केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण

विभाग, जल शक्ति मंत्रालय

भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development and Ganga Rejuvenation,

Ministry of Jal Shakti

Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

BURHANPUR DISTRICT, MADHYA PRADESH

उत्तर मध्य क्षेत्र, भोपाल

North Central Region, Bhopal

Government of India

Central Ground Water Board

Ministry of Water Resources, River Development & Ganga Rejuvenation

AQUIFER MAPPING AND MANAGEMENT PLAN

BURHANPUR DISTRICT, MADHYA PRADESH

By

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(Scientist - 'C')

CENTRAL GROUND WATER BOARD

NORTH CENTRAL REGION, BHOPAL

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PREFACE

Aquifer mapping studies have been carried out in the Burhanpur district, Madhya Pradesh State with an objective to identify and map the aquifers at micro level, quantify the availability of ground water resource and suggest Aquifer Management Plans to address the basic ground water related issues in the area. Aquifer mapping study involves integration and analysis of multi-disciplinary scientific aspects including geological, hydrogeological, geophysical, hydrological and hydrochemical. These studies help to characterize the quantity, quality and ground water movement in the aquifers and devise their optimal management plans. The representative area of the study was in the State of Madhya Pradesh, forming part of Deccan Trap Province spread over an area of 3427 Sq. Km. The study area includes two blocks namely Burhanpur and Khaknar. The report on "Aquifer Mapping & Management Plan of Burhanpur district of Madhya Pradesh" elaborates the outcome of the Aquifer Mapping Study, in particular, the vertical and lateral extent of the aquifer units, their characteristics and response of the aquifer units to different stress conditions and their redressal through appropriate management plans. Various water stress mitigation options by integrating technical and scientific measures are also recommended for sustainable ground water development and management in the area. The effort put forth by Ms. Sayelli Umesh Tembhurne, Scientist-C in bringing this report are duly appreciated, as this report would not have seen the light of the day without her hard work and dedication. The report shall be of immense use for the planners and managers as well as academicians / researchers as a guide and reference volume in the field of Ground Water Resource Management.

Place: Bhopal
Date:

(Sri Ashok Kumar Biswal)
Head of Office

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Sayelli Tembhurne
Scientist 'C'

BURHANPUR DISTRICT AT A GLANCE

1. GENERAL INFORMATION			
	Geographical Area		3427 Sq Km
	Administrative Divisions (2011)		Blocks-2: Burhanpur, Khaknar
	Villages) Census 2011)		263 Nos.
	Population		757847
	Rainfall 2020		853.9 mm
	Normal rainfall (2000-2020)		823.06
	Long term rainfall Trend (2000-2020)		Falling 6.1014 m/year
2. GEOMORPHOLOGY			
	Major Physiographic unit		Four Units: Northern hilly region Central high plateau region Southern low grounds Upland trough of Jam & Kanhan rivers
	Major Drainage		Tapti
3. LAND USE (sources: https://pmksy.gov.in/mis/Uploads/2017)			
	Forest Area		2018.81 Sq. Km.
	Net Area Sown		1189.18 Sq. Km.
	Area under agriculture use		1246.01 Sq. Km.
	Net irrigated		581.27 Sq. Km.
	Net rainfed		607.92 Sq. Km.
4. SOIL TYPE			Three types: Black cotton soil, Sandy loam and Clayey loam soil
5. PRINCIPAL CROPS (Economical survey of Madhya Pradesh, 2007-08. Directorate of Economics & Statistics, Madhya Pradesh)			
	Banana		182 sq km
	Cotton		460 sq km
	Wheat		95 sq km
	Soyabeen		143 sq km
6. IRRIGATION BY DIFFERENT SOURCES (2020) - Nos. / Potential Created (ha)			
	Dugwells		32688
	Tubewells/Borewells		47560
	Surface Flow Schemes		5572
7. GROUND WATER MONITORING WELLS (2022)			
	Dugwells		17
8. GEOLOGY			
	Recent		Alluvium
	Upper Cretaceous-Lower Eocene		Deccan Trap Basalt
	Upper Carboniferous - Permian		Gondwana

	Achaean		Gneisses, Schist & Granites
9. HYDROGEOLOGY			
	Water Bearing Formation		Archaeans (Gneisses, Schist, Granites& Pegmatite), Gondwanas, Deccan traps and Alluvium
	Depth to water level in Shallow Aquifer		
	Premonsoon Depth to Water Level (May-2021)		4.35 to 19.90 mbgl
	Postmonsoon Depth to Water Level (Nov.-2021)		1.9 to 15.4 mbgl
10.GROUNDWATER EXPLORATION (Upto march 2007)			
	Wells Drilled		EW-19
	Depth Range		93 to 232 mbgl
	Discharge		0.01 to 15.80 lps
	Storativity		8.4 x 10-5 to 0.4 x 10-3
	Transmissivity		Upto 52 m2/day (Basalt)
			Upto 74 m2/day (Alluvium)
11. GROUNDWATER QUALITY			
	Good and suitable for drinking and irrigation purpose		
	Type of Water		Shallow Aquifer-
			Deeper Aquifer-
12. DYNAMIC GROUND WATER RESOURCES - (2020)			
	Annual Extractable Ground Water Recharge (MCM)		373.43
	Current Annual Ground Water Extraction (Irrigation + Domestic+ Industrial) (MCM)		235.81
	Stage of Ground Water Extraction (%)		63.15 %
	Category		Blocks are Safe
13. MAJOR GROUND WATER PROBLEMS AND ISSUES			
	Declining Trend of groundwater, Sand Mining, Low stage of Extraction, & Sustainability		
14. AQUIFER MANAGEMENT PLAN			
	Supply side Management		Total Volume of water expected to be saved: 0.21 mcm
	Demand side Management		Total Volume of water expected to be saved: 175.21
	Expected Benefit		Additional area that can be brought under assured GW irrigation: 309.14 Sq.km
	Development Plan		Proposed Dug wells: 12056 Proposed Bore wells : 2010

AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN
BURHANPUR DISTRICT, MADHYA PRADESH

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1 INTRODUCTION

Central Ground Water Board has pioneered extensive groundwater studies, in all the hydrogeological terrain of the country. It has remarkably brought out comprehensive regional picture of the aquifers in terms of their water quality and yield potential. To meet the challenges of growing groundwater demand and sustainability of the resource, an effective aquifer based groundwater management in the country, through adequate and precise information on aquifers in time and space at a scale as large as possible, is the most imperative and earnestly desired. The aquifer-mapping programme demands for a multi-disciplinary, multi-institutional, innovative and modern approach to arrive at a comprehensive aquifer data base under National Aquifer Mapping Programmer.

1.1 BACKGROUND OF AQUIFER MAPPING

'Aquifer mapping' is a holistic approach for aquifer-based groundwater management. It may not be construed as aquifer geometry mapping only. In a broader perspective it can be defined as understanding the aquifers, ascertaining and establishing their quantity and quality sustainability through multi-disciplinary scientific approach integrating the techniques of geology, remote sensing, hydrogeology, geophysics, borehole drilling, hydrochemistry, hydrology, hydrometeorology, mathematical modelling, agriculture and soil science, water treatment and remediation, economics and social and environmental sciences. Out of these the Geophysical technique will help as a strong tool to identify the aquifer geometry precisely.

1.2 OBJECTIVES

Various developmental activities over the years have adversely affected the groundwater regime in the state. There is a need for scientific planning in developmentof groundwater under different hydrogeological situation and to evolve effective management practices with involvement of community for better ground water governance. In view of sprouting challenges in the ground water sector in the state there is an urgent need for comprehensive and realistic information pertaining to various aspects of groundwater resource available in different hydrogeological setting through a process of systematic data collection, compilation, data generation, analysis and synthesis. Hence, aquifer mapping and management of the study area is the need of the hour.

1.3 SCOPE OF THE STUDY

Aquifer mapping can be understood as a scientific process wherein a combination of geological, geophysical, hydrological & chemical fields and laboratory analyses are applied to characterize the quantity, quality, and sustainability of ground water in aquifers. Aquifer mapping is expected

to improve our understanding of the geological framework of aquifer, their hydrologic characteristics, and water level in aquifer and how they change over time and space and the occurrence of natural and anthropogenic contaminants that affect the portability of groundwater. Results of these studies will contribute significantly to resource management tools such as long-term aquifer monitoring network and conceptual and quantitative regional groundwater flow models to be used by planners, policy makers and other stake holders. Aquifer mapping at appropriate scale can help to prepare, implement, and monitor the efficacy of various management interventions aimed at long term sustainability of our precious groundwater recourses, which in turn will help to achieve drinking water scarcity, improved irrigation facilities and sustainability of water resource in the state.

1.4 APPROACH & METHODOLOGY

Aquifer mapping is an attempt to integrate the geological, geophysical, hydrological & chemical field and laboratory analyses and are applied to characterize the quality, quantity and sustainability of groundwater in aquifer. Under the National AquiferProgram, it is proposed to generate Aquifer Maps on 1:50000 scale, which basically aims at characterizing the aquifer geometry, behaviour of groundwater levels and status of groundwater development in various aquifer system to facilitate planning of their suitable management. The major activities involved in this process encompass compilation of existing data, identification of data gaps, generation of data for feeling data gaps and preparation of different aquifer layers. Aquifer mapping is a process wherein a combination of geologic, geophysical, hydrologic and chemical analyses is applied to characterize the quantity, quality and sustainability of ground water in aquifers

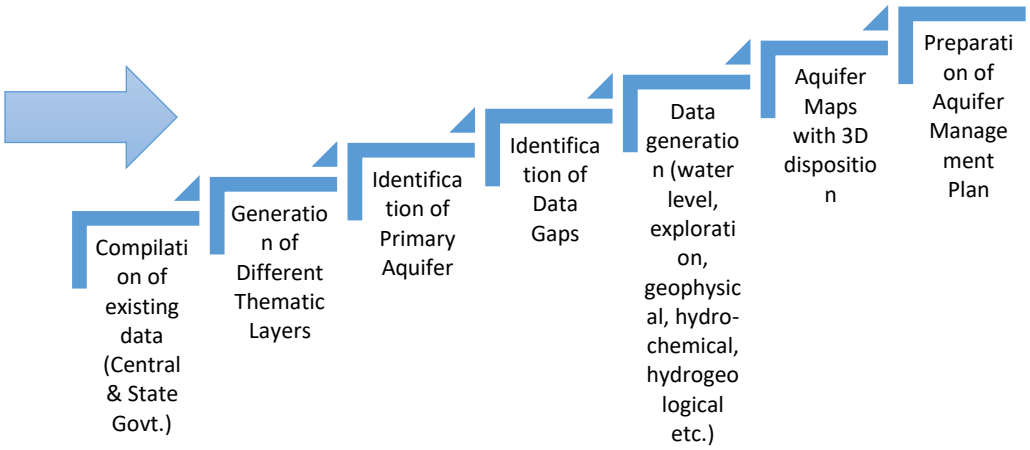

Figure 1 Methodology of NAQUIM

1.5 STUDY AREA

Burhanpur district is located in the south western part of Madhya Pradesh, covering an area of about 2316 Sq. Km falling between North Latitudes 210 11' 00'' and 210 32' 00'' and East longitudes 750 59' 00'' and 760 46'00'' and falls under the Survey of India Topo Sheet No. 46 O & 55C. The district is bounded in the North by Khandwa district, in the East by Amaravati district of Maharashtra State, in the South by Buldana and Jalgoan districts of Maharashtra state and in the West by West Nimar district of Madhya Pradesh. The district is divided into two development blocks namely Burhanpur and Khaknar. As per Census 2011, the total population of the district is 757,847. The district has 2 blocks, 3 tehsil and 263 villages. Major part of the area is drained by Tapti River and its tributaries. A small portion in the North is drained by Sukta River, a tributary of Narmada.

The total area of the district is 3427 sq km. All the Blocks are categorized as safe as per Ground Water Resources Estimation as on March 2020. The Administrative and Index map of the study area is presented in **Figure. 2 .** Exploratory drilling in the district has been taken up in different phases since 1993 with an objective to delineate aquifer zones. The ground water exploration has been done in Alluvial and hard rock areas occupied by Deccan Trap Basalt and Gondawana and Archeans. To establish the aquifer geometry, disposition and potential of aquifers, ground water exploration down to the depth of 200 m bgl has been taken up where the data gap exists and accordingly total of 19 EW have been constructed till today. A total of 17 existing ground water monitoring stations were being monitored 4 times in a year to assess the ground water scenario of the district**.** The details of ground water monitoring stations and exploratory wells are shown in **Figure.3.**

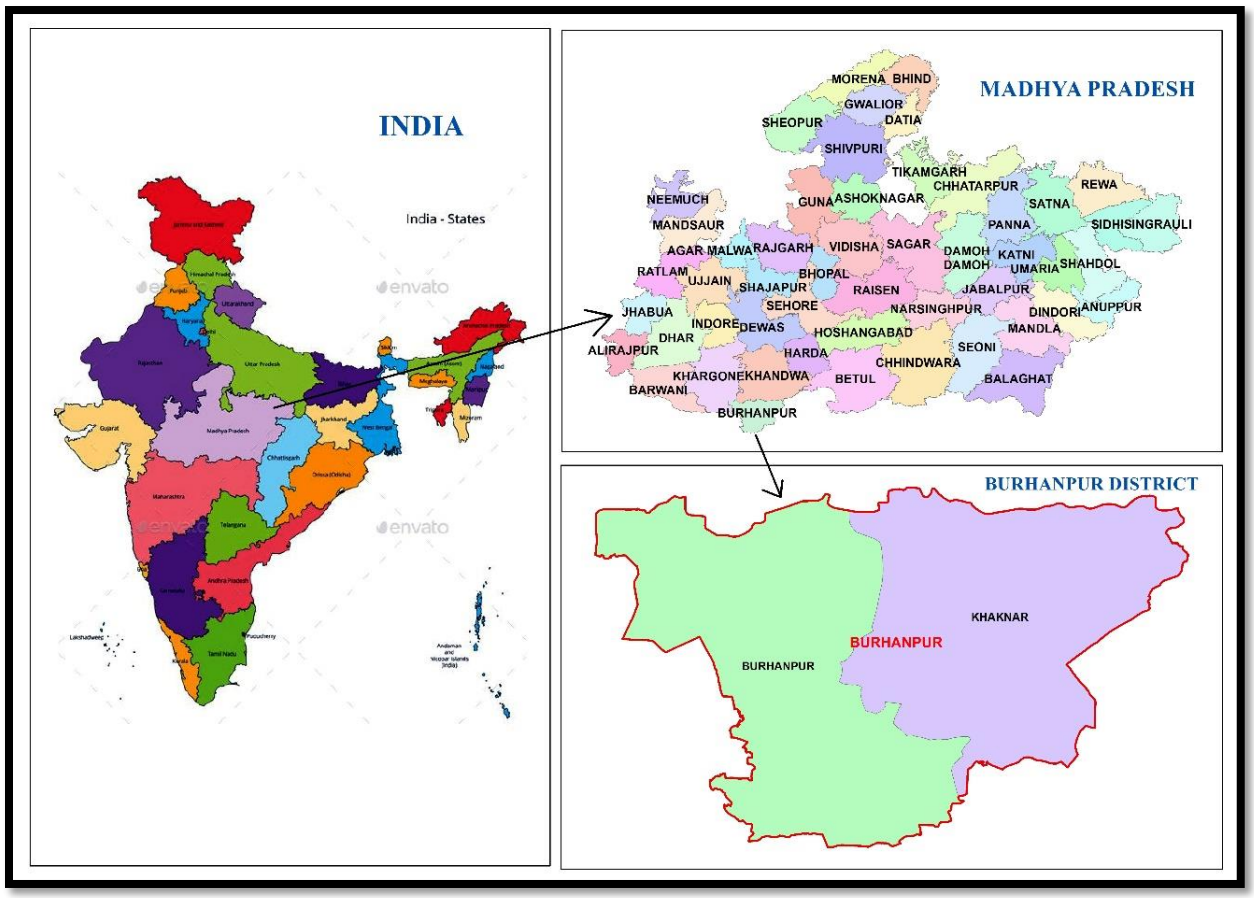

Figure 2 Index and Administrative map, Burhanpur District

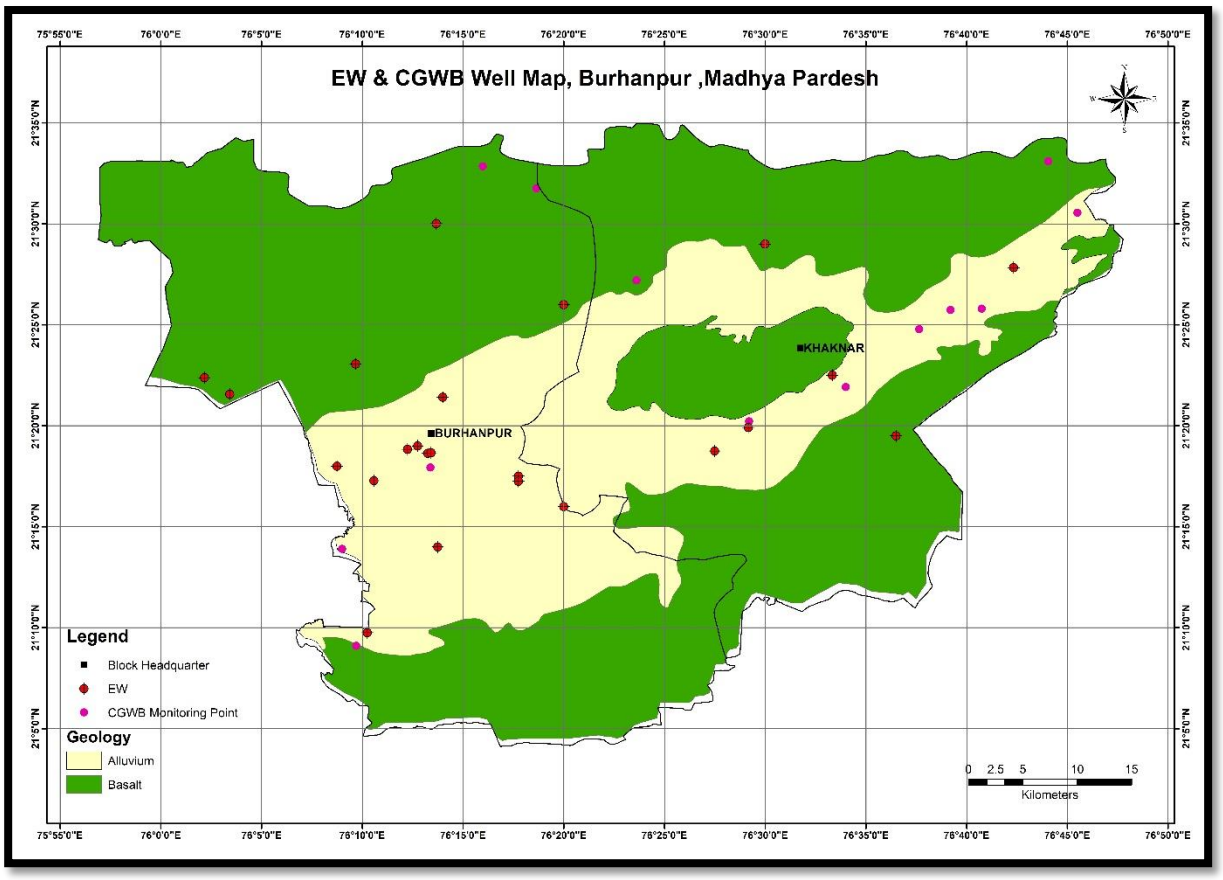

Figure 3 Locations of Existing Exploratory wells and Monitoring Wells

1.6 CLIMATE AND RAINFALL

The normal annual rainfall of the district is 978.9 mm. About 89% of the annual rainfall takes place during the southwest monsoon. July is the wettest month of the year and about 28% of the annual rainfall takes place only during this month. During the southwest monsoon season, the relative humidity generally exceeds 84% (August month) and the rest of the year is drier. The driest part of the year is the summer season, when relative humidity is less than 41%. The wind velocity is higher during the pre-monsoon period as compared to post-monsoon period. The maximum wind velocity, 15.8 km/hr observed during the month of June and minimum, 4.3 km/hr during the month of November. The monthly average high and low temperatures are shown in **figure 4.**

The normal annual rainfall varies from about 830 to 1488 mm .The spatial distribution of the rainfall is given in **figure 5.** Based on long term rainfall analysis it is observed that: Annual Average rainfall data of last ten years is analysed and presented which indicates that minimum rainfall occurred in 2016 (830 mm) and maximum in 2013 (1488 mm).

