



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

**Koriya District
Chhattisgarh**

उत्तर मध्य छत्तीसगढ़ क्षेत्र, रायपुर
North Central Chhattigarh Region, Raipur

FOREWORD

Groundwater resources are being developed over years in order to meet domestic, irrigation and industrial requirements. The spatial distribution of availability of ground water resources however, is uneven and is being indiscriminately exploited by various users thereby creating relentless pressure. On the other hand, rapid urbanization, industrialization and land use changes has resulted decline of water levels in many parts of the country.

There is an urgent need for scientific approach for proper management of the available ground water resources for sustainability of this precious natural resource for present and future generation.

Central Ground Water Board has been in the forefront of activities for occurrence, development, and management of this resource through various scientific studies and techniques. Over the last four decades CGWB, NCCR, Raipur has gathered a huge amount of data regarding ground water resources of Chhattisgarh. Based on this experience aquifer mapping of Koriya district was prepared with the vast amount of data generated and available with North Central Chhattisgarh Region. The report embodies all the features of ground water and related aspects of the study area including physiography, meteorological conditions, hydrology, drainage, geomorphology, geology, hydrogeology, ground water resources, hydrochemistry, geophysics, ground water problems etc.

The report titled "A REPORT ON AQUIFER MAPS AND GROUNDWATER MANAGEMENT PLAN OF KORIYA DISTRICT, CHHATTISGARH" is prepared by Sh. Sudeepta Sundar Parida, Assistant Hydrogeologist under supervision of Mrs. Prachi Gupta, Scientist-B. I appreciate the concerted efforts put by the author to make it possible to bring the report in its present shape. I hope this report will no doubt be useful and worthy for the benefit of Koriya district and would be a useful document for academicians, administrators, planners and all the stakeholders in ground water.

Though utmost care has been taken to minimize the errors, some errors may have inadvertently crept in. It is expected that these mistakes will be taken in the proper spirit.

Dr. P. K. Naik
(REGIONAL DIRECTOR)

Executive summary

Aquifer mapping is a multidisciplinary scientific process wherein a combination of geological, hydrogeological, geophysical, hydrological and quality data is integrated to characterize the quantity, quality and movement of ground water in aquifers. However, due to paradigm shift in focus from development to management of ground water in last one decade, the need for more reliable and comprehensive aquifer maps on larger scale has been felt for equitable and sustainable management of the ground water resources at local scale. Volumetric assessment of ground water and strategies for future development and management are the primary objectives of aquifer mapping.

Under the aquifer mapping Programme, all the development blocks of Koriya District namely Bharatpur, Manendragarh, Khadgawan, Baikunthpur and Sonhat were taken up for study covering an area of 6578 sq. km. The Koriya district is located on the Northwestern part of Chhattisgarh state. It is bounded by North Latitude 22°56'45" to 23°55'30" and East Longitudes 81°34'45" to 82°45'30" covering Survey of India Degree sheet No. 64, E(9,10,11,13,14,15), I(1,2,3,4,5,6,7,8,9,10,11,12,15) and J(1,5,9). It is bounded by Sidhi district (of M.P.) in the North, Korba district in the South, Surguja district in the East, Shahdol (of M.P.) district in the West and Bilaspur district in the South-South West (Fig.1). Baikunthpur is the district headquarters. Sonhat, Manendragarh, Chirmiri, Janakpur, Bhagwanpur are some of the major places in the district. The Bijuri-Busidand- Bishrampur and Anuppur- Chirmiri railway line of the southeastern passes through the district. All the important places within the district are connected by a network of State highways and all weather roads.

The total population of the study area as per 2011 Census is 658917 out of which rural population is 453618 & the urban population is 205299 only.

The study area experiences sub-tropical climate. The average annual rainfall for the study area is around 1162.5 mm (Average of the last ten years i.e. 2010-11 to 2019-20)

Geomorphologically, the area is characterized by Structural Plain, Structural Plateau, Region of Plateau, Denudational Hills and Valleys with an elevation ranging from 380 to 1025 amsl.

The net sown area is 96978 Ha, while double-cropped area is 9945 Ha. The gross cropped area of the district is 106923 Ha. The net Irrigated cropped area is 6739 Ha, while the area under groundwater irrigation is 2676 Ha which is about 39.70% of net irrigated area.

Based on the exploratory drilling data generated for the blocks, the existing aquifer systems in the area may be divided into two namely phreatic and deeper fractured aquifer. The major

aquifers present in the study area is Sandstone, Shale with coal beds of Gondwana Supergroup rocks. Discharge varies from negligible to 4.56 lps in fractured aquifer and 10 to 100 m³/day in weathered aquifer. Higher yields are obtained where thick weathered zones are associated with bedrock fracturing.

As per 2020 ground water resource calculation stage of ground water development in the study area is only 32.924 %. So, there is scope of utilizing more ground water for future irrigation purpose and other purposes. Additional number of Ground water abstraction structure may be developed for the effective utilization of ground water resources.

The existing demand for irrigation in the area is 7886.936 Ham while the same for domestic use is 1688.685 Ham and for industrial field is 754.648 Ham. To meet the future demand for ground water, a total quantity of 35781.8 Ham of ground water is available for future use.

The major ground water issues identified during the survey in the study area are as follows: (i) Drying of Dugwells and handpumps during summer, (ii) Inherent hydrogeological character of aquifer, (iii) High Fluoride concentration, (iv) High Iron Concentration, (v) Nitrate contamination, (vi) Uranium contamination and (vii) High EC .

In study area because of complex hydrogeological conditions ground availability is scattered. In area where ground water availability is limited, surface water may be conserved and utilized. High value of Iron, EC, Fluoride and Nitrate has been reported from several locations. In Sandstone Shale with Coal beds aquifer system at many places ground water is contaminated with Fluoride because of geogenic reasons. The problem of fluoride contamination in drinking water may be tackled by setting up of small defluorination units in affected villages or alternate source may be identified. Similarly, Iron filter may be used for the villages having high Iron concentration. Regular ground water quality monitoring is also required.

So far as Management strategies are concerned for ground water availability, for effective utilization of Ground water existing draft for irrigation may be coupled with micro irrigation system. Change in irrigation pattern, optimum use of available resource, use of ground water potential created after artificial recharge can lead to groundwater savings and increase in gross cropped area of the district.

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**AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN,
KORIYA DISTRICT, CHHATTISGARH
(05 BLOCKS- BHARATPUR, MANENDRAGARH, KHADGAWAN,
BAIKUNTHPUR & SONHAT)**

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ABBREVIATIONS

a msl	above mean sea level
BDR	Basic Data Report
BW	Borewell
CGWB	Central Ground Water Board
Dia	Diameter
DTW	Depth to Waterlevel
DW	Dugwell
EC	Electrical Conductivity
EW	Exploratory Wells
GS	Gabion structures
GW/ gw	Ground Water
ham	Hectare meter
HP	Handpump (Shallow)
lpcd	litres per capita per day
lpm	litres per minute
lps	liters per second
m	meter
m bgl	meter below ground level
m²/day	Square meter/ day
m³/day	cubic meter/day
MCM/mcm	Million Cubic Meter
NCCR	North Central Chhattisgarh Region
NHNS/ NHS	National Hydrograph Network Stations
OW	Observation Well
PZ	Piezometre
STP	Sewage Treatment Plan
T	Transmissivity
TW	Tubewell

1. INTRODUCTION

1.1 Objective

The groundwater is the most valuable resource for the country. However, due to rapid and uneven development, this resource has come under stress in several parts of the country. Central Ground Water Board (CGWB) is, therefore, involved in hydrogeological investigations for the re-appraisal of groundwater regime. CGWB has also carried out ground water exploration in different phases with prime objective of demarcating and identifying the potential aquifers in different terrains for evaluating the aquifer parameters and also for developing them in future. The reports and maps generated from the studies are mostly based on administrative units such as districts and blocks and depict the subsurface disposition of aquifer on regional scale. However, due to paradigm shift in focus from development to management of ground water in last one decade, the need for more reliable and comprehensive aquifer maps on larger scale has been felt for equitable and sustainable management of the ground water resources at local scale.

1.2 Scope of study

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

- a) Identifying the aquifer geometry
- b) Aquifer characteristics and their yield potential
- c) Quality of water occurring at various depths
- d) Assessment of ground water resources
- e) Preparation of aquifer maps and
- f) Formulate ground water management plan

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

1.3 Approach and Methodology

The activities under the aquifer project can be summarized as follows:

i) Data Compilation & Data Gap Analysis: One of the important aspects of the aquifer mapping Programme was the synthesis of the large volume of data already collected during specific studies carried out by the Central Ground Water Board and various other government organizations with a new set of data generated that broadly describe an aquifer system. The data were compiled, analyzed, synthesized and interpreted from available sources. These sources were predominantly non-computerized data that were converted into computer-based GIS data sets. On the basis of these available data, Data Gaps were identified.

ii) Data Generation: It was evident from the data gap that additional data should be generated to fill the data gaps in order to achieve the objective of the aquifer mapping Programme. This was done by multiple activities like exploratory drilling, hydro chemical analysis, use of geophysical techniques as well as detail hydrogeological surveys.

ii) Aquifer map Preparation: On the basis of integration of data generated through various hydrogeological and geophysical studies, aquifers have been delineated and characterized in terms of quality and potential. Various maps have been prepared bringing out the Characterization of Aquifers. These maps may be termed as Aquifer Maps depicting spatial (lateral and vertical) variation of the aquifers existing within the study area, quality, water level and vulnerability (quality and quantity).

iv) Aquifer Management Plan: Based on the integration of these generated, compiled, analysed and interpreted data, the management plan has been prepared for sustainable development of the aquifer existing in the area.

1.4 Area Details

Under the aquifer mapping Programme, an area comprising of 5 no of blocks of Koriya district was taken up covering an area of 6578 sq. km. The Koriya district is located on the Northwestern part of Chhattisgarh state. It is bounded by North Latitude 22°56'45" to 23°55'30" and East Longitudes 81°34'45" to 82°45'30" covering Survey of India Degree sheet No. 64, E(9,10,11,13,14,15), I(1,2,3,4,5,6,7,8,9,10,11,12,15) and J(1,5,9). It is bounded by Sidhi district (of M.P.) in the North, Korba district in the South, Surguja district in the East, Shahdol (of M.P.) district in the West and Bilaspur district in the South-South West (Fig.1). Baikunthpur is the district headquarters. Sonhat, Manendragarh, Chirmiri, Janakpur, Bhagwanpur are some of the major places in the district. The Bijuri-Busidand- Bishrampur and Anuppur- Chirmiri railway line of the southeastern passes through the district. All the

important places within the district are connected by a network of State highways and all weather roads.

In all, a total of 663 no. of villages are existing in the district. For administrative convenience, the district is divided into 5 blocks, 363 grampanchayats and 5 janpad panchayats. The block headquarters are located at Baikunthpur, Manendragarh, Khadgaon, Sonhat and Janakpur.

As per 2011 census the total population of the district is 658917. The urban population is 31.16 % and the rural population is 68.84 % in the district. The population density is 100. The literacy rate is around 70.6 %.

Koriya District has vast reserves of high-grade Coal. The main coal belts are in the Hasdeo basin. Major deposits are in Chirimiri, Jhagrakhand, Charcha, Katkona, Pandavpara and Sonhat. Other deposits are in Nagar, Amritdhara, Gutra, Kelhari, Pathargaon and Damuj-Labji. The coalfields are 1. Chirimiri Coalfields:- Seven main Coal mines are comes under this Area. They are Chirimiri, Kurasia, N.C.P.H., Korea, Domanhill, Gelhopani (North Chirimiri) and West Chirimiri. 2. Baikunthpur Coalfields:- Main coal mines are Charcha, Pandavpara, Katkona under the Baikunthpur coalfields and 3. Jhagrakhand or Hasdev Coalfields.

There are small deposits of limestone, fire clay and red oxide in Koriya District. District Koriya has vast range of forests. Upto the last decade of the 19th century, Korea District was a vast stretch of forests dotted here and there with villages. These forests were very dense and thick. Forests and Coals play a very important role in the economy of district.

1.4.1 Administrative Division

For administrative convenience, the district is divided into 5 blocks, 363 grampanchayats and 5 janpad panchayats. The block headquarters are located at Baikunthpur, Manendragarh, Khadgawan, Sonhat and Janakpur.

The name of the 5 blocks are given below.

1. Baikunthpur Block
2. Manendragarh Block
3. Khadgawan Block
4. Sonhat Block
5. Bharatpur Block

The administrative map for the study area is given in Figure 1.

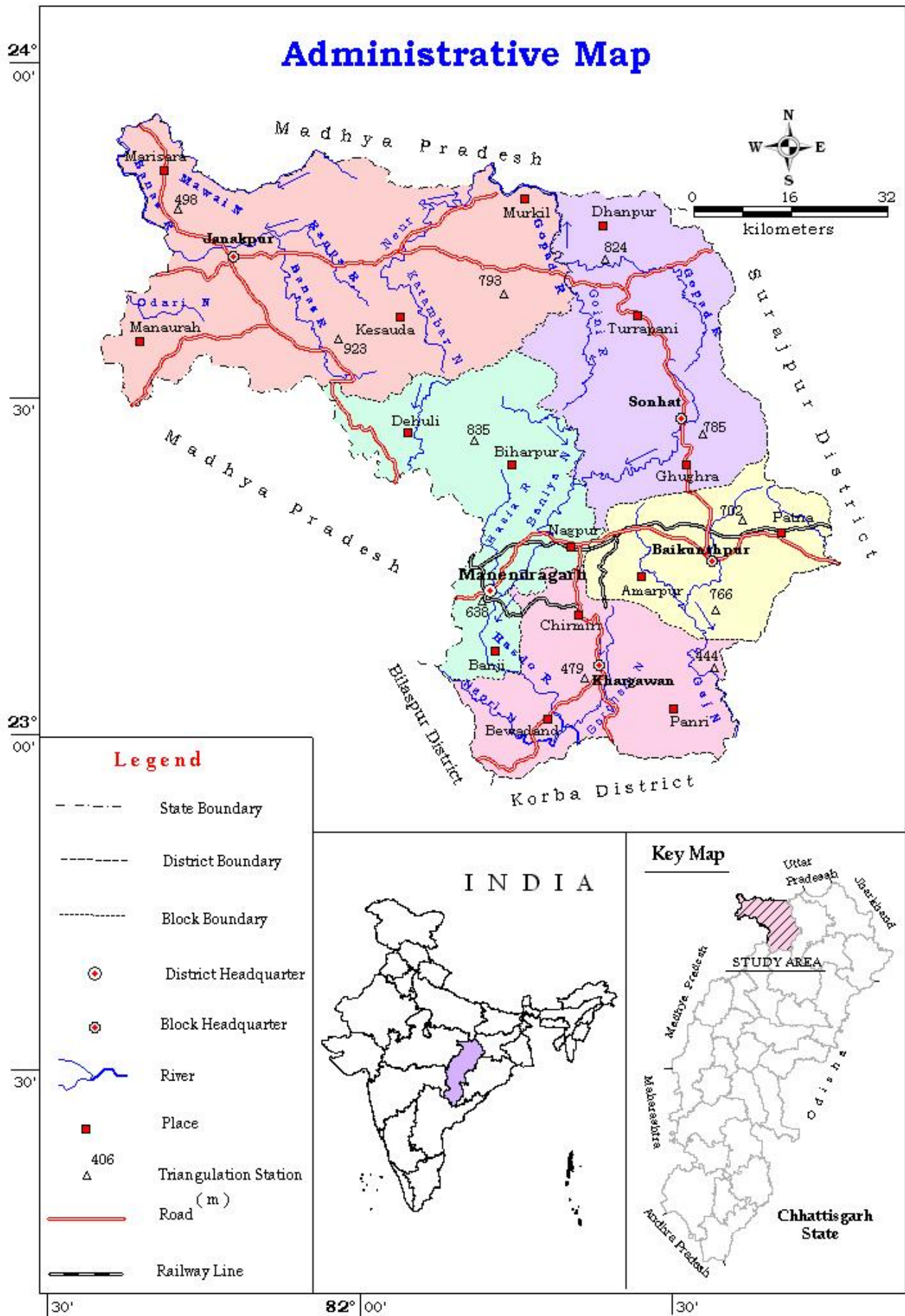


Figure 1 Administrative Map of Koriya District

1.5 Data Availability, Data Adequacy and Data gap Analysis

Table 1 Data Integration

District	Blocks	Existing				Data Generation			
		EW	Chem	VES	WL	EW	Chem	VES	WL
Koriya	Baikunthpur	0	20	6	33	0	14	0	37
	Manendragarh	5	0	2	18	3	26	0	31
	Khadgawan	2	12	3	23	1	8	0	25
	Sonhat	2	0	2	6	3	8	0	14
	Bharatpur	3	0	0	6	0	7	0	14
TOTAL		12	32	13	86	7	63	0	121

1.6 Rainfall

The study area receives rainfall mainly from south-west monsoon. It sets in third/fourth week of June and continues till mid-August/September with heaviest showers in the months of July and August and nearly 95% of the annual rainfall is received during this period. The average annual rainfall for the study area is around 1162.5 mm (Average of the last ten years i.e. 2010-11 to 2019-20) which is presented below in Figure 2. Source: Statistical handbook Koriya district.

