Academic Year 2022-23

6.5
Water in the Community

6.5.5 Cooperation on Water Security

MRIIRS Weblink to SDG 6:

https://mriirs.edu.in/sdg06-clean-water-and-sanitation/

Cooperation of MRIIRS with Local, Regional, National or Global Governments on Water Security:

MRIIRS have developed cooperation on water security at local, regional and national level:

- ✓ Manav Rachna Centre for Advanced Technology and Management (MRCAWTM) is having active coordination with Faridabad Smart City Ltd, Faridabad Municipal Corporation and Faridabad Metropolitan Development Authority in solving water issues of the city.
- ✓ MRIIRS is working with Haryana Irrigation and Water Resource Department (IWRD) Panchkula in implementing Atal Bhujal Yojna Haryana as District Implementation Partner for Faridabad, Rewari and Palwal districts of Haryana State of India towards sustainable development of groundwater through participatory Ground Water management by formulating Gram Panchayat level Water Security Plan.
- ✓ MRCAWTM is also working with DST (Department of Science and Technology, Government of India) and has worked with National Institute of Urban Affairs funded research projects towards solving real time water security issues.

As evidence in support to 6.5.5 Letter of Approvals, agreements, reports with pictures, NOC, brochure of Manav Rachna Centre for Advanced Water Technology and Management etc, exists. All the data are available in public domain through, newspaper & web site of MRIIRS.

Details of Cooperation of MRIIRS with Local, Regional, National or Global Governments on Water Security:

S. No	Project Details	Funding Agency	From Date & Period	Objective	Region wise Corporation on Water Security
1	Co-Solving Water Logging and Groundwater depletion issue in parts of Faridabad Smart City	WTI, DST, Govt of India	(Ongoing) 21-05-2021	DST Project on solution to flash flood and groundwater (GW) depletion	**Local**
2	Hydro Geological Survey for Aquifer Monitoring in Barmer Area, Rajasthan	Cairn Oil & Gas Vedanta Ltd	(Ongoing) 02-07-2021 36 months	Industrial project on impact study on GW use	**National**
3	Haryana Atal Bhujal Yojna- Cluster 06 (Faridabad-Rewari Districts)	IWRD Haryana	(Ongoing) 11-8-2021 48 months	Haryana Govt Project on improving sustainability of GW through participatory approach at Gram panchayat level in Haryana	**Regional**
4	Haryana Atal Bhujal Yojna- Cluster 07 (Palwal District)	IWRD Haryana	(Ongoing) 11-08-2021 48 months	Haryana Govt Project on improving sustainability of GW through participatory approach at Gram panchayat level in Haryana	**Regional**
5	Haryana Jal Jeevan Mission-State Implementation Support Agency (SISA)	PHED Haryana	(Ongoing) 27-09-2021 24 months	Haryana Govt Project on assured household water supply in rural Haryana	**Regional**
6	Haryana Jal Jeevan Mission-Energy Audit State Implementation Support Agency	PHED Haryana	(Ongoing) 01-11-2022 12 months	Haryana Govt project on auditing energy consumption for GW abstraction	**Regional**
7	Groundwater condition study in core and buffer zone of proposed Iron ore mine around Villages, Eklama, District Kabirdham	WCS Bhubaneswar	(Ongoing) 01-07-2023 04 months	Impact assessment of mining on GW for NOC under CGWA accreditation.	**National**
8	Technical guidance in construction of Rainwater Harvesting Structures in Faridabad City	M/s Navjyoti Foundation, Gurugram	Completed on (29.03.2023)	Rainwater conservation	**Local**

9	Impact assessment of mining of Iron core on GW in and around Raikela Sundargarh Odisha.	M/s WCS Bhubaneshwar, Odissa	Completed on (08.10.2022 04 months)	Impact assessment of Mining on GW	**National**

All this work is being carried out with the lead of Manav Rachna Centre for Advanced Water Technology and Management (MRCAWTM). The brochure of MRCAWTM highlighting the summary of work being carried out during the academic year 2022-23 is provided. Page No. 5

Cooperation of MRIIRS with Local Government on Water Security Page No. 13

Cooperation of MRIIRS with Regional Government on Water Security Page No. 27

Cooperation of MRIIRS with National Government on Water Security Page No. 66

Manav Rachna International Institute of Research and Studies

NAAC A++Grade, Deemed-to be- University

BROCHURE

Manav Rachna Centre for Advance Water Technology & Management (MRCAWTM)

July 2023

ABOUT THE CENTRE

Manav Rachna Centre for Advance Water Technology & Management (**MRCAWTM**) was established in 2017 to pursue teaching, research, consultancy and impart training programmes in hydrogeology, water resources engineering and management, water quality and collateral environment and ecology issues. The Centre forms a pool of professionals and researchers from the field of hydrology, hydrogeology, hydrochemistry, eco-hydrology and environment management. Besides, the Center has also developed a skill set on community centric water resource development, socio-hydrology and watershed based sustainable management. The Center aims to address real challenges faced by the stakeholders and also provides a platform for science and technology-based solutions through non-invasive investigation, water quality analysis, recycling of waste water, surface and ground water flow and resource analysis, satellite databased interpretation, local and regional scale hydro-statigraphic analysis, mathematical modeling of water resources and GIS based applications.

Aqua Excellence Awardee 2017

MRCAWTM is having five field units, one each at Barmer, Ballabhgarh, Khol-Rewari, Palwal and Panchkula where two to ten field specialists are working. MRCAWTM in its short period of journey, has been able to achieve significant milestones in the form of projects obtained, executed, and completed. So far 16 projects have been successfully completed between June 2018 and June 2023 of worth ~Rs2.63 Cr. Further, 07 more projects of Rs 12.34 Cr are in progress as on 1st July 2023. MRCAWTM is working for its vision of **clean water for all forever.** The major area of work is divided into 1. R&D Studies, 2. Technical Interventions, 3. Training and Capacity Building, 4. Outreach programs, 5. Product and Innovation. The Center has also established linkage with various Governmental, academic, and non-Governmental agencies through MoUs.

Vision: "Clean water for all forever" (सदा सबके लिए शुद्ध जल)

MRCAWTM has been able to **achieve Accreditation of CGWA, GOI** on 1st Oct 2021 for next 5 yrs. MRCAWTM has grabbed the **Aqua Foundation Excellence Award, 2017** under the category of Institutional Excellence in Resource Management. The faculties of Center have published high impact research papers in National and International Scientific Journals and written Books and Book chapters of reputed publishers.

Accreditation Board of CGWA

Certificate of Accreditation

M/s. Manav Rachna Centre for Advance Water Technology and Management, (MRCAWTM) of (MRIIRS)

Has been accredited as a Ground Water Professionals to prepare reports in the Functional Areas of

- Impact Assessment Report without Modelling.
- Hydrogeological Report for mining projects.

Valid from : 01.10.2021 Certificate No. : CGWA/RG1/025

Valid thru : 30.09.2026 Dated : 30.11.2021

क्षेत्रीय निदेशक
Regional Director
आरजीएनजीडब्ल्यूटीआरआई
RGNGWT&RI

सदस्य
Member
आरजीएनजीडब्ल्यूटीआरआई
RGNGWT&RI

MOUs OF CENTER

Active MOUs of MR Center for Advance Water Technology and Management, MRIIRS

SNo	Name of Organization	Date of MOU	Activates Taken up under MOU	Valid for
1	Central Ground Water Board, MoJS, GOI	26.06.2020	Faculty exchange- CGWB Scientists were invited as External Examiners, MRIIRS Civil Eng, students visited CGWB Campus. MRCAWTM experts attended group discussion at CGWB, Joint Water Summit 2023 on 24th Feb23.	2 Years further Extended
2	Geovale Services Kolkata	18.08.2021	Geovale used our expertise on Rockworks for their project, MRCAWTM experts invited to attend one day workshop at Kolkata on 18th Jan23	4 Years
3	EMTRC New Delhi	21.09.2021	MRCAWTM expert assisted EMTRC in fly ash project.	3 Years
4	CAIRNS-Vedanta Oil & Gas Pvt Ltd Gurugram	11.06.2021	Joint monitoring of aquifers of Barmer area through half yearly hydrocensus of about 1000 water wells.	3 Years
5	IWRD, Govt of Haryana	11.08.2021	MRCAWTM is District Implementation Partner of IWRD in participatory ground water management in Gram Panchayat level in three districts of Haryana	4 Years
6	WCS Bhubaneswar	03.03.2022	MRCAWTM conducted 7 consultancy projects of Fe ore mines for WCS during last one year	5 Years
7	SGSD, Gurugram	01.07.2022	SGSD experts carried out civil construction of ASR systems established under MRCAWTM owned DST Project.	1 Year
8	Ministry of Jal Shakti, WR&RD	12.04.2023	Establishing a Program Support Unit for Namami Gange Under National Water Mission	3 Years

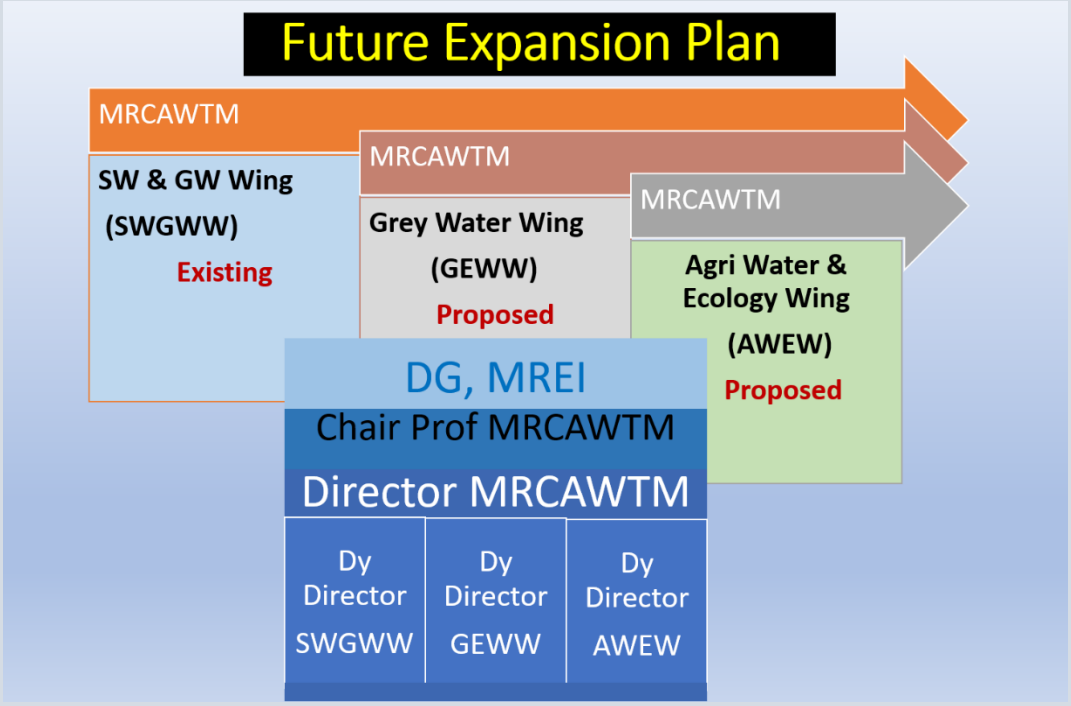
MRCAWTM is accredited under CGWA to prepare reports in the functional areas of
1. Groundwater Impact Assessment 2. Hydrogeological reports of Mining Projects

ON GOING PROJECTS OF MRCAWTM

As on 01st July 2023

Sn.	Ongoing Projects of MRCAWTM, MRIIRS	Funding Agency	From Date & Period	Objective
1	Co-solving Water logging and Groundwater depletion issue in parts of Faridabad Smart City	WTI, DST, GOI	21 .05. 21 36 months	DST Project on solution to flash flood and groundwater (GW) depletion
2	Hydro Geological Survey for Aquifer Monitoring in Barmer Area, Rajasthan,	Cairn Oil & Gas Vedanta Ltd	02.07.21 36 months	Industrial project on impact study on GW use
3	Haryana Atal Bhujal Yojna-Cluster 06 (Faridabad-Rewari Districts)	IWRD Haryana	11.8.2021 48 months	Haryana Govt Project on improving sustainability of GW through participatory approach at Gram panchayat level in Haryana
4	Haryana Atal Bhujal Yojna-Cluster 07 (Palwal District)	IWRD Haryana	11.8.2021 48 months	
5	Haryana Jal Jeevan Mission – State Implementation Support Agency (SISA)	PHED Haryana	27.09.2021 24 months	Haryana Govt Project on assured household water supply in rural Haryana
6	Haryana Jal Jeevan Mission – Energy Audit State Implementation Support Agency	PHED Haryana	01.11.2022 12 months	Haryana Govt project on auditing energy consumption for GW abstraction
7	Groundwater condition study in core and buffer zone of proposed Iron ore mine around Villages, Eklama, District Kabirdham, CG	WCS Bhubaneswar	01.07.2023 04 months	Impact assessment of mining on GW for NOC under CGWA accreditation.

