केन्द्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण

विभाग, जल शक्ति मंत्रालय

भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development and Ganga Rejuvenation,

Ministry of Jal Shakti

Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

RAMPUR DISTRICT
UTTAR PRADESH

उत्तरी क्षेत्र, लखनऊ

Northern Region, Lucknow

जल शक्ति मंत्रालय

केंद्रीय भूजल बोर्ड
Central Ground Water Board (CGWB)

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REPORT OF

AQUIFER MAPPING AND MANAGEMENT PLANS OF

RAMPUR DISTRICT,

UTTAR PRADESH

AQUIFER MAPPING AND MANAGEMENT PLANS OF RAMPUR DISTRICT, UTTAR PRADESH STATE

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DISTRICT AT A GLANCE

1		**GENERAL INFORMATION**		
	i	**Geographical area (km^2)**	**:**	2651
	ii	**Administrative divisions**	**:**	
	a	No. of Tehsils	**:**	3
	b	No. of Blocks	**:**	6
	c	No. of Towns and urban areas	**:**	5
	d	No. of villages	**:**	892
	iii	**Population (as per 2011 census)**		
	a	No. of Males	**:**	1,223,889
	b	No. of Females	**:**	1,111,930
	c	Population density (people per km^2)	**:**	987
	d	Urban population	**:**	5,88,647
	e	Rural population	**:**	15,06,338
	iv	**Literacy Rate (as per 2011 census)**	**:**	53.3%
	v	**Per Capita net income (at current prices)[2018-19]** [1]	**:**	₹ 48,351
	vi	Climate	**:**	Subtropical
	a	Normal Annual precipitation (2018)	**:**	509 mm
	b	Minimum temperature (°C)	**:**	-

	c	Maximum temperature (°C)	:	-
2		**GEOMORPHOLOGY**		Central Ganga Plain
	i	**Major Physiographic units**	:	Tarai, Older Alluvium, Younger Alluvium Flood Plain
	ii	**Major Drainage**	:	Ram Ganga, Kosi
3		**Land Use [Ha]**		
	i	**Forest Land**	:	6,611
	ii	**Fallow Land**	:	4,335
	iii	**Gross Area sown**	:	3,54,000 Ha.
	iv	**Net Area sown**	:	1,87,416 Ha.
	v	**Gross Area irrigated**	:	3,41,000 Ha.
	vi	**Net Area irrigated**	:	1,87,000 Ha.
4		**Major Soil types**	:	Loamy, silty soil
5		**The area under Principal crops**		
	i	**Rabi**	:	46,093.63
	ii	**Kharif**	:	1,17.661
	iii	**Zaid**	:	-
6		**Sources of irrigation [2016-17]**		
	i	**No. of dug wells**	:	0

	ii	**No. of Tube wells**	**:**	1,335 (Government)
			:	10,495 (Private)
	iii	**Canals [Ha]**	**:**	94
	iv	**Other sources**	**:**	77,406
7		**No. of CGWB GW monitoring stations [2019]**		
	i	**No. of Dug wells**	**:**	1
	ii	**No. of Piezometers**	**:**	2
8		**Groundwater exploration by CGWB**		
	a	**No. of wells drilled**	**:**	EW = 6
	b	**Depth range (mbgl)**	**:**	150.00 to 300.00
	c	**Discharge (lpm)**	**:**	1533 to 1800
	d	**Storativity (S)**	**:**	$1.21*10^{-3}$ to $1.93*10^{-5}$
	e	**Transmissivity (m^2/day)**	**:**	326 to 709
9		**Groundwater quality**		
	a	**Major Hydrochemical facies**	**:**	Mainly Fresh
	b	**Presence of Trace metals**	**:**	None
10		**Dynamic Groundwater Resources [as per GEC-2020] (in Ham)**		
	a	**Net annual Groundwater availability**	**:**	71890.6 ham

	b	**Existing Gross Groundwater draft**	**:**	51838.73 ham
	c	**Net Groundwater availability**	**:**	19403.58 ham
	d	**Stage of Groundwater Development**	**:**	72.11 %
11		**Groundwater Control and Regulation**		
	a	**No. of over-exploited blocks**	**:**	2
	b	**No. of critical blocks**	**:**	1
	c	**No. of semi-critical blocks**	**:**	3
	d	**No. of notified blocks**	**:**	0

INDEX

Aquifer Mapping and Management of Ground Water Resources
Rampur District, Uttar Pradesh

1. INTRODUCTION

1.1 Objectives

Aquifer Mapping and Management Program is launched by "Central Ground Water Board under MoWR, RD & GR" in response to the overuse, pollution, and other associated problems with groundwater. The initiative was started as part of the XII plan's Ground Water Management and Regulation Plan Scheme. The following are the project's main goals:

- Delineation and characterization of aquifers in three dimensions,
- Evaluation of aquifers, groundwater regime behavior, hydraulic characteristics, and hydrogeochemistry of aquifer groups on a 1:50,000 scale,
- Identification and quantification of issues,
- Development of management plans to ensure the sustainability of groundwater resources.

As part of the program, management plans are being created for every aquifer system, proposing several actions to optimize groundwater extraction, and recognizing aquifers with potable groundwater for consumption in areas with poorer quality. In addition to demand-side management options such as crop diversification, improving water use efficiency, etc., the management choices also involve recognition of possible areas for artificial recharge to groundwater and water conservation which aid in stopping dropping water levels.

1.2 Scope of the Study

Gathering and compendium of accessible data on aquifer structures, the boundary of their stretches and portrayal, assessment of data gaps, creation of extensive information to complete the recognized data gaps, and eventually preparation of aquifer maps at the preferred magnitude are all part of the systematic mapping of an aquifer. The findings of this research will help strategists, decision-makers, and other stakeholders employ resource management techniques, including long-term aquifer monitoring networks and theoretical and statistical regional ground-water-flow models. Aquifer mapping at the adequate level can aid in the planning, implementation, and monitoring of numerous managerial treatments focusing on ensuring the

long-term viability of our valuable groundwater resources, which will, in turn, aid in the achievement of drinking water security, better irrigation amenities, and overall "water resource development sustainability" in the nation.

1.3 Approach and Methodology

For the creation of aquifer maps and management plans, a multidisciplinary technique utilizing cutting-edge technologies and techniques is being used, involving remote sensing, GIS, geophysical techniques, groundwater modeling, etc.

To guarantee the quality of the deliverables, a multi-tier evaluation procedure has been implemented. The Regional Directors of the different regions of CGWB assess the aquifer maps and management plans created by the team of officers. Subsequently, at the central headquarters level, the updated maps and management plans are provided to the respective CGWB members. "The National Level Expert Committee" (NLEC), which was established for this objective, is then provided with the maps and management plans. The experts' group includes domain experts in the fields of groundwater from JNU, Delhi; IIT, Roorkee; former Chairman of CGWB; agriculture scientists, etc. The ICAR's agricultural experts have also contributed to the formulation of the management plans for every state. "The State Ground Water Coordination Committee" (SGWCC), which is chaired by the principal secretary of the relevant department, has been established in every state and UT in order to facilitate cooperation on different aquifer mapping-related matters between the State and Union Governments. In order for the suggested aquifer-specific groundwater management plans to be adopted by the State Government, the results are exchanged and discussed in the State Ground Water Coordination Committee.

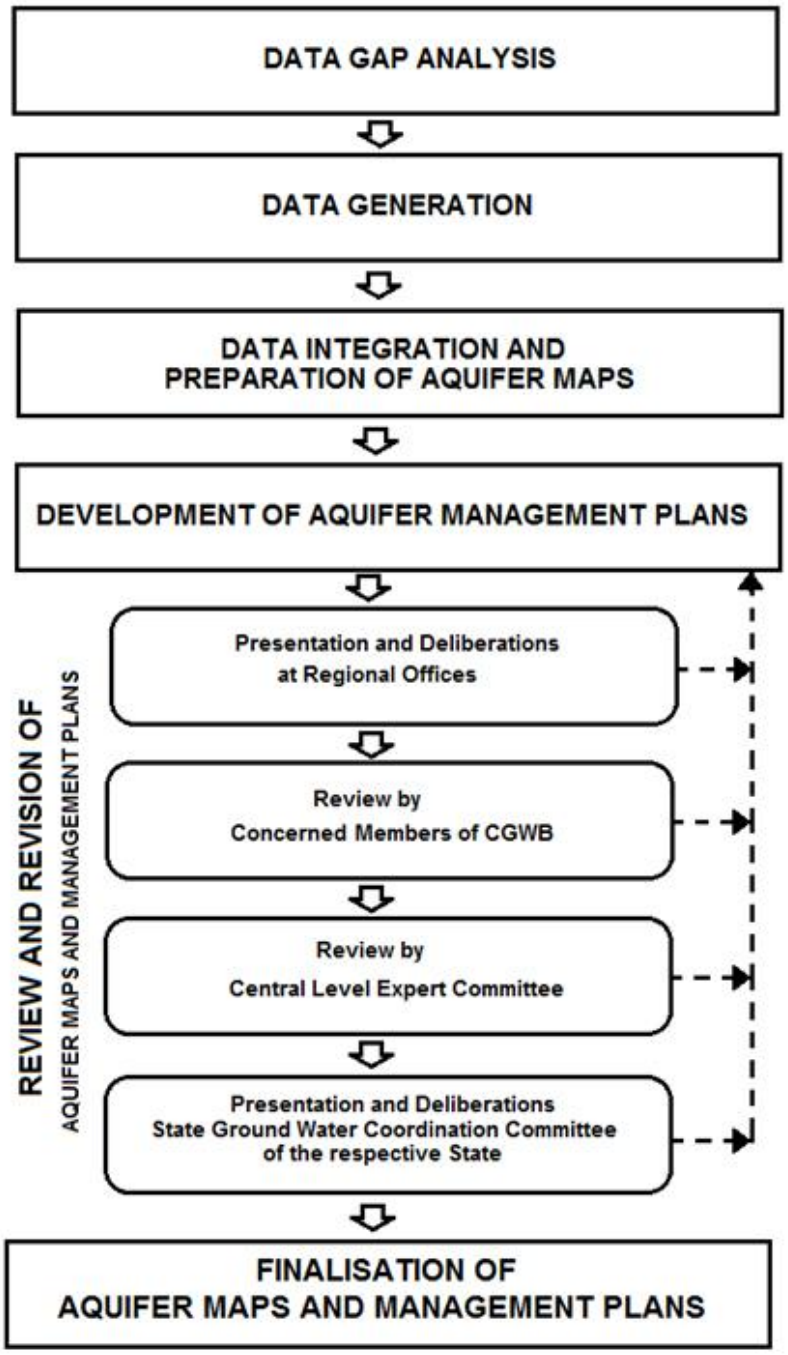


Figure 1: Methodology of NAQUIM

Location of the study area

Rampur district is one of the districts in the Indian state of Uttar Pradesh, and Rampur town serves as the district's administrative center. The Moradabad Division includes the Rampur District. According to medieval history, Rampur was split between the Badaun and Sambhal districts and belonged to the Delhi area. As a result, it was discovered in 1775. District Udham Singh Nagar in the north, Bareilly in the east, Moradabad in the west, and Badaun in the south encircle Rampur district.

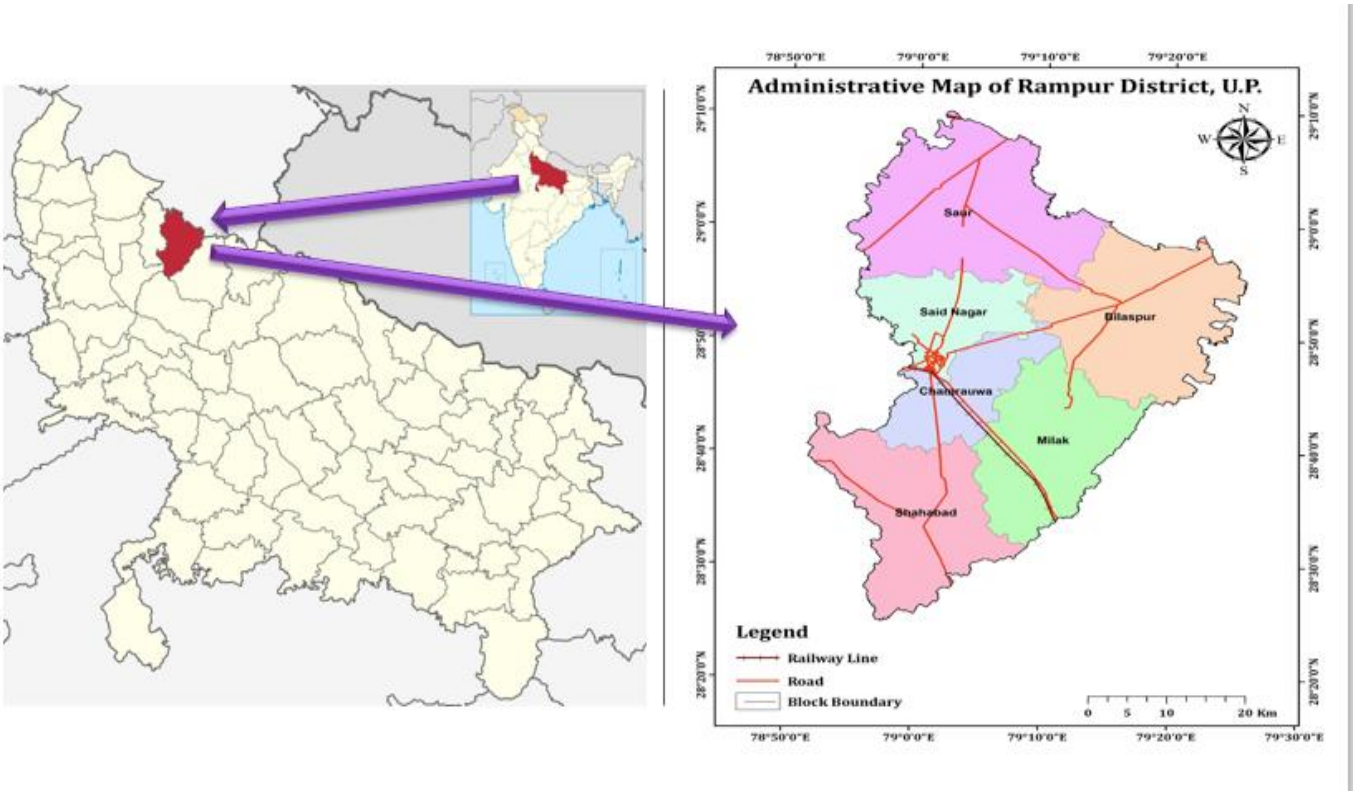


Figure 1: Location Map of Rampur District, U.P.

1.4 Data Availability

Data on the numerous characteristics of groundwater were gathered from publications of the "Central Ground Water Board," state departments, and other organizations. The collected data were displayed on a map on a scale of 1:50,000, and a data gap analysis was done to determine the need for future hydrological, hydrogeological, hydrochemical, and geophysical research. The following table lists the key facts:

Table 1: Status of Data availability, data gap, and data generation

Sl. No.	Parameter (s)	Data Required	Data Available	Data Gap	Data Generation
1.	Rainfall Data	IMD Meteorological station in the study area	No. Data obtained from European Space Agency.	No.	No.
2.	Soil	Soil Map and Soil infiltration test data.	Soil shape file available from U.P.R.S.A.C	Soil infiltration test data.	Soil infiltration across the study area.
3.	Land Use/ Land cover	Land Use/Land cover pattern	Land Use/ Land cover shape file available from U.P.R.S.A.C	No.	No.
4.	Geomorphology	Digitized Geomorphological map	District Resource Map available from G.S.I	No.	Map generated on GIS platform.
5.	Geology	Digitized Geological map	District Resource Map available from G.S.I	No.	Map generated on GIS platform.

6.	Exploration Data	EW in each quadrant	Available from old CGWB & UPGWD records	Yes	Carried out in 3 blocks.
7.	Aquifer Parameters	Aquifer parameters in all the quadrants	From 6 exploratory wells under NAQUIM	Yes	Data to be generated.

1.5 Climate

Since Rampur lacks a meteorological station, the data from the closest station in Bareilly has been used. A hot, dry summer and winter are characteristics of the sub-humid climate. The district receives 967 mm of rainfall on average per year. June through September sees the lion's share of the region's rainfall or about 85%. With an average daily high temperature of around 46°C and an average daily low temperature of around 40°C, May is the warmest month of the year. The daytime temperature decreases noticeably when the southwest monsoon moves in, but the evenings remain pleasant. With an average daily high temperature of 21°C and an average daily minimum temperature of roughly 8°C, January is the coldest month. The average highest monthly temperature is 29.4°C, while the average lowest monthly temperature is 12°C. In the southwest monsoon period and to a smaller extent in the post-monsoon season, the air is quite humid. The average monthly relative humidity in the morning is 69 percent, while in the evening, it is 51 percent. The average wind speed is 5 to 1 kph, which is considered to be mild. There might be 1402.8 mm of evapotranspiration.

1.6 Geomorphology and Geology

a. Geology

District Rampur lies over alluvial deposits of the quaternary period brought by river systems of Ganga and Ram Ganga. These comprise sand, silt and clays in various proportions.

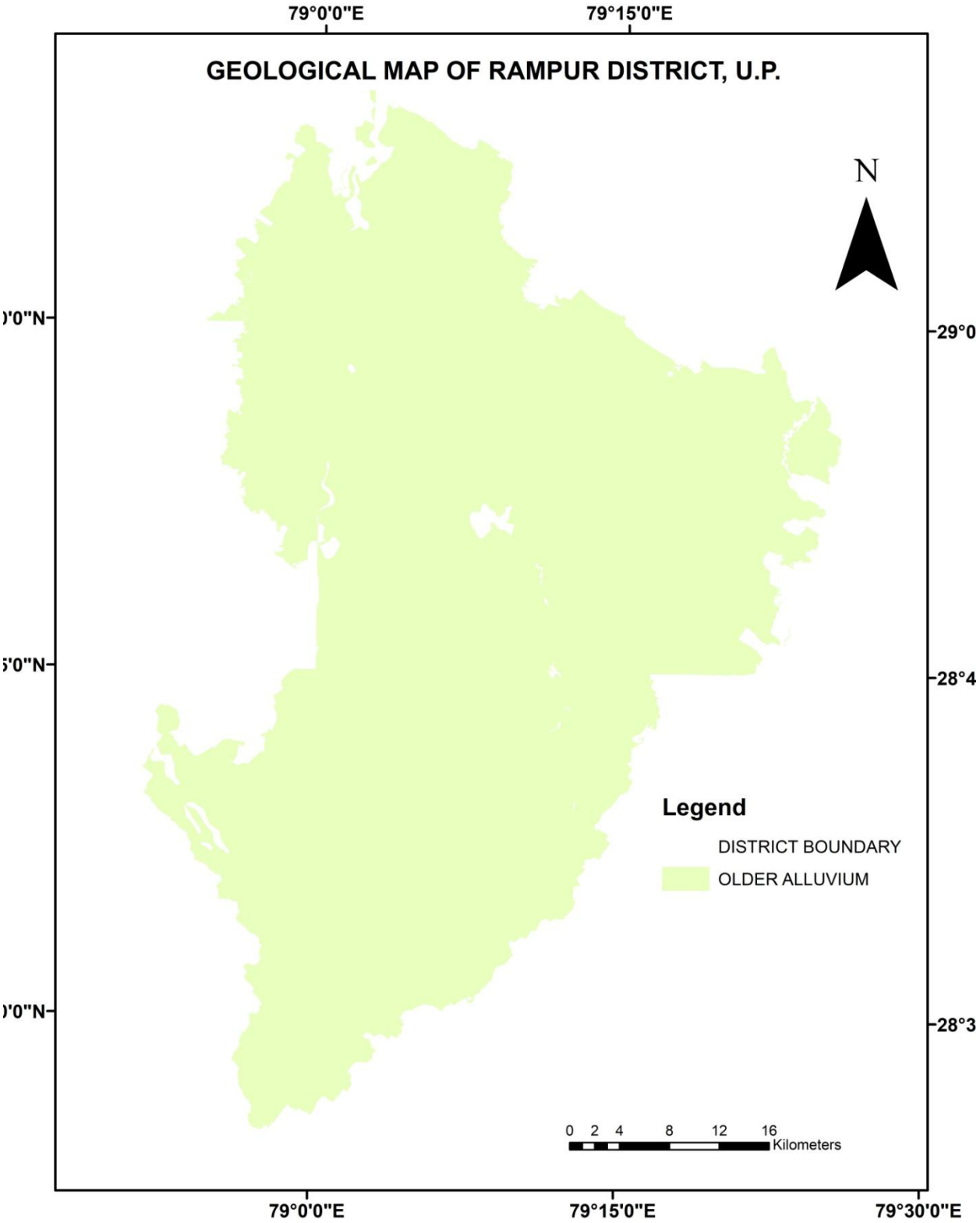
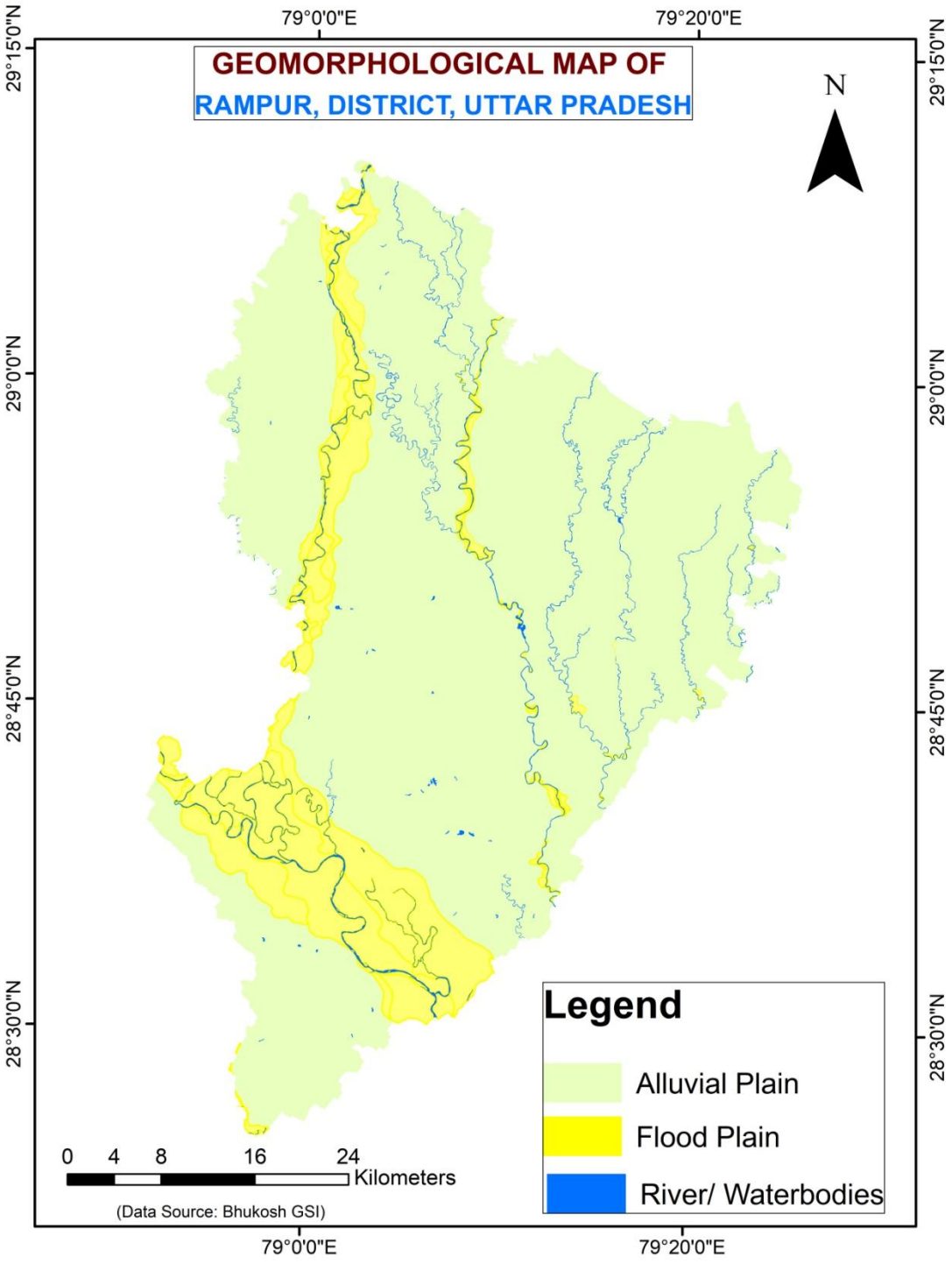


Figure 2: Geological Map of Rampur District

1.7.1 Geomorphology



1.7.1.1 Physiography, Geomorphologic Features and Landforms

The Central Ganga Alluvial Plain includes the Rampur district, which is characterized by steep topography in the north and progressively flattens as it moves south. Manunagar, a hamlet in the district, has the greatest elevation (224 mamsl), whereas Gangapur, a community on the Ram Ganga flood plain, has the lowest elevation (172 mamsl). The enumerated geomorphic units are as follows.

a) **Tarai Tract:** This tract is the Tarai tract's southern extension in the Nainital district. It is located at the district's farthest northern location. This region is characterized by intermittent running wells and shallow water levels.
b) **Meander Flood Plain:** It is a flat, low-lying, badly drained terrain with little to no relief that is restricted to the Kosi, Pilkhau, and Ram Ganga river systems. In this category, common geomorphic characteristics are Sand and Point bars.
c) **Younger Alluvial Plain:** These plain regions are only found alongside the Kosi, Pilkhau, and Ram Ganga rivers, with the greatest lateral length of around 10 km, and are characterized by a flat to gently sloping and slightly undulating surface. Common fluvial landforms include oxbow lakes, palaeo-channels, and meander scars.
d) **Older Alluvial Plain:** The Terai tract's southern border is an older alluvial plain or upland. The inter stream region is formed by this plain, which is substantially higher in elevation than the younger alluvial plain. The district's land is made up of this plain to the extent of around 80%.
e) **Ravinous Tract:** This tract, which is distinguished by a chain of gullies alongside the rivers Kosi, Pilakhau, and Ram Ganga, was created by the erosional activity of runoff water. This tract, which is distinguished by a chain of gullies along the rivers Pilakhau, Ram Ganga, and Kosi, was created by the erosional activity of runoff water.

