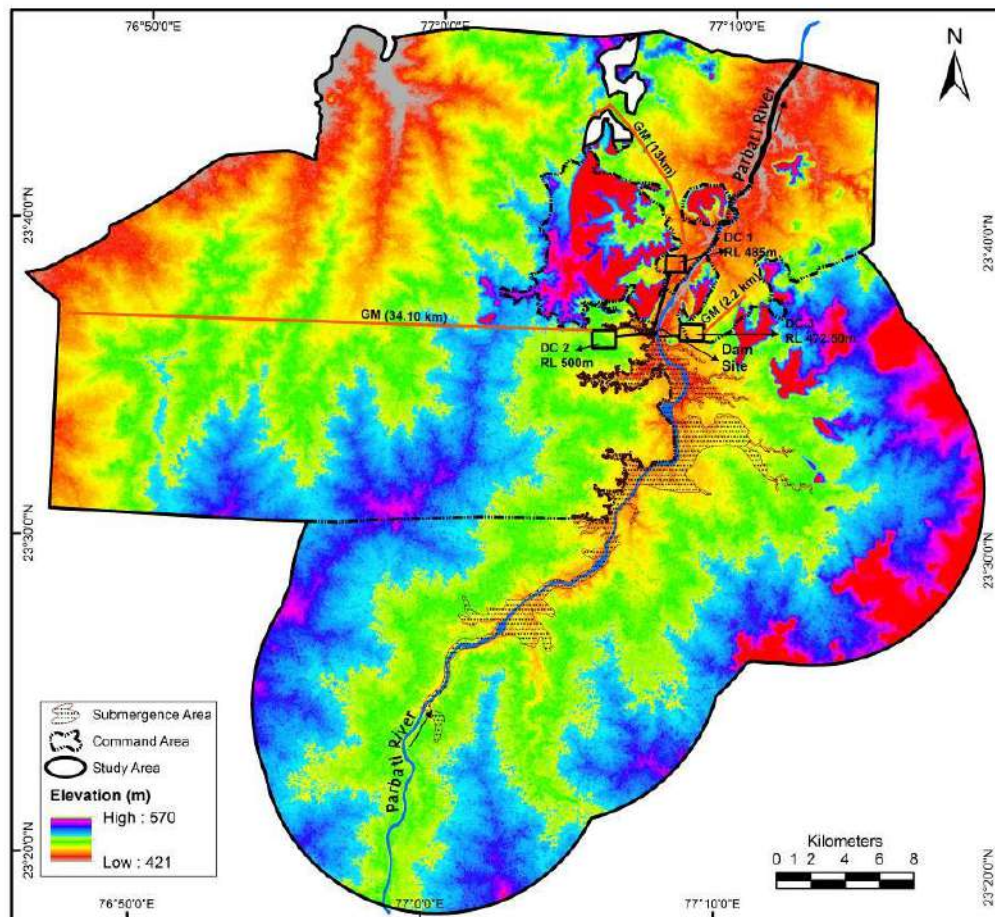


Figure 3.2: Digital Elevation Map of the Study Area

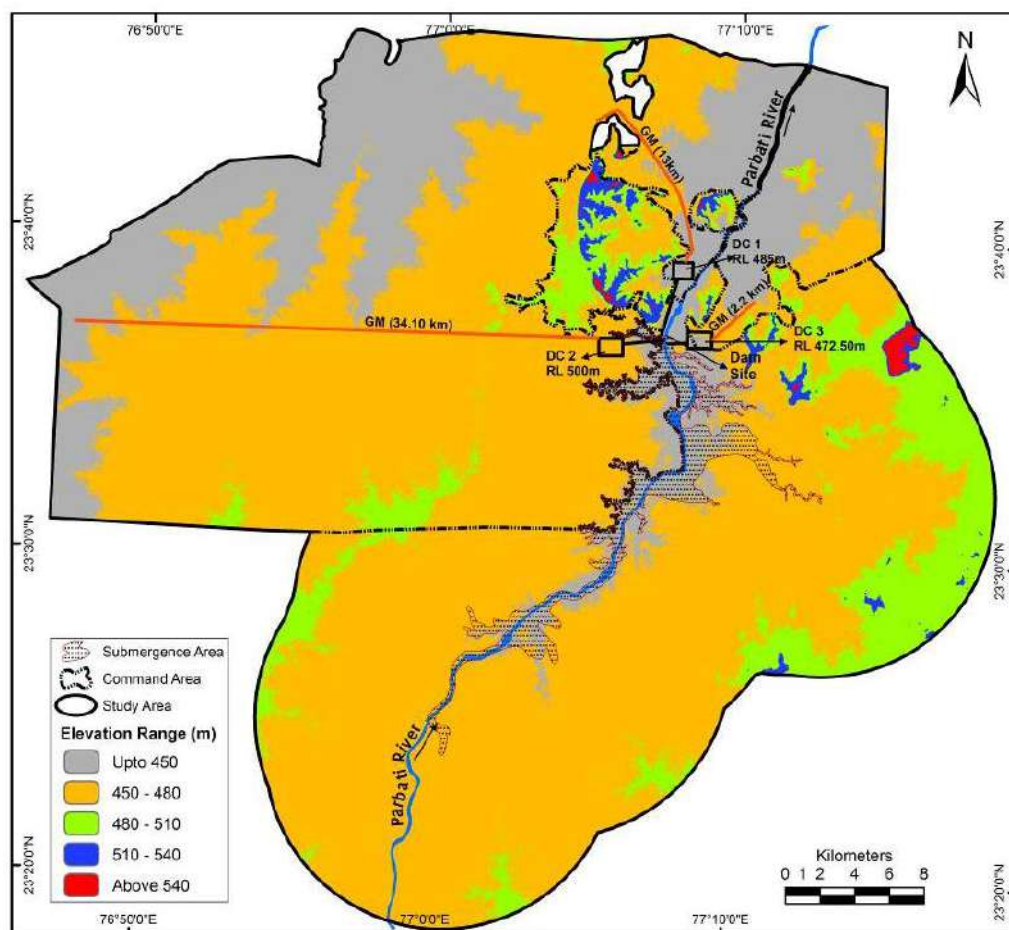


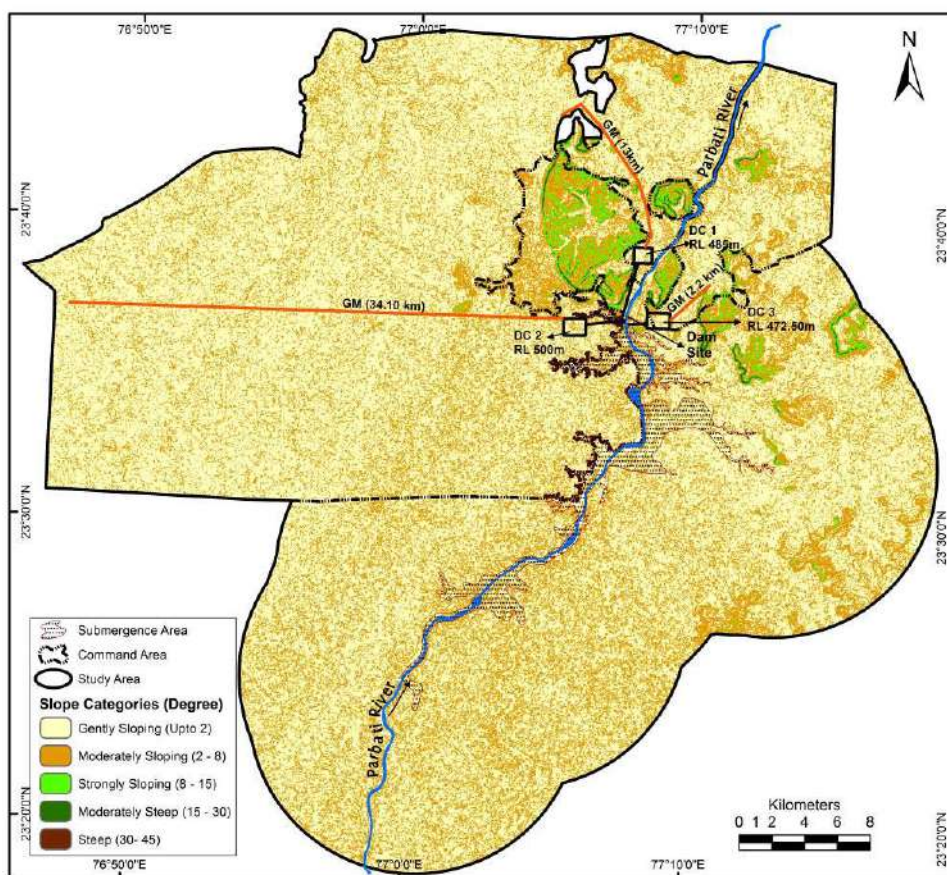
Figure 3.3: Relief Map of the Study Area

Table 3.1: Area under different elevation categories in the Study Area

Elevation Range (m)	Area (ha)	Area (%)
Up to 450	39207.55	21.06
450-480	126492.70	67.93
480-510	18266.15	9.81
510-540	1832.70	0.98
Above 540	413.83	0.22
Total	186212.92	100

Relief map and data given in **Table 3.1** shows that majority of the study area lies in the elevation band of 420 to 480m with maximum area in elevation band of 450 and 480m.

Slope map of the study area and data given in **Table 3.2** shows that predominantly the command area is gently sloping while rest of the area in general is strongly sloping especially area under Narsingh Wildlife Sanctuary which though lies outside the command area.

**Figure 3.4: Slope map of the Study Area****Table 3.2: Area under different slope categories in the Study Area**

Slope Category (Slope in Degrees)	Area (Sq km)	Area (%)
Up to 2	128949.29	69.25
2-8	54288.51	29.15
8-15	2230.81	1.20

Slope Category (Slope in Degrees)	Area (Sq km)	Area (%)
15-30	732.07	0.39
30-45	12.24	0.01
Total	186212.92	100

3.3 DATA COLLECTION

As described above, baseline status has been prepared from primary data collected during field surveys undertaken which was then supplemented with secondary data/information gathered during interaction with concerned persons of various government departments and available literature and reports published by various institutions and organizations.

3.3.1 Data Collected during Field Surveys

The Environmental Baseline Chapter comprises of compilation of data on different environmental parameters both physical and biological environment (water quality of surface as well as ground water, soil characteristics, ambient air quality, noise levels, traffic density, vegetation structure, faunal composition covering mammals, birds, herpetofauna) which was collected during field surveys conducted in three seasons Winter/lean (February 2018), Pre-monsoon (May 2018) and Monsoon (July 2018).

Part of the data on physical environment relevant to the study area i.e. on air, noise and water quality in the study area was provided by the Regional Office of Madhya Pradesh Pollution Control Board (MPPCB), Bhopal for the field monitoring undertaken during monsoon and winter and for soil analysis by Central Laboratory, MPPCB, Bhopal. The data provided by MPPCB is based upon the surveys conducted during the month of February 2018 corresponding with winter season and in May 2018 which corresponds with pre-monsoon season. This data provided by MPPCB however was supplemented and updated with data collected during the field surveys conducted during Winter/lean (February 2018), Pre-monsoon (May 2018) and Monsoon (July 2018) wherein the baseline data was collected by our team as per the scoping clearance to cover physical, chemical and biological parameters i.e. flora and fauna during 3 seasonal studies.

3.3.2 Secondary Data

The published documents were collected from government agencies, scientific studies and project officials as the secondary information source of the area, required for EIA studies. Sources and data so collected have been mentioned below:

- For soil maps, Soil Atlas by National Bureau of Soil Survey & Land Use Planning (NBSS & LUP), Nagpur

- District Ground Water Information Booklet of Rajgarh and Bhopal Districts by Central Ground Water Board
- National Ambient Air Quality Series: NAAQMS/36/2012-13, Guidelines for the measurement of Ambient Air Pollutants
- Water Quality Criteria of Central Pollution Control Board (<http://www.cpcb.nic.in/Water Quality Criteria.php>)
- For the generation of FCC, Satellite data of LANDSAT 8 bands 3, 4 and 5 were used
- Rajgarh, Sehore, Bhopal and Shajapur Districts Statistical Handbooks published by Directorate of Economics and Statistics, Govt. of Madhya Pradesh
- Census of India 2011: Demography of the study area
- Madhya Pradesh Forest Department: Forest Working Plan of Rajgarh and Bhopal Forest Division, Sehore Forest Division under Bhopal Circle <http://intranet.mpforest.gov.in/MPFD15/WPMS/Workingplanlibrary/ViewContent.aspx?circularid=23&DivId=11203>
- 'A Revised Survey of the Forest Types of India' by Champion and Seth (1968) for forest type classification of the forests found in study area
- Meteorological Data: The data on meteorology was downloaded from <https://www.worldweatheronline.com> which is available for last 9 years
- Partial data on Water Quality and Ambient Air Quality monitoring was obtained from Madhya Pradesh Pollution Control Board
- Partial Data on Ambient Air quality Monitoring was provided by State Pollution Control Board which was supplemented and updated during the field surveys

3.4 PHYSICAL ENVIRONMENT

This section describes the study area characteristics like various meteorological attributes like average mean minimum and maximum temperature, rainfall, wind speed, and relative humidity, ground water depth, etc. It also covers the results of data collected on ambient air quality, noise and traffic, physico-chemical characteristics of surface and ground water

3.4.1 Meteorology

The proposed command area of the project lies in Rajgarh, Bhopal, Sehore and Shajapur districts, which experience mostly hot summer. The south-west monsoon rainfall occurs in the months of June to October in the study area with maximum rainfall occurring between these months. The temperature in the command area starts rising in the month of February and attain its maximum value in the month of May and then decreases. May and January are the hottest and coldest months of the year, respectively. In summer,

though day temperature remains high, nights are colder and pleasant. The meteorological data for Rajgarh and Bhopal districts was downloaded from online weather portal <https://www.worldweatheronline.in/>. Monthly data for the years 2009-2017 is given at **Annexure-IV**.

Brief account of different meteorological attributes is given in the preceding paragraphs.

3.4.1.1 Temperature

The average mean monthly maximum and minimum temperature was plotted and the same is given at **Figure 3.5**. Average mean maximum temperature of 40.6°C in Rajgarh district and 42°C in Bhopal district was recorded during the month of May while average mean minimum temperature of 14°C was recorded during the month of January in Rajgarh district and 13.4°C in the month of January in Bhopal district (*reference year 2009-17*).

Average mean maximum temperature of 42°C in Sehore and 41.7°C in Shajapur district was recorded during the month of May while average mean minimum temperature of 16.98°C in Sehore and 13.11°C in Shajapur district was recorded during the month of January. (Reference Year 2009-17).

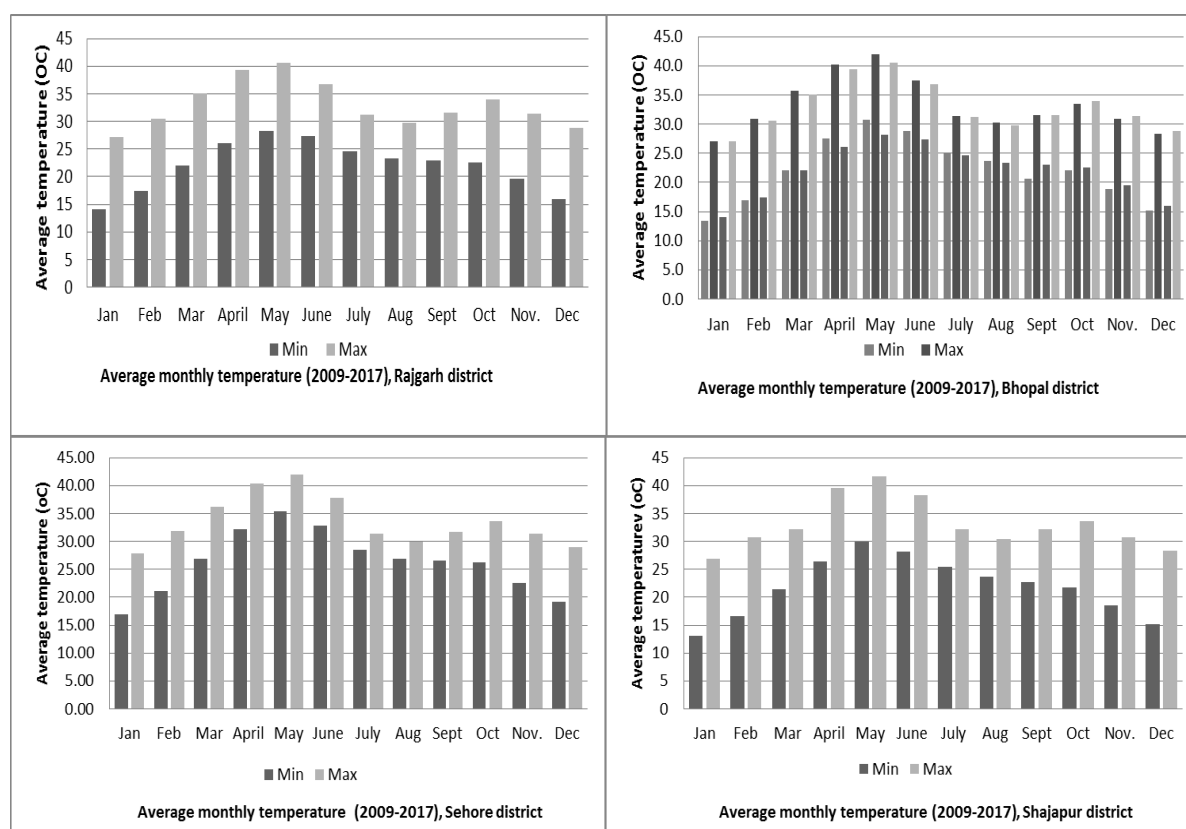


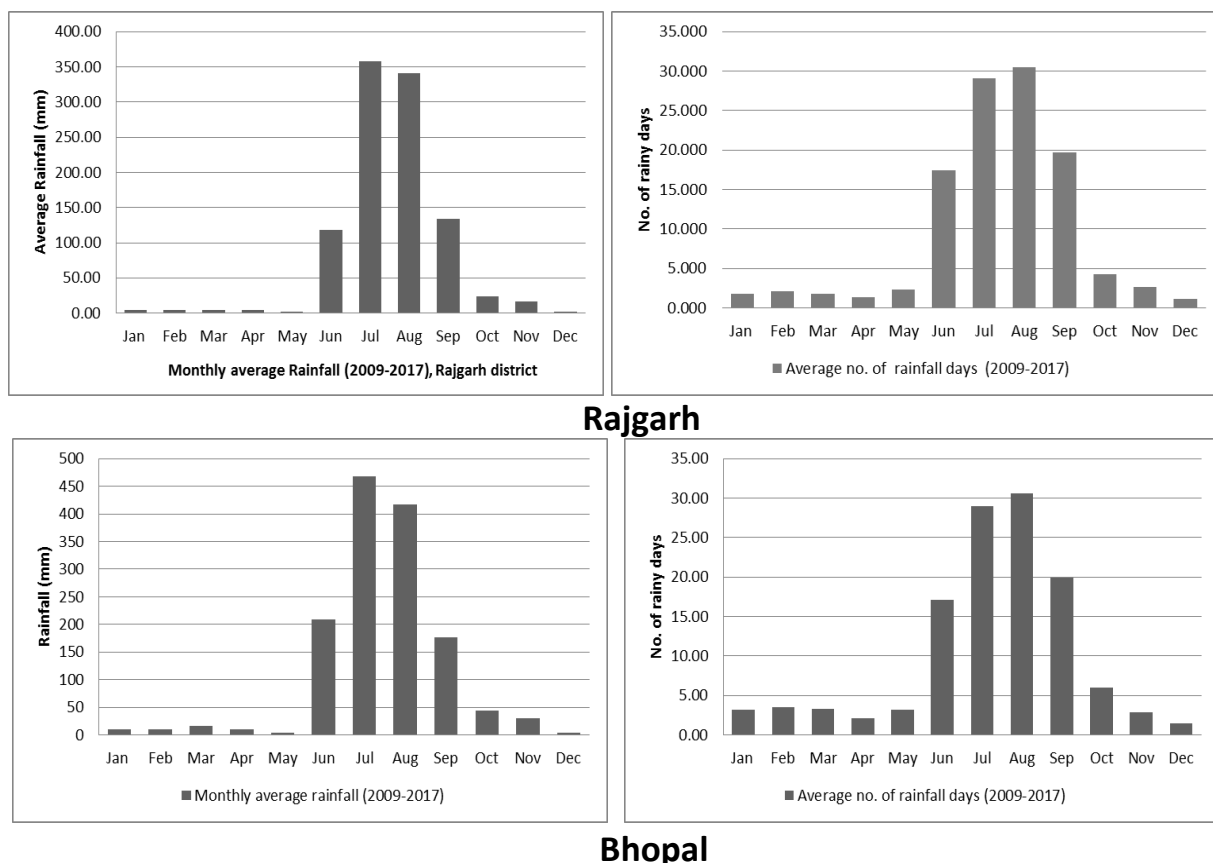
Figure 3.5: Monthly average Maximum and Minimum Temperature (2009-2017) in districts falling in the study area

3.4.1.2 Rainfall

The mean annual average rainfall of Rajgarh district was recorded as 1014.51 mm (based on data for a period of 2009-2017). Maximum rainfall in the area was recorded during 2009 with annual rainfall of 1330 mm with 93 rainy days. Minimum annual rainfall was recorded during the year 2014 with annual average of 616.66 mm. The area receives maximum rainfall during south west monsoon i.e. between June and October, where about 96% of the annual average rainfall is received. Only 4% of the annual average rainfall occurs between November and May (see **Figure 3.6**).

The mean annual average rainfall in Sehore district was recorded as 1021 mm (based on data for a period of 2009-2017). Maximum rainfall in the area was recorded during 2011 with annual rainfall of 1941 mm with 117 rainy days. Minimum annual rainfall was recorded during the year 2014 with annual average of 881 mm.

The annual average rainfall of Shajapur district was recorded as 816 mm (based on data for a period of 2009-2017). Maximum rainfall in the area was recorded during 2016 with annual rainfall of 1412 mm with 128 rainy days. Minimum annual rainfall was recorded during the year 2015 with 589 mm. The area receives maximum rainfall during south west monsoon i.e. between June and September, where about 92% of the annual average rainfall is received. Only 8% of the annual average rainfall occurs between October to May (see **Figure 3.6**).



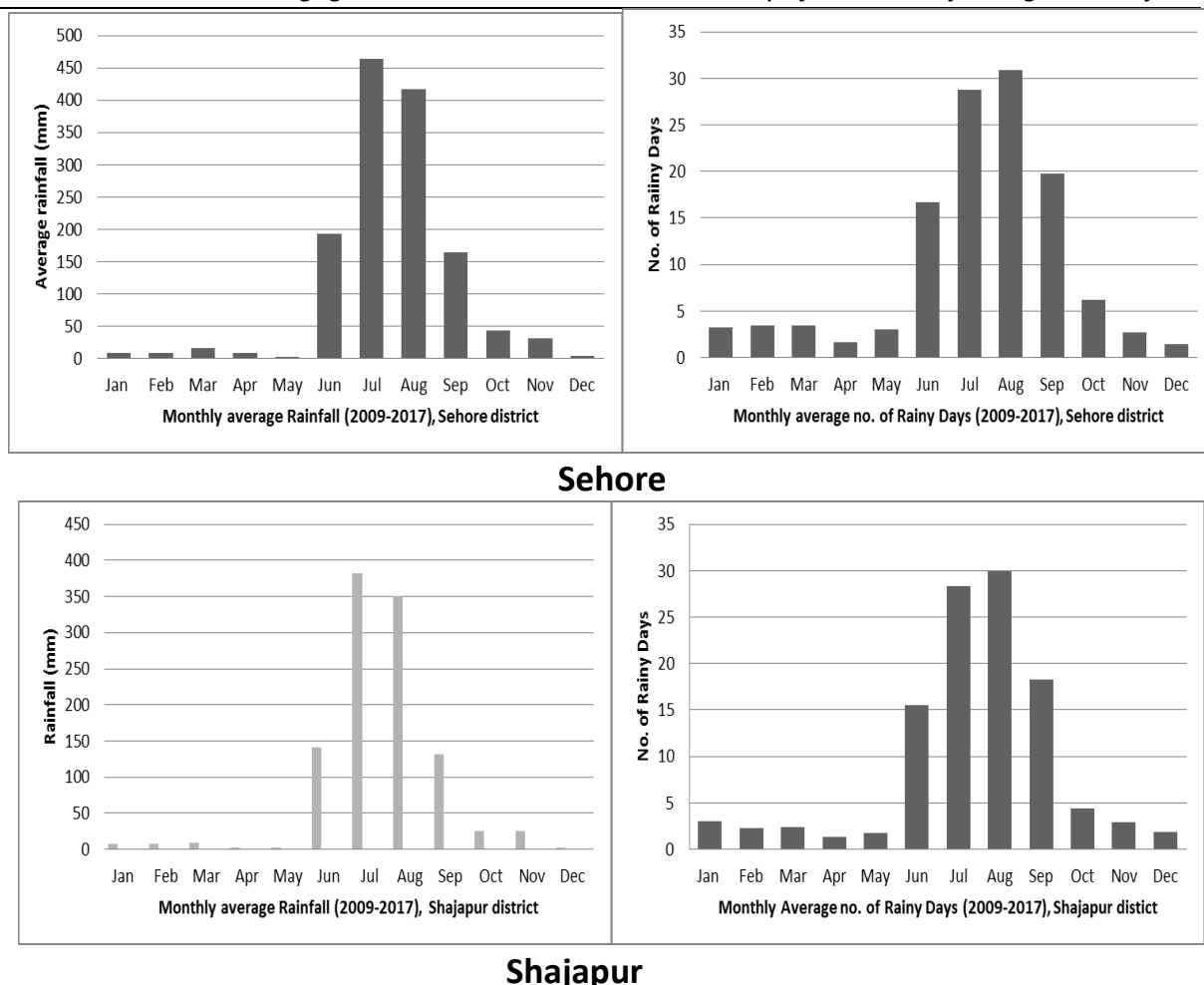


Figure 3.6: Monthly average rainfall and number of rainy days in districts falling in the study area

3.4.1.3 Relative Humidity

The Humidity is generally low throughout the year, except during monsoon months when average humidity is close to 84% for Rajgarh and 85% for Bhopal district in the month of August. The summer months are generally the dry months of the year with average humidity as low as 19.5% for Rajgarh and 15.8% for Bhopal district reference year 2009-2017. Average monthly variation in relative humidity is given at **Figure 3.7**.

The Relative Humidity is generally low throughout the year, except during monsoon months when average relative humidity is close to 85% in Sehore and 82% in Shajapur district in the month of August. The summer months are generally the dry months of the year with average relative humidity as low as 16.1% in Sehore and 17% in Shajapur district reference year 2009-2017 (see **Figure 3.7**).

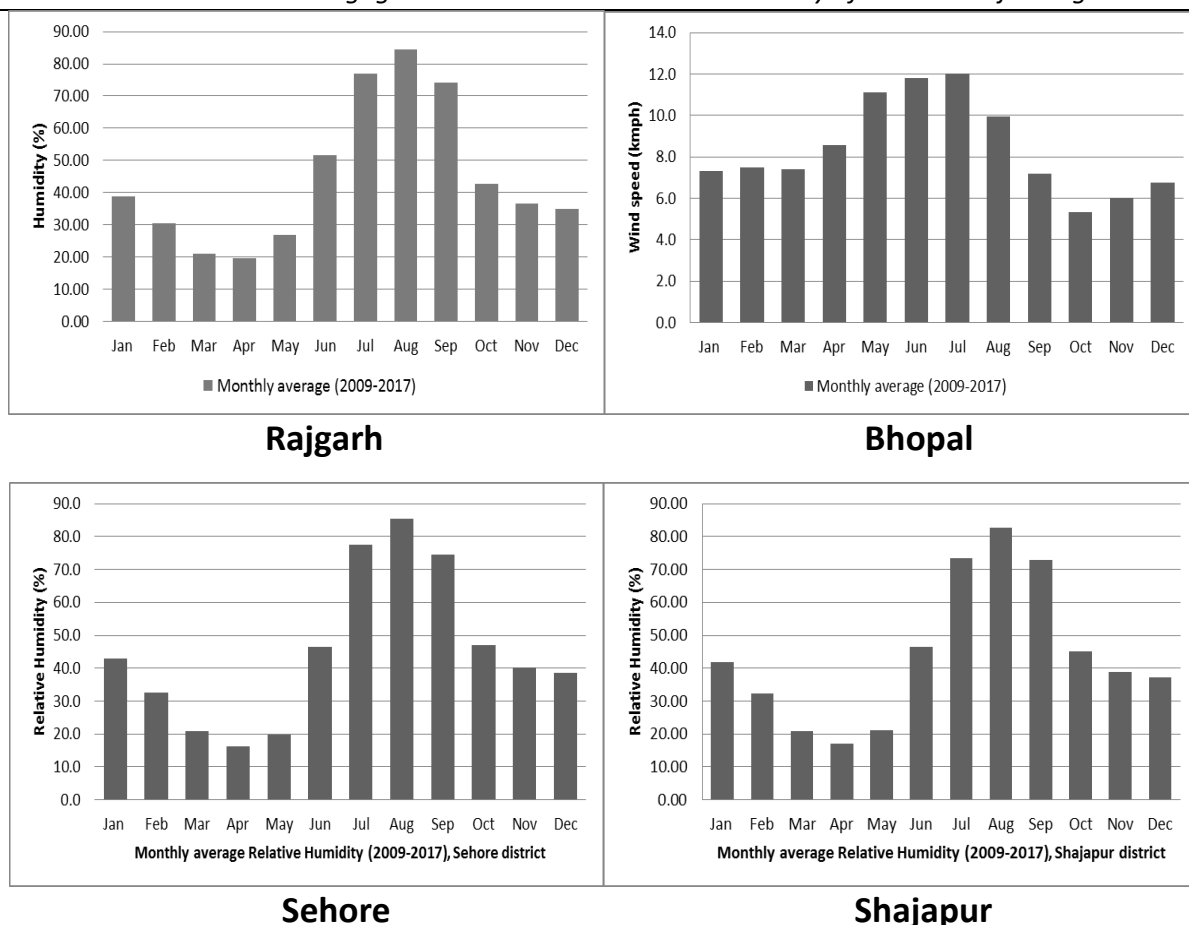
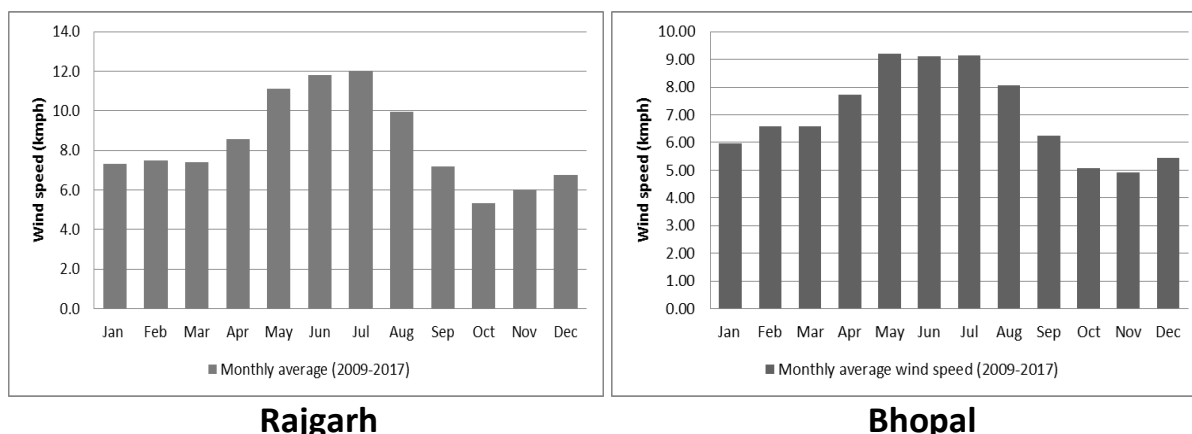


Figure 3.7: Monthly Variation in Average Relative Humidity (2009-2017) in districts falling in the study area

3.4.1.4 Wind Speed

The wind speed is higher during the pre-monsoon period as compared to the post monsoon period. The average maximum wind speed of 12 kmph is observed during the month of July at Rajgarh district and 9.2 Kmph in month of May for Bhopal district. Monthly variation in wind speed during reference years 2009-17 is given at **Figure 3.8**.

Average maximum wind speed of 9.3 kmph for Sehore in month of May. In case of Shajapur district average maximum wind speed of 10.4 kmph is recorded in the month of July.



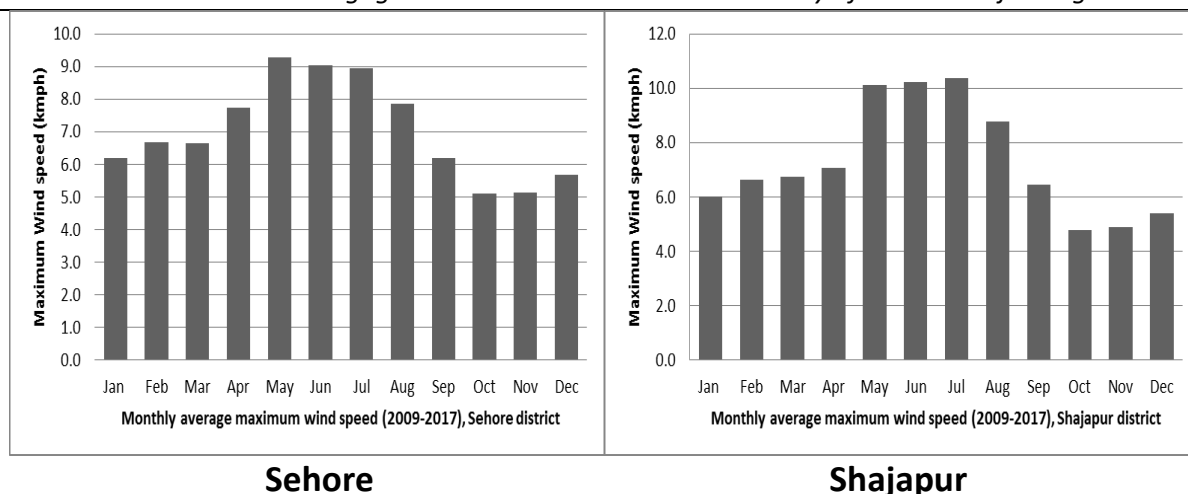


Figure 3.8: Monthly Variations in Wind Speed (2009-2017) in different districts falling in the study area

In order to understand the wind direction and wind speed in the study area during different season data were analyzed to draw Wind Rose diagram. Result of analysis areas is given in **Annexure V**.

3.4.2 Geomorphology

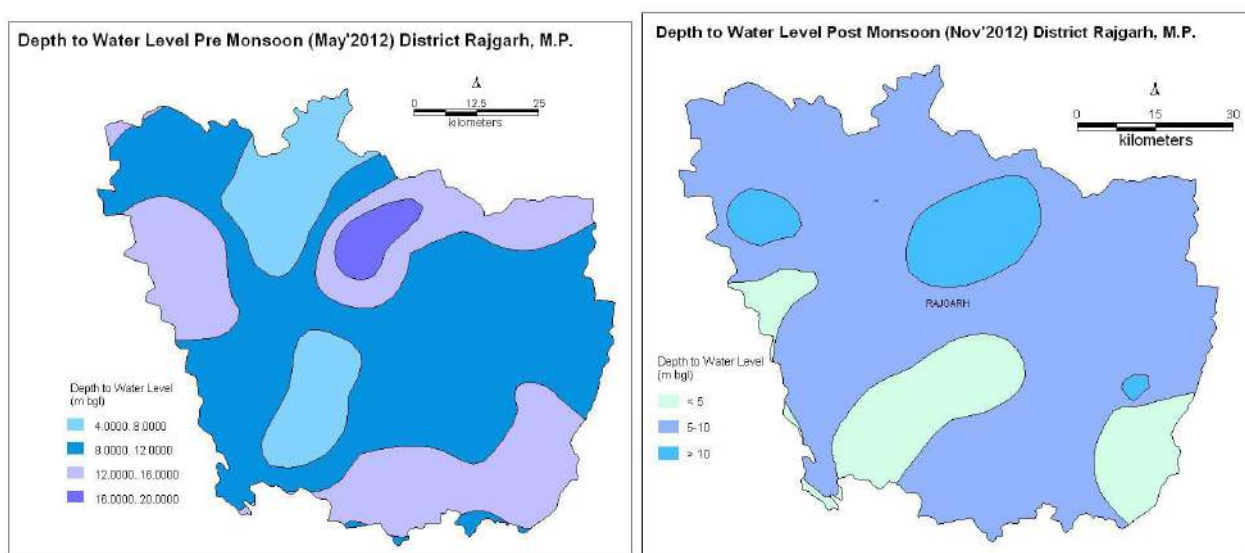
Geomorphological description of Rajgarh, Bhopal, Sehore and Shajapur districts is based upon District Ground Water Information Booklet published in 2013 by Central Ground Water Board, North Central Region, Ministry of Water Resources, and Government of India. Rajgarh district and Bhopal are under deccan trap group and have basalt rock formation except southeastern part. These districts form the part of Malwa plateau, generally an undulating topography. Rajgarh district is located at western part of the Madhya Pradesh and is bounded by Shajapur district in south as well as west. In the north it is surrounded by Guna district, east by Bhopal district and southeast by Sehore district. The highest elevation of 576.08 m amsl is recorded near to Narsinghgarh, a hillock of Vindhyan ranges. Kalisindh, Newaj and Parwati rivers are the main rivers present in the district. Bhopal district is present in the centre of the Madhya Pradesh. In north bounded by Guna district, northeast by Vidisha district, east by Raisen district, Sehore in southwest and west by Rajgarh district. The highest elevation is 622m amsl in the Singar Choli and lowest is recorded at 421m amsl in Phada block.

3.4.3 Ground Water

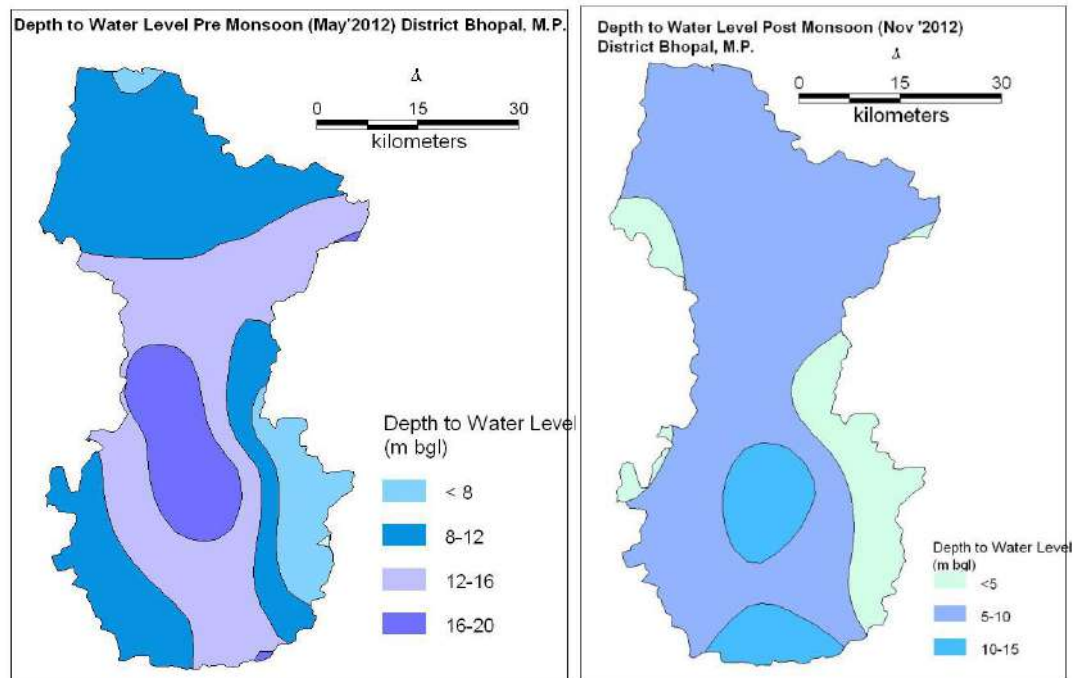
Central Ground Water Board (CGWB), Rajgarh district has total 32 ground water monitoring wells that includes 18 dugwell and 14 piezometers. Bhopal has 28 ground water monitoring well that includes 24 dugwell 4 piezometers and Hydrogeological maps of Rajgarh and Bhopal districts has been prepared on the bases of available data by CGWB. To study ground water regime of the area, pre-& post monsoon depth to water level maps of the district are used.

In general, depth to the ground water level in the Rajgarh district; during pre-monsoon ranges from 4.75m – 22.32m bgl; however, entire study area falls in 9-12 m bgl range. Similarly, for the post-monsoon period, district range of depth to ground water is 2.94 m-15.17 m bgl, however, study area falls in 8 & 12 m bgl. In general, depth to the ground water level in the Bhopal district; during pre-monsoon ranges from 5.15m – 18.4m bgl; however, entire study area falls in 10-18 m bgl range (In Northern part of district Berasia block and eastern Phada block have water level ranges 5-10m bgl). Similarly, for the post-monsoon period, district range of depth to ground water is 1.24m-11.61 m bgl, however, study area falls in less than 10-13 m bgl (In eastern part of Phada block and southeastern part of Berasia block the water level lies between 0.5-6m bgl. (refer Figure 3.9).

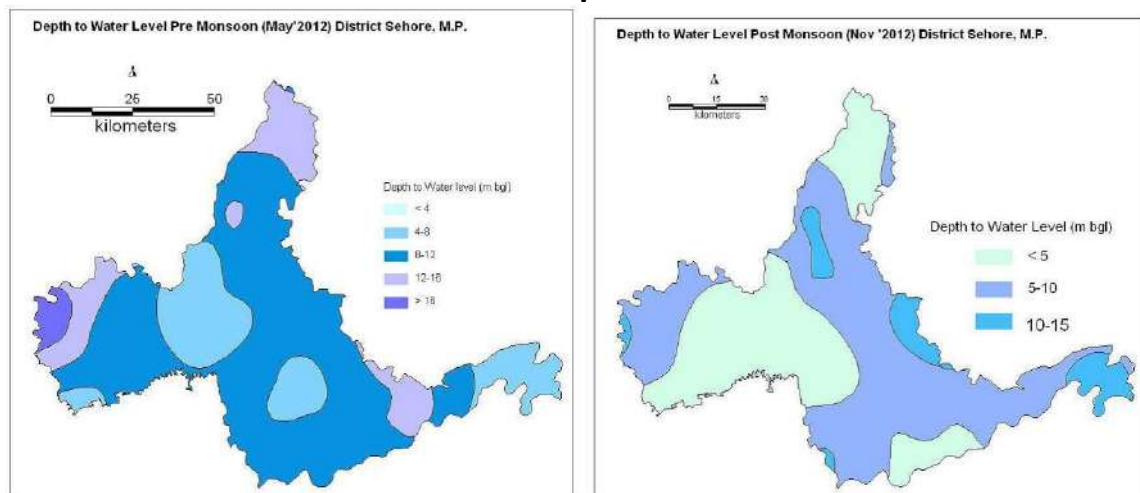
In Sehore district Central Ground Water Board (CGWB) has 26 ground water monitoring wells that includes 14 dug wells and 12 piezometers and in Shajapur district it has 47 ground water monitoring wells that includes 35 dug wells and 12 piezometers (as on 31/03/2013). Hydrogeological maps of Rajgarh, Bhopal, Sehore and Shajapur districts have been prepared on the bases of available data by CGWB. To study ground water regime of the area, pre-& post monsoon depth to water level maps of the district are used.



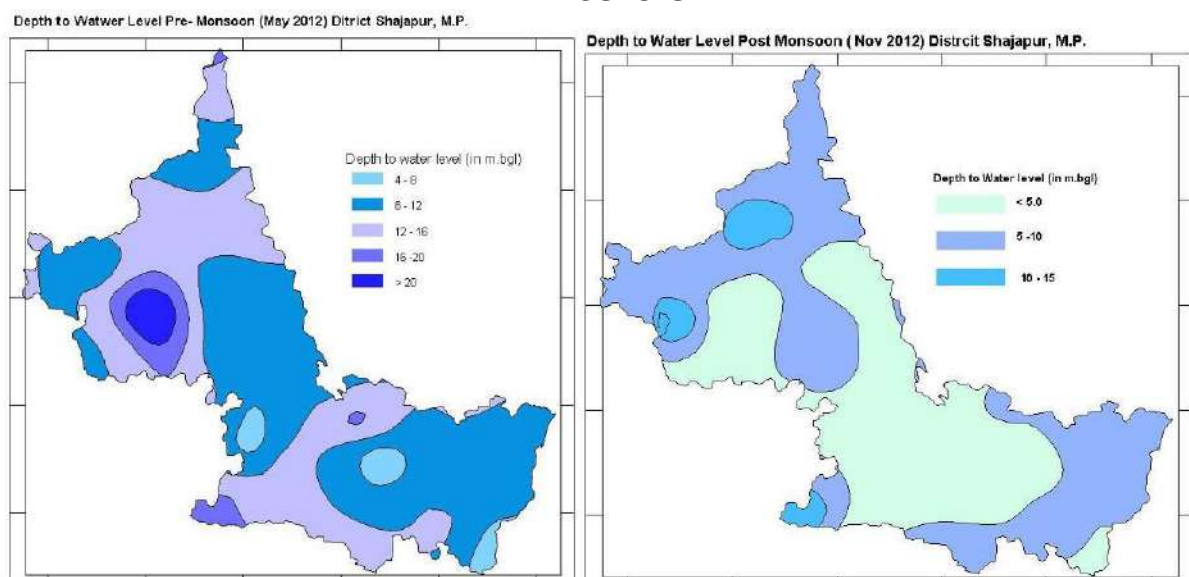
Rajgarh



Bhopal



Sehore



Shajapur

Figure 3.9: Depth to Ground Water Level – pre and post monsoon in districts falling in the study area

In general, depth to the ground water level in the Sehore district; during pre-monsoon ranges from 4.3m – 16.86 m bgl; however, entire study area falls in 6-12 m bgl range. Similarly, in the post-monsoon period, district range of depth to ground water is 0.4m-11.95 m bgl (refer **Figure 3.9**).

In general, depth to the ground water level in the Shajapur district; during pre-monsoon ranges from 6.9m – 23.40 m bgl; however, entire study area falls in 8-12 m bgl range. Similarly, for the post-monsoon period, district range of depth to ground water is 1.07m-15.68 m bgl (refer **Figure 3.9**).

In general, depth to the ground water level in the Rajgarh district; during pre-monsoon ranges from 4.75m – 22.32m bgl; however, entire study area falls in 9-12 m bgl range. Similarly, for the post-monsoon period, district range of depth to ground water is 2.94 m-15.17 m bgl, however, study area falls in 8 & 12 m bgl.

In general, depth to the ground water level in the Bhopal district; during pre-monsoon ranges from 5.15m – 18.4m bgl; however, entire study area falls in 10-18 m bgl range (In Northern part of district Berasia block and eastern Phada block have water level ranges 5-10m bgl). Similarly, for the post-monsoon period, district range of depth to ground water is 1.24m-11.61 m bgl, however, study area falls in less than 10-13 m bgl (In eastern part of Phada block and southeastern part of Berasia block the water level lies between 0.5-6m bgl (refer **Figure 3.9**).

CGWB, has concluded that the highest stage of ground water development of Rajgarh is 98% and Bhopal district is about 93% which reveals adequate scope for future development of ground water for irrigation. However, since depletion of ground water levels is recorded in ground water monitoring wells over a period, therefore a plan for artificial recharge to be prepared so that important natural resource is again used to recharge ground water system through feasible techniques. CGWB, also recommended conjunctive use of surface and ground water in the area for irrigation.

Ground water is the main source for drinking and irrigation in the Sehore and Shajapur districts is from ground water. Average water levels of the districts are deep, the decadal fluctuations and the long-term trends are showing a decline, and the water balance left is limited. The population and progress coupled with poor aquifers are responsible for this alarming situation. Thus, special caution is to be observed while developing the resource.

3.4.4 Soil

The state of Madhya Pradesh is endowed with variety of soils ranging from rich clayey to gravelly. The major groups of soil found in the state can be divided into 4 categories viz. i) Alluvial Soil, ii) Deep Medium Black Soil, iii) Shallow and Medium Black Soil, and iv) Mixed Red and Black Soils. The predominant soil type in the project area is Deep Medium Black Soil. Major crops grown in the study area are wheat, soybean, gram and vegetables.

3.4.4.1 Soil Taxonomic Classification

The soil taxonomic (family) classification map of study area was prepared as per the data by National Bureau of Soil Survey & Land Use Planning (NBSS&LUP) Nagpur in cooperation with Department of Agriculture, Government of Madhya Pradesh (1998). Soil map prepared from this data is given at **Figure 3.10**.

According to **Figure 3.10** and **Table 3.3** Soil Unit 379 is the most dominant Group (14.88% of study area) which is characterized by Fine, montmorillonitic, hyper-thermic, Chromic Haplusterts which have Deep, moderately well drained, clayey soils on gently sloping plain land with moderate erosion. Soil Units 377 and 407 are the other Soil Groups.

Table 3.3: Soil Taxonomic groups in the Study Area

Soil Unit	Main Group	Sub Group	Area (ha)	Area (%)
332	Clayey, montmorillonitic, hyperthermic, Lithic Ustochrepts Shallow, well drained clayey soils on very gently sloping undulating plateau with moderate erosion and moderately stony, associated with:	Fine, montmorillonitic, (Cal.), hyperthermic, Vertic Ustochrepts Deep, well drained, calcareous, clayey soils on gently sloping with moderate erosion.	3177.25	1.71
339	Clayey, montmorillonitic, hyper-thermic, Typic Ustochrepts Shallow, well drained clayey soils on gently sloping plateau with moderate erosion, associated with:	Fine, montmorillonitic, hyper-thermic, Typic Haplusterts Slightly deep, well drained, clayey soils on very gently sloping with moderate erosion	4437.05	2.38
344	Loamy, mixed, hyper-thermic, Lithic Ustorthents Extremely shallow, somewhat excessively drained, loamy soils on moderately sloping plateau with severe erosion, associated with:	Loamy, mixed, hyperthermic, Typic Ustochrepts Shallow, well drained, loamy soils on gently sloping with moderate erosion and slightly stony.	6904.06	3.71
354	Loamy, mixed, hyper-thermic, Lithic Ustorthents Very shallow, well drained, loamy soils on moderately steep sloping interveinal plateau with severe erosion and slightly stony, associated with:	Clayey, montmorillonitic, hyper-thermic, Typic Ustochrepts Shallow, well drained, clayey soils on very gently sloping with moderate erosion.	7734.70	4.15
360	Clayey, montmorillonitic hyper-thermic, Typic Ustochrepts Shallow, well drained, clayey soils on very gently sloping plateau (slightly dissected) with moderate erosion, associated with:	Clayey, montmorillonitic hyper-thermic, Lithic Ustorthents Very shallow, somewhat excessively drained, clayey soils on very gently sloping with moderate erosion.	3907.08	2.10
363	Fine montmorillonitic, hyper-thermic,	Loamy, mixed, hyperthermic,	10524.60	5.65

Soil Unit	Main Group	Sub Group	Area (ha)	Area (%)
	Typic Haplusterts Deep, moderately well drained, clayey soils on very gently sloping plateau (moderately dissected) with moderate erosion, associated with:	Typic Ustorthents Shallow, well drained, loamy soils on moderately sloping with severe erosion and moderately stony.		
377	Fine, montmorillonitic, hyper-thermic, Typic Haplusterts Deep, moderately well drained, clayey soils on very gently sloping plain land with moderate erosion, associated with:	Fine, montmorillonitic, (Cal.), hyperthermic, Chromic Haplusterts Deep, moderately well drained, calcareous, clayey soils on very gently sloping with moderate erosion.	22974.91	12.34
379	Fine, montmorillonitic, hyper-thermic, Chromic Haplusterts Deep, moderately well drained, clayey soils on gently sloping plain land with moderate erosion, associated with:	Fine, montmorillonitic, (Cal.), hyperthermic, Typic Haplusterts Deep, moderately well drained, calcareous, clayey soils on very gently sloping with moderate erosion.	27702.32	14.88
385	Fine, montmorillonitic, (Cal.), hyperthermic, Typic Haplusterts Deep, moderately well drained, calcareous, clayey soils on very gently sloping undulating plain with moderate erosion, associated with:	Fine, montmorillonitic, (Cal.), hyperthermic, Vertic Ustochrepts Deep, well drained, calcareous, clayey soils on very gently sloping with moderate erosion.	2392.80	1.28
394	Fine, montmotrillonitic, (Cal.), hyperthermic, Typic Haplusterts Deep, moderately well drained, calcareous, clayey soils on very gently sloping undulating plain with mounds with moderate erosion associated with:	Fine, montmotrillonitic, hyper-thermic, Typic Ustochrepts Slightly deep, well drained, clayey soils on very gently sloping with moderate erosion.	12918.09	6.94
395	Fine, montmotrillonitic, hyper-thermic, Typic Haplusterts Deep, moderately well drained, clayey soils on very gently sloping undulating plain with mounds with slight erosion associated with:	Fine, montmotrillonitic, hyper-thermic, Vertic Ustochrepts Deep, moderately well drained, clayey soils on gently sloping with moderate erosion.	20136.14	10.81
399	Fine, montmotrillonitic, hyper-thermic, Typic Haplusterts Deep, moderately well drained, clayey soils on very gently sloping plains with valleys with moderate erosion associated with:	Fine, montmotrillonitic, (Cal.), hyperthermic, Vertic Ustochrepts Deep, moderately well drained, calcareous, clayey soils on very gently sloping with moderate erosion.	811.12	0.44
402	Fine, montmotrillonitic, hyper-thermic, Typic Haplusterts Deep moderately well drained, clayey soils on gently sloping plain with valleys (moderately dissected) with moderate erosion, associated with:	Fine, montmotrillonitic, (Cal.), hyperthermic, Typic Haplusterts Deep, moderately well drained, calcareous, clayey soils on very gently sloping with moderate erosion.	11354.25	6.10
404	Fine, montmotrillonitic, (Cal.), hyperthermic, Typic Haplusterts Deep, well drained, calcareous, clayey soils on very gently sloping plain with valleys (severely dissected) with moderate erosion associated with:	Fine, montmotrillonitic, (Cal.), hyperthermic, Vertic Ustochrepts Deep, moderately well drained, calcareous, clayey soils on very gently sloping with moderate erosion.	16139.10	8.67
407	Fine, montmotrillonitic, (Cal.), hyperthermic, Typic Haplusterts Deep, moderately well drained, calcareous, clayey soils on very gently sloping plain with valleys (severely dissected) with moderate erosion associated with:	Fine, montmotrillonitic, hyperthermic, Vertic Ustochrepts Slightly deep, well drained, clayey soils on gently sloping with moderate erosion.	22818.62	12.25
412	Clayey, montmotrillonitic, hyper-thermic, Typic Ustochrepts Shallow, well drained, clayey soils on	Fine, montmotrillonitic, hyper-thermic, Typic Haplusterts Deep, moderately well drained,	368.17	0.20

Soil Unit	Main Group	Sub Group	Area (ha)	Area (%)
	gently sloping plateau with mesas and buttes with moderate erosion associated with:	clayey soils on very gently sloping with moderate erosion.		
418	Fine, montmorillonitic, (Cal.), hyperthermic, Typic Ustochrepts Slightly deep, well drained, calcareous, clayey soils on moderately sloping undulating table land (moderately dissected) with moderate erosion associated with:	Loamy-skeletal, mixed, hyperthermic, Lithic Ustorthents Very shallow, somewhat excessively drained, loamy-skeletal soils on gently sloping with moderate erosion and moderate stony.	11912.67	6.40
	TOTAL		186212.92	100

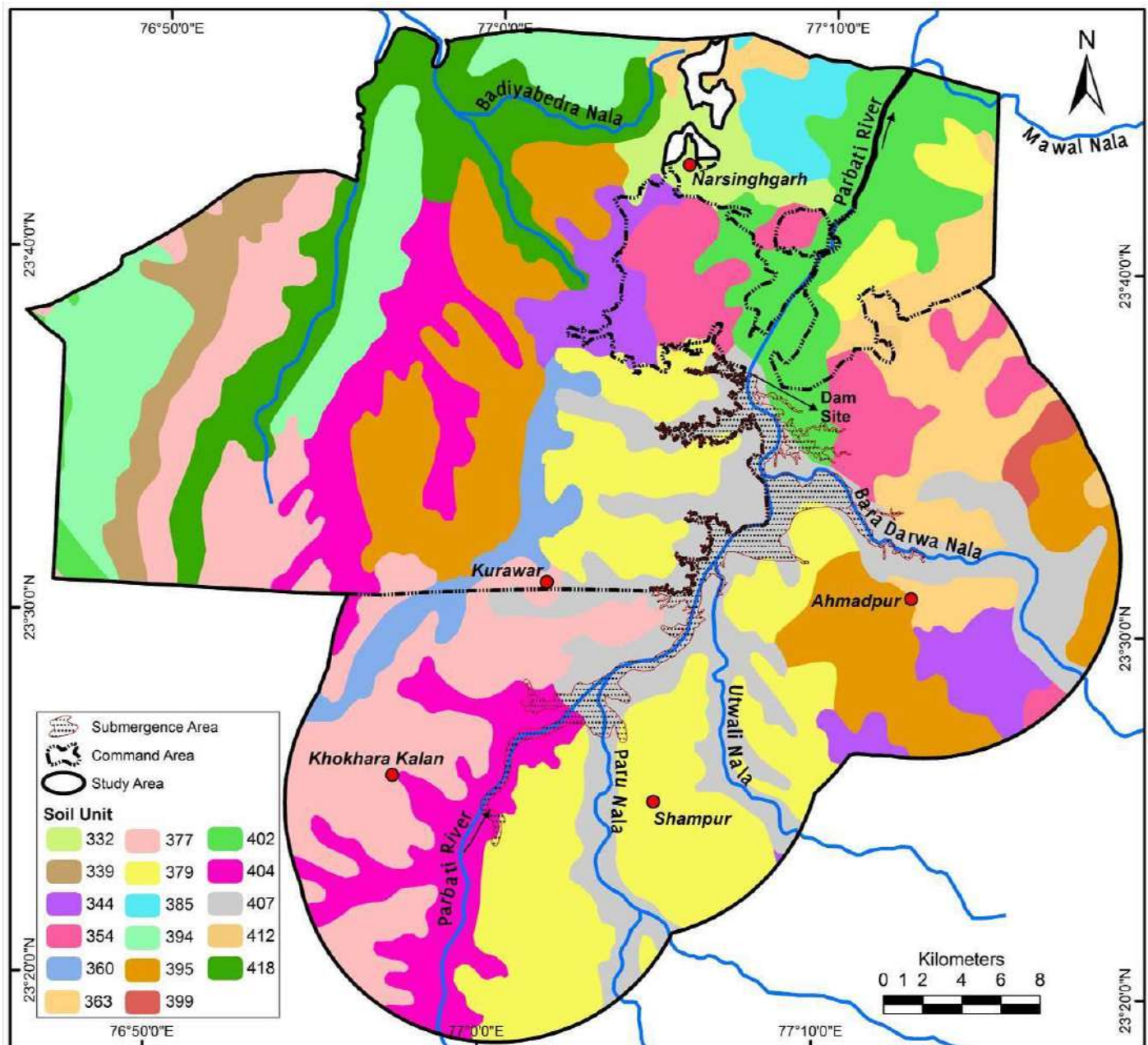


Figure 3.10: Soil Map of the Study Area (refer Table 3.3 for Soil Legend)

3.4.4.2 Physico-chemical Properties of Soil

In order to assess the soil fertility at different locations in the study area, physical and chemical characteristics were analyzed for 8 locations from where soil samples collected from the study area (refer **Figure 3.11 and Table 3.4**). Soil samples were collected with help of Khurpi from a depth of 15 cm and from surface (top soil) after removing the grasses. Samples were brought to laboratory for physico-chemical analysis. The soil analysis was carried out at the Apex Testing and Research Laboratory (NABL accredited Lab.), New Delhi. NABL accreditation of lab is attached as **Annexure VI**. Results of analysis are given in **Table 3.4**.

Table 3.4: Soil sampling locations

Site Code	Location	Characteristics
S1	Near Bagsi village	Agriculture
S2	Sundi Village	Agriculture
S3	Marethi village	Agriculture
S4	Mawasa	Agriculture
S5	Gathala	Agriculture
S6	Anwali	Agriculture
S7	Fatehpur	Agriculture
S8	Fatehpur	Forest

The following parameters were analyzed for soil.

Texture - Sand (%), Silt (%) and Clay (%)	Alkalinity (mg/l)
Porosity (g/cc)	Chloride Content (mg/kg)
Bulk Density (g/cc)	Organic Carbon (%)
Water Holding Capacity (%)	Potassium (kg/ha)
pH	Phosphorus (kg/ha)
Electrical Conductivity (μ mho/cm)	Nitrogen (kg/ha)
Calcium (mg/kg)	Salinity (ppt)
Magnesium (mg/kg)	

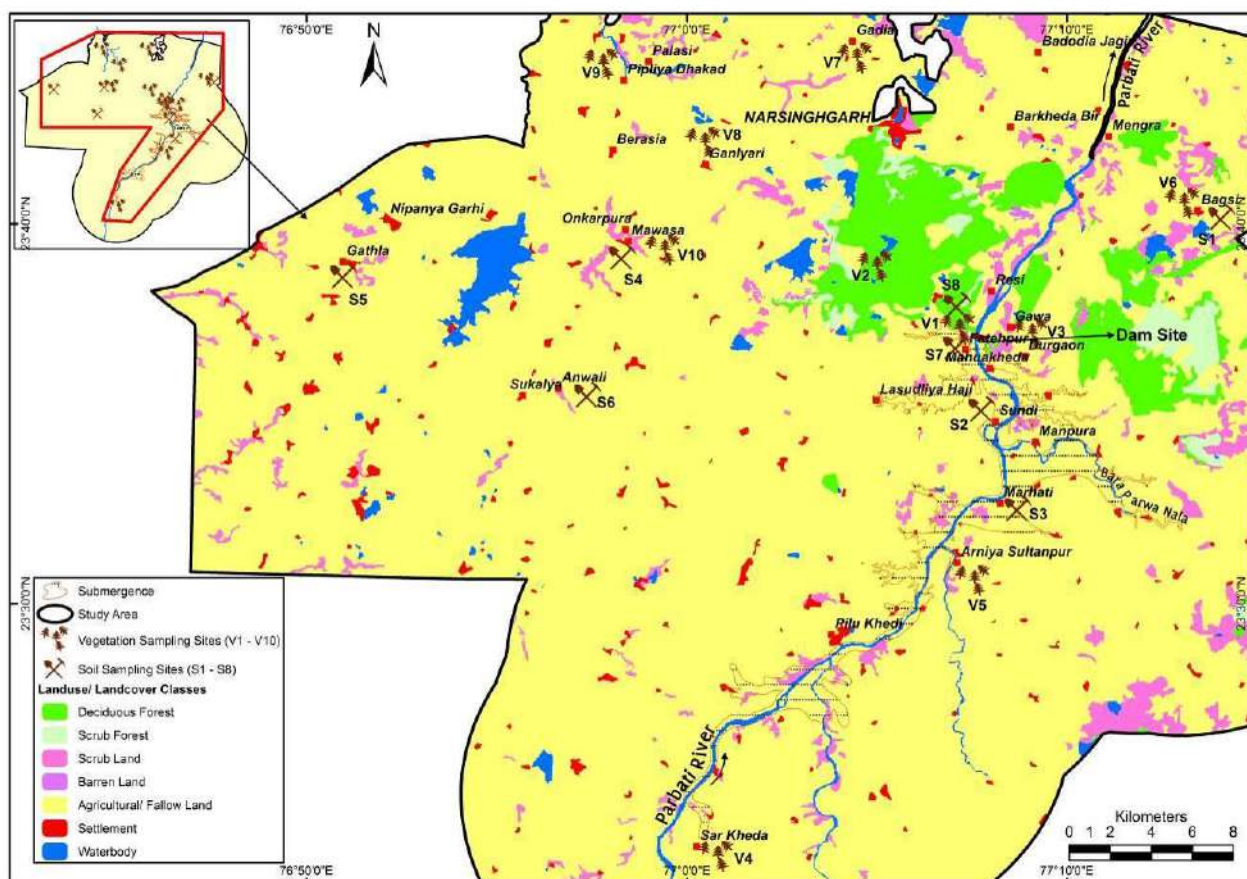


Figure 3.11: Map of study area showing location of Soil Sampling sites (S1-S8) and Vegetation sampling sites (V1-V10)

Bulk density reflects the soil's ability to function for structural support, water and solute movement, and soil aeration. The bulk density of soil varied from 1.13 to 1.9 (g/cc) at various locations in the study area indicating soil in general is suitable for plant growth. Porosity of the soil samples varied between 0.41 and 0.50 during winter, between 0.37 and 0.63 during pre-monsoon and between 0.36 and 0.62 during monsoon. The soil of the area is reddish brown and black and the texture of soil in general is predominantly sandy-loamy (see **Table 3.5**). In general, all the physical soil quality indicators reflect good quality of soil in the study area.

Table 3.5: Physico-chemical Characteristics of Soil (Winter)

S. No.	Test Parameters	S1	S2	S3	S4	S5	S6	S7	S8
1	Texture								
	Sand (% w/w)	70	72	67	75	70	71	72	70
	Silt (% w/w)	12	9	12	11	10	9	10	12
	Clay (% w/w)	18	19	21	14	20	20	18	18
2	Porosity (g/cc)	0.41	0.44	0.45	0.50	0.41	0.45	0.44	0.41
3	Bulk Density (g/cc)	1.25	1.31	1.23	1.31	1.34	1.24	1.33	1.25
4	Water Holding Capacity (%)	26.9	25	29.9	32	32	32	28	26.9
5	pH	8.2	8.4	8.5	8.2	7.9	8.22	8.1	8.2
6	Electrical Conductivity	311	282	337	268	281	429	315	311

	(μ mhos/cm)								
7	Calcium (mg/kg)	645.7	569.9	575.7	652.2	656.3	659.7	798.6	645.7
8	Magnesium (mg/kg)	219.7	245.4	356.4	223.4	230.6	272.2	245.4	219.7
9	Alkalinity (mg/l)	28	32	25	40	28	29	25	28
10	Chloride (mg/kg)	46.9	44	44	45	37	38	40	46.9
11	Sodium (mg/kg)	145.8	176.9	166.8	182.3	159.7	167.9	170.9	145.8
12	Organic Carbon (%)	0.62	0.71	0.69	0.68	0.52	0.56	0.68	0.62
13	Phosphorus (kg/ha)	32.8	25	26	29	19	35.9	32.3	32.8
14	Nitrogen (kg/ha)	122	124	144	149	124	130	142	122
15	Potassium (kg/ha)	112	116	118	126	125	120	114	112
16	Salinity (ppt)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Table 3.6: Physico-chemical Characteristics of Soil (Pre-Monsoon)

S. No.	Parameters	S1	S2	S3	S4	S5	S6	S7	S8
1	Texture								
	Sand (% w/w)	64	63	58	49	50	42	39	48
	Silt (% w/w)	10	13	13	12	8	9	10	8
	Clay (% w/w)	26	24	29	39	42	49	50	44
2	Porosity (g/cc)	0.38	0.37	0.43	0.59	0.53	0.55	0.63	0.53
3	Bulk Density (g/cc)	1.3	1.2	1.4	1.6	1.6	1.6	1.9	1.7
4	Water Holding Capacity (%)	33.0	28.8	35.4	64.2	48.5	50.8	56.0	51.2
5	pH	8.5	8.5	8.5	7.5	8.6	8.7	8.5	7.9
6	Electrical Conductivity (μ mho/cm)	279.9	286.9	328.1	318.2	310.8	445.8	341.0	205.9
7	Calcium (mg/kg)	658.9	694.6	811.3	821.8	765.5	811.3	881.2	764.0
8	Magnesium (mg/kg)	217.5	294.8	350.8	281.6	267.5	288.7	306.8	263.5
9	Alkalinity (mg/l)	36.9	60.1	65.4	54.9	52.8	54.7	62.2	59.6
10	Chloride Content (mg/kg)	40.1	45.2	49.4	47.1	44.9	45.0	53.6	44.7
11	Sodium (mg/kg)	158.2	186.4	205.7	194.2	181.0	209.5	220.6	186.4
12	Organic Carbon (%)	0.5	0.5	0.6	0.6	0.5	0.5	0.5	0.5
13	Available Phosphorus (kg/ha)	21.6	31.4	32.1	30.1	31.0	35.0	34.3	30.9
14	Available Nitrogen (kg/ha)	126.5	135.7	151.9	150.2	132.5	144.8	160.4	127.5
15	Available Potassium (kg/ha)	126.1	113.4	131.0	132.6	115.1	122.0	132.8	115.1
16	Salinity (ppt)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Table 3.7: Physico-chemical Characteristics of Soil in the study area (Monsoon)

S. No.	Test Parameters	S1	S2	S3	S4	S5	S6	S7	S8
1	Texture								
	Sand (% w/w)	62	61	56	48	49	41	38	47
	Silt (% w/w)	11	14	14	12	8	9	10	8
	Clay (% w/w)	27	25	30	40	43	50	52	45
2	Porosity (g/cc)	0.39	0.36	0.42	0.57	0.52	0.54	0.62	0.52
3	Bulk Density (g/cc)	1.32	1.13	1.40	1.60	1.52	1.55	1.85	1.63
4	Water Holding Capacity (%)	31.41	27.44	33.70	61.12	46.22	48.36	53.30	48.73
5	pH	8.05	8.08	8.12	7.12	8.16	8.24	8.13	7.49
6	Electrical Conductivity (μ mhos/cm)	288.60	295.80	338.25	328.04	320.46	459.60	351.54	212.30
7	Calcium (mg/kg)	679.32	716.04	836.40	847.24	789.16	836.40	908.46	787.60
8	Magnesium (mg/kg)	224.22	303.96	361.62	290.28	275.77	297.60	316.26	271.70

S. No.	Test Parameters	S1	S2	S3	S4	S5	S6	S7	S8
9	Alkalinity (mg/l)	38.85	63.24	68.88	57.82	55.59	57.60	65.52	62.70
10	Chloride (mg/kg)	42.18	47.53	52.03	49.56	47.31	47.40	56.45	47.08
11	Sodium (mg/kg)	166.50	196.25	216.48	204.38	190.53	220.56	232.22	196.24
12	Organic Carbon (%)	0.53	0.51	0.50	0.48	0.47	0.52	0.49	0.58
13	Phosphorus (kg/ha)	20.98	30.50	31.12	29.26	30.08	33.96	33.26	30.03
14	Nitrogen (kg/ha)	133.20	142.80	159.90	158.12	139.52	152.40	168.84	134.20
15	Potassium (kg/ha)	122.43	110.06	127.18	128.74	111.73	118.44	128.90	111.76
16	Salinity (ppt)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Soil fertility status of the area was assessed based upon soil test results and based upon Soil Fertility Rating given in table below.

Soil Fertility Rating as per Soil Fertility Book*

Soil Parameter	Low	Medium	High
Organic Carbon (%)	<0.5	0.5 to 0.75	>0.75
Available Nitrogen (kg/ha)	<280	280 to 560	>560
Available Phosphorus (kg/ha)	<10	10 to 25	>25
Available Potassium (kg/ha)	<108	108 to 280	>280

*Source: Department of Agriculture & Cooperation, Ministry of Agriculture, Government of India (2011)

Organic matter an important indicator of soil health is in 'Medium' range throughout the study area (see table below). The soil fertility rating in terms of nitrogen concentration was 'Low' and potassium concentration is in 'Medium' range in case of phosphorus is in 'High' range in general at all sampling locations in the study area.

Parameter	Season/ Sites	S1	S2	S3	S4	S5	S6	S7	S8
Organic Carbon (%)	W	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
	PM	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
	M	Medium	Medium	Medium	Low	Low	Medium	Low	Medium
Nitrogen (kg/ha)	W	Low	Low	Low	Low	Low	Low	Low	Low
	PM	Low	Low	Low	Low	Low	Low	Low	Low
	M	Low	Low	Low	Low	Low	Low	Low	Low
Phosphorus (kg/ha)	W	High	High	High	High	High	High	High	High
	PM	Medium	High	High	High	High	High	High	High
	M	Medium	High	High	High	High	High	High	High
Potassium (kg/ha)	W	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
	PM	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
	M	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium

W=Winter; PM=Pre-monsoon; M=Monsoon

Based upon Soil Fertility rating overall Nutrient Index (NI) of soils in the study area vis-à-vis NPK was calculated as follows:

(Percent samples falling in Low category x 1) + (Percent samples falling in Medium category x 2) + (Percent samples falling in High category x 3)/100.

Based upon above Nutrient Index Soil Fertility is assessed as follows:

< 1.67 : Low

1.67 – 2.33 : Medium
> 2.33 : High

The soil fertility in the study area in general based upon Nutrient Index in terms of NPK as above in case of Nitrogen is Low (1.00), in case of Potassium is 'Medium' (2.0) while in case of Phosphorus it is High i.e. NI is 2.88.

Parameter	Winter		Pre-Monsoon		Monsoon	
	Nutrient Index	Fertility Rating	Nutrient Index	Fertility Rating	Nutrient Index	Fertility Rating
Nitrogen (kg/ha)	1.00	Low	1.00	Low	1.00	Low
Phosphorus (kg/ha)	3.00	High	2.88	High	2.88	High
Potassium (kg/ha)	2.00	Medium	2.00	Medium	2.00	Medium



Soil Sample collection in the study area

3.4.4.3 Conclusion

The soil of the area is reddish brown and black and the texture of soil in general is predominantly sandy-loamy. The soil fertility based upon Nutrient Index in terms of NPK as above in case of Nitrogen is Low (1.00), Potassium is 'Medium' while in case of Phosphorus is High. Wheat, soybean, gram and vegetables are the major crops grown in the study area.

3.4.5 Air Environment

Ambient Air Quality (AAQ) Monitoring was carried out to establish the baseline data with respect to ambient air quality of the region and superimposition of potential releases of air pollutants during the project's construction and operation phase; for impact assessment and preparation of mitigation and management measures. In the lift irrigation scheme, where the project involves distribution of water for irrigation, potential for air pollution is not significant. Releases of air pollutants are limited to project construction phase.

3.4.5.1 Methodology

The ambient air quality monitoring was done at 8 locations in the study area during Winter, Pre-monsoon and Monsoon seasons by RSET team with the help of team of NABL accredited laboratory (refer **Table 3.8**). Map showing sampling locations for Air quality monitoring in the study area is given at **Figure 3.12**. Ambient air quality monitoring was carried out for sulphur dioxides (SO_x), nitrogen oxides (NO_x), PM₁₀ and PM_{2.5}. Air quality monitoring was carried out conforming to the National Ambient Air Quality Standards for Industrial Residential, Rural & Other Areas and Ecologically Sensitive Areas. The monitoring was done twice a week for 24 h, 4 times in a month during three seasons at each location in the study area.

Table 3.8: Sites for ambient air quality monitoring in the study area

Code	Monitoring Location	Remarks
AQ1/NT1	Dam site/Rensi village	Residential area
AQ2/NT2	Fatehpur	Residential area
AQ3/NT3	Mahuakheda	Residential area
AQ4/NT4	Gva	Residential area
AQ5/NT5	Lasudia haji	Residential area
AQ6/NT6	Barkheda Bir	Residential area
AQ7/NT7	Badodia Jagir	Residential area
AQ8/NT8	Pipliya Dhakad	Residential area

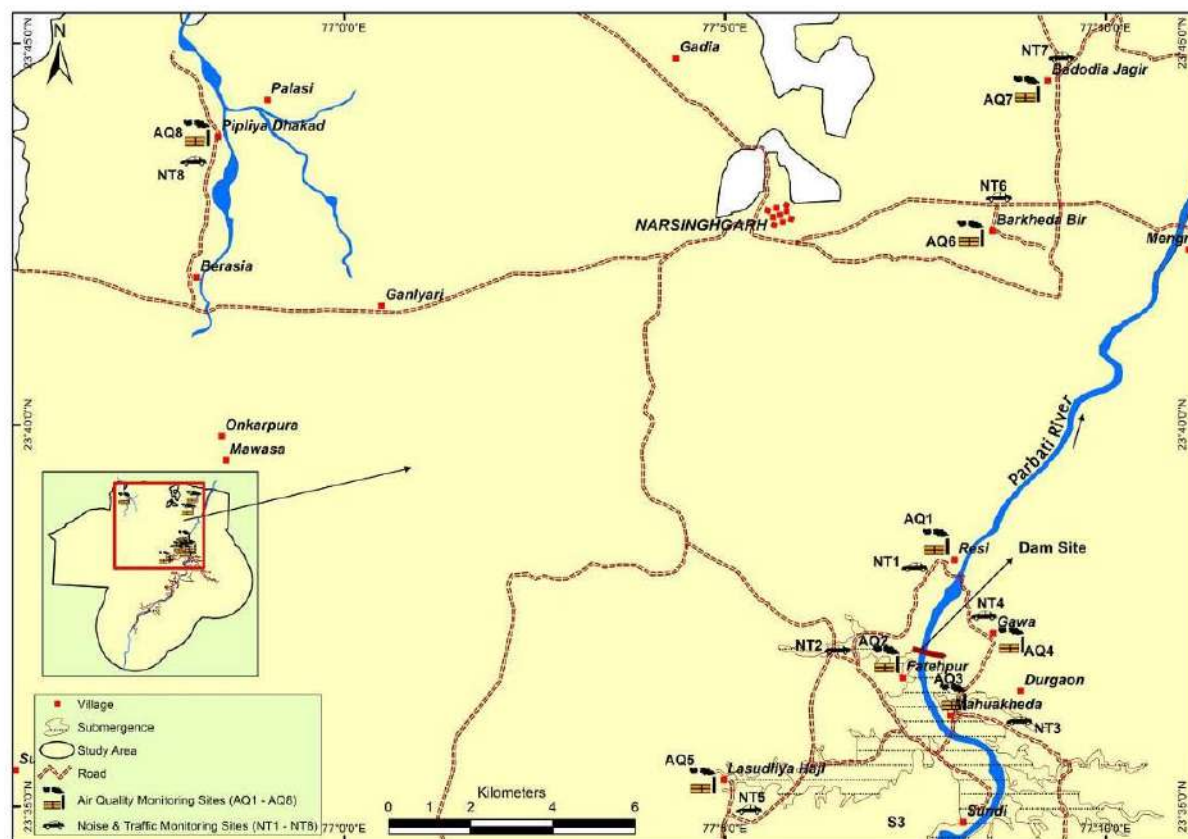


Figure 3.12: Map of study area showing location of Air and Noise Monitoring sites (AQ1/NT1 – AQ8/NT8)

3.4.5.2 Results of AAQ monitoring

The air around project site in general is free from any pollution source. The results of ambient air quality monitoring are given in **Tables 3.9**.

Concentrations of $PM_{2.5}$ in the study area were observed from the minimum $12.3 \mu\text{g}/\text{m}^3$ to the maximum value $23.8 \mu\text{g}/\text{m}^3$ during winter, 9.5 to $21.8 \mu\text{g}/\text{m}^3$ during pre-monsoon and from 8.1 to $27.1 \mu\text{g}/\text{m}^3$ during monsoon sampling. The minimum concentrations observed at the 8 sampling stations were in the range 8.1 to $21.9 \mu\text{g}/\text{m}^3$, whereas the maximum concentrations were observed in the range 9.7 to $27.1 \mu\text{g}/\text{m}^3$, and the average concentrations in the range 8.9 to $24.3 \mu\text{g}/\text{m}^3$. The concentration of 98th percentile is observed in the range from 9.6 to $27 \mu\text{g}/\text{m}^3$.

The concentration of 98th percentile of PM_{10} monitoring in all seasons was observed from 26.2 to $57.7 \mu\text{g}/\text{m}^3$.

The concentration of 98th percentile of SO_2 monitoring in all seasons was observed between 3.4 to $8.4 \mu\text{g}/\text{m}^3$.

The concentration of 98th percentile of NO_x monitoring in all seasons was observed between 5.4 to 12.3 µg/m³. These maximum observed values are well below the ambient air quality standard (80µg/m³) for Industrial, residential, rural and other areas.

Based on the results of monitoring, the concentrations of PM_{2.5}, PM₁₀, SO_x and NO_x at all the sites were well within the Residential & Rural area permissible limits prescribed by National Ambient Air Quality Standard 2009 notified by CPCB.

Table 3.9: Ambient Air Quality in the study area (unit: µg/m³)
Winter

Monitoring Location	Feb-18	Parameters (µg/m ³)			
		PM _{2.5}	PM ₁₀	SO _x	NO _x
AQ 1 Bhadeli Village	Min	14.0	51.3	5.2	9.0
	Max	14.2	54.2	5.9	10.3
	Average	14.1	53.4	5.7	9.7
	98 Percentile	14.2	54.2	5.9	10.3
AQ2 Jalpani Village	Min	15.3	54.2	5.4	8.6
	Max	16.7	57.7	6.1	9.6
	Average	16.0	56.6	5.8	9.1
	98 Percentile	16.7	57.7	6.1	9.6
AQ3 Chamrach	Min	15.6	48.3	5.3	8.6
	Max	18.2	53.7	6.1	10.7
	Average	16.8	50.9	5.7	9.5
	98 Percentile	18.0	53.5	6.1	10.6
AQ4 Niwas	Min	15.4	47.0	5.7	8.0
	Max	18.2	52.6	6.5	9.8
	Average	17.2	49.9	5.9	9.2
	98 Percentile	18.2	52.5	6.5	9.8
AQ5 Sarai Village	Min	19.7	51.7	5.7	9.6
	Max	23.8	56.8	7.0	10.9
	Average	22.3	54.0	6.2	10.2
	98 Percentile	23.8	56.7	7.0	10.9
AQ6 Khajuriha Village	Min	13.2	37.0	5.0	8.0
	Max	16.4	43.4	6.1	10.1
	Average	15.2	41.0	5.7	9.1
	98 Percentile	16.4	43.4	6.1	10.1
AQ7/ Badodia Jagir	Min	18.3	49.1	6.0	10.5
	Max	22.1	54.0	7.4	12.0
	Average	20.7	51.3	6.5	11.2
	98 Percentile	22.1	53.8	7.4	11.9
AQ8/ Pipliya Dhakad	Min	12.3	35.1	5.3	8.8
	Max	15.2	41.2	6.4	11.1
	Average	14.1	39.0	6.0	10.0
	98 Percentile	15.2	41.2	6.4	11.1
Permissible Limit	24 h NAAQS 2009	60	100	80	80

Pre-monsoon

Monitoring Location	May-18	Parameters (µg/m ³)			
		PM _{2.5}	PM ₁₀	SO _x	NO _x
AQ 1 Bhadeli Village	Min	10.0	48.6	6.5	8.0
	Max	11.8	52.5	7.1	8.9
	Average	11.1	50.9	6.9	8.5
	98 Percentile	11.8	52.4	7.1	8.9

Monitoring Location	May-18	Parameters ($\mu\text{g}/\text{m}^3$)			
		PM _{2.5}	PM ₁₀	SOx	NOx
AQ2 Jalpani Village	Min	9.5	41.4	4.4	7.7
	Max	12.4	46.1	5.1	8.8
	Average	11.6	43.7	4.8	8.4
	98 Percentile	12.4	46.0	5.1	8.8
AQ3 Chamrach	Min	11.8	51.3	5.5	6.8
	Max	13.3	55.6	6.2	7.3
	Average	12.7	53.6	5.8	7.1
	98 Percentile	13.3	55.5	6.2	7.3
AQ4 Niwas	Min	13.6	53.2	5.4	7.4
	Max	14.5	56.1	7.0	7.9
	Average	14.1	54.9	6.0	7.6
	98 Percentile	14.5	56.1	7.0	7.9
AQ5 Sarai Village	Min	19.1	54.3	5.0	8.1
	Max	21.8	57.1	6.2	10.6
	Average	20.5	55.4	5.5	9.4
	98 Percentile	21.8	57.1	6.2	10.5
AQ6 Khajuriha Village	Min	14.7	38.0	4.7	9.0
	Max	17.4	41.6	5.5	10.6
	Average	16.2	39.8	5.1	9.9
	98 Percentile	17.4	41.6	5.5	10.5
AQ7/ Badodia Jagir	Min	14.7	38.0	4.7	9.0
	Max	17.4	41.6	5.5	10.6
	Average	16.2	39.8	5.1	9.9
	98 Percentile	17.4	41.6	5.5	10.5
AQ8/ Pipliya Dhakad	Min	14.7	38.0	4.7	9.0
	Max	17.4	41.6	5.5	10.6
	Average	16.2	39.8	5.1	9.9
	98 Percentile	17.4	41.6	5.5	10.5
Permissible Limit	24 h NAAQS 2009	60	100	80	80

Monsoon

Monitoring Location	Jul-18	Parameters ($\mu\text{g}/\text{m}^3$)			
		PM _{2.5}	PM ₁₀	SOx	NOx
AQ 1 Bhadeli Village	Min	8.8	27.7	3.5	6.2
	Max	10.9	30.4	4.0	7.3
	Average	9.8	29.0	3.7	6.8
	98 Percentile	10.8	30.4	4.0	7.2
AQ2 Jalpani Village	Min	8.1	23.3	2.8	4.9
	Max	9.7	26.3	3.5	5.4
	Average	8.9	24.9	3.2	5.2
	98 Percentile	9.6	26.2	3.5	5.4
AQ3 Chamrach	Min	12.1	25.9	3.4	4.8
	Max	13.5	29.5	4.1	5.6
	Average	12.7	28.0	3.7	5.2
	98 Percentile	13.4	29.4	4.1	5.6
AQ4 Niwas	Min	13.7	23.9	4.2	5.1
	Max	15.1	27.8	5.2	5.8
	Average	14.3	25.8	4.7	5.5
	98 Percentile	15.1	27.7	5.1	5.8
AQ5 Sarai Village	Min	18.1	42.0	5.2	7.3
	Max	21.5	45.4	6.0	8.3
	Average	20.2	43.7	5.6	7.8
	98 Percentile	21.5	45.3	6.0	8.3
AQ6 Khajuriha Village	Min	15.9	3.5	4.4	7.6
	Max	17.6	36.4	5.2	9.2
	Average	16.8	31.3	4.8	8.2

	98 Percentile	17.6	36.4	5.1	9.1
AQ7/ Badodia Jagir	Min	21.9	51.3	6.8	10.8
	Max	27.1	57.2	8.4	12.3
	Average	24.3	54.9	7.5	11.5
	98 Percentile	27.0	57.2	8.4	12.3
AQ8/ Pipliya Dhakad	Min	15.8	40.7	6.0	9.1
	Max	19.6	47.8	7.3	11.4
	Average	18.2	45.1	6.8	10.3
	98 Percentile	19.6	47.7	7.3	11.4
Permissible Limit	24 h NAAQS 2009	60	100	80	80

3.4.6 Noise & Traffic Monitoring

3.4.6.1 Noise Levels

While some part of data on sound pressure Level monitoring was provided by Madhya Pradesh Pollution Control Board, Regional Laboratory, Bhopal however most of the data on noise was generated during field surveys using digital sound level meter during day and night to establish baseline.