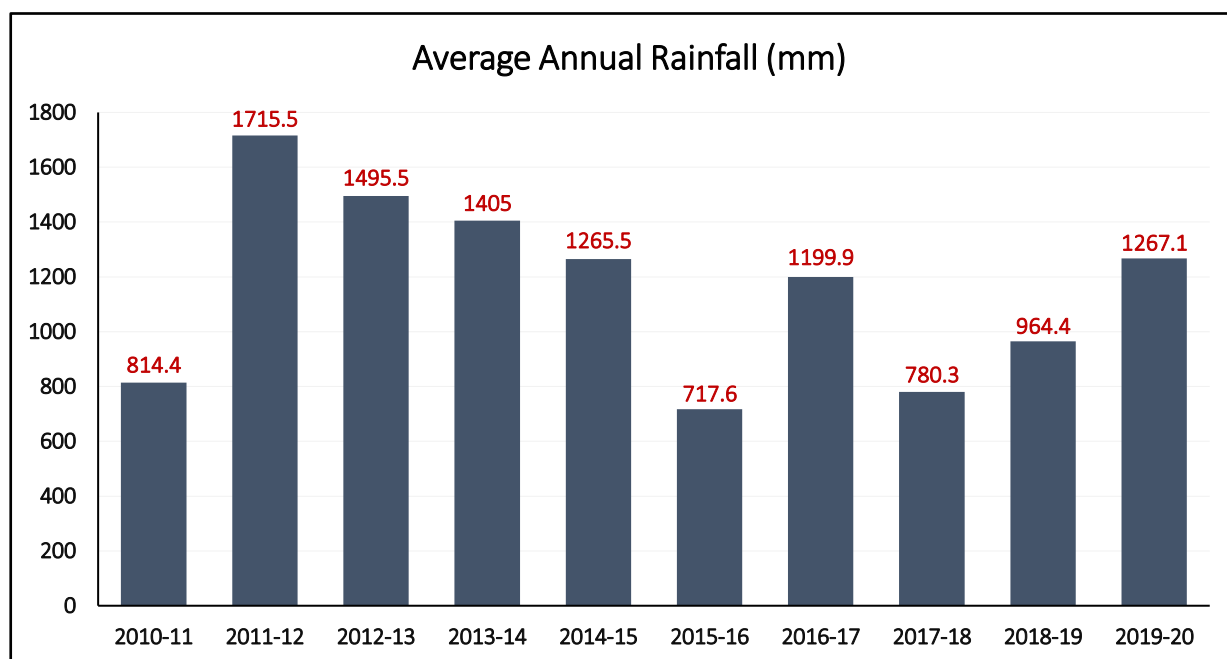


Figure 2 Avg. Rainfall in Koriya District

1.7 Physiography/Geomorphology

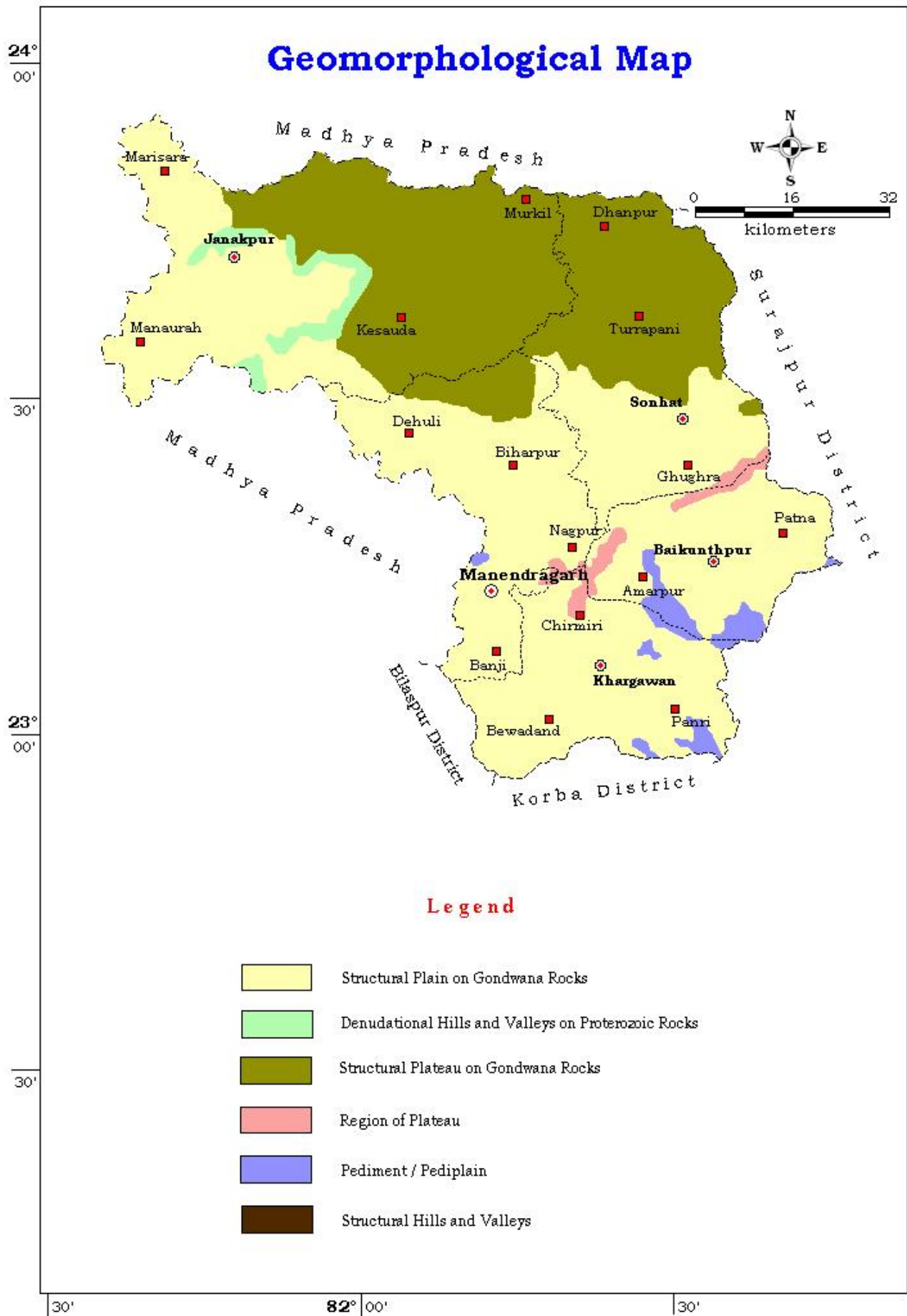


Figure 3 Geomorphology Map of the study area

Geomorphologically, the area is characterized by Structural Plain, Structural Plateau, Region of Plateau, Denudational Hills and Valleys. The area covered by the Gondwana formations and is characterized by undulating topography with high hills, dissected plateaus, steep slopes and scarps. The Basaltic terrain is characterized by highly undulating topography with steep hills and plateau tops. The plateaus and ridges in the area are of 600 m amsl. Structural plain is developed over rocks of Purana sedimentary basin of Chhattisgarh. This unit has extensive criss-crossed fractures and joints. They are having gently sloping erosional surfaces and thin to moderate cover of soil.

Structural plateaus are marked by extensive flat top and steep slope relief controlled by structure. Region of Plateaus are marked by flat top and steep slope relief controlled by structure. Denudational Hills & Valleys formed due to differential erosion and weathering, so that a more resistant formation or intrusion stand as mountains/ hills. The maximum elevation observed for hilly areas is 1025 m amsl and is at the central part of the district namely the Devgarh peak. The lowest elevation is 380 m amsl and is along the Banas river, which is on the northwestern part of the district.

1.8 Land use

There is 71826 ha revenue forest, protected forest and other forest in the district. Area not available for cultivation is 37667 ha. Details are presented in Table no.2. Figure 4 shows the Land use pattern in the study area.

Table 2 Land use pattern (in ha)

Blocks	Total Geographical Area	Revenue forest area	Area not available for cultivation	Non-agricultural & Fallow land	Agricultural Fallow land	Net sown area	Double cropped area	Gross cropped area
	(In ha)	(In ha)	(In ha)	(In ha)	(In ha)	(In ha)	(In ha)	(In Ha)
Bharatpur	230094	27615	13112	6392	6565	19598	2179	21777
Baikunthpur	56221	2526	8023	4092	8270	27155	3410	30565
Sonhat	35471	3192	2935	2892	3410	10838	1161	11999
Manendragarh	46383	6971	7562	5217	5384	14409	1180	15589
Khadgawan	229601	6826	6035	14810	7613	24978	2015	26993
Koriya	597770	47130	37667	33403	31242	96978	9945	106923
(Total)								

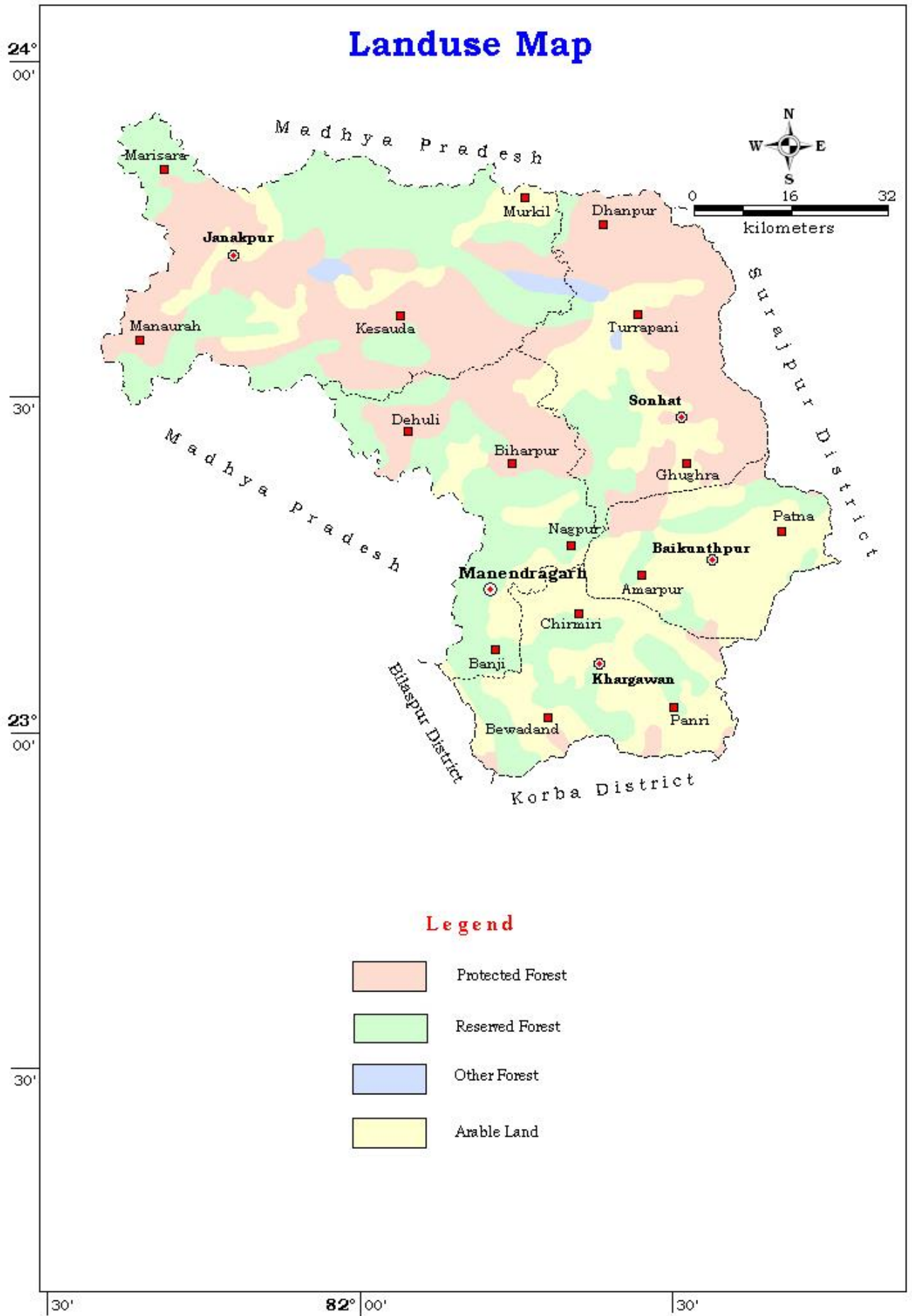


Figure 4 Landuse map of the study area

1.9 Soil

The soils in the district are having wide variations. Three types of soils occur in the district viz. Alfisols, Inceptisols and Ultisols and are mostly insitu in nature.

- 1. Alfisol:** Alfisol soils are fertile leached soils found in humid areas where annually dropping leaves form a thick humus layer. There is two types of Indian equivalent of this soil found in Koriya district namely Red gravelly and Red sandy soil. They both covered the major part in northern and southern part of the district. It occurs over the Suprabarakars (Mahadeva/ Suprapanchet/ Parsora formations) in the area.
- 2. Inceptisol:** There is one type of Indian equivalent of this soil found in Koriya district namely Shallow black soil. It is exposed in northern, western and south-central part of the district in patches. The Shallow black Inceptisols are present over the Panchet and the Barakar formations.
- 3. Ultisol:** The Indian equivalent of this soil found in Koriya district is Red and Yellow soil. It is exposed in central part in small patch. The Red and Yellow Ultisols rich in iron oxide occur on the Upper Pali and the Mahadeva/ Suprapanchet/ Parsora formations. The Figure 5 represents the different kind of soil that present in the study area.

Table 3 Details of different kind of soil

Sl. No.	US Soil taxonomy	Indian equivalent
1	Alfisol	Red gravelly soil
		Red sandy soil
2	Inceptisol	Shallow black soil
3	Ultisol	Lateritic soil
		Red and yellow soil

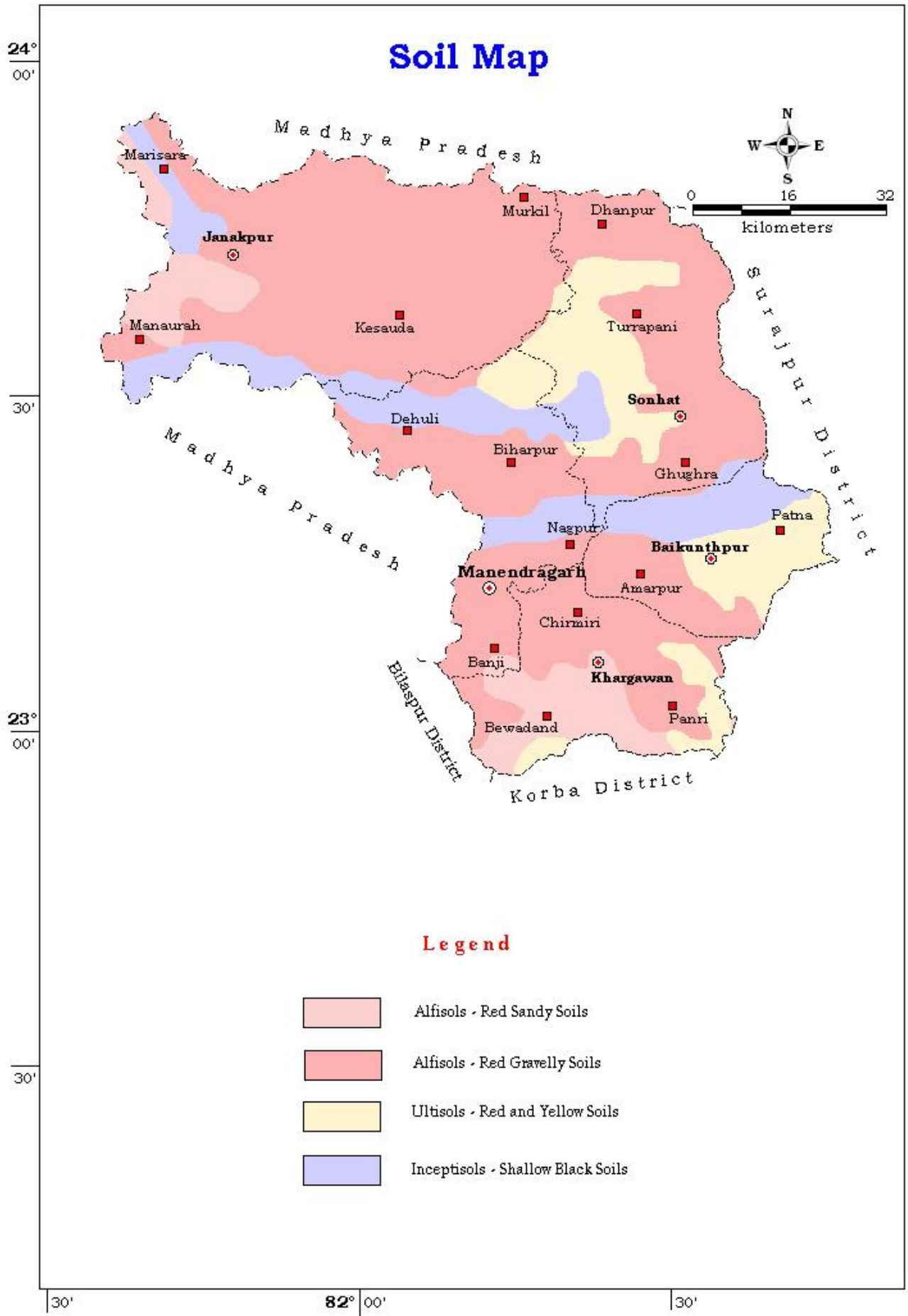


Figure 5 Soil map of the study area

1.10 Hydrology and Drainage

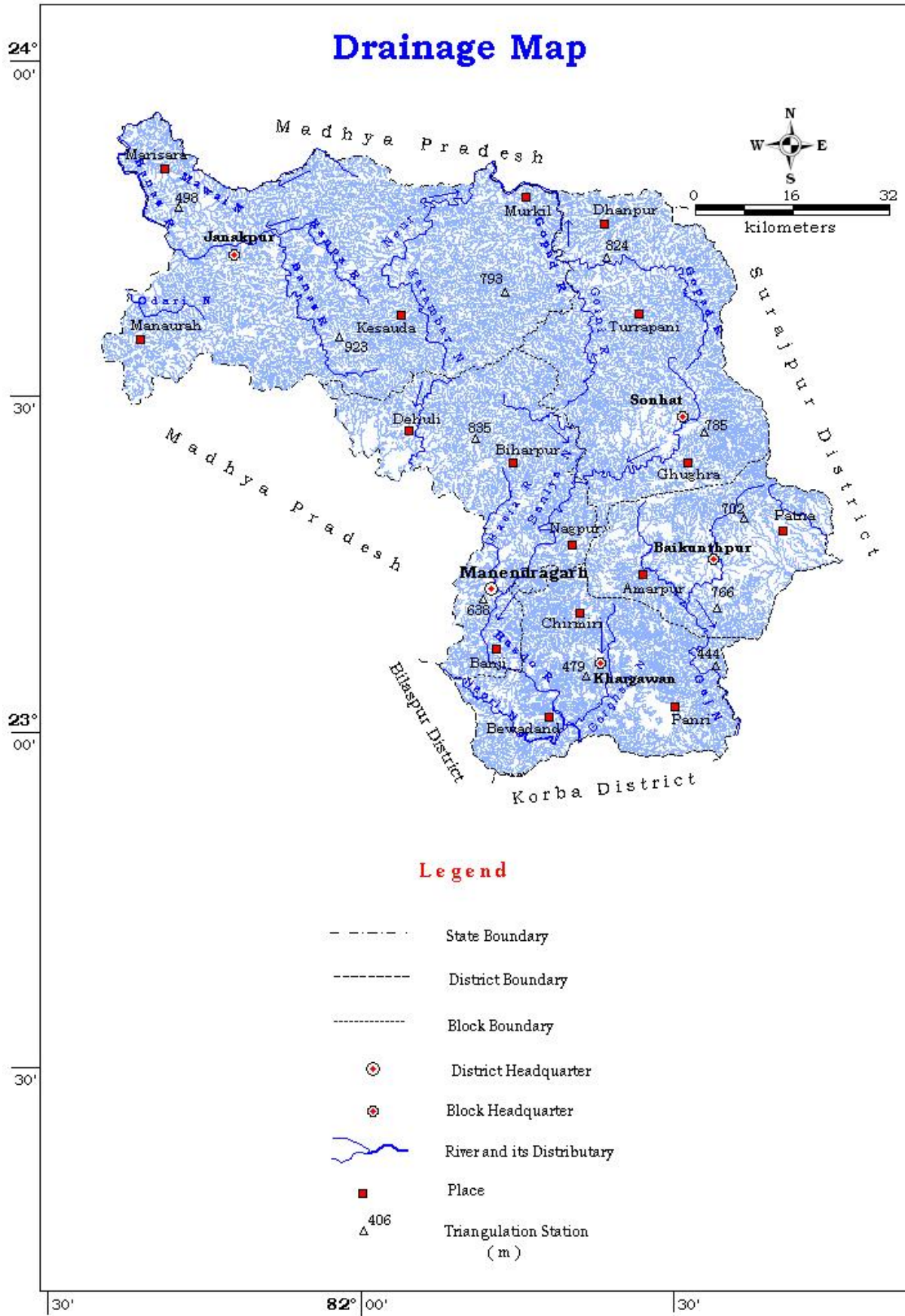


Figure 6 Drainage map of the study area

The district can be broadly divided into 2 major basins. They are the Ganga basin and the Mahanadi basin. The Ganga basin covers 60% of the area on the northern part covering Bharatpur (Janakpur), Sonhat and parts of Manendragarh and Baikunthpur blocks. The remaining area is drained by Mahanadi basin covering Manendragarh, Baikunthpur and Khadgawan blocks. The Banas, Singhore, Gaini, Gopad, Bijadure, Godhar Pairi, Garbara, Neur, Ranpa, Andhar and Mawani are the major tributaries to Ganga river. The Hasdeo, Neor, Kewai, Soi, Gej, Bania, Haldhali, Jhunka, Kudra, Anjan, Gorghula and Kaoriya are the major tributaries to Mahanadi river.

The drainage pattern in the district is dendritic to sub-dendritic and the drainage density is high in central and southern parts. The high drainage density indicates high runoff and less infiltration.

