भारत सरकार
Government of India
जल शक्ति मंत्रालय,
Ministry of Jal Shakti,
जल संसाधन, नदी विकास और गंगा संरक्षण विभाग,
Department of Water Resources,
River Development and
Ganga Rejuvenation

केंद्रीय भूमि जल बोर्ड
Central Ground Water Board

NAQUIM 2.0

जलभृत प्रबंधन योजना
Aquifer Management Plan

मदनपुर एवं रफीगंज प्रखंड, औरंगाबाद जिला, बिहार
Madanpur and Rafiganj Block, Aurangabad district, Bihar

मध्य -पूर्वी क्षेत्र, पटना
Mid -Eastern Region, Patna
April -2024

Govt. of India

Ministry of Jal Shakti

CENTRAL GROUND WATER BOARD

AQUIFER MANAGEMENT PLAN OF MADANPUR AND RAFIGANJ BLOCKS, AURANGABAD, BIHAR

AAP: 2023-24

Under

National Aquifer Mapping and Management Plan (NAQUIM 2.0)

Mid EasternRegion
Patna, Bihar

April -2024

डॉ. सुनील कुमार अम्बष्ट
अध्यक्ष
Dr. Sunil Kumar Ambast
Chairman

भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन,
नदी विकास और गंगा संरक्षण विभाग
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Government of India
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Department of Water Resources,
River Development & Ganga Rejuvention
Central Ground Water Board

Message

National Aquifer Mapping and Management Programme (NAQUIM) was initiated by Central Ground Water Board (CGWB) in 2012 with the goal of mapping and managing aquifers across India to promote sustainable groundwater use. So far the entire mappable area of 25 lakh km^2 has been covered under the NAQUIM programme. While these initial efforts have been highly impactful, they faced certain limitations especially in terms of spatial resolution.

Taking it forward, CGWB has now initiated **NAQUIM 2.0,** the next phase of aquifer mapping designed to provide a deeper, more detailed understanding of India's groundwater systems. During 2023-24, CGWB had completed NAQUIM 2.0 studies in 68 study areas. The study areas were selected in consultation with the State/UT government agencies.

I am confident that this report of NAQUIM 2.0 study will serve as a critical resource for government agencies, research institutions, NGOs, and the general public. By fostering a collaborative approach to groundwater management, this report will play a key role in safeguarding and sustaining India's precious ground water resources.

(Dr. Sunil Kumar Ambast)

Chairman, CGWB

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सत्यमेव जयते

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केंद्रीय भूमि जल बोर्ड

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

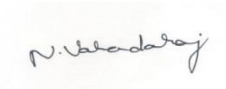
Message

A realistic evaluation of the availability and utilization of a natural resource is imperative for formulating strategies to ensure its sustainable development and its management. This significance is heightened, especially in the context of ground water in the Country, which faces escalating stress due to its extraction for diverse purposes. The consequence of this situation is a decline in ground water levels, the desaturation of aquifers and the deterioration of water quality among other issues. Ground water needs to be used and managed in a sustainable way to ensure its long-term sustainability.

The NAQUIM 2.0 study has involved meticulous fieldwork, advanced analysis, and detailed interpretation to ensure that our findings are both accurate and informative. The study covers various aspects, including availability, and potential for future development. The data and recommendations outlined after this study will be instrumental in guiding strategic decisions and supporting sustainable management of ground water resources. The findings obtained after this study are of great importance not only to policymakers and stakeholders but also to the public. Understanding the status and potential of our ground water resources is crucial for informed decision-making and fostering community engagement.

The report, titled “Aquifer Management Plan of Madanpur and Rafiganj Block, Aurangabad district” under priority type “Ground water contamination” presents comprehensive outcome of the study. The report embodies water level behavior, ground water exploration, geophysical exploration, and geochemical analysis in Madanpur and Rafiganj block of Aurangabad District, Bihar state. This is the first attempt to synthesize the entire set of related data, analyze and interpret them and to present the findings on micro level in a format that appeal to the academicians, administrators and all the stakeholders in ground water.

The commendable endeavors undertaken by the Central Ground Water Board, Mid-Eastern Region, Patna in the creation of the “Aquifer Management Plan of Madanpur and Rafiganj Block, Aurangabad district” deserve praise. I have every confidence that this report will offer substantial benefits to a wide range of stakeholders, academicians, administrators and the public alike and will go a long way in the planning and management of the ground water resources for the state of Chhattisgarh.



N.Varadaraj
Member (East)

राजीव रंजन शुक्ला
Rajeev Ranjan Shukla

भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन, नदी विकास और गंगा संरक्षण विभाग
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Central Ground Water Board

Foreword

Ground water has emerged as a primary water source for economic development in rural India, owing to its widespread availability, reliability, and cost-effectiveness. It has made significant contribution in fueling India's economic growth and fostering socio-economic progress. Along with its quantity, the quality issues also play an important role; particularly in the southern part of the state where marginal alluvium aquifer is underlain by Chhotanagpur gneiss and associated rocks forming the basement. The fluoride concentration more than permissible limit in parts of the study area makes it unsuitable for drinking purpose.

Central Ground Water Board has completed NAQUIM studies in 1:50000 scale for the entire state. Aquifer Mapping and Ground Water Management Plan implementation under NAQUIM 2.0 during AAP 2023-24 in Madanpur and Rafiganj Blocks of Aurangabad was undertaken under. The main objective was to map the aquifer system, demarcation of Fluoride contaminated area and proposing suitable management plans at village level. Aquifers with potable ground water for drinking purposes have been identified in quality affected areas. The management options also include household level Fluoride treatment system the villages which are still devoid of getting fluoride free drinking water.

The sincere efforts of Sh. Alok Kumar Sinha, Scientist-D (Hydrogeology) and multidisciplinary team consisting of Sh. Imam Hasan, Scientist-B (Hydrogeology), Ms Divya Kujur, STA (Hydrogeology), Ms. Manashi Bhattacharya, Scietntist-C (Chemistry), Dr. Suresh Kumar, Assistant Chemist and Sh. Ritik Das, Scientist-B (Geophysics) are appreciated. The team has completed the task overcoming various logistic issues mainly non availability of fields vehicles along with the team engaged in completing many other time bound tasks.

Hopefully the report covering Madanpur and Rafiganj blocks of Aurangabad district would be of immense help in formulating and implementing strategies; scientifically for efficient management of ground water resources and ensuring its sustainability.

(Rajeev Ranjan Shukla)
Regional Director

ACKNOWLEDGEMENTS

I am deeply grateful to Shri Rajeev Ranjan Shukla, Regional Director of CGWB, Mid-Eastern Region, Patna, for entrusting me with this assignment. His unwavering guidance and support were indispensable throughout the entire process of managing the study and preparation of this report.

I appreciate the diligent efforts of Sh. Imam Hasan, Scientist-B (HG) and Ms. Divya Kujur, STA (HG) for the extensive field work for hydrogeological data generation. I extend my thanks to Ms. Manasi Bhattacharya, Scientist-B (Chemistry) and Dr. Suresh Kumar, Assistant Chemist for the Chemical analysis of major ions of the water samples collected from the field. I extend my regards to Regional Director, Northern Region, Lucknow and the Officers of Regional Chemical Laboratory, Lucknow for analysis of trace elements. I extend my thanks to Sh. Rittik Das, Scientist-B (Geophysics), CGWB, MER, Patna for conducting TeM and VES surveys and Sh. Anirudh Singh, Assistant Geophysicist, Northern Region, Lucknow for conducting ERT survey in the study area. Geophysical studies helped a lot in deciphering depth and thickness of the alluvial aquifer.

I extend my heartfelt thanks to fellow officers Sh. Pankaj Kumar, Scientist-D (HG) and Sh. Satyendra Kumar, Scientist-C (HG) for their valuable insights and critical comments during the study and preparation of the report. I extend my special thanks to Sh. Akash Kumar, Young Professional for rendering help during formatting and finalization of report.

The collective effort of the NAQUIM team and fellow officers have been instrumental in shaping the findings and conclusions presented in this NAQUIM 2.0 report on Ground water Quality studies in Madanpur and Rafiganj Blocks of Aurangabad District, Bihar

Alok Kumar Sinha
Scientist-D

Report on

Aquifer Management Plan of

Madanpur and Rafiganj Blocks, Aurangabad District, Bihar

AAP: 2023-24

Contributors Page

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Composition of the Team

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Executive Summary

In 2023, the Central Ground Water Board (CGWB) initiated NAQUIM 2.0, a comprehensive program aimed at extending the aquifer mapping efforts to a more localized level, with a focus on gram panchayats or villages. The program has identified 11 priority areas across the country; that require urgent attention due to issues such as water scarcity, ground water pollution, urbanization, and industrial activities. These areas will undergo detailed mapping and analysis, which will inform the development of customized management plans to address the specific ground water management needs of each region, ultimately contributing to more effective and sustainable ground water management.

The present study is focused on conducting a detailed examination of the ground water contaminated areas of Madanpur and Rafiganj block in the Aurangabad district of Bihar, India. The study seeks to investigate the underlying causes of water contamination in these regions and identify potential strategies for mitigating the impacts of contamination on the local population and environment.

The study focuses on mapping the aquifer structure in the area by analyzing subsurface lithology using data from CGWB and PHED wells, as well as geophysical surveys. It involves determining aquifer depth, thickness, and potential zones through geological and geophysical interpretations. A Depth to Bedrock map was created, and cross-sections and 3D models were developed using Rockworks software. The study included 52 Transient Electromagnetic Surveys (TEM) at 17 locations and 3 Vertical Electrical Soundings (VES) and 6 ERT to enhance understanding of the subsurface aquifer systems.

The study assessed the aquifer-wise water levels during the pre-monsoon and post-monsoon seasons of 2023, utilizing data from a network of wells. The water level data was then used to create depth to water level and contour maps using ArcGIS, which helped to identify spatial patterns and trends in the data. Furthermore, the study examined long-term water level trends by analyzing hydrographs that combined historical and current data, allowing for a comprehensive understanding of the changes in ground water levels over time.

Studying ground water quality is crucial for the sustainable management of ground water resources. A total of 164 ground water samples were collected during pre-monsoon and 213 during post-monsoon for major ion analysis, along with 125 pre-monsoon & 211 post-monsoon samples for trace metal analysis. The samples were stored in HDPE bottles, with nitric acid added for trace metal analysis. Sampling points were georeferenced, and all chemical analyses followed standard methods. Quality control was ensured through duplicate samples, standard materials, and maintaining ionic charge balance within ±10%.

The major findings of this study suggest that the area is underlain by older alluvium/weathered residuum and hard rock, forming two aquifer systems: Aquifer I (shallow) from alluvium and Aquifer II (deeper) from weathered/fractured hard rock. Depth to bed rock in the study area varies from around 14 m to more than 80 m. accordingly, depth of shallow aquifer varies. The thickness of Aquifer I is more than 80m and this aquifer is promising. Depth of bed rock relatively increases towards north side of the study area. In general, Rafiganj block has relatively greater depth to bed

rock than in Madanpur block. Pumping test conducted in private irrigation wells reveals that the transmissivity is 87.56 (hard rock) to 224.71 m^2/day (alluvial) in Rafiganj block. The transmissivity value in Madanpur block varies between 2.38 m^2/day in hard rock aquifer to 157.32 m^2/day in alluvial aquifer. Fluoride levels range from 1.51 mg/L (Kushaha, Madanpur block) to 8.86 mg/L (Garwa, Rafiganj block). Majority of these samples are falling in Madanpur block (38 samples). The central portion of the study area is mainly affected by fluoride contamination. An area of 263 sq.km; which is almost 35% of the total area is demarcated as fluoride affected. A total number of 66 villages come into this region.The fluoride content of ground water is highly variable- laterally as well as vertically.

The quality of ground water is a significant concern in the study area.To dilute the fluoride contaminated ground water; artificial recharge strategy is essential for sustainable ground water management. Areas with post-monsoon water levels greater than 3 m bgl are suitable for recharge. The southern region, with higher elevations and slopes, generates more runoff, requiring measures to capture it. Gully plugs are proposed for steep slopes, while percolation tanks, check dams, and Nala Bunds are suggested for areas with moderate slopes and fractured rock, especially near 2nd and 3rd order streams. The study estimates that a total of 9 percolation tanks, 4 check dams, and 16 gully plug can be constructed in the area to enhance water conservation and artificial recharge. In addition to constructing water conservation structures, de-silting of tanks and ponds can improve ground water health. Renovating the traditional Ahar Pyne system and adopting rooftop rainwater harvesting in government buildings are also recommended to further enhance water sustainability in the study area.

This study will serve as a crucial resource for the state government and relevant departments, providing them with the necessary insights and recommendations to develop and implement effective ground water management strategies at the local level. By doing so, the study will contribute to the development of policies and actions that prioritize ground water sustainability and support the long-term health of the region's water resources.

कार्यकारी सारांश

2023 में, केंद्रीय भूमि जल बोर्ड (सीजीडब्ल्यूबी) ने ग्राम पंचायतों या गांवों पर ध्यान केंद्रित करते हुए, जलभृत मानचित्रण को अधिक स्थानीय स्तर तक विस्तारित करने के उद्देश्य से एक व्यापक कार्यक्रम naquim 2.0 शुरू किया। इसमें भूजल से जुड़े देश के 11 प्राथमिकता वाले मुद्दों की पहचान की है जिन में पानी की कमी, भूजल प्रदूषण, शहरीकरण और औद्योगिक गतिविधियों जैसे मुद्दों पर तत्काल ध्यान देने की आवश्यकता है। इन क्षेत्रों में विस्तृत मानचित्रण और विश्लेषण किया जाएगा, जो प्रत्येक क्षेत्र की विशिष्ट भूजल प्रबंधन जरूरतों को पूरा करने के लिए अनुकूलित प्रबंधन योजनाओं के विकास को सूचित करेगा, अंततः अधिक प्रभावी और टिकाऊ भूजल प्रबंधन में योगदान देगा।

वर्तमान अध्ययन भारत के बिहार राज्य के औरंगाबाद जिले में मदनपुर और रफीगंज प्रखंड के भूजल दूषित क्षेत्रों की विस्तृत जांच करने पर केंद्रित है। अध्ययन का उद्देश्य इन क्षेत्रों में जल संदूषण के अंतर्निहित कारणों की जांच करना और स्थानीय आबादी और पर्यावरण पर संदूषण के प्रभावों को कम करने के लिए संभावित रणनीतियों की पहचान करना है।

अध्ययन केंद्रीय भूमि जल बोर्ड और लोक स्वास्थ्य अभियंत्रण विभाग के बोरेवेल डेटा के साथ-साथ भूभौतिकीय सर्वेक्षणों का उपयोग करके उपसतह लिथोलॉजी का विश्लेषण करके क्षेत्र में जलभृत संरचना के मानचित्रण पर केंद्रित है। इसमें भूवैज्ञानिक और भूभौतिकीय व्याख्याओं के माध्यम से जलभृत की गहराई, मोटाई और विस्तार का निर्धारण शामिल है। आधारशिला की गहराई का मानचित्र बनाया गया, और रॉकवर्क्स सॉफ्टवेयर का उपयोग करके क्रॉस-सेक्शन और 3डी मॉडल विकसित किए गए। अध्ययन के दौरान 17 स्थानों पर 52 ट्रांजिएंट इलेक्ट्रोमैग्नेटिक सर्वे (टीईएम) और उपसतह जलभृत प्रणालियों की समझ बढ़ाने के लिए 3 वर्टिकल इलेक्ट्रिकल साउंडिंग (वीईएस) और 6 ईआरटी सर्वे किये गए।

अध्ययन में 2023 के मानसून से पहले और मानसून के बाद के मौसमों के दौरान जलभृत-वार भूजल स्तर का आकलन किया गया जिसमें कुओं एवं बोरेवेल के नेटवर्क से डेटा का उपयोग किया गया। भूजल स्तर के डेटा का उपयोग तब ArcGIS सॉफ्टवेयर का उपयोग करके भूजल स्तर और समोच्च मानचित्रों की गहराई बनाने के लिए किया गया था, जिसने डेटा में स्थानिक पैटर्न और रुझानों की पहचान करने में मदद की। इसके अलावा, अध्ययन ने ऐतिहासिक और वर्तमान डेटा को जोड़ने वाले हाइड्रोग्राफ का विश्लेषण करके दीर्घकालिक भूजल स्तर के रुझानों की जांच की, जिससे समय के साथ भूजल के स्तर में परिवर्तन की व्यापक समझ मिली।

भूजल संसाधनों के सतत प्रबंधन के लिए भूजल की गुणवत्ता का अध्ययन करना महत्वपूर्ण है। प्रमुख आयन विश्लेषण के लिए मानसून पूर्व 164 और मानसून के बाद 213 भूजल के नमूने एकत्र किए गए, साथ ही ट्रेस धातु विश्लेषण के लिए 125 पूर्व-मानसून और 211 पोस्ट-मानसून फील्ड कार्य के दौरान नमूने एकत्र किए गए। नमूनों को एचडीपीई बोतलों में संग्रहीत किया गया था, जिसमें भारी धातु के नमूनों का पता लगाने के लिए नाइट्रिक एसिड मिलाया गया था। नमूना एकत्रित करने की स्थान को भू-संदर्भित किया गया था, और सभी रासायनिक विश्लेषणों में मानक तरीकों का पालन किया। प्रतिरूप नमूनों, मानक सामग्रियों के उपयोग के माध्यम से गुणवत्ता नियंत्रण सुनिश्चित किया गया था, और आयनिक चार्ज बैलेंस ± 10% के भीतर बनाए रखा गया ।

इस अध्ययन के प्रमुख निष्कर्षों से पता चलता है कि यह क्षेत्र पुराने जलोढ़ / अपक्षयित चट्टान और कठोर चट्टान द्वारा बना है, जो दो जलभृत प्रणालियों का निर्माण करता है: जलोढ़ और अपक्षयित चट्टान से जलभृत I (उथला) और खंडित कठोर चट्टान से जलभृत II (गहरा)। अध्ययन क्षेत्र में बेड रॉक की गहराई लगभग 14 मीटर से 80 मीटर तक है। इसी अनुसार उथले जलभृत की गहराई पाई जाती है। जलभृत I की मोटाई 80 मीटर से अधिक है, यह जलभृत आशाजनक है। अध्ययन क्षेत्र के उत्तर की ओर बेड रॉक की गहराई अपेक्षाकृत बढ़ जाती है। सामान्य तौर पर, रफीगंज ब्लॉक में मदनपुर ब्लॉक की तुलना में बेड रॉक की अपेक्षाकृत अधिक गहराई है। निजी सिंचाई कुओं में किए गए पंपिंग परीक्षण से पता चलता है कि रफीगंज ब्लॉक में ट्रांसमिसिविटी

87.56 (हार्ड रॉक) से 224.71 एम^2 / दिन (जलोढ़) है। मदनपुर ब्लॉक में ट्रांसमिसिविटी हार्ड रॉक में 2.38 m^2 / दिन से जलोढ़िय जलभृत में 157.32 m^2 / दिन तक है। फ्लोराइड का की सांद्रता 1.51 मिलीग्राम प्रति लीटर (कुशाहा, मदनपुर ब्लॉक) से 8.863 मिलीग्राम प्रति लीटर (गरवा, रफीगंज ब्लॉक) तक है। इनमें से अधिकांश नमूने मदनपुर ब्लॉक (38 नमूने) में हैं। अध्ययन क्षेत्र का मध्य भाग मुख्य रूप से फ्लोराइड संदूषण से प्रभावित है। लगभग 263 वर्ग किलोमीटर का क्षेत्र फ्लोराइड प्रभावित क्षेत्र के रूप में सीमांकित किया गया है जो कुल अध्ययन क्षेत्र का लगभग 35% है। इस क्षेत्र में कुल 66 गांव आते हैं। भूजल में फ्लोराइड की मात्रा अत्यधिक परिवर्तनीय है – गहराई में और साथ ही लंबवत रूप से।

अध्ययन क्षेत्र में भूजल में फ्लोराइड की अधिकता एक महत्वपूर्ण चिंता का विषय है। फ्लोराइड संदूषित भूजल को पतला करने के लिए सतत भूजल प्रबंधन के लिए कृत्रिम पुनर्भरण रणनीति आवश्यक है। 3 मीटर गहराई से अधिक के मानसून के बाद के भूजल स्तर वाले क्षेत्र रिचार्ज के लिए उपयुक्त हैं। दक्षिणी क्षेत्र में उच्च ऊंचाई और ढलानों वाले विस्तार में अधिक अपवाह उत्पन्न होता है, इसे रोकने के उपायों की आवश्यकता होती है। गली प्लग खड़ी ढलानों के लिए प्रस्तावित हैं, जबकि परकोलेशन टैंक, चेक डैम और नाला बंड मध्यम ढलानों और खंडित चट्टान वाले क्षेत्रों के लिए सुझाए गए हैं; विशेष रूप से दूसरे और तीसरे क्रम की धाराओं के पास। अध्ययन का अनुमान है कि जल संरक्षण और कृत्रिम रिचार्ज को बढ़ाने के लिए क्षेत्र में कुल 9 पर्कोलेशन टैंक, 4 चेक डैम और 16 गली प्लग का निर्माण किया जा सकता है। जल संरक्षण संरचनाओं के निर्माण के अलावा, टैंकों और तालाबों की डी-सिल्टिंग से भूजल के स्वास्थ्य में सुधार हो सकता है। अध्ययन क्षेत्र में भूजल स्रोतों की स्थिरता को और बढ़ाने के लिए पारंपरिक आहार पाइन प्रणाली का नवीनीकरण करने और सरकारी भवनों में छत पर वर्षा जल संचयन को अपनाने की भी सिफारिश की जाती है।

यह अध्ययन राज्य सरकार और संबंधित विभागों के लिए एक महत्वपूर्ण संसाधन के रूप में काम करेगा , इसके द्वारा उन्हें स्थानीय स्तर पर प्रभावी भूजल प्रबंधन रणनीतियों को विकसित करने और लागू करने के लिए आवश्यक अंतर्दृष्टि और सिफारिशें प्रदान की जा रही है। ऐसा करने से, यह अध्ययन उन नीतियों और कार्यों के विकास में योगदान देगा जो भूजल स्थिरता को प्राथमिकता देते हैं और क्षेत्र के जल संसाधनों के दीर्घकालिक प्रबंधन में मदद करेगा।

Chapter 1

Introduction

Aquifer mapping is a scientific process that characterizes the quantity, quality, and sustainability of ground water in aquifers. Results of these studies can help with resource management, long-term aquifer monitoring, and regional ground water models. Proper mapping can also aid in the implementation of management interventions, achieving drinking water security, improved irrigation facilities, and sustainability in water resources development. Due to development activities, comprehensive data collection and analysis is urgently needed to develop effective management practices for better ground water governance and address emergent challenges.
The Aquifer Mapping project undertaken by the Central Ground Water Board has successfully mapped 32 lakh sq. km area of the entire country at 1:50,000 scale, during 2012-2023. This project has provided aquifer geometry, parameters, and ground water quality data for 14 Principal and 42 Major aquifers at regional scale. Management plans have been proposed based on the data generated from this study. In Bihar about 86000 sq. km area has been mapped under the National Aquifer Mapping program. The study identified water stressed areas, ground water quality-affected areas, urban agglomerates and industrial areas for further detailed mapping and specific management plan formulation.
The present study investigates the further detailed study of fluoride affected two blocks of Aurangabad District of Bihar. The area was selected after discussions with state government in the priority area of ground water contamination.

Central Ground Water Board (CGWB) implemented the National Aquifer Mapping Programme in Study area, with broad objective of mapping of the aquifers (2D and 3D), determination of aquifer-wise ground water quality, aquifer wise water level, aquifer-wise ground water quantity and based upon the results, preparation of a management plan for the district. The report prepared on “Ground Water Quality Studies in Madanpur and Rafiganj blocks of Aurangabad district.” will be very useful for the planners and various executive agencies engaged in the development and management of ground water for agricultural, industrial, and drinking purposes.

1.1 Objectives of the present study

The presence of fluoride in ground water is a significant challenge in managing ground water resources in southern part of Bihar. Fluoride concentrations above the permissible limit have been detected in several districts of southern part of Bihar adjoining Jharkhand border underlain by granitic basement. Previous scientific research conducted by various organizations, including CGWB, has indicated that fluoride contamination found in all depths below ground level (mbgl). Consequently, hand pumps and shallow tube wells that rely on ground water extraction from these shallow aquifers are most susceptible to fluoride contamination in affected areas.

Periodic ground water quality monitoring conducted by the Central Ground Water Board (CGWB) and the National Aquifer Mapping and Management Program (NAQUIM) water quality analysis of Hand pumps by PHED, Govt. of Bihar has revealed the presence of fluoride above permissible limits in certain areas of two identified blocks. In response, CGWB has initiated a further detailed investigation with the objectives outlined under NAQUIM2.0.

I) The present water demand for drinking and domestic purposes are dependent upon ground water, hence it is essential to analyze the fluoride concentrations in the ground water of each village. Thus, the proposed study aims to investigate the fluoride levels in ground water in every habitation. Upon completion of the analysis of fluoride contamination in each habitation, the study will focus on identifying potential hotspots, if any, and characterizing the pattern of contamination. These results will guide further investigations to spatially extend the analysis of fluoride contamination.

II) To obtain a depth-wise distribution of fluoride contamination, the proposed study will analyse the concentration of fluoride in ground water samples from various sources, including hand pumps, kachcha wells, domestic- irrigation tube wells, and public water supply wells. By collecting samples from these diverse sources, the study aims to obtain a comprehensive understanding of the distribution of fluoride contamination in ground water across different depths.

III) The study aims to propose practical and implementable strategies for managing ground water resources in the affected blocks. These strategies will take into account the findings ofthe study and aim to mitigate the impact of fluoride contamination on the affected communities.
Objectives are enumerated below

- Demarcation of Contaminants Zones
    - Zonation of the area
    - Aquifer identification for poor quality
- Identification of Fresh GW sources for Drinking Water Supply
- drinking water source sustainability
    - Recharge area identification & measures for sources sustainability
    - If required identification of alternate source for water supply
    - Tracing source of contamination

Suggesting regulatory measures for prevention of contamination

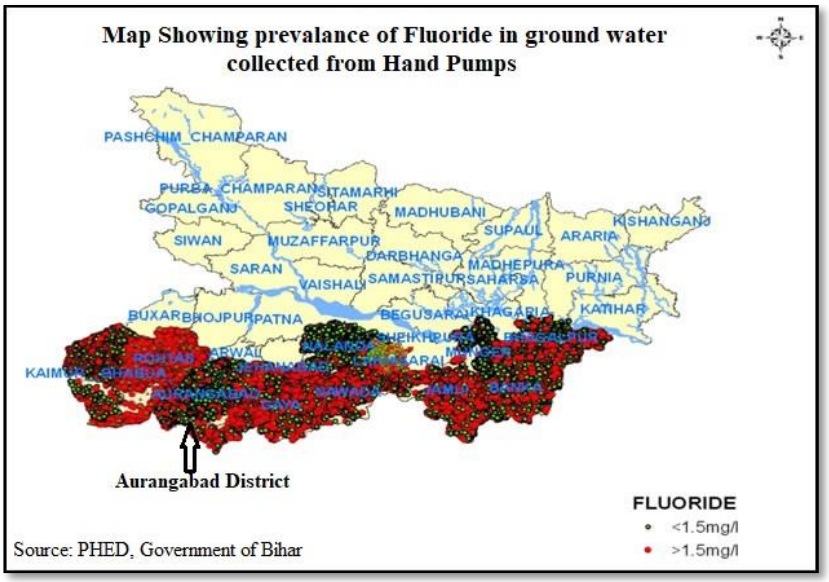


Figure 1: Fluoride in Ground Water Collected from Hand Pumps

1.2 Deliverables of the Study

With the aforementioned objective in mind, the study aims to generate the following outputs within the designated research area in the form of maps and tables.

- Map and suggested interventions with -
    - Demarcation of Poor Quality affected area (As per drinking water specification)
    - Demarcation of fresh water aquifers for drinking water supply
    - Location for ground waterabstraction structures& their optimum discharge
    - Recharge area demarcation and design of suitable recharge structure
    - Sources of contamination and plume movement
    - Location of alternate source for water supply
    - Extent of meeting demand - supply gap
    - Regulation mechanism for prevention from contamination

1.3 Previous Studies

Central Ground Water Board, Mid-eastern region in Patna has undertaken various studies related to ground water in this area. Additionally, numerous research organizations and scientific departments of both the State and Central Government have conducted several studies on the quality aspect in the southern parts of Bihar. A summary of these studies is provided below,

- Aquifer Mapping and Management (NAQUIM) studies in Aurangabad districts as part of the Annual Action Plan for the years 2018-19.
- CGWB, MER (Mid- Eastern Region), Patna has published District Ground Water Brochures for Aurangabad district in 2013.
- Ground water Management study in parts of Aurangabad district, Bihar (AAP2011-2012).
- Hydrogeology and Ground water Development Potential of Aurangabad district (1986).
- A report on the geo-hydrological investigation in the drought affected areas of the Aurangabad sub division, Gaya district, Bihar (Field Season1966-67).
- Basic data report of exploratory boreholes drill in Aurangabad district in various annual action plans.

Chapter 2

About The Study Area

The study area consists of Fluoride contaminated two blocks of Aurangabad district. Madanpur and Rafiganj blocks are located in south eastern part of Aurangabad district. The blocks are located between 24°30’03' and 24°56’04' North latitude and 84°24’47” and 84°46’38” East longitude. The cumulative area under study is 733.47 Sq. Km. The area is covered by toposheet number 72D/5, 6,9&10. In this study, Madanpur and Rafiganj block of Aurangabad district, Bihar have been taken as Priority area under ***“Ground Water Contamination.”***

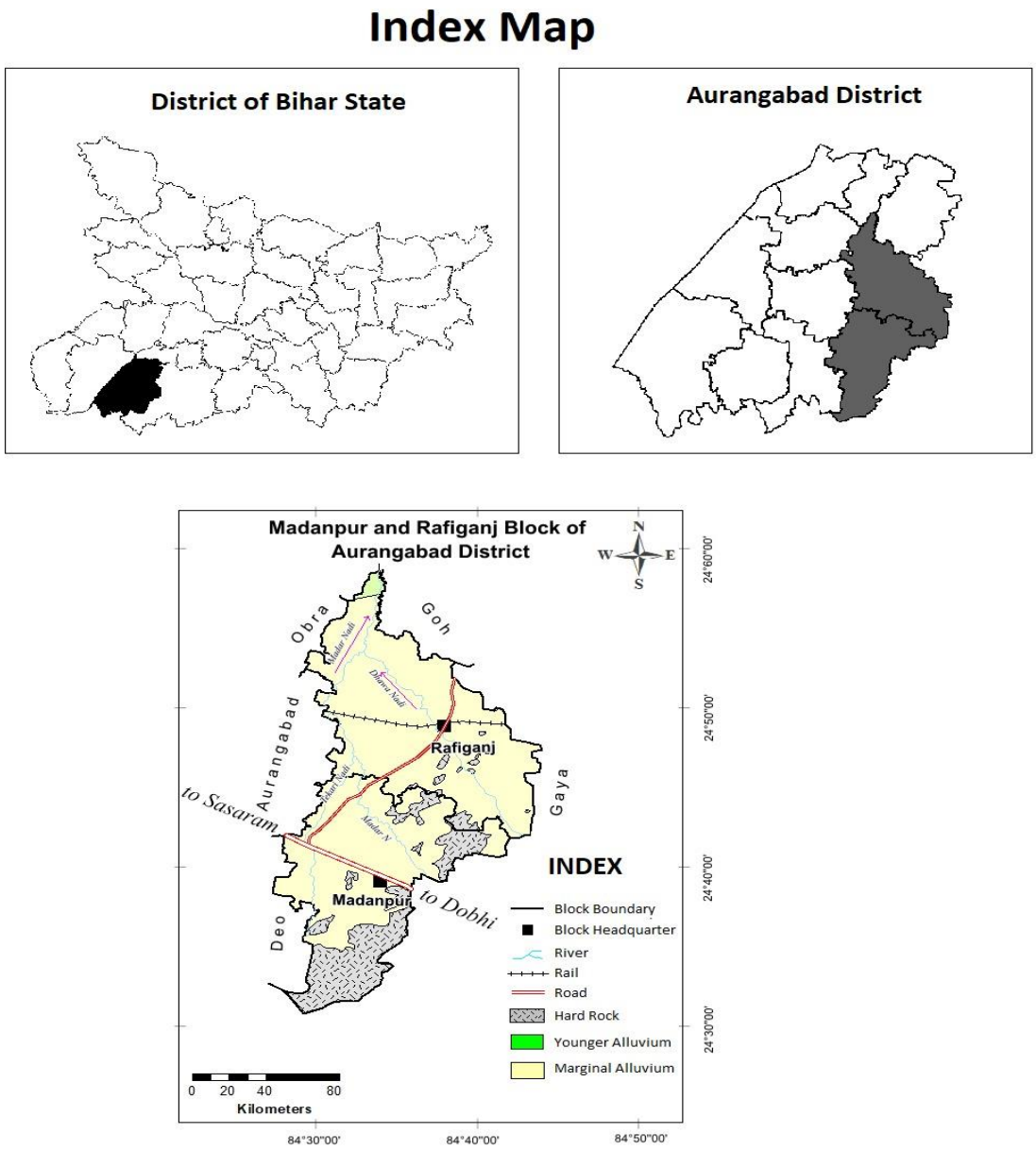


Figure 2: Index Map of the Study Area.

Table 1: General information of the study area.

S.No.	Data Elements	Madanpur Block	Rafiganj Block
1.	**GENERAL INFORMATION**		
	• Geographical area (Sq. Km)	349.94	383.93
	• Mappable area (Sq. Km)	269.04	321.43
	Administrative Division		
	• Number of Villages Panchayat	19	23
	• Number of Villages	124	220
	• Population (As on 2011 Census) o Total: o Rural: o Urban:	 211329 211329 0	 312367 276831 35536
	• Average Annual Rainfall (mm)	1176.8	1141.7
2.	**GEOMORPHOLOGY**		
	• Major physiographic unit:	Structural Hill Denudational Hill Marginal Alluvium/Alluvial	Structural Hill Denudational Hill Marginal Alluvium/Alluvial
	• Major Drainages:	Madar, Kesar, Tekari Nadi	Dhava Nadi
3.	**LAND USE (Sq Km)** **Source: DIP 2015-20, PMKSY**		
	• Forest Area	52.14	63.66
	• Barren land	55.25	82.19
	• Net Sown area	154.53	175.81
	• Gross Cropped area	168.64	218.50
4.	**MAJOR SOIL TYPE**	Clay and Sandy loam	Clay and Sandy loam
5.	**MI Census (Sixth)**		
	• Dugwell	5	6
	• Tubewell/Borewell	458 (STW) 917 (MTW) 6 (DTW)	144 (STW) 1554 (MTW) 221 (DTW)
	• Tank/ponds	51	76
6.	**PREDOMINANT GEOLOGICAL FORMATIONS**	Chhotanagpur Granite Gneiss, Alluvium	Chhotanagpur Granite Gneiss, Alluvium
7.	**GROUND WATER QUALITY**	Fluoride affected (Sporadic)	Fluoride affected (Sporadic)

2.1 Demography

The total population of the Madanpur and Rafiganj blocks is 613,039 (As per 2011 census) out of which about 94% is rural and remaining is urban with decadal population growth 23.6%. Total Male population is 318,309 and Female population is 294,730. Projected population for the year 2024 is 372647. Average population density of the study area is 688 persons/ Sq. Km.

Table 2: Population of Madanpur and Rafiganj Blocks.

S. No	Block	Population	Male	Female	Population Density(Person/km^2)
1	Madanpur	253,945	131,414	122,531	606
2	Rafiganj	359,094	186,895	172,199	770
Total		613,039	318,309	294,730	

Source: Census 2011

2.2 Physiographic setup

The southern hilly ranges and the northern Gangetic Plain form two broad physiographic units of the blocks. The southern hilly area is undulating in character, occupied by hilly ranges and low valleys covering parts of Madanpur blocks. The constituting rocks of the hills dip northward and form the basement of the northern lying Gangetic Plain. In the transition parts, from hard rock to alluvial plain, the hard rocks are exposed (linearly) at places as inliers. The northern alluvial plain gently sloped towards NNE.

2.3 Physiographic DEM

The elevation in the area ranges from 76 to 440 m above mean sea level (SRTM data with WGS 84 Spheroid).The generated elevation map by SRTM map is given in fig 3. It shows that general slope of the area is towards north-east direction.

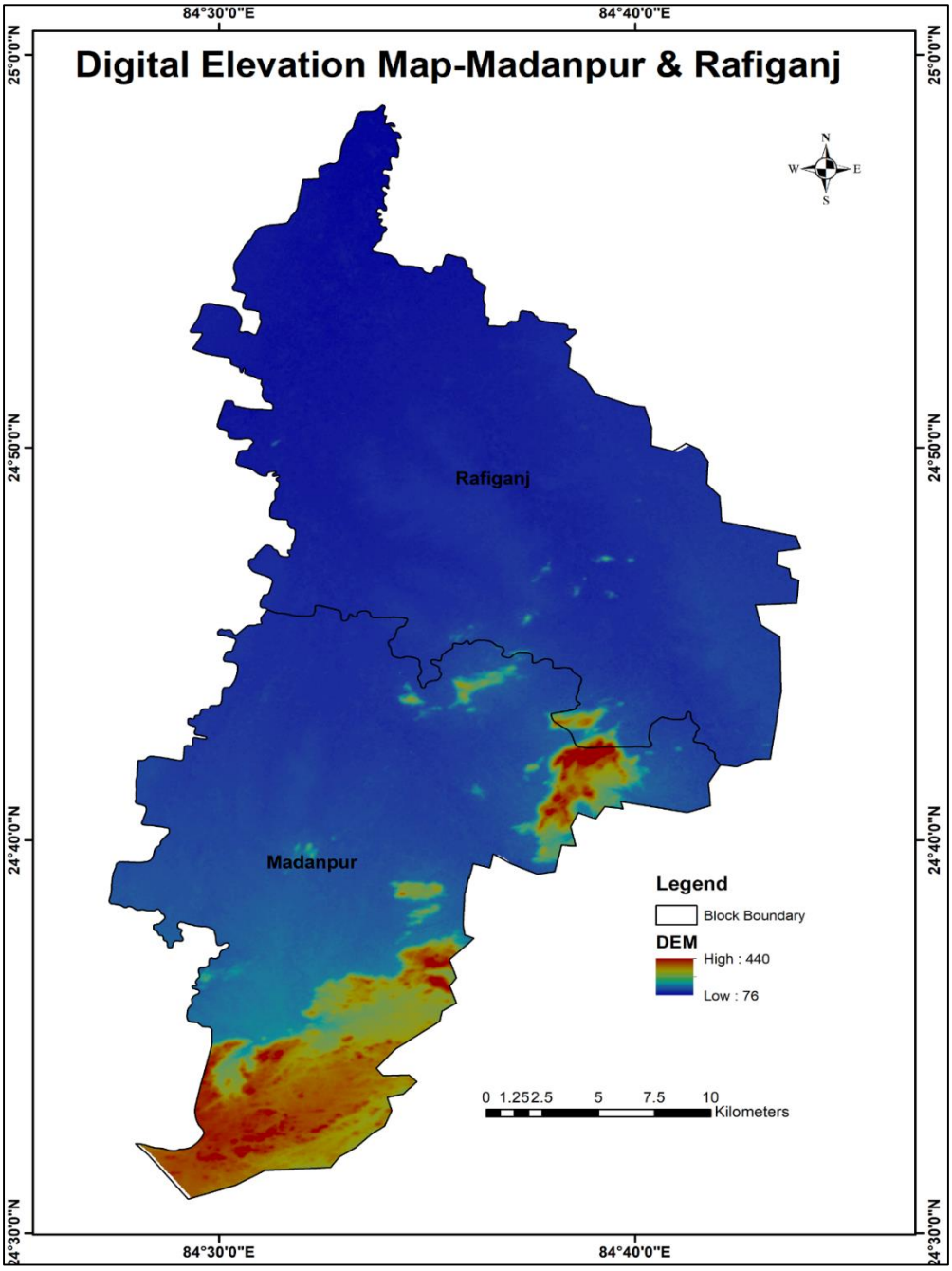


Figure 3: Digital Elevation Model of the study area.

2.4 Geomorphology and Drainage

Broadly, both blocks can be divided into three physiographic units. Structural hills near south eastern boundary, followed by the denudational structural hill towards north and rest of the major part are alluvial plain of fluvial origin gently sloping towards NE direction. It is shown in fig 4.

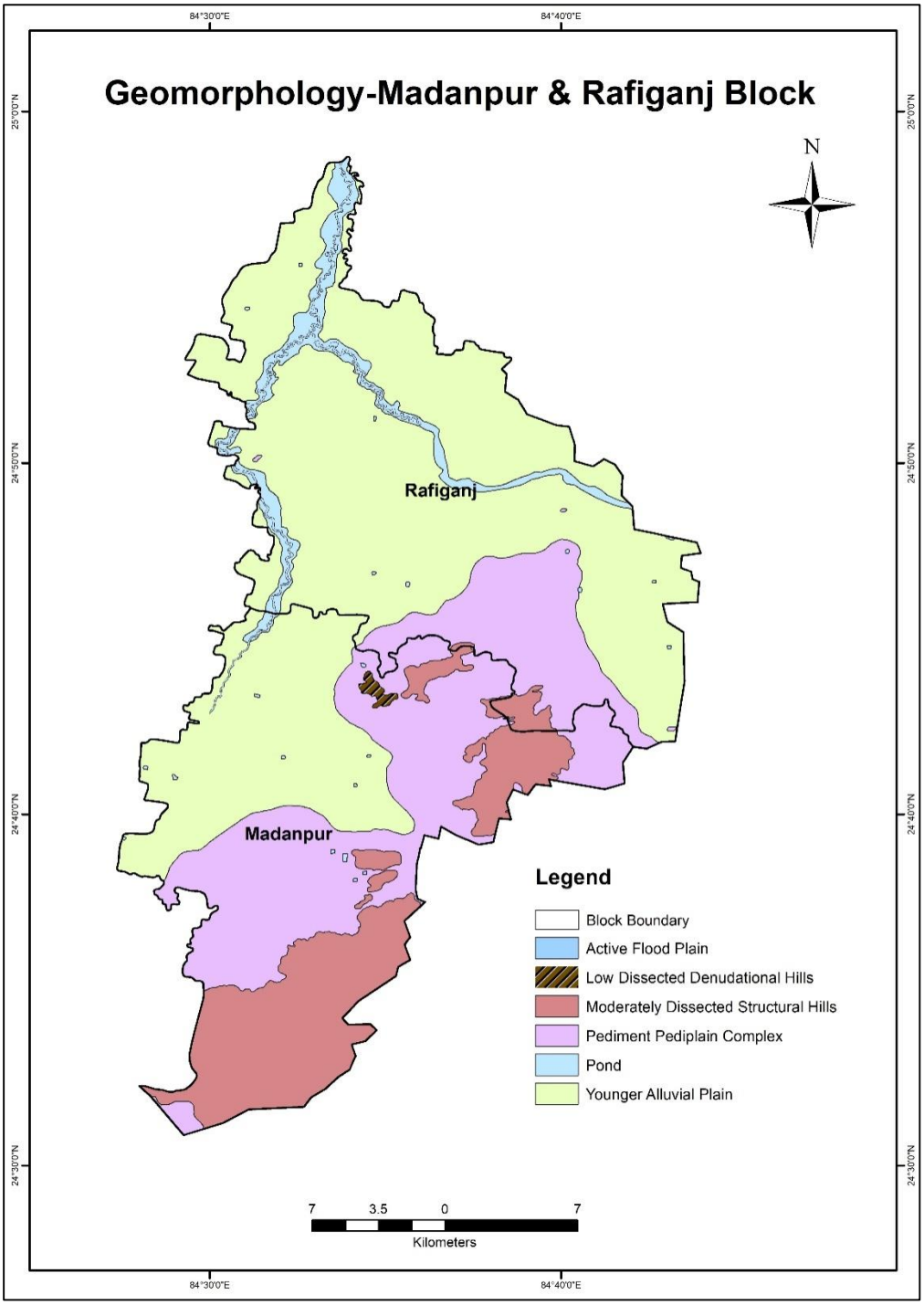


Figure 4: Geomorphology Madanpur and Rafiganj block.

The study area forms a part of Madad river basin controlling the main drainage system.The river follows the Western border of Madanpur and Rafiganj Block, Dhava is the major right bank tributary to River Madad, it meets with Madadat the northern border of Rafiganj. The river meet with Punpun River at Haspura block, Aurangabad which further meet with the Ganga River at Fatuha.The shifting of River course and intense meandering is a common phenomenon of the study area. In lean period, these rivers become effluent and are fed through ground water.

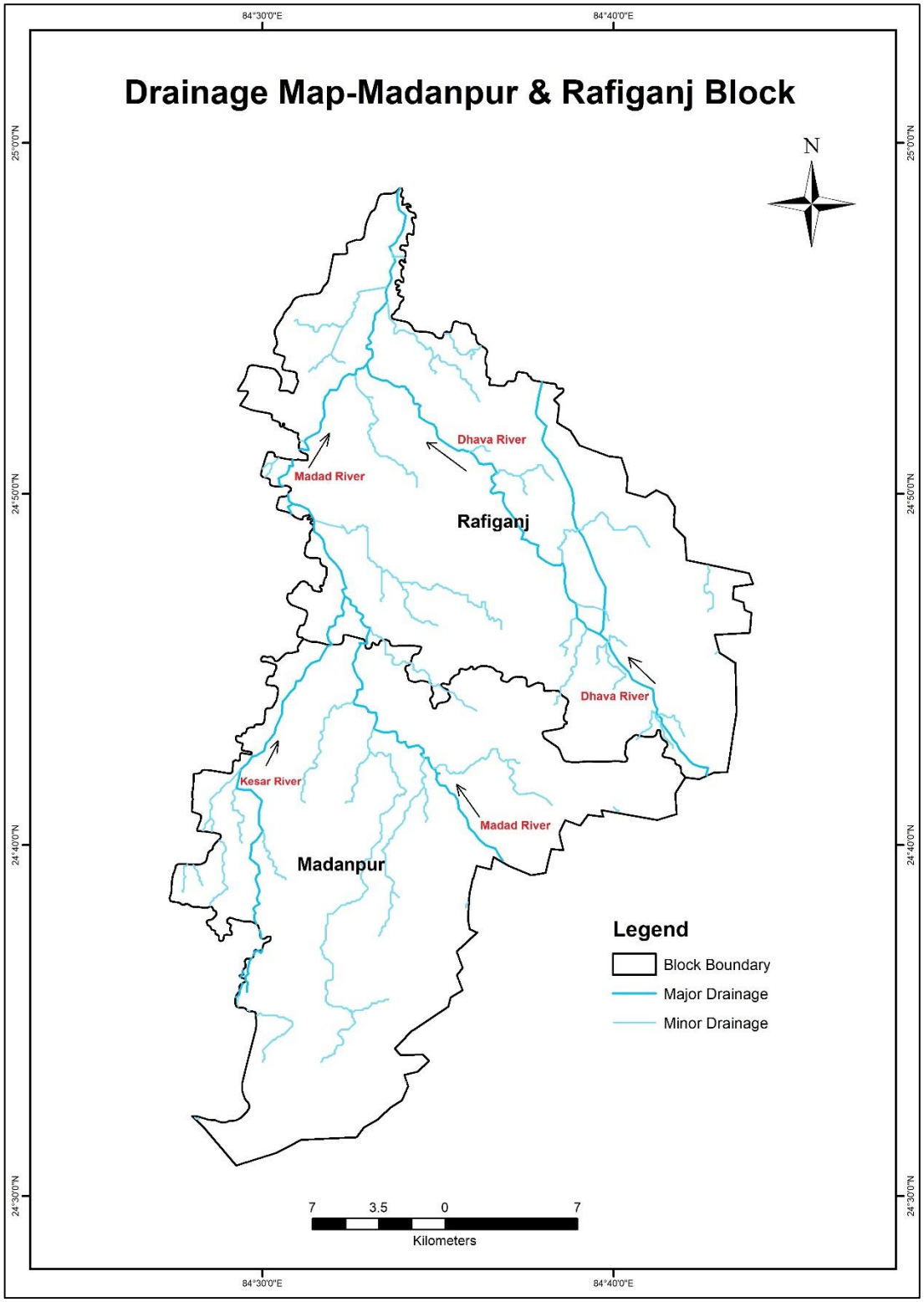


Figure 5: Drainage map of Madanpur and Rafiganj block.

2.5 Land Use, Irrigation and Cropping Pattern

Economy of the study area is mainly governed by agricultural activity; hence most of the study area is agricultural land with some patches of urban/ settlements. Other than this, forest area, Scrubland, Ponds, and Plantation founds. The total reported area of Madanpur and Rafiganj Blocks is 72,746 hectares, out of which 53% is under cultivation and the remaining about 27% area is mainly in the form of forest, barren cultivable waste land, fallow land, other fallow land, barren uncultivable land, pastureland, under bush/gardens, and land usedother than agriculture.

Table 3: Land Use Pattern.

(In hectare)

Block	Area	Forest	Non cultivable land	Land not available for cultivation			Fallow land	Permanent and other grazing land	Misc. tree crops and groves	Other fallow land	Current fallow land Net sown	Net sown area
				Land area	Water logged							
					Permanent	Seasonal						
Madanpur	34226	10531	943	5271	99	219	75	255	4	26	4027	12775
Rafiganj	38520	971	654	779	16	134	19	42	40	87	8794	26982
Total	72746	11502	1597	6050	115	353	94	297	44	113	12821	39757

Source: District Statistical Department

The local population mostly depends on agriculture for their sustenance. Agriculture depends on monsoon rainfall. The most common source of irrigation is the ground water tapped through dug wells, Tube wells and Bore wells. Compared to the 5th MI census no. of medium and deep tube well have increased considerably in the block.

Table 4: Ground water abstraction structure data

S. No	Block	Surface water	Ground water			
		LI	DW	STW	MTW	DTW
1	**Madanpur**	51	5	458	917	6
2	**Rafiganj**	76	6	144	1554	221
	TOTAL	127	11	612	2471	227

Source: 6th MI census.

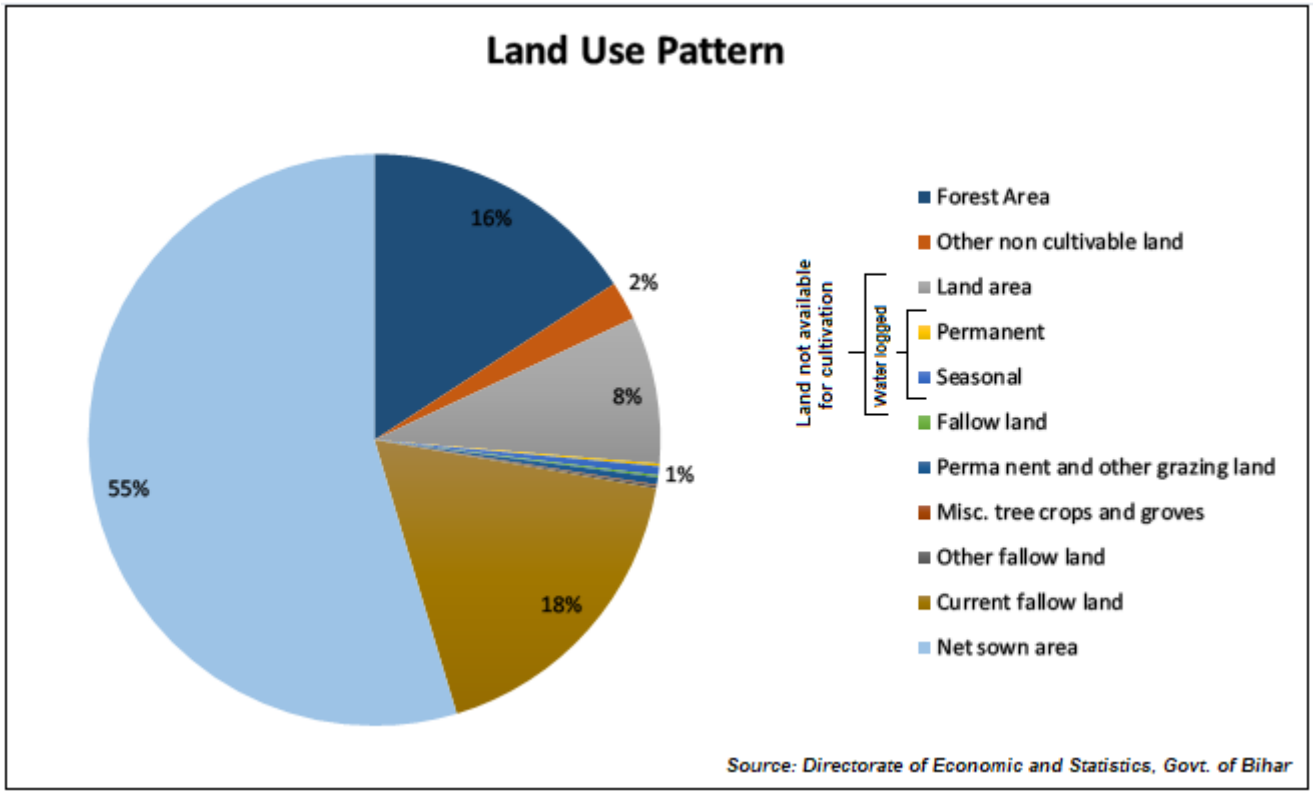


Figure 6: Land Use Pattern in Madanpur & Rafiganj blocks.

Table 5: Irrigation based Classification in the study area.

Block	Irrigated (Area in ha)		Rain fed (Area in ha.)	
	Gross Irrigated Area	Net Irrigated Area	Partially Irrigated /Protective Irrigation	Un- Irrigated or Totally rain fed
Madanpur	16864	10354	1099	1794.09
Rafiganj	21850	14989	1260	11892.69
Source: Dist. Stat. Office/Irrigation Department.				

Table 6: Duration and crops harvested in different seasons in study area.

Cropping Season	Period	Main crops grown
Bhadai	Aprill/May to August/Septemebr	Paddy, maize and millet, moong, Jute
Agahani	June to October/November	Paddy harv, Paddy general, urd, vegetables
Rabi	October/November to March	Wheat, maize, and masoor, khasari, vegetables, oilseeds, spices
Garma	March/April to June	Paddy, maize and millet, moong, vegetables

Table 7: Agriculture and Irrigation status in study area.

(Area in ha)

S.No	Blocks	Net sown area	Area sown more than once	Gross area sown	Cropping intensity	Irrigation intensity	Gross area irrigated
1	Madanpur	15453	1411	16864	109	78	13199
2	Rafiganj	17581	4269	21850	124	72	15694
Total		33034	5680	38714	233	150	28893

(Source: District Statistics Department, GOB)

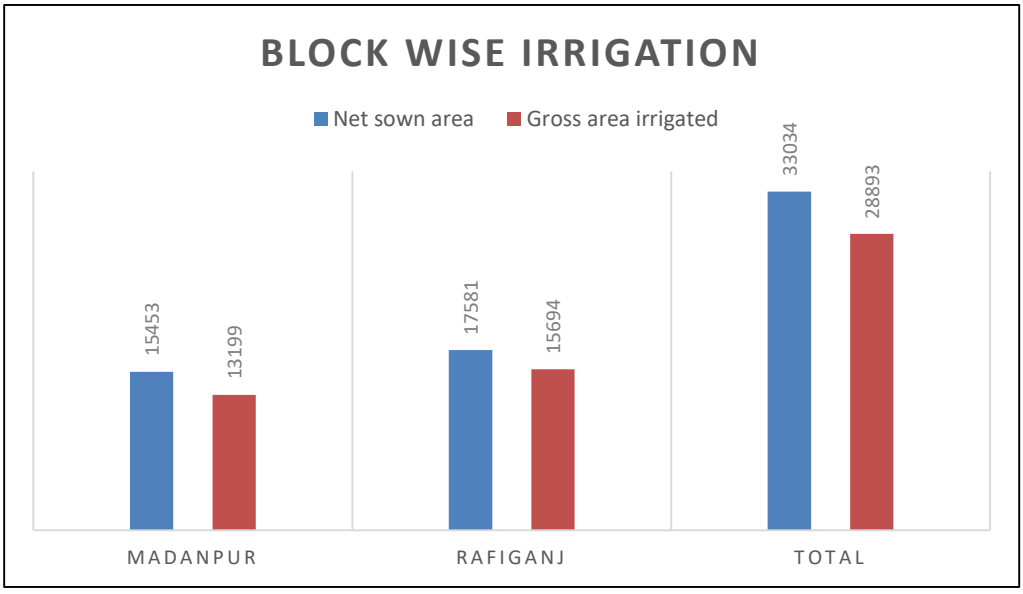


Figure 7: Block wise irrigation in the study area.

2.6 Soil type

Soil, the loose surface material, consists of inorganic particles and organic matter, provides water and nutrients to plants. Soils tend to become acidic when rainwater leaching away basic ions, from decaying organic matter, oxidation of ammonium and sulfur fertilizers etc.
These blocks broadly covered by mainly three (03) types of soil with different texture and color.
Mainly three types of soil are observed:

1. Younger Alluvial soils
2. Older Alluvial soils
3. Foot hill soils

I. Younger Alluvial soil

This type of soils covers northern part of the Rafiganj block. These are generally yellowish white to reddish yellow in color, sandy to loamy sand in texture, neutral to slightly acidic in reaction with low to moderate fertility status.

II.Older Alluvial soil

Major parts of the block are occupied by the Older Alluvial soils. These soils are composed of very fine to fine sand and clay. These are grey to greyish yellow in color and moderate to heavy in texture. They develop wide polygonal cracks during the dry season. Layers of calcium carbonate concretions are also common in some places. These soils are neutral to slightly alkaline in reaction.

