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

BARAN DISTRICT, RAJASTHAN

पश्चिमी क्षेत्र, जयपुर

Western Region, Jaipur

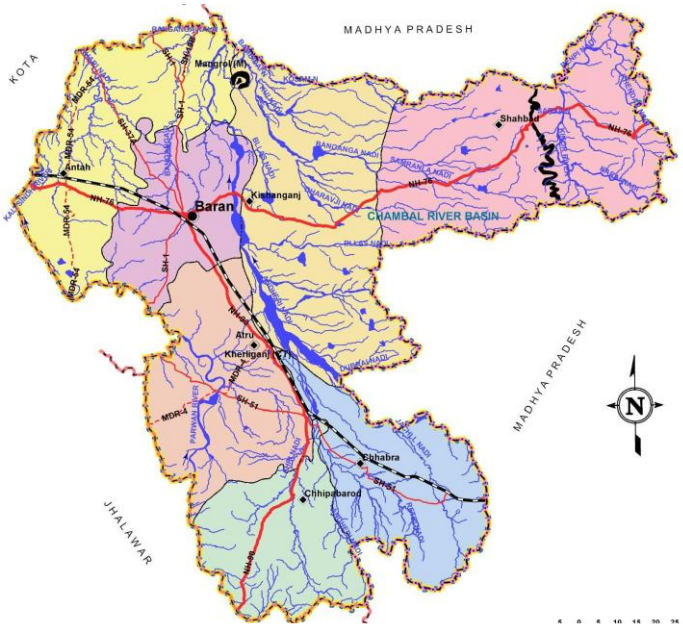
CENTRAL GROUND WATER BOARD

MINISTRY OF JAL SHAKTI

DEPARTMENT OF WATER RESOURCES, RD & GR

GOVERNMENT OF INDIA

REPORT
ON
AQUIFER MAPPING AND GROUND WATER MANAGEMENT
DISTRICT BARAN, RAJASTHAN



WESTERN REGION, JAIPUR

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National Aquifer Mapping and Management
Baran District, Rajasthan

1.0 Introduction

1.1 Objective

Various developmental activities over the years have adversely affected the groundwater regime in the state. There is a need for scientific planning in development of 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.

1.2 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, water level in aquifer and how they change over time & 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.

1.3 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 Aquifer Prograrmme, it is proposed to generate Aquifer Maps on 1:50000 scale, which basically aims at characterizing the aquifer geometry, behavior 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. The flow chart is as follow

1.4 Location, Administrative set up and Population

Baran District was covered out of east whole Kota district of Rajasthan state on 10th April, 1991 through Government order dated 31st March, 1991. The district is named after the town of Baran which is also the district headquarters. The Baran town is said to have been founded by Solanki Rajputs during the 14th or 15th century and is believed to be called by its present name because it was populated by the inhabitants of twelve (Baran) adjacent villages.

Baran district with an area of 6992 sq km is located between latitude 24°25'00" and 25°27'00" east and longitude 76°12'00" and 77°25'00" north. The district forms a part of Kota Division. It is bounded by Kota district in the west and Madhya Pradesh in the northeast and in south by Jhalawar district. It falls on Survey of India toposheet numbers 54C, 54D, 54G & 54H (on 1:2,50,000 scale).

Administratively, the district is divided into eight tehsils and six development blocks. Total number of inhabited villages in the district are 1114 with 4 urban towns and 6 sub urban townships. The population of the district as per 2011 census is 1222755 persons including 633945 males and 588810 females. Rural and urban population of the district is 968541 and 254214 souls respectively (as per 2011 census). A map showing administrative divisions is given inFig.1 and administrative set up of the district is given in Table 1.

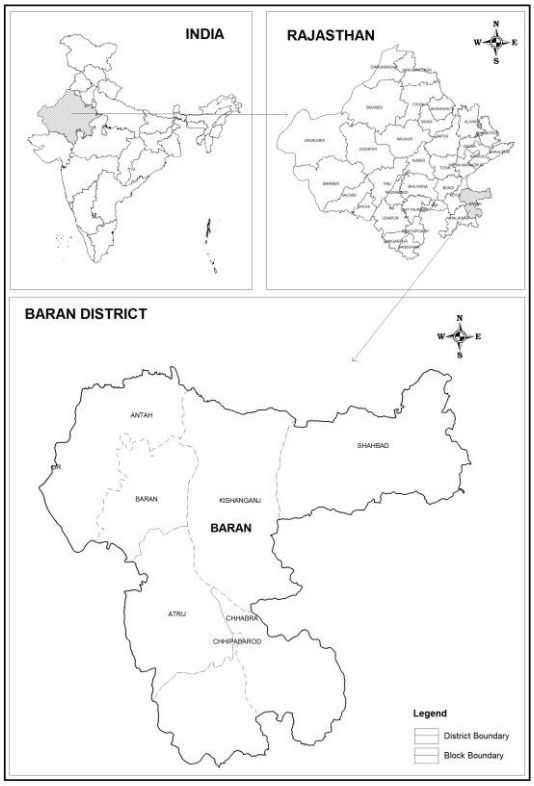


Fig. 1: Index and Administrative map of Baran district

Table 1: Administrative set up, Baran district

S. No.	Name of block	Geographical area (sq km)	Name of Tehsil it covers	Name of Sub division
1	Anta	949.01	Mangrol/Anta	Baran
2	Atru	860.30	Baran& Mangrol	Chhabra
3	Baran	626.21	Baran & Anta	Baran
4	Chhabra	790.79	Chhabra	Chhabra
5	Chhipabarod	828.76	Chhipabarod	Chhabra
6	Kishanganj	1430.98	Kishanganj	Chhabra
7	Shahbad	1469.26	Shahbad	Shahbad

1.5 Data availability and Data Adequacy

1.5.1 Data Availability

Various ground water related data viz. water level, exploration, aquifer parameters, quality, resources etc. generated so far by CGWB have been utilized for aquifer mapping programme in the area and similar consistent data of Ground Water Department, Govt. of Rajasthan have been amalgamated for the purpose.

CGWB has explored aquifer geometry and aquifer parameters determination and deciphering of aquifer quality through construction of 7 exploratory wells, 2 observation wells and 3 piezometers in the district as on March 2019. Ground water regime monitoring is being done through 20 hydrograph stations representing /various hydrogeolgical settings to observe the changes in water level in time and space along with ground water quality.

To minimize the data gap, consistent available ground water data of GWD, Govt. of Rajasthan have been integrated and utilized for aquifer mapping. Data of 38 boreholes have been integrated. Estimation of ground water resources is carried out in collaboration with the GWD, Govt. of Rajasthan and approved by the State Level Coordination Committee under the chairmanship of Principal Secretary (PHED & GWD), Govt. of Rajasthan.

1.5.2 Data Adequacy

The available data of CGWB and consistent/validated data of State GWD, have been integrated and analysed the data gap if any in the area. Data gap analysis indicate that the existing/available various related ground water data are not adequate to represent the area in terms of data on aquifer parameters in various hard rock aquifers, their quality. Ground water regime monitoring data are not adequate for better understanding of its behaviors in terms of quantity and quality therefore, there is need to increase the density of hydrograph stations in the area.

1.5.3 Data Gap Analysis

Based on the available data of CGWB and relevant ground water related data collected from State agencies like, PHED, Water Resources, Agriculture and their integration on 1:50,000 scale, data gaps have been identified in the district. Therefore, to attain a clear 3D hydrogeological geometry of the aquifer system, its potentiality, parameters and quality in the data gaps and in present changing ground water scenario, more information/data through construction of additional exploratory bore holes is requir5ed as per data gap and increase the density of

hydrograph stations & integration of key wells of State GWD for better representation of existing aquifers and understanding of behaviors of ground water regime in terms of quantity and quality.

1.5.4 Data Generation

A total 63 number of wells have been inventoried to have the precise information on hydrogeology and sampling done for 63 wells during pre monsoon and was repeated during post monsoon, 2018 to study the changes in ground water quality.14 ground water samples have been collected to study the presence of heavy elements in ground water.

1.6 Hydrometeorology

(Hydrometeorology chapter has been written by Sh .D.C.Sharma, Sc-B(HM)

The climate of Baran study area is mainly dry with very hot summer and cold winter except during monsoon season when moist air of oceanic origin penetrates into the district. There are four seasons in a year. The hot weather season starts from mid March to last week of the June followed by the south-west monsoon which lasts upto September. The transition period from September to October forms the mild climate. The winter season starts late in November and remains up to first week of March.

1.6.1 Rainfall : The normal annual rainfall of the area is 806 mm(1989-2018) which is unevenly distributed over the area in 42 days. Monthly normal of rainfall of period 1989-2018 are given in Table 2A. The south west monsoon , sets in from last week of June and withdraws in end of September, contributed about 88.7 of annual rainfall. July and August are the wettest months. Rest 11.3% rainfall is received during non-monsoon period in the wake of western disturbances and thunder storms. The heaviest one day rainfall recorded at any station is 217 mm on 1972 July 08.

The annual rainfall of 30 years from 1989 to 2018 have been analyzed to know the behavior of rainfall(Fig.2A). The analysis indicates that annual variation of rainfall is large and significant. The average annual rainfall from 1989 to 2018 is 907 mm. The highest rainfall of 93% more than the normal was recorded in 2015 whereas the lowest of 64% less than the normal was experienced in 2002.

The standard deviation of rainfall from 1989 to 2018 is 297 mm which indicates that 600 mm rainfall is assured. The coefficient of variation of rainfall is 33%. It indicates that rainfall in the area is highly variable.

The trend of annual rainfall by least square method shows increasing . The possibility of Excess, normal, deficient and scanty rainfall are 20%, 57%,23% and 3% respectively as given in Table 2B.

Rainfall study for 30 years depicts that only 23% of the years i.e. 1989, 2002 2003,2007,2009 ,2010,,2017,2010,2011 experienced drought conditions. It means that study area is not classified under chronically drought affected area. The probability of mild and severe drought are 16 % and 7% respectively as given in Table 3. In seven years 1989,2002,2003,2007,2009, 2010, and 2017 the amount of rainfall was much less

than their corresponding normal and ranges between -64% to - 21% and the study area is affected by severe or mild drought conditions. One drought of mild intensity may be possible after 5 years. In 6-years 1989, 2003,2007, 2009, 2010, 2017 this area is affected with drought of mild intensity. And one mild drought would be possible within 5 years. One day ever heaviest rainfall is 249 mm on 13th July1945.

Table 2A: Annual Rainfall and % deviation (1989-2018), Baran District

year	ANNUAL RAINFALIN MM	%DEV.FROM MEAN	REMARK	TYPOF DROUGHT
1989	589	-35	Deficient	Severe
1990	910	0.3845	normal	
1991	970	7	normal	
1992	728	-20	Deficient	
1993	829	-9	normal	
1994	1080	19	normal	
1995	864	-5	normal	
1996	1093	20	excess	
1997	984	8	normal	
1998	806	-11	normal	
1999	929	2	normal	
2000	802	-12	normal	
2001	899	-1	normal	
2002	322	-64	scanty	most severe
2003	715	-21	Deficient	
2004	805	-11	normal	
2005	839	-7	normal	
2006	830	-9	normal	
2007	650	-28	Deficient	MILD
2008	952	5	normal	
2009	694	-23	Deficient	MILD
2010	614	-32	Deficient	MILD
2011	1416	56	excess	
2012	731	-19	normal	
2013	1602	77	Large excess	
2014	1106	22	excess	
2015	1752	93	Large excess	
2016	1213	34	excess	
2017	589	-35	Deficient	MILD
2018	907	0	normal	
mean	907	0	normal	
LONG TERM	907.3314655			

RAIN MEAN(1989-2018)				

Table 2B : Frequency of Excess, Normal, Deficient and Scanty Rainfall (1989-2018)

Rainfall	No. of Years	Possibility of occurrence(per/year)
Excess	**6**	**0.20**
Normal	17	0.57
Deficient	7	0.23
Scanty	1	0.03

Table 3 Drought Analysis – (1989-2018)

Drought	No. of Years	Possibility of occurrence
Mild	6	20%
Severe	1	3.3%

One severe drought is possible after 30 or 31 years when deficit rainfall lies between-50 and-75%deviation from mean rainfall.

Table 4 Monthly Normals, Baran District

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec	Annual
Rainfall (mm)	8.9	1.7	4.5	1.4	7.7	55.7	275.9	281.3	149.7	10.4	5.3	3.5	**754.3**
Rainy Days	1	0.50	30.	0.40.	1.0	4.7	13.6	12.3	6.3	0.9	0.6	0.5	**42.1**

Normal Annual rainfall = 754.3 mm
Normal rainy days = 42
South west monsoon rainfall (June to September) =669.1mm (88.7%)
Non Monsoon rainfall = 85.2mm (11.30%)

1.6.2 Temperature : There is no meteorological observatory in the area which monitors temperature. Therefore, the normal of neighboring stations have been considered as representative, prevailing the similar meteorological conditions in the area. The cold weather season generally starts by mid November when temperature begins to drop rapidly. January is the coldest month of the year with mean daily maximum and minimum temperature being about 24.5^{o}C and 10.6^{o}C respectively. In association with passing of western disturbances, the district gets affected with the severe cold wave conditions and on such occasion minimum temperature may go

down to freezing point of water. The rise in minimum temperature from 10.6°C in January to 29.7°C in May is observed.

The temperature starts rising rapidly from March to June. May and June are the hottest months of the year. When the area experiences daily mean maximum and minimum temperature of 41.5°C and 29.6°C respectively. The variation in maximum temperature from January to June is about 20°C.From about April hot westerly dust ladden winds locally known as *'Luh'* begin to blow and the weather becomes very hot under heat wave conditions. In May and June maximum temperature may generally go above 45°C. Occasional dust storms and thunder storms causes drop in temperature.

With the onset of the south-west monsoon currents into the area at the end of June, there is appreciable decline in the day temperature where as nights temperature remain as high as in summer. The increased moisture content in the air causes the weather sultry and unpleasant. After the withdrawal of monsoon by about mid September there is an increase in the day temperature but night temperature drops down steeply. Table 5 and Fig3 shows variation of temperature**.**

1.6.3 Humidity : The air is generally dry over the district during greater part of the year. During the southwest monsoon the humidity is high and generally being 74% to 65%. Humidity decreases in the post monsoon season. May and April are the driest months of the year when relative humidity being about 18% or less in the afternoon(Table 5) .

1.6.4 Cloudiness : During the south west monsoon the skies are heavily clouded or overcast particularly in July and August. Rest of the year sky is mostly clear or lightly clouded except for a brief spells of one or two days in association with the passage of western disturbances during winter season.

1.6.5 Winds : Winds are generally light with some strengthening of speed during summer and early part of the south west monsoon season. The maximum wind speed of 9 km./hr. is recorded in May and June, while minimum speed of about 2 km./hr. is during November to December. In southwest monsoon season winds direction is mostly westerly or southwesterly. Rest of the year winds are predominantly easterly or northeasterly or calm Table 5 and Fig 4 shows variation of monthly wind speed .

One severe drought is possible after 30 or 31 years when deficit rainfall ranges betbeen-50 and-75%deviation from mean rainfall.

Table 5 : Climatological data, Baran District

Months	Temperature mean daily ^{o}C		Relative Humidity in %		Wind speed in km./hr.	Daily pan Evaporation In mm
	Max.	Min.	At 8.30 hrs.	At 17.30 hrs.		
January	24.5	10.6	64	34	2.2	61.6
February	28.5	13.1	51	25	2.3	80.3
March	34.1	18.5	24	18	3.9	131.4
April	39.0	24.4	24	13	3.7	166.9
May	42.6	29.7	28	16	8.2	225
June	40.3	29.5	45	35	9.1	210.3
July	363.3	26.4	74	65	8.2	138.6
August	31.7	25.4	81	69	6.9	120.6
September	33.1	24.7	73	58	5.5	133.3
October	34.5	21	53	34	3	122.4
November	30.8	14.8	51	29	1.7	75.4
December	26.7	11.3	61	35	1.7	58.4

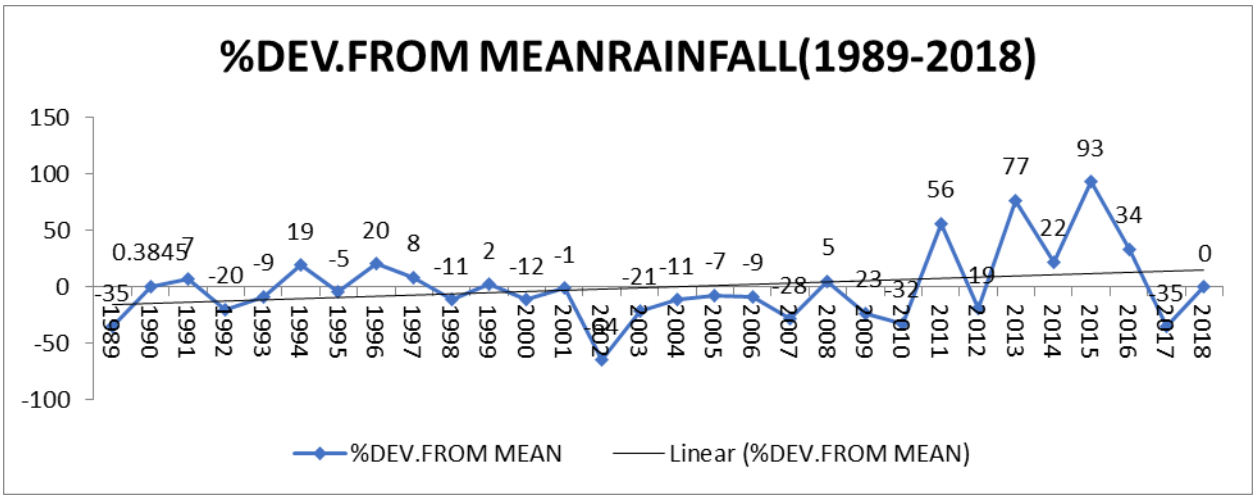


Figure2 : Rainfall trend, Baran District

1.7 Soil, Land Use, Agriculture, Irrigation, Cropping Pattern

1.7.1 Soil

The soils of the district are alluvial in nature and are generally non-calcareous. Its colour varies from dark brown to black. This type of soil generally occurs in plains. Mainly black kachari soils are found in Baran and Mangrol tehsils, which is highly fertile. Red gravelly loam hilly soils are found in the southern and eastern parts of the district.

1.7.2 Land Use

The landuse data of 2014-15 (latest published) have been incorporated based on the District Statistics Outline, Baran District, Govt. of Rajasthan,2016

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 presented in Table 6.

Table 6: Land Use, Baran District(2014-15)

Sl.No.	Land Use	Area in hectare	%
1	Total geographical area	699461	
2	Forest	217806	31.15

3	Uncultivable land	64604	9.23
4	Land not cultivated including pasture land; barren land; trees, grooves & orchards; padat land	70740	10.10
5	Actual sown area (subtracting double)	346311	
6	Gross sown area	493597	49.52
7	Area sown more than once		

1.7.3 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:

Food Grain	Wheat, Rice, Maize, Bajra, Barley,Jowar
Cereals	Gram,Urad,Moong, Peas,Masoor, Arhar,Moth
Spices	Coriander,Garlic, Methi
Oil seeds	Soyabeen, Rai & Mustard,Til, Ground Nut, Alsi, Taramira
Non food grains	Fodder, White Musli, Opium,Potato, Onion, Melon
Others	Sugercane

1.7.4 Irrigation Practices

Gross irrigated area in the district is 351031hectare. Ground water plays an important role for irrigation contribution. Major part of the district is irrigated from ground water forming 71.03%(249354hectare) and is utilized through dug wells, dug cum bore wells and bore wells run almost by electricity in the area. Other sources of irrigation are from canal 21.13%(74178hectare), Talab 2.86%(10036hectare) and from others sources 4.98%(17463hectare). sq.km.). Out of gross sown area of 493597 hectare, only 351031 hectare (71.12%) area is irrigated. There are total 35180 wells including 28394 utilizable wells and 6786 unutilizable/abandoned.

1.7.5 Cropping Pattern

Gross sown area is 493597 hec with net sown area is 346311 hec. and area sown more than once is 147286hec. Crop wise irrigation status is given below in Table7.:

Table 7: Crop-wise irrigation status, Baran District(2014-15)

Crop		Irrigates area in hectare
Food Grains	Wheat	174319
	Rice	14614
	Barley	253
	Sub Total	**189186**
Cereals	Gram	6727
	Moong	56
	Peas	24
	Massor	19
	Urad	1
	Sub Total	**6827**
Sugercane		42
Spices	Coriander	64815
	Garlic	14604
	Methi	286
	Red Chilly	45
	Sof	1
	Ginger	1
	Sub Total	**79752**
Fruit	Melon,Mango,Cucumber,Guava,Lemon,Pomegranate, Orange,Papaya,	321
Vegetables	Singada,Potato,Onion,	1244
Non-Food	Rai and Mustard	73057

Grains(Oil Seeds)		
	Alsi	193
	Soyabeen	91
	Tarameera	14
	Ground Nut	1
	Sub Total	**73356**
Non Food Grains (Others)	Fodder,Opium,	303
	Grand Total	**351031**

Perusal of tabular data indicates that 189186 hectare area is irrigated for food grains,79752 hectare for spice, 73356 hectare for oil seeds and 6827 for cereals

1.8 Physiography & Geomorphology

1.8.1 Physiography

The land slope gently from south to north and drained by the Chambal and its distributaries. Hills are seen in south north and eastern portions. Mukundara range of Vindhyan hills which 145km long is located in the district. At many places, it has a curious double formation of the separate ridges running parallel to each other. The portion lying between these ridges are often covered with dense forest.

1.8.2 Topography

The topography of Baran district is in general, undulating in the western part , but hilly in eastern and southern part constituting predominant landforms visible in Shahbad, Chhabra and Chippabarod blocks. The general topographic elevation in the district is between 250m to 450m AMSL. The narrow elongated hills rise up to 548.8m elevation in eastern part of the district. Apart from the well known Chambal river, the other rivers that flow through the district are Andheri and Kali Sindh and their tributaries are Bambidai, kui, Kosam, Khari, Ballas and Samranla.Elevation ranges from a minimum of 200m AMSL in Anta Block in the north western part of the district to a maximum of 548.8m AMSL in Shahbad block in eastern part of the district. Block-wise minimum and maximum elevation of the study area is given in Table 8.

Table8 : Block-wise minimum and maximum elevation, Baran District

Sl.No.	**Block**	**Minimum Elevation(MAMSL)**	**Maximum Elevation(MAMSL)**
1	Anta	200.0	288.3
2	Attru	252.2	429.5
3	Baran	207.7	293.5
4	Chhabra	281.0	488.9
5	Chippabarod	290.5	471.5
6	Kishanganj	212.2	442.9
7	Shahbad	283.9	548.8

1.8.3 Geomorphology

The district is a part of “Hadoti Region”, which is a distinct geomorphic region of Rajasthan state. The hill ranges of the Vindhyan in the northeast and low rounded hills of Malwa plateau in the south bound the region, while sedimentary rocks belonging to the Vindhyan super group occupy northwestern part. The various geomorphological units are given in Table 9 and depicted in Figure 3.

Table3 : Geomorphological units, Baran District

Landform Units	Lithology / Material / Description	Occurrence in District	Land Use / Land Cover
Fluvial Origin			
Alluvial Plain	Mainly undulating land scape formed due to fluvial activity, consisting of gravel, sand silt and clay. Terrain mainly undulating produced by extensive deposition of alluvium by rive system.	Around Baran town.	Double crop, single crop(Rabi). Fallow.
Valley fill	Formed by fluvial activity, usually at lower topographic locations, comprising of boulders, cobbles, pebbles gravels, sands , silt and clay. The unit has consolidated sediment deposits.	In south east and north east part.	Single crop (Rabi), open scrub.
Ravine	Small, narrow, deep, depression, smaller than gorges, larger than gulley, usually carved by running water.	Along Parwati , Kalisindh and Kaku rivers.	Single crop (Kharif), open scrub.
Denudation Origin			
Pediment	Broad gently sloping rock flooring, erosional surface of low relief between hill and plain, comprised of varied lithology, criss crossed by fractures & faults.	Scattered in entire district, Main concentration in north east and south west.	Marginal double crop, single crop (Kharif). Open scrub, fallow land.
Buried pediment	Pediment covered essential with relatively thicker alluvial, colluvial or weathered materials.	Scattered in entire district, Main concentration in north west central and south.	Marginal double crop, single crop (Rabi/ Kharif) fallow, open scrub.
Structural Origin			
Dissected Plateau	Plateau, criss-crossed by	South, south east and	Land with or without

	fractures forming deep valleys.	north east.	scrub.
Hills Structural Hill	Linear to arcuate hills showing definite trend-lines with varying lithology associated with faulting etc.	Near Ramgarh village.	Forest, open scrub.