1.11 Geology and Structure

The geological formations existing in the district are from Archaean to Cretaceous in age. The Chhota Nagpur Gneissic Complex of Archaean to Proterozoic age covers the southern part of the district. The Chhota Nagpur Gneissic Complex mainly consists of Quartzite, Mica Schist, Amphibolite, Schist, Granite gneiss, Biotite gneiss and Calc Silicate. Gondwana Supergroup of rocks including both upper and lower Gondwana sequence covers the northern part of the district. The Gondwana Supergroup consists of Talchir, Barakar, Barren Measure, Upper and Middle Pali, Raniganj, Undifferentiated Coal measures, Panchet, Mahadeva/Supra Panchet/Parsora (Suprabarakar) Formations.

Talchir formations occurring on the southern part of the district consists of tillite, shale and sandstone of varying grain sizes. The Barakar formation occurring on the south- central, south- western part of the district consists of sandstone, shale, clay and coal seams. The Barren Measure formation is exposed in a semicircular form at about 3 km south of Sonhat. It consists of sandstone, shale, and clay with thin bands of coal. The Middle Pali formation comprises of sandstone, siltstone with intercalations of grey shale, carbonaceous shale and clay. The Raniganj formation is exposed as east- west trending belt in the eastern part of the district and it consists of feldspathic sandstone, siltstone, and carbonaceous shale with coal seams. Some of the important fossils found in the Raniganj formation are Glossopteris, Vertebraria and Schizoneura. Undifferentiated Gondwana Super Group of rocks are occupying the central part of the district and comprises of felspathic sandstone, siltstone, and carbonaceous shale. The Panchet formation is mainly exposed on the central part of the

district and is along the northern side of the EW trending fault zone. It consists of arkosic sandstone, shale with clay clast. The SupraPanchet/Parsora formations (Suprabarakar) cover major part of the area on northern side of the district. It consists of ferruginous sandstone with siltstone/mudstone, shale and clay. Fossil remains of Cladophelis and Equisetous stem are reported from this formation. The Deccan traps occur on the northwestern part of the district. The Dolerite and Gabbro occurs as dykes trending E-W and NNE directions in Gondwana formations. Geologically the district can be categorised into two groups. The Generalized geological successions in Koriya district are given in Table 4.

Table 4 Generalized geological successions in Koriya district

Lithology	Stratigraphy		Age	Nature and characteristics of the formation
Dykes, sills, Basalt flows		Deccan Trap	Cretaceous to Palaeogene	Dark green, dark grey, fine to medium grained, hard and compact
Sandstone, shale, clay and siltstone	Mahadeva/Supra Panchet/ Parsora formation	G O N D W A N A S U P	Upper Triassic	Pinkish, yellowish white, fine to coarse grained sandstone with green clay clast. Grey coloured, fine grained shale, red fossiliferous clay
Shale, arkosic sandstone, clay	Panchet formation		Triassic	Greenish to whitish, medium to coarse grained felspathic sandstone. Green, buff coloured shale with clay
Sandstone, shale, clay	Upper Pali formation		Lower Triassic	Greenish, white felspathic sandstone with grey shale
Sandstone, shale, clay with thin coal seams	Undifferentiated coal measure formation		Carboniferous to Triassic	Fine grained, flaggy sandstone, shale, carbonaceous shale and coal seams
Sandstone, siltstone with intercalations of shale, with coal bands	Middle Pali formation		Upper Permian	Greenish grey, micaceous, felspathic sandstone. Buff to yellow in colour carbonaceous shale with coal bands

Sandstone, shale, carbonaceous shale with coal seams	Barakar formation	E R G R O U P	Lower Permian	Grayish white, fine to coarse grained, cross bedded, massive sandstone. Grey shale, carbonaceous shale. Light yellow to creamy white clay with coal seams
Shale, sandstone and tillite	Talchir formation		Lower Permian	Buff and khaki green shale with splintery fragments. Greenish white, fine to medium grained sandstone. Tillite comprises sub-angular clasts of quartzite and gneiss in greenish grey fine to medium grained matrix
Granite gneiss and Biotite gneiss		Chhota Nagpur Complex	Archean to Proterozoic	Fine to medium grained, grey, pink in colour, foliated and porphyritic at places
Quartzite, mica schist, calc silicate rocks, marble and amphibolite, quartz-staurolite-kyanite schist	Meta sediments and meta basic rocks, mica schists			Quartzite, pink, grey in colour, fine grained. Schist are fine grained showing foliation and schistosity

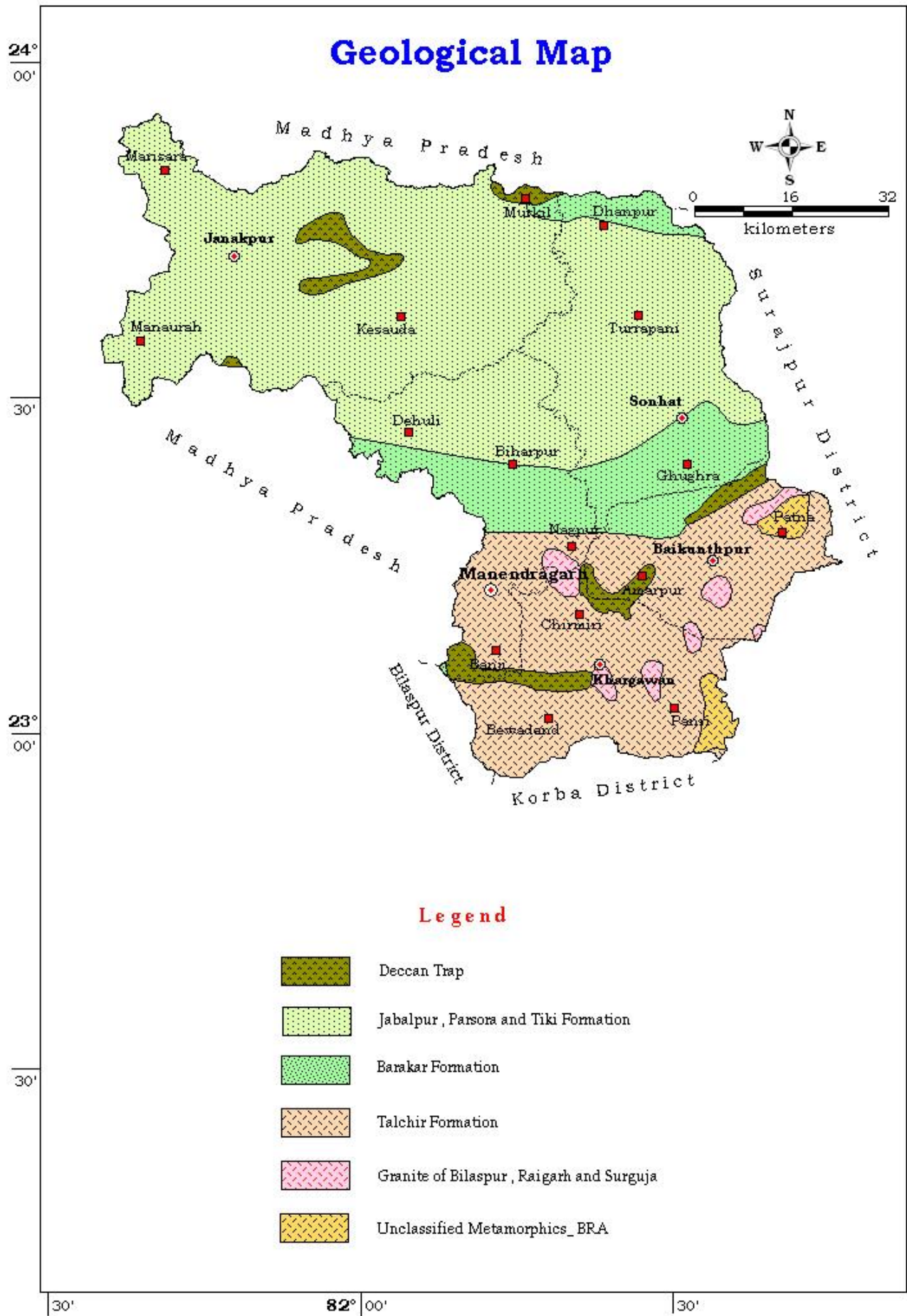


Figure 7 Geological map of the study area

1.12 Agriculture, Irrigation, Cropping Pattern

Agriculture is practiced in the area during Kharif and Rabi season every year. During the Kharif, cultivation is done through rainfall while during the Rabi season, it is done through ground water as well as partly through surface water like canals and other sources. The groundwater abstraction structures are generally Dugwells, Borewells/Tubewells. The principal crops are paddy, wheat, maize, vegetables and pulses. In some areas, double cropping is also practiced. The agricultural pattern, cropping pattern and area irrigated data of Koriya district is given in Table No. 5 (A, B, C).

Table 5(A) Cropping pattern (in ha)

		Cereal										
Kharif	Rabi	Paddy	Wheat	Jowar & Maize	Kodo Kutki	Others	Pulses	Tilhan	Fruits Vegetables	Reshe	Mirch Masala	Sugarcane
96276	10647	72599	3783	6652	3139	773	11440	5783	2314	137	302	0

Table 5(B) Area irrigated by various sources (in ha)

No. of canal s (private and Govt.)	Irrigated area	No. of bore wells/ Tube wells	Irrigated area	No. Of dug wells	Irrigated area	No. of Ponds	Irrigated area	Irrigated area by other sources	Net Irrigated area	% of irrigated area wrt. Net sown area
96	3042	2614	2005	8224	671	790	212	1514	6739	13.44

Table 5(C) Contribution of Groundwater in Irrigation Pattern (in ha)

Area Irrigated through Borewells/Tube wells	Area Irrigated through Dug wells	Area Irrigated through Groundwater	Net Area Irrigated through all sources	% Groundwater contribution in Irrigation wrt Net Irrigated Area
2005	671	2676	6739	39.70

2. DATA COLLECTION, DATA GENERATION, DATA INTEGRATION AND DATA INTERPRETATION

2.1 Hydrogeological Data

The area is mainly underlain by the Gondwana Supergroup rocks including both upper and lower Gondwana sequence of Lower Permian to Upper Triassic age which covers most of the part of Koriya district. The other formations are the Chhota Nagpur Gneissic Complex of Archean to Proterozoic age and the Deccan traps of Cretaceous to Paleogene age occurs in small isolated patches.

The semi-consolidated rocks of study area mainly represented Gondwana Supergroup of rocks (Predominantly by upper Gondwana and lower Gondwana Group). The lower Gondwana group consists of Barakar and Talchir sandstone, shales, siltstone with coal seams. The upper Gondwana group includes Mahadeva/Suprapanchet/Parsora (Suprabarakar) formations covering the northern part of the district (51% of the total area). These formations are fine to coarse grained sand stones with green clay clast and fine grained grey colored shales with intercalations of red clay. The thickness of the weathered formation varies from 6 to 15 m and at times it reaches 30 m. The ground water occurs under water table conditions, semi-confined and confined conditions. At places auto-flow conditions are encountered (near Chutki village). The auto flow condition here may be due to the elevation difference of this place and the recharge area which may be closer to the site.

In general two aquifers exist in the area. The depth range of the first shallow unconfined/phreatic aquifer between 3 to 30 mbgl and the second fractured aquifer below 15 mbgl. It has been found that within the fractured aquifer, there are 1-8 nos. of water bearing zones are found with different thickness as well as of varying horizontal extent. In the study area, key wells were established during the pre-monsoon period and have been subsequently monitored in the post-monsoon period. The key wells are distributed throughout the study area covering all the geological formations, the details of which are presented in the Figure 8 and Annexure 1.

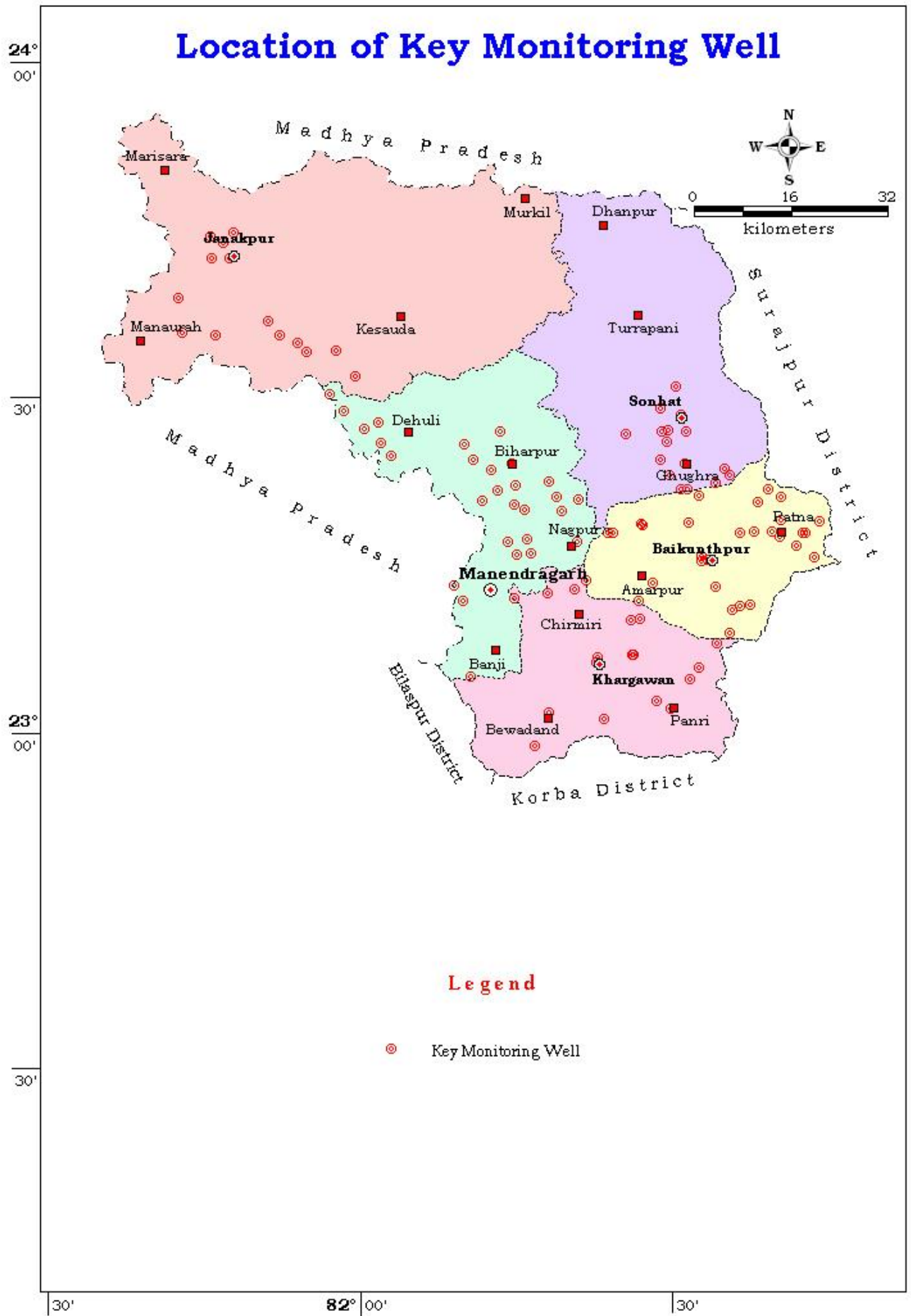


Figure 8 Key Montoring Wells of the study area

2.1.1 Water level behavior

Pre-monsoon and Post-monsoon depth to water level maps as well as seasonal fluctuation maps have been prepared on the basis of the depth to waterlevel periodically monitored data of the key wells established in the study area.