Monitoring locations were selected keeping in view the project activity area along the roadside and the location of receptors. The monitoring was carried out during Day time (7.00 am to 10.00 pm) and Night time (from 10.00 pm to 12.00 am and from 5 am to 7 am). The exercise was carried out for 6 to 8 h in the said time frame of day and night. The monitoring was carried out at 8 locations (refer **Figure 3.12**). From the data on sound pressure levels equivalent levels (Leq) for day time, night time as well as day-night average were calculated using equation given in CPCB protocol. From these day and night values, day-night averages were also calculated using the same CPCB protocol.

The noise level monitoring locations and equivalent levels are given in (**Table 3.10**).

Noise Levels were compared with the Ambient Air Quality Standard in respect of Noise, given in Schedule as part of The Noise Pollution (Regulation and Control) Rules, 2000 (amended to date). It can be seen from the table that noise levels in the study area are within the threshold levels prescribed by CPCB as major source of noise in the study area is vehicular movement only.

Table 3.10: Equivalent Noise levels (Leq dB(A) in the study area

Site Code/ Monitoring location	Leq Day dB(A)	Leq Night dB(A)	Leq Day - Night dB(A)	Leq Day dB(A)	Leq Night dB(A)	Leq Day - Night dB(A)	Leq Day dB(A)	Leq Night dB(A)	Leq Day - Night dB(A)	CPCB Limits	
										Day	Night
	Winter			Pre-monsoon			Monsoon				
NT1 Dam	47	35	46.6	52	44	52.8	52	41	51.4	55	45

Site Code/ Monitoring location	Leq Day dB(A)	Leq Night dB(A)	Leq Day - Night dB(A)	Leq Day dB(A)	Leq Night dB(A)	Leq Day - Night dB(A)	Leq Day dB(A)	Leq Night dB(A)	Leq Day - Night dB(A)	CPCB Limits	
										Day	Night
	Winter			Pre-monsoon			Monsoon				
site/Rensi village											
NT2 Fatehpur	44	25	42.6	54	41	53	53	40	52.2	55	45
NT3 Mahuakheda	52	45	53.2	49	42	50.5	54	41	52.6	55	45
NT4 Gva	46	44	50.9	51	40	50.9	54	42	53	55	45
NT5 Lasudia haji	48	33	46.5	48	41	49.1	52	41	51.9	55	45
NT6 Barkheda Bir	47	40	48.5	47	44	50.1	53	42	52.5	55	45
NT7 Badodia Jagir	45	41	48.1	54	40	53.3	51	40	50.9	55	45
NT8 Pipliya Dhakad	48	41	49.1	49	41	49.6	51	42	51.2	55	45

3.4.6.2 Traffic Density

Traffic density data was recorded by physically counting the number of different types of vehicles passing through a point in a fixed time interval. Some major villages along the road, towns were considered as nodes for monitoring movement of traffic. The analysis of traffic counts provides an estimate of average daily traffic (ADT). To convert recorded vehicles into a common scale, the passenger car units (PCU) equivalent factor as per IRC:64 - 1990 was adopted. The **Table 3.11** reveals that during winters total ADT at Lasudia Haji and Barkheda Bir villages was 204 and 196, respectively during winter in terms of number which translates into 243 and 255, respectively in terms of PCU. During pre-monsoon and monsoon surveys ADT in terms of PCU was highest at Badodia Jagir. Looking at the total volume of traffic at different locations the vehicular traffic movement is generally low to medium.

Table 3.11: Average Daily Traffic in the study area

Site/Monitoring location	Winter			PCUs	Pre-monsoon			PCUs	Monsoon			PCUs
	HMV	LMV	TW		HMV	LMV	TW		HMV	LMV	TW	
NT1 Dam site/Rensi village	21	77	68	213	2	11	28	37	3	10	21	35
NT2 Fatehpur	27	81	77	241	11	32	42	102	17	37	45	129
NT3 Mahuakheda	31	63	50	213	8	25	34	79	11	15	32	72
NT4 Gva	33	63	90	239	13	27	31	95	8	26	33	80
NT5 Lasudia haji	24	81	99	243	11	23	38	87	9	20	37	76
NT6 Barkheda Bir	34	72	90	255	23	49	45	165	17	48	53	150

NT7 Badodia Jagir	32	77	68	246	22	65	41	184	21	51	61	170
NT8 Pipliya Dhakad	36	72	81	257	17	44	52	143	17	37	44	129

HMV= Heavy Motor Vehicle; LMV= Light Motor Vehicle; TW= Two Wheelers

NOISE AND TRAFFIC MONITORING IN THE STUDY AREA



3.4.6.3 Conclusion

As seen from the results of ambient air quality monitoring the air quality is very good in the study area and noise levels are also well within permissible limits as per CPCB standards. This is mainly due to absence of any industrial establishment and low to moderate volume of traffic in the study area.

3.4.7 Water Environment

The data on water quality has been collected to:

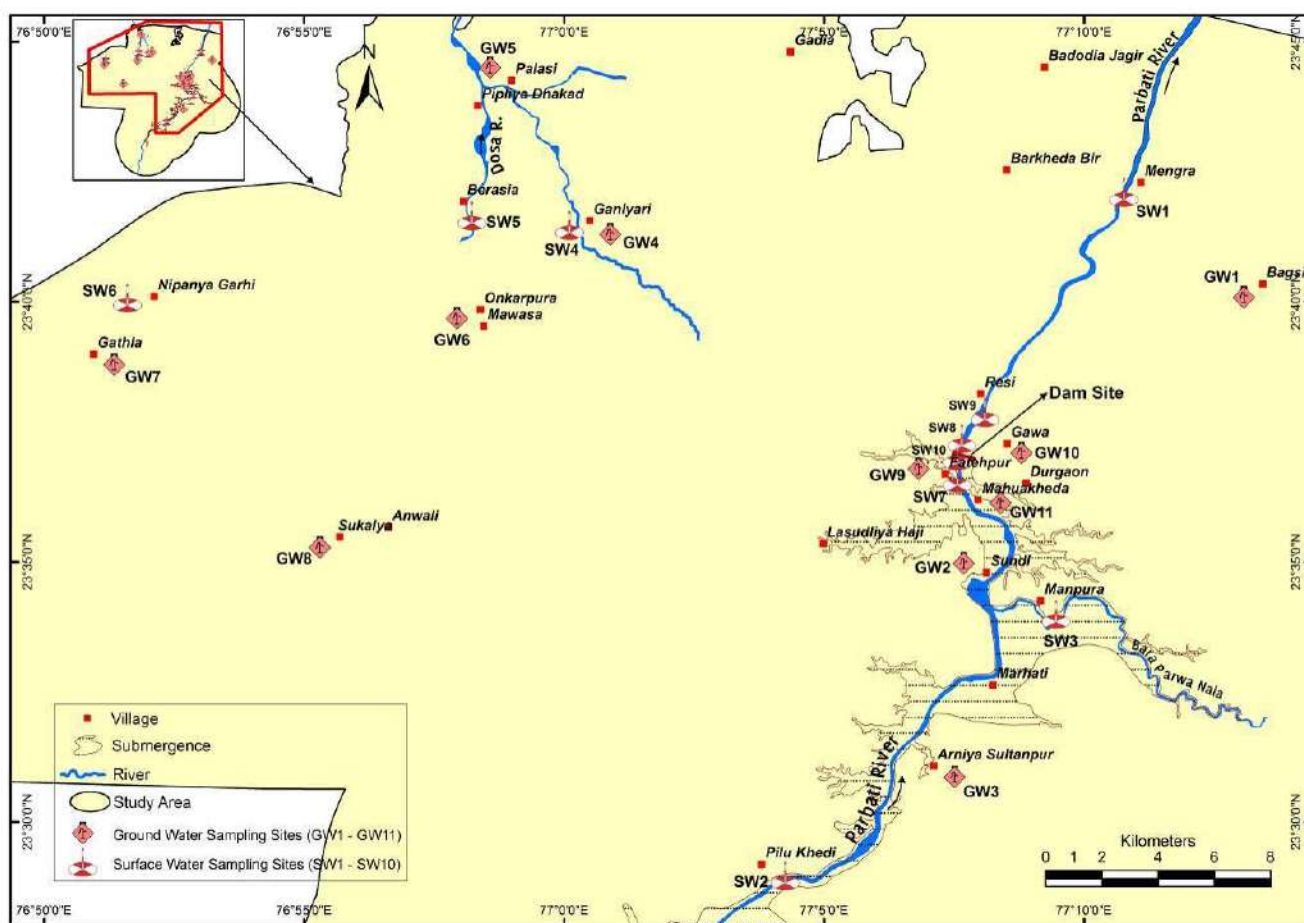
- Assess the ground water quality in the study area
- Assess the surface water quality for river and few streams/ponds in the study area of water conductor system

3.4.7.1 Surface Water Quality

Surface water sampling was done at 10 locations and the names of sites are given in table below and their location is marked on map given at **Figure 3.13**.

Table 3.12: Surface water quality sampling locations

Site Code	Location	Source
SW1	Mengra village	Parbati river
SW2	Pilu Khedi village	Parbati river
SW3	Manpura	Nala
SW4	Ganlyari village	Nala
SW5	Berasiya	Dosa river
SW6	Nipaniya Garhi village	Pond
SW7	Fatehpur	Parbati river
SW8	D/s of Dam site	Parbati river
SW9	Gva village	Parbati river
SW10	Near Dam site	Parbati river

**Figure 3.13: Map of study area showing location of Surface water and Ground water sampling sites**

The pH varied from 7 to 8.1 during these monitoring studies. The EC varied from low of 150 to highest of 328.4 ($\mu\text{S}/\text{cm}$) at site located downstream of dam in Parbati river (SW8) in pre-monsoon. Dissolved oxygen ranged from 6.9 to 7.5 mg/l at all sampling locations. All the heavy metals were either not detectable or are below detectable limits. BOD levels were low and ranged from 1.2 to 2 mg/l only at all sampling locations. COD however ranged from 5.8 to 9.06 mg/l at water samples collected from a Nala near Manpura village

Table 3.13: Physico-Chemical Characteristics of Surface water at different sampling locations in different seasons

S. No.	Parameters	SW1			SW2			SW3			SW4			SW5		
		W	PM	M	W	M	W	PM	PM	M	W	PM	M	W	PM	M
1	Temperature (°C)	27.5	28.2	27.9	26.2	27.9	26.2	27	28.0	27.1	28.8	27.0	26.6	25.5	27.0	26.3
2	pH	7.4	7.6	7.5	7.8	7.8	7.5	7.2	7.5	7.6	8.1	7.5	7.4	7.0	7.0	7.0
3	Dissolved Oxygen (mg/l)	7.15	7.3	7.2	7.2	7.3	7.29	7.4	7.3	7.2	7.3	7.4	7.3	7.2	7.3	7.2
4	Electrical Conductivity (µS/cm)	263	268.3	265.7	285.0	163.6	320	326.4	290.7	287.9	162.0	165.2	323.2	258.0	263.2	260.6
5	Total Dissolved Solids (mg/l)	156	163.8	159.9	173.0	100.5	195.2	205	181.7	177.4	98.0	102.9	200.1	157.0	164.9	161.0
6	Turbidity (NTU)	5.6	5.9	5.8	6.8	2.9	4.2	4.4	7.1	7.0	2.8	2.9	4.3	6.2	6.5	6.4
7	Total Suspended Solids (mg/l)	15.7	15.2	15.5	14.6	5.9	14.8	14.4	14.2	14.4	6.0	5.8	14.6	13.8	13.4	13.6
8	Chloride (as Cl) (mg/l)	60.4	58.6	59.5	72.4	41.4	74.8	72.6	70.2	71.3	42.0	40.7	73.7	78.9	76.5	77.7
9	Alkalinity (mg/l)	30.9	30	30.5	51.0	62.1	44	42.7	49.5	50.3	63.0	61.1	43.4	45.5	44.1	44.8
10	Total Hardness (mg/l)	95.8	91	93.4	145.4	91.3	83.2	79	138.1	141.8	93.6	88.9	81.1	157.3	149.4	153.4
11	Calcium (as Ca) (mg/l)	21.6	20.5	21.1	38.8	21.9	18.2	17.3	36.9	37.9	22.4	21.3	17.8	35.7	33.9	34.8
12	Magnesium (as Mg) (mg/l)	10.2	9.7	10.0	11.8	8.9	9.2	8.7	11.2	11.5	9.2	8.7	9.0	16.6	15.8	16.2
13	Nitrate (NO ₃) (mg/l)	3.2	3.3	3.3	3.4	4.3	2.4	2.5	3.5	3.5	4.2	4.3	2.5	4.2	4.3	4.3
14	Phosphate (as PO ₄) (mg/l)	0.1	0.1	0.1	0.1	0.1	0.15	0.15	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1
15	Sulphate (SO ₄) (mg/l)	14.2	14.6	14.4	34.3	19.6	20.4	21	35.3	34.8	19.3	19.9	20.7	20.4	21.0	20.7
16	Silicon Dioxide (mg/l)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0

S. No.	Parameters	SW1			SW2			SW3			SW4			SW5		
		W	PM	M	W	M	W	PM	PM	M	W	PM	M	W	PM	M
17	Silicate (Si) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
18	Sodium (mg/l)	30	30.9	30.5	40.0	22.5	32	33	41.2	40.6	22.1	22.8	32.5	44.0	45.3	44.7
19	Sodium Adsorption Ratio	1.33	1.4	1.4	1.4	1.0	1.52	1.6	1.5	1.5	1.0	1.0	1.6	1.5	1.6	1.6
20	Potassium (mg/l)	1.4	1.45	1.4	1.4	1.4	1.2	1.2	1.4	1.4	1.4	1.4	1.2	2.0	2.0	2.0
21	Phenolic Compounds (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
22	Oil & Grease (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
23	Iron (Fe) (mg/l)	0.07	0.07	1.07	0.1	0.1	0.05	0.05	0.1	0.1	0.1	0.1	0.07	0.09	0.08	0.09
24	Cadmium (Cd) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
25	Arsenic (As) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
26	Mercury (Hg) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
27	Copper (Cu) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
28	Zinc (Zn) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
29	Total Chromium (Cr) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
30	Chromium-6 (Cr-6) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
31	Manganese (Mn) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
32	Lead (Pb) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
33	Biological Oxygen	1.32	1.36	1.3	1.3	1.8	1.85	1.91	1.3	1.3	1.8	1.9	1.9	1.2	1.3	1.3

S. No.	Parameters	SW1			SW2			SW3			SW4			SW5		
		W	PM	M	W	M	W	PM	PM	M	W	PM	M	W	PM	M
	Demand (mg/l)															
34	Chemical Oxygen Demand (mg/l)	7.6	7.83	7.7	5.8	6.0	8.8	9.06	6.0	5.9	5.9	6.1	8.9	6.2	6.4	6.3
35	Total Coliform (MPN/100ml)	170	175	172.5	172.0	124.0	84	87	177.0	174.5	122.0	126.0	85.5	160.0	165.0	162.5

S. No.	Parameters	SW6			SW7			SW8			SW9			SW10		
		W	PM	M	W	PM	M	W	PM	M	W	PM	M	W	PM	M
1	Temperature (°C)	29.9	28	29	28.1	29	28.6	27.2	28	27.6	28	29	28.5	29	29.5	29.25
2	pH	7.9	7.9	7.9	7.8	7.8	7.8	7.3	7.3	7.3	7.3	7.3	7.3	7.6	7.6	7.6
3	Dissolved Oxygen (mg/l)	7.1	7.3	7.2	7.4	7.5	7.5	6.9	7	7	7.1	7.2	7.2	7.2	7.3	7.25
4	Electrical Conductivity (µS/cm)	150	153	151.5	310	316.2	313.1	322	328.4	325.2	265	270.3	267.7	275	280.5	277.75
5	Total Dissolved Solids (mg/l)	91.5	96.1	93.8	189.1	198.6	193.9	196	205.8	200.9	159	167	163	173	181.7	177.35
6	Turbidity (NTU)	3.8	4	3.9	3	3.2	3.1	7.8	8.2	8	9.8	10.3	10.1	7.5	7.9	7.7
7	Total Suspended Solids (mg/l)	8	7.8	7.9	6	5.8	5.9	12.9	12.5	12.7	13.5	13.1	13.3	15.5	15	15.25
8	Chloride (as Cl) (mg/l)	42.9	41.6	42.3	42	40.7	41.4	63.5	61.6	62.6	62.9	61	62	58.5	56.7	57.6
9	Alkalinity (mg/l)	52.4	50.8	51.6	67	65	66	53.5	51.9	52.7	50	48.5	49.3	61	59.2	60.1
10	Total Hardness (mg/l)	116.3	110.5	113.4	93.6	88.9	91.3	157.3	149.4	153.4	145	137.8	141.4	97	92.2	94.6
11	Calcium (as Ca) (mg/l)	25.7	24.4	25.1	22.4	21.3	21.9	36.7	34.9	35.8	35.8	34	34.9	23.4	22.2	22.8
12	Magnesium (as Mg) (mg/l)	12.7	12.1	12.4	9.2	8.7	8.9	17.6	16.7	17.2	11.5	10.9	11.2	9.8	9.3	9.55
13	Nitrate (NO ₃)	5.2	5.4	5.3	4.2	4.3	4.3	3.4	3.5	3.5	3.2	3.3	3.3	3.8	3.9	3.85

S. No.	Parameters	SW6			SW7			SW8			SW9			SW10		
		W	PM	M	W	PM	M	W	PM	M	W	PM	M	W	PM	M
	(mg/l)															
14	Phosphate (as PO ₄) (mg/l)	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.13	0.13	0.13
15	Sulphate (SO ₄) (mg/l)	38.4	39.6	39	19.3	19.9	19.6	19.3	19.9	19.6	38.4	39.6	39	19.3	19.9	19.6
16	Silicon Dioxide (mg/l)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
17	Silicate (Si) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
18	Sodium (mg/l)	28.5	29.4	29	22.1	22.8	22.5	22.1	22.8	22.5	28.5	29.4	29	22.1	22.8	22.45
19	Sodium Adsorption Ratio	1.2	1.2	1.2	1	1	1	1.5	1.6	1.6	1.4	1.5	1.5	0.99	1	0.995
20	Potassium (mg/l)	1.6	1.6	1.6	1.4	1.4	1.4	2	2	2	1.4	1.4	1.4	1.4	1.4	1.4
21	Phenolic Compounds (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
22	Oil & Grease (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
23	Iron (Fe) (mg/l)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.08	0.08	0.08
24	Cadmium (Cd) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
25	Arsenic (As) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
26	Mercury (Hg) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
27	Copper (Cu) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
28	Zinc (Zn) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
29	Total Chromium (Cr) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
30	Chromium-6 (Cr-6) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

S. No.	Parameters	SW6			SW7			SW8			SW9			SW10		
		W	PM	M	W	PM	M	W	PM	M	W	PM	M	W	PM	M
31	Manganese (Mn) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
32	Lead (Pb) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
33	Biological Oxygen Demand (mg/l)	1.2	1.3	1.2	1.9	2	1.9	1.5	1.5	1.5	1.3	1.3	1.3	1.8	1.85	1.825
34	Chemical Oxygen Demand (mg/l)	8.2	8.5	8.3	6.6	6.8	6.7	6.2	6.4	6.3	7.5	7.7	7.6	6.2	6.39	6.295
35	Total Coliform (MPN/100ml)	210	216	213	88	91	89.5	165	170	167.5	160	165	162.5	154	159	156.5

W=Winter; PM=Pre-monsoon: M=Monsoon

(SW3) during pre-monsoon sampling. Total coliform count was quite high i.e. between 86 and 216 MPN/100 ml with 150 MPN/100ml on average at all sampling sites.

Surface water quality of all the samples collected during winter, Pre-Monsoon and monsoon season was compared with the Water Quality Criteria of Central Pollution Control Board (http://www.cpcb.nic.in/Water_Quality_Criteria.php) (Table 3.14). None of the samples fall under Class 'A' with designated best use as drinking water source due to total coliform count is more than 50 MPN/100 ml in all samples collected during different season.

The surface water in the study area at all the locations fall under Class 'B' i.e. designated best use of outdoor bathing (organized) according to CPCB, Water Quality Criteria. This is because of higher count of total coliform i.e. more than 50 MPN/100 ml but is 500 MPN/100 ml, DO is more than 5 mg/l and BOD is less than 3 mg/l.

Table 3.14: Water Quality Criteria for designated Best Use by CPCB, New Delhi

Designated-Best-Use	Class of water	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	Total Coliforms Organism MPN/100ml shall be 50 or less
		pH between 6.5 and 8.5
		Dissolved Oxygen 6mg/l or more
		Biochemical Oxygen Demand 5 days 20°C 2mg/l or less
Outdoor bathing (Organised)	B	Total Coliforms Organism MPN/100ml shall be 500 or less, pH between 6.5 and 8.5, Dissolved Oxygen 5mg/l or more
		Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	Total Coliforms Organism MPN/100ml shall be 5000 or less, pH between 6 and 9, Dissolved Oxygen 4mg/l or more
		Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Propagation of Wild life and Fisheries	D	pH between 6.5 to 8.5, Dissolved Oxygen 4mg/l or more
		Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	pH between 6.0 and 8.5
		Electrical Conductivity at 25°C micromhos/cm Max.2250
		Sodium Absorption Ratio Max. 26
		Boron Max. 2mg/l
	Below-E	Not Meeting A, B, C, D & E Criteria

Irrigation Water Quality is mainly assessed as a function of the level of certain quality parameters. The various parameters for determining irrigation water

quality can be categorized into the following major groups: (a) salinity hazard and (b) permeability and infiltration problems. The two most common water quality factors that influence the normal rate of infiltration of water are the salinity of water and the relative concentrations of sodium, magnesium and calcium ions in water that is also known as the sodium adsorption ratio (SAR). Irrigation water quality developed by Simsek and Gunduz (2007) based upon parameters that can have negative impact on soil quality and crop yield.

Sodium Adsorption Ratio (SAR) is an irrigation water quality parameter used in the management of sodium-affected soils. It is calculated using Sodium, Calcium and Magnesium concentrations expressed in meq/L. At a given SAR, the infiltration rate increases as salinity increases or the other way around. Therefore, the SAR and EC are used in combination to evaluate potential problems. All the samples from the study area have SAR below 10. Based on the classification given by Todd, 1959; SAR values from the study area is categorized as excellent class.

In the present study, Electrical conductivity values varied between 150 $\mu\text{S}/\text{cm}$ and 328.4 $\mu\text{S}/\text{cm}$ while SAR varied from 0.99 to 1.6 (see **Table 3.15**). All the samples from the study area have SAR below 10. Based on the classification given by Todd, 1959; SAR values in the study area is grouped as excellent class and there are no management concerns (**Table 3.15**).

Table 3.15: Classification of Water Based on SAR Values (Todd, 1959)

SAR Value	Water Quality
<10	Excellent
10-18	Good
19-26	Doubtful
>26	Unsuitable

Classification for infiltration and permeability parameters for Irrigation water suitability

	SAR					Rating	Suitability
	<3	3 – 6	6 – 12	12– 20	>20		
EC ($\mu\text{S}/\text{cm}$)	>700	>1200	>1900	>2900	>5000	3	High
	700-200	1200-300	1900-500	2900-1300	5000 - 2900	2	Medium
	<200	<300	<500	<1300	<2900	1	Low

(Source: Simsek and Gunduz, 2007; Spandana *et al.* 2013)

As seen from the **Table 3.15** suitability of water for irrigation is High in general.

3.4.7.2 Ground Water Quality

Partial data on Ground water monitoring data was provided by Madhya Pradesh Pollution Control Board. However, during field surveys ground water quality assessment was done during field surveys by collecting water samples from 11 locations in the study area. The samples were collected from hand pumps (HP), well and tube wells (TW) in the study area (**Table 3.16**). The names of sampling points have been shown in table below and their location in the study area is given at **Figure 3.13**.

Table 3.16: Ground water sampling locations

Code	Monitoring Location	Source
GW1	Bagsi village	Handpump
GW2	Sundi village	Handpump
GW3	Arnia Sultanpur	Handpump
GW4	Ganlyari	Tube-well
GW5	Palasi	Handpump
GW6	Onkarpura	Handpump
GW7	Gathla	Handpump
GW8	Sukhleya	Handpump
GW9	Fatehpur	Handpump
GW10	Gva	Handpump
GW11	Mahuakhedi	Handpump

Table 3.17: Physico-Chemical Characteristics of Ground Water
(Winter)

S. No.	Parameters	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	GW11	Permissible Limits (IS 10500:2012)
1	Temperature (°C)	23.1	24.3	24.4	25.2	26.2	25.3	27.1	27.9	28.1	26.7	29.5	-
2	pH	7.2	7.5	7.2	7.7	7.7	7.6	7.7	7.9	7.2	7.6	7.9	6.5-8.5
4	Electrical Conductivity (µS/cm)	188	263	164	176	203	212	238	217	208	218	250	-
5	Total Dissolved Solids (mg/l)	114	138	102	106	127	115	149	122	118	116	156	2000
6	Chloride (as Cl) (mg/l)	30	25	32	29	30	34	34.2	34.9	36.4	32.3	29.4	1000
7	Total Alkalinity (mg/l)	25.6	14.5	22.3	25.7	20.6	24	97.4	25.3	28	28.4	24	600
8	Total Hardness (as CaCO ₃) (mg/l)	35.45	69.05	94.18	50.8	68.41	90.06	69.89	69.97	49.1	23.6	31.9	600
9	Calcium (as Ca) (mg/l)	24.5	30.4	25.6	46.7	38.5	40.6	34.5	24.8	29.3	23.2	21.6	200
10	Magnesium (as Mg) (mg/l)	12	10.5	9.8	20.5	17.6	21.6	20.4	11.7	18.5	16	19	100
11	Sulphate (SO ₄) (mg/l)	4.7	6.3	6.5	9.5	7.5	8	8.4	5.4	6.4	9.3	4.2	400
12	Nitrate (NO ₃) (mg/l)	1.2	0.8	1.2	0.8	0.9	0.8	0.5	0.7	1.1	0.4	0.3	45
13	Phosphate (as PO ₄) (mg/l)	0.012	0.02	0.012	0.011	0.08	0.015	0.08	0.06	0.014	0.05	0.07	-
14	Sodium (mg/l)	45	38	48	50	55	43	42	38	40	38	42	-
15	Potassium (mg/l)	0.4	0.4	0.8	1.2	0.5	0.4	1	0.8	0.8	0.8	0.1	-
16	Silicate (Si) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-
17	Salinity (mg/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
18	Iron (Fe) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.3
19	Phenolic Compounds (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.002
20	Oil & Grease (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-
21	Residual Sodium Carbonate (meq/l)	1.1	1.15	1.2	1.12	1.16	1.13	1.13	1.15	1.14	1.14	1.13	-
22	Cadmium (Cd) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.003
23	Arsenic (As) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.05
24	Mercury (Hg) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.001
25	Copper (Cu) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.5
26	Zinc (Zn) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	15
27	Total Chromium (Cr) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.05

S. No.	Parameters	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	GW11	Permissible Limits (IS 10500:2012)
28	Chromium-6 (Cr-6) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-
29	Manganese (Mn) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.3

BDL= Below Detectable Limits

(Summer : Pre-monsoon)

S. No.	Parameters	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	GW11	Permissible Limits (IS 10500:2012)
1	Temperature (°C)	22.4	23.6	23.7	24.4	25.4	24.5	26.3	27.1	27.3	25.9	28.6	-
2	pH	7.1	7.4	7.1	7.6	7.6	7.5	7.6	7.8	7.1	7.5	7.8	6.5-8.5
4	Electrical Conductivity (µS/cm)	191.76	268.26	167.28	179.52	207.06	216.24	242.76	221.34	212.16	222.36	255	-
5	Total Dissolved Solids (mg/l)	116.3	140.8	104.0	108.1	129.5	117.3	152.0	124.4	120.4	118.3	159.1	2000
6	Chloride (as Cl) (mg/l)	30.6	25.5	32.64	29.58	30.6	34.68	34.884	35.598	37.128	32.946	29.988	1000
7	Total Alkalinity (mg/l)	27	15	23	27	22	25	102	27	29	30	25	600
8	Total Hardness (as CaCO ₃) (mg/l)	34.4	67.0	91.4	49.3	66.4	87.4	67.8	67.9	47.6	22.9	30.9	600
9	Calcium (as Ca) (mg/l)	23.8	29.5	24.8	45.3	37.3	39.4	33.5	24.1	28.4	22.5	21.0	200
10	Magnesium (as Mg) (mg/l)	11.6	10.2	9.5	19.9	17.1	21.0	19.8	11.3	17.9	15.5	18.4	100
11	Sulphate (SO ₄) (mg/l)	4.5	6.0	6.2	9.0	7.1	7.6	8.0	5.1	6.1	8.8	4.0	400
12	Nitrate (NO ₃) (mg/l)	1.14	0.76	1.14	0.76	0.855	0.76	0.475	0.665	1.045	0.38	0.285	45
13	Phosphate (as PO ₄) (mg/l)	0.011	0.019	0.011	0.010	0.076	0.014	0.076	0.057	0.013	0.048	0.067	-
14	Sodium (mg/l)	46.4	39.1	49.4	51.5	56.7	44.3	43.3	39.1	41.2	39.1	43.3	-
15	Potassium (mg/l)	0.41	0.41	0.82	1.24	0.52	0.41	1.03	0.82	0.82	0.82	0.10	-
16	Silicate (Si) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-
17	Salinity (mg/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
18	Iron (Fe) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.3
19	Phenolic Compounds (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.002
20	Oil & Grease (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-
21	Residual Sodium Carbonate (meq/l)	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	-
22	Cadmium (Cd) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.003

S. No.	Parameters	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	GW11	Permissible Limits (IS 10500:2012)
23	Arsenic (As) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.05
24	Mercury (Hg) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.001
25	Copper (Cu) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.5
26	Zinc (Zn) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	15
27	Total Chromium (Cr) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.05
28	Chromium-6 (Cr-6) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-
29	Manganese (Mn) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.3

BDL= Below Detectable Limits

(Monsoon)

S. No.	Parameters	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	GW11	Permissible Limits (IS 10500:2012)
1	Temperature (°C)	22.8	24.0	24.1	24.8	25.8	24.9	26.7	27.5	27.7	26.3	29.1	-
2	pH	7.2	7.5	7.2	7.7	7.7	7.6	7.7	7.9	7.2	7.6	7.9	6.5-8.5
4	Electrical Conductivity (µS/cm)	189.9	265.6	165.6	177.8	205.0	214.1	240.4	219.2	210.1	220.2	252.5	-
5	Total Dissolved Solids (mg/l)	115.2	139.4	103.0	107.1	128.3	116.2	150.5	123.2	119.2	117.2	157.6	2000
6	Chloride (as Cl) (mg/l)	30.3	25.3	32.3	29.3	30.3	34.3	34.5	35.2	36.8	32.6	29.7	1000
7	Total Alkalinity (mg/l)	26.30	14.75	22.65	26.35	21.30	24.50	99.70	26.15	28.50	29.20	24.50	600
8	Total Hardness (as CaCO ₃) (mg/l)	34.93	68.03	92.79	50.05	67.41	88.73	68.85	68.94	48.35	23.25	31.40	600
9	Calcium (as Ca) (mg/l)	24.15	29.95	25.20	46.00	37.90	40.00	34.00	24.45	28.85	22.85	21.30	200
10	Magnesium (as Mg) (mg/l)	11.80	10.35	9.65	20.20	17.35	21.30	20.10	11.50	18.20	15.75	18.70	100
11	Sulphate (SO ₄) (mg/l)	4.60	6.15	6.35	9.25	7.30	7.80	8.20	5.25	6.25	9.05	4.10	400
12	Nitrate (NO ₃) (mg/l)	1.17	0.78	1.17	0.78	0.88	0.78	0.49	0.68	1.07	0.39	0.29	45

S. No.	Parameters	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	GW11	Permissible Limits (IS 10500:2012)
13	Phosphate (as PO ₄) (mg/l)	0.012	0.020	0.012	0.011	0.078	0.015	0.078	0.059	0.014	0.049	0.069	-
14	Sodium (mg/l)	45.7	38.6	48.7	50.8	55.9	43.7	42.7	38.6	40.6	38.6	42.7	-
15	Potassium (mg/l)	0.41	0.41	0.81	1.22	0.51	0.41	1.02	0.81	0.81	0.81	0.10	-
16	Silicate (Si) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-
17	Salinity (mg/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
18	Iron (Fe) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.3
19	Phenolic Compounds (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.002
20	Oil & Grease (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-
21	Residual Sodium Carbonate (meq/l)	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	-
22	Cadmium (Cd) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.003
23	Arsenic (As) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.05
24	Mercury (Hg) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.001
25	Copper (Cu) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.5
26	Zinc (Zn) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	15
27	Total Chromium (Cr) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.05
28	Chromium-6 (Cr-6) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-
29	Manganese (Mn) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.3

BDL= Below Detectable Limits

The pH of ground water samples collected varied from 7.1 to 7.9. Electrical Conductivity varied from low of 164 to highest of 268.26 ($\mu\text{S}/\text{cm}$). Total dissolved solids varied from 102 to 159.1 mg/l. All the heavy metals were either not detectable or below detectable limits. The concentrations of Nitrate, Phosphorus and Sulphate were also low.

Analysis results of ground water samples were compared with drinking water standards IS-10500:2012 to assess the status of ground water taken from tube wells and hand pumps as this water is used for drinking purpose in villages. All the samples were found within permissible limits as per drinking water standards prescribed by CPCB.

In addition to the above Water Quality Index developed for ground water quality by Tiwari & Mishra (1985) and Singh and Hussain (2016) was also used to assess the ground water quality in the study area. It is based upon key parameters like Total Dissolved Solids, Chlorides, Sulphate, Nitrate, Calcium, Magnesium, Sodium, Potassium and pH. Based upon WQI range calculated based formula using parameters they have categorized the ground water into different groups as follows:

WQI range	Water Quality
<50	Excellent water
50-100	Good water
100-200	Poor water
200-300	Very poor water
>300	Water unsuitable for drinking purpose

The WQI calculated for ground water samples collected from different locations in the study area is given in table below.

Ground Water Quality Index

Site	Winter	Pre-monsoon	Monsoon
GW1	6.31	6.32	6.31
GW2	6.08	6.08	6.09
GW3	6.37	6.38	6.38
GW4	8.24	8.21	8.23
GW5	8.11	8.11	8.12
GW6	7.72	7.69	7.71
GW7	7.61	7.60	7.61
GW8	6.00	6.00	6.00
GW9	6.95	6.92	6.93
GW10	6.24	6.23	6.24
GW11	6.66	6.67	6.25

According to WQI tabulated in table above all the ground water samples fall in Excellent ground water quality class.

Collection of Water Samples



3.4.7.3 Conclusion

The water quality in the study area in general is good. Except for agricultural activities there are no sources of pollution of water bodies in the area. Summary of the same is as follows:

- According to BIS standards for Drinking Water (2012) all the ground water samples collected from the study area fall within permissible limits of the same.
- According to WQI all the ground water samples fall in Excellent ground water quality class.
- All the samples of surface water qualify for **Class 'B'** i.e. designated best use of outdoor bathing (organized) according to Water Quality Criteria of Central Pollution Control Board.

3.4.8 Land use/Land cover

For the preparation of land use/ landcover map of the study area, digital data on land use/landcover maps prepared by National Remote Sensing Centre (NRSC), Indian Space Research Organisation (ISRO) of Dept. of Space with Remote Sensing Applications Centre, MP Council of Science & Technology as partner were downloaded from their web portal <http://bhuvan.nrsc.gov.in/gis/thematic/index.php>. The raster data thus downloaded was processed in GIS environment for further refinement using information from Landsat 8 data as well as Google Earth. The Landsat 8 satellite data of Path 146 Row 44 dated 25.04.2018 was downloaded from <https://earthexplorer.usgs.gov/>. From Landsat 8 OLI TIRS data False Color Composite (FCC) of the study area was generated using bands 3, 4 and 5 and the same is given at **Figure 3.14**.

The land use/ land cover map of study area is shown at **Figure 3.15**. Agriculture land constitutes predominant land use in the command area (see **Figure 3.14 & Table 3.18**). As seen from the table agriculture is the main land use in the area. Little more than 6% of the study area is under forest comprised of Open Deciduous and Scrub forest which is mainly found in area around the Narsingh wildlife Sanctuary.

Table 3.18: Area under different land use/ land cover classes in the Study Area

Land use/ land cover	Area (ha)	Area (%)
Deciduous Forest	9577.45	5.14
Scrub Forest	3070.55	1.65
Scrub Land	8962.82	4.81
Barren Land	204.01	0.11
Agricultural/ Fallow	158222.54	84.97

Land use/ land cover	Area (ha)	Area (%)
Land		
Settlement	2274.69	1.22
Waterbody	3900.85	2.09
Total	186212.92	100

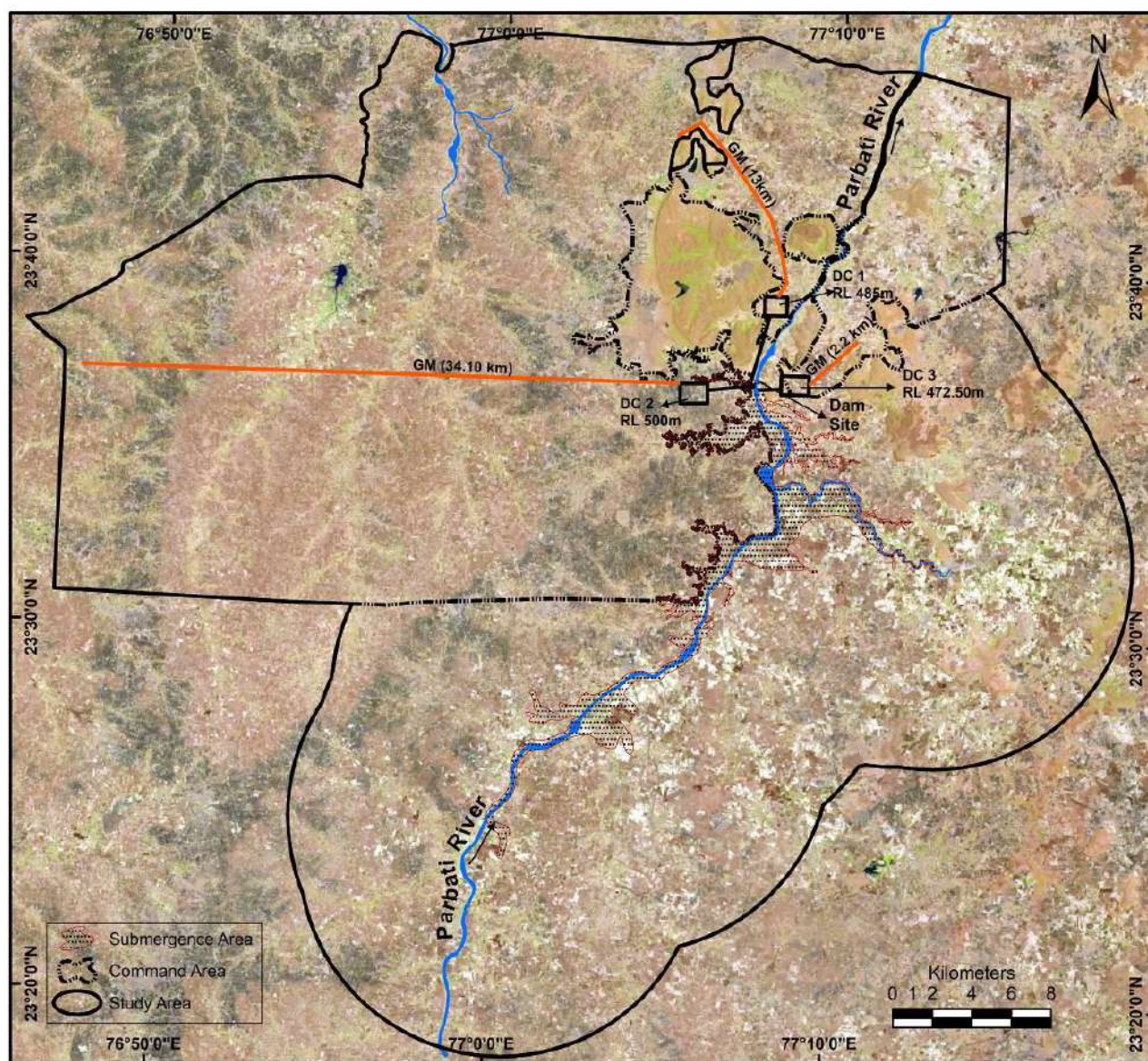


Figure 3.14: FCC generated from Satellite imagery of the study area

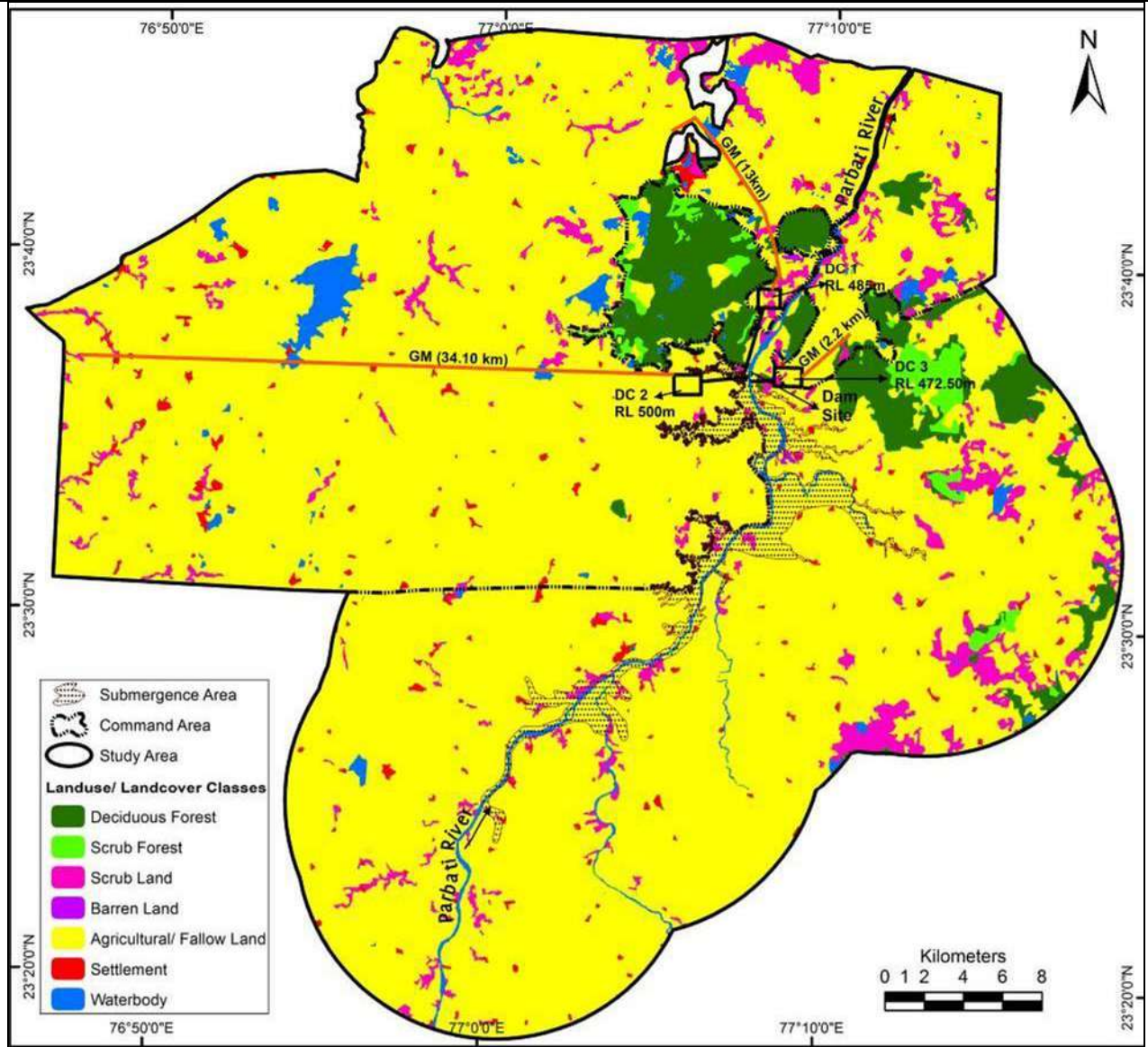


Figure 3.15: Land Use/ Land Cover Map of the study area

Landscape and Vegetation Profile in the Study Area





3.5 BIOLOGICAL ENVIRONMENT

3.5.1 Forest Types in the Study Area

As seen from the land use map of the study area, large part of vegetation is comprised of forests especially in area upstream of dam and surrounding submergence area. These forests in the study area can be classified in accordance with the 'A Revised Survey of the Forest Types of India' by Champion and Seth (1968) fall under Group 5. Tropical Dry Deciduous Forest type with 3 forest types and the same is given in **Table 3.19**. Forest areas in the study area fall under Rajgarh, Bhopal and Sehore Forest Divisions under Bhopal Circle.

Table 3.19: Forest types found in the Study area

Group	Sub-Group	Forest Type
5. Tropical Dry Deciduous Forests	5A. Southern Tropical Dry Deciduous Forests	5A/C1b: Dry teak forest 5A/C3: Southern Mixed Deciduous Forest 5/DS1: Dry deciduous scrub forest

5A/C1b - Dry teak Forest

These types of forest occur on shallow porous soils. Teak (*Tectona grandis*) is the major component of this forest type. Other important associated species are *Anogeissus latifolia*, *Diospyros tomentosa*, *Pterocarpus marsupium*, *Dalbergia latifolia*, *Cassia fistula*, *Butea monosperma*, *Ziziphus xylopyrus* and *Haldina cordifolia*. Shrubs are comprised of species like *Senna tora*, *Euphorbia* spp., *Justicia adhatoda*, *Aristida* spp., *Heteropogon contortus* and *Dichanthium annulatum* are common herbaceous elements in this forest.

5A/C3 – Southern mixed deciduous forest

Terminalia tomentosa, *Anogeissus latifolia*, *Diospyros tomentosa*, *Boswellia serrata*, *Hardwickia binata* and *Buchanania cochinchinensis* are common associations found in this forest type. *Senna tora*, *Achyranthes aspera*, *Abutilon indicum*, *Corchorus* spp., *Ocimum* spp. and grasses like *Apluda mutica*, *Aristida* spp., *Chloris barbata*, *Heteropogon contortus*, *Dichanthium annulatum*, etc. are common herbaceous species in this forest type.

5/DS1: Dry deciduous scrub forest

This is the degraded stage of the dry mixed deciduous forests characterized by stunted trees and thorny shrubs. Trees are *Albizia lebeck*, *Dichrostachys cinerea*, *Firmiana simplex* and *Ziziphus jujuba*. Shrubs are *Carissa spinarum*,

Calotropis gigangtea, *Lantana camara*, etc. Herbaceous flora is represented by *Heteropogon contortus*, *Apluda mutica*, *Cymbopogon martini*, *Cyperus rotundus*, *Abutilon indicum*, etc.

3.5.2 Floristics

The objectives of the present floristic study are as follows:

- To prepare an inventory of various plant species found in the study area
- To assess the vegetation composition and community structure in the study area in different land uses

3.5.2.1 Vegetation Profile of the Study Area

Field surveys were undertaken to understand overall vegetation profile and floral resources available in the study area of the proposed project. Administratively the project study area falls in Rajgarh, Sehore and Bhopal districts.

As evident from the land use/ land cover map of the area the project study area is mainly under agricultural farms and settlements. There are very sparse patches of open forests comprised of mixed deciduous forest. Tree species are mostly found near settlements and along the edges of roads outside the sampling area. *Madhuca longifolia* var. *latifolia*, *Azadirachta indica*, *Mangifera indica*, *Aegle marmelos*, *Cassia fistula*, are the frequently found tree species in the command area. Among the agricultural crops, wheat, gram, soybean, pigeon pea, barley, maize, lentil and linseed are most common.

There are number of invasive species which are either weeds of agricultural crop fields or nearby degraded areas near the settlements and as ruderals along roadsides. These are mainly species like *Parthenium hysterophorus*, *Argemone mexicana*, *Achyranthes aspera*, *Lantana camara*, *Xanthium strumarium*, *Echinops echinatus*, *Senna tora*, *Heliotropium indicum*, etc.

3.5.2.2 Species Composition

Field surveys were undertaken to prepare inventory of plant species occurring in the study area. Identification of plants was made with the help of published literature like research papers, reports and with the help of consultation with local people. To document the natural resource utilization pattern in the study area consultations were done with people from the villages located in the area.

As per data collected during field surveys 121 species of flowering plants belonging to 40 families could be identified which occur in the study area. This list includes 62 species of trees, 24 species of shrubs and 35 climbers and herbaceous species. The list of plant species recorded from the study area is

given at **Annexure-VII**. The taxonomic classification and nomenclature are as per www.theplantlist.org accessed in April 2019.

The degraded nature of vegetation in the study area is reflected in dominance of shrub species. Fabaceae is the most dominant family represented by 24 species followed by Poaceae with 11, Apocynaceae (6), Lamiaceae (6), Malvaceae (6), Asteraceae (5), and Euphorbiaceae (5) in the study area.

In addition to flowering plants 5 species of pteridophytes were also recorded from the study area. These are *Diplazium esculentum* (Athyriaceae), *Equisetum diffusum* (Equisetaceae), *Adiantum capillus-veneris*, *Pteris cretica* and *Pteris vittata* (Pteridaceae). These were found mainly in monsoon season.

Among the Bryophytes *Funaria hygrometrica* of Funariaceae, *Lejeunea indica* of Lejeuneaceae, *Marchantia polymorpha* of Marchantiaceae, *Plagiochasma articulatum* of Aytoniaceae and *Riccia robusta* of Ricciaceae were recorded.

3.5.2.3 Rare Threatened and Endangered Species

None of the plant species found in the study area falls under any of the IUCN Red list of Threatened Species Version 2019-1 accessed in April 2019. Majority of the 121 species have not been evaluated or assessed yet by IUCN. All species that have been assessed are under Least Concern category (LC).

3.5.2.4 Economically Important Plant Species

The people of the area use wild plants in their daily life as food, medicine, fiber, vegetables, fruits and various minor forest products. Plant species are used internally for treating Pneumonia, asthma, swelling, dysentery, diarrhea, tumor, fever, typhoid and externally for skin diseases, cuts and boils, etc. List of plant species used for various economic uses was prepared consulting literature viz. "Study of natural dye-yielding plants with its medicinal value in district Rajgarh (MP)" by Ajra Khan and Shail Bala Sanghi and "A Preliminary ethnobotanical survey of Sehore district of Madhya Pradesh" by Bharti Khare. List of economically important plant species found in the study area is given at **Table 3.20**.

Table 3.20: List of commonly used Plant Species for medicinal purposes

S. No.	Family	Scientific name	Common name	Part Used	Uses
1	Acanthaceae	<i>Barleria prionitis</i>	Cutsaeya	Flower	Juice of leaves given with honey in catarrhal infections of children
2	Acanthaceae	<i>Justicia adhatoda</i>	Vasaka	Leaf	In bronchial infection
3	Amaranthaceae	<i>Achyranthes aspera</i>	Chirchitta	Root	Pneumonia
4	Annonaceae	<i>Annona squamosa</i>	Sitaphal		

S. No.	Family	Scientific name	Common name	Part Used	Uses
5	Asteraceae	<i>Tagetes erecta</i>	Genda	Flower	Used in skin infections
6	Asteraceae	<i>Tridax procumbens</i>	Ghav pani	Leaves	Skin disease, cuts and wounds
7	Asteraceae	<i>Xanthium strumarium</i>	Chhota Datura	Leaves	Leaf juice is applied on painful teeth to relieve pain
8	Bombacaceae	<i>Bombax ceiba</i>	Semal	Seeds	For typhoid
9	Combretaceae	<i>Terminalia bellirica</i>	Behra	Fruit	The fruits have antibacterial properties and useful in many diseases
10	Combretaceae	<i>Terminalia arjuna</i>	Arjun	Bark	For cardiovascular diseases & blood pressure
11	Euphorbiaceae	<i>Jatropha curcas</i>	Ratanjot	Bark/Leaves	Used in sciatica, dropsy and paralysis externally for skin disorders and rheumatism
12	Euphorbiaceae	<i>Ricinus communis</i>	Arandi	Seeds	For arthritis, diarrhea & dehydration
13	Fabaceae	<i>Acacia catechu</i>	Khair	Bark	Sore throat and cough
14	Fabaceae	<i>Butea monosperma</i>	Palas	Flower	Bark astringent, used for piles tumor and menstrual disorders
15	Fabaceae	<i>Cassia fistula</i>	Amlatas	Bark	Bark astringent, used for piles tumor, menstrual disorders used for rheumatism
16	Fabaceae	<i>Senna tora</i>	Panwar	Seeds and leaves	For asthma & skin disease
17	Lamiaceae	<i>Ocimum tenuiflorum</i> (Syn. <i>Ocimum sanctum</i>)	Tulsi	Leaves	For earache, nausea & dysentery
18	Lamiaceae	<i>Vitex negundo</i>	Nirgundi	Leaves, roots and flowers	For liver problem & diarrhea
19	Lythraceae	<i>Lawsonia inermis</i>	Heena	Leaf	Used as prophylactic against skin disorder
20	Meliaceae	<i>Azadirachta indica</i>	Neem	Bark	Skin disorders, leaves considered as antiseptic
21	Myrtaceae	<i>Syzygium cumini</i>	Jamun	Bark	Decoction of bark and seeds used in diabetes
22	Phyllanthaceae	<i>Phyllanthus emblica</i>	Aonla	Fruit	Fruit used for Diarrhea and dysentery liver diseases and cough
23	Rutaceae	<i>Aegle marmelos</i>	Bel	Fruit rind	Unripe or half ripe fruit is astringent used as digestive and for curing stomach ache, diarrhea
24	Xanthorrhoeaceae	<i>Aloe vera</i>	Aloe	Whole plant	Fresh juice of leaves is cathartic, and refrigerant used in liver and spleen ailment and for eye infection

3.5.2.5 Community Structure

a) Methodology

Field surveys were undertaken to understand overall vegetation profile and floral resources available in the study area of the proposed project. These surveys were undertaken in seasons to assess the community structure and to prepare inventory of plant species occurring in the study area.

Identification of plants was made with the help of published literature like research papers, reports and with the help of consultation with local people. To document the natural resource utilization pattern in the study area consultations were done with people from the villages located in the area.

Sampling Site Selection

The study has been conducted covering submergence zone, dam site, d/s dam site and proposed command area. Phyto-sociological surveys of the vegetation were conducted at eight sampling locations. Selection of sampling sites for vegetation analysis was based on the land use pattern in the study area viz. Forest, Scrub/grassland and Agriculture to represent all the land use/land cover classes in the study area.

List of sampling locations is given at **Table 3.21** and their location marked on the study area map is given in **Figure 3.11**.

Table 3.21: Sampling Locations for phytosociological surveys

Site Code	Sampling Location	Site Characteristics
V1	Proposed dam site, Near Fatehpur village	Scrub land/ Open forest patch
V2	Near Chidi Kho	Open forest patch
V3	Near Durgnav village	Agriculture and settlement
V4	Upstream of proposed dam site, Near Sarkhedi village	Agriculture and settlement
V5	Proposed reservoir area, Near Arnia Sultanpur village	Agriculture and settlement
V6	Near Bagsi village	Agriculture and settlement
V7	Near Gadiya village	Agriculture and settlement
V8	Near Ganlyari village	Agriculture and settlement
V9	Near Palasi village	Agriculture and settlement
V10	Near Mawasa village	Agriculture and settlement

The inventory of plant species in the study area was prepared by noting and keeping records of plant species encountered during the field visit. Most of the plant species were identified in the field itself whereas the species that could not be identified, their photographs were taken for identification later with the help of available published literature.

b) Sampling Methodology

Standard methods of vegetation sampling were used for quantitative analysis of community structure. For these quadrats (a sampling unit) of different sizes were used depending upon the habit. For trees quadrat size of 10m x 10m was used and for shrubs quadrats of 5m x 5m were used while for herbs quadrat size of 1m x 1m was used. In each quadrat number of individuals of each plant species present was counted. For trees, shrubs and herbs, 10 quadrats were laid at each sampling site.

The data thus obtained was compiled in tabular form and analysed for different attributes like density, frequency and basal cover (basal area).

The density was calculated as follows:

$$\text{Density} = \frac{\text{Total no. of individuals of a plant species recorded from all quadrats}}{\text{Total number of quadrats studied}}$$

$$\text{Frequency (\%)} = \frac{\text{Number of quadrats of occurrence of a species}}{\text{Total number of quadrats studied}} \times 100$$

For calculation of dominance Basal area/cover of trees was calculated by measuring the 'cbh' (circumference at breast height) of each individual tree belonging to different species, which was then converted into basal area using the formula as follows:

$$\text{Basal area} = \pi r^2 \text{ where } r \text{ value was calculated from cbh using the formula } \text{cbh} = 2 \pi r$$

The data on density and basal cover obtained above was then converted into per ha.

The Importance Value Index (IVI) for trees was determined as the sum of relative density, relative frequency and relative dominance (Curtis, 1959).

Diversity Indices

The index of diversity was computed by using **Shannon Wiener Diversity Index** (Shannon Wiener, 1963) as:

$$H = - \sum (n_i/n) \times \ln (n_i/n)$$

Where, n_i is individual density of a species and n is total density of all the species

The **Evenness Index (E)** was calculated by using Shannon's Evenness formula (Magurran, 2004).

Evenness Index (E) = $H / \ln(S)$

Where, H is Shannon Wiener Diversity index; S is number of species

The description of vegetation structure at different sampling locations is given in the following paragraphs.

I. Vegetation Composition around the open forest area

V1: Proposed dam site, near Fatehpur Village

Sampling site V1 located at proposed dam site of Parbati river near Fatehpur village and characterized as open forest. Among the tree species *Acacia nilotica*, *Butea monosperma*, *Albizia lebbeck* and *Prosopis juliflora* are the predominant tree species in the area (Table 3.22).

Among the shrub species *Calotropis gigantea* is the most dominant shrub in the area. *Carissa opaca* and *Jatropha curcas* are other shrubs recorded at this site (Table 3.23).

Among herbs grass species *Cynodon dactylon* is the most dominant species and its density was highest during all seasons. *Parthenium hysterophorus* is another species which was found in all seasons. *Amaranthus viridis*, *Bidens pilosa* and *Tridax procumbens* are the other frequently found species mostly recorded from the bunds of agricultural farms and scrub land (Table 3.24).

Table 3.22: Community structure –Trees (V1)

S. No.	Name of Species	Frequency (%)	BASAL AREA (sq m)	Density (Indiv./ha)	IVI
1	<i>Acacia nilotica</i>	50	0.1618	60	65.84
2	<i>Butea monosperma</i>	50	0.0766	60	51.53
3	<i>Phoenix sylvestris</i>	40	0.055	40	37.31
4	<i>Azadirachta indica</i>	30	0.0439	20	24.86
5	<i>Albizia lebbeck</i>	40	0.0740	30	36.94
6	<i>Madhuca longifolia</i>	20	0.084	20	28.15
7	<i>Ailanthus excelsa</i>	20	0.027	20	18.58
8	<i>Prosopis juliflora</i>	40	0.0732	30	36.80

Table 3.23: Community structure –Shrubs (V1)

S. No.	Name of Species	Frequency (%)	Density (Indiv./ha)
1	<i>Calotropis gigantea</i>	60	1600
2	<i>Carissa opaca</i>	40	1200
3	<i>Colebrookea oppositifolia</i>	20	800
4	<i>Jatropha curcas</i>	40	1200
5	<i>Justicia adhatoda</i>	20	800
6	<i>Lantana camara</i>	30	800
7	<i>Phyllodium pulchellum</i>	30	800

Table 3.24: Community structure – Herbs (V1)

S. No.	Name of Species	Frequency (%)
Winter		
1	<i>Achyranthes aspera</i>	40
2	<i>Senna tora</i>	40
3	<i>Cynodon dactylon</i>	100
4	<i>Parthenium hysterophorus</i>	30
5	<i>Xanthium strumarium</i> Syn. <i>Xanthium indicum</i>)	30
Pre-monsoon		
1	<i>Achyranthes aspera</i>	16
2	<i>Cynodon dactylon</i>	127
3	<i>Parthenium hysterophorus</i>	6
4	<i>Senna tora</i>	15
Monsoon		
1	<i>Amaranthus viridis</i>	40
2	<i>Bidens pilosa</i>	40
3	<i>Cynodon dactylon</i>	100
4	<i>Parthenium hysterophorus</i>	30
5	<i>Saccharum spontaneum</i>	30
6	<i>Tridax procumbens</i>	40

V2. Near Chidi Kho

Sampling site V4 is located near Chidi Kho lake. The area is characterized as open forest patch. Vegetation cover is mainly represented by shrubs and herbs.

Among the tree species *Butea monosperma* and *Prosopis juliflora* are dominant species found in the forest area. *Pongamia pinnata* and *Azadirachta indica* are the species recorded at this site (see Table 3.25).

Colebrookea oppositifolia is most dominant shrub species at this site. *Calotropis gigantea* is the other dominant shrub here (Tables 3.26).

Cynodon dactylon is the most dominant species at this site also. *Achyranthes aspera* is another predominant species. Grass species *Heteropogon contortus*, *Cyperus rotundus* and *Echinops echinatus* were other frequently occurring species in the study area (Table 3.27).

Table 3.25: Community structure –Trees (V2)

S. No.	Name of Species	Frequency (%)	Basal Area (m ²)	Density trees/ha)	IVI
1	<i>Butea monosperma</i>	80	0.259	100	102.91
2	<i>Azadirachta indica</i>	30	0.0638	30	31.09
3	<i>Prosopis juliflora</i>	70	0.2245	90	90.55
4	<i>Terminalia arjuna</i>	30	0.0428	30	27.96
5	<i>Pongamia pinnata</i>	50	0.0773	50	47.48

Table 3.26: Community structure –Shrubs (V2)

S. No.	Name of Species	Frequency (%)	Density (ind./ha)
1	<i>Jatropha curcas</i>	30	880
2	<i>Colebrookea oppositifolia</i>	50	1200
3	<i>Lantana camara</i>	20	800
4	<i>Calotropis gigantea</i>	40	1200
5	<i>Abutilon indicum</i>	20	800

Table 3.27: Community structure – Herbs (V2)

S. No.	Name of Species	Frequency (%)
Winter		
1	<i>Achyranthes aspera</i>	30
2	<i>Senna tora</i>	50
3	<i>Xanthium strumarium</i> (Syn. <i>Xanthium indicum</i>)	50
4	<i>Parthenium hysterophorus</i>	60
5	<i>Cynodon dactylon</i>	100
Pre-monsoon		
1	<i>Achyranthes aspera</i>	13
2	<i>Cynodon dactylon</i>	132
3	<i>Euphorbia hirta</i>	3
4	<i>Rumex hastatus</i>	8
5	<i>Senna tora</i>	14
Monsoon		
1	<i>Achyranthes aspera</i>	30
2	<i>Cyperus rotundus</i>	50
3	<i>Echinops echinatus</i>	50
4	<i>Eclipta prostrata</i>	60
5	<i>Heteropogon contortus</i>	70
6	<i>Ocimum basilicum</i>	20
7	<i>Cynodon dactylon</i>	90

II. Vegetation in and Agricultural fields and Settlements

Sampling sites in the area was dominated by shrubs and grass species. Trees are rarely found and are few in numbers and sparsely distributed. *Lantana camara*, *Colebrookea oppositifolia*, *Calotropis gigantea*, *Abutilon indicum*, *Argemone mexicana* and *Dendrocalamus strictus* are the dominant shrub species mostly found on the bunds of agricultural field or in fallow land at the sampling sites.

V3. Near Durgnav

Sampling site V3, located near proposed dam site near Durgnav Village is characterized as scrub land as well as has agricultural fields. Vegetation is mainly composed of shrub and herbs. Scattered trees are found only along the road side and field bunds.

Shrub species are dominated by weed species like *Colebrookea oppositifolia*, *Justicia adhatoda*, *Lantana camara* and *Phyllodium pulchellum* (see Table 3.28).

Herbaceous flora is dominated by *Cynodon dactylon*, *Achyranthes aspera* and *Parthenium hysterophorus*. *Datura stramonium* and *Argemone mexicana* are the other frequently found species at this site (Table 3.29).

Table 3.28: Community structure –Shrubs (V3)

S. No.	Name of Species	Frequency (%)	Density (Invid./ha)
1	<i>Colebrookea oppositifolia</i>	50	1200
2	<i>Jatropha curcas</i>	40	800
3	<i>Justicia adhatoda</i>	50	1200
4	<i>Lantana camara</i>	40	1200
5	<i>Phyllodium pulchellum</i>	40	1600

Table 3.29: Community structure – Herbs (V3)

S. No.	Name of Species	Frequency (%)
Winter		
1	<i>Achyranthes aspera</i>	30
2	<i>Senna tora</i>	50
3	<i>Xanthium strumarium</i> (Syn. <i>Xanthium indicum</i>)	50
4	<i>Parthenium hysterophorus</i>	60
5	<i>Cynodon dactylon</i>	100
Pre-monsoon		
1	<i>Amaranthus viridis</i>	80
2	<i>Argemone mexicana</i>	60
3	<i>Commelina benghalensis</i>	40
4	<i>Cynodon dactylon</i>	40
5	<i>Datura stramonium</i>	70
Monsoon		
1	<i>Achyranthes aspera</i>	40
2	<i>Cynodon dactylon</i>	100
3	<i>Parthenium hysterophorus</i>	70
4	<i>Senna tora</i>	60
5	<i>Xanthium strumarium</i> (Syn. <i>Xanthium indicum</i>)	40

V4. Upstream of proposed dam site, Near Village Sarkhedi

The sampling site V2 is located at proposed reservoir site near Arnia Sultanpur Village in the study area. The sampling area is predominantly characterized by Agriculture and settlements. Vegetation is mainly represented as shrub and herbs.

Among the shrub species *Ricinus communis* is the most dominant species recorded from the area. *Woodfordia fruticosa* and *Ziziphus nummularia* are the other dominant shrub species recorded from the area (Table 3.30).

Herbaceous flora was mainly dominated by *Parthenium hysterophorus*. Other dominant species is *Achyranthes aspera*. Other dominant species were *Cyperus rotundus*, *Heteropogon contortus* and *Boerhavia diffusa* are the other herb species recorded from the area (Table 3.31).

Table 3.30: Community structure –Shrubs (V4)

S. No.	Name of Species	Frequency (%)	Density (indiv./ha)
1	<i>Ricinus communis</i>	60	2400
2	<i>Senna occidentalis</i>	30	1200
3	<i>Vitex negundo</i>	30	1600
4	<i>Woodfordia fruticosa</i>	40	1200
5	<i>Ziziphus nummularia</i>	40	

Table 3.31 Community structure – Herbs (V4)

S. No.	Name of Species	Frequency (%)
Winter		
1	<i>Achyranthes aspera</i>	50
2	<i>Ocimum basilicum</i>	30
3	<i>Cynodon dactylon</i>	100
4	<i>Parthenium hysterophorus</i>	50
5	<i>Senna tora</i>	40
Pre-monsoon		
1	<i>Achyranthes aspera</i>	13
2	<i>Amaranthus viridis</i>	3
3	<i>Cynodon dactylon</i>	119
4	<i>Parthenium hysterophorus</i>	7
Monsoon		
1	<i>Argemone mexicana</i>	40
2	<i>Boerhavia diffusa</i>	50
3	<i>Commelina benghalensis</i>	30
4	<i>Cyperus rotundus</i>	80
5	<i>Echinops echinatus</i>	50
6	<i>Heteropogon contortus</i>	60
7	<i>Parthenium hysterophorus</i>	30

V5. Proposed reservoir area, Near Arnia Sultanpur

The site V5 lies in the downstream of proposed dam site near Arnia Sultanpur village. This site is represented as agriculture area.

Shrubs in the area are mainly represented by *Justicia adhatoda*, *Calotropis gigantea* and *Carissa opaca* (Table 3.32).

Cynodon dactylon is the most dominant species. Other dominant species were *Argemone Mexicana*, *Achyranthes aspera*, *Amaranthus viridis* and *Parthenium hysterophorus* (Table 3.33).

Table 3.32: Community structure –Shrubs (V5)

S. No.	Name of Species	Frequency (%)	Density (Indiv./ha)
1	<i>Calotropis gigantea</i>	40	1600
2	<i>Carissa opaca</i>	40	1600
3	<i>Colebrookea oppositifolia</i>	20	800
4	<i>Jatropha curcas</i>	30	1200
5	<i>Justicia adhatoda</i>	60	2400
6	<i>Lantana camara</i>	40	700
7	<i>Vitex negundo</i>	30	800

Table 3.33: Community structure – Herbs (V5)

S. No.	Name of Species	Frequency (%)
Winter		
1	<i>Argemone mexicana</i>	50
2	<i>Cynodon dactylon</i>	100
3	<i>Achyranthes aspera</i>	50
4	<i>Amaranthus viridis</i>	33
Pre-monsoon		
1	<i>Amaranthus viridis</i>	50
2	<i>Argemone mexicana</i>	80
3	<i>Cynodon dactylon</i>	50
4	<i>Parthenium hysterophorus</i>	30
5	<i>Senna tora</i>	20
6	<i>Tridax procumbens</i>	20
Monsoon		
1	<i>Achyranthes aspera</i>	8
2	<i>Bidens Pilosa</i>	12
3	<i>Commelina benghalensis</i>	6
4	<i>Cynodon dactylon</i>	129
5	<i>Cyperus rotundus</i>	5
6	<i>Euphorbia hirta</i>	5
7	<i>Parthenium hysterophorus</i>	5
8	<i>Senna tora</i>	16
9	<i>Xanthium strumarium</i>	4

V6. Bagsi village (Downstream of proposed Dam site)

The sampling site V6 is located downstream of dam site near Bagsi village in the command area. The sampling area is characterized by agricultural farms. No tree species is recorded in the sampling area.

Shrub layer is comprised of *Abutilon indicum*, *Jatropha curcas* and *Colebrookea oppositifolia* with *Abutilon indicum* as the most dominant shrub species (Table 3.34).

Cynodon dactylon as usual is the frequently found herb species found along the bunds of agricultural fields. Other herbaceous species reported from the area are *Parthenium hysterophorus* and *Achyranthes aspera* (Table 3.35).

Table 3.34: Community structure –Site: V6 (Shrubs)

S. No.	Name of Species	Frequency (%)	Density (indiv./ha)
1	<i>Jatropha curcas</i>	40	1600
2	<i>Colebrookea oppositifolia</i>	40	1600
3	<i>Lantana camara</i>	20	800
4	<i>Calotropis gigantea</i>	30	1200
5	<i>Abutilon indicum</i>	60	2400

Table 3.35: Community structure –Site: V6 (Herbs)

S. No.	Name of Species	Frequency (%)
Winter		
1	<i>Amaranthus viridis</i>	40
2	<i>Bidens pilosa</i>	40
3	<i>Cynodon dactylon</i>	100
4	<i>Parthenium hysterophorus</i>	30
5	<i>Senna tora</i>	40
Pre-monsoon		
1	<i>Achyranthes aspera</i>	13
2	<i>Cynodon dactylon</i>	123
3	<i>Parthenium hysterophorus</i>	8
4	<i>Senna tora</i>	13
Monsoon		
1	<i>Achyranthes aspera</i>	50
2	<i>Argemone mexicana</i>	30
3	<i>Cynodon dactylon</i>	80
4	<i>Heteropogon contortus</i>	40
5	<i>Xanthium strumarium</i> (Syn. <i>Xanthium indicum</i>)	40

V7. Near Gadiya Village:

The sampling site V7 is located near Gadiya village in the command area. The sampling area is characterized by agricultural farms and settlements.

Shrub layer is comprised of *Lantana camara*, *Carissa opaca*, *Ricinus communis* and *Colebrookea oppositifolia* (Table 3.36).

Cynodon dactylon is the most dominant species. *Achyranthes aspera* is the other frequently found herb species found along the bunds of agricultural fields and near settlements (Table 3.37).

Table 3.36: Community structure –Site: V7 (Shrubs)

S. No.	Name of Species	Frequency (%)	Density (indiv./ha)
1	<i>Carissa opaca</i>	70	160
2	<i>Justicia adhatoda</i>	50	90
3	<i>Lantana camara</i>	80	180
4	<i>Colebrookea oppositifolia</i>	60	120
5	<i>Jatropha curcas</i>	30	60
6	<i>Calotropis gigantea</i>	40	80

Table 3.37: Community structure –Site: V7 (Herbs)

S. No.	Name of Species	Frequency (%)
Winter		
1	<i>Saccharum spontaneum</i>	80
2	<i>Argemone mexicana</i>	50
3	<i>Cynodon dactylon</i>	100
4	<i>Senna tora</i>	60
5	<i>Datura stramonium</i>	30
Pre-monsoon		
1	<i>Achyranthes aspera</i>	9

S. No.	Name of Species	Frequency (%)
2	<i>Commelina benghalensis</i>	5
3	<i>Cynodon dactylon</i>	129
4	<i>Parthenium hysterophorus</i>	7
Monsoon		
1	<i>Achyranthes aspera</i>	60
2	<i>Boerhavia diffusa</i>	50
3	<i>Cynodon dactylon</i>	90
4	<i>Heteropogon contortus</i>	80
5	<i>Xanthium strumarium</i> (Syn. <i>Xanthium indicum</i>)	30

V8. Near Ganliyari Village:

The sampling site V8 is located near Ganliyari village in the command area. The sampling area is characterized by agricultural farms and settlement. No tree species is recorded in the sampling area.

Shrub layer is comprised mainly of *Lantana camara*, *Ziziphus xylopyrus* and *Abutilon indicum*. Other shrubs also present in the area like *Calotropis gigantea* and *Vitex negundo* (Table 3.38).

Cynodon dactylon again is the most dominant species. *Commelina benghalensis* and *Achyranthes aspera* are the other frequently found herbaceous species (Table 3.39).

Table 3.38: Community structure –Site: V8 (Shrubs)

S. No.	Name of Species	Frequency (%)	Density (ind./ha)
1	<i>Ziziphus xylopyrus</i>	80	230
2	<i>Abutilon indicum</i>	60	190
3	<i>Calotropis gigantea</i>	50	130
4	<i>Vitex negundo</i>	50	90
5	<i>Ricinus communis</i>	30	60
6	<i>Lantana camara</i>	70	120

Table 3.39: Community structure –Site: V8 (Herbs)

S. No.	Name of Species	Frequency (%)
Winter		
1	<i>Achyranthes aspera</i>	50
2	<i>Argemone mexicana</i>	50
3	<i>Boerhavia diffusa</i>	50
4	<i>Cynodon dactylon</i>	100
5	<i>Xanthium strumarium</i> (Syn. <i>Xanthium indicum</i>)	60
Pre-monsoon		
1	<i>Achyranthes aspera</i>	9
2	<i>Amaranthus viridis</i>	7
3	<i>Bidens pilosa</i>	5
4	<i>Cynodon dactylon</i>	126
5	<i>Parthenium hysterophorus</i>	5
Monsoon		
1	<i>Commelina benghalensis</i>	60
2	<i>Cynodon dactylon</i>	70

S. No.	Name of Species	Frequency (%)
3	<i>Eclipta prostrata</i>	50
4	<i>Ocimum basilicum</i>	50
5	<i>Senna tora</i>	20
6	<i>Heteropogon contortus</i>	30

V9. Near Palasi Village:

The sampling site V9 is located near Palasi village in the command area. The sampling area is characterized by agricultural farms.

Shrub layer is dominated by *Colebrookea oppositifolia* and *Abutilon indicum* (Table 3.40).

Most dominant species is *Cynodon dactylon*. *Commelina benghalensis* is other the common species found along the bunds of agricultural fields (Table 3.41).

Table 3.40: Community structure –Site: V9 (Shrubs)

S. No.	Name of Species	Frequency (%)	Density (Indiv./ha)
1	<i>Abutilon indicum</i>	50	90
2	<i>Colebrookea oppositifolia</i>	60	160
3	<i>Justicia adhatoda</i>	50	130
4	<i>Woodfordia fruticosa</i>	30	80
5	<i>Ziziphus oenopolia</i>	40	120

Table 3.41: Community structure –Site: V9 (Herbs)

S. No.	Name of Species	Frequency (%)
Winter		
1	<i>Commelina benghalensis</i>	60
2	<i>Cynodon dactylon</i>	100
3	<i>Datura stramonium</i>	30
4	<i>Echinops echinatus</i>	50
5	<i>Saccharum spontaneum</i>	60
6	<i>Xanthium strumarium</i> Syn. <i>Xanthium indicum</i>)	60
Pre-monsoon		
1	<i>Achyranthes aspera</i>	13
2	<i>Cynodon dactylon</i>	139
3	<i>Parthenium hysterophorus</i>	6
4	<i>Senna tora</i>	15
Monsoon		
1	<i>Argemone mexicana</i>	60
2	<i>Bidens pilosa</i>	60
3	<i>Boerhavia diffusa</i>	60
4	<i>Commelina benghalensis</i>	30
5	<i>Cynodon dactylon</i>	80

V10. Near Mawasa Village:

The sampling site V10 is located near Mawasa village in the command area. The sampling area is characterized by agricultural farms and fellow land. No tree species is recorded in the sampling area.

Shrub layer is comprised of *Ziziphus nummularia*, *Calotropis gigantea*, *Phyllodium pulchellum* and *Lantana camara* (Table 3.42).

Cynodon dactylon is the dominant species here also. *Achyranthes aspera* is other dominant herb species found along the bunds of agricultural fields (Table 3.43).

Table 3.42: Community structure –Site: V10 (Shrubs)

S. No.	Name of Species	Frequency (%)	Density (ind./ha)
1	<i>Calotropis gigantea</i>	50	90
2	<i>Lantana camara</i>	50	60
3	<i>Phyllodium pulchellum</i>	50	90
4	<i>Vitex negundo</i>	30	100
5	<i>Ziziphus nummularia</i>	60	130
6	<i>Woodfordia fruticosa</i>	20	70

Table 3.43: Community structure –Site: V10 (Herbs)

S. No.	Name of Species	Frequency (%)
Winter		
1	<i>Achyranthes aspera</i>	60
2	<i>Argemone mexicana</i>	50
3	<i>Cynodon dactylon</i>	100
4	<i>Cyperus rotundus</i>	80
5	<i>Xanthium strumarium</i> (Syn. <i>Xanthium indicum</i>)	60
Pre-monsoon		
1	<i>Achyranthes aspera</i>	10
2	<i>Cynodon dactylon</i>	134
3	<i>Senna tora</i>	10
Monsoon		
1	<i>Achyranthes aspera</i>	60
2	<i>Argemone mexicana</i>	30
3	<i>Commelina benghlensis</i>	60
4	<i>Datura stramonium</i>	30
5	<i>Saccharum spontaneum</i>	50
6	<i>Senna tora</i>	20
7	<i>Xanthium strumarium</i> (Syn. <i>Xanthium indicum</i>)	40

3.5.2.6 Dominance

Based upon the Importance Value Index (IVI) given in table below *Azadirachta indica*, *Butea monosperma* and *Prosopis juliflora* area the most dominant trees in the project study area at both the sites where the tree cover is present.

Name of species	IVI	
	Site V1	Site V2
<i>Acacia nilotica</i>	65.84	-
<i>Ailanthus excelsa</i>	18.58	-
<i>Albizia lebbeck</i>	36.94	-
<i>Azadirachta indica</i>	24.86	31.09

Name of species	IVI	
	Site V1	Site V2
<i>Butea monosperma</i>	51.53	102.9
<i>Madhuca longifolia</i>	28.15	-
<i>Phoenix sylvestris</i>	37.31	-
<i>Pongamia pinnata</i>	-	47.48
<i>Prosopis juliflora</i>	36.8	90.55
<i>Terminalia arjuna</i>	-	27.96

3.5.2.7 Shannon Wiener Diversity Index (H')

Overall the diversity Index for trees in forested areas ranged from 1.33 to 1.83. Tree cover in the area is very sparse and are found at sites located near agriculture/ fallow land and scrub/ grass land. The vegetation in general is represented by the thorny shrubs and grasses.

Diversity index for shrub species in the sampling sites varies from 1.26 to 1.76. (Table 3.44).

The species diversity of herbs is very low varying from 0.48 to 0.93. (Table 3.44).

Table 3.44: Shannon Weiner Species Diversity Index (H')

Sampling Site Code	Trees	Shrubs	Herbs		
			W	PM	M
V1	1.83	1.26	0.72	0.62	0.77
V2	1.33	1.27	0.79	0.77	0.66
V3	-	1.51	0.89	0.84	0.55
V4	-	1.76	0.93	0.83	0.65
V5	-	1.34	0.68	0.48	0.66
V6	-	1.55	0.66	0.60	0.76
V7	-	1.35	0.77	0.74	0.64
V8	-	1.56	0.81	0.60	0.61
V9	-	1.31	0.73	0.73	0.66
V10	-	1.68	0.62	0.52	0.72

3.5.3 Faunal Elements

The fauna of the study area has been compiled based on the primary surveys carried out during the three season study.

In addition, secondary sources and information available for the study area has also been referred to specially to identify any schedule I species in project's proximity. Forest Working Plan of Rajgarh, Bhopal and Sehore Forest Divisions were consulted. In addition, data was compiled from published literature like Prater (1998) for mammals, Daniel (2002) for reptiles and Ali & Ripley (1983) for birds.

3.5.3.1 Mammals

List of mammals sighted during the field survey is given at **Table 3.45**. A total of 9 species of mammals have been sighted. All of them fall under Least Concern Category as per IUCN and Schedule II to IV of WPA, 1972. None of the schedule I species of mammals were recorded during the field surveys.

Table 3.45: Mammalian Species sighted in the Study Area

S. No.	Order	Family name	Common name	Scientific name	Conservation Status	
					IUCN (2019-1)	WPA (1972)
1	CARNIVORA	Canidae	Jackal	<i>Canis aureus</i>	LC	IV
2	CETARTIODACTYLA	Suidae	Wild Boar	<i>Sus scrofa</i>	LC	III
3	CETARTIODACTYLA	Cervidae	Chital	<i>Axis axis</i>	LC	III
4	CETARTIODACTYLA	Bovidae	Nilgai	<i>Boselaphus tragocamelus</i>	LC	IV
5	LAGOMORPHA	Leporidae	Common Hare	<i>Lepus nigricollis</i>	LC	IV
6	PRIMATES	Cercopithecidae	Rhesus macaque	<i>Macaca mulatta</i>	LC	II
7	PRIMATES	Cercopithecidae	Common Langur	<i>Semnopithecus entellus</i>	LC	II
8	RODENTIA	Muridae	Field rat	<i>Rattus rattus</i>	LC	V
9	RODENTIA	Sciuridae	Five-striped Palm Squirrel	<i>Funambulus pennantii</i>	LC	IV

IUCN Ver. 2019-1 - International Union for Conservation of Nature; LC - Least Concern
WPA – Wildlife (Protection) Act, 1972

In addition, we have referred to Forest working Plans (FWP) for Bhopal and Sehore Forest Divisions for identifying the list of Schedule I species, if any, in project vicinity or study area. Bhopal FWP, has mentioned presence of Leopard, Indian Wolf and Sloth Bear in their plan. Similarly, in addition, Sehore FWP has mentioned presence of Four Horned Antelope, Indian Gazelle and Honey badger. However, these plans refer to the entire forest divisions spread over the districts and are not specific to project/study area.

3.5.3.2 Birds

To prepare inventory of the birds in the area was prepared using the field guide of birds by Ali & Ripley (1983), Grimmett *et al.* (1998, 2011), Inskipp *et al.* (1999) and Kazmierczak (2000).

Based upon the surveys conducted, a list of birds reportedly found in the study area was prepared. According to list prepared as above there are 49

species of birds belonging to 12 Orders and 33 families which are reportedly found in the study area and the same is given at **Table 3.46**.

Table 3.46: List of birds reported from the study area with their conservation status in the study area (Species marked as* were sighted during the field survey)

S. No./ Order	Family	Common Name	Scientific name	Conservation Status	
				IUCN status (2019-1)	WPA, 1972
Anseriformes					
1	Anatidae	Spot-billed duck	<i>Anas poecilorhyncha</i>	LC	IV
Bucerotiformes					
2	Upupidae	Common hoopoe*	<i>Upupa epops</i>	LC	IV
Charadriiformes					
3	Charadriidae	Red-wattled lapwing*	<i>Vanellus indicus</i>	LC	IV
4	Recurvirostridae	Black-winged stilt	<i>Himantopus himantopus</i>	LC	IV
Columbiformes					
5	Columbidae	Rock pigeon	<i>Columba livia</i>	LC	IV
6	Columbidae	Laughing dove	<i>Streptopelia senegalensis</i>	LC	IV
7	Columbidae	Yellow-footed Green-pigeon	<i>Treron phoenicoptera</i>	LC	IV
Coraciiformes					
8	Alcedinidae	Common kingfisher*	<i>Alcedo atthis</i>	LC	IV
9	Alcedinidae	Pied kingfisher	<i>Ceryle rudis</i>	LC	IV
10	Alcedinidae	White-throated kingfisher*	<i>Halcyon smyrnensis</i>	LC	IV
11	Coraciidae	Indian roller	<i>Coracias benghalensis</i>	LC	IV
Cuculiformes					
12	Cuculidae	Asian koel*	<i>Eudynamys scolopaceus</i>	LC	IV
13	Cuculidae	Pied cuckoo	<i>Clamator jacobinus</i>	LC	IV
14	Cuculidae	Southern coucal	<i>Centropus sinensis</i>	LC	IV
15	Meropidae	Green bee-eater*	<i>Merops orientalis</i>	LC	IV
Galliformes					
16	Phasianidae	Pea fowl*	<i>Pavo cristatus</i>	LC	I
Gruiformes					
17	Gruidae	Sarus crane	<i>Antigone antigone</i>	VU	IV
18	Rallidae	White breasted waterhen	<i>Amaurornis phoenicurus</i>	LC	IV
Passeriformes					
19	Aegithinidae	Common lora	<i>Aegithina tiphia</i>	LC	IV
20	Alaudidae	Rufous tailed lark	<i>Ammomanes phoenicura</i>	LC	IV
21	Cisticolidae	Common tailor bird	<i>Orthotomus sutorius</i>	LC	IV
22	Cisticolidae	Grey breasted Prinia	<i>Prinia hodgsonii</i>	LC	IV
23	Cisticolidae	Ashy prinia	<i>Prinia socialis</i>	LC	IV
24	Corvidae	Indian jungle crow*	<i>Corvus culminatus</i>	LC	V
25	Corvidae	House crow*	<i>Corvus splendens</i>	LC	V
26	Corvidae	Rufous tree pie*	<i>Dendrocitta vagabunda</i>	LC	IV
27	Dicruridae	Black Drongo*	<i>Dicrurus macrocercus</i>	LC	IV
28	Emberizidae	Crested bunting	<i>Melophus lathamii</i>	LC	IV
29	Estrildidae	Indian silverbill	<i>Euodice malabarica</i>	LC	V
30	Estrildidae	Scaly-breasted munia	<i>Lonchura punctulata</i>	LC	IV
31	Hirundinidae	Red rumped swallow	<i>Cecropis daurica</i>	LC	IV
32	Laniidae	Bay backed shrike	<i>Lanius vittatus</i>	LC	IV
33	Leiothrichidae	Large grey babbler	<i>Turdoides malcolmi</i>	LC	V
34	Motacillidae	White browed wagtail	<i>Motacilla maderaspatensis</i>	LC	IV
35	Muscicapidae	Oriental magpie robin	<i>Copsychus saularis</i>	LC	IV

S. No./ Order	Family	Common Name	Scientific name	Conservation Status	
				IUCN status (2019-1)	WPA, 1972
36	Muscicapidae	Indian robin*	<i>Saxicoloides fulicatus</i>	LC	V
37	Nectariniidae	Purple Sunbird	<i>Cinnyris asiaticus</i>	LC	IV
38	Passeridae	House sparrow*	<i>Passer domesticus</i>	LC	V
39	Ploceidae	Baya weaver*	<i>Ploceus philippinus</i>	LC	IV
40	Sturnidae	Common myna*	<i>Acridotheres tristis</i>	LC	IV
41	Sturnidae	Asian pied starling	<i>Gracupica contra</i>	LC	IV
42	Sturnidae	Brahminy starling	<i>Sturnia pagodarum</i>	LC	IV
43	Sylviidae	Yellow-eyed babbler	<i>Chrysomma sinense</i>	LC	IV
44	Zosteropidae	Oriental white eye	<i>Zosterops palpebrosus</i>	LC	IV
Pelecaniformes					
45	Ardeidae	Cattle egret*	<i>Bubulcus ibis</i>	LC	IV
46	Ardeidae	Pond heron*	<i>Ardeola grayii</i>	LC	IV
47	Phalacrocoracidae	Little cormorant	<i>Microcarbo niger</i>	LC	IV
Piciformes					
48	Megalaimidae	Copper smith barbet	<i>Megalaima haemacephala</i>	LC	IV
Psittaciformes					
49	Psittaculidae	Rose ringed parakeet	<i>Psittacula krameri</i>	LC	IV

IUCN Ver. 2019-1 - International Union for Conservation of Nature; LC - Least Concern WPA – Wildlife (Protection) Act, 1972

3.5.3.3 Herpetofauna

Linear transects were established and the whole narrow strip (and the adjoining areas) was searched for animals. The transects were set along the gradient, parallel as well as perpendicular to the gradient i.e. along a river. The data collected was supplemented with data from secondary sources. Based upon this exercise main species of herpetofauna in the study area are *Eutropis carinata* (Skink), *Ophiophagus hannah* (King Cobra), *Carbrus rynchops* (Water snake), *Ptyas mucosa* (Common Rat Snake), *Hoplobatrachus tigerinus* (Common Bull Frog) and *Duttaphrynus melanostictus* (Toad). List of herpetofauna reported from the area is given at **Table 3.47**.