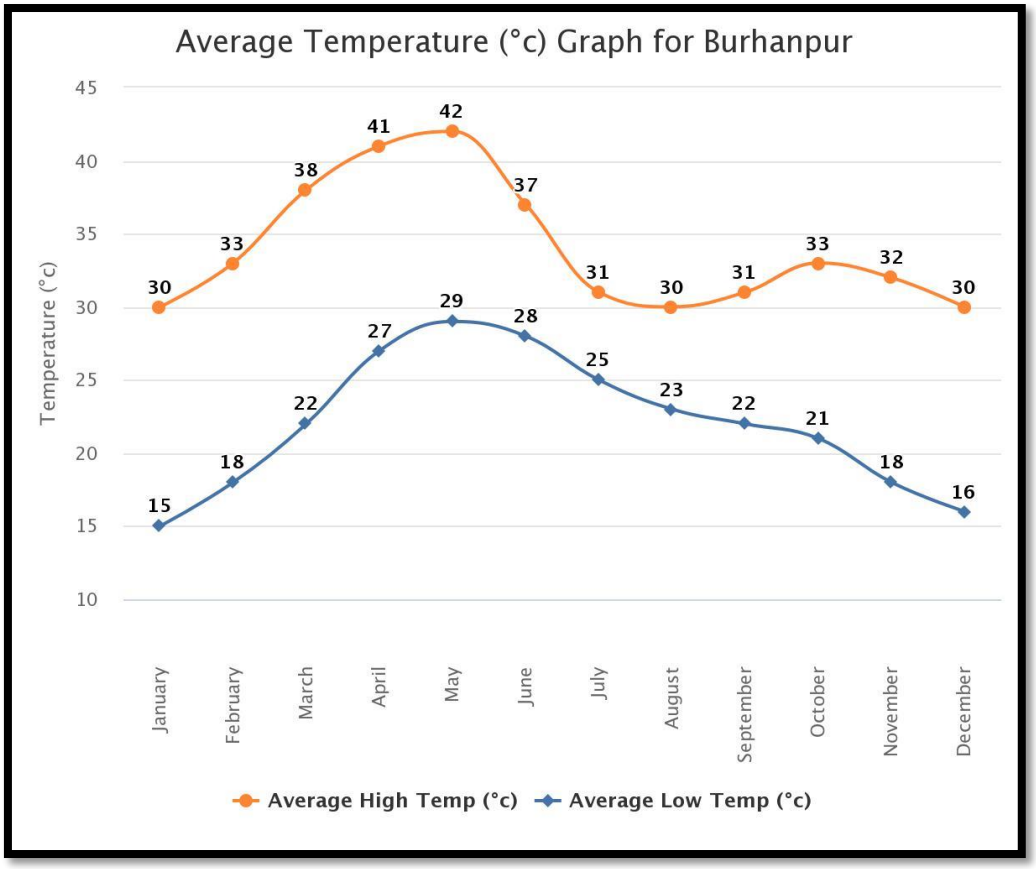

Figure 4 Monthly Temperature Graph of Burhanpur District

(Source:https://www.worldweatheronline.com/burhanpur-weather-averages/madhya-pradesh/in.aspx)

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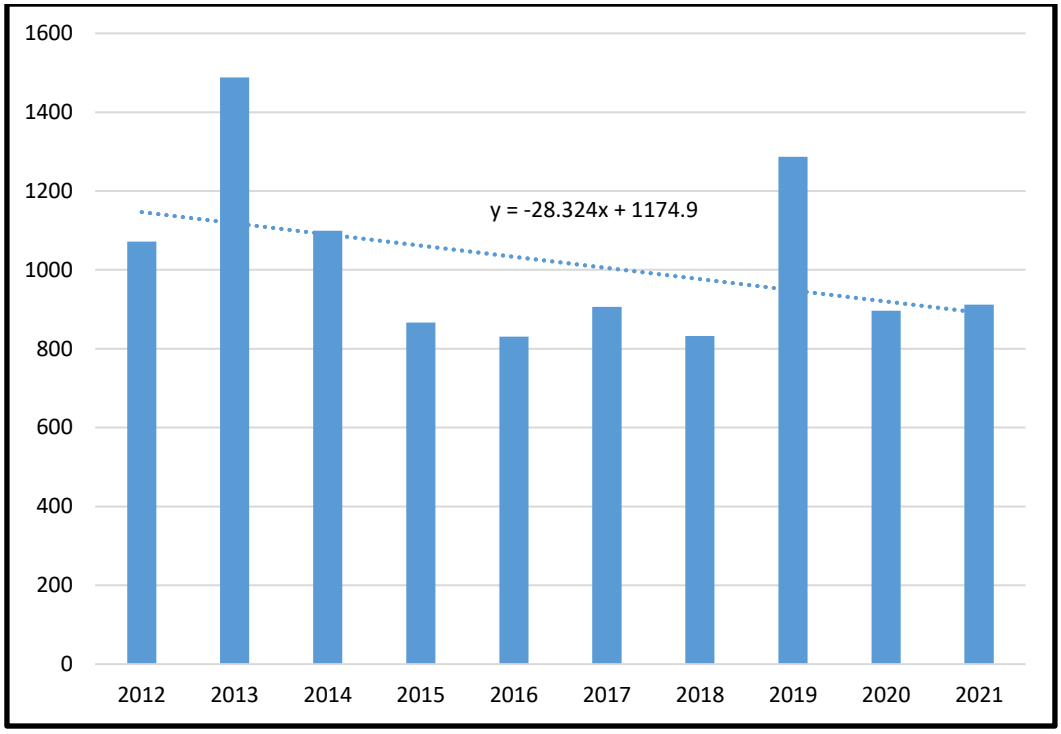


Figure 5 Rainfall Analysis (2012-2021), Burhanpur District

1.7 PHYSIOGRAPHY AND GEOMORPHOLOGY

The area of the district exhibits an undulating topography which includes highly dissected plateau, linear ridges, residual hills and low lying plains. It can be divided into two distinct physiographic units Viz., the northern and southern uplands and the Central low lands. A prominent hill range (Satpura Range) traverses the southern part of the district. The highest elevation in the district is 778 m amsl, seen on the Satpura Range in the Western part. The river Tapti carves out a narrow valley bifurcating this range into two parts. The northern area exhibits a low rising hill range and the area in the central part is generally plain dotted with isolated residual hills. The lowest elevation is around 249 m amsl, along Tapti River, southwest of Burhanpur town. Alluvium consisting of sand, clay and gravels occurs along Tapi river course. Black cotton soil is found as a thin surface soil cover mainly in a country mainly covered with Deccan Trap. The geomorphological map of Burhanpur district is shown in **figure. 6**

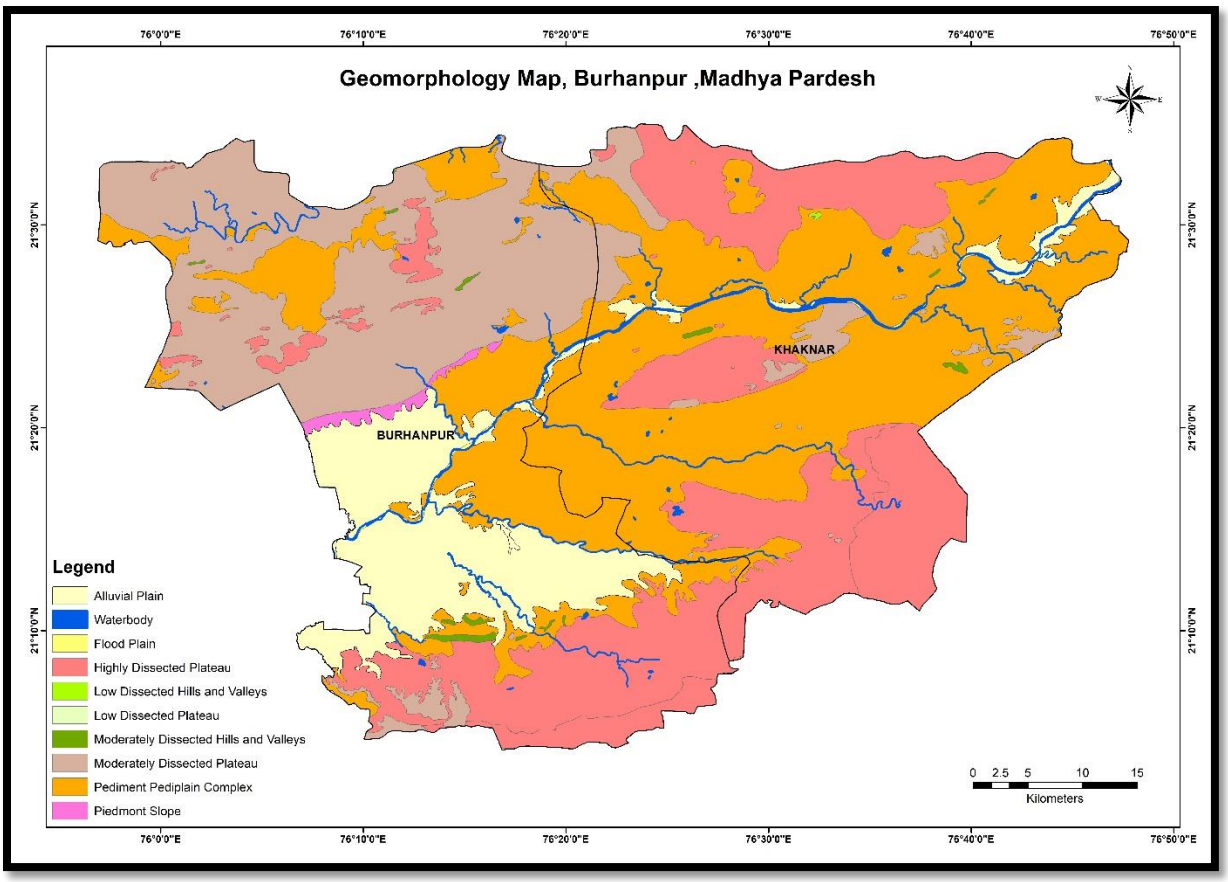


Figure 6 Geomorphology, Burhanpur District

1.8 DRAINAGE

The district lies in Tapti basin. The chief rivers of the district are the Tapti which flow along the north eastern and south western district diagonally. Major part of the area is drained by Tapti River and its tributaries. A small portion in the North is drained by Sukta River, a tributary of Narmada. The drainage map of Burhanpur district is shown in **figure. 7.**

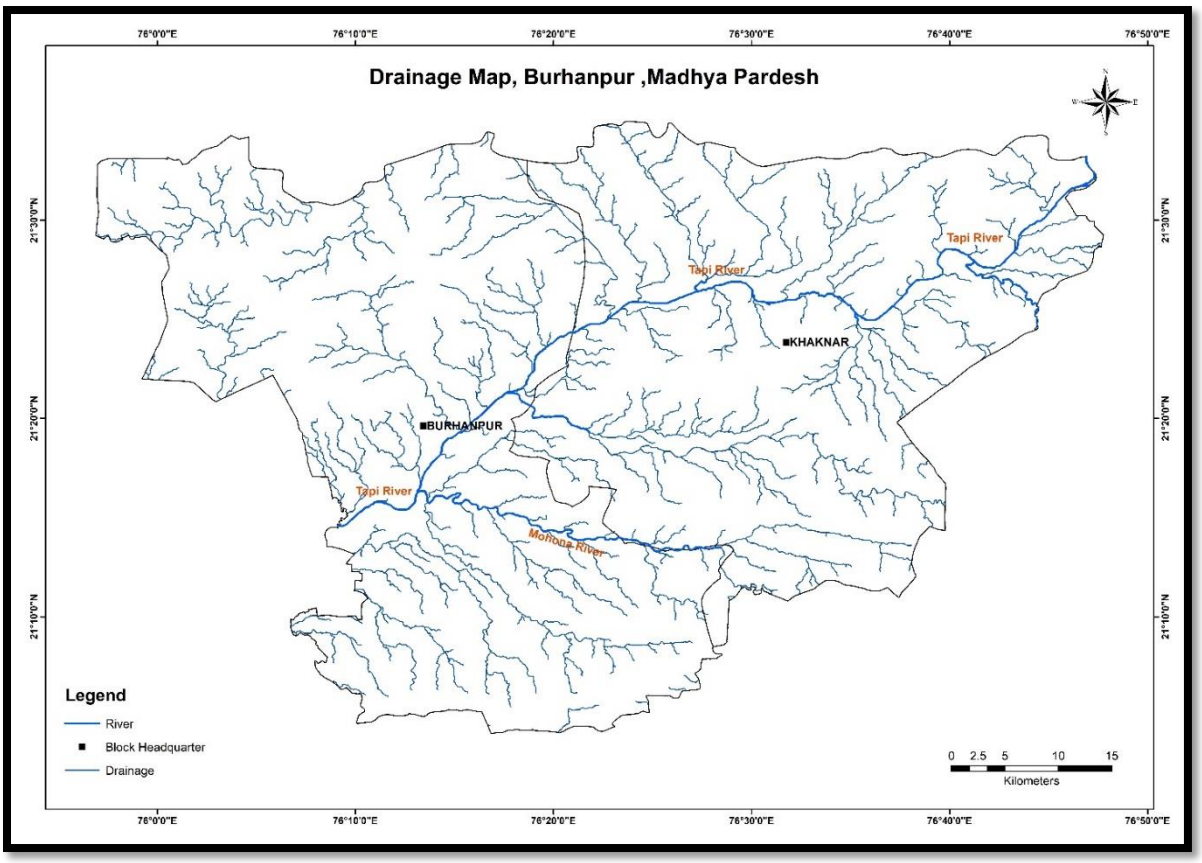


Figure 7 Drainage, Burhanpur District

1.9 LANDUSE

The socio-cultural and economic factors have significantly influenced over land use both in rural and urban areas in the district. Land forms, slope, soils and natural resources are some of the important which control the land use pattern of the district. The land use pattern of district is based on the District Survey report 2020, published by Government of Madhya Pradesh and is presented in **table 1** Detailed landuse land cover is shown in landuse map in **figure 9 and presented in table 2**

Table 1 : Land Use Pattern of Burhanpur District

S.No.	Land Use	Area in hectare
1	Total geographical area	**342741**
2	Forest	**195521**
3	Land not cultivated including pasture land; barren land; trees, grooves & orchards	**16169**
4	Fallow and current fallow land	**2392**
5	**Gross sown area**	**141733**

(Source: District Survey Report, Burhanpur, 2020)

Table 2 Land Use Land Cover of Burhanpur District

Land Use Land Cover Type	Area in Km2
Barren Land	7.3
Built-up Land	15.7
Crop Land	1129.4
Deciduous Broadleaf Forest	1370.7
Fallow Land	230.9
Mixed Forests	179.8
Shrubland	83.2
Wasteland	2.0
Water Bodies	58.9
Grand Total	3078.0

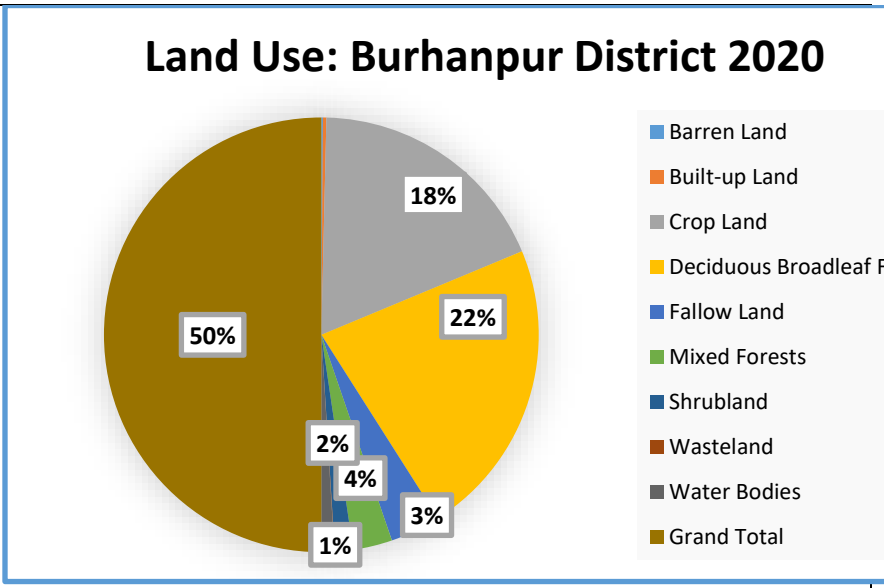


Figure 8 Land use Land cover of Burhanpur District.