i.Pre- monsoon waterlevel

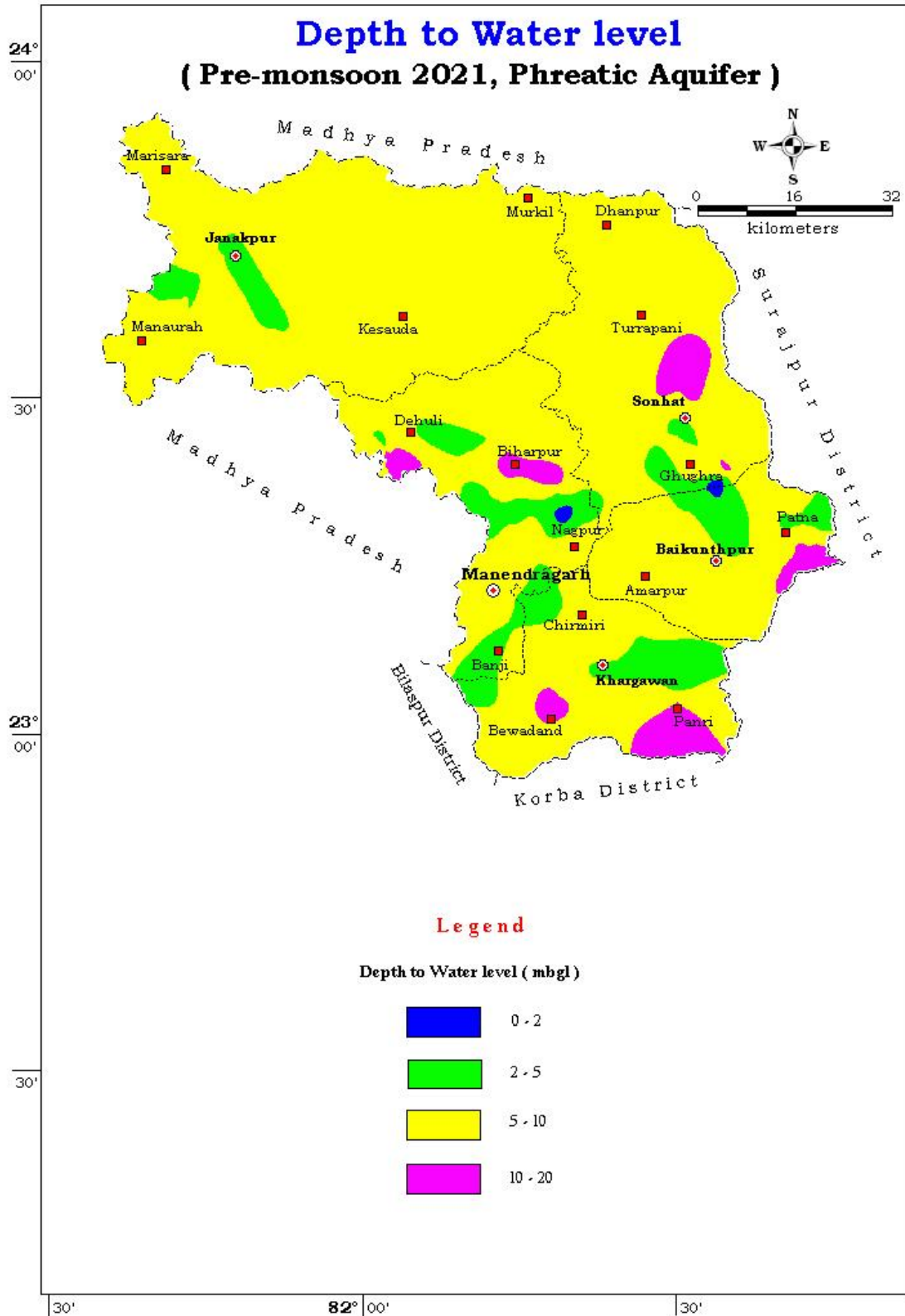


Figure 9 Pre-monsoon Waterlevel Map of Phreatic Aquifer

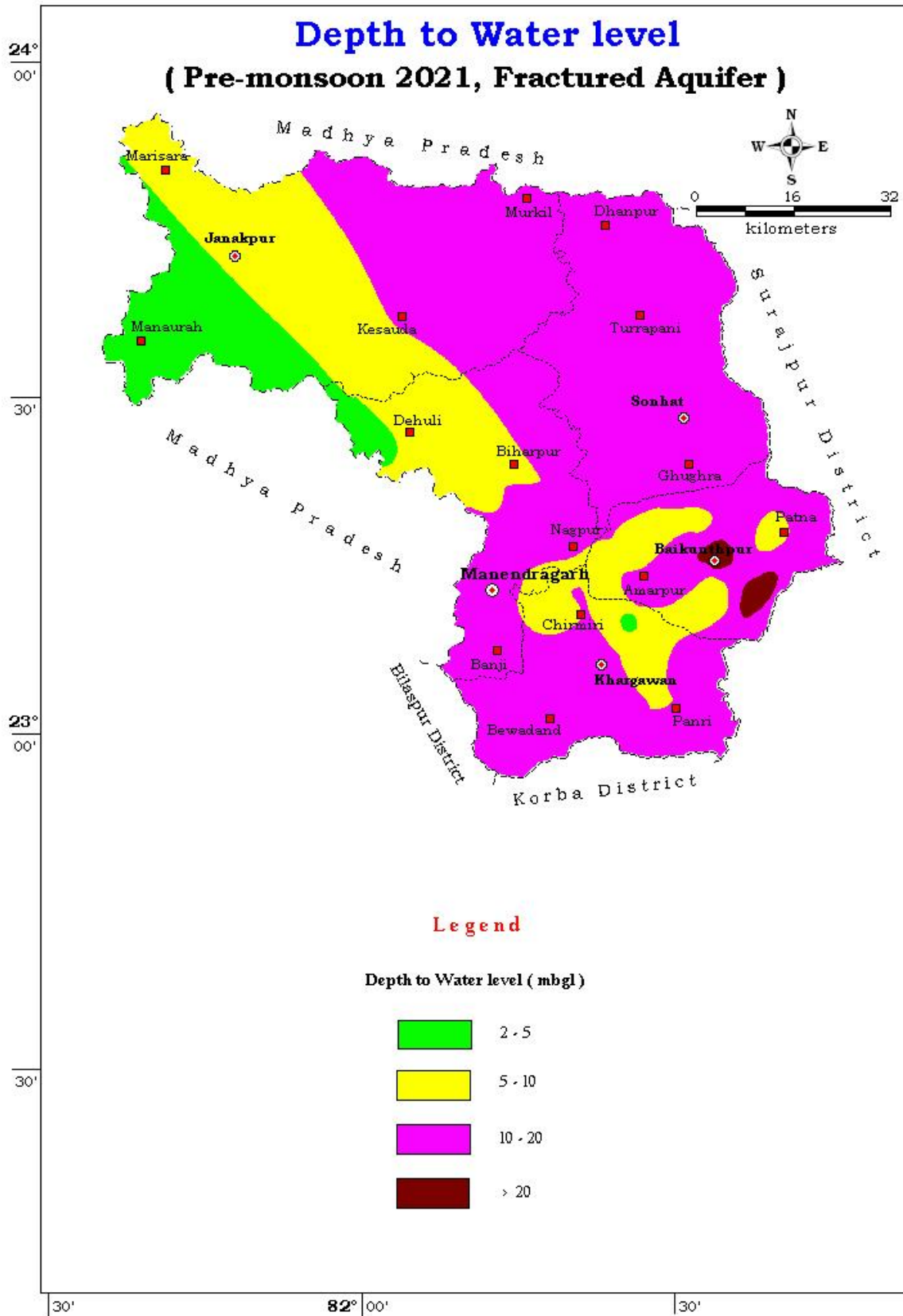


Figure 10 Pre monsoon Water Level Map of Fractured Aquifer

In the pre-monsoon period, it has been observed that in the study area water level in phreatic aquifer vary between 0.95 to 12.16 m bgl with average water level of 6.63 m bgl. In deeper fractured aquifer, water level varies between 3.9 to 27.8 m bgl with average water level of 13.51 m bgl shown in Table 6(A).

Table 6(A) Aquifer wise Depth to Waterlevel (Pre-monsoon)

District	Aquifer Type	Min (m. bgl)	Max (m. bgl)	Avg (m. bgl)
Koriya	Phreatic aquifer	0.95	12.16	6.63
	Fractured Aquifer	3.9	27.8	13.51

ii.Post- monsoon waterlevel

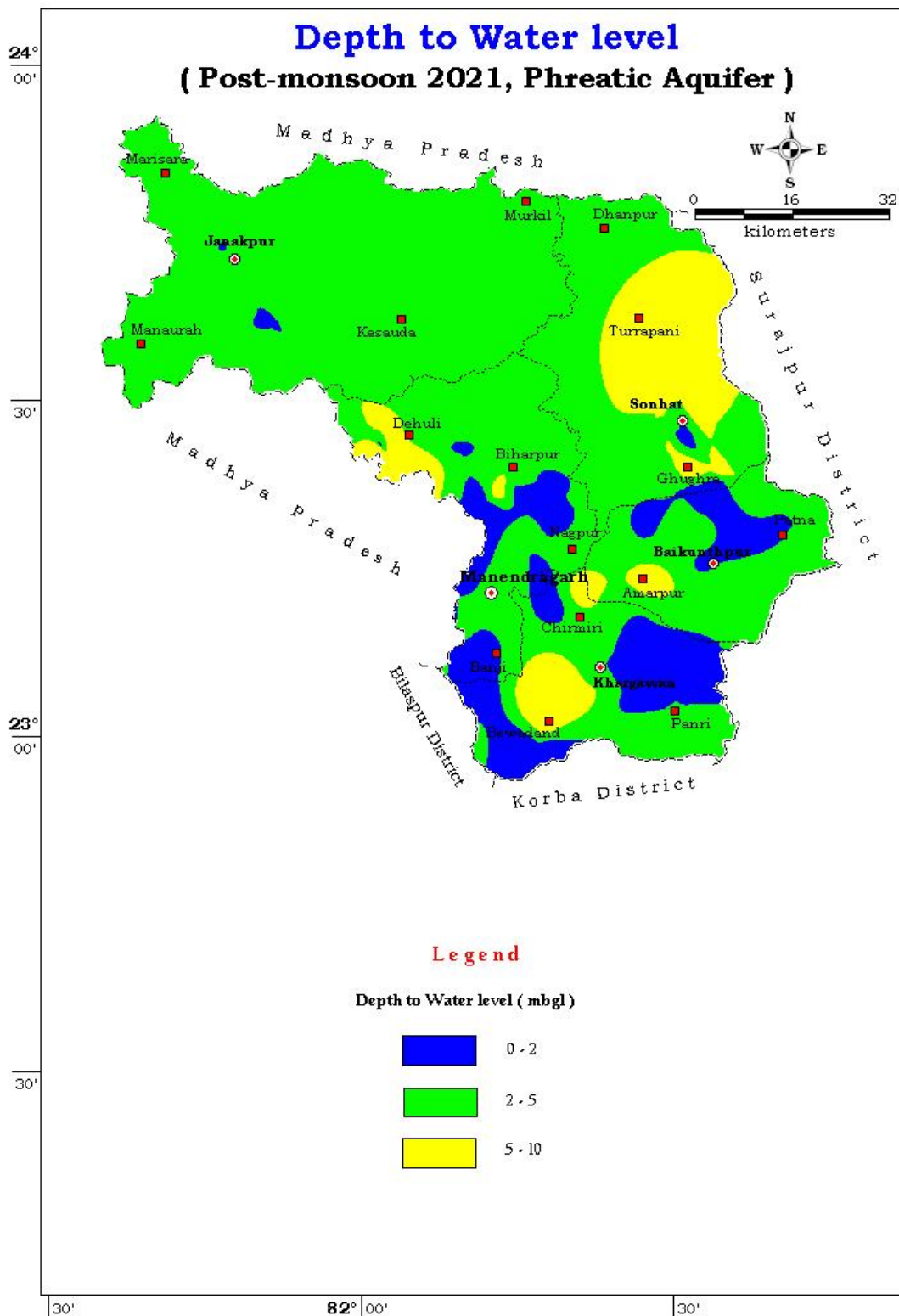


Figure 11 Post-monsoon Water Level Map of Phreatic Aquifer

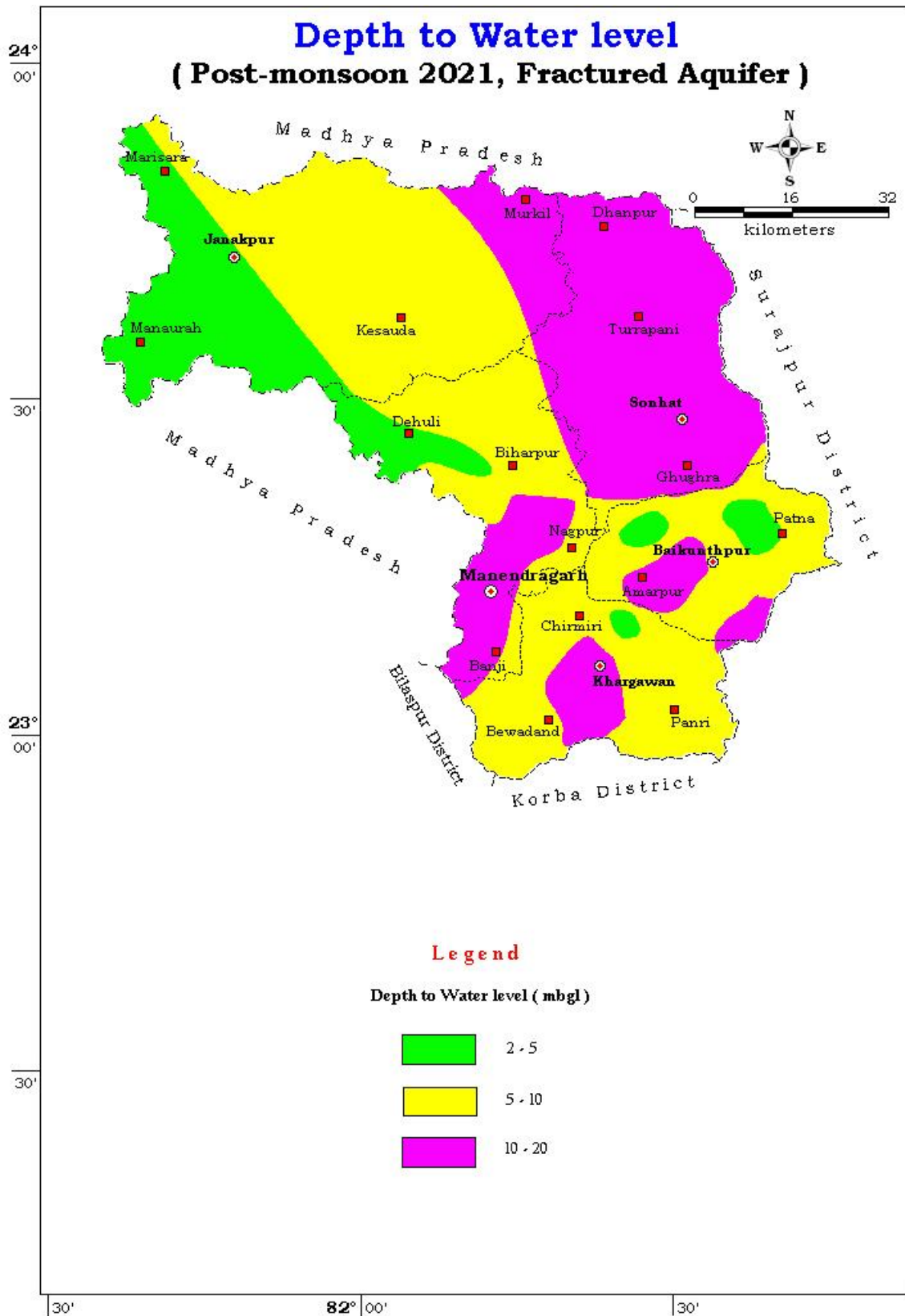


Figure 12 Post-monsoon Water Level Map of Fractured Aquifer

In the post-monsoon period, it has been observed that in the study area, water level in phreatic aquifer varies between 0.25 to 10.25 m bgl with average water level of 3.16 m. In

deeper fractured aquifer, water level varies between 2.4 to 19.7 m bgl with average water level of 9.25 m bgl shown in Table 6(B).

Table 6(B) Aquifer wise Depth to Water Level (Post-monsoon)

District	Aquifer Type	Min (m. bgl)	Max (m. bgl)	Avg (m. bgl)
Koriya	Phreatic aquifer	0.25	10.28	3.16
	Fractured Aquifer	2.4	19.7	9.25

iii. Seasonal water level fluctuation:

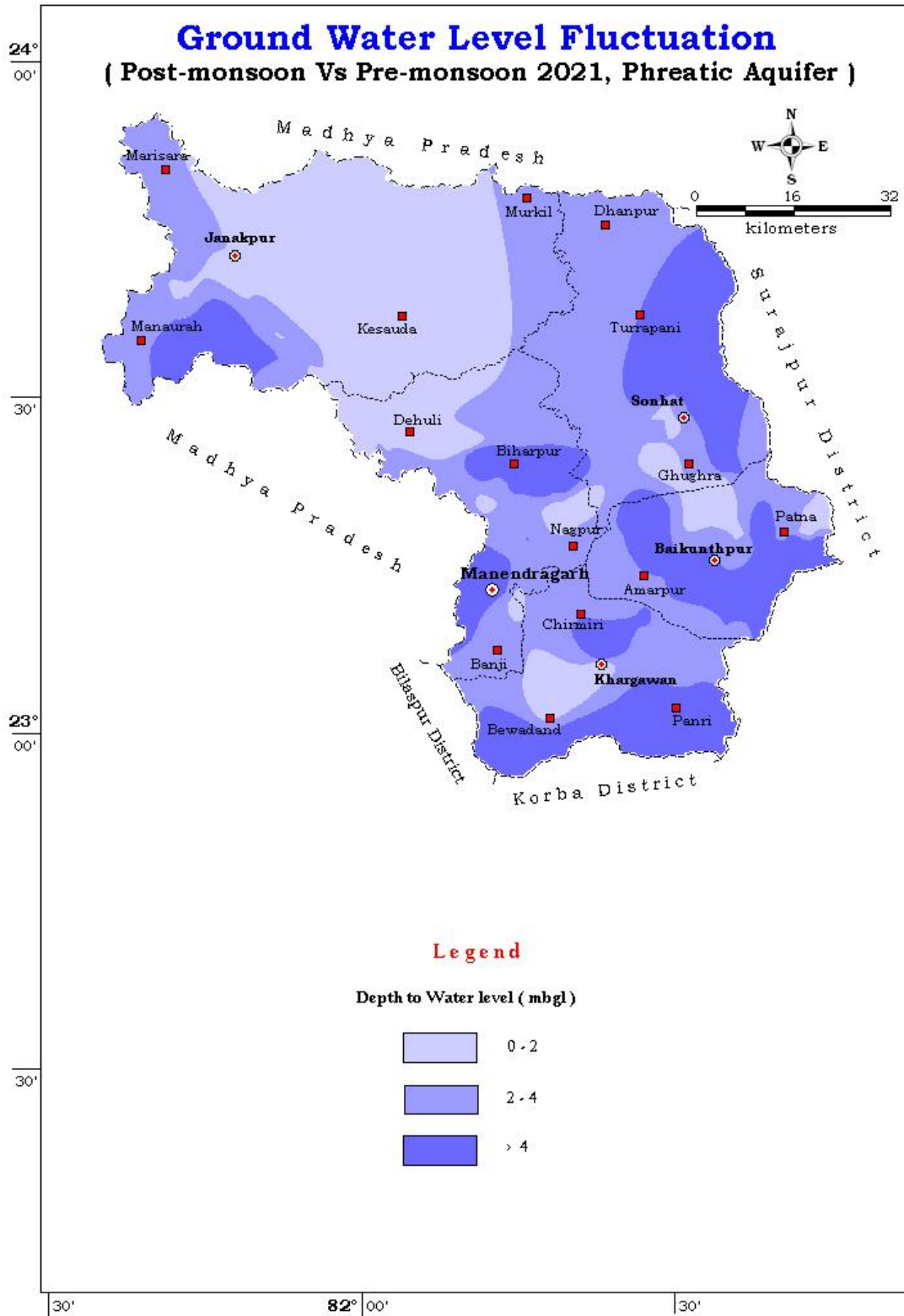


Figure 13 Water level fluctuation of phreatic aquifer

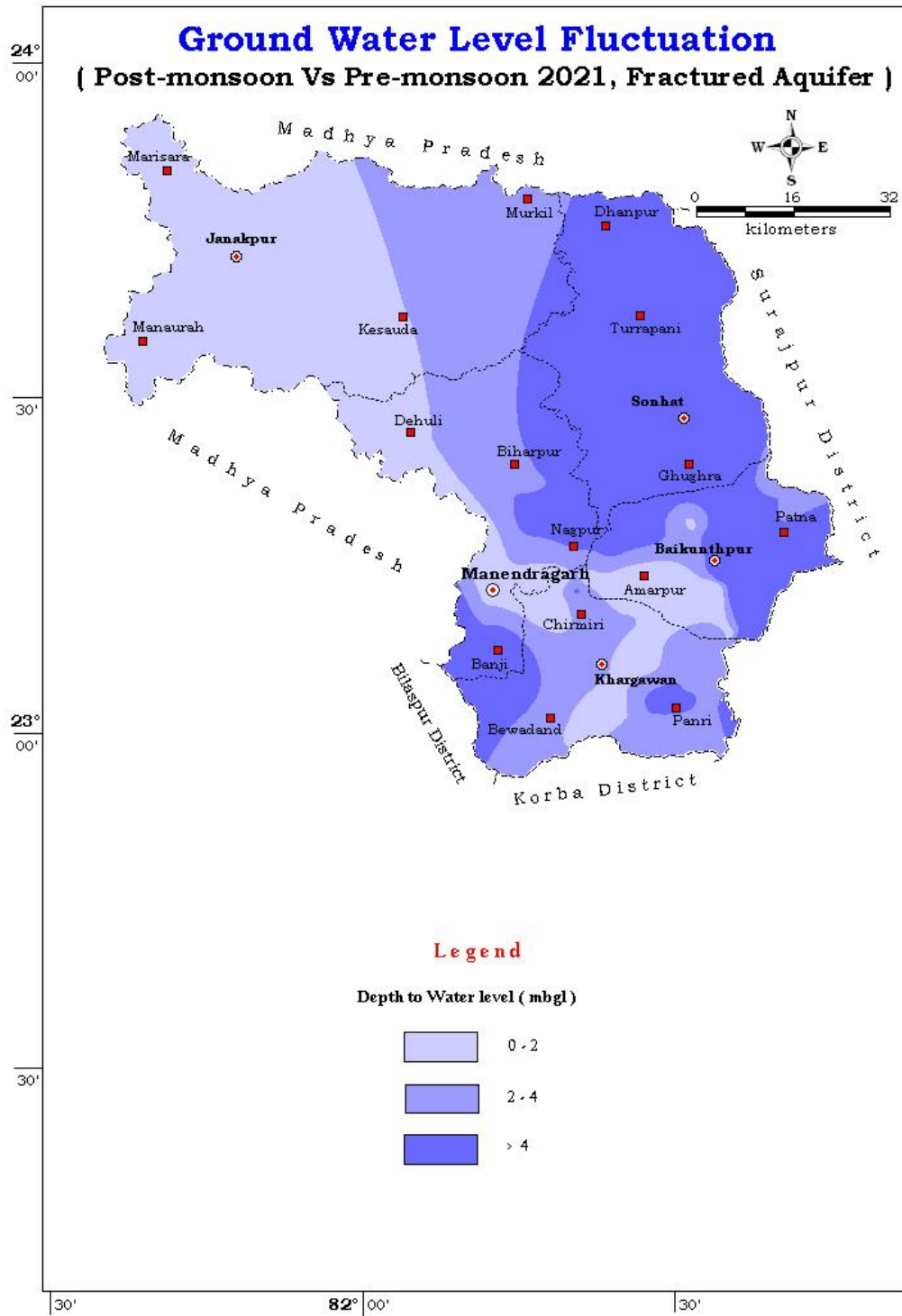


Figure 14 Water level fluctuation of Semi-confined aquifer

The water level fluctuation data indicates that in the study area, water level fluctuation in phreatic aquifer varies from 0.06 to 10.04 m with an average fluctuation of 3.47 m. In deeper fractured aquifer, water level varies from 0.1 to 20.14 m with an average fluctuation of 4.26 m shown in Table 6(C).