Table 3.47: List of Herpetofauna reported from the study area

		Scientific name	Common name	IUCN (2019-1)
CLASS	AMPHIBIA			
Order	Anura			
Family	Bufonidae	<i>Duttaphrynus melanostictus</i>	Common toad	-
	Dicroglossidae	<i>Hoplobatrachus tigerinus</i>	Bull frog	LC
CLASS	REPTILIA			
Order	Squamata			
Family	Pythonidae	<i>Python molurus</i>	Python	
	Elapidae	<i>Ophiophagus hannah</i>	King cobra	VU
	Viperidae	<i>Daboia siamensis</i>	Viper	LC
	Boidae	<i>Eryx johnii</i>	Domuhi	-
	Colubridae	<i>Ptyas mucosa</i>	Common rat snake	-
	Homalopsidae	<i>Carbrus rynchops</i>	Water snake	-

		Scientific name	Common name	IUCN (2019-1)
	Scincidae	<i>Eutropis carinata</i>	Skink	LC
	Testudinidae	<i>Testudo graeca</i>	Tortoise	-
	Varanidae	<i>Varanus varius</i>	Varanus	LC

(The list has been compiled based on field survey and description given in Forest Working Plan of Rajgarh, Bhopal and Sehore Forest Divisions)

3.5.3.4 Butterflies

From the study area 8 species of butterflies are reported. During field survey only 4 species of butterflies were recorded from the project area (**Table 3.48**). These are observed along the main river, Open forest patches and settlements. Pieridae is the largest family with 4 species. The nomenclature and classification of butterfly species is based upon <http://www.ifoundbutterflies.org/> (Kunte, K., S. Sondhi, and P. Roy (Chief Editors) 2019. Butterflies of India, v. 2.60. Indian Foundation for Butterflies).

Table 3.48: Butterflies recorded from Study Area

S. No.	Family	Scientific name	Common name
1	Nymphalidae	<i>Junonia orithya</i>	Blue Pansy
2	Nymphalidae	<i>Danaus chrysippus</i>	Plain Tiger
3	Papilionidae	<i>Papilio demoleus</i>	Lime Swallowtail
4	Papilionidae	<i>Papilio polytes</i>	Common Mormon
5	Pieridae	<i>Eurema hecabe</i>	Common Grass Yellow
6	Pieridae	<i>Belenois aurota</i>	Pioneer
7	Pieridae	<i>Catopsilia pyranthe</i>	Mottled Emigrant
8	Pieridae	<i>Pieris brassicae</i>	Large Cabbage White

3.5.3.5 Conservation Status of Fauna

Different faunal species like mammals, birds and butterflies were assessed for their conservation status according to IUCN Red List categories (Ver. 2019-1) accessed in April 2019 and WPA (1972) Schedules. Among mammals, no schedule I species was sighted in the study area. Forest working plans, prepared for the forest divisions did mention presence of schedule I mammalian species in the districts where project is located, however, their presence in project vicinity could not be established.

Among the birds only one species viz. Pea fowl is listed as Schedule I species. According to IUCN Red List Sarus crane is under Vulnerable category. Rest of the species are listed under Least Concern category.

Among Herpetofauna only King cobra is listed under Vulnerable category by IUCN otherwise all are Least Concern species.

3.5.3.6 Fish Fauna

The study area of the proposed Parbati Major Irrigation project lies area which experiences semi-arid conditions with long dry season. The rainfall in the occurs only during south-west monsoon i.e. in the months of June to September. After the receding of monsoon water in the river reduces considerably due to lack of rainfall some fragmented pools can be seen in the riverbed. Therefore, during dry season in the riverbed of Parbati river some deep-water pools in low lying areas where some aquatic life can be seen. These low-lying areas in the river have deep water pools at places alternating with drier river bed with muddy and small to large pools depending upon presence of depression in the river bed. There is no organized commercial fishery practiced in the area.

Fish fauna of Parbati river data was documented through data collected from secondary sources as well as information collected during field visits. According to this list 8 species are found in the study area. Most common are *Cirrhinus mrigala*, *Bangana dero*, *Rita rita*, *Devario devario* and *Chanda nama* (refer Table 3.49). All these species are under Least Concern category of IUCN Red List Ver.2019-1.

Table 3.49: List of fish species reported from the study area

S. No.	Order	Family	Scientific name	Local name	IUCN 2019-1	CAMP Report (1998)
1	Cypriniformes	Cyprinidae	<i>Bangana dero</i>	Kalabans	LC	VU/N
2	Cypriniformes	Cyprinidae	<i>Cirrhinus mrigala</i>	Mrigal	LC	LRnt/N
3	Cypriniformes	Cyprinidae	<i>Devario devario</i>	Patai	LC	LRnt/N
4	Cypriniformes	Cyprinidae	<i>Crossocheilus latius</i>	Gauma	LC	DD
5	Cypriniformes	Nemacheilidae	<i>Acanthocobitis botia</i>	Goonch	LC	-
6	Perciformes	Ambassidae	<i>Chanda nama</i> (Syn. <i>Ambassis nama</i>)	Chahal	LC	-
7	Siluriformes	Bagridae	<i>Rita rita</i>	Katua	LC	LRnt/N
8	Siluriformes	Bagridae	<i>Sperata oar</i>	Khora	-	-

3.5.4 Conclusions

The plant life in the project study area especially in the command area is in degraded condition and irregular distribution found in scattered patches. However, vegetation around the periphery of Narsingharh WLS and some patches in the command area comprised of open deciduous forest. Major conclusions are as follows.

- i) The dam site and submergence area are located in the vicinity of the Narsingharh Wildlife Sanctuary however none of project components fall within the sanctuary.
- ii) According to 'A Revised Survey of the Forest Types of India' by Champion and Seth (1968) the forests types are under Group 5 Tropical Dry Deciduous Forests with Southern Mixed Deciduous forest type

- iii) Anthropogenic factors are mainly responsible for degradation of forests in the area.
- iv) During the study period 121 flowering plant species were recorded belonging to 40 families.
- v) *Azadirachta indica*, *Prosopis juliflora* and *Butea monosperma* are the dominant tree species in areas with tree cover.
- vi) *Mangifera indica*, *Ficus racemosa*, *Ficus religiosa*, *Madhuca longifolia*, *Dalbergia sissoo*, *Syzygium cumini* and *Pongamia pinnata*, etc. are the most common tree species found near the settlements.
- vii) Shrubby vegetation comprises of species like *Lantana camara*, *Calotropis gigantea*, *Justicia adhatoda*, *Colebrookea oppositifolia* and *Ipomoea carnea*
- viii) There are no RET plant species found in the study area.
- ix) Mammals are represented by 9 species of which Common langur (*Semnopithecus entellus*), Five-striped Palm Squirrel (*Funambulus pennantii*), *Sus scrofa* (Wild boar), *Canis aureus* (Jackal) and *Lepus nigricollis* (Common hare) are commonly sighted.
- x) Birds are represented by 51 species of which 19 were sighted during surveys; out of which only pea fowl is schedule I species.

Chapter 4

DESCRIPTION OF THE SOCIAL ENVIRONMENT

4.1 INTRODUCTION

For sustainable development, it is important to understand social and economic conditions of the community in the region, impacts of development on the community, measures to mitigate negative impacts and enhance the positive impacts. For new development initiatives, socio economic assessment plays an important role to ensure community participation and their acceptance of the development activity. It also helps in planning the activities for local area development.

Parbati Major Irrigation Project under the Water Resource Department, Govt. of Madhya Pradesh has planned to construct dam across the Parbati river and irrigate 48,000 ha of land in 132 villages. The water will be distributed through canal in the culturable command area (CCA), spread in 132 villages of Rajgarh and Bhopal districts. There are 18 villages where families will be displaced, due to construction of dam and creation of reservoir. In total, 4 villages would be fully submerged and 14 villages would be partially submerged.

4.2 STUDY AREA

Study area considered for the study of social environment is same as considered for physical and biological environmental parameters and is explained in previous chapter. Study area comprises of 391 villages falling under Biaora and Narsinghgarh CD Blocks of Rajgarh district; Berasia CD Block of Bhopal district; Sehore CD Block of Sehore district; and Kalapipal CD Block of Shajapur district. Study area villages include 132 benefited villages and 18 affected villages also. The villages, where land/ property irrespective of their ownership are likely to be partially or fully submerged due to the project have been taken as Project Affected Villages while villages located in the command area have been termed as Project Benefited Villages. List of study area villages is given in **Table 4.1** and location of study area villages is shown in **Figure 4.1**.

Table 4.1: List of Villages in Study Area

S. No.	Village Code	Village Name	Village Category	S. No.	Village Code	Village Name	Village Category
District: Rajgarh						Kalan	
CD Block: Biaora				4	779	Motipura	Benefited
1	774	Amlyahat	Benefited	5	787	Agar	Benefited
2	777	Barkhedi	Benefited	6	792	Lodipura	Benefited
3	778	Kharetiya	Benefited	7	793	Amdor	Benefited

S. No.	Village Code	Village Name	Village Category
8	796	Bhanwas	Benefited
9	797	Tumdia	Benefited
10	799	Karondiya	Benefited
11	798	Sadli	Study Area
12	800	Muwalya Gujar	Study Area
District: Rajgarh			
CD Block: Narsingharh			
13	151	Kotra Kalan	Affected
14	164	Partappura	Affected
15	165	Fatehpur	Affected
16	168	Bherupura	Affected
17	274	Naihedi	Affected
18	276	Barodi	Affected
19	277	Mangatpura	Affected
20	281	Sanka Jagir	Affected
21	282	Sundi	Affected
22	283	Shivpura	Affected
23	284	Gadupura	Affected
24	285	Gahun Khedi Kalan	Affected
25	288	Jhadkiya	Affected
26	289	Terni Dhakad	Affected
27	291	Hiran Khedi	Affected
28	299	Badnagar	Affected
29	304	Turkipura	Affected
30	306	Pilu Khedi	Affected
31	307	Shivpura	Affected
32	308	Senwas	Affected
33	68	Kishorepura	Benefited
34	77	Mandawar	Benefited
35	84	Berasia	Benefited
36	85	Bhojpuria	Benefited
37	86	Mundla Bajrang	Benefited
38	87	Amba Pura	Benefited
39	89	Khanpura	Benefited
40	91	Pipliya Dhakad	Benefited
41	93	Moi	Benefited
42	97	Palasi	Benefited
43	98	Banjari	Benefited
44	99	Sonkatch	Benefited
45	100	Achalpura	Benefited
46	101	Andalheda	Benefited
47	102	Kadia Mitrasen	Benefited
48	103	Kolu Khedi	Benefited
49	104	Padaliya Bana	Benefited

S. No.	Village Code	Village Name	Village Category
50	107	Kadia Chandrawat	Benefited
51	108	Chainpura Kalan	Benefited
52	109	Dhamdhore	Benefited
53	110	Pipliya Bag	Benefited
54	111	Bhawanipura	Benefited
55	112	Madora	Benefited
56	113	Madori	Benefited
57	114	Mundli	Benefited
58	115	Gadia	Benefited
59	117	Charpura	Benefited
60	118	Bandi	Benefited
61	119	Manpuradeo	Benefited
62	120	Mittanpur	Benefited
63	121	Shankarpura	Benefited
64	122	Panjra	Benefited
65	123	Panjri	Benefited
66	124	Pura Baraitha	Benefited
67	125	Badodia Jagir	Benefited
68	126	Lakdia	Benefited
69	127	Lachhmanpura	Benefited
70	128	Sanwasi	Benefited
71	129	Hedapura	Benefited
72	130	Gandhigram	Benefited
73	131	Pachhtalai	Benefited
74	134	Baodiya	Benefited
75	135	Muwalia Khedar	Benefited
76	137	Hinoti	Benefited
77	138	Ilahipura	Benefited
78	140	Doongapura	Benefited
79	142	Neenore	Benefited
80	143	Barkheda Bir	Benefited
81	144	Baraytha	Benefited
82	149	Ramgarh	Benefited
83	152	Charpura	Benefited
84	153	Chainpura Khurd	Benefited
85	166	Bihar	Benefited
86	167	Beejwa	Benefited
87	178	Ganlyari	Benefited
88	179	Dharmya Khedi	Benefited
89	181	Jamonia Ganesh	Benefited
90	183	Badbeli Bihar	Benefited
91	184	Barkheda Amardas	Benefited

S. No.	Village Code	Village Name	Village Category
92	185	Onkarpura	Benefited
93	186	Nandgaon	Benefited
94	187	Mawasa	Benefited
95	188	Lasoodlya Pata	Benefited
96	190	Nipanya Garhi	Benefited
97	211	Gagar	Benefited
98	214	Sendri	Benefited
99	215	Gathla	Benefited
100	216	Guradiya	Benefited
101	217	Jhad Pipliya	Benefited
102	218	Bakani	Benefited
103	223	Hinotiya	Benefited
104	225	Khaleli	Benefited
105	226	Jasapura	Benefited
106	227	Jhumka	Benefited
107	228	Pakhari	Benefited
108	229	Padalaya Khedi	Benefited
109	230	Barkheda Dor	Benefited
110	231	Bisarti	Benefited
111	232	Anwali	Benefited
112	233	Piplya Jiya	Benefited
113	235	Mengla Deep	Benefited
114	236	Sukalya	Benefited
115	237	Hikmi	Benefited
116	238	Kotdi Kalan	Benefited
117	240	Kandara Kotdi	Benefited
118	241	Piplya Biram	Benefited
119	254	Mugal Khedi	Benefited
120	256	Kalali	Benefited
121	257	Bijori	Benefited
122	262	Kalyanpura	Benefited
123	263	Chhapri Khurd	Benefited
124	264	Chhapri Kalan	Benefited
125	266	Jhadla	Benefited
126	267	Badlya	Benefited
127	268	Manpichudi	Benefited
128	270	Jamoniya Gov Chauhan	Benefited
129	271	Palkhedi	Benefited
130	272	Bilwa Bhat	Benefited
131	280	Lasudliya Haji	Benefited
132	292	Kankaria Meena	Benefited
133	293	Mana	Benefited
134	375	Tuti	Benefited
135	412	Khajuri	Benefited
136	417	Bamora Sukha	Benefited

S. No.	Village Code	Village Name	Village Category
137	302	Boda	Benefited
138	80	Gadria Khedi	Study Area
139	81	Bhagor	Study Area
140	82	Bhil Khedi	Study Area
141	83	Ranawa	Study Area
142	90	Chandbad	Study Area
143	94	Ranjitpura	Study Area
144	95	Kalyadeh	Study Area
145	105	Pal	Study Area
146	136	Sagpur	Study Area
147	145	Baodi Kheda	Study Area
148	146	Vijaygarh	Study Area
149	148	Rugnathpura	Study Area
150	150	Amalya Ghat	Study Area
151	154	Chhawada	Study Area
152	156	Barkhedi Garhi	Study Area
153	157	Bhatpura	Study Area
154	158	Gopal Pura	Study Area
155	159	Rasid Khedi	Study Area
156	160	Resi	Study Area
157	161	Hanapura	Study Area
158	162	Tindonia	Study Area
159	163	Dev Garh	Study Area
160	169	Khedi	Study Area
161	171	Narsingpura	Study Area
162	172	Badodiya Talab	Study Area
163	173	Sarana	Study Area
164	174	Sobhagpura	Study Area
165	175	Shyampura	Study Area
166	176	Laljipura (Kudali)	Study Area
167	177	Khajuria	Study Area
168	180	Salaya	Study Area
169	182	Jamonia Johar	Study Area
170	189	Kunwar Kotri	Study Area
171	191	Hoshiyarkhedi	Study Area
172	194	Chor Khedi	Study Area
173	209	Umri	Study Area
174	210	Karwa	Study Area
175	212	Chumli	Study Area
176	213	Sukli	Study Area
177	219	Dhabla	Study Area
178	220	Panwadi	Study Area
179	221	Chandarpura	Study Area
180	222	Jhagaria	Study Area
181	224	Kankarria	Study Area

S. No.	Village Code	Village Name	Village Category
182	234	Mundla Barol	Study Area
183	239	Lula Khal	Study Area
184	242	Hulkhedi	Study Area
185	243	Kathiri	Study Area
186	244	Tajipura	Study Area
187	246	Dhan Khedi	Study Area
188	247	Bor Kheda	Study Area
189	248	Pipal Kheda	Study Area
190	249	Babron	Study Area
191	250	Birgadi	Study Area
192	251	Lalauti	Study Area
193	252	Nipanya Chetan	Study Area
194	253	Nipanya Bela	Study Area
195	255	Lasudiya Bhama	Study Area
196	258	Mastu Khedi	Study Area
197	259	Sahu Khedi	Study Area
198	260	Semla Goga	Study Area
199	261	Agwani	Study Area
200	265	Janukhedi	Study Area
201	273	Moyali Kalan	Study Area
202	275	Piplya Kaji	Study Area
203	278	Miru Khedi	Study Area
204	279	Laskarpur	Study Area
205	286	Gehun Khedi Khurd	Study Area
206	287	Chouki	Study Area
207	290	Semla Ramsingh	Study Area
208	294	Chand Badli	Study Area
209	295	Manpura Gujrati	Study Area
210	296	Lasudalya Ramnath	Study Area
211	297	Semal Khedi	Study Area
212	298	Kurawar	Study Area
213	300	Bilhari	Study Area
214	301	Kher Khedi	Study Area
215	302	Gila Khedi	Study Area
216	303	Chatar Pura	Study Area
217	305	Naihedi	Study Area
218	392	Lakha Khedi	Study Area
219	407	Jangibad	Study Area
220	408	Nahli	Study Area
221	409	Bamanpura	Study Area
222	410	Radhanpura	Study Area
223	411	Hirapura	Study Area

S. No.	Village Code	Village Name	Village Category
224	415	Bucha Khedi	Study Area
225	416	Ank Kheda	Study Area
226	418	Motipura	Study Area
227	419	Rawatpura	Study Area
228	420	Sehat Khedi	Study Area
229	421	Halya Hedi	Study Area
230	423	Turkipura	Study Area
231	424	Daulatpura	Study Area
232	426	Banapura	Study Area
District: Bhopal			
CD Block: Berasia			
233	79	Neem Khedi	Benefited
234	82	Bandikhedi	Benefited
235	84	Mengra	Benefited
236	85	Bijawan Kalan	Benefited
237	86	Ankia	Benefited
238	88	Mangalgarh	Benefited
239	93	Dhoot Khedi	Benefited
240	94	Bhaupura	Benefited
241	95	Bagasi	Benefited
242	98	Manikhedi	Benefited
243	74	Amarpur	Study Area
244	75	Barkheda Kalan	Study Area
245	76	Bhakhwaha	Study Area
246	77	Runaha	Study Area
247	83	Sumer	Study Area
248	90	Thikariya Laxmanpur	Study Area
249	91	Padli	Study Area
250	96	Gonda Khedi	Study Area
251	97	Parason	Study Area
252	99	Jajankhedi	Study Area
253	101	Kalapipal	Study Area
254	105	Mithi Chhapri	Study Area
255	106	Jhirniya	Study Area
District: Sehore			
CD Block: Sehore			
256	722	Gawa	Affected
257	727	Durgaon	Affected
258	728	Mahuakheda	Affected
259	729	Magardi Khurd	Affected
260	730	Chandbad	Affected
261	731	Bishan Kheda	Affected
262	732	Manpura	Affected
263	733	Rawat Kheda	Affected
264	734	Chhatarpura	Affected

S. No.	Village Code	Village Name	Village Category
265	735	Magardi Kalan	Affected
266	764	Charnal	Affected
267	765	Accharohi	Affected
268	766	Marhati	Affected
269	767	Bherupura	Affected
270	768	Arniya Sultanpur	Affected
271	771	Padiyala	Affected
272	777	Barri	Affected
273	778	Hingoni	Affected
274	779	Bamuliya	Affected
275	780	Bairagarh Khuman	Affected
276	840	Shyampur	Affected
277	842	Ghat Palasi	Affected
278	843	Raipur	Affected
279	844	Panbihar	Affected
280	845	Mukhtyar Nagar	Affected
281	846	Rawan Kheda	Affected
282	847	Kadrabad	Affected
283	848	Sar Kheda	Affected
284	849	Khandwa	Affected
285	562	Devli	Study Area
286	564	Londiya	Study Area
287	565	Dhankhedi	Study Area
288	719	Pili Karar	Study Area
289	720	Bansia	Study Area
290	721	Pater	Study Area
291	723	Satanwadi	Study Area
292	724	Barnawad	Study Area
293	726	Mendora	Study Area
294	736	Magarda	Study Area
295	737	Motipura Kalan	Study Area
296	738	Pathariya	Study Area
297	739	Jetla	Study Area
298	740	Patera	Study Area
299	741	Kushalpura	Study Area
300	742	Lodhipura	Study Area
301	743	Mungaoli	Study Area
302	744	Bazar Gaon	Study Area
303	745	Silkheda	Study Area
304	746	Jugrajpur	Study Area
305	747	Kolukhedi	Study Area
306	748	Garhi Baghraj	Study Area
307	749	Padaliya	Study Area
308	750	Barkheda	Study Area

S. No.	Village Code	Village Name	Village Category
		Hasan	
309	751	Suakhedi	Study Area
310	752	Dehri	Study Area
311	753	Jahangirgarh	Study Area
312	754	Phanda	Study Area
313	755	Salehpur	Study Area
314	756	Gundi	Study Area
315	757	Bankheda	Study Area
316	758	Karlat	Study Area
317	759	Ahmadpur	Study Area
318	760	Hirapur	Study Area
319	761	Majheda	Study Area
320	762	Kaku Khedi	Study Area
321	763	Sankla	Study Area
322	769	Pilukhedi	Study Area
323	770	Gopalpura	Study Area
324	772	Bairagarh Chhatri	Study Area
325	773	Chhatri	Study Area
326	774	Bhoja Khedi	Study Area
327	775	Khasta Khedi	Study Area
328	776	Ramja Khedi	Study Area
329	781	Sonthi	Study Area
330	782	Waheedganj	Study Area
331	783	Barkheda Deva	Study Area
332	784	Kasar Khedi	Study Area
333	785	Hasanpur Tinoniya	Study Area
334	786	Pipal Kheda	Study Area
335	787	Khaikheda	Study Area
336	788	Bheela Khedi	Study Area
337	789	Sikandarpur	Study Area
338	790	Mandkheda	Study Area
339	791	Rasulpura	Study Area
340	792	Budha Kheda	Study Area
341	793	Hinoti	Study Area
342	794	Shahjahanpur	Study Area
343	795	Ajmatnagar	Study Area
344	796	Naihedi	Study Area
345	797	Badarkasani	Study Area
346	798	Sankheda	Study Area
347	800	Hathiya Kheda	Study Area
348	801	Daulatpura	Study Area
349	814	Imaliya Hasan	Study Area
350	833	Mittukhedi	Study Area
351	837	Bichhiya	Study Area
352	839	Mahuakheda	Study Area

S. No.	Village Code	Village Name	Village Category	S. No.	Village Code	Village Name	Village Category
353	841	Niwariya	Study Area	373	145	Shekhpur Bongi	Study Area
354	850	Dhobikhedi	Study Area	374	146	Lasudalya Patla	Study Area
355	851	Khadampur	Study Area	375	147	Raghokhedi	Study Area
356	852	Gulkhedi	Study Area	376	148	Ganeshpur	Study Area
357	854	Munjkheda	Study Area	377	150	Mohammadpur (Machhnai)	Study Area
358	855	Khajuriya Khurd	Study Area	378	153	Chhapri	Study Area
359	856	Jajankhedi	Study Area	379	154	Jhundi	Study Area
360	857	Bairagarh Ganesh	Study Area	380	155	Hanumant Kheda	Study Area
361	860	Karanj Kheda	Study Area	381	156	Hajipur	Study Area
362	862	Rampalasi	Study Area	382	158	Khokara Kalan	Study Area
363	863	Kachnariya	Study Area	383	160	Semliya	Study Area
364	864	Khajuriya Kalan	Study Area	384	161	Mundla Maina	Study Area
District: Shajapur				385	162	Bamuliya Maina	Study Area
CD Block: Kalapipal				386	163	Parda Khedi	Study Area
365	149	Bapcha	Affected	387	164	Bhaisaya Gadha	Study Area
366	151	Ghat Khedi	Affected	388	165	Badbeli	Study Area
367	152	Chakrana Bad	Affected	389	169	Bhesaya Nagan	Study Area
368	136	Richhadi	Study Area	390	187	Dhabla Dheer	Study Area
369	138	Kohada	Study Area	391	189	Chayani	Study Area
370	139	Kohadi	Study Area				
371	142	Khardon Kalan	Study Area				
372	144	Galbi	Study Area				

4.2.1 Description of District

All project components as well as entire study area falls under Rajgarh, Bhopal, Sehore and Shajapur districts. Rajgarh district is located in the northern part of Malwa plateau. It forms the North western part of Bhopal Commissioner's division. Rajgarh district extends between the parallels of latitude 23°28' and 24°16' N and between the meridians of longitude 76°12' and 77°15' E. The district is bound by Shajapur district in the south as well as west. The districts of Sehore, Bhopal, Guna and Jhalawar (Rajasthan) enclose it from the south-east, east, north-east, and north directions respectively. The total geographical area of the district is 6,153 sq.km. According to Census 2011, there are 7 tehsils, 6 CD Blocks and 13 towns in the district. There are total 1,728 villages in the district, out of which, 1,677 villages are inhabited and rest of the 51 villages are un-inhabited. Total households in the district are 3,45,297 with household size of 4.5. Total population of the district is 1,545,814 and the sex ratio of district is 956. The scheduled caste and scheduled tribes percentage population of the district is 19.1% and 3.5% respectively. Literacy rate of the district is quite good i.e. 61.2%. Total working population of the district is 48.2%.

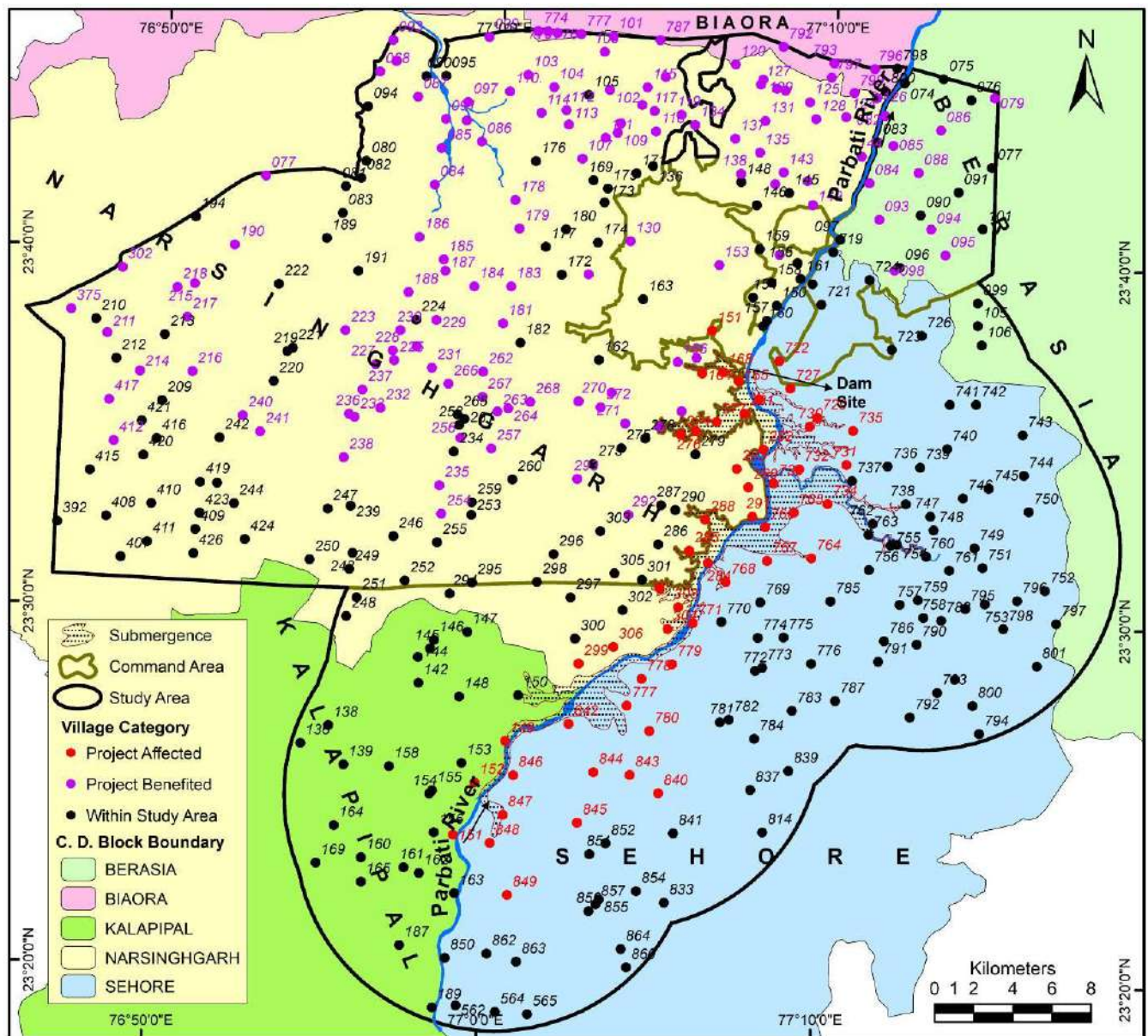


Figure 4.1: Map showing villages in the Study Area
(Refer Table 4.1 for name of villages)

The district Bhopal lies in the eastern edge of Malwa Plateau and is situated in the central part of the state between latitude $23^{\circ}04'$ and $23^{\circ}53'$ north and longitude $77^{\circ}12'$ and $77^{\circ}40'$ east. The district is bounded by Rajgarh district in the northwest, Guna district in the north, Vidisha district in the north-east, Raisen district in the south-east and Sehore district in the south-west. The district is spread across a total geographical area of 2,772 sq. Km. According to Census 2011, there are 2 tehsils, 2 CD Blocks and 3 statutory towns in the district. There are total 519 villages in the district, out of which, 501 villages are inhabited and rest of the 18 villages are un-inhabited. Total households in the district are 5,01,805 with household size of 4.7. Total population of the district is 2,371,061 and the sex ratio of district is 918. The scheduled caste and scheduled tribes percentage population of the district is 15.1% and 2.9%

respectively. Literacy rate of the district is very good i.e. 80.4%. Total working population of the district is 36.6% only.

District Sehore is 39 Km away from state capital Bhopal towards south and on Bhopal-Indore highway. Sehore is surrounded by seven districts i.e. Bhopal, Raisen, Hoshangabad, Dewas, Shajapur, Rajgarh, and Harda. Sehore District extends between the parallels of Latitude 22°32' N to 23°40' North and between the meridians of Longitude 76°22' E to 78°03' East. The district stands in the foothills of Vindhya range in the middle of Malwa region. The district is spread across a total geographical area of 6,578 sq. Km. According to Census 2011, there are 8 tehsils, 5 CD Blocks and 5 towns in the district. There are total 1,072 villages in the district, out of which, 1,031 villages are inhabited and rest of the 41 villages are un-inhabited. Household size of the district is 5.1 persons. Total population of the district is 1,311,332 and the sex ratio of district is 918. The scheduled caste and scheduled tribes percentage population of the district is 20.7% and 11.1% respectively. Literacy rate of the district is quite good i.e. 70.1%. Total working population of the district is 44.7%.

Shajapur district is a part of the Central Madhya Pradesh Plateau-Ratlam plateau Micro region according to the present scheme of regional delineation. The district is situated in the north-western part of the state and lies between latitudes 23°06' and 24°19' North and longitudes 75°41' and 77°02' East. The district is bounded by Ujjain in the west, Dewas and Sehore in the south, Rajgarh in the east and Jalawar district of Rajasthan in the north. The district is spread across a total geographical area of 6,195 sq. Km. According to Census 2011, there are 9 tehsils, 8 CD Blocks and 13 towns in the district. There are total 1,107 villages in the district, out of which, 1,071 villages are inhabited and rest of the 36 villages are un-inhabited. Household size of the district is 5.0 persons. Total population of the district is 1,512,681 and the sex ratio of district is 938. The scheduled caste and scheduled tribes percentage population of the district is 23.4% and 2.5% respectively. Literacy rate of the district is quite good i.e. 69.1%. Total working population of the district is 47.5%.

4.3 SOCIO ECONOMIC PROFILE OF THE STUDY AREA

Study area of Parbati Major Irrigation Project comprising of 391 villages is spread over Biaora and Narsinghgarh CD Blocks of Rajgarh district; Berasia CD Block of Bhopal district; Sehore CD Block of Sehore district; and Kalapipal CD Block of Shajapur district.

4.3.1 Demographic Profile

As per Census 2011, total households in the 391 study area villages 90471. Total population of the study area is 422,184, out of which, 218,368 are male 203,816 are female and the sex ratio is 933. The scheduled caste and scheduled tribe's percentage population is 18.6% and 3.3% respectively (refer **Table 4.2**).

4.3.2 Literacy Profile

Literacy profile of the study area is given in **Table 4.3**. The literate population is 231,818, of which male and female are 142,750 and 89,068, respectively. Literacy rate is 65.3%, of which male and female literacy rate is 61.6% and 38.4% respectively.

4.3.3 Occupation Pattern

The occupation pattern in the study area is given in **Table 4.4**. As per Census data of 2011, it is observed that 46.9% of the total population has been classified as "Total Workers". Of the total workers, 59.5% are classified as "Main Workers" while, 40.5% are classified as "Marginal Workers". Of the total population, 53.1% are "Non Workers".

Table 4.2: Demographic Profile

District	CD Block	Category of Villages	No. of Villages	No. of Households	Population			Sex Ratio	Scheduled Caste			Scheduled Tribe		
					T	M	F		T	M	F	T	M	F
Rajgarh	Biaora	Affected	0	0	0	0	0	0	0	0	0	0	0	0
		Benefited	10	2207	10350	5281	5069	960	1500	750	750	1971	1020	951
		Study Area	2	121	436	222	214	964	0	0	0	26	11	15
		Sub Total	12	2328	10786	5503	5283	960	1500	750	750	1997	1031	966
	Narsinghgarh	Affected*	20	3671	16375	8448	7927	938	3038	1560	1478	191	97	94
		Benefited	111	25878	114287	58521	55766	953	23023	11833	11190	4180	2173	2007
		Study Area	89	23284	102613	52807	49806	943	18518	9521	8997	3625	1796	1829
		Sub Total	220	52833	233275	119776	113499	948	44579	22914	21665	7996	4066	3930
Bhopal	Berasia	Affected	0	0	0	0	0	0	0	0	0	0	0	0
		Benefited	11	1564	7819	4064	3755	924	1490	785	705	282	151	131
		Study Area	12	1934	9645	4963	4682	943	2042	1040	1002	354	181	173
		Sub Total	23	3498	17464	9027	8437	935	3532	1825	1707	636	332	304
Sehore	Sehore	Affected	29	8280	42920	22625	20295	897	7515	3907	3608	876	465	411
		Benefited	0	0	0	0	0	0	0	0	0	0	0	0
		Study Area	80	15204	73904	38602	35302	915	13802	7210	6592	982	509	473
		Sub Total	109	23484	116824	61227	55597	908	21317	11117	10200	1858	974	884
Shajapur	Kalapipal	Affected	3	316	1520	785	735	936	516	257	259	0	0	0
		Benefited	0	0	0	0	0	0	0	0	0	0	0	0
		Study Area	24	8012	42315	22050	20265	919	7136	3713	3423	1352	710	642
		Sub Total	27	8328	43835	22835	21000	920	7652	3970	3682	1352	710	642
Total		Affected	52	12267	60815	31858	28957	909	11069	5724	5345	1067	562	505
		Benefited	132	29649	132456	67866	64590	952	26013	13368	12645	6433	3344	3089
		Study Area	207	48555	228913	118644	110269	929	41498	21484	20014	6339	3207	3132
Grand Total			391	90471	422184	218368	203816	933	78580	40576	38004	13839	7113	6726

Source: Census of India: 2011, T=Total, M=Male, F=Female

Note: * Lasudliya Haji village of Narsingharh CD Block in Rajgarh district is benefited as well as affected village, hence, has been calculated under benefited.

Table 4.3: Literacy Profile

District	CD Block	Category of Villages	Population Aged 7+	Literate Population			Literacy Rate (%)		
				Total	Male	Female	Total*	Male**	Female***
Rajgarh	Biaora	Affected	0	0	0	0	0	0	0
		Benefited	8618	4829	3002	1827	56.0	62.2	37.8
		Study Area	359	220	130	90	61.3	59.1	40.9
		Sub Total	8977	5049	3132	1917	56.2	62	38.0
	Narsinghgarh	Affected	13418	8409	5154	3255	62.7	61.3	38.7
		Benefited	96738	60146	37184	22962	62.2	61.8	38.2
		Study Area	86322	57930	35448	22482	67.1	61.2	38.8
		Sub Total	196478	126485	77786	48699	64.4	61.5	38.5
Bhopal	Berasia	Affected	0	0	0	0	0	0	0
		Benefited	6456	3608	2305	1303	55.9	63.9	36.1
		Study Area	8002	4966	3037	1929	62.1	61.2	38.8
		Sub Total	14458	8518	5310	3208	58.9	62.3	37.7
Sehore	Sehore	Affected	36042	24188	15016	9172	67.1	62.1	37.9
		Benefited	0	0	0	0	0	0	0
		Study Area	62246	40940	25356	15584	65.8	61.9	38.1
		Sub Total	98288	65128	40372	24756	66.3	62.0	38.0
Shajapur	Kalapipal	Affected	1275	995	568	427	78.0	57.1	42.9
		Benefited	0	0	0	0	0	0	0
		Study Area	35765	25587	15550	10037	71.5	60.8	39.2
		Sub Total	37040	26582	16118	10464	71.8	60.6	39.4
Total		Affected	50735	33592	20738	12854	66.2	61.7	38.3
		Benefited	111812	68583	42491	26092	61.3	62.0	38.0
		Study Area	192694	129643	79521	50122	67.3	61.3	38.7
Grand Total			355241	231818	142750	89068	65.3	61.6	38.4

Source: Census of India: 2011,

Note: *Literacy Rate = No. of Literates/ Population aged 7+ x 100

** Male Literacy Rate = No. of Male Literates/ Total Literates x 100

*** Female Literacy Rate = No. of Female Literates/ Total Literates x 100

Table 4.4: Occupational Pattern

District	CD Block	Category of Villages	P	Working Population									Non Worker		
				Total Workers			Main Worker			Marginal Worker					
				T	M	F	T	M	F	T	M	F	T	M	F
Rajgarh	Biaora	Affected	0	0	0	0	0	0	0	0	0	0	0	0	0
		Benefited	10350	5582	2907	2675	3246	2195	1051	2336	712	1624	4768	2374	2394
		Study Area	436	250	128	122	137	71	66	113	57	56	186	94	92
		Sub Total	10786	5832	3035	2797	3383	2266	1117	2449	769	1680	4954	2468	2486
	Narsinghgarh	Affected	16375	6875	4199	2676	5095	3348	1747	1780	851	929	9500	4249	5251
		Benefited	114287	56876	31746	25130	31576	21691	9885	25300	10055	15245	57411	26775	30636
		Study Area	102613	47725	27929	19796	28676	20581	8095	19049	7348	11701	54888	24878	30010
		Sub Total	233275	111476	63874	47602	65347	45620	19727	46129	18254	27875	121799	55902	65897
Bhopal	Berasia	Affected	0	0	0	0	0	0	0	0	0	0	0	0	0
		Benefited	7819	3909	2095	1814	2628	1813	815	1281	282	999	3910	1969	1941
		Study Area	9645	4779	2661	2118	2876	1985	891	1903	676	1227	4866	2314	2552
		Sub Total	17464	8688	4756	3932	5504	3798	1706	3184	958	2226	8776	4283	4493
Sehore	Sehore	Affected	42920	18487	11342	7145	9346	8215	1131	9141	3127	6014	24433	11283	13150
		Benefited	0	0	0	0	0	0	0	0	0	0	0	0	0
		Study Area	73904	34130	20179	13951	18905	15170	3735	15225	5009	10216	39774	18423	21351
		Sub Total	116824	52617	31521	21096	28251	23385	4866	24366	8136	16230	64207	29706	34501
Shajapur	Kalapipal	Affected	1520	755	400	355	679	386	293	76	14	62	765	385	380
		Benefited	0	0	0	0	0	0	0	0	0	0	0	0	0
		Study Area	42315	18634	11184	7450	14504	9888	4616	4130	1296	2834	23681	10866	12815
		Sub Total	43835	19389	11584	7805	15183	10274	4909	4206	1310	2896	24446	11251	13195
Total		Affected	60815	26117	15941	10176	15120	11949	3171	10997	3992	7005	34698	15917	18781
		Benefited	132456	66367	36748	29619	37450	25699	11751	28917	11049	17868	66089	31118	34971
		Study Area	228913	105518	62081	43437	65098	47695	17403	40420	14386	26034	123395	56575	66820
Grand Total			422184	198002	114770	83232	117668	85343	32325	80334	29427	50907	224182	103610	120572

Source: Census of India: 2011, P=Population, T=Total, M=Male, F=Female

4.4 SOCIO-ECONOMIC SURVEY

Socio-economic survey of villages located in the project study area was carried out on sample survey basis. Under the sample survey, 20 villages out of the total 132 project benefitted villages and the 18 project affected villages which will be rehabilitated/resettled were selected, which constitute about 25% sample size.

4.4.1 Socio Economic Profile of the Project Affected Villages

Due to the project 18 villages shall be rehabilitated/resettled. The demographic profile of the sampled project affected villages is given in **Table 4.5**. In the project affected villages studied there are 2476 total number of households with a total population of 10488 comprising of 5451 and 5037 male and females, respectively. The sex ratio is 924 females per thousand males. Jhadkiya is the largest village with a population of 1451 whereas Fatehpur is smallest with a population of only 63 persons. Fatehpur village has the highest sex ratio (1172) and Pura Village has the least (863). The population of Scheduled Castes and Scheduled Tribes in the project affected villages is 21.4% and 3.2%, respectively.

The literacy profile of the project affected villages is given in **Table 4.6**. The male and female literate population in surveyed project affected villages is 3355 and 2061, respectively, which implies that the literacy rate of the project affected area is 61.9 % of which the male 61.9% while the female 38.1%. Rawat Kheda village has the highest literacy rate (75.8%) while Mangatpura Village has the least literacy rate of 53.2%. Fatehpur has the highest female literacy rate also (48.3%) and Durgaon has the lowest female literacy rate of 32.3%.

The education facilities in the project affected villages are shown in **Table 4.7**. Apart from Bherupura village, primary school is there in all the villages. Barodi, Sundi, Teni Dhakad, Durgaon, Chandbad, Marhati and Arniya Sultanpur villages have middle school. Secondary school is village Chandbad only. There are no senior secondary school in any of the project affected villages.

Available medical facility in surveyed villages is given in **Table 4.8**. The data shows that Chandbad is the only village having medical facility in terms of public health sub center and maternity & child welfare facility. Apart from this there is no medical facility in the affected villages.

Table 4.5: Demographic Profile of the Project Affected Villages

S. No.	Village Name	CD Block	Total Households	Total Population			Scheduled Castes			Scheduled Tribes			Sex Ratio
				Total	Male	Female	Total	Male	Female	Total	Male	Female	
1	Partappura	Narsingharh	25	111	55	56	40	23	17	0	0	0	1018
2	Fatehpur	Narsingharh	14	63	29	34	0	0	0	0	0	0	1172
3	Bherupura	Narsingharh	16	90	44	46	0	0	0	0	0	0	1045
4	Barodi	Narsingharh	137	469	249	220	101	57	44	0	0	0	884
5	Mangatpura	Narsingharh	98	373	182	191	220	104	116	0	0	0	1049
6	Sanka Jagir	Narsingharh	257	1229	626	603	153	81	72	49	26	23	963
7	Sundi	Narsingharh	137	533	280	253	198	96	102	0	0	0	904
8	Gadupura	Narsingharh	54	252	132	120	58	30	28	0	0	0	909
9	Jhadkiya	Narsingharh	379	1451	752	699	455	245	210	28	14	14	930
10	Terni Dhakad	Narsingharh	245	1090	561	529	208	99	109	0	0	0	943
11	Hiran Khedi	Narsingharh	61	244	131	113	0	0	0	0	0	0	863
12	Durgaon	Sehore	257	1003	531	472	75	40	35	9	6	3	889
13	Mahuakheda	Sehore	146	589	315	274	34	19	15	0	0	0	870
14	Magardi Khurd	Sehore	70	321	174	147	39	18	21	127	67	60	845
15	Chandbad	Sehore	202	835	434	401	162	83	79	77	38	39	924
16	Rawat Kheda	Sehore	81	456	236	220	95	52	43	16	7	9	932
17	Marhati	Sehore	153	665	340	325	177	97	80	0	0	0	956
18	Arniya Sultanpur	Sehore	144	714	380	334	226	121	105	27	11	16	879
	Total		2476	10488	5451	5037	2241	1165	1076	333	169	164	924

T=Total, M=Male, F=Female

Table 4.6: Literacy Profile of the Project Affected Villages

S. No.	Village Name	CD Block	Population Aged 7+	Literate Population			Literacy Rate (%)		
				T	M	F	T*	M	F
1	Partappura	Narsingharh	94	53	29	24	56.4	54.7	45.3
2	Fatehpur	Narsingharh	49	29	15	14	59.2	51.7	48.3
3	Bherupura	Narsingharh	79	59	32	27	74.7	54.2	45.8
4	Barodi	Narsingharh	396	264	176	88	66.7	66.7	33.3
5	Mangatpura	Narsingharh	308	164	90	74	53.2	54.9	45.1
6	Sanka Jagir	Narsingharh	1015	629	390	239	62	62	38.0
7	Sundi	Narsingharh	443	246	155	91	55.5	63	37.0
8	Gadupura	Narsingharh	187	122	72	50	65.2	59	41.0
9	Jhadkiya	Narsingharh	1220	767	457	310	62.9	59.6	40.4
10	Terni Dhakad	Narsingharh	911	482	303	179	52.9	62.9	37.1
11	Hiran Khedi	Narsingharh	208	145	94	51	69.7	64.8	35.2
12	Durgaon	Sehore	803	449	304	145	55.9	67.7	32.3
13	Mahuakheda	Sehore	521	303	202	101	58.2	66.7	33.3
14	Magardi Khurd	Sehore	291	200	129	71	68.7	64.5	35.5
15	Chandbad	Sehore	726	484	293	191	66.7	60.5	39.5
16	Rawat Kheda	Sehore	372	282	161	121	75.8	57.1	42.9
17	Marhati	Sehore	530	332	205	127	62.6	61.7	38.3
18	Arniya Sultanpur	Sehore	602	406	248	158	67.4	61.1	38.9
Total			8755	5416	3355	2061	61.9	61.9	38.1

Table 4.7: Education Facility in Project Affected Villages

S. No.	Villages	CD Block	Primary School	Middle School	Secondary School	Senior Secondary School
1	Partappura	Narsingharh	Yes	No	No	No
2	Fatehpur	Narsingharh	Yes	No	No	No
3	Bherupura	Narsingharh	No	No	No	No
4	Barodi	Narsingharh	Yes	Yes	No	No
5	Mangatpura	Narsingharh	Yes	No	No	No
6	Sanka Jagir	Narsingharh	Yes	No	No	No
7	Sundi	Narsingharh	Yes	Yes	No	No
8	Gadupura	Narsingharh	Yes	No	No	No
9	Jhadkiya	Narsingharh	Yes	No	No	No
10	Terni Dhakad	Narsingharh	Yes	Yes	No	No
11	Hiran Khedi	Narsingharh	Yes	No	No	No
12	Durgaon	Sehore	Yes	Yes	No	No
13	Mahuakheda	Sehore	Yes	No	No	No
14	Magardi Khurd	Sehore	Yes	No	No	No
15	Chandbad	Sehore	Yes	Yes	Yes	No
16	Rawat Kheda	Sehore	Yes	No	No	No
17	Marhati	Sehore	Yes	Yes	No	No
18	Arniya Sultanpur	Sehore	Yes	Yes	No	No

Table 4.8: Medical Facilities in Project Affected Villages

S. No.	Villages	CD Block	CHC	PHC	PHSC	MCW	Private MBBS Doctor	VH
1	Partappura	Narsingharh	No	No	No	No	No	No
2	Fatehpur	Narsingharh	No	No	No	No	No	No
3	Bherupura	Narsingharh	No	No	No	No	No	No
4	Barodi	Narsingharh	No	No	No	No	No	No

S. No.	Villages	CD Block	CHC	PHC	PHSC	MCW	Private MBBS Doctor	VH
5	Mangatpura	Narsingharh	No	No	No	No	No	No
6	Sanka Jagir	Narsingharh	No	No	No	No	No	No
7	Sundi	Narsingharh	No	No	No	No	No	No
8	Gadupura	Narsingharh	No	No	No	No	No	No
9	Jhadkiya	Narsingharh	No	No	No	No	No	No
10	Terni Dhakad	Narsingharh	No	No	No	No	No	No
11	Hiran Khedi	Narsingharh	No	No	No	No	No	No
12	Durgaon	Sehore	No	No	No	No	No	No
13	Mahuakheda	Sehore	No	No	No	No	No	No
14	Magardi Khurd	Sehore	No	No	No	No	No	No
15	Chandbad	Sehore	No	No	Yes	Yes	No	No
16	Rawat Kheda	Sehore	No	No	No	No	No	No
17	Marhati	Sehore	No	No	No	No	No	No
18	Arniya Sultanpur	Sehore	No	No	No	No	No	No

The availability of water sources in the project affected villages is given in **Table 4.9**. The data states that villagers depend on handpump and tube wells for drinking water facility. For irrigation few villages depend on river Parbati through pumping of water and tube wells. Wheat, Soybean, Tur, Gram, Onion, Garlic are the main crop grown in the area.

Table 4.9: Water Sources and Agricultural Crops in Project Affected villages

S. No.	Village Name	CD Block	Hand Pump	Tube well	River	Pond	Agriculture Crops
1	Partappura	Narsingharh	Yes	Yes	No	Yes	Wheat, Soybean, Tur, Gram, Onion, Garlic
2	Fatehpur	Narsingharh	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
3	Bherupura	Narsingharh	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
4	Barodi	Narsingharh	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
5	Mangatpura	Narsingharh	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
6	Sanka Jagir	Narsingharh	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
7	Sundi	Narsingharh	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram
8	Gadupura	Narsingharh	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
9	Jhadkiya	Narsingharh	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
10	Terni Dhakad	Narsingharh	Yes	Yes	Yes	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
11	Hiran Khedi	Narsingharh	Yes	Yes	Yes	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
12	Durgaon	Sehore	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
13	Mahuakheda	Sehore	Yes	Yes	Yes	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
14	Magardi	Sehore	Yes	Yes	Yes	Yes	Wheat, Soybean, Tur, Gram,

S. No.	Village Name	CD Block	Hand Pump	Tube well	River	Pond	Agriculture Crops
	Khurd						Onion, Garlic
15	Chandbad	Sehore	Yes	Yes	Yes	Yes	Wheat, Soybean, Tur, Gram, Onion, Garlic
16	Rawat Kheda	Sehore	Yes	Yes	Yes	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
17	Marhati	Sehore	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
18	Arniya Sultanpur	Sehore	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic

In addition to available amenities and facilities in the surveyed villages other infrastructure and characteristics of surveyed villages are given in **Table 4.10**. Electricity is available in all the villages. The water level varies from 220 to 245ft in all the villages. Quality of drinking water is good and there are no cases of malaria reported from the area. Agriculture is main economic activity while other occupation is labour work. There are cooperative societies in all the villages and nearest market are available in Pachore, Narsingharh, Sonkacch and Shyampur.

4.4.2 Socio Economic Profile of the Project Benefited Villages

The demographic profile of the surveyed project benefited villages is given in **Table 4.11**. In the project benefited villages studied there are 6290 total number of households with a total population of 28953. The sex ratio is 945 females per thousand males. Kotdi Kalan is the largest village with maximum number of households (1402) with a population of 6711 whereas Bandikhedi is smallest with 94 households and a population of only 564 persons. The population of Scheduled Castes and Scheduled Tribes in the surveyed villages is 19.9% and 3.9%, respectively.

The literacy profile of the project benefited villages is given in **Table 4.12**. The male and female literate population in surveyed project benefited villages is 9253 and 5567, respectively, which implies that the literacy rate of the surveyed project benefited villages is 61.0 % of which the male 62.4% while the female 37.6%. Bakani village has the highest literacy rate (72.9%) while Bijawan Kalan Village has the least literacy rate of 44.0%. Bakani has the highest female literacy rate (43.2%) and Nipanya Garhi has the lowest female literacy rate of 31.7%.

Table 4.10: Other Available Amenities/Facilities and Characteristics of Surveyed Project Affected Villages

S. No.	Villages	Water Tank	Electricity	Water level in tube wells and open well (ft)	Availability of water up to which month	Quality of drinking water	Malaria Cases detected and treated	Economy/ Occupation	Nearest Market	Cooperative Society
1	Partappura	Yes	Yes	210	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
2	Fatehpur	No	Yes	215	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
3	Bherupura	No	Yes	230	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
4	Barodi	No	Yes	180	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
5	Mangatpura	No	Yes	195	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
6	Sanka Jagir	No	Yes	200	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
7	Sundi	No	Yes	195	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
8	Gadupura	No	Yes	220	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
9	Jhadkiya	No	Yes	235	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
10	Terni Dhakad	No	Yes	245	August/	Good	No	Agriculture/	Pachore,	Yes

S. No.	Villages	Water Tank	Electricity	Water level in tube wells and open well (ft)	Availability of water up to which month	Quality of drinking water	Malaria Cases detected and treated	Economy/ Occupation	Nearest Market	Cooperative Society
					September			Labour	Narsingharh, Sonkacch, Shyampur	
11	Hiran Khedi	No	Yes	180	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
12	Durgaon	No	Yes	195	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
13	Mahuakheda	No	Yes	175	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
14	Magardi Khurd	Yes	Yes	150	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
15	Chandbad	Yes	Yes	205	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
16	Rawat Kheda	No	Yes	210	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
17	Marhati	No	Yes	200	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
18	Arniya Sultanpur	No	Yes	220	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes

Table 4.11: Demographic Profile of the Surveyed Project Benefited Villages

S. No.	Village Name	CD Block	Total Households	Total Population	Total Male	Total Female	Sex Ratio	Total Scheduled Castes Population	Scheduled Castes Population (%)	Total Scheduled Tribes Population	Scheduled Tribes Population (%)
1	Amlyahat	Biaora	242	1249	630	619	983	287	23.0	5	0.4
2	Bhanwas	Biaora	339	1855	944	911	965	103	5.6	48	2.6
3	Mundla Bajrang	Narsingharh	134	683	351	332	946	80	11.7	0	0.0
4	Palasi	Narsingharh	157	565	302	263	871	103	18.2	0	0.0
5	Gandhigram	Narsingharh	319	1336	701	635	906	1096	82.0	63	4.7
6	Ganlyari	Narsingharh	552	2477	1269	1208	952	529	21.4	0	0.0
7	Onkarpura	Narsingharh	154	924	482	442	917	142	15.4	0	0.0
8	Nandgaon	Narsingharh	132	652	324	328	1012	115	17.6	31	4.8
9	Mawasa	Narsingharh	402	1474	756	718	950	334	22.7	141	9.6
10	Lasoodlya Pata	Narsingharh	147	671	350	321	917	157	23.4	0	0.0
11	Nipanya Garhi	Narsingharh	395	2001	1044	957	917	195	9.7	380	19.0
12	Gathla	Narsingharh	299	1084	547	537	982	198	18.3	136	12.5
13	Jhad Pipliya	Narsingharh	439	1723	856	867	1013	338	19.6	0	0.0
14	Bakani	Narsingharh	290	1000	490	510	1041	131	13.1	73	7.3
15	Sukalya	Narsingharh	177	812	429	383	893	289	35.6	155	19.1
16	Kotdi Kalan	Narsingharh	1402	6711	3431	3280	956	924	13.8	32	0.5
17	Bandikhedi	Berasia	94	564	306	258	843	25	4.4	0	0.0
18	Bijawan Kalan	Berasia	114	704	377	327	867	106	15.1	2	0.3
19	Ankia	Berasia	187	953	494	459	929	162	17.0	28	2.9
20	Bagasi	Berasia	315	1515	804	711	884	451	29.8	26	1.7
Total			6290	28953	14887	14066	945	5765	19.9	1120	3.9

Table 4.12: Literacy Profile of the Surveyed Project Benefited Villages

S. No.	Village Name	CD Block	Population Aged 7+	Literate Population			Literacy Rate (%)		
				T	M	F	T	M	F
1	Amlyahat	Biaora	1088	668	429	239	61.4	64.2	35.8
2	Bhanwas	Biaora	1555	812	524	288	52.2	64.5	35.5
3	Mundla Bajrang	Narsingharh	612	303	197	106	49.5	65.0	35.0
4	Palasi	Narsingharh	499	308	206	102	61.7	66.9	33.1
5	Gandhigram	Narsingharh	1126	748	448	300	66.4	59.9	40.1
6	Ganlyari	Narsingharh	2094	1241	773	468	59.3	62.3	37.7
7	Onkarpura	Narsingharh	802	491	301	190	61.2	61.3	38.7
8	Nandgaon	Narsingharh	541	375	223	152	69.3	59.5	40.5
9	Mawasa	Narsingharh	1261	905	539	366	71.8	59.6	40.4
10	Lasoodlya Pata	Narsingharh	555	334	211	123	60.2	63.2	36.8
11	Nipanya Garhi	Narsingharh	1725	1082	739	343	62.7	68.3	31.7
12	Gathla	Narsingharh	931	614	378	236	66.0	61.6	38.4
13	Jhad Pipliya	Narsingharh	1491	795	479	316	53.3	60.3	39.7
14	Bakani	Narsingharh	867	632	359	273	72.9	56.8	43.2
15	Sukalya	Narsingharh	708	481	310	171	67.9	64.4	35.6
16	Kotdi Kalan	Narsingharh	5357	3321	2049	1272	62.0	61.7	38.3
17	Bandikhedi	Berasia	464	271	180	91	58.4	66.4	33.6
18	Bijawan Kalan	Berasia	568	250	168	82	44.0	67.2	32.8
19	Ankia	Berasia	814	488	294	194	60.0	60.2	39.8
20	Bagasi	Berasia	1228	701	446	255	57.1	63.6	36.4
Total			24286	14820	9253	5567	61.0	62.4	37.6

The data on available education facilities in the project benefited villages is given in **Table 4.13**. Primary school facility is available in all villages. Except Onkarpura, Sukalya, Bandikhedi and Bijawan Kalan, each village has Middle school. The secondary school facilities available in only 9 villages viz. Amlyahat, Bhanwas, Gandhigram, Ganlyari, Mawasa, Nipanya Garhi, Bakani, Kotdi Kalan and Bagasi while senior secondary school is in only 2 villages viz. Nipanya Garhi and Kotdi Kalan.

Table 4.13: Education Facility in the Surveyed Project Benefited Villages

S. No.	Villages	CD Block	Primary School	Middle School	Secondary School	Senior Secondary School
1	Amlyahat	Biaora	Yes	Yes	Yes	No
2	Bhanwas	Biaora	Yes	Yes	Yes	No
3	Mundla Bajrang	Narsingharh	Yes	Yes	No	No
4	Palasi	Narsingharh	Yes	Yes	No	No
5	Gandhigram	Narsingharh	Yes	Yes	Yes	No
6	Ganlyari	Narsingharh	Yes	Yes	Yes	No
7	Onkarpura	Narsingharh	Yes	No	No	No
8	Nandgaon	Narsingharh	Yes	Yes	No	No
9	Mawasa	Narsingharh	Yes	Yes	Yes	No
10	Lasoodlya Pata	Narsingharh	Yes	Yes	No	No
11	Nipanya Garhi	Narsingharh	Yes	Yes	Yes	Yes
12	Gathla	Narsingharh	Yes	Yes	No	No
13	Jhad Pipliya	Narsingharh	Yes	Yes	No	No

S. No.	Villages	CD Block	Primary School	Middle School	Secondary School	Senior Secondary School
14	Bakani	Narsingharh	Yes	Yes	Yes	No
15	Sukalya	Narsingharh	Yes	No	No	No
16	Kotdi Kalan	Narsingharh	Yes	Yes	Yes	Yes
17	Bandikhedi	Berasia	Yes	No	No	No
18	Bijawan Kalan	Berasia	Yes	No	No	No
19	Ankia	Berasia	Yes	Yes	No	No
20	Bagasi	Berasia	Yes	Yes	Yes	No

Available medical facility in surveyed benefited villages is given in **Table 4.14**. There are no community health centres (CHC), maternity & child welfare (MCW), private medical practitioner and veterinary hospital in any of the villages. Primary Health Centres are available in Ganlyari and Kotdi Kalan villages only. Similarly, Primary Health Sub-Centres are available in Amlyahat and Nandgaon villages only.

Table 4.14: Medical Facilities in the Surveyed Project Benefited Villages

S. No.	Villages	CD Block	CHC	PHC	PHSC	MCW	Private MBBS Doctor	VH
1	Amlyahat	Biaora	No	No	Yes	No	No	No
2	Bhanwas	Biaora	No	No	No	No	No	No
3	Mundla Bajrang	Narsingharh	No	No	No	No	No	No
4	Palasi	Narsingharh	No	No	No	No	No	No
5	Gandhigram	Narsingharh	No	No	No	No	No	No
6	Ganlyari	Narsingharh	No	Yes	No	No	No	No
7	Onkarpura	Narsingharh	No	No	No	No	No	No
8	Nandgaon	Narsingharh	No	No	Yes	No	No	No
9	Mawasa	Narsingharh	No	No	No	No	No	No
10	Lasoodlya Pata	Narsingharh	No	No	No	No	No	No
11	Nipanya Garhi	Narsingharh	No	No	No	No	No	No
12	Gathla	Narsingharh	No	No	No	No	No	No
13	Jhad Pipliya	Narsingharh	No	No	No	No	No	No
14	Bakani	Narsingharh	No	No	No	No	No	No
15	Sukalya	Narsingharh	No	No	No	No	No	No
16	Kotdi Kalan	Narsingharh	No	Yes	No	No	No	No
17	Bandikhedi	Berasia	No	No	No	No	No	No
18	Bijawan Kalan	Berasia	No	No	No	No	No	No
19	Ankia	Berasia	No	No	No	No	No	No
20	Bagasi	Berasia	No	No	No	No	No	No

CHC-Community Health Centre; PHC- Primary Health Centre; PHSC- Primary Health Sub Centre; MCW- Maternity & Child Welfare; VH-Veterinary Hospital.

The availability of water sources in the project benefited villages is given in **Table 4.15**. The data states that villagers depend on handpump and tube wells for drinking water facility. For irrigation villagers depend and tube wells. Wheat, Soybean, Tur, Gram, Onion, Garlic are the main crop grown in the area.

**Table 4.15: Water Sources and Agricultural Crops in the Surveyed Project
Benefited Villages**

S. No.	Village Name	CD Block	Hand Pump	Tube well	River	Pond	Agriculture Crops
1	Amlyahat	Biaora	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
2	Bhanwas	Biaora	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
3	Mundla Bajrang	Narsingharh	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
4	Palasi	Narsingharh	Yes	Yes	No	Yes	Wheat, Soybean, Tur, Gram, Onion, Garlic
5	Gandhigram	Narsingharh	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
6	Ganlyari	Narsingharh	Yes	Yes	No	Yes	Wheat, Soybean, Tur, Gram, Onion, Garlic
7	Onkarpura	Narsingharh	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram
8	Nandgaon	Narsingharh	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
9	Mawasa	Narsingharh	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
10	Lasoodlya Pata	Narsingharh	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
11	Nipanya Garhi	Narsingharh	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
12	Gathla	Narsingharh	Yes	Yes	No	Yes	Wheat, Soybean, Tur, Gram, Onion, Garlic
13	Jhad Pipliya	Narsingharh	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
14	Bakani	Narsingharh	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
15	Sukalya	Narsingharh	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
16	Kotdi Kalan	Narsingharh	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
17	Bandikhedi	Berasia	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
18	Bijawan Kalan	Berasia	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
19	Ankia	Berasia	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic
20	Bagasi	Berasia	Yes	Yes	No	No	Wheat, Soybean, Tur, Gram, Onion, Garlic

In addition to available amenities and facilities in the surveyed villages other infrastructure and characteristics of surveyed villages are given in **Table 4.16**. Electricity is available in all the villages. The water level varies from 150 to 245ft in all the villages. Quality of drinking water is good and there are no cases of malaria reported from the villages in project benefited area. Agriculture is main

economic activity while other occupation is labour work. There are cooperative societies in all the villages and nearest market is in Pachore, Narsinghgarh, Sonkacch and Shyampur.

4.4.3 Villagers Perception Regarding Proposed Project

Villager's opinion was sought during the survey regarding proposed Parbati Major Irrigation Project in the region from Project Affected as well as Benefitted Villages.

Since the project will benefit 132 villages therefore in interest of large scale benefit to the neighbouring as well as adjoining villages, people from project affected villages are willing to relocate. They will be relocated outside the submergence area at a mutually agreed nearby location. Therefore, they will not be moving at a far distance and therefore, there won't be much of a change in their livelihood or surrounding environment. Affected villagers are expecting that there will be much better infrastructural facilities like, drinking water, drainage system, education, health care etc. in the rehabilitated site. Their only concern is that they should be sufficiently compensated so that they can build a good house, animal shed and can have a new better beginning.

The Villagers from benefitted villages, informed that this Project will be a blessing for the area because agriculture is the main occupation in the area and they have very fertile soil but due to limited extraction of ground water and low rainfall, there is acute shortage of water especially during Rabi season. Lack of irrigation facility results in low income from crop production. In search of livelihood and better job opportunities people migrate towards the cities of Madhya Pradesh and Gujarat.

4.4.4 Main Findings of the Survey

- Various respondents of surveyed villages were asked that which crop they would like to take if they have sufficient sources of irrigation. Most of farmers are interested in summer crop which is not possible in the present scenario due to acute shortage of water after August-September every year. Villagers also like to grow vegetables and flowers.
- Villagers carry drinking water from privately owned tube wells.
- Respondents were asked that if they get sufficient water for irrigation then what will be the cost of irrigation; all the respondents expect that cost of irrigation will reduce, if Government gives ample water for irrigation.

- Respondents were asked whether they are prepared to switch to micro irrigation facility and prepared to bear the cost of micro irrigation system; all respondents confirmed their interest in switching to micro irrigation. About the cost, they said that at present they are paying electricity for the tube-well to the government and in the same manner they can pay for micro irrigation as they expect the yield to go up many times.
- Respondents were asked that if they get sufficient water, then how many crops they would be able to cultivate in a year. Most of the respondents said, that they will be able to cultivate at least two crops. The analysis indicates that there is more demand for two or more crops especially for cash crop of vegetables.
- The analysis of the data indicates that most of the villagers depend on agriculture. Because of low productivity the income is low. With increasing cost of living, villagers are not able to avail good medical and education facilities. This has resulted in increase in migration of youths and landless agricultural labour in search of employment.
- The findings of the survey indicate that the needy farmers either have to pay a huge amount to purchase water for irrigation or have to give their land on Adhiya (Hire) to resourceful persons having ample sources of irrigation. Thereby, substantial reduction in income in the absence of adequate water supply for irrigation.

The above analysis shows a clear picture that the project will be able to improve quality of life, paving a path of development for the present and future generation. The increased yield due to assured irrigation will lead to integrated development of agriculture in the region.

Table 4.16: Other Available Amenities/Facilities and Characteristics of the Surveyed Project Benefited Villages

S. No.	Villages	Water Tank	Electricity	Water level in tube wells and open well (ft)	Availability of water up to which month	Quality of drinking water	Malaria Cases detected and treated	Economy/ Occupation	Nearest Market	Cooperative Society
1	Amlyahat	No	Yes	195	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
2	Bhanwas	No	Yes	170	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
3	Mundla Bajrang	No	Yes	150	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
4	Palasi	No	Yes	205	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
5	Gandhigram	No	Yes	175	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
6	Ganlyari	No	Yes	220	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
7	Onkarpura	No	Yes	210	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
8	Nandgaon	No	Yes	180	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
9	Mawasa	No	Yes	195	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
10	Lasoodlya Pata	No	Yes	200	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
11	Nipanya Garhi	No	Yes	230	August/	Good	No	Agriculture/	Pachore,	Yes

S. No.	Villages	Water Tank	Electricity	Water level in tube wells and open well (ft)	Availability of water up to which month	Quality of drinking water	Malaria Cases detected and treated	Economy/ Occupation	Nearest Market	Cooperative Society
					September			Labour	Narsingharh, Sonkacch, Shyampur	
12	Gathla	Yes	Yes	195	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
13	Jhad Pipliya	No	Yes	245	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
14	Bakani	No	Yes	180	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
15	Sukalya	No	Yes	235	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
16	Kotdi Kalan	Yes	Yes	215	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
17	Bandikhedi	No	Yes	210	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
18	Bijawan Kalan	No	Yes	200	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
19	Ankia	No	Yes	220	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes
20	Bagasi	No	Yes	210	August/ September	Good	No	Agriculture/ Labour	Pachore, Narsingharh, Sonkacch, Shyampur	Yes

PHOTOGRAPHS OF VILLAGES SURVEYED





**Chapter
5****ASSESSMENT OF IMPACTS****5.1 DETAILS OF INVESTIGATED ENVIRONMENTAL IMPACTS**

This chapter deals with environmental and social impacts and identifies and discusses, both positive and negative impacts associated with the proposed project along with the mitigation and management measures. Based on the project details and the baseline environmental status, potential impacts because of construction and operation of Parbati Major Irrigation project have been assessed. Environmental impact assessment has been done based upon the understanding of the project features/activities, environmental setting in the area and interaction of project activities with environmental components leading to generation of likely impacts due to implementation of the project in the area/region. To ensure that all the negative environmental impacts are mitigated to a large extent possible with minimum environmental impacts due to implementation of the project, Mitigation and Management measures have been appropriately formulated and suggested along with budgetary allocation for all the mitigation and management measures in EMP volume. Baseline environmental status in the project area, as established through field studies and based on data obtained from various secondary sources is discussed in Chapters 3 and 4. Project related information has been sourced from project proponent and from Detailed Project Report (DPR) of the project to carry out the impact assessment during project construction as well as during operation phase.

Impacts and Mitigation/Management Measures are discussed under following heads:

- Air Quality
- Noise Environment
- Water Resources
- Land Environment
- Terrestrial Ecology
- Socio-Economic Environment
- Public Health and
- Command Area Development

For each of the above, potential adverse/positive impacts along with the recommendations for mitigation measures have been discussed in the EMP volume. Wherever possible, the impacts have been quantified and otherwise, qualitative assessment has been undertaken.

5.1.1 Ambient Air Quality

5.1.1.1 Construction Phase Impacts

Irrigation schemes in general do not have much impact on air environment during their operation, however, due to construction activities such as excavation, movement of material, operation of construction equipment, storage of material, etc. air pollution do occur requiring control by mitigation measures.

5.1.1.2 Pollution due to fuel combustion in various equipment

The operation of various construction equipment requires combustion of fuel. Normally, diesel is used in such equipment. The major pollutant which gets emitted because of combustion of diesel is SO₂. The suspended particulate matter emissions are minimal due to low ash content in diesel. Depending upon the fuel quality and quantity and rating of DG sets and other equipment, it is important to provide adequate stack height for emission to be dispersed in the atmosphere to have minimum increase in Ground Level Concentrations (GLCs).

5.1.1.3 Emissions from various construction sites

The operation of the construction plants during the construction phase is likely to generate fugitive emissions, which can impact area and surrounding area as well, depending on wind direction. Such fugitive emissions comprise mainly of the suspended particulate matter. Various mitigation measures have been recommended to control such emissions and further reduce their impacts.

5.1.1.4 Fugitive Emissions from material handling and transportation

During construction phase, there will be increased vehicular movement. Normally, on windy days, especially when the environment is dry, some of the stored material can get entrained in the atmosphere. These emissions will also get deposited on leaf surface, thus affecting their physiological processes like transpiration, photosynthesis, etc. Although it is very difficult to eliminate such impact *in toto*, it is however, possible to reduce its intensity by implementing mitigation measures as discussed in EMP volume.

5.1.1.5 Operation Phase Impacts

In an irrigation project, air pollution occurs mainly during project construction phase. During operation phase, no major impacts are envisaged.

5.1.2 Noise Environment

5.1.2.1 Construction Phase Impacts

Sources of noise will be the vehicles and equipment for excavation and construction at the project site. Due to construction activity in the area, noise levels will increase during the period of construction, however, they will remain limited to the work area mainly where large-scale construction activity will progress. Additionally, noise levels will increase on approach roads due to increased traffic.

Impact of noise generation due to operation of construction machines and equipment is the exposure of workers operating these machines and other who are working in the surrounding. Such impacts can become significant if they are exposed to high noise for long hours continuously.

Occupational Safety and Health Administration (OSHA) of USA has done substantial work to establish the impacts of exposure to high noise levels on humans and have established limits for safe exposure. Continuous exposures to high noise levels above 90 dB(A) affects the hearing ability of the workers/operators and hence, should be avoided. Factories Rules by various state governments has also adopted these limits to check exposure of factory workers to high noise for longer duration. To prevent impact of high noise exposure on workers, it is recommended that contractors should enforce standards, recommended by Occupational Safety and Health Administration (OSHA), during the construction phase. **Refer Table 5.1.**

Table 5.1: Maximum Exposure Periods Specified by OSHA

Maximum equivalent continuous noise level dB(A)	Unprotected exposure period per day for 8 hrs/day and 5 days/week
90	8
95	4
100	2
110	½
120	¼

5.1.2.2 Operation Phase Impacts

No major impacts are envisaged on noise environment during project operation phase.

5.1.3 Water Environment

5.1.3.1 Construction Phase Impacts

Water is used in construction activities leading to wastewater generation with high suspended solids. Similarly, effluents due to washing from truck or equipment etc. would have high concentration of oil and grease. Assessment of quantum of wastewater from such activities is difficult, however, they can impact the nearby water bodies if surface run off with high suspended solid is washed into them.

Conservation of water should be implemented at construction sites to minimize the generation of wastewater. With regards to water quality, wastewater from construction activities would mostly contain suspended impurities and oil and & grease. Adequate care should be taken so that excess suspended solids in the wastewater are removed before these are disposed into water body or over land, although effluent is expected to be small to cause any adverse impact.

5.1.3.2 Operation Phase Impacts

The major impacts considered as a part of the study are

- Changes in flow regime in downstream
- Impact on ground water
- Impacts on waterlogging and soil salinity
- Changes in water quality due to increased use of fertilizers

Changes in flow regime in downstream

Construction of dam and storage and use of water for irrigation would lead to the reduction in water discharge in the river stretch downstream of dam. Since water will be stored during monsoon and diverted for irrigation, during the lean season i.e. during winters there will be decrease in flow in the river in the stretch of the river downstream of the dam.

Catchment area at dam site is 3150 sq km and average rainfall in upstream is 1100 mm. Total 75% dependable virgin yield is computed as 924.09 MCM by NIH and after deducting upstream utilization of 197 MCM the net yield comes out to 726.66 MCM. 99% of the yield is contributed by monsoon flow and only about 1% or approximately 10 MCM yield will be come from non-monsoon period.

Therefore, to mitigate the impact of reduced flow or drying up of the river downstream of the dam; the project is designed with live storage/proposed

utilization of 162.62 MCM, and remaining water from monsoon contribution will be continuously discharged for downstream users. The quantum works out to be 554.04 MCM or almost 76% of the water available in pre-project conditions. Therefore, no additional environment flow is required to be released during monsoon period.

To ensure that downstream conditions do not change during non-monsoon period, entire discharge of non-monsoon period i.e. 10 MCM is recommended to be released as environmental flow.

Positive Impact on ground water

Improved availability of irrigation water in the area shall lead to reduced extraction of ground water for irrigation and domestic uses. Although, at present the stage of ground water development in study area falls in safe category, however, continuous extraction for irrigation is not recommended. The project, by providing water for irrigation will reduce the extraction of ground water and bring a positive impact on this count.

Impacts on waterlogging and soil salinity

The project is designed to carry out irrigation in command area through sprinkler / drip irrigation system; problem of water logging and salinity is not envisaged.

Changes in water quality due to increased use of fertilizers

The fertilizer dose is likely to increase once irrigation is introduced in the command area. Under the best farming practices in case of flood irrigation, only 40-50% of the applied fertilizers are used by the crop and the balance finds its way into the aquatic environment through drainage runoff which causes eutrophication of water bodies. But since, piped irrigation (drip/sprinkler) system has been planned in the proposed project, this possibility is minimal.

5.1.4 Land Environment

5.1.4.1 Impact Due to Muck Generation

For construction of different components of the project surface excavation in earth mixed with boulders, soft/disintegrated rock and hard rock would be carried out. The excavation shall result in large quantity of excavated material i.e. muck which shall have to be evacuated, disposed of 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 cause

turbidity impairing the quality of water. The disposal of muck has to be scientifically planned keeping in view the pecuniary aspects necessitating nearness to the generating component of work, which understandably reduce the travel time of dumpers, interference to surface flow and ground water aquifer, and disposition of habitation.

The construction of dam and water conductor system for conveyance of water up to farm level would generate about 14.97 lakh cum of muck for disposal. About 10.10 lakh cum expected to be generated from the dam foundation excavation will be utilised for the construction of earthen dam and about 4.86 lakh cum generated from laying of underground pipeline will be utilised for filling up low lying fields along the route of the pipeline.

Muck, if not securely transported and dumped at pre-designated sites, can have serious environmental impacts, such as:

- Can be washed away into the main river which can cause negative impacts on the aquatic ecosystem of the river.
- Can lead to impacts on various aspects of environment. Normally, the land is cleared before muck disposal. During clearing operations, trees are cut, and undergrowth perishes as a result of muck disposal.
- In many of the sites, muck is stacked without adequate stabilisation measures. In such a scenario, the muck moves along with runoff and creates landslide like situations. Many a times, boulders/large stone pieces enter the river/water body, affecting the benthic fauna and other components of aquatic biota.
- Normally muck disposal is done at low lying areas, which get filled up due to stacking of muck. This can sometimes affect the natural drainage pattern of the area leading to accumulation of water or partial flooding of some area which can provide ideal breeding habitat for mosquitoes.

Muck disposal needs to be carefully planned else it becomes a major impact from construction of project.

5.1.4.2 Impact due to Waste Generation

Construction activities are associated with 3 types of waste generation:

- Construction and Demolition Waste
- Hazardous Waste
- Municipal Solid Waste from labour camps/colonies

There will be an influx of technical staff, laborers and other service providers into the project area. Sewage and solid waste will be generated from the colonies. It is very essential that from the planning stage, sewage

management and solid waste disposal facilities should be conceptualized to maintain the health of the people and the environment. The main sources of wastes in case of the proposed project can be divided into following categories:

- Municipal waste from residential areas
- Solid wastes from labour camps
- Bio-medical wastes from Dispensary
- Construction and demolition waste

The solid waste is primary problem during the construction phase of the project as during operation phase, people working on dam operation will be staying in permanent colony. Solid waste generated from temporary and permanent colonies during construction and operation phase will be disposed off as per Solid Wastes Management Rules, 2016.

Solid Waste from Labour Colony

About 1050 migratory population is expected to reside in the area during peak construction period. Proper sanitary facilities would be provided at the labour colonies. In the absence of proper solid waste management plan, there can be serious impacts of land and water pollution due to indiscriminate disposal. In addition, there will be odour issues and health impacts. Therefore, for maintaining the cleanliness of the labour colony and to restrict from disposing the solid waste into the river, no dumping of solid waste should be allowed near any water body or nalla. A solid waste management plan is prepared as part of EMP.

Solid Waste from Permanent Colony

The project authority, as principal waste generator, shall, within the territorial area of the project complex/ colony, be responsible for the implementation of the provisions of Solid Wastes Management Rules, 2016, issued by MOEF vide S.O.1357 (E) dated 8th, April 2016, and for any infrastructure development for collection, storage, segregation, transportation, processing and disposal of municipal solid wastes.

Any municipal solid waste generated in the project complex/ project colony/ labour colony, shall be managed and handled in accordance with the duties set forth under clause 4 (1) through 4(3) and clause 20 in respect of landfill.

Construction Waste

Apart from the municipal solid waste in labour colony of project area, a lot of waste is expected to be generated on account of construction activities mainly consisting of cement bags, iron scrap, packing material, etc. It is expected that most of the iron scrap and packing material would be recycled since it has reuse value and hence, it is proposed that stipulations should be imposed on suppliers and contractors to take away the scrap and packing materials.

Hazardous and Biomedical Waste

Hazardous waste will be generated from construction activities in terms of empty containers of construction chemicals, drums of oil and grease used in construction equipment. Similarly, Biomedical Waste will be generated from first aid posts created for labour. As the waste quantum is not expected to be very large, on site treatment and disposal is not recommended. Such wastes should be collected and stored separately in specially designated bins/areas and disposed at regular intervals to authorised vendors only.

5.1.4.3 Impact due to Land Requirement and change in land-use

About 2290.57ha (64.76%) of private land, 1246.62ha (35.24%) of Revenue land is to be acquired. The land required for various project components is of about 3537.19 ha. The details of land requirement for the project are given in Table 5.2.

Table 5.2: Details of Land Requirement

S. No.	Project Components	Revenue Land (ha)	Forest Land (ha)	Private Land (ha)	Total (ha)
1.	Dam & Reservoir	1204.07	0	2290.57	3494.64
2.	Canal Network		0		
3	Colony & Approach Road and other project components	10.00		-	10.00
4	Resettlement and Rehabilitation	32.55		-	32.55
	Total	1246.62	0	2290.57	3537.19

Major impact of land acquisition is permanent change of landuse, which is unavoidable. Additionally, land acquisition has impacts on local population by way of loss of their agriculture land and hence livelihood and also impact on flora and fauna by way of loss of forest land and clearing of vegetation on acquired land. Mitigation and management of such impacts is discussed as part of EMP.

5.1.5 Terrestrial Ecology

i) Flora

During project construction phase, labour population is likely to congregate near various construction sites. It can be assumed that the technical staff likely to congregate will be of higher economic status and will live in a more urbanized habitat, and will not use wood as fuel. However, workers and other population groups residing in the area may use fuel wood for whom kerosene and other fuels like cooking gas could be provided. Overall there will be marginal increase in population at various construction sites, of which major populations may be inclined to use fuel wood which may have adverse impact on flora. Hence, to minimize such impacts, community kitchens and use of kerosene and cooking gas have been recommended.

The project construction doesn't require acquisition of any forest land.

ii) Fauna

Narsingharh Wildlife Sanctuary is in close proximity and earlier a small portion of submergence area was falling within the sanctuary. **To avoid project component falling within protected area, dam site has been shifted upstream by about 2 km.**

Area is rich in wildlife and project construction and operation can have impacts on the wildlife habitat and their migration between protected areas. It is recommended that a separate wildlife management plan should be prepared in consultation with expert agency and local forest department to ensure that project construction and operation should not interfere with the habitat of wildlife in surroundings.

5.1.6 Socio-economic Environment

Construction phase of projects is generally associated with impacts related to labor congregation in an area, where labour camps/colonies are constructed and such phase is expected to last for 5 years. Keeping in view the health concerns and reduces the impact of sanitation and hygiene of local area, where temporary labour camps will be set up; following minimum facilities are proposed at these locations:

- Potable drinking water
- Temporary shelters with sanitation facilities
- Mobile toilets
- Crèche for female workers
- First aid facilities
- Personal Protective Equipment (PPEs), as required

Positive Impacts

The entire project has been designed to benefit the farmers and bring about positive change by providing water for irrigation which will have many cascading positive impacts not only on the farmers but also on other non-farming local population. The scheme in general will bring about prosperity in the area leading to improved quality of life.

A number of marginal activities and jobs would be available to local skilled and unskilled workers during construction phase and also more employment opportunities will be available to locals during operation phase with increased income of farmers. The command area will have increased demand for services like schools, hospital transportation, communication etc. This will further generate employment.