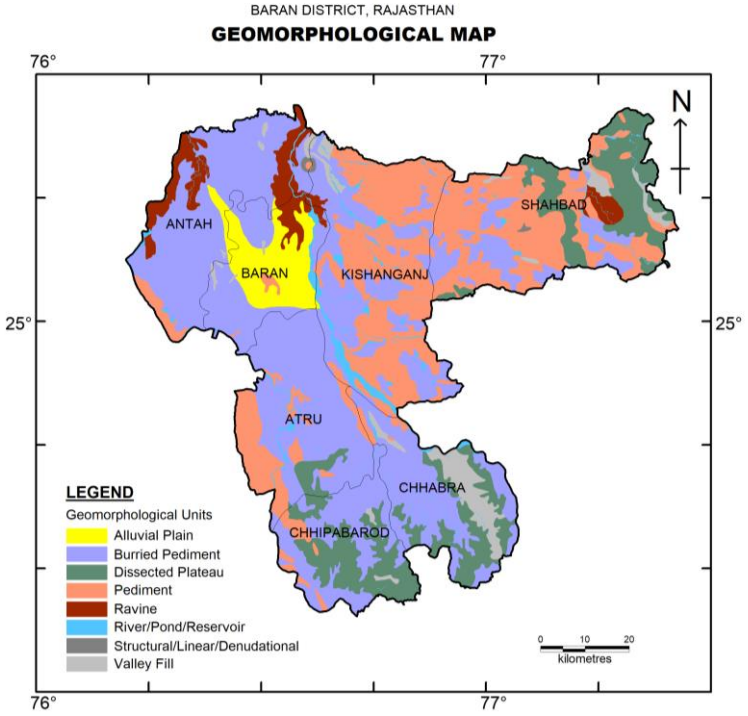


Figure 3. Geomorphology, Baran District

1.8.4 Drainage

The district is served by the sub-basins of Chambal river These sub-basins include Kali sindh, Parvati, Parwan and Kuno. Kalisindh, a tributary of Chambal, on being joined by Parwan river flows northward forming western boundary of Mangrol tahsil for about 40 kms. from Rajgarh to Dheepari and joins Chambal at pipalda in Kota district. The important villages en route are Palaitha, Nonera, Dip Singh Kotra, Barod and Patonda. Parvati, a tributary of Chambal originates from Vindhyan ranges. It enters the

district in the south near village Karaihat. It first forms the district's boundary with Madhya Pradesh and then traverse through the central parts of the district. Parwan originates from Vindhyan ranges, enters the district near Harnawada Shahji and flowing through the central parts of the Atru tahsil, joins Kali Sindh near Rajgarh. Kuno enters Shahhad tahsil in the south from Madhya Pradesh and after flowing northward and passing about 9 km east of Shahhbad, re-enters Madhya Pradesh. Andheri river enters Chhipabarod tahsil from Madhya Pradesh and joins Parvati, about 6 kms. east of Atru. Banganga river originates in the south of Baran somewhere from Bamla and Shrod and joins Parvati near Mithod. Other small rivers and Lhasi, Sukar,Ghadavat, Khadela, Kelwara, Bangardi, Bilas, Barni, Kori, Retri, Kol etc.

1.8.5 Hydrology

There is no natural lake in the district. However, there are 99 talab (93 utilizable) in the district used for irrigation if water is available. The tehsil wise status of Talab/bunds existing the district is presented in Table10.

Table10 : Tehsil-wise status of Talab Baran District

Sl.No.	Block	No. of Talab(Utilizable)	No. of Taslab(Un-utilizable)	Total
1	Anta	**5**	**2**	**7**
2	Attru	**52**	**0**	**52**
3	Baran	**0**	**0**	**0**
4	Chhabra	**1**	**0**	**1**
5	Chippabarod	**2**	**0**	**2**
6	Kishanganj	**17**	**3**	**20**
7	Shahbad	**15**	**1**	**16**
8	Mangrol	**1**	**0**	**1**
	Total	**93**	**6**	**99**

Irrigated area by talab is only 10036 hectare(2.9%) *(Source:Department of Economics & Statistics, Govt. of Rajasthan 2014-15).*

The district has 1 major, 7 medium and 14 minor irrigations projects. In addition to this, 7 lift irrigation projects exits in the area. Details of the same are given in Table11 .

Table11 : Details of irrigation projects , Baran District

S.No.	Name of Project	District	C.C.A. (Ha.)	Year of Completion
I	**Major Project**			
1	Right Main Canal of Chambal Project	Baran	26647	1958-59
II	**Medium Project**			
1	Parwati Pick Up Weir	Baran	12250	State Time
2	Parwati Pick Up Weir	Baran	7464	State Time
3	Bilas	Baran	5863	1996
4	Gopalpura	Baran	5458	1980
5	Ummed Sagar	Baran	2968	State Time
6	Bethali	Baran	5026	2005
7	Parwan Lift	Baran	9531	2005
Total			**48560**	
III	**Minor Project**			
1	Eklera Sagar	Baran	1858	State Time
2	Nahar Garh	Baran	319	1982
3	Kalisot	Baran	875	1978
4	Mahodari	Baran	421	1982
5	Chhatrapura	Baran	1012	1984
6	Ratai	Baran	1576	1979
7	Khatka	Baran	620	1980

8	Bedra	Baran	118	2004
9	Utawali	Baran	710	2004
10	Phaliya	Baran	343	2005
11	Akawad	Baran	494	2005
12	Narayankhera	Baran	900	2008
13	Khiriya	Baran	172	
14	Semliphatak	Baran	448	
Total			**9866**	
IV	**Lift Project**			
1	**Ganeshganj Lift**	**Baran**	**6960**	**1992**
2	Kachari Lift	Baran	1788	1996
3	Sorkahand Lift	Baran	1138	1995
4	Anta Lift (Delahedi)	Baran	1587	1981
5	Anta Lift (Chak Shahbad)	Baran	462	1981
6	Pachel Lift	Baran	324	1981
7	Digod Lift	Baran	2972	1986
Total			**15231**	
Grand Total			**73657**	

Source: Water Resources Department, Govt. of Rajasthan

2.0 Data Integration, Interpretation, Aquifer Mapping And Ground Water Scenario.

2.1 Geology

Geology of an area plays an important role in occurrence and movement of ground water in it. The ground water potential depends upon these aquifers present in the area. Therefore, it is necessary to consider the nature of the geological formations present in

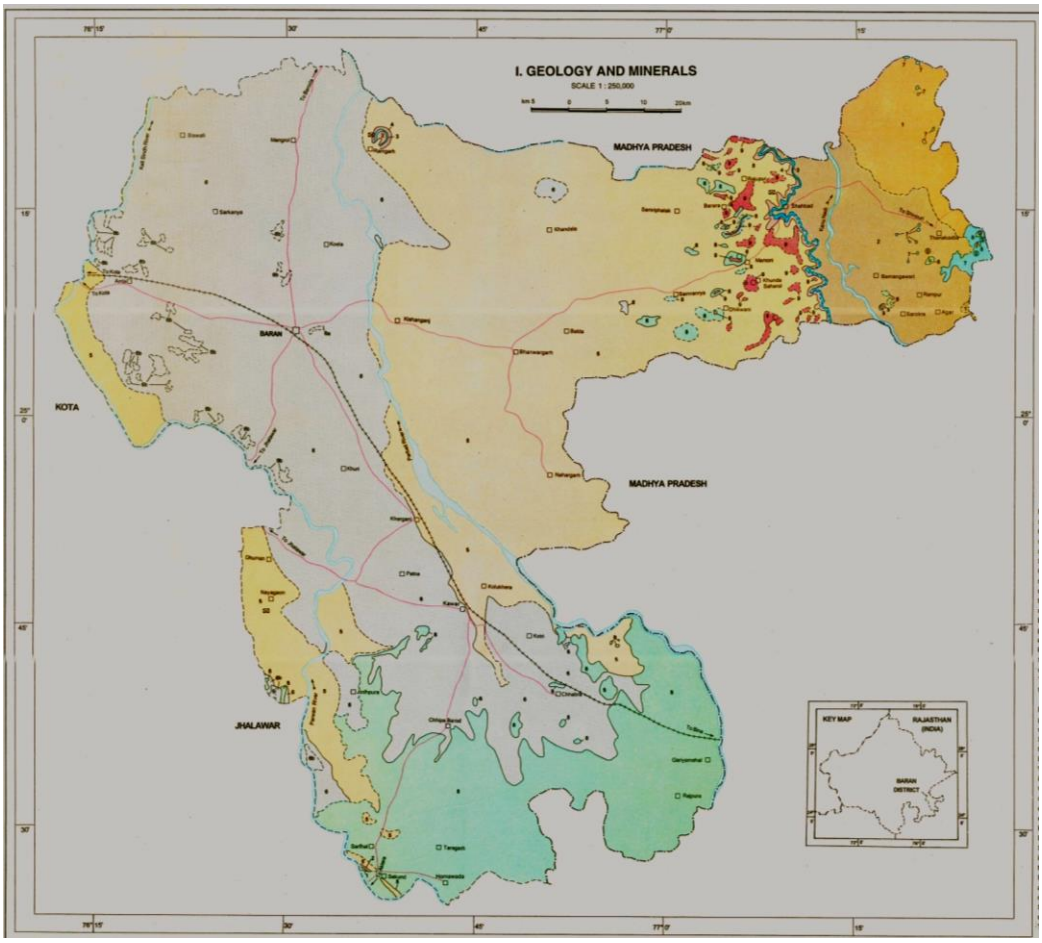
Baran district. The sandstone, limestone and shale of Bhander group of Vindhyan Super Group constitute the basement overlain by Deccan Trap basalt. At places a thin Alluvial cover is also found

Major Part of Baran district is occupied by shale- sandstone- limestone sequences belonging to the Vindhyan Supergroup (Middle to Upper Proterozoin) and the Deccan Traps and laterite (Cretaceous to Eocene). The oldest rock types belong to the Vindhyan Supergroup. These are classified into the Rewa and Bhander Groups. The Rewagroup is represented by the Govindgarh Sandstone (Upper Rewa Sandstone) and is well exposed north of Thanakasba in the north east. This is conformably overlain by the Bhander Group Comprising Ganurgarh Shale, Lakheri Limestone,Samria shale, Bundi Hill Sandstone and the Sirbu Shale formations in ascending order of succession. Bhander group occupies 84% of the area in north and northeastern parts of Anta, Atru, Baran, Kishanganj & Shahbad blocks. Of these the Bundi Hill Sandstone and the Sirbu Shale formations are most predominant and occupy almost the entire district. Southern part of the district is occupied by Deccan Trap flows and constitutes about 16% area of the district covering parts of Chhabra & Chhipabarod blocks. Small outcrops of basalt and laterite are also seen in the western part around Dhikwani and Thanakasba. Infra-trappean chert, sandstone and limestone occur around Thanaksba. Laterite occurs as capping over basalt. Quaternary deposits, about l million year old, occur as terraces and are extensively dissected to form ravines. Younger Alluvium, is found along the present day flood plains of the rivers, supports extensive cultivation.

The general stratigraphic succession of the district is given in Table 12 and geological map is given in Figure 4 .

Table12: General stratigraphic succession

Era	Group	Sub-group	Lithology
Recent	---	---	Alluvium and soil
Upper Cretaceous to Palaeocene	---	Deccan traps	Basaltic flows with inter-trappean beds
Upper Vindhyan	Bhander group	Lower Bhander sandstone	Sandstone with shale intercalation
		Bhander limestone	Impure argillaceous stromatolitic limestone
		Ganurgarh shale	Variegated shale



LEGEND : I. *GEOLOGY AND MINERALS*

	Lithology	*Group*	*Supergroup*	*Age*	*Nature and Geotechnical Characteristics of Rocks*		
					Nature	*Bearing Capacity / Compressive Strength (Kg/cm²)*	*Foundation Characteristics*
9	Laterite			Cretaceous to Eocene	Soft, Concretionary rock	Low 120 - 525	Poor
8	Basalt flows with inter-trappean beds	Deccan Traps			Hard rock medium grained with soft patches	Moderate to very good 740 - 4550	Fair to excellent
7	Sandstone and limestone (Infra-trappean beds)				Hard rock with soft patches	Moderate 458 - 1975	Poor to fair
6 b / a	Sirbu Shale with (a) siltstone sandstone, grit and (b) cherty limestone	Bhander Group	Vindhyan Supergroup	Middle to Upper Proterozoic	Soft rock with interbeds of hard rock	Low to moderate 150 - 1975	Poor to fair
5	Bundi Hill Sandstone (Lower Bhander Sandstone)				Hard rock	Moderate 458 - 1975	Fair
4	Samria Shale				Soft rock	Low 103 - 150	Poor
3	Lakheri Limestone (Lower Bhander Limestone)				Hard rock	Moderate 458 - 1975	Fair
2	Gaunrgarh Shale				Soft rock	Low 103 - 150	Poor
1	Govindgarh Sandstone (Upper Rewa Sandstone)	Rewa Group			Hard rock	Moderate 458 - 1975	Fair

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Figure 4 : Geological Map, Baran District

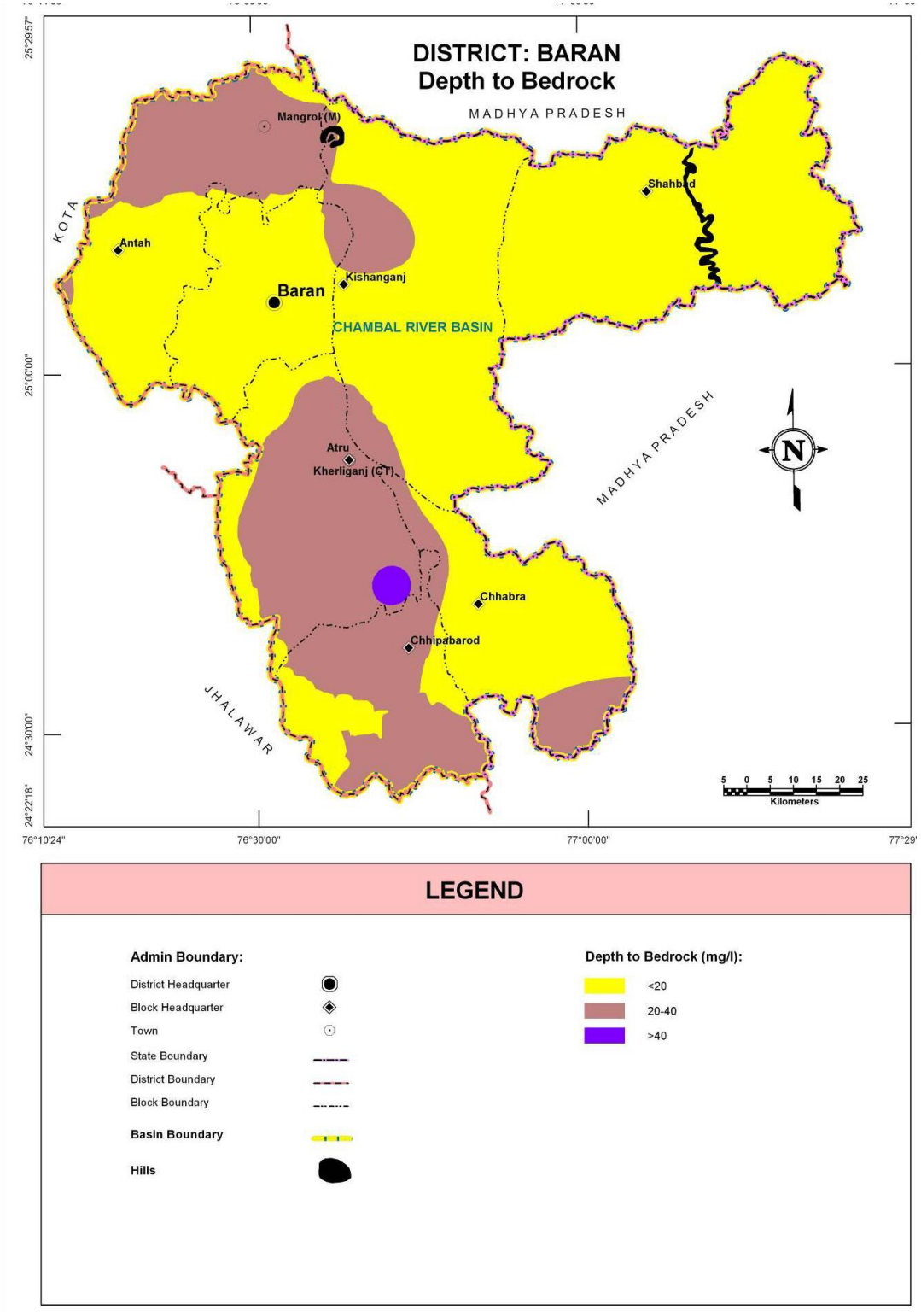


Figure 5 : Depth to bed rock, Baran District

Based on the consistent data of 38 boreholes (including of CGWB and GWD) using Rock Works software, borehole lithology and a three dimension picture of the regional lithology of the district has also been generated which are shown in Figure 6 and 7. Study of 3 D picture of lithological model indicates deposit of Quaternary sediments of limited thickness and is observed that thickness of alluvium ranges from less than 20m to 40m. The bore hole depth varies from 23 to 207 m. Weathered part ranges from than 2m to less than 10m and hard rocks from 0.00 to 200 m below ground level.

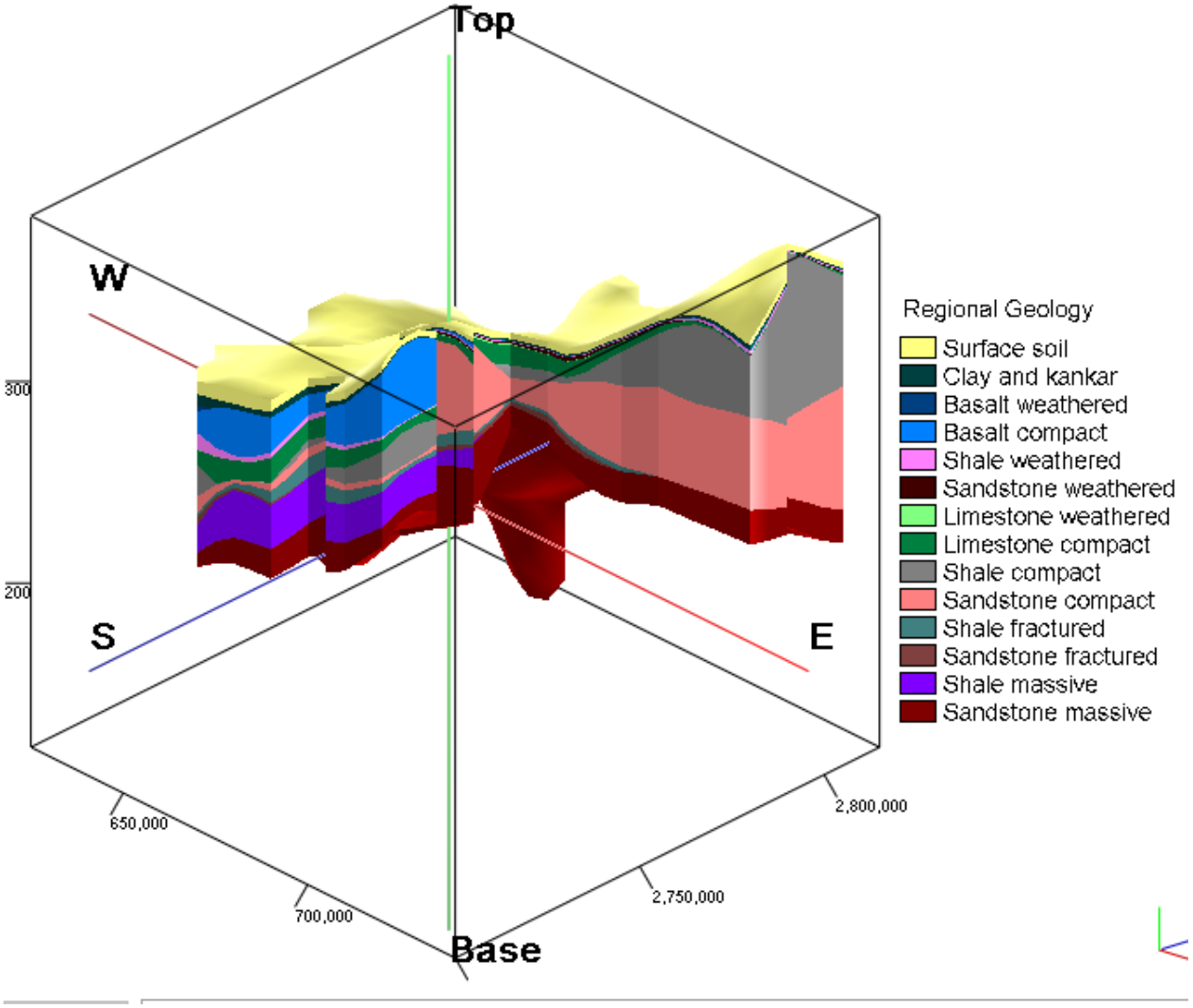


Figure 6: 3 Dimentional Regional Geology, Alwar District

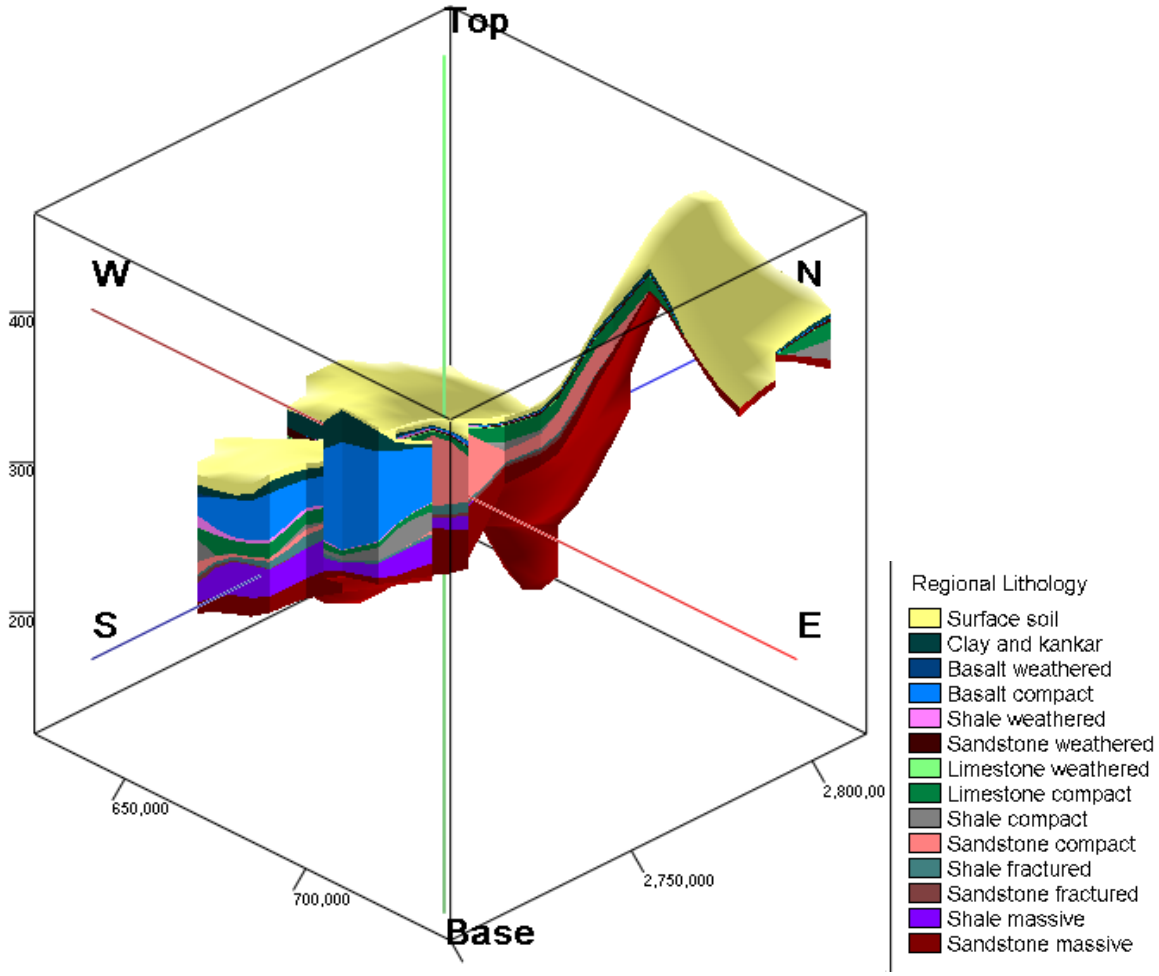


Figure 7: Regional Lithological Model, Baran District

Various geological sections exhibiting lithology disposition, have been prepared using Rock works software (Figure 8 A to 8G) and their alignment is depicted in Figure 9 .

