केन्द्रीय 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

Sheikhpura District
Bihar

मध्य पूर्वी क्षेत्र, पटना

Mid Eastern Region, Patna

जल शक्ति मंत्रालय
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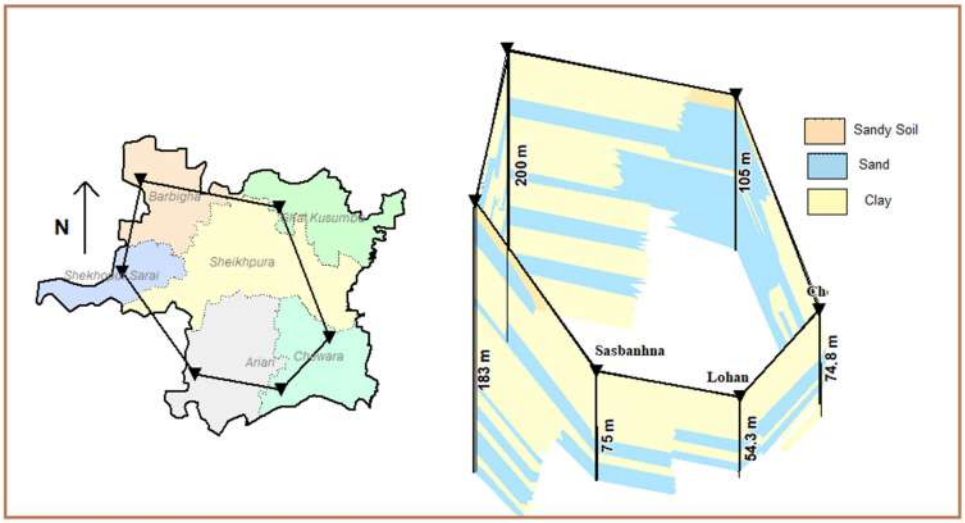
Aquifer Maps and Ground Water Management Plan of Sheikhpura district, Bihar

जलभृत नक्शे तथा भूजल प्रबंधन योजना शेखपुरा जिला, बिहार



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जुलाई 2022

Mid – Eastern Region, Patna

July 2022

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ACKNOWLEDGEMENT

I would like to thank CGWB for providing an opportunity for being part of the prestigious National Aquifer Mapping Program.

I express my sincere gratitude and thanks to Sh. A K Agrawal, Ex Regional Director, CGWB, MER, Patna, and Sh. T.B.N. Singh present Regional Director, CGWB, MER, Patna for their valuable guidance and advices throughout the period. I express my sincere gratitude to Dr Sudhanshu Shekhar, Scientist-D, & Nodal Officer (NAQUIM) and Dr. Indranil Roy, Sc. C & Nodal Officer (NAQUIM) for their valuable guidance and advice, untiring efforts, constant inspiration and suggestions throughout the period for field studies and preparation of this report.

I express my sincere thanks Sh. Sudama Upadhyay Sc B, Sh. Suresh Kumar, Asst. Chemist for their valuable and essential inputs.

I express my sincere thanks to Sh. S S Purty, Sc. B, Sh Pankaj Kumar Sc B, Sh. C K Gogoi, Sc. B, Sh Aneesh Kr V Sc B, for their valuable suggestions.

I express my thanks to Miss Arya Mishra, Young professional, for her assistance during preparation of the report.

Last but not the least, I am very much thankful to my entire colleagues for their help and support.

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CHAPTER- 1

Introduction

The vagaries of rainfall, inherent heterogeneity, over exploitation of once copious aquifers, lack of regulation mechanism etc. has a detrimental effect on ground water scenario of the Country in last decade or so. Thus, prompting the paradigm shift from "Traditional Groundwater Development concept" to "Modern Groundwater Management concept". Varied and diverse hydrogeological settings demand precise and comprehensive mapping of aquifers down to the optimum possible depth at appropriate scale to arrive at the robust and implementable ground water management plans. This leads to concept of Aquifer Mapping and Ground Water Management Plan. Aquifer mapping is a process wherein a combination of geologic, geophysical, hydrologic and chemical analyses is applied to characterize the quantity, quality and sustainability of ground water in aquifers. The proposed management plans will provide the "Road Map" for ensuring sustainable management and equitable distribution of ground water resources, thereby primarily improving drinking water security and irrigation coverage. Thus the crux of NAQUIM is not merely mapping, but reaching the goal-that of ground water management through community participation.

During XII five year plan (2012-17) National Aquifer Mapping (NAQUIM) study was initiated by CGWB to carry out detailed hydrogeological investigation. The Aquifer Mapping programme has been continued till 2023 to cover whole country. The present studies of Sheikhpurs district, Bihar have been taken up in AAP 2019-20 as a part of NAQUIM Programme. The aquifer maps and management plans will be shared with the administration of Sheikhpura district and other user agencies for its effective implementation.

1.1 Objective and Scope

The major objectives of aquifer mapping are

- Delineation of lateral and vertical disposition of aquifers and their characterization
- Quantification of ground water availability and assessment of its quality to formulate aquifer management plans to facilitate sustainable management of ground water resources at

appropriate scales through participatory management approach with active involvement of stakeholders.

The groundwater management plan includes Ground Water recharge, conservation, harvesting, development options and other protocols of managing groundwater. These protocols will be the real derivatives of the aquifer mapping exercise and will find a place in the output i.e, the aquifer map and management plan.

The main activities under NAQUIM are as follows:

a). Identifying the aquifer geometry

b). Aquifer characteristics and their yield potential

c). Quality of water occurring at various depths

d). Aquifer wise assessment of ground water resources

e). Preparation of aquifer maps and

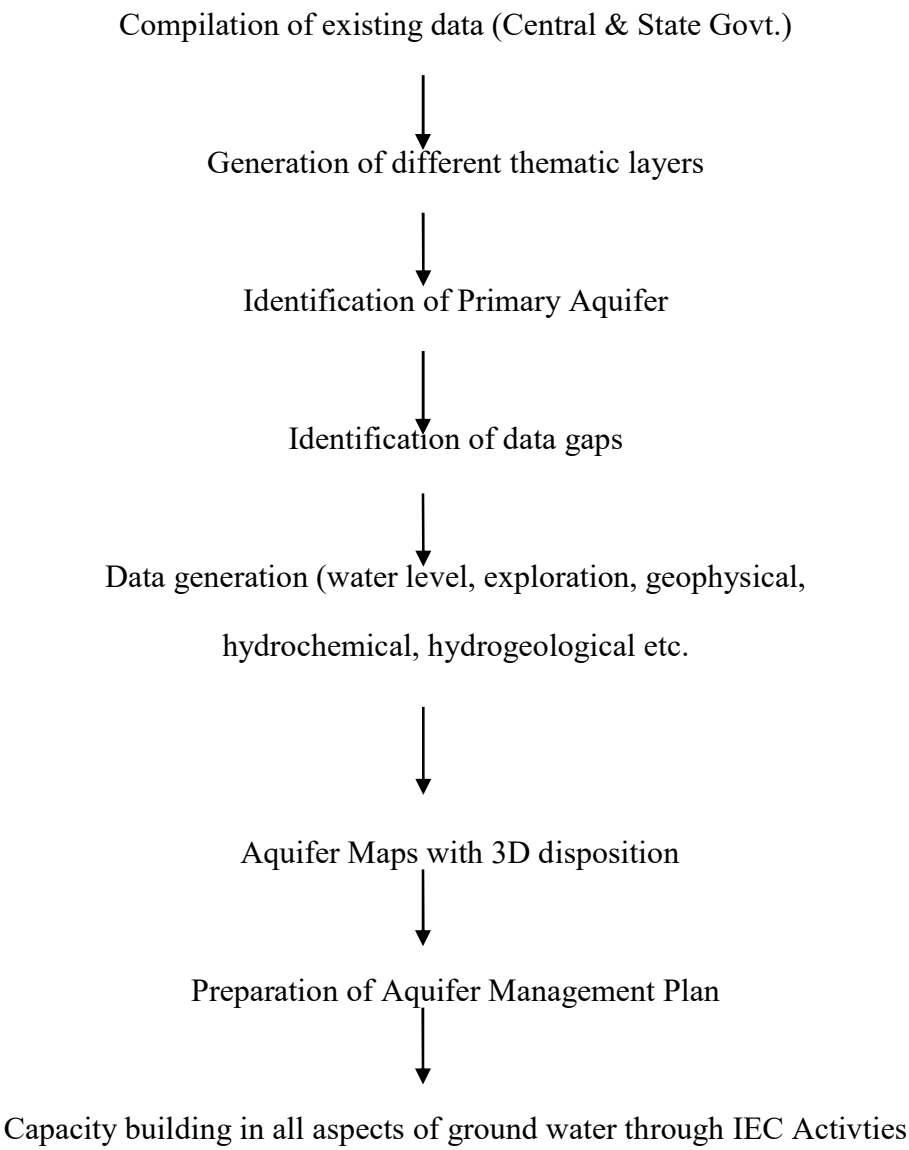
f). Formulate ground water management plan.

The demarcation of aquifers and their potential will help the agencies involved in water supply in ascertaining, how much volume of water is under their control. The robust and implementable ground water management plan will provide a "Road Map" to systematically manage the ground water resources for equitable distribution across the spectrum.

1.2 Approach and methodology

The ongoing activities of NAQUIM include hydrogeological data acquisition supported by geophysical and hydro-chemical investigations supplemented with ground water exploration down to the depths of 200 meters in hard rocks and 300m in soft rock

Considering the objectives of the NAQUIM, the data on various components was segregated, collected and brought on GIS platform by geo-referencing the available information for its utilization for preparation of various thematic maps. The approach and methodology followed for Aquifer mapping is as given below:



1.3 Area Detalis

Sheikhpura district located in South Bihar Plane. The district occupies an area of 689 square kilometers, covering 6 administrative blocks. The district is bounded on the north by the district Nalanda, on the south by the district Jamui and some part of Nawada, on the west by Nawada and Nalanda, on the east by the districts Lakhisarai. Sheikhpura district is located on global map between 24º45′ and 25º North Latitude and 85º45′ and 86º45′ East longitude, comes under Survey of India Toposheet No. 72 G/11,12,15 & 16, H/13, K/4. The location of the study area is shown in ***Fig. 1.*** The population density of the district is 765 persons per sq. km. The salient demographic details of the administrative blocks falling in the area are given in ***Table 1.1.***

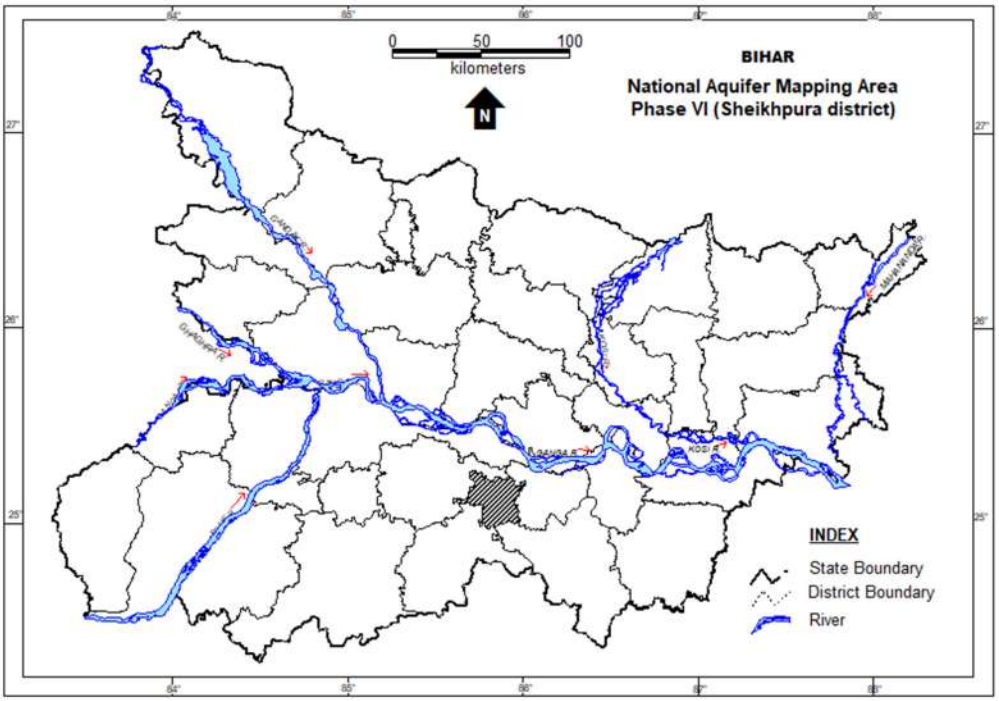


Figure 1: Aquifer mapping area- Sheikhpura district

Table 1.1: Demographic details of the administrative blocks (Ref. Census of India 2011)

Block	*Total area (sq.Km)*	*Rural Population*	*Urban Population*	*Total Population*
Barbigha	94.22	90092	46075	136167
Shekhopur Sarai	55.32	67481	0	67481
Sheikhpura	185.23	136084	62927	199011
Ghat Kusumbha	92.6	48346	0	48346
Chewara	115.05	73267	0	73267
Ariari	146.63	112070	0	112070
	689.05	527340	109002	**636342**

(As per census 2011)

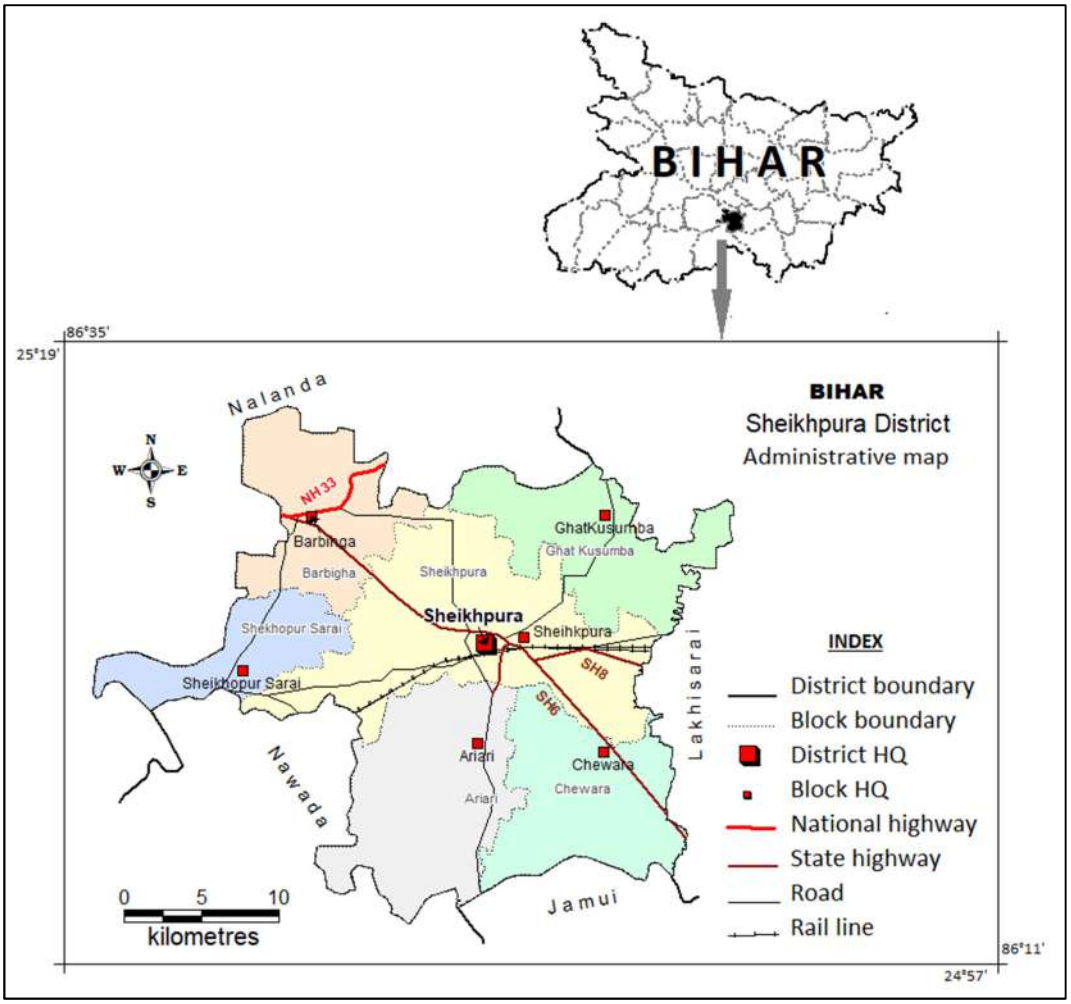


Figure 2: Administrative Map

1.4 Brief Description

The administrative map (***Fig. 2.***) of the area shows that main cities of Sheikhpura district are Sheikhpura, Ariari, Chewara, Ghatkusumba, Barbigha, and Sheikhopursarai. One national highway NH 33 is passing through the district, which connect the district from Jehanabad via Nalanda to Lakhisarai. Two state highways, SH6 and SH8 passes through the district, which connect the main city and district head quarter Sheikhpura to the other parts of the district. Railways through Sheikhpura connected to Nawada and Lakhisarai.

1.4.1 Data availability

Central Ground Water Board has carried out systematic and reappraisal hydrogeological surveys, exploratory drilling under groundwater exploration programme and depth to water level monitoring under "ground water regime monitoring" etc. In Bihar state, data available in the

aquifer mapping area from the previous works of CGWB, Public Health Engineering Department, Govt. of Bihar, Minor Water Resource Department, Govt. of Bihar, etc. have been compiled and data gap analysis has been carried out for working out the need for additional data generation in the study area. Though, the data generation through in-house and outsourcing exploration drilling is in progress and this has been incorporated as far as possible.

1.4.2 Data adequacy and data gap analysis and data generation

As per the existing data availability on March 2019, data gap analysis has been carried out. On the basis of this data gap analysis, fresh data has been generated for depth to water level record. The block wise total number NHS wells have been given in ***Table 1.2.***

Table 1.2: Blockwise number of NHS Data Points (2019)

SN	District	Block	Area (sq Km)	Total numbers of data points
1	Sheikhpura	Barbigha	94.22	4
2	Sheikhpura	Shekhopur Sarai	55.32	1
3	Sheikhpura	Sheikhpura	185.23	2
4	Sheikhpura	Ghat Kusumbha	92.6	1
5	Sheikhpura	Chewara	115.05	1
6	Sheikhpura	Ariari	146.63	1

1.4.3 Climate & Rainfall spatial and temporal distribution

The climate of this district is characterized by mild winter, hot summer and hot and humid monsoon season, i.e. “Tropical” type. The year may be divided into four seasons. The cold season starts from December and lasts till the beginning of March. The summer season follows and continues till first week of June when the southwest monsoon commences. June to September is the southwest monsoon season. The post monsoon months October and November constitute a transition period from the monsoon to the winter season. The average annual rainfall in the district is 996.6 mm. The rainfall in the southwest monsoon season constitutes to about 86% of the annual normal rainfall. July is the rainiest month with an average rainfall of 281.3 mm. January is the coldest month when the mean maximum temperature at about 25°C and the mean minimum temperature at about 11°C. The minimum temperatures may sometimes go down to about 4°C.May is the hottest month with the mean maximum temperature at about 40°C and the mean minimum temperature at about 26°C. The maximum temperatures may sometimes be above 44°C.

The season of rain commences from mid of June with the outburst of south-west monsoon. The advent of monsoon brings a complete change in weather with appreciable falls in temperature.

As per the data available with the department, the average annual rainfall in the district is 1127 mm. Maximum rainfall occurs during the month of June to September when the district receives almost 80 percent of its average total rainfall. The district receives minimum rainfall during the month of December. Weather conditions become hot and humid during the rainy season. The average number of rainy days in district is 45. The heavy rainfall during the monsoon months is due to the change of direction impressed upon the monsoon current by Himalayan range. Rainfall is more irregular in September than in other monsoon months. 5 years monthly rainfall is given in ***Table 1.3.***

Table 1.3: Rainfall Departure

Year	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
	RF	%D	RF	%D	RF	%D	RF	%D	RF	%D	RF	%D	RF	%D	RF	%D	RF	%D	RF	%D	RF	%D	RF	%D
2014	27	97	16	95	6.7	-18	0	-100	155	362	131.6	-9	383.1	31	259	8	257.5	36	14.8	-75	0	-100	2.2	-56
2015	2.6	-81	0	-100	33.4	307	7	-28	10.1	-70	186.7	29	305.5	5	267.3	11	79	-58	0	-100	0	-100	0	-100
2016	0	-100	0	-100	0	-100	0	-100	36.6	9	180.9	25	211.5	-27	230.5	-4	282.5	49	106	82	0	-100	0	-100
2017	0	-100	0	-100	0.3	-96	0	-100	67.4	101	87.8	-39	285.6	-2	183.7	-24	72.4	-62	39.7	-32	0	-100	0	-100
2018	0	-100	0	-100	0	-100	0	-100	20.2	-40	35.2	-76	293.1	1	147.4	-39	79.7	-58	20.3	-65	0	-100	5.8	16

Source: IMD

1.4.4 Physiographic Set up

The district is the part of South Bihar Plane. The major physiographic units are Hill, Pediplane and alluvial plane. The main rivers are Hoarohar and Sakri.

1.4.5 Physiography/DEM

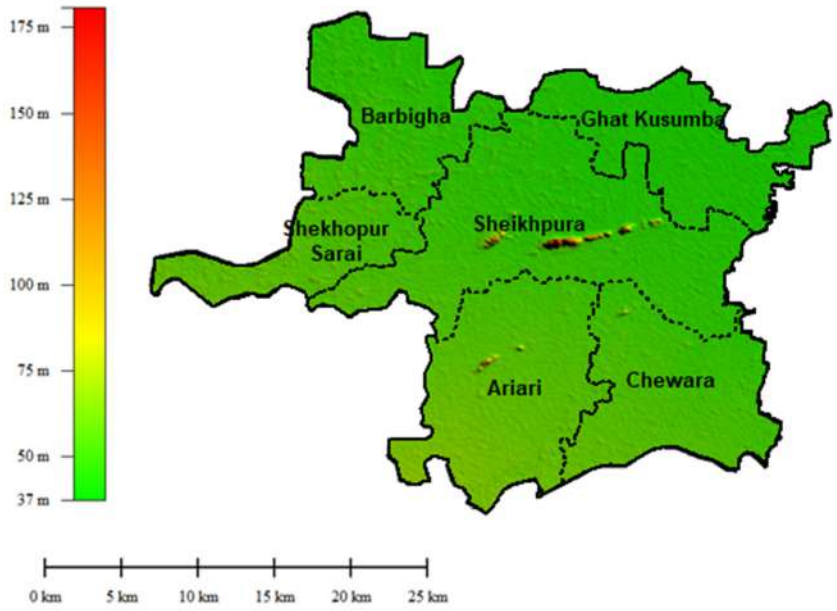


Figure 3: Digital Elevation Model of the area based on SRTM Data

Elevation of the area ranges from 37 m and 187.5 m above mean sea level (SRTM) data with WGS 84 Spheroid). The generated elevation map by SRTM map is given in ***Fig.3***.

1.4.6 Geomorphology

Sheikhpura district is part of Mid-Ganga basin, in the southern margin of the Gangetic plains. The district mainly represents flat alluvium terrain except some hilly area in the middle part. The maximum elevation is 187.5 m above MSL. The general trend of structural hill is E-W direction. The middle part covering the hilly area and south west area is covered by pediplanes. The rest part of the Sheikhpura district is mainly covered by alluviums. Small part in north in Ghatkusumba block is older alluvium other part is of younger alluvium made by rivers of the districts flowing south to north/north east. ***(Fig 4)***

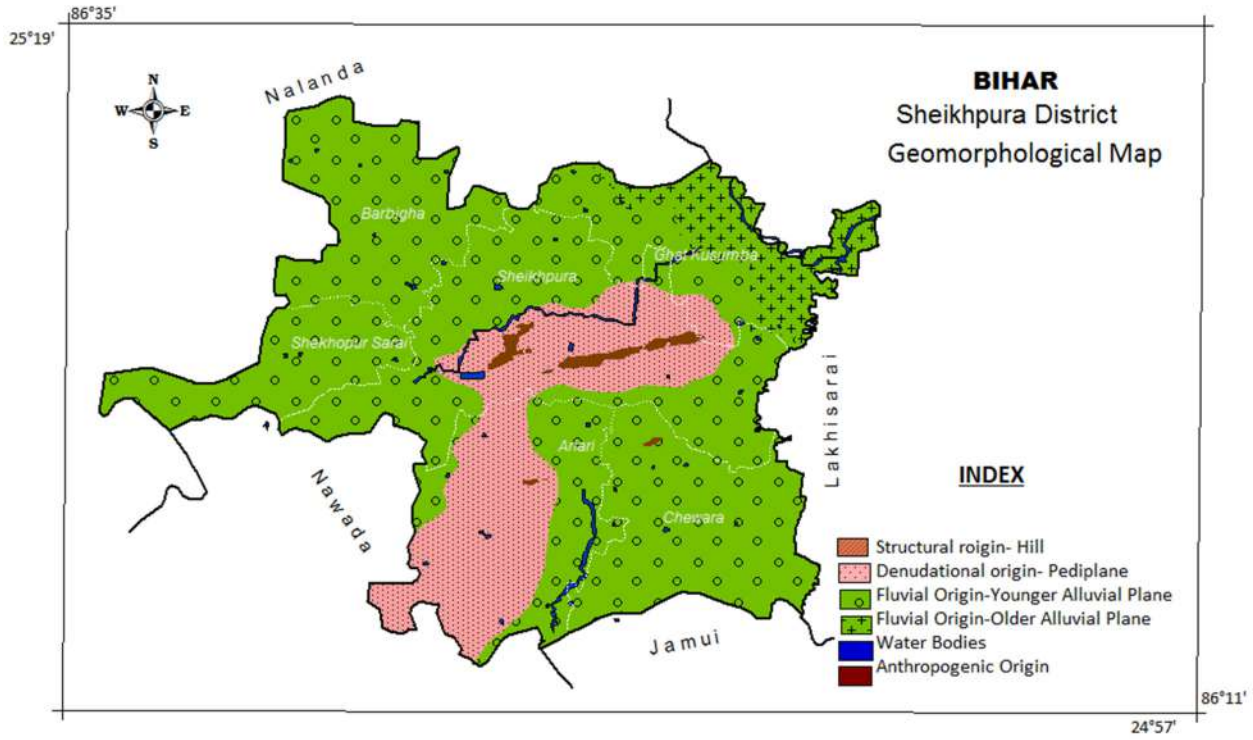


Figure 4: Geomorphology

1.4.7 Land-Use Pattern

Land use is the term used to describe the human use of land. It represents the economic and cultural activities (e.g., agricultural, residential, industrial, mining, and recreational uses) that are practiced at a given place. Looking into the different land use patterns of Sheikhpura distict, the maximum area (above 90%) is being utilized in agricultural purpose followed by built

up rural area. A very small percentage area is under mining. ***Fig.5***. shows the different land use patterns of Sheikhpura district and also their graphical representations. ***Table 1.4*** shows the area under different land use patterns and their percentages. Amongst all land use patterns water use involved mainly in agriculture, mining and urban areas. As most of the area is under agricultural use therefore there is maximum water utilization for irrigation purpose etc.

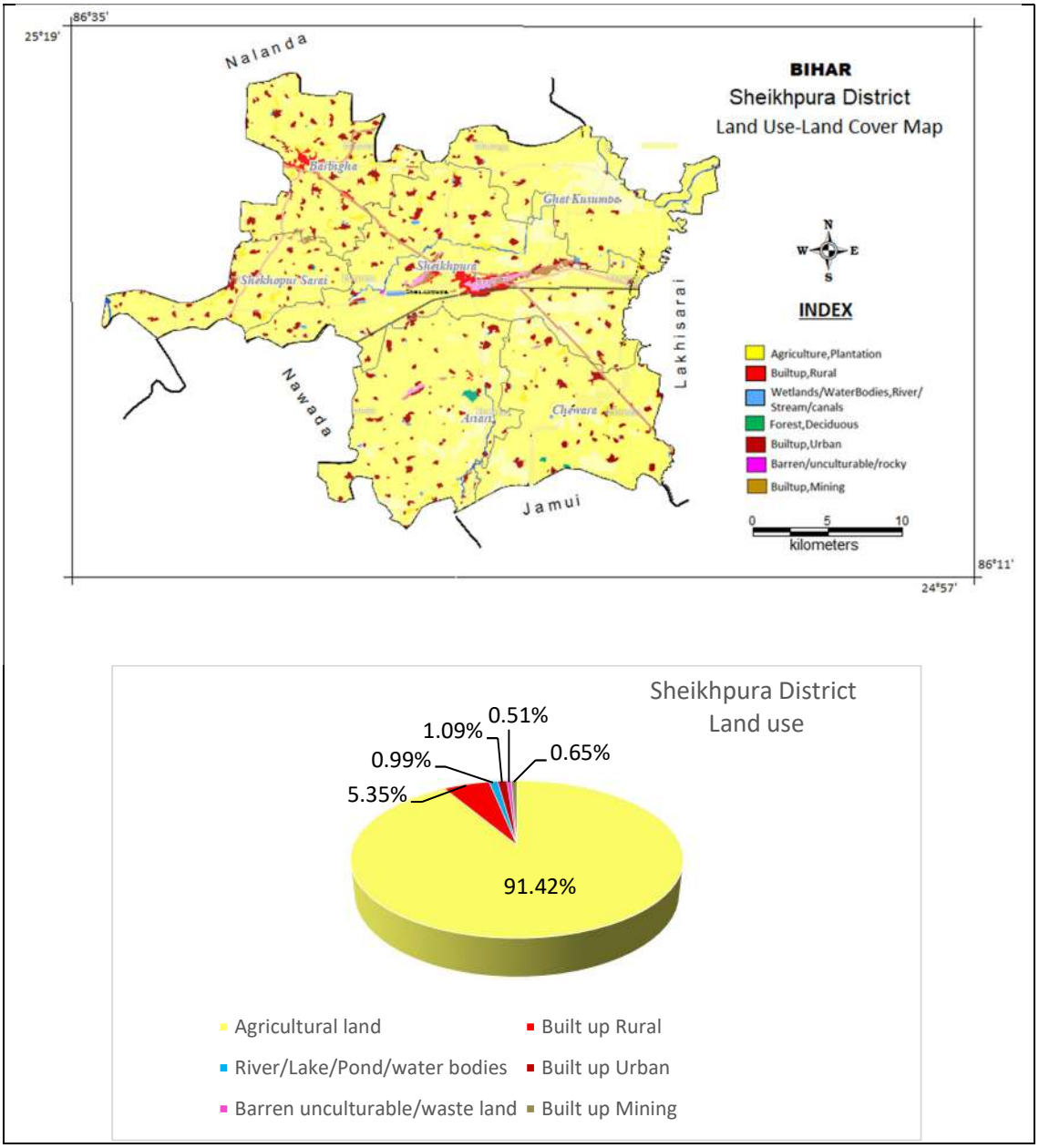


Figure 5: Land use

Table 1.4: Percentage of area under different Land use patterns

SN	Land use Pattern	Area (sq km)	% Area
1	Agricultural land	493.65	91.417
2	Built up Rural	28.89	5.35
3	River/Lake/Pond/water bodies	5.34	0.9889
5	Built up Urban	5.86	1.0852
6	Barren unculturable/waste land	2.77	0.513
7	Built up Mining	3.49	0.6463
	Total Area	540	100

As maximum land utilization is under agricultural purpose, the further break up of agricultural use given in ***Table 1.5***. For this some important nomenclatures are as follows:

Net Irrigated Area: It is the area irrigated through any source once in a year for a particular crop.

Total/Gross Irrigated Area: It is the total area under crops, irrigated once and/or more than once in a year. It is counted as many times as the number of times the areas are cropped and irrigated in a year.

Net Area Sown: This represents the total area sown with crops and orchards. Area sown more than once in the same year is counted only once.

Gross Cropped Area: This represents the total area sown once and/or more than once in a particular year, i.e. the area is counted as many times as there are sowings in a year. This total area is also known as total cropped area or total area sown.

Cropping Intensity: (Gross cropped Area / Net Cropped Area) * 100

Table 1.5: Lans Use Statistics

SN	Block	Block area	Gross cropped area	Net sown area	Area sown more than once (1-2)	Cropping Intensity	Area under Waste land	Area under other uses
1	Ariari	14505	14802	6751	14802	219	34	1990
2	Barbigha	9274	10782	7474	10782	144	0	933
3	Chewara	11378	10608	5600	10608	189	17	1294
4	Ghatkusumbha	7722	6065	4609	6065	132	0	815
5	Sheikhpura	18329	18348	9110	18348	201	340	3131
6	Shekhopursarai	5685	6441	3249	6441	198	0	1042
	Total	66894	67046	36793	45140	182	391	9205

Source: District irrigation Plan, Sheikhpura: Department of Agriculture, Pmksy Cell, Patna (Bihar)

1.4.8 Soil

Soil texture and structure impacts water holding capacity and infiltration rate through specific formation. Soil texture refers to the composition of the soil in terms of the proportion of small, medium, and large particles (clay, silt, and sand, respectively) in a specific soil mass. For example, a coarse soil is sand or loamy sand, a medium soil is a loam, silt loam, or silt, and a fine soil is sandy clay, silty clay, or clay.Soil structure refers to the arrangement of soil particles (sand, silt, and clay). Coarse soils have a higher infiltration rate than fine soils. Coarse soils with granular subsoils have higher permeability. Slow permeability is characteristic of moderately fine subsoil with angular to subangular blocky structure. Soil with a high percentage of silt and clay particles, has a higher water-holding capacity. In Sheikhpura district, there are broadly three types of soil viz. Clay or very fine loam, fine loam, and course loam. ***Fig.6***. shows the type of soils in district Sheikhpura. Central and south part of the district covered by coarse soil, northern part contains fine loamy soil and in extreme north the district contains very fine soil.