Participation in Water Users Association (WUA) and increased interaction with different Irrigation Department personnel and officials will add to awareness. Piped irrigation is a new technology for the community of this area for which training of different durations on different related aspects will be considered.

Negative Impacts

Project would require acquisition of 2290.57 ha of private land leading to affecting 1125 families. These families will be resettled and rehabilitated as per the provisions of The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.

In addition, influx of workers and floating population during project construction phase can lead to cultural clashes, law and order concerns and health issues. Such impacts are best managed by involving NGOs, local panchayat/community leaders and local administration.

Project construction may bring about some 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.

- Chances of spread of new diseases in the area due to migrant workers.
- Chances of increase in respiratory troubles due to increase in suspended particles during the construction phase are expected mainly for the labour.
- Chances of occurrence of gastroenteritis, cholera and typhoid in the labour camp.

- Possibility of some site accidents cannot be ruled out and therefore, use of PPEs should be strictly followed and provisions should be made for emergency medication and ambulance
- Workers health and hygiene issues need to be addressed to minimize the impact on this count especially for female workers with/without child(ren).

5.2 MEASURES FOR MINIMIZING/OFFSETTING ADVERSE IMPACTS

Pollution generation mainly during construction phase will be in the form of air, water and noise pollution; which will be mitigated by adopting various mitigation measures during construction activities as discussed in subsequent sections.

Other impacts of projects such as muck generation, solid waste generation from labour colonies, impact on workers' health, impact of tree cutting for fuel etc. will be mitigated by implementing various management plans prepared to address these specific impacts.

In addition, other management plans such as CAT, Fisheries, Biodiversity, R&R, etc., have also been prepared to manage the project impact and bring benefits to local population. These plans have been separately discussed in detail along with their budget for implementation under additional studies.

5.3 ASSESSMENT OF SIGNIFICANCE OF IMPACTS

Impacts, as discussed in subsequent sections, along with the mitigation for Construction and Operation Phase respectively. These are further subjected to categorization in the form of magnitude, significance and duration of impact. Categorization is largely judgement based as assessed by experts who were involved in carrying out the study and are discussed at **Table 5.3**.

Impacts with medium/high magnitude; significant and permanent are all addressed by Environment management plan; which are covered under additional studies. These plans will help mitigate significant impacts such as impacts due to muck generation, solid waste generation from construction sites, etc. In addition, where impacts cannot be mitigated; plans address these impacts and provide compensation to alleviate the impact such as R&R Plan, Biodiversity and Wildlife Conservation plan, etc.

Impacts with medium/high magnitude, significant and temporary are addressed by suggesting mitigation measures as discussed in next section.

Table 5.3: Impact Assessment Matrix

Sl. No.	Environmental attribute	Potential impacts	Nature of impact	Phase	Magnitude of impacts			Significance		Long Term/Short Term	
					Low	Medium	High	Significant	Insignificant	Permanent	Temporary
A.	Physical Resources										
1.	Land use and Topography	Change in the surface features and present aesthetics due to the construction of the project components	Direct/Local/irreversible	Before construction phase		X		X		X	
B.	Environmental Resources										
1.	Air Quality	Project will have impact on air quality during the construction period due to increase in the dust emission, fuel combustion in various equipment, crushers and other construction plants & Emissions from material handling and transportation	Direct/Local/reversible	During construction activity		X		X			X
2.	Noise	Noise due to general construction activities and equipment, increased vehicular traffic, blasting etc. during construction phase	Direct/Local/reversible	During construction activity		X		X			X
3.	Surface and Ground Water quality	Waste from construction labor camps, effluent from construction plants and workshops Runoff from the	Direct/Local/reversible	Before and during construction activity		X		X			X

Sl. No.	Environmental attribute	Potential impacts	Nature of impact	Phase	Magnitude of impacts			Significance		Long Term/Short Term	
					Low	Medium	High	Significant	Insignificant	Permanent	Temporary
		construction site and its disposal									
		Domestic wastewater from construction sites	Direct/Local/reversible	During construction and operation		X			X		X
4.	Soils	Soil erosion due to excavation, muck generation, construction activities and clearing of vegetation and access roads. Muck disposal	Direct/Local/reversible	During and after the construction activity		X		X		X	
C.	Ecological Resources										
1.	Terrestrial Flora	Loss of vegetation	Direct/Local/irreversible	Before the construction phase			X	X		X	
2.	Terrestrial Fauna	Disturbance to the local fauna during construction	Direct/Local/reversible	Before, during and after construction phase		X			X		X
3.	Aquatic Ecology	Disturbance to the aquatic fauna after construction	Direct/Local/reversible	Before, during and after the construction phase		X		X		X	
D.	Human Environment										
1.	Health and Safety	Increased incidence of Diseases	Direct/Local/Continuous	Before and after the construction	X			X			

Sl. No.	Environmental attribute	Potential impacts	Nature of impact	Phase	Magnitude of impacts			Significance		Long Term/Short Term	
					Low	Medium	High	Significant	Insignificant	Permanent	Temporary
		Fires, explosion and other accidents at construction sites		phase.							
2.	Agriculture	Impact envisaged as there is private land involved	Direct/Local/reversible			X		X		X	
3.	Socio-economics	Positive and negative impacts on socio-economic environment Job opportunities during construction phase.	Direct/regional/Continuous	During operational phase		X		X		X	
4.	Resettlement	Impact envisaged as there is private land involved	Direct/Local/reversible				X	X		X	
5.	Historical and archaeological sites	No archaeological, historical or cultural important sites are affected by the construction.	Direct/Local/reversible		X				X		X
6.	Traffic and Transportation	Traffic congestion due to movement of construction vehicles	Direct/Local/reversible	During construction phase	X				X		X
7.	Solid Waste Generation	Surface and ground water pollution	Indirect/Local / reversible	During operation phase		X		X			X

Implementation of these mitigation measures will help control/mitigate these impacts.

5.4 MITIGATION MEASURES

Irrigation projects like Parbati Major Irrigation project, involves construction of dam and other associated infrastructure, water conductor and distribution system, access roads, etc. The project construction period is planned for 5 years and various construction related impacts are envisaged during this period, as discussed above. Though these impacts are considered temporary and are not expected to last beyond the construction phase, in the absence of adequate mitigation and management measures, such impacts can become serious and affect not only construction workers but also surrounding population.

Management of construction-related impacts would be the responsibility of the project proponent (through its contractors, as and where relevant, and as described in the EMP). Muck generation and its transportation is one of the major construction phase impact and has been dealt in separate chapter for its management. Similarly, a separate plan is proposed to mitigate construction phase impacts due to sanitation and solid waste generation from worker's colonies and one for energy conservation measures to mitigate the impacts of indiscriminate tree cutting by workers for fuel wood.

Other construction phase impacts are generation of air pollution, noise pollution and waste water generation from construction and associated activities such as transportation handling and storage of materials, etc. would require implementation of mitigation measures.

Air and water are two major environmental factors that are directly affected by any kind of construction activity. The major air pollutants, which could be generally, released during various construction activities of proposed projects and vehicular movements are Particulate Matter (PM), SO_x and NO_x. During construction period, generation and release of effluents, oil and grease from diesel generator sets, vehicles and other machinery etc. cause water pollution and may affect the quality of surface as well ground water. In addition to that the construction activities also generate noise due to the use of heavy machinery, heavy vehicles, excavation, etc. which has serious impacts on humans as well as the wildlife of the area.

5.4.1 Air Pollution

The various sources causing air pollution during the construction phase are as follows.

- **Particulate Matter (PM):** Various activities such as, crushing, transportation of material in open trucks, open dumping in muck disposal sites, vehicle movements, operation of Diesel Generator Sets, etc.
- **Oxides of Sulphur (SO_x):** SO_x is released into the air from vehicular exhaust, Diesel Generator Sets, coal burning chulas etc.
- **Oxides of Nitrogen (NO_x):** Motor vehicles and fuel burning are generally responsible for the release of oxides of nitrogen into the ambient air.

5.4.1.1 Impacts of Air Pollution

The various impacts of air pollution associated with PM, SO₂ and NO_x are as under:

- **Impacts of PM:** High quantities of PM in the ambient air can cause emphysema, bronchial asthma, and eye-irritation and in some cases can also result in cancer. PM containing lead particles (emitted from automobiles) is considered responsible for anemia as it affects haemoglobin formation. Lead is also a proven carcinogen. Dust coating on leaves of plants reduces photosynthesis and reduces plant growth.
- **Impacts of SO_x:** The oxides of Sulphur cause irritation of the mucous membranes of the respiratory tract. Higher concentrations may cause bronchitis. Plants are particularly sensitive to high concentrations of SO₂ and suffer from chlorosis, metabolic inhibition, plasmolysis and even death.
- **Impacts of NO_x:** Oxides of nitrogen can combine with haemoglobin to reduce the oxygen carrying capacity of the blood. This can cause irritation of alveoli of the lungs and high concentrations may even cause acute bronchitis.

5.4.1.2 Control of Air Pollution

For the control of air pollution during construction phase of the project, it is suggested that it should be made mandatory for the contractor/s engaged in the construction works to ensure the following conditions:

- I. For all major construction activities, curtaining of the site will be done to protect the surrounding areas from dust emissions.
- II. In addition, regular sprinkling of the water will be done on construction

- sites for dust suppression.
- III. All construction equipment/machinery will be properly maintained and tuned to minimize emissions.
 - IV. Mobile DG sets shall be used for lighting only during construction phase and they should meet emission and noise standards as per guidelines/standards issued by CPCB.
 - V. The entire contractor's vehicle should have valid PUC certificate and same condition may be enforced on transporters bringing in material for construction.
 - VI. Road damage caused by sub-project activities will be promptly attended to with proper road repair and maintenance work.
 - VII. Excessive soil on paved areas will be sprayed (wet) and/or swept and unpaved areas will be sprayed and/or mulched.
 - VIII. All the construction workers and other staff, who get directly exposed to dust, should necessarily be provided with dust masks.

5.4.2 Noise Pollution

Various sources of noise pollution in the project area during the construction phase include vehicular movement, operation of heavy machinery, crushing, aggregate processing plants, diesel generator sets, etc.

5.4.2.1 Impacts of Noise Pollution

Noise is generally harmful and is considered to be a serious health hazard. It has far-reaching consequences and has many physical, physiological as well as psychological effects on human beings and animals. Continuous exposure to noise may result in temporary or permanent shifting of the hearing threshold depending upon the level and duration of exposure. The immediate and acute effect of noise causes impairment of hearing (total deafness). The major impacts of noise pollution are given as under:

- It causes headache and increased heartbeat.
- It causes anxiety, eye-strain, memory loss and muscular strain.
- It also causes fatigue, loss of sleep and emotional disturbance.
- In case of wild animals, the noise pollution has been observed to interfere with their breeding efficiencies.

5.4.2.2 Control of Noise Pollution

Since continuous exposure to noise is lethal, it is essential to control the noise pollution. Various measures for control of noise pollution in the project area are suggested below:

- Contractors will be required to maintain proper functioning of equipment

and comply with occupational safety and health standards. DG sets will have a valid Type Approval Certificate and Conformity of Production certificate as per CPCB guidelines.

- All the construction equipment will be required to use available noise suppression devices and properly maintained mufflers.
- Workers in high noise area, will be provided with ear muffs and their use will be monitored. Workers exposure (time duration) to high noise will also be controlled.
- Minimize the use of noise producing equipment during night hours to avoid the disturbance to locals and wild animals of surrounding area.
- Monitoring of noise levels will be conducted during 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.

5.4.3 Water pollution

Various sources of water pollution in the project area during the construction phase include disposal of effluents with high turbidity from crushers commissioned at project site and effluents from construction sites like Dam, Intake, channels, sewage disposal from labour camp, excavation and other land clearing activities, washing of oil, grease and other chemical from diesel generator sets, vehicles and other machinery etc.

5.4.3.1 Impacts of Water Pollution

Water pollution is harmful and is considered to be a serious health hazard. It has far-reaching consequences and effects on human beings and animals also. The effect can be felt not only in the area but also the surface and ground water quality in the area. The affect may be of temporary or permanent nature. The major impacts of water pollution are given as under:

- The construction of civil and allied structures could lead to stockpiling and excavation activity on site, thereby exposing the base soil to erosion. The runoff from this site and also from muck disposal sites may contain high quantity of Suspended Solids which shall add to the inorganic load of stream. The impact of runoff may not be very significant except during rainy season.
- During construction phase, waste water, sewage etc shall be generated from the labour camp. If disposed untreated, this would substantially

deteriorate the quality of ground water as well as water quality of Parbati river with respect to BOD, TDS, TSS, *E. coli* etc.

- The oil and grease released from the project related activities may also change the physico-chemical characteristics of water.

5.4.3.2 Control of Water Pollution

To avoid deterioration of water quality of the receiving water body following measures are suggested

- During Construction phase provision of septic tank/ soak pit of adequate capacity for labour camp so that it can function properly for the entire duration of construction phase
- Construction of settling tank to settle the suspended impurities from various sources before discharging into the main stream
- During project operation, suitable treatment facilities need to be created to treat the sewage generated from the colony
- Provision of sedimentation cum grease traps at the outer mouth of drains located along workshops, fuel filling stations, diesel generator rooms etc. so as to prevent entry of contaminants to the water bodies.
- Oil interceptors shall be provided for refueling areas, vehicle parking, washing areas etc. All spills and collected petroleum products will be disposed off in accordance with MPPCB guidelines.

Schedule of monitoring and final provision for monitoring of Ambient Air quality, Ambient Noise level and surface & Ground water quality during construction phase and first three year of operational phase in the project area is given under Environmental Monitoring Plan.

5.4.4 Workers Safety

Apart from pollution aspect from construction sites and construction activities, another major concern during construction work is related to worker's safety. Many of the construction activities involves significant risk of accidents where workers at site can get severely affected in the absence of adequate safety measures and emergency response. First aid posts and ambulances have proposed separately as first responders during an accident/emergency situation.

Contractors need to have a worker's safety plan in place, identifying the risk operations areas, risks involved, precautions required to be taken and requirement and use of Personal Protective Equipment (PPEs). Work instructions should be boldly displayed for workers working in such area. Provision of adequate number of PPEs such as safety belts/harness, helmets,

gum boots, etc. and enforcing their use should be contractor's responsibility with supervision from project authority/developer.

Table 5.4 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. Relevant codes should be used to ensure safety of workers at sites.

Table 5.4: List of relevant BIS Standards

	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 liquids

5.4.4.1 Environment and Safety Audits

As the operations are large, it is important to ensure that all the mitigation measures remain in place for the entire duration of the project. To ensure the same it is proposed that a rapid audit will be carried out every three months and a detailed third party audit every year to take corrective and preventive measures for control of pollution and ensuring workers safety. At the beginning of the project, with the help of environmental and safety experts, SOPs, Work Instructions and formats/templates will be prepared to keep records of environmental and safety performance.

The audit scope will include review of all the documents/formats filled up to substantiate environmental and safety performance of the project; any complaints/concerns received from local population and developer/contractor's response; training imparted to workers and staff and

results of such programs; records of implementation of various mitigation and management measures as per approved EIA/EMP reports; results of environmental monitoring and accident records; physical inspection of the sites and the area; interaction with workers and staff, etc. Regular audits will ensure that there is continual improvement in environmental and safety performance of the project.

5.4.5 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 be a constrain in 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 5.5**.

Table 5.5: Estimated Cost for Implementation of Mitigation and Safety measures

S. No.	Particulars	Amount (Rs. in lakhs)
1	Air Pollution control measures for 5 years @ 5 lakh/year	25.00
2	Water Pollution Control Measures (lump sum)	25.00
3	Procuring and replenishing the stock of PPEs during the construction phase (lump sum)	15.00
5	Training and Awareness programs for local residents, contractors labour, drivers, cleaners, etc. @ Rs. 2 lakh per annum for 5 years	10.00
6	Internal audit (every 3 months) and third party detailed audit (every year) @ Rs. 10.00 lakh per annum for 5 years	50.00
	Total	125.00

Chapter 6

ANALYSIS OF ALTERNATIVES

The proposed Parbati major Irrigation project is an irrigation project planned to cater to irrigation water requirement for 132 villages in Rajgarh and Bhopal districts. A 23.5 m earthen dam has been planned across Parbati river to store water and facilitate pumping and distribution to villages in command area. Project siting is done keeping in view the most suitable location for the dam in proximity to the command area.

Preliminary study of different alternative schemes was based on the study of topography on the Survey of India topo-sheets followed by site visit to verify the ground realities along with geological aspects. This is a location specific project and therefore, alternative studies have done pre-scoping clearance and scoping clearance was taken for the final location. EAC in its 11th meeting, dated January 30th, 2018, recommended grant of scoping clearance for the Parbati (Rinsi) Major Irrigation Project (48,663 ha CCA). Based upon recommendation of EAC, Scoping clearance of Parbati (Rinsi) Major Irrigation Project (48,663 ha CCA) was accorded by MoEF&CC, Govt. of India vide letter no. J-12011/01/2018-IA-I (R) dated February 26th, 2018. However, post scoping clearance, when detailed survey and investigation work were undertaken, it was found that Narsingharh Wildlife Sanctuary is in close proximity and a small portion of submergence area will fall within the sanctuary.

Therefore, to avoid project component falling within the protected area, a second alternative was evaluated, where dam site was shifted upstream by about 2 Km. Although command area was reduced slightly to 48000 ha, this alternative was found better from environment point of view as the project falls completely outside the Narsingharh Wildlife Sanctuary and also need for diversion of 49.75 ha of forest land for the project was completely eliminated.

A comparison of both alternatives is given below.

LOCATION	Alternative I	Alternative II
Latitude	23° 37' 49" N	23° 37' 05" N
Longitude	77° 08' 21" N	77° 08' 37" N
Falling in Protected Area	Yes	No
Catchment Area up to Dam Site	3302 Sq. km	3150 Sq. km
Gross Storage	171.47 MCM	172.54 MCM
Live Storage	162.21 MCM	162.62 MCM
Dead Storage	9.25 MCM	9.92 MCM

Gross area of submergence at FRL	3719.13 ha	3494.64 ha
Private Land	2434.42 ha	2290.57 ha
Revenue Land	1246.21 ha	1204.07 ha
Forest Land	38.50 ha	0 ha
No. of villages Submerged	13	18
No. of Families affected	864	1125
Total GCA	54000 ha	62500 ha
Total CCA	48663 ha	48000 ha
Annual Irrigation - Rabi	48663 ha	48000 ha

Comparison of alternatives was discussed and presented before EAC during its meeting held in October 2018 while seeking amendment of scoping clearance for the project for Alternative II. EAC recommended the amendment of Tor for second alternative and same has been adopted for the project.

**Chapter
7****ENVIRONMENTAL MONITORING
PLAN****7.1 INTRODUCTION**

Environmental monitoring provides feedback about the actual environmental impacts of a project after implementation of mitigation and management measures. Monitoring results help judge the success of mitigation measures in protecting the environment. They are also used to ensure compliance with environmental standards, and to facilitate any needed project design or operational changes.

Monitoring shall be performed during all stages of the project (namely: construction, commissioning, 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 Gond Major Irrigation Project will be undertaken to meet the following objectives:

- To monitor the environmental conditions (Ambient air and noise quality) in the project area and nearby villages during construction as well as operational phase of the project;
- To monitor the surface and ground water quality in the project area
- To monitor the status of terrestrial biodiversity within the project area.
- 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.

7.2 WATER QUALITY**Construction Phase**

The water quality monitoring should be carried out in seasonal intervals i.e. three times a year. Three sampling sites for surface water and 5 sites for ground water have been identified along with parameters to be monitored, as detailed in **Table 7.1**. The total cost for analysis the samples work out to be **Rs. 2.00 lakhs** per year. The monitoring is proposed to be for a period of 5 years of construction phase.

Operation phase

The surface water quality of the Parbati River within the project area at three different locations can be monitored thrice a year (winter, pre and post-monsoon seasons). The proposed parameters to be monitored include; pH, temperature, electrical conductivity, turbidity, total dissolved solids, calcium, magnesium, total hardness, chlorides, Sulphates, Nitrates, DO, COD, BOD, Iron, Zinc and Manganese, Total coliforms, fecal coliforms. The sampling sites are Upstream of weir site, weir Site and at Powerhouse site. The total cost of analysis will be **Rs. 2.00 lakhs** per year.

Table 7.1: Water Quality Monitoring Schedule

Physical & Chemical Parameter	Sampling Location in Construction and Operational Phase	Monitoring
A. Surface water		
pH, Temperature, Electrical Conductivity, Turbidity, DO, BOD, TDS, Total Hardness, Total alkalinity, Chloride, Nitrate, Phosphate, Total coliforms, fecal coliforms	Parbati river: Proposed reservoir area	Once in 3 months (seasonal)
	Parbati river: near Dam site	
	Parbati river: Downstream of Dam site	
B. Ground Water	Sampling Location in Construction and Operational Phase	
pH, Temperature, Electrical conductivity, Turbidity, Total dissolved solids, Calcium, Magnesium, Total hardness, Chlorides, Sulphates, Nitrates, , Iron, Zinc and Manganese, Total coliforms	Bagsi village	Winter, pre and post monsoon
	Palasi village	
	Arniya Sultanpur Village	
	Sukhleya Village	
	Gathla village	

7.3 AIR QUALITY

Construction Phase

The ambient air quality monitoring during construction phase will be carried out as per the requirement of State Pollution Control Board. Every year monitoring is proposed to be done for the following three seasons; Winter, Pre – monsoon and Post – monsoon.

The frequency of monitoring could be twice a week for four consecutive weeks at each station for each season (**Table 7.2**). The parameters to be monitored are PM₁₀, PM_{2.5}, 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) 72 days. A total cost of **Rs. 3.00 lakh/year** has been earmarked for this purpose.

Operation Phase

Same schedule, as followed during construction phase, should be continued for operation phase as well.

Table 7.2: Air Quality Monitoring Schedule

Air Quality	Sampling Location	Monitoring
SO ₂ , NO _x , PM ₁₀ , PM _{2.5}	Near Proposed Dam site	Winter
	Proposed DC-1	Pre - monsoon
	Proposed DC-2	Post - monsoon

7.4 NOISE

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 a month. For monitoring of noise generators, an Integrating Sound Level Meter will be required for which an amount of **Rs. 1.00 lakh** per year has been earmarked.

Operation Phase

Same schedule, as followed during construction phase, should be continued for operation phase as well.

7.5 ECOLOGICAL MONITORING

The monitoring of various activities suggested under Biodiversity conservation, Fisheries management, etc. like ecological surveys for composition of flora and fauna, Survey & observation Density of vegetation Survival rate of species planted, and Status/ Survival rate of bio-engineering and engineering structures for controlling soil erosion. For this an amount of **Rs. 5.00 Lakhs** per year has been earmarked (**Table 7.3**). Under this programme the survival rate and recruitment of the seedlings planted in the plots taken up afforestation programme would be monitored through annual sampling either by belt transect method or circular plot method. Not only the survival and recruitment percentage but their height and other growth parameters would also be monitored on annual basis.

7.6 MINIMUM ENVIRONMENTAL FLOW

During the operation phase of the project, most crucial environmental aspect is the monitoring of flow released from the dam site to ensure that minimum flow is maintained at all times especially during lean season. Therefore, monitoring mechanism will be established to monitor river flow immediately downstream of the diversion structure.

7.7 MUCK DUMPING

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 projects is also a major environmental issue.

As all the excavated material generated from earth work will be utilized for various construction works. Therefore, regular monitoring of the muck transportation will be carried out by State forest department and Madhya Pradesh State Pollution Control Board (MP SPCB).

7.8 FINANCIAL REQUIREMENT

A sum of **Rs. 90.5 lakh** have been allocated to implement various activities and programmes envisaged under EMP, the details are given in **Table 7.3**. The detailed matrix of EMP listing all the activities to be monitored and implementing agency has been given in **Table 7.4**.

Table 7.3: Cost Estimates for Environmental Monitoring Programme

S. No.	Activities			Cost (Rs. lakh)
1	Monitoring	Construction Phase (5 years)	Water quality	10.0
			Air quality	15.0
			Noise	5.0
			Total	30.0
		Operation Phase (for 3 years)	Water quality	6.00
			Air quality	9.00
			Noise	3.00
			Total	18.00
	Total Monitoring (1)			48.00
2	Ecological Studies/ monitoring @Rs. 5.00 lakh per year for 5 years (2 year + 3 years)			25.00
3	Monitoring of minimum environmental flow @Rs. 0.50 lakh per year for first 3 years during operation phase			1.50
4	Documentation & Reporting- Six monthly reporting @ Rs.2.00 lakhs per year for 8 years (5 + 3 years)			16.00
	GRAND TOTAL (1-5)			90.50

Table 7.4: Matrix of Environmental Monitoring Plan

Sl. No.	Aspect	Source of Impact	Monitoring Methods & Parameters	Frequency	Executing Agency	Monitoring Agency
1.0	Construction Phase					
1.1	Local manpower absorption	Construction works	Contractor's report No. of people working in the project	Monthly	Contractor and WRD	District Administration
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	Monthly	Contractor	WRD
1.3	Biodiversity	Land clearing activities fauna in the project area for access roads, colonies	Composition of flora and fauna	Twice in a year	WRD/ State Forest Dept.	WRD/ State Forest Dept.
1.4	Revegetation & Afforestation	Land clearing, disposal works	Survey & observation Density of vegetation Survival rate of species planted	Every six months	WRD/ State Forest Dept.	WRD/ State Forest Dept.
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	Twice in a year	Contractor/ WRD	State Forest Dept.
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	Monthly	Contractor and WRD	SPCB
1.7	Air Quality	Operation of DG sets, transportation of muck, road construction, mobilization of material, running of crushers	Survey & observation Levels of PM ₁₀ , PM _{2.5} , SO ₂ , NO _x	Monthly	Contractor and WRD	SPCB
1.8	Public Health	Dust, noise, influx to labour	Regular medical checkups and camps	Monthly	Contractor and WRD	Public Health Dept.
1.9	Health Delivery System		Status of water and vector borne diseases, improvement observed, if any, status of women and child health	Twice in a year	Contractor and WRD	Public Health Dept.
1.10	Fish Management		Impact of project construction on fish, and aquatic life, if any Status of infrastructure developed for fish management like hatcheries	Once every Season	State Fisheries Directorate	WRD
1.11	Restoration of construction areas and handling of Muck		Status of protection measures, sausage/ gabion walls, etc. at the dumping sites.	Twice a year	Contractor and WRD	State Forest Department and SPCB.

Sl. No.	Aspect	Source of Impact	Monitoring Methods & Parameters	Frequency	Executing Agency	Monitoring Agency
			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 of afforestation/ turfing works on the dumping sites			
2.0	Operation Phase					
2.1	Water Quality and Quantity (for irrigation & domestic use)	Reservoir water regulation Diversion of water for power generation	Surveys, sample collection & field measurement Water discharge d/s of barrage water quality (turbidity, coliform, bacteria and others)	Fortnightly during the lean period	Contractor and WRD	SPCB.
2.2	Fish production	Reservoir regulation	Survey & observation	Monthly	State Fisheries Directorate	WRD
2.3	Aquatic weeds		Surveys & sample collection Kinds of species	Seasonal	WRD	SPCB.
2.4	Catchment conditions	Deforestation	Survey & observation of Barren areas for Afforestation	Every year	Forest Dept.	WRD
2.5	Risk of Leakage and Bursting of Pipelines	Sudden discharge of water	Regular monitoring	Every Month	WRD	District Administration
2.6	Accidents	Sudden discharge of water for power generation	Surveillance	Monthly	WRD	Meteorological Department
2.7	Disaster	Heavy rainfall, flash flood situation	Surveillance and disaster management exercises, Regular information to people	--	WRD	Meteorological Department

WRD: Water Resource Department; SPCB: State Pollution Control Board

**Chapter
8****ADDITIONAL STUDIES**

Scoping clearance of Parbati Major Irrigation Project was accorded by Ministry of Environment Forests and Climate Change (MoEF&CC), Government of India vide letter no. J-12011/01/2018-IA-I (R) dated February 26, 2018 and subsequently amendment in TOR was accorded by MoEF&CC, Govt. of India vide letter no. J-12011/01/2018-IA-I (R) dated February 22nd, 2019.

As per the scope of work issued by MoEF&CC, additional studies have carried out as summarized below.

Biodiversity Conservation & Management Plan: It delineates the plan for mitigation of anticipated adverse impacts likely to accrue as a result of the proposed project on the biodiversity of the area. The approach for formulation of Biodiversity Conservation Plan is to maximize the positive environmental impacts and minimize the negative ones. After suggesting environmental mitigation measures, the cost required for implementation of various measures is also estimated.

Catchment Area Treatment (CAT) plan: CAT plan methodology suggested by SLUSI has been used and Silt Yield Index (SYI) method has been used for categorization of sub-watersheds into priority classes. Treatment measures for very severe and severe categories of sub-watersheds have been formulated. Cost required for implementation of CAT Plan too has been estimated.

Fisheries Conservation and Management Plan: It describes the various measures to be undertaken for the Conservation & Management of the fish fauna.

Command Area Development (CAD) Plan: It gives the details of implementation schedule with a sample CAD plan.

Rehabilitation & Resettlement Plan: The Rehabilitation & Resettlement Plan for Project Affected Families has been formulated as a part of this Chapter based upon the socio-economic status assessed through the surveys conducted for the same.

Landscaping & Restoration Plan: This chapter covers adverse impact of construction activities on the landscape and suggests measures for restoration of the disturbed area back to their similar or near-similar pre-construction conditions and land use. It also includes green belt to be created along reservoir periphery and around the colony areas.

Reservoir Rim Treatment Plan: This Chapter describes the possibility of slope failures, land slips, etc. due to fluctuation in water level along the reservoir periphery. In order to mitigate the same, Reservoir Rim Treatment Plan and measures for treatment of existing landslides/ slips, and prevention of further slides by undertaking engineering as well as biological measures have been suggested. The cost estimation for various activities involved has also been made.

Muck Management Plan: It deals with the rehabilitation of muck that is likely to be generated during the construction of various project components and also suggests measures for both engineering and biological measures for restoration of muck disposal sites in environmentally sustainable manner.

Solid Waste Management Plan: This chapter describes issues related to solid waste disposal that are likely to accrue during the construction period and also the formulation of management plan for the same. It also includes labour management plan for their health and safety.

Public Health Delivery System: This chapter deals with the basic health care facilities available in the area and setting up of new infrastructure as well as improvement of existing infrastructure along with the cost estimates.

Energy Conservation Measures: It deals with the provisions being made for the reduction of pressure on the adjoining forest of the project area during the construction period, energy conservation measures like subsidy for fuel wood, etc. along with the cost of these measures.

Dam Break Modeling & Disaster Management plan: Dam Break Modeling using MIKE11 model has been conducted. The results of the modeling exercise are outlined in this Chapter. Disaster Management Plan (DMP) too has been outlined for implementation in case of Dam Break.

Corporate Environment Responsibility Plan: It deals with the provisions being made by project proponent under Corporate Environmental Responsibility Policy. The cost of CER Plan is in addition to the cost envisaged for the implementation of EIA/EMP.

Public Consultation Issues and Responses: This chapter covers issues raised during public hearing and reply given by project developer and district administration.

As the above content is quite voluminous, it has been compiled as a separate volume, titled, “Additional Studies”.

**Chapter
9****PROJECT BENEFITS****9.1 ECONOMIC VIABILITY OF PARBATI MAJOR IRRIGATION PROJECT**

Irrigation projects are planned to benefit the local farmers by ensuring availability of water for irrigation in water scarce area with agriculture potential. Economic viability of Parbati Major Irrigation project has been worked at DPR stage and project was taken forward keeping in view its cost-benefit ratio and availability of water in Parbati river.

Benefit to cost ratio has been calculated in DPR as per the approved guidelines for irrigation projects of Technical Advisory Committee of Ministry of Water Resources, Government of India. Annual costs of running the system is calculated which includes power charges, operation and maintenance cost, interest on capital cost and depreciation. On the other hand, annual benefits are worked out based on increased farm produce due to implementation of the medium irrigation project. Farm produce are estimated before and after the system along with expenditures and net values are calculated. Net annual increase in terms of monetary value is considered as the benefit to calculate benefit to cost ratio. For Parbati Major Irrigation project this works out to be 1.71 at 10% rate of return which indicates the viability of the project.

9.2 BENEFITS OF COMMAND AREA DEVELOPMENT

The project will bring water to 48,000 ha command area covering 132 villages, which are presently water scarce and cannot irrigate their land efficiently due to shortage of water. The project will bring direct environment and social benefits, which in turn will bring prosperity to the area and increase spending power of farmers, bringing economic benefits to the region. Direct benefits include public health infrastructure, awareness and training programs for farmers, etc. Some of the major benefits of command area development through Parbati Major Irrigation project are discussed below:

9.2.1 Improved Agriculture Production

Introduction of irrigation is sure to give great boost to the agricultural production. Irrigation projects provide direct benefits in terms of increased agriculture output; crop diversification by addition of new varieties including cash crop or higher value crops and provide more stability to yield and hence income to farmers.

The present project is designed for efficient water usage for irrigation by drip/sprinkler method. Apart from reducing water consumption, proposed drip/sprinkler method of irrigation shall help reducing cost of cultivation and improving productivity of crops as compared to the same crops cultivated under flood method of irrigation. Many individual evaluation studies on sprinkler irrigation carried out in different crops suggest more yield in sprinkler irrigation method (SIM) than flood irrigation system (FIM) e.g. using three years experimental data, a study was carried out in Udaipur district of Rajasthan on maize and wheat crops which indicated the average incremental yield in maize and wheat was 4.45 and 6.95 percent respectively with SIM over FIM. Water saving due to SIM was 14.48 and

16.89 percent respectively for maize and wheat. Another similar study carried out highlights following results indicating higher yield and water saving:

Crop	Location	Yield (q/ha)		Irrigation water (cm)		Benefits over FIM (%)	
		FIM	SIM	FIM	SIM	Water	Yield
Wheat	Udaipur	26.61	33.02	33.02	14.52	56.03	24.09
Wheat	Rahuri	32.41	36.39	35.00	20.25	42.14	12.28
Maize	Udaipur	15.62	18.10	12.80	9.00	33.00	15.88
Bajra	Rahuri	6.97	8.33	17.78	7.82	56.02	19.51

Source: INCID (1998) "Potential For Drip And Sprinkler Irrigation In India" by A. Narayanamoorthy*

9.2.2 Distribution of Income

(a) Equity

Irrigation in the plains of north-western India such as Punjab and Haryana had an initial negative distribution impact i.e. inequalities increased, in general, however, in the long run distribution of income was more equitable due to employment generation and secondary benefits of the projects. It is expected that this project will benefit non-farmers as well through more employment opportunities, more spending leading to more secondary employment and income generation. All the irrigation benefits would be net additions to the economy as irrigation would not displace any other activity (opportunity cost is almost zero).

(b) Diversification of the Economy

Irrigated agriculture is invariably followed by diversification not only of agriculture but also of the local economy. Growth of several non- agricultural activities due to input needs on the one hand and creation of new needs for servicing higher production values (transport, markets, processing etc.) transforms traditional economic structure. Output multiplier of investment in agriculture particularly investment in irrigation has been estimated at about 1.8. This means that the income effect of irrigation investment is likely to generate additional income that is almost twice the level of original investment. Such changes are likely to be more dramatic in this area as the current economic structure is highly unstable with a very low-level productivity.

9.2.3 Positive Ecological Changes

No forest land will be diverted for any of the project activity. On the other hand, with increased availability of water, some changes in composition of tree species are bound to take place. Most of the tree plantation projects shall be under planned programmes. Availability of good quality water shall provide more choice. Farmers can choose plantations, which may yield them some return in the form of fodder, fruits or fuel wood. Another direct benefit of the project to the local ecology is the proposal of 209 hectares of plantation, distributed under different heads in the catchment area.

9.2.4 Improved Livestock

Water and fodder situation can be expected to change for the betterment of the farmers. The likely improvement in livestock breeding may even be more dramatic and more immediate than improvements in agriculture that require more time and more investment. A more productive animal husbandry sector would not only be a source of higher incomes but

would be another source of diversification of the economy. Infrastructure - roads, milk routes and chilling centres - would be required for faster development of animal husbandry.

9.2.5 Improved Infrastructure Facilities

A big boost will be provided to infrastructure due to improved irrigation in the area and thus increased productivity and general well-being. With economic well-being there will be demand for more and better medical facilities. Similarly, education facilities for children are normally the first requirement of the society. State is expected to meet this demand, especially for higher education. Several privately run schools are likely to come-up to provide primary/middle schools.

9.2.6 Increased Industrial Activity

The area is not bestowed with mineral resources or infrastructural facilities required for industries are poor. However, in post project scenario, small-scale industries based on agricultural products e.g. floor mill, dal mill, oil mill etc. are expected to come up. Apart from this workshops and small enterprises dealing in repairs and maintenance of farm machinery and equipment and manufacturing of small farm implements shall also grow with the actual need.

**Chapter
10****ENVIRONMENT MANAGEMENT
PLAN****10.1 ENVIRONMENT MANAGEMENT PLAN**

This chapter deals with the description of the administrative aspects of ensuring that mitigation measures are implemented and their effectiveness monitored. WRD is the project proponent/implementing agency for design and execution of the work including its operation post commissioning. Institutional arrangement for planning and implementing various mitigation and management measures along with carrying out environment monitoring are given at **Table 10.1**.

WRD is committed to ensure that all possible impacts are mitigated and shall ensure compliance to the national and state level regulatory requirements with a view to mitigate potential adverse environmental impacts resulting from the proposed project activities. The proposed EMP aims at ensuring the implementation of proposed mitigation and monitoring measures along with the responsible agency for implementation.

EIA process has evaluated various impacts due to the proposed project and has proposed mitigation measures and management plans; which will further reduce the severity of identified adverse impacts on environment due to the proposed project.

The overall responsibility for implementation of the EMP measures rests with WRD through their contractors. Member (E&F), WRD reporting directly to the Vice Chairman shall ensure coordination and implementation of the EMP measures. He will be responsible for progress monitoring of environmental and social safeguards during project construction and execution stage and submission of monitoring and compliance report to the authority.

The roles and responsibilities of WRD shall be:

1. Review contract documents to ensure that EMP provisions related to works are included in the contract documents.
2. Participate in and facilitate consultations with stakeholders.

3. Participate in project meetings and report on the issues related to environmental management and social safeguards to provide for any mid-course corrections that may be required based on situation on the ground.
4. Assist Project Affected Persons (PAPs) to resolve their grievances.
5. Liaison with state administration for land acquisition and provision of adequate compensation.
6. Develop rapport with PAFs and between PAFs and project.
7. Carry out other responsibilities as required from time to time.
8. Coordinate on the training of locals and capacity building initiatives.
9. Ensuring the implementation of all the planned mitigation and management measures
10. Review the monitoring report and assess the effectiveness of mitigation and management measures.
11. Take preventive and corrective actions as and when required.
12. Oversee and report implementation of EMP provisions included in the works contract.

Table 10.1: EMP Implementation

Sl. No.	Activities	Implementing Agency	Monitoring/ Supervising/ Approving Agency
1	Muck Management	Contractor	WRD/Forest Department
2	Sanitation and Solid Waste Management	Contractor	WRD/Pollution Control Board
3	Public Health Delivery System	Contractor	WRD/Health Department
4	Energy Conservation Measures	Contractor	WRD
5	Control of Air Pollution	Contractor	WRD/Pollution Control Board
6	Control of Noise Pollution	Contractor	WRD/Pollution Control Board
7	Control of Water Pollution	Contractor	WRD/Pollution Control Board
8	Waste Management at Sites	Contractor	WRD/Pollution Control Board
9	Biodiversity Conservation and Management	WRD	Forest Department
10	Compensatory Afforestation Programme	WRD	Forest Department
11	Rehabilitation and Resettlement Plan	WRD	District Administration
12	Disaster Management	WRD	District Administration (DDMA)
13	CER	WRD	MoEF&CC
14	Environmental Monitoring	WRD	Pollution Control Board

Chapter 11

COST ESTIMATES

The costs involved for implementation of Environmental Management Plan and Corporate Environment Responsibility Plan for Parbati Major Irrigation Project are summarized in the table given below. The total expenditure on Environmental Management Plan and Corporate Environment Responsibility Plan will be about **Rs. 13218.16 lakhs**.

S. No.	Management Plans	Amount (Rs. in lakh)
A	Environmental Management Plan	
1	Biodiversity Conservation And Wildlife Management Plan	130.00
2	Catchment Area Treatment Plan	360.89
3	Fisheries Conservation and Management Plan	91.00
4	Command Area Development Plan	750.00
5	Rehabilitation and Resettlement Plan	9959.50
6	Landscaping, Restoration and Green Belt Development Plan	78.00
7	Reservoir Rim Treatment Plan	65.00
8	Muck Management Plan	300.00
9	Solid Waste Management Plan	92.50
10	Public Health Delivery System	147.00
11	Energy Conservation Measures	121.50
12	Disaster Management Plan	90.00
13	Implementation of Mitigation and Safety Measures	125.00
Total A		12310.39
B	Corporate Environment Responsibility Plan	907.77
Total (A+B)		13218.16

**Chapter
12****DISCLOSURE BY THE CONSULTANT****12.1 DISCLOSURE BY THE CONSULTANT**

Final EIA report of Parbati Major Irrigation Project has been prepared by M/s RS Envirolink Technologies Pvt. Ltd., (RSET) Gurgaon which is a QCI-NABET accredited company to undertake River Valley, Hydroelectric, Drainage and Irrigation Projects (Category 'A') according to the TOR approved by MoEF&CC. A copy of the Accreditation certificate along with the list of experts involved is appended at the beginning of the report.

ANNEXURES

No. J-12011/01/2018-IA-I (R)
Ministry of Environment, Forest & Climate Change
Government of India
(IA.I Division)

Indira Paryavaran Bhawan
3rd Floor, Vayu Wing
Jor Bagh Road
New Delhi-3

Date: 26th February, 2018

To

The Engineer-in-Chief
Office of the Engineer-in- Chief
Water Resources Department
Jal Sansadhan Bhawan
Tulsi Nagar, Bhopal - 3.
E-mail : encwrbbpl@mp.nic.in

Subject: Parbati (Rinsi) Major Irrigation Project in Rajgarh District of Madhya Pradesh by Water Resources Department, Govt. of Madhya Pradesh – TOR - Regarding.

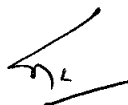
Sir,

This is with reference to your letter No. 72/CAD.Env./2017/3087 dated 29.12.2017 on the above mentioned subject.

2. The said proposal was appraised by the Expert Appraisal Committee (EAC) for River Valley and Hydro Electric Power Projects (RV&HEP) in its meeting held on 30.1.2018. The comments and observations of EAC may be seen in the minutes of the meeting which are available on the Ministry's web-site.

3. The Parbati (Rinsi) major Irrigation project envisages construction of 22.70 m high and 1350 m long concrete barrage across Parbati river (tributary of River Chambal) near village Rinsi in Rajgarh District of Madhya Pradesh to store 171.47 MCM of water to irrigate 48,663 ha of command area. The gross storage is 171.47 MCM and the live storage is 162.21 MCM of water. The gross command area is 54,000 ha. The total submergence is about 3719.13 ha (of which forest land – 38.50 ha + private land – 2434.42 ha + revenue land – 1246.21 ha). The catchment area of the project is 3302 Sq.km. About 13 villages are coming under submergence and 864 families are likely to be affected due to the proposed scheme. Total cost of the project is Rs. 1732.17 crores.

4. Based on recommendations of the EAC, the Ministry of Environment Forest & Climate Change hereby accords a Terms of Reference for pre-construction activities at the proposed site as per the provisions of the Environmental Impact Assessment Notification, 2006 and subsequent amendment in 2009 along with the following conditions for preparation of EIA/EMP report:



- (k) The EIA/EMP Report must contain an Index showing details of compliance of all ToR conditions. The Index will comprise of page no., etc., vide which compliance of a specific ToR is available. It may be noted that without this index, EIA/EMP report will not be accepted.
- (l) In case the validity is to be extended, necessary application is to be submitted to Regulatory Authority before expiry of validity period together with an updated form -1 based on proper justification.

This has approval of the Competent Authority.

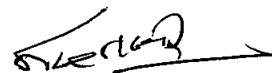
Yours faithfully,



(Dr S. Kerketta)
Director

Copy to:

1. The Secretary, Ministry of Water Resources, RD & GR, Shram Shakti, Bhawan, Rafi Marg, New Delhi - 110 001.
2. The Principal Secretary (Water Resources Department), Government of Madhya Pradesh, Secretariat, Bhopal -462 016.
3. The Secretary, Department of Environment, Government of Madhya Pradesh, Secretariat, Bhopal - 462 016.
4. The Chief Engineer, Project Appraisal Directorate, Central Water Commission, Sewa Bhawan, R.K. Puram, New Delhi-110 066.
5. The Additional PCCF (Central), Regional Office (WR), Ministry of Environment, Forest & Climate Change, Kendriya Paryavaran Bhavan, Link Road No-3, Ravi Shanker Nager, Bhopal - 462 016.
6. The Member Secretary, Madhya Pradesh State Pollution Control Board, Paryavaran Parisar, E-5, Arera Colony, Bhopal - 462 016.
7. Guard file.



(Dr. S. Kerketta)
Director

TERMS OF REFERENCE FOR CONDUCTING ENVIRONMENT IMPACT ASSESSMENT STUDY FOR 'A' CATEGORY RIVER VALLEY PROJECTS AND INFORMATION TO BE INCLUDED IN EIA/EMP REPORT

(1) Scope of EIA Studies

The EIA Report should identify the relevant environmental concerns and focus on potential impacts that may change due to the construction of proposed project. Based on the baseline data collected for three (3) seasons (Pre-monsoon, Monsoon and Winter seasons), the status of the existing environment in the area and capacity to bear the impact on this should be analyzed. Based on this analysis, the mitigation measures for minimizing the impact shall be suggested in the EIA/EMP study.

(2) Details of the Project and Site

- General introduction about the proposed project.
- Details of project and site giving L-sections of all U/S and D/S projects of River with all relevant maps and figures. Connect such information as to establish the total length of interference of Natural River and the committed unrestricted release from the site of diversion into the main river.
- A map of boundary of the project site giving details of protected areas in the vicinity of project location.
- Location details on a map of the project area with contours indicating main project features. The project layout shall be superimposed on a contour map of ground elevation showing main project features (viz. location of dam, Head works, main canal, branch canals, quarrying etc.) shall be depicted in a scaled map.
- Layout details and map of the project along with contours with project components clearly marked with proper scale maps of at least a 1:50,000 scale and printed at least on A3 scale for clarity.
- Existence of National Park, Sanctuary, Biosphere Reserve etc. in the study area, if any, should be detailed and presented on a map with distinct distances from the project components.
- Drainage pattern and map of the river catchment up to the proposed project site.
- Delineation of critically degraded areas in the directly draining catchment on the basis of silt Yield Index as per the methodology of All India Soil and Land Use Survey of India.
- Soil characteristics and map of the project area.
- Geological and seismo-tectonic details and maps of the area surrounding the proposed project site showing location of dam site and powerhouse site.
- Remote Sensing studies, interpretation of satellite imagery, topographic sheets along with ground verification shall be used to develop the land use/land cover pattern of the study using overlaying mapping techniques viz. Geographic Information System (GIS), False Color composite (FCC) generated from satellite data of project area.
- Land details including forests, private and other land.
- Demarcation of snow fed and rain fed areas for a realistic estimate of the water availability.

✓

the absence of such species in the study area based on such methodology is misleading. It is very important to document the status of such species owing to their high conservation value. Hence likely presence of such species should be ascertained from secondary sources by a proper literature survey for the said area including referring to field guides which are now available for many taxonomic groups in India. Even literature from studies/surveys in the larger landscapes which include the study area for the concerned project must be referred to since most species from adjoining catchments is likely to be present in the catchments in question. In fact such literature from the entire state can be referred to. Once a listing of possible R.E.T. species from the said area is developed, species specific methodologies should be adopted to ascertain their presence in the study area which would be far more conclusive as compared to the conventional sampling. If the need be, modern methods like camera trapping can be resorted to, particularly for areas in the eastern Himalayas and for secretive/nocturnal species. A detailed listing of the literature referred to, for developing lists of R.E.T. species should be provided in the EIA reports.

- The R.E.T. species referred to in this point should include species listed in Schedule I and II of Wildlife (Protection) Act, 1972 and those listed in the red data books (BSI, ZSI and IUCN).

(6) Components of the EIA Study

Various aspects to be studied and provided in the EIA/EMP report are as follows:

A. Physical and Chemical Environment

(i) Geological & Geophysical Aspects and Seismo – Tectonics:

- Physical geography, Topography, Regional Geological aspects and structure of the Catchment.
- Tectonics, seismicity and history of past earthquakes in the area. A site specific study of the earthquake parameters will be done. The results of the site specific earthquake design shall be sent for approval of the NCSDP (National committee of Seismic Design Parameters, Central water commission, New Delhi for large dams.
- Landslide zone or area prone to landslide existing in the study area should be examined.
- Presence of important economic mineral deposit, if any.
- Justification for location & execution of the project in relation to structural components (dam height).
- Impact of project on geological environment.

(ii) Meteorology, Air and Noise:

- Meteorology (viz. Temperature, Relative humidity, wind speed/direction etc.) to be collected from nearest IMD station.
- Ambient Air Quality with parameters viz. Suspended Particulate Matter (SPM), Respirable Suspended Particulate Matter (RSPM) i.e. suspended particulate materials <10 microns, Sulphur Dioxide (SO₂) and Oxides of Nitrogen (NO_x) in the study area at 6 locations.
- Existing noise levels and traffic density in the study area at 6 locations.

- Norms for release of Environmental flows, i.e. 30% in monsoon season, 20% in lean season and 25% in non-monsoon & non-lean season to be followed corresponding to 90% dependable year. A site specific study on minimum environment flow should be carried out.
- Hydrological studies/data as approved by CWC shall be utilized in the preparation of EIA/EMP report. Actual hydrological annual yield may also be given in the report.
- A minimum of 1 km distance from the tip of the reservoir to the tail race tunnel should be maintained between upstream and downstream projects.

C. Biological Environment

Besides primary studies, review of secondary data/literature published for project area on flora & fauna including RET species shall be reported in EIA/EMP report.

(i) Flora

- Characterization of forest types (as per Champion and Seth method) in the study area and extent of each forest type as per the Forest Working Plan.
- Documentation of all plant species i.e. Angiosperm, Gymnosperm, Pteridophytes, Bryophytes, Lichens (all groups). All species list may be provided.
- General vegetation profile and floral diversity covering all groups of flora including lichens and orchids. A species wise list may be provided.
- Assessment of plant species with respect to dominance, density, frequency, abundance, diversity index, similarity index, importance value index (IVI), Shannon Weiner index etc. of the species to be provided. Methodology used for calculating various diversity indices along with details of locations of quadrates, size of quadrates etc. to be reported within the study area in different ecosystems.
- Existence of National park, Sanctuary, Biosphere Reserve etc in the study area, if any, should be detailed.
- Economically important species like medicinal plants, timber, fuel wood etc.
- Details of endemic species found in the project area.
- Flora under RET categories should be documented using International Union for the Conservation of Nature and Natural Resources (IUCN) criteria and Botanical Survey of India's Red Data list along-with economic significance. Species diversity curve for RET species should be given.
- Biodiversity study, a sub-component of EIA study, is to be carried-out by associating a reputed organisation/institution as recommended by WII, Dehradun or by ICFRE, Dehradun. A list of such institutes is available on MoEF's website.
- Cropping pattern and Horticultural Practices in the study area.

(ii) Fauna

- Fauna study and inventorisatation should be carried out for all groups of animals in the study area. Their present status along-with Schedule of the species.
- Documentation of fauna plankton (phyto and zooplankton), periphyton, benthos and fish should be done and analysed.
- Information (authenticated) on Avi-fauna and wildlife in the study area.
- Status of avifauna their resident/ migratory/ passage migrants etc.



(7) Impact Prediction and Mitigation Measures

The adverse impact due to the proposed project should be assessed and effective mitigation steps to abate these impacts should be described.

(i) Air Environment

- Changes in ambient and ground level concentrations due to total emissions from point, line and area sources.
- Effect on soil, material, vegetation and human health.
- Impact of emissions from DG set used for power during the construction, if any, on air environment.
- Pollution due to fuel combustion in equipments and vehicles
- Fugitive emissions from various sources
- Impact on micro-climate

(ii) Water Environment

- Changes in surface and ground water quality
- Steps to develop pisci-culture and recreational facilities
- Changes in hydraulic regime and downstream flow.
- Water pollution due to disposal of sewage
- Water pollution from labour colonies/ camps and washing equipment.

(iii) Land Environment

- Adverse impact on land stability, catchment of soil erosion, reservoir sedimentation and spring flow (if any) (a) due to considerable road construction / widening activity (b) interference of reservoir with the inflowing stream (c) blasting for commissioning of HRT, TRT and some other structures.
- Changes in land use / land cover and drainage pattern.
- Immigration of labour population.
- Quarrying operation and muck disposal.
- Changes in land quality including effects of waste disposal.
- River bank and their stability.
- Impact due to submergence.

(iv) Biological Environment

- Impact on forests, flora, fauna including wildlife, migratory avi-fauna, rare and endangered species, medicinal plants etc.
- Pressure on existing natural resources.
- Deforestation and disturbance to wildlife, habitat fragmentation and wild animal's migratory corridors.
- Compensatory afforestation-identification of suitable native tree species for compensatory afforestation and green belt.
- Impact on fish migration and habitat degradation due to decreased flow of water.
- Impact on breeding and nesting grounds of animals and fish.

(v) Socio-economic aspects

- Impact on local community including demographic profile.
- Impact on socio-economic status.
- Impact on economic status.
- Impact on human health due to water / vector borne disease



- **Green Belt Development Plan** along the periphery of the reservoir, approach roads around the colonies and other project components, local plant species must be suggested with physical and financial details. Local plant species suitable for greenbelt should be selected.
- **Reservoir Rim Treatment Plan** for stabilization of land slide/ land slip zones, if any, around the reservoir periphery is to be prepared based on detailed survey of geology of the reservoir rim area. Suitable engineering and biological measures for treatment of identified slip zones to be suggested with physical and financial schedule.
- **Muck Disposal Plan** suitable sites for dumping of excavated materials should be identified in consultation with State Pollution Control Board and State Forest Department. All muck disposal sites should be minimum 30 m away from the HFL of river. Plan for rehabilitation of muck disposal sites should also be given. The L-section/cross section of muck disposal sites and approach roads should be given. The plan shall have physical and financial details of the measures proposed.
- **Restoration Plan for Quarry Sites and landscaping** of colony areas, working areas, roads etc. Details of the coarse/fine aggregate/clay etc. required for construction of the project and the rock/clay quarries/river shoal sites identified for the project should be discussed along-with the Engineering and Biological measures proposed for their restoration with physical and financial details. Layout map showing quarry sites vis-à-vis other project components, should be prepared.
- **Study of Design Earthquake Parameters:** A site specific study of earthquake parameters should be done. Results of the site specific earthquake design parameters should be approved by National Committee of Seismic Design Parameters, Central Water Commission (NCSDP), New Delhi.
- **Dam Break Analysis and Disaster Management Plan** The outputs of dam break model should be illustrated with appropriate graphs and maps clearly bringing out the impact of Dam Break scenario. The action plan will include Emergency Action and Management plan including measures like preventive action notification, warning procedure and action plan for co-ordination with various authorities.
- **Water, Air and Noise Management Plans** to be implemented during construction and post-construction periods.
- Mitigating measures for **impacts due to Blasting** on the structures in the vicinity.
- **Ground Water Management Plan.**
- **Public Health Delivery Plan** including the provisions of drinking water supply for local community.
- **Labour Management Plan** for their Health and Safety.
- **Sanitation and Solid waste Management plan** for domestic waste from colonies and labour camps etc.
- **Local Area Development Plan** to be formulated in consultation with the Revenue Officials and Village Panchayats. Local skill development schemes should be given. Details of various activities to be undertaken along with its financial outlay should be provided.
- Environmental safeguards during construction including Road Construction.

No.J-11013/25/2014-IA.I
Government of India
Ministry of Environment & Forests

Indira Paryavaran Bhawan,
Jor Bagh Road, Ali Ganj,
New Delhi-11003

Dated the 11th August, 2014

OFFICE MEMORANDUM

Subject: Environment sustainability and CSR related issues-guidelines

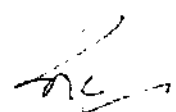
The Environment Impact Assessment (EIA) Notification 2006, issued under the Environment (Protection) Act 1986, as amended from time to time, prescribes the process for granting prior environment clearance (EC) in respect of certain development projects / activities listed out in the Schedule to the notification.

2. Sustainable development has three components, viz., social, economic and environmental. All the three components are closely inter-related and mutually re-enforcing. Considering this, the general structure of EIA document, under Appendix-III to the notification, prescribes inter-alia public consultation, social impact assessment and R&R action plan besides environment management plan (EMP).

3. It is noticed that while there is clarity on the guidelines on EMP, as regards sustainability related issues, different formulations have been prescribed in the conditions in EC letters for the projects under different sectors listed out in Schedule to the EIA Notification, 2006. Thus, there is a need to issue guidelines on the subject.

4. Section 135 of the Companies Act, 2013 deals with corporate social responsibility and Schedule-VII of the Act lists out the activities which may be included by companies in their CSR Policies. The activities relating to "ensuring environmental sustainability", are listed in this schedule. Further, Ministry of Corporate Affairs has also notified the Companies (Corporate Social Responsibility Policy) Rules, 2014.

5. The concept of CSR as provided for in the Companies Act, 2013 and covered under the Companies (Corporate Social Responsibility Policy) Rules, 2014 comes into effect only in case of companies having operating projects and making net profit as also subject to other stipulations contained in the aforesaid Act and Rules. The environment clearance given to a project may involve a situation where the concerned company is yet to make any net profit and / or is not covered under the purview of the aforesaid Act and Rules. Obviously, in such cases, the provisions of aforesaid Act and Rules will not apply.



No. J-12011/01/2018-IA-I (R)
Ministry of Environment, Forest & Climate Change
Government of India
(IA.I Division)

Indira Paryavaran Bhawan
3rd Floor, Vayu Wing
Jor Bagh Road
New Delhi-3
Date: 22nd February, 2019

To

The Engineer-in-Chief
Office of the Engineer-in-Chief
Water Resources Department
Jal Sansadhan Bhawan
Tulsi Nagar Bhopal-3
Email: encwrbpl@mp.nic.in

Sub: Parbati (Rinsi) Major Irrigation Project in Rajgarh District of Madhya Pradesh by M/s Water Resources Department, Government of Madhya Pradesh - for amendment in TOR

Sir,

This is with reference to your application dated 17.09.2018 letter No. 72/CAD/ENV/2017 on the above mentioned subject.

2. The said proposal was appraised by the Environment Appraisal Committee (EAC) for River Valley and Hydro Electric Power Projects (RV&HEP) in its meeting held on 26th October, 2018. The Terms of Reference (TOR) for Parbati (Rinsi) Major Irrigation Project in Rajgarh District of Madhya Pradesh was accorded on 26.2.2018. Your request to shift construction 2 Km upstream of original site to avoid submergence of the Narsinghgarh wildlife sanctuary has been examined by the Expert Appraisal Committee (EAC) for River Valley & Hydroelectric Projects.

3. The EAC duly considered the relevant documents submitted by you and have recommended for an amendment of ToR/Scoping clearance to avoid submergence of Narsinghgarh wildlife sanctuary. Accordingly, the Ministry hereby accords amendment of ToR with following changes:

S.No.	Details	Original	Revised
1	Dam height/Dam Length	22.70 m/1350 m	23.40 m/1050 m
2	Gross Command Area (GCA)	54,000 ha	70,000 ha
3	Culturable Command Area (GCA)	48,663 ha	48,000 ha
4	Catchment Area	3302 Sq. km	3150 Sq.km
5	Gross Storage	171.47 MCM	172.54 MCM
6	Live Storage	162.21 MCM	162.62 MCM
7	Total submergence area	3719.13 ha	3494.64 ha
8	Private land	2434.42 ha	2290.57 ha
9	Revenue land	1246.21 ha	1204.07 ha
10	Forest land	38.50 ha	---
11	Canals Length of Rising Main (left)		

ok

Received
today
10/3/19
3

Issued
10/3/19

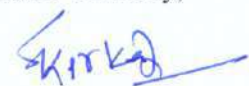
	Length of Rising Main (Right)	5 Km	5 Km
	Dia. of Rising Main (Left)	5 Km	1 Km
	Dia. of Rising Main (Right)	2.75 m	2.80 m
	Lift (Left)	1.60 m	1.50 m
	Lift (Right)	30 m	59.5 m
		30 m	39 m
12	Number of villages under submergence	13	18
13	Number of families affected	864	1125
14	Total cost of the project (Rs. in Crores)	1732.17	1815.54

4. Detailed Resettlement and Rehabilitation plan shall be prepared as per Land Acquisition, Rehabilitation and Resettlement Act, 2013 for the all affected families in the Environmental Management Plan.

5. All other terms and conditions of the Scoping/TOR clearance stipulated in letter No. J-12011/1/2018-IA-I (R) dated 26.2.2018 shall remain unchanged.

This issues with approval of the Competent Authority.

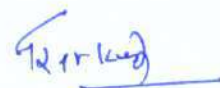
Yours faithfully,



(Dr S. Kerketta)
Director

Copy to:

1. The Secretary, Ministry of Water Resources, RD & GR, Sharm Shakti Bhawan, Rafi Marg, New Delhi-110001.
2. The Principal Secretary (Water Resources Department), Govt. of Madhya Pradesh, Secretariat, Bhopal-462 016.
3. The Secretary, Department of Environment, Govt. of Madhya Pradesh, Secretariat, Bhopal-462 016.
4. The Chief Engineer, Project Appraisal Directorate, Central Electricity Authority, Sewa Bhawan R.K. Puram, New Delhi-110066.
5. The Addl. PCCF(Central), Regional Office(WR), Ministry of Environment, Forest & Climate Change, Kendriya Paryavaran Bhawan, Link Road No-3, Ravi Shanker Nagar, Bhopal-462 016.
6. PPs to JS (GM).
7. The Member Secretary, Madhya Pradesh Pollution Control Board, Paryavaran Parisar, E-5, Area Colony, Bhopal-462 016.
8. Guard File.



(Dr. S. Kerketta)
Director

Annexure - II

ToR Compliance - Parbati Major Irrigation Project

S. No	Clause in ToR	Compliance
1	Scope of EIA Studies	Chapter 1: Introduction Section 1.4, Page 1.2
2	Details of the Project and Site - General introduction about the proposed project. - A map of boundary of the project site giving details of protected areas in the vicinity of project location. - Location details on a map of the project area with contours indicating main project features. The project layout shall be superimposed on a contour map of ground elevation showing main project features (viz. location of dam, Head works, main canal, branch canals, quarrying etc.) shall be depicted in a scaled map. - Existence of National Park, Sanctuary, Biosphere Reserve etc. in the study area, if any, should be detailed and presented on a map with distinct distances from the project components. - Drainage pattern and map of the river catchment up to the proposed project site. - Delineation of critically degraded areas in the directly draining catchment on the basis of Silt Yield Index as per the methodology of Soil and Land use Survey of India. - Soil characteristics and map of the project area. - Geological and Seismo-tectonic details and maps of the area surrounding the proposed project site showing location of dam site and canal sites. - Remote Sensing studies, interpretation of satellite imagery, topographic sheets along with ground verification shall be used to develop the land use/land cover pattern of the study using overlaying mapping techniques viz. Geographic Information System (GIS), False Color Composite (FCC) generated from satellite data of project area. - Land details including forests, private and other land.	Chapter 2: Project Description Section 2.1, Page 2.1 Figure 2.4, Page 2.13 Figure 2.1, Page 2.4 Section 2.10, Page 2.12 Figure 2.4, Page 2.13 Additional Studies, Chapter 2: Catchment Area Treatment Plan Figure 2.1, Page 2.3 Additional Studies, Chapter 2: Catchment Area Treatment Plan Figure 2.11, Page 2.17 Chapter 3: Description of Environment Section 3.4.3, Page 3.14 Figure 3.10, Page 3.18 Section 3.4.2.2, Page 3.11 Section 3.4.7, Page 3.46 Figure 3.14, Page 3.48 Figure 3.15, Page 3.49 Chapter 2: Project Description Section 2.3, Page 2.3
3	Description of Environment and Baseline Data The study area should comprise of the following:	Chapter 3: Description of Environment

	• Catchment area up to the dam/barrage site. • Submergence Area. • Project area or the direct impact area should comprise of area within 10 km radius from the periphery of reservoir, land coming under submergence and area downstream of dam upto the point where Tail Race Tunnel (TRT) meets the river.	Section 3.2, Page 3.1 Figure 3.1, Page 3.3
4	Details of the Methodology • The methodology followed for collection of base line data along with details of number of samples and their locations in the map should be included. • Study area should be demarcated properly on the appropriate scale map. • Sampling sites should be depicted on map for each parameter with proper legends. • For forest classification, Champion and Seth (1968) classification should be followed.	Chapter 3: Description of Environment Section 3.3, Page 3.7, Section 3.4.3.2, Page 3.19, Section 3.4.4, Page 3.26, Section 3.4.5, Page 3.30, Section 3.4.6, Page 3.32 Figure 3.1, Page 3.3 Figure 3.11, Page 3.20, Figure 3.12, Page 3.28, Figure 3.13, Page 3.38 Section 3.5.1, Page 3.50
5	Methodology for Collection of Biodiversity Data • The number of sampling locations should be adequate to get a reasonable idea of the diversity and other attributes of flora and fauna. The guiding principles should be the size of the study area (larger area should have larger number of sampling locations) and inherent diversity at the location, as known from secondary sources (e.g. eastern Himalayan and low altitude sites should have a larger number of sampling locations owing to higher diversity). • The R.E.T. species referred to in this point should include species listed in Schedule I and II of Wildlife (Protection) Act, 1972 and those listed in the red data books (BSI, ZSI and IUCN).	Chapter 3: Description of Environment Section 3.5.2, Page 3.51 Section 3.5.3, Page 3.69 Section 3.5.2.3, Page 3.52 Section 3.5.3.5, Page 3.75
6	Components of the EIA Study	
A	Physical and Chemical Environment	
(i)	Geological and Geophysical Aspects and Seismo-Tectonics	Chapter 3: Description of Environment Section 3.4.2.2, Page 3.11

(ii)	Meteorology, Air and Noise • Meteorology (viz., Temperature, Relative Humidity, wind speed/direction etc.) to be collected from nearest IMD station. • Ambient Air Quality with parameters viz., Suspended Particulate Matter (SPM), Respirable Suspended Particulate Matter (RSPM) i.e., suspended particulate materials <10-microns, Sulphur Dioxide (SO₂), Oxides of Nitrogen (NO_x), in the study area at 6 locations. • Existing noise levels and traffic density in the study area at 6 locations.	Chapter 3: Description of Environment Section 3.4.2, Page 3.9 Section 3.4.4, Page 3.26 Section 3.4.5, Page 3.30
(iii)	Soil Characteristics • Soil classification, physical parameters (viz., texture, porosity, bulk density and water holding capacity) and chemical parameters (viz. pH, electrical conductivity, Magnesium, calcium, total alkalinity, chlorides, sodium, potassium, organic carbon, available potassium, available phosphorus, SAR, nitrogen and salinity, etc.,) (6 locations).	Chapter 3: Description of Environment Section 3.4.3, Page 3.14
(iv)	Remote sensing and GIS Studies • Generation of thematic maps viz., slope map, drainage map, soil map, land use and land cover map, etc. Based on these, thematic maps, an erosion intensity map should be prepared. • New Configuration map to be given in EIA report	Chapter 3: Description of Environment Figure 3.2, Page 3.4; Figure 3.3, Page 3.5; Figure 3.4, Page 3.6; Figure 3.10, Page 3.18; Figure 3.15, Page 3.49 Additional Studies, Chapter 2: Catchment Area Treatment Plan Figure 2.1, Page 2.3; Figure 2.11, Page 2.17

(v)	Water Quality - History of the ground water table fluctuation in the study area. - Water quality for both surface water and ground water for (i)Physical parameters'(pH, temperature, electrical conductivity, TSS); (ii)Chemical parameters (Alkalinity, Hardness, BOD, COD, NO₂, PO₄, Cl, SO₄, Na, K, Ca Mg, Silica, Oil & Grease, phenolic compounds, residual sodium carbonate); (iii)Bacteriological parameters (MPN, Total coliforms) and (iv) Heavy Metals (Pb, As, Hg, cd, cr-6, total Cr, Cu, Zn, Fe). - Delineation of sub and micro-watersheds, their locations and extent based on the All India Soil and Land Use Survey of India (AISLUS), Department of Agriculture, Government of India. Erosion levels in each micro-watershed and prioritization of micro-watershed through silt yield index (SYI) method of AISLUS.	Chapter 3: Description of Environment Section 3.4.2.3, Page 3.12 Section 3.4.6.1, Page 3.32 Section 3.4.6.2, Page 3.40 Additional Studies, Chapter 2: Catchment Area Treatment Plan Section 2.4.1, Page 2.2
B	Water Environment & Hydrology	Chapter 3: Description of Environment Section 3.4.6, Page 3.32
C	Biological Environment	
(i)	Flora: - Characterization of forest types (as per Champion and Seth method) in the study area and extent of each forest type as per the Forest Working Plan. - Documentation of all plant species i.e. Angiosperm, Gymnosperm, Pteridophytes, Bryophytes (all groups). - General vegetation profile and floral diversity covering all groups of flora including lichens and orchids. A species wise list may be provided. - Assessment of plant species with respect to dominance, density, frequency, abundance, diversity index, similarity index, importance value index (IVD, Shannon Weiner index etc. of the species to be provided. Methodology used for calculating various diversity indices along with details of locations of quadrates, size of quadrates etc. to be reported within the study area in different ecosystems. - Existence of National park, Sanctuary, Biosphere Reserve etc. in the study area, if, any, should be detailed. - Economically important species like medicinal plants, timber, fuel wood etc.	Chapter 3: Description of Environment Section 3.5.1, Page 3.50 Section 3.5.2, Page 3.51 Annexure-VII Section 3.5.2.2, Page 3.51 Section 3.5.2.6, Page 3.67 Section 2.10, Page 2.12 Figure 2.4, Page 2.13 Section 3.5.2.4, Page 3.52

	• Flora under RET categories should be documented using International Union for the Conservation of Nature and Natural Resources (IUCN) criteria and Botanical Survey of India's Red Data list along-with economic significance. Species diversity curve for RET species should be given. • Cropping pattern and Horticulture Practices in the study area.	Section 3.5.2.3, Page 3.52 Chapter 2: Project Description Section 2.8, Page 2.9
(ii)	Fauna: • Fauna study and inventorisations should be carried out for all groups of animals in the study area. Their present status along with Schedule of the species. • Documentation of fauna plankton (Phyto and zooplankton), periphyton, benthos and fish should be done and analyzed. • Information (authenticated) on Avi-fauna and wildlife in the study area. • Status of avifauna their resident/ migratory/ passage migrants etc. • Documentation of butterflies, if any, found in the area. • Details of endemic species found in the project area. • RET species-voucher specimens should be collected alongwith GPS readings to facilitate rehabilitation. RET faunal species to be classified as per IUCN Red Data list and as per different schedule of Indian Wildlife (Protection) Act, 1972. • Existence of barriers and corridors, if any, for wild animals. • Compensatory afforestation to compensate the green belt area that will be removed, if any, as part of the proposed project development and loss of biodiversity. • Collection of primary data on agricultural activity, crop and their productivity and irrigation facilities components.	Chapter 3: Description of Environment Section 3.5.3.1, Page 3.69 Section 3.5.3.6, Page 3.75 Section 3.5.3.6, Page 3.75 Section 3.5.3.5, Page 3.75 Section 3.5.3.4, Page 3.74 NA Additional Studies, Chapter 15: Compensatory Afforestation Plan Chapter 4: Description of Social Environment Section 4.4, Page 4.13
D	Aquatic Ecology	Chapter 3: Description of Environment
	• Documentation of aquatic fauna like macro-invertebrates, zooplankton, phyto-planktons, benthos etc.	Section 3.5.3.6, Page 3.75

	• Fish and fisheries, their migration and breeding grounds. • Fish diversity composition and maximum length & weight of the measured populations to be studied for estimation of environmental flow. • Conservation status of aquatic fauna.	
E	Socio-Economic	Chapter 4: Description of Social Environment
7	Impact Prediction and Mitigation Measures The adverse impact due to the proposed project should be assessed and effective mitigation steps to abate these impacts should be described.	Chapter 5: Assessment of Impacts
(i)	Air Environment	Section 5.1.1, Page 5.2
(ii)	Water Environment	Section 5.1.3, Page 5.4
(iii)	Land Environment	Section 5.1.4, Page 5.5
(iv)	Biological Environment	Section 5.1.5, Page 5.9
(v)	Socio – Economic Aspects	Section 5.1.6, Page 5.9
8	Environmental Management Plan (EMP)	Additional Studies
(i)	Catchment Area Treatment (CAT) Plan	Additional Studies, Chapter 2: Catchment Area Treatment Plan
(ii)	Command area Development(CAD) Plan	Additional Studies, Chapter 4: Command Area Development Plan
(iii)	Compensatory Afforestation	Additional Studies, Chapter 15: Compensatory Afforestation Plan
(iv)	Biodiversity and Wild Life Conservation & Management Plan	Additional Studies, Chapter 1: Biodiversity Management and Wildlife Conservation Plan
(v)	Fisheries Conservation & Management Plan	Additional Studies, Chapter 3: of Fisheries Conservation and Management Plan
(vi)	Resettlement and Rehabilitation (R&R) Plan	Additional Studies, Chapter 5: Rehabilitation and Resettlement Plan
(vii)	Green Belt Development Plan along the periphery of reservoir, colonies, approach road, canals etc.	Additional Studies, Chapter 6: Landscaping, Restoration & Green Belt Development Plan
(viii)	Reservoir Rim Treatment Plan	Additional Studies, Chapter 7: Reservoir Rim Treatment Plan
(ix)	Muck Disposal Plan	Additional Studies, Chapter 8: Muck Management Plan
(x)	Restoration plan of quarry sites and landscaping of colony areas, working areas, roads, etc.	Additional Studies, Chapter 6: Landscaping, Restoration & Green Belt Development Plan
(xi)	Study of Design Earthquake Parameters	NA
(xii)	Dam Break Analysis and Disaster Management Plan	Additional Studies, Chapter 12: Dam Break Modeling and Disaster Management Plan
(xiii)	Water, Air and Noise Management Plans	Chapter 5: Assessment of Impacts Section 5.4.3, Page 5.18

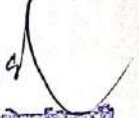
		Section 5.4.1, Page 5.16 Section 5.4.2, Page 5.17
(xiv)	Mitigating measures for impacts due to Blasting on the structures in the vicinity.	NA
(xv)	Ground Water Management Plan	NA
(xvi)	Public Health Delivery Plan	Additional Studies, Chapter 10: Public Health Delivery System
(xvii)	Labour Management Plan	Additional Studies, Chapter 9: Solid Waste Management Plan Chapter 10: Public Health Delivery System Chapter 11: Energy Conservation Measures
(xviii)	Sanitation and Solid-waste management plan	Additional Studies, Chapter 9: Solid Waste Management Plan
(xix)	Local Area Development Plan	Additional Studies, Chapter 13: Corporate Environment Responsibility Plan
(xx)	Environmental Safeguards during construction activities including Road Construction.	Chapter 5: Assessment of Impacts Section 5.4.4.1, Page 5.20
(xxi)	Energy Conservation Measures	Additional Studies, Chapter 11: Energy Conservation Measures
(xxii)	Environmental Monitoring Programme	Chapter 7: Environmental Monitoring Plan
9	In the EMP, a sample CAD plan for a distributary outlet command is also included. Such a plan is to show the alignment of irrigation and drainage channels. The components of the On Farm Development (OFD) works to be undertaken may be clearly mentioned along with a time schedule for their completion vis-&-vis the progress of irrigation development.	Additional Studies, Chapter 4: Command Area Development Plan
10	Additional Conditions	
(i)	Three (3) season's data should be collected for the entire project.	Chapter 3: Description of Environment Section 3.3.1, Page 3.5
(ii)	Land acquired for the project shall be suitably compensated in accordance with the law of the land with the prevailing guidelines. Private land shall be acquired as per provision of Right to Fair Compensation and Transparency in land acquisition, Rehabilitation and Resettlement Act, 2013	Additional Studies, Chapter 5: Rehabilitation and Resettlement Plan
(iii)	The project involves about 38.50 ha of forest land. Forest clearance should be obtained as per the prevailing norms of FC Act, 1980.	NA

प्रमाण-पत्र

प्रमाणित किया जाता है कि जल संसाधन संभाग नरसिंहगढ़ जिला राजगढ़ म.प्र. द्वारा पार्वती नदी पर वृहद् सिंचाई परियोजना का बांध निर्माण स्थल वन्यप्राणी अभयारण्य नरसिंहगढ़ (सामान्य वनमण्डल राजगढ़ म.प्र.) की परिधि सीमा से 50 मीटर दूरी पर राजस्व भूमि में निर्माण किया जाना प्रस्तावित है। निकटतम बिन्दू की जी.पी.एस. रीडिंग $N23^{\circ}38'09''$ $E077^{\circ}07'41''$ है।


उपवन मण्डलाधिकारी
वन मण्डल राजगढ़


वनसंरक्षक एवं पदेन
वनमण्डलाधिकारी
(स.प्र.) वनमण्डल राजगढ़


उपपरिवेक्षक
वन्य प्राणी अभयारण्य
नरसिंहगढ़

Annexure IV

Wind Rose diagram and Data

Wind rose diagram of the study for different seasons is presented as figures. The wind speed and wind direction data generated at site is tabulated in **Table-1** taking into the account the predominant wind direction.

Table-1: Summary of Wind Pattern in study area during different seasons

Seasons	First Predominant wind Direction	Second Predominant Wind direction	Calm
Winter	N (13.4%)	NE (12.51%)	4.91%
Pre-Monsoon	WNW (31.85%)	NW (22.58%)	0%
Monsoon	W (54.44%)	WSW (21.78%)	0%

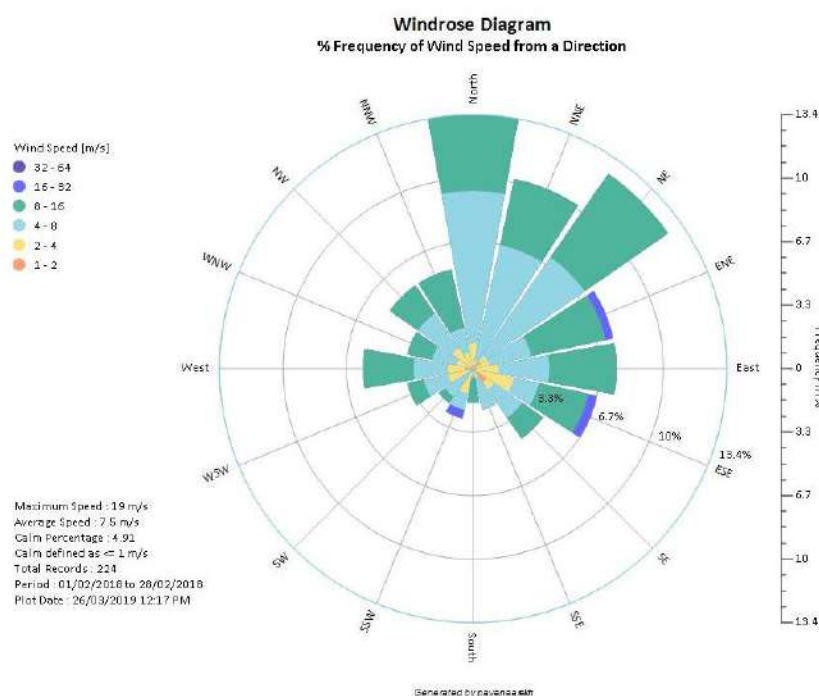


Figure-1:- Wind Rose diagram during Winter Season

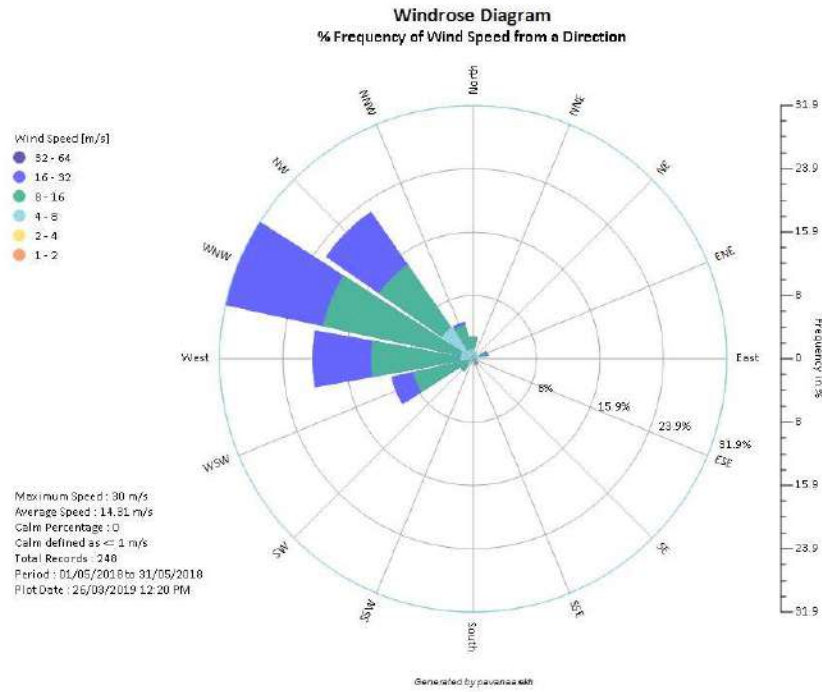


Figure-2:- Wind Rose diagram during Pre-Monsoon Season

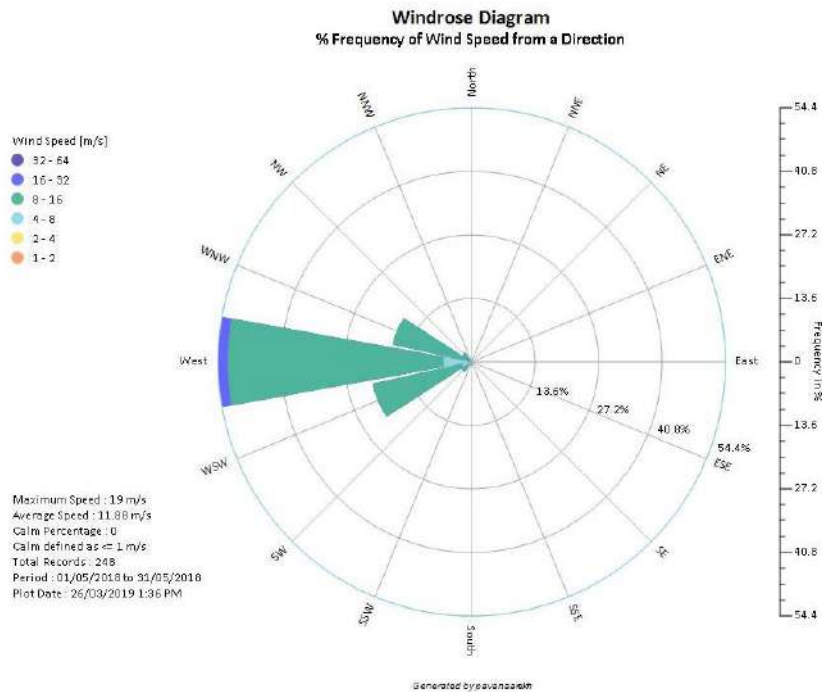


Figure-3:- Wind Rose diagram during Monsoon Season.

