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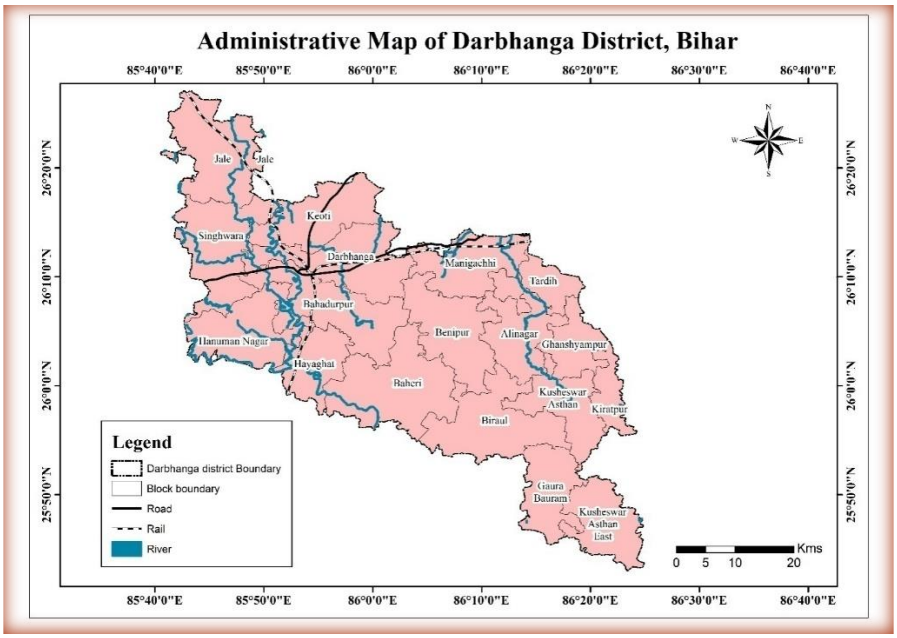
Department of Water Resources, River Development and Ganga Rejuvenation

AQUIFER MAPPING AND MANAGEMENT PLAN IN DARBHANGA DISTRICT, BIHAR



Central Ground Water Board

Mid-Eastern Region

Patna

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REPORT ON AQUIFER MAPPING AND MANAGEMENT PLAN IN DARBHANGA DISTRICT, BIHAR (AAP 2022-23)

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Chapter 1: Introduction

The state of Bihar is located in eastern region of India and is a completely land locked state in the subtropical region of the temperate zone. Bihar has three parts on the basis of physical and structural conditions: the Southern Plateau Region, the Indo-Gangetic Plain, and the Siwalik Region in the northern part of the state. The naturally fertile Indo-Gangetic plain is an asset of the state and the backbone of agricultural and Industrial development. The Indo-Gangetic plain in Bihar consists of a thick alluvial mantle of drift origin overlying in most part, the Siwalik and older tertiary rocks. The soil is mainly young loam, rejuvenated every year by constant deposition of silt, clay and sand brought by streams and floods in Bihar. Alluvial plains are the great repositories of ground water. The Mid-Ganga plains attain maximum thickness of alluvium in the Ganga basin. Thick sequences of potential aquifers are common at shallow levels in these plains that can be harnessed very economically.

The National Aquifer Mapping and Management Programme (NAQUIM) of Central Ground Water Board (CGWB) has been envisaged to focus on the aquifer geometry, occurrences, availability of ground water resources and quality and to formulate management plan of the individual aquifer system for the sustainable development.

Under the Annual Action Plan of 2022-23 of CGWB, MER, NAQUIM study was undertaken in Darbhanga district, Bihar. The present study includes a mappable area of 2504 sq kms covering 18 blocks.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. The aquifer maps and management plans will be shared with the administration of Darbhanga district and other user agencies for its effective implementation.

1.1. Objective and Scope of the study

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 scope of the present study is broadly within the framework of National Aquifer Mapping & Management Programme (NAQUIM) being implemented by CGWB. There are four major activity components viz.: (i) Data collection / compilation (ii) Data gap analysis (iii) Data generation and (VI) Preparation of aquifer maps and management plan to achieve the primary Objective. Data compilation includes collection, and wherever required procurement, of all maps and data from concerned agencies, such as the Survey of India, Geological Survey of India, State Governments etc., computerization and analysis of all acquired data, and preparation of a data base. Collection and compilation of lithologs, wells assembly, electrical log reports and yield test data of the tube wells of PHED, Govt. of Bihar and Agri-Irrigation Department of Govt. of Bihar is vital in accomplishing the work. Identification of Data Gap includes ascertaining requirement for further data generation (hydro-geological, geophysical, chemical, hydrological, hydro-meteorological etc.) in addition to the existing data in respect of prevailing hydrogeological subsurface geological condition in the area. Data generation includes pre and post monsoon monitoring of aquifer wise water level from the existing network monitoring wells and other available feasible wells, spot measurements of electrical conductivity of the water samples from the wells, incorporation of observation based on field studies, data collection through ground water exploration work in the study area, collection of water samples etc.

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 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

- Compilation of existing data and reports of CGWB.
- Identification of data gaps.
- Data generation through monitoring of pre and post monsoon water level from the NHNS stations and key observation wells in different aquifers, monitoring of water

quality, spot measurement of conductivity, exploratory drilling for study of subsurface geology, preparation of lithological logs, yield and aquifer parameter data through construction of tube wells.

- Collection, compilation and analysis of lithologs, electrical logs and yield data of the water supply wells of PHED, Govt of Bihar and Agri-Irrigation Department, Govt. of Bihar.
- Preparation of thematic maps on GIS platform.
- Identification/demarcation of individual aquifer systems in the area from the available lithologs, electrical logs, previous literature, and observation from field studies etc.
- Preparation of 2D/3D aquifer disposition maps in Rockworks Platform.
- Analysis of 2D and 3D maps, assessment of existing draft and resource of individual aquifer systems. Considering the demand and supply status in drinking, domestic, industrial and agriculture sectors the suitable management plan has been designed. The scope for rainwater harvesting for artificial recharge or conservation is reviewed and accordingly suitable structures are recommended.
- Capacity building in all aspects of ground water through IEC Activities.

1.3. Area details

Darbhanga district forms a part of the north Bihar Plain and lies in the northern portion of the state of Bihar. It covers a mappable area of 2504 sq.kms. and consists of 18 blocks namely, Bahadurpur, Jale, Hayaghat, Singhwara, Benipur, Ghanshyampur, Baheri, Keoty, Manigachhi, Darbhanga, Biraul, Kusheswar Asthan, Kusheswarsthan East,Alinagar, Gaura Bauram, Kiratpur, Hanuman Nagar and Tardih. The study area (*Figure 1*) geographically lies between 25°42' and 26°24' North latitude and 85°4' and 86 ° 23’ East longitudes. The area is covered in Survey of India toposheet nos. 72F/11, 72F/12, 72F/15, 72F/16, 72G/13, 72J/3, 72J/4, 72J/8, 72K/1, 72K/5, 72K/6. It is bounded on the north by the districts of Sitamarhi and Madhubani, on the south by the district of Samastipur, on the east by the districts of Saharsa and Supaul and on the west by the district of Muzaffarpur.

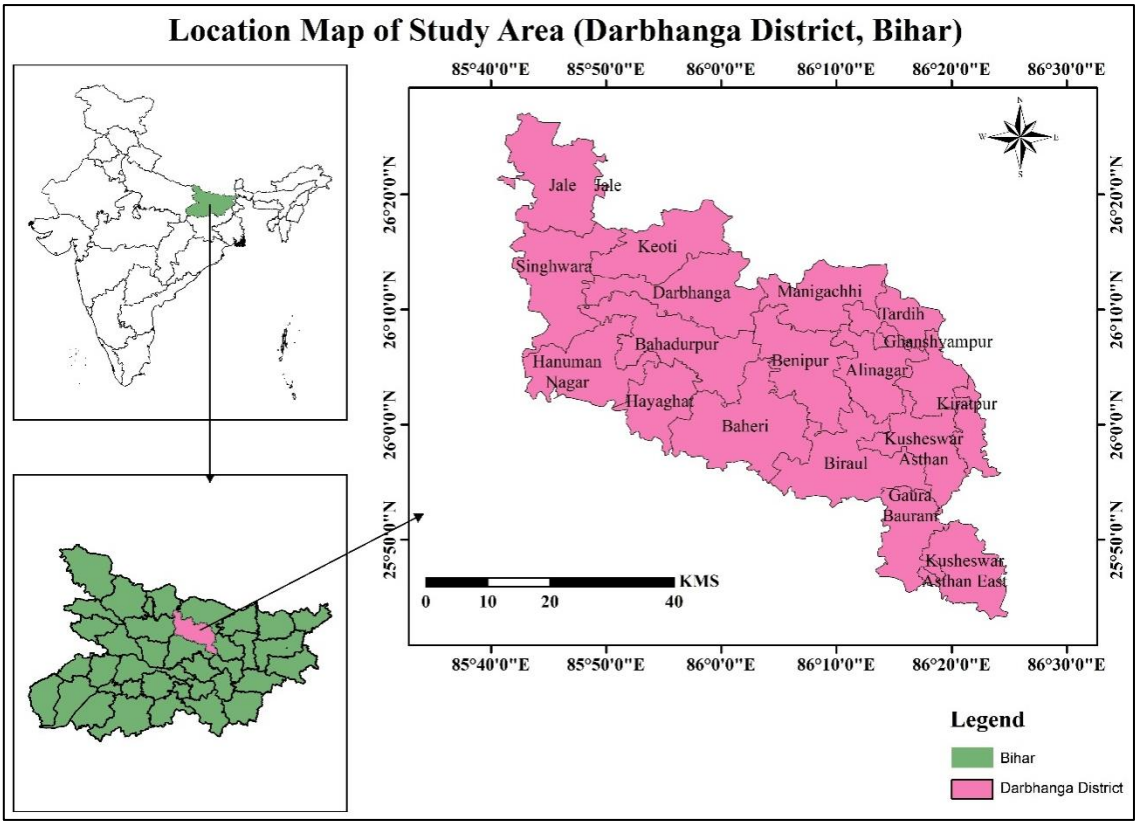

Figure 1: Study Area Map (Darbhanga District)

1.4. Administrative and Demographic details

There are three subdivisions in the district- Darbhanga Sadar, Benipur and Biraul. Darbhanga (MC) is the only town in the district. The administrative map of Darbhanga district is given in *Figure 2*. In terms of population per sq.km. Darbhanga is the 3rd densely populated district in the state with1728 persons per sq.km.

According to 2011 census, Darbhanga has a sex ratio of 911 female for every 1000 male.Jale (under Jale C.D. Block) is the most populated village and Baghela (under Hanumannagar C.D.Block) is the least populated village in the district. The total population of the district is 3921971 (Urban- 380125 and rural- 3541846). There are 329 panchayat in the district and 1269 villages. The demographic details of the district is given in *Table 1*.

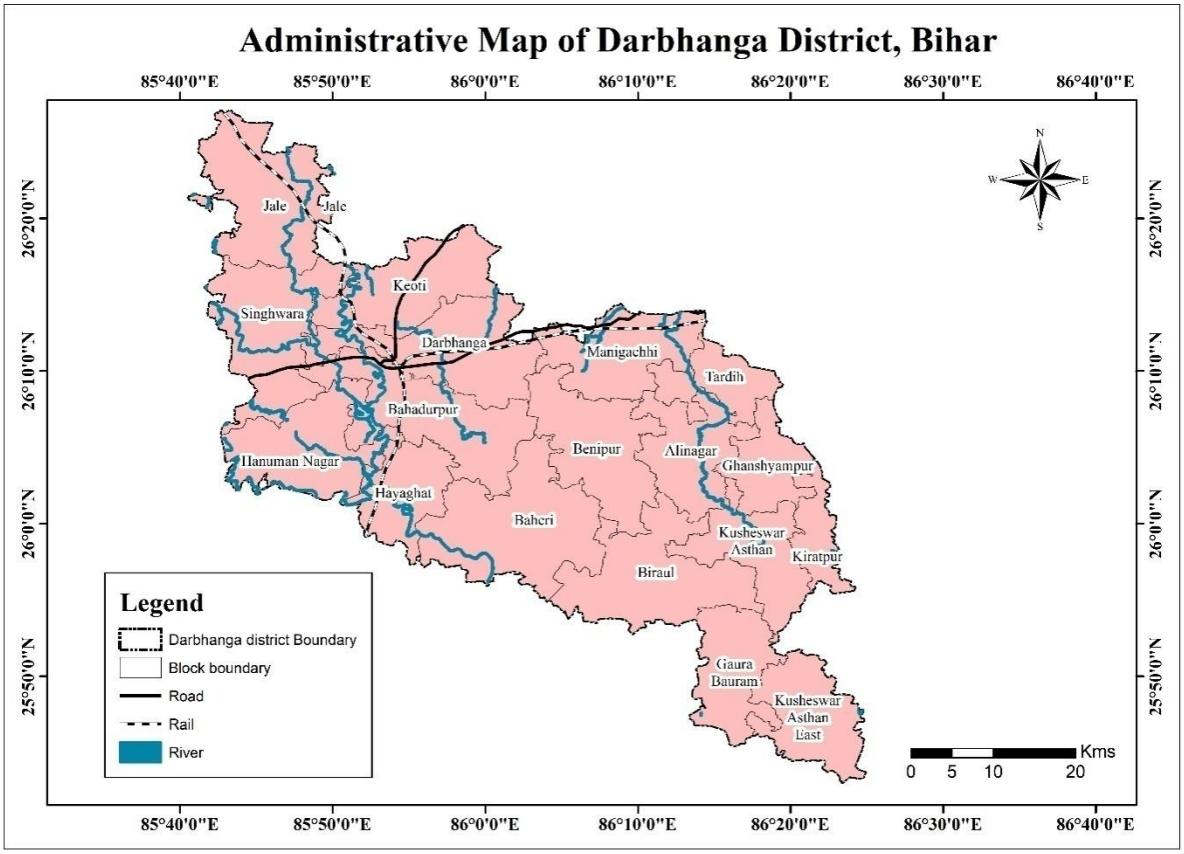

Figure 2: Administrative Map of Darbhanga district, Bihar

Table 1: Demographic Details of Darbhanga district (as per Census 2011)

Block	Male	Female	Children	SC no.of households	SC Population	ST no. of households	ST Population
Alinagar	74574	69223	27928	3050	15627	1	9
Bahadurpur	138473	12332	47178	11204	57335	34	156
Baheri	159342	143303	56819	9246	46115	78	337
Benipur	91241	83799	30075	5033	26066	7	24
Biraul	149326	136787	55410	10562	54359	38	187
Darbhanga	148422	132575	52256	9114	44842	10	82
Gaura Bouram	78823	73289	30121	3921	19788	11	49
Ghanshyampur	69394	63816	23654	4161	19952	9	53
Hanuman Nagar	82107	72524	28180	6275	30443	3	19
Hayaghat	78245	69836	27297	5357	26765	22	90
Jale	136448	127800	49732	6478	31911	15	92
Kusheshwar asthan	84977	77893	33958	6211	29911	40	241
Kusheshwar Asthan East	67877	60940	30020	6994	35273	23	120
Keoti	142147	128575	49794	8246	38571	71	346
Kiratpur	42458	38965	17092	3684	18091	1	10
Manigachhi	118772	109846	39950	6396	31018	40	255
Singhwara	138285	129316	49800	6739	34251	18	106
Tardih	64000	59299	20916	3018	13936	6	35
Total	**1864911**	**1590118**	**670180**	**115689**	**574254**	**427**	**2211**

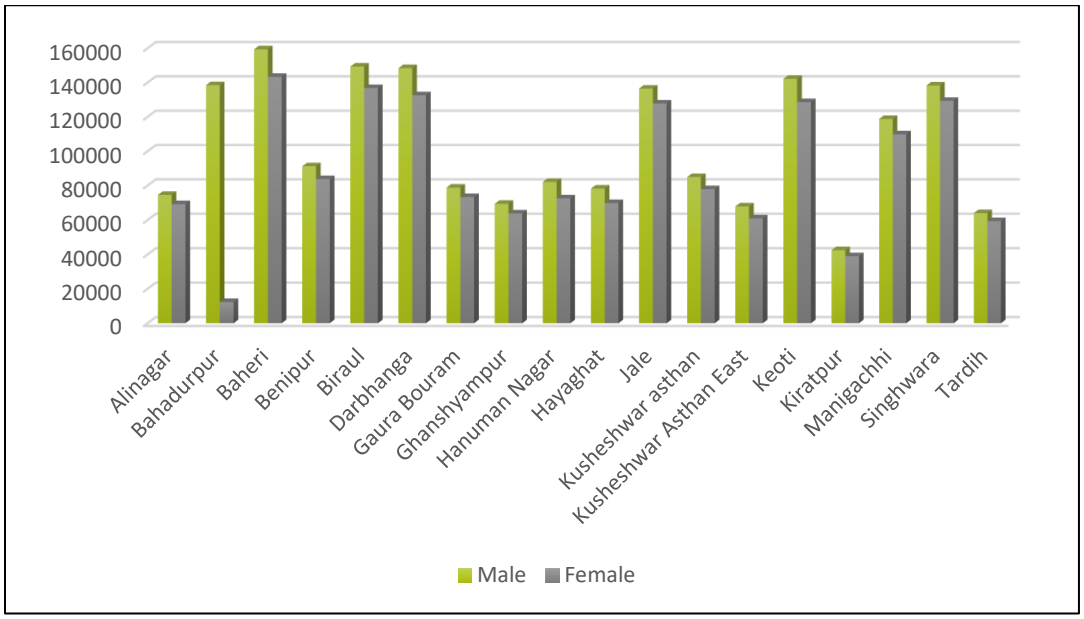

Figure 3: Blockwise Male vs Female population details of Darbhanga district, Bihar

1.5. Climate and Rainfall

The district of Darbhanga has somewhat dry climate. There are three well-marked seasons, the winter, the summer & the Rainy season. The cold weather begins in November and continues up to February, though March is also somewhat cool. Westerly winds begin to blow in the second half of March and temperature rises considerably. May is the hottest month when the temperature goes up to 42 ºC. Rain sets in towards the middle of June. The rainy season commences from mid of June with the outburst of south-west monsoon. The advent of monsoon brings a complete change in weather with appreciable decrease in temperature. The average annual rainfall in the district is 1142.3 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. The blockwise rainfall data of Darbhanga district is given in *Table 2*. Weather conditions become hot and humid during the rainy season. The average number of rainy days in district is 36.5. 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.

Table 2: Blockwise Rainfall data of Darbhanga district

Block	**Normal Annual Rainfall (mm)**	**Average Monthly Rainfall (mm)**	**No.of rainy days**	**Maximum Rainfall Intensity upto 15mins (mm)**	**Maximum Rainfall Intensity beyond 15mins upto 30mins (mm)**	**Maximum Rainfall Intensity beyond 30mins upto 60mins (mm)**
Alinagar	1227	102.2	53	20	15	18
Bahadurpur	1236	103	53	19	17	17
Baheri	1242	103.5	54	18	16	20
Benipur	1232	102.6	50	17	19	14
Biraul	1245	103.7	58	21	17	20
Darbhanga	1226	102.1	52	18	21	13
Gaura Bauram	1233	102.7	50	17	17	16
Ghanshyampur	1237	103	52	22	17	13
Hanuman Nagar	1239	103.2	59	15	19	25
Hayaghat	1230	102.5	53	19	15	19
Jale	1225	102	51	15	18	18
KusheshwarAsthan	1226	102.1	53	15	19	19
KusheshwarAsthan East	1230	102.5	59	19	18	22
Keoti	1243	103.5	57	19	12	26
Kiratpur	1232	102.6	55	13	23	19
Manigachhi	1239	103.2	59	23	17	19
Singhwara	1231	102.5	58	13	20	25
Tardih	1238	103.1	52	21	16	15

Table 3: Month wise departure from Normal Rainfall, Darbhanga district (Source:IMD)

YEAR	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEPT		OCT		NOV		DEC	
	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP
2017	0.0	-100	0.0	-100	27.6	124	54.0	154	138.0	130	108.3	-31	432.4	46	443.4	56	66.9	-64	1.9	-97	0.0	-100	0.0	-100
2018	0.0	-100	0.0	-100	2.1	-83	11.9	-44	22.3	-63	97.0	-38	246.8	-17	195.9	-31	96.5	-48	1.8	-97	0.0	-100	0.0	-100
2019	1.8	-84	21.3	104	0.4	-96	63.7	217	17.8	-70	96.0	-36	416.4	41	126.9	-53	337.5	91	6.2	-90	0.0	-100	15.6	248
2020	3.3	-71	13.2	27	37.8	274	82.3	310	83.9	42	325.0	117	660.5	123	143.3	-47	290.4	65	33.7	-48	0.0	-100	0.0	-100
2021	0.0	-100	0.0	-100	0.0	-100	11.6	-42	276.6	366	431.0	188	317.2	7	439.2	63	57.1	-68	243.8	280	0.0	-100	6.0	34

1.6. Physiographic setup

The district has a vast alluvial plain devoid of any hills. The area is a part of the Baghmati Sub-Basin in the Ganga Basin. There is a gentle slope from north to south with a depression at the centre. The maximum ground elevation is 52.50 m amsl in northern part of the district and the minimum is 41.08 m amsl in the south- eastern parts, average being 47 m amsl.The district is mainly drained by four rivers- the Bagmati, the little Bagmati, the Kamla and the Tiljuga. The sources of these rivers mainly lies in the Himalayas.Other than rivers and their tributaries, levees along the stream banks, back swamps or flood basins/ chaurs of various sizes are the only significant features over the area.Occasionally depressions are formed by levees-back swamp complexes in interfluvial tract between two adjacent rivers. The district area stretches to the south of the piedmont (Terai/Bhabar) belt of Nepal Himalaya. It is devoid of any appreciable relief feature and thus forms a vast monotonous plain.

1.7. Geomorphology

The District of Darbhanga can be divided into four natural divisions. The eastern portion consisting of Ghanshyampur, Biraul and KusheshwarAsthan blocks contain fresh silt deposited by the Kosi River. This region was under the influence of Kosi floods till the construction of Kosi embankment in the Second Five Year Plan. It contains large tracts of sandy land covered with wild marsh. The second division comprised of the anchals lying south of the BurhiGandak river and is the most fertile area in the district. It is also on higher level than the other part of the district and contains very few marshes. It is well suited for the rabi crops. The third natural region is the doab between the BurhiGandak and Baghmati and consists of the low-lying areas dotted over by chaur and marshes. It gets floods every year. The fourth division covers the Sadar 13 sub-division of the district. This tract is watered by numerous streams and contains some uplands (*Figure 4*).

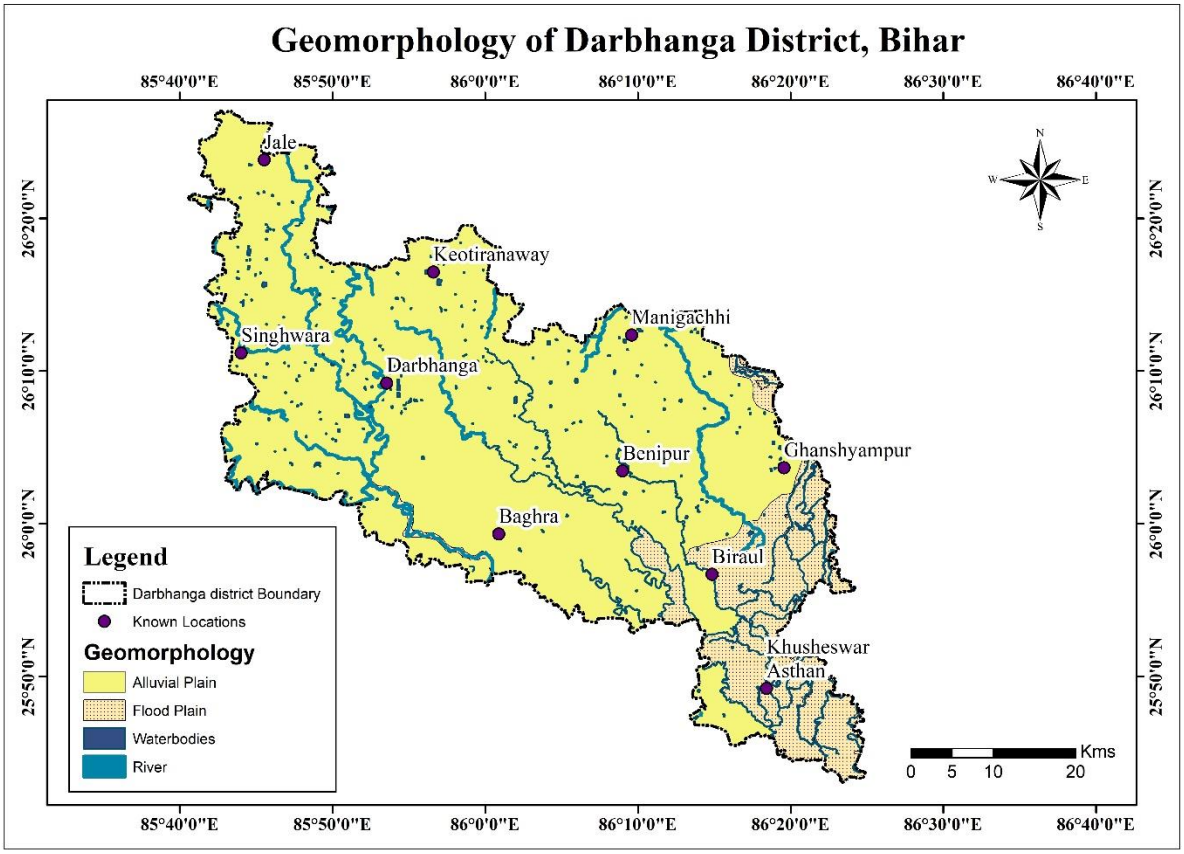

Figure 4: Geomorphology of Darbhanga district, Bihar

1.8. Land Use Land Cover

The total geographical area (TGA) of Darbhanga is 2504 km^2. The largest block of the district is Bahera which comprises about 8.2 percent of the TGA of the district. This is followed by Biraul block, Jale Block and Keoti Block each of comprised of 7.9 percent of the total geographical area of the district. Kiratpur is the smallest block of the district which comprise of around 2.4 percent of total geographical area of the district. It has been observed from Bihar state ICAR data that the Gross Cropped Area of the district is 2.53 lakh hectare, and the Net Sown Area is 1.72 lakh hectare. The cropping intensity in all the blocks have been recorded at 148 percent. No forest area has been notified in the district (*Table 4*).