(Source: GSI land use land cover shape file)

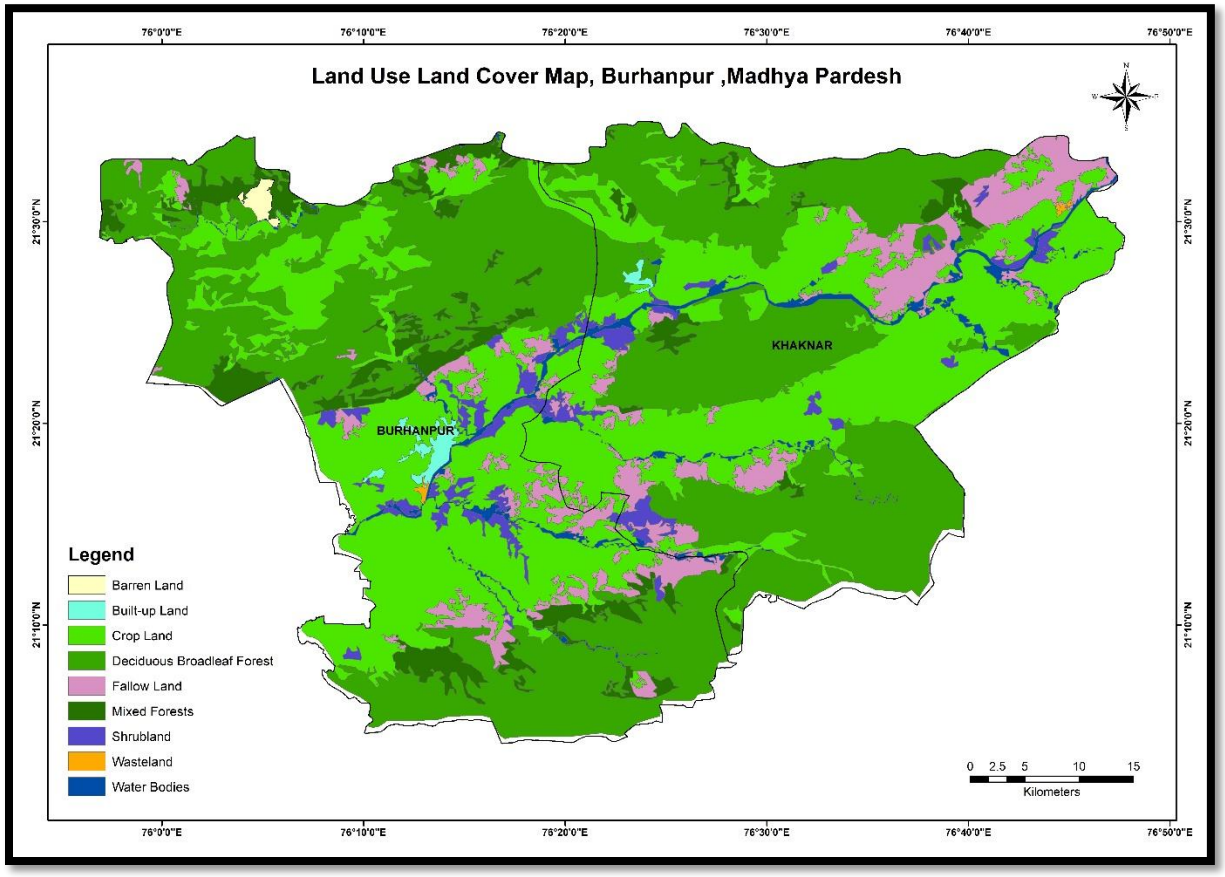


Figure 9 Land use, Burhanpur District

1.10 AGRICULTURE

Agriculture activity in the district is, by and large, confined to traditional kharif cultivation depending on monsoon rainfall and rabi cultivation is prevailing in areas where irrigation facilities are available. The major crops grown in the area are given in table no. 3. Banana is the major cash crop in the region.

Table 3 Major crops of Burhanpur District

Food Grain	Wheat, Bajra, Sorghum, Maize, Paddy
Cereals	Gram, Mung, Arhar, Urad
Non-food grains	Banana , Sugarcane, Cotton and other

(Source: https://pmksy.gov.in/mis/Uploads/2017)

1.11 IRRIGATION

Irrigation is the artificial application of water to the land or soil. It is used to assist in the growing of agricultural crops, maintenance of landscapes, and revegetation of disturbed soils in dry areas and during periods of inadequate rainfall. There is a great necessity of irrigation in Indian agriculture.
The principal means of irrigation in the district are through wells though very small areas irrigated by canals (8.52 sq.km.). Ground water plays an important role for irrigation contribute almost 100% and is utilized through dug wells and tubewells run almost by electricity in the area. Details of Area irrigated with sources in Burhanpur District is given in **table 4.**

Table 4 Details of Area irrigated with sources in Burhanpur District

District	Dugwells	Tubewell	Ponds	Canals	Other	Total
Burhanpur	32688	47560	304	852	4420	85824

(Source: District Survey report, Burhanpur, 2020)

1.12 HYDROLOGY

About 37 irrigation projects exists in the area. The various tanks and bunds made are used for irrigation and other purposes, details of Major/ Medium Irrigation Schemes are given in **table 5.**

Table 5 Block-wise Major/ Medium Irrigation Schemes in Burhanpur District

Block	**Medium/Minor Project**	
	Number	**Irrigated Area**
Burhanpur	20	**2905**
Khaknar	17	**3488**
Total	**37**	**6393**

(Source: Irrigation Department, District Burhanpur)

1.13 GEOLOGY

DECCAN TRAP BASALT: The Burhanpur district is characterized by the presence of thick pile of basaltic flows belonging to Deccan trap basalt. Alluvium in the district occurs as narrow strip along the Tapi river and as an extensive blanket over the traps south of Gawilgarh hill range forming the Purana alluvium. The individual's flows are 15 to 20 meter thick. Older flows are highly weathered and transformed into fertile soils. The basalts are fine grained, hard compact rock. Colour varies from light grey to dark grey. Deccan trap are generally regarded as fissure eruptions. Amygdaloidal types with infillings of various forms of silica and zeolites and vesicles or spherules or nodules of green earth (Celadonite) also occur. Spheroidal weathering is characteristic feature of Deccan Trap basalt. This can be observed in entire area. Spheroid from 10mm to 30mm diameter. Three sets of vertical joints

have been observed measuring N 1350, N 750 and N-S. These joint planes have infilling of calcite and quartz at places.

INTER TRAPPEAN: Thin lenticular beds of fossiliferous intertrappean limestone have been noticed at near Jhiri and Jhanjhar village (55 C/7).The limestone is off white and argillaceous in nature. It is weathered and converted into clay in nala section. Physa are recovered from this bed. The limestone is off white and argillaceous in nature. Thickness of limestone is 3 to 3.5 m. in this area. Due to ground water activity the tuffaceous limestone has also been formed in the small fractures. The extension of the intertrappean limestone is about 1.5 kms. Upto Jhanjhar village. The limestone is off white to light grey in colour. Brecciation is also noticed. Old workings have been seen near east of village Jhiri. The major portion of the district is occupied by Deccan trap Basalts. Small quantity of Calcite, Quartz, Zeolites occur as a cavity and fracture filling in the Deccan traps Basalts. These are invariably uneconomical. However, calcite veins of variable dimensions, intruding into Deccan trap Basalt have been reported around villages Dewatiya, Komal Khera, Gardev, Basali, Boribuzurg, Utambi and Sarai-Garhi in the forest area. These calcite veins can be exploited economically. The Basalts are being utilized in building and road construction. In Basaltic areas black cotton soil and brownish soil are being used in making bricks.

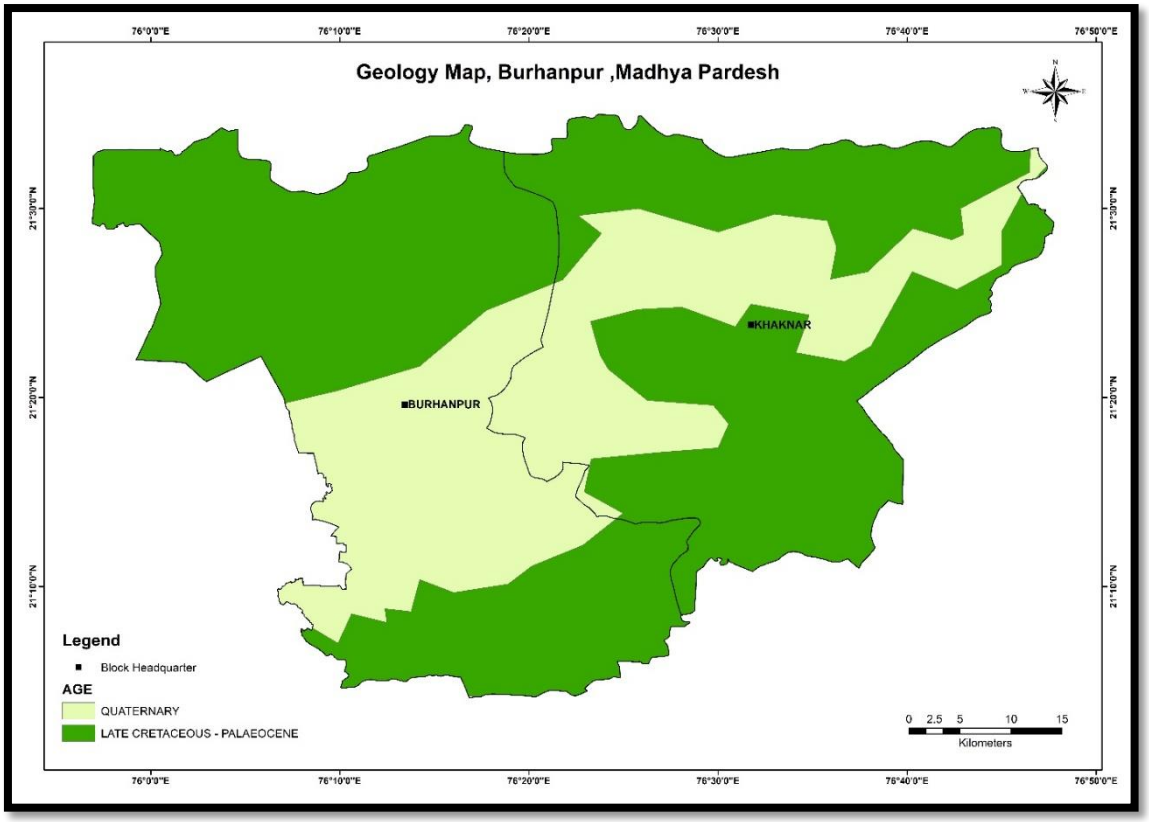


Figure 10 Geological Map of Burhanpur District

1.14 SOIL TYPE

Soil is the mixture of minerals, organic matter, gases, liquids, and the countless organisms that together support life on Earth. Majority part of block is covered by fine and loamy hyperthermic soil (Fig 11).

Table 6 Soil Type and Percentage

Soil Type	Area	% of Soil
Clayey-skeletal, mixed, hyperthermic Soil	22.07	0.72
Fine, montmorillonitic, (Cal.), hyperthermic Soil	1252.53	40.62
Fine,mixed,(Cal) hypierthermic, Vertic Ustocharepts	129.35	4.20
Loamy Skeletal kaolinitic hyperthermic Soil	1611.43	52.26
Loamy, mixed, isohyperthermic	67.93	2.20
Grand Total	3083.32	100%

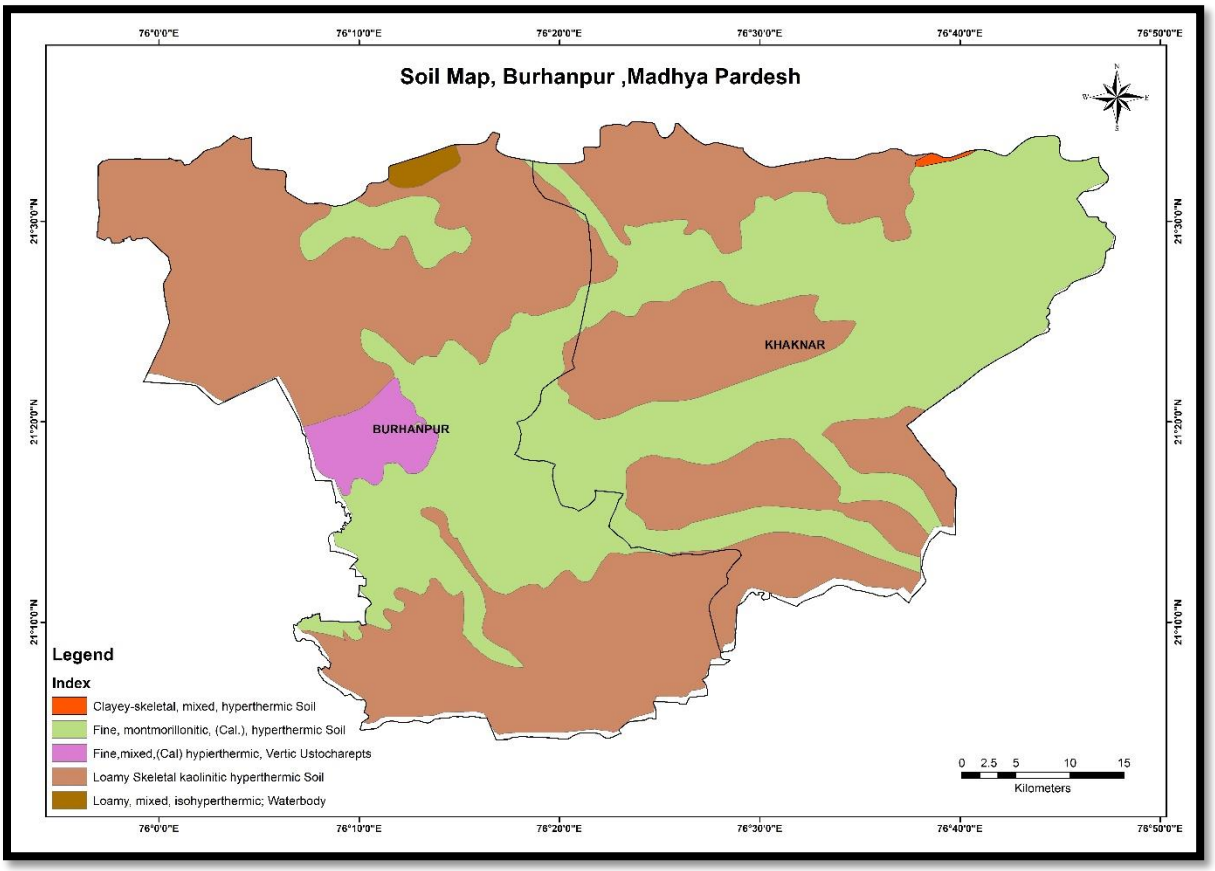


Figure 11 Soil type of Burhanpur District

2 DATA COLLECTION AND GENERATION

2.1 DATA AVAILABILITY

The compiled data were plotted on a 1:50000 scale map, and analysis of the data gap was carried out. The available data of the Exploratory wells drilled by Central Ground Water Board, North Central Region, Bhopal, Geophysical Survey carried out in the area, Ground water monitoring stations and ground water quality stations monitored by Central Ground Water Board were compiled and analysed for adequacy of the same for the aquifer mapping studies. The summarized table presenting the data requirement, data availability, and data gap analysis is presented in the following table.

Table 7 Data Requirement, Data Availability, and Data Gap Analysis

S.No	Items	Data Requirement	Data Availability	Data Gap
1	Rainfall Data	Meteorological stations spread over the project area.	hydro.imd.gov.in	
2	Soil	Soil map and Soil infiltration rate	Soil Map	
3	Land Use	Latest Land Use Pattern	Prepared from Land Sat 8 Imagery in GIS.	
4	Geomorphology	Digitized Geomorphological Map	Bhukosh.	
5	Geophysics	Geophysical data in each Quadrant	No VES done till now	35 VES
6	Exploration Data	EW in each Quadrant with Aquifer Parameters	Exploratory wells along with aquifer parameters are available	exploratory wells required
7	Aquifer Parameters	Aquifer parameters for all the quadrants	Not Available	
8	Recharge Parameters	Recharge parameters for different soil and aquifer types based on field studies	Recharge parameters are given in Ground Water resource estimation	
9	Discharge Parameters / Draft Data	Discharge parameters for different GW abstraction structures	Discharge parameters are given in Ground Water Resource Estimation GEC 2020	
10	Geology	All the maps on a 1:50000 scale	Bhukosh	

2.2 DATA COLLECTION AND GENERATION

Data on all the attributes of Aquifer Mapping has been generated based on the data availability and data gap analysis. The data generated and data collected from various state governments agencies are summarized in the following table.

Table 8 Data Generated and Data collected for Aquifer Mapping Area

S.No	Items	Data Generated	Data Collected
1	Rainfall Data	-	hydro.imd.gov.in
2	Ground Water Exploration	-	Basic Data Report
3	GW Regime Monitoring	32 Key wells established	Pre-monsoon Water level
4	Chemical Quality	30 Samples of Naquim in 2022 and 17 samples of NHS in 2022.	Water samples collected for analysis