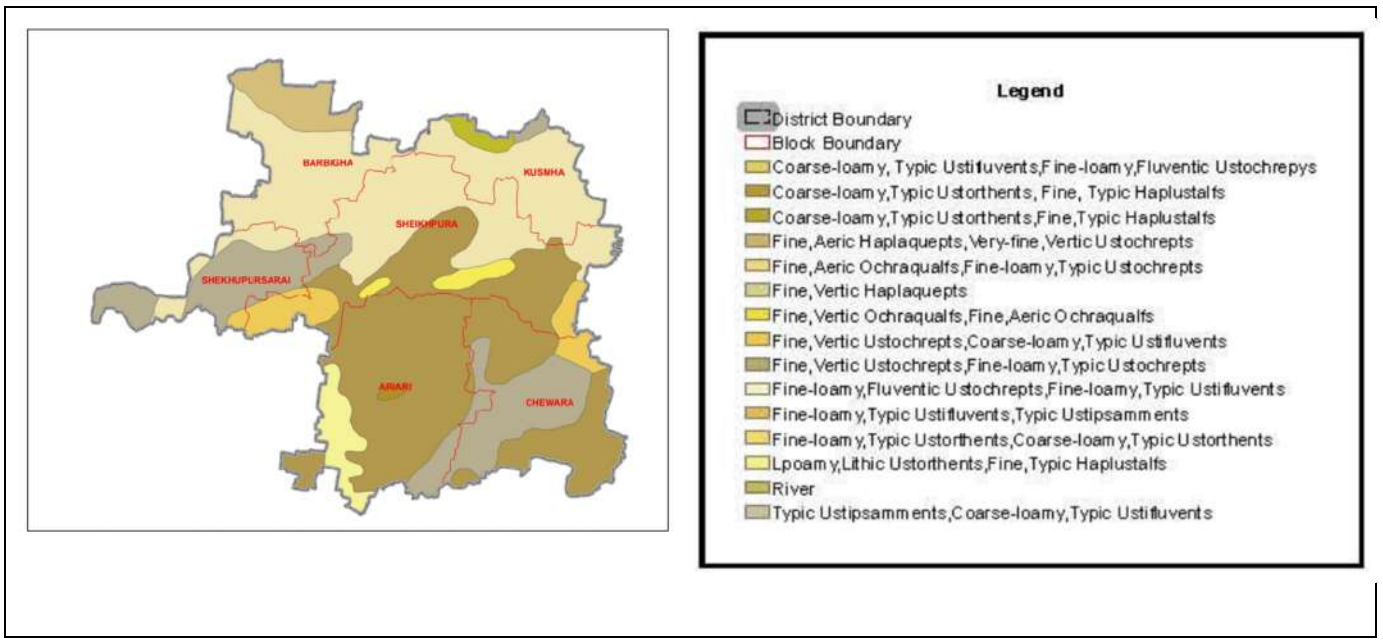


Figure 6: Soil Map

1.4.9 Hydrology and Drainage

Sheikhpura district falls under Harohar Basin Phalgu-Kiul sub basin. The general slope of the area is towards northeast. The Major rivers are Harohar and Sakri river. All rivers flow

towards NE and meets Ganges towards North. The Harohar Nadi touches in western part of Sheikhopursarai, and flows towards Katrisarai, Nalanda. Finally flows towards north east and through sarmera it meets the Ganges. Harohar nadi again flows through north eastern corner of Sheikhpura district in GhatKusumba block. Flow direction has been shown in ***Fig.7***.

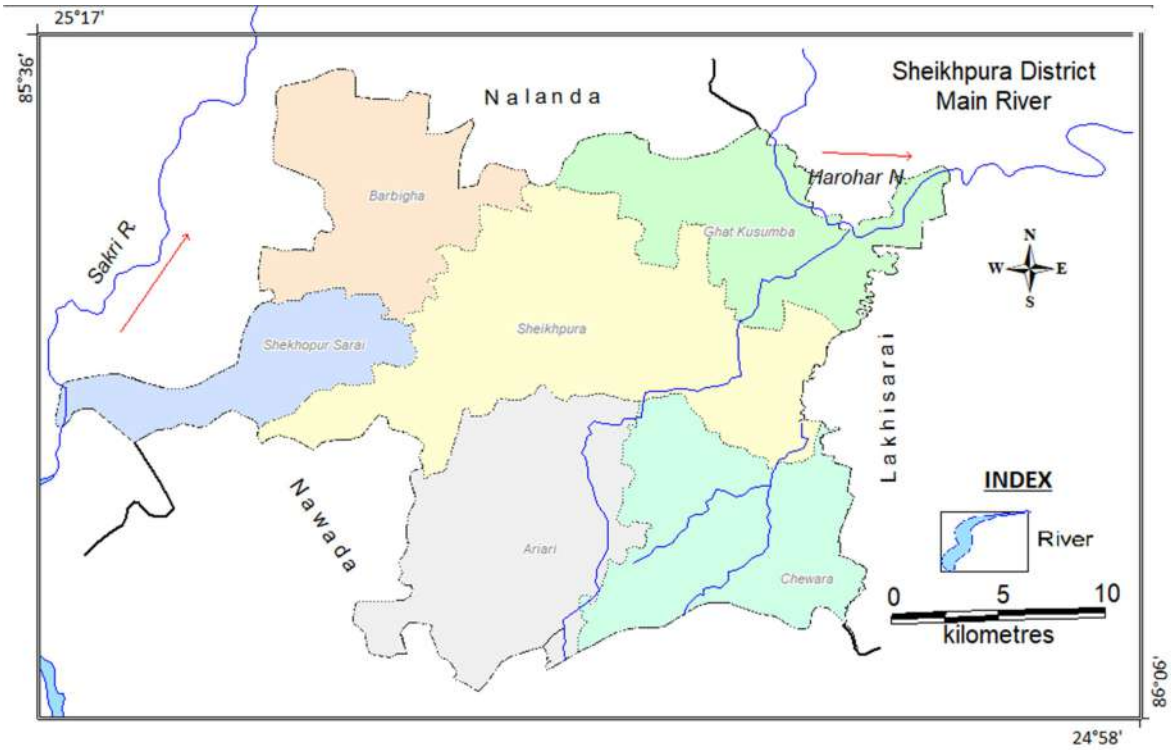


Figure 7: Drainage Map

1.4.10 Agriculture

Agriculture is the main occupation of the people of the district and also the main source of livelihood of the people. The main crops of the district are rice, wheat, gram, maize, pulses (masoor). The district occupies a prominent position in the state in the production of potato. Area under major crops of Sheikhpura district (As2018-19). Table below shows the area under principal crops. *Source: Bihar Agriculture Department (https://state.bihar.gov.in/krishi/CitizenHome.html)*

Area in 000 hectares					
Rice	Wheat	Gram	Maize	Masoor	Khesari
22	22	1	1	3	2

(Bihar statistical Handbook 2018) http://dse.bihar.gov.in/

1.4.11 Irrigation

Irrigation is the process of applying water to the crops artificially to fulfil their water requirements. The different sources of surface irrigation are cannal, aharpyne, lift irrigation, and perennial source of water. Sources of irrigation through ground water is open well, deep tube well, medium tube well and shallow tube well. To understand the irrigation practices some terminologies are there.

Net Irrigated Area: It is the area irrigated through any source once in a year for a particular crop.

Total Net Un-Irrigated Area: It is the area arrived at by deducting the net irrigated area from net sown area.

Total/Gross Irrigated Area: It is the total area under crops, irrigated once and/or more than once in a year. It is counted as many times as the number of times the areas are cropped and irrigated in a year.

Blockwise area irrigated and area rainfed have shown ***Table 1.6***. The data shows that more than 50% of irrigated area of the district is irrigated by ground/surface water and rest area is rainfed.

Table 1.6: Area Irrigated and rainfed *Area in hectare*

Block	Irrigated		Un- Irrigated or Totally Rainfed
	Gross Irrigated Area	Net Irrigated Area	
Ariari	7001	3431	7801
Barbigha	8508	5367	2274
Chewara	5655	2975	4953
GhatKusumba	3785	2454	2280
Sheikhpura	15072	7286	3276
Sheikhpurosarai	5411	2721	1030
Total	45432	24234	21614

(Source: District Irrigation Plan, https://pmksy.gov.in/mis).

Ground and surface water irrigation in Sheikhpura district:

Ground water irrigation			Surface water irrigation		
Kharif	Rabi	Total	Kharif	Rabi	Total
55.97	6.22	62.19	89.10	28.14	117.24

The data says that most of the area is being irrigated by surface water.

As per the 4th and 5th MI Census data ***Table 1.7*** the number of dug wells has been decreased from 30 to 12 which indicate that the use of water of unconfined aquifer has been decreased.

Table 1.7: Distribution of dugwells as in 4th MI and comparison with 5 th MI

Number of dug wells				
Block	4th MI			5th MI
	0-20 m	>20 m	Total	
Ariari	6	0	6	9
Barbigha	83	2	85	1
Chewara	25	0	25	12
Ghat Kusumba	1	0	1	2
Sheikhpuro Sarai	46	2	48	_
Sheikhpura	9	21	30	12
			195	**36**

Table 1.8: Distribution of Shallow tube well as in 4th MI and comparison with 5 th MI

Block	0-20 mts		20-40 mts		40-60 mts		60-70 mts		>70 mts		Total	
	4th MI	5th MI	4th MI	5th MI	4th MI	5th MI	4th MI	5th MI	4th MI	5th MI	4th MI	5th MI
Ariari	916	616	0	532	3	0	0	0	0	0	919	1148
Barbigha	764	75	0	97	0	0	0	0	2	0	766	172
Chewara	567	260	0	720	0	0	0	0	1	0	568	980
Ghatkusumba	139	132	0	13	0	0	0	0	0	0	139	145
Sheikhpuro sarai	429	152	0	251	0	0	0	0	2	0	431	403
Sheikhpura	696	153	50	347	98	0	9	0	6	0	859	500
Total	3511	1388	50	1960	101	0	9	0	11	0	3682	3348

Table 1.9: Distribution of Deep tube well as in 4th MI and comparison with 5 th MI

Block	70-90 mts		90-110 mts		110-130 mts		130-150 mts		>150 mts		Total	
	4th MI	5th MI	4th MI	5th MI	4th MI	5th MI	4th MI	5th MI	4th MI	5th MI	4th MI	5th MI
Ariari	42	13	0	0	0	2	0	2	0	1	42	18
Barbigha	147	9	1	0	0	0	0	0	0	41	148	50
Chewara	31	20	0	8	0	0	0	1	0	0	31	29
Ghatkusumba	7	23	0	4	0	1	0	1	0	0	7	29
Sheikhpuro sarai	5	2	0	22	0	9	0	1	0	0	5	34
Sheikhpura	4	11	1	29	0	15	0	15	0	11	5	81
Total	236	78	2	63	0	27	0	20	0	53	238	241

Compared the number of shallow tube well ***Table 1.8*** of 4th and 5th MI cencus, the number has been decreased, while the number of deep tube well increased ***Table 1.9***. The number of shallow tube well of depth range of 0 to 20 mts, has been decreased in almost all blocks and depth range of 20 to 40 mts has been increased, indicating the shallow aquifer has been developed more, and deeper aquifer is being developed.

1.4.12 Cropping Patterns

The main crops of the district are rice, wheat, gram, maize, pulses (masoor) and potato (***Table 1.10***). The district occupies a prominent position in the state in the production of potato. Barley, Jowar, Bazra, Ragi, small millets, oil seeds, Maize etc are production done throughout the year, while in rabi season wheat is being produced and in Kharif season rice and some other kharif pulses produced.

Table 1.10: Cropping Pattern

Area in ha

Type of Crop	Season	Area (Ha)	Net Area Sown	Cropped Area	Area Sown More Than Once
Barley, Jowar, Bazra, Ragi & Small Millets	Whole year	2	47013	60650	13637
Oil Seeds	Whole year	602			
Kharif Pulses	Kharif	309			
Rabi Pulses	Rabi	4182			
Maize	Whole year	654			
Rice	Kharif	27254			
Wheat	Rabi	21234			

Source: state.bihar.gov.in (Agriculture Department)

1.4.13 Prevailing Water Conservation/Recharge Practices

In Sheikhpura district, the Ahar Pyne system is the traditional water conservation structures present. Apart from these, village ponds and tanks used for irrigation in agriculture field acts as water conservation structures.

1.5 Geology

Sheikhpura district is mainly occupied by Quarternary sediments, except a small portion in central part of the district occupied by metasediments of Munger group belonging to middle Proterozoic age. The metasediments include highly folded and fractured quartzite, phyllite and

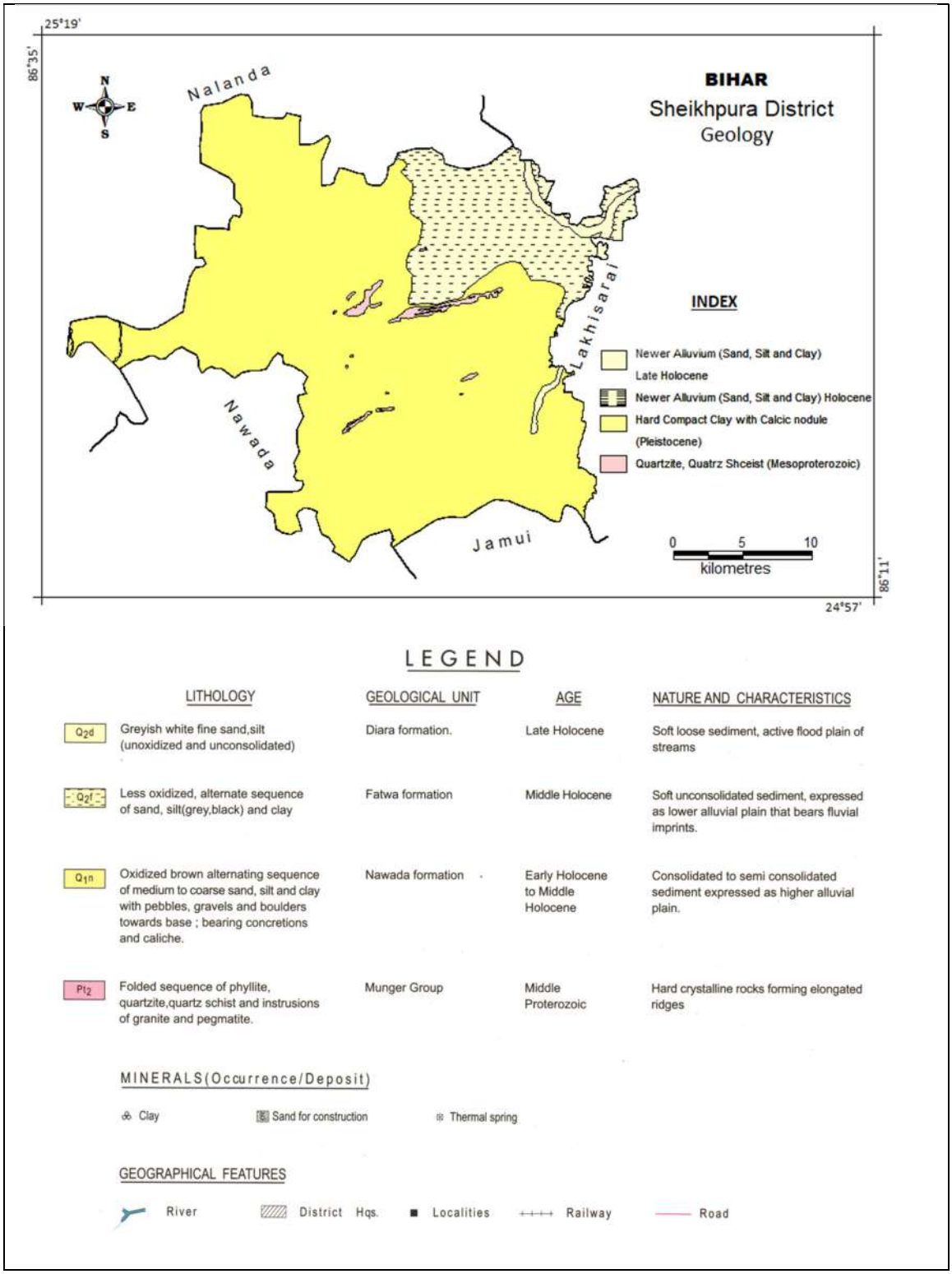


Figure 8: Geology Map

schiest with intrusive granite and pegmatites. These are overlain by various sequence of clay, Kankar, sand, silt, gravel of Diara, Fatwa and Nawada formation of quarternary (***Fig.8***).

Ground water occur both in alluvium and metasediments. In alluvium ground water is in unconfined condition whereas in metasediments ground water present in the formation due to secondary porosity that is between fault and fractures within rocks.

CHAPTER- 2

Data collection and generation

The water level and quality data are being collected and recorded regularly from National hydrograph monitoring Stations. The data gap analysis has been done and new data has been generated for more information. Exploration data has also been complied. To understand the sub–surface geology, identify the various water bearing horizons including their depth, thickness and compute the hydraulic characteristics such as transmissivity and storativity of the aquifers, exploratory drilling programme was carried out by Central Ground Water Board.

2.1 Hydrogeology

Sheikhpura district falls under Harohar Basin Phalgu-Kiul sub basin. The district is mainly occupied by Quarternary sediments, except a small portion in central part of the district occupied by metasediments of Munger group belonging to middle Proterozoic age.

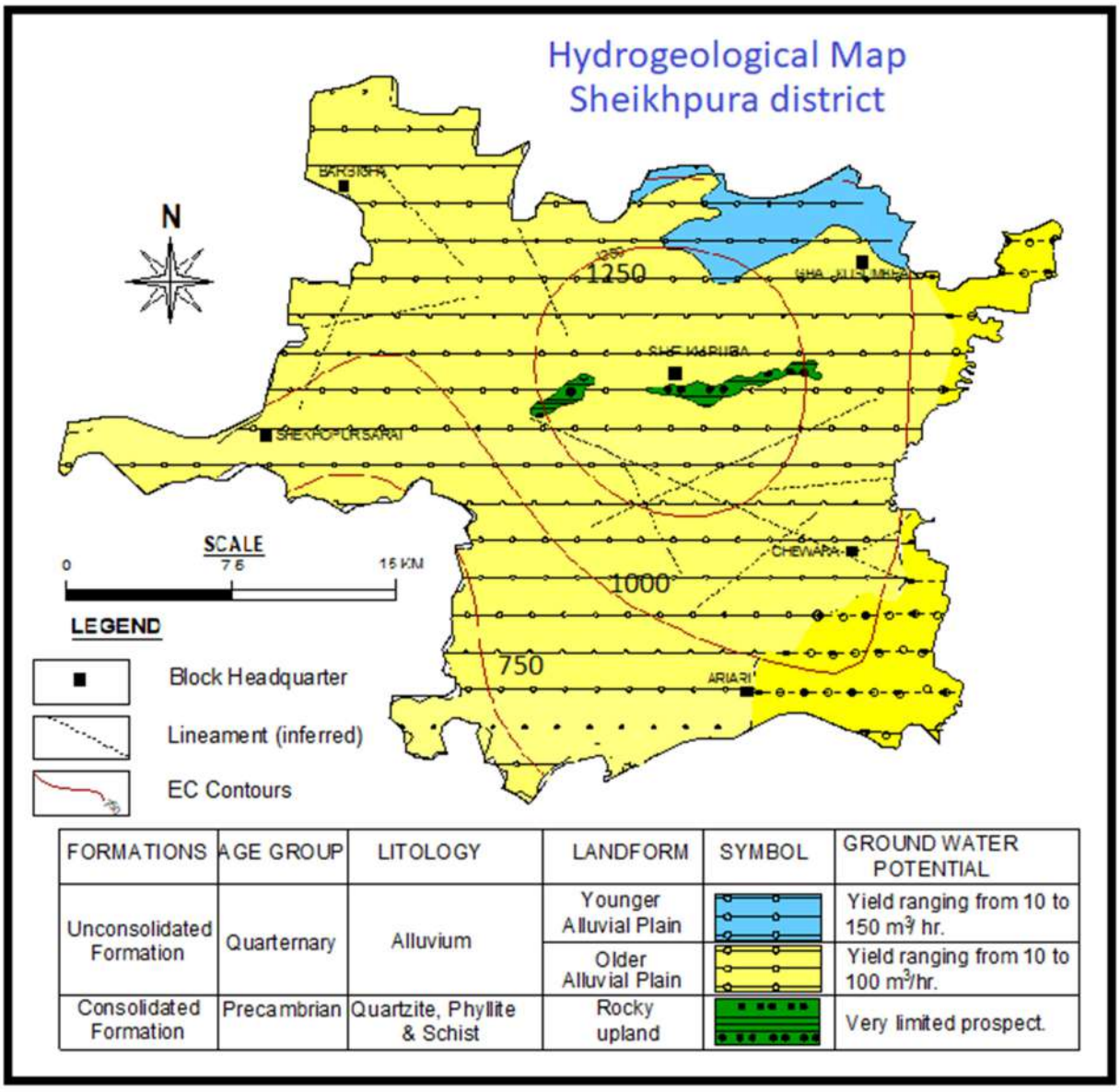
Ground water occurs both in Alluvium and metasediments. In alluvium ground water is in unconfined condition whereas in metasediments ground water present in the formation due to secondary porosity that is between fault and fractures within rocks.

Hydrogeologically, the district is divided into two parts (a) unconsolidated / porous formation (b) hard rock/ fissured formation (***Fig.9***.)

(a) Porous formation: The Quaternary alluvium constitutes this hydrogeological unit. The alluvial tract spread over the major part of the district, with sediment thickness ranging from 20 to 190 m. The variation in thickness of the alluvium is due to uneven bed-rock topography. Alluvium comprises clay, silt and sand. There are 22 tube wells drilled by CGWB and maximum depth being 190m bgl at Barbigha village. Aquifers in this formation are in unconfined to semi-confined conditions and discharge varies from 25 to 65 lps.

(b) The hard rock / fissured formation: It comprises mainly quartzite. The secondary porosities developed by means of weathering and / or fracturing are main repository of ground water. In general these rocks form poor aquifers. The exploratory drilling data of this area reveal three sets of fracturs/ joints occuring at different depths up to 100m bgl. Identification of groundwater potential area has been done based on study of lineaments picked up from satellite imageries. The zones of lineaments are the potential areas for ground water exploration and recharge. Weathered residium, saprolite zone and fractures within 15-35m bgl depths constitute shallow aquifer in the hard rocks. There is one bore wells drilled in hard rock area to a maximum

depth of 104m bgl in Sheikhpura town. Ground water occurs under semi-confined condition in hard rock and normally discharge ranges from 1 to 10 lps with drawdown of 12-18 m. Detailed exploratory data is given in ***Annexture II***.



FORMATIONS	AGE GROUP	LITOLOGY	LANDFORM	SYMBOL	GROUND WATER POTENTIAL
Unconsolidated Formation	Quarternary	Alluvium	Younger Alluvial Plain		Yield ranging from 10 to 150 m^3/ hr.
			Older Alluvial Plain		Yield ranging from 10 to 100 m^3/hr.
Consolidated Formation	Precambrian	Quartzite, Phyllite & Schist	Rocky upland		Very limited prospect.

District Brochure: Sheikhpura District

Figure 9: Hydrogeological map-Sheikhpura district

2.1.1 Depth to water level:

To study the ground water behavior, all over the district total 10 National Hydrograph Monitoring Stations (***Fig.10***) are being monitored four times a year, May'19, August'19, November'19 and January'20. The pre and post monsoon data for the year 2019 and details of 10 monitoring stations have shown in ***Annexture I.***

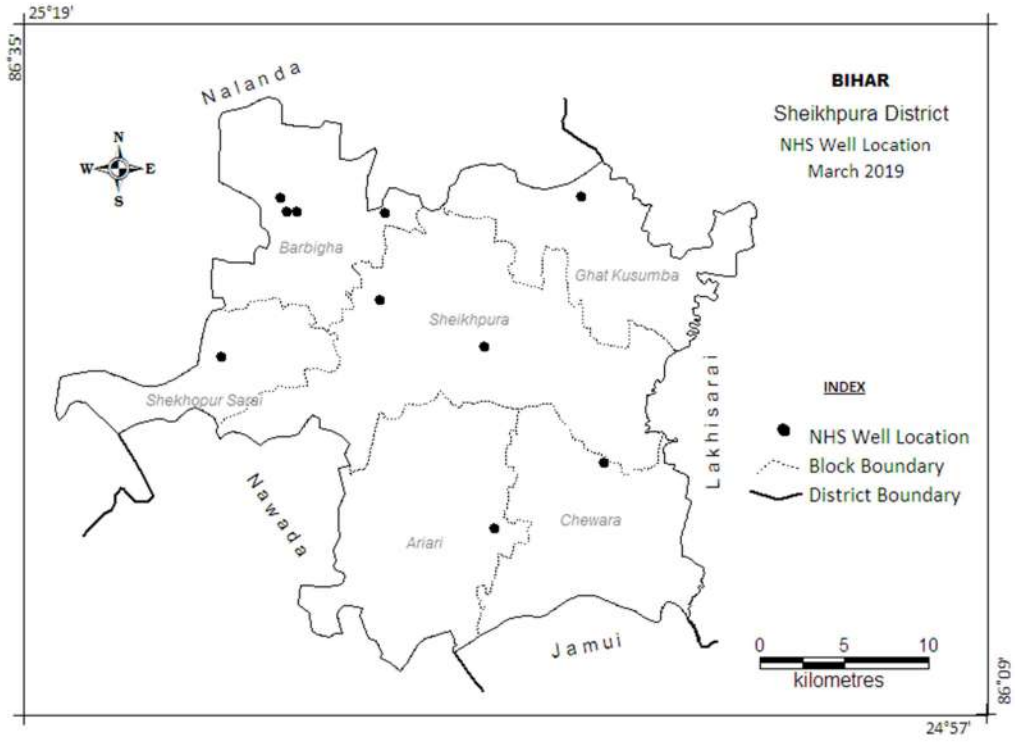


Figure 10: Location of National Hydrograph Monitoring Stations.

Premonsoon 2019 depth to water level

The premonsoon depth to water level data varies from 2.00 m bgl (Ghatkusumba) and 10.5 m bgl (Sheikhpura). The depth to water level map premonsoon 2019 (***Fig.11***) shows most of the area of the district shows depth to water level 5 to 10 m bgl. Central part of the district shows depth to water level more than 10 mbgl. Very small part in western side shows depth to water level 2 to 5 m bgl.

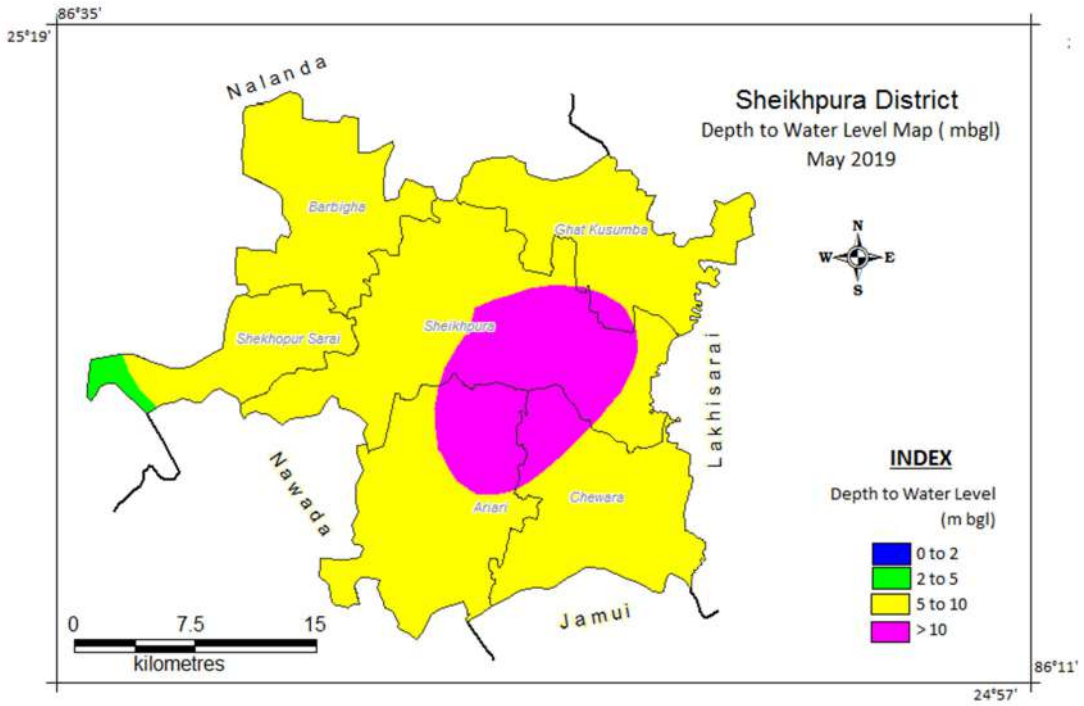


Figure 11: Depth to Water Level Map- Premonsoon 2019

Postmonsoon 2019

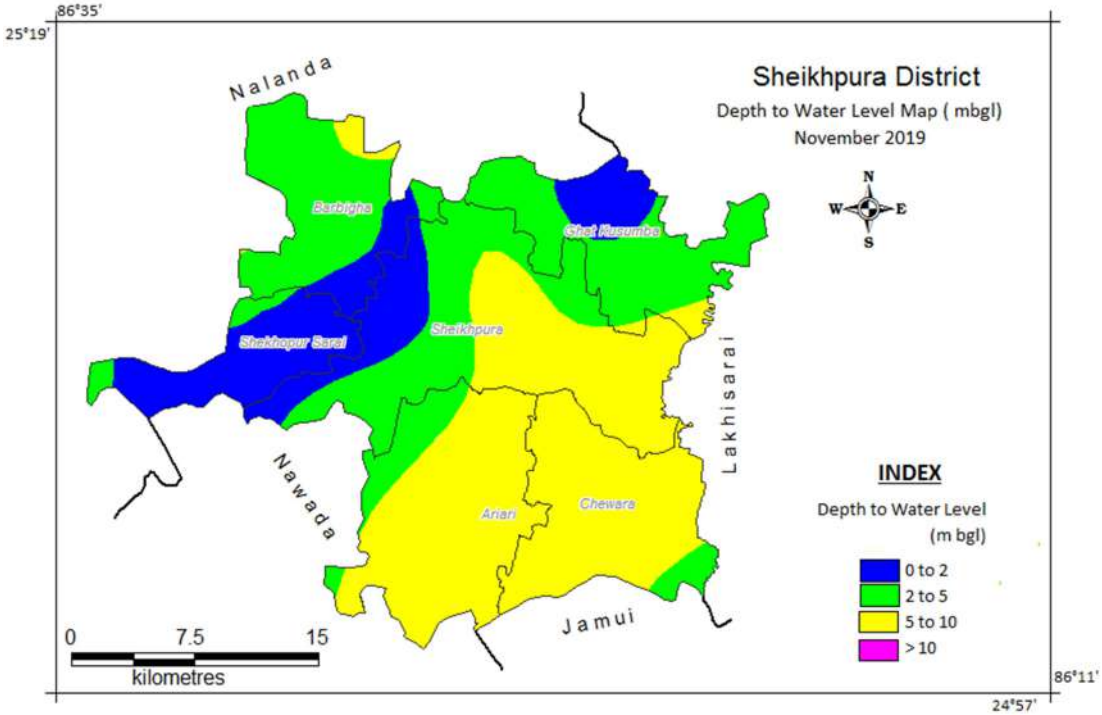


Figure 12: Depth to Water Level Map- Post-monsoon 2019

Depth to water level map (***Fig.12***) post-monsoon 2019, shows that post monsoon depth to water level varies from 1.2 (Nemdarganj) and 6.6 (Chewara). southern part of the district shows

depth to water level 5 to 10 mbgl, and north eastern part shows depth to water level 2 to 5 mbgl, except maximum part of sheikhpurosarai block, western part of Sheikhpura, eastern part of Barbigha block, and small part of eastern side of Ghatkusumba block which shows depth to water level 0 to 2 mbgl.

Water level fluctuation of November 2019 wrt May 2019:

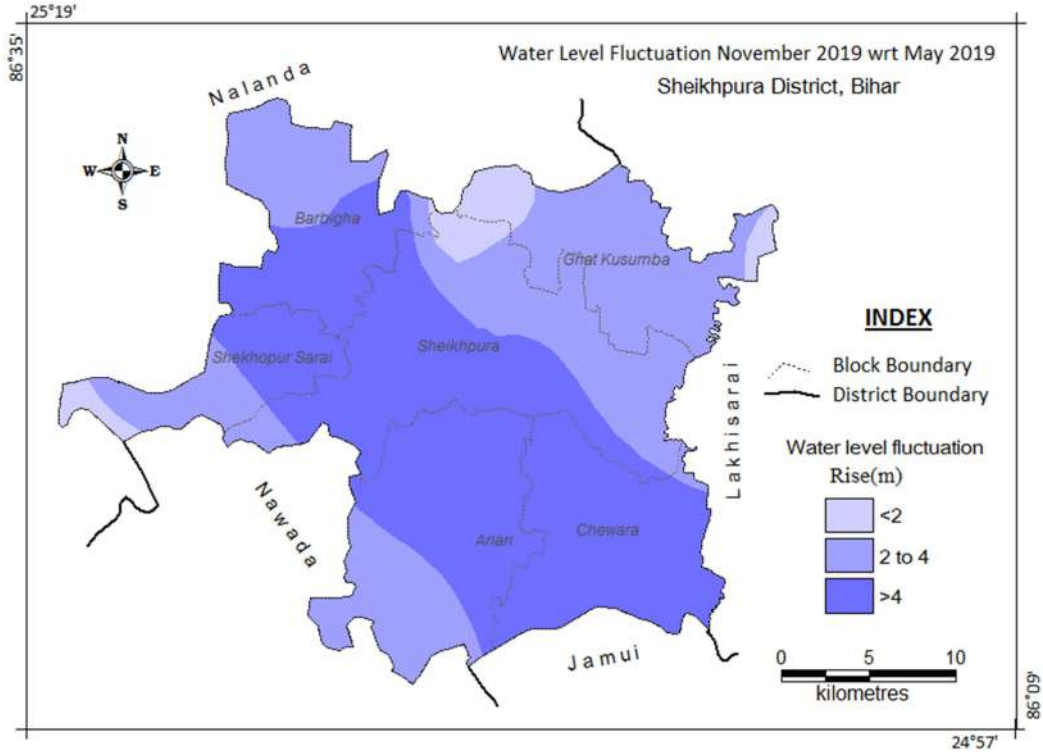


Figure 13: Water Level Fluctuation Map Postmonsoon 2019 wrt Premonsoon 2019

The water level fluctuation map (***Fig.13***) shows that there is rise in water level when compared to pre mosoon and post monsoon 2019. Water level rise varies from 0.3m (Chewara) to 7.68 m (Sherpar). Most of the area of the district shows water level rise within the range of 2 to 4 m. Central NW-SE part shows water level rise more than 4 m. very small part in the north and southeastern corner shows water level rise within 2m, rest part of the district shows water level rise within 2 to 4m.