- Section A - A': Niyana-Kewra-Bijors-Harsoli-Mau-Tonk-Kashipura(Anta Block) (Figure 8A)
- Section B – B' :Tulsan-Kalmanda-Gopalpurs-Koyla(Baran Block) (Figure 8B)
- Section C – C' :Neemoda-Jeerod-Kharkhara -Asan(Atru Block) (Figure 8C)
- Section D–D':Moosal Gujran-Tancha-Dhomal-Chhipabarod- Harnawada Shahji(Chhipabarod Block)(Figure 8D)
- Section E – E' :Moosal Gujran-Chachora-Chowki(Chhapra Block) (Figure 8E)

- Section F – F’ :Rampuria Todiya-Dhikoniya-Naihroopur-Lakrai(Kishanganj Block)(Figure 8F)
- Section G –G’ :Rampuria Todiya-Rajpur-Kasba Thana(Shahabad Block) (Figure 8G)

Figure 9 : Geological section line, Baran District

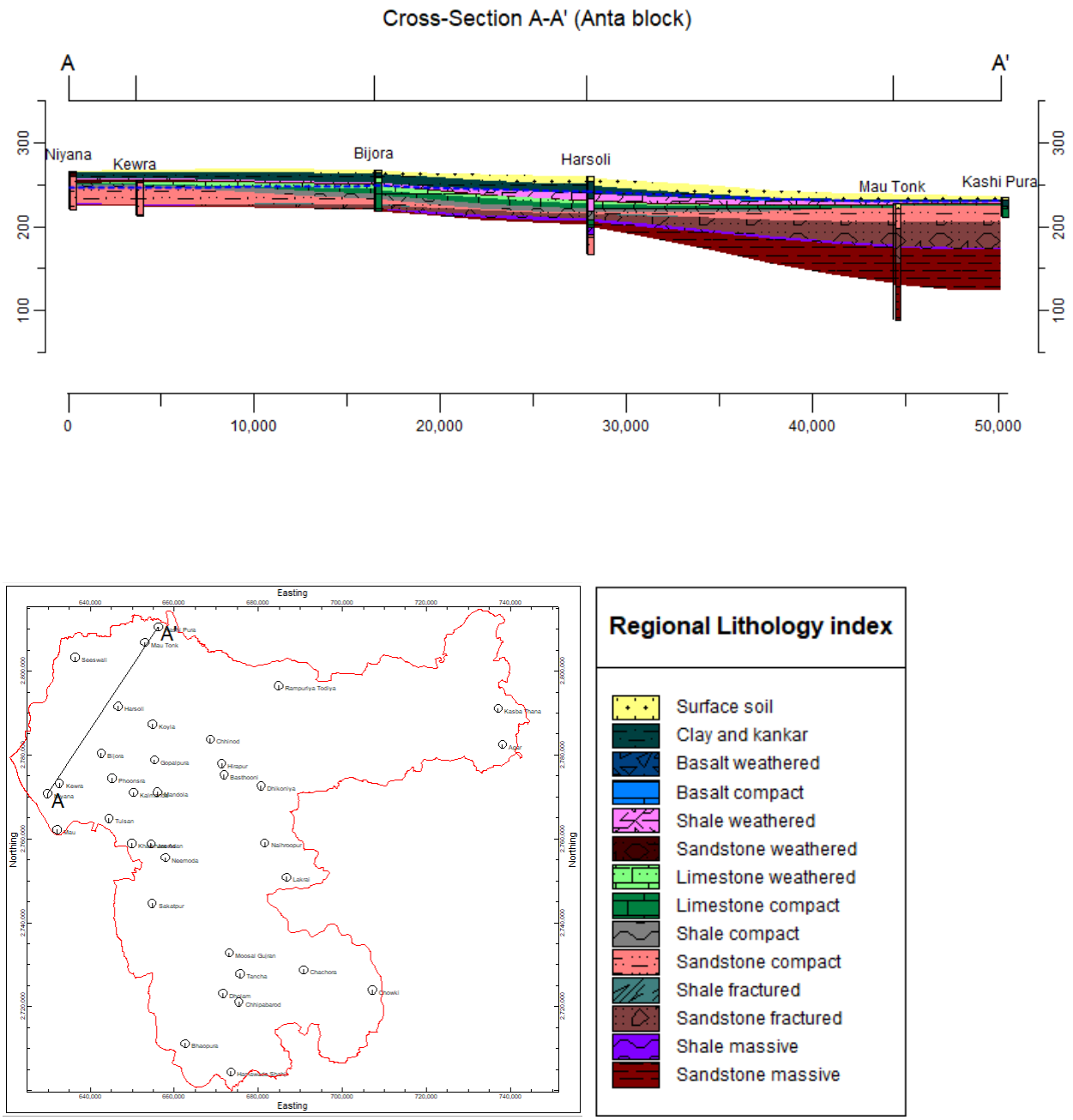
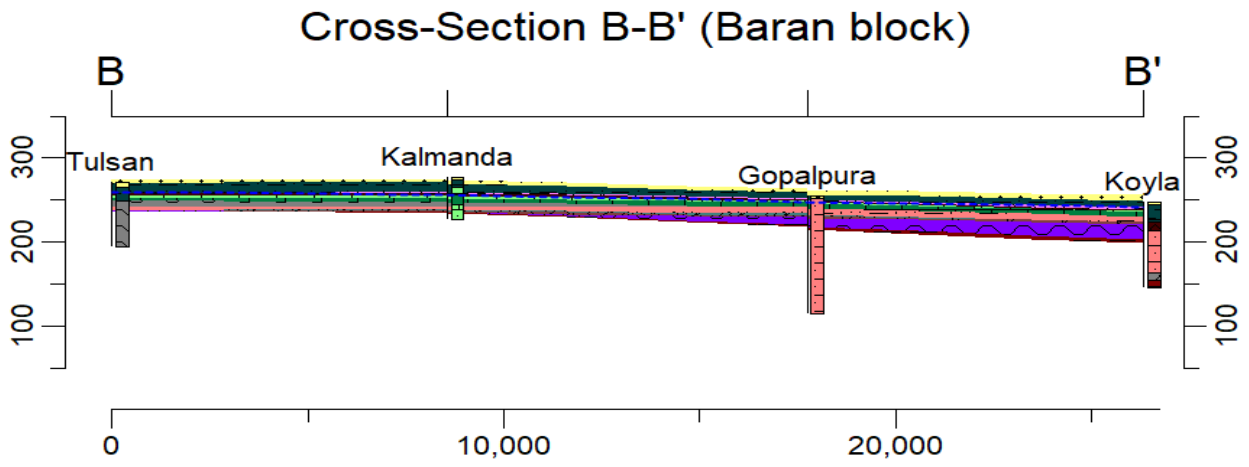


Figure8A: Section A - A': Niyana-Kewra-Bijors-Harsoli-Mau-Tonk-Kashipura(Anta Block)



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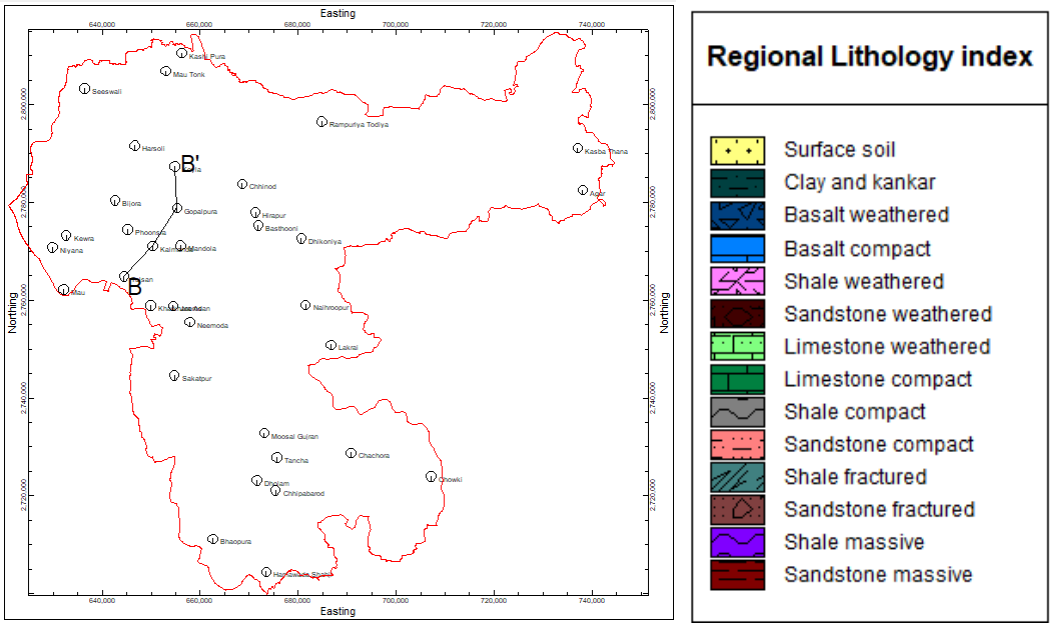


Figure8B: Section B – B' :Tulsan-Kalmanda-Gopalpurs-Koyla(Baran Block)

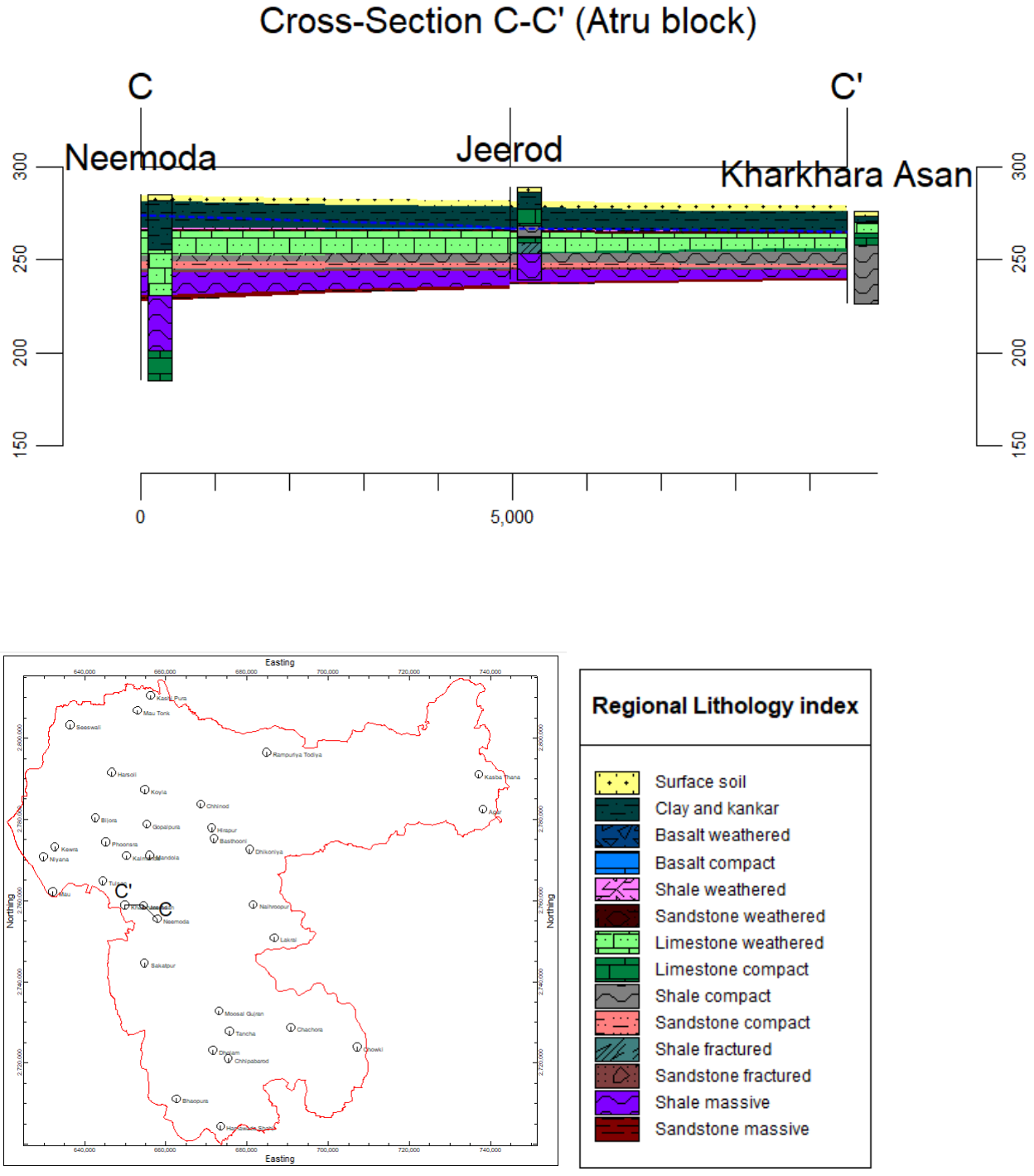


Figure8C: Section C – C’ :Neemoda-Jeerod-Kharkhara -Asan(Atru Block)

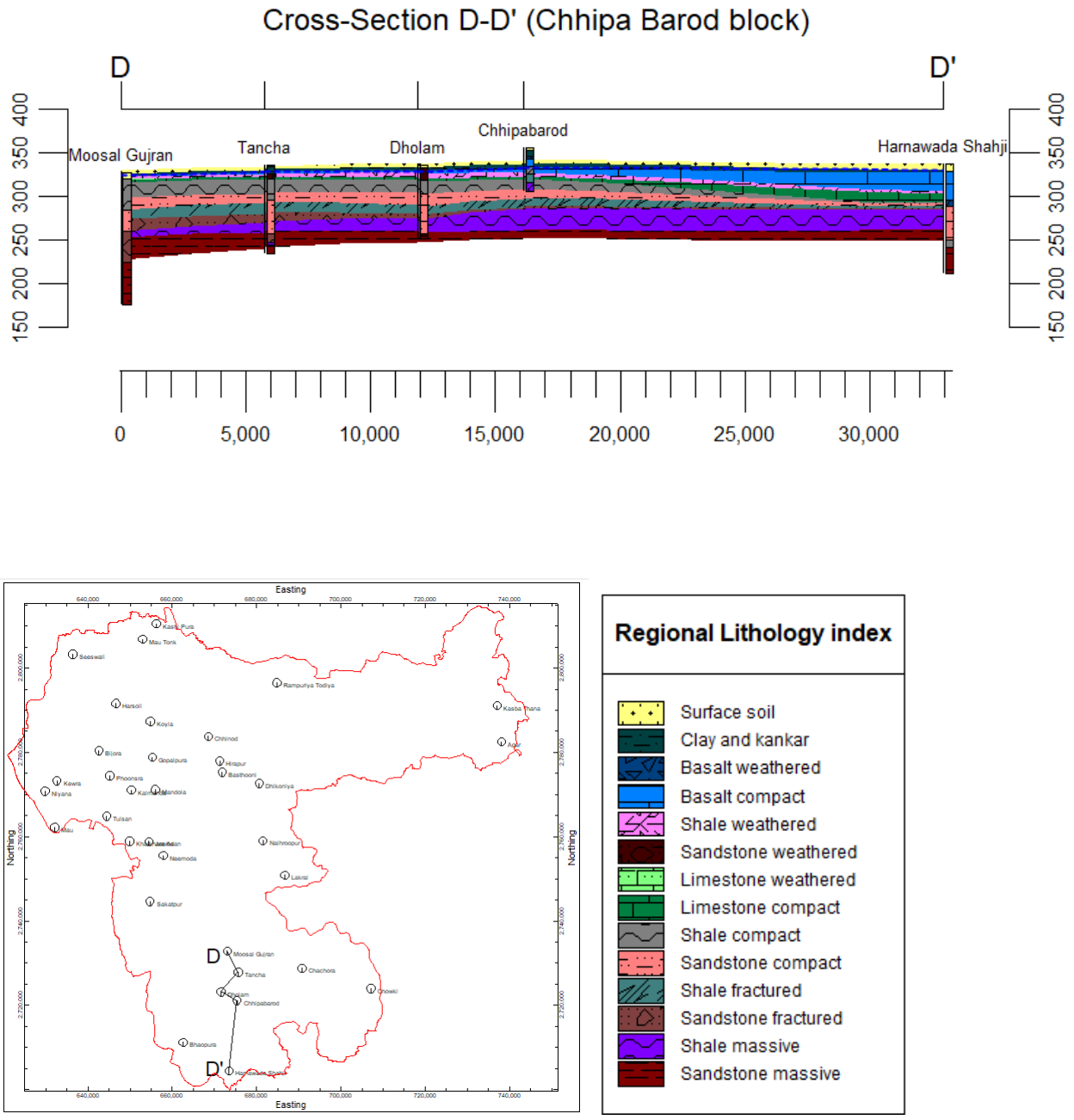
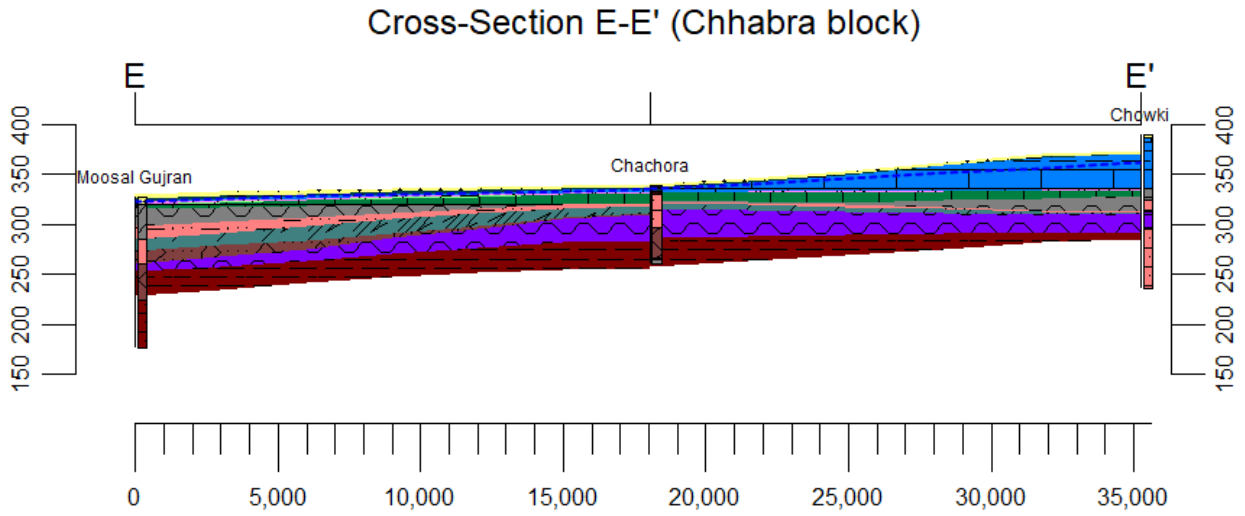


Figure8D: Section D–D':Moosal Gujran-Tancha-Dhomal-Chhipabarod- Harnawada Shahji(Chhipabarod Block)



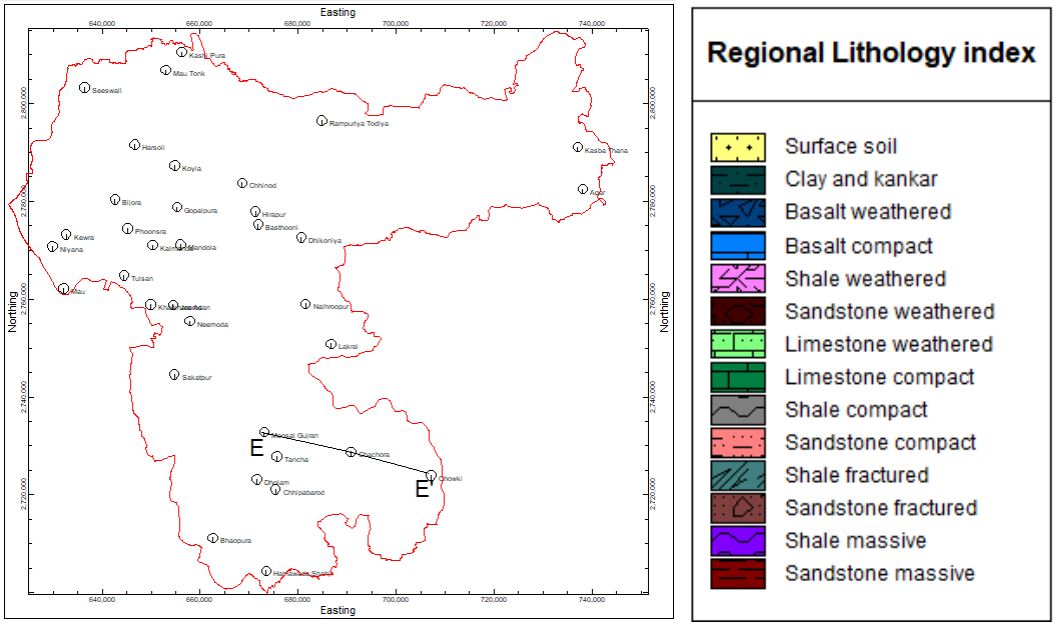
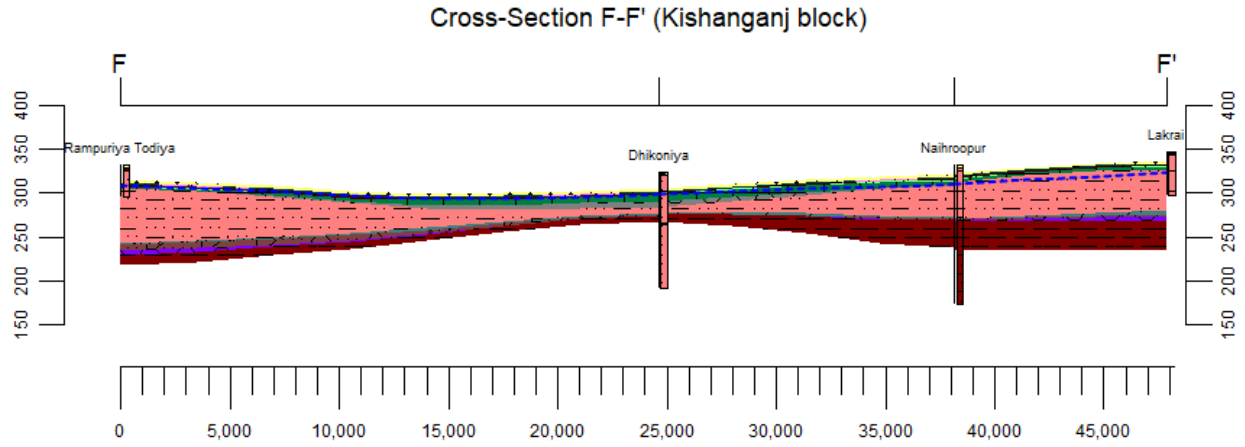
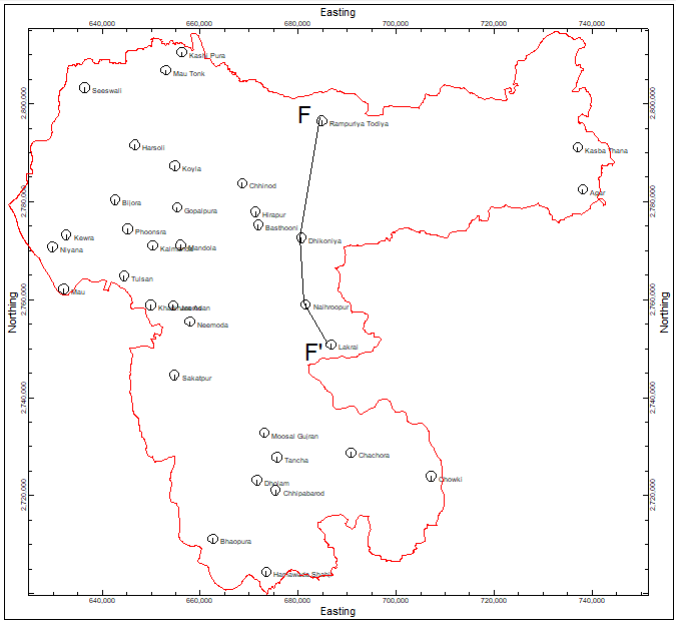


Figure 8E: Section E – E’ :Moosal Gujran-Chachora-Chowki(Chhapra Block)





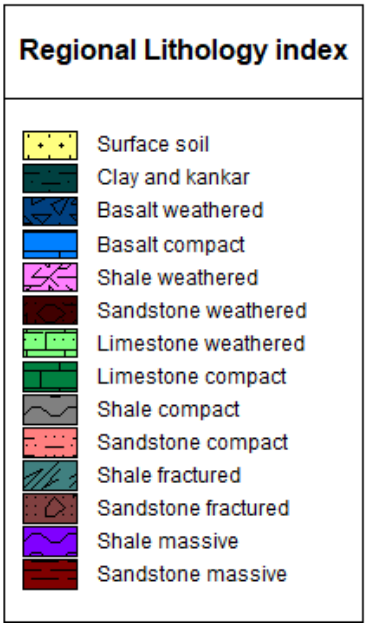


Figure8F: Section F – F’ :Rampuria Todiya-Dhikoniya-Naihroopur-Lakrai(Kishanganj Block)

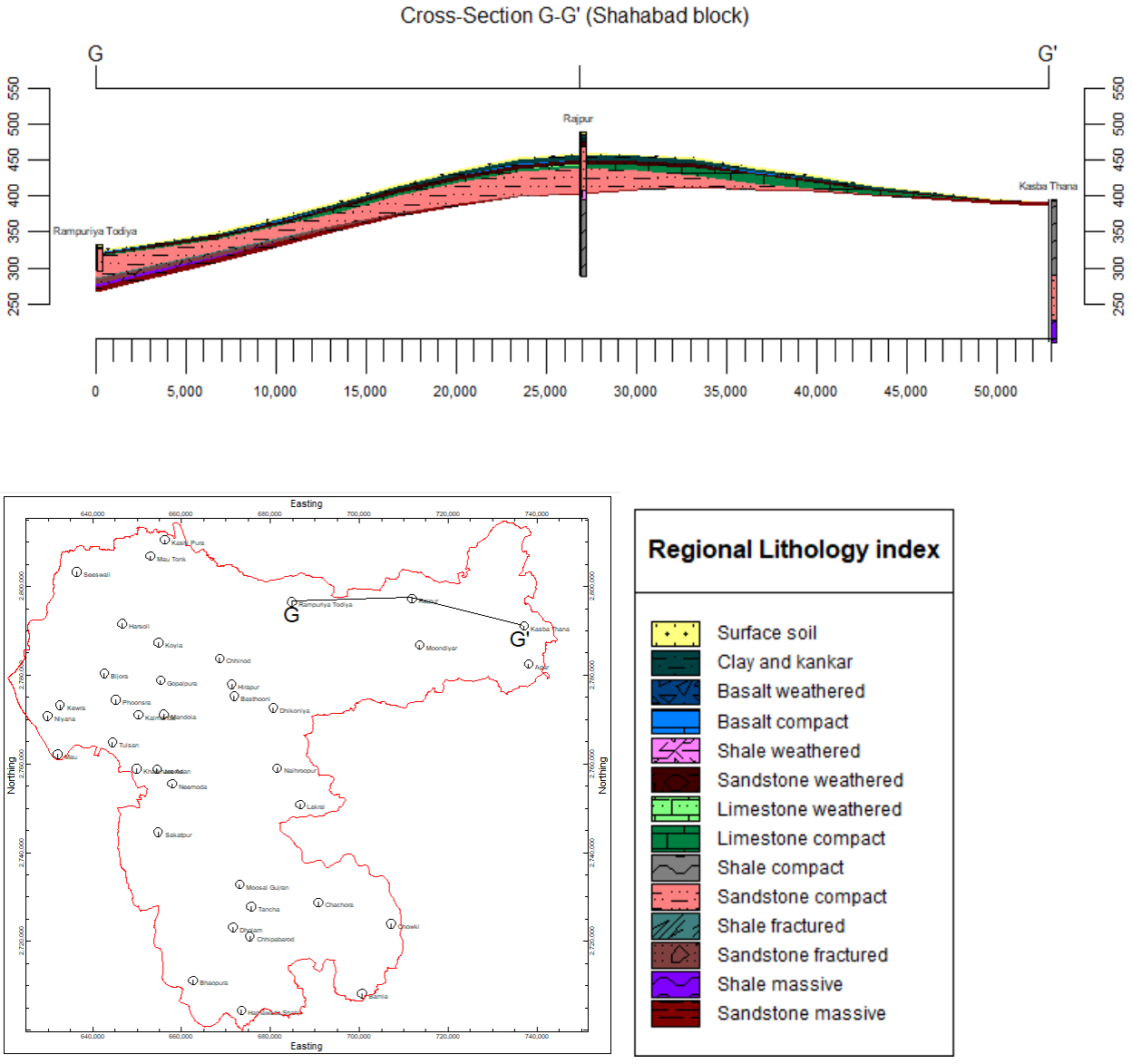


Figure8G: Section G –G’ :Rampuria Todiya-Rajpur-Kasba Thana(Shahabad Block)

2.2 Hydrogeology

A total of 63 wells have been inventoried to decipher the aquifer more precisely and ground water sampling also done to know its quality in terms of potability etc(Annexure-I).