Table 6(C) Aquifer wise Depth to Water Level Fluctuation

District	Aquifer Type	Min (m)	Max (m)	Avg (m)
Koriya	Phreatic aquifer	0.06	10.04	3.47
	Semi-Confined Aquifer	0.1	20.14	4.26

2.2 Hydrochemical Data

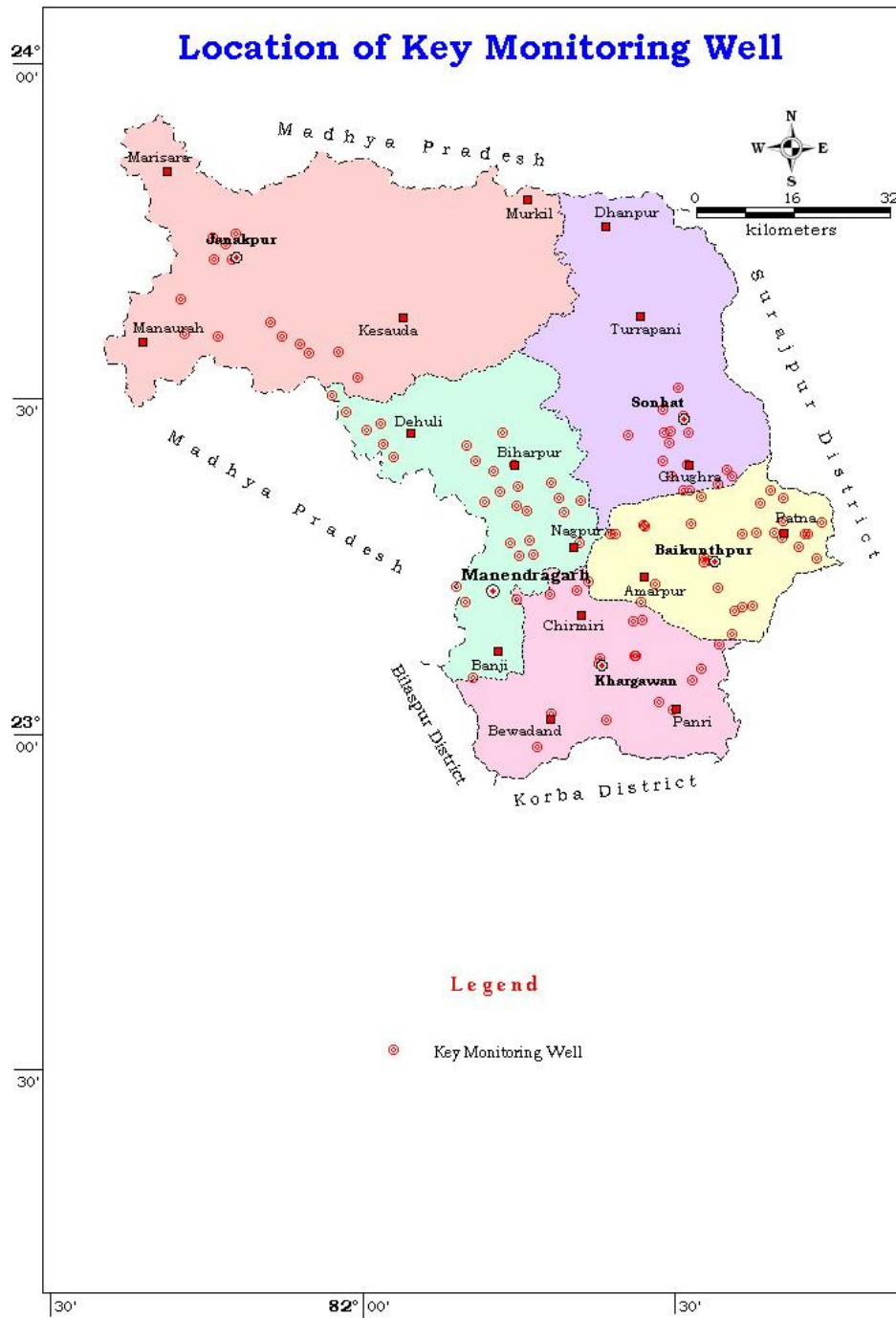


Figure 15 Location of hydrochemical data collection

To know the hydro chemical behaviour of the ground water in the study area, 95 nos. of ground water samples were collected from the key wells including NHS wells during pre-monsoon period of measurement. Also, water samples were collected from borewells during exploration carried out in the area and analysed in the chemical laboratory of Central Ground Water Board, NCCR, Raipur for determination of various chemical parameters. The results and findings are presented in Annexure 3.

2.3 Exploratory Data

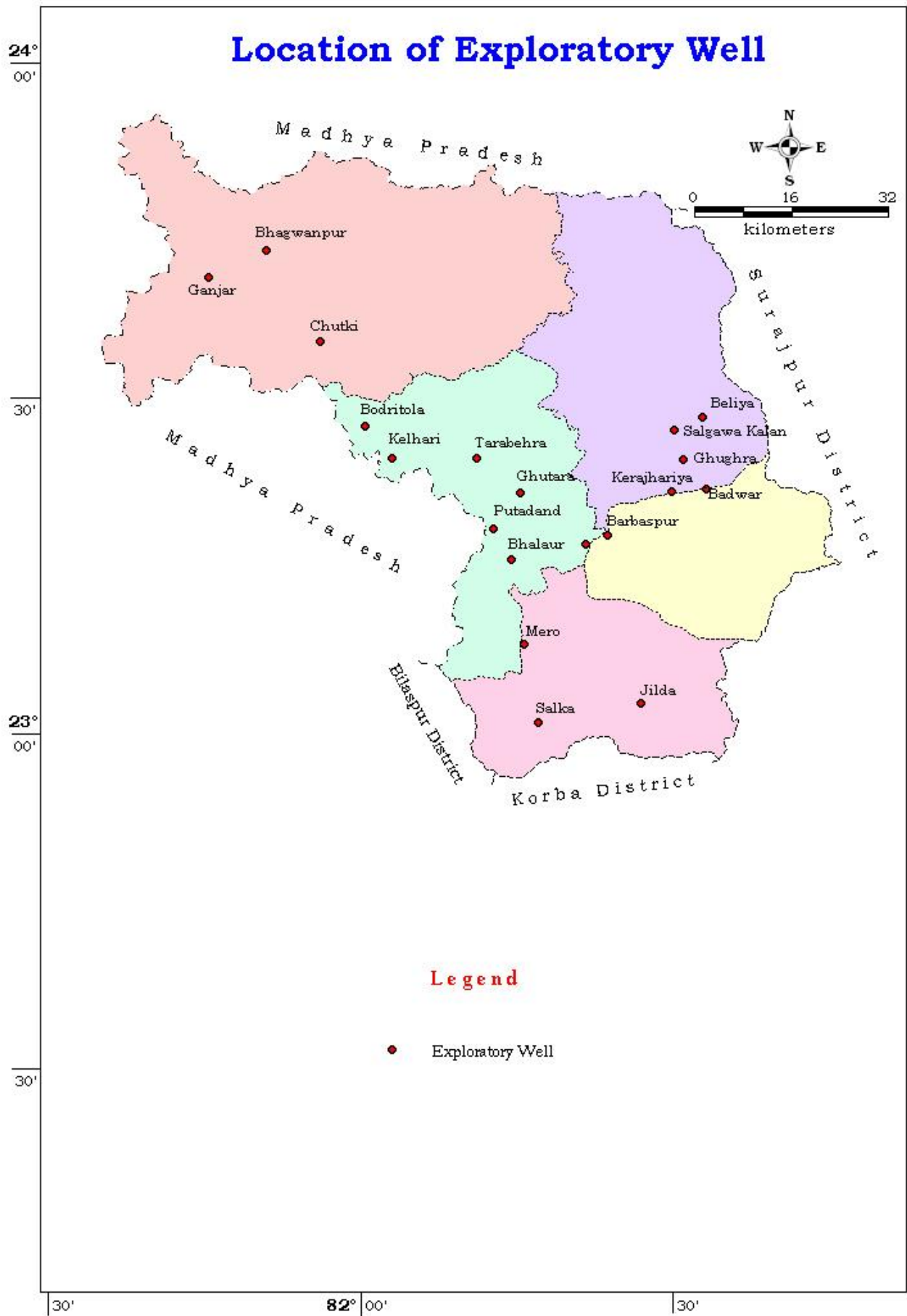


Figure 16 Location of Exploratory wells in the study area

A total of 19 Exploratory well exist in the study area out of which 12 nos. are Existing exploratory well and and 7 nos. are newly generated exploratory wells in the study area. Location of the exploratory wells shown in Figure 16. The results and findings are presented in Annexure 2.

2.4 Geophysical Data

Geophysical surveys (Vertical Electrical Sounding or VES and Gradient Resistivity Profiling or GRP) have been conducted in the study area in Koriya district to delineate the disposition of the existing aquifer system. A total of 13 nos. of soundings (VES) and 1 GRP were carried out in Baikunthpur, Khadgawan, Manendragarh, and Sonhat blocks of Koriya district.

3. AQUIFER DISPOSITION AND GROUND WATER RESOURCES

3.1 Aquifer Geometry and Characterization

Based on the exploratory drilling data generated for the blocks (Annexure 2), the existing aquifer systems in the area may be divided into two namely phreatic and deeper fractured aquifer. The major aquifers present in the study area is Sandstone, Shale with coal beds Details are represented in Table 7.

Table 7 Aquifer Characteristics of Koriya District

CHARACTERISTICS	AQUIFER SYSTEM	
	Weathered	Fractured
Major Rock type	Sandstone, Shale	Sandstone, Shale/coal beds
Weathered thickness (mbgl)	6.1 to 30	-
Depth range of the aquifer (mbgl)	6.1 to 30	14 to 95.90
Fracture encountered (mbgl)	-	14 to 233
No. of waterbearing zones	-	1 to 8
Transmissivity (m ² /day)	-	1 to 50
Yield	10 to 100 m ³ /day	Up to 4.56 lps
Sustainability	1 to 3 hours	0.5 to 6 hours