WAY FORWARD



Completed projects under MRCAWTM, as on 30th June 2023

No	Project Name and Status	Funding Agency	Date of Comp.	Objective
1	Technical guidance in construction of Rainwater Harvesting Structures in Faridabad City	M/s Navjoti Foundation, Gurugram	29.03.2023	Rainwater conservation
2	Impact assessment of mining of Iron ore on GW in and around Raikela Sundargarh Odisha.	M/s WCS Bhubaneshwar, Odissa	08.10.2022 04 months	Impact assessment of Mining on GW
3	Impact assessment of mining of Iron ore on GW in and around Dholta Pahar, Sundergarh, Odissa	M/s WCS Bhubaneshwar, Odissa	04.4.2022 08 months	Impact assessment of Mining on GW
4	Impact assessment of mining of Iron ore on GW in and around Netrabandh Pahar, Sundergarh,	M/s WCS Bhubaneshwar, Odissa	04.4.2022 04 months	Impact assessment of Mining on GW
5	Study for Rainwater harvesting around Iron ore mine of Dholta Pahar, Sundergarh, Odissa	M/s WCS Bhubaneshwar, Odissa	04.4.2022 04 months	Study for Rainwater harvesting in Mining area
6	Study for Rainwater harvesting around Iron ore mine of Netrabandh Pahar, Sundergarh, Odissa	M/s WCS Bhubaneshwar, Odissa	04.4.2022 04 months	Study for Rainwater harvesting in Mining area
7	Biodiversity study around Iron ore mine of Dholta Pahar, Sundergarh, Odissa	M/s WCS Bhubaneshwar, Odissa	04.4.2022 04 months	Study for Biodiversity in Mining area
8	Biodiversity study around Iron ore mine of Netrabandh Pahar Sundergarh, Odissa	M/s WCS Bhubaneshwar, Odissa	04.4.2022 04 months	Study for Biodiversity in Mining area
9	Impact assessment of underground mining of Manganese on GW in and around Miragpur, MP.	M/s D P Rai, Balaghat MP	April 2022 3 months	Impact assessment of Mining on GW
10	Impact assessment of underground mining of Manganese on GW in and around Pandarwani, MP.	M/s D P Rai, Balaghat MP	April 2022 3 months	Impact assessment of Mining on GW
11	Hydro Geological Survey for Aquifer Monitoring in Barmer Area, Rajasthan (2018-21).	Cairns O&G Vedanta Ltd	June 2021 36 months	Industrial project on impact study on GW use
12	Communicating Science through Model Water and Eco-Health Clinic for quality of life.	NCSTC, DST, GOI	May 2020 15 months	Water literacy through hands on experiments for students
13	USAID URBAN WASH Innovation Lab,	USAID-NIUA	Dec 2019 30 months	Awareness on water and sanitation
14	Detailed investigations in Khoh Village for Rainwater Harvesting,	MSF, Gurgaon	April, 2019 3months	Sustainable solutions of groundwater use
15	ISP system for treating saline Groundwater-Techno-Commercial, **abandoned** due to Change in policy of State of Haryana on saline water use	Maharani Innovative Paints Pvt Ltd. Prithla	Sept 2020 12 months	Use of saline water through eco-friendly technology
16	Reconnaissance survey for Water prospect in 10 adopted villages of Maruti-Suzuki Foundation	MSF, Gurgaon	Dec 2018	Sustainable solutions of groundwater use

DST FUNDED PROJECT-FARIDABAD

Co- solving Water Logging and Ground Water Depletion Issue in parts of Faridabad Smart City using Underground Taming of Flood Water for Aquifer Storage and Recovery:

WTC-DST GOI Supported Project No-DST/TMD/EWO/WTT/2K19/EWFH/237(G)&(C)

PI: Dr Arunangshu Mukherjee, Director, MRCAWTM and Co-PI: Dr Nidhi Didwania, BT, MRIIRS

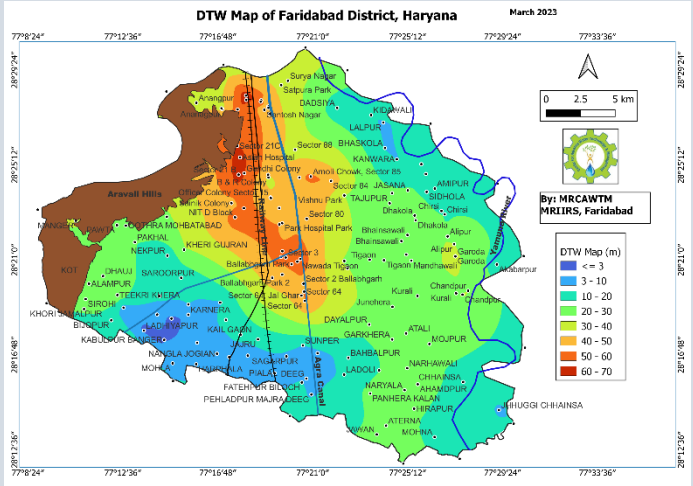
Steps followed for site selection and construction of ASRS at FSC area

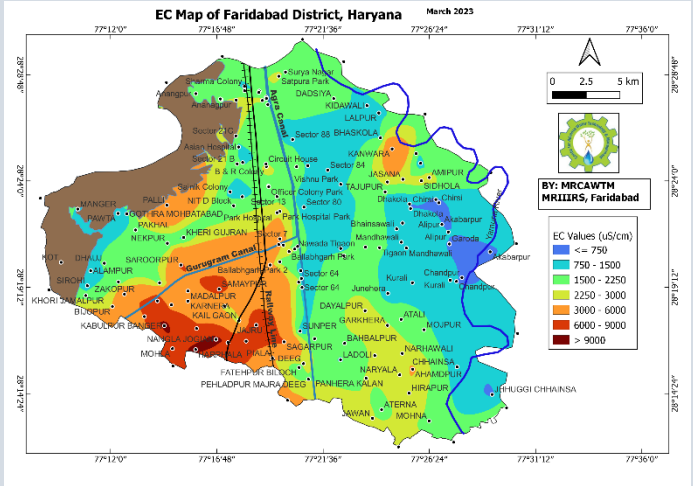
Site selection

1. Joint inspection for finalization of possible locations for construction of ASRS
2. Detailed field investigations on hydrogeology for identification of sites on agreed locations for construction of ASRS
3. Identification and hiring of agencies for Surface geophysical and DGPS study
4. Surface geophysical study and DGPS survey to pin point the site within identified locations.
5. Hydraulic investigations on identified and pinpointed site for catchment delineation
6. Finalization of site for construction of ASRS

Construction of ASRS at FSC area

7. Based on results of detailed hydraulic studies calculated the runoff generation and silt load and dimension of de-siltation, coagulation and filtration chambers for each site.
8. Preparation of working drawing and BOQ for tendering
9. Construction of ASRS involving various steps
    a. Selection of Rig as per the geology of the area for drilling
    b. Drilling of pilot hole on pinpointed site to decipher the aquifer geometry and nature-character of aquifer at selected site and preparation of litho-log
    c. Borehole logging to finalize the well assembly in accordance to the litho-log
    d. Lowing of assembly and construction of gravel pack tube well
    e. Slug test to determine the intake capacity of constructed tube well
    f. Mechanical digging of pits for construction of de-siltation, coagulation and filtration chamber.
    g. Construction of de-siltation, coagulation and filtration chambers as per calculated dimensions given in the working drawing.
    h. Filling of filter material in the filtration chamber constructed around tube well
    i. Roof casting of ASRS
    j. Hanging of Ferric chlorite dope through specially provided hanger in the coagulation chamber
10. Installation of Automatic water level recorder with telemetry at ASRS site
11. Testing of functioning of ASRS during monsoon and finalization of structure.
12. Feedback collection and monitoring of impact and radius influence of the constructed system. Popularization of the concept implemented through various media. Maintenance of constructed ASRS

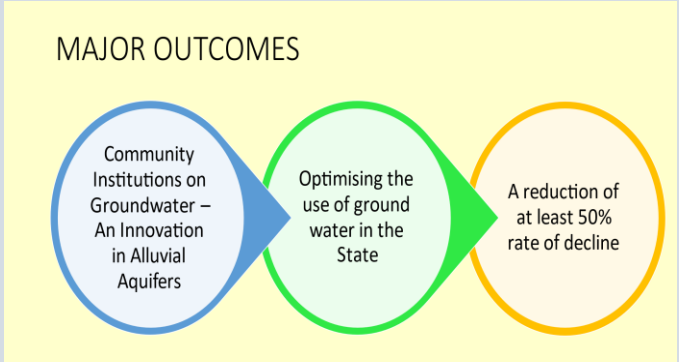




ATAL BHUJAL YOJANA HARYANA

(Sanction no- ABY/2122/26w/952-956 -Cluster06 and Sanction no -ABY/2122/27w/957-961 -Cluster07)

Under World Bank Assisted, Central Sector Scheme of GOI- Atal Bhujal Yojana is being implemented in 14 districts of Haryana by IWRD, Govt of Haryana. MRCAWTM has been engaged as District Implementation Partner for three districts- Faridabad, Rewari and Palwal for an initial duration of 48 months through two projects. The project is about participatory groundwater management utilizing funds through convergence mode. MRCAWTM has to develop Gram Panchayat wise Water Security Plans for 296 GPs of 7 administrative blocks involving Gram Sabha in the planning. The Village Water and Sanitation Committee has to be engaged for data collection for Supply side and Demand Side Management works. The project is approaching to fulfil following objectives:



DESERT HYDROGEOLOGICAL STUDIES-BARMER

Hydrogeological studies in Barmer district covering 5900Km2 for last 5 years is summarised below

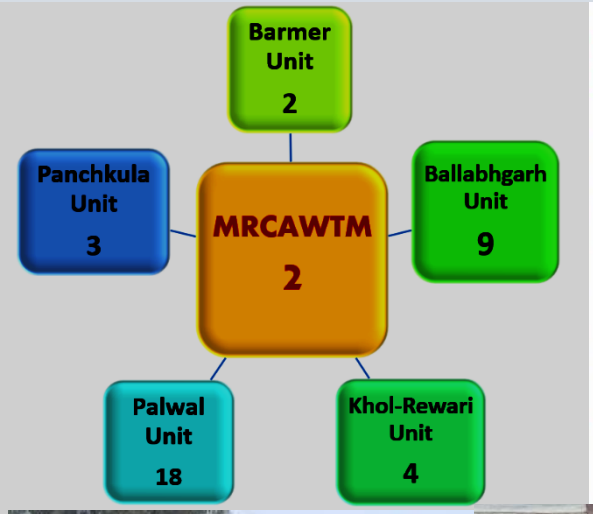
1. **Depth of wells drilled ranges from120 to 165m (Chowkhla 270 m)**
2. **Water level ranges from 82 to 108 mbgl,**
3. **Zone tapped largely from 90 to 163mbgl, at Chowkhla 234-268mbgl**
4. **Length of slotted casing used 24 to 34 m but one 45m**
5. **Dia of casing/ slotted pipe used 254mm, bore hole dia 508mm**
6. **Depth of lowering of pump 90 to 117m by and large**
7. **Pump HP 20 to 30**
8. **Lignite zone found in two locations at Sheo 60 to 64m and at Siyag 136m**
9. **The Jagadia sandstone aquifer at Siyag having water level 72m bgl**

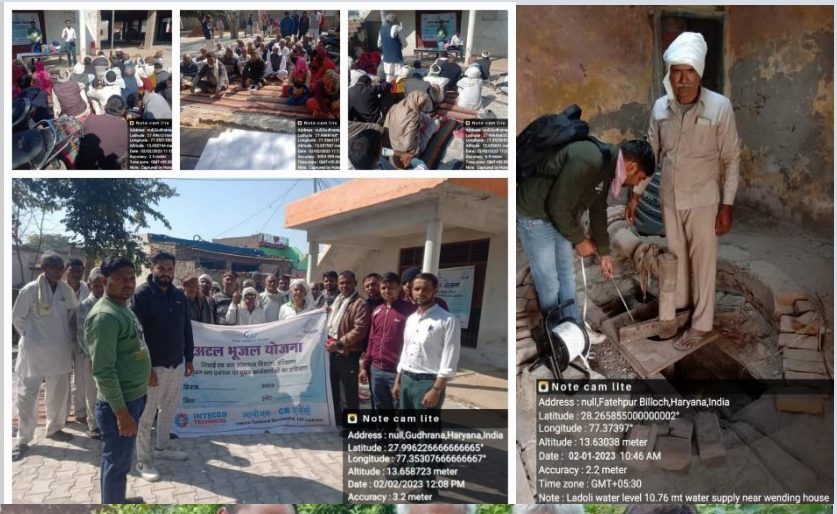
TEAM MRCAWTM

Founder Chair Professor **Late Dr D K Chadha**, Former Chairman CGWB
(13th April 2017- 30th Dec 2020)

Working Team

Overarching leadership	Dr N C Wadhwa, DG, MREI
ED & Dean Research	Dr Sarita Sachdeva, Professor, Biotechnology
Chair Professor	Dr Dipankar Saha, Former Member CGWB
Director	Dr Arunangshu Mukherjee, Prof & Head, ES&E & Former Scientist, CGWB
Dy Director	Ms Sneha Rai, Assistant Prof, ES&E, SET, MRIIRS
Associates:	Prof Nidhi Didwania, Director, MRCMPP Prof Brijesh Kumar, Dean Academics and Dr H S Saini, Former Director GSI
Research Associates:	Dr S Ali Khan, Sh Sandeep Punia & Mrs Priya Pahil
Field Research Team	Barmer-(2) Ballabhgarh (9) Khol-Rewari (4) Palwal (18) and Panchkula (3) TOTAL=39 person





Manav Rachna Center for Advance Water Technology and Management (MRCAWTM),
Manav Rachna International Institute of Research and Studies (MRIIRS),
AT25- Sector-43, Surajkund Road, Faridabad 121004, Haryana, India
Dr Arunangshu Mukherjee, director.cawtm@mriu.edu.in, www.mrcawtm.in

Report

On

Cooperation of MRIIRS with Local Government on Water Security

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEACH AND STUDIES, FARIDABAD

Cooperation of MRIIRS with Local Government on Water Security:

MRCAWTM is having active coordination with Faridabad Smart City Ltd, Faridabad Municipal Corporation and Faridabad Metropolitan Development Authority in solving water issues of the city.

A. Co-solving of Water Logging and Ground Water Depletion Issues in Sector 15A of Faridabad City of Haryana State of India

B. Technical guidance in construction of Rainwater Harvesting Structures in Faridabad City

For detailed report: Click to view

The detailed work done and till date progress is as outlined in the following section.

A. Co-solving of Water Logging and Ground Water Depletion Issues in Sector 15A of Faridabad City of Haryana State of India

MRIIRS with the funding of Department of Science and Technology, Government of India, has created rainwater recharge structure at **officer's colony, sector 15A Faridabad, Haryana, India** for water co-solving logging and groundwater depletion as a pilot project and with the hope to replicate it in entire city area.

A.1 Introduction

Urban waterlogging and groundwater depletion are two diverse but major challenges of Indian cities under changing climatic conditions. The enhanced extreme events of rainfall in recent years along with rapidly altered hydrological conditions in urban environment pose conducive situation for urban water logging. On the other hand, intense and large withdrawal of groundwater, higher than the natural annual recharge has depleted the groundwater level severely in many Indian cities. A pilot project is executed in Faridabad Smart City of National Capital Region India, to combat water logging and to rejuvenate groundwater resource.

In the study all steps were undertaken meticulously, beginning from hydrogeological study, site selection, rainfall analysis, calculations of runoff generation, framing well design after identification of suitable recharge zones within depleted aquifer and determination of its intake capacity. It further elucidates estimation of suitable dimension of desilting chamber, fixing suitable dose of ferric chloride for coagulation and assessment of recharge volume. The constructed recharge system is tested whether it is working effectively as per the feedback obtained from independent sources. It has high scalability in similar hydrogeological situation in other parts of India.

Picture of Actual Waterlogging in the Officer's Colony Area of Sec-15A, Faridabad City of Haryana State of India

A.2 Details of Project:

The project of 36 months duration with 0.7012 crore budget, submitted with the title "**Co-solving water logging and groundwater depletion issues in parts of Faridabad Smart City using Underground Taming of Flood Water for Aquifer Storage and Recovery**" to the Department of Science and Technology, Government of India, got sanctioned to Manav Rachna CAWTM in May 2021.

Motivation and Problem Statement:

Groundwater over extraction due to urbanization and growing population of Faridabad city of India area has depleted its aquifers. In the recent past, increasing extreme events of rainfall and growing paved area has witness huge waterlogging in low lying

parts of city particularly in areas with shallow impervious layers.

Urban waterlogging is a major concern growing fast in India due to an increase in climate-change-related extreme rainfall events. The National Disaster Management Authority has classified urban foods as separate disasters. Urban waterlogging happens in parts of Faridabad Smart City on such a scale that the residents are bound to remain under house arrest for days during heavy pores in monsoons each year. Streets remain submerged under 2-3 feet of water for several hours; transport and movement are totally abandoned. Even if water is removed, mud and dirt persist for several days creating an unhealthy atmosphere and enhancing the risk of waterborne and communicable diseases. A smart solution to a smart city addressing these two critical issues of Faridabad Smart City (FSC) is the need of the hour.