Table-2: Wind Rose data during Winter season

S.No	YYYY	MM	DD	HH	W_dir	W_Sp
1	2018	2	1	0:00	22.5	6
2	2018	2	1	3:00	45	5
3	2018	2	1	6:00	67.5	3
4	2018	2	1	9:00	360	9
5	2018	2	1	12:00	337.5	10
6	2018	2	1	15:00	360	7
7	2018	2	1	18:00	337.5	5
8	2018	2	1	21:00	22.5	5
9	2018	2	2	0:00	67.5	4
10	2018	2	2	3:00	112.5	4
11	2018	2	2	6:00	157.5	3
12	2018	2	2	9:00	247.5	8
13	2018	2	2	12:00	270	11
14	2018	2	2	15:00	270	5
15	2018	2	2	18:00	247.5	4
16	2018	2	2	21:00	247.5	3
17	2018	2	3	0:00	270	4
18	2018	2	3	3:00	247.5	3
19	2018	2	3	6:00	270	6
20	2018	2	3	9:00	292.5	10
21	2018	2	3	12:00	270	12
22	2018	2	3	15:00	315	10
23	2018	2	3	18:00	337.5	13
24	2018	2	3	21:00	360	10
25	2018	2	4	0:00	22.5	11
26	2018	2	4	3:00	45	13
27	2018	2	4	6:00	67.5	17
28	2018	2	4	9:00	67.5	14
29	2018	2	4	12:00	90	9
30	2018	2	4	15:00	45	8
31	2018	2	4	18:00	45	8
32	2018	2	4	21:00	45	8
33	2018	2	5	0:00	67.5	9
34	2018	2	5	3:00	90	11
35	2018	2	5	6:00	90	12
36	2018	2	5	9:00	112.5	12
37	2018	2	5	12:00	135	6
38	2018	2	5	15:00	67.5	8
39	2018	2	5	18:00	45	12

S.No	YYYY	MM	DD	HH	W_dir	W_Sp
40	2018	2	5	21:00	67.5	11
41	2018	2	6	0:00	67.5	11
42	2018	2	6	3:00	90	10
43	2018	2	6	6:00	90	9
44	2018	2	6	9:00	180	9
45	2018	2	6	12:00	270	9
46	2018	2	6	15:00	337.5	3
47	2018	2	6	18:00	360	13
48	2018	2	6	21:00	360	12
49	2018	2	7	0:00	22.5	10
50	2018	2	7	3:00	22.5	5
51	2018	2	7	6:00	22.5	5
52	2018	2	7	9:00	337.5	10
53	2018	2	7	12:00	315	14
54	2018	2	7	15:00	360	5
55	2018	2	7	18:00	90	6
56	2018	2	7	21:00	135	2
57	2018	2	8	0:00	315	0
58	2018	2	8	3:00	360	4
59	2018	2	8	6:00	90	4
60	2018	2	8	9:00	225	5
61	2018	2	8	12:00	247.5	12
62	2018	2	8	15:00	315	9
63	2018	2	8	18:00	360	8
64	2018	2	8	21:00	360	8
65	2018	2	9	0:00	360	6
66	2018	2	9	3:00	360	5
67	2018	2	9	6:00	337.5	6
68	2018	2	9	9:00	315	6
69	2018	2	9	12:00	292.5	12
70	2018	2	9	15:00	292.5	6
71	2018	2	9	18:00	337.5	4
72	2018	2	9	21:00	22.5	5
73	2018	2	10	0:00	45	7
74	2018	2	10	3:00	67.5	9
75	2018	2	10	6:00	90	13
76	2018	2	10	9:00	112.5	19
77	2018	2	10	12:00	135	16
78	2018	2	10	15:00	112.5	10

S.No	YYYY	MM	DD	HH	W_dir	W_Sp
79	2018	2	10	18:00	90	13
80	2018	2	10	21:00	112.5	14
81	2018	2	11	0:00	112.5	11
82	2018	2	11	3:00	157.5	6
83	2018	2	11	6:00	135	7
84	2018	2	11	9:00	180	15
85	2018	2	11	12:00	202.5	18
86	2018	2	11	15:00	112.5	3
87	2018	2	11	18:00	135	9
88	2018	2	11	21:00	135	8
89	2018	2	12	0:00	135	9
90	2018	2	12	3:00	180	8
91	2018	2	12	6:00	157.5	8
92	2018	2	12	9:00	315	1
93	2018	2	12	12:00	202.5	4
94	2018	2	12	15:00	315	3
95	2018	2	12	18:00	360	8
96	2018	2	12	21:00	22.5	8
97	2018	2	13	0:00	45	11
98	2018	2	13	3:00	45	8
99	2018	2	13	6:00	45	12
100	2018	2	13	9:00	45	11
101	2018	2	13	12:00	360	10
102	2018	2	13	15:00	22.5	9
103	2018	2	13	18:00	22.5	13
104	2018	2	13	21:00	22.5	12
105	2018	2	14	0:00	45	14
106	2018	2	14	3:00	45	13
107	2018	2	14	6:00	45	16
108	2018	2	14	9:00	67.5	14
109	2018	2	14	12:00	360	10
110	2018	2	14	15:00	22.5	7
111	2018	2	14	18:00	360	6
112	2018	2	14	21:00	360	8
113	2018	2	15	0:00	360	6
114	2018	2	15	3:00	360	4
115	2018	2	15	6:00	45	6
116	2018	2	15	9:00	45	5
117	2018	2	15	12:00	22.5	5
118	2018	2	15	15:00	22.5	6

S.No	YYYY	MM	DD	HH	W_dir	W_Sp
119	2018	2	15	18:00	22.5	5
120	2018	2	15	21:00	22.5	5
121	2018	2	16	0:00	22.5	5
122	2018	2	16	3:00	22.5	6
123	2018	2	16	6:00	45	6
124	2018	2	16	9:00	67.5	6
125	2018	2	16	12:00	360	5
126	2018	2	16	15:00	360	6
127	2018	2	16	18:00	360	7
128	2018	2	16	21:00	22.5	5
129	2018	2	17	0:00	67.5	1
130	2018	2	17	3:00	22.5	1
131	2018	2	17	6:00	202.5	4
132	2018	2	17	9:00	292.5	6
133	2018	2	17	12:00	315	8
134	2018	2	17	15:00	315	6
135	2018	2	17	18:00	360	7
136	2018	2	17	21:00	45	5
137	2018	2	18	0:00	112.5	4
138	2018	2	18	3:00	90	3
139	2018	2	18	6:00	112.5	3
140	2018	2	18	9:00	247.5	6
141	2018	2	18	12:00	270	9
142	2018	2	18	15:00	315	5
143	2018	2	18	18:00	360	7
144	2018	2	18	21:00	45	7
145	2018	2	19	0:00	45	8
146	2018	2	19	3:00	67.5	6
147	2018	2	19	6:00	90	7
148	2018	2	19	9:00	90	8
149	2018	2	19	12:00	360	4
150	2018	2	19	15:00	22.5	4
151	2018	2	19	18:00	45	8
152	2018	2	19	21:00	22.5	9
153	2018	2	20	0:00	45	11
154	2018	2	20	3:00	67.5	9
155	2018	2	20	6:00	90	10
156	2018	2	20	9:00	112.5	12
157	2018	2	20	12:00	90	5
158	2018	2	20	15:00	67.5	7

S.No	YYYY	MM	DD	HH	W_dir	W_Sp
159	2018	2	20	18:00	90	8
160	2018	2	20	21:00	135	6
161	2018	2	21	0:00	112.5	4
162	2018	2	21	3:00	90	4
163	2018	2	21	6:00	112.5	5
164	2018	2	21	9:00	157.5	8
165	2018	2	21	12:00	270	3
166	2018	2	21	15:00	270	1
167	2018	2	21	18:00	135	2
168	2018	2	21	21:00	90	1
169	2018	2	22	0:00	270	1
170	2018	2	22	3:00	45	2
171	2018	2	22	6:00	135	4
172	2018	2	22	9:00	202.5	5
173	2018	2	22	12:00	270	7
174	2018	2	22	15:00	270	5
175	2018	2	22	18:00	292.5	3
176	2018	2	22	21:00	270	2
177	2018	2	23	0:00	292.5	3
178	2018	2	23	3:00	315	4
179	2018	2	23	6:00	157.5	5
180	2018	2	23	9:00	180	12
181	2018	2	23	12:00	225	13
182	2018	2	23	15:00	225	7
183	2018	2	23	18:00	202.5	8
184	2018	2	23	21:00	270	10
185	2018	2	24	0:00	315	10
186	2018	2	24	3:00	315	4
187	2018	2	24	6:00	202.5	3
188	2018	2	24	9:00	225	8
189	2018	2	24	12:00	247.5	13
190	2018	2	24	15:00	247.5	8
191	2018	2	24	18:00	225	5
192	2018	2	24	21:00	315	7

S.No	YYYY	MM	DD	HH	W_dir	W_Sp
193	2018	2	25	0:00	337.5	7
194	2018	2	25	3:00	67.5	1
195	2018	2	25	6:00	202.5	1
196	2018	2	25	9:00	292.5	5
197	2018	2	25	12:00	270	12
198	2018	2	25	15:00	292.5	9
199	2018	2	25	18:00	337.5	11
200	2018	2	25	21:00	360	12
201	2018	2	26	0:00	22.5	11
202	2018	2	26	3:00	45	10
203	2018	2	26	6:00	67.5	14
204	2018	2	26	9:00	67.5	13
205	2018	2	26	12:00	337.5	9
206	2018	2	26	15:00	337.5	10
207	2018	2	26	18:00	337.5	11
208	2018	2	26	21:00	360	9
209	2018	2	27	0:00	360	7
210	2018	2	27	3:00	45	4
211	2018	2	27	6:00	45	5
212	2018	2	27	9:00	45	10
213	2018	2	27	12:00	360	9
214	2018	2	27	15:00	360	6
215	2018	2	27	18:00	360	6
216	2018	2	27	21:00	22.5	9
217	2018	2	28	0:00	45	9
218	2018	2	28	3:00	67.5	7
219	2018	2	28	6:00	90	8
220	2018	2	28	9:00	112.5	9
221	2018	2	28	12:00	247.5	1
222	2018	2	28	15:00	202.5	0
223	2018	2	28	18:00	112.5	6
224	2018	2	28	21:00	112.5	8

YYYY-Year; MM-Month; DD-Date; HH-Hour; W_dir-Wind Direction (Degree); W_Sp-Wind Speed (m/s).

Table-3: Wind Rose data during Pre-Monsoon Season.

S.no	YYYY	MM	DD	HH	W_dir	W_Sp
1	2018	5	1	0:00	270	8
2	2018	5	1	3:00	270	10
3	2018	5	1	6:00	270	11

S.no	YYYY	MM	DD	HH	W_dir	W_Sp
4	2018	5	1	9:00	292.5	11
5	2018	5	1	12:00	270	11
6	2018	5	1	15:00	270	9

S.no	YYYY	MM	DD	HH	W_dir	W_Sp
7	2018	5	1	18:00	270	8
8	2018	5	1	21:00	270	7
9	2018	5	2	0:00	270	10
10	2018	5	2	3:00	270	12
11	2018	5	2	6:00	270	12
12	2018	5	2	9:00	247.5	14
13	2018	5	2	12:00	247.5	15
14	2018	5	2	15:00	247.5	13
15	2018	5	2	18:00	247.5	11
16	2018	5	2	21:00	247.5	9
17	2018	5	3	0:00	247.5	12
18	2018	5	3	3:00	247.5	12
19	2018	5	3	6:00	247.5	13
20	2018	5	3	9:00	247.5	13
21	2018	5	3	12:00	247.5	13
22	2018	5	3	15:00	247.5	11
23	2018	5	3	18:00	247.5	10
24	2018	5	3	21:00	270	13
25	2018	5	4	0:00	247.5	16
26	2018	5	4	3:00	247.5	14
27	2018	5	4	6:00	247.5	13
28	2018	5	4	9:00	247.5	12
29	2018	5	4	12:00	247.5	10
30	2018	5	4	15:00	247.5	11
31	2018	5	4	18:00	225	11
32	2018	5	4	21:00	247.5	11
33	2018	5	5	0:00	247.5	14
34	2018	5	5	3:00	247.5	13
35	2018	5	5	6:00	270	12
36	2018	5	5	9:00	292.5	12
37	2018	5	5	12:00	292.5	13
38	2018	5	5	15:00	292.5	12
39	2018	5	5	18:00	270	9
40	2018	5	5	21:00	270	9
41	2018	5	6	0:00	247.5	9
42	2018	5	6	3:00	270	10
43	2018	5	6	6:00	270	11
44	2018	5	6	9:00	270	11
45	2018	5	6	12:00	292.5	10
46	2018	5	6	15:00	247.5	9

S.no	YYYY	MM	DD	HH	W_dir	W_Sp
47	2018	5	6	18:00	225	8
48	2018	5	6	21:00	247.5	12
49	2018	5	7	0:00	270	12
50	2018	5	7	3:00	270	11
51	2018	5	7	6:00	292.5	11
52	2018	5	7	9:00	292.5	10
53	2018	5	7	12:00	337.5	7
54	2018	5	7	15:00	315	4
55	2018	5	7	18:00	270	6
56	2018	5	7	21:00	247.5	9
57	2018	5	8	0:00	270	10
58	2018	5	8	3:00	270	10
59	2018	5	8	6:00	292.5	12
60	2018	5	8	9:00	315	13
61	2018	5	8	12:00	315	11
62	2018	5	8	15:00	270	7
63	2018	5	8	18:00	225	9
64	2018	5	8	21:00	247.5	13
65	2018	5	9	0:00	270	14
66	2018	5	9	3:00	292.5	15
67	2018	5	9	6:00	292.5	15
68	2018	5	9	9:00	292.5	16
69	2018	5	9	12:00	292.5	15
70	2018	5	9	15:00	270	12
71	2018	5	9	18:00	270	13
72	2018	5	9	21:00	270	15
73	2018	5	10	0:00	270	15
74	2018	5	10	3:00	292.5	13
75	2018	5	10	6:00	292.5	13
76	2018	5	10	9:00	292.5	13
77	2018	5	10	12:00	315	11
78	2018	5	10	15:00	292.5	10
79	2018	5	10	18:00	270	9
80	2018	5	10	21:00	270	11
81	2018	5	11	0:00	270	14
82	2018	5	11	3:00	270	14
83	2018	5	11	6:00	292.5	14
84	2018	5	11	9:00	315	14
85	2018	5	11	12:00	315	15
86	2018	5	11	15:00	292.5	15

S.no	YYYY	MM	DD	HH	W_dir	W_Sp
87	2018	5	11	18:00	270	15
88	2018	5	11	21:00	270	14
89	2018	5	12	0:00	270	13
90	2018	5	12	3:00	292.5	12
91	2018	5	12	6:00	292.5	11
92	2018	5	12	9:00	292.5	14
93	2018	5	12	12:00	292.5	15
94	2018	5	12	15:00	292.5	14
95	2018	5	12	18:00	292.5	11
96	2018	5	12	21:00	270	11
97	2018	5	13	0:00	270	12
98	2018	5	13	3:00	270	12
99	2018	5	13	6:00	270	11
100	2018	5	13	9:00	270	9
101	2018	5	13	12:00	270	9
102	2018	5	13	15:00	270	9
103	2018	5	13	18:00	270	8
104	2018	5	13	21:00	270	6
105	2018	5	14	0:00	247.5	6
106	2018	5	14	3:00	247.5	7
107	2018	5	14	6:00	270	8
108	2018	5	14	9:00	270	9
109	2018	5	14	12:00	270	9
110	2018	5	14	15:00	292.5	10
111	2018	5	14	18:00	292.5	9
112	2018	5	14	21:00	292.5	7
113	2018	5	15	0:00	270	7
114	2018	5	15	3:00	247.5	8
115	2018	5	15	6:00	270	8
116	2018	5	15	9:00	270	5
117	2018	5	15	12:00	225	4
118	2018	5	15	15:00	202.2	7
119	2018	5	15	18:00	202.2	11
120	2018	5	15	21:00	225	12
121	2018	5	16	0:00	225	11
122	2018	5	16	3:00	225	9
123	2018	5	16	6:00	247.5	8
124	2018	5	16	9:00	270	7
125	2018	5	16	12:00	270	5
126	2018	5	16	15:00	270	5

S.no	YYYY	MM	DD	HH	W_dir	W_Sp
127	2018	5	16	18:00	270	6
128	2018	5	16	21:00	247.5	7
129	2018	5	17	0:00	270	11
130	2018	5	17	3:00	292.5	13
131	2018	5	17	6:00	292.5	12
132	2018	5	17	9:00	292.5	11
133	2018	5	17	12:00	292.5	9
134	2018	5	17	15:00	292.5	10
135	2018	5	17	18:00	270	9
136	2018	5	17	21:00	270	10
137	2018	5	18	0:00	270	11
138	2018	5	18	3:00	270	11
139	2018	5	18	6:00	270	13
140	2018	5	18	9:00	270	15
141	2018	5	18	12:00	292.5	15
142	2018	5	18	15:00	292.5	14
143	2018	5	18	18:00	292.5	12
144	2018	5	18	21:00	270	13
145	2018	5	19	0:00	270	15
146	2018	5	19	3:00	292.5	15
147	2018	5	19	6:00	270	14
148	2018	5	19	9:00	270	11
149	2018	5	19	12:00	270	11
150	2018	5	19	15:00	292.5	10
151	2018	5	19	18:00	292.5	9
152	2018	5	19	21:00	292.5	10
153	2018	5	20	0:00	270	13
154	2018	5	20	3:00	270	15
155	2018	5	20	6:00	270	13
156	2018	5	20	9:00	247.5	11
157	2018	5	20	12:00	247.5	13
158	2018	5	20	15:00	247.5	14
159	2018	5	20	18:00	247.5	13
160	2018	5	20	21:00	270	12
161	2018	5	21	0:00	270	13
162	2018	5	21	3:00	270	14
163	2018	5	21	6:00	270	13
164	2018	5	21	9:00	247.5	12
165	2018	5	21	12:00	270	13
166	2018	5	21	15:00	270	11

S.no	YYYY	MM	DD	HH	W_dir	W_Sp
167	2018	5	21	18:00	270	11
168	2018	5	21	21:00	270	12
169	2018	5	22	0:00	270	14
170	2018	5	22	3:00	270	14
171	2018	5	22	6:00	270	13
172	2018	5	22	9:00	270	11
173	2018	5	22	12:00	270	11
174	2018	5	22	15:00	270	11
175	2018	5	22	18:00	270	12
176	2018	5	22	21:00	270	12
177	2018	5	23	0:00	270	14
178	2018	5	23	3:00	292.5	15
179	2018	5	23	6:00	292.5	15
180	2018	5	23	9:00	292.5	13
181	2018	5	23	12:00	270	13
182	2018	5	23	15:00	270	13
183	2018	5	23	18:00	270	14
184	2018	5	23	21:00	292.5	16
185	2018	5	24	0:00	270	14
186	2018	5	24	3:00	270	17
187	2018	5	24	6:00	270	19
188	2018	5	24	9:00	270	17
189	2018	5	24	12:00	270	16
190	2018	5	24	15:00	270	14
191	2018	5	24	18:00	247.5	11
192	2018	5	24	21:00	247.5	11
193	2018	5	25	0:00	247.5	12
194	2018	5	25	3:00	247.5	13
195	2018	5	25	6:00	247.5	13
196	2018	5	25	9:00	247.5	14
197	2018	5	25	12:00	247.5	15
198	2018	5	25	15:00	247.5	15
199	2018	5	25	18:00	270	13
200	2018	5	25	21:00	247.5	12
201	2018	5	26	0:00	247.5	13
202	2018	5	26	3:00	247.5	13
203	2018	5	26	6:00	247.5	14
204	2018	5	26	9:00	270	17
205	2018	5	26	12:00	270	17
206	2018	5	26	15:00	270	15

S.no	YYYY	MM	DD	HH	W_dir	W_Sp
207	2018	5	26	18:00	270	12
208	2018	5	26	21:00	270	11
209	2018	5	27	0:00	247.5	12
210	2018	5	27	3:00	247.5	11
211	2018	5	27	6:00	270	12
212	2018	5	27	9:00	270	16
213	2018	5	27	12:00	270	16
214	2018	5	27	15:00	270	15
215	2018	5	27	18:00	270	12
216	2018	5	27	21:00	270	10
217	2018	5	28	0:00	247.5	11
218	2018	5	28	3:00	270	12
219	2018	5	28	6:00	270	12
220	2018	5	28	9:00	270	13
221	2018	5	28	12:00	270	15
222	2018	5	28	15:00	270	16
223	2018	5	28	18:00	270	15
224	2018	5	28	21:00	270	11
225	2018	5	29	0:00	270	10
226	2018	5	29	3:00	270	12
227	2018	5	29	6:00	270	14
228	2018	5	29	9:00	270	14
229	2018	5	29	12:00	270	14
230	2018	5	29	15:00	270	15
231	2018	5	29	18:00	270	14
232	2018	5	29	21:00	270	13
233	2018	5	30	0:00	270	14
234	2018	5	30	3:00	270	13
235	2018	5	30	6:00	270	13
236	2018	5	30	9:00	270	14
237	2018	5	30	12:00	270	13
238	2018	5	30	15:00	270	14
239	2018	5	30	18:00	270	11
240	2018	5	30	21:00	270	11
241	2018	5	31	0:00	270	13
242	2018	5	31	3:00	247.5	14
243	2018	5	31	6:00	247.5	13
244	2018	5	31	9:00	270	14
245	2018	5	31	12:00	270	16
246	2018	5	31	15:00	247.5	15

S.no	YYYY	MM	DD	HH	W_dir	W_Sp
247	2018	5	31	18:00	270	14

S.no	YYYY	MM	DD	HH	W_dir	W_Sp
248	2018	5	31	21:00	270	11

YYYY-Year; MM-Month; DD-Date; HH-Hour; W_dir-Wind Direction (Degree); W_Sp-Wind Speed (m/s).

Table-4: Wind Rose data during Monsoon Season.

S.No	YYYY	MM	DD	HH	W_dir	W_sp
1	2018	7	1	0:00	270	8
2	2018	7	1	3:00	270	10
3	2018	7	1	6:00	270	11
4	2018	7	1	9:00	292.5	11
5	2018	7	1	12:00	270	11
6	2018	7	1	15:00	270	9
7	2018	7	1	18:00	270	8
8	2018	7	1	21:00	270	7
9	2018	7	2	0:00	270	10
10	2018	7	2	3:00	270	12
11	2018	7	2	6:00	270	12
12	2018	7	2	9:00	247.5	14
13	2018	7	2	12:00	247.5	15
14	2018	7	2	15:00	247.5	13
15	2018	7	2	18:00	247.5	11
16	2018	7	2	21:00	247.5	9
17	2018	7	3	0:00	247.5	12
18	2018	7	3	3:00	247.5	12
19	2018	7	3	6:00	247.5	13
20	2018	7	3	9:00	247.5	13
21	2018	7	3	12:00	247.5	13
22	2018	7	3	15:00	247.5	11
23	2018	7	3	18:00	247.5	10
24	2018	7	3	21:00	270	13
25	2018	7	4	0:00	247.5	16
26	2018	7	4	3:00	247.5	14
27	2018	7	4	6:00	247.5	13
28	2018	7	4	9:00	247.5	12
29	2018	7	4	12:00	247.5	10
30	2018	7	4	15:00	247.5	11
31	2018	7	4	18:00	225	11
32	2018	7	4	21:00	247.5	11
33	2018	7	5	0:00	247.5	14
34	2018	7	5	3:00	247.5	13
35	2018	7	5	6:00	270	12
36	2018	7	5	9:00	292.5	12

S.No	YYYY	MM	DD	HH	W_dir	W_sp
37	2018	7	5	12:00	292.5	13
38	2018	7	5	15:00	292.5	12
39	2018	7	5	18:00	270	9
40	2018	7	5	21:00	270	9
41	2018	7	6	0:00	247.5	9
42	2018	7	6	3:00	270	10
43	2018	7	6	6:00	270	11
44	2018	7	6	9:00	270	11
45	2018	7	6	12:00	292.5	10
46	2018	7	6	15:00	247.5	9
47	2018	7	6	18:00	225	8
48	2018	7	6	21:00	247.5	12
49	2018	7	7	0:00	270	12
50	2018	7	7	3:00	270	11
51	2018	7	7	6:00	292.5	11
52	2018	7	7	9:00	292.5	10
53	2018	7	7	12:00	337.5	7
54	2018	7	7	15:00	315	4
55	2018	7	7	18:00	270	6
56	2018	7	7	21:00	247.5	9
57	2018	7	8	0:00	270	10
58	2018	7	8	3:00	270	10
59	2018	7	8	6:00	292.5	12
60	2018	7	8	9:00	315	13
61	2018	7	8	12:00	315	11
62	2018	7	8	15:00	270	7
63	2018	7	8	18:00	225	9
64	2018	7	8	21:00	247.5	13
65	2018	7	9	0:00	270	14
66	2018	7	9	3:00	292.5	15
67	2018	7	9	6:00	292.5	15
68	2018	7	9	9:00	292.5	16
69	2018	7	9	12:00	292.5	15
70	2018	7	9	15:00	270	12
71	2018	7	9	18:00	270	13
72	2018	7	9	21:00	270	15

S.No	YYYY	MM	DD	HH	W_dir	W_sp
73	2018	7	10	0:00	270	15
74	2018	7	10	3:00	292.5	13
75	2018	7	10	6:00	292.5	13
76	2018	7	10	9:00	292.5	13
77	2018	7	10	12:00	315	11
78	2018	7	10	15:00	292.5	10
79	2018	7	10	18:00	270	9
80	2018	7	10	21:00	270	11
81	2018	7	11	0:00	270	14
82	2018	7	11	3:00	270	14
83	2018	7	11	6:00	292.5	14
84	2018	7	11	9:00	315	14
85	2018	7	11	12:00	315	15
86	2018	7	11	15:00	292.5	15
87	2018	7	11	18:00	270	15
88	2018	7	11	21:00	270	14
89	2018	7	12	0:00	270	13
90	2018	7	12	3:00	292.5	12
91	2018	7	12	6:00	292.5	11
92	2018	7	12	9:00	292.5	14
93	2018	7	12	12:00	292.5	15
94	2018	7	12	15:00	292.5	14
95	2018	7	12	18:00	292.5	11
96	2018	7	12	21:00	270	11
97	2018	7	13	0:00	270	12
98	2018	7	13	3:00	270	12
99	2018	7	13	6:00	270	11
100	2018	7	13	9:00	270	9
101	2018	7	13	12:00	270	9
102	2018	7	13	15:00	270	9
103	2018	7	13	18:00	270	8
104	2018	7	13	21:00	270	6
105	2018	7	14	0:00	247.5	6
106	2018	7	14	3:00	247.5	7
107	2018	7	14	6:00	270	8
108	2018	7	14	9:00	270	9
109	2018	7	14	12:00	270	9
110	2018	7	14	15:00	292.5	10
111	2018	7	14	18:00	292.5	9
112	2018	7	14	21:00	292.5	7

S.No	YYYY	MM	DD	HH	W_dir	W_sp
113	2018	7	15	0:00	270	7
114	2018	7	15	3:00	247.5	8
115	2018	7	15	6:00	270	8
116	2018	7	15	9:00	270	5
117	2018	7	15	12:00	225	4
118	2018	7	15	15:00	202.2	7
119	2018	7	15	18:00	202.2	11
120	2018	7	15	21:00	225	12
121	2018	7	16	0:00	225	11
122	2018	7	16	3:00	225	9
123	2018	7	16	6:00	247.5	8
124	2018	7	16	9:00	270	7
125	2018	7	16	12:00	270	5
126	2018	7	16	15:00	270	5
127	2018	7	16	18:00	270	6
128	2018	7	16	21:00	247.5	7
129	2018	7	17	0:00	270	11
130	2018	7	17	3:00	292.5	13
131	2018	7	17	6:00	292.5	12
132	2018	7	17	9:00	292.5	11
133	2018	7	17	12:00	292.5	9
134	2018	7	17	15:00	292.5	10
135	2018	7	17	18:00	270	9
136	2018	7	17	21:00	270	10
137	2018	7	18	0:00	270	11
138	2018	7	18	3:00	270	11
139	2018	7	18	6:00	270	13
140	2018	7	18	9:00	270	15
141	2018	7	18	12:00	292.5	15
142	2018	7	18	15:00	292.5	14
143	2018	7	18	18:00	292.5	12
144	2018	7	18	21:00	270	13
145	2018	7	19	0:00	270	15
146	2018	7	19	3:00	292.5	15
147	2018	7	19	6:00	270	14
148	2018	7	19	9:00	270	11
149	2018	7	19	12:00	270	11
150	2018	7	19	15:00	292.5	10
151	2018	7	19	18:00	292.5	9
152	2018	7	19	21:00	292.5	10

S.No	YYYY	MM	DD	HH	W_dir	W_sp
153	2018	7	20	0:00	270	13
154	2018	7	20	3:00	270	15
155	2018	7	20	6:00	270	13
156	2018	7	20	9:00	247.5	11
157	2018	7	20	12:00	247.5	13
158	2018	7	20	15:00	247.5	14
159	2018	7	20	18:00	247.5	13
160	2018	7	20	21:00	270	12
161	2018	7	21	0:00	270	13
162	2018	7	21	3:00	270	14
163	2018	7	21	6:00	270	13
164	2018	7	21	9:00	247.5	12
165	2018	7	21	12:00	270	13
166	2018	7	21	15:00	270	11
167	2018	7	21	18:00	270	11
168	2018	7	21	21:00	270	12
169	2018	7	22	0:00	270	14
170	2018	7	22	3:00	270	14
171	2018	7	22	6:00	270	13
172	2018	7	22	9:00	270	11
173	2018	7	22	12:00	270	11
174	2018	7	22	15:00	270	11
175	2018	7	22	18:00	270	12
176	2018	7	22	21:00	270	12
177	2018	7	23	0:00	270	14
178	2018	7	23	3:00	292.5	15
179	2018	7	23	6:00	292.5	15
180	2018	7	23	9:00	292.5	13
181	2018	7	23	12:00	270	13
182	2018	7	23	15:00	270	13
183	2018	7	23	18:00	270	14
184	2018	7	23	21:00	292.5	16
185	2018	7	24	0:00	270	14
186	2018	7	24	3:00	270	17
187	2018	7	24	6:00	270	19
188	2018	7	24	9:00	270	17
189	2018	7	24	12:00	270	16
190	2018	7	24	15:00	270	14
191	2018	7	24	18:00	247.5	11
192	2018	7	24	21:00	247.5	11

S.No	YYYY	MM	DD	HH	W_dir	W_sp
193	2018	7	25	0:00	247.5	12
194	2018	7	25	3:00	247.5	13
195	2018	7	25	6:00	247.5	13
196	2018	7	25	9:00	247.5	14
197	2018	7	25	12:00	247.5	15
198	2018	7	25	15:00	247.5	15
199	2018	7	25	18:00	270	13
200	2018	7	25	21:00	247.5	12
201	2018	7	26	0:00	247.5	13
202	2018	7	26	3:00	247.5	13
203	2018	7	26	6:00	247.5	14
204	2018	7	26	9:00	270	17
205	2018	7	26	12:00	270	17
206	2018	7	26	15:00	270	15
207	2018	7	26	18:00	270	12
208	2018	7	26	21:00	270	11
209	2018	7	27	0:00	247.5	12
210	2018	7	27	3:00	247.5	11
211	2018	7	27	6:00	270	12
212	2018	7	27	9:00	270	16
213	2018	7	27	12:00	270	16
214	2018	7	27	15:00	270	15
215	2018	7	27	18:00	270	12
216	2018	7	27	21:00	270	10
217	2018	7	28	0:00	247.5	11
218	2018	7	28	3:00	270	12
219	2018	7	28	6:00	270	12
220	2018	7	28	9:00	270	13
221	2018	7	28	12:00	270	15
222	2018	7	28	15:00	270	16
223	2018	7	28	18:00	270	15
224	2018	7	28	21:00	270	11
225	2018	7	29	0:00	270	10
226	2018	7	29	3:00	270	12
227	2018	7	29	6:00	270	14
228	2018	7	29	9:00	270	14
229	2018	7	29	12:00	270	14
230	2018	7	29	15:00	270	15
231	2018	7	29	18:00	270	14
232	2018	7	29	21:00	270	13

S.No	YYYY	MM	DD	HH	W_dir	W_sp
233	2018	7	30	0:00	270	14
234	2018	7	30	3:00	270	13
235	2018	7	30	6:00	270	13
236	2018	7	30	9:00	270	14
237	2018	7	30	12:00	270	13
238	2018	7	30	15:00	270	14
239	2018	7	30	18:00	270	11
240	2018	7	30	21:00	270	11

S.No	YYYY	MM	DD	HH	W_dir	W_sp
241	2018	7	31	0:00	270	13
242	2018	7	31	3:00	247.5	14
243	2018	7	31	6:00	247.5	13
244	2018	7	31	9:00	270	14
245	2018	7	31	12:00	270	16
246	2018	7	31	15:00	247.5	15
247	2018	7	31	18:00	270	14
248	2018	7	31	21:00	270	11

YYYY-Year; **MM**-Month; **DD**-Date; **HH**-Hour; **W_dir**-Wind Direction (Degree); **W_Sp**-Wind Speed (m/s).

Annexure V: Weather Data

Mean monthly Maximum and Minimum Temperature (°C) (refer. years 2009-2017) district Rajgarh.

Month	2009		2010		2011		2012		2013		2014		2015		2016		2017	
	Temperatu re (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
January	28	17	27	14	27	12	24	13	27	13	27	14	27	14	29	16	28	14
February	32	18	31	17	31	16	28	16	29	17	29	17	31	19	32	19	32	18
March	36	22	37	22	36	21	34	21	34	22	34	22	33	22	36	24	36	22
April	40	26	41	26	40	25	38	26	38	26	40	27	38	26	39	27	40	25
May	41	27	42	28	39	27	40	28	40	28	41	29	42	30	41	29	39	28
June	38	28	39	28	35	27	35	27	35	27	39	28	37	27	39	28	34	26
July	30	24	32	25	30	24	31	25	30	24	34	25	31	25	32	25	31	24
August	29	23	31	24	28	23	28	23	29	23	32	24	31	23	28	23	32	24
September	33	24	31	22	28	22	30	23	33	23	33	23	33	23	32	23	31	24
October	33	21	34	22	33	22	34	22	33	22	36	23	35	24	33	22	34	25
November	30	19	29	20	32	20	30	18	31	18	33	21	33	21	33	19	31	20
December	28	17	27	14	29	16	29	16	30	16	28	15	30	16	31	16	27	17

Mean annual average Rainfall (mm) and Numbers of Rainy Days (refer. years 2009-2017) district Rajgarh

Months	2009		2010		2011		2012		2013		2014		2015		2016		2017	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
January	1.39	1	3.4	1	0	0	2.4	1	0	0	18.29	4	13.68	5	3.01	3	0.7	1
February	0	0	2.61	2	1.51	2	0	0	13.21	7	17.88	3	5.66	4	0.4	1	0	0
March	0	0	0	0	0.2	0	0	0	4.31	1	0.1	0	35.34	10	4.6	4	0.1	1
April	0.51	0	0	0	1.07	0	6.02	1	9.42	6	0.2	0	22.12	4	0	0	0.7	1
May	0.3	1	0	0	1.23	2	1.5	2	0.27	0	2.2	3	1.6	2	6.6	5	5	6
June	25.2	9	101.8	13	223.24	23	90.67	16	278.91	28	14	9	118.52	21	114.72	15	101.8	23

Annexure V: Weather Data

Months	2009		2010		2011		2012		2013		2014		2015		2016		2017	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
July	678.11	28	274	29	315.76	31	450.31	29	365.72	31	236.54	24	245.57	30	282.56	31	366.2	29
August	396.15	30	381.3	31	489.92	31	481.97	31	306.92	31	169.35	30	69.02	29	449.51	31	327.7	30
September	108.34	10	137.22	20	155.49	27	167.91	27	106.04	20	148.89	20	24.2	14	66.75	24	289.5	15
October	46.91	3	29.38	8	0.29	1	0.3	0	54.17	12	1.3	2	3	3	80.79	9	0	0
November	71.59	7	68.21	14	0	0	0	0	0	0	3.11	2	2.24	1	0	0	0	0
December	1.79	4	0	0	0	0	0	0	0.6	0	4.8	2	1.27	1	0	0	13.5	3

Note:- A-Rainfall (mm); B-No. of Rainy days

Monthly Average Maximum Wind speed (kmph) (refer. years 2009-2017) district Rajgarh.

Months	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average
January	40	35	32	45	30	45	46	35	41	39
February	27	29	32	29	37	37	30	25	27	30
March	19	21	19	17	19	24	29	21	19	21
April	14	20	16	21	22	17	27	19	20	20
May	29	25	32	28	25	22	22	29	29	27
June	44	44	57	55	61	44	52	45	63	52
July	82	78	79	76	81	67	74	77	78	77
August	83	84	89	90	89	78	80	90	77	84
September	67	76	87	81	72	76	62	75	72	74
October	42	49	42	36	56	37	35	54	34	43
November	50	60	35	29	32	33	33	28	30	37
December	44	41	35	31	35	31	29	32	36	35

Annexure V: Weather Data

Monthly Average Humidity (%) (refer. years 2009-2017) district Rajgarh.

Months	2009	2010	2011	2012	2013	2014	2015	2016	2017	Humidity (%)
January	6.9	6.3	6.7	8.1	8.5	8.1	7.6	6.5	7.2	7.3
February	6.3	6	6.3	8.1	8.5	7.6	7.8	8.9	7.8	7.5
March	6.3	6.9	7.2	7.2	7.4	7.2	8.7	8.1	7.8	7.4
April	6.5	8.1	6	8.5	8.1	7.6	10.7	11	10.7	8.6
May	10.1	9.8	11.2	10.5	11.4	9.4	13.6	14.1	9.8	11.1
June	9.8	8.7	12.3	13.2	11.4	13.2	14.3	12.8	10.5	11.8
July	8.7	7.2	9.8	12.8	11	11.6	18.8	13.4	14.8	12.0
August	7.6	5.8	9.6	9.8	9.6	9.4	13.6	12.8	11.4	10.0
September	6.3	5.4	8.1	7.2	6.3	7.4	8.9	8.3	6.7	7.2
October	4.9	4.7	5.4	4.9	5.4	4.9	6.3	5.8	5.6	5.3
November	5.4	5.8	6	6.7	6.5	5.1	6.7	5.6	6.3	6.0
December	4.7	6.5	6.3	7.2	5.8	7.8	7.6	6.5	8.3	6.7

Annexure V: Weather Data

Mean monthly Maximum and Minimum Temperature (°C) (refe. years 2009-2017) district Bhopal.

Month	2009		2010		2011		2012		2013		2014		2015		2016		2017	
	Temperatu re (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
January	29	16	27	13	27	12	24	13	27	12	28	14	25	13	29	15	28	13
February	33	18	31	17	31	16	29	16	29	17	30	16	31	18	32	18	32	17
March	37	23	38	23	37	21	35	21	35	22	35	22	33	21	36	24	36	22
April	41	26	42	28	41	26	39	28	39	28	41	29	38	27	40	29	41	27
May	43	31	44	31	42	30	41	31	42	31	42	31	43	32	42	31	39	29
June	40	30	40	29	32	28	37	28	35	28	41	31	38	29	40	30	34	26
July	31	25	31	25	30	25	31	25	30	25	35	27	32	25	32	25	31	24
August	30	24	30	24	28	24	29	23	30	23	33	24	32	24	28	23	32	24
September	32	24	30	22	29	22	31	2	34	23	33	23	33	23	31	23	31	24
October	32	21	34	22	33	21	34	22	33	22	35	22	35	23	32	21	33	24
November	28	18	30	20	31	19	31	18	31	17	33	19	32	21	32	18	30	20
December	27	17	27	14	29	15	29	15	30	15	28	14	29	15	29	15	27	16

Mean annual average Rainfall (mm) and Numbers of Rainy Days (refer. years 2009-2017) district Bhopal.

Months	2009		2010		2011		2012		2013		2014		2015		2016		2017	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
January	6.1	3	5.11	2	0	0	12.83	2	0.5	0	21.27	7	37.97	10	6.49	3	2.4	2
February	0	0	3.19	3	2.5	2	0	0	45.61	11	23.92	7	10.94	6	0.5	1	3.4	2
March	0	0	0.4	1	1.89	2	0	0	36.61	3	7.92	4	88.97	10	9.7	9	0.1	1
April	9.3	1	0	0	2.7	2	2.91	2	7.7	4	2.21	2	61.69	5	0.6	2	0.5	1
May	0.4	0	0	0	5.39	1	4.08	2	0	0	2.39	1	2.08	6	7.49	10	12.7	9
June	57.99	9	61.66	9	743.96	23	81.83	16	442.98	22	32.96	14	181.18	20	139.83	19	138.6	22

Annexure V: Weather Data

Months	2009		2010		2011		2012		2013		2014		2015		2016		2017	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
July	527.3	29	627.28	30	491.98	31	706.68	27	506.9	30	395.22	25	224.96	27	404.35	31	325.4	31
August	476.45	29	397.62	31	627.41	31	503.25	31	379.84	30	271.61	30	306	31	558.62	31	235.5	31
September	193.57	13	247.48	21	308.86	23	139.85	23	67.91	17	153.88	16	37.8	17	123.3	29	319.6	20
October	161.32	7	34.58	8	0.5	0	4.51	2	68.73	13	12.6	9	3.4	4	93.48	7	14.9	4
November	204.87	8	59.25	14	0	0	0	0	0	0	0.1	0	7.33	2	0	0	3.9	2
December	8.99	4	7	2	7.17	1	0	0	0.1	0	11.33	4	0.87	1	0	0	0.1	1

Note:- A-Rainfall (mm); B-No. of Rainy days

Monthly Average Maximum Wind speed (kmph) (refer. years 2009-2017) district Bhopal.

Months	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average
January	45	43	37	53	34	50	54	38	46	44
February	28	33	34	32	44	39	35	28	29	34
March	18	19	20	16	22	25	33	22	18	21
April	13	14	16	17	18	14	23	14	13	16
May	18	18	21	18	16	17	17	22	26	19
June	34	38	56	47	58	32	46	41	60	46
July	81	81	81	74	82	65	71	80	78	77
August	83	88	90	89	88	77	80	91	79	85
September	70	79	85	75	69	73	62	80	75	74
October	52	54	44	36	61	44	38	55	45	48
November	61	62	38	32	36	33	39	32	37	41
December	54	46	40	34	40	39	33	37	36	40

Annexure V: Weather Data

Monthly Average Humidity (%) (refer. years 2009-2017) district Bhopal.

Months	2009	2010	2011	2012	2013	2014	2015	2016	2017	Humidity (%)
January	5.4	4.9	5.4	6.3	6.3	6.5	6.5	6	6.5	6.0
February	5.6	5.4	5.6	6.7	6.9	6	7.6	8.3	7.2	6.6
March	5.4	6	6	6.5	5.8	6	8.1	7.8	7.6	6.6
April	5.6	6.9	5.4	7.2	6.3	6.3	10.3	11	10.5	7.7
May	8.1	7.8	8.5	8.7	10.1	8.1	13	11.6	6.9	9.2
June	8.1	6.9	9.8	10.1	8.5	9.8	11.9	9.4	7.6	9.1
July	6.9	5.6	7.2	9.2	7.8	8.7	14.8	10.1	11.9	9.1
August	6	4.7	7.4	7.4	7.6	7.4	11.6	11	9.4	8.1
September	5.6	4.7	6.5	5.6	5.4	6.3	8.1	7.6	6.3	6.2
October	4	4.3	4.9	4.5	5.4	4.9	6.5	6	5.1	5.1
November	4.3	4.9	4.7	5.1	5.1	4.7	5.8	5.1	4.7	4.9
December	4.3	5.1	4.9	5.1	4.9	5.8	6.9	5.8	6.3	5.5

Annexure V: Weather Data

Mean monthly Maximum and Minimum Temperature (°C) (refe. years 2009-2017) district Sehore.

Month	2009		2010		2011		2012		2013		2014		2015		2016		2017	
	Temperatu re (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
January	16	29	14	28	12	28	13	25	13	28	14	28	13	26	16	30	14	28
February	18	34	18	32	17	32	16	30	17	30	17	30	18	32	19	33	18	33
March	23	38	24	39	22	37	22	36	23	35	23	35	22	33	24	37	22	36
April	27	42	28	43	26	41	28	39	28	39	29	41	27	38	29	40	27	41
May	31	43	31	44	30	42	31	41	31	42	31	42	32	43	31	42	29	39
June	30	40	29	40	28	35	28	37	27	35	31	41	29	38	30	40	26	34
July	25	31	25	31	25	30	25	31	25	30	26	35	25	32	25	32	24	31
August	24	30	24	30	23	28	23	28	23	30	24	33	24	31	23	28	24	32
September	24	33	22	31	22	29	23	31	23	34	23	33	23	33	23	31	24	30
October	22	33	22	34	22	33	22	34	22	33	23	35	23	35	22	33	24	33
November	18	28	20	30	19	32	18	31	18	32	20	34	21	33	18	32	20	30
December	17	28	14	28	16	29	16	30	16	30	15	29	16	30	16	30	17	27

Mean annual average Rainfall (mm) and Numbers of Rainy Days (refer. years 2009-2017) district Sehore

Months	2009		2010		2011		2012		2013		2014		2015		2016		2017	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
January	3.49	3	5.92	2	0	0	6.28	2	0.71	1	18.71	7	36.42	9	5.28	3	1.5	2
February	0	0	2.3	3	1.39	3	0	0	40.98	11	27.03	6	7.65	5	0.2	1	2	2
March	0	0	0.61	1	1.89	2	0	0	32.81	4	8.91	5	92.86	10	7.31	8	0.1	1
April	6.9	1	0	0	2.3	1	2.89	1	7.29	3	2.12	1	55.39	6	0.6	1	0.6	1
May	0.51	0	0.2	0	3.5	2	3.39	2	0	0	1.5	0	1.29	4	5.68	9	11.2	10

Annexure V: Weather Data

Months	2009		2010		2011		2012		2013		2014		2015		2016		2017	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
June	65	10	49.47	9	571.39	23	102.69	12	417.05	24	21.59	7	178.88	22	167.73	20	161.2	23
July	554	28	601.6	31	465.37	31	689.97	27	468.04	31	353.97	24	257.96	25	417.31	31	371.6	31
August	462	31	470.5	31	565.68	31	393.97	31	411.69	31	272.78	30	322.7	31	610.36	31	242.7	31
September	168	12	202.3	20	323.94	23	150.01	25	69.19	16	148.43	17	30.56	17	144.44	29	238.7	19
October	139	7	36.79	9	0.2	0	1.7	2	57.94	14	14.41	9	3.01	4	105.37	7	26.3	4
November	213	8	60.05	13	0	0	0	0	0.1	0	0.1	0	4.47	2	0	0	1.3	1
December	10.6	3	5.88	2	5.44	1	0	0	0.3	1	11.5	4	0.43	1	0	0	0.5	1

Note:- A-Rainfall (mm); B-No. of Rainy days

Monthly Average Maximum Wind speed (kmph) (refer. years 2009-2017) district Sehore.

Months	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average
January	5.6	4.9	5.6	6.7	6.7	6.7	6.5	6.3	6.7	6.2
February	5.6	5.4	5.8	6.9	7.2	6	7.6	8.5	7.2	6.7
March	5.4	6	6.3	6.7	6	6.3	7.8	7.8	7.4	6.6
April	5.8	7.2	5.4	7.2	6.5	6.3	10.3	10.7	10.3	7.7
May	8.3	8.1	8.5	8.7	10.1	8.1	12.8	11.9	6.9	9.3
June	8.1	6.9	9.6	9.8	8.5	10.1	11.6	9.4	7.2	9.0
July	6.9	5.6	7.2	9.2	7.8	8.7	14.1	9.8	11.2	8.9
August	6	4.7	7.2	7.4	7.6	7.2	11.2	10.3	9.2	7.9
September	5.6	4.9	6.5	5.6	5.4	6.3	8.1	7.4	6	6.2
October	3.8	4.3	5.1	4.5	5.4	4.9	6.5	6	5.4	5.1
November	4.3	5.1	4.9	5.4	5.4	4.9	6	5.6	4.7	5.1
December	4.3	5.4	5.1	5.4	5.1	6	7.2	6	6.5	5.7

Annexure V: Weather Data

Monthly Average Humidity (%) (refer. years 2009-2017) district Sehore.

Months	2009	2010	2011	2012	2013	2014	2015	2016	2017	Humidity (%)
January	44	42	35	51	32	49	53	37	44	41.6
February	28	32	33	30	42	38	34	27	29	43.0
March	17	19	19	15	21	25	33	21	18	32.6
April	13	15	15	18	18	14	23	15	14	20.9
May	19	18	22	18	17	17	18	23	25	16.1
June	35	38	56	49	59	33	46	42	61	19.7
July	82	80	81	74	83	65	72	80	80	46.6
August	83	88	90	90	88	77	81	91	81	77.4
September	69	78	85	76	70	73	63	80	77	85.4
October	51	53	43	36	60	43	37	55	46	74.6
November	61	61	37	31	35	32	38	31	37	47.1
December	53	44	39	33	39	37	32	35	36	40.3

Annexure V: Weather Data

Mean monthly Maximum and Minimum Temperature (°C) (refe. years 2009-2017) district Shajapur.

Month	2009		2010		2011		2012		2013		2014		2015		2016		2017	
	Temperatu re (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)		Temperatur e (°C)	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
January	16	28	13	27	11	26	12	24	12	26	13	27	13	26	15	30	13	28
February	17	32	17	31	16	31	15	29	16	29	16	29	18	31	18	32	17	32
March	22	37	22	38	20	36	20	34	21	34	21	35	22	3	24	37	21	36
April	25	40	26	41	25	41	27	38	27	38	27	40	27	38	28	40	26	40
May	29	42	29	43	29	41	30	41	30	41	30	42	31	43	31	42	30	40
June	29	40	29	40	25	41	28	36	27	35	30	41	29	38	30	40	26	34
July	25	32	25	32	25	31	26	32	25	31	27	35	26	32	25	33	25	32
August	24	30	24	30	24	29	23	29	23	30	24	33	24	32	23	29	24	32
September	23	33	22	31	22	29	23	31	23	34	22	34	23	34	23	32	23	31
October	21	33	21	33	21	33	21	34	21	33	22	35	23	35	21	33	24	33
November	18	28	19	29	19	31	17	30	17	31	19	33	21	33	17	32	20	30
December	17	28	13	27	15	28	15	29	15	29	14	28	16	29	15	30	17	27

Mean annual average Rainfall (mm) and Numbers of Rainy Days (refer. years 2009-2017) district Shajapur.

Months	2009		2010		2011		2012		2013		2014		2015		2016		2017	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
January	4.49	4	4.39	2	0	0	1.1	1	0	0	17.89	5	32.97	9	4.49	4	1.7	2
February	0	0	5.09	3	0	0	0	0	28.57	8	22.08	4	6.83	4	0.4	1	0.4	1
March	0	0	0.4	0	0.1	0	0	0	34.31	3	0.8	1	44.88	10	5.62	6	0.7	2
April	2.2	1	0	0	2	1	1.4	1	2.3	2	0.2	0	13.99	5	0.6	1	0.1	1
May	0	0	0	0	0.81	0	1.2	0	0.2	0	0.5	0	1.7	3	5.91	7	8.5	6
June	47.6	8	24.12	7	252.98	25	100.67	14	394.16	22	18.8	6	159.5	18	132.95	17	138.7	23

Annexure V: Weather Data

Months	2009		2010		2011		2012		2013		2014		2015		2016		2017	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
July	448	28	392.4	27	366.21	31	499.68	26	415.44	31	263.43	26	267.15	25	423.77	31	368.9	30
August	300	29	513.9	31	371.29	31	379.53	30	410.47	29	215.56	28	22.54	31	686.58	30	259.8	30
September	99.7	10	166.3	19	240.73	23	114.38	25	85.46	16	116.32	18	28.77	13	77.51	24	257.6	17
October	83.2	5	25.68	8	0	0	0	0	37.04	11	2.7	4	2.2	3	74	7	4.7	2
November	165	8	55.05	15	0	0	0	0	0	0	0.3	1	6.74	2	0	0	0	0
December	3.69	3	0.2	0	0.6	1	0	0	1.71	2	9.92	4	1.57	2	0	0	2.1	5

Note:- A-Rainfall (mm); B-No. of Rainy days

Monthly Average Maximum Wind speed (kmph) (refer. years 2009-2017) district Shajapur.

Months	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average
January	5.8	5.4	5.6	6.7	6.7	6.7	6.3	5.4	5.6	6.0
February	6	5.6	6	7.2	7.4	6.5	6.9	7.8	6.3	6.6
March	5.8	6.9	6.5	6.7	6.5	6.7	7.6	7.4	6.7	6.8
April	6.5	8.1	5.4	7.8	6.9	6.5	10.3	11	1.1	7.1
May	9.8	9.6	9.8	9.6	10.5	8.5	12.5	12.8	8.1	10.1
June	9.4	8.1	11	11.2	9.8	11.2	12.8	10.7	7.8	10.2
July	8.1	6.3	8.1	11	8.9	10.1	16.3	11.6	12.8	10.4
August	7.2	5.1	8.1	8.3	8.5	8.1	12.1	11.6	9.8	8.8
September	6.5	5.1	6.9	5.8	5.6	6.5	8.1	7.2	6.3	6.4
October	4.3	4.5	4.5	4.3	5.1	4.7	5.4	5.4	4.9	4.8
November	4.9	4.9	4.9	5.4	5.1	4.5	5.6	4.3	4.5	4.9
December	4.7	5.4	4.9	5.6	4.9	6	6.3	4.7	6	5.4

Annexure V: Weather Data

Monthly Average Humidity (%) (refer. years 2009-2017) district Shajapur.

Months	2009	2010	2011	2012	2013	2014	2015	2016	2017	Humidity (%)
January	43	39	34	49	31	49	51	37	44	41.6
February	28	32	33	31	41	38	32	26	29	41.89
March	18	20	19	16	20	24	31	21	19	32.22
April	14	16	15	19	19	15	23	16	16	20.89
May	21	19	25	21	19	18	18	24	25	17.00
June	37	38	54	49	58	36	46	40	60	21.11
July	77	75	77	71	79	62	69	75	75	46.44
August	81	86	87	87	86	75	78	88	77	73.33
September	65	76	85	77	69	73	61	77	74	82.78
October	47	51	43	35	58	41	37	54	40	73.00
November	56	61	37	30	34	32	36	31	33	45.11
December	49	42	37	32	38	35	31	36	35	38.89



National Accreditation Board for Testing and Calibration Laboratories

(A Constituent Board of Quality Council of India)



Annexure VI

NABL / T-2900

01.05.2019

ASHISH KANT JAIN

APEX TESTING AND RESEARCH LABORATORY

9/50, KIRTI NAGAR INDL AREA, NEAR
RAILWAY RESERVATION

DELHI

Mobile: 8376945025

E-mail: info.apex2015@gmail.com

Subject: **Renewal of Accreditation**

Dear Sir/Ma'am,

I would like to inform you that NABL has examined the Re-assessment report of your laboratory and decided to give the renewal of accreditation in accordance with ISO/IEC 17025:2017 in the discipline of Biological, Chemical and Mechanical testing as per the scope (except as mentioned below) and authorized signatories recommended by the assessment team.

However, your laboratory is advised to take the following actions within 30 days:

- To segregate Density/ Specific gravity test under wood & wood products in Mechanical scope.
- To provide sample area for test parameters under Environment Swab wherever not given in Biological scope.
- To provide the sample size wherever not given in Biological scope.
- To review upper limit of range of testing for Total Coliform Bacteria test as per MPN table in Biological scope.
- To review the unit of range of testing for particle size test under Salt in Chemical scope.

Parameters mentioned in NC no 11 (raised by Dr. R Ruban) is not recommended as these parameters are not applicable to the product tested and subsequently withdrawn by the laboratory.

Lab to participate in available PT program in Mechanical discipline and performance to be verified in next assessment.

Accreditation Certificate No. **TC-8463** for disciplines Biological, Chemical and Mechanical with issue date 29.04.2019 valid till 28.04.2021 is in the process of preparation. Thereafter the certificate will be sent to you.

Being an accredited laboratory of NABL, you must fulfil all the Terms and Conditions laid down in our document NABL-131. You are requested to follow NABL-133 (current issue) for using NABL symbol.

Yours faithfully,

Suman Kharayat

suman@nabl.qcin.org



NABL

National Accreditation Board for Testing and Calibration Laboratories

(An Autonomous Body under Department of Science & Technology, Govt. of India)

CERTIFICATE OF ACCREDITATION

APEX TESTING AND RESEARCH LABORATORY

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2005

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

B-90, Shardapuri, Ramesh Nagar, New Delhi

in the discipline of

BIOLOGICAL TESTING

(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Certificate Number T-4019

Issue Date 16/06/2016



Valid Until 15/06/2018

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the additional requirements of NABL.

Signed for and on behalf of NABL

N. Venkateswaran
Program Manager

Anil Relia
Director

Prof. S. K. Joshi
Chairman

Annexure -VII

List of Plant Species recorded from the Study Area

S. No.	Family	Scientific Name	Common Name	Habit	IUCN Redlist Ver. 2019-1
1	Acanthaceae	<i>Justicia adhatoda</i>	Basaka	H	-
2	Amaranthaceae	<i>Achyranthes aspera</i>	Prickly chaff flower	H	-
3	Amaranthaceae	<i>Amaranthus viridis</i>	Chulai	H	-
4	Anacardiaceae	<i>Lannea coromandelica</i> (Syn. <i>Lannea grandis</i>)	Gurjon	T	-
5	Anacardiaceae	<i>Mangifera indica</i>	Aam	T	DD
6	Annonaceae	<i>Annona squamosa</i>	Sitafal	T	-
7	Apocynaceae	<i>Calotropis gigantea</i>	Madar	S	-
8	Apocynaceae	<i>Calotropis procera</i>	Ak	S	-
9	Apocynaceae	<i>Carissa spinarum</i> (Syn. <i>Carissa opaca</i>)	Karanda	S	-
10	Apocynaceae	<i>Cascabela thevetia</i> (Syn. <i>Thevetia neriifolia</i>)	Agave	S	-
11	Apocynaceae	<i>Holarrhena pubescens</i> (Syn. <i>Holarrhena antidysenterica</i>)	Kurchi	S	-
12	Apocynaceae	<i>Wrightia tinctoria</i>	Dhudhi	S	LC
13	Arecaceae	<i>Phoenix dactylifera</i>	Khajur	T	-
14	Arecaceae	<i>Phoenix sylvestris</i>	Palm	T	-
15	Asparagaceae	<i>Agave americana</i>	Agave	S	-
16	Asparagaceae	<i>Asparagus racemosus</i>	Satwari	H	-
17	Asparagaceae	<i>Chlorophytum tuberosum</i>	Safed Musli	T	LC
18	Asteraceae	<i>Eclipta prostrata</i>	Bhringraj	H	-
19	Asteraceae	<i>Parthenium hysterophorus</i>	Congress grass	H	-
20	Asteraceae	<i>Tridax procumbens</i>	Ghamra	H	-
21	Asteraceae	<i>Vernonia divergens</i>	Bandar	H	-
22	Asteraceae	<i>Xanthium strumarium</i> (Syn. <i>Xanthium indicum</i>)	Gokhru	S	-
23	Boraginaceae	<i>Cordia dichotoma</i>	Lasora	T	-
24	Boraginaceae	<i>Heliotropium indicum</i>	Hathajori	H	-
25	Burseraceae	<i>Boswellia serrata</i>	Salai	T	-
26	Burseraceae	<i>Garuga pinnata</i>	Kekad	T	-
27	Cannabaceae	<i>Cannabis sativa</i>	Bhang	H	-
28	Celastraceae	<i>Celastrus paniculatus</i>	Malkangani	T	-
29	Combretaceae	<i>Terminalia arjuna</i>	Koha	T	-

S. No.	Family	Scientific Name	Common Name	Habit	IUCN Redlist Ver. 2019-1
30	Combretaceae	<i>Terminalia bellirica</i>	Behra	T	-
31	Commelinaceae	<i>Commelina benghalensis</i>	Puwar	H	LC
32	Convolvulaceae	<i>Ipomoea carnea</i>	Reed	H	-
33	Cornaceae	<i>Alangium salvifolium</i>	Ankol	T	-
34	Ebenaceae	<i>Diospyros melanoxylon</i>	Tendu	T	-
35	Ebenaceae	<i>Diospyros chloroxylon</i> (Syn. <i>Diospyros tomentosa</i>)	Tendu	T	-
36	Euphorbiaceae	<i>Antidesma acidum</i>	Khatua	S	-
37	Euphorbiaceae	<i>Euphorbia neriifolia</i>	Thuar	T	-
38	Euphorbiaceae	<i>Jatropha curcas</i>	Jatropha	S	-
39	Euphorbiaceae	<i>Mallotus philippensis</i>	Rohini	T	-
40	Euphorbiaceae	<i>Ricinus communis</i>	Castor	S	-
41	Fabaceae	<i>Acacia catechu</i>	Katha	T	-
42	Fabaceae	<i>Acacia nilotica</i>	Babool	T	LC
43	Fabaceae	<i>Acacia pennata</i>	Raoni	C	-
44	Fabaceae	<i>Albizia lebbek</i>	Kala siris	T	-
45	Fabaceae	<i>Andrographis paniculata</i>	Kulanjan	H	-
46	Fabaceae	<i>Bauhinia racemosa</i>	Asta	T	-
47	Fabaceae	<i>Bauhinia vahlii</i>	Mahul	C	-
48	Fabaceae	<i>Bauhinia variegata</i>	Kachnar	T	LC
49	Fabaceae	<i>Butea monosperma</i>	Palas	T	-
50	Fabaceae	<i>Butea superba</i>	Palasbel	T	-
51	Fabaceae	<i>Cassia fistula</i>	Amaltas	T	LC
52	Fabaceae	<i>Dalbergia sissoo</i>	Shisham	T	-
53	Fabaceae	<i>Delonix regia</i>	Gulmohar	T	LC
54	Fabaceae	<i>Indigofera cassioides</i>	-	S	-
55	Fabaceae	<i>Mimosa pudica</i>	Chui Mui	H	LC
56	Fabaceae	<i>Phyllodium pulchellum</i> (Syn. <i>Hedysarum pulchellum</i>)	-	H	-
57	Fabaceae	<i>Pongamia pinnata</i>	Karanj	T	-
58	Fabaceae	<i>Prosopis juliflora</i>	Jungli Kikar	T	-
59	Fabaceae	<i>Pterocarpus acerifolius</i>	Bija	T	-
60	Fabaceae	<i>Senna obtusifolia</i> (Syn. <i>Cassia obtusifolia</i>)	-	H	LC
61	Fabaceae	<i>Senna occidentalis</i>	-	S	-
62	Fabaceae	<i>Senna tora</i> (Syn. <i>Cassia tora</i>)	-	H	-
63	Fabaceae	<i>Tamarindus indica</i>	Imli	T	LC
64	Fabaceae	<i>Tephrosia purpurea</i>	Srphanka	S	-
65	Lamiaceae	<i>Hyptis suaveolens</i>	-	H	-
66	Lamiaceae	<i>Ocimum basilicum</i>	Jungali Tulsi	H	-

S. No.	Family	Scientific Name	Common Name	Habit	IUCN Redlist Ver. 2019-1
67	Lamiaceae	<i>Ocimum tenuiflorum</i> (Syn. <i>Ocimum sanctum</i>)	Tulsi	H	-
68	Lamiaceae	<i>Pogostemon benghalensis</i>	Kora	H	-
69	Lamiaceae	<i>Tectona grandis</i>	Sagun	T	-
70	Lamiaceae	<i>Vitex negundo</i>	Morpai	S	-
71	Lythraceae	<i>Lagerstroemia parviflora</i>	Seja	T	-
72	Lythraceae	<i>Lawsonia inermis</i>	Hina	S	-
73	Lythraceae	<i>Woodfordia fruticosa</i>	Dhawai	S	LC
74	Malvaceae	<i>Abutilon indicum</i>	-	S	-
75	Malvaceae	<i>Bombax ceiba</i>	Semal	T	-
76	Malvaceae	<i>Firmiana simplex</i> (Syn. <i>Sterculia urens</i>)	Kulu	T	-
77	Malvaceae	<i>Grewia rothii</i>	-	T	-
78	Malvaceae	<i>Grewia tiliifolia</i>	Dhaman	T	-
79	Malvaceae	<i>Helicteres isora</i>	Maror phali	H	-
80	Meliaceae	<i>Azadirachta indica</i>	Neem	T	LC
81	Meliaceae	<i>Toona ciliata</i>	Toon	T	LC
82	Moraceae	<i>Ficus bengalensis</i>	Bar	T	-
83	Moraceae	<i>Ficus religiosa</i>	Pipal	T	-
84	Moraceae	<i>Morus nigra</i>	Shahtoot	T	-
85	Moringaceae	<i>Moringa oleifera</i>	Sahjan	T	-
86	Myrtaceae	<i>Corymbia citriodora</i> (Syn. <i>Eucalyptus citriodora</i>)	-	T	-
87	Myrtaceae	<i>Psidium guajava</i>	Amrud	T	LC
88	Myrtaceae	<i>Syzygium cumini</i>	Jamun	T	-
89	Nyctaginaceae	<i>Boerhavia diffusa</i>	Punarnava	H	-
90	Oleaceae	<i>Nyctanthes arbor-tristis</i>	Sirari	T	-
91	Oxalidaceae	<i>Oxalis corniculata</i>	-	H	-
92	Phyllanthaceae	<i>Bridelia retusa</i>	Kasai	T	-
93	Phyllanthaceae	<i>Phyllanthus emblica</i>	Aonla	T	-
94	Poaceae	<i>Bothriochloa pertusa</i>	-	H	-
95	Poaceae	<i>Chrysopogon zizanioides</i>	Khas	H	-
96	Poaceae	<i>Cynodon dactylon</i>	Dub	H	-
97	Poaceae	<i>Dendrocalamus strictus</i>	Bans	S	-
98	Poaceae	<i>Dichanthium annulatum</i>	Marwel	H	-
99	Poaceae	<i>Eragrostis tenella</i>	Bhurbhusi	H	-
100	Poaceae	<i>Eragrostis amabilis</i>	-	H	-
101	Poaceae	<i>Heteropogon contortus</i>	-	H	-
102	Poaceae	<i>Saccharum spontaneum</i>	Kans	S	LC
103	Poaceae	<i>Sorghum halepense</i>	-	S	-

S. No.	Family	Scientific Name	Common Name	Habit	IUCN Redlist Ver. 2019-1
104	Poaceae	<i>Themeda caudata</i>	Gunher	H	-
105	Punicaceae	<i>Punica granatum</i>	Anar	T	LC
106	Rhamnaceae	<i>Ziziphus jujuba</i>	Ber	T	LC
107	Rhamnaceae	<i>Ziziphus nummularia</i>	-	S	-
108	Rubiaceae	<i>Gardenia gummifera</i>	-	T	-
109	Rubiaceae	<i>Gardenia latifolia</i>	Papra	T	-
110	Rubiaceae	<i>Haldina cordifolia</i>	Haldu	T	-
111	Rubiaceae	<i>Neolamarckia cadamba</i>	Kadam	T	-
112	Rutaceae	<i>Aegle marmelos</i>	Bel	T	-
113	Rutaceae	<i>Citrus medica</i>	Nimboo	T	-
114	Rutaceae	<i>Feronia limonia</i>	-	T	-
115	Rutaceae	<i>Swietenia chloroxylon</i>	Bhira	T	-
116	Sapindaceae	<i>Schleichera oleosa</i>	Kusum	T	-
117	Sapotaceae	<i>Madhuca longifolia</i>	Mahua	T	-
118	Simaroubaceae	<i>Ailanthus excelsa</i>	Mahanimb	T	-
119	Solanaceae	<i>Datura stramonium</i>	Datura	S	-
120	Solanaceae	<i>Solanum nigrum</i>	Mako	H	-
121	Verbenaceae	<i>Lantana camara</i>	Raimunia	S	-

ADDITIONAL STUDIES

**Chapter
1****Biodiversity Management &
Wildlife Conservation Plan****1.1 BACKGROUND**

Habitat degradation that happens due to anthropogenic pressures leading to land use /land cover changes, and activities like hunting and poaching, and invasion of exotic species are main threats to the native biodiversity and wildlife. Most of these phenomena are related to activities like population growth, increasing agricultural practices, urbanization, road construction and other developmental activities. The rapid development phase in recent years has led to additional pressures on biodiversity which as a result not only poses threats to wildlife but also leads to increasing incidences of man – wildlife conflicts in many areas of India. The biodiversity conservation plan therefore needs to face such challenges and devise strategies to mitigate such threats to the biodiversity and wildlife of the area.

The biodiversity management plan is based upon the understanding of diversity and distribution of floral and faunal species gathered during preparation of baseline, identification of existing threats to biodiversity, concerns of local inhabitants and impacts of developmental activities on animal and plant species.

To achieve these goals, the objectives of the biodiversity conservation and wildlife management 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 and around project area
- iii. Habitat conservation and rehabilitation of Schedule-I (IWPA, 1972),
- iv. Mitigation and control of project induced biotic and/or abiotic pressures/ influences that may affect the natural habitats,
- v. Habitat enhancement in project area and 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.
- vii. To promote eco-tourism and generate awareness regarding environmental values among local masses especially school children.
- viii. Identification and removal of Invasive Species.

1.2 PROJECT ACTIVITIES AND LIKELY IMPACTS

The proposed project consists of:

Dam – 25.0 m high

Submergence Area - 3494.64 ha

Water Conductor System – It is proposed to supply water from the dam/reservoir by canal network and later distribute in the command area.

Command Area - The gross command area of Parbati Major Irrigation Project is 70000 ha to irrigate 48000 ha of command area by drip/sprinkler system. Some of the command area falls outside the study area.

Land Requirement – 3537.19 ha

1.3 BIODIVERSITY IMPORTANCE OF THE AREA

The project area of Parbati Major Irrigation project mainly categories under agriculture farms and private land. No forest land is required for any component of the proposed project.

None of the plant species found in the study area falls under any Threatened category of IUCN Version 2019-1 as well as Red data Book of Indian Plants (Nayar and Shastri, 1990). Majority of the plant species have not been evaluated or assessed yet by IUCN. Plant species that have been assessed by IUCN are under Least Concern category (LC).

Among the mammals 9 species were sighted during the baseline data collection from the study area. *Boselaphus tragocamelus* (Nilgai), *Macaca mulatta* (Rhesus macaque), *Semnopithecus entellus* (Common langur) and *Funambulus pennantii* (Five-striped Palm Squirrel) are common and frequently sighted in the study area. No species sighted from the study area are under Schedule-I of IWPA 1972 or RET category IUCN Red list of Threatened Species Version 2019-1 accessed in April 2019.

Among the birds species recorded during field survey only *Pavo cristatus* (Pea fowl) is listed under Schedule I of IWPA 1972. Rest of the species are listed under Schedule IV and V.

The proposed Biodiversity Conservation Plan will focus mainly on habitat conservation and creating environmental awareness among the stakeholders around the project area. In order to achieve the same following activities have been proposed.

1.4 CONSERVATION MEASURES

As already discussed, only Pea fowl is the Schedule I bird species found in and around the project area. Therefore, a conservation plan has been suggested for it.

An Indian Peafowl or Peacock (*Pavo Cristatus*) is a large pheasant declared as the National Bird of India in 1963. In India, it is given the utmost protection by inclusion in Schedule I of Indian Wildlife Act, 1972 (2016). Being a wide spread species, apart from the various urban habitats, it is also found in agriculture field, along stream with good vegetation and close to human habitation in semi-feral conditions.

In the present study area this species has been confirmed from various habitats located near the village periphery. According to the villagers, during day time that temporally move towards the surrounding areas like agricultural fields or water bodies for feeding while during night time roosts on the trees present in vicinity of the human settlement and also road side trees.

Food and Feeding Habitats: Peafowls are omnivores, eating plant parts, flower petals, seed heads, insects, and other arthropods, reptiles and amphibians. In the study area tree canopy, scrub forest, agricultural farms and grasslands supports good insect diversity which is very common food for peafowls.

Threats to the peacocks in the area are:

- 1) Habitat loss, especially the shortage of tall trees in and around the villages for roosting and for providing shade during hot summer months,
- 2) Shortage of drinking water for the birds during the hot summer days,
- 3) Casualties caused by eating chemically treated agricultural crop seeds, and
- 4) Illegal hunting.

Habitat Improvement Action Plan: Conservation Measures Direct and indirect approach is required to provide effective conservation, which is recommended as under:

1. Increasing the tree cover in the area for shelter and roosting of pea fowls. This will be achieved by planting of tree groves. Some local species such as *Azadirachta indica* (Neem), *Madhuca longifolia* (Mahuwa), *Mangifera indica* (Aam), *Albizia sp.* (Siris), *Cassia fistula* (Amaltash), *Dalbergia sissoo* (Shesham), *Butea monosperma* (Dhak), trees etc. will be planted.
2. By conducting awareness programmes (community and school level) for conservation of peacocks in the area during “Wildlife Week” and “Van Mahotsave” celebrations.

3. Some provision of rewards to informers for the control of poaching and illegal trade in wildlife.
4. Carrying out census to population status of the species and know the potential threats.
5. Provision of veterinary care and cages for injured or sick deformed birds.

In order to supplement the ongoing conservation programmes for Schedule I and RET species being implemented by the Department of Forests, an amount of **Rs. 40.00 lakh** has been allocated.

1.5 CONCERNS OF LOCAL INHABITANTS

Animal hunting and poaching for food, games and trophies is rarely reported from the proposed project area. As the project is located near the Narsinghgarh Wildlife Sanctuary it has been noticed that a few species like Wild Boar, Indian Hare, are reported to raid agricultural land and reportedly damage the crops, which results in the man – wildlife conflicts. To control such conflicts, this issue is also needed to address in biodiversity management plan.

1.6 INFRASTRUCTURE DEVELOPMENT & STRENGTHENING OF PATROLLING

To protect the biodiversity of the in the project area as well as in Narsinghgarh Wildlife Sanctuary, improvement in infrastructure facilities is warranted. In this plan project authorities would assist State Forest Department in strengthening the infrastructures, so that State Forest Department can contribute to the biodiversity protection of this area. This plan will be implemented in the zone of influence of proposed project. Project authorities would provide one time grant to State Forest Department to improve the infrastructure for the conservation of biodiversity. To improve the vigilance, to monitor the wildlife movement, and to check the poaching, State Forest Department shall be provided with grant to build necessary facilities like watch towers, check posts and patrolling paths and grant for purchase of equipment like, cameras, binoculars, sleeping bags, search lights, health kits etc. Patrolling parties need to be equipped with Wireless communication system for more efficient system. Project authorities would provide funds to State Forest Department. Total financial outlay under this head would be **Rs. 50,00,000** only.

1.7 AWARENESS PROGRAMME

An effective wildlife conservation plan is a participatory management, involving the local communities in the conservation strategies. This approach requires a comprehensive awareness programme on the significance, benefits and sustainable utilization of biodiversity and forest resources. The awareness

programme would focus on the fact that the protection of species like Peafowl, and mammalian species.

The awareness programme would take certain issues like prevention of forest fire, to avoid the man-wildlife conflicts, not to damage the eggs/nests of bird species, etc. Awareness programme can be implemented by organising the public meetings with the help of NGOs and Forest Department, distributing pamphlets, posters and hoardings, etc.

Total budget estimated for awareness programme is **Rs.15.00 lakh** only.

1.8 MEASURES FOR CONTROL OF INVASIVE SPECIES

Out of a total of 121 plant species recorded from the study area, there are number of invasive alien plant species that are commonly found in the study area. *Parthenium hysterophorus*, *Argemone mexicana*, *Achyranthes aspera*, *Lantana camara*, *Xanthium strumarium*, *Echinops echinatus*, *Senna tora*, *Heliotropium indicum*, etc. These are frequently found in the study area along the canals, crop fields, etc. These invasive species are known to cause lot of nuisance and affect the natural vegetation. They are also responsible for reduction in productivity of the farm land as they grow aggressively and colonise and form thickets wherever they find space and outgrow other plant species.

The actions proposed under this plan are:

- (a) Improvement of landscape by eco-restoration
- (b) Removal of invasive species
- (c) Implementing Fire protection measures
- (d) Soil and water conservation measures
- (e) Awareness programme among the local villagers to minimize conflict with wild animals

For the control of invasive species, a budget of **Rs. 20.00 Lakh** has been earmarked.

1.9 GOOD PRACTICES

Project authorities would follow a few precautionary and good practices in the project areas. Such types of practices are not expensive but play a vital role in protecting the biodiversity. Important safeguard measures as good practices are given below:

- i. Project authorities shall organise a training programme for the workers. All project workers must be aware of importance of biodiversity and all such types of activities related to endangering the wildlife including plants and

- animals. All project workers must be aware of presence of a few threatened and Schedule species in the sanctuary area and legal consequences of hunting, poaching of animals and harvesting of forest produces.
- ii. Each project worker shall be provided with an identity card and would not be allowed to enter in the village, forest, grassland and protected areas without a valid permission.
 - iii. Project authorities will be bound by rules and regulation of Wildlife (Protection) Act, 1972 of India and any others rule and guidelines, stipulated by the state Government.
 - iv. Project workers will be discouraged to plant any alien and/or invasive species in the camp and colony areas, which may spread in the forest areas. State Forest Department can provide the list of such plant species. Project authorities would ensure to uproot all existing alien/invasive species from the colony and other working areas. Restriction shall be imposed on the disposal of any types of pesticide, poison and other toxic material in the forest areas.
 - v. Project authorities are suggested to follow the mechanism of control blasting especially in the breeding season of a threatened species wandering in the close vicinity of the project. This activity is to be restricted during nights, early mornings and late afternoons, which are the feeding times of most of the fauna. Total budget allocated for the implementation of good practices is **Rs. 5,00,000** only.

1.10 BUDGETARY ESTIMATES

Total budget allocated for the Biodiversity Management and Wildlife Conservation Plan for the Project would be **Rs.130.00 lakh** (Rs. One hundred Thirty lakh) only. Break-up of the budget is given in **Table 1.1**.

Table 1.1: Break-up of the Biodiversity Management and Wildlife Conservation Plan

S. No.	Particulars	Total Budget (in Rs. Lakh)
1	Infrastructure Development, Equipment, etc.	50.00
2	Conservation of RET species	40.00
3	Awareness Programme	15.00
4	Control of Invasive species	20.00
5	Good Practices	5.00
	Total Budget	130.00

**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 steady erosion and 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 land productivity in the area. Thus, a well-designed Catchment Area Treatment (CAT) Plan is essential to ameliorate the above mentioned adverse effects of soil erosion. Soil erosion can be defined as detachment, transportation and deposition of soil particles from one place to other by means of transporting agent like air, water or animals. Soil erosion is mainly affected by rainfall intensity and runoff, slope gradient and length, soil erodibility and vegetation cover (landuse pattern). Therefore, study of erosion and sediment yield from catchments are of great importance. 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

To control the rate of soil erosion in the catchment, Catchment Area Treatment (CAT) is an ineluctable part. The CAT plan pertains to preparation of a management plan for treatment of erosion prone areas through adequate preventive measures. An effective CAT plan is a key factor to make the project eco-friendly and sustainable. Thus, a well-designed Catchment Area Treatment (CAT) Plan is essential to ameliorate the above mentioned adverse process of soil erosion. CAT plan essentially consist of following steps.

1. Calculation of soil erosion using Revised Universal Soil Loss Equation (RUSLE), combined with Remote Sensing (RS) and Geographic Information System (GIS) technologies.
2. Prioritizing the areas for treatment using Silt Yield Index (SYI).

3. Planning of suitable erosion control measures.
4. Cost estimation for CAT plan.

2.2 RIVER SYSTEM

River Parbati is a tributary of river Chambal which itself is a tributary of river Yamuna. It is also known as the Western Parbati as distinguished from river Parbati, a tributary of Sindh river. This river originates from Siddiqganj village in Sehore district of Madhya Pradesh. After flowing about 234 km in Madhya Pradesh, the river forms the boundary between Rajasthan and Madhya Pradesh for a length of about 80 km. After running for a further distance of about 96 km in Rajasthan, it again forms the boundary between Rajasthan and Madhya Pradesh for about 64 km and joins the Chambal river about 32 km south east of Sawai Madhopur city in Rajasthan.

2.3 CATCHMENT AREA

The catchment area of the project up to the proposed dam site is 3150 km². The elevation of the catchment varies from about El. 426.0m to about El. 610.0m. Length of Parbati river up to the proposed dam site is around 130.0 km. The major tributaries of river Parbati in the catchment area upto dam site viz. Ajhar Nala, Sewan Nala, Paru Nala, Utaoli Nala and Bara Darwa Nala meets at its right bank.

2.4 METHODOLOGY ADOPTED FOR THE STUDY

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

- Defining study area
- Defining data requirement
- Data acquisition and preparation
- Output presentation

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

2.4.1 Defining Study Area

Purpose of the study is preparation of CAT plan for the catchment of Parbati Major Irrigation Project. Since Rampurakhurd medium irrigation project is already under operation on river Parbati therefore, study area is defined as free draining catchment area of Parbati major irrigation project. Free draining catchment area has been delineated as intercepting catchment area between the dam site of upstream Rampurakhurd medium irrigation project and dam site of proposed Parbati major irrigation project.

In order to plan watershed management and to formulate action plans it requires watershed delineation, therefore, catchment area was further delineated into watersheds. For the delineation of watershed, Watershed Atlas of India prepared by Soil and Land Use Survey of India (SLUSI) has been referred.

Soil and Land Use Survey of India (SLUSI) has Watershed Atlas of India under digital environment using GIS and produced a Digital Watershed Atlas (DWA) where the delineation and codification of watersheds in the country has been undertaken in GIS environment. The delineation for DWS has been done in seven stages starting with Water Resource Regions and their subsequent division and subdivisions into Basins, Catchments, Sub-catchments, Watershed, Sub watershed and Micro-watersheds in decreasing size of the delineated hydrologic unit.

As per Watershed Atlas of India, the free draining catchment area of Parbati major irrigation project falls in 6 watersheds. Out of these 6 watersheds, 3 watersheds falls completely within the free draining catchment area while 3 watersheds fall partially within the free draining catchment area. The nomenclature of watersheds has been assigned as follows: Ganga Region (2); Chambal Basin (2D); Chambal above Banas upto Gandhi Sagar Catchment (2D2); Parbati Sub-Catchment (2D2B); Parbati (2D2B4), Paru & Utaoli (2D2B5), Parbati (2D2B6), Sewan & Ajhar (2D2B7), Sewan & Ajhar (2D2B8) and Chambal & Kunoli (2D2B9) Watersheds. The detail of watersheds delineated for the free draining catchment area is given below (**Table 2.1 and Figure 2.1**).

Table 2.1: Names and Codes of Watersheds Delineated

S. No	Water Resource Region	Basin	Catchment	Sub-Catchment	Watershed Code	Watershed Area (ha)
1.	Ganga (2)	Chambal (2D)	Chambal above Banas upto Gandhi Sagar (2D2)	Parbati (2D2B)	Parbati (2D2B4)	7541.90
2.					Paru & Utaoli (2D2B5)	8625.64
3.					Parbati (2D2B6)	97911.18
4.					Sewan & Ajhar (2D2B7)	53781.51
5.					Sewan & Ajhar (2D2B8)	80844.94
6.					Chambal & Kunoli (2D2B9)	82338.79
	TOTAL					331043.97

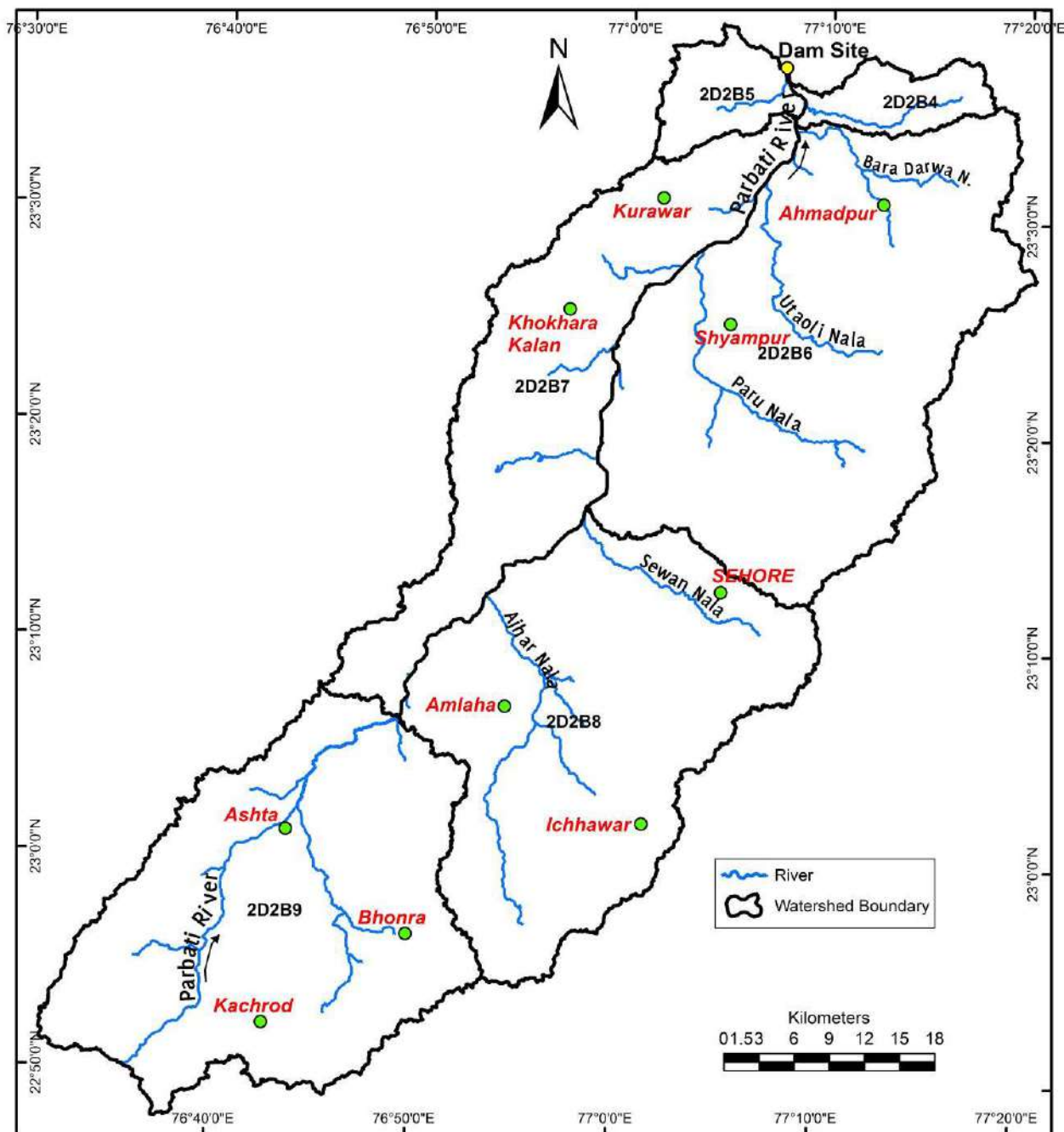


Figure 2.1: Watershed Map of Free Draining Catchment Area

2.4.2 Defining Data Requirement

Soil loss has been calculated through RUSLE (Revised Universal Soil Loss Equation) model which is computed by the following equation:

$$\text{Soil Loss (A)} = R * K * LS * C * P$$

Wherein;

A = Soil loss (Tons/ha/year)

R is Rainfall & Runoff Erosivity Factor ($\text{MJ mm/ha}^{-1}/\text{h}^{-1}/\text{year}^{-1}$), which depends upon the annual average rainfall in mm. Data required for R factor is rainfall intensity.

K is Soil Erodibility Factor ($\text{Tons/ha/h/ha}^{-1}/\text{MJ}^{-1}/\text{mm}^{-1}$), which depends on the organic matter, texture permeability and profile structure of the soil. Also, it is a constant value for each soil type. Data required for K factor is soil type.

LS is Topographic Factor (dimensionless) which depends upon flow accumulation and steepness and length of slope in the area. Data required for LS factor is slope length and slope gradient.

C = Vegetation Cover and Crop Management Factor (dimensionless), which is the ratio of bare soil to vegetation and non- photosynthetic material. It is a constant value for each land use category. Data required for C factor is land use/ land cover.

P is Conservation Supporting Practice Factor (dimensionless), which takes into account specific erosion control practices like contour bunding, bench terracing etc.

2.4.3 Data Acquisition and Preparation

The base map of study area as already discussed was prepared from Survey of India Toposheets at 1:50000 scale. The data on various aspects was collected from different sources. The rainfall data in the Study area was procured from the Tropical Rainfall Measuring Mission (TRMM) of NASA from their website <https://pmm.nasa.gov/data-access/downloads/trmm>. Soil map of the study area was prepared from soil map of Madhya Pradesh procured from Regional Centre of National Bureau of Soil Survey & Land Use Planning (NBSS&LUP), New Delhi.

For the preparation of DEM and preparation of Slope map, Shuttle Radar Topography Mission (SRTM) 3 Arc-Second Global Digital Terrain Elevation Data (DTED) data has been used. For the preparation of land use/ land cover, map prepared by National Remote Sensing Centre (NRSC), Indian Space Research Organisation (ISRO) of Dept. of Space with Remote Sensing Applications Centre, MP Council of Science & Technology as partners has been used.

2.4.3.1 Rainfall Erosivity (R) Factor

R factor is a function of the falling raindrop and rainfall intensity and is estimated as the product of the kinetic energy (E) of the raindrop and the maximum intensity of rainfall (I_{30}) over duration of 30 min in a storm. The erosivity of rain is calculated for each storm, and these values are summed up for each year.

In this study, the storm wise rainfall data were not available for the computation of rainfall erosivity factor (R); therefore, the relationship between seasonal value

of R and average rainfall has been used. The rainfall erosivity factor has been defined as $R = 81.5 + 0.38X$, where, R is the average seasonal erosivity factor ($\text{MJ mm/ha}^{-1}/\text{h}^{-1}/\text{year}^{-1}$), and X is the annual average rainfall (mm).