Lomg term water level trend:

The long term water level data and hydrograph of Barbigha block of Sheikhpura district shows falling trend in 3 locations in postmonsoon (10 to 17 mm/yr) period and 2 locations in premosoon (3 to 22 mm/yr) period. Only one location shows rising trend (5 mm/yr) in Barbigha

block during pre monsoon. The hydrographs are shown below in ***Fig.14 (i), Fig.14(ii), Fig.14(iii) and Fig.14(iv).***

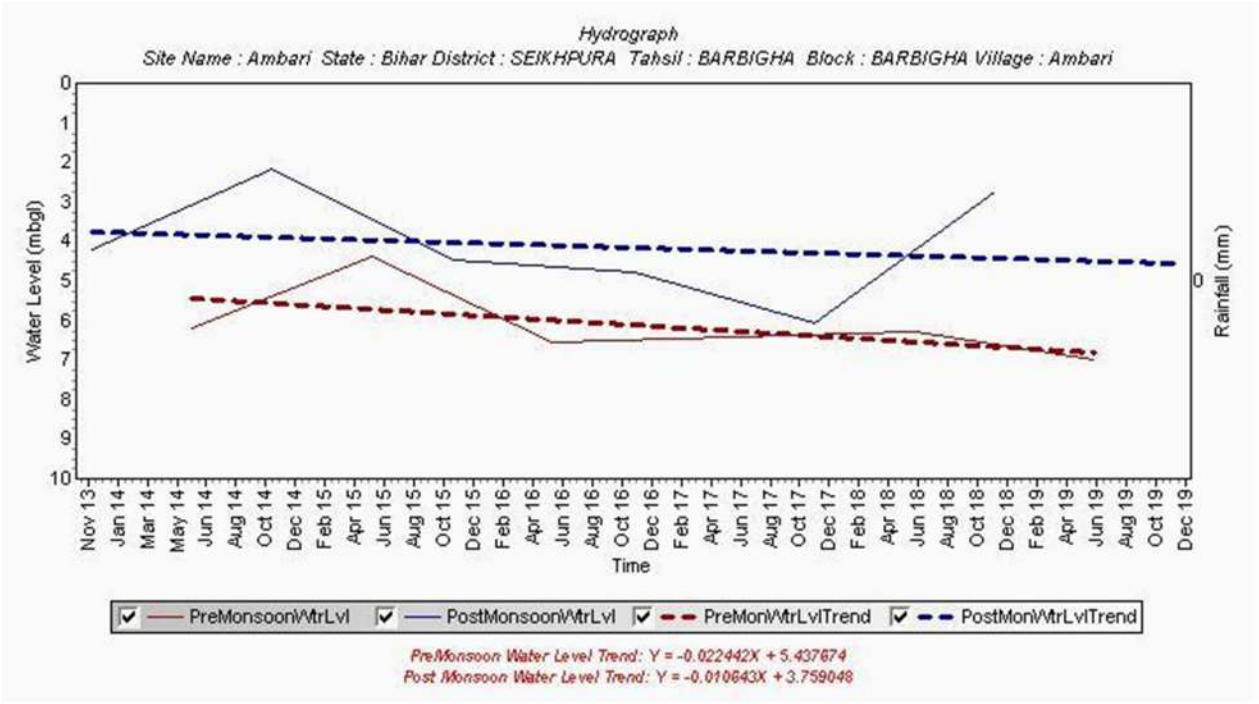


Figure 14 (i): Water Level Trend – Hydrograph1

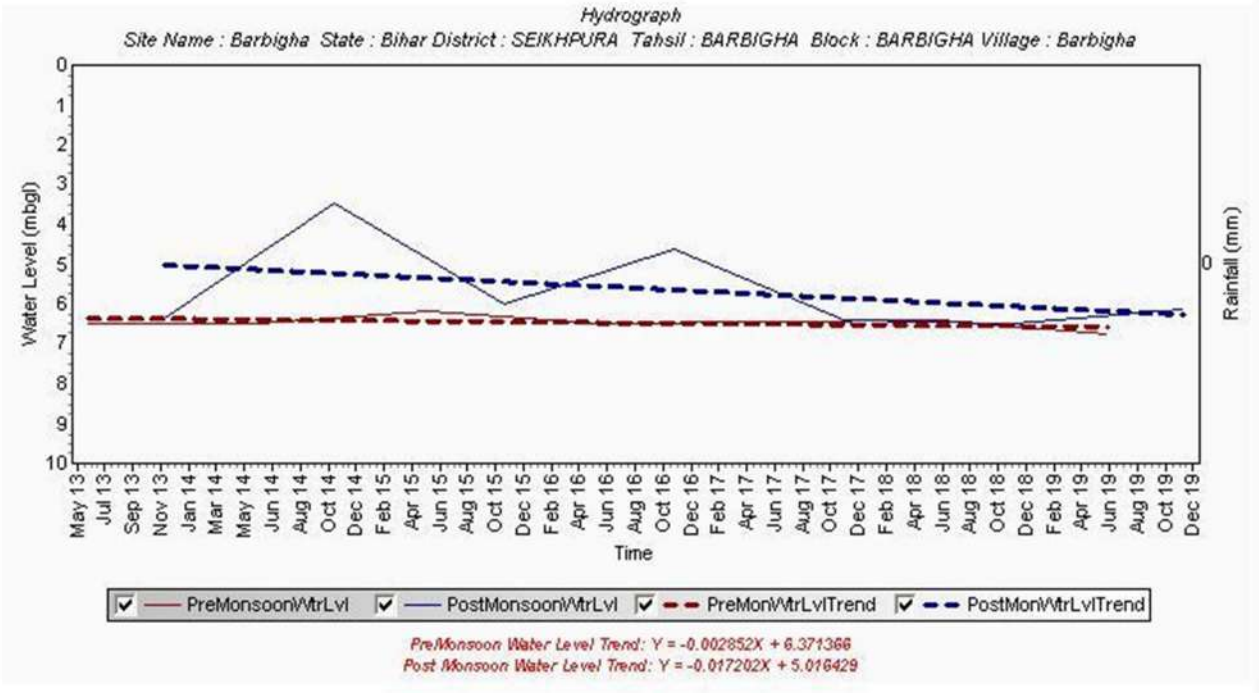


Figure 14 (ii): Water Level Trend – Hydrograph2

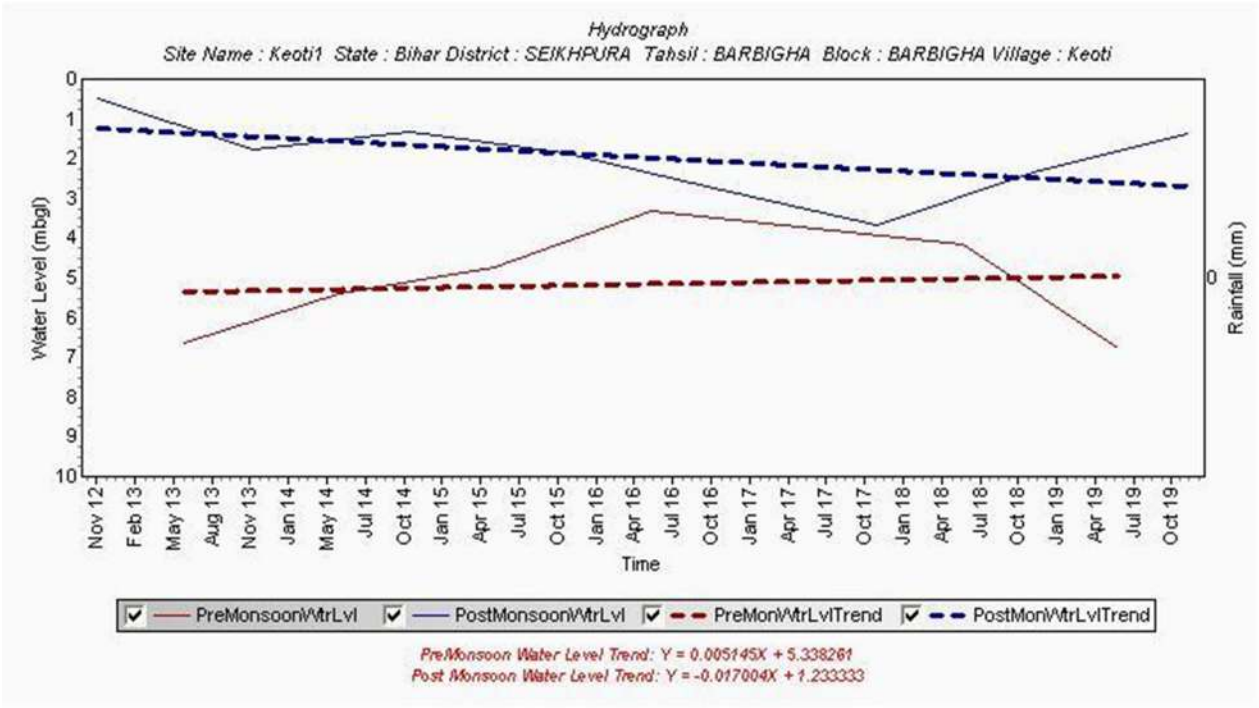


Figure 14 (iii): Water Level Trend – Hydrograph3

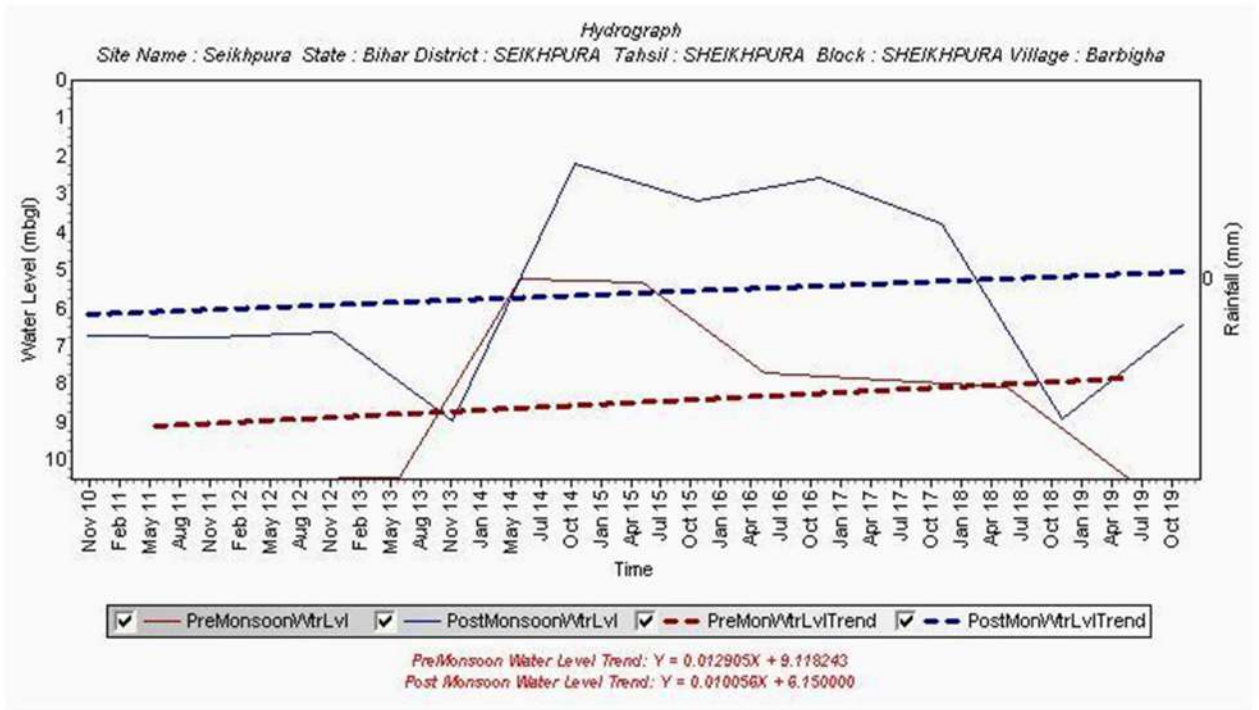


Figure 14 (iv): Water Level Trend – Hydrograph4

Water Table Contour:

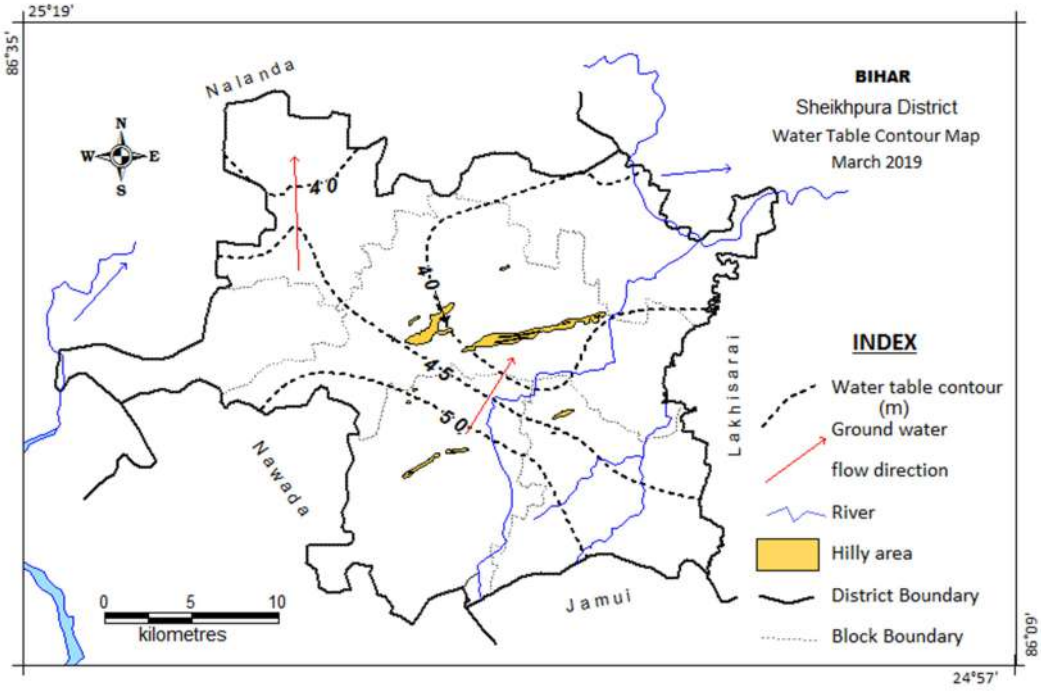


Figure 15: Water Table Contour Map

The water table contour map (***Fig.15***) shows the height of water table varies from 40 m to 50 m above MSL. As shown in map, water table become shallower in NE direction, therefore the ground water flow direction is towards NE, which is following the general slope of the area.

2.1.2 Pumping test:

Total 15 exploratory wells (***Table 2.1***) have been constructed. The transmissivity calculated varies from 1.8 m2/ day) (Sheikhpura college campus, Sheikhpura) to 2250.4 m2/day (Barbigha, Barbigha). Storativity varies from 1.9X10-4 (Nimi, Ariari) to 01.9X10-1 (Barbigha, Barbigha). Details of exploratory well has been given in ***Annexture II.***

Table 2.1: List of Exploratory and observation wells of CGWB

SN	Block	Location	EW & OW constructed	Latitude	Longitude
1	Barbigha	Barbigha	Both	25.225	84.718
2	Barbigha	Charuana	Only EW	25.125	85.681
3	Barbigha	Samas	Both	25.179	85.733
4	Sheikhpura	Sheikhpura college campus	Only EW	25.136	85.854
5	Sheikhpura	Sheikhpura	Both	25.136	85.854
6	Ariari	Nimi	Both	25.119	85.700

7	Ariari	Hussainabad	Both	25.108	85.863
8	Ariari	Ariari	Only EW	25.046	85.867
9	Ariari	Kasar	Only EW	25.050	85.808
10	Chewara	Sohdi	Only EW	25.029	85.867
11	Chewara	Lohan	Only EW	25.019	85.875
12	Chewara	Chordargah	Both	25.008	85.854
13	Ariari	Beman	Only EW	25.054	85.825
14	Ariari	Sasbahna	Only EW	25.036	85.779
15	Chewara	Chewara	Both	25.075	85.929

2.1.3 Exploratory drilling:

In Sheikhpura district 15 exploratory wells and 7 observation wells have been constructed (***Fig.16***). Out of 15, 14 wells are in alluvium area and 1 well is in hard rock area (College campus Sheikhpura). The exploratory drilling has been done down to a depth upto 200.00 m below ground level.

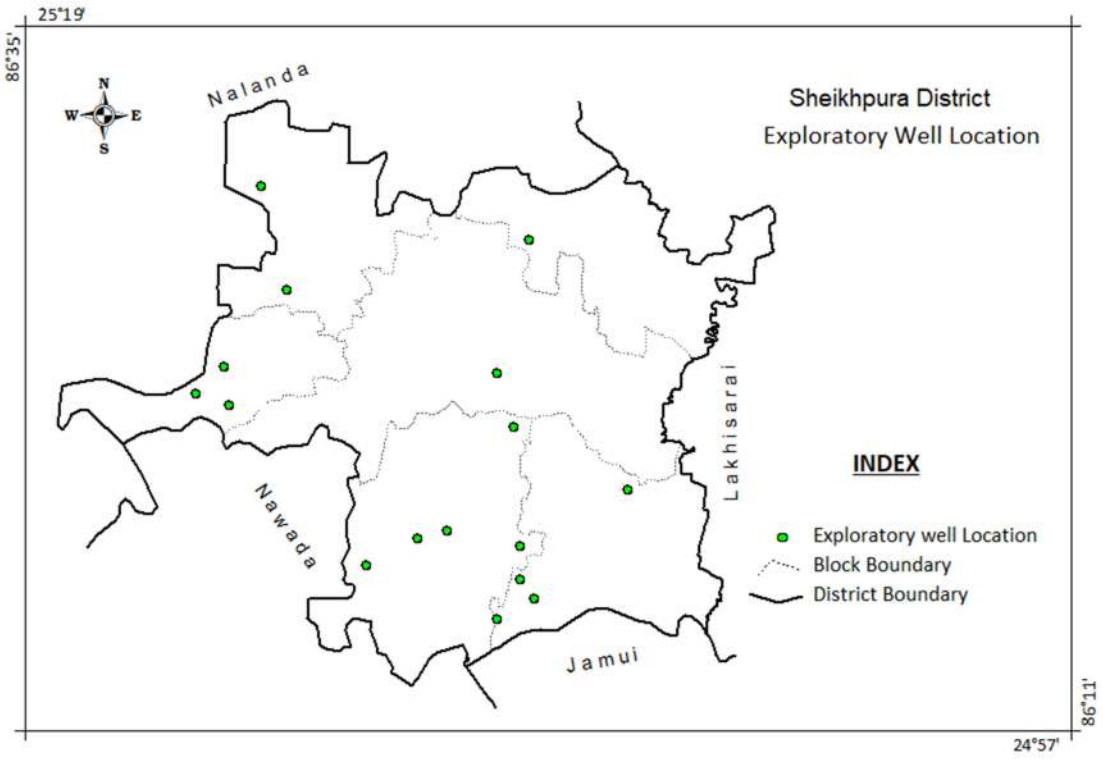


Figure 16: Locations of Exploratory Well

Major part of the district covered by thick quaternary alluvium, showing both single or

double sand zones grading from fine medium to coarse, with alternate clay lenses. As per drilling data, in the northern and central part thickness of sand layer generally less thick than clay layer. In the southern part thicker sand layer is present. Subsurface lithological information extracted from exploration data has been shown ***Table 2.2.*** Data showing the depth of drilling of each location and granular zone/ fracture tapped. Tabulated data shows that within 150 m depth maximum 5 to 6 granular/fracture zone is present.

Table 2.2: Subsurface granular zone/fracture tapped

Sl.	Block	Location	Depth drilled m bgl	Granular zone/ fracture tapped (m)		Thickness
				From	To	
1	Barbigha	Barbigha	200	31	43	12
				79	85	6
				103	115	12
				133	145	12
				169	182	13
2	Barbigha	Charuana	153.4	–	–	–
3	Barbigha	Samas	159.5	41.3	53.3	12
				59.3	65.3	6
				86.3	98.3	12
				108	113.9	6
				123	132	9
				138	147	9
4	Sheikhpura	Sheikhpura college campus	103	59	60	1
				99	100	1
				103	104	1
5	Sheikhpura	Sheikhpura	107.3	52	64	12
6	Ariari	Nimi	154.6	45.5	48.5	3
				51.5	54.5	3
				87.5	96.5	9
				105.5	117.5	12
				126.5	138.5	12
7	Ariari	Hussainabad	116.94	57.6	61.6	4
				63.6	75.6	12
				90.6	91.6	1
				96.8	99.3	2.5
				105.9	109.3	3.4
				111	114	3

8	Ariari	Ariari	87	20.93	26.98	6.05
				45.98	52.02	6.04
				80	86	6
9	Ariari	Kasar	74	32.5	50	17.5
				60	68	8
10	Ariari	Sohdi	51.7	30	42	12
11	Ariari	Lohan	54.3	28	37	9
				43	49	6
12	Ariari	Chordargah	58.8	32	44	12
				46	55	9
13	Ariari	Beman	47	21	27	6
14	Ariari	Sasbahna	75	46	56	10
				62.5	75	12.5
15	Chewara	Chewara	74.8	33	45	12
				48	54	6
				57	63	6

2.2 Hydrogeochemical Investigation

2.2.1 Water quality sampling, numbering of samples and analysis mechanism

During premonsoon 2019 total 10 nos of ground water samples were collected from dug wells in all over the district. The result of quality of phreatic aquifer is tabulated in ***Table 2.3***

From the above values of different parameters, it is clear that the water all over the district is portable, however in some places the NO3 and K value is beyond permissible limit.

Hardness *(mg/l) as* $caco_3$		*Water Class*
0-75	-	Soft
75-150	-	Moderate
150-300	-	Hard
300-600	-	Very hard
>600	-	Extremely

Table 2.3: Chemical Quality of Phreatic aquifer

SN	Block	location	pH	EC	TH	Ca	Mg	Na	K	HCO3	Cl	SO4	NO3	Fl	TDS
1	Barbigha	Barbigha	7	1038	229.795	34	35.2	119.3	7.81	276.75	117	74.64	5.28	0.4	674.7
2	Barbigha	Keoti	8.4	1047	319.706	42	52.2	74.96	12.23	381.3	89.33	26.37	0	0.6	680.55
3	Barbigha	Koeribigha	8.2	1141	229.86	48	26.7	135.2	31.28	498.15	89.2	19.3	16.2	0.9	741.65
4	Berbigha	Sherpar	8.4	412	104.937	22	12.2	47.26	1.34	153.75	20.81	25.4	0	0.6	267.8
5	Sheikhpura	Nemdarganj	8.3	444	99.9096	18	13.4	61.7	4.39	209.1	18.35	27.3	1.9	0.5	288.6
6	Shekhpura	Shekhpura	8.2	630	184.86	30	26.7	57.39	1.85	282.9	31.05	185.4	26.4	0.4	409.5
7	Barbigha	Ambari	8.2	1645	254.833	56	27.9	127.4	212.8	276.75	139.2	54.36	128.4	0.1	1069.3
8	Sheikhpura	Shekhpura Deole	8	655	199.833	34	27.9	54	2.8	350.55	3.54	8	55	0.4	425.75
9	Berbigha	Sherpar	8.4	390	94.9492	22	9.72	49	0.73	153.75	17.72	20	2.6	0.5	253.5
10	Shekhpura	Shekhpura	8.1	611	179.873	32	24.3	59	2.67	276.75	31.05	21	23.6	0.4	397.15
		Minimum	7.03	387.00	94.95	18.00	9.72	23.00	0.73	122.04	3.54	6.00	0.00	0.11	251.55
		Maximum	8.44	1645.00	319.71	56.00	52.24	135.22	212.80	498.15	139.20	185.37	128.35	0.94	1069.25
		Average	8.10	720.79	190.61	33.29	26.12	64.30	20.65	258.75	55.50	37.34	20.38	0.38	468.51
BIS 2012		*Acceptable limit*	**<6.5**	500	**200**	**75**	**30**	_	**1.9**	**200**	**250**	**200**	**NA**	**1**	_
		Permissible limit (in absence of alternate source)	**>8.5**	2000	**600**	**200**	**100**	_	**50**	**600**	**1000**	**400**	**45**	**1.5**	_

Suitability for Irrigation

The suitability of groundwater for irrigation purpose is based on its chemical characteristics which create soil condition hazardous to crop growth and yield. It depends on the following prevailing criteria: -

Salinity: - Total concentration of soluble salt

Sodicity: Concentration of sodium relative to calcium and magnesium.

Relative proportion of carbonates + bicarbonate to calcium + magnesium.

Based on the above, many methods have been suggested by the scientist/chemist to check its suitability. Some of them are as under:

(i)Sodium Adsorption Ratio (SAR): It is a measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration.

Excessive sodium in irrigation water promotes soil dispersion and structural breakdown but only if sodium exceeds calcium by more than a ratio of about 3:1. Such a relatively high sodium content (>3:1) often results in a water infiltration problem due to soil dispersion and plugging and sealing of the surface pores. In other words higher the SAR lower the rate of infiltration which leads to the problem with crop production.

(ii) Sodium Soluble Percentage (SSP): It is a parameter for classifying irrigation water in terms of soil permeability. Sodium ion in groundwater tends to be exchanged by Mg2+ and Ca2+ of clay particles. This exchange process reduces the permeability of soil. Sodium also combines with chloride and carbonates generating salinity and alkalinity in soil.

(iii) Residual Sodium Carbonate (RSC): It indicates the hazardous effect of carbonate and bicarbonate on the quality of water for agricultural purpose. RSC determines how much unreacted Ca and Mg remain available to counteract any Na present. When Na is present, no residual Ca and Mg remains, but residual carbonates are present, the RSC determines how much additional Ca amendments is required to react with the unreacted carbonate to prevent accumulation of sodium carbonate.

(iv) Kelly's Index: It is measurement of Na+ against Ca2+ and Mg2+ in meq/1. A Kelley‘s index more than 1, indicates an excess level of sodium in water.

(vi) Magnesium Ratio: In general, Ca2 + and Mg2 + maintain a state of equilibrium in water. But the level Mg2 + will be high if exchangeable Na + is present in irrigated soil. In equilibrium, more Mg2 + tends to make the soil alkaline. Thus, it affects the soil quality for crops.

(v) Permeability Index: Permeability of soil is greatly influenced by Na +, Ca2 +, Mg2 +, and Cl– contents of soil, and is affected by long-term use of irrigation water, with high salt content.

The above suggested method wise suitability of groundwater of the area for irrigation purpose is given in the ***Table 2.4***: -

Table 2.4: Suitability of ground water for irrigation

SN	Block	location	Sodium Adsorption Ratio	Sodium Soluble Percentage	Kelley's Index	Magnesium Ratio	Permeability Index
			Na/sqrt(Ca+Mg/2)	***Na*100/Ca+Mg+Na***	***Na/(Ca+Mg)***	***(Mg*100)/(Ca+Mg)***	***Na+sqrtHCo3)/(Ca+Mg+Na)*100***
1	Barbigha	Barbigha	16.60	63.27	1.72	50.89	72.10
2	Barbigha	Keoti	9.08	44.30	0.80	55.43	55.84
3	Barbigha	Koeribigha	17.26	64.41	1.81	35.77	75.04
4	Berbigha	Sherpar	8.92	58.05	1.38	35.58	73.28
5	Sheikhpura	Nemdarganj	12.42	66.30	1.97	42.60	81.84
6	Shekhpura	Shekhpura	8.71	50.29	1.01	47.12	65.03
7	Barbigha	Ambari	15.22	60.27	1.52	33.29	68.15
8	Sheikhpura	Shekhpura Deole	7.80	46.58	0.87	45.11	62.72
9	Berbigha	Sherpar	9.45	60.70	1.54	30.64	76.06
10	Shekhpura	Shekhpura	8.88	51.17	1.05	43.16	65.60
		Minimum	3.01	23.13	0.30	30.64	36.73
		Maximum	17.26	66.30	1.97	57.75	81.84
		Average	9.45	50.06	1.13	43.20	63.83
		Suitable	<10	<50	<1	<50	25-75
		Marginal	NA	NA	1.2	NA	NA
		Not suitable	>10	>50	>2	>50	>75

In Barbigha and Sheikhpura block most of the sample showing SAR, SSP, Mg ration and permeability index value over permissible limit which indicates that ground water may cause some problem for quality of crop produced, because there is some possibility of increasing of alkalinity of ground water. In rest locations, values of all parameters indicate that ground water is suitable for irrigation.

Fluoride concentration:

The graph (***Fig.17)*** shows the area is not fluoride affected as all samples are showing F value within desirable limit.

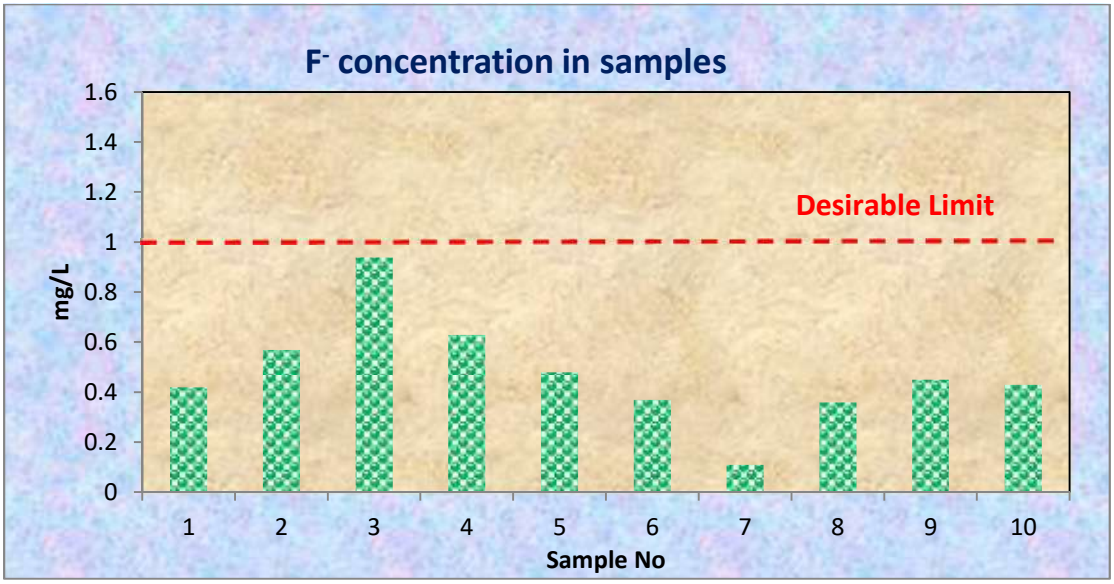


Figure 17: Fluoride concentration plot

USSL diagram:

The United States Soil Laboratory Staff's (USSLS's) diagram classifies the water quality into 16 zones to assess the degree of suitability of water for irrigation (Figure 58.1) in which waters have been divided into C1, C2 C3 and C4 types on the basis of salinity hazard and S1, S2, S3, S4 types on the basis of sodium hazard.

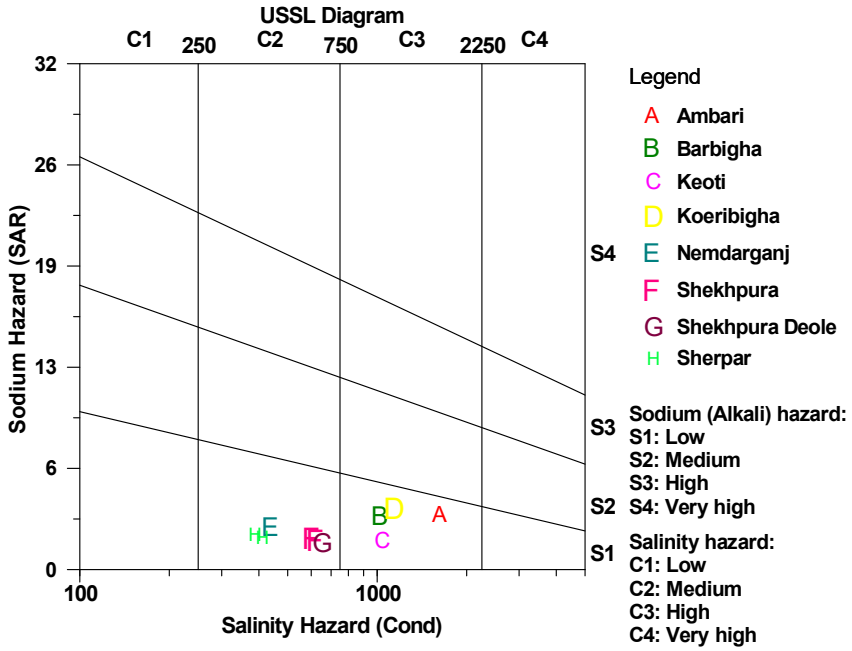


Figure 18: USSL diagram

The salinity hazard classes and the EC value observed has been given below

Classes	*EC (µS/cm)*	*Water salinity*	*No. of samples*	*Percentage of Samples*
C_1	0-250	Low (excellent quality)	--	--
C_2	250-750	Medium (good quality)	4	50
C_3	750-2250	High (permissible quality)	4	50
C_4	2250-600	Very high	--	--

The diagram ***(Fig.18)*** shows 50% of the sample showing category of C1 and rest 50% in category of C2. As per as sodium hazard concern all the samples comes under S1 (low hazard) zone.