- Under this investigation it was proposed to divert the urban flash flood creating water logging condition and is hampering day-to-day life during monsoon period to improve the groundwater condition within the depleted aquifer. This **aquifer storage and recovery project of taming urban flood water is addressing two critical issues of urban hydrology to improve the sustainability.**
  - ✓ Developing solutions to the street water logging and groundwater depletion through Underground Taming of Flood water (UTF) for Aquifer Storage Recovery (ASR) in Faridabad Smart City.
  - ✓ Identification of suitable aquifer zones for recharge in the Faridabad Smart City

- **Impact Assessment**: Under this sponsored project, MRIIRS with the funding of Department of Science and Technology, Government of India, has created rainwater recharge structure at officer's colony, sector 15A Faridabad, Haryana, India for water co-solving logging and groundwater depletion as a pilot project and with the hope to replicate it in entire city area.
  - ✓ Real time monitoring of groundwater level, temperature, and electrical conductivity for impact assessment on the ground water system.
  - ✓ Periodic monitoring of groundwater quality to assess the impact of Aquifer Storage and Recovery through comparison of the source water and product

water.

- ✓ To study the reduction in energy consumption for groundwater pumping due to UTF & ASR

- Two locations were identified under FSC area in sector 16A (PWD, B&R colony) and 15A (Officers' colony) in consultation with FSCL and PWD, Faridabad. Here, streets remain submerged under 2-3 feet of water for several hours; transport and movement are totally abandoned. Even if water is removed, mud and dirt persist for several days creating an unhealthy atmosphere and enhancing the risk of waterborne and communicable diseases.
- The newly constructed systems at Officers Colony, Sector 15A, and B&R Colony Sector 16A Faridabad are working absolutely fine and has been tested during last two monsoons. First during 73mm of rainfall on 30th Aug 2022 and is reconfirmed during last two days wide spread rain of 22nd and 23rd Sept 2022 (110mm in 24hr on 22 Sept 2022, IMD). The system collects water first in a de-siltation chamber through a gutter having a baffle wall to reduce silt load and provide laminar flow transfers to the coagulation chamber by gravity for pretreatment of storm water to reduce suspended particles, the water moves further to filtration cum recharge well by gravity flow. From where the silt-free storm water enters to recharge well and transfer to the vadose zone just above the water table by passing a large dry zone to release water through a slotted casing. The water moves to the aquifer travelling through a small part of the vadose zone. It provides a faster absorption rate and safer discharge of rainwater to the aquifer to co-solve two critical water issues in gainful manner.

- Project Investigators: Dr. Arunangshu Mukherjee (Principal Investigator- PI)
  Dr. Nidhi Didwania (Co- PI)
  Ms. Alifia Ibkar, Research Assistant

- **Capacity Building for Replication:** Capacity building of Urban Local Body (ULB) officials such as Municipal Corporation Faridabad (MCF), Haryana Shehri Vikas Pradhikaran (HUDA) & Faridabad Smart City Limited (FSCL) etc related to Underground Taming of Flood water (UTF) for Aquifer Storage Recovery (ASR).

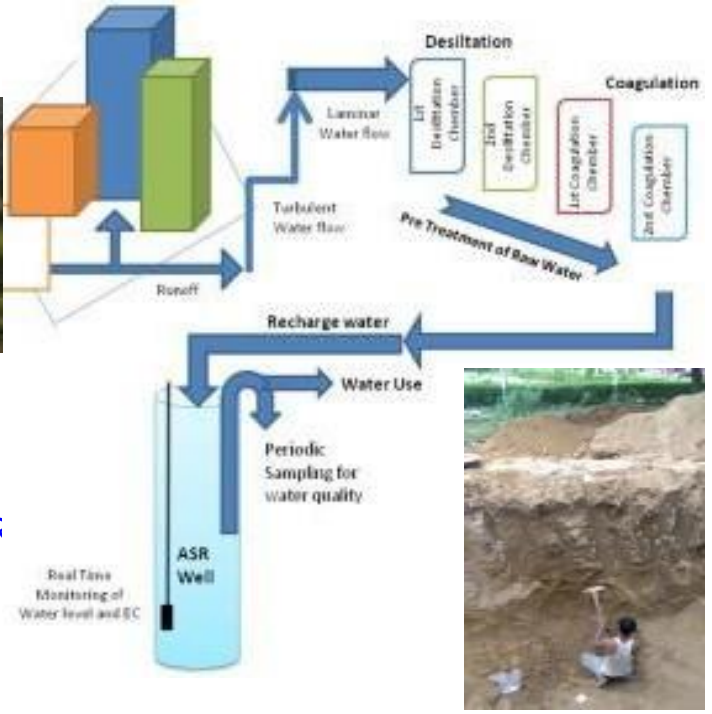
SDG 6- CLEAN WATER AND SANITATION

DEPARTMENT OF SCIENCE & TECHNOLOGY
Ministry of Science & Technology
Government of India

Department of Science and Technology
Technology Missions Division,
Water Technology Initiative Programme
WTI - (Action Research)

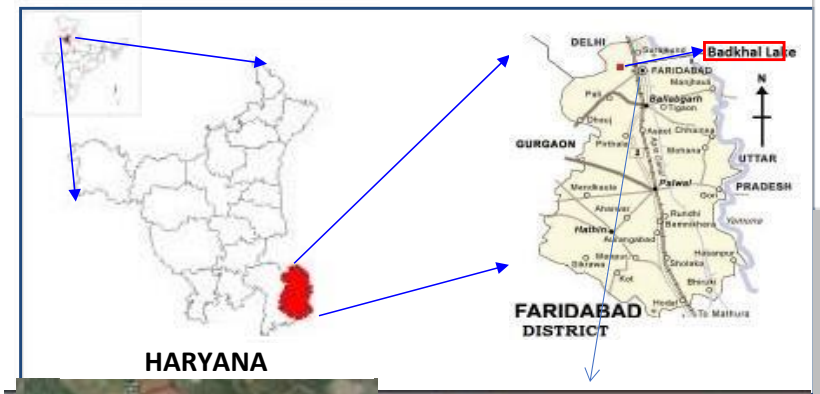
Co–solving Water logging and Groundwater depletion issue in parts of Faridabad S using Underground Taming of Flood water for Aquifer Storage and Recover

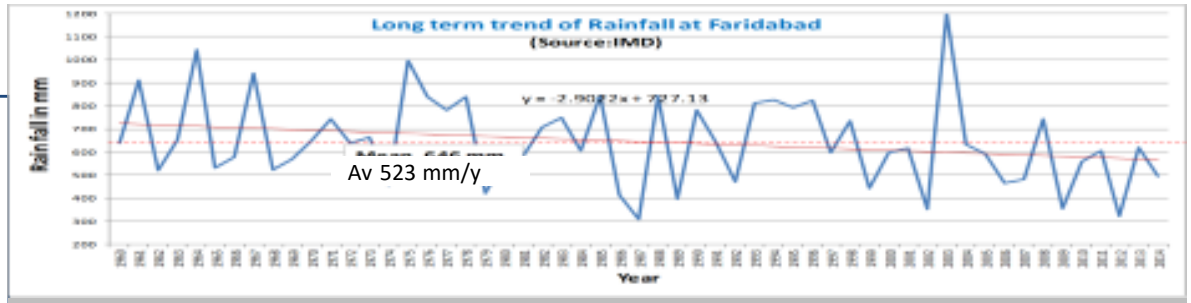
- Topographic survey and DvPX elevation mapping of the area of interest
- Micro level nydrological and nydrogeological study for designing for UTFW during pre monsoon and monsoon period
- Xurface geopnysical Investigation-s VEX & Profiling
- Xtudy for construction of connecting drain, d-esiltation cnambers, coagulation cnamber
- Experiments for selection of suitable Iron based coagulant
- Xtudy for Optimization of flow rate and dosing of coagulan
- Auger nole drilling and slug testing- Vadose zone study
- Drilling of bore nole andlitno sampling
- Xubsurface geopnysical logging
- Well completion and development
- Pumping test for aquifer cnaracterization and well efficiency test
- Collection and analysis of groundwater samples for base level data acquisition
- DWLR witn EC and Temp sensor and installation
- Installation of UTFW system by connection civil construction and drilled well for AX F
- Installation of energy meter and pump
- Water sampling for analysis of regular and emerging pollutants /contaminants
- Impact assessment of UTFW

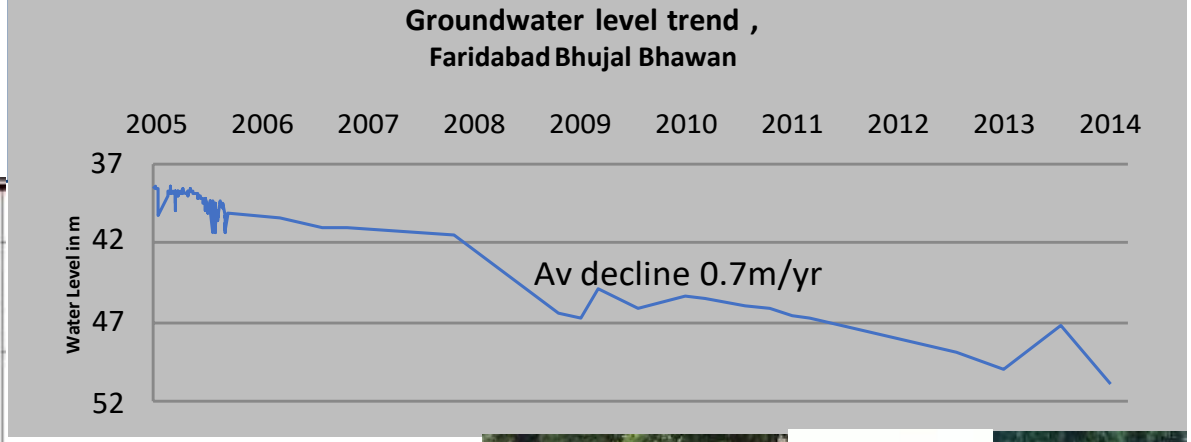


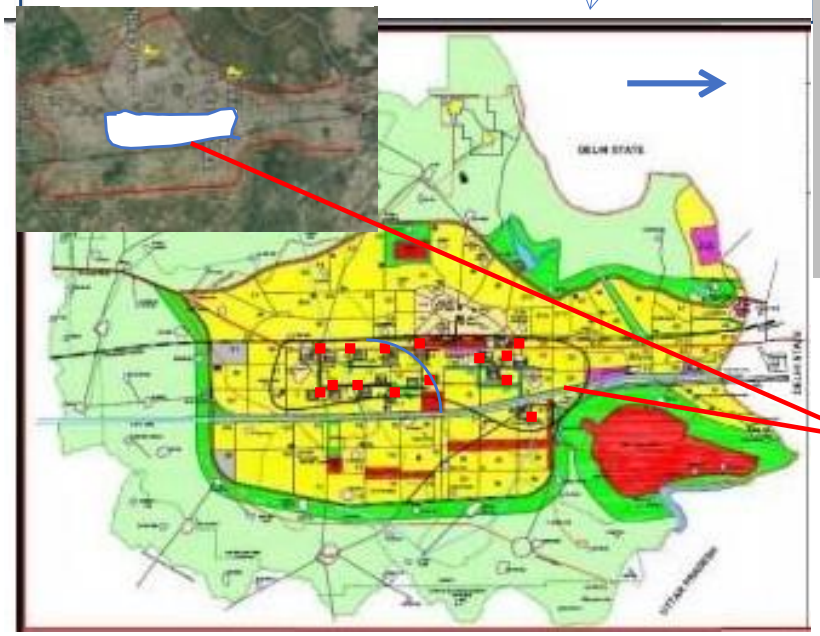
MANAV RACHNA
vidyanatariksha

Faridabad Smart City









Faridabad Area–187Km^2
Population– 16 lakh
Water logging area–17Km^2
Effected population–~3lakh
Present av DTW+40mbgl

SDG 6- CLEAN WATER AND SANITATION

Construction of Structures for Co-solving of Water Logging and Ground Water Depletion Issues in Officer's Colony, Sector 15A of Faridabad City of Haryana State of India

SDG 6- CLEAN WATER AND SANITATION

Inspection of site - Officer's Colony, Sector 15A of Faridabad City of Haryana State of India

SDG 6- CLEAN WATER AND SANITATION

Constructed Structure at Officer's Colony, Sector 15A of Faridabad City of Haryana State of India

Salient features of the project

1. The project is own by MRCAWTM, MRIIRS through Principal Investigator Dr Arunangshu Mukherjee and Co PI Dr Nidhi Didwania
2. The total cost of Project is Rs 70.12 lakh
3. Duration of project is 36 months and the project started in May 2021
4. It is proposed to construct 04 Aquifer Storage and Recovery Structures to co-solve urban water logging and groundwater depletion.
5. Locations were identified considering the waterlogging due to near surface impervious layer in the depleted groundwater areas of Faridabad
6. The area is having over exploited unconfined to semi confined alluvial aquifer
7. In the first phase, two such structures are created in sector 15A and 16A in last two years.
8. Catchment area for each structure is about 3.25ha
9. The suitable subsurface recharge zone has been identified through drilling, well logging and water quality analysis.
10. Each structure has been deigned to absorb maximum up to 2000m3/day rain
11. There are three chambers in this structure (i) de-siltation chamber (ii) coagulation chamber and (iii) filtration cum recharge well
12. The filtered water is released above groundwater table in vadose zone for further natural filtration for safe disposal of recharge water.
13. The structures were tested during the last 2 monsoon period. With about 100mm rainfall in 24 hrs time these structures were able to absorb all generated runoff within few hours.
14. Positive impact has been observed on EC concentration of groundwater in the vicinity of created ASR system
15. The structures have been constructed in the land of PWD and will be handed over to PWD after completion of the project for further maintenance. Faridabad Smart City Limited (FSCL)has helped to obtain NOC for the construction of structures in PWD premises.
16. Positive Feedback has been recorded from the residents of respective colony area about the working of these structures.
17. The success of this pilot project has already created buzz in the area and FMDA (Faridabad Metropolitan Development Authority) shown its keen interest to replicate these systems in about 20 places in Faridabad. A concept note has been submitted by Manav Rachna in this regard.
18. NIUA (National Institute of Urban Affair), New Delhi also keen in replicating the project at suitable localities in Delhi –NCR, discussions are in progress.

Fig Actual pictures of site at Sector 16A B&R Faridabad, before and after construction of ARS System and inauguration event.