1.7 Drainage

Rampur city lies along the Kosi River, about 15 miles (24 km) east-southeast of Moradabad. The district, which is a portion of the "Central Ganga Alluvial Plain," is characterized by steep hills in the north that progressively flatten out as you move south. The Ram Ganga River and its tributaries, including the Baigul, Bauri, Pilakhau, Ghuga, Dhimri, Saijni, Nahal, and Kosi, are in charge of controlling the drainage of the study area. The Ram Ganga river runs south-easternly and enters the region close to its southwest corner.

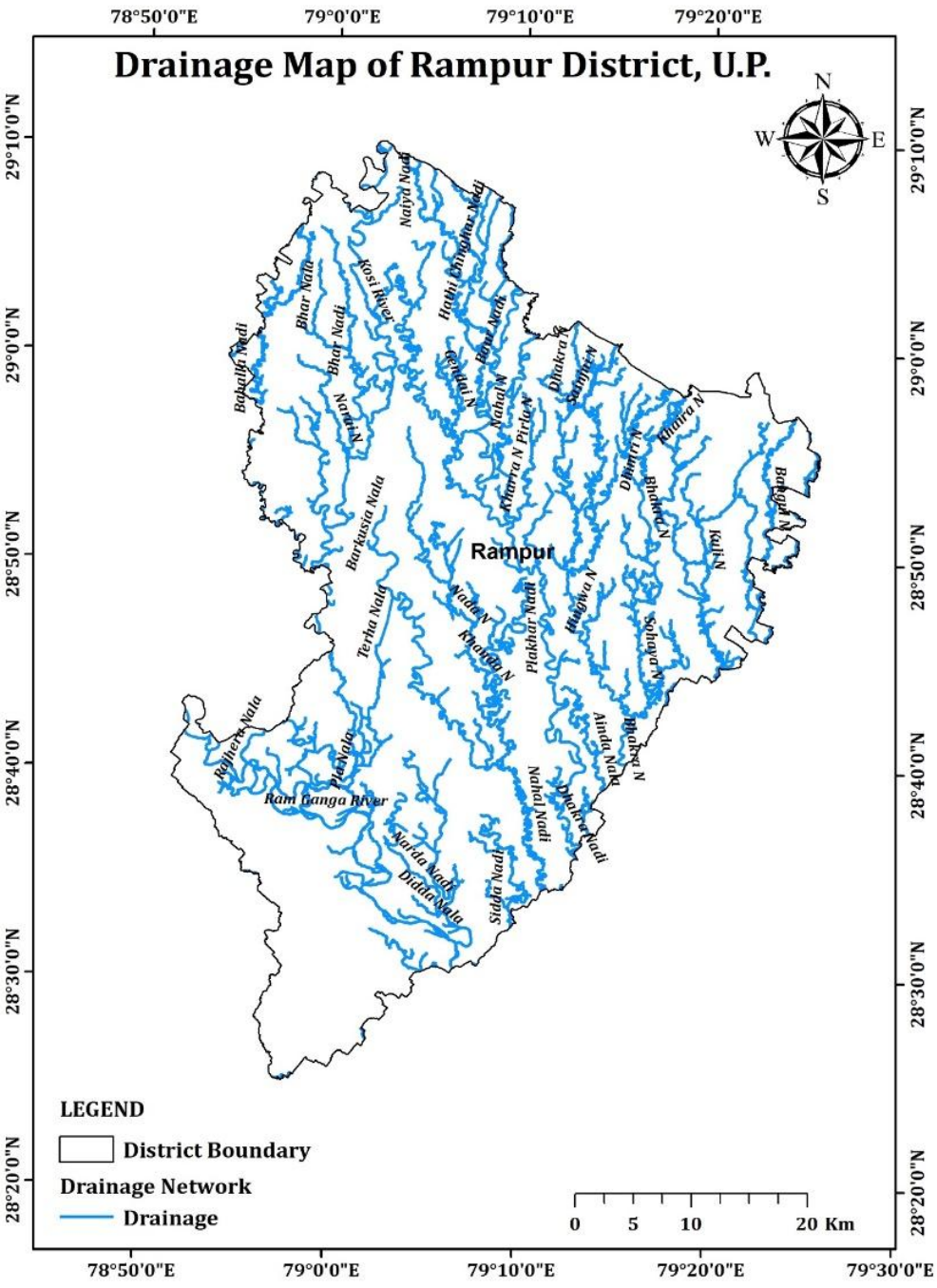


Figure 3: Drainage Map of Rampur

1.8 Soil

Distinct fertile kinds of soil have emerged in several geomorphic divisions based on the topography of the location. Tarai tract has fine-textured, organic matter-rich soil. Uplands are where loamy soil formed. Younger alluvial plains have silty soil. The district's pattern of land

use has been greatly influenced by the kind of soil. The lush alluvial soil that covers the whole northern plain is the sort of soil that is present here. The majority of alluvial soils are quite fruitful. These soils often have suitable levels of potash, phosphoric acid, and lime, making them perfect for the development of cereal and pulse crops, including sugarcane, rice, wheat, and others. Alluvial soil locations, like Rampur, are actively farmed and densely inhabited due to their high productivity.

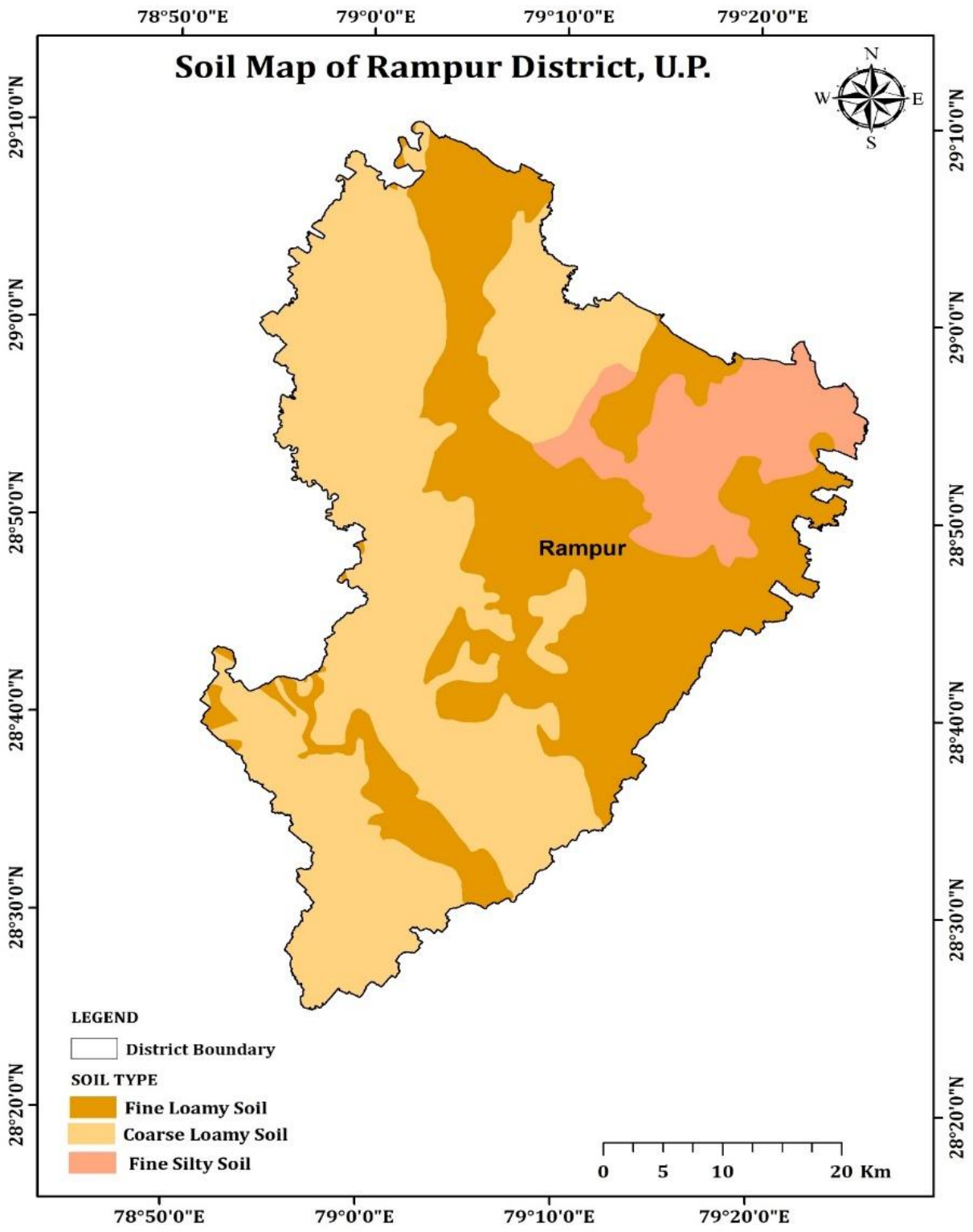


Figure 4: Soil Map of Rampur, Uttar Pradesh

Table 2: Soils of Rampur District (U.P.)

Legend	Plains	Description
1	**Piedmont Plains**	Deep, loamy soils.
2		Deep, loamy soils and silty soils.
3	**Alluvial plain**	Deep, loamy soils.
4		Deep, loamy soils and silty soils.
5		Deep, fine soils and loamy soils.
6		Deep, loamy soils(moderate salinity and sodicity) and loamy soils (moderate salinity and strong sodicity).
7		Deep, silty soils and loamy soils.
8		Deep, silty soils and slightly eroded.
9		Deep, loamy soils and loamy soils.
10	**Old Alluvial plain**	Deep, loamy soils and sandy soils.
11	**Recent Alluvial Plain**	Deep, loamy soils with slight flooding.
12	**Active Flood Plain**	Deep, sandy soils(moderate flooding) and loamy soils(slight flooding).
13		Deep, loamy soils (moderate flooding) and sandy soils(moderate flooding.

1.9 Land Use/Land Cover

The term “land use” describes the function that a piece of land performs, such as agriculture, wildlife habitat, or recreation. Because quick information is needed to determine what current quantity of land is in what sort of use and to detect the land use variations from year to year, land use applications entail both baseline mapping and subsequent surveillance. This information will be used to create plans that manage growth demands, competing uses, and preservation.

The term "land cover" describes the material that covers the surface of the ground, such as vegetation, urban infrastructure, water, bare soil, etc. For planning, resource management, and monitoring studies, it is crucial to identify, delineate, and map the land cover. The baseline for monitoring operations is established by the classification of the land cover.

Table 3 gives the land use pattern in the district. Land put to agricultural uses comes to 2145.39 Sq. Km including the area of cropland 2090.20 Sq. Km, fallow 37.39 Sq. Km, (thus, current fallows are required to be enhanced to raise the level of productivity of the crops), plantation 17.80 Sq. Km, (current plantations are required to be enhanced to raise the level of productivity of the veggies and fruits). Also, Barren/unculturable/ Wastelands cover an area of 4.18 sq. Km, including salt-affected land 0.33 Sq. Km, sandy area 0.09 Sq. Km and scrubland 3.76 Sq. Km. The Forest area in the district comes to 36.74 Sq. Km, including deciduous 33.79 Sq. Km and scrub forest 2.95 Sq. Km. Moreover, wetlands/water bodies cover an area of 73.22 sq. Km in the district, including the area of inland wetland 1.49 Sq. Km., river/stream/canals 68.60 Sq. Km and water bodies cover the area of 3.13 sq. Km. Also, the built-up area of the district covers 107.48 Sq. Km, which includes a mining area of 0.29 Sq. Km, rural area 78.62 Sq. Km and urban area 28.57 Sq. Km.

Thus, there is a pressing need for afforestation in the district. Grazing uses of land in the district are found to be nil. It would be necessary that grazing of land is enhanced in the district.

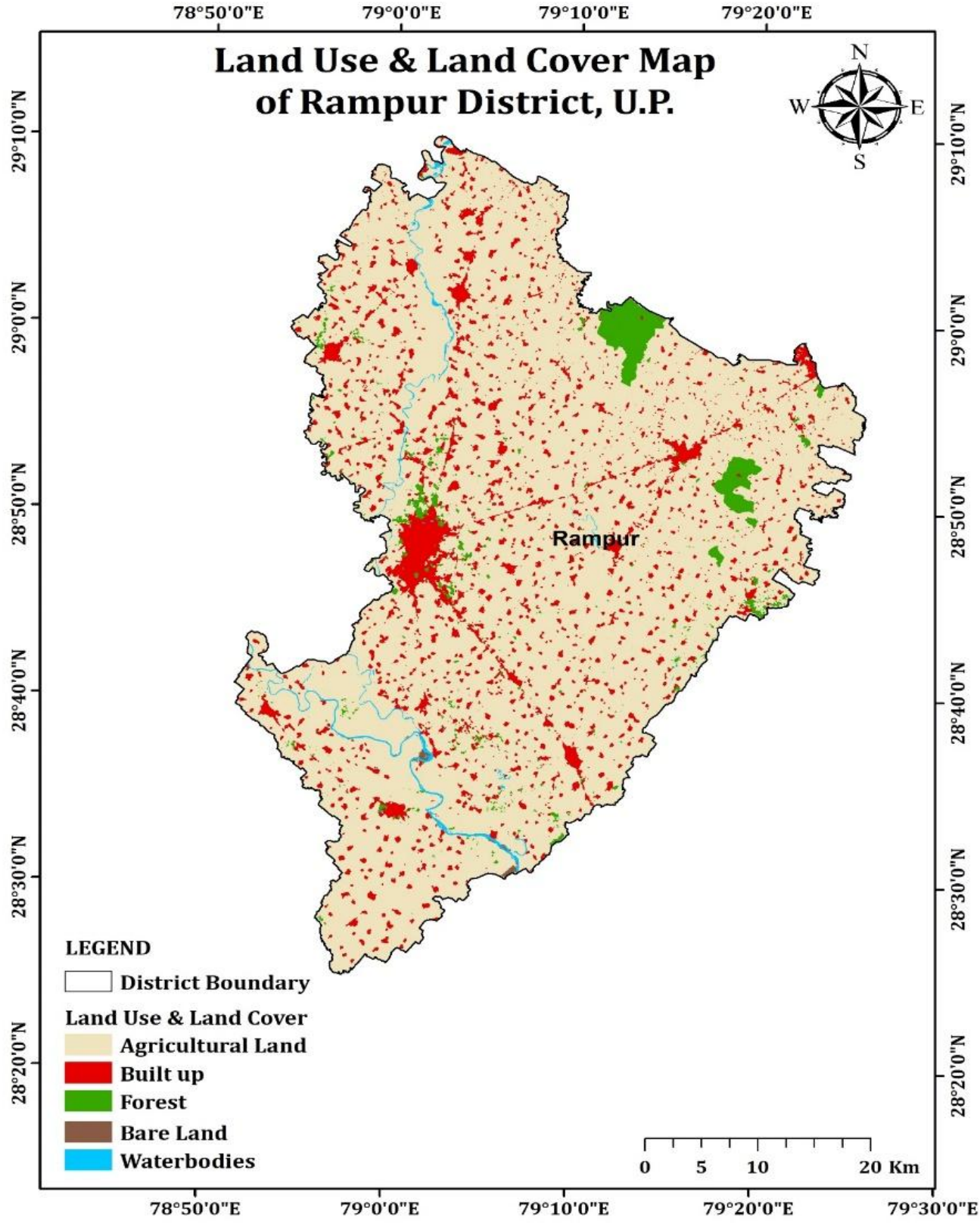


Figure 5: Land Use & Land Cover Map of Rampur District

Table 3: Land Use Pattern of the Rampur District

Categories	Land Use Pattern of the District	Area in Sq. Km
Agriculture	Cropland	2090.20
	Fallow	37.39
	Plantation	17.80
Barren/unculturable/ Wastelands	Salt Affected Land	0.33
	Sandy Area	0.09
	Scrub Land	3.76
Built-up	Mining	0.29
	Rural	78.62
	Urban	28.57
Forest	Deciduous	33.79
	Scrub Forest	2.95
Wetlands / Water bodies	Inland Wetland	1.49
	River/Stream/Canals	68.60
	Water bodies	3.13

Source: https://bhuvan-app1.nrsc.gov.in/2dresources/thematic/LULC502/MAP/UP.pdf

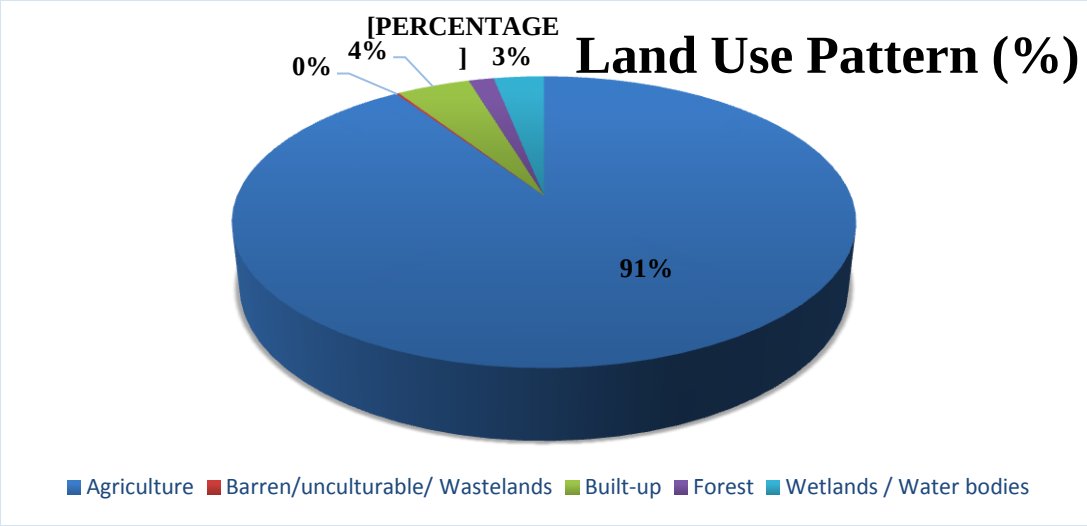


Figure 6: Land use Pattern of Rampur district

1.10 Agriculture and Cropping Pattern

Rampur's economy is largely centered on agriculture. Despite having a lot of fertile lands, it has relatively little industry and almost little mineral exploitation. Rampur's primary industries include the production of agricultural tools, textile weaving, sugar processing, and zari embroidery.

The principal crops in the district include (i) wheat, (ii) rice, (iii) sugarcane, and (iv) pulses. Of the total land in the district, 135.63 (‘000) hectares are engaged in the production of wheat. Similarly, 116.154 (‘000) hectares of land are utilized to produce rice in the district. The land used to produce sugarcane comes to 22.385 (‘000) hectares in the district (Table-4). It suggests that there is a need to increase the area underutilization for various crops in the district, such as (i) jowar (ii) bajra, (iii) maize (iv) urd (v) moong, (vi) gram and (vii) potato vis-à-vis the state of Uttar Pradesh.

Table:4 Area under major field crops & horticulture (as per latest figures) (2008-09)

Major field crops cultivated	Area ('000 ha)							
	Kharif			Rabi				
	Irrigated	Rainfed	Total	Irrigated	Rainfed	Total	Summer	Grand total
Rice	110.054	-	116.154	-	-	-	6.100	116.154
Wheat	-	-	-	135.63	-	135.63	-	135.63
Sugarcane	-	-	-	22.385	-	22.385	-	22.385
Maize/Pearl millet	-	1.507	1.507	-	-	-	0.887	2.394
Toria	-	-	-	12.228	3.768	15.996	-	15.996
Lentil	-	-	-		1.432	1.432	-	1.432
Mentha	-	-	-	1.321	-	1.321	-	1.321
Mustard	-	-	-	3.276	1.548	4.824	-	4.824
Horticulture crops - Fruits	Area ('000 ha)							
	Total			Irrigated			Rainfed	
Mango	2.523			1.513			1.009	
Muskmelon	0.778			0.446			0.311	
Guava	0.139			0.083			0.055	

Horticulture crops - Vegetables	**Total**	**Irrigated**	**Rainfed**
Potato	1.722	1.722	-
Pea	0.677	0.677	-
Plantation crops	**Total**	**Irrigated**	**Rainfed**
Poplar	5.465	5.465	-
Eucalyptus	1.654	-	1.654
Fodder crops	**Total**	**Irrigated**	**Rainfed**
Sorghum	28.658	13.216	15.442
Pearl millet	6.889	-	6.889
Berseem	3.162	3.162	-
Total fodder crop area	38.709	16.378	22.331

Source:http://www.nicra-icar.in/nicrarevised/images/statewiseplans/Uttar%20Pradesh/UP4-Rampur-26.7.2012.pdf

1.11 Irrigation

In the entire district, farming is the main industry. Large-scale surface and groundwater development is being conducted in order to provide irrigation. According to several sources, the Rampur district's irrigated area is provided in (Table-5). The total area that has been irrigated in any way is 355.061 ('000) hectares.

Table:5 Irrigation Pattern of Rampur District

Irrigation	Area (‘000 ha)		
Net irrigated area	168.118		
Gross irrigated area	355.061		
Rainfed area	25.125		
Sources of Irrigation	**Number**	**Area (‘000 ha)**	**Total Irrigated Area (%)**
Canals		1.313	0.78%
Tanks		0.314	0.18%
Open wells		48.624	28.90%
Bore wells		117.371	69.98%
Lift irrigation schemes	Nil		-
Other sources (please specify)		0.496	0.30%

Source:http://www.nicra-icar.in/nicrarevised/images/statewiseplans/Uttar%20Pradesh/UP4-Rampur-26.7.2012.pdf

The net area sown in the district is 168.118 (‘000) hectares. The length of the major canal in the district was 1.313 (‘000) hectares. The state tube wells and canals constitute the state irrigation works, while tanks, open wells, bore wells etc., constitute the private works.

1.12 Prevailing Water Conservation and Recharge Practices

Data not available

2 DATA COLLECTION, INTEGRATION, AND AQUIFER MAPPING

2.1 Aquifer Geometry

To know the lithological framework and sub-surface disposition of aquifers in the study area, the lithological data of wells drilled by CGWB and UPGWD was first compiled and redefined as per ROCKWORKS software format and then plotted for visualization of aquifer disposition.

The major lithology is Quaternary alluvium, underlain by the Vindhyan basement. Quaternary alluvium is divided into "Older and Newer alluvium." Older alluvium consists of oxidized sediments of the polycyclic sequence of silt, clay with calcareous concretions (kankar), and micaceous beds. Newer alluvium was deposited by the annual flooding of the Ghaghara River and has non-oxidized sediments made of alternate clay and sand layers.

Three aquifer groups were identified visually upon generation of 2-D and 3-D models and fence diagrams. The quality of formation water is good, barring the occurrence of Iron at a few places in the unconfined aquifer.

2.2 Groundwater scenario

Groundwater in the district occurs in an aquifer system mainly made of alluvial sediments deposited by the Ghaghara River and its tributaries. Granular zones comprise fine-grained sand to silty sand with the occurrence of calcareous concretions (kankar) and possess moderate transmissivity and permeability. Clay layers act as barriers separating the three aquifer groups in the district and possess insignificant transmissivity and permeability, resulting in clay acting as confining layers.

A hydrogeological map of the study area has been attached in Figure 8 below. Perusal reveals that the groundwater flow is mainly towards the Ghaghara River and its tributaries, Tons and Choti Sarju.

2.3 Depth to Water Level

"Pre-monsoon and post-monsoon water level" data were collected from the key wells and piezometers in the district for 2021. The depth to water level data and fluctuation data has been attached in Table 6. Depth to water level maps prepared for the pre-monsoon and post-monsoon periods have been below, as shown in Figures 9 and 10. Pre-monsoon depth to water level fluctuates between 3.15 mbgl to 11.68 mbgl, and post-monsoon depth to water level varies between 2.43 mbgl to 12.16 mbgl. The majority of the district shows water levels between 3 and 18 mbgl, according to a review of the depth to water level contour map for the period of May 2021.