Piper diagram:

A Piper diagram is a graphic procedure proposed by Arthur M. Piper in 1944 for presenting water chemistry data to help in understanding the sources of the dissolved constituent salts in water. This procedure is based on the premise that cations and anions in water are in such amounts to assure the electroneutrality of the dissolved salts, in other words the algebraic sum of the electric charges of cations and anions is zero. A Piper diagram is a graphical representation of the chemistry of a water sample or samples. The plot below ***(Fig.19)*** shows the cation-anion proportion of water samples of sheikhpura district. Most of the sample shows relatively high carbonate (anion) proportion and high Ca-Mg (caion) proportion.

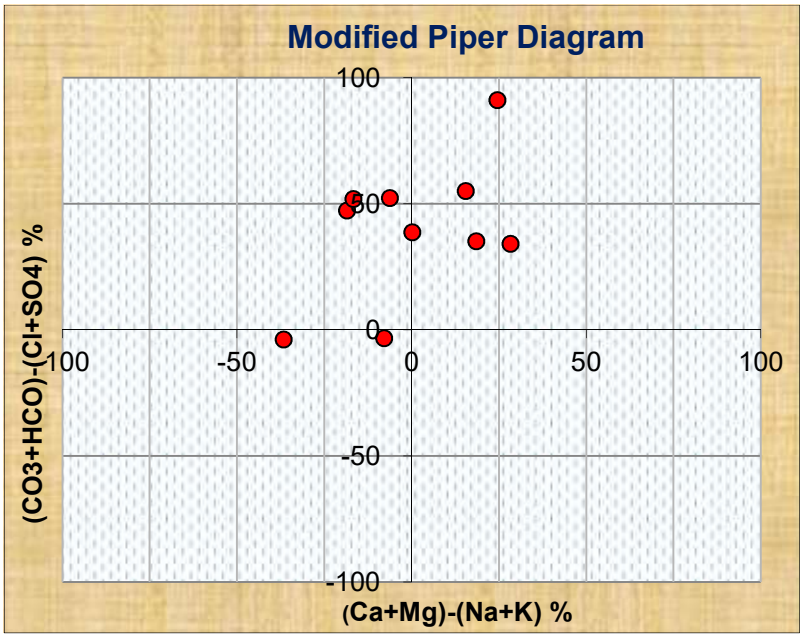


Figure 19: Piper diagram

CHAPTER- 3

GENERATION OF AQUIFER MAPS

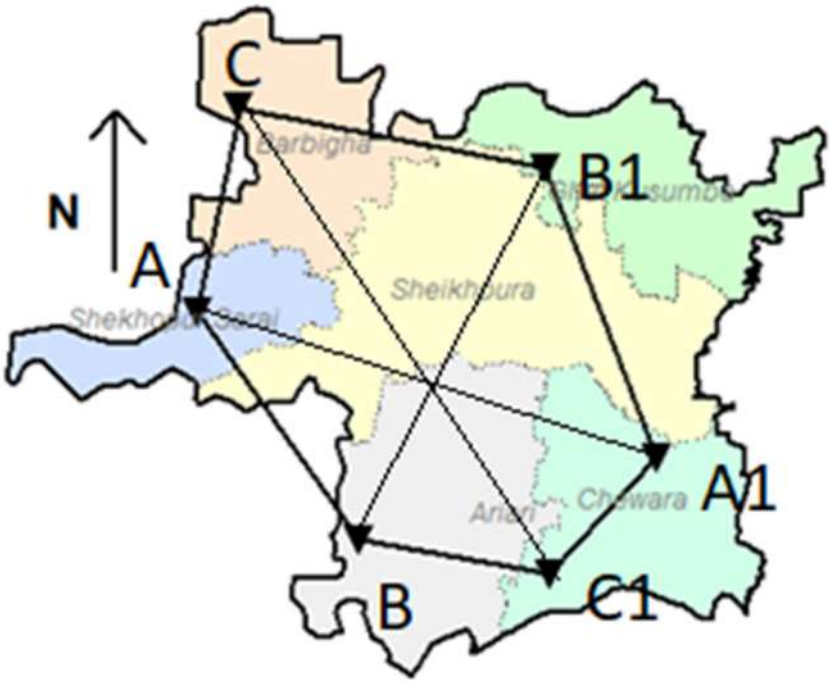
3.1 Aquifer Disposition

Sheikhpura district falls in Phalgu-Kiul sub-basin under Harohar basin. Major part of the district covered by hard clayey formation except small part of newer alluvium. A very small patch like area contains metamorphosed rock like quartzite, quartz schist etc.

Ground water occur both in Alluvium and metasediments. In alluvium ground water is in unconfined condition whereas in metasediments ground water present in the formation due to secondary porosity that is between fault and fractures within rocks.

Aquifer disposition of the area has been studied by different data of drilling sites. From the drilling data different lithology has been prepared which depicts the vertical and lateral orientation of aquifer of the area. Presence of both single and double layered aquifer has been reviled from different panels and lithology. Aquifer made up of fine medium and coarse sand layers separated by clay layers.

The disposition of aquifer has been shown by preparing different cross sections **(*Fig.20,Fig.21 and Fig.22)*** and also 3D panel diagram **(*Fig.23)***, given below:



3.1.1 Hydrogeological Section along A-A1

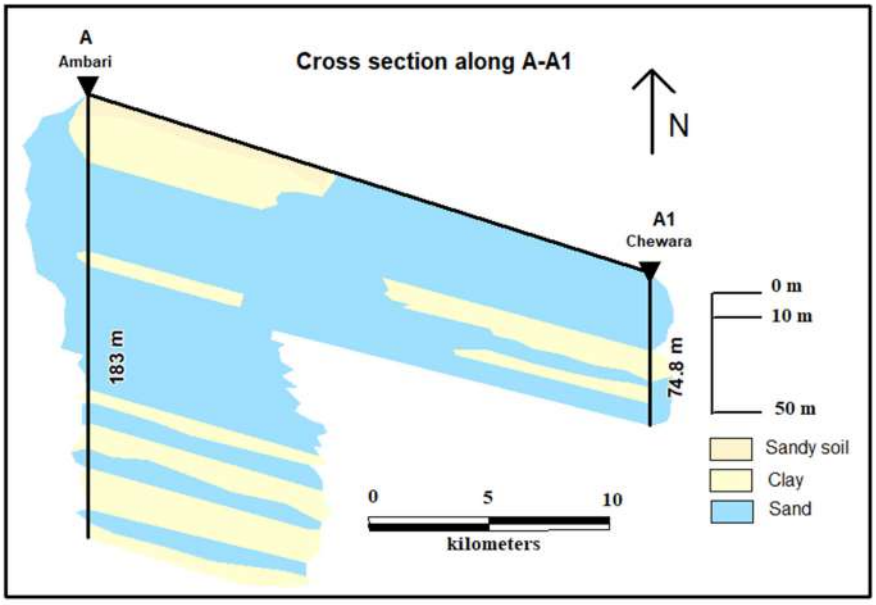


Figure 20: Hydrogeological Section along A-A1

3.1.2 Hydrogeological Section along B-B1

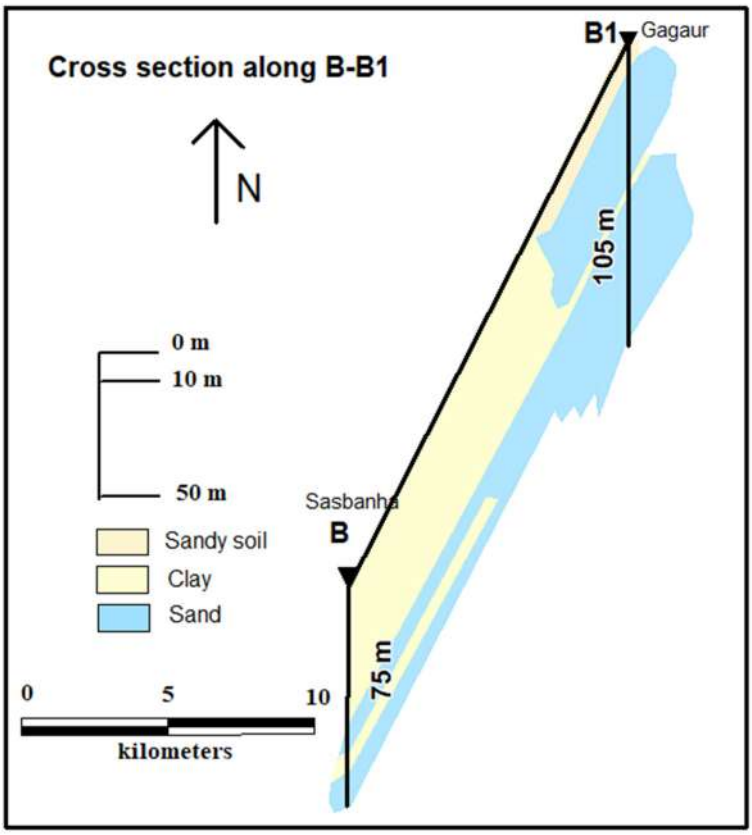


Figure 21: Hydrogeological Section along B-B1

3.1.3 Hydrogeological Section along C-C1

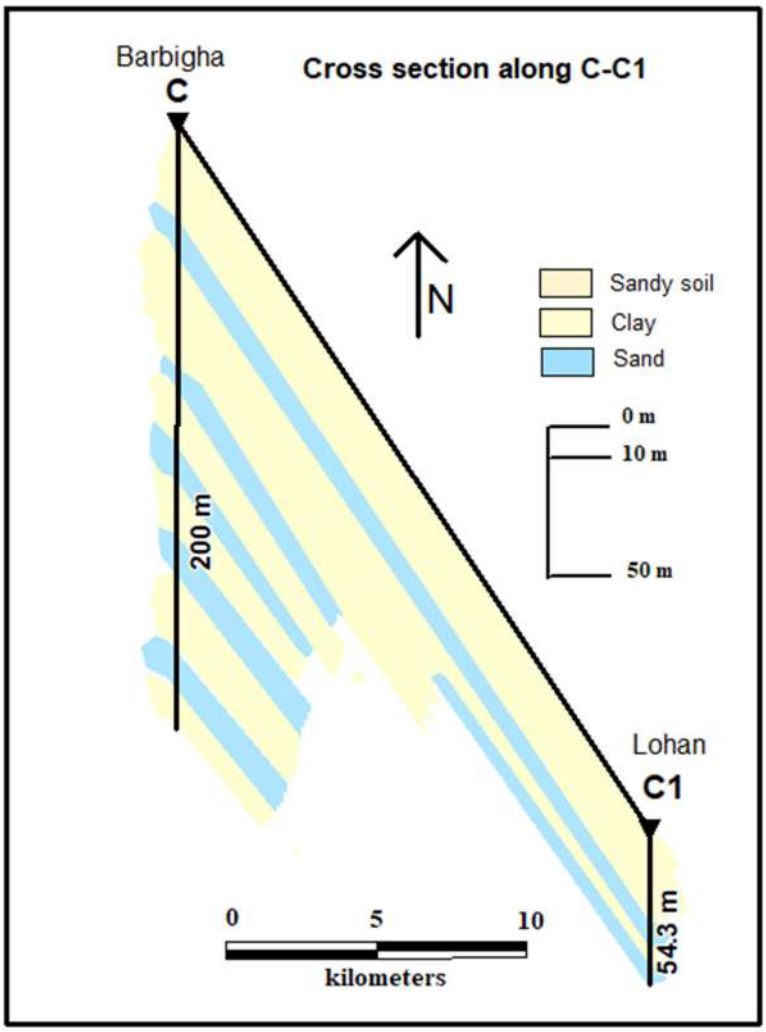


Figure 22: Hydrogeological Section along C-C1

3.1.4 Pannel diagram

One panel diagram ***(Fig.23)*** has been prepared which showing aquifer disposition in Sheikhpura block. As per the panel diagram shows a top thick clay layer (thickness varies from 30m to 45 m) all over the area except north eastern side. In north eastern side (Gangaur) there are two sand layers present within the depth of 105m. 1st and 2nd sand layer is 40m and 50m thick respectively. 1st sand layer occurs at 10 m depth and thickness varies from 17 m to 40 m. The 1st sand layer discontinued on other sides of the panel and 2nd layer continued in different thickness (vary from 7 m to 50 m) and sometimes incorporating clay layers/ patches.

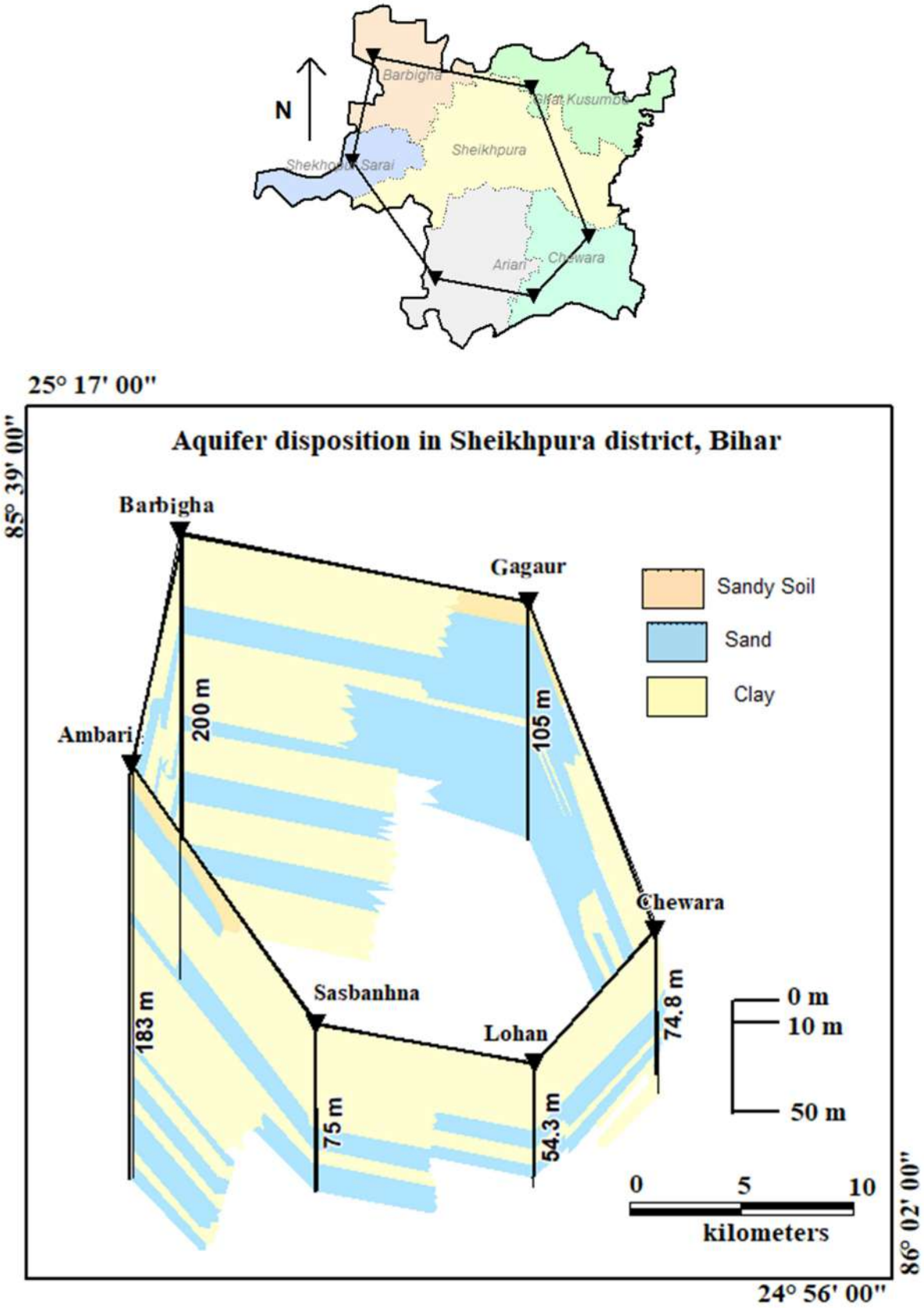


Figure 23: Pannel diagram

3.2 Aquifer Parameters/Pumping Test Results

Aquifer Performance Test (APT) was conducted in exploratory wells in order to determine the aquifer parameters. APT was conducted at constant discharge, and drawdown has been measured at regular intervals. Also the residual drawdown has been measured periodically during recovery. The time-drawdown data has been plotted by using Cooper-Jacob's Straight Line method and using Theis's Recovery Method and transmissivity values are approximated. Average T value has been calculated for each well and enumerated in ***Table 3.1.*** Storativity values are calculated from the time-drawdown data. From the data it can be observed that EW's specific capacity varies from 10.84 m3/hr/m to 36.64 m3/hr/m. one exploratory well in Barbigha showing very high discharge.

Table 3.1: Aquifer Parameters calculated from APT (Existing Data)

Sl..	Location/	Depth	Discharge	Drawdown	Transmissivity	Storativity	Specific capacity
		mbgl.	m^3/hr.	m.	m^2/day		m^3/hr./m.
1	Barbigha	200	247.32	6.75	2250.4	$01.9X10^{-1}$	36.64
2	Sheikhpura	107.3	208	14.2	648	$5.37X10^{-4}$	14.64
3	Nimmie	154.6	188.6	17.4	766.7	$1.9X10^{-4}$	10.84
4	Hussainabad	116.94	160.7	8.38	697.88	$4.05X10^{-4}$	19.17

3.3 Aquifer Characteristics

Ground water occurs under unconfined conditions in the weathered rocks while it is semi confined to confined in fractured rocks. Sheikhpura township area consists of hard rock (mainly quartzite). Total 15 nos of exploratory wells and 8 observation well (fig-24) were constructed in Sheikhpura district. Out of 15, 14 wells are in alluvium area and 1 well is in hard rock area (College campus Sheikhpura). Discharge varies between 7.29 m3/hr to 247.32 m3/hr. In general, groundwater quality of the district sis good and suitable for drinking purposes. The detailed exploration data has been attached in **Annexture II.**

3.4 Aquifer Map

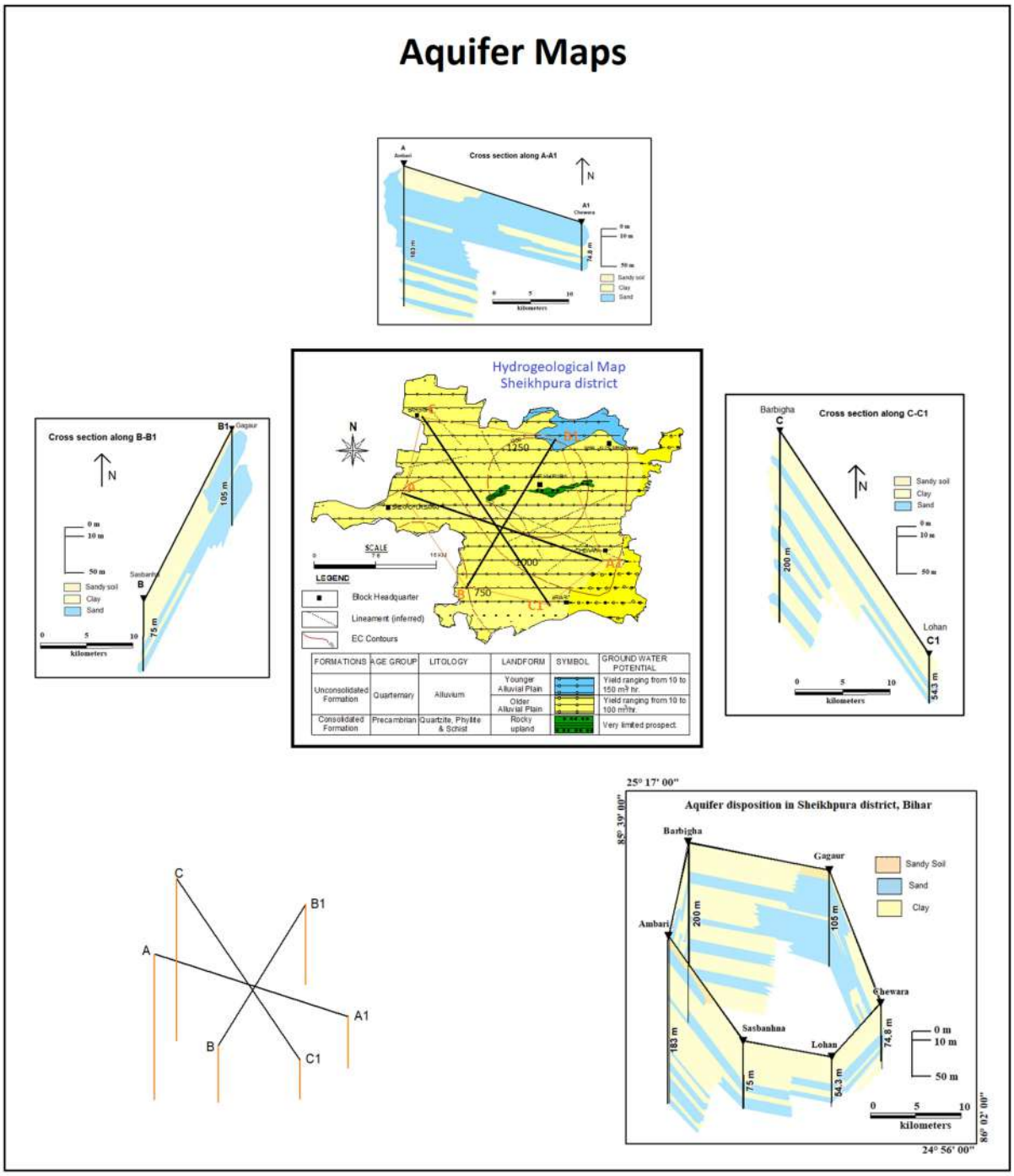


Figure 24: Aquifer Maps

CHAPTER- 4

GROUND WATER RESOURCES

4.1 Dynamic Ground Water Resources

Ground Water Resource of the area has been estimated block wise based on for base year as on 2020. In the present report GEC 2015 methodology has been used and based on the assessment has been made using appropriate assumptions. This methodology recommends aquifer wise ground water resource assessment of both the Ground water resources components, i.e., replenishable ground water resources or Dynamic Ground Water Resources and In-storage Resources or Static Resources. The assessment of ground water includes assessment of dynamic and in-storage ground water resources, but the development planning should mainly depend on dynamic resource only as it gets replenished every year. Changes in static or in-storage resources reflect impacts of ground water mining. Such resources may not be replenishable annually and may be allowed to be extracted only during exigencies with proper recharge planning in the succeeding excess rainfall years.

Assessment of Annually Replenishable or Dynamic Ground Water Resources (Unconfined Aquifer i. e Aquifer-I)

The methodology for ground water resources estimation is based on the principle of water balance as given below –

Inflow – Outflow = Change in Storage (of an aquifer)

The equation can be further elaborated as

ΔS= RRF+RSTR+RC+RSWI+RGWI+RTP+RWCS±VF ± LF -GE-T-E-B

Where,

ΔS – Change is storage, RRF – Rainfall recharge, RSTR- Recharge from stream channels

RC – Recharge from canals, RSWI – Recharge from surface water irrigation

RGWI- Recharge from ground water irrigation, RTP- Recharge from Tanks & Ponds

RWCS – Recharge from water conservation structures, VF – Vertical flow across the aquifer system, LF- Lateral flow along the aquifer system (through flow), GE-Ground Water Extraction, T- Transpiration, E- Evaporation, B-Base flow

The dynamic Ground Water Resources has been assessed by CGWB, MER, Patna in association with State Ground Water Direcorate, Bihar based on GEC, Methodology 2015. The summarized detail of Annually Replenishable or Dynamic Ground Water Resources of Sheikhpura district is in ***Table 4.1.*** Other details information regarding Dynamic Ground Water Resources of Godda district is provided in Annexure-VII.

Table 4.1: Block-wise Net Annual Ground Water Availability

SN	Administrative Units	Recharge from Rainfall		Recharge from Other Sources		Total Annual Ground Water Recharge	Provision for Natural Discharges	Net Annual Ground Water Availability
		Monsoon	Non-monsoon	Monsoon	Non-monsoon			
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)
1	Ariari	3230.27	148.28	783.24	431.25	4593.04	459.3	1582.27
2	Barbhiga	2058.65	94.5	87.35	81.79	2322.29	232.23	1211.16
3	Chewara	2534.44	116.34	404.95	344.64	3400.37	340.04	1061.61
4	Ghat Kusumba	2039.49	93.62	178.54	114.72	2426.37	242.63	1474.75
5	Sheikhpura	2624.27	120.46	193.72	183.98	3122.43	312.24	1328.81
6	Shekhopur Sarai	1214.79	55.76	677.05	402.2	2349.8	234.98	799.36
	Total	13701.91	628.96	2324.85	1558.58	18214.3	1821.42	7457.96

Table 4.2: Blockwise Stage of Ground Water Development

SN	Administrative Units	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground Water Draft for Domestic Uses	Existing Gross Ground Water Draft for Industrial Uses	Existing Gross Ground Water Draft for All Uses	Provision for Domestic and Industrial Requirement for Next 25 years	Net GW Availability for Future Irrigation Development	Stage of Ground Water Development
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(%)
1	Ariari	1582.27	2226.58	193.07	108.00	2527.66	216.88	1582.27	61.15
2	Barbhiga	1211.16	383.05	393.35	54.00	830.4	441.85	1211.16	39.73
3	Chewara	1061.61	1766.92	126.22	90.00	1983.15	141.79	1061.61	64.80
4	Ghat Kusumba	1474.75	588.43	83.29	27.00	698.72	93.56	1474.75	32.00
5	Sheikhpura	1328.81	798.7	559.68	54.00	1412.37	628.69	1328.81	50.26
6	Shekhopur Sarai	799.36	1112.87	116.26	72.00	1301.13	130.59	799.36	61.52
	Total	7457.96	6876.55	1471.871	405	8753.43	1653.36	7457.96	53.40

As per the "Dynamic ground water resource" calculation of Bihar, 2020, the figures for Sheikhpura district are in the ***Table 4.1*** and ***Table 4.2.*** As per the data the SOD (Sage of development) of the district is 53.40%. Block-wise SOD value varies from 32.00% (Ghat kusumba block) to 64.8% (Chewara). All blocks of Sheikhpura district are in "safe" category.

4.2 Static Ground water Resources

In-storage groundwater resource of unconfined aquifer has been estimated and given in ***Table 4.3***. The exercise has been carried out block-wise based on available data. Specific yield has been taken as per the prescribed norms in GWRE-2020. Static resource of Sheikhpura district is estimated to be 0.85 BCM. Highest static resource is estimated in the prolific aquifers of Ariari block, while low static resource is estimated in Sheikhopursarai block.

Table 4.3: Estimated In-storage resource of first aquifer in Sheikhpura district

Sl. No.	Block	Lithology	GW Worthy Area (ha)	Bottom of Unconfined Aquifer (m bgl)	Pre-Monsoon Water Level (m bgl)	Specific Yield	In-Storage Resource (ham)	In-Storage Resource (BCM)
1	Ariari	Alluvium	14665	55	7.1	0.04	28098.14	0.28
2	Barbhiga	Alluvium	9346	45	6.89	0.04	14247.04	0.14
3	Charware	Alluvium	11506	35	6.9	0.04	12932.74	0.13
4	Ghat kusumba	Alluvium	9259	50	2	0.04	17777.28	0.18
5	Sheikhpura	Alluvium / Hard Rock	15968	20	8.5	0.04	7345.28	0.07
6	Shekhopur sarai	Alluvium	5515	30	7	0.04	5073.8	0.05
Total							**85474.29**	**0.85**

CHAPTER- 5

GROUND WATER RELATED ISSUES

5.1 Identification of issues

The net ground water availability of Sheikhpura district is 7457.96 ham and stage of ground water development is 53.40%, and when look into block-wise stage of development all 6 blocks are in “safe” category. That means overall there is large scope of ground water extraction of the district.

The comparison of MI Census data of 5th with respect to 4th shows the use of deep tube wells is gradually increasing and use of shallow tube wells decreasing in almost all blocks of the district.

Cropping intensity varies from 132 to 219 only. Higher percentage of area is being irrigated by surface water.

Except some few places (Barbigha and Keoti) the ground water may be used for irrigation and domestic purpose.

All the data shows the ample scope of ground water development throughout the district.

5.2 Major Ground Water Issues

Since all the blocks of the district is in “safe” category in ground water resource point of view, there is wide scope of further development of ground water. Almost all the blocks are of low cropping intensity value, and irrigation is mostly done by using surface water, the ground water may be used for irrigation purpose, more cultivation and more crop production.

The cross sections showing aquifer disposition, says there is monolayer and double layered aquifer present in the district, in some places bed rock encountered. The layered aquifers are overlain by thick clay layers in most of the places, especially in south and east part. Therefore for sustainable source of water deeper tube wells may be used abundantly than shallow tube well. The comparison of MI Census data of 5th with respect to 4th shows the use of deep tube wells is gradually increasing and use of shallow tube wells decreasing in almost all blocks of the district.

CHAPTER- 6

MANAGEMENT STRATEGIES

6.1 Supply side management plan

All 6 blocks of Sheikhpura district is under "safe" category, with stage of development range from 32% to 64.80% only. means there is scope of further development of Ground Water.

6.1.1 Ground Water Development strategies

Ground water may be developed further by constructing additional number of tube wells. Considering the unit draft of 1.5 ham of a tube well, additional number of tube wells may be calculated up to the projected SOD of 70%.Based on the above, block wise additional number of tube wells has been calculated and given in the ***Table 6.1.***

Table 6.1 Further scope of Development of Ground Water:

		GW Resources Position in Bihar as per GW Resource Estimation - 2020					**Calculation for additional TW**		
Sl.	*Block*	*Total Annual Recharge*	*Net Resource*	*Gross Draft All Uses*	*Provision for Future Domestic and Industrial Requirement*	*SOD% 2020*	*GW draft at Projected SOD (70%)*	*Additional Resource Available*	*Additional Nos. of STW feasible based on GW availability*
1	Ariari	4593.04	4133.74	2527.66	216.88	61.15	2893.62	1023.24	682
2	Barbhiga	2322.29	2090.06	830.4	441.85	39.73	1463.04	185.17	123
3	Charware	3400.37	3060.33	1983.15	141.79	64.80	2142.23	776.31	518
4	Ghat Kusumba	2426.37	2183.74	698.72	93.56	32.00	1528.62	561.56	374
5	Sheikhpura	3122.43	2810.19	1412.37	628.69	50.26	1967.13	214.37	143
6	Shekhopur Sarai	2349.8	2114.82	1301.13	130.59	61.52	1480.37	503.86	336
	Total	18214.3	16392.88	8753.43	1653.36	309.4595	11475.02	3264.5	2176.336

6.1.2 Artificial recharge to ground water

As per ground water resource 2020 though all the 6 blocks of the district is under safe category, in some blocks (Ariari, Chewara, Sheikhpura and Sheikhpurosarai) stage of development is above 40% and an overview of 5th MI and 4th MI cencus data of Sheikhpura district shows decrease in number of dugwell and shallow tube wells and increase in number of deep tube wells in almost all blocks and all over the district. It indicates the development of deeper aquifer is more than shallow aquifer. All the data concludes that phreatic aquifer being dried out

gradually and deeper auifer are being exploited to meet all industrial, irrigation and domestic needs of Sheikhpura district. Therefore, artificial recharge may be implemented for aquifer management or to balance aquifer stress. Details norms given in ***Table 6.2.***

Table 6.2 Details of Norms adopted for Artificial Recharge Structures in Bihar

Terrain Type	Recharge Structure Type	Recharge	Unit Cost (inLakh)
Hard Rock Area	Percolation Tank	20%	30
	Gully Plug	20%	0.4
	Contour Bunding&Trenching	40%	2
	Check Dam	30%	20
Marginal Alluvial Area	NalaBunding	20%	1
	Contour Bunding& Trenching	20%	2
	Recharge Shaft	25%	5
	Percolation Tank	35%	30
Alluvial Area	De-silting of existing tank /pond /talao	50%	5
	De-silting of Mauns (Ox-bow Lake)	<1%	100.0 /100 ha
	Injection Well in Village Tank	10%	4
	Renovation of traditional Ahar-Pyne System	40%	20.0 / Km
Urban Areas	Roof-top Rain Water Harvesting Structures	80%	1
	De-silting and revival of existing ponds	20%	10

Source: Master Plan for Artificial Recharge to ground water in India 2020
(http://cgwb.gov.in/Master%20Plan%20to%20GW%20Recharge%202020.pdf)

Table 6.3 Scope of Artificial Recharge in Sheikhpura district

Area of District (Sq.Km.)	Area Identified for AR (Sq.Km.)	Volume of Unsaturated Zone (MCM)	Available Subsurface Space for AR (MCM)	Water Required for Recharge (MCM)	Surplus Available for Recharge (MCM)
688.09	382.3	1917.7	153.42	236.27	448.38

Source: Master Plan for Artificial Recharge to ground water in India 2020
(http://cgwb.gov.in/Master%20Plan%20to%20GW%20Recharge%202020.pdf)

Artificial Recharge and Cost Estimates:

Rural Areas

Considering hydrogeological diversities among different areas of Sheikhpura district, a simplified and generalized norm has been adopted where design and efficiency of individual artificial recharge structure has been defined specific to the existing terrain types in the district. Terrain-wise norms adopted along with unit cost estimates for different types of structures are

given in ***Table 6.2*** in Sheikhpura district there are alluvium, marginal alluvium, and hard rock area. Different type of artificial recharge structure may be used as per area type, amongst all, recharge by Ahar-Pyne system is very common in South Bihar. These structures, if revitalized would assist immensely in water conservation as groundwater recharge in South Bihar.