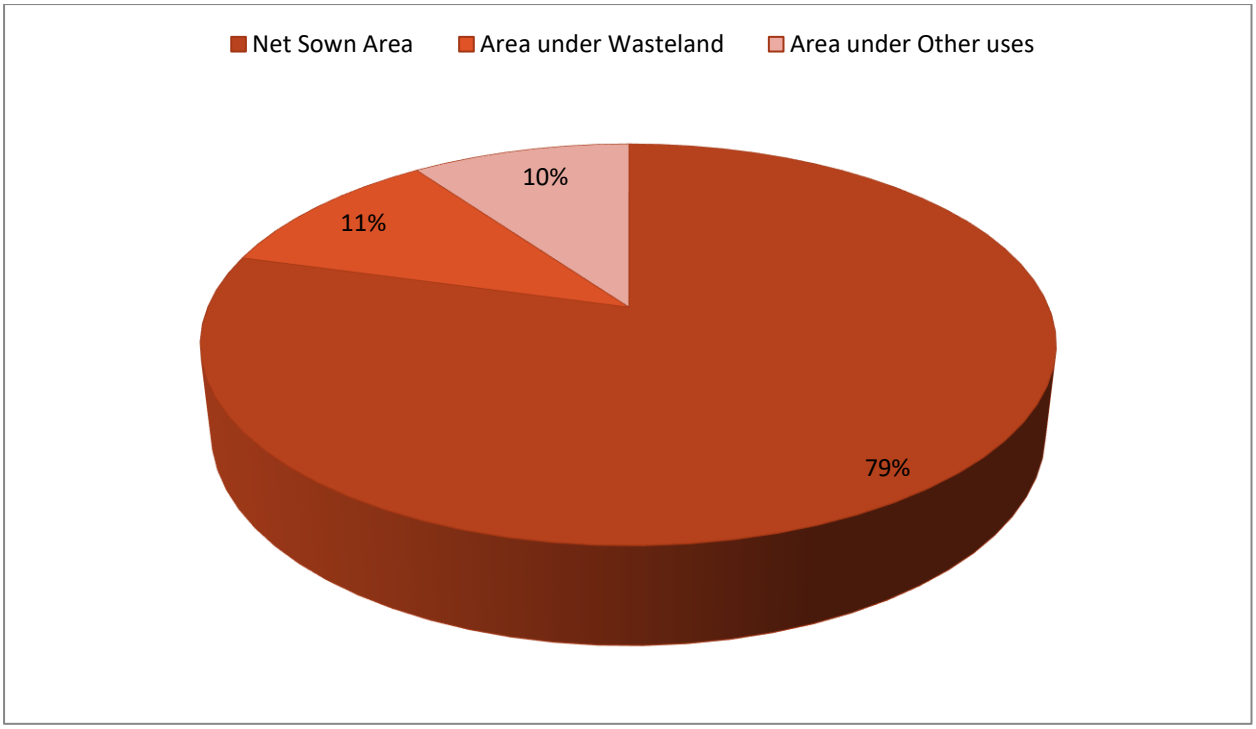

Figure 5: Graphical representation of Landuse pattern in Darbhanga district, Bihar

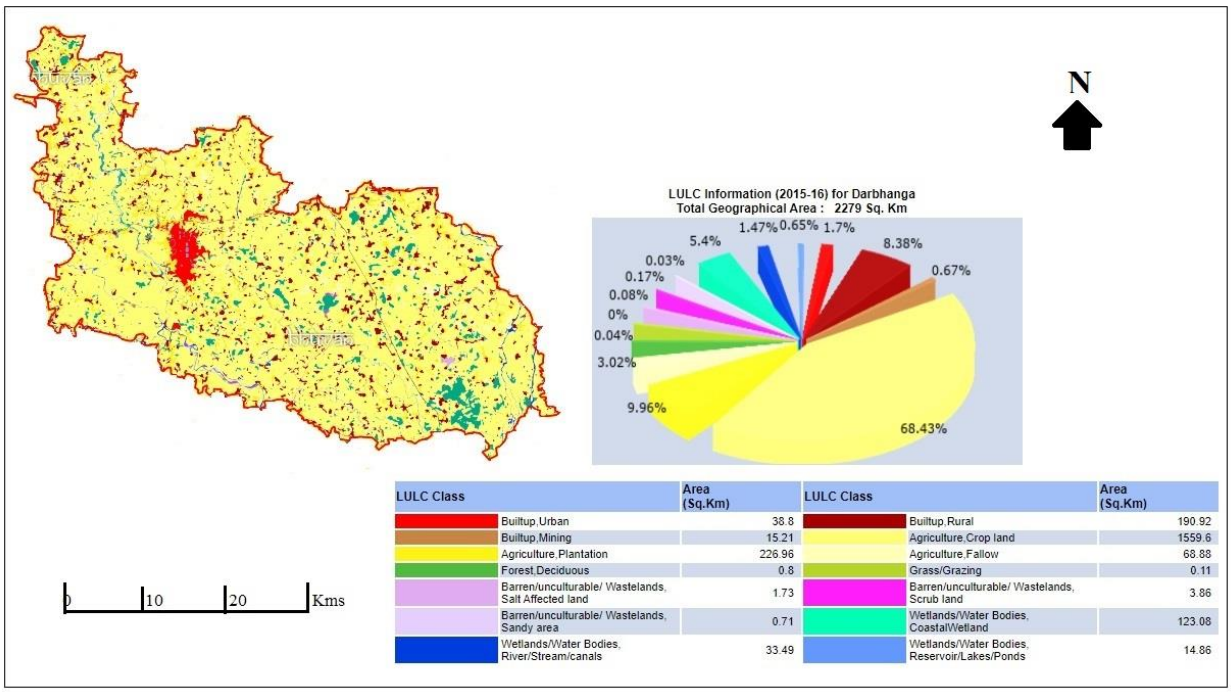

Figure 6: Land Use Land Cover details of Darbhanga district(Source: https://bhuvan.nrsc.gov.in)

Table 4: Landuse Pattern of Darbhanga district (area in hectares)

Block	Total Geographical Area	Area under Agriculture			Cropping Intensity (%)	Area under Forest	Area under Wasteland	Area under Other uses
		Gross cropped Area	Net Sown Area	Area sown more than once				
Alinagar	9504	8492	5751	2741	148	0	786	715
Bahadurpur	16851	17756	12024	5732	148	0	1643	1495
Baheri	21482	20844	14156	6688	148	0	1928	1755
Benipur	16259	16984	11502	5482	148	0	1571	1430
Biraul	18443	20072	13593	6479	148	0	1857	1690
Darbhanga	20612	17756	12024	5732	148	0	1643	1495
Gaura Bouram	10345	10036	6796	3240	148	0	928	845
Ghanshyampur	11619	9264	6274	2990	148	0	857	780
Hanuman Nagar	13979	10808	7319	3489	148	0	1000	910
Hayaghat	8601	10808	7319	3489	148	0	1000	910
Jale	18679	20072	13593	6479	148	0	1857	1690
Kusheshwarasthan	15008	10808	7319	3489	148	0	1000	901
Kusheshwar Asthan East	6236	7720	5228	2492	148	0	714	650
Keoti	11659	20072	13593	6479	148	0	1857	1690
Kiratpur	12124	6176	4182	1994	148	0	571	520
Manigachhi	13620	16984	11502	5482	148	0	1571	1430
Singhwara	17038	19300	13070	6230	148	0	1786	1625
Tardih	8370	10036	6796	3240	148	0	928	845
Total	250429	253988	172041	81947	148	0	23497	21385

(Source: DAP, PPR,District Statistical office/lus.dacnet.nic.in)

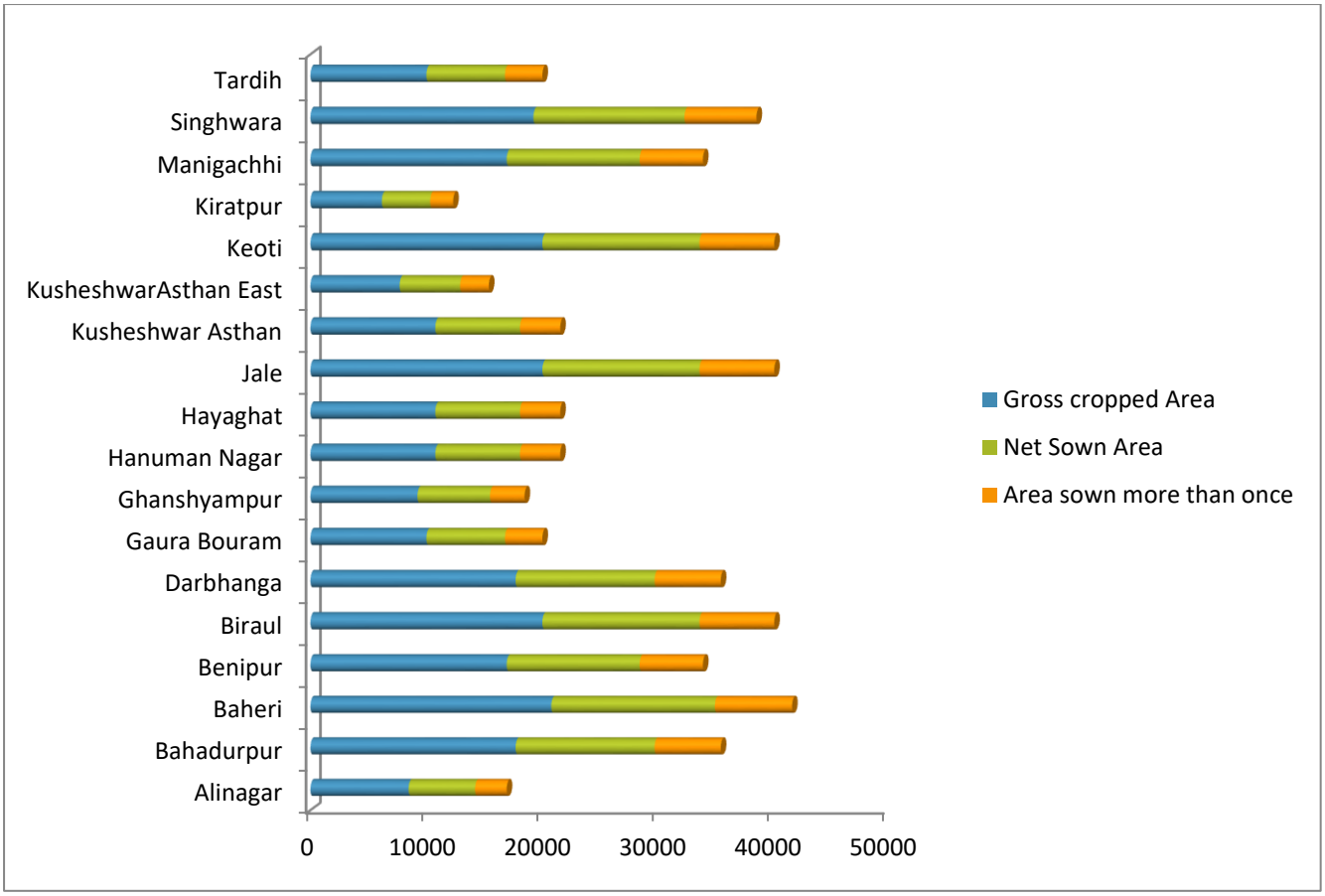

Figure 7: Graphical representation of block wise agricultural area(in hectrares) in Darbhanga district, Bihar

1.9. Soil

The soil of the district is highly calcareous. It is a mixture of clay, sand and silt in varying proportions. ‘‘Bhangar’’soil is found in the low-lying areas. The following type of soils are found in the district:

Entisols: This soil type is developed along the kamla river and in marshy land, as well as in back swamp areas. The texture is loose and of black or dark grey in colour. It consists of sand and clay with minor silt. This soil is suitable for seasonal crops in selected patches.

Inceptisols: This soil type is developed in the central part of the district and locally known as Bhangar. It is highly calcareous in nature.

1.10. Hydrology and Drainage

The area is a part of the Baghmati Sub-Basin in the Ganga Basin. The district contains four main river systems, viz, the Bagmati, little Bagmati, Kamla and Tiljuga. The Bagmati, which enters this district form Muzaffarpur, forms a natural boundary between it and Samastipur district and pursues a southeasterly course till it empties itself into the BurhiGandak River

near Rosera. The little Bagmati enters the district from Madhubani near Pali and turns past the town of Darbhanga down to Hayaghat, where the Bagmati proper joins it. The Kamla enters the district at Singar Pandaul, and flowing east of Darbhanga, joins the Tiljuga at the southeastern corner of Rosera block. The Tiljuga skirts the eastern boundary of the district. The rivers are highly unpredictable in nature. Water flows throughout the year, but during the monsoon water level rises quickly and causes wide-spread floods. Kamala has changed its course several times during the historical past and has deposited huge quantity of sediments throughout the area of its influence alongwith its tributaries such as Jiwach, old Kamala,etc. Apart from the rivers, other prominent physiographic features of the area are enormous ponds, swamps, lakes and water logged low lands.

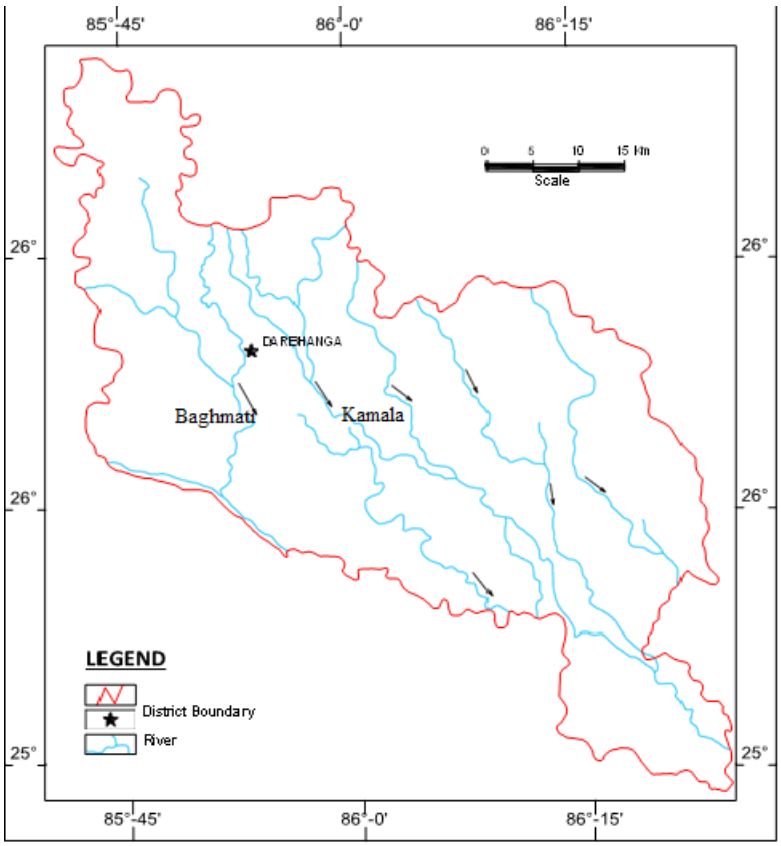

Figure 8: Major Rivers flowing through Darbhanga district

1.11. Agriculture

The soil of the district is highly calcareous and a mixture of clay & sand, which makes it suitable for rice and Rabbi crops. The total geographical area of the district is divided into cultivable areas, uplands, medium and low lands and chaur areas.

In the district of Darbhanga, 82.17% of the total area is cultivable. Among Kharif crops, paddy has the highest sown area (96 %), which is followed by maize (2.1 %) and oil seeds (1.5 %). During Rabi season wheat is the principal crop covering around 54 % of the area sown and is followed by pulses (21 %), maize (10 %), oil seeds (9.4 %) and potato (6 %). Vegetables are grown liberally in all the seasons. The district is full of mango orchards. Sisoo, Khair, Palm, Khajur, Jackfruit, Litchi, Pipal, Jamun, Guava trees are found near human settlements. Many ponds can be seen full of Makhan & Lotus. The district also has some tracts of grasslands. The production and productivity details of major crops in Darbhanga district is given in *Table 5*.

Table 5: Production and productivity of major crops in Darbhanga district, Bihar

Season	**Rainfed Cultivation**		**Irrigated condition**	
	Production	**Yield (Kg/Ha)**	**Production**	**Yield (Kg/Ha)**
Kharif	340612	850	646646	1105
Rabi	252201	645	499517	853
Summer	141769	910	230639	988
Horticulture and plantation	1017244	4600	827344	5600
Total	1751826	1499	2204146	1420

1.12. Irrigation

The irrigation in Darbhanga district still depends on rainfall as only 19 % of the total cultivable area has been put to irrigation sources other than rainfall. Irrigation in the district has been linked to flood control measures and drainage schemes. In the recent past considerable effort has been paid to the expansion of irrigational facilities from ground water resources and lift irrigation schemes under minor irrigation system. In the present day, out of the total irrigated area, near about 70 % is being irrigated from ground water.

Total water available through surface sources in the district is 280 MCM while through well 814 MCM water is available. Deep tubewell provides water for irrigation with 46.74 MCM of water. The availability of water through medium tube wells found to be highest as the same provides around 730 MCM of Water. However, during Kharif season, medium tubewells provide maximum water (303.5 MCM) while the same during Rabi and summer season provides an equal quantity of 213.6 MCM from different sources.

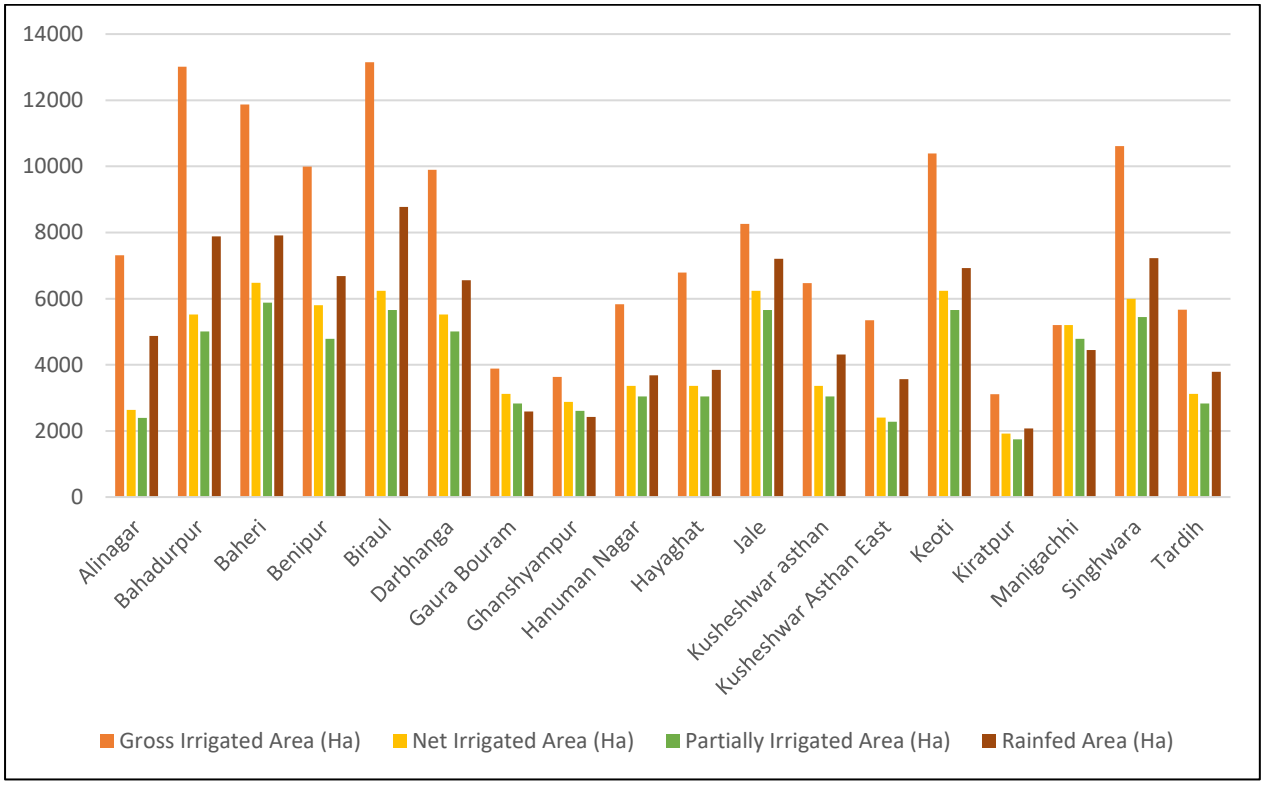

Figure 9: Graphical representation of blockwise Irrigation Based Classification of Darbhanga district, Bihar.

Table 6: Blockwise Irrigation Based Classification of Darbhanga district, Bihar.

Block	Gross Irrigated Area (Ha)	Net Irrigated Area (Ha)	Partially Irrigated Area (Ha)	Rainfed Area/ Un-irrigated Area (Ha)
Alinagar	7311.7	2640	2393.82	4874.5
Bahadurpur	13012.9	5520	5005.26	7884.1
Baheri	11870.4	6480	5875.74	7913.6
Benipur	9992.9	5800	4787.64	6678.6
Biraul	13153.1	6240	5658	8768.7
Darbhanga	9897.8	5520	5005.26	6558.5
Gaura Bouram	3881.4	3120	2829	2587.6
Ghanshyampur	3633.3	2880	2611.44	2422.2
Hanuman Nagar	5826.1	3360	3046.68	3680
Hayaghat	6786.1	3360	3046.68	3844
Jale	8258.1	6240	5658	7205.3
Kusheshwar asthan	6465.8	3360	3046.68	4307.9
Kusheshwar Asthan East	5348.8	2400	2280.25	3565.9
Keoti	10389.2	6240	5658	6926.1
Kiratpur	3107.4	1920	1740.96	2071.6
Manigachhi	5205.6	5200	4787.64	4450.3
Singhwara	10617.6	6000	5440.5	7224.1
Tardih	5665.8	3120	2829	3790.5
Total	140424	79400	71700.55	94753.5

Table 7: Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Alinagar	414	336	3
Bahadurpur	954	494	1
Baheri	2056	1140	8
Benipur	202	878	13
Biraul	1489	856	106
Darbhanga	959	262	959
Gaura Bouram	908	262	0
Ghanshyampur	662	459	0
Hanuman Nagar	882	944	1
Hayaghat	561	11	0
Jale	853	328	34
Kusheshwar asthan	1015	282	53
Kusheshwar Asthan East	261	150	193
Keoti	413	687	267
Kiratpur	350	625	1
Manigachhi	610	399	13
Singhwara	1040	587	67
Tardih	405	307	0
Total	14034	9007	1719

1.13. Slope

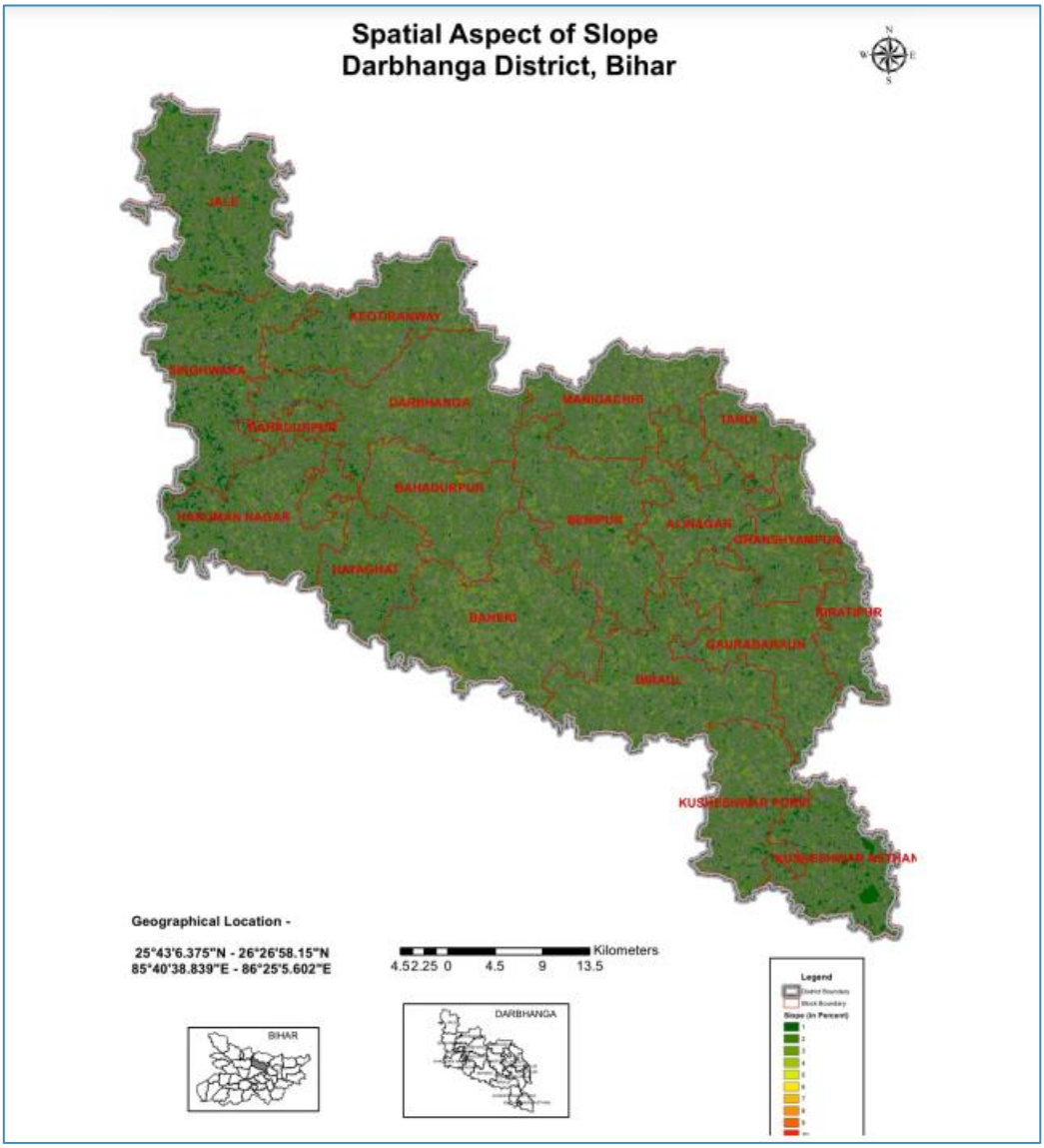

Figure 10: Slope Map of Darbhanga District (Source: DIP Darbhanga 2016-2020)

Darbhanga District overall has low to medium slope, which is helpful for rainwater percolation and recharge of groundwater.

Chapter 2: Data Collection and Generation

The primary data such as water level, quality, geophysical data and exploration details available with CGWB has been collected and utilized as baseline data. The Central Ground Water Board has established a network of observation wells under National Hydrograph Network program to study the behavior of ground water level and quality of ground water in the district. 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 program was carried out by Central Ground Water Board. For other inputs such as hydrometeorological, landuse, cropping pattern etc. were collected from concerned State and Central govt. departments and compiled.

2.1. Hydrogeological Data

Hydrogeological data of the district was collected from CGWB reports, BDRs and unpublished reports. Water level data collected from the National Hydrograph Network Stations (NHNS) of CGWB in Darbhanga District. Data of 12 monitoring wells were collected and historical water level trend compiled representing phreatic aquifer (Aquifer-1). 25 new key wells were also established in blocks lacking NHNS and water level data was collected from these wells also to see the trend in seasonal water level fluctuation.

2.2. Hydrochemical data

Groundwater quality of an area is a function of physical and chemical parameters that are greatly influenced by geological formations and anthropogenic activities. Quality of ground water is as much demanding as its quantity. Suitability of ground water for drinking and irrigational purpose is important for its safe and effective use. The concentration of the major ions and other dissolved ions in ground water are function of the availability of the constituents in the aquifer matrices and their solubility. Rocks, through which water circulate are composed of minerals and amorphous solids, which in turn are composed of chemical elements that greatly affect the ground water quality. Ground water samples of 12 NHNS locations and 25 key well locations has been analyzed in the Chemical lab of CGWB,MER,Patna to assess the chemical quality of Aquifer-1 in this area.

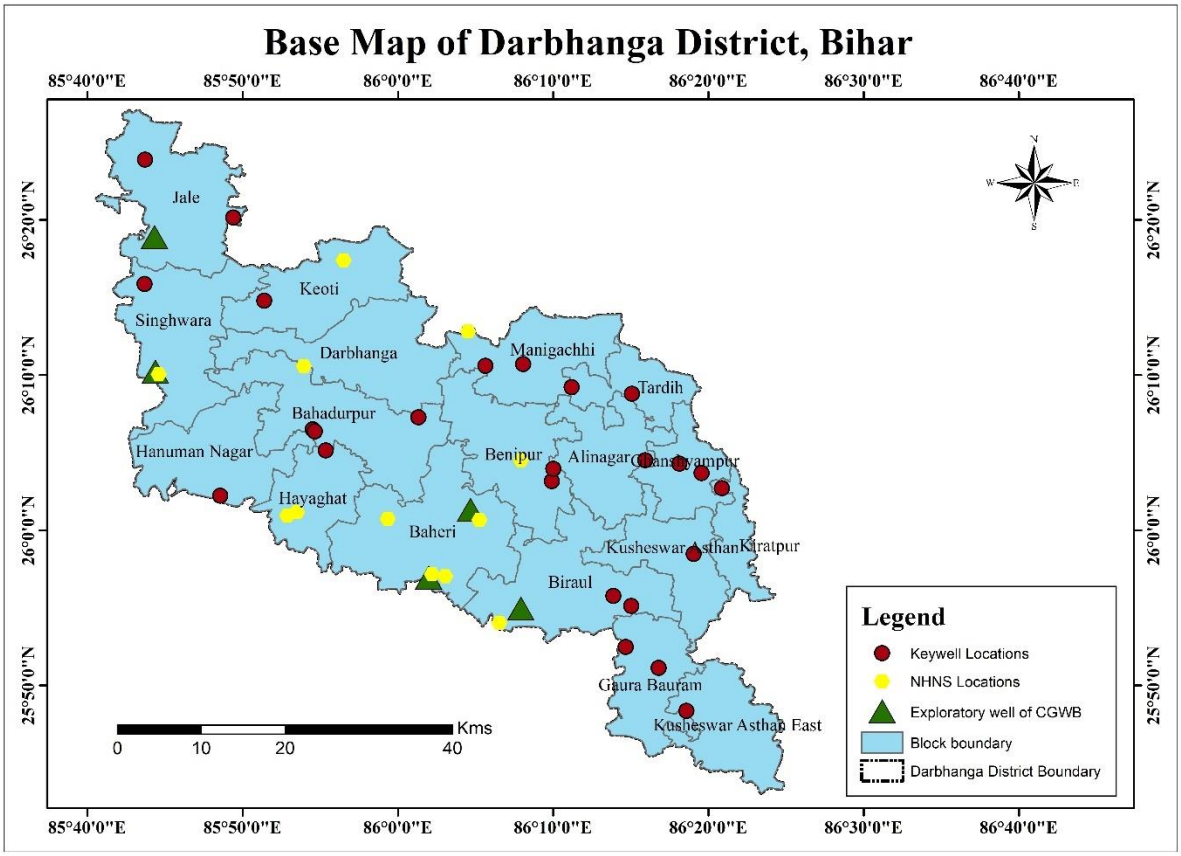

Figure 11: Base Map of Darbhanga district, Bihar showing NHNS locations, Key well locations and Exploratory Well locations.

2.3. Geophysical Survey

Geophysical survey was carried out at 21 locations in Darbhanga district under AAP 2022-23 to get an idea of the subsurface litholgy and delineate the aquifer geometry. Both Vertical Electrical Sounding (VES) and Transient Electromagnetic Survey (TEM) was carried out in the district.

2.4. Exploratory Drilling

A total of 04 exploratory wells (EW), 02 observation wells (OW)and 08piezometers (Pz)are existing in alluvium terrain of Darbhanga district through departmental rigs.

The details of Exploratory wells are given in Annexure - III.

2.5. Thematic Layers

The following thematic layers were also generated which supported the primary database and provided precise information to assess the present ground water scenario and to propose the future management plan.

1. Soil Map
2. Drainage Map
3. Geomorphology
4. Slope
4. Land use
5. Geology & structure

The thematic layers such as drainage, geomorphology, DEM, and land use has been described in Chapter-1.

Chapter 3: Data Interpretation, Integration and Aquifer Mapping

The data collected and generated on various parameters viz., water levels, water quality, exploration, aquifer parameters, geophysical, hydrology, hydrometeorology, irrigation, thematic layers was interpreted and integrated. Based on this the various aquifer characteristic maps on hydrogeology, aquifer wise water level scenario both current and long-term scenarios, aquifer wise ground water quality, 2-D and 3-D sub-surface disposition of aquifers by drawing fence and lithological sections, aquifer wise yield potential, aquifer wise resources, aquifer maps were generated and as discussed in detail.

