केन्द्रीय भूमि जल बोर्ड

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भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development and Ganga Rejuvenation,

Ministry of Jal Shakti

Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

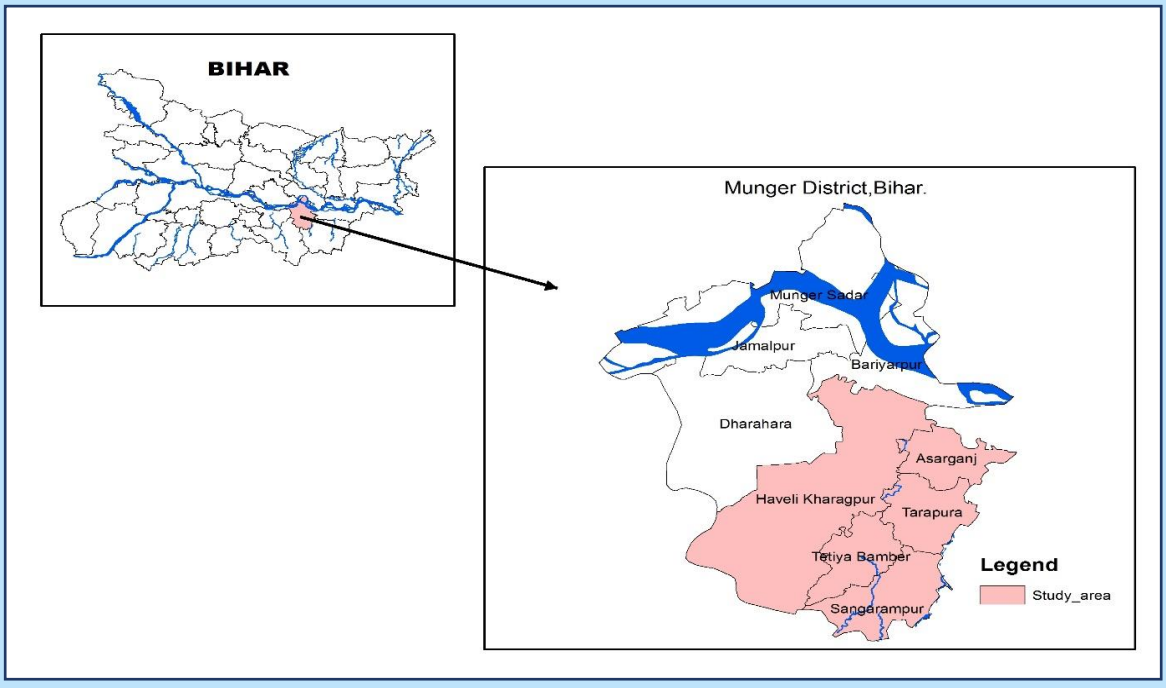
In Parts of Munger District, Bihar

मध्य पूर्वी क्षेत्र, पटना

Mid Eastern Region, Patna

Government of India
Ministry of Jalshakti
Central Ground Water Board
Department of Water Resources, River Development and Ganga Rejuvenation

AQUIFER MAPPING AND MANAGEMENT PLAN IN PARTS OF MUNGER DISTRCT, BIHAR (AAP 2019-20)



Mid-Eastern Region, Patna

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Introduction

Munger district in Bihar lies in the southern parts of the State and on the south bank of River Ganga. Geo-morphologically and geologically the district is characterized by flat alluvial plains and undulating hilly tracts. Kharagpur hill stands as a distinct land form in the district. The district is rural one and people are largely depending on agriculture. The district represents water scares hard rock terrain as well as alluvial plain with abundant land and water resources. The fissured formation in hard rock area and porous formation in alluvial tracts broadly constitutes the hydrogeological frame work of the district. So far, the scope for irrigation development in the district is moderate.

Total geographical area of the district is 1420 sq km. National Aquifer Mapping in Munger district was undertaken by CGWB, MER, Patna during 2016-2017 under phase III where 762 sq km was covered.
Under the Annual Action Plan of 2019-20 of CGWB, MER, Patna, aquifer mapping program and subsequent formulation of management plan were undertaken in the remaining 5 blocks comprising an area of 660 sq km.
The present report is a compilation of block wise picture of geology, geomorphology, water level, ground water development, aquifer disposition and management plan for further sustainable development of water resources in the district. In absence of exploratory well data in few blocks of the district, the aquifer dispositions of the adjacent blocks have been presented. There exists further scope for detail aquifer disposition in prevalence of sufficient lithological data.

AQUIFER MAPS AND MANAGEMENT PLAN OF ASARGANJ BLOCK, MUNGER DISTRICT, BIHAR

Salient Information

Name of the Block/Area	Asarganj / 59.48 sq. km
District/State	Munger/Bihar
Population	Total- 74380 Rural- 68053 Urban- 6327
Rainfall	Normal Monsoon- 970.80 Non-monsoon rainfall- 202.80
Agriculture and Irrigation	Principal crops - Rice – Wheat, Rice – Gram, Rice – Lentil, Rice – Rai Gross cropped area- 4784 Net sown area- 3659 Irrigation practices- Surface water by canal -Ground water by tube well and LDTW Cropping intensity- 131%, Number and types of abstraction structures – STW- 578, MDTW-179, DTW- 74
Geology	Older alluvium
Geomorphology	Major Physiographic units- Alluvial plain Major Drainage- Ganga, Badua-Chandan, Sunder-Gumani Sub basin
Ground water resource availability and extraction	Annual Ground Water Resource (Ham)-1949 Net Ground Water Availability for future use (Ham)- 655.46 Ground water extraction (Ham)- 1275.05
Existing and future water demand	1275 Ham/168.43 Ham (annual GW allocation for domestic as on 2025)

Water level behaviour	Pre-monsoon SWL- 3.79-7.63 mbgl Post-monsoon SWL- 2.60-6.70 mbgl

2. Aquifer Disposition

Number of Aquifers	02; up to the explored depth of 60m
Aquifer disposition and basic characteristics	1st Aquifer from 19m to 27m, fine sand mostly phreatic, 2nd Aquifer from 30m to 48m, medium to coarse sand, Semi-confined to Confined

3. Ground water resource, extraction, contamination and other issues

GW Resource/Categorization	Safe
Availability	
Chemical quality of ground water and contamination	Potable The block has been reported with fluoride contamination in ground water

4. Supply Side Interventions

Ground Water Development Strategies-	Number of STW and DTW may be proposed for irrigation uses- STW-28, DTW-05
Aquifer wise space available for recharge and proposed interventions	As per ARMP, 2020, for Munger district 345.84 sq km is suitable for recharge, Volume of de-saturated zone 193 MCM. Percolation tanks, desilting of existing tanks, check dam , renovation of Ahar-Pyne system etc. are some suitable structures in the area

5. Demand side interventions

Advanced Irrigation Practices	Project based drip/sprinkler irrigation, lining of field channels etc.
Change in cropping pattern	Less water intensive crop like pulses, oilseeds may be encouraged.
Alternate water sources	Conjunctive uses of groundwater/surface water sources,
Regulation and Control	Capacity building for awareness generation for fluoride contamination.

1.0 General Information

1.	Total area		:	59.48 sq. km
2.	Total number of Panchayat		:	07
3.	Total number of villages		:	73
4.	Population (Census 2011)	Total	:	74380
		Rural	:	68053
		Urban	:	6327
5.	Normal annual rainfall		:	1173.6 mm
6.	Basin / Sub-basin		:	Ganga Basin / Badua-Chandan, Sunder-Gumani Sub basin
7.	Location			
	Latitude		:	25.13931 to 25.21622
	Longitude		:	86.61946 to 86.73558

Asarganj is a block in Munger district of Bihar State, India. Asarganj block head quarter is in Asarganj town. It belongs to Munger sub-division. Asarganj block is located between 25.139031, 25.216220 latitude and 86.619461, 86.735580 longitude**.** The block is surrounded in the north by Bariarpur block, in the south by Tarapur block and in the west by Kharagpur block and in the east by Sultanganj block of Bhagalpur district (*Fig-1*).

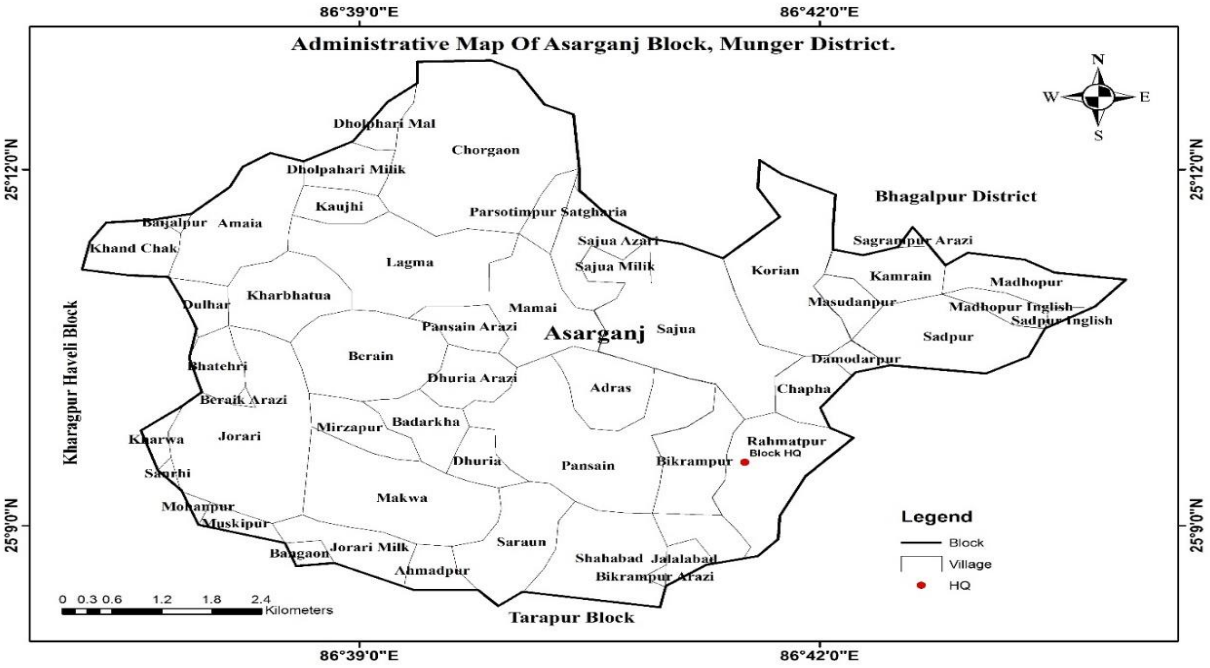

Fig-1 Administrative Map of Asarganj Block, Munger District

1.1 Basic demographic detail of Asarganj block (Census 2011)

As per census 2011 the total population of Asarganj block is 74380 among which 6327 people live in urban area that is 8.50% of total population *(Table 1A)*. Therefore, the block is a rural one.

Table 1A- Population of Asarganj block

	Rural Population	Urban Population	Total
Block	68053	6327	74380

The block consists of 07 Gram Panchayats, 73 villages and 14,589 households *(Table 1B)*.

Table 1B- List of panchayat wise villages of Asarganj block

Sl. No.	Panchayat	Village
1	AMAIYA.	9
2	ASARGANJ	2
3	CHORGAON	8
4	JORARI	8
5	MAKWA	12
6	RAHAMATPUR	22
7	SAJUA	12
	Total	**73**

1.2 Rainfall and Temperature

Normal annual rainfall of Asarganj block is 1173.6 mm of which 85.46% occurs during the monsoon season. The normal rainfall during monsoon season is 822.2 mm and during non-monsoon season is 76.8 mm. The variation of rainfall in this zone is from 1173.6 mm to 899.0 mm and the temperature varies from 44 to 6˚C.

1.3 Distribution of persons engaged in agriculture and other workers/ non workers in the block

In Asarganj block, 65% of total population is non workers. It is evident from below diagram that 20% of the total population in the block is engaged in agriculture, 4% are cultivator, 2% comprises household industrial workers and 9% comprises other worker (*Fig-2*).

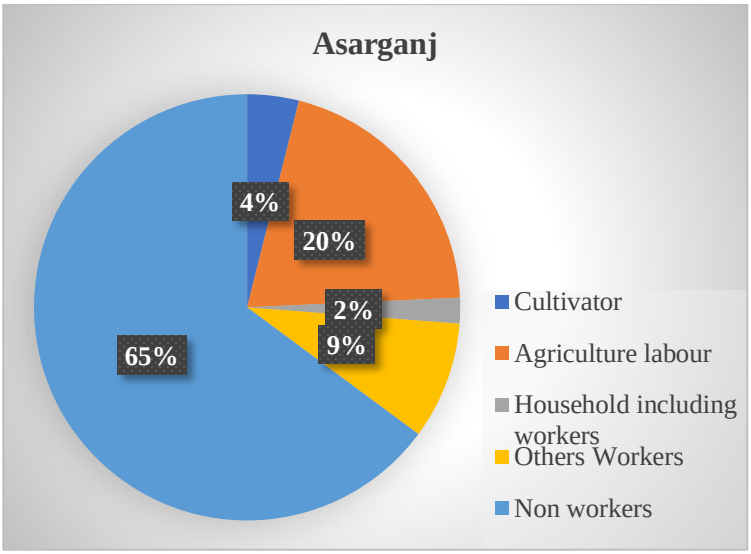

Fig 2- Distribution of persons engaged in Asarganj block

Source- Census 2011

1.4 Soil

Asarganj block contains mainly calcareous sandy soils, coarse loamy soils, fine loamy Soils, clayey soils with pH in the range of 6.8 – 8.0 (*Fig-3*)

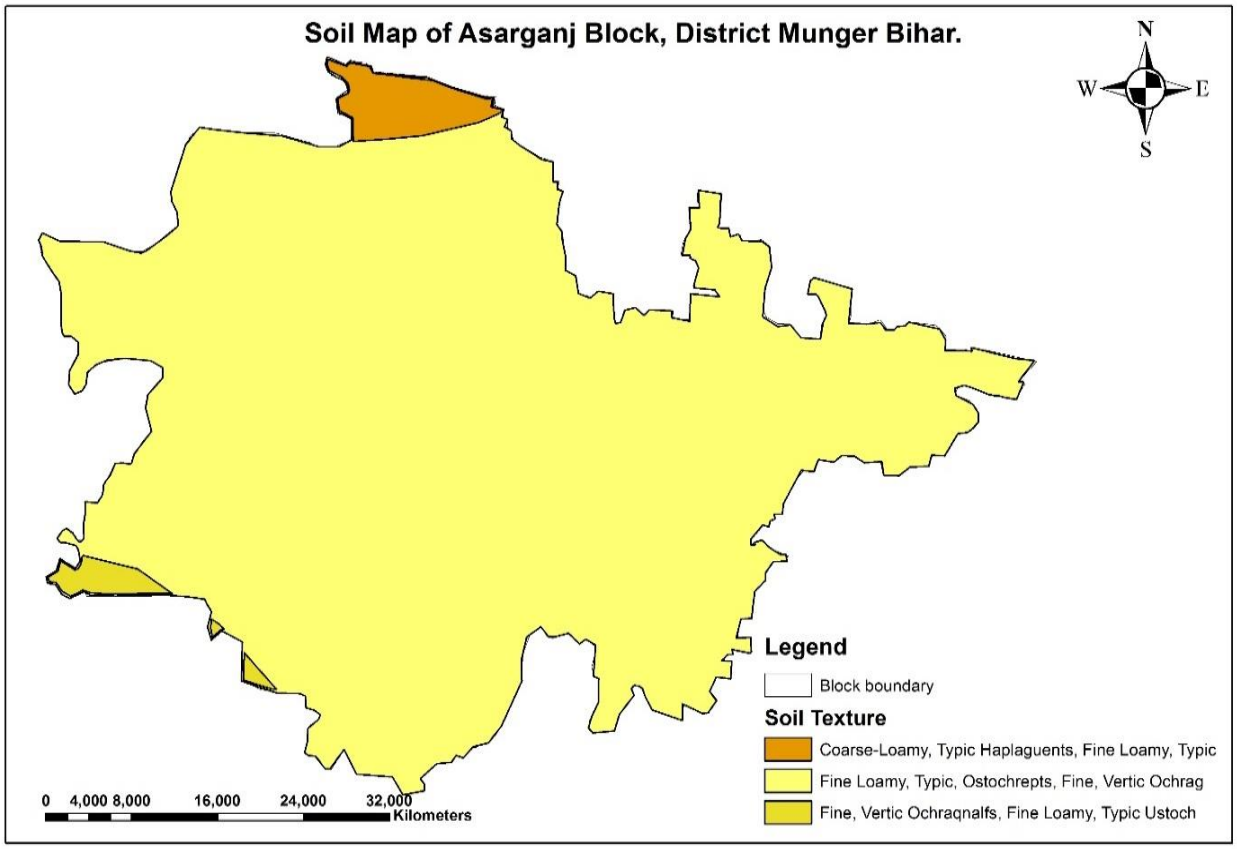

Fig -3 Soil Map of Asarganj block, district Munger, Bihar

1.5 Physiographic, Basin/sub-basin, and Drainage:

The Asarganj block forms a part of Badua-Chandan, Sunder-Gumani sub-basin of the Ganga Basin. The block is having moderate to low drainage density. Parallel to sub-parallel drainage patterns are dominating in the block. Major rivers of the district are Ganga, Man, Belharni and Mahana. Except the Ganga River, all are ephemeral in nature, having meager water during lean periods.

The block having average elevation of 44 meters (144 feet). Asarganj block represent a flat terrain and the entire block is with land slope of 0-3%.

1.6 Geomorphology

The block is underlain by older alluvial deposits and it is made up of sediments derived from the denudation of Chota Nagpur Plateau and Kharagpur Hills (*Fig- 4*).

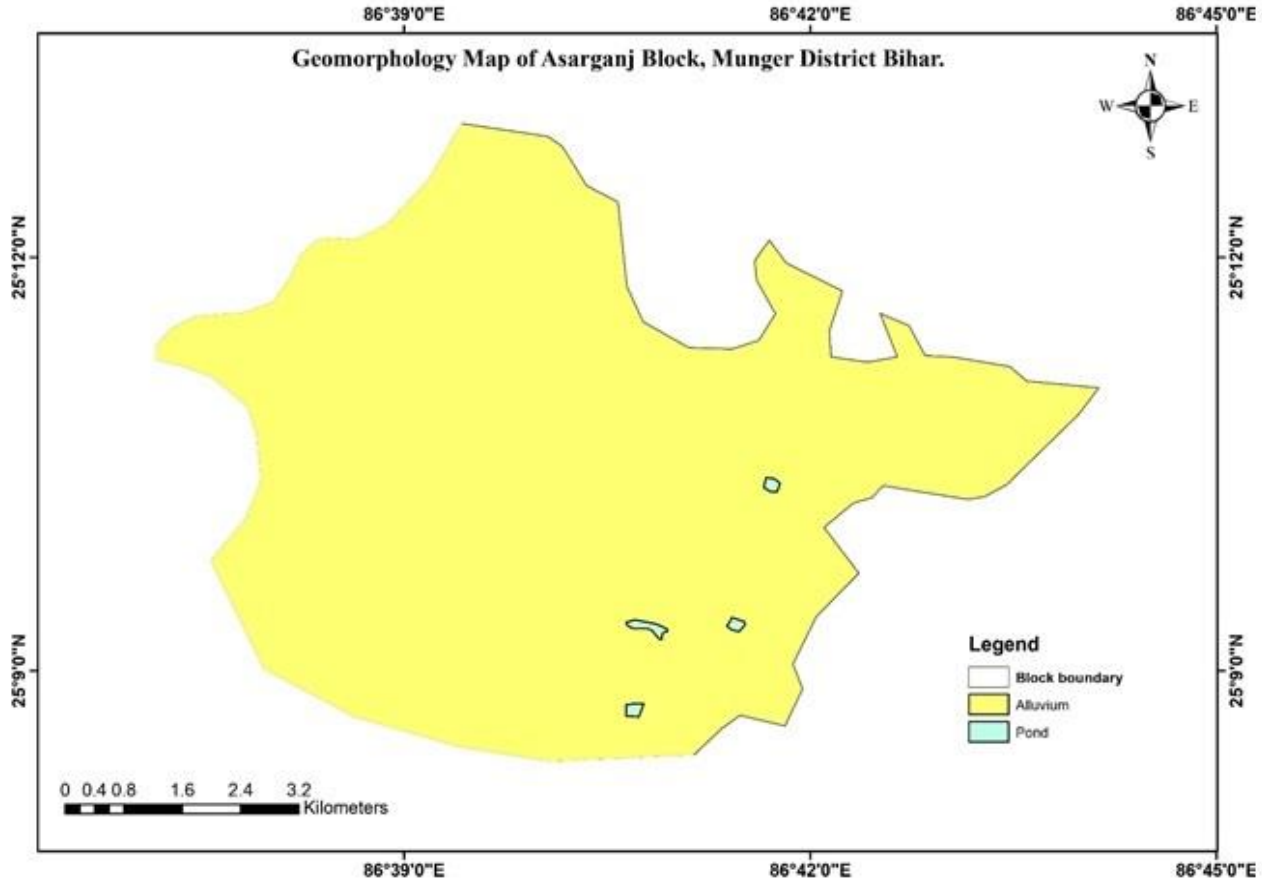

Fig 4- Geomorphology Map of Asarganj block

1.7 Land use pattern

Total geographic area of the Asarganj block is 5948 ha among which net sown area 3659 ha and gross cropped area is 4785 ha. Therefore, area under multiple cultivation is 1125 ha and 2255 ha area is under waste land. It is evident that net sown area comprises 61.51% of total geographical area in the block and 18.91% area

under multiple cultivation. A considerable part of the block, 37.9% of total area, is under waste land. The cropping intensity of the block is 131% *(Table 1C)*.

Table 1 C- Details of Land use pattern of block (area in ha)

Name of the block	Total Geographical area	Gross cropped area	Net sown area	Area sown more than once	Cropping intensity	Area under forest	Area under wasteland	Area under other uses
Asarganj	5948	4784	3659	1125	131 %	0	2255	0

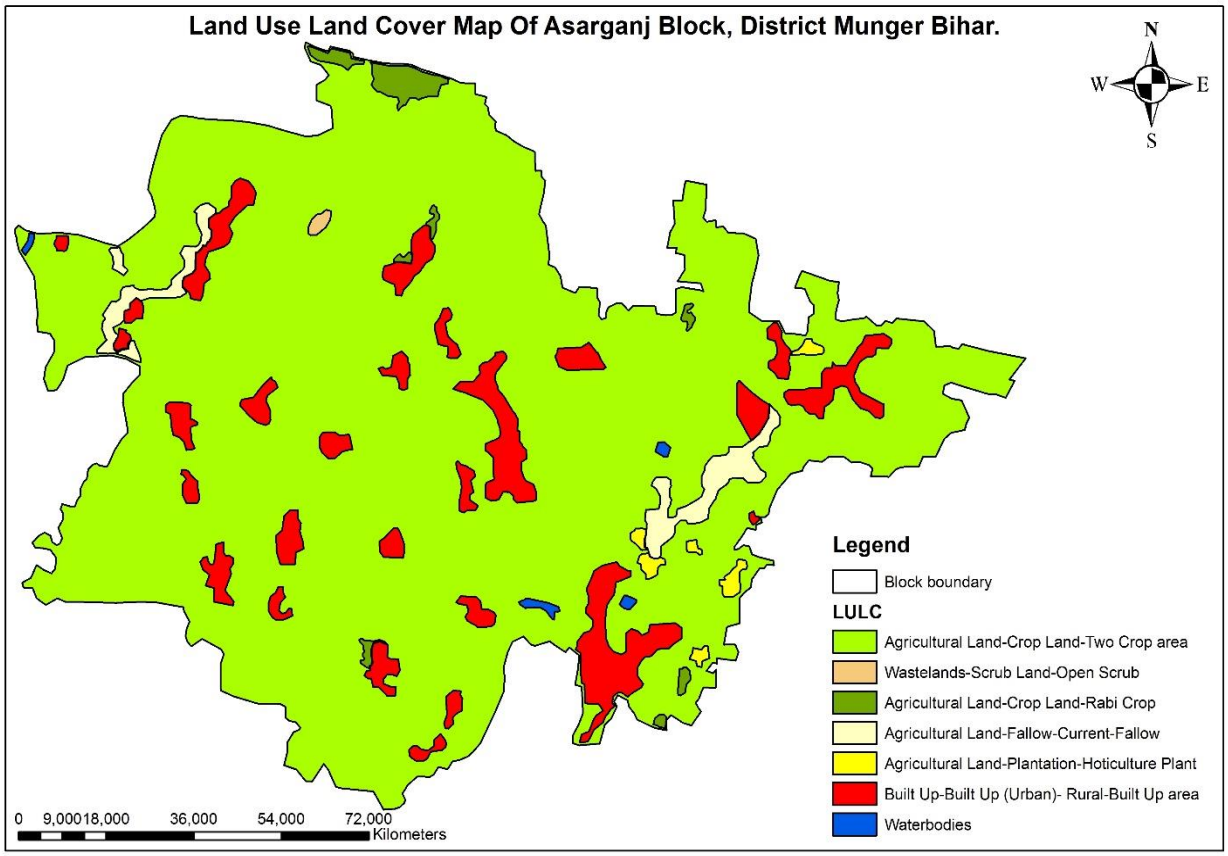

Fig 5- LULC Map of Asarganj block

1.8 Agriculture and Irrigation

Asarganj block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice – Wheat, Rice – Gram, Rice – Lentil, Rice – Rai. Out of the total area under cultivation in the block, 48.8 percent area (5948 ha) is covered by cereals crop during Kharif season, 15.4 percent during Rabi season and 0.1

percent during summer season. The irrigation by surface water canals is provided in Asarganj block, besides a large area is irrigated by ground water irrigation by tube wells and large diameter dug wells. Majority of the ground water structures are fitted with diesel-operated pumps. The numbers of irrigation structure as per 5thMI Census are presented in *(Figure-6).*

Table 1D- of MI structure in Asarganj block

DW	STW	MTW				DTW
		35-40m	40-60m	60-70m	TOTAL	
1	578	1	175	3	179	74

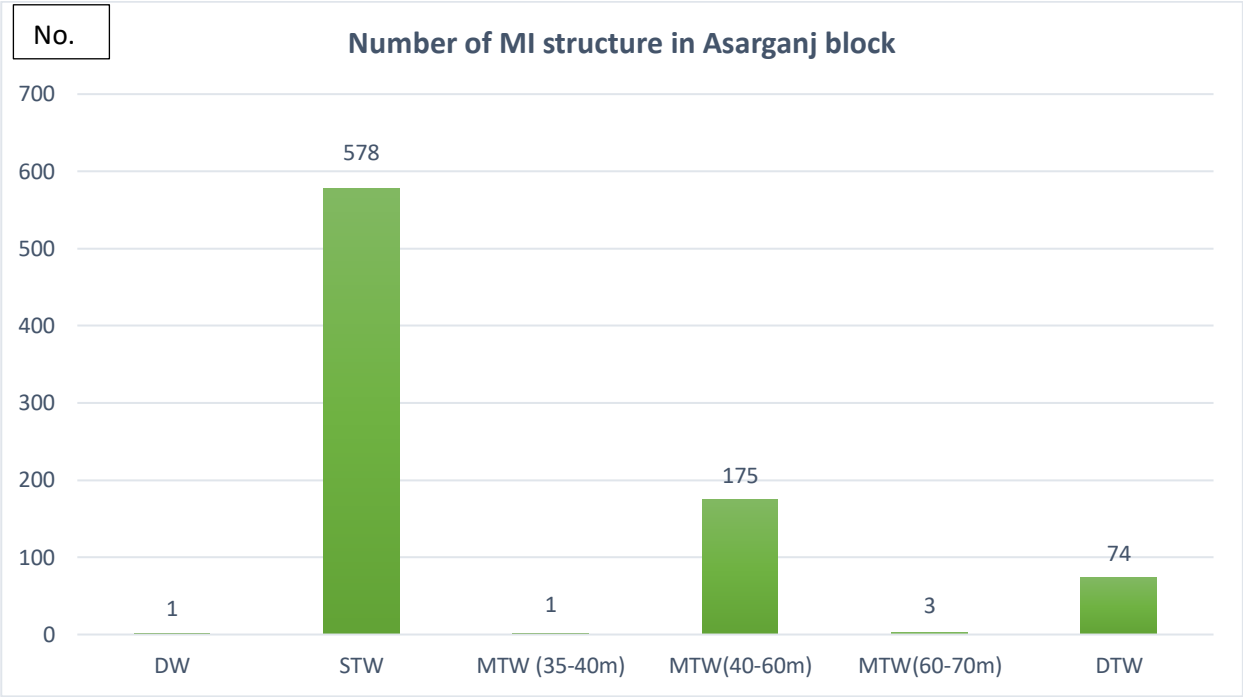

Fig 6- No. of MI structure in Asarganj block

2.0 Geology

The major parts, southern and central parts of the block are covered by older alluvium deposit of Quaternary period which comes under Belhar Formation of middle Holocene age. In the northern parts few area is under younger alluvial deposits of Ganga-Kosi Formation of Middle to upper Holocene age. The nature and characteristics of these formations is semi unconsolidated and consist of fine sand feebly oxidized. It is underlain by Precambrian formation. The average thickness of this alluvium in this block is about 45m (fig -7).

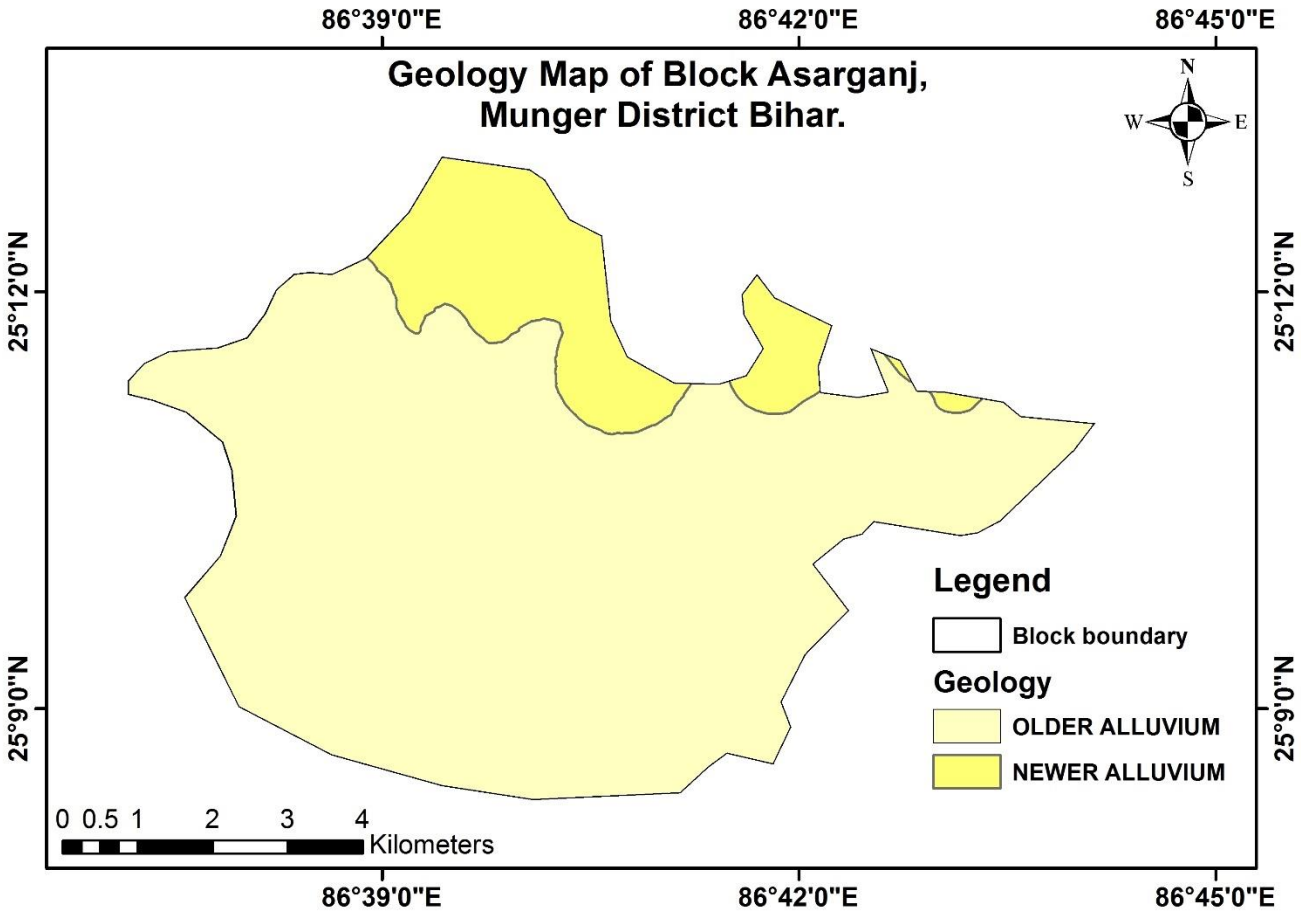

Fig 7- Geology Map of Asarganj block, District Munger Bihar

3.0 Hydrogeology

The block is having older alluvium unconsolidated / porous formation. The Quaternary alluvium constitutes this hydrogeological unit and occupies all part of the block and below the alluvial part hard granitic basement is encountered at the depth of 70-80 m approximately. On the basis of occurrence of potential fracture granitic rocks may constitute potential aquifer also. Generally, aquifers in this block are under unconfined to semi-confined conditions. Yield ranging from 10 to 100 m^3/hr. Average discharge of STW/MDTW and DTW may safely be assumed as 25m^3/hr and 50 m^3/hr respectively.

3.1 Aquifer Disposition

In absence of exploratory well data in the block, lithologs of the adjacent blocks have been used to decipher aquifer disposition in Asarganj block. Using the lithology of exploratory wells drilled at Ramankabad, Khaira and Bamber, a cross section has been prepared. Cross section shows two aquifer layers separated by clay layers. The 1st aquifer is about 10 m thick at Ramankabad and about 20 m thick at Bamber. 2nd aquifer, comprising medium to coarse sands constitute the principal water bearing zone in the area. The coarse sands layer is often underlain by hard crystalline granitic rock. Section depicting the aquifer is shown below (fig 8).

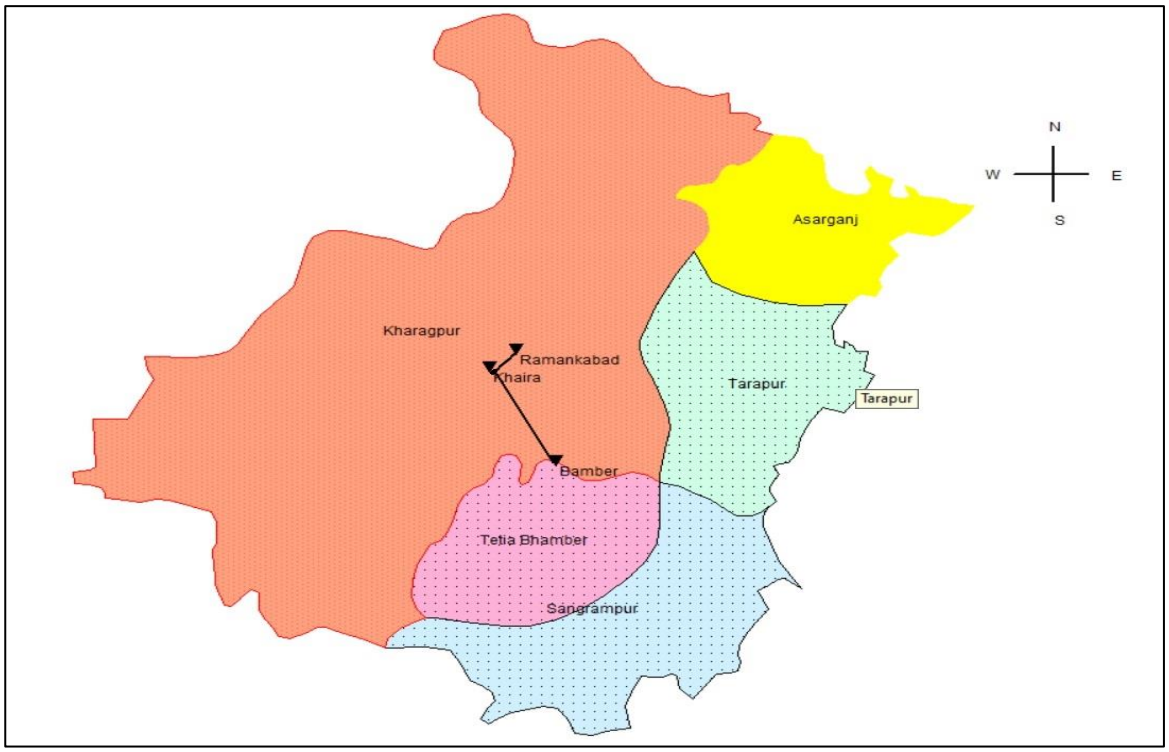

Fig.8a Location of the boreholes

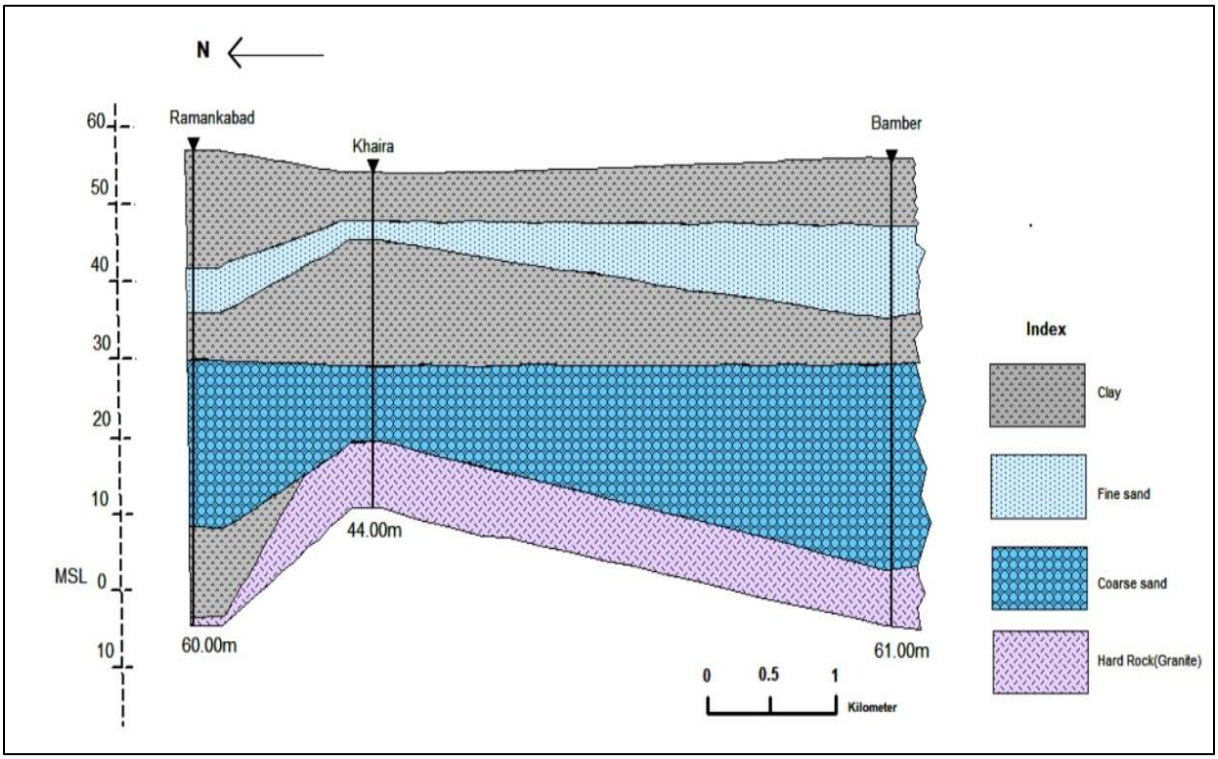

Fig 8b- Diagram showing Aquifer disposition

3.2 Water Level Behaviour

The Ground water regime of the block has been monitored from the existing network monitoring wells and inventoried observation wells. Observation wells are private dug wells, piezometer of minor irrigation department (MID) Government of Bihar and deep tube well of PHED Government of Bihar.