For the estimation of rainfall erosivity in the catchment area, average rainfall of 10 years has been taken from the Tropical Rainfall Measuring Mission (TRMM) data (**Figure 2.2**). In the absence of site specific periodic data, TRMM data from the year 1998 to 2009 has been used for the calculation of R factor. As can be seen in the **Figure 2.2**, the catchment area comprises of two average annual rainfall ranges i.e. 1000-2000 mm/year and 500-1000 mm/year. Similarly, catchment area was divided into two zones and was assigned with X values 1500 mm and 750 mm for the average annual rainfall range of 1000-2000 mm/year and 500-1000 mm/year respectively. The R factors thus arrived are 366.5 and 651.5 for the zones having average annual rainfall range of 500-1000 mm/year and 1000-2000 mm/year respectively and zones have been shown on study area map given at **Figure 2.3**.

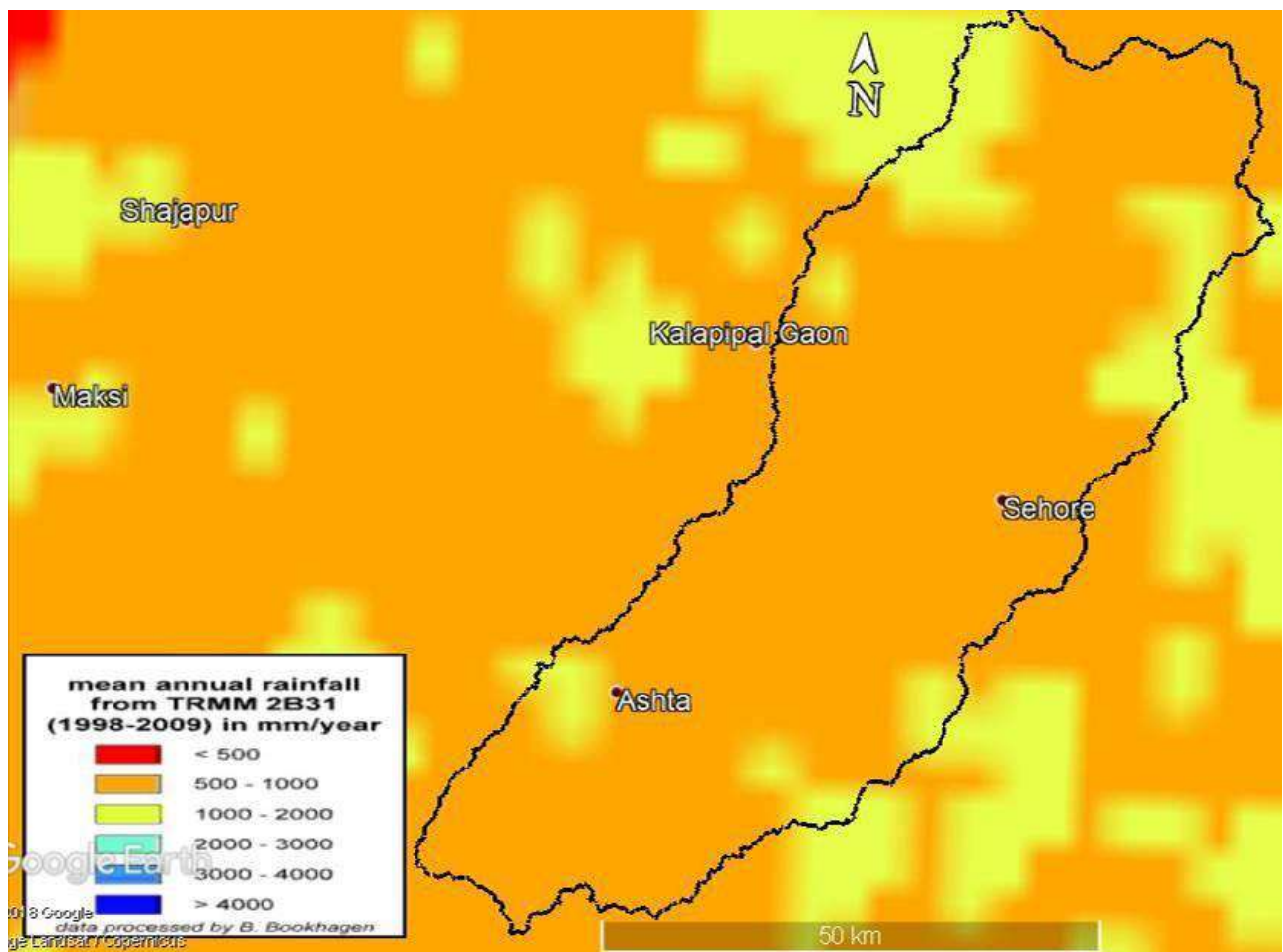


Figure 2.2: Average Annual Rainfall map of Free Draining Catchment Area as per TRMM

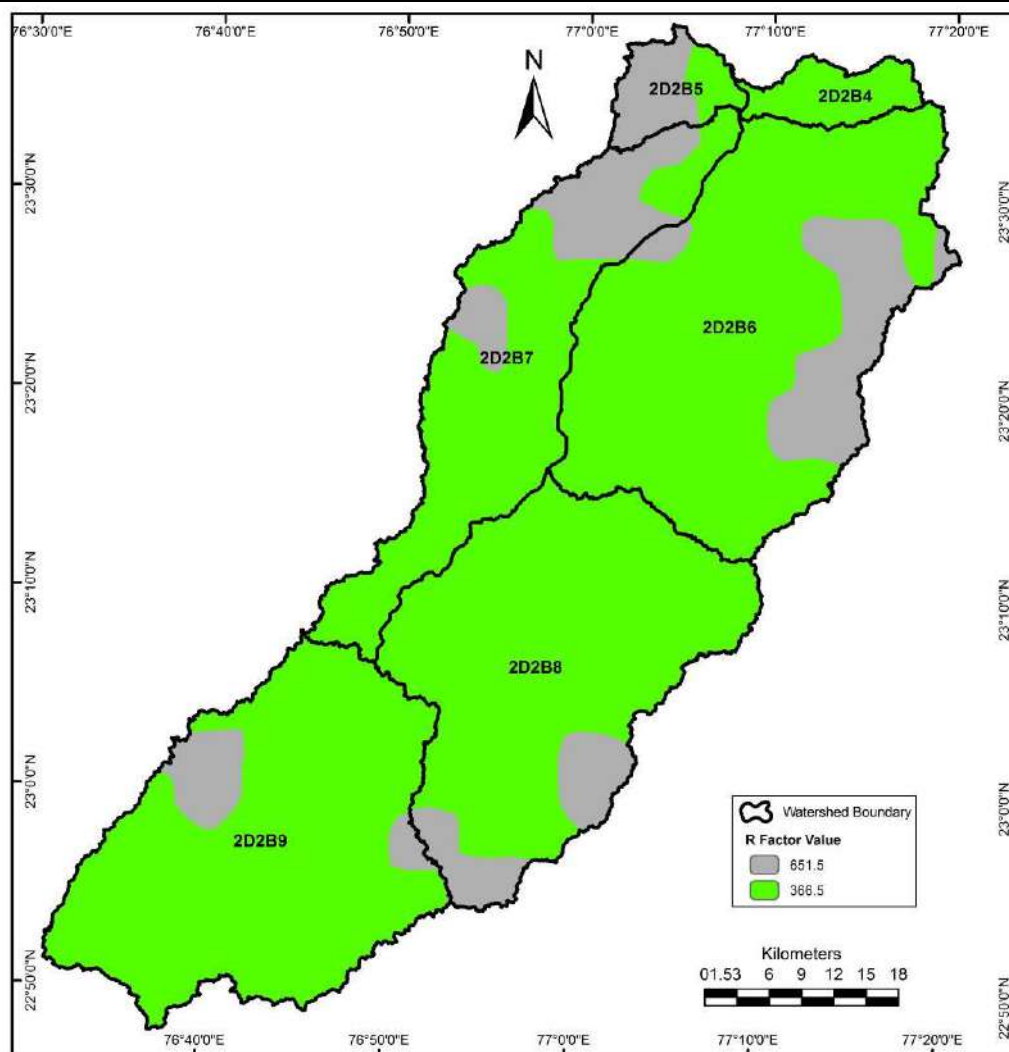


Figure 2.3: R Factor Values Map of Free Draining Catchment Area

2.4.3.2 Soil Erodibility (K) Factor

The K factor is an expression of the inherent erodibility of the soil or surface material at a particular site under standard experimental conditions. It is a function of the particle-size distribution, organic-matter content, structure, and permeability of the soil or surface material. Prior to deciding the K values, soil map for the area is prerequisite. Soil map procured from NBSS&LUP, Nagpur was digitized. The dominant soil unit is 404 (19.60%), which is characterised by deep, well drained, calcareous, clayey soils on very gently sloping plain with valleys (severely dissected) with moderate erosion. Equally prominent type is soil unit 377 (17.38%), which is characterised by deep, moderately well drained, clayey soils on very gently sloping plain land with moderate erosion. Soil map has been shown in **Figure 2.4**. The legend for soil unit classes is given in **Table 2.2**.

Table 2.2: Description of Soil Units in the Free Draining Catchment Area

Soil Unit	Main Group	Sub Group	Area (ha)	Area (%)
319	Loamy, mixed, hyperthermic, Lithic Ustorthents	Clayey, mixed, hyperthermic, Typic Ustorthents	4781.05	1.44

Soil Unit	Main Group	Sub Group	Area (ha)	Area (%)
	Very Shallow, somewhat excessively drained, loamy soils on moderately steep sloping hills with escarpments with very severe erosion and slightly stony, <i>associated with:</i>	Very Shallow, somewhat excessively drained, clayey soils on moderately steep sloping with very severe erosion and strongly stony		
322	Loamy-skeletal, mixed, hyper-thermic, Lithic Ustorthents Extremely shallow, somewhat excessively drained, loamy-skeletal soils on moderately steep sloping hilly terrain (highly dissected) with very severe erosion and moderately stony, <i>associated with:</i>	Loamy, mixed, hyperthermic, Lithic Ustorthents Extremely shallow, somewhat excessively drained loamy soils on moderately steep sloping with very severe erosion and strongly stony.	1758.97	0.53
331	Clayey, montmorillonitic, hyper-thermic, Typic Haplustolls Shallow, well drained, clayey soils on gently sloping undulating plateau with severe erosion and moderately stony, <i>associated with:</i>	Fine, montmorillonitic, hyperthermic, Vertic Ustochrepts Slightly deep, well drained, clayey soils on gently sloping with severe erosion and moderately stony.	10034.25	3.03
332	Clayey, montmorillonitic, hyperthermic, Lithic Ustochrepts Shallow, well drained clayey soils on very gently sloping undulating plateau with moderate erosion and moderately stony, <i>associated with:</i>	Fine, montmorillonitic, (Cal.), hyperthermic, Vertic Ustochrepts Deep, well drained, calcareous, clayey soils on gently sloping with moderate erosion.	1855.22	0.56
339	Clayey, montmorillonitic, hyper-thermic, Typic Ustochrepts Shallow, well drained clayey soils on gently sloping plateau with moderate erosion, <i>associated with:</i>	Fine, montmorillonitic, hyper-thermic, Typic Haplusterts Slightly deep, well drained, clayey soils on very gently sloping with moderate erosion	3051.72	0.92
343	Loamy, mixed, hyper-thermic, Lithic Ustorthents Very shallow, somewhat excessively drained, loamy soils on moderately sloping plateau with very severe erosion and slightly stony, <i>associated with:</i>	Clayey, mixed, hyperthermic, Lithic Ustorthents Very shallow, somewhat excessively drained, clayey soils on gently sloping with severe erosion.	1344.84	0.41
344	Loamy, mixed, hyper-thermic, Lithic Ustorthents Extremely shallow, somewhat excessively drained, loamy soils on moderately sloping plateau with severe erosion, <i>associated with:</i>	Loamy, mixed, hyperthermic, Typic Ustochrepts Shallow, well drained, loamy soils on gently sloping with moderate erosion and slightly stony.	29404.98	8.88
354	Loamy, mixed, hyper-thermic, Lithic Ustorthents Very shallow, well drained, loamy soils on moderately steep sloping interveinal plateau with severe erosion and slightly stony, <i>associated with:</i>	Clayey, montmorillonitic, hyper-thermic, Typic Ustochrepts Shallow, well drained, clayey soils on very gently sloping with moderate erosion.	5741.26	1.73

Soil Unit	Main Group	Sub Group	Area (ha)	Area (%)
360	Clayey, montmorillonitic hyper-thermic, Typic Ustochrepts Shallow, well drained, clayey soils on very gently sloping plateau (slightly dissected) with moderate erosion, <i>associated with:</i>	Clayey, montmorillonitic hyper-thermic, Lithic Ustorthents Very shallow, somewhat excessively drained, clayey soils on very gently sloping with moderate erosion.	11226.30	3.39
361	Fine, montmorillonitic, (Cal.), hyperthermic, Vertic Ustochrepts Deep, well drained, calcareous, clayey soils on very gently sloping plateau (slightly dissected) with moderate erosion, <i>associated with:</i>	Clayey, mixed, hyperthermic, Lithic Ustorthents Very shallow, well drained, clayey soils on gently sloping with severe erosion and slightly stony.	6839.82	2.07
363	Fine montmorillonitic, hyper-thermic, Typic Haplusterts Deep, moderately well drained, clayey soils on very gently sloping plateau (moderately dissected) with moderate erosion, <i>associated with:</i>	Loamy, mixed, hyperthermic, Typic Ustorthents Shallow, well drained, loamy soils on moderately sloping with severe erosion and moderately stony.	6502.93	1.96
366	Clayey, montmorillonitic hyperthermic, thermic, Lithic Ustorthents Extremely shallow, somewhat excessively drained, clayey soils on very gently sloping plateau (highly dissected) with moderate erosion, <i>associated with:</i>	Clayey, Mixed, hyperthermic, Typic Ustochrepts Shallow, well drained, clayey soils on gently sloping with severe erosion.	22690.81	6.85
377	Fine, montmorillonitic, hyper-thermic, Typic Haplusterts Deep, moderately well drained, clayey soils on very gently sloping plain land with moderate erosion, <i>associated with:</i>	Fine, montmorillonitic, (Cal.), hyperthermic, Chromic Haplusterts Deep, moderately well drained, calcareous, clayey soils on very gently sloping with moderate erosion.	57549.70	17.38
378	Fine, montmorillonitic, (Cal.), hyperthermic, Typic Haplusterts Deep, well drained, calcareous, clayey soils on very gently sloping plain land with moderate erosion, <i>associated with:</i>	Fine, montmorillonitic, (Cal.), hyperthermic, Vertic Ustochrepts Slightly deep, well drained, clayey soils on gently sloping with moderate erosion.	7883.18	2.38
379	Fine, montmorillonitic, hyper-thermic, Chromic Haplusterts Deep, moderately well drained, clayey soils on gently sloping plain land with moderate erosion, <i>associated with:</i>	Fine, montmorillonitic, (Cal.), hyperthermic, Typic Haplusterts Deep, moderately well drained, calcareous, clayey soils on very gently sloping with moderate erosion.	46318.01	13.99
380	Fine, montmorillonitic, (Cal.), hyperthermic, Typic Haplusterts Deep moderately well drained calcareous, clayey soils on gently	Fine, montmorillonitic, (Cal.), hyperthermic, Vertic Ustochrepts Deep moderately well drained,	2644.64	0.80

Soil Unit	Main Group	Sub Group	Area (ha)	Area (%)
	sloping plain land with moderate erosion, <i>associated with:</i>	calcareous, clayey soils on gently sloping with moderate erosion.		
385	Fine, montmorillonitic, (Cal.), hyperthermic, Typic Haplusterts Deep, moderately well drained, calcareous, clayey soils on very gently sloping undulating plain with moderate erosion, <i>associated with:</i>	Fine, montmorillonitic, (Cal.), hyperthermic, Vertic Ustochrepts Deep, well drained, calcareous, clayey soils on very gently sloping with moderate erosion.	179.18	0.05
395	Fine, montmorillonitic, hyperthermic, Typic Haplusterts Deep, moderately well drained, clayey soils on very gently sloping undulating plain with mounds with slight erosion <i>associated with:</i>	Fine, montmorillonitic, hyperthermic, Vertic Ustochrepts Deep, moderately well drained, clayey soils on gently sloping with moderate erosion.	10789.46	3.26
399	Fine, montmorillonitic, hyperthermic, Typic Haplusterts Deep, moderately well drained, clayey soils on very gently sloping plains with valleys with moderate erosion <i>associated with:</i>	Fine, montmorillonitic, (Cal.), hyperthermic, Vertic Ustochrepts Deep, moderately well drained, calcareous, clayey soils on very gently sloping with moderate erosion.	1088.57	0.33
402	Fine, montmorillonitic, hyperthermic, Typic Haplusterts Deep moderately well drained, clayey soils on gently sloping plain with valleys (moderately dissected) with moderate erosion, <i>associated with:</i>	Fine, montmorillonitic, (Cal.), hyperthermic, Typic Haplusterts Deep, moderately well drained, calcareous, clayey soils on very gently sloping with moderate erosion.	530.21	0.16
404	Fine, montmorillonitic, (Cal.), hyperthermic, Typic Haplusterts Deep, well drained, calcareous, clayey soils on very gently sloping plain with valleys (severely dissected) with moderate erosion <i>associated with:</i>	Fine, montmorillonitic, (Cal.), hyperthermic, Vertic Ustochrepts Deep, moderately well drained, calcareous, clayey soils on very gently sloping with moderate erosion.	64895.03	19.60
407	Fine, montmorillonitic, (Cal.), hyperthermic, Typic Haplusterts Deep, moderately well drained, calcareous, clayey soils on very gently sloping plain with valleys (severely dissected) with moderate erosion <i>associated with:</i>	Fine, montmorillonitic, hyperthermic, Vertic Ustochrepts Slightly deep, well drained, clayey soils on gently sloping with moderate erosion.	33496.33	10.12
412	Clayey, montmorillonitic, hyperthermic, Typic Ustochrepts Shallow, well drained, clayey soils on gently sloping plateau with mesas and buttes with moderate erosion <i>associated with:</i>	Fine, montmorillonitic, hyperthermic, Typic Haplusterts Deep, moderately well drained, clayey soils on very gently sloping with moderate erosion.	437.49	0.13
TOTAL			331043.97	100

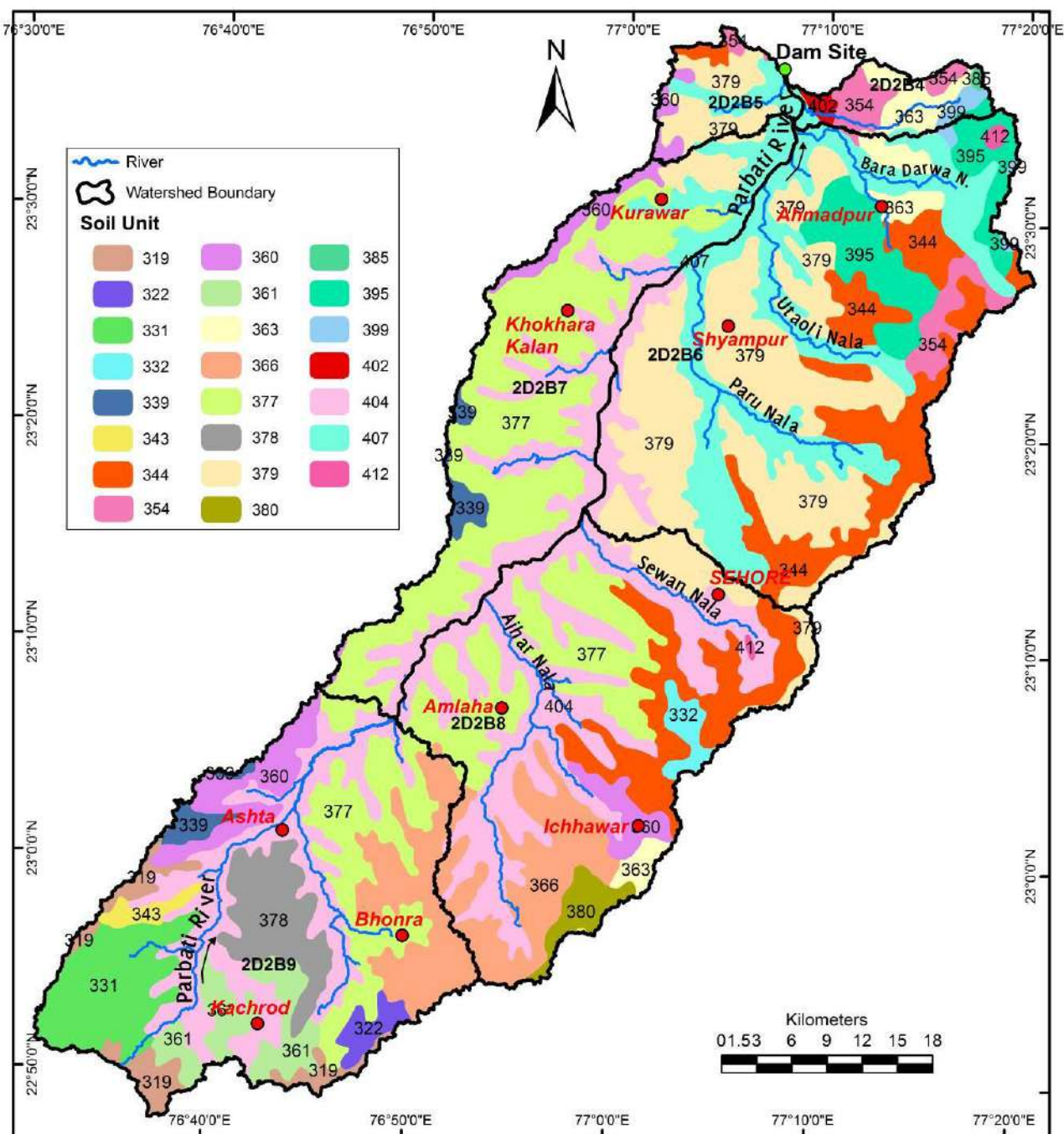
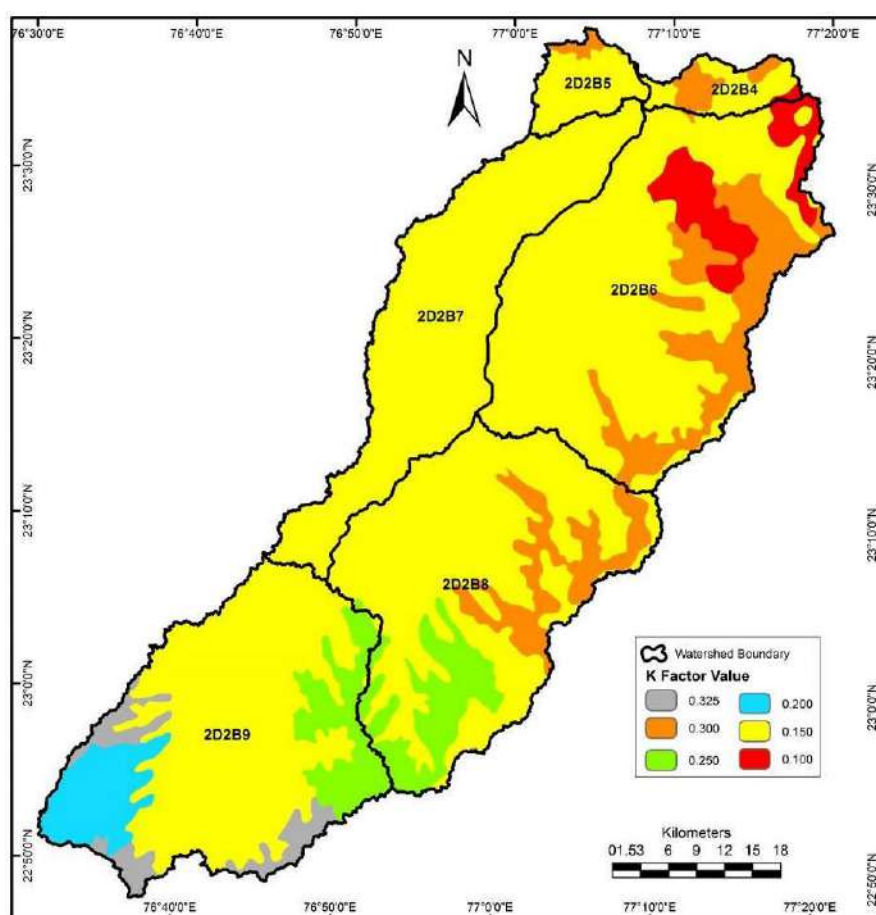


Figure 2.4: Soil Map of Free Draining Catchment Area
(For details of Soil Unit legend refer Table 2.2)

As per the soil map of the catchment area, the soil can be classified in six major categories. deep with slight erosion have low K values i.e. 0.10 because of high infiltration resulting in low runoff even though these particles are easily detached. Shallow to deep with moderate erosion have moderate K value i.e. 0.15, because they are less susceptible to particle detachment and they produce runoff at moderate rates. Shallow with severe erosion have slightly high K value i.e. 0.2. Extremely shallow to very shallow with moderate to very severe erosion have high K value i.e. from 0.25 to 0.325. Various classes of soil and the values of K are shown in **Figure 2.5** and given in **Table 2.3**.

Table 2.3: Soil Erodibility Factor for different Soil Types

S. No.	Soil Unit	Soil Type	Erosion Intensity	K Value
1	319, 322, 343	Extremely Shallow to Very Shallow	Very Severe	0.325
2	344, 354	Extremely Shallow to Very Shallow	Severe	0.3
3	366	Extremely Shallow	Moderate	0.25
4	331	Shallow	Severe	0.2
5	332, 339, 360, 361, 363, 377, 378, 379, 380, 385, 399, 402, 404, 407, 412	Shallow to Deep	Moderate	0.15
6	395	Deep	Slight	0.1

**Figure 2.5: K Factor Value Map of Free Draining Catchment Area**

2.4.3.3 Topographic (LS) Factor

The LS factor is an expression of the effect of topography, specifically hill slope length and steepness, on rates of soil loss at a particular site. The value of 'LS' increases as hill slope length and steepness increase, under the assumption that runoff accumulates and accelerates in the down-slope direction. Digital Elevation Model (DEM) and Slope of a particular area is prerequisite for LS factor. As already discussed, SRTM data has been used for DEM and the sae DEM has been used for the preparation of slope map. The slope map in degrees prepared for the catchment area is given at **Figure 2.6**. As can be seen from the figure, in the catchment area, the slope ranges from 0° to around 33°. The LS factor prepared for the catchment area is given at **Figure 2.7**.

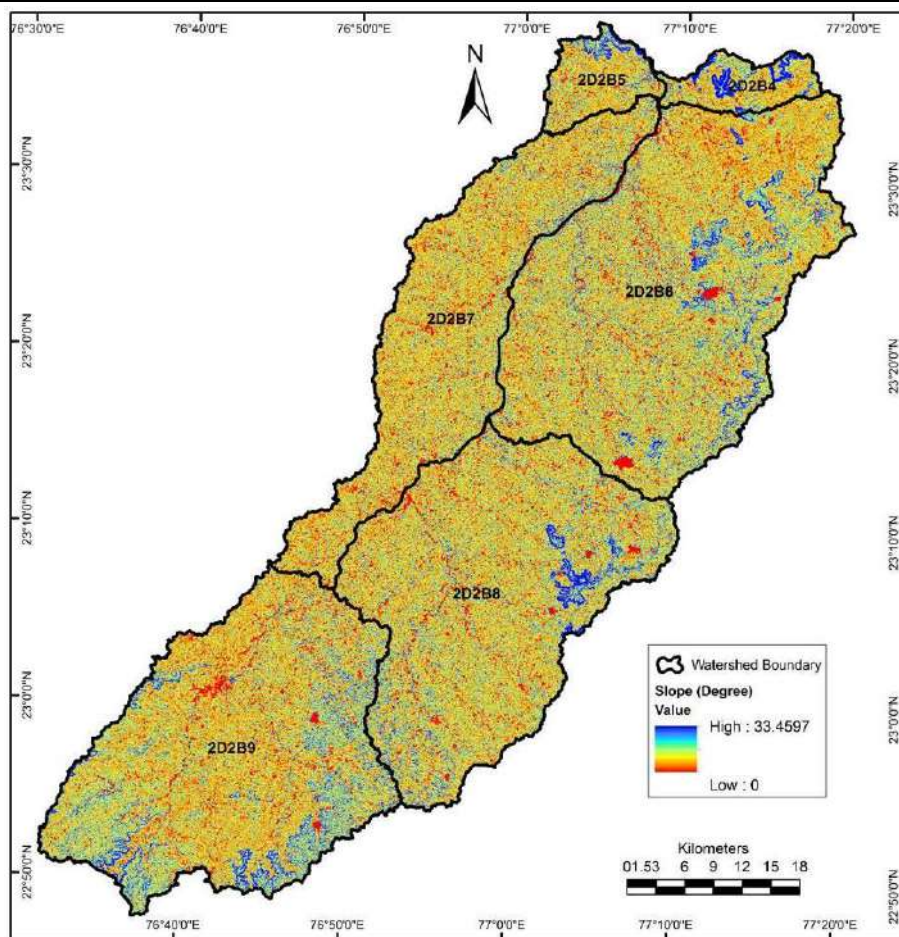


Figure 2.6: Slope Map of Free Draining Catchment Area

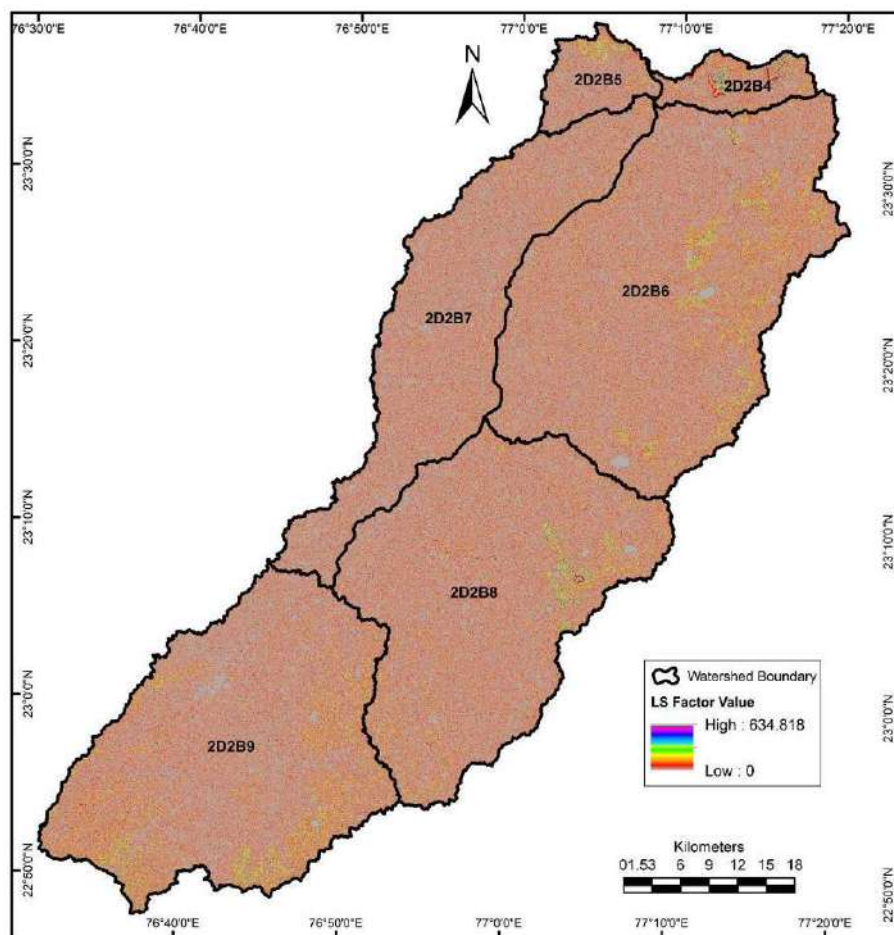


Figure 2.7: LS Factor Map of Free Draining Catchment Area

2.4.3.4 Crop Management (C) Factor

The C factor is an expression of the effect of surface cover and roughness, soil biomass, and soil-disturbing activities on rates of soil loss at a particular site. The value of C decreases as surface cover and soil biomass increase, thus protecting the soil from rain splash and runoff. In the present study, the land use/land cover map prepared from Landsat Data has been used in the allocation of C factor for different land use classes.

For the present study, land use/land cover maps prepared by National Remote Sensing Centre (NRSC), Indian Space Research Organisation (ISRO) of Dept. of Space with Remote Sensing Applications Centre, MP Council of Science & Technology and Google Earth was also referred.

The classified land use/ land cover map of the catchment area is shown as **Figure 2.8**. The land use/ land cover pattern of the catchment area has been given in **Table 2.4**. As can be seen from the map and table, the land use/ land cover pattern can be classified into nine classes, out of these nine classes, agricultural land covers the maximum area i.e. 85.11%, followed by scrub land, covering 5.16. Rest all the other classes covers less than 3%.

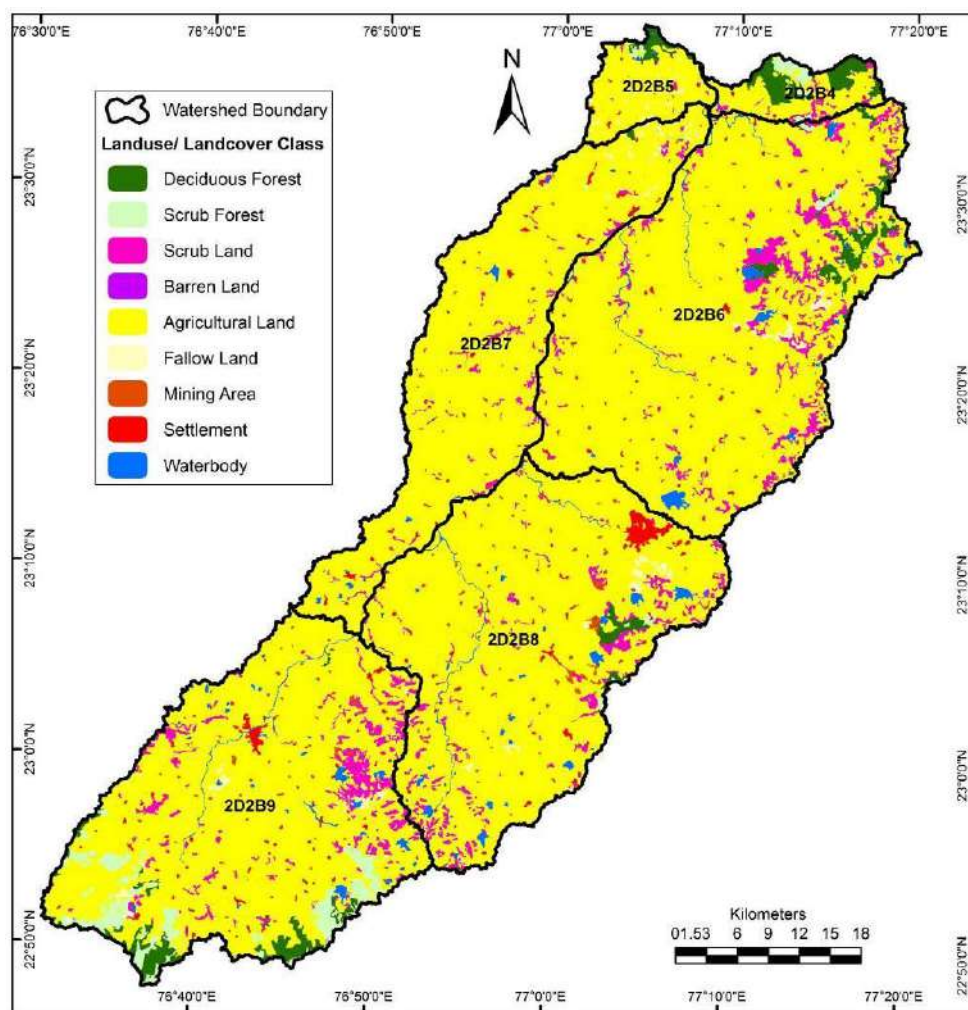


Figure 2.8: Land use/ Land cover map of Free Draining Catchment Area

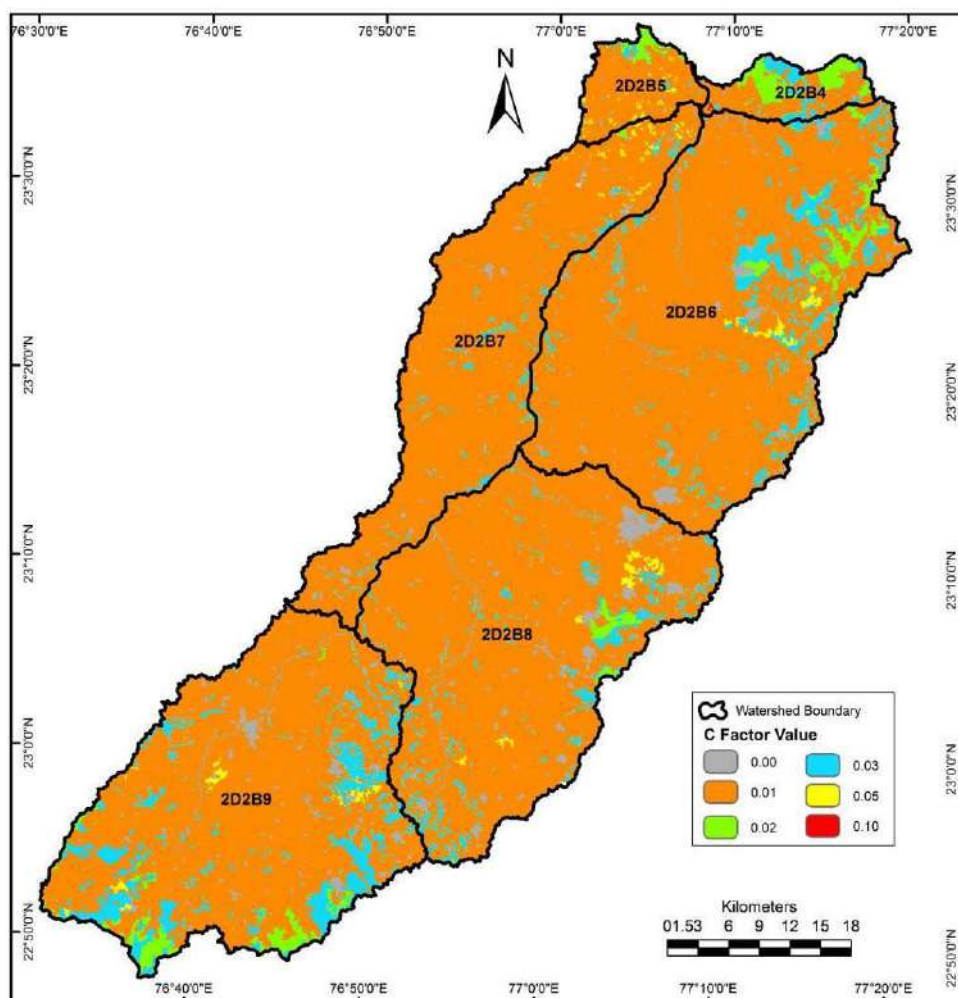
Table 2.4: Area falling under different land use/ land cover classes

Land use/ Land cover Classes	Area (ha)	Area (%)
Deciduous Forest	8521.82	2.57
Scrub Forest	7905.88	2.39
Scrub Land	17091.31	5.16
Fallow Land	4416.17	1.33
Barren Land	34.09	0.01
Agricultural Land	281757.54	85.11
Settlement	4512.46	1.36
Mining	1465.60	0.44
Waterbody	5339.11	1.61
Total	331043.97	100

Table 2.5 describes the cover management factors used in the model under different land use/land cover categories and the same is shown in the map of cover management factors given at **Figure 2.9**.

Table 2.5: Crop Management Factor

S. No.	Land use/ Land cover Type	C Value
1	Deciduous Forest	0.02
2	Scrub Forest & Scrub Land	0.03
3	Fallow Land	0.05
4	Agricultural Land & Barren land	0.01
5	Settlement, Mining Area & Waterbody	0.00

**Figure 2.9: C Factor value map of Free Draining Catchment Area**

2.4.3.5 Conservation Support Practice (P) Factor

The P factor is an expression of the effects of supporting conservation practices, such as contouring, buffer strips of vegetation, and terracing, on soil loss at a particular site. It is the ratio of soil loss with specific support practice to the corresponding loss with up- or down-slope cultivation. In the present study, the P factor has been considered as 1.

2.4.4 Output Presentation

A thematic map for soil loss of the catchment area has been prepared using RUSLE model mentioned in the above section. The catchment area was then demarcated into different soil erosion intensity mapping units or classes based upon the extent of soil loss (see **Table 2.6 & Figure 2.10**). The catchment area under different Erosion Intensity categories is given in **Table 2.7**. As can be seen from the figure and table, around 53% of the catchment area is prone to less than 1 tons/ha/annum soil erosion, i.e. under negligible erosion intensity category. Almost negligible i.e. 0.14% of its area is prone to Severe and Very Severe soil erosion.

Table 2.6: Soil Loss Range and Erosion Intensity Categories

S. No.	Soil loss in tons/hectare/annum	Erosion Intensity Category
1	<1	Negligible
2	1-5	Slight
3	5-10	Very Low
4	10-20	Low
5	20-40	Moderate
6	40-80	Severe
7	>80	Very Severe
	Total	

Table 2.7: Area falling under different Erosion Intensity Categories

Erosion Intensity Category	Area (ha)	Area (%)
Negligible	175199.07	52.92
Slight	125040.08	37.77
Very Low	25484.22	7.70
Low	3573.99	1.08
Moderate	1291.74	0.39
Severe	428.85	0.13
Very Severe	26.02	0.01
Total	331043.97	100

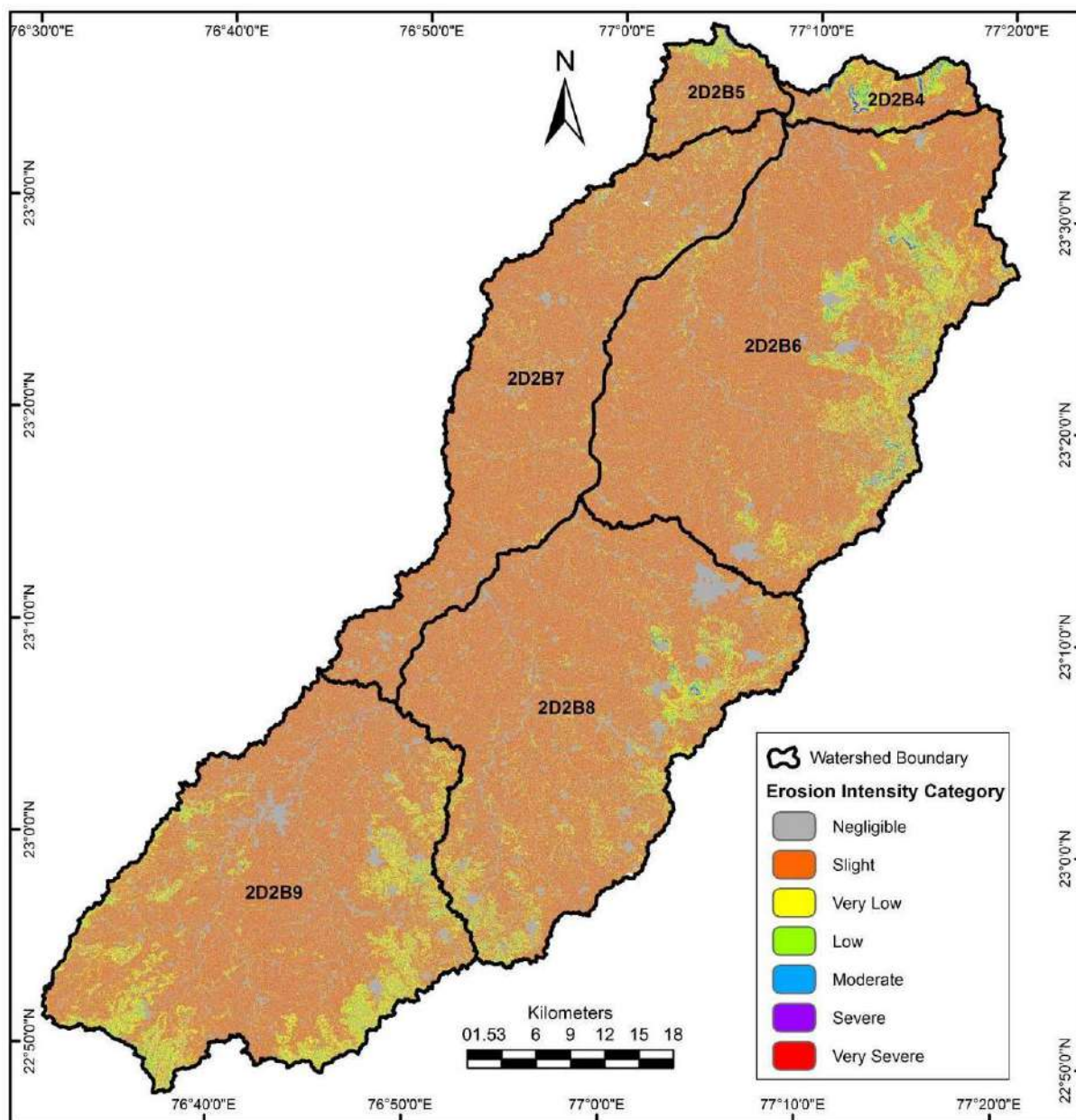


Figure 2.10: Erosion Intensity Map of Free Draining Catchment Area

2.5 PRIORTIZATION OF WATERSHEDS USING SILT YIELD INDEX (SYI) METHOD

'Silt Yield Index' (SYI), method has been used for prioritization of watersheds in the catchment for treatment. The Silt Yield Index (SYI) is defined as the Yield per unit area and SYI value for hydrologic unit is obtained by taking the weighted arithmetic mean over the entire area of the hydrologic unit by using suitable empirical equation. The Silt Yield Index Model (SYI) considers sedimentation as product of erosivity, morphometry and delivery ratio of a particular watershed and was conceptualized by Soil and Land Use Survey of India (SLUSI) as early as 1969 and has been operational since then to meet the requirements of prioritization of smaller hydrologic units within river valley project catchment areas. Silt yield index (SYI) was calculated using following empirical formula:

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

where,

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

2.5.1 Erosion Intensity Mapping Unit

Erosion Intensity Mapping Units (EIMU) are demarcated and defined as per the soil erosion intensity map prepared above. Various EIMU categories, such as Very Severe, Severe, Moderate, Low, Very Low, and Negligible & Slight (clubbed together), were then used to calculate watershed-wise SYI. Erosion Intensity Mapping Units (EIMU) is a composite expression of physiography, land use, and conservation practices adopted. While computing soil erosion intensity in a catchment all the factors (physiography, land use, and conservation practices) are already taken into consideration. Therefore, EIMUs are assumed as per the soil erosion intensity in the watershed.

2.5.2 Weightage Value

Each erosion intensity unit is assigned a weightage value. When considered collectively, the weightage value represents approximately the 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. The weightage value assigned to erosion mapping unit in a watershed ranges from 11-20.

2.5.3 Delivery Ratio

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. 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:

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

2.5.4 Silt Yield Index

The area of each of the mapping units is computed and silt yield indices of individual watersheds are calculated using the equations mentioned above. The SYI values for classification of various categories of erosion intensity rates are given in **Table 2.8**.

Table 2.8: Calculation of SYI in Watersheds

Watershed	EIMU	EIMU Area (hectare) (EA)	Weightage factor (WF)	Silt Yield (SY) = EA * (WF)	Delivery Ratio (DR)	SYI = (SY*DR*100)/SA
2A5F7k	1	1.43	19	27.26	0.9	1290
	2	83.82	18	1508.72		
	3	178.97	17	3042.49		
	4	284.21	16	4547.41		
	5	1049.65	15	15744.69		
	6	5943.82	14	83213.52		
Total		7541.90		108084.09		1290
2A5F7m	1	2.05	19	38.96	0.9	1277
	2	48.80	18	878.39		
	3	80.20	17	1363.34		
	4	199.43	16	3190.94		
	5	827.76	15	12416.47		
	6	7467.40	14	104543.57		
Total		8625.64		122431.67		1277
2A5F7n	1	13.22	19	251.19	0.8	1130
	2	139.97	18	2519.54		
	3	442.53	17	7523.06		
	4	1162.97	16	18607.60		
	5	7635.12	15	114526.86		
	6	88517.35	14	1239242.97		
Total		97911.18		1382671.22		1130
2A5F7p	1	2.78	19	52.74	0.8	1124
	2	20.78	18	374.06		
	3	55.60	17	945.12		
	4	160.15	16	2562.38		
	5	2237.39	15	33560.84		
	6	51304.82	14	718267.53		
Total		53781.51		755762.66		1124
2A5F7q	1	4.12	19	78.26	0.75	1058
	2	73.33	18	1319.85		
	3	252.69	17	4295.74		
	4	710.91	16	11374.58		
	5	5605.60	15	84084.02		
	6	74198.29	14	1038776.04		
Total		80844.94		1139928.50		1058
2A5F7r	1	2.42	19	45.97	0.7	990
	2	62.15	18	1118.76		
	3	281.75	17	4789.81		
	4	1056.31	16	16900.99		
	5	8128.69	15	121930.38		
	6	72807.46	14	1019304.49		
Total		82338.79		1164090.40		990

2.5.5 Prioritization of Watersheds

The watersheds are subsequently rated into various categories corresponding to their respective SYI values. The criteria followed for priority categorization of watersheds depending upon their SYI values is given below and the priority classification of individual watershed is given in **Table 2.9** and **Figure 2.11**.

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

Table 2.9: Priority Number as per SYI Classification

S. No.	Watershed	SYI	Priority	Priority Number
1	2D2B4	1290	High	1
2	2D2B5	1277	High	1
3	2D2B6	1130	Medium	2
4	2D2B7	1124	Medium	2
5	2D2B8	1058	Low	3
6	2D2B9	990	Very Low	4

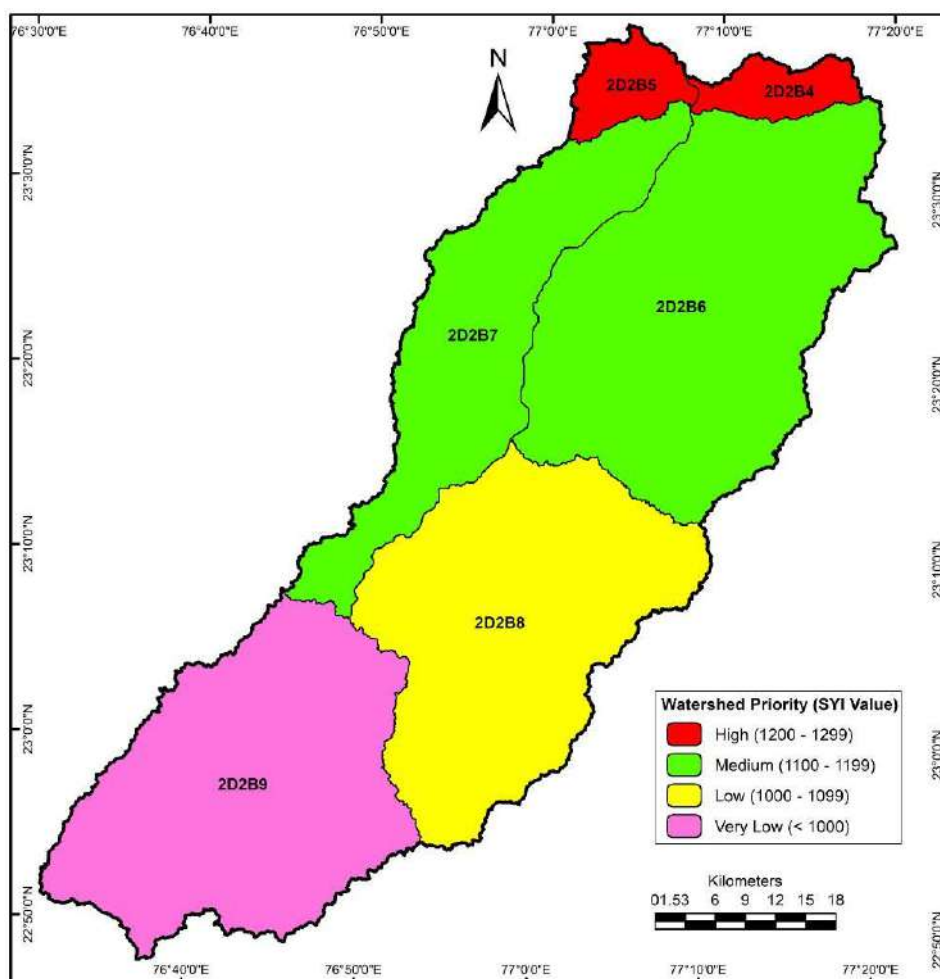


Figure 2.11: Watersheds Priority Classification Map of Free Draining Catchment Area

2.6 TREATMENT PLAN

2.6.1 Area to be taken up for Treatment

Area under severe and very severe erosion intensity category in all the 06 watersheds will be taken up for treatment. To arrive at such an area, first of all area under severe and very severe erosion intensity category was extracted for each watershed, which comes out to be **454.87 ha**. Thereafter, area under severe and very severe erosion intensity category falling inside proposed submergence area was excluded, the area thus arrived at is **423.97 ha**.

Lastly, area under severe and very severe erosion intensity category (**423.97**) falling under settlements, agricultural land, mining area and waterbody classes of land use/ land cover have been excluded as they are not being disturbed. The watershed wise and land use/ land cover wise area thus arrived at and considered as treatable area is **322.61 ha (or say 322 ha)** and is presented below in **Table 2.10**. Out of the total 322 ha to be treated, it is proposed to treat **209** ha by biological measures and the rest **113** ha by engineering measures.

Table 2.10: Watershed wise treatable area under different Land use/ Land cover classes in Catchment Area

Watersheds	Land use/ Land cover Classes Wise Area (ha)					Total Area (ha)
	Deciduous Forest	Scrub Forest	Scrub Land	Fallow Land	Barren Land	
2D2B4	77.66	2.42	0.28	0.04	0.09	80.49
2D2B5	38.41	2.54	0.28	3.26	0.00	44.49
2D2B6	3.39	8.84	71.00	15.51	0.09	98.83
2D2B7	0.00	0.58	6.87	2.41	0.15	10.01
2D2B8	6.85	5.97	22.57	11.46	0.00	46.85
2D2B9	7.51	15.09	10.48	8.86	0.00	41.94
Total	133.82	70.88	222.96	41.54	0.33	322.61

The period for implementing CAT plan interventions including maintenance has been taken as 9 years. It is proposed to prepare micro plans for sub/ micro-watersheds, establish administrative setup and implement other entry point activities in the first year itself. It is proposed to implement treatment measures in watersheds falling under high priority in the first year itself, followed by implementation of treatment measures in watershed falling under medium priority in second year and watershed falling under low and very low priority in fourth year. Maintenance period will be subsequent 5 years.

2.6.2 Treatment Measures

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.

The basis of site selection for different engineering treatment measures under CAT are given in **Table 2.11**.

Table 2.11: Basis for selection of catchment area treatment measures

<i>Treatment measure</i>	<i>Basis for selection</i>
Afforestation	Scrub forest land
Enrichment	Deciduous forest land
Energy Plantation	Scrub land and Fallow land
Brushwood Check Dams	Gullies formed around the streams
Dry Stone Masonry Check Dams	In the streams of 3 rd and 4 th order
Gabion Check Dams	Wherever loose boulders are not stable in particular stretch of a stream

2.6.2.1 Biological Measures

The biological measures would comprise of:

- Afforestation
- Enrichment
- Energy Plantation

2.6.2.1.1 Afforestation

A well-stocked forest is the best insurance against soil loss as well as for ecological rehabilitation. It is therefore proposed to increase the vegetation cover in the tract. For this, patches of scrub forest land falling under sever and very severe erosion intensity category shall be brought under afforestation. The locality factors prevalent in the area such as fires, grazing etc. are fairly adverse to the establishment of plantations. Thus special and intensive efforts are needed to ensure the success of afforestation work. Owing to the above enumeration factors, the plantation will require higher levels of maintenance also. This will include raising of multi-tier mixed vegetation of suitable local species. 1100 plants per hectare will be planted under this scheme. Planting will be done in pits. Earth work should be done well in advance. Plants should be healthy with strong stems. Planting should be done in June when the water

supply starts. RCC fence posts with 4 strand barbed wire fencing, interlaced with thorny bushes will be done in the plantation areas. Further, it is assessed that it is essential to make provision for soil and moisture conservation measures in the areas proposed for afforestation. Provision had been made for undertaking various necessary soil and moisture conservation measures in these areas. Provision is also made for five years maintenance of afforestation undertaken as part of the catchment area treatment. The unit cost for afforestation including maintenance cost for five years is estimated to be **Rs 74,400** per ha consisting of Rs 56,400 for afforestation and Rs 18,000 for maintenance for five years. The detailed break-up of item-wise cost for afforestation is furnished in **Annexure I**. The area to be brought under afforestation is given at **Table 2.12**.

2.6.2.1.2 Enrichment Plantation

Maintaining and enhancing existing forest cover reduces soil erosion to a great extent. It is therefore proposed to increase the vegetation cover of the existing forests. For this, patches of deciduous forest land falling under severe and very severe erosion intensity category shall be brought under enrichment plantation. 800 plants per hectare will be planted under this scheme. The plantation will be maintained for subsequent five years. Wooden fence posts with 4 strand barbed wire fencing, interlaced with thorny bushes will be done in the plantation areas. The unit cost for enrichment plantation including maintenance cost for five years is estimated to be **Rs. 73,580** ha consisting of Rs. 49,800 for plantation and Rs. 23,780 for maintenance for five years. The detailed break-up of item-wise cost for energy plantation is furnished in **Annexure I**. The area to be brought under enrichment plantation is given at **Table 2.12**.

2.6.2.1.3 Energy Plantation

Energy plantation scheme is essential for a continuous supply of fuel and fodder. It can be easily carried out and it is economical to carry out. Agricultural land will not be used for energy plantation, instead, fallow land and scrub land falling under severe and very severe erosion intensity category will be used for energy plantation. 1100 plants per hectare will be planted under this scheme. The plantation will be maintained for subsequent three years. Wooden fence posts with 4 strand barbed wire fencing, interlaced with thorny bushes will be done in the plantation areas. The unit cost for energy plantation including maintenance cost for three years is estimated to be **Rs. 69,560** per ha consisting of Rs. 51,900 for plantation and Rs. 17,660 for maintenance for three years. The detailed break-up of item-wise cost for

energy plantation is furnished in **Annexure I**. The area to be brought under energy plantation is given at **Table 2.12**.

2.6.2.2 Engineering Measures

The engineering treatment measures require less time to be put in place and can provide quick solutions. These would comprise mainly of Brushwood check dams, Dry stone masonry check dams and Gabion check dams.

2.6.2.2.1 Brushwood Check Dam

Brushwood check dams are very feasible where vegetative material for construction is abundant. Brushwood check dams can only be constructed in small gullies not deeper than 1m depth. As material required for construction of these types of dam is available locally these can be constructed faster and in very short span of time thereby effectively reducing the erosion in early phase of Project. The numbers of check dams are estimated using number of first order streams in an area under severe and very severe erosion intensity, and constructed at an interval of 100 m. The detailed break-up of item-wise cost is furnished in **Annexure I**. The number of brushwood check dams suggested is given at **Table 2.12**.

2.6.2.2.2 Dry Stone Masonry Check Dam

Dry stone masonry check dams can be made of boulder piled up across the gulley and along the banks if they are locally available. Such structures for damming a gulley or a stream to refine the flow velocity and to control bank erosion are called dry stone masonry/ loose bolder check dams. The detailed break-up of item-wise cost is furnished in **Annexure I**. The number of dry stone masonry check dams suggested is given at **Table 2.12**.

2.6.2.2.3 Gabion Check Dam

If dry stone masonry check dams are considered not to be stable in a particular reach of the stream, Gabion structure can be installed. This is not very much encouraged therefore with proper judgment about the site conditions these structures may be installed. The detailed break-up of item-wise cost is furnished in **Annexure I**. The number of gabion check dams suggested is given at **Table 2.12**.

2.6.2.3 Summary of Treatment Measures

Watershed wise areas identified for treatment with different treatment measures is given in **Table 2.12**. The total cost required for the treatment of 322 ha by the means of different treatment measures is **Rs. 300.74 lakh**. The summary of treatment measures and their cost is given in **Table 2.13**.

Table 2.12: Watershed wise Summary of treatment measures

S. No.	Watershed	Afforestation (ha)	Enrichment Plantation (ha)	Energy Plantation (ha)	Brushwood Check Dams (No)	Dry stone Masonry Check Dams (No)	Gabion Check Dams (No)
1	2D2B4	2	39	0	59	40	29
2	2D2B5	3	19	3	68	46	33
3	2D2B6	9	3	51	85	54	41
4	2D2B7	1	0	6	72	46	34
5	2D2B8	6	7	23	76	47	36
6	2D2B9	15	8	14	78	51	37
	Total	36	76	97	438	284	210

Table 2.13: Summary of treatment measures and their cost for CAT Plan

Treatment Measures	Quantity	Unit Cost (Rs)*	Total Cost (Rs.)
Afforestation (ha)	36	86,380	31,09,680
Enrichment Plantation (ha)	76	73,580	55,92,080
Energy Plantation (ha)	97	69,560	67,47,320
Brushwood Check Dams (Nos)	438	2,000	8,76,000
Dry Stone Masonry Check Dams (Nos)	284	26,000	75,54,400
Gabion Check Dams (Nos)	210	29,500	61,95,000
TOTAL			3,00,74,480

Note*: Unit Cost has been taken as per the cost norms given in Annexure I

2.7 OTHER COMPONENTS OF CAT PLAN

Apart from the biological and engineering treatment measures in the catchment area there are other aspects of the CAT Plan to be addressed and their cost included in the overall cost estimate of the plan. The charges for operational support, forest protection, social mobilization, documentation and publication, monitoring and evaluation and providing environmental services are some of the integral ingredients which have to be considered and included while formulating the CAT plans.

2.7.1 Administrative Charges

For an efficient management of forest resources, it is essential that operational support to the Forest Department is adequately developed. Similarly, in remote localities there are no places for shelter for the staff, people and trekkers. Therefore, a budgetary provision of **Rs 15.04 lakh** has been kept for this component.

2.7.2 Provision for Micro Planning

The year-wise areas requiring treatment measures have been suggested but have not been marked. The spatial location of specific treatment to be carried out in the catchment area would require extensive detailing during the implementation of CAT and a provision for micro-planning has been made in

the total CAT financial allocation. For this purpose a provision of **Rs 6.01 lakh** is being made.

2.7.3 Monitoring & Evaluation

Monitoring and evaluation will be undertaken as a part of project management. A process of self-evaluation at specified intervals of time will ensure the field level verification of suggested treatment measures and efficacy of the CAT plan.

The year-wise areas requiring treatment measures have been suggested but have not been marked. The spatial location of specific treatment to be carried out in the catchment area would require extensive detailing during the implementation of CAT and a provision for micro-planning has been made in the total CAT financial allocation. Thereafter, annual work plan would be prepared well in advance after undertaking initial ground surveys during micro-planning, specifying physical and financial targets, sites, locations and beneficiaries of each component of the project activity. Month-wise work schedule of various items of each component for the financial year would also be prepared in advance and its timely implementation would be ensured. Monthly progress report on all activities would be submitted by the Range Officers to Divisional Forest Officer. The monitoring committee shall be constituted at the project level for this purpose which too would monitor on a regular basis the quality and quantity of works being carried out under the CAT plan area.

A provision of **Rs 9.02 lakh** has been made for this component.

2.7.4 Contingencies

A provision of **Rs 30.07 lakh** has been kept under this component for some leeway to adjust any unforeseen expenditure.

2.8 COST ESTIMATE

The estimated cost of implementation of CAT plan is **Rs. 360.89 lakh** and is given at **Table 2.14**. Year wise phasing of physical and financial outlay has been given in **Table 2.15**.

Table 2.14: Estimated Cost of CAT Plan Implementation

S. No.	Item	Rate (Rs)	Unit	Target	
				Physical	Financial (Rs)
I	Biological Measures				
1	Afforestation		ha		
	i) Creation	58,900		36	21,20,400.00

S. No.	Item	Rate (Rs)	Unit	Target	
				Physical	Financial (Rs)
	ii) Maintenance for 5 years	27,480		36	9,89,280.00
2	Enrichment Plantation		ha		
	i) Creation	49,800		76	37,84,800.00
	ii) Maintenance for 5 years	23,780		76	18,07,280.00
3	Energy Plantation		ha		
	i) Creation	51,900		97	50,34,300.00
	ii) Maintenance for 3 years	17,660		97	17,13,020.00
	Sub Total I (1+2+3)				1,54,49,080.00
II	Engineering Measures				
4	Brushwood Check Dams	2,000	No	438	8,76,000.00
5	Check Dams (DRSM)	26,600	No	284	75,54,400.00
6	Gabion Check Dams	29,500	No	210	61,95,000.00
	Sub Total II (4+5+6)				1,46,25,400.00
A	Treatment Cost (Sub Total I + II)				3,00,74,480.00
III	Administrative Measures				
7	Administrative Charges @5% of Total				15,03,724.00
8	Micro planning @2% of Treatment Cost				6,01,489.60
9	Monitoring & Evaluation Cost @3% of Treatment Cost				9,02,234.40
10	Contingencies @10% of Treatment Cost				30,07,448.00
B	Sub Total III				60,14,896.00
	Total CAT Plan Cost (A + B)				3,60,89,376.00

Table 2.15: Year Wise Phasing of Physical and Financial Targets

S. No.	Year Wise Treatment Plan	Year - 1 (2020-21)		Year - 2 (2021-22)		Year - 3 (2022-23)		Year - 4 (2023-24)		Year - 5 (2024-25)		Year - 6 (2025-26)		Year - 7 (2026-27)		Year - 8 (2027-28)		Year - 9 (2028-29)		Total	
		Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)
I	Afforestation Measures (ha)																				
1	Normal Afforestation			5	2,94,500	10	5,89,000	21	12,36,900											36	21,20,400
	1 st Year maintenance					5	34,400	10	68,800	21	1,44,480									36	2,47,680
	2 nd Year maintenance							5	29,350	10	58,700	21	1,23,270							36	2,11,320
	3 rd Year maintenance									5	24,550	10	49,100	21	1,03,110					36	1,76,760
	4 th Year maintenance											5	24,550	10	49,100	21	1,03,110			36	1,76,760
	5 th Year maintenance													5	24,550	10	49,100	21	1,03,110	36	1,76,760
2	Enrichment Plantation			58	28,88,400	3	1,49,400	15	7,47,000											76	37,84,800
	1 st Year maintenance					58	3,19,000	3	16,500	15	82,500									76	4,18,000
	2 nd Year maintenance							58	2,77,240	3	14,340	15	71,700							76	3,63,280
	3 rd Year maintenance									58	2,61,000	3	13,500	15	67,500					76	3,42,000
	4 th Year maintenance											58	2,61,000	3	13,500	15	67,500			76	3,42,000
	5 th Year maintenance													58	2,61,000	3	13,500	15	67,500	76	3,42,000
3	Energy Plantation			3	1,55,700	57	29,58,300	37	19,20,300											97	50,34,300
	1 st Year maintenance					3	20,640	57	3,92,160	37	2,54,560									97	6,67,360
	2 nd Year maintenance							3	17,610	57	3,34,590	37	2,17,190							97	5,69,390
	3 rd Year maintenance									3	14,730	57	2,79,870	37	1,81,670					97	4,76,270
	Sub Total I			66	33,38,600	136	40,70,740	209	47,05,860	209	11,89,450	206	10,40,180	149	7,00,430	49	2,33,210	36	1,70,610		1,54,49,080
II	Soil & Water Conservation Measures																				
4	Brushwood Check Dams (Nos)			127	2,54,000	157	3,14,000	154	3,08,000											438	8,76,000
5	Dry Stone Masonry Check Dams (Nos)			86	22,87,600	100	26,60,000	98	26,06,800											284	75,54,400
6	Gabion Check Dams (Nos)			62	18,29,000	75	22,12,500	73	21,53,500											210	61,95,000
	Sub Total II			275	43,70,600	332	51,86,500	325	50,68,300												1,46,25,400
A	Total (I and II)				77,09,200		92,57,240		97,74,160		11,89,450		10,40,180		7,00,430		2,33,210		1,70,610		3,00,74,480
III	ADMINISTRATIVE MEASURES																				
7	Administrative Charges @5% of Total		3,00,745		3,00,745		3,00,745		3,00,745		3,00,745										15,03,724
8	Micro planning @2% of Treatment Cost		6,01,490																		6,01,490
9	Monitoring & Evaluation Cost @3% of Treatment Cost				2,31,276		2,77,717		2,93,225		35,684		31,205		21,013		6,996		5,118		9,02,234
10	Contingencies @10% of Treatment Cost				7,70,920		9,25,724		9,77,416		1,18,945		1,04,018		70,043		23,321		17,061		30,07,448
B	Sub Total III		9,02,234		13,02,941		15,04,186		15,71,386		4,55,373		1,35,223		91,056		30,317		22,179		60,14,896
	Total (A and B)		9,02,234		90,12,141		1,07,61,426		1,13,45,546		16,44,823		11,75,403		7,91,486		2,63,527		1,92,789		3,60,89,376

1. Per Hectare Cost Norm for Afforestation

S. No.	Particulars of Work	Unit	Qty.	Rate (Rs.)	Amount (Rs.)
1	Survey & demarcation and preparation of map	Ha.	1	450	450.00
2	Bush cutting in the plantation site	Ha.	1	750	750.00
3	Interlacing of thorny bushes in B/wire	Rmt	180	3	540.00
4	Preparation of inspection path 60 cm wide	Rmt	150	15	2250.00
5	Layout of Pits	Ha.	1	500	500.00
6	Digging of pits 45x45x45 cm (40% of total)	00	4.4	1200	5280.00
7	Digging of pits 30x30x30 cm(60% of total)	00	6.6	900	5940.00
8	Filling of pits 45x45x45 cm (40% of total)	00	4.4	200	880.00
9	Filling of pits 30x30x30 cm (60% of total)	00	6.6	150	990.00
10	Carriage of naked roots plants over a distance of 0.5 km up hill	00	2	100	200.00
11	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	3.5	150	525.00
12	Planting of entire Plants raised in P/bags	00	7	300	2100.00
13	Planting of naked root plants	00	4	200	800.00
14	Nursery cost of Plants	Nos	1100	9	9900.00
	Total				31105.00
15	Soil & moisture conservation works (25% of initial planting cost)		25%		7776.25
16	Add cost of RCC fence post and B/Wire			LS	20000.00
	Grand Total				58881.25
	Or Say				58900.00
I	1st Year Maintenance - 25% Mortality				
1	Re-digging of Pits 45x45x45 cm	00	1.1	600	660.00
2	Re-digging of Pits 30x30x30 cm	00	1.65	450	742.50
3	Filling of pits 45x45x45 cm	00	1.1	100	110.00
4	Filling of pits 30x30x30 cm	00	1.65	75	123.75
5	Planting of P/bags plants	00	1.75	300	525.00
6	Planting of naked root plants	00	1	200	200.00
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	0.88	150	132.00
8	Carriage of naked roots plants over a distance of 0.5 km up hill	00	0.5	100	50.00
9	Nursery cost of Plants	No.	275	9	2475.00
10	Repair of fence	Rmt	180	2	360.00
11	Repair of Inspection path	LS			500.00
12	Repair of soil and moisture conservation works	LS			1000.00
	Total I				6878.25
	Or Say				6880.00
II	2nd Year Maintenance - 20% Mortality				
1	Re-digging of Pits 45x45x45 cm	00	0.88	600	528.00
2	Re-digging of Pits 30x30x30 cm	00	1.32	450	594.00
3	Filling of pits 45x45x45 cm	00	0.88	100	88.00
4	Filling of pits 30x30x30 cm	00	1.32	75	99.00

S. No.	Particulars of Work	Unit	Qty.	Rate (Rs.)	Amount (Rs.)
5	Planting of P/bags plants	00	1.4	300	420.00
6	Planting of naked root plants	00	0.8	200	160.00
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	0.70	150	105.00
8	Carriage of naked roots plants over a distance of 0.5 km up hill	00	0.40	100	40.00
9	Nursery cost of Plants	No.	220	9	1980.00
10	Repair of fence	Rmt	180	2	360.00
11	Repair of Inspection path	LS			500.00
12	Repair of soil and moisture conservation works	LS			1000.00
	Total I				5874.00
	Or Say				5870.00
III	3rd Year Maintenance - 15% Mortality				
1	Re-digging of Pits 45x45x45 cm	00	0.66	600	396.00
2	Re-digging of Pits 30x30x30 cm	00	0.99	450	445.50
3	Filling of pits 45x45x45 cm	00	0.66	100	66.00
4	Filling of pits 30x30x30 cm	00	0.99	75	74.25
5	Planting of P/bags plants	00	1.05	300	315.00
6	Planting of naked root plants	00	0.6	200	120.00
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	0.53	150	78.75
8	Carriage of naked roots plants over a distance of 0.5 km up hill	00	0.30	100	30.00
9	Nursery cost of Plants	No.	165	9	1485.00
10	Repair of fence	Rmt	200	2	400.00
11	Repair of Inspection path	LS			500.00
12	Repair of soil and moisture conservation works	LS			1000.00
	Total I				4910.50
	Or Say				4910.00
IV	4th Year Maintenance - 15% Mortality				
1	Re-digging of Pits 45x45x45 cm	00	0.66	600	396.00
2	Re-digging of Pits 30x30x30 cm	00	0.99	450	445.50
3	Filling of pits 45x45x45 cm	00	0.66	100	66.00
4	Filling of pits 30x30x30 cm	00	0.99	75	74.25
5	Planting of P/bags plants	00	1.05	300	315.00
6	Planting of naked root plants	00	0.6	200	120.00
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	0.53	150	78.75
8	Carriage of naked roots plants over a distance of 0.5 km up hill	00	0.30	100	30.00
9	Nursery cost of Plants	No.	165	9	1485.00
10	Repair of fence	Rmt	200	2	400.00
11	Repair of Inspection path	LS			500.00
12	Repair of soil and moisture conservation works	LS			1000.00
	Total I				4910.50
	Or Say				4910.00
V	5thYear Maintenance - 15% Mortality				
1	Re-digging of Pits 45x45x45 cm	00	0.66	600	396.00
2	Re-digging of Pits 30x30x30 cm	00	0.99	450	445.50
3	Filling of pits 45x45x45 cm	00	0.66	100	66.00

S. No.	Particulars of Work	Unit	Qty.	Rate (Rs.)	Amount (Rs.)
4	Filling of pits 30x30x30 cm	00	0.99	75	74.25
5	Planting of P/bags plants	00	1.05	300	315.00
6	Planting of naked root plants	00	0.6	200	120.00
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	0.53	150	78.75
8	Carriage of naked roots plants over a distance of 0.5 km up hill	00	0.30	100	30.00
9	Nursery cost of Plants	No.	165	9	1485.00
10	Repair of fence	Rmt	200	2	400.00
11	Repair of Inspection path	LS			500.00
12	Repair of soil and moisture conservation works	LS			1000.00
	Total I				4910.50
	Or Say				4910.00
	Total Maintenance Cost				27480.00
	GRAND TOTAL	Ha.	1		86380.00

2. Per Hectare Cost Norm for Enrichment Plantation

S. No.	Particulars of Work	Unit	Qty.	Rate (Rs.)	Amount (Rs.)
1	Survey & demarcation and preparation of map	Ha.	1	450	450.00
2	Bush cutting in the plantation site	Ha.	1	750	750.00
3	Interlacing of thorny bushes in B/wire	Rmt	180	3	540.00
4	Preparation of inspection path 60 cm wide	Rmt	150	15	2250.00
5	Layout of Pits	Ha.	1	500	500.00
6	Digging of pits 45x45x45 cm (40% of total)	00	3.2	1200	3840.00
7	Digging of pits 30x30x30 cm(60% of total)	00	4.8	900	4320.00
8	Filling of pits 45x45x45 cm (40% of total)	00	3.2	200	640.00
9	Filling of pits 30x30x30 cm (60% of total)	00	4.8	150	720.00
10	Carriage of naked roots plants over a distance of 0.5 km up hill	00	1.5	100	150.00
11	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	2.5	150	375.00
12	Planting of entire Plants raised in P/bags	00	5	300	1500.00
13	Planting of naked root plants	00	3	200	600.00
14	Nursery cost of Plants	Nos	800	9	7200.00
	Total				23835.00
15	Soil & moisture conservation works (25% of initial planting cost)		25%		5958.75
16	Add cost of RCC fence post and B/Wire			LS	20000.00
	Grand Total				49793.75
	Or Say				49800.00
I	1st Year Maintenance - 25% Mortality				
1	Re-digging of Pits 45x45x45 cm	00	0.8	600	480.00
2	Re-digging of Pits 30x30x30 cm	00	1.2	450	540.00
3	Filling of pits 45x45x45 cm	00	0.8	100	80.00
4	Filling of pits 30x30x30 cm	00	1.2	75	90.00
5	Planting of P/bags plants	00	1.25	300	375.00
6	Planting of naked root plants	00	0.75	200	150.00

S. No.	Particulars of Work	Unit	Qty.	Rate (Rs.)	Amount (Rs.)
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	0.62 5	150	93.75
8	Carriage of naked roots plants over a distance of 0.5 km up hill	00	0.37 5	100	37.50
9	Nursery cost of Plants	No.	200	9	1800.00
10	Repair of fence	Rmt	180	2	360.00
11	Repair of Inspection path	LS			500.00
12	Repair of soil and moisture conservation works	LS			1000.00
	Total I				5506.25
	Or Say				5500.00
II	2nd Year Maintenance - 20% Mortality				
1	Re-digging of Pits 45x45x45 cm	00	0.64	600	384.00
2	Re-digging of Pits 30x30x30 cm	00	0.96	450	432.00
3	Filling of pits 45x45x45 cm	00	0.64	100	64.00
4	Filling of pits 30x30x30 cm	00	0.96	75	72.00
5	Planting of P/bags plants	00	1	300	300.00
6	Planting of naked root plants	00	0.6	200	120.00
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	0.50	150	75.00
8	Carriage of naked roots plants over a distance of 0.5 km up hill	00	0.30	100	30.00
9	Nursery cost of Plants	No.	160	9	1440.00
10	Repair of fence	Rmt	180	2	360.00
11	Repair of Inspection path	LS			500.00
12	Repair of soil and moisture conservation works	LS			1000.00
	Total I				4777.00
	Or Say				4780.00
III	3rd Year Maintenance - 15% Mortality				
1	Re-digging of Pits 45x45x45 cm	00	0.48	600	288.00
2	Re-digging of Pits 30x30x30 cm	00	0.72	450	324.00
3	Filling of pits 45x45x45 cm	00	0.48	100	48.00
4	Filling of pits 30x30x30 cm	00	0.72	75	54.00
5	Planting of P/bags plants	00	0.75	300	225.00
6	Planting of naked root plants	00	0.45	200	90.00
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	0.38	150	56.25
8	Carriage of naked roots plants over a distance of 0.5 km up hill	00	0.23	100	22.50
9	Nursery cost of Plants	No.	165	9	1485.00
10	Repair of fence	Rmt	200	2	400.00
11	Repair of Inspection path	LS			500.00
12	Repair of soil and moisture conservation works	LS			1000.00
	Total I				4492.75
	Or Say				4500.00
IV	4th Year Maintenance - 15% Mortality				
1	Re-digging of Pits 45x45x45 cm	00	0.48	600	288.00
2	Re-digging of Pits 30x30x30 cm	00	0.72	450	324.00
3	Filling of pits 45x45x45 cm	00	0.48	100	48.00
4	Filling of pits 30x30x30 cm	00	0.72	75	54.00
5	Planting of P/bags plants	00	0.75	300	225.00

S. No.	Particulars of Work	Unit	Qty.	Rate (Rs.)	Amount (Rs.)
6	Planting of naked root plants	00	0.45	200	90.00
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	0.38	150	56.25
8	Carriage of naked roots plants over a distance of 0.5 km up hill	00	0.23	100	22.50
9	Nursery cost of Plants	No.	165	9	1485.00
10	Repair of fence	Rmt	200	2	400.00
11	Repair of Inspection path	LS			500.00
12	Repair of soil and moisture conservation works	LS			1000.00
	Total I				4492.75
	Or Say				4500.00
V	5thYear Maintenance - 15% Mortality				
1	Re-digging of Pits 45x45x45 cm	00	0.48	600	288.00
2	Re-digging of Pits 30x30x30 cm	00	0.72	450	324.00
3	Filling of pits 45x45x45 cm	00	0.48	100	48.00
4	Filling of pits 30x30x30 cm	00	0.72	75	54.00
5	Planting of P/bags plants	00	0.75	300	225.00
6	Planting of naked root plants	00	0.45	200	90.00
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	0.38	150	56.25
8	Carriage of naked roots plants over a distance of 0.5 km up hill	00	0.23	100	22.50
9	Nursery cost of Plants	No.	165	9	1485.00
10	Repair of fence	Rmt	200	2	400.00
11	Repair of Inspection path	LS			500.00
12	Repair of soil and moisture conservation works	LS			1000.00
	Total I				4492.75
	Or Say				4500.00
	Total Maintenance Cost				23780.00
	GRAND TOTAL	Ha.	1		73580.00

3. Per Hectare Cost Norm for Energy Plantation

S. No.	Particulars of Work	Unit	Qty.	Rate (Rs.)	Amount (Rs.)
1	Survey & demarcation and preparation of map	Ha.	1	450	450.00
2	Bush cutting in the plantation site	Ha.	1	750	750.00
3	Interlacing of thorny bushes in B/wire	Rmt	180	3	540.00
4	Preparation of inspection path 60 cm wide	Rmt	150	15	2250.00
5	Layout of Pits	Ha.	1	500	500.00
6	Digging of pits 45x45x45 cm (40% of total)	00	4.4	1200	5280.00
7	Digging of pits 30x30x30 cm(60% of total)	00	6.6	900	5940.00
8	Filling of pits 45x45x45 cm (40% of total)	00	4.4	200	880.00
9	Filling of pits 30x30x30 cm (60% of total)	00	6.6	150	990.00
10	Carriage of naked roots plants over a distance of 0.5 km up hill	00	2	100	200.00
11	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	3.5	150	525.00
12	Planting of entire Plants raised in P/bags	00	7	300	2100.00
13	Planting of naked root plants	00	4	200	800.00

S. No.	Particulars of Work	Unit	Qty.	Rate (Rs.)	Amount (Rs.)
14	Nursery cost of Plants	Nos	1100	9	9900.00
	Total				31105.00
15	Soil & moisture conservation works (25% of initial planting cost)		25%		7776.25
16	Add cost of Wooden fence post and B/Wire			LS	13000.00
	Grand Total				51881.25
	Or Say				51900.00
I	1st Year Maintenance - 25% Mortality				
1	Re-digging of Pits 45x45x45 cm	00	1.1	600	660.00
2	Re-digging of Pits 30x30x30 cm	00	1.65	450	742.50
3	Filling of pits 45x45x45 cm	00	1.1	100	110.00
4	Filling of pits 30x30x30 cm	00	1.65	75	123.75
5	Planting of P/bags plants	00	1.75	300	525.00
6	Planting of naked root plants	00	1	200	200.00
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	0.88	150	132.00
8	Carriage of naked roots plants over a distance of 0.5 km up hill	00	0.5	100	50.00
9	Nursery cost of Plants	No.	275	9	2475.00
10	Repair of fence	Rmt	180	2	360.00
11	Repair of Inspection path	LS			500.00
12	Repair of soil and moisture conservation works	LS			1000.00
	Total I				6878.25
	Or Say				6880.00
II	2nd Year Maintenance - 20% Mortality				
1	Re-digging of Pits 45x45x45 cm	00	0.88	600	528.00
2	Re-digging of Pits 30x30x30 cm	00	1.32	450	594.00
3	Filling of pits 45x45x45 cm	00	0.88	100	88.00
4	Filling of pits 30x30x30 cm	00	1.32	75	99.00
5	Planting of P/bags plants	00	1.4	300	420.00
6	Planting of naked root plants	00	0.8	200	160.00
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	0.70	150	105.00
8	Carriage of naked roots plants over a distance of 0.5 km up hill	00	0.40	100	40.00
9	Nursery cost of Plants	No.	220	9	1980.00
10	Repair of fence	Rmt	180	2	360.00
11	Repair of Inspection path	LS			500.00
12	Repair of soil and moisture conservation works	LS			1000.00
	Total I				5874.00
	Or Say				5870.00
III	3rd Year Maintenance - 15% Mortality				
1	Re-digging of Pits 45x45x45 cm	00	0.66	600	396.00
2	Re-digging of Pits 30x30x30 cm	00	0.99	450	445.50
3	Filling of pits 45x45x45 cm	00	0.66	100	66.00
4	Filling of pits 30x30x30 cm	00	0.99	75	74.25
5	Planting of P/bags plants	00	1.05	300	315.00
6	Planting of naked root plants	00	0.6	200	120.00
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	0.53	150	78.75

S. No.	Particulars of Work	Unit	Qty.	Rate (Rs.)	Amount (Rs.)
8	Carriage of naked roots plants over a distance of 0.5 km up hill	00	0.30	100	30.00
9	Nursery cost of Plants	No.	165	9	1485.00
10	Repair of fence	Rmt	200	2	400.00
11	Repair of Inspection path	LS			500.00
12	Repair of soil and moisture conservation works	LS			1000.00
	Total I				4910.50
	Or Say				4910.00
	Total Maintenance Cost				17660.00
	GRAND TOTAL	Ha.	1		69560.00

4. Cost Norm for per Brushwood Check Dam

S. No.	Particulars of Work	Unit	Qty.	Rate (Rs.)	Amount (Rs.)
1	Survey and alignment	LS			850.00
2	Purchase and transport of wooden pegs (size - 5cm dia and 65 cm long)	Nos	10	40	400.00
3	Construction of bund by fixing wooden pegs at distance of 20cm in 2 rows and supporting soil and moorum	Nos	10	40	400.00
4	Plantation of bushes at distance of 0.5m	Nos	2	50	100.00
5	Plantation of trees at distance of 2.5m	Nos	1	120	120.00
6	Inter cultivation 3 times	Nos	9	15	135.00
	Total				2,005.00
	or Say				2,000.00

5. Cost Norm for per Dry Stone Masonry Check Dam

S. No.	Particulars of Work	Qty.	Rate (Rs.)	Amount (Rs.)
1	Excavation in hard soil including 50m lead and 1.5m lift with dressing	18	26	468.00
2	Collection of boulders at source (max. size 0.014cum), without quarrying i.e. picked up boulder	18	44	792.00
3	Labour only for boulder soling hand packed excluding consolidation	18	52.8	950.40
4	Collection of rubble for masonry (size 0.014 to 0.06 cum) other than black trap, basalt, organite	36	304	1,0944.00
5	Labour only for dry random rubble masonry	36	181	6516.00
6	Transportation of boulder, late rite, ruble pitching stone lead 4 km	54	100.40	5,421.60
7	Bush Planting work	20	50	1,000.00
8	Wedding and soil work (inter cultivation)	20	25	500.00
	Total			26,592.00
	or Say			26,600.00

6. Cost Norm for per Gabion Check Dam

S. No.	Particulars of Work	Unit	Qty.	Rate (Rs.)	Amount (Rs.)
1	Survey and alignment	LS			170.00
2	Excavation of earth work for foundation on both bank	Cum	28.78	26	748.28
3	Bund construction, collection of dry rubble	Cum	36.25	44	1,595.00
4	Foundation for pitching on banks	Cum	2.94	26	76.44
5	Pitching on both banks	Sqm	10.9	262	2,855.80
6	Transportation charges	Cum	39	145	5,655.00
7	Galvanized wire mash 15x15cm wire mash having 3 mm dia	Sqm	150	120	18,000.00
8	Transportation of wire mash upto 50 km	Item	1		200.00
	Survey during construction	LS			170.00
	Total				29,470.52
	or Say				29,500.00

Chapter**3****FISHERIES CONSERVATION AND
MANAGEMENT PLAN****3.1 INTRODUCTION**

The construction of dam across Parbati river shall lead to creation of reservoir resulting in submergence area of 3494.64 ha. The formation of reservoir would bring about significant changes in the riverine ecology, as the river will transform from a fast-flowing water system to a quiescent lacustrine environment. Such an alteration of the habitat would bring changes in physico-chemical and biotic characteristics of river water. The fish community will be one of most affected biotic communities due to habitat alteration in downstream as well as upstream section. The fishes in the riverine profile shows spatial and temporal variation depending on water depth, velocity of current, substrate, water discharge, physico-chemical conditions, etc. Among the biotic communities, certain species are able survive the transitional phase and adapt to the changed riverine habitat. There are other species amongst the biotic communities, which for various reasons are unable to acclimatize to the changed environment. Under such conditions some of the biotic communities may disappear in the early years of impoundment of water.

