
**केन्द्रीय भूमि जल बोर्ड**

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**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 $m^3$/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 Sanstone 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.

# *Acknowledgment*

*The author is grateful to Shri Sunil Kumar, Chairman, Central Ground Water Board for giving opportunity for preparation of Aquifer Map and Management Plan of, Koriya district of Chhattisgarh state. I express my sincere gratitude to Shri Sateesh Kumar Member (East), CGWB for giving valuable guidance, encouragement and suggestions during the preparation of this report. The author is thankful to Dr. P. K Naik, Regional Director, Central Ground Water Board, NCCR, Raipur for extending valuable guidance and constant encouragement during the preparation of this report. I am extremely grateful to Sh. A.K. Biswal, Scientist-E for his continuous guidance and support during preparation of this report. The author is also thankful to Sh. Sidhant Kumar Sahu, Sc-B for the guidance and suggestions. I would like to acknowledge the help rendered by Smt Prachi Gupta, Sc-B while preparing aquifer map and 3-d disposition of aquifers. The author is also thankful to Sh Uddeshya kumar, Sc-B for rendering help and valuable inputs while preparing the report. The author is also thankful to Sh Rakesh Dewangan, Sc-B for the chemical analysis and valuable inputs on quality issues. The author is also thankful to Sh A. K. Sinha, Sc-B for sharing the geophysical studies. The efforts made by Sh. T.S. Chouhan, Draftsman, for digitization of maps are thankfully acknowledged. The author is also thankful to the state agencies for providing the various needful data. The author is thankful to Technical Section, Data Centre, Chemical Section, Report Processing Section and Library of CGWB, NCCR, Raipur for providing the various needful data.*