3.1. Geology

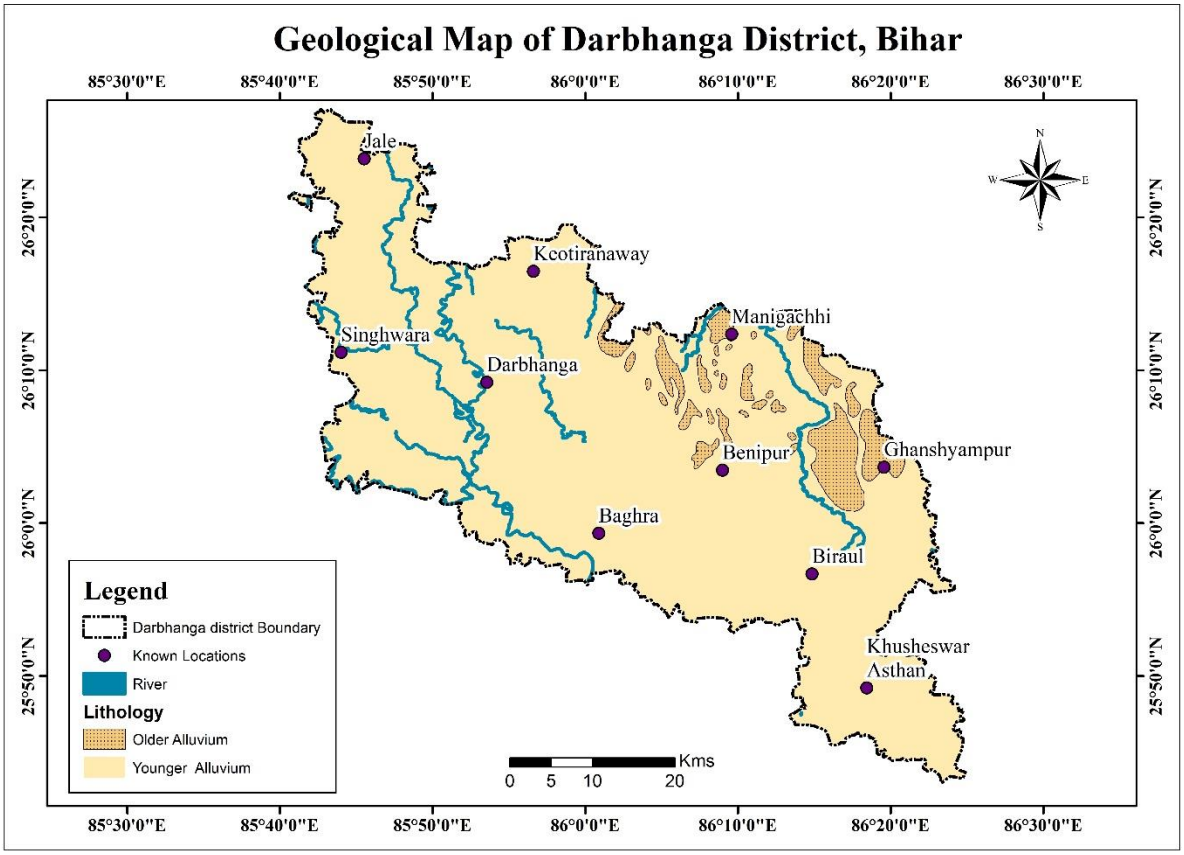

Figure 12: Geological Map of Darbhanga District, Bihar

Darbhanga district lies in the Kosi-Gandak interfluves region and mainly represented by younger Alluvium. Older alluvium is found near the north-eastern and eastern part of the district (*Figure 12*). Quaternary sediments comprising sand,silt and clay have been encountered in all the boreholes. These sediments have been deposited by the flooding rivers

and streams in this area. Coarser sediments occur mainly near the present and old rivers, finer clastics being deposited away from the channels.

3.2. Hydrogeology

The whole of Darbhanga district has very high potential for large scale groundwater development. Thick deposit of the quaternary sediments, derived from the Himalayan terrain acts as a huge storehouse for groundwater. Groundwater occurs both under unconfined and confined conditions, flowing conditions being observed near the north-eastern part of the study area.

The water bearing formations in the district occurs within the thick pile of quaternary sediments. The thickness of these sediments is about 1000 to 2000 m in the south of the district as inferred from the geophysical survey of Geological Survey of India. There are cyclic deposits of sand, gravel and pebbles of various grades along with clay and silt. Lithological information is available to a maximum depth of 150 m bgl from the boreholes drilled by Bihar Tube well Corporation, Govt. of Bihar.

Lithology of boreholes indicates that there is persistent clay capping in the district. It is variable in thickness and becomes thinner towards south and southeast. In the upper part of the alluvial sequence, sand is fine to medium grained whereas in the lower parts those are medium to coarse with occasional association of gravels. The clay part contains sandy and silty materials. Kankars (calcareous nodules) are found in abundance in clays. A thick clay deposit of over 40 m thickness occurs in the northern part. Below this clay, a potential aquifer of about 40 m thickness occurs. In the southern part, there are predominant aquifers at the depth ranges of 40 – 67, 71 – 86, and 125 – 149 m bgl. Aquifer system in the northwestern part occurs at depth between 41 – 63, 66 – 142 and 109 – 128 m bgl. A thick aquifer system exists in the southeastern part below the 10 m thick top clay down to a depth of 86 m and below.

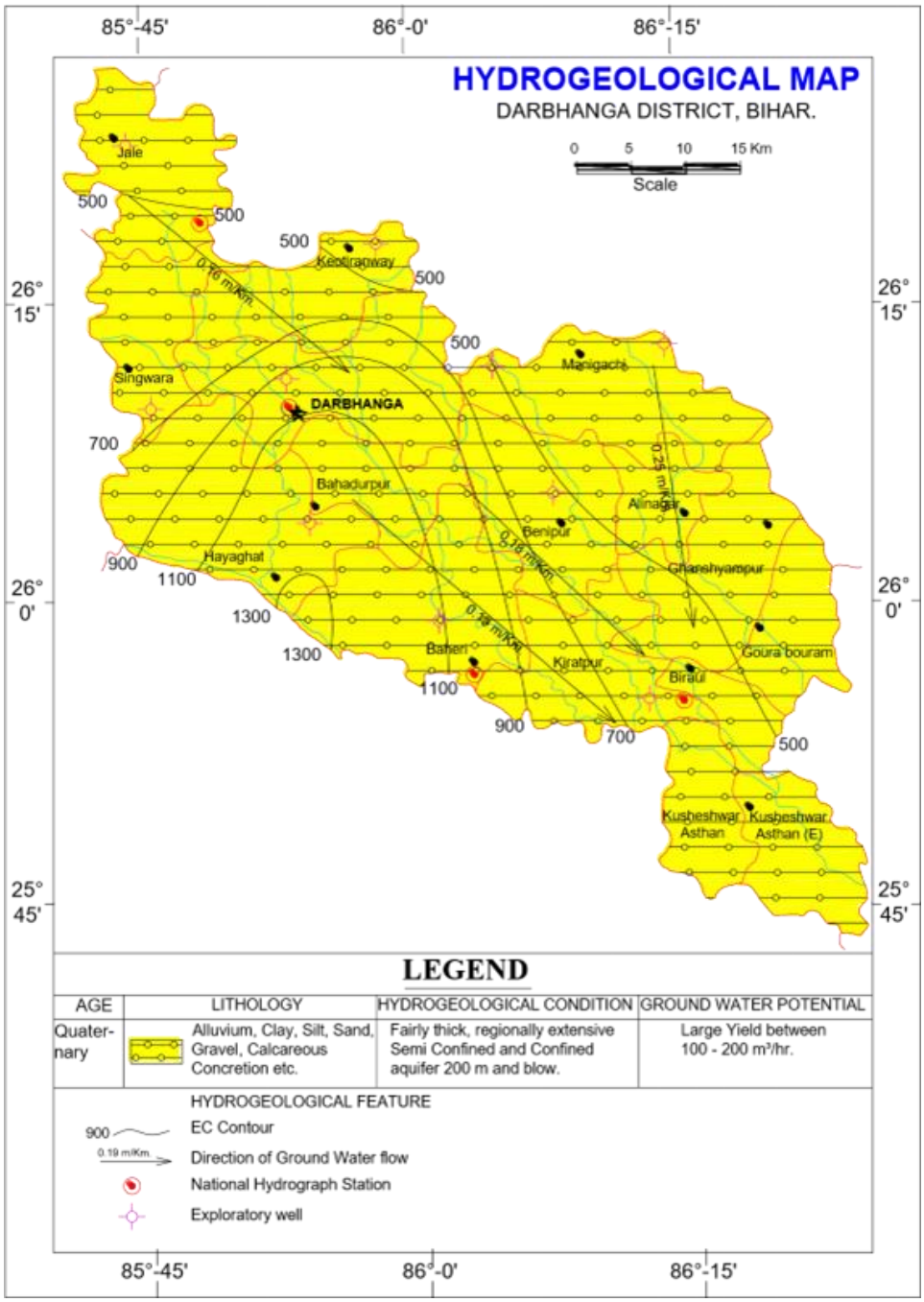

Figure 13: Hydrogeological Map of Darbhanga district (CGWB District Brochure 2013)

3.3. Groundwater Dynamics

Water Level Scenario – Aquifer – I (Shallow Aquifer):Water level scenario of shallow aquifer was generated by utilizing water level data of 12 monitoring wells and 25 key wells representing shallow aquifer. The pre monsoon (May 2022) depth to water level monitored varies between as low as 0.37 mbgl at Pirhauli (Alinagar) to as high as 6.96 mbgl at Ucchti(Biraul) and average of the district being3.15 mbgl*(Figure 14)*.The post monsoon (Nov 2022) depth to water level varies from as low as 0.56 m bgl at Motipur,Antour (Alinagar) to as deep as 5.25 mbgl at MakrandaBhandairSoump (Manigachhi) and average of the district being 2.58 m bgl*(Figure 16)*.Deeper ground water levels were not observed in the district.

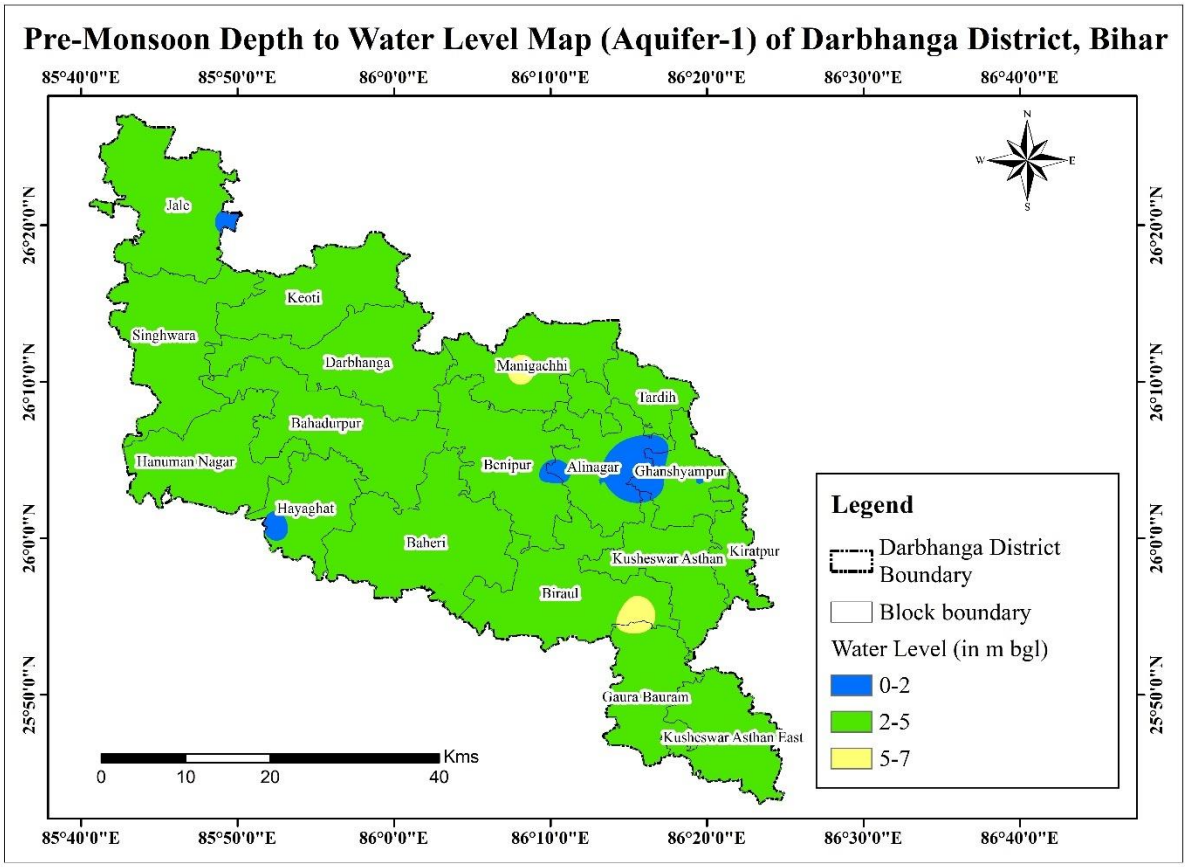

Figure 14: Pre-Monsoon Depth to Water Level Map (Aquifer-1) of Darbhanga District, Bihar

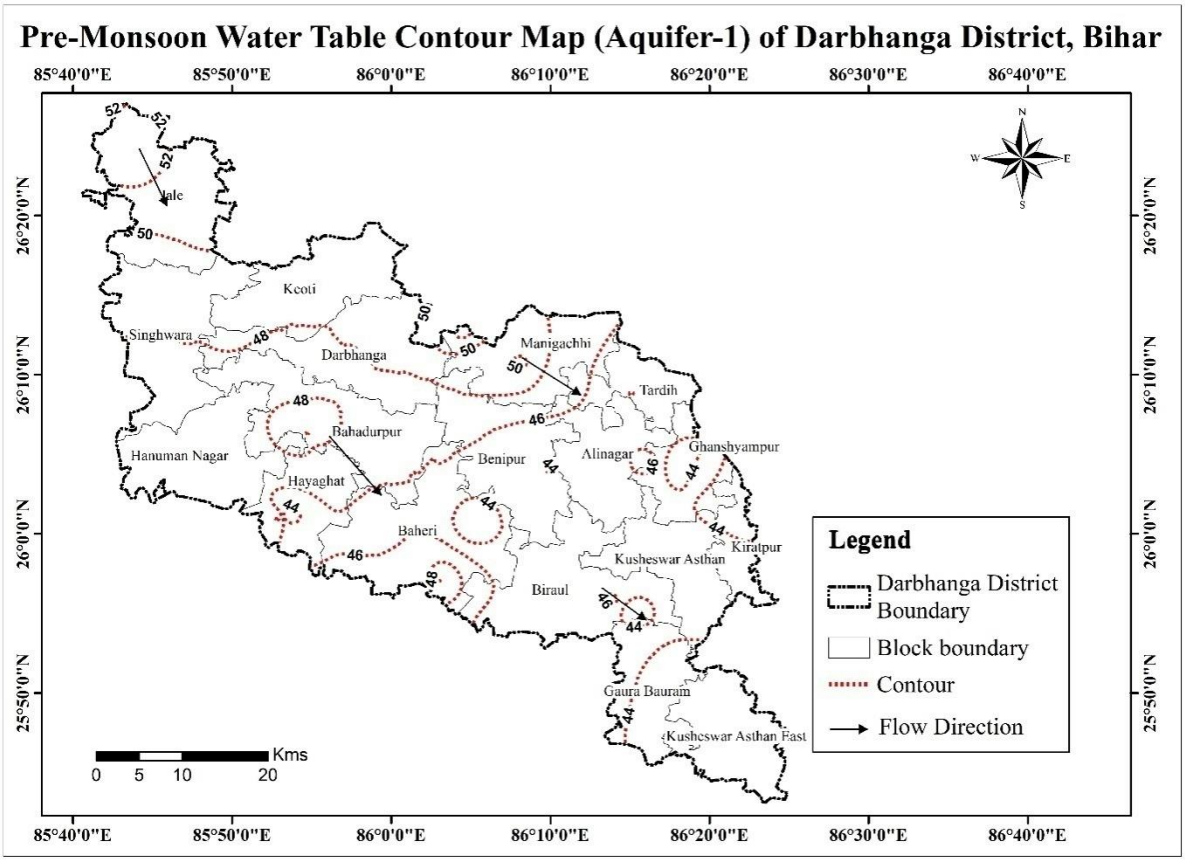

Figure 15: Pre-Monsoon water table contour map (Aquifer-1) of Darbhanga District, Bihar

The direction and movement of ground water is determined from water table contour map of the district. The water table elevation ranges from 52 m above mean sea level in the north-western part to 44 m above mean sea level in the south-eastern part of the district. The water table contour map clearly shows that the overall flow direction of groundwater in the district is from northwest to southeast direction*(Figure 15 and Figure 17).*

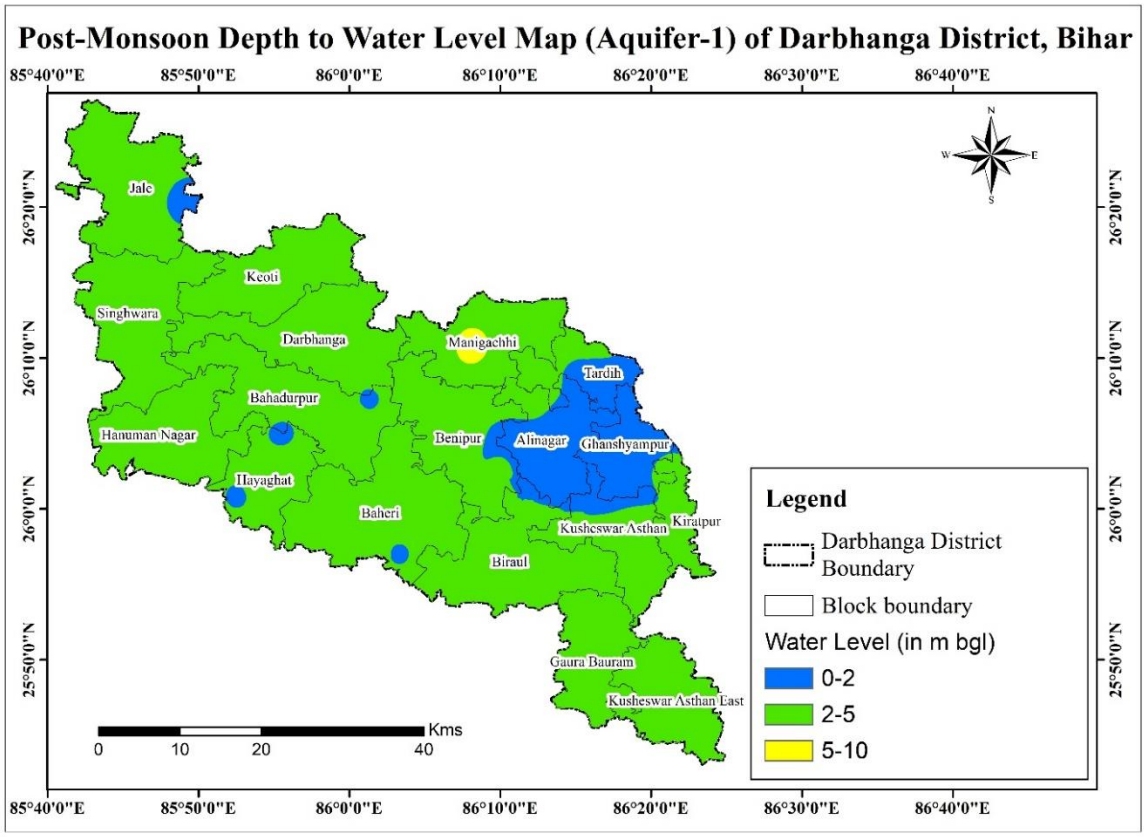

Figure 16: Post-Monsoon Depth to Water Level Map (Aquifer-1) of Darbhanga District, Bihar

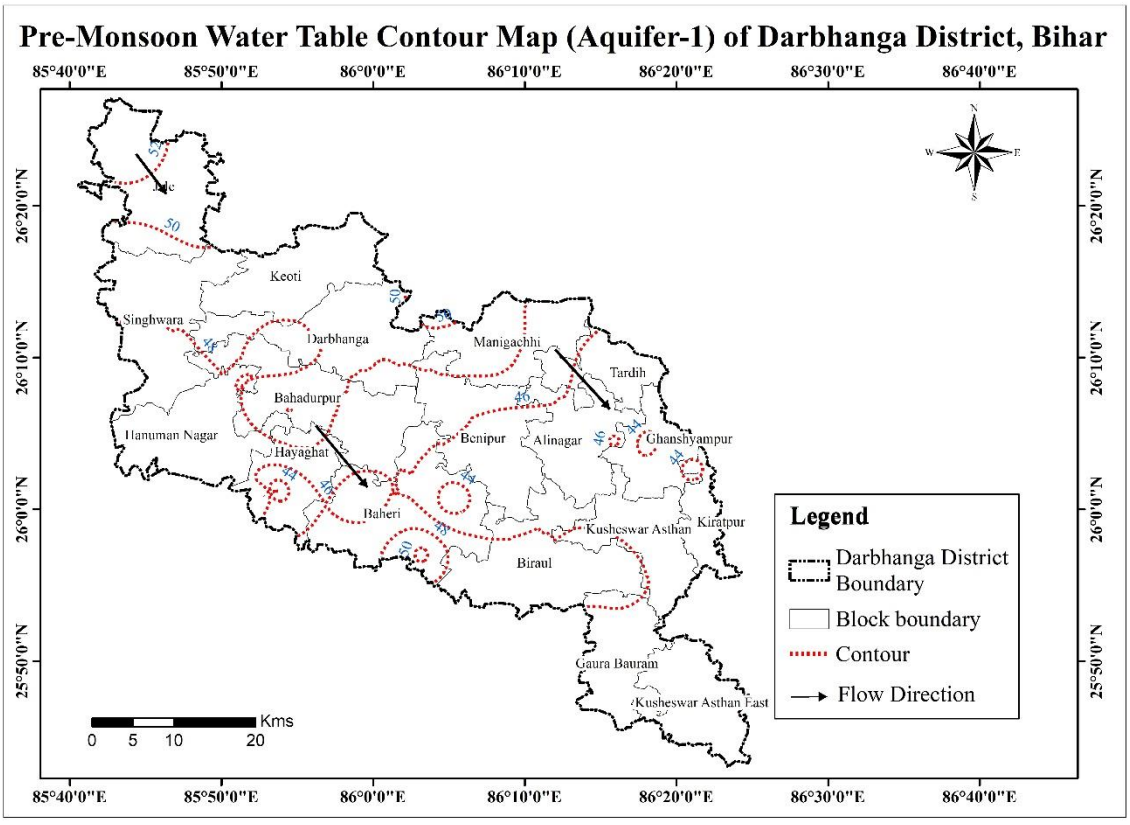

Figure 17: Post-Monsoon water table contour map (Aquifer-1) of Darbhanga District, Bihar

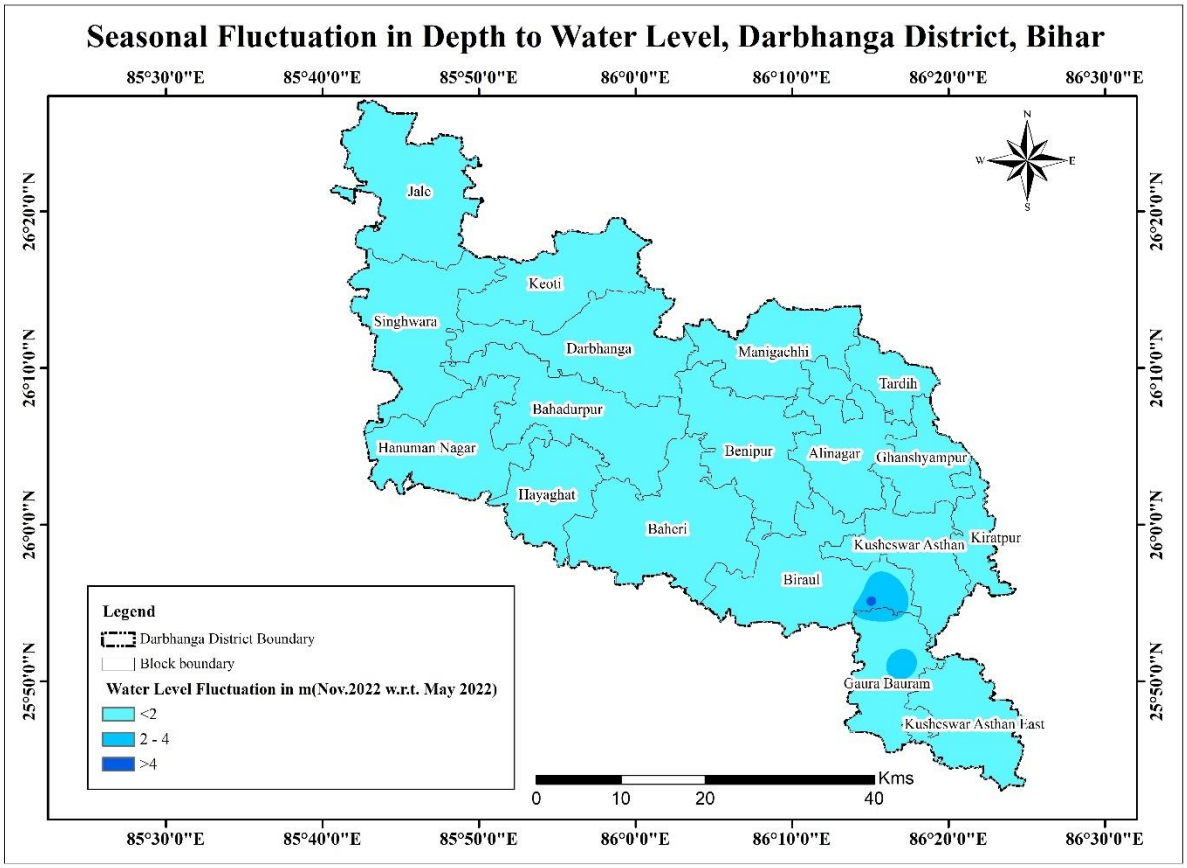

Figure 18: Water Level Fluctuation Map (Nov. 2202 w.r.t. May 2022) of Darbhanga district, Bihar

3.4. Hydrograph Analysis (Water level trend)

Analysis of two hydrograph network stations located at Biraul and Bahadurpur were carried out using GEMS software and analyzed for the period from 2010-2019 *(Figure 19, 20)*. It is observed that the long-term water level trends during pre-monsoon is nearly constant while during post-monsoon seasons the trend is slightly rising.

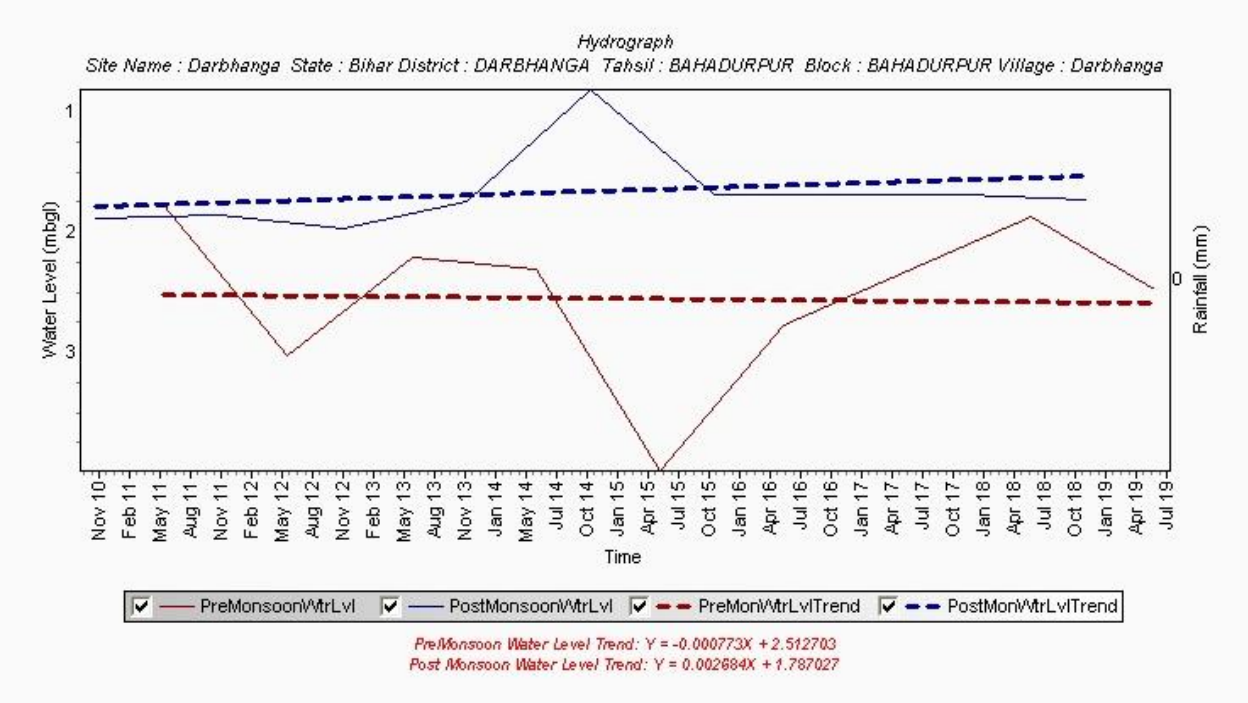

Figure 19: Water Level trend at Bahadurpur, Darbhanga district

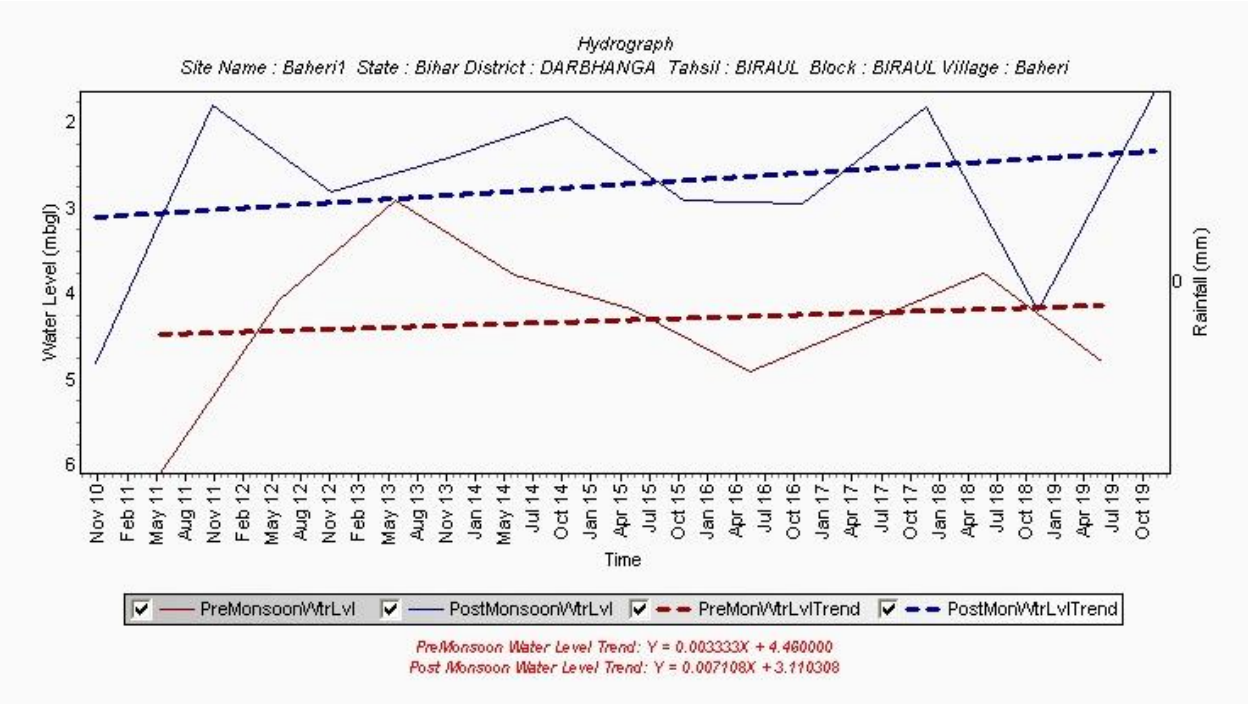

Figure 20: Water Level trend at Biraul, Darbhanga district

3.5. Groundwater Exploration

5 no. of Exploratory wells (EW), 2 observation wells (OW) and8 nos. of piezometers have been constructed in the district. The drilling depth was limited upto205 m.The wells constructed gave low to moderate discharge. Thick alluvial deposits down to the depth of 200

m have been explored. High potential aquifers exist within 50-200 m depth, which can be tapped with discharge around 150-200 m^3/hr. The district also possesses potential shallow aquifers within 50 mbgl with discharge around 50 m^3/hr. The details of the exploration done by CGWB is given in Annexure-III. In the arsenic affected areas the deeper arsenic safe aquifers beyond 50 m depth can be tapped for drinking water and other purposes.