During the operation of the project, flow in Parbati river downstream of dam would be considerably reduced. It will lead to drying of riverbed and very little water will remain in the river restricted mainly in the central portion. The low flow in river will affect the aquatic habitat. The condition will be more critical during the lean season when volume of water is significantly reduced in the main river.

The conservation of fishes under such conditions is one of important task because they typically use different habitats along the river stretch for spawning, feeding, shelter and growth.

3.2 FISH COMPOSITION & STATUS

As per the secondary sources and field visit survey was used to collect information on fish diversity in the study area. According to information provided by locals 8 species are found in the study area. Most common *Cirrhinus mrigala*, *Bangana dero*, *Rita rita*, *Devario devario* and *Chanda nama*. Local fishermen use cast net, drag nets and gill net for harvesting of fish.

3.3 MITIGATION MEASURES

To mitigate the adverse impact of Parbati Major Irrigation project on the aquatic ecology of the area fishes the following measures shall be adopted to protect and preserve existing aquatic life:

- Development of reservoir fishery
- Releasing /ensuring minimum Environment flow in the river

3.4 FISHERY DEVELOPMENT

The proposed reservoir will present an opportunity to develop fishery in the area as fisheries are not well developed in the project area and large-scale fishing is not being practiced. The proposed reservoir will provide opportunity for commercial fishery development. Overall, this would improve the availability of fish for local population and may play an important role in the growth of local economy.

It is proposed that the reservoir and river stretch downstream and upstream of the proposed dam be stocked with fingerlings. It is proposed to implement supplementary stocking programme for the project area. The setting up of fish hatchery will be executed by the Department of Fisheries, Government of Madhya Pradesh and funds for the same shall be provided by the project proponent.

Environment considerations require that a portion of flow should be released downstream of the dam in different seasons. As discussed in EIA report in detail, about 99% of the river discharge is in monsoon period; total 75% dependable year virgin yield is computed as 924.09 MCM by NIH and after deducting upstream utilization of 197 MCM the net yield comes out to 726.66 MCM, out of which about 10 MCM is in non Monsoon period. The project is designed with live storage/proposed utilization of 162.62 MCM, and remaining water from monsoon contribution will be continuously discharged for downstream users. The quantum works out to be 554.04 MCM or almost 76% of the water available in pre-project conditions. Therefore, no additional environment flow is required to be released during monsoon period. In monsoon months' sufficient surplus water will be available in the river downstream of the dam.

However, during non-monsoon months, in order to provide adequate water to downstream users and for the survival of aquatic life in the river, entire available 10 MCM available in non-monsoon months shall be released as environmental flow.

3.5 COST ESTIMATES

The cost required for non-recurring expenditure i.e. developing of hatchery, office complex, laboratory etc. shall be **Rs. 21.10 lakh**. The dimension of the hatching nurseries and rearing unit and their approximate cost is given in **Table 3.1**. The total recurring expenditure for 3 years will be Rs.35.73 lakh. Thus, total cost for fish hatchery and farm will be **Rs. 91.00 lakh** after adding 10% escalation of cost.

Table 3.1: Estimated cost of setting of hatchery

S. No.	Particulars	Dimensions/ Rate (Rs.)	Amount (Rs. in lakh)
A.	Capital – Non-recurring Expenditure		
1.	Construction of Hatchery (Hatchery building (one concrete hall with provision of hatching troughs each with 4 trays) for production of fingerlings-1 No.	15mx6mx5m	7.30
2.	Nursery ponds -10 No.	5mx2mx1m	1.20
3.	Rearing Ponds -4 No.	10mx5mx2m	2.10
4.	Stocking Ponds -2 No.	30mx10mx3m	4.70
5.	Office Complex, with all infrastructure and separate provision for store and two laboratories and fish feed room etc. -1 No.	8m x6 m	3.80
6.	Watchmen hut -1 No.		1.00
7.	Other items like Dragnet, wide mouth earthen pots, bucket, bamboo patches etc.	Lump Sum	1.00
	Total - A		21.10
B.	Recurring Expenditure		
1.	Salaries (For 5 years)		
	Farm Manager -1 No.	25000/- per month	15.00
	Farm cum Reservoir Assistant-1 No.	20000/- per month	12.00
	Farm Attendants-2 Nos.	15000/- per month	18.00
	Chowkidar-1 No.	10000/- per month	6.00
2.	Fish seed (carried over seed with A V. Weight 25 gm each 10,000 nos.)	Lump Sum	0.25
3.	Fish food (rice bran oil cake) 1:1	Lump Sum	1.00
4.	Nursery and Rearing tanks management (Lime, natural fertilizer, wages nursery, etc.)	Lump Sum	1.80
5.	Brooders tank management (Lime, fertilizer, artificial food, prophylactic measures, netting and etc.)	Lump Sum	1.00
6.	Training and research	Lump Sum	1.50
7.	Maintenance for 5 years	50000/ year	1.50

S. No.	Particulars	Dimensions/ Rate (Rs.)	Amount (Rs. in lakh)
8.	Travel & transport – 5 years	50000/ year	1.50
9.	Contingency & miscellaneous expenditure	30000/ year for 5 years	1.50
	Total - B		61.05
TOTAL A+B			82.15
GRAND TOTAL (After adding 10% escalation of cost)			90.37 Say 91.00 lakhs

*In addition, in DPR, the following infrastructure has been suggested to be developed as a part of reservoir fisheries.

- Fish landing Centers (2 No.)
- Carrier boots (10 No.)
- Special boat (1 No.)
- Mini Trucks (4 No.)
- Truck with trolley (4 No.)
- Jeeps with trolley (4No.)
- Ice plant cum cold storage unit (1No.)
- Ice crushing machines

**Chapter
4****COMMAND AREA
DEVELOPMENT PLAN****4.1 GENERAL**

The Command Area Development Plan (CAD) must be implemented in a holistic manner with irrigation project so that irrigation potential created gets utilized with improvement in water use efficiency, increase in agricultural productivity and production and to bring sustainability in the irrigated agriculture in a participatory environment. The main objective is reducing the gap between irrigation potential created and that utilized. The programme aims at enhancing agricultural production and productivity in irrigated commands by judicious and equitable distribution of the available irrigation water with active involvement of farmers through participatory irrigation management (PIM).

4.2 COMMAND AREA

The proposed command of this Dam is situated on the left and right bank of river Parbati. On left flank, the command area covers the area of Tehsil Narsinghgarh, Pachore, Biaora of Rajgarh district covering area of 121 villages, whereas, on right flank command area covers the area of Tehsil Berasia of Bhopal district covering area of 11 villages. Thus, total area to be irrigated is 48,000 ha. covering 132 villages.

4.2.1 Climate of the Command Area

Climate is the principal aspect of the physical environment affecting agriculture. The characteristics of the soil - the essential medium for plant growth, are largely the product of present and past climates and the vegetation that has flourished in them. It consists of the elements like rainfall, temperature, length of growing session, sunlight, frost, fog conditions, hailstorms and winds. All these elements of weather have direct and indirect influence on the cropping pattern of a region. Consequently, the expression of agriculture, the cultivable area, the spatial and temporal cropping pattern and above all strategy of farm economy and its ecology depend on climatic conditions.

The year is divided into three main seasons i.e. (1) Summer Season (middle of March to middle of June), (2) Rainy Season (middle of June to October), (3) Winter Season (November to middle of March).

The climate of command area experiences mostly semi-arid condition, sub-tropical zone with long dry season. The south-west monsoon hit the months of June to October, maximum rainfall occurring between these months. The temperature in the command area start rising in the month of February and reaches maximum in the month of May and then decrease till January. May and January are the hottest and coldest months of the year respectively. In summer, through day temperature remains high, nights are colder and pleasant. The normal maximum temperature received during the month of May is 40.6° C and minimum during the month of January around 14°C. The Relative Humidity is generally low throughout the year, except during monsoon months when average relative humidity is close to 84% in the month of August. Summer are generally the dry months of the year with average relatively humidity as low as 19.5%. The wind speed is higher during the pre-monsoon period as compared to the post-monsoon period. The average maximum wind speed of 12 Kmph is observed during the month of July. The area receives maximum rainfall during south west monsoon i.e. between June and October, where about 96% of the annual average rainfall is received. Only 4% of the annual average rainfall occurs between November and May.

4.2.2 Irrigation Facilities in the Command Area

The proposed command area at present is not being facilitated by surface (gravity canal) or ground water source (tube wells) by state agency. Though some projects of small size exist in the command area. The prevalent practice of irrigation in some chunks in the command is by river pumping and harnessing underground water through private tube wells /wells.

4.2.3 Soil of the Command Area

The main functions of the soils, from agricultural point of view, are to give mechanical support to plants and store and supply the required nutrients and water for plant growth. These functions of the soil depend on its physical, chemical and biological characteristics. Among physical properties texture and structure are very important which determine such characteristics of soil as water absorbing and retentive capacity and movement of air and water. Chemical and biological properties determine its fertility status. The soil of the command area has already been described in Chapter 3 of EIA report.

4.3 PROPOSED CROPPING PATTERN IN COMMAND AREA

Based on the existing cropping pattern and for boosting the production per hectare emphasis has been laid on development of improved varieties of wheat, gram and oil seeds. The crop intensity has been adopted as 100% of

the CCA viewing the availability of water earmarked in the reservoir for irrigation purpose. The proposed cropping pattern is shown in **Table 4.1**.

Table 4.1: Proposed Cropping Pattern in Command Area

S No.	Type of Crop	Name of Crop	Area (Ha)	Intensity of Irrigation (% of CCA)	Method of Irrigation
1	Rabi	Wheat HYV	15000	31.25%	By Gravity Pressure/ Sprinkler
2	Rabi	Wheat OLV	8000	16.67%	By Gravity Pressure/ Sprinkler
3	Rabi	Gram	20000	41.66%	By Gravity Pressure/ Sprinkler
4	Rabi	Oil Seeds	5000	10.42%	By Gravity Pressure/ Sprinkler
	Total Rabi		48000	100%	
	Annual Irrigation		48000	100%	

4.4 PROPOSED WORKS STIPULATED UNDER CAD

The various components of works underlined in the revised guidelines for CAD&WM programme issued by the Government of India, MoWR, River Development and Ganga Rejuvenation SP Wing, New Delhi, dated 17th September, 2015 in conjunction with the guidelines issued by the MPWRD have been followed along with the cost norms suggested therein.

The command area development programme is an integrated action plan tailor made to accomplish the desired benefits due to irrigation through efficacy in the system with equitable distribution of water to the fields of stake holders on pro rata basis in the command of a specific project without degrading the command. It also includes such programme which are necessary for facilitating marketing of the produce. The other term Water Management connotes judicious and efficient management of the water resource created by participatory irrigation management by users by inculcating in them a sense of belongingness and ownership of the system created. The latter is achieved by formulating Water User's Association for management and water distribution below outlet among beneficiaries. Besides formation of WUA, Distributary and Project Committee shall be formulated to dwell on the matters touching and arising from the regulation, operation, and maintenance of the system under their administrative jurisdiction. All aspects need to be taken up in an integrated and coordinated manner to achieve the envisaged objectives of raising food grains production to meet the increasing need for growing population.

4.4.1 Topographic Survey in Command Area

Topographical survey is carried out departmentally by the technical staff in the total command area of the project for fixing alignment of distribution

network. The work of carrying out topographical and cadastral survey for command area including alignment of canal/ distributary/minors by using Total Station, DGPS etc., with minimum of 20 readings per ha to generate 30mx30m grid and 0.5m contour interval. The topography survey has been carried out as part of DPR preparation and its cost is considered in DPR cost.

4.4.2 On Farm Development Works

This comprises laying of distribution network and micro irrigation through sprinklers/drip irrigation. This is an important activity under the programme for efficient utilization of irrigation water. Again the activity is considered as part of the DPR and its cost is built into DPR cost.

4.4.3 Reclamation of Water Logged Areas

The command area is well dissected with streams of up to 6th order like Parbati river, Dosa river and many small unnamed nalas. Around 98% of the command area is below 8° slope. Thus, it is having good surface drainage and suitable outlets are available for discharging the surface flow resulting from rainfall excess. The problem of water logging is not encountered in the command area and there is no occasion for development of surface/sub-surface drainage for reclaiming the water-logged area. Besides, the soil of the command is neutral and the water for irrigation has low SAR and shall be applied in small depth as compared to the paddy, the salinity problem is not expected. At present no salinity problem is witnessed in the area.

4.4.4 Ayacut Roads and Communication Networks

A well-connected network of service roads is necessary to provide access to the fields of farmers, movement of bullock carts, tractors and for transport of seeds, fertilizers and agricultural produce to the markets besides, for movement of equipment and materials for maintenance and repairs by the O&M organization. Improved communications in and around command area are necessary for integrated development of the project. These may be achieved by

- Ayacut Roads, which are necessitated within the command for transportation of inputs to agriculture and produce.
- Link Roads, which connect command area to Ayacut roads and inter alia include works related to strengthening and reconstruction of existing roads to make them compatible with latest norms.
- Transmittal of messages from command area

This site is also connected with tehsil head quarter Narsinghgarh, situated at a distance of 25 km via and district head quarter Rajgarh, situated at a distance

of 60 km. The command area is well connected by NH 46 i.e. Bhopal road and NH 52 i.e. Rajgarh road as well as SH 14. The proposed command is having a very good network of CMGSY road, PMGSY road, PWD road, state highway and main WCR railway network running all through the command area between Biaora, Sehore and Guna railway station. However, the strengthening and reconstruction of some roads shall be needed for expeditious transport besides construction of new roads. In general, the following criteria shall be adopted for the development of road network:

- To provide all-weather road access within a distance of 1.5 Km from almost all parts of irrigated area
- To provide all-weather access to each village having population of 1500 and above.
- To include roads located outside the command area boundaries to the extent necessary and to link the network to market centres, railway stations, villages or administrative headquarters to have full impact on development of command area
- To limit the total provisions of roads to the minimum necessary subject to organization of the above criteria
- To provide minimum number of bridges or causeways necessary to comply with IRC requirements, which specify the acceptable interruptions to traffic appropriate to each category of road
- To allocate construction priorities in such a manner as to enable road works to be completed well in advance of the commencement of constructions of irrigation distribution network system.

All the Ayacut roads are classified as village roads and relevant IRC standards (IRC:64-1990), specifications and code of practice for village roads are adopted for design and construction of roads. Requirement of road construction has been assessed as part of DPR and its is part of the DPR cost.

4.4.5 Water Management through WUA

After creation of an irrigation resource in a region it is of paramount importance to chalk out a schedule of irrigation deliveries with details of the mode and duration of supplies drawn up for regulation of irrigation in the command area of an irrigation system.

In order to develop participatory irrigation management through stake holders or farmers' organization, the M.P Government promulgated "Madhya Pradesh Sinchai Prabandhan Me Kishan Ki Bhagidari Adhiniyam, 1999".

Under Chapter –II of the Act the power has been vested in the District Collector to cause notification to

- Delineation of water users' area and constitution of an association
- Delineation of Distributary area and constitution of the Distributary Committee
- Delineation of Project area and construction of project committee

The District Collector shall make arrangements for the election of President and members of the Managing Committee of the Water Users' Association by direct election. There shall be a Managing Committee for every Distributary Committee and a Project Committee called by its distinct name for every project area. All the Presidents, of the Distributary Committees in the project area so long as they hold such office, shall constitute the general body for the Project Committee.

The Project Committee shall have two nominated members, one of whom shall act as a coordinator between various departments and farmers' associations and who will be an Executive Engineer of Water Resources Department and second member will act as Advisor who will be from Agriculture or Ayacut Department.

The objects of the farmers' organization shall be to promote and secure distribution of water among its users; adequate maintenance of the irrigation system, efficient and economical organization of water to organization agricultural production, to protect the environment, and to ensure ecological balance by involving the farmers, inculcating a sense of ownership of the irrigation system in accordance with the water budget and the operational plan.

In view of the command area being three in zones, it is proposed to have Farmers Organization to comprise of three project committees. Further, there shall be 10 WUAs for command of each minor and each shall have four territorial constituencies.

One-time functional grant shall be payable to the elected/registered WUAs @ Rs. 500/ha. Thus, on this account, functional grant for 48,000 ha works out to be Rs. 240.00 lakh. The infrastructure grants for 10 WUAs @ Rs. 3 lakh works out to be Rs. 30 lakh.

4.4.6 Farmers Training, Monitoring and Evaluation

Training camps are organized in villages to educate the farmers on water management and crop management. This is important activity for educating the farmers to adopt modern technologies for achieving higher production with regulated water supply. Various activities viz. farmers training, monitoring, evaluation, demonstration on micro irrigation, mechanized land leveling, water use efficiency shall be covered under farmers training programme. The cost on this head @ Rs. 1000/ha works out to be Rs. 480.00 lakh.

4.5 PROPOSED BUDGET FOR CAD

Most of the activities under CAD form part of DPR and their cost budgeted therein. Budget for two additional components viz. grants to WUA and Farmers training is given below in **Table 4.2**.

Table 4.2: Budget for Additional Activities under CAD

S. No.	Item	Cost (Rs Lakh)
1	One-time financial grant to WUAs	240.00
2	One-time Infra-Structure grant to WUAs	30.00
3	Training, Monitoring and Evaluation	480.00
Grand Total		750.00

**Chapter
5****Rehabilitation and Resettlement Plan****5.1 INTRODUCTION**

The proposed Parbati Major Irrigation Project of Madhya Pradesh Irrigation Department, Government of Madhya Pradesh would be located on Parbati River in Narsingharh Tehsil & District Rajgarh in the state of Madhya Pradesh. The project proposes construction of a 23.40 m high dam across Parbati River near Fahetpur village to irrigate a total designed area of 48,000 ha of Culturable Command Area (CCA). The project is envisaged to have a live storage capacity of 162.62 MCM.

The construction and operation of Parbati Major Irrigation Project will result in a range of impacts to the social and human environments of the project area. One of major impact of such development requiring land acquisition is loss of land of local population in project area. Such impacts cannot be fully mitigated, however, the Rehabilitation and Resettlement Plan has been prepared to comprehensively address the issues arising out of land acquisition, assessment of land/house/asset coming under acquisition, estimation of extent of loss and compensation to be offered in line with The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCT_LARR). The R&R plan has been prepared keeping in view the following objectives:

- To compensate families whose land or other assets are acquired for the project.
- To create better living conditions and to improve the quality of life of Project Affected Families in particular and also of other people residing in the project area.
- To contribute to the overall development of the project affected areas.
- To create good rapport with the local people for long-term relationship and mutual benefits.

The plan has been prepared for the purpose of EIA study only. As per the provision of the RFCT_LARR, while initiating the process of land acquisition, SIA study will be carried out and final R&R plan prepared by the authorities from concerned districts.

5.2 LAND REQUIREMENT

For the development of Parbati Major Irrigation Project, land would be acquired for construction of project components and submergence area. Based on the

final project layout, the total land requirement for the project is about 3704.64 ha, of which, 3494.64 ha will be submergence area and 210 ha land will be required for canals. Submergence area will lead to permanent acquisition of land whereas, land required for canals will be of temporary basis. Out of the total 3494.64 ha land required for submergence area, 1204.07 ha is government revenue land and 2290.57 ha is private land. The total cost of the project is about Rs. 1815.54 Crores. The detail of land requirement for submergence area of Parbati Major Irrigation Project is given in **Table 5.1**.

Table 5.1: Details of Land Requirement

S. No.	Component	Area Required (ha)		
		Government Revenue Land (ha)	Private Land (ha)	Total Land
1	Submergence	1204.07	2290.57	3494.64

5.3 PROFILE OF PROJECT AFFECTED VILLAGES AND FAMILIES

A detailed survey was carried out for the land which will come under submergence along with the identification of families who will get affected due to loss of land and/or houses. Total 53 villages shall be affected due to acquisition of land for submergence of proposed Parbati Major Irrigation Project. Out of the 53 villages, 4 villages namely, Fatehpur, Sanka Jagir, Rawatkhera and Maukhera will be fully submerged, 14 villages will be partially submerged (i.e. partial acquisition of land and houses), Govt/private land will be acquired from 23 villages; however there is no displacement of families; only government land will be acquired from the remaining 12 villages i.e. there is no project affected family. (**Table 5.2**).

Table 5.2: Different Categories of Acquisition (Village wise)

S. No.	District Name	CD Block Name	Village Name	Submergence Status	Description of Acquisition
1	Rajgarh	Narsinghgarh	Badnagar	Partially	Land
2	Rajgarh	Narsinghgarh	Barodi	Partially	Land & Houses
3	Rajgarh	Narsinghgarh	Bherupura	Partially	Land & Houses
4	Rajgarh	Narsinghgarh	Fatehpur	Fully	Land & Houses
5	Rajgarh	Narsinghgarh	Gadupura	Partially	Land & Houses
6	Rajgarh	Narsinghgarh	Gahun Khedi Kalan	Partially	Land
7	Rajgarh	Narsinghgarh	Hiran Khedi	Partially	Land & Houses
8	Rajgarh	Narsinghgarh	Jhadkiya	Partially	Land & Houses
9	Rajgarh	Narsinghgarh	Kotra Kalan	Partially	Land
10	Rajgarh	Narsinghgarh	Lasudliya Haji	Partially	Land
11	Rajgarh	Narsinghgarh	Mangatpura	Partially	Land & Houses
12	Rajgarh	Narsinghgarh	Naihedi	Partially	Land
13	Rajgarh	Narsinghgarh	Partappura	Partially	Land & Houses
14	Rajgarh	Narsinghgarh	Pilu Khedi	Partially	Land
15	Rajgarh	Narsinghgarh	Sanka Jagir	Fully	Land & Houses
16	Rajgarh	Narsinghgarh	Senwas	Partially	Land

S. No.	District Name	CD Block Name	Village Name	Submergence Status	Description of Acquisition
17	Rajgarh	Narsinghgarh	Shivpura	Partially	Land
18	Rajgarh	Narsinghgarh	Shivpura	Partially	Land
19	Rajgarh	Narsinghgarh	Sundi	Partially	Land & Houses
20	Rajgarh	Narsinghgarh	Terni Dhakad	Partially	Land & Houses
21	Rajgarh	Narsinghgarh	Turkipura	Partially	Land
22	Sehore	Sehore	Accharohi	Partially	Land
23	Sehore	Sehore	Arniya Sultanpur	Partially	Land & Houses
24	Sehore	Sehore	Bairagarh Khuman	Partially	Govt. Land
25	Sehore	Sehore	Bamuliya	Partially	Land
26	Sehore	Sehore	Barri	Partially	Land
27	Sehore	Sehore	Bherupura	Partially	Land
28	Sehore	Sehore	Bishan Kheda	Partially	Land
29	Sehore	Sehore	Chandbad	Partially	Land & Houses
30	Sehore	Sehore	Charnal	Partially	Land
31	Sehore	Sehore	Chhatarpura	Partially	Land
32	Sehore	Sehore	Durgaon	Partially	Land & Houses
33	Sehore	Sehore	Gawa	Partially	Land
34	Sehore	Sehore	Ghat Palasi	Partially	Land
35	Sehore	Sehore	Hingoni	Partially	Land
36	Sehore	Sehore	Kadradbad	Partially	Govt. Land
37	Sehore	Sehore	Khandwa	Partially	Govt. Land
38	Sehore	Sehore	Magardi Kalan	Partially	Land
39	Sehore	Sehore	Magardi Khurd	Partially	Land & Houses
40	Sehore	Sehore	Mahuakheda	Fully	Land & Houses
41	Sehore	Sehore	Manpura	Partially	Land
42	Sehore	Sehore	Marhati	Partially	Land & Houses
43	Sehore	Sehore	Mukhtyar Nagar	Partially	Govt. Land
44	Sehore	Sehore	Padiyala	Partially	Land
45	Sehore	Sehore	Panbihar	Partially	Govt. Land
46	Sehore	Sehore	Raipur	Partially	Govt. Land
47	Sehore	Sehore	Rawan Kheda	Partially	Govt. Land
48	Sehore	Sehore	Rawat Kheda	Fully	Land & Houses
49	Sehore	Sehore	Sar Kheda	Partially	Govt. Land
50	Sehore	Sehore	Shyampur	Partially	Govt. Land
51	Shajapur	Kalapipal	Bapcha	Partially	Govt. Land
52	Shajapur	Kalapipal	Chakrana Bad	Partially	Govt. Land
53	Shajapur	Kalapipal	Ghat Khedi	Partially	Govt. Land

There are 1125 project affected families, who are identified as the families whose land and houses will be acquired for the project. A total of 1400 private houses will be submerged and 97 amenities (sarvajanik/ govt.) will also be submerged. Pratappura is the only village where apart from 1 sarvajanik building, no structure will be submerged.

A temple, "Sakha Shyam Ji" is also coming under submergence and project authorities shall ensure adequate measure to relocate the temple in consultation with local devotees and district administration. Village wise list of project affected families is given in **Table 5.3**.

Table 5.3: Village wise list of Project Affected Families

S. No.	District	Tehsil	Village	Submergence Status	Caste Category					Population				Houses				Amenities	
					HH	SC	ST	OBC	G	M	F	C	T	Kucha	Pakka	Pashu Hut	T	Sarvjanik	Govt
1	Rajgarh	Narsingharh	Fatehpur	Full	18	0	0	18	0	19	19	32	70	10	10	4	24	0	2
2	Rajgarh	Narsingharh	Sanka Jagir	Full	373	46	9	318	0	467	400	461	1328	218	162	49	429	13	12
3	Rajgarh	Narsingharh	Terni Dhakad	Partially	95	66	0	27	2	126	103	155	384	71	18	13	102	4	1
4	Rajgarh	Narsingharh	Sundi	Partially	50	37	0	13	0	61	54	95	210	51	35	13	99	1	5
5	Rajgarh	Narsingharh	Mangatpura	Partially	61	61	0	0	0	78	73	92	243	31	29	25	85	1	2
6	Rajgarh	Narsingharh	Barodi	Partially	10	2	0	8	0	16	13	22	51	8	3	2	13	1	3
7	Rajgarh	Narsingharh	Jhadkiya	Partially	32	5	0	25	2	49	34	45	128	19	18	3	40	1	4
8	Rajgarh	Narsingharh	Partappura	Partially	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
9	Rajgarh	Narsingharh	Bherupura	Partially	7	0	0	7	0	11	9	19	39	9	2	2	13	2	0
10	Rajgarh	Narsingharh	Hiran Khedi	Partially	9	0	0	9	0	15	13	28	56	7	5	2	14	1	0
11	Rajgarh	Narsingharh	Gadupura	Partially	2	0	0	2	0	4	3	5	12	2	0	0	2	0	5
1	Sehore	Shyampur	Rawat kheda	Full	128	30	1	3	94	154	137	199	490	73	84	7	164	3	6
2	Sehore	Shyampur	Chandbad	Partially	37	9	0	21	7	51	36	75	162	32	37	5	74	1	15
3	Sehore	Shyampur	Mahuakheda	Full	248	17	0	142	89	323	269	384	976	162	85	36	283	4	3
4	Sehore	Shyampur	Durgaon	Partially	30	0	0	26	4	41	31	82	154	16	7	1	24	1	0
5	Sehore	Shyampur	Magardi Khurd	Partially	7	0	0	7	0	13	9	16	38	5	3	1	9	1	0
6	Sehore	Shyampur	Marhati	Partially	11	6	3	2	0	17	13	26	56	9	3	3	15	1	1
7	Sehore	Shyampur	Arniya Sultanpur	Partially	7	2	0	5	0	9	7	17	33	6	2	2	10	0	2
					1125	281	13	633	198	1454	1223	1753	4430	729	503	168	1400	36	61

HH: Households, SC: Scheduled Caste, ST: Scheduled Tribe, OBC: Other Backward Class, G: General, M: Male, F: Female, C: Children, T: Total

5.4 RESETTLEMENT & REHABILITATION ACT AND POLICY

The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCT_LARR) has been made effective from January 01, 2014. As per Chapter 1, para 1(2) of the Act, the Act extends to whole of India except the State of Jammu and Kashmir. For the purpose of R&R awards, provisions/compensations as per the new Act have been adopted.

Following key definitions have been taken from RFCT_LARR, 2013:

- (a) "Administrator" means an officer appointed for the purpose of rehabilitation and resettlement of affected families under sub-section (l) of section 43;
- (b) "affected area" means such area as may be notified by the appropriate Government for the purposes of land acquisition;
- (c) "affected family" includes-
 - (i) a family whose land or other immovable property has been acquired;
 - (ii) a family which does not own any land but a member or members of such family may be agricultural labourers, tenants including any form of tenancy or holding of usufruct right, share-croppers or artisans or who may be working in the affected area for three years prior to the acquisition of the land, whose primary source of livelihood stand affected by the acquisition of land;
 - (iii) the Scheduled Tribes and other traditional forest dwellers who have lost any of their forest rights recognized under the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 due to acquisition of land;
 - (iv) family whose primary source of livelihood for three years prior to the acquisition of the land is dependent on forests or water bodies and includes gatherers of forest produce, hunters, fisher folk and boatmen and such livelihood is affected due to acquisition of land;
 - (v) a member of the family who has been assigned land by the State Government or the Central Government under any of its schemes and such land is under acquisition;
 - (vi) a family residing on any land in the urban areas for preceding three years or more prior to the acquisition of the land or whose primary source of livelihood for three years prior to the acquisition of the land is affected by the acquisition of such land;
- (d) "agricultural land" means land used for the purpose of--
 - (i) agriculture or horticulture;

- (ii) dairy farming, poultry farming, pisciculture, sericulture, seed farming breeding of livestock or nursery growing medicinal herbs;
 - (iii) raising of crops, trees, grass or garden produce; and
 - (iv) land used for the grazing of cattle;
- (e) "appropriate Government" means-
- (i) in relation to acquisition of land situated within the territory of, a State, the State Government;
 - (ii) in relation to acquisition of land situated within a Union territory (except Puducherry), the Central Government;
 - (iii) in relation to acquisition of land situated within the Union territory of Puducherry, the Government of Union territory of Puducherry;
 - (iv) in relation to acquisition of land for public purpose in more than one State, the Central Government, in consultation with the concerned State Governments or Union territories; and
 - (v) in relation to the acquisition of land for the purpose of the Union as may be specified by notification, the Central Government:
Provided that in respect of a public purpose in a District for an area not exceeding such as may be notified by the appropriate Government, the Collector of such District shall be deemed to be the appropriate Government;
- (f) "Authority" means the Land Acquisition and Rehabilitation and Resettlement Authority established under section 51;
- (g) "Collector" means the Collector of a revenue district, and includes a Deputy Commissioner and any officer specially designated by the appropriate Government to perform the functions of a Collector under this Act;
- (h) "Commissioner" means the Commissioner for Rehabilitation and Resettlement appointed under sub-section (1) of section 44;
- (i) "cost of acquisition" includes-
- (i) amount of compensation which includes solatium, any enhanced compensation ordered by the Land Acquisition and Rehabilitation and Resettlement Authority or the Court and interest payable thereon and any other amount determined as payable to the affected families by such Authority or Court;
 - (ii) demurrage to be paid for damages caused to the land and standing crops in the process of acquisition;
 - (iii) cost of acquisition of land and building for settlement of displaced or adversely affected families;
 - (iv) cost of development of infrastructure and amenities at the resettlement areas;
 - (v) cost of rehabilitation and resettlement as determined in accordance with the provisions of this Act;

- (vi) administrative cost,-
 - (A) for acquisition of land, including both in the project site and out of project area lands, not exceeding such percentage of the cost of compensation as may be specified by the appropriate Government;
 - (B) for rehabilitation and resettlement of the owners of the land and other affected families whose land has been acquired or proposed to be acquired or other families affected by such acquisition;
- (vii) cost of undertaking 'Social Impact Assessment study';
- (j) "company" means-
 - (i) a company as defined in section 3 of the Companies Act, 1956. Other than a Government company;
 - (ii) a society registered under the Societies Registration Act, 1860 or under any corresponding law for the time being in force in a State;
- (k) "displaced family" means any family, who on account of acquisition of land has to be relocated and resettled from the affected area to the resettlement area;
- (l) "entitled to act" in relation to a person, shall be deemed to include the following persons, namely:
 - (i) trustees for other persons beneficially interested with reference to any such case, and that to the same extent as the person beneficially interested could have acted if free from disability;
 - (ii) the guardians of minors and the committees or managers of lunatics to the same extent as the minors, lunatics or other persons of unsound mind themselves, if free from disability, could have acted:

Provided that the provisions of Order XXXII of the First Schedule to the Code of Civil Procedure, 1908 shall, mutatis mutandis, apply in the case of persons interested appearing before a Collector or Authority by a next friend, or by a guardian for the case, in proceedings under this Act:
- (m) "family" includes a person, his or her spouse, minor children, minor brothers and minor sister's dependent on him:

Provided that widows, divorcees and women deserted by families shall be considered separate families:

Explanation-An adult of either gender with or without spouse or children or dependents shall be considered as a separate family for the purposes of this Act.
- (n) "holding of land" means the total land held by a person as an owner, occupant or tenant or otherwise;
- (o) "infrastructure project" shall include any one or more of the items specified in clause (b) of sub-section (/) of section 2;

- (p) "land" includes benefits to arise out of land, and things attached to the earth or permanently fastened to anything attached to the earth;
- (q) "landless" means such persons or class of persons who may be-
 - (i) considered or specified as such under any State law for the time being in force; or
 - (ii) in a case of landless not being specified under sub-clause (i), as may be specified by the appropriate Government;
- (r) "land owner" includes any person-
 - (i) whose name is recorded as the owner of the land or building or part thereof, in the records of the authority concerned; or
 - (ii) any person who is granted forest rights under the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 or under any other law for the time being in force; or
 - (iii) who is entitled to be granted Patta rights on the land under any law of the State including assigned lands: or
 - (iv) any person who has been declared as such by an order of the court or Authority;
- (s) "local authority" includes a town planning authority (by whatever name called) set up under any law for the time being in force, a Panchayat as defined in article 243 and a Municipality as defined in article 243P, of the Constitution;
- (t) "marginal farmer" means a cultivator with an un-irrigated land holding up to one hectare or irrigated land holding up to one-half hectare;
- (u) "market value" means the value of land determined in accordance with section 26;
- (v) "notification" means a notification published in the Gazette of India or, as the case may be, the Gazette of a State and the expression "notify" shall be construed accordingly;
- (w) "patta" shall have the same meaning as assigned to it in the relevant Central or State Acts or rules or regulations made thereunder;
- (x) "person interested" means-
 - (i) all persons claiming an interest in compensation to be made on account of the acquisition of land under this Act;
 - (ii) the Scheduled Tribes and other traditional forest dwellers, who have lost any forest rights recognized under the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006;
 - (iii) a person interested in an easement affecting the land;
 - (iv) persons having tenancy rights under the relevant State laws including share-croppers by whatever name they may be called; and
 - (v) any person whose primary source of livelihood is likely to be adversely affected;

- (y) "prescribed" means prescribed by rules made under this Act;
- (z) "project" means a project for which land is being acquired, irrespective of the number of persons affected;
- (za) "public purpose" means the activities specified under sub-section (l) of section 2;
- (zb) "Requiring Body" means a company, a body corporate, an institution, or any other organisation or person for whom land is to be acquired by the appropriate Government, and includes the appropriate Government, if the acquisition of land is for such Government either for its own use or for subsequent transfer of such land is for public purpose to a company, body corporate, an institution, or any other organisation, as the case may be, under lease, license or through any other mode of transfer of land;
- (zc) "Resettlement Area" means an area where the affected families who have been displaced as a result of land acquisition are resettled by the appropriate Government;
- (zd) "Scheduled Areas, means the Scheduled Areas as defined in section 2 of the Provisions of the Panchayats (Extension to the Scheduled Areas) Act, 1996;
- (ze) "small farmer" means a cultivator with an un-irrigated land holding up to two hectares or with an irrigated land holding up to one hectare, but more than the holding of a marginal farmer.

5.5 R&R PACKAGE FOR PROJECT AFFECTED FAMILIES

Rehabilitation and Resettlement benefits to be given to the project affected families have been discussed in Schedule I, II and III of RFCT_LARR. Applicability of the provision of the Act for R&R benefits is briefly discussed below:

5.5.1 Compensation for Land Owners

The following components shall constitute the minimum compensation package to be given to those whose land is acquired and to tenants referred to in clause (c) of Section 3 in a proportion to be decided by the appropriate Government.

S. No.	Component of compensation package in respect of land acquired under the Act	Manner of determination of value
1	Market value of land	To be determined as provided under section 26.
2	Factor by which the market value is to be multiplied in the case of rural areas	1.00 (one) to 2.00 (Two) based on the distance of project from urban area, as may be notified by the appropriate Government
3	Factor by which the market value is to be multiplied in the	1 (One)

S. No.	Component of compensation package in respect of land acquired under the Act	Manner of determination of value
	case of urban areas	
4	Value of assets attached to land or building	To be determined as provided under section 29
5	Solatum	Equivalent to one hundred per cent of the market value of land mentioned against serial number 1 multiplied by the factor specified against serial number 2 for rural areas plus value of assets attached to land or building against serial number 4 under column (2)
6	Final award in rural areas	Market value of land mentioned against serial number 1 multiplied by the factor specified against serial number 2 plus value of assets attached to land or building mentioned against serial number 4 under column (2) plus solatium mentioned against serial number 5 under column (2).
7	Final award in urban areas	Market value of land mentioned against serial number 1 multiplied by the factor specified against serial number 3 plus value of assets attached to land or building mentioned against serial number 4 under column (2) plus solatium mentioned against serial number 5 under column (2).
8	Other component, if any, to be included	

5.5.2 Elements of Rehabilitation and Resettlement

In addition to compensation for land, the second schedule provides following elements of rehabilitation and resettlement entitlements for all the affected families (both land owners and families whose livelihood is primarily dependent on land acquired).

S. No.	Elements of Rehabilitation and Resettlement Entitlements	Entitlement/ provision
1.	Provisions of housing units in case of displacement	(1) If a house is lost in rural areas, a constructed house shall be provided as per the Indira Awas Yojana specifications. If a house is lost in urban areas, a constructed house shall be provided, which will be not less than 50 sq mtrs in plinth area. (2) The benefits listed above shall also be extended to any affected family which is without homestead land and which has been residing in

S. No.	Elements of Rehabilitation and Resettlement Entitlements	Entitlement/ provision
		the area continuously for a period of not less than three years preceding the date of notification of the affected area and which has been involuntarily displaced from such area: Provided that any such family in urban areas which opts not to take the house offered, shall get a one-time financial assistance for house construction, which shall not be less than one lakh fifty thousand rupees: Provided further that if any affected family in rural areas so prefers, the equivalent cost of the house may be offered in lieu of the constructed house: Provided also that no family affected by acquisition shall be given more than one house under the provisions of this Act. Explanation- The houses in urban areas may, if necessary, be provided in multi-storied building complexes.
2.	Land for Land	In the case of irrigation project, as far as possible and in lieu of compensation to be paid for the land acquired, each affected family owning agricultural land in the affected area and whose land has been acquired or lost, or who has, as a consequence of the acquisition or loss of land, been reduced to the status of a marginal farmer or landless, shall be allotted, in the name of each person included in the records of rights with regard to the affected family, a minimum of one acre of land in the command area of the project for which the land is acquired: <i>Provided that in every project those persons losing land and belonging to the Scheduled Castes or the Scheduled Tribes will be provided land equivalent to land acquired or two and a one-half acres, whichever is lower.</i>
3	Offer for Developed Land	In case the land is acquired for urbanization purposes, twenty per cent of the developed land will be reserved and offered to land owning project affected families, in proportion to the area of their land acquired and at a price equal to the cost of acquisition and the cost of development. Provided that in case the land owning project

S. No.	Elements of Rehabilitation and Resettlement Entitlements	Entitlement/ provision
		affected family wishes to avail of this offer, an equivalent amount will be deducted from the land acquisition compensation package payable to it.
4	Choice of Annuity or Employment	The appropriate Government shall ensure that the affected families are provided with the following options: (a) Where jobs are created through the project, after providing suitable training and skill development in the required field, make provision for employment at a rate not lower than the minimum wages provided for in any other law for the time being in force, to at least one member per affected family in the project or arrange for a job in such other project as may be required; or (b) One-time payment of 5 lakh rupees per affected family; or (c) Annuity policies that shall pay not less than 2000 rupees per month per family for 20 years, with appropriate indexation to the consumer price index for agricultural labourers
5	Subsistence grant for displaced families for a period of one year	Each affected family which is displaced from the land acquired shall be given a monthly subsistence allowance equivalent to 3000 rupees per month for a period of one year from the date of award. In addition to this amount, the schedule castes and the scheduled tribes displaced from scheduled areas shall receive an amount equivalent to 50000 rupees. In cases of displacement from the scheduled areas, as far as possible, the affected families shall be relocated in a similar ecological zone, so as to preserve the economic opportunities, language, culture and community life of the tribal communities.
6	Transportation cost for displaced families	Each affected family which is displaced shall get a one-time financial assistance of 50000 rupees as transportation cost for shifting of the family, building materials, belongings and cattle.
7	Cattle shed / Petty shops cost	Each affected family having cattle or having a petty shop shall get one time financial assistance of such amount as the appropriate Government may, by notification, specify subject to a minimum of 25000 rupees for construction of cattle shed or petty shop as the case may be.

S. No.	Elements of Rehabilitation and Resettlement Entitlements	Entitlement/ provision
8	One time grant to artisan, small traders and certain others	Each affected family of an artisan, small traders or self employed person or an affected family which owned non agricultural land or commercial, industrial or institutional structure in the affected area, and which has been involuntarily displaced from the affected area due to land acquisition , shall get one time assistance of such amount as the appropriate Government may, by notification, specify subject to a minimum of 25000 rupees
9	Fishing rights	In cases of irrigation or hydel projects, the affected families may be allowed fishing rights in the reservoirs, in such manner as may be prescribed by the appropriate Government
10	One time Resettlement Allowance	<i>Each affected family shall be given a onetime "Resettlement Allowance" of 50000 rupees only</i>
11	Stamp duty and registration fee	<i>(1) The stamp duty and other fees payable for registration of the land or house allotted to the affected families shall be borne by the Requiring Body.</i> (2) The land for house allotted to the affected families shall be free from all encumbrances. (3) The land or house allotted may be in the joint names of wife and husband of the affected family.

Keeping in view the above provisions, R&R Package has been developed for Project Affected Families; and same is given at **Table 5.4**.

Table 5.4: Rehabilitation & Resettlement package for affected families

Clause No. as per II Schedule	Provision as per " LA, R&R Act, 2013"	No. of Eligible Nuclear Families	Rate as per " LA, R&R Act, 2013"	Cost (for eligible families) as per the ACT
4	Choice of Annuity or Employment			
	The appropriate Government shall ensure that the affected families are provided with the following options:			
	(a) where jobs are created through the project, after providing suitable training and skill development in the required field, make provision for employment at a rate not lower than the minimum wages provided for in any other law for			

Clause No. as per II Schedule	Provision as per " LA, R&R Act, 2013"	No. of Eligible Nuclear Families	Rate as per " LA, R&R Act, 2013"	Cost (for eligible families) as per the ACT
	the time being in force, to at least one member per affected family in the project or arrange for a job in such other project as may be required; or			
	(b) one time payment of five lakhs rupees per affected family; or	1125	Rs 500,000.00 one time payment per family (option B)	56,25,00,000.00
	(c) annuity policies that shall pay not less than two thousand rupees per month per family for twenty years, with appropriate indexation to the Consumer Price Index for Agricultural Labourers.			
5	Subsistence grant for Displaced Families for a period of one year			
	Each affected family which is displaced from the land acquired shall be given a monthly subsistence allowance equivalent to three thousand rupees per month for a period of one year from the date of award.	1125	Rs. 36,000.00 per family	4,05,00,000.00
6	Transportation cost for displaced families			
	Each affected family which is displaced shall get a one-time financial assistance of fifty thousand rupees as transportation cost for shifting of the family, building materials, belongings and cattle.	1125	Rs. 50,000.00 per family	5,62,50,000.00
7	Cattle shed/petty shops cost			
	Each affected family having cattle or having a petty shop shall get one-time financial assistance of such amount as the appropriate Government may, by notification, specify subject to a minimum of twenty-five thousand rupees for construction of cattle shed or petty shop as the case may be.	168	Rs. 25,000.00 per family	42,00,000.00
10	One-time Resettlement Allowance			
	Each affected family shall be given a onetime "Resettlement	1125	Rs. 50,000.00	5,62,50,000.00

Clause No. as per II Schedule	Provision as per " LA, R&R Act, 2013"	No. of Eligible Nuclear Families	Rate as per " LA, R&R Act, 2013"	Cost (for eligible families) as per the ACT
	Allowance" of 50000 rupees only		per family	
11	Stamp Duty and registration fee			
	The stamp duty and other fees payable for registration of the land allotted to the affected families shall be borne by the Requiring Body (approximately Rs. 50,000.00 per family)	1125	Rs. 50,000.00	5,62,50,000.00
Total				77,59,50,000.00

***Cost of land as per market value including assets and solatium is in addition to the above budget and will be assessed by Collector**

5.5.3 Resettlement of Displaced Families

As 1125 families will be involuntarily displaced, a plan needs to be prepared to resettle these families in a new village/colony with adequate infrastructure. For resettlement of populations, infrastructural facilities and basic minimum amenities are to be provided at the cost of the Requisitioning Authority to ensure that the resettled population in the new village or colony can secure for themselves a reasonable standard of community life and can attempt to minimise the trauma involved in displacement. A reasonably habitable and planned settlement would have, as a minimum, the following facilities and resources, as appropriate:

1. Roads within the resettled villages and an all-weather road link to the nearest pucca road, passages and easement rights for all the resettled families be adequately arranged.
2. Proper drainage and sanitation
3. Assured sources of safe drinking water
4. Provision of drinking water for cattle
5. Grazing land
6. Two Fair Price Shops
7. One Panchayat Ghar
8. Village level post office with facilities for opening of saving accounts
9. Appropriate seed-cum-fertilizer storage facility
10. Irrigation facilities for the agricultural land allocated to the families from the project
11. Public transport facilities
12. Burial or cremation ground
13. Electric connections for households and common lighting preferably solar
14. Anganwadi's providing child and mother supplemental nutritional services
15. Primary School

16. Sub-health centre within two kilometres range
17. Primary Health Centre
18. Playground for children
19. One community centre
20. Two Places of worship and chowpal/tree platform

Approximate additional budget of **Rs. 20 crore** needs to be kept for the infrastructure facilities.

5.6 INSTITUTIONAL ARRANGEMENT FOR R & R IMPLEMENTATION

RFCT_LARR, 2013 defines the process of implementation of R&R Plan and institutional arrangement in Chapter VI. It is proposed to follow the Act for implementation of R&R plan as similar procedure is adopted in other projects in state. The procedure covers the following:

1. Where the appropriate Government is satisfied that there is likely to be involuntary displacement of persons due to acquisition of land, then, the State Government shall by notification appoint in respect of that project, an officer not below the rank of Joint Collector or Additional Collector or Deputy Collector or equivalent official of Revenue Department to be the Administrator for Rehabilitation and Resettlement. The Administrator shall, with a view to enable him to function efficiently and to meet the special time-frame, be provided with such powers, duties and responsibilities as may be prescribed by the appropriate Government and provided with office infrastructure and be assisted by such officers and employees who shall be subordinate to him as the appropriate Government may decide. Subject to the superintendence, directions and control of the appropriate Government and the Commissioner for Rehabilitation and Resettlement, the formulation, execution and monitoring of the Rehabilitation and Resettlement Scheme shall vest in the Administrator.
2. The state government shall appoint an officer of the rank of Commissioner or Secretary of that Government for Rehabilitation and Resettlement of affected families under this Act, to be called the Commissioner of Rehabilitation and Resettlement. The Commissioner shall be responsible for supervising the formulation of rehabilitation and resettlement schemes or plans and proper implementation of such schemes or plans. The Commissioner shall also be responsible for the post-implementation social audit in consultation with the Gram Sabha in rural areas and municipality in urban areas.

3. Where land proposed to be acquired is equal to or more than one hundred acres, the appropriate Government shall constitute a Committee under the chairmanship of the Collector to be called the Rehabilitation and Resettlement Committee, to monitor and review the progress of implementation of the Rehabilitation and Resettlement scheme and to carry out post-implementation social audits in consultation with the Gram Sabha in rural areas and municipality in urban areas. The Rehabilitation and Resettlement Committee shall include, apart from officers of the appropriate Government, the following members, namely: -
- a) representative of women residing in the affected area;
 - b) representative each of the Scheduled Castes and the Scheduled Tribes residing in the affected area
 - c) representative of a voluntary organisation working in the area
 - d) representative of a nationalized bank
 - e) Land Acquisition Officer of the project;
 - f) Chairpersons of the panchayats or municipalities located in the affected area or their nominees
 - g) Chairperson of the District Planning Committee or his nominee;
 - h) Member of Parliament and Member of the Legislative Assembly of the concerned area or their nominees
 - i) representative of the Requiring Body
 - j) Administrator for Rehabilitation and Resettlement as the Member-Convener

5.7 MONITORING & EVALUATION

Monitoring and Evaluation (M&E) must be simultaneous with the implementation of Rehabilitation Plan. It requires specialized skill for application of general project monitoring procedures to the process of land acquisition and rehabilitation. Conventional monitoring, normally carried out by the Government machinery, often misses focus on certain vital aspects and does not identify certain shortcomings, which may otherwise prove very important. While the conventional government monitoring will continue, an external M&E agency will also be engaged to help in proper monitoring of land acquisition and rehabilitation plans. The main purpose of involving such an agency is to bring the problems and difficulties faced by the PAFs to the notice of Administrator R&R on a regular basis for their redress as well as to help in formulating and undertaking corrective measures. The external Monitoring and Evaluation (M&E) agency can submit half yearly reports on the progress of implementing Rehabilitation Master Plan (RMP) along with suggestions and corrective measures required for improvement in the implementation of Rehabilitation Plan.

For Land Acquisition and rehabilitation plan, M&E system will consist of:

- Administrative monitoring;
- Socio-economic performance and
- Impact evaluation.

Administrative monitoring will be conventionally carried out by the Land Acquisition Officer of project authorities, Resettlement Commissioner and other concerned government agencies/departments. The focus will be on physical (like number of land holders affected, area identified for allotment to Village Level Committee, etc.) and financial (like compensation paid, payment to M&E agency, office establishment cost, etc.) parameters. The socio-economic monitoring, which will be carried out concurrently is the crux of M&E exercise to provide interim measures based on the field level situations. This along-with impact evaluation at the end of plan period will be carried out by the M&E agency. While covering the affected community, monitoring will focus on the vulnerable groups like women, physically handicapped, etc. The household information collected through the socio-economic survey will form the benchmarks for comparison. However, these benchmarks will be supplemented in order to create new reference points against performance, effects and objectives.

5.7.1 Monitoring and Evaluation Guidelines

Monitoring of the progress of R&R is important because of the sensitivity of these issues. The objective of monitoring is to assess the progress of resettlement activity, to identify difficulties, ascertain problem areas, and provide indication for the need of calling attention to some specific issues at an early stage. Following tasks have to be performed by the group at different stages of the project:

- Establish baseline information on individual PAFs and their pre-project standards of living, health conditions, nutritional patterns, etc. This should precede the implementation of R&R package in general after the completion of the project.
- The planning of the monitoring studies could cover disbursement of compensation and grants.
- After the completion of the project, a few sensitive indicators using 100% survey techniques should be undertaken mainly to understand how effective the R&R plan and project economic development package has been in reality.

5.7.2 Post-Project Monitoring

It is suggested that the monitoring be conducted by an independent agency not connected with the project. Therefore, an independent consultant having experience in R&R studies in similar areas, i.e. North-eastern states and not connected with the project can be appointed for monitoring the project.

5.7.3 Participation of PAFs

Involvement of affected communities in planning and implementation of rehabilitation programmes according to their felt needs and socio-economic conditions is of vital importance. To obtain co-operation, participation and feedback, PAFs need to be systematically informed and consulted during preparation and implementation of R&R plan about their options and rights. In the proposed project, co-operation and participation of PAFs in this process could be ensured through their involvement in each of the following stages.

As a part of participatory planning, community meetings should be held on a routine basis to explain about the project and the benefits of the project. Direct communication with the PAFs will negate the politicization of the R&R Process. The communication with the PAFs can be through the Village Level Committee.

The Consultant/Expert Agency will review the rehabilitation and resettlement programme every year till the completion of the project. A total provision of **Rs. 2.00 Crore** has been kept in the cost estimate for this purpose.

5.8 FINANCIAL PACKAGE

The summary of the financial requirement for implementation of the Rehabilitation and Resettlement plan and Economic Development Package is **Rs. 99.595 Crore** as per the summary given below at **Table 5.5**.

Table 5.5: Summary of Budgetary Estimates

S. No.	R&R Components	Cost (Rs in crore)
1	Rehabilitation Grant	77.595
2	Infrastructure in Resettlement Area	20.000
3	Monitoring and Evaluation	2.000
	Total	99.595

***Cost of land as per market value including assets and solatium is in addition to the above budget and will be assessed by Collector**

**Chapter
6****LANDSCAPING, RESTORATION &
GREEN BELT DEVELOPMENT PLAN****6.1 INTRODUCTION**

The proposed Parbati Major Irrigation Project on River Parbati would require construction of various project components and infrastructural facilities such as Dam, Open Canal, Distribution chambers and residential 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.

6.2 LANDSCAPING AND RESTORATION OF CONSTRUCTION AREAS

The proposed project would involve construction of dam, canal, water distribution network, 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 disturbed 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. 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.

6.2.1 Restoration/ Landscaping of Disturbed Areas/Sites

The construction activities like roads, quarry sites, colonies, batching plants, etc. will change the existing land use/ land cover in the region. After completion of the construction work, these areas are required to be restored to their original condition. Various engineering and biological measures have been suggested for the restoration of proposed project affected areas.

Setting up of infrastructure for construction including colonies for labor will lead to clearing of the vegetation and forests. The forest land may also be cleared for the movement of heavy equipments required for different project related activities which would lead to the fragmentation and destruction of the habitats at these sites.

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

- On completion of construction area will be restored by proper leveling
- Retaining walls will be built to avoid the landslides and slips. Slopes will be covered with geotextiles.
- The open area will be covered with the vegetation. Ornamental plants and trees will be planted in rows along the roads and lanes.
- Parks and play grounds for children would be developed on the restored land.

The estimated cost of restoration of construction is **33.00 lakh** (see Table 6.1).

Table 6.1: Cost estimates for bio-engineering measures for construction areas

S. No.	Item of work	Quantity	Rate/ unit (in Rs.)	Amount Rs. (In lakh)
1	Leveling of the area	10 ha	50000/ha	5.00
2	Covering the slopes with geo-textiles like coir, etc.	5000 sq m	500/sq.m	25.00
3	Grass seeding	Lump sum		3.00
Total				33.00

6.3 GREEN BELT DEVELOPMENT

Green belt development will comprise of plantations at various places like alongside roads and around the periphery of reservoir rim. The green belt is proposed to be developed within the project area around reservoir periphery, along the network of approach roads, residential areas and other working areas restored. The strategy worked out for development of green belt consists of the following:

- Generally local/indigenous fast-growing trees shrubs should be planted.
- The species should form a dense crown cover.
- The trees should be protected by plantation of non-palatable shrub species to avoid browsing by animals.
- Placement of tree guards should be provided to save avenue plantation.
- Against biotic interference, thorn fencing around the plantation and circular trench around the planting pit should be followed.

Before development of green belt in surrounding of project area extensive

survey shall be undertaken to observe the vegetation type. Soil characteristics were also kept in mind. Based on the survey and environmental conditions suitable plant species have been proposed for green belt development. The supply of seedlings for green belt development shall be maintained through the forest department nursery.

It is proposed that extensive plantation in land around the periphery of dam and reservoir will be taken up besides road side plantation along approach roads. In areas, wherever private land falls along the periphery of the project area the plantation will be done by distributing saplings free of cost to villagers, so that they are motivated to take up plantation in their land.

A list of indigenous trees found suitable for development of green belt around the project area is given in **Table 6.2**.

Table 6.2: Plant species suggested for landscaping for reservoir periphery and other construction sites

Family	Name of Species	Common Name
Anacardiaceae	<i>Lannea grandis</i>	Kankar/Moyan
Anacardiaceae	<i>Mangifera indica</i>	Aam
Combretaceae	<i>Anogeissus latifolia</i>	Dhoo/Dhawda
Combretaceae	<i>Terminalia arjuna</i>	Koha/ Arjun
Combretaceae	<i>Terminalia bellirica</i>	Behda
Combretaceae	<i>Terminalia tomentosa</i>	Sajad
Fabaceae	<i>Acacia catechu</i>	Khair
Fabaceae	<i>Acacia nilotica</i>	Babul
Fabaceae	<i>Ailanthus excelsa</i>	Meharukh
Fabaceae	<i>Cassia fistula</i>	Amaltas
Fabaceae	<i>Dalbergia sissoo</i>	Sissoo
Fabaceae	<i>Leucaena leucocephala</i>	Safed babool
Fabaceae	<i>Prosopis juliflora</i>	Kikar
Lamiaceae	<i>Tectona grandis</i>	Sagon
Meliaceae	<i>Azadirachta indica</i>	Neem
Myrtaceae	<i>Syzygium cumini</i>	Jamun
Phyllanthaceae	<i>Phyllanthus emblica</i>	Anola
Rutaceae	<i>Aegle marmelos</i>	Bel

For Roadside/Avenue Plantation

S.No.	Family	Name of Species	Common Name
1	Anacardiaceae	<i>Lannea grandis</i>	Kankar/Moyan
2	Anacardiaceae	<i>Mangifera indica</i>	Aam
3	Fabaceae	<i>Acacia catechu</i>	Khair
4	Fabaceae	<i>Acacia nilotica</i>	Babul
5	Fabaceae	<i>Albizia lebbek</i>	Kala Siras
6	Fabaceae	<i>Albizia procera</i>	Safed Siris
7	Fabaceae	<i>Cassia fistula</i>	Amaltas

S.No.	Family	Name of Species	Common Name
8	Fabaceae	<i>Dalbergia sissoo</i>	Sissoo
9	Fabaceae	<i>Delonix regia</i>	Gulmohar
10	Fabaceae	<i>Leucaena leucocephala</i>	Safed babool
11	Fabaceae	<i>Tamarindus indica</i>	Imli
12	Lamiaceae	<i>Tectona grandis</i>	Sagon
13	Meliaceae	<i>Azadirachta indica</i>	Neem
14	Meliaceae	<i>Toona ciliata</i>	Tun
15	Moraceae	<i>Morus alba</i>	Sehtoot
16	Myrtaceae	<i>Corymbia citriodora</i>	Nilgiri
17	Myrtaceae	<i>Syzygium cumini</i>	Jamun
18	Rutaceae	<i>Aegle marmelos</i>	Bel

Table 6.3: Cost estimates for Green Belt Development

S. No.	Green Belt Development	Cost (Rs. in lakhs)
1	Green belt around dam, powerhouse and Reservoir periphery	30.00
2	Roadside plantation	15.00
	Total	45.00

6.4 PLAN IMPLEMENTATION

The landscaping and restoration plan will be implemented with help of landscaping experts and in consultation with State Horticulture Department as well as concerned Forest Division and the coordination and funding will be provided by the project proponent for successful implementation of this plan.

6.5 COST ESTIMATES

The estimated cost for the restoration works, landscaping of working areas, road side plantations, and creation of green belt around reservoir and colonies and working sites would be **Rs. 78.00 lakh (Table 6.4)**.

Table 6.4: Total budget for landscaping of project components

S. No.	Item	Amount (Rs. In lakh)
1.	Cost estimates for bio-engineering measures for construction areas	33.00
2.	Green belt Development	45.00
	TOTAL	78.00

Chapter 7

RESERVOIR RIM TREATMENT

7.1 INTRODUCTION

The Parbati Major Irrigation project is proposed on the Parbati River and total extent of the reservoir is about 3494.64 ha. The total gross storage volume at FRL (El. 445.45) is 172.54 MCM. During operation reservoir level would fluctuate between FRL and MDDL level, and in addition at FRL the water movement due to waves induced by wind. It makes the slopes along the reservoir prone to slips and minor slides due to repeated water level fluctuation and charging of slips and soil erosion along the reservoir periphery. Therefore, the susceptible slopes along the reservoir would require treatment to avoid any slope failure.

7.2 RESERVOIR AREA

Within the submergence area up to tail end of reservoir soil was classified under Typic Haplusterts class described as Deep, moderately well drained, calcareous, clayey soils on very gently sloping plain with valleys (severely dissected) with moderate erosion. Most of the area along the reservoir is pre dominantly categorized under agriculture/ fallow land and settlements. (Figures 7.1, 7.2 and 7.3).



Figure 7.1: View of right and left bank of Parbati river



Figure 7.2: View of right and left bank of Parbati river



Figure 7.3: Left Bank view of proposed reservoir area

7.3 NEED FOR RESERVOIR RIM TREATMENT

The reservoir would lead to submergence of 3494.64 ha of land at FRL. Two types of factors e.g. internal factors and external factors are responsible for sliding in such water spread conditions. The reduction in the shearing strength of the rocks, the water content of the rock masses, change in their mineralogical composition and meteorological character, structural features and the state of stress are some of the important internal factors. External factors include mainly vibrations either naturally by an earthquake or artificial

due to heavy traffic and rock blasting. The rock mass which had not before experienced the flow of river shall be subjected to hydraulic conditions apart from many other direct and indirect factors responsible for instability of land masses. The water level of the reservoir will fluctuate during operational period. However, the variation is not very frequent and does not last over a considerable long period/duration, there are little chances of sudden draw down of water in the reservoir, yet due to presence of loose material at the banks of reservoir sliding cannot be ruled out.

7.4 TREATMENT MEASURES

A combination of engineering as well as biological measures have been suggested for slope stability and control of landslides in the reservoir area. The slides observed in the reservoir area and the places where mass movement has been noted can be treated by biological and engineering methods depending upon the cause of land slips and soil erosion and its disposition with respect to the reservoir bed level. These would be controlled by engineering means by constructing retaining walls, wire bolsters along with wire mesh treatment in the submergence zone in combination with biological measures such as planting of shrubs and spraying of seeds, brush layering in the non-submergence zone i.e. above the FRL. Various proposed measures both engineering and biological depending upon the slide characteristics have been described below:

7.4.1 Stabilization of slopes

For stabilization and restoration of slopes and landslips gabion walls are proposed. Wire bolster, wire mesh and plantation of deep rooted fast growing tree species and shrubs followed by spray of seeds are proposed in the non-submergence zone. Above the submergence zone retaining walls of varying lengths have been proposed. Below the submergence zone, retaining wall and gabion walls would be provided. Retaining walls of 2 m and 5 m length respectively would also be provided to modify the slope cause landslips just above the submergence zone. The depletion zone shall be treated with shrub and tree plantation. The rocky surface shall be reinforced with wire mesh. This treatment shall be clubbed with Green Belt development and part cost has already been included in the same.

7.5 COST ESTIMATES

The cost of various activities for protection works for under reservoir rim treatment plan is **Rs. 65.00 lakh**. As details of quantities of various treatments are not available presently, an estimated cost of each proposed treatment

measure is given in table below. Cost of plantation is already estimated under Green belt development plan.

Table 7.1: Estimated cost of proposed treatment measure

Type of work	Total cost Rs. In lakh
Construction of Gabion walls, Gabion basket works to protect landslips and unstable slopes	30.00
Catch water drains, side channels and protection walls	20.00
Benching, Contour bunding and terracing	15.00
Plantation works*	--
Total	65.00

*Cost of plantation is under Green Belt Development Plan

Chapter 8

MUCK MANAGEMENT PLAN

8.1 INTRODUCTION

Large quantity of material would be excavated due to construction of dam, canal, and distributary network. Muck generation is considered a significant impact on land environment as the project involves laying of underground pipelines of MS and HDPE of various diameters. The excavation shall result in large quantity of excavated material i.e. muck which shall have to be evacuated and disposed of in a planned manner so that it takes a least possible space and is not hazardous to the environment.

8.2 QUANTITY OF MUCK TO BE GENERATED

The proposed system is a closed conduit system for conveyance of water up to farm level. To understand the impact of muck generation, quantification of this impact was carried out by calculating the muck volume which shall be generated from excavation of earth for laying of pipeline, adding a swell factor of 25% to the muck generated and subtracting the quantity of back filling. The resultant quantum is the muck generation requiring disposal.

For calculation of the trench volume, depth is taken 1 m plus pipe dia; bottom width is taken as 9 cm more than the pipe dia on each side and top width is taken as $\frac{1}{2}$ of the trench depth in addition to the bottom width i.e. $\frac{1}{4}$ depth on each side. Muck expected to be generated from pump houses and sub-stations construction has also been added. Muck from dam's foundation has been computed assuming depth of foundation considering $\frac{2}{3}$ of the dam height with 2:1 upstream face slope and 1.5:1 downstream face slope and 6.5 m top width.

Muck generated from dam's foundation:

750 m (length of earthen part of dam) * 14 ($\frac{2}{3}$ of dam height) * 22 (dam height) * 3.5 (upstream and downstream face slope) = 8, 08,500 cum

Assuming swell factor of 25%, total muck to be disposed off = 10,10,625 cum

Muck from rising main and gravity main:

(48 km (approximate length) * 3.89 (depth of trench) * (2.89+0.09+0.09) (bottom width of trench) + (3.07+2.045) (top width of trench))/2

Total quantity of muck excavated = 7,64,151 cum

Total quantity of muck with swell factor of 25% = 9,55,190 cum

Backfill quantity = 4,68,740 cum

Muck requiring disposal = 4,86,450 cum

8.3 DISPOSAL OF MUCK

Muck generated from dam's foundation after assuming swell factor of 25% has been estimated as 10,10,625 cum which shall be utilized for earthen dam, producing coarse and fine aggregate for concrete production and in fillings for developing areas for construction facilities.

Muck requiring disposal from laying pipe line network especially rising and gravity mains has been estimated as 4,86,450 cum. In addition, some muck will also be generated while laying distributary network and field channels. The total muck so generated will be utilized for refilling of the trenches and the approach road proposed to be constructed along the canal.

For laying of the pipeline network in command area, muck generation will be along the linear route of pipeline. Care will be taken that top fertile soil is kept aside and will be used for re-filling the top area after laying of pipe line. The surplus soil requiring disposal will be spread on low lying farmers field with their consent. Balance muck will be managed by spreading along the route in the low lying areas. As the topography is undulating, such low lying areas are available along the route. Any further surplus muck, shall be laid in the community undulating area of the connected villages, backfilling/ reclaiming of pits in designated borrow area with the consent of concerning Gram-panchayat or Janpad Panchayat. The muck may also be used by nearby Gram Panchayats for construction of village roads etc.

Therefore, muck generated from the construction work and laying of pipeline, though of significant quantity can be managed without creating a serious impact on this count. For management, transportation and temporary storage of muck, a lump sum provision of capital expenditure of **Rs. 300 lakh** has been made to ensure proper management.

**Chapter
9****SOLID WASTE MANAGEMENT PLAN****9.1 INTRODUCTION**

The construction of the proposed Parbati Major 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 5 years. Some of the workers will be accompanied by their families. The total population of workers and their families has been estimated as 1050 persons during peak construction time. 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:

- Municipal waste (includes commercial and residential wastes generated in either solid or semi-solid form excluding industrial hazardous wastes and bio-medical wastes)
- Construction and demolition debris (C&D waste)
- Bio-medical waste (waste generated by health-care and veterinary establishments)
- Hazardous waste (generated from construction machinery and equipment)
- e-Waste (computer parts, Printer cartilages, electronic parts, etc.).

Solid Waste Management is one among the basic essential requirement for public health and aesthetic surroundings. Therefore, the removal of any scattered and littered waste is important. This also brings to focus the necessity of synergy in the design, construction and maintenance of roads, surface (storm water) drains and storage, collection and transport of solid waste.

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 Solid Wastes Management Rules (SWM) 2016. 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 labours 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.

9.2 INFLUX OF MIGRANT POPULATION

At the time of peak construction work in the project, maximum of 500 persons may be engaged, most of these will be from the local population. Around 350 nos. of the work force, which will include technical, non-technical and service class, will come from outside. In the first, fourth and fifth year 60% of the peak force will be required and in the second and third year 80% of the peak force will be required.

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

- (i) family size is assumed as 4; 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 1050 persons (**Table 9.1**). This population is expected to reside in the project area at any given time.

Table 9.1: Calculation of Total Migrant Population (Peak time)

Migrant Population of Labourers	
Total labour force	350
Married labourers (80% of 350)	280
Single labourers (20% of 350)	70
Husband and wife both working (80% of 280)	224
Number of families where both husband and wife work (224/2)	112
Number of families where only husband work (20% of 280)	56
Total number of labourers families (112+56)	168
Total Migrant Population of Labourers (168 x 4 + 70)	742
Migrant Population of Technical Staff	
Total technical staff	100
Married technical staff	20
Single technical staff	80
Total migrant population of technical staff (20x5+80)	180

Migrant Workforce (Labour plus Technical)	922
Service Providers	
Total service providers (approx. 4% of total migrant workforce)	43
Married service providers (50 % as assumed)	22
Single service providers	21
Total migrant population of service providers (22 x 4 + 21)	109
Total Migrant Population	1031
Round off	1050

Waste generation rate in Indian cities ranges between 200 - 870 grams/capita/day, depending upon the region's lifestyle and the size of the city. The per capita waste generation is increasing by about 1.3% per year in India (*Annepu, 2012*). State-wise data show that Madhya Pradesh average is about 400 gm/capita/day. It is assumed for the estimation of quantum of waste generation, for the purpose of preparation of solid waste management plan, that migrant labour population will follow the local pattern. Therefore, when project will go for construction, about 400 grams/capita/day is expected to be generated. Further, the peak labour population is estimated to be 1050 persons and it is also expected that locals in the proximity will also use solid waste management facilities; keeping this in view, the plan is prepared for about 1500 persons.

For 1500 persons an estimated amount of about 219 tons/annum (0.4 kg x 1500 individuals x 365 days = 220 ton) of solid waste will be generated. A figure of 220 tonnes per annum has been taken to prepare the solid waste management plan. This waste will be collected, segregated and disposed off in line with the provisions laid down in Solid Waste Management Rules, 2016.

9.3 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. Adequate facilities for collection, transportation and disposal of solid waste will be developed. Any solid waste generated in the project complex/ project colony/ labour colony, shall be managed and handled appropriately. Various aspects of solid waste management include:

- Reuse/Recycling
- Storage/Segregation
- Collection and Transportation
- Disposal

9.3.1 Reuse/Recycling

Project proponent will explore opportunity to recycle the waste generated at the project site, in this context project will identify authorized vendors for

recycling or disposal of used batteries, used oil and used oil filters (as these are hazardous waste).

Bio-degradable waste will be disposed by composting and the manure generated will be provided to local community for cultivating vegetables and flowers and other agricultural activities.

9.3.2 Storage and Segregation

In the labour colony, provisions shall be made to separately store the degradable and non- degradable solid waste. Two different coloured bins will be supplied to each labour family, who will segregate the waste generated in their household. Green and Biodegradable waste is to be deposited in one container and non-biodegradable waste in another container. In case of canteens and community kitchens also, two different coloured dust bins will be used for separately storing the biodegradable and non-biodegradable waste generated. A sustained awareness programme will be conducted to educate workers about the segregation of degradable and biodegradable wastes.

9.3.3 Collection and Transportation

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

- Organizing house-to-house collection of solid waste on regular pre-informed timing by using tractor mounted trolley.
- Collected waste from residential areas shall be transferred to community bin by hand-driven containerized carts or other small vehicle
- Collection of wastes from office complexes and commercial areas
- Construction / demolition wastes or debris shall be separately collected and disposed off
- Wastes from vegetable and fruit shops and meat shops shall be separately collected

Solid waste collected shall be disposed-off at a common storage point. Three trucks will be commissioned to collect the solid waste and dispose the same at sites designated for disposal of solid waste.

9.3.4 Disposal

The solid waste will be transported for disposal at the designated landfill sites. The landfill shall have impervious clay at the bottom most layers. The second layer shall be impervious liner (Geo membrane), third layer will be of

sand, after that well compacted solid waste is to be put over the sand, then again a layer of clay, finally a layer of soil. Vegetation shall be grown on the topmost layers. It will give a good aesthetic view of landfill.

9.3.4.1 Degradable component

The bio degradable portion of the solid waste would be disposed off by composting. The degradable portion is expected to be about 50% i.e. about 300 kg/day of degradable portion of solid waste will be generated. Composting process takes around 45 days to mature.

A pit of 1m x 1m x 1m deep (0.3m free board) size can take 0.7 m³ (around 550 Kg) of compostable waste. Therefore, 12 pits would be needed to store the biodegradable waste with 60 days retention time, however, a provision of 15 pits should be kept. The total area required would be almost two times the pit area as some area in between pits will be required for transportation and stacking of waste. Hence, total area required will be 30m². The pits will be covered with GI sheets. Additional 30m² would be kept for storage for compost plus screening and other activities.

The pits to be constructed will have around 25 cm of bottom lining consisting of about 5 cm thick stone grit over which 15 cm thick coarse sand followed by 15 cm thick earth lining will be done. There fuse along with animal dung will have to be laid in layers of 5 to 10 cm thickness. The pit will be then watered on alternate days. There after waste is laid in 5 to 10 cm thick layers twice in a week till the whole pits filled up. Every week the waste will need to be turned up and water will have to be sprinkled every day to keep adequate moisture. The process will take around 45 to 60 days where after the composted waste from the pits taken out and after drying it is screened with screens having 2 mm dia holes. The screened compost would be filled in plastic bags and used as good manure especially for cultivation of vegetables and flowers.

9.3.4.2 Non-Degradable component

The non-degradable portion (about 75 tons /annum) such as plastic bottles, cans, etc. shall be segregated and transported to dispose at designated sites. The details of land fill site are given as below:

Waste Generation	:	110 tons per annum
Design Life	:	5 years (construction phase)
Total Waste Generation in 5 Years	:	550 tons
Volume of waste	:	846 m ³ (assumed density =0.65 tonnes/m ³)

Provision of daily cover, liner, etc	:	20% approx.
Total Volume	:	1000 m ³ say
Pits of Size (LxWxD)	:	30 m x 25 m x 3 m (effective depth 2.7 m)
Pit Area	:	750 m ²

A provision of additional 50% of the total area, for accommodating infrastructure facilities will be included while working out requirement of space. The liner system will comprise of the following layers below the waste:

- 0.30 m thick drainage layer comprising of coarse sand or gravel
- 0.2 m thick protective layer of sandy silt
- 1.50 mm thick HDPE geo-membrane
- 1 m thick clay layer/amended soil layer, comprising of local soil

9.3.5 Bio-medical Wastes

Biomedical 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. In proposed project, biomedical waste will be generated from first aid posts and other medical establishments in the area. As the quantity of biomedical waste generated is not expected to be very significant requiring separate incineration, it is proposed to have a tie up with government hospital or private hospital in Narsingharh to treat/ dispose-off biomedical waste generated from project activities in their facility. Provision has been made in Local Area Development Plan to upgrade medical facilities in the area; handling of biomedical waste generated from such facilities will also be included as part of upgrading component as the existing facilities are not in place.

9.4 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 as **Rs. 92.50 lakh (Table 9.2)**.

Table 9.2: Cost Estimate for Solid Waste Management Plan

S. No.	Item	Cost (Rs. lakh)
1	Cost of land*	
2	Construction at composting site and land fill site - digging of pits, construction of pits, boundary wall, drainage, lining, etc.	10.00
3	Reclamation and stabilization of land fill and composting site	8.00
4	Manpower cost for 3 persons @ Rs. 10000 per person per month for 5 years	18.00
5	One covered truck for conveyance of solid waste to landfill site @ Rs. 12.50 lakhs per truck	12.50
6	1 tractor with trolleys @ Rs. 10.00 lakh per tractor with trolley	10.00
7	Running, operation and maintenance of trucks and trolleys including driver's salaries @ Rs. 20000 per vehicle per month for 1 vehicles	24.0
8	Awareness programme/ Periodical Training for waste disposal and Management	5.00
9	Tools & Implements	5.00
Total Cost (Rs. lakh)		92.50

* Cost of land is taken in DPR

**Chapter
10****PUBLIC HEALTH DELIVERY
SYSTEM****10.1 EXISTING MEDICAL FACILITIES**

Medical services at secondary level play a vital and complimentary role to the tertiary and primary health care systems and together form a comprehensive district based health care system.

In the study area most of the villages are not covered by the primary health facilities. Primary Health Sub-centers in some of the villages provide basic medical facilities. Government hospital at Narsingharh provides all the basic medical facilities and also works as referral center for complicated cases. Beside Government hospital, private hospitals and clinics also provide basic health services primarily to the inhabitants of project areas.

10.2 THREATS TO PUBLIC HEALTH

Project construction and operation will bring about several 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.

i) 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. The peak labour force during the construction period is estimated to be around 350. 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, 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 influx of outside population in this area. Therefore, it would be obvious for the project authorities and their contractors to have all the laborers including their family members registered, quarantined, and 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, etc. and health card will be issued. Only after valid certification a labour 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 will be

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

- ii) **Chances of increase in water borne diseases as malaria, and dengue are high** if there is a stagnant water body in the vicinity, which are generally created during construction phase. Therefore, proper monitoring, control and management needs to be done to prevent outbreak of water-borne diseases.
- iii) **Chances of increase in respiratory troubles due to increase in suspended particles during the construction phase.** Air pollution control measures need to be strictly implemented at construction sites and directly exposed workers need to be provided with dust masks to minimize this impact.
- iv) **Chances of occurrence of gastroenteritis, cholera and typhoid in the labour camps.** The project should make proper arrangements for maintaining high hygienic conditions in the colonies and labour camps, by providing good sanitation and drinking water facilities. Medicine should be distributed free of cost to the labour during construction period as and when required.

10.3 MEDICAL FACILITIES

A population of about 1050 nos. is likely to congregate during the peak construction phase. 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:

- Two fully equipped ambulance 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. The ambulance should be equipped with lifesaving equipment, drugs along with trained manpower and communication system. Typically, the ambulance should have equipment 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 equipment, additional battery, First Aid bag, BP instrument, stethoscope, etc. Free service of ambulance will be provided for the patient of the nearby villages in the project area.

- Three first-aid posts need to be established; location can be decided based on major construction sites and can be shifted as per needs during the construction phase. The first aid posts will have essential medicines including dressing material, stretcher, wheel chair, ORS packets, 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 at a fixed time. First aid post also provides medical facilities to the local peoples in the area.
- As the existing medical facilities in the area are not adequate, budget provisions have been made for strengthening existing Hospital, and PHCs in the area.

10.4 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 sanitary habits 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 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.

10.5 COST ESTIMATES

Budgetary estimates for public health delivery system have been worked out as **Rs. 147.00 lakh**, as per the break up given at **Table 10.1**.

Table 10.1: Budgetary estimates for developing health care facilities

Sl. No.	Particulars	Amount (Rs. lakh)
1	Ambulance : 2 no. with all the basic Medicare facilities and small DG set, etc. to cater for villages in the project area	30.00
2	Budget for running the ambulances including driver, fuel and maintenance for 5 years @ 5 lakhs per annum	25.00
3	First aid posts (3) including sheds, furniture and basic equipment	12.00
4	Budget for running the first aid posts @ Rs. 3 lakhs per annum per post including cost of medico, consumables, etc. for 5 years	45.00
5	Budget for strengthening existing medical facilities	20.00
6	Budget for Health Awareness/ Vaccination Camps @ Rs. 3.00 lakhs per annum for 5 years	15.00
Total (Rs. lakh)		147.00

**Chapter
11****ENERGY CONSERVATION MEASURES****11.1 INTRODUCTION**

As discussed in the earlier chapters, the proposed project would remain under construction for about 5 years and it is estimated that migrant population during peak construction phase will be of the order of 400 persons. It is the general tendency of the migrant laborers to use forest wood for the fuel and other domestic uses, especially when it is easily available. This would create serious biotic pressure on the nearby forest. To mitigate such impacts, various management measures need to be put in place and strictly implemented.

Energy Conservation Measure (ECM) are to be planned and implemented during construction phase either directly by developer or through contractor to reduce the pressure on natural resources in the project area and minimize impacts on this count. These measures can affect a variety of resources mainly forest, from negative impact of fuel wood collection by stakeholders as well as by labors during construction period. To mitigate such impacts, feasible measures will be adopted to help minimize pressure on forest. These are briefly discussed in the ensuing text.

11.2 ENERGY CONSERVATION MEASURES

Renewable natural resources like Forests should be protected/ cared to enhance quality of life and can also to be used and replenished for the future use. In study area, supply of cooking gas and kerosene is available in all the villages, but fuel wood is the dominant source of energy due to easy availability; therefore there is need to reduce the pressure on the natural forests for wood. With an estimated migrant population of 1050 persons in the area, the existing facilities will become insufficient for supply of kitchen fuel for the migrant population during the construction of the project. Fuel for cooking is an essential requirement and in the absence of adequate fuel availability they will resort to tree cutting for use of fuel wood. The project authorities would need to make adequate arrangements for supply of kitchen fuel.

Provisions for Kitchen Fuel

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.

Community kitchen: The project developer would make sufficient arrangement for the establishment of at least two community kitchens. These will be established near the project colonies. The kitchen should provide food to the labour at subsidized rates. The facility should maintain proper hygiene while preparing and supplying food, with adequate arrangement for waste collection and disposal. In addition, three canteens are also proposed for labour near major construction sites to provide tea/snacks at subsidized rates.

Kitchen fuel: During the construction period of the project, 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 at subsidized rates.

It is estimated that about 50% of married labour families and all the technical and supervisory staff would prefer doing their own cooking. Additional connections would be needed for community kitchens, Project Affected Families and other interested local families. Based on this, it is estimated that a total of 100 LPG connections would be needed for locals, labour and community kitchen. Therefore, developer will coordinate with the LPG storage depot/ Kerosene depot to ensure regular supply of LPG cylinders/ Kerosene in the project area during construction period.

Efficient cooking facilities: Project authority should also take measures for reducing the fuel consumption. The authority should provide solar cookers and pressure cookers to the families of migrant workers as well to local villagers. Accordingly, budget has been allocated for the supply of solar cookers. This facility will also increase the work efficiency of migrant workers and they will also get proper daily diet.

Solar Lantern: Provision of solar lantern has also been made in the project budget and these will be distributed free of cost to labor camps and villagers for use.

Awareness Programmes on Energy Conservation: Special awareness programmes against tree cutting should be held, which should concentrate on the awareness of labor families and villagers on environment conservation and sustainable development for the future generations. Thus, issues like saving trees, electricity and water should be covered in such programmes.

11.3 COST ESTIMATES

A total grant of **Rs. 121.50 lakh** has been assigned towards the provision of kitchen fuel, and other facilities including establishment of community kitchen or canteens for the migrant workers (**Table 11.1**).

Table 11.1: Financial Provision for Energy Conservation Measures

Sl. No.	Particulars	Amount (Rs. In lakh)
1	Upgradation of LPG Depot	5.00
2	Connection cost of 100 connections @ Rs. 5000.00 per connection	5.00
3	Distribution of Pressure Cooker and Solar Lantern	15.00
4	Community Kitchen (2 No.) – capital cost (Rs. 2.00 lakhs per kitchen) and running cost for 5 years @ Rs. 7 lakh per kitchen per annum	74.00
5	Canteen (3 No.) – capital cost (Rs. 2.50 lakh per canteen) and running cost/subsidy @ Rs. 2.00 lakh/year for 5 years	17.50
6	Community Awareness Programme	5.00
	Total (Rs. lakh)	121.50

**Chapter
12****DAM BREAK MODELING &
DISASTER MANAGEMENT PLAN****12.1 DAM BREAK PHENOMENON**

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 breached structure. A dam break may result in a flood wave up to tens of meters deep travelling along a valley at quite high speeds. The impact of such a wave on developed areas can be sufficient to completely destroy infrastructure. With such destructive force comes an inevitable loss of life, if advance warning and evacuation was not possible.

12.2 NEED FOR DAM BREAK MODELING

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:

- Travel time of flood water
- Peak water level – extent of inundation
- Peak discharge
- Duration 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.

Emergency Planning

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

- Inundation maps at a scale sufficient to determine the extent of and duration of flooding
- Timing of the arrival and peak of the flood wave

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.

12.3 PRESENT DAM BREAK MODELING STUDY

The present study for Parbati Major Irrigation Project comprises of the following hydrodynamic simulations due to occurrence of:

- DESIGN FLOOD with Dam break with initial reservoir level at FRL of the dam
- DESIGN FLOOD without dam in place (virgin condition)

The study comprises of:

1. Prediction of outflow hydrograph due to dam breach
2. Routing of dam breach flood hydrograph through the downstream valley to get the maximum water level and discharge along with time of travel at different locations of the river downstream of the dam
3. Channel routing the design flood hydrograph through the downstream valley in the virgin condition of River i.e. without Dam to get the maximum discharge and water level at different locations of the river downstream of the dam

12.4 INTRODUCTION TO DAM BREAK MODELING

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 analysis. 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 the flood wave characteristics over a large distance from the dam are of main interest. In the instant case, as these valleys are long and the flood wave characteristics over a large distance from the dam are of main interest, one dimensional modeling was adopted.