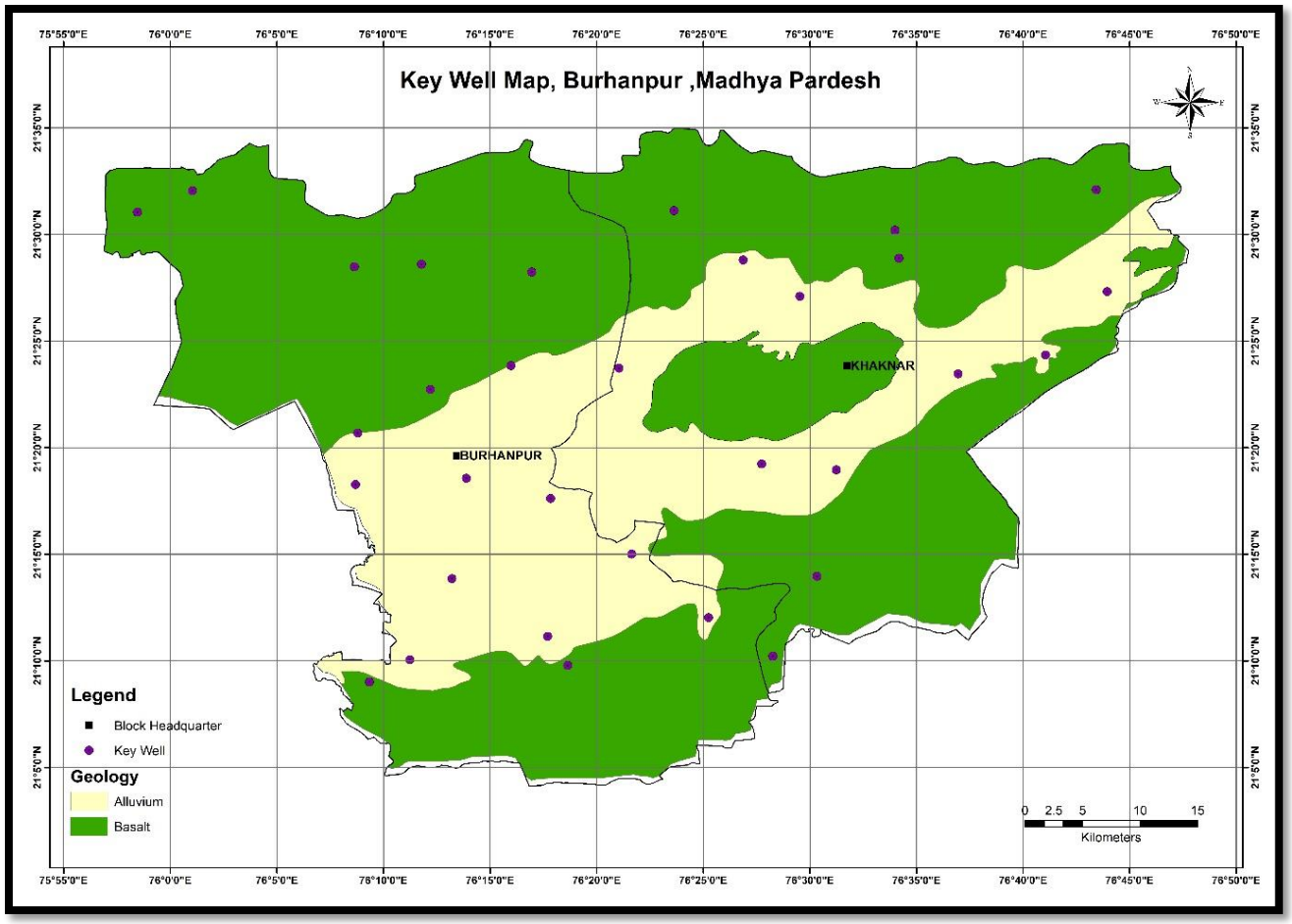


Figure 12 Data Gap of Burhanpur District

Table 9 Key well details

Sr.No	Location	Latitute	Longitude	Water Level mbgl	Temp°C	EC µS/cm
1	Shahpur	21.2309	76.220216	32	30.2	872
2	Icchapur	21.1503	76.155711	13.6	32.4	1541
3	Khaparkheda	21.167573	76.187273	dry	35.2	740
4	bhawasa	21.185843	76.295037	17	33.2	541
5	Chaundi	21.163109	76.310673	9.2	33.8	395
6	daryapur	21.293573	76.29737	10.8	35.5	479
7	Bodarli	21.250192	76.36073	5.6	31.7	1556
8	Jafarpura	21.1989	76.4187	7	40.8	748
9	Karauli	21.170386	76.471091	16	35.5	822
10	Doiphodia	21.32065	76.462277	13.1	37.4	1044
11	Nagjhiri	21.315906	76.520754	13.6	34.2	778
12	Usarani	21.2294	76.5055	5	31.3	554
13	Tembhi	21.39089	76.615845	9	31.8	1004
14	Chidiyamal	21.405749	76.684298	13.8	37	728
15	Dahoti	21.455283	76.732428	dry		
16	Sajni Railway	21.534927	76.723893	dry		
17	Jhiri	21.397392	76.266394	7.8	31.9	1092
18	Ambada	21.395387	76.350841	22	32.4	1244
19	Palasur	21.45163	76.492132	6.6	36.7	560
20	Rahamanpur	21.2294	76.5055	13	744	31.5
21	Ghagarla	21.50332	76.56659	14.5	31.5	792
22	Siwal	21.479967	76.447851	4	31	1090
23	Mandava	21.518553	76.393754	4.2	31.8	821
24	Viroda	21.304511	76.144855	24	26.8	2650
25	Bholana	21.344779	76.146465	18.1	28.4	1252
26	Thathar	21.378721	76.203372	14.3	33.9	1042
27	Piprana	21.476618	76.196459	8	34.1	494
28	Bhagwania	21.474645	76.143958	8	30.5	660
29	Kamalkheda	21.3073	76.2304	11.3	29	752
30	Amba	21.5275	76.0189	5	28.5	916
31	Paratkundya	21.5124	76.9783	8.5	27.8	625
32	Asirgarh	21.4718	76.2927	6	32.1	522

2.3 PREPARATION OF AQUIFER MAP

To understand the sub surface disposition in the district, geological sections and fence diagram have been prepared by synthesizing the various sub-surface sections on the basis of study of the Lithological data collected from CGWB bore wells, Piezometers. The data is plotted using the RockWorks16 software and a 3D lithological model has been prepared. The 3D lithological fence and 2D lithology sections diagram and has been prepared using lithology model.

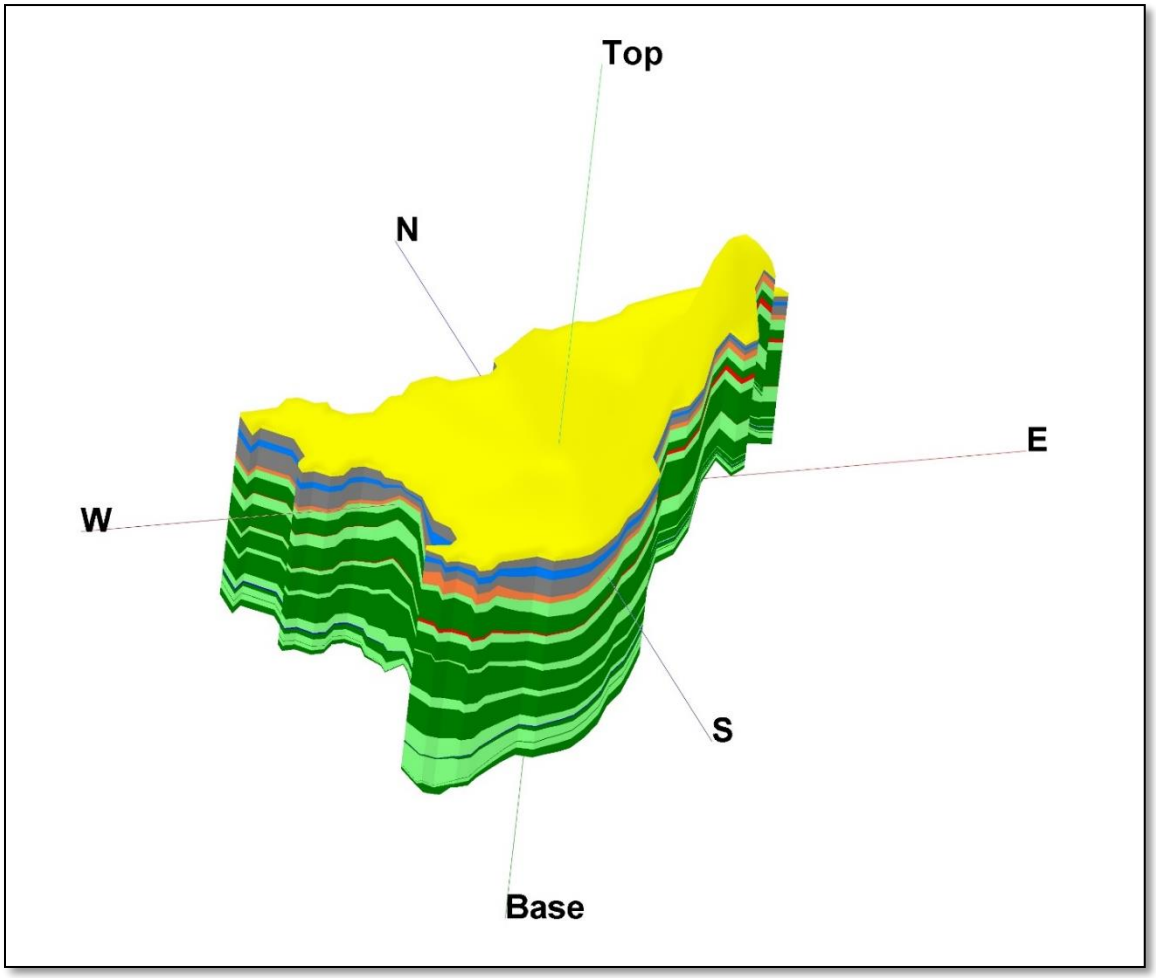


Figure 13 3D lithological Section

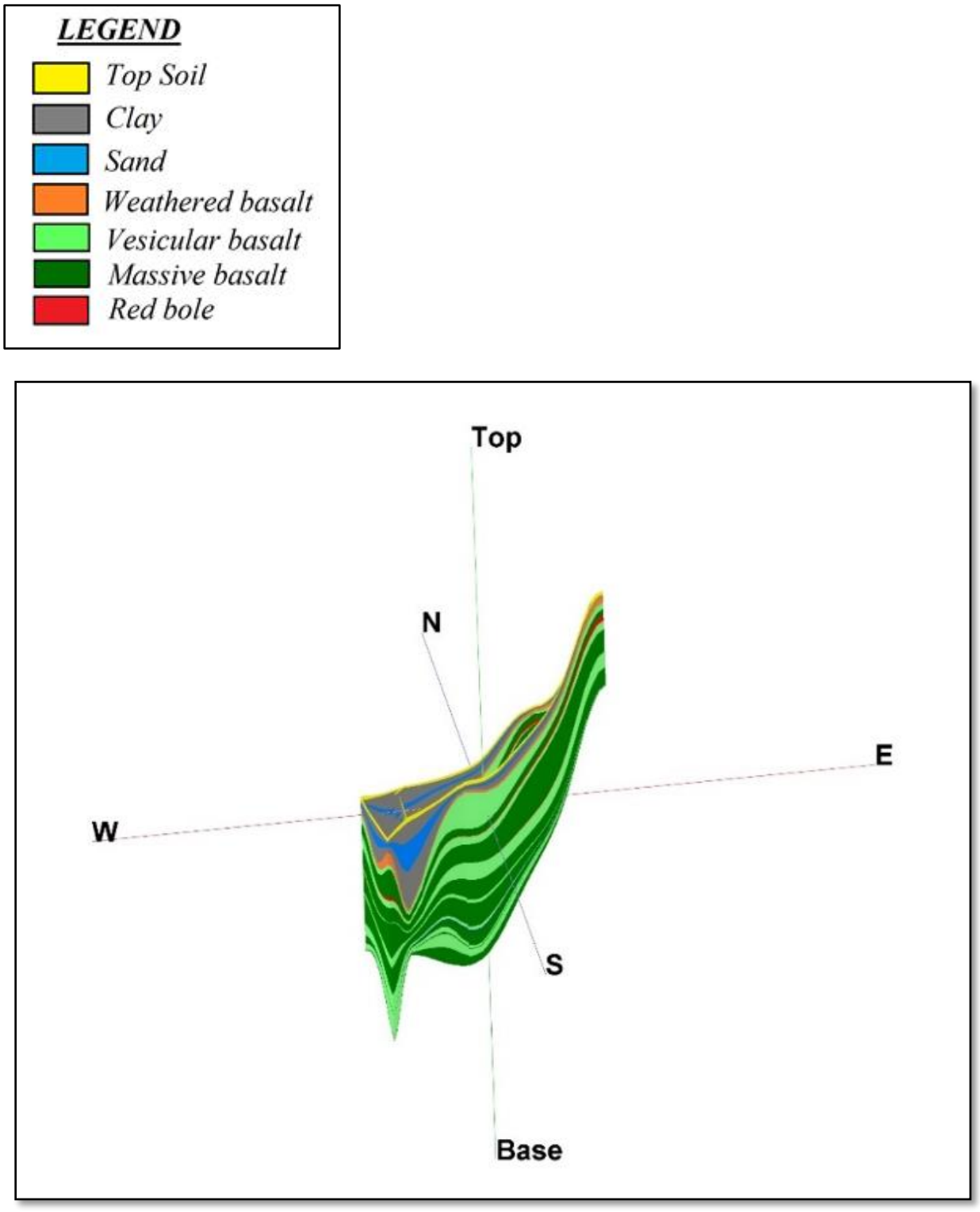


Figure 14 Fence Diagram

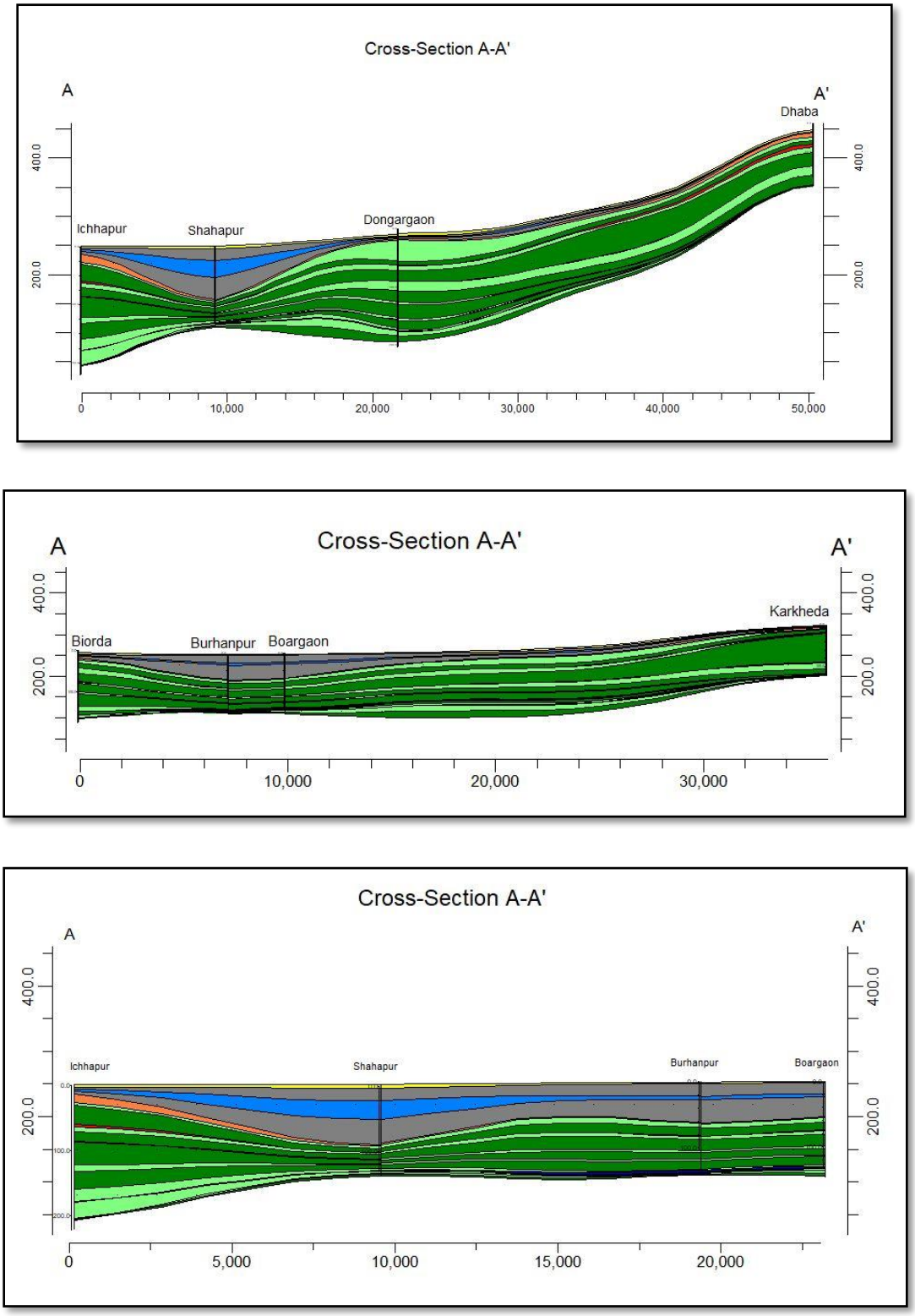


Figure 15 Lithological Cross Section

3 HYDROGEOLOGY

Deccan Trap consisting of different lava flows whose thickness ranges between 15 to 20 m, occupies the major part of the district. There are mainly two types of sedimentary deposits in the area. The predominant deposits are formed due to deposition from the river sediments transported by the Tapi River and its tributaries and is defined as alluvium. The second predominant formation is due to deposition of material transported from the Satpura hill ranges by small streams through gravity. These talus and scree deposits are commonly known as bazada. Satpura Fault (Burhanpur lineament) is a major fault trending ENE-WSE across the entire northern part of the watershed area along the Satpura foot hills which is correspond to the Narmada lineament. The fault zone is distinct and evidence of faulting in the area the Nawanath temple along the Ambapani and Jhiri stream, is marked by crushing of basalt, presence of brecciaed basalt, fault escarpment, presence of spring, sharp contact of Basaltic lava flows with Bazada formation .The geomorphic location of fault zone favors arresting surface runoff and recharge to ground water.

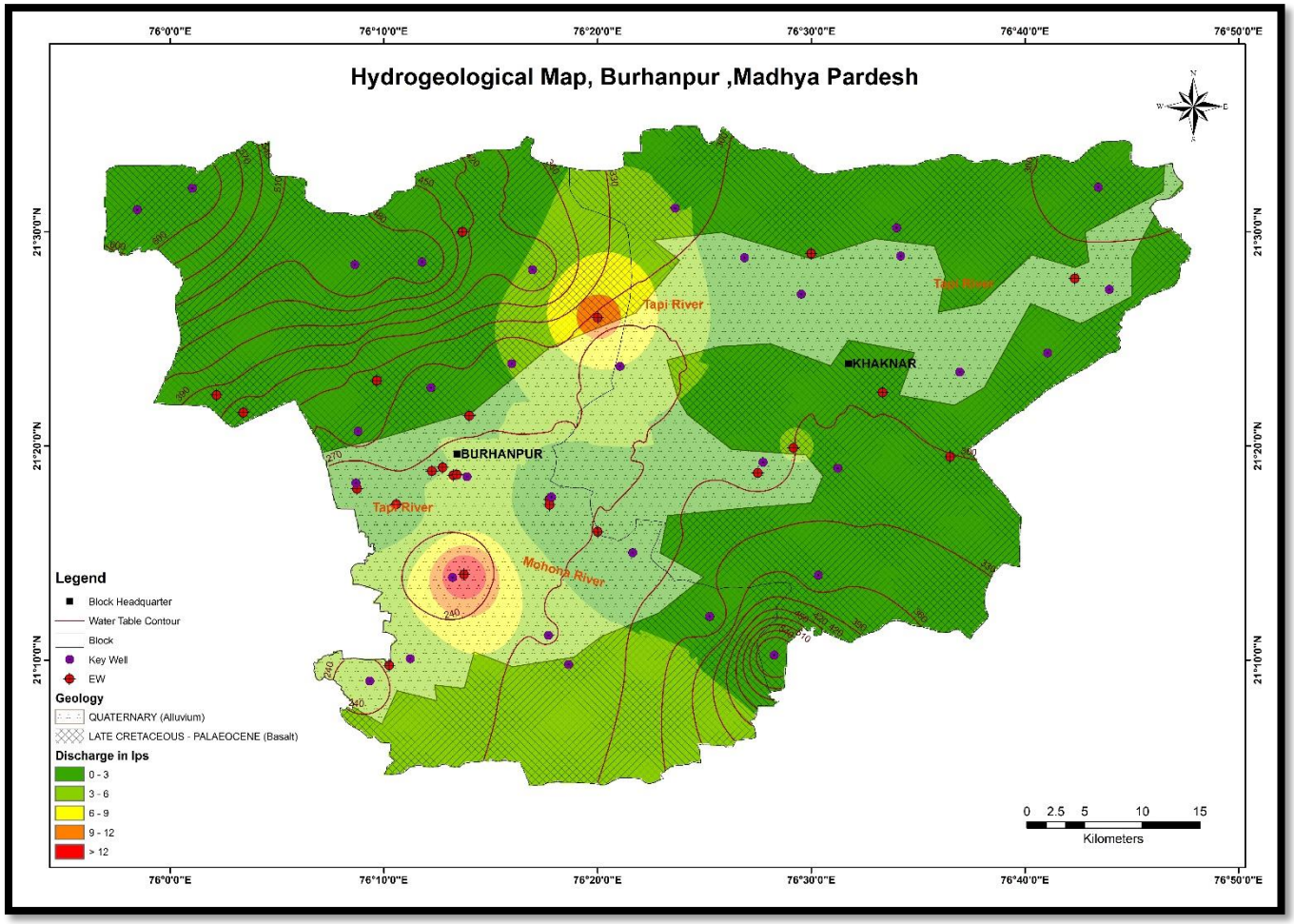


Figure 16 Hydrogeology

3.1 MAJOR AQUIFER SYSTEMS

There are two major aquifer systems in the district area namely Alluvium and Basalt.