Table 6.4 Number of Artificial recharge structures and Cost Estimates in Sheikhpura district

Districr -Sheikhpura	Number of Artificial Recharge Structures	Cost of Artificial Recharge Structures (Lakh)
Percolation Tank	0	0
Gully Plug	0	0
Contour Bunding& Trenching	0	0
Check Dam	0	0
NalaBunding	5	5
Contour Bunding& Trenching	37	74
Recharge Shaft	74	374
Percolation Tank	3	90
De-silting of existing tank /pond /talao	134	670
De-silting of Mauns (Ox-bow Lake)	0	0
Injection Well in Village Tank	179	716
Renovation of traditional Ahar-Pyne System	41	820
Roof-top Rain Water Harvesting Structures	800	800
De-silting and revival of existing ponds	4	40
Total		**3585**

Source: Master Plan for Artificial Recharge to ground water in India 2020 (http://cgwb.gov.in/Master%20Plan%20to%20GW%20Recharge%202020.pdf)

The proposed plan envisages utilization of 236.27 MCM (Table 6.3) of source water for recharge purpose through different structures. On the basis of the norm, number of structures has been worked out based on gross storage capacity of individual structure. Numbers of various types of artificial recharge structures and cost estimate in Sheikhpura are given in Table 6.4. As per estimate, 5 Nala Bunding, 37 Contour Bunding & Trenching, 74 Recharge Shaft and 3 Percolation Tank may be created to enhance groundwater recharge. On the other hand, in alluvial tract of Sheikhpura, augmentation of groundwater resource may be achieved through renovation of natural

and man-made surface water structures. It is proposed that, De-silting of existing 4 village tanks /ponds /talaos, Injection Well creation in 179 Village Tanks, and Renovation of 41 km of traditional aharpyne System may result in expected rise in water table. However, actual numbers of structures implementable may vary significantly based on scale of implementation. Total cost of work has been estimated to be Rs. 35.85 crore

Urban Areas

In urban areas, two aspects are considered, viz., revival of urban water bodies and roof top rainwater harvesting. Total cost for revival of 4 existing surface water bodies (ponds) with an estimated cost of Rs. 40 Lakhs (***Table 6.4***), whereas construction of 800 rainwater harvesting structures costs Rs. 800 lakh. The total cost estimate for artificial recharge in Sheikhpura district is Rs 3585 Lakh with a break up of Rs 2745 Lakh for rural areas & Rs 840 Lakhs for urban areas (***Table 6.4***).

6.2 Demand side management plan

The Stage of development of 4 blocks of Sheikhpura district is above 60% and as per census data water of shallow aquifer is being used more. Micro irrigation practices may be adopted, and at the same time coordinated use of surface and ground water for irrigation purpose is required for management. On the other hand cropping intensity of the district varies from 132 to 219 only. For this, crop rotation may be applied in agriculture.

CHAPTER- 7

SUM UP – DISTRICT FINDINGS

Sheikhpura district is a part of Munger Division. Sheikhpura was separated from Munger District and was made a separate district with headquarter at Sheikhpura on 31 July 1994. The district is situated almost middle part of South Bihar Plane. During 2019-20 the district Sheikhpura has been taken for National Aquifer Mapping

Sheikhpura district is located on global map between 24º45′ and 25º North Latitude and 85º45′ and 86º45′ East longitude, comes under Survey of India Toposheet No. 72 G/11,12,15 & 16, H/13, K/4. Elevation of the area ranges from 37 m and 187.5 m above mean sea level. The district occupies an area of 689 square kilometers, covering 6 administrative blocks. Total population is 636342.

The district is part of Mid-Ganga basin, in the southern margin of the Gangetic plains. The Major rivers are Harohar and Sakri river. The district mainly represents flat alluvium terrain except some hilly area in the middle part. Maximum land utilization is under agricultural purpose. The main crops produced are rice wheat etc. and irrigation mainly done by surface water.

The water level behavior has been analyzed from NHS monitoring data. Pre-monsoon depth to water level varies from 2 to 10.5 m bgl whereas post-monsoon depth to water level varies from 1.37 to 6.6 m bgl. Looking into long term water level trend most of the data shows falling trend both pre and post monsoon. Ground water flow direction is towards NE direction.

Coming to Geologic and hydrogeologic point of view the district contains formation of Mesoproterozoic (Quartzite, Quartz schist etc) to Holocene (Alluvium) age. Ground water occurs both in Alluvium and metasediments. Exploration data shows the characteristics of aquifer in both formations. Total 15 number of drilling has been done upto depth of 190 m. In alluvium ground water is in unconfined condition and discharge varies from 25 to 65 lps, whereas in metasediments ground water present in the formation due to secondary porosity where discharge ranges from 1 to 10 lps with drawdown of 12-18 m. Specific capacity varies from 10.84 m3/hr/m to 36.64 m3/hr/m.

Aquifer maps shows clay layer (thickness varies from 30m to 45 m) all over the area except north eastern side. In north eastern side of the district (Gangaur) there are two sand layers present within the depth of 105m. 1st and 2nd sand layer is 40m and 50m thick respectively. 1st sand layer occurs at 10 m depth and thickness varies from 17 m to 40 m. The 1st sand layer discontinued on other sides of the panel and 2nd layer continued in different thickness (vary from 7 m to 50 m) and sometimes incorporating clay layers/ patches.

In Sheikhpura district the deeper aquifer is being used more and cropping intensity is much low. Therefore as management the shallow tube wells may be used for irrigation and other purposes. Total 2176 no of STW and other artificial recharge structure may construct to recharge deeper aquifer. Micro irrigation practices may be adopted, and at the same time coordinated use of surface and ground water for irrigation purpose is required for management. The ground water is potable for drinking and irrigation purposes except some few places.

CHAPTER- 8

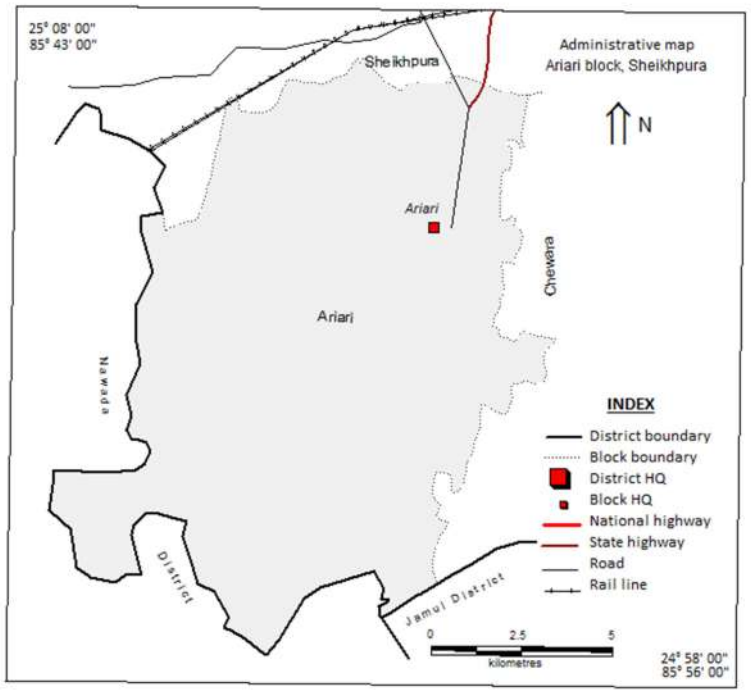
BLOCK-WISE AQUIFER MAPS AND MANAGEMENT PLAN.

8.1 Ariari block

8.1.1 Salient Information

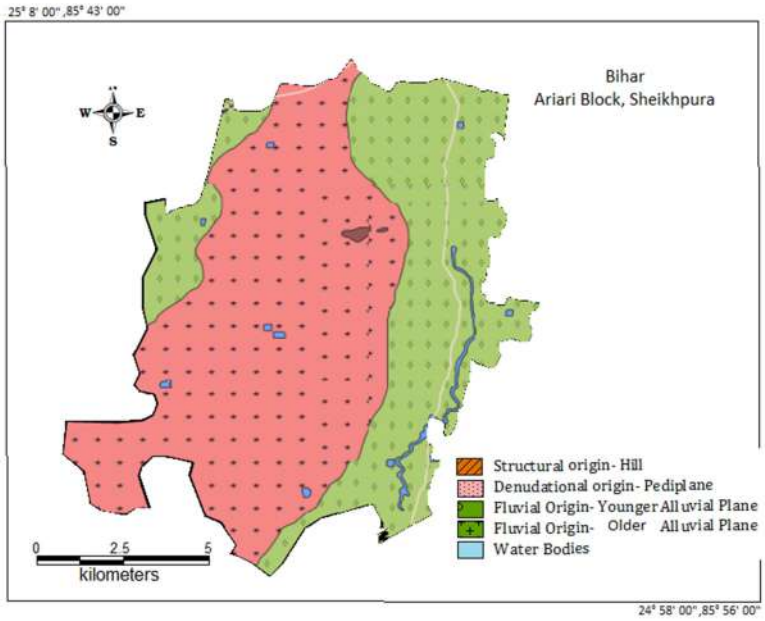
1.	Name of the block and area			Ariari - 146.63 Sq. Km
2.	District/State			Sheikhpura/ Bihar
3.	Population (2011)	Total	:	112070
		Rural		112070
		Urban		0
4.	Normal rainfall (District)	(mm)	:	716.7
5.	Agriculture and irrigation			Main crops are Paddy, Wheat, oil seeds etc. Gross irrigated area: 7001Ha Net irrigated area: 3431 Ha Rainfed area: 7801 Ha GW Extraction structure: (5^{th} MI) DW : 9 STW : 1148 DTW : 18
6.	Ground water resource availability and extraction	As per 2020 Resource Calculation	:	Net GW Availability: 1582.27 ham Gross GW Draft : 2527.66 ham
7.	Existing and future water demand		:	For next 25 years: 216.88 ham
8.	Water level behaviour	Depth to water level		Pre-monsson : 5 to >10 m bgl Post-monsoon : 2 to 10 mbgl
9.	Basin / Sub-basin		:	Gandak and others

The Aiari block of Sheikhpura district is surrounded by Sheikhpura Block in the North, Chewara Block in the East, District Boundary, Nawada in South-West and Jamui in South. Block headqarter is in Ariari.



Geomorphology

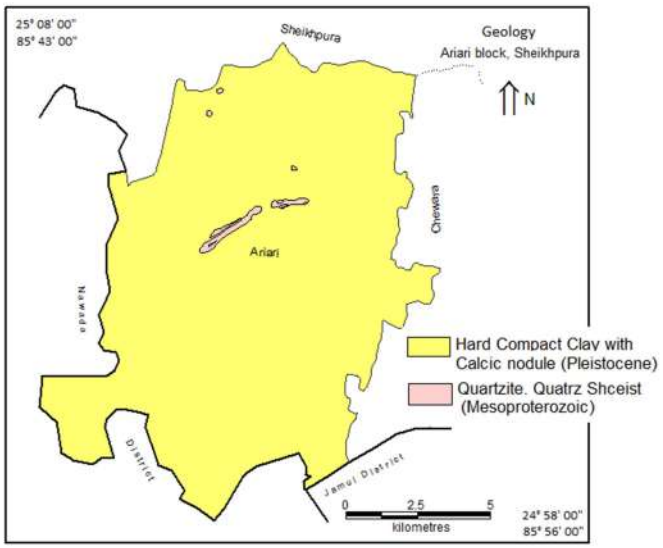
Ariari block is a part of Mid-Ganga basin. Small middle part of the block contains hilly area. The major part of the district is covered by pediplanes of denudational origin, surrounding the hilly area. A small western part and eastern part of the block covered by younger alluviums. Very small patch like area of the block covered by water bodies.



Source: https://bhuvan.nrsc.gov.in/home/index.php

Geology

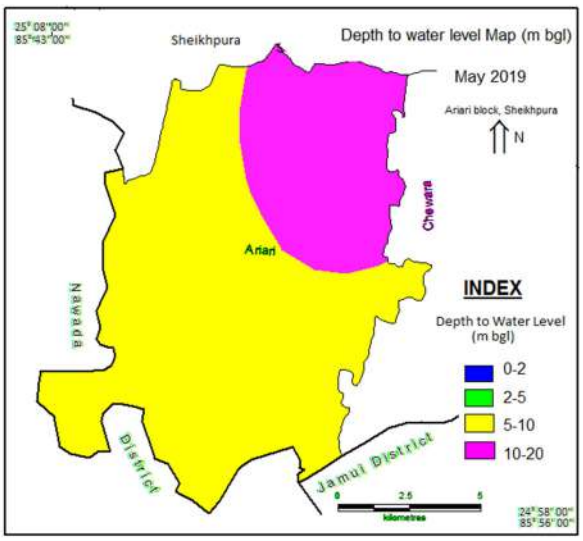
Major part of the block is covered by newer alluvium of Pleistocene age identified by the presence of hard clay and calcic nodules, except some metasediments –quartzite, quartz schist in the middle part.

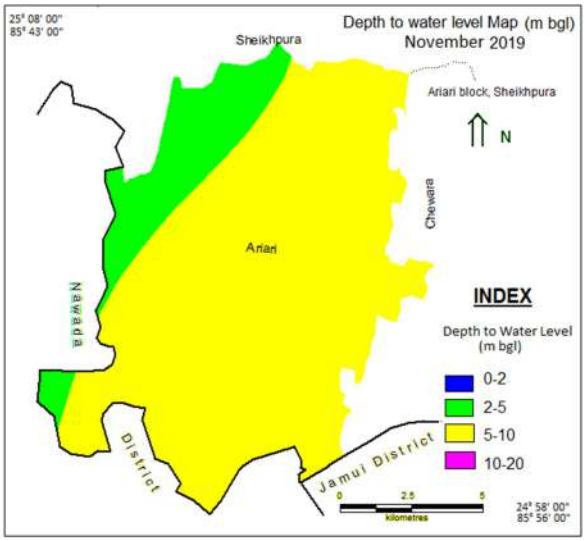


Source: Geological Survey of India

Depth to Water Level

There is one National Hydrograph monitoring station in Ariari block. Depth to water level map of both pre and post monsoon 2019 shows that maximum part of the block has depth to water level within the range 5-10 m.





Location	Latitude	Longitude	Depth to Water Level (m bgl)		Elevation (m amsl)	Fluctuation	Depth	RL
			May-19	Nov-19				
Ariari	25.049	85.860	7.1	6.26	58.8	0.84	10.5	51.7

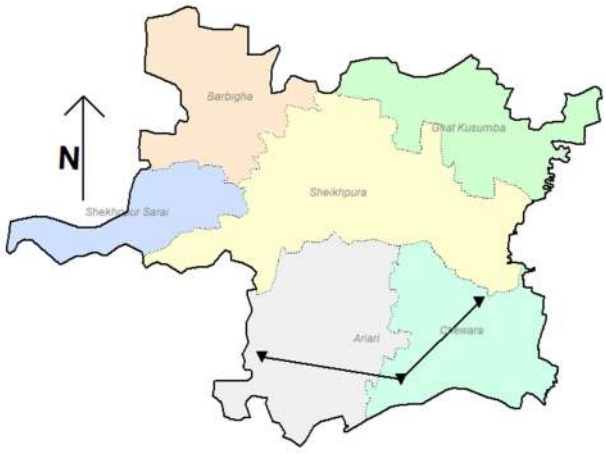
Soil

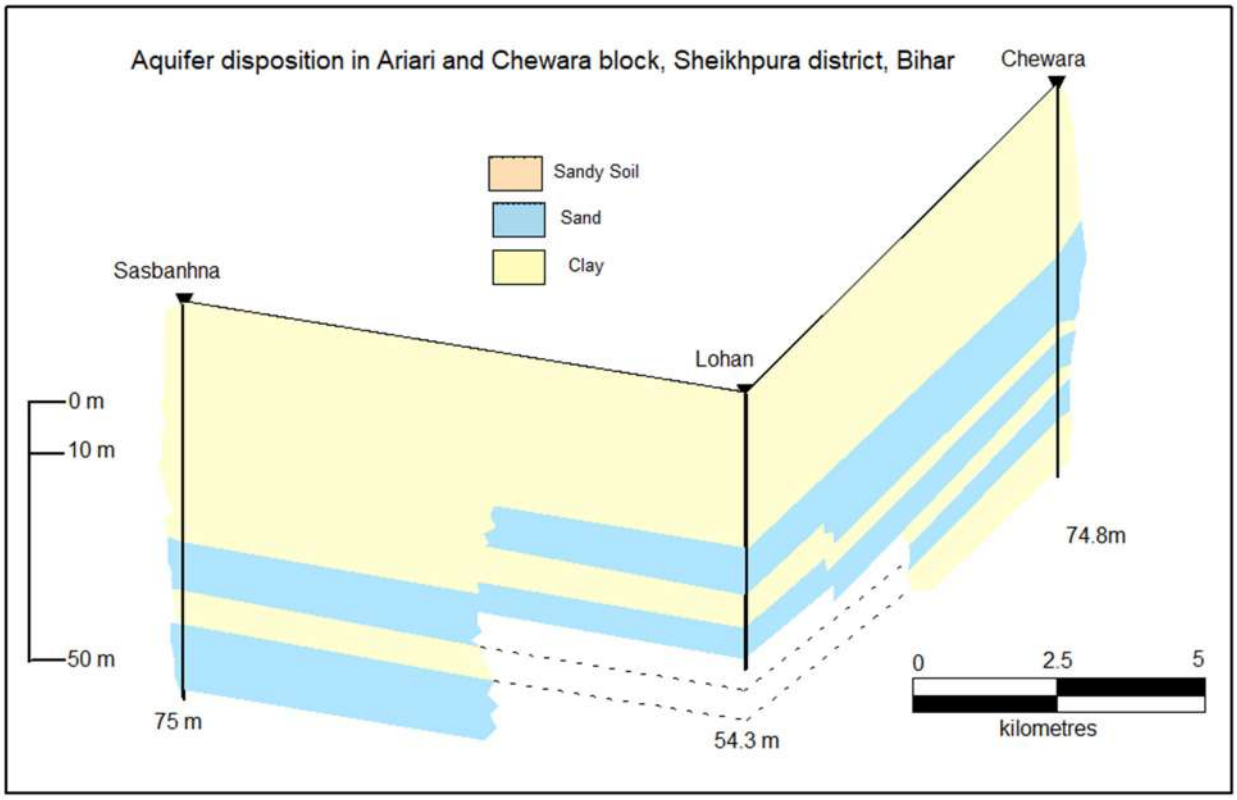
Re-prepared map from 'District Irrigation Plan' reveals that Ariari block can be divided into three types of soil classes based on soil texture. Fine soil is found along the river Sone. Very fine soil covers the central part of the block. Fine loamy soil is found in small south-eastern part of the block.

8.1.2 Aquifer Disposition and Characteristics

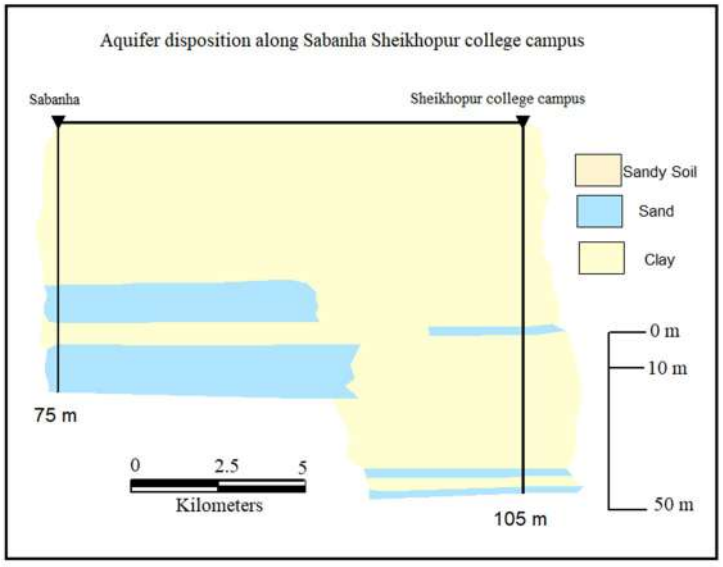
Two sections along Sabahna – Lohan – Chewara and Sabanha - Sheikhpura college campus has been prepared, which shows the disposition of different formation of southern and western part of Ariari block. In western part the cross section Sabanha - Sheikhpura college campus shows top 45 m thick clay layer, below that two sand layer of 10 m and 14 m thickness respectively, again separated by 6 m clay layer. When proceeding towards northern part, i.e towards sheikhpura block, the clay layer is of 100 m thickness incorporating three thin sand patches of 1m – 2m thickness.

The cross section along Sabahna – Lohan – Chewara, shows aquifer disposition of southern part of Ariari block. The thick (45 m) clay layer in Sasbahna become thinner (30m) towards east and 8 m thick sand layer appears in comparatively shallower depth (30m). One more 7 m thick sand layer present below that which is separated by 7 m thick clay layer.




Aquifer disposition in Ariari and Chewara block, Sheikhpura district, Bihar
Chewara
Sandy Soil
Sand
Clay
Sasbanhna
Lohan
0 m
10 m
50 m
74.8m
75 m
54.3 m
0
2.5
5
kilometres


N
Barbigha
Sheikhpura
Ariari
Chewara
Bhat Kusumba


Aquifer disposition along Sabanha Sheikhpur college campus
Sabanha
Sheikhpur college campus
Sandy Soil
Sand
Clay
0 m
10 m
50 m
75 m
105 m
0
2.5
5
Kilometers

The exploration data in Ariari bloxk says discharge varies from 7.29 to 46.9 m3/hr. transmisivity varies from 5.25 to 375

8.1.3 Ground water resource, extraction, contamination and other issues

Ground Water Resources - 2020

About 21.22 % of the net ground water availability of Sheikhpura district is available in Ariari block. The existing gross ground water draft for irrigation in Ariari block is highest in the district. The SOD is 61.15 % whereas of the district SOD is 53.40 %. The block is in "safe" category. So there may be a little scope for further development of ground water.

In ham

Administrative Units	*Recharge from Rainfall*		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Provision for Natural Discharges*	*Net Annual Ground Water Availability*
	Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
	(ham)	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*
Ariari	3230.27	148.28	783.24	431.25	4593.04	459.3	1582.27

Table 4.2: Blockwise Stage of Ground Water Development

Administrative Units	*Net Annual Ground Water Availability*	*Existing Gross Ground Water Draft for irrigation*	*Existing Gross Ground Water Draft for Domestic Uses*	*Existing Gross Ground Water Draft for Industrial Uses*	*Existing Gross Ground Water Draft for All Uses*	*Provision for Domestic and Industrial Requirement for Next 25 years*	*Net GW Availability for Future Irrigation Development*	*Stage of Ground Water Development*
	(ham)	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(%)*
Ariari	1582.27	2226.58	193.07	108.00	2527.66	216.88	1582.27	61.15

Chemical quality of Ground Water

Chemical analysis of nearby blocks shows the ground water of Ariari block is potable and may be used for irrigation purpose too.

8.1.4 Supply side management

Dynamic Ground water resource of Ariari block has been assessed as 1582.27 ham.The stage of Development is 61.15%. Therefore there is scope of ground water development. Ground water may be developed further by constructing additional number of tube wells. Considering the unit draft of 1.5 ham of a tube well, additional number of tube wells may be calculated up to the

projected SOD of 70%.Based on the above, block wise additional number of tube wells has been calculated and given in the Table

Block	GW Resources Position in Bihar as per GW Resource Estimation - 2020					Calculation for additional TW		
	Total Annual Recharge	*Net Resource*	*Gross Draft All Uses*	*Provision for Future Domestic and Industrial Requirement*	*SOD% 2020*	*GW draft at Projected SOD (70%)*	*Additional Resource Available*	*Additional Nos. of STW feasible based on GW availability*
Ariari	4593.04	4133.74	2527.66	216.88	61.15	2893.62	1023.24	682

For ground water management, some artificial structure may be constructed in Ariari block. Based on the, geology, geomorphology, depth to water level and surface water availability, the types and number of the artificial recharge structures has been worked out for Ariari block and given in the table below. Based on available literature and previous experiences, unit cost of above structures is also worked out. As per Master plan of artificial recharge 2020, the table is as follows.

Ariari Block			
Recharge Structure		Cost (in Lakh)	Total Cost (Lakh)
Type	Number		
Nala Bunding	2	2	663
Lateral Recharge Shaft	9	18	
Recharge Shaft	26	130	
Percolation Tank	1	30	
De-silting of existing tank /pond /talao	47	235	
Injection Well in Village Tank	62	248	

8.1.5 Demand side management Plan

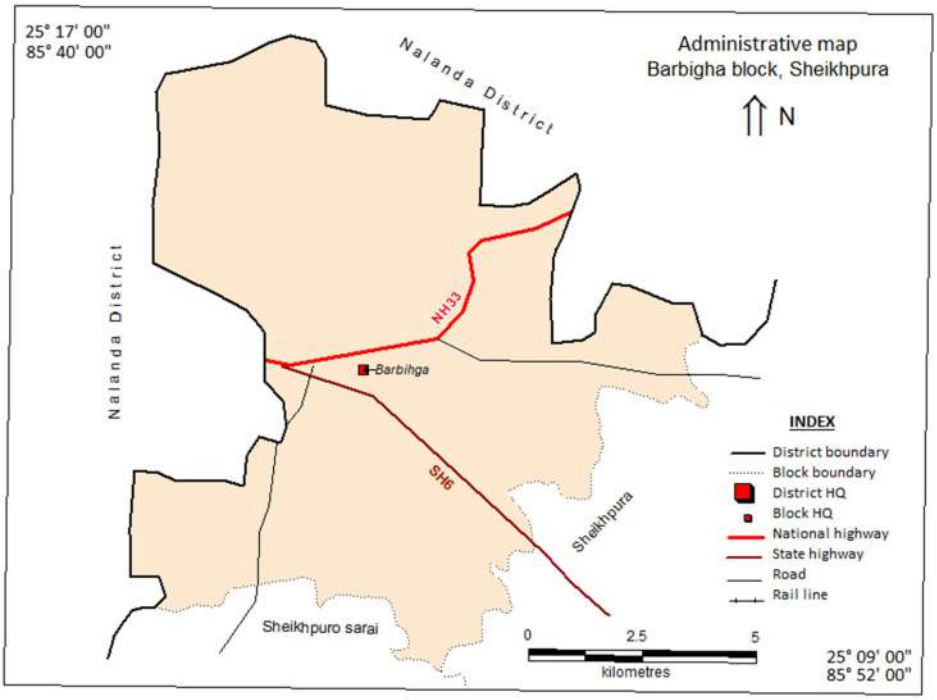
Some advance irrigation practices may be adopted such as drip/sprinkle irrigation etc. lining of field channels, change of cropping pattern also may be taken up for conservation purpose.

8.2 Barbigha block

8.2.1 Salient Information

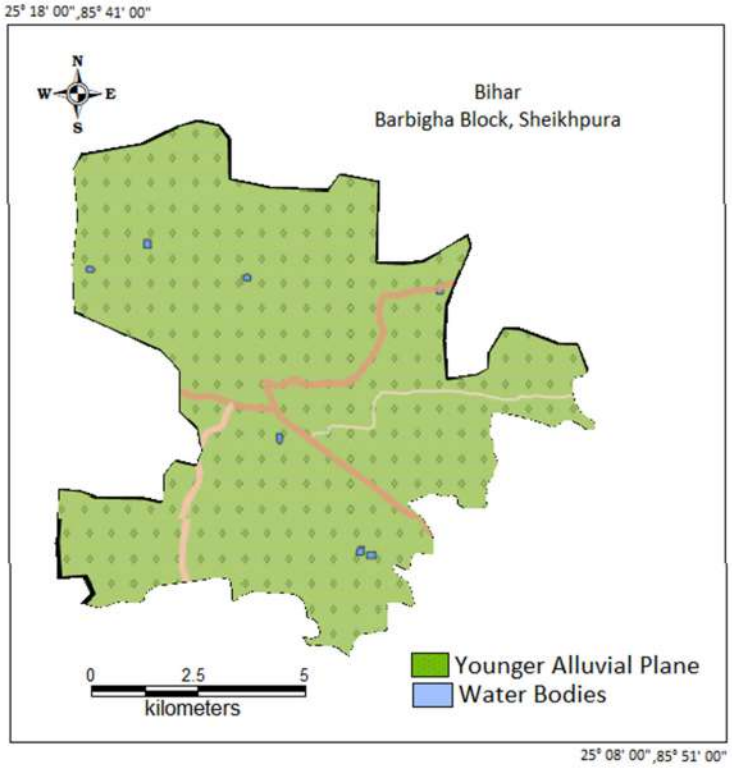
1.	Name of the block and area		:	Barbigha – 94.22 Sq. Km
2.	District/State		:	Sheikhpura/ Bihar
3.	Population (2011)	Total	:	136167
		Rural		90092
		Urban		46075
4.	Normal rainfall (District)	(mm)	:	1087.9
5.	Agriculture and irrigation		:	Main crops are Paddy, Wheat, maize, oil seeds etc. Gross irrigated area: 8508 Ha Net irrigated area: 5367 Ha Rainfed area: 2274 Ha GW Extraction structure: (5th MI) Dug Well : 1 Shallow Tube Well : 172 Deep Tube Well : 50
6.	Ground water resource availability and extraction	As per 2020 Resource Calculation	:	Net GW Availability: 1211.16 ham Gross GW Draft : 830.4 ham
7.	Existing and future water demand		:	For next 25 years: 441.85 ham
8.	Water level behaviour	WL Trend	:	Pre-monsson : - 0.02242 m/yr Post-monsoon : -0.010643m/yr
9.	Basin / Sub-basin		:	Gandak and others

The northern, north eastern and western boundary of Barbigha block shares the boundary of Nalanda district. The north eastern side there is Sheikhpura block and southern side there is Sheikhpurosarai block. The block HQ is in Barbigha. There is one state highway and one national highway passes through the block SH6 and NH33.



Geomorphology

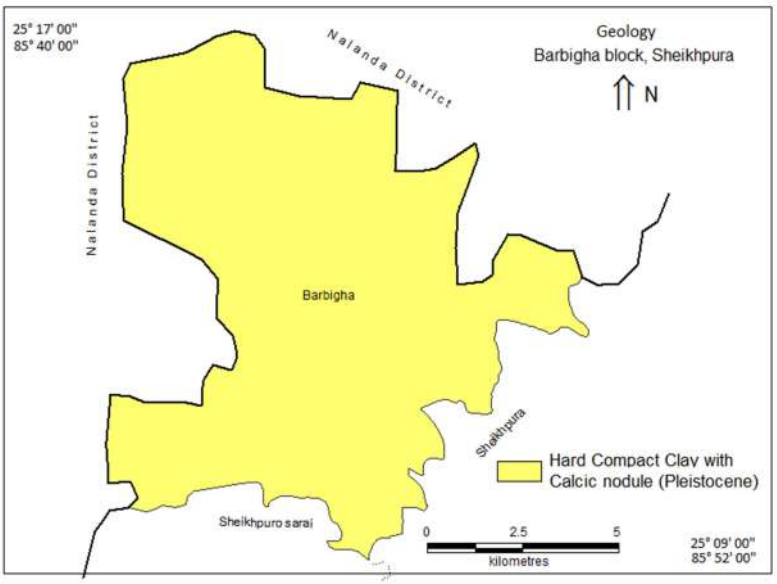
The Barbigha block is a part of Mid-Ganga basin. Barbigha block mainly made up of younger alluvium plane, except some small water bodies.



Source: https://bhuvan.nrsc.gov.in/home/index.php

Geology

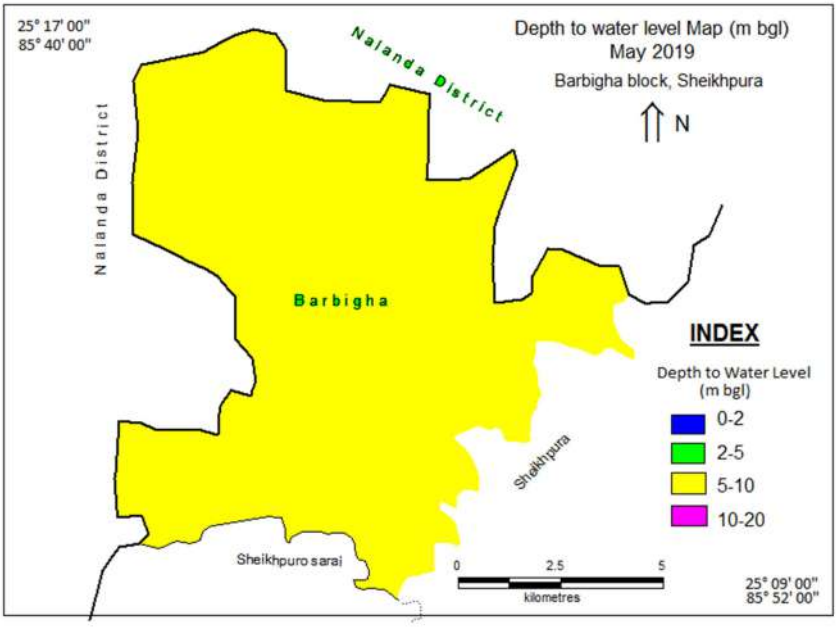
Almost whole block is covered by older alluvium identified by the presence of hard clay and Caliche Nodules.