The availability, occurrence and movement of ground water depends upon the rock formations present in the area. In Baran district, alluvium, limestone, sandstone, shale and inter trappeans are the main hydrolith units. Among these formations, alluvium is the most potential among different hydrogeological formations. The ground water in these formations occurs under water table conditions. At places, semi-confined conditions also exist.

Ground water in hard rocks viz. Vindhyan limestone, sandstone, shale and Deccan basalt occurs in secondary porosity developed by weathering and/ or fracturing. The ground water potential of these rocks depends upon the intensity of joints and fracture systems and their interconnection. These formations are known to be water-bearing down to more than 100 mbgl. These deeper zones are tapped by bored wells mostly for irrigation purpose.

Exploratory drilling in the district has revealed that the hard rock forms the main aquifer over large parts of the district. Depth of tubewells ranges from 20m to 150m.Yield of tube wells ranges from meagre to 2000 lpm. Hydrogelogiocal map of the area is depicted in Figure .

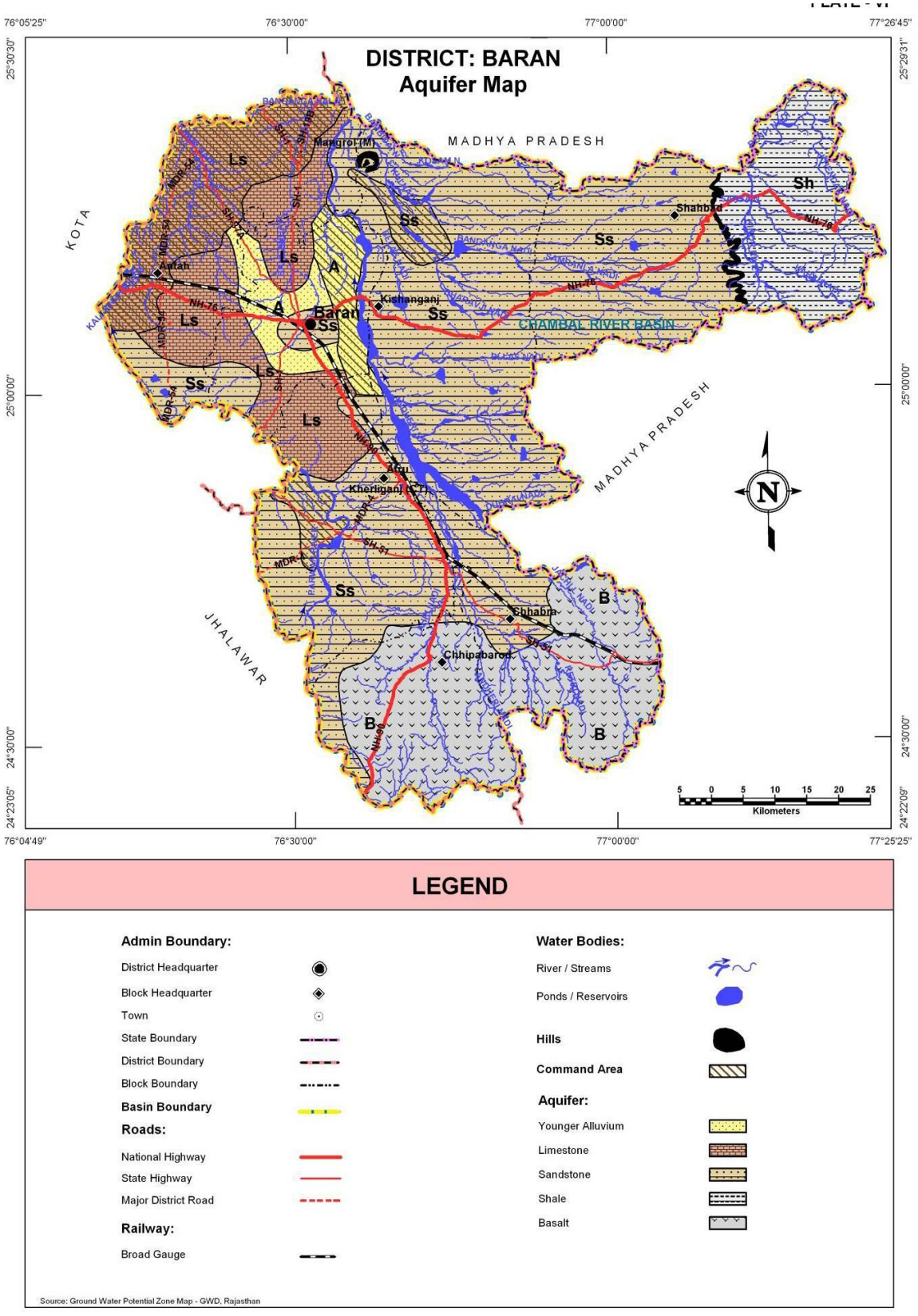


Figure : Hydrogeologiacal map, Baran District

2.2.1 Aquifer system

a. Alluvial Aquifer(Quaternary)

Alluvium comprises unconsolidated to semi-consolidate, sand, silt and clays. Thickness of alluvium varies from few meters to about 40m. The litho unit occurs in a localized pocket confined to Baran block. It occupies nearly 4% potential area.

b. Basalt (Upper Cretaceous to Palaeocene)

Basalt is dark green to steel grey, fine to medium grained and porphyritic at place. It varies from hard, massive to amygdaloidal and vesicular type. Intertrappeans are practically absent. Then litho unit encompasses southern part of the area and confined to Chhabra and Chhipabarod blocks. It covers nearly 14% potential area.

c. Sandstone(Vindhyan Super Group)

Sandstone is buff to red colour, hard, compact and quartzitic. The litho unit covers most extensive area. It occupies Kishanganj and major part of Atru and Shahbad blocks and spreads in peripheral part of the adjoining blocks. Sandstone, shale and sandstone occupy nearly 56% potential area.

d. Shale, Limestone (Vindhyan Super Group)

Shale is fine to medium grained, grey, yellow, buff, red and chocolate colour. Grey and yellowish limestones, at places are siliceous, hard and less susceptible to weathering. Limestone is often interbedded with shales. Shale occupies eastern part of Shabad block. Limestone spreads in major part of Anta block with some peripheral area of adjoining Anta and Baran block. Shale and limestone cover nearly 9% and 16% potential area respectively.

Depth of exploratory drilling in the district varies from 23-207m. Discharge of borewells from <50lpm to 1500 lpm. However, discharge of borewells drilled in the area has been analyzed in terms of their potentiality and their discharge ranges is given below:

Discharge range(lpm)		**/Borewell**	
From	**To**	**Number**	**Precentage(%)**
Less than 100		9	25.72
100	200	4	11.43
200	400	6	17.14
400	600	6	17.14
More than 600 lpm		10	28.57

Thickness of saturated portion of alluvial aquifer as well of hard formations have been reduced significantly owing to the over draft of ground water resources over the years for various uses.

2.2.2 Depth to Water Level

Central Ground Water Board periodically monitors the ground water regime through 21 active National Hydrograph Network Stations (NHNS) stations four times a year i.e. in January, May (Premonsoon), August and November (Postmonsoon) including one time ground water sampling during May measurement. Depth to water level varies widely depending upon topography, drainage, bed rock, geology etc.

Pre-monsoon (May-2017):

The depth to water level varies widely from less than 2 mbgl to more than 40m.Shallow water level i.e. <10m is observed in mostly in northern and south eastern parts of the district and water level between 10 and 20mbgl is noticed in south eastern part of district . Ground water level map prepared using Pre-monsoon, 2017 water level data has been prepared and depicted in Figure10 and 3dimentional depth to water level model(Pre-monsoon, 2018) is depicted in Figure11.

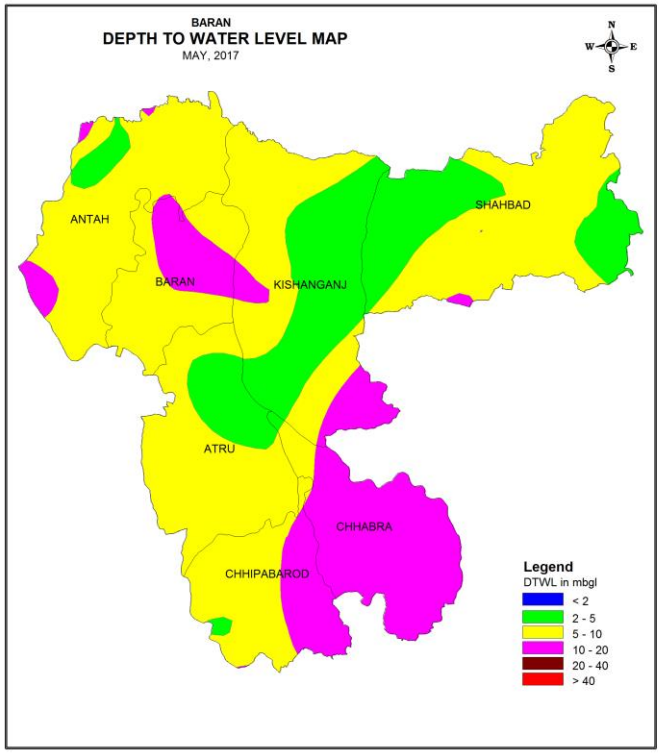


Figure 10: Depth to Ground Water Level (May, 2017), Baran District

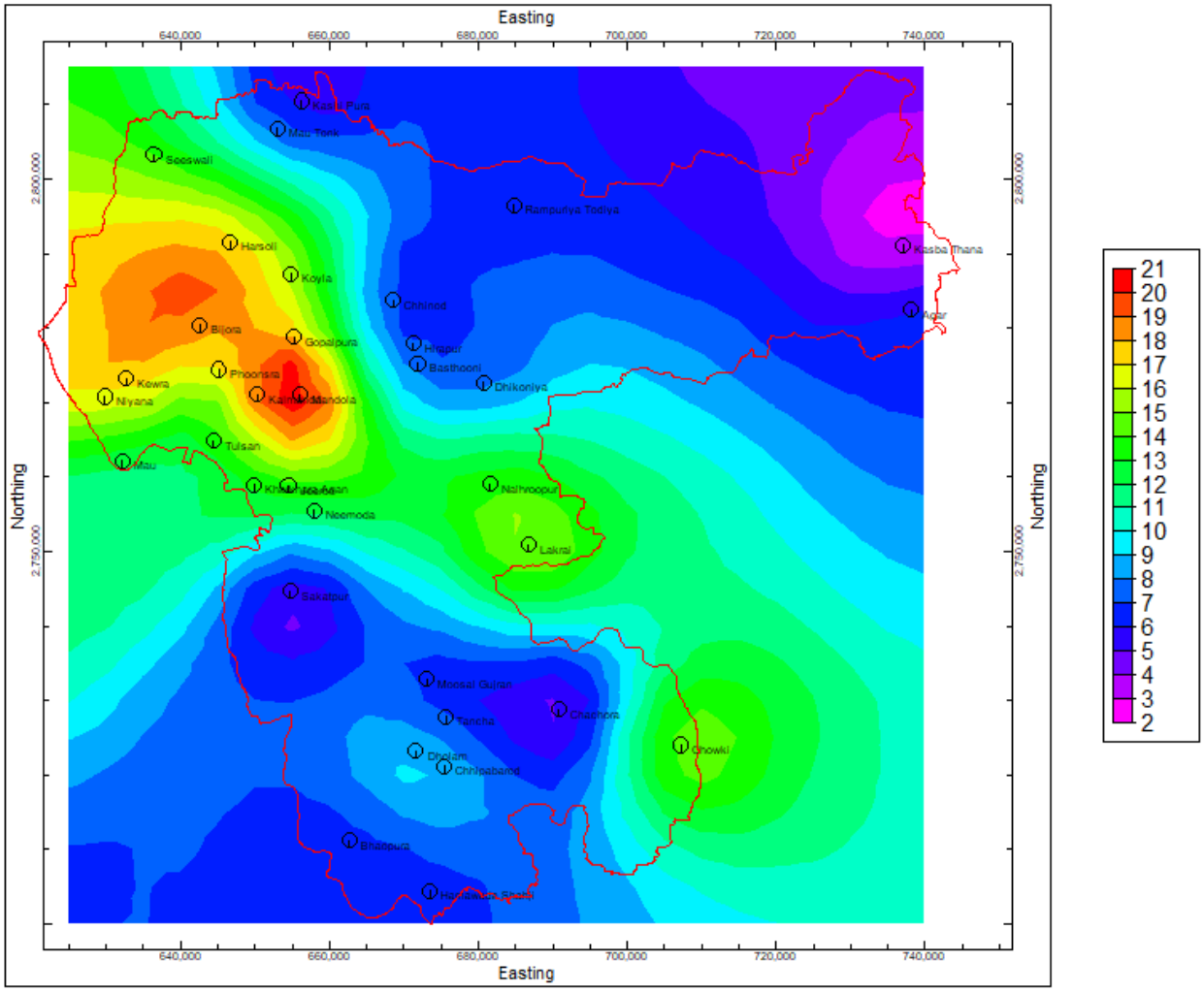


Figure 11: 3 Dimensional depth to water level model(Pre-monsoon, 2018), Baran District

Block-wise water level ranges are given below in Table13:

Table 13: Block-wise range of depth to ground water level, Baran, District(May, 2017)

Sl.No.	Name of Block	Depth to Ground Water Level Range (mbgl)	
		From	To
1	Anta	5.73	10.32
2	Atru	3.79	5.99
3	Baran	5.50	10.40

4	Chhabra	19.82	19.82
5	Chhipabarod	4.65	9.38
6	Kishanganj	9.74	10.46
7	Shahabad	3.40	10.02

Post-monsoon (Nov, 2017):

The depth to water level varies from less than 2 mbgl to more than 40m. Perusal of map indicates most of the area lies with water level with in 10m . Deeper water level i.e. >10m is observed in extreme north western part of district. Ground water level map prepared using post-monsoon, 2017 water level data has been prepared and depicted in Figure12 .

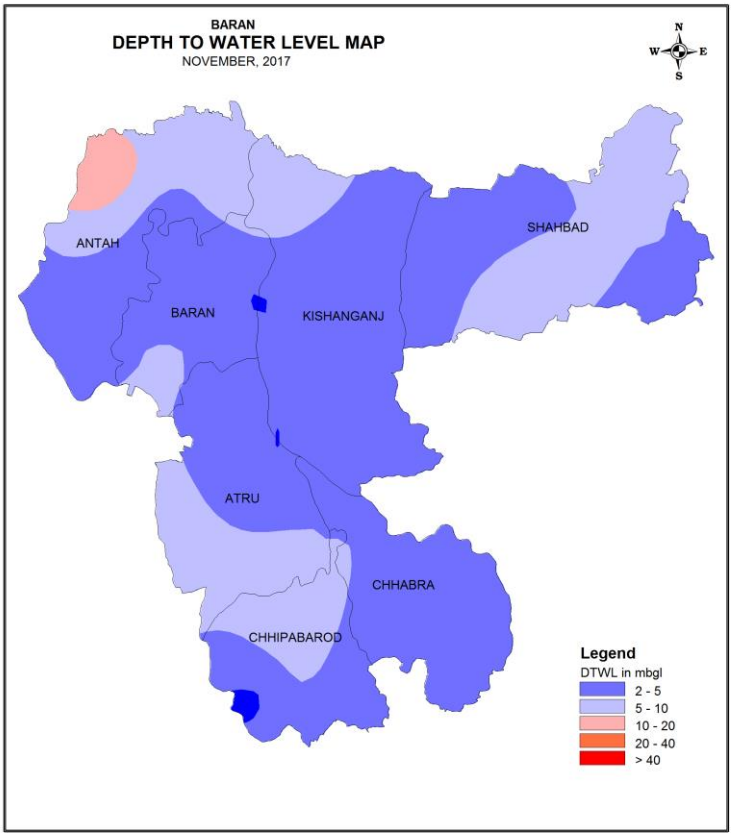


Figure 12: Depth to ground water level (Nov, 2017), Baran District

Block-wise water level ranges are given below in Table14 :

Table14: Block-wise range of depth to ground water level, Baran, District(November, 2017)

Sl.No.	Name of Block	Depth to Ground Water Level Range (mbgl)	
		From	To
1	Anta	2.32	6.93
2	Atru	1.97	4.89
3	Baran	4.89	5.08
4	Chhabra	Not available	
5	Chhipabarod	1.69	7.51
6	Kishanganj	1.91	4.47
7	Shahabad	2.20	7.86

Seasonal Water level Fluctuation (Nov, 2017 versus May, 2017):

Seasonal water level fluctuation map (pre-monsoon versus post-monsoon, 2017) has been prepared (Figure). Perusal of map indicate that major part of the district exhibits positive i.e. rise in water level ranging from <2m to >4m whereas decline i.e. decline in water level of less than 2m has been noticed in norther, central and north eastern border of the district falling in parts of Anta, Kishanganj and Shahabad blocks. Block-wise seasonal water level fluctuation data are given in Table15 and map prepared is depicted in Figure13:

Table 15: Block-wise seasonal ground water level fluctuation data (pre versus post monsoon,2017), Baran District

Block	Range of fluctuation(m)			
	Rise		Fall	
	Minimum	Maximum	Minimum	Maximum
Anta	3.02	8.02	1.20	1.20
Atru	1.10	1.82	-	-
Baran	0.42	0.42	-	-

Chhabra	Not Available			
Chhipabarod	1.87	5.82	-	-
Kishanganj	6.85	8.55	1.73	1.73
Shahabad	0.24	2.83	0.10	0.10

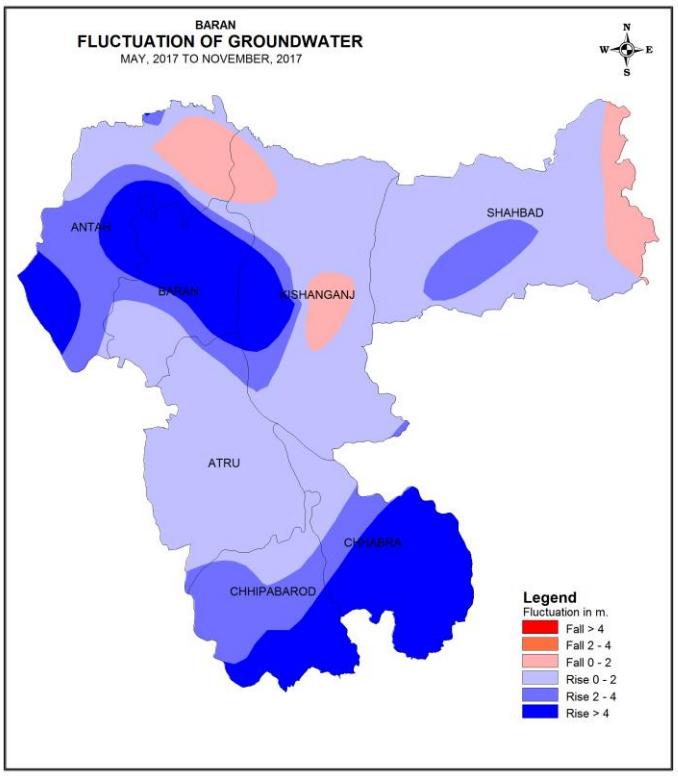


Figure 13: Seasonal ground water level fluctuation (pre monsoon versus post monsoon, 2017), Baran District

Decadal Water level Fluctuation (May,2007-16 versus May, 2017)

Decadal water level fluctuation map (2007-16 versus May, 2017) has been prepared (Figure 14). Perusal of map indicate decline in water level ranging from less than 2m to more than 4m in isolated pockets falling in parts of Anta, Baran, Kishanganj and Shahabad blocks. Whereas rest of area exhibits rise in water level ranging from <2m to >4m. Rise of water level more than 4m

has been observed in in Baran, and Atru and Kishanganj blocks of the district. Most of the area shows marginal rise in water level in view of existing canal command area spread in the district.

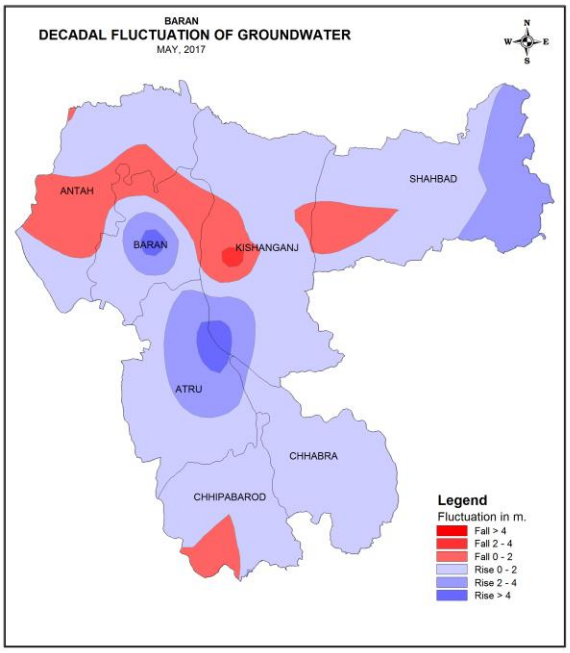


Figure 14: Decadal Fluctuation (Period May, 2007 -May,2016) versus May,2017, Baran District

Long Term Water Level Trend (2008-2017):

Block-wise long term ground water level trend for the period 2008-2017 are given below in Table 16:

Table16: Block-wise ground water level trend(2008-2017), Baran District

Sl.No.	Name of Block	Ground Water Level Trend (metre/year)			
		Pre-monsoon		Post Monsoon	
		Rise(average)	Fall(Average)	Rise(Average)	Fall(Average)
1	Anta	0.08325	-	0.5541	0.0673
2	Atru	0.15695	-	0.1891	-
3	Baran	1.5366	0.0593	0.5102	-

Sl.No.	Name of Block	Ground Water Level Trend (metre/year)			
		Pre-monsoon		Post Monsoon	
		Rise(average)	Fall(Average)	Rise(Average)	Fall(Average)
4	Chhabra	NA	NA	0.4323	-
5	Chhipabarod	0.0738	0.2845	0.1698	-
6	Kishanganj	0.3144	-	0.0857	0.0983
7	Shahabad	0.24193	0.0049	0.1207	-

Marginal rising as well as declining trends have been observed in the study area. Declining trend has been observed in parts of Chhabra and Chhipabarod blocks which are devoid of canal command area and also in Atru and Baran blocks which have canal command area in minor parts. Rising trend observed in the Atru, Kishanganj and Shahabad blocks which are laden with canal command area in their major part. The long term hydrograph of selected monitoring stations are depicted in Figure 15A to 15F which show marginal rising trend.