Alluvium It is deposited at the foot hill of Satpura ranges stretching upto Tapti River, lying over Deccan Trap. It is valley fill deposit in tectonic depression resulted by sympathetic faults. The thickness of this formation increases towards Satpura, which is found to be more than 236 m. Alluvium consisting of sand, clay and gravels occurs along Tapti river course and formed unconfined, semi-confined to confined ground water conditions. Thickness of alluvium ranges from 30 to 229 m. Granular zones were encountered between 32 and 42 m bgl. The yields of the bore wells constructed in the formation ranges from 4.41 to 15.8 l /s.

Deccan Trap Basaltic lava flows of Deccan Trap forming Satpura, underline by alluvium and exposed also an inliers in southern part of the area closer to Tapti River. Basaltic lava flows are fractured and jointed constituting two aquifer systems. The unconfined aquifer is restricted up to 15 m bgl while semi- confined and confined aquifers are encountered between 45 to 190 mbgl. The potentiality of aquifers is very diversified in nature due to structural disturbances. Higher potential aquifers occur only at the influenced zone of lineaments. Shallow ground water occurs in the weathered, vesicular, jointed and fractured basalts under semi-confined to confined conditions. In irrigation wells the aquifer zone forms below thick clay of 4 to7 m in the depth ranges of 6.70 to 25.80 m bgl, around Burhanpur town area.

Bazada formation It occurs between 320 m and 290m a msl in the foothill of Satpura and covers around 4.5 km2 in the upland of watershed area of well-known infiltration galleries. It consists of mainly big boulders admixed with pebbles, gravels, silt & clay in the loose form. These deposits are partly sorted and generally devoid of any layer sequence. These are formed due to the deposition of rock fragments transported mechanically from the local streams from the Satpura hill ranges. The maximum thickness of these deposits is yet to be ascertained.

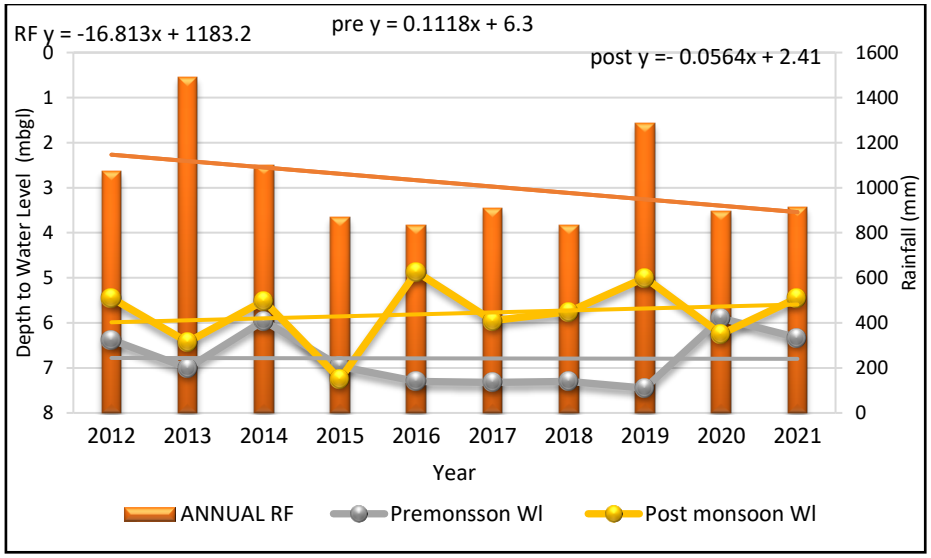
The water of these wells is mainly being used in Banana cultivation with installation of drip irrigation. Shallow aquifer zones were noticed in the boreholes at Chandni, khoknar, Diaphodia, Khar kheda, Raitalai between 6.50 – 29.00 m bgl. Deeper aquifers were encountered at Diaphodia, Haiderpur, Dariyapur. The discharges of exploratory wells found to be 0.08 – 10 l/s. The transmissitivity of wells constructed in Deccan Trap ranges from 2 to 74 m2 /day and storage co-efficient from 8.4x10-5 to 0.41x 10-3. Aquifer Characteristic of Burhanpur district is given in **table 10.**

Table 10 Aquifer Characteristic of Burhanpur district

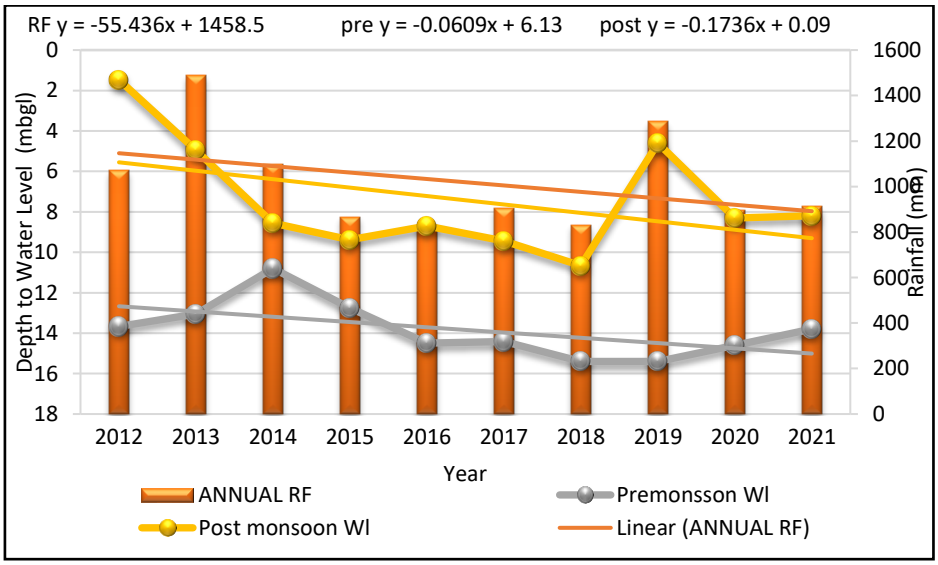
Major Aquifers	Basalt (Deccan Traps)		Alluvium	
Type of Aquifer	Aquifer-I	Aquifer-II	Aquifer-I	Aquifer-II
Formation	Weathered/Fractured Basalt	Jointed / Fractured Basalt	Alluvium	Alluvium/gravel sand
Depth of Occurrence (mbgl)	8-30	35-200	8-45	30-150
SWL (mbgl)	3-20	5.0 -37.00	2.5-19	11.68-60
Fractures/granular zone encountered (mbgl)	Upto 35	Upto 203	Upto 45	Upto 175
Yield	1-100 m3/day	Upto 10 lps	10-100 m3/day	Upto 15.00 lps
Transmissivity (m2/day)	Upto 80 m2/day	Upto 52 m2/day	-	Upto 74 m2/day
Specific Yield/ Storativity (Sy/S)	-	Upto 8.4 x10-5	-	Upto 2.9 X 10-4
Suitability for drinking/ irrigation	Suitable for Drinking and Irrigation Except High nitrate	Suitable for Drinking and Irrigation Except High nitrate	Suitable for Drinking and Irrigation Except High nitrate	Suitable for Drinking and Irrigation Except High nitrate

3.2 HYDROGRAPH ANALYSIS

The variation in short term and long-term water level trends may be due to variation in natural recharge due to rainfall and withdrawal of groundwater for various agricultural activities, domestic requirements, and industrial needs. The analysis of hydrographs shows that the annual rising limbs in hydrographs indicate the natural recharge of groundwater regime due to monsoon rainfall, as the monsoon rainfall is the sole source of natural recharge to the ground water regime (**Figure. 17 a & b**).



a. Block Burhanpur, Village Dehnala



b. Block Khaknar, Village Pipalpani

Figure 17 a & b Behaviour of Water level with respect to time

4 HYDRO-CHEMICAL SCENARIO OF BURHANPUR DISTRICT

The water samples were collected from NAQUIM study in clean double stopper HDPE poly ethylene bottles from 30 nos. different locations for basic analysis of ground water of Burhanpur district during pre-monsoon 2022.

4.1 QUALITY OF GROUND WATER FOR DRINKING PURPOSE:

The ground water samples from Burhanpur district have varied range of pH from 7.29 to 7.98. As per BIS (IS 10500 : 2012) recommendation, all the water samples have pH recorded within the permissible limits of 6.5 to 8.5, the maximum pH recorded in the water sample of Viroda (7.98). The ground water of the study area can be assessed as slightly alkaline in nature. The electrical conductivity of ground water samples in Burhanpur district varies from 562 to 1566 µS/cm at 25°C. In the 25 nos. of ground water samples recorded electrical conductivity less than 1000µS/cm; 4 nos. of water samples recorded electrical conductivity in between 1000 to 1500 µS/cm at 25°C whereas 1 no. of water samples recorded electrical conductivity more than 1500 µS/cm at 25°C namely Shahpur (1566 µS/cm at 25°C). So, overall ground water quality in Burhanpur district is good to slightly saline in nature. The maximum electrical conductivity has been observed in the water sample of Shahpur (1566 µS/cm at 25°C).

The fluoride concentration in Burhanpur district lies in between 0.02 to 1.32 mg/l, which represents that all the samples are within the permissible limit i.e. 1.5 mg/l as per BIS (IS 10500 : 2012). The maximum fluoride concentration has been observed in the water sample of Palasur village i.e. 1.32 mg/l. Nitrate concentration in ground water samples of Burhanpur district falls within the 2 to 20 mg/l. It is observed that the nitrate concentrations in all ground water samples are within the acceptable limit i.e. 45 mg/l. The highest concentration of nitrate more than 45 mg/l is recorded in the water samples of Shahpur (20 mg/l). High nitrate in ground water samples may be due to anthropogenic activities or excessive use of fertilizers. The range of Total Hardness (as $CaCO_3$) in ground water samples of study area is 155 to 690 mg/l. In all locations, total hardness concentrations are within the permissible limit of 600 mg/l. The maximum concentration of total hardness is observed in the village of Shahpur i.e. 690 mg/l.

Piper diagram (Figure 18) has three parts: a Cation triangle, an Anion triangle, and a Central diamond-shaped field. In Cation triangle, the relative percentages of the major cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}) are plotted. In Anion triangle the major anions (HCO_3^{-}+CO_3^{2-}, SO_4^{2-}, Cl^{-}) are plotted. These points are then projected to the central diamond shaped field. The piper diagram of Burhanpur district shows the ground water samples are Calcium-Bicarbonate type (28 nos.) i.e. temporary hardness; Mixed type i.e. Calcium-Sodium Bi-carbonate type (1 no.) and Sodium Chloride types (1 no.) i.e. saline in nature.

4.2 QUALITY OF GROUND WATER FOR IRRIGATION PURPOSE:

In classification of water for irrigation purpose, it is assumed that the water will be used for irrigation purpose based upon its soil texture, infiltration rate, drainage and climate. The chemical data of all the water samples from Burhanpur district is plotted on U.S. Salinity Laboratory diagram.

U.S. Salinity Laboratory diagram (Figure 19). The ground water samples of Burhanpur district are C_2-S_1 Class (Medium Salinity & Low Sodium) and C_3-S_1 Class (High Salinity & Low Sodium) which means that these waters may be used for irrigation purpose for most of the crops. The ground water of C_3-S_1 Class may be used for irrigation, considering the salinity content of the ground water.

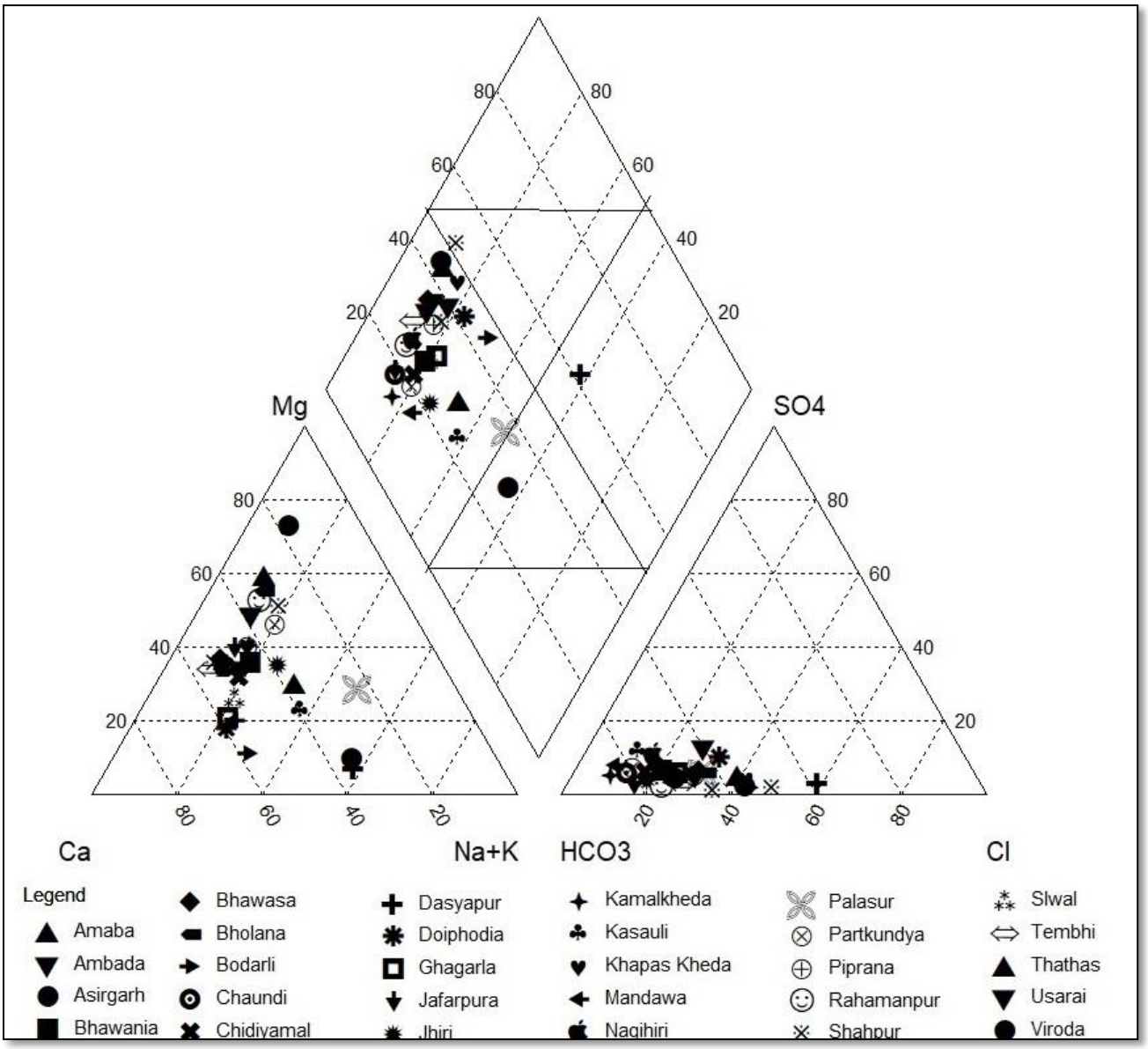


Figure 18 Hill Piper Diagram representing classification of water samples collected from National Hydrograph Stations, Burhanpur District, Madhya Pradesh

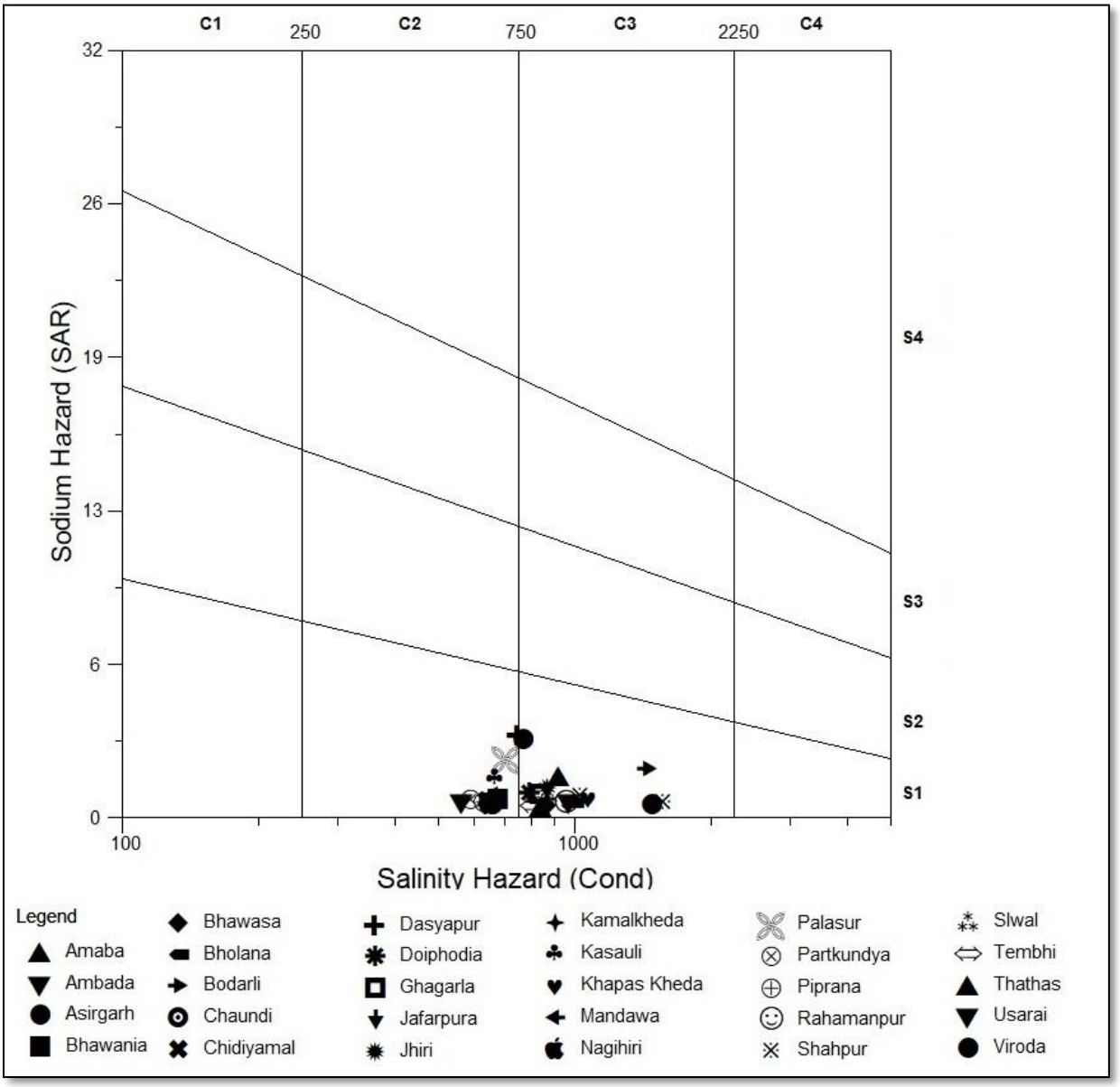


Figure 19 US Salinity Diagram for water samples collected from National Hydrograph Stations of Burhanpur District, Madhya Pradesh.