Table 6: Water Level and Fluctuation Data of Water Level Monitoring Stations of GWD & CGWB

S. No.	Block Name	Loc Names	Long	Lat	Type Of well	PRM_21	PTM_21	FLU_21
1	BILASPUR	BILASPUR*	79.26	28.89	P	5.85	3.92	1.93
2	BILASPUR	PANWARIYA	79.36	28.79	P	6.98	5.75	1.23
3	BILASPUR	BAIRKHERI	79.28	28.92	P	4.18	3.57	0.61
4	BILASPUR	PAIGAMBARPUR DANDIA	79.35	28.82	P	6.71	6.80	-0.09
5	BILASPUR	KAUSHAL GANJ	79.38	28.89	P	7.99	5.99	2.00
6	CHAMRAUA	BHONT*	79.11	28.81	P	6.65	6.22	0.43
7	CHAMRAUA	CHAMRAUA*	79.11	28.79	P	7.00	6.10	0.90
8	CHAMRAUA	KOYALA*	79.08	28.83	P	5.30	4.23	1.07
9	CHAMRAUA	MDHEEYA UDAYRAJ	79.05	28.71	P	7.15	6.60	0.55
10	CHAMRAUA	PNJABNAGAR*	79.00	28.74	P	5.12	3.30	1.82
11	CHAMRAUA	SAIDPUR (LADAURI)	79.01	28.68	P	5.43	3.69	1.74
12	MILAK	BARAKHAS	79.14	28.75	P	7.37	6.00	1.37
13	MILAK	BHAWERKA	79.26	28.71	P	6.63	5.18	1.45
14	MILAK	DHANELI (NORTH)	79.23	28.65	P	6.43	5.72	0.71
15	MILAK	GANGAPUR KDIM*	79.20	28.77	P	5.90	5.05	0.85
16	MILAK	KAMAURA	79.16	28.67	P	7.95	7.13	0.82
17	MILAK	KAPNERI	79.26	28.72	P	6.62	5.15	1.47
18	MILAK	KHATA CHINTAMAN	79.19	28.68	P	6.37	6.44	-0.07
19	MILAK	KUNDANPUR PIEZ	79.11	28.60	P	5.82	5.39	0.43
20	MILAK	BALBHADRAPUR	79.27	28.69	P	8.04	7.40	0.64
21	MILAK	PARAM	79.15	28.57	P	8.54	8.30	0.24
22	MILAK	INAYTPUR	79.30	28.74	P	7.82	5.98	1.84

23	SAIDNAGAR	DILPURA*	79.14	28.86	P	5.30	3.85	1.45
24	SAIDNAGAR	HAMIRPUR*	78.95	28.89	P	7.10	6.15	0.95
25	SAIDNAGAR	KARANPUR*	79.07	28.91	P	7.30	6.42	0.88
26	SAIDNAGAR	KISHANPUR ATARI	79.12	28.88	P	6.20	4.98	1.22
27	SAIDNAGAR	LALPUR*	79.02	28.87	P	7.75	4.01	3.74
28	SAIDNAGAR	NAGALA GANESH*	79.05	28.83	P	6.45	5.85	0.60
29	SAIDNAGAR	SAID NAGAR*	78.98	28.89	P	6.20	5.66	0.54
30	SAIDNAGAR	SHAUKAT NAGAR	79.04	28.81	P	7.10	5.80	1.30
31	SHAHABAD	CHAKARPUR*	78.99	28.54	P	15.50	15.05	0.45
32	SHAHABAD	KHADELI*	78.97	28.52	P	15.20	16.07	-0.87
33	SHAHABAD	MATHURAPUR*	79.08	28.60	P	3.15	2.43	0.72
34	SHAHABAD	NARKHERI*	79.06	28.65	P	5.03	4.18	0.85
35	SHAHABAD	REVRI KHURAD	79.04	28.62	P	5.49	4.33	1.16
36	SHAHABAD	TANDA*	79.04	28.50	P	15.86	16.40	-0.54
37	SHAHABAD	UCHA GAWA*	79.03	28.52	P	15.61	15.10	0.51
38	SHAHABAD	UDAYAPUR JAGIR	79.02	28.63	P	6.15	5.70	0.45
39	SHAHABAD	JAITOLI	78.99	28.60	P	7.57	5.98	1.59
40	SHAHABAD	ISHAKHERA	79.07	28.53	P	11.68	12.16	-0.48
41	SHAHABAD	DEVIYA NAGLA	78.98	28.62	P	5.80	4.03	1.77
42	SWAR	DHANUPURA	79.02	28.90	P	5.80	3.62	2.18
43	SWAR	SHIKAMPUR*	78.94	29.02	P	8.54	6.18	2.36
44	SWAR	SWAR*	79.06	29.03	P	5.20	6.28	-1.08
45	SWAR	DHAKKANAGLAIYA	78.94	28.96	P	6.45	5.70	0.75
46	SWAR	SHIKARPUR	79.14	29.06	P	7.70	6.95	0.75
47	BILASPUR	BILASPUR PZ GWD	79.28	28.88	P	5.62	3.84	1.78
48	MILAK	DHANELI PURWI	79.18	28.57	W	6.52	6.1	0.42
49	SHAHABAD	SHAHABAD PZ GWD	79.95	27.65	P	10.78	10.07	0.71

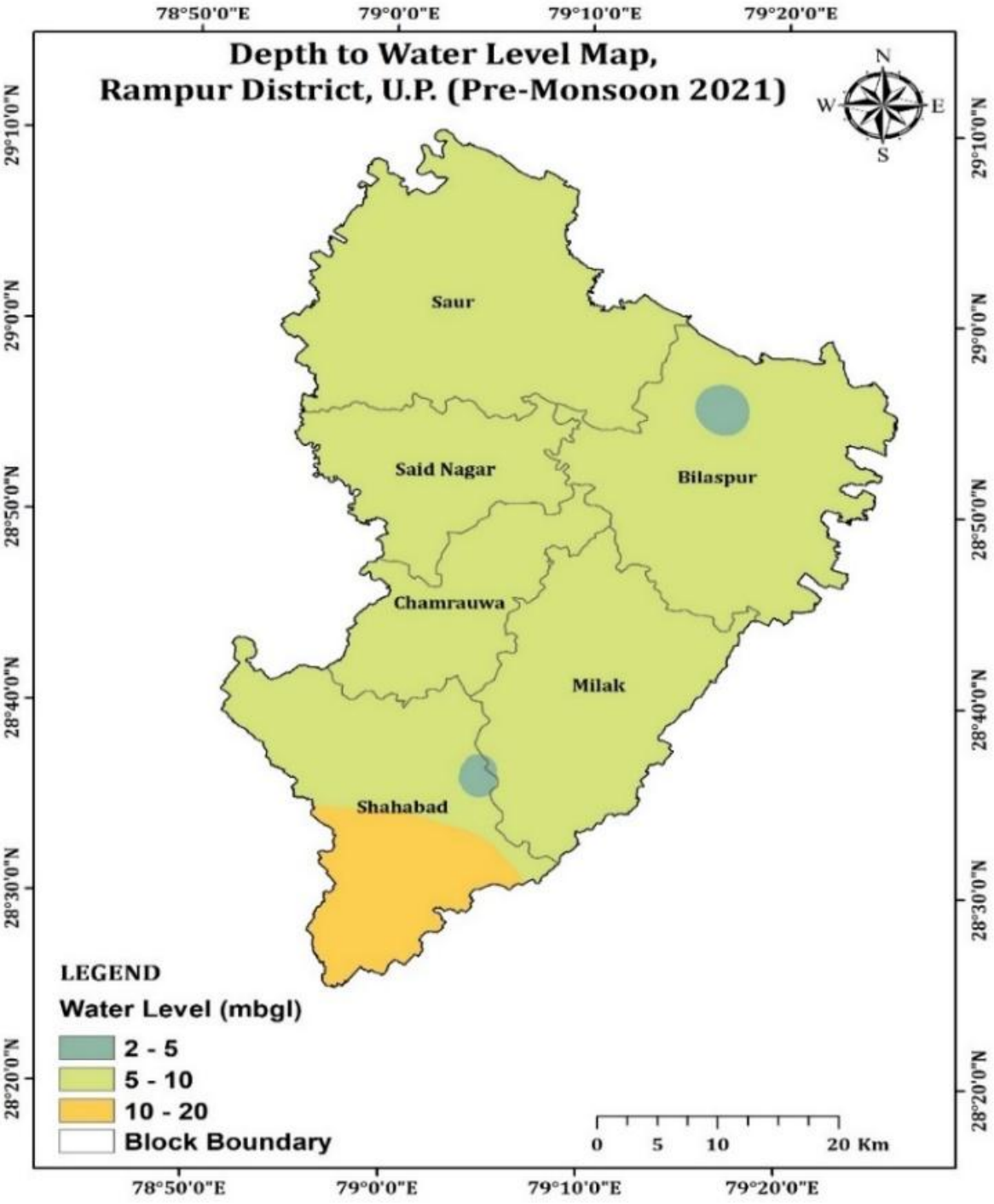


Figure 8: Depth of Water Level Map of Rampur District (Pre-Monsoon)

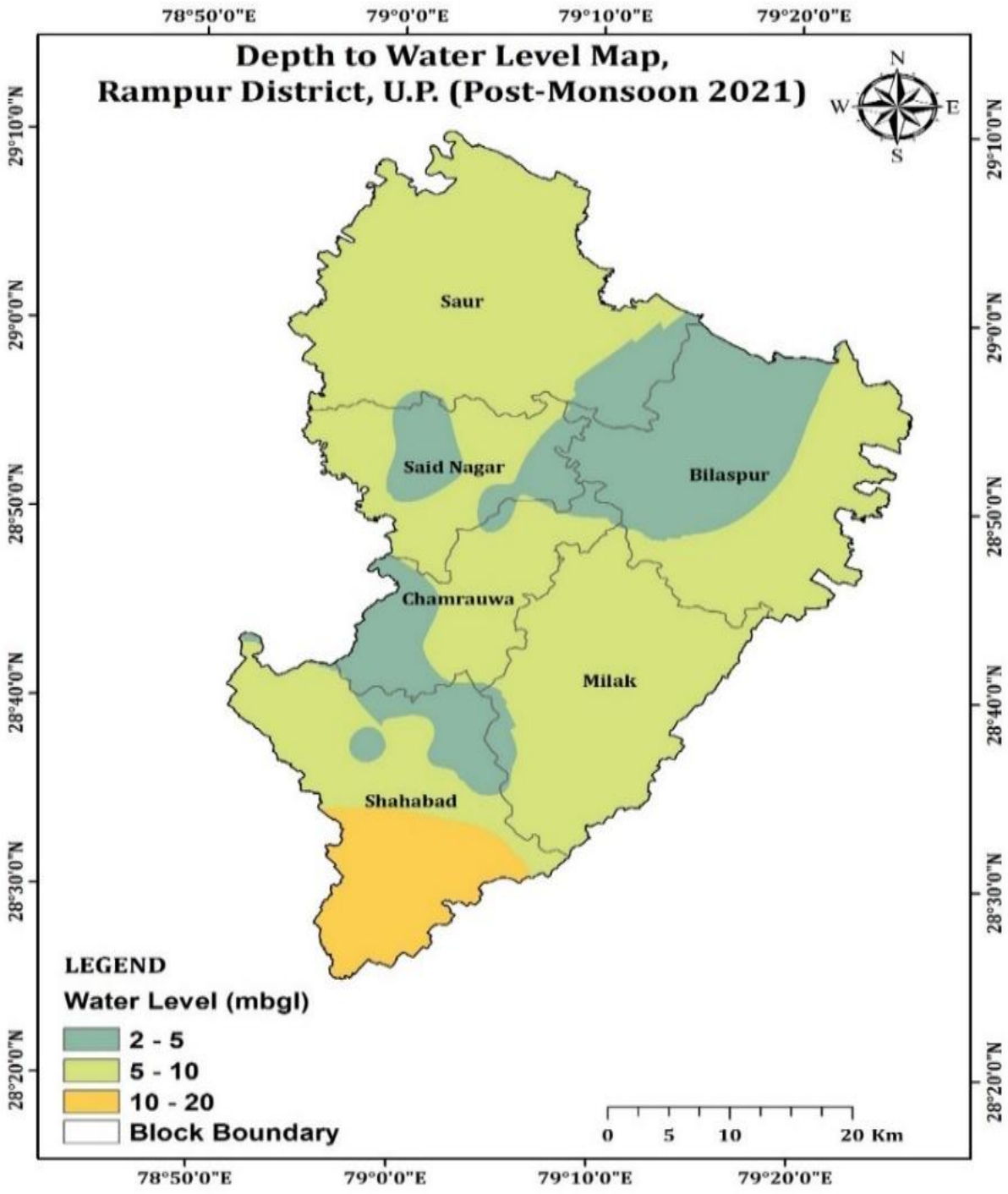


Figure 9: Depth of Water Level Map of Rampur District (Pre-Monsoon)

The water level grows shallower due to the recharging of the aquifer from rainfall, and the bulk of the region has water levels of 2 - 20 mbgl, according to a review of the depth to water level contour map for the period of November 2021.

2.3.1 Water Level Fluctuation

The district's water level is rising, according to statistics from wells in the Rampur district for the year 2021. The majority of the district's water level fluctuations are between 0.0 and 2.0 mbgl and are trending upward. Figure 11 depicts the variation in water level. A review of the map reveals that the water level is mainly rising between 0 mbgl to 4 mbgl across the district. A small part of the Shahabad, Saur, and Bilaspur block display falls at a water level between 2-0 mbgl. Parts of Saur, Said Nagar, Bilaspur, Chamrauwa, Milak, and Shahabad blocks display a rise in water level between 0-2 mbgl. Parts of Saur and Said Nagar blocks show water level rise between 2-4 mbgl.

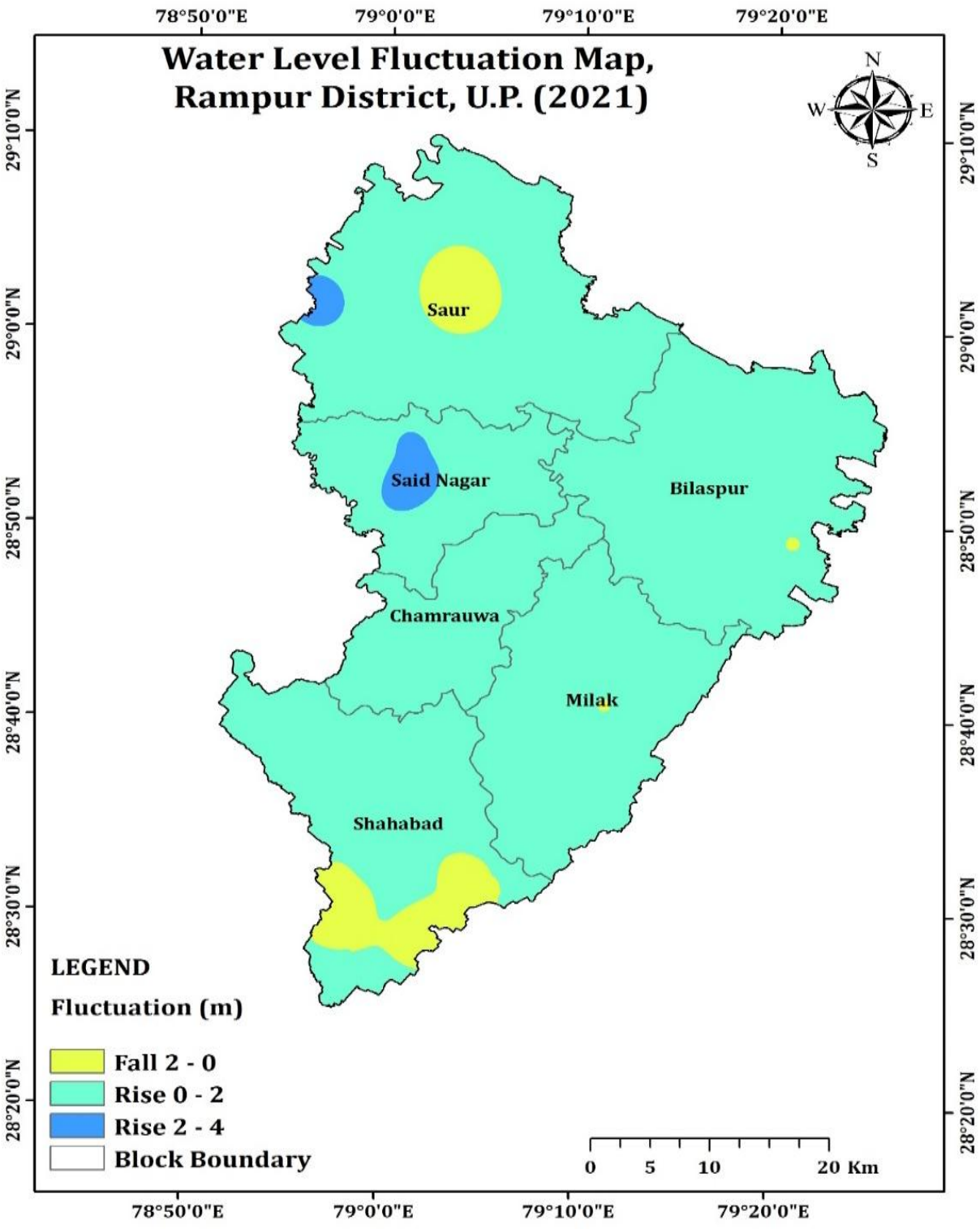


Figure 10:Water Level Fluctuation Map of Rampur district for the year 2021

2.3.2 Water Level Trend

Water level hydrographs show a long-term water level trend that shows how groundwater storage in the phreatic zone changes over time. The effects of air pressure, variations in recharge, and withdrawal over time have an impact on storage. A long-term water level trend for the pre and post-monsoon period has been calculated using water level data from the past nine years and is summarized as follows (Table-7)

Table 7: Water Level Trend of Rampur District (from 2012 to 2021)

S. No.	Location	Pre-Monsoon			Post-Monsoon			Annual		
		Data Points	Rise (m/year)	Fall (m/year)	Data Points	Rise (m/year)	Fall (m/year)	Data Points	Rise (m/year)	Fall (m/year)
1	Karanpur 1	1			2			6		
2	Pahari Dis	3			6		0.1777	19		
3	Bilaspur Pz CGWB	5			7		0.1338	27	0.4948	
4	Shahabad Pz GWD	7		0.3248	10	0.4555	0.2632	35		0.2859
5	Tanda	3			9		0.0021	28	0.0174	
6	Thunapur	1			1			5		
7	Kemri Pz GWD	3			3			12		

When looking at the hydrograph trend (2012–2021) over a nine-year period, it is seen that there is often a modest reduction in water level in the majority of the district both before and after the monsoon, which may be caused by overusing groundwater and inadequate recharging (figures 12-17). Both before and after the monsoon, Karanpur1 and Bilaspur Pz CGWB's water levels have risen. This rising pattern is seen at the same site of Bilaspur Pz CGWB and Karanpur1. Increased precipitation and recharging in the area may be to blame for the increase in water level.

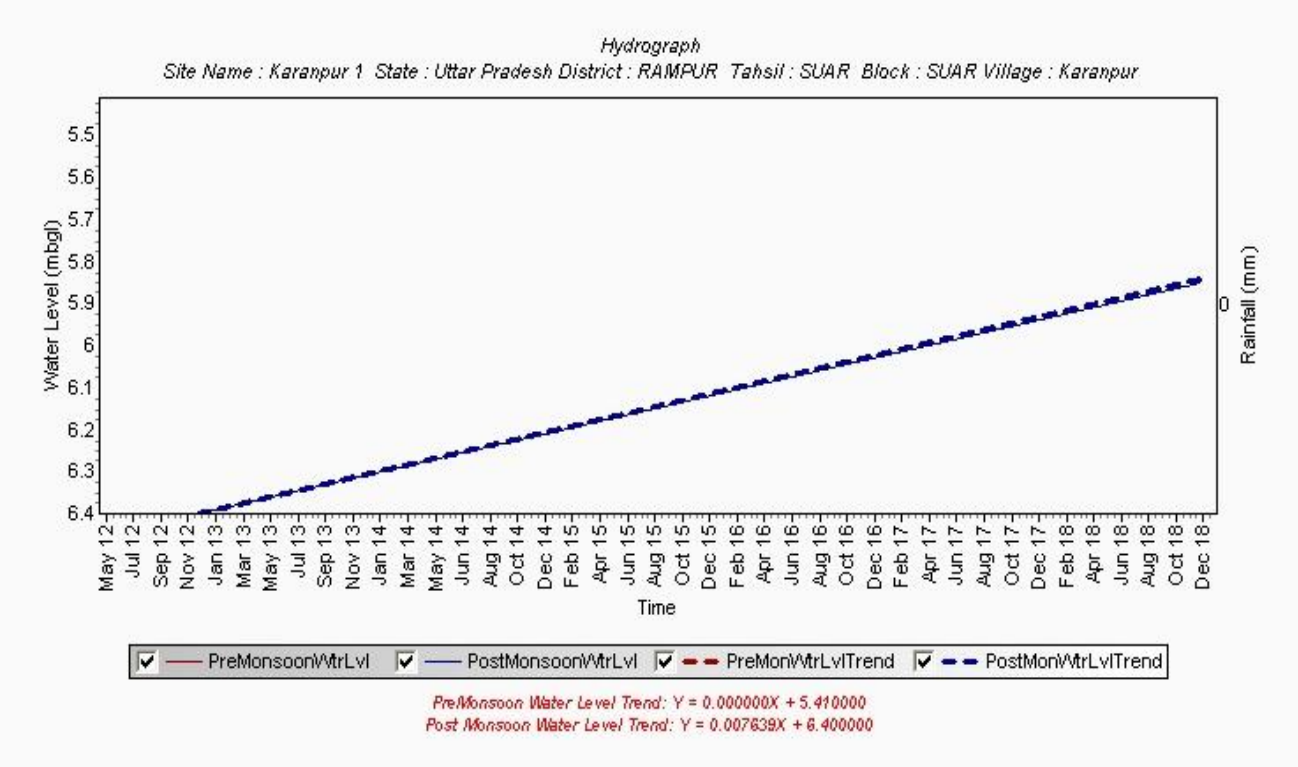


Figure 11:Long Term Water Level Trend of Karanpur1 (2012 – 2021), Rampur District

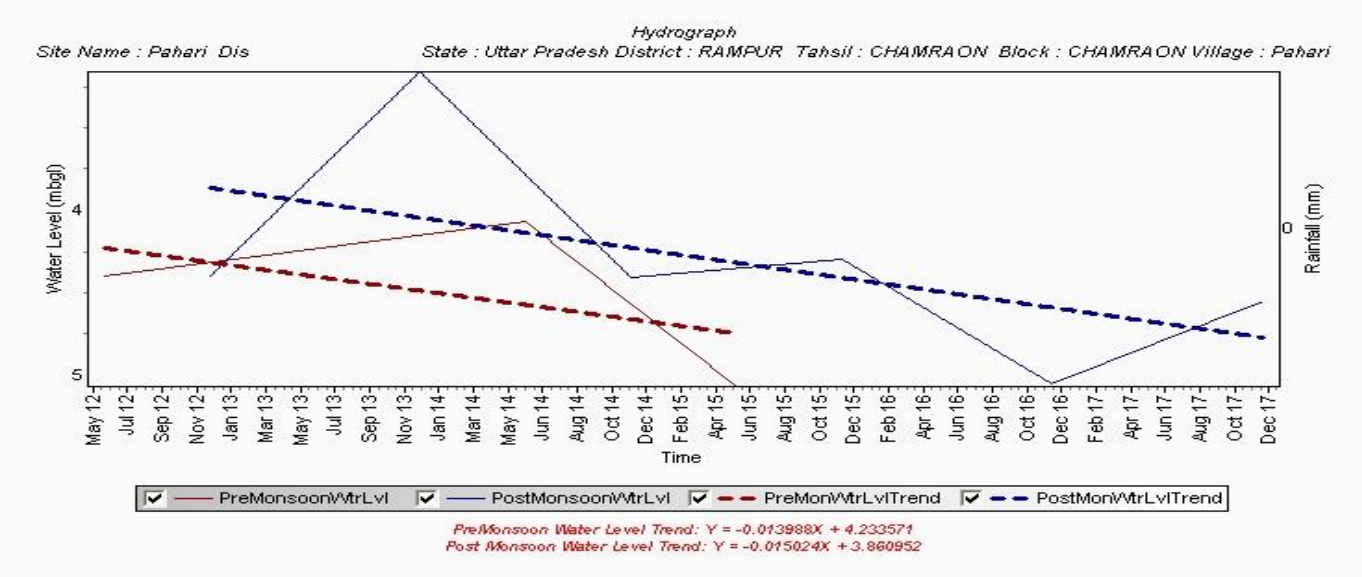


Figure 12:Long Term Water Level Trend of Pahari Dis (2012 – 2021), Rampur District

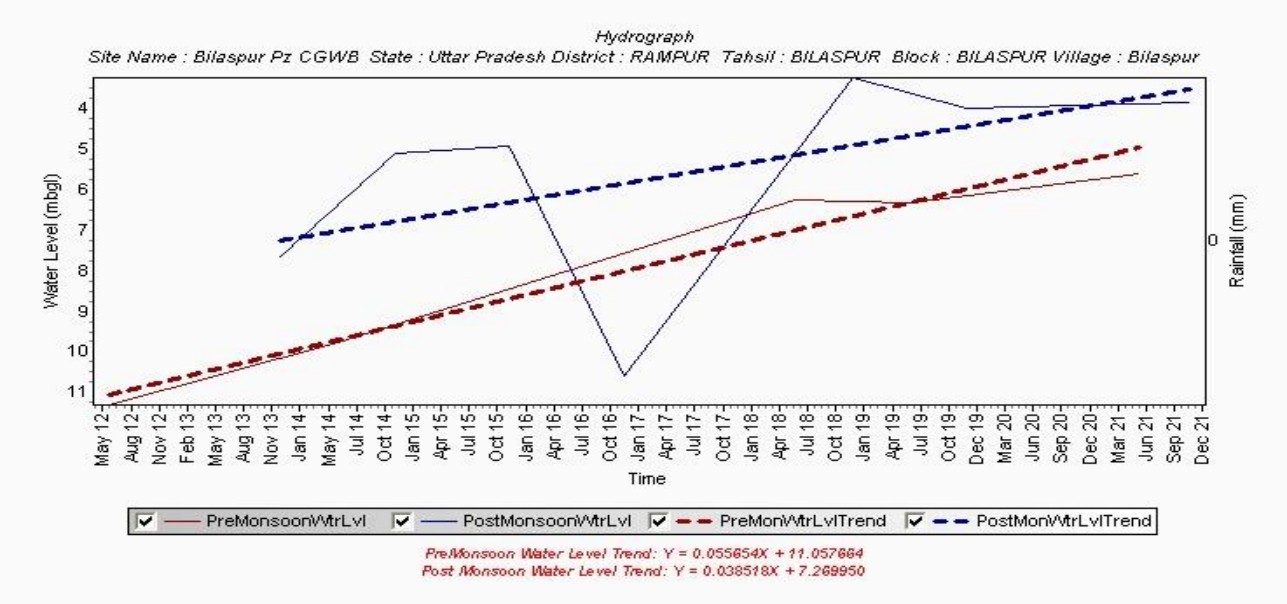


Figure 13:Long Term Water Level Trend of Bilaspur Pz CGWB (2012 – 2021), Rampur District