Specific capacity, discharge and draw down data are available from the tube wells constructed by Bihar Tube Well Corporation, Govt. of Bihar. The average discharge of the tube wells has been found out to be around 180 m3/hr on tapping about 25 m saturated aquifer thickness. The specific capacity varies from the lowest 37 m^3/hr/m at Abdullahpur in Bahadurpur block, to the maximum of 73 m^3/ hr/ m at Gausa in Darbhanga block.

3.6. Geophysical Interpretation

Geophysical survey was carried out at 21 locations in Darbhanga district under AAP 2022-23 to get an idea of the subsurface lithology and delineate the aquifer geometry. Both Vertical Electrical Sounding (VES) and Transient Electromagnetic Survey (TEM) was carried out in the district. The survey locations are shown in *Figure 21*. A brief discussion about the findings of the study along with the principles are discussed below.

3.6.1. VES Survey in Darbhanga District

A total of 11 soundings were carried out in Darbhanga district. Schlumberger configuration was used to study the subsurface lithologic configuration to ascertain aquifer disposition in the study area. The maximum spreading AB/2 deployed was 350.0 m in all places except two locations. A few VES curves are shown below. The data was interpreted using the software IPI2Win. The interpreted results are shown in *Table 8*. In most of the locations, sand was found to be the prominent lithological layer.

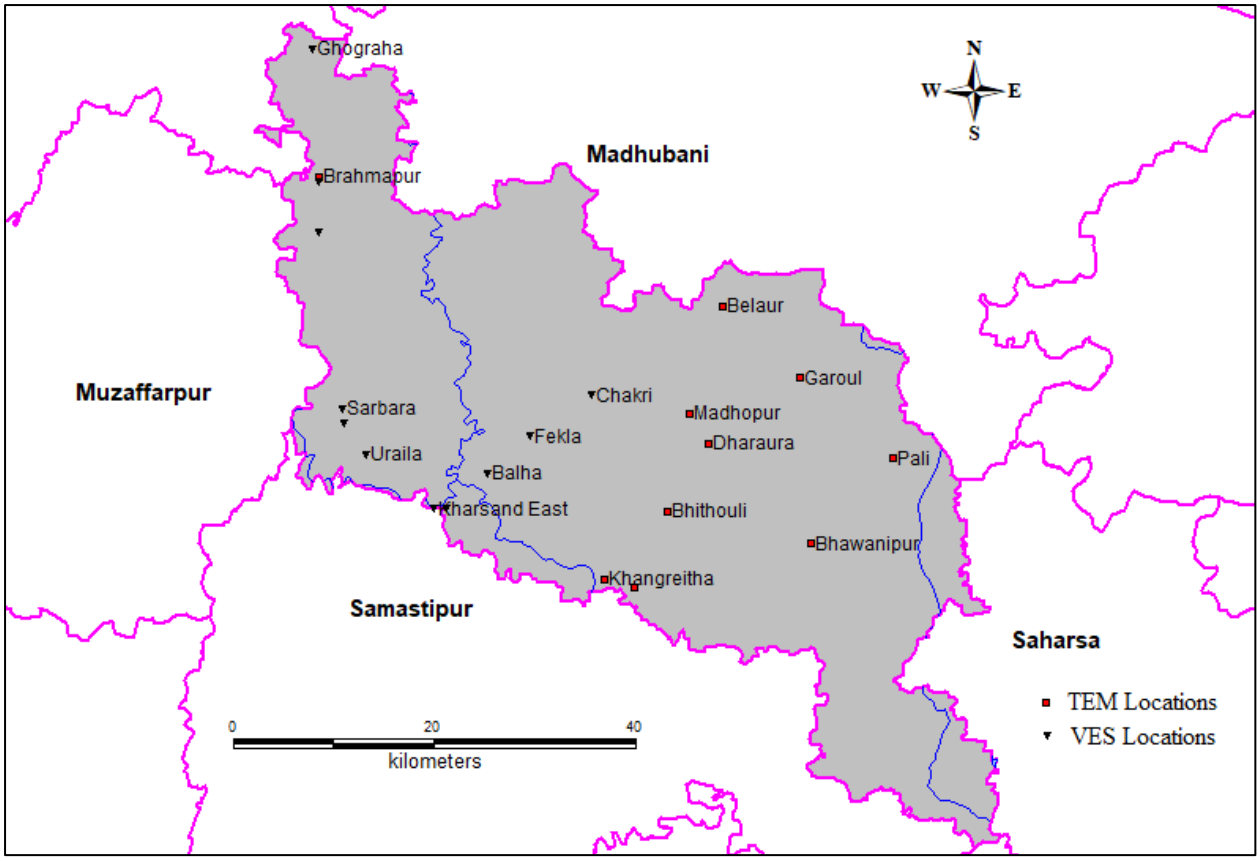

Figure 21: Map showing locations where VES and TEM survey was carried out

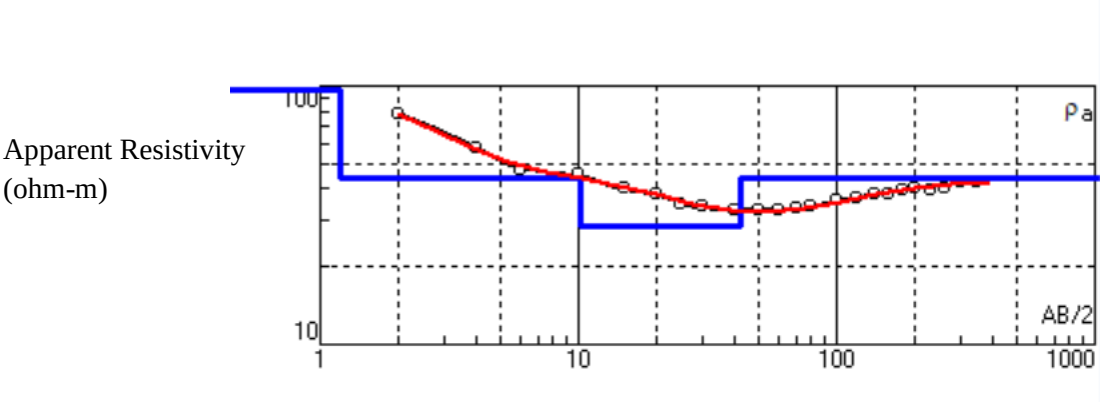

Figure 22: Obtained VES Curve and interpreted resistivity model at Chakri, Darbhanga District, Bihar

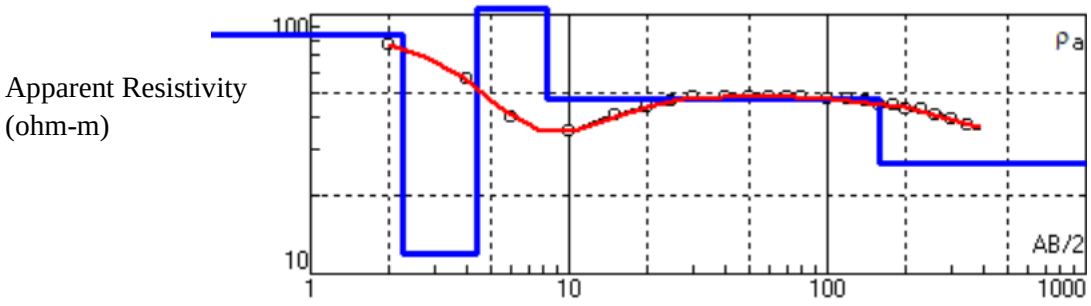

Figure 23: Obtained VES Curve and interpreted resistivity model at Sarbara, Darbhanga district, Bihar

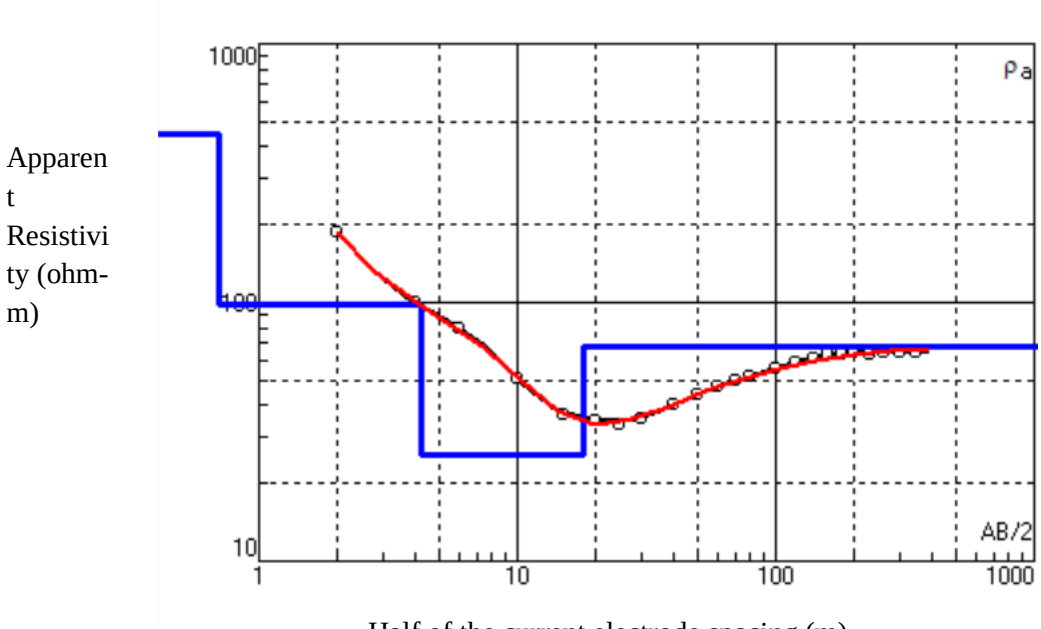

Figure 24: Obtained VES curve and interpreted resistivity model at Barhampur, Darbhanga district, Bihar.

Table 8: Interpreted results of VES survey at Darbhanga District, Bihar

S.No.	Location	District	Coordinates		Resistivity (ohm-m)						Depth (m)				
			Latitude	Longitude	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6	d_1	d_2	d_3	d_4	d_5
1	Chakri	Darbhanga	26.12047	86.00994	95.76	43.97	28.69	43.84			1.2	10.15	42.17		
2	Fekla	Darbhanga	26.08372	85.94839	176	36	155				4.59	96.7			
3	Balha	Darbhanga	26.05097	85.90564	88.87	589.5	122.5	34.95			0.8697	1.645	19.89		
4	Kharsand East	Darbhanga	26.01917	85.85353	214	47.2	42.2				1.67	10.1			
5	Sarbara	Darbhanga	26.10831	85.76239	83.4	11.89	105.6	46.95	26.88		2.267	4.389	8.174	160.1	
6	Areila	Darbhanga	26.09614	85.76353	75.7	312	50.1	166	33.4	8.41	0.627	1.4	2.81	17.4	350
7	Kharsand	Darbhanga	26.01981	85.86528	1768	112.5	16.42	60.83	14.87	61.36	0.3725	3.596	6.559	12.21	27.38
8		Darbhanga	26.26497	85.73853	439.3	97.9	25.64	67.47			0.7009	4.291	18.1		
9	Brahmapur	Darbhanga	26.31006	85.73867	445.2	98.27	25.75	67.49			0.6956	4.273	18.18		
10	Ghograha	Darbhanga	26.42917	85.73264	139	270	42.9	16.4	52.6	VH	1.45	2.91	14.8	32.3	270

3.6.2. TEM Survey at Darbhanga District, Bihar

In order to ascertain aquifer disposition at Darbhanga district, TEM survey was carried out in F.S.P 2022-23. A total of 31 soundings at 10 locations were carried out. The coincident loop configuration was used to collect the transient decay curve. The dimension of the loop was set at 40 x 40 m^2. An offset of 2.5 m was set between the transmission and receiver loop. Further, in order to collect data of better quality, utmost care was taken to avoid sources of noise such as transmission line, power source etc. Also, in order to enhance signal to noise ratio, the stacking was increased to 1024 while acquiring data. The interpreted results of TEM survey at a few locations are shown below.

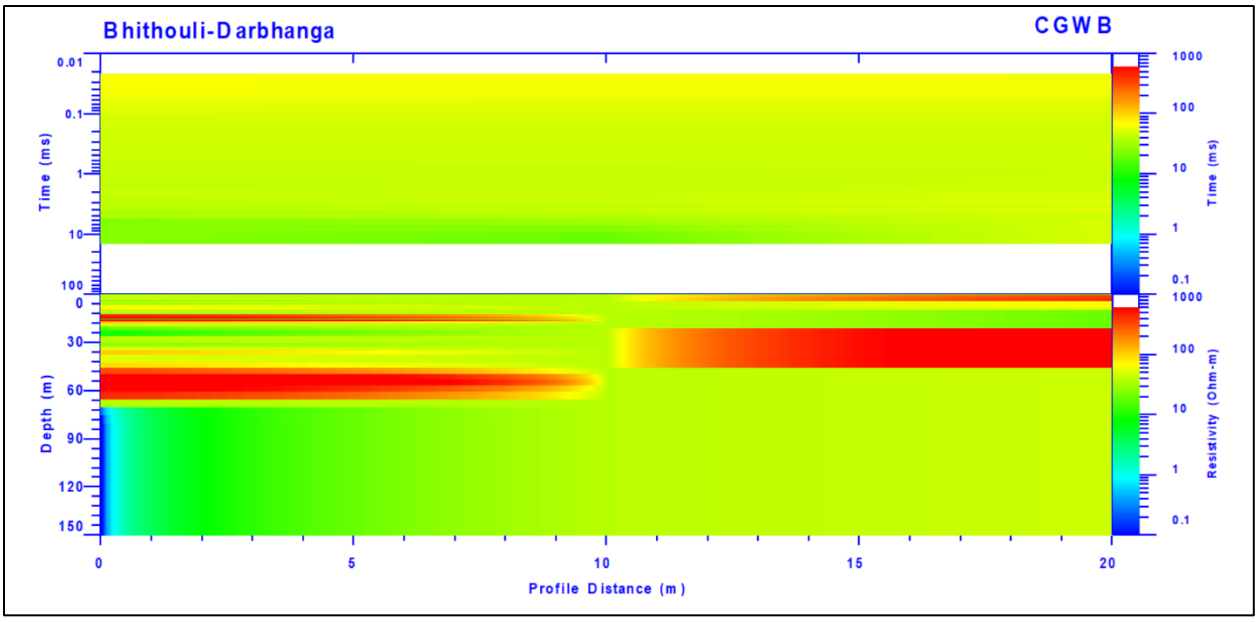

Figure 25: Interpreted Resistivity Profile of Bhithouli, Darbhanga

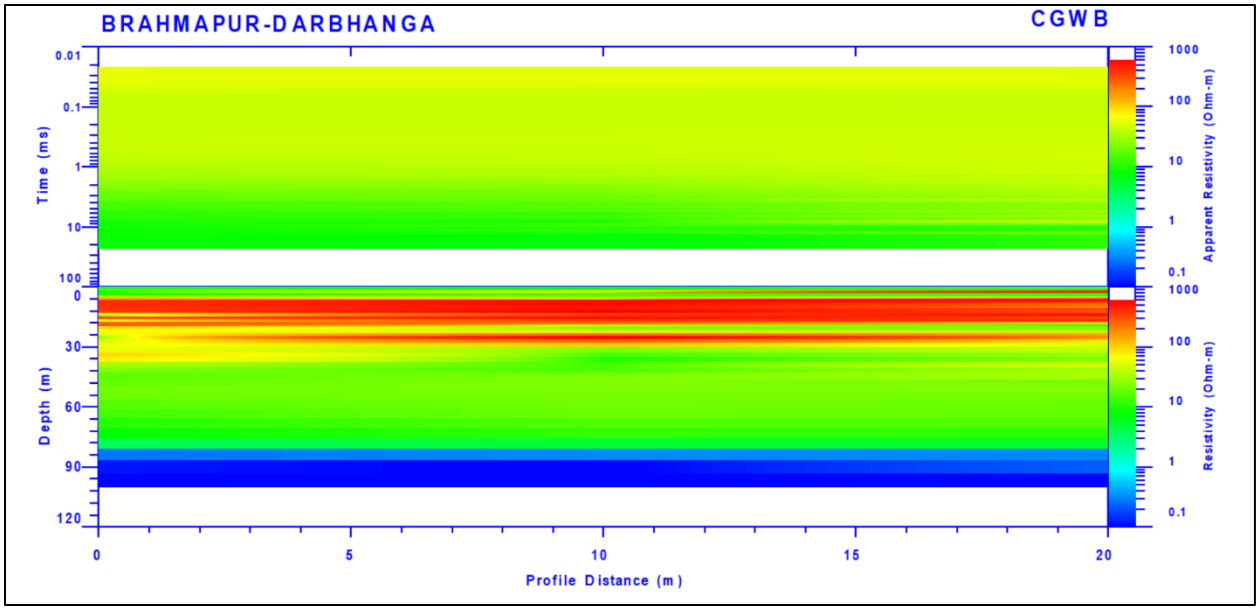

Figure 26: Interpreted Resistivity Profile of Brahmapur area of Darbhanga District

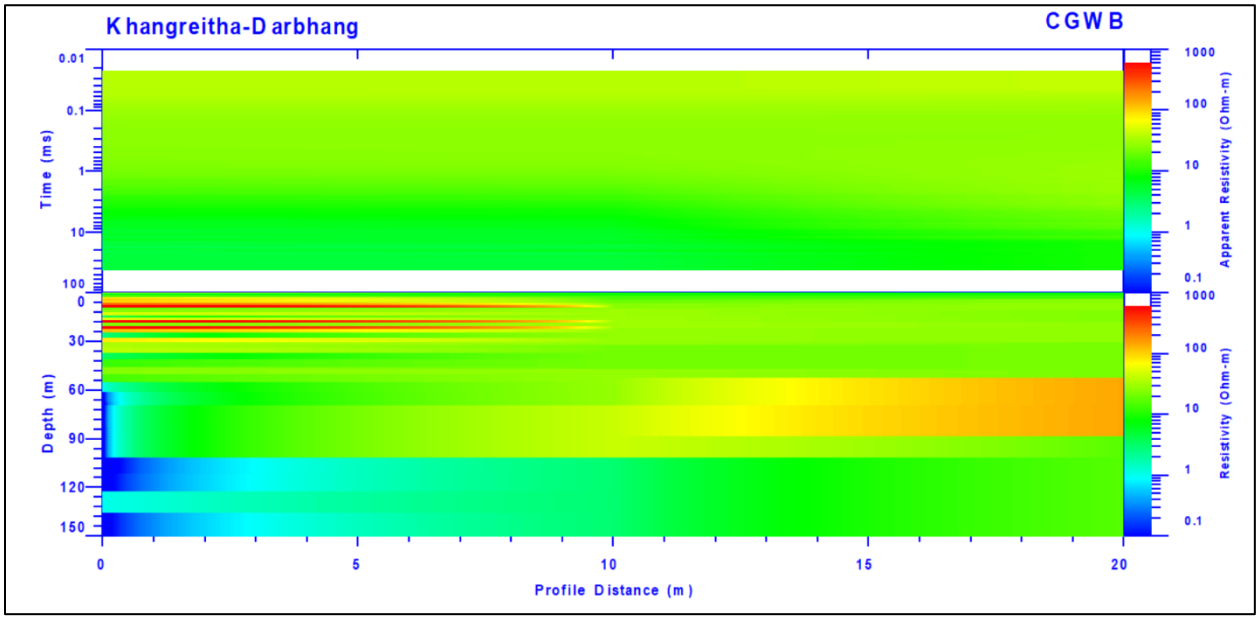

Figure 27: Interpreted Resistivity profile of Khangreitha area of Darbhanga District, Bihar

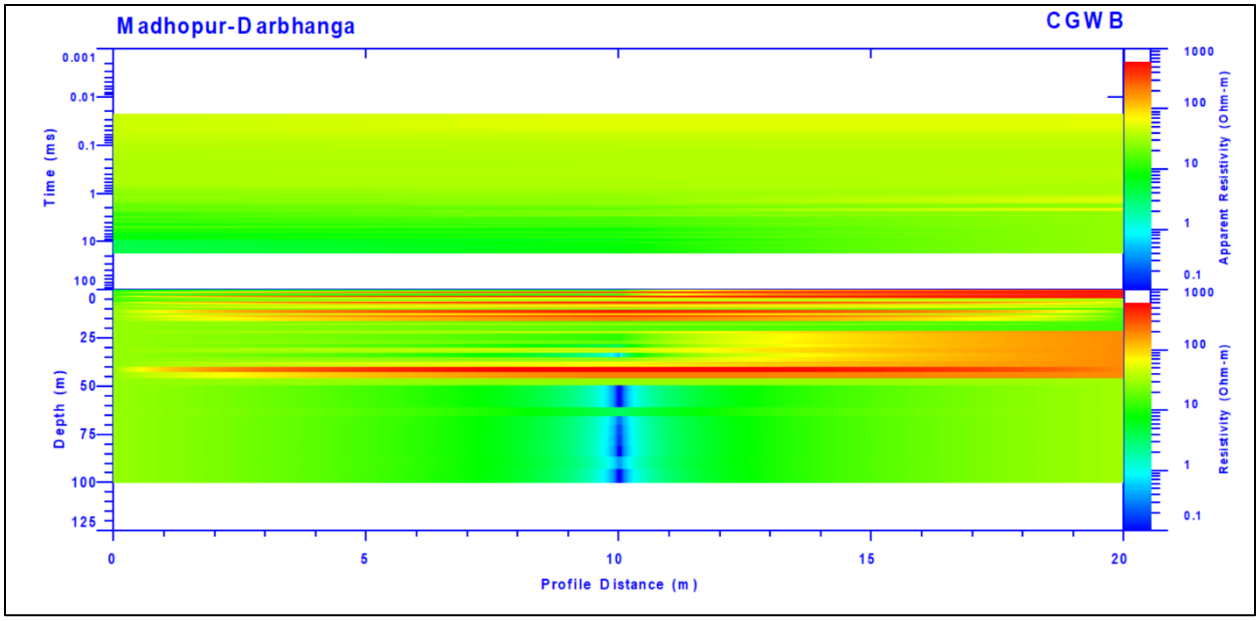

Figure 28: Interpreted Resistivity Profile of Madhopur area, Darbhanga District, Bihar

Table 9: Interpreted TEM results of Darbhanga District, Bihar

Location	District	Longitude	Latitude	Rho (ohm-m)								Depth (m)						
				ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6	ρ_7	ρ_8	d_1	d_2	d_3	d_4	d_5	d_6	d_7
Baheri	Darbhanga	86.05131	25.94993	11.853	3.6697	71.637	0.68507	74.148	1.3693			0.10364	0.57321	17.527	21.394	128.27		
		86.05119	25.94988	56.932	4.0573	116.46	1.0194	121.69	2.7536			0.13731	0.89848	19.881	24.787	124.87		
		86.05117	25.94986	47.791	8.8713	210.98	1.3891	225.45	12.645			0.1074	0.47841	21.622	28.01	151		
Belaur	Darbhanga	86.14	26.2	25.015	2.4644	71.233	19.984	19.937	4.7139			0.0891	0.64567	1.5604	11.409	142.73		
		86.14	26.20018	3.1988	1.4529	130.13	218.53	22.333	48.147			0.13447	1.14	7.246	21.037	105.06		
		86.14012	26.20022	54.604	3.5148	26.192	107.59	20.27	34.526			0.10817	0.99527	3.6124	9.3684	52.1		
Bhawanipur	Darbhanga	86.22654	25.98859	80.43	38.351	92.155	141.61	29.959	1.4578			0.0661	0.3943	3.3062	14.872	134.09		
		86.22679	25.9886	8.1878	4.9789	39.458	17.949	124.75	42.675	31.66	2.169	0.0489	0.28836	1.3257	2.4573	6.3851	43.699	135.83
		86.22685	25.9886	119.63	4.0687	115.45	39.145	41.169	6.4044			0.12187	0.75048	8.3044	37.507	139.22		
Bhithouli	Darbhanga	86.08453	26.01698	28.737	19.829	35.511	27.511	41.383	15.966			0.0958	0.45039	2.4424	10.391	209.73		
		86.08462	26.01697	2.47E+03	5.4016	39.87	8.5534	0.15053				0.15841	0.80847	141.96	228.4			
		86.08458	26.01699	0.61883	3.0576	121.56	34.663	48.969				0.0948	0.35781	12.4	45.955			
Brahmapur	Darbhanga	85.7389	26.31486	59.619	1.778	26.172	9.2161	142.93	41.08	7.6842		0.0789	0.46205	1.5711	3.961	13.365	116.67	
		85.7388	26.31483	201.08	4.2597	38.093	43.43	4.8855				0.16638	1.668	6.4054	157.09			
		85.73874	26.31472	89.286	5.2854	124.87	40.374	1.1268				0.14626	2.1877	7.1103	207.08			
Dharaura	Darbhanga	86.12489	26.07728	8.6079	1.0443	112.16	15.295	1.6824				0.10469	0.83213	34.56	113.57			
		86.12483	26.0773	9.93	5.603	30.703	24.173	1.9715				0.0763	0.60416	4.8785	130.76			
		86.12482	26.0773	2.0264	7.7635	109.2	23.092	46.26				0.18061	0.96392	6.6942	47.763			
Garoul	Darbhanga	86.21667	26.13567	108.49	6.0433	187.26	29.622	37.978	19.34			0.0925	2.8048	10.946	55.314	164.94		
		86.21662	26.13569	1.9407	76.855	26.837	35.339	22.89				0.706	15.131	42.464	146.65			
		86.21664	26.1357	8.2848	3.1758	53.144	120.88	24.395	41.056	19.046		0.10766	0.38181	1.5964	5.1371	38.581	152.92	
Khangreitha	Darbhanga	86.02144	25.9571	7.7394	30.601	58.34	20.028	2.6138	10.969			1.633	2.9637	8.0695	110.66	205.41		
		86.02144	25.95705	7.2371	6.5138	36.951	20.95	2.0042				0.12039	1.1705	6.1103	125.97			
		86.02145	25.9571	14.097	6.0919	15.389	24.891	40.029	7.4544			0.0995	0.79053	4.8759	82.1	195.65		
Madhopur	Darbhanga	86.10703	26.10401	6.4458	11.869	40.512	29.509	4.0162				1.4169	2.716	17.931	124.1			
		86.10704	26.10399	45.773	4.2911	71.715	36.832	124.25	15.159	79.438	9.2176	0.0910	0.32854	1.4842	4.178	16.234	39.625	102.65
		86.10704	26.10393	1.7914	9.5462	96.085	25.031	37.642	14.552			0.0906	0.41403	4.7698	32.103	164.02		

3.7. Ground Water Quality

The quality of ground water of an area is derived from both physical and chemical parameters that are greatly influenced by geological formations of that area, but may also get altered by anthropogenic activities such as over exploitation, industrial density etc. Availability of ground water supply as well as the quality of the same for drinking and irrigation purposes is always a major concern. Suitability of ground water for drinking and irrigation purpose is important for its safe and effective use. The dissolved ions in different amount in ground water are function of the availability of the constituents in the aquifer matrices and their solubility. Rocks, through which water circulates, are composed of minerals and amorphous solids, which in turn are composed of chemical elements that greatly affect the ground water quality.

Total 39 water samples have been collected in pre monsoon season 2022. Out of 39 samples, 14 samples were from Dug well (Shallow aquifer), 21 water samples from Tube well (Deeper aquifer) and 04 water samples from Pond (surface water). These water samples were analysed in chemical laboratory of CGWB MER-Patna for various parameters. As can be seen by the analysis results, pH values of the collected water samples vary between 6.8 and 8.35 with an average value of 7.97. From the pH value range, it can be observed that the groundwater samples are slightly acidic to mild basic in nature but all remained well within the acceptable limit. Electrical Conductivity is an important measure in the determination of ground water quality. It is the ability of water to pass an electric current. It is influenced by the presence of dissolved cations (Na^+, K^+, Ca^{2+}, Mg^{2+}, Fe, Al^{3+} etc.) and anions (Cl^-. NO_3^-, PO_4^{3-}, SO_4^{2-} etc.). The electrical conductivity (EC) values range from 427-3330µs/cm with an average value of 930.07µs/cm. It can be seen that large variations in EC values are primarily attributed to geochemical processes that prevail in the region. Similarly, Total dissolved solids (TDS) value ranges from 277.5 to 2164.5 mg/L. The maximum value of EC and TDS is observed at Asho, Kusheshwar Asthan (Satighat) block, Darbhanga district. The high value of salinity (EC) indicates the stagnation of water in a well, the high value of potassium ion and nitrate in the same well suggests that there may be anthropogenic or natural activities such as over use of fertilizers, manure, liquid waste discharged from septic tanks etc.