***Sudeepta Sundar Parida***
***Assistant hydrogeologist***

# 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 deposists 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.

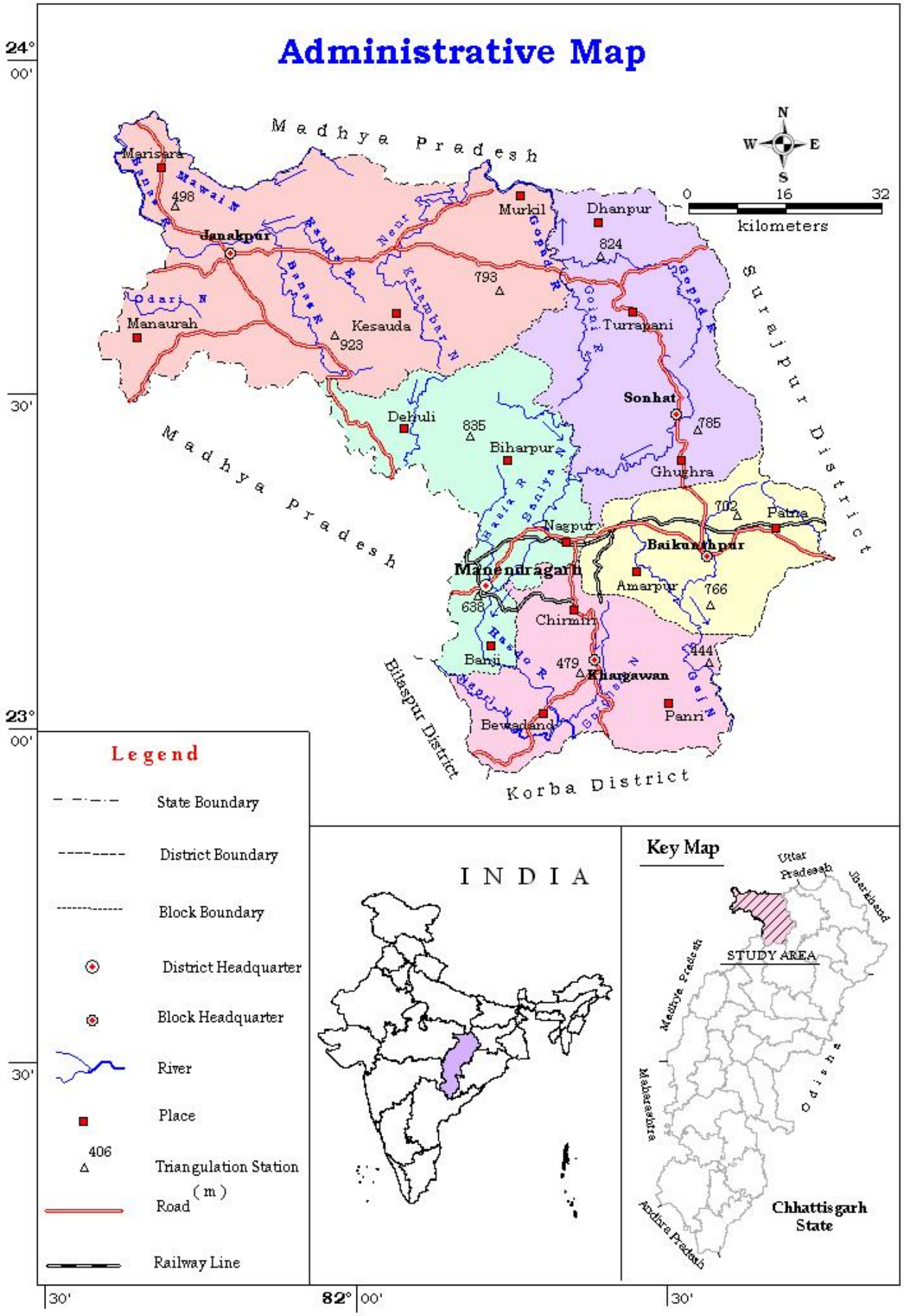


**Figure 1** Administrative Map of Koriya District

## 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.

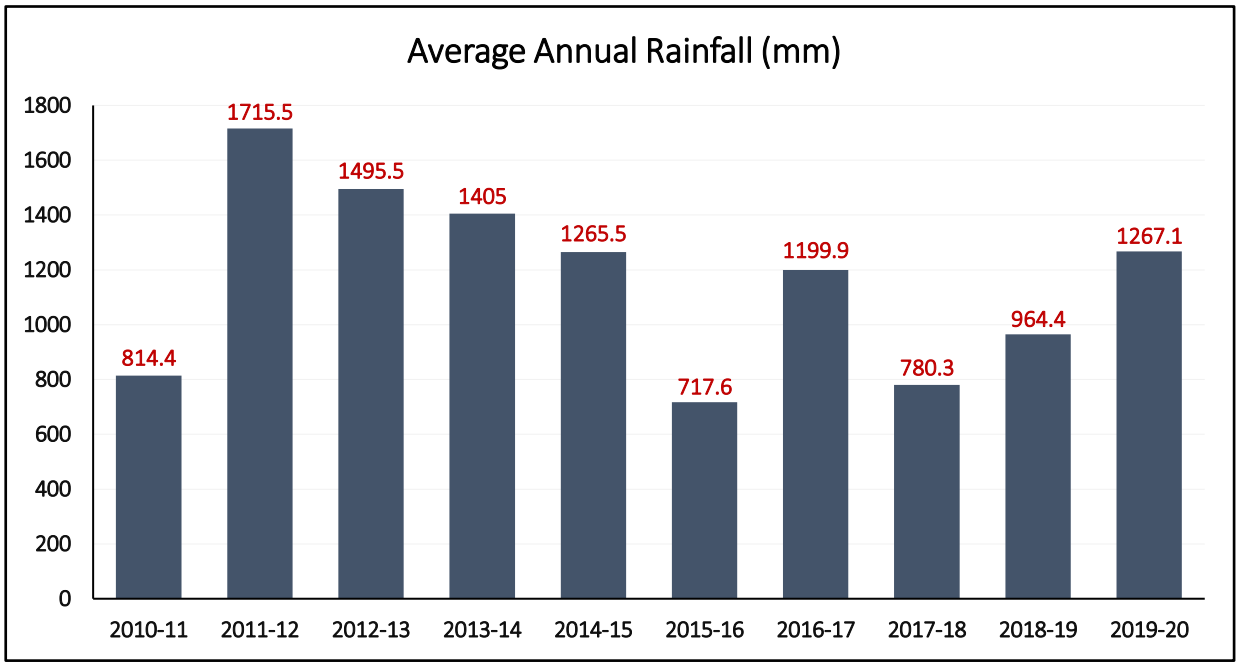


**Figure 2** Avg. Rainfall in Koriya District

## 1.7 Physiography/Geomorphology

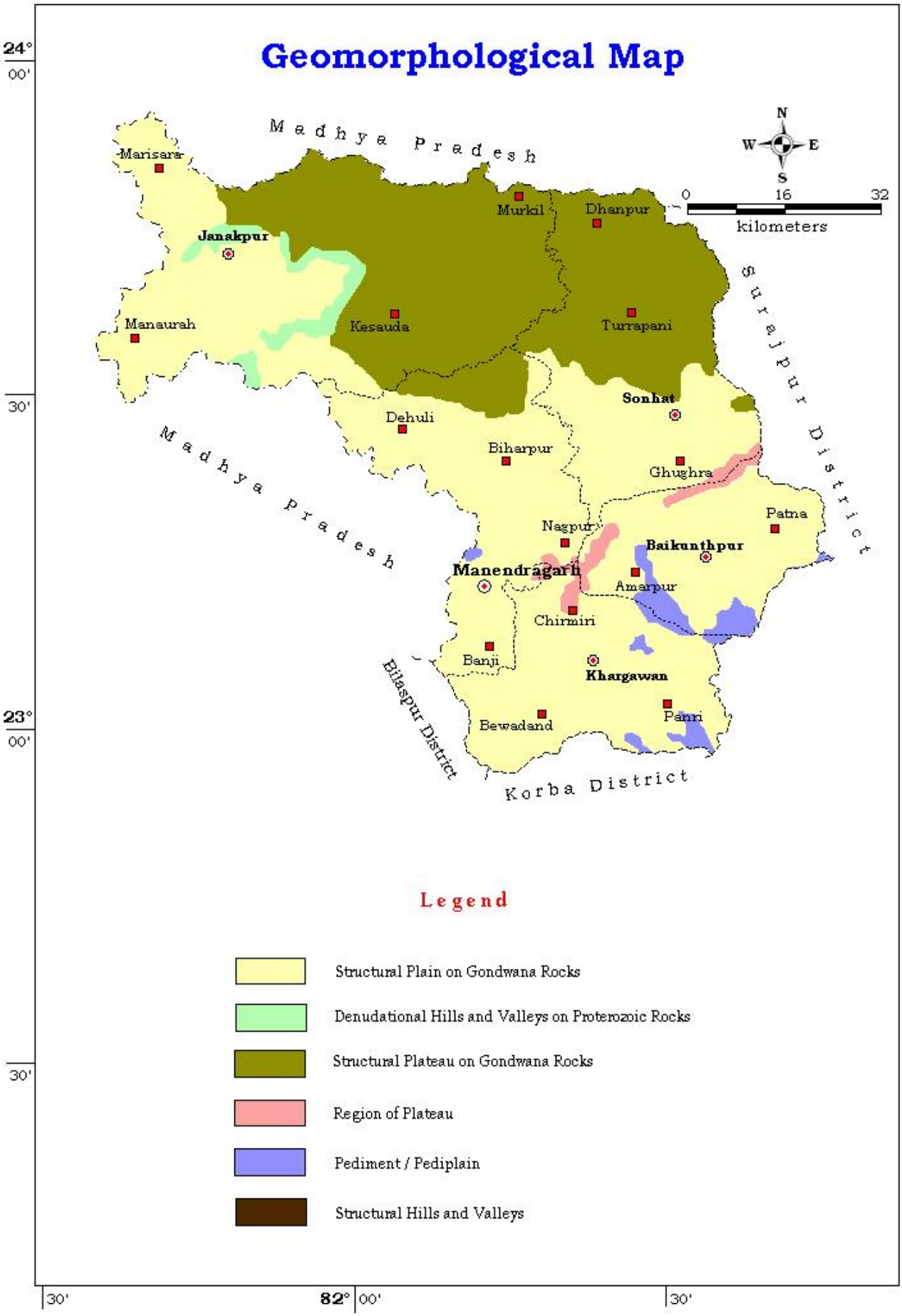


**Figure 3** Geomorphology Map of the study area

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 plateaues, steep slopes and scarps. The Basaltic terrain is characterized by highly undulating topography with steep hills and plateau tops. The plateaues 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 cris-crossed fractures and joints. They are having gently sloping erosional surfaces and thin to moderate cover of soil.

Structural plateus are marked by extensive flat top and steep slope relief controlled by structure. Region of Plateus 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 Landuse pattern in the study area.

**Table 2** Land use pattern (in ha)

| Blocks | Total Geogra-phical 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 (Total)** | **597770** | **47130** | **37667** | **33403** | **31242** | **96978** | **9945** | **106923** |