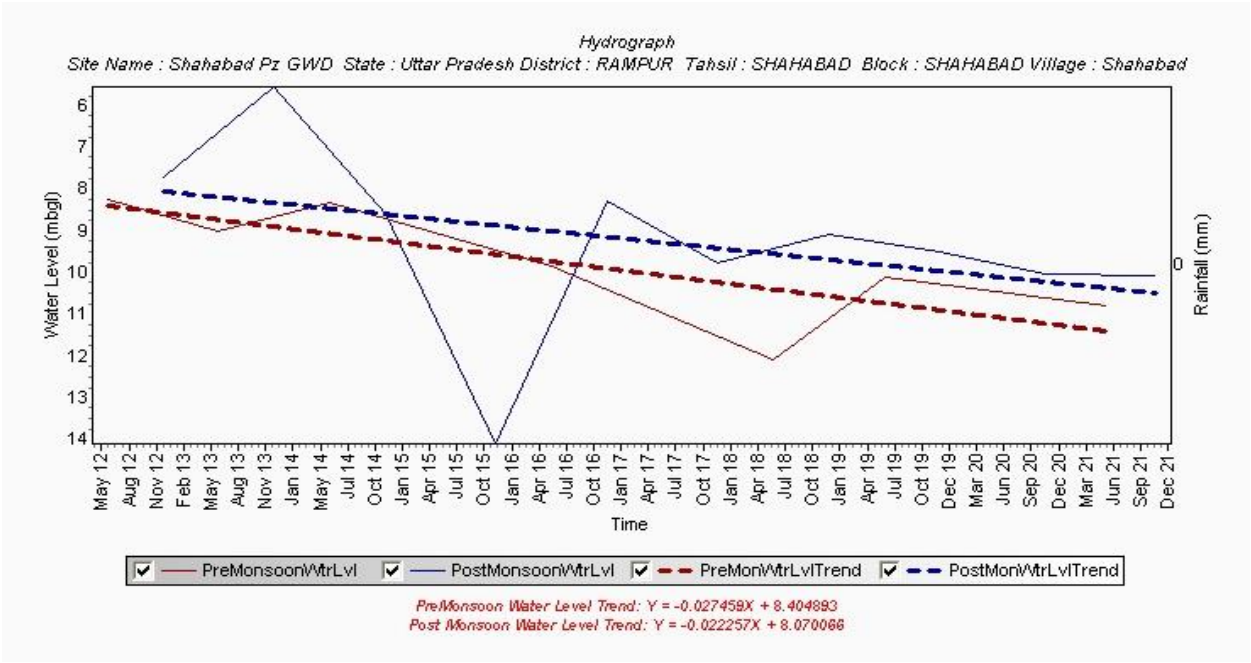


Figure 14:Long Term Water Level Trend of Shahabad Pz GWD (2012 – 2021), Rampur District

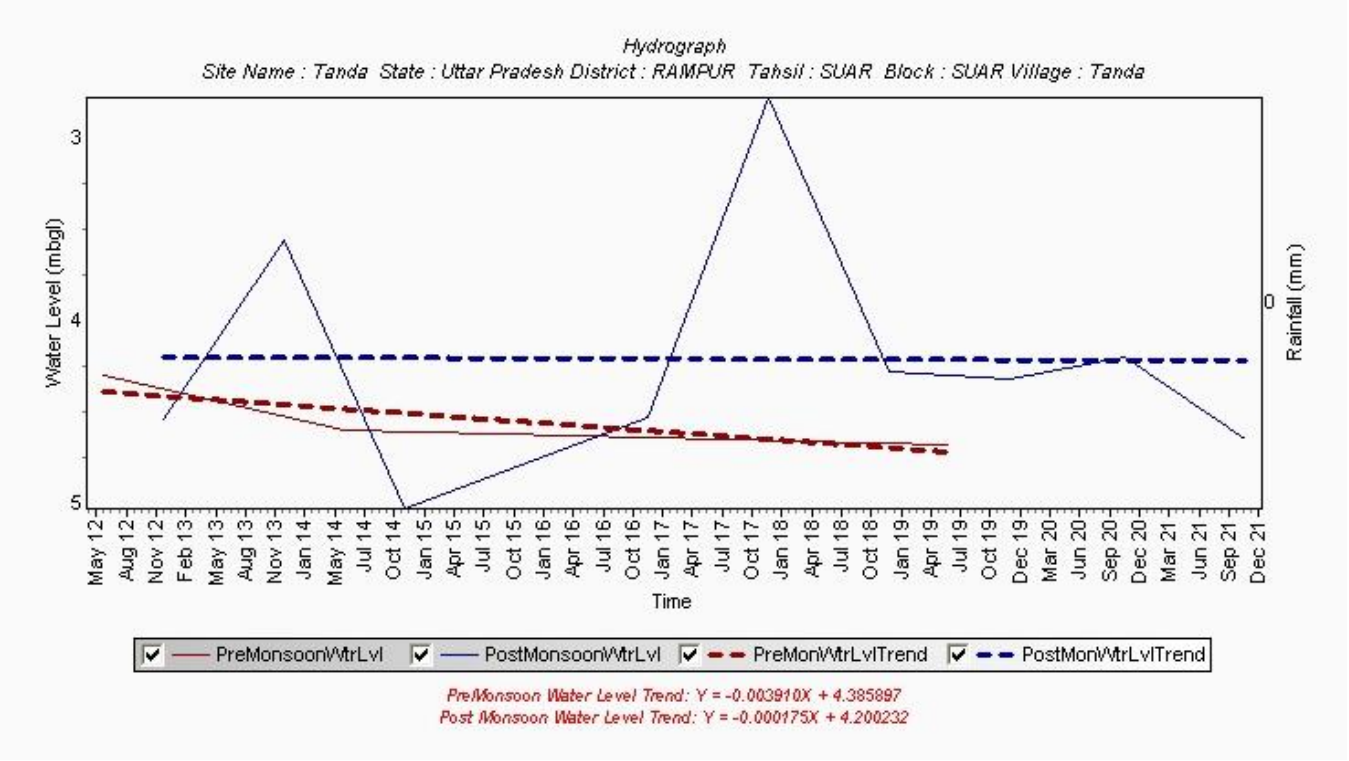


Figure 15:Long Term Water Level Trend of Tanda (2012 – 2021), Rampur District

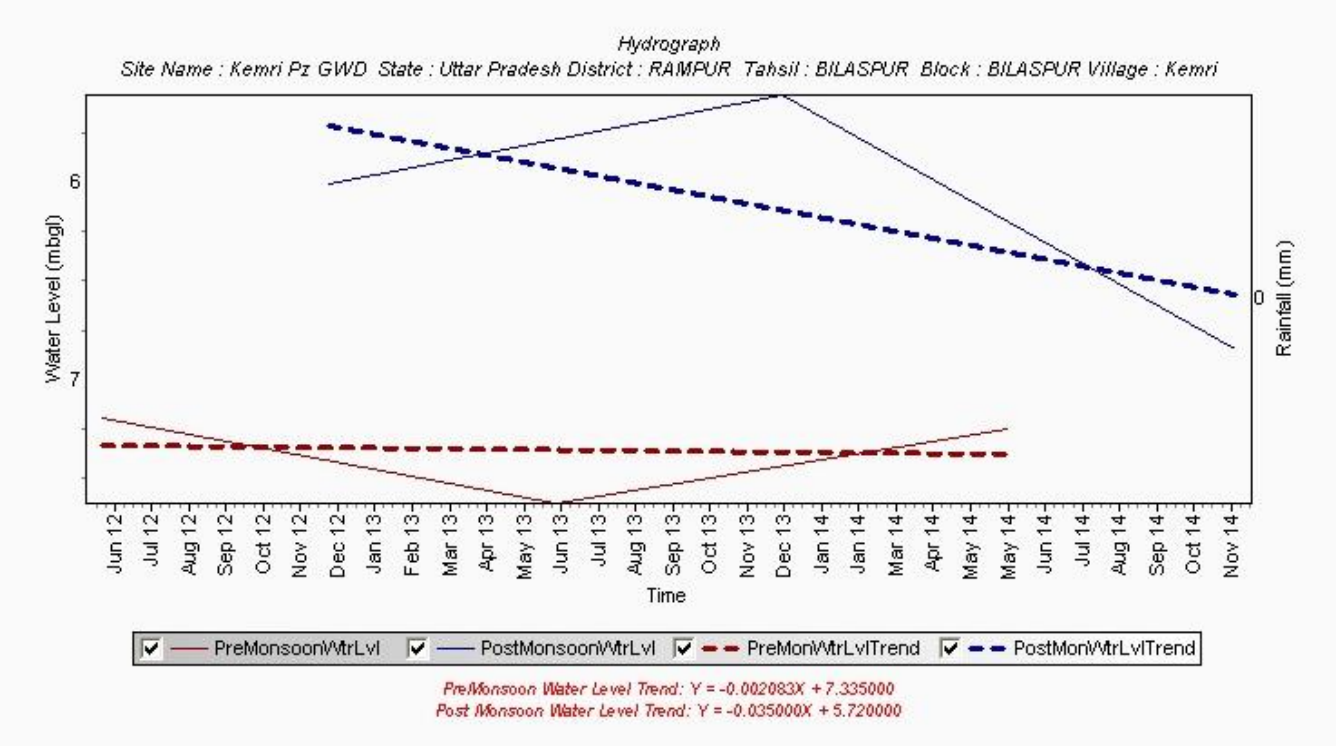


Figure 16:Long Term Water Level Trend of Kemri Pz GWD (2012 – 2021), Rampur District

2.4 Groundwater Quality

The concentration of elements in groundwater is governed by many factors. i.e.

- Nature of formation,
- Minerals present in the rock,
- Characteristics of soil,
- Anthropogenic activities like Irrigation run-off, Discharge of effluents, Industrial and domestic activities, etc.

In order to have a clear picture and to study the hydrochemistry of groundwater, the analytical data of monitored wells and hand pumps were analyzed by the NABL accredited Regional Chemical Laboratory at Lucknow.

2.4.1 Groundwater sampling

In June 2021, pre-monsoon monitoring was done to identify locations with poor water quality by determining basic metrics and trace metal concentrations.

2.4.2 General Aspects of the unconfined aquifer

6 groundwater samples were collected during the pre-monsoon season in 2019 to analyze basic parameters and trace metals. The analyzed data has been attached as Annexures 1 and 2.

2.4.3 Classification with respect to agricultural use

The unconfined aquifer's water quality has been categorized according to agricultural criteria as required by IS 11624-1986.

- **Total salt concentration –** It is represented as "Electrical Conductivity (EC)," and Table 8 below lists the categorization in regard to the danger it poses to soils.

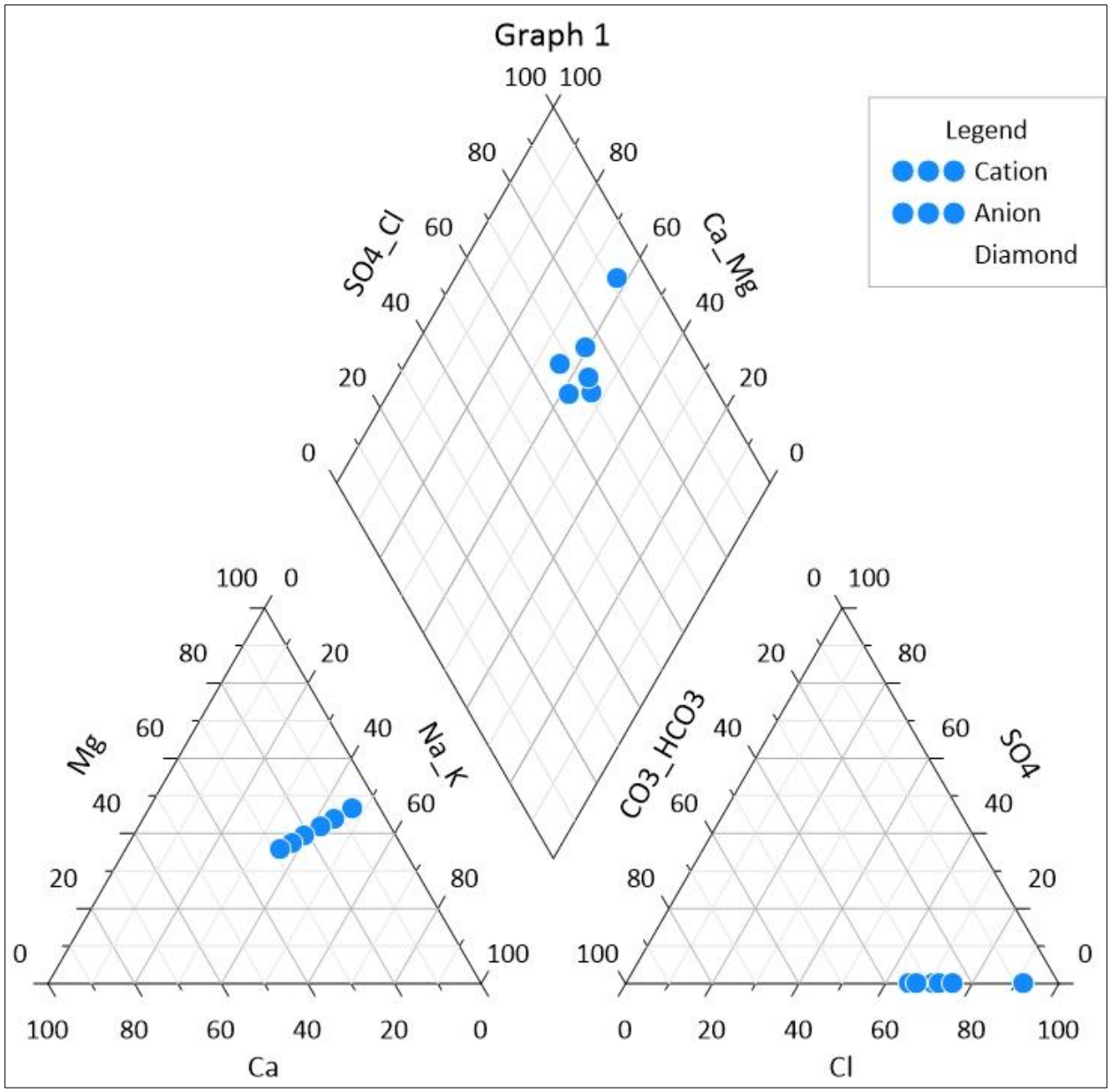


Figure 17: Trilinear Hill-Piper plot of the unconfined aquifer

Table 8: Summarized table of GW samples with respect to EC

Sl. No.	Class	Range of EC (µS/cm)	No. of samples
1.	Low	0 – 1,500	6
2.	Medium	1,500 – 3,000	-
3.	High	3,000 – 6,000	-
4.	Very High	>6,000	-

All the samples lie within the ambit of the 'Low' class with reference to EC and pose no problem for irrigation.

- **Residual Sodium Carbonate –** It is computed using the below formula, where all constituents are expressed in meq/l, and is characterized in terms of the potentially harmful consequences of bicarbonate ion concentration on soil:

$$RSC = (CO_3^{2-} + HCO_3^-) - (Ca^{2+} + Mg^{2+})$$

Table 9: Summarized table of GW samples with respect to RSC

Sl. No.	Class	Range of RSC (meq/l)	No. of samples
1.	Low	< 1.5	6
2.	Medium	1.5 – 3.0	0
3.	High	3.0 – 6.0	0
4.	Very High	> 6.0	0

All the samples lie within the ambit of the 'Low' class with reference to RSC and pose no problem for irrigation.

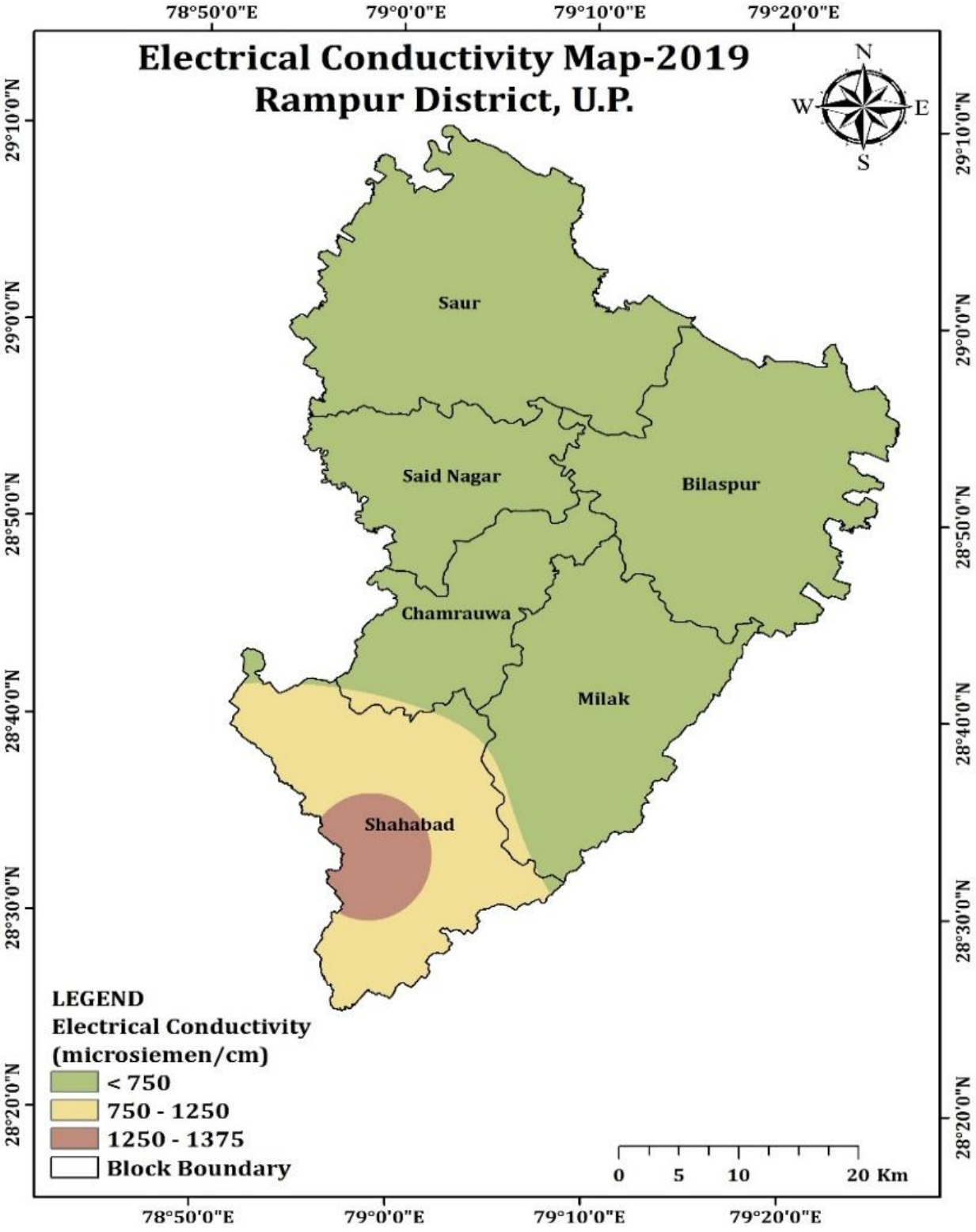


Figure 18:Electrical Conductivity Map Rampur District

- **Sodium Adsorption Ratio –** It is a measure of the quality of irrigation water that is utilized to manage soils that have been impacted by salt. The amount of the principal alkaline and alkaline earth cations found in groundwater serves as a sign of the water's appropriateness for irrigation of agricultural land. It may also be used as a diagnostic measure for a soil's sodicity risk based on an investigation of soil pore water.

It is computed from the formula given below:

$$SAR = \frac{Na}{\sqrt{(Ca + Mg)/2}}$$

Table 10: Summarized table of GW samples with respect to SAR

Sl. No.	Class	Range of SAR (meq/l)	No. of samples
1	Low	<10	6
2	Medium	10 - 18	0
3	High	18 - 26	0
4	Very High	> 26	0

All the samples lie within the ambit of the 'Low' class with reference to RSC and pose no problem for irrigation.

2.4.4 Note on Trace elements

- **Chromium as Cr:** No Chromium was found in any sample.
- **Copper:** No Copper was found in any sample.
- **Iron:** Five samples (approx. 83.33% of total samples), namely Bilaspur, Chamrauwa, Milak, Said Nagar, and Swar, display values of Iron greater than 0.3 mg/l, which is an acceptable limit as per BIS 10500:2012-2nd Revision.

- **Manganese:** Two samples (33.33%), namely Chamrauwa and Shahabad, display values of Mn smaller than 0.5 ppm/l, which is an acceptable limit as per BIS 10500:2012-2nd Revision.
- **Zinc:** Five samples (approx. 83.33% of total samples), namely Bilaspur, Chamrauwa, Milak, Shahabad, and Swar, display values of Zinc small than 10.0 mg/l, which is an acceptable limit as per BIS 10500:2012-2nd Revision.
- **Arsenic as As:** Only one sample, Milak block, displays Arsenic values of As greater than 0.01 mg/l, which is a permissible limit as per BIS 10500:2012-2nd Revision.
- **Lead:** No Lead was found in any sample.
- **Nitrate:** Only one sample, the Shahabad block, displays Nitrate higher than the limit as per BIS 10500:2012-2nd Revision.

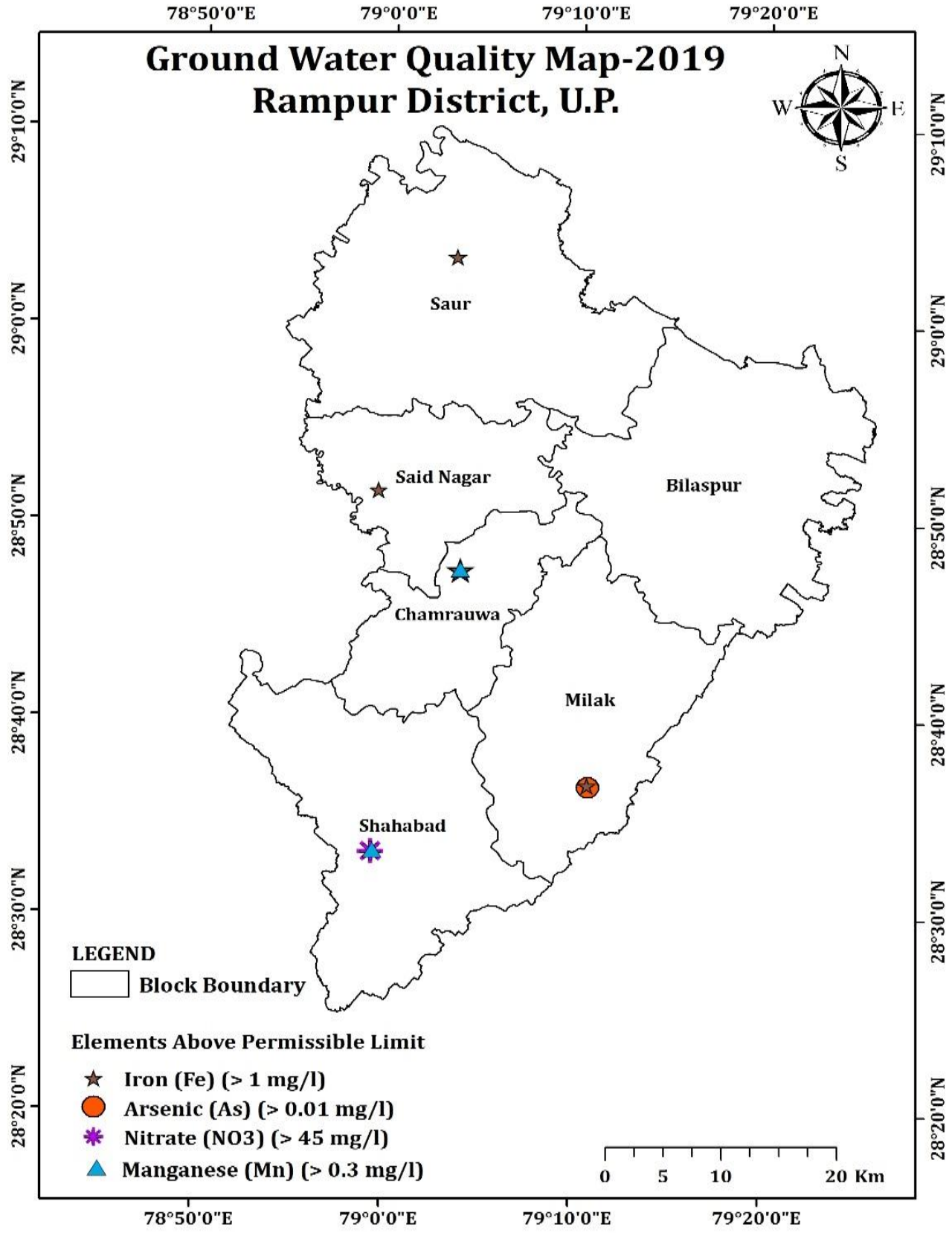


Figure 19: Water Quality Map of Rampur District

2.4.5 General hydrochemistry of deeper aquifers

6 groundwater samples were collected in May 2019 when pumping tests were carried out to determine aquifer parameters. 2 samples were earmarked for the determination of basic parameters, namely pH, EC, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, HCO_3^{-}, CO_3^{2-}, SO_4^{2-}, Cl^{-}, F^{-} and PO_4^{3-}. 3 samples were earmarked for analysis of trace metals, namely Fe, Mn, Cu, Cr, Zn, Pb, As, and U by ICP-MS. After obtaining the results of chemical analyses, the samples were plotted on a trilinear Hill-Piper plot, and the samples were classified into different hydrochemical facies based on dominant cations and anions.