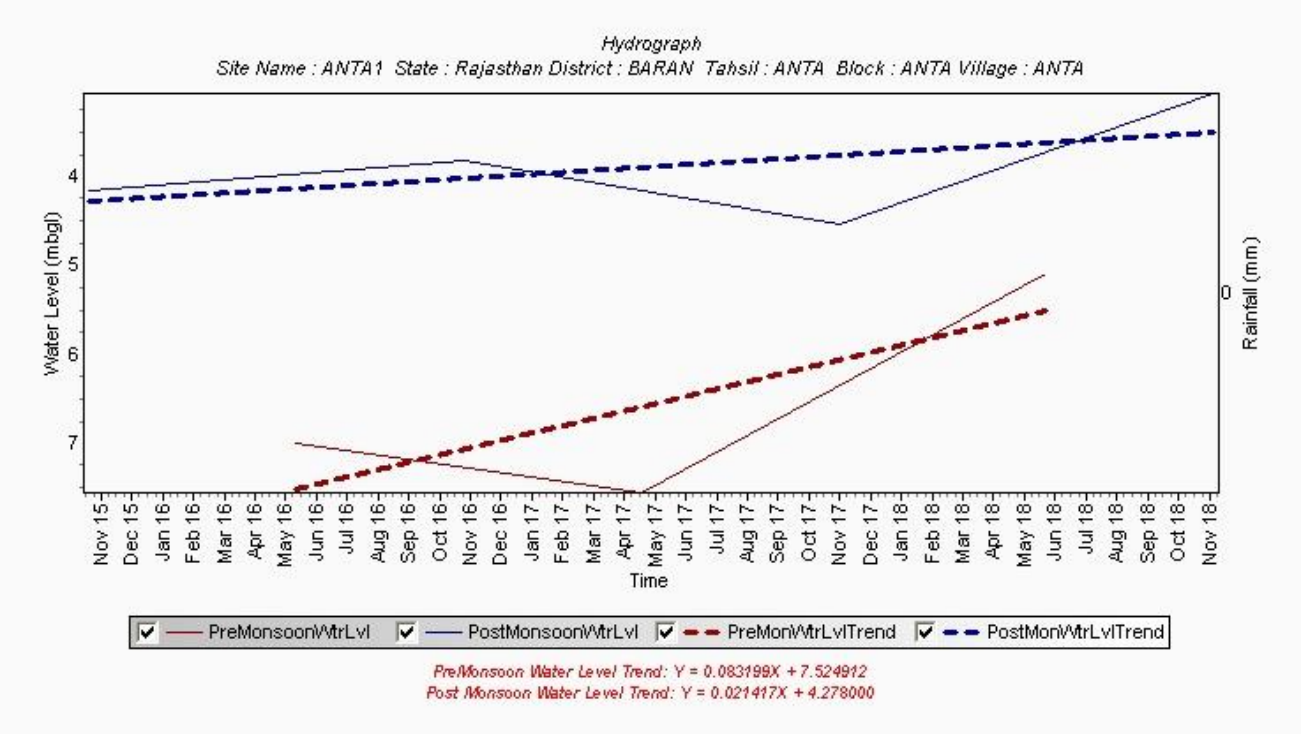


Figure 15A:Anta, Anta Block(Aquifer- Limestone)

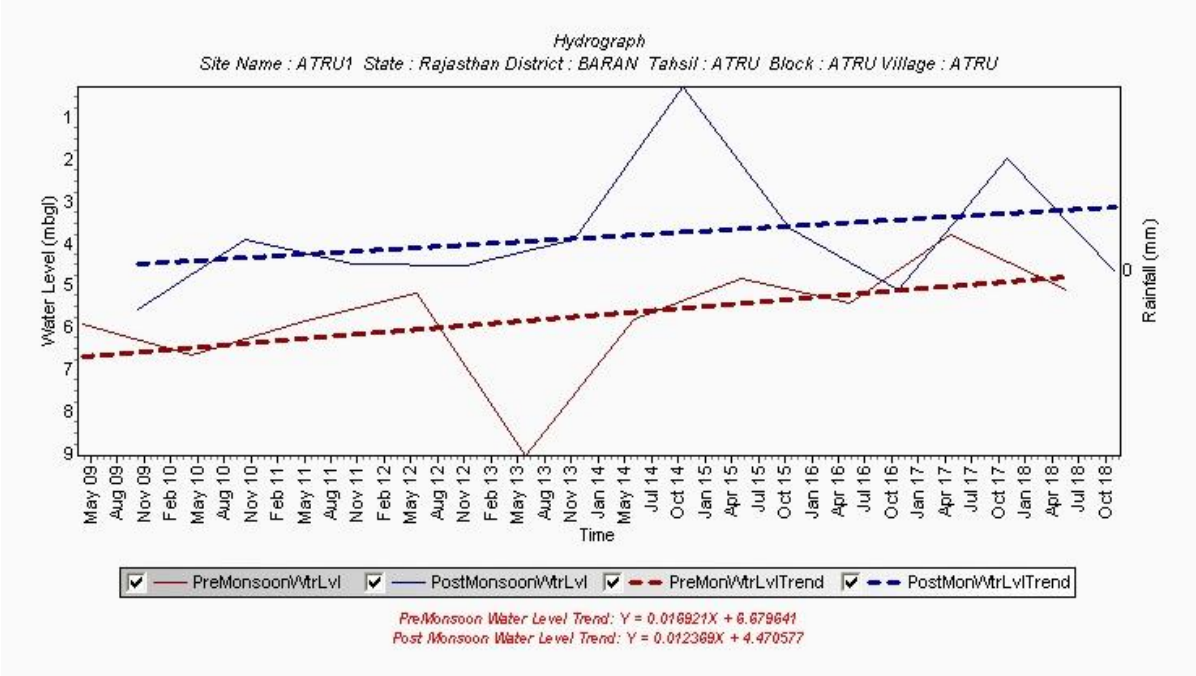


Figure 15B:Atru,Atru Block(Aquifer-Sandstone)

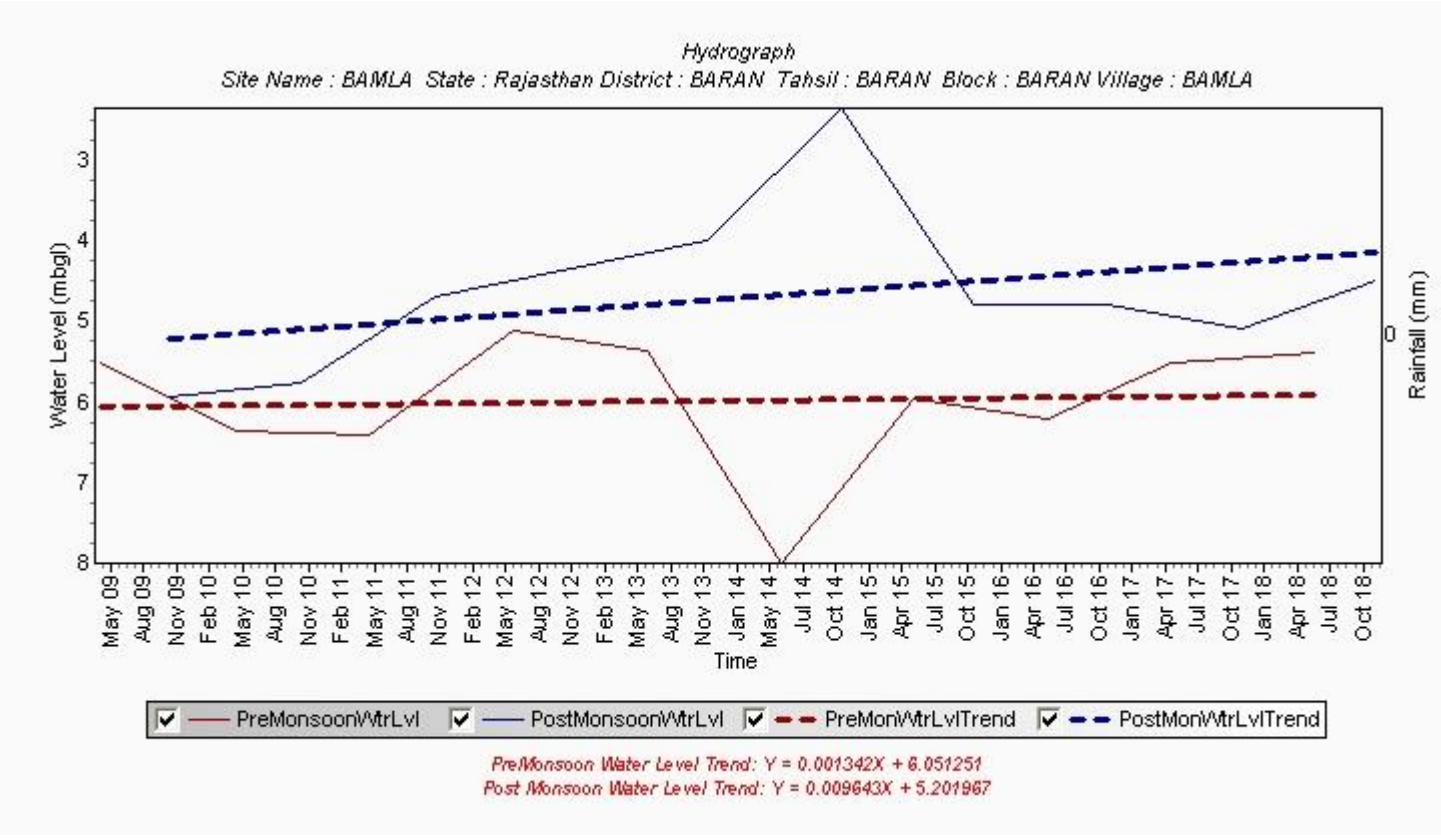


Figure 15C:Bamla, Baran Block(Aquifer-Limestone)

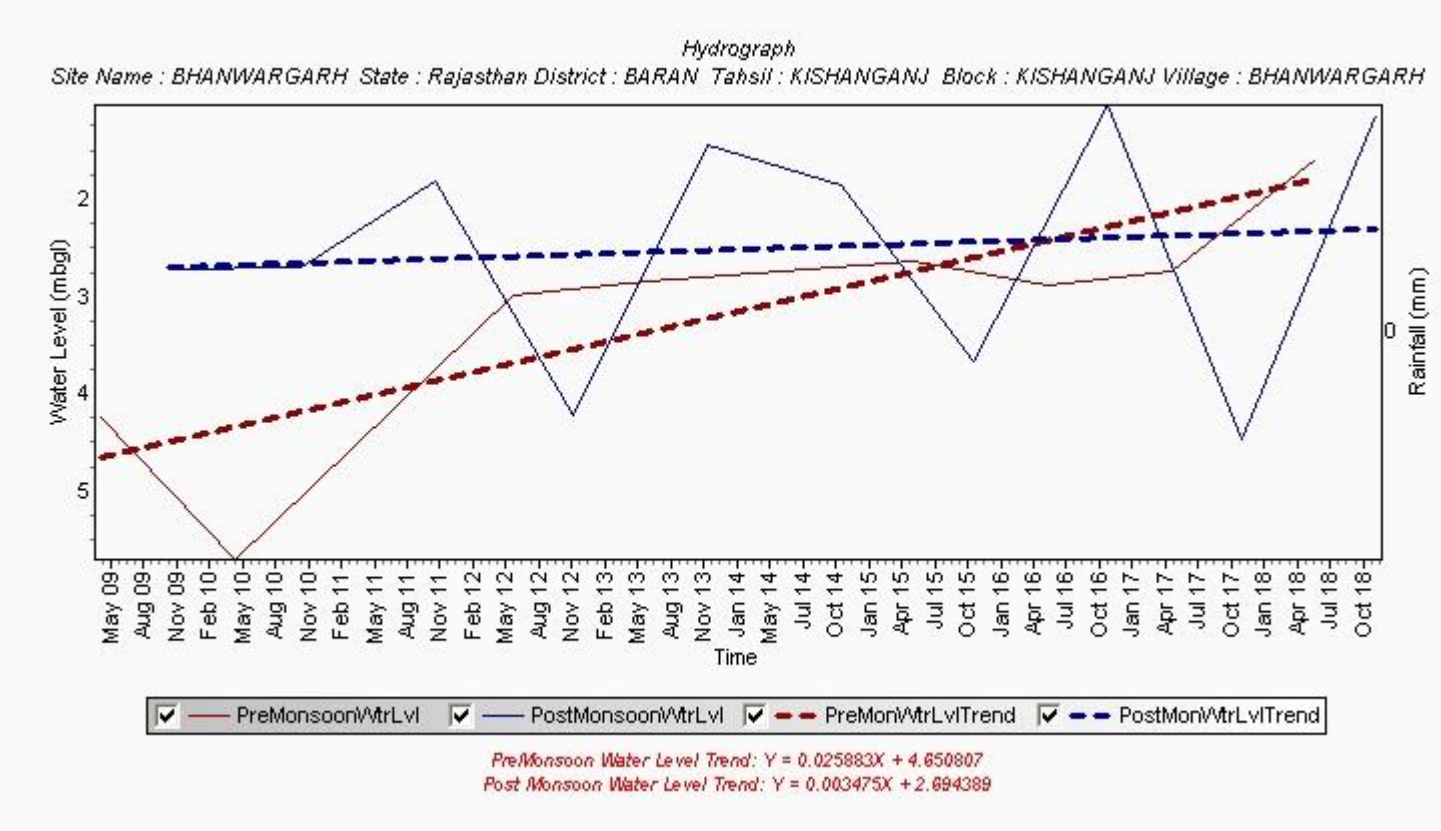


Figure 15D:Bhanwargarh, Kishangarh Block(Aquifer-Sandstone)

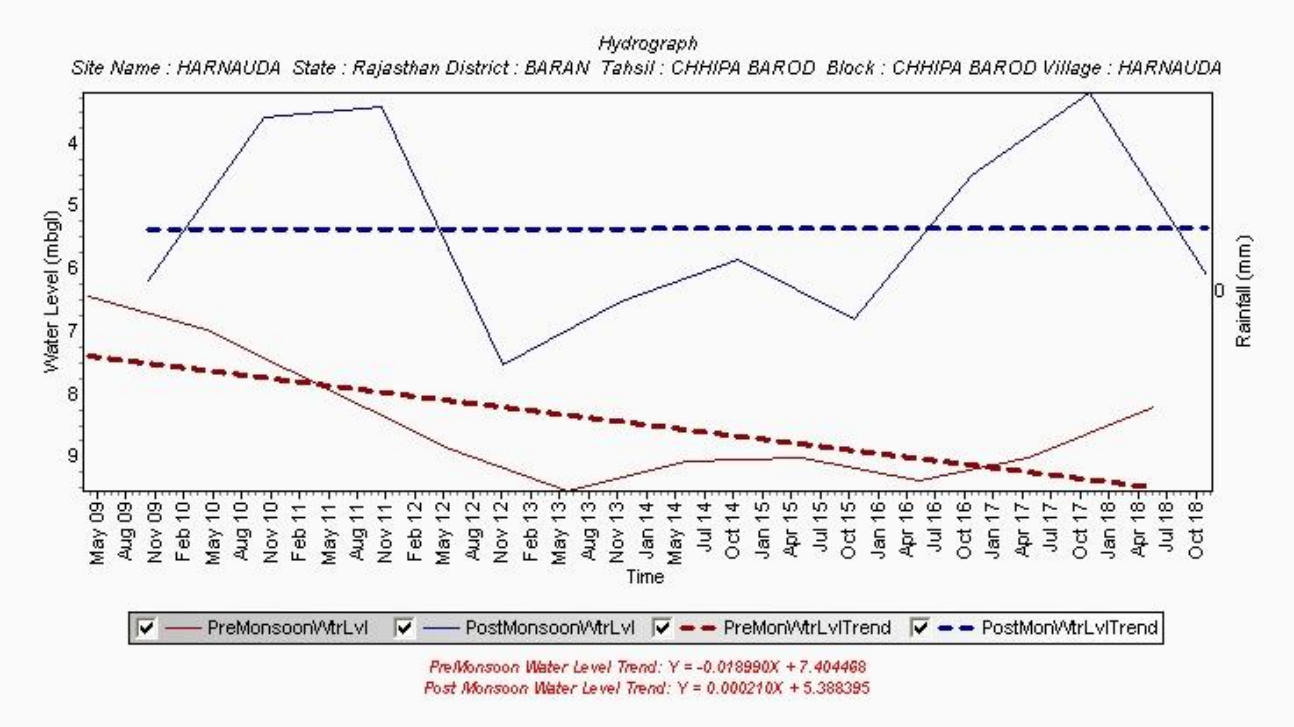


Figure 15E:Harnauda, Chhipabarod(Aquifer-Basalt)

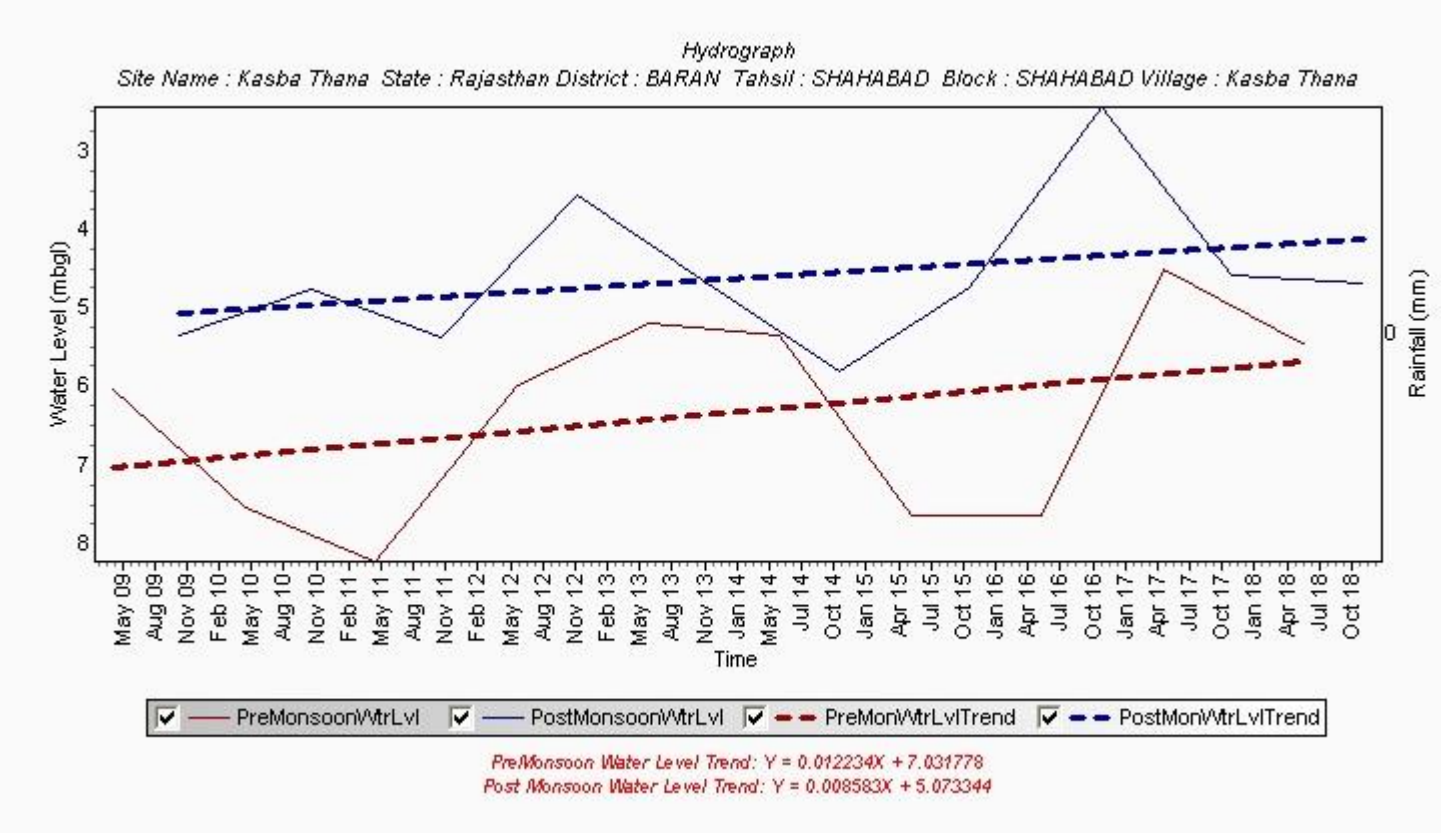


Figure 15F:Kasba Thana, Shahabad Block(Aquifer-Shale)

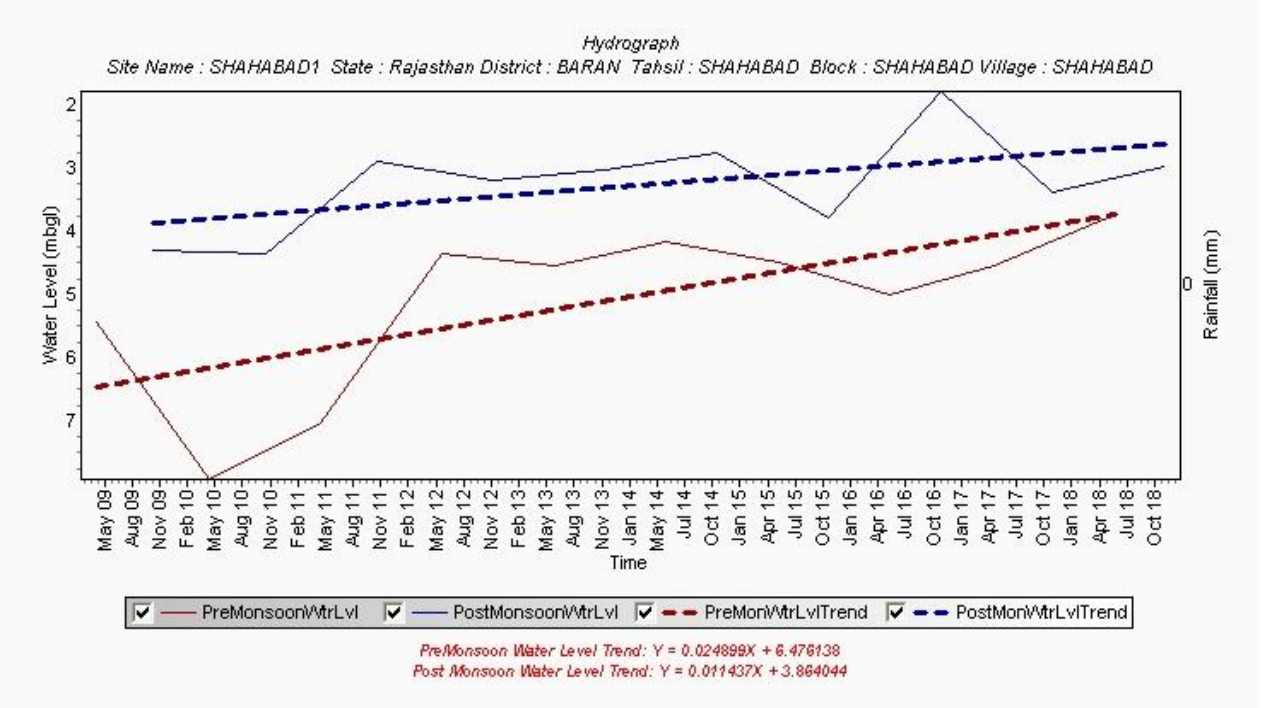


Figure 15G:Shahabad, Shahabad Block(Aquifer-Sandstone)