The TDS is measure of inorganic salts and small amount of organic matter. The common inorganic salts found in water generally includes calcium, magnesium, sodium, potassium as cations and carbonates, bicarbonates, chlorides, sulphates, nitrates as anions. These minerals can also come from anthropogenic sources such as urban and agricultural runoff, wastewater discharge, industrial effluent etc.

The total load of dissolved solids in water is determined theoretically by considering the EC of that particular water body. It is calculated as the formula given in Equation 1.

$$\mathbf{TDS = EC * 0.65\ mg\ L^{-1}} \quad \text{..... (Equation1)}$$

where EC is in µS/cm at 25º C.

A relationship between Total dissolved solids and salinity is given in *Table 10*. As can be seen from *Table 11* comparing the range of degree of salinity, the study area is dominated by fresh (non-saline) water, 36 out of 39 samples have shown TDS values less than 1000 mg/L. Only 03 water samples (02 from DW and 01 from pond) have slightly saline nature, which may be attributed to stagnancy.

Table 10: Total Dissolved Solids – Salinity Relationship

TDS (mg/L)	**Degree of Salinity**
0-1000	Fresh, Non-Saline
1001-3000	Slightly Saline
3001-6000	Moderately Saline
6001-10,000	Highly Saline
10,001-35,000	Excessively Saline
>35000	Brine

Table 11: Frequency Distribution of TDS in Darbhanga district

Salinity as per T.D.S range	No. of Samples	Percentage
Fresh, non-saline (0-1000 mg/l)	36	92.30
Slightly saline (1001-3000 mg/l)	03	7.70

As can be seen in chemical analysis results, Ca^{2+} and Na^{+} are the major dominant cation and Ca^{2+} concentration ranges between 14 mg/L and 196 mg/L with an average of 62.2 mg/L. Results revealed that Na^{+} concentration ranges between 29 mg/L and 210 mg/L with an average of 82.54 mg/L. The bicarbonate ion concentrations were in the range of 170.8 mg/L to 1049.2 mg/L, with an average value of 388.22 mg/L. Total 36 out of the collected samples were found to have alkalinity (bicarbonate concentration) within the permissible limit of 600 mg/L (*Table 12*) and only 03 samples collected from DW, and pond had alkalinity more than 600 mg/L.

Table 12: Distribution of Ground Water Samples in Different Alkalinity Ranges

Alkalinity Range (mg/l)	Percentage
0 - 600	92.30
> 600	7.69

Analysis results reveal that only 02 samples of the study area have Nitrate concentration above acceptable limit. Uranium concentration above permissible limit of 30 ppb (BIS, 2012) has been detected in only 01 sample of Darbhanga sadar, Darbhanga.

The hydrogeochemical facies of groundwater were studied using modified piper diagram (Chadha's diagram), given in *Figure 29*. It was observed that majority of the water samples collected from Darbhanga districts are of Ca/Mg-HCO_3 type, followed by Na/K-HCO_3 Ca/Mg-Cl_2 type, and only 01 sample falls in the category of Na/K-Cl/SO_4 type. The study suggested that the area of study is dominated by HCO^{3-} anion , which further shows alkaline earth metals (Ca^{2+} and Mg^{2+}) dominating by a slight margin over alkali metals (Na^{+} and K^{+}).

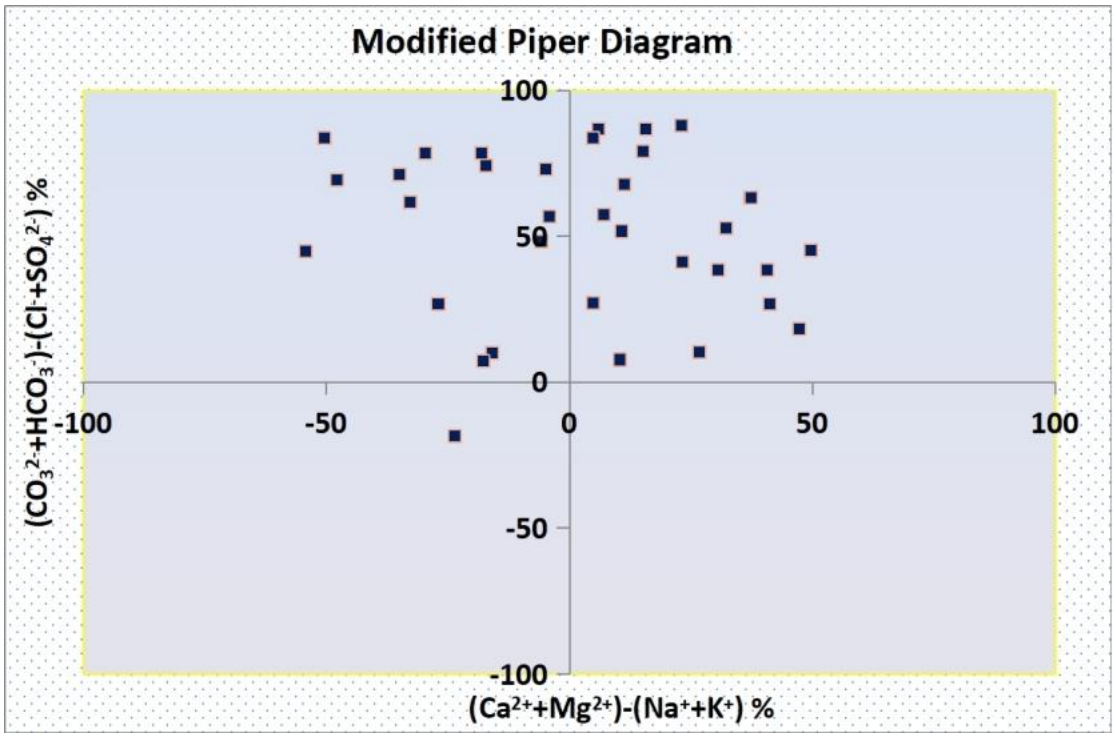

Figure 29: Modified Piper Diagram for water samples collected from Darbhanga district

US Salinity plot (*Figure 30*) showed that most of the groundwater samples were in the C2-S1 category and C3-S1 category, only 01 samples was in C4-S2 category and 01 sample was in C3-S2 category. The C2-S1 category suggests that the groundwater has less sodium content and medium salinity thus can be used for irrigation purpose.C3-S1 category suggests that samples have high salinity and low sodium hazard, C4-S2 type suggests groundwater to be very high saline, so it is not fit to be used for irrigation. Most of the samples in the study area were found suitable for irrigation.

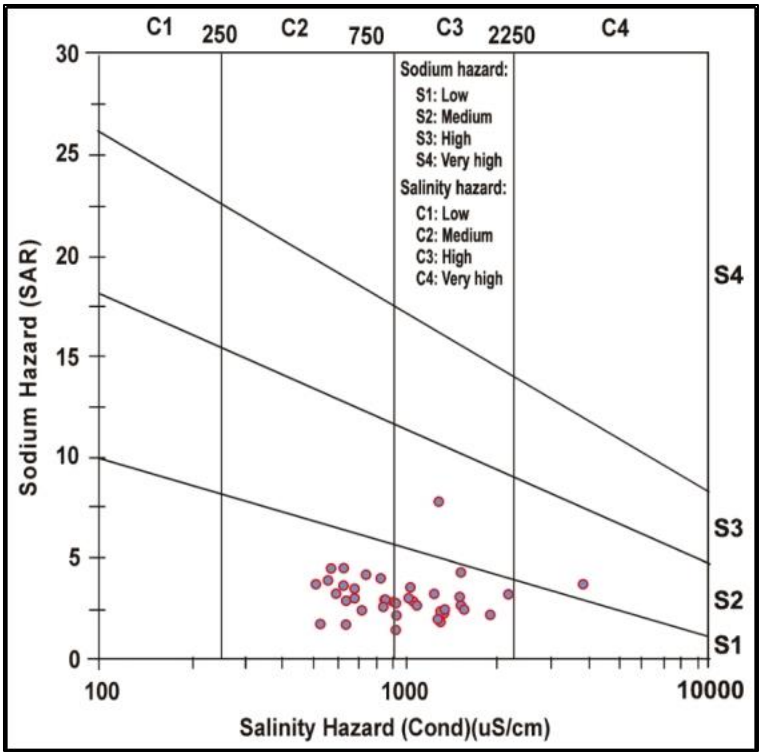

Figure 30: USSL Plot of water samples collected from Darbhanga district.

As can be illustrated by the Wilcox plot (*Figure 31*), majority of the samples are in the category of excellent to good category followed by good to permissible category. Only 01 sample was found in the permissible to doubtful category and 01 sample in Unsuitable category for irrigation purpose. 01 sample which is Unsuitable in Wilcox plot is just due to its high EC value (High salinity) which may require some corrective measures for irrigation.

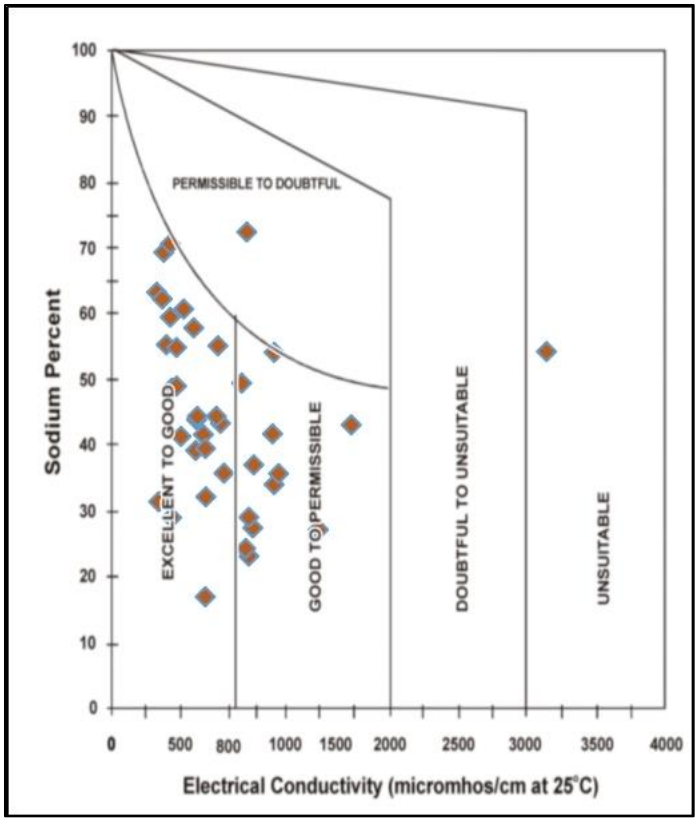

Figure 31: Wilcox Plot of water samples collected from Darbhanga district

A statistical evaluation of ground water samples has been displayed in *Table 13*. The SAR and Percent Sodium value collectively suggests that most of the samples are fit for irrigation, in few samples where % Na value is high is doubtful for irrigation and some treatment before use.

Table 13: Classification of Ground Water Samples for Irrigation purpose

Parameter	**Range**	**Classification**	**% Of samples**
SAR value	<10	Excellent	100
	10-18	Good	0
	18-26	Doubtful	0
	>26	Unsuitable	0

% Sodium	<20	Excellent	2.56
	20-40	Good	30.76
	40-60	Permissible	46.15
	60-80	Doubtful	20.51
	>80	Unsuitable	0

In *Table 14*, statistical results of chemical variables with their comparison to the BIS 2012, acceptable limit is given.

Table 14: Statistical results of the studied chemical parameters

Parameter	**Minimum value**	**Maximum value**	**Average value**	**BIS 2012, acceptable limit**
pH	6.8	8.35	7.96	6.5-8.5
TDS (mg/L)	277.55	2164.5	604.55	500
HCO_3^- (mg/L)	170.8	1049.2	388.22	200
Cl^- (mg/L)	10.65	376.3	69.95	250
NO_3^- (mg/L)	0.23	98	12.66	45
SO_4^{2-} (mg/L)	4.83	165	33.77	200
F^- (mg/L)	0	1.22	0.49	1
Ca^{2+} (mg/L)	14	196	62.20	75
Mg^{2+} (mg/L)	1.21	51.03	20.15	30
TH (mg/L)	50	550	238.46	200

3.8. Aquifer Disposition

Preparation of litholog is one of the important components of ground water exploration being carried out by Central Ground Water Board (CGWB). The drilled cuttings are collected at regular interval or whenever there is any change in lithology during exploratory drilling. This data has been collected from the previous reports of CGWB as well as State agencies and new data are also generated to fill-up the data gap. Various cross sections and fence diagram has been prepared with the help of lithology to know the aquifer disposition of the area.

The aquifer geometry on regional scale has been attempted to establish in Darbhanga district to cover all administrative blocks as per the available data. Principal aquifers in the area have been delineated by grouping the fine to medium sand, coarse sand and gravelly sand as aquifers separated by considerable thickness of clay. These cross sections/fence diagrams, 3D dispositions are given below along with the map to locate the area concerned (*Figure 32- Figure 38*).

Characterization of aquifer upto a depth of ~200 m bgl in the study area has been arrived at by convergence of the observations from the study of the different lithological sections, fence diagrams, geo-electrical sections, sections based on lithologs and overall lithological model of the area. All these figures reveal the presence of a thick pile of alluvial sediments with alternation of various grades of sand with gravel, clay and silt. The area is characterized by occurrence of fairly thick sands of various grades forming aquifers.

There are three aquifer systems in Darbhanga district, out of which Aquifer-I and Aquifer-II are prominently defined and explored. The first aquifer (aquifer-I) occurs under unconfined to semi-confined condition, overlain by a thin layer of clay. In the north-western part of the district, in Jale and Singwara blocks, a thick layer of gravel occurs overlying the sand layer. This gravel layer gradually thins out towards the eastern and southern parts of the district. In Jale block, nearly 50m thick gravel layer mixed with sand overlies the sand layer. Well defined aquifer lies below this depth of around 70 m. In Singhwara block also about 50m thick gravel mixed with sand layer overlies the aquifer.

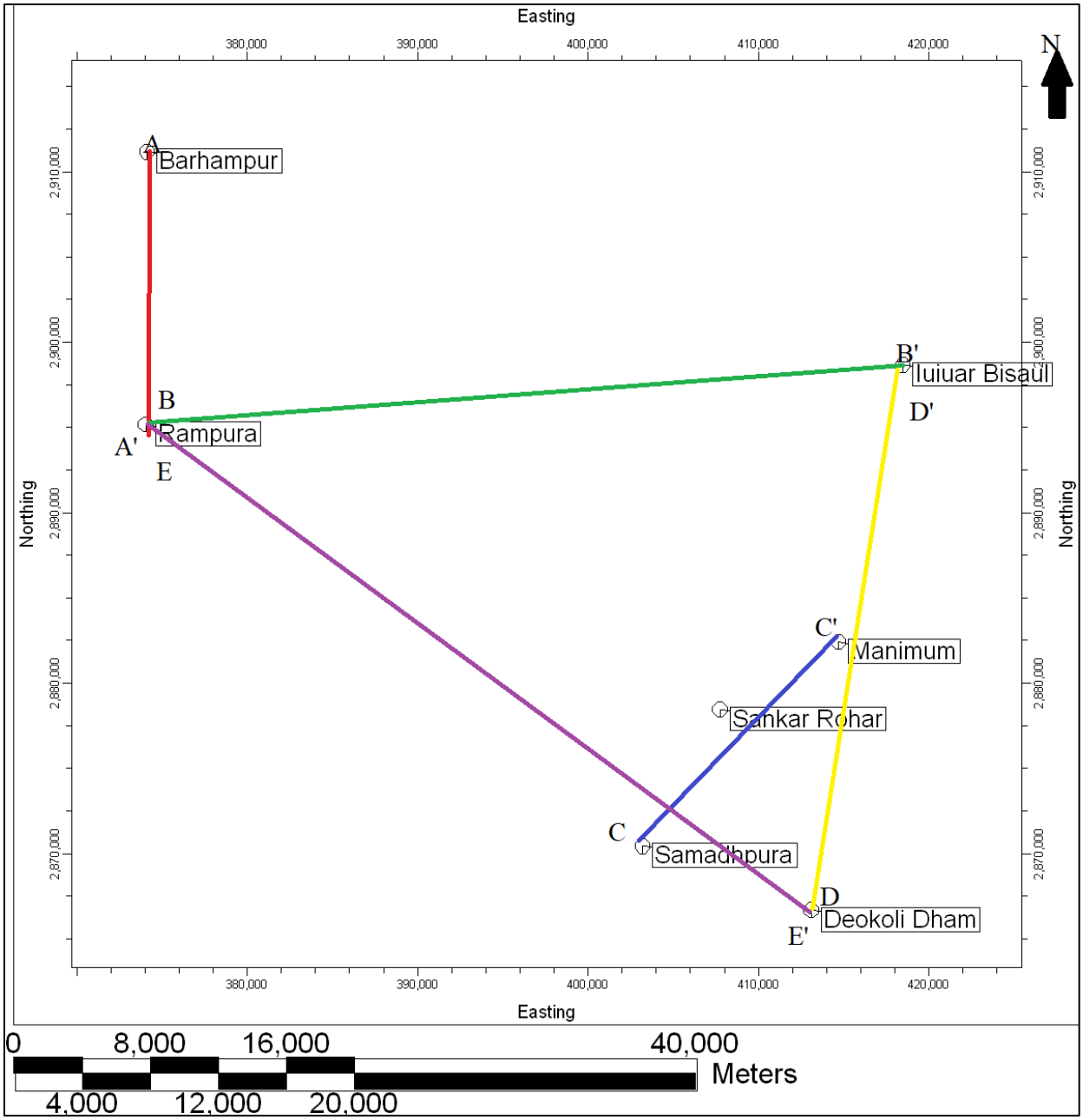

Figure 32: The Well locations and directions along which cross-sections have been prepared (Darbhanga district, Bihar)

3.8.1. Hydrogeological Cross-section

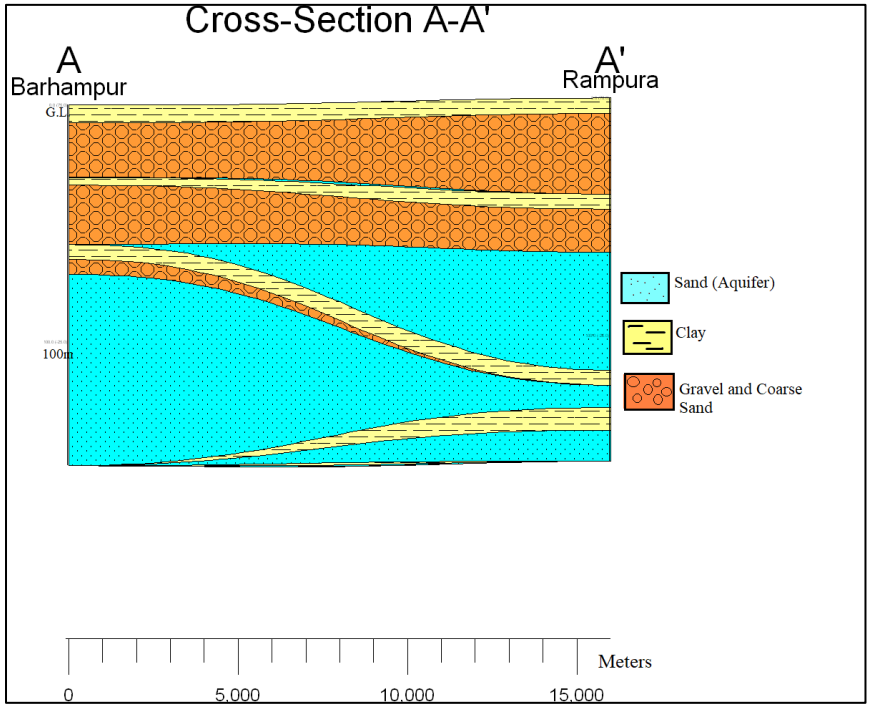

Figure 33: Cross-section along A-A'

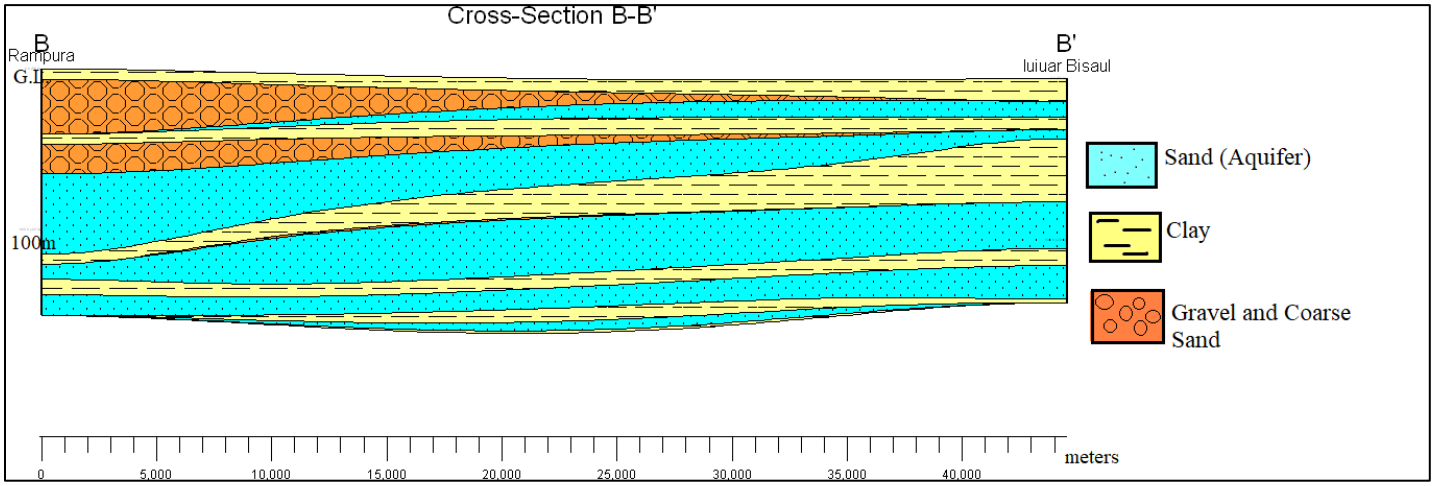

Figure 34: Cross-section along B-B'

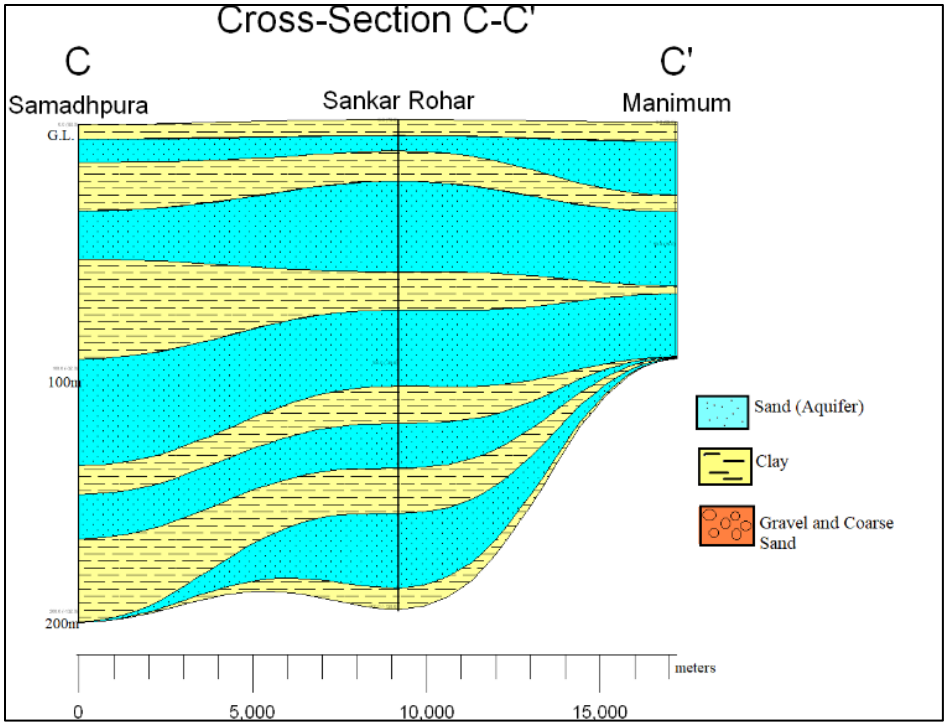

Figure 35: Cross-section along C-C'

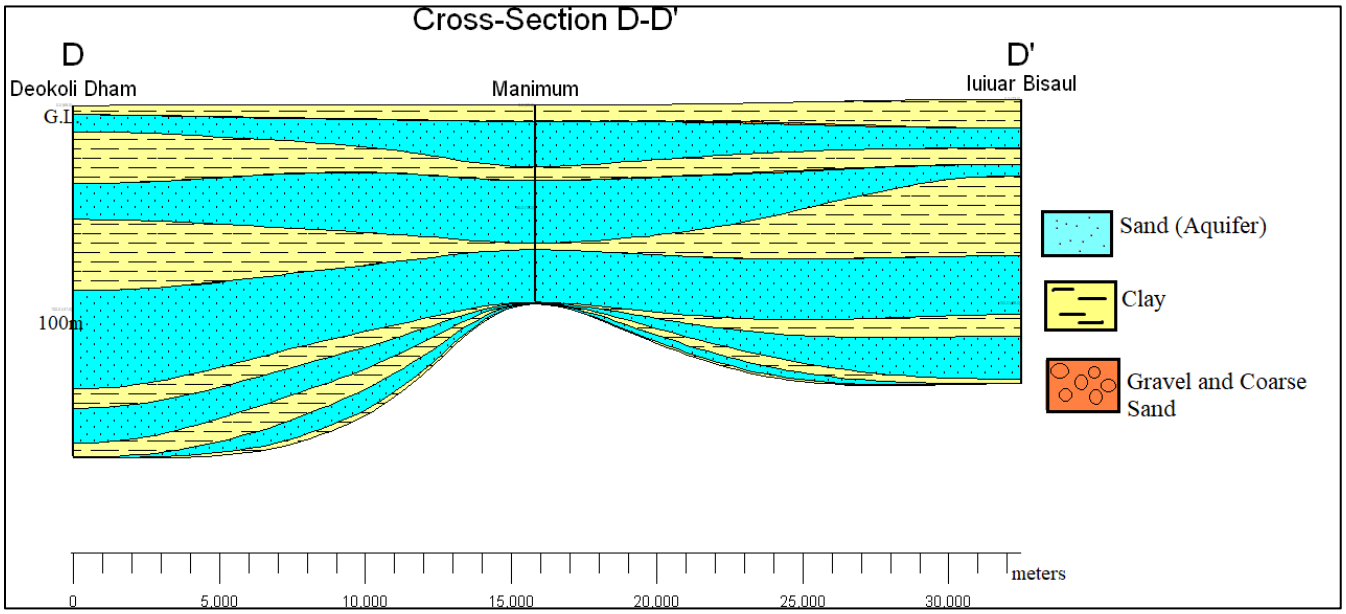

Figure 36: Cross-section along D-D'

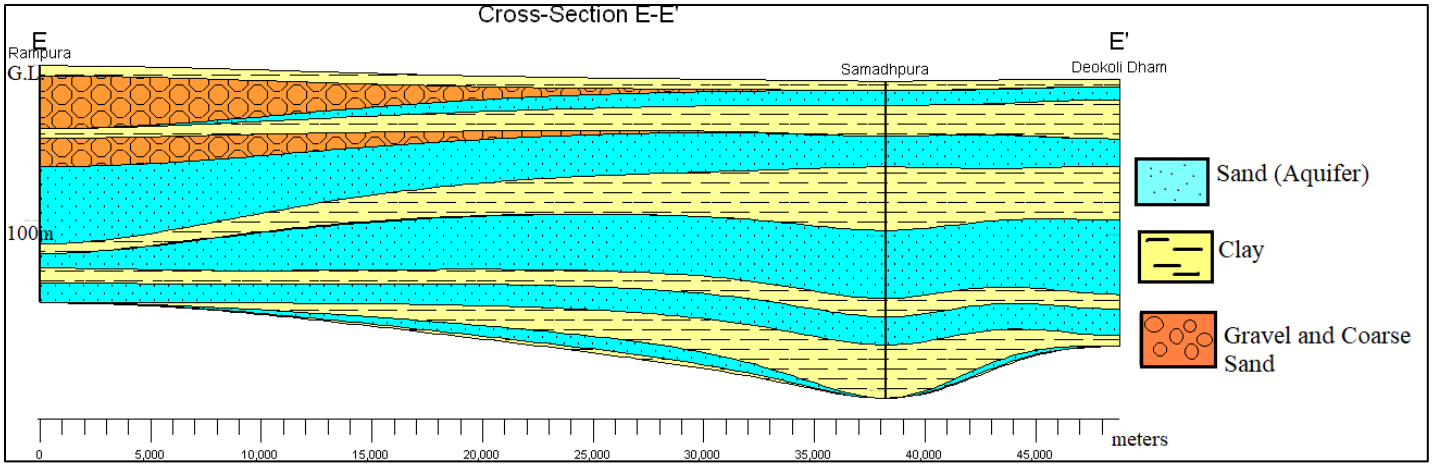

Figure 37: Cross-section along E-E'

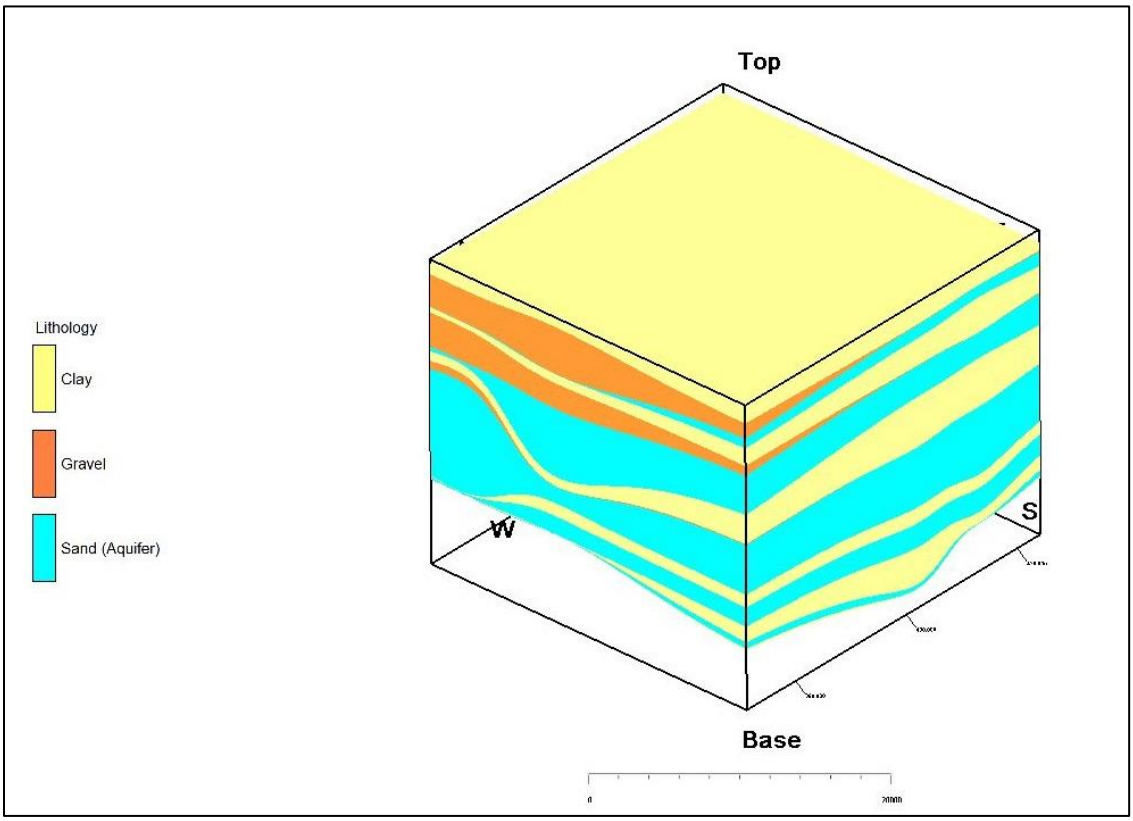

Figure 38: 3D model showing aquifer disposition in Darbhanga district

In other parts of the district, about 30m thick sand layer occurs between a depth of 10m-50m (Aquifer-I). Another thick sand layer of about 30-40m occurs under semi-confined to confined condition beyond 100m depth (Aquifer-II). These two aquifers are separated by clay layer whose thickness varies from place to place.