III. Foot hill soil

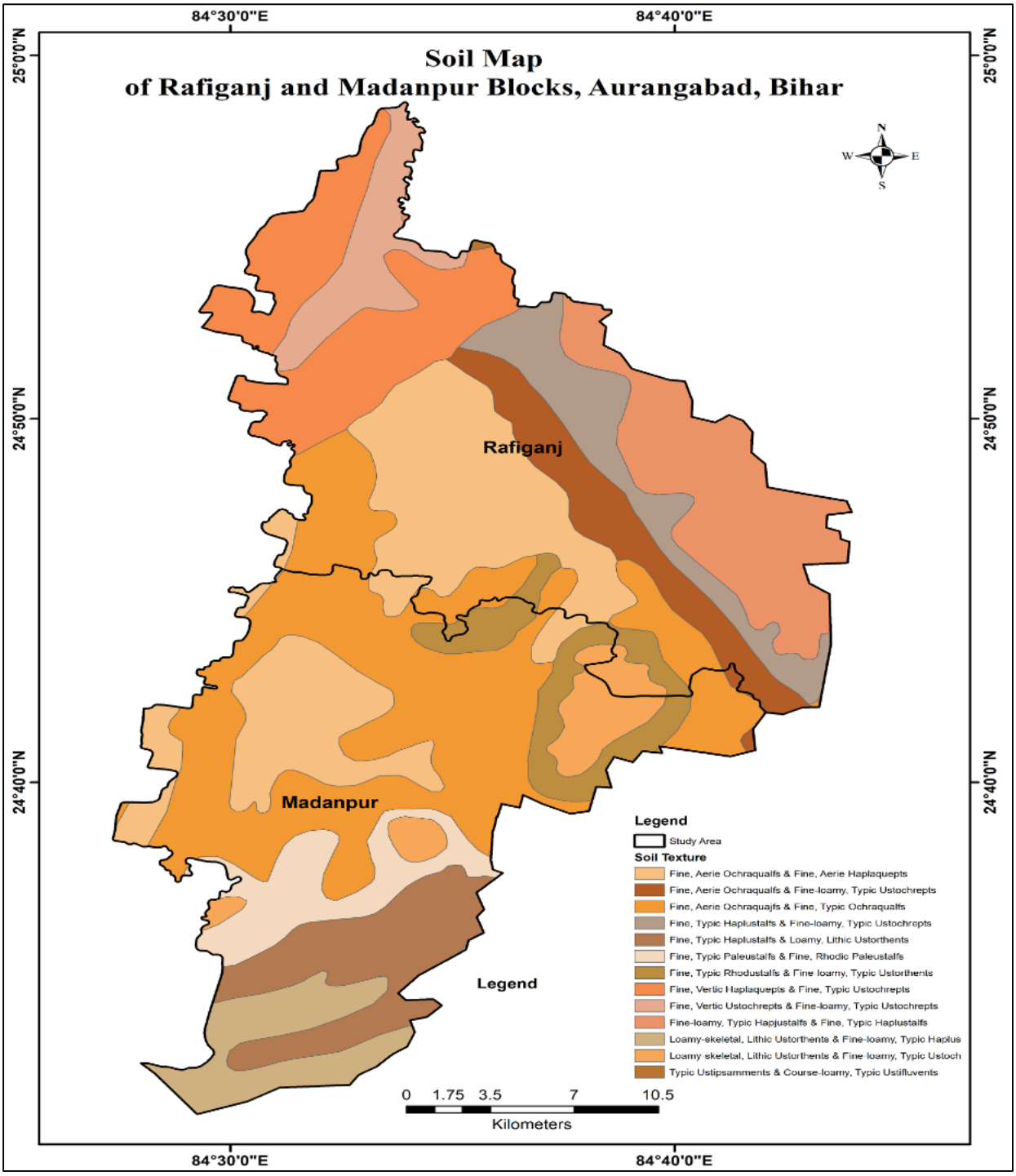
The foot hill soils occur at the southern parts of the district in Madanpur block. These soils are mainly derived from the crystalline rocks. These soils form a very thin veneer over the bed-rocks. These are generally light textured, stony and gravelly, moderately acidic in nature.

Table 8: Major soil classes and land slope in the study area

Sl. No	Name of Block	Soil Type		Land Slope			
		Major Soil Classes	Area (ha)	0-3% (ha)	3-8% (ha)	8-25% (ha	>25% (ha)
1	**Madanpur**	alluvial,clay,sandy loam	34953.88	29710.8	4194.46	1048.62	0
2	**Rafiganj**	alluvial,clay,sandy loam	37937.1	32246.53	4552.45	1138.11	0
Total			72890.98	61957.33	8746.91	2186.73	0

Source : National Bureau of Land Use Planning, University/KVK/BIRSAC/BAU/RAU

Taxonomical classification of soil types is presented in the figure 8. the soils in the study area are mostly Very deep, poorly drained, fine soils on very gently sloping plain with clayey surface texture, very slight erosion, severe flooding and slight sodicity; associated with: Very deep, imperfectly drained, fine-loamy soils with loamy surface texture, slight changes in the class.



Source: NBSS, LUP, Nagpur

Figure 8: Soil map of Madanpur and Rafiganj block.

2.7 Climate and Rainfall

The study area experiences sub-tropical and sub humid climate with three distinct seasons namely, summer, winter, and monsoon. The coldest month is January with mean monthly temperature ranging from 4-19^{o}C where the hottest month is June with mean monthly temperature ranging from 27-39 ^{o}C.

The normal Rainfall of the district comprises to 1158.55 mm out of which average normal monsoon rainfall is 1021.9 mm and non-monsoon rainfall is136.65mm.Monsoon

Season extends from 1st week of June- Last week of September. The average monsoon rainfall of the study area for the last 6 years (2014-2023) is 859.6 mm and non-monsoon rainfall is 115.6 mm.

Figure 9: Monsoon and Non-Monsoon rainfall of Madanpur and Rafiganj block.

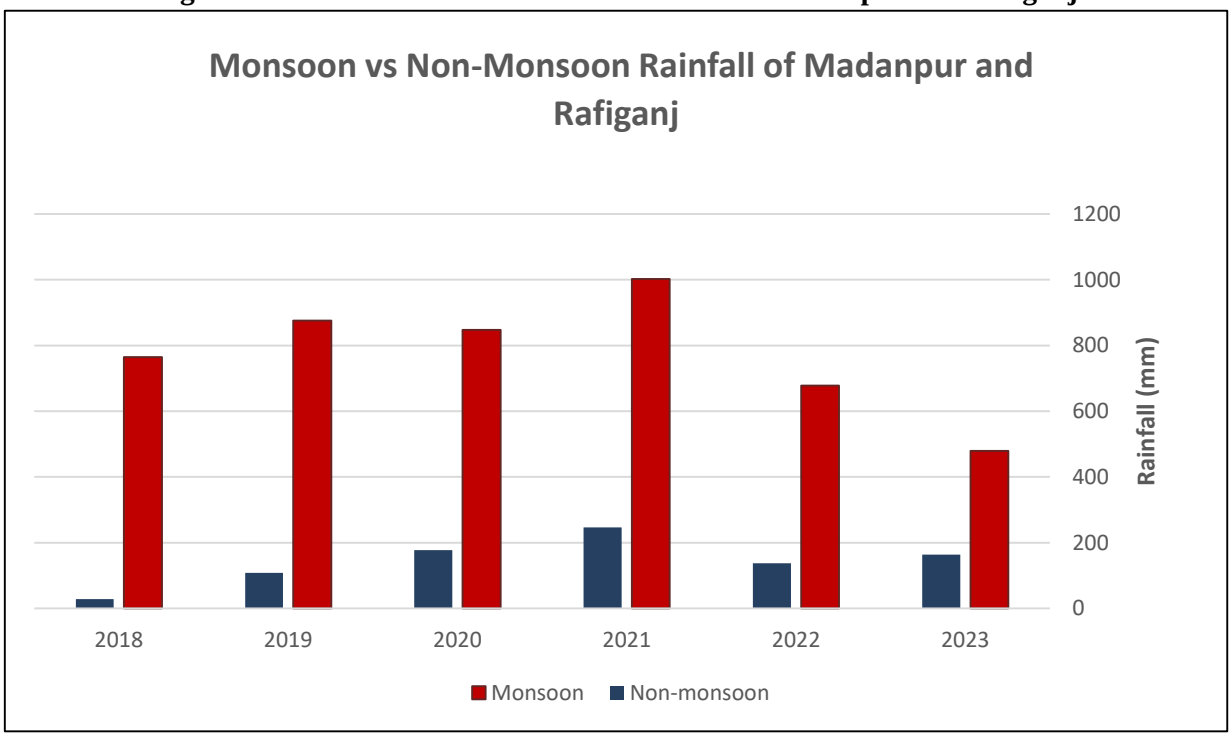


Figure 10: Month wise average Rainfall (2018-2023).

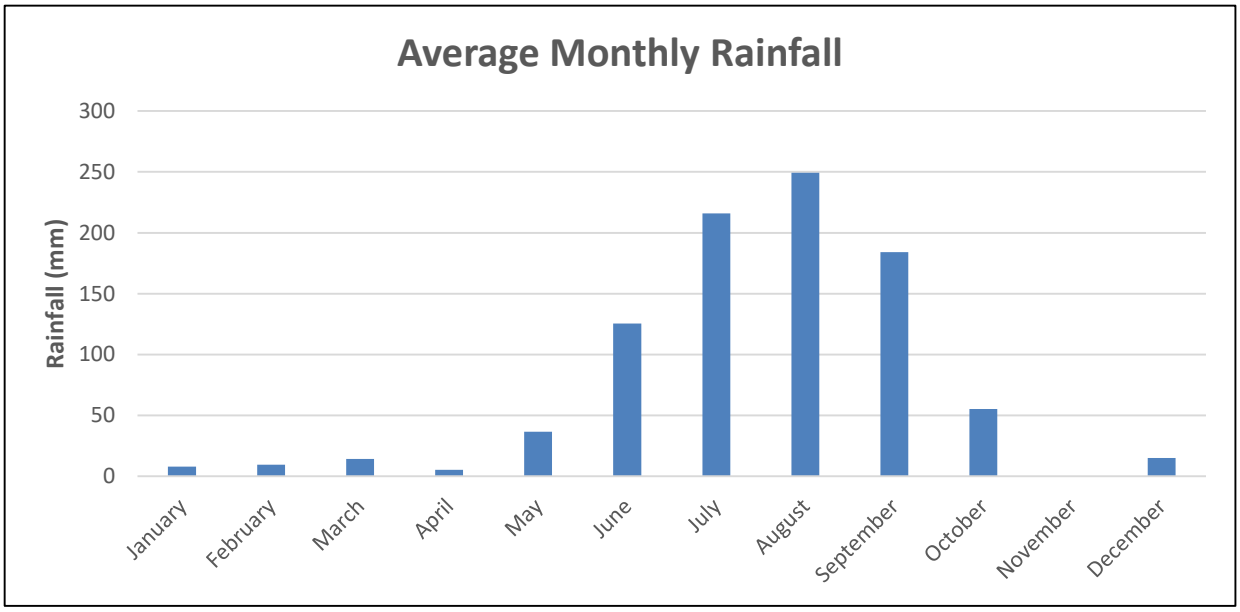


Table 9: Month wise Rainfall data from 2018-2023.

Madanpur and Rafiganj Block							
Year	**2023**	**2022**	**2021**	**2020**	**2019**	**2018**	**Average**
January	0	32.1	0	7.6	8.2	0	7.98
February	0	19.5	0	33.3	3.6	0	9.40
March	4	0	0	79.2	2.6	0	14.30
April	23.3	0	0	8.8	0	0	5.35
May	11.9	20.2	152.5	28.5	5.7	0	36.47
June	34.5	91.9	289.5	245	20.75	71.6	125.54
July	196.1	124.8	211.5	211	187	364.5	215.82
August	119.5	277.4	387	215.5	321	176	249.40
September	129.4	184.3	114.7	175.5	347	153	183.98
October	105	65.4	86	20.2	32.95	21.6	55.19
November	0	0	0	0	0	0	0.00
December	19.8	0	8.4	0	54.95	6.8	14.99
Monsoon	479.5	678.4	1002.7	847	875.75	765.1	774.74
Non-Monsoon	164	137.2	246.9	177.6	108	28.4	143.68
Annual	643.5	815.6	1249.6	1024.6	983.75	793.5	918.43

2.8 Geological Set-Up

The general geology of Aurangabad district is given in Table. Stretches hard/crystalline rocks exists along the southern parts covering the parts of, Rafiganj and Madanpur blocks. As far as rock types are concerned, in the south-western parts, a narrow stretch of Vindhyan rocks (sandstones and quartzite) exists, whereas in the central and eastern parts granitic (porphyritic) and gneissic rocks predominate. The remaining major part of the block is occupied by alluvium, which lies directly and unconformably over the basement rocks. The basement rocks dip northward. In the southern parts of the district the alluvial cover over the basement is thin ranging in thickness from few meters to few tens of meters, whereas in the northern parts, the alluvial cover goes up to a depth of 100-150 m below ground. In the southern parts, basement is exposed as inliers in a linear fashion at many patches.

Broadly the geology of the study area is described in below table 9 and in fig 11.

Table 10: Geology of the Study area.

Group	**Formation**		**Lithology**
Quaternary	Alluvium	Recent	Fine to coarse sand, clay and silt
		Older	Fine to coarse sand,gravel, kankars, clay
….....…….Unconformity…….....			

Pre-Cambrian	Chhotnagpur Granite Gneiss Granite	Coarse grained, porphyritic, gray in color
	Granite gneiss	Grayish black to black in color

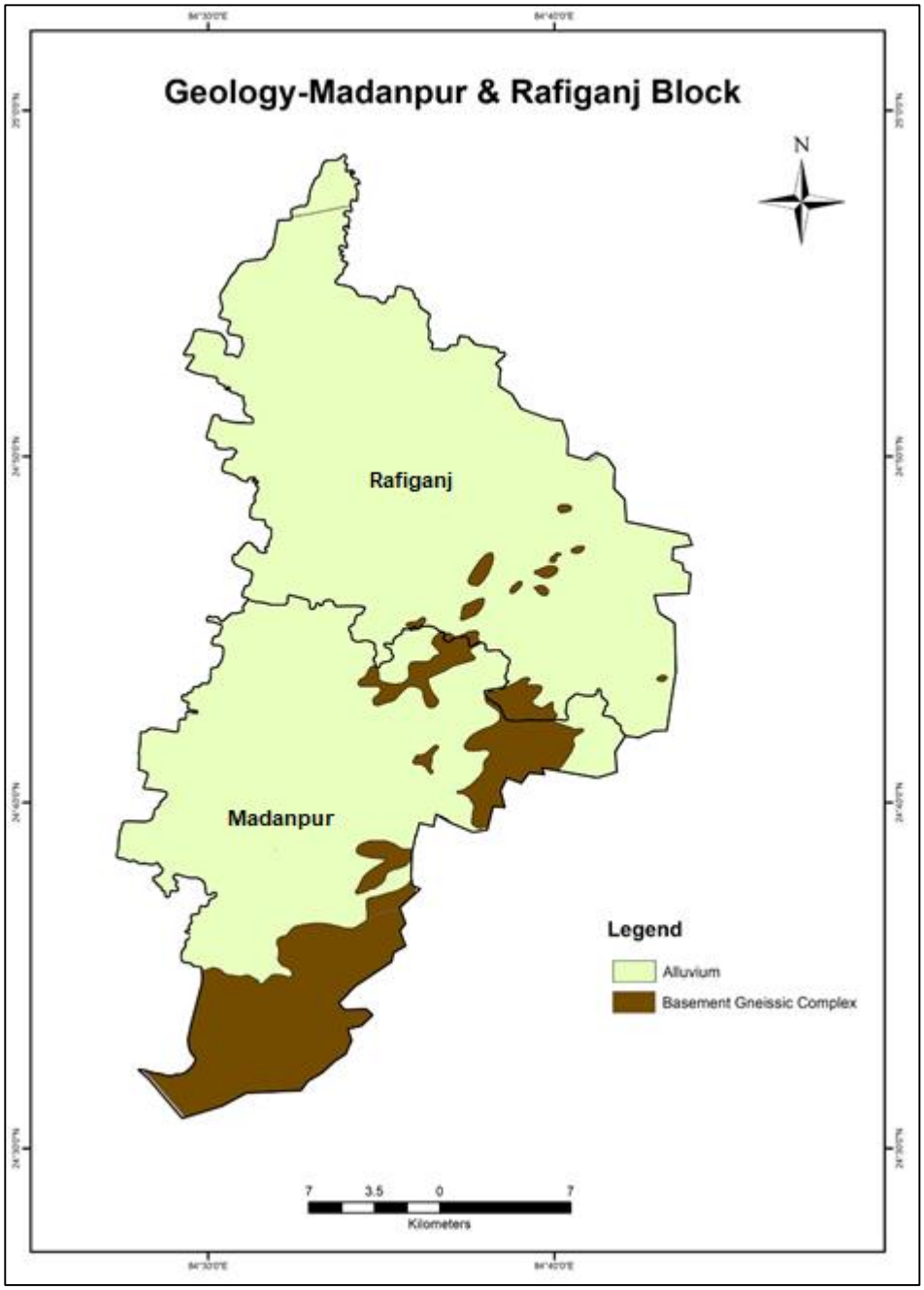


Figure 11: Geological Map of Madanpur and Rafiganj Block, District-Aurangabad.

Chapter 3

Data Collection and Data Generation

3.1 Existing data in Study area

Central Ground Water Board has constructed 4 exploratory wells in which one abandoned well at Rafiganj with drilled depth of 65.00m. Till date which has been drilled in Alluvium. Total 4 permanent observation well (National hydrograph Network Station) are being monitored by Central Ground Water Board 04 times in a year for ground water regime of phreatic (shallow) aquifer and one time ground water sampling for chemical analysis (Pre-monsoon) to assess its chemical quality.

CGWB, MER, Patna, has conducted exploratory drilling for determination of hydraulic parameters of different aquifers, ground water regime, and quality of multiple aquifers as part of the NAQUIM studies. Additionally, the study area has been subject to regular monitoring of ground water levels and quality. A comprehensive summary of the available data is presented below.

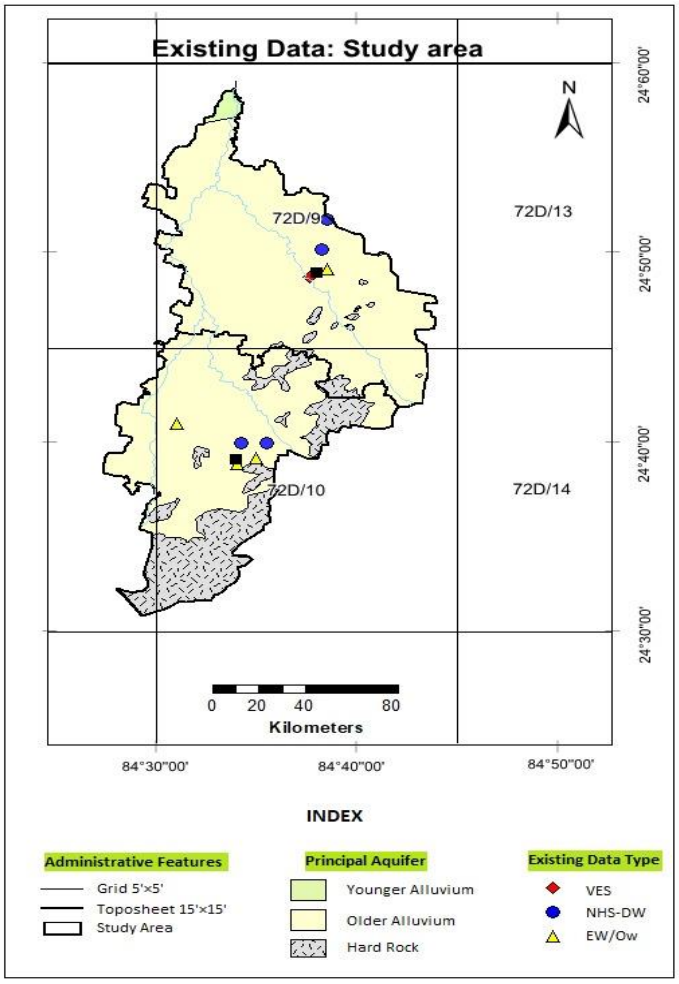


Figure 12: Existing data of the study area.

Table 11: Data Availability in the Study Area.

Sl No	District	Block	Area (sq. km)	Exploration (EW/ OW/Pz)	Geophysical Data (VES/ TeM/ Log)	Aquifer Parameters	Ground Water Level Monitoring Stations	Ground Water Quality Monitoring Stations	Infiltration Test
1	**Aurangabad**	**Madanpur**	350	3 EW upto 201m depth	Nil	Not Available	2 NHS wells	2	Nil
2		**Rafiganj**	384	1 Abandoned well	1 VES	Not Available	2 NHS Well	2	Nil

3.2 Data Collection and Data Generation

Data on the numerous characteristics of ground water were gathered from previous publications of the Central Ground Water Board, state departments, and other organizations. Additional data like Ground Water Exploration, Water level data of Shallow and Deeper Aquifer, Geophysical investigations, ground water sample collection, surface water sample collection, soil infiltration test etc. has been carried out.

Table 12: New data Generated during 2023-24.

EW/OW/PZ	PYT	VES	TEM	ERT	WQ samples collected (Pre-Monsoon)	WQ samples collected (post-monsoon)	Number of User Feedback collected	No of Key wells established	Soil Infiltration Test
5 (03 EW,02 OW)	2	3	52	6	Basic-164 Hm-125	Basic-213 Hm- 211	37	170	5

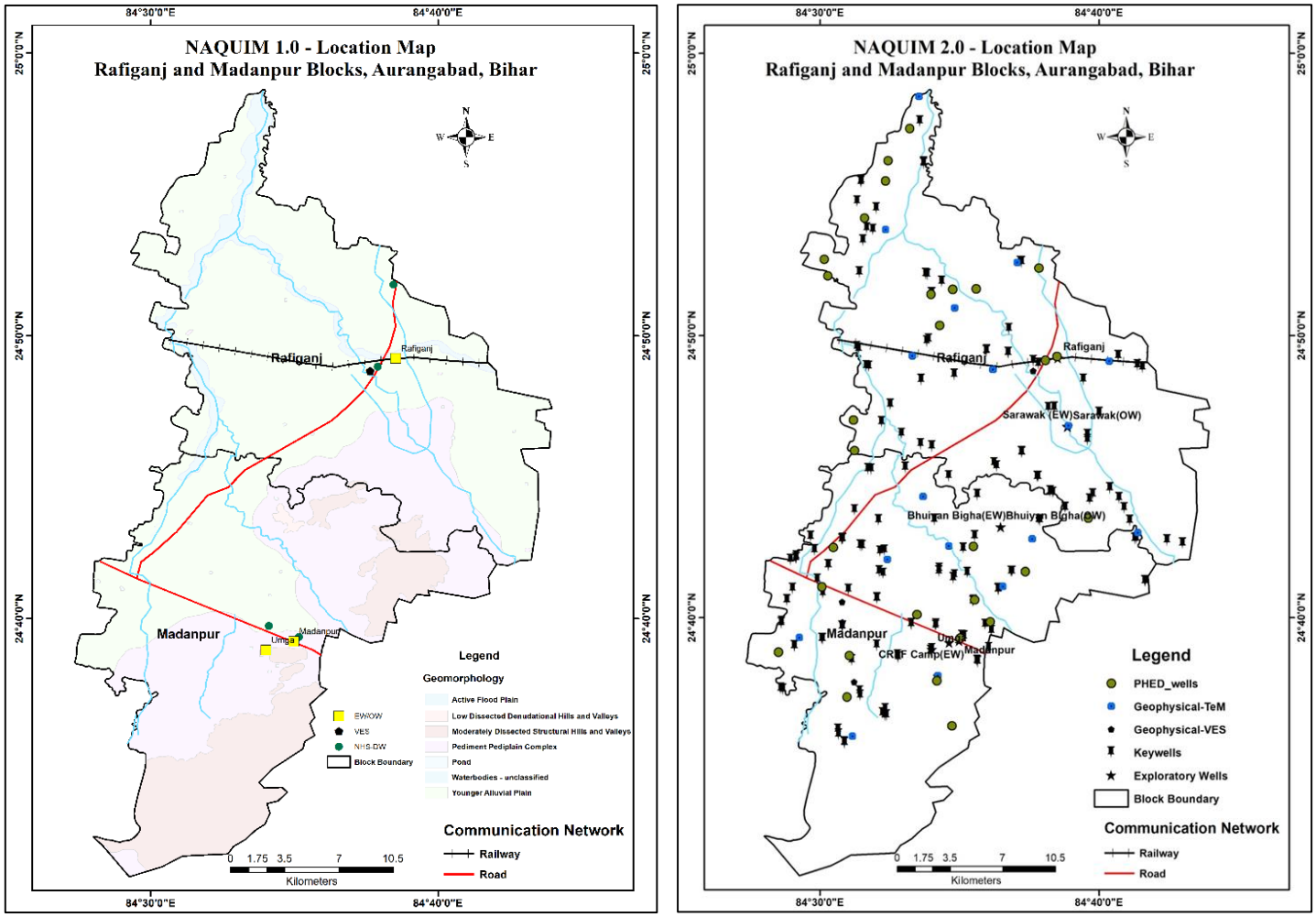


Figure 13: Comparison of data density of EW/VES/TEM of NAQUIM 2 with previous Studies.

3.3 Soil Infiltration Test

Soil infiltration testing is a vital aspect of hydrological studies, offering insights into how water moves through the soil. A commonly used method for these tests is the double ring infiltrometer technique. This method provides valuable information on soil-water interactions, infiltration dynamics, and hydraulic conductivity. Understanding soil infiltration is essential for effective water resource management, particularly in regions prone to drought or water scarcity. It aids in estimating ground water recharge rates and designing efficient irrigation systems. Therefore, to know the infiltration rate 05 nos. of test were conducted in the study area covering the range of soil type which are indicated in figure 15 and table 12

Table 13: Location details & results of Soil Infiltration test.

S.No.	Block	Location	Latitude	Longitude	Infiltration Rate (mm/hr.)
1	Rafiganj	Sarawak	24.7859	84.6461	3
2	Madanpur	Manika	24.654483	84.496453	6
3	Madanpur	Mahuawan	24.65441	84.490913	6
4	Madanpur	Noniadih Tola	24.644822	84.5957659	6
5	Rafiganj	Kajpa	24.819941	84.523577	150

Figure 14: Field photograph of soil infiltration test using double ring infiltrometer technique.

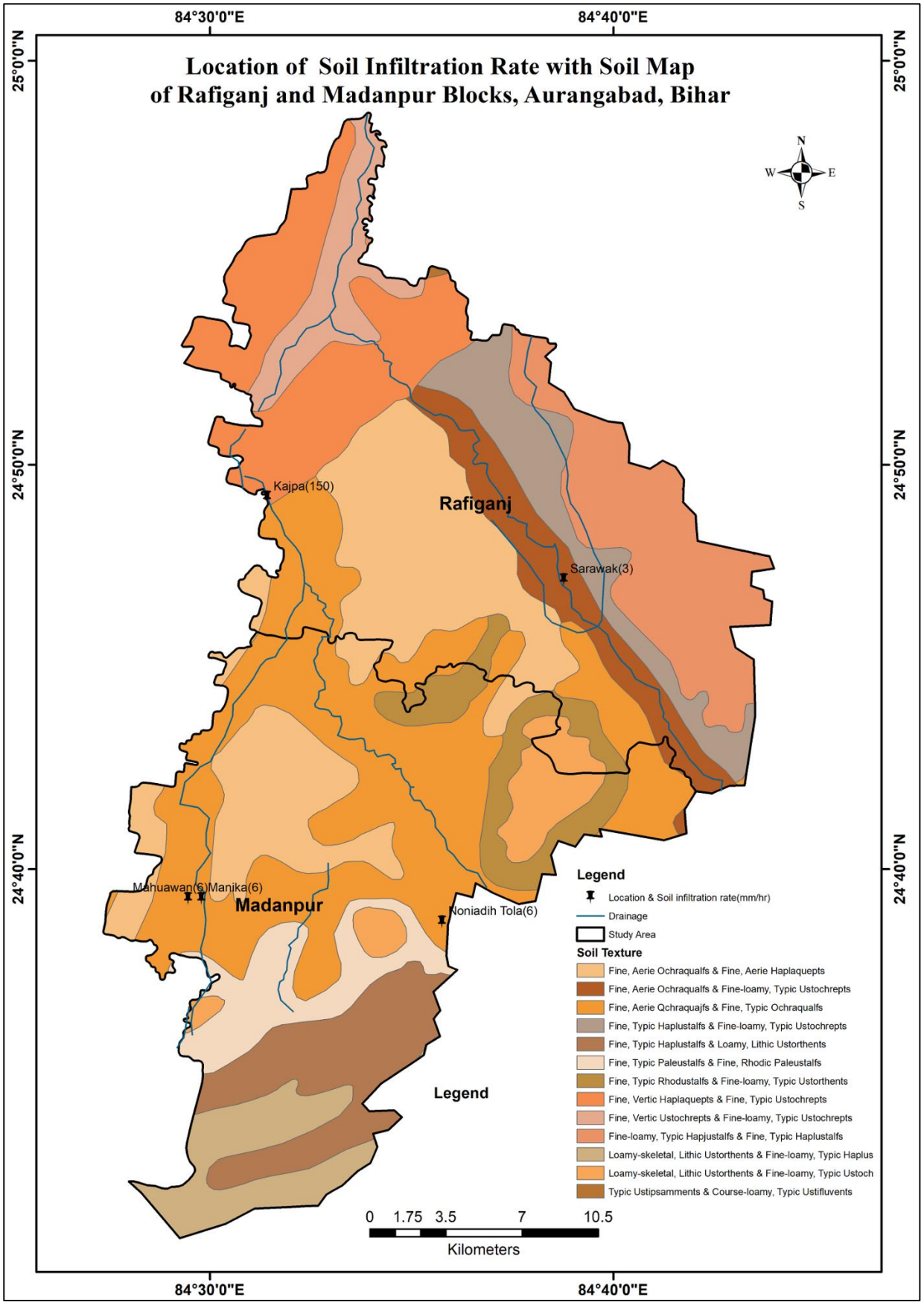


Figure 15: Soil infiltration test location.

3.4 Geophysical Data generation

3.4.1 TEM (Transient Electromagnetic Survey)

As part of NAQUIM 2.0 studies, Rafiganj and Madanpur blocks of Aurangabad district in Bihar were taken up under the category "Water Quality" in AAP 2023-24. Geophysical investigations were also carried out in both the blocks as part of the study. A total of 52 TEM (Transient Electromagnetic Survey) at 17 locations, 6 ERT surveys and 3 VES (fig 16) covering the whole study area were conducted. The findings of the study are discussed below.

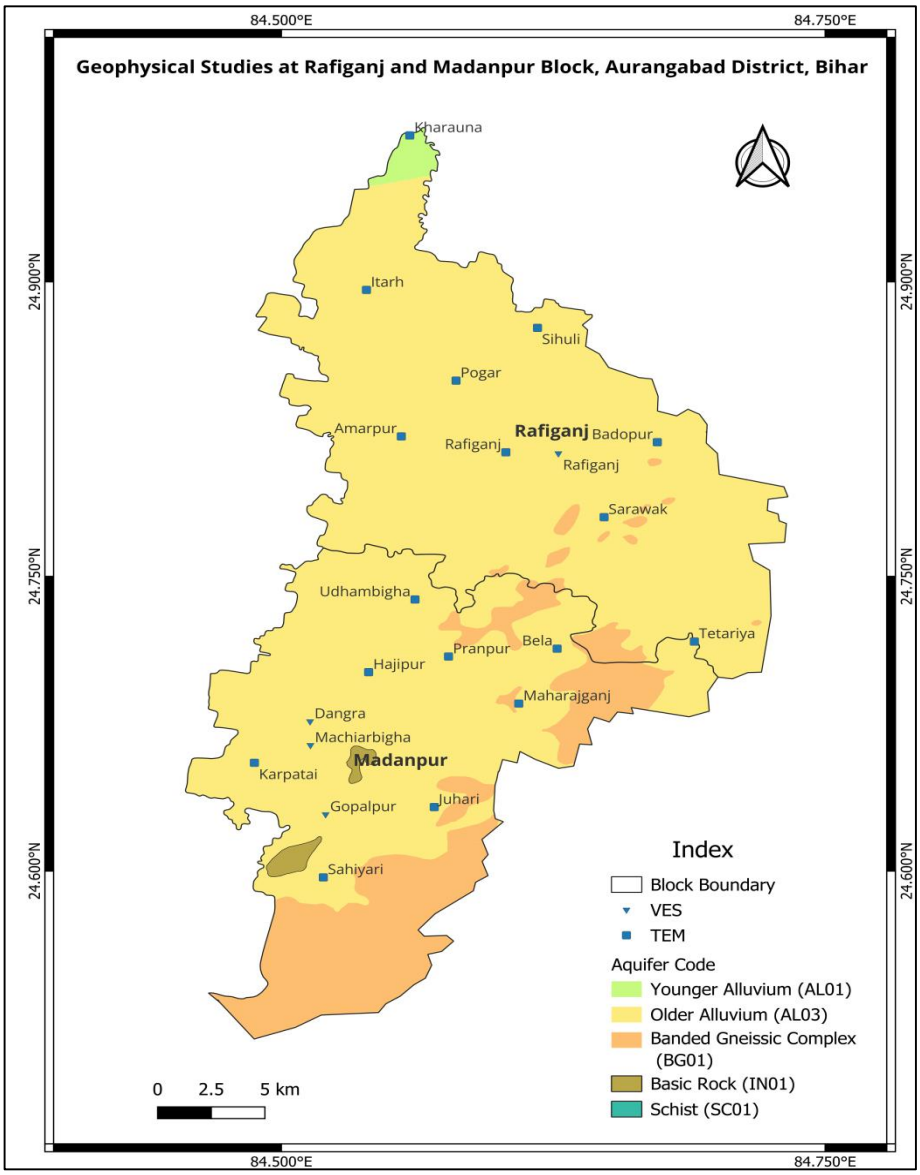


Figure 16: Map showing locations of TEM & VES points.

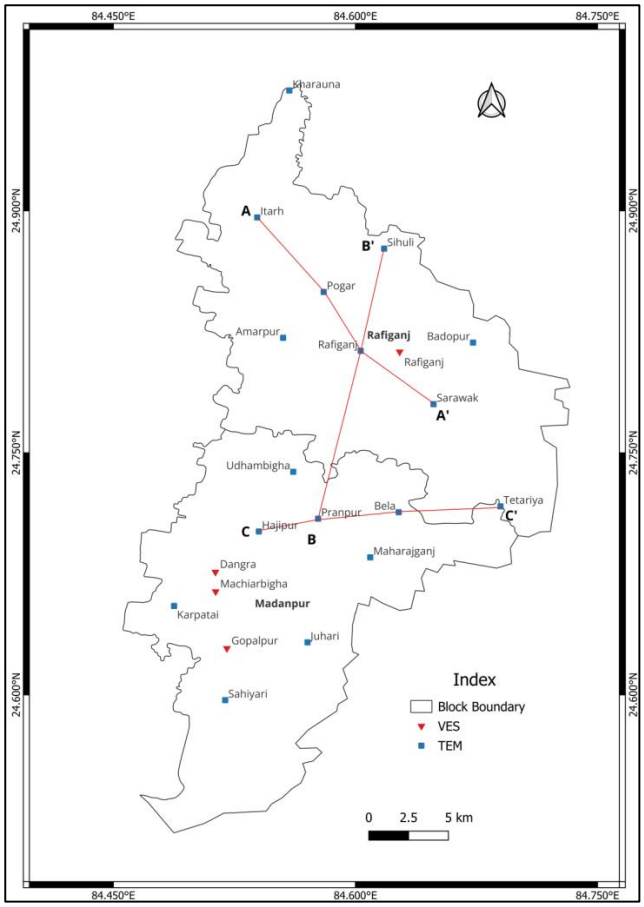


Figure 17: Geo electrical section in the study area.

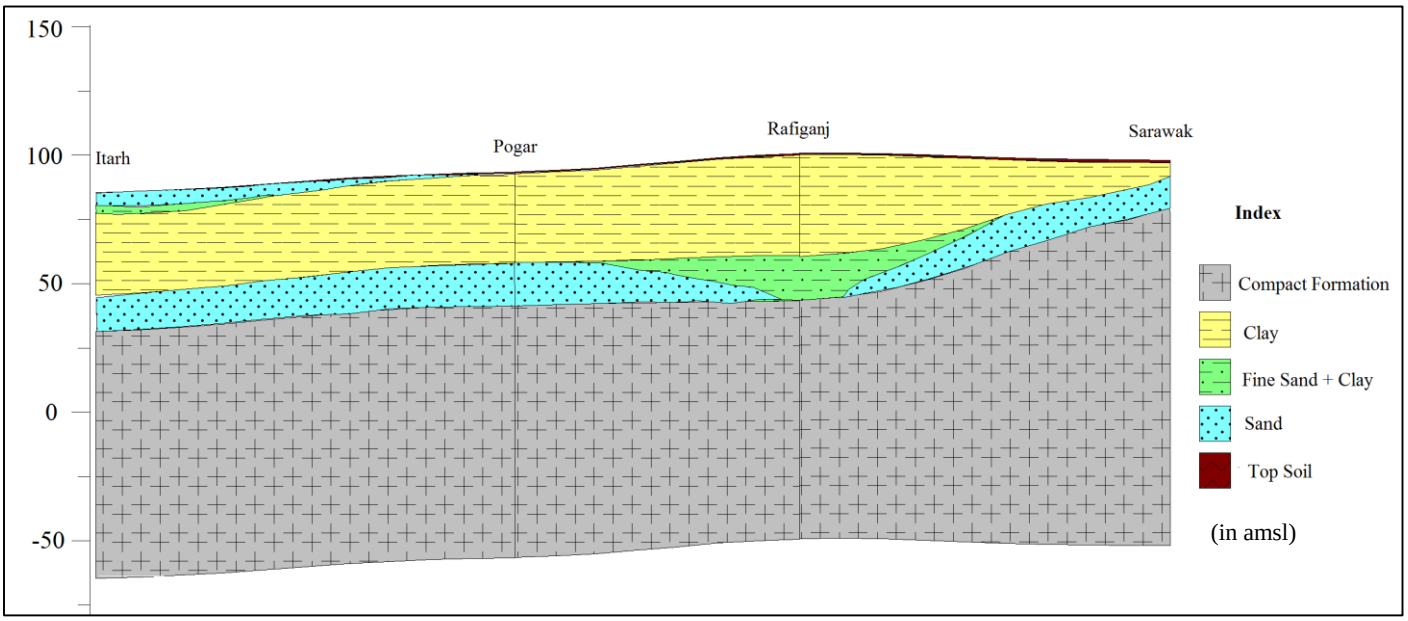


Figure 18: Section A-A' (Itrah-Sarawak).

The section A-A’ extends in NW-SE direction from Itarh to Sarawak of Rafiganj block. A thick clay layer has been inferred in all the four locations. The thickness of the clay layer varies from 22.0 m in Itarh to 4.7 m in Sarawak. Also, the depth to bedrock decreases as one traverse along the

section from Itarh to Sarawak. Further beneath the clay layer, at Itarh, Pogar and Sarawak, a sand layer having thicknesses 14.2 m, 16.5 m and 12.2 m respectively has been inferred, which can be a potential water bearing zone. At Rafiganj, no prominent sand layer could be inferred, but a layer having resistivity 25 Ω-m was interpreted. This layer can be a layer comprising of mixture of fine sand and clay.

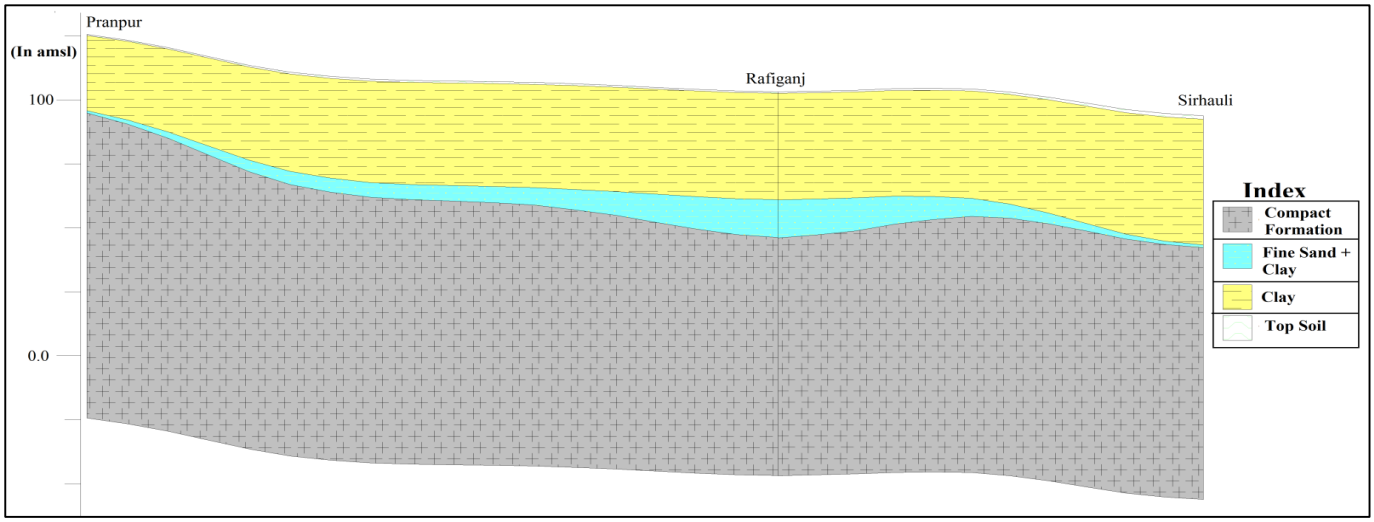


Figure 19: Section B-B'(Pranpur-Sirhauli).

Geoelectrical section B-B' extends in SW-NE direction from Pranpur to Sirhauli. The depth to bedrock decreases as one traverse in the profile direction. A prominent clay layer has been inferred underneath top soil in all the three locations. The thickness of the clay layer is 27.4 m, 42 m and 51.1 m in Pranpur, Rafiganj and Sirhauli respectively. Beneath the clay layer, at Rafiganj, a layer with intermittent resistivity 25 Ω-m was inferred, which may be a layer having mixture of fine sand and clay.

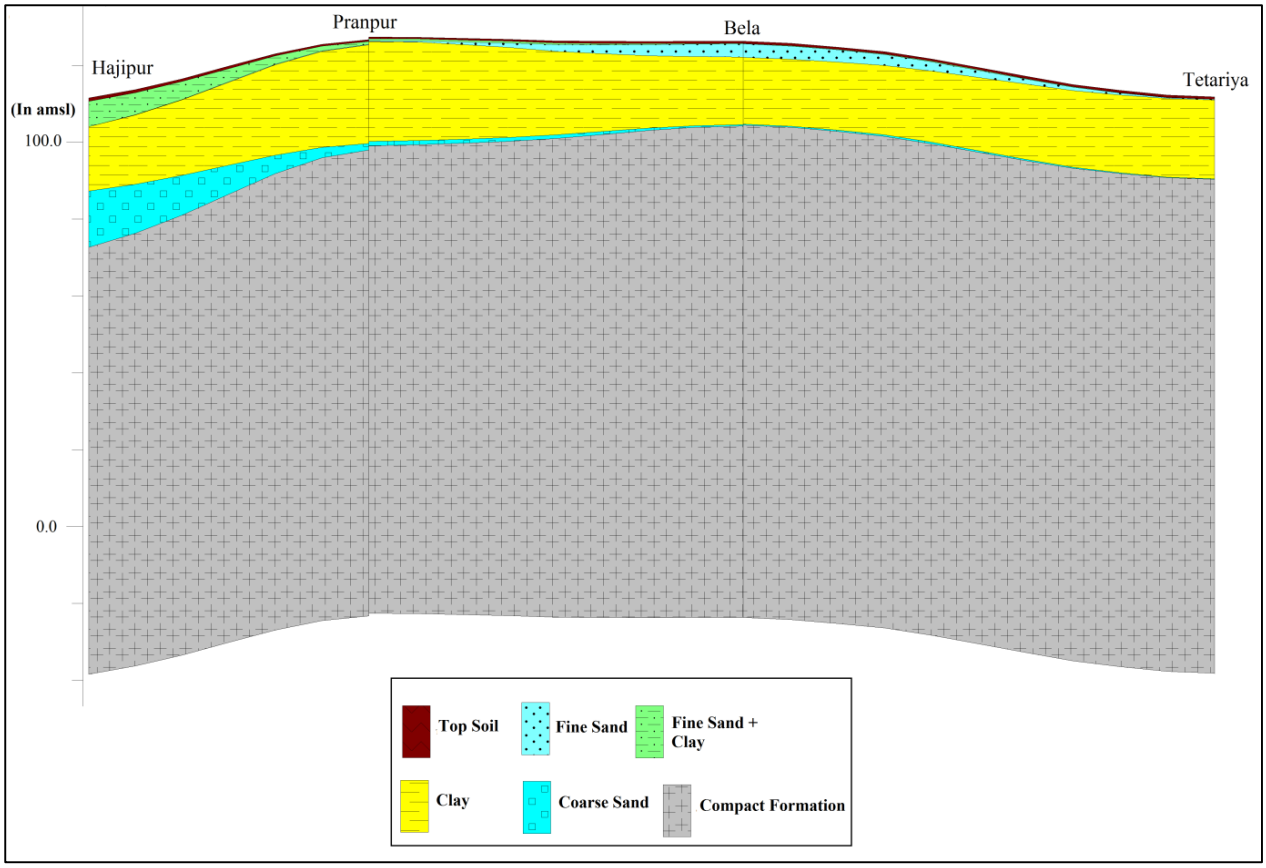


Figure 20: Geoelectrical Section C-C'(Hajipur-Tetariya).

The geoelectrical section C-C' extends in W-E direction from Hajipur to Tetariya covering a distance of 19.5 km. Here, the depth to bedrock has been found to be shallower towards the eastern direction. The depth to bedrock varies from 40.0 mbgl at Hajipur to 21.25 mbgl at Tetariya.

3.4.1.1 Depth to Bed rock

An attempt was made to prepare a depth to bedrock map of the study area based on interpreted TEM data.

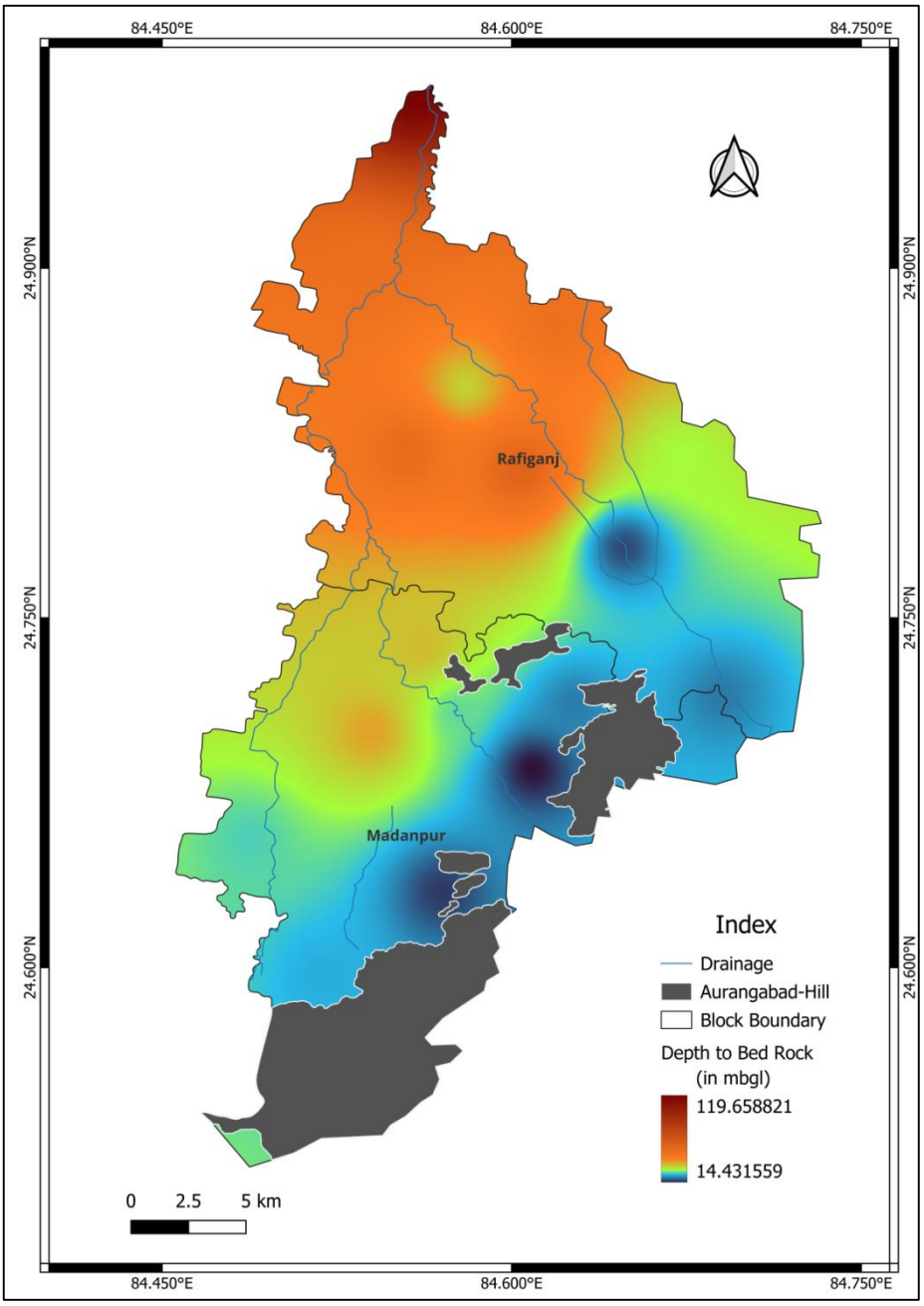


Figure 21: Depth to bed rock.

From the figure 21 it is evident that the depth to bed rock increases as one move from southern part to the northern part of the study area.

Table 14: Interpreted TEM results of Rafiganj and Madanpur Block, Aurangabad District, Bihar.

S. No	Location	Coordinates		ρ_1	h_1	Inferred Lithology	ρ_2	h_2	Inferred Lithology	ρ_3	h_3	Inferred Lithology	ρ_4	h_4	Inferred Lithology	ρ_4	h_4	Inferred Lithology	ρ_5	Inferred Lithology
		Longitude	Latitude																	
1	Amarpur	84.55517	24.82128	3.9	2.8	Top Soil	31.6	2.2	Fine Sand	6.2	34.3	Clay	147.3	16.2	Coarse Sand/ Weathered Formation	19573		Compact Formation		
2	Amarpur	84.55519	24.82136	1.4	0.6	Top Soil	7.3	6.0	Clay	7.1	36.2	Clay	106.5	15.5	Coarse Sand/ Weathered Formation	1499.7		Compact Formation		
3	Amarpur	84.55522	24.82144	15.8	0.2	Top Soil	9.7	2.4	Clay	5.7	31.8	Clay	103.4	21.0	Coarse Sand/ Weathered Formation	549		Compact Formation		
4	Badopur	84.67286	24.81833	65.3	7.9	Top Soil	5.3	22.6	Clay	1586.9		Compact Formation								
5	Badopur	84.67297	24.81831	32.2	8.9	Top Soil	5.3	21.6	Clay	647.1		Compact Formation								
6	Badopur	84.67306	24.81831	21.3	2.8	Top Soil	15.2	8.5	Fine Sand + Clay	5.4	20.1	Clay	345.5		Compact Formation					
7	Bela	84.62681	24.71319	8.7	23.8	Top Soil	480.1	20.4	Compact Formation	1781.8	100.8	Compact Formation	424.0		Compact Formation					
8	Bela	84.62683	24.71311	401.0	37.5	Top Soil	1596.2		Compact Formation		0.0									
9	Bela	84.62686	24.713	7.4	21.6	Top Soil	406.3	26.3	Compact Formation	1601.4		Compact Formation								
10	Hajipur	84.54014	24.70125	12.0	0.9	Top Soil	6.0	24.7	Clay	125.2	14.2	Coarse Sand/ Weathered Formation	1100.9		Compact Formation					
11	Hajipur	84.54022	24.70125	3.4	0.3	Top Soil	14.2	8.1	Clay	3.9	13.0	Clay	112.9	19.2	Coarse Sand/ Weathered Formation	2943		Compact Formation		
12	Hajipur	84.54033	24.70125	1.0	0.3	Top Soil	21.6	5.1	Fine Sand + Clay	5.5	19.3	Clay	124.0	16.8	Coarse Sand/ Weathered Formation	5832.4		Compact Formation		
13	Itarh	84.53914	24.89589	41.9	4.5	Top Soil	20.2	3.5	Fine Sand + Clay	12.3	32.1	Clay	100.3	14.1	Coarse Sand/ Weathered Formation	5598.7		Compact Formation		
14	Itarh	84.53917	24.89597	38.9	4.4	Top Soil	19.7	3.4	Fine Sand + Clay	12.4	32.3	Clay	101.4	14.2	Coarse Sand/ Weathered Formation	5599.6		Compact Formation		

S. No	Location	Coordinates		ρ_1	h_1	Inferred Lithology	ρ_2	h_2	Inferred Lithology	ρ_3	h_3	Inferred Lithology	ρ_4	h_4	Inferred Lithology	ρ_4	h_4	Inferred Lithology	ρ_5	Inferred Lithology
		Longitude	Latitude																	
15	Itarh	84.53919	24.89606	35.2	4.7	Top Soil	19.6	3.3	Fine Sand + Clay	12.0	29.6	Clay	102.2	14.0	Coarse Sand/ Weathered Formation	5665.8		Compact Formation		
16	Juhari	84.57031	24.63253	225.8	1.0	Top Soil	3.5	1.1	Clay	30.6	6.7	Fine Sand + Clay	4.0	8.1	Clay	832.3		Compact Formation		
17	Juhari	84.57028	24.63244	80.4	0.9	Top Soil	25.0	5.9	Fine Sand + Clay	4.6	10.5	Clay	622.1		Compact Formation					
18	Juhari	84.57028	24.63236	21.0	1.6	Top Soil	33.5	2.8	Fine Sand	5.5	12.8	Clay	11589.0		Compact Formation					
19	Karpatai	84.48761	24.65508	4.5	0.4	Top Soil	27.6	6.4	Fine Sand	6.9	16.9	Clay	345.9	86.2	Weathered Formation	3180.5		Compact Formation		
20	Karpatai	84.48764	24.65519	27.2	0.4	Top Soil	14.6	8.1	Fine Sand + Clay	6.4	13.6	Clay	209.7	26.8	Weathered Formation	593.7		Compact Formation		
21	Karpatai	84.48767	24.65528	8.9	0.2	Top Soil	54.4	9.0	Medium Sand	3.6	8.7	Clay	254.0	29.4	Weathered Formation	8318.4		Compact Formation		
22	Kharauna	84.55906	24.97456	88.8	1.2	Top Soil	3.9	1.1	Clay	32.7	11.2	Fine Sand	10.5	9.0	Clay	45.4	9.0	Fine Sand	11.2	Clay
23	Kharauna	84.55892	24.97461	60.7	1.1	Top Soil	4.7	1.8	Clay	16.6	14.3	Fine Sand + Clay	70.5	18.0	Medium Sand	11.7	18.0	Clay	2	Clay
24	Kharauna	84.55883	24.97461	19.0	0.4	Top Soil	16.8	4.2	Fine Sand + Clay	12.3	12.2	Clay	35.8	22.4	Fine Sand	14.8	22.4	Fine Sand + Clay	37.4	Fine Sand
25	Maharajganj	84.60917	24.68522	108.8	8.3	Top Soil	19.1	6.1	Fine Sand + Clay	369.1	9.4	Weathered Formation	5658.2	343.9	Compact Formation	532.1		Compact Formation		
26	Maharajganj	84.60925	24.68517	67.0	2.9	Top Soil	28.4	12.6	Fine Sand	811.8	103.4	Compact Formation		11.4						
27	Maharajganj	84.77603	24.68514	1621.7	0.1	Top Soil	10.4	3.1	Clay	70.8	9.3	Medium Sand	1194.1	7.6	Compact Formation	31021		Compact Formation		
28	Pogar	84.58033	24.84969	0.9	0.2	Top Soil	7.3	5.2	Clay	5.8	30.2	Clay	40.1	20.5	Fine Sand	1059.7		Compact Formation		
29	Pogar	84.58044	24.84967	0.9	0.3	Top Soil	8.6	7.5	Clay	5.5	25.8	Clay	32.5	25.9	Fine Sand	879.16		Compact Formation		
30	Pogar	84.58053	24.84964	0.5	0.3	Top Soil	18.3	1.5	Fine Sand + Clay	8.3	14.4	Clay	4.8	18.0	Clay	49.8	18.0	Fine Sand	13349	Compact Formation
31	Pranpur	84.57686	24.70919	68.8	0.4	Top Soil	19.3	3.0	Fine Sand + Clay	10.2	23.0	Clay	300.9	54.9	Compact Formation					
32	Pranpur	84.57675	24.70919	541.2	1.4	Top Soil	4.8	3.2	Clay	15.5	33.0	Fine Sand + Clay	1369.3	87.7	Compact Formation					
33	Pranpur	84.57667	31.02589	6.6	0.4	Top Soil	29.2	3.6	Fine Sand	9.3	21.0	Clay	276.6	61.2	Compact Formation	598.5		Compact Formation		
34	Pranpur	84.57656	24.70922	492.0	0.1	Top Soil	525.4	1.3	Top Soil	1.3	0.4	Top Soil	22.8	10.1	Fine Sand + Clay	3.1	10.1	Clay	396.7	Compact Formation

S. No	Location	Coordinates		ρ_1	h_1	Inferred Lithology	ρ_2	h_2	Inferred Lithology	ρ_3	h_3	Inferred Lithology	ρ_4	h_4	Inferred Lithology	ρ_4	h_4	Inferred Lithology	ρ_5	Inferred Lithology
		Longitude	Latitude																	
35	Rafiganj	84.60322	24.81319	3.0	0.5	Top Soil	8.3	6.8	Clay	5.6	34.7	Clay	23.2	20.6	Fine Sand + Clay	949		Compact Formation		
36	Rafiganj	84.60331	24.81319	0.9	0.2	Top Soil	10.5	6.5	Clay	5.6	37.1	Clay	27.1	16.0	Fine Sand + Clay	393.9		Compact Formation		
37	Rafiganj	84.60342	24.81319	3.7	0.2	Top Soil	6.8	11.4	Clay	5.6	33.4	Clay	26.2	16.0	Fine Sand + Clay	321.2		Compact Formation		
38	Sahiyari	84.51931	24.59672	8.6	0.3	Top Soil	30.0	11.4	Fine Sand + Clay	4.1	12.0	Clay	256.0	22.9	Compact Formation	2730.5		Compact Formation		
39	Sahiyari	84.51931	24.59683	8.9	0.4	Top Soil	26.7	9.3	Fine Sand + Clay	5.2	15.6	Clay	409.6	56.9	Compact Formation	1389.4		Compact Formation		
40	Sahiyari	84.51931	24.59692	32.4	0.3	Top Soil	6.5	0.8	Clay	174.3	11.8	Coarse Sand	2.5	7.8	Clay	356.8		Compact Formation		
41	Sarawak	84.64839	24.78017	1149.8	0.3	Top Soil	1.4	0.4	Top Soil	26.3	21.8	Fine Sand + Clay	474.2		Compact Formation					
42	Sarawak	84.64847	24.78017	157.6	2.0	Top Soil	5.7	3.8	Clay	94.2	12.5	Medium Sand	1306.3		Compact Formation					
43	Sarawak	84.64858	24.78017	29.5	1.1	Top Soil	0.7	0.4	Top Soil	121.2	2.2	Medium Sand	138.6		Coarse Sand / Weathered Formation	13189		Compact Formation		
44	Sihuli	84.61778	24.87656	113.8	1.4	Top Soil	5.3	34.5	Clay	7.4	30.6	Clay	336.0		Compact Formation					
45	Sihuli	84.61775	24.87667	125.7	0.6	Top Soil	7.7	3.2	Clay	5.4	47.9	Clay	392.6		Compact Formation					
46	Sihuli	84.61778	24.87675	64.1	3.8	Top Soil	4.4	15.8	Clay	6.5	34.0	Clay	257.3		Compact Formation					
47	Tetariya	84.68989	24.71683	16.3	0.6	Top Soil	7.1	20.6	Clay	761.9		Compact Formation								
48	Tetariya	84.68997	24.71683	18.1	0.7	Top Soil	8.0	23.4	Clay	3160.0		Compact Formation								
49	Tetariya	84.69008	24.71683	61.6	1.0	Top Soil	6.7	18.4	Clay	783.8	60.9	Compact Formation	3539.0		Compact Formation					
50	Udhambigha	84.56147	24.73825	81.1	1.6	Top Soil	2.7	2.2	Clay	72.8	6.2	Medium Sand	7.1	27.4	Clay	367.3		Compact Formation		
51	Udhambigha	84.56147	24.73836	68.7	1.4	Top Soil	3.0	2.1	Clay	12.6	12.2	Clay	6.9	21.7	Clay	774.6		Compact Formation		
52	Udhambigha	84.5615	24.73842	185.5	1.0	Top Soil	1.6	1.5	Clay	48.7	10.7	Fine Sand	5.7	19.9	Clay	968.5		Compact Formation		

ρ – Resistivity (in ohm-m), h – Thickness (in m)

3.5 2D ERT Survey:

ERT is a geophysical imaging technique that generates 2D models or subsurface resistivity images delineating resistivity distribution with depth.Electrical Resistivity Tomography(ERT)is an advanced geophysics method used to determine the sub-surface's resistivity distribution by measuring the ground surface. Data collection is fast with an automated multi-electroderesistivity meter. ERT profiles consist of a modeled cross-sectional (2-D) plot of resistivity (Ω·m) versus depth.