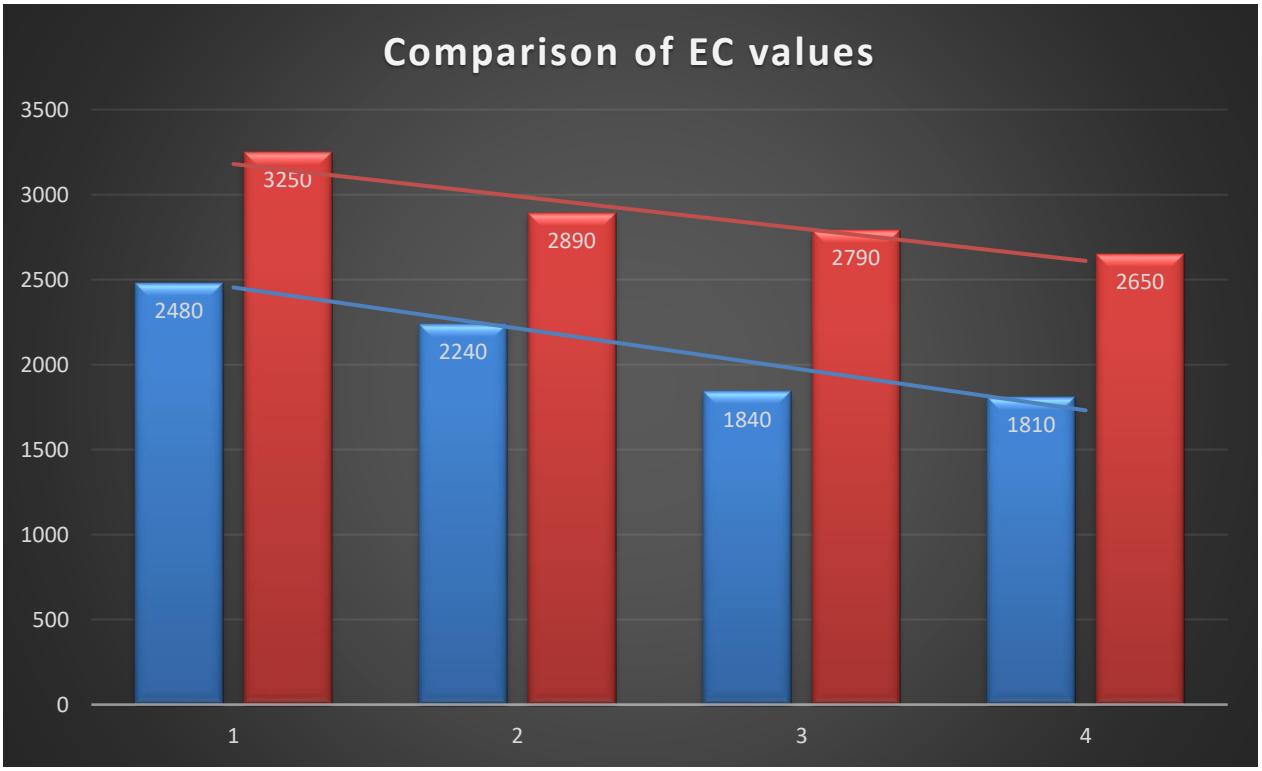


Fig Comparison EC values of two conjunctive years at Officers colony (blue) and B&R Colony (Orange)

Media Coverage:

english.jagran.com/india/dc-faridabad-inaugurates-aquifer-storage-and-recovery-structure-constructed-by-mcawtm-

ENGLISH Jagran

SHARE MARKET TOP DEALS

JE SPECIALS HOME WORLD CUP 2023 ISRAEL-HAMAS WAR LATEST NEWS ENTERTAINMENT LIFESTYLE SPIRITUAL INDIA BUS

DC Faridabad Inaugurates Aquifer Storage And Recovery Structure Constructed By MCAWTM

The silt-free stormwater enters to recharge well and transfers to the vadose zone just above the water table by passing a large dry zone to release water through a slotted casing.

By JE News Desk Published: Sun, 09 Jul 2023 03:51 PM (IST) Source:JND

Facebook Twitter Whatsapp Google News

https://english.jagran.com/india/dc-faridabad-inaugurates-aquifer-storage-and-recovery-structure-constructed-by-mcawtm-10086767

https://indiaeducationdiary.in/manav-rachna-launches-acquifer-storage-recovery-structure-in-presence-of-dc-faridabad/#google_vignette

- ✓ The Project sanction order by Department of Science and Technology is appended.

Report

On

Cooperation of MRIIRS with Regional Government on Water Security

Cooperation of MRIIRS with Government on Water Security at Regional Level:

Project Details	Funding Agency	From Date & Period	Objective	Region wise Corporation on Water Security
Haryana Atal Bhujal Yojna- Cluster 06 (Faridabad-Rewari Districts)	IWRD Haryana	(Ongoing) 11-8-2021 48 months	Haryana Govt Project on improving sustainability of GW through participatory approach at Gram panchayat level in Haryana	**Regional**
Haryana Atal Bhujal Yojna- Cluster 07 (Palwal District)	IWRD Haryana	(Ongoing) 11-08-2021 48 months	Haryana Govt Project on improving sustainability of GW through participatory approach at Gram panchayat level in Haryana	**Regional**
Haryana Jal Jeevan Mission-State Implementation Support Agency (SISA)	PHED Haryana	(Ongoing) 27-09-2021 24 months	Haryana Govt Project on assured household water supply in rural Haryana	**Regional**
Haryana Jal Jeevan Mission-Energy Audit State Implementation Support Agency	PHED Haryana	(Ongoing) 01-11-2022 12 months	Haryana Govt project on auditing energy consumption for GW abstraction	**Regional**

For detailed Report: Click to view

Atal Bhujal Yojna- Cluster 6

Atal Bhujal Yojna- Cluster 7

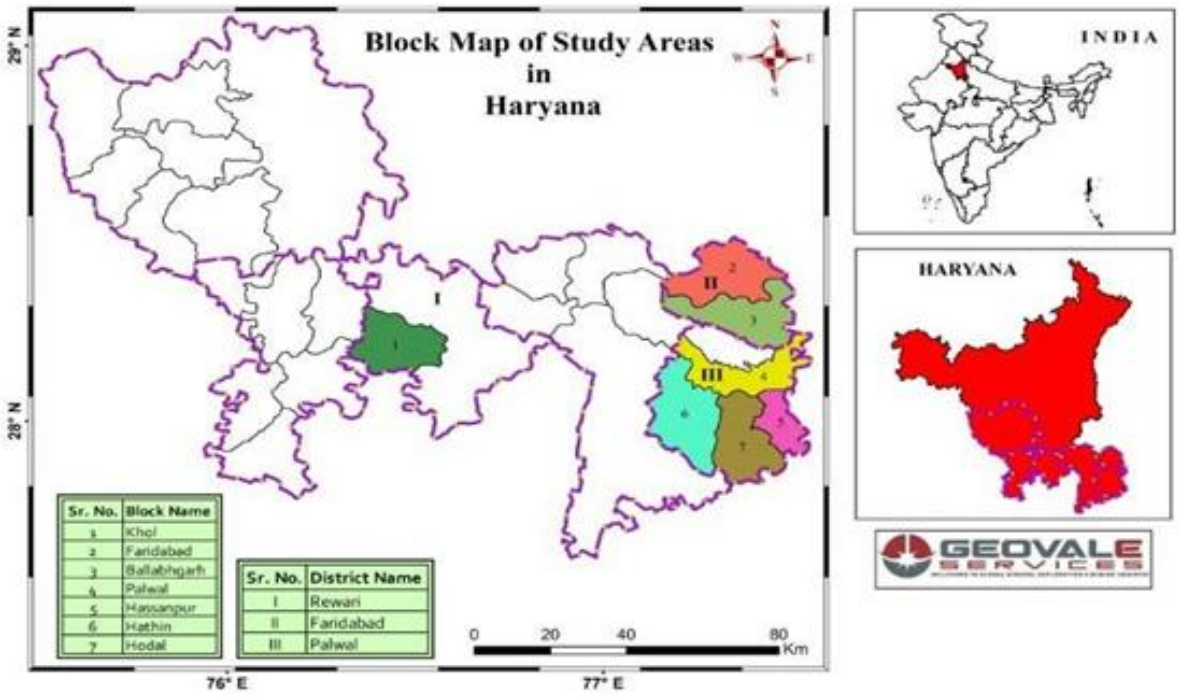
MRIIRS is working with Haryana Irrigation and Water Resource Department (IWRD) Panchkula, Haryana, India in implementing **Atal Bhujal Yojna Haryana** as District Implementation Partner for Faridabad, Rewari and Palwal districts of Haryana State of India towards sustainable development of groundwater through participatory Ground Water management by formulating Gram Panchay (GP) at level Water Security Plan (WSP).

Atal Bhujal Yojana is to demonstrate community-led sustainable ground water management which can be taken to scale. The major objective of the scheme is to improve the management of groundwater resources in select water stressed areas in identified states. It is a community-centric program and emphasizes the importance of community understanding, preparation and ownership of their water security plans. The Atal Bhujal Yojana which is implemented in seven water stress states of India, including Haryana, is funded by **Govt. of India and World Bank**. 14 water stress districts of Haryana are in target under Atal Bhujal Yojana. MRIIRS, MRCAWTM has been engaged by Atal Bhujal Yojana Haryana as **District Implementation Partner (DIP)** for 7 blocks of 3 districts (Faridabad, Palwal and Rewari) under two clusters:

A. Cluster 6: for District Faridabad and Rewari

B. Cluster 7: for District Palwal

Under this initiative it has been envisaged the preparation of **community led** Gram Panchayat level **Water Security Plan** and ensuring its implementation through **convergence** of various government programs for 296 Gram Panchayats. The main objective of this program is to restore or revive the groundwater scenario in the targeted villages in participatory approach. This involves supply side and demand side management of water through various intervention, behavioral changes, awareness and improved water use efficiency. The project involves strengthening of infrastructure for measurement and monitoring and capacity building of community level managers. The program is of 4 year duration started in July 2021 and expected to complete by June 2025. Total budget provision for this work allocated for MRIIRS is Rs. 7.78 crore.



2. ATAL BHUJAL YOJANA

- A Central Sector Scheme, Funded by World Bank Implemented by Mo Jal Shakti GOI in association with State Govt.
- Implemented in 7 states- MP, UP, KN GJ, RJ, MH & Haryana.
- Groundwater over exploited districts are in target
- 14 districts of Haryana included covering 36 block and 1895 GP
- Manav Rachna is involved in three districts– Palwal, Rewari and Faridabad as DIP (District Implementation Partner). Working in 296 GPs

Progress

- Inception Report, work plan and Base line Reports of boththe clusters submitted.
- Quarterly Reports for periods July-Sept 2021, Oct- Dec 2021 and Jan- March 2022 of both clusters submitted.
- Water Security Plans of 41+72 GP of Palwal, 18GP+25 of Faridabad and 05+19 GP of Rewari district submitted in three rounds in Oct 2021 Jan 2022 and March 2022 respectively
- Accompanied the DPMU, SPMU, RO, QCI and NPMUauthorities in field who visited separately all the three districts for field level inspections of work carried out by the DIP-MRIIRS.
- WSPs for 8GP of Fbd and 15GP of Palwal**approved** in 1st round and others are under approval
- Attended meetings with the DCs, Nodal officers, RO and Block level officers in all 3 distt.
- Conducted capacity building of >200 VWSC members of 20 GPs for Fbd and Ballabhgarh
- Convergence planning and field level inspection carried out with department of Forest, Panchayati Raj, Irrigation-MICADA and Soil conservation.
- School level painting competition conducted under ABY jointly with CGWB Chandigarh.

ATAL BHUJAL YOJANA

ANNUAL PROGRESS OF CLUSTER-07 PALWAL

S. N	Progress on WSP preparation in cluster 07 (Palwal)	Palwal	Hodal	Hathin	Hassanpur	TOTAL
1	Total GPs selected block wise	41	34	75	35	185
2.	Target of WSP till June 22	41	34	75	35	185
3.	WSP approved till March	6	18	28	20	72
4.	WSP approved till December	20	5	16	0	41
5	WSP uploaded on MIS during the quarter (Apr-June 22)	15	11	31	15	72

Quarterly WSP Submitted			
1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
16	25	72	72

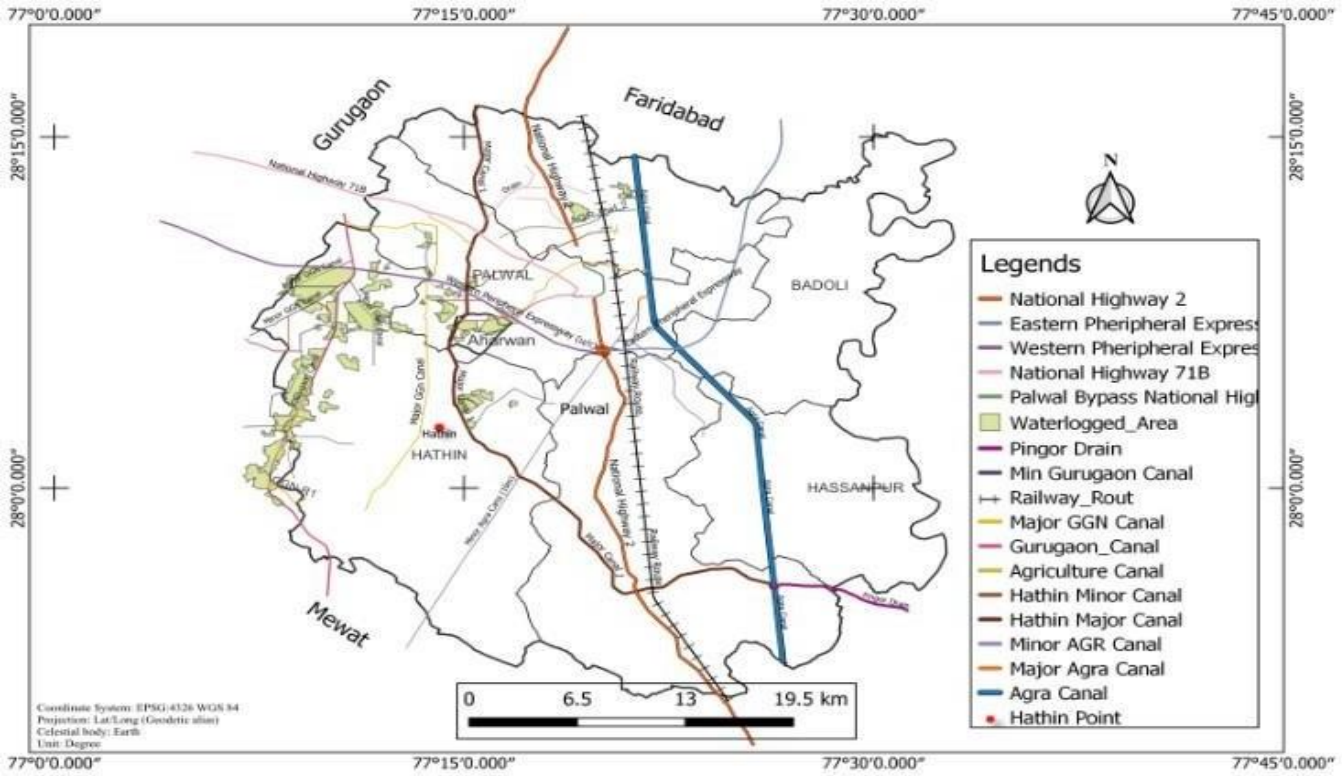
ANNUAL PROGRESS OF CLUSTER-06 FARIDABAD-REWARI

S. N	Progress on WSP preparation in cluster 06 (Fbd- Rewari)	Faridabad	Ballabhgarh	Khol	TOTAL
1	Total GPs selected block wise	30	41	40	111
2.	Actual Target	28	41	39	108**
3.	WSP approved upto December (Jan-Mar 22)	11	14	19	44
4.	WSP approved upto December	8	10	5	23
5	WSP uploaded till June 2022	9	17	15	41

**Deducted 2 from Faridabad block and 1from Khol block, Rewari.

Quarterly WSP Submitted			
1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
8	15	44	41

Water Logging Map of Hathin Block, Palwal district, Haryana



The detailed work done and till date progress of both clusters A and B is appended with the following inclusions:

A. Cluster 6: for District Faridabad and Rewari

- ✓ **Letter of Acceptance**
- ✓ **Inception Report**
- ✓ **Progress Report**
- ✓ **Compiled Details**

B. Cluster 7: for District Palwal

- ✓ **Letter of Acceptance**
- ✓ **Inception Report**
- ✓ **Progress Report**
- ✓ **Compiled Details**

8th Quarterly Progress Report

April to June, 2023

Cluster No. 06, Faridabad, Haryana

Submitted to,

Chief Engineer / LCU, Irrigation & water Resource Department, Haryana, Panchkula

Submitted by

District Implementing Partner (DIP), Cluster-06

Centre for Advance Water Technology and Management

Manav Rachna International Institute of Research and Studies

Faridabad, Haryana

1.Introduction

The Government of Haryana has received financing from World Bank towards the "Atal Jal Haryana". The Irrigation & Water Resource Department, Government of Haryana an implementing agency invited proposals to provide the consulting services "Engagement of District Implementation Partner to support in Implementation of Atal Bhujal yojana (Atal Jal) for nine clusters of the State.