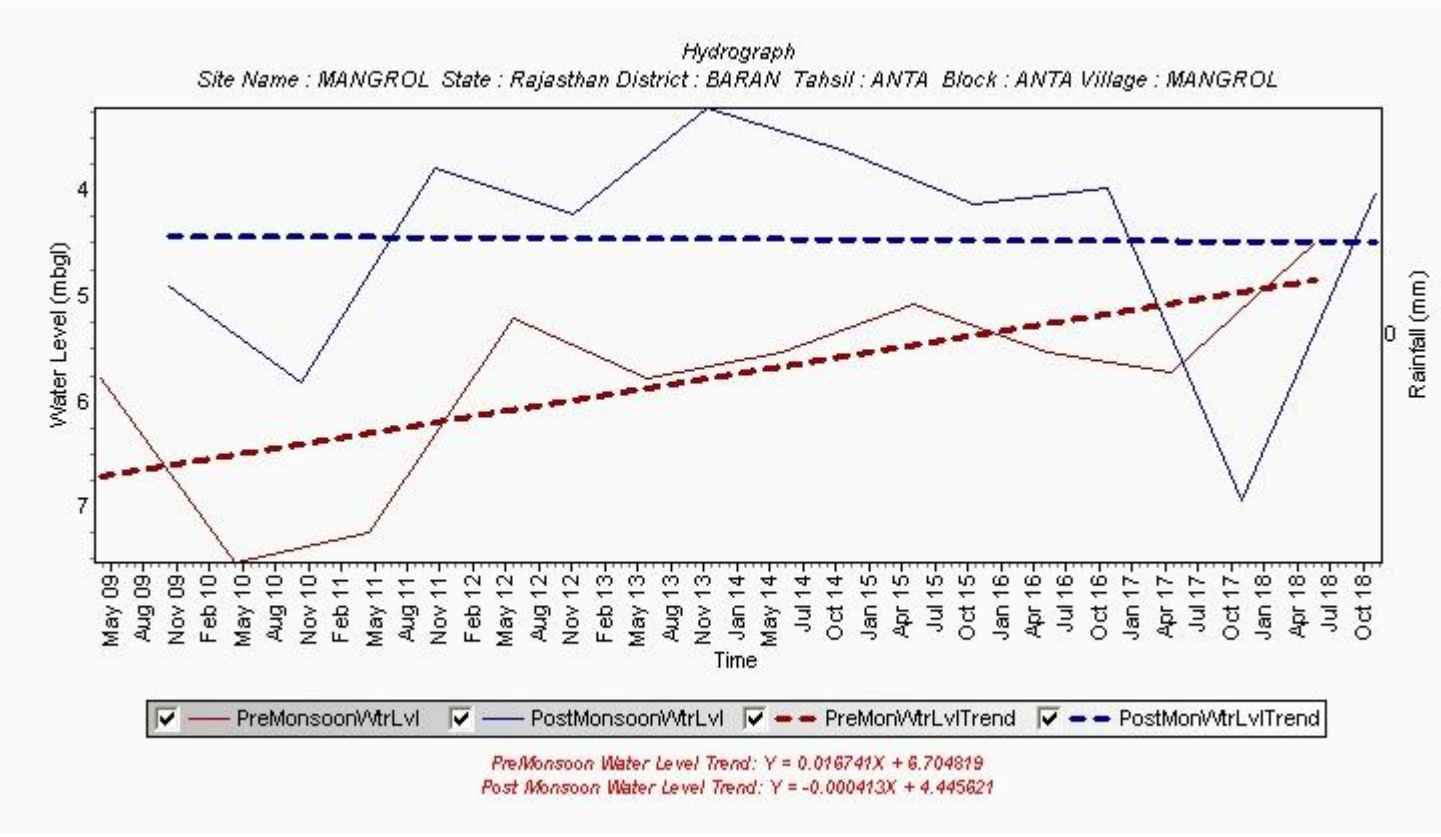


Figure 15H:Mangrol, Anta Block(Aquifer-Limestone)

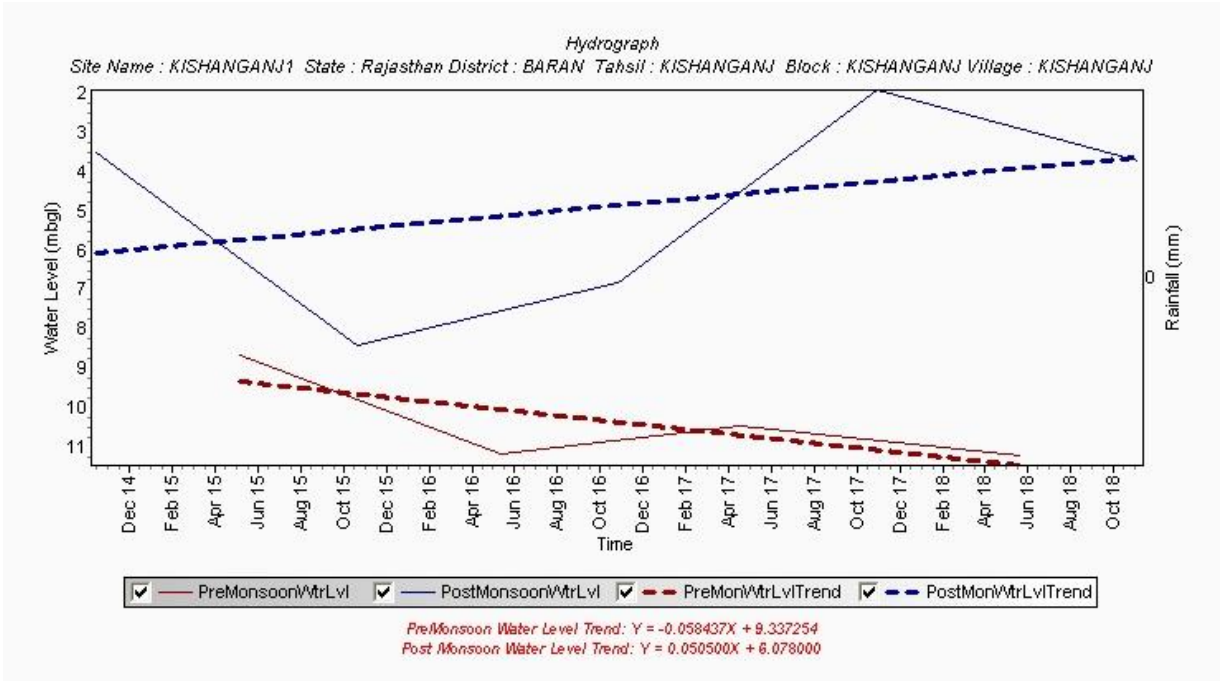


Figure 15I:Kishanganj, Kishanganj Block(Aquifer-Sandstone)

Ground water gradient:

The general direction of ground water flow varies. Around Shahabad, ground water mound has been located. In other parts flow direction has been inferred South-East or North-West or East to West. hydraulic gradient around Baran-Anta-Atru is comparatively low. Water table maps on plane and 3D of area have been prepared using Rock Works Software and portrayed in Figure 16. Perusal of 3 D model indicates that the highest water table lies at an elevation of anent 380mamsl in Shahabad block and minimum elevation about 220mamsl in Anta block.

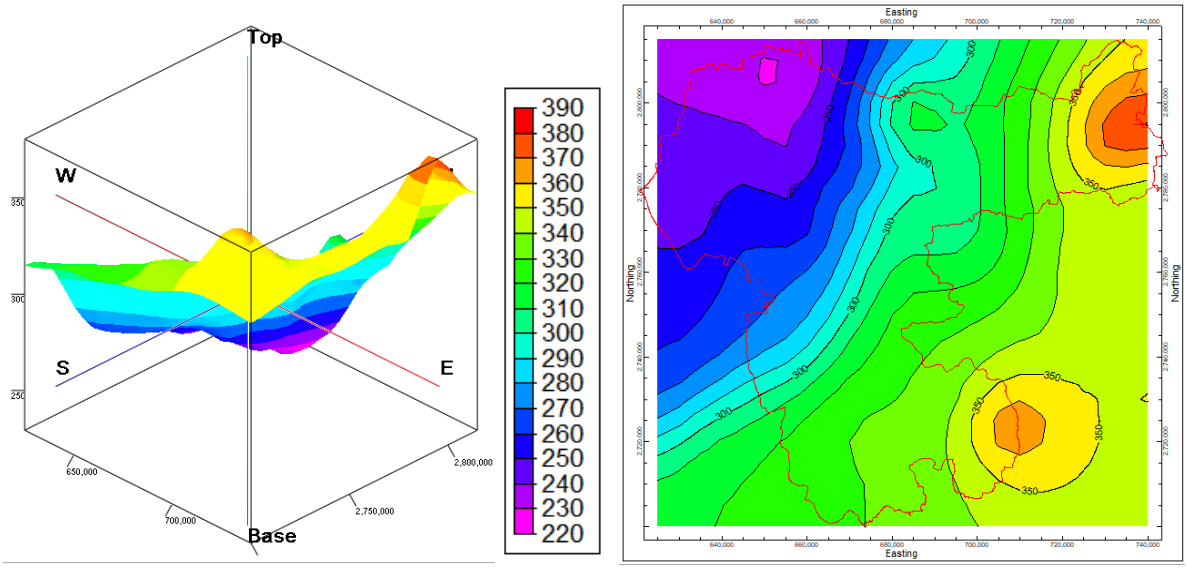


Figure 16 : 3Dimentioal model of ground water table (Pre-monsoon, 2018), Baran District

3. Ground Water Quality

A total of 63 ground water samples have been collected from inventoried wells during pre-monsoon, 2018 to decipher the ground water quality of the area(Annexure II). 32 ground water samples from 18 locations(repeated) have also been collected during post monsoon,2018(AnnexureIII).Apart from this, 14 representative ground water samples have also been collected from the study area to notice the presence of heavy metals. (analytical results of 21 ground water samples of NHS,2018 are awaited).

Ground water is alkaline in nature and mostly fresh and potable.

The range of various chemical constituents of groundwater in Baran district during(pre-monsoon' 2017) is furnished in Table 17.

Table17: Minimum and maximum range of chemical constituents in ground water, Baran District(Pre-monsoon, 2018)

S. No.	Chemical constituent	Range	
		Minimum	Maximum
1	pH	7.08	8.20
2	EC(µS/cm at 25°C)	480	7600
3	CO_3 (ppm)	0	0
4	HCO_3(ppm)	134	976
5	Chloride(ppm)	14	1631
6	SO_4(ppm)	5	580
7	Nitrate(ppm)	0	510
8	Phosphate(ppm)	0	0.42
9	Total Hardness as (as Ca CO_3) (ppm)	170	1600
10	Calcium (ppm)	40	360
11	Magnesium (ppm)	5	170
12	Sodium (ppm)	20	1680
13	Potassium (ppm)	0.4	2.8
14	Fluoride (ppm)	0	1.2
15	Iron (ppm)	0	1.8
16	TDS(ppm)	312	4940

However, ingeneral the range of major constituents is presented in Table18 .

Table18: In general range of major chemical constituents in ground water, Baran District (Pre-monsoon, 2018)

S. No.	Chemical constituent	Range	
1	EC(µS/cm at 25°C)	500	3000
2	Nitrate(ppm)	20	100
3	Total Hardness as (as Ca CO_3) (ppm)	250	500
4	Fluoride (ppm)	0.3	1.0
5	Iron (ppm)	0.1	0.2

3.1 Electrical Conductivity (EC)

EC varies from 320µs/cm at 25^0C minimum at Memoni, Block Shahabad to a maximum of 7600ms/cm at 25 ^{0}C at Batawada, Blocck Baran. However, in general it lies between 500 and 3000ms/cm at 25°C (Figure 17). EC value of more than 3000ms/cm at 25^0C has been observed at Mangrol, Baran block(3310 ms/cm at 25^0C), Udpuria, Anta block(3510 ms/cm at 25^0C),Batawada, Baran block(7600 ms/cm at 25^0C) and at Baran, Baran block(4410 ms/cm at 25^0C).

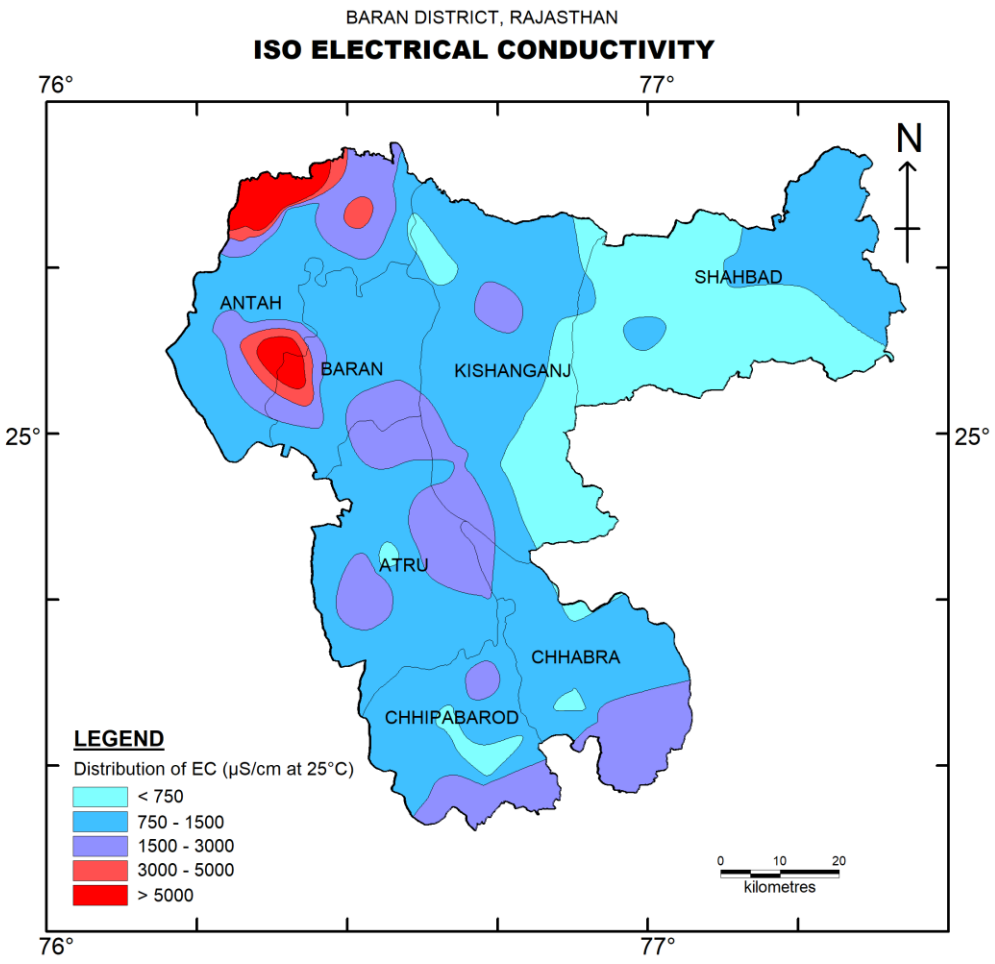


Figure 17 : Distribution of electrical conductivity in ground water(pre -monsoon,2018), Baran District

Perusal of map indicates that ground water is potable in most part of the study area except in isolated pockets of north western part where electrical conductivity is more than 3000ms/cm at 25^0C. Such pockets lies in Anta block and small part in Baran block.

3.2 Fluoride

Fluoride concentration in ground water varies from 0 to 1.2 mg/l (at Jalwada, Block Kishanganj). Fluoride concentration has been found within permissible limit (i.e. 1.5mg/l of Drinking Water Standard-IS 10500:2012) in all the 63 ground water samples analysed. A map showing the spot values of fluoride is given in Figure 18(pre-monsoon,2018). Only at two locations one each falling in Kishanganj and Anta block has been found having fluoride concertation beyond acceptable limit i.e. 1.00mg/l of Drinking Water Standard-IS 10500:2012.

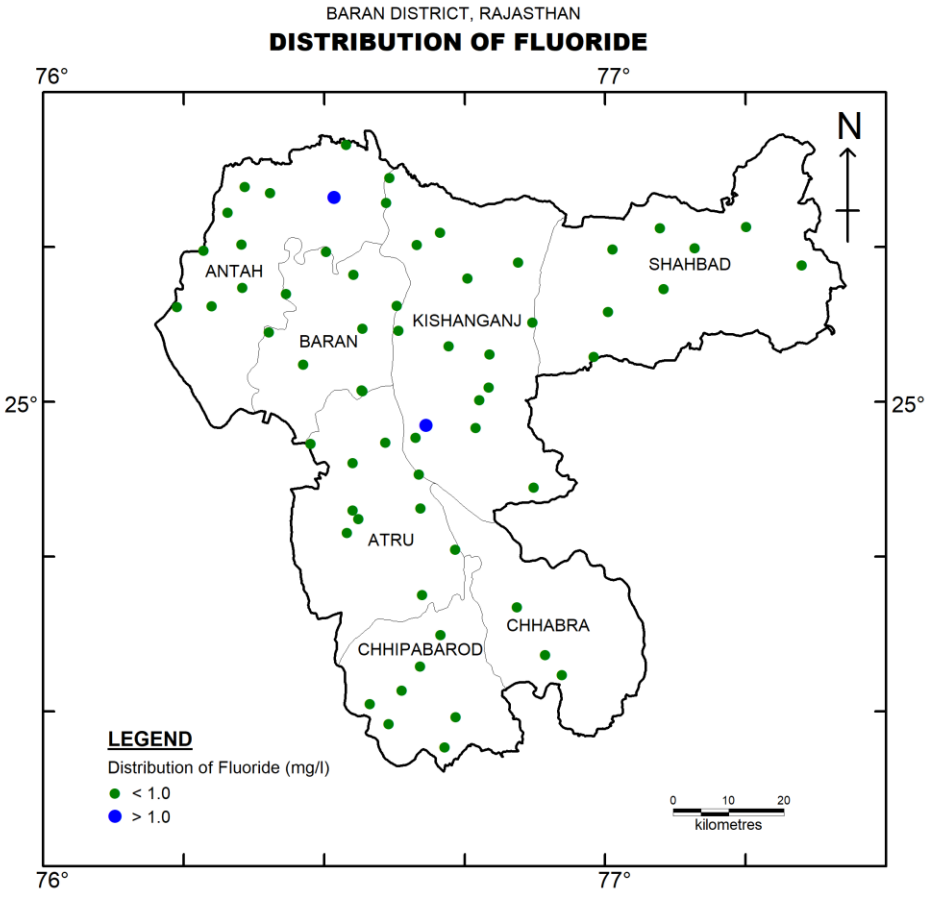


Figure 18 : Distribution of fluoride in ground water (pre -monsoon,2018), Baran District

3.3 Nitrate

Nitrate concentration in ground water ranges from 0 to 510mg/l maximum at Jalwada, Bl.ock Kishangang. Study of analytical data indicates that 67% of samples has nitrate concentration within acceptable limit i.e. 45ppm of Drinking Water Standard (IS 10500:2012). There is no relaxation under permissible limit of standards, 33% of ground water samples exhibit nitrate concentration beyond acceptable limit (scattered in the district) indicating high nitrate hazards in ground water which may be due to the seepage from sewerages into the ground water in the areas having shallow ground water. A map has been prepared using the data of pre-monsoon, 2018 and is depicted with spot value in Figure 19.

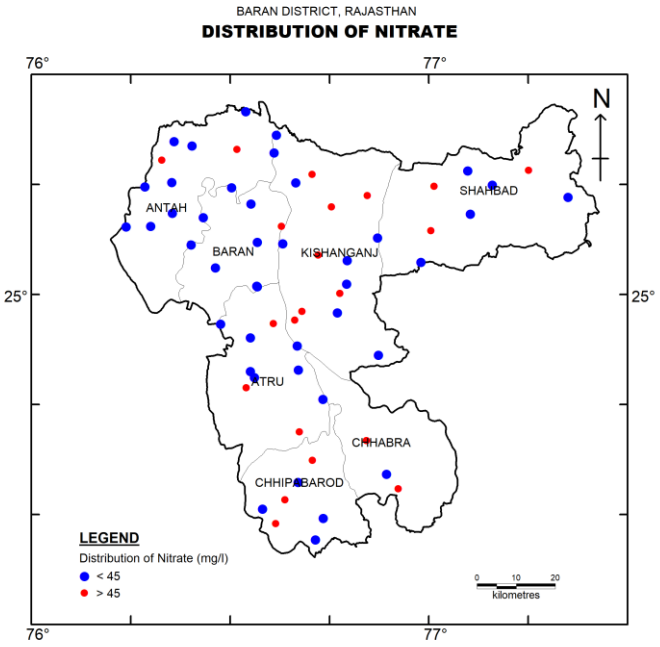


Figure 19 : Distribution of nitrate in ground water (pre -monsoon,2018), Baran District

3.4 Iron

Iron concentration in ground water ranges from 0 to 1.2mg/l maximum at Mangrol, Block Baran.

Study of analytical data indicates that 98% of samples has iron concentration within acceptable limit i.e. 1.0mg/l of Drinking Water Standard (IS 10500:2012). There is no relaxation under permissible limit of standards. 2% of ground water samples exhibit iron concentration beyond acceptable limit and is noticed at Bargaon, Block Anta(1.8mg/l). A map has been prepared using the data of pre-monsoon, 2018 and is depicted with spot value in Figure 20.

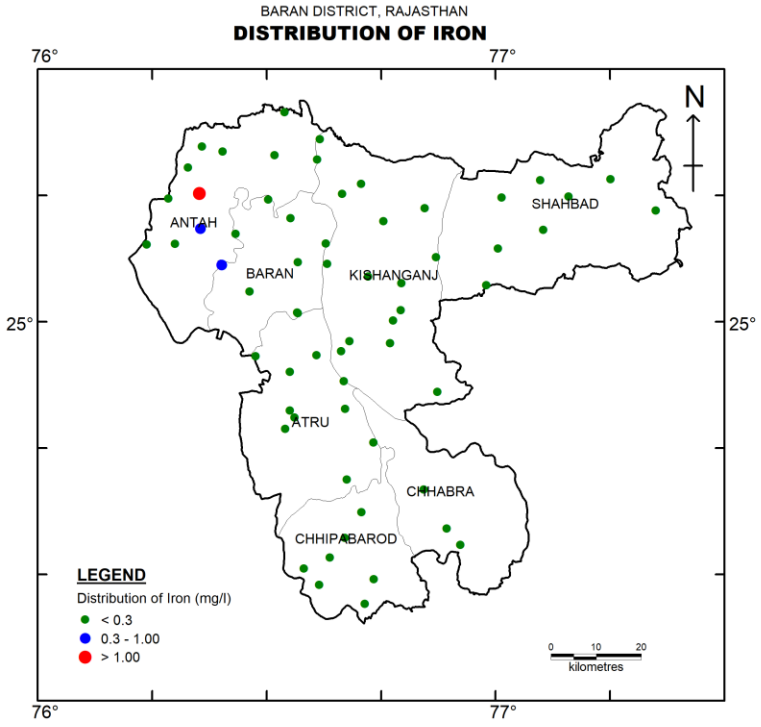


Figure 20 : Distribution of Iron in ground water (pre -monsoon,2018), Baran District

Changes in ground water quality during post monsoon, 2018

During post monsoon, 2018,ground water sampling was repeated for 18 wells which were inventoried during premonsoon,2018. The comparative study of analytical data of samples during pre and post monsoon is give in Table 19 . The perusal of comparative tabular data indicates that concentration of EC, nitrate and fluoride have been reduced significantly during the post-monsoon where as concentration of total hardness is variable

Table19 : Comparative analytical data of ground water during pre and post monsoon,2018

Sl. No.	Location	Block	Chemical constituents(mg/l)								
			EC		Nitrate		TH		Fluoride		
			Pre	Post	Pre	Post	Pre	Post	Pre	Post	
1	Mangrol	Baran	3310	3000	140	27	1000	1280	1.2	0.5	
2	Udpuria	Anta	3510	2480	350	3	1600	1000	0.85	0.50	
3	Batawada	Baran	7600	2485	0	105	330	1000	0.48	0.10	
4	Rampura	Kisjanganj	790	450	95	38	84	170	0.7	0.30	
5	Paraniya	Kishanganj	760	310	80	36	260	140	0.25	0.05	
6	Jalwara	Kishanganj	1540	1540	510	160	460	490	1.2	0.85	
7	Arrand	Atru	1090	840	105	40	350	300	0.5	0.05	
8	Atru	Atru	2680	1120	19	25	440	390	0.26	0.40	
9	Katawar	Atru	1630	1180	95	100	600	580	0.18	0.25	
10	Ajnawar	Chhipabarod	970	860	52	80	350	400	0.4	0.3	
11	Chhipabarod	Chhipabarod	1610	1210	75	100	520	350	0.68	0.55	
12	Kalpa	Chhipabarod	880	680	75	60	480	210	0.2	0.05	
13	Sarthal	Chhipavarod	980	860	55	72	370	390	0.25	0.6	
14	Arnawada	Chhipabarod	2910	2550	0	1	1200	1000	0.7	0.7	
15	Chhabra	Chhabra	1040	1240	55	140	400	430	0.45	0.3	
16	Hinglot	Chhaabra	1650	760	506	4	400	280	0.35	0.04	
17	Deori	Shahabad	1040	790	65	65	400	300	0.05	0.1	

3.5 Distribution of heavy elements in ground water

14 ground water samples were collected to study the concentration of heavy elements viz. Copper, Zinc, Nickle, Manganese, Cadmium and Lead in ground water. The analytical results are presented in Table 20. The perusal of tabular data indicates that heavy metal concentration of Cu, Zc, Ni, Mn and Cd in ground water has been found with in permissible limit of BIS Drinking water Standards(IS 10500:2012) in all the samples except Lead, where 3 samples out of 14 have lead concentration more than permissible limit of Drinking Water Standards.