2.5 Principal Aquifer System in the study area

There are four main aquifer systems in the study area; the principal aquifer system is Indo-Gangetic plain which is mainly comprising sand, silty, clay, loamy soil and alluvial soils which are separated by restricting clay layers (aquicludes). The "electrical resistivity" (64 inches Normal) and "gamma radioactivity" records of the boreholes drilled in the region were merged to identify granular zones (the aquifers) with varying resistivity. The lithological characteristics, hydraulic parameters and quality, as determined by exploratory drilling and geophysical logging, have been used to demarcate various aquifer grouping. "Aquifer group I, Aquifer group II, Aquifer group III, and Aquifer group IV" are the four aquifer systems existing in the research area.

The details of Exploratory drilling details has been attached in annexure-4.

2.5.1 Aquifer Systems & their Characteristics

The research area's main aquifers were identified by grouping sand, clay, Loamy soil, Silty soil, and Alluvial soils as aquifers separated by restricting clay layers called aquicludes. The "electrical resistivity" (64 inches Normal) and "gamma radioactivity" records of the boreholes drilled in the region were merged to identify granular zones (the aquifers) with varying resistivity. The "lithological character, hydraulic parameters, and quality," as determined by exploratory drilling and geophysical logging, have been used to demarcate various aquifer groupings. "Aquifer group I, Aquifer group II, Aquifer group III and Aquifer group IV" are the three aquifer systems that exist in the research region.

- **Aquifer Group- I**

The Aquifer group-I lies beneath the topsoil and is found between the depths of 60-90 mbgl. Ground water occurs under water table conditions in this aquifer category, which is unconfined/phreatic. Shallow tube wells, drilled wells, and hand pumps are the most common methods of tapping this aquifer. This aquifer has clay lenses in certain spots. Following the first aquifer is a clay layer that ranges in thickness from 10 to 24 meters. This aquifer was accessed by the majority of state tube wells and public wells.

- **Aquifer Group- II**

A zone of intermixing where clay and sand layers are intercalated makes up the second aquifer. In the Nanital district, this zone stretches from 90 to 160 meters at Milak and from 125 to 204 meters in Bazpur.

- **Aquifer Group- III**

This aquifer group occurs between the depths of 240-284 mbgl and below, divided from the overlying aquifer group by clay. The granular zone thickness ranges from 23 to 111 meters, with an average of 42 meters.

- **Aquifer Group- IV**

The fourth aquifer, which is rather thick at Milak, stretches from 294 m to a total depth of 440 m that has been examined.

The data are available from exploratory drilling summarizing the depth of aquifer groups, feasible extraction structure, discharge, and other details that have been summarized below:

Table 11: Summarized details of Aquifer groups in the district

Aquifer	Group – 1 [AL03]	Group – 2 [AL03]	Group – 3 [AL03]	Group – 4 [AL03]
Formation	Sand, clay, and loamy soil.	Pebbles, mostly sand.	Sand, loamy soil & thick clay.	Loamy soil, silty soil, and alluvial soils.
Abstraction Structure	Tube wells and public wells.	Exploratory wells	Tube-well	Tube-well
Depth Range (mbgl)	60-90	90-160	240-284	294 m to total explored depth of 440 m
Discharge (lpm)	65 – 100	1,445	1125 – 1,185	1,220
Tranmissivity (m2/day)	890-1052	871-1866.5	298-1324	1052

Storage Coefficient	0.000121-0.000154	0.0012-0.00128	0.00857	0.000181-0.000193

2.6 Lithological Disposition and Aquifer Disposition

To effectively comprehend the "lithological and aquifer disposition" in the study area, a 3-D model, sections, and stratigraphy diagrams founded on lithological information gathered through exploratory drilling and geophysical investigations carried out by CGWB in the district have been created. The lithological layers were developed using borehole data. Aquifer/Lithological sections, Stratigraphy diagrams, and 3D Aquifer/ Lithological dispositions diagrams are all prepared using the same color codes. The existence of a substantial pile of various grades of sand with a varying sequence of clay is shown in the research region by lithology and geophysical logging. The models were used to evaluate the lithological and aquifer dispositions; stratigraphic sections were created using Rockworks software. The vertical and horizontal scales in meters are used on the sections created for subsurface formations and aquifers.

➢ 3-D lithological and Aquifer Model

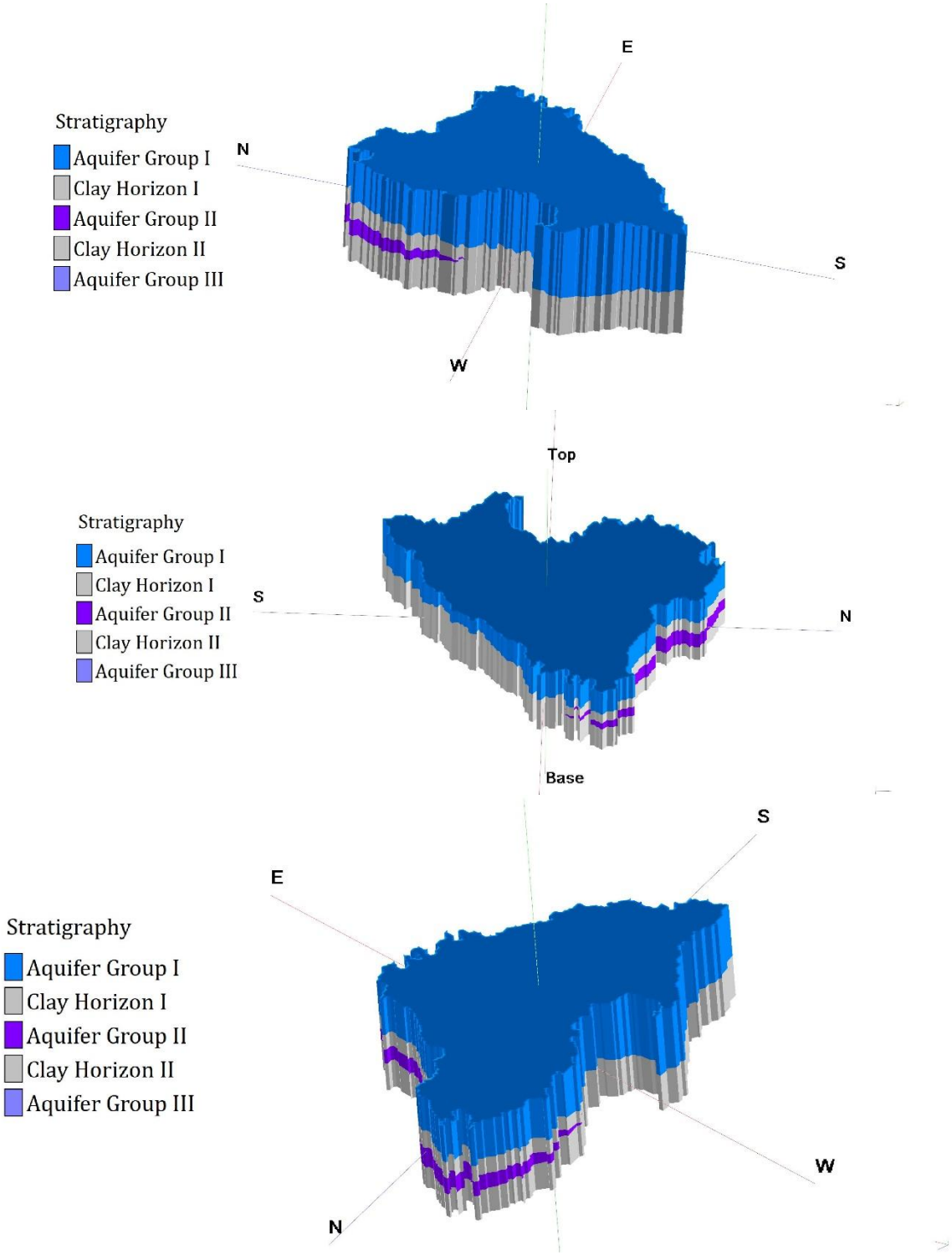


Figure 20: 3D model of Rampur district

The thickness of Aquifer Group – 1 extends down to 60-90 mbgl (meters below ground level) from the ground surface. It is separated from the Aquifer Group – 2 by a clay layer. Aquifer Group – 2 is observed between 90-160 mbgl (meters below ground level). It is further separated from Aquifer Group - 3 (is observed between 240-284) by thick clay with thickness greater than the one separating Aquifers 1 and 2. Aquifer Group – 4 is observed between 294 to the total explored depth of 440 mbgl (meters below ground level).

- **Fence diagram**

Figure 23 displays fence diagrams built in the research area that delineate the lithology on a regional scale.

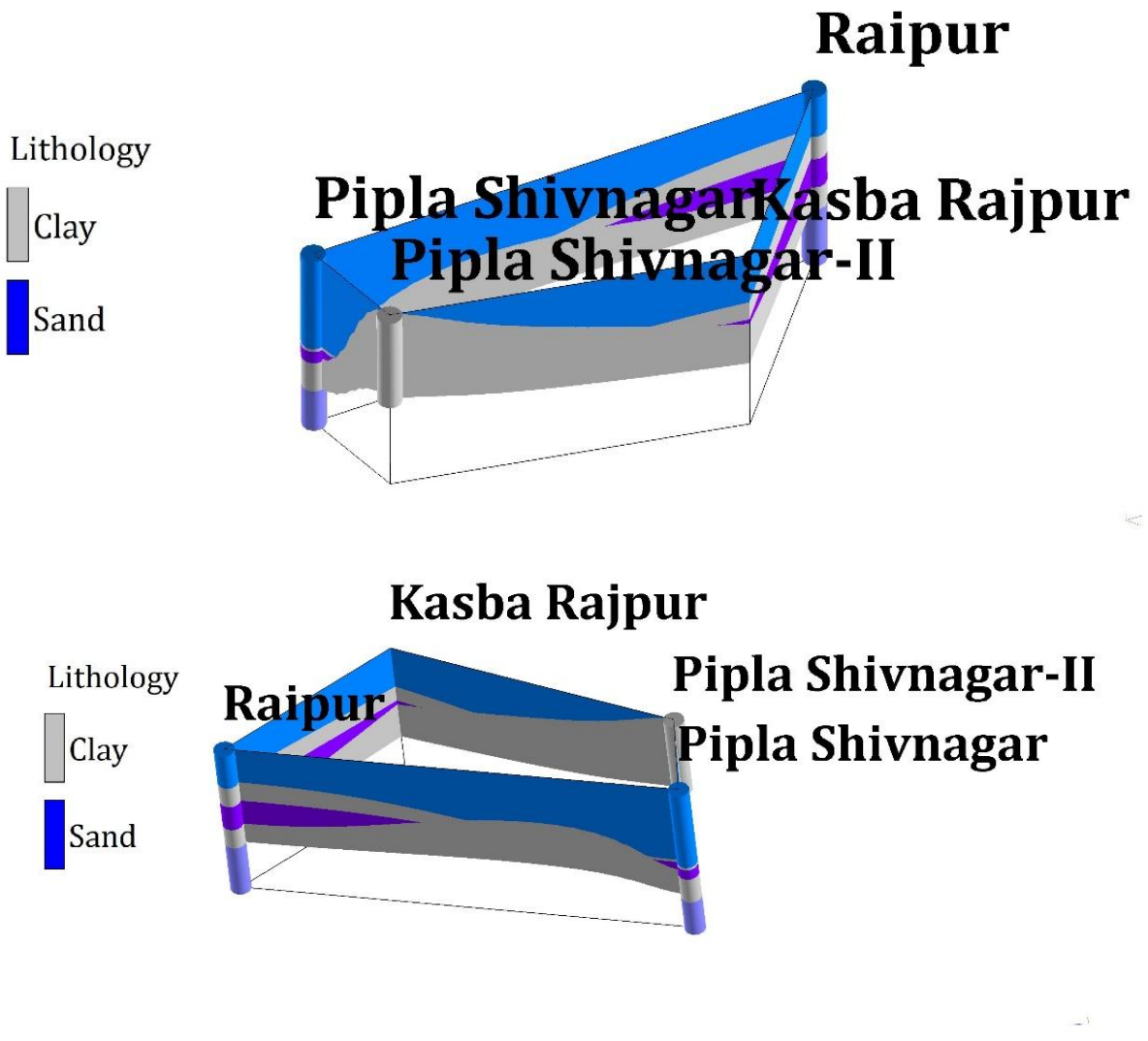


Figure 21: 3D diagram showing lithological variation in Rampur district

3 GROUNDWATER RESOURCE POTENTIAL

- **Stage of Groundwater Development:**

The current stage of Groundwater Development in the Rampur district has been pegged at 72.11% as per GWRE 2021, which is categorized as Safe. 2 blocks of the district, namely Bilaspur, Milak have been categorized as "Safe" as their Stage of GW Development is 59.37% and 64.65% respectively. 3 blocks of the district, namely Said Nagar, Saur, and Shahabad, have been categorized as "Semi-critical" as their Stage of GW Development is 80.16%, 81.95%, and 75.64%, respectively. And remaining 1 block of the district, namely Chamrauwa, have categorized as "Critical" as its Stage of GW Development is 94.46%. Said Nagar block has the lowest groundwater availability, whereas the Bilaspur block has the highest groundwater availability.

The groundwater resource potential of the district (block-wise) has been calculated on the methodology given in Groundwater Estimation Committee (GEC) Report 2020.

Table 12: Dynamic Groundwater Resources of Rampur district

S. No	Assessment Unit Name	Net Annual Ground Water Availability (in ham)	Existing Gross Ground Water Draft for all Uses (in ham)	Existing Gross Ground Water Draft for Irrigation (in ham)	Net Ground Water Availability for future use	Stage of Ground Water Development	Categorization (OE/Critical/Semi critical/Safe)
1	**BILASPUR**	21459.27	12740.95	12008.62	8623.98	59.37%	Safe
2	**CHAMRAUWA**	6604.48	6238.71	5676.04	306.59	94.46%	Critical
3	**MILAK**	13698.95	8856.68	7995.59	4743.98	64.65%	Safe
4	**SAID NAGAR**	5162.18	4138.08	3526.37	927.82	80.16%	Semi-critical
5	**SAUR**	15550.19	12742.84	11520.84	2645.19	81.95%	Semi-critical
6	**SHAHABAD**	9415.53	7121.48	6180.53	2156.02	75.64%	Semi-critical
Total		71890.6	51838.73	46907.99	19403.58	72.11%	

Map displaying the block-wise categorization as well as Stage of Groundwater Development has been attached below as Figure 24.

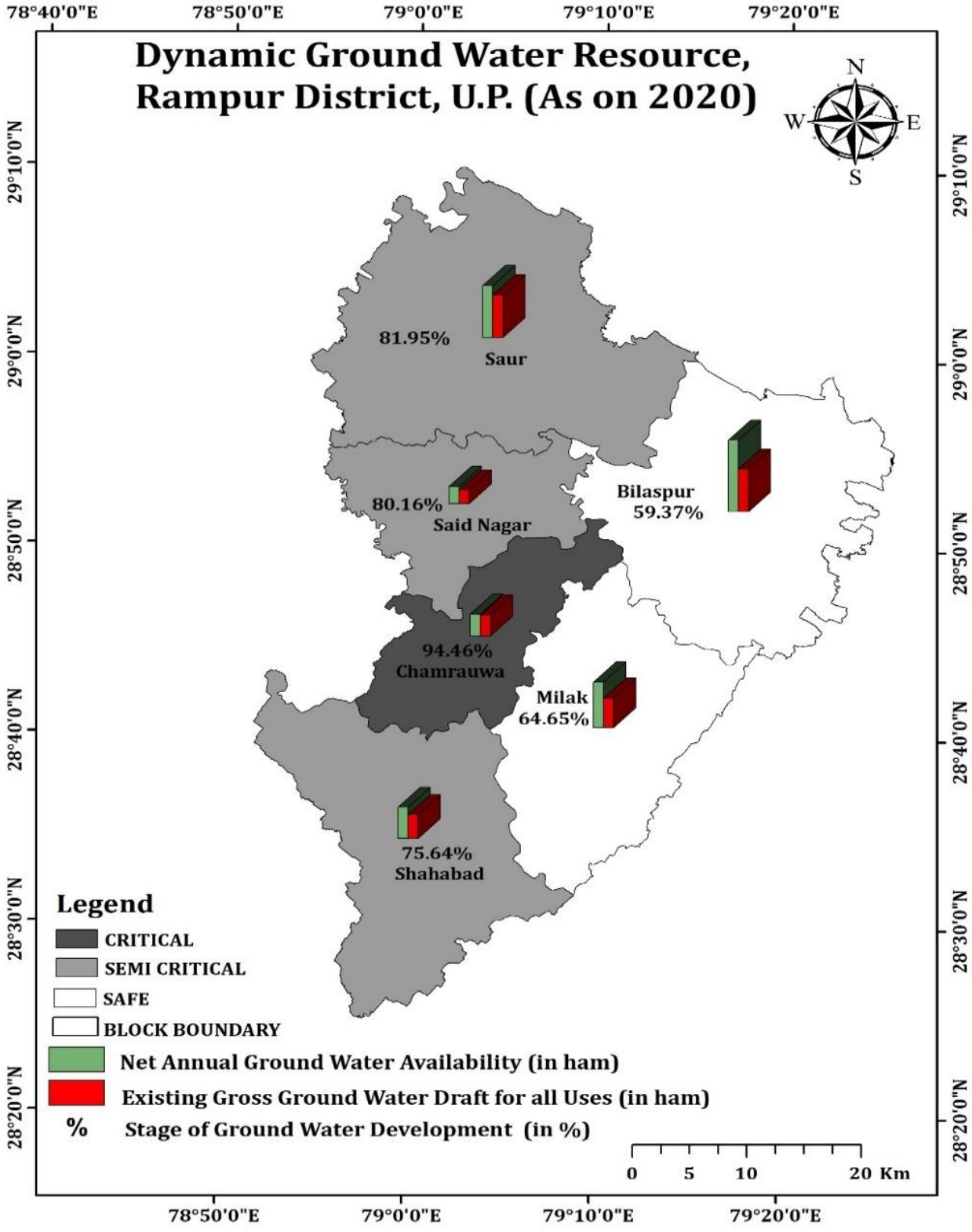
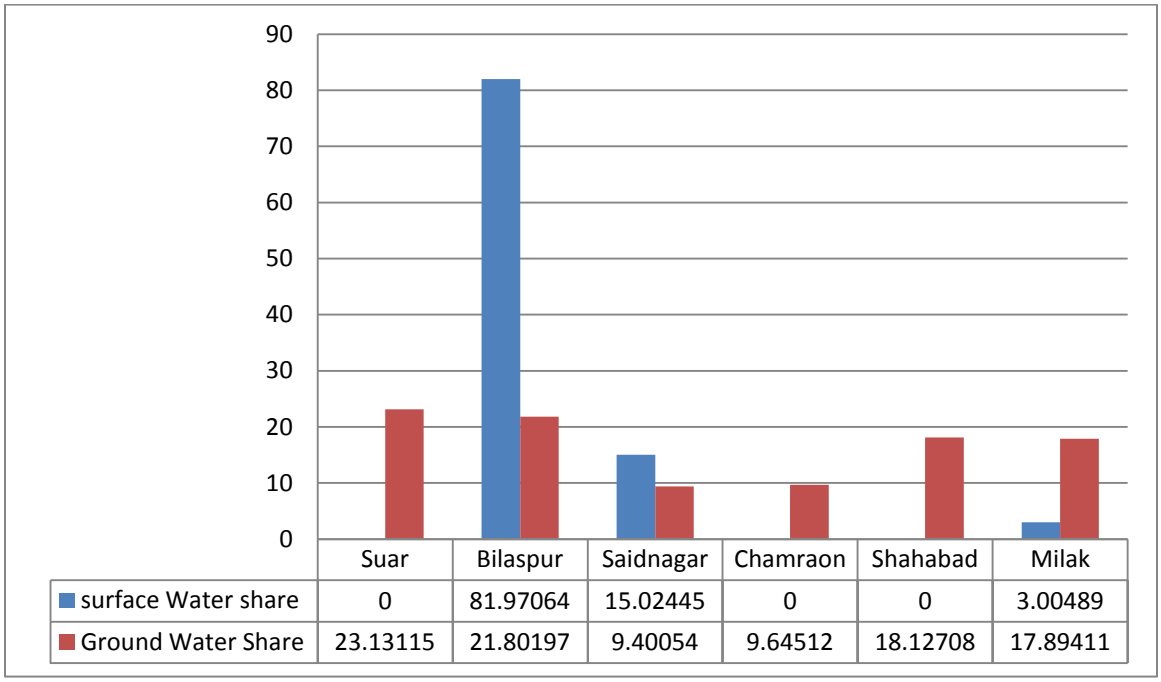


Figure 22: Dynamic Ground Water Resources Map of Rampur district

4 GROUND WATER-RELATED ISSUES

4.1 Identification of issues

- The high contribution of groundwater towards irrigation: The contribution of surface water from the existing canal network towards irrigation ranges from 81.97% in the Bilaspur block to a paltry 3.00% in the Milak block. The balance is made up by harnessing groundwater. The blocks of Suar, Chamraon, and Shahabad are entirely reliant on groundwater for irrigation.



	Suar	Bilaspur	Saidnagar	Chamraon	Shahabad	Milak
surface Water share	0	81.97064	15.02445	0	0	3.00489
Ground Water Share	23.13115	21.80197	9.40054	9.64512	18.12708	17.89411

Figure 23: Graph displaying contribution of surface and groundwater for irrigation for each block

- Data on rainfall through 2021-2022 show a tendency toward decline, which will only lead to less rainfall recharging subsurface aquifers.

4.2 Groundwater quality issues and contamination

- Sporadic occurrence of Iron, Nitrate and Arsenic in the unconfined aquifer.

4.3 Miscellaneous issues

- Farmers in the district mainly cultivate sugarcane rather than cash crops and vegetables cultivation practices.

5 MANAGEMENT STRATEGIES

In order to reduce the demand for groundwater resources and enhance their accessibility, management measures must be quickly established and put into action by the responsible agencies. The following table summarizes management techniques by demand- and supply-side actions for implementation:

Table 13: Proposed Supply-side and Demand-side interventions

SUPPLY-SIDE INTERVENTIONS	DEMAND-SIDE INTERVENTIONS
To enhance retention, de-silt of ponds, tanks, and surface water bodies.	Instead of using conventional flood irrigation techniques, drip, sprinkler, and pressured irrigation are encouraged to increase irrigation efficiency.
Construction of Rainwater harvesting structures at suitable locations.	
Construction of check dams at suitable locations to increase the quantum of groundwater recharge	

Flooding recharge to arrest declining GW levels:

It is a direct surface recharge technique and suitable for relatively flat topography. Here, water is spread as a thin sheet. It requires system of distribution channel for the supply of water for flooding. High rate of vertical infiltration is obtained on areas with undisturbed vegetation and sandy soil covering. Flooding temporarily increases river bed permeability by moving clay soils downstream, and this increases aquifer recharge.

5.1 Supply Side Interventions

In order to raise the amount of available water by expanding storage, encouraging community involvement in the reemergence and recovery of conventional water bodies like tanks, ponds, etc., and adequate rainwater harvesting frameworks at urban locations, it has been suggested to embrace that kind initiatives only in groundwater stressed blocks. The following is a description of the various interventions:

5.1.1 Carrying out de-siltation of tanks, streams, surface water, and pond catchments to increase storage.

- Conventional water features like tanks, ponds, and can be desalted to expand storage space by catching extra rainwater, which can then be used for home and irrigation needs.

5.1.2 Construction of Rainwater harvesting structures at suitable locations

Rooftop rainwater harvesting is a process where rainwater from roofs of homes, buildings, schools, and other businesses is redirected to a storage tank or used to rehydrate an underground aquifer via a network of pipes and filter media (by Manager Aquifer Recharge techniques). Additionally, it takes far less upkeep to operate.

If not held in a tank, it reduces excess rainfall pouring into sewers that cause urban floods, stops soil erosion, and raises groundwater levels. It can assist get through the summer's peak water demand if kept in a tank or sump.

The amount of rainfall harvested depends on 3 factors:

- Quantum of annual Rainfall (mm)
- Rooftop area (m2)
- Runoff factor (0.2 to 0.8 depending on roofing material)

Formula to calculate harvested rainfall = Quantum of annual Rainfall (mm)* Rooftop area (m2)* Runoff factor

5.1.3 Construction and maintenance of Arsenic removal units

Construction and maintenance of arsenic removal units at places where the deeper aquifer is Arsenic affected.

5.1.4 Construction of deeper tube-wells tapping 2nd Aquifer group at locations where quality issues plague the unconfined aquifer.

Deeper tube-wells tapping the 2nd Aquifer group between 70 – 152 mbgl can be constructed at suitable locations where the unconfined aquifer is affected by quality issues like high Iron, Manganese, Arsenic, etc.

5.1.5 Construction of check dams at suitable locations to increase the quantum of groundwater recharge.

5.2 Demand-side interventions

Agriculture is the main user of groundwater, followed by domestic and industrial needs. There is increased interest in promoting the use of micro-irrigation techniques like spray and drip watering as the traditional form of irrigation via canals provides decreased efficiency. The several approaches are described below:

5.2.1 Promoting drip and sprinkler irrigation to enhance crop production.

- The amount of groundwater used for irrigation will be reduced, and the farmer's revenue will increase since they will be able to plant one or two extra crops.
- As little as 20–25 percent of water is lost with drip irrigation and 30–40 percent with sprinkler irrigation.
- Drip irrigation can also be used to water wheat, cotton, pulses, and oil seeds crops that are spread out. Sprinkler irrigation works well for crops that are close to each other, like sugarcane, spices, vegetables, flowers, fruits, and so on.
- The department in charge (Revenue, Agriculture, Land Holding, etc.) should do a rigorous survey to find out how much land small and marginal farmers own since most micro-irrigation practices are run on a large scale, and most land holdings are small, usually less than 1 hectare.

5.2.2 Introduction of water-tolerant rice crops

- Popularization of rice varieties like Madhukar for flooded areas and Jal Priya & Jal Lahari varieties for waterlogged conditions by Krishi Vigyan Kendra among the farmers.
- These problematic areas have been identified by KVK. It has been attached in Annexure-3.