In tune with it, CAWTM, Manav Rachna International Institute of Research and Studies Faridabad, Haryana is selected to provide consultancy services as "District Implementing Partner to support in implementation of Atal Jal Yojana (Atal Jal) for Cluster No. 06- Faridabad and Rewari (Blocks: Faridabad, Ballabhgarh and Khol).

District Faridabad is the part of CLUSTER 06. Which includes the 02 Blocks; Faridabad & Ballabgarh.

Block Name	No. of GP Allotted	Actual working GP's
FARIDABAD	30	28
BALLABHGARH	41	41
TOTAL	71	69

In 8th quarter i.e. April to June 2023, every work has been conducted which is assigned in tender, as well as directed by SPMU and DPMU in 69 GPs of Faridabad district, Cluster-06. 02 of the GP's are selected in MCF, so the assigned works in these GP's are suspended till the new guideline will come or new GP's will assign.

DIP team has worked on following activates from April to June, 2023

I.1 Awareness meetings were conducted with farmers and women in 69 Gram panchayat of District.

I.2 In this quarter, DIP Team has collected the documents for MI (Sprinkler, Drip System) and have also conducted awareness program with the farmers. Total 34 awareness programmes were conducted for achieving the target.

I.3 Meetings were held with different line departments such as: MICADA, and PHED Department, Forest and other line departments for the information collection of on-going works and for implementation of WSP.

I.4 Rainfall data has collected in every gram panchayat, all GPs register has maintained and successfully uploaded in app too.

I.5 Readings of Water flow meter had taken and updated in In-house MIS and in the registers of every gram panchayats.

I.6 CB meetings attended and facilitated at gram panchayat level. Total CB meeting organised in Faridabad block is 22 and in Ballabgarh block is 35.

I.7 Facilitated 17 GPs Visit by QCI under DLI3 and DL4 verification.

I.8 Facelifted 6 GPs Visit by NPMU for DLI3 and DL4 verification.

I.9 Abandoned well has been identified to convert into recharge structure. This work has been taken care in association of DPMU.

I.10 Updating of Rain gauge details at Atal Jal app is under progress.

I.11 Trainings for CRP had conducted for understanding of work under ABY and under DLI1 data collection, record maintenance and community discloser.

I.12 Jal Saheli has been selected in all 69 gram panchayats.

I.13 Meeting with SPMU Raman for using of mobile application

I.14 Other works allotted by DPMU and SPMU.

I.15 Millet seed distributed 1500kg in 23 gram panchayat.

I.16 Water sample collected all 69 gram panchayat, according to shape file special distribution 5 sample per GP.

I.17 Population data collection by anganwadi/sarpanch completed all 69 gram panchayats.

I.18 GPDCI module filled has been completed all 69 gram panchayats.

I.19 Display board installation has been completed all 69 gram panchayats.

I.20 Display board data discloser of DLI1 has been completed all 69 gram panchayats.

I.21 Hoarding location identify and NOC taken has been completed all 69 gram panchayat.

I.22 40 Injection well phase 1 sheet prepared and also locations verified by DPMU at 8 gram panchayat.

I.23 In this quarter 7 gram panchayat well inventory completed.

I.24 Block level training programme is attended by DIP team.

I.25 In the Faridabad district DPMU and DIP team visited Budiya Nalah site inspection to convert the canal for groundwater recharge from the Yamuna River.

2. Targets given during (April to June 2023)

2.1 To support DPMU in IEC activities and achieving Disbursement Link Indicators (DLIs).

2.2 Work towards capacity building of all the concerned stakeholders in districts (village community, Village Water Sanitation Committee (VWSC) members, village level government officials.

2.3 Work towards the convergence of the various ongoing government (both state and centre) schemes, for the better implementation of the plan in coordination with the Gram panchayat and VWSC.

2.4 Take regular follow ups from line departments to ensure proper implementation of the plans.

2.5 To do the awareness generation activities for community mobilization through campaigns in the allotted villages and document the same.

2.6 Collection of documents for MI.

2.7 Collecting data regarding (water flow meter, rain guage).

2.8 Work according to fortnightly plan and achieve the target.

2.9 Identification of Jal Saheli at grampanchayat level.

2.10 Other specified work given for example, sheet updation, IEC activities, visits and other etc.

2.11 GPDCI module filled at gram panchayats level

2.12 Display board installation at gram panchayat level.

2.13 Display board DLI1 data disclosure at gram panchayats level.

2.14 Water sample collected at gram panchayat level.

2.15 Millet seed distribution at gram panchayats level.

2.16 Population data collection by Anganwadi or sarpanch at gram panchayat level.

3. Challenges faced during (April to June 2023)

3.1 VWSC committee has been dissolved and the previous members are not taking interest.

3.2 Farmers are contradicting while visiting at their tubewell for WFM reading.

3.3 The use of Micro-Irrigation such as Sprinklers and Drip is not a common practice in Faridabad district so people are less aware about the benefits of MI,

hence it's not easy to accept new pattern in agricultural crops. UGPL is mostly demanded by farmers. Land size is also small for MI. online Site for application is not working.

3.4 Most of the rain gauge system installed in government building and those building are without stairs so rain gauge data measuring are not an easy task in all GP's.

3.5 Many WFM has been stolen and same is the case for rain gauge.

3.6 Many water level indicators are stopped working and some of them are not working properly.

3.7 Some farmers removed WFM because it gives pressure on the motors. So there is a chance of burning of the motor.

3.8 More task compare to time and repetition of work.

3.9 The community members in the Faridabad district are reluctant to participate in the meetings as there is less land holdings of farmland, most of the lands are converted into commercial lands because of rapid urbanisation.

3.10 Community is more engage in various activities rather than farming, they daily travel to nearby cites for job, so it's very uncertain to find them in village, especially in weekdays.

3.11 In some GPs EC is too high, so it's not suitable for agriculture. Peoples demand canal water for agriculture.

3.12 It's hard to gather the people for meeting if any mishappening / marriage/ death were happened in villages.

3.13 Rapid growth of convergence is required in Supply side management.

4 Achievement during (April to June 2023)

4.1 Water level record through water level indicator has been done all 69 gram panchayat and share the list of DPMU for this quarter and also updated on register.

4.2 Water flow meter readings has been taken two times for each month of this quarter and successfully updated at In-house MIS for this quarter and also updated on register.

4.3 Rainfall record is maintained on register and updation of rain gauge details on app is completed

4.4 DLI3 and DLI4 verification has been done in 23 GPs.

4.5 GPDCI module has been updated for 69 gram panchayats as mentioned below:

Name of Block	No. of GPDCI updated at gp level
Faridabad	28

Ballabhgarh	**41**
Total Block: 02	**Total GPDCI updated: 69**

4.6 Convergence work is on progress for Micro irrigation, rooftop rainwater harvesting structures, rainwater harvesting structures, pond rejuvenation.

4.7 Many farmers are awarded for saving groundwater and agreed for crop diversification and micro irrigation.

4.8 Farm pond are also constructed and some are under progress.

4.9 RWHS and Recharge pits and Shaft are constructed and in under progress in most of the grampanchayat.

4.10 Display board installed in all 69 gram panchayat.

4.11 Display board DLI1 data disclosed all 69 gram panchayat.

4.12 Water sample collection completed all 69 gram panchayats.

4.13 Millet seed distributed 1500 kg in 23 gram panchayat.

4.14 Population data collected by sarpanch or anganwadi in all 69 gram panchayat.

4.1540 Injection well phase 1 sheet prepared and also locations verified by DPMU at 8 gram panchayat.

5. IEC Activities

5.1 In the Gram panchayat level, DIP team had organized the various IEC activities such as- Awareness meeting at so many gram panchayat. Awareness meeting with women and farmers, meetings with Horticulture & agriculture dept. For the IEC activities the target groups were, students, youths, women and farmers. In the awareness programme for irrigation and groundwater conservation, farmers and women were involved in discussions and interactive sessions. Community were engaged in the discussions and interaction which involve around day-to-day use of groundwater and its management in our daily lives. In these activities, women participation has been improving to 30 %, earlier it was less and it's hard to move then out. We are distribute a millet seed for farmers and motivate for those crops which are less water consume, and

5.2 People understood the deficit of groundwater, and they are interested for applying for MI schemes. Some farmers are registration for MI to apply drip & sprinkler, and so many people also interesting for recharge pit, rain water harvesting structure to recharge ground water. Farmers also ready to install water flow meter in own tube wells. Now the community and committee were marginally aware for groundwater depletion and on water quality.

5.3 Wall painting are representative of DIP in village level/ ground level and providing eye contract to farmers/ villagers to push day to day live habit for

improvement of thinking on ground water. Villagers are starting aware for wall painting slogan and it is very impactful for water saving practices.

5.4 Display board DLI-1 data disclosure are very effective IEC activities, as peoples shows their interest in knowing the situation of their village in terms of water quality and water level.

5.5 Stickers of Atal Bhujal Yojana play an important role in creating long time memories among the villagers.

5.6 Many visits and awareness programmes had conducted in Atal bhujal yojana.

5.7 Exposure visit is organized for progressive farmers to awareness the cropping pattern techniques and new methods of irrigation, this was held at KVK Bhupani, Faridabad. And farmers also aware for organic farming.

5.8 Sh. Subhash Chandra Bisnoi, a representative of Saugat NGO, is on a cycling ride for the promotion of atal bhujal yojana throughout the district of Haryana. In the Faridabad district he is visited Kailgaon and Khandawali gram panchayat in Ballabgharh block.

5.9 Block level training programme is attended by DIP team. Which is helpful for convergence progress through the line department in Ballabgarh and Faridabad block.

6. Training conducted and it's impact on community

6.1 In this section DIPs have to describe the overall training conducted at Gram Panchayat level, Panchayat level, issues faced/challenges, achievements and its positive impact on the community

6.2 DIP provide training to the VWSC member and Anganwadi worker, Village resource person and other community member about Water testing kit and how to measure water level by Sounder.

6.3 After all these activity, some of them Peoples of community were save water and trying to store rain water for domestic works.

❖ Capacity Building Training has been started at all grampanchayat with the help of DIP team and is going on successfully.

- Capacity building training contract has been allotted to Intecco technical service Lucknow and Dip team has full supported the CB trainers in their work.
- Dip team had monitor and shared all village documents to conduct activities

successfully.

- CB agency has to conduct 5 meetings at every grampanchayat level.
- IEC expert of DIP was always present at the site for support.

❖ Data Collection field activities:

BLOCK->	TARGET	FARIDABAD (ACHIEVED)	BALLABHGARH (ACHIEVED)	REMARK
RAIN GAUGE	69	8	11	MISSING/BROKEN (27 IN NO.) NOT FEASIBLE (22 IN NO.)
WATER LEVEL	69	28	41	COMPLETED
WATER FLOW METER	30	06	16	MISSING/NOT FEASIBLE(8 IN NO.
DISPLAY BOARD DLI1 DATA DISCLOSURE	69	28	41	COMPLETED
GPDCI Module fill	69	28	41	COMPLETED

- App is not working properly so data has been collected and updated on register and In-house MIS.
- All the details are available on In-house MIS.

7. Plan for Further months: -

7.1 Awareness Program with farmers & Women's.
7.2 Water flow meter Reading.
7.3 Meetings with Line Department.
7.4 Completion of Pending Work.
7.5 MIS updating work.
7.6 Convergence work.
7.7 Quiz & Competition in Schools.
7.8 Nukkad Natak program in Gram Panchayat level.
7.9 Water level monitoring.
7.8 Rain guage reading.
7.9 Micro irrigation registration.
7.9 Rain guage & WFM training.
7.10 Work regarding implementation.
7.14 Maintaining register to be work done in GP (water flow meter, Rain guage, water level and water level monitoring).
7.15 Any other work at DIP level if provided by NPMU/SPMU/DPMU.
7.16 Identify other areas to conserve water.

8th Quarterly Progress Report

April to June, 2023

Cluster No. 06, Rewari, Haryana

Submitted to,

Chief Engineer / LCU, Irrigation & water Resource Department, Haryana, Panchkula

Submitted by

District Implementing Partner (DIP), Cluster-06, Rewari

Centre for Advance Water Technology and Management

Manav Rachna International Institute of Research and Studies

Faridabad, Haryana.

1-Introduction

- Atal Bhujal Yojana is a central sector scheme launched on the auspicious day of Birth anniversary of former Prime Minister of India Late Sh. Atal Bihari Vajpayee, 25 December 2019. It is funded jointly by the World Bank and Government of India on a 50-50% partnership basis. The scheme is to be implemented for a period of 5 years (up to 31-03-2025). The purpose of Atal Jal is to achieve community led participatory sustainable ground water management, in 7 states. As an outcome, the scheme desires to reduce the rate of depletion of groundwater by 50% of the baseline level in the stipulated time period of 5 years. Haryana state is also selected for Atal Bhujal Yojana covering 14 districts, 36 blocks, 1658 Gram Panchayat. The Irrigation & Water Resource Department, Government of Haryana an implementing agency invited proposals to provide the consulting services "Engagement of District Implementation Partner to support in Implementation of Atal Bhujal yojana (Atal Jal) for nine clusters of the State.
- In Rewari District There are only one Khol Block is to be Covered Under Atal Bhujal Yojana. There are 38 Gram panchayat comes under this Block. The district broadly forms part of Indo-Gangetic alluvial plain of Yamuna sub Basin. At khol Block 50% of the Gram panchayat are surrounded by Aravalli hill. Major soil is here Sandy soil and Rock are mainly found is Slate, Phyllite, Schist and Hard Rock.
- The tasks assigned to the Manav Rachna International Institute of Research and Studies, Faridabad, Haryana is selected to provide

consultancy services as '' District Implementation Partner (DIP)'', to support in Implementation of Atal Bhujal Yojana for cluster -06 in Rewari District.