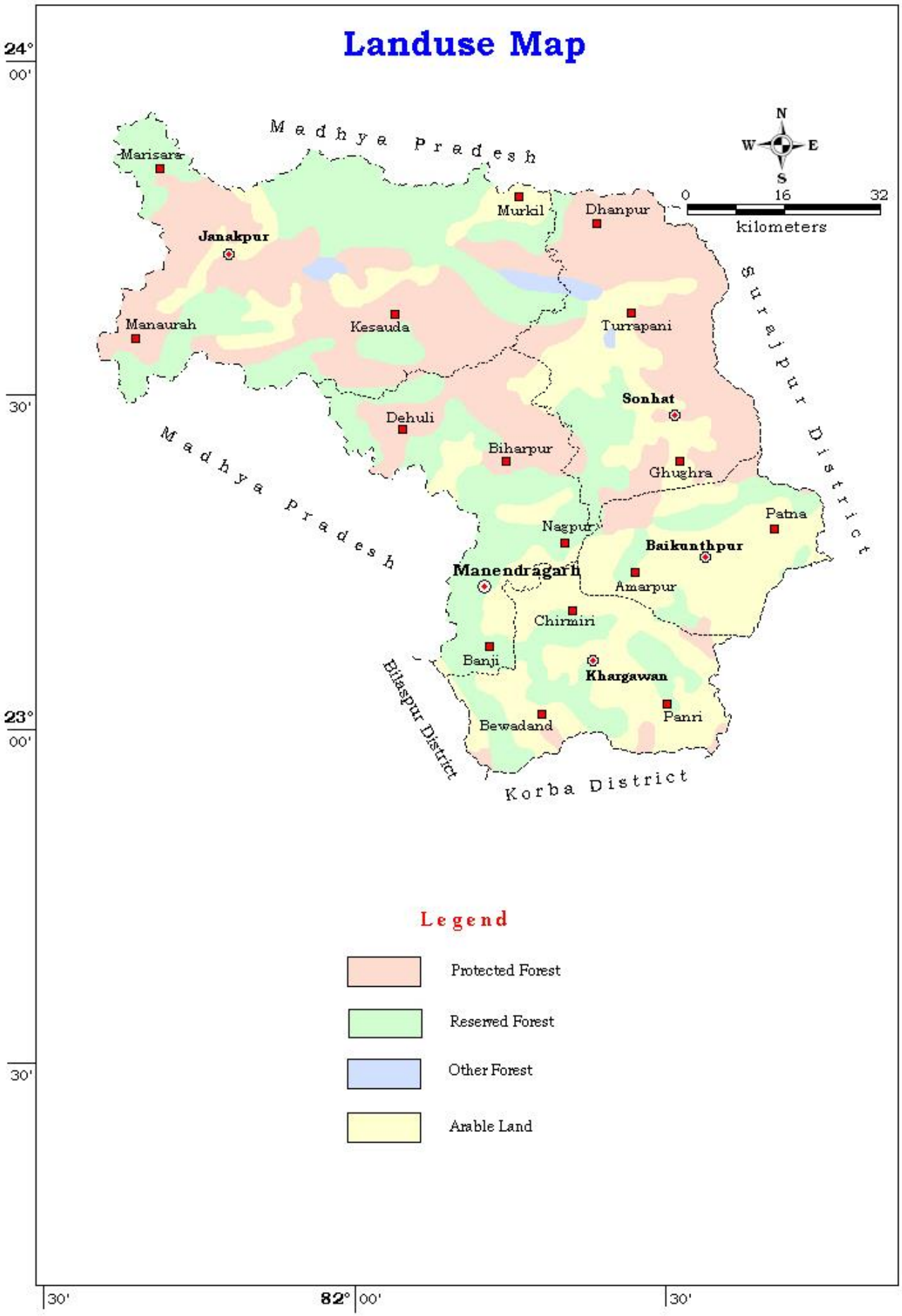


**Figure 4** Landuse map of the study area

## 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 |

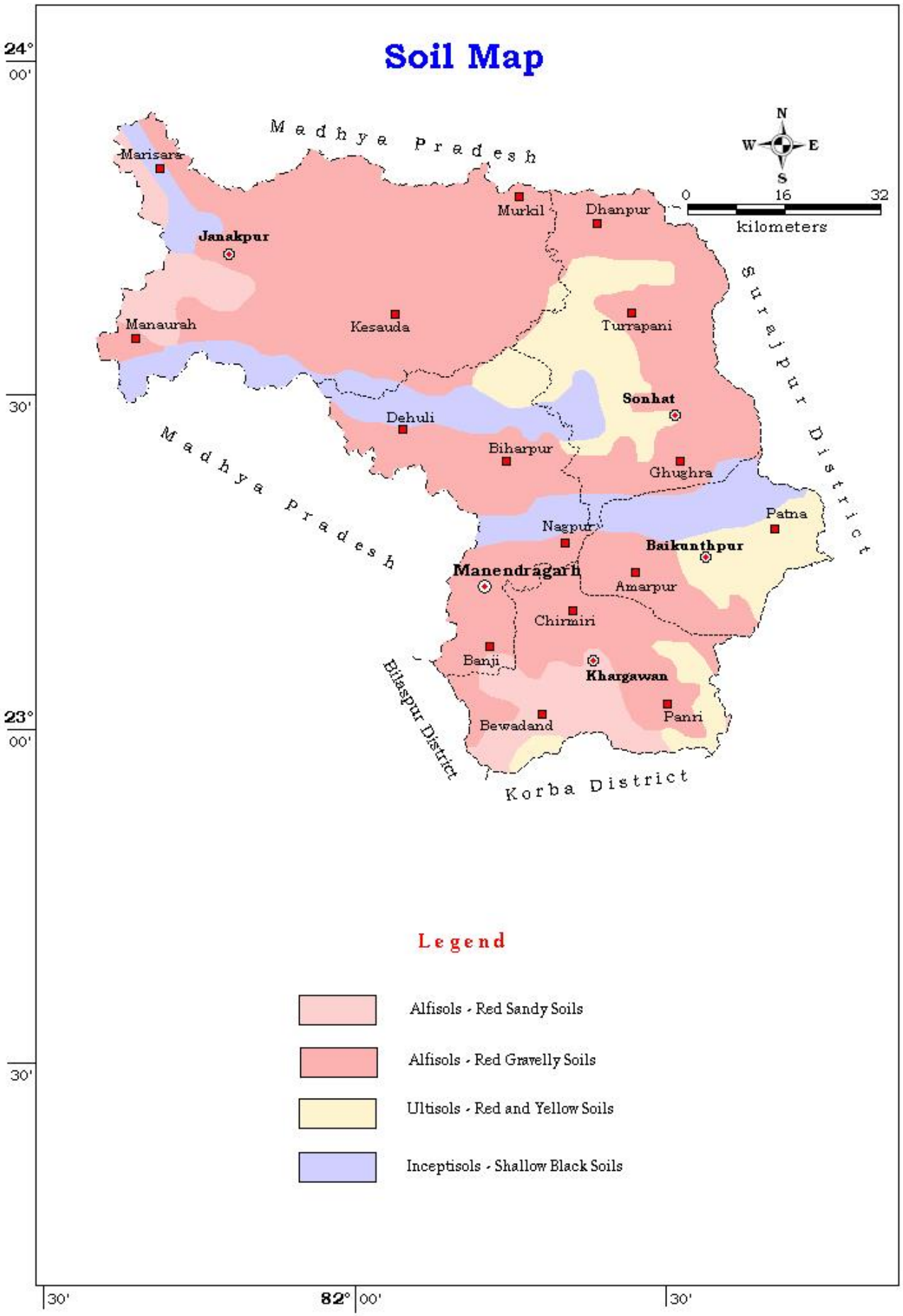


**Figure 5** Soil map of the study area

## 1.10 Hydrology and Drainage

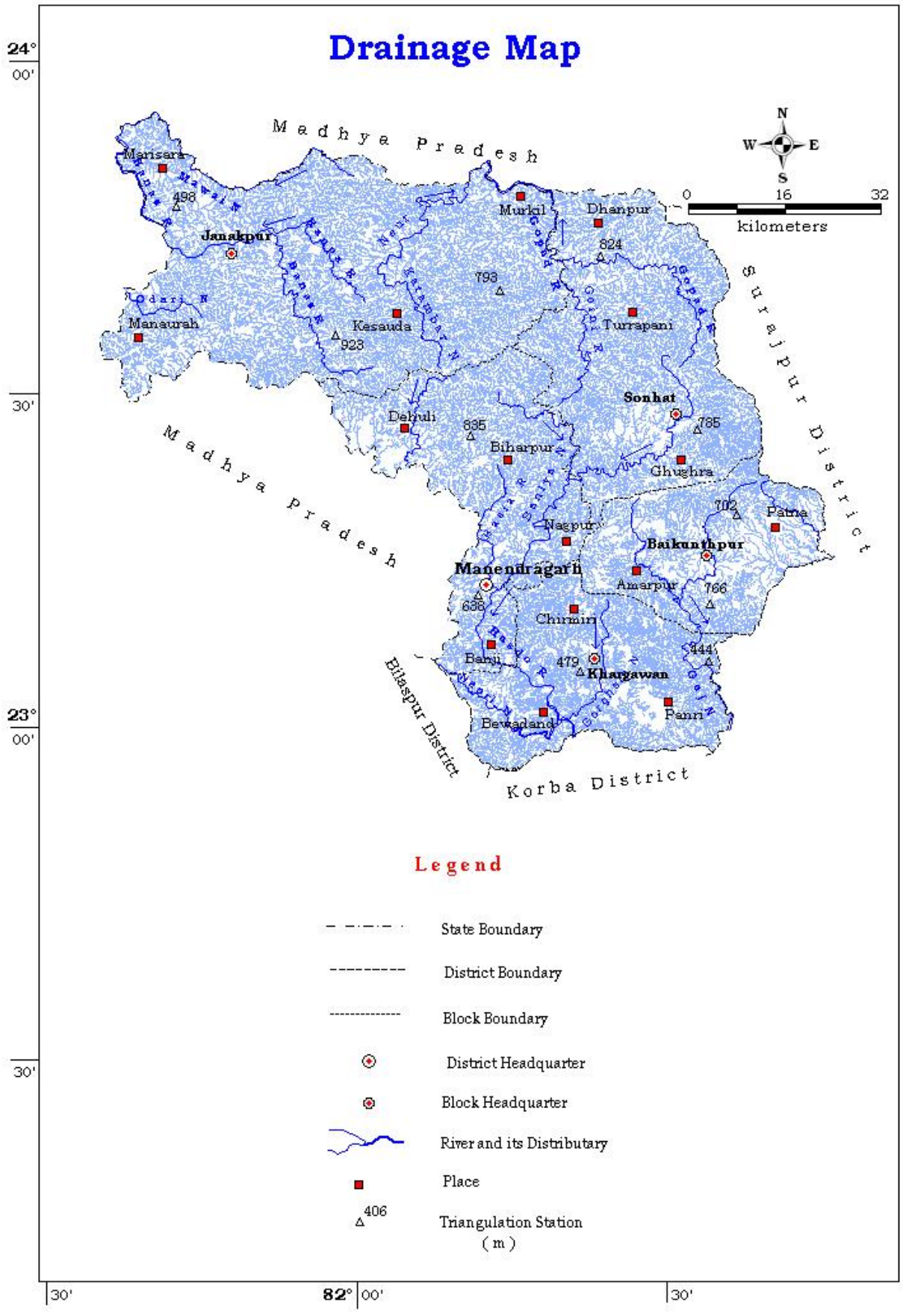


**Figure 6** Drainage map of the study area

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 Cladophebis and Equisetalous 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 |