5 GROUND WATER RESOURCES

5.1 GROUND WATER RESOURCES – AQUIFER-I

Central Ground Water Board and Ground Water Survey and Development Agency (GSDA) have jointly estimated the ground water resources of BURHANPUR district based on GEC-15 methodology. Block wise ground water resources for the year 2020 have been discussed here. During the monsoon season, the rainfall recharge is the main recharge parameter, which is estimated as the sum total of the change in storage and gross draft. The change in storage is computed by multiplying groundwater level fluctuation between pre and post-monsoon periods with the area of assessment and specific yield. Monsoon recharge can be expressed as:-

$R = h \times Sy \times A + DG$

Where h = rise in water level in the monsoon season, Sy = specific yield A = area for computation of recharge, DG = gross ground water draft

The monsoon ground water recharge has two components- rainfall recharge and recharge from other sources. The other sources of groundwater recharge during monsoon season include seepage from canals, surface water irrigation, tanks and ponds, ground water irrigation, and water conservation structures. During the non-monsoon season, rainfall recharge is computed by using Rainfall Infiltration Factor (RIF) method. Recharge from other sources is then added to get total non-monsoon recharge.

Ground Water Resources estimation carried out in the year 2020 are given in **Table 11** and shown in **Figure 20** The resources were computed for 3233 sq. km. area out of which 2570.50 .sq. km. is recharge worthy area. As per the estimation, the net annual extractable ground water resource is 373.43 MCM. The gross draft for all uses is estimated at 235.81 MCM with irrigation sector being the major consumer having a draft of 221.12 MCM. The domestic and industrial water requirements are worked at 14.69 MCM. The net ground water availability for future irrigation is estimated at 135.66 MCM.

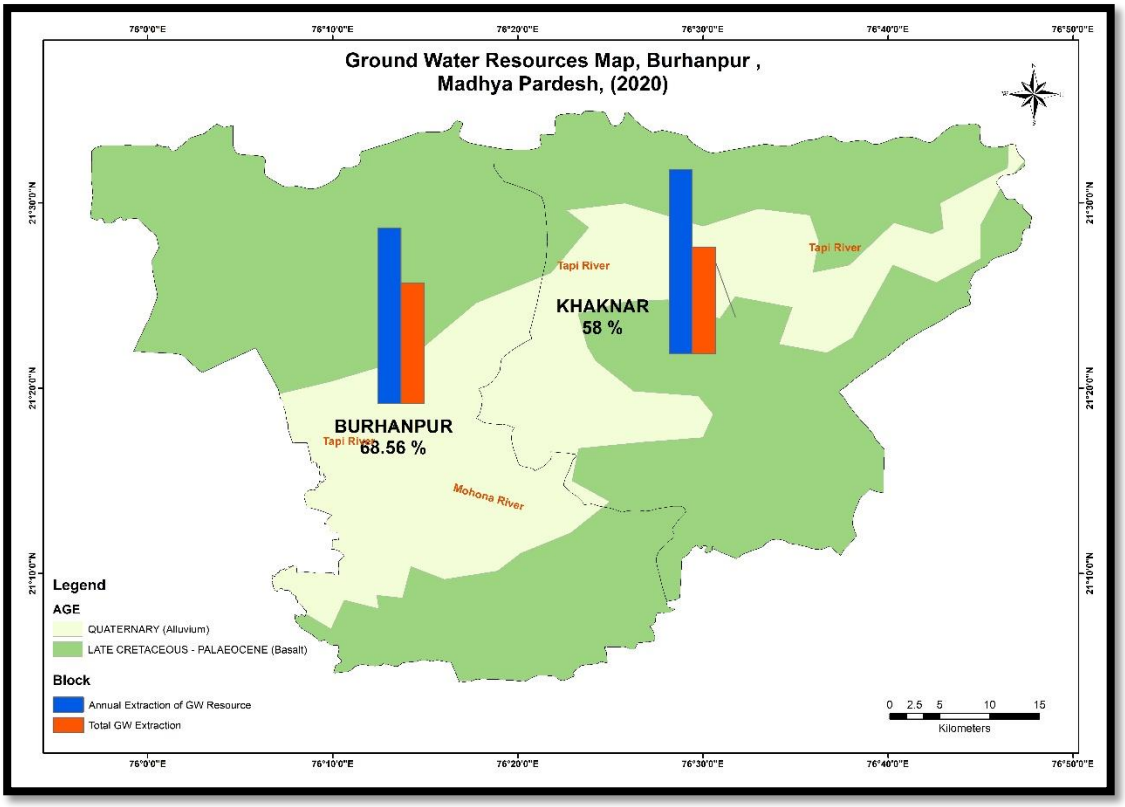


Figure 20 Ground Water Resources (2020), Burhanpur district

Table 11 Ground Water Resources (2020), Burhanpur district

Assessment Unit Name	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization
BURHANPUR	11567.34	914.6907	12482.04	1039.69	5598.85	68.56	Safe
KHAKNAR	10544.877	554.8913	11099.78	625.49	7967.65	58.00	Safe
DISTRICT TOTAL	22112.22	1469.58	23581.82	1665.18	13566.5	63.15	Safe

6 GROUND WATER RELATED ISSUES

6.1 SUSTAINABILITY

The major part of the district is occupied by basaltic rock formation that inherently consist of limited extent of porous and pervious zone; absence of primary porosity; predominance of secondary porosity that has evolved from prevailing erratic joint pattern, absence of primary porosity and also, low rainfall results in poor sustainability of the aquifers. However, the erratic nature of existing joints/fractures pattern results in highly varying yield capacities of the aquifers in the area. In the area depth of potential aquifers is generally restricted up to 35 m. The potential of the fracture zones reduces substantially below 100 m depth.

6.2 SAND MINING

River channels and their floodplains are important sources of construction grade aggregate materials like sand and gravel. The durability of river-borne coarser clastics (e.g. sand and gravel) and their sorting by fluvial action make them best suitable raw materials / ingredients for building constructions. Most of the rivers in the world are overexploited for living and non-living resources and today the challenge posed to the society is to restore its natural ecology.

Sand Mining Sand Mining is an activity referring to the process of the removal of sand from rivers, streams and lakes. Sand is mined from beaches and dredged from river beds which leads to disturbances in hydrogeological cycle, base flow and also affect the ground water quality.

6.3 TRADITIONAL/FLOOD IRRIGATION PRACTICES

Flood irrigation is the oldest and most popular irrigation system in the India. Yet flood irrigation is also the most water-intensive method of irrigating crops, an increasing concern as rising temperatures, prolonged drought, and growing populations place more demand on the planet's finite water resources. Unfortunately, flood irrigation is the most inefficient of all irrigation systems, including center pivot and drip irrigation systems. Flood irrigation wastes upwards of 50% of the water used.

6.4 LOW STAGE OF EXTRACTION

Both the block Burhanpur and Khaknar shows stage of groundwater extraction 68% & 58% respectively. Low development of groundwater is one of the reason for low agricultural productivity which ultimately leads to slower economic growth of the region.

7 GROUND WATER MANAGEMENT PLAN

The management plan has been proposed to manage the ground water resources and to arrest further decline in water levels. The management plan comprises two components namely supply-side management and demand side management. The supply side management is proposed based on surplus surface water availability and the unsaturated thickness of aquifer whereas the demand side management is proposed by use of micro irrigation techniques and change in cropping pattern.

7.1 NEED OF MANAGEMENT PLAN

The demand of fresh water for agriculture, drinking and industrial uses etc. has significantly increased due to population growth and socio-economic development. There is urgent need for taking up suitable water management interventions based on integrated approach, which on one hand includes augmentation of ground water resources through appropriate techniques, and on the other hand requires the adoption of suitable water conservation measures, such as ensuring water use efficiency through creation of additional water storage facility, maintenance/ renovation of existing water bodies etc. This plan is focusing on the technical aspects of the ground water recharge through various means so that various implementing agencies may get the appropriate technical guidelines. The existing/ongoing schemes of the central or state govt. like MANERGA, IWSP, PMKSY (Prime Minister Krishi Sinchai Yojna), NABARD funded schemes, Urban Development schemes, departmentally funded projects etc. may be benefitted from the recharge plan by incorporating the input in the operational guidelines/ design and for locating the specific sites. Agriculture University, engineering Collages, Academic and Research Institution, NGO may also take up the pilot or demonstrative projects in the blocks suitable to them to plan at local level as per local conditions

7.2 DISTRICT GROUNDWATER LEVEL MANAGEMENT PLAN (OUTCOME OF NAQUIM)

As per directions of Ministry of Water Resources, River Development and Ganga Rejuvenation, Government of India, preparation of Aquifer Management Plan for Burhanpur district has been carried out and financial outlay plan is also shown. Each Plan discusses the broad framework of ground water situation in the block, status of water availability (both surface and ground water), identification of feasible areas for interventions, feasibility of abstraction structures and other water conservation structures, their design considerations, numbers and cost estimates. The expected outcomes of the proposed interventions have also been elucidated and given in tables below 7.3.

7.3 SUPPLY SIDE MANAGEMENT

In Burhanpur district, after 2020 water resource assessment all blocks are under safe category. Two blocks i.e., Burhanpur and Khaknar block are having less than 70% stage of groundwater development. Adoption of suitable Artificial Recharge structures in Burhanpur and Khaknar block has been proposed(Table 12).

Table 12 Supply side interventions proposed

Block	Volume of unsaturated granular zone Hard Rock	Area identified for AR (WL>3) (sq km) in master plan	Availability of Surplus surface runoff	Surplus runoff considered for planning	Proposed Structures		Volume of Water expected to be conserved/ recharged @ 75% efficiency
	(MCM)	HR	**Hard Rock (MCM)**	**Hard Rock (MCM)**	PT (f=0.2)	CD (f=.03)	(MCM)
Burhanpur	5.93	1170.00	26.21	0.12	0	1	0.09
Khaknar	7.93	1400.50	31.37	0.16	1	2	0.12
Total	**13.86**	**2570.50**	57.58	**0.28**	**1**	**3**	**0.21**

7.4 DEMAND SIDE MANAGEMENT

The Demand Side Management is proposed in areas where the Stage of Ground Water Development is relatively high and adopting micro-irrigation techniques for water intensive crops Banana and cotton or change in cropping pattern or both are required to save water.

It is proposed to adopt drip irrigation under banana crop in 117.18 sq. km and Cotton in 38.13 sq.km area in 2 talukas of the district. This demand side intervention would lead to saving of 175.21 MCM of water (**Table 13**).

Table 13 Demand side interventions proposed

Block	Proposed Cropping Pattern change	Proposed to be covered under Drip (sq.km.)		Volume of Water expected to be saved (MCM)		Total Volume of Water expected to be saved (MCM)
		Banana crop area	Cotton crop area	Banana crop area	Cotton crop area	
Burhanpur	None	117.18	190.57	35.15	57.93	93.09
Khaknar	None	38.13	232.50	11.44	70.68	82.12
Total		155.31	423.07	46.59	128.61	175.21

7.5 EXPECTED BENEFITS

The impact of groundwater management plans on the groundwater system in the district after its implementation is evaluated and the outcome shows significant improvement in groundwater scenario in all Blocks as given in the **Table 14**

It can be seen that after proposed supply side and demand side interventions, there would be 200.94 MCM ground water available for development. With this about 710.04 sq.km additional area can be irrigated.

Table 14 Expected benefits after management options

Block	Volume of Water expected to be saved (MCM). After Demand Side Intervention	Total GW Extraction after Demand side intervention (MCM)	Stage of GWD after Supply side and demand side interventions	Balance GWR available for GW Development so that STAGE OF GWD is ENHANCED to 70% (MCM)	Additional area that can be brought under assured GW irrigation with av. CWR of 0.65 m	Stage of GWD after Management
	(MCM)	(MCM)	(%)	(MCM)	(Sq.Km)	(%)
Burhanpur	93.09	31.73	17.42	95.77	147.34	70.00
Khaknar	82.12	28.88	15.08	105.17	161.8	70.00
TOTAL	**175.21**	**60.61**	**16.25**	**200.94**	**309.14**	**70.00**

7.6 DEVELOPMENT PLAN

The ground water development plan has been proposed in the view of developing the additional ground water resources available after supply side and demand side interventions to bring the stage of ground water development up to 70%. About 200.94 MCM of ground water would be available. This ground water can be used to irrigate additional 309.14 sq.km area. For this purpose, it is proposed to construct 12056 dugwells and 2010 borewells. The block wise details are given in **Table 15.**

Table 15 Block wise additional area under assured GW Irrigation

Block	GW Resources Available for Development and Bring Stage of GWD upto 70% from present SOD (MCM)	Proposed no. of DW (@ 1.5 ham for 90% of GWR Available)	Proposed no. of BW* (@ 1.0 ham for 10% of GWR Available)	Additional area that can be brought under assured GW irrigation with av. CWR of 0.65 m
Burhanpur	95.77	5746	958	147.34
Khaknar	105.17	6310	1052	161.8
TOTAL	**200.94**	**12056**	**2010**	**309.14**

8 WATER HERITAGE SITE: KUNDI BHANDARA

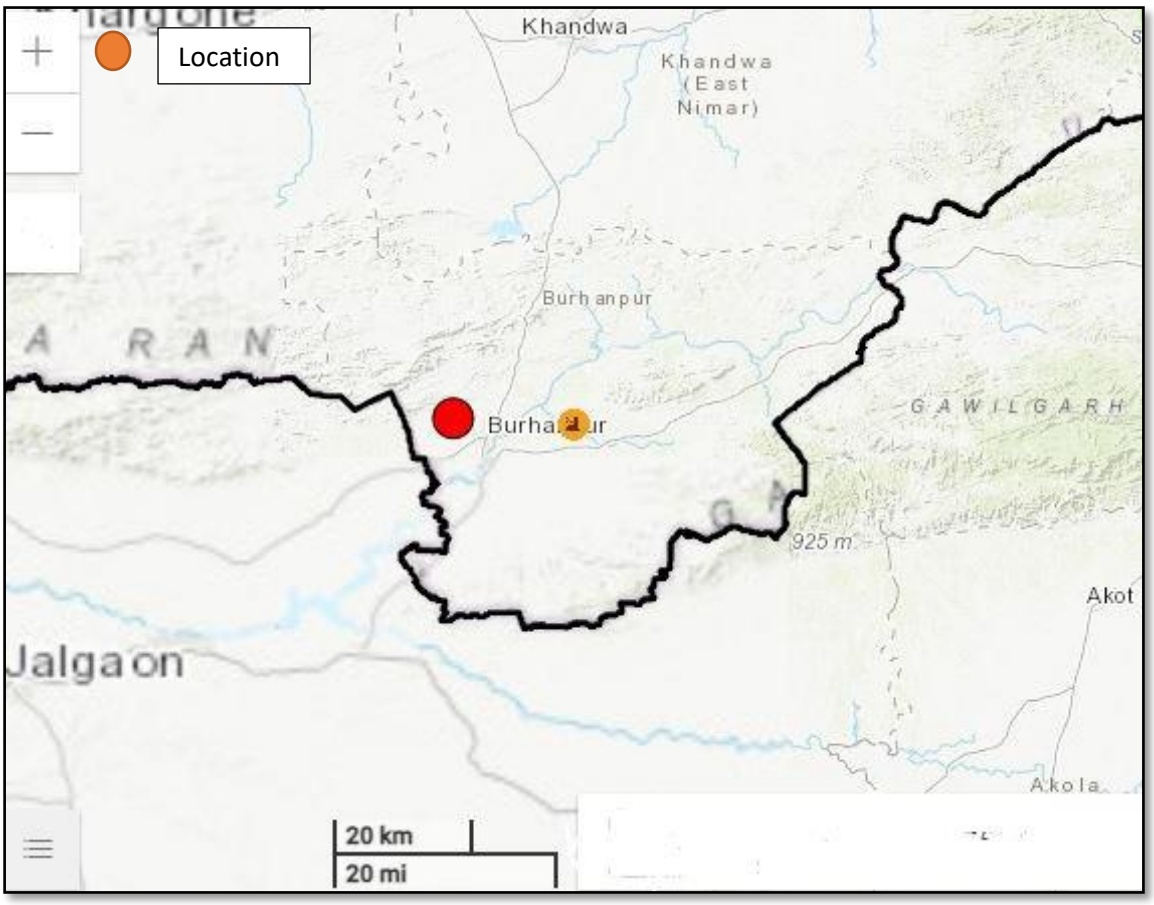


Figure 21 Location of Kundi Bandara

8.1 INFILTRATION GALLERY: SUBSURFACE SOURCES OF WATER FOR WATER SUPPLY

An infiltration gallery is a horizontal or nearly horizontal tunnel with permeable boundaries that are constructed near highly permeable aquifers to permit groundwater to infiltrate into the same. It is also defined as subsurface source of water used for a water supply system whose structure is like a horizontal drain that is positioned below the water table so that it collects the groundwater. It collects the subsurface sources of water. The horizontal drain can be made out of an open jointed pipe or a perforated pipe. The water collected can be taken to a sump, a storage tank or a collection well.

One or more galleries are constructed that together connect to a central point like a spring box or a hand-dug well. Hence these center point water collection structures are called collector wells.

Yield Capacity of Infiltration Gallery

The yield of infiltration gallery is given by the formula:

q = k [(H2-h2)/L)

Where

k = coefficient of permeability,

H = depth of the permeable stratum above the bottom of the infiltration gallery,

h = height of the water surface inside the infiltration gallery,

L = distance through which seepage takes place.

8.2 INFILTRATION GALLERY OF KUNDI BHANDARA, BURHANPUR DISTRICT

Name of Heritage	Kundi Bhandara
State	Madhya Pradesh
District	Burhanpur
Village	Burhanpur
Latitude	21.33760389
Longitude	76.18235611
Built By	
Present Ownership	Burhanpur Municipal Corporation
Typology	Tank
Year	1615 CE
Description	Qanat is an underground water supply system. This qanat is an excellent example of engineering, an **infiltration gallery**, which collects seepage from the hillside. Persian geologist Tabukul Arj drew up an ambitious plan in 1615, which centred on capturing the flow of rainwater from the Satpura hills towards Tapti and storing it at various junctures.