- To support DPMU in IEC activities and achieving Disbursement Link Indicators (DLIs).
- Work towards capacity building of all the concerned stakeholders in districts (village community, Village Water Sanitation Committee (VWSC) members, and village level government officials.
- To prepare Water Security Plans GP wise and work towards the convergence of the various ongoing government (both state and center) schemes, for the better implementation of the plan in coordination with the Gram Panchayat and VWSC.
- Take regular follow ups from line departments to ensure proper implementation of the plans.
- To do the awareness generation activities for community mobilization through campaigns in the allotted villages and document the same.
- To prepare the inception report and work plan in the selected GPs in coordination with the district level officers to take the Atal Jal work ahead.
- To prepare the baseline reports of the villages covering details like village profile, hydrological, meteorological, water conservation and agriculture related data about the village.

In the 8th Quarter (April to June) DIP team had worked upon the following activities, details are given below: -

- Data disclosure under DLI-1, through pamphlets and by other activities.
- Awareness meetings were conducted with farmers and women in 38 Gram Panchayats at khol block.
- Social audit program was being conducted in Nangal jamalpur Gram panchayat along with community person.
- Rainguage reading had been collected and similarly maintained in register of all the respective GPs.
- Meeting would be scheduled along with different line departments such as: MICADA, and Panchayati Raj Engineering Department, Forest, Soil & conservation department and other line departments for the collection of data on-going works and for implementation in WSP.
- In this quarter, DIP Team have been collected the documents for MI (Sprinkler, Drip System) and have also conducted awareness program with the farmers.
- CB meeting have been attended at gram panchayat level by Dip.
- Jal Saheli have to be identified in all gram panchayats.
- QCI Visit for field verification had been conducted under DLI-03, DLI-04 In the following gram panchayats is that kolana, Shahbajpur Istmurar,m.m Bhalkhi, Nandha, Balwari, Chimnawas and mamaria asampur.
- Arranged Training for new CRP to know the field data collection and other community level meeting.
- T-shrit and cap distribution to Bhujal shalei and other community person for awareness regarding to the ground water management.
- Three Feasible sites for RO have to identified for proper installation.
- Millet seed of 6394.5 kg had distributed in 26 grampanchyat.
- Data Collected for GPDCI Module.
- Water samples to collected in all 38 gram panchayat, according to shape file spatial distribution 5 sample per GP.
- Location for the Hoarding would be identified and it's NOC took from each gram panchayats from chairperson.
- Block level training programme is attended by DIP team.
- To provide the list of the participants and facilitate meeting with CB Trainer for the 5^{th} events in every grampanchyat.

- Collected Geotag photos of the seed sowing areas and was upload in house MIS.
- Well monitoring is being done in all of the gram panchyats on the regular basis.

Targets given during (April to June 2023)-:

- To support DPMU in IEC activities and achieving Disbursement Link Indicators (DLIs).
- School bags Distribution done in government school under the Atal Bhujal Yojana.
- To provide the list of the participants to CB Trainer for the 5th events.
- To collection of the Stage Wise Photographs of demand & supply side intervention
- Work towards capacity building of all the concerned stakeholders in districts (village community, Village Water Sanitation Committee (VWSC) members, and village level government officials.
- Work towards the convergence of the various on-going government (both state and centre) schemes, for the better implementation of the plan in coordination with the Gram Panchayat and VWSC.
- Take regular follow-up was taken from line departments to ensure proper implementation of plans.
- To do the awareness activities for community mobilization through campaigns in the allotted villages and document the same.
- To collection of Field data for rain gauge and well monitoring on the monthly basics.
- Work according to fortnightly plan and achieve the target.
- Other specified work given i.e. sheet updating, IEC activities and in - house Entry.
- Collection of the M.I documents.
- GPDCI module data have to filled in each gram panchayat module.
- Other works done according to Monthly action plan.

Challenges faced during (April to June 2023)-:

- Most of the rain gauge system installed in government building. In some of the GPs Rain Gauges are not assessable, and in some ware it destroyed by unknown peoples.
- Some water level indicator is not in working properly. Due to this, Dip team got problem in field while WL measurement.

Achievement during (April to June 2023)-:

- Water Security Plans of all the Gram Panchayat updated as per the demonstration.
- Convergence work is being on progress for Micro irrigation, rooftop rainwater harvesting structures, rainwater harvesting structures, pond renovation.
- Water level of identified wells had collected and successfully updated at In-house MIS for this quarter and it also updated on register.
- DLI-3 and DLI-4 verification has been done by TPV.
- All of the WSP updated in 38 Gram panchayat.
- People are of the our model GPs i.e. Harjipur, Kolana and khol panchayat had cultivated marigold and vegetable by drip irrigation facilitated under Atal Bhujal Yojana.
- DLI -1 data disclosure to completed in all of the gram panchayat.
- RWHS i.e. Recharge pits and Shaft are had constructed in punsika and mamaria asampur gram panchayats. It is in progress in other grampanchyat.
- Well inventory: well inventory is essential and important part of WSP it holds the very informative information of wells, their location, depth of well, water level & casing pipes of well of any particular area where it had been done.

- **IEC Activities-:**

  - Installation of Rain Gauge and training for data Collection:
  - Rain-Gauge is the instrument which is to be used measure the rainfall of a particular site. In Rewari district 38 manual Rain-gauge had been installed in 38 Gram panchayat of khol block. Training of Rain-Gauge people are knowing how major rainfall (mm) precipitation in their own village. Training was the part of IEC Activates.
  - The community person knows the discrepancy of groundwater, and they are interested to adopted the available MI schemes. Farmers were applied for drip & sprinkler under the MI. So many people are also interesting for recharge pit and other rain water harvesting structures for recharging the ground water. Now the community and committee were aware for groundwater depletion and also about the importance of water quality.
  - Wall painting is an attractive method of spreading the information and awareness among the largest group at the same time. 38GPs had been covered, each GP's have 5 painting were painted. Through this more people were aware about water conservation. Team sense the impact of these activities during the field visit.
  - Water testing is the process in which water quality has been tested with different parameters. Five Ground Water Samples were collected from each panchayat and sent for testing in NABL approved lab. The test results have been disclosed among the villagers.
  - Activities which are performed to inform, educate & to increase the communication for strong bonding with community are counted in IEC activates. A lot of IEC activities; Water Awareness meeting with Anganwadi, with Farmers, School Child water awareness program, VWSC meetings are conducted at khol Block.
  - VWSC & Community Training:
  - Training sessions are conducted in GPs to make the community strengthening & VWSC more capable & strong.".
  - Micro-irrigation system documents collection:
  - In this activity we try to convince the farmer for micro irrigation system and to collect the documents of MI go for further registration.
  - Stickers regarding Atal Bhujal Yojana have been distributed at several places at gram panchayat level.

- The meeting under DLI-1 for Data discloser increase the interest among villagers to know the groundwater condition.
- Farmers, women, youth, VWSC members, SHG members, Aanganwadi workers, ASHA workers, panchayat members and government school staff and school students were the target audience of these IEC activities done throughout the quarter in several of the gram panchayats.
- The community engaged actively in all of these activities through constructive discussion, question answer sessions at the end of the events, participating in the events as a member of the team and looking/observing the demonstration, performances and by learning from them. Pledges were also taken by farmers and women of the villages to conserve water both in agricultural use and household use. The percentage of women participation in all of these activities was more than 30% of the total attendees.
- Sunboard for DLI-1 data disclosure are very effective in IEC activities, as peoples shows their interest in knowing the situation of their village in terms of water quality, water level and Rainfall data.
- Block level training programme is attended by DIP team. Which is helpful for convergence progress through the line department in khol Block.
- Sh. Subhash Chandra Bisnoi, a representative of Saugat NGO, is on a cycling ride for the promotion of atal bhujal yojana throughout the district of Haryana. In the Rewari district he would be visited in Khol Gram panchayat.
- Conducted Other IEC activities as given by DPMU.

1. **Targets given during April to June-:**

Sr no.	Type of Work	Target (April to June)
1	Registration of MI	100 ha
2	T-shirt & cap distribution	38
3	Well Inventory of Gram panchayat	38

4	Well monitoring per month in numbers	76
5	Plastic Mulching through MIHD Scheme	5
6	Awarness activity with community/SHGs/ school/ farmers	28
7	Meeting with line department and other block level	10
8	Millet seed distribution in gps	23
9	CB Trainer has to conduct 5 meetings at every grampanchayat level.	38
10.	RO site selection	Done in all of the sites according to provide by Spmu
11.	GPDCI Module data filled in Gps	38
12.	School Bag Distribution in school	23
13	Millet Seed Distribution in kg	
14	Facilitate the vendor for the installation of Sun board at GP level.	38
15	Pond Renovation & Rejuvenation work in Gp under CSR	1
16	Weekly meeting with DPMU per week one	12

2. Achievement during April to June 2023 -:

Sr. no	Type of Work	Target achieve (April to June)
1	Registration of MI	36 Ha
2	Tshirt & cap distribution in Gps	38
3	Well monitoring per month in Gps numbers	76
4	Well Inventory complete in Gps	38
5	Plastic Mulching through MIHD Scheme	5 ha
6	Meeting with line department and other block level	8
7	CB Trainer has to conduct 5 meetings at every grampanchayat level.	38
8	RO site selection	Done in all of the sites according to the list which was provided by spmu
9	School Bag Distribution in school	23
10	Millet Seed Distribution in 23 Gps kg	6394.5kg
11	Facilitate the vendor for the installation of Sunboard at GP level.	38

Training conducted and its impact on community-:

- Youth and Women are participating enthusiastically and show their participation to preserve Ground water.
- Wall painting slogan plays a vital role for awareness of the community.
- organised training for the VWSC member and Anganwadi worker, Village resource person and other community member about How to measure water level by Water level indicator, Rain gauge data by beaker and do other activity.

Capacity Building Training has been started at gram panchayat level since December with the help of DIP team and is going to be on successfully at field-:

- Capacity building training contract had been allotted to Intecco Technical Services pvt .LTD. and Dip team has been supported to CB master trainers for their work.

- Dip team if facelifted and discuss about all the ground level issues in the villages by data disclose under DLI-1. Detail discussion on halt the rate of groundwater depilation through adopted scientific practices

- CB agency has to be conduct 5 meetings at each Gp in one year. Other meeting is going on progress.

- Continue discussion with community people to invite their ideas to stop the ground water depilation.
- The meetings are much effective at Gp level. People were aware about the different scams of governments.

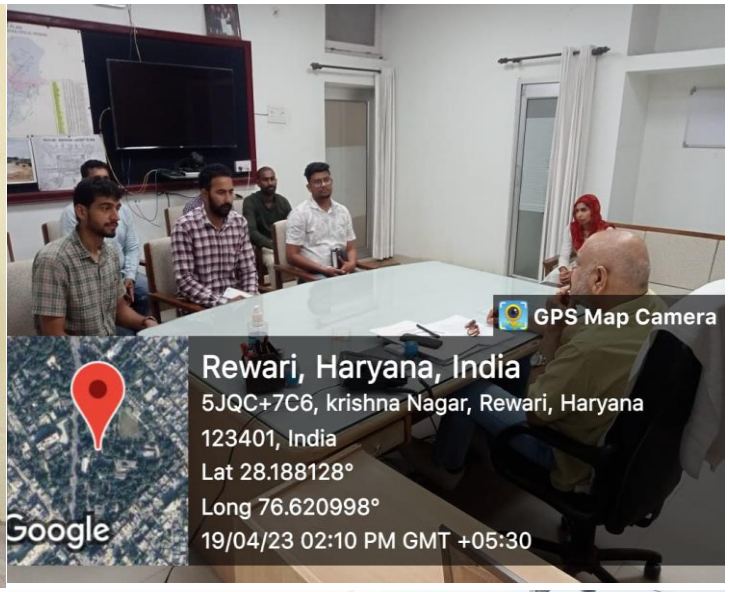
Plan for July to September 2023-:

- To fill the data in sun board
- To conduct meeting regarding WSP
- To provided mobile app training at community level
- To identify site for Hoarding 12*8 each Gps.
- Awareness Program with farmers & Women's.
- Meetings with Line Department.

- Completion of the Pending Work.
- Continue with GPDCI module.
- Convergence work.
- Water level monitoring.
- Rain gauge reading.
- Micro irrigation registration
- Work regarding implementation of water conservation structures.
- Maintaining the village level register about to be work done in GP (Rain gauge, water level, water quality testing, water level monitoring).
- Any other work at DIP level provided by NPMU/SPMU/DPMU

Photos of IEC Activities


GPS Map Camera
Chimnawas, Haryana, India
6F8W+VFV, Khori - Govindpuri Rd, Chimnawas, Haryana 123101, India
Lat 28.217105
Long 76.496609
16/05/23 11:20 AM GMT +05:30
Google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Rewari, Haryana, India
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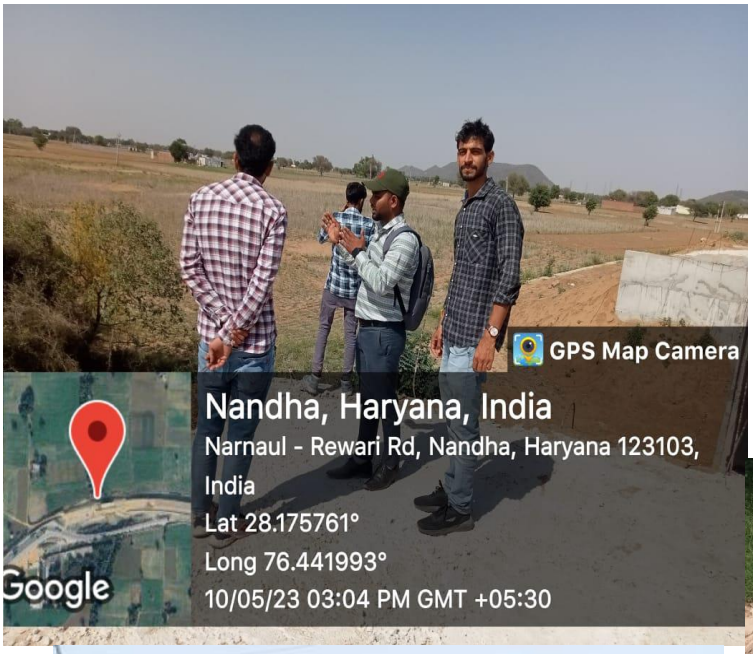
19/04/23 02:10 PM GMT +05:30
Google


GPS Map Camera
Pali, Haryana, India
5FM6+RV, Pali, Haryana 123103, India
Lat 28.183435°
Long 76.461754°
24/05/23 01:01 PM GMT +05:30
Google