Table20: Analytical data of heavy elements in ground water, Baran District(Pre-monsoon,2018)

Sl. No.	Location	Block	Aquifer	Date of collection	Heavy Metals(ppm)					
					Cu	Zn	Ni	Mn	Cd	Pb
1	Palaita	Anta	Lst	18.7.18	0.0214	0.1092	0.0083	0.0056	0.0000	0.0019
2	Mangrol	Baran	Lst	19.7.18	0.0683	0.2343	0.0133	0.0208	0.0000	0.0122
3	Garara	Kishanganj	Sst	20.7.18	0.0247	0.3560	0.0171	0.1381	0.0010	0.0087
4	Nahargarh	Kishanganj	Sst	26.7.18	0.0280	0.2990	0.0083	0.0056	0.0017	0.0053
5	Jalwara	Kishanganj	Sst	26.7.18	0.0015	0.0032	0.0033	0.0000	0.0005	BDL
6	Arrand	Atru	Lst	23.7.18	0.0258	0.0176	0.0058	0.0038	0.0017	0.0053
7	Amli	Atru	Lst	25.7.18	0.0258	0.5091	0.0021	0.0161	0.0014	0.0122
8	Kharkhara	Atru	Sst	25.7.18	0.1301	7.2680	0.0058	0.0261	0.0021	0.0336
9	Chhipabarod	Chipabarod	Basalt	26.7.18	BDL	0.0050	0.0083	0.0005	0.0017	0.0019
10	Harnawada	Chipabarod	Basalt	26.7.18	0.0126	0.0052	0.0133	0.1322	0.0020	0.0019
11	Hinglot	Chhabra	Basalt	26.7.18	BDL	0.4713	0.0058	0.0005	0.0005	BDL
12	Khandela	Kishanganj	Sst	25.7.18	0.0501	3.5800	0.0095	0.1216	0.0014	0.0087
13	Rajpur	Shahbad	Sst	27.7.18	0.0477	0.0281	0.0099	0.0355	0.0002	0.0092
14	Thana Kasba	Shahbad	Shale	27.7.18	0.0319	0.0636	0.0099	0.0020	0.0005	0.0092
	Acceptable limit as per BIS Drinking Water Standards (IS 10500:2012)				**0.05**	**5**	**0.02**	**0.1**	**0.003**	**0.01**
	Permissible limit in the absence of alternate source as per BIS Drinking Water Standards (IS 10500:2012)				**1.5**	**15**	**No Relaxation**	**0.3**	**No Relaxation**	**No Relaxation**

4. Ground Water Resources

The Groundwater resources have been reassessed as on 31.3.2017 based on the methodology recommended by Groundwater Estimation Committee (2015). The block wise resources for Baran district are given in Table 21. Out of seven blocks, 4 blocks categorized under over exploited and 3 blocks under semi critical. Groundwater resource estimation data of Baran district shows that net groundwater availability of the district is 4883441 Ham whereas ground water draft for all uses is 5797013 Ham. The stage of groundwater development is 118.71%.

Table21 : Ground water resource, Baran District (as on 31.03.2017)

Block	Area of Block	Type of area	Water Bearing Formation	Potential Zone Area	Total Annual Ground Water Recharge	Estimated Base Flow Restricted to ecological Flow Or 5-10% of Annual Ground Water Recharge	Annual Extractable Ground Water Resource [(7) - (8)]	Current annual gross ground water extraction for 'Irrigation'	Current annual Gross Ground Water extraction for Dom.& Industrial Use	Current annual gross ground water extraction for 'All Uses'	Annual ground water allocation for domestic water supply as on 2025.	Net annual ground water availability for 'Future Use'	Stage of ground water Extraction as a percentage	Quantity Categorisation for future ground water development (Safe/ Semi-Critical/ Critical/ Over exploited)
	(ha.m)			(ha)	(ha.m)	(ha.m)	(ha.m)	(ha.m)	(ha.m)	(ha.m)	(ha.m)	(ha.m)	(%)	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	17
Anta	94901	Command	Ls1	54034.00	8346.14	834.61	7511.53	3613.43	738.03	4351.46	1107.05	2791.06	57.93	
		Non-com.	Ls2	28866.00	2060.14	206.01	1854.13	3031.84	359.38	3391.22	628.92	0.00	182.90	
		Non-com.	Ss	12000.00	540.86	54.09	486.77	532.80	157.72	690.52	236.58	0.00	141.86	
		Block total		**94900.00**	**10947.14**	**1094.71**	**9852.43**	**7178.07**	**1255.13**	**8433.20**	**1972.54**	**2791.06**	**85.60**	**Semicritical**
Atru		Command	Ss1	6173.00	1025.89	102.59	923.30	985.43	109.36	1094.79	164.04	-226.17	118.57	
	86003	Non-com.	Ss2	64481.00	3015.99	301.60	2714.39	3668.16	549.22	4217.38	1373.05	-2326.82	155.37	
		Non-com.	Ls	13993.00	1210.55	121.06	1089.49	1914.50	197.39	2111.89	345.43	-1170.44	193.84	
		Block total		**84647.00**	**5252.43**	**525.25**	**4727.18**	**6568.09**	**855.97**	**7424.06**	**1882.52**	**0.00**	**157.05**	**Over Explo.**
Baran	62621	Command	Ls1	12550.00	2431.54	243.15	2188.39	1896.12	234.34	2130.46	351.51	-59.24	97.35	
		Non-com.	Ls2	38060.00	3406.67	340.67	3066.00	7032.60	541.08	7573.68	946.89	-4913.49	247.02	
		Non-com.	Ss	12011.00	498.86	49.89	448.97	916.32	258.13	1174.45	451.73	-919.08	261.59	
		Block total		**62621.00**	**6337.07**	**633.71**	**5703.36**	**9845.04**	**1033.55**	**10878.59**	**1750.13**	**0.00**	**190.74**	**Over Explo.**
Chhabra	79079	Non-com.	Ss	27497.00	2269.41	226.94	2042.47	3419.64	300.21	3719.85	525.37	-1902.54	182.13	
		Non-com.	B	49840.00	3984.78	398.48	3586.30	3039.72	343.28	3383.00	514.92	31.66	94.33	
		Block total		**77337.00**	**6254.19**	**625.42**	**5628.77**	**6459.36**	**643.49**	**7102.85**	**1040.29**	**0.00**	**126.19**	**Over Explo.**
Chhipabarod	82876	Non-com.	Ss	33610.00	2831.04	283.10	2547.94	4241.28	251.05	4492.33	439.34	-2132.68	176.31	
		Non-com.	B	46840.00	3188.07	318.81	2869.26	4660.68	466.65	5127.33	816.64	-2608.06	178.70	
		Block total		**80450.00**	**6019.11**	**601.91**	**5417.20**	**8901.96**	**717.70**	**9619.66**	**1255.98**	**0.00**	**177.58**	**Over Explo.**

Kishanganj	143098	Command	Ss1	14366.00	2774.43	277.44	2496.99	799.20	124.10	923.30	217.18	1480.62	36.98	
		Non-com.	Ss2	128606.00	7833.47	783.35	7050.12	7061.40	342.55	7403.95	599.46	0.00	105.02	
		Block total		**142972.00**	**10607.90**	**1060.79**	**9547.11**	**7860.60**	**466.65**	**8327.25**	**816.64**	**1480.62**	**87.22**	**Semicritical**
Shahbad	146926	Non-com.	Ss	82580.00	5937.51	296.88	5640.63	4752.92	624.59	5377.51	1093.03	-205.32	95.34	
		Non-com.	Sh	63714.00	2575.26	257.53	2317.73	649.32	157.69	807.01	275.96	1392.45	34.82	
		Block total		**146294.00**	**8512.77**	**554.41**	**7958.36**	**5402.24**	**782.28**	**6184.52**	**1368.99**	**1187.13**	**77.71**	**Semicritical**
	Total	**Command**		87123.00	14578.00	1457.79	13120.21	7294.18	1205.83	8500.01	1839.77	4271.67	64.79	
	Total	**Non-Command**		260013.00	39352.61	3638.41	35714.20	44921.18	4548.94	49470.12	8247.31	1187.13	138.52	
	Grand Total			**347136.00**	**53930.61**	**5096.20**	**48834.41**	**52215.36**	**5754.77**	**57970.13**	**10087.08**	**5458.80**	**118.71**	

Groundwater Recharge

The total groundwater recharge during monsoon and non monsoon season through rainfall and other sources in Baran district is 53930.61 Ham. Considering the natural discharges @ 10%, the Net groundwater Availability comes out to the value of 48834.41Ham

Groundwater Abstraction

The groundwater development in the district is being done through dug wells and bore wells. Dug wells with horizontal boring are very common. The diameter of dug well varies from 3 m to 5 m. The depth and diameter of the dug wells and tube wells depend on formation and geomorphology. However, general depth of dug wells ranges from 25 to 30 m and bore wells between 80 to 100 m in hard rocks. The present stage of ground water development in the district is 118.71%, which indicates that the scope of groundwater development is in semi critical blocks Anta, Kishanganj and Shahbad . The year wise comparison of net ground water availability with gross ground water is shown in Figure 21. It shows that gross draft has significantly increased over time from 2011 to 2017 due to over usage of ground water resources for agricultural, domestic and industrial uses.

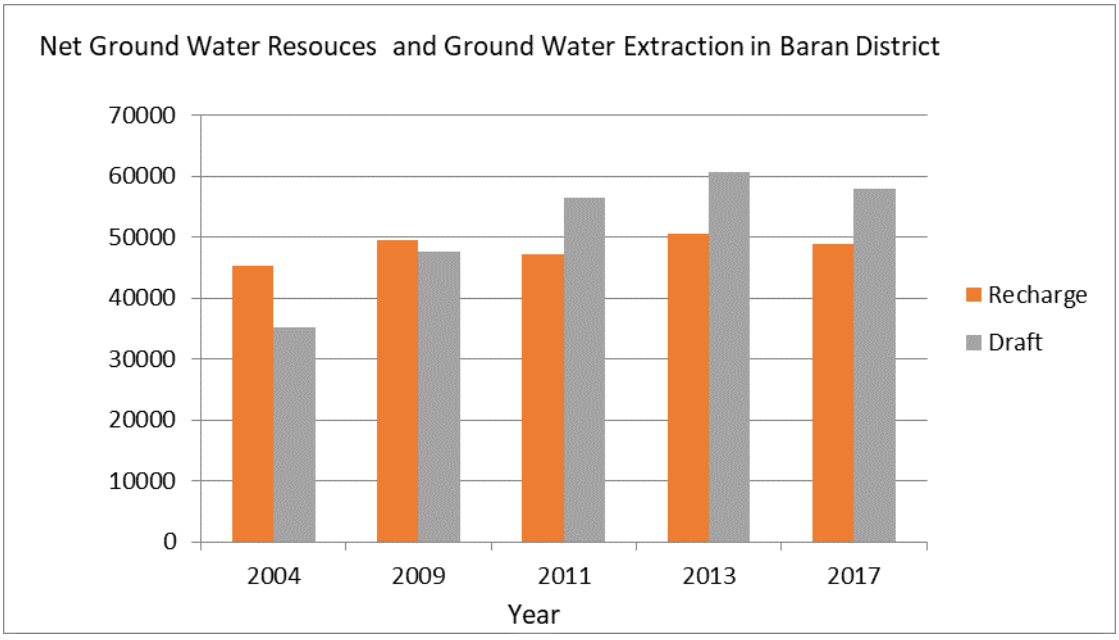


Figure 21 : Status of ground water development. Baran District

5.0 Groundwater related issues

The following ground water related issues have been emerged:

5.1 Decline in water level

Long term water level data (pre-monsoon, 2008-17) have indicated marginal declining ground water level trend ranging from 0.0049 to 0.2845m/year in areas falling in Atru, Baran, Chhabra and Chhipabarod blocks. It has resulted due to the over draft of ground water resources for various uses than its annual recharge. All the blocks are over exploited having stage of ground water development ranging from 126.19% (minimum in Chhabra Block) to 190.74% (maximum in Baran Block).

5.2 Ground Water Salinity

Ground water salinity with EC more than 3000µs/cm at 25ºC has been found at Mangrol, Baran block(3310 ms/cm at 25^0C), Udpuria, Anta block(3510 ms/cm at 25^0C),Batawada, Baran block(7600 ms/cm at 25^0C) and at Baran, Baran block(4410 ms/cm at 25^0C).

5.3 Nitrate hazards

33% of ground water samples exhibit nitrate concentration beyond acceptable limit (scattered in the district) indicating high nitrate hazards in ground water which may be due to the seepage from sewerages into the ground water in the areas having shallow ground water.

6.0 Management Strategies

Out of 7 blocks, four blocks viz. Atru, Baran,Chhabra and Chhipabarod fall under over-exploited and remaining three blocks i.e. Anta, Kishanganj and Shahabad under semi-critical. Over exploited blocks, thereby, leaving no/limited scope of further ground water development for various consumptions. In order to manage the ground water resources and to control further decline in water levels, a management plan has been proposed. In order to manage the ground water resources and to control further decline in water levels, a management plan has been proposed. The management plan comprises two components- supply side management and demand side management.

6.1 Supply Side Management

The supply side management of ground water resources can be done through the artificial recharge of surplus runoff available within river sub basins and micro watersheds. Also it is necessary to understand the unsaturated aquifer volume available for recharge. The unsaturated volume of aquifer for the Baran district (exclusive for over exploited blocks i.e. Atru, Baran, Chhabra and Chhipabarod blocks) is computed based on following; the area feasible for recharge, unsaturated depth below 5 m bgl and the specific yield of the aquifer.

6.1.1 Artificial recharge to ground water through interventions of various structures

The following parameters are inevitable for planning of artificial recharge to ground water.

- *Availability of sufficient storage space to accommodate recharged water*
- *Availability of surplus water to recharge*
- *Feasibility of sub-surface geological formations*

As per the studies carried out by Water Resources Department(WRD), Govt. of Rajasthan, ,there is surplus water available for further development at 75 % dependability. Based on the data made available from Ground Wtaer Departm,ent(GWD, Govt. of Rajasthan, surplus run off available at 75% dependability level has ben worked out for the zones as part of water shed with in the block. Total surplus water in respect of four OE blocks has been computed to the tune of 907.88 mcm including 391.22mcm for Atru block,102.95mcm for Baran block, 154.34mcm for Chhaabra block and 259.37 for Chhipabarod block.

In case of Baran district, there is limitation of sub-surface storage and topography to accommodate the recharged water. Volume of sub-surface storage space calculated for artificial recharge is 193.5226 mcm, details of the same given in Table22.

Table 22: Computation of volume of aquifer available for artificial recharge, Baran District

Block	Geographical area of Block (Sq.km.)	Potential zone area (Sq.km.)	Type of Aquifer	Average DTW (mbgl) Post monsoon 2016	Thickness of unsaturated zone 3 m below ground level (m)	Sp Yield (%)	Volume of sub surface storage space (50% of unsaturated thickness) available for artificial recharge (MCM)	Volume of water required for recharge (MCM)
Atru	860.00	846.47	Hard rock	12.44	9.44	0.017	67.92	95.09
Baran	626.21	626.21	Hard rock	13.84	10.84	0.032	108.6099	217.2198
Chhabra	790.79	773.37	Hard rock	4.13	1.13	0.015	6.5543	9.1760
Chhipabarod	828.76	804.5	Hard rock	4.73	1.73	0.015	10.4384	14.6137
	Grand Total						193.5226	336.0995
Note: Computed for OE blocks only								

Total amount of water required to recharge the available sub-surface storage of 336.0995mcm.

Details of feasible recharge structures to recharge the surplus water in respective block is given in Table 23.

Table 23: Block-wise details of feasible recharge structures and conserve recharge, Baran District

Sl. No.	Block	Category of Block	Aquifer	Surplus water available	Recharge structures constructed/proposed	Volume of water harnessed/propose to harness(mcm)	Volume of water conserve by recharge(mcm)
1	Atru	Over Exploited	Hard Rock	391.22	210(Already constructed under MJSA by State Govt.)	21.00	4.20
					68Percolation Tank(Proposed)	27.2	13.6
					94Recharge Shaft in existing mini percolation tanks(Proposed)	3.94	2.82
					Sub-Total	**52.14**	**20.62**
2	Baran	Over Exploited	Hard Rock	102.95	97(Already constructed under MJSA by State Govt.)	7.5	1.5
					11 Percolation Tank(Proposed)	4.4	2.2
					Sub-Total	**11.9**	**3.7**
3	Chhabra	Over Exploited	Hard Rock	154.34	275(Already constructed under MJSA by State Govt.)	18.9	3.8
					12Percolation Tanks(Proposed)	4.8	2.4
					34Recharge Shafts in existing mini percolation tanks (Proposed)	1.43	1.00
					Sub-Total	**25.13**	**7.2**
4	Chhipabarod	Over Exploited	Hard Rock	259.37	486(Already constructed under MJSA by State Govt.)	8.4	1.7
					38Percolation Tanks(Proposed)	15.2	7.6
					150Recharge Shafts in existing mini percolation tanks (Proposed)	6.3	4.5
					Sub-Total	**29.9**	**13.8**
5	**Anta**	Semi-Critical	Hard Rock	Not computed being block under semi-critical			
6	**Kishanganj**	Semi-Critical	Hard Rock	Not computed being block under semi-critical			
7	**Shahabad**	Semi-Critical	Hard Rock	Not computed being block under semi-critical			

	GRAND TOTAL	**907.88**		**119.07**	**45.32**

Note: MJSA-Mukhya Mantri Jal Swawalamban Abhiyan

6.2 Demand Side Management

Apply of techniques of demand side management can also save large amount of water. Demand side management has been proposed through two interventions – changing the more water intensive wheat crop to gram (chick pea) and use of sprinkler irrigation in the areas where rabi crop is being irrigated through ground water. Computation in respect of demand side management component (including use of sprinkler irrigation and change in cropping pattern) have been done for OE blocks only viz, Atru, Baran, Chhabra and Chhipabarod only.

6.2.1 Change in cropping pattern

In view of the alarming decline of water level, drastic reduction in saturated thickness of aquifer and resulting of depletion of aquifer, there is need to bring paradigm change/shift in cropping pattern in the area. It is proposed to grow low water requirement crop like gram in the instead of wheat. Growing of gram will save the water to the tune of about 39.47mcm per annum @ 0.1m (Table24).

6.2.2 Adoption of modern practice of sprinkler irrigation/improved irrigation practices

Data indicate that flooding method of irrigation is still in practice in many parts of the district which causes wastage of ample quantity of water. In view of this, it is proposed to bring about 50% of total irrigated area under sprinkler irrigation which may save water to the tune of about 73.24mcm/annum @0.08m (Table 24). Total cost of sprinkler sets has been computed as Rs. 434.29 crore @50,000/hectar

Table 24: Block-wise details of water saving through change in cropping pattern and irrigation practice, Baran District

Block	**Irrigated Area (ha) proposed for irrigation through sprinkler**(50% of gross irrigated area)	**Water Saving by sprinkler in mcm @0.08 m**	**Irrigated Area (ha) under wheat proposed for Gram cultivation** (50% of wheat irrigated area considered for gram)	**Water Saving by change in cropping pattern in mcm @0.1 m**	**Total water saving (mcm)**
Atru	25536	20.43	9722	9.72	30.15
Baran	26076	20.86	9983	9.98	30.84
Chhabra	21383	17.11	11192	11.19	28.3
Chhipabarod	18556	14.84	8578	8.58	23.42
Anta	Not computed as block falls under semi-critical category				
Kishanganj	Not computed as block falls under semi-critical category				
Shahabad	Not computed as block falls under semi-critical category				
Total	**91551**	**73.24**	**39475**	**39.47**	**112.71**

Growing of gram in place of wheat will not affect the economy of farmer and is explicit from the table below.

Summary of Economic Statistics of Growing of Gram instead of Wheat, Baran District

Irrigated Area (ha) under wheat proposed for Gram cultivation	**Production of wheat (ton)/ha**	**Production of gram (ton)/ha**	**Unit cost (Rs) of wheat /ton**	**Unit cost (Rs) of gram /ton**	**Market value (Rs) of wheat (ton)/ha**	**Market value (Rs) of gram (ton)/ha**
40684	5	1.5	16000	53000	80000	79500

7.0 Expected Benefit of Management Strategies

Considerable saving of ground water can be achieved if the proposed supply side and demand side management plans are implemented. With the implementation of supply side management, additional 45.32 MCM/year can be recharged. This would increase the replenishable recharge to ground water from 488.3441/year to 533.6641MCM/year.

Ample of augmentation in ground water resources can be achieved through artificial recharge as district has enough surplus surface water. However, considerable improvement in ground water situation can also be achieved with implementation of demand side management plans.

With the proposed use of sprinkler irrigation in the areas where rabi crop is being irrigated through ground water it is expected that 73.24MCM/year can be saved due to reduction in pumping and with changing the wheat crop to gram (chick pea) an additional 39.47MCM/year can be saved due to reduction of pumping. With implementation of these two interventions, a total of 112.71MCM/year can be saved. This may lead to a total reduction in ground water draft from 579.7013MCM/year to 466.9913MCM/Year and with this, the stage of ground water development may come down from 118.71 to 87.22%. These interventions may progressively lead to further improvement in ground water situation over the years.

Enhancement of ground water resources through artificial recharge, improved irrigation practices and change in cropping pattern is abridged below as under.

- The additional net ground water recharge – 45.32mcm
- **Sprinkler**
    - Area proposed under irrigation by sprinkler – 915.51 sq km (50% of gross irrigated area)
    - Net Water saving - 73.24 MCM (20% of crop water requirement)
    - Total cost for sprinklers – Rs 434.29 crore @Rs 50,000 per hectare
- **Change in cropping pattern**
    - From wheat to gram in 394.75 sq km irrigated area
    - Net water saving - 39.47 MCM
    - **TOTAL WATER SAVING : 112.71 MCM**
    - **Total Cost / Outlay: Rs. 434.29 Crores**

The overall expected benefit through the additional net ground water recharge is 48.8mcm. Block wise details of ground water recharged and saved along with expected improvement in stage of ground water development is given in Table 25. The perusal of data indicate that saving of ground water through projects may lead to decrease in the net ground water draft and may reduce the stage of ground water development from 118.71% to 87.22% after interventions.