3.5.1 Data Acquisition

The ERT method was developed to elucidate complex subsurface structures (Griffiths and Barker, 1993). It is used for obtaining a high-resolution image of subsurface patterns of electrical resistivity.To obtaina 2D image of the subsurface, it is necessary to carry out various true resistivity measurements over a short period. This process was carried out with a multi-electrode 2D device, using 41 electrodes separated by10m, depending on available space.The profile length of each Imaging in the study area is presented below table-14.

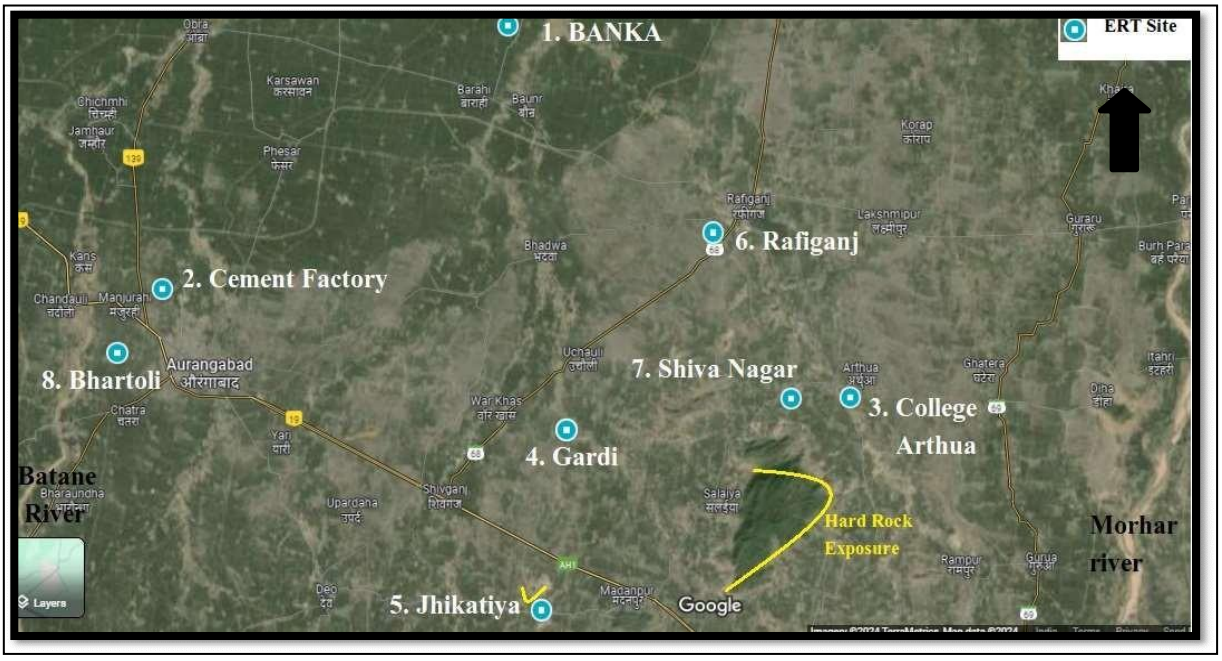


Figure 22: Study area Google map, showing the eight ERT sites, principal rivers, and hard rock exposure.

The sites where the ERT survey was executed are shown in Figure 22, along with main features like rivers and hard rock exposure.

Table 15: Details of ERT study location sites.

S.No	Location (Block)	Latitude	Longitude	Profile Length (m)
1.	Banka (Rafiganj)	24.894950	84.521117	350 m
2.	College Aurthua(Madanpur)	24.739738	84.682098	210 m
3.	Gardi(Madanpur)	24.7262710	84.5487079	350 m
4.	Jhikatiya(Madanpur)	24.6509030	84.5369500	350 m

5	Rafiganj(Rafiganj)	24.8085445	84.6175911	350 m
6	Shivnagar(Rafiganj)	24.739453	84.654190	350 m

3.5.2 Results and Discussion

In the study area, 6 ERT profiles have been executed at 6 sites, with a total of 1.96 line km stretch. All efforts were made to locate the profile line to find fresh ground water pocket and saline interface space availability using three electrode configurations, i.e., Gradient and Wenner configurations. Based on ERT results, two low-medium and high-resistive zones were identified.

Table 16: Interpreted Lithology with Resistivity range

Resistivity range	Lithology
0-15Ohm-m	Top Soil/Clay
15-30Ohm-m	Sand-Clay(Saturated)
150-250Ohm-m	Weathered rock
>200	Hard Rock/Consolidated Formation

3.5.3 Detailed Interpretation

S.No.1 Survey Location: Banka

Total Length 350.00m

1. **Very Low Resistivity** (2.65 -7 Ohm-m):

- Lithology: Zones with very low resistivity and moist corresponding clay. Moist clays are found at a depth below 2.0 to 40.0 mbgl.

2. Low Resistivity(10 - 30 Ohm-m):

- Lithology: Low resistivity (10 - 30 Ohm-m) zones indicate areas with moderate water content suitable for potential aquifer identification.Most formations consist of moist soils,loose sediments,or unconsolidated deposits throughout the ERT stretch below the depth of 10.0mbgl up to~53.0 mbgl suitable for ground water development.

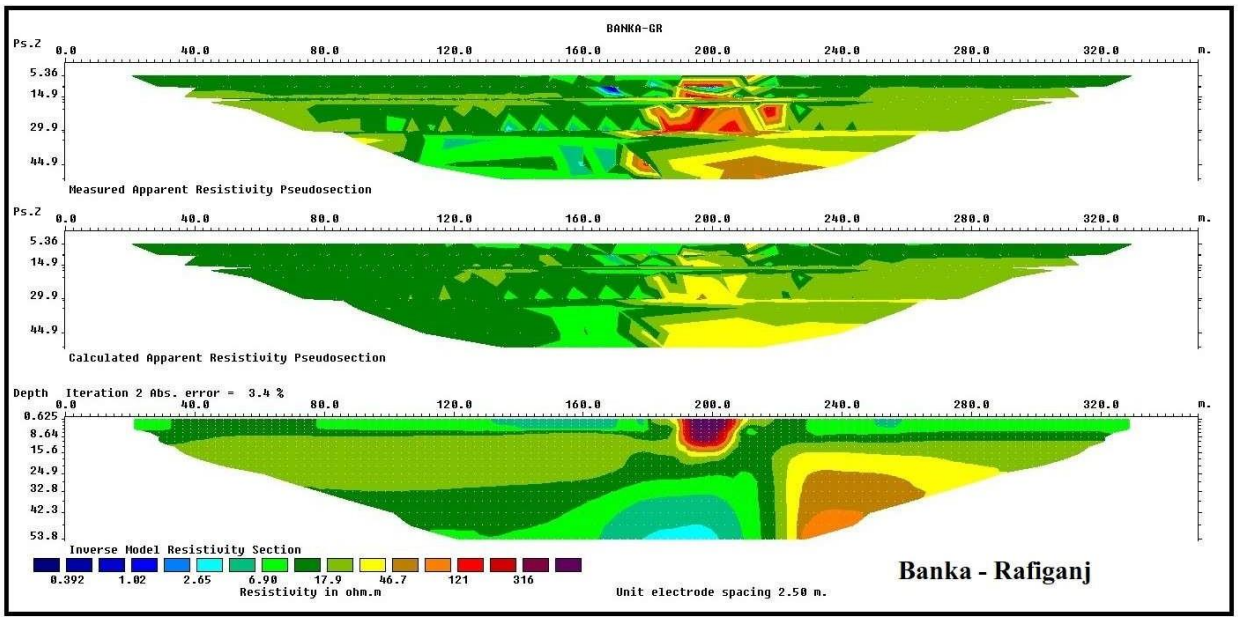


Figure 23:2D electrical resistivity tomography section at Banka.

3. **Medium Resistivity** (30 - 75 Ohm-m):

-Lithology: Medium resistivity (30 -75 Ohm-m) regions often correlate with unconsolidated deposits and may have good ground water potential. Sand, gravel, or mixed sediments,such Lithology found at 240 m stretch length below 24 mbgl.

4. **High Resistivity**(100 -30 Ohm-m):

- Lithology: Due to field conditions at a 200m stretch, dry sand was dumped from the excavated canal. Lithology: Unconsolidated Sediments

Table 17: Interpreted Lithology with Depth (Banka)

S. No	Depth	Lithology
1	0 -2	Top Soil
2	2 – 40	Clay with fine sand
3	40 – 49	Sand
4	49 -54	Clayey Sand

S.No.2 Survey Location: Engineering College Arthua

Total Length 210.00m

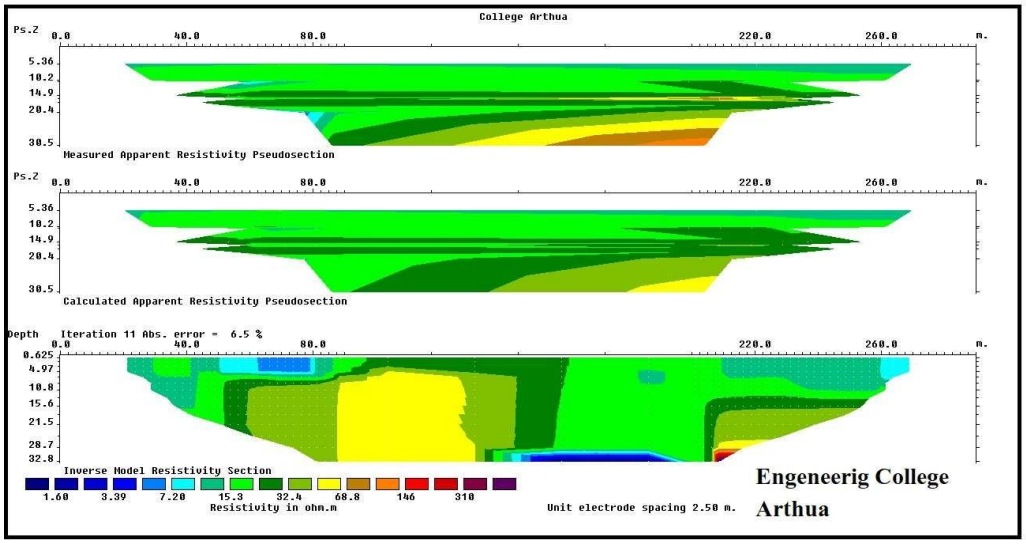


Figure 24:2D electrical resistivity tomography section at College Arthua Site.

1. **Very Low Resistivity** (3.3 -15 Ohm-m):

- Lithology: Low resistivity, indicating clay was found throughout the stretch profile stretch.

2. **Low Resistivity** (15 -35 Ohm-m):

- Lithology: Most of the formation consists of loose material in sand or unconsolidated deposits throughout the ERT stretch below the clay layer.

3. **Medium Resistivity** (30 -45 Ohm-m):

-Lithology: Sand, gravel or mixed sediments.

4. **High Resistivity** (100 Ohm-m):

The hard rock exposer is near the 220.0 spread length at the bottom.

- Lithology: Unconsolidated sediments are deposited over the weathered zone resting over the hard rock (granite).

Table 18 : Interpreted Lithology with Depth (Engineering College Arthua)

S.No.	Depth	Lithology
1	0 – 2.5	Top Soil
2	2.5– 5.5	Clay with Kankar
3	5.5– 30	Sand with Clay
4	30 – 31.5	Weathered Zone
5	31.5– 32.8	Hard Rock(Granite)

S.No.4 Survey Location: Gardi

Total Length 350.00 m

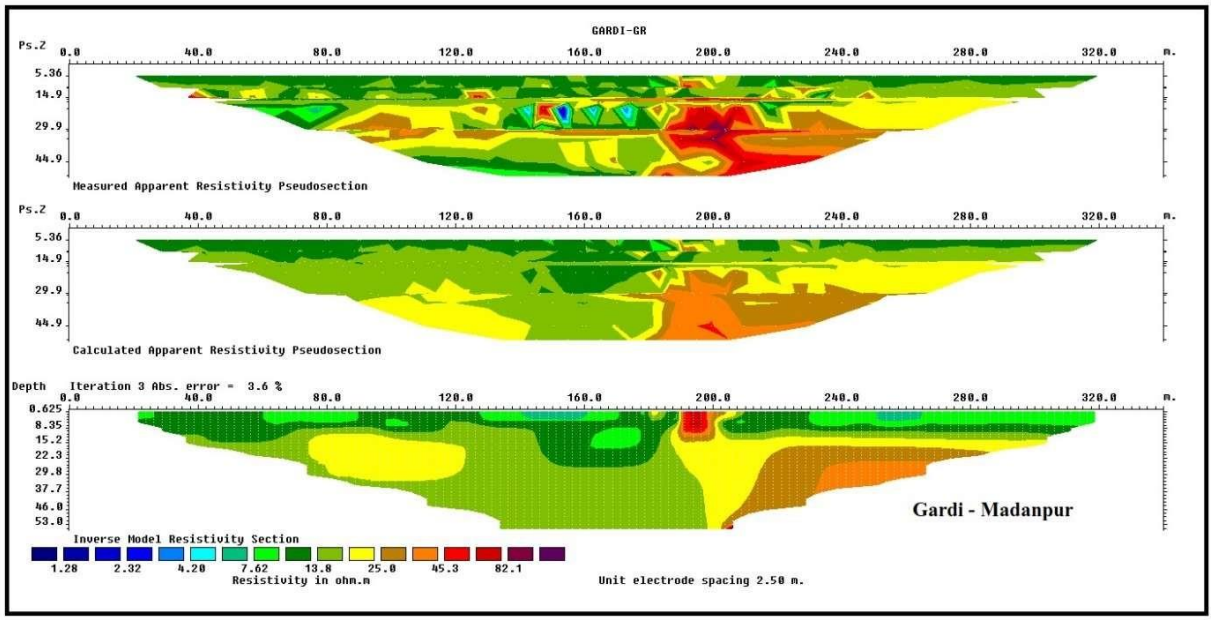


Figure 25:2D electrical resistivity tomography section at College Gardi Site.

1. **Very Low Resistivity**(2.65 -7 Ohm-m):

-Lithology: Clay.

2. **Low Resistivity**(10 -30 Ohm-m):

- Lithology: Most of the formation consists of moist soils, loose sediments, or unconsolidated deposits throughout the ERT stretch below the depth of 8.0 mbgl up to ~51.0mbgl suitable for ground water development in unconsolidated formation.

3. **Medium Resistivity**(30 -75Ohm-m):

-Lithology: Sand, gravel or mixed sediments through out the stretch.

4. **High Resistivity**(100 -30 Ohm-m):

- Lithology: Weathered rock signature delineated beyond a 230 m stretch at a depth of 36m.

S.No.5 Survey Location: Jhikatiya

Total Length 350.00m

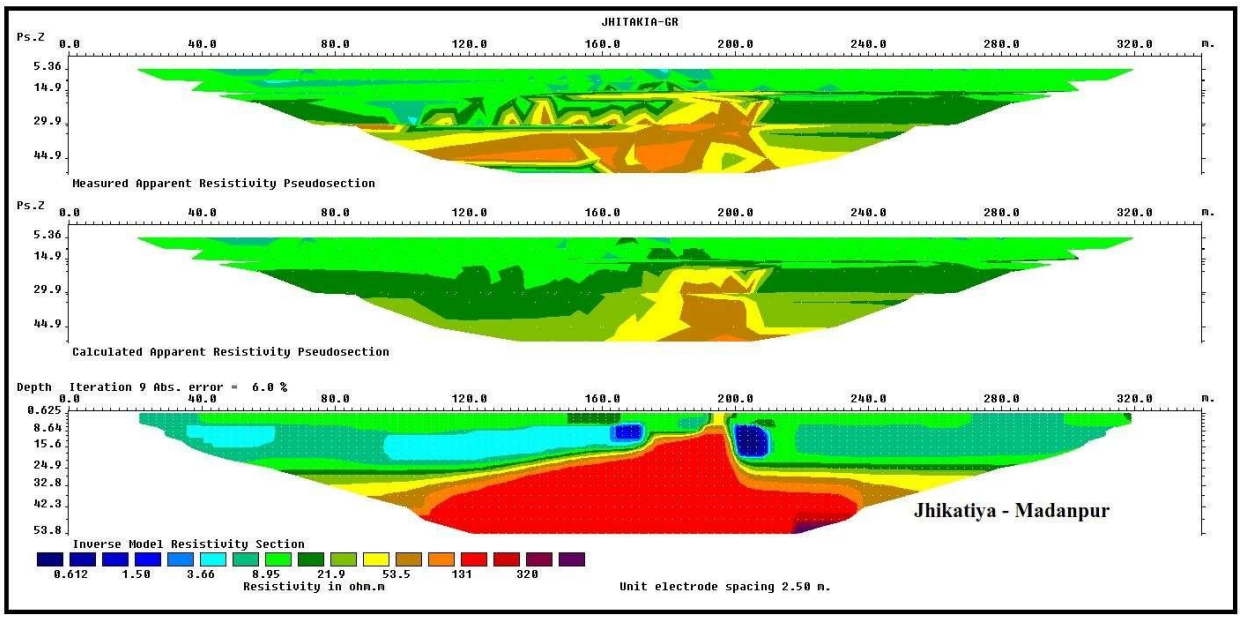


***Figure* 26: 2D electrical resistivity tomography section at College Jhikatiya Site.**

Table 19 : Interpreted Lithology with Depth (Jhikatiya)

S.No	Depth	Lithology
1	0 – 3	Top Soil
2	3 – 14	Clay with Kankar
3	14 – 37	Sand with Clay
4	37 – 49	Weathered Zone
5	49 – 53.8	Hardrock(Bottom Right) at 235m stretch

1. **Very Low Resistivity**(2.65– 13 Ohm-m):

-Lithology: Clay.

2. **Low Resistivity**(10 -30 Ohm-m):

- Lithology: Most of the formation consists of moist soils, loose sediments, or unconsolidated deposits throughout the ERT stretch below the depth of 10.0 mbgl up to 27.0mbgl suitable for ground water development.

3. **Medium Resistivity**(30 -75Ohm-m):

- Lithology: Sand, gravel, or mixed sediments, such lithology found

4. **High Resistivity**(100 -300 Ohm-m):

-Lithology: Weathered Zone onwards hardrock

S.No.6 Survey Location: Rafiganj

Total Length 350.00m

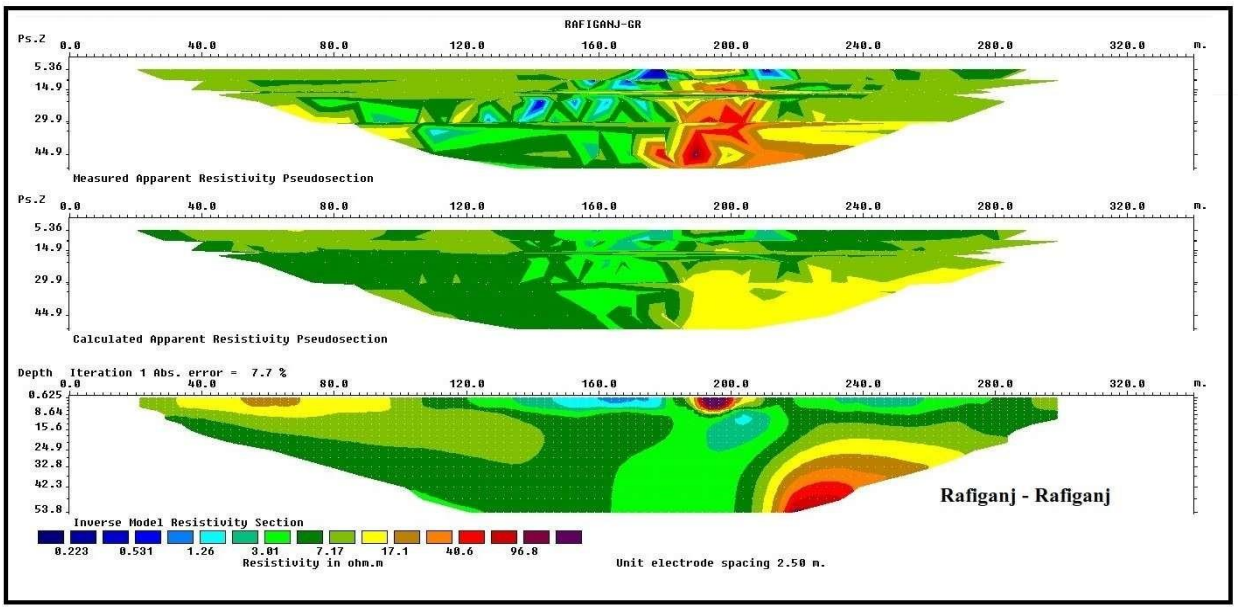


Figure 27: 2D electrical resistivity tomography section at College Rafiganj Site.

Table 20: Interpreted Lithology with Depth (Rafiganj)

S. No	Depth	Lithology
1	0 – 4.5	Top Soil
2	4.5– 11	Clay with Kankar
3	11 – 25.5	Sand with Clay
4	25.5– 52	Clay with Kankar
5	52 – 53.8	Weathered rock(at235 stretch)

1.**Very Low Resistivity**(3.3 -15 Ohm-m):

-Lithology: Low resistivity, indicating clay.

2.**Low Resistivity**(15 -40 Ohm-m):

- Lithology: Most of the formation consists of loose material in sand or unconsolidated deposits throughout the ERT stretch below the clay layer.

3.**Medium Resistivity**(30 -Ohm-m):

-Lithology: Sand, gravel or mixed sediments,such lithology,throughout the stretch length.

4.**High Resistivity** (100 Ohm-m):

Near the 235.0 spread length, a weathered rock signature was delineated.

- Lithology: Unconsolidated sediments are deposited over the weathered zone resting overthehard rock (granite).

The water level was monitored at 10.23 mbgl, and surface excavation was water-saturated clay.

S.No.7 Survey Location: Shivnagar

Table 21: Interpreted Lithology with Depth (Shivnagar)

S.No	Depth	Lithology
1	0 – 4	Top Soil
2	4– 13.5	Clay with Kankar
3	13.5– 21	Sand with Clay
4	21-45	Weathered zone
5	45. 53.8	Hardrock

1. **Very Low Resistivity** (3.3 -15 Ohm-m):

-Lithology: Low resistivity, indicating clay.

2. **Low Resistivity**(15 -35 Ohm-m):

- Lithology: Most of the formation consists of loose material in sand or unconsolidated deposits throughout the ERT stretch below the clay layer.

3. **Medium Resistivity**(30 -70Ohm-m):

-Lithology: Sand, gravel or mixed sediments such lithology found at200 m stretch length.

4. **High Resistivity** (100 Ohm-m):Weathered rock followed by hardrock.

- Lithology: Unconsolidated sediments are deposited over the weathered zone resting over the hard rock (granite).

3.5.4 Finding & Conclusions

Based on the ERTgeophysical investigation, the study has yielded the following key findings:

1. In the Madanpur block, fresh ground water pockets are available up to a depth of approximately 10 to 35meters below ground level (mbgl) in marginal alluvium.Conversely, in Rafiganj, ground water is accessible upto around 62.5meters in unconsolidated formations, exhibiting spatial variations.
2. The thickness of saturated freshwater pockets varies across different locations.Waterlevels were measured 10.23 mbgl in Rafiganj.
3. The ERT results indicate that the topsoil in the area with uneven clay composition dominates, as depicted in Figure 18. This is followed by sandy clay and clayey sandlayers, overlaying a weathered zone of hard rock (granite) in the south and alluvium with a sand-clay mixture in the north.
4. The surface exposure of hard rock, specifically granite, continues the underlying formation. This is prominently observed in locations such as Jhikhatiya, Ugma, Shivnagar, and Hathiyvan outcrops.
5. According to local contacts with farmers, ground water has been broadly observed to be developed up to a depth of 130feet (43 mbgl).

These findings provide a comprehensive understanding of the ground water distribution, soil composition, and geological features in the studied region.

Chapter 4

Aquifer Disposition

4.1 Aquifer Geometry

The aquifer geometry refers to the physical characteristics and arrangement of the aquifer system. With a view to decipher the configuration of the subsurface aquifer ystems of the study area depth down to 200 mbgl, Central Ground Water Board, Mid-Eastern Region, Patna constructed 5 Exploratory Wells, Vertical Electrical Soundings (3 VES), 52 TEM & 6 ERT in different part of the blocks. Aquifer geometry was also deciphered incorporating water supply borewell/tubewell data from the PHED (Public Health Engineering Department) drilled under the "Haar Ghar Nal Yojna" scheme by the state government, Bihar. The lithological log, composite log and geophysical logs of the exploratory wells were used to prepare 3D synoptic picture of aquifer system by using the RockWorks15 Version software.

Total 34 nos of wells of various depth taken into consideration for generation of aquifer model/ lithological model. The Exploratory wells (EW) has been constructed at different depth in different part of block by State government. Details of wells given in table 15

Figure 28: Photograph of field activity during exploration at Sarwak, Deokuli, Rafiganj.

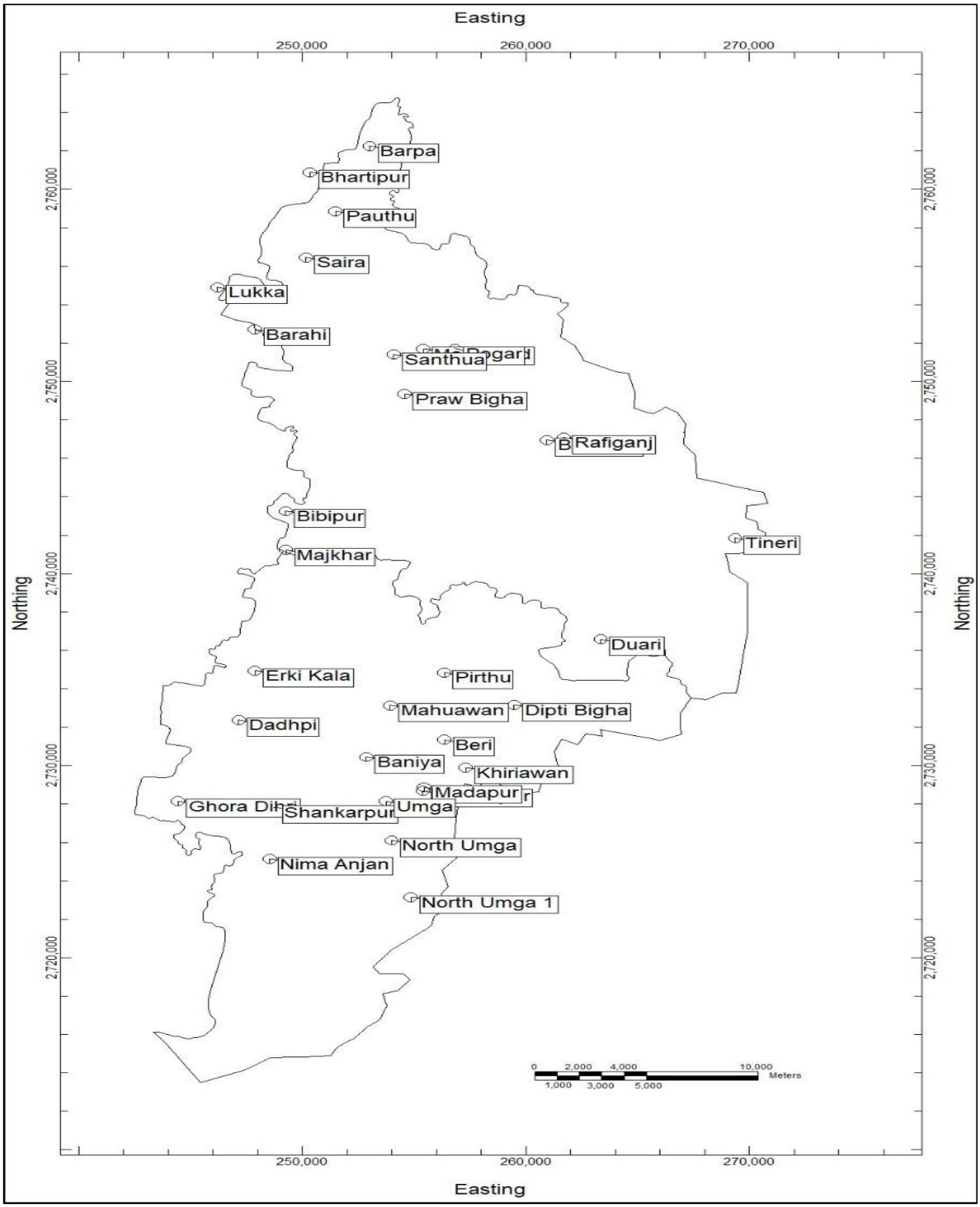


Figure 29: Wells used for deciphering the aquifer geometry in study area.

Table 22: Details of wells used for deciphering Aquifer geometry.

S.No.	Block	Panchayat	Village/Site Name	Latitude	Longitude	Depth (mbgl)
1	Rafiganj	Pogar	Pogar	24.86102	84.59326	77
2	Rafiganj	Pogar	Tineri	24.87714	84.6525	77
3	Rafiganj	Pauthu	Pauthu	24.924723	84.539144	93
4	Rafiganj	Pogar	Santhua	24.85782	84.56628	85.3
5	Rafiganj	Pogar	Mai Khurd	24.86069	84.57922	82
6	Rafiganj	Pogar	Praw Bigha	24.8393	84.57138	82
7	Rafiganj	Pauthu	Barpa	24.955578	84.55361	91
8	Rafiganj	Rafiganj NP	Near rafiganj railway station	24.82107	84.64161	74
9	Rafiganj	Bhetniya	Saira	24.90278	84.52658	82
10	Rafiganj	Bhetniya	Lukka	24.88812	84.48758	84
11	Rafiganj	Bhetniya	Barahi	24.868554	84.504708	82
12	Rafiganj	Bhetniya	Bhetniya	24.81881	84.63474	85
13	Rafiganj	Pauthu	Bhartipur	24.942911	84.527421	85
14	Rafiganj	Bhadwa	Bibipur	24.7835	84.51993	83
15	Rafiganj	Dugul	Duari	24.725553	84.660283	100
16	Rafiganj	Bhadwa	Majkhar	24.765332	84.52047	60
17	Rafiganj	Rafiganj	Rafiganj	84.6422	24.82	65
18	Madanpur	Manika	Anjan	24.644273	84.517443	91
19	Madanpur	Salaiya	Shankarpur	24.644273	84.517443	122
20	Madanpur	Salaiya	Dipti Bigha	24.694	84.62267	125
21	Madanpur	Mahuawan	Mahuawan	24.566576	84.708363	40
22	Madanpur	Baniya	Baniya	24.66858	84.55777	90
23	Madanpur	Erki Kala	Erki Kala	24.708249	84.50781	55
24	Madanpur	Madanpur	Madapur	24.654733	84.583572	130
25	Madanpur	Pirthu	Pirthu	24.70883	84.59152	120
26	Madanpur	Ghora Dihri	Ghora Dihri	24.646476	84.474994	98
27	Madanpur	Dadhpi	Dadhpi	24.685019	84.501027	95
28	Madanpur	Beri	Beri	24.677298	84.592265	90
29	Madanpur	Khiriawan	Khiriawan	24.664258	84.601801	90
30	Madanpur	North Umga	North Umga	24.629596	84.56977	37
31	Madanpur	North Umga	North Umga 1	24.602938	84.578747	85
32	Madanpur	Nimanjan	Nimanjan	24.619899	84.516014	66
33	Madanpur	Madanpur	Madanpur	84.58305556	24.65305556	201
34	Madanpur	Umga	Umga	84.56688056	24.64798889	201

The aquifer geometry on regional scale has been attempted to establish in Madanpur and Rafiganj blocks as per the available data. Principal aquifers in the area have been delineated by fine to medium

sand, coarse and gravelly sand and weathered & fracture hard rock. These cross sections/fence diagrams are given below along with the map to locate the area concerned.

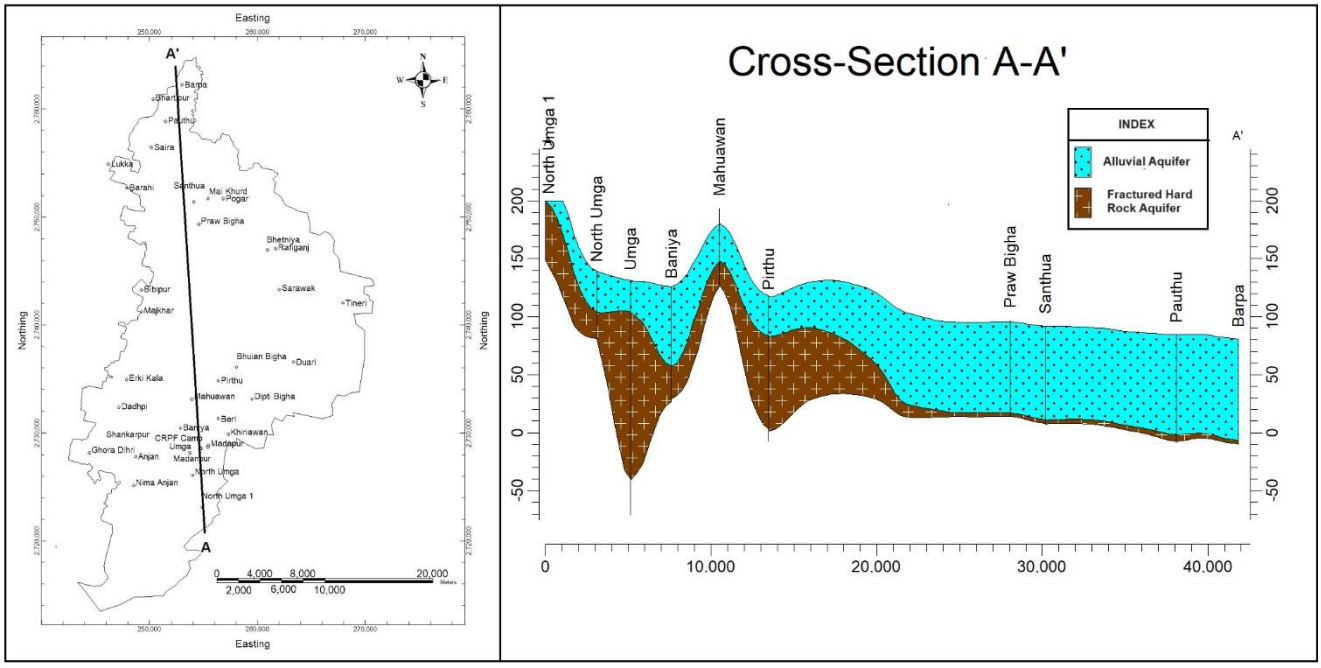


Figure 30: Aquifer disposition along N-S from village North Umga in south to Barpa in North

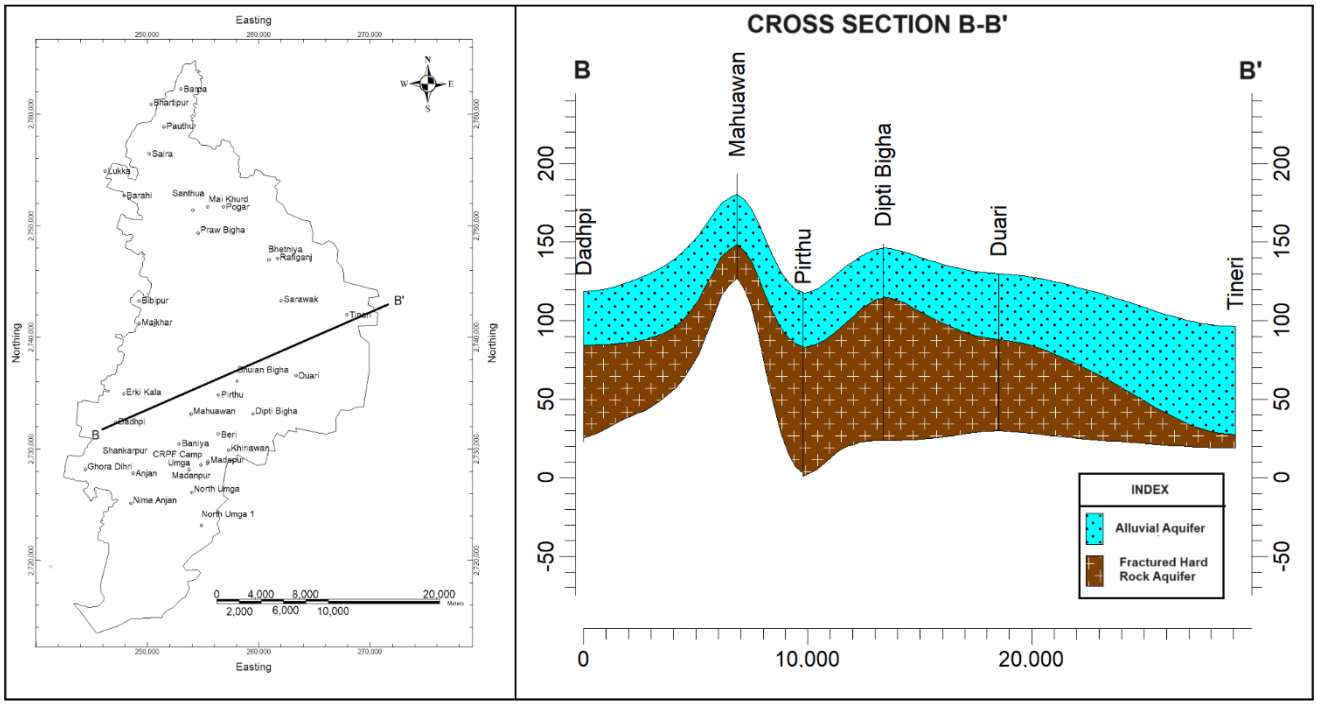


Figure 31: Aquifer disposition along NE-SW along Tineri to Dadhpi village of the area.

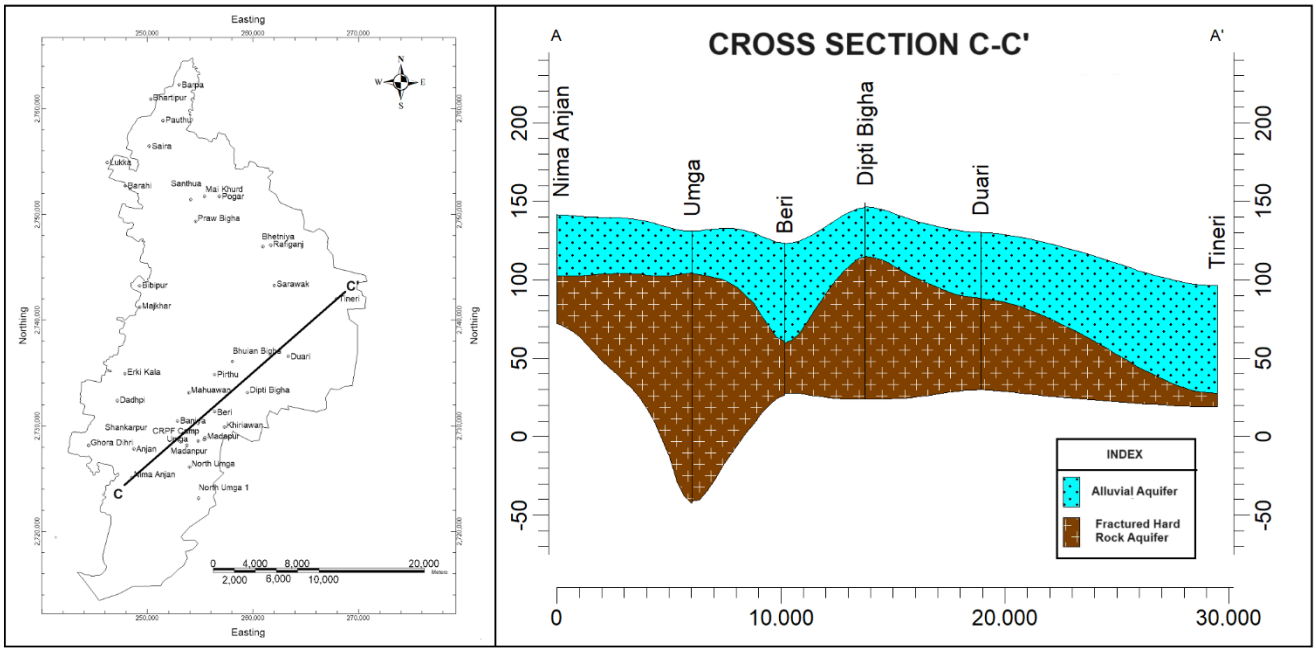


Figure 32: Aquifer disposition along NE-SW along Tineri - Nima Anjan village.

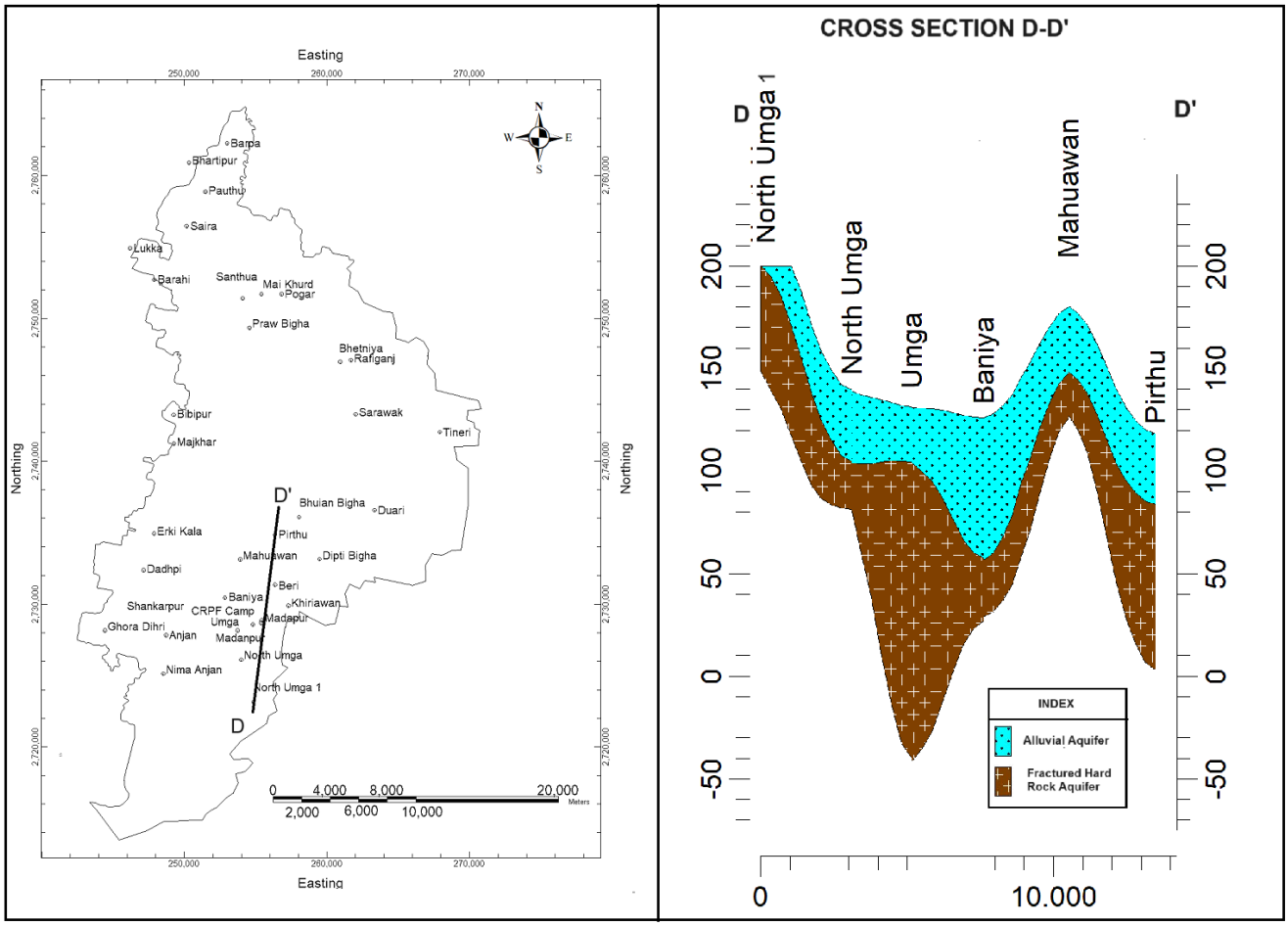


Figure 33: Aquifer disposition along NW-SE in Northern part (along North Umga - Pirthu).

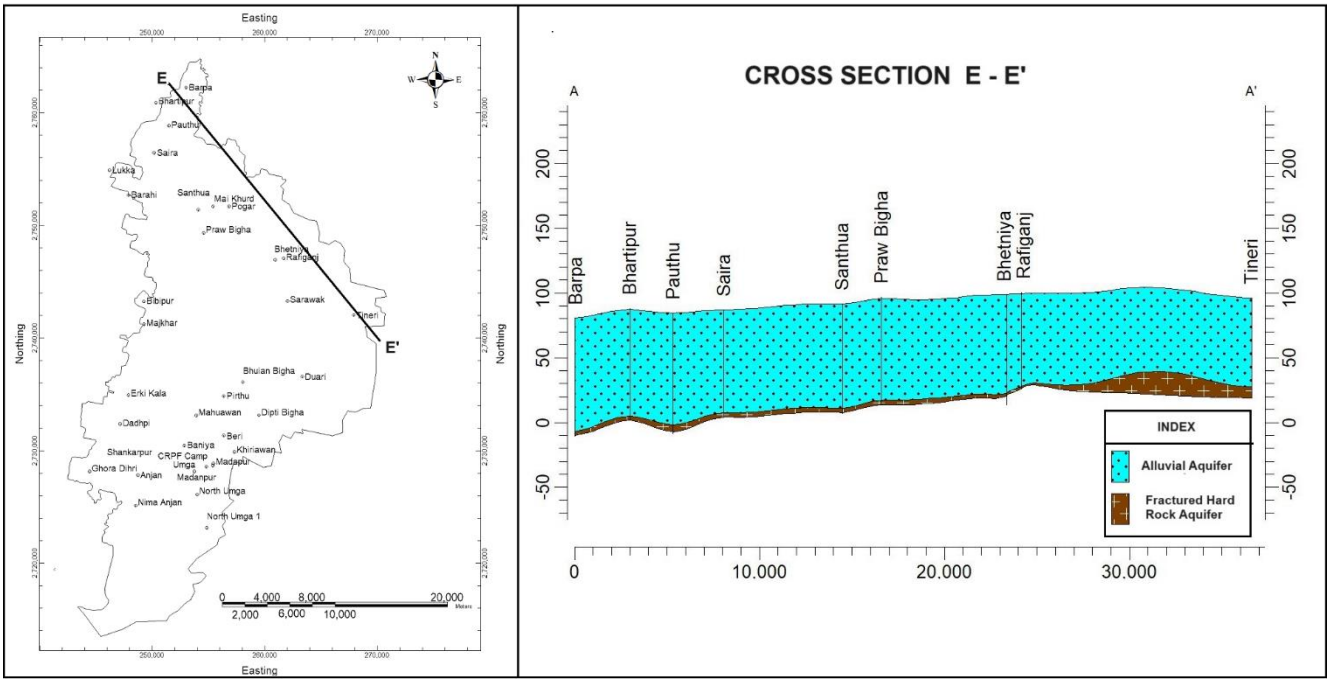


Figure 34:Aquifer disposition in Southern part (along Tineri - Barpa).

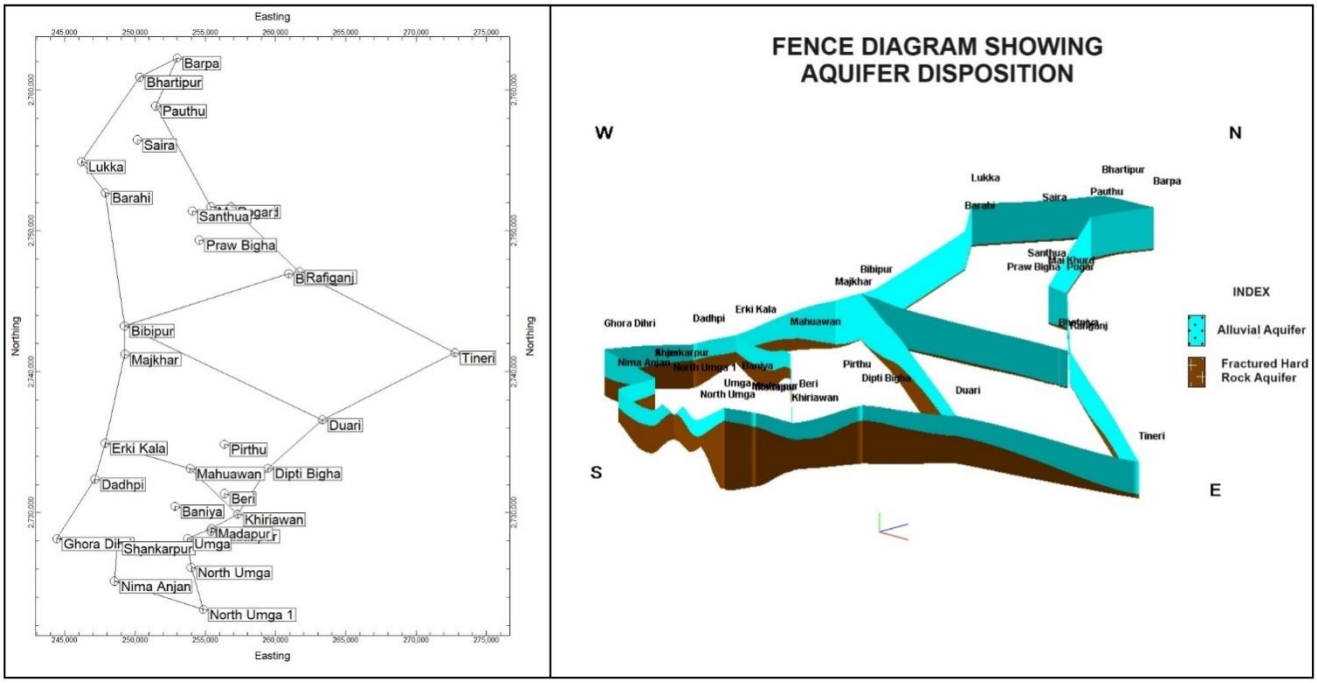


Figure 35: Fence Diagram Showing Aquifer Disposition.

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

Thickness of sediments gradually increases towards north. Near southern and eastern boundary depth to bed rock is shallow. The perusals of the sections, fence diagram and lithological model indicate that in the southern part of the block aquifer are mainly characterized by the weathered fractured hard rock overlying thin alluvium layer.

Towards further north, in Rafiganj block, depth to bed rock is down to 94 m. The 1st porous aquifer delineated in the overlying sediments. This zone is extended towards southern part of Rafiganj, and small eastern part of Madanpur block. In the eastern part of Rafignaj block the depth to bed rock is shallow with overlying thick clay layer. This clay layer, at places, is sandy.The thickness of the alluvium aquifer ranges from 21m (Umga village, Madanpur block) to 94m (Bibipur village, Rafiganj Block).

In the southern part of the study area aquifer mainly characterized in the weathered fractured hard rock region where thickness of hard rock area varies from 10 to 180 m minimum thickness encountered at Barpa village and maximum at Umga village.

Table 23: Potential fractures identified based on based on in house exploratory drilling.

Location	Depth Drilled (m bgl)	Discharge(lps)	Fracture Encountered Depth (m bgl)	Casing Depth (m agl)	Transmissivity (m2/day)
Umga	201	Dry		21	
Madanpur	201	0.0855		27.4	
Rafiganj	65	Abandoned			
CRPF Camp, Madanpur (EW)	170.2	NA	Dry well	16.5	
Bhuiyan Bigha, Madanpur (EW)	172.3	4.4	49 145	12.7	1.53
Bhuiyan Bigha, Madanpur (OW)	135.7	0.35	48.2	28.2	
Sarawak, Rafiganj (EW)	170.22	6.6	24.9 124.5	21.1	25.06
Sarawak, Rafiganj (OW)	170.2	1.257	79.8 94	24.9	

4.2 3D Aquifer Model

Lithological log of all the exploratory sites has been prepared on field. Based on drill cuttings, geophysical log and composite log, aquifer model of the area obtained by 3D co-relation in Rockworks Software. The 3D Lithological Model as shown in fig 36

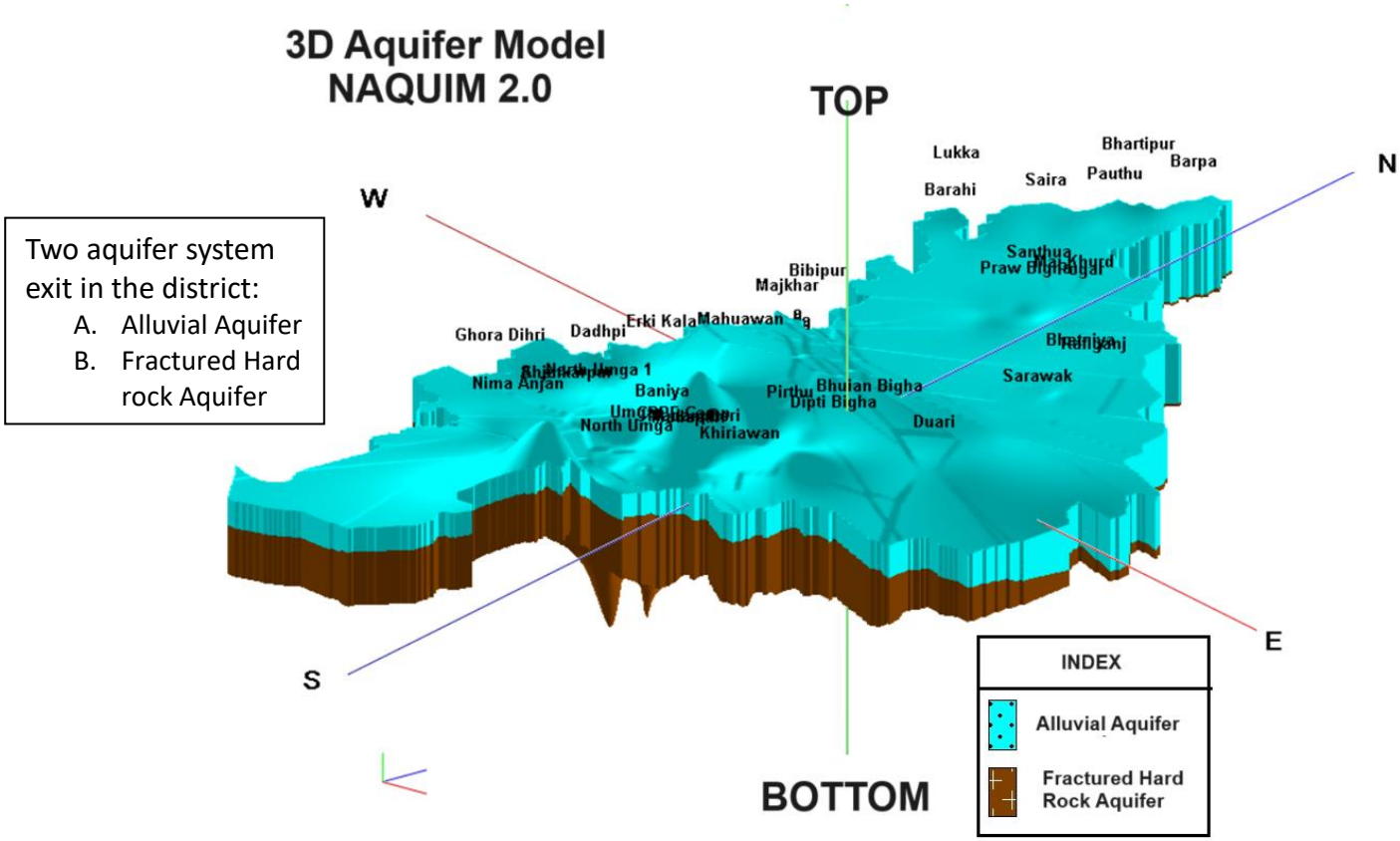


Figure 36: 3D Aquifer model of the study area under NAQUIM 2.0

Major lithological units encountered down to depth 200 mbgl are Coarse to Fine Sand, Silt, Clay, Clay mixed with Kankar, Weathered and fractured granite with quartzite etc. Lithological Model reveals in the Northern parts of the districts, prominent clay horizons are observed up to depth 100mbgl with some thin patches of sand horizons. Clays mixed with fine sand in depth below 100m in the both blocks reveals deposition of Younger Alluvium. The Fence diagram prepared from lithological and geophysical log depicts that the sand beds are thick in Northern part of the district and very frequent occur than clay beds, whereas weathered and fractured hard rock more prominent in the Southern Part. In general clay beds up to 200 m thickness show variation in width and lateral extent and give rise a single aquifer system.