GPS Map Camera
Khol, Haryana, India
59WX+M23, Khol, Haryana 123103, India
Lat 28.196577°
Long 76.397397°
17/06/23 06:25 PM GMT +05:30
Google


GPS Map Camera
Bas Dooda, Haryana, India
5987+RWH, Bas Dooda, Haryana 123102, India
Lat 28.167567°
Long 76.363736°
18/05/23 12:31 PM GMT +05:30
Google


GPS Map Camera
Nandha, Haryana, India
Narnaul - Rewari Rd, Nandha, Haryana 123103, India
Lat 28.175761°
Long 76.441993°
10/05/23 03:04 PM GMT +05:30
Google


अटल भूजल योजना
पानी बचाने की तकनीक
पानी रिचार्ज की व्यवस्था


AMINS
INDIA
GPS Map Camera
Rewari, Haryana, India
5CQ7+GHC, Haryana 123103, India
Lat 28.188761°
Long 76.412923°
23/06/23 12:13 PM GMT +05:30
Google


GPS Map Camera
Rewari, Haryana, India
5CQ7+GHC, Haryana 123103, India
Lat 28.188761°
Long 76.412923°
23/06/23 01:33 PM GMT +05:30
Google

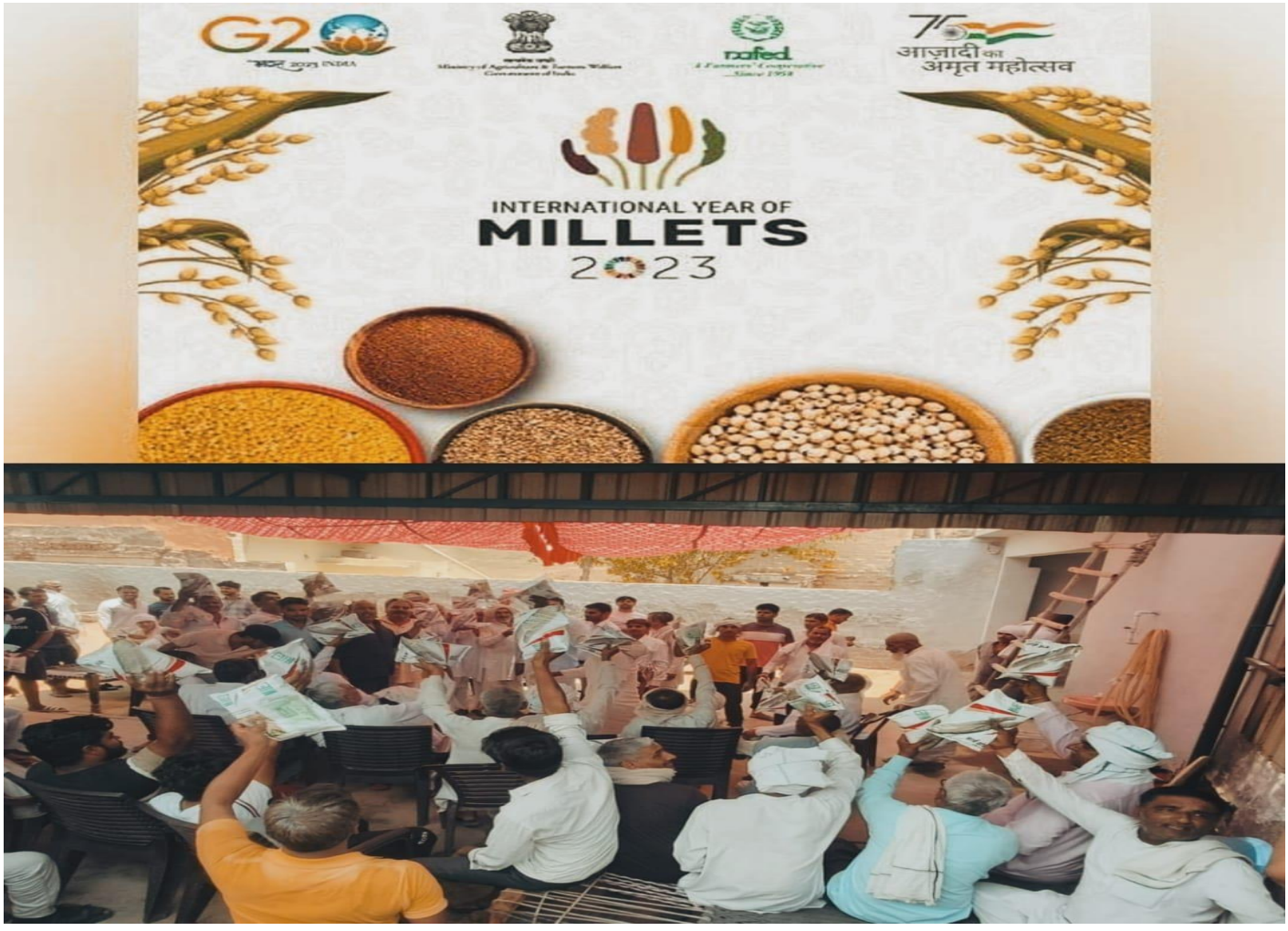
8th Quarterly Progress Report

April to June, 2023

Cluster No. 07, Palwal, Haryana

Submitted to,

Chief Engineer / LCU, Irrigation & water Resource Department, Haryana, Panchkula



Submitted by

District Implementing Partner (DIP), Cluster-07

Centre for Advance Water Technology and Management

Manav Rachna International Institute of Research and Studies

Faridabad, Haryana

❖ *INTRODUCTION:*

The Government of Haryana has received financing from World Bank towards the "Atal Jal Haryana". The Irrigation & Water Resource Department, Government of Haryana an implementing agency invited proposals to provide the consulting services "Engagement of District Implementation Partner to support in Implementation of Atal Bhujal yojana (Atal Jal) for nine clusters of the State.

In tune with it, CAWTM, Manav Rachna International Institute of Research and Studies Faridabad, Haryana is selected to provide consultancy services as "District Implementing Partner to support in implementation of Atal BhuJal Yojana (Atal Jal) for Cluster No. 07- Palwal (Blocks: Palwal,Hathin,Hodal,Hassanpur).

District Palwal is the part of CLUSTER 07. Which includes the 04 Blocks; Palwal,Hodal,Hassanpur,Hathin.

Block Name	No. of GP Covered
PALWAL	41
HATHIN	75
HASSANPUR	35
HODAL	34
TOTAL BLOCK-04	TOTAL GP-185

In 8th quarter i.e. April to June 2023, every work has been conducted which is assigned in tender, as well as directed by SPMU and DPMU in 185 GPs of Palwal district, Cluster-07.

➢ *DIP team has worked on following activates in 8th quarter from April to June, 2023..*

- Conference on Jal Amrit,2023 was attended.
- Data disclosure for DLI-1 records at grampanchayat level through pamphlets.
- Awareness meetings were conducted with farmers and women's about watersaving practices and schemes of the government for water saving practices at Gram Panchayats of District.
- In this quarter DIP Team has collected the documents for MI (Sprinkler, Drip System) and have also conducted awareness program with the farmers.

- Meetings were held with different line departments such as: MICADA, PHED Department,line departments for the information collection of ongoing works and for implementation of WSP.
- Rainfall data has collected through and panchayat register has maintained for all therespective GPs and also updated at INHOUSE MIS.
- Water flow meter reading had taken and updated at Inhouse Mis and panchayat register is maintained for the respective GPs.
- Water level of all grampanchayat was recorded through and updated at inhouse MIS and Panchayat register is also maintained of the respective GP.
- Awareness meeting was conducted with the childrens of Schools and colleges.
- CB meetings attended at grampanchayat level.
- Details of Exposure visit places was provided to CB Agency.
- Exposure visit was successfully completed for all grampanchayats.
- District Capacity building program attended at district palwal.
- Block level Capacity Building program was facilitated and successfully completed.
- Visit for QCI was facilitated for DLI3 and DL4 verification.
- Visit for Audit team verification was successfully completed.
- Various types of IEC activities done for creating awareness among the communities.
- New wells are identified for ground water level monitoring.
- Trainings of CRP had conducted for using Atal Jal app.
- Training of CRP and other experts conducted for water sample collection.
- Millets(Bajra) seed was distributed.
- School bag was Distributed to girls of govt. schools.
- Nukkad Nata was successfully completed.
- Honorable Chief Minister visit was attended.
- DLI data Disclosure board was installed at all 185 grampanchayats.
- Awareness camp at kisan mela.
- Other works allotted by DPMU and SPMU.
- Atal Bhujal Awareness was done through NGF radio.
- Data collection was done for GPDCI module.
- GPDCI module updated for all grampanchyats.

❖ ***Targets given during (April to June 2023)***

- To support DPMU in IEC activities and achieving Disbursement Link Indicators (DLIs).
- Work towards the convergence of the various ongoing government (both state and center) schemes, for the better implementation of the plan in coordination with the

Gram Panchayat and VWSC.

- Work towards capacity building of all the concerned stakeholders in districts (village community, Village Water Sanitation Committee (VWSC) members, village level government officials.
- To do the awareness generation activities for community mobilization through campaigns in the allotted villages and document the same.
- Collection of documents for MI.
- Collecting data through Atal Jal app and updating same at Inhouse MIS and register (water flow meter, rainguage,waterlevel.)
- Attending CB meetings.
- Completion of exposure visits.
- DLI1 Data disclosure board data filling at grampanchayat level.
- Work according to fortnightly plan and achieve the target.
- School bag Distribution.
- Water sample collection.
- Other specified work given for example sheet updation,IEC activities,visits and other etc.
- Distribution of Seeds.
- Data collection and filling of GPDCI module work.

❖ ***Challenges faced during (April to June 2023)***

- VWSC committee has been dissolved and the previous members are not taking interest.
- Some Farmers are contradicting while visiting foe wfm reading and they had removed wfm installed.
- The use of Micro-Irrigation such as Sprinklers and Drip is not a common practice in Palwal district so people are less aware about the benefits of MI, hence it's not easy to accept new pattern in agricultural crops. UGPL is mostly demanded by farmers
- Most of the rain gauge system installed in government building and those building are without stairs so rain gauge data measuring are not possible for all GP's.
- Many WFM has been stolen and same is the case for rain gauge.
- Many water level indicators are stopped working and some of them are not working properly.
- The new version of Atal Jal app sometimes dosent work properly.
- Data that was updated by backend at Atal jal App is different from what we had updated earlier.
- So much problem faced during Data collection for GPDCI module.
- Some farmers removed WFM because it gives pressure on the motors. So there is a chance of burning of the motor.
- More task compare to time and repetition of work.
- Warm weather condition affect the gp level awareness meetings.
- Community is more engage in various activities rather than farming, they daily travel

to nearby cites for job,so it's very uncertain to find them in village, especially in weekdays.

- In most GPs EC is too high, so it's not suitable for agriculture. Peoples demand canal water for agriculture.
- It's hard to gather the people for meeting if any mishappening / marriage/ death were happened in villages.
- Rapid growth of convergence is required in Supply side management.

❖ ***Achievement during (April to June,2023):***

- Water level record through water level indicator was completed at Atal Jal app for the identified wells and successfully updated at Inhouse MIS for this quarter and also updated on register.
- Water flow meter readings was taken two times for each month of this quarter and successfully updated at Inhouse MIS for this quarter and also updated on register.
- Rainfall record is maintained on register and updation of rain gauge details on app is completed.
- DLI3 and DLI4 verification was completed.
- GPDCI module was updated for 185 grampanchayats as mentioned below:

Name of Block	No. of WSP updated at gp level
Palwal	41
Hathin	75
Hassanpur	35
Hodal	34
Total Block: 04	Total GPDCI updated: 185

- DLI 1 data disclosure completed at all the grampanchayat.
- Convergence work is on progress for Micro irrigation, rooftop rainwater harvesting structures, rainwater harvesting structures, pond rejuvenation.
- Many farmers are awared for saving groundwater and agreed for crop diversification and micro irrigation.
- Farm pond are also contructed and some are under progress.
- RTRWHS and Recharge pits and Shaft are also constructed and are under progress in most of the grampanchayat.
- Pond rejuvenation work is under progress at some grampanchayat.
- Millets seed distribution work completed.
- District level, Block level , Gp level training completed.
- School bag was distributed.
- Visit of audit team completed successfully.
- All Capacity Building meetings were completed successfully.

❖ *IEC Activities:*

- Diary distribution work completed with geotag photos.
- Pamphlets regarding Atal Bhujal Yojana and different government schemes was distributed at gp level.
- School bag was distributed at govt. schools.
- Atal Bhujal Yojana Stall was installed at Palwal during kisan mela utsav.
- Millets seeds was distributed.
- Jute Bag with Atal Bhujal logo was distributed to Jal Saheli, sarpanch at gp level and also to the youngsters and other persons from line departments to encourage them for saving water.
- Nukkad natak was completed at 20 grampanchayat of palwal district.
- Filling of DLI data disclosure board.
- Other IEC activities as given by DPMU.
- Wall painting are representative of DIP in village level/ ground level and providing eye contract to farmers/ villagers to push day to day live habit for improvement of thinking on ground water. Villagers are starting aware for wall painting slogan and it is very impactful for water saving practices.
- DLI-1 data disclosure meetings are very effective IEC activities, as peoples shows their interest in knowing the situation of their village in terms of water quality and water level.
- Stickers of Atal Bhujal Yojana play an important role in creating long time memories among the villagers.
- Exposure visit is organized for progressive farmers to awareness the cropping pattern techniques and new methods of irrigation.
- Sh. Subhash Chandra Bisnoi, a representative of Saugat NGO, is on a cycling ride for the promotion of atal bhujal yojana throughout the district of Haryana
- Atal jal mobile application was installed at community mobile so that they can know details regarding water efficiency of their villages.

❖ Capacity Building Training has been started at all grampanchayat with the help of DIP team and is going on successfully.

- Capacity building training contract has been allotted to Intecco technical service Lucknow and Dip team has full supported the CB trainers in their work.
- Dip team had monitored and shared all village documents to conduct activities successfully.
- CB agency has to conduct 6 meetings at every grampanchayat.
- All the meeting successfully conducted at all grampanchayats and exposure visit was also completed successfully.