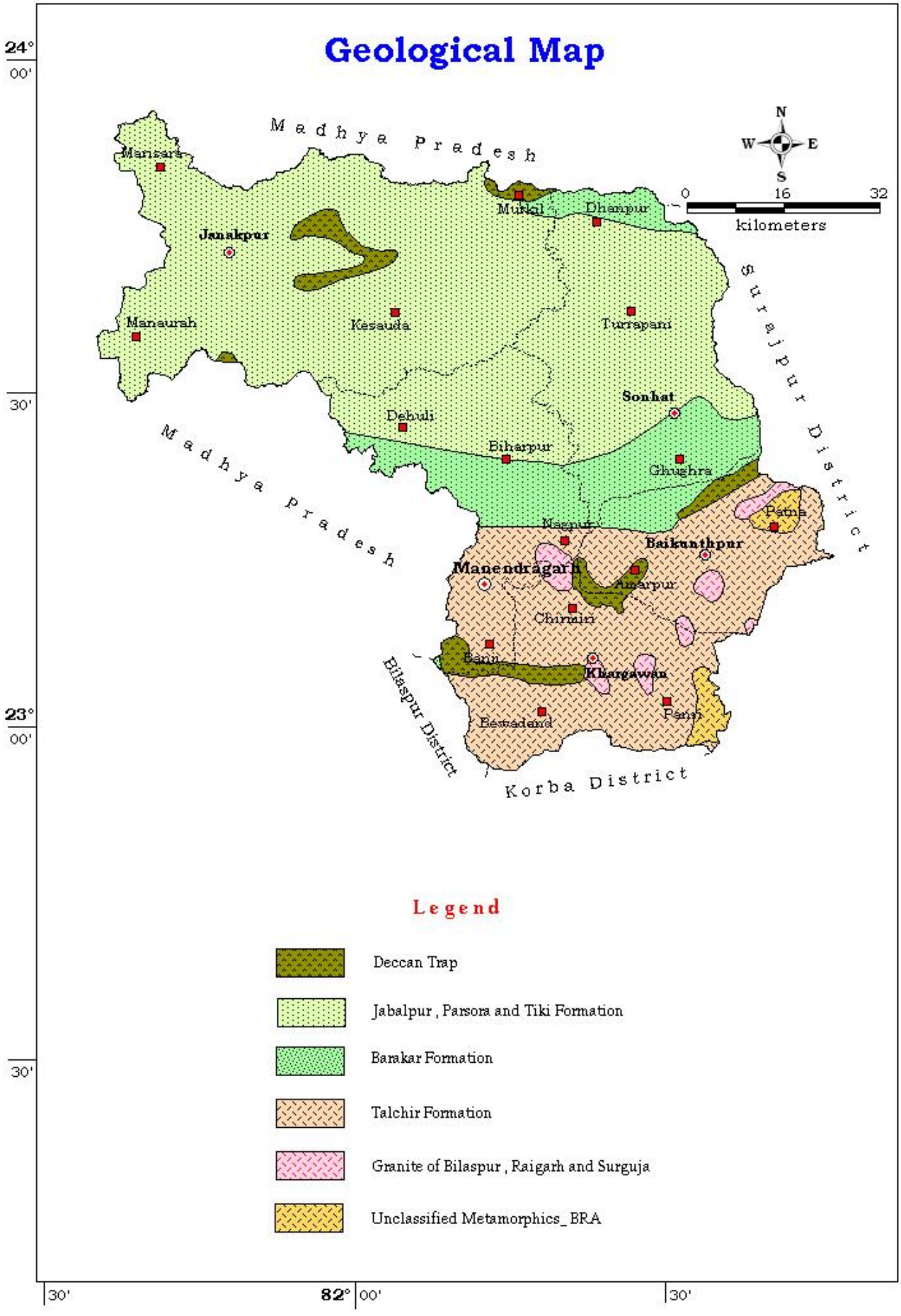


**Figure 7** Geological map of the study area

## 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.

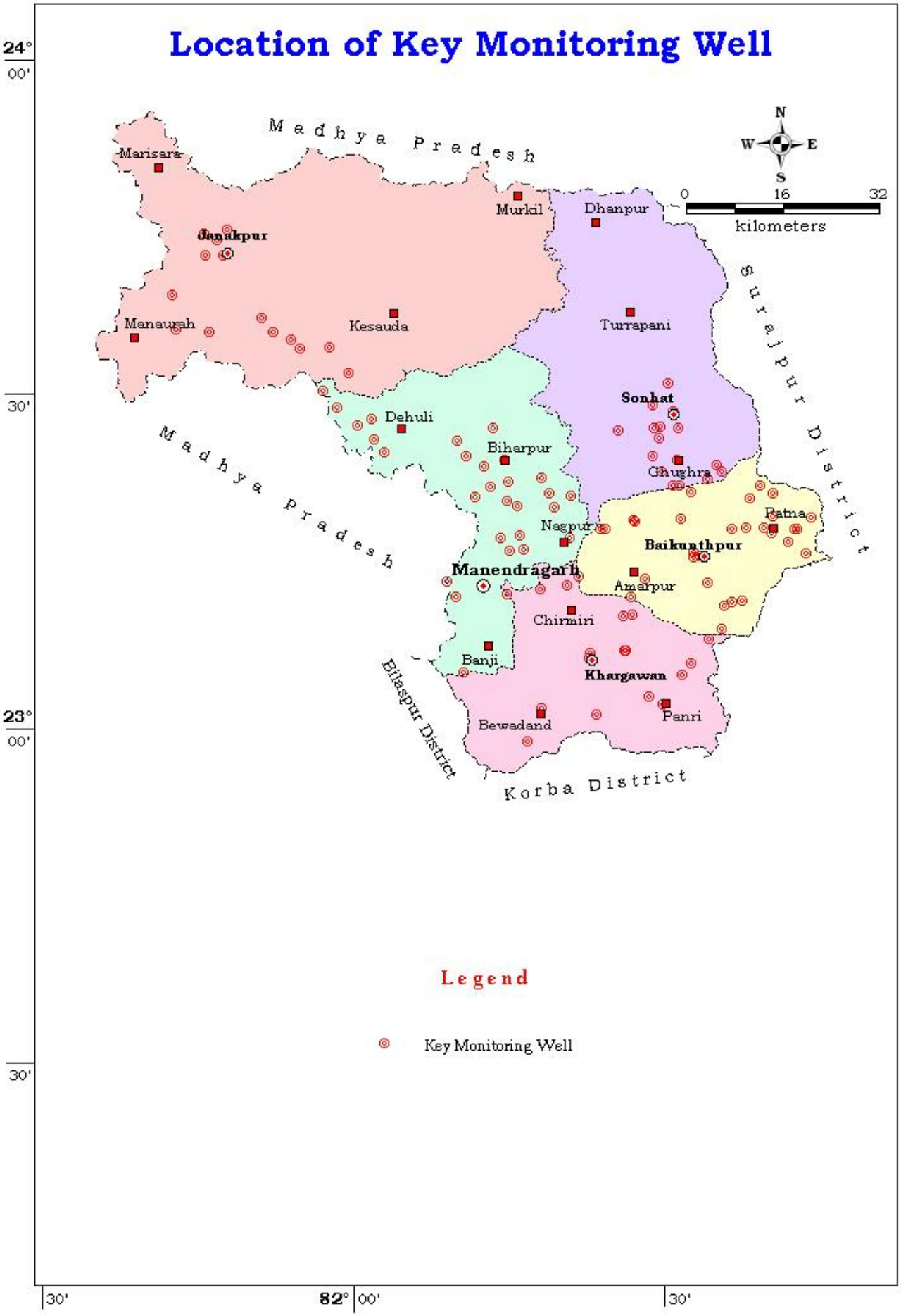


**Figure 8** Key Montoring Wells of the study area

### 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**

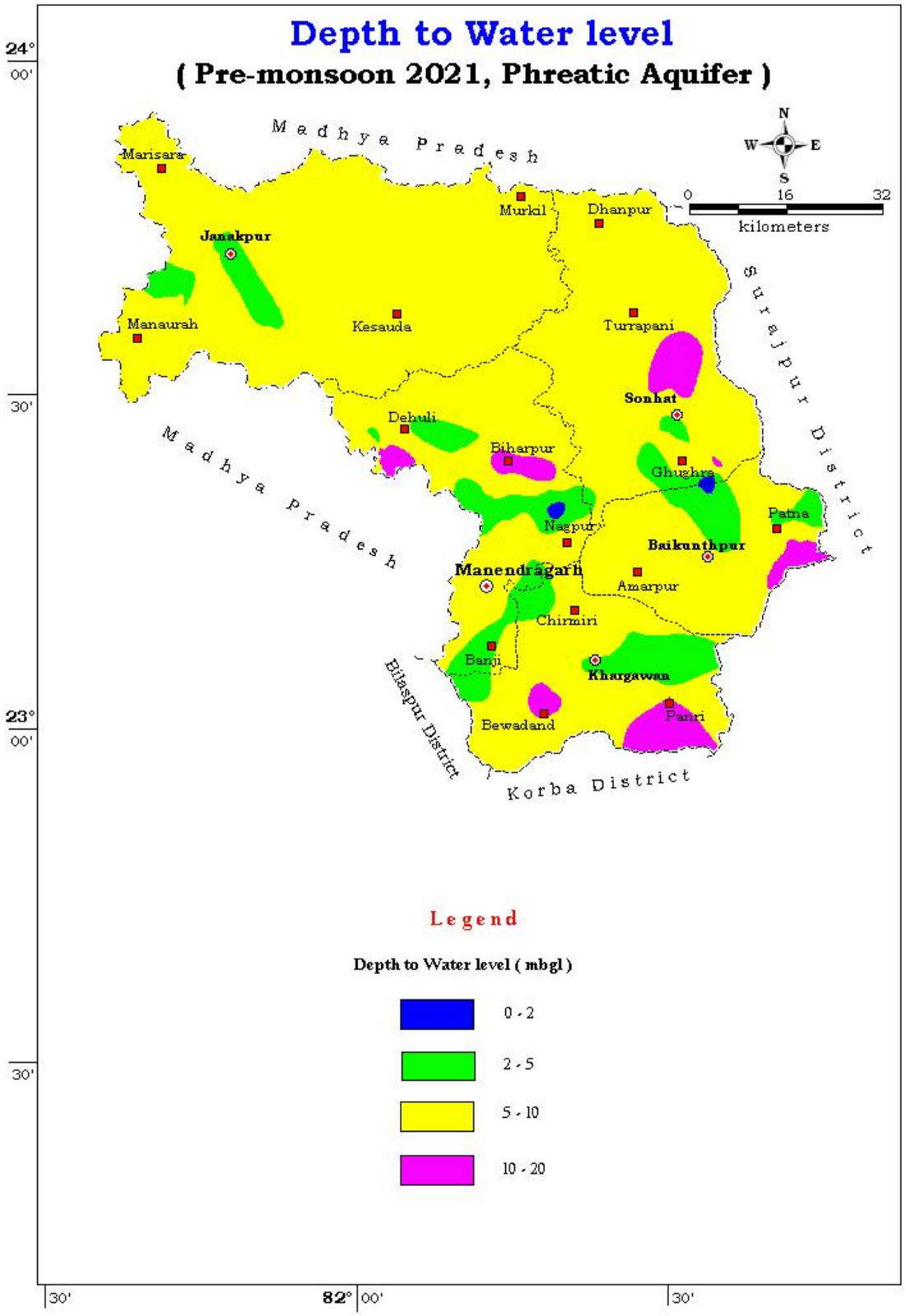


**Figure 9** Pre-monsoon Waterlevel Map of Phreatic Aquifer

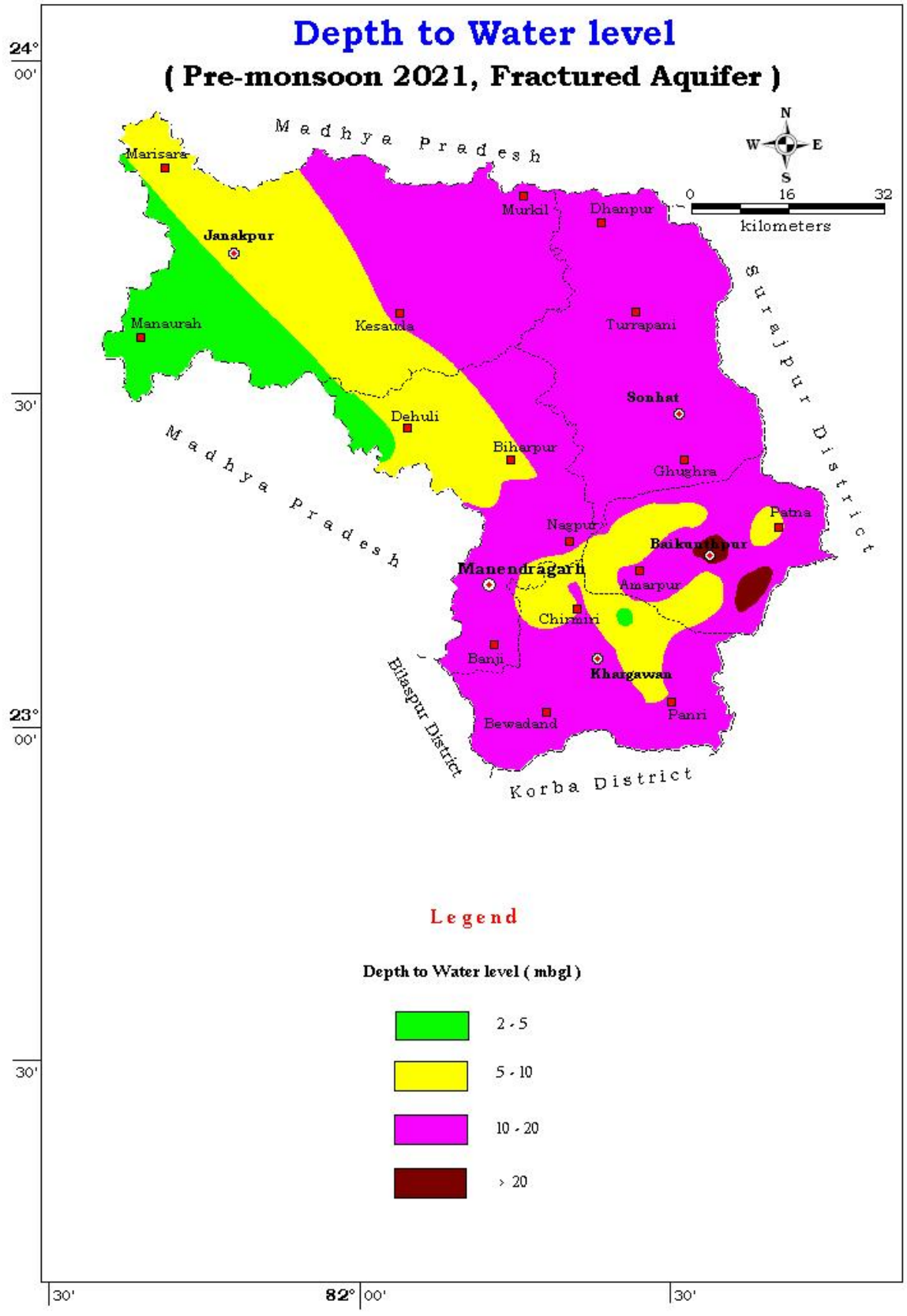