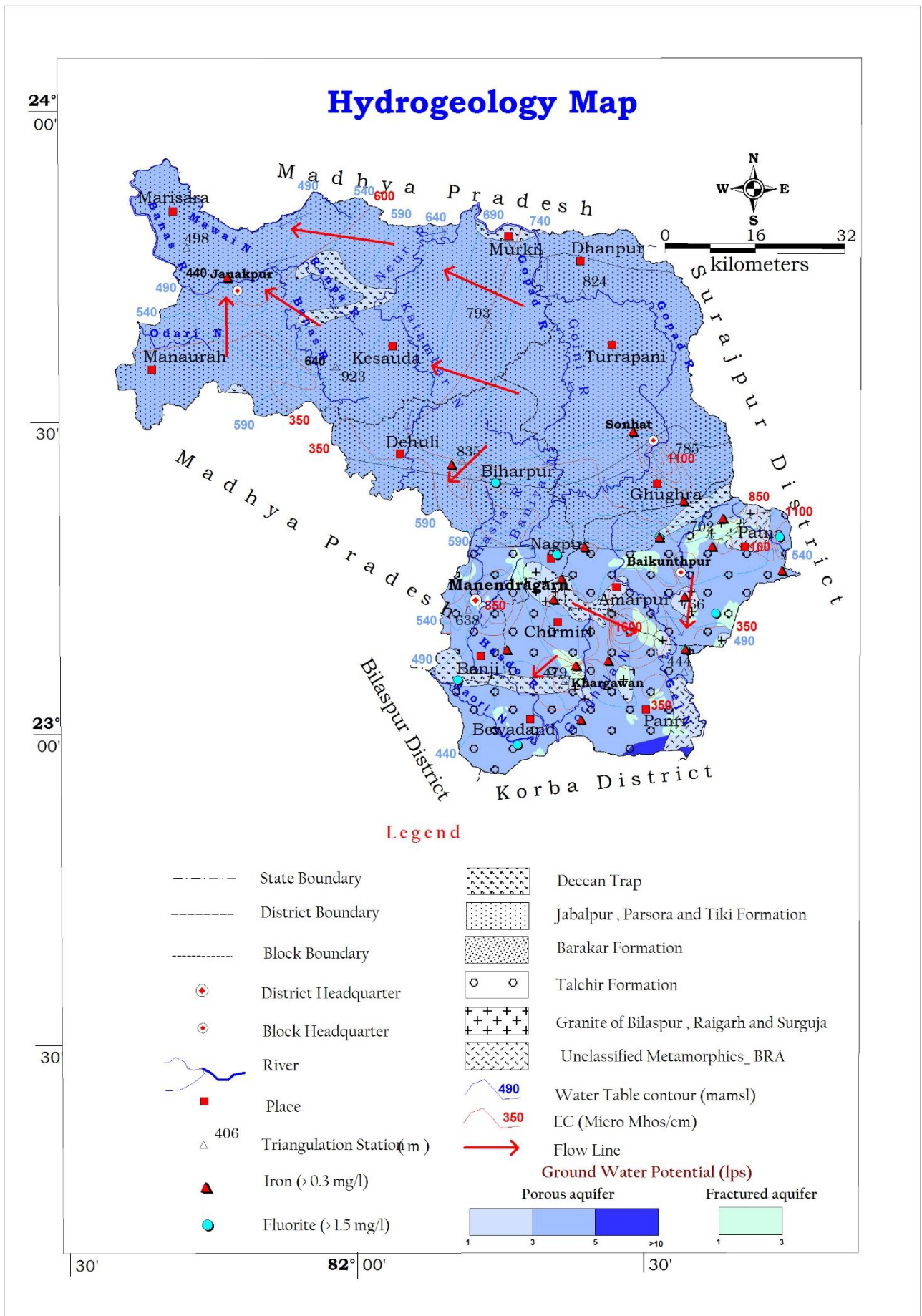


Figure 17 Aquifer Map of the study area

2D Cross-section of Study area

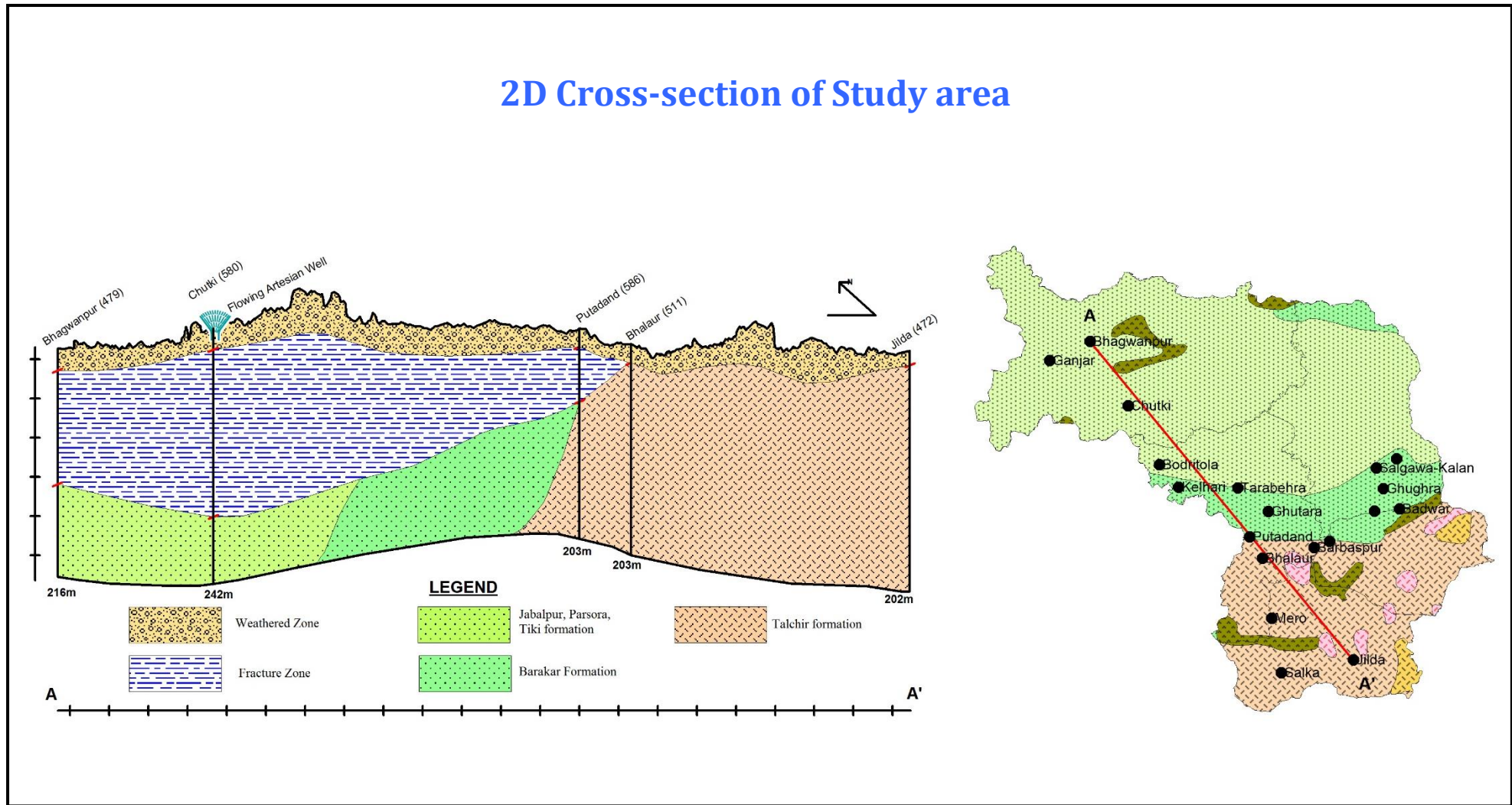


Figure 18(A) 2D Cross-section of the study area

2D Disposition of Aquifer in Koriya District

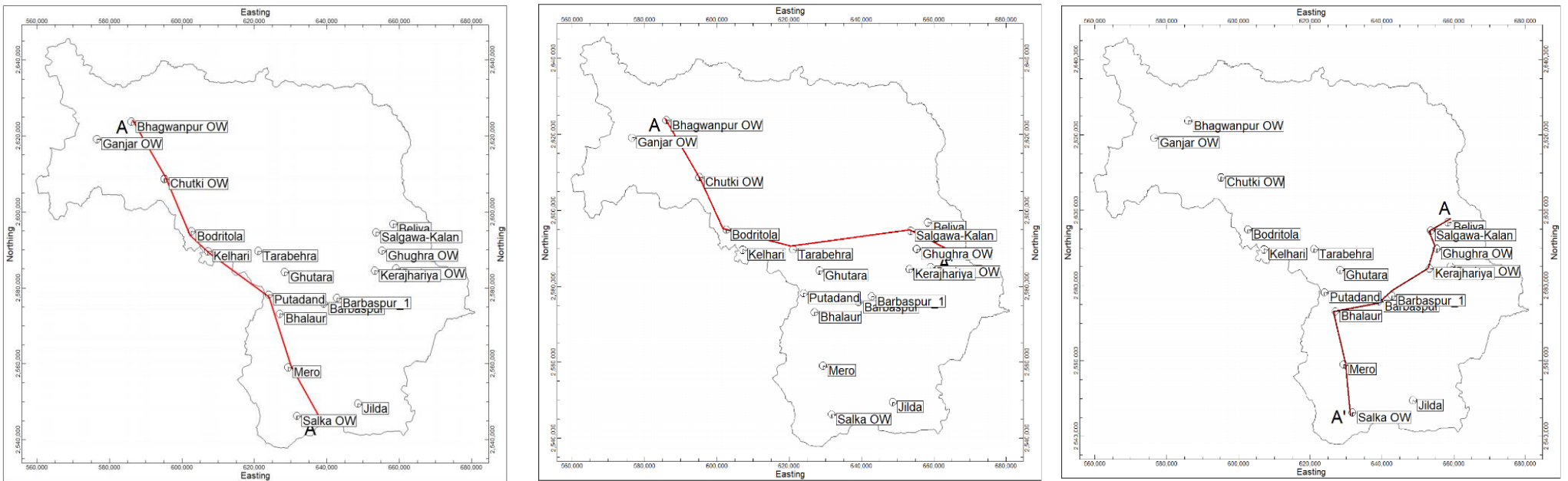


Figure 18(B) 2D Disposition of Aquifer in the study area

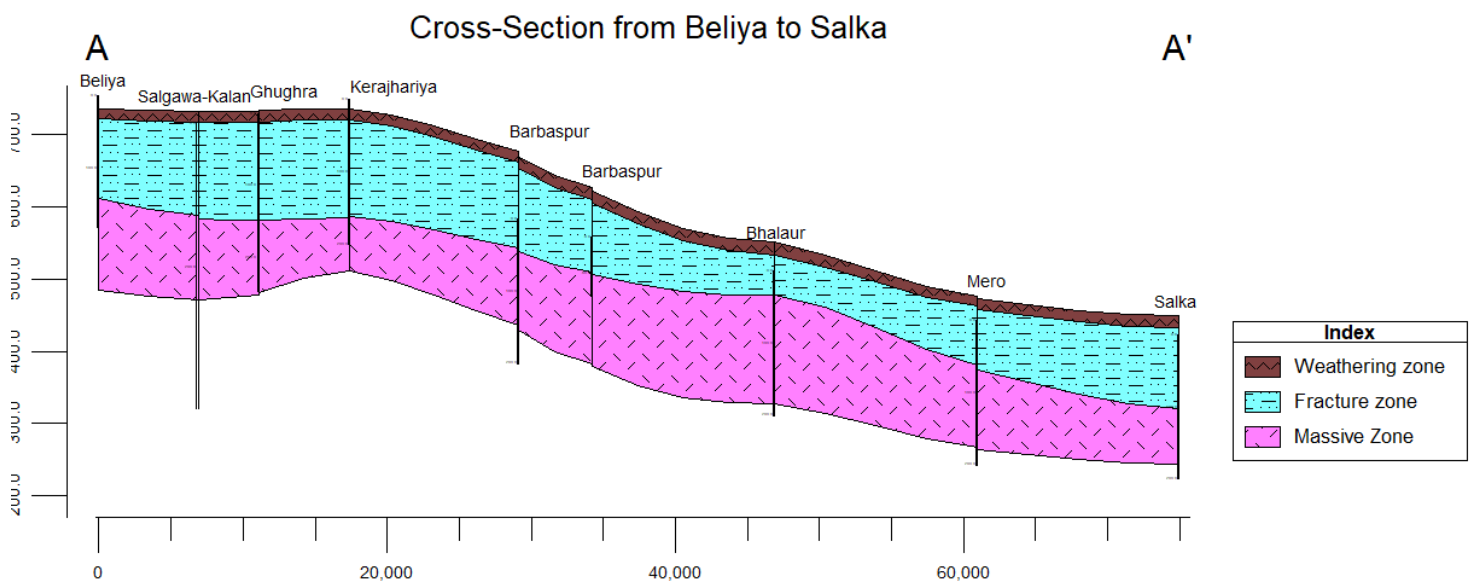
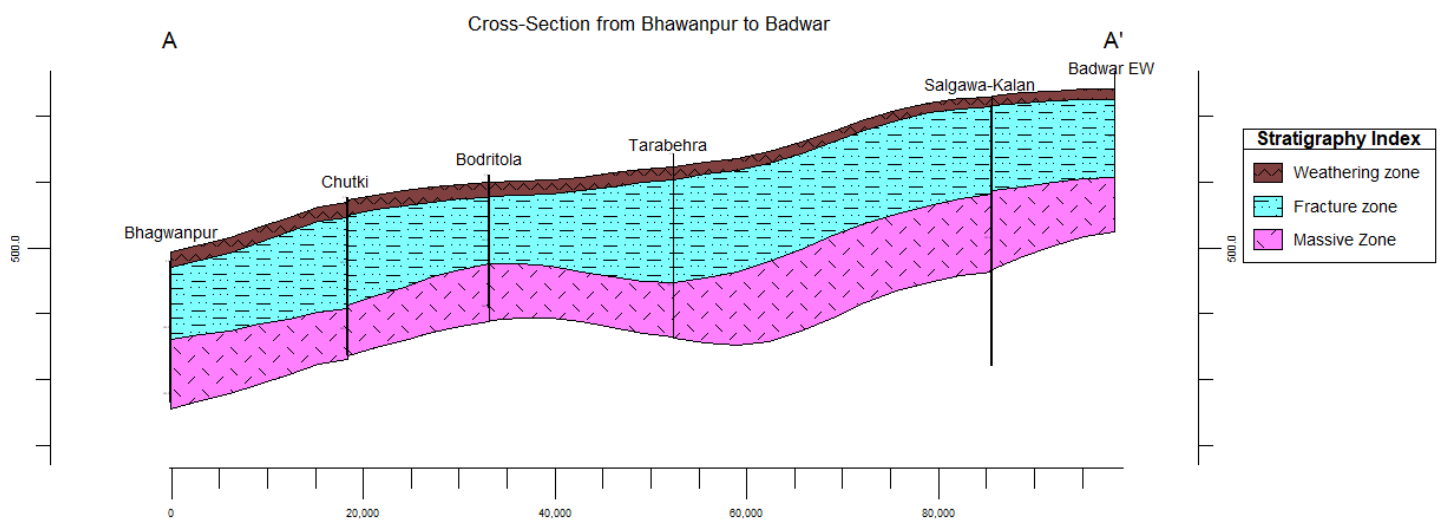
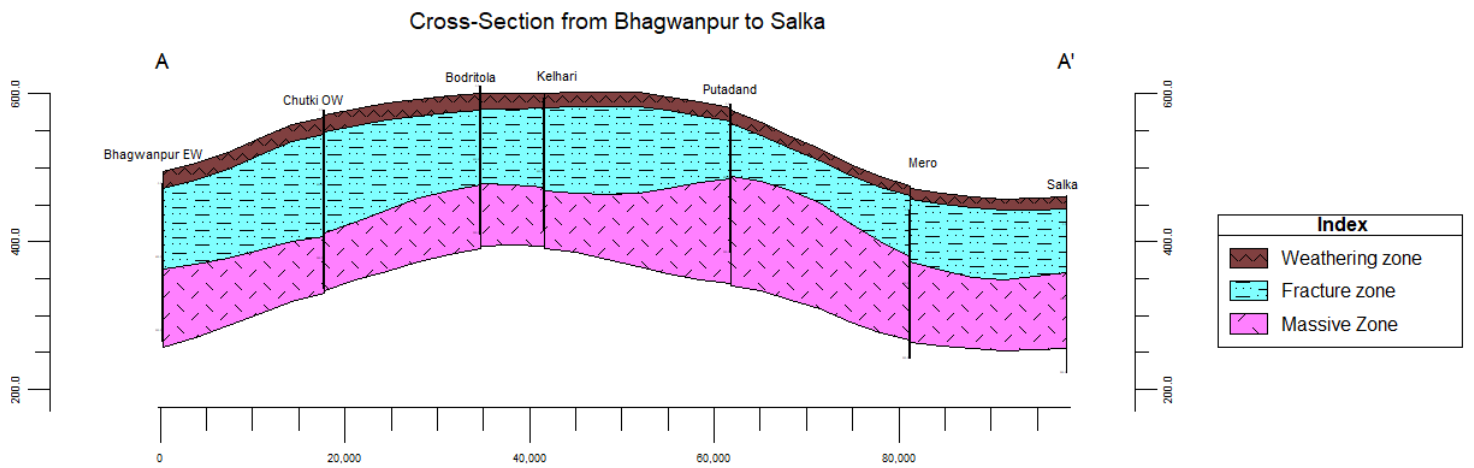


Figure 18(B) 2D Disposition of Aquifer in the study area

3D Disposition of Aquifer in Koriya District

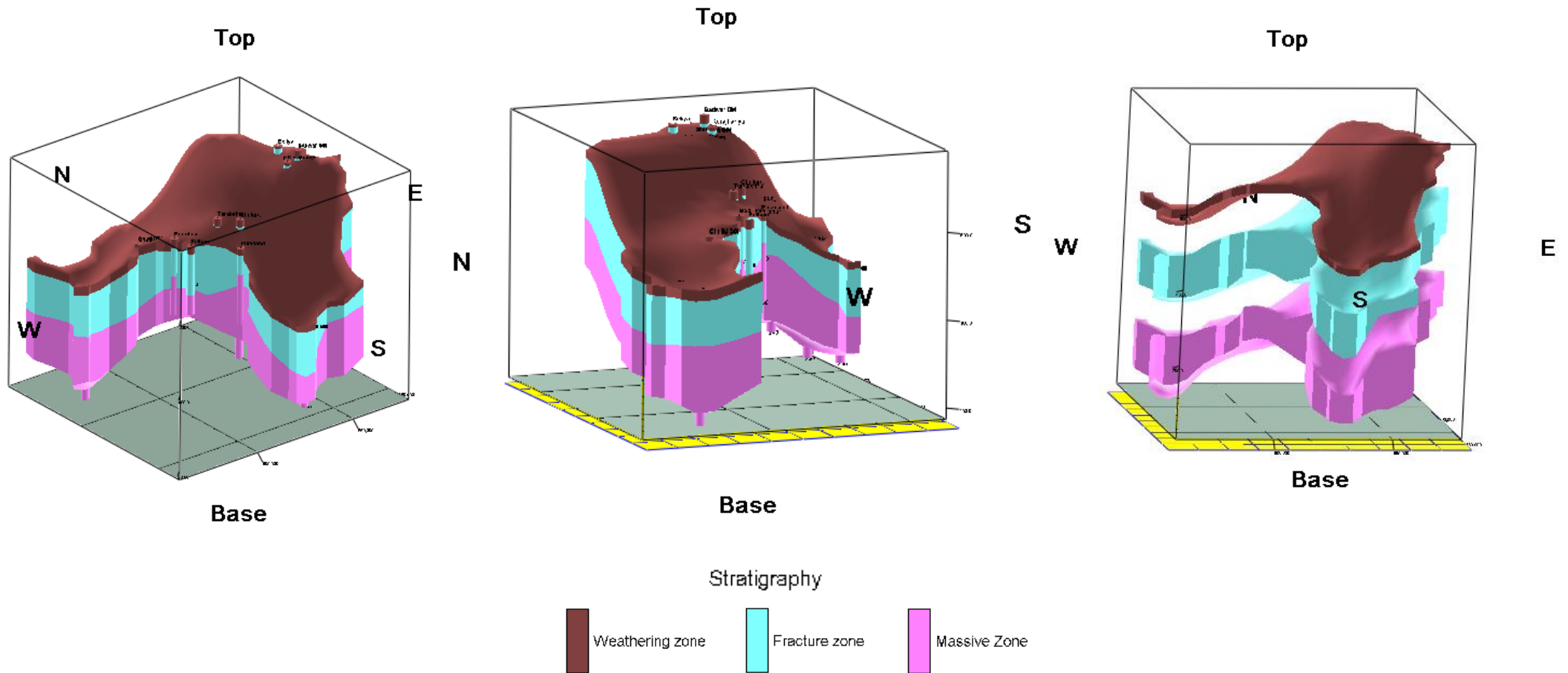


Figure 19 3D Disposition of Aquifer in the study area

3.2 Groundwater Resources Availability and Extraction

In the ground water resource estimation, the unit of assessment to ground water resources has been taken as the smallest administrative unit i.e. Block. The hilly areas (slope greater than 20%) have been excluded from the computations. The assessment unit has been divided into command and non-command areas and ground water resources have been estimated separately for command and non-command areas. The ground water recharge in the monsoon season and non- monsoon season has also been estimated separately.

The water level data collected by CGWB through NHS monitoring and from state ground water survey, has been utilized for resource estimation. The rainfall data from Indian Meteorological Department has been incorporated in the assessment. The irrigation data for tube wells and dug wells were provided by Water Resources Department. The state could not get success to obtain the stream data from the concern department. The domestic dug wells & bore wells data are not available, therefore per capita consumption of 60 liters per day per person for rural areas and 100 liters per day per person for urban areas have been taken into consideration. The data of ground water withdrawal for industries incorporated from the NOC issued by CGWA and from State Industries Department.

Stage of ground water extraction of the Koriya district is 32.924%. The category and stage of ground water extraction of all the blocks in the district are given in the Table 8. Based on the resource assessment made, the Block wise resource availability in Koriya district upto 200m depth is given in Table 9.

Table 8 Blockwise Stage of Extraction and Category

District	Block Name	Stage of Ground Water Extraction (%)	Category
Koriya	Baikunthpur	58.85	Safe
	Bharatpur	6.46	Safe
	Khadgawan	27.30	Safe
	Manendragarh	45.83	Safe
	Sonhat	26.18	Safe

Table 9 Groundwater Resource up to 200m bgl (MCM)

District	Block	Dynamic Resources (MCM)		Insitu Resources (MCM)		Total Resources (MCM)
		Aquifer I	Aquifer II	Aquifer I	Aquifer II	
Koriya	Baikunthpur	45.43	64.17	79.27	1982.68	2171.55
	Bharatpur	157.25	96.82	561.98	10560.30	11376.35
	Khadgawan	65.92	52.59	200.83	3314.61	3633.95
	Manendragarh	26.86	18.03	61.24	1478.11	1584.24
	Sonhat	17.67	50.40	65.86	1283.39	1417.32

3.3 Existing and Future Water Demand (2025)

Table 10 Ground Water Resources of the Study area in Ham

Block	Total Annual Ground Water (Ham) Recharge	Total Natural Discharges (Ham)	Annual Extractable Ground Water (Ham) (3=1-2)	Current Annual Ground Water Extraction (Ham)				Annual GW Allocation for Domestic Use as on 2025	Net Ground Water Availability for future use (9=3-4-5-8)	Stage of ground water development in % (7/3*100)
				Irrigation Use	Industrial Use	Domestic Use	Total Extraction (7=4+5+6)			
	1	2	3	4	5	6	7	8	9	
Baikunthpur	6337.85	633.78	5704.07	2462.578	388	506.3123	3356.88	538.44	2315.06	58.85
Bharatpur	24250.81	1260	22990.81	1249.775	0.072	234.7505	1484.6	268.77	21472.19	6.46
Khadgawan	9546.41	512.29	9034.12	2035.264	0.576	430.4503	2466.28	447.91	6550.38	27.30
Manendragarh	4291.12	253.03	4038.09	1094.986	366	389.7207	1850.71	419.48	2157.62	45.83
Sonhat	4973.43	497.35	4476.08	1044.333	0	127.4514	1171.79	145.19	3286.55	26.18
TOTAL	49399.62	3156.45	46243.17	7886.936	754.648	1688.685	10330.26	1819.79	35781.8	32.924

Total annual ground water recharge and annual extractable ground water resource of the district have been estimated to be 36364.06 Ham and 46243.17 Ham respectively. Gross ground water Extraction for all uses in the district is 10330.26 Ham. The existing demand for irrigation in the area is 7886.936 Ham while the same for domestic use is 1688.685 Ham and for industrial field is 754.648 Ham. To meet the future demand for ground water, a total quantity of **35781.8** Ham of ground water is available for future use.

4. GROUND WATER RELATED ISSUES

- **Drying of Dugwells and handpumps during summer-** At several places of Manendragarh, Bharatpur, Khadgawan and Baikunthpur blocks phreatic aquifer i.e. zone of dugwells dried up in summer due to large number of shallow borewells in the area.
- **Inherent hydrogeological character of aquifer-** The fractures are also very localised which results very low yield and less transmissivity in aquifers. The Barakar sandstone are of felspathic in composition and medium to coarse grained. When the sand stone is enriched with siliceous material it acts like a hard rock, becomes impervious and hence is not a good aquifer. The shales are fine grained and at times are carbonaceous in nature. They are not good aquifers. The ground water movement is controlled by the intergranular pore spaces, joints and fractures. The ground water occurs under water table, semi-confined to confined conditions. The shale beds acts as confining layer thereby differentiating various aquifer systems existing this part of the area. The Talchir sandstones are mostly fine grained, compact and yield low discharges.
- **Fluoride concentration-** High Fluoride concentration observed in HPs of Baikunthpur, Khadgawan and Manendragarh blocks of Koriya district. More than permissible limit reported in HPs at Baikunthpur Road, Kadamnara, Tengni of Baikunthpur block, Bhauta, Katkona, Khandora of Khadgawan block and Biharpur, Nagpur of Manendragarh block of Koriya district. (Annexure-3)
- **Nitrate contamination-** More than permissible limit found in villages like Bharatpur in Bharatpur block, Kailashpur and Sonhat in Sonhat block, Khadgaon and Podidih in Khadgawan block, Mansukha in Baikunthpur block and Tarabahara in Manendragarh block. (Annexure-3)
- **Uranium contamination-** Uranium observed more than permissible limit in places like Sirouli in Manendragarh block-1.6 µg/l.(Annexure-3)
- **Iron Contamination-** More than permissible limit found in many villages in all blocks of Koriya district. (Annexure-3)
- **EC-** More than 1000 µs/cm EC reported in locations like Khadgawan, Akhradand, Banjaridand in Khadgawan block, Tengni in Baikunthpur block and Kailashpur of Sonhat block. (Annexure-3)

5. GROUND WATER MANAGEMENT STRATEGY

- It has been observed during fieldwork, there is colossal wastage of groundwater through private well and public water supply system. So, Information, Education and Communication (IEC) activities need to be organized to sensitize people on the issues of depleting groundwater resource. Massive awareness campaigns are essential to aware people about the importance of community participation in saving water.
- Desiltation of existing Check dams, Tanks and Talabs to be carried out for efficient storage of rainwater. Also Rain water harvesting structures may be constructed in villages to reduce stress on groundwater.
- It has been observed that the demand of ground water is increasing for irrigation, industrial and domestic uses. At locations where water level is declining, we have to go for artificial recharge on a long-term sustainability basis. Artificial Recharge structures may be constructed at suitable locations especially in the areas where the water level remains more than 3m in the post-monsoon period in the district to arrest the huge non-committed run-off and augment the ground water storage in the area. The different types of artificial recharge structures feasible in the block are described in Table 11.

Table 4 Types and number of Artificial Recharge structures feasible

Block/District	Area Identified for Artificial recharge (sq.km)	Vol. of Sub Surface Potential for Artificial recharge (MCM)	Types of Structures Feasible and their Numbers			
			Percolation tank	Nalas bunding cement plug/ check dam	Gravity head /Dug well/ tube well/Recharge shaft	Gully plugs Gabion structures
Recharge Capacity - (MCM)/structure			0.2192	0.0326	0.00816	0.0073
Baikunthpur	312.70	6.595	22	73	164	125
Bharatpur	28.29	0.806	3	9	20	15
Khadgawan	537.60	15.56	52	172	388	296
Manendragarh	183.41	7.527	25	83	188	143
Sonhat	19.90	0.706	2	8	18	13
Total (Koriya)	1081.9	31.194	104	345	778	592

- Abandoned tube well and dug well may be used for the recharge through shaft especially in urban and water stressed areas.
- Fluoride and Iron filter plant may be installed in the villages having higher value of contaminants.
- In urban areas STP may be installed for the treatment of sewage water in proper numbers to avoid contamination of ground water. Treatment of sewage water in village through soak pit for the individual houses and Seechewal model or similar model for community level may be adopted to avoid contamination of ground water. Treated water may also be reused for irrigation and other industrial purposes.
- Since the stage of development in the district is 32.924 %. There is scope of utilizing more ground water for future irrigation purpose. Additional number of Ground water abstraction structure may be developed for the effective utilization of ground water resources in the district (Figure 20). The ground water is presently developed through dug wells and tube wells. Yield potential for the block has been shown in Aquifer map (Figure 17). Sites for wells need to be selected only after proper scientific investigation. The ground water quality also needs to be ascertained and the wells used for water supply should be first checked for Iron, Fluoride, Nitrate and other pollutants.
- Contour trenches is one of the best artificial recharge method in hilly areas of Koriya district where slope is high. Gully plugs and Nala bunds need to be constructed more in number in villages to augment irrigation and domestic uses and to recharge the groundwater.