❖ WORK OVERVIEW:

SL NO.	ACTIVITY	TARGET	ACHIEVEMENT	REMARK
1	WATER LEVEL MONITORING	185	189(UPDATED AT APP AND IN HOUSE MIS)	4 NEW WELLS IDENTIFIED ,
2	RAIN GAUGE READING	185	39	142 STOLEN AND 4 WAS NOT FEASIBLE.
3	WFM READING	160	107(UPDATED AT INHOUSE MIS)	35 STOLEN,2 NOT WORKING AND REMAINING REMOVED BY FARMER
4	WATER SAMPLE COLLECTION	185 (IN GP)	COMPLETED IN 150 GP	WILL BE COMPLETED IN NEXT MONTH
5	SUN BOARD INSTALLATION	185	185 9UPDATED AT INHOUSE MIS)	
6	FILLING DATA IN SUNBOARD	185	82	UNDER PROGRESS DUE TO OTHER WORKS .
7	GPDCI MODULE	185	185	
8	SEED DISTRIBUTION	AS PER REQUIREMENT	COMPLETED	
9	SCHOOL BAG DISTRIBUTION		IN 80 SCHOOL	SCHOOL CLOSED
10	DLI3 & DLI4 VERIFICATION	AS PER REQUIREMENT	COMPLETED	
11	NUKKAD NATAK	20	20	
12	CB MEETINGS AND EXPOSURE VISITS	AS SCHEDULED	COMPLETED	
13	DISTRICT LEVEL TRAINING	1	1	
14	BLOCK LEVEL TRAINING	4	4	
15	AUDIT TEAM VISIT	4 (IN GP)	4	
16	GP REGISTER UPDATION	185	185	
17	JUTE BAG DISTRIBUTION	600	600	
18	T-SHIRTS DISTRIBUTION	585	585	
19	AWARENESS MEETINGS	185 (IN GP)	185	ALL GP IS COVERED
20	DOOR TO DOOR CAMPAIGN AND PAMPHLETS DISTRIBUTION	185 (IN GP)	185	ALL GP IS COVERED
21	CEMT TOOL	19	19	

➢ All the details are Updated at Atal Jal Application and at MIS.

❖ ***Plan for further months:***

- WFM data collection.
- Water level data collection.
- Rainfall reading records.
- Filling of Sun Board.
- Attending CB meetings.
- IEC activities.
- Work regarding implementation.
- MIS updating work.
- Convergence work.
- Identify other areas to conserve water.
- School bag Distribution
- Millets seed sowing geotag photos.
- Meetings with Line Department.
- Completion of Pending Work.
- NOC for Water Harvesting Structure (Tanka) with geotag photos of the places.
- Any other work at DIP level if provided by NPMU/SPMU/DPMU.

LIST OF DIP TEAM MEMBERS WITH DESIGNATION		
SL NO.	NAME	DESIGNATION
1	AKASH KUMAR	HYDROGEOLOGIST (GROUNDWATER EXPERT)
2	RAHUL MEHLAWAT	WATER CONSERVATION EXPERT
3	RAHUL KUMAR	WATER CONSERVATION EXPERT
4	MANOHARLAL SHARMA	AGRICULTURE EXPERT
5	MAHESH KUMAR	IEC EXPERT (BLOCK HATHIN)
6	ABHISHEK CHAUDHARY	IEC EXPERT (BLOCK PALWAL)
7	ASHOK KUMAR	IEC EXPERT (BLOCK HODAL)
8	PARMOD KUMAR	IEC EXPERT (BLOCK HASSANPUR)
9	AJAY KUMAR	CRP (BLOCK HATHIN)
10	SOHAN CHAND	CRP (BLOCK HATHIN)
11	SUDHA KUMARI	CRP (BLOCK HATHIN)
12	GAJENDER KUMAR	CRP (BLOCK HATHIN)
13	JITENDER KUMAR	CRP (BLOCK PALWAL)
14	DEEPAK KUMAR	CRP (BLOCK PALWAL)
15	BADAM	CRP (BLOCK HASSANPUR)
16	LALIT KUMAR	CRP (BLOCK HASSANPUR)
17	YUDDHRAJ	CRP (BLOCK HODAL)
18	JAIPAL	CRP (BLOCK HODAL)

SDG 6- CLEAN WATER AND SANITATION

Report

On

Cooperation of MRIIRS with National Government on Water Security

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEACH AND STUDIES, FARIDABAD

Cooperation of MRIIRS with Government on Water Security at National Level:

MRCAWTM is also working with DST (Department of Science and Technology, Government of India) and has worked with National Institute of Urban Affairs funded research projects towards solving real time water security issues.

A. Impact assessment of mining of Iron core on GW in and around Raikela Sundargarh Odisha.- **Click to view detailed report**

B. Hydro Geological Survey for Aquifer Monitoring in Barmer Area, Rajasthan- **Click to view detailed report**

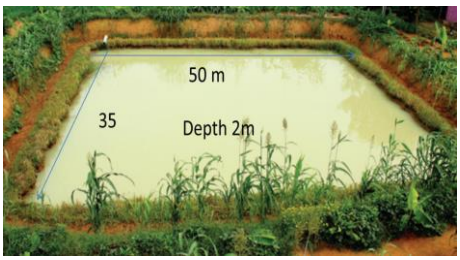
C. Groundwater condition study in core and buffer zone of proposed Iron ore mine around Villages, Eklama, District Kabirdham, Bhubneshwar

The detailed work done and till date progress is as outlined in the following section.

A. Study for Rainwater harvesting around Iron ore mine of Dholta Pahar, and Netrabandh Pahar, Sundergarh, Odissa

- ✓ Investigation of Water use and water balance completed.
- ✓ Proposal of Water Utilization submitted.
- ✓ Proposed two Rainwater Harvesting Structures in core zones
- ✓ Reports submitted after investigation.
- ✓ Reports approved.

Study for Rainwater harvesting around Iron ore mine of Dholta Pahar, and Netrabandh Pahar, Sundergarh, Odissa



Hydrogeological Investigation and Impact Assessment for Dholtapahar and Netrabandha Pahar (West) for Iron Ore Block, Sundergarh District, Odisha (2 Projects)

- Geological, Remote Sensing, Hydrogeological, Geophysical, Geochemical and Socio-economical investigations completed.
- Draft reports submitted after investigation.
- Reply submitted to CGWA on querry
- Report approved




SDG 6- CLEAN WATER AND SANITATION

WORKS UNDER CGWA ACCREDITATION

Consultancy under Accreditation from CGWA- Dholtapahar and Netrabandha Pahar Mine Sundergarh District, Odisha – Two Projects		M/s D P Rai	04.08.2022 4 months
S.No.	Activity completed/ taken up	Budget	2.36 lakh
1	Work order obtained for study based on our quotation		
2	Field visit to Balaghat MP by Sandeep and Alifia for collection of data from field on Groundwater		
3	Inspection visit by Ms Sneha Rai and Dr Arunangshu Mukherjee conducted to Balaghat and Nagpur for discussions and planning		
4	Outsourcing of RS–GIS work and Geophysical Investigation done, and data obtained, and analysis of data conducted		
5	Report for both the mine area SUBMITTED and approved.		

B. Hydrogeological Studies for Aquifer Monitoring in Barmer Area, Rajasthan, India

"Hydro Geological Survey for Aquifer Monitoring in Barmer Area, Rajasthan" with contract value of INR Rs 2.28 Crores, from Cairns Oil & Gas Vedanta Limited in order to evaluate that the abstraction of deep saline aquifer is not impacting the available fresh water resource in the area. (Contract No 4600008827, Block RJ-ON - 90/1) 1st july,2021 to 24

Hydrogeological surveillance of fresh water and saline water interface at **Barmer area** of Rajasthan funded by CAIRN – Vedanta Oil & Gas Pvt. Ltd. CAIRN Oil and Gas use saline water for increasing oil production. For which they withdraw huge quantity of saline water from deeper aquifers of Barmer area developed within the **cenozoic faulted basin**. There exists fresh to blackish water aquifers at shallow depth and is being used by local farmers for to meet domestic and irrigational requirements.

MRCAWTM through more than 1000 observation point covering nearly 5800 km2 area monitor groundwater level and quality and collect various dynamic and static well and aquifer data. Keep vigilant eye on groundwater development so that impact if any due to withdrawal of saline water on shallow blackish water/ fresh water lenses can be observed. Thus, maintaining the sustainability of domestic/ irrigation water in part of Thar Desert. This project is of long-term duration. The 1st phase of three-year duration completed in May 2021 and the 2nd phase for further three-year duration is going on since July 2021. The budget provision for the first phase was Rs. 1.678 crore and that of 2nd phase is Rs. 2.28 crore.

Aquifer monitoring program of Barmer area to study possible impact on freshwater zone due to developing saline aquifer for hydrocarbon extraction by CAIRN Oil and Gas Vedanta Ltd.

- Area of investigation: 5860 km2 of Thar Desert, Including parts of Barmer and Jallor districts, Raj.
- Hydro census Frequency: Twice a year.
- Per census: 40 days activity,
- Data collection points :975.
- Water sampling points: 100. Vehicle movement about 0.17lakh km By VTS tracer.

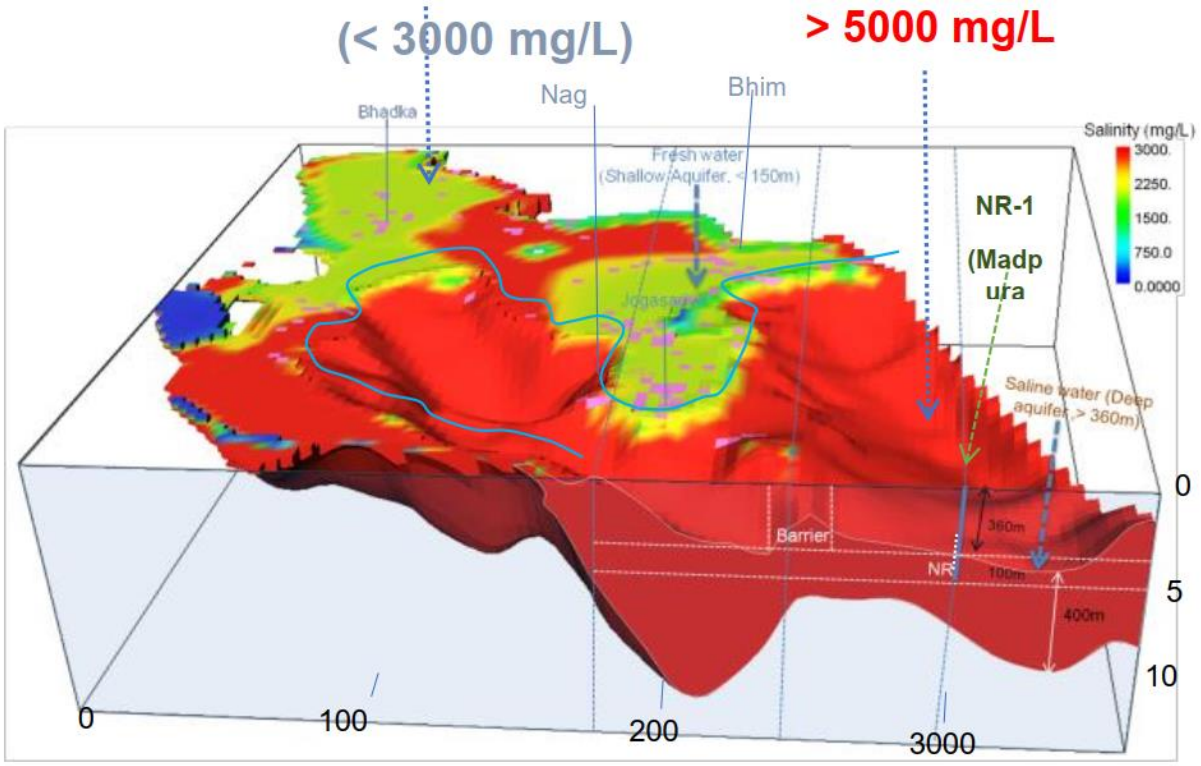
SDG 6- CLEAN WATER AND SANITATION

Aquifer monitoring program of Barmer area to study possible impact on fresh water zone due to developing saline aquifer for hydrocarbon extraction by CAIRN Oil and Gas Vedanta Lt d.

Project duration :3.0 Yrs , Status: Ongoing

Area of investigation : 5860 km2 of *Thar Desert, Including parts of Barmer and Jallor districts, Raj.*
Hydro census Frequency: Twice a year
Per census: 40 days activity, Data collection points :1005. Water sampling points: 105. Vehicle movement about 0.17lakh km By VTS tracer

Volumetric of Saline Water Resources in Aquifer at Thumbli Village, District Barmer, Rajasthan, India



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- ✓ **The contract of Hydro Geological Survey for Aquifer Monitoring in Barmer Area, Rajasthan" with contract value of INR Rs 2.28 Crores, from Cairns Oil & Gas Vedanta Limited in order to evaluate that the abstraction of deep saline aquifer is not impacting the available fresh water resource in the area. (Contract No 4600008827, Block RJ-ON - 90/1) 1st july,2021 to 24 is appended.**

Update on the Project Approval:

https://twitteí.com/manav_íachna/status/1410839135112241154

MANAV RACHNA
vidyanatariksha

Detailed Project Report on Hydro-census of Aquifer Monitoring, Barmer, Rajasthan

Center for Advance Water Technology & Management

Manav Rachna International Institute of Research and Studies (MRIIRS)

(Deemed to be Iniversity under section 3 of the UGC Act, 1956)

Sector-43, Delhi - Surajkund Road, Aravali Hills, Faridabad - 121004

June 2021

Report
On
Hydro– Census of Aquifer Monitoring, Barmer, Rajasthan

Author

CAIRN Oil and Gas Vedanta limited

June 2021

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Executive Summary

Manav Rachna Centre for Advance Water Technology and Management, MRIIRS, Faridabad has been assigned the investigation of Thar Desert on "Provision of Water Well Data and Samples Collection for groundwater monitoring in Barmer area Rajasthan" through contract no 4600008827 of July 2018 for 3 years by CAIRN Oil & Gas Vedanta Ltd, Gurugram. CAIRN Oil and Gas Vedanta has discovered a significant amount of hydrocarbon in the RJ-ON-90/1 block Rajasthan. The RJ-ON-90/1 study area is located in Barmer and Jalore district of the south – western Rajasthan extended over 5800km2. The area covers part of Shiv, Baytoo, Barmer, Gudda Malani tehsil of the Barmer district and Bhimda & Sanchore tehsil of the Jalore district. The study area lies between 24°47'77.58 to 26°26'00.99'' N latitude and 71°15'41.17 to 72 ° 4'39.29'' E longitudes.

The objective of the study area is to monitor the impact of groundwater development in the area on the shallow low TDS zone and produce a significant data set for long term groundwater modelling of the semi-consolidated and unconsolidated aquifer system of the extreme arid region. Aquifer monitoring of the study area is a continuous process twice a year, pre monsoon and post monsoon for 3 years. All the hydrogeological field data is to be collected on the basis of verbal enquiry available records with other agencies i.e PHED, GWD etc. To negotiate the extreme weather conditions, two field teams were deployed with fully covered AC 4*4 drive vehicles fitted with VTS system. The samples were kept in an ice box while collecting from the field. During each monitoring about 1000 data points were covered taking GPS coordinates to ensure accuracy. The collected field data include:

- The lithology encountered while drilling.
- Type of rig used for drilling
- Diameter of the well
- Casing – Type of Casing
- Specific capacity/Yield of the well
- Type of pump and its HP
- Drawdown in the well due to pumping and recuperation time.
- Precise and accurate field EC, Ph and temperature through the use of high-quality instruments.
- Tentative well location of the existing wells is available with the company.
- Information about abstraction usage of water.

The geological succession of the Barmer area is represented by formation of Proterozoic to recent age. The surface exposure of the formation other than Malani Igneous suite (MIS) and Aeolian sands are scanty. The MIS is largely represented by rhyolitic porphyry, along with ash beds, also having granite, pyroclastic and volcanoclastic