**Figure 10** Pre monsoon Water Level Map of Fractured Aquifer

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

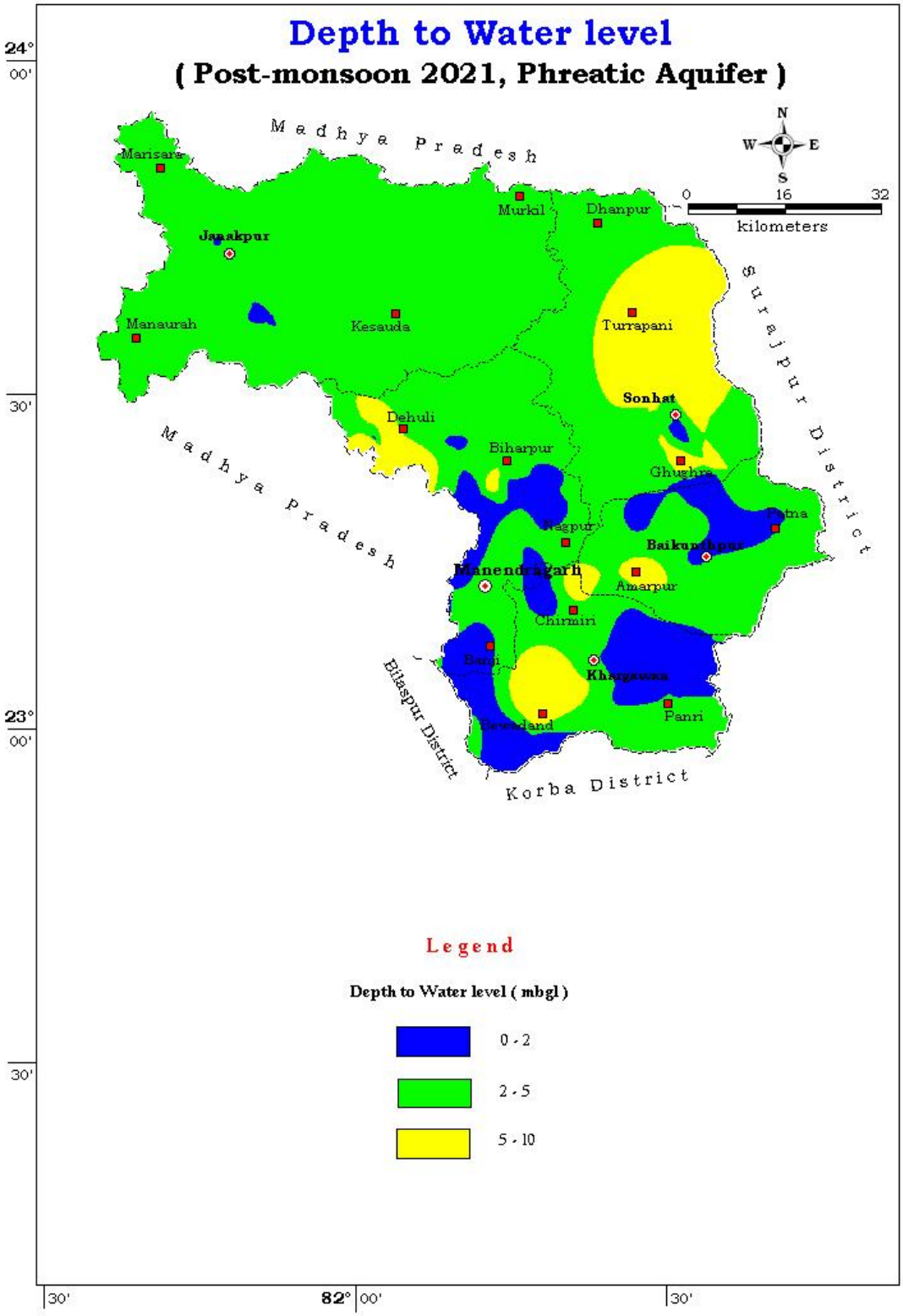

**Figure 11** Post-monsoon Water Level Map of Phreatic Aquifer

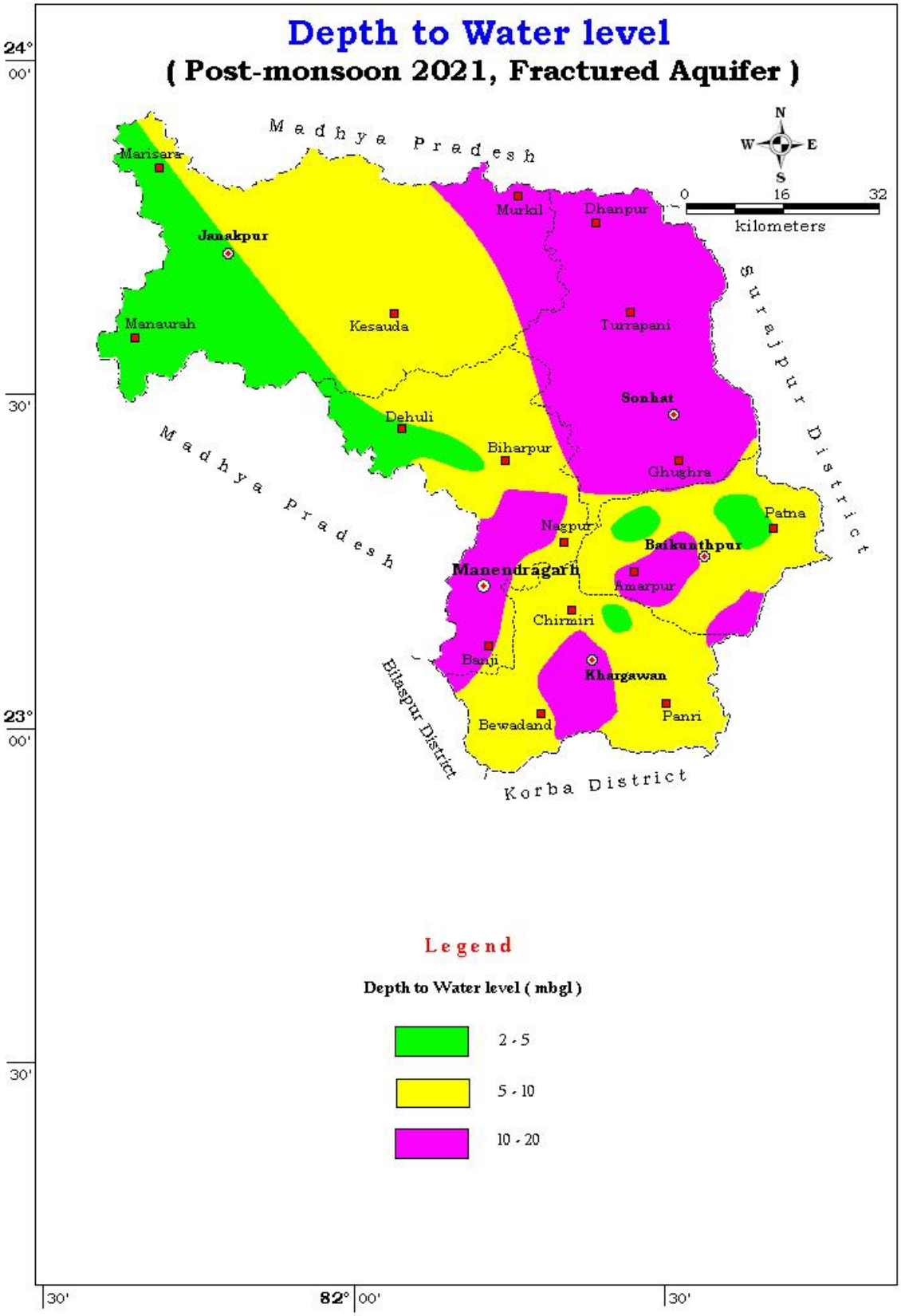


**Figure 12** Post-monsoon Water Level Map of Fractured Aquifer

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:

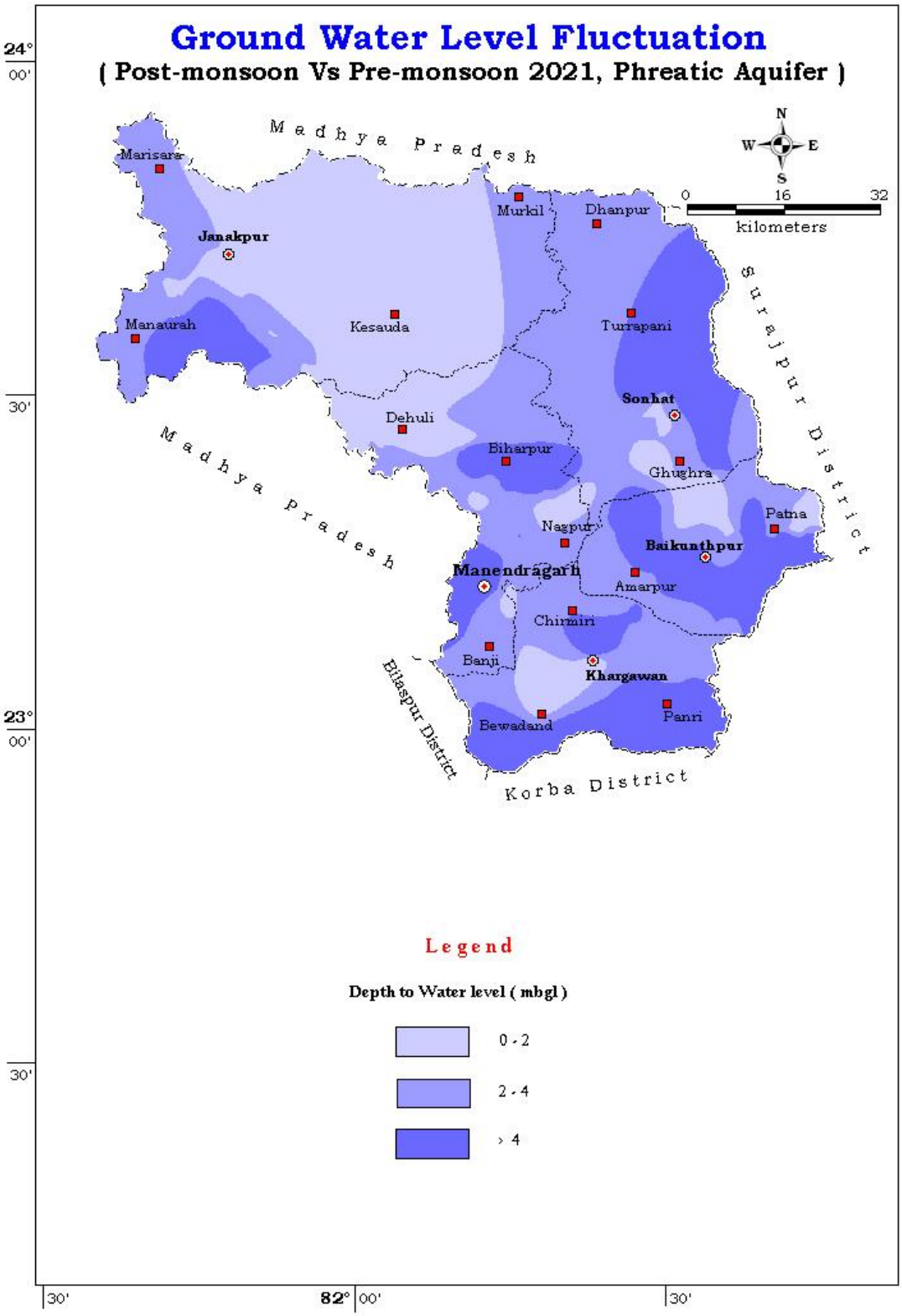


**Figure 13** Water level fluctuation of phreatic aquifer

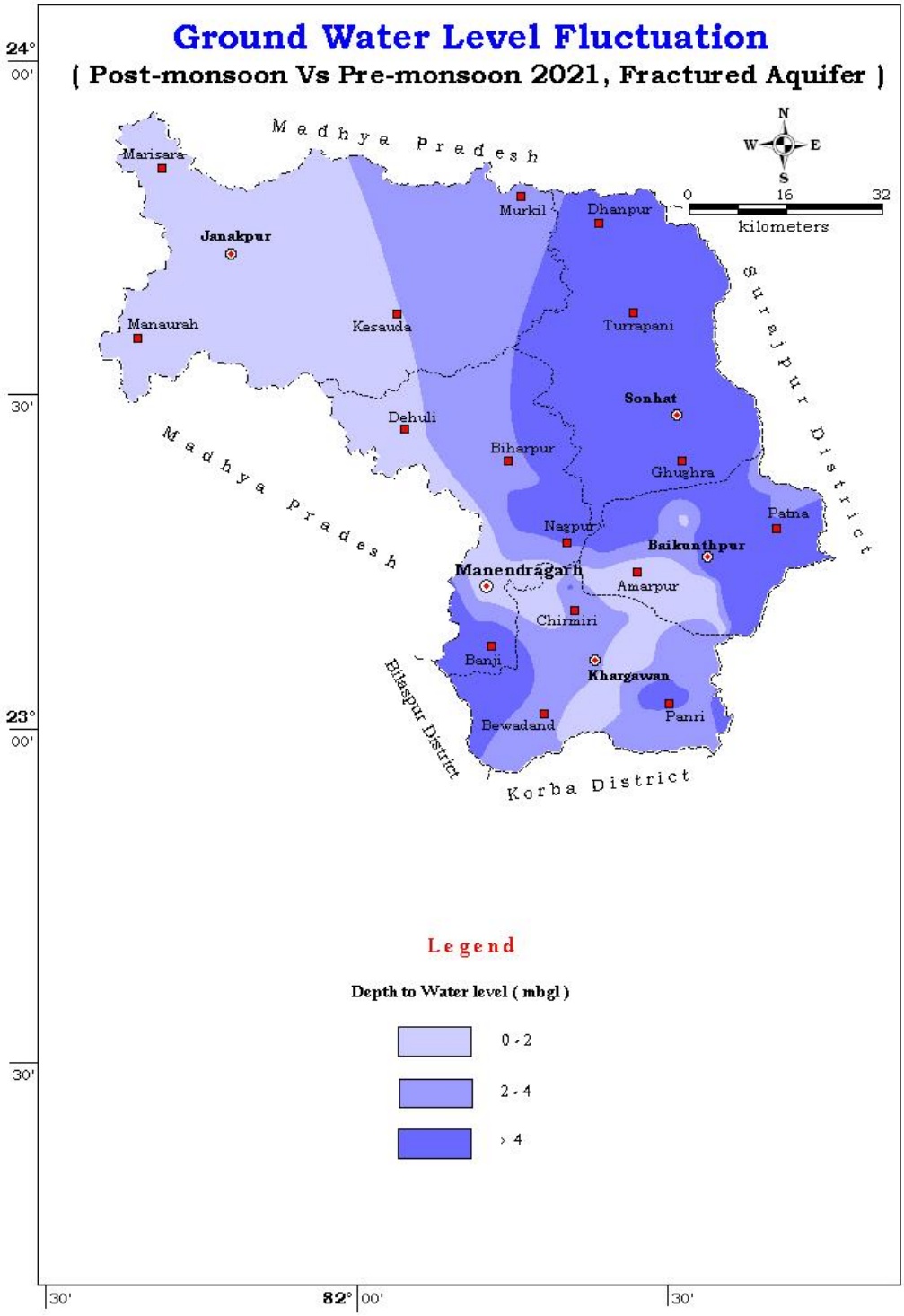


**Figure 14** Water level fluctuation of Semi-confined aquifer

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

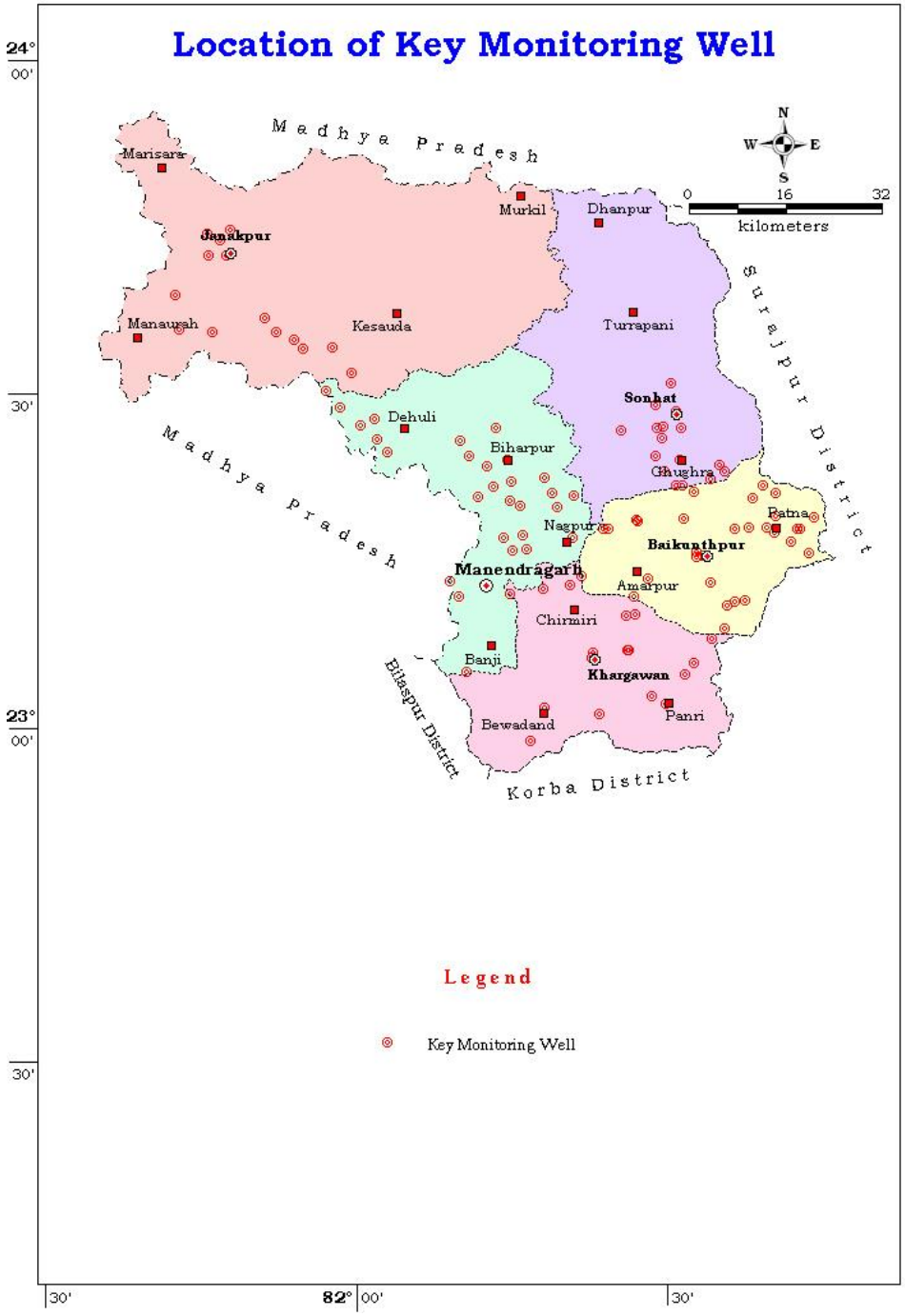


**Figure 15** Location of hydrochemical data collection

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

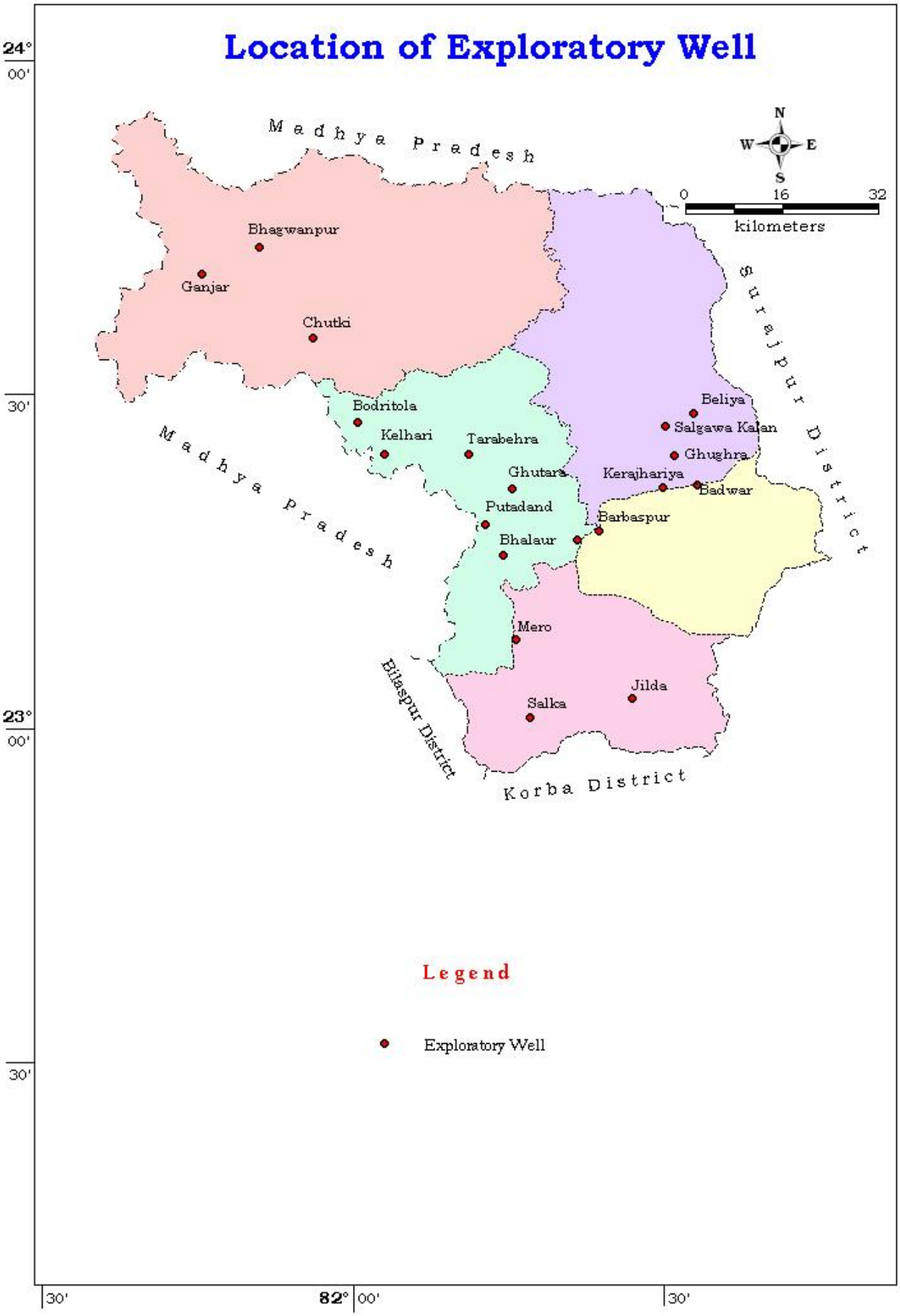


**Figure 16** Location of Exploratory wells in the study area

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 |

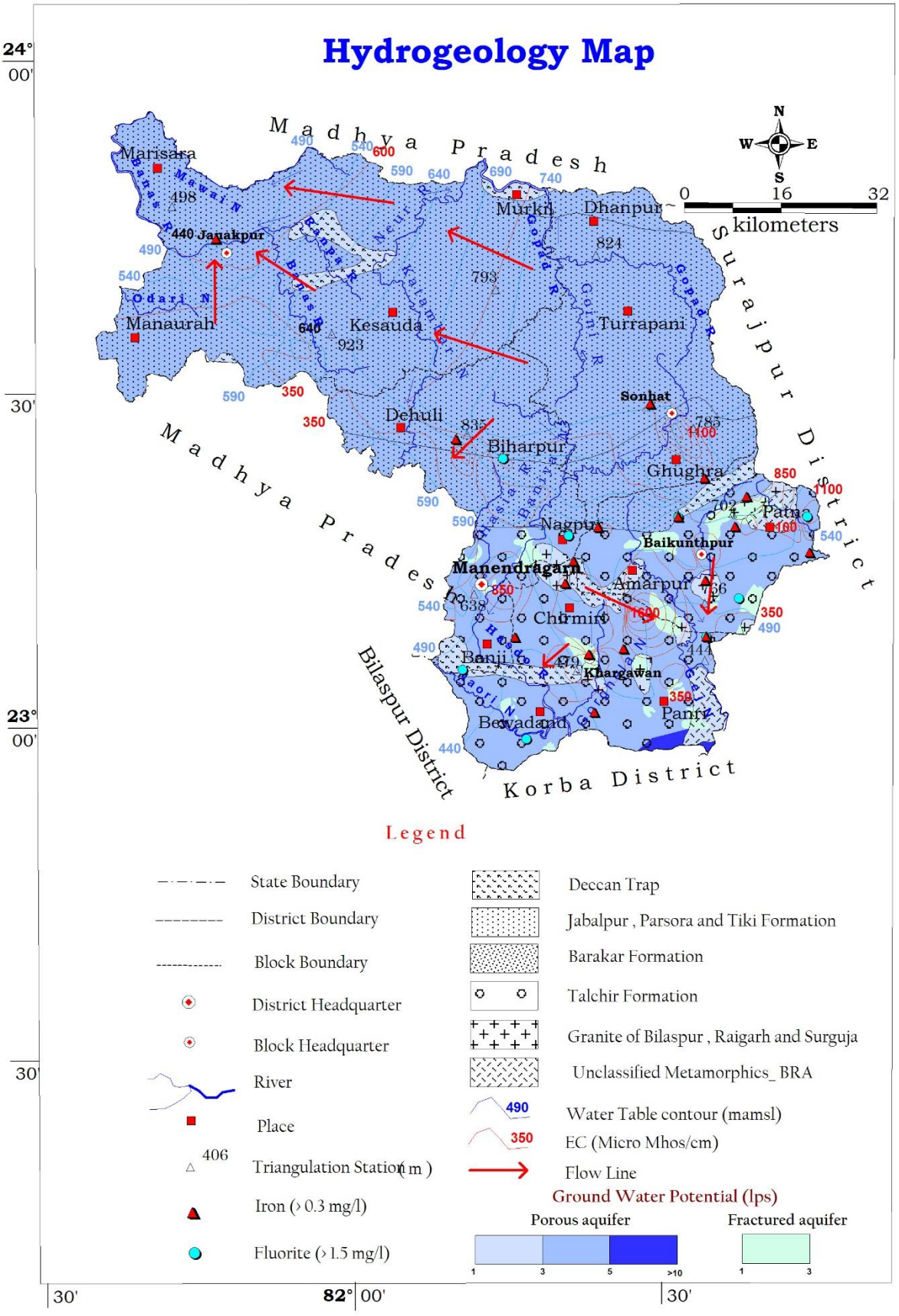