In existing network monitoring wells depth to water level varies from 3.60 to 4.64 mbgl during pre-monsoon season. In post monsoon season, the depth to water level varies from 2.76 to 4.25 mbgl.

Water level measured in piezometer of minor irrigation department 6.76 mbgl during pre-monsoon season and in post monsoon season water level is 5.57 mbgl.

Water level measured in bore well of PHED (Government of Bihar) 7.63 mbgl during pre-monsoon season and post monsoon season water level lies at 6.70 mbgl.

The water level fluctuation between pre-monsoon and post-monsoon ranges from 0.90m to 1.19m in this block.

Table 3A- Water level in Asarganj block

Sl No	Block_Name	Type_of_Well	Latitude	Longitude	RL	Depth (mbgl)	Premonsoon/SWL mbgl	Postmonsoon SWL/mbgl	Fluctuation (m)	Pre WT (m amsl)	Post WT (m amsl)
1	Asarganj	DW/ NHNS	25.150	86.692	50	5.20	4.60	3.70	0.90	45.40	46.30
2	Asarganj	PHED_DTW	25.159	86.693	48	110.00	7.63	6.70	0.93	40.37	41.30
3	Asarganj	Mk_II	25.153	86.692	49	30.00	3.79	2.60	1.19	45.21	46.40
4	Asarganj	Pz	25.140	86.68	48	50.00	6.76	5.57	1.19	41.24	42.43

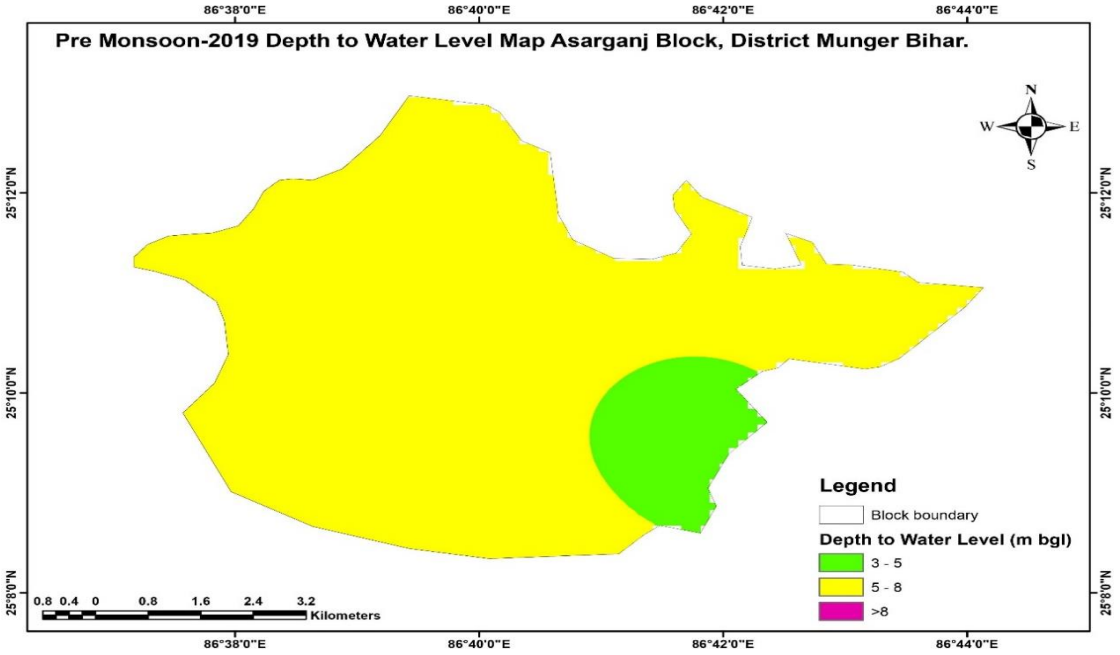

Fig 9- Pre-monsoon (2019) water level Map of Asarganj Block

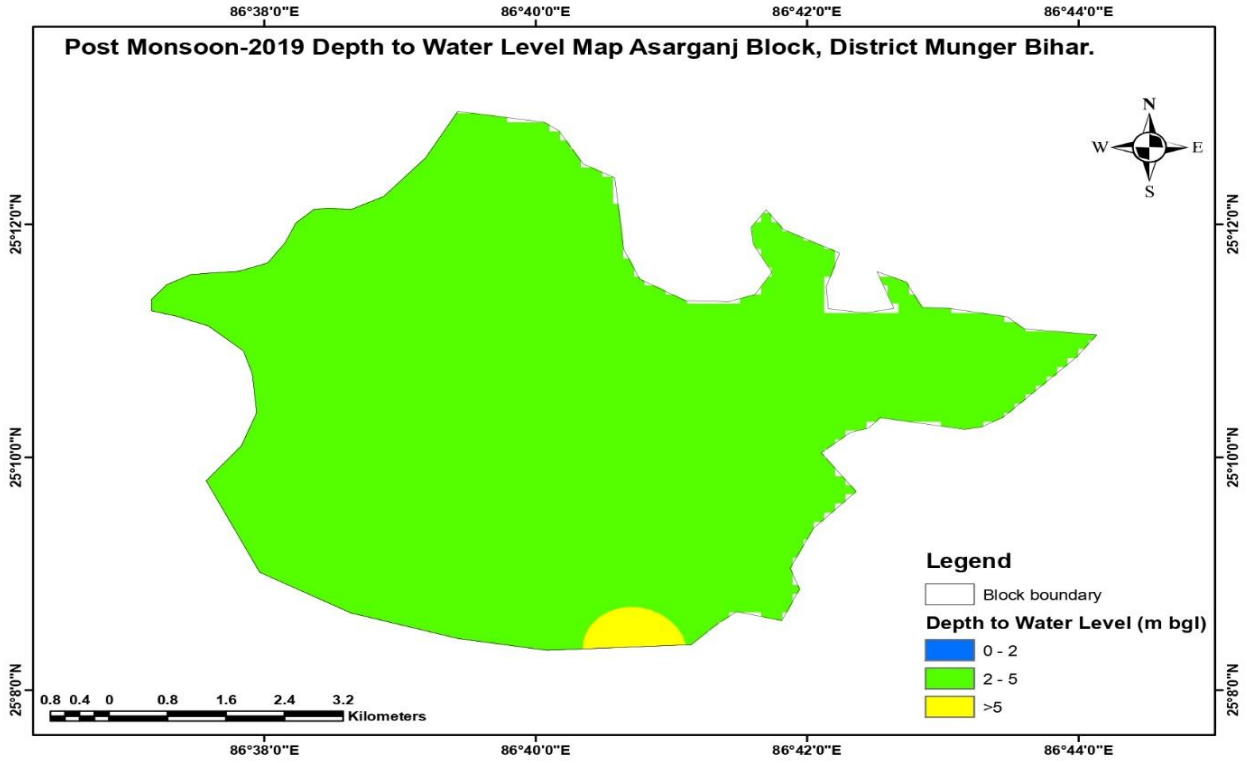

Fig 10- Post-monsoon (2019) water level Map of Asarganj Block

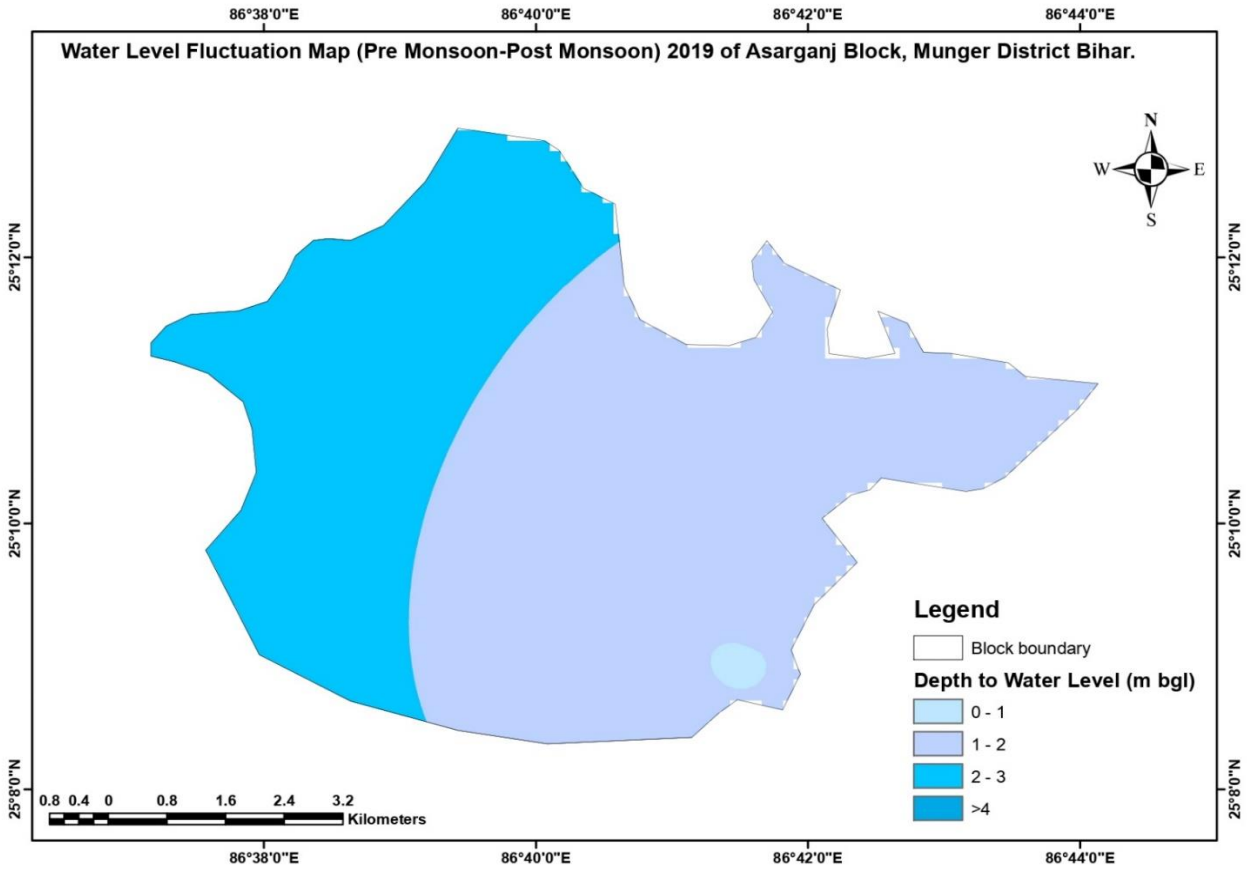

Fig 11- Water level Fluctuation Map (pre-monsoon- post monsoon 2019) of Asarganj Block

3.3 Water table contour

The water table contour map of Asarganj block shows the height of water table during pre-monsoon season varies from 40.37 m to 45.40 m and during post monsoon season height of water table varies from 41.30m to 46.40m above from mean sea level. The pre and post monsoon water table contour map revels that, ground water flow direction is towards NE direction in this block (fig-12).

3.4 Aquifer properties

Asarganj block comprises high potential zone. From the exploratory well data of CGWB, the discharge of the deeper aquifer in Munger district may vary from 31- 160.70 m^3/hr with average drawdown 8-10 m. The transmissivity of the aquifer varies 697.88 m^2/day specific capacity 19.29 m^3/hr/m and storativity is 4.5 x 10^{-4}**.**

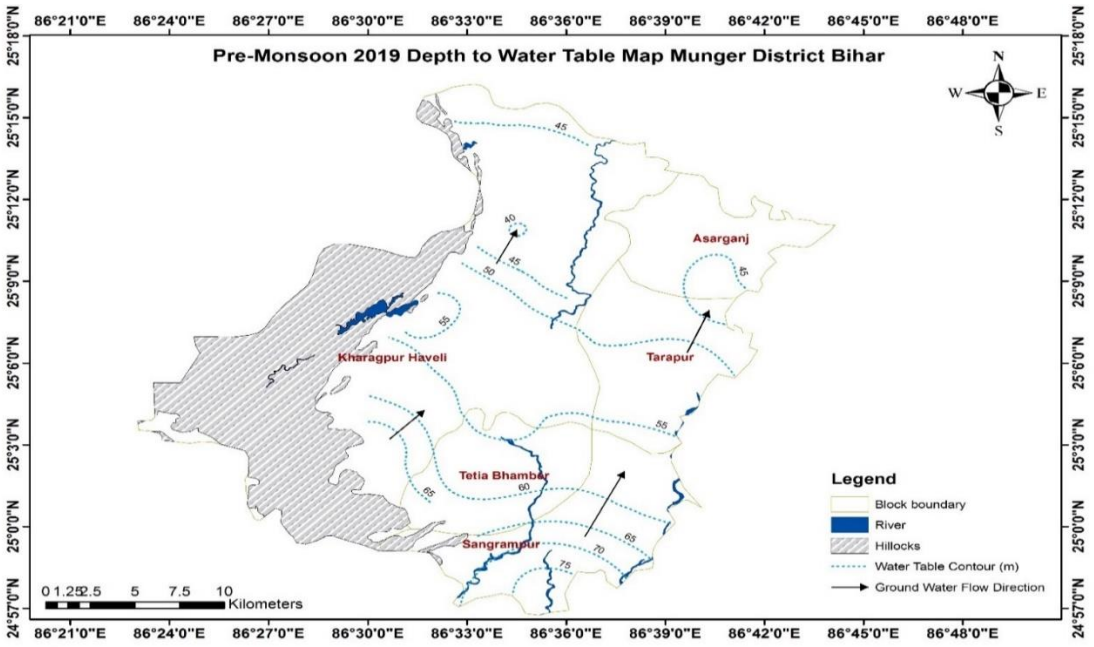

Fig 12: Pre-monsoon (2019) water table contour Map of Asarganj Block

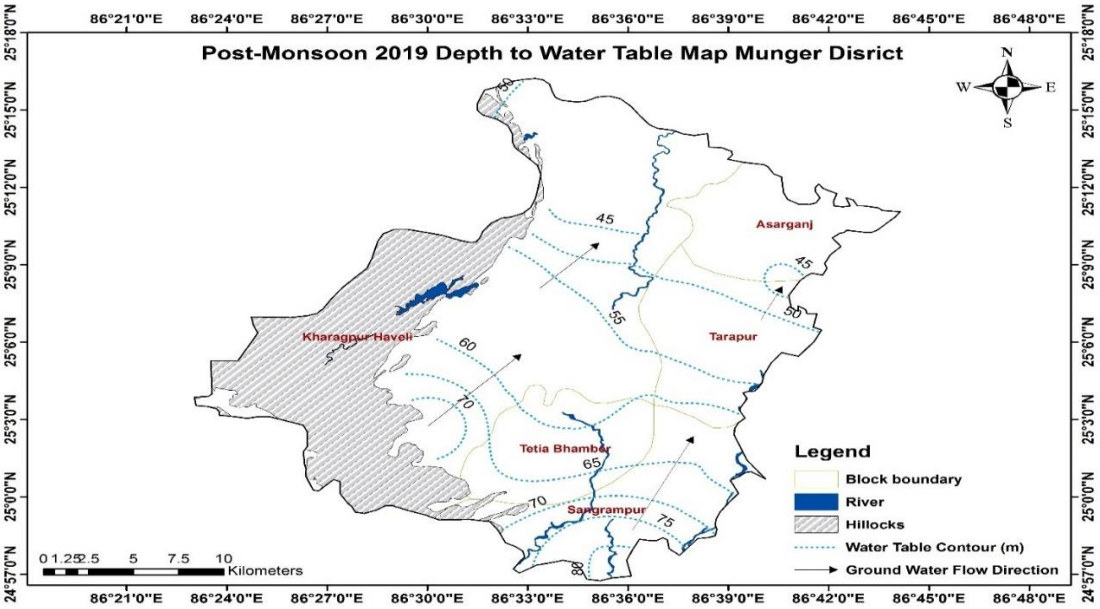

Fig 13: Post-monsoon (2019) water table contour Map of Asarganj Block

4.0 Ground Water Resource Availability and Extraction

As per dynamic ground water resource of Bihar 2020 annual extractable ground water resource of Asarganj block is 1949 ham, Total annual ground water recharge is 2165.55 ham and net ground water availability for future use is 655.46 ham. Stage of ground water extraction is 65.42% and the block is categorized as safe.

Table 4A: Dynamic Ground Water Resource (as on 22nd March, 2021)

Block	Total Area of Assessment Unit (Ha)	Recharge Worthy Area(Ha)	Total Annual Ground Water (Ham) Recharge	Total Natural Discharges (Ham)	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 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semicritical/Safe/Saline)
ASARGANJ	5948	5948	2165.55	216.55	1949	1062.1	63.00	149.94	1275.05	168.43	655.46	65.42	safe

4.1 Chemical Analysis

Result of chemical analysis of ground water of shallow aquifer is given in the table below (*Table 5B*). In general, chemical quality of shallow aquifer is potable. Few areas in the block have been reported with Fluoride contamination in ground water.

Table 4B- Result of Chemical Analysis of Ground Water Samples

Sl.No.	District	Block	Location	Latitude	Longitude	pH	EC	TDS	TH	Ca	Mg	Na	K	CO3	HCO3	Cl
1	Munger	Asarganj	Asarganj	25.150	86.690	8	1568	1019	415	74	61	122	152	0	510	179

(Source: NHS data-2020)

5.0 Management Plan

5.1. Supply side intervention in Agriculture and irrigation

From the existing land/agriculture and irrigation data it is understood that the block is principally agricultural depending. However, the average cropping intensity is recorded as 131 %. It reveals that considerable cropped area is not under assured irrigation coverage. The dynamic ground water resource reports stage of development is 58.52 % which indicates there exist further scope of ground water development in the block both for agriculture and drinking/domestic purposes. 5th MI Census data shows that majority of irrigation tube wells accompanied within the depth of 50 m. therefore further development may be planed from the deeper part.

Considering projected 70% development 89.25 ham further resources may be developed safely for irrigation development. This balance resource is recommended for development through STW/DTW as per the prevailing terrain condition and hydrogeology of the area. Considering unit draft of 2.4 and 4.8 for STW and DTW respectively following number of irrigation structures have been proposed. Thus, in Asarganj block 28 STW and 5 DTW may be constructed for future development. *(Table 5A & 5B).*

Table 5A- Additional resource for 70% development

Assessment Unit Name	Total Area of Assessment Unit (Ha)	Recharge Worthy Area (Ha)	Annual Extractable Ground Water Resource (Ham)	Total Extraction (Ham)	Draft for 70% development (Ham)	Additional resource available for 70% development (Ham)
ASARGANJ	5948	5948	1949	1275.05	1364.3	89.25

Table -5B Recommended number of structures for further irrigation development

Additional resource available for 70% development (Ham)	Resource allocated for development by STW (Ham)	Resource allocated for development by DTW (Ham)	Unit draft of STW (Ham)	Unit draft of DTW (Ham)	No. of STW proposed	No. of DTW proposed
89.25	66.938	22.313	2.4	4.8	28	5

5.2 Supply side intervention through Artificial Recharge and rain water harvesting

The block receives 1007.6 mm of annual rainfall on an average but most of rain water goes as run off. Construction of suitable artificial recharge structure will help to reduce the run off as well as it also recharges the aquifers and maintain the soil moisture of the area. As per Artificial recharge master plan ,2020, following number of recharge structures have been recommended in Munger district. Percolation tank-07, Gully plug-43, contour bunding and trenching-83, Check dam-02, Nala-bunding-05, Recharge shaft-80, De-silting of existing tank /pond /talao-145, Injection Well in Village Tank-194, Renovation of traditional Ahar-Pyne System (km)-

45. Based on the local geology / hydrogeology and underlying lithological disposition desiltation of existing tanks, check dam, percolation tank etc. may be practiced in Asarganj block.

Before construction of these recharges' structures, selection of suitable site is required for getting better benefits from these structures.

5.3 Demand side intervention

Considering the moderate potentiality of the area water intensive crop may be to some extent by replaced by less water consuming crop. Therefore pulses, oilseeds other horticulture crops etc as per the local requirement may be encouraged. This may create further irrigation potential in the block. Suitable crop rotation may be practiced.

5.4 Ground water contamination

The block has been reported with fluoride contamination in ground water. Therefore, before using of ground water from shallow or deep tube wells for drinking, domestic and irrigation purpose should be tested for fluoride contamination. Domestic fluoride removal technique may be adopted for short term measures whereas for long term intervention commercial fluoride removal plan may be installed.

Capacity building for Awareness generation among the stake holders and end users may be a suitable approach to address and to mitigate fluoride contamination in the ground water.

AQUIFER MAPS AND MANAGEMENT PLAN OF HAVELI KHARAGPUR, BLOCK IN MUNGER DISTRICT, BIHAR

Name of the Block of Aquifer	Haveli Kharagpur/ 344.94 sq km
District/State	Munger/Bihar
Population	Total- 212305 Rural- 180920 Urban- 31385
Rainfall	Normal Monsoon- 970.80 Non-monsoon rainfall- 202.80
Agriculture and Irrigation	Principal crops - Rice – Wheat, Rice – Gram, Rice – Lentil, Rice – Rai Gross cropped area- 17316 ha Net sown area- 12415.89 ha Irrigation practices - Surface water by canal -Ground water by tube well and LDDW Cropping intensity- 131% Number and types of abstraction structures- STW- 788, MTW- 22, DTW- 04
Geology	Older alluvium, Chhotnagpur Gneissic Complex
Geomorphology	Major Physiographic units- Hill, Pedi plain, Alluvial plain Major Drainage- Ganga, Badua-Chandan, Sunder-Gumani Sub basin
Ground water resource availability and extraction	Annual Extractable Ground Water Resource (Ham)-4924.35 Net Ground Water Availability for future use (Ham)- 2520.31 Ground water extraction (Ham)- 2345.30
Existing and future water demand	2345.3 Ham /532.34 Ham (annual GW allocation for domestic as on 2025)

Water level behaviour	Pre-monsoon SWL- 4.46-8.18 mbgl Post-monsoon SWL-1.15-4.50 mbgl

2. Aquifer Disposition

Number of Aquifers	02; up to the explored depth of 60m
3D aquifer disposition and basic characteristics of each aquifer	1st Aquifer from 19m to 27m, fine sand mostly phreatic, 2nd Aquifer from 30m to 48m, medium to coarse sand, Semi-confined to Confined

3. Ground water resource, extraction, contamination and other issues

GW Resource/Categorization Availability	Safe
Chemical quality of ground water and contamination	Potable The block has been reported with fluoride contamination in ground water

4. Supply Side Interventions

Ground Water Development Strategies-	Number of LDTW, STW and DTW may be proposed for irrigation uses- LDTW- 410 STW-252, DTW-46
Aquifer wise space available for recharge and proposed interventions	As per ARMP, 2020, for Munger district 345.84 sq km is suitable for recharge, Volume of de-saturated zone 193 MCM. Contour bunding and trenching, gully plug, recharge shaft, De-silting of existing tank/pond/talao, injection well in village tank etc. are some suitable structures in area

5. Demand side interventions

Advanced Irrigation Practices	Project based drip/sprinkler irrigation, lining of field channels etc.
Change in cropping pattern	Less water intensive crop like pulses, oilseeds may be encouraged.
Alternate water sources	Conjunctive uses of groundwater/surface water sources, micro water shed development
Regulation and Control	Capacity building for awareness generation for fluoride contamination.

1.0 General Information

1.	Total area		:	344.94 sq km
2.	Total number of Panchayat		:	18
3.	Total number of villages		:	120
4.	Population (Census 2011)	Total	:	212305
		Rural	:	180920
		Urban	:	31385
5.	Normal annual rainfall		:	1173.6 mm
6.	Basin / Sub-basin		:	Ganga / Chandan- Badua,
7.	Location			Burhi Gandak
	Latitude		:	24.9850 to 25.2700
	Longitude		:	86.3827 to 86.6569

The Haveli Kharagpur block comes under south circle of the Munger district and it is located in southern part of Bihar state. It extends between latitude 24.9850 to 25.2700 N and longitude 86.3827 to 86.6569 E. Block is 204 km in distance from Patna. Block is bounded by Asarganj block, Tarapur block, & Tetiya Bamber block in the east; in the south block it is bonded by Jamui district; Dharhara block in the west and Bariyarpur block in the North (*Fig-1*).

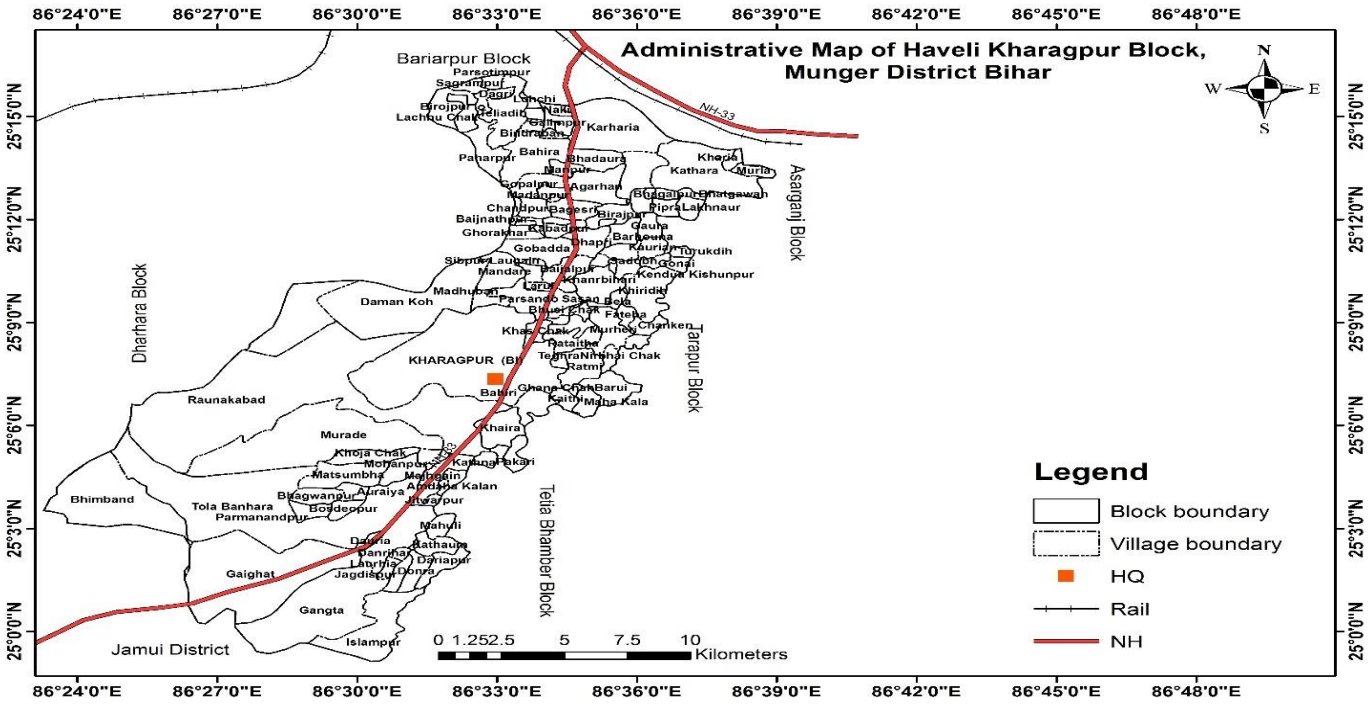

Fig-1 Administrative Map of Haveli Kharagpur Block, Munger District

1.1 Basic demographic detail of Haveli Kharagpur block (Census 2011)

As per census 2011 the total population of Kharagpur block is 212305 among which 31385 people live in urban area that is 14.78% of total population *(Table 1A)*. Therefore, the block is a rural one.

Table 1A- Population of Haveli Kharagpur block

Block	Rural	Urban	Total
Haveli Kharagpur	180920	31385	212305

The block consists of 18 Gram Panchayats, 120 villages and 35,753 households *(Table 1B)*.

Table 1B- List of panchayat wise villages of Haveli Kharagpur block

S.No.	Panchayat	Villages	House Holds	Population
1	Teliyadih	13	2281	11418
2	Agarhan	8	2157	11529
3	Badouna	9	2222	10798
4	Bahira	8	2327	12128
5	Bajalpur	6	1951	10238

S.No.	Panchayat	Villages	House Holds	Population
6	Barui	6	1383	7311
7	Darayapur I	8	2296	11832
8	Darayapur II	6	1394	6540
9	Gagata	9	2219	10764
10	Gobadah	5	2193	10760
11	Kouria	7	2172	10706
12	Majhagai	7	1723	9182
13	Mudhery	3	1977	10067
14	Muraday	4	1977	9850
15	Naki	7	1896	9613
16	Ramankabad E	1	706	3366
17	Ramankabad W	1	3451	17108
18	Rataitha	3	1428	7710
	Total	120	35753	180920

1.2 Rainfall and Temperature

Normal annual rainfall of Asarganj block is 1173.6 mm of which 85.46% occurs during the monsoon season. The normal rainfall during monsoon season is 822.2 mm and during non-monsoon season is 76.8 mm. The variation of rainfall in this zone is from 1173.6 mm to 899.0 mm and the temperature varies from 44 to 6˚C.

1.3 Distribution of persons engaged in agriculture and other workers/ non workers in the block

In Haveli Kharagpur Block, 78% of total population is non workers. It is evident from above diagram that 16% of the total population in the block is engaged in agriculture either as cultivator 2%, 1% comprises household industrial workers and 3% comprises other worker(*Fig-2*).

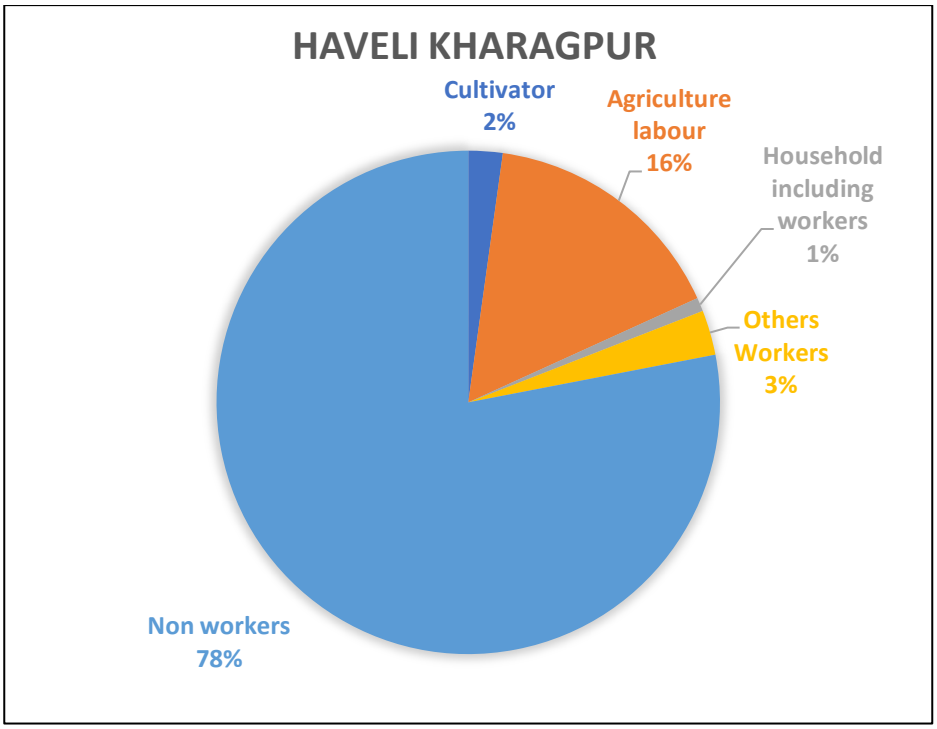

Fig 2- Distribution of persons engaged in Haveli Kharagpur block

Source- Census 2011

1.4 Soil

Haveli Kharagpur block contains mainly calcareous sandy soils, coarse loamy soils, fine loamy Soils, clayey soils with pH in the range of 6.8 – 8.0 (*Fig-3*).

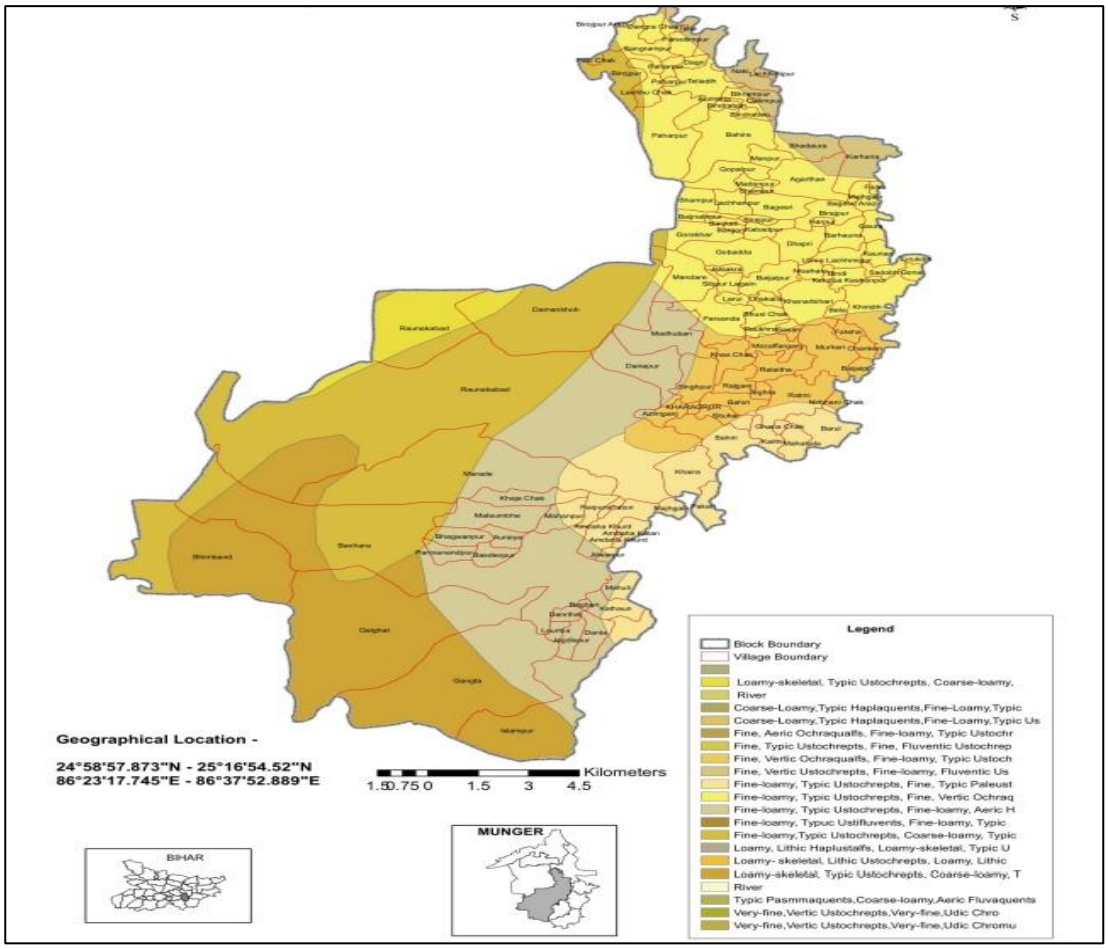

Fig -3 Soil Map of Haveli Kharagpur block, district Munger, Bihar *Source- (DIP 2019)*

1.5 Physiographic, Basin/sub-basin, and Drainage:

The Kharagpur Hill is a prominent landscape as a distinct watershed. Western half of Kharagpur hills forms part of Phalgu-Kiul Sub-basin. Dendritic and rectangular drainage patterns are dominating in the hilly regions, while in the plain area the pattern is parallel to sub-parallel. The block having average elevation of 48 m.

1.6 Geomorphology

The block has a diverse landscape ranging from hills to flood plains. The major geomorphic units are rocky upland, Pediplain and alluvial plain. The Kharagpur Hill tract: it constitutes dominantly elevated and rugged landmasses, except south surrounded on all sides by alluvial plains. The Ganga flows along its northern tip. The altitude of hills varies from 500 to 250 m a msl. It comprises mainly quartzite and phyllite of Kharagpur Formation. The rock of Kharagpur Formation has undergone multi-phase tectonic deformation, which has given rise to many types of deformational structures. Thermal springs are common in Kharagpur Hills and these springs emerge from fissures in highly jointed or sheared quartzites. Older alluvial Plain is

represented in some part of Kharagpur block and it is made up of sediments derived from the denudation of Chota Nagpur Plateau and Kharagpur Hills (*Fig- 4*).