Table 25: Summary of expected benefit of management strategies, Baran district

Block	**Net GW availability (mcm)**	**Additional recharge from RWH & conservation (mcm)**	**Total net GW availability after intervention (mcm)**	**Existing GW draft for all purpose (mcm)**	**Saving of GW through projects (mcm)**	**Net GW draft after interventions (mcm)**	**Present stage of GW development (%)**	**Projected stage of GW development (%)**
Atru	47.2718	20.62	67.8918	74.2406	30.15	44.0906	157.05	64.94
Baran	57.0336	3.7	60.7336	108.7859	30.84	77.9459	190.74	128.34
Chhabra	56.2877	7.20	63.4877	71.0285	28.3	42.7285	126.19	67.30
Chhipabarod	54.1720	13.80	67.9720	96.1966	23.42	72.7766	177.58	107.07
Anta	98.5243	-	98.5243	84.3320	-	84.3320	85.60	85.60
Kishanganj	95.4711	-	95.4711	83.2725	-	83.2725	87.22	87.22
Shahabad	79.5836	-	79.5836	61.8452	-	61.8452	77.71	77.71
Total	**488.3441**	**45.32**	**533.6641**	**579. 7013**	**112.71**	466.1913	**118.71**	**87.22**

Annexure-I

Hydrogeological data of wells inventoried , Baran District

S.No.	Location	Block	District	Source	Latitude	Longitude	Aquifer	Depth (m)
1	PALAITA	ANTA	BARAN	H/P	25°8'46.79"	76°14'16.36"	Lime Stone	50
2	ANTA (BARKHEDA)	ANTA	BARAN	H/P	25°7'59"	76°19'34"	Lime Stone	50
3	KOELA	BARAN	BARAN	H/P	25°12'15.84"	76°33'10.43"	Alluvium	50
4	BOTH	BARAN	BARAN	H/P	25°14'28.17"	76°30'13.64"	Lime Stone	50
5	MANGROL	ANTA	BARAN	D/W	25°19'44.53"	76°30'36.25"	Lime Stone	10 *
6	BAMORI KALAN	ANTA	BARAN	H/P	25°24'48.42"	76°32'22.28"	Lime Stone	50
7	MAL BAMORI	ANTA	BARAN	H/P	25°23'56.48"	56°27'47.60"	Lime Stone	50
8	SHAHPURA	ANTA	BARAN	H/P	25°20'3.13"	76°30'8.25"	Lime Stone	50
9	SISWALI	ANTA	BARAN	H/P	25°20'45.11"	76°21'34.30"	Lime Stone	50
10	UDPURIA	ANTA	BARAN	D/W	25°18'16.31"	76°19'42.58"	Lime Stone	25
11	BARGAON	ANTA	BARAN	H/P	25°15'2.74"	76°20'37.39"	Lime Stone	50
12	KACHRI	ANTA	BARAN	H/P	25°10'59.10"	76°21'18.72"	Lime Stone	50
13	BATAVDA	BARAN	BARAN	H/P	25°6'50.67"	76°23'5.33"	Lime Stone	50
14	FATEHPUR	BARAN	BARAN	H/P	25°7'1.76"	76°34'6.54"	Sand Stone	50
15	MEHRAWTA	KISHANGANJ	BARAN	H/P	25°9'27.83"	76°37'33.73"	Sand Stone	50
16	GARARA	KISHANGANJ	BARAN	H/P	25°11'54.64"	76°45'18.53"	Sand Stone	50
17	RELAWAN	KISHANGANJ	BARAN	H/P	25°15'0.33"	76°40'4.06"	Sand Stone	50
18	KARWARI KHURD	KISHANGANJ	BARAN	H/P	25°16'19.34"	76°42'23.60"	Sand Stone	50
19	RAMGARH	KISHANGANJ	BARAN	H/P	25°18'57.75"	76°36'40.43"	Sand Stone	50
20	ASHWAR	KISHANGANJ	BARAN	H/P	25°21'37.36"	76°36'59.05"	Sand Stone	50
21	THAMLI	BARAN	BARAN	H/P	25°10'23.95"	76°25'56.82"	Sand Stone	50
22	KISHANGANJ	KISHANGANJ	BARAN	D/W	25°6'22.23"	76°38'47.62"	Sand Stone	14 *

23	RAMPURA	KISHANGANJ	BARAN	H/P	25°5'20.69"	76°43'19.08"	Sand Stone	15
24	BHANWARGARH	KISHANGANJ	BARAN	D/W	25°4'34.35"	76°47'38.68"	Sand Stone	15 *
25	PARANIYA	KISHANGANJ	BARAN	H/P	25°0'5.94"	76°46'53.10"	Sand Stone	50
26	NAHARGARH	KISHANGANJ	BARAN	H/P	24°55'18.36"	76°50'35.86"	Sand Stone	50
27	DURJANPURA	KISHANGANJ	BARAN	H/P	24°51'39.46"	76°52'22.41"	Sand Stone	50
28	CHATARGANJ	KISHANGANJ	BARAN	H/P	24°57'26.65"	76°46'12.22"	Sand Stone	150
29	JALWARA	KISHANGANJ	BARAN	H/P	24°57'27.46'	76°40'56.19"	Sand Stone	20
30	BAJRANG GARH	KISHANGANJ	BARAN	H/P	24°56'28.95"	76°39'46.42"	Sand Stone	60
31	KELWADA	SHAHBAD	BARAN	T/W	25°7'47.21"	76°52'21.82"	Sand Stone	50
32	SAMARANIA	SHAHBAD	BARAN	T/W	25°8'40.44"	77°0'19.56"	Sand Stone	50
33	BARAN	BARAN	BARAN	D/W	25°6'10.91"	76°31'38.92"	Sand Stone	15*
34	BARANA	BARAN	BARAN	H/P	25°1'4.19"	76°34'2.91"	Sand Stone	50
35	ARRAND	ATRU	BARAN	T/W	24°55'59.9"	76°36'33.83"	Lime Stone	50
36	DIWALI	ATRU	BARAN	T/W	24°53'57.71"	76°33'11.13"	Sand Stone	150
37	ATRU	ATRU	BARAN	T/W	24°52'52.02"	76°39'50.44"	Sand Stone	150
38	BAMORI	ATRU	BARAN	H/P	24°49'25.96"	76°35'35.23"	Sand Stone	100
39	AMLI	ATRU	BARAN	H/P	24°48'35.56"	76°33'39.48"	Lime Stone	50
40	KARARIYA	ATRU	BARAN	H/P	24°49'26.48"	76°33'3.42"	Sand Stone	50
41	KATAWAR	ATRU	BARAN	H/P	24°47'12.95"	76°32'33.16"	Sand Stone	50
42	BADORA	ATRU	BARAN	T/W	24°45'37.74"	76°29'45.03"	Sand Stone	50
43	KHARKHARA	ATRU	BARAN	H/P	24°47'16.53"	76°36'25.69"	Sand Stone	50
44	KAWAI	ATRU	BARAN	T/W	24°45'37.97"	76°44'0.4"	Sand Stone	250
45	BARLAN	ATRU	BARAN	H/P	24°49'37.78"	76°40'19.62"	Sand Stone	65
46	AJNAWAR	CHHIPA BAROD	BARAN	T/W	24°41'13.31"	76°40'30.19"	Sand Stone	50
47	CHHIPA BAROD	CHHIPA BAROD	BARAN	H/P	24°27'20.73"	76°42'26.22"	Basalt	70
48	KALPA	CHHIPA BAROD	BARAN	H/P	24°32'2.0"	76°38'22.35"	Basalt	45
49	SARTHAL	CHHIPA BAROD	BARAN	H/P	24°28'43.99"	76°36'54.99"	Basalt	60

50	HARNAWADA	CHHIPA BAROD	BARAN	T/W	24°26'27.91"	76°42'54.13	Basalt	45
51	SRIPURA	CHHIPA BAROD	BARAN	H/P	24°29'24.09"	76°44'3.88"	Basalt	50
52	RAJPURA	CHHIPA BAROD	BARAN	T/W	24°34'19.06"	76°40'15.01"	Basalt	50
53	CHHABRA	CHHABRA	BARAN	H/P	24°40'3.46"	76°50'29.59"	Sand Stone	45
54	NANU KHERI	CHHABRA	BARAN	H/P	24°35'24.20"	76°53'35.49"	Basalt	90
55	HINGLOT	CHHABRA	BARAN	H/P	24°33'28"	76°55'24.27"	Basalt	30
56	KHANDELA	KISHANGANJ	BARAN	H/P	25°13'27.37"	76°50'42.87"	Sand Stone	90
57	SIRSOD	SHAHBAD	BARAN	T/W	25°4'39.92"	76°58'51.6"	Sand Stone	150
58	SEMLI PHATAK	SHAHBAD	BARAN	T/W	25°14'43.69"	77°0'49.25"	Sand Stone	150
59	RAJPUR	SHAHBAD	BARAN	T/W	25°16'47.19"	77°5'51.31"	Sand Stone	150
60	SHAHBAD	SHAHBAD	BARAN	H/P	25°14'5.80"	77°09.104'	Sandstone	50
61	DEORI	SHAHBAD	BARAN	H/P	25°16'39.72"	77°14'51.90"	Shale	50
62	THANA KASBA	SHAHBAD	BARAN	H/P	25°13'10.33"	77°21'1.11"	Shale	50
63	MAMONI	SHAHBAD	BARAN	H/P	25°10'51.69"	77°6'16.68"	Sand Stone	50
	Remarks: Depths of inventoried wells are reported except starred values.							

Annexure-II

Hydrogeological data of NHS_Baran

Block	Village	Type	MP	Depth	Long	Lat	Elevation	May-17	Aug-17	Nov-17	Jan-18	Mean May 17	Mean Aug 17	Mean Nov17	Mean Jan 18	Flu Mean May17	Flu Mean Aug178	Flu Mean Nov17	Flu Mean Jan 18	River Basin	Aquifer
Antah	ANTA1	Dug	0.44	8	76.3	25.158	249	7.56	0	4.54	5.1	6.21	0.00	4.16	4.12	1.35	0.00	0.38	0.98	Chambal	Limestone
Atru	ATRU1	Dug	0.81	11.12	76.661	24.888	284	3.79	1.89	1.97	5.06	8.43	0.64	3.72	4.67	-4.64	1.25	-1.75	0.39	Chambal	Sandstone
Baran	BAMLA	Dug	0.9	10.87	76.475	24.992	276	5.5	5.09	5.08	5.36	5.96	3.73	4.66	5.70	-0.46	1.36	0.42	-0.34	Chambal	Limestone
Kishanganj	Banthoni	Dug	1	150	76.7	25.083	276	10.15	3.25	3.3	10.7	7.15	3.45	5.58	4.94	3.00	-0.20	-2.28	5.76	Chambal	Sandstone
Baran	Baran		0	0	76.5	25.1	0	0	0	4.89	8.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Chambal	Sandstone
Baran	Baran2	Dug	1	150	76.517	25.1	259	10.4	0	0	0	15.13	0.00	0.00	0.00	-4.73	0.00	0.00	0.00	Chambal	Sandstone

Kishanganj	BHANWARGARH	Dug	0.76	13.7	76.794	25.091	321	2.74	4.41	4.47	1.66	3.68	0.68	2.24	1.80	-0.94	3.73	2.23	-0.14	Chambal	Sandstone
Antah	BOHAT	Dug	0.68	11	76.504	25.242	241	10.32	4.18	2.32	3.07	9.38	5.97	6.90	8.15	0.94	-1.79	-4.58	-5.08	Chambal	Limestone
Chhabra	CHABRA	Dug	0.78	15.93	76.844	24.663	330	19.82	0	0	0	12.93	0.00	0.00	0.00	6.89	0.00	0.00	0.00	Chambal	Sandstone
Chhipabarod	CHHIPABAROD1	Dug	0.92	15	76.702	24.624	334	9.38	7.41	7.51	10.13	9.83	5.08	9.25	9.90	-0.45	2.33	-1.74	0.23	Chambal	Basalt
Chhipabarod	HARNAUDA	Dug	0.58	11	76.7	24.436	330	9.02	3.13	3.2	8.12	8.08	3.05	5.54	7.44	0.94	0.08	-2.34	0.68	Chambal	Basalt
Atru	KANWAI	Dug	0.41	9	76.742	24.758	310	5.99	0	4.89	6.39	7.35	0.00	6.51	6.61	-1.36	0.00	-1.62	-0.22	Chambal	Sandstone
Shahbad	Kasba Thana	Dug	0.3	10.9	77.358	25.208	392	4.5	4.52	4.6	5.37	7.07	3.53	4.81	5.67	-2.57	0.99	-0.21	-0.30	Chambal	Shale
Shahbad	KELWARA1	Dug	0.8	5	76.9	25.133	363	3.4	2.02	2.2	3.1	3.18	0.73	2.49	3.15	0.22	1.29	-0.29	-0.05	Chambal	Sandstone
Kishanganj	KISHANGANJ1	Dug	0.89	14.5	76.633	25.108	257	10.46	1.81	1.91	11.11	9.92	1.76	6.24	9.61	0.55	0.05	-4.33	1.50	Chambal	Sandstone
Shahbad	MAMO	Dug	0.5	11	77.1	25.1	475	10.0	7.1	7.19	7.64	10.0	3.4	3.74	6.5	-	3.7	3.45	1.1	Cha	San

	NI				06	88		2	7			4	4		0	0.02	3		4	mbal	dstone
Antah	MANGROL	Dug	0.57	8.81	76.513	25.325	238	5.73	6.87	6.93	4.37	5.97	3.36	4.14	4.31	-0.24	3.51	2.79	0.06	Chambal	Limestone
Shahbad	PAJALTORI	Dug	0.5	13.2	77.263	25.263	315	8.1	7.74	7.86	8.78	10.11	2.72	4.65	6.54	-2.01	5.02	3.21	2.24	Chambal	Shale
Chhipabarod	SARTHAL	Dug	0.3	8	76.6	24.483	311	4.65	1.5	1.69	2.27	4.68	1.52	2.96	3.72	-0.03	-0.02	-1.27	-1.45	Chambal	Basalt
Shahbad	SHAHABAD1	Dug	1.07	7.3	77.133	25.25	470	4.53	3.23	3.39	3.77	5.28	2.42	3.32	4.33	-0.75	0.81	0.07	-0.56	Chambal	Sandstone
Antah	URPURIA	Dug	0.65	6.87	76.329	25.306	240	4.25	0	0	0	5.50	0.00	0.00	0.00	-1.25	0.00	0.00	0.00	Chambal	Limestone

ANNEXURE-III

Block	Location	pH*	EC*in µS/cm at 25°C	CO_3	HCO_3	Cl*	SO_4	NO_3*	PO4	TH*	Ca*	Mg	Na*	K*	F*	Fe	TDS
				mg/l													
Anta	Palaita	7.8	760	0	256	64	55	22	0	250	60	24	60	0.9	0.9	0.2	494
Anta	Anta (BARAKHEDA)	7.6	1920	0	744	92	235	20	0	440	120	34	260	1.3	0.72	0.2	1248
Baran	Koela	7.9	1330	0	464	113	102	32	0	350	80	36	150	1.1	0.73	0.1	865
Baran	Both	7.25	1125	0	549	71	50	33	0	430	120	32	92	1	0.7	0.1	731
Baran	Mangrol	7.95	3310	0	976	355	250	140	0	1000	248	92	310	2.8	1.2	0.2	2152
Anta	Bamri Kalan	8.11	2210	0	744	92	355	17	0	800	204	71	150	1.8	0.42	0.1	1437
Anta	Mal Bamori	8.05	1120	0	451	64	105	7	0	350	80	36	105	1.1	0.92	0.1	728
Anta	Shahpura	7.08	1030	0	403	57	105	20.1	0	250	84	10	132	1.2	0.9	0.1	670
Anta	Siswali	8.15	22450	0	1110	7019	675	1	0.45	3750	800	426	3560	28.7	0	0.1	14593
Anta	Udpuria	8.2	3510	0	732	659	20	350	0.14	1600	360	170	110	1.9	0.85	0.1	2282
Anta	Bargaon	8	1025	0	488	78	52	20	0.12	280	80	19	140	2.1	0.95	1.8	666
Anta	Kachri	7.14	1115	0	488	92	45	21.4	0.16	400	84	46	92	1.1	0.9	0.5	725
Baran	Batavada	8.1	7600	0	976	1631	855	0	0.42	330	80	32	1680	10.7	0.48	0.8	4940
Baran	Fatehpur	8	800	0	305	50	140	9	0	300	88	19	80	2.1	0.8	0.1	520
Kishanganj	Mehrawata	7.9	1240	0	410	177	10	54	0	440	124	32	92	1.1	0.3	0.2	806
Kishanganj	Garara	8	1690	0	366	213	170	120	0	570	120	66	140	1.7	0.14	0.2	1099
Kishanganj	Relawan	8.1	630	0	244	14	120	30	0	310	84	24	29	0.5	0.48	0.2	410
Kishanganj	Karwari Khurd	8	1150	0	366	113	45	110	0	400	104	34	92	1.1	0.52	0.1	748
Kishanganj	Ramgarh	7.8	690	0	244	57	110	40	0	370	88	36	28	0.7	0.3	0.1	449
Kishanganj	Ashwar	7.4	935	0	244	106	150	41	0	440	116	36	46	1.1	0.15	0.1	608
Baran	Thamli	7.65	1200	0	488	57	200	0	0	390	88	41	138	1	0.8	0.1	780

Kishanganj	Kishangang	7.4	795	0	293	64	105	20	0.05	400	88	44	28	1.1	0.9	0	517
Kishanganj	Rampura	7.65	790	0	244	71	62	95	0.04	380	84	41	30.1	1.9	0.7	0.1	514
Kishanganj	Bhanwargarh	7.4	895	0	354	71	35	35	0.05	370	84	39	40	1	0.4	0.1	582
Kishanganj	Paraniya	7.9	760	0	281	57	35	80	0	260	52	32	69	1.1	0.25	0.1	494
Kishanganj	Nahargarh	7.8	750	0	183	128	25	40	0.05	280	60	32	50	1	0.4	0.1	488
Kishanganj	Durjanpura	7.4	480	0	183	28	75	30	0.08	250	60	24	20	0.5	0.35	0.1	312
Kishanganj	Chatarganj	7.15	690	0	244	50	85	27	0.02	330	60	44	23	1	0	0.1	449
Kishanganj	Jalwara	7.15	1540	0	210	130	5	510	0	460	44	85	144	1.9	1.2	0.1	1001
Kishanganj	Bajranggarh	7.8	1265	0	366	128	90	65	0	310	116	5	148	1.1	0.72	0.1	822
Shahbad	kelwada	8	620	0	317	28	40	30	0	320	80	29	23	1	0.12	0.1	403
Shahbad	Samarania	7.95	810	0	256	78	48	95	0	320	84	27	60	1.1	0.15	0	527
Baran	Baran	7.9	4410	0	622	1241	10	36	0.42	800	84	143	690	2.4	0.3	0.3	2867
Baran	Barana	8	990	0	366	78	80	39	0.13	390	124	19	62	1.1	0.1	0.1	644
Atru	Aprand	8.1	1090	0	354	85	52	105	0	350	124	10	92	1	0.5	0.1	709
Atru	Diwali	8.12	910	0	366	71	58	21	0	330	80	32	69	1	0.55	0.1	592
Atru	ATRU	7.4	2680	0	708	468	175	19	0.01	440	120	34	460	1.9	0.26	0.1	1742
Atru	Bamori	7.1	810	0	268	43	95	38	0.12	280	84	17	60	1	0.15	0.1	527
Atru	Amli	7.9	510	0	244	28	40	8.8	0.05	200	44	22	42	0.7	0.15	0.1	332
Atru	Karariya	8.1	780	0	329	43	37	30	0.02	200	52	17	90	1.1	0.88	0.1	507
Atru	Katawar	8.2	1630	0	525	184	47	95	0	600	160	49	100	1	0.18	0.1	1060
Atru	Badora	8.11	860	0	365	78	15	20	0	300	80	24	65	1.1	0.42	0.1	559
Atru	Kharkhara	8.1	840	0	342	64	60	40	0	380	80	44	40.3	1	0.15	0.1	546
Atru	kawai	8	1510	0	390	220	130	11.1	0	500	124	46	126	1.1	0.4	0.1	982
Atru	Barlan	7.9	2330	0	732	213	225	34	0	380	88	39	360	1.9	0.31	0.1	1515
Chipabarod	Ajnwar	8	970	0	366	64	65	52	0	350	80	36	69	1.1	0.4	0.1	631
Chipabarod	Chhipa barod	8.1	1610	0	610	163	50	75	0	520	160	29	150	1.3	0.68	0.1	1047
Chipabarod	Kalpa	7.45	880	0	256	128	66	75	0	480	120	44	20.1	0.5	0.2	0.1	572
Chipabarod	SARTHAL	8.1	980	0	354	85	62	55	0	370	80	41	69.2	1.3	0.25	0.1	637
Chipabarod	Harnawada	8.11	2910	0	634	248	580	0	0.15	1200	280	122	126	2.4	0.7	0.1	1892
Chipabarod	Sripura	7.1	650	0	256	28	115	24	0.02	350	116	15	20.2	0.5	0.25	0.1	423

Chipabarod	RAAJPURA	7.2	690	0	256	64	45	34	0	330	84	29	22	0.4	0.3	0.1	449
Chhabra	Chhbra	7.4	1040	0	268	85	150	55	0	400	120	24	65	1.1	0.45	0.1	676
Chhabra	Nanu Kheri	7.45	710	0	159	128	55	18	0	300	80	24	38	1	0.1	0.1	462
Chhabra	Hinglot	7.1	1650	0	134	78	195	506	0.12	400	112	29	200	1.3	0.35	0	1073
Kishanganj	Khandela	7.85	860	0	244	21	125	140	0	340	84	32	63	1	0.28	0.1	559
Shahbad	Sirsod	7.1	480	0	183	35	68	20	0	240	44	32	23	0.8	0.11	0	312
Shahbad	Semli Phatak	7.8	510	0	207	35	20	55	0	200	44	22	40.2	0.6	0.25	0	332
Shahbad	Rajpur	7.9	580	0	146	78	40	19	0	200	48	19	40.3	0.5	0.15	0	377
Shahbad	Shabad	7.9	920	0	390	21	140	0	0	350	84	34	69	1.1	0.4	0	598
Shahbad	Deori	7.4	1040	0	134	113	207	65	0	400	88	44	65	1	0.05	0.1	676
Shahbad	Thana Kasba	7.54	780	0	244	78	92	0	0	170	40	17	110	1.2	0.29	0.1	507
Shahbad	Manmoni	7.85	500	0	244	28	35	17.2	0	230	84	5	28	1	0.38	0.1	325

Annexure –IV

ANALYTICAL DATA OF GROUND WATER SAMPLES COLLECTED DURING POST MONSOON,2018, BARAN DISTRICT

Block	Location	Depth in mt	Aquifer	pH*	EC*in µS/cm at 25°C	CO_3	HCO_3	Cl*	SO_4	NO_3*	F*	PO_4	TH*	Ca*	Mg	Na*	K*	Fe	TDS
						<----------mg/l---------->													
Antah	Mangrol-1 D/W	10	DW	8.00	3000	Nil	488	567	345	27	0.50	0.15	1280	320	117	140	2	NSS	1950
Antah	Mangrol -2H/P	15	HP	8.00	1610	Nil	488	135	205	70	0.70	0.10	300	80	24	260	1	NSS	1047
Antah	Siswali-1 hp	50	HP	7.95	11230	Nil	732	3191	1385	7	0.10	0.52	2060	600	136	2050	27	NSS	7300
Antah	Siswali-2hp	50	HP	7.98	1820	Nil	488	227	280	24	0.45	0.12	470	120	41	260	1	NSS	1183
Antah	Udaipuria-1 dw	12	DW	8.00	2480	Nil	366	553	250	3	0.50	0.11	1000	280	73	160	1	NSS	1612
Antah	Udaipuria-2 DW	12	DW	8.10	950	Nil	244	99	185	36	0.52	0.23	370	80	41	90	1	NSS	618
Antah	Batavda-1 HP	50	HP	8.00	2485	Nil	366	567	155	105	0.10	0.11	1000	240	97	160	1	NSS	1615
Antah	Batavda-2 TW	75	TW	7.95	1300	Nil	244	142	285	115	0.42	0.05	400	120	24	180	1	NSS	845
Kishangang	Rampura-1 HP	15	HP	7.80	450	Nil	122	21	120	38	0.30	0.02	170	40	17	56	1	NSS	293
Kishangang	Rampura-2 TW	180	TW	7.90	660	Nil	122	85	115	23	0.20	0.03	250	60	24	50	1	NSS	429
Shahbad	Deori-1 HP	50	HP	7.60	790	Nil	122	121	122	65	0.10	0.05	300	80	19	80	1	NSS	514
Shahbad	Deori-2 HP	50	HP	7.80	570	Nil	183	50	175	24	0.05	0.03	250	44	34	80	1	NSS	371
Chipabarod	Ajnawar-1TW	50	TW	7.90	860	Nil	195	85	155	80	0.30	0.02	400	80	49	50	1	NSS	559
Chipabarod	Ajnawar-2 TW	50	TW	8.00	740	Nil	195	71	142	44	0.35	0.20	250	60	24	90	1	NSS	481
Chipabarod	Chipabarod-1 HP	70	HP	8.02	1210	Nil	275	156	165	100	0.55	0.02	350	100	24	160	1	NSS	787
Chipabarod	Chipabarod-2 HP	75	HP	8.00	1480	Nil	281	184	260	90	0.10	0.03	470	120	41	168	1	NSS	962
Chipabarod	Kalpa-1 HP	45	HP	8.00	680	Nil	195	50	80	60	0.05	0.05	210	48	24	68	1	NSS	442
Chipabarod	Kalpa-2HP	45	HP	7.95	1040	Nil	244	71	220	34	0.05	0.02	460	100	51	45	0	NSS	676
Chipabarod	Sarthal-1HP	60	HP	7.80	860	Nil	195	85	120	72	0.60	0.02	390	80	46	35	1	NSS	559
Chipabarod	Sarthal-2 TW	75	TW	7.60	320	Nil	122	21	85	4	0.25	0.10	160	40	15	30	1	NSS	208

Chipabarod	Harnavda-1 TW	45	TW	7.65	2550	Nil	610	284	402	1	0.70	0.10	1000	240	97	150	1	NSS	1658
Chipabarod	Harnavda-2 DW	40	DW	7.45	510	Nil	122	35	150	21	0.10	0.20	270	60	29	25	1	NSS	332
Chhabra	Chhabra-1 HP	45	HP	7.50	1240	Nil	183	177	135	140	0.30	0.06	430	120	32	105	1	NSS	806
Chhabra	Chhabra-2 TW	60	TW	7.60	750	Nil	183	78	110	34	0.05	0.05	350	80	36	25	1	NSS	488
Chhabra	Hinglot-1 HP	30	HP	7.80	760	Nil	171	113	85	4	0.04	0.02	280	60	32	52	1	NSS	494
Chhabra	Hinglot-2 TW	130	TW	7.90	660	Nil	183	71	102	9	0.02	0.05	270	60	29	45	1	NSS	429
Atru	Katawar-1 HP	50	HP	7.88	830	Nil	207	50	150	55	0.45	0.06	300	80	19	75	1	NSS	540
Atru	Katawar-2HP	50	HP	7.45	1180	Nil	299	78	190	100	0.25	0.20	580	160	44	25	1	NSS	767
Atru	Atru-1 TW	150	TW	7.65	1120	Nil	244	206	95	25	0.40	0.09	390	80	46	102	1	NSS	728
Atru	Arrand-1 TW	150	TW	7.45	840	Nil	281	50	110	40	0.05	0.05	300	80	24	69	1	NSS	546
Kishangang	Jalwara-1 HP	20	HP	7.60	1540	Nil	244	184	215	160	0.85	0.05	490	120	46	150	1	NSS	1001
Kishangang	Paraniya-1 TW	50	TW	7.96	310	Nil	122	21	20	36	0.05	0.02	140	36	12	20	1	NSS	202