4.3 Depth to Bed rock (Alluvium thickness):

The area is underlain by granitic basement of Chotonagpur gneissic complex, overlain by recent alluvium deposit which forms the major potential aquifer in the study area. To determine the block wise alluvial aquifer thickness, data collected from well inventory & geophysical surveys were utilized. It is evident from all the maps showing basement configuration that alluvium thickness increases towards north.

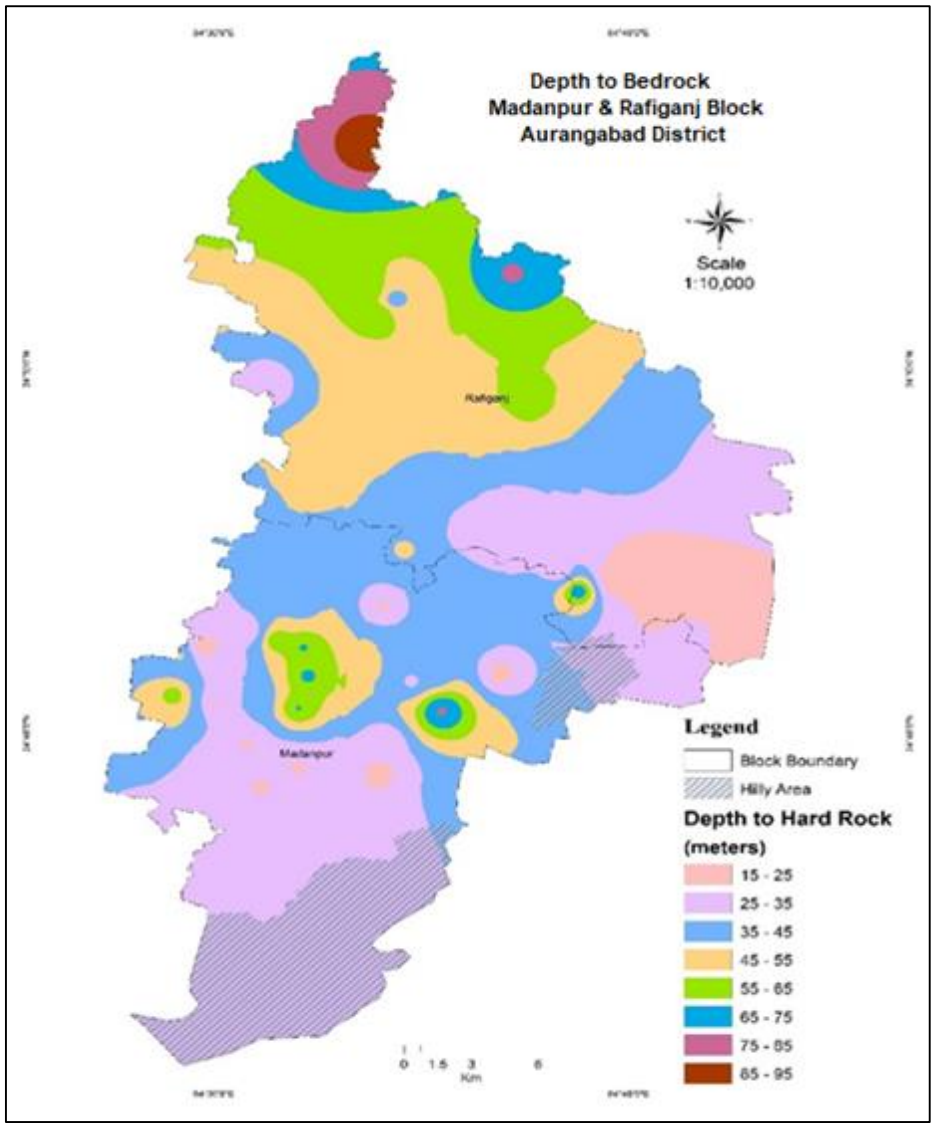


Figure 37: Depth to bedrock (Based on well inventory).

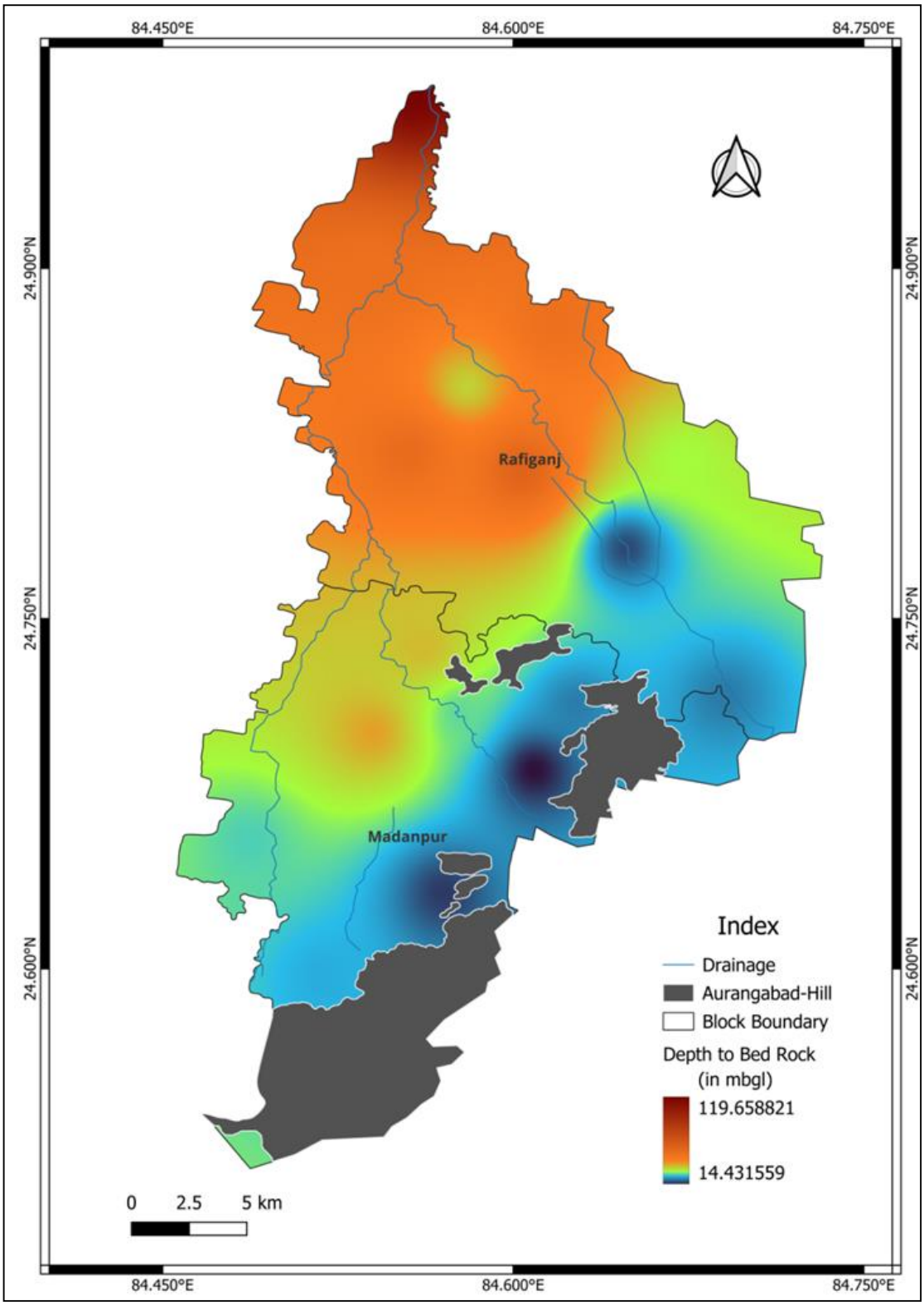


Figure 38: Depth to bedrock (Based on Geophysical Survey).

Chapter 5

Hydrogeological Data

5.1 Aquifer Parameters:

Pumping tests were conducted in the exploratory wells to determine the aquifer parameters such as T and S by Theis Method. There was not any pumping test data of the study area generated so far prior to take up the study. CGWB had constructed 05 nos. of exploratory wells up to the depth of 172.30 m bgl to know the subsurface lithology and aquifer disposition during AAP 2023-24. Due to non-availability of sufficient discharge (≥ 3.0 lps. air compressor), pumping test had not been carried out as drilled exploratory wells had negligible discharge. However, an effort had been made to conduct pumping test in 05 nos. of private/ farmer wells tapping weathered aquifer and large diameter dug wells to derive the hydrogeological properties. Sites are indicated in figure 25 and tabulated in table 16. Data of 5 exploratory wells tapped in different aquifers are analysed and the aquifer parameters derived.

Two Exploratory wells tapped in hard rock aquifer are tapped below 40m depth for fulfilment of economic and future demand. Overall the hard rock aquifer has a potential to yield 1-2 LPS discharge. The average Transmissivity of the aquifer determined as 2-225 m2 /day. As per hydrogeological scenario and transmissivity of this aquifer, the hard rock aquifer having less potential to yield ground water in the Southern and Western part.

In the eastern and the northern portion of block ground water mainly found in the alluvium portion, which having potential to yield 1-2 LPS discharge. And the average transmissivity of the aquifer ranges from 110-1300 m2 /day. Hence alluvium aquifer group is more potential to yield ground water in the northern part of the blocks.

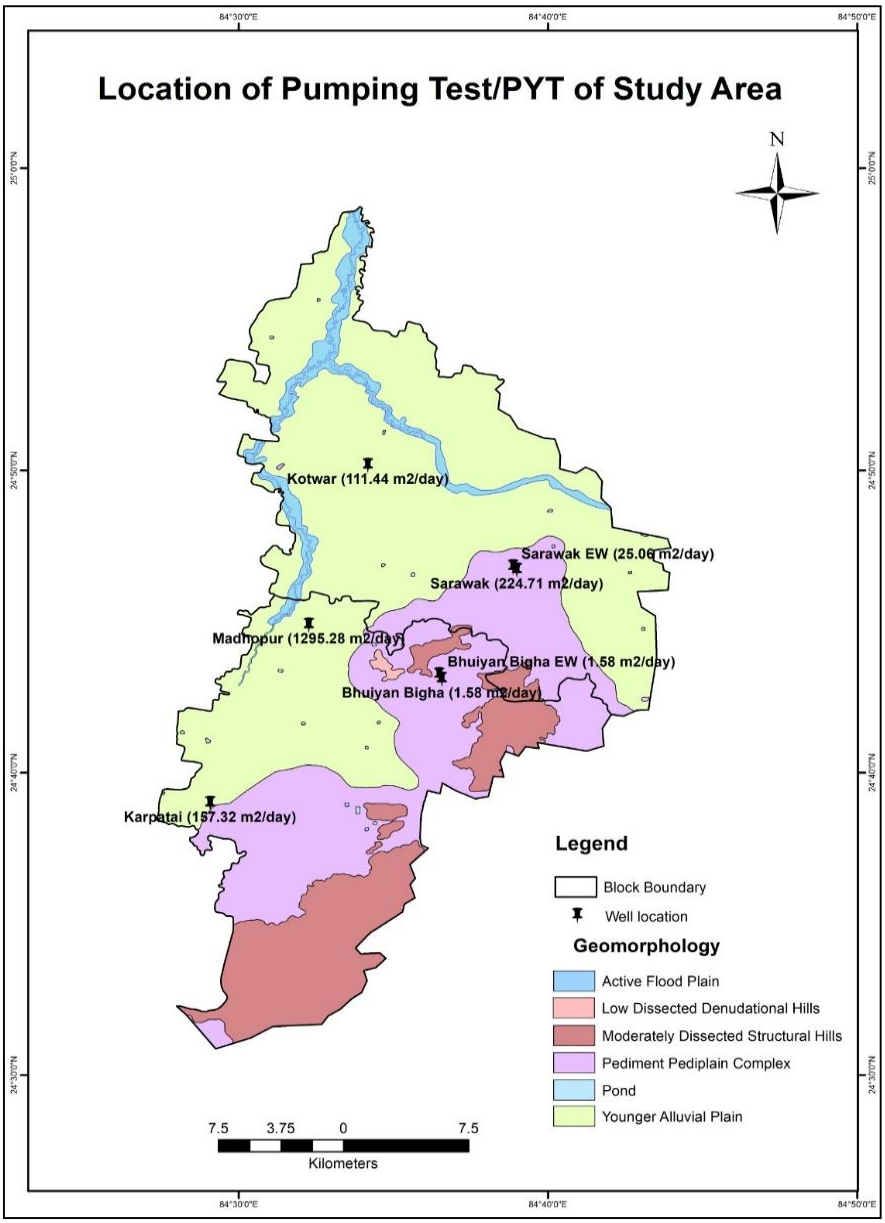


Figure 39: Location of Pumping Test/PYT of Study Area.

Table 24: Aquifer Properties in study area (based on short duration pumping test in farmer TW/BW)

Block	Village	Water Level (m bgl)	Discharge (lps.)	Drilling Depth (m bgl)	Depth to bed rock Reported (m bgl.)	Transmissivity (m^2/day)	Aquifer
Rafiganj	Sarawak	5.73	2	54.25	24.38	224.71	Hard rock
Rafiganj	Kotwar	16.69	1.25	54.86		111.44	Alluvium
Madanpur	Madhopur	6.92	2	33.52		1295.3	Alluvium
Madanpur	Karpatai	5.53	1.65	17.67		157.32	Alluvium
Madanpur	Bhuiyan Bigha	5.12	1.2	42.67	10.66	1.58	Hard rock

5.2 Aquifer-wise ground water Levels

5.2.1 Ground Water Regime (Aquifer Group I/ Shallow Aquifer)

The water level data recorded during the pre and post-monsoon periods for the year 2023 from the Water Level Monitoring Stations (N.H.S.-Dug Wells / Piezometers) of CGWB has been taken into consideration. All the block-wise depth to water level data have also been analysed. Additional wells (Key wells) have been establish and periodically monitored for water level, to understand water level behaviour in spatial and temporal domain. The data has been given in Annexure II& Annexure III.and the Location of key wells and NHNS wells are shown in Figure 13.

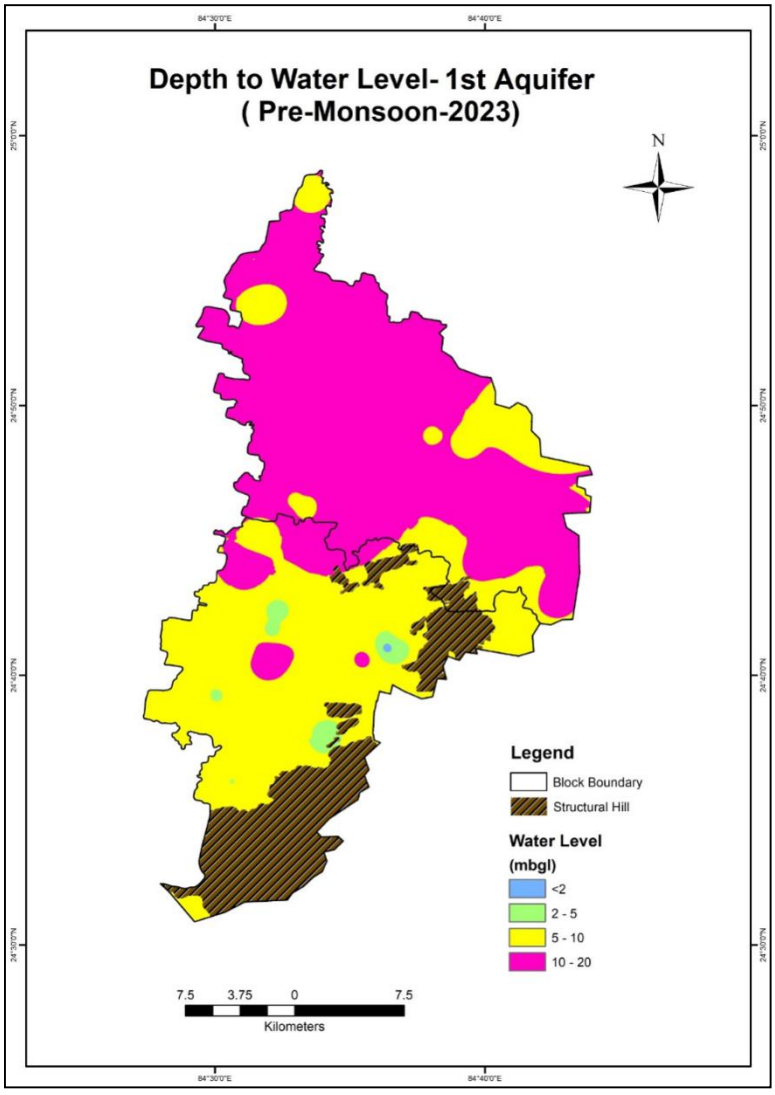


Figure 40: Depth to Water level Map, Pre-Monsoon (May 2023)

During Pre Monsoon period 2023, observation reflects that, water level in the shallow aquifer ranges between 1.36 mbgl (Kolhuan, Madanpur Block)-22.73 mbgl (Kusaha, Madanpur Block) mbgl. The northern part of the blocks shows relatively deeper water level in the range of 10-20 mbgl. Whereas in the southern part blocks shows shallow water level in the range of 5-10 mbgl.

Table 25: Depth to Water Level (Pre-Monsoon)

S. No.	Block Name	No. of wells Analyzed	Depth to Water Level (mbgl)		Number & Percentage of Wells Showing Depth to Water Level (mbgl) in the Range of							
					0-2		2-5		5-10		>10	
			Min	Max	No	%	No	%	No	%	No	%
1	Rafiganj	36	5	20	0	0	1	2.8	12	33.3	23	63.9
2	Madanpur	34	1.36	22.73	1	2.9	5	15	24	70.6	4	11.8

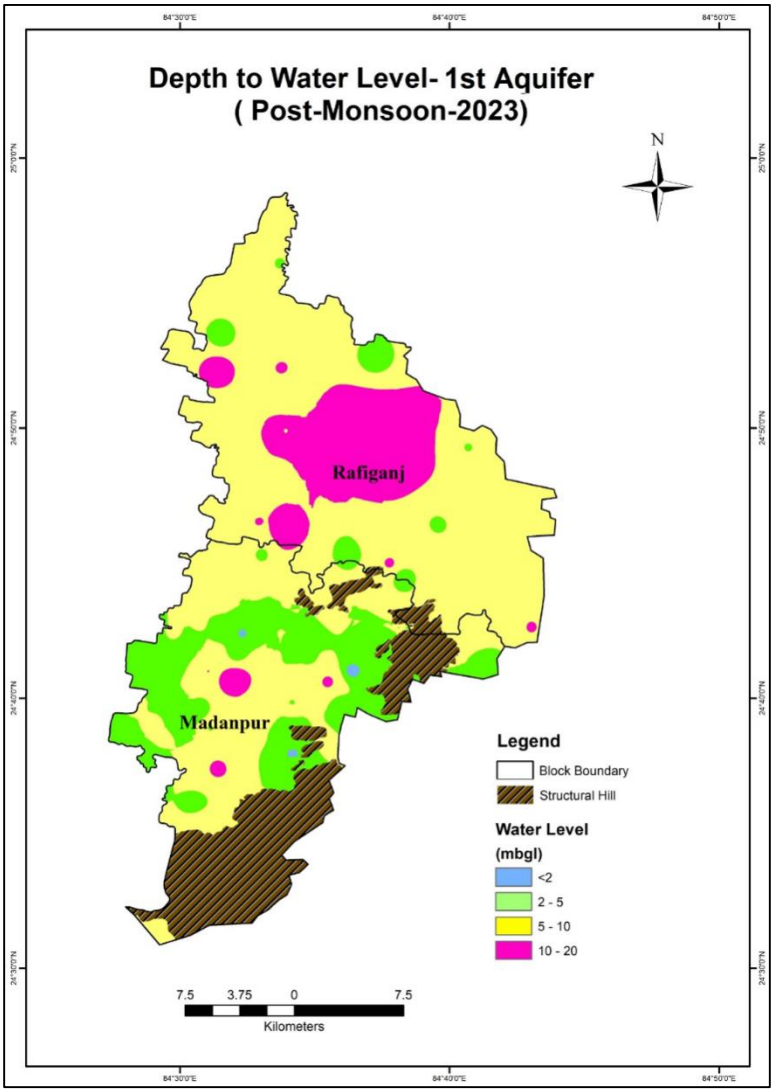


Figure 41: Depth to Water level Map, Pre-Monsoon (May 2023).

During Post Monsoon period 2023, observation reflects that, water level in the shallow aquifer ranges between 0.7 mbgl (Kolhuan, Madanpur Block)-20 mbgl (Kusaha, Madanpur Block) mbgl.

Table 26: Depth to Water Level (Post-Monsoon)

S. No.	Block Name	No. of wells Analyzed	Depth to Water Level (mbgl)		Number & Percentage of Wells Showing Depth to Water Level (mbgl) in the Range of							
					0-2		2-5		5-10		>10	
			Min	Max	No	%	No	%	No	%	No	%
1	Rafiganj	35	2.57	17.3	0	0	8	23	16	45.7	11	31.4
2	Madanpur	57	0.7	20	4	7	27	47	22	38.6	4	7.0

5.2.2 Ground Water Regime (Aquifer Group II/ Hard rock Aquifer)

The water level data recorded during the pre and post-monsoon periods for the year 2023 from the Water Level Monitoring Stations (Piezometers) of CGWB, State Government tube well and also Private Bore well has been taken into consideration. All the block-wise depth to water level data have also been analysed. Additional wells (Key wells) have been establish and periodically monitored for water level, to understand water level behaviour in spatial and temporal domain. The data has been given in Annexure II & Annexure III.And the Location of key wells and NHNS wells are shown in Figure 13.

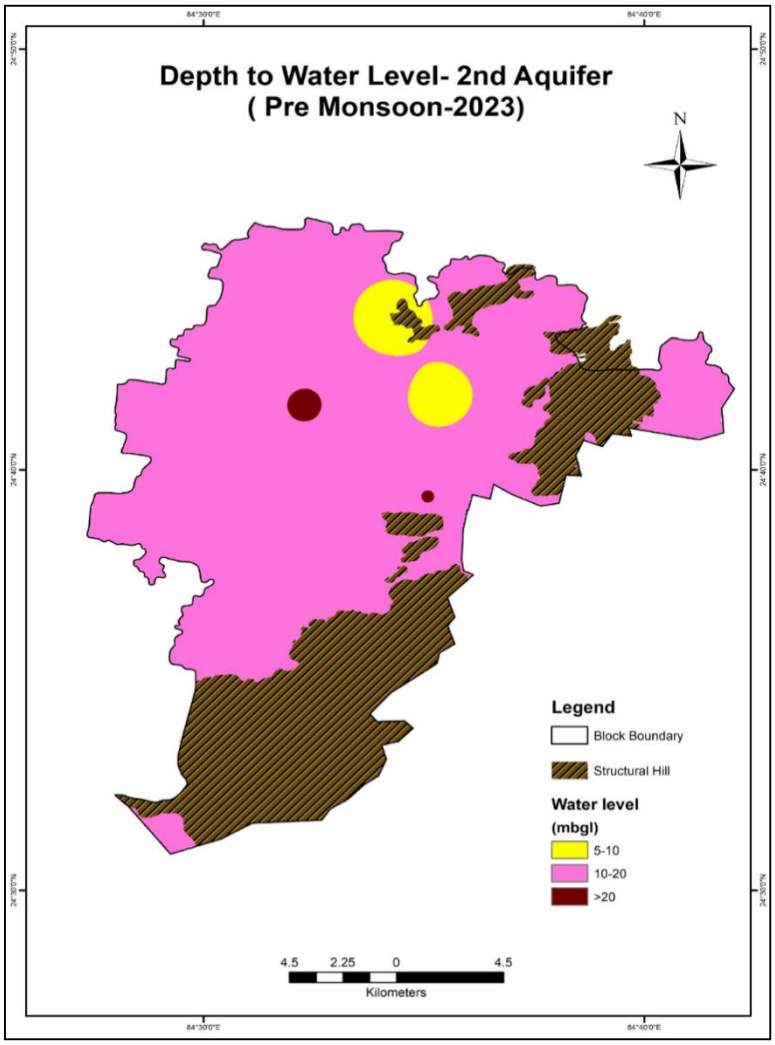


Figure 42: Depth to Water level Map (HR), Pre-Monsoon (May 2023).

During Pre Monsoon period 2023, observation reflects that, water level in the deeper hard rock aquifer ranges between 7.98 mbgl (Ratan Bigha, Madanpur Block)-21.74 mbgl (Hajipur, Madanpur Block) mbgl.

Table 27: Depth to Water Level (Hard rcok aquifer), Pre-Monsoon.

S. No.	Block Name	No. of wells Analyzed	Depth to Water Level (mbgl)		Number & Percentage of Wells Showing Depth to Water Level (mbgl) in the Range of							
					0-2		2-5		5-10		>10	
			Min	Max	No	%	No	%	No	%	No	%
1	Rafiganj	1	16.7	16.7	0	0	0	0	0	0.0	1	100.0
2	Madanpur	10	7.98	21.74	0	0	0	0	2	20.0	8	80.0

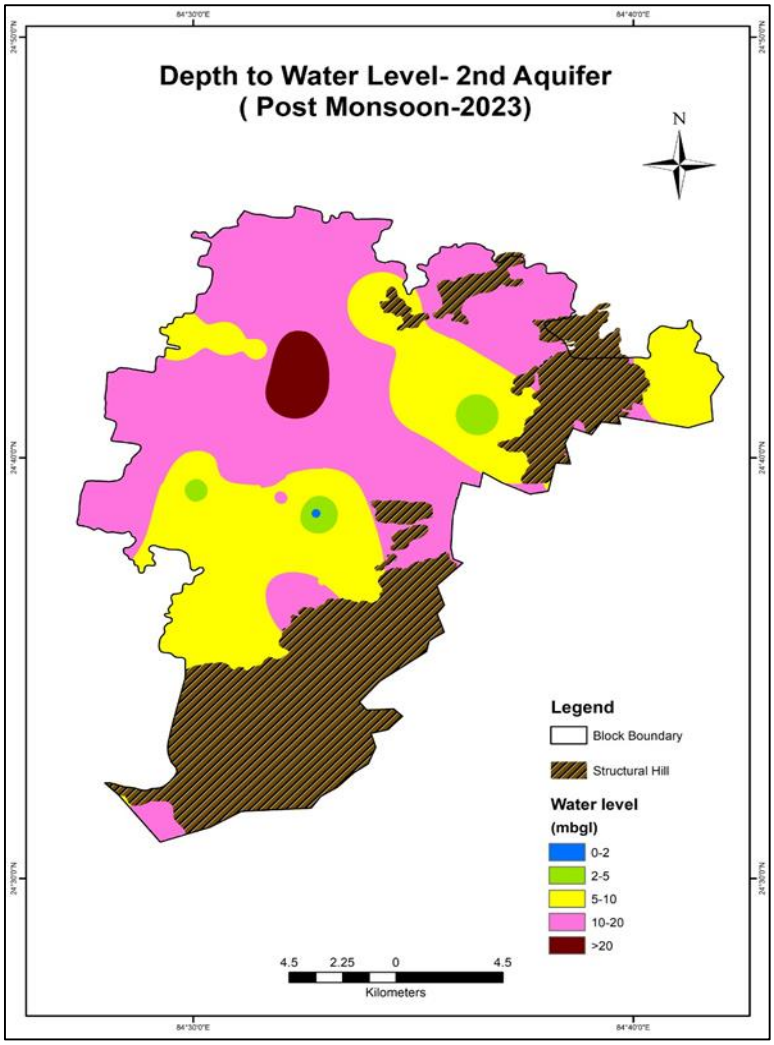


Figure 43: Depth to Water level Map (HR), Pre-Monsoon (May 2023).

During Post Monsoon period 2023, observation reflects that, water level in the deeper hard rock aquifer ranges between 1.7 mbgl (Gulab Bigha, Madanpur Block)-32.6 mbgl (Sondih, Madanpur Block) mbgl.

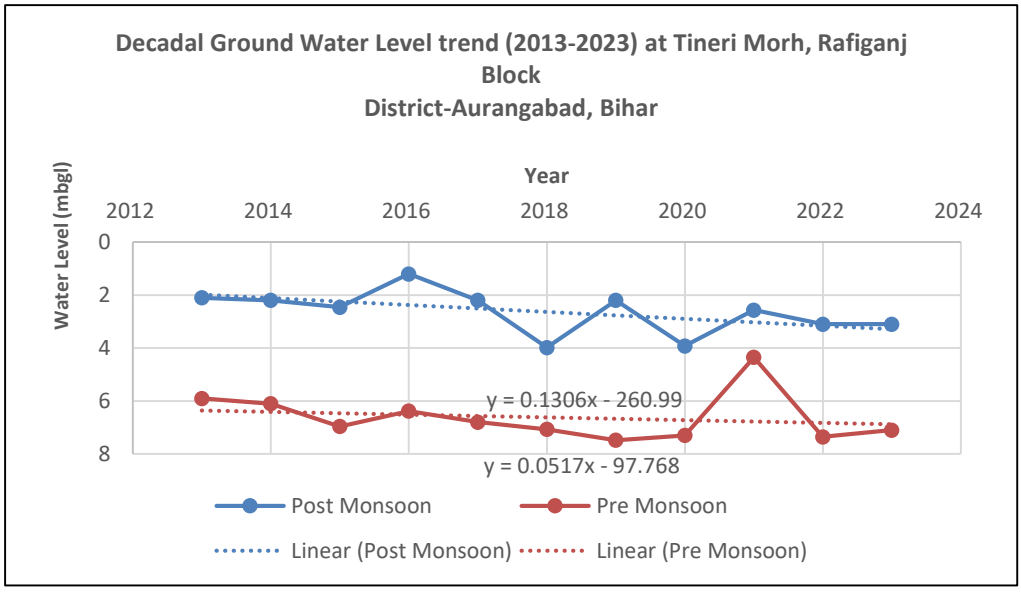
Table 28: Depth to Water Level (Hard rock aquifer), Post-Monsoon.

S. No.	Block Name	No. of wells Analyzed	Depth to Water Level (mbgl)		Number & Percentage of Wells Showing Depth to Water Level (mbgl) in the Range of							
					0-2		2-5		5-10		>10	
			Min	Max	No	%	No	%	No	%	No	%
1	Rafiganj	1	9.45	9.45	0	0	0	0	1	100.0	0	0.0
2	Madanpur	19	1.7	32.6	1	5.3	2	11	7	36.8	9	47.4

5.3 Long Term Water Level Trend Analysis

To study the behavior of Water Level in space and time, block wise long-term (2013- 2023) water level trend of CGWB stations for pre monsoon andpost monsoon period has been worked out. Pre-Monsoon decadal (2013-23) ground water level trend analysis reveals that, average of water levels for all monitoring stations shows falling trend ranging from 4 to 5 cm/ year in Madanpur and Rafiganj blocks.

As the decadal trend of rise and decline for pre monsoon and post monsoon season are <20 cm/ year, no significant rise or decline in water level for all the blocks can be considered.



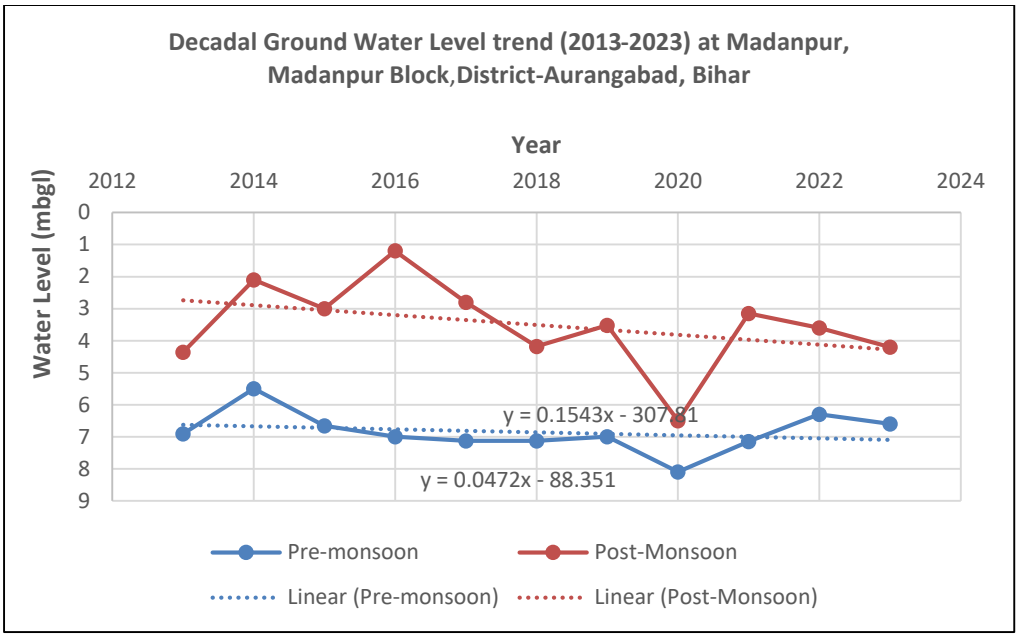


Figure 44: Decadal Water level trend of Madanpur and Rafiganj Blocks.

Table 29: Long term Water level Trend analysis (2014 to 2023).

S. No.	Block	Pre-Monsoon(2013-23)		PostMonsoon(2013-23)		SignificantRise/Decline	
		Rise (m/year)	Fall (m/year)	Rise (m/year)	Fall (m/year)	Pre-Monsoon	Post Monsoon
1	Madanpur		.04		0.15	No	No
2	Rafiganj		.05		0.13	No	No

5.4 Ground Water Flow Regime

To comprehend the ground water flow regime, it is necessary to draw the water table elevation contour map. All water level data for the monitoring stations of CGWB and PHED are compiled and used to understand the flow regime of ground water over the study area. The water table elevation map brings out following salient features concerning the ground water flow regime,

- The general Ground Water Flow is from Southeast to Northwestin conformity to prevailing topography and drainage trend.

- The shape of water table contours and the flow regime indicate that, all the rivers are influent in nature.

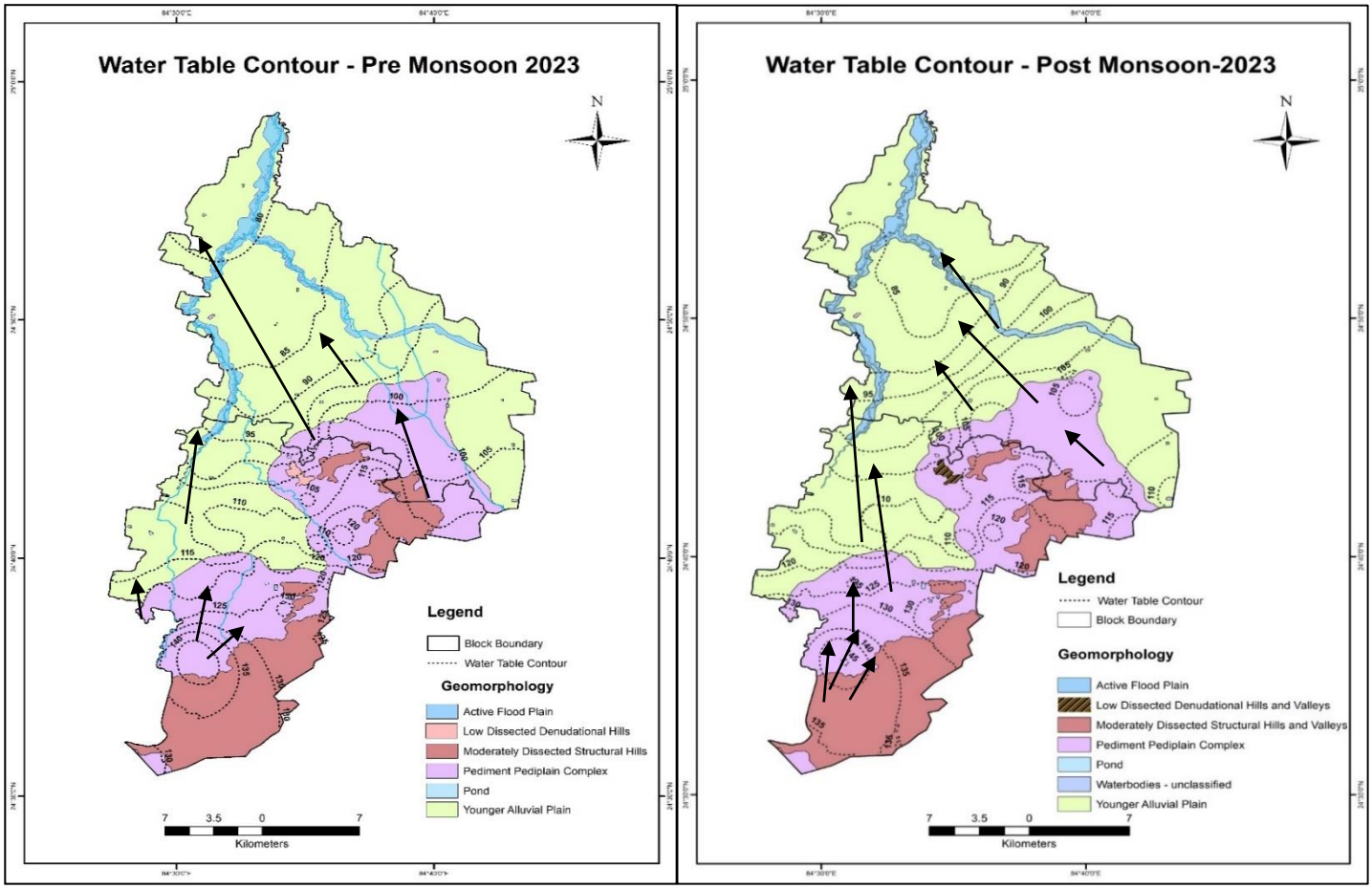


Figure 45: Water table contour Pre and Post monsoon.

The concentration of the major ions and other dissolved ions in ground water are functions of the availability of the constituents in the aquifer matrices and their solubility. Rocks, through which water circulate, are composed of minerals and amorphous solids, which in turn are composed of chemical elements that greatly affect the ground water quality.

In Pre-monsoon total number of samples collected from Madanpur & Rafiganj block is 164. Among which 78 samples from Rafiganj block and 86 samples Madanpur block. Samples collected mostly from Hand pump and Tube well. Few samples collected from River, ponds, DTW and Bore well.

During Post-monsoon periodtotal number of sampling locations were intensified & collected from Madanpur & Rafiganj block is 213. Among which 78 samples from Rafiganj block and 135 samples Madanpur block.

Chapter 6

Hydro Geochemical Data Generation

6.1 Methodology:

All the samples were analyzed for the determination of pH, EC, CO_3^{2-}, HCO_3^-, Cl^-, NO_3^-, SO_4^{2-}. F^-. PO_4^{3-} Total hardness (T.H), Ca^{2+}, Mg^{2+}, Na^+& K^+, ions. The analysis of water samples was done as per standard methods (APHA 1991). The standard methods that have been adopted for the chemical analysis of different constituents in water samples are given in Table below.

Table 30: Method used for Chemical Analysis of Basic parameters of Ground Water Samples

Sl. No.	Constituents	Method Used
1.	pH	pH Meter
2.	EC	EC Meter
3.	Carbonate	Titrimetric method
4.	Bi-carbonate	Titrimetric method
5.	Chloride	Mohr's Titrimetric method
6.	Total Hardness	Complexometric Titration
7.	Calcium	Complexometric Titration
8.	Magnesium	Evaluation from TH and Ca
9.	Sodium	Flame emission photometric method
10.	Potassium	Flame emission photometric method
11.	Nitrate	Ultraviolet Spectrophotometric method
12.	Sulphate	Turbidimetric method
13.	Phosphate	Ascorbic Acid method
14.	Fluoride	Ultraviolet Spectrophotometric method

Heavy Metals analyzed using ICP-MS Method. Following are the parameters of heavy metals detected for pre-monsoon and post-monsoon given in below table

Table 31: Method used for Chemical Analysis of Heavy Metals in Ground Water Samples

S.No	Elements	TEST & METHODS
1.	Cu	APHA 23rd Ed. 3111 B Air-C2H2 Flame Method: 2017
2.	Zn	APHA 23rd Ed. 3125 B ICP-MS Method: 2017
3.	Mn	APHA 23rd Ed. 3125 B ICP-MS Method: 2017
4.	U	APHA 23rd Ed. 3125 B ICP-MS Method: 2017
5.	Fe	APHA 23rd Ed. 3125 B ICP-MS Method: 2017
6.	Pb	APHA 23rd Ed. 3125 B ICP-MS Method: 2017

7.	As	APHA 23rd Ed. 3125 B ICP-MS Method: 2017
8.	Cr	APHA 23rd Ed. 3125 B ICP-MS Method: 2017

6.2 Chemical Character of Water:

Alkalinity:

In water bodies, according to Hem (1989), carbonate species can contribute only small amounts to alkalinity in water. In pre-monsoon, 164 samples studied, no sample has shown carbonate alkalinity. The variation observed in the concentration of bicarbonate species was in the range of 85-1281 mg L^{-} with an average value of 419mg L^{-1}, respectively. In post monsoon out of 213 samples bicarbonate varies from 61-1196 ground mg/ L with average value 399mg/L. Distribution of ground water samples the basis of alkalinity is given in below table.

Table 32: Distribution of Ground Water Samples in Different Alkalinity Range Pre-monsoon

Alkalinity Range (mg/l)	Percentage (%)
0 - 600	92.07
> 600	7.93

Table 33: Distribution of Ground Water Samples in Different Alkalinity Range Post-monsoon

alkalinity Range (mg/l)	Percentage (%)
0 - 600	89.67
> 600	10.39

From table it can be seen that most of the ground water samples collected in pre-monsoon is maximum within permissible limit of 600 mg L^{-1}.

Chloride:

The concentration of chloride ions in pre-monsoon was in the range of 11 to 529 mg L^{-1}, with an average value of 79 mg L^{-1} and in post monsoon it ranges from 7 to 561mg L^{-1} with an average value of 83 mg L^{-1} respectively.

Table 34: Frequency Distribution of Chloride in pre-monsoon

Chloride concentration (mg/l)	Percentage (%)
Within Acceptable limit (0 – 250)	95.12
Within Permissible limit (1000)	100

Table 35: Frequency Distribution of Chloride in post-monsoon

Chloride concentration (mg/l)	Percentage(%)
Within Acceptable limit (0 – 250)	93.43
Within Permissible limit (1000)	100

From above tables it can be seen that all of the ground water samples collected in pre-monsoon and post monsoon is within permissible limit of 1000 mg L^{-1}.

Calcium (Ca)

The absence of calcium in drinking water causes rickets in the body, while excess concentration causes gout and rheumatism. The calcium concentration in zone I ground water samples in pre-monsoon was in the range of 12-150 mg L^{-1}, with an average value of 53 mg $L^{-1}$and in post monsoon in the range of 6-274 mg $L^{-1}$with average value 68 mg L^{-1}

Table 36: Frequency Distribution of Magnesium in pre-monsoon

Calcium concentration (mg/l)	Percentage (%)
0-200	100
>200	0

Table 37: Frequency Distribution of Magnesium in post-monsoon

Calcium concentration (mg/l)	Percentage (%)
0-200	98.60
>200	1.40

From above table it can be seen that almost all of the ground water samples collected in pre-monsoon and post monsoon are within permissible limit of 200 mg L^{-1}.

Magnesium (Mg)

Magnesium is one of the constituents responsible for hardness of water. The lower concentration of magnesium is not harmful but higher concentration is laxative.

Table 38: Frequency Distribution of Magnesium in pre monsoon

Magnesium concentration (mg/l)	Percentage (%)
0-100	98.8
>100	1.21

Table 39: Frequency Distribution of Magnesium in Postmonsoon

Magnesium concentration (mg/l)	Percentage (%)
0-100	99.5
>100	0.46

Total Hardness (T.H. as $CaCO_3$)

The hardness results from the divalent metallic ions of which the calcium and magnesium are the most abundant ions in ground water. These ions react with soap to form precipitates, and with certain anions present in water form scales. The degree of hardness in water can be judged from the classification presented below table

Table 40: Water Class as depicted by different T.H. range

Total Hardness as $CaCO_3$ (mg/l)	Water Class
<75	Soft
75 – 150	Moderately hard
151-300	Hard
301-600	Very hard
>600	Extremely Hard

In the study area pre-monsoon, the total hardness in ground water samples range from 25 to 550mg L^{-1}, with an average value of 260.4 mg L^{-1}. In post monsoon ground water sample ranges from 65-940 mg L^{-}1with average value266.9 mg L^{-1}. Water is hard in both pre and post monsoon.

Potassium (K)

The major sources of potassium in natural waters are (i) rain water, (ii) weathering of Potash silicate minerals, (iii) potash fertilizers. K enters into structure of clay and clay bearing minerals during weathering.

Table 41: Frequency Distribution of Potassium in pre-monsoon

Potassium concentration (mg/l)	Percentage (%)
Within permissible limit (0-12) (in drinking water)	83.54
>12	16.46

From the above table it can be seen that 16% of the ground water samples collected in pre-monsoon and 20% in post monsoon all in alluvium aquifer are more than permissible limit of 12 mg L^{-1} which is not suitable for drinking purpose.

Table 42: Frequency Distribution of Potassium in Post-monsoon

Potassium concentration (mg/l)	Percentage (%)
Within permissible limit (0-45) (in drinking water)	79.81
>12	20.19

Nitrate (NO_3^-)

Nitrate is one of the end products of the biologic nitrification process, is the most ubiquitous chemical contaminant in the world's aquifers and the concentration levels are increasing. The distribution of

nitrate in ground water is controlled by a number of factors. They include source availability, thickness and composition of the vadose zone, precipitation, irrigation, ground water flow, aquifer heterogeneity, dissolved oxygen concentrations and electron donor availability and dispersion.
From table belowin most of the samples, the concentration of nitrate ions was found to be within the acceptable limit of BIS 2012 (45 mg L^{-1}) both in pre and post monsoon.

Table 43: Frequency Distribution of Nitrate in pre-monsoon

Nitrate concentration (mg/l)	Percentage (%)
Within permissible limit (0-45)	98.2
>45	1.8

Table 44: Frequency Distribution of Nitrate in Post-monsoon

Nitrate concentration (mg/l)	Percentage (%)
Within permissible limit (0-45)	99.06
>45	0.94

However, its higher concentration beyond the permissible limit of 45mg/L can cause severe human health problems (WHO,2022). Major cause of nitrate contamination is anthropogenic; excessive use of NPK-fertilizers, insecticides, pesticides etc. in agriculture.

In pre-monsoon, high concentration of nitrate has been found in 03 locations of the study area; Maya Bigha (52 mg/L), Machiar Bigha (68 mg/L), and Sri Ramper (70 mg/L) in dugwell and pond in an alluvium aquifer. In post-monsoon, high concentration of nitrate has been found in Pirbigha (50.19 mg/L) and Badal Bigha (91 mg/L) in hardrock aquifer.

Fluoride (F^-)

It is well established in the scientific literature that Fluorine is the most reactive of all elements and no chemical substance is capable of freeing it from any of its compounds, Therefore, in nature it does not occur in Free State.
In case of unavailability of an alternative source, the maximum permissible limit prescribed by Bureau of Indian Standards for fluoride in drinking water is 1.5 ppm. Althoughthe desired limit is from 0.6 to 1.0 ppm. In the present study the samples were analysed by Schot Sauchis visual calorimetery method initially (during FS 2010-12) and later on with the Ion Selective Electrode method.
In the study area e concentration of Fluoride ions was in the range of 0 to 1.53 mg L^{-1}, with an average value of 0.29 mg L^{-1} in pre-monsoon, but in post-monsoon it ranges from 0-3.85 with average value 1.08 mg L^{-1}.
Consumption of higher concentration of fluoride above 1.5 mg/L in ground water leads to dental fluorosis (pitting in tooth enamel). Fluoride levels of 2.5 mg/L or higher may increase the risk of crippling skeletal fluorosis associated with bone deformities. It is a condition that causes bones to break easily and causes calcium to build up in ligaments and tendons. In pre monsoon 99% of the samples, the concentration of fluoride was found to be within the permissible limit (0-1.5 mg L^{-1}) and in 23% of

samples in post monsoon has fluoride concentration more than permissible limit (>1.5 mg/L). Higher concentration of fluoride (>2.5 mg/L) found in Kolhua (3.85 mg/L). Bhuyian Bigha, (3.39 mg/L) Hari Bigha (2.6 mg/L) and Siraundha Tola(3.5 mg/L) in shallow and deeper aquifer both in alluvium and hard rock of the study area.

Table 45: Frequency Distribution of Fluoride in pre-monsoon

Fluoride concentration (mg/l)	Percentage
Within permissible limit (0-1.5)	99.4
>1.5	0.6

Table 46: Frequency Distribution of Fluoride in Post-monsoon

Fluoride concentration (mg/l)	Percentage
Within permissible limit (0-1.5)	76.53
>1.5	23.47

Complete analysis of the ground water samples (Annexure-7,8,9&10) has given broad geochemical characteristics of ground water of the study area, salient features of which are given in table below.

Table 47: Geochemical characteristics of Ground water of the study area (Pre-Monsoon)

Parameter	Min.	Max.	Avg.	Parameter	Min.	Max.	Avg.
pH	7.15	8.2	7.68	***EC***	290	3990	979
Hardness	25	550	260	***Cl***	11	529	79
F	0	1.53	0.29	***HCO_3***	85	1281	419
Ca	12	150	53	***CO_3***	0	0	0
Mg	4	114	32	***NO_3***	0.12	70	15.2
Na	21	750	100	***SO_4***	2.22	168	23.73
K	0.12	293	8.54				

Table 48: Comparison of major chemical parameters of the ground water with WHO and BIS specifications (Pre Monsoon)

Sl. No.	Parameters	Range inGround water	Mean	WHO(1997)		BIS(1991)IS:10500	
				Max.desirable	Highestpermissible	Max.desirable	Highestpermissible
1.	pH	7.15–8.2	7.68	7.0– 8.5	6.5– 9.2	6.5– 8.5	8.5– 9.2
2.	EC	290-3990	979	750	1500	-	-
3.	Hardness	25- 250	260	100	500	300	600
4.	HCO_3	85-1281	419	200	600	200	600
5.	SO_4	2.2– 168	23.73	200	600	200	400
6.	Cl	11-529	79	250	600	250	1000
7.	NO_3	0.12-70	15	-	50	45	-
8.	Ca	12-150	53	75	200	75	200
9.	Mg	4-114	32	30	150	30	100
10.	Na	21-750	79	50	200	-	-
11.	K	0.12-293	2.54	100	200	-	-

Table 49: Geochemical characteristics of Ground water of the study area (Post monsoon)

Parameter	Min.	Max.	Avg.	Parameter	Min.	Max.	Avg.
pH	7.06	8.19	7.80	*EC*	203	3202	994
Hardness	65	940	266.9	*Cl*	7	561	83
F	0	3.85	1.08	HCO_3	61	1196	399
Ca	6	274	68	CO_3	0	0	0
Mg	2	118	23	NO_3	0	91	12
Na	13	500	99	SO_4	2.22	168	23.73
K	0	395	14				

Table 50: Comparison of major chemical parameters of the ground water with WHO and BIS specifications (Post monsoon)

Sl. No.	Parameters	Range inGround water	Mean	WHO(1997)		BIS(1991)IS:10500	
				Max.desirable	Highestpermissible	Max.desirable	Highestpermissible
1.	pH	7.06–8.19	7.80	7.0– 8.5	6.5– 9.2	6.5– 8.5	8.5– 9.2
2.	EC	203-3202	994	750	1500	-	-
3.	Hardness	65- 940	266.9	100	500	300	600
4.	HCO_3	61– 1196	399	200	600	200	600
5.	SO_4	2.22– 168	23.73	200	600	200	400
6.	Cl	7- 561	83	250	600	250	1000
7.	NO_3	0- 91	12	-	50	45	-
8.	Ca	6-274	68	75	200	75	200
9.	Mg	2-118	23	30	150	30	100
10.	Na	13-500	99	50	200	-	-
11.	K	0-395	14	100	200	-	-

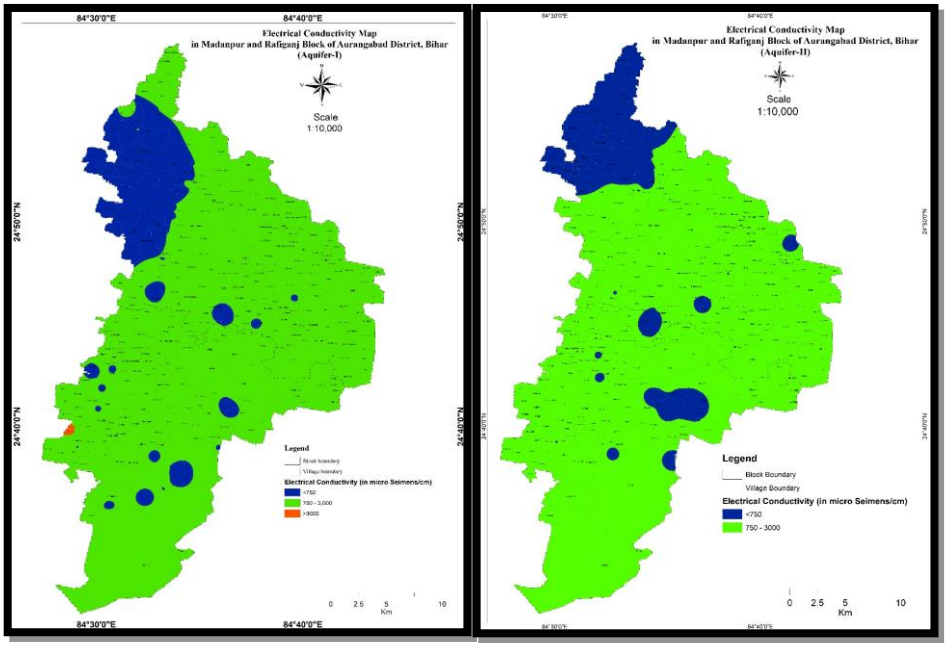


Figure 46: Electrical conductivity map of Alluvium (Left) & Hard rock (Right) aquifer.

6.3 Anomalous Fluoride Concentration Zones and Geological Controls:

In the study area, the ground water samples, drawn from open dug wells as well as tube wells ranging in depth below surface from 6m to 90m, have shown fluoride concentration ranging from traces to 8 ppm. Fluoride zonation maps were prepared for the study area. Localized and discontinuous zones/ pockets of high fluoride incidence (>1.5 ppm) in the ground water have been demarcated. They mostly fall over the Pediplain, or nearby fringe areas of older alluvium in contact with the pediplain. However, within the zone all the ground water samples had not shown high values,and there are stray high fluoride values outside the zones.

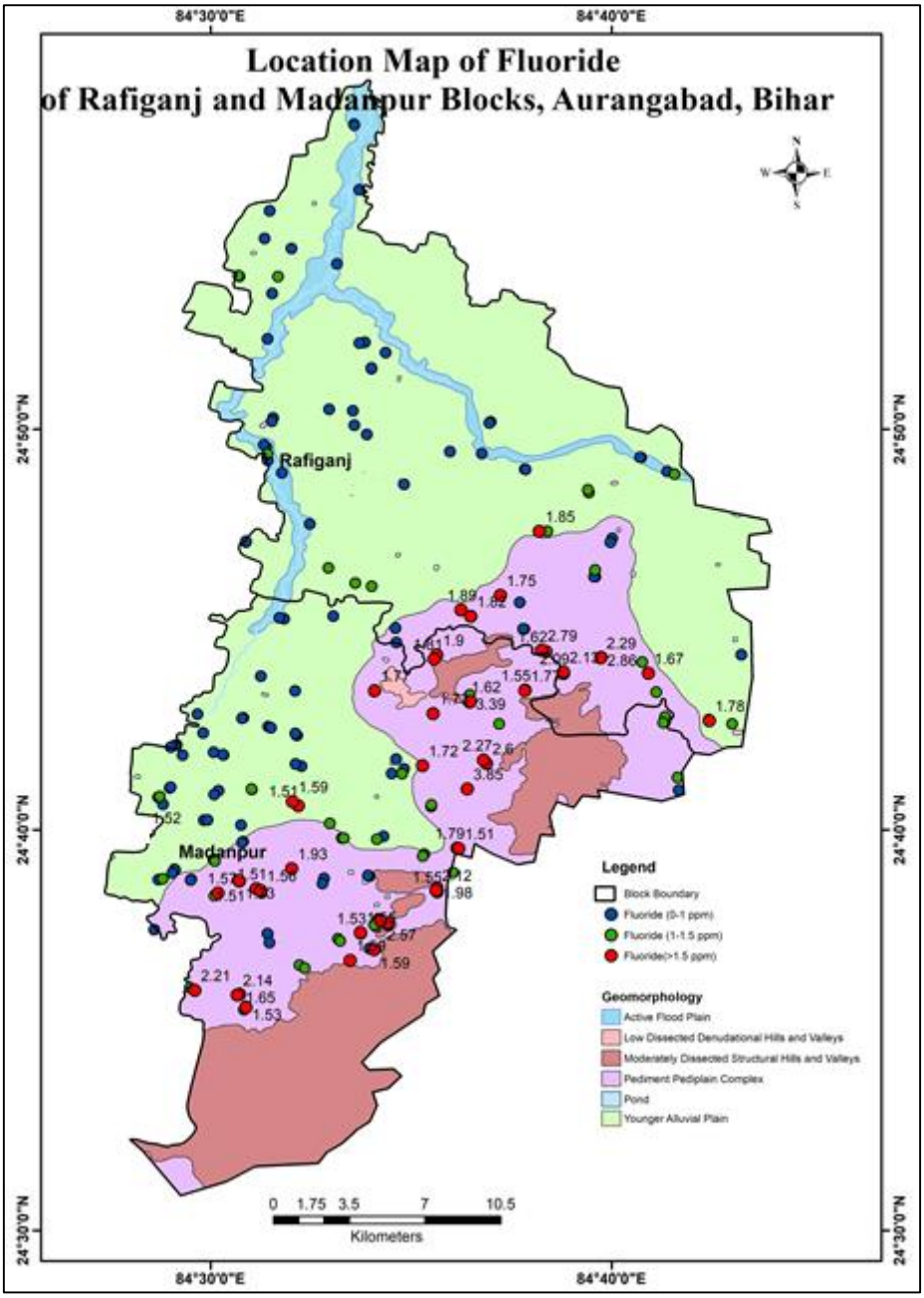


Figure 47: Location map of fluoride (>1.5 ppm) in the study area.