Kundi Bhandara (Fig 22) is an infiltration Gallery which runs from Sultanpur to Shahi Quila in Burhanpur and drain the groundwater to Tapti River and is located in Burhanpur District (Fig 21). There are total of 108 Collector wells which are above the horizontal gallery 80 feet below the ground surface. All these Collector wells are small and are perpendicular to the horizontal gallery 1.5 to 2 meter above ground surface. These Collector wells are groundwater providers as well as they allow the water to flow by adding air pressure in the infiltration gallery.

The main objective of Kundi Bhandara is to provide fresh ground water to the common people as well as to provide the fresh water to the shahi Quila on Banks of Tapti River. Kundi bandara is an excellent example of groundwater management and thus its preservation and conservation is important.

Figure 22 A: Inside view of Infiltration gallery, B: Wall of Infiltration gallery, C: Collector Wells

9 BLOCK MANAGEMENT PLANS

9.1 BURHANPUR BLOCK, BURHANPUR DISTRICT, MADHYA PRADESH

1. SALIENT FEATURE		
1.1 Introduction		
Block Name		Burhanpur
Geographical Area (Sq. Km.)		1542.34 Sq. Km.
Population (2011)		433584
Climate		Tropical wet and dry or savanna
1.2 Rainfall Analysis		
Normal Rainfall		823 mm
Annual Rainfall (2020)		850 mm
1.3 Geomorphology, Soil & Geology		
Geomorphic Unit	Dissected plateau, linear ridges, residual hills and low lying plains	
Geology	Deccan Traps (Basalt)	
Soil	Black Soil, Red Soil, Sandy Soil and Yellow Soil	
1.4Hydrology & Drainage		
Drainage	Dendritic to sub-dendritic pattern.	
Hydrology	Medium/Miner Project	20
	Pond	170
1.5 Land Use, Agriculture, Irrigation & Cropping Pattern		
Geographical Area		1542.34
Cultivable Area		603.48
Cultivated Area		673.31
Current Fallow Land		5.67
Pasture Land		46.08
Principal Crops *(Reference year 2019-20)*		**Crop Type**
		Cotton
		Sugarcane
		Banana
		Maize
		wheat
		Sorghum
2. Hydrographs		

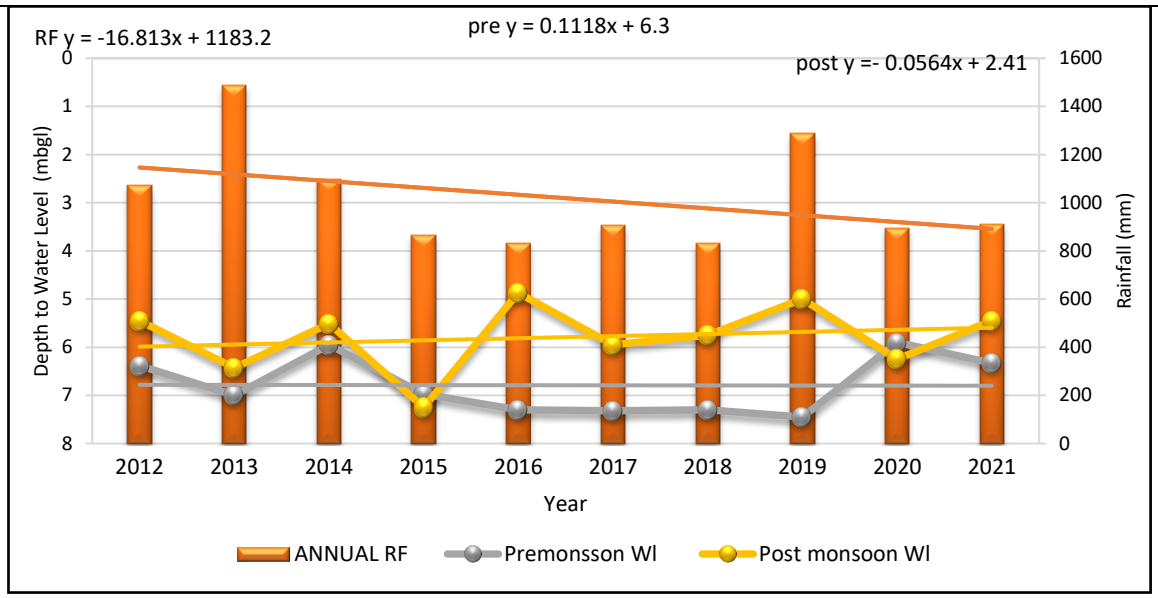


Figure 23 hydrograph of Block Burhanpur, Village Dehnala

3. AQUIFER DISPOSITION	
3.1 Number of Aquifers	**Basalt – Aquifer-I (weathered & fractured basalt)** **Basalt –Aquifer-II (Jointed & fractured basalt)**

3.2 AQUIFER DISPOSITION

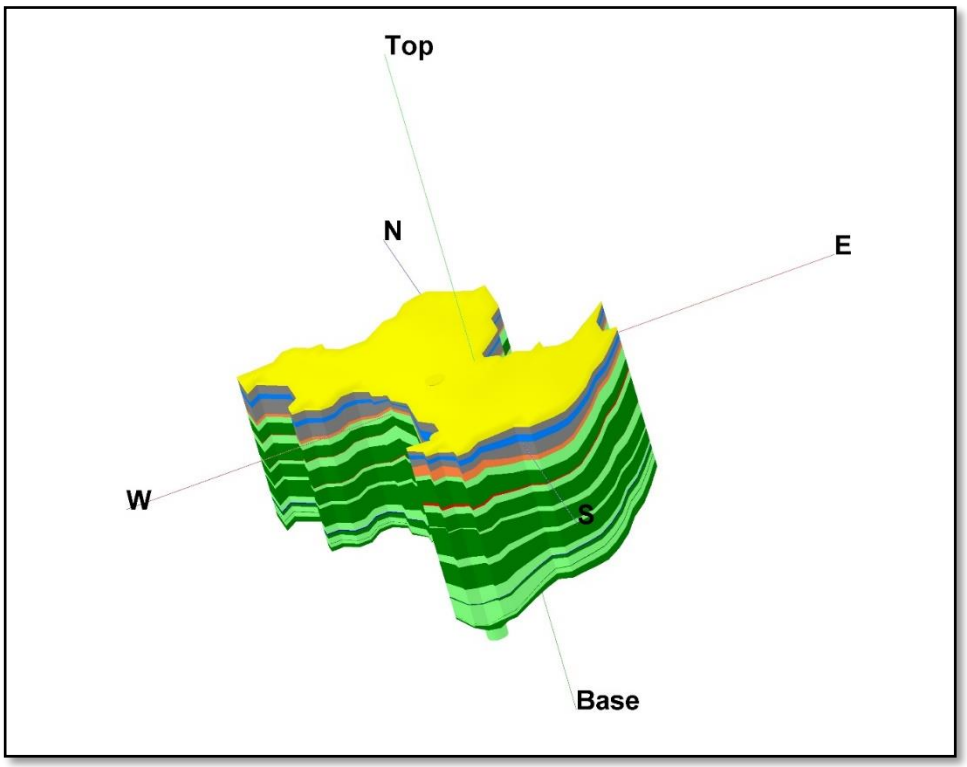
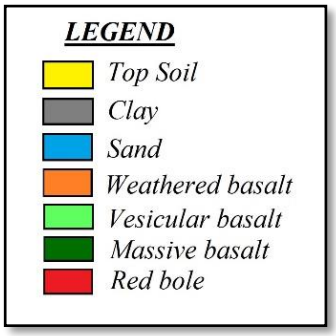


Figure 24 3D Model of Burhanpur Block



3.3 Cross Sections:Section AA'

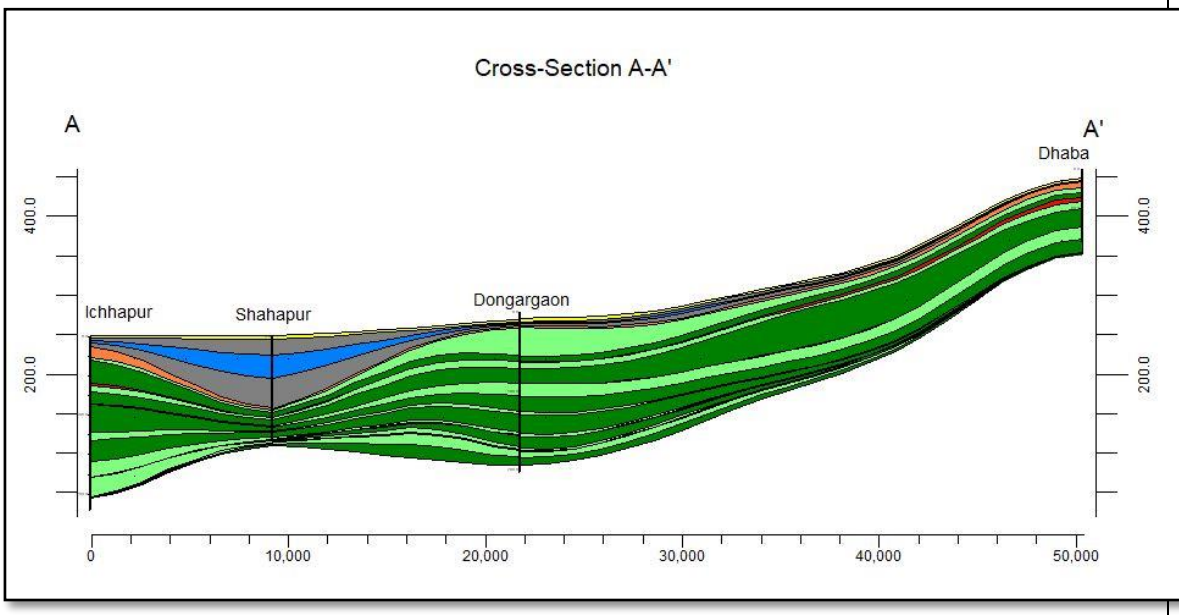


Figure 25 Cross Section of Burhanpur Block

4. GROUND WATER RESOURCES	
4.1 Aquifer-I/Shallow Aquifer	
Total Annual Ground Water Recharge (MCM)	201.28
Natural Discharge (MCM)	19.22
Net Annual Ground Water Availability (MCM)	182.06
Existing Gross Ground Water Draft for irrigation (MCM)	115.67
Existing Gross Ground Water Draft for domestic and industrial water supply(MCM)	9.15
Existing Gross Ground Water Draft for All uses (MCM)	124.82
Provision for domestic and industrial requirement supply to 2025(MCM)	10.40
Net Ground Water Availability for future irrigation development (MCM)	57.24
Stage of Ground Water Development (%)	68.56
Category	**SAFE**
6. GROUND WATER RESOURCE MANAGEMENT	
Available Resource (MCM)	182.06
Gross Annual Draft (MCM)	124.82
6.1 Supply Side Management	
Type of Aquifer	Hard Rock
Area feasible for Artificial Recharge (WL >5mbgl) (Sq. Km.)	1170

Proposed Structures	Percolation Tank (Av. Gross Capacity-100 TCM*2 fillings = 200 TCM)	Check Dam (Av. Gross Capacity-10 TCM * 3 fillings = 30 TCM)
Number of Structures	0	1
Volume of Water expected to be conserved / recharged @ 75% efficiency (MCM)	0.09	
6.2 Demand Side Management		
Micro irrigation techniques		
Irrigation Area (sq. km.) proposed for irrigation through Drip		307.75
Water Saving by use of Drip		93.09
Proposed Cropping Pattern change		
Ground water Irrigated area under Water Intensive Crop (sq.km)		Not proposed
Water Saving by water use efficiency (MCM)		Nil
6.3 EXPECTED BENEFITS		
Volume of Water expected to be saved (MCM). After Demand Side Intervention		93.09
GW draft after Demand Side Interventions (MCM)		31.73
Present stage of Ground Water Development (%)		68
Expected Stage of Ground Water Development after interventions (%)		17.42
6.4 Development Plan		
Volume of water available for GWD after stage of GWD brought to 70% (ham)		95.77
Proposed Number of DW (@ 1.5 ham for 90% of GWR Available)		5746
Proposed Number of BW (@ 1.5 ham for 10% of GWR Available)		958
Additional Area (sq.km.) proposed to be brought under assured GW irrigation with av. CWR of 0.65 m		147.34
Regulatory Measures	**60m borewells/tube wells**	

9.2 KHAKNAR BLOCK, BURHANPUR DISTRICT, MADHYA PRADESH

1. SALIENT FEATURE		
1.1 Introduction		
Block Name		Khaknar
Geographical Area (Sq. Km.)		1885.07 Sq. Km.
Population (2011)		324263
Climate		Tropical wet and dry or savanna
1.2 Rainfall Analysis		
Normal Rainfall		878 mm
Annual Rainfall (2020)		846 mm
1.3 Geomorphology, Soil & Geology		
Geomorphic Unit	Dissected plateau, linear ridges, residual hills and low lying plains	
Geology	Deccan Traps (Basalt)	
Soil	Black Soil, Red Soil, Sandy Soil and Yellow Soil	
1.4 Hydrology & Drainage		
Drainage	Dendritic to sub-dendritic pattern.	
Hydrology	Medium/Miner Project	17
	Pond	154
1.5 Land Use, Agriculture, Irrigation & Cropping Pattern		
Geographical Area		1885.07
Cultivable Area		642.53
Cultivated Area		725.35
Current Fallow Land		6.81
Pasture Land		59.92
Principal Crops *(Reference year 2019-20)*		**Crop Type**
		Cotton
		Sugarcane
		Banana
		Maize
		wheat
		Sorghum

10 Hydrographs

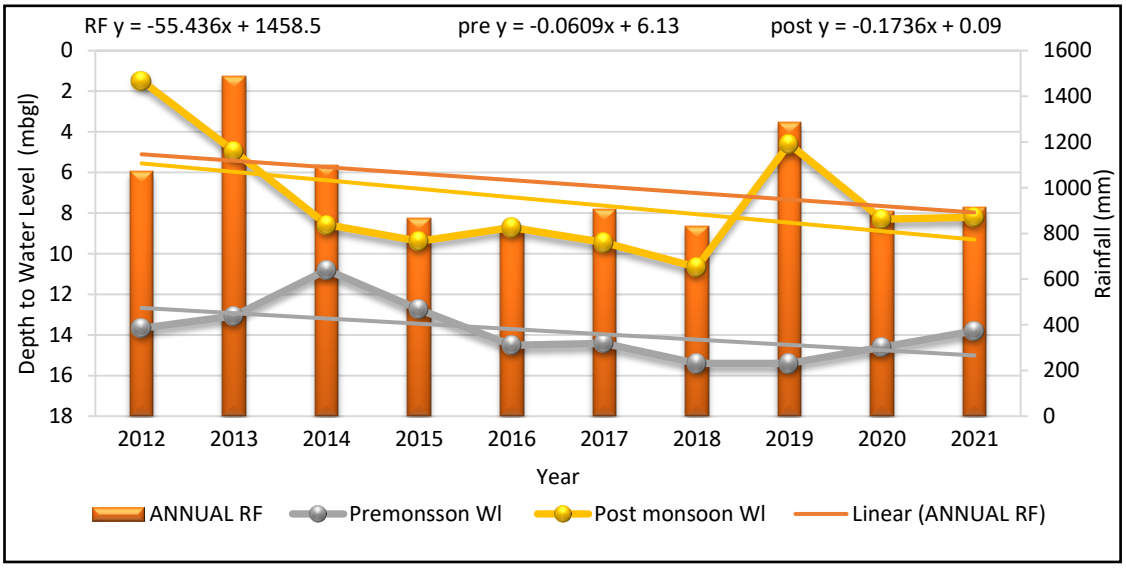


Figure 26 Block Khaknar, Village Pipalpani

3. AQUIFER DISPOSITION	
3.1 Number of Aquifers	**Basalt – Aquifer-I (weathered & fractured basalt)** **Basalt –Aquifer-II (Jointed & fractured basalt)**

3.2 AQUIFER DISPOSITION

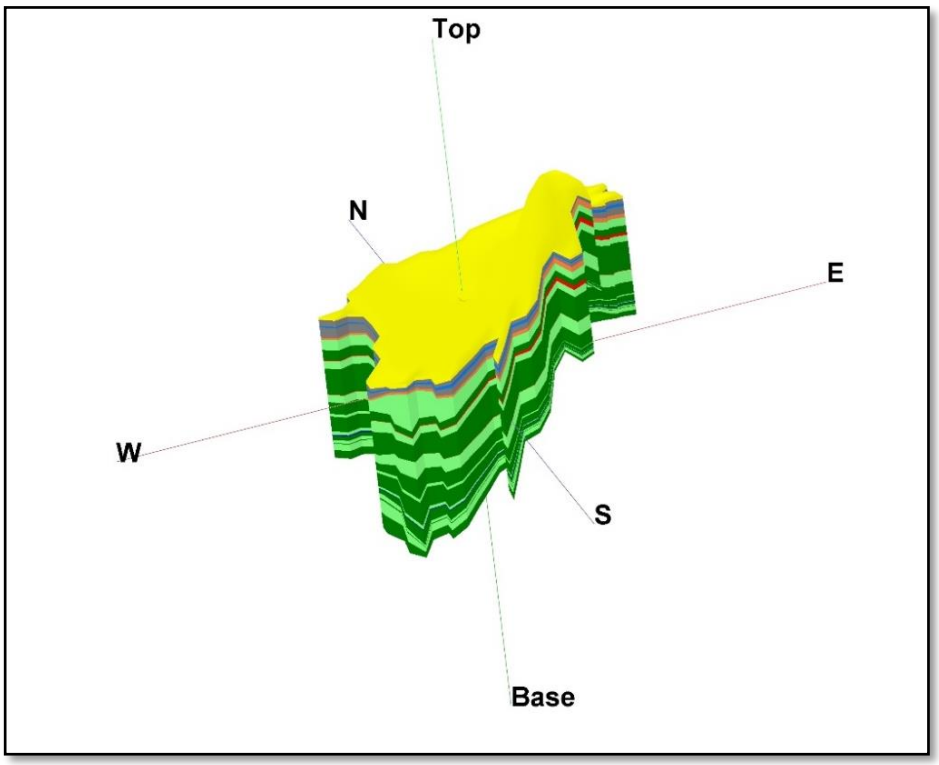
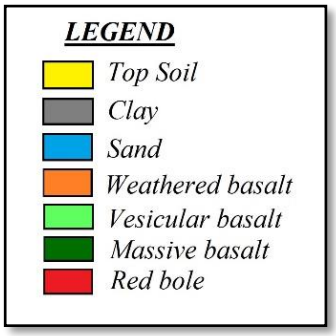