**Figure 17** Aquifer Map of the study area

## 2D Cross-section of Study area

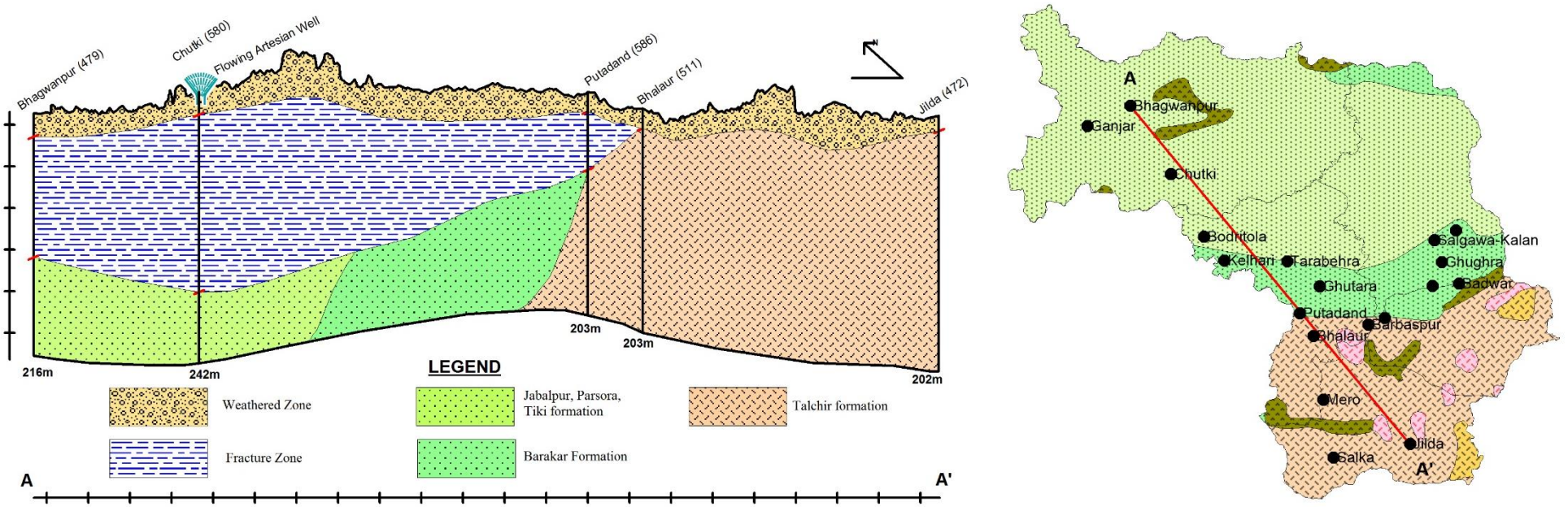


**Figure 18(A)** 2D Cross-section of the study area

# 2D Disposition of Aquifer in Koriya District

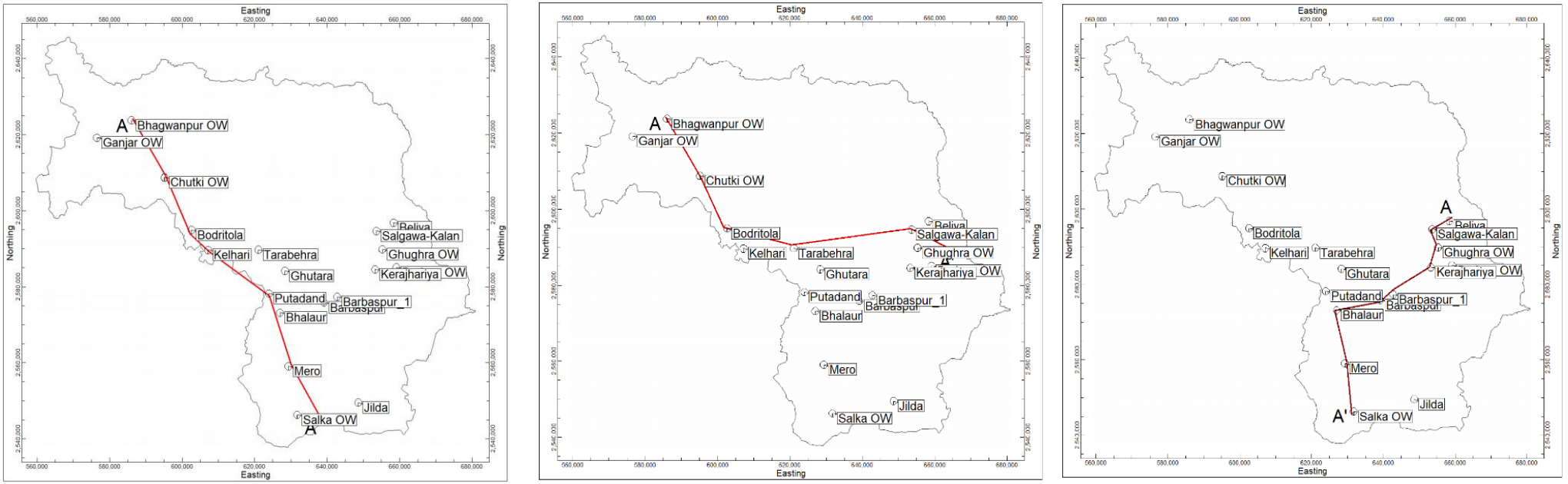


**Figure 18(B)** 2D Disposition of Aquifer in the study area

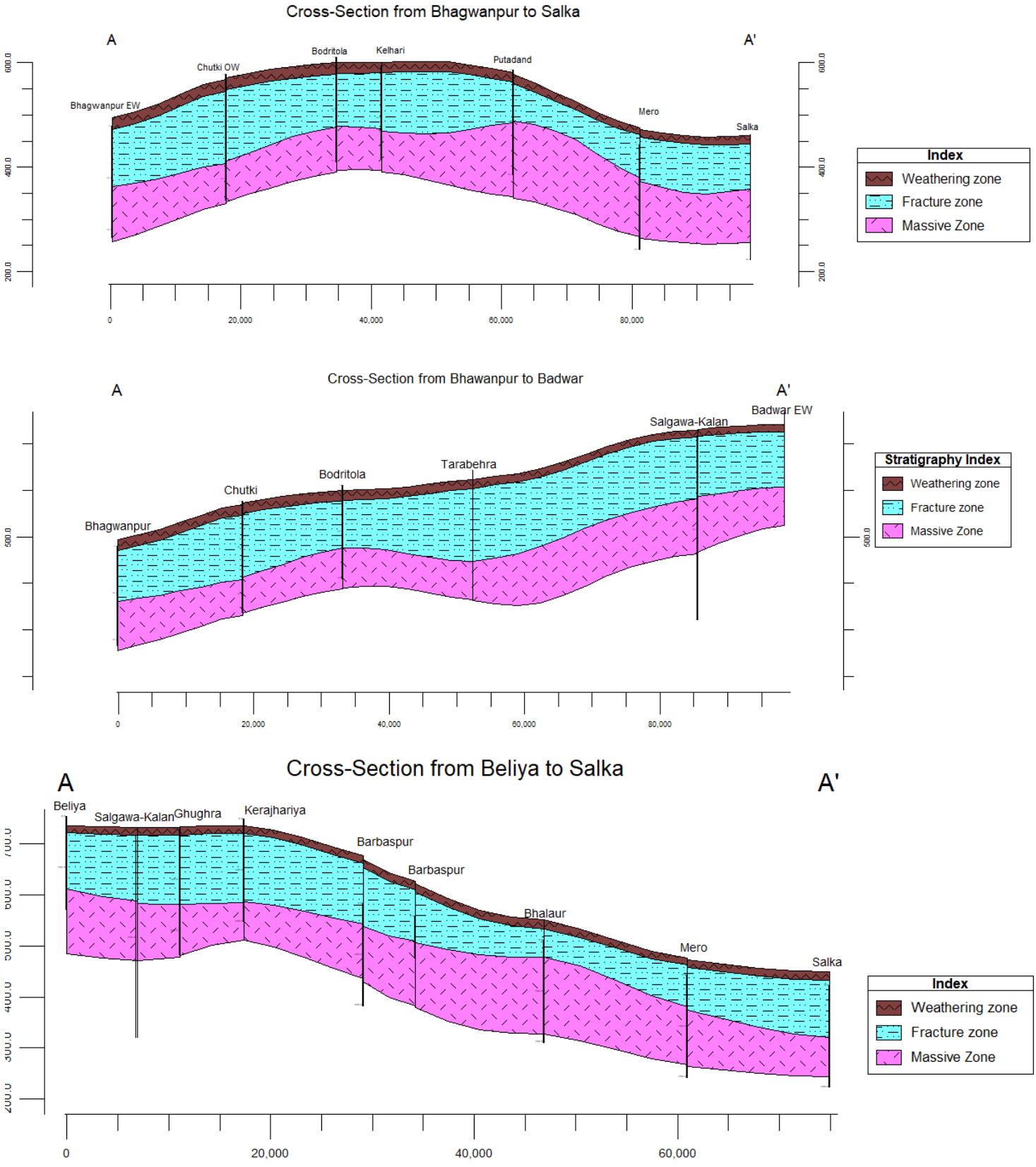


**Figure 18(B)** 2D Disposition of Aquifer in the study area

## 3D Disposition of Aquifer in Koriya District

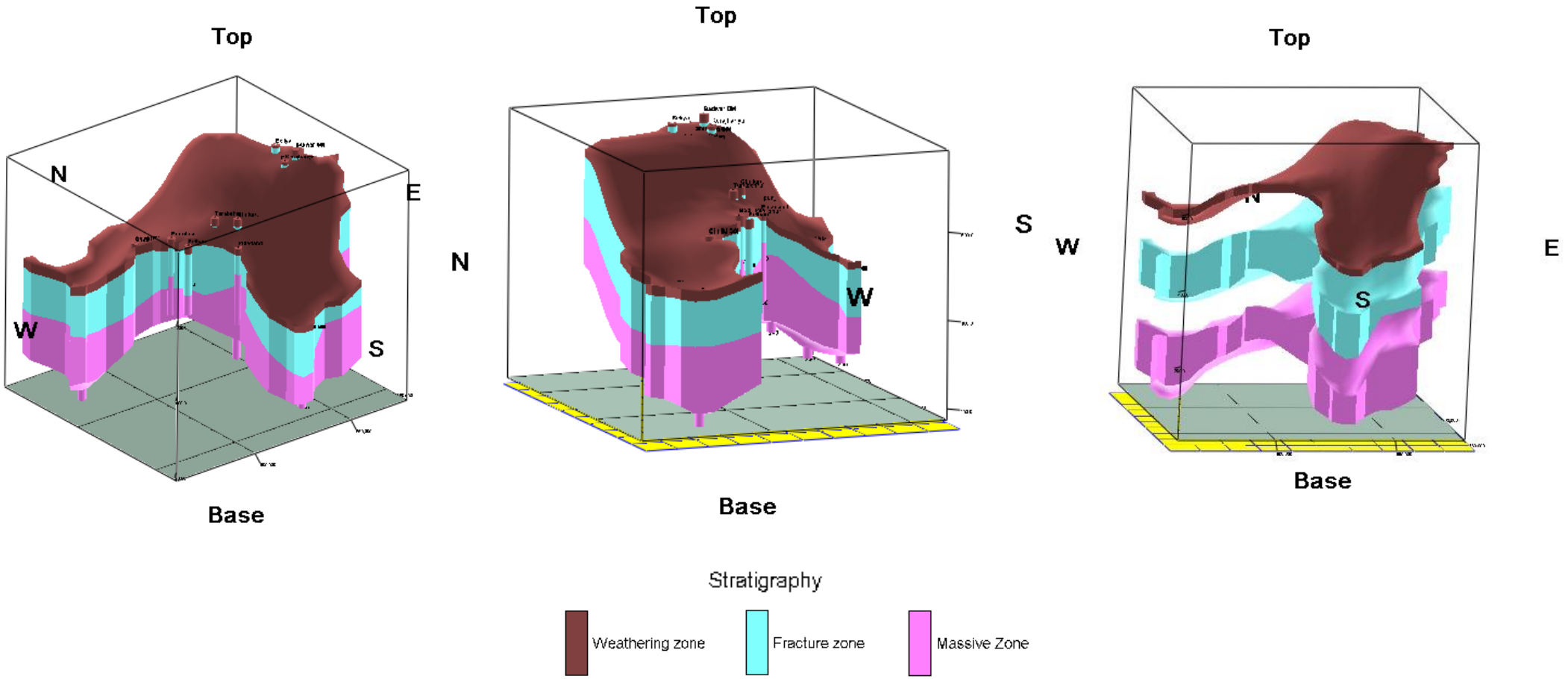


**Figure 19** 3D Disposition of Aquifer in the study area

## 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 Sonaht 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.