213 samples have been analysed. Out of these; fluoride value >1.5 mg/l found in 50 locations. Maximunm value reported in Kolhua, Madanpur block (3.9 mg/l) and minimum value reported from Nimanjan, Madanpur block (1.50 mg/l). Some localities with high fluoride values are Siraundha tola,

Rasalpur, Haribigha in Madanpur block. However, in the central parts of the area have analysed high fluoride (> 1.5 ppm) ground water samples.

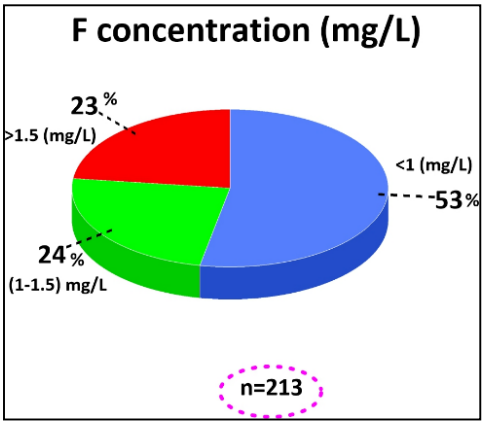


Table 51: Summary of Fluoride Content of Water Samples.

Sl.No.	Parameter	Ground water samples	Surfacewater samples
1.	Minimum	Nil	Nil
2.	Maximum	8.863ppm	1.9
3.	≤1.5 ppm	213(77%)	12 (85.8%)
4.	>1.5ppm	51(23%)	2 (14.2%)

Table 52: Summary of fluoride concentration in Alluvium and Hard Rock aquifer.

Fluoride Range (mg/ l)	No of Wells - Aquifer I (Alluvium Aquifer)		Total	No of Wells - Aquifer II (Hard Rock Aquifer)		Total
	Madanpur	Rafiganj		Madanpur	Rafiganj	
< 1.5	123	127	250	**60**	**18**	**78**
> 1.5	22	7	29	**17**	**5**	**22**
Total	145	134	279	**77**	**23**	**100**

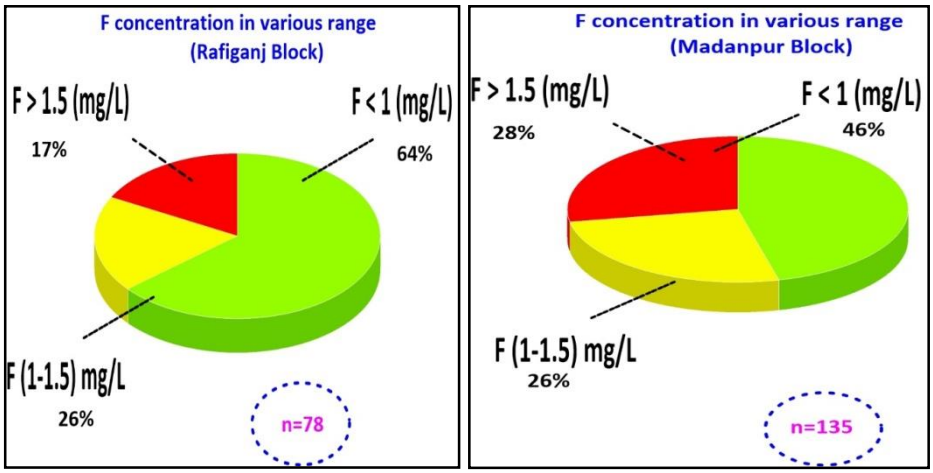


Figure 48: Concentration of fluoride in various range in Rafiganj (left) and Madanpur (Right) block.

Fluoride content in deeper hard rock aquifer is more prominent than the shallower alluvium aquifer. Almost 43% of the total sample collected from the deeper aquifer has been reported fluoride

concentration more than the permissible limit on the other hand shallower aquifer has been reported only 16%

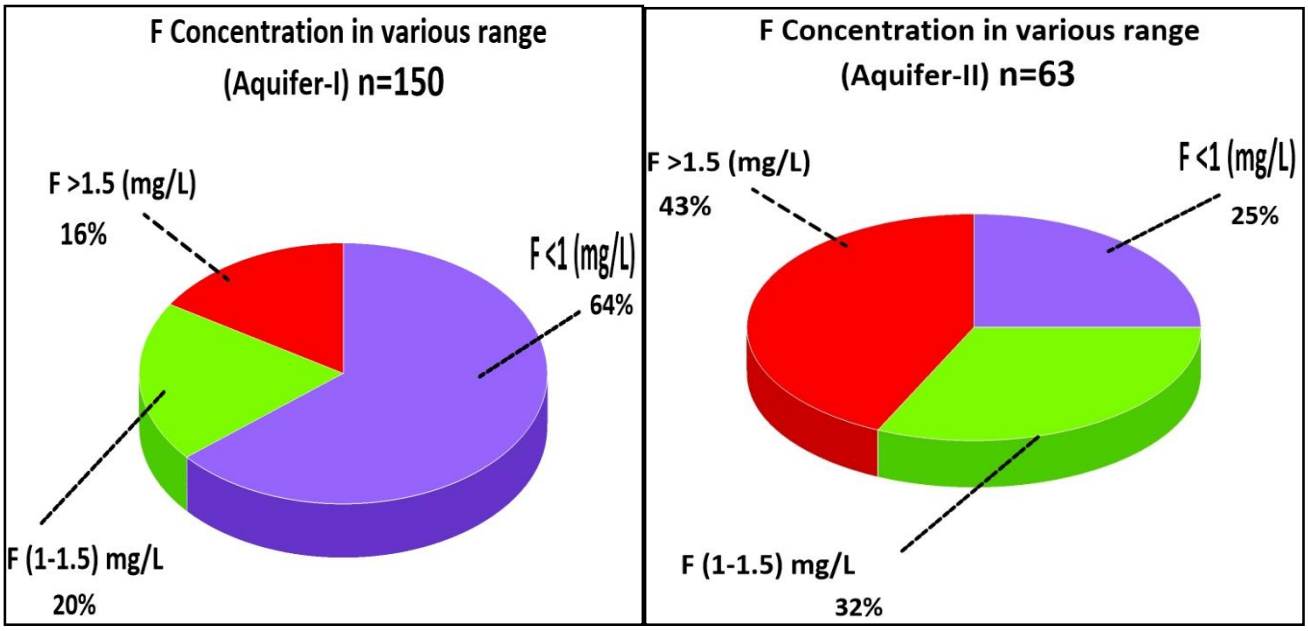


Figure 49: Fluoride concentration in various ranges in Alluvium/Aquifer-I (Left) and Hardrock/Aquifer-II (Right) aquifer.

Higher concentration of fluoride has been found at shallow as well as deeper levels. A look at the depthdistribution of wells shows that nearly 95 % of the wells are located within the depth of 45 m from below the ground surface. The fluoride content in ground water in comparison to well depth does not indicate any clear depth relationship/control as given in figure below

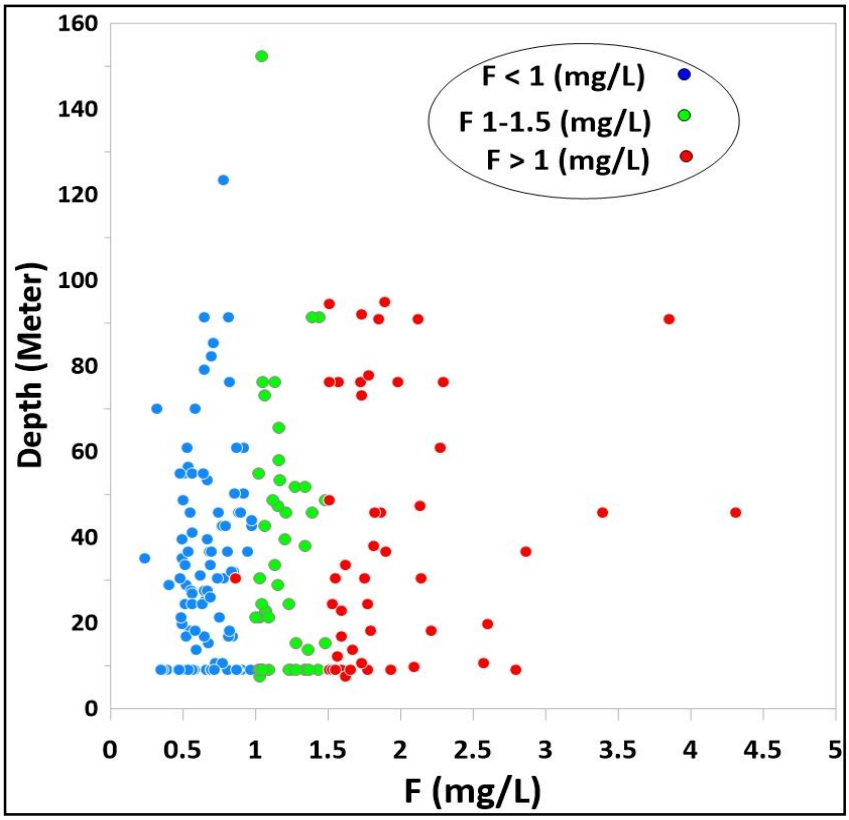


Figure 50: Correlation of fluoride with depth.

6.4 Correlation of Fluoride with Major Ions of Ground Water / SurfaceWater:

Correlation matrix plotted for the major parameters including cations, anions and fluoride content for ground water as well as surface waters samples.

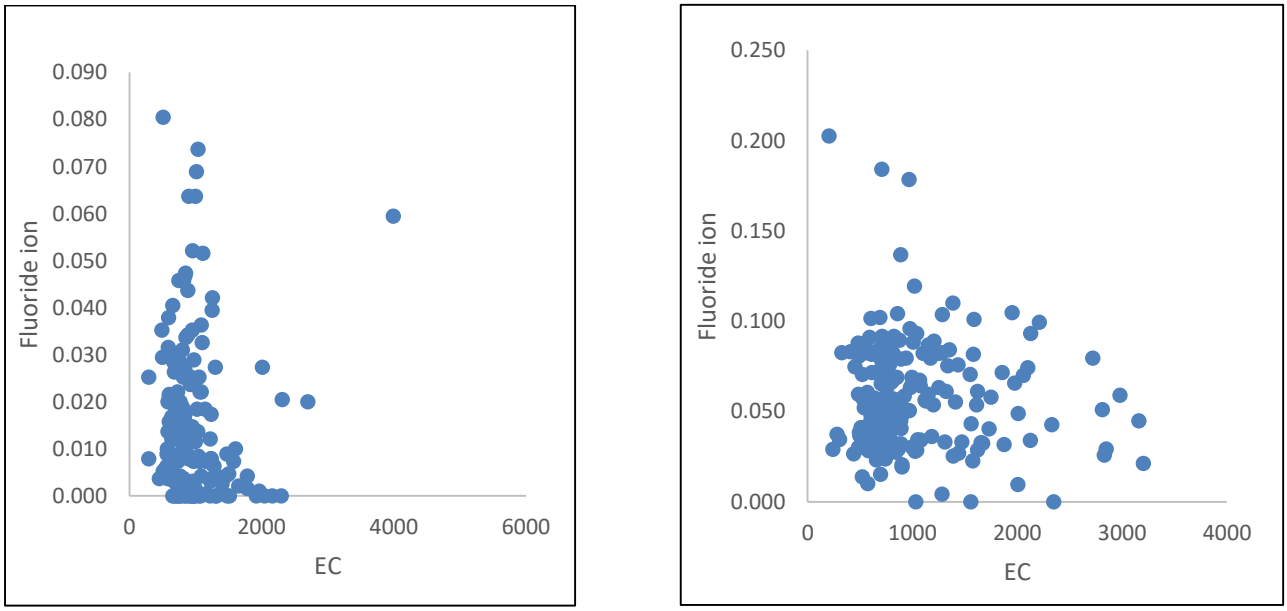


Figure 51: Comparison between Fluoride vs EC in Pre monsoon (left) & Post monsoon (right).

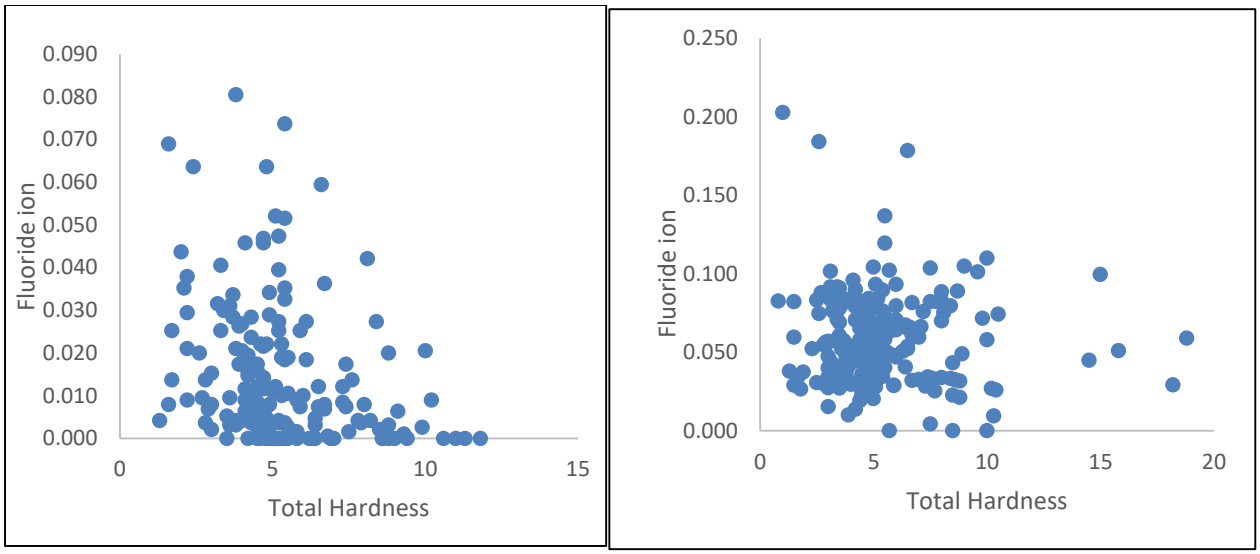


Figure 52: Comparison between Fluoride vs Total hardness in Pre monsoon (left) & Post monsoon (right).

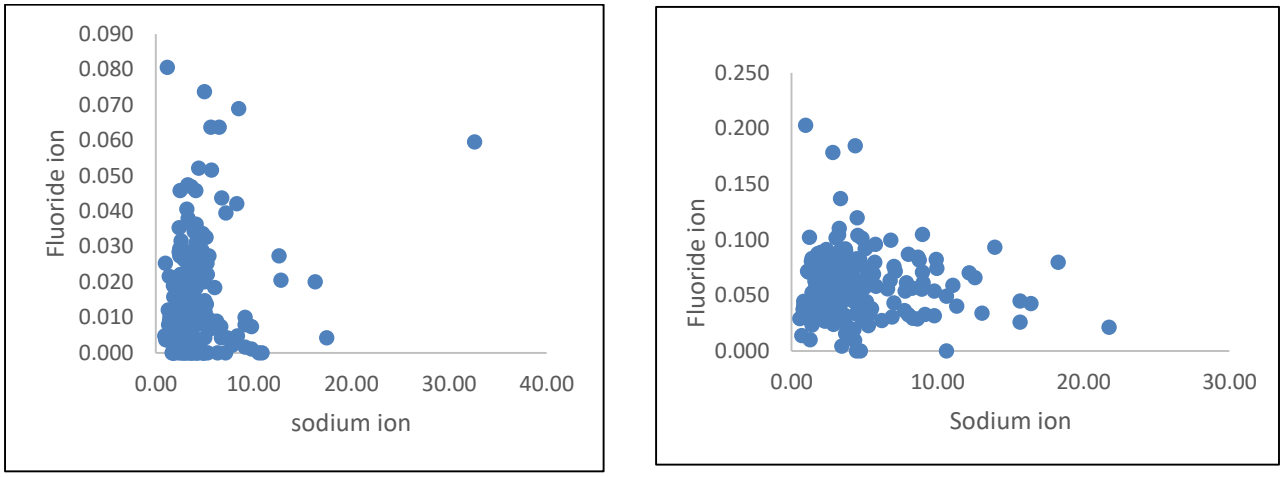


Figure 53:Comparison between Fluoride vs Sodium ion in Pre monsoon (left) & Post monsoon (right).

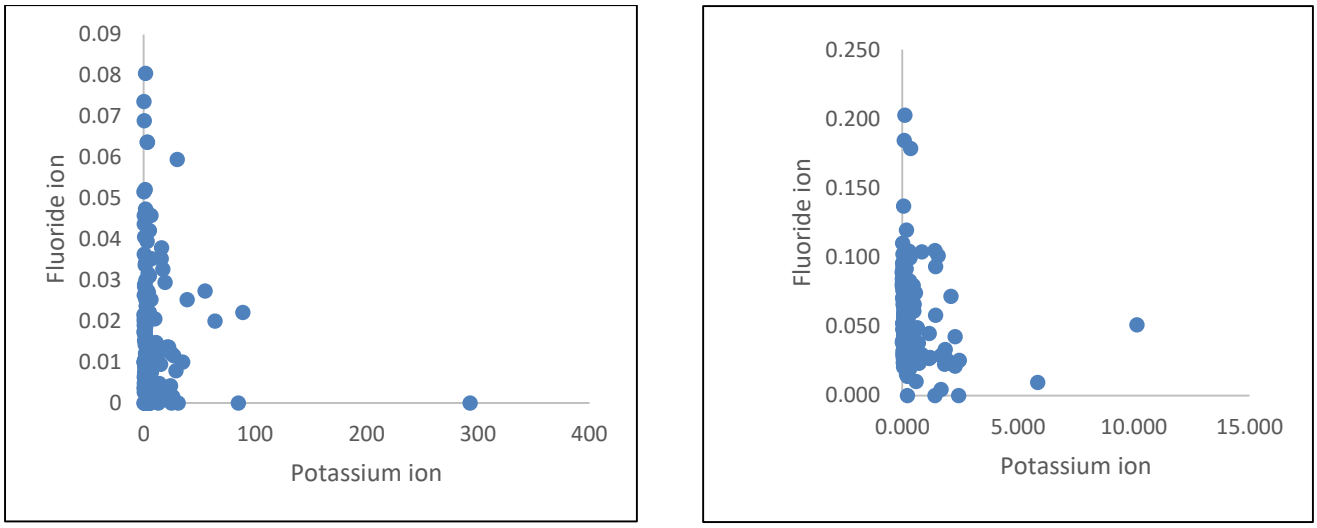


Figure 54: Comparison between Fluoride vs Potassium ion in Pre monsoon (left) & Post monsoon (right).

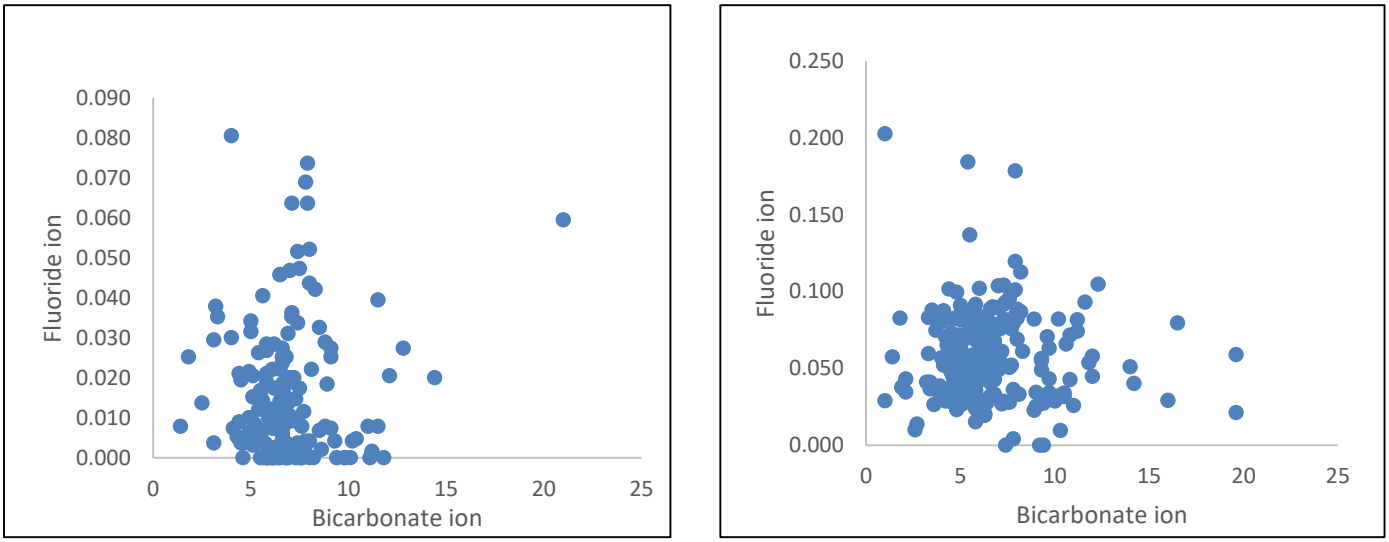


Figure 55: Comparison between Fluoride vs Potassium ion in Pre monsoon (left) & Post monsoon (right).

It indicates that in ground water fluoride shows moderate to weak correlation with HCO_3, and does not show any relationship with pH or Mg, K, NO_3 and CO_3 content of the samples. On the other hand in surface water fluoride shows moderate correlation with CO_3 and HCO_3, and weak correlation with pH, TDS and conductivity. However it does not indicate any relationship with cations especially Ca, K or Mg.

The high fluoride ground water samples have low as well as high pH. Similarly, low F ground water show high as well as low pH. Same is the case with surface water. However, when the fluoride content and pH of samples collected within a short span of time over a smaller area is considered, a unidirectional positive relationship i.e. high pH associated with high Fcontent or *vise-versa* was noticed.

6.5 Sources and Causes of High Fluoride in Ground water:

Granites, gneisses and basics/ultrabasic reportedly contain mineral silk apatite, biotite, sphene and amphiboles which may be contributors of Fluoride leading to fluoride contamination. The alluvial plains are made up of sediments derived from the said metamorphic terrain which lies to its south also found some fluoride contamination. But the hard rock terrain is more prevalent to fluoride contamination Hardrocks are exposed further south which need further investigation for detail study. Select smaller parcels of the area whichare highly affected may be studied in detail by high density sampling or sampling of all the available ground waterpoints, including monthly monitoring. Drilling few boreholes at select locations for core sampling and their analysis is also recommended for understanding the phenomena.

There are many small granitic hills around Madanpur and Rafiganj and hillocks/linear ridges. Thus the area appears to be a hard rock area covered by surficial Quaternary alluvium. Therefore, it is expected that hardrocks and the overlying weathered zone will be cut at varying depths inthe wells and the same will have a bearing on the ground water quality.

The depth of HR underneath the alluvium is quite irregular and highly variable. For example, in Bisambharpur (Sample no.72-9/10 W-1), people reported that in general hard rock is cut in wells around 7-8 m below the surface. However, in the tube well sampled no hard rock was cut up to a depth of 30.5m. As hard rock exposures exhibit prominences and depressions on the surface, a similar situation may be expected under the alluvial cover.

It was found during the study that tube wells in many parts of the area go into hardrock below alluvium or rest over it. Thus, even though parts of the area are located well within the alluvial country away from hard rock exposures, the wells are giving high fluoride or fluoride values near to the maximum permissible limit.

In case fluoride contamination were controlled by lineament, i.e. if the lineament served as conduit for emplacement of fluid/material containing F, the lower (deeper) aquifers at all the affected places would have been contaminated and showed higher values. However, this is not the case. The variation in fluoride content of ground water is quite intriguing. Though scientists have established relationship between drainage, lineament, rock types etc., here no such clear relationship could be established conclusively,except that high fluoride is a phenomenon primarily of pediplain and the nearby adjoining parts of the alluvial upland/older alluvium.

Figure 56: Dental/Skeletal Fluorosis was observed villages located in the pediplain or the nearby adjoining parts of older alluvium near to porphyritic granite gneiss.

Chapter 7

Identification of Potential Aquifer for drinking water supply and Plan for drinking water source sustainability

7.1 Dynamic Ground Water Resource assessment:

The estimation of Dynamic Ground Water Resources of the State was conducted collaboratively by the Central Ground Water Board, Mid-eastern Region, Patna in 2020, and 2022. Based on the recent two estimations, Madanpur and Rafiganj blocks in the Aurangabad District have been categorized as "Safe". A summary of the findings from GWRA 2020 and 2022 is provided below.

Table 53: Ground Water Resource Estimation in year 2020, 2022 & 2023

S. No	Block	GWRE-2020				GWRE-2022				GWRE-2023			
		Annual Extractable GW Resources (ham)	Total Extraction (ham)	SOGE (%)	Category	Annual Extractable GW Resources (ham)	Total Extraction (ham)	SOGE (%)	Category	Annual Extractable GW Resources (ham) Total Extraction (ham)	Total Extraction (ham)	SOGE (%)	Category
1	MADANPUR	6443.08	2505.83	38.89	safe	10470.78	2156.61	20.6	safe	10650.93	715.7	23.07	safe
2	RAFIGANJ	8177.23	4197.84	51.34	safe	10511.36	3721.8	35.41	safe	10943.21	4123.51	37.68	safe

7.2 Dynamic Ground Water Resources of unconfined Aquifer (As on March 2023)

Dynamic Ground water resources of unconfined aquifer, in storage of unconfined aquifer and static resource of the Aquifer-II has been estimated for identification of the potential aquifer for fulfilment of uncontaminated ground water for domestic demand.

The district has potential dynamic ground water resources in an unconfined Aquifer. The main source of ground water recharge in the district is rainfall and the other sources of rechargeare Canal Seepages, return seepages from irrigation and infiltration from Lakes, Ponds etc. The dynamic ground water resources of Madanpur and Rafiganj blocks are as follows.

Table 54: Block-wise Dynamic GW Recharge and Annual Extractable GW Resources of Study area.

Sl No	AssessmentUnit Name	Recharge worthy area (Ha)	Recharge from Rainfall-Monsoon Season	Recharge from Other Sources-Monsoon Season	Recharge from Rainfall-Non-Monsoon Season	Recharge from Other Sources-Non-Monsoon Season	Total Annual Ground Water (Ham) Recharge	Total Natural Discharges (Ham)	Annual Extractable Ground Water Resource (Ham)
1	Rafiganj	32143	5810.57	3302.59	114.49	2931.47	12159.12	1215.91	10943.21
2	Madanpur	26904	4524.64	4648.12	95.83	2565.79	11834.38	1183.45	10650.93
	Total	59047	10335.21	7950.71	210.32	5497.26	23993.5	2399.36	21594.14

The average recharge per unit area calculated from total recharge by recharge worth area and observed that 0.37 meter for Madanpur Block and 0.43meter for Rafiganj Block.

7.3 Ground Water Draft/ Extraction:

The block wise estimation of ground water draft has been done based on the actual number of different ground water exploitation structures & their unit draft values. The gross annual draft for the domestic and industrial has been calculated from extrapolated population in March 2023 and per capita water requirements. In the study area, the estimated gross annual draft for irrigation is 4451.2 ham, and gross annual draft for domestic and industrial purpose is 2129.59 ham. Thus, the estimated gross annual draft for all uses accounts for 6580.8 ham

Table 55: Block-wise Ground Water Extraction of study area.

S.No.	Assessment Unit Name	Total Area of Assessment Unit (Ha)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extractionfor Domestic and Industrial Use (Ham)	Total Extraction (Ham)	Extraction per unit area (m)
1	Rafiganj	38393	2963.44	90	1070.05	4123.51	0.10
2	Madanpur	34954	1487.75	300	669.53	2457.29	0.07
Total		73347	4451.2	390	1739.59	6580.8	0.08

7.4 Stage of Ground Water Extraction

The block wise determination of the present level of ground water Extraction has been done based on the percentage ratio between the net annual availability of ground water and present gross annual ground water Extraction for all uses. Thus, the present level of ground water Extraction is 67.19 in Madanpur Block, and 59.36% in Rafiganj block

Table 56 : Stage of Ground Water Extraction.

Sl No	AssessmentUnit Name	Annual Extractable Ground Water Resource (Ham)	Total Extraction (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
1	Rafiganj	10943.21	4123.51	37.68	safe
2	Madanpur	10650.93	715.7	23.07	safe
	Total	21594.14	6580.8	30.37	Safe

7.5 Net Annual Ground Water Availability for Future Uses and Annual GW allocation for domestic use as on 2025:

This component for the study area has been estimated block wise based on net annual availability and gross annual extraction of ground water for all purposes. Thus, the net annual ground water availability for all future uses has been estimated 14893.38 ham and allocation of GW for domestic purposes in 2025 as 1859.55 ham.

Table 57: Net Annual Ground Water Availability for Future Uses.

Sl No	Assessment Unit Name	Annual GW Allocation for Domestic Use as on2025(Ham)	Net Ground Water Availability for future use (Ham)
1	Rafiganj	1143.85	6745.91
2	Madanpur	715.7	8147.47
	District Total	9175.33	91452.59

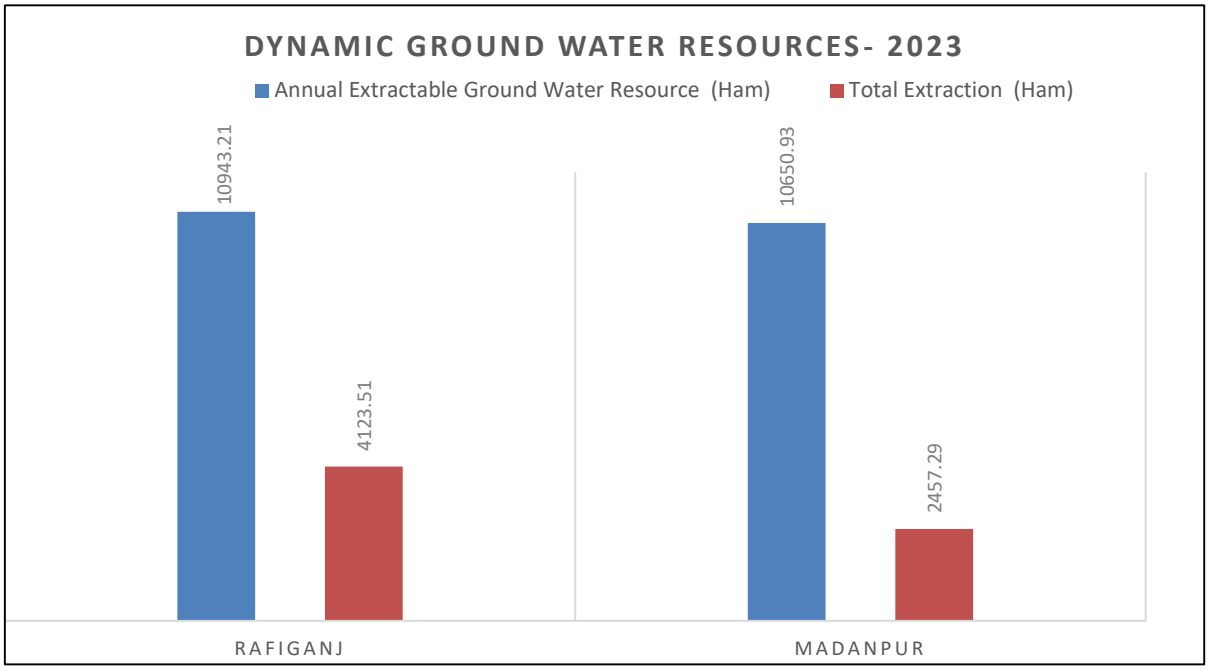


Figure 57: Dynamic Ground Water Resource 2023.

7.6 Plan for drinking water source sustainability:

7.6.1 Status of Tap water supply / "Har Ghar Nal Yojna" Status

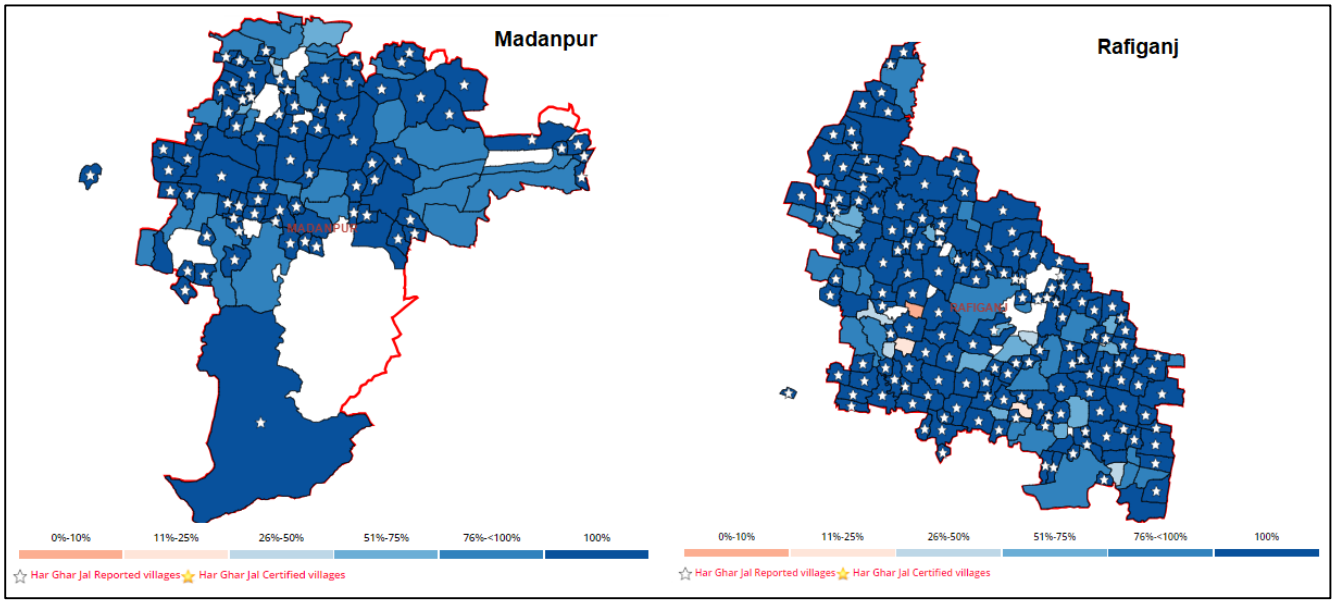
"Har Ghar Nal Yojana" (HGNY) is an initiative by the Government of Bihar aimed at providing piped drinking water to every rural household. The scheme's goal is to ensure that every rural household has access to clean and safe drinking water through a tap connection by 2024.

Key objectives of the scheme include:

1. **Universal Access**: To provide potable water to every rural household through piped water supply.
2. **Sustainable Water Management**: To promote sustainable and efficient water management practices at the local level.
3. **Improved Health**: To reduce water-borne diseases by providing clean and safe drinking water.
4. **Community Participation**: To involve local communities in the planning, implementation, and maintenance of water supply systems.

Table 58: Har Ghar Nal Yojna tap water connection status in Madanpur and Rafiganj block.

District	Block	No. of Panchyat	No. of Village	Total Number of households	Household provided with tap water connection through JJM mission	Percentage (%)
Aurangabd	Madanpur	18	120	41,913	40,915	97.87
Aurangabd	Rafiganj	23	209	45,674	44,036	96.41



Source:https://ejalshakti.gov.in/jjmreport/JJMIndia.aspx

Figure 58: Har ghar Nal Jal certified village.

7.7 Fluoride affected villages:

The central part of the study area is mainly affected by fluoride contamination. About 263 sq.km area which is almost 35% of the total study area has been demarcated as fluoride affected region. A total number of 66 villages come into this region. However, PHED under "Har Ghar Nal Yojna" is supplying fluoride free water by installing de-fluoridation plant with their water supply schemes through BW/TW.

Table 59: Area and villages affected with fluoride contamination

Block Name	Study Area (Sq.km.)	Area affected with fluoride in drinking water (Sq.km.)	Total number of Village affected
Madanpur & Rafiganj	734	263	99

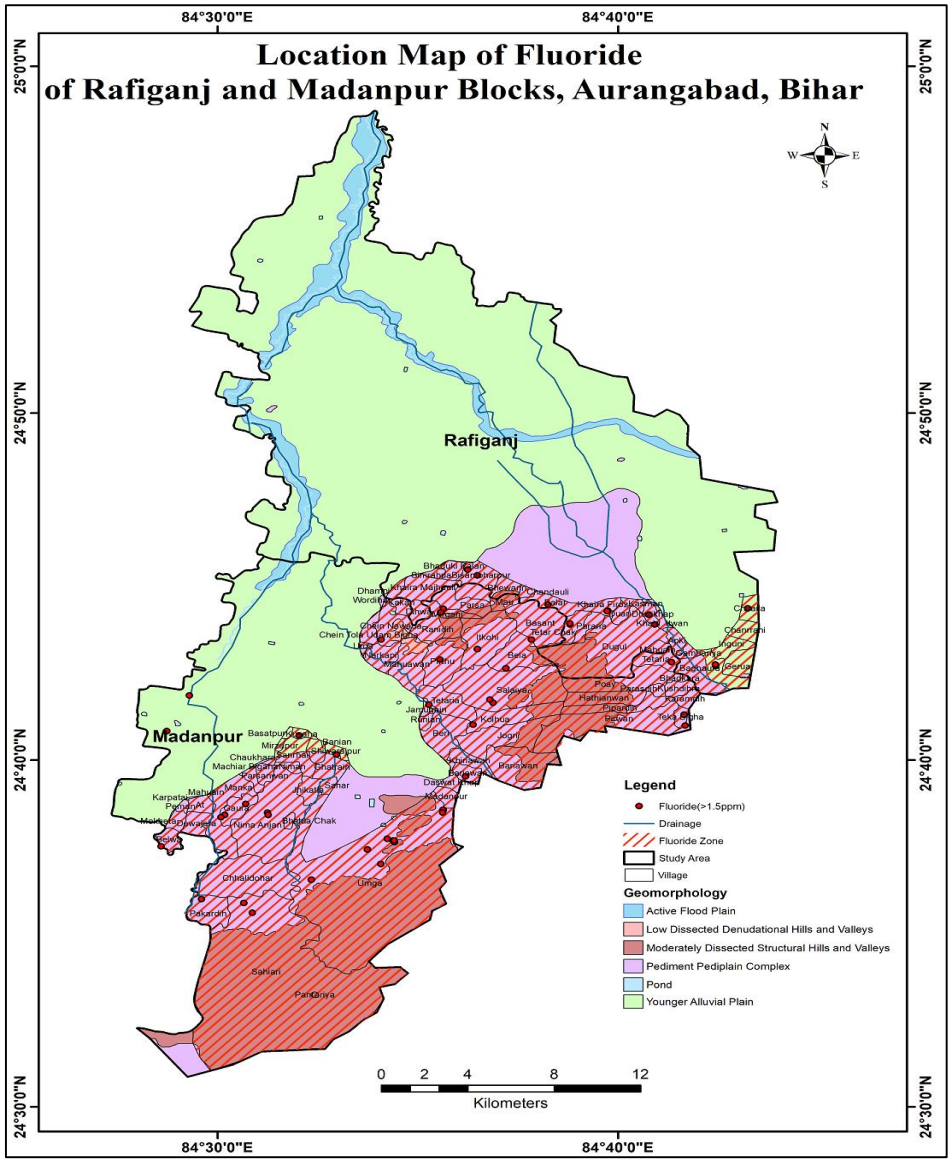


Figure 59: Demarcation of Villages drinking water contaminated by Fluoride.

7.8 Plan for fluoride free drinking water

Although most of the villages in the study area are covered by fluoride free tap water supply by PHED, Govt. of Bihar. However, there are few households in the demarcated fluoride affected area still don't have tap water supply. The details of villages & no. of household are listed in below table

Table 60: Name of villages & no. of households without tap water supply

S. No.	Block	Villages	No. of Households
1	Madanpur	Pirthu	54
2	Madanpur	Salaiya	79
3	Madanpur	Kolhua	47
4	Madanpur	Jogri	108

5	Madanpur	Bariawan	32
6	Madanpur	Pirwan	22
7	Madanpur	Pipardih	7
8	Madanpur	Banian	4
9	Madanpur	Sailwa	15
10	Madanpur	Kusaha	22
11	Madanpur	Nima Anjan	10
12	Madanpur	Manka	5
13	Madanpur	Ghora Dihri	28
14	Rafiganj	Dugul	12
15	Rafiganj	Inguni	25
16	Rafiganj	Gamharia	4
17	Rafiganj	Khaira Manorath	4
18	Rafiganj	Apki	151

Source:https://ejalshakti.gov.in/jjmreport/JJMVillageMapView.aspx& field observation.

NEERI evaluated de fluoridation treatment plant suitable for individual households which is attached to hand pump is proposed for the households not getting fluoride free tap water supply in the study area.

7.8.1 Removal of fluoride from drinking water by chemically functionalized sugarcane bagasse biochar and bagasse pellets in a fixed-bed sorption system

This study aimed to investigate the design parameters for a filter intended to remove fluoride from ground water particularly in areas where non-availability of safe drinking water from other than Ground water resources. This study utilized chemically functionalized sugarcane bagasse (residue) biochar adsorbent (SCBB), which is low-cost and easily accessible, to remove fluoride from ground water.

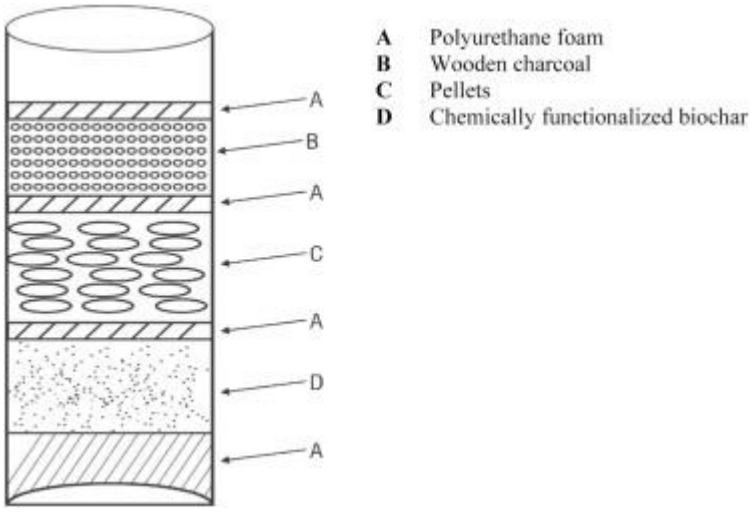
limited treatment options are currently available for addressing increased fluoride levels in potable water, such as chemical precipitation, coagulation, ion exchange, electrocoagulation, nanofiltration, catalytic ozonation, and electrochemical oxidation. Nevertheless, these methods could be more effective due to their high operational, maintenance, and waste production costs. Adsorption is the preferred defluoridation method in rural areas due to its cost-effectiveness, operational simplicity, accessibility, environmental friendliness, independence from skilled operators and electricity.

Sugarcane bagasse is a byproduct produced in a bulk quantity in sugar industries processes. The bagasse comprises approximately 50% moisture, 48% fibres, and 2% soluble solids

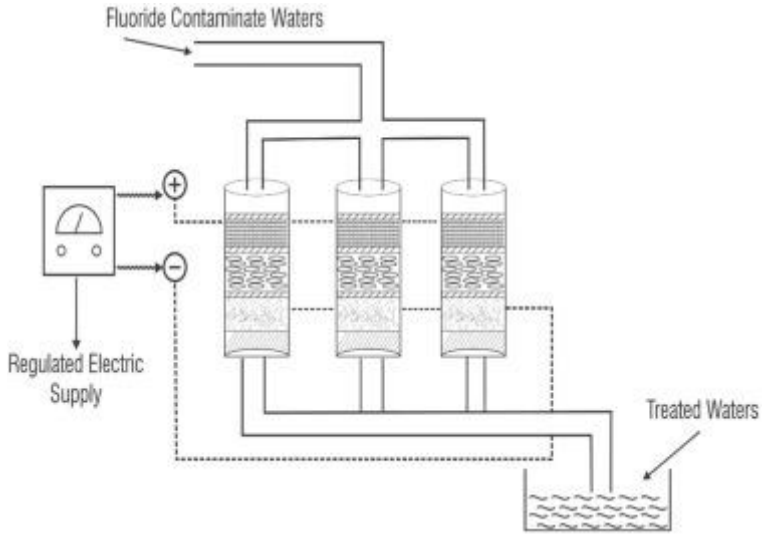
Materials and methods

Designing a novel column

The column comprised of 250 g chemically functionalized biochar with 1% KCL at the base, eight porous pellets in the middle, and 500 g wooden charcoal on top. The column contains a 4 mm layer of polyurethane foam in the upper and lower sections. This measure effectively captured particles and impurities during the water treatment process. No significant movement is observed in the biochar particles within the treated water.



Filtration unit



Cost analysis

The approximately cost of one filtration unit INR 6000.

With an investment of INR 6000, a villager can establish a fluoride removal filter that yields 30 litres of safe water daily (equivalent to 900 litres monthly) during the filter's initial phase. Therefore, the cost per litre of water is determined by dividing 6000 by 900, yielding INR 6.66.
The filtration unit recoups its price within the initial month of installation. The single bed is exhausted after five cycles, each filtering 60 litres per day. Each column has a capacity of 60 litres, resulting in a total filtration capacity of 300 litres when three columns are used.
The unit consists of three columns, each valued at INR 15, resulting in a total value of INR. 45 (INR 15 multiplied by 3 column).
The approximate cost of 1 litre of water is 15 paise, based on the total price of INR 45 for 300 litres. The monthly cost of filtering 900 litres of water for a family of five members, with each member consuming 5–6 litres per day for drinking and cooking, amounts to INR 135. Based on cost analysis, a monthly expenditure of 135 INR is adequate for one month to secure a fluoride-free and safe water supply. This cost is affordable for individuals living below the poverty threshold.

Reference: https://www.sciencedirect.com/science/article/pii/S1944398624000584

Figure 60: De-Fluoridation treatment plant attached to Hand pumps tube wells, specification evaluated by NEERI (National environmental engineering research institute) Nagpur.

Table 61: Others Removal methods for fluoride from drinking water (after Solsona, 1985; Heidweiller, 1990)

Removal method	Capacity/ dose	Working pH	Interferences	Advantages	Disadvantages	Relative Cost
Precipitation						
Alum	150mg/	Non-specific	-	Established	Sludge produced,	Med-high
(aluminium	mgF			process	Treatedwater is acidic,	
sulphate)					Residual Al present	
Lime	30mg/mg F	Non-specific	-	Established	Sludge produced,	Med-high
				process	Treatedwater isalkaline	
Alum+lime	150mg	Non-specific,	-	Low-tech,	Sludge produced,	Med-high
('Nalgonda')	alum+7mg	optimum6.5		established	High chemical dose,	
lime/mgF				process	Residual Al present	
Gypsum+	5mg gypsum	Non-specific	-	Simple	Requires trained operators	Low-med
Fluorite	+<2mg				Lowefficiency,high residual	
fluorite/mg F					Ca,SO4	
Adsorption/ionexchange						
Activate d carbon	Variable	<3	Many	-	Large pH changesbefore and after treatment	High
Plantcarbon	300mgF/kg	7	-	Locally available	Requires soaking in potassium hydroxide	Low-med
Zeolites	100mgF/kg	Non-specific	-		Poor capacity	High
Defluoron2	360gF/m^3	Non-specific	Alkalinity		Disposal of chemicals used in resin regeneration	Medium
Claypots	80mgF/kg	Non-specific	-	Locally	Low capacity,slow	Low

Removal method	Capacity/ dose	Working pH	Interferences	Advantages	Disadvantages	Relative Cost
Activated alumina	1200gF/m^3	5.5	Alkalinity	available Effective,well-established	Needs trained operators, chemicals not always available	Medium
Bone	900gF/m^3	>7	Arsenic	Locally available	Maygive taste;degenerates Not universally accepted	Low
Bonechar	1000gF/m^3	>7	Arsenic	Locally available High capacity	Notuniversallyaccepted	Low
Other						
Electrodialysis	High	Non-specific	Turbidity	Can remove Other ions.Used For high salinity	Skilled operators High cost. Not much used	Veryhigh
Reverse osmosis	High	Non-specific	Turbidity	Can remove Other ions.Used For high salinity	Skilled operators Hig hcost	Veryhigh

7.9 Artificial Recharge Plan

Artificial recharge structures such as check dams, recharge pits, diversion drains and mini-percolation tanks are suggested for recharge of ground water. As a result, the impounded water would not only recharge the ground water but will help in diluting the fluoride rich ground water.

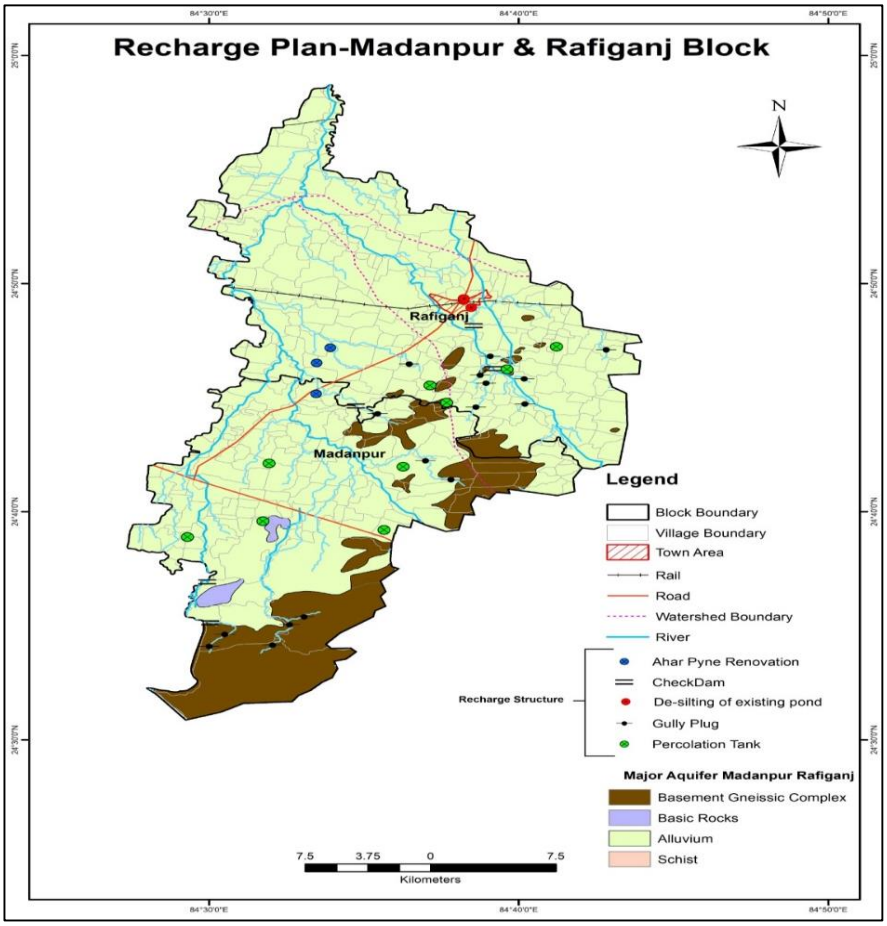


Table 62: Details of proposed structures

Ahar Pyne	3
Check Dam	4
De siltation of Pond	3
Gully Plug	16
Percolation Tank	9
Total	35

Figure 61: Artificial Recharge Plan for Madanpur and Rafiganj block.

Although, all the blocks are in safe category the artificial recharge should be encouraged to arrest the decline of ground water level caused by the increasing demand of ground water.

Availability of non-committed source water for the purpose of artificial recharge to ground water is the primary concern for the preparation of the artificial recharge plan, as data availability for surplus runoff is only river-basin or sub-basin wise, and not directly co relatable with identified feasible areas for artificial recharge.

Considering hydrogeological diversities, geomorphological set up and relative ground water potentialities in the district, various types of artificial recharge / conservation structure is possible for augmentation & conservation of ground water resources in different hydrogeological setup. To simplify the situation, based on generalized hydrogeological, a general norm has been adopted to arrive at number of various artificial recharge structures feasible. However, actual numbers of structures implementable may vary significantly based on scale of implementation. Based on available literature and previous experiences, unit cost of structures is also worked out. Suitable area for artificial recharge has been identified where the post monsoon (2023) water level is more than 3 m bgl.

Chapter 8

Identification of Potential Aquifer for Irrigation

As per the Dynamic Ground water Resources of 2023, both the Madanpur and Rafiganj blocks fall under the safe category, with an average ground water extraction stage of 30.37%. The unconfined aquifer in these areas shows significant potential. Approximately 67% of all ground water extractions are used for irrigation purposes. Ground water samples from the unconfined aquifer have been analyzed for suitability for irrigation.

The electrical conductivity (EC), sodium absorption ratio (SAR), Na%, and Permeability Index parameters have been analyzed, revealing that most samples are excellent and suitable for irrigation purposes.

8.1 Total Dissolved Solids (TDS)

Total dissolved solids represent the total concentration of dissolved substances in water. It is made up of inorganic salts and small amount of organic matter. The common inorganic salts found in water generally includes calcium, magnesium, sodium, potassium as cations and carbonates, bicarbonates, chlorides, sulphates, nitrates as anions. These minerals can also come from anthropogenic sources such as urban and agricultural runoff, wastewater discharge, industrial effluent etc.

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

TDS = EC * 0.65mg L^{-1} (Equation1)

Where EC is in µS/cm at 25º C

TDS is responsible for the mineralization of water and gives its degree of salinity. The TDS – Salinity relationship is presented below

Table 63: Total Dissolved Solids – Salinity Relationship

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

Table 64: Frequency Distribution of T.D.S. in Study area (Pre-monsoon)

Salinity as per T.D.S range	Percentage (%)
Fresh, non-saline (0-1000 mg/l)	91.46%
Slightly saline (1001-3000 mg/l)	8.53%

Table 65: Frequency Distribution of T.D.S. in Study area (post-monsoon)

Salinity as per T.D.S range	Percentage
Fresh, non-saline (0-1000 mg/l)	84.5%
Slightly saline (1001-3000 mg/l)	15.5%

8.2 United States Salinity Laboratory (USSL) Diagram

The diagram illustrates the salinity and sodium hazards of irrigation water. It assumes that water is used under average conditions with respect to soil texture, drainage, infiltration rates, quantity of water used, climate and tolerance of crops. The diagram for the classification of irrigation water is based on salinity hazard i.e., Electrical Conductivity in µS/cm at 25º C versus the Sodium hazard i.e., Sodium Adsorption Ratio (SAR).

Salinity Hazard– The irrigation waters have been divided into four classes with respect to the EC value ranges as below-

C_1 – Low Salinity Water (EC range <250 µS/cm at 25º C)

Such waters can be used for irrigation of most of the soils and crops with little or no problem of salinity and practically with no leaching requirements.

C_2 – Medium Salinity Water (EC range 250-750 µS/cm at 25º C)

Such waters can be used for irrigation of plants with moderate salt tolerance and on soils without special practices for salinity control.

C_3 – High Salinity Water (EC range 750-2250 µS/cm at 25º C)

Such water requires adequate drainage and special management for salinity control to grow plants with good salt tolerance.

C_4 – Very High Salinity Water (EC range >2250 µS/cm at 25º C)

Such water can be used occasionally under very special conditions. For use of such water the soil must be permeable with good drainage. Irrigation water must be applied in excess to produce considerable leaching and crop with high salt tolerance must be grown.

Table 66 : Frequency Distribution of E.C. in pre-monsoon

E.C range (µS/cm at 25º C)	Percentage (%)	Class of water (for irrigation)
<250 (low saline, C_1)	0	Class-1, Excellent
250-750 (medium saline, C_2)	32.31	Class-2, Good
751-2250 (high saline, C_3)	65.24	Class-3, Permissible
>2250 (very high saline, C_4)	2.44	Class-4, Unsuitable

Table 67: Frequency Distribution of E.C. in post-monsoon.

E.C range (µS/cm at 25º C)	Percentage (%)	Class of water (for irrigation)
<250 (low saline, C_1)	0.94	Class-1, Excellent
250-750 (medium saline, C_2)	42.72	Class-2, Good
751-2250 (high saline, C_3)	52.11	Class-3, Permissible
>2250 (very high saline, C_4)	4.22	Class-4, Unsuitable

As per Table 41 it is evident that in the study area in pre-monsoon, most of the water samples are observed to lie in C2 & C3 class exhibiting medium to high salinity. Thus 32.31% water samples in the area are found to be of good class for irrigation and 65.24% samples lie within the permissible limit as per class of water for irrigation. Only 2.44% water samples exhibited unsuitable class of water for irrigation purposes. Extremely high values, 3990 µS/cm at 25º C at Badal bigha, Madanpur block was observed in dugwell.