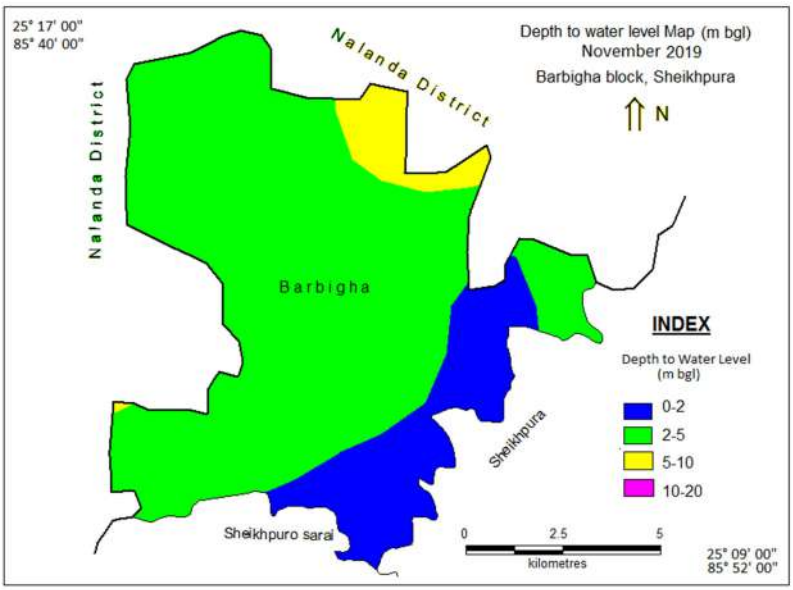


Source: Geological Survey of India

Depth to Water Level

There are 4 NHS monitoring stations in Barbigha block. CGWB NHS monitoring data shows that during the pre-monsoon period (2019-20), the whole block was under the depth to water level within 5 to 10 m bgl. During the post-monsoon period, maximum part of the block was under 2 to 5 m bgl depth to water level range.





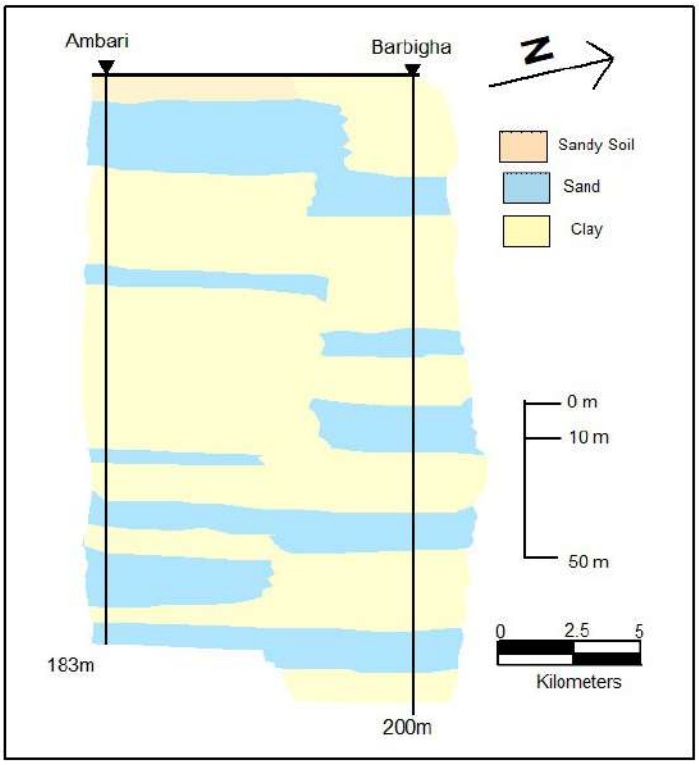
SN	Location	Latitude	Longitude	Depth to Water Level (m bgl)		Elevation (m amsl)	Fluctuation	Depth	RL
				May-19	Nov-19				
1	Barbigha	25.217	85.738	6.77	6.14	51.5	0.63	7.5	44.73
2	Keoti1	25.217	85.796	6.76	1.37	47	5.39	1.98	40.24
3	Koeri Bigha	25.217	85.744	7.15	4.18	51.6	2.97	8.2	44.45
4	Sherpar	25.225	85.734	9.82	2.14	49.5	7.68	9.83	39.68

8.2.2 Aquifer Disposition and Characteristics

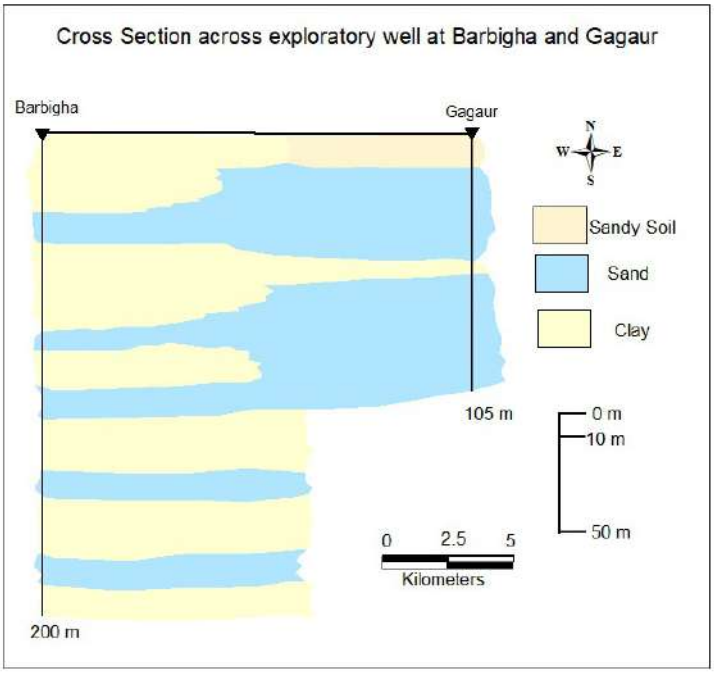
Two cross sections along Ambari-Barbigha and Barbigha-Gangaur has been prepared, which shows the disposition of different formation in this block. As per the cross sections mainly there are 4 clay layers separated by numbers of thin sand layers and sand patches in Barbigha district. The clay layers are 40 m, 105 m, 26m and 9 m thick respectively. The 2nd clay layer is the thickest and occurs at 54 m depth. The clay layer maintained the same thickness towards Ambari (Sheikhopursarai block) but become tapered towards Gangaur (Ghatkusumba block). Thickness of sand patches varies from 9 to 14 m. When moving towards south west i.e. towards Barbigha the sand layers discontinued but towards north east i.e. towards GhatKusumba block the sand layers continued and thickened upto 40 to 50 m.

The exploration data in Barbigha block says discharge varies from 63.74 to 130 m3/hr. transmisivity varies from 1100 to 1334


Barbigha
Sheikhpura
Ariari
Ghat Kusumba
Chewara


Ambari
Barbigha
Sandy Soil
Sand
Clay
0 m
10 m
50 m
0 2.5 5
Kilometers
183m
200m


Barbigha
Gagaur
N


Cross Section across exploratory well at Barbigha and Gagaur
Barbigha
Gagaur
N
W
E
S
Sandy Soil
Sand
Clay
105 m
0 m
10 m
50 m
0 2.5 5
Kilometers
200 m

8.2.3 Ground water resource, extraction, contamination and other issues

Ground Water Resources - 2020

About 16.24 % of the net ground water availability of Sheikhpura district is available in Barbigha block. The SOD is 39.73 % only whereas of the district SOD is 53.40 %. It shows ample scope for further development of ground water.

In ham

Administrative Units	*Recharge from Rainfall*		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Provision for Natural Discharges*	*Net Annual Ground Water Availability*
	Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
	(ham)	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*
Barbhiga	2058.65	94.5	87.35	81.79	2322.29	232.23	1211.16

Table 4.2: Blockwise Stage of Ground Water Development

Administrative Units	*Net Annual Ground Water Availability*	*Existing Gross Ground Water Draft for irrigation*	*Existing Gross Ground Water Draft for Domestic Uses*	*Existing Gross Ground Water Draft for Industrial Uses*	*Existing Gross Ground Water Draft for All Uses*	*Provision for Domestic and Industrial Requirement for Next 25 years*	*Net GW Availability for Future Irrigation Development*	*Stage of Ground Water Development*
	(ham)	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(%)*
Barbhiga	1211.16	383.05	393.35	54.00	830.4	441.85	1211.16	39.73

Chemical quality of Ground Water

Result of chemical analysis of ground water of shallow aquifer is given in the table below. The TDS ranged from 268 to 742 ppm and fluoride concentration is below the acceptable limit of 1 mg/l. In general Chemical quality of shallow aquifer is potable and also suitable for irrigation purpose, except some places like Keoti, Barbigha. Result of chemical analysis is given in the table below.

SN	Block	location	pH	EC	TH	Ca	Mg	Na	K	HCO3	Cl	SO4	NO3	Fl	TDS
1	Barbigha	Barbigha	7	1038	229.795	34	35.2	119.3	7.81	276.75	117	74.64	5.28	0.4	674.7
2	Barbigha	Keoti	8.4	1047	319.706	42	52.2	74.96	12.23	381.3	89.33	26.37	0	0.6	680.55
3	Barbigha	Koeribigha	8.2	1141	229.86	48	26.7	135.2	31.28	498.15	89.2	19.3	16.2	0.9	741.65
4	Berbigha	Sherpar	8.4	412	104.937	22	12.2	47.26	1.34	153.75	20.81	25.4	0	0.6	267.8
5	Barbigha	Ambari	8.2	1645	254.833	56	27.9	127.4	212.8	276.75	139.2	54.36	128.4	0.1	1069.3

6	Berbigha	Sherpar	8.4	390	94.9492	22	9.72	49	0.73	153.75	17.72	20	2.6	0.5	253.5
		Minimum	7.03	387.00	94.95	18.00	9.72	23.00	0.73	122.04	3.54	6.00	0.00	0.11	251.55
		Maximum	8.44	1645.00	319.71	56.00	52.24	135.22	212.80	498.15	139.20	185.37	128.35	0.94	1069.25
		Average	8.10	720.79	190.61	33.29	26.12	64.30	20.65	258.75	55.50	37.34	20.38	0.38	468.51
BIS 2012		*Acceptable limit*	**<6.5**	500	**200**	**75**	**30**	_	**1.9**	**200**	**250**	**200**	**NA**	**1**	_
		Permissible limit (in absence of alternate source)	**>8.5**	2000	**600**	**200**	**100**	_	**50**	**600**	**1000**	**400**	**45**	**1.5**	_

Hardness *(mg/l) as caco₃*		*Water Class*
0-75	-	Soft
75-150	-	Moderate
150-300	-	Hard
300-600	-	Very hard
>600	-	Extremely

SN	**Block**	**location**	Sodium Adsorption Ratio	Sodium Soluble Percentage	Kelley's Index	Magnesium Ratio	Permeability Index
			Na/sqrt(Ca+Mg/2)	***Na*100/Ca+Mg+Na***	***Na/(Ca+Mg)***	***(Mg*100)/(Ca+Mg)***	***Na+sqrtHCo3)/(Ca+Mg+Na)*100***
1	Barbigha	Barbigha	16.60	63.27	1.72	50.89	72.10
2	Barbigha	Keoti	9.08	44.30	0.80	55.43	55.84
3	Barbigha	Koeribigha	17.26	64.41	1.81	35.77	75.04
4	Berbigha	Sherpar	8.92	58.05	1.38	35.58	73.28
5	Barbigha	Ambari	15.22	60.27	1.52	33.29	68.15
6	Berbigha	Sherpar	9.45	60.70	1.54	30.64	76.06
		Minimum	3.01	23.13	0.30	30.64	36.73
		Maximum	17.26	66.30	1.97	57.75	81.84
		Average	9.45	50.06	1.13	43.20	63.83
		Suitable	<10	<50	<1	<50	25-75
		Marginal	NA	NA	1.2	NA	NA
		Not suitable	>10	>50	>2	>50	>75

Sn	Block	Location	Sodium Adsorption Ratio	Sodium Soluble Percentage	Kelley's Index	Magnesium Ratio	Permeability Index
			Na/sqrt(Ca+ Mg/2)	*Na*100/Ca+Mg+ Na*	*Na/(Ca+Mg)*	*(Mg*100)/(Ca+ Mg)*	*Na+sqrtHCo3)/ (Ca+Mg+Na)* 100*
1	Barbigha	Barbigha	16.58	63.30	1.72	50.72	72.15
2	Barbigha	Keoti	9.10	44.38	0.80	55.32	55.93
3	Barbigha	Koeribigha	17.21	64.29	1.80	36.00	74.91
4	Barbigha	Sherpar	8.88	58.02	1.38	35.29	73.35
		Suitable	<10	<50	<1	<50	25-75
		Marginal	NA	NA	1.2	NA	NA
		Not suitable	>10	>50	>2	>50	>75

8.2.4 Supply side management

Dynamic Ground water resource of Barbigha block has been assessed as 1211.16 ham.The stage of Development 39.73%. Therefore there is scope of ground water development. Ground water may be used for irrigation purpose etc. additional ground water abstraction structure may be constructed.

Block	**GW Resources Position in Bihar as per GW Resource Estimation - 2020**					**Calculation for additional TW**		
	Total Annual Recharge	*Net Resource*	*Gross Draft All Uses*	*Provision for Future Domestic and Industrial Requirement*	*SOD% 2020*	*GW draft at Projected SOD (70%)*	*Additional Resource Available*	*Additional Nos. of STW feasible based on GW availability*
Barbhiga	2322.29	2090.06	830.4	441.85	39.73	1463.04	185.17	123

8.2.5 Demand side management Plan

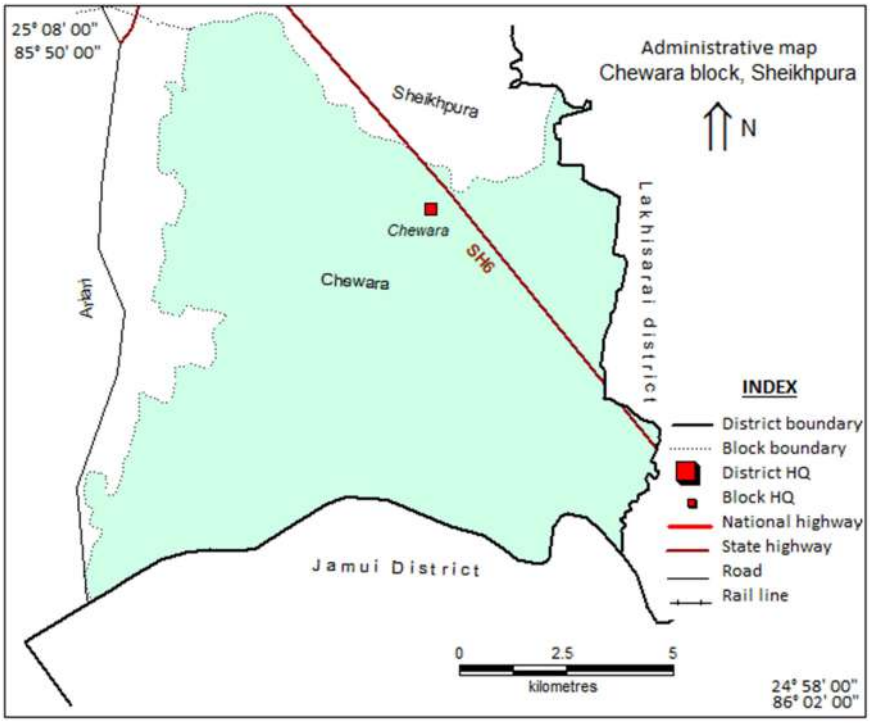
For conjunctive use of ground water some advance irrigation practices may be adopted such as drip/sprinkle irrigation etc. lining of field channels, change of cropping pattern also may be taken up for conservation purpose.

8.3 Chewara block

8.3.1 General Information

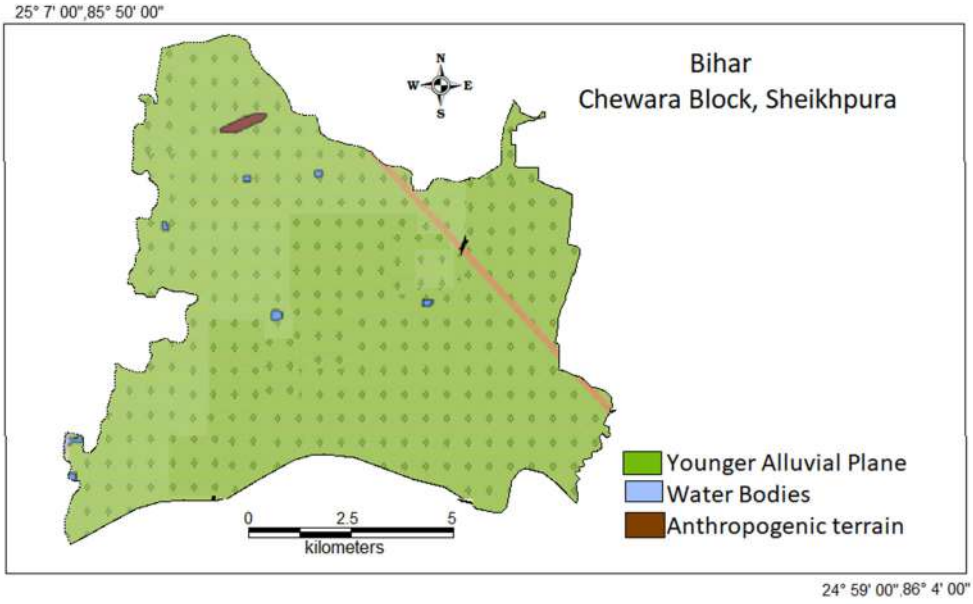
1.	Name of the block and		:	Chewara - 115.05 Sq. Km
2.	District/State		:	Sheikhpura/ Bihar
3.	Population (2011)	Total	:	73267
		Rural		73267
		Urban		0
4.	Normal rainfall (District)	(mm)	:	1087.9
5.	Agriculture and irrigation		:	Main crops are Paddy, Wheat, oil seeds etc. Gross irrigated area: 5655 Ha Net irrigated area: 2975 Ha Rainfed area: 4953 Ha GW Extraction structure: (5^{th} MI) Dug Well : 12 Shallow Tube Well : 980 Deep Tube Well : 29
6.	Ground water resource availability and extraction	As per 2020 Resource Calculation	:	Net GW Availability: 1061.61ham Gross GW Draft : 1983.15ham
7.	Existing and future water demand		:	For next 25 years: 141.79 ham
8.	Water level behaviour	Depth to water level	:	Pre-monsson: 5 to >10 m bgl Post-monsoon: 2 to 10 mbgl
9.	Basin / Sub-basin		:	Gandak and others

Charwara block of Sheikhpura district is surrounded by Sheikhpura Block in the Norht, Ariari Block in the West, Sharing East boundary with Lakhisarai District and South Boundary with Jamui District. One state highway SH6 passes through the block.



Geomorphology

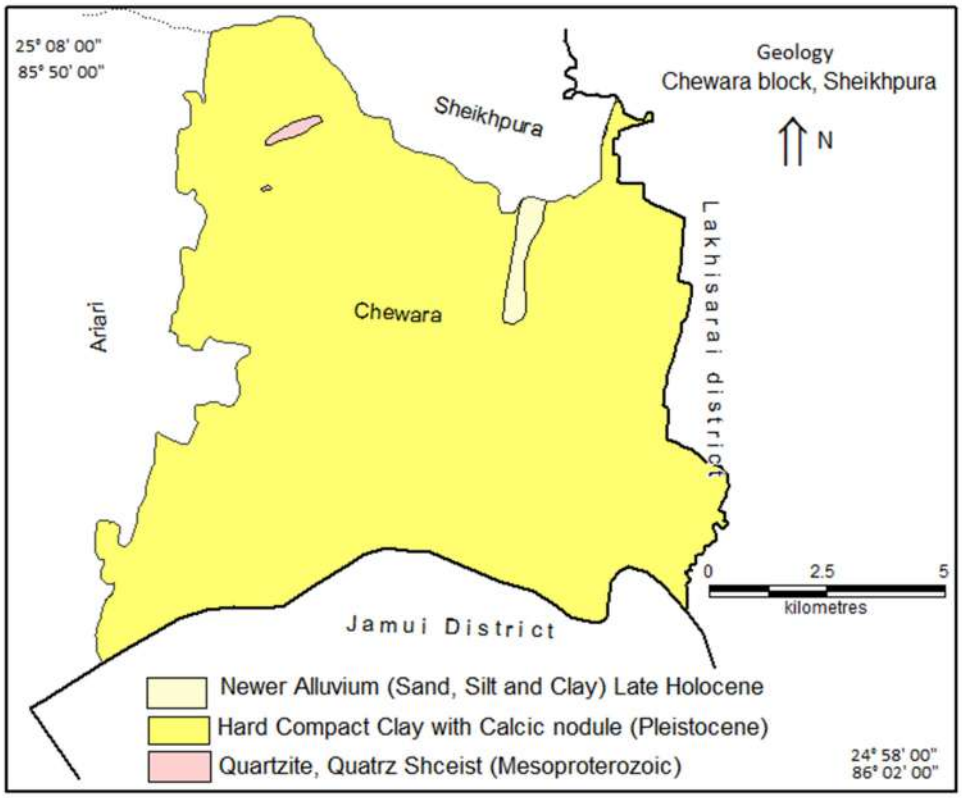
The Chewara block is a part of Mid-Ganga basin. Chewara block mainly made up of younger alluvium plane, except some small water bodies anthropogenic terrain.



Source: https://bhuvan.nrsc.gov.in/home/index.php

Geology

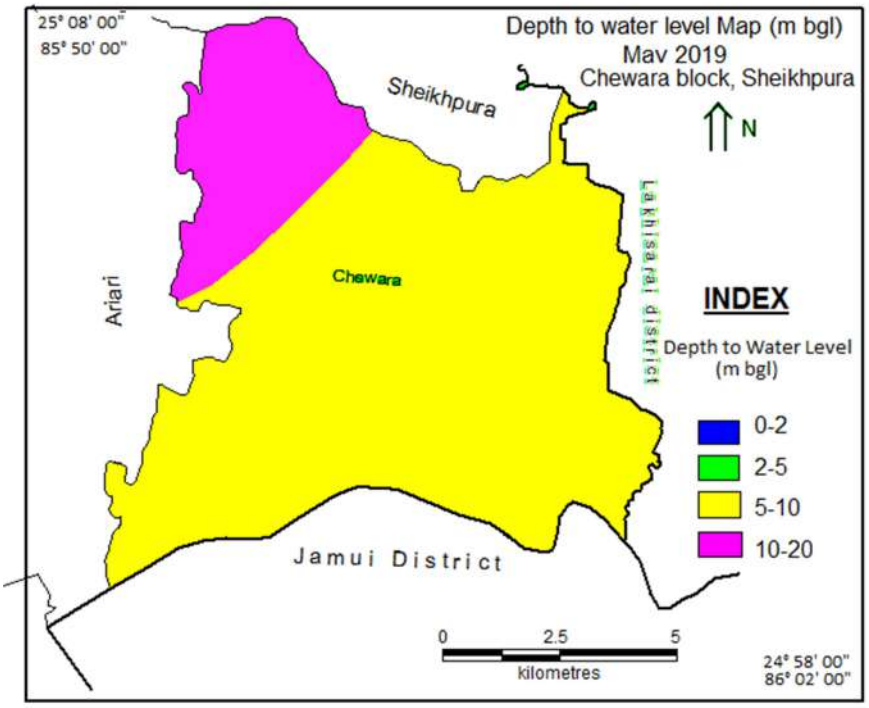
Almost whole block is covered by older alluvium identified by the presence of hard clay and Caliche Nodules of Pleistocene age. A very small part in north west side consists of quartzite, quartz schist of Mesoproterozoic age.

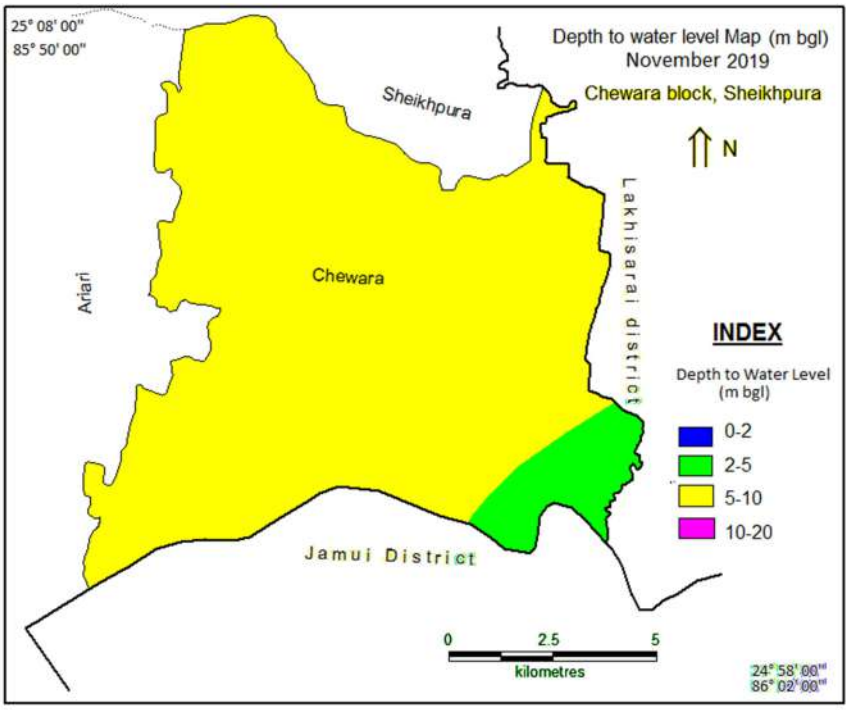


Source: Geological Survey of India

Depth to Water Level

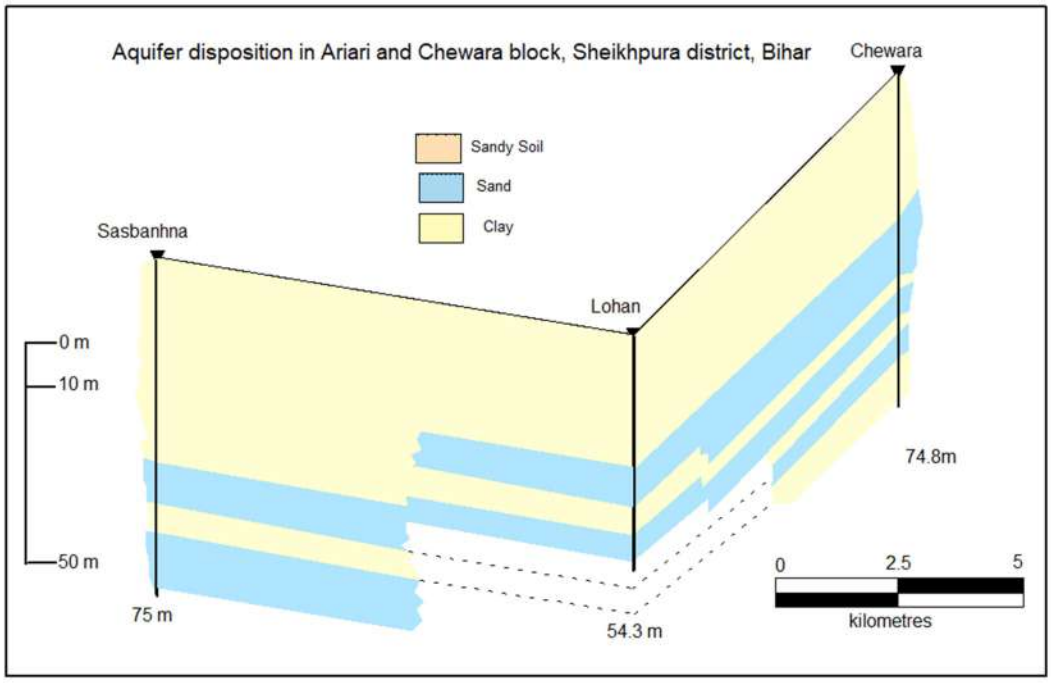
There is one National Hydrograph monitoring station in Chewara block. Depth to water level map of both pre and post monsoon 2019 shows that maximum part of the block has depth to water level within the range 5-10 m bgl.





SN	Location	Latitude	Longitude	Depth to Water Level (m bgl)		Elevation (m amsl)	Fluctuation	Depth	RL
				May-19	Nov-19				
1	Chewara	25.084	85.924	6.9	6.6	50	0.3	11.5	43.1

8.3.2 Aquifer Disposition and Characteristics



Cross sections along Sabahna – Lohan – Chewara has been prepared, which shows the disposition of different formation of southwest to northwestern part of Chewara block. In south western part there is topr 30 m clay layer, below that two sand layer of average thickness 8 m and 7m sand layer, separated by m thick clay layer. All the layers continued towards north east side of block. One more sand layer of 5m thickness and clay layer of 8.5m thickness is present as per the cross section.

The exploration data in Chewara block says discharge varies from 61.31 to 160.8 m3/hr. transmisivity varies from 295 to 672

8.3.3 Ground water resource, extraction, contamination and other issues

Ground Water Resources - 2020

About 14.23 % of the net ground water availability of Sheikhpura district is available in Chewara block. SOD is 64.80 % only whereas of the district SOD is 53.40 %. It shows ample scope for further development of ground water.

In ham

Administrative Units	*Recharge from Rainfall*		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Provision for Natural Discharges*	*Net Annual Ground Water Availability*
	Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
	(ham)	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*
Chewara	2534.44	116.34	404.95	344.64	3400.37	340.04	1061.61

Table 4.2: Blockwise Stage of Ground Water Development

Administrative Units	*Net Annual Ground Water Availability*	*Existing Gross Ground Water Draft for irrigation*	*Existing Gross Ground Water Draft for Domestic Uses*	*Existing Gross Ground Water Draft for Industrial Uses*	*Existing Gross Ground Water Draft for All Uses*	*Provision for Domestic and Industrial Requirement for Next 25 years*	*Net GW Availability for Future Irrigation Development*	*Stage of Ground Water Development*
	(ham)	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(%)*
Chewara	1061.61	1766.92	126.22	90.00	1983.15	141.79	1061.61	64.80

8.3.4 Supply side management

Dynamic Ground water resource of Chewara block has been assessed as 1061.61 ham.The stage of Development is 64.80%. Therefore there is scope of ground water development. Ground water may be used for irrigation purpose etc. additional ground water abstraction structure may be constructed.

Block	GW Resources Position in Bihar as per GW Resource Estimation - 2020					Calculation for additional TW		
	Total Annual Recharge	*Net Resource*	*Gross Draft All Uses*	*Provision for Future Domestic and Industrial Requirement*	*SOD% 2020*	*GW draft at Projected SOD (70%)*	*Additional Resource Available*	*Additional Nos. of STW feasible based on GW availability*
Charware	3400.37	3060.33	1983.15	141.79	64.80	2142.23	776.31	518

For ground water management, some artificial structure may be constructed in Chewara block. Based on the, geology, geomorphology, depth to water level and surface water availability, the types and number of the artificial recharge structures has been worked out for Chewara block and given in the table below. Based on available literature and previous experiences, unit cost of above structures is also worked out. As per Master plan of artificial recharge 2020, the table is as follows.

Chewara Block			
Recharge Structure		Cost (in Lakh)	Total Cost (Lakh)
Type	Number		
Nala Bunding	1	1	532
Lateral Recharge Shaft	8	16	
Recharge Shaft	20	100	
Percolation Tank	1	30	
De-silting of existing tank /pond /talao	37	185	
Injection Well in Village Tank	50	200	

Chemical quality of Ground Water

Result of chemical analysis of ground water of shallow aquifer of surrounding area shows In general Chemical quality of shallow aquifer is potable and also suitable for irrigation purpose.

8.3.5 Demand sidemManagement Plan

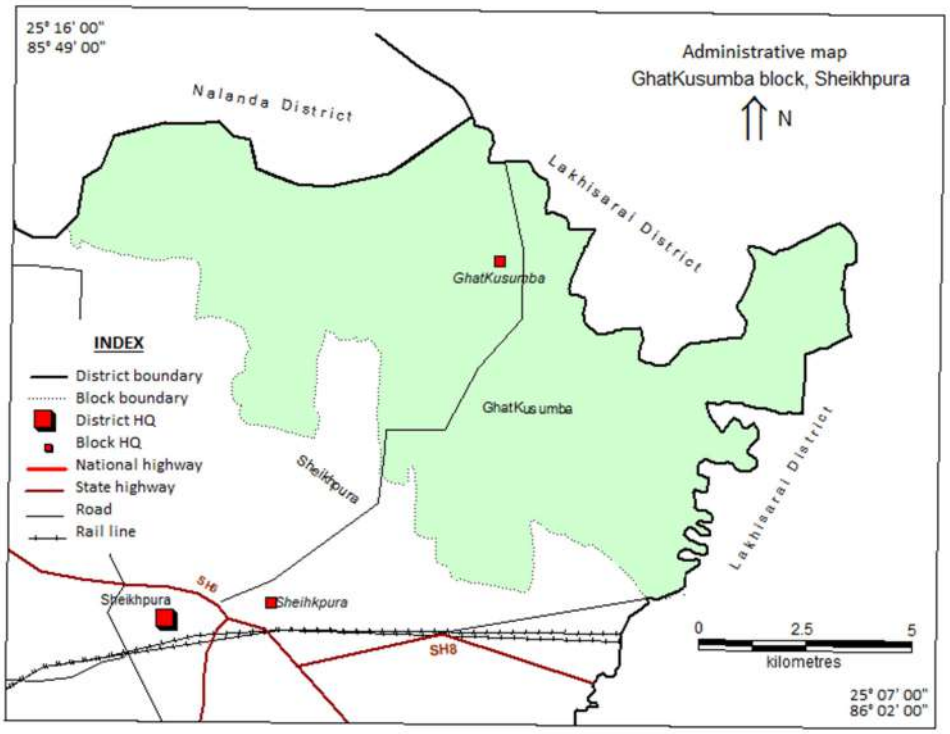
Some advance irrigation practices may be adopted such as drip/sprinkle irrigation etc. lining of field channels, change of cropping pattern also may be taken up for conservation purpose.