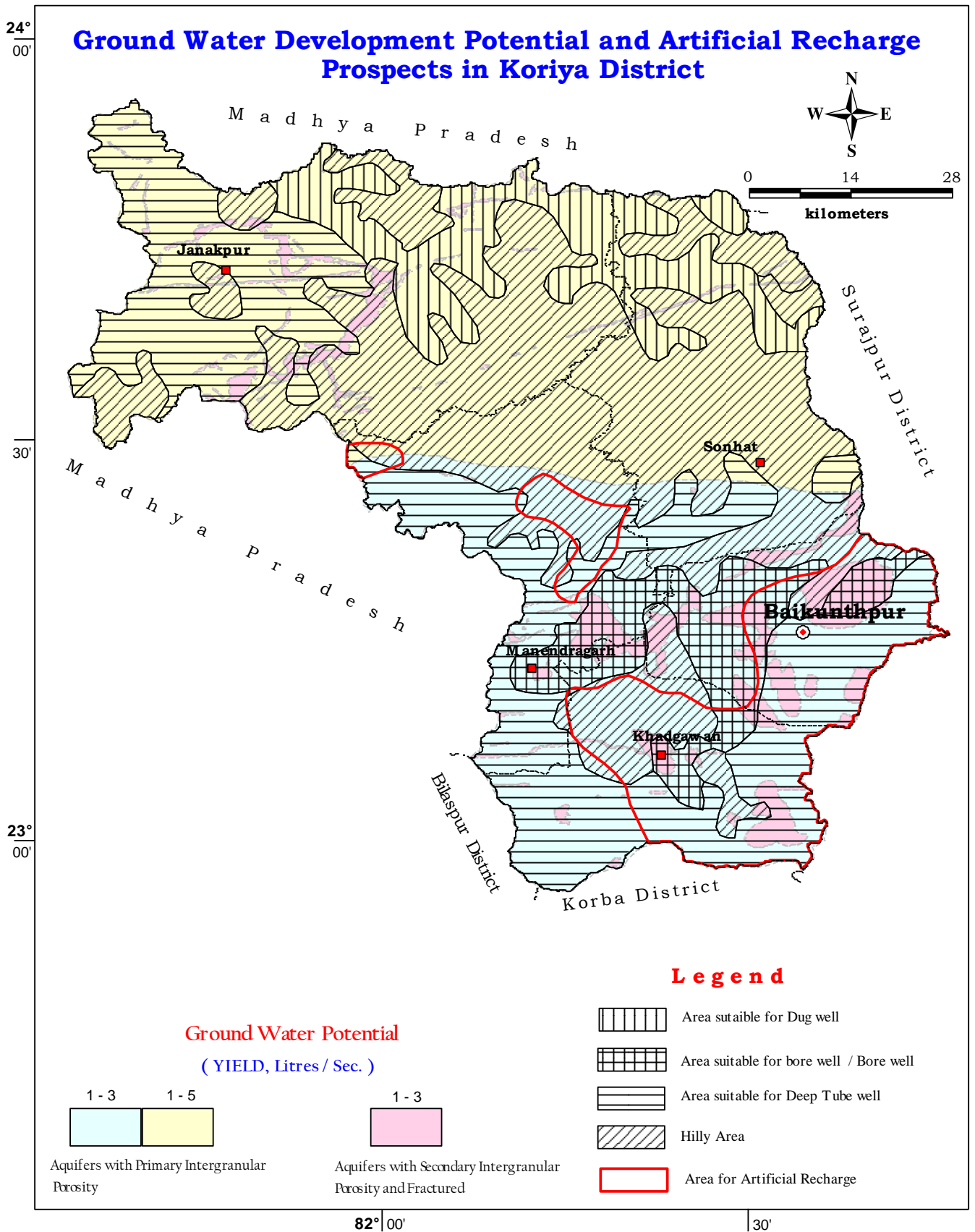


Figure 20 Feasibility of GW Abstraction and Area Identified for Artificial Recharge Map

Table 12 Additional groundwater abstraction structure proposed

Block	Annual Extractable Ground Water Resource (ham)	Stage of ground water Development (%)	Present ground water draft (ham)	Ground water draft at 60% stage of development (ham)	Surplus ground water at present Stage of Development (ham)	Number of TW Recommended in each block (Assuming unit draft as 1.6 ham/structure/year)	Number of DW Recommended in each block (Assuming unit draft as 0.72 ham/structure/year)	Additional Irrigation potential creation for Maize/ wheat in winter season in Ha (Assuming 500 mm water requirement)	Additional Irrigation potential creation for Paddy in Ha (Assuming 900 mm water requirement)
Baikunthpur	5704.07	58.85	3356.88	3422.44	65.56	25	36	131.124	5704.07
Bharatpur	22990.81	6.46	1484.6	13794.49	12309.89	4616	6839	24619.772	22990.81
Khadgawan	9034.12	27.3	2466.28	5420.47	2954.19	1108	1641	5908.384	9034.12
Manendragarh	4038.09	45.83	1850.71	2422.85	572.14	215	318	1144.288	4038.09
Sonhat	4476.08	26.18	1171.79	2685.65	1513.86	568	841	3027.716	4476.08
TOTAL (Koriya)	46243.17	32.924	10330.26	27745.9	17415.64	6532	9675	34831.28	46243.17

6. CONCLUSION:

For effective utilization of Ground water existing draft for irrigation may be coupled with micro irrigation system. Change in irrigation pattern, optimum use of available resource, use of ground water potential created after artificial recharge can lead to groundwater savings and increase in gross cropped area of the district (Table 13).

Table 13 Detail of groundwater saved through change in cropping pattern and other interventions

Block	Existing Gross Ground Water Draft for Irrigation in Ham	Additional Saving of GW after using Micro Irrigation methods in Ham (Assuming 30 % saving)	GW recharge through Artificial recharge structure in Ham	Total GW Resource Enhancement in Ham	Stage of Ground Water Extraction (%) As per 2020 GWRE	Expected Stage of Ground Water Extraction (%) after intervention
Baikunthpur	2462.578	738.77	659.5	1398.27	58.85	38.52
Bharatpur	1249.775	374.93	80.6	455.53	6.46	6.58
Khadgawan	2035.264	610.58	1556.2	2166.78	27.3	21.78
Manendragarh	1094.986	328.5	752.7	1081.2	45.83	20.93
Sonhat	1044.333	313.3	70.6	383.9	26.18	18.12
TOTAL (Koriya)	7886.936	2366.08	3119.6	5485.68	32.92	21.19

Annexure 1 Details of Key Wells established in Koriya District

Block	Village	Latitude	Longitude	Pre-monsoon WL in m bgl	Post-monsoon WL in m bgl	Fluctuation in m	Type of well
Baikunthpur	Baikunthpur	23.258333	82.550000	7.00	2.95	4.05	DW
Baikunthpur	Baikunthpur	23.260780	82.560050	27.80	7.66	20.14	HP
Baikunthpur	Baikunthpur Station	23.258300	82.550000	6.53	0.90	5.63	DW
Baikunthpur	Baikunthpur Station	23.316120	82.528960	9.26	7.28	1.98	HP
Baikunthpur	Baikunthpur-D	23.266667	82.550000	22.60	19.70	2.90	PZ
Baikunthpur	Barbaspur	23.300390	82.398280	12.06	6.40	5.66	HP
Baikunthpur	Bardiya	23.318720	82.678330	4.80	1.66	3.14	DW
Baikunthpur	Barpara	23.186050	82.599620	8.50	2.37	6.13	DW
Baikunthpur	Bhandi	23.300100	82.612120	3.80	1.98	1.82	DW
Baikunthpur	Chharcha Basti	23.354200	82.314900	4.20	1.48	2.72	DW
Baikunthpur	Dumaria	23.264700	82.731500	12.60	3.70	8.90	DW
Baikunthpur	Ghugra	23.404200	82.523700	9.20	6.90	2.30	DW
Baikunthpur	Girjapur	23.301220	82.716960	6.70	5.18	1.52	DW
Baikunthpur	Girjapur	23.301010	82.712070	15.50	10.00	5.50	HP
Baikunthpur	Jamgahana	23.299989	82.612201	3.90	1.80	2.10	DW
Baikunthpur	Jatasemar	23.151667	82.595833	15.10	13.10	2.00	HP
Baikunthpur	Kadamnara	23.194140	82.627370	26.40	11.50	14.90	HP
Baikunthpur	Kategori	23.365902	82.515659	4.15	2.22	1.93	DW
Baikunthpur	Katkona 1	23.353440	82.678920	13.70	10.40	3.30	HP
Baikunthpur	Khodri	23.410300	82.482700	4.00	3.27	0.73	DW
Baikunthpur	Mansukha	23.226927	82.470761	10.10	6.10	4.00	DW
Baikunthpur	Mohra	23.303456	82.634847	8.00	1.48	6.52	DW
Baikunthpur	Nagar (Station)	23.316355	82.528928	5.50	3.80	1.70	DW
Baikunthpur	Nagar Station	23.313410	82.453030	7.10	1.60	5.50	DW
Baikunthpur	Nagar Station	23.313410	82.453030	7.83	2.40	5.43	HP
Baikunthpur	Nagar(Tilwandar)	23.313161	82.453670	10.90	2.02	8.88	DW
Baikunthpur	Nakeridand	23.199990	82.447250	12.90	12.80	0.10	HP
Baikunthpur	Patna	23.302270	82.664280	8.30	3.90	4.40	HP
Baikunthpur	Patna New	23.294227	82.675578	5.88	2.25	3.63	DW
Baikunthpur	Patrapali	23.221100	82.573000	8.10	3.42	4.68	DW
Baikunthpur	Patrapali	23.221111	82.573056	8.47	6.79	1.68	HP
Baikunthpur	Putra	23.346880	82.640550	14.08	4.20	9.88	HP
Baikunthpur	Ranai	23.280556	82.702778	9.85	4.16	5.69	DW
Baikunthpur	Ranai	23.280600	82.702800	12.40	2.36	10.04	DW
Baikunthpur	Satipara	23.192000	82.611380	8.80	3.82	4.98	DW
Baikunthpur	Tengni	23.316699	82.739217	4.20	2.80	1.40	DW
Baikunthpur	Tummibari	23.365020	82.657310	7.50	3.70	3.80	DW
Bharatpur	Ara	23.593600	81.764100	9.90	3.30	6.60	DW
Bharatpur	Baharsi.1	23.614555	81.849846	4.60	1.95	2.65	DW
Bharatpur	Barail	23.532821	81.990671	10.21	8.47	1.74	HP
Bharatpur	Barhori	23.747497	81.791971	5.20	4.80	0.40	DW

Bharatpur	Bharatpur	23.732327	81.775782	4.10	1.60	2.50	DW
Bharatpur	Chutki	23.569896	81.911167	5.60	3.15	2.45	DW
Bharatpur	Dhovatal	23.572361	81.960042	5.75	4.30	1.45	DW
Bharatpur	Janakpur	23.709168	81.787087	4.95	4.48	0.47	DW
Bharatpur	Khetouli	23.593469	81.867745	5.85	3.90	1.95	DW
Bharatpur	Kuwarpur	23.597778	81.710833	9.35	2.10	7.25	DW
Bharatpur	Larkonda	23.740967	81.755038	7.45	4.04	3.41	DW
Bharatpur	Patwahi	23.708605	81.756590	5.95	4.00	1.95	DW
Bharatpur	Seri	23.648800	81.704500	4.20	2.29	1.91	DW
Bharatpur	Umarwah	23.582070	81.896185	6.65	2.90	3.75	DW
Khadgawan	Akhradand	23.204129	82.247921	5.15	3.32	1.83	DW
Khadgawan	Banjaridand	23.172500	82.449700	6.00	1.90	4.10	DW
Khadgawan	Banjaridand	23.170833	82.436389	4.92	2.70	2.22	HP
Khadgawan	Bhauta	23.087320	82.177230	4.10	0.32	3.78	DW
Khadgawan	Bhauta	23.087320	82.177230	19.30	11.50	7.80	HP
Khadgawan	Bodemuda	23.023140	82.392270	14.35	13.65	0.70	HP
Khadgawan	Chirmi	23.100440	82.545700	13.00	9.50	3.50	HP
Khadgawan	Chirmiri	23.216701	82.345219	7.90	5.75	2.15	DW
Khadgawan	Chirmiri	23.216930	82.344910	12.40	8.17	4.23	HP
Khadgawan	Chote Salhe	23.082360	82.530110	3.70	0.25	3.45	DW
Khadgawan	Devadand	23.033410	82.302980	11.50	10.28	1.22	DW
Khadgawan	Jilda	23.050000	82.476600	6.20	1.20	5.00	DW
Khadgawan	Jilda	23.050170	82.476550	11.70	7.00	4.70	HP
Khadgawan	Katkona	22.983630	82.281640	7.35	1.52	5.83	DW
Khadgawan	Katkona 2	22.983630	82.281640	13.10	10.40	2.70	HP
Khadgawan	Khadgaon	23.108333	82.379167	4.20	2.90	1.30	DW
Khadgawan	Khadgaon	23.108333	82.379167	15.15	12.56	2.59	PZ
Khadgawan	Khadgawan	23.116080	82.381098	9.35	2.80	6.55	DW
Khadgawan	Khandora	23.136667	82.574167	5.20	2.25	2.95	DW
Khadgawan	podidih	23.026386	82.085942	6.50	4.16	2.34	DW
Khadgawan	Pouri	23.038611	82.499444	11.80	3.18	8.62	DW
Khadgawan	Sajapahar	23.211350	82.301100	4.29	0.75	3.54	DW
Khadgawan	Sajapahar	23.211350	82.301100	7.21	6.50	0.71	HP
Khadgawan	Singhat	23.118610	82.439960	3.87	0.50	3.37	DW
Khadgawan	Singhat	23.119410	82.438560	10.70	10.05	0.65	HP
Manendragarh	Amritdhar	23.332475	82.323727	0.95	0.89	0.06	DW
Manendragarh	Bairagi	23.452552	82.224064	6.75	4.05	2.70	DW
Manendragarh	Banhi	23.348162	82.196567	3.05	1.20	1.85	DW
Manendragarh	Belbehra	23.291128	82.267459	7.28	3.20	4.08	DW
Manendragarh	Biharpur	23.403544	82.243029	12.20	5.10	7.10	DW
Manendragarh	Chainpur	23.222000	82.151400	8.30	0.70	7.60	DW
Manendragarh	Dhanhar	23.506727	81.948806	3.90	2.90	1.00	HP
Manendragarh	Dodki	23.454880	82.005660	6.00	4.16	1.84	DW
Manendragarh	Garundol	23.377599	82.302493	11.00	1.85	9.15	DW
Manendragarh	Godrakund	23.393760	82.209702	8.18	5.39	2.79	HP
Manendragarh	Kachhod	23.432419	82.166322	2.83	1.93	0.90	DW

Manendragarh	Kalua	23.465724	82.026917	6.21	5.81	0.40	DW
Manendragarh	Kelhari	23.414389	82.047806	11.52	9.20	2.32	DW
Manendragarh	Khongapani	23.199443	82.165315	8.58	3.70	4.88	DW
Manendragarh	Manendragarh	23.216667	82.205833	10.48	3.36	7.12	DW
Manendragarh	Manendragarh-D	23.216667	82.205833	17.59	16.20	1.39	PZ
Manendragarh	Musra	23.363398	82.219868	8.75	6.15	2.60	DW
Manendragarh	Nagpur	23.288086	82.349822	6.80	4.10	2.70	DW
Manendragarh	Pendri	23.342099	82.248350	4.40	2.15	2.25	DW
Manendragarh	Phatpani	23.370943	82.249344	8.37	2.10	6.27	DW
Manendragarh	Piparia	23.269000	82.250900	7.00	3.48	3.52	DW
Manendragarh	Podi(chirmiri)	23.229167	82.362500	9.60	7.98	1.62	PZ
Manendragarh	Rojhi	23.482400	81.971490	4.00	2.75	1.25	DW
Manendragarh	Salwa	23.334758	82.264697	19.36	14.68	4.68	HP
Manendragarh	Sarbhoka	23.350891	82.351228	4.10	2.70	1.40	DW
Manendragarh	Shankargarh	23.286810	82.237955	6.05	2.55	3.50	DW
Manendragarh	Shripur	23.435060	82.032460	3.00	1.90	1.10	DW
Manendragarh	Sirouli	23.269324	82.274089	5.31	2.16	3.15	DW
Manendragarh	Tarabahara	23.410572	82.180788	8.80	2.65	6.15	DW
Manendragarh	Tilokhan	23.482339	81.971129	7.20	5.90	1.30	DW
Manendragarh	Ujiyarpur	23.301707	82.407645	7.45	3.70	3.75	DW
Sonhat	Amhar	23.485463	82.483639	7.00	5.40	1.60	DW
Sonhat	Anandpur	23.355642	82.545982	2.85	1.15	1.70	DW
Sonhat	Bhainswar	23.448413	82.427535	7.10	4.20	2.90	DW
Sonhat	Bikrampur	23.452017	82.484895	6.60	3.55	3.05	DW
Sonhat	Bodar	23.437157	82.493397	7.82	5.65	2.17	DW
Sonhat	kailashpur	23.451281	82.523931	3.40	0.70	2.70	DW
Sonhat	Katgodi	23.365706	82.527834	3.07	1.29	1.78	DW
Sonhat	Latma	23.374383	82.571831	1.02	0.50	0.52	DW
Sonhat	Majhartola	23.395807	82.586787	10.75	6.00	4.75	DW
Sonhat	Mendrakala	23.519430	82.508030	10.80	6.10	4.70	DW
Sonhat	Pusla	23.386172	82.497707	20.72	13.68	7.04	HP
Sonhat	Salgawan	23.454359	82.495213	3.37	2.87	0.50	DW
Sonhat	Sonhat	23.475997	82.517168	5.65	2.84	2.81	DW
Sonhat	Sundarpur	23.387203	82.596114	6.80	3.90	2.90	DW