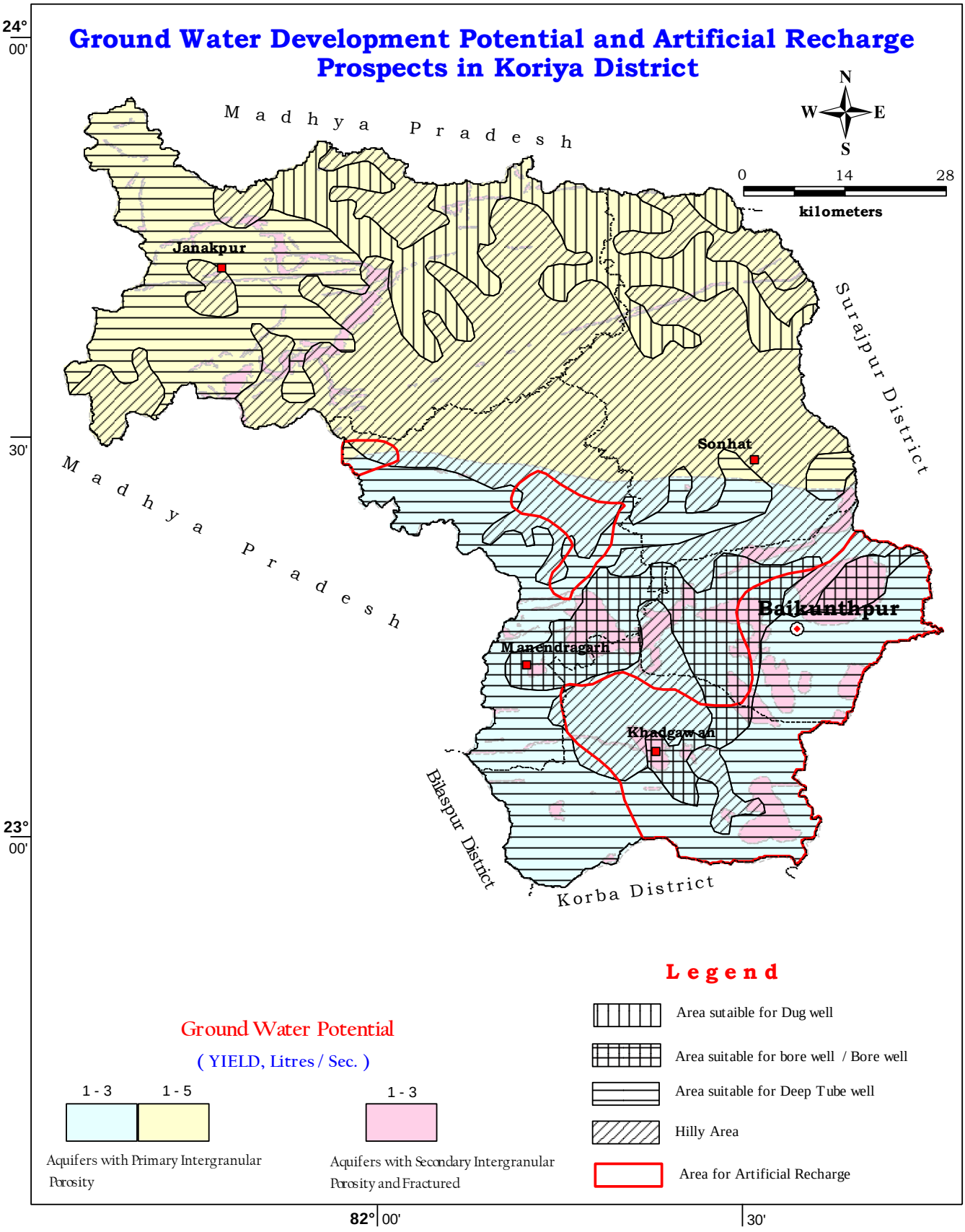


**Figure 20** Feasibility of GW Abstraction and Area Identified for Artificial Recharge Map

**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 | Katgori | 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 | Puta | 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** |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 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 | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Manendragarh | Ujiyarpur | 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 | | |