8.4 Ghatkusumba block

8.4.1 General Information

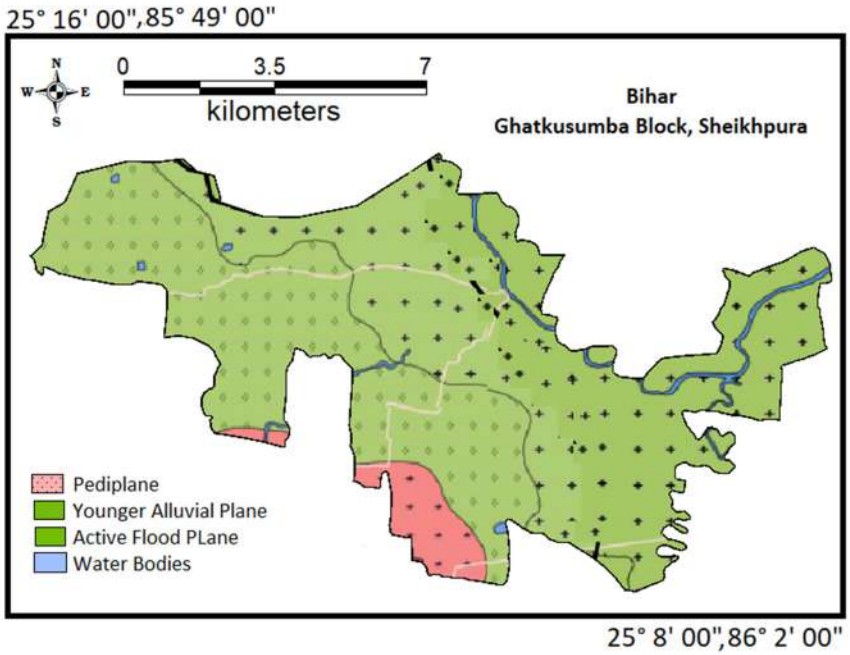
1.	Name of the block and area		:	Ghat Kusumbha - 92.6 Sq. Km
2.	District/State		:	Sheikhpura/ Bihar
3.	Population (2011)	Total	:	48346
		Rural		48346
		Urban		0
4.	Normal rainfall (District)	(mm)	:	1087.9
5.	Agriculture and irrigation		:	Main crops are Paddy, Wheat, Maize etc. Gross irrigated area: 3785 Ha Net irrigated area: 2454 Ha Rainfed area: 2280 Ha GW Extraction structure: (5th MI) Dug Well : 2 Shallow Tube Well : 145 Deep Tube Well : 29
6.	Ground water resource availability and extraction	As per 2020 Resource Calculation	:	Net GW Availability: 1474.75 ham Gross GW Draft : 698.72 ham
7.	Existing and future water demand		:	For next 25 years: 93.56 ham
8.	Water level behaviour	Depth to Water level	:	Pre-monsson: 5 to >10 m bgl Post-monsoon: 0 to 10 mbgl
9.	Basin / Sub-basin		:	Gandak and others

The Ghatkusumba block of Sheikhpura district is surrounded by Sheikhpura block in the South-West, and sharing North-West boundary with Nalanda District and North-East boundary with Lakhisarai District. The block head quarter is in Ghatkusumba.



Geomorphology

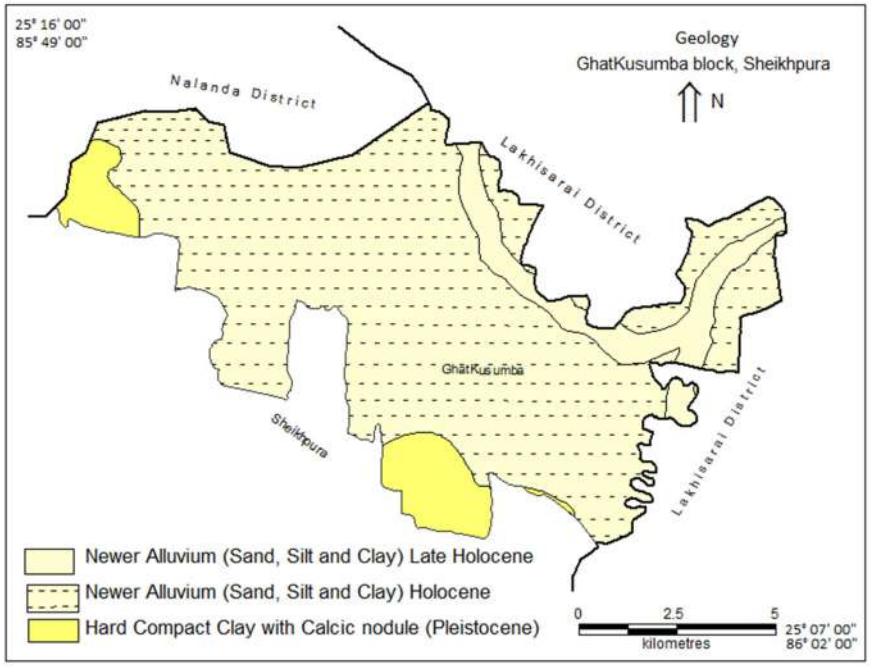
The GhatKusumba block is a part of Mid-Ganga basin. GhatKusumba block mainly made up of younger alluvium plane, except some small water bodies. The southern part of the block covered by pediplanes.



Source: https://bhuvan.nrsc.gov.in/home/index.php

Geology

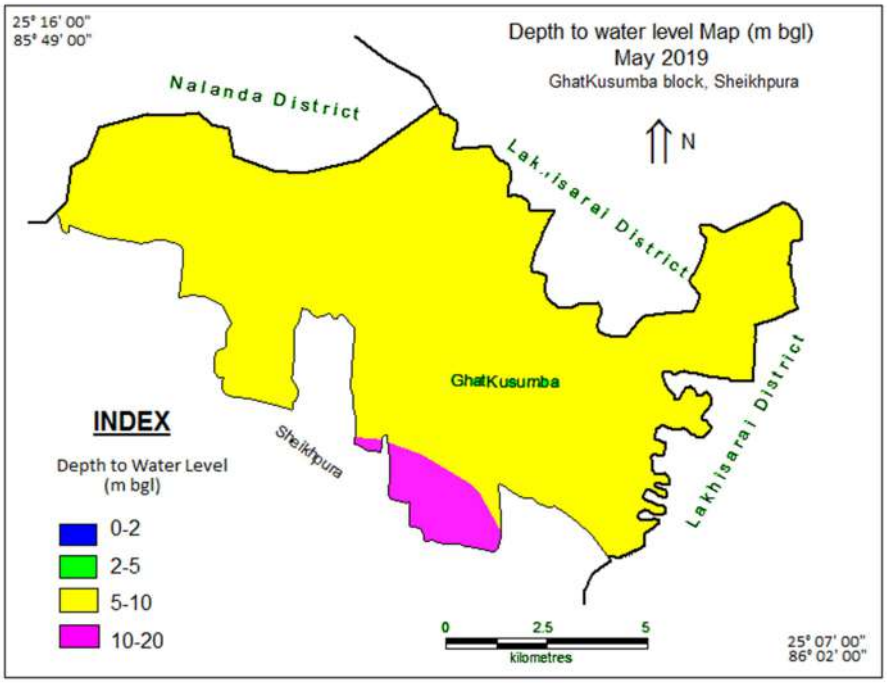
Major part of Ghatkusumba block is covered by newer alluvium of Holocene age made up of sand silt and clay. A very small northwestern and southern part of the block made up of hard compact clay of Pleistocene age. North eastern part of the block contains alluvium of late Holocene age.

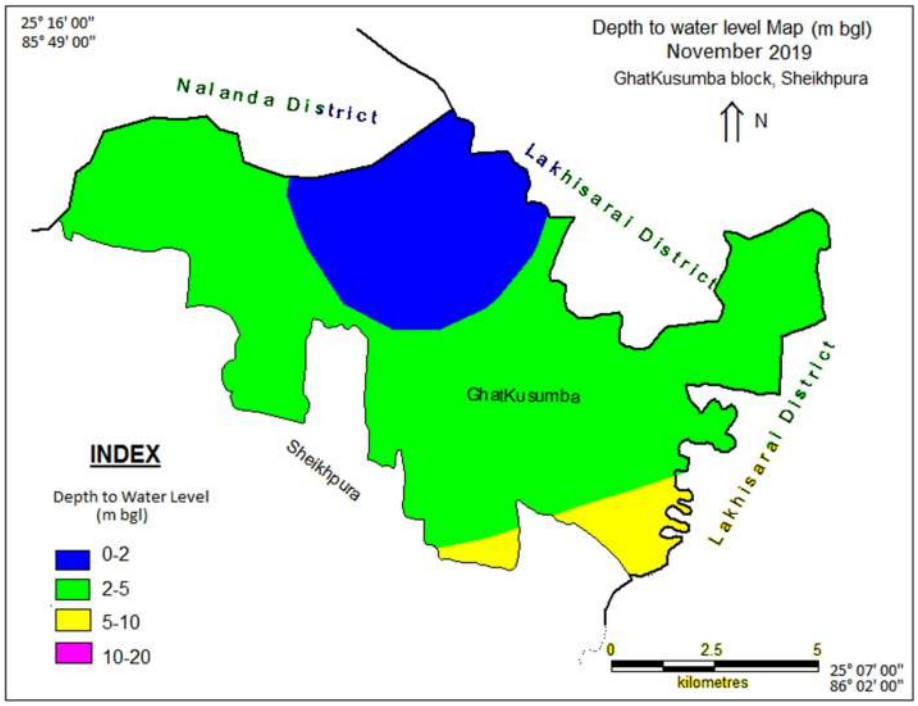


Source: Geological Survey of India

Depth to Water Level

There is one national hydrograph monitoring station in the block. CGWB NHS monitoring data shows that during the pre-monsoon period (2019-20), depth to water level was 4.38 m bgl and during post-monsoon the well show the 1.40 m bgl depth to water level.



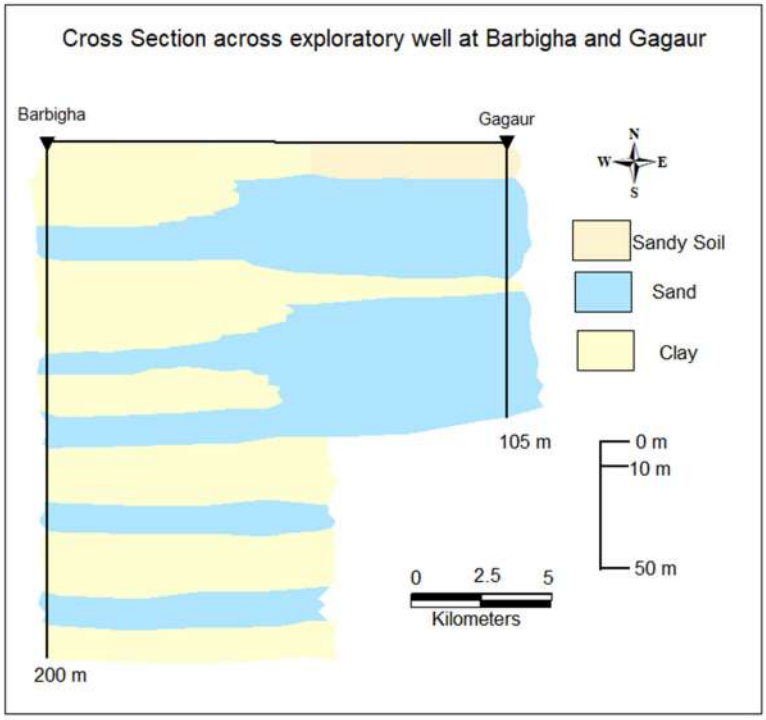


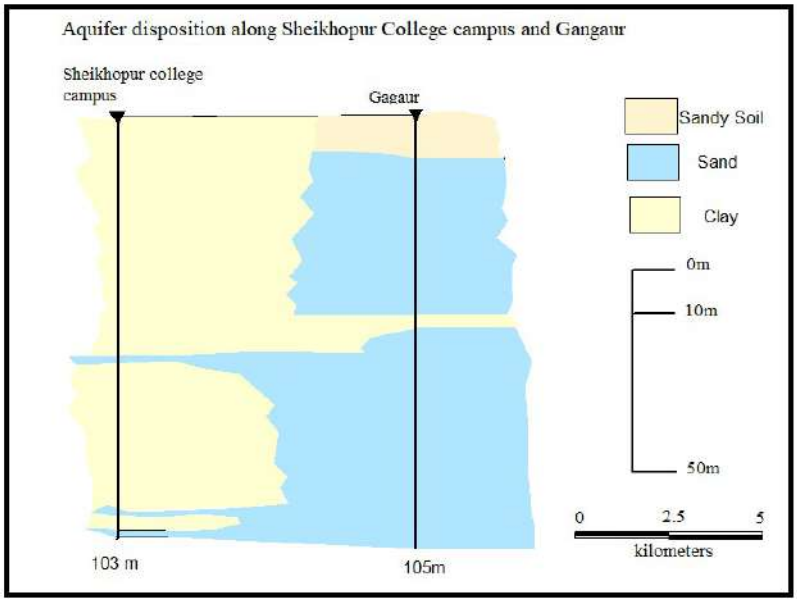
Location	Latitude	Longitude	Depth to Water Level (m bgl)		Elevation (m amsl)	Fluctuation	Depth	RL
			May-19	Nov-19				
Ghat Kusumba	25.225	85.911	2	1.37	42	0.63	11	40

Soil

Map from 'District Irrigation Plan' reveals that almost whole area of Ghatkusumba block covered by fine loamy soil, except northern part. In northern small part there is water body, and adjacent to that small area covered by coarse loamy soil.

8.4.2 Aquifer Disposition and Characteristics





Two cross sections along Barbigha - Gagaur and Sheikhopur college campus-Gangaur has been prepared, which shows the disposition of different formation in Ghatkususmba block. As per the cross sections mainly there are 2 sand layer of 38m and 54m thickness in Gagaur occurs at 10m and 53 m depth respectively. These two area seperated by thin clay layer. As proceeding towards north-west i.e. towards Barbigha, there are multiple sand layers present, varies in thickness 10m to 15m and clay layers become thick upto 30m. As proceeding towards south, thick clay layers of 100m thickness is there, incorporating thin sand layers.

8.4.3 Ground water resource, extraction, contamination and other issues

Ground Water Resources - 2020

About 19.77 % of the net ground water availability of Shekhpura district is available in Ghatkusumba block. The SOD is 32.00 % only whereas of the district SOD is 53.40 %. It shows ample scope for further development of ground water.

In ham

Administrative Units	*Recharge from Rainfall*		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Provision for Natural Discharges*	*Net Annual Ground Water Availability*
	Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
	(ham)	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*
Ghat Kusumba	2039.49	93.62	178.54	114.72	2426.37	242.63	1474.75

Table 4.2: Blockwise Stage of Ground Water Development

Administrative Units	*Net Annual Ground Water Availability*	*Existing Gross Ground Water Draft for irrigation*	*Existing Gross Ground Water Draft for Domestic Uses*	*Existing Gross Ground Water Draft for Industrial Uses*	*Existing Gross Ground Water Draft for All Uses*	*Provision for Domestic and Industrial Requirement for Next 25 years*	*Net GW Availability for Future Irrigation Development*	*Stage of Ground Water Development*
	(ham)	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(%)*
Ghat Kusumba	1474.75	588.43	83.29	27.00	698.72	93.56	1474.75	32.00

8.4.4 Supply side management

Dynamic Ground water resource of Ghat Kusumbha block has been assessed as 1474.75 ham. The stage of Development is 32.00%. Therefore there is scope of ground water development. Ground water may be used for irrigation purpose etc. additional ground water abstraction structure may be constructed.

Block	GW Resources Position in Bihar as per GW Resource Estimation - 2020					Calculation for additional TW		
	Total Annual Recharge	*Net Resource*	*Gross Draft All Uses*	*Provision for Future Domestic and Industrial Requirement*	*SOD% 2020*	*GW draft at Projected SOD (70%)*	*Additional Resource Available*	*Additional Nos. of STW feasible based on GW availability*
Ghat Kusumba	2426.37	2183.74	698.72	93.56	32.00	1528.62	561.56	374

For ground water management, some artificial structure may be constructed in Ghatkusumbha block. Based on the, geology, geomorphology, depth to water level and surface water availability, the types and number of the artificial recharge structures has been worked out for Ghatkusumbha block and given in the table below. Based on available literature and previous experiences, unit cost of above structures is also worked out. As per Master plan of artificial recharge 2020, the table is as follows.

GhatKusumba Block			
Recharge Structure		Cost (in Lakh)	Total Cost (Lakh)
Type	Number		
Nala Bunding	1	1	200
Lateral Recharge Shaft	2	4	
Recharge Shaft	8	40	
Percolation Tank	0	0	
De-silting of existing tank /pond/talao	15	75	
Injection Well in Village Tank	20	80	

Chemical quality of Ground Water

Result of chemical analysis of ground water of shallow aquifer of surrounding area shows In general Chemical quality of shallow aquifer is potable and also suitable for irrigation purpose.

8.4.5 Demand side management Plan

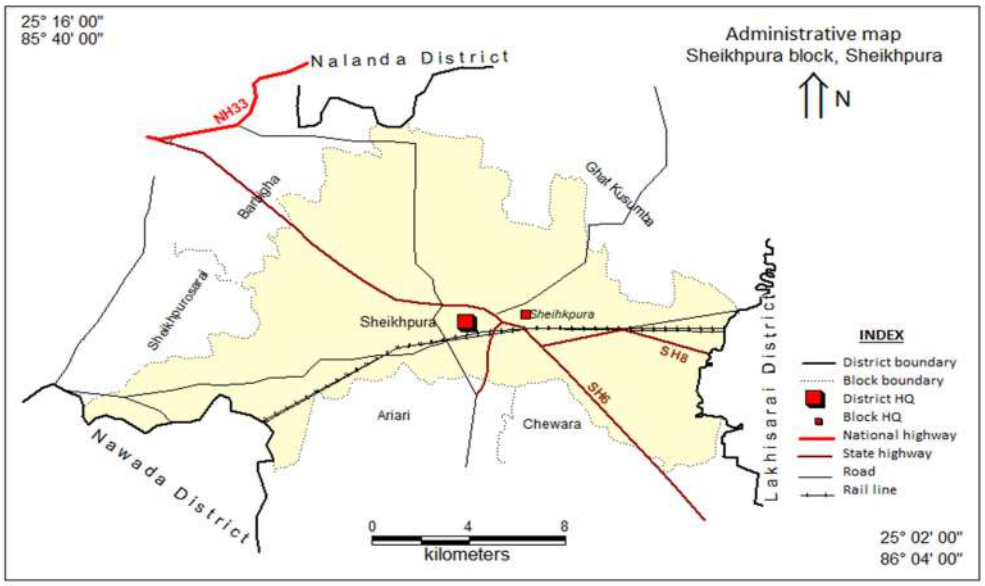
Some advance irrigation practices may be adopted such as drip/sprinkle irrigation etc. lining of field channels, change of cropping pattern also may be taken up for conservation purpose.

8.5 Sheikhpura block

8.5.1 General Information

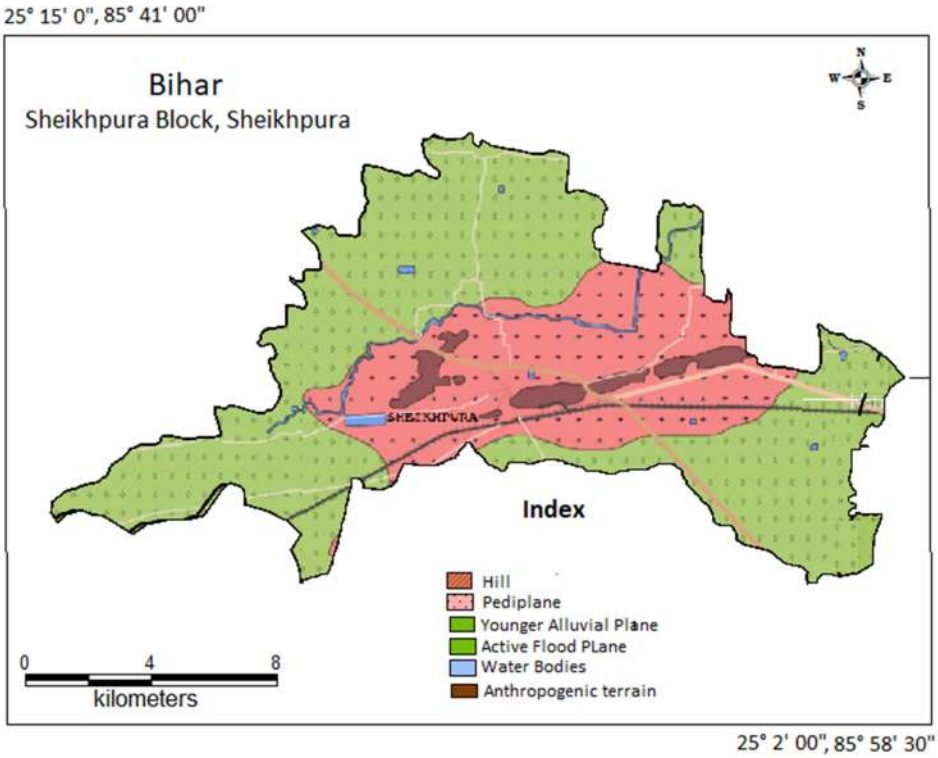
1.	Name of the block and area			Sheikhpura - 185.23 Sq. Km
2.	District/State			Sheikhpura/ Bihar
3.	Population (2011)	Total	:	199011
		Rural		136084
		Urban		62927
4.	Normal rainfall (District)	(mm)	:	1087.9
5.	Agriculture and irrigation		:	Main crops are Paddy, Wheat, Maize etc. Gross irrigated area: 15072 Ha Net irrigated area: 7286 Ha Rainfed area: 3276 Ha GW Extraction structure: (5th MI) Dug Well : 12 Shallow Tube Well : 500 Deep Tube Well : 81
6.	Ground water resource availability and extraction	As per 2020 Resource Calculation	:	Net GW Availability: 1328.81 ham Gross GW Draft : 1412.37 ham
7.	Existing and future water demand		:	For next 25 years: 628.69 ham
8.	Water level behaviour	WL Trend	:	Pre-monsson: 0.012905 m/yr Post-monsoon: 0.010056 m/yr
9.	Basin / Sub-basin		:	Gandak and others

The Sheikhpura block of Sheikhpura district is surrounded by Ghatkusumba Block in the Norht-East, Barbigha block in the Noth-West, Chewara block and Ariari block in the South, Sheikhopursarai block in the South-West and Sharing District Boundary in the North with Nawada and in the East with Lakhisarai. Two State highway SH6 and SH8 passes through the block connecting block headquarter with other parts.

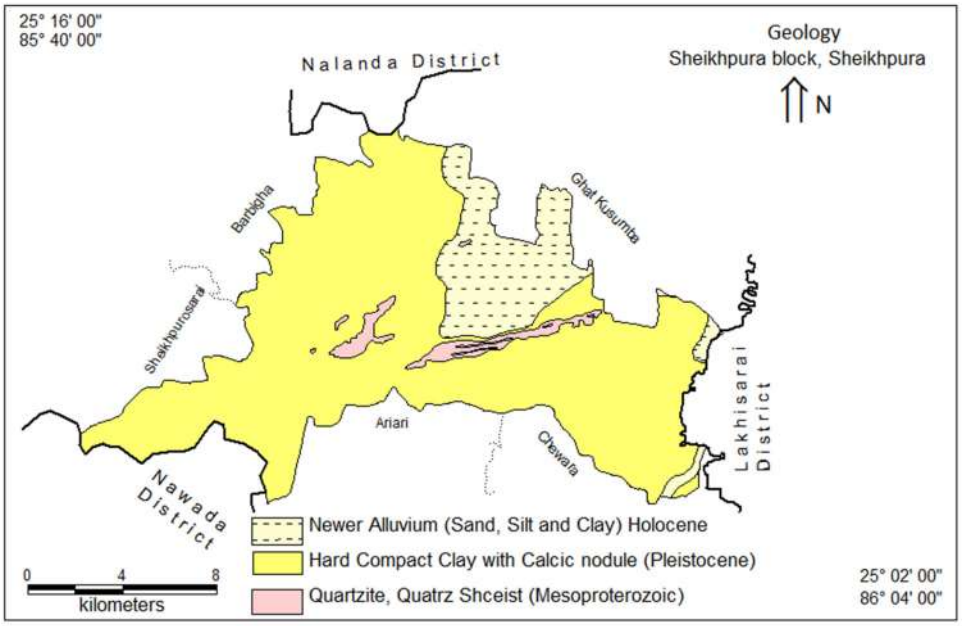


Geomorphology

The GhatKusumba block is a part of Mid-Ganga basin. GhatKusumba block mainly made up of younger alluvium plane, except some small water bodies. The mid elongated part contains hilly area which are surrounded by broad pediplanes of denudational origin.



Source: https://bhuvan.nrsc.gov.in/home/index.php



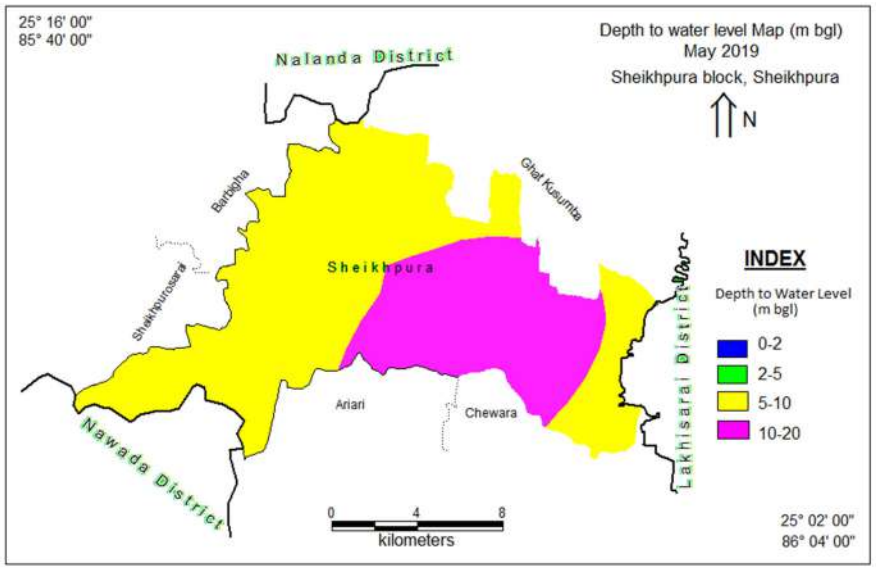
Source: Geological Survey of India

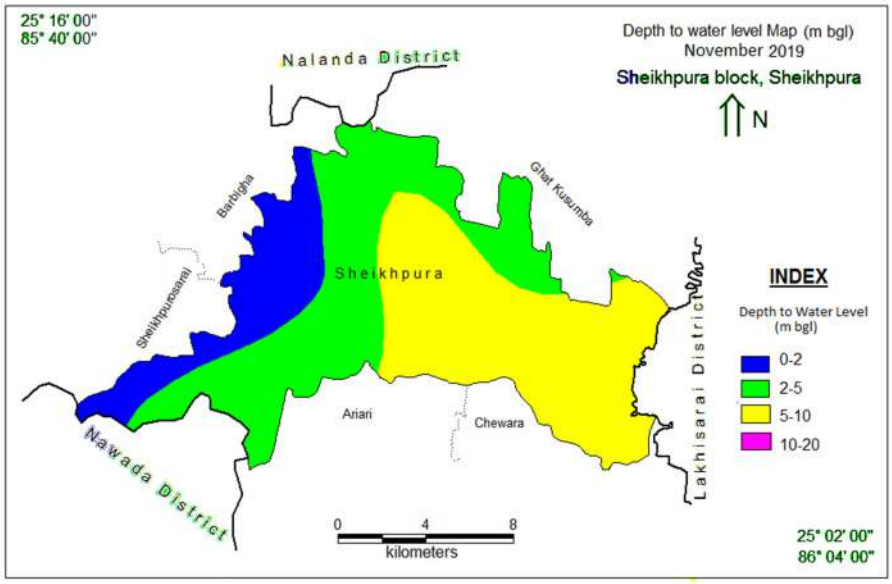
Geology

Major part of Sheikhpura block made up of alluviums characterised by clay with calcic nodules of Pleistocene age. Northern part of the block contains newer alluvium of Holocene age consists of sand silt and clay. Mid part of the block contains some metasediments of Mesoproterozoic age mainly made up of quartzite, quart schist etc.

Depth to Water Level

There are two hydrograph monitoring stations in Sheikhpura block. The depth to water level data and map shows that during pre-monsoon 2019, maximum block shows depth to water level within 5 to 10 m bgl, during post-monsoon, some area shows water level within range of 0 to 2 m and 2 to 5m bgl along with 5 to 10 m bgl depth to water level range.



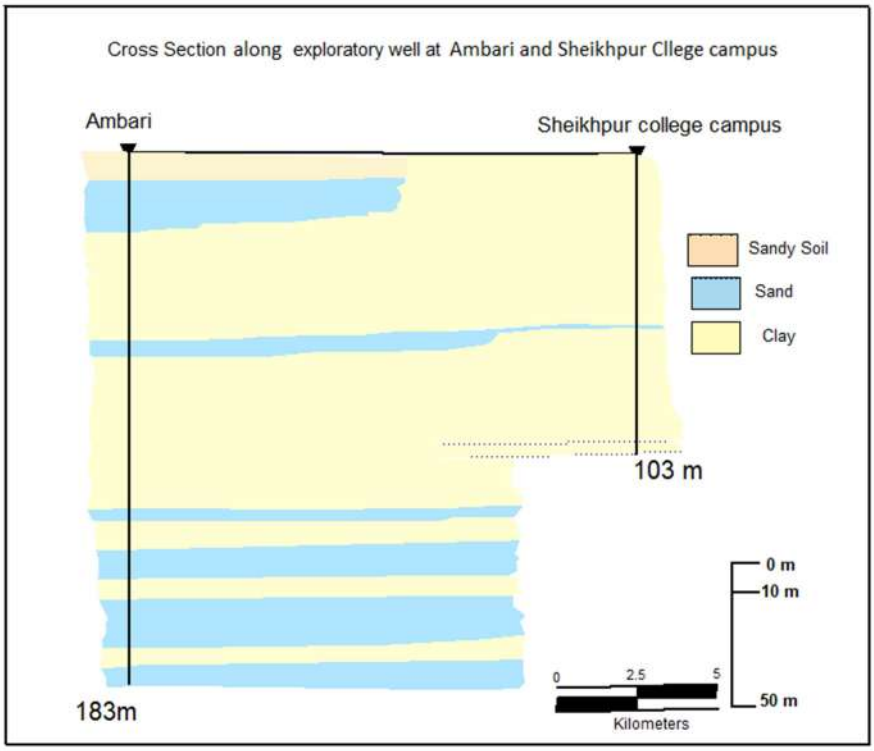


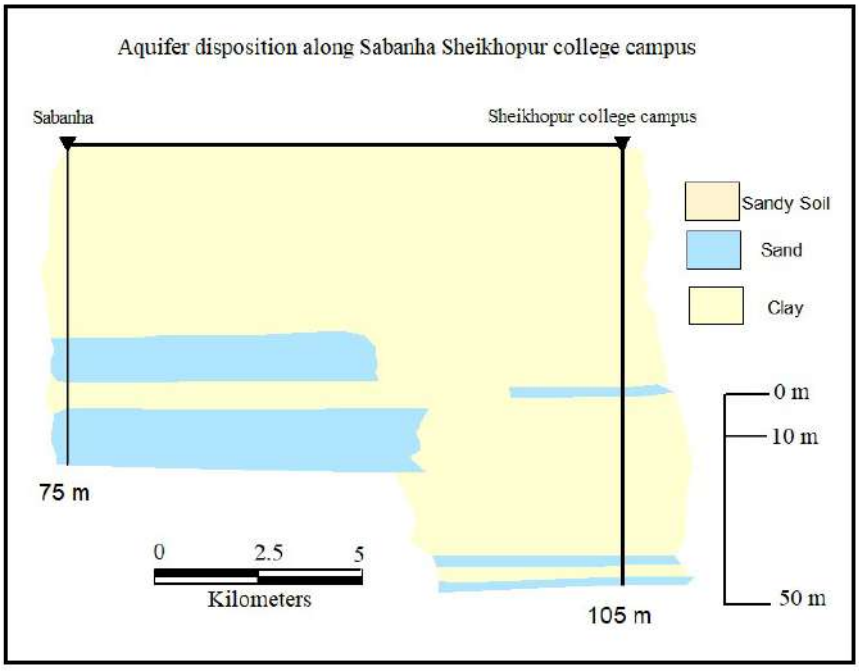
SN	Location	Latitude	Longitude	Depth to Water Level (m bgl)		Elevation (m amsl)	Fluctuation	Depth	RL
				May-19	Nov-19				
1	Nemdarganj	25.170	85.793	6.5	1.2	49	5.3	6	42.5
2	Seikhpura	25.146	85.854	10.5	6.4	46.9	4.1	10.5	36.4

Soil

The map from District irrigation plan of Sheikhpura block shows northern part of the block covered by fine loamy soil. Southern part covered by coarse soil. In south part a few patches shows loamy soil.