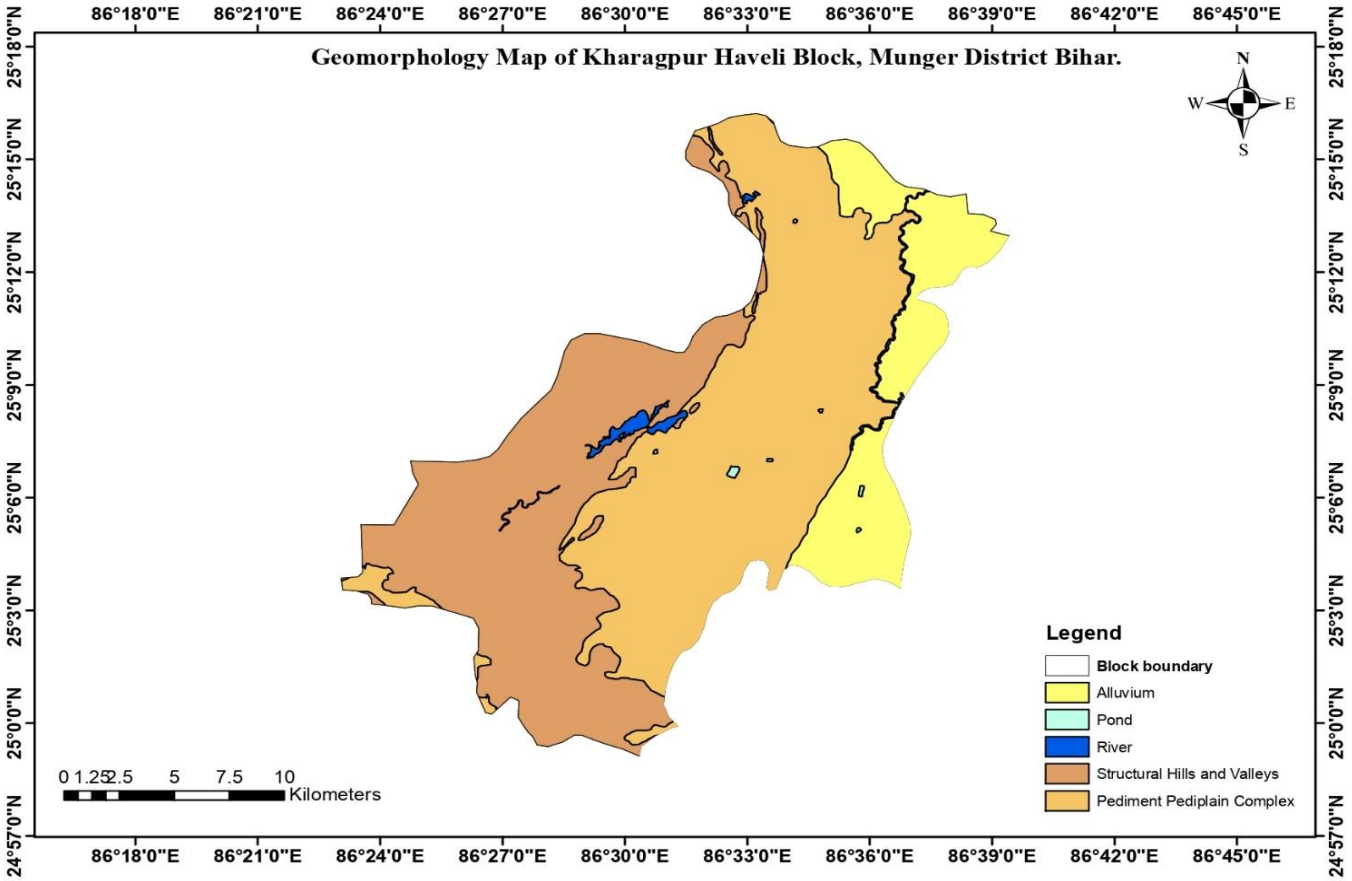

Fig 4- Geomorphology Map of Haveli Kharagpur block

1.7 Land use pattern

Block has net sown area as 12230.96 ha with area sown more than once is 4025 ha, 3815 ha hilly area and gross cropped area 17316 ha *(Table 1C).*

Table 1 C- Details of Land use pattern of block (area in ha)

Name of the Panchayat	Reporting area (ha)	Forest area (ha)	Area under non-agriculture wastes (ha)	Barren and un-culturable lands (ha)	Permanent pastures and grazing lands (ha)	Land under misc. tree crops (ha)	Culturable wastes	Net area sown
Agarhan	1081	6	126.7	6.12	0	223.49	308.32	388.77
Badouna	744	0	84.29	19.47	0	94.42	2.5	518.12

Name of the Panchayat	Reporting area (ha)	Forest area (ha)	Area under non-agriculture wastes (ha)	Barren and un-culturable lands (ha)	Permanent pastures and grazing lands (ha)	Land under misc. tree crops (ha)	Culturable wastes	Net area sown
Bahira	1372	216.22	66.44	72.83	8.68	14.45	242.9	750.48
Bajalpur	698	0	54.76	8.9	0	307.11	0	317.08
Barui	928	0	73.45	5.15	0	19.9	4	767.85
Darayapur I	1770	0	646.24	0	23.12	273.12	11	560.41
Darayapur II	3389	1282.61	248.77	0	2.06	347.07	0	1456.71
Gagata	6341	2089.2	1400.83	1232.68	30.97	96.95	260.6	622.08
Gobadah	730	56	14.51	13.58	56.95	40.95	0	548.01
Kouria	1111	25.5	158.3	47.7	108	1.85	6	762.5
Majhagai	588	3.8	66.85	1.25	3.7	19.89	0	472.2
Mudhery	731	0	122.16	37.41	1.77	53.13	1.34	515.19
Muraday	2261	347.4	67.38	8.15	5.59	384.27	0	1041.69
Naki	351.28	10.3	24.3	4.52	0	53.3	37.9	208.74
RamankabadE	268	0	8.4	3.1	0	0.58	19.57	235.25
RamankabadW	5583	3912	0	149.2	0	0	41	1480.8
Rataitha	478	0	75.5	0	0	7.05	6.6	382.6
Teliyadih	1766.27	224.2	86.36	0	1.7	66.5	0	1387.41
Total	30190.55	8173.23	3325.24	1610.06	242.54	2004.03	941.73	12415.89

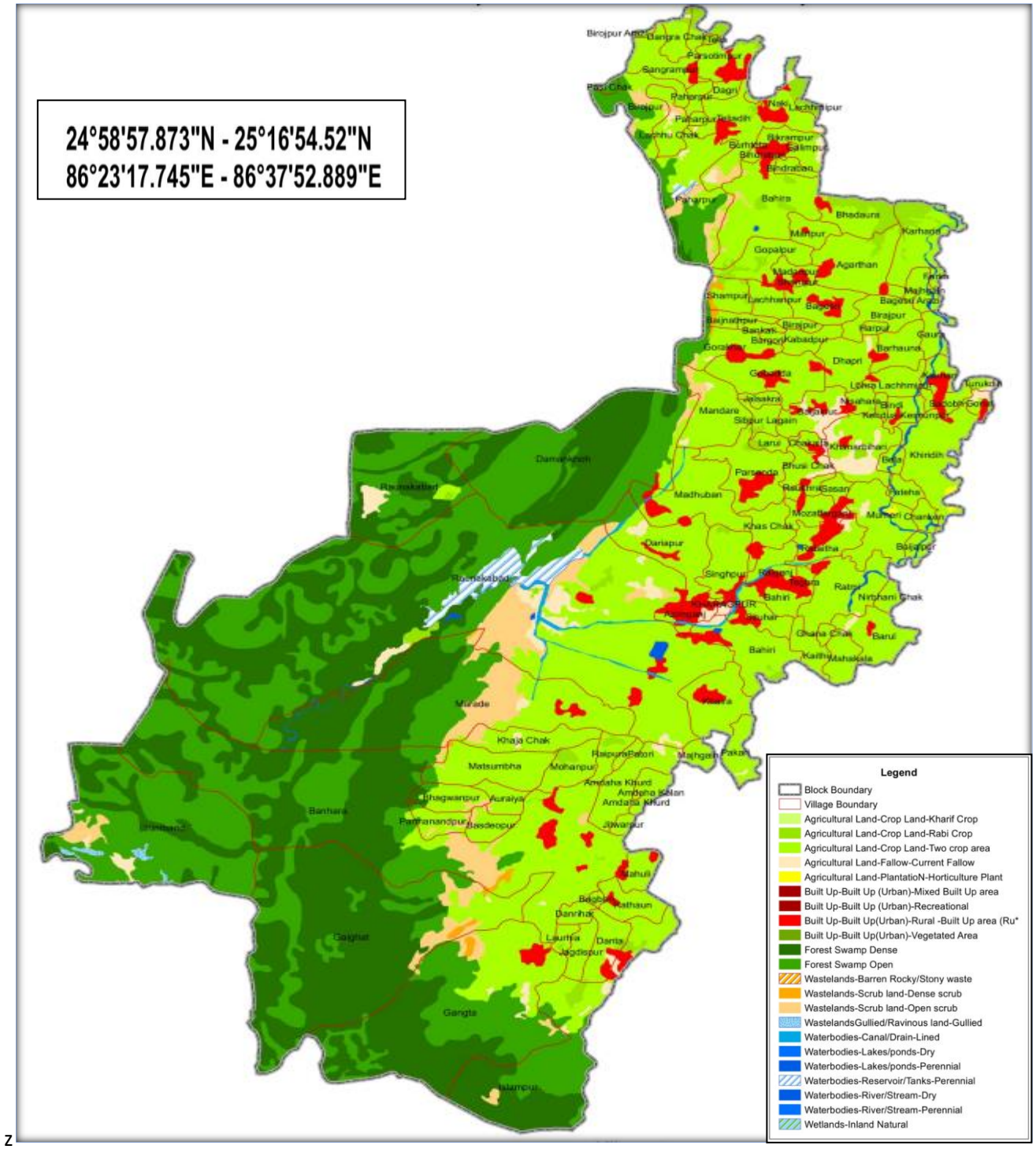

Fig 5- LULC Map of Haveli Kharagpur block

Source- DIP (2019)

1.8 Agriculture and Irrigation

Haveli Kharagpur block falls in the Agro-climatic Zone III B. The gross irrigated area is 9225 ha and dependency on ground water for irrigation is 7.68%. Cultivable area in the block compromises of 20% in ditrict with cropping intensity has been recorded 131%. Out of total command area of 35,751 ha, 4290.12 ha (22%) of

the the canal command area. Block ranks at the bottom as it is the only block where 9.4 % of the total command is undeveloped. The cropping sequence followed in this zone is Rice – Wheat, Rice – Gram, Rice – Lentil, Rice– Rai.

Surface irrigation network comprises canal irrigation, tanks, surface flow and lift irrigation. As per the DIP, 2016, 38.5 MCM water availability have been brought under irrigation through canal. A considerable area is brought under irrigation by numbers of tanks. Surface flow, lift irrigation comprises other mode of surface irrigation networks in the block.

Ground water irrigation is limited and is accomplished mainly through shallow tube wells and limited numbers or deep tube wells. Ground water availability 45.85 MCM with Draft irrigation 12.77 MCM.The numbers of irrigation structure as per 5th MI Census are presented in (*Figure-6*).

Table 1D- of MI structure in Haveli Kharagpur block

STW	MDTW	MDTW	MDTW	TOTAL MDTW	DTW
	35-40m	40-60m	60-70m	TOTAL	
788	3	19	0	22	4

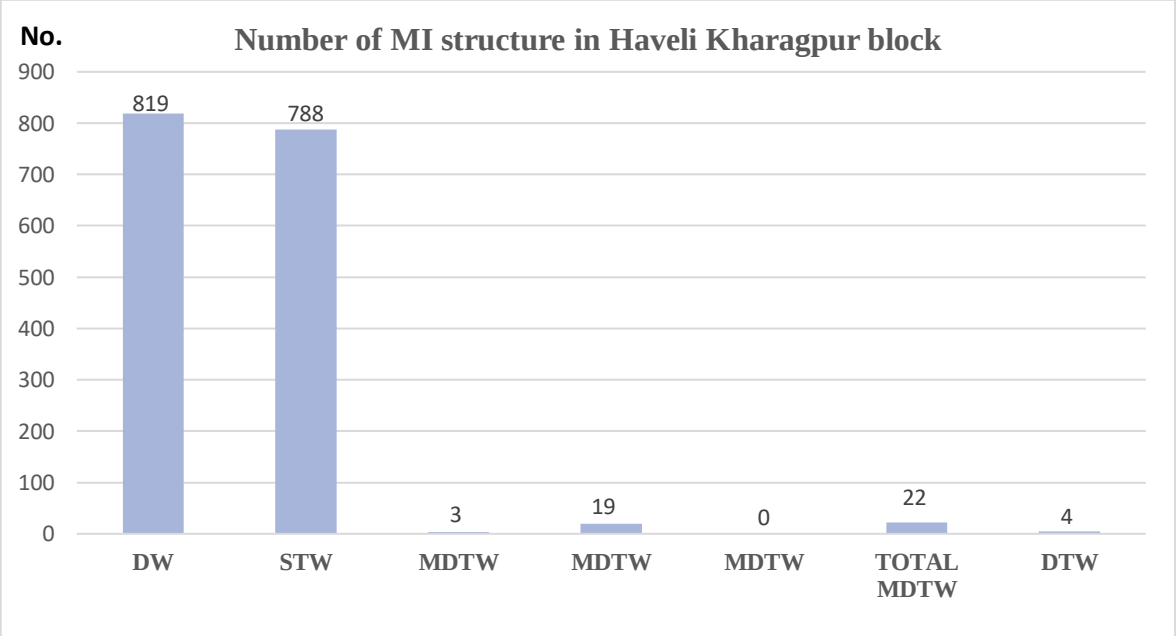

Fig 6- No. of MI structure in Haveli Kharagpur block

2.0 Geology

The block is covered by Precambrian and Quaternary sediments and Munger and Jamui Formation of Lower Holocene and Middle Proterozoic in age. Lithological formation is greenish clay with caliche, Quartzite and Quartz sericite schist has consolidated sediment and soft sediment hard rock.

The Munger Group of rocks overlying the Chhotanagpur Gneissic Complex consist of thick beds of low grade metamorphic e.g., phyllite, slate, quartzite and quartz- sericite schist. Aluminous laterites and residual soils of

Lalgarh formation show patchy development over the pediplain areas of south. Clay deposits are formed by alteration of phyllites around the Kharagpur hills area. Occurrences of lithomarge clay are widely used as building material. ***(Fig -7).***

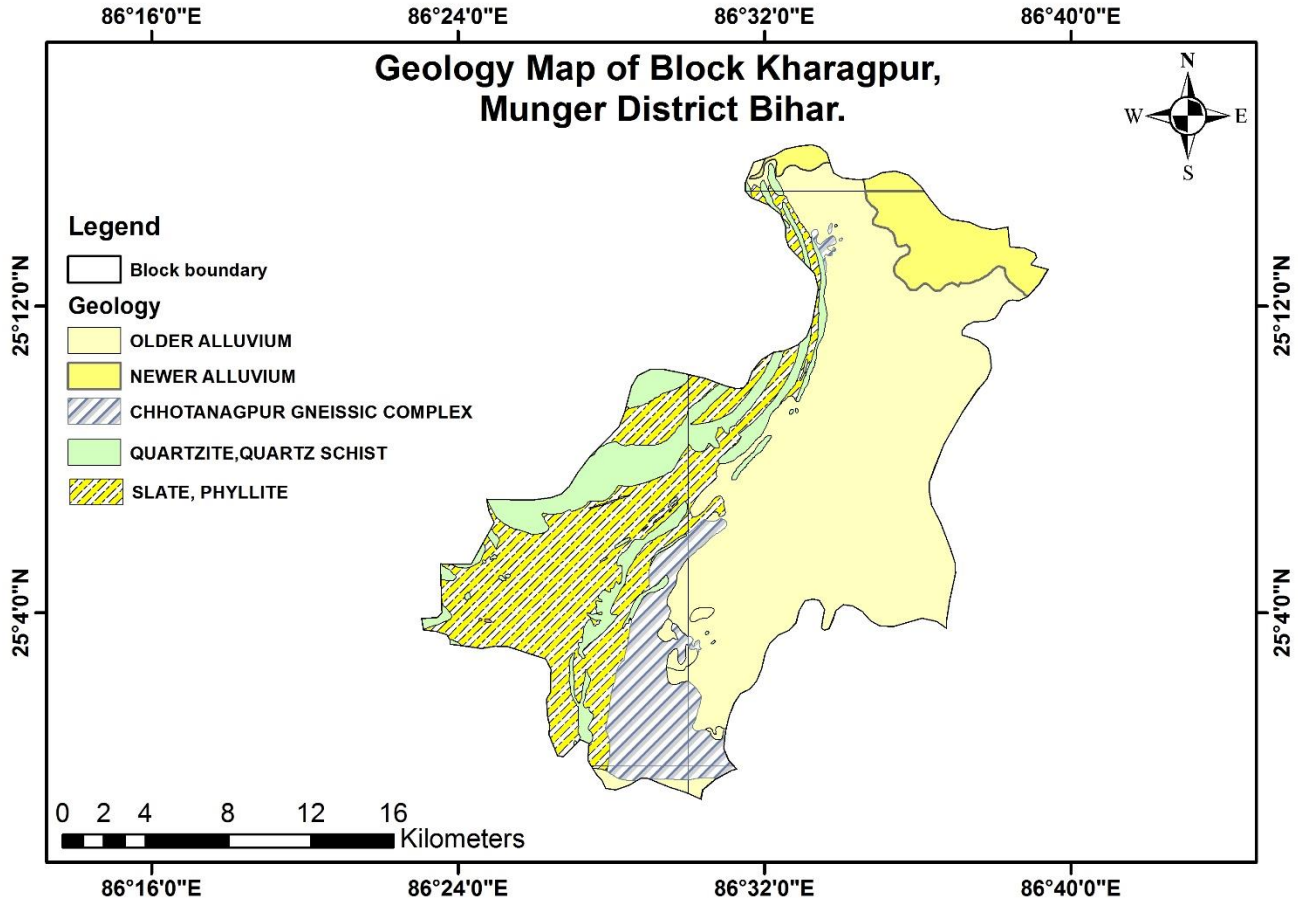

Fig 7: *Geology Map of Haveli Kharagpur block, District Munger Bihar*

3.0 Hydrogeology

The major part of block is made up of the rock of Chotanagpur Gneissic Complex (CGC) and Kharagpur Formation, which is mainly composed of granite gneisses, quartzite and phyllites. In general, these rocks possess poor aquifers until or unless secondary porosities are developed by means of weathering and or fracturing. Ground water occurs under unconfined condition at shallow depth and semi-confined condition at deeper level. Sessional fluctuation of depth of groundwater level ranges from 1.73m to 6.85m. Shallow and deeper aquifer found in this block yield ranging from 10 to 100 m^3/hr. Average discharge of STW/MDTW and DTW may safely be assumed as 25m^3/hr and 50 m^3/hr respectively.

3.1 Aquifer Disposition

Using the lithology of exploratory wells drilled at Ramankabad, Khaira and Bamber, a cross section has been prepared. Cross section shows two aquifer layers separated by clay layers. The 1st aquifer is about 10 m

thick at Ramankabad and about 20 m thick at Bamber. 2nd aquifer, comprising medium to coarse sands constitute the principal water bearing zone in the area. Thickness of the 2nd aquifer ranges between 25-30 m. The coarse sands layer is often underlain by hard crystalline granitic rock. Section depicting the aquifer is shown below (fig 8).

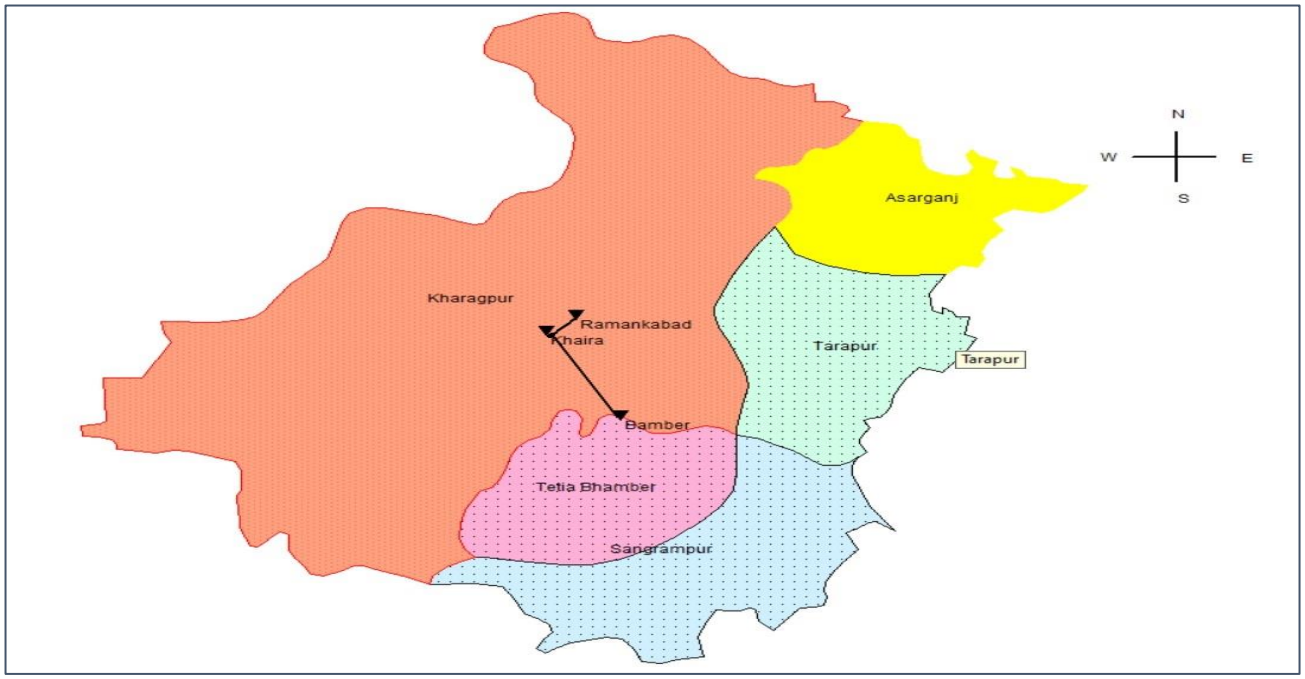

Fig8a: *Location of the boreholes*

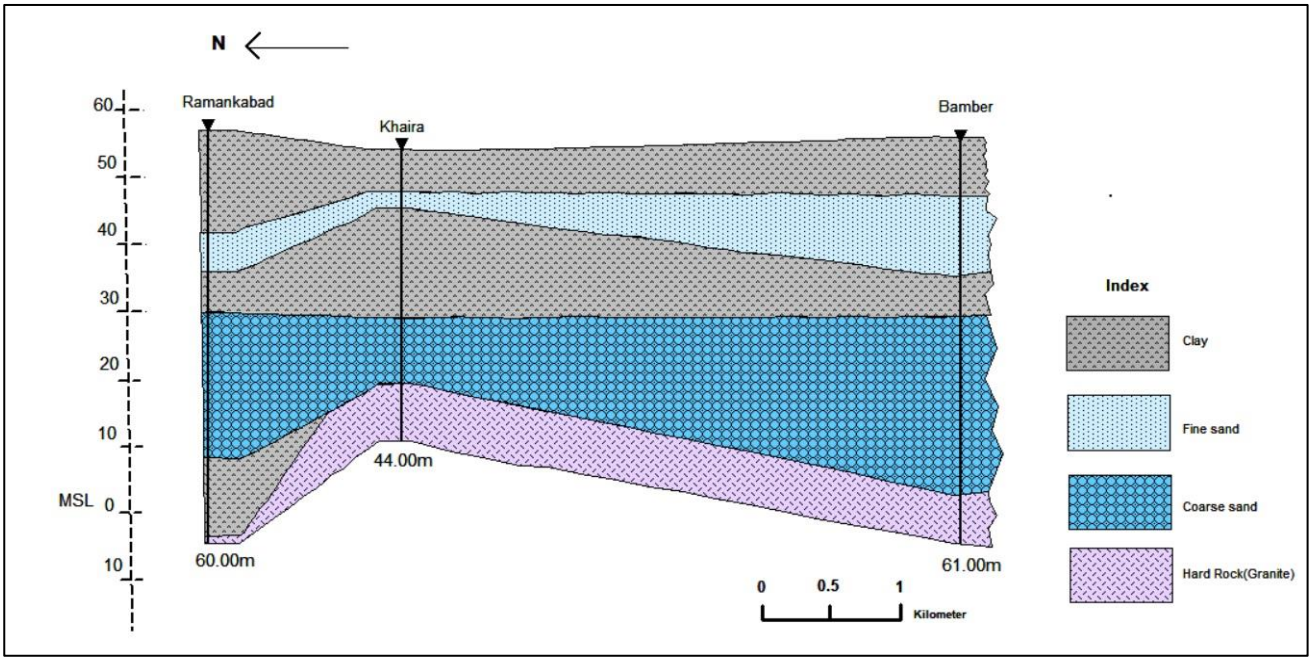

Fig 8b- *Diagram showing Aquifer disposition*

3.2 Water Level Behaviour

The Ground water regime of the block has been monitored from the existing network monitoring wells, inventoried observation wells. Observation wells are private dug wells, piezometer of minor irrigation department (MID) Government of Bihar and deep tube well of PHED Government of Bihar.

In existing network monitoring wells depth to water level varies from 4.63 to 8.18 mbgl during pre-monsoon season. In post monsoon season, the depth to water level varies from 1.15 to 2.80 mbgl.

Water level measured in piezometer of minor irrigation department 6.02 mbgl during pre-monsoon season and in post monsoon season water level is 3.83 mbgl.

Water level measured in bore well of PHED (Government of Bihar) 4.56 mbgl during pre-monsoon season and post monsoon season water level lies at 2.75 mbgl.

The water level fluctuation between pre-monsoon and post-monsoon ranges from 1.73 m to 6.85 m in this block.

Table 3A: *Water level in Haveli Kharagpur block*

Sl No.	Block_Name	Type_of_Well	Latitude	Longitude	RL (m)	Depth (mbgl)	Premonsoon/SWL mbgl	Postmonsoon SWL/mbgl	Fluctuation (m)	Pre WT (m amsl)	Post WT (m amsl)
1	Haveli Kharagpur	DW/ NHNS	25.0468	86.5034	77	11.20	8.18	2.6	5.58	68.82	74.4
2	Haveli Kharagpur	DW/ NHNS	25.1824	86.5753	47	6.45	7.48	2	5.48	39.52	45
3	Haveli Kharagpur	DW/ NHNS	25.1344	86.5314	63	9.50	8	1.15	6.85	55	61.85
4	Haveli Kharagpur	DW	25.1899	86.5738	47	12.00	4.63	2.8	1.83	42.37	44.2
5	Haveli Kharagpur	TW/Subm	25.1898	86.5738	47	27.00	6.23	4.5	1.73	40.77	42.5
6	Haveli Kharagpur	TW/Subm	25.1292	86.5375	62	32.00	4.56	2.75	1.81	57.44	59.25
7	Haveli Kharagpur	CGWB_OW	25.0985	86.5591	54	55.00	4.46	2.50	1.96	49.54	51.5
8	Haveli Kharagpur	Pz	25.1200	86.5500	58	50.00	6.02	3.83	2.19	51.98	54.17

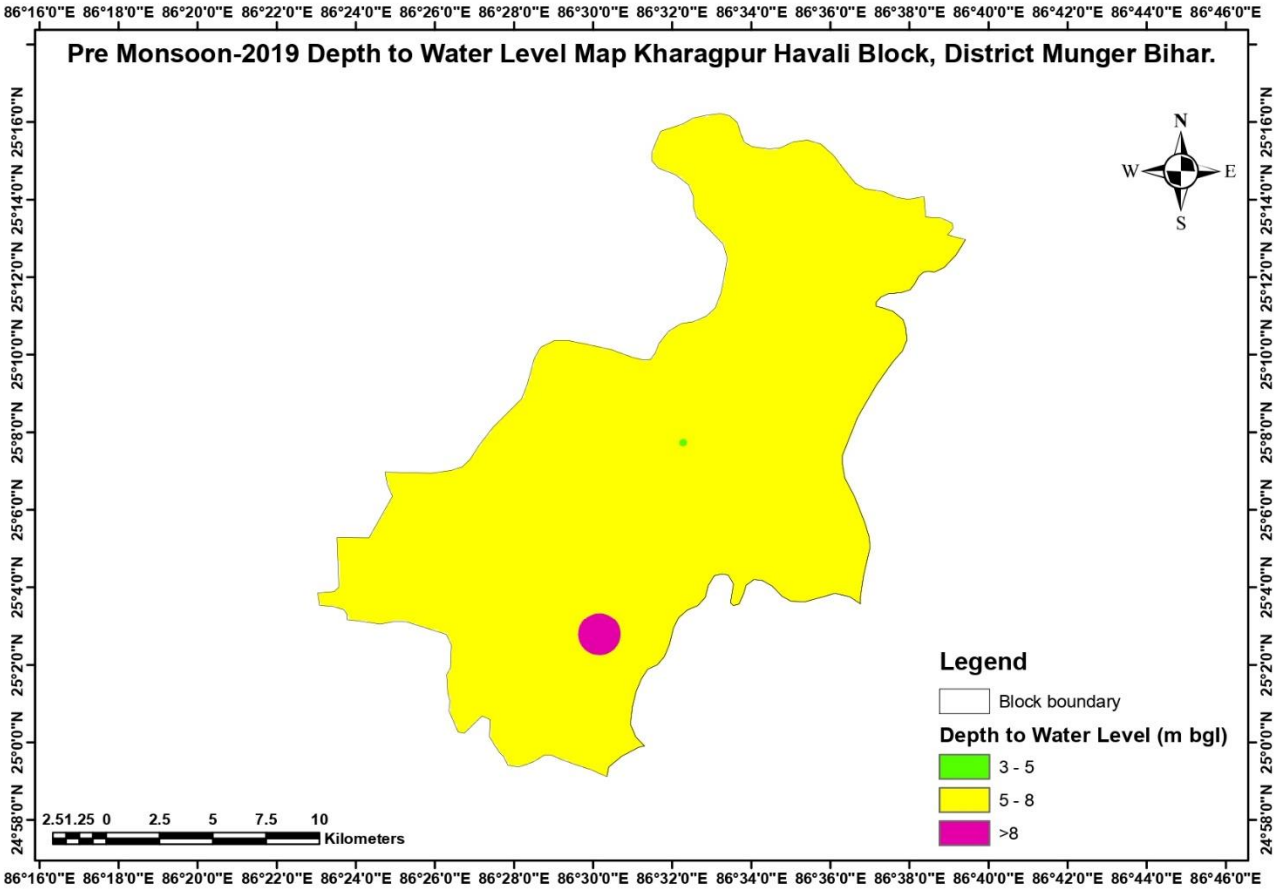

Fig 9: *Pre-monsoon (2019) water level Map of Haveli Kharagpur Block*

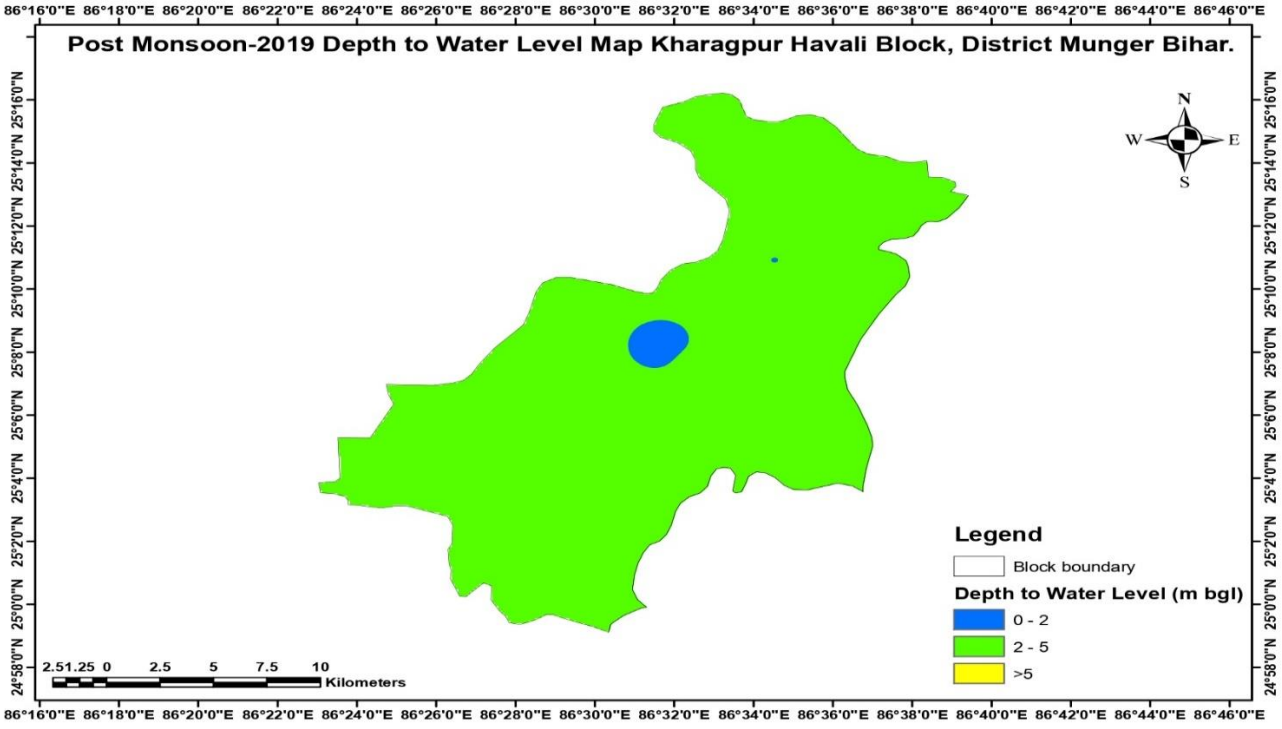

Fig 10:*Post-monsoon (2019) water level Map of Haveli Kharagpur Block*

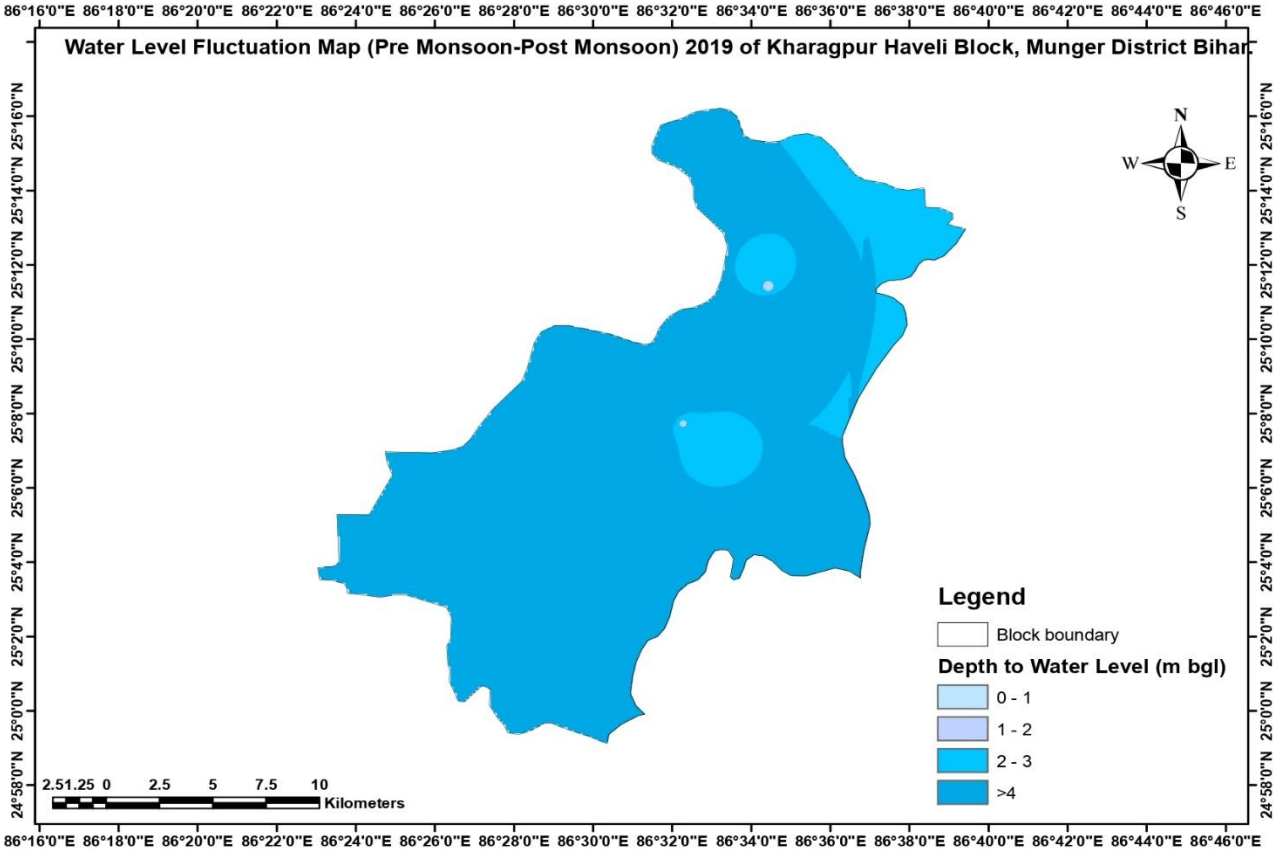

Fig 11: *Water level Fluctuation Map (pre-monsoon- post monsoon 2019) of Haveli Kharagpur Block*

3.3 Water table contour

The water table contour map of Haveli kharagpur block shows the height of water table during pre-monsoon season varies from 39.52 m to 68.82 m and during post monsoon season height of water table varies from 44.2 m to 74.4 m above from mean sea level. As shown in map, ground water flow direction is towards NE direction in this block (fig-12).