Chapter 4: Groundwater Resource

Ground Water Resource of the area has been estimated block wise based on for base year as on 2022. 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.

4.1. 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:

$\Delta S = RRF+RSTR+RC+RSWI+RGWI+RTP+RWCS \pm VF \pm LF - GE - T - E - B$

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 Minor Water Resources Department, Government of Bihar based on GEC, Methodology 2015. The salient features of Dynamic Ground Water Resources of Darbhanga district (as on 31st March, 2022) are given in table.

As per Ground Water Resource Estimation (GWRE) 2022, all the blocks in Darbhanga district are safe assessment unit (*Figure 39*).

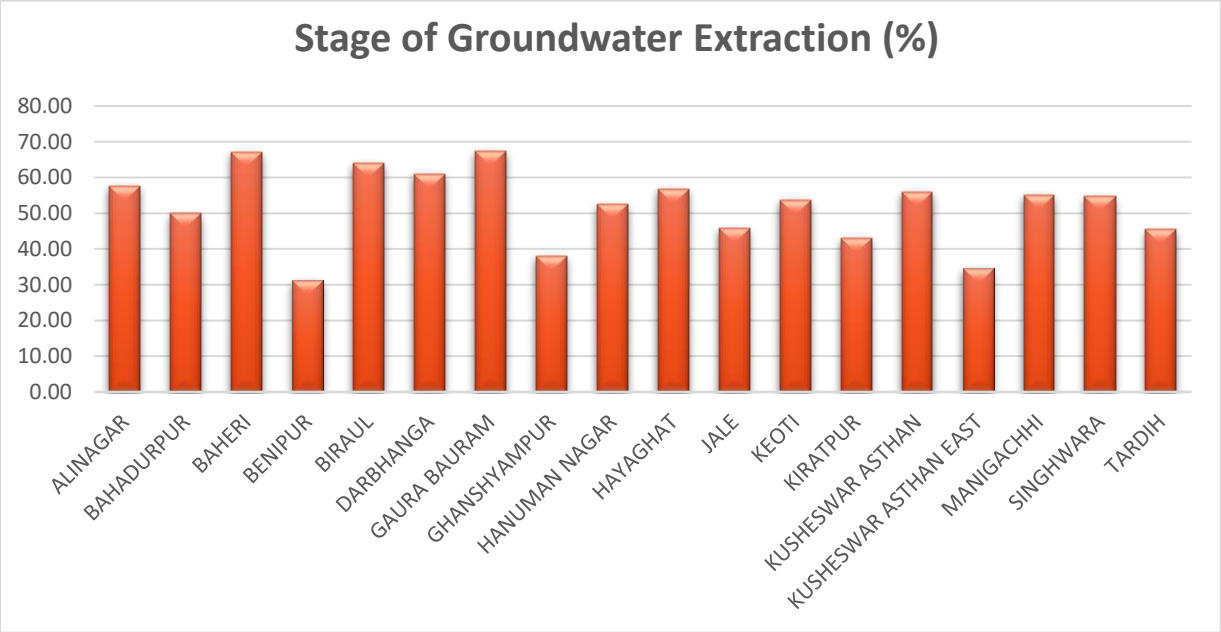

Figure 39: Block-wise Stage of Groundwater extraction in Darbhanga district, Bihar

Table 15: Dynamic Groundwater Resource (till 2022) of Darbhanga district, Bihar

Block	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
ALINAGAR	1909.81	652.86	0.00	448.23	1101.09	486.99	769.96	57.65	safe
BAHDURPUR	4721.70	1505.79	24.00	825.88	2355.67	897.31	2631.76	49.89	safe
BAHERI	5874.47	2827.85	165.00	943.37	3936.22	1024.96	1856.66	67.01	safe
BENIPUR	4163.58	319.41	30.00	948.08	1297.49	1030.07	3554.10	31.16	safe
BIRAUL	5111.98	2352.24	30.00	891.84	3274.08	968.97	1760.77	64.05	safe
DARBHANGA	5102.57	1087.75	33.60	1987.95	3109.29	2159.87	1821.36	60.94	safe
GHANSHYAMPUR	2283.70	1065.29	0.00	474.15	1539.42	515.15	703.28	67.41	safe
GOURA BOURAM	3841.79	1044.77	0.00	415.23	1459.98	451.14	2345.90	38.00	safe
HANUMANNA	3572.19	1392.26	0.00	482.00	1874.26	523.68	1656.25	52.47	safe

GAR									
HAYGHAT	2201.33	712.94	75.00	461.58	1249.51	501.50	911.90	56.76	safe
JALE	4742.70	1346.63	0.00	823.69	2170.32	894.92	2501.15	45.76	safe
KEOTIRANWAY	4562.29	1602.86	0.00	843.87	2446.72	916.84	2115.57	53.63	safe
KIRATPUR	1544.43	410.67	0.00	253.80	664.47	275.75	858.01	43.02	safe
KUSHESHWARSTHAN (W)	2071.78	651.11	0.00	507.68	1158.79	551.59	869.08	55.93	safe
KUSHESWARSTHAN (E)	2761.59	552.83	0.00	401.54	954.36	436.26	1772.51	34.56	safe
MANIGACHHI	3825.71	964.04	430.00	712.63	2106.67	774.25	1657.42	55.07	safe
SINGHWARA	4529.39	1644.84	0.00	834.14	2478.98	906.27	1978.28	54.73	safe
TARDIH	2251.17	638.82	0.00	384.34	1023.1	417.57	1194.78	45.45	safe

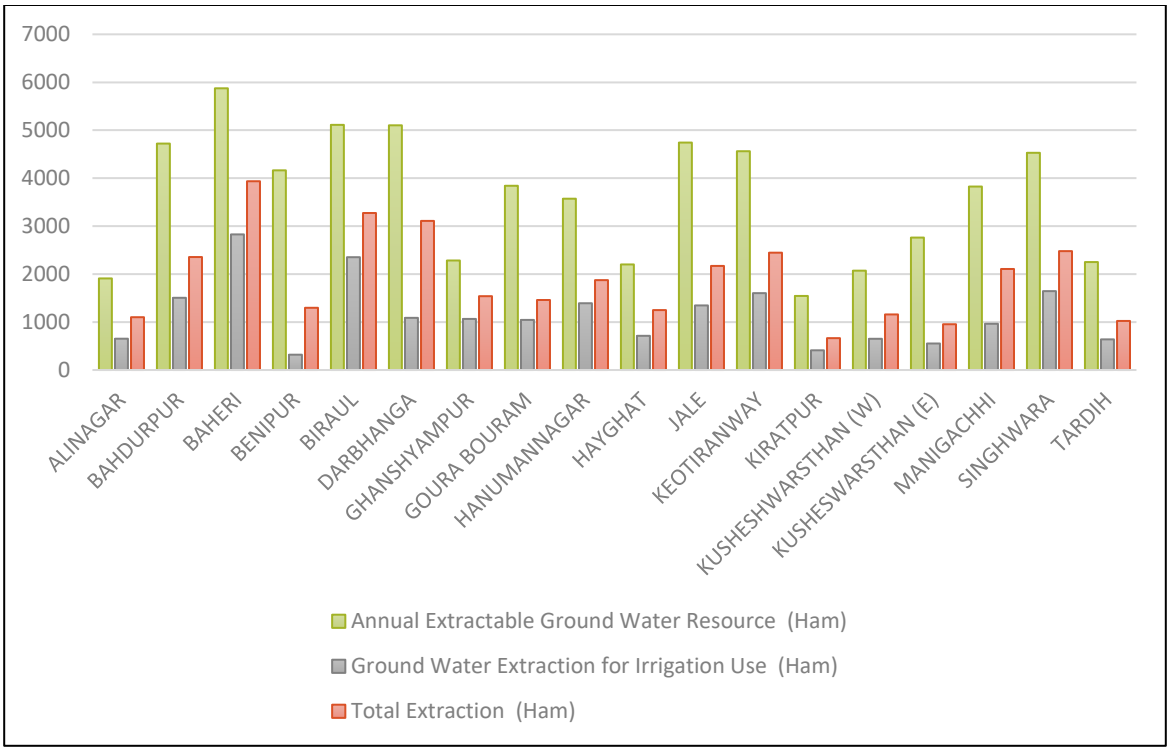

Figure 40: Block wise Net Resources vis-a-vis Gross Draft

Chapter 5: Groundwater Related Issues

Water-Logging and Flooding: The district has several small patches of area which remain submerged for longer periods. As the district is bounded on two sides by two major rivers, and several small river flows through the district, flooding is a major problem in the district. Water logging is prevalent mainly in northern and north-western parts of the district due to higher water table elevation.

Arsenic affected areas: Ground water quality in some blocks is a matter of concern as geogenic contamination of Arsenic in ground water above permissible limit of 10ppb has been observed in southern parts of Darbhanga district. High Arsenic concentration is observed in Baheri, Benipur, Biraul, Hayaghat, Alinagar blocks as per the previous CGWB data (2009-2010) which was again reconfirmed during 2019 sampling. The locations details of Arsenic contaminated groundwater samples is given in Annexure- IV and *Figure 41*.

Low Stage of Groundwater Development: The aquifers are highly potential and prolofic in nature. The GW development in Darbhanga district is only 52.56%. All the blocks in the district are safe assessment units and the scope of groundwater development potential of the district is very high.

Declining Water Level: The hydrographs show that the long-term water level trend is declining. Thus, arises the need for artificial recharge.

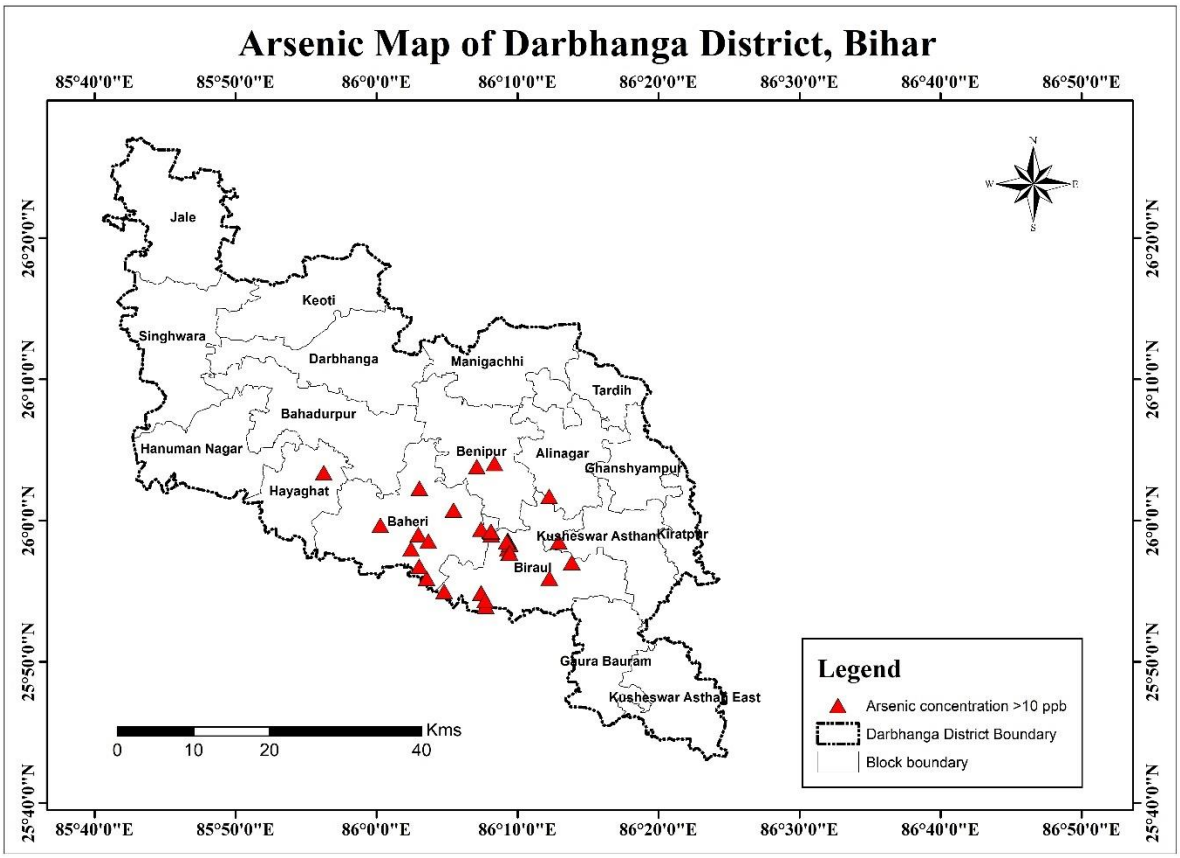

Figure 41: Arsenic contamination of Ground water in Darbhanga District (Based on water quality samples collected during previous studies)

Chapter 6: Groundwater Management Plan

6.1. Proposal for well construction

Darbhanga town and the surrounding areas are generally waterlogged. The direction of groundwater flow in the district is from NW to SE, it is recommended that the heavy duty tubewells should extensively be constructed in the northern and north-western parts of the district comprising Darbhanga, Keotiranaway, Jale and Singhwara blocks. It will act both as a perennial source of water supply and also to some extent eliminate the water logging problem in the affected areas.

In the southern and south-eastern parts of the district where potential aquifer occurs at shallow depths below 15m, cavity well should be encouraged where aquifer lies below plastic clay and in the absence of plastic clay, bamboo boring or shallow tubewell should be constructed which will be very economical to the marginal and small farmers.

It has been observed that due to lack of knowledge, the farmers generally construct tubewell very closely which after sometimes adversely affects each other's discharge which is generally shown in the form of lowering of discharge. It happens due to mutual interference. Therefore,it is of prime importance, that a farmer or a user should know about the spacing of the wells. As per the hydrogeological conditions of Darbhanga district, the spacing between two wells should be kept 200m in case of shallow tubewells and 600m in case of deep tubewells, for the smooth running and longer life of the tubewells.

Table 16: Proposed Well Assembly in Darbhanga District for Well Construction (CGWB District Report, 1992)

Sl.No	**Discharge m3/hr**	**Proposed depth of well**	**Proposed Well Assembly**		**Slot size**	**Minimum % of open area per unit length**	**H.P. of Motor**
			Dia of the pipe	**Length of the pipe (m)**			
1	50	60	203mm Housing 102mm Slotted pipe 102mm Blank pipe	20 15 25	1/16”	9	20
2	100	100	305mm Housing 152mm Slotted pipe 152mm Blank pipe	25 20 55	1/16”	12	35
3	150-200	150	305mm Housing 203mm Slotted pipe 203mm Blank pipe	30 25 95	1/16”	12	45

6.2. Arsenic free alternate aquifer

In Aquifer I ground water is contaminated by arsenic in Baheri, Benipur, Biraul, Hayaghat, Alinagar blocks. Therefore, in these areas for drinking purpose tube well should be constructed by tapping arsenic free aquifer with proper cement sealing in the clay zone above the aquifer to be tapped; for pipe water supply, Arsenic Removal Plant should be installed.

The technique advocates to tap safe alternate aquifers right within the affected areas. The Gangetic Plains of Bihar is marked by is marked by multi-aquifer system (CGWB 1999, Acharyya 2005, Saha2009, Shah 2007). The sedimentary sequence is made up Quaternary deposits, where the aquifers made up of unconsolidated sands which are separated by clay/sandy clay, making the deeper aquifer/aquifers semi-confined to confined. The contamination is confined in the upper slice of the sediments, within 80 m and affecting the shallow aquifer system (CGWB, 1999, Saha et al 2009).

Detailed CGWB exploration, isotope and hydrochemical modelling carried out by CGWB along with other agencies like BARC has identified that the deep aquifers (>100 m bgl) underneath the contaminated shallow aquifer, have been normally found as arsenic free. Long duration pumping tests and isotopic studies have indicated that there is limited hydraulic connection between the contaminated shallow and contamination free deep aquifers and the groundwater belongs to different age groups having different recharge mechanisms (CGWB 1999, Saha et al 2010, 2011, CGWB and BARC 2009). The deep aquifers have the potential to be used for community-based water supply.

Proposed Design of Arsenic Free Wells by CGWB: A specially designed tube-well using cement seal technique is suggested to provide arsenic free water in the block. Cement sealing is applied to a suitably thick intervening clay layer separating the arsenic contaminated aquifer from arsenic free aquifer. Cement seal prevents seeping of contaminated water through the annular space which is filled with gravel material(*Figure 42*).

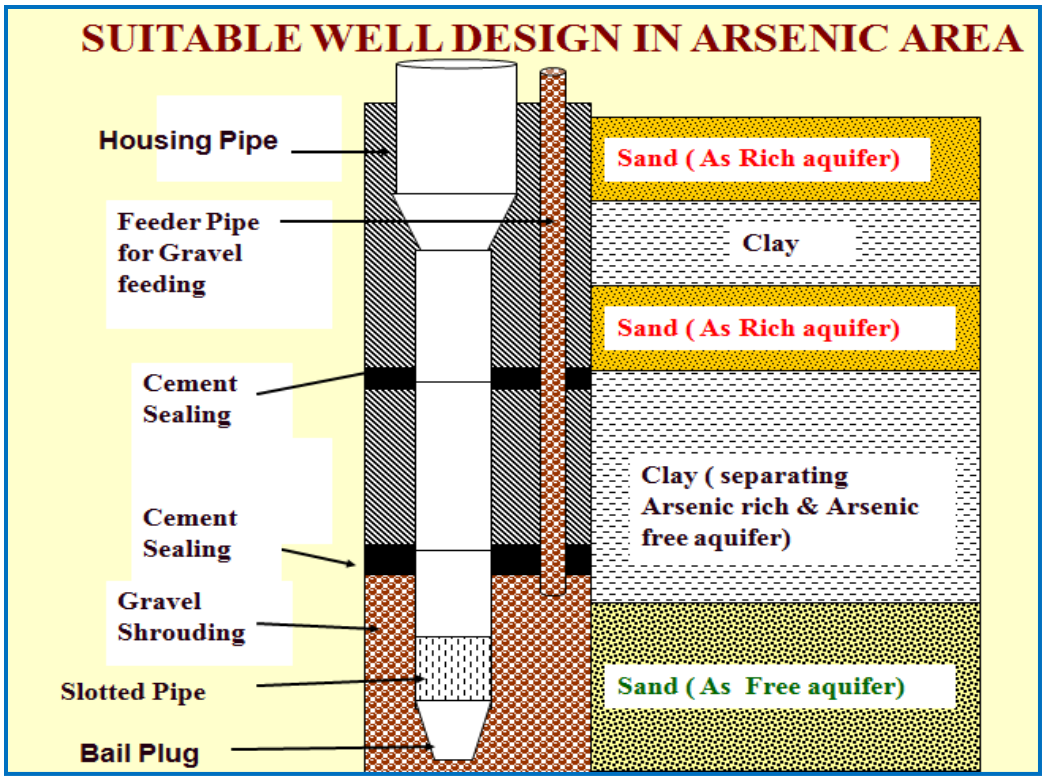

Figure 42: Suitable well design in Arsenic Affected Area

6.3. Water Conservation and Artificial Recharge

Although, all the 18 blocks are in safe category, artificial recharge should beencouraged to arrest the decline of ground water level in future caused by the increasing demand of ground water.
By considering entire non-monsoon rainfall as committed, excess monsoonrainfall can be safely harnessed to replenish groundwater table without affecting surface waterresource. For the present calculation for artificial recharge, 60% of the normal monsoon rainfallfor identified feasible areas is considered as available non- committed surface runoff.

Table 17: Identified Area, Computed Storage Volume and Source Water availability for Artificial Recharge to Ground Water in Darbhanga district (ARMP 2020)

District	Area	Area Identified for AR	Volume of Desaturated Zone	Source Water Requirement	Total Surplus Runoff Available
	(sq.km.)	(sq.km.)	(MCM)	(MCM)	(MCM)
Darbhanga	2504.29	260.70	156.42	240.88	1651.29

Table 18: Types and Number of different Artificial recharge structures proposed for Darbhanga district (ARMP 2020)

Nala Bunding	Lateral Recharge Shaft	Recharge Shaft	Percolation Tank	De-silting of existing tank /pond /talab	Injection Well in Village Tank
5	38	75	4	137	182

Darbhanga town and the adjacent Bahadurpur are the main urban area in the district, thus rooftop rainwater harvesting is proposed for Darbhanga district.Artificial recharge is mainly encouraged in areas where post monsoon depth to water level is >3m bgl.

6.4. Groundwater resource development strategy:

The district has a medium stage of groundwater extraction 52.56%. Few blocks like Jale, Benipur, Ghanshyampur, Kiratpur, Kusheshwar Asthan East, Tardih have very low groundwater development. The focus of proposed management plan is to enhance the overall ground water development up to 70% in most of the blocks.

On the basis of Ground Water Resource Estimaton-2022 additional number of shallow tube well for alluvium area for each block has been calculated within the safe limit of the Stage of Development upto 70% by considering unit draft for each tube well 1.95 ha m. As per the calculation, a total of 3285 number of tube wells can be constructed to fulfil the future demand of ground water. The block wise additional number of tubewell is given in *Table 19*.

The crop water requirement in alluvial terrain for various crops as norm fixed by the Agricultural University Pusa, Samastipur District, Bihar is as follows:

For Paddy, depth of water applied is 0.80m and for wheat and other Rabi crops depth of water applied is 0.35m. Thus, average water application is 0.575m and considering that 70% field application efficiency, the net irrigation requirement will be 0.575×0.70 = 0.402m. Therefore,

Irrigation Potential = Utilisable ground water resource/0.402

Thus, the total future irrigation potential feasible (area) in Darbhanga district after enhancing the overall ground water development up to 70% in each block is 14471.4 Ha (*Table 20*).

Table 19: Additional NumberShallow tube wells feasible based on Groundwater availability

Block	Total Annual Recharge	Annual Extractable groundwater resource(Ham)	Gross Draft all uses(Ham)	Annual GW Allocation for Domestic Use as on 2025 (Ham)	Stage of Development (SOD)% 2022	Category	Projected SOD%	Groundwater Draft at Projected SOD(Ham)	Additional Resource available (Ham)	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
ALINAGAR	2122.01	1909.81	1101.09	486.99	57.65	safe	70	1336.867	85.95	1.95	44
BAHDURPUR	5246.34	4721.70	2355.67	897.31	49.89	safe	70	3305.19	519.20	1.95	266
BAHERI	6527.18	5874.47	3936.22	1024.96	67.01	safe	70	4112.129	737.38	1.95	378
BENIPUR	4626.21	4163.58	1297.49	1030.07	31.16	safe	70	2914.506	219.00	1.95	112
BIRAUL	5679.98	5111.98	3274.08	968.97	64.05	safe	70	3578.386	564.62	1.95	289
DARBHANGA	5669.52	5102.57	3109.29	2159.87	60.94	safe	70	3571.799	-629.10	1.95	*
GHANSHYAMPUR	2537.45	2283.70	1539.42	515.15	67.41	safe	70	1598.59	169.96	1.95	87
GOURA BOURAM	4268.65	3841.79	1459.98	451.14	38.00	safe	70	2689.253	701.40	1.95	359
HANUMANNAGAR	3969.10	3572.19	1874.26	523.68	52.47	safe	70	2500.533	547.98	1.95	281
HAYGHAT	2445.92	2201.33	1249.51	501.50	56.76	safe	70	1540.931	158.90	1.95	81
JALE	5269.67	4742.70	2170.32	894.92	45.76	safe	70	3319.89	527.89	1.95	270
KEOTIRANWAY	5018.50	4562.29	2446.72	916.84	53.63	safe	70	3193.603	451.85	1.95	231
KIRATPUR	1716.03	1544.43	664.47	275.75	43.02	safe	70	1081.101	187.58	1.95	96
KUSHESHWARSTHAN (W)	2301.98	2071.78	1158.79	551.59	55.93	safe	70	1450.246	69.94	1.95	35
KUSHESWARSTHAN (E)	2906.94	2761.59	954.36	436.26	34.56	safe	70	1933.113	392.22	1.95	201
MANIGACHHI	4250.79	3825.71	2106.67	774.25	55.07	safe	70	2677.997	373.46	1.95	191
SINGHWARA	5032.66	4529.39	2478.98	906.27	54.73	safe	70	3170.573	452.55	1.95	232
TARDIH	2501.30	2251.17	1023.16	417.57	45.45	safe	70	1575.819	257.78	1.95	132
Total											**3285**

*Darbhanga block being urban area, future allocation of Groundwater Resources for domestic purpose is quite high which will put stress on the existing Groundwater resources. Thus, additional number of tubewells are not suggested for Darbhanga block as it is densely populated. Any additional tubewell will result in overdraft of Groundwater resource in future.

Table 20: Estimation of Area (in Ha) which can be irrigated with the additional GW resource available

Block	**Additional Resource available(Ham)**	**Net Irrigation Requirement (m)**	**Further irrigation potential feasible (in Ha)**
ALINAGAR	85.95	0.4	214.875
BAHDURPUR	519.20	0.4	1298
BAHERI	737.38	0.4	1843.45
BENIPUR	219.00	0.4	547.5
BIRAUL	564.62	0.4	1411.55
DARBHANGA	*	*	*
GHANSHYAMPUR	169.96	0.4	424.9
GOURA BOURAM	701.40	0.4	1753.5
HANUMANNAGAR	547.98	0.4	1369.95
HAYGHAT	158.90	0.4	397.25
JALE	527.89	0.4	1319.725
KEOTIRANWAY	451.85	0.4	1129.625
KIRATPUR	187.58	0.4	468.95
KUSHESHWARSTHAN (W)	69.94	0.4	174.85
KUSHESWARSTHAN (E)	392.22	0.4	980.55
MANIGACHHI	373.46	0.4	933.65
SINGHWARA	452.55	0.4	1131.375
TARDIH	257.78	0.4	644.45
Total	**5788.56**		**14471.4**

Chapter 7: Blockwise Groundwater Management Plan in Darbhanga District

7.1. Alinagar Block

General Information:

Total Geographical Area (hectares): 9504
Total Population (as per census 2011): 171725
Normal annual rainfall (mm): 1227
Average monthly rainfall (mm): 102.2

Irrigation based classification

Block	Gross Irrigated Area (Ha)	Net Irrigated Area (Ha)	Partially Irrigated Area (Ha)	Rainfed Area/ Un-irrigated Area (Ha)
Alinagar	7311.7	2640	2393.82	4874.5

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Alinagar	414	336	3

Dynamic Groundwater Resource (till 2022)

Block	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
ALINAGAR	1909.81	652.86	0.00	448.23	1101.09	486.99	769.96	57.65	safe

Aquifer Disposition:

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Alinagar	Motipur, Antour	26.066	86.1668	1.18	43.82	0.56	44.44
Alinagar	Pirhauli	26.0752	86.2655	0.37	46.63	0.92	46.08

Water Quality:

The water is potable in nature but in previous studies of CGWB, As has been detected in Alinagar block.

Aquifer Characterisation:

The block possesses potential shallow aquifers within 50 m bgl (unconfined aquifer-I) which is quiet evident from the very shallow depth to water level.High potential (deeper) aquifers exist within 50-200 m depth (Aquifer-II). The two aquifers are separated by aquitard (clay layer) of varying thickness.

Groundwater Management Plan:

Arsenic(As) contamination is observed in this block at certain locations. Thus, the deeper arsenic safe aquifers beyond 50 m depth can be tapped for drinking water and other purposes in Alinagar block. The suitable well design for getting As-free water is already discussed in chapter 6.