As per Table 42 it is evident that in the study area in post-monsoon, most of the water samples are observed to lie in C2 & C3 class exhibiting medium to high salinity. Thus 43.66% water samples in the area are found to be of good class for irrigation and 52.11% samples lie within the permissible limit as per class of water for irrigation. Only 4.22% water samples exhibited unsuitable class of water for irrigation purposes. Extremely high values, 3202 µS/cm at 25º C at Raniganj, Madanpur block was observed in dugwell.

8.3 Alkali Hazard

The suitability of irrigation water is characterized by absolute and relative concentrations of cations. If the concentration of sodium ions is high, the alkali hazard is high and if the calcium & magnesium levels are high, this hazard is low. The alkali soils are formed by the accumulation of exchangeable sodium and are characterized by poor tilt and low permeability. The U.S. Salinity laboratory has recommended the use of sodium adsorption ratio (SAR) as it is closely related to adsorption of sodium by the soil and can be calculated by using Equation 2.

$$SAR = \frac{Na^{+}}{\left(\frac{Ca^{2+} + Mg^{2+}}{2}\right)^{(1/2)}}$$ (Equation 2)

Where Na^{+}, Ca^{2+} and Mg^{2+} are in mq/L.

The water with regard to SAR is classified into four categories –

(i) **S_1 – Low Sodium Water** (SAR <10):
Such waters can be used on practically all kinds of soils without any risk or increase in exchangeable sodium.

(ii) **S_2 – Medium Sodium Water** (SAR 10-18)
Such waters may produce an appreciable sodium hazard in fine textured soil having high cation exchange capacity under low leaching.

(iii) **S_3 – High Sodium Water** (SAR >18-26)
Such waters indicate harmful concentrations of exchangeable sodium in most of the soil and would require special management, good drainage, high leaching and addition of organic matter to the soil. If such waters are used on gypsiferrous soils the exchangeable sodium could not produce harmful effects.

(iv) **S_4 – Very High Sodium Waters** (SAR >26)
Generally, such waters are unsatisfactory for irrigation purposes except at low or perhaps at medium salinity where the solution of calcium from the soil or addition of gypsum or other amendments make the use of such waters feasible. A classification of the collected ground water samples on the basis of SAR values is given in Table 44. The SAR values in the study area zone I, ranges from 0.21 to 4.74, with an average value of 1.39. Thus, in the study area of 100 % of the water samples are observed to lie in S_1 class exhibiting low sodality.

As per USSL diagram given in Figure 63, the ground water in the study area zone I, mostly comes under the C2-S1 type suggesting medium salinity and low sodality, followed by C3-S1 type and a very few in C4-S2 type. The salinity hazard is posed by the water samples as they fall in class C3 and C4. Thus, on the whole 4.54 % of the water samples indicate C4-S2 class rendering the water unsuitable for irrigation purposes under ordinary conditions, however, it may be used occasionally after taking suitable measures.

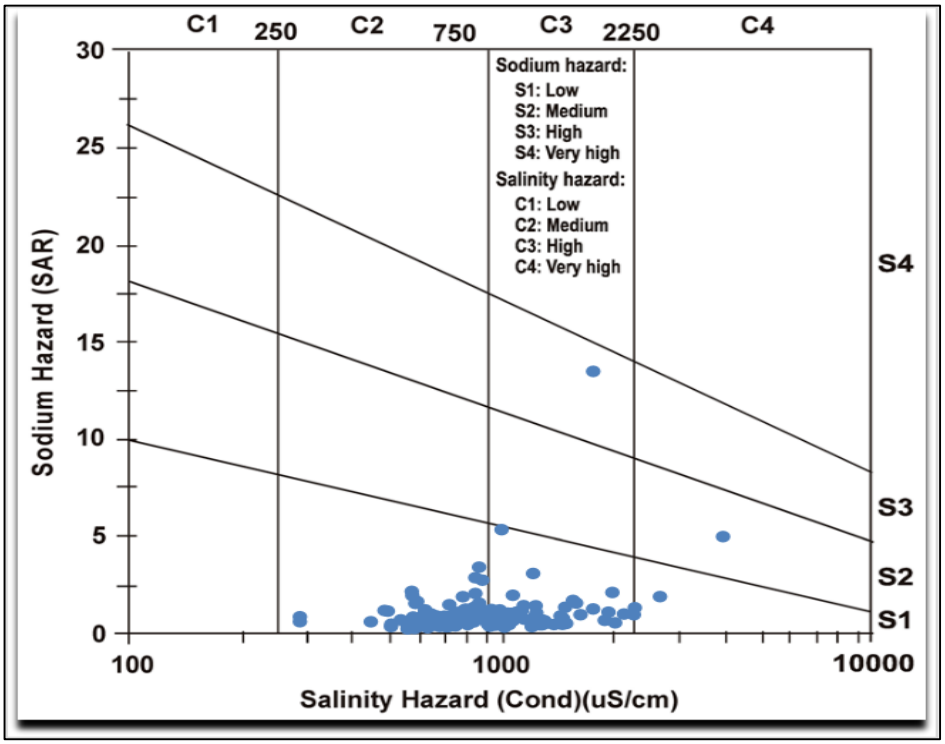


Figure 62: SAR vs Salinity hazard (Pre Monsoon)

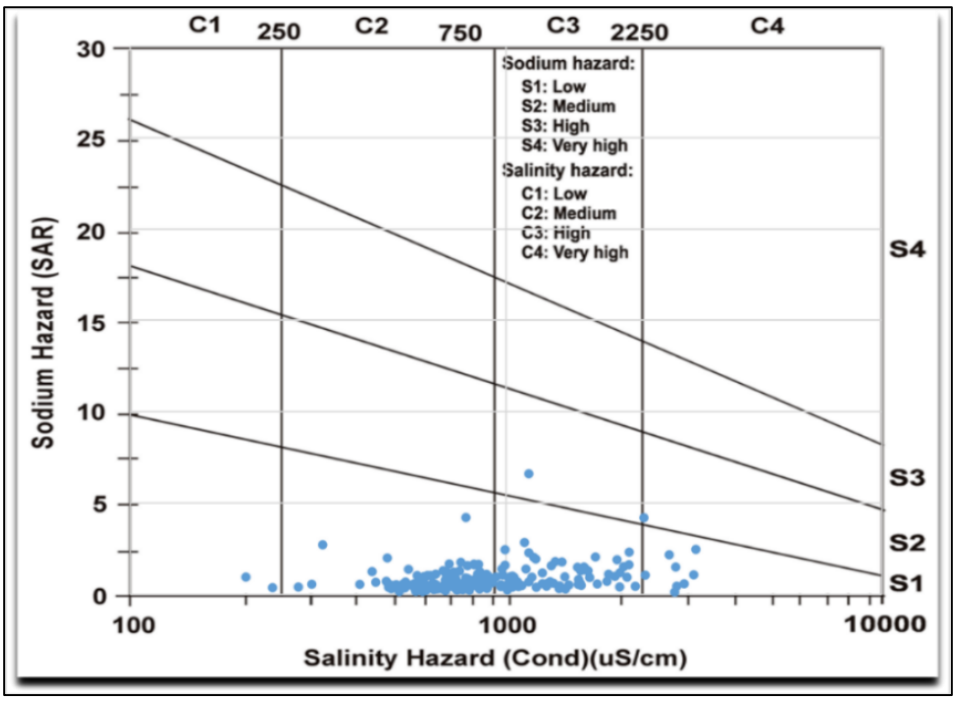


Figure 63: SAR vs Salinity hazard (Post Monsoon)

USSL diagram Figure 63 and 64 describes in pre monsoon water is C2S1 and C3S1 type but in post monsoon water is little bit in C1S1 Maximum in C2S1, C3S1 and few in C4S1 and one in C3S2.

C1S1- Excellent, Situatable for all most of crops I most of clays.
C2S1- Good, suitable for plants that have high tolerance of salts but its use can create problem to clays.
C3S1 and C3S2- Acceptable, salinity must be controlled, irrigation to tolerable crops to salt on well drained soils.
C4S1- Poor, highly mineralized water used only for very salt resistant plant with good soil permeability.

8.4 Alkalinity Hazard or Residual Sodium Carbonate (RSC)

When carbonate or bicarbonate concentration in irrigation water is relatively higher than the alkaline earth metals, there is tendency for calcium and magnesium ions to precipitate as carbonates in the soil, thereby reducing the level of calcium and magnesium ions and increasing the relative levels of sodium in the soil. The highly soluble sodium carbonate (black alkali) known as residual sodium carbonate (RSC) is defined as –

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

Where, concentrations are expressed in meq/l.

Table 68: Classification of ground water Samples as per RSC values (Eaton, 1950)

RSC range (meq/L)	Suitability for Irrigation
< 1.25	Very safe water
1.25-2.5	Marginally safe water
>2.5	Unsuitable water

The ground water samples collected from premonsoon has shown that the Residual Sodium Carbonate in the area was in the range of -10 to 3.30 meq L^{-1}, with an average value of -0.45 meq L^{-1}.

A classification of the collected ground water samples on the basis of RSC values is given in Table 11**.**

8.5 Soluble Sodium Percentage (S.S.P) (Wilcox Plot)

It takes into account the concentration of major ions in meq L^{-1}. It is calculated using equation 3.

$$\%\, Sodium = \frac{Na^+ + K^+}{(Ca^{2+} + Mg^{2+} + Na^+ + K^+)}\ X\ 100 \qquad \text{(Equation 3)}$$

Where, Na^+, K^+, Ca^{2+} and Mg^{2+} are in meq L^{-1}.

A classification of ground water samples on the basis of % sodium values is given in Table I.11.

It was observed that 34.1 % of the samples were in the excellent category, followed by 50 % samples in good and 15.9 % in permissible category. No samples were found to be in the category of doubtful and unsuitable, according to their % sodium values. A Wilcox plot is given in Figure 65 & 66, relating Electrical conductivity to % sodium, showing usability of ground water towards irrigation purpose. As can be seen from Figure 65 & 66 most of the ground water samples were in the category excellent to good and good to permissible zone. Only 2.27 % of the samples were in permissible to doubtful and 4.54 % of the samples were in the unsuitable zone.

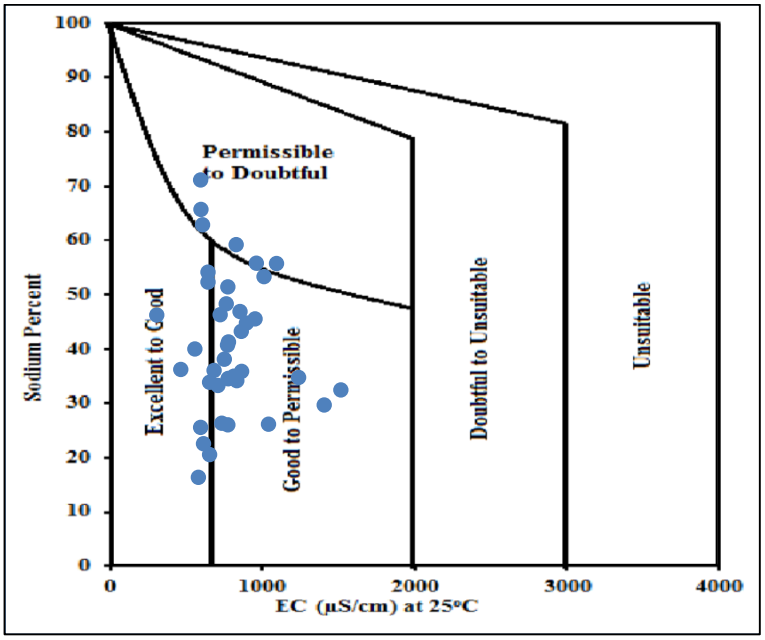


Figure 64: Na% vs Ec (Pre Monsoon)

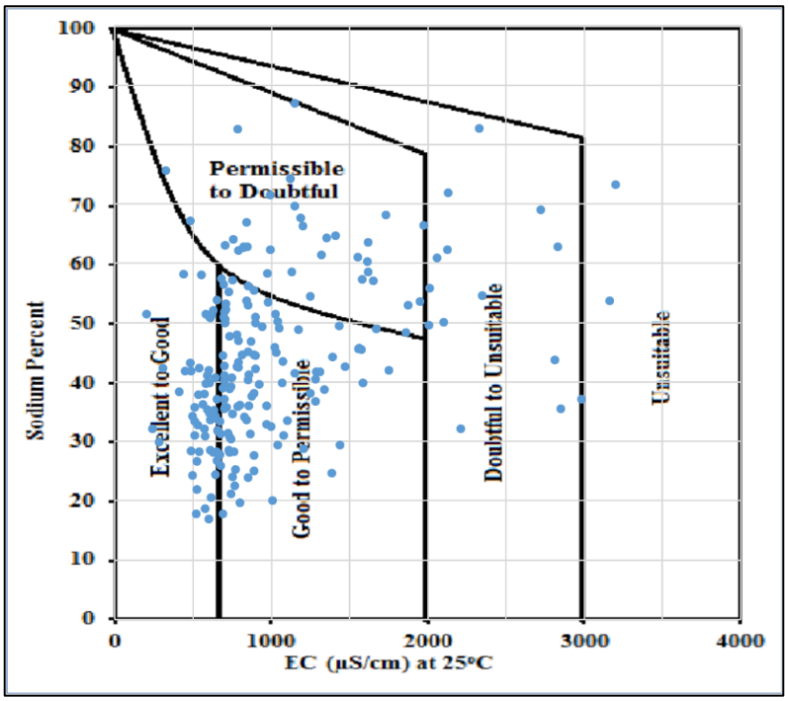


Figure 65: Na% vs Ec (Post Monsoon)

Wilcox diagram shows that during pre monsoon few samples are in excellent to good quality, maximum samples are in good to permissible and very few in permissible to doubtful quality. But during post monsoon Maximum are in excellent to good and good to permissible and permissible to doubtful. But few are in doubtful to unsuitable and unsuitable also present. It supports USSL diagram.

8.6 Hydrogeochemical facies of Ground water

Hydro geochemical facies primarily describe the distribution of principal type of ground water. This provides information on progressive ion enrichment on the basis of residence time of ground water in subsurface and on the level of rock-water interaction. Hydro geochemical faces are separate zones that have concentration of cations and anions within defined composition categories. Here, the ground water samples collected from zone I, has been classified utilizing the Piper's trilinear diagram.

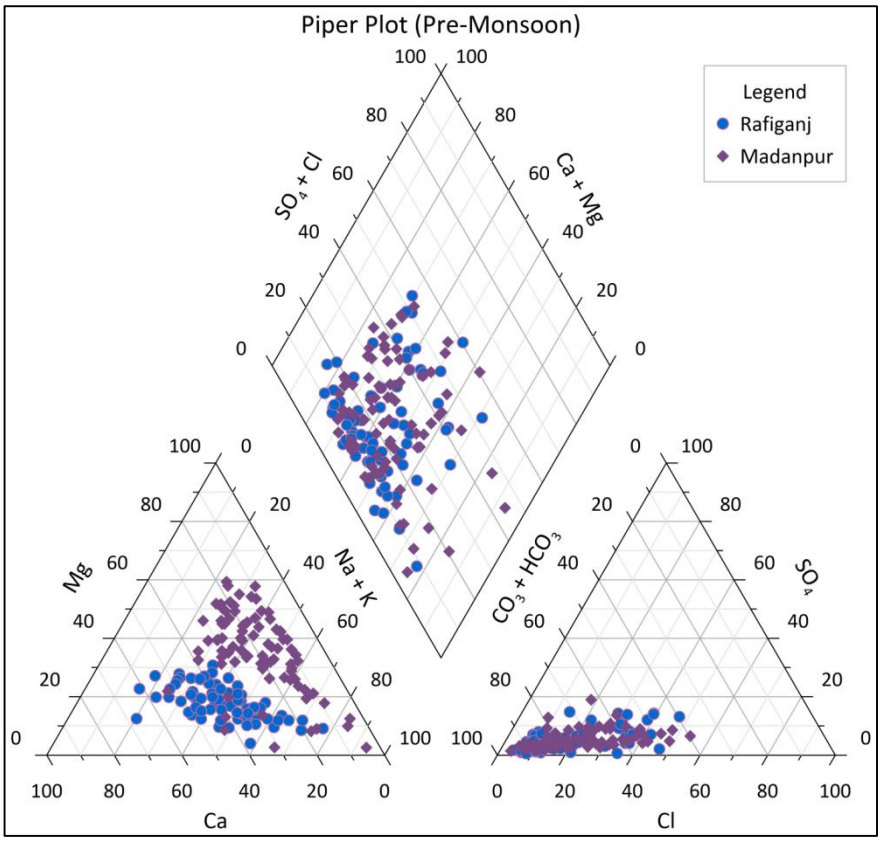


Figure 66: Piper Plot (Pre Monsoon)

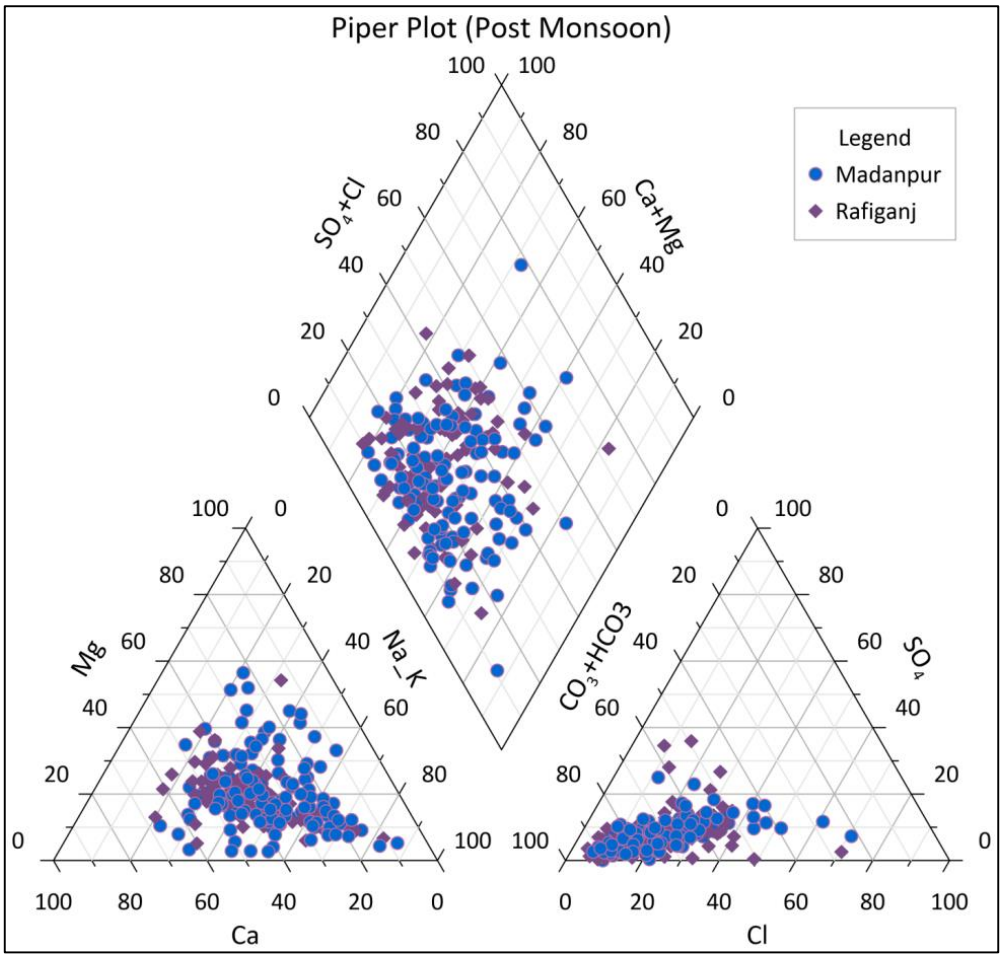


Figure 67: Piper Plot (Post Monsoon)

Piper diagram Fig 67 and 68 Indicate that during premonsoon and postmonsoon period water quality is mainly Ca-HCO3 type, mixed type and Na-Cl type.

Table 69: Classification of Ground Water Samples

Pre-Monsoon			Post-Monsoon		
Based on EC			**Based on EC**		
EC (µs/cm)	**WaterClass**	**%of samples**	**EC(µs/cm)**	**WaterClass**	**%of samples**
<250	Excellent	0	**<250**	Excellent	0.94
250-750	Good	32.31	**250-750**	Good	42.72
751-2250	Permissible	65.24	**751-2250**	Permissible	52.11
>2250	Unsuitable	2.44	**>2250**	Unsuitable	4.22
Based on Na%			**Based on Na%**		
Na%	**Water Class**	**%of samples**	**Na%**	**Water Class**	**%of samples**
<20	Excellent	34.1	**<20**	Excellent	
20-40	Good	50	**20-40**	Good	
40-60	Permissible	15.9	**40-60**	Permissible	

60-80	Doubtful	0	**60-80**	Doubtful	
>80	Unsuitable	0	**>80**	Unsuitable	
Based on SAR			**Based on SAR**		
SAR	**WaterClass**	**%of samples**	**SAR**	**WaterClass**	**%of samples**
<10	Excellent	100	**<10**	Excellent	100
10.0-18.0	Good	0	**10.0-18.0**	Good	0
18.0-26	Doubtful	0	**18.0 -26**	Doubtful	0
>26	Unsuitable	0	**>26**	Unsuitable	0
Based on RSC			**Based on RSC**		
RSC	**WaterClass**	**%of samples**	**RSC**	**WaterClass**	**%of samples**
< 1.25	Good	93.8	**< 1.25**	Good	
1.25-2.5	Doubtful	2.27	**1.25-2.5**	Doubtful	
> 2.5	Unsuitable	4.55	**> 2.5**	Unsuitable	

In premonsoon %Na is excellent in 34.1% samples. In Case of SAR average value < 10 in both period so excellent.

Over all the Aquifer I (Alluvial aquifer) is most suitable for catering irrigation water demand. The aquifer II (Hard rock aquifer) has limited yield prospect in the study area.

Chapter 9

Major Findings and Discussion

- Two prominent aquifers have been demarcated. The alluvium and weathered part of the rock form the Aquifer I (Shallow Aquifer). Fractured Hard rock represent Aquifer II (Deeper Aquifer). Depth to bed rock in the study area varies from around 14 m to more than 80 m. accordingly, depth of shallow aquifer varies. Though, the thickness of Aquifer I is more than 80m, the aquifer is not promising.

- Depth of bed rock relatively increases towards north side of the study area. In general, Rafiganj block has relatively greater depth to bed rock than in Madanpur block.

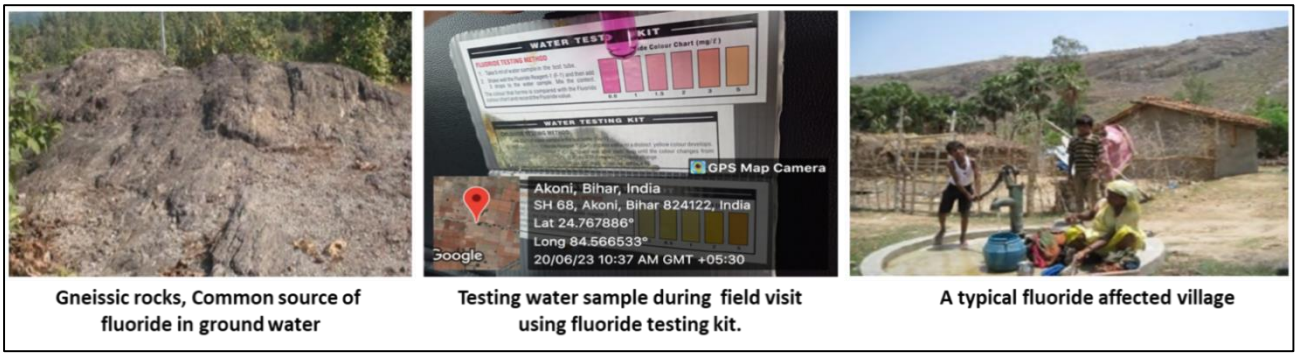
- Some deep seated fractured encountered in the wells drilled by CGWB. Deep seated fractures are encountered at 124.50 mbgl at Rafiganj (Sarawak village) and 145 mbgl at Madanpur (Bhuiyan Bigha village). However, no deep regional potential fractures are deciphered.

- Pumping test conducted in private irrigation wells reveals that the transmissivity is 87.56 (hard rock aquifer) to 224.71 m^2/day (alluvial aquifer) in Rafiganj block. The transmissivity value in Madanpur block varies between 2.38 m^2/day in hard rock aquifer to 157.32 m^2/day in alluvium.

- Ground water is suitable for drinking purpose, except occurrence of fluoride concentration of more than permissible limit (1.5mg/L). 213 samples collected for chemical analysis, of which 51 samples show fluoride above permissible limit from 1.51 mg/L (Kushaha, Madanpur block) to 8.86 mg/L (Garwa, Rafiganj block). Majority of these samples are falling in Madanpur block (38 samples). It can be inferred from the depth to bed rock data and fluoride contamination that fluoride occurrence is relatively more in areas of shallower depth to bed rock.

- The fluoride content of ground water is highly variable- laterally as well as vertically. This is quite intriguing.

- Ground water from hard rock area is more enriched in fluoride than in alluvial terrain in Aurangabd district. Dissolution of Fluoride bearing minerals like fluorite, apatite, biotite, hornblende etc. from granite, gneiss, pegmatites, mica schist host rocks



Gneissic rocks, Common source of fluoride in ground water

Testing water sample during field visit using fluoride testing kit.

A typical fluoride affected village

9.1 Management Interventions

- The high yielding wells having fluoride free water should be used to provide supply of drinking water to populations residing in fluoride affected areas. Centralised community drinking water supply schemes should be implemented in the affected areas tapping the fluoride free sources such as larger

streams, larger reservoirs or fluoride free aquifers in adjacent areas in consultation with the agencies like Geological Survey of India and Central Ground Water Board.

- Wells should be constructed tapping multiple aquifers (Shallow alluvium and Fractured Hard Rock Aquifer) to blend the fluoride contaminated water which may be source for supply of drinking water. Different soft sediment and hard rock aquifers in the affected areas may be tested in detail. Eventually the safest/safer horizon at a place for the purpose of tapping it for community supply.

- Artificial Recharge structure in areas of high fluoride concentration for lowering the concentration through dilution.

- Defluoridation plant should be installed in fluoride affected areas, which is being done by PHED, GoB in fluoride affected wards for providing safe drinking water supply to households. 131 wards in Madanpur and 93 wards in Rafiganj have Water Treatment Plant.

- Surface water supply scheme should be used for providing safe drinking water supply to households in fluoride affected as well as low ground water potential areas.

- No potential water bearing zones have been found in the borehole constructed previously by CGWB in the area. During present drilling activity, two -three deep seated water bearing fractures have been encountered at depth – 94 m, 124.50 m and 145 m. Hence, no deep regional potential fractures are deciphered and ground water development shall be restricted to the phreatic zones in these areas.

- Since the area represents the marginal alluvium with thickness of overburden varying from 14 m to more than 90 m, increasing towards north (Rafiganj block); dug wells and hand pumps should be kept in operational conditions along with wells used for drinking purpose. Artificial recharge, through recharge wells at suitable locations are to be constructed to augment ground water.

- For providing succor to the people, testing of each and every ground water point for fluoride and other harmful impurities before its utilization may be made mandatory for the entire affected stretch.

Field Survey at Shivnagar Site

Field Survey at Bhartoli Site.

Water Level Monitoring in Dugwell Bhartoli site.

Water Level Monitoring in Bore well Rafiganj.

Clay formation up to 4 m at excavation near Rafiganj.

Hard rock (Granite) exposed at Madanpur Block)

Figure 68: Field Photographs.

Annexures

Annexure 1: Data for Water table (Pre Monsoon)

S.N	District	Block	Village/Location	Lat	Long	RL	DW/TW/BW/Pond	Aquifer	Water Table (Post Monsoon)
1	Aurangabad	Madanpur	AgraPar	24.709497	84.524083	110	DW	Alluvium	106.6
2	Aurangabad	Madanpur	AgraPar	24.709088	84.525158	110	BW	Hard Rock	102.2
3	Aurangabad	Madanpur	At	24.641984	84.489749	131	TW	Alluvium	125.3
4	Aurangabad	Madanpur	Badal Bigha	24.665337	84.473108	122	DW	Alluvium	116.7
5	Aurangabad	Madanpur	Badal Bigha	24.665908	84.473381	123	BW	Hard Rock	103.32
7	Aurangabad	Madanpur	badki chechani	24.62326	84.52365	146	TW	Alluvium	134.64
8	Aurangabad	Madanpur	Bahlola	24.683917	84.483617	122	TW	Alluvium	117.06
9	Aurangabad	Madanpur	Belbigha	24.693286	84.588069	113	BW	Hard Rock	106.65
10	Aurangabad	Madanpur	Belwa	24.625002	84.4766	136	TW	Alluvium	131.43
11	Aurangabad	Madanpur	Belwa	24.624355	84.477773	134	DW	Alluvium	131.39
12	Aurangabad	Madanpur	Beri	24.676275	84.591377	116	TW	Alluvium	105.92
13	Aurangabad	Madanpur	Beri	24.67703	84.591727	117	TW	Alluvium	106.25
14	Aurangabad	Madanpur	Bishunganj	24.650503	84.533955	132	DW	Alluvium	124.8
15	Aurangabad	Madanpur	Bishunganj	24.650398	84.533888	132	BW	Hard Rock	121.85
16	Aurangabad	Madanpur	Chanki Bigha	24.714957	84.592443	116	DW	Alluvium	110.7
17	Aurangabad	Madanpur	Chanki Bigha	24.714925	84.592497	116	TW	Alluvium + Hard Rock rock	109.65
19	Aurangabad	Madanpur	Dadhpi	24.689248	84.498457	117	DW	Alluvium	114.1
21	Aurangabad	Madanpur	Erki Kalan	24.714682	84.494481	109	BW	Hard Rock	100.5
22	Aurangabad	Madanpur	Erki Kalan	24.706666	84.496751	114	DW	Alluvium	108.9
23	Aurangabad	Madanpur	Ghatrain	24.662906	84.554591	127	TW	Alluvium	118.47
24	Aurangabad	Madanpur	ghatrain	24.663032	84.55453	127	DW	Alluvium	124.38
25	Aurangabad	Madanpur	Gulab Bigha	24.644652	84.546405	133	DW	Hard Rock	131
26	Aurangabad	Madanpur	Gulab Bigha	24.64341	84.546774	132	HP	Alluvium	126.4
27	Aurangabad	Madanpur	Hajipur	24.694152	84.535367	121	DW	Alluvium	118.43
28	Aurangabad	Madanpur	Hajipur	24.692883	84.537698	118	BW	Hard Rock	91.82
29	Aurangabad	Madanpur	Hari Bigha	24.694104	84.614211	122	DW	Alluvium	119.54
31	Aurangabad	Madanpur	jamugain	24.6919	84.580373	116	DW	Alluvium	111.6
34	Aurangabad	Madanpur	Karpatai	24.65012	84.484712	127	TW	Alluvium	121.72
36	Aurangabad	Madanpur	Kathri	24.713215	84.513638	111	BW	Hard Rock	102.2
37	Aurangabad	Madanpur	Kathri	24.712988	84.51301	111	DW	Alluvium	105.57
38	Aurangabad	Madanpur	Kolhua	24.683523	84.60643	125	DW	Alluvium	124.7
39	Aurangabad	Madanpur	Kolhua	24.683763	84.606773	126	BW	Hard Rock rock	123
40	Aurangabad	Madanpur	Kusaha	24.678308	84.534092	122	DW	Alluvium	113.6
41	Aurangabad	Madanpur	Kusaha	24.67803	84.534033	121	BW	Alluvium + Hard Rock rock	101.4
42	Aurangabad	Madanpur	machiar bigha	24.661558	84.513246	124	DW	Alluvium	120.25
43	Aurangabad	Madanpur	machiar bigha	24.661668	84.513465	124	BW	Hard Rock	113.45
45	Aurangabad	Madanpur	Madanpur	24.656138	84.584859	127	BW	Hard Rock	111.45
47	Aurangabad	Madanpur	mahuwawan	24.695645	84.571292	113	DW	Alluvium	108.7
48	Aurangabad	Madanpur	Manika	24.65434	84.501117	123	DW	Alluvium	120.7
49	Aurangabad	Madanpur	Manika	24.654204	84.501635	126	BW	Hard Rock	121.74
51	Aurangabad	Madanpur	manwa dohar	24.612802	84.53901	149	BW	Hard Rock	138.89
52	Aurangabad	Madanpur	Maya bigha	24.701938	84.485825	115	DW	Alluvium	110.1

S.N	District	Block	Village/Location	Lat	Long	RL	DW/TW/BW/Pond	Aquifer	Water Table (Post Monsoon)
53	Aurangabad	Madanpur	Maya bigha	24.701895	84.485607	113	HP	Alluvium	108.27
57	Aurangabad	Madanpur	Nawadih	24.597802	84.511055	152	BW	Hard Rock	145.98
58	Aurangabad	Madanpur	Nawadih	24.600728	84.510742	148	DW	Alluvium	144.82
60	Aurangabad	Madanpur	Nima Anjan	24.648203	84.519106	131	DW	Alluvium	125.78
64	Aurangabad	Madanpur	Parariya	24.662614	84.59876	122	TW	Alluvium	118.64
66	Aurangabad	Madanpur	Pateya	24.662893	84.569275	122	DW	Alluvium	118.25
67	Aurangabad	Madanpur	Pateya	24.662071	84.569122	124	TW	Alluvium	116.2
68	Aurangabad	Madanpur	Pipraura	24.754456	84.530498	101	TW	Alluvium	96.2
69	Aurangabad	Madanpur	Pipraura	24.754555	84.528787	103	DW	Alluvium	96.9
70	Aurangabad	Madanpur	Pir Bigha	24.724334	84.631473	124	BW	Hard Rock	104.4
71	Aurangabad	Madanpur	Pir Bigha	24.724597	84.630717	124	DW	Alluvium	118.6
72	Aurangabad	Madanpur	Rama Bandh	24.609172	84.538814	152	BW	Hard Rock	141
74	Aurangabad	Madanpur	Raniganj	24.683328	84.516994	114	BW	Alluvium + Hard Rock rock	98.67
75	Aurangabad	Madanpur	Raniganj	24.683358	84.516912	114	DW	Alluvium	110.24
76	Aurangabad	Madanpur	Rasulpur	24.67726	84.480205	119	DW	Alluvium	115.4
77	Aurangabad	Madanpur	Rasulpur	24.677073	84.48028	119	TW	Alluvium	114.46
78	Aurangabad	Madanpur	Ratan Bigha	24.707573	84.585591	110	DW	Alluvium +concrete	106.82
79	Aurangabad	Madanpur	Ratan Bigha	24.724601	84.568386	107	BW	Hard Rock	100.35
80	Aurangabad	Madanpur	Sahiari	24.592735	84.514693	153	DW	Alluvium	145.31
82	Aurangabad	Madanpur	Sondih	24.705883	84.535936	116	BW	Hard Rock	83.1
83	Aurangabad	Madanpur	Sondih	24.706545	84.538535	110	DW	Alluvium	108.83
84	Aurangabad	Madanpur	sri rampur	24.641452	84.593757	138	TW	Alluvium	131.35
85	Aurangabad	Madanpur	sri rampur	24.64085	84.594227	134	DW	Alluvium	127.48
87	Aurangabad	Madanpur	Teka Bigha	24.688432	84.694073	121	DW	Alluvium	117.23
89	Aurangabad	Madanpur	Teldiha	24.697842	84.50501	112	DW	Alluvium	109.85
90	Aurangabad	Madanpur	Tetaria	24.713335	84.688162	114	BW	Hard Rock	107.02
91	Aurangabad	Madanpur	Tetaria	24.713718	84.689115	115	DW	Alluvium	109.35
92	Aurangabad	Madanpur	Theriya	24.64887	84.60081	124	DW	Alluvium	122.16
93	Aurangabad	Madanpur	Uchauli	24.755524	84.550994	103	DW	Alluvium	98.2
95	Aurangabad	Madanpur	Umga	24.647192	84.566105	130	DW	Alluvium	126.76
96	Aurangabad	Madanpur	Umga	24.648227	84.566785	128	TW	Alluvium	123.28
97	Aurangabad	Madanpur	Umga	24.631748	84.569742	135	DW	Alluvium	134.3
98	Aurangabad	Madanpur	Umga	24.629596	84.56977	136	TW	Alluvium	133.66
99	Aurangabad	Madanpur	War tola	24.730329	84.52059	109	TW	Alluvium	99.5
100	Aurangabad	Rafiganj	Abdulpur	24.818435	84.627508	99.3	HP	Alluvium	82
101	Aurangabad	Rafiganj	Abdulpur	24.816694	84.630637	100	HP	Alluvium	83.6
102	Aurangabad	Rafiganj	Akoni	24.767916	84.566876	106	TW	Alluvium	89.6
104	Aurangabad	Rafiganj	Asa Bighah	24.815428	84.527595	94.1	HP	Alluvium	87.88
105	Aurangabad	Rafiganj	Asa Bighah	24.815056	84.529208	94.9	TW	Alluvium	88.08
107	Aurangabad	Rafiganj	Aurawan	24.821388	84.678222	107	HP	Alluvium	102.5
108	Aurangabad	Rafiganj	Baghora	24.712418	84.707352	119	TW	Alluvium	111.38
113	Aurangabad	Rafiganj	Barpa	24.959962	84.559715	86	DW	Alluvium	80.55
114	Aurangabad	Rafiganj	Batura	24.76436	84.620625	114	TW	HR	104.95
115	Aurangabad	Rafiganj	Batura	24.764736	84.620574	113	HP	Alluvium	103.65

S.N	District	Block	Village/Location	Lat	Long	RL	DW/TW/BW/Pond	Aquifer	Water Table (Post Monsoon)
117	Aurangabad	Rafiganj	Belar	24.741418	84.637592	112	DW	Alluvium	109.1
122	Aurangabad	Rafiganj	Bishambharpur	24.756217	84.605534	118	HP	Alluvium +HR	113.8
123	Aurangabad	Rafiganj	Bishambharpur	24.758079	84.603994	117	HP	Alluvium+HR	113.1
125	Aurangabad	Rafiganj	Chandauli	24.749926	84.62982	116	HP	Alluvium	105.51
128	Aurangabad	Rafiganj	Chenwan	24.787827	84.666786	107	TW	Alluvium	96.9
134	Aurangabad	Rafiganj	Deokuli	24.774671	84.659899	107	TW	Alluvium	103.02
138	Aurangabad	Rafiganj	Garwa	24.807317	84.560473	97.4	HP	Alluvium	87.9
139	Aurangabad	Rafiganj	Gerua	24.710648	84.716745	119	HP	Alluvium	108.7
141	Aurangabad	Rafiganj	Gulab Bigha	24.83726	84.612941	96.8	HP	Alluvium	80.5
144	Aurangabad	Rafiganj	Kajpa	24.825557	84.523156	94	HP	Alluvium	87.6
147	Aurangabad	Rafiganj	Khaira	24.736578	84.661256	113	HP	Alluvium	106.1
149	Aurangabad	Rafiganj	Khaira Manjhauli	24.750418	84.576883	105	TW	Alluvium	98.2
150	Aurangabad	Rafiganj	Kona	24.775402	84.548713	97.7	HP	Alluvium	87.6
151	Aurangabad	Rafiganj	Kona	24.775402	84.548713	97.7	TW	Alluvium	86.9
152	Aurangabad	Rafiganj	Kotwara	24.830022	84.5638	95.4	TW	Alluvium	81.1
153	Aurangabad	Rafiganj	Kotwara	24.831102	84.564872	95	HP	Alluvium	86.4
155	Aurangabad	Rafiganj	Kurwan	24.934941	84.56195	86.8	TW	Alluvium	81.85
157	Aurangabad	Rafiganj	Kutkuri	24.86986	84.56316	87.7	TW	Alluvium	77.25
162	Aurangabad	Rafiganj	Narhi Pirhi	24.925059	84.524832	87.6	TW	Alluvium	82.16
163	Aurangabad	Rafiganj	Narhi Pirhi	24.924088	84.524479	87	HP	Alluvium	81.95
168	Aurangabad	Rafiganj	Saira	24.870656	84.52358	88.1	TW	Alluvium	75.47
169	Aurangabad	Rafiganj	Saira	24.889691	84.525657	89.5	HP	Alluvium	86.4
170	Aurangabad	Rafiganj	Santhua	24.858484	84.56692	90.1	TW	Alluvium	81.48
171	Aurangabad	Rafiganj	Santhua	24.858466	84.566499	91.6	HP	Alluvium	85.1
172	Aurangabad	Rafiganj	Sihuli	24.876862	84.62054	98.7	DW	Alluvium	96.13
174	Aurangabad	Rafiganj	Thekahi	24.73 1984	84.645658	120	HP	Alluvium	113.9

Annexure 2: Data for Water Table (Post-Monsoon).

S.N	District	Block	Village/Location	Lat	Long	RL	DW/TW/BW	Aquifer	Water Table (Post Monsoon)
1	Aurangabad	Madanpur	AgraPar	24.709497	84.524083	110	DW	Alluvium	106.6
2	Aurangabad	Madanpur	AgraPar	24.709088	84.525158	110	BW	Hard Rock	102.2
3	Aurangabad	Madanpur	At	24.641984	84.489749	131	TW	Alluvium	125.3
4	Aurangabad	Madanpur	Badal Bigha	24.665337	84.473108	122	DW	Alluvium	116.7
5	Aurangabad	Madanpur	Badal Bigha	24.665908	84.473381	123	BW	Hard Rock	103.32
7	Aurangabad	Madanpur	badki chechani	24.62326	84.52365	146	TW	Alluvium	134.64
8	Aurangabad	Madanpur	Bahlola	24.683917	84.483617	122	TW	Alluvium	117.06
9	Aurangabad	Madanpur	Belbigha	24.693286	84.588069	113	BW	Hard Rock	106.65
10	Aurangabad	Madanpur	Belwa	24.625002	84.4766	136	TW	Alluvium	131.43
11	Aurangabad	Madanpur	Belwa	24.624355	84.477773	134	DW	Alluvium	131.39
12	Aurangabad	Madanpur	Beri	24.676275	84.591377	116	TW	Alluvium	105.92
13	Aurangabad	Madanpur	Beri	24.67703	84.591727	117	TW	Alluvium	106.25
14	Aurangabad	Madanpur	Bishunganj	24.650503	84.533955	132	DW	Alluvium	124.8
15	Aurangabad	Madanpur	Bishunganj	24.650398	84.533888	132	BW	Hard Rock	121.85
16	Aurangabad	Madanpur	Chanki Bigha	24.714957	84.592443	116	DW	Alluvium	110.7
17	Aurangabad	Madanpur	Chanki Bigha	24.714925	84.592497	116	TW	Alluvium + Hard Rock rock	109.65
19	Aurangabad	Madanpur	Dadhpi	24.689248	84.498457	117	DW	Alluvium	114.1
21	Aurangabad	Madanpur	Erki Kalan	24.714682	84.494481	109	BW	Hard Rock	100.5
22	Aurangabad	Madanpur	Erki Kalan	24.706666	84.496751	114	DW	Alluvium	108.9
23	Aurangabad	Madanpur	Ghatrain	24.662906	84.554591	127	TW	Alluvium	118.47
24	Aurangabad	Madanpur	ghatrain	24.663032	84.55453	127	DW	Alluvium	124.38
25	Aurangabad	Madanpur	Gulab Bigha	24.644652	84.546405	133	DW	Hard Rock	131
5.8	Aurangabad	Madanpur	Gulab Bigha	24.64341	84.546774	132	HP	Alluvium	126.4
27	Aurangabad	Madanpur	Hajipur	24.694152	84.535367	121	DW	Alluvium	118.43
28	Aurangabad	Madanpur	Hajipur	24.692883	84.537698	118	BW	Hard Rock	91.82
29	Aurangabad	Madanpur	Hari Bigha	24.694104	84.614211	122	DW	Alluvium	119.54
31	Aurangabad	Madanpur	jamugain	24.6919	84.580373	116	DW	Alluvium	111.6
34	Aurangabad	Madanpur	Karpatai	24.65012	84.484712	127	TW	Alluvium	121.72
36	Aurangabad	Madanpur	Kathri	24.713215	84.513638	111	BW	Hard Rock	102.2
37	Aurangabad	Madanpur	Kathri	24.712988	84.51301	111	DW	Alluvium	105.57
38	Aurangabad	Madanpur	Kolhua	24.683523	84.60643	125	DW	Alluvium	124.7
39	Aurangabad	Madanpur	Kolhua	24.683763	84.606773	126	BW	Hard Rock rock	123
40	Aurangabad	Madanpur	Kusaha	24.678308	84.534092	122	DW	Alluvium	113.6
41	Aurangabad	Madanpur	Kusaha	24.67803	84.534033	121	BW	Alluvium + Hard Rock rock	101.4
42	Aurangabad	Madanpur	machiar bigha	24.661558	84.513246	124	DW	Alluvium	120.25
43	Aurangabad	Madanpur	machiar bigha	24.661668	84.513465	124	BW	Hard Rock	113.45
45	Aurangabad	Madanpur	Madanpur	24.656138	84.584859	127	BW	Hard Rock	111.45
47	Aurangabad	Madanpur	mahuwawan	24.695645	84.571292	113	DW	Alluvium	108.7
S.N	District	Block	Village/Location	Lat	Long	RL	DW/TW/BW	Aquifer	Water Table

									(Post Monsoon)
48	Aurangabad	Madanpur	Manika	24.65434	84.501117	123	DW	Alluvium	120.7
49	Aurangabad	Madanpur	Manika	24.654204	84.501635	126	BW	Hard Rock	121.74
51	Aurangabad	Madanpur	manwa dohar	24.612802	84.53901	149	BW	Hard Rock	138.89
52	Aurangabad	Madanpur	Maya bigha	24.701938	84.485825	115	DW	Alluvium	110.1
53	Aurangabad	Madanpur	Maya bigha	24.701895	84.485607	113	HP	Alluvium	108.27
57	Aurangabad	Madanpur	Nawadih	24.597802	84.511055	152	BW	Hard Rock	145.98
58	Aurangabad	Madanpur	Nawadih	24.600728	84.510742	148	DW	Alluvium	144.82
60	Aurangabad	Madanpur	Nima Anjan	24.648203	84.519106	131	DW	Alluvium	125.78
64	Aurangabad	Madanpur	Parariya	24.662614	84.59876	122	TW	Alluvium	118.64
66	Aurangabad	Madanpur	Pateya	24.662893	84.569275	122	DW	Alluvium	118.25
67	Aurangabad	Madanpur	Pateya	24.662071	84.569122	124	TW	Alluvium	116.2
68	Aurangabad	Madanpur	Pipraura	24.754456	84.530498	101	TW	Alluvium	96.2
69	Aurangabad	Madanpur	Pipraura	24.754555	84.528787	103	DW	Alluvium	96.9
70	Aurangabad	Madanpur	Pir Bigha	24.724334	84.631473	124	BW	Hard Rock	104.4
71	Aurangabad	Madanpur	Pir Bigha	24.724597	84.630717	124	DW	Alluvium	118.6
72	Aurangabad	Madanpur	Rama Bandh	24.609172	84.538814	152	BW	Hard Rock	141
74	Aurangabad	Madanpur	Raniganj	24.683328	84.516994	114	BW	Alluvium + Hard Rock rock	98.67
75	Aurangabad	Madanpur	Raniganj	24.683358	84.516912	114	DW	Alluvium	110.24
76	Aurangabad	Madanpur	Rasulpur	24.67726	84.480205	119	DW	Alluvium	115.4
77	Aurangabad	Madanpur	Rasulpur	24.677073	84.48028	119	TW	Alluvium	114.46
78	Aurangabad	Madanpur	Ratan Bigha	24.707573	84.585591	110	DW	Alluvium +concrete	106.82
79	Aurangabad	Madanpur	Ratan Bigha	24.724601	84.568386	107	BW	Hard Rock	100.35
80	Aurangabad	Madanpur	Sahiari	24.592735	84.514693	153	DW	Alluvium	145.31
82	Aurangabad	Madanpur	Sondih	24.705883	84.535936	116	BW	Hard Rock	83.1
83	Aurangabad	Madanpur	Sondih	24.706545	84.538535	110	DW	Alluvium	108.83
84	Aurangabad	Madanpur	sri rampur	24.641452	84.593757	138	TW	Alluvium	131.35
85	Aurangabad	Madanpur	sri rampur	24.64085	84.594227	134	DW	Alluvium	127.48
87	Aurangabad	Madanpur	Teka Bigha	24.688432	84.694073	121	DW	Alluvium	117.23
89	Aurangabad	Madanpur	Teldiha	24.697842	84.50501	112	DW	Alluvium	109.85
90	Aurangabad	Madanpur	Tetaria	24.713335	84.688162	114	BW	Hard Rock	107.02
91	Aurangabad	Madanpur	Tetaria	24.713718	84.689115	115	DW	Alluvium	109.35
92	Aurangabad	Madanpur	Theriya	24.64887	84.60081	124	DW	Alluvium	122.16
93	Aurangabad	Madanpur	Uchauli	24.755524	84.550994	103	DW	Alluvium	98.2
95	Aurangabad	Madanpur	Umga	24.647192	84.566105	130	DW	Alluvium	126.76
96	Aurangabad	Madanpur	Umga	24.648227	84.566785	128	TW	Alluvium	123.28
97	Aurangabad	Madanpur	Umga	24.631748	84.569742	135	DW	Alluvium	134.3
98	Aurangabad	Madanpur	Umga	24.629596	84.56977	136	TW	Alluvium	133.66
99	Aurangabad	Madanpur	War tola	24.730329	84.52059	109	TW	Alluvium	99.5
100	Aurangabad	Rafiganj	Abdulpur	24.818435	84.627508	99.3	HP	Alluvium	82
101	Aurangabad	Rafiganj	Abdulpur	24.816694	84.630637	100	HP	Alluvium	83.6
102	Aurangabad	Rafiganj	Akoni	24.767916	84.566876	106	TW	Alluvium	89.6
S.N	**District**	**Block**	**Village/Location**	**Lat**	**Long**	**RL**	**DW/TW/BW**	**Aquifer**	**Water Table**

									(Post Monsoon)
104	Aurangabad	Rafiganj	Asa Bighah	24.815428	84.527595	94.1	HP	Alluvium	87.88
105	Aurangabad	Rafiganj	Asa Bighah	24.815056	84.529208	94.9	TW	Alluvium	88.08
107	Aurangabad	Rafiganj	Aurawan	24.821388	84.678222	107	HP	Alluvium	102.5
108	Aurangabad	Rafiganj	Baghora	24.712418	84.707352	119	TW	Alluvium	111.38
113	Aurangabad	Rafiganj	Barpa	24.959962	84.559715	86	DW	Alluvium	80.55
114	Aurangabad	Rafiganj	Batura	24.76436	84.620625	114	TW	HR	104.95
115	Aurangabad	Rafiganj	Batura	24.764736	84.620574	113	HP	Alluvium	103.65
117	Aurangabad	Rafiganj	Belar	24.741418	84.637592	112	DW	Alluvium	109.1
122	Aurangabad	Rafiganj	Bishambharpur	24.756217	84.605534	118	HP	Alluvium +HR	113.8
123	Aurangabad	Rafiganj	Bishambharpur	24.758079	84.603994	117	HP	Alluvium+HR	113.1
125	Aurangabad	Rafiganj	Chandauli	24.749926	84.62982	116	HP	Alluvium	105.51
128	Aurangabad	Rafiganj	Chenwan	24.787827	84.666786	107	TW	Alluvium	96.9
134	Aurangabad	Rafiganj	Deokuli	24.774671	84.659899	107	TW	Alluvium	103.02
138	Aurangabad	Rafiganj	Garwa	24.807317	84.560473	97.4	HP	Alluvium	87.9
139	Aurangabad	Rafiganj	Gerua	24.710648	84.716745	119	HP	Alluvium	108.7
141	Aurangabad	Rafiganj	Gulab Bigha	24.83726	84.612941	96.8	HP	Alluvium	80.5
144	Aurangabad	Rafiganj	Kajpa	24.825557	84.523156	94	HP	Alluvium	87.6
147	Aurangabad	Rafiganj	Khaira	24.736578	84.661256	113	HP	Alluvium	106.1
149	Aurangabad	Rafiganj	Khaira Manjhauli	24.750418	84.576883	105	TW	Alluvium	98.2
150	Aurangabad	Rafiganj	Kona	24.775402	84.548713	97.7	HP	Alluvium	87.6
151	Aurangabad	Rafiganj	Kona	24.775402	84.548713	97.7	TW	Alluvium	86.9
152	Aurangabad	Rafiganj	Kotwara	24.830022	84.5638	95.4	TW	Alluvium	81.1
153	Aurangabad	Rafiganj	Kotwara	24.831102	84.564872	95	HP	Alluvium	86.4
155	Aurangabad	Rafiganj	Kurwan	24.934941	84.56195	86.8	TW	Alluvium	81.85
157	Aurangabad	Rafiganj	Kutkuri	24.86986	84.56316	87.7	TW	Alluvium	77.25
162	Aurangabad	Rafiganj	Narhi Pirhi	24.925059	84.524832	87.6	TW	Alluvium	82.16
163	Aurangabad	Rafiganj	Narhi Pirhi	24.924088	84.524479	87	HP	Alluvium	81.95
168	Aurangabad	Rafiganj	Saira	24.870656	84.52358	88.1	TW	Alluvium	75.47
169	Aurangabad	Rafiganj	Saira	24.889691	84.525657	89.5	HP	Alluvium	86.4
170	Aurangabad	Rafiganj	Santhua	24.858484	84.56692	90.1	TW	Alluvium	81.48
171	Aurangabad	Rafiganj	Santhua	24.858466	84.566499	91.6	HP	Alluvium	85.1
172	Aurangabad	Rafiganj	Sihuli	24.876862	84.62054	98.7	DW	Alluvium	96.13
174	Aurangabad	Rafiganj	Thekahi	24.73 1984	84.645658	120	HP	Alluvium	113.9

Annexure 3: Depth of Water level Pre & Post Monsoon (2023) Madanpur & Rafiganj Block

S.No.	Block	Village/Location	Lat	Long	Aquifer	SWL(mbgl) Pre Monsoon	SWL(mbgl) Post Monsoon
1	Madanpur	AgraPar	24.7095	84.5241	Alluvium	15.47	3.3
2	Madanpur	AgraPar	24.7091	84.5252	Hard Rock	8.55	7.3
3	Madanpur	At	24.642	84.4897	Alluvium	8.87	5.4
4	Madanpur	Badal Bigha	24.6653	84.4731	Alluvium	8.23	5.7
5	Madanpur	Badal Bigha	24.6659	84.4734	Hard Rock	11.54	19.68
6	Madanpur	badki chechani	24.6233	84.5237	Alluvium	7.56	11.36
7	Madanpur	Bahlola	24.6839	84.4836	Alluvium	7.72	4.54
8	Madanpur	Belbigha	24.6933	84.5881	Hard Rock	5.43	6.35
9	Madanpur	Belwa	24.625	84.4766	Alluvium	11.61	4.57
10	Madanpur	Belwa	24.6244	84.4778	Alluvium	5.93	2.61
11	Madanpur	Beri	24.6763	84.5914	Alluvium	3.32	10.48
12	Madanpur	Beri	24.677	84.5917	Alluvium	21.74	10.95
13	Madanpur	Bishunganj	24.6505	84.534	Alluvium	5.55	7
14	Madanpur	Bishunganj	24.6504	84.5339	Hard Rock	10.61	10.15
15	Madanpur	Chanki Bigha	24.715	84.5924	Alluvium	1.36	5.3
16	Madanpur	Chanki Bigha	24.7149	84.5925	Alluvium + Hard Rock	9.43	6.35
17	Madanpur	Dadhpi	24.6892	84.4985	Alluvium	22.73	3.2
18	Madanpur	Erki Kalan	24.7147	84.4945	Hard Rock	8.05	8.6
19	Madanpur	Erki Kalan	24.7067	84.4968	Alluvium	11.45	5.4
20	Madanpur	Ghatrain	24.6629	84.5546	Alluvium	7.38	8.53
21	Madanpur	ghatrain	24.663	84.5545	Alluvium	20.1	2.62
22	Madanpur	Gulab Bigha	24.6447	84.5464	Hard Rock	4.14	1.7
23	Madanpur	Gulab Bigha	24.6434	84.5468	Alluvium	15.44	5.8
24	Madanpur	Hajipur	24.6942	84.5354	Alluvium	4.88	2.47
25	Madanpur	Hajipur	24.6929	84.5377	Hard Rock	7.5	26.18
26	Madanpur	Hari Bigha	24.6941	84.6142	Alluvium	7.88	2.66
27	Madanpur	jamugain	24.6919	84.5804	Alluvium	6.7	4.5
28	Madanpur	Karpatai	24.6501	84.4847	Alluvium	6.25	5.68
29	Madanpur	Kathri	24.7132	84.5136	Hard Rock	7.7	8.6
30	Madanpur	Kathri	24.713	84.513	Alluvium	10.56	5.43
31	Madanpur	Kolhua	24.6835	84.6064	Alluvium	6.55	0.7
32	Madanpur	Kolhua	24.6838	84.6068	Hard Rock rock	7.98	3
33	Madanpur	Kusaha	24.6783	84.5341	Alluvium	8.87	8.1
34	Madanpur	Kusaha	24.678	84.534	Alluvium + Hard Rock rock	3.47	20
35	Madanpur	machiar bigha	24.6616	84.5132	Alluvium	7.88	3.45
36	Madanpur	machiar bigha	24.6617	84.5135	Hard	7.97	10.55

S.No.	Block	Village/Location	Lat	Long	Aquifer	SWL(mbgl) Pre Monsoon	SWL(mbgl) Post Monsoon
					Rock		
37	Madanpur	Madanpur	24.6561	84.5849	Hard Rock	7.98	15.95
38	Madanpur	mahuwawan	24.6956	84.5713	Alluvium	10.62	4.1
39	Madanpur	Manika	24.6543	84.5011	Alluvium	8.73	2.7
40	Madanpur	Manika	24.6542	84.5016	Hard Rock	5.98	3.76
41	Madanpur	manwa dohar	24.6128	84.539	Hard Rock	5.14	10.21
42	Madanpur	Maya bigha	24.7019	84.4858	Alluvium	5.66	4.8
43	Madanpur	Maya bigha	24.7019	84.4856	Alluvium	2.85	5.03
44	Madanpur	Nawadih	24.5978	84.5111	Hard Rock	12.72	6.12
45	Madanpur	Nawadih	24.6007	84.5107	Alluvium	13.9	3.18
46	Madanpur	Nima Anjan	24.6482	84.5191	Alluvium	7.8	4.92
47	Madanpur	Parariya	24.6626	84.5988	Alluvium	20	2.86
48	Madanpur	Pateya	24.6629	84.5693	Alluvium	5	3.35
49	Madanpur	Pateya	24.6621	84.5691	Alluvium	11	7.7
50	Madanpur	Pipraura	24.7545	84.5305	Alluvium	12.8	5
51	Madanpur	Pipraura	24.7546	84.5288	Alluvium	8.8	5.7
52	Madanpur	Pir Bigha	24.7243	84.6315	Hard Rock	10.9	20
53	Madanpur	Pir Bigha	24.7246	84.6307	Alluvium	8	5.3
54	Madanpur	Rama Bandh	24.6092	84.5388	Hard Rock	8.9	11
55	Madanpur	Raniganj	24.6833	84.517	Alluvium + Hard Rock rock	16.7	15.13
56	Madanpur	Raniganj	24.6834	84.5169	Alluvium	6.6	4.06
57	Madanpur	Rasulpur	24.6773	84.4802	Alluvium	10.3	4
58	Madanpur	Rasulpur	24.6771	84.4803	Alluvium	10.6	4.54
59	Madanpur	Ratan Bigha	24.7076	84.5856	Alluvium +concrete	14.5	3.18
60	Madanpur	Ratan Bigha	24.7246	84.5684	Hard Rock	9.1	6.75
61	Madanpur	Sahiari	24.5927	84.5147	Alluvium	12.3	7.89
62	Madanpur	Sondih	24.7059	84.5359	Hard Rock	10.5	32.6
63	Madanpur	Sondih	24.7065	84.5385	Alluvium	18	1.57
64	Madanpur	sri rampur	24.6415	84.5938	Alluvium	12.7	6.75
65	Madanpur	sri rampur	24.6409	84.5942	Alluvium	11.2	6.72
66	Madanpur	Teka Bigha	24.6884	84.6941	Alluvium	16.9	3.57
67	Madanpur	Teldiha	24.6978	84.505	Alluvium	9	2.35
68	Madanpur	Tetaria	24.7133	84.6882	Hard Rock	15.2	6.98
69	Madanpur	Tetaria	24.7137	84.6891	Alluvium	15.9	5.75
70	Madanpur	Theriya	24.6489	84.6008	Alluvium	9.5	1.94
71	Madanpur	Uchauli	24.7555	84.551	Alluvium	14.9	4.4
72	Madanpur	Umga	24.6472	84.5661	Alluvium	12.5	3.14
73	Madanpur	Umga	24.6482	84.5668	Alluvium	13.6	5.12
74	Madanpur	Umga	24.6317	84.5697	Alluvium	9.1	1.1
75	Madanpur	Umga	24.6296	84.5698	Alluvium	7.9	2.54

S.No.	Block	Village/Location	Lat	Long	Aquifer	SWL(mbgl) Pre Monsoon	SWL(mbgl) Post Monsoon
76	Madanpur	War tola	24.7303	84.5206	Alluvium	15.4	9.4
77	Rafiganj	Abdulpur	24.8184	84.6275	Alluvium	8.5	17.3
78	Rafiganj	Abdulpur	24.8167	84.6306	Alluvium	17.6	16.7
79	Rafiganj	Akoni	24.7679	84.5669	Alluvium	8.5	16
80	Rafiganj	Asa Bighah	24.8154	84.5276	Alluvium	11.6	6.22
81	Rafiganj	Asa Bighah	24.8151	84.5292	Alluvium	15.6	6.82

Annexure 4: Details of wells used for deciphering Aquifer geometry.