12.5 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**

$$(\partial Q / \partial t) + \{ \partial(Q^2 / A) / \partial X \} + g A ((\partial h / \partial X) + S_f + S_c) = 0$$

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.

12.6 SELECTION OF MODEL

Selection of an appropriate model to undertake dam break flood routing is essential to ensure the right balance between modeling accuracy and cost (both in terms of software cost and time spent in developing & running the model). In the instant case, MIKE 11 model developed by Danish Hydraulic Institute has been selected for the present study because of its wide acceptability in India and abroad.

12.7 MIKE 11 MODEL

The core of the MIKE 11 system consists of the HD (hydrodynamic) module, which is capable of simulating unsteady flows in a network of open channels. The results of a HD simulation consist of time series of water levels and discharges. MIKE 11 hydrodynamic module is an implicit, finite difference model for unsteady flow computation. The model can describe sub-critical as well as supercritical flow conditions through a numerical description, which is altered according to the local flow conditions in time and space.

Advanced computational modules are included for description of flow over hydraulic structures, including possibilities to describe structure operation. The formulations can be applied for looped networks and quasi two-dimensional flow simulation on flood plains. The computational scheme is applicable for vertically homogeneous flow conditions extending from steep river flows to tidal influenced tributaries.

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 chosen. The dynamic and diffusive wave descriptions differ from kinematic wave description by being capable of calculating backwater effects. The solution algorithm for the different flow descriptions is identical in the inner programme structure, implying that the user does not have to distinguish between the different computational levels, when running the program. In the instant case, dynamic wave approach was adopted for a better simulation.

Hydrodynamic module utilizes a space staggered grid consisting of alternating **h** and **Q** points, i.e., points where water levels (**h**) and discharges (**Q**) are computed sequentially. Topographic data are entered at the **h** points, and discharge relations are evaluated at **Q** points. During simulations, the complete non-linear equations of open channel flow are solved numerically at the grid points at specified time intervals for the given boundary conditions.

12.7.1 Solution Technique

In order to obtain a stable solution to the finite difference scheme, two conditions viz. (i) Velocity condition and (ii) Courant condition have to be satisfied.

(i) Velocity condition: $(V \cdot \Delta t / \Delta x) \leq 1-2$

(ii) Courant condition: $C_r = [(V + v(g \cdot d)) \cdot \Delta t] / \Delta x \leq 10-15$

C_r is the Courant number, **v** is the cross-sectional mean velocity, **g** is the acceleration due to gravity, **d** is the mean depth, **Δt** is the time step, **Δx** is the space step (the distance between adjacent **h**-points)

The most important considerations determining the selection of space and time steps for a particular model application are the expected wave lengths and duration of the wave period, and the ability to adequately resolve the channel topography. The space step length must be chosen ensuring a sufficient number of points along the channel axis to resolve the expected waves. The wavelength is determined by the wave period and the speed of propagation. A second concern is the adequate resolution of rapid changes in topography along the channel axis, and this may require extra grid points. The time step must be selected so that all expected significant wave periods are adequately resolved in time. As the duration of tidal waves is generally shorter than flood waves, the time step of a hydrodynamic model, which simulates tidal flows requires a shorter time step than that used in flood wave computations.

The solution to the combined system of equations at each time step is performed in a computational grid consisting of alternative **Q**-point and **h**-point, i.e. points where the discharge "**Q**" and water level "**h**" respectively, are computed at each time step. A typical layout of channel section with computational net is shown in **Figure 12.1**.

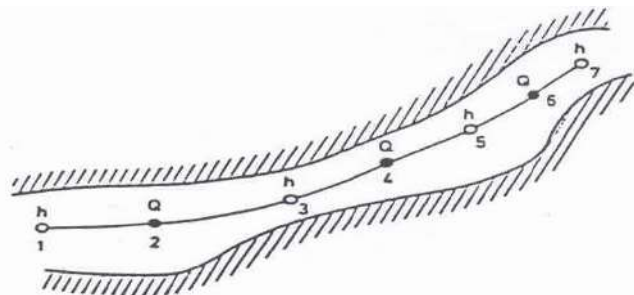


Figure 12.1: Layout of channel section with computational net

The computational grid is generated by the model on the basis of the user requirements. Q-points are always placed midway between neighbouring h-points, while the distance between h-point may differ. The discharge will, as a rule, be defined as positive in the positive x-direction (increasing chainage).

12.7.2 Topographical requirement and discretization

MIKE 11 HD is a physical modeling system, and hence, data related to the detailed physical characteristics of the study area must be obtained, if realistic results are to be expected. Topographic data are necessary to provide an adequate geometrical and topographical description of the river system, flood plains, and all important structures.

First, the layout of the channel network is determined, and all significant channels identified, including the locations of the main channel confluences and bifurcations. Flood cells subject to inundation must be delimited, and the network of discharge exchange between the flood cells and the main river channels need to be identified.

Cross-sections are required at regular intervals along the river. These must extend up to the river bank to encompass any natural or man-made river embankments. In the model schematization, the available cross-sections are placed at **h**-points. The cross-sections should be representative of the entire channel reach between the adjacent **Q**-points. Hence, channels which exhibit highly irregular cross-sectional variations require denser grid, and hence, have greater data requirements.

Possible sources of data for the topographical input include contour maps, hydrographic charts, aerial photographs, satellite imagery, etc. However, in the majority of cases, sufficiently detailed information can only be obtained from controlled field surveys. It is essential that all topographical data levels relate to a common fixed reference level, preferably mean sea level.

Besides topographic data, hydrometric data are necessary to enable the model to be calibrated against actual events, and thus, provide a basis for verification of the chosen schematization. Hydrometric data are also required at the model boundaries for any subsequent operation of the model. The main types of hydrometric data required are water levels and discharges.

12.8 MIKE 11 MODEL SET-UP

The Dam Break Module in MIKE 11 simulates the outflow hydrograph resulting from the failure of a dam. The model set-up consists of a single or several channels, reservoirs, dam break structures and other auxiliary dam structures such as spillways, bottom outlets etc. As the flood propagation due to the dam break will be of highly unsteady nature, the river course needs to be described accurately through the use of as many cross-sections as possible, particularly where the cross-section is changing rapidly. Further, the cross-sections should extend as far as possible to cover the highest modelled water level, which normally will be in excess of the highest recorded flood level. If the modelled water level exceeds the highest level in the cross-section for a particular location, MIKE 11 will extrapolate the processed Data as a vertical wall, and this will give conservative results.

12.8.1 River channel set-up

The river channel set-up for dam break modeling is the same as for the HD model except that the dam break structure is located in a separate reservoir branch, which contains 3 calculation points, i.e., two h-points and one Q-point. If a spillway is added to the dam, it can be described as a separate branch with 3 calculation points. The dam and spillways are located at a Q-point. The river set-up with a dam and, with dam and spillway are shown in **Figure 12.2** and **Figure 12.3** respectively.

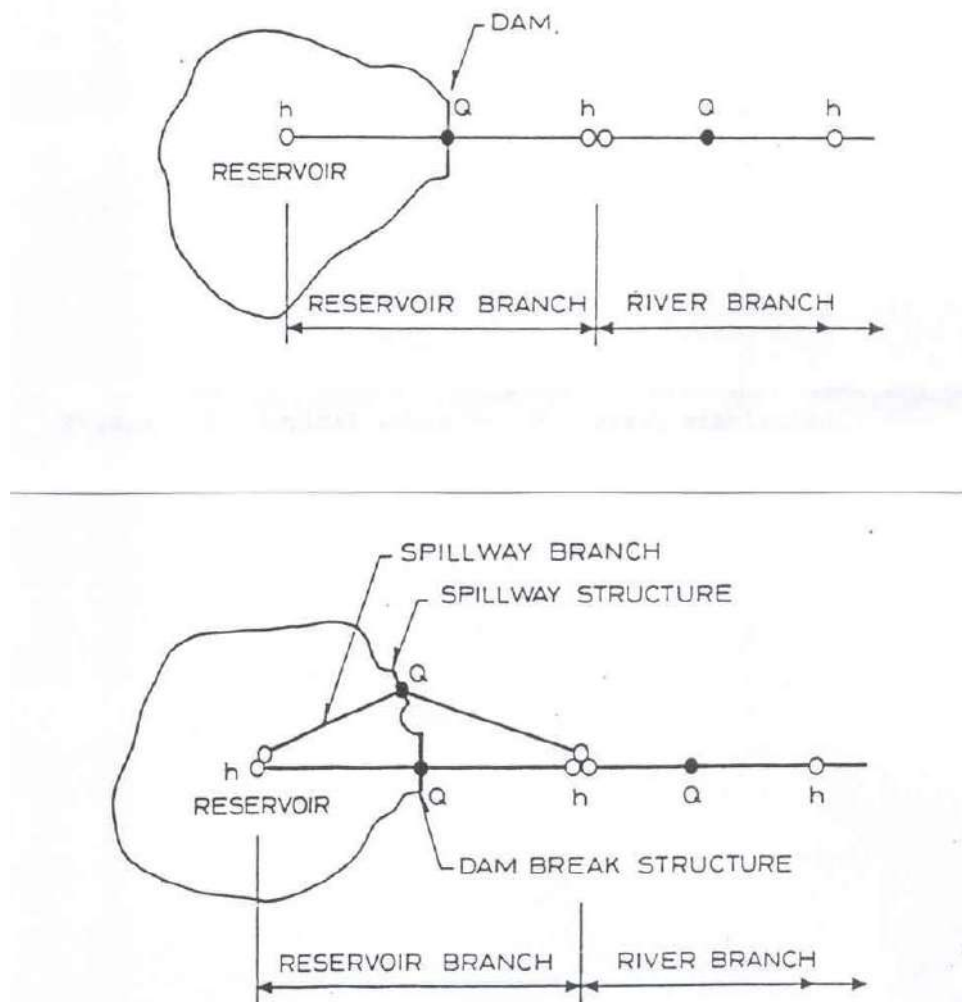


Figure 12.2 & 12.3: River set up with dam and spillway

12.8.2 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 also 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:

$$A_{total} = b.2\Delta x + \text{Additional flooded area}$$

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, no cross-section is interpolated between the actual cross-sections.

Spillways and other structures

At the node, where two branches meet the surface flooded area is taken as the sum of the individual flooded areas specified at the **h**-points. Therefore, if the reservoir storage has already been specified at the reservoir **h**-point, the spillway **h**-point should not contain any flooded areas. Both the width b , and the “additional flooded area” should be set to zero and other parameters such

as the cross-sectional area and hydraulic radius should be the same as for the reservoir.

12.8.3 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 h-point. The downstream boundary will generally be a stage-discharge relationship at the last cross section of the set up.

12.9 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

12.9.1 Breach development

Earth and Rockfill dams usually do not collapse instantaneously, but they develop breaches, which increase gradually. The failure time 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.

12.9.2 Failure modes

The dam break module of MIKE 11 allows selection of one of various breach development modes. Either linear failure mechanism or an erosion based formulation may be selected. The linear failure mode assumes a linear increase in the breach dimensions in time between specified limits. In the erosion based mode, the increase in breach dimensions is calculated from the prevailing hydraulic conditions in the breach, and from the given geometrical data. For both modes, limits of the final breach width and level are specified. These may be determined, for example, by the original valley embankments.

a) Linear failure modes

The necessary data required to fully specify a linear dam failure are shown in **Figure 12.4**. In addition, the user specifies the duration of the breach

development and whether the failure is to commence at a given time, or is initiated by overtopping of the dam. This facility has applications in simulating the cascading failure of several dams located on the same river.

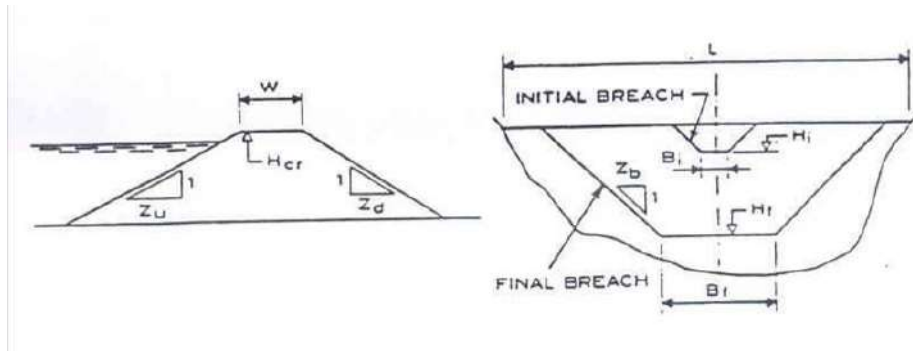


Figure 12.4: Breach parameters for linear mode

b) Erosion based failure

The enlargement of the breach in earth fill dams from erosion of the dam core material may also be determined from sediment transport considerations. Erosion based breach formulations are based on sediment continuity equation for the breach. Numerous sediment transport formulae are available, of which two have been implemented in the breach formulation, being those of Engelund-Hansen (1967), and Meyer-Peter and Muller (1947). Modeling of the variation of the width of the breach is more difficult to relate to the classical theories of sediment transport. Due to the development of a wall boundary layer along the often very steep side walls of the breach, the theories for bed load and suspended load do not apply. As an approximation, the sediment transport at the sloping walls is assumed to be proportional to that in the central part of the breach. The coefficient of proportionality (side erosion index) is of the order of 0.5 – 1.0.

12.10 INITIAL CONDITIONS

Though in many cases, dam failure may occur on a dry river bed downstream of the dam, but such conditions are not possible in MIKE 11, which require a finite depth of water, in order to ensure “the continuity” of the finite difference algorithm. Therefore, before a dam break is actually simulated, it is necessary to create a steady state “hot-start” file, which can be used for all subsequent dam break simulation. This file is created by:

- (i) Giving a lateral inflow at the first h-point in the river
- (ii) Setting the inflow into the reservoir to zero, and
- (iii) Specifying the dam break structure to fail by overtopping, ensuring that the dam crest level is greater than the specified reservoir level.

Initial conditions (water level and discharge) must be specified in HD parameter file, including the reservoir level, at which the dam break

simulation should commence. The set-up should be run until a steady state condition is reached (i.e., $Q = \text{constant} = \text{lateral inflow up to the downstream boundary}$).

12.11 DAM BREAK SIMULATIONS

The dam break simulation may be carried out using the hotstart file generated as mentioned above, specifying the upstream boundary as the inflow hydrograph. The time step depends upon the slope of the river bed and should be selected of the order of 0.5 to 5 minutes according to the slope.

12.12 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-surface area 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

For the present study, the following data supplied has been used;

12.12.1 River cross sections

For dam break studies of Parbati Project, the River for a length of about 51000 m downstream of the dam site have been represented in the model by numerous cross sections taken at a suitable interval. In the case of extreme floods the flood water spreads beyond the normal course of the river, where the resistance to flow will be high due to presence of bushes, vegetation etc. Considering the above the Manning's roughness coefficient for the entire study reach of the river has been taken as 0.035.

12.12.2 Reservoir and dam

The reservoir has been represented in the model by a separate reservoir branch and its elevation-surface area relation, which has been specified at Chainage “0” km of the reservoir branch. The dam has been placed at Chainage 500 m of the reservoir branch and dam breach parameters specified therein.

12.12.3 Spillway

The spillway has been represented in the model by number and size of spillway gates. The same has been specified at Chainage 500 m of the spillway branch.

Design Flood Hydrograph

The design flood hydrograph which is the DESIGN FLOOD for the present case has been used as for the upstream boundary of the dam break model set up. The same applied at chainage “0” km of the reservoir branch in the model set up, is 19853.86 cumec.

12.12.4 Downstream boundary

In order to avoid its influence in the study reach normally the downstream boundary should be applied at a distant location from the last river cross section of study reach. The same has been worked out using Manning’s equation and applied at a location 51000 m downstream for dam site, as given in **Table 12.1**.

Table 12.1: Stage-discharge relationship - downstream boundary of MIKE11 model set up

Stage (m)	Discharge (cumec)
405.10	0.00
405.94	7.05
406.77	45.80
407.61	190.69
408.45	466.26
409.28	869.42
410.12	1397.28
410.96	2045.06
411.79	2816.29
412.63	3750.04
413.47	4851.29
414.31	6101.96
415.14	7494.06
415.98	9022.64
416.82	10681.21
417.65	12464.51
418.49	14368.52
419.33	16389.97
420.16	18526.09
421.00	20774.49

12.13 SELECTION OF DAM BREACH PARAMETERS

Estimation of the dam break flood will depend on time of failure, extent of overtopping before failure, size, shape and time of the breach formation, etc., which are called dam breach parameters. The breach characteristics that are needed as input to the existing dam break models are i) Initial and final breach width; 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.

A study of the different dam failures indicates that earthen or rockfill dams never collapse instantaneously as concrete dams which breach by sudden collapse. Earthen or rockfill dams develop breaches which increase gradually. The breaching time may vary from a few minutes to a few hours, depending on amongst other the dam geometry and the construction material. The development of the breach largely determines the reservoir outflow hydrograph, and a reasonable description of the breach development is therefore required in near field dam break models. In far field models a reasonable flood routing procedure is of more importance, because the outflow variation is rapidly damped out as the flood wave propagates downstream.

The way earthen or rockfill dam starts to breach can be specified as one of the following failure modes:

- Linear failure, ie the increase in breach dimensions is assumed to occur linearly over a given time (the time of breach development)
- Erosion based failure, ie the increase in the breach depth is calculated from a classical sediment transport formula. The increase in breach width is calculated as the increase in breach depth multiplied by side index.

In present case, upstream elevation view can be considered as a section consisting of side gated portion and earthen embankments which have been considered as failure zone. Linear failure has been adopted in the present case; breach of trapezoidal shape has been considered with a side slope of 1 V: 1.5 H. End shape of the breach should reflect the bounds imposed by the valley bathymetry accordingly the value has been taken. Breach starts from top of dam when water is at FRL ie 447.95 m and reaches level of 426.1 (river bed level) in one hour developing breach in trapezoidal form and with initial breach width of 43.68 m.

Accordingly, the breach parameter given in **Table 12.2** has been selected for the dam break study.

Table 12.2: Breach Parameters

Breach Level (m)		Initial Breach Width (m)	Breach Slope	Breach Development Time (Minutes)	Remarks
Initial	Final				
447.95	426.1	43.68	1 V: 1.5 H	60	The final breach level at El 426.1 m has been taken (river bed level)

12.14 CRITICAL CONDITIONS FOR DAM BREAK STUDY

The critical condition for a Dam break study is when the reservoir is at FRL and design flood hydrograph is impinged. Hence for the hypothetical case of Dam break simulation and also to get the maximum Dam breach flood peak it would be appropriate to assume the starting of the breach, when the reservoir level is at FRL.

12.15 DAM BREAK SIMULATION (BREACH WIDTH 43.68 M, BREACH DEPTH 21.84 M, BREACH DEVELOPMENT TIME ONE HOUR)

Taking the above breach parameter and critical condition of para 9.14 the dam break condition has been simulated. In the simulation the dam has been assumed to breach 59 hour after the impingement of the DESIGN FLOOD, when the water level in the reservoir is at EL 447.95 m after the impingement of the DESIGN FLOOD. The dam breach flood hydrograph just downstream of the dam is given in **Figure 12.5**.

The peak of the dam breach flood just downstream of the dam is 24772.088 cumec which includes about 19853.86 cumec due to DESIGN FLOOD itself. Hence the contribution of reservoir storage in the dam breach flood peak is 4918 cumec. The maximum discharge, water level and their time of occurrence at different locations of the River downstream of the dams are given in **Table 12.3 and 12.4** respectively.

Table 12.3: Maximum discharge due to dam breach flood (breach initial width 43.68 m and breach depth 21.84 m)

<i>The breach has been assumed to start on 28-09-2018 11:00:00</i>		
<i>hours</i>		
<i>Chainage (m) d/s of dam</i>	<i>Maximum discharge (cumec)</i>	<i>Time of occurrence (Date:hours:Minutes:Seconds)</i>
PARBATI 200.00	22894	28-09-2018 12:00:45
PARBATI 800.00	22834	28-09-2018 12:01:30
PARBATI 1600.00	22749	28-09-2018 12:02:30
PARBATI 2500.00	22656	28-09-2018 12:03:45
PARBATI 3500.00	22554	28-09-2018 12:04:59
PARBATI 4500.00	22452	28-09-2018 12:06:15

The breach has been assumed to start on 28-09-2018 11:00:00 hours		
<i>Chainage (m) d/s of dam</i>	<i>Maximum discharge (cumec)</i>	<i>Time of occurrence (Date:hours:Minutes:Seconds)</i>
PARBATI 5500.00	22354	28-09-2018 12:07:15
PARBATI 6500.00	22259	28-09-2018 12:08:29
PARBATI 7500.00	22166	28-09-2018 12:09:44
PARBATI 8500.00	22073	28-09-2018 12:11:00
PARBATI 9500.00	21979	28-09-2018 12:12:14
PARBATI 10500.00	21883	28-09-2018 12:13:14
PARBATI 11500.00	21785	28-09-2018 12:14:29
PARBATI 12500.00	21686	28-09-2018 12:15:45
PARBATI 13500.00	21592	28-09-2018 12:16:59
PARBATI 14500.00	21500	28-09-2018 12:18:14
PARBATI 15500.00	21404	28-09-2018 12:19:30
PARBATI 16500.00	21304	28-09-2018 12:20:44
PARBATI 17500.00	21202	28-09-2018 12:22:15
PARBATI 18500.00	21130	28-09-2018 12:30:59
PARBATI 19500.00	21113	28-09-2018 12:37:30
PARBATI 20500.00	21103	28-09-2018 12:39:00
PARBATI 21500.00	21091	28-09-2018 12:40:29
PARBATI 22500.00	21076	28-09-2018 12:42:14
PARBATI 23500.00	21056	28-09-2018 12:46:14
PARBATI 24500.00	21030	28-09-2018 12:47:59
PARBATI 25500.00	20995	28-09-2018 12:49:15
PARBATI 26500.00	20955	28-09-2018 12:52:15
PARBATI 27500.00	20920	28-09-2018 12:54:44
PARBATI 28500.00	20888	28-09-2018 12:58:00
PARBATI 29500.00	20858	28-09-2018 13:00:30
PARBATI 30500.00	20828	28-09-2018 13:02:45
PARBATI 31500.00	20793	28-09-2018 13:05:59
PARBATI 32500.00	20758	28-09-2018 13:10:15
PARBATI 33500.00	20730	28-09-2018 13:14:00
PARBATI 34500.00	20705	28-09-2018 13:17:30
PARBATI 35500.00	20682	28-09-2018 13:20:15
PARBATI 36500.00	20660	28-09-2018 13:23:00
PARBATI 37500.00	20640	28-09-2018 13:26:00
PARBATI 38500.00	20621	28-09-2018 13:29:00
PARBATI 39500.00	20603	28-09-2018 13:31:45
PARBATI 40500.00	20585	28-09-2018 13:34:59
PARBATI 41500.00	20567	28-09-2018 13:38:00
PARBATI 42500.00	20549	28-09-2018 13:41:00
PARBATI 43500.00	20531	28-09-2018 13:44:29
PARBATI 44500.00	20513	28-09-2018 13:47:59
PARBATI 45500.00	20495	28-09-2018 13:51:30
PARBATI 46500.00	20477	28-09-2018 13:55:29
PARBATI 47500.00	20457	28-09-2018 14:00:45
PARBATI 48500.00	20440	28-09-2018 14:06:59
PARBATI 49500.00	20432	28-09-2018 14:12:14
PARBATI 50500.00	20429	28-09-2018 14:16:30

Table 12.4: Maximum water level due to dam breach flood breach initial width 43.68 m and breach depth 21.84 m

The breach has been assumed to start on 28-09-2018 11:00:00 hours

Chainage (m) d/s of dam	Bed Level (m)	Maximum discharge (cumec)	Time of occurrence (Date:hours:Minutes:Seconds)
PARBATI 0.00	426.1	443.17	28-09-2018 12:02:45
PARBATI 400.00	425.1	443.29	28-09-2018 12:01:30
PARBATI 1200.00	*	442.81	28-09-2018 12:02:45
PARBATI 2000.00	425.1	442.17	28-09-2018 12:03:59
PARBATI 3000.00	*	441.65	28-09-2018 12:10:00
PARBATI 4000.00	425.1	441.24	28-09-2018 12:15:30
PARBATI 5000.00	*	440.90	28-09-2018 12:17:59
PARBATI 6000.00	424.1	440.63	28-09-2018 12:23:44
PARBATI 7000.00	*	440.33	28-09-2018 12:28:29
PARBATI 8000.00	422.1	440.06	28-09-2018 12:31:14
PARBATI 9000.00	*	439.82	28-09-2018 12:35:30
PARBATI 10000.00	422.1	439.59	28-09-2018 12:37:15
PARBATI 11000.00	*	439.36	28-09-2018 12:37:15
PARBATI 12000.00	422.1	439.12	28-09-2018 12:37:30
PARBATI 13000.00	*	438.81	28-09-2018 12:38:15
PARBATI 14000.00	422.1	438.45	28-09-2018 12:39:44
PARBATI 15000.00	*	438.13	28-09-2018 12:40:44
PARBATI 16000.00	422.1	437.82	28-09-2018 12:41:45
PARBATI 17000.00	*	437.44	28-09-2018 12:43:00
PARBATI 18000.00	421.1	437.00	28-09-2018 12:42:14
PARBATI 19000.00	*	436.35	28-09-2018 12:44:00
PARBATI 20000.00	421.1	435.15	28-09-2018 12:46:59
PARBATI 21000.00	*	434.11	28-09-2018 12:49:59
PARBATI 22000.00	420.1	433.00	28-09-2018 12:55:15
PARBATI 23000.00	*	431.99	28-09-2018 13:01:59
PARBATI 24000.00	418.1	431.00	28-09-2018 13:11:29
PARBATI 25000.00	*	430.41	28-09-2018 13:17:45
PARBATI 26000.00	413.1	430.09	28-09-2018 13:20:44
PARBATI 27000.00	*	429.85	28-09-2018 13:22:44
PARBATI 28000.00	413.1	429.68	28-09-2018 13:24:00
PARBATI 29000.00	*	429.28	28-09-2018 13:27:14
PARBATI 30000.00	413.1	428.62	28-09-2018 13:32:45
PARBATI 31000.00	*	428.49	28-09-2018 13:34:15
PARBATI 32000.00	413.1	428.42	28-09-2018 13:34:59
PARBATI 33000.00	*	428.08	28-09-2018 13:37:30
PARBATI 34000.00	413.1	427.46	28-09-2018 13:41:45
PARBATI 35000.00	*	427.16	28-09-2018 13:44:00
PARBATI 36000.00	411.1	426.97	28-09-2018 13:45:30
PARBATI 37000.00	*	426.64	28-09-2018 13:47:59
PARBATI 38000.00	411.1	426.21	28-09-2018 13:50:30
PARBATI 39000.00	*	425.80	28-09-2018 13:53:44
PARBATI 40000.00	411.1	425.37	28-09-2018 13:56:29
PARBATI 41000.00	*	424.85	28-09-2018 13:59:45
PARBATI 42000.00	410.1	424.25	28-09-2018 14:03:45
PARBATI 43000.00	*	423.71	28-09-2018 14:06:30
PARBATI 44000.00	410.1	423.17	28-09-2018 14:10:15
PARBATI 45000.00	*	422.57	28-09-2018 14:13:00
PARBATI 46000.00	410.1	421.91	28-09-2018 14:16:45
PARBATI 47000.00	*	421.84	28-09-2018 14:16:59
PARBATI 48000.00	405.1	421.81	28-09-2018 14:16:59
PARBATI 49000.00	*	421.62	28-09-2018 14:17:45
PARBATI 50000.00	*	421.33	28-09-2018 14:17:30
PARBATI 51000.00	405.1	420.87	28-09-2018 14:17:45

* cross sections interpolated by MIKE11

From the **Table 12.4** it can be seen that the rise in water level along the reach of the river is about 11.80 m to 18.19 m.

12.16 MAXIMUM WATER LEVEL IN THE VIRGIN CONDITION OF THE RIVER DUE TO OCCURRENCE OF DESIGN FLOOD

To know the maximum discharge and water level due to occurrence of DESIGN FLOOD in the virgin condition of the River the necessary simulation has been run. In this case, the DESIGN FLOOD has been impinged at chainage "0" of the River (just d/s of dam site) without considering the dam. The maximum discharge and water level obtained at the different locations along the river reach is given in **Table 12.5** and **12.6** respectively.

Table 12.5: Maximum discharge due to occurrence of DESIGN FLOOD in virgin river condition

<i>The Design Flood has been impinged at chainage "0" of River on 28-09-2018 at 11:00:00 hr</i>		
<i>Chainage (m) d/s of dam</i>	<i>Maximum discharge (cumec)</i>	<i>Time of occurrence (Date:hours:Minutes:Seconds)</i>
PARBATI 200.00	19852	28-09-2018 11:00:14
PARBATI 800.00	19846	28-09-2018 11:00:59
PARBATI 1600.00	19837	28-09-2018 11:01:59
PARBATI 2500.00	19827	28-09-2018 11:03:14
PARBATI 3500.00	19815	28-09-2018 11:04:44
PARBATI 4500.00	19803	28-09-2018 11:05:59
PARBATI 5500.00	19791	28-09-2018 11:07:15
PARBATI 6500.00	19779	28-09-2018 11:08:29
PARBATI 7500.00	19767	28-09-2018 11:09:44
PARBATI 8500.00	19755	28-09-2018 11:11:15
PARBATI 9500.00	19744	28-09-2018 11:12:29
PARBATI 10500.00	19732	28-09-2018 11:13:45
PARBATI 11500.00	19720	28-09-2018 11:15:00
PARBATI 12500.00	19709	28-09-2018 11:16:30
PARBATI 13500.00	19698	28-09-2018 11:17:59
PARBATI 14500.00	19687	28-09-2018 11:19:30
PARBATI 15500.00	19677	28-09-2018 11:20:59
PARBATI 16500.00	19668	28-09-2018 11:33:14
PARBATI 17500.00	19663	28-09-2018 11:35:44
PARBATI 18500.00	19659	28-09-2018 11:41:00
PARBATI 19500.00	19657	28-09-2018 11:43:14
PARBATI 20500.00	19655	28-09-2018 11:45:00
PARBATI 21500.00	19653	28-09-2018 11:46:30
PARBATI 22500.00	19650	28-09-2018 11:48:30
PARBATI 23500.00	19647	28-09-2018 11:50:44
PARBATI 24500.00	19641	28-09-2018 11:53:00
PARBATI 25500.00	19634	28-09-2018 11:56:00
PARBATI 26500.00	19626	28-09-2018 11:58:45
PARBATI 27500.00	19619	28-09-2018 12:01:45
PARBATI 28500.00	19613	28-09-2018 12:04:44
PARBATI 29500.00	19607	28-09-2018 12:07:30
PARBATI 30500.00	19601	28-09-2018 12:10:15
PARBATI 31500.00	19594	28-09-2018 12:13:45
PARBATI 32500.00	19586	28-09-2018 12:17:30
PARBATI 33500.00	19580	28-09-2018 12:21:15
PARBATI 34500.00	19575	28-09-2018 12:24:15
PARBATI 35500.00	19569	28-09-2018 12:27:14

The Design Flood has been impinged at chainage "0" of River on 28-09-2018 at 11:00:00 hr		
Chainage (m) d/s of dam	Maximum discharge (cumec)	Time of occurrence (Date:hours:Minutes:Seconds)
PARBATI 36500.00	19564	28-09-2018 12:30:30
PARBATI 37500.00	19560	28-09-2018 12:33:45
PARBATI 38500.00	19556	28-09-2018 12:36:44
PARBATI 39500.00	19552	28-09-2018 12:40:00
PARBATI 40500.00	19548	28-09-2018 12:43:00
PARBATI 41500.00	19544	28-09-2018 12:45:59
PARBATI 42500.00	19540	28-09-2018 12:49:15
PARBATI 43500.00	19536	28-09-2018 12:52:15
PARBATI 44500.00	19532	28-09-2018 12:55:29
PARBATI 45500.00	19528	28-09-2018 12:58:45
PARBATI 46500.00	19524	28-09-2018 13:02:14
PARBATI 47500.00	19519	28-09-2018 13:06:44
PARBATI 48500.00	19515	28-09-2018 13:12:29
PARBATI 49500.00	19513	28-09-2018 13:17:30
PARBATI 50500.00	19512	28-09-2018 13:21:30

Table 12.6: Maximum water level due to occurrence of DESIGN FLOOD in virgin river condition

The Design Flood has been impinged at chainage "0" of River on 28-09-2018 at 11:00:00 hr			
Chainage (m) d/s of dam	Bed Level (m)	Maximum water level (m)	Time of occurrence (Date:hours:Minutes:Seconds)
PARBATI 0.00	426.1	442.52	28-09-2018 11:06:15
PARBATI 400.00	425.1	442.60	28-09-2018 11:05:15
PARBATI 1200.00	*	442.15	28-09-2018 11:06:30
PARBATI 2000.00	425.1	441.55	28-09-2018 11:12:14
PARBATI 3000.00	*	441.06	28-09-2018 11:18:14
PARBATI 4000.00	425.1	440.67	28-09-2018 11:23:15
PARBATI 5000.00	*	440.34	28-09-2018 11:27:00
PARBATI 6000.00	424.1	440.07	28-09-2018 11:29:29
PARBATI 7000.00	*	439.79	28-09-2018 11:32:30
PARBATI 8000.00	422.1	439.52	28-09-2018 11:34:59
PARBATI 9000.00	*	439.29	28-09-2018 11:36:59
PARBATI 10000.00	422.1	439.06	28-09-2018 11:39:00
PARBATI 11000.00	*	438.83	28-09-2018 11:39:29
PARBATI 12000.00	422.1	438.59	28-09-2018 11:40:44
PARBATI 13000.00	*	438.29	28-09-2018 11:42:45
PARBATI 14000.00	422.1	437.93	28-09-2018 11:43:45
PARBATI 15000.00	*	437.62	28-09-2018 11:44:45
PARBATI 16000.00	422.1	437.31	28-09-2018 11:46:59
PARBATI 17000.00	*	436.93	28-09-2018 11:47:14
PARBATI 18000.00	421.1	436.49	28-09-2018 11:48:14
PARBATI 19000.00	*	435.86	28-09-2018 11:49:59
PARBATI 20000.00	421.1	434.70	28-09-2018 11:53:15
PARBATI 21000.00	*	433.68	28-09-2018 11:57:14
PARBATI 22000.00	420.1	432.60	28-09-2018 12:01:59
PARBATI 23000.00	*	431.60	28-09-2018 12:10:00
PARBATI 24000.00	418.1	430.61	28-09-2018 12:18:14
PARBATI 25000.00	*	430.01	28-09-2018 12:24:00
PARBATI 26000.00	413.1	429.69	28-09-2018 12:27:00
PARBATI 27000.00	*	429.46	28-09-2018 12:29:14
PARBATI 28000.00	413.1	429.29	28-09-2018 12:30:30
PARBATI 29000.00	*	428.90	28-09-2018 12:33:30
PARBATI 30000.00	413.1	428.26	28-09-2018 12:40:00
PARBATI 31000.00	*	428.12	28-09-2018 12:40:15
PARBATI 32000.00	413.1	428.05	28-09-2018 12:41:15
PARBATI 33000.00	*	427.72	28-09-2018 12:44:14

The Design Flood has been impinged at chainage "0" of River on 28-09-2018 at 11:00:00 hr			
Chainage (m) d/s of dam	Bed Level (m)	Maximum water level (m)	Time of occurrence (Date:hours:Minutes:Seconds)
PARBATI 34000.00	413.1	427.10	28-09-2018 12:47:45
PARBATI 35000.00	*	426.80	28-09-2018 12:49:59
PARBATI 36000.00	411.1	426.62	28-09-2018 12:50:44
PARBATI 37000.00	*	426.29	28-09-2018 12:53:29
PARBATI 38000.00	411.1	425.87	28-09-2018 12:55:44
PARBATI 39000.00	*	425.47	28-09-2018 12:58:45
PARBATI 40000.00	411.1	425.04	28-09-2018 13:00:45
PARBATI 41000.00	*	424.53	28-09-2018 13:03:45
PARBATI 42000.00	410.1	423.92	28-09-2018 13:06:59
PARBATI 43000.00	*	423.38	28-09-2018 13:10:00
PARBATI 44000.00	410.1	422.84	28-09-2018 13:13:14
PARBATI 45000.00	*	422.24	28-09-2018 13:16:59
PARBATI 46000.00	410.1	421.57	28-09-2018 13:21:15
PARBATI 47000.00	*	421.49	28-09-2018 13:20:59
PARBATI 48000.00	405.1	421.46	28-09-2018 13:22:15
PARBATI 49000.00	*	421.27	28-09-2018 13:22:30
PARBATI 50000.00	*	420.98	28-09-2018 13:21:44
PARBATI 51000.00	405.1	420.53	28-09-2018 13:21:44

* cross sections interpolated by MIKE11

The rise in water level along the reach of the river downstream of the dam is about 11.47 m to 17.50 m.

12.17 COMPARISON OF MAXIMUM DISCHARGE AND WATER LEVEL

For the different hydrodynamic scenario simulated so far, the maximum discharge and water level occurring at different locations of River downstream of dam have been compared in **Table 12.7** and **12.8** respectively.

Table 12.7: Comparison of maximum discharge obtained in different cases

Chainage (m) d/s of dam	Maximum discharge (cumec)	
	DESIGN FLOOD and dam breach (<i>Table 12.5</i>)	DESIGN FLOOD in virgin condition (<i>Table 12.6</i>)
PARBATI 200.00	24772	19852
PARBATI 800.00	24436	19846
PARBATI 1600.00	24107	19837
PARBATI 2500.00	23852	19827
PARBATI 3500.00	23432	19815
PARBATI 4500.00	22854	19803
PARBATI 5500.00	22354	19791
PARBATI 6500.00	22259	19779
PARBATI 7500.00	22166	19767
PARBATI 8500.00	22073	19755
PARBATI 9500.00	21979	19744
PARBATI 10500.00	21883	19732
PARBATI 11500.00	21785	19720
PARBATI 12500.00	21686	19709
PARBATI 13500.00	21592	19698
PARBATI 14500.00	21500	19687
PARBATI 15500.00	21404	19677
PARBATI 16500.00	21304	19668
PARBATI 17500.00	21202	19663
PARBATI 18500.00	21130	19659

Chainage (m) d/s of dam	Maximum discharge (cumec)	
	DESIGN FLOOD and dam breach (<i>Table 12.5</i>)	DESIGN FLOOD in virgin condition (<i>Table 12.6</i>)
PARBATI 19500.00	21113	19657
PARBATI 20500.00	21103	19655
PARBATI 21500.00	21091	19653
PARBATI 22500.00	21076	19650
PARBATI 23500.00	21056	19647
PARBATI 24500.00	21030	19641
PARBATI 25500.00	20995	19634
PARBATI 26500.00	20955	19626
PARBATI 27500.00	20920	19619
PARBATI 28500.00	20888	19613
PARBATI 29500.00	20858	19607
PARBATI 30500.00	20828	19601
PARBATI 31500.00	20793	19594
PARBATI 32500.00	20758	19586
PARBATI 33500.00	20730	19580
PARBATI 34500.00	20705	19575
PARBATI 35500.00	20682	19569
PARBATI 36500.00	20660	19564
PARBATI 37500.00	20640	19560
PARBATI 38500.00	20621	19556
PARBATI 39500.00	20603	19552
PARBATI 40500.00	20585	19548
PARBATI 41500.00	20567	19544
PARBATI 42500.00	20549	19540
PARBATI 43500.00	20531	19536
PARBATI 44500.00	20513	19532
PARBATI 45500.00	20495	19528
PARBATI 46500.00	20477	19524
PARBATI 47500.00	20457	19519
PARBATI 48500.00	20440	19515
PARBATI 49500.00	20432	19513
PARBATI 50500.00	20429	19512

Table 12.8: Comparison of maximum water level obtained in different cases

Chainage (m) d/s of dam	Bed Level (m)	Maximum water level (m)	
		DESIGN FLOOD and dam breach (<i>Table 12.5</i>)	DESIGN FLOOD in virgin condition (<i>Table 12.6</i>)
PARBATI 0.00	426.1	443.17	442.52
PARBATI 400.00	425.1	443.29	442.60
PARBATI 1200.00	*	442.81	442.15
PARBATI 2000.00	425.1	442.17	441.55
PARBATI 3000.00	*	441.65	441.06
PARBATI 4000.00	425.1	441.24	440.67
PARBATI 5000.00	*	440.90	440.34
PARBATI 6000.00	424.1	440.63	440.07
PARBATI 7000.00	*	440.33	439.79
PARBATI 8000.00	422.1	440.06	439.52
PARBATI 9000.00	*	439.82	439.29
PARBATI 10000.00	422.1	439.59	439.06
PARBATI 11000.00	*	439.36	438.83
PARBATI 12000.00	422.1	439.12	438.59
PARBATI 13000.00	*	438.81	438.29
PARBATI 14000.00	422.1	438.45	437.93

Chainage (m) d/s of dam	Bed Level (m)	Maximum water level (m)	
		DESIGN FLOOD and dam breach (<i>Table 12.5</i>)	DESIGN FLOOD in virgin condition (<i>Table 12.6</i>)
PARBATI 15000.00	*	438.13	437.62
PARBATI 16000.00	422.1	437.82	437.31
PARBATI 17000.00	*	437.44	436.93
PARBATI 18000.00	421.1	437.00	436.49
PARBATI 19000.00	*	436.35	435.86
PARBATI 20000.00	421.1	435.15	434.70
PARBATI 21000.00	*	434.11	433.68
PARBATI 22000.00	420.1	433.00	432.60
PARBATI 23000.00	*	431.99	431.60
PARBATI 24000.00	418.1	431.00	430.61
PARBATI 25000.00	*	430.41	430.01
PARBATI 26000.00	413.1	430.09	429.69
PARBATI 27000.00	*	429.85	429.46
PARBATI 28000.00	413.1	429.68	429.29
PARBATI 29000.00	*	429.28	428.90
PARBATI 30000.00	413.1	428.62	428.26
PARBATI 31000.00	*	428.49	428.12
PARBATI 32000.00	413.1	428.42	428.05
PARBATI 33000.00	*	428.08	427.72
PARBATI 34000.00	413.1	427.46	427.10
PARBATI 35000.00	*	427.16	426.80
PARBATI 36000.00	411.1	426.97	426.62
PARBATI 37000.00	*	426.64	426.29
PARBATI 38000.00	411.1	426.21	425.87
PARBATI 39000.00	*	425.80	425.47
PARBATI 40000.00	411.1	425.37	425.04
PARBATI 41000.00	*	424.85	424.53
PARBATI 42000.00	410.1	424.25	423.92
PARBATI 43000.00	*	423.71	423.38
PARBATI 44000.00	410.1	423.17	422.84
PARBATI 45000.00	*	422.57	422.24
PARBATI 46000.00	410.1	421.91	421.57
PARBATI 47000.00	*	421.84	421.49
PARBATI 48000.00	405.1	421.81	421.46
PARBATI 49000.00	*	421.62	421.27
PARBATI 50000.00	*	421.33	420.98
PARBATI 51000.00	405.1	420.87	420.53

* cross sections interpolated by MIKE11

From the **Table 12.8**, it can be concluded that the rise in water level along the river reach in dam breach condition is about 0.33 m to 0.69 m more in comparison to non dam breach condition (col. 3 &4)

The water levels given in **Table 12.7** can be used for the preparation of inundation map. The tables of few cross sections of the River used have been given in **Table 12.8**. The maximum water level at these cross sections due to dam breach flood has also been superimposed over them.

12.18 PREPARATION OF INUNDATION MAP

An inundation map (**Figure 12.5**) is a map depicting the d/s areas vulnerable to inundation by the Dam break flood. The MIKE11 model computes maximum flood elevation at each original or interpolated cross-section. In present case, the cross-sections are available up to 51000 m d/s of Dam. The profile of water levels below the Dam at all cross-sections (original and interpolated) is given as **Table 12.8**. 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.

From the **Table 12.8**, *it can be concluded that the rise in water level along the river reach in dam breach condition is only about 0.33 m to 0.69 m more in comparison to non dam breach condition which is almost insignificant. It can be concluded that flood attributable to dam break scenario is insignificant.* Still, impact has been assessed in case on design flood as well as design flood with dam break scenario both

It is clear from the inundation map that in case of design flood plus Dam break scenario, following villages are likely to be affected :

S. No.	Village Name	S. No.	Village Name	S. No.	Village Name
1	Amarpur Chhoti	14	Dhamantori	27	Mengalgarh
2	Bajawan Kalan	15	Dongergaon	28	Mengra
3	Bandikheri	16	Ghogalpur	29	Mualiya
4	Baniyatori	17	Hanapura	30	Parason
5	Bansiya	18	Kajikhara	31	Paror
6	Barayatha	19	Kanarkheri	32	Pater
7	Barbatpura	20	Kankriya	33	Pilikarar
8	Barkhera	21	Kherar	34	Pipakheri
9	Barkheri Garhi	22	Kherkheri	35	Raghunathpura
10	Berar	23	Khuda	36	Somlapar
11	Bhakuwaha	24	Kishangarh	37	Sumer
12	Bhatpura	25	Kotra	38	Tejakheri
13	Chauki	26	Lakariya		

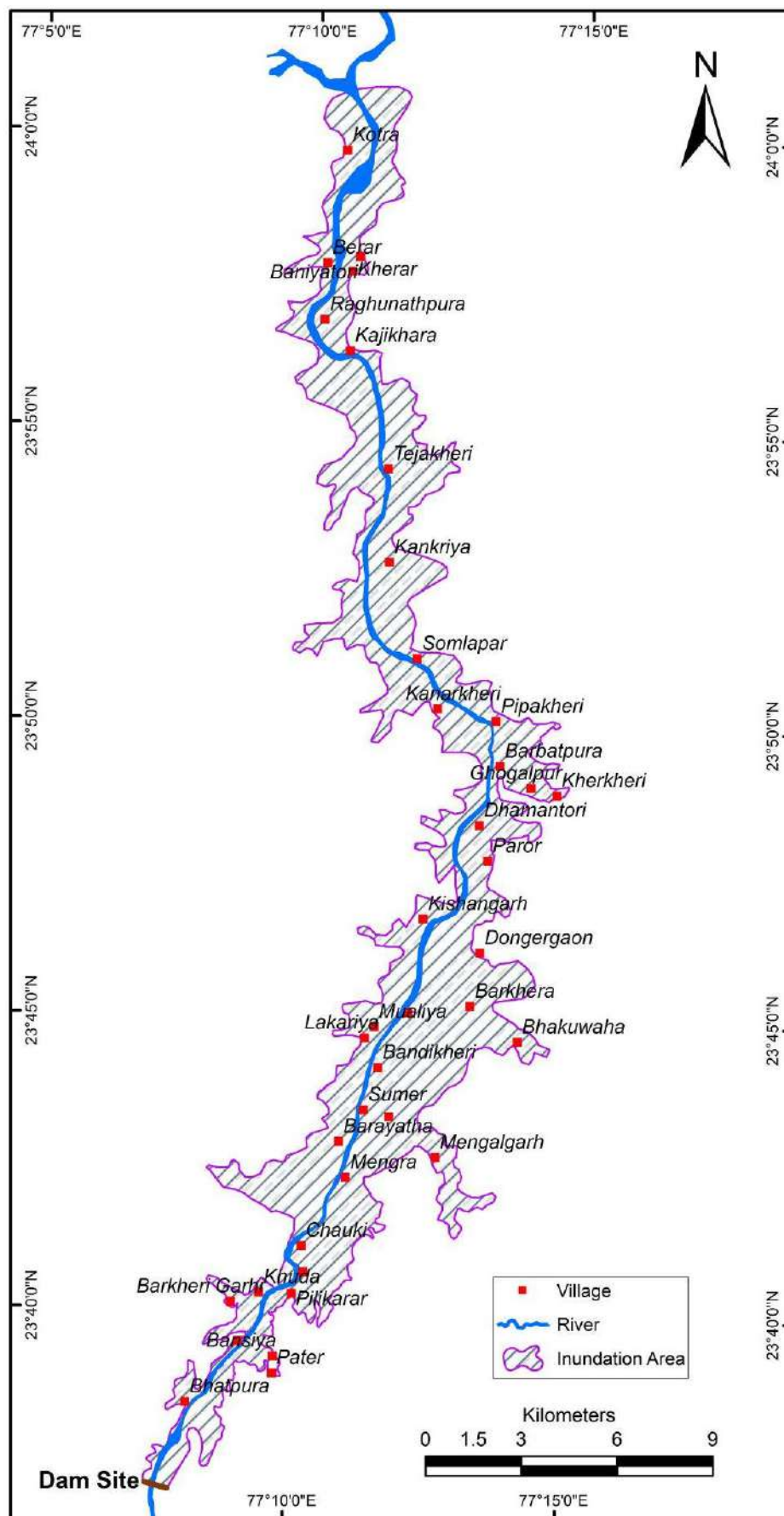


Figure 12.5: Inundation Map

12.19 DISASTER MANAGEMENT PLAN

In order to cope with the probable disaster a comprehensive and integrated Disaster Management Plan (DMP) should be prepared which is participative and people oriented. The concise management system should incorporate both pre-and post-disaster responses with the sole aim of being prepared for prevention and mitigation with lessening loss of life and property due to natural as well as man-made disasters.

The main objectives of DMP are as follows:

- Establish early warnings and alert system
- Assessment of the damage potential
- Formulation of Emergency Action plan
- Emergency organization and constitution of first response/action teams.
- Defining roles and responsibilities of key personnel responsible for Disaster Response
- Training of the personnel for disaster events
- Setting up of procedures for mitigation
- Mapping of safe access routes and safe locations
- Formulation of Emergency Action Plan
- Dissemination of information to public

12.19.1 Vulnerability Assessment of project

From the result of Dam Break Modeling it is evident that up to about 51000 m³/s of the Dam, time required in reaching the flood wave elevation to the maximum is about 2.25 hour. It doesn't leave much possibility of any rescue or evacuation. Since the time available is very short, the Disaster Management Plan should concentrate on preventive actions. Also as evident from the inundation map, that in case of design flood plus Dam break scenario, few villages (as tabulated above) are likely to be affected, Disaster Management Plan is more of a precautionary measure.

12.19.1.1 Surveillance & Monitoring

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 effective 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.

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, apart from informing in an appropriate manner the relevant authorities. 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 DESIGN FLOOD, 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 few 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 only one 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.

- 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.

Therefore in case of any disaster resulting from dam break the following steps are planned:

- In the event of any unusual weather phenomena, alarm should be sounded in the project and all the operations and machines in operation should be automatically tripped.
- During the unusually high rainfall constant vigil should be kept on the slopes near project structures for any possible sliding or slippage. If anything is detected appropriate measures should be taken to take preventive action for checking damage to the hill slope down under.
- Requisite training of the project staff should be done apprising them of first aid practices and what actions are required to be taken following a natural disaster.

12.19.2 Disaster Management Plan (DMP) for Project

A Disaster Management Plan essentially consists of Disaster Response Plan, Contingency Plans and Standard Operating Procedures (SOPs). A well-coordinated Disaster Response Plan, which makes best use of the organisation's combined expertise and resources, is essential for efficient and successful disaster response. During an actual emergency, rapid and effective action is required. For this to happen, disaster response and contingency plans must be in place before a disaster strikes along with the necessary resources. If appropriate action is not taken or if the response is delayed, lives may be needlessly lost.

12.19.2.1 Disaster Response Plan

Though many details remain unknown until an actual disaster occurs nevertheless, it is essential to prepare a preliminary disaster plan, which should include:

- an overview of all available resources;
- identification of emergency shelter sites;

- relief activity planning, including the identification of suppliers, warehouses and transportation means;
- identification of emergency water sources;
- establishment of chains of command and communication procedures;
- training of response personnel;
- community education and awareness-raising activities about what to do in case of an emergency; and,
- identification and implementation of key mitigation and early-warning activities.

12.19.2.2 Contingency Plan

The Contingency Plan comprises of the following:

- Emergency assessment
- Continuity of operations during an emergency
- Rescue and medical assistance
- Health services
- Water, sanitation and hygiene promotion
- Food and nutrition
- Relief
- Shelter
- Protection, safety and security
- Logistics and transport
- Information technology (IT) and telecommunications
- Communication and reporting
- Monitoring and evaluation

12.19.2.3 Awareness and Emergency Preparedness

Emergency preparedness requires the identification of the emergency response participants and to establish their roles, resources and concerns. It requires evaluation of the risks and hazards that may result in emergency situations in the community, review of participant's emergency plan for adequacy relative to a coordinated response, including the adequacy of communication plans. The following points need to be reviewed under this:

- Identification of the required response tasks not covered by the existing plans
- Matching of these tasks to the resources available at the sites
- Making the changes necessary to improve existing plans, integrating the same into an overall emergency response and communication plan and gain agreement
- Committing of the integrated plan to writing and obtain approvals from local governments

- Establishing procedures for periodic testing, review and updating of the plan
- Communicating the integrated plan to the general community.

12.19.2.4 Emergency Action Plan (EAP)

The Emergency Action Plan shall include all the potential indicators of disasters, since the primary concern is for timely and reliable identification and evaluation of potential emergency. Once the Emergency situation is foreseen, the Emergency Action Plan may be put in operation, which may include:

- Areas likely to be inundated and evacuated with priorities to be notified.
- Safe routes to be used for evacuation. Such routes have to be identified, discussed and planned sufficiently in advance for proper implementation of the Plan.
- Means of transportation.
- Traffic Control.
- Shelters for evacuees.
- Procedures for care and security of property from evacuated areas from anti-social elements.
- Instructions regarding assignment of specific functions and responsibilities of various members of evacuation teams

This plan presents warning and notification procedures to be followed in case of potential disaster. The purpose is to provide timely warning to nearby residents and alert key personnel responsible for taking action in case of an emergency. For this Early Warning Systems (EWS) like sirens should be installed at key locations in the project area. In this project two sirens are proposed.

12.19.2.5 Emergency Response Cell (ERC)

The Emergency Response Cell (ERC) at project should be constituted by the Project Implementation Unit (PIU) which would be responsible for implementation of Emergency Action Plan (EAP). The PM will be assisted by Project Emergency Coordinator (PEC) and Emergency Management Group (EMG) at PIU. The Administrative and Procedural Aspects of Emergency Action Plan shall consist of a flowchart depicting the names, addresses and telephone numbers of the responsible officials.

12.19.2.6 Functions & Responsibilities of PEC & EMG

In the event of potential emergency, the observer at the site is required to report it to the PM, PEC and EMG at PIU through a wireless system, if available, or by

the fastest communication system available. The PM shall be responsible for contacting the Civil Administration. In order to oversee all the operations required to tackle the emergency situations, a centralized control room could be set up by the project authorities near dam site.

Each person would be made aware of his/her responsibilities/ duties and the importance of work assigned under the Emergency Action Plan. All the villages falling under the flood prone zone or on the margins would be connected through wireless communication system with backup of standby telephone lines.

12.19.2.7 Emergency Control Centre (ECC)

In order to coordinate all the actions to be taken in case of disaster Emergency Control Centre (ECC) or Crisis Management Centre (CMC) should be at the centre of operations to handle the emergency which will give directions and execution orders. The ECC will be equipped with resources to receive and transmit information and directions from the PEC. The PIU should ensure that the ECC starts activating other systems without any delay once the hazard is declared. A pre-designated room located at a safe location will be converted as ECC. It should have the following equipment and paraphernalia:

- At least two landline telephones (one incoming and the other one out going fitted with simultaneous/ selective broadcasting systems) connected through an EPBAX.
- Wireless Communication System/ Radio equipment (VHF/ Walkie Talkies/mobiles).
- Vulnerable Area maps marking risk prone zones, assembly points, alternate evacuation routes, safe areas, rehabilitation centers, etc.
- Telephone directory of emergency response system and that of important district and PIUs.
- An inventory of all emergency equipment and personnel for evacuation, personnel protection, medical aid, etc., under the plan as well as with government agencies in the district.
- List of ambulances, base medical facilities, hospitals, rehabilitation centers, etc.
- Copies of Disaster Management Plan

12.19.2.8 Communication System

In addition to setting up of alert and warning systems, emergency communication systems also need to be established for effective communications within the identified affected zones. For this an up-to-date

telephone directory of key personnel concerned with the emergency should be prepared and made available to all concerned. In order to coordinate efficiently various communications, a communication coordinator (skilled telephone operator or PA) may be appointed at the time of emergency for maintaining a log book for the messages received in/ out and actions taken. Standby power backup and maintenance of communication equipment should be given utmost importance.

An efficient communication system and a downstream warning system are 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. In this project 2 sirens are proposed one at dam site and second one at least 5-10 km downstream of dam in the command. In addition, a centralized siren system is to be installed at project headquarters so that in event of a warning, all villages in the project area and at vulnerable locations can be alerted through early warning system discussed already.

i) Merits of Satellite Communication System

Keeping the disaster scenario in mind, any terrestrial system such as land lines, etc. is likely to be the first casualty in earthquakes or floods. The restoration of such systems is time consuming. Moreover the maintenance of such lines becomes a great problem in emergency even for the technical personnel who are required to reach the site of fault, which may be struck by the disaster. So the system cannot be put back into operation soon. The fault repairs and restoration of communication services are usually not possible for a considerable period of time after the calamity has struck. Moreover, it is critical that the communication systems are restored at the earliest so that relief/medical teams and other personnel can be arranged at the earliest possible time. All the subsidiary help depends solely on the communication system. As this criteria is paramount, existing systems such as telephones and telex, etc. are practically of little use in case of such events and situations. Similarly, microwave links are expected to be down due to collapse of towers, etc. Restoration of towers and alignment of equipment is again a time consuming activity.

Keeping in view the urgency of services and their dependability during emergency relevant to the disaster conditions, satellite based systems present an ideal solution. The satellite based system usually comprises following components.

- i) A small dish of approximately one-meter diameter
- ii) Associated radio equipment
- iii) A power source

The deployment of the system is not dependent on the restoration of land routes. The existing satellite-based communication systems are designed in such a manner that they are able to withstand fairly high degree of demanding environmental conditions. Secondly, the restoration of the satellite based system can be undertaken by carrying maintenance personnel and equipment by helicopters at a very short notice. Even the fresh systems could be inducted in a matter of an hour or so because most of these are designed for transportability by air. The deployment takes usually less than an hour. The power requirements are not large and can be met by sources such as UPS/batteries/ generators.

An efficient and reliable communications system is required for the success of disaster management plan. The proposed communications systems must essentially integrate the following into an Emergency Communication System:

- An Alert System
- A warning or control system
- An Emergency communication system

12.19.2.9 Emergency Alert System

An emergency alert is to be provided to the public immediately after sensing the hazard, based on the first response (FR) received from any source. Chief Emergency Coordinator should activate emergency Control Centre, and the Emergency Alert may be disseminated. Initially, attempts be made to control or localise the event in the first instance by looking into all technical aspects of the hazard and if necessary activate the needed emergency action groups to localize the event as a first response measure. If it is not possible to control the emergency, on- site emergency be declared and response action be initiated in accordance with the plan.

12.19.2.10 Emergency Warning and Control System

Based on the report of Emergency alert, the emergency is to be notified. If the Principal Emergency Coordinator (PEC) determines that the disaster is inevitable and is likely to adversely affect the public in the project area, he triggers the Emergency Control Centre and activates emergency response under on-site plan. He also immediately notifies accordingly the District Collector about the situation.

Therefore, in the process of notification, the concerned regulatory authorities are alerted and public is to be alerted by appropriate warning systems such as sirens, alarms and broadcasts.

Each type of emergency has to be given a code for easy identification of the type of emergency as also for notifying and seeking the support from various agencies. Suggested warning systems of sirens are as follows:

- Disaster Warning: High pitched continuous wailing siren
- All clear: Long continuous note

These alarms/ sirens should be deployed such that the all affected zones are covered. Communication devices like Radio, Walkie-talkie and Paging system are extremely useful for during emergency situations, for which predetermined codes need to be developed.

12.19.2.11 Health & Medical Response System

In the event of emergency health care personnel like doctors, surgeons; hospitals and ambulances have a vital part to play as they comprise an integral part of medical and health emergency plan. The medical response plan is required to cater for immediate pooling of all available medical resources and provide emergency medical treatment to the victims of the incident. A coordinated utilisation of all available local medical resources in the affected areas as well as the additional resources should be mobilized under the overall charge of the on-site plan.

12.19.2.12 Training

Even a very well prepared Disaster Management Plan cannot be effective unless accompanied by training program that include periodical exercises and mock drills.

Any such training programme should have the following:

- Appraising of concerned personnel with the content and implementation procedure of the DMP
- Training of personnel for specific response which are assigned particular duties with special skills
- Arrange periodic workshops to introduce personnel to new equipment, techniques, and detailing concepts of operation
- Updating of concerned personnel of changes in the plan or procedures, if any
- Checking and testing the preparedness of response personnel
- Testing the validity, effectiveness, timing, and content of the plan and implementing procedures

- Testing the emergency equipment
- Update and modify the plan/ strategy on the basis of the experience acquired through exercises and drills
- Maintain cooperative capability within first response team and with other response/ mutual aid and agencies
- Maintain good emergency response capability

12.19.2.13 Mock Drills & Exercises

As discussed in preceding paragraph above that during training of personnel, Mock Drills and exercises are vital to emergency preparedness. Mock scenario involves enactment of the implementation of the response actions performed during the crisis. There are two types of exercises are recommended for implementation according to the situation:

- Brainstorming in office with tabletop drills or exercises prove very useful for orientation purpose. During this the emergency response organization is presented with a situation to be resolved under different hypothetical situations that can develop
- Actual On-site Exercises are the more comprehensive to test the entire response organization set up including communication with all response functionaries.

Above mentioned exercises are recommended to be conducted at least once in a year, wherein members of first response team could be actively involved. Any deficiencies that may be found during such exercises of the plan and procedures should be corrected immediately.

12.19.2.14 Public Information System

It is important to give timely information to the public at large in order to prevent panic and rumours during a crisis following an accident. It is the duty of PIU to inform the affected people, public and media representatives about the situation from time to time and the response of the emergency authority to the crisis. The emergency public information could be carried out as follows.

Pre- crisis

The Pre-crisis situation will include the dissemination of information regarding the safety procedure/s to be followed during an emergency through posters, talks and mass media in local language. The literature like leaflets containing Do's/ Don'ts should be circulated to educate the affected population.

Crisis Period

During the crisis the dissemination of information about the nature of the incident, actions taken and instructions to the public about protective measures to be taken, evacuation, etc. are the important steps to be followed.

Post- crisis

Immediately once the crisis is over all the attention should now be focused on information concerning restoration of essential services, movement/restrictions, etc.

The tasks of the public information system now would be:

- Quick dissemination of emergency instructions to the personnel and public
- To receive all calls from people in distress to obtain current information from the ECC and respond immediately
- To obtain current information from the ECC
- Prepare briefs/ news release for media, and
- To keep an update about the casualties from the hospitals

12.19.2.15 Information Dissemination and Safety Procedures & Plan

The community participation is an important element in implementation of any Emergency Preparedness plan, as it can foster understanding amongst the people of the area and help in managing and controlling emergency situations.

The public at large are in not conversant with the Early Warning System (EWS) i.e. warning signals and protective actions. During any crisis the local people often run hither thither to seek confirmation of the hazard from neighborhood and the media, which takes time. Therefore for any warning system, to be effective, it must act as a trigger to initiate a preplanned protective action by the locals in the area. The awareness efforts conducted by local planning committees, the public need to be made aware of protective options like sheltering within their work places and evacuation.

The following information should be made available to the public:

- The likely hazards that can occur in their vicinity
- The type of warning system like sirens employed to alert them, in case of a disaster
- The protective action/s that should be adopted in different situations of emergency

- The knowledge of the escape routes and assembly points, in case of evacuation from disaster affected areas/ zones

12.19.2.16 Safety Procedures & Plan

In case of any disaster situation Emergency Officer should immediately intimate the ERC. The safety of men & materials and especially women and child during construction and operation phases is the area of concern. Keeping in view the safety requirement during construction, operation and maintenance phases, safety policy with the following regulations need to be adopted with special priority given to the women and child at the work site.

- To allocate sufficient resources to maintain safe and healthy conditions of work.
- To take steps to ensure that all known safety factors are taken into account in the design, construction, operation and maintenance of plants, machinery and equipment.
- To ensure that adequate safety instructions are given to employees.
- To provide wherever necessary protective equipment, safety appliances and clothing, and to ensure their proper use.
- To inform employees about materials, equipment or processes used in their work which are known to be potential hazardous to health or safety.
- To keep all operations and methods of work under regular review for making necessary changes from the point of view of safety in the light of experience and up to date knowledge.
- To provide appropriate facilities of First aid and promote treatment for injuries and illness at work.
- To provide appropriate instruction, training, retraining and supervision to employees in health and safety, first aid and to ensure that adequate publicity is given to these matters.

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.

12.19.2.17 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 little time in reaching these villages, its populace shall be informed 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.

12.19.2.18 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 because 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.

12.19.3 Financial Outlay for Installation of VSAT Communication System

The cost of deployment and maintenance of a telecommunication system in disaster prone areas is not as important as the availability, reliability and quick restoration of the system. The cost of both satellite bandwidth and the ground components of the satellite communication system has been decreasing rapidly like that of V-SAT (Very Small Aperture Terminal) based systems supporting a couple of voice and data channels. Some highly superior communication systems in VSAT without time delay are marketed by National agencies like HECL, HFCL and HCL Comet. There are two different types of systems with the above mentioned capabilities available in the market viz. SCPCDAMA and TDMA. However, the first one named SCPCDAMA has been recommended for the project. Two such systems would be installed at suitable upstream and downstream locations. The estimated cost of installation of such a communication system has been given in **Table 12.9**.

12.20 COST ESTIMATES FOR DISASTER MANAGEMENT

The estimated total cost of execution of disaster management plan including the equipment would be **Rs. 90.00 lakh** and the breakup of the same is given at **Table 12.9**.

Table 12.9: Estimated cost of setting up of satellite communication system and disaster management plan

S. No.	Particulars	Amount Rs. in Lakh
A.	Capital Expenditure	
1	Installation of alert systems, 2 sirens, setting up of Central Control Room, etc.	15.00

S. No.	Particulars	Amount Rs. in Lakh
2	Setting up of communication system	25.00
3	Setting up of Emergency Response Organisation	10.00
4	Public Information System	10.00
	Total - A	60.00
B.	Recurring Expenditure	
5	Training & Miscellaneous	5.00
6	Maintenance of alert systems and other equipment	25.00
	Total - B	30.00
	Grand Total A+B	90.00

**Chapter
13****CORPORATE ENVIRONMENT RESPONSIBILITY PLAN****13.1 INTRODUCTION**

In addition to the provisions under R& R benefits for the Project Affected Families, project developer would aim at the improvement in the living standards of inhabitants in the project area by not only by being a catalyst for development but also will develop infrastructure in the area.

Accordingly, in line with the company policy, MOEF&CC OM No. 22-65/2017.IA.III dated 1st August 2018 and consultations during the public hearing, Corporate Environment Responsibility (CER) Plan is proposed for the Project covering many important components of the sustainable development such as social, economic, livelihoods and environment.

13.2 CER BUDGET

The total budget allocated for implementing the various activities and program envisaged under CER is **Rs. 907.77 lakh**.

Chapter

14

PUBLIC HEARING ISSUES AND RESPONSE

Public Hearings for the Parbati Major Irrigation Project were conducted by Madhya Pradesh State Pollution Control Board (MPSPCB) on 2nd, 6th and 8th March 2019. Details are as follows:

02.03.2019	11:00 am	Gram Panchayat Bhawan, Village: Mangalgarh, Tehsil: Bersia, District: Bhopal
06.03.2019	12:00 Noon	Gram Panchayat Bhawan, Village: Chandbad, Tehsil: Shyampur, District: Sehore
08.03.2019	11:00 am	Gram Panchayat Bhawan, Village: Shivpura Jagir, Tehsil: Narsinghgarh, District: Rajgarh

Meeting at Mangalgarh was chaired by Additional District Magistrate, Bhopal District.

Meeting at Chandbad was chaired by Additional District Magistrate, Sehore District.

Meeting at Shivpur Jagir was chaired by Sub Divisional Magistrate, Rajgarh District.

Many other government officials of the various government departments attended the public hearing meeting. **Proceeding of the Public Hearing has been prepared by MPSPCB and is enclosed as a separate document.** Major issues raised by the local people during the meetings have been tabulated below district wise for ready reference.

Publications of notice for public hearing were given in Times of India and Navduniya dated 31st January 2019 in district Bhopal; Dainik Bhaskar and Patrika dated 31st January 2019 in district Sehore; and Local newspaper and Hindustan Time dated 3rd February 2019 and 6th February 2019 respectively. Based on this publication, no objections/comments were received by Regional office of MP state pollution control board.

SUGGESTIONS/ COMMENTS GIVEN BY STAKEHOLDERS (District Bhopal)

S. No.	Suggestions/ Comments/ Observations	Reply of Project Proponent
1	Dam proposed under Parbati Major Irrigation project should be constructed. Construction of dam will increase agricultural production as sufficient water will be provided as well as ground water level will rise.	Farmer friendly activities will be carried out under command area development.
2	Villagers should be given employment during project construction phase. Kewat community should be permitted to do fishing in the submergence area.	Employment opportunities will be provided in submergence as well as command area.
3	We have no objection, however, it has to be ensured that there is no water, air, noise and noise pollution. Forest area should not be disturbed.	Provisions have been made to keep environmental pollution at minimal level.
4	Bhujpura Kalan, Aankhiya, Parason, Runha, Bhakwaha villages should also be included in the list of benefited villages and provided with water for irrigation.	Provision will be made for all possible as well as feasible benefits in the command area.
5	Since there is lack of power supply therefore it is desired to provide sufficient water for irrigation.	A systematic water distribution system will be developed.
6	Compensation against acquired land is not given on time to the farmers.	Immediate action will be taken after compensation is sanctioned.
7	Employment opportunities to be provided. Provision for high school in command area. Seeds and fertilizers at subsidized rates to the farmers.	Necessary steps will be taken for employment opportunities, high school and subsidized rates for seeds and fertilizers.
8	Since water will be distributed through piped system agricultural land will not be wasted. Ground water level will rise in the villages. Irrigated land will increase.	Piped system for water distribution will increase agricultural production with less water.
9	Downstream to this project, another project should be developed on river Parbati.	Downstream to this project, Suthaliya scheme is proposed on river Parbati.
10	There will be increase in dairy farming due to this project.	This scheme will lead to increase in animal husbandry, dairy farming and agricultural production.

SUGGESTIONS/ COMMENTS GIVEN BY STAKEHOLDERS (District Sehore)

S. No.	Name and Address	Suggestions/ Comments/ Observations	Reply of Project Proponent
1	Sh. Bharat Singh, Village: Acharohi	My house is in agricultural field which is coming under submergence therefore compensation for house should also be given.	The compensation for the affected Property will be given as per the The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCT_LARR).
2	Sh. Shivpal Singh, Surender Singh, Upender Singh, Village: Acharohi	As per the demarcation of Water Resource Department our agricultural land with survey no – 13/4, 13/7, 13/6 & 13/2 is fully coming under submergence area, however, it is not mentioned in the list provided by the department. It should be inspected and records should be corrected.	The compensation for the affected land will be given as per the The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCT_LARR).
3	Sh. Ratan Singh, Village: Mahuakheda	- In revenue records, my name is there as owner of my agricultural land and is irrigated land, however, electricity connection is on my father's name. It is requested to consider connection on my name only. - There are around 2000 trees on my land which is coming under submergence. Loss of 2000 trees will have negative impact on environment. Hence it is requested to plant trees on my outside the submergence area land.	- Appropriate solution will be adopted. - Action will be taken as per provision.
4	Sh. Gorelal Ganpat and Smt. Bhagwati Bai, Village: Chandbad Jagir	Our 3 acre and 1.5 acre of land respectively is coming under submergence. However, our house is not coming under submergence. We want compensation for our house too.	Solution will be carried out as per affected land.
5		Compensation should be provided with appropriate rate to all the farmers who are losing their land.	Demand will be conveyed to the competent level.
6	Sh. Vishram	My whole land is coming under	The competent authority for

S. No.	Name and Address	Suggestions/ Comments/ Observations	Reply of Project Proponent
	Singh Gurjar, Village: Mahuakheda	submergence. It is my ancestral land and is shown as nontransferable in revenue records. Hence revenue records should be corrected procedure for compensation should be initiated.	nontransferable to transferable land is the collector of respective district.
7	Mo. Sadik, Village: Marheti	Since land of our village is very productive therefore, rate of compensation should be at least Rs. 40 lakh per ha.	Demand will be conveyed to the competent level.
8	Sh. Raghunandan Singh, Village: Magardi Khurd	Houses of our village is coming under submergence, however, survey is yet to be conducted. Therefore, property survey should be carried out at the earliest.	The compensation for the affected Property will be given as per the The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCT_LARR).
9	Sh. Vimlesh Pal, Village: Chandbad Jagir	My house is coming under submergence, however, survey is yet to be conducted. Therefore, property survey should be carried out at the earliest.	The compensation for the affected Property will be given as per the The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCT_LARR).
10	Sh. Bhawarlal, Village: Rawatkhedha	Entire village is my entire land is coming under submergence. However, my one of the house is above FTL level. Since this house is surrounded by submergence from all sides therefore, there wont be any approach to reach the house. In view of this it is requested to conduct survey of my property and provide me with compensation.	As per submergence area, land acquisition officer will take necessary action.
11	Smt. Rajbai, Village: Chandbad	My agricultural land is coming under submergence however my house is outside the submergence area. Acquisition of agricultural land will impact our livelihood. Administration should come out with proper plan so that we can serve our family.	As per submergence area, land acquisition officer will take necessary action.
12	Sh. Sarjan Singh,	Compensation rate should be Rs. 50	As per submergence area, land

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	Amar Singh, Village: Mahuakheda Pura	lakh per ha. In addition compensation for well, tube well, pipe line, new house etc. should also be given.	acquisition officer will take necessary action and demand will be conveyed to the competent level.
13	Sh. Tularam, Batturam, Village: Chandbad	My agricultural land is coming under submergence however my house is outside the submergence area. We do not wish to stay in village therefore, compensation for house should also be given.	As per submergence area, land acquisition officer will take necessary action.
14	Sh. Shyam Singh Tanwar, Village: Mahuakheda	I was not informed that after notification of land to be acquired no new construction can be carried out. Since I have constructed new house therefore, compensation for the same should be given.	After section-11 of LA Act 2013 all the affected villages were duly informed.
15	Villagers and Sarpanch of village Acharohi	1) The Rawatkhedha village to be treated as fully submerged and compensation to be given to be residents as early as possible so that they can make necessary arrangement for their new residence within time. 2) The compensation of land should be four times of the rates, as well as compensation for trees, plants, well & tube well, pipe line etc. should also be given separately. 3) No new construction work can be carried out on the land to be acquired was informed by janpad panchayat on 13.02.2019. Work carried out prior to this date should be duly compensated. 4) The land owner losing his entire agricultural land should be compensated for house too.	1) As per submergence area, land acquisition officer will take necessary action. 2) Demand to be conveyed at appropriate level. 3) Prior to monsoon season property survey was carried out through drone. Necessary orders by competent authorities were passed to stop any new construction after section -11 of LA Act 2013. All the matters related to compensated will be dealt by district administration. 4) All provision will be undertaken in accordance to The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCT_LARR).
16	Sh. Nirbhay Singh, Village:	Section -11 was imposed in July 2018. Compensation should be paid	Prior to monsoon season property survey was carried out through

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	Durgaon	for construction work carried after publication of section – 11 also as nobody informed that no new construction can be carried out after imposition of section-11.	drone. Necessary orders by competent authorities were passed to stop any new construction after section -11 of LA Act 2013. All the matters related to compensated will be dealt by district administration.
17	Sh. Mahendra Singh Gurjar, Village: Mahuakheda	Construction work will result in negative impacts on the village environment. Since whole village is going to be resettled, we want to know what all provisions have been made at resettlement location.	All provision will be undertaken in accordance to The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCT_LARR).
18	Sh. Kamlya Ahiwar, Village: Magardi Khurd	I am holding land with survey no 57/3 since 40 years, however, in revenue records its on somebody else name. Compensation should be paid to me only.	Solution will be carried out as per land record.
19	Sh. Sohan Singh Rathore, Village: Bherupura	Rs. 5 lakh to every person above 18 years of age from the affected family to make necessary arrangement for their livelihood.	All provision will be undertaken in accordance to The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCT_LARR).
20		Proper survey of the land to be acquired should be carried out at the earliest. Since nowadays there is scarcity of land therefore, rate of compensation should be Rs. 50 lakh per ha. People are not fully aware or clear whether their land is coming under submergence or not, therefore, complete information to be provided at the earliest.	Survey is already completed for the land coming under submergence. Demand to be conveyed at appropriate level. All provision will be undertaken in accordance to The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCT_LARR).
21	Sh. Devraj Singh, Village: Chandbad Jagir	Since affected villages won't be approachable by existing roads therefore bridges should be constructed.	Action will be taken as per the provision after site visit.
22		Local people should be given employment according to their qualification during and after construction phase.	Same has been already instructed to the construction agency.

SUGGESTIONS/ COMMENTS GIVEN BY STAKEHOLDERS (District Rajgarh)

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1	Shri Shajid Khan s/o Jahir Khan Village – Shivpura Jagir	Due to the construction of dam, my land, fish pond, tubewell etc. will be affected. It is requested to conduct property survey.	Section – 19 of The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCT_LARR) is under process. Joint survey of area coming under submergence will be carried out by the Water Resources Department & Revenue Department under section -20. All the appeals, objections made under section -21 will be inspected and necessary actions will be taken as per governing law.
2	Shri Badru Khan s/o Mehwar Khan Village – Shivpura Jagir	My request to the E.E. WRD, proper compensation of house should be given for the house coming under submergence.	Compensation for the land/property acquired will be paid after inspection and as per Govt. Guideline.
3	Shri Ashik Khan s/o Yasin Khan Village – Sewas Jagir	I have a well in the land to be acquired for the project, it is requested to conduct property survey.	Compensation will be given as per Govt. Guideline before awarding the contract for construction and evaluation of property.
4	Shri Enamul Hasan s/o Salauddin Village – Shivpura Jagir	My land is getting affected due to the project activities, however, survey has not been conducted till date. It is requested to conduct survey at the earliest.	Section – 19 of The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCT_LARR) is under process. Joint survey of area coming under submergence will be carried out by the Water Resources Department & Revenue Department under section -20. All the appeals, objections made under section -21 will be inspected and necessary actions will be taken as per governing law.
5	Shri Sharif Khan s/o Ajij Khan Village – Shivpura Jagir	My house is getting submerged due to project, therefore, it is request to provide me with a new constructed house.	Compensation will be given after inspection of all the property getting affected due to the submergence and as per as per The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and

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			Resettlement Act, 2013 (RFCT_LARR)
6	Shri Habib Khan s/o Ajij Khan Village – Shivpura Jagir	My house is getting submerged due to project, therefore, it is request to provide me with proper compensation and land to construct new house.	Necessary actions for the affected persons will be taken after inspection and as per Govt. guidelines.
7	Shri Bahid Khan s/o Chand Khan Village – Shivpura Jagir	I shall be paid proper compensation for the well and trees on my land getting affected due to submergence.	Compensation will be given as per Govt. Guideline before awarding the contract for construction and evaluation of property.
8	Shri Vishnu Prasad s/o Radhelal Village – Gadupura	Survey has been conducted for my land and property getting affected due to submergence, however, rate of compensation is very low. It is requested to increase the rate of compensation.	Compensation will be given after inspection of all the property getting affected due to the submergence and as per as per The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCT_LARR)
9	Shri Shakil Khan s/o Shabuddin Khan Village – Gehukhedhi Kla	Please inform when and how much compensation will be paid to us for the land coming under submergence.	Different sections, time schedule and process have been defined in The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCT_LARR). Compensation will be given according to act only.
10	Shri Arshad Village – Shivpura	Please inform whether compensation will be given or not for the land not coming under submergence however surrounded by submergence area. Will any arrangements be made for the approach to such area.	Compensation will be given for the land coming submergence only. Alternative will be provided incase approach is getting disturbed or blocked. Necessary steps will be taken after joint inspection and as per Govt. guidelines.
11	Shri Parwage Khan s/o hanim Khan Village – Shivpura	The compensation of the land with property such as well, tubewell and pipeline affected by the submergence to be given.	Compensation for the land/property acquired will be paid after inspection and as per Govt. Guideline.
12	Shri Munne Khan s/o Kale Khan Village – Shivpura	My land and house is getting affected due to the project activities, however, survey has not been conducted till date. It is requested to conduct survey at the earliest.	Section – 19 of The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCT_LARR) is under process. Joint survey of area coming under submergence will be

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			carried out by the Water Resources Department & Revenue Department under section -20. All the appeals, objections made under section -21 will be inspected and necessary actions will be taken as per governing law.
13	Shri Ajj Khan s/o Halil Khan Village – Shivpura	My house is getting affected due to the project activities, however, survey has not been conducted till date. It is requested to conduct survey at the earliest.	Section – 19 of The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCT_LARR) is under process. Joint survey of area coming under submergence will be carried out by the Water Resources Department & Revenue Department under section -20. All the appeals, objections made under section -21 will be inspected and necessary actions will be taken as per governing law.
14	Shri Mo. Hasim s/o Nisbat Khan Village – Shivpura	Survey of my house which will be surrounded by water due to submergence is yet to be done. It is requested to conduct survey at the earliest.	Necessary steps and decisions will be taken after joint survey and inspection and will be as per Govt. guidelines.
15	Shri Himmat Khan s/o Natte Khan Village – Shivpura	My house is getting affected due to the submergence, please provide proper compensation for the same.	Compensation will be given as per Govt. Guideline before awarding the contract for construction and evaluation of property.
16	Shri Nijjamuddin s/o Ishhak Khan Village – Shivpura	My pipeline is getting submerged, proper compensation after evaluation to be provided.	Compensation for the land/property acquired will be paid after inspection and as per Govt. Guideline.
17	Shri Yashin Khan s/o Gafur Khan Village – Shivpura	Survey of my house which will be surrounded by water due to submergence is yet to be done. It is requested to conduct survey at the earliest and provide proper compensation for the same.	Compensation for the land/property acquired will be paid after inspection and as per Govt. Guideline. All the appeals, objections made under section -21 will be inspected and necessary actions will be taken as per governing law.
18	Shri Altaf Khan s/o Khuman Khan	My land in Gadpura is getting affected due to the project activities,	All the appeals, objections made under section -21 will be inspected

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	Village – Shivpura	however, survey has not been conducted till date. It is requested to conduct survey at the earliest.	and necessary actions will be taken as per governing law.
19	Shri Sajit Khan s/o Altaf Khan Village – Shivpura	My house is getting affected due to the project activities, however, survey has not been conducted till date. It is requested to conduct survey at the earliest and provide proper compensation for the same.	Necessary steps and decisions will be taken after joint survey and inspection and will be as per Govt. guidelines.
20	Shri Munna Khan s/o Vassal Khan Village – Shivpura	My house is getting affected due to the project activities, however, survey has not been conducted till date. It is requested to conduct survey at the earliest.	Bases upon your application appropriate action will be taken after inspection.
21	Shri Farid Khan s/o Sarif Khan Village – Shivpura	My house is getting affected due to the project activities, however, survey has not been conducted till date. It is requested to conduct survey at the earliest.	FTL level of submergence will be again assessed and after inspection appropriate action will be taken.
22	Shri Navi Khan s/o Vasse Khan Village – Shivpura	Provide us with maximum possible compensation for the land and property coming under submergence.	Compensation will be given as per Govt. Guideline before awarding the contract for construction and evaluation of property.
23	All resident of Village – Shivpura	Please provide us with land for graveyard as existing graveyard is coming under submergence.	If coming under submergence steps will be taken and land will be provided at suitable location.
24	Shri Seffuddin s/o Eshfaaq Khan Village – Shivpura	My land in Gadpura including pipeline is getting affected due to the project activities. Provide us with maximum possible compensation	Section – 19 of The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCT_LARR) is under process. Joint survey of area coming under submergence will be carried out by the Water Resources Department & Revenue Department under section -20. All the appeals, objections made under section -21 will be inspected and necessary actions will be taken as per governing law.
25	Shri Pir Khan s/o Rehman Khan	My land coming under submergence has been surveyed, however, well	Section – 19 of The Right to Fair Compensation and Transparency in

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	Village – Shivpura	and tubewell are yet to be evaluated. It is requested to evaluate the same.	Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCT_LARR) is under process. Joint survey of area coming under submergence will be carried out by the Water Resources Department & Revenue Department under section -20. All the appeals, objections made under section -21 will be inspected and necessary actions will be taken as per governing law.
26	Shri Nishpat Khan s/o Uman Khan Village – Shivpura	My house alongwith 5 neighboring houses will be surrounded by water due to submergence. It is requested to conduct survey at the earliest.	Necessary steps and decisions will be taken after joint survey and inspection and will be as per Govt. guidelines.
27	Shri Vahid Khan s/o Ghise Khan Village – Shivpura	My land coming under submergence has been surveyed, however, tubewell is yet to be evaluated. It is requested to evaluate the same.	Compensation will be given as per Govt. Guideline before awarding the contract for construction and evaluation of property.
28	All villagers, Village Mangatpur	Some land parcels will be surrounded by water due to submergence and there won't be any approach left for such land parcels. Some houses coming under submergence are not yet surveyed. It is requested to conduct survey at the earliest.	Appropriate action will be taken as per guideline.
29	All Villagers, Village Shivpura	Appropriate provisions to be made for culverts, edgah and graveyards coming under submergence.	Appropriate lawful action will be taken as per govt. guideline under R&R plan.
30	All Villagers, Village Shivpura	Land not surveyed will be surrounded by submergence by all sides. It is requested to conduct survey at the earliest and provide proper compensation for the same.	Necessary steps and decisions will be taken after joint survey and inspection and will be as per Govt. guidelines.
31	All Villagers, Village Shivpura	Please inform us by when compensation will be paid to us for the land and property coming under submergence.	Section – 19 of The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCT_LARR) is under process. Joint survey of area coming under submergence will be

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			carried out by the Water Resources Department & Revenue Department under section -20. All the appeals, objections made under section -21 will be inspected and necessary actions will be taken as per governing law.
32	Shri Yauddin, Rahup Khan, Jafferuddin, Tafuddin, Nizamuddin Village – Shivpura	Our land is coming under submergence, however, well and tubewell are yet to be evaluated. It is requested to evaluate the same.	Section – 19 of The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCT_LARR) is under process. Joint survey of area coming under submergence will be carried out by the Water Resources Department & Revenue Department under section -20. All the appeals, objections made under section -21 will be inspected and necessary actions will be taken as per governing law.
33	Shri Nasir Khan Village – Shivpura	Due to the construction of dam, my land, fish pond, tubewell etc. will be affected. It is requested to conduct property survey and provide us proper compensation	Compensation will be given as per Govt. Guideline before awarding the contract for construction and evaluation of property.
34	All Villagers, Village Shivpura	All the houses coming under submergence should be surveyed and affected families to be provided with house at different location or sufficient compensation.	Appropriate lawful action will be taken as per govt. guideline under R&R plan.