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 2122.01
Annual Extractable GW resource (Ham):1909.81
Gross Draft all uses (Ham): 1101.09
Annual GW allocation for domestic use os on 2025 (Ham): 486.99
Stage of GW development (SOD) %: 57.65
GW draft at projected SOD (Ham): 1336.867
Additional Resource available (Ham): 85.95
Unit draft of STW :1.95
Additional Nos. of STW feasible based on GW availability: **44**
Further irrigation potential feasible (in Ha): 214.875

No artificial recharge (AR) structure is suggested for the block as per ARMP 2020

7.2. Bahadurpur Block

General Information:

Total Geographical Area (hectares): 16851
Total Population (as per census 2011): 197983
Normal annual rainfall(mm): 1236
Average monthly rainfall (mm): 103

Irrigation based classification

Block	Gross Irrigated Area (Ha)	Net Irrigated Area (Ha)	Partially Irrigated Area (Ha)	Rainfed Area/ Un-irrigated Area (Ha)
Bahadurpur	13012.9	5520	5005.26	7884.1

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Bahadurpur	954	494	1

Dynamic Groundwater Resource (till 2022)

Block	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
Bahadurpur	4721.70	1505.79	24.00	825.88	2355.67	897.31	2631.76	49.89	safe

Aquifer Disposition:
Water Quality:
The groundwater is potable in nature.
Aquifer Characterisation:
The block possesses potential shallow aquifers within 50 m bgl (unconfined aquifer-I) which is quiet evident from the very shallow depth to water level.High potential (deeper) aquifers exist

within 50-200 m depth (Aquifer-II). The two aquifers are separated by aquitard (clay layer) of varying thickness.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Bahadurpur	Rampur Madan	26.1063	85.9108	2.51	47.49	1.84	48.16
Bahadurpur	Dekoli	26.0858	85.9225	2.09	47.91	1.59	48.41
Bahadurpur	BahadurpurDakli Panchayat	26.1085	85.9085	3.65	50.35	3.55	50.45

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 5246.34
Annual Extractable GW resource (Ham):4721.70
Gross Draft all uses (Ham): 2355.67
Annual GW allocation for domestic use os on 2025 (Ham): 897.31
Stage of GW development (SOD) %: 49.89
GW draft at projected SOD (Ham): 3305.19
Additional Resource available (Ham): 519.20
Unit draft of STW :1.95
Additional Nos. of STW feasible based on GW availability: **266**
Further irrigation potential feasible (in Ha): 1298

Artificial Recharge (AR) structures suggested for the block as per ARMP 2020.

Nala Bunding	Lateral Recharge Shaft	Recharge Shaft	Percolation Tank	De-silting of existing tank /pond /talao	Injection Well in Village Tank
1	10	20	1	35	47

7.3. Baheri Block

General Information:

Total Geographical Area (hectares): 21482
Total Population (as per census 2011): 359464
Normal annual rainfall(mm): 1242
Average monthly rainfall (mm): 103.5

Irrigation based classification

Block	Gross Irrigated Area (Ha)	Net Irrigated Area (Ha)	Partially Irrigated Area (Ha)	Rainfed Area/ Un-irrigated Area (Ha)
Baheri	11870.4	6480	5875.74	7913.6

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Baheri	2056	1140	8

Dynamic Groundwater Resource (till 2022)

Block	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
BAHERI	5874.47	2827.85	165.00	943.37	3936.22	1024.96	1856.66	67.01	safe

Aquifer Disposition:

Water Quality:
The water is potable in nature but in previous studies of CGWB, As has been detected in Baheri block.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Baheri	Baheri	25.95065	86.05076	1.97	50.03	1.4	50.6
Baheri	Bithauli	26.01112	86.08747	3.58	42.42	3	43
Baheri	Samadhpura	25.95282	86.0366	4.88	47.12	3.76	48.24

Aquifer Characterisation:
The block possesses potential shallow aquifers within 50 m bgl (unconfined aquifer-I) which is quiet evident from the very shallow depth to water level.High potential (deeper) aquifers exist within 50-200 m depth (Aquifer-II). The two aquifers are separated by aquitard (clay layer) of varying thickness.

Groundwater Management Plan:
Arsenic(As) contamination is observed in this block at certain locations. Thus, the deeper arsenic safe aquifers beyond 50 m depth can be tapped for drinking water and other purposes in Alinagar block. The suitable well design for getting As-free water is already discussed in chapter 6.

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 6527.18
Annual Extractable GW resource (Ham):5874.47
Gross Draft all uses (Ham): 3936.22
Annual GW allocation for domestic use os on 2025 (Ham): 1024.96
Stage of GW development (SOD) %: 67.01
GW draft at projected SOD (Ham): 4112.129
Additional Resource available (Ham): 737.38
Unit draft of STW :1.95
Additional Nos. of STW feasible based on GW availability: **378**

Further irrigation potential feasible (in Ha): 1843.45

Artificial Recharge (AR) structures suggested for the block as per ARMP 2020.

Lateral Recharge Shaft	Recharge Shaft	De-silting of existing tank /pond /talao	Injection Well in Village Tank
2	4	8	11

7.4. Benipur Block

General Information:
Total Geographical Area (hectares): 16259
Total Population (as per census 2011): 205115
Normal annual rainfall(mm): 1232
Average monthly rainfall (mm): 102.6

Irrigation based classification

Block	Gross Irrigated Area (Ha)	Net Irrigated Area (Ha)	Partially Irrigated Area (Ha)	Rainfed Area/ Un-irrigated Area (Ha)
Benipur	9992.9	5800	4787.64	6678.6

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Benipur	202	878	13

Dynamic Groundwater Resource (till 2022)

Block	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
BENIPUR	4163.58	319.41	30.00	948.08	1297.49	1030.07	3554.10	31.16	safe

Aquifer Disposition:

Water Quality:
The water is potable in nature but in previous studies of CGWB, As has been detected in Benipur block.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Benipur	Bahera (Brahmnath chogma)	26.07519	86.13202	3.64	44.36	2.77	45.23
Benipur	Bheruk	26.0527	86.1653	2.64	45.36	2.5	45.5

Aquifer Characterisation:
The block possesses potential shallow aquifers within 50 m bgl (unconfined aquifer-I) which is quiet evident from the very shallow depth to water level.High potential (deeper) aquifers exist within 50-200 m depth (Aquifer-II). The two aquifers are separated by aquitard (clay layer) of varying thickness.

Groundwater Management Plan:
Arsenic(As) contamination is observed in this block at certain locations. Thus, the deeper arsenic safe aquifers beyond 50 m depth can be tapped for drinking water and other purposes in Benipur block. The suitable well design for getting As-free water is already discussed in chapter 6.

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:
Total Annual Recharge: 4626.21
Annual Extractable GW resource (Ham):4163.58
Gross Draft all uses (Ham): 1297.49
Annual GW allocation for domestic use os on 2025 (Ham): 1030.07
Stage of GW development (SOD) %: 31.16
GW draft at projected SOD (Ham): 2914.506
Additional Resource available (Ham): 219.00
Unit draft of STW: 1.95
Additional Nos. of STW feasible based on GW availability: **112**
Further irrigation potential feasible (in Ha): 547.5

Artificial Recharge (AR) structures suggested for the block as per ARMP 2020.

Nala Bunding	Lateral Recharge Shaft	Recharge Shaft	Percolation Tank	De-silting of existing tank /pond /talao	Injection Well in Village Tank
1	6	12	1	22	28

7.5. Biraul Block

General Information:
Total Geographical Area (hectares): 18443
Total Population (as per census 2011): 341523
Normal annual rainfall(mm): 1245
Average monthly rainfall (mm): 103.7

Irrigation based classification

Block	Gross Irrigated Area (Ha)	Net Irrigated Area (Ha)	Partially Irrigated Area (Ha)	Rainfed Area/ Un-irrigated Area (Ha)
Biraul	13153.1	6240	5658	8768.7

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Biraul	1489	856	106

Dynamic Groundwater Resource (till 2022)

Block	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
BIRAUL	5111.98	2352.24	30.00	891.84	3274.08	968.97	1760.77	64.05	safe

Aquifer Disposition:

Water Quality:
The water is potable in nature but in previous studies of CGWB, As has been detected in Biraul block.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Biraul	Deokoli Dham Hospital, Biraul	25.9007	86.10873	3.47	45.53	2.78	46.22
Biraul	AfzalaBalia	25.9297	86.2313	2.73	46.27	2.11	46.89
Biraul	Ucchti	25.9188	86.2505	6.96	43.04	2.65	47.35

Aquifer Characterisation:
The block possesses potential shallow aquifers within 50 m bgl (unconfined aquifer-I) which is quiet evident from the very shallow depth to water level.High potential (deeper) aquifers exist within 50-200 m depth (Aquifer-II). The two aquifers are separated by aquitard (clay layer) of varying thickness.

Groundwater Management Plan:
Arsenic(As) contamination is observed in this block at certain locations. Thus, the deeper arsenic safe aquifers beyond 50 m depth can be tapped for drinking water and other purposes in Biraul block. The suitable well design for getting As-free water is already discussed in chapter 6.

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 5679.98
Annual Extractable GW resource (Ham):5111.98

Gross Draft all uses (Ham): 3274.08
Annual GW allocation for domestic use os on 2025 (Ham): 968.97
Stage of GW development (SOD) %: 64.05
GW draft at projected SOD (Ham): 3578.386
Additional Resource available (Ham): 564.62
Unit draft of STW :1.95
Additional Nos. of STW feasible based on GW availability: **289**
Further irrigation potential feasible (in Ha): 1411.55

No artificial recharge (AR) structure is suggested for this block as per ARMP 2020.

7.6. Darbhanga Block

General Information:

Total Geographical Area (hectares): 20612
Total Population (as per census 2011): 333253
Normal annual rainfall(mm): 1226
Average monthly rainfall (mm): 102.1

Irrigation based classification

Block	Gross Irrigated Area (Ha)	Net Irrigated Area (Ha)	Partially Irrigated Area (Ha)	Rainfed Area/ Un-irrigated Area (Ha)
Darbhanga	9897.8	5520	5005.26	6558.5

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Darbhanga	959	262	959

Dynamic Groundwater Resource (till 2022)

Block	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
DARBHANGA	5102.57	1087.75	33.60	1987.95	3109.29	2159.87	1821.36	60.94	safe

Aquifer Disposition:

Aquifer Characterisation:

The block possesses potential shallow aquifers within 50 m bgl (unconfined aquifer-I) which is quiet evident from the very shallow depth to water level.High potential (deeper) aquifers exist within 50-200 m depth (Aquifer-II). The two aquifers are separated by aquitard (clay layer) of varying thickness. Thin layer of gravel is also observed in between the two aquifers.

Water Quality:

The water is potable in nature.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Darbhanga Sadar	Darbhanga Sadar	26.17612	85.89903	3.62	46.38	3	47
Darbhanga Sadar	Sonki (Chikni)	26.1214	86.022	2.7	46.3	1.9	47.1

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 5669.52
Annual Extractable GW resource (Ham):5102.57
Gross Draft all uses (Ham): 3109.29
Annual GW allocation for domestic use as on 2025 (Ham): 2159.87
Stage of GW development (SOD) %: 60.94
GW draft at projected SOD (Ham): 3571.799

*Darbhanga block being urban area, future allocation of Groundwater Resources for domestic purpose is quite high which will put stress on the existing Groundwater resources. Thus, additional number of tubewells are not suggested for Darbhanga block as it is densely populated. Any additional tubewell will result in overdraft of Groundwater resource in future.

Artificial Recharge (AR) structures suggested for the block as per ARMP 2020.

Nala Bunding	Lateral Recharge Shaft	Recharge Shaft	Percolation Tank	De-silting of existing tank /pond /talao	Injection Well in Village Tank
2	14	25	1	48	63

7.7. Ghanshyampur

General Information:
Total Geographical Area (hectares): 11619
Total Population (as per census 2011): 341523
Normal annual rainfall(mm): 1237
Average monthly rainfall (mm): 103

Irrigation based classification

Block	Gross Irrigated Area (Ha)	Net Irrigated Area (Ha)	Partially Irrigated Area (Ha)	Rainfed Area/ Un-irrigated Area (Ha)
Ghanshyampur	3633.3	2880	2611.44	2422.2

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Ghanshyampur	662	459	0

Dynamic Groundwater Resource (till 2022)

Block	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/ Saline)
GHANSHYAMPUR	2283.70	1065.29	0.00	474.15	1539.42	515.15	703.28	67.41	safe

Aquifer Disposition:

Water Quality:
The water is potable in nature.

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Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Ghanshyampur	Ahirainbasti	26.0715	86.3021	2.42	42.58	1.79	43.21
Ghanshyampur	Ghanshyampur	26.0616	86.326	1.95	45.05	1.05	45.95

Aquifer Characterisation:
The block possesses potential shallow aquifers within 50 m bgl (unconfined aquifer-I) which is quite evident from the very shallow depth to water level.High potential (deeper) aquifers exist within 50-200 m depth (Aquifer-II) under semi-confined to confined condition. The two aquifers are separated by aquitard (clay layer) of varying thickness.

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 2537.45
Annual Extractable GW resource (Ham):2283.70

Gross Draft all uses (Ham): 1539.42

Annual GW allocation for domestic use as on 2025 (Ham): 515.15

Stage of GW development (SOD) %: 67.41
GW draft at projected SOD (Ham): 1598.59
Additional Resource available (Ham): 169.96
Unit draft of STW :1.95
Additional Nos. of STW feasible based on GW availability: **87**
Further irrigation potential feasible (in Ha): 424.9

No artificial recharge (AR) structure is suggested for this block as per ARMP 2020.

7.8. Gaura Bouram

General Information:
Total Geographical Area (hectares): 10345
Total Population (as per census 2011): 182233
Normal annual rainfall(mm): 1233
Average monthly rainfall (mm): 102.7

Irrigation based classification

Block	Gross Irrigated Area (Ha)	Net Irrigated Area (Ha)	Partially Irrigated Area (Ha)	Rainfed Area/ Un-irrigated Area (Ha)
Gaura Bouram	3881.4	3120	2829	2587.6

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Gaura Bouram	908	262	0

Dynamic Groundwater Resource (till 2022)

Block	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
GOURA BOURAM	3841.79	1044.77	0.00	415.23	1459.98	451.14	2345.90	38.00	safe

Aquifer Disposition:

Water Quality:
The water is potable in nature.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
GouraBouram	Bouram	25.9748	86.3175	3.44	44.56	2.14	45.86

Aquifer Characterization:
The block possesses potential shallow aquifers within 50 m bgl (unconfined aquifer-I). High potential (deeper) aquifers exist within 50-200 m depth (Aquifer-II) under semi-confined to confined condition. The two aquifers are separated by aquitard (clay layer) of varying thickness.

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 4268.65
Annual Extractable GW resource (Ham):3841.79

Gross Draft all uses (Ham): 1459.98

Annual GW allocation for domestic use as on 2025 (Ham): 451.14

Stage of GW development (SOD) %: 38.00
GW draft at projected SOD (Ham): 2689.253
Additional Resource available (Ham): 701.40
Unit draft of STW :1.95
Additional Nos. of STW feasible based on GW availability: **359**
Further irrigation potential feasible (in Ha): 1753.5

No artificial recharge (AR) structure is suggested for this block as per ARMP 2020.

7.9. Hanuman Nagar

General Information:
Total Geographical Area (hectares): 13979
Total Population (as per census 2011): 182811
Normal annual rainfall(mm): 1239
Average monthly rainfall (mm): 103.2

Irrigation based classification

Block	Gross Irrigated Area (Ha)	Net Irrigated Area (Ha)	Partially Irrigated Area (Ha)	Rainfed Area/ Un-irrigated Area (Ha)
Hanuman Nagar	5826.1	3360	3046.68	3680

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Hanuman Nagar	882	944	1

Dynamic Groundwater Resource (till 2022)

Block	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/ Saline)
HANUMANNAGAR	3572.19	1392.26	0.00	482.00	1874.26	523.68	1656.25	52.47	safe

Aquifer Disposition:

Water Quality:
The groundwater is potable in nature.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Hanuman Nagar	Okhra	26.0373	85.8092	4.05	46.95	4	47

Aquifer Characterisation:
The block possesses potential shallow aquifers within 50 m bgl (unconfined aquifer-I). High potential (deeper) aquifers exist within 50-200 m depth (Aquifer-II) under semi-confined to confined condition. The two aquifers are separated by aquitard (clay layer) of varying thickness.

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 3969.10
Annual Extractable GW resource (Ham):3572.19

Gross Draft all uses (Ham): 1874.26

Annual GW allocation for domestic use as on 2025 (Ham): 523.68

Stage of GW development (SOD) %: 52.47
GW draft at projected SOD (Ham): 2500.533
Additional Resource available (Ham): 547.98
Unit draft of STW :1.95
Additional Nos. of STW feasible based on GW availability: **281**
Further irrigation potential feasible (in Ha): 1369.95

No artificial recharge (AR) structure is suggested for this block as per ARMP 2020.

7.10. Hayaghat Block

General Information:
Total Geographical Area (hectares): 8601
Total Population (as per census 2011): 175378
Normal annual rainfall(mm): 1230
Average monthly rainfall (mm): 102.5

Irrigation based classification

Block	Gross Irrigated Area (Ha)	Net Irrigated Area (Ha)	Partially Irrigated Area (Ha)	Rainfed Area/ Un-irrigated Area (Ha)
Hayaghat	6786.1	3360	3046.68	3844

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Hayaghat	561	11	0

Dynamic Groundwater Resource (till 2022)

Block	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
HAYGHAT	2201.33	712.94	75.00	461.58	1249.51	501.50	911.90	56.76	safe

Aquifer Disposition:

Water Quality:
The water is potable in nature but in previous studies of CGWB, As has been detected in Hayaghat block.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Hayaghat	Pouram	26.01952	85.89156	3.78	42.22	4.32	41.68
Hayaghat	Rustampur	26.01595	85.88109	0.79	48.21	0.87	48.13

Aquifer Characterisation:
The block possesses potential shallow aquifers within 50 m bgl (unconfined aquifer-I).High potential (deeper) aquifers exist within 50-200 m depth (Aquifer-II). The two aquifers are separated by aquitard (clay layer) of varying thickness.

Groundwater Management Plan:
Arsenic (As) contamination is observed in this block at certain locations. Thus, the deeper arsenic safe aquifers beyond 50 m depth can be tapped for drinking water and other purposes in Hayaghat block. The suitable well design for getting As-free water is already discussed in chapter 6.

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 2445.92
Annual Extractable GW resource (Ham):2201.33

Gross Draft all uses (Ham): 1249.51
Annual GW allocation for domestic use as on 2025 (Ham): 501.50
Stage of GW development (SOD) %: 56.76
GW draft at projected SOD (Ham): 1540.931
Additional Resource available (Ham): 158.90
Unit draft of STW :1.95
Additional Nos. of STW feasible based on GW availability: **81**
Further irrigation potential feasible (in Ha): 397.25

No artificial recharge (AR) structure is suggested for this block as per ARMP 2020.

7.11. Jale Block

General Information:
Total Geographical Area (hectares): 18679
Total Population (as per census 2011): 313980
Normal annual rainfall(mm): 1225
Average monthly rainfall (mm): 102

Irrigation based classification

Block	Gross Irrigated Area (Ha)	Net Irrigated Area (Ha)	Partially Irrigated Area (Ha)	Rainfed Area/ Un-irrigated Area (Ha)
Jale	8258.1	6240	5658	7205.3

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Jale	853	328	34

Dynamic Groundwater Resource (till 2022)

Block	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
JALE	4742.70	1346.63	0.00	823.69	2170.32	894.92	2501.15	45.76	safe

Aquifer Disposition:
Water Quality:
The water is potable in nature.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Jale	Hiranagar Chowk	26.398	85.7285	2.95	53.05	2.57	53.43
Jale	Kamtaul	26.3358	85.8233	1.9	51.1	1.74	51.26

Aquifer Characterization:
The block possesses potential shallow aquifers within 50 m bgl (unconfined aquifer-I). High potential (deeper) aquifers exist within 50-200 m depth (Aquifer-II) under semi-confined to confined condition. The two aquifers are separated by aquitard (clay layer) of varying thickness. A thick layer of gravel mixed with sand occurs overlying the sand layer of aquifer-I.

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 5269.67
Annual Extractable GW resource (Ham):4742.70

Gross Draft all uses (Ham): 2170.32

Annual GW allocation for domestic use as on 2025 (Ham): 894.92

Stage of GW development (SOD) %: 45.76
GW draft at projected SOD (Ham): 3319.89
Additional Resource available (Ham): 527.89
Unit draft of STW: 1.95
Additional Nos. of STW feasible based on GW availability: **270**
Further irrigation potential feasible (in Ha): 1319.725

No artificial recharge (AR) structure is suggested for this block as per ARMP 2020.

7.12. Kusheshwar Asthan Block

General Information:
Total Geographical Area (hectares): 15008
Total Population (as per census 2011): 196828
Normal annual rainfall(mm): 1226
Average monthly rainfall (mm): 102.1

Irrigation based classification

Block	Gross Irrigated Area (Ha)	Net Irrigated Area (Ha)	Partially Irrigated Area (Ha)	Rainfed Area/ Un-irrigated Area (Ha)
Kusheshwar asthan	6465.8	3360	3046.68	4307.9

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Kusheshwar asthan	1015	282	53

Dynamic Groundwater Resource (till 2022)

Block	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/ Saline)
KUSHESHWARSTHAN	2071.78	651.11	0.00	507.68	1158.79	551.59	869.08	55.93	safe

Aquifer Disposition:

Water Quality:

The water is potable in nature but in previous studies of CGWB, As has been detected in Kusheshwar Asthan block.

Water Level Data of 2022:

Block	**Location**	**Latitude**	**Longitude**	**WL May 2022 (m bgl)**	**RL May 2022 (in m)**	**WL Nov 2022 (m bgl)**	**RL Nov 2022 (in m)**
KusheshwarAsthan	Sultanpur	25.8522	86.28	4.83	43.17	2.49	45.51
KusheshwarAsthan (Satighat)	Asho	25.8747	86.2447	3.58	45.42	3.74	45.26

Aquifer Characterisation:

The block possesses potential shallow aquifers within 50 m bgl (unconfined aquifer-I).High potential (deeper) aquifers exist within 50-200 m depth (Aquifer-II). The two aquifers are separated by aquitard (clay layer) of varying thickness.

Groundwater Management Plan:

Arsenic(As) contamination is observed in this block at certain locations. Thus, the deeper arsenic safe aquifers beyond 50 m depth can be tapped for drinking water and other purposes in Kusheshwar Asthan block. The suitable well design for getting As-free water is already discussed in chapter 6.

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 2301.98

Annual Extractable GW resource (Ham):2071.78

Gross Draft all uses (Ham): 1158.79

Annual GW allocation for domestic use as on 2025 (Ham): 551.59

Stage of GW development (SOD) %: 55.93

GW draft at projected SOD (Ham): 1450.246

Additional Resource available (Ham): 69.94

Unit draft of STW :1.95

Additional Nos. of STW feasible based on GW availability: **35**

Further irrigation potential feasible (in Ha): 174.85

No artificial recharge (AR) structure is suggested for this block as per ARMP 2020.

7.13. Kusheshwar Asthan (East) Block

General Information:
Total Geographical Area (hectares): 6236
Total Population (as per census 2011): 158837
Normal annual rainfall(mm): 1230
Average monthly rainfall (mm): 102.5

Irrigation based classification

Block	Gross Irrigated Area (Ha)	Net Irrigated Area (Ha)	Partially Irrigated Area (Ha)	Rainfed Area/ Un-irrigated Area (Ha)
Kusheshwar Asthan East	5348.8	2400	2280.25	3565.9

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Kusheshwar Asthan East	261	150	193

Dynamic Groundwater Resource (till 2022)

Block	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/ Saline)
KUSHESWARSTHAN (E)	2761.59	552.83	0.00	401.54	954.36	436.26	1772.51	34.56	safe

Aquifer Disposition:

Water Quality:
The groundwater is potable in nature.

Water Level Data of 2022:

Block	**Location**	**Latitude**	**Longitude**	**WL May 2022 (m bgl)**	**RL May 2022 (in m)**	**WL Nov 2022 (m bgl)**	**RL Nov 2022 (in m)**
KusheshwarAsthan (E)	Khalasi	25.8063	86.3097	4.23	42.77	2.7	44.3

Aquifer Characterisation:
The block possesses potential shallow aquifers within 50 m bgl (unconfined aquifer-I). High potential (deeper) aquifers exist within 50-200 m depth (Aquifer-II) under semi-confined to confined condition. The two aquifers are separated by aquitard (clay layer) of varying thickness.

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 2906.94
Annual Extractable GW resource (Ham):2761.59

Gross Draft all uses (Ham): 954.36

Annual GW allocation for domestic use as on 2025 (Ham): 436.26

Stage of GW development (SOD) %: 34.56
GW draft at projected SOD (Ham): 1933.113
Additional Resource available (Ham): 392.22
Unit draft of STW :1.95
Additional Nos. of STW feasible based on GW availability: **201**
Further irrigation potential feasible (in Ha): 980.55

No artificial recharge (AR) structure is suggested for this block as per ARMP 2020.

7.14. Keoti Block

General Information:
Total Geographical Area (hectares): 11659
Total Population (as per census 2011): 320516
Normal annual rainfall(mm): 1243
Average monthly rainfall (mm): 103.5

Irrigation based classification

Block	Gross Irrigated Area (Ha)	Net Irrigated Area (Ha)	Partially Irrigated Area (Ha)	Rainfed Area/ Un-irrigated Area (Ha)
Keoti	10389.2	6240	5658	6926.1

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Keoti	413	687	267

Dynamic Groundwater Resource (till 2022)

Block	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
KEOTI	4562.29	1602.86	0.00	843.87	2446.72	916.84	2115.57	53.63	safe

Aquifer Disposition:

Water Quality:
The groundwater is potable in nature.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Keoty	Pindaruch	26.2466	85.8565	2.95	49.05	2.28	49.72
Keoty	DarimaNapulia	26.29007	85.94157	2.85	49.15	2.61	49.39

Aquifer Characterisation:
The block possesses potential shallow aquifers within 50 m bgl (unconfined aquifer-I). High potential (deeper) aquifers exist within 50-200 m depth (Aquifer-II) under semi-confined to confined condition. The two aquifers are separated by aquitard (clay layer) of varying thickness. A thick layer of gravel mixed with sand occurs overlying the sand layer of aquifer-I.

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 5018.50
Annual Extractable GW resource (Ham):4562.29

Gross Draft all uses (Ham): 2446.72

Annual GW allocation for domestic use as on 2025 (Ham): 916.84

Stage of GW development (SOD) %: 53.63
GW draft at projected SOD (Ham): 3193.603
Additional Resource available (Ham): 451.85
Unit draft of STW :1.95
Additional Nos. of STW feasible based on GW availability: **231**
Further irrigation potential feasible (in Ha): 1129.625

No artificial recharge (AR) structure is suggested for this block as per ARMP 2020.

7.15. Kiratpur Block

General Information:
Total Geographical Area (hectares): 12124
Total Population (as per census 2011): 98515
Normal annual rainfall(mm): 1232
Average monthly rainfall (mm): 102.6

Irrigation based classification

Block	Gross Irrigated Area (Ha)	Net Irrigated Area (Ha)	Partially Irrigated Area (Ha)	Rainfed Area/ Un-irrigated Area (Ha)
Kiratpur	3107.4	1920	1740.96	2071.6

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Kiratpur	350	625	1

Dynamic Groundwater Resource (till 2022)

Block	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
KIRATPUR	1544.43	410.67	0.00	253.80	664.47	275.75	858.01	43.02	safe

Aquifer Disposition:

Water Quality:
The groundwater is potable in nature.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Kiratpur	Rasiyari	26.0452	86.3478	3.35	42.65	2.39	43.61

Aquifer Characterisation:
The block possesses potential shallow aquifers within 50 m bgl (unconfined aquifer-I). High potential (deeper) aquifers exist within 50-200 m depth (Aquifer-II) under semi-confined to confined condition. The two aquifers are separated by aquitard (clay layer) of varying thickness.

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 1716.03
Annual Extractable GW resource (Ham):1544.43

Gross Draft all uses (Ham): 664.47

Annual GW allocation for domestic use as on 2025 (Ham): 275.75

Stage of GW development (SOD) %: 43.02
GW draft at projected SOD (Ham): 1081.101
Additional Resource available (Ham): 187.58
Unit draft of STW :1.95
Additional Nos. of STW feasible based on GW availability: **96**
Further irrigation potential feasible (in Ha): 468.95

No artificial recharge (AR) structure is suggested for this block as per ARMP 2020.

7.16. Manigachhi Block

General Information:
Total Geographical Area (hectares): 13620
Total Population (as per census 2011): 268568
Normal annual rainfall(mm): 1239
Average monthly rainfall (mm): 103.2

Irrigation based classification

Block	Gross Irrigated Area (Ha)	Net Irrigated Area (Ha)	Partially Irrigated Area (Ha)	Rainfed Area/ Un-irrigated Area (Ha)
Manigachhi	5205.6	5200	4787.64	4450.3

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Manigachhi	610	399	13

Dynamic Groundwater Resource (till 2022)

Block	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/ Saline)
MANIGACHHI	3825.71	964.04	430.00	712.63	2106.67	774.25	1657.42	55.07	safe

Aquifer Disposition:

Water Quality:
The groundwater is potable in nature.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Manigachi	Raghopur	26.1767	86.094	3.38	48.62	3.58	48.42
Manigachi	MakrandaBhandairSoump	26.1786	86.1344	5.8	50.2	5.25	49.75

Aquifer Characterisation:
The block possesses potential shallow aquifers within 50 m bgl (unconfined aquifer-I). High potential (deeper) aquifers exist within 50-200 m depth (Aquifer-II) under semi-confined to confined condition. The two aquifers are separated by aquitard (clay layer) of varying thickness. This system is at some places disrupted owing to the pinching out of aquifers.

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 4250.79
Annual Extractable GW resource (Ham):3825.71

Gross Draft all uses (Ham): 2106.67

Annual GW allocation for domestic use os on 2025 (Ham): 774.25

Stage of GW development (SOD) %: 55.07
GW draft at projected SOD (Ham): 2677.997
Additional Resource available (Ham): 373.46
Unit draft of STW :1.95
Additional Nos. of STW feasible based on GW availability: **191**
Further irrigation potential feasible (in Ha): 933.65

Artificial Recharge (AR) structures suggested for the block as per ARMP 2020:

Lateral Recharge Shaft	Recharge Shaft	De-silting of existing tank /pond /talao	Injection Well in Village Tank
2	5	8	12

7.17. Singhwara Block

General Information:
Total Geographical Area (hectares): 17038
Total Population (as per census 2011): 317401
Normal annual rainfall(mm): 1231
Average monthly rainfall (mm): 102.5

Irrigation based classification

Block	Gross Irrigated Area (Ha)	Net Irrigated Area (Ha)	Partially Irrigated Area (Ha)	Rainfed Area/ Un-irrigated Area (Ha)
Singhwara	10617.6	6000	5440.5	7224.1

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Singhwara	1040	587	67

Dynamic Groundwater Resource (till 2022)

Block	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
SINGHWARA	4529.39	1644.84	0.00	834.14	2478.98	906.27	1978.28	54.73	safe

Aquifer Disposition:

Water Quality:
The groundwater is potable in nature.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Singhwara	Bharwara	26.2644	85.728	3.45	49.55	3.8	49.2

Aquifer Characterisation:
The block possesses potential shallow aquifers within 50 m bgl (unconfined aquifer-I). High potential (deeper) aquifers exist within 50-200 m depth (Aquifer-II) under semi-confined to confined condition. The two aquifers are separated by aquitard (clay layer) of varying thickness. A thick layer of gravel mixed with sand occurs overlying the sand layer of aquifer-I.