S.No.	Block	Panchayat	Village/Site Name	Latitude	Longitude	Depth (mbgl)
1	Rafiganj	Pogar	Pogar	24.86102	84.59326	77
2	Rafiganj	Pogar	Tineri	24.87714	84.6525	77
3	Rafiganj	Pauthu	Pauthu	24.924723	84.539144	93
4	Rafiganj	Pogar	Santhua	24.85782	84.56628	85.3
5	Rafiganj	Pogar	Mai Khurd	24.86069	84.57922	82
6	Rafiganj	Pogar	Praw Bigha	24.8393	84.57138	82
7	Rafiganj	Pauthu	Barpa	24.955578	84.55361	91
8	Rafiganj	Rafiganj NP	Near rafiganj railway station	24.82107	84.64161	74
9	Rafiganj	Bhetniya	Saira	24.90278	84.52658	82
10	Rafiganj	Bhetniya	Lukka	24.88812	84.48758	84
11	Rafiganj	Bhetniya	Barahi	24.868554	84.504708	82
12	Rafiganj	Bhetniya	Bhetniya	24.81881	84.63474	85
13	Rafiganj	Pauthu	Bhartipur	24.942911	84.527421	85
14	Rafiganj	Bhadwa	Bibipur	24.7835	84.51993	83
15	Rafiganj	Dugul	Duari	24.725553	84.660283	100
16	Rafiganj	Bhadwa	Majkhar	24.765332	84.52047	60
17	Rafiganj	Rafiganj	Rafiganj	84.6422	24.82	65
18	Madanpur	Manika	Anjan	24.644273	84.517443	91
19	Madanpur	Salaiya	Shankarpur	24.644273	84.517443	122
20	Madanpur	Salaiya	Dipti Bigha	24.694	84.62267	125
21	Madanpur	Mahuawan	Mahuawan	24.566576	84.708363	40
22	Madanpur	Baniya	Baniya	24.66858	84.55777	90
23	Madanpur	Erki Kala	Erki Kala	24.708249	84.50781	55
24	Madanpur	Madanpur	Madapur	24.654733	84.583572	130
25	Madanpur	Pirthu	Pirthu	24.70883	84.59152	120
26	Madanpur	Ghora Dihri	Ghora Dihri	24.646476	84.474994	98
27	Madanpur	Dadhpi	Dadhpi	24.685019	84.501027	95
28	Madanpur	Beri	Beri	24.677298	84.592265	90
29	Madanpur	Khiriawan	Khiriawan	24.664258	84.601801	90
30	Madanpur	North Umga	North Umga	24.629596	84.56977	37
31	Madanpur	North Umga	North Umga 1	24.602938	84.578747	85
32	Madanpur	Nimanjan	Nimanjan	24.619899	84.516014	66
33	Madanpur	Madanpur	Madanpur	84.58305556	24.65305556	201
34	Madanpur	Umga	Umga	84.56688056	24.64798889	201

Annexure 5: Interpreted TEM results of Rafiganj and Madanpur Block, Aurangabad District, Bihar.

S. No	Location	Coordinates		Resistivity (ohm-m)						Depth (m)				
		Longitude	Latitude	ρ_1	ρ_1	ρ_1	ρ_1	ρ_1	ρ_1	d_1	d_2	d_3	d_4	d_5
1	Amarpur	84.55517	24.82128	3.939	31.582	6.1736	147.3	19573		2.7642	4.959	39.228	55.378	
2	Amarpur	84.55519	24.82136	1.4316	7.2859	7.147	106.54	1499.7		0.56551	6.5942	42.81	58.356	
3	Amarpur	84.55522	24.82144	15.827	9.7137	5.6594	103.42	549.04		0.24373	2.6673	34.439	55.448	
4	Badopur	84.67286	24.81833	65.346	5.3022	1586.9				7.9456	30.529			
5	Badopur	84.67297	24.81831	32.176	5.2608	647.14				8.9166	30.483			
6	Badopur	84.67306	24.81831	21.292	15.166	5.4166	345.48			2.847	11.347	31.404		
7	Bela	84.62681	24.71319	8.749	480.05	1781.8	423.95	0.61748	2.1553	23.782	44.203	145.04		
8	Bela	84.62683	24.71311	400.99	1596.2			3.5107	17.9	37.46				
9	Bela	84.62686	24.713	7.3617	406.32	1601.4		0.45059	4.0694	21.58	47.865			
10	Hajipur	84.54014	24.70125	12.049	6.0318	125.16	1100.9			0.89784	25.574	39.758		
11	Hajipur	84.54022	24.70125	3.4072	14.186	3.8792	112.87	2943		0.34139	8.4123	21.372	40.575	
12	Hajipur	84.54033	24.70125	0.99001	21.57	5.4713	124.03	5832.4		0.28819	5.4374	24.693	41.466	
13	Itarh	84.53914	24.89589	41.907	20.232	12.282	100.25	5598.7		4.4698	7.9528	40.015	54.163	
14	Itarh	84.53917	24.89597	38.915	19.692	12.435	101.36	5599.6		4.3573	7.7225	40.034	54.254	
15	Itarh	84.53919	24.89606	35.184	19.629	11.968	102.15	5665.8		4.7218	8.0128	37.622	51.587	
16	Juhari	84.57031	24.63253	225.81	3.526	30.574	3.9881	832.32	37.604	1.0305	2.0807	8.7832	16.9	74.266
17	Juhari	84.57028	24.63244	80.382	24.989	4.64	622.05	21.265		0.87885	6.7293	17.223	107.18	
18	Juhari	84.57028	24.63236	21.014	33.473	5.5238	11589			1.6013	4.37	17.184		
19	Karpatai	84.48761	24.65508	4.5115	27.594	6.9194	345.9	3180.5		0.44184	6.8305	23.762	109.94	
20	Karpatai	84.48764	24.65519	27.185	14.623	6.3517	209.69	593.7		0.43143	8.497	22.139	48.951	
21	Karpatai	84.48767	24.65528	8.9094	54.415	3.55	254.04	8318.4		0.23841	9.1909	17.925	47.301	
22	Kharauna	84.55906	24.97456	88.755	3.9493	32.709	10.467	45.442	11.212	1.2188	2.35	13.549	22.583	40.973
23	Kharauna	84.55892	24.97461	60.721	4.6852	16.554	70.492	11.699	1.8678	1.1316	2.9259	17.183	35.162	156.17
24	Kharauna	84.55883	24.97461	18.952	16.834	12.333	35.766	14.794	37.365	0.36723	4.5781	16.755	39.144	94.126
25	Maharajganj	84.60917	24.68522	108.84	19.131	369.08	5658.2	532.08		8.2568	14.383	23.756	367.68	
26	Maharajganj	84.60925	24.68517	66.95	28.43	811.83	1.91E-02	0.63961		2.9304	15.533	118.93	130.32	
27	Maharajganj	84.77603	24.68514	1621.7	10.426	70.812	1194.1	31021		0.11747	3.2076	12.493	20.046	
28	Pogar	84.58033	24.84969	0.88109	7.3219	5.7696	40.082	1059.7		0.15729	5.3304	35.485	55.956	
29	Pogar	84.58044	24.84967	0.86706	8.5622	5.4626	32.54	879.16		0.25879	7.7097	33.482	59.371	
30	Pogar	84.58053	24.84964	0.53604	18.322	8.2501	4.8483	49.848	13349	0.33988	1.8085	16.234	34.253	51.43
31	Pranpur	84.57686	24.70919	68.839	19.328	10.221	300.85	102.37		0.35907	3.3861	26.414	81.274	

S. No	Location	Coordinates		Resistivity (ohm-m)						Depth (m)				
		Longitude	Latitude	ρ_1	ρ_1	ρ_1	ρ_1	ρ_1	ρ_1	d_1	d_2	d_3	d_4	d_5
32	Pranpur	84.57675	24.70919	541.22	4.7939	15.54	1369.3	7.192	752.85	1.446	4.6622	37.679	125.4	159.47
33	Pranpur	84.57667	31.02589	6.5829	29.226	9.2509	276.62	598.48		0.36684	3.9832	24.976	86.209	
34	Pranpur	84.57656	24.70922	4.92E+02	525.39	1.3275	22.788	3.0757	396.62	0.10945	1.3948	1.7678	11.895	16.246
35	Rafiganj	84.60322	24.81319	2.9762	8.3359	5.5684	23.19	949.04		0.49855	7.2627	42.004	62.65	
36	Rafiganj	84.60331	24.81319	0.88355	10.523	5.6147	27.065	393.93		0.21131	6.6643	43.765	59.73	
37	Rafiganj	84.60342	24.81319	3.7042	6.8033	5.646	26.216	321.19		0.20521	11.64	45.039	61.062	
38	Sahiyari	84.51931	24.59672	8.5917	30.045	4.0886	255.99	2730.5		0.29772	11.706	23.719	46.586	
39	Sahiyari	84.51931	24.59683	8.9364	26.712	5.1988	409.55	1389.4		0.39366	9.7188	25.315	82.25	
40	Sahiyari	84.51931	24.59692	32.375	6.5159	174.27	2.5453	356.83	149.65	0.33565	1.1445	12.994	20.751	246.8
41	Sarawak	84.64839	24.78017	1149.8	1.3761	26.306	474.22			0.28728	0.65624	22.451		
42	Sarawak	84.64847	24.78017	157.62	5.7459	94.193	1306.3			2.0238	5.8672	18.363		
43	Sarawak	84.64858	24.78017	29.481	0.72385	121.24	138.6	13189		1.1335	1.5562	3.72	18.072	
44	Sihuli	84.61778	24.87656	113.76	5.278	7.352	335.99			1.3693	35.886	66.453		
45	Sihuli	84.61775	24.87667	125.73	7.6738	5.4324	392.64			0.64608	3.891	51.814		
46	Sihuli	84.61778	24.87675	64.148	4.4316	6.4734	257.25			3.8044	19.599	53.64		
47	Tetariya	84.68989	24.71683	16.292	7.1135	761.86				0.61726	21.25			
48	Tetariya	84.68997	24.71683	18.088	7.9784	3160				0.71327	24.067			
49	Tetariya	84.69008	24.71683	61.601	6.7361	783.84	3539			1.0486	19.489	80.397		
50	Udhambigha	84.56147	24.73825	81.098	2.6588	72.831	7.0829	367.3		1.6393	3.8286	10.055	37.414	
51	Udhambigha	84.56147	24.73836	68.683	3.0217	12.602	6.8522	774.59	6.9963	1.3786	3.484	15.673	37.396	185.52
52	Udhambigha	84.5615	24.73842	185.54	1.5662	48.672	5.7145	968.52	163	1.047	2.5962	13.342	33.253	160.61

Annexure 6: Feedback from Fluoride Infested areas of Madanpur and Rafiganj Blocks.

S.No	Village	Block	Is the water used from thehandpump	Are there any symptoms such as dental/ skeletal fluorosis observed	Any Alternate sourceofdrinking wateravailable	Date	Structure	Remarks
1	Thekahi	Rafiganj	No	No	No	09.01.2024	BW	Fluoride found more than 1mg/l using fluoride testing kit. Color changes to light pink
2	Belar	Rafiganj	Yes	No	No	09.01.2024	H.P	Fluoride found more than 1.5 mg/l.
3	Belar	Rafiganj	No	Yes	No	09.01.2024	DW	Fluoride found more than 3 mg/l. color changes instantly.
4	Sirandha tola	Madanpur	Yes	Yes	No	20.12.2023	HP-150ft	Fluoride found more than 5mg/l. Water color changes to Dark pink instantly.
5	Sirandha tola	Madanpur	Yes	Yes	No	20.12.2023	HP-35 ft	Fluoride value found between 1.5-2 mg/l
6	Badam	Madanpur	Yes	No	No	20.12.2023	HP-75ft	Fluoride found more than 1.5 mg/l
7	Srirampur	Madanpur	No	Yes	No	21.12.2023	TW-300 ft	Fluoride found more than 1.5 mg/l

Annexure 7: Chemical analysis of Basic parameter (Pre-monsoon).

Sl No.	BLOCK	LOCATION	Source	Lat	Long	pH	EC	TH	Ca	Mg	Na	K	CO_3^{2-}	HCO_3^-	Cl^-	NO_3^-	SO_4^{2-}	PO_4^{3-}	TDS	F
1	Rafiganj	Akoni	TW	24.767916	84.566876	7.74	765	250	60	24	60	0.83	0	427	18	4.5	3.36	0.32	497	0.32
2	Rafiganj	Akoni	DCB	24.76938	84.560057	7.52	883	245	56	26	90	1.51	0	305	110	4.43	34	0.56	574	0.65
3	Rafiganj	Gandhra	TW	24.782363	84.536799	7.64	1400	495	124	45	95	0.6	0	384	188	27	93	0	910	0.05
4	Rafiganj	Kona	HP	24.775402	84.548713	7.78	640	215	46	24	50	0.68	0	336	21	5.59	9.64	0	416	0.32
5	Rafiganj	Kona	TW	24.775402	84.548713	7.93	738	320	78	30	90	0.22	0	372	117	17	61	0	480	0
6	Rafiganj	Tikri	HP	24.792735	84.54198	7.85	800	265	60	28	65	0.5	0	427	28	8.8	8.93	1.1	520	0.36
7	Rafiganj	Tikri	TW	24.792735	84.54198	7.94	852	275	68	26	70	0.72	0	427	43	8.38	11.2	0	554	0.2
8	Rafiganj	Bibpur	Pond water	24.786706	84.515278	7.93	593	110	28	10	76	16	0	195	64	24	23	0.16	385	0.72
9	Rafiganj	Asa Bighah	HP	24.815428	84.527595	7.82	582	130	34	11	114	0.33	0	439	25	4.21	3.83	0	378	0.38
10	Rafiganj	Asa Bighah	TW	24.815056	84.529208	7.43	765	225	64	16	72	0.68	0	397	28	7.84	8.25	0	497	0
11	Rafiganj	Kajpa	HP	24.825557	84.523156	7.92	542	225	58	19	68	1.06	0	403	36	14.92	10.64	0	352	0.11
12	Rafiganj	Kajpa	TW	24.826723	84.522037	7.62	842	225	56	21	90	1.57	0	409	39	15.33	14	0.24	547	0.3
13	Rafiganj	Jakhim	Pond water	24.837765	84.529593	7.85	1084	240	70	16	86	89	0	372	135	13.46	36	0	705	0.42
14	Rafiganj	Saira	TW	24.870656	84.52358	7.91	695	235	56	23	52	2.6	0	342	28	11.17	19	0.24	452	0.27
15	Rafiganj	Saira	HP	24.889691	84.525657	7.62	630	150	40	12	75	0.65	0	311	21	13.76	18	0	410	0.29
16	Rafiganj	Rampur Parasiya	TW	24.896739	84.527995	7.63	600	235	70	15	31	0.29	0	299	14	15.46	19	0	390	0.41
17	Rafiganj	Rampur Parasiya	HP	24.895826	84.531576	7.72	630	145	38	12	78	0.75	0	342	14	1.58	14	0.15	410	0.13
18	Rafiganj	Banka	HP	24.908498	84.533578	7.68	751	195	50	17	83	0.92	0	378	32	7.6	13	0.21	488	0.33
19	Rafiganj	Choti english	TW	24.912616	84.522142	7.53	580	215	54	19	33	1.07	0	311	18	3.18	5.55	0	377	0.07
20	Rafiganj	Narhi Pirhi	TW	24.925059	84.524832	7.92	450	140	44	7	36	0.58	0	189	36	7.03	11	0	293	0.07
21	Rafiganj	Narhi Pirhi	HP	24.924088	84.524479	7.82	759	225	50	24	67	6.16	0	372	21	14.84	28	0	493	0.23
22	Rafiganj	Barpa	TW	24.959858	84.559684	7.69	720	265	68	23	42	2.02	0	366	25	7.53	13	0	468	0
23	Rafiganj	Barpa	DW	24.959962	84.559715	7.81	820	270	76	19	63	1.79	0	415	28	6.47	20	0	533	0.07
24	Rafiganj	Kurwan	HP	24.935707	84.56195	7.62	762	250	70	18	59	2.2	0	336	53	21.6	12	0	495	0
25	Rafiganj	Madar	River water	24.935707	84.56195	7.82	815	165	46	12	87	39	0	403	21	26.25	25	0	530	0.48
26	Rafiganj	Kurwan	TW	24.934941	84.56195	7.92	710	190	50	16	74	1.85	0	354	32	13.09	11	0	462	0.4
27	Rafiganj	Sihuli	DW	24.876862	84.62054	7.45	1510	530	144	41	115	2.32	0	458	206	27	88	0	982	0

Sl No.	BLOCK	LOCATION	Source	Lat	Long	pH	EC	TH	Ca	Mg	Na	K	CO_3^{2-}	HCO_3^-	Cl^-	NO_3^-	SO_4^{2-}	PO_4^{3-}	TDS	F
28	Rafiganj	Sihuli	TW	24.877022	84.619784	7.69	940	255	70	19	97	1	0	488	36	11.11	10	0	611	0
29	Rafiganj	Garwa	HP	24.807317	84.560473	7.32	760	290	76	24	46	0.94	0	421	21	6.93	6.58	0	494	0.17
30	Rafiganj	Kotwara	TW	24.830022	84.5638	7.58	1230	400	124	22	95	4.23	0	671	32	8.91	9.8	0	800	0.15
31	Rafiganj	Kotwara	HP	24.831102	84.564872	7.64	849	240	60	22	83	1.36	0	421	39	13.76	13	0	552	0
32	Rafiganj	Santhua	TW	24.858484	84.56692	7.21	580	85	24	6	83	22.24	0	153	75	26.59	36	0	377	0.26
33	Rafiganj	Santhua	HP	24.858466	84.566499	7.65	1030	380	102	30	49	21	0	409	78	9.44	58	0	670	0.26
34	Rafiganj	Bhita	TW	24.865177	84.572744	7.39	670	215	60	16	55	0.69	0	354	18	9.84	14	0	436	0.54
35	Rafiganj	Bhita	HP	24.865177	84.572744	7.41	760	185	50	15	89	1.28	0	378	21	24.1	17	0	494	0.54
36	Rafiganj	Kutkuri	HP	24.869386	84.564071	7.56	565	240	70	16	21	0.5	0	268	21	24.1	13	0	367	0.09
37	Rafiganj	Kutkuri	TW	24.86986	84.56316	7.28	640	255	86	10	29	1.75	0	329	18	22.39	7.79	0.12	416	0.23
38	Rafiganj	Indrapuri Barrage Canal	Canal Water	24.84568	84.566966	7.46	290	80	26	4	30	2.65	0	85	25	28.04	17	0.07	189	0.15
39	Rafiganj	Chandrehta	TW	24.824688	84.59957	7.39	950	210	50	21	115	11	0	445	53	7.12	25	0.31	618	0.28
40	Rafiganj	Chandrehta	HP	24.824254	84.599398	7.64	1000	235	62	19	116	12.21	0	470	60	0.47	29	0.05	650	0.22
41	Rafiganj	Labhri	TW	24.823087	84.612563	7.82	1165	340	92	27	108	4	0	409	142	25	22	0	757	0.01
42	Rafiganj	Labhri	HP	24.823309	84.612352	7.91	1320	410	108	34	115	4.16	0	476	174	1.04	26	0	858	0.08
43	Rafiganj	Gulab Bigha	HP	24.83726	84.612941	7.65	1050	260	78	16	120	1.77	0	555	46	0.12	4.25	0	683	0.48
44	Rafiganj	Gulab Bigha	HP	24.83726	84.612941	7.83	852	185	56	11	110	1.35	0	451	32	6.09	5	0	554	0.64
45	Rafiganj	Abdulpur	HP	24.818435	84.627508	7.82	1255	405	116	28	190	5	0	506	241	15.13	55	0	816	0.8
46	Rafiganj	Abdulpur	HP	24.816694	84.630637	7.46	1962	465	134	32	225	20	0	464	323	23.71	121	0	1275	0.02
47	Rafiganj	Aurawan	TW	24.821388	84.678222	7.58	810	180	46	16	100	3.11	0	439	11	25.44	6.15	0	527	0.18
48	Rafiganj	Aurawan	HP	24.821388	84.678222	7.62	890	245	68	18	90	2.87	0	464	28	13.44	11.2	0	579	0.15
49	Rafiganj	Banauli DW	HP	24.81465	84.692832	7.35	750	225	56	21	68	2.5	0	409	18	9.94	8.73	0	488	0.16
50	Rafiganj	Banauli	HP	24.815788	84.689744	7.92	700	235	58	22	50	3.16	0	354	28	9.84	6.53	0	455	0.23
51	Rafiganj	Dadhar	TW	24.807401	84.657325	7.83	1075	290	80	22	111	3.87	0	360	135	24.1	35	0	699	0
52	Rafiganj	Dadhar	HP	24.807401	84.657325	7.46	1575	295	88	18	225	1.77	0	555	170	24.1	67	0	1024	0.14
53	Rafiganj	Chenwan	TW	24.787827	84.666786	7.92	785	205	50	19	69	27	0	378	25	22.39	26	0	510	0.22
54	Rafiganj	Chenwan	HP	24.787807	84.666783	7.81	1300	440	122	33	82	25	0	445	138	28.04	64	0.13	845	0
55	Rafiganj	Thekahi	HP	24.73 1984	84.645658	7.53	840	235	68	16	83	2.55	0	427	36	7.12	11	0.07	546	0.89
56	Rafiganj	Thekahi	TW	24.731615	84.646627	7.46	744	235	70	15	57	6.43	0	397	25	0.47	4.9	0.12	484	0.87

Sl No.	BLOCK	LOCATION	Source	Lat	Long	pH	EC	TH	Ca	Mg	Na	K	CO_3^{2-}	HCO_3^-	Cl^-	NO_3^-	SO_4^{2-}	PO_4^{3-}	TDS	F
57	Rafiganj	Khaira	TW	24.743254	84.673247	7.61	800	180	56	10	95	4.96	0	421	28	0.62	9.4	0	520	0.59
58	Rafiganj	Khaira	HP	24.736578	84.661256	7.79	880	100	24	10	155	0.6	0	488	21	1.04	6.6	0	572	0.83
59	Rafiganj	Khaira	TW	24.739543	84.663008	7.65	1250	260	94	6	165	3.07	0	702	28	0.12	7.99	0	813	0.75
60	Rafiganj	Dholikhap	HP	24.737457	84.67875	7.62	920	215	56	18	111	2.24	0	403	64	6.09	28	0	598	0.45
61	Rafiganj	Mahuain	TW	24.724038	84.685124	7.47	1250	335	110	15	130	3.98	0	519	103	15.13	39	0	813	0.13
62	Rafiganj	Gerua	HP	24.710648	84.716745	7.92	752	190	62	9	77	13	0	311	36	23.71	51	0.08	489	0.06
63	Rafiganj	Baghora	TW	24.712418	84.707352	7.36	1220	365	116	18	95	25	0	390	131	25.44	78	0	793	0.23
64	Rafiganj	Bishambharpur	HP	24.756217	84.605534	7.52	840	200	56	15	99	4.21	0	354	64	13.44	28	0	546	0.51
65	Rafiganj	Bishambharpur	HP	24.758079	84.603994	7.85	585	160	50	9	59	3.94	0	305	21	5.86	5.86	0	380	0.6
66	Rafiganj	Batura	TW	24.76436	84.620625	7.64	600	110	30	9	81	5.27	0	268	39	11.33	11	0	390	0.4
67	Rafiganj	Batura	HP	24.764736	84.620574	7.15	1020	305	30	19	95	1.58	0	403	107	14.68	15	0	663	0.35
68	Rafiganj	Niman	HP	24.7907	84.636447	7.63	975	245	90	17	108	0.89	0	537	28	2.22	2.22	0.13	634	0.55
69	Rafiganj	Niman	TW	24.790868	84.640078	7.92	730	225	70	13	60	6.8	0	372	32	6.53	6.53	0.18	475	0.14
70	Rafiganj	Deokuli	HP	24.771714	84.659897	7.21	715	260	68	17	40	4.44	0	336	53	3.29	3.29	0.2	465	0.08
71	Rafiganj	Deokuli	TW	24.774671	84.659899	7.64	813	245	76	19	70	4.25	0	360	57	17.17	17	0	528	0.02
72	Rafiganj	Bhalu Khaoira	TW	24.810428	84.580276	7.92	855	225	66	19	90	4.61	0	421	46	8.83	8.83	0	556	0.05
73	Rafiganj	Dholikhap	HP	24.731576	84.681734	7.42	770	260	58	24	56	1.81	0	403	28	4.88	4.88	0	501	0.52
74	Rafiganj	Belar	TW	24.740727	84.639254	7.61	1475	510	64	33	100	4.53	0	451	241	14.88	15	0	959	0.17
75	Rafiganj	Belar	DW	24.741418	84.637592	7.58	2010	305	150	29	290	55	0	781	249	5.91	5.94	0	1307	0.52
76	Rafiganj	Chandauli	TW	24.75	84.63047	7.62	1235	335	74	32	114	29	0	537	92	25.44	25	0	803	0.15
77	Rafiganj	Chandauli	HP	24.749926	84.62982	7.64	572	215	82	16	33	0.5	0	299	18	7.38	7.38	0	372	0.19
78	Rafiganj	Khaira Manjhauli	TW	24.750418	84.576883	7.95	590	240	60	19	23	3.55	0	281	36	6.06	6.06	0	384	0.07
79	Madanpur	Maya bigha	HP ~160ft	24.701895	84.485607	7.81	1458	390	118	23	154	1.65	0	488	163	31	67	0	948	0.08
80	Madanpur	Maya bigha	Pond	24.70202	84.485192	7.23	1102	270	36	44	118	17.26	0	518.5	46	52	14.2	0	716	0.62
81	Madanpur	Maya bigha	DTW ~300ft	24.703	84.485927	7.45	1230	150	36	13	210	2.03	0	701.5	14	6	7.97	0	800	0.15
82	Madanpur	Maya bigha	HP ~120ft	24.701092	84.48241	7.33	1046	270	38	41	112	5.73	0	573.4	25	2	15.41	0	680	0
83	Madanpur	Dadhpi	TW ~80ft	24.681202	84.501727	7.69	655	230	40	26	41.5	1.75	0	341.6	21	4	13	0	426	0
84	Madanpur	Manika	DW	24.65434	84.501117	7.72	1500	320	50	55	192	14	0	634.4	121	17	49	0	975	0.09

Sl No.	BLOCK	LOCATION	Source	Lat	Long	pH	EC	TH	Ca	Mg	Na	K	CO_3^{2-}	HCO_3^-	Cl^-	NO_3^-	SO_4^{2-}	PO_4^{3-}	TDS	F
85	Madanpur	Manika	BW ~200ft	24.654204	84.501635	7.64	735	235	38	28	60	1.44	0	396.5	21	3	7.59	0.52	478	0.27
86	Madanpur	Bishunganj	BW ~130ft	24.650398	84.533888	7.82	961	320	48	67	71	1.2	0	475.8	43	19	13.62	0	625	0.06
87	Madanpur	Umga	Pond	24.647668	84.565444	7.66	490	105	18	16	55	15.66	0	201.3	32	9	21.41	0	319	0.67
88	Madanpur	Umga	DW	24.647192	84.566105	7.49	820	210	16	9	40	85	0	390.4	25	1	50.6	0	533	0
89	Madanpur	Madanpur	BW ~300ft	24.656138	84.584859	7.71	1280	455	70	70	85	3.88	0	402.6	178	26	40	0	832	0.12
90	Madanpur	Pateya	HP	24.662145	84.568605	7.62	1300	420	66	61	125	3.56	0	555.1	117	21	55.46	0	845	0.52
91	Madanpur	Pateya	HP ~150ft	24.662071	84.569122	7.63	1250	395	68	64	105	0.39	0	451.4	121	20	62.21	0.18	813	0.07
92	Madanpur	Bahlola	DTW ~200ft	24.683917	84.483617	7.79	765	200	52	29	82	3.3	0	402.6	18	23	7.94	0.02	497	0.08
93	Madanpur	Rasulpur	DW	24.67726	84.480205	8.2	748	260	38	40	72	3.51	0	469.7	18	0	13.48	0.09	486	0.07
94	Madanpur	Rasulpur	DTW ~180ft	24.677073	84.48028	7.46	800	250	36	39	67	2.68	0	359.9	46	24	18.53	0	520	0.21
95	Madanpur	Badal Bigha	DW	24.665337	84.473108	7.84	3990	330	32	61	750	30	0	1281	529	30	168.4	0	2594	1.13
96	Madanpur	Badal Bigha	BW ~210ft	24.665908	84.473381	7.46	1068	265	32	41	121	3.25	0	494.1	60	17	27.62	0	694	0.42
97	Madanpur	Belwa	TW ~80-85ft	24.625002	84.4766	7.73	730	275	38	19	41.36	0.65	0	353.8	36	11	12.91	0	475	0.36
98	Madanpur	Belwa	HP ~40ft	24.624355	84.477773	7.79	1225	440	78	58	79	0.82	0	427	160	7	32.35	0	796	0.06
99	Madanpur	Karpatai	HP ~60ft	24.65012	84.484712	7.8	720	275	80	40	38	0.79	0	353.8	36	3	19.17	0	468	0.05
100	Madanpur	At	HP ~70ft	24.641984	84.489749	7.91	1480	430	44	61	145	1.3	0	616.1	124	21	43.53	0.16	962	0
101	Madanpur	Gulab Bigha	BW ~150ft	24.644652	84.546405	7.66	635	225	72	35	40	2.21	0	347.7	18	1	7.18	0	413	0.07
102	Madanpur	Gulab Bigha	HP~30ft	24.64341	84.546774	7.75	640	200	32	27	52	0.41	0	311.1	25	6	19.25	0	416	0.39
103	Madanpur	Rama Bandh	BW ~150ft	24.609172	84.538814	7.41	820	205	36	36	94	0.52	0	396.5	36	21	16.21	0	533	0.87
104	Madanpur	manwa dohar	HP ~100 ft	24.610289	84.537371	7.92	653	165	22	24	73	0.67	0	341.6	21	6	8.92	0	424	0.77
105	Madanpur	badki chechani	STW ~60ft-70ft	24.620822	84.523968	7.8	1012	80	26	12	195	0.34	0	475.8	60	16	15.37	0	658	1.31
106	Madanpur	badki chechani	DTW ~80-90ft	24.62326	84.52365	7.81	920	275	12	46	86	1.28	0	354	99	18	15.62	0	598	0
107	Madanpur	Sahiari	DW	24.592735	84.514693	7.71	725	230	34	40	58	4.98	0	397	18	5	6.51	0	471	0.42
108	Madanpur	Sahiari	HP ~95ft	24.593242	84.514507	7.42	840	225	26	39	90	0.17	0	458	18	11	9	0.19	546	0.33
109	Madanpur	Nawadih	BW ~105ft	24.597802	84.511055	7.69	1110	270	20	53	131	0.29	0	451	103	18	21	0	722	0.98

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110	Madanpur	Nawadih	DW	24.600728	84.510742	7.72	500	110	30	9	56	19.21	0	189	32	4	45	0	325	0.56
111	Madanpur	ghatrain	DW	24.663032	84.55453	7.65	1085	335	30	62	95	0.53	0	433	82	26	48.51	0	705	0.69
112	Madanpur	Ghatrain	HP ~100ft	24.662906	84.554591	7.72	975	350	32	62	62	1.25	0	354	96	26	40.11	0	634	0
113	Madanpur	Umga	DW	24.631748	84.569742	7.95	565	205	38	24	32	5.05	0	268	32	6	11.61	0	367	0.17
114	Madanpur	Umga	HP ~100ft	24.629596	84.56977	7.76	690	260	42	49	38	2.03	0	354	32	0	6.26	0.35	449	0
115	Madanpur	Theriya	DW	24.64887	84.60081	7.71	680	195	24	28	66	0.44	0	329	32	4	18.25	0	442	0.5
116	Madanpur	Parariya	TW ~30ft-60ft	24.658941	84.602437	7.81	898	120	32	19	149	2.94	0	482	25	1	11.25	0	584	1.21
117	Madanpur	Parariya	Pond	24.662853	84.598773	7.72	950	270	16	53	89	6.99	0	433	67	11	11.07	0	618	0.67
118	Madanpur	Parariya	DTW ~170ft	24.662614	84.59876	7.79	925	295	20	50	74	3.63	0	415	64	8	22.73	0	601	0.48
119	Madanpur	Kolhua	DW	24.683523	84.60643	7.65	290	85	36	11	22	6.37	0	110	21	20	6.44	0	189	0.48
120	Madanpur	Kolhua	BW ~150-200ft	24.683763	84.606773	7.72	510	190	16	32	27	1.55	0	244	18	2	22.12	0	332	1.53
121	Madanpur	Hari Bigha	DW	24.694104	84.614211	7.75	1000	240	24	46	129	3.3	0	433	96	4	23.81	0	650	1.21
122	Madanpur	Hari Bigha	TW ~60ft	24.694053	84.614912	7.79	1036	270	20	53	114	0.12	0	482	71	6	11.54	0	673	1.4
123	Madanpur	Pir Bigha	BW ~280ft	24.724334	84.631473	7.85	850	260	20	51	75	1.66	0	458	21	1	15.89	0	553	0.9
124	Madanpur	Pir Bigha	DW	24.724597	84.630717	7.81	955	255	20	50	101	1.44	0	488	39	3	18	0.12	621	0.99
125	Madanpur	Uchauli	DTW ~110ft-115ft	24.755524	84.550994	7.65	970	325	24	64	74	1.6	0	378	85	13	45	0	631	0.14
126	Madanpur	Pipraura	PHED ~140ft	24.754456	84.530498	7.66	980	315	24	63	78	1.29	0	415	85	19	13	0	637	0
127	Madanpur	Pipraura	HP ~100ft	24.7547	84.528608	7.59	940	345	22	58	52	4.97	0	372	92	25	11.5	0	611	0
128	Madanpur	Erki Kalan	BW ~210ft	24.714682	84.494481	7.66	796	140	42	22	119	3.22	0	421	21	17	10.62	0	517	0.26
129	Madanpur	Erki Kalan	HP ~50-60ft	24.711642	84.496452	7.64	568	205	20	39	39	0.47	0	299	21	7	6.46	0	369	0.12
130	Madanpur	Kathri	TW ~100ft	24.713585	84.513522	7.79	648	240	18	40	39	1.64	0	275	57	4	15.32	0	421	0.07
131	Madanpur	Kathri	BW ~270ft	24.713215	84.513638	7.71	511	175	30	24	35	1.64	0	262	21	4	7.02	0	332	0.1
132	Madanpur	Kathri	HP ~40ft	24.713935	84.513732	7.69	1320	450	30	64	96	1.47	0	378	206	12	46	0	858	0
133	Madanpur	AgraPar	HP ~60ft	24.709537	84.524037	7.65	1160	240	74	45	153	0.67	0	384	110	40	72	0.11	754	0.14

Sl No.	BLOCK	LOCATION	Source	Lat	Long	pH	EC	TH	Ca	Mg	Na	K	CO_3^{2-}	HCO_3^-	Cl^-	NO_3^-	SO_4^{2-}	PO_4^{3-}	TDS	F
134	Madanpur	AgraPar	BW ~260ft	24.709088	84.525158	7.64	880	175	22	28	122	2.29	0	464	32	6	12	0	572	0
135	Madanpur	Sondih	BW ~330ft	24.705883	84.535936	7.8	675	180	24	28	71	3.26	0	354	25	8	5.41	0	439	0.06
136	Madanpur	Sondih	DW	24.706545	84.538535	7.81	860	135	26	22	125	15.04	0	372	60	20	22	0	559	0.18
137	Madanpur	Hajipur	DW	24.694152	84.535367	7.92	1785	25	18	6	402	24	0	622	249	6	59	0	1160	0.08
138	Madanpur	Hajipur	BW ~320ft	24.692883	84.537698	7.73	991	290	30	52	90	3.33	0	397	75	29	32	0	644	0.03
139	Madanpur	Kusaha	DW	24.678308	84.534092	7.78	2310	500	42	96	294	10	0	738	341	13	51	0	1502	0.39
140	Madanpur	Kusaha	BW ~250ft	24.67803	84.534033	7.81	1145	270	48	36	138	1.13	0	543	53	13	41	0	744	0.35
141	Madanpur	mahuwawan	DTW ~100ft	24.694189	84.571127	7.8	662	230	48	38	43	6.07	0	250	75	11	11	0	430	0.14
142	Madanpur	mahuwawan	DW	24.695645	84.571292	7.46	2045	430	30	72	100	293	0	720	256	32	45	0	1329	0
143	Madanpur	jamugain	HP ~50ft	24.692197	84.580312	7.49	1220	470	54	89	66	0.69	0	464	117	15	52	0	793	0
144	Madanpur	jamugain	BW ~150ft	24.690256	84.579585	7.56	666	210	42	35	53	2.5	0	275	53	20	14	0	433	0.37
145	Madanpur	Beri	STW ~50-60ft	24.676275	84.591377	7.63	1060	370	26	66	71	2.05	0	403	117	4	26	0.19	689	0.14
146	Madanpur	Beri	DTW ~250ft	24.67703	84.591727	7.72	601	210	40	36	42	2.35	0	336	11	4	9.2	0	391	0.3
147	Madanpur	Teldiha	HP ~95ft	24.697775	84.505032	7.95	670	240	24	40	43	0.66	0	281	57	4	21	0	436	0
148	Madanpur	Raniganj	BW ~150ft	24.683328	84.516994	7.9	1650	425	30	84	180	2.33	0	525	213	32	63	0	1073	0.04
149	Madanpur	Raniganj	DW	24.683358	84.516912	7.91	2700	440	32	63	375	64	0	878	380	32	52	0	1755	0.38
150	Madanpur	machiar bigha	DW	24.661558	84.513246	7.85	930	325	72	45	65	1.85	0	372	64	68	19	0	605	0.23
151	Madanpur	machiar bigha	BW ~102ft	24.661668	84.513465	7.76	2160	550	56	78	242	3.17	0	598	362	35	49	0	1404	0
152	Madanpur	Nima Anjan	BW ~200-210ft	24.641813	84.518978	7.72	1237	370	92	49	87	1.25	0	397	131	32	28	0	804	0.33
153	Madanpur	Nima Anjan	TW ~90ft	24.648203	84.519106	7.64	2296	250	68	102	250	0.63	0	598	376	21	92	0.51	1492	0
154	Madanpur	sri rampur	DTW ~130ft	24.641452	84.593757	7.91	607	245	44	15	60	1.8	0	244	32	42	22	0	395	0.57
155	Madanpur	sri rampur	DW	24.64085	84.594227	7.85	1606	495	44	46	210	35	0	360	284	70	47	0	1044	0.19
156	Madanpur	Chanki Bigha	BW ~150ft	24.714925	84.592497	7.94	1040	215	44	57	72	0.95	0	317	138	39	32	0	676	0.16
157	Madanpur	Parsa	HP ~120-150ft	24.739385	84.593992	7.9	834	320	52	38	70	0.29	0	390	39	33	15	0	542	0.19

Sl No.	BLOCK	LOCATION	Source	Lat	Long	pH	EC	TH	Ca	Mg	Na	K	CO_3^{2-}	HCO_3^-	Cl^-	NO_3^-	SO_4^{2-}	PO_4^{3-}	TDS	F
158	Madanpur	Ratan Bigha	DW	24.724644	84.568099	7.56	957	265	44	39	69	13	0	415	57	40	22	0	622	0
159	Madanpur	Ratan Bigha	BW ~160ft	24.724601	84.568386	7.84	860	275	60	9	143	3.09	0	403	46	28	9.56	0.05	559	0.17
160	Madanpur	Paharpur	BW ~135ft	24.724445	84.535036	7.79	732	110	30	23	99	1.83	0	360	36	21	8.49	0	476	0.04
161	Madanpur	Wartola	DTW ~110ft	24.730329	84.52059	7.64	1917	130	22	114	164	31	0	677	227	43	46	0	1246	0
162	Madanpur	Tetaria	BW ~200ft	24.713335	84.688162	7.52	1085	225	38	4	168	3.37	0	567	32	17	17	0	705	0.08
163	Madanpur	Tetaria	DW	24.713718	84.689115	7.63	1784	225	70	66	210	26	0	683	170	35	36	0	1160	0.03
164	Madanpur	Teka Bigha	HP ~30ft	24.688528	84.694518	7.71	984	225	42	47	110	5.99	0	500	39	22	8.72	0	640	0

Annexure 8: Chemical Parameter (Post-monsoon)

S. No.	BLOCK	LOCATION	Source	Lat	Long	Date	pH	EC	TH	Ca	Mg	Na	K	CO_3^{2-}	HCO_3^-	Cl^-	NO_3^-	SO_4^{2-}	PO_4^{3-}	F
1	Madanpur	Chariya	PHED ~175ft	24.600902	84.491373	19.12.2023	7.73	854	270	80	17.01	66	6.68	0	378.2	60.35	15.05	12.47	0	0.9
2	Madanpur	Umga	HP ~100ft	24.629596	84.56977	20.12.2023	7.64	752	275	58	31.59	36.41	6.15	0	396.5	24.85	0.27	0	0	1.19
3	Madanpur	North Koel Canal	Canal	24.629422	84.569911	20.12.2023	7.61	450	130	34	10.935	40.2	4.87	0	225.7	17.75	1.51	5.08	0	1.42
4	Madanpur	Siraundha Tola	HP ~150ft	24.627934	84.573104	20.12.2023	7.46	706	130	38	8.505	100.18	2.9	0	329.4	31.95	11.24	16	0	4.8
5	Madanpur	Siraundha Tola	BW ~150ft	24.627268	84.573671	20.12.2023	7.29	325	40	26	-6.075	50.07	12	0	109.8	17.75	3.59	0.46	0	1.57
6	Madanpur	Siraundha Tola	HP ~35ft	24.627923	84.573522	20.12.2023	7.34	1102	375	94	34.02	85.01	3.18	0	542.9	191.7	19	65	0.13	1.56
7	Madanpur	Siraundha	HP ~35ft	24.628779	84.570666	20.12.2023	7.85	710	170	46	13.365	84.42	1.54	0	353.8	35.5	2.1	7.25	0	1.74
8	Madanpur	Siraundha	BW ~170ft	24.62912	84.57041	20.12.2023	7.92	612	240	34	37.665	24.95	6.04	0	305	17.75	0.47	2.87	0	1.36
9	Madanpur	Siraundha	PHED ~215ft	24.62641	84.568687	20.12.2023	7.77	825	260	58	27.945	60.47	2.78	0	414.8	31.95	1.3	5.59	0	1.29
10	Madanpur	Siraundha	DW	24.627058	84.567973	20.12.2023	8.14	1073	300	32	53.46	96	17.2	0	305	124.25	32	69	0	1.22
11	Madanpur	Munshi Bigha	HP ~80ft	24.623637	84.562335	20.12.2023	7.4	1352	240	50	27.945	199	0	0	481.9	149.1	18.11	45	0	1.6
12	Madanpur	Munshi Bigha	DW	24.62389	84.562279	20.12.2023	7.84	1434	360	38	64.395	161	1.08	0	469.7	152.65	28	78	1.2	1.44
13	Madanpur	Badam	HP ~70-75ft	24.616736	84.567966	20.12.2023	7.61	690	210	22	37.665	61	1.21	0	317.2	24.85	1.9	13	0	1.58
14	Madanpur	Badam	PHED ~200ft	24.617248	84.566028	20.12.2023	7.46	711	225	36	32.805	48	16.06	0	353.8	31.95	6.2	7.77	0	0.69
15	Madanpur	Pichauliya	HP ~55ft	24.6122	84.557981	20.12.2023	7.31	729	270	96	7.29	49	1.2	0	366	31.95	15	18	0	1.45
16	Madanpur	Dhobi Bagh	HP ~70ft	24.621332	84.552904	20.12.2023	7.42	799	355	72	42.525	39	1.71	0	396.5	71	0.1	11	0	1.26
17	Madanpur	Dhobi Bagh	PHED ~190ft	24.620329	84.553791	20.12.2023	7.71	740	300	34	52.245	34	5.12	0	347.7	53.25	0.03	13	0	0.89
18	Madanpur	Manwa Dohar	HP ~140ft	24.610295	84.536957	20.12.2023	7.32	700	170	54	8.505	83	1.55	0	372.1	21.3	5.54	5.64	0	1.35
19	Madanpur	Rama Bandh	HP ~80ft	24.609118	84.539015	20.12.2023	7.35	726	165	60	3.645	93	0.78	0	347.7	39.05	15.29	12	0.78	1.52
20	Madanpur	Erki Kalan	PHED ~150ft	24.714716	84.4945	21.12.2023	7.4	790	150	34	15.795	109	7.73	0	414.8	24.85	12	8.7	0	0.9
21	Madanpur	Erki Kalan	DW	24.706888	84.496885	21.12.2023	7.81	841	280	52	36.45	59	10.89	0	366	46.15	1.54	47	0	0.95
22	Madanpur	Kathri	PHED ~90ft	24.713187	84.51352	21.12.2023	7.63	538	190	32	26.73	32	4.31	0	274.5	21.3	2.35	7.22	0	0.99
23	Madanpur	Kathri	DW	24.712988	84.51301	21.12.2023	7.69	745	220	34	32.805	65	7.7	0	384.3	21.3	2.46	25	0	1.1
24	Madanpur	Agrapar	DW	24.709552	84.523954	21.12.2023	7.42	790	225	42	29.16	77	3.41	0	384.3	35.5	13.16	21	0	0.84
25	Madanpur	Agrapar	PHED ~260ft	24.709042	84.525067	21.12.2023	7.4	840	195	36	25.515	100	6.38	0	433.1	35.5	4.18	13	0	1.03
26	Madanpur	Sondih	PHED ~300ft	24.705883	84.535936	21.12.2023	7.43	800	255	38	38.88	62	7.54	0	427	24.85	6.48	6.07	0	0.93
27	Madanpur	Sondih	Pond	24.705858	84.535732	21.12.2023	7.29	888	190	28	29.16	97	20	0	280.6	106.5	10.08	37	0	0.85
28	Madanpur	Sondih	DW	24.706724	84.535165	21.12.2023	7.82	980	230	44	29.16	113	14	0	408.7	81.65	3.96	31	0	1.2
29	Madanpur	Hajipur	PHED ~270ft	24.693052	84.537785	21.12.2023	7.45	970	315	54	43.74	77	7.76	0	463.6	56.8	8.11	18	0.87	0.96

S. No.	BLOCK	LOCATION	Source	Lat	Long	Date	pH	EC	TH	Ca	Mg	Na	K	CO_3^{2-}	HCO_3^-	Cl^-	NO_3^-	SO_4^{2-}	PO_4^{3-}	F
30	Madanpur	Hajipur	DW	24.693969	84.535278	21.12.2023	7.4	2010	445	92	52.245	244	25	0	567.3	315.95	3.42	93	0	0.93
31	Madanpur	Paharpur	PHED ~140ft	24.724437	84.535103	21.12.2023	7.35	852	190	22	32.805	109	5.35	0	420.9	42.6	5.07	19	0	0.92
32	Madanpur	Warkhas tola	HP ~88ft	24.73055	84.520845	21.12.2023	7.46	1576	425	82	53.46	121	71	0	542.9	156.2	24	91	0	0.43
33	Madanpur	Sri Rampur	HP ~250ft	24.642596	84.593975	21.12.2023	7.29	480	135	34	12.15	45	3.77	0	213.5	21.3	9.5	20	0	1.67
34	Madanpur	Sri Rampur	HP ~300ft	24.642635	84.593822	21.12.2023	7.46	408	125	28	13.365	32	6.33	0	201.3	10.65	6.1	11	0	1.58
35	Madanpur	Sri Rampur	DW	24.640782	84.59421	21.12.2023	7.62	2056	400	84	46.17	280	12	0	335.5	440.2	14.07	113	0	1.33
36	Madanpur	Sri Rampur	PHED	24.641457	84.593697	21.12.2023	7.53	604	210	42	25.515	61	5.03	0	292.8	42.6	18	29	1.2	1.58
37	Madanpur	Mithaiya	DW	24.64887	84.60081	21.12.2023	7.42	700	210	20	38.88	65	0.04	0	335.5	35.5	4.93	20	0	1.5
38	Madanpur	Pararaiya	HP ~60ft	24.658988	84.602445	21.12.2023	7.32	752	160	22	25.515	95	5.96	0	378.2	28.4	2.89	13	0	1.45
39	Madanpur	Pararaiya	TW ~75ft	24.658697	84.603334	21.12.2023	7.4	740	225	20	42.525	66	1.36	0	353.8	42.6	3.57	17	0	0.45
40	Madanpur	Pararaiya	BW ~160ft	24.658815	84.603158	21.12.2023	7.35	823	155	24	23.085	116	6.36	0	445.3	24.85	2.12	8.6	0	1.74
41	Madanpur	Beri	PHED ~250ft	24.677012	84.591777	22.12.2023	7.86	767	295	16	61.965	36	5.9	0	353.8	53.25	3.66	5.59	0	0.91
42	Madanpur	Beri	HP ~55ft	24.676262	84.591675	22.12.2023	7.71	890	320	48	48.6	54	4.07	0	402.6	56.8	12.99	23	0	0.77
43	Madanpur	Jamugain	PHED	24.6899	84.57952	22.12.2023	7.62	743	255	32	42.525	48	5.58	0	305	56.8	15	20	0	1.23
44	Madanpur	Jamugain	DW	24.692009	84.580345	22.12.2023	7.42	1470	420	68	60.75	101	72	0	494.1	166.85	21	75	0	0.63
45	Madanpur	Mahuawan	PHED ~70ft	24.696037	84.577055	22.12.2023	7.35	643	240	28	41.31	30	9.57	0	311.1	31.95	3.1	12	0	0.51
46	Madanpur	Madar river	river	24.69004	84.575259	22.12.2023	7.63	630	225	32	35.235	37	5.85	0	317.2	28.4	1.06	9.16	0	0.88
47	Madanpur	Belbigha	PHED ~250ft	24.693245	84.588072	22.12.2023	7.52	730	260	20	51.03	45	2.99	0	390.4	17.75	2.49	7.17		1.6
48	Madanpur	Ratan Bigha	BW ~170ft	24.724287	84.567873	22.12.2023	7.34	770	290	48	41.31	44	1.75	0	353.8	49.7	4.87	24	0	1.3
49	Madanpur	Ratan Bigha	HP ~80ft	24.724518	84.568158	22.12.2023	7.4	1150	75	18	7.29	228	3.54	0	622.2	35.5	1.2	11	1.34	1.56
50	Madanpur	Ratan Bigha	BW ~160ft	24.72458	84.568135	22.12.2023	7.62	994	175	34	21.87	129	6.16	0	488	28.4	6.16	12	0	1.31
51	Madanpur	Ratan Bigha	DW	24.724122	84.567925	22.12.2023	7.51	560	180	46	15.795	43	6.81	0	274.5	24.85	6.81	13	0	0.99
52	Madanpur	Teka Bigha	DW	24.688432	84.694073	07.01.2024	7.69	2209	750	190	67	156	13	0	293	550	13	76.33	0	1.89
53	Madanpur	Teka Bigha	BW ~140ft	24.683123	84.694567	07.01.2024	7.52	856	250	64	22	74	11	0	445	25	11	7.29	0	1.98
61	Madanpur	Tetaria	DW	24.713638	84.688883	07.01.2024	7.62	1950	450	138	26	206	55	0	750	174	6.03	95	0	1.99
62	Madanpur	Tetaria	BW ~155ft	24.711152	84.688168	07.01.2024	7.93	1409	250	62	23	205	9.47	0	567	138	17	28	0	1.05
65	Madanpur	Pipraura	PHED ~110-120ft	24.754456	84.530498	08.01.2024	7.81	671	240	70	16	42	0.9	0	342	25	2.6	11	0.54	0.91
66	Madanpur	Pipraura	HP ~100ft	24.754863	84.528585	08.01.2024	8.06	1440	510	168	22	71	45	0	439	181	33	75	0	0.51
67	Madanpur	Unchauli	DW	24.755524	84.550994	08.01.2024	8.19	657	225	64	16	32	28	0	293	43	6.62	24	0	0.44
72	Madanpur	Parsa	HP ~120ft	24.739316	84.594018	08.01.2024	7.75	695	175	44	16	83	1.2	0	354	28	0	21	0	1.62

S. No.	BLOCK	LOCATION	Source	Lat	Long	Date	pH	EC	TH	Ca	Mg	Na	K	CO_3^{2-}	HCO_3^-	Cl^-	NO_3^-	SO_4^{2-}	PO_4^{3-}	F
73	Madanpur	Parsa	BW ~125ft	24.737622	84.592862	08.01.2024	7.63	487	170	38	18	31	0	0	244	18	0	12	0.87	1.53
74	Madanpur	Chanki Bigha	BW	24.714925	84.592497	08.01.2024	7.77	609	200	76	2	46	1.1	0	305	21	4.59	13	0	1.55
54	Rafiganj	Chiraila	TW ~100ft	24.739497	84.720627	07.01.2024	7.94	690	285	78	22	28	0.79	0	366	18	5.13	7.84	0	1.94
55	Rafiganj	Dholikhap	HP ~50ft	24.736435	84.67945	07.01.2024	7.89	1204	435	116	35	80	1.59	0	403	131	30	67.58	0	1.69
56	Rafiganj	Dholikhap	HP ~45ft	24.731759	84.681916	07.01.2024	7.71	875	270	74	21	75	0	0	421	43	2.31	20.38	1.23	1.7
57	Rafiganj	Mahuain	PHED ~150ft	24.723933	84.685209	07.01.2024	7.79	1067	320	90	23	96	2.32	0	415	92	6.23	47.42	0	1.28
58	Rafiganj	Baghaura	PHED ~255ft	24.711997	84.707248	07.01.2024	7.64	1284	375	102	29	104	33	0	427	124	33	83	0	1.97
59	Rafiganj	Baghaura	DW	24.712463	84.707089	07.01.2024	7.9	1586	480	136	34	111	60	0	482	181	19	119	0	1.92
60	Rafiganj	Gerua	HP ~65-70ft	24.710648	84.716745	07.01.2024	7.86	759	275	78	19	46	6.66	0	275	57	23	54	0	1.39
63	Rafiganj	Khaira Firoz	HP ~120ft	24.738325	84.662363	07.01.2024	8.05	975	205	58	15	132	0.27	0	464	64	5.02	13	0	1.82
64	Rafiganj	Khaira Firoz	PHED ~250ft	24.738116	84.662089	07.01.2024	7.84	790	210	62	13	85	0.74	0	409	25	6.88	17	0	1.71
68	Rafiganj	Khaira Manjhauli	PHED ~130ft	24.750568	84.57684	08.01.2024	7.95	898	265	82	15	87	3.54	0	470	36	5.6	14	0	0.99
69	Rafiganj	Khaira Manjhauli	DW	24.744522	84.57718	08.01.2024	7.56	1875	440	112	39	225	5.46	0	641	234	6.98	72	0	0.6
70	Rafiganj	Bishambharpur	HP	24.758088	84.604102	08.01.2024	7.85	510	165	42	15	41	2.11	0	250	21	4.07	12	0	1.66
71	Rafiganj	Bishambharpur	BW ~150ft	24.755416	84.608134	08.01.2024	7.72	531	170	40	17	44	6.2	0	281	18	6.82	8.85	0	1.56
75	Rafiganj	Thekahi	HP ~32ft	24.73167	84.646645	08.01.2024	7.79	1008	400	134	16	46	0	0	488	57	0	19	0	1.68
76	Rafiganj	Thekahi	BW ~155ft	24.732222	84.646679	09.01.2024	8.12	1250	390	98	35	107	5.54	0	445	135	26.01	45	0	1.56
77	Rafiganj	DomanBigha, Balar Tola	HP ~110ft		84.639324	09.01.2024	8.15	1338	405	112	30	115	5.15	0	415	167	12.8	70	0	1.43
78	Rafiganj	DomanBigha, Balar	DW	24.741318	84.637493	09.01.2024	7.62	2128	300	78	26	320	56	0	708	266	27	86	0	1.77
79	Rafiganj	Chandauli	HP ~105ft	24.750121	84.630438	09.01.2024	7.74	1560	425	126	27	161	5.54	0	592	142	27	69	0	0.82
80	Rafiganj	Chandauli	BW ~150ft	24.750221	84.629835	09.01.2024	7.69	850	325	68	38	45	3.2	0	336	64	29	34	0	0.99
81	Rafiganj	Mathparia	BW ~150ft	24.761187	84.628502	09.01.2024	7.79	495	190	52	15	28	0	0	238	21	5.04	20	0	0.73
82	Rafiganj	Batura	HP ~100ft	24.764125	84.620456	09.01.2024	7.84	650	240	70	16	39	2.47	0	293	36	13	24	1.34	1.36
83	Rafiganj	Akoni	TW ~150ft	24.767914	84.566895	09.01.2024	7.93	640	185	46	17	53	9.46	0	342	18	3.82	1	0	1.09
84	Rafiganj	Akoni	DW	24.769285	84.560077	09.01.2024	7.99	850	250	56	27	77	1.21	0	305	103	5.8	17	0	1.31
85	Rafiganj	Kona	HP ~80ft	24.775603	84.548915	09.01.2024	7.7	631	205	56	16	50	2.49	0	317	28	0	15	0	0.99
86	Rafiganj	Tikri	HP	24.793842	84.541245	09.01.2024	7.83	890	335	82	32	51	0.94	0	403	50	20	29	0	0.61
87	Rafiganj	Asha Bigha	HP ~80ft	24.815103	84.529648	09.01.2024	7.62	676	250	58	26	36	7.08	0	311	36	14	17	0	0.54
88	Rafiganj	Madar river	river	24.820272	84.523714	10.01.2024	7.71	633	125	36	9	28	2.5	0	317	21	0	19	0	0.58

S. No.	BLOCK	LOCATION	Source	Lat	Long	Date	pH	EC	TH	Ca	Mg	Na	K	CO_3^{2-}	HCO_3^-	Cl^-	NO_3^-	SO_4^{2-}	PO_4^{3-}	F
89	Rafiganj	Kajpa	DW	24.823052	84.523636	10.01.2024	7.82	1612	325	92	23	225	2.55	0	720	124	11	40	0	1.02
90	Rafiganj	Kajpa	HP ~55ft	24.825655	84.523208	10.01.2024	7.89	730	225	58	19	65	1.42	0	323	43	21	22	0	0.55
91	Rafiganj	Kajpa	BW ~200ft	24.82683	84.522102	10.01.2024	7.74	780	225	50	24	76	1.21	0	366	39	21	19	0	0.98
92	Rafiganj	Jakhim	HP	24.837963	84.525993	10.01.2024	7.58	1282	375	106	27	79	65	0	476	114	30	56	0	0.08
93	Rafiganj	Jakhim	HP ~115ft	24.836618	84.525472	10.01.2024	7.69	572	195	46	19	29	23	0	159	67	30	38	0	0.19
94	Rafiganj	Saira	TW ~80ft	24.870883	84.52363	10.01.2024	7.61	783	250	62	23	60	7.32	0	354	36	23	29	0.51	0.66
95	Rafiganj	Prasdih	HP ~60ft	24.889753	84.525518	10.01.2024	7.77	550	115	30	10	73	0.26	0	250	21	13	24	0	0.99
96	Rafiganj	Rampur Parasiya	HP ~60-70ft	24.896792	84.528013	10.01.2024	7.69	522	210	52	19	27	0.24	0	256	11	18	23	0	1.34
97	Rafiganj	Harbansa Bigha	DW	24.897211	84.511537	10.01.2024	7.79	1026	255	68	21	114	17	0	464	50	22	55	0	0.53
98	Rafiganj	Harbansa Bigha	TW ~135 ft	24.896853	84.511867	10.01.2024	7.73	525	200	54	16	32	2.34	0	268	21	7.91	11	0	0.58
99	Rafiganj	Banka	HP ~60ft	24.908498	84.533578	10.01.2024	7.8	618	150	42	11	72	1.05	0	317	11	10	20	0	0.76
100	Rafiganj	Temura	HP ~100ft	24.902054	84.552497	10.01.2024	7.74	694	150	44	10	85	7.06	0	354	21	11	17	0	0.29
101	Rafiganj	Choti English	HP ~70-80ft	24.91266	84.522363	10.01.2024	7.62	509	175	52	11	35	1.91	0	287	7	2.13	8.81	0	0.58
102	Rafiganj	Narhi Pirhi	HP ~120ft	24.924136	84.524493	10.01.2024	7.78	704	230	64	17	54	8.25	0	275	46	24	41	0	0.71

Annexure 9: Heavy metal analysis for Pre-Monsoon.