3.4 Aquifer properties

Haveli Kharagpur block comprises high to moderate potential zone. From the exploratory well data of CGWB, the discharge of the deeper aquifer in Munger district may vary from 31- 160.70 m^3/hr with average drawdown 8-10 m. The transmissivity of the aquifer varies 697.88 m^2/day specific capacity 19.29 m^3/hr/m and storativity is 4.5 x 10^{-4}**.**

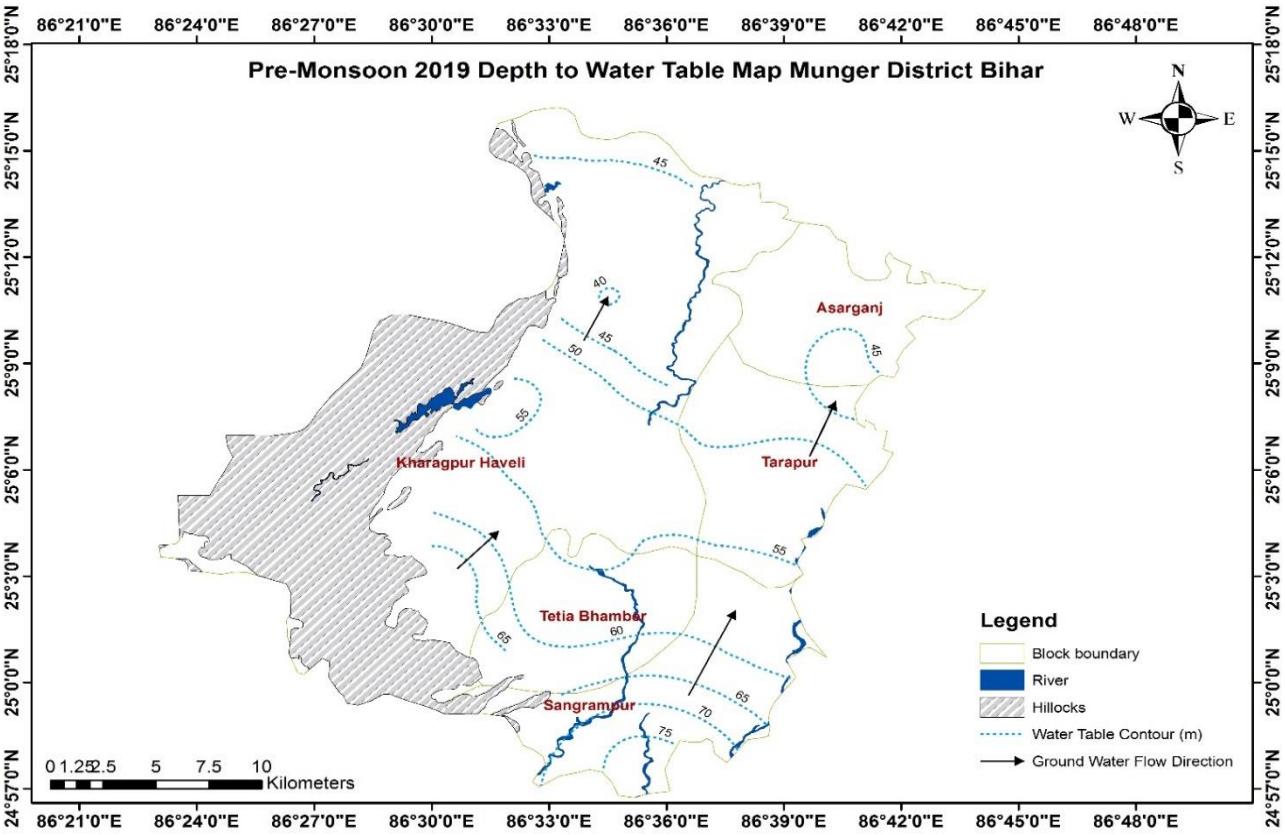

Fig 12: *Post-monsoon (2019) water table contour Map of Haveli kharagpur Block*

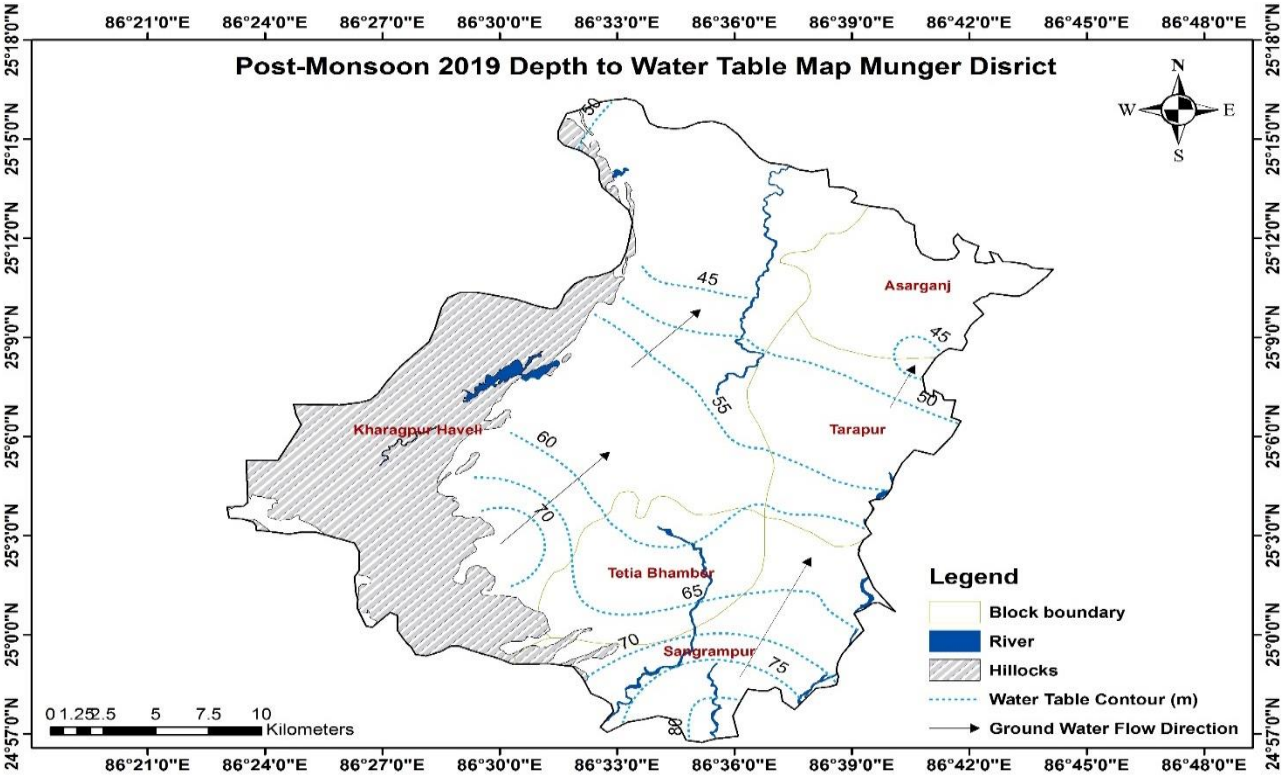

Fig 13: *Post-monsoon (2019) water table contour Map of Haveli kharagpur Block*

4.0 Geophysical Studies around Khaira Village, Haveli Kharagpur Block in Munger District

i. Vertical Electrical Sounding (VES) Survey:

Surface geophysical resistivity surveys are usually designed to measure the electrical resistivity of sub-surface materials by making measurements at the earth surface. In VES, the vertical (depth wise) variations in the resistivity of the sub-surface are measured. This is done by imposing an electrical field in the ground by a pair of electrodes at varying spacing expanding symmetrically from a central point, while measuring the surface expression of the resulting potential field with additional pair of electrodes at the appropriate spacing (Fig.14). For an array of current electrodes (C1 & C2) or A & B, and potential electrodes (P1 & P2) or M & N, the 'apparent resistivity', 'ρ_a' is expressed by the equation:

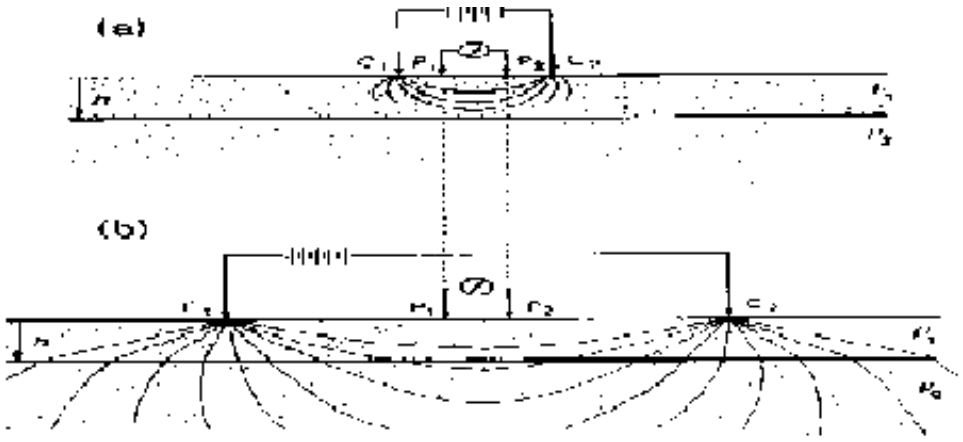

Fig.14 VES Schematic diagram for electrode array

$\rho_a = 2 \pi R * [\{(AB/2) + (MN/2)\} * \{(AB/2) – (MN/2)\}] / MN.$

Where, R = resistance { $R = \triangle V / I$ },

I is the current introduced in the earth,

$\triangle V$ is the potential difference between the potential electrodes,

AB = distance between the current electrodes A & B and

MN = distance between the potential electrodes M & N.

The values of apparent resistivity (ρ_a: - product of resistance and geometric factor) in ohm-m are plotted against the related half-current electrode separation on double logarithmic scale paper of moduli 62.5 mm, for interpretation by curve matching technique and Resistivity Sounding Interpretation software. The interpreted result gives the resistivity of different layers and the depth of various interfaces underneath.

ii. Groundwater pollution (Fluoride) study at Khaira, Munger district, Bihar.

The purpose of the study is to address the influence of lithological set up in controlling fluoride contamination and the efficacy of DC resistivity survey in deciphering existing lithological set up in the study

area. The study also helped in demarcating fluoride safe aquifer zone at Khaira village and developing possible groundwater management plan for fluoride dilution in groundwater.

A total of 22 VES were conducted with Schlumberger array along two traverses one in N-S direction covering a length of 2 km and other one in E-W direction, with aim of evaluating sub surface hydrogeological sequence within the study area and to demarcate fluoride safe aquifer zone. The locations of sounding point are presented in fig. 15. The Geological sections prepared on basis of VES results, along NS direction (A-A') and along E-W direction (B-B') are presented in Fig. 16. and Fig. 17. respectively.

Resistivity (ohm.m)	Lithology
<10	Clay
10-17	Sandy clay
17-20	Fine sand
20-35	Weathered Granite
>100	Massive Granite

***Table4A**: Resistivity range of different lithological units in Khaira village, Munger*

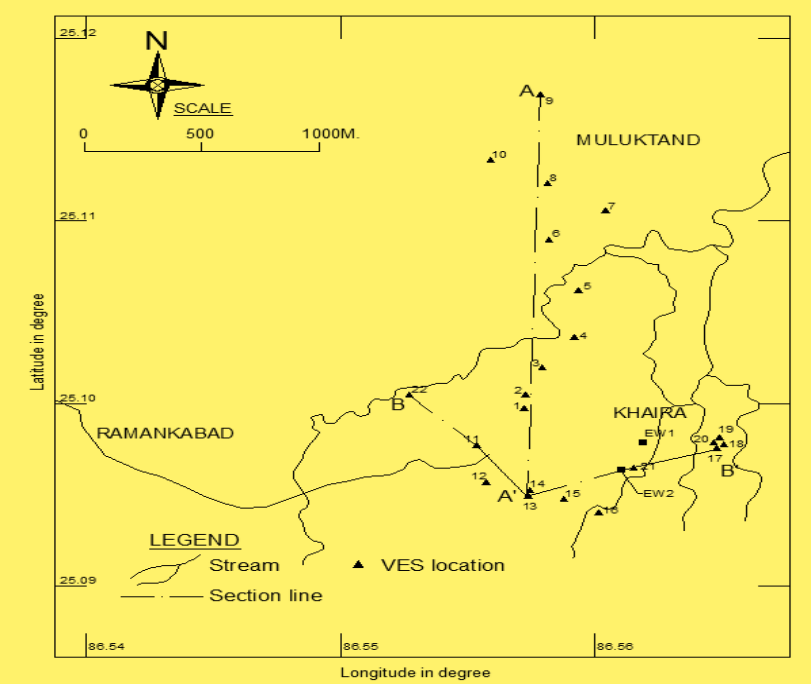

***Fig15:** Survey point at Khaira Village*

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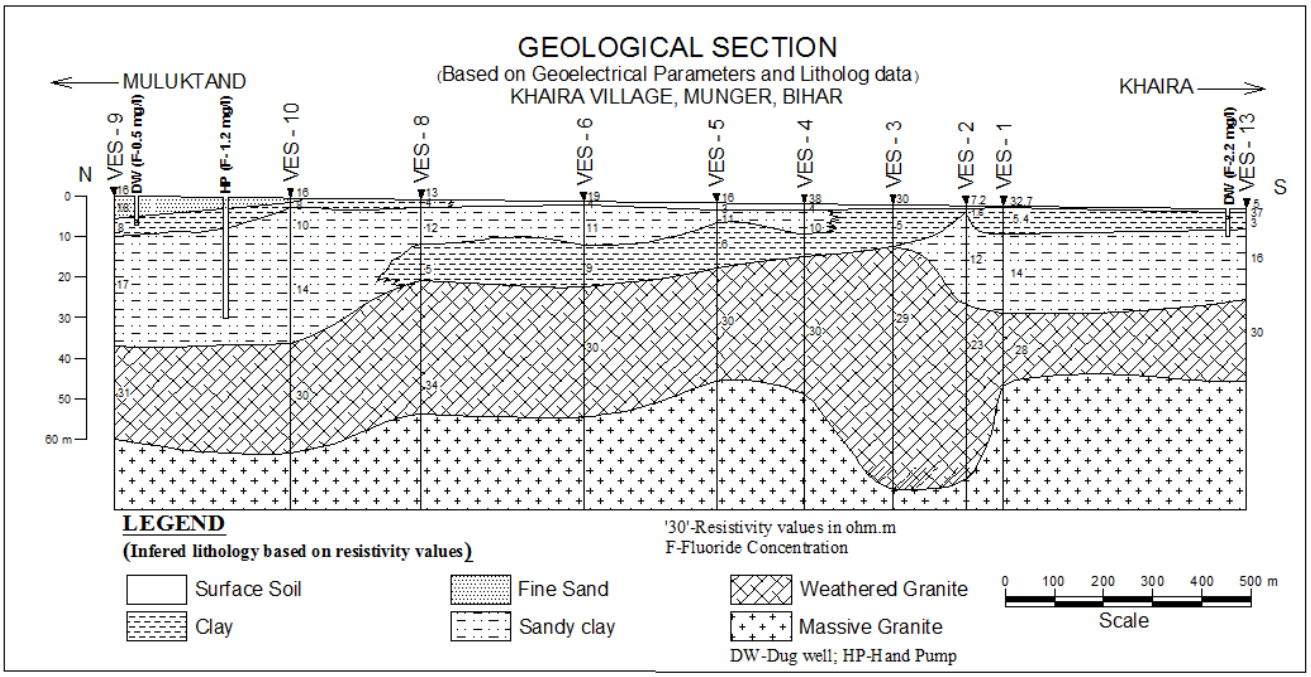

Fig16: *Cross-section A-A' (N-S direction*)

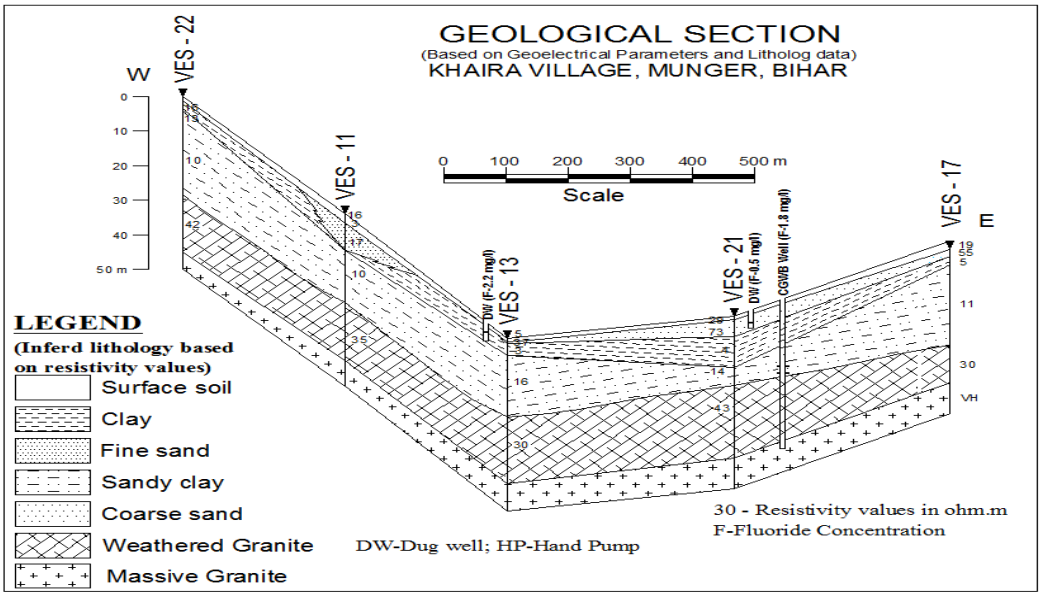

Fig17: *Cross-section B-B' (E-W direction)*

Following conclusion are drawn based on the study

- The fluoride concentration in groundwater in the study area is strongly influenced by its interaction with hydrogeologic condition such as lithology, flow path and residence time. This study also

confirms that at Khaira village, in general, fluoride concentration in groundwater is above the upper limit proposed by WHO for human consumption.

- A coarse sand bed is present at eastern part of Khaira village, which has maximum thickness at VES-21. This bed forms fluoride safe aquifer. This zone needs to be sustained and to be recharged through dug well recharge process. This zone can be exploited through dug well only for catering the need for drinking water.
- Sandy clay zone extending up to the average depth of 20-25 m with 10-15m average thickness is fluoride-contaminated aquifer at Khaira village. Tapping this aquifer for drinking water purposes must be avoided.
- At Muluktand village, dug wells tapping the top fine sand bed which is fluoride safe and hand pumps tapping the sandy clay zone is relatively safe for drinking water purposes. This sandy clay aquifer is not in hydraulic contact with the sandy clay aquifer at Khaira village; hence it has remained relatively fluoride safe aquifer.
- Fluoride contamination is mainly controlled by the lithological set up of the study area and residence time of groundwater for rock water interaction.

Table 4B: *Interpreted VES Results*

Dist	Block	Vill	Longitude	Latitude	□1	□□	□□	□□	□□	□□	□□	h□	h2	h□	h4	h□	h6
Munger	Karagpur	Khaira	86.55719	25.09963	32.7	5.4	14	28	VH	-		0.5	6.5	19.6	16.5	-	-
Munger	Karagpur	Khaira	86.55740	25.10048	7.2	1.6	11	23	VH			0.8	1	22.6	43	-	
Munger	Karagpur	Khaira	86.55808	25.10180	30	5	29	VH	-	-		1	9.4	60	-	-	-
Munger	Karagpur	Khaira	86.55923	25.10350	38	4	10	30	VH	-		1.2	0.6	11.5	32.5	-	-
Munger	Karagpur	Khaira	86.55935	25.10609	16	3	11	6	30	VH		1	0.8	3	11	25	-
Munger	Karagpur	Khaira Village	86.55821	25.10885	19	4	11	9	30	VH		1	0.7	9	21.1	32.4	-
Munger	Karagpur	Khaira Village	86.56046	25.11038	11	17	11	47	VH			1	4	28.6	23	-	-
Munger	Karagpur	Khaira Village	86.55821	25.11191	13	4	12	5	34	VH		1	0.8	9	8.8	33.5	-
Munger	Karagpur	Khaira	86.5	25.116	16	18.	8.2	17	31	VH		1	4.3	4.5	26.	23	-

Dist	Block	Vill	Longitude	Latitude	□1	□□	□□	□□	□□	□□	□□	h□	h2	h□	h4	h□	h6
		Village	5787	72		2									6		
Munger	Karagpur	Khaira Village	86.55600	25.11323	16	8	10	14.1	30	VH		1	0.8	10	25	27	-
Munger	Karagpur	Khaira Village	86.55527	25.09759	15.6	3	17	10	35	VH		2.2	0.5	8	15	17	-
Munger	Karagpur	Khaira Village	86.55578	25.09559	9	3	9	22	VH	-		1	0.5	7	19.5	-	-
Munger	Karagpur	Khaira Village	86.55740	25.09478	5	37	3	16	30	VH		1	0.5	3.5	17	20	-
Munger	Karagpur	Khaira Village	86.55880	25.09470	13	6	18	28	VH	-		5	3	9	14.5	-	-
Munger	Karagpur	Khaira Village	86.56008	25.09380	97	73	3	76	VH	-		1	3	4	20.4	-	-
Munger	Karagpur	Khaira Village	86.56492	25.09737	19	55	5	11	30	VH		2.3	2.1	3	22	11.4	-
Munger	Karagpur	Khaira Village	86.56492	25.09810	29	73	4	15	44	VH		1	5	8.4	5.2	21	-
Munger	Karagpur	Khaira Village	86.56152	25.09614	16	13	10	42	VH	-		1.3	3.5	26	14	-	-

5.0 Ground Water Resource Availability and Extraction

As per dynamic ground water resource of Bihar 2020 annual extractable ground water resource is 4924.35 ham, Total annual ground water recharge is 5471.50 ham and net ground water availability for future use is 2520.61 ham. Stage of ground water extraction is 47.63% and the block is categorized as safe.

Block	Total Area of Assessment Unit (Ha)	Recharge Worthy Area(Ha)	Total Annual Ground Water (Ham) Recharge	Total Natural Discharges (Ham)	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 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semicritical/Safe/Saline)
Haveli Kharagpur	30679	26864	5471.5	547.15	4924.35	1754.4	117.00	473.90	2345.3	532.34	2520.61	47.63	safe

Table 5A: Dynamic Ground Water Resource (as on 22nd March, 2021

5.1 Chemical Analysis

Result of chemical analysis of ground water of shallow aquifer is given in the table below (*Table 5B*). In general, chemical quality of shallow aquifer is potable. . Few areas in the block have been reported with Fluoride contamination in ground water.

Table 5B- Result of Chemical Analysis of Ground Water Samples

S.No	District	Block	Village	Lat	Long	pH	EC (µs) /cm at 25	TDS	TH	Ca	Mg	Na\	K	HCO3	F	SO4
1	Munger	Haveli Kharapur	Gangta Morh	25.04	86.51	7.8	625	406	176	20	26	79	0.9	231	0.55	37
2	Munger	Haveli Kharapur	Gobadda	25.19	86.59	8.1	874	568	371	32	82	55	0.8	421	0.82	37

(Source: NHS data-2020)

6.0 Management Plan

6.1 Supply side intervention in Agriculture and Irrigation

From the existing land/agriculture and irrigation data it is understood that the block is principally agricultural depending. However, the average cropping intensity is recorded as 130 %. It reveals that considerable cropped area is not under assured irrigation coverage. As per the dynamic ground water resource,2020, stage of development in Kharagpur block is 47.63 % which indicates there exist further scope of ground water development in the block both for agriculture and drinking/domestic purposes. 5th MI Census data shows that majority of irrigation tube wells accompanied within the depth of 50-70 m. Therefore, further development may be planed from the deeper part.

Considering projected 70% development 1101.75 ham further resources may be developed safely for irrigation development. This balance resource is recommended for development through LDTW/STW/DTW as per the prevailing terrain condition and hydrogeology of the area. Considering unit draft of 0.67, 2.4 and 4.8 for LDTW, STW and DTW respectively, following number of irrigation structures have been proposed. In Haveli Kharagpur block 410 LDTW, 252 STW and 46 DTW may be constructed. (*Table 5A and 5B*). The Large Dia Dug Wells may be effective for generation of small command area in otherwise water scare area.

Table 6A- Additional resource for 70% development

Assessment Unit Name	Total Area of Assessment Unit (Ha)	Recharge Worthy Area (Ha)	Annual Extractable Ground Water Resource (Ham)	Total Extraction (Ham)	Draft for 70% development (Ham)	Additional resource available for 70 % development (Ham)
Haveli Kharagpur	30679	26864	4924.35	2345.3	3447.045	1101.745

Table -6B Recommended number of structures for further irrigation development

Additional resource available for 70% development (Ham)	Resource allocated for development by LDTW (Ham)	Resource allocated for development by STW (Ham)	Resource allocated for development by DTW (Ham)	Unit draft of LDTW (Ham)	Unit draft of STW (Ham)	Unit draft of DTW (Ham)	No. of LDTW proposed	No. of STW proposed	No. of DTW proposed
1101.745	275.43625	605.960	220.349	0.672	2.4	4.8	410	252	46

6.2 Supply side intervention through Artificial Recharge and rain water harvesting

Based on post monsoon water level, long term water level trend, local geological and geomorphological settings and availability, non-committed surplus runoff, the feasibility of artificial recharge to augment ground water resources in the Haveli Kharagpur block has been worked out (Artificial Recharge Master Plan, 2019). An area of 29.04 Sq. km has been found as suitable for artificial recharge in the block. Based on the local geology / hydrogeology and underlying lithological disposition Contour bunding and trenching , gulley plugs, check dams, recharge shafts, injection wells in village tank, de-silting of existing tank/ talao / pond may be practiced in Kharagpur block. The tentative number of the above structures is as follows

Tentative no. of structure for artificial recharge in Haveli Kharagpur block

Gully Plugs	Contour Bunding and trenching	Check dams	Recharge Shafts	Desilting of existing tanks/ponds/talao	Injection well in village tanks
4	4	3	7	12	16

6.3 Demand side intervention

Considering the fact, that, a considerable area in the block faces water scarcity during summer, water intensive crop to some extent may be replaced by less water consuming crop. Therefore, pulses, oilseeds other horticulture crops etc., as per the local requirement may be encouraged. This may create further irrigation potential in the block. Suitable crop rotation may be practiced.

6.4 Ground water contamination

The block has been reported with fluoride contamination in ground water. Therefore, before using of ground water from shallow or deep tube wells for drinking, domestic and irrigation purpose, monitoring of water quality is mandated for fluoride contamination. Domestic fluoride removal technique may be adopted for short term measures whereas for long term intervention, commercial fluoride removal plan may be installed. As per the geophysical studies in the block fluoride safe area in Khaira village, of the block has been suggested.

Capacity building for awareness generation among the stake holders and end users may be a suitable approach to address and to mitigate fluoride contamination in the ground water.

AQUIFER MAPS AND MANAGEMENT PLAN OF SANGRAMPUR, BLOCK IN MUNGER DISTRICT, BIHAR

1. Salient Information

Name of the Block of Aquifer (in Km^2)	Sangrampur/ 85.94 sq km
District/State	Munger/Bihar
Population	Total- 97729 Rural- 97729 Urban- 0
Rainfall	Normal Monsoon- 970.80 Non-monsoon rainfall- 202.80
Agriculture and Irrigation	Principal crops - Rice – Wheat, Rice – Gram, Rice – Lentil, Rice – Rai Gross cropped area-6336 Net sown area- 4734 Irrigation practices - Surface water by canal -Ground water by tube well and LDTW Cropping intensity- 131%, Number and types of abstraction structures- STW- 540, MTW- 58, DTW- 140
Geology	Older alluvium, Chhotnagpur Gneiss Complex
Geomorphology	Major Physiographic units- Hill, Pediplain, Alluvial plain Major Drainage- Ganga, Badua-Chandan, Sunder-Gumani Sub basin
Ground water resource availability and extraction	Annual Extractable Ground Water Resource (Ham)-2303.7 Net Ground Water Availability for future use (Ham)- 1054.18 Ground water extraction (Ham)- 1228.76
Existing and future water demand	1228.76 Ham/ 189.13 Ham (annual GW allocation for domestic as on 2025)

Water level behaviour	Pre-monsoon SWL- 6.30-8.60 mbgl Post-monsoon SWL- 1.20-2.86 mbgl

2. Aquifer Disposition

Number of Aquifers	02; up to the explored depth of 60m
3D aquifer disposition and basic characteristics of each aquifer	1st Aquifer from 19m to 27m, fine sand mostly phreatic, 2nd Aquifer from 30m to 48m, medium to coarse sand, Semi-confined to Confined

3. Ground water resource, extraction, contamination and other issues

GW Resource/Categorization Availability	Safe
Chemical quality of ground water and contamination	Potable The block has been reported with fluoride contamination in ground water

4. Supply Side Interventions

Ground Water Development Strategies-	Number of LDTW, STW and DTW may be proposed for irrigation uses- LDTW- 64 STW-96 , DTW-24
Aquifer wise space available for recharge and proposed interventions	As per ARMP, 2020, for Munger district 345.84 sq. km is suitable for recharge, Volume of de-saturated zone in the district 193 MCM. Percolation tanks, desilting of existing tanks, check dam/Nalabunds, renovation of Ahar-Pyne system etc. are some suitable structures in the area

5. Demand side interventions

Advanced Irrigation Practices	Project based drip/sprinkler irrigation, lining of field channels etc.
Change in cropping pattern	Less water intensive crop like pulses, oilseeds may be encouraged.
Alternate water sources	Conjunctive uses of groundwater/surface water sources,
Regulation and Control	Capacity building for awareness generation to combat fluoride contamination in ground water.

1.0 General Information

1.	Total area		:	85.94 sq km
2.	Total number of Panchayat		:	10
3.	Total number of villages		:	76
4.	Population (Census 2011)	Total	:	97729
		Rural	:	97729
		Urban	:	-
5.	Normal annual rainfall		:	1173.6 mm
6.	Basin / Sub-basin		:	Ganga Basin / Badua-Chandan, Sunder-Gumani Sub basin
7.	Location			
	Latitude		:	24.945760 to 25.059513
	Longitude		:	86.505860 to 86.668280

Sangrampur is a block in Munger district of Bihar State, India. Sangrampur block head quarter is Sangrampur town. It belongs to Munger division. Sangrampur block is located between 24.945760, 25.059513 latitude and 86.505860, 86.668280 longitude. The block is surrounded in the north by Tetiya bamber block, in the south by Banka district in the west by Jamui district and in the East by Banka district (*Fig-1*).

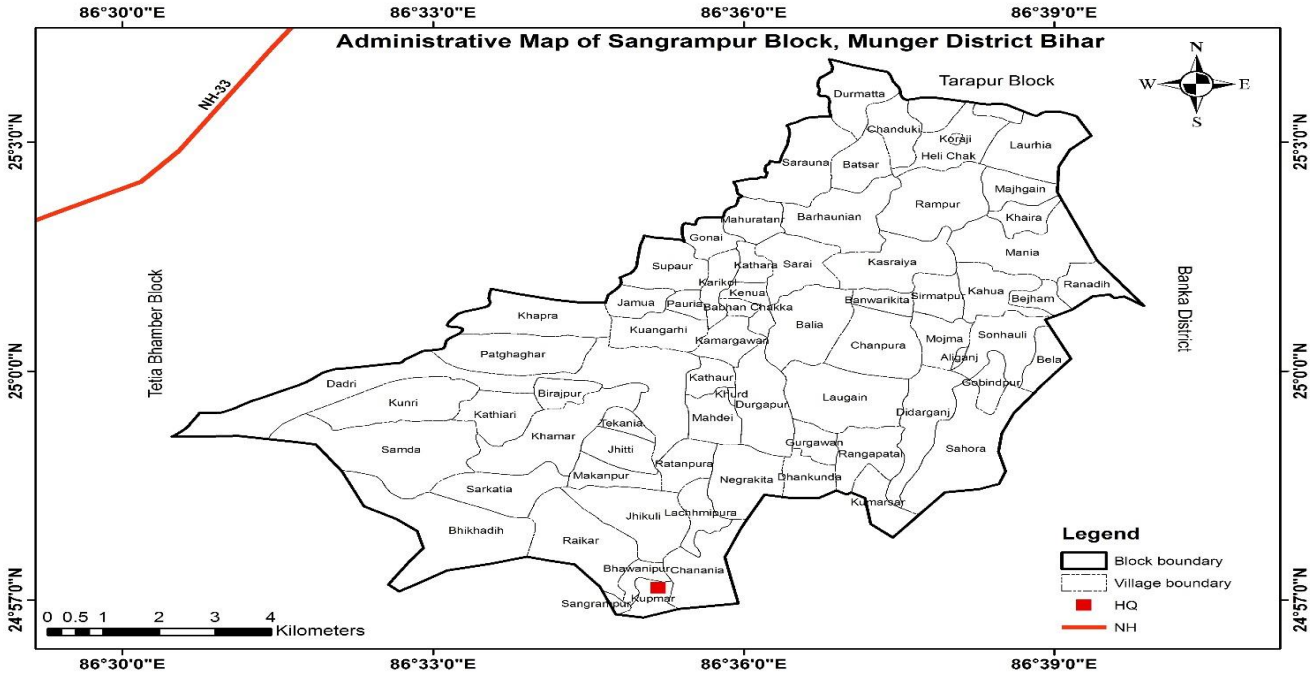

Fig-1 Administrative Map of Sangrampur Block, Munger District

1.1 Basic demographic detail of Sangrampur block (Census 2011)

As per census 2011 the total population of Sangrampur block is 97729 total population of this block live in rural area. There is no urban area in this block.

Table 1A- Population of Sangrampur block

	Rural Population	Urban Population	Total
Block	97729	-	97729

The block consists of 10 Gram Panchayets, 76 villages and 13,906 households *(Table 1B)*.

Table 1B- List of panchayat wise villages of Sangrampur block

S.No.	Panchayat	Villages
1	Balia	13
2	Barhaunia	02
3	Dadri Jala	07
4	Didar Ganj	11
5	Durgapur	11
6	Durmatta	05
7	Jhikuli	07
8	Katiyari	07
9	Kusmar	04
10	Rampur	09
	Total	**76**

1.2 Rainfall and Temperature

Normal annual rainfall of Sangrampur block is 1173.6 mm of which 85.46% occurs during the monsoon season. The normal rainfall during monsoon season is 822.2 mm and during non-monsoon season is 76.8 mm. The variation of rainfall in this zone is from 1173.6 mm to 899.0 mm and the temperature varies from 44 to 6˚C.

1.3 Distribution of persons engaged in agriculture and other workers/ non workers in the block

In Sangrampur block, 77% of total population is non workers. It is evident from below diagram that 13% of the total population in the block is engaged in agriculture, 3% are cultivator, 1% comprises household industrial workers and 6% comprises other worker (*Fig-2*).

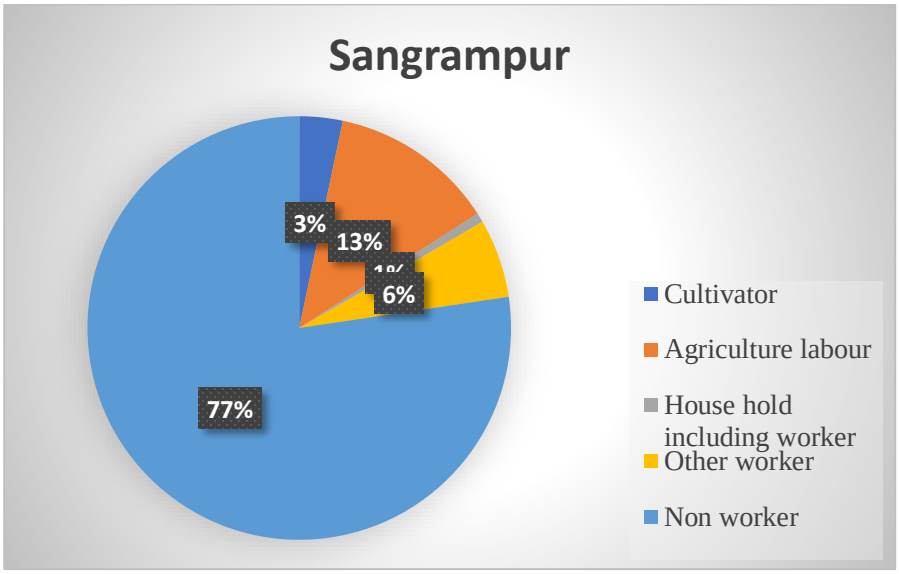

Fig 2- Distribution of persons engaged in Sangrampur block *Source- Census 2011*

1.4 Soil

Sangrampur block contains mainly calcareous sandy soils, coarse loamy soils, fine loamy Soils, clayey soils with pH in the range of 6.8 – 8.0 (*Fig-3*).

1.5 Physiographic, Basin/sub-basin, and Drainage:

The Sangrampur block forms a part of Badua-Chandan, Sunder-Gumani sub-basin of the Ganga Basin. The block is having moderate to low drainage density. Parallel to sub-parallel drainage patterns are dominating in the block. Major rivers of the district are Ganga, Man, Belharni and Mahana. The Ganga flows to the east, but it takes northward turn near Munger town. Other rivers flow towards NNE and join the Ganga. Except the Ganga River, all are ephemeral in nature, having meager water during lean periods.

The block having average elevation of 44 metres (144 feet). Sangrampur block represent a flat terrain and the entire block is with land slope of 0-3% ha.

1.6 Geomorphology

Older alluvial Plain is represented in major part of Sangrampur block and it is made up of sediments derived from the denudation of Chota Nagpur Plateau and Kharagpur Hills. Other geomorphic features includes structural hills, valleys , pediplain complex. (*Fig- 4*).

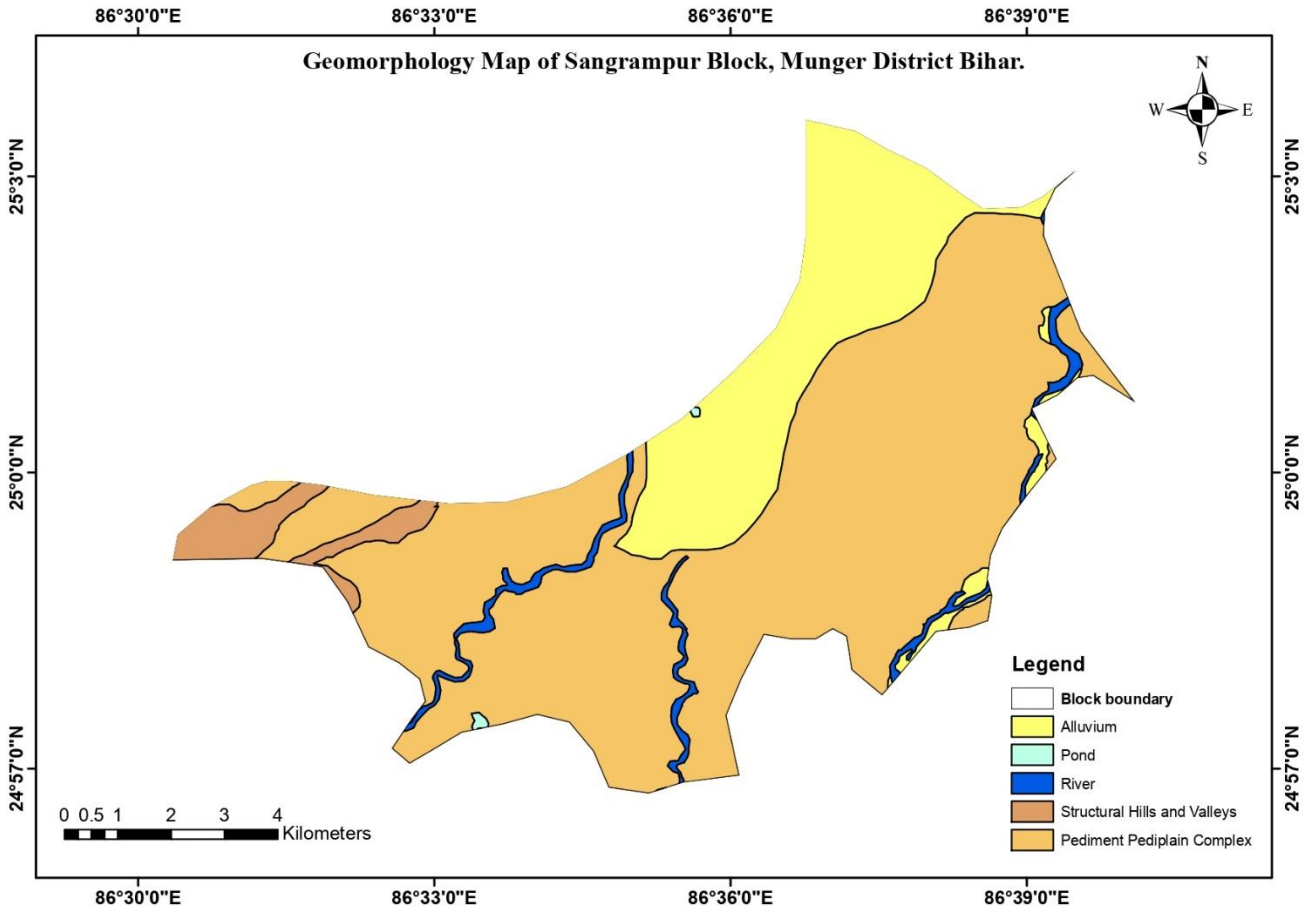

Fig 4- Geomorphology Map of Sangrampur block

1.7 Land use pattern

Total geographic area of the Sangrampur block is 8594 ha among which net sown area 4734 ha and gross cropped area is 6336 ha. Therefore, area under multiple cultivation is 1602 ha and 2897 ha area is under waste land. It is evident that net sown area is 55.08%, area under multi cultivation is 18.64% and waste land is 33.70 % of the total geographic area. The cropping intensity of the block is 134% *(Table-1C).*

Table 1 C- Details of Land use pattern of block (area in ha)

Name of the block	Total Geographical area	Gross cropped area	Net sown area	Area sown more than once	Cropping intensity	Area under forest	Area under wastel and	Area under other uses
Sangrampur	8594	6336	4734	1602	134%	0	2897	963

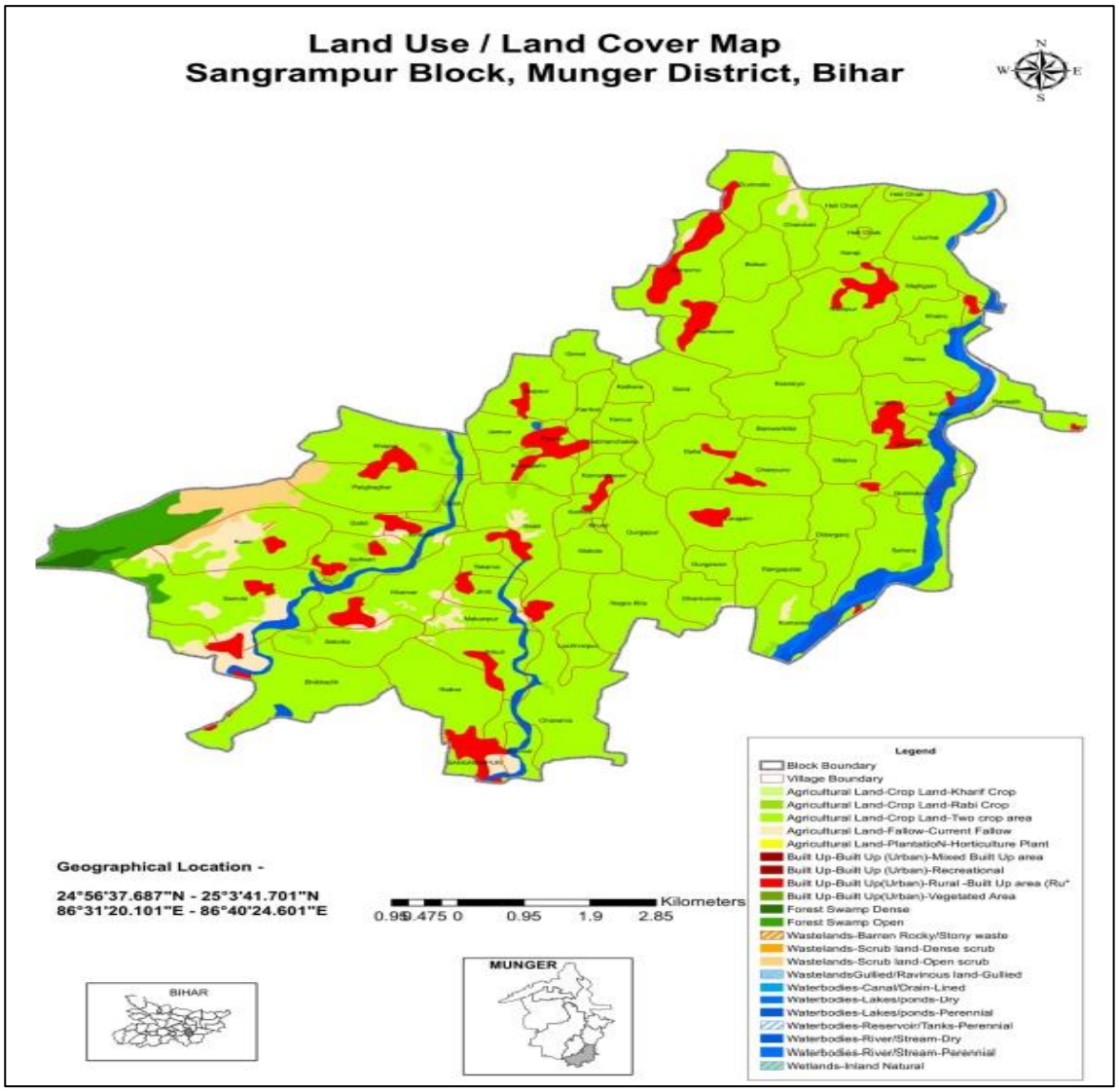

Fig 5- LULC Map of Sangrampur block *(Source- DIP-2019)*

1.8 Agriculture and Irrigation

Sangrampur block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice – Wheat, Rice – Gram, Rice – Lentil, Rice – Rai. Out of the total area under cultivation in the block, 43.8% area (4350 ha) is covered by cereals crop during Kharif season, 16.1% (1600 ha) during Rabi season and 0.2% (20 ha) during summer season.