Annexure 2 Details of Exploration in Koriya District

Block	Type of Well	Location	Latitude	Longitude	Depth (m bgl)	Casing (m)	Formation	Lithology	Zones encountered	Discharge (lps)
Sonhat	EW	Salgawa-Kalan	23.454600	82.503500	397.03	147	Barakar	Sandstone and Shale	50.5-55,59-63,74-78,88-96.5,98.5-102,106-111,121-125,138-144	0.45
Manendragarh	EW	Ghutara	23.362200	82.255400	369.16	176	Barakar	Sandstone and Shale	40-46,58-63,67-93,120-143,150-173	1.7
Bharatpur	EW	Ganjar	23.681700	81.750700	297.44	123	Jabalpur, Parsora, Tiki	Sandstone and Shale	14-35,60.5-63,80-100,103-122	2.5
Bharatpur	OW	Ganjar	23.681855	81.750598	297.44	123	Jabalpur, Parsora, Tiki	Sandstone and Shale	14-35,60.5-63,80-100,103-121	2.5
Manendragarh	EW	Kelhari	23.413400	82.048800	181.83	133	Barakar	Sandstone and Shale	55-67,68-130	1.2
Bharatpur	EW	Bhagwanpur	23.722500	81.843900	216	130	Jabalpur, Parsora, Tiki	Sandstone and Shale	14-16,30-39,45-54,60-75,85-108,116-129	3.2
Bharatpur	OW	Bhagwanpur	23.722530	81.843796	216	130	Jabalpur, Parsora, Tiki	Sandstone and Shale	30-39,45-54,60-75,85-108,116-129	3.2
Manendragarh	EW	Barbaspur	23.285900	82.360500	83.25	62	Barakar	Sandstone, Shale with Coal bed	35-60	0.5
Bharatpur	EW	Chutki	23.586300	81.932100	242.26	183	Jabalpur, Parsora, Tiki	Sandstone and Shale	14-16,76-130,138-160,168-180	4.21
Bharatpur	OW	Chutki	23.586300	81.932600	242.26	183	Jabalpur, Parsora, Tiki	Sandstone and Shale	14-16,76-130,138-160,168-180	4.21
Manendragarh	EW	Tarabehra	23.412500	82.184700	276	236	Barakar	Sandstone and Shale	40-52,55-58,70-76,82-102,110-120,171-180,203-206.5,216-233	0.5
Sonhat	EW	Ghughra	23.410700	82.519400	248.5	21.5	Barakar	Sandstone, Shale with Coal bed	81-90,110-118,131-137,164-170,176-200,206-212	2
Sonhat	OW	Ghughra	23.411100	82.519400	248.5	21.5	Barakar	Sandstone, Shale with Coal bed	81-90,110-118,131-137,164-170,176-200,206-212	2

Khadgawan	EW	Jilda	23.047600	82.450400	202	14	Talchir	Tillite, Sandstone, Siltstone and Boulder	dry	Dry
Khadgawan	EW	Salka	23.019900	82.285500	202	18	Talchir	Tillite, Sandstone, Siltstone and Boulder	15-17,44.10, 153-156	3.2
Khadgawan	OW	Salka	23.019791	82.285521	202	18	Talchir	Tillite, Sandstone, Siltstone and Boulder	15-17,44.10, 153-156	2.2
Manendragarh	EW	Barbaspur	23.299137	82.395989	202	25.5	Talchir	Shale with Sandstone	14-16	Dry
Manendragarh	EW	Bhalaur	23.263001	82.241478	202.70	18.1	Talchir	Shale, Sandstone, Siltstone	dry	Dry
Khadgawan	EW	Mero	23.135485	82.263146	202.70	12	Talchir	Shale, Sandstone	96-98	0.84
Manendragarh	EW	Putadand	23.308676	82.212177	202.60	18	Barakar	Sandstone, Shale	67-68.50	0.14
Manendragarh	EW	Bodritola	23.460922	82.004641	202.60	24	Jabalpur, Parsora, Tiki	Sandstone, Shale, Shaly coal	95.90-99.00	0.8
Sonhat	EW	Badwar	23.367823	82.556583	153.90	19	Barakar	Sandstone, Shale, Shaly coal	25.80-28.80, 80.70-83.70,108.10-111.20	4.36
Sonhat	OW	Badwar	23.367848	82.556418	147.80	18	Barakar	Sandstone, Shale, Shaly coal	80.70-83.70,111.20-114.20	4.56
Sonhat	EW	Beliya	23.474050	82.550153	184.40	6.1	Barakar	Shale, Clay, Sandstone	49.5-50.0	Negligible
Sonhat	EW	Kerajhariya	23.363300	82.499151	202.80	8	Barakar	Sandstone, Shale, Shaly coal	52-53.20,129.50-132.50	1.7

Annexure 3 Details of Chemical Analysis

Block	Location	Latitude	Longitude	Source	pH	EC	CO3	HCO3	Cl	SO4	NO3	F	TH	Ca	Mg	Na	K	Si	PO4	U	Pb	Fe
						µs/cm	mg/l														µg/l	mg/l
Baikunthpur	Baikunthpur	23.260780	82.560050	HP	7.6	904	0	244	113	55		0.21	290	68	29	76	0.9	13	0			0.065
Baikunthpur	Baikunthpur	23.258333	82.550000	BW	6.9	130	0	24	18	6.94	14	0.0	50	10	6	3	5	14	0	0		
Baikunthpur	Baikunthpur Road	23.316120	82.528960	HP	7.8	566	0	207	28	33		6.5	100	16	14	87	0.4	9	0			1.693
Baikunthpur	Banjaridand	23.170800	82.436400	DW	7.4	405	0	207	14	16		0.13	160	48	9.6	23	1.8	10	0			0.159
Baikunthpur	Bardiya	23.318720	82.678330	DW	7.6	315	0	122	35	5		0	110	20	14	24	3.4	11	0			0.284
Baikunthpur	Charcha Basti	23.326432	82.559004	DW	7.5	229	0	98	14	4		0.54	110	36	4.8	6	0.7	14	0			0.159
Baikunthpur	Charcha Basti	23.354200	82.314900	HP	6.9	338	0	98	35	37.96	6	0.6	115	32	8	30	4	7	0	0		
Baikunthpur	Dumariya	23.264700	82.731540	DW	7.6	430	0	207	21	7.5		0.61	110	36	4.8	48	1.9	13	0			0.128
Baikunthpur	Dumariya	23.263080	82.742780	HP	7.6	376	0	207	14	0		0.35	160	40	14	16	0.4	11	0			1.067
Baikunthpur	Ghugra	23.404200	82.523700	HP	7.3	224	0	104	14	3.17	29	0.2	125	34	10	4	1	12	0	0		
Baikunthpur	Girjapur	23.301220	82.716960	HP	6.8	92	0	31	7	3.89	13	0.0	35	8	4	3	4	11	0	0		
Baikunthpur	Jamgahana	23.299989	82.612201	BW	7.8	479	0	220	14	26.28	0	1.1	220	42	28	0	0	13	0	0		
Baikunthpur	Jamgahna	23.301900	82.621100	DW	7.4	251	0	122	14	0		0.6	100	28	7.2	11	0.9	23	0			2.382
Baikunthpur	Jatasemar	23.151667	82.595833	HP	7.5	319	0	183	14	5		0.32	150	40	12	12	0.4	19	0			0.19
Baikunthpur	Kadamnara	23.194140	82.627370	HP	7.7	427	0	220	31	13		2.5	50	16	2.4	82	0.4	8	0			0.034
Baikunthpur	Katghori	23.365902	82.515659	HP	7.4	231	0	67	46	10.41	6	0.1	90	24	7	23	2	10	0	0		
Baikunthpur	Katkona	23.353440	82.678920	HP	7.6	428	0	207	21	12		0.45	170	40	17	26	0.8	14	0			0.034
Baikunthpur	Khodri	23.410300	82.482700	DW	7.4	210	0	104	18	4.14	8	0.0	105	32	6	4	3	17	0	0		
Baikunthpur	Mansukh	23.225930	82.470230	HP	7.2	733	0	244	50	25		0.11	230	80	7.2	61	0.9	16	0			0.065
Baikunthpur	Mansukha	23.226927	82.470761	HP	7.0	739	0	171	67	93.29	66.66	0.6	330	90	25	29	0	30	0	0		
Baikunthpur	Mohra	23.303456	82.634847	HP	7.2	772	0	256	91	45.1	15	0.1	355	62	48	22	2	62	0	0		
Baikunthpur	Nagar (Station)	23.316355	82.453670	HP	7.6	749	0	226	81	56.7	2	1.0	260	60	26	52	1	25	0	0		
Baikunthpur	Nagar(Tilwandar)	23.313161	82.453670	HP	7.8	368	0	183	28	12.82	1	0.2	95	24	8	52	1	15	0	0		
Baikunthpur	Patna	23.294227	82.675578	HP	7.7	393	0	171	14	12		0.42	150	44	9.6	12	0.9	20	0			0.096
Baikunthpur	Patrapali	23.221111	82.573056	DW	7.4	783	0	293	64	32		0.22	320	84	26	37	13	14	0			0.034
Baikunthpur	Patrapali	23.221111	82.573056	HP	7.6	366	0	183	7	22		0.38	140	44	7.2	25	0.4	22	0			3.133

Baikunthpur	Patrapali	23.221100	82.573000	HP	7.4	341	0	140	21	37.65	0	0.2	145	42	10	17	0	17	0	0		
Baikunthpur	Puta	23.346880	82.640550	HP	7.7	346	0	134	21	10		0.45	120	40	4.8	17	6.3	16	0			0.723
Baikunthpur	Ranai	23.280556	82.702778	HP	8.0	443	0	165	53	25.3	5	0.1	145	30	17	47	1	17	0	0		
Baikunthpur	Sarbokha	23.250000	82.358300	HP	7.5	469	0	244	7	8		0.46	120	28	12	56	2.7	12	0			0.66
Baikunthpur	Satipara	23.192000	82.611380	DW	7.5	435	0	195	14	15		0.31	160	44	12	22	6.2	9	0			0.096
Baikunthpur	Tengni	23.316699	82.739217	HP	8.0	1166	0	189	189	99.06	1	1.51	545	152	40	9	11	22	0	0		
Baikunthpur	Tummibari	23.365020	82.657310	DW	7.8	128	0	61	7	15		0.32	50	8	7.2	6.8	1.1	12	0			0.096
Bharatpur	Ara	23.593600	81.764100	HP	7.2	289	0	67	21	9.85	0	0.3	85	18	10	5	4	10	0	0		
Bharatpur	Baharsi.1	23.614555	81.849846	HP	7.8	252	0	171	14	4.15	0	0.7	150	34	16	6	3	11	0	0		
Bharatpur	Barail	23.532821	81.990671	HP	7.7	377	0	122	49	4.37	4.37	0.41	155	46	9.6	4.67	8.86	10	0	0	0.011	ND
Bharatpur	Bharatpur	23.732327	81.775782	BW	7.7	658	0	189	52.5	59.75	59.75	0.03	235	50	26.4	31.1	6.67	14	0	0	0.009	0.978
Bharatpur	Chutki	23.569896	81.911167	HP	7.4	303	0	116	42	4.42	0	0.2	145	42	10	5	1	13	0	0		
Bharatpur	Dhovatal	23.572361	81.960042	DW	7.9	513	0	128	80.5	19.31	19.31	0.31	240	58	22.8	7.67	2.31	16	0	0	0.005	ND
Bharatpur	Umarwah	23.582070	81.896185	BW	7.7	150	0	61	14	3.96	3.96	0.66	70	16	7.2	1.94	1.68	2.6	0	0	0.003	0.056
Khadgawan	Akhradand	23.204129	82.247921	HP	7.7	1092	0	433	84	71.59	39	0.3	440	128	29	50	32	21	0	0		
Khadgawan	Banjaridand	23.172500	82.449700	BW	6.9	1727	0	159	81	537.7	0	0.0	790	254	37	29	0	7	0	0		
Khadgawan	Barbaspur	23.300390	82.398280	HP	7.4	411	0	134	35	21		0.16	180	48	14	16.5	0.5	14	0			3.728
Khadgawan	Bhauta	23.087320	82.177230	HP	7.2	502	0	244	21	12		1.83	110	28	9.6	71	1.9	14	0			0.159
Khadgawan	Bodemuda	23.023140	82.392270	HP	7.1	478	0	244	14	4		0.26	60	16	4.8	87	0.5	14	0			0.503
Khadgawan	Chirmi	23.100440	82.545700	HP	7.6	435	0	159	14	5		0.52	150	44	9.6	23	0.4	14	0			0.034
Khadgawan	Chirmiri	23.216930	82.344910	HP	7.7	302	0	134	28	5		0.36	150	40	12	4.7	1.8	15	0			1.943
Khadgawan	Chirmiri	23.216701	82.345219	HP	7.5	251	0	116	21	10.11	0	0.1	125	30	12	6	0	14	0	0		
Khadgawan	Chote Salhe	23.082360	82.530110	DW	7.5	224	0	122	7	5.5		0.33	90	20	9.6	14	0.7	11	0			0.128
Khadgawan	Jilda	23.050170	82.476550	HP	7.1	393	0	232	7	2		0.24	160	36	17	24	2.2	14	0			0.159
Khadgawan	Jilda	23.050000	82.476600	HP	7.7	544	0	214	39	51.75	2	0.2	250	68	19	20	3	12	0	0		
Khadgawan	Katkona	22.983630	82.281640	HP	7.8	487	0	268	21	8		1.55	150	20	24	54	0.4	12	0			0.034
Khadgawan	Khadgawan	23.108333	82.379167	HP	7.3	1079	0	189	147	78.41	72.59	0.4	340	72	38	87	3	49	0	0		
Khadgawan	Khadgawan	23.110470	82.383250	HP	7.8	1432	0	329	170	94		0	480	116	46	88	5.1	30	0			2.037
Khadgawan	Khadgawan	23.116080	82.381098	HP	6.7	104	0	31	7	3.31	19	0.9	50	10	6	3	0	16	0	0		
Khadgawan	Khandora	23.136667	82.574167	HP	7.5	445	0	207	21	12		1.67	70	16	7.2	73	0.4	38	0			0.347

Khadgawan	Mero	23.135680	82.263210	HP	7.3	432	0	183	21	12		0.21	110	24	12	45	0.4	21	0					1.036	
Khadgawan	podidih	23.026386	82.085942	BW	7.9	531	0	177	42	26.03	65.43	0.6	215	48	23	31	2	21	0	0					
Khadgawan	Pouri	23.038611	82.499444	HP	8.0	477	0	128	63	14.62	44.94	0.3	150	32	17	42	1	17	0	0					
Khadgawan	Sajapahar	23.211350	82.301100	HP	7.2	536	0	293	21	14		0.14	230	48	26	29	1.7	20	0						0.065
Khadgawan	Singhat	23.118610	82.439960	HP	7.5	546	0	183	42	24		0.17	210	56	17	34	0.6	17	0						2.069
Manendragarh	Amritdhar	23.332475	82.323727	HP	7.7	452	0	189	31.5	6.74	0.27	0.19	195	54	14.4	5.72	6.42	11	0	0	0.014				ND
Manendragarh	Bairagi	23.452552	82.224064	BW	7.8	256	0	116	14	6.31	13.16	0.61	130	30	13.2	0.48	2.04	2.3	0	0	0.006				ND
Manendragarh	Banhi	23.348162	82.196567	BW	7.2	387	0	159	24.5	10.31	0.87	0.43	160	36	16.8	3.57	3.47	6.8	0	0	0.014				0.091
Manendragarh	Belbehra	23.291128	82.267459	HP	7.5	366	0	195	21	12.34	0	0.0	130	30	13	29	1	18	0	0					
Manendragarh	Biharpur	23.403544	82.243029	HP	7.4	646	0	281	56	22.33	0	1.51	140	36	12	82	1	16	0	0					
Manendragarh	Chainpur	23.222000	82.151400	HP	7.1	110	0	37	18	6.66	0	0.1	55	12	6	3	2	7	0	0					
Manendragarh	Dhanhar	23.506727	81.948806	HP	7.5	546	0	226	24.5	36.58	0.48	0.61	260	62	25.2	0.86	7.15	8.9	0	0	0.006				ND
Manendragarh	Dodki	23.454880	82.005660	HP	7.1	125	0	31	14	3.32	5	0.1	45	8	6	2	2	11	0	0					
Manendragarh	Garundol	23.377599	82.302493	HP	7.3	412	0	226	14	10.92	0	0.3	175	40	18	17	3	10	0	0					
Manendragarh	Godrakund	23.393760	82.209702	HP	8.0	120	0	54.9	10.5	2.99	0.31	0.27	55	20	1.2	2.93	1.6	1.2	0	0	0.006				ND
Manendragarh	Kachhod	23.432419	82.166322	BW	7.2	370	0	189	17.5	9.21	1.07	0.43	140	34	13.2	15	5.09	11	0	0	0.005				0.301
Manendragarh	Kalua	23.465724	82.026917	DW	7.3	472	0	146	63	7.3	10.7	0.27	220	46	25.2	9.2	5.67	14	0	0	0.008				0.123
Manendragarh	Kelhari	23.415278	82.048611	HP	6.8	115	0	43	14	4.04	10	0.5	60	20	2	4	1	6	0	0					
Manendragarh	Khongapani	23.199443	82.165315	DW	7.5	491	0	85.4	63	56.41	4.37	0.12	100	18	13.2	49	8.1	5.6	0	0	0.005				ND
Manendragarh	Manendragarh	23.216667	82.349822	BW	7.0	161	0	24	21	60.77	4	0.0	80	8	14	11	5	4	0	0					
Manendragarh	Nagpur	23.288086	82.349822	HP	7.8	513	0	171	63	23.29	0	1.51	30	10	1	101	0	10	0	0					
Manendragarh	Pendri	23.342099	82.248350	HP	7.5	243	0	85	21	22.39	0	0.2	95	16	13	13	3	6	0	0					
Manendragarh	Piparia	23.269000	82.250900	HP	7.5	582	0	256	46	22.81	1	0.9	90	20	10	98	1	16	0	0					
Manendragarh	Rojhi	23.482400	81.971490	HP	7.7	322	0	122	35	15.61	19	0.4	145	44	8	14	5	8	0	0					
Manendragarh	Salwa	23.334758	82.264697	BW	7.7	238	0	128	17.5	13.92	0.34	0.06	120	28	12	10.5	2.64	4.1	0	0	0.007				ND
Manendragarh	Sarbhoka	23.350891	82.351228	HP	8.0	566	0	311	21	11.74	0	0.2	150	36	14	78	3	19	0	0					
Manendragarh	Shripur	23.435060	82.032460	HP	8.0	301	0	165	14	7.03	4	0.0	155	32	18	5	1	14	0	0					
Manendragarh	Sirouli	23.269324	82.274089	HP	7.6	555	0	171	45.5	29.61	23.07	0.93	215	42	26.4	26.8	0.68	9.6	0	0	1.6	0.014			0.161
Manendragarh	Tarabahara	23.410572	82.180788	HP	7.7	941	0	177	133	68.27	58.69	0.2	230	56	22	110	20	6	0	0					
Manendragarh	Tilokhan	23.482339	81.971129	HP	7.8	196	0	37	28	7.47	40	0.0	60	8	10	25	2	10	0	0					

Manendragarh	Ujjiyarpur	23.301707	82.407645	BW	8.0	325	0	171	18	7.03	0	0.1	100	24	10	29	1	6	0	0		
Sonhat	Amhar	23.485463	82.483639	BW	8.01	372	0	97.6	45.5	23.88	23.88	0.99	155	32	18	10.1	1.06	5.6	0	0	0.003	4.951
Sonhat	Bikrampur	23.452017	82.484895	BW	7.1	121	0	61	11	3.91	0	0.1	60	14	6	3	2	15	0	0		
Sonhat	kailashpur	23.451281	82.523931	HP	7.6	1211	0	268	123	82.68	62.73	0.2	380	118	20	78	1	20	0	0		
Sonhat	Latma	23.374383	82.571831	HP	7.81	211	0	67.1	10.5	14.84	14.84	0.66	75	12	10.8	8.95	2.86	6.7	0	0	0.004	1.734
Sonhat	Mendrakala	23.519430	82.508030	HP	7.8	102	0	18	32	3.93	0	0.1	35	8	4	12	2	12	0	0		
Sonhat	Pusla	23.386172	82.497707	HP	7.62	131	0	61	10.5	4.19	4.19	0.2	65	18	4.8	3.82	4.52	14	0	0	0.004	ND
Sonhat	Salgawan	23.454359	82.495213	BW	7.92	455	0	177	21	29.79	29.79	0.4	225	46	26.4	2.94	2.75	9.6	0	0	0.004	ND
Sonhat	Sonhat	23.475997	82.517168	HP	7.4	436	0	67	60	28.03	59.09	0.2	145	30	17	38	8	19	0	0		