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:
Total Annual Recharge: 5032.66
Annual Extractable GW resource (Ham):4529.39
Gross Draft all uses (Ham): 2478.98
Annual GW allocation for domestic use as on 2025 (Ham): 906.27
Stage of GW development (SOD) %: 54.73
GW draft at projected SOD (Ham): 3170.573
Additional Resource available (Ham): 452.55
Unit draft of STW :1.95
Additional Nos. of STW feasible based on GW availability: **232**
Further irrigation potential feasible (in Ha): 1131.375

Artificial Recharge (AR) structures suggested for the block as per ARMP 2020.

Nala Bunding	Lateral Recharge Shaft	Recharge Shaft	Percolation Tank	De-silting of existing tank /pond /talao	Injection Well in Village Tank
1	4	9	1	16	21

7.18. Tardih Block

General Information:
Total Geographical Area (hectares): 8370
Total Population (as per census 2011): 144215
Normal annual rainfall(mm): 1238
Average monthly rainfall (mm): 103.1

Irrigation based classification

Block	Gross Irrigated Area (Ha)	Net Irrigated Area (Ha)	Partially Irrigated Area (Ha)	Rainfed Area/ Un-irrigated Area (Ha)
Tardih	5665.8	3120	2829	3790.5

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Tardih	405	307	0

Dynamic Groundwater Resource (till 2022)

Block	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
TARDIH	2251.17	638.82	0.00	384.34	1023.1	417.57	1194.78	45.45	safe

Aquifer Disposition:
Water Quality:
The groundwater is potable in nature.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Tardih	Nabbi Chowk	26.1538	86.1865	2.83	46.17	2.4	46.6
Tardih	Tardih/Sakatpur	26.1467	86.2513	3.01	43.99	1.91	45.09

Aquifer Characterization:
The block possesses potential shallow aquifers within 50 m bgl (unconfined aquifer-I). High potential (deeper) aquifers exist within 50-200 m depth (Aquifer-II) under semi-confined to confined condition. The two aquifers are separated by aquitard (clay layer) of varying thickness. This system is at some places disrupted owing to the pinching out of aquifers.

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 2501.30
Annual Extractable GW resource (Ham):2251.17

Gross Draft all uses (Ham): 1023.16

Annual GW allocation for domestic use as on 2025 (Ham): 417.57

Stage of GW development (SOD) %: 45.45
GW draft at projected SOD (Ham): 1575.819
Additional Resource available (Ham): 257.78
Unit draft of STW :1.95
Additional Nos. of STW feasible based on GW availability: **132**
Further irrigation potential feasible (in Ha): 644.45

No Artificial Recharge (AR) structure is suggested for the block as per ARMP 2020.

Annexure- I

NHNS location data of Darbhanga district, Bihar

Sl.No.	Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
1	Benipur	Bahera (Brahmnath chogma)	26.07519	86.13202	3.64	44.36	2.77	45.23
2	Baheri	Baheri	25.95065	86.05076	1.97	50.03	1.4	50.6
3	Baheri	Bithauli	26.01112	86.08747	3.58	42.42	3	43
4	Darbhanga Sadar	Darbhanga Sadar	26.17612	85.89903	3.62	46.38	3	47
5	Baheri	Jorja	26.01252	85.98904	3.2	44.8	3.07	44.93
6	Keoty	DarimaNapulia	26.29007	85.94157	2.85	49.15	2.61	49.39
7	Hayaghat	Pouram	26.01952	85.89156	3.78	42.22	4.32	41.68
8	Hayaghat	Rustampur	26.01595	85.88109	0.79	48.21	0.87	48.13
9	Sakri	Sakri	26.22378	86.07729	2.58	52.42	3.1	51.9
10	Simri	Simri (Bithauli)	26.16754	85.74322	3.45	46.55	3.4	46.6
11	Biraul	Deokoli Dham Hospital, Biraul	25.9007	86.10873	3.47	45.53	2.78	46.22
12	Baheri	Samadhpura	25.95282	86.0366	4.88	47.12	3.76	48.24

Annexure-II

Key well data of Darbhanga district, Bihar

Sl.No.	Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
1	Singhwara	Bharwara	26.2644	85.728	3.45	49.55	3.8	49.2
2	Jale	Hiranagar Chowk	26.398	85.7285	2.95	53.05	2.57	53.43
3	Jale	Kamtaul	26.3358	85.8233	1.9	51.1	1.74	51.26
4	Keoty	Pindaruch	26.2466	85.8565	2.95	49.05	2.28	49.72
5	Darbhanga Sadar	Sonki (Chikni)	26.1214	86.022	2.7	46.3	1.9	47.1
6	Benipur	Bheruk	26.0527	86.1653	2.64	45.36	2.5	45.5
7	Biraul	AfzalaBalia	25.9297	86.2313	2.73	46.27	2.11	46.89
8	Biraul	Ucchti	25.9188	86.2505	6.96	43.04	2.65	47.35
9	KusheshwarAsthan	Sultanpur	25.8522	86.28	4.83	43.17	2.49	45.51
10	KusheshwarAsthanPurbi	Khalasi	25.8063	86.3097	4.23	42.77	2.7	44.3
11	KusheshwarAsthan (Satighat)	Asho	25.8747	86.2447	3.58	45.42	3.74	45.26
12	Bahadurpur	BahadurpurDakli Panchayat	26.1085	85.9085	3.65	50.35	3.55	50.45
13	Bahadurpur	Rampur Madan	26.1063	85.9108	2.51	47.49	1.84	48.16
14	Bahadurpur	Dekoli	26.0858	85.9225	2.09	47.91	1.59	48.41
15	Alinagar	Motipur, Antour	26.066	86.1668	1.18	43.82	0.56	44.44
16	Alinagar	Pirhauli	26.0752	86.2655	0.37	46.63	0.92	46.08
17	Ghanshyampur	Ahirainbasti	26.0715	86.3021	2.42	42.58	1.79	43.21
18	Ghanshyampur	Ghanshyampur	26.0616	86.326	1.95	45.05	1.05	45.95
19	Kiratpur	Rasiyari	26.0452	86.3478	3.35	42.65	2.39	43.61
20	GouraBouram	Bouram	25.9748	86.3175	3.44	44.56	2.14	45.86
21	Manigachi	Raghopur	26.1767	86.094	3.38	48.62	3.58	48.42
22	Manigachi	MakrandaBhandairSoump	26.1786	86.1344	5.8	50.2	5.25	49.75
23	Tardih	Nabbi Chowk	26.1538	86.1865	2.83	46.17	2.4	46.6
24	Tardih	Tardih/Sakatpur	26.1467	86.2513	3.01	43.99	1.91	45.09
25	Hanuman Nagar	Okhra	26.0373	85.8092	4.05	46.95	4	47

Annexure-III

Details of Exploratory Wells drilled by CGWB in Darbhanga district, Bihar.

Location	Depth Drilled (m bgl)	Granular Zones (m bgl)	Aquifer	Static Water Level (m bgl)	Discharge m^3/hr
Barhampur	152.50	90.00-96.00 102.00-108.00 129.00-135.00 138.00-144.00	Sand and Gravel	4.5	108.2
Rampura	153.02	72.00-84.00 108.00-114.00 144.00-150.00	Sand and Gravel	6.15	52.10
Sankar Rohar	202.56	92.00-98.00 110.00-116.00 140.00-158.00	Sand	-	-
Samadhpura	205.74	74.50-89.50	Sand	5.95	3.6
Deokoli Dham	171.61	63.00-72.00 92.00-104.00 125.00-134.00	Sand	3.8	46.8

Annexure- IV

Arsenic concentration from selective locations of Darbhanga district (Previous study)

Location	Longitude	Latitude	As (ppb)
Padh	86.04944444	25.98361111	35.9
Khangraitha-1	86.04083333	25.96666667	<5
Khangraitha-2	86.04083333	25.96666667	12.57
Khangraitha-3	86.04083333	25.96694444	6.3
Gangdah	86.04944444	25.98361111	24
Parari-1	86.155	25.97583333	6.5
Parari-2	86.155	25.97555556	24.4
Parari-3	86.15472222	25.97611111	95.6
Parari-4	86.15527778	25.97555556	20.4
Parari-5	86.155	25.97666667	17
Parari-6(a)	86.155	25.96666667	15.5
Parari-7	86.155	25.97694444	122
Parari-8	86.15416667	25.975	45.6
Parari-9	86.155	25.97583333	38.9
Parari-10(a)	86.155	25.97666667	102.8
Parari-11	86.15444444	25.97555556	18.06
Parari-12	86.155	25.97527778	47.18
Parari-13	86.15555556	25.97583333	<5.0
Bijulia	86.12361111	25.99	23.5
Sahoo-a	86.1575	25.9725	14.12
Sahoo-b	86.15722222	25.97277778	<5.0
Dumri	86.23083333	25.95083333	44.8
Paghari-1	86.00472222	25.99444444	<5.0
Paghari-2	86.00444444	25.99472222	21.26
Baghauni-1	86.05916667	25.93194444	28.5
Baghauni-2	86.93194444	86.05833333	22.6
Jaganathpur-1	86.12916667	25.89861111	70.5
Jagnathpur-2	86.12944444	25.89861111	20.82
Bairampur	86.12361111	25.915	13.4
Bairampur-1	86.12361111	25.915	17.36
Bairampur-2	86.12333333	26.05444444	<5.0
Bairampur-3	86.12361111	25.91472222	23.2
Bairampur-4	86.12361111	25.91472222	<5.0
Bairampur-5	86.12361111	25.91472222	14.6
Bairampur-6	86.12361111	25.91472222	18.4
Bairampur-7	86.12361111	25.91472222	21.5
Baheri	86.05027778	25.94611111	18.36
Naudaga	86.06111111	25.97583333	33.72
Gangdah	86.06916667	25.9925	<5
Sankar	86.09111111	26.0125	59.98

Rohar(Bithauli)			
Shiv Ngar-1	86.13555556	25.98333333	31.2
Shiv Ngar-2	86.13583333	25.98666667	28.58
Shiv Ngar-3	86.13527778	25.98722222	52.39
Shiv Ngar-4	86.13527778	25.98722222	51
Shiv Ngar-5	86.13527778	25.98722222	65.58
Parari-1a	86.15472222	25.97555556	26.8
Parari-2a	86.15416667	25.975	16
Parari-3a	86.15416667	25.97527778	36.2
Parari-4a	86.15416667	25.97555556	35.6
Parari-5a	86.15444444	25.975	30.2
Parari-6a	86.15444444	25.97527778	10.5
Parari-7a	86.15388889	25.975	50.4
Parari-8a	86.15388889	25.975	92.4
Sahoo-1	86.15666667	25.96194444	35.8
Sahoo-2 (Mahwa)	86.1575	25.96166667	98.4
Pokhram	86.20444444	25.93222222	46.5
Kamalpur	86.21555556	25.97527778	43
Dath	86.20416667	26.02861111	46.4
Benipur	86.13944444	26.0675	55.95
Bahera	86.11861111	26.06388889	52
Anandpur	85.9375	26.05666667	16.5
Tathopur	86.0325	25.97222222	<5
Adharpur-1	86.94194444	86.01472222	220.5
Majargahi	86.08	25.91666667	47
Jagannathpur	86.12916667	25.89861111	215.6
Jagannathpur	86.12888889	25.89944444	27.6
Mirjapur	86.12833333	25.90583333	29.4
Devkulidham-1	86.11138889	25.90611111	<5
Devkulidham-2	86.11138889	25.90555556	<5
Devkulidham-3	86.11111111	25.90583333	<5
Devkulidham-4	86.11166667	25.90555556	<5
ArjunaBijulia-1	86.11861111	25.91888889	<5
ArjunaBijulia-2	86.11916667	25.91888889	<5
ArjunaBijulia-3	86.11861111	25.91861111	<5
Kamar-1	86.1275	25.93694444	<5
Sauna (Sonadih)	86.13416667	25.12555556	<5
Lohini(Gaunara more)	86.13416667	25.12555556	<5
Dherukh	86.16333333	26.045	<5
Tirmuhani	86.11333333	26.02861111	<5
Turki	86.07111111	26.02833333	<5
Turki-1	86.07111111	26.02861111	<5
Turki-2	86.07055556	26.02833333	<5
Turki-3	86.07055556	26.02777778	<5
Turki-4	86.07111111	26.02777778	<5

Turki-5	86.07083333	26.02833333	<5
Atahi-1	86.05055556	26.03833333	41.12
Surhachatti-1	85.885	26.04972222	<5
Surhachatti-2	85.885	25.04972222	<5

Annexure-V

Lithological log of Exploratory wells

1. Location: Barahmpur, Block:Jale (drilled during current AAP)

Coordinates: 26.314945, 85.738798

Depth Drilled : 152.5 m

Depth (in m bgl)		Thickness (in m)	Lithology
From	To		
0.00	7.50	7.5	Top soil - very fine, yellowish brown, sticky clay
7.50	24.25	16.75	Gravel-poorly sorted, angular granules, grey
24.25	30.50	6.25	Gravel-Mixed with fine sand,grey
30.50	33.75	3.25	Clay- Mixed with gravel, yellowish grey
33.75	36.75	3	Gravel-Mixed with fine sand,grey
36.75	46.25	9.5	Gravel- Medium, poorly sorted, angular, grey
46.25	58.75	12.5	Gravel-Mixed with sand,poorlysorted,grey,angular
58.75	65.00	6.25	Clay-Mixed with gravel,fine, yellowish grey
65.00	71.25	6.25	Gravel- Mixed with fine sand and mud; poorly sorted, pale grey
71.25	74.25	3	Sand - Medium grained, mixed with gravel,poorly sorted, grey
74.25	90.00	15.75	Sand - Medium grained, well sorted, grey
90.00	102.50	12.5	Sand - Medium to coarse grained, grey
102.50	105.50	3	Sand - coarse grained, mixed with mud, well sorted, yellowish grey
105.50	115.00	9.5	Sand- medium to coarse grained, poorly sorted
115.00	124.25	9.25	Sand- Fine to medium grained
124.25	133.75	9.5	Sand- Medium grained
133.75	143.00	9.25	Sand- Coarse grained
143.00	152.50	9.5	Sand- coarse to very coarse grained

2. Location: Rampura, Block: Singhwara (drilled during current AAP)

Coordinates: 26.170508, 85.7397

Depth Drilled : 153.02 m

Depth (in m bgl)		Thickness (in m)	Lithology
From	To		
0.00	3.00	3	Top soil/ Clay, Dark grey in colur, sticky
3.00	8.50	5.5	Clay, Brownish grey in colour
8.50	18.70	10.2	Gravel-Mixed with fine sand,grey Gravel, brownish grey in colour, sub rounded grain moderately sorted
18.70	22.21	3.51	Gravel mixed with clay, yellowish brown colour, well sorted
22.21	25.21	3	Gravel, yellowish brown colour, poorly sorted
25.21	28.51	3.3	Gravel, yellowish brown colour, well sorted
28.51	34.76	6.25	Gravel mixed with very fine sand, yellowish grey colour, moderately sorted sub angular grain
34.76	41.06	6.3	Sand medium grain, greyish white in colour
41.06	50.31	9.25	Sand fine grain, greyish yellow in colour
50.31	56.56	6.25	Sand, medium grain, greyish white in colour
56.56	71.91	15.35	Sand, fine grain, dark grey in colour
71.91	74.91	3	Sand, medium grain, yellowish grey in colour
74.91	78.16	3.25	Sand medium grain, grey in colour
78.16	84.41	6.25	Sand, medium to coarse , grey colour
84.41	87.41	3	Sand, medium grain, in colour
87.41	109.01	21.6	Sand, fine grain, greyish white in colour
109.01	115.26	6.25	Sand, medium grain, yellowish grey in colour
115.26	140.52	25.26	Sand, fine grain, greyish white in colour
140.52	146.77	6.25	Sand, medium to coarse grain, greyish white in colour
146.77	153.02	6.25	Sand, medium grain, greyish white in colour

3. Location: Sankar Rohar, Block: Singhwara (Previously drilled EW of CGWB)

Coordinates: 26.022, 86.078

Depth Drilled : 205.04 m

Depth (in m bgl)		Thickness (in m)	Lithology
From	To		
0.00	6.50	6.50	Clay- Yellow Plastic clay, with construction stone cutting
6.50	12.72	6.22	Sand-Grey, medium grained
12.72	25.10	12.38	Clay- Grey sticky clay with kankar nodules>60%
25.10	62.46	37.36	Sand-Grey, fine sand, well sorted
62.46	78.14	15.68	Clay- Grey sticky clay with kankar nodules
78.14	93.60	15.46	Sand- Medium to fine sand, mixed with kankar, clay parting
93.60	103.60	10.00	Sand-Fine sand
103.60	109.28	5.68	Sand- Grey, fine-medium grained sand
109.28	124.74	15.46	Clay-grey, mixed with fine sand
124.74	143.24	18.50	Sand- Fine grey sand mixed with kankar
143.24	155.72	12.48	Clay-Grey, clay mixed with fine sand layers
155.72	161.94	6.22	Silt- Gray silty clay
161.94	174.40	12.46	Sand- Grey fine sand, 20% coarse sand and kankar
174.40	193.10	18.70	Sand- Light yellow fine sand with clay parting
193.10	202.56	9.46	Clay-Yellow sticky clay with kankar

4. Location: Samadhpura, Block: Baheri (Previously drilled EW of CGWB)

Coordinates: 25.9494, 86.0331

Depth Drilled: 205.74m

Depth (in m bgl)		Thickness (in m)	Lithology
From	**To**		
0.00	6.00	6	Clay, Brownish grey in colour
6.00	15.5	9.5	Sand-Grey, medium grained
15.5	35.5	20	Clay- Grey sticky clay with kankar nodules>60%
35.5	55.25	19.75	Sand-Grey, fine sand, well sorted
55.25	96.5	41.25	Clay- Grey sticky clay with kankar nodules
96.5	112.75	16.25	Sand- Medium to fine sand, mixed with kankar, clay parting
112.75	126.40	13.65	Sand-Fine sand
126.40	140.4	14	Sand- Grey, fine-medium grained sand
140.4	152.25	11.85	Clay-grey, mixed with fine sand
152.25	170.5	18.25	Sand- Fine grey sand mixed with kankar
170.5	189.25	18.75	Clay-Grey, clay mixed with fine sand layers
189.25	205.74	16.49	Clay- Gray silty clay

5. Location: Deokoli Dham, Block: Biraul (Previously drilled EW of CGWB)

Coordinates: 25.9161, 86.1323

Depth Drilled: 172 m

Depth (in m bgl)		Thickness (in m)	Lithology
From	To		
0.00	4.5	4.5	Clay, Brownish grey in colour
4.5	12.8	8.3	Sand-Grey, medium grained
12.8	38.2	25.4	Clay- Grey sticky clay with kankar nodules>60%
38.2	55.72	17.52	Sand-Grey, fine sand, well sorted
55.72	90.5	34.78	Clay- Grey sticky clay with kankar nodules
90.5	112.75	22.25	Sand- Medium to fine sand, mixed with kankar, clay parting
112.75	138.72	25.97	Sand-Fine sand
138.72	148.25	9.53	Clay-grey, mixed with fine sand
148.25	165.25	17	Sand- Fine grey sand mixed with kankar
165.25	171.61	6.36	Clay- Gray silty clay

6. Location: Iuiuar Bisual, Block: Manigachhi (Well drilled by State Govt.)

Coordinates: 26.20527, 86.18388

Depth Drilled: 139 m

Depth (in m bgl)		Thickness (in m)	Lithology
From	To		
0	14.02	14.02	Dark grey silty clay
14.02	23.77	9.75	Sand- Grey, very fine to fine grained
23.77	31.7	7.93	Silty Clay- yellow, medium plasticity
31.7	33.83	2.13	Sand- Grey, fine to medium sand with excess of mica
33.83	37.19	3.36	Sand- Grey, Medium grained
37.19	57.91	20.72	Clay- Sticky, yellow
57.91	61.87	3.96	Sand – Grey, very fine grained
61.87	73.46	11.59	Clay- Greyish yellow, sticky clay
73.46	76.50	3.04	Sandy Clay- Yellowish
76.50	105.16	28.66	Sand- Grey, fine to medium grained
105.16	115.82	10.66	Clay- Dark grey, silty clay
115.82	133.20	17.38	Sand- Grey, Medium to coarse grained
133.20	136.86	3.66	Sand – Grey, fine grained
136.86	139.29	2.43	Clay- Dark grey, Silty Clay with boulder

7. Location: Manimum, Block: Benipur (Well drilled by State Govt.)

Coordinates: 26.0583, 86.14722

Depth Drilled: 96 m

Depth (in m bgl)		Thickness (in m)	Lithology
From	To		
0.0	7.92	7.92	Clay- Dark grey, silty Clay
7.92	18.59	10.67	Sand- very fine, grey, silty
18.59	30.18	11.59	Sand- Grey, fine to medium grained
30.18	36.88	6.7	Clay- Dark grey, sticky
36.88	42.98	6.1	Sand- Grey, fine grained
42.98	58.22	15.24	Sand- Medium to Coarse grained
58.22	67.36	9.14	Sand- Grey, fine sand
67.36	70.41	3.05	Clay- Grey, clayey medium to fine sand with carbonate nodules and mica
70.41	93.57	23.16	Sand- Grey, Medium grained
93.57	95.71	2.14	Sand- Grey, fine grained

Annexure-VI

Results of chemical analysis of Groundwater collected from Darbhanga district (May 2022)

S.no	BLOCK	LOCATION	Lat	Long	Source	pH	EC	TDS	TH	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	NO_3^{-}	SO_4^{2-}	F^{-}	$PO4^{3-}$	SiO_2	U (in ppb)
1	Singhwara	Atarbel	26.1675	85.7432	Dugwell	8.01	1098	713.7	135	36	11	210	0.1	0	500	71	25	54	1.01	0.06	11	11.137
2	Singhwara	Bharwara	26.2644	85.728	Tubewell	8.29	499	324.35	95	30	5	62	1.89	0	256	11	0.64	9.74	0.26	0.05	11.2	1.714
3	Jale	Hiranagar Chowk	26.3980	85.7285	Tubewell	8.25	427	277.55	65	24	1	61	1.87	0	244	18	0.3	8.25	0	0	5.5	0.272
4	Jale	Kamtaul	26.3358	85.8233	Dugwell	7.92	902	586.3	210	52	19	78	10	0	378	53	19	8.25	0.11	0	8.1	4
5	Keoty	Pindaruch	26.2466	85.8565	Tubewell	7.24	469	304.85	80	14	11	72	1.4	0	238	14	2.06	25	0	0	8.7	0.806
6	Darbhanga Sadar	Sonki (Chikni)	26.1214	86.022	Tubewell	8.25	480	312	55	20	1	71	1.23	0	220	14	0.84	12	0.03	0	7.9	0
7	Benipur	Bheruk	26.0527	86.1653	Dugwell	7.94	1301	845.65	420	88	49	100	20	0	415	124	85	97	0.49	0	8.4	0.015
8	Biraul	AfzalaBalia	25.9297	86.2313	Tubewell	8.03	539	350.35	125	28	13	61	2.6	0	250	11	1.38	40	0.41	0.13	9.8	0
9	Biraul	Ucchti	25.9188	86.2505	Tubewell	7.96	528	343.2	95	24	9	72	6.92	0	207	64	1.02	7.6	0	0	9.7	5.868
10	KusheshwarAsthan	Sultanpur	25.8522	86.28	Tubewell	7.91	608	395.2	145	32	16	51	3.77	0	329	21	4.11	21	0.39	0	11.4	1.105
11	KusheshwarAsthan Purbi	Khalasi	25.8063	86.3097	Tubewell	8.02	442	287.3	135	40	9	29	4.83	0	189	18	1.77	22	0.1	0	12	0.443
12	KusheshwarAsthan (Satighat)	Asho	25.8747	86.2447	Dugwell	7.85	3330	2164.5	535	162	32	175	280	0	1049	376	98	165	0	0	14	6.89
13	Bahadurpur	BahadurpurDakli Panchayat	26.1085	85.9085	Tubewell	8.14	871	566.15	210	30	33	84	6.32	0	312	78	10	35	0.24	0	13	0.9
14	Bahadurpur	Rampur Madan	26.1063	85.9108	Tubewell	7.93	775	503.75	210	64	12	77	1.67	0	378	30	0.61	54	1.01	0	11	13.054
15	Bahadurpur	Dekoli	26.0858	85.9225	Tubewell	8.07	575	373.75	135	32	13	67	2.58	0	293	18	8.5	12	0.72	0	14	1.129
16	Alinagar	Motipur, Antour	26.066	86.1668	Tubewell	8.27	628	408.2	110	26	11	92	2.06	0	336	18	1.4	8	0.68	0.63	12	0
17	Alinagar	Pirhauli	26.0752	86.2655	Tubewell	8.19	724	470.6	190	60	10	77	1.13	0	403	11	1.5	8.04	0.52	0	10	0.292
18	Ghanshyampur	Ahirainbasti	26.0715	86.3021	Tubewell	8.25	729	473.85	185	58	10	76	2.07	0	397	14	1.43	8.7	0.77	0	9.83	0.021

19	Ghanshyampur	Ghanshyampur	26.0616	86.3260	Tubewell	8.2	717	466.05	205	60	13	67	2.75	0	397	11	12	7.5	0.83	0	7.7	0
20	Kiratpur	Rasiyari	26.0452	86.3478	Tubewell	8	529	343.85	50	16	2	68	3.35	0	287	11	1.13	5.7	0.17	0	8.13	0
21	GouraBouram	Bouram	25.9748	86.3175	Tubewell	7.85	1143	742.95	400	130	18	77	1.2	0	464	78	25	56	0	0	8.95	8.51
22	Manigachi	Raghopur	26.1767	86.094	Dugwell	8.24	575	373.75	115	28	11	75	0	0	293	14	0.63	15	0.28	0.33	9.03	0.66
23	Manigachi	MakrandaBhandairSoump	26.1786	86.1344	Dugwell	7.86	1113	723.45	380	108	27	80	0	0	549	60	2.53	16	0	0	11	0.68
24	Tardih	Nabbi Chowk	26.1538	86.1865	Tubewell	8.21	928	603.2	285	86	17	82	0	0	525	11	1.43	12	0.49	0	13	0.46
25	Tardih	Tardih/Sakatpur	26.1467	86.2513	Tubewell	8.23	790	513.5	230	72	12	78	0	0	421	21	11	10	0.79	0	12	0
26	Hanuman Nagar	Okhra	26.0373	85.8092	Tubewell	7.76	538	349.7	175	40	18	32	8.08	0	262	28	0.23	8	0	0	12	5.23
27	Tardih	Kathra	26.1382	86.2233	Pond	7.98	883	573.95	165	48	11	92	28.6	0	281	124	11	23	0.32	0	13	3.81
28	Manigachhi	Belaur	26.2041	86.1395	Pond	7.77	1060	689	225	64	16	95	36.3	0	458	85	20	10	0.42	0	11	1.04
29	Ghanshyampur	Pohdi	26.0805	86.2857	Pond	7.92	1335	867.75	375	130	12	84	40	0	555	121	15	19	0.76	0.21	11	1.42
30	Bahadurpur	Dekoli	26.0858	85.9225	Pond	7.82	1631	1060.15	550	196	15	86	33	0	622	188	17	28	0.15	0	7	2.04
31	Darbhanga Sadar	Darbhanga Sadar	26.17612	85.89903	DW	6.8	793	515.45	260	56	29.16	57.83	9.6	0	311.1	39.05	28.55	55.61	1.22	0.12	8.7	91.2
32	Keoty	Darima	26.29007	85.94157	DW	7.5	1290	838.5	355	60	49.815	112.09	34.6	0	420.9	205.9	5.8	4.83	0.55	0.24	11.5	11.68
33	Benipur	Bahera (Brahmnath chogma)	26.07519	86.13202	Dugwell	8.18	1113	723.45	415	104	37.665	56.23	13.51	0	488	85.2	5.35	29.14	0.94	0.21	12.7	3.13
34	Baheri	Baheri	25.95065	86.05076	Dugwell	8.06	1090	708.5	400	98	37.665	62.12	6.54	0	390.4	117.15	3.76	53.34	1	0.14	11.5	4.68
35	Baheri	Bithauli	26.01112	86.08747	Dugwell	8.35	703	456.95	135	18	21.87	96.57	6.57	0	170.8	113.6	6.58	41.6	0.77	0.11	9.5	0.98
36	Baheri	Jorja	26.01252	85.98904	Dugwell	8.11	1302	846.3	275	42	41.31	150.32	39.71	0	481.9	117.15	7.04	78.21	1.05	0.16	10.7	13.18
37	Hayaghat	Pouram	26.01952	85.89156	Dugwell	7.9	1876	1219.4	505	118	51.03	141.14	99.54	0	610	188.15	30.51	137.12	1.04	0.25	11.4	25.61
38	Hayaghat	Rustampur	26.01595	85.88109	Dugwell	7.65	1150	747.5	345	58	48.6	80.7	41.21	0	427	88.75	25.58	75.14	1.16	0.19	9.1	12.83
39	Sakri	Sakri	26.22378	86.07729	Tubewell	7.91	789	512.85	320	74	32.805	31.06	4.51	0	335.5	56.8	1.13	36.45	0.78	0.11	4.6	6.13

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Disclaimer

The Report has been prepared based on the available data, observations from fields and discussion with the local farmers. Additional data, incorporated in future, may change the understanding of hydrogeological scenario of the area.