The irrigation by surface water canals is provided in Sangrampur block, besides a large area is irrigated by ground water irrigation by tube wells and large diameter dug wells. Majority of the ground water structures are fitted with diesel-operated pumps. The numbers of irrigation structure as per 5th MI Census are presented in Figure-6.

Table 1D- of MI structure in Sangrampur block

DW	STW	MTW				DTW
		35-40m	40-60m	60-70m	TOTAL	
36	540	1	32	25	58	140

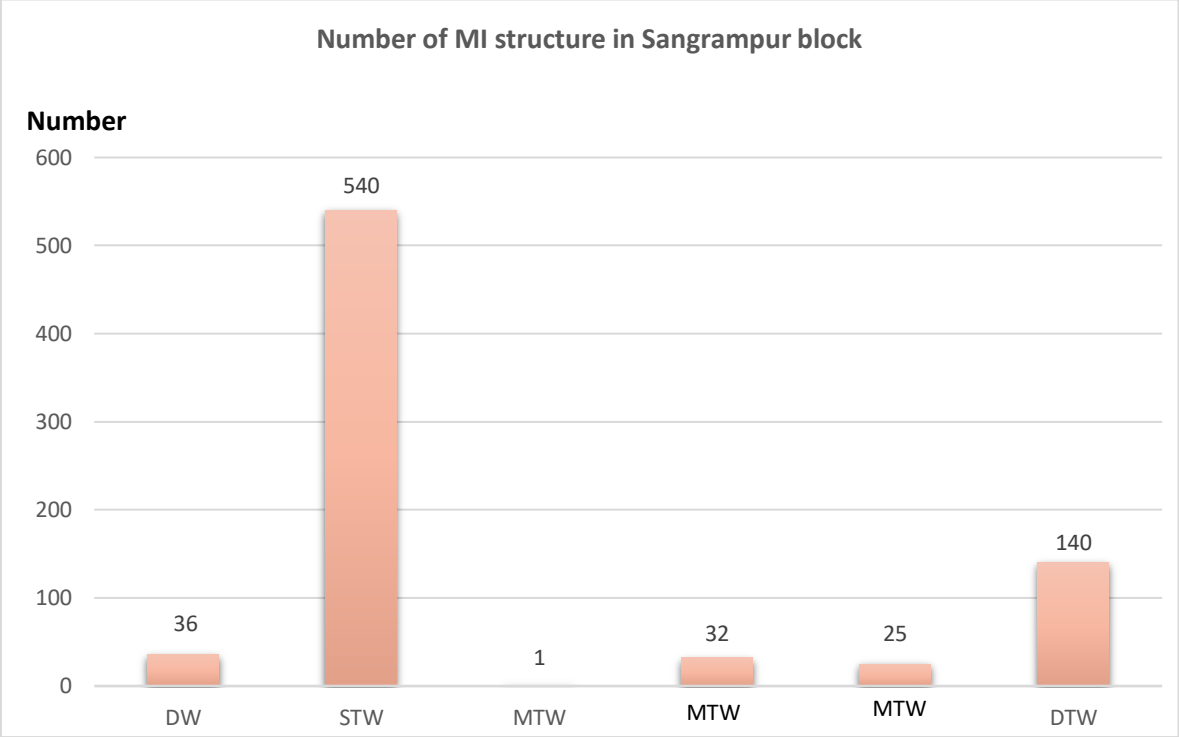

Fig 6- No. of MI structure in Sangrampur block

2.0 Geology

The block is mainly covered by older alluvium deposit of quaternary period which comes under Belhar Formation of middle Holocene age and western most part of the block is covered by Pre-Cambrian Granite Gneiss. The nature and characteristics of this formation is semi unconsolidated and consist of fine sand feebly oxidized. In the western part few area is under Chotanagpur gneissic complex of Proterozoic age .Chhotanagpur Gneissic Complex consist of thick beds of low grade metamorphic e.g., phyllite, slate, quartzite and quartz-sericite schist. It is underlain by Precambrian formation. The average thickness of this alluvium in this block is about 45m. (fig -7).

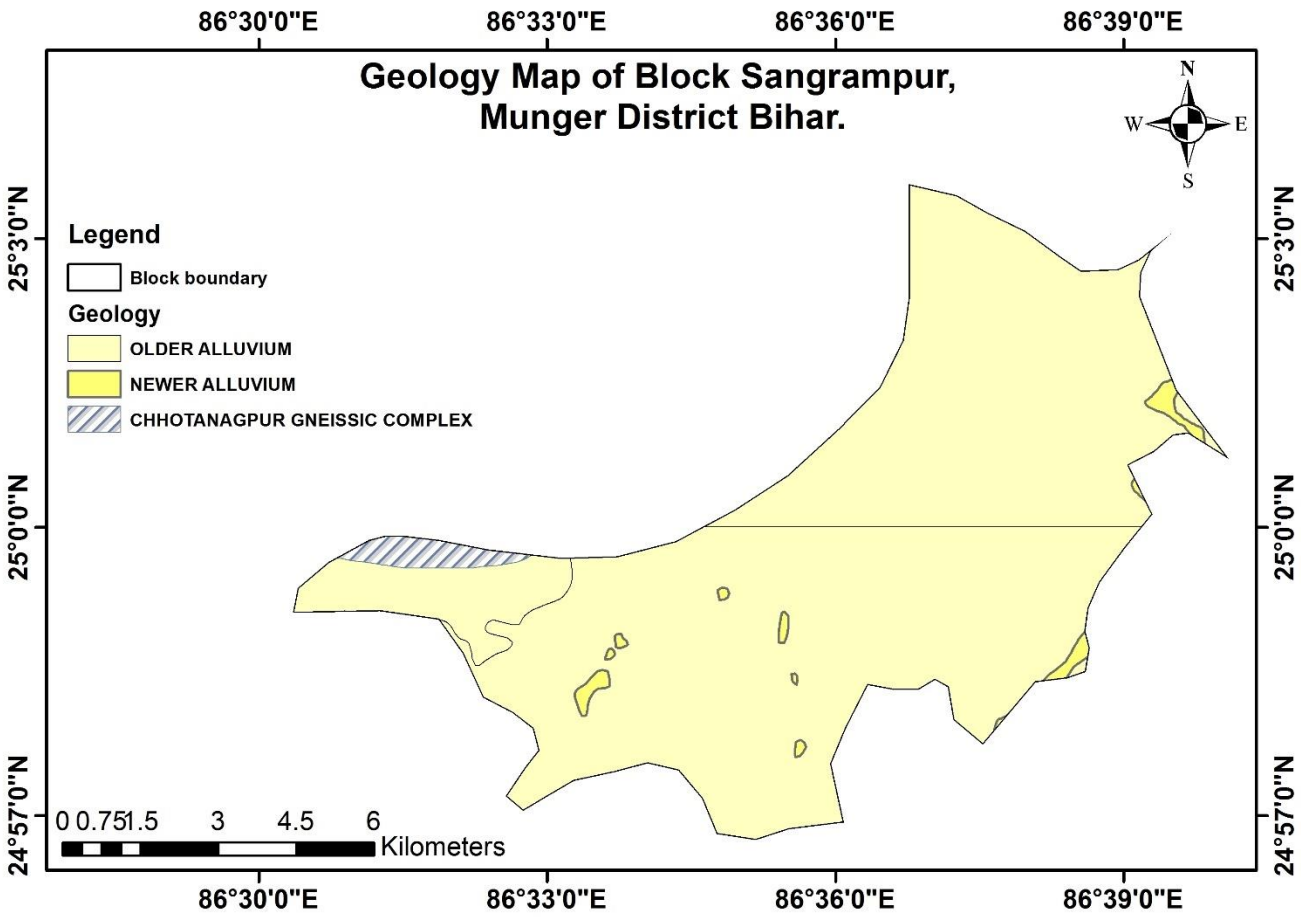

Fig 7- Geology Map of Sangrampur block, District Munger Bihar

3.0 Hydrogeology

Some part of block is made up of the rock of Chotanagpur Gneissic Complex (CGC) and Kharagpur Formation, which is mainly composed of granite gneisses, quartzite and phyllites. In general, these rocks possess poor aquifers until or unless secondary porosities are developed by means of weathering and or fracturing. The area possesses diverse ground water potential. Sessional fluctuation of depth of groundwater level ranges from 3.93m to 7.4m. Shallow aquifer (<50m) found in this block yield ranging from 10 to 100 m^3/hr. Average discharge of STW/MDTW and DTW may safely be assumed as 25m^3/hr and 50 m^3/hr respectively.

3.1 Aquifer Disposition

In absence of exploratory well data in the block, lithologs of the adjacent blocks have been used to decipher aquifer disposition in Sangrampur block. Utilising the lithologs of exploratory well drilled at Ramankabad, Khaira and Bamber, a cross section has been prepared. Cross section shows two aquifer layers separated by clay layers. The 1st aquifer is about 10 m thick at Ramankabad and about 20 m thick at Bamber. 2nd aquifer, comprising medium to coarse sands constitute the principal water bearing zone in the area. The coarse sands layer is often underlain by hard crystalline granitic rock. Section depicting the aquifer is shown below (fig 8).

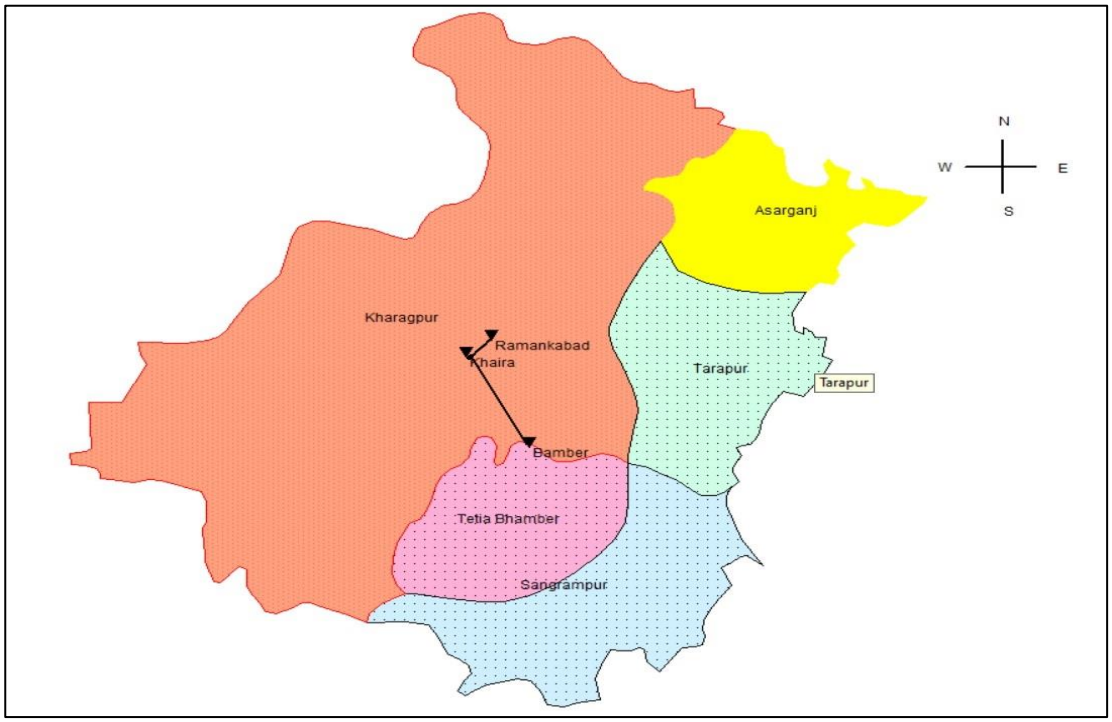

Fig.8a Location of the boreholes

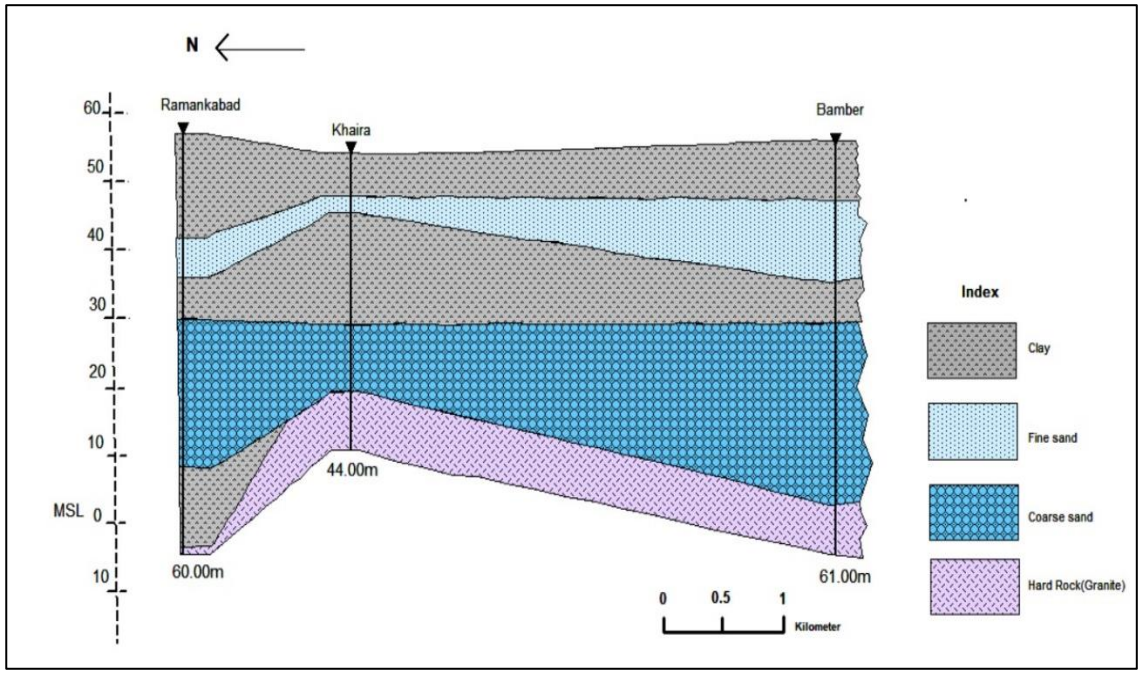

Fig 8b- Diagram showing Aquifer disposition

3.2 Water Level Behaviour

The Ground water regime of the block has been monitored from the existing network monitoring wells, inventoried observation wells. Observation wells are private dug wells, piezometer of minor irrigation department (MID) Government of Bihar and deep tube well of PHED Government of Bihar.

In existing network monitoring wells depth to water level varies from 6.30 to 8.60 mbgl during pre-monsoon season. In post monsoon season, the depth to water level varies from 1.20 to 2.10 mbgl.

Water level measured in piezometer of minor irrigation department 6.79 mbgl during pre-monsoon season and in post monsoon season water level is 2.86 mbgl.

The water level fluctuation between pre-monsoon and post-monsoon ranges from 3.93m to 7.40m in this block.

Table 3A- Water level in Sangrampur block

Sl No	Block_Name	Type_of_Well	Latitude	Longitude	RL	Depth (mbgl)	Pre-monsoon/ SWL mbgl	Post-monsoon SWL/mbgl	Fluctuation (m)	Pre WT (m amsl)	Post WT (m amsl)
1	Sangrampur	DW/ NHNS	24.9529	86.59744	85	10.30	6.3	2.1	4.2	78.7	82.9
2	Sangrampur	DW/ NHNS	25.0351	86.6384	67	9.20	8.6	1.2	7.4	58.4	65.8
3	Sangrampur	Pz	24.963	86.588	83	50.00	6.79	2.86	3.93	76.21	80.14

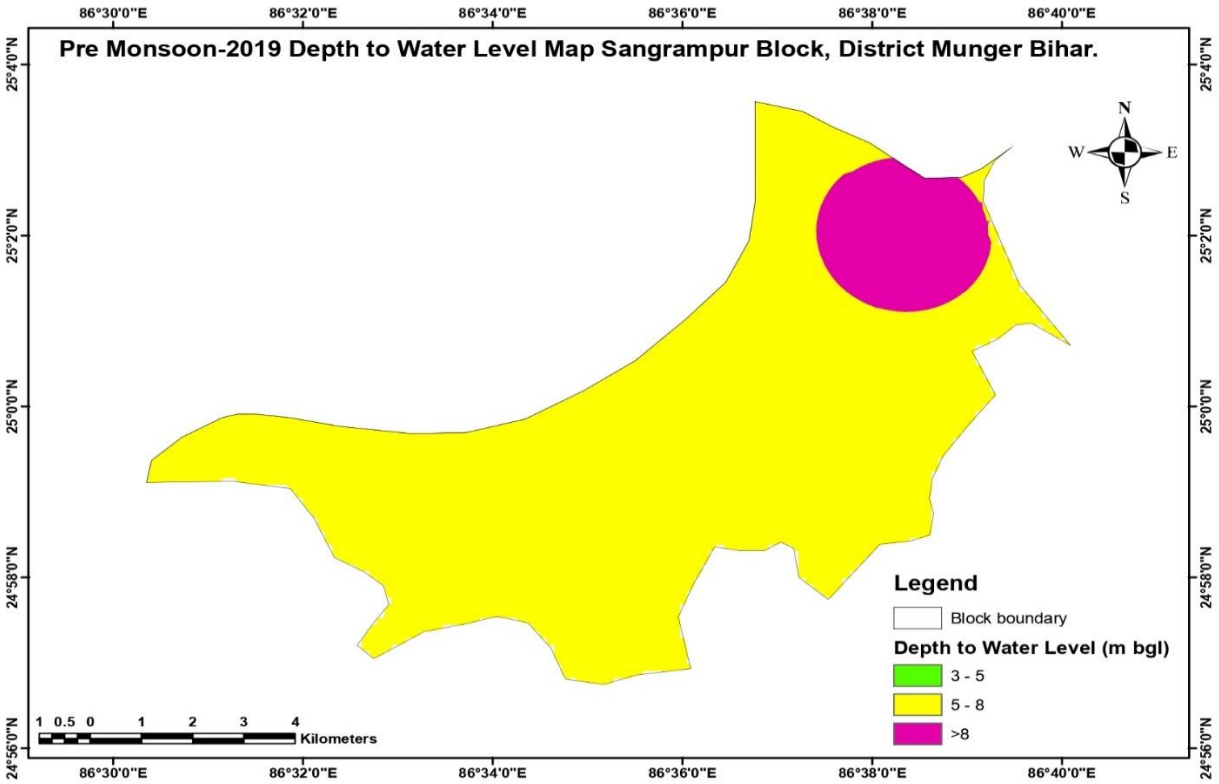

Fig 9- Pre-monsoon (2019) water level Map of Sangrampur Block

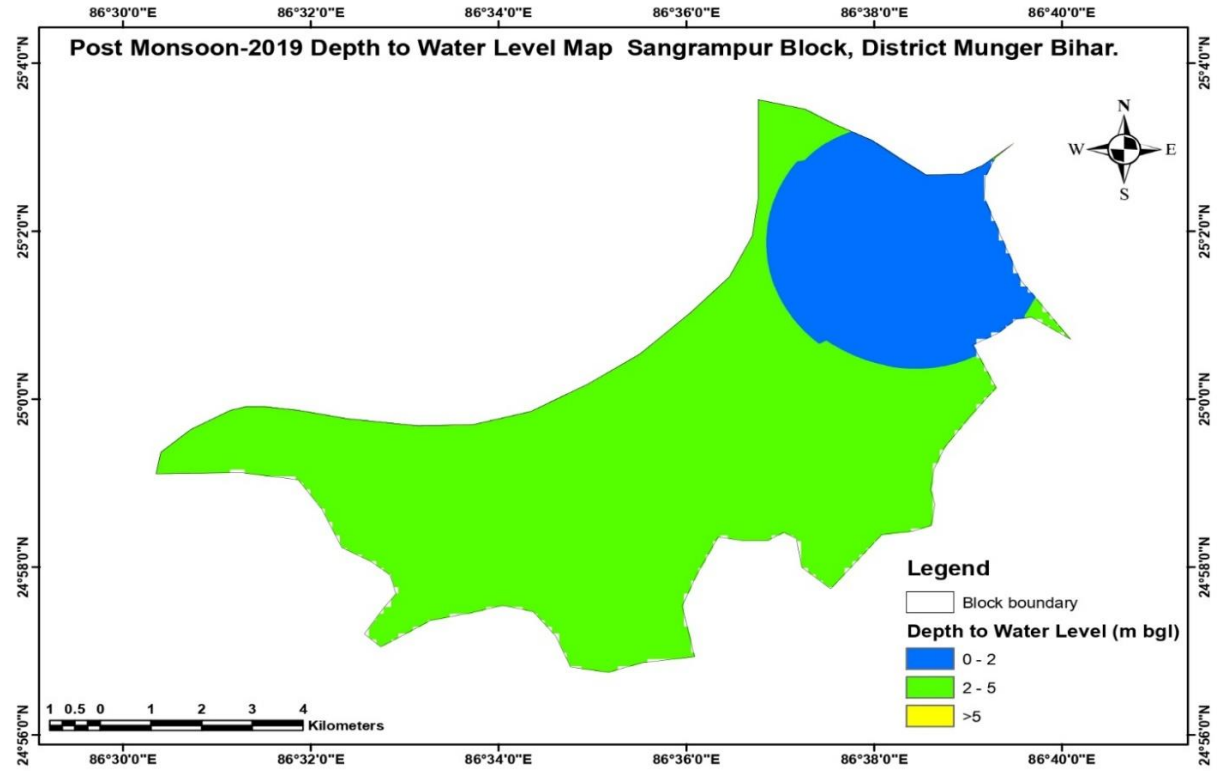

Fig 10- Post-monsoon (2019) water level Map of Sangrampur Block

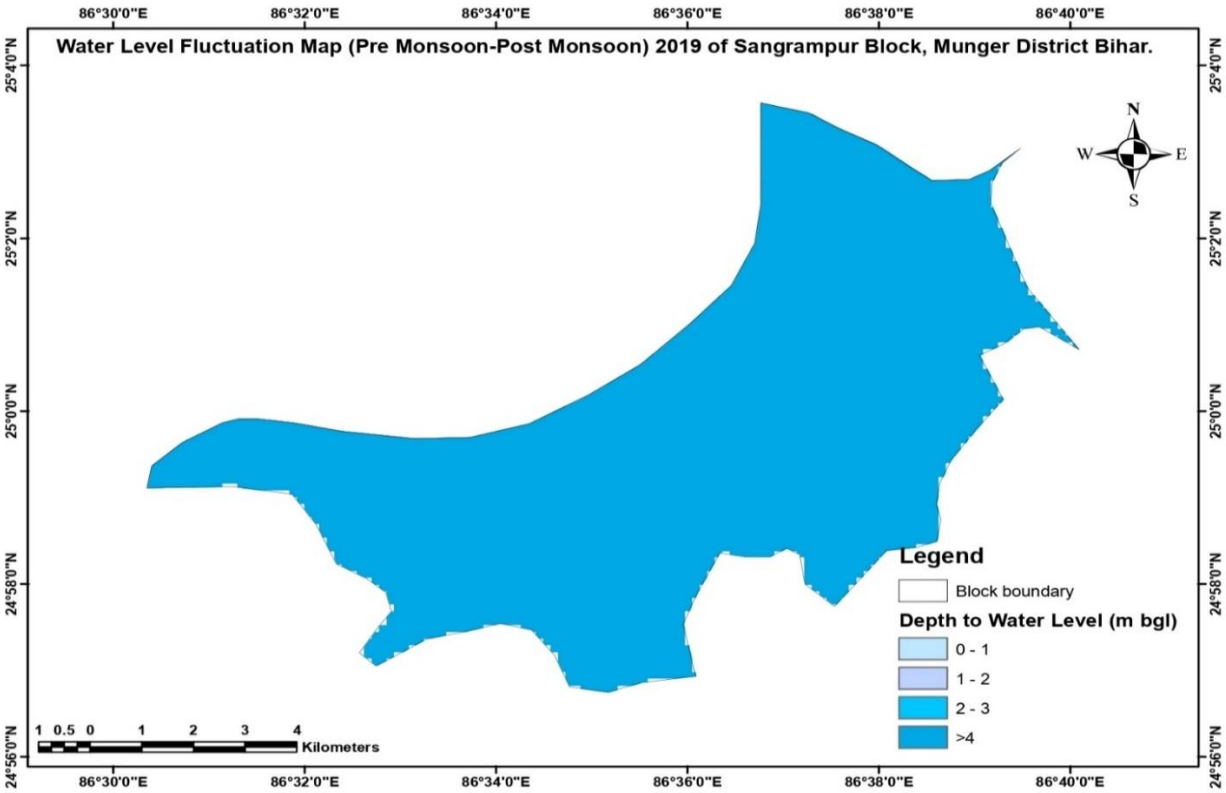

Fig 11- Water level Fluctuation Map (pre-monsoon- post monsoon 2019) of Sangrampur Block

3.3 Water table contour

The water table contour map of Sangrampur block shows the height of water table during pre-monsoon season varies from 58.4 to 78.7 m and during post monsoon season height of water table varies from 65.8 to 82.90 m above from mean sea level. As shown in map, ground water flow direction is towards NE direction in this block (fig-12).

3.4 Aquifer properties

Sangrampur block comprises moderate to high potential zone. From the exploratory well data of CGWB. the discharge of the deeper aquifer in Munger district may vary from 31- 160.70 m^3/hr with average drawdown 8-10 m. The transmissivity of the aquifer varies 697.88 m^2/day specific capacity 19.29 m^3/hr/m and storativity is 4.5×10^{-4}

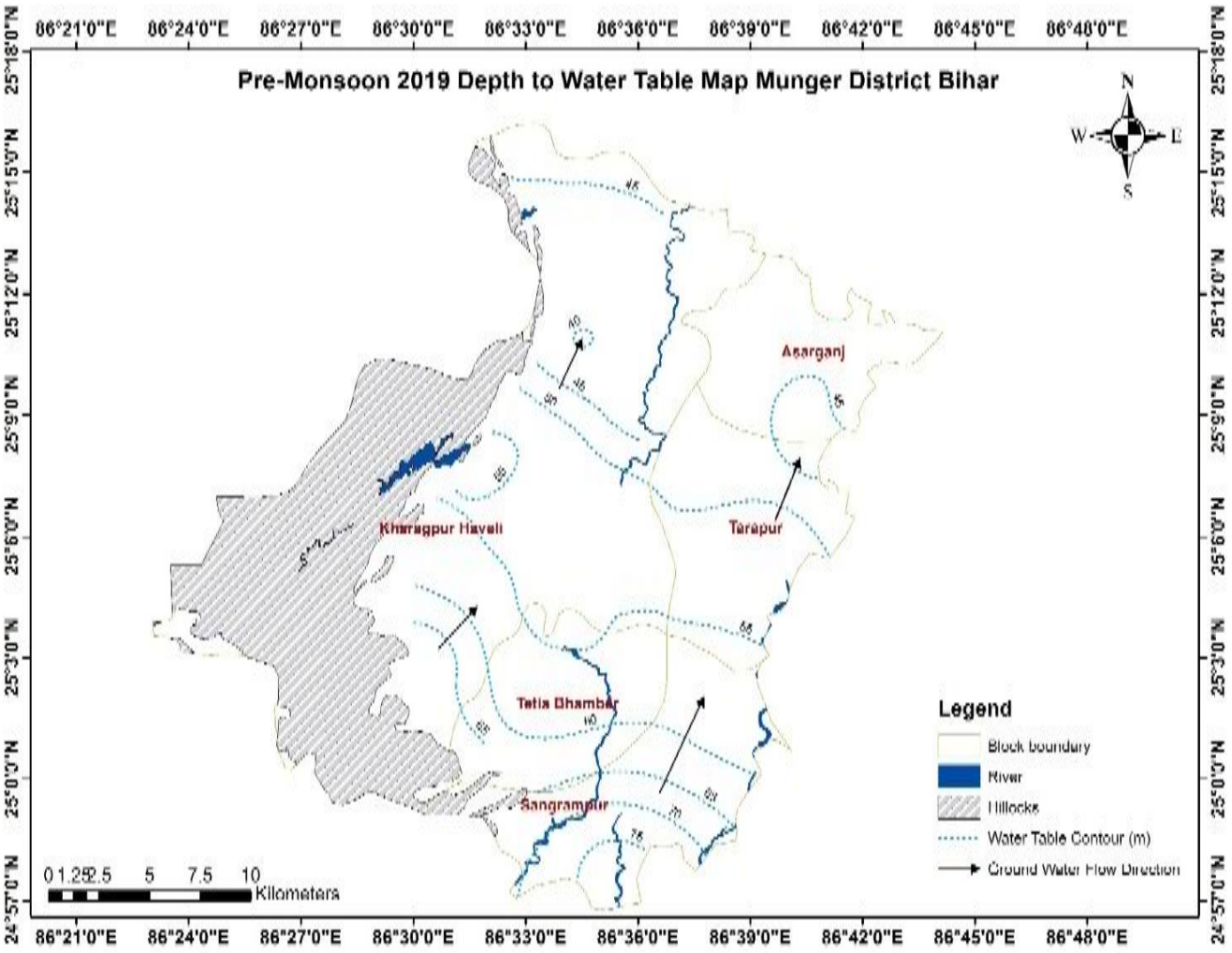

Fig 12: Pre-monsoon (2019) water table contour Map of Sangrampur Block

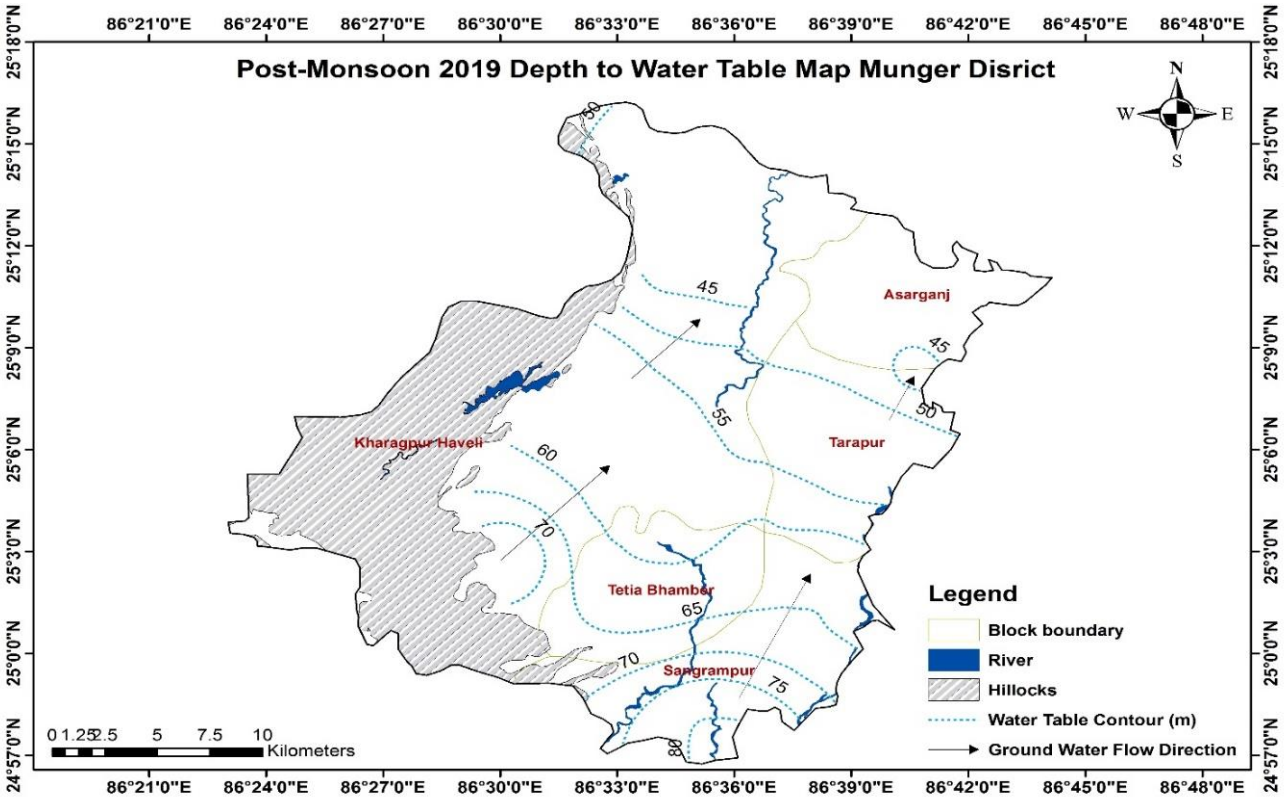

Fig 13: Post-monsoon (2019) water table contour Map of Sangrampur Block

4.0 Ground Water Resource Availability and Extraction

As per dynamic ground water resource of Bihar 2020 annual extractable ground water resource is 2303.7 ham, Total annual ground water recharge is 2559.67 ham and net ground water availability for future use is 1054.18 ham. Stage of ground water extraction is 53.34% and the block is categorized as safe.

Table 4A: Dynamic Ground Water Resource (as on 22nd March, 2021)

Block	Total Area of Assessment Unit (Ha)	Recharge Worthy Area(Ha)	Total Annual Ground Water (Ham) Recharge	Total Natural Discharges (Ham)	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 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semicritical/Safe/Saline)
Sangrampur	8594	8594	2559.67	255.97	2303.7	1006.4	54.00	168.37	1228.76	189.13	1054.18	53.34	safe

4.1 Chemical Analysis

Result of chemical analysis of ground water of shallow aquifer is given in the table below (*Table 5B*). In general, chemical quality of shallow aquifer is potable. Few areas in the block have been reported with Fluoride contamination in ground water.

Sl. No.	District	Block	Location	Latitude	Longitude	pH	EC	TDS	TH	Ca	Mg	Na	K	CO3	HCO3	Cl
1	Munger	Sangrampur	Rampur	25.03	86.63	7.7	391	254	86	17	14	49	1.9	0	156	39

Table 4B- Result of Chemical Analysis of Ground Water Samples

(Source: NHS data-2020)

5.0 Management Plan

5.1. Supply side intervention in Agriculture and Irrigation

From the existing land/agriculture and irrigation data it is understood that the block is principally agricultural depending. However, the average cropping intensity is recorded as 134 %. It reveals that considerable cropped area is not under assured irrigation coverage. The dynamic ground water resource reports stage of development is 53.34 % which indicates there exist further scope of ground water development in the block both for agriculture and drinking/domestic purposes. 5th MI Census data shows that majority of irrigation tube wells accompanied within the depth of 50 m. Therefore, along with the present development trends, further development may be planed from the deeper part.

Considering projected 70% development 383.83 ham further resources may be developed safely for irrigation development. This balance resource is recommended for development through LDTW, STW/DTW as per the prevailing terrain condition and hydrogeology of the area. Considering unit draft of 0.67, 2.4 STW and 4.8 DTW respectively. Recommended number of irrigation structures have been proposed. Thus, in Sangrampur block 64 LDTW, 96 STW and 24 DTW may be constructed *(Table 5A & 5B).The proposed LDDW may be proved as effective for generation of small command area in comparatively water deficient hard rock and marginal area in the western parts of the block.*

Table 5A- Additional resource for 70% development

Assessment Unit Name	Total Area of Assessment Unit (Ha)	Recharge Worthy Area (Ha)	Annual Extractable Ground Water Resource (Ham)	Total Extraction (Ham)	Draft for 70% development (Ham)	Additional resource available for 70 % Development (Ham)
SANGRAMPUR	8594	8594	2303.7	1228.76	1612.59	383.83

Table- 5B- Recommended number of structures for further irrigation development

Additional resource available for 70% development (Ham)	Resource allocated for development by LDTW (Ham)	Resource allocated for development by STW (Ham)	Resource allocated for development by DTW (Ham)	Unit draft of LDTW (Ham)	Unit draft of STW (Ham)	Unit draft of DTW (Ham)	No. of LDTW proposed	No. of STW proposed	No. of DTW proposed
383.83	38.383	230.298	115.149	0.6	2.4	4.8	64	96	24

5.2 Supply side intervention through Artificial Recharge and rain water harvesting

The block receives 1007.6 mm of annual rainfall on an average but most of rain water goes as run off. Construction of suitable artificial recharge structure will help to reduce the run off as well as it also recharges the aquifers and maintain the soil moisture of the area. . As per Artificial recharge master plan following number of recharge structures have been recommended in Munger district. Percolation tank-07, Gully plug-43, contour bunding and trenching-83, Check dam-02, Nala-bunding-05, Recharge shaft-80, De-silting of existing tank /pond /talao-145, Injection Well in Village Tank-194, Renovation of traditional Ahar-Pyne System (km)-45. Based on the local geology / hydrogeology and underlying lithological disposition desiltation of existing tanks, check dam, percolation tank etc.in alluvial parts and Nala bunds, contour bunding etc. in hard rock area may be practiced in Sangrampur block.

Before construction of these recharges' structures, selection of suitable site is required for getting better benefits from these structures.

5.3 Demand side intervention

Considering the moderate potentiality of the area water intensive crop may be to some extent by replaced by less water consuming crop. Therefore pulses, oilseeds other horticulture crops etc as per the local requirement may be encouraged. This may create further irrigation potential in the block. Suitable crop rotation may be practiced.

5.4 Ground water contamination

The block has been reported with fluoride contamination in ground water. Therefore, before using of ground water from shallow or deep tube wells for drinking, domestic and irrigation purpose should be tested for fluoride contamination. Domestic fluoride removal technique may be adopted for short term measures whereas for long term intervention commercial fluoride removal plan may be installed.

Capacity building for awareness generation among the stake holders and end users may be a suitable approach to address and to mitigate fluoride contamination in the ground water.

AQUIFER MAPS AND MANAGEMENT PLAN OF TARAPUR, BLOCK IN MUNGER DISTRICT, BIHAR

1. Salient Information

Name of the Block of Aquifer (in Km^2)	Tarapur/ 71.04 sq km
District/State	Munger/Bihar
Population	Total- 110214 Rural- 91465 Urban- 18749
Rainfall	Normal Monsoon- 970.80 Non-monsoon rainfall- 202.80
Agriculture and Irrigation	Principal crops - Rice – Wheat, Rice – Gram, Rice – Lentil, Rice – Rai Gross cropped area- 8305 Net sown area- 6795 Irrigation practices - Surface water by canal -Ground water by tube well and LDTW Cropping intensity- 122%, Number and types of abstraction structures – 587 STW, 369 MTW, 42 DTW
Geology	Older alluvium
Geomorphology	Major Physiographic units- Alluvial plain Major Drainage- Ganga, Badua-Chandan, Sunder-Gumani Sub basin
Ground water resource	Annual Extractable Ground Water Resource (Ham)- 2113.17

availability and extraction	Net Ground Water Availability for future use (Ham)- 681.42 Ground water extraction (Ham)- 1400.37
Existing and future water demand	1400.37 ham/285.86 (annual GW allocation for domestic as on 2025)
Water level behaviour	Pre-monsoon SWL- 5.92- 7.21 mbgl Post-monsoon SWL- 3.1-5.6 mbgl
2. Aquifer Disposition	
Number of Aquifers	02; up to the explored depth of 60m
Aquifer disposition and basic caracteristics of each aquifer	1st Aquifer from 19m to 27m, fine sand mostly phreatic, 2nd Aquifer from 30m to 48m, medium to coarse sand, Semi-confined to Confined
3. Ground water resource, extraction, contamination and other issues	
GW Resource/Categorization Availability	Safe
Chemical quality of ground water and contamination	Potable The block has been reported with fluoride contamination in ground water
4. Supply Side Interventions	
Ground Water Development Strategies-	Number of STW and DTW may be proposed for irrigation uses- STW-25, DTW-04

Aquifer wise space available for recharge and proposed interventions	As per ARMP, 2020, for Munger district 345.84 sq km is suitable for recharge, Volume of de-saturated zone 193 MCM. Percolation tanks, desilting of existing tanks, check dam, renovation of Ahar-Pyne system etc. are some suitable structures in the area.
5. Demand side interventions	
Advanced Irrigation Practices	Project based drip/sprinkler irrigation, lining of field channels etc.
Change in cropping pattern	Less water intensive crop like pulses, oilseeds may be encouraged.
Alternate water sources	Conjunctive uses of groundwater/surface water sources
Regulation and Control	Capacity building for awareness generation for fluoride contamination

1.0 General Information

1.	Total area		:	71.04 sq km
2.	Total number of Panchayat		:	12
3.	Total number of villages		:	51
4.	Population (Census 2011)	Total	:	110214
		Rural	:	91465
		Urban	:	18749
5.	Normal annual rainfall		:	1173.6 mm
6.	Basin / Sub-basin		:	Ganga Basin / Badua-Chandan, Sunder-Gumani Sub basin
7.	Location			
	Latitude		:	25.0445 to 25.1633
	Longitude		:	86.6051 to 86.6964

Tarapur is a block in Munger district of Bihar State, India. Tarapur block head quarter is Tarapur town. It belongs to Munger Division. Tarapur block is located between 25.0445 to 25.1633 latitude and 86.6051, 86.696440 longitude. Tarapur block is bounded in the north by Asarganj block, in the south by Sangrampur block and in the west by Kharagpur & Tetiya Bamber block and in the east by Banka and Bhagalpur district (*Fig-1)*.

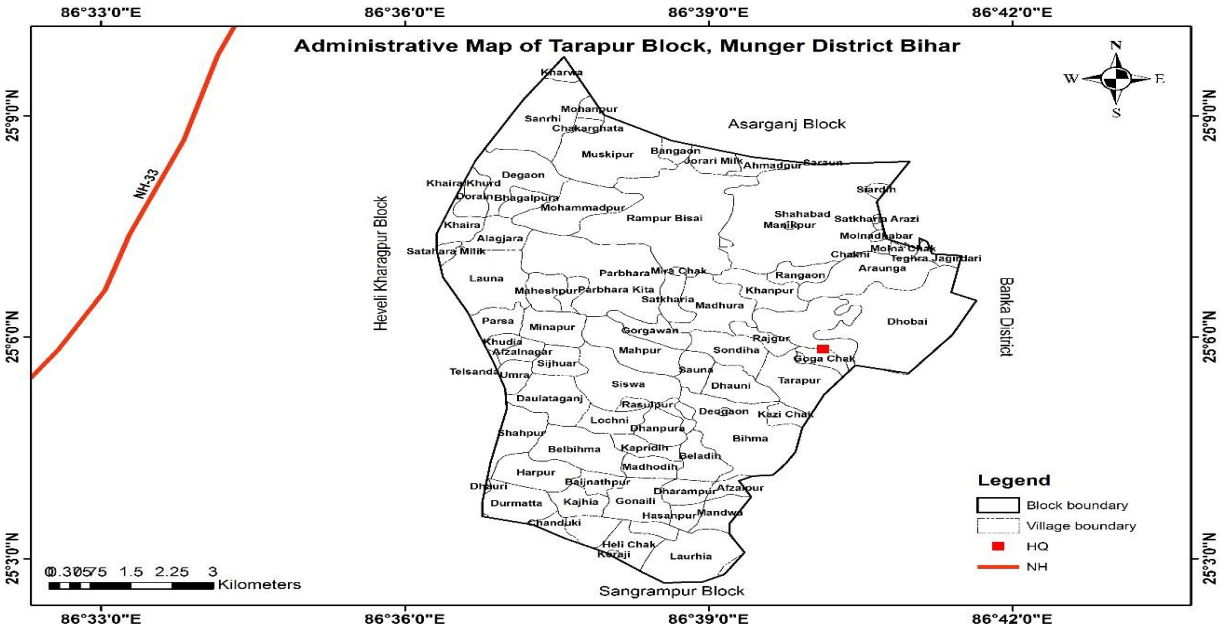

Fig-1 Administrative Map of Tarapur Block, Munger District

1.1 Basic demographic detail of Tarapur block (Census 2011)

As per census 2011 the total population of Tarapur block is 110214 among which 18749 people live in urban area that is 17.01% of total population. Therefore, the block is preferring a rural one.

Table 1A- Population of Tarapur block

	Rural Population	Urban Population	Total
Block	91465	18749	110214

The block consists of 12 Gram Panchayets, 51 villages and 21,536 households.

Table 1B- List of panchayat wise villages of Tarapur block

S.No.	Panchayat	Villages
1	Afzal Nagar	11
2	Beladih	06
3	Bihma	12
4	Dhobai	04
5	Ganaili	09
6	Gazipur	02
7	Khaira	14
8	Launa	03
9	Manikpur	10
10	Parbhara	11
11	Rampur Bisai	01
12	Tarapur	02
	Total	**85**

1.2 Rainfall and Temperature

Normal annual rainfall of Tarapur block is 1173.6 mm of which 85.46% occurs during the monsoon season. The normal rainfall during monsoon season is 822.2 mm and during non-monsoon season is 76.8 mm.

The variation of rainfall in this zone is from 1173.6 mm to 899.0 mm and the temperature varies from 44 to 6˚C.

1.3 Distribution of persons engaged in agriculture and other workers/ non workers in the block

In Asarganj block, 84% of total population is non workers. It is evident from below diagram that 11% of the total population in the block is engaged in agriculture, about 1% are cultivator, 1% comprises household industrial workers and 4% comprises other worker (*Fig-2*).

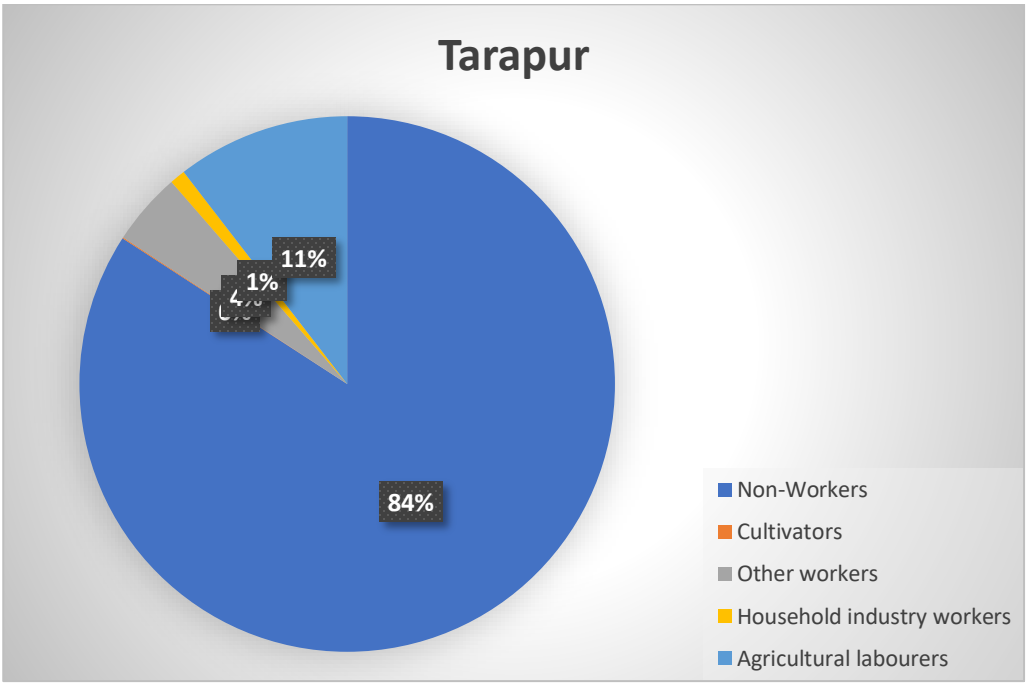

Fig 2- Distribution of persons engaged in Tarapur block

Source- Census 2011

1.4 Soil

Tarapur block contains mainly calcareous sandy soils, coarse loamy soils, fine loamy Soils, clayey soils with pH in the range of 6.8 – 8.0 (*Fig-3*).

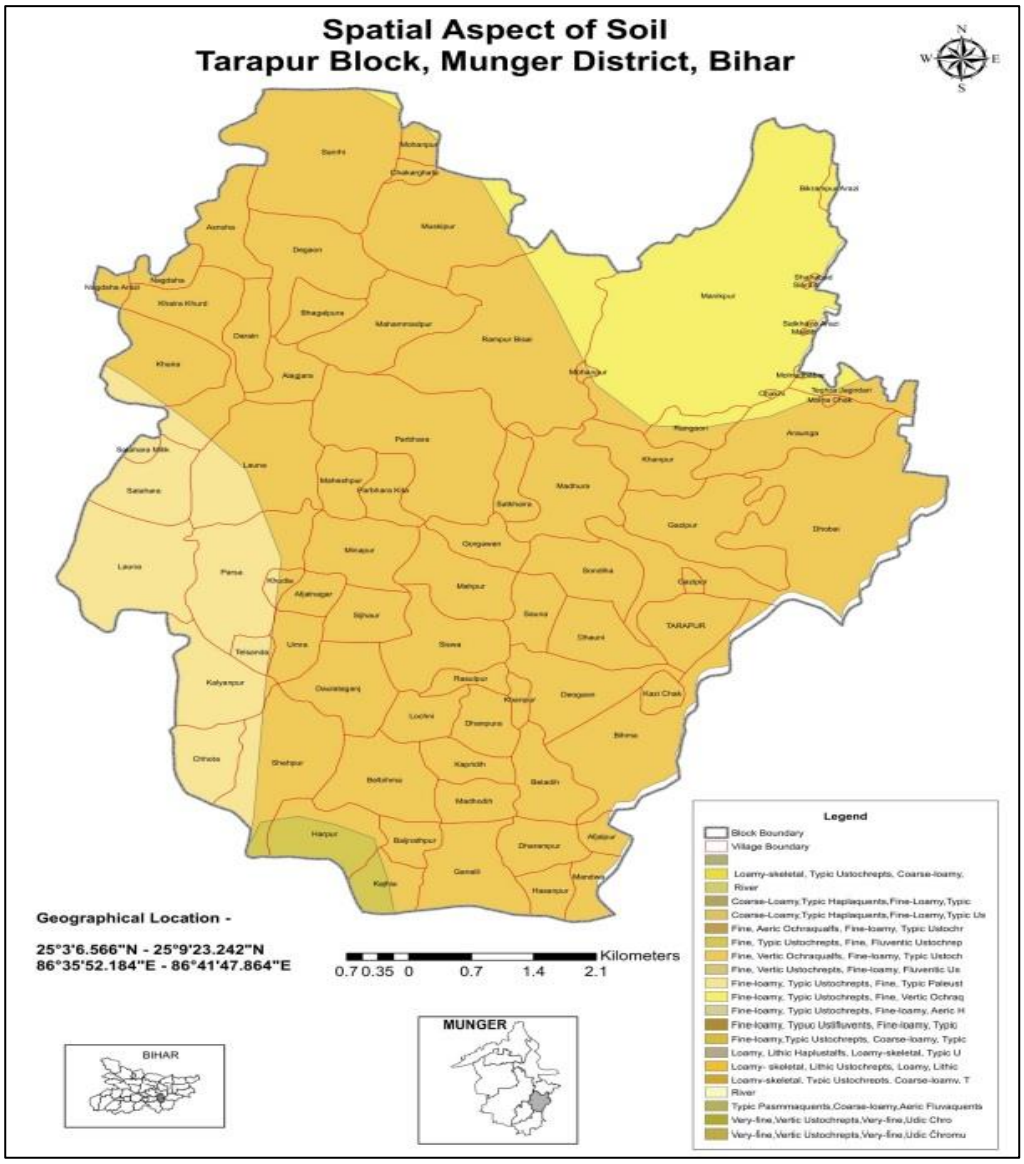

Fig -3 Soil Map of Tarapur block, district Munger, Bihar

1.5 Physiographic, Basin/sub-basin, and Drainage:

The Tarapur block forms a part of Badua-Chandan, Sunder-Gumani sub-basin of the Ganga Basin. The block is having moderate to low drainage density. Parallel to sub-parallel drainage patterns are dominating in the block. Major rivers of the district are Ganga, Man, Belharni and Mahana. The Ganga flows to the east, but it takes northward turn near Munger town. Other rivers flow towards NNE and join the Ganga. Except the Ganga River, all are ephemeral in nature, having meager water during lean periods.

The block having average elevation of 44 meters (144 feet). Tarapur block represent a flat terrain and the entire block is with land slope of 0-3% ha.

1.6 Geomorphology

Older alluvial Plain is represented in major part of Tarapur block and it is made up of sediments derived from the denudation of Chota Nagpur Plateau and Kharagpur Hills (*Fig- 4*).

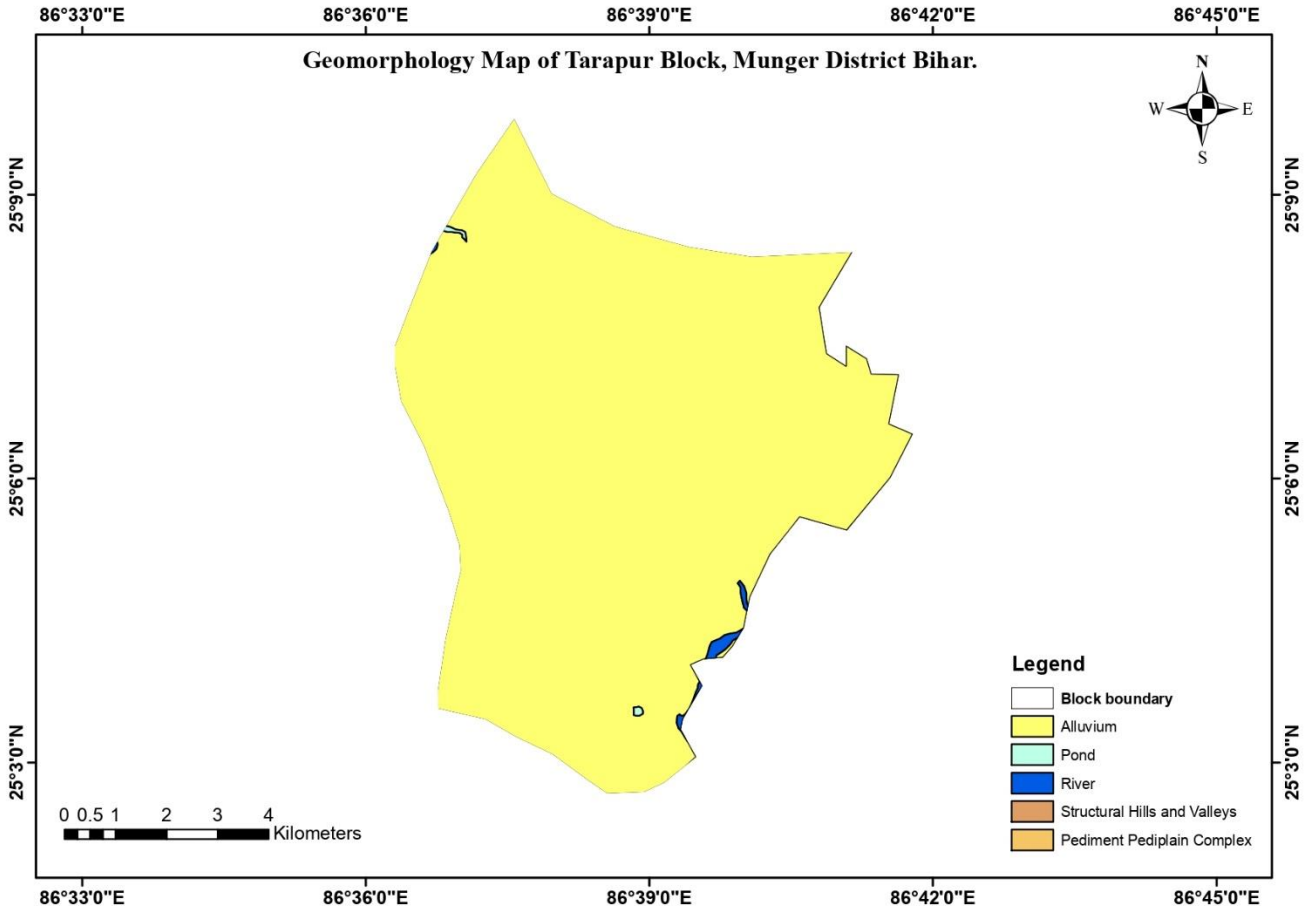

Fig 4- Geomorphology Map of Tarapur block

1.7 Land use pattern

Total geographic area of the Tarapur block is 7104 ha among which net sown area 6795 ha and gross cropped area is 8305 ha. Therefore, area under multiple cultivation is 1510 ha and 308 ha area is under waste land. It is evident that net sown area is 95.65%, area under multi cultivation is 21.25% and waste land is 4.33% of the total geographic area. The cropping intensity of the block is 122% *(Table 1C).*

Name of the block	Total Geographical area	Gross cropped area	Net sown area	Area sown more than once	Cropping intensity	Area under forest	Area under wasteland	Area under other uses
Tarapur	7104	8305	6795	1510	122%	0	308	0

Table 1 C- Details of Land use pattern of block (area in ha)

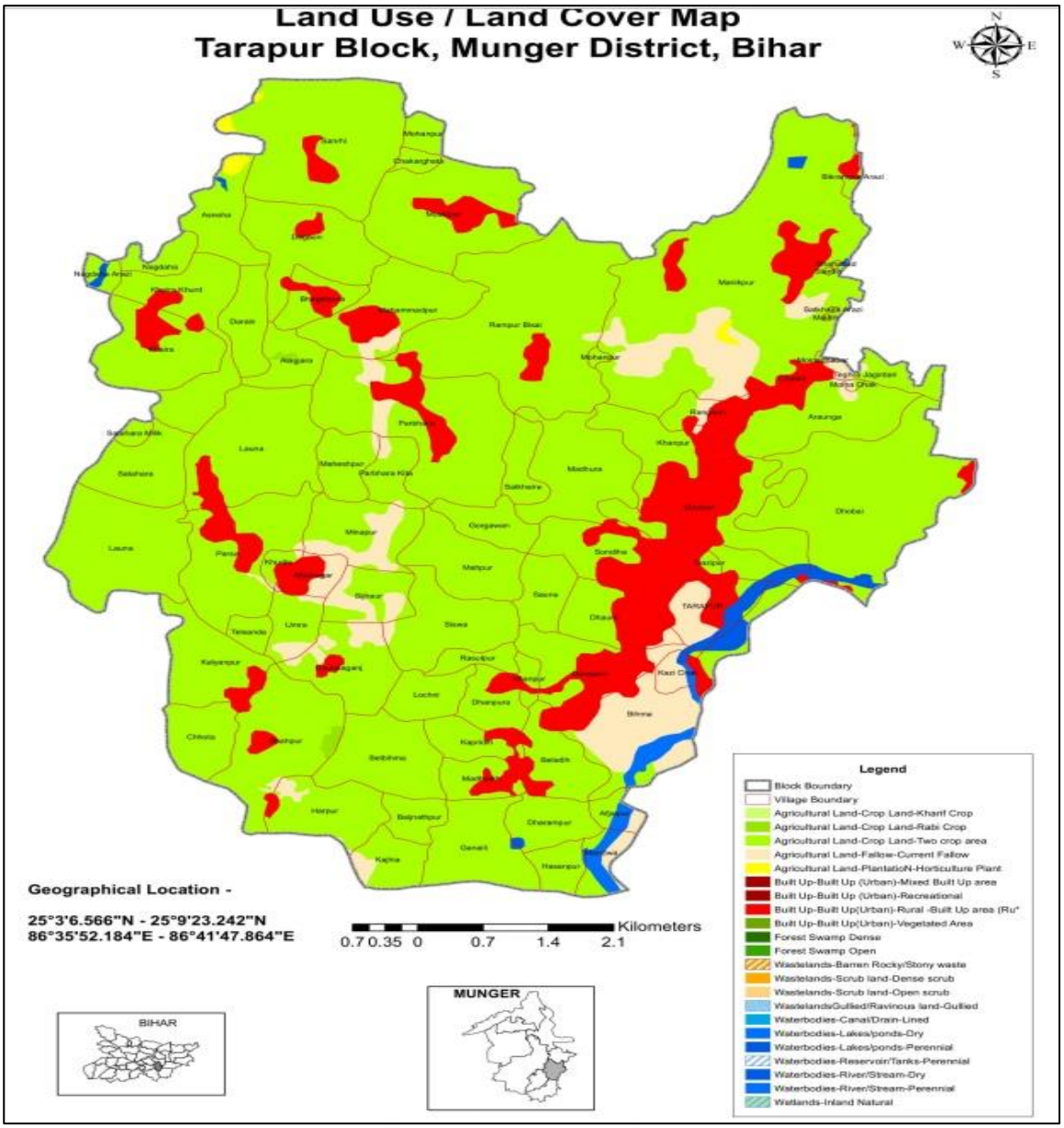

Fig 5- LULC Map of Tarapur block *(Source DIP-2019)*

1.8 Agriculture and Irrigation

Tarapur block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice – Wheat, Rice – Gram, Rice – Lentil, Rice – Rai. Out of the total area under cultivation in the block, 50.2 percent area (5798 ha) is covered by cereals crop during Kharif season, 13.8 percent (1600 ha) during Rabi season and 0.1 percent (10 ha) during summer season.

The irrigation by surface water canals is provided in Tarapur block, besides a large area is irrigated by ground water irrigation by tube wells and large diameter dug wells. Majority of the ground water structures are fitted with diesel-operated pumps. The numbers of irrigation structure as per 5th MI Census are presented in Figure-6.

Table 1D- of MI structure in Tarapur block

DW	STW	MDTW	MDTW	MDTW	MDTW	DTW
		35-40m	40-60m	60-70m	TOTAL	
4	587	10	359	0	369	42

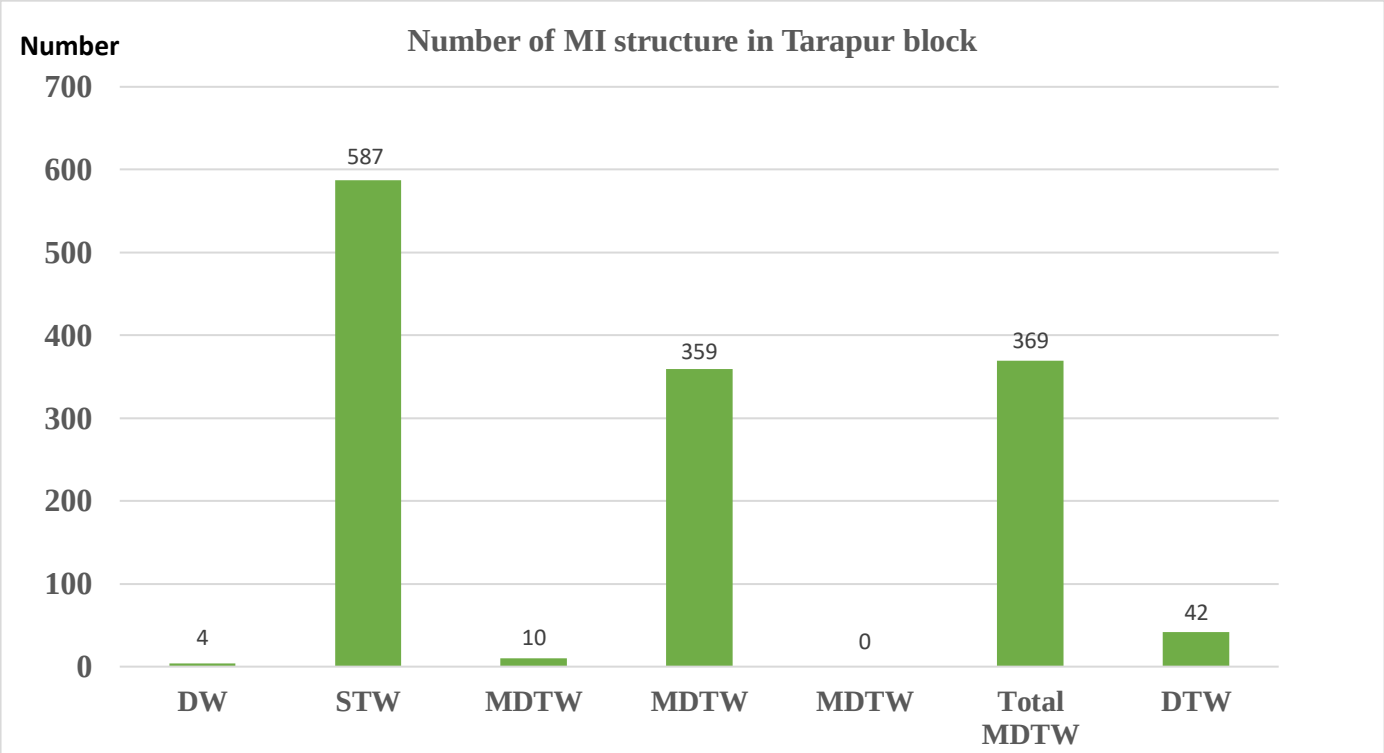

Fig 6- No. of MI structure in Tarapur block

2.0 Geology

The block is covered by older alluvium deposit of quaternary period which comes under Belhar Formation of middle Holocene age. The nature and characteristics of this formation is semi unconsolidated and consist of fine sand feebly oxidized. It is underlain by Precambrian formation. The average thickness of this alluvium in this block is about 40m (fig -7).

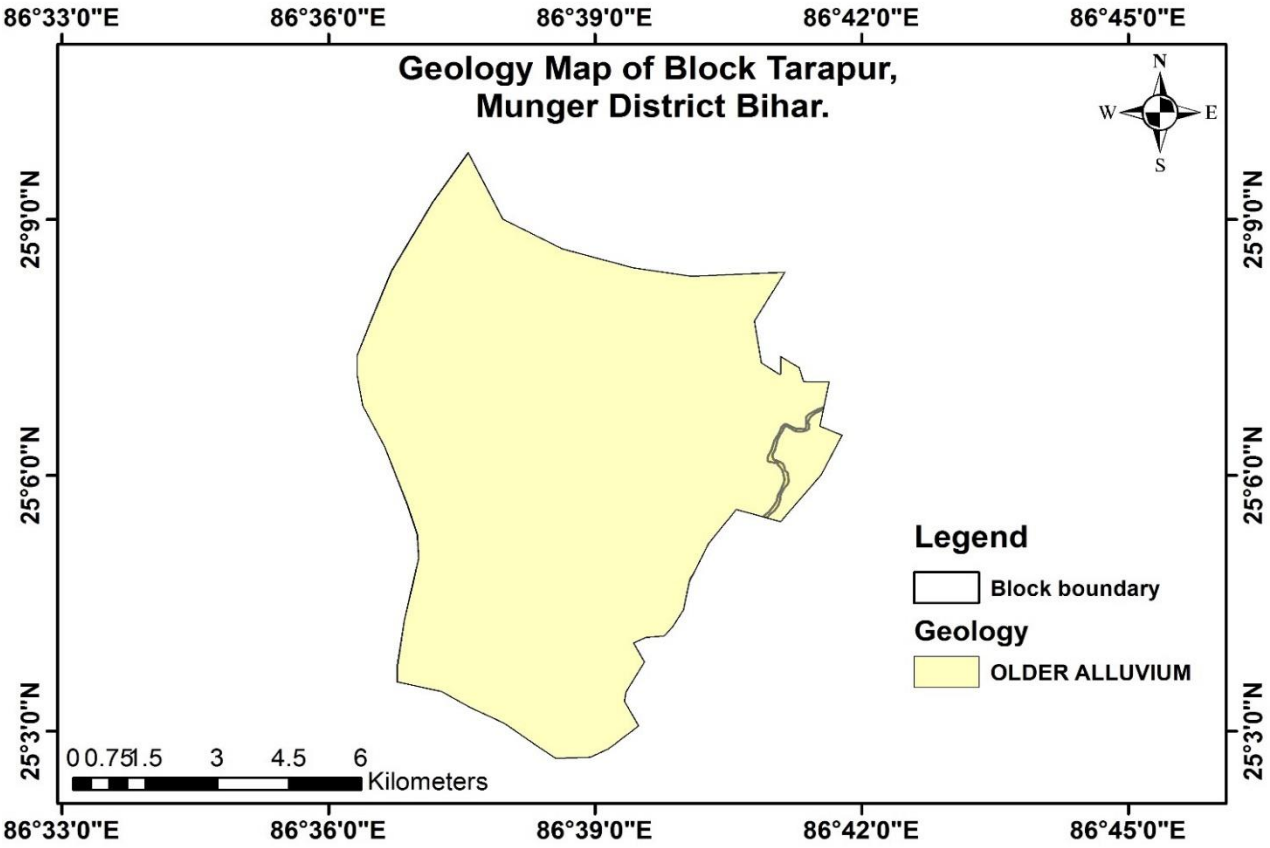

Fig 7- Geology Map of Tarapur block, District Munger Bihar

3.0 Hydrogeology

The block having older alluvium unconsolidated / porous formation. The quaternary alluvium constitutes this hydrogeological unit and occupies all part of the block. Aquifers in this block are under unconfined to semi-confined conditions. Shallow aquifer (<30m) found in this block yield ranging from 10 to 100 m^3/hr. Yield ranging from 10 to 100 m^3/hr. Average discharge of STW/MDTW and DTW may safely be assumed as 25m^3/hr and 50 m^3/hr respectively.

3.1 Aquifer Disposition

In absence of exploratory well data in the block, lithologs of the adjacent blocks have been used to decipher aquifer disposition in Tarapur block Using the lithology of exploratory well drilled at Ramankabad, Khaira and Bamber, a cross section has been prepared. Cross section shows two aquifer layers separated by clay layers. The 1st aquifer is about 10 m thick at Ramankabad and about 20 m thick at Bamber. 2nd aquifer is major aquifer in this area where found coarse sand and it is underlain by hard rock granite. Section depicting the aquifer is shown below (fig 8).

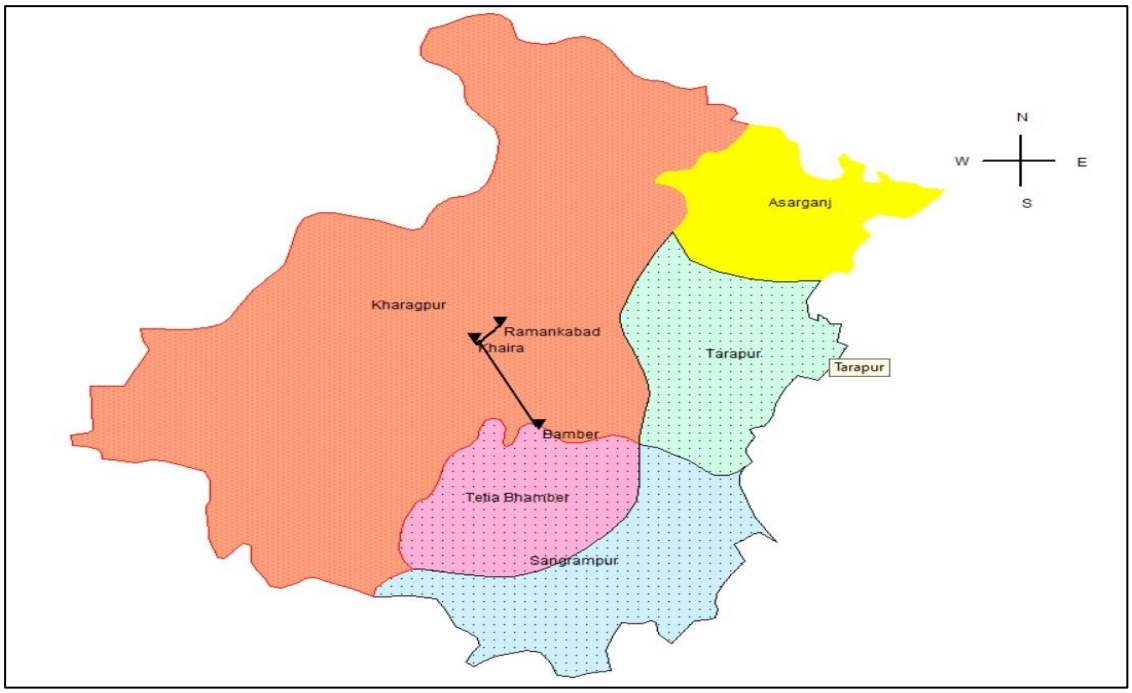

Fig.8a Location of the boreholes

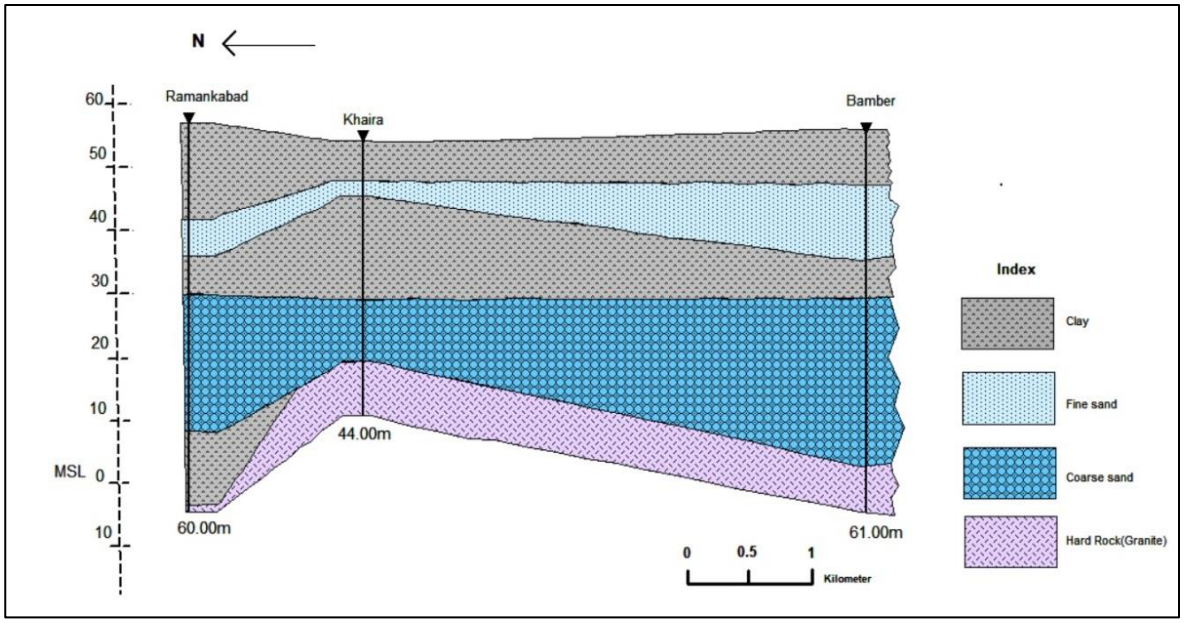

Fig 8b- Diagram showing Aquifer disposition

3.2 Water Level Behaviour

The Ground water regime of the block has been monitored from the existing network monitoring wells, inventoried observation wells. Observation wells are private dug wells, piezometer of minor irrigation department (MID) Government of Bihar and deep tube well of PHED Government of Bihar.

In existing network monitoring wells depth to water level varies from 3.10 to 3.55 mbgl during pre-monsoon season. In post monsoon season, the depth to water level varies from 5.92 to 6.80 mbgl.

Water level measured in piezometer of minor irrigation department 3.55 mbgl during pre-monsoon season and in post monsoon season water level is 5.92 mbgl.

Water level measured in bore well of PHED (Government of Bihar) 5.60 mbgl during pre-monsoon season and post monsoon season water level lies at 7.21 mbgl.

The water level fluctuation between pre-monsoon and post-monsoon ranges from 1.61m to 2.37m in this block.

Sl No	Block_Name	Type_of_Well	Latitude	Longitude	RL (m)	Depth (mbgl)	Postmonsoon SWL/mbgl	Premonsoon/SWL mbgl	Fluctuation (m)	Pre WT (m amsl)	Post WT (m amsl)
1	Tarapur	PHED_DTW	25.0979	86.6689	56	100.00	5.6	7.21	1.61	48.79	50.4
2	Tarapur	DW/ NHNS	25.0981	86.6591	59	7.20	3.1	6.8	3.7	52.2	55.9
3	Tarapur	Pz	25.0900	86.6600	57	50.00	3.55	5.92	2.37	51.08	53.45

Table 3A- Water level fluctuations in Tarapur block

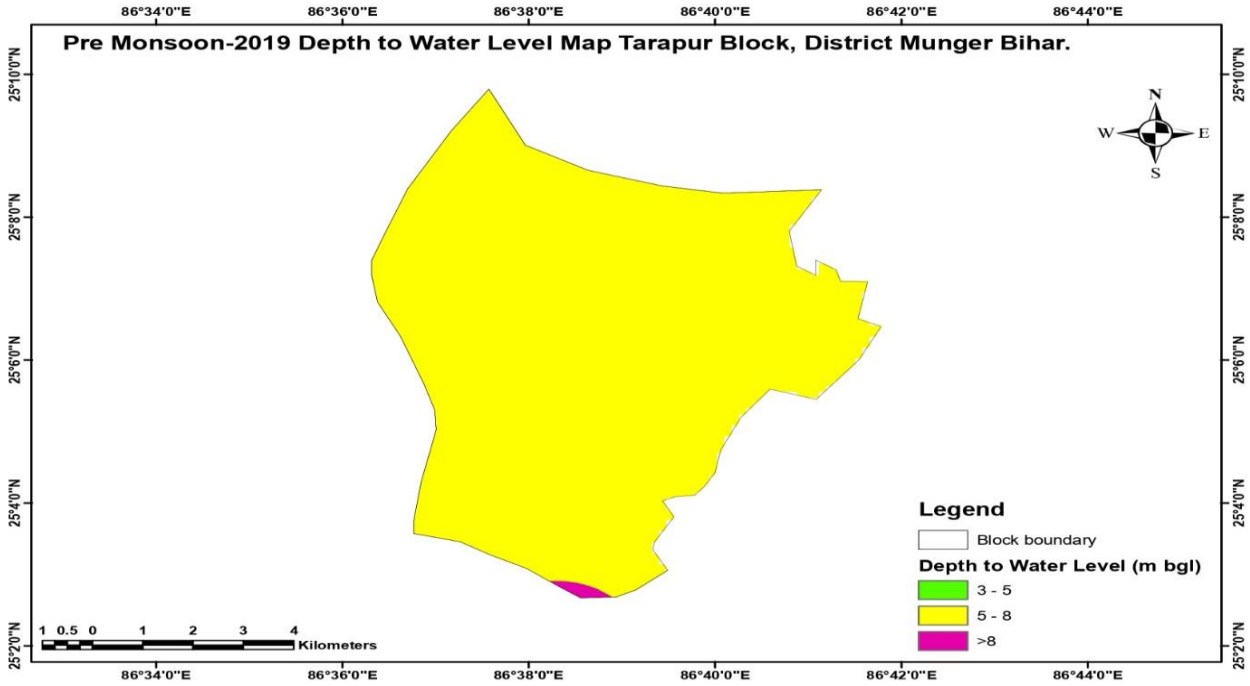

Fig 9- Pre-monsoon (2019) water level Map of Tarapur Block

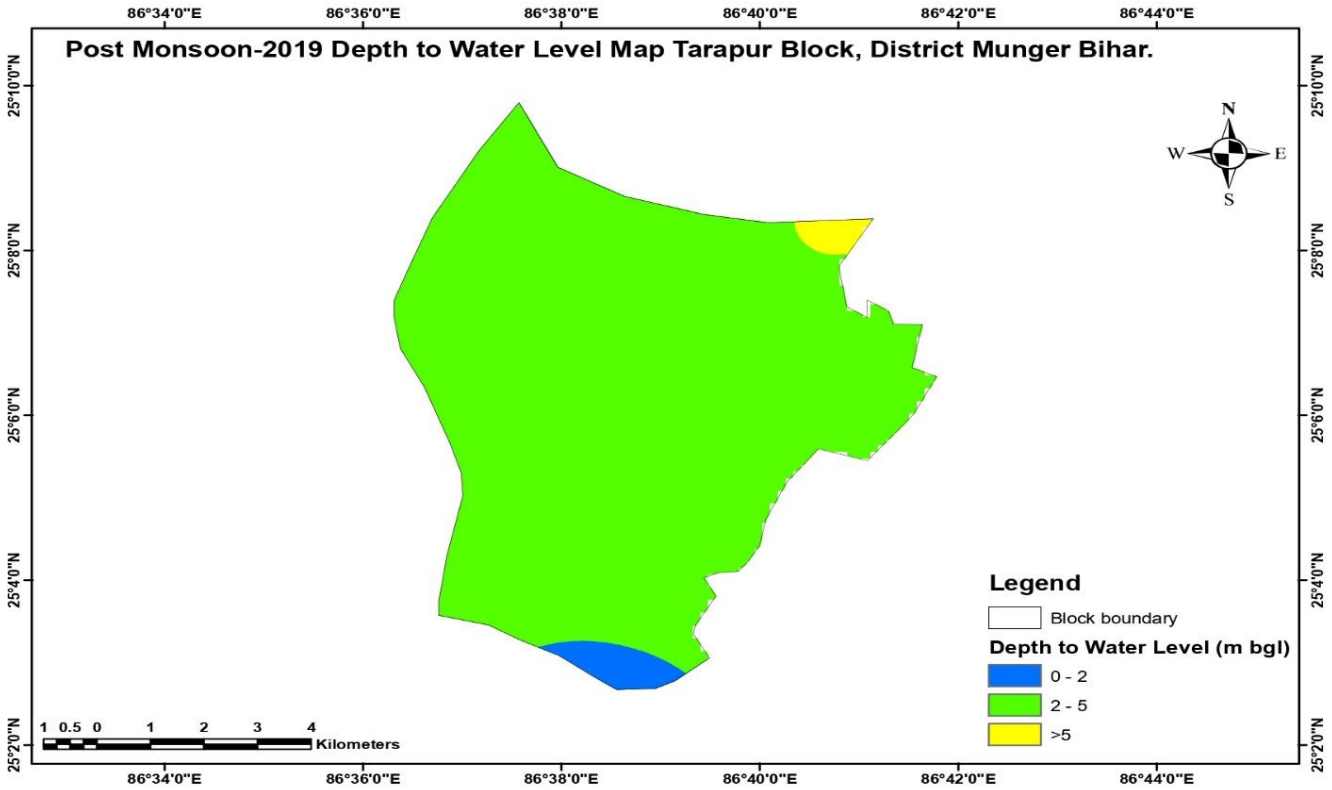

Fig 10- Post-monsoon (2019) water level Map of Tarapur Block

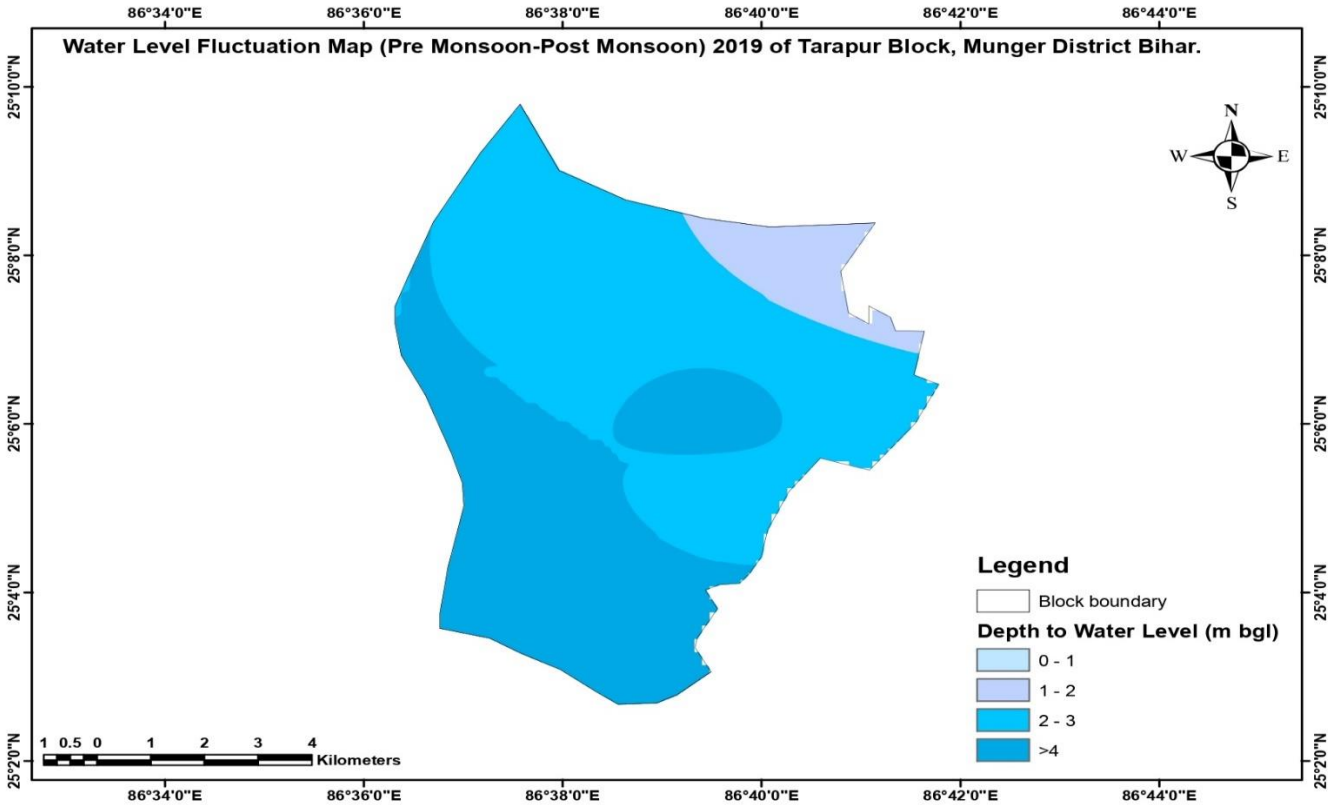

Fig 11- Water level Fluctuation Map (pre-monsoon- post monsoon 2019) of Tarapur Block

3.3 Water table contour

The water table contour map of Tarapur block shows the height of water table during pre-monsoon season varies from 48.79 m to 52.20 m and during post monsoon season height of water table varies from 50.4 m to 55.90 m above from mean sea level. As shown in map, ground water flow direction is towards NE direction in this block (fig-12).

3.4 Aquifer properties

Tarapur block comprises high potential zone. From the exploratory well data of CGWB, the discharge of the deeper aquifer in Munger district may vary from 31- 160.70 m^3/hr with average drawdown 8-10 m. The transmissivity of the aquifer varies 697.88 m^2/day specific capacity 19.29 m^3/hr/m and storativity is 4.5 x 10^{-4}

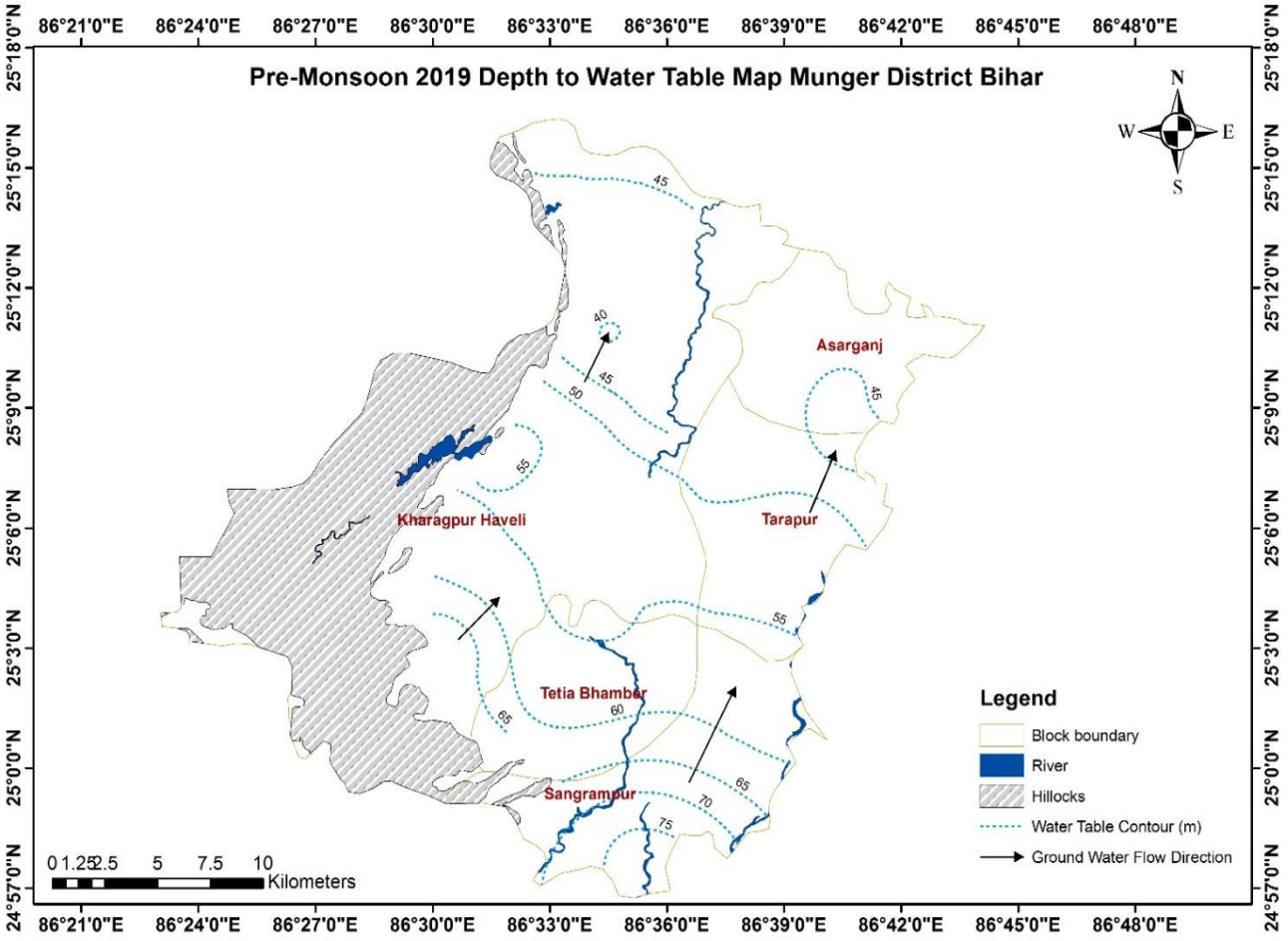

Fig 12: Pre-monsoon (2019) water table contour Map of Tarapur Block

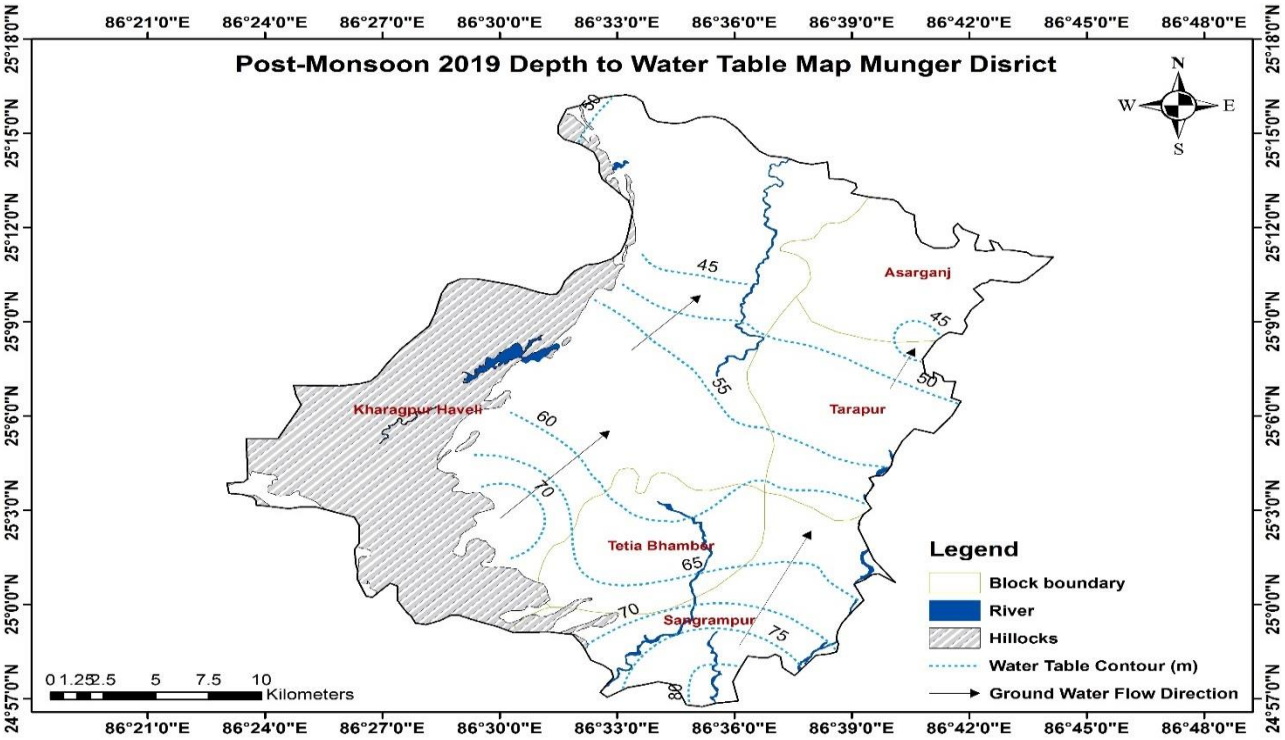

Fig 13: Post-monsoon (2019) water table contour Map of Tarapur Block

4.0 Ground Water Resource Availability and Extraction

As per dynamic ground water resource of Bihar 2020 annual extractable ground water resource is 2113.17 ham, Total annual ground water recharge is 2347.97 ham and net ground water availability for future use is 681.42 ham. Stage of ground water extraction is 66.27% and the block is categorized as safe.

Table 4A: Dynamic Ground Water Resource (as on 22nd March, 2021)

Block	Total Area of Assessment Unit (Ha)	Recharge Worthy Area(Ha)	Total Annual Ground Water (Ham) Recharge	Total Natural Discharges (Ham)	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 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semicritical/Safe/Saline)
Tarapur	7104	7104	2347.97	234.8	2113.17	1082.9	63.00	254.48	1400.37	285.86	681.42	66.27	safe

4.1 Chemical Analysis

Result of chemical analysis of ground water of shallow aquifer is given in the table below (*Table 5B*). In general, chemical quality of shallow aquifer is potable. Few areas in the block have been reported with Fluoride contamination in ground water.

Sl. No.	District	Block	Location	Latitude	Longitude	pH	EC	TDS	TH	Ca	Mg	Na	K	CO3	HCO3	Cl
1	Munger	Tarapur	Tarapur	25.10	86.50	7.9	444	289	220	31	39	13	6.4	0	214	42

Table 4B- Result of Chemical Analysis of Ground Water Samples ***(****Source: NHS data-2020)*

5.0 Management Plan

5.1 Supply side intervention in Agriculture and Irrigation

From the existing land/agriculture and irrigation data it is understood that the block is principally agricultural depending. However, the average cropping intensity is recorded as 122 %. It reveals that considerable cropped area is not under assured irrigation coverage. The dynamic ground water resource reports stage of development is 66.27 % which indicates there exist further scope of ground water development in the block both for agriculture and drinking/domestic purposes. 5th MI Census data shows that majority of irrigation tube wells accompanied within the depth of 50 m. Therefore, further development may be planed from the deeper part.

Considering projected 70% development 78.85 ham further resources may be developed safely for irrigation development. This balance resource is recommended for development through STW/DTW as per the prevailing terrain condition and hydrogeology of the area. Considering unit draft of 2.4 and 4.8 for STW and DTW respectively following number of irrigation structures have been proposed. Thus, in Tarapur block 25 STW and 04 DTW may be constructed. (*Table 5A & 5B*).

Table 5A- Additional resource for 70% development

Assessment Unit Name	Total Area of Assessment Unit (Ha)	Recharge Worthy Area (Ha)	Annual Extractable Ground Water Resource (Ham)	Total Extraction (Ham)	Draft for 70% development	Additional resource available for 70 & development
TARAPUR	7104	7104	2113.17	1400.37	1479.219	78.849

Table- 5B- Recommended number of structures for further irrigation development

Additional resource available for 70% development	Resource allocated for development by STW (Ham)	Resource allocated for development by DTW (Ham)	Unit draft of STW (Ham)	Unit draft of DTW (Ham)	No. of STW proposed	No. of DTW prosed
78.849	59.137	19.712	2.4	4.8	25	4

5.2 Supply side intervention through Artificial Recharge and rain water harvesting

The block receives 1007.6 mm of annual rainfall on an average but most of rain water goes as run off. Construction of suitable artificial recharge structure will help to reduce the run off as well as it also recharges the aquifers and maintain the soil moisture of the area. As per Artificial recharge master plan,2020, following

number of recharge structures have been recommended in Munger district. Percolation tank-07, Gully plug-43, contour bunding and trenching-83, Check dam-02, Nala-bunding-05, Recharge shaft-80, De-silting of existing tank /pond /talao-145, Injection Well in Village Tank-194, Renovation of traditional Ahar-Pyne System (km)-45. Based on the local geology / hydrogeology and underlying lithological disposition de-siltation of existing tanks, check dam, percolation tank etc., may be practiced in Tarpur block.

Before construction of these recharges' structures, selection of suitable site is required for getting better benefits from these structures.

5.3 Demand side intervention

Considering the moderate potentiality of the area water intensive crop may be to some extent by replaced by less water consuming crop. Therefore pulses, oilseeds other horticulture crops etc as per the local requirement may be encouraged. This may create further irrigation potential in the block. Suitable crop rotation may be practiced.

5.4 Ground water contamination

The block has been reported with fluoride contamination in ground water. Therefore, before using of ground water from shallow or deep tube wells for drinking, domestic and irrigation purpose should be tested fluoride contamination. Domestic fluoride removal technique may be adopted for short term measures whereas for long term intervention commercial fluoride removal plan may be installed.

Capacity building for Awareness generation among the stake holders and end users may be a suitable approach to address and to mitigate fluoride contamination in the ground water.

AQUIFER MAPS AND MANAGEMENT PLAN OF TETIA BHAMBAR, BLOCK IN MUNGER DISTRICT, BIHAR

1. Salient Information

Name of the Block of Aquifer (in Km^2)	Tetia Bhambar/ 101.38 sq km
District/State	Munger/Bihar
Population	Total- 76303 Rural- 76303 Urban- -
Rainfall	Normal Monsoon- 970.80 Non-monsoon rainfall- 202.80
Agriculture and Irrigation	Principal crops - Rice – Wheat, Rice – Gram, Rice – Lentil, Rice – Rai Gross cropped area- 8594 Net sown area- 4734, Irrigation practices Surface water by canal -Ground water by tube well and LDTW Cropping intensity- 134%, Number and types of abstraction structures- 560 STW, 77 MDTW, 01 DTW
Geology	Older alluvium, Chhotnagpur Gneiss Complex
Geomorphology	Major Physiographic units-Hill, Pediplain, Alluvial plain Major Drainage- Ganga, Badua-Chandan, Sunder-Gumani Sub basin
Ground water resource availability and extraction	Annual Extractable Ground Water Resource (Ham)- 2293.39 Net Ground Water Availability for future use (Ham)- 1048.43 Ground water extraction (Ham)- 1228.76

Existing and future water demand	1228.76 (Ham)/147.66 (Ham) (annual GW allocation for domestic as on 2025)
Water level behaviour	Pre-monsoon SWL- 5.10- 8.23 mbgl Post-monsoon SWL- 2.03-6.20 mbgl
2. Aquifer Disposition	
Number of Aquifers	02; up to the explored depth of 60m
3D aquifer disposition and basic characteristics of each aquifer	1st Aquifer from 19m to 27m, fine sand mostly phreatic, 2nd Aquifer from 30m to 48m, medium to coarse sand, Semi-confined to Confined

3. Ground water resource, extraction, contamination and other issues

GW Resource/Categorization Availability	Safe
Chemical quality of ground water and contamination	Potable The block has been reported with fluoride contamination in ground water
4. Supply Side Interventions	
Ground Water Development Strategies-	Number of STW and DTW may be proposed for irrigation uses- LDTW- 112, STW-25, DTW-04
Aquifer wise space available for	As per ARMP, 2020, for Munger district 345.84 sq km is

recharge and proposed interventions	suitable for recharge, Volume of de-saturated zone 193 MCM. Percolation tanks, desilting of existing tanks, check dam , renovation of Ahar-Pyne system etc. are some suitable structures in the area
Other interventions proposed, if any	
5. Demand side interventions	
Advanced Irrigation Practices	Project based drip/sprinkler irrigation, lining of field channels etc.
Change in cropping pattern	Less water intensive crop like pulses, oilseeds may be encouraged.
Alternate water sources	Conjunctive uses of groundwater/surface water sources,
Regulation and Control	Capacity building for awareness generation for fluoride contamination.

1.0 General Information

1.	Total area		:	101.38 sq km
2.	Total number of Panchayat		:	07
3.	Total number of villages		:	47
4.	Population (Census 2011)	Total	:	76303
		Rural	:	76303
		Urban	:	-
5.	Normal annual rainfall		:	1173.6 mm
6.	Basin / Sub-basin		:	Ganga Basin / Badua-Chandan, Sunder-Gumani Sub basin
7.	Location			
	Latitude		:	24.9947 to 25.0723
	Longitude		:	86.5158 to 86.6127

Tetia Bhambar is a block in Munger district of Bihar State, India. Tetia Bhambar block head quarter is Tetia town. It belongs to Munger Division. Tetia Bhambar block is located between 24.9947 to 25.072361 latitude and 86.5158 to 86.6127 longitude. Tetia Bhambar block is bounded in the north by Kharagpur block, in the south by Sangrampur block and in the west by Kharagpur block and in the east by Tarapur block of Munger district. (*Fig-1*).

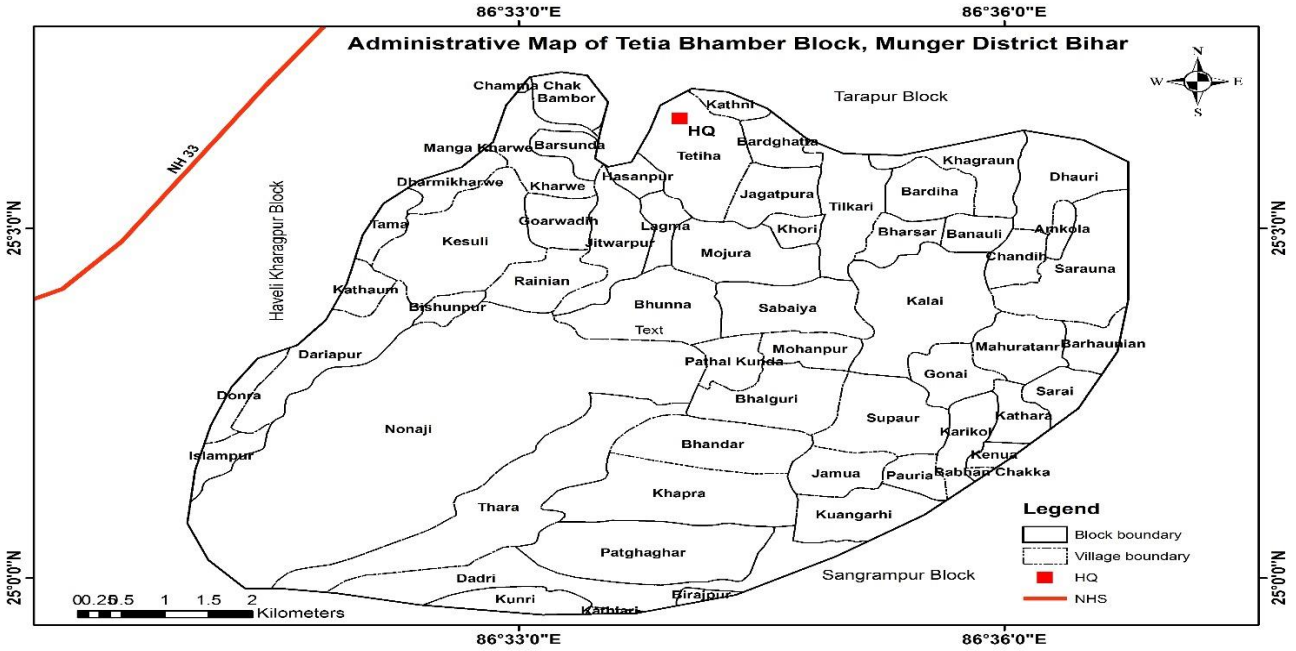

Fig-1 Administrative Map of Tetia bhambar block, Munger District

1.1 Basic demographic detail of Tetia bhambar block (Census 2011)

As per census 2011 the total population of Tetia bhambar block is 76303.

Table 1A- Population of Tetia bhambar block

	Rural Population	Urban Population	Total
Block	76303	-	76303

The block consists of 07 Gram Panchayets, 61 villages and 10,331 households.

Table 1B- List of panchayat wise villages of Tetia bhambar block

S.No.	Panchayat	Villages
1	Bangama	13
2	Banhara	02
3	Bhuna	15
4	Dharui	08
5	Kesauli	10
6	Nonaji	07
7	Tetia	06
	Total	**61**

1.2 Rainfall and Temperature

Normal annual rainfall of Tetia Bhambar block is 1173.6 mm of which 85.46% occurs during the monsoon season. The normal rainfall during monsoon season is 822.2 mm and during non-monsoon season is 76.8 mm. The variation of rainfall in this zone is from 1173.6 mm to 899.0 mm and the temperature varies from 44 to 6˚C.

1.3 Distribution of persons engaged in agriculture and other workers/ non workers in the block

In Tetia Bhambar block, 71% of total population is non workers. It is evident from below diagram that 20% of the total population in the block is engaged in agriculture, 5% are cultivator, 1% comprises household industrial workers and 3% comprises other worker (*Fig-2*).

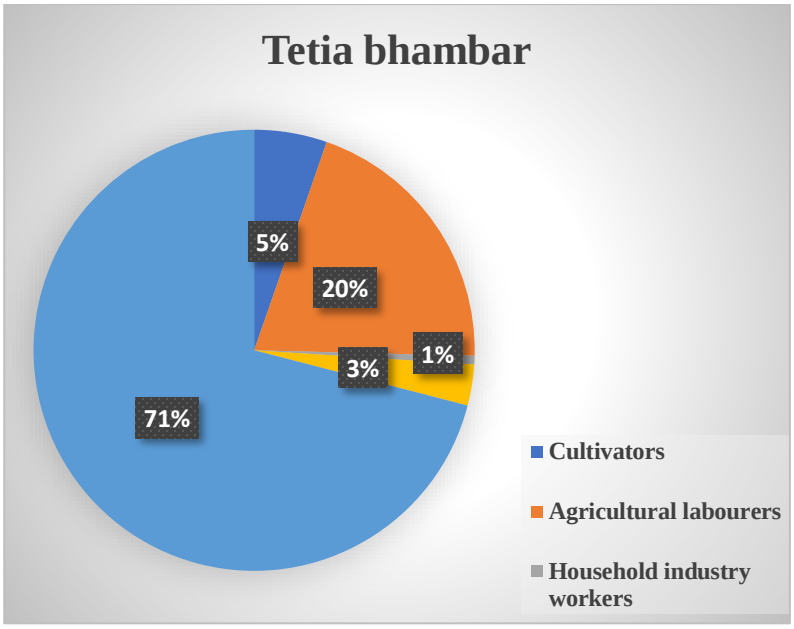

Fig 2- Distribution of persons engaged in Tetia bhambar block Source- Census 2011

1.4 Soil

Tetia bhambar block contains mainly calcareous sandy soils, coarse loamy soils, fine loamy Soils, clayey soils with pH in the range of 6.8 – 8.0 (*Fig-3*).

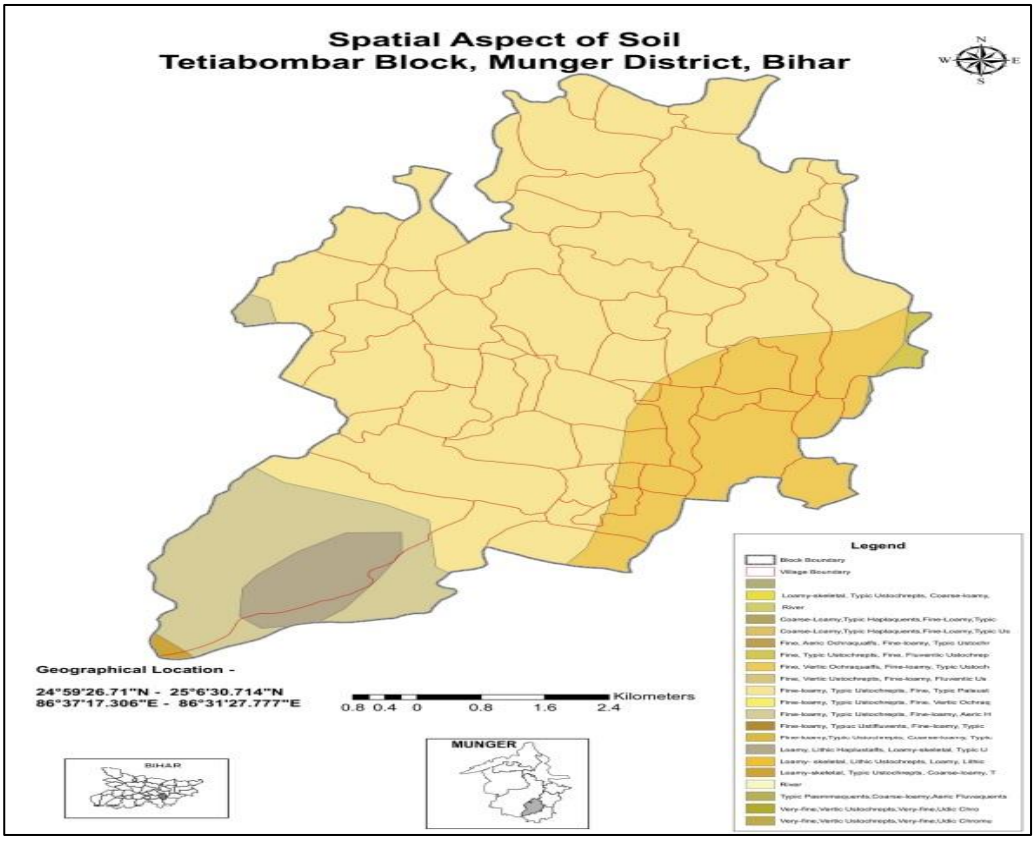

Fig -3 Soil Map of Tetia bhambar block, district Munger, Bihar (Source- DIP 2019)

1.5 Physiographic, Basin/sub-basin, and Drainage:

The Tetia bhambar block forms a part of Badua-Chandan, Sunder-Gumani sub-basin of the Ganga Basin. The block is having moderate to low drainage density. Parallel to sub-parallel drainage patterns are dominating in the block. Major rivers of the district are Ganga, Man, Belharni and Mahana. The Ganga flows to the east, but it takes northward turn near Munger town. Other rivers flow towards NNE and join the Ganga. Except the Ganga River, all are ephemeral in nature, having meager water during lean periods.

The block having average elevation of 44 metres (144 feet). Tetia bhambar block represent a flat terrain and the entire block is with land slope of 0-3% ha.

1.6 Geomorphology

Older alluvial Plain is represented in major part of Tetia bhambar block and it is made up of sediments derived from the denudation of Chota Nagpur Plateau and Kharagpur Hills. Pre-Cambrian Granite Gneiss represent some part of the block (*Fig- 4*).

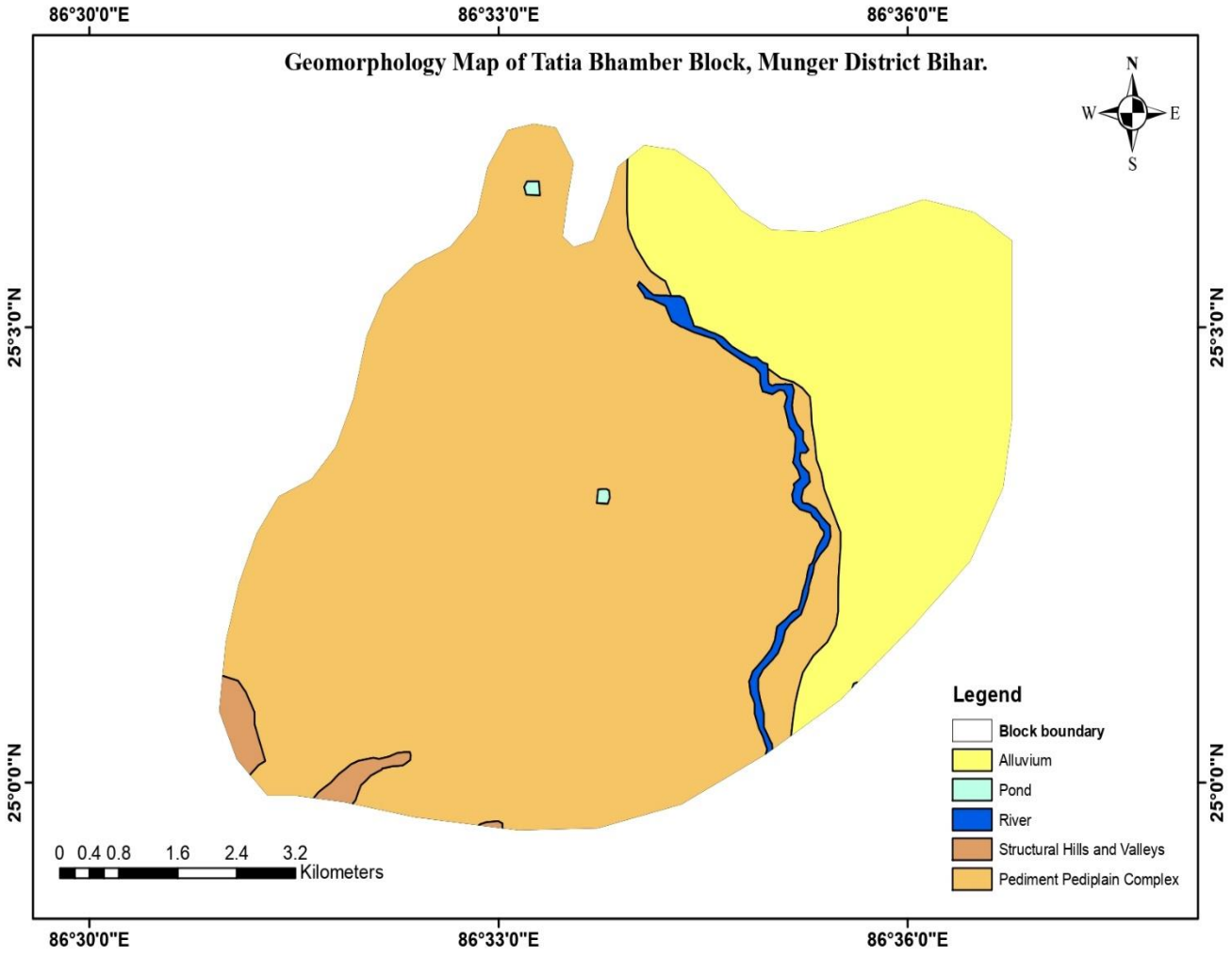

Fig 4- Geomorphology Map of Tetia bhambar block

1.7 Land use pattern

Total geographic area of the Tetia bhambar block is 8594 ha among which net sown area 4734 ha and gross cropped area is 6336 ha. Therefore, area under multiple cultivation is 1602 ha and 2897 ha area is under waste land. It is evident that net sown area is 55.08%, area under multi cultivation is 18.64% and waste land is 33.70% of the total geographic area. The cropping intensity of the block is 134% (Table 1C).

Name of the block	Total Geographical area	Gross cropped area	Net sown area	Area sown more than once	Cropping intensity	Area under forest	Area under wasteland	Area under other uses
Tetia bhambar	8594	6336	4734	1602	134 %	0	2897	963

Table 1 C- Details of Land use pattern of block (area in ha)

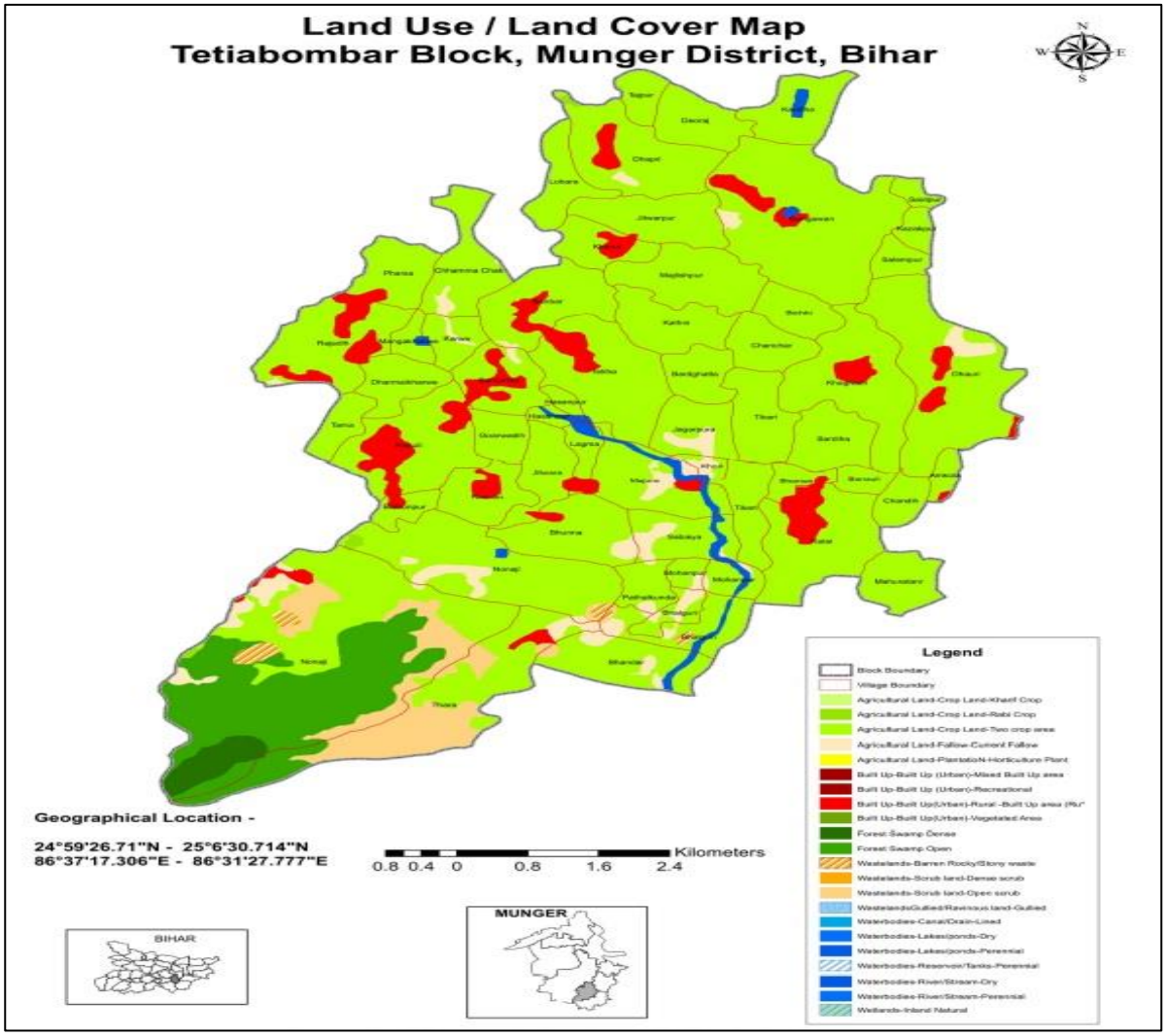

Fig 5- LULC Map of Tetia bhambar block (Source- DIP-2019)

1.8 Agriculture and Irrigation

Tetia bhambar block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice – Wheat, Rice – Gram, Rice – Lentil, Rice – Rai. Out of the total area under cultivation in the block, 43.8 % area (4350 ha) is covered by cereals crop during Kharif season, 16.1% (1600 ha) during Rabi season and 0.2 % during summer season.

The irrigation by surface water canals is provided in Tetia bhambar block, besides a large area is irrigated by ground water irrigation by tube wells and large diameter dug wells. Majority of the ground water structures are fitted with diesel-operated pumps. The numbers of irrigation structure as per 5th MI Census are presented in Figure-6.

Table 1D- of MI structure in Tetia bhambar block

DW	STW	MDTW	MDTW	MDTW	Total MDTW	DTW
		35-40m	40-60m	60-70m		
58	560	1	76	0	77	1

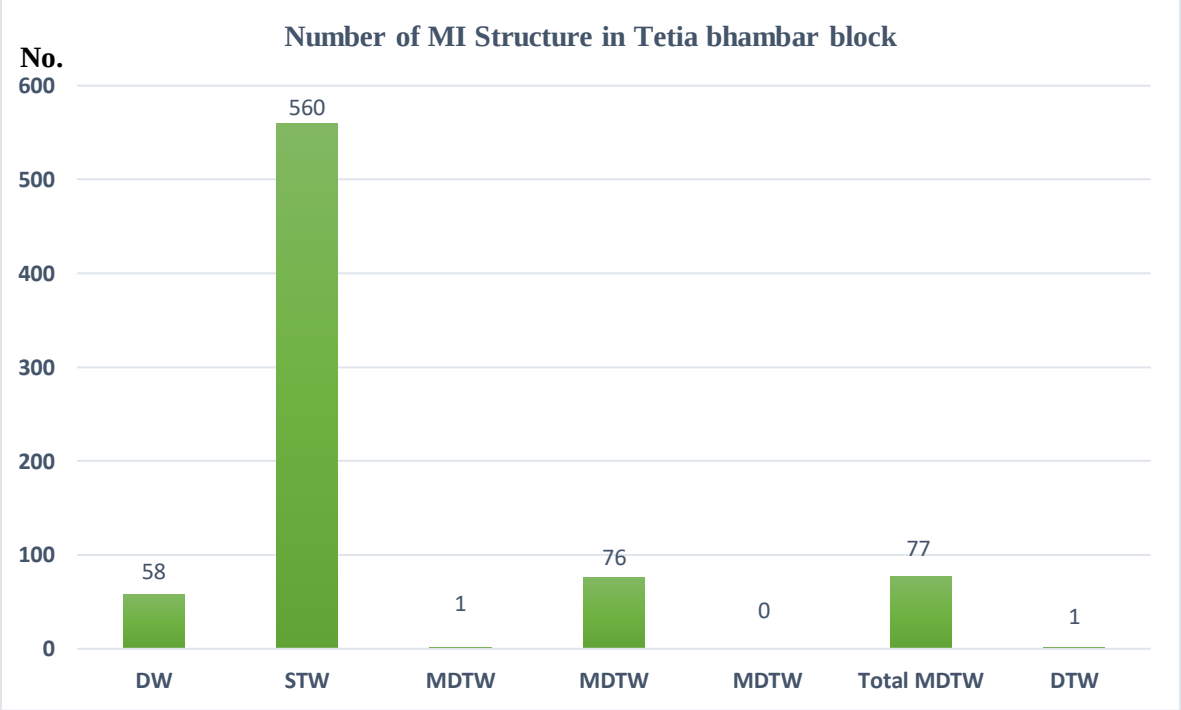

Fig 6- No. of MI structure in Tetia bhambar block

2.0 Geology

The block is mainly covered by older alluvium deposit of quaternary period which comes under Belhar Formation of middle Holocene age.. The nature and characteristics of this formation is semi unconsolidated and consist of fine sand feebly oxidized. The south western part of the block is covered by Pre-Cambrian Granite Gneiss of Precambrian age. The average thickness of this alluvium in this block is about 40 m. (fig -7).

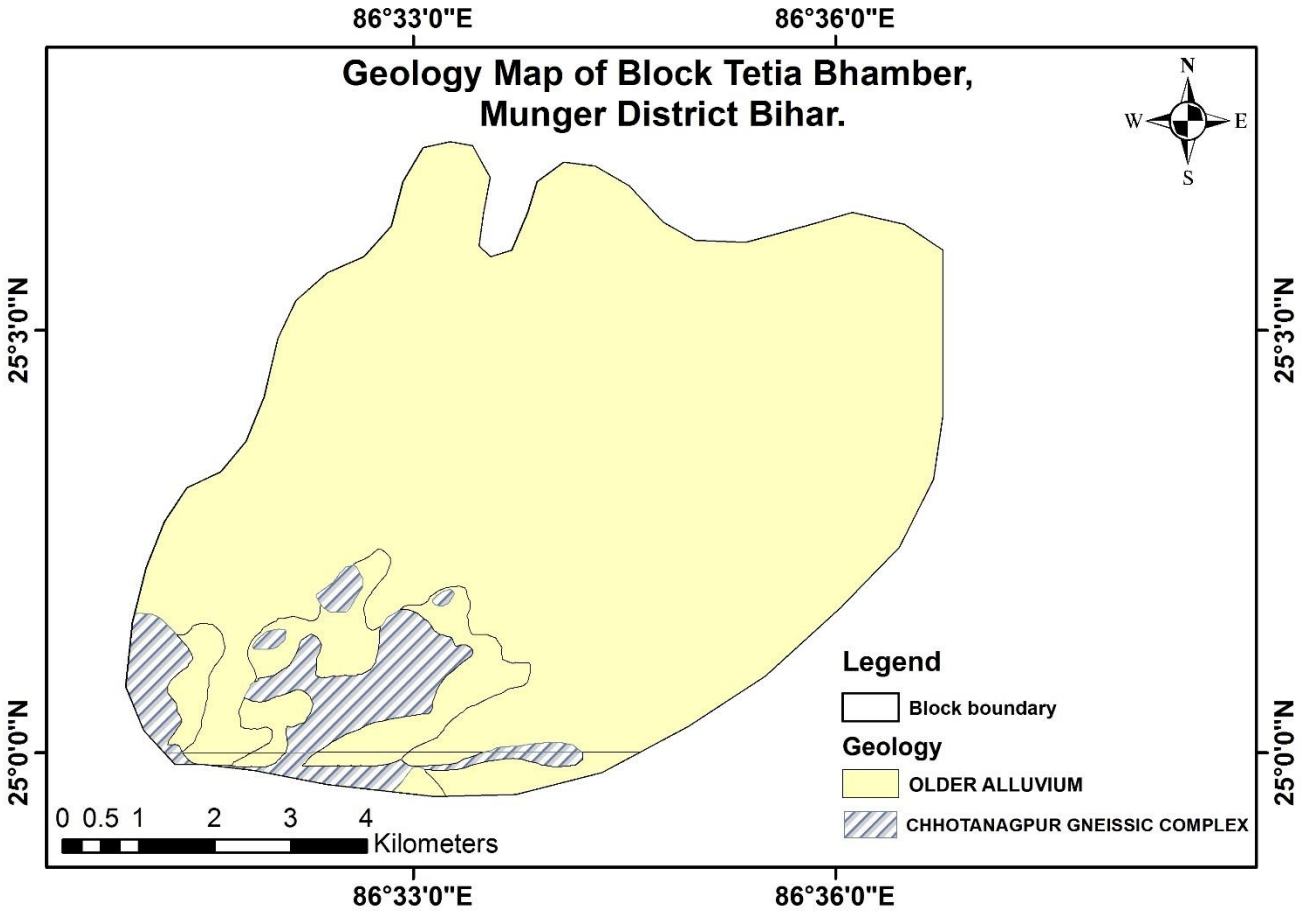

Fig 7- Geology Map of Tetia bhambar block, District Munger Bihar

3.0 Hydrogeology

The alluvial area comprises prolific aquifer top the depth of 30-40 m. Some part of block is made up of the rock of Chotanagpur Gneissic Complex (CGC) and Kharagpur Formation, which is mainly composed of granite gneisses, quartzite and phyllites. In general, these rocks possess poor aquifers until or unless secondary porosities are developed by means of weathering and or fracturing. The area possesses diverse ground water potential. Sessional fluctuation of depth of groundwater level ranges from 3.93m to 7.4m. Shallow aquifer (<50m) found in this block yield ranging from 10 to 100 m^3/hr.

3.1 Aquifer Disposition

In absence of exploratory well data in the block, lithologs of the adjacent blocks have been used to decipher aquifer disposition in Tetia Bhambar block. Using the litholog of exploratory well drilled at

Ramankabad, Khaira and Bamber, a cross section has been prepared. Cross section shows two aquifer layers separated by clay layers. The 1st aquifer is about 10 m thick at Ramankabad and about 20 m thick at Bamber. 2nd auifer is major aquifer in this area where found coarse sand and it is underlain by hard rock granite. Section depicting the aquifer is shown below (fig 8).

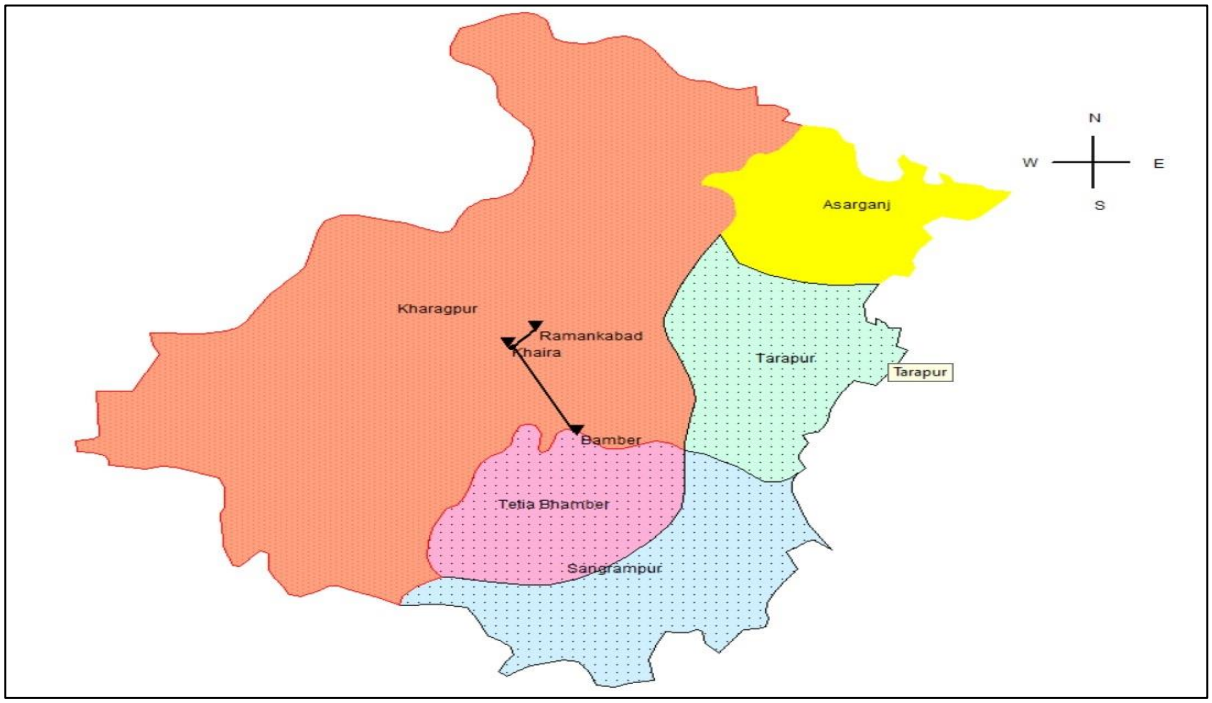

Fig.8a Location of the boreholes

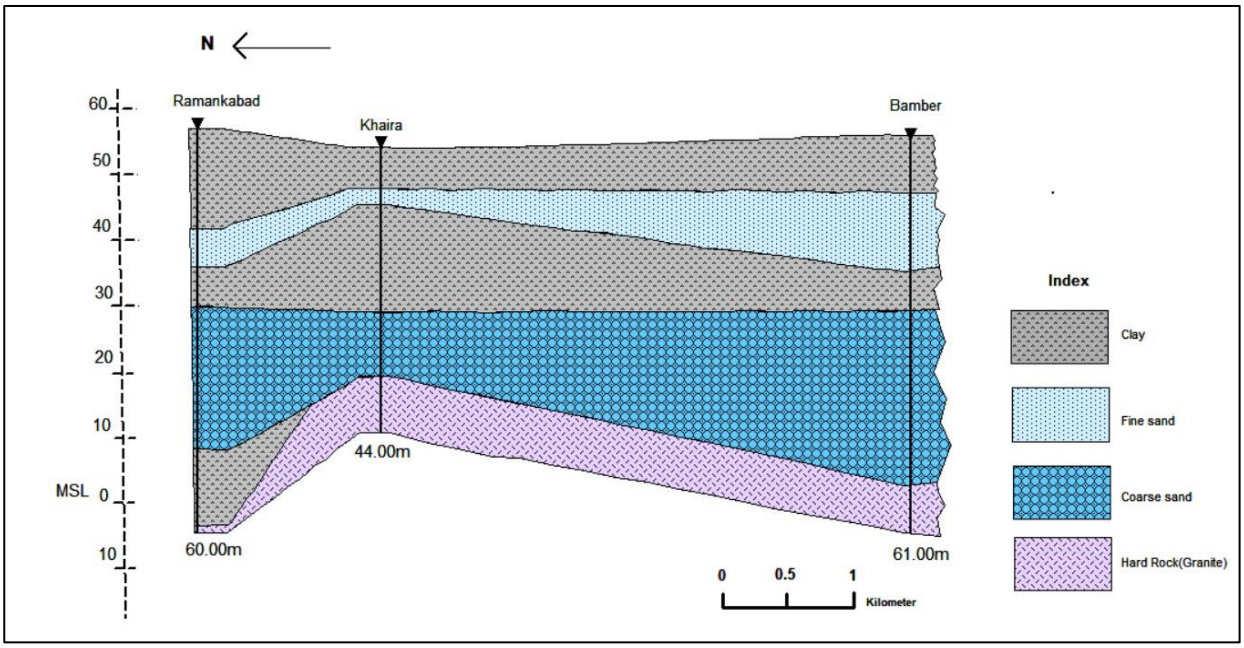

Fig.8b Diagram showing Aquifer disposition

3.2 Water Level Behaviour

The Ground water regime of the block has been monitored from the existing network monitoring wells, inventoried observation wells. Observation wells are private dug wells, piezometer of minor irrigation department (MID) Government of Bihar and deep tube well of PHED Government of Bihar.

In existing network monitoring wells depth to water level measured 5.1 mbgl during pre-monsoon season. In post monsoon season, the depth to water level 2.3 mbgl.

Water level measured in piezometer of minor irrigation department 7.13 mbgl during pre-monsoon season and in post monsoon season water level is 3.70 mbgl.

Water level measured in bore well of PHED (Government of Bihar) 8.23 mbgl during pre-monsoon season and post monsoon season water level lies at 6.20 mbgl.

The water level fluctuation between pre-monsoon and post-monsoon ranges from 2.03m to 2.80m in this block.

Sl No	Block_Name	Type_of_Well	Latitude	Longitude	RL (m)	Depth (mbgl)	Premonsoon/SWL mbgl	Postmonsoon SWL/mbgl	Fluctuation (m)	Pre WT (m amsl)	Post WT (m amsl)
1	Tetia Bhambar	DW	25.0424	86.5587	63	11.00	5.1	2.3	2.8	57.9	60.7
2	Tetia Bhambar	Pz	25.0651	86.5661	59	50.00	7.13	3.70	3.43	51.87	55.3
3	Tetia Bhambar	PHED_DTW	25.0653	86.5750	57	120.00	8.23	6.2	2.03	48.77	50.8

Table 3A- Water level fluctuations in Tetia bhambar block

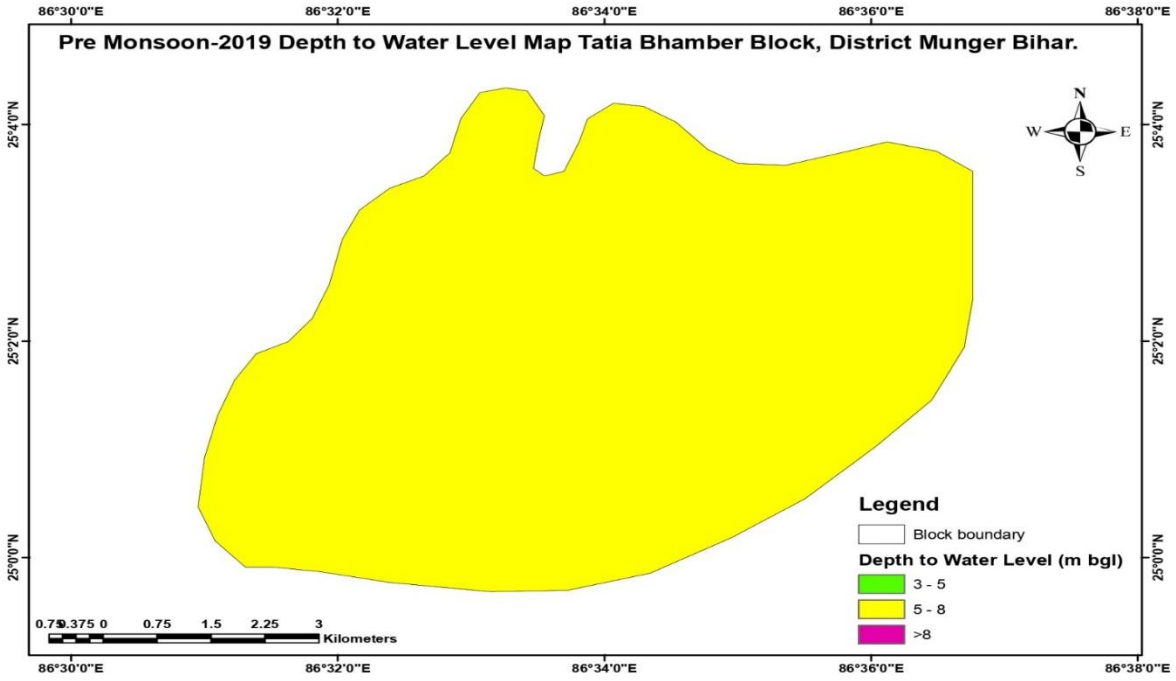

Fig 9- Pre-monsoon (2019) water level Map of Tetia bhambar Block

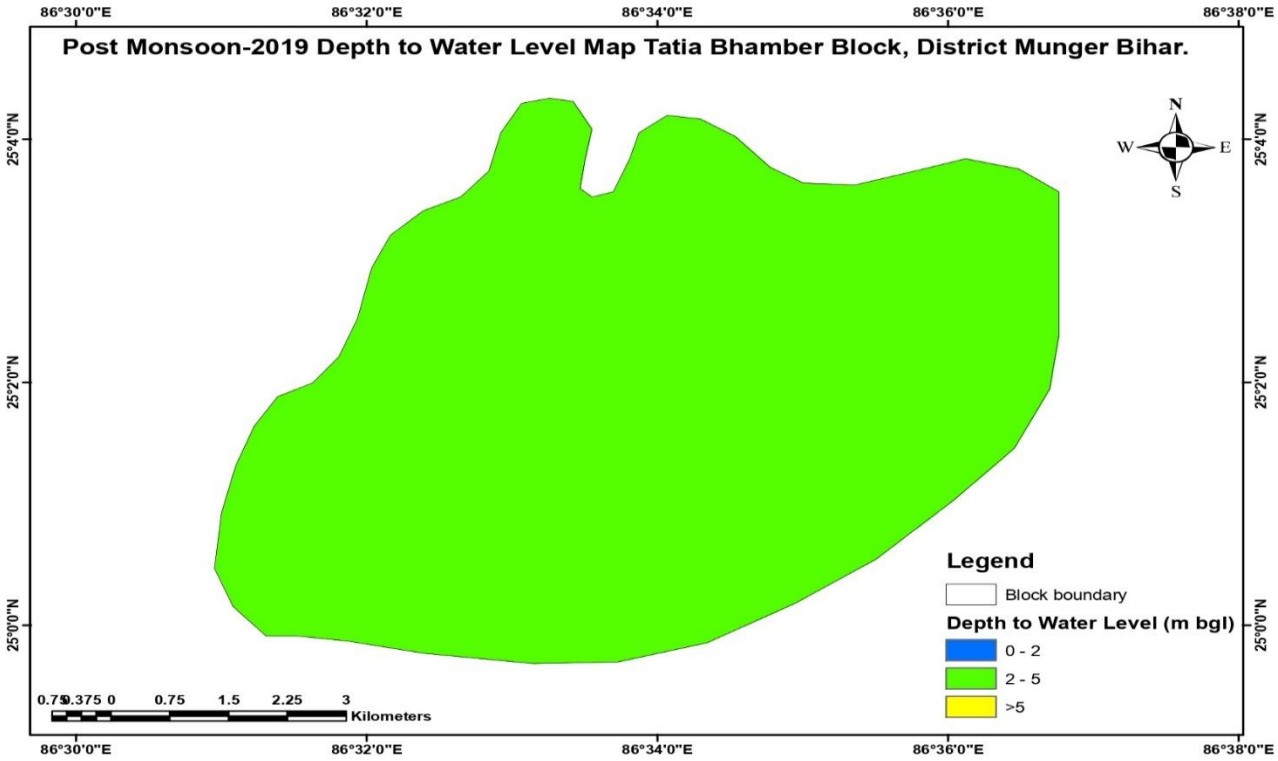

Fig 10- Post-monsoon (2019) water level Map of Tetia bhambar Block

Fig 11- Water level Fluctuation Map (pre-monsoon- post monsoon 2019) of Tetia bhambar Block

3.2 Water table contour

The water table contour map of Tetia bhambar block shows the height of water table during pre-monsoon season varies from 48.77 m to 57.90 m and during post monsoon season height of water table varies from 50.8 to 60.70 m above from mean sea level. As shown in map, ground water flow direction is towards NE direction in this block (fig-12).

3.3 Aquifer properties

Tetia bhambar block comprises under moderate potential zone. From the exploratory well data of CGWB. The discharge of the aquifer is 24.45 m^3/hr with drawdown 3.83 m. The transmissivity of the aquifer varies 143.55m^2/day.

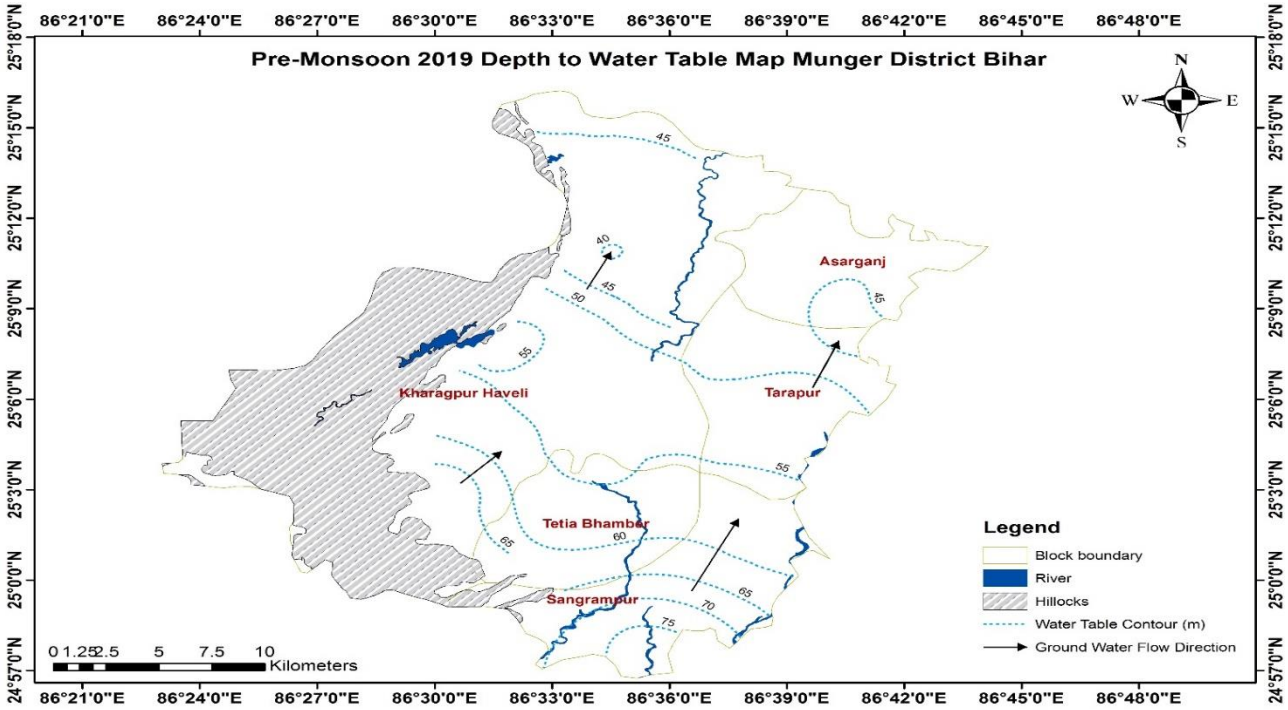

Fig 12: pre-monsoon (2019) water table contour Map of Tetia Bhambharj Block

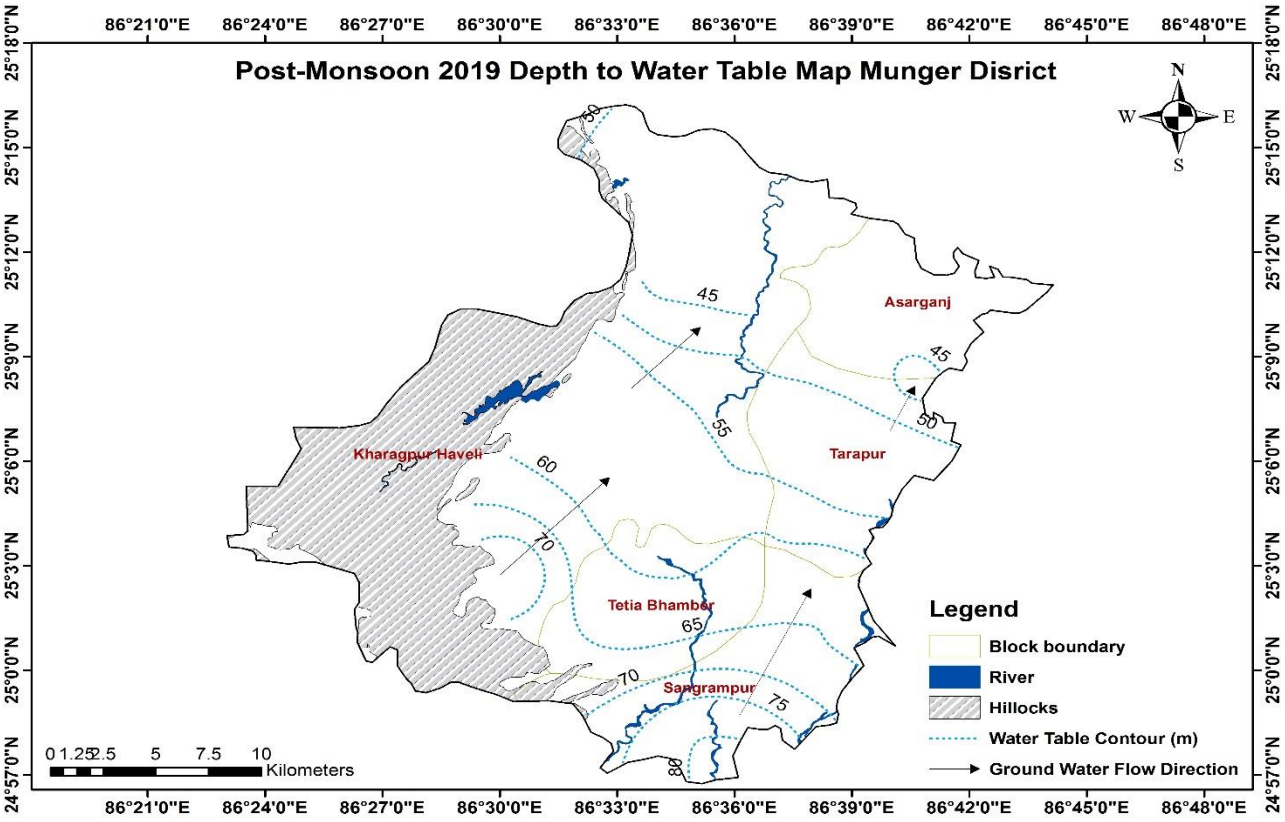

Fig 13: Post-monsoon (2019) water table contour Map of Tetia Bhambharj Block

4.0 Ground Water Resource Availability and Extraction

As per dynamic ground water resource of Bihar 2020 annual extractable ground water resource is 2293.39 ham, Total annual ground water recharge is 2548.21 ham and net ground water availability for future use is 1048.43 ham. Stage of ground water extraction is 53.58% and the block is categorized as safe.

Block	Total Area of Assessment Unit (Ha)	Recharge Worthy Area(Ha)	Total Annual Ground Water (Ham) Recharge	Total Natural Discharges (Ham)	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 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semicritical/Safe/Saline)
Tetia Bhambar	10138	10138	2548.21	254.82	2293.39	1052.3	45.00	131.46	1228.76	147.66	1048.43	53.58	safe

Table 4A: Dynamic Ground Water Resource (as on 22nd March, 2021)

4.1 Chemical Analysis

Result of chemical analysis of ground water of shallow aquifer is given in the table below (*Table 5B*). In general, chemical quality of shallow aquifer is potable. Few areas in the block have been reported with Fluoride contamination in ground water.

Sl. No.	District	Block	Location	Latitude	Longitude	pH	EC	TDS	TH	Ca	Mg	Na	K	CO3	HCO3	Cl
1	Munger	Tetia bhambar	Rampur	25.03	86.63	7.7	391	254	86	17	14	49	1.9	0	156	39

Table 4B- Result of Chemical Analysis of Ground Water Samples (Source: NHS data-2020)

5.0 Management Plan

5.1 Supply side intervention in Agriculture and Irrigation

From the existing land/agriculture and irrigation data it is understood that the block is principally agricultural depending. However, the average cropping intensity is recorded as 134 %. It reveals that considerable cropped area is not under assured irrigation coverage. The dynamic ground water resource reports stage of development is 53.34 % which indicates there exists further scope of ground water development in the block both for agriculture and drinking/domestic purposes. 5th MI Census data shows that majority of irrigation tube wells accompanied within the depth of 50 m. Therefore, further development may be planed from the deeper part.

Considering projected 70% development, 376.61 ham further resources may be developed safely for irrigation development. This balance resource is recommended for development through LDTW/STW/DTW as per the prevailing terrain condition n and hydrogeology of the area. Considering unit draft of 0.67, 2.4 and 4.8 for LDTW, STW and DTW respectively. Recommended number of irrigation structures have been proposed. thus, in Tetia Bhambar block 112 LDTW, 94 STW and 16 DTW may be constructed. (*Table 5A & 5B*). The LDDW may serve as suitable sources of irrigation in small command area.

Table 5A- Additional resource for 70% development

Assessment Unit Name	Total Area of Assessment Unit (Ha)	Recharge Worthy Area (Ha)	Annual Extractable Ground Water Resource (Ham)	Total Extraction (Ham)	Draft for 70% development (Ham)	Additional resource available for 70 % Development (Ham)
TETIA BHAMBAR	10138	10138	2293.39	1228.76	1605.373	376.613

Table- 5B- Recommended number of structures for further irrigation development

Additional resource available for 70% development (Ham)	Resource allocated for development by LDTW (Ham)	Resource allocated for development by STW (Ham)	Resource allocated for development by DTW (Ham)	Unit draft of LDTW (Ham)	Unit draft of STW (Ham)	Unit draft of DTW (Ham)	No. of LDTW proposed	No. of STW proposed	No. of DTW proposed
376.613	75.3226	225.968	75.323	0.672	2.4	4.8	112	94	16

5.2 Supply side intervention through Artificial Recharge and rain water harvesting

The block receives 1007.6 mm of annual rainfall on an average but most of rain water goes as run off. Construction of suitable artificial recharge structure will help to reduce the run off as well as it also recharges the aquifers and maintain the soil moisture of the area. As per Artificial recharge master plan,2020 following number of recharge structures have been recommended in Munger district. Percolation tank-07, Gully plug-43, contour bunding and trenching-83, Check dam-02, Nala-bunding-05, Recharge shaft-80, De-silting of existing tank /pond /talao-145, Injection Well in Village Tank-194, Renovation of traditional Ahar-Pyne System (km)-45. Based on the local geology / hydrogeology and underlying lithological disposition desiltation of existing tanks, check dam, percolation tank etc.in alluvial parts and nalabunds, contour bunding etc in hard rock area may be practiced in Tetia block.

Before construction of these recharges' structures, selection of suitable site is required for getting better benefits from these structures.

5.3 Demand side intervention

Considering the moderate potentiality of the area water intensive crop may be to some extent by replaced by less water consuming crop. Therefore pulses, oilseeds other horticulture crops etc., as per the local requirement may be encouraged. This may create further irrigation potential in the block. Suitable crop rotation may be practiced. In hard rock area micro watershed development may be suitable solution for sustainable development of water resources in the block.

5.4 Ground water contamination

The block has been reported with fluoride contamination in ground water. Therefore, before using of ground water from shallow or deep tube wells for drinking, domestic and irrigation purpose should be tested fluoride contamination. Domestic fluoride removal technique may be adopted for short term measures whereas for long term intervention commercial fluoride removal plan may be installed.

Capacity building for awareness generation among the stake holders and end users may be a suitable approach to address and to mitigate fluoride contamination in the ground water.