5.2.3 Promoting the cultivation of pulses

- Pulses not only give you the protein you need, but the nitrogen-fixing bacteria in their roots also add about 40 kg/Ha of nitrogen to the soil. It also helps the succeeding crop grow by making the soil's microenvironment, quality, and yield better.
- By combining the farming of pulses with other government programs already in place, such as the "Integrated Scheme of Oilseeds, Pulses, Oil Palm and Maize" (ISOPOM) program, Accelerated Pules Production program, and Pulses Development Program under "Rashtriya Krishi Vikas Yojana," the cultivation of pulses can be given a boost.
- Via seminars and other events, the state agricultural department may educate farmers on the advantages of growing pulses as intercrops and including short-duration pulse types as cash crops.
- Promoting cultivation of pulses has been identified by KVK. It has been attached in Annexure-3.

5.2.4 Promoting oilseed cultivation with subsidies and incentives

- Because the output of oil seeds is inadequate to meet the demands of the population and involves a 40 percent import charge, India is the second biggest importer of oil seeds and the third-largest consumer of oil seeds, spending a total of 74,996 crores on imports in 2017–18.
- In the long-term, it will be advantageous for the nation to double the import duty in addition to providing bonuses for domestic oilseed cultivation by integrating the "Minimum Support Price" (MSP) with the "Minimum Remunerative Price" (MRP) and assent the oil seed sector special prestige under the "National Food Security Mission" (NFSM).
- The "Integrated Scheme of Oilseeds, Pulses, Oil Palm and Maize" (ISOPOM) is a federal program whereby every State develops a five-year seed plan outlining the needs of every farmer and designates ICAR as the nodal organization. In moreover to securing infrastructure

support, technical training for farmers, and demonstrations of the most recent agricultural inputs to increase yield, ICAR is responsible for the purchasing and dispersion of seeds, "weedicides/bio-pesticides, distribution of Gypsum/Pyrite/Liming/Dolomite for lining soils, and sprinkler sets."

- These oilseeds may be grown on appropriate soils, as determined by State Agricultural Universities: Linseed, Mustard, Rap seed, Sunflower, Castor Soybean, Safflower, Niger, Sesamum, and Groundnuts.
- Promoting cultivation of oilseeds has been identified by KVK. It has been attached in Annexure-3.

5.2.5 Providing impetus to horticulture and orchards under Rashtriya Krishi Vikas Yojana

National Agriculture Development Scheme is being operated by the Department of Horticulture & Food Processing, Government of Uttar Pradesh, that covers districts left out of the ambit of the National Horticulture Mission (N.H.M). 60% of the budgetary allocation is covered by the Central government, whereas 40% of budgetary allocation is covered by the State government's budget.

5.3 Miscellaneous interventions

5.3.1 Formulation of village water security and safety plan under the ambit of the National Rural Drinking Water Program (NRDWP).

With the primary goal of institutionalizing community participation and involvement in "Panchayat Raj Institution (PRI)" for water quality monitoring & surveillance of all drinking water sources, the "National Rural Drinking Water Quality Monitoring & Surveillance Program (NDWQM&S)" was introduced in February 2006. The following are the main components of NDWQM&S:

- To establish district- and sub-district-level drinking water quality testing labs (or enhance the current ones) for routine and ongoing evaluation of the water quality of rural drinking water sources.
- To provide "Field Test Kits (FTKs)" and bacteriological vials to GPs for on-the-field testing of essential general parameters (including Arsenic).
- Raising public awareness of problems with water quality and health.

- Developing the capacity of five local staff members in every GP to test water sources under their control utilizing straightforward FTKs and receiving verification from the closest water testing laboratory for samples that test positively.
- Perform a sanitary survey with certified Panchayat staff to check for potential bacterial contamination.

Underneath the program, all states receive full funding for Information, Education, and Communication (IEC) initiatives, human resource development initiatives, bolstering district-level drinking water quality testing laboratories, purchasing FTK for drinking water testing, travel and transportation costs, data reporting costs, stationery costs, honoraria for district-level surveillance coordinators, water testing, documentation, and data entry costs. Since 2009, the WQMS Program has been included into the NRDWP.

The NRDWP offers grants to all the states for the development of rural water supply schemes, with a concentration on areas that are water-stressed and have poor water quality, as well as for initiatives to collect rainwater and recharge the groundwater, as well as for operation, and maintenance, including minor repairs. Every year, the states get their assigned cash in three installments (40 percent, 40 percent, and 30 percent, correspondingly). The NRDWP gives the states the authority to develop, authorize, and carry out water supply plans, including, among other things, the choice of acceptable treatment technology.

5.3.2 Implementation agricultural contingency plan for Rampur by KVK.

The same has been attached in the Annexure-III

5.3.3

- Promoting cultivation of pulses with high per hectare yield along with incentives.
- Promoting oilseed cultivation with subsidies and incentives.
- Providing impetus to horticulture and orchards by Rashtriya Krishi Vikas Yojana by State Government agencies.
- Construction and maintenance of arsenic removal units at places where the deeper aquifer is Fluoride affected.
- Construction of deeper tube-wells tapping 2nd Aquifer group at locations where quality issues plague the unconfined aquifer

- Construction of check dams at suitable locations to increase the quantum of groundwater recharge

BLOCK-WISE, GROUNDWATER MANAGEMENT PLANS

5.4 Groundwater Management Plan of Bilaspur block

Block: BILASPUR District: Rampur

1. General Information

State	**Uttar Pradesh**
District name	**Rampur**
Block Name	**BILASPUR**
Location	
Geographical area	**487 Sq.Km.**
Basin/Sub-basin	**Central Ganga Plain**
Principal Aquifer System	**Alluvium**
Major Aquifer System	**Older Alluvium (AL03)**
Normal Annual Rainfall	**509 mm**

2. Aquifer Disposition

Aquifer Disposition	• Aquifer Disposition: One aquifer group with 3 Aquifer layers exist.
	  o Aquifer 1 (mbgl): From Surface to 60mbgl.
	  o Aquifer 2 (mbgl): 90 to 210 mbgl.
	  o Aquifer 3 (mbgl): 230 to 300 mbgl.
	• Fresh Aquifer Depth: Upto 300 mbgl.
	• Transmissivity (m2/day): 1083.05
	• Sp. Yield: 0.00857

Groundwater Monitoring Status	• Ground Water Monitoring Wells: 7
Ground Water Quality	• For Aquifer Group I: No Quality Problem
Aquifer Potential	• Aquifer Group I: 1517.7 lpm
Groundwater Resource	• Annual Extractable GW Recharge: 214.59 MCM • GW Draft: 127.40 MCM • Stage of GW Development: 63.49 % • Total in-storage resource of the block (fresh) is 86.23 MCM
Existing and Future Water Demand	• Present demand for All Usage: 214.59 MCM • Future Demand for Domestic and Industrial Use: 30.53 MCM

3. Aquifer Management Plan

Groundwater Management issues	• Location of feasible sites for successful wells. • Decline in water levels in some parts. • Decline in water levels in some parts. • GW quality Iron and Arsenic are present in an unconfined aquifer
AR & Conservation Possibilities	Construction of Recharge Structures mainly ponds and adoption of water use efficiency practices.
Groundwater Management Plan	• SUPPLY SIDE MANAGEMENT: Water conservation and Artificial Recharge to ground water and on Farm Activities. • DEMAND SIDE MANAGEMENT: Promoting Micro irrigation, especially drip and sprinkler irrigation method in Cultivation of rice crops, pulses, oilseed and

	horticulture.
Status of GW Exploration	Exploratory Wells: 2 Observation Wells: 2 Piezometers: 5
Aquifer Characteristics	Aquifer Group I: o Transmissivity: 1083.05 m2/day o Storativity: 0.00857

- **Water Level Behaviour**

In Bilaspur, there is a rise in water level in Pre-monsoon and post-monsoon.

- **Issues**

Groundwater contribution to agriculture is above 91.8%.

- **Groundwater Management Plan**

The proposed groundwater management plan for the block has been tabulated below. Upon implementation, 4.47 MCM of groundwater is expected to be available for additional utilization, and Stage of Groundwater Development is expected to decrease by 1.22 %.

Table 14(a): Summarized details of interventions proposed

Block	Check Dams (Nos.)	Stream Development (kms)	Nala Bunds (kms)	Ponds (Nos.)	On-farm area (Ha)	WUE area (Ha)
Bilaspur	-	-	-	05	5350	4882

Table 14(b): Projected GW Recharge & savings by supply and demand-side management

Net Annual GW Availability (MCM)	Existing GW Draft for all uses (MCM)	Stage of GW Development (%)	Total recharge through interventions (MCM)	Total GW savings through interventions (MCM)	Projected Net GW Availability (MCM)	Projected Stage of GW Development after interventions (%)
214.59	127.40	59.37	1.10	3.37	219.06	58.15

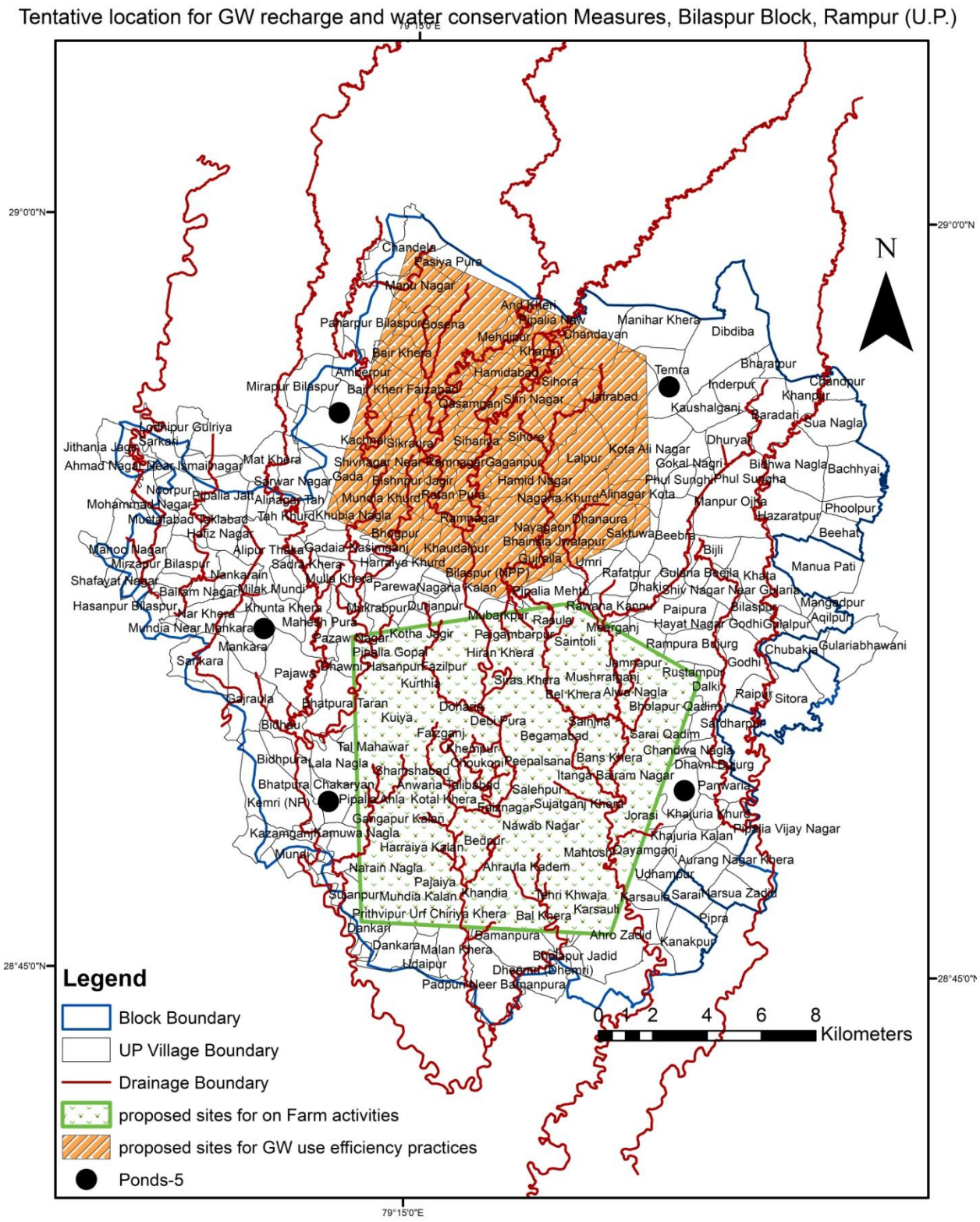


Figure 26: Proposed demand and supply side interventions in Bilaspur block.

5.5 Groundwater Management Plan of Chamraua block

Block: ***CHAMRAUWA*** **District:** ***Rampur***

4. General Information

State	**Uttar Pradesh**
District name	**Rampur**
Block Name	**CHAMRAUWA**
Location	
Geographical area	**281.26 Sq. Km.**
Basin/Sub-basin	**Central Ganga Plain**
Principal Aquifer System	**Alluvium**
Major Aquifer System	**Older Alluvium(AL03)**
Normal Annual Rainfall	**509 mm**

5. Aquifer Disposition

Aquifer Disposition	• Aquifer Disposition:
	  ○ Aquifer 1 (mbgl):
	  ○ Aquifer 2 (mbgl):
	  ○ Aquifer 3 (mbgl):
	• Fresh Aquifer Depth:
	• Transmissivity (m2/day):
	• Sp. Yield:

Groundwater Monitoring Status	• Ground Water Monitoring Wells: 8

Ground Water Quality	• For Aquifer Group I: No Quality Problem
Aquifer Potential	• Aquifer Group I: lpm
Groundwater Resource	• Annual Extractable GW Recharge: 66.04 MCM • GW Draft: 62.38 MCM • Stage of GW Development: 65.78 % • Total in-storage resource of the block (fresh) is 3.06 MCM
Existing and Future Water Demand	• Present demand for All Usage: 66.04 MCM • Future Demand for Domestic and Industrial Use: 32.30 MCM

6. Aquifer Management Plan

Groundwater Management issues	• Location of feasible sites for successful wells. • Decline in water levels in some parts. • Decline in water levels in some parts. • GW quality Iron and Arsenic are present in an unconfined aquifer
AR & Conservation Possibilities	Construction of Recharge Structures mainly ponds and adoption of water use efficiency practices.
Groundwater Management Plan	• SUPPLY SIDE MANAGEMENT: Water conservation and Artificial Recharge to ground water and on Farm Activities. • DEMAND SIDE MANAGEMENT: Promoting Micro irrigation, especially drip and sprinkler irrigation method in Cultivation of rice crops ,pulses,oilseed and horticulture.

Status of GW Exploration	Exploratory Wells: 0 Observation Wells: 0 Piezometers: 6
Aquifer Characteristics	Aquifer Group I: o Transmissivity: m2/day o Storativity:

- **Water Level Behaviour**

In Chamraua, there is no rise in both water levels Pre-monsoon as well as post-monsoon.

- **Issues**

Nitrate is present in an unconfined aquifer.

Groundwater contribution to agriculture is above 90.00%.

- **Groundwater Management Plan**

The proposed groundwater management plan for the block has been tabulated below. Upon implementation, 3.69 MCM of groundwater is expected to be available for additional utilization, and Stage of Groundwater Development is expected to decrease by 5.01 %.

Table 15(a): Summarized details of interventions proposed

Block	**Check Dams (Nos.)**	**Stream Development (kms)**	**Nala Bunds (kms)**	**Ponds (Nos.)**	**On-farm area (Ha)**	**WUE area (Ha)**
Chamraua	-	-	-	05	2905	1403

Table 15(b): Projected GW Recharge & savings by supply and demand-side management

Net Annual GW Availability (MCM)	Existing GW Draft for all uses (MCM)	Stage of GW Development (%)	Total recharge through interventions (MCM)	Total GW savings through interventions (MCM)	Projected Net GW Availability (MCM)	Projected Stage of GW Development after interventions (%)
66.04	62.38	94.46	1.10	2.59	69.73	89.45

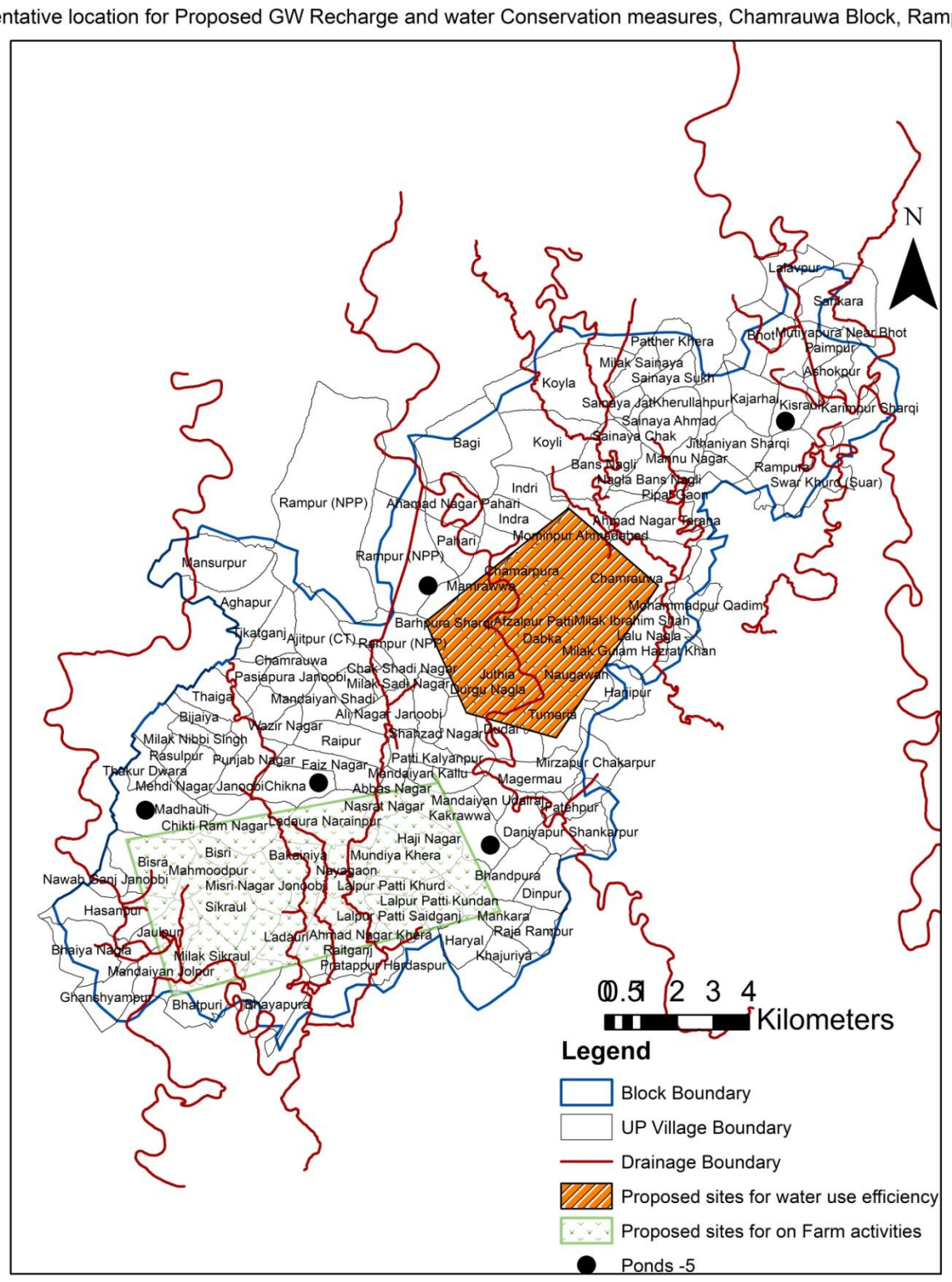


Figure 27: Proposed demand and supply side interventions in Chamrauwa block.

5.6 Groundwater Management Plan of Milak block

Block: MILAK District: Rampur

7. General Information

State	Uttar Pradesh
District name	Rampur
Block Name	MILAK
Location	
Geographical area	522.97 Sq.Km.
Basin/Sub-basin	Central Ganga Plain
Principal Aquifer System	Alluvium
Major Aquifer System	Older Alluvium(AL03)
Normal Annual Rainfall	509 mm

8. Aquifer Disposition

Aquifer Disposition	• Aquifer Disposition: One aquifer group with 3 Aquifer layers exist. o Aquifer 1 (mbgl): From Surface to 90 mbgl. o Aquifer 2 (mbgl): 120.00 to 180.00 mbgl. o Aquifer 3 (mbgl): 200 to 300 mbgl. • Fresh Aquifer Depth: Upto 300 mbgl. • Transmissivity (m2/day): 1207.74 • Sp. Yield: 0.0012
Groundwater	• Ground Water Monitoring Wells: 4

Monitoring Status	
Ground Water Quality	• For Aquifer Group I: No Quality Problem
Aquifer Potential	• Aquifer Group I: 1555.2 lpm
Groundwater Resource	• Annual Extractable GW Recharge: 136.98 MCM • GW Draft: 88.56 MCM • Stage of GW Development: 60.13 % • Total in-storage resource of the block (fresh) is 47.13 MCM
Existing and Future Water Demand	• Present demand for All Usage: 136.98 MCM • Future Demand for Domestic and Industrial Use: 51.98 MCM

9. Aquifer Management Plan

Groundwater Management issues	• Location of feasible sites for successful wells. • • Decline in water levels in some parts. • • Decline in water levels in some parts. • GW quality Iron and Arsenic are present in an unconfined aquifer
AR & Conservation Possibilities	Construction of Recharge Structures mainly ponds and adoption of water use efficiency practices.
Groundwater Management Plan	• SUPPLY SIDE MANAGEMENT: Water conservation and Artificial Recharge to ground water and on Farm Activities. • DEMAND SIDE MANAGEMENT: Promoting Micro irrigation, especially drip and sprinkler irrigation method in Cultivation of

	rice crops, pulses, oilseed and horticulture.
Status of GW Exploration	Exploratory Wells: 2 Observation Wells: 2 Piezometers: 11
Aquifer Characteristics	Aquifer Group I: o Transmissivity: 1207.74 m2/day o Storativity: 0.0012

- **Water Level Behaviour**

In Milak, there is no rise in both water levels Pre-monsoon as well as post-monsoon.

- **Issues**

Arsenic and Iron is present in an unconfined aquifer.

Groundwater contribution to agriculture is above 90.00%.

- **Groundwater Management Plan**

The proposed groundwater management plan for the block has been tabulated below. Upon implementation, 10.63 MCM of groundwater is expected to be available for additional utilization, and Stage of Groundwater Development is expected to decrease by 4.66%.

Table 16(a): Summarized details of interventions proposed

Block	Check Dams (Nos.)	Stream Development (kms)	Nala Bunds (kms)	Ponds (Nos.)	On-farm area (Ha)	WUE area (Ha)
Milak	-	-	-	05	9413	5752

Table 16(b): Projected GW Recharge & savings by supply and demand-side management

Net Annual GW Availability (MCM)	Existing GW Draft for all uses (MCM)	Stage of GW Development (%)	Total recharge through interventions (MCM)	Total GW savings through interventions (MCM)	Projected Net GW Availability (MCM)	Projected Stage of GW Development after interventions (%)
136.98	88.56	64.65	1.10	9.53	147.61	59.99

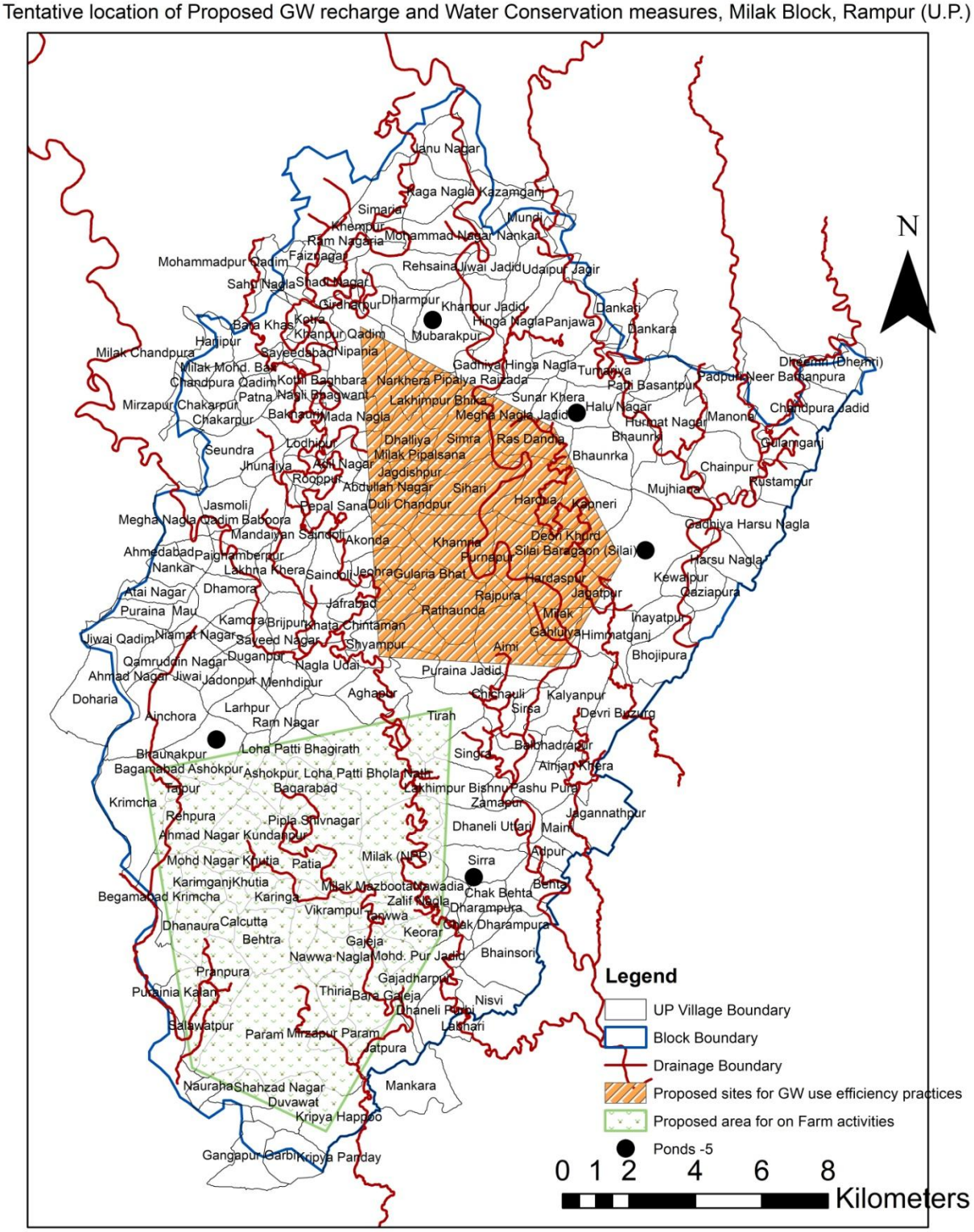


Figure 28: Proposed demand and supply side interventions in Milak block.