Figure 27 3D Model of Khaknar Block



3.3 Cross Sections:Section AA'

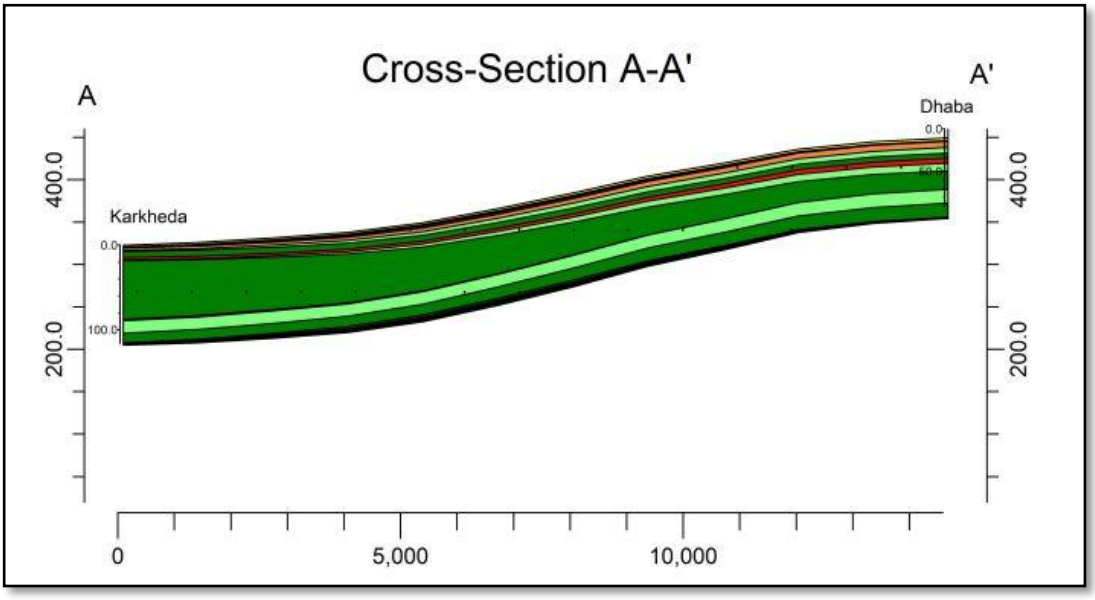


Figure 28 Cross section of Khaknar BLock

5. GROUND WATER RESOURCES	
5.1 Aquifer-I/Shallow Aquifer	
Total Annual Ground Water Recharge (MCM)	201.45
Natural Discharge (MCM)	10.07
Net Annual Ground Water Availability (MCM)	191.38
Existing Gross Ground Water Draft for irrigation (MCM)	105.45
Existing Gross Ground Water Draft for domestic and industrial water supply(MCM)	5.55
Existing Gross Ground Water Draft for All uses (MCM)	111
Provision for domestic and industrial requirement supply to 2025(MCM)	6.25
Net Ground Water Availability for future irrigation development (MCM)	80.38
Stage of Ground Water Development (%)	58
Category	**SAFE**
6. GROUND WATER RESOURCE MANAGEMENT	
Available Resource (MCM)	191.38
Gross Annual Draft (MCM)	111
6.1 Supply Side Management	
Type of Aquifer	Hard Rock
Area feasible for Artificial Recharge (WL >5mbgl) (Sq. Km.)	184.1

Proposed Structures	Percolation Tank (Av. Gross Capacity-100 TCM*2 fillings = 200 TCM)	Check Dam (Av. Gross Capacity-10 TCM * 3 fillings = 30 TCM)
Number of Structures	1	2
Volume of Water expected to be conserved / recharged @ 75% efficiency (MCM)	0.12	
6.2 Demand Side Management		
Micro irrigation techniques		
Irrigation Area (sq. km.) proposed for irrigation through Drip		270.63
Water Saving by use of Drip		82.12
Proposed Cropping Pattern change		
Ground water Irrigated area under Water Intensive Crop (sq.km)		Not proposed
Water Saving by water use efficiency (MCM)		Nil
6.3 EXPECTED BENEFITS		
Volume of Water expected to be saved (MCM). After Demand Side Intervention		82.12
GW draft after Demand Side Interventions (MCM)		28.88
Present stage of Ground Water Development (%)		58
Expected Stage of Ground Water Development after interventions (%)		15.08
6.4 Development Plan		
Volume of water available for GWD after stage of GWD brought to 70% (ham)		105.17
Proposed Number of DW (@ 1.5 ham for 90% of GWR Available)		6310
Proposed Number of BW (@ 1.5 ham for 10% of GWR Available)		1052
Additional Area (sq.km.) proposed to be brought under assured GW irrigation with av. CWR of 0.65 m		161.8
Regulatory Measures	**60m borewells/tube wells**	

11 SUM UP

The highly diversified occurrence and considerable variations in the availability and utilization of groundwater makes its management a challenging task. Scientific development and management strategy for groundwater has become imperative to avert the looming water crisis. In this context, various issues such as, prioritization of areas for development of groundwater resources vis-a-vis its availability, augmentation of groundwater through rainwater harvesting and artificial recharge, pricing and sectoral allocation of resources and participation of the stakeholders must be considered. In view of the above, the present study area a systematic, economically sound and politically feasible framework for groundwater management is required.

A thorough study was carried out based on data gap analysis, data generated in-house; data acquired from State Govt. departments and GIS maps prepared for various themes. All the available data was brought on GIS platform and an integrated approach was adopted for preparation of block wise aquifer maps and aquifer management plans of Burhanpur district.

Geographically, Burhanpur district covers an area of 3233 sq. km, out of this 1955 sq. km area is occupied by forest. Geologically, the area is occupied by Basalt and Alluvium formations. As per Ground water assessment year 2020 the average stage of ground water development is 63.75 %. As per Ground water assessment 2020 the stage of ground water development are categorised as safe. The area has declining water level, sand mining and low yield potential of aquifers are the major issues in the district.

These interventions also need to be supported by regulation for deeper aquifer and hence it is recommended to regulate/ban deeper tubewells/borewells of more than 60 m depth in these Blocks, so that the deeper ground water resources are protected for future generation and also serve as ground water sanctuary in times of distress/drought.

Recommendations

- The interventions discussed above needs to be implemented to bring the Stage of Ground Water extraction up and further develop ground water extraction through DW with emphasis on improving the sustainability of groundwater resources.
- Land based interventions like construction of lined farm ponds, rehabilitation of existing farm ponds along with horticulture plantation as may be feasible to take on to increase the availability of irrigation water during both kharif (July to October) as well as rabi (October to March) season.
- Sustainable management of the area is required to be taken off to improve the quality and quantity of the groundwater and regular monitoring is therefore recommended.
- The interventions above need to be supported by regulation on extraction from deeper aquifer. So, the deeper ground water resources are protected for future generation and also serve as ground water sanctuary in times of distress/drought.
- In terms of the critical issues for the drinking water such as source sustainability, water quality management and better operation and maintenance, it is important that strong grassroots awareness is generated. Thus, IEC activities and capacity building activities needs to be aggressively propagated to establish the institutional framework for participatory ground water management. Awareness among stakeholders & their participation for ground water recharge and conjunctive use of available resource.

Farmers should be trained for adopting more efficient irrigation techniques and water conservation practices and boosting recharge.

- As it is peek time to move to multi-disciplinary approach to save more water viz. Diversification in agriculture (horticulture, vegetables, green houses, agro-forestry, fodder crops, Diversification of Livelihoods (Agriculture, Animal Husbandry, Self-Employment), limiting extensive groundwater withdrawals which will in turn require limiting agricultural electricity subsidies provided by state governments and rationing of power.

12 REFERENCES

BIS (IS: 10500:2012), "Indian Standard Drinking Water Specification (Second Revision)", Bureau of Indian Standards, New Delhi.

District Census Hand Book, Burhanpur.

District Survey report of Burhanpur, 2020.

District Brochure, Burhanpur, Central Ground Water Board, North Central Region, Bhopal, 2018.

13 FIELD PHOTOS

Figure 29 Traditional irrigation

Figure Contour trenches in forest area

Figure 30 **A & B** Anicut

Figure 31 **A & B** Micro-irrigation practices(Drip irrigation)

Figure 32 A & B Key Well Establishment and Water level monitoring

14 ANNEXURES

14.1 KEY WELL LOCATIONS AND WATER LEVEL-2022

Sr.No	Location	Latitute	Longitude	Water Level mbgl	Temp°C	EC µS/cm
1	Shahpur	21.2309	76.220216	32	30.2	872
2	Icchapur	21.1503	76.155711	13.6	32.4	1541
3	Khaparkheda	21.167573	76.187273	dry	35.2	740
4	bhawasa	21.185843	76.295037	17	33.2	541
5	Chaundi	21.163109	76.310673	9.2	33.8	395
6	daryapur	21.293573	76.29737	10.8	35.5	479
7	Bodarli	21.250192	76.36073	5.6	31.7	1556
8	Jafarpura	21.1989	76.4187	7	40.8	748
9	Karauli	21.170386	76.471091	16	35.5	822
10	Doiphodia	21.32065	76.462277	13.1	37.4	1044
11	Nagjhiri	21.315906	76.520754	13.6	34.2	778
12	Usarani	21.2294	76.5055	5	31.3	554
13	Tembhi	21.39089	76.615845	9	31.8	1004
14	Chidiyamal	21.405749	76.684298	13.8	37	728
15	Dahoti	21.455283	76.732428	dry		
16	Sajni Railway	21.534927	76.723893	dry		
17	Jhiri	21.397392	76.266394	7.8	31.9	1092
18	Ambada	21.395387	76.350841	22	32.4	1244
19	Palasur	21.45163	76.492132	6.6	36.7	560
20	Rahamanpur	21.2294	76.5055	13	744	31.5
21	Ghagarla	21.50332	76.56659	14.5	31.5	792
22	Siwal	21.479967	76.447851	4	31	1090
23	Mandava	21.518553	76.393754	4.2	31.8	821
24	Viroda	21.304511	76.144855	24	26.8	2650
25	Bholana	21.344779	76.146465	18.1	28.4	1252
26	Thathar	21.378721	76.203372	14.3	33.9	1042
27	Piprana	21.476618	76.196459	8	34.1	494
28	Bhagwania	21.474645	76.143958	8	30.5	660
29	Kamalkheda	21.3073	76.2304	11.3	29	752
30	Amba	21.5275	76.0189	5	28.5	916
31	Paratkundya	21.5124	76.9783	8.5	27.8	625
32	Asirgarh	21.4718	76.2927	6	32.1	522

14.2 CHEMICAL ANALYSIS DATA OF GROUND WATER OF BURHANPUR DISTRICT UNDER NAQUIM (PRE-MANSOON-2022)

S. No.	District	Block	Location	Source	Lat.	Long.	Field Temp (oC)	pH	EC	CO3	HCO3	Cl	SO4	NO3	F	PO4	SiO2	TH	Ca	Mg	Na
								at 25°C	µS/cm at 25°C	mg/liter											
1	Burhanpur	Burhanpur	Shahpur	TW	21.231	76.220	30.2	7.48	1029	0	389	124	6	5	0.02	BDL	21	415	62	63	42
2	Burhanpur	Burhanpur	Shahpur	DW	21.150	76.156	32.4	7.29	1566	0	443	252	13	20	0.20	0.015	28	690	166	67	38
3	Burhanpur	Burhanpur	Khapas Kheda	TW	21.168	76.187	35.2	7.69	1071	0	329	146	20	13	0.10	BDL	24	445	92	52	39
4	Burhanpur	Burhanpur	Bhawasa	TW	21.186	76.295	33.2	7.60	865	0	311	82	25	9	0.10	BDL	30	375	88	38	22
5	Burhanpur	Burhanpur	Chaundi	DW	21.161	76.311	33.8	7.51	659	0	299	27	16	5	0.20	BDL	20	275	66	27	20
6	Burhanpur	Burhanpur	Dasyapur	DW	21.294	76.297	35.5	7.55	745	0	161	144	10	7	0.61	BDL	30	155	52	6	97
7	Burhanpur	Burhanpur	Bodarli	DW	21.250	76.361	31.7	7.35	1443	0	466	213	13	8	0.18	0.014	25	495	166	19	102
8	Burhanpur	Burhanpur	Jafarpura	DW				7.54	663	0	311	35	8	3	0.24	BDL	23	285	62	32	20
9	Burhanpur	Burhanpur	Kasauli	DW	21.170	76.471	35.5	7.71	664	0	287	27	35	7	0.70	BDL	28	205	52	18	55
10	Burhanpur	Burhanpur	Doiphodia	DW	21.321	76.462	37.4	7.54	790	0	269	87	36	7	0.38	BDL	30	305	94	17	40
11	Burhanpur	Burhanpur	Nagihiri	DW	21.316	76.521	34.2	7.55	648	0	263	35	30	10	0.54	BDL	27	275	66	27	20
12	Burhanpur	Burhanpur	Usarai	DW			31.3	7.59	562	0	197	52	32	4	0.84	BDL	26	230	54	23	22
13	Burhanpur	Kakhner	Tembhi	DW	21.391	76.616	31.8	7.5	810	0	329	74	10	5	0.81	BDL	24	355	88	33	20
14	Burhanpur	Kakhner	Chidiyamal	DW	21.406	76.684	37	7.54	639	0	281	35	17	5	0.69	BDL	26	255	62	24	26
15	Burhanpur	Kakhner	Jhiri	DW	21.397	76.266	31.9	7.8	865	0	397	54	15	4	1.18	BDL	23	315	66	36	50
16	Burhanpur	Kakhner	Ambada	DW	21.395	76.351	32.4	7.69	973	0	366	94	22	12	0.59	BDL	21	420	74	57	29
17	Burhanpur	Kakhner	Palasur	TW	21.452	76.492	36.7	7.89	708	0	256	72	20	2	1.32	BDL	24	180	32	24	75
18	Burhanpur	Kakhner	Rahamanpur	DW			31.5	7.52	957	0	427	74	8	7	0.83	0.01	26	410	66	60	28
19	Burhanpur	Kakhner	Ghagarla	DW	21.503	76.567	31.5	7.67	831	0	342	69	22	9	0.92	BDL	20	325	96	21	40
20	Burhanpur	Kakhner	Slwal	DW	21.480	76.448	31	7.68	869	0	354	69	19	5	0.47	BDL	29	340	92	27	40
21	Burhanpur	Kakhner	Mandawa	DW	21.519	76.394	31.8	7.5	664	0	317	20	24	6	0.36	BDL	25	250	74	16	35
22	Burhanpur	Kakhner	Viroda	DW	21.305	76.145	26.4	7.98	1481	0	488	215	15	16	0.66	0.018	30	665	52	130	32

23	Burhanpur	Kakhner	Bholana	DW	21.345	76.146	28.4	7.54	992	0	354	101	26	20	0.52	BDL	21	430	64	66	28
24	Burhanpur	Kakhner	Thathas	DW	21.379	76.203	33.9	7.48	919	0	366	72	23	10	0.54	BDL	23	305	68	33	68
25	Burhanpur	Kakhner	Piprana	DW	21.477	76.196	34.1	7.49	631	0	244	62	15	5	0.34	BDL	24	260	54	30	23
26	Burhanpur	Kakhner	Bhawania	DW	21.475	76.144	30.5	7.37	675	0	287	47	20	5	0.52	BDL	25	270	60	29	29
27	Burhanpur	Kakhner	Kamalkheda	DW			29	7.8	650	0	317	20	15	8	0.66	BDL	28	270	56	32	24
28	Burhanpur	Kakhner	Amaba	DW			28	7.68	840	0	275	111	19	7	0.53	BDL	24	370	50	60	20
29	Burhanpur	Kakhner	Partkundya	DW			27.8	7.66	592	0	275	27	20	2	0.65	BDL	28	235	40	33	26
30	Burhanpur	Kakhner	Asirgarh	DW			32	7.7	768	0	305	62	15	8	0.32	BDL	23	165	52	9	97

14.3 EXPLORATION DETAILS

Location	Latitude	Longitude	Depth drilled (mbgl)	Depth constructed (mbgl)	Lithology	Aquifer zones tapped (mbgl)	SWL (mbgl) / Date	Discharge (lps)	Drawdown (m)	T (m^2 / day)	S
Boregaon	21.3569	76.2333	133.30	61.00	Alluvium /	45.00 - 50.00, 54.00 - 56.00, 58.00 - 61.00	17.38	2.00	14.85	44.00	2.9×10^{-4}
Chichola	21.3111	76.2236	232.45	43	Deccan Trap/	34.00 - 40.00	13.2	1.42	18.94	34	2.6×5^{-4}
Burhanpur (e.w)	21.3106	76.2208	187.54	187.5	Basalt/	32.00 - 42.00 176.00 - 187.00	19.9	10.00	19.4	5.16	1.71×10^{-4}
Lalbag (pz)	21.3167	76.2125	105.1	29	Alluvium	20.00-28.00	11.68	1.50	18		
Biroda	21.3	76.1458	202.8	135.00	Alluvium/	23.00 - 32.00 58.00 - 80.00 93.00 - 134.00	26.22	4.00	32.22	2.00	--

Patonda (pz)	21.3139	76.2042	100.00	100	Deccan Trap/	94.00 - 100.00	15.60	2.50			
Loni	21.2881	76.1764	121	---	Basalt/	7.40 - 20.00 38.00 - 48.00 92.50 - 105.00 110.00 - 115.00	4.8	0.30	5.65	96	0.41×10^{-3}
Shahpur	21.2333	76.2292	128.15	63	Alluvium	40.50 - 45.50 57.00 - 60.00	27.35	15.80	6.57	74.2	
Ichhapur	21.1625	76.1708	220.87	169	Alluvium/	47.90 – 56.87 137.00 - 145.00	>100	3.33			
Chandni	21.4333	76.3333	154	154	Weathered and poorly jointed basalt	14.00 - 20.00 47.00 - 62.00 81.00 - 93.00 109.00 - 154.00	37.10	10.00	9.91	52	8.4×10^{-5}
Khadkhod	21.2875	76.2958	200	---	Alluvium/	19.30 - 75.00-	26.1	0.01			
Dariyapur (pz)	21.2917	76.2958	120	107	Gravel sand	97.00 - 107.00	53.25	3.50	4.50		
Dongargaon	21.2667	76.3333	154		Deccan Trap Basalt/ Fractured Basalt	27.00 - 29.00 66.00 - 68.00 194.00 - 203.00	8.26	0.08	38.68	6.5	3.5×10^{-4}
kharkhera	21.3319	76.4861	120	120	Alluvium/	15.00 - 24.00 78.00 - 88.00 105.00 - 120.00	13.16	3.50	46.57		

Doiphoria	21.3125	76.2153	202.8	174	Gravel Sand	18.00 - 24.00 94.00 - 102.00 128.00 - 132.00 147.00 - 174.00	11.87	0.10	14.61	27	
Dhaba	21.275	76.6083	93.3	93.3	Deccan Trap/	10.50 - 23.00 29.00 - 35.00 38.00 - 50.00 58.00 - 76.00	8.26	2.03	38.68	27.7	3.5×10^{-4}
Khaknaar (pz)	21.3319	76.4861	160	160	Weathered, fractured vesicular basalt	16.00 - 29.00 123.00 - 126.00	18.7	0.50			
Raitalai	21.4639	76.7056	172.3	136	Alluvium	6.50 - 21.00 26.00 - 28.00 57.00 - 63.00 82.00 - 93.00 129.00 - 136.00	60	6.67	2.56	17.54	
Haiderpur	21.4833	76.5	200.8	200.8	Deccan Trap/	182.00 - 200.00	18.30	0.03	45.27		

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