S. No.	District	Block	Location	Source	Latitude	Longitude	Cr	Fe	Mn	Cu	Zn	As	Pb	U
							mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
1	Aurangabad	Madanpur	Maya bigha	HP ~160ft	24.7019	84.485607	0.012	0.173	BDL	BDL	0.778	BDL	BDL	0.006
2	Aurangabad	Madanpur	Maya bigha	Pond	24.70202	84.485192	0.002	0.664	0.099	BDL	BDL	0.007	0.001	0.008
3	Aurangabad	Madanpur	Maya bigha	DTW ~300ft	24.703	84.485927	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.010
4	Aurangabad	Madanpur	Maya bigha	HP ~120ft	24.70109	84.48241	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.007
5	Aurangabad	Madanpur	Dadhpi	TW ~80ft	24.6812	84.501727	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.006
6	Aurangabad	Madanpur	Manika	DW	24.65434	84.501117	BDL	BDL	BDL	BDL	0.075	0.002	BDL	0.005
7	Aurangabad	Madanpur	Manika	BW ~200ft	24.6542	84.501635	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.005
8	Aurangabad	Madanpur	Bishunganj	BW ~130ft	24.6504	84.533888	0.002	0.932	BDL	BDL	0.057	BDL	0.002	0.012
9	Aurangabad	Madanpur	Umga	Pond	24.64767	84.565444	0.010	7.052	0.573	BDL	BDL	0.008	0.009	BDL
10	Aurangabad	Madanpur	Umga	DW	24.64719	84.566105	BDL	BDL	BDL	BDL	BDL	0.006	0.001	BDL
11	Aurangabad	Madanpur	Madanpur	BW ~300ft	24.65614	84.584859	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.007
12	Aurangabad	Madanpur	Pateya	HP	24.66215	84.568605	0.003	1.659	0.291	BDL	BDL	BDL	0.002	0.013
13	Aurangabad	Madanpur	Pateya	HP ~150ft	24.66207	84.569122	BDL	0.141	BDL	BDL	0.107	BDL	0.001	0.012
14	Aurangabad	Madanpur	Bahlola	DTW ~200ft	24.68392	84.483617	BDL	BDL	BDL	BDL	0.062	BDL	BDL	0.004
15	Aurangabad	Madanpur	Rasulpur	DW	24.67726	84.480205	BDL	0.164	BDL	BDL	BDL	BDL	0.001	0.007
16	Aurangabad	Madanpur	Rasulpur	DTW ~180ft	24.67707	84.48028	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.007
17	Aurangabad	Madanpur	Badal Bigha	DW	24.66534	84.473108	BDL	0.084	BDL	BDL	BDL	0.003	BDL	0.016
18	Aurangabad	Madanpur	Badal Bigha	BW ~210ft	24.66591	84.473381	BDL	BDL	BDL	BDL	BDL	BDL	0.001	0.013
19	Aurangabad	Madanpur	Belwa	TW ~80-85ft	24.625	84.4766	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.007
20	Aurangabad	Madanpur	Belwa	HP ~40ft	24.62436	84.477773	BDL	0.143	0.463	BDL	0.857	BDL	0.002	0.008

S. No.	District	Block	Location	Source	Latitude	Longitude	Cr	Fe	Mn	Cu	Zn	As	Pb	U
							mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
21	Aurangabad	Madanpur	Karpatai	HP ~60ft	24.65012	84.484712	BDL	0.067	BDL	BDL	0.080	BDL	BDL	0.004
22	Aurangabad	Madanpur	At	HP ~70ft	24.64198	84.489749	BDL	0.315	0.482	BDL	0.693	BDL	0.002	0.006
23	Aurangabad	Madanpur	Gulab Bigha	BW ~150ft	24.64465	84.546405	BDL	BDL	BDL	BDL	BDL	BDL	0.001	0.003
24	Aurangabad	Madanpur	Gulab Bigha	HP~30ft	24.64341	84.546774	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.006
25	Aurangabad	Madanpur	Rama Bandh	BW ~150ft	24.60917	84.538814	BDL	0.146	BDL	BDL	0.064	BDL	BDL	0.007
26	Aurangabad	Madanpur	manwa dohar	HP ~100 ft	24.61029	84.537371	0.001	1.381	BDL	0.038	1.544	BDL	0.005	0.005
27	Aurangabad	Madanpur	badki chechani	STW ~60ft-70ft	24.62082	84.523968	0.003	1.380	BDL	BDL	0.159	BDL	0.002	0.004
28	Aurangabad	Madanpur	badki chechani	DTW ~80-90ft	24.62326	84.52365	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.011
29	Aurangabad	Madanpur	Sahiari	DW	24.59274	84.514693	BDL	0.094	0.192	BDL	BDL	0.004	BDL	BDL
30	Aurangabad	Madanpur	Sahiari	HP ~95ft	24.59324	84.514507	0.002	0.512	BDL	0.168	0.258	BDL	0.007	0.007
31	Aurangabad	Madanpur	Nawadih	BW ~105ft	24.5978	84.511055	BDL	0.318	0.069	BDL	BDL	BDL	0.001	0.014
32	Aurangabad	Madanpur	Nawadih	DW	24.60073	84.510742	BDL	BDL	BDL	BDL	BDL	0.004	BDL	BDL
33	Aurangabad	Madanpur	ghatrain	DW	24.66303	84.55453	BDL	0.167	0.229	BDL	BDL	BDL	BDL	0.012
34	Aurangabad	Madanpur	Ghatrain	HP ~100ft	24.66291	84.554591	BDL	0.961	BDL	BDL	0.800	BDL	0.003	0.010
35	Aurangabad	Madanpur	Umga	DW	24.63175	84.569742	BDL	0.386	2.222	BDL	BDL	0.005	BDL	BDL
36	Aurangabad	Madanpur	Umga	HP ~100ft	24.6296	84.56977	BDL	0.812	BDL	BDL	0.081	BDL	0.002	BDL
37	Aurangabad	Madanpur	Theriya	DW	24.64887	84.60081	0.001	BDL	BDL	BDL	BDL	BDL	BDL	BDL
38	Aurangabad	Madanpur	Parariya	TW ~30ft-60ft	24.65894	84.602437	0.003	0.330	BDL	BDL	0.199	BDL	0.003	0.007

Note: BDL- Below Detection Limit i.e. For Cu <0.02 mg/L; for Mn, Zn, Fe <0.05 mg/L; for Pb, As, Cr <0.001 mg/L; for U <0.003 mg/L

Annexure 10: Heavy metal analysis for Post-Monsoon.

S. No.	District	Block	Location	Source	Aquifer	Latitude	Longitude	Date of collection	Cr	Fe	Mn	Cu	Zn	As	Pb	U
									mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
1	Aurangabad	Madanpur	Maya bigha	PHED ~180ft	Hardrock	24.70175	84.48518	16.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.011
2	Aurangabad	Madanpur	Maya bigha	Pond	Alluvium	24.70105	84.48348	16.12.2023	BDL	0.188	BDL	BDL	BDL	0.002	BDL	BDL
3	Aurangabad	Madanpur	Kusaha	PHED ~310ft	Hardrock	24.67658	84.53647	16.12.2023	BDL	0.505	BDL	0.072	0.051	BDL	0.003	0.020
4	Aurangabad	Madanpur	Kusaha	DW	Alluvium	24.67837	84.53397	16.12.2023	BDL	BDL	BDL	BDL	BDL	0.003	BDL	0.016
5	Aurangabad	Madanpur	Jhari Nadi	River	Alluvium	24.66929	84.54955	16.12.2023	BDL	BDL	BDL	BDL	BDL	0.002	BDL	BDL
6	Aurangabad	Madanpur	Ghatrain	DW	Alluvium	24.66315	84.55451	16.12.2023	BDL	BDL	BDL	BDL	BDL	0.002	BDL	0.008
7	Aurangabad	Madanpur	Ghatrain	TW ~110ft	Alluvium	24.66315	84.55533	16.12.2023	BDL	BDL	BDL	BDL	0.285	BDL	BDL	0.009
8	Aurangabad	Madanpur	Kolhua	HP - Fe rich	Hardrock	24.68359	84.60673	16.12.2023	BDL	18.762	0.579	BDL	0.447	BDL	0.001	0.004
9	Aurangabad	Madanpur	Kolhua	DW	Alluvium	24.68354	84.60627	16.12.2023	BDL	0.508	0.351	BDL	BDL	0.003	BDL	BDL
10	Aurangabad	Madanpur	Bhuyian Bigha	BW ~150ft	Hardrock	24.71970	84.60769	16.12.2023	BDL	0.551	BDL	BDL	1.030	BDL	BDL	0.009
11	Aurangabad	Madanpur	Bhuyian Bigha	DW ~25ft	Alluvium	24.71995	84.60806	16.12.2023	BDL	0.179	1.081	BDL	BDL	0.007	BDL	BDL
12	Aurangabad	Madanpur	Bhuyian Bigha	DW ~25ft	Alluvium	24.71066	84.61995	16.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
13	Aurangabad	Madanpur	Bhuyian Bigha	HP ~130ft	Hardrock	24.72274	84.60768	16.12.2023	BDL	0.160	BDL	BDL	BDL	BDL	BDL	0.018
14	Aurangabad	Madanpur	Pirbihga	BW ~100ft	Hardrock	24.72476	84.63069	16.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.038
15	Aurangabad	Madanpur	Pirbihga	DW	Alluvium	24.72449	84.63058	16.12.2023	BDL	BDL	BDL	BDL	BDL	0.003	BDL	0.010
16	Aurangabad	Madanpur	Hari Bigha	HP ~65ft	Alluvium	24.69418	84.61465	16.12.2023	BDL	0.064	BDL	BDL	BDL	BDL	BDL	0.018
17	Aurangabad	Madanpur	Hari Bigha	PHED BW~150-200ft	Hardrock	24.69565	84.61341	21.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.015
18	Aurangabad	Madanpur	Rasalpur	BW~125ft	Hardrock	24.68048	84.47886	17.12.2023	BDL	BDL	0.102	BDL	BDL	BDL	BDL	0.028
19	Aurangabad	Madanpur	Rasalpur	HP ~40-45ft	Alluvium	24.68022	84.47812	17.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.015
20	Aurangabad	Madanpur	Bahlola	PHED ~185ft	Hardrock	24.68408	84.48303	17.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.005
21	Aurangabad	Madanpur	Bahlola	pond	Alluvium	24.68431	84.48338	17.12.2023	BDL	0.481	0.146	BDL	BDL	0.006	BDL	0.004
22	Aurangabad	Madanpur	Rasalpur	DW	Alluvium	24.67726	84.48021	17.12.2023	BDL	BDL	BDL	BDL	BDL	0.001	BDL	0.005
23	Aurangabad	Madanpur	Badal Bigha	PHED ~300ft	Hardrock	24.66591	84.47338	17.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.017
24	Aurangabad	Madanpur	Badal Bigha	DW	Alluvium	24.66540	84.47290	17.12.2023	BDL	BDL	BDL	BDL	BDL	0.006	BDL	0.004
25	Aurangabad	Madanpur	Belma	TW ~50ft	Alluvium	24.62507	84.47657	17.12.2023	0.001	0.268	BDL	BDL	BDL	BDL	0.002	0.008

S. No.	District	Block	Location	Source	Aquifer	Latitude	Longitude	Date of collection	Cr	Fe	Mn	Cu	Zn	As	Pb	U
									mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
26	Aurangabad	Madanpur	Karpatai	HP ~55ft	Alluvium	24.65015	84.48495	17.12.2024	0.001	0.103	BDL	BDL	0.157	BDL	0.001	0.007
27	Aurangabad	Madanpur	Karpatai	BW ~405ft	Hardrock	24.64998	84.48520	17.12.2023	BDL	0.365	BDL	BDL	BDL	BDL	0.002	0.006
28	Aurangabad	Madanpur	Karpatai	HP ~60ft	Alluvium	24.64867	84.48408	17.12.2023	BDL	0.345	BDL	BDL	0.122	BDL	0.003	0.004
29	Aurangabad	Madanpur	Peman	TW ~60-65ft	Alluvium	24.64588	84.47823	17.12.2023	0.002	BDL	0.064	BDL	BDL	BDL	0.006	0.011
30	Aurangabad	Madanpur	Peman	HP ~45ft	Alluvium	24.64623	84.48009	17.12.2023	BDL	BDL	0.067	BDL	BDL	BDL	BDL	0.015
31	Aurangabad	Madanpur	At	DW	Alluvium	24.64602	84.49186	17.12.2023	0.008	BDL	BDL	BDL	BDL	0.002	0.001	0.003
32	Aurangabad	Madanpur	At	TW ~95ft	Alluvium	24.64572	84.49167	17.12.2023	0.007	BDL	BDL	BDL	BDL	0.002	0.001	0.003
33	Aurangabad	Madanpur	Manika	DW	Alluvium	24.65427	84.50113	17.12.2023	BDL	BDL	BDL	BDL	BDL	0.005	0.001	0.003
34	Aurangabad	Madanpur	Bishunganj	HP ~105ft	Alluvium	24.65045	84.53365	17.12.2023	BDL	0.499	BDL	BDL	0.079	BDL	0.002	0.013
35	Aurangabad	Madanpur	Bishunganj	DW	Alluvium	24.65043	84.53366	17.12.2023	BDL	BDL	BDL	BDL	BDL	0.003	BDL	0.003
36	Aurangabad	Madanpur	Khesar river	River	Alluvium	24.69767	84.48834	18.12.2023	BDL	0.107	BDL	BDL	BDL	0.003	0.001	0.004
37	Aurangabad	Madanpur	Dadhpi	DW	Alluvium	24.68288	84.50328	18.12.2023	BDL	0.425	1.007	BDL	BDL	0.007	0.002	BDL
38	Aurangabad	Madanpur	Dadhpi	TW ~75-83ft	Alluvium	24.68131	84.50148	18.12.2023	0.001	BDL	BDL	BDL	BDL	BDL	0.002	0.007
39	Aurangabad	Madanpur	Kesahar river	River	Alluvium	24.67066	84.49716	18.12.2023	BDL	0.105	BDL	BDL	BDL	0.002	0.001	0.004
40	Aurangabad	Madanpur	Dhobdiha	TW ~95ft	Alluvium	24.67074	84.49871	18.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	0.001	0.006
41	Aurangabad	Madanpur	Raniganj	DW	Alluvium	24.68366	84.51699	18.12.2023	BDL	BDL	0.430	BDL	BDL	0.003	BDL	0.007
42	Aurangabad	Madanpur	Raniganj	PHED ~105ft	Alluvium	24.68339	84.51705	18.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	0.001	0.013
43	Aurangabad	Madanpur	Dangra	pond	Alluvium	24.66856	84.51265	18.12.2023	BDL	0.075	BDL	BDL	BDL	0.002	0.003	BDL
44	Aurangabad	Madanpur	Machiar Bigha	TW ~102ft	Alluvium	24.66167	84.51347	18.12.2023	BDL	0.071	BDL	BDL	BDL	BDL	BDL	0.020
45	Aurangabad	Madanpur	Machiar Bigha	DW	Alluvium	24.66134	84.51301	18.12.2023	BDL	BDL	BDL	BDL	BDL	0.002	0.002	0.015
46	Aurangabad	Madanpur	Damri Bigha	DW	Alluvium	24.64524	84.51186	18.12.2023	0.002	BDL	BDL	BDL	BDL	BDL	0.001	0.010
47	Aurangabad	Madanpur	Damri Bigha	PHED ~240ft	Hardrock	24.64551	84.51179	18.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	0.002	0.013
48	Aurangabad	Madanpur	Gaura	PHED ~250ft	Hardrock	24.64027	84.50311	18.12.2023	BDL	0.129	BDL	BDL	BDL	BDL	0.001	0.007
49	Aurangabad	Madanpur	Gaura	HP ~50ft	Alluvium	24.63915	84.50149	18.12.2023	0.007	1.009	0.072	BDL	0.250	BDL	0.004	0.014
50	Aurangabad	Madanpur	Manika	PHED ~250ft	Hardrock	24.65361	84.50179	18.12.2023	BDL	BDL	BDL	BDL	0.106	BDL	0.002	0.007
51	Aurangabad	Madanpur	Nima Anjan	PHED ~250ft	Hardrock	24.64216	84.51888	18.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.044
52	Aurangabad	Madanpur	Nima Anjan	HP ~40ft	Alluvium	24.64133	84.52084	18.12.2023	0.003	0.812	BDL	BDL	0.077	BDL	0.002	0.031
53	Aurangabad	Madanpur	Nima Anjan	PHED ~300ft	Hardrock	24.64026	84.52120	18.12.2023	BDL	0.079	BDL	BDL	BDL	BDL	BDL	0.016

S. No.	District	Block	Location	Source	Aquifer	Latitude	Longitude	Date of collection	Cr	Fe	Mn	Cu	Zn	As	Pb	U
									mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
54	Aurangabad	Madanpur	Badki Chechani	TW ~110ft	Alluvium	24.62332	84.52375	18.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
55	Aurangabad	Madanpur	Badki Chechani	HP ~55ft	Alluvium	24.62342	84.52358	18.12.2023	0.002	0.823	0.057	BDL	0.662	BDL	0.007	0.009
56	Aurangabad	Madanpur	Badki Chechani	BW ~180ft	Hardrock	24.61965	84.52441	18.12.2023	BDL	0.067	BDL	BDL	BDL	BDL	0.001	0.007
57	Aurangabad	Madanpur	Teldiha	DW	Alluvium	24.69781	84.50532	19.12.2023	BDL	0.208	0.198	BDL	BDL	0.005	BDL	0.004
58	Aurangabad	Madanpur	Teldiha	HP ~90ft	Alluvium	24.69785	84.50506	19.12.2023	BDL	0.489	0.146	BDL	2.582	BDL	0.004	0.004
59	Aurangabad	Madanpur	Teldiha	TW ~90ft	Alluvium	24.69891	84.50124	19.12.2023	0.001	BDL	BDL	BDL	BDL	BDL	BDL	BDL
60	Aurangabad	Madanpur	Pateya	DW	Alluvium	24.66273	84.56908	19.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	0.001	0.016
61	Aurangabad	Madanpur	Pateya	PHED ~250ft	Hardrock	24.66393	84.57185	19.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	0.001	0.007
62	Aurangabad	Madanpur	Madanpur	PHED ~500ft	Hardrock	24.65569	84.58822	19.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.006
63	Aurangabad	Madanpur	Madanpur	HP ~140ft	Alluvium	24.65645	84.58877	19.12.2023	BDL	0.265	BDL	BDL	0.093	BDL	0.001	0.006
64	Aurangabad	Madanpur	Umga	DW	Alluvium	24.64734	84.56607	19.12.2023	BDL	BDL	BDL	BDL	BDL	0.008	0.001	BDL
65	Aurangabad	Madanpur	Umga	pond	Alluvium	24.64767	84.56543	19.12.2023	0.003	1.663	0.134	BDL	BDL	0.002	0.004	BDL
66	Aurangabad	Madanpur	Gulab Bigha	PHED ~150ft	Alluvium	24.64639	84.54706	19.12.2023	BDL	0.065	BDL	BDL	BDL	BDL	0.002	0.006
67	Aurangabad	Madanpur	Gulab Bigha	DW	Alluvium	24.64423	84.54648	19.12.2023	BDL	BDL	0.070	BDL	BDL	BDL	0.001	0.005
68	Aurangabad	Madanpur	Sahiari	DW	Alluvium	24.59274	84.51469	19.12.2023	BDL	0.496	0.144	BDL	2.600	BDL	0.004	0.004
69	Aurangabad	Madanpur	Sahiari	HP ~95ft	Alluvium	24.59324	84.51451	19.12.2023	0.001	BDL	BDL	BDL	BDL	BDL	BDL	BDL
70	Aurangabad	Madanpur	Sahiari	TW ~140ft	Alluvium	24.59174	84.51388	19.12.2023	BDL	0.082	BDL	BDL	BDL	BDL	0.001	0.005
71	Aurangabad	Madanpur	Nawadih	DW	Alluvium	24.59816	84.51204	19.12.2023	BDL	0.164	0.507	BDL	BDL	0.004	BDL	0.007
72	Aurangabad	Madanpur	Nawadih	HP ~100ft	Alluvium	24.59790	84.51096	19.12.2023	BDL	0.077	0.067	BDL	0.054	BDL	0.001	0.016
73	Aurangabad	Madanpur	Chariya	HP ~60ft	Alluvium	24.59979	84.49342	19.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	0.002	0.015
74	Aurangabad	Madanpur	Chariya	PHED ~175ft	Hardrock	24.60090	84.49137	19.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	0.002	0.014
75	Aurangabad	Madanpur	Umga	HP ~100ft	Hardrock	24.62960	84.56977	20.12.2023	BDL	0.450	BDL	BDL	0.164	BDL	0.002	BDL
76	Aurangabad	Madanpur	North Koel Canal	Canal	Alluvium	24.62942	84.56991	20.12.2023	0.002	1.094	0.122	BDL	BDL	0.002	0.003	0.003
77	Aurangabad	Madanpur	Siraundha Tola	HP ~150ft	Hardrock	24.62793	84.57310	20.12.2023	BDL	0.059	BDL	BDL	BDL	BDL	0.002	BDL
78	Aurangabad	Madanpur	Siraundha Tola	BW ~150ft	Hardrock	24.62727	84.57367	20.12.2023	0.001	10.978	0.214	BDL	1.230	BDL	0.039	BDL
79	Aurangabad	Madanpur	Siraundha Tola	HP ~35ft	Alluvium	24.62792	84.57352	20.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	0.001	0.004
80	Aurangabad	Madanpur	Siraundha	HP ~35ft	Alluvium	24.62878	84.57067	20.12.2023	0.001	0.246	0.083	BDL	BDL	BDL	BDL	0.004
81	Aurangabad	Madanpur	Siraundha	BW ~170ft	Hardrock	24.62912	84.57041	20.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

S. No.	District	Block	Location	Source	Aquifer	Latitude	Longitude	Date of collection	Cr	Fe	Mn	Cu	Zn	As	Pb	U
									mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
82	Aurangabad	Madanpur	Siraundha	PHED ~215ft	Hardrock	24.62641	84.56869	20.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.004
83	Aurangabad	Madanpur	Siraundha	DW	Alluvium	24.62706	84.56797	20.12.2023	BDL	BDL	BDL	BDL	BDL	0.001	BDL	0.003
84	Aurangabad	Madanpur	Munshi Bigha	HP ~80ft	Alluvium	24.62364	84.56234	20.12.2023	BDL	0.134	BDL	BDL	BDL	0.001	BDL	0.007
85	Aurangabad	Madanpur	Munshi Bigha	DW	Alluvium	24.62389	84.56228	20.12.2023	BDL	BDL	BDL	BDL	BDL	0.001	BDL	0.010
86	Aurangabad	Madanpur	Badam	HP ~70-75ft	Alluvium	24.61674	84.56797	20.12.2023	BDL	0.225	BDL	BDL	BDL	BDL	0.002	BDL
87	Aurangabad	Madanpur	Badam	PHED ~200ft	Hardrock	24.61725	84.56603	20.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	0.001	BDL
88	Aurangabad	Madanpur	Pichauliya	HP ~55ft	Alluvium	24.61220	84.55798	20.12.2023	BDL	0.126	BDL	BDL	BDL	BDL	BDL	0.012
89	Aurangabad	Madanpur	Dhobi Bagh	HP ~70ft	Alluvium	24.62133	84.55290	20.12.2023	BDL	5.595	0.114	BDL	0.078	BDL	0.002	0.008
90	Aurangabad	Madanpur	Dhobi Bagh	PHED ~190ft	Hardrock	24.62033	84.55379	20.12.2023	BDL	0.098	BDL	BDL	BDL	BDL	0.001	0.008
91	Aurangabad	Madanpur	Manwa Dohar	HP ~140ft	Hardrock	24.61030	84.53696	20.12.2023	BDL	0.366	BDL	BDL	0.178	BDL	0.003	0.004
92	Aurangabad	Madanpur	Rama Bandh	HP ~80ft	Alluvium	24.60912	84.53902	20.12.2023	0.001	0.479	BDL	BDL	0.088	BDL	0.002	0.008
93	Aurangabad	Madanpur	Erki Kalan	PHED ~150ft	Hardrock	24.71472	84.49450	21.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.006
94	Aurangabad	Madanpur	Erki Kalan	DW	Alluvium	24.70689	84.49689	21.12.2023	BDL	0.145	0.373	BDL	BDL	0.010	BDL	0.022
95	Aurangabad	Madanpur	Kathri	PHED ~90ft	Alluvium	24.71319	84.51352	21.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.004
96	Aurangabad	Madanpur	Kathri	DW	Alluvium	24.71299	84.51301	21.12.2023	BDL	BDL	BDL	BDL	BDL	0.001	BDL	BDL
97	Aurangabad	Madanpur	Agrapar	DW	Alluvium	24.70955	84.52395	21.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	0.001	0.003
98	Aurangabad	Madanpur	Agrapar	PHED ~260ft	Hardrock	24.70904	84.52507	21.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.009
99	Aurangabad	Madanpur	Sondih	PHED ~300ft	Hardrock	24.70588	84.53594	21.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.009
100	Aurangabad	Madanpur	Sondih	Pond	Alluvium	24.70586	84.53573	21.12.2023	BDL	0.471	0.051	BDL	BDL	0.010	0.001	BDL
101	Aurangabad	Madanpur	Sondih	DW	Alluvium	24.70672	84.53517	21.12.2023	BDL	BDL	0.287	BDL	BDL	0.003	BDL	BDL
102	Aurangabad	Madanpur	Hajipur	PHED ~270ft	Hardrock	24.69305	84.53779	21.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.012
103	Aurangabad	Madanpur	Hajipur	DW	Alluvium	24.69397	84.53528	21.12.2023	BDL	BDL	BDL	BDL	BDL	0.003	BDL	0.005
104	Aurangabad	Madanpur	Paharpur	PHED ~140ft	Hardrock	24.72444	84.53510	21.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	0.002	0.009
105	Aurangabad	Madanpur	Warkhas tola	HP ~88ft	Alluvium	24.73055	84.52085	21.12.2023	0.001	0.333	BDL	BDL	0.079	BDL	BDL	0.005
106	Aurangabad	Madanpur	Sri Rampur	HP ~250ft	Hardrock	24.64260	84.59398	21.12.2023	BDL	0.302	BDL	BDL	BDL	BDL	0.002	BDL
107	Aurangabad	Madanpur	Sri Rampur	BW ~300ft	Hardrock	24.64264	84.59382	21.12.2023	BDL	0.509	BDL	BDL	BDL	BDL	0.001	BDL
108	Aurangabad	Madanpur	Sri Rampur	DW	Alluvium	24.64078	84.59421	21.12.2023	BDL	BDL	BDL	BDL	BDL	0.003	BDL	0.006
109	Aurangabad	Madanpur	Sri Rampur	PHED	Hardrock	24.64146	84.59370	21.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.003

S. No.	District	Block	Location	Source	Aquifer	Latitude	Longitude	Date of collection	Cr	Fe	Mn	Cu	Zn	As	Pb	U
									mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
110	Aurangabad	Madanpur	Mithaiya	DW	Alluvium	24.64887	84.60081	21.12.2023	BDL	0.052	BDL	BDL	BDL	BDL	BDL	BDL
111	Aurangabad	Madanpur	Pararaiya	HP ~60ft	Alluvium	24.65899	84.60245	21.12.2023	BDL	0.713	BDL	0.027	0.391	BDL	0.006	0.007
112	Aurangabad	Madanpur	Pararaiya	TW ~75ft	Alluvium	24.65870	84.60333	21.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.006
113	Aurangabad	Madanpur	Pararaiya	BW ~160ft	Hardrock	24.65882	84.60316	21.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.008
114	Aurangabad	Madanpur	Beri	PHED ~250ft	Hardrock	24.67701	84.59178	22.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.006
115	Aurangabad	Madanpur	Beri	HP ~55ft	Alluvium	24.67626	84.59168	22.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	0.001	0.006
116	Aurangabad	Madanpur	Jamugain	PHED	Hardrock	24.68990	84.57952	22.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	0.002	0.007
117	Aurangabad	Madanpur	Jamugain	DW	Alluvium	24.69201	84.58035	22.12.2023	BDL	BDL	BDL	BDL	BDL	0.002	BDL	0.004
118	Aurangabad	Madanpur	Mahuawan	PHED ~70ft	Alluvium	24.69604	84.57706	22.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	0.001	0.003
119	Aurangabad	Madanpur	Madar river	river	Alluvium	24.69004	84.57526	22.12.2023	BDL	0.055	BDL	BDL	BDL	0.001	0.001	BDL
120	Aurangabad	Madanpur	Belbigha	PHED ~250ft	Hardrock	24.69325	84.58807	22.12.2023	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.008
121	Aurangabad	Madanpur	Ratan Bigha	BW ~170ft	Hardrock	24.72429	84.56787	22.12.2023	BDL	0.667	BDL	BDL	0.258	BDL	0.001	0.007
122	Aurangabad	Madanpur	Ratan Bigha	HP ~80ft	Alluvium	24.72452	84.56816	22.12.2023	BDL	0.551	BDL	BDL	0.154	0.001	0.002	0.009
123	Aurangabad	Madanpur	Ratan Bigha	BW ~160ft	Hardrock	24.72458	84.56814	22.12.2023	BDL	0.110	0.397	BDL	BDL	0.001	BDL	0.010
124	Aurangabad	Madanpur	Ratan Bigha	DW	Alluvium	24.72412	84.56793	22.12.2023	BDL	0.055	BDL	BDL	BDL	0.001	BDL	BDL
125	Aurangabad	Madanpur	Teka Bigha	DW	Alluvium	24.68843	84.69407	07.01.2024	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.005
126	Aurangabad	Madanpur	Teka Bigha	BW ~140ft	Hardrock	24.68312	84.69457	07.01.2024	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.008
127	Aurangabad	Rafiganj	Chiraila	TW ~100ft	Alluvium	24.73950	84.72063	07.01.2024	0.001	0.095	BDL	BDL	BDL	BDL	0.001	0.006
128	Aurangabad	Rafiganj	Dholikhap	HP ~50ft	Alluvium	24.73644	84.67945	07.01.2024	BDL	0.328	0.094	BDL	BDL	BDL	BDL	0.011
129	Aurangabad	Rafiganj	Dholikhap	HP ~45ft	Alluvium	24.73176	84.68192	07.01.2024	BDL	0.237	0.804	BDL	BDL	BDL	BDL	0.013
130	Aurangabad	Rafiganj	Mahuain	PHED ~150ft	Hardrock	24.72393	84.68521	07.01.2024	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.008
131	Aurangabad	Rafiganj	Baghaura	PHED ~255ft	Alluvium	24.71200	84.70725	07.01.2024	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.011
132	Aurangabad	Rafiganj	Baghaura	DW	Alluvium	24.71246	84.70709	07.01.2024	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.011
133	Aurangabad	Rafiganj	Gerua	HP ~65-70ft	Alluvium	24.71065	84.71675	07.01.2024	0.002	0.742	BDL	BDL	BDL	BDL	0.002	0.004
134	Aurangabad	Madanpur	Tetaria	DW	Alluvium	24.71364	84.68888	07.01.2024	BDL	BDL	BDL	BDL	BDL	0.003	BDL	BDL
135	Aurangabad	Madanpur	Tetaria	BW ~155ft	Hardrock	24.71115	84.68817	07.01.2024	BDL	0.926	BDL	BDL	1.006	BDL	0.002	0.014
136	Aurangabad	Rafiganj	Khaira Firoz	HP ~120ft	Hardrock	24.73833	84.66236	07.01.2024	BDL	0.298	BDL	BDL	BDL	BDL	BDL	0.032
137	Aurangabad	Rafiganj	Khaira Firoz	PHED ~250ft	Hardrock	24.73812	84.66209	07.01.2024	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.011

S. No.	District	Block	Location	Source	Aquifer	Latitude	Longitude	Date of collection	Cr	Fe	Mn	Cu	Zn	As	Pb	U
									mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
138	Aurangabad	Madanpur	Pipraura	HP ~100ft	Alluvium	24.75486	84.52859	08.01.2024	BDL	0.071	BDL	BDL	BDL	BDL	BDL	0.006
139	Aurangabad	Madanpur	Unchauli	DW	Alluvium	24.75552	84.55099	08.01.2024	BDL	BDL	BDL	BDL	BDL	0.002	BDL	BDL
140	Aurangabad	Rafiganj	Khaira Manjhauli	PHED ~130ft	Hardrock	24.75057	84.57684	08.01.2024	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.008
141	Aurangabad	Rafiganj	Khaira Manjhauli	DW	Alluvium	24.74452	84.57718	08.01.2024	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
142	Aurangabad	Rafiganj	Bishambharpur	HP	Hardrock	24.75809	84.60410	08.01.2024	BDL	0.205	BDL	BDL	0.092	BDL	0.002	BDL
143	Aurangabad	Rafiganj	Bishambharpur	BW ~150ft	Hardrock	24.75542	84.60813	08.01.2024	BDL	BDL	BDL	BDL	BDL	BDL	0.001	0.006
144	Aurangabad	Madanpur	Parsa	HP ~120ft	Hardrock	24.73932	84.59402	08.01.2024	BDL	0.084	BDL	BDL	BDL	BDL	BDL	0.008
145	Aurangabad	Madanpur	Parsa	BW ~125ft	Hardrock	24.73762	84.59286	08.01.2024	BDL	BDL	BDL	BDL	BDL	BDL	0.002	0.004
146	Aurangabad	Madanpur	Chanki Bigha	BW	Hardrock	24.71493	84.59250	08.01.2024	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.007
147	Aurangabad	Rafiganj	Thekahi	HP ~32ft	Alluvium	24.73167	84.64665	08.01.2024	BDL	0.131	BDL	BDL	0.506	BDL	0.002	0.034
148	Aurangabad	Rafiganj	Thekahi	BW ~155ft	Hardrock	24.73222	84.64668	09.01.2024	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.043
149	Aurangabad	Rafiganj	DomanBigha, Balar Tola	HP ~110ft	Hardrock	24.74074	84.63932	09.01.2024	BDL	0.267	BDL	BDL	BDL	BDL	BDL	0.048
150	Aurangabad	Rafiganj	DomanBigha, Balar	DW	Alluvium	24.74132	84.63749	09.01.2024	BDL	BDL	BDL	BDL	BDL	0.003	BDL	0.042
151	Aurangabad	Rafiganj	Chandauli	HP ~105ft	Hardrock	24.75012	84.63044	09.01.2024	BDL	BDL	0.074	BDL	BDL	0.002	BDL	0.006
152	Aurangabad	Rafiganj	Chandauli	BW ~150ft	Hardrock	24.75022	84.62984	09.01.2024	BDL	BDL	BDL	BDL	BDL	0.004	BDL	0.004
153	Aurangabad	Rafiganj	Mathparia	BW ~150ft	Hardrock	24.76119	84.62850	09.01.2024	BDL	0.355	BDL	BDL	0.106	BDL	0.006	BDL
154	Aurangabad	Rafiganj	Batura	HP ~100ft	Alluvium	24.76413	84.62046	09.01.2024	BDL	0.898	BDL	BDL	0.153	BDL	0.002	0.004
155	Aurangabad	Rafiganj	Akoni	TW ~150ft	Alluvium	24.76791	84.56690	09.01.2024	0.003	BDL	BDL	BDL	BDL	BDL	BDL	0.007
156	Aurangabad	Rafiganj	Akoni	DW	Alluvium	24.76929	84.56008	09.01.2024	BDL	0.052	0.790	BDL	BDL	0.005	BDL	BDL
157	Aurangabad	Rafiganj	Kona	HP ~80ft	Alluvium	24.77560	84.54892	09.01.2024	BDL	0.125	BDL	BDL	0.060	BDL	BDL	0.007
158	Aurangabad	Rafiganj	Tikri	HP	Alluvium	24.79384	84.54125	09.01.2024	BDL	1.546	BDL	BDL	1.206	BDL	0.003	0.009
159	Aurangabad	Rafiganj	Asha Bigha	HP ~80ft	Alluvium	24.81510	84.52965	09.01.2024	0.002	0.327	BDL	BDL	0.322	BDL	0.001	0.004
160	Aurangabad	Rafiganj	Madar river	river	Alluvium	24.82027	84.52371	10.01.2024	BDL	0.155	BDL	BDL	BDL	0.001	BDL	BDL
161	Aurangabad	Rafiganj	Kajpa	DW	Alluvium	24.82305	84.52364	10.01.2024	BDL	BDL	BDL	BDL	BDL	0.001	BDL	0.016
162	Aurangabad	Rafiganj	Kajpa	HP ~55ft	Alluvium	24.82566	84.52321	10.01.2024	BDL	0.477	BDL	BDL	0.124	BDL	BDL	0.006
163	Aurangabad	Rafiganj	Kajpa	BW ~200ft	Hardrock	24.82683	84.52210	10.01.2024	0.002	BDL	BDL	BDL	BDL	BDL	BDL	0.008
164	Aurangabad	Rafiganj	Jakhim	HP	Alluvium	24.83796	84.52599	10.01.2024	0.002	0.301	BDL	BDL	0.139	0.001	BDL	0.004

S. No.	District	Block	Location	Source	Aquifer	Latitude	Longitude	Date of collection	Cr	Fe	Mn	Cu	Zn	As	Pb	U
									mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
165	Aurangabad	Rafiganj	Jakhim	HP ~115ft	Alluvium	24.83662	84.52547	10.01.2024	BDL	0.646	0.090	BDL	1.871	0.001	0.005	BDL
166	Aurangabad	Rafiganj	Saira	TW ~80ft	Alluvium	24.87088	84.52363	10.01.2024	BDL	BDL	BDL	BDL	BDL	BDL	0.001	0.005
167	Aurangabad	Rafiganj	Prasdih	HP ~60ft	Alluvium	24.88975	84.52552	10.01.2024	BDL	0.196	BDL	BDL	BDL	BDL	BDL	BDL
168	Aurangabad	Rafiganj	Rampur Parasiya	HP ~60-70ft	Alluvium	24.89679	84.52801	10.01.2024	0.001	0.365	BDL	0.070	0.179	BDL	0.006	0.004
169	Aurangabad	Rafiganj	Harbansa Bigha	DW	Alluvium	24.89721	84.51154	10.01.2024	BDL	0.203	1.144	BDL	BDL	0.009	0.001	BDL
170	Aurangabad	Rafiganj	Harbansa Bigha	TW ~135 ft	Alluvium	24.89685	84.51187	10.01.2024	BDL	0.119	0.153	BDL	0.269	BDL	0.002	0.003
171	Aurangabad	Rafiganj	Banka	HP ~60ft	Alluvium	24.90850	84.53358	10.01.2024	BDL	0.164	BDL	BDL	BDL	BDL	BDL	0.006
172	Aurangabad	Rafiganj	Temura	HP ~100ft	Alluvium	24.90205	84.55250	10.01.2024	BDL	0.182	BDL	BDL	BDL	BDL	BDL	0.012
173	Aurangabad	Rafiganj	Choti English	HP ~70-80ft	Alluvium	24.91266	84.52236	10.01.2024	0.001	0.386	BDL	BDL	0.205	BDL	0.002	BDL
174	Aurangabad	Rafiganj	Narhi Pirhi	HP ~120ft	Alluvium	24.92414	84.52449	10.01.2024	BDL	0.639	0.412	BDL	0.098	BDL	0.001	0.006
175	Aurangabad	Rafiganj	Kurwan	HP ~70ft	Alluvium	24.93415	85.56104	10.01.2024	BDL	0.095	0.253	BDL	BDL	0.002	BDL	BDL
176	Aurangabad	Rafiganj	Kurwan	PHED ~280ft	Alluvium	24.93287	84.56179	10.01.2024	0.003	BDL	BDL	BDL	BDL	BDL	BDL	0.006
177	Aurangabad	Rafiganj	Barpa	DW	Alluvium	24.96011	84.55964	10.01.2024	BDL	BDL	BDL	BDL	BDL	0.002	BDL	BDL
178	Aurangabad	Rafiganj	Barpa	TW ~115ft	Alluvium	24.95986	84.55968	10.01.2024	BDL	0.981	BDL	BDL	0.770	BDL	BDL	0.005
179	Aurangabad	Rafiganj	Bibpur	TW ~144ft	Alluvium	24.78635	84.51465	11.01.2024	BDL	0.167	BDL	BDL	BDL	BDL	0.001	0.008
180	Aurangabad	Rafiganj	Bibpur	PHED ~165ft	Alluvium	24.78669	84.51467	11.01.2024	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.010
181	Aurangabad	Rafiganj	Garwa	HP ~100ft	Alluvium	24.80740	84.56048	11.01.2024	BDL	0.513	BDL	BDL	1.878	BDL	BDL	0.005
182	Aurangabad	Rafiganj	Garwa	pond	Alluvium	24.80741	84.56031	11.01.2024	BDL	0.234	0.060	BDL	BDL	0.002	BDL	BDL
183	Aurangabad	Rafiganj	Ballu Khaira	TW ~180ft	Alluvium	24.81034	84.58035	11.01.2024	0.002	BDL	BDL	BDL	BDL	BDL	BDL	0.007
184	Aurangabad	Rafiganj	Niman	HP	Alluvium	24.79080	84.63659	11.01.2024	BDL	0.592	BDL	BDL	0.166	BDL	BDL	0.007
185	Aurangabad	Rafiganj	Niman Chaturbhuja	PHED ~240ft	Alluvium	24.79079	84.63992	11.01.2024	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.011
186	Aurangabad	Rafiganj	Deokuli	HP ~35ft	Alluvium	24.77187	84.65991	11.01.2024	BDL	0.233	0.095	BDL	BDL	BDL	BDL	0.009
187	Aurangabad	Rafiganj	Deokuli Jarha	pond	Alluvium	24.77188	84.65942	11.01.2024	0.005	2.951	0.052	BDL	BDL	0.001	0.003	BDL
188	Aurangabad	Rafiganj	Deokuli	PHED ~180ft	Hardrock	24.77473	84.65983	11.01.2024	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.013
189	Aurangabad	Rafiganj	Aurwan	HP ~35ft	Alluvium	24.82151	84.67894	11.01.2024	0.002	1.105	BDL	BDL	BDL	BDL	0.001	0.006
190	Aurangabad	Rafiganj	Aurwan	TW ~130ft	Alluvium	24.82166	84.67853	11.01.2024	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.006
191	Aurangabad	Rafiganj	Lahas (Banauli)	TW ~180ft	Alluvium	24.81577	84.68977	11.01.2024	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.006
192	Aurangabad	Rafiganj	Banauli	DW	Alluvium	24.81462	84.69284	11.01.2024	BDL	0.075	0.067	BDL	BDL	0.001	BDL	0.011

S. No.	District	Block	Location	Source	Aquifer	Latitude	Longitude	Date of collection	Cr	Fe	Mn	Cu	Zn	As	Pb	U
									mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
193	Aurangabad	Rafiganj	Dadhar	DW	Alluvium	24.80692	84.65726	11.01.2024	BDL	0.357	BDL	BDL	BDL	BDL	0.001	0.010
194	Aurangabad	Rafiganj	Dadhar	BW ~160ft	Hardrock	24.80815	84.65684	11.01.2024	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.014
195	Aurangabad	Rafiganj	Chewan	HP ~120ft	Alluvium	24.78787	84.66690	11.01.2024	BDL	2.274	BDL	BDL	BDL	BDL	BDL	0.019
196	Aurangabad	Rafiganj	Chewan	HP ~200-230ft	Hardrock	24.78620	84.66619	11.01.2024	0.002	1.989	0.060	BDL	0.248	BDL	0.011	BDL
197	Aurangabad	Rafiganj	Kotwara	PHED ~160ft	Alluvium	24.83497	84.55968	12.01.2024	0.002	BDL	BDL	BDL	0.055	BDL	BDL	0.005
198	Aurangabad	Rafiganj	Kotwara	HP	Alluvium	24.83110	84.56489	12.01.2024	0.001	0.248	BDL	BDL	BDL	BDL	BDL	0.006
199	Aurangabad	Rafiganj	Bishunpur	DW	Alluvium	24.84156	84.54920	12.01.2024	BDL	BDL	BDL	BDL	BDL	0.003	BDL	0.004
200	Aurangabad	Rafiganj	Indrapuri Barrage Canal	Canal	Alluvium	24.84093	84.55910	12.01.2024	BDL	0.258	BDL	BDL	BDL	BDL	BDL	BDL
201	Aurangabad	Rafiganj	Santhua	PHED ~230ft	Alluvium	24.85842	84.56685	12.01.2024	0.002	BDL	BDL	BDL	BDL	BDL	BDL	0.007
202	Aurangabad	Rafiganj	Santhua	DW	Alluvium	24.85880	84.56688	12.01.2024	BDL	0.071	BDL	BDL	BDL	0.004	BDL	BDL
203	Aurangabad	Rafiganj	Bihta	TW ~120ft	Alluvium	24.86518	84.57274	12.01.2024	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
204	Aurangabad	Rafiganj	Kutkuri	HP ~85ft	Alluvium	24.86947	84.56404	12.01.2024	BDL	1.515	0.105	BDL	BDL	BDL	BDL	0.004
205	Aurangabad	Rafiganj	Kutkuri	HP ~110ft	Alluvium	24.86912	84.56183	12.01.2024	0.001	BDL	BDL	BDL	BDL	BDL	BDL	0.004
206	Aurangabad	Rafiganj	Chandrahta	TW ~175ft-180ft	Alluvium	24.82400	84.59951	12.01.2024	0.002	BDL	BDL	BDL	BDL	BDL	BDL	0.007
207	Aurangabad	Rafiganj	Labhri	TW ~180ft	Alluvium	24.82320	84.61269	12.01.2024	BDL	BDL	BDL	0.110	0.195	BDL	0.013	0.012
208	Aurangabad	Rafiganj	Gulab Bigha	TW ~165ft	Alluvium	24.83588	84.61588	12.01.2024	0.002	BDL	BDL	BDL	BDL	BDL	BDL	0.009
209	Aurangabad	Rafiganj	Rafiganj Abdulpur	TW ~120ft	Alluvium	24.81669	84.63064	12.01.2024	0.002	1.174	BDL	BDL	BDL	BDL	BDL	0.021
210	Aurangabad	Rafiganj	Rafiganj Abdulpur	BW ~200ft	Hardrock	24.81657	84.63087	12.01.2024	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.017

Note: BDL- Below Detection Limit i.e. For Cu <0.02 mg/L; for Mn, Zn, Fe <0.05 mg/L; for Pb, As, Cr <0.001 mg/L; for U <0.003 mg/L

Annexure 11: List of locations with fluoride concentration more than permissible limit (>1.5mg/l)

S.No	District	BLOCK	LOCATION	Source	Aquifer	Lat	Long	F
1	Aurangabad	Madanpur	Kusaha	DW	Alluvium	24.678372	84.533968	1.5
2	Aurangabad	Madanpur	Jhari Nadi	River	Surface Water	24.669289	84.549546	1.6
3	Aurangabad	Madanpur	Kolhua	DW	Alluvium	24.683538	84.606272	3.9
4	Aurangabad	Madanpur	Bhuyian Bigha	DW ~25ft	Alluvium	24.719947	84.608057	3.4
5	Aurangabad	Madanpur	Bhuyian Bigha	DW ~25ft	Alluvium	24.710655	84.61995	1.6
6	Aurangabad	Madanpur	Pirbihga	DW	Alluvium	24.724493	84.630577	1.6
7	Aurangabad	Madanpur	Hari Bigha	HP ~65ft	Alluvium	24.694178	84.614652	1.8
8	Aurangabad	Madanpur	Hari Bigha	PHED BW~150-200ft	Hardrock	24.695646	84.613409	2.6
9	Aurangabad	Madanpur	Rasalpur	BW~125ft	Hardrock	24.680475	84.478855	2.3
10	Aurangabad	Madanpur	Belma	TW ~50ft	Alluvium	24.625073	84.476568	1.5
11	Aurangabad	Madanpur	Khesar river	River	Surface Water	24.697671	84.488339	1.9
12	Aurangabad	Madanpur	Damri Bigha	PHED ~240ft	Hardrock	24.64551	84.511785	1.5
13	Aurangabad	Madanpur	Gaura	PHED ~250ft	Hardrock	24.640269	84.503111	1.7
14	Aurangabad	Madanpur	Gaura	HP ~50ft	Alluvium	24.639148	84.501491	1.6
15	Aurangabad	Madanpur	Nima Anjan	HP ~40ft	Alluvium	24.641332	84.520837	1.5
16	Aurangabad	Madanpur	Nima Anjan	PHED ~300ft	Hardrock	24.640258	84.521199	1.6
17	Aurangabad	Madanpur	Sahiari	HP ~95ft	Alluvium	24.593242	84.514507	1.5
18	Aurangabad	Madanpur	Nawadih	HP ~100ft	Alluvium	24.597901	84.510964	1.7
19	Aurangabad	Madanpur	Chariya	HP ~60ft	Alluvium	24.599785	84.493422	2.1
20	Aurangabad	Madanpur	Siraundha Tola	HP ~150ft	Fractured/hardrock	24.627934	84.573104	3.5
21	Aurangabad	Madanpur	Siraundha Tola	BW ~150ft	Fractured/hardrock	24.627268	84.573671	1.6
22	Aurangabad	Madanpur	Siraundha Tola	HP ~35ft	Alluvium	24.627923	84.573522	1.6
23	Aurangabad	Madanpur	Siraundha	HP ~35ft	Alluvium	24.628779	84.570666	1.7
24	Aurangabad	Madanpur	Munshi Bigha	HP ~80ft	Alluvium	24.623637	84.562335	1.6
25	Aurangabad	Madanpur	Badam	HP ~70-75ft	Alluvium	24.616736	84.567966	1.6
26	Aurangabad	Madanpur	Rama Bandh	HP ~80ft	Alluvium	24.609118	84.539015	1.5
27	Aurangabad	Madanpur	Sri Rampur	HP ~250ft	Hardrock	24.642596	84.593975	1.7
28	Aurangabad	Madanpur	Sri Rampur	BW ~300ft	Hardrock	24.642635	84.593822	1.6
29	Aurangabad	Madanpur	Sri Rampur	PHED	Hardrock	24.641457	84.593697	1.6
30	Aurangabad	Madanpur	Pararaiya	BW ~160ft	Hardrock	24.658815	84.603158	1.7
31	Aurangabad	Madanpur	Belbigha	PHED ~250ft	Hardrock	24.693245	84.588072	1.6
32	Aurangabad	Madanpur	Ratan Bigha	HP ~80ft	Alluvium	24.724518	84.568158	1.6

S.No	District	BLOCK	LOCATION	Source	Aquifer	Lat	Long	F
33	Aurangabad	Madanpur	Teka Bigha	DW	Alluvium	24.688432	84.694073	1.9
34	Aurangabad	Madanpur	Teka Bigha	BW ~140ft	Hardrock	24.683123	84.694567	2
35	Aurangabad	Rafiganj	Chiraila	TW ~100ft	Alluvium	24.739497	84.720627	1.9
36	Aurangabad	Rafiganj	Dholikhap	HP ~50ft	Alluvium	24.736435	84.67945	1.7
37	Aurangabad	Rafiganj	Dholikhap	HP ~45ft	Alluvium	24.731759	84.681916	1.7
38	Aurangabad	Rafiganj	Baghaura	PHED ~255ft	Alluvium	24.711997	84.707248	2
39	Aurangabad	Rafiganj	Baghaura	DW	Alluvium	24.712463	84.707089	1.9
40	Aurangabad	Madanpur	Tetaria	DW	Alluvium	24.713638	84.688883	2
41	Aurangabad	Rafiganj	Khaira Firoz	HP ~120ft	Hardrock	24.738325	84.662363	1.8
42	Aurangabad	Rafiganj	Khaira Firoz	PHED ~250ft	Hardrock	24.738116	84.662089	1.7
43	Aurangabad	Rafiganj	Bishambharpur	HP	Hardrock	24.758088	84.604102	1.7
44	Aurangabad	Rafiganj	Bishambharpur	BW ~150ft	Hardrock	24.755416	84.608134	1.6
45	Aurangabad	Madanpur	Parsa	HP ~120ft	Hardrock	24.739316	84.594018	1.6
46	Aurangabad	Madanpur	Parsa	BW ~125ft	Hardrock	24.737622	84.592862	1.5
47	Aurangabad	Madanpur	Chanki Bigha	BW	Hardrock	24.714925	84.592497	1.6
48	Aurangabad	Rafiganj	Thekahi	HP ~32ft	Alluvium	24.73167	84.646645	1.7
49	Aurangabad	Rafiganj	Thekahi	BW ~155ft	Hardrock	24.732222	84.646679	1.6
50	Aurangabad	Rafiganj	Doman Bigha, Balar	DW	Alluvium	24.741318	84.637493	1.8