8.5.2 Aquifer Disposition and Characteristics





Two cross sections along Ambari - Sheikhpura college campus and Sabanha - Sheikhpura college campus has been prepared, which shows the disposition of different formation

in Sheikhpura block. As per the cross sections there is very thick (97 m) top clay layer present in this block. Only 1m -2m thin sand layer present within the clay layer. As proceeding towards Sabanha, Ariari block, i.e towards south west the 45 m thick clay layer incorporates comparatively thick sand layer. The sand layers are 10-15 m thick there, and occurs at the depth of 45 and 62 m respectively. When proceeding towards west, there are many sand layers below one 15 m thick sand and 97 m thick clay layer. Thickness of sand layer varies from 5 to 15 m. Thin clay layers separate the sand layers.

The exploration data in Sheikhpura block shows discharge 12.24 m3/hr. and transmisivity 1.80

8.5.3 Ground water resource, extraction, contamination and other issues

Ground Water Resources - 2020

About 17.82 % of the net ground water availability of Shekhpura district is available in Sheikhpura block. The SOD calculated is 50.26% whereas the district SOD is 53.4%. It shows ample scope for further development of ground water in alluvium areas.

In ham

Administrative Units	*Recharge from Rainfall*		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Provision for Natural Discharges*	*Net Annual Ground Water Availability*
	Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
	(ham)	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*
Sheikhpura	2624.27	120.46	193.72	183.98	3122.43	312.24	1328.81

Table 4.2: Blockwise Stage of Ground Water Development

Administrative Units	*Net Annual Ground Water Availability*	*Existing Gross Ground Water Draft for irrigation*	*Existing Gross Ground Water Draft for Domestic Uses*	*Existing Gross Ground Water Draft for Industrial Uses*	*Existing Gross Ground Water Draft for All Uses*	*Provision for Domestic and Industrial Requirement for Next 25 years*	*Net GW Availability for Future Irrigation Development*	*Stage of Ground Water Development*
	(ham)	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(%)*
Sheikhpura	1328.81	798.7	559.68	54.00	1412.37	628.69	1328.81	50.26

Chemical quality of Ground Water

Result of chemical analysis of ground water of shallow aquifer is given in the table below. The TDS ranged from 289 to 410 ppm and fluoride concentration is below the acceptable limit of 1 mg/l. In general Chemical quality of shallow aquifer is potable and also suitable for irrigation purpose. Result of chemical analysis is given in the table below.

SN	Block	location	pH	EC	TH	Ca	Mg	Na	K	HCO3	Cl	SO4	NO3	Fl	TDS
1	Sheikhpura	Nemdarganj	8.3	444	99.9096	18	13.4	61.7	4.39	209.1	18.35	27.3	1.9	0.5	288.6
2	Shekhpura	Shekhpura	8.2	630	184.86	30	26.7	57.39	1.85	282.9	31.05	185.4	26.4	0.4	409.5
3	Sheikhpura	Shekhpura Deole	8	655	199.833	34	27.9	54	2.8	350.55	3.54	8	55	0.4	425.75
4	Shekhpura	Shekhpura	8.1	611	179.873	32	24.3	59	2.67	276.75	31.05	21	23.6	0.4	397.15
		Minimum	7.03	387.00	94.95	18.00	9.72	23.00	0.73	122.04	3.54	6.00	0.00	0.11	251.55
		Maximum	8.44	1645.00	319.71	56.00	52.24	135.22	212.80	498.15	139.20	185.37	128.35	0.94	1069.25
		Average	8.10	720.79	190.61	33.29	26.12	64.30	20.65	258.75	55.50	37.34	20.38	0.38	468.51
BIS 2012		*Acceptable limit*	**<6.5**	500	**200**	**75**	**30**	_	**1.9**	**200**	**250**	**200**	**NA**	**1**	_
		Permissible limit (in absence of alternate source)	**>8.5**	2000	**600**	**200**	**100**	_	**50**	**600**	**1000**	**400**	**45**	**1.5**	_

Hardness *(mg/l) as* $caco_3$		*Water Class*
0-75	-	Soft
75-150	-	Moderate
150-300	-	Hard
300-600	-	Very hard
>600	-	Extremely

SN	Block	location	Sodium Adsorption Ratio	Sodium Soluble Percentage	Kelley's Index	Magnesium Ratio	Permeability Index
			Na/sqrt(Ca+Mg/2)	*Na*100/Ca+Mg+Na*	*Na/(Ca+Mg)*	*(Mg*100)/(Ca+Mg)*	*Na+sqrtHCo3)/(Ca+Mg+Na)*100*
1	Sheikhpura	Nemdarganj	12.42	66.30	1.97	42.60	81.84
2	Shekhpura	Shekhpura	8.71	50.29	1.01	47.12	65.03
3	Sheikhpura	Shekhpura Deole	7.80	46.58	0.87	45.11	62.72
4	Shekhpura	Shekhpura	8.88	51.17	1.05	43.16	65.60
		Minimum	3.01	23.13	0.30	30.64	36.73
		Maximum	17.26	66.30	1.97	57.75	81.84
		Average	9.45	50.06	1.13	43.20	63.83
		Suitable	<10	<50	<1	<50	25-75
		Marginal	NA	NA	1.2	NA	NA
		Not suitable	>10	>50	>2	>50	>75

8.5.4 Supply side management

Dynamic Ground water resource of Sheikhpura block has been assessed as 1328.81 ham. The stage of Development is 50.26%. Therefore there is scope of ground water development. Ground water may be used for irrigation purpose etc. additional ground water abstraction structure may be constructed.

Block	GW Resources Position in Bihar as per GW Resource Estimation - 2020					Calculation for additional TW		
	Total Annual Recharge	*Net Resource*	*Gross Draft All Uses*	*Provision for Future Domestic and Industrial Requirement*	*SOD% 2020*	*GW draft at Projected SOD (70%)*	*Additional Resource Available*	*Additional Nos. of STW feasible based on GW availability*
Sheikhpura	3122.43	2810.19	1412.37	628.69	50.26	1967.13	214.37	143

For ground water management, some artificial structure may be constructed in Sheikhpura block. Based on the, geology, geomorphology, depth to water level and surface water availability, the types and number of the artificial recharge structures has been worked out for Sheikhpura block and given in the table below. Based on available literature and previous experiences, unit

cost of above structures is also worked out. As per Master plan of artificial recharge 2020, the table is as follows.

Sheikhpura Block			
Recharge Structure		Cost (in Lakh)	Total Cost (Lakh)
Type	Number		
Nala Bunding	1	1	530
Contour bunding and Trenching	17	34	
Lateral Recharge Shaft	1	2	
Recharge Shaft	20	100	
Percolation Tank	1	30	
De-silting of existing tank /pond /talao	35	175	
Injection Well in Village Tank	47	188	

8.5.5 Demand side management Plan

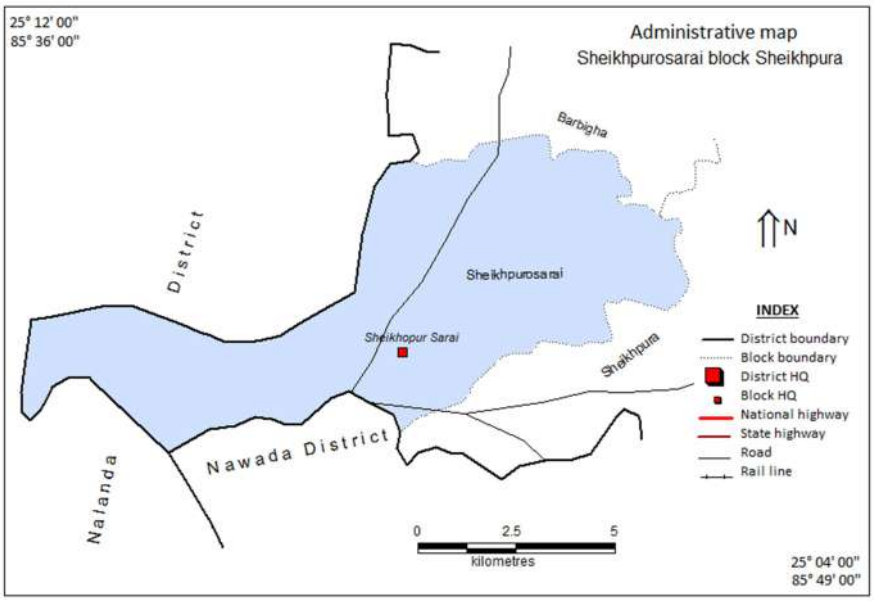
Advance irrigation practices may be adopted such as drip/sprinkle irrigation etc. lining of field channels, change of cropping pattern also may be taken up for conservation purpose. In addition shallow tube wells may be used in place of deeper one.

8.6 Sheikhopursarai block

8.6.1 General Information

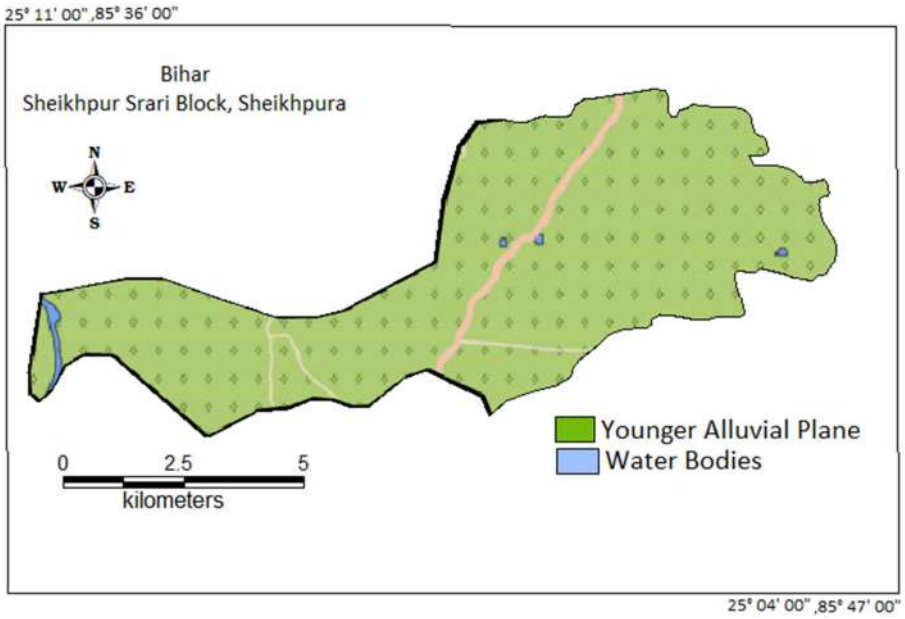
1.	Name of the block and area		:	Sheikhopur sarai – 55.32 Sq. Km
2.	District/State		:	Sheikhpura/ Bihar
3.	Population (2011)	Total	:	67481
		Rural		67481
		Urban		0
4.	Normal rainfall (District)	(mm)	:	1087.9
5.	Agriculture and irrigation		:	Main crops are Paddy, Wheat and Oil seeds etc. Gross irrigated area: 5411 Ha Net irrigated area: 2721 Ha Rainfed area: 1030 Ha GW Extraction structure: (5^{th} MI) Shallow Tube Well : 403 Nos Deep Tube Well : 34 Nos
6.	Ground water resource availability and extraction	As per 2020 Resource Calculation	:	Net GW Availability: 799.36 ham Gross GW Draft : 1301.13 ham
7.	Existing and future water demand		:	For next 25 years: 130.59 ham
8.	Water level behaviour	Depth to water level	:	Pre-monsson: 2 to 10 m bgl Post-monsoon: 0 to 5 m bgl
9.	Basin / Sub-basin		:	Gandak and others

The Sheikhopursarai block of Sheikhpura district is surrounded by Sheikhpura block in the East, Barbigha block in the North, and sharing western boundary with Nalanda district, in the south with Nawada district.



Geomorphology

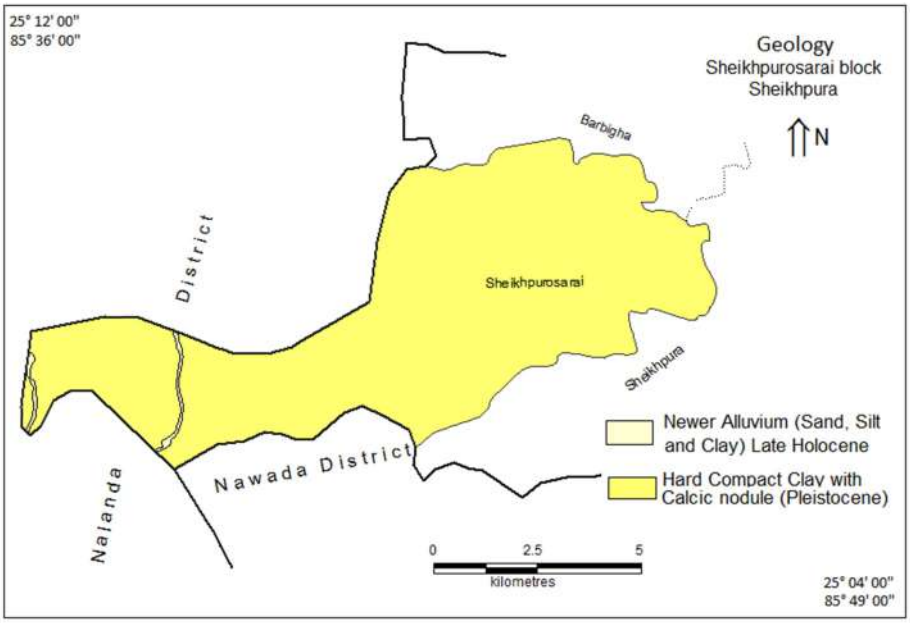
The Sheikhpurosarai block is a part of Mid-Ganga basin. Sheikhpurosarai block mainly made up of younger alluvium plane, except some small water bodies.



Source: https://bhuvan.nrsc.gov.in/home/index.php

Geology

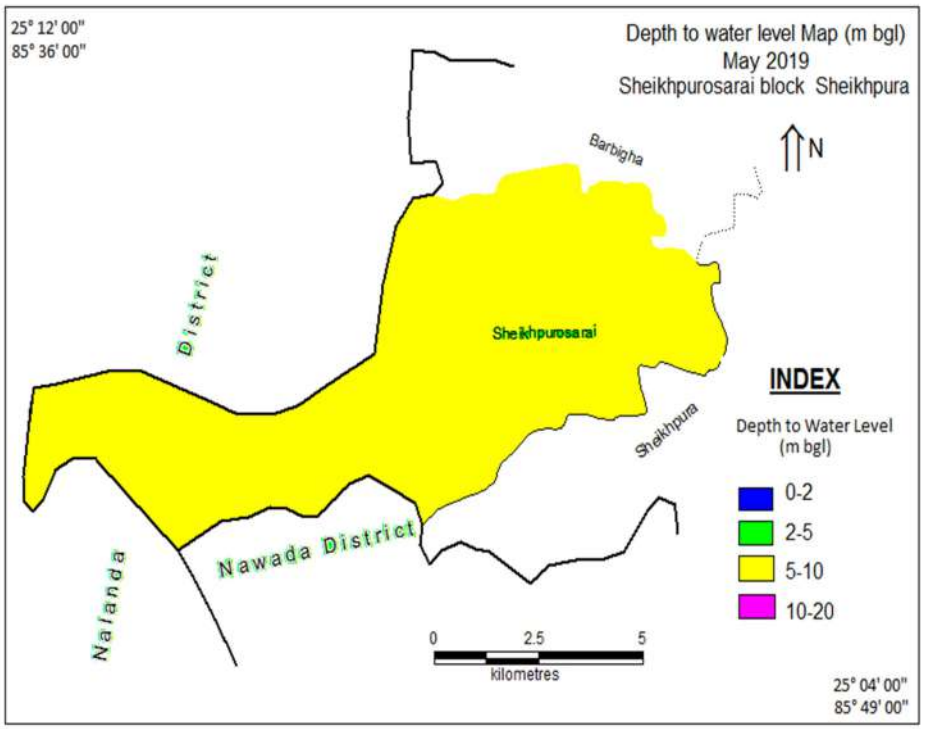
Almost whole block is covered by older alluvium identified by the presence of hard clay and Caliche Nodules of Pleistocene age. A small part in west contains newer alluvium of Holocene age made up of sand silt and clay.

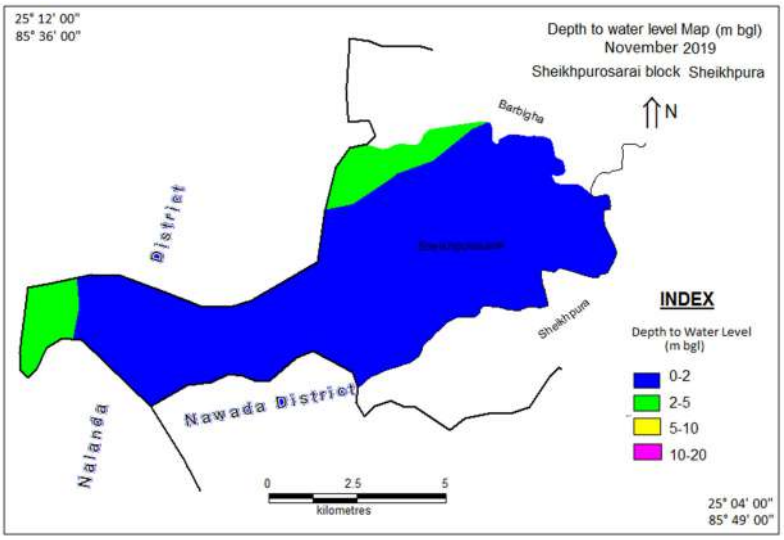


Source: Geological Survey of India

Depth to Water Level

There is one National Hydrograph monitoring station in Sheikhpurosrari block. Depth to water level map of pre- monsoon 2019 shows that whole block has depth to water level within the range 5-10 m. During post monsoon season maximum part of the block shows 0 to 2 m bgl depth to water level range.



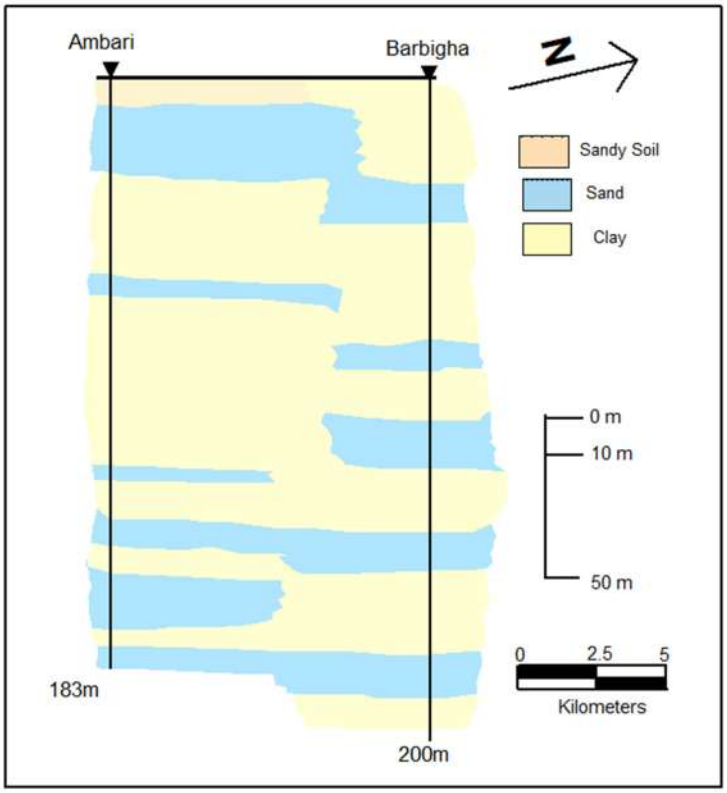


Location	Latitude	Longitude	Depth to Water Level (m bgl)		Elevation (m amsl)	Fluctuation	Depth	RL
			May-19	Nov-19				
Ambari	25.140	85.699	7	4.05	55.6	2.95	6.2	48.6

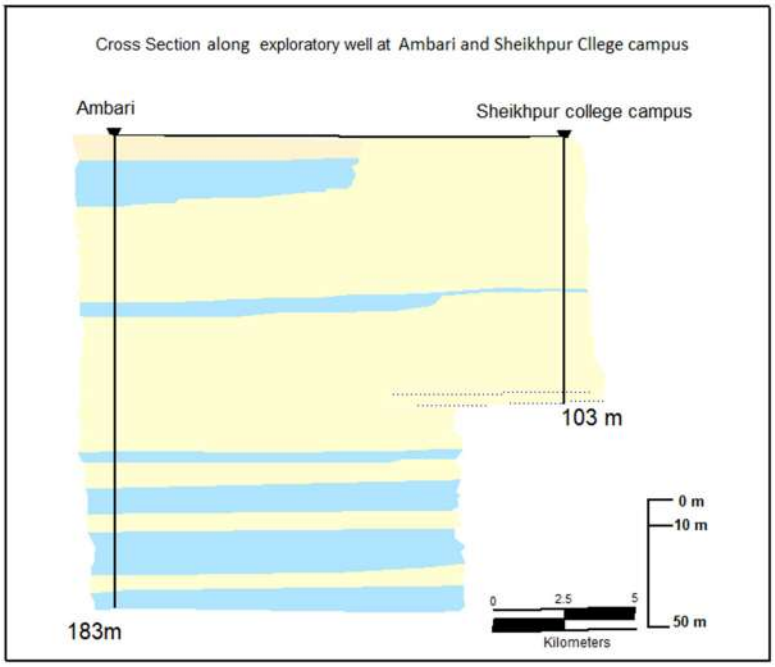
Soil

Maximum part of Sheikhpurosarai block shows coarse lomay soil. Small northern and southerm part shows fine loamy soil.

8.6.2 Aquifer Disposition and Characteristics


Ambari
Barbigha
N
Sandy Soil
Sand
Clay
0 m
10 m
50 m
0
2.5
5
Kilometers
183m
200m


N


Cross Section along exploratory well at Ambari and Sheikhpur Cllege campus
Ambari
Sheikhpur college campus
103 m
0 m
10 m
50 m
0
2.5
5
Kilometers
183m

Two cross sections along Ambari Barbigha and Ambari Sheikhopur sarai has been prepared, which shows the disposition of different formation in this block. As per the cross sections mainly there are 2 sand layers in Sheikhpurosarai block. Some of the layers continued towards east, i.e towards Sheikhpura block, but discontinued towards northern side, i.e. towards Barbigha block. The top sand layer is 23 m thick and occurs at the depth of 7 m. The 2nd sand layer is about 14.5 m thick and occurs at the depth of 15 m. There is about 105 m thick clay layer separating the two sand layers. The clay layer incorporates many sand patches. There are three or more sand patches below these two thick layer which are separated by thin clay layers.

8.6.3 Ground water resource, extraction, contamination and other issues

Ground Water Resources - 2020

About 17.72 % of the net ground water availability of Shekhpura district is available in Shekhpurosarai block. The SOD is 61.52 % whereas of the district SOD is 53.4 %. It shows scope for further development of ground water.

Table 4.1: Block-wise Net Annual Ground Water Availability

In ham

Administrative Units	*Recharge from Rainfall*		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Provision for Natural Discharges*	*Net Annual Ground Water Availability*
	Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
	(ham)	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*
Shekhopur Sarai	1214.79	55.76	677.05	402.2	2349.8	234.98	799.36

Table 4.2: Blockwise Stage of Ground Water Development

Administrative Units	*Net Annual Ground Water Availability*	*Existing Gross Ground Water Draft for irrigation*	*Existing Gross Ground Water Draft for Domestic Uses*	*Existing Gross Ground Water Draft for Industrial Uses*	*Existing Gross Ground Water Draft for All Uses*	*Provision for Domestic and Industrial Requirement for Next 25 years*	*Net GW Availability for Future Irrigation Development*	*Stage of Ground Water Development*
	(ham)	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(%)*
Shekhopur Sarai	799.36	1112.87	116.26	72.00	1301.13	130.59	799.36	61.52

8.6.4 Supply side management

Dynamic Ground water resource of Sheikhopursarai block has been assessed as 799.36ham. The stage of Development is 61.15%. Therefore there is scope of ground water development. Ground water may be used for irrigation purpose etc. additional ground water abstraction structure may be constructed.

Block	GW Resources Position in Bihar as per GW Resource Estimation - 2020					Calculation for additional TW		
	Total Annual Recharge	*Net Resource*	*Gross Draft All Uses*	*Provision for Future Domestic and Industrial Requirement*	*SOD% 2020*	*GW draft at Projected SOD (70%)*	*Additional Resource Available*	*Additional Nos. of STW feasible based on GW availability*
Shekhopur Sarai	2349.8	2114.82	1301.13	130.59	61.52	1480.37	503.86	336

Chemical quality of Ground Water

Result of chemical analysis of ground water of shallow aquifer is given in the table below. In general Chemical quality of shallow aquifer is potable and also suitable for irrigation purpose. Result of chemical analysis is given in the table below.

SN	Block	location	pH	EC	TH	Ca	Mg	Na	K	HCO3	Cl	SO4	NO3	Fl	TDS
1	Sheikhpuro sarai	Ambari	8.24	1645	254.83	56	28	127	212.8	277	139	54	128.35	0.11	1069
BIS 2012		Acceptable limit	<6.5	500	200	75	30	_	1.9	200	250	200	NA	1	_
		Permissible limit (in the absence of alternate source)	>8.5	2000	600	200	100	_	50	600	1000	400	45	1.5	_

Sn	Block	Location	Sodium Adsorption Ratio	Sodium Soluble Percentage	Kelley's Index	Magnesium Ratio	Permeability Index
			Na/sqrt(Ca+ Mg/2)	*Na*100/Ca+Mg+ Na*	*Na/(Ca+Mg)*	*(Mg*100)/(Ca+ Mg)*	*Na+sqrtHCo3)/ (Ca+Mg+Na)* 100*
7	Sheikhpuro sarai	Ambari	15.18	60.19	1.51	33.33	68.08
		Minimum	17.21	66.67	2.00	55.32	82.21
		Maximum	8.64	44.38	0.80	33.33	55.93
		Average	12.59	58.12	1.46	42.85	70.20
		Suitable	<10	<50	<1	<50	25-75
		Marginal	NA	NA	1.2	NA	NA
		Not suitable	>10	>50	>2	>50	>75

8.6.5 Demand side management Plan

Advance irrigation practices may be adopted such as drip/sprinkle irrigation etc. lining of field channels, change of cropping pattern also may be taken up for conservation purpose.

Annexture I

NHS Well Details of Sheikhpura district

SN	Block	Location	Latitude	Longitude	Depth to Water Level (m bgl)		Elevation (m amsl)	Fluctuation (m)	Depth (m)	RL
					May-19	Nov-19				
1	Sheikhpuro sarai	Ambari	25.140	85.699	7	4.05	55.6	2.95	6.2	48.6
2	Ariari	Ariari	25.049	85.860	7.1	6.26	58.8	0.84	10.5	51.7
3	Barbigha	Barbigha	25.217	85.738	6.77	6.14	51.5	0.63	7.5	44.73
4	Chewara	Chewara	25.084	85.924	6.9	6.6	50	0.3	11.5	43.1
5	Ghat Kusumba	Ghat Kusumba	25.225	85.911	2	1.37	42	0.63	11	40
6	Barbigha	Keoti1	25.217	85.796	6.76	1.37	47	5.39	1.98	40.24
7	Barbigha	Koeri Bigha	25.217	85.744	7.15	4.18	51.6	2.97	8.2	44.45
8	Sheikhpura	Nemdarganj	25.170	85.793	6.5	1.2	49	5.3	6	42.5
9	Sheikhpura	Seikhpura	25.146	85.854	10.5	6.4	46.9	4.1	10.5	36.4
10	Barbigha	Sherpar	25.225	85.734	9.82	2.14	49.5	7.68	9.83	39.68

Annexture II.

Sl.. No	Location/ Block	Depth Drilled mbgl.	Length of Casing pipe/ Depth const. m.	Granular/ Zone/ fracture Tapped m.	Static Water level m. bgl.	Discharge m^3/hr.	Drawdown m.	Specific Capacity m^3/hr./m.	Trans-missivity m^2/day	Storativity	Diameter of assembly mm.	Formation
1	2	3	4	5	6	7	8	9	10	11	12	13
1	Barbigha	200	190	031.00-043.00 079.00-085.00 103.00-115.00 133.00-145.00 169.00-182.00	7.63	247.32	6.75	36.64	2250.4	$01.9X10^{-1}$	12"/6"	Alluvium
	OW1	200										
	OW2	60										
2	Sheikhpura	107.3	106	052.00-064.00	6.47	208	14.2	14.64	648	$5.37X10^{-4}$	12"/6"	-Do-
	OW	107.6										
3	Nimmie	154.6	142	045.50-048.50 051.50-054.50 087.50-096.50 105.50-117.50 126.50-138.50	7.6	188.6	17.4	10.84	766.7	$1.9X10^{-4}$	12"/6"	-Do-
	OW	144.6										
4	Hussainabad	116.94	116.5	057.60-061.60 063.60-075.60 090.60-091.60 096.80-099.30 105.90-109.30 111.00-114.00	6.18	160.7	8.38	19.17	697.88	4.05X10^-4	12"/6"	-Do-
	OW	121										
5	Ariari		87	020.93-026.98 045.98-052.02 080.00-086.00			10.8 (Air comsp)					

Sl.. No	Location/ Block	Depth Drilled mbgl.	Length of Casing pipe/ Depth const. m.	Granular/ Zone/ fracture Tapped m.	Static Water level m. bgl.	Discharge m^3/hr.	Drawdown m.	Specific Capacity m^3/hr./m.	Trans- missivity m^2/day	Storativity	Diameter of assembly mm.	Formation
1	2	3	4	5	6	7	8	9	10	11	12	13
6	Chewara	74.8	65	033.00-045.00 048.00-054.00 057.00-063.00	1.45	160.8	22.98	6.99	672	$1.50X10^{-2}$	305 302	Alluvium
	OW	68.5	.....									
7	Kasar	74	74	032.50-050.00 060.00-068.00	6.06	7.29	17.36	0.83	5.25	NO OW	305/203	-Do-
8	Sohdi	51.7	45	030.00-042.00	3.94	61.32	12.56	4.38	295		305/203	Alluvium
9	Lohani	54.3	50	028.00-037.00 043.00-049.00							305/203	Alluvium
10	Chordargah	58.8	56	032.00-044.00 046.00-055.00							305/203	Alluvium
	OW	43.6										
11	Beman	47	28	021.00-027.00							152	Alluvium
12	Samas	159.5	149.3	041.30-053.30 059.30-065.30 086.30-98.30 107.80-113.90 123.00-132.00 138.00-147.30	-	130	6	21.6	1100	-	305/152	Alluvium
	OW	153.5										
13	Sasbahna	75	74	046.50-056.50 062.50-	6.22	46.9	7		375		305/203	Alluvium
14	Sheikhpura College Campus	103	60	059.00-060.00 099.00-100.00 103.00-104.00	4.6	12.24	15.22	-	1-.80	-	-	Quartzite
15	Charuwana	153.4	-	-	6.9	63.74	2.54		1334	-	-	-

Annexture III.

Village : Ambari				Co-ordinates: 26.364295,85.483082
Block: Sheikhpurosarai				
District : Sheikhpura				Total depth- 183 m
S.No.	**Depth (in m)**		**Thickness**	**Composite Lithology**
	From	**To**	**(m)**	
1	0	10	10	**Surface soil** : greyish in colour
2	10	28	18	**Clayey sand** : intermixed with kankar greyish in colour
3	28	52	24	**Sandy clay :** intermixed with kankar greyish in colour
4	52	65	13	**Clay :** Greyish in colour mixed with kankar
5	65	70	5	**Sand :** Coarse sand Light brown in colour
6	70	122	52	**Clay** : Greyish in colour
7	122	126	4	**Sand :** Coarse sand Light brown in colour
8	126	136	10	**Clay :** Greyish in colour mixed with kankar
9	136	146	10	**Sand :** Coarse sand intermixed with kankar Light brown in colour
10	146	153	7	**Clay** : Greyish in colour
11	153	170	17	**Sand :** Coarse sand with gravel brown in colour
12	170	176	6	**Clay :** Greyish in colour mixed with kankar
13	176	183	7	**Sand :** Coarse sand with gravel brown in colour

Location : Gagaur				Co-ordinates: 25.204849,85.871815
Block: Ghat kusumba				
District : Sheikhpura				Total depth- 105 m
Sr No	**Depth Range (m bgl)**		**Thickness (m)**	**Composite Lithology**
	From	To		
1	0	10	10	**Sandy soil :** Greyish in colour
2	10	18	8	**Sand :** Fine sand, greyish in colour
3	18	52	34	**Sand :** Medium to coarse sand, greyish in colour
4	52	56	4	**Clay :** Greyish in colour
5	56	75	19	**Sand :** Fine sand intercalation of clay, greyish in colour
6	75	98	2	**Sand :** Fine sand with kankar, greyish in colour
7	98	105	7	**Sand :** Fine sand, greyish in colour

References:

1. Ground Water Resources of Bihar -2017 (CGWB)
2. Ground Water Exploration Report – Bihar (CGWB)
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4. District Irrigation Plan- Sheikhpura district. (*https://pmksy.gov.in/mis*)
5. Master Plan for Artificial Recharge to ground water in India 2020 (http://cgwb.gov.in/Master%20Plan%20to%20GW%20Recharge%202020.pdf)
6. 4th and 5th MI Census Report