5.7 Groundwater Management Plan of Said Nagar block

Block: ***SAID NAGAR*** **District:** ***Rampur***

10. General Information

State	**Uttar Pradesh**
District name	**Rampur**
Block Name	**SAID NAGAR**
Location	
Geographical area	**307.96 Sq.Km.**
Basin/Sub-basin	**Central Ganga Plain**
Principal Aquifer System	**Alluvium**
Major Aquifer System	**Older Alluvium(AL03)**
Normal Annual Rainfall	**509 mm**

11. Aquifer Disposition

Aquifer Disposition	• Aquifer Disposition:
	  o Aquifer 1 (mbgl):
	  o Aquifer 2 (mbgl):
	  o Aquifer 3 (mbgl):
	• Fresh Aquifer Depth:
	• Transmissivity (m2/day):
	• Sp. Yield:

Groundwater Monitoring Status	• Ground Water Monitoring Wells: 9
Ground Water Quality	• For Aquifer Group I: No Quality Problem
Aquifer Potential	• Aquifer Group I: lpm
Groundwater	• Annual Extractable GW Recharge: 51.62 MCM

Resource	• GW Draft: 41.38 MCM • Stage of GW Development: 55.98 % • Total in-storage resource of the block (fresh) is 9.27 MCM
Existing and Future Water Demand	• Present demand for All Usage: 51.62 MCM • Future Demand for Domestic and Industrial Use: 33.03 MCM

12. Aquifer Management Plan

Groundwater Management issues	• Location of feasible sites for successful wells. • Decline in water levels in some parts. • Decline in water levels in some parts. • GW quality Iron and Arsenic are present in an unconfined aquifer
AR & Conservation Possibilities	Construction of Recharge Structures mainly ponds and adoption of water use efficiency practices.
Groundwater Management Plan	• SUPPLY SIDE MANAGEMENT: Water conservation and Artificial Recharge to ground water and on Farm Activities. • DEMAND SIDE MANAGEMENT: Promoting Micro irrigation, especially drip and sprinkler irrigation method in Cultivation of rice crops, pulses, oilseed and horticulture.
Status of GW Exploration	Exploratory Wells: 0 Observation Wells: 0 Piezometers: 8
Aquifer Characteristics	Aquifer Group I: o Transmissivity: m2/day

	○ Storativity:

- **Water Level Behaviour**

In Said Nagar, there is no rise in both water levels Pre-monsoon as well as post-monsoon.

- **Issues**

Iron is present in an unconfined aquifer.

Groundwater contribution to agriculture is 9.40%.

- **Groundwater Management Plan**

The proposed groundwater management plan for the block has been tabulated below. Upon implementation, 6.96 MCM of groundwater is expected to be available for additional utilization, and Stage of Groundwater Development is expected to decrease by 9.47 %.

Table 17(a): Summarized details of interventions proposed

Block	**Check Dams (Nos.)**	**Stream Development (kms)**	**Nala Bunds (kms)**	**Ponds (Nos.)**	**On-farm area (Ha)**	**WUE area (Ha)**
Said Nagar	-	-	-	05	7844	4183

Table 17(b): Projected GW Recharge & savings by supply and demand-side management

Net Annual GW Availability	**Existing GW Draft for all uses**	**Stage of GW Developme**	**Total recharge through**	**Total GW savings through**	**Projected Net GW Availability**	**Projected Stage of GW**

(MCM)	(MCM)	nt (%)	interventions (MCM)	interventions (MCM)	(MCM)	Development after interventions (%)
51.62	41.38	80.16	1.10	5.86	58.58	70.63

Tentative location for proposed GW recharge and GW Conservation Measure, Said Nagar, Rampur (U.P.)

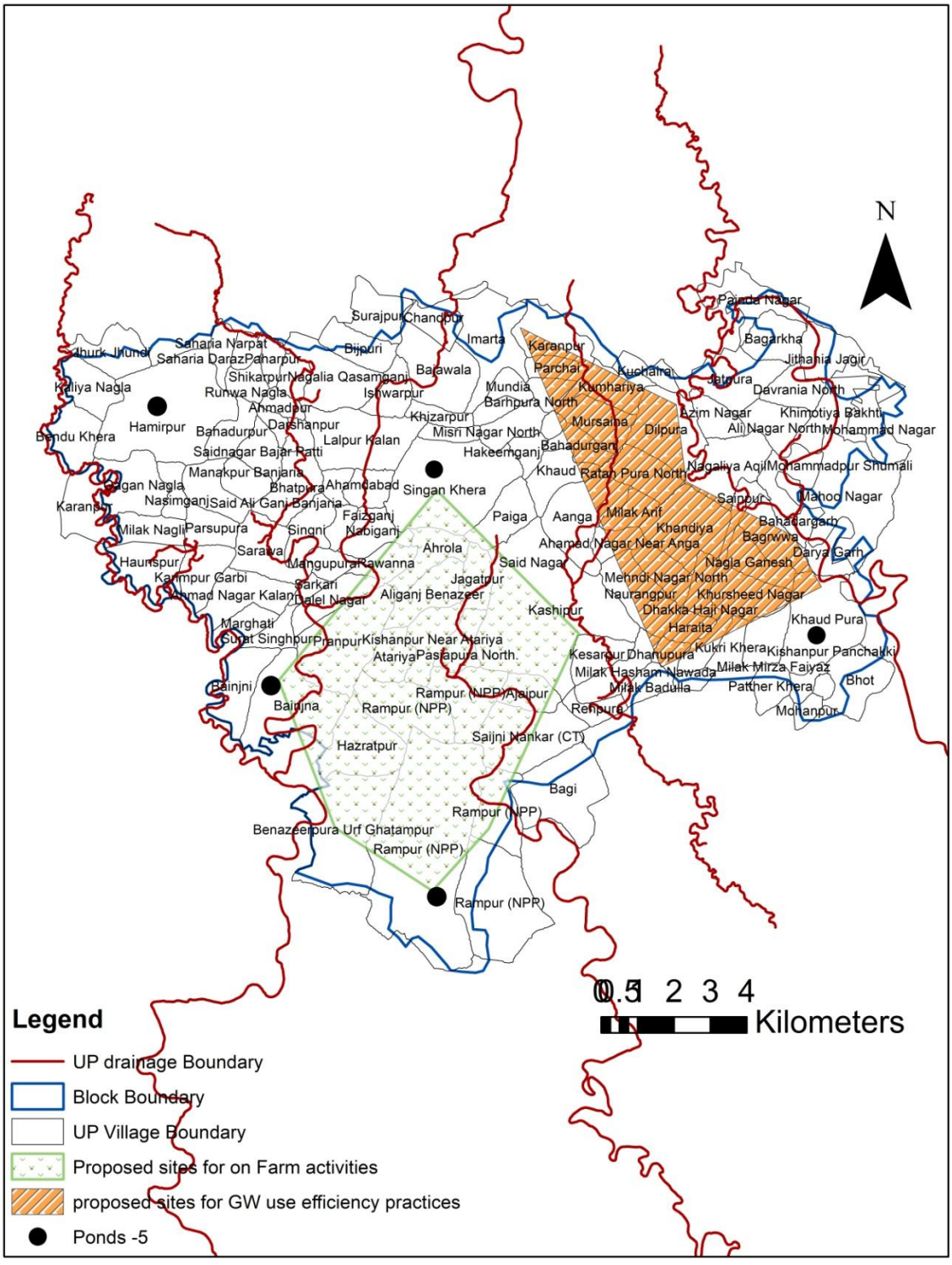


Figure 29: Proposed demand and supply side interventions in Saidnagar block.

5.8 Groundwater Management Plan Suar block

Block: ***SAUR*** **District:** ***Rampur***

13. General Information

State	**Uttar Pradesh**
District name	**Rampur**
Block Name	**SAUR**
Location	
Geographical area	**408 Sq.Km.**
Basin/Sub-basin	**Central Ganga Plain**
Principal Aquifer System	**Alluvium**
Major Aquifer System	**Older Alluvium(AL03)**
Normal Annual Rainfall	**509 mm**

14. Aquifer Disposition

Aquifer Disposition	• Aquifer Disposition: One aquifer group with 3 Aquifer layers exist.
	  o Aquifer 1 (mbgl): From Surface to 60 mbgl.
	  o Aquifer 2 (mbgl): 70 to 112 mbgl.
	  o Aquifer 3 (mbgl): 120 to 150 mbgl.
	• Fresh Aquifer Depth: Upto 150 mbgl.
	• Transmissivity (m2/day): 1080.61
	• Sp. Yield: 0.000181

Groundwater Monitoring Status	• Ground Water Monitoring Wells: 5
Ground Water Quality	• For Aquifer Group I: No Quality Problem
Aquifer Potential	• Aquifer Group I: 1555.2 lpm
Groundwater Resource	• Annual Extractable GW Recharge: 155.50 MCM • GW Draft: 127.42 MCM • Stage of GW Development: 44.08 % • Total in-storage resource of the block (fresh) is 26.45 MCM
Existing and Future Water Demand	• Present demand for All Usage: 155.50 MCM • Future Demand for Domestic and Industrial Use: 48.14 MCM

15. Aquifer Management Plan

Groundwater Management issues	• Location of feasible sites for successful wells. • Decline in water levels in some parts. • Decline in water levels in some parts. • GW quality Iron and Arsenic are present in an unconfined aquifer
AR & Conservation Possibilities	Construction of Recharge Structures mainly ponds and adoption of water use efficiency practices.
Groundwater Management Plan	• SUPPLY SIDE MANAGEMENT: Water conservation and Artificial Recharge to ground water and on Farm Activities. • DEMAND SIDE MANAGEMENT: Promoting Micro irrigation, especially drip and

	sprinkler irrigation method in Cultivation of rice crops ,pulses,oilseed and horticulture.
Status of GW Exploration	Exploratory Wells: 2 Observation Wells: 2 Piezometers: 5
Aquifer Characteristics	Aquifer Group I: o Transmissivity: 1080.61 m2/day o Storativity: 0.000181

- **Water Level Behaviour**

In Shahbad, there is no rise in both water levels Pre-monsoon as well as post-monsoon.

- **Issues**

Iron is present in an unconfined aquifer.

Groundwater contribution to agriculture is above 90.00%.

- **Groundwater Management Plan**

The proposed groundwater management plan for the block has been tabulated below. Upon implementation, 4.64 MCM of groundwater is expected to be available for additional utilization, and Stage of Groundwater Development is expected to decrease by 2.39 %.

Table 18(a): Summarized details of interventions proposed

Block	**Check Dams (Nos.)**	**Stream Development (kms)**	**Nala Bunds (kms)**	**Ponds (Nos.)**	**On-farm area (Ha)**	**WUE area (Ha)**
Shahbad	-	-	-	05	4896	2448

Table 18(b): Projected GW Recharge & savings by supply and demand-side management

Net Annual GW Availability (MCM)	Existing GW Draft for all uses (MCM)	Stage of GW Development (%)	Total recharge through interventions (MCM)	Total GW savings through interventions (MCM)	Projected Net GW Availability (MCM)	Projected Stage of GW Development after interventions (%)
155.5	127.42	81.95	1.10	3.54	160.14	79.56

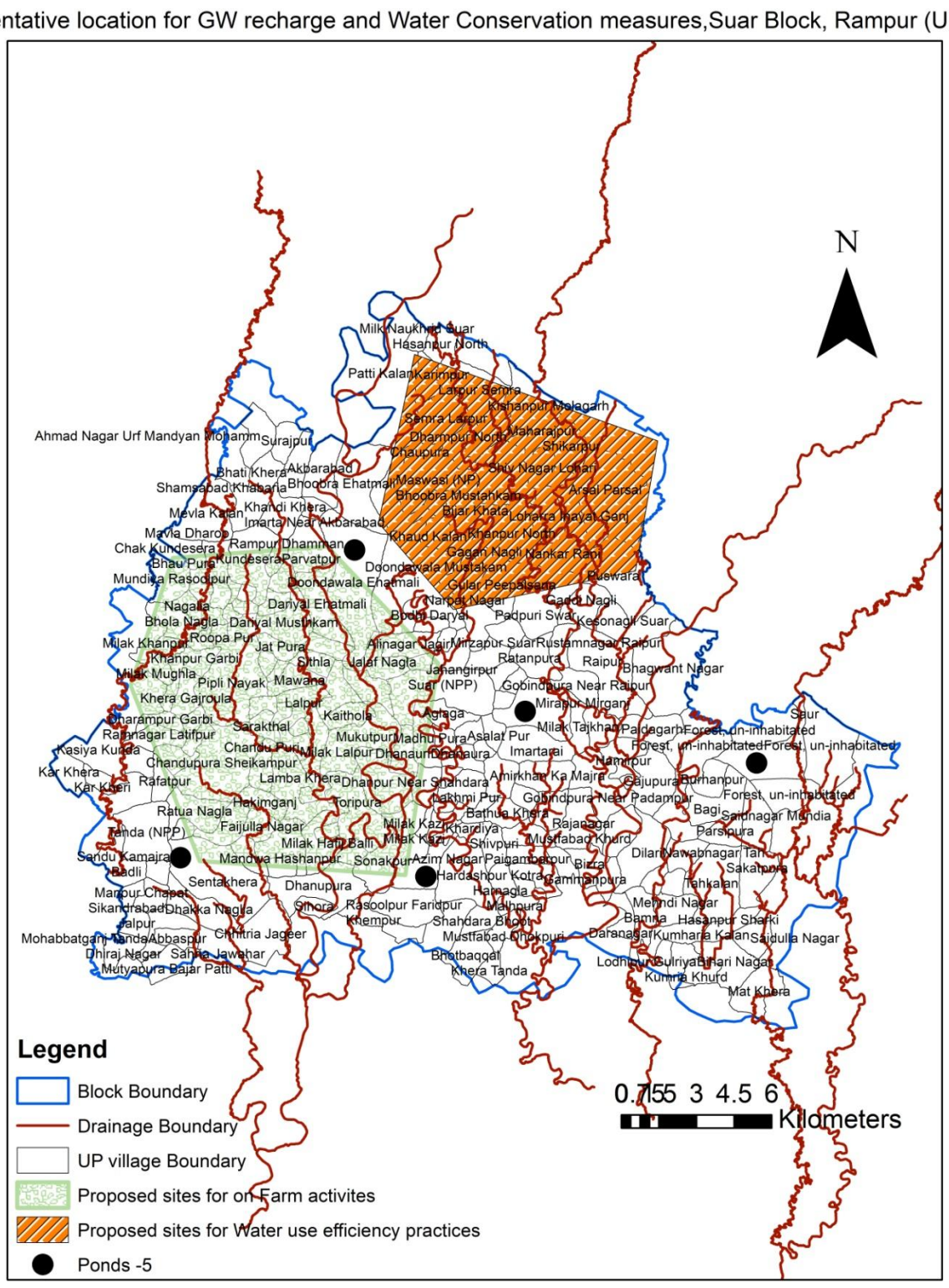


Figure 30: Proposed demand and supply side interventions in Suar block.

5.9 Groundwater Management Plan of Shahbad block

Block: SHAHABAD **District:** Rampur

16. General Information

State	**Uttar Pradesh**
District name	**Rampur**
Block Name	**SHAHABAD**
Location	
Geographical area	**560.19 Sq.Km.**
Basin/Sub-basin	**Central Ganga Plain**
Principal Aquifer System	**Alluvium**
Major Aquifer System	**Older Alluvium(AL03)**
Normal Annual Rainfall	**509 mm**

17. Aquifer Disposition

Aquifer Disposition	• Aquifer Disposition:
	  ○ Aquifer 1 (mbgl):
	  ○ Aquifer 2 (mbgl):
	  ○ Aquifer 3 (mbgl):
	• Fresh Aquifer Depth:
	• Transmissivity (m2/day):
	• Sp. Yield:

Groundwater Monitoring Status	• Ground Water Monitoring Wells: 5

Ground Water Quality	• For Aquifer Group I: No Quality Problem
Aquifer Potential	• Aquifer Group I: lpm
Groundwater Resource	• Annual Extractable GW Recharge: 94.15 MCM • GW Draft: 71.21 MCM • Stage of GW Development: 50.25 % • Total in-storage resource of the block (fresh) is 21.56 MCM
Existing and Future Water Demand	• Present demand for All Usage: 94.15 MCM • Future Demand for Domestic and Industrial Use: 30.73 MCM

- **Water Level Behaviour**

In Shahbad, there is no rise in both water levels Pre-monsoon as well as post-monsoon.

- **Issues**

Nitrate is present in an unconfined aquifer.

Groundwater contribution to agriculture is above 90%.

- **Groundwater Management Plan**

The proposed groundwater management plan for the block has been tabulated below. Upon implementation, ____ MCM of groundwater is expected to be available for additional utilization, and Stage of Groundwater Development is expected to decrease by ____%.

Table 18(a): Summarized details of interventions proposed

Block	Check Dams (Nos.)	Stream Development (kms)	Nala Bunds (kms)	Ponds (Nos.)	On-farm area (Ha)	WUE area (Ha)
Shahbad	-	-	-	05	9523	5041

Table 18(b): Projected GW Recharge & savings by supply and demand-side management

Net Annual GW Availability (MCM)	Existing GW Draft for all uses (MCM)	Stage of GW Development (%)	Total recharge through interventions (MCM)	Total GW savings through interventions (MCM)	Projected Net GW Availability (MCM)	Projected Stage of GW Development after interventions (%)
94.15	71.21	75.64	1.10	6.81	102.06	69.77

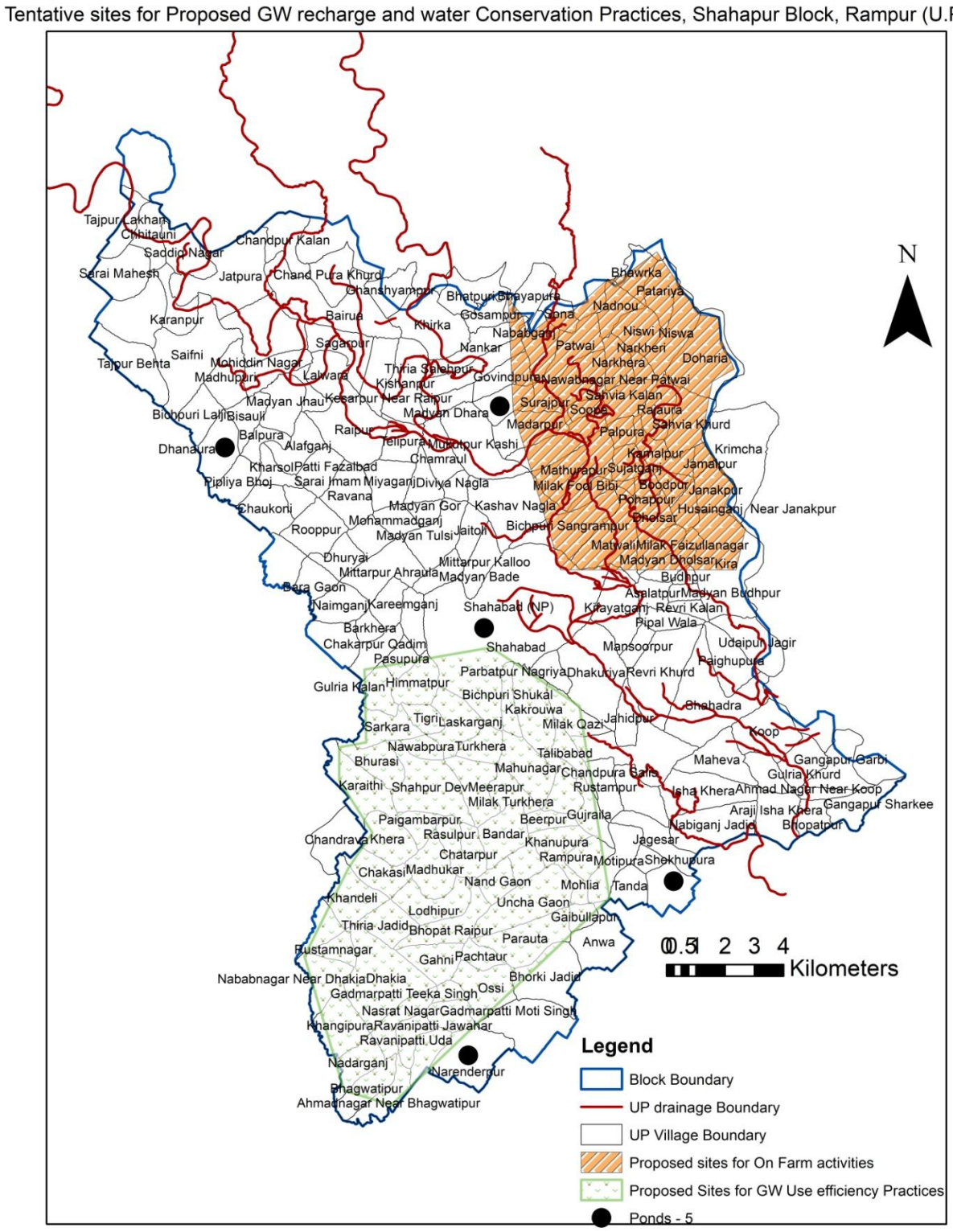


Figure 31: Proposed demand and supply side interventions in Shahbad block.

ANNEXURE – 1

(BASIC GW QUALITY DATA OF UNCONFINED AQUIFER)

Block	Sample Location	Source	Lat	Long	pH	Conductivity	CO_3	HCO_3
						µmho/cm at 25°C	mg/L	mg/L
Bilaspur	Block Office	H/P-IM-II	28.8912	79.2606	7.34	595	nil	244
Chamraua	Block Office	H/P-IM-II	28.8081	79.0281	7.39	397	nil	153
Milak	Block Office	H/P-IM-II	28.6066	79.1797	7.75	575	nil	305
Said Nagar	Block Office	H/P-IM-II	28.8580	78.9885	7.34	449	nil	146
Shahbad	Block Office	H/P-IM-II	28.5553	78.9885	7.49	1376	nil	122
Swar	Block Office	H/P-IM-II	29.0565	79.0557	7.50	488	nil	238

Block	Cl	F	NO_3	SO_4	Hardness as $CaCO_3$	Ca Hardness	Mg Hardness	Na	K
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Bilaspur	28	0.31	BDL	51	225	36	32	38	2.0
Chamraua	21	0.11	BDL	33	150	32	17	21	3.6

Milak	21	0.14	BDL	31	185	16	35	55	21
Said Nagar	36	0.11	BDL	46	165	44	13	28	2.5
Shahbad	170	BDL	182	181	475	64	76	96	14
Swar	14	0.18	BDL	40	205	24	35	28	2.4

ANNEXURE – 2
(TRACE METAL DATA OF UNCONFINED AQUIFER)

Block	**Fe**	**Mn**	**Cu**	**Zn**	**As**	**Pb**	**U**	**Cr**
	(ppm)	**(ppm)**	**(ppm)**	**(ppm)**	**(ppb)**	**(ppb)**	**(ppb)**	**(ppb)**
Bilaspur	0.99	0.00	0.00	1.10	0.00	0.00	7.00	0.00
Chamrarura	4.00	0.39	0.00	1.16	3.00	0.00	3.00	0.00
Milak	4.30	0.00	0.00	1.02	22.00	0.00	0.00	0.00
Said nagar	1.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shahbad	0.00	0.33	0.00	3.42	0.00	0.00	17.00	0.00
Swar	1.16	0.00	0.00	0.61	0.00	0.00	3.00	0.00

ANNEXURE – 3

1.0 Strategies for weather related contingencies

1.1 Drought

1.2 Rainfed situation

Condition			Suggested Contingency measures		
Early season drought (delayed onset)	Major Farming situation	Normal Crop / Cropping system	Change in crop / cropping system including variety	Agronomic measures	Remarks on Implementatio n
Delay by 2 weeks 4th Week of June	Deep soil, yellow colored alluvial loam soils	Maize/ Pearl millet/ Pigeonpea/	Maize: Kanchan, Navin Navjyoti, Azad utam,Surya,Meerut pili,Ganga 2,11 Samrat etc Sorghum: CSH 14, 16, CSB 13, 15, SPB 1338 etc Pearl millet: Raj-171,WCC- 75,Pusa 23, 322 icmh-451 Pigeonpea: UPAS 120, ICPL 151,Pusa 33,	• Conservation furrow • Inter- cultivation • Sowing with multi seed drill • Wider spacing for pigeonpea	• Seed-drill under RKVY • Supply of seed through govt. agencies *ie*. NFSM,RKVY • Re-scheduling of canal calendar
Condition			Suggested Contingency measures		
Early season drought (delayed onset)	Major Farming situation	Normal Crop/cropping system	Change in crop/cropping system	Agronomic measures	Remarks on Implementatio n
Delay by 4 weeks 2nd Week of July	Deep soil, yellow colored alluvial loam soils	Maize/ Pearl millet/ Sesame/ Blackgram	Maize: Kanchan, Navin Navjyoti, Azad utam,Surya,Meerut pili,Ganga 2,11 Samrat etc Pearl millet: Raj-171,WCC- 75,Pusa 23, 322 icmh-451 Sesame: Pergati, shekar, TA- 78, TA-12	• Conservation furrow • Inter- cultivation • Sowing with multi seed drill	Seed-drill under RKVY Supply of seed through govt. agencies *ie*. NFSM

			Blackgram: Narender Blackgram-1, Pant U-30, 19, 35 etc		
Condition			Suggested Contingency measures		
Early season drought	Major Farming situation	Normal Crop/cropping system	Change in crop/cropping system	Agronomic measures	Remarks on Implementation
Delay by 6 weeks 4th week of July	Deep soil, yellow colored alluvial loam soils	Blackgram/Greengram/ Toria Pearl millet	Blackgram: Narender Blackgram-1, Pant U-30, 19, 35 Greengram: Pantmung - 2, 3, Narender mung -1, 4, SML-668, PDM-11	• Sowing with multi seed drill	Re-scheduling of canal calendar
			Pearl millet: Raj-171,WCC- 75,Pusa 23, 322 icmh-451		
Condition			Suggested Contingency measures		
Early season drought	Major Farming situation		Change in crop/cropping system	Agronomic measures	Remarks on Implementatio n
Delay by 8	Deep soil,	Toria	Toria: P.T.-30, 507, 303,	• Conservation furrow • Inter-cultivation • Sowing with multi seed drill	• Seed-drill under RKVY Supply of seed through govt. agencies *ie*. NFSM
Weeks 2nd	yellow colored alluvial loam		Bhawani, T-9		
Week of	soils				
August					

Condition			Suggested Contingency measures		
Early season	Major	Normal Crop / Cropping system	Crop management	Soil nutrient &	Remarks on
drought (Normal onset)	Farming situatio n			moisture conservation measures	Implementation

Normal onset followed by 15-20 days dry spell after sowing leading to poor germination/crop stand etc.	Irrigated up land	Rice: PS 4, 5, PB 1, PRH 10 / Sugarcane: 64, 88230, 92254, 95255, COS 767, 8432, 97284 / Toria: T-36,T-9,Bhawani, PT-30,303,507 / Maize: Kanchan, Sweta, Navin, Surya, Azad uttam, Navjyoti, Jaunpuri, Meerut pili / Pearl millet: Raj-171, -75, Pusa 23, 322 icmh-451	. Thining, weeding and gap filling in existing crop. . Re sowing . Selection/nursery sowing of short duration rice cultivar	• Inter cultivation • Conservation furrow • Thinning and weeding • Mulching	• Supply of inter cultural implements through RKVY • Farm ponds through IWSM programme • Pulse crop seeds supply through NFSM
	Irrigated low land	Rice: PS 2,3, PB 1, Sarju 52, Pant 4 Narendra 359, Saket 4 / Sorghum (Fodder): Kanpuri, UP Chari 1,2 / Sugarcane: 64, 88230, 92254, 95255, COS 767, 8432, 97284			
	Un irrigated up land	Maize/Sorghum / Toria: T-36, T-9, Bhawani, PT-30,303,507 / Pigeonpea: UPAS 120, ICPL 151			
	Un irrigated low land	Pigeonpea: UPAS 120, ICPL 151 / Pearl millet: Local Merut pili			
Condition			Suggested Contingency measures		
Mid season drought (long dry spell, consecutive 2 weeks rainless (>2.5 mm) period)	Major Farming situation	Normal Crop/cropping system	Crop management	Soil nutrient & moisture conservation measures	Remarks on Implementation
At vegetative stage	Irrigated up land	Rice: PS 4, 5, PB 1, PRH 10 / Sugarcane: 64, 88230,	. Thining, weeding and gap filling in	• Inter cultivation • Conservation	• Supply of inter cultural implements

		92254, 95255, COS 767, 8432, 97284 / Toria: T-36,T-9,Bhawani, PT-30,303,507 / Maize: Kanchan, Sweta, Navin, Surya, Azad uttam, Navjyoti, Jaunpuri, Meerut pili / Pearl millet: Raj-171,WCC-75,Pusa 23, 322 icmh-451	existing crop. . Re sowing 3.Postponement of top dressing 4.Life saving irrigation	furrow • Thinning and weeding Mulching	through RKVY • Farm ponds through IWSM programme • Pulse crop seeds supply through NFSM Micro/drip/sprinkler
	Irrigated low land	Rice: PS 2,3, PB 1, Sarju 52, Pant 4, Narendra 359, Saket 4 / Sorghum (Fodder): Kanpuri, UP Chari 1,2 / Sugarcane: 64, 88230, 92254, 95255, COS 767, 8432, 97284			irrigation under govt. schemes
At vegetative stage	Un irrigated up land	Maize/Sorghum / Toria: T-36,T-9,Bhawani, PT-30,303,507 / Pigeonpea: UPAS 120, ICPL 151	. Thining, weeding and gap filling in existing crop. . Re sowing 3.Postponement of top dressing 4.Life saving irrigation	• Inter cultivation • Conservation furrow • Thinning and weeding Mulching	• Supply of inter cultural implements through RKVY • Farm ponds through IWSM programme • Pulse crop seeds supply through NFSM Micro/drip/sprinkler
	Un irrigated low land	Pigeonpea: UPAS 120, ICPL 151 / Pearl millet: Local Merut pili			• irrigation under govt. schemes irrigation under govt. schemes

Condition			Suggested Contingency measures		
Mid season drought (long dry spell)	Major Farming situation	Normal Crop/cropping system	Crop management	Soil nutrient & moisture conservation measures	Remarks on Implementation
At flowering/ fruiting stage	Irrigated up land	Rice: PS 4, 5, PB 1, PRH 10 / Sugarcane: 64, 88230, 92254, 95255, COS 767, 8432, 97284 / Toria: T-36,T-9,Bhawani, PT-30,303,507 / Maize: Kanchan, Sweta, Navin, Surya, Azad uttam, Navjyoti, Jaunpuri, Meerut pili / Pearl millet: Raj-171,WCC-75,Pusa 23, 322 icmh-451	1. Thining, weeding and gap filling in existing crop. 2.Life saving irrigation 3. Weeding and weed mulching	• Conservation furrow • Thinning and weeding • Mulching • Urea spray or KCL spray	• Farm ponds through IWSM programme
	Irrigated	Rice: PS 2,3, PB 1, Sarju 52, Pant 4, Narendra			
	low land	359, Saket 4 / Sorghum (Fodder): Kanpuri, UP Chari 1,2 /			
		Sugarcane: 64, 88230, 92254, 95255, COS 767,			
		8432, 97284			
	Un irrigated up land	Maize/Sorghum / Toria: T-36,T-9,Bhawani, PT-30,303,507 / Pigeonpea: UPAS 120, ICPL 151			
	Un irrigated low land	Pearl millet: Local Merut pili / Toria: T-36,T-9,Bhawani, PT-30,303,507			

Condition			Suggested Contingency measures		
	Major Farming situation	Normal Crop/cropping system	Crop management	Rabi crop planning	Remarks on Implementation
Terminal drought (Early withdrawal of monsoon)	Irrigated up land	Rice: PS 4, 5, PB 1, PRH 10 / Sugarcane: 64, 88230, 92254, 95255, COS 767, 8432, 97284 / Toria: T-36,T-9,Bhawani, PT-30,303,507 / Maize: Kanchan, Sweta, Navin, Surya, Azad uttam, Navjyoti, Jaunpuri, Meerut pili / Pearl millet:Raj-171,WCC-75,Pusa 23, 322 ICMH-451 /	1. Life saving irrigation 2. Picking/harvesting of pods/ear 3. Harvest at physiological maturity stage 4. Harvest for fodder	• Toria/mustard • Potato • Pea/gram • Barseem/oat • Land labeling	• Farm ponds through IWSM programme • Supply of seed through ISOPM • Harvesting and threshing implements through RKVY • Supply of land lazer labeler through CLDP or RKVY
	Irrigated	Rice: PS 2,3, PB 1, Sarju 52, Pant 4, Narendra			
	lowland	359, Saket 4 / Sorghum (Fodder): Kanpuri, UP Chari 1,2 /			
		Sugarcane: 64, 88230, 92254, 95255, COS 767,			
		8432, 97284			
	Un irrigated	Maize/Sorghum/			
	up land	Toria: T-36,T-9,Bhawani, PT-30,303,507 / Pigeonpea: UPAS 120, ICPL 151			
	Un irrigated	Pigeonpea: UPAS 120, ICPL 151 /			
	low land	Pearl millet: Local Merut pili / Toria: T-36,T-9,Bhawani, PT-30,303,507			

1.1.2. Draught Irrigated situation

<table>
<tr><td rowspan="2">Condition</td><td></td><td></td><td colspan="3">Suggested Contingency measures</td></tr>
<tr><td>Major Farming situation</td><td>Normal Crop/ cropping system</td><td>Change in crop/cropping system</td><td>Agronomic measur</td><td>Remarks on Implementation</td></tr>
<tr><td rowspan="4">Delayed release of water in canals due to low rainfall</td><td rowspan="4">Up land sandy loam soils</td><td>Rice (Basmati)-Wheat</td><td>Replace rice with maize or aerobic rice</td><td rowspan="4">Use short duration varieties Rice: PS 4, 5, PB 1, PRH 10 Maize: Kanchan, Sweta, Navin, Surya
Pearl millet:Wcc-75,Raj-171,Pusa-23,Pusa-322
Light irrigation with tube well water
Follow alternate wetting and drying schedule of irrigation in rice
Alternate Furrow irrigation
Mulching in sugarcane / maize</td><td rowspan="4">• Seed through KSSC and NFSM
• Adequate supply of electricity/diesel should be ensured by the Govt. agencies.</td></tr>
<tr><td>Sorghum (Fodder)/ Maize-Potato/ Wheat</td><td>Pearl millet/Greengram/ Blackgram - Potato/ Wheat</td></tr>
<tr><td>Sugarcane +cucurbits –</td><td>No change</td></tr>
<tr><td>Ratoon-Wheat</td><td></td></tr>
<tr><td rowspan="4"></td><td rowspan="4">Low land clay loam soils</td><td>Rice-wheat</td><td>Basmati rice - Wheat</td><td rowspan="4">• Use short duration varieties e.g.
Rice: PS 4, 5, PB1, PRH 10
Maize: Kanchan, Sweta, Navin, Surya
Pearl millet (Fodder): Wcc- 75,Raj-171,Pusa-23,Pusa-322
• Light irrigation with tube well water
• Follow alternate wetting and drying schedule of irrigation in rice
• Alternate Furrow irrigation
• Mulching in sugarcane</td><td rowspan="4">• Seed through KSSC and NFSM
• Adequate supply of electricity/diesel should be ensured by the Govt. agencies.</td></tr>
<tr><td>Sorghum Fodder-Wheat</td><td>Pearl millet-Wheat</td></tr>
<tr><td></td><td>Sugarcane-Ratoon-</td><td>No change</td></tr>
<tr><td></td><td>Wheat</td><td></td></tr>
</table>

Condition			Suggested Contingency measures		
	Major Farming situation	Normal Crop/cropping system	Change in crop/cropping system	Agronomic measures	Remarks on Implementation
Limited release of water in canals due to low rainfall	Up land sandy loam soils	Rice (Basmati)-Wheat	No change	• Light irrigation with tube well water at critical stages only e.g CRI, Tillering &.Flowering stage • Follow alternate wetting and drying schedule of irrigation in rice • Alternate Furrow irrigation • Mulching in sugarcane/ maize	• Adequate supply of electricity/diesel should be ensured by the Govt. agencies.
		Sorghum (Fodder)/ Maize-Potato/ Wheat	No change		
		Sugarcane +cucurbits – Ratoon- Wheat	No change		
	Low land clay loam	Rice-wheat	No change	• Light irrigation with tube well	• Supply of inter
Condition			Suggested Contingency measures		
	Major Farming situation	Normal Crop/ cropping system	Change in crop/cropping system	Agronomic measur	Remarks on Implementation
	soils	Sorghum Fodder-Wheat	No change	water at critical stages only e.g CRI, Tillering &.Flowering stage • Follow alternate wetting and drying schedule of irrigation in rice • Alternate Furrow irrigation • Mulching in sugarcane	cultural implements through RKV • Adequate supply of electricity/diesel should be ensured by the Govt. agencies.
		Sugarcane-Ratoon-Wheat	No change		

Condition			Suggested Contingency measures		
	Major Farming situation	Normal Crop/cropping system	Change in crop/cropping system	Agronomic measures	Remarks on Implementation
Non release of water in canals under delayed onset of monsoon in catchment	Up land tube well irrigated canal sandy loam soil	Basmati rice	Maize/ Arabic Rice	• Limited irrigation • Alternate Furrow irrigation • Drip irrigation • Mulching	• Seed through KSSC and NFSM • Supply of inter cultural implements through RKVY
		Sorghum/Maize	Pearl millet / Pigeon pea /Blackgram		
		Sugarcane +cucurbits	Sugarcane		
	Low land tube well irrigated canal clay loam soil	Rice	Pearl millet/ Blackgram /Greengram	• Limited irrigation • Alternate Furrow irrigation • Drip irrigation • Mulching • Alternate furrow irrigation	• Seed through KSSC and NFSM • Harvesting and threshing implements through RKVY
		Sorghum Fodder	Pearl millet/Sorghum Fodder		
		Sugarcane + cucurbits	Sugarcane		

Condition			Suggested Contingency measures		
	Major Farming situation	Normal Crop/cropping system	Change in crop/cropping system	Agronomic measures	Remarks on Implementation
Lack of inflows into tanks due to insufficient /delayed onset of monsoon			NA	NA	NA
Condition			Suggested Contingency measures		
	Major Farming situation	Normal Crop/cropping system	Change in crop/cropping system	Agronomic measures	Remarks on Implementation

Insufficient groundwater recharge due to low rainfall	Up land tube well irrigated canal sandy loam soil	Basmati rice	Maize/ Arabic Rice / Vegetable (Tomato, Brinjal, cucrbits etc)	• Limited irrigation • Alternate Furrow irrigation • Drip irrigation • Mulching	• Seed through KSSC and NFSM • Harvesting and threshing implements through RKVY
		Sorghum/ Maize	Pearl millet / Pigeon pea/ Blackgram		
		Sugarcane +cucurbits	Sugarcane		
	Low land tube well irrigated canal clay loam soil	Rice	Pearl millet/ Blackgram/ Greengram	• Limited irrigation • Alternate Furrow irrigation • Drip irrigation • Mulching • Alternate furrow irrigation	• Seed through KSSC and NFSM • Micro/drip/sprinkler irrigation under govt. schemes • Supply of inter cultural implements through RKVY
		Sorghum Fodder	Pearl millet/ Sorghum Fodder		
		Sugarcane + cucurbits	Sugarcane		

2.0 Unusual rains (untimely, unseasonal etc) (for both rainfed and irrigated situations)

Condition	Suggested contingency measure			
Continuous high rainfall in a short span leading to water logging	Vegetative stage	Flowering stage	Crop maturity stage	Post-harvest
Maize + Blackgram / Greengram/ Cucurbits	Provide drainage	Provide drainage	Drain out Harvesting at physiological maturity stage	Shift to safer place
Sugarcane +Cucurbits	Provide drainage	Provide drainage	Drain out Harvesting at physiological maturity stage and Picking of cucurbits crop.	Shift to safer place
Blackgram / Greengram	Provide drainage	Provide drainage	Drain out Harvesting at physiological maturity stage.	Safe storage against storage pest and disease
Horticulture				
Okra	Provide drainage	Provide drainage	Picking of vegetables at	Shift to safer

			physiological maturity stage	place
Cucurbits	Provide drainage	Provide drainage	Drain out & Harvesting at physiological maturity stage and picking of cucurbits crop.	Shift to safer place
Brinjal	Provide drainage	Provide drainage	Picking at physiological maturity stage	Shift to safer place
Tomato	Provide drainage	Provide drainage	Picking at physiological maturity stage	Shift to safer place
Mango	-	-	Spray of 2% urea+fungicide	-
Guava	-	-	Spray of 2% urea+fungicide	-
Muskmelon	-	-	Spray of 2% urea+fungicide	-
Heavy rainfall with high speed winds in a short span				
Sugarcane	• Ear thing • Tying • Use Wind breaks	Provide drainage Use Wind breaks	Drain out &Harvesting at physiological maturity stage Use Wind breaks	Shift to safer place
Maize/ Sorghum	Provide drainage Use Wind breaks	Provide drainage Use Wind breaks	Drain out & Harvesting at physiological maturity stage Use Wind breaks	Shift to safer place
Blackgram	Provide drainage Use Wind breaks	Provide drainage Use Wind breaks	Drain out& Harvesting at physiological maturity stage Use Wind breaks	Shift to safer place
Rice basmati	Provide drainage Use Wind breaks	Provide drainage Use Wind breaks	Drain out & Harvesting at physiological maturity stage Use Wind breaks	Shift to safer place
Pigeon pea	• Provide drainage • Sowing on raised bed • Use Wind breaks	Provide drainage Use Wind breaks	Drain out & Harvesting at physiological maturity stage Use Wind breaks	Shift to safer place
Horticulture				

Okra	• Provide drainage • Sowing on raised bed • Use Wind breaks	Provide drainage Use Wind breaks	Drain out Harvesting at physiological maturity stage Use Wind breaks	Shift to safer place
Brinjal	• Provide drainage • Sowing on raised bed • Use Wind breaks	Provide drainage Use Wind breaks	Drain out Harvesting at physio- logical maturity stage Use Wind breaks	Shift to safer place
Tomato	• Provide drainage • Sowing on raised bed • Use Wind breaks	Provide drainage Use Wind breaks	Drain out Harvesting at physio- logical maturity stage Use Wind breaks	Shift to safer place
Cauliflower	• Provide drainage • Sowing on raised bed • Use Wind breaks	Provide drainage Use Wind breaks	Drain out Harvesting at physio- logical maturity stage Use Wind breaks	Shift to safer place
Cucurbits	• Provide drainage • Sowing on raised bed • Use Wind breaks	Provide drainage Use Wind breaks	Drain out Harvesting at physio- logical maturity stage Use Wind breaks	Shift to safer place
Mango	Use Wind breaks	Use of NAA spray	Use of NAA spray	-
		Use Wind breaks	Use Wind breaks	
Guava	Use Wind breaks	Use of NAA spray Use Wind breaks	Use of NAA spray Use Wind breaks	-
Muskmelon	Use Wind breaks	Use of NAA spray Use Wind breaks	Use of NAA spray Use Wind breaks	-
Outbreak of pests and diseases due to unseasonal rains				
Rice basmati Sugarcane	Need based plant protection IPDM	Need based plant protection IPDM	Do not use Hazardous pesticide at maturity stage	Shift to safer

Sorghum fodder	for Rice/pluses	for Rice/pluses		place
Blackgram/ Greengram				
Pigeonpea				
Horticulture				
Okra	Need based plant protection IPDM for Rice/pluses	Need based plant protection IPDM for Rice/pluses	Do not use Hazardous pesticide at maturity stage	Shift to safer place
Brinjal				
Tomato				
Cucurbits				
Cauliflower				

2.1 Floods

Condition	Suggested contingency measure			
Transient water logging/ partial inundation	Seedling / nursery stage	Vegetative stage	Reproductive stage	At harvest
Rice basmati	• Re sowing of nursery • Direct sowing of rice • Sowing of nursery on raised bed	• Provide drainage	• Provide drainage	Shift to safer place
Sugarcane	• Direct sowing	• Provide drainage	• Provide drainage	Shift to safer place
Sorghum fodder	• Direct sowing	• Provide drainage	• Provide drainage	Shift to safer place
Blackgram/ Greengram	• Direct sowing	• Provide drainage	• Provide drainage	Shift to safer place
Pigeonpea	• Direct sowing	• Provide drainage	• Provide drainage	Shift to safer place
Horticulture				
Okra	• Re sowing of nursery • Sowing of nursery on raised bed • Re transplanting	• Provide drainage	• Provide drainage	Shift to safer place
Brinjal	• Re sowing of nursery • Sowing of nursery on raised bed • Re transplanting	• Provide drainage	• Provide drainage	Shift to safer place

Tomato	• Re sowing of nursery • Sowing of nursery on raised bed • Re transplanting	• Provide drainage	• Provide drainage	Shift to safer place
Continuous submergence for more than 2 days				
Rice	• Re sowing of nursery • Direct sowing of rice • Sowing of nursery on raised bed	• Provide drainage	• Provide drainage	Shift to safer place
Horticulture	NA	NA	NA	NA
Okra	• Re sowing of nursery • Sowing of nursery on raised bed • Re transplanting	• Provide drainage	• Provide drainage	Shift to safer place
Brinjal	• Re sowing of nursery • Sowing of nursery on raised bed • Re transplanting	• Provide drainage	• Provide drainage	Shift to safer place
Tomato	• Re sowing of nursery • Sowing of nursery on raised bed • Re transplanting	• Provide drainage	• Provide drainage	Shift to safer place
Mango	• Re sowing of nursery • Sowing of nursery on raised bed • Re transplanting	• Provide drainage	• Provide drainage	Shift to safer place
Sea water intrusion	NA	NA	NA	NA

2.2 Extreme events: Heat wave / Cold wave/Frost/ Hailstorm /Cyclone/Fog

Extreme event type	Suggested contingency measure			
	Seedling / nursery stage	Vegetative stage	Reproductive stage	At harvest
Heat Wave				
Rice basmati	• Re sowing of nursery	• Irrigation interval should be	• Irrigation interval should be decreased	Light and frequent
	• Light and frequent irrigation during night	decreased		irrigation

Sugarcane	• Mulching	• Irrigation interval should be decreased	• Irrigation interval should be decreased	Light and frequent irrigation
Sorghum fodder	• Re sowing	• Irrigation interval should be decreased	• Irrigation interval should be decreased	Make silage
Blackgram / Greengram	• Re sowing • Mulching	• Light irrigation for survival	• Light irrigation for survival	• Pod picking
Pigeonpea	• Re sowing • Mulching	• Light irrigation for survival	• Light irrigation for survival	• Pod picking
Horticulture				
Okra	• Re sowing of nursery • Re transplanting • Mulching • Light watering during night	• Light irrigation for survival	• Light irrigation for survival	• Harvesting of fruits
Brinjal	• Re sowing of nursery • Re transplanting • Mulching • Light watering during night	• Light irrigation for survival	• Light irrigation for survival	• Harvesting of fruits
Tomato	• Re sowing of nursery • Re transplanting • Mulching of nursery beds • Light irrigation during night	• Light irrigation for survival	• Light irrigation for survival	• Harvesting of fruits
Mango	• Spray of water	• Spray of water	• Spray of water	
Guava	• Spray of water	• Spray of water	• Spray of water	
Muskmelon	• Spray of water	• Spray of water	• Spray of water	
Cold wave				
Wheat	Light irrigation	Light irrigation	Light irrigation	Light irrigation
Sugarcane	• Mulching	• Light irrigation	--	• Harvesting of cane
Horticulture				
Tomato	Grow some inter crop	• Light Sprinkler irrigation	--	• Harvesting of fruits
Pea	Grow some inter crop	• Light Sprinkler irrigation	--	• Harvesting of fruits

Potato	Grow some inter crop	• Light Sprinkler irrigation	--	•Harvesting
Frost				
Sugarcane	• Light irrigation for survival	•Light irrigation for survival	•Light irrigation for survival	•Harvesting of cane
Pigeon pea	• Grow as inter crop • Smoke at night	• Light Sprinkler irrigation • Smoke at night	• Light irrigation for survival • Smoke at night	Smoke at night
Horticulture				
Potato	•Light irrigation for survival •Smoke at night	•Light irrigation for survival •Smoke at night	•Light irrigation for survival •Smoke at night	•Harvesting
Tomato	•Light irrigation for survival •Smoke at night	•Light irrigation for survival •Smoke at night	•Light irrigation for survival •Smoke at night	•De halming
Pea	•Light irrigation for survival •Smoke at night	•Light irrigation for survival •Smoke at night	•Light irrigation for survival •Smoke at night	•Harvesting
Mango	• Irrigation &Smoking during night	•Irrigation &Smoking during night	•Irrigation &Smoking during night	
Guava	•Irrigation &Smoking during night	•Irrigation &Smoking during night	•Irrigation &Smoking during night	
Hailstorm				
All the crops	Re sowing	Re sowing of Catch crop	Harvest for fodder	Pre Harvesting
Horticulture				
All the Vegetable crops	Re sowing	Re sowing of Catch crop	Harvest for fodder	Pre Harvesting
All the Fruit crops	• Use anti hail net • Spray of fungicide with 2% urea solution	• Use anti hail net • Spray of fungicide with 2% urea solution	• Use anti hail net • Spray of fungicide with 2% urea solution	•Harvest the damaged fruits •Spray of fungicide with 2% urea solution
Fog				

Annexure-4

S.No	District	Block_Taluk_Mandal_Firka	Village	Latitude	Longitude	Aquifer_1_Thickness_m	T_m2perday	S_Sy	Q_lpm	EC	Aquifer_2_Thickness_m	T_m2perday	S_Sy	Q_lpm	EC
1	Rampur	Suar	Khempur (ITI Campus)	28.9367	79.0578	50					90	298.8	1.44E-05	679	11600
2	Rampur	Bilaspur	Kasba Rajpur	28.8658	79.2734	110					80	1052.9	0.000181	1555	406
3	Rampur	Milak	Pipla-I (Dp)	28.6192	79.1322	170					150	871.15	0.00857	1517	380
4	Rampur	Milak	Pipla-II (Sh)	28.6192	79.1322	170	890.51	0.000121	1517	443	100	1026.58	0.0012	1555	495
5	Rampur	Suar	Raipur	29.0196	79.152	150					100				
6	Rampur	Bilaspur	Sikraura	28.9236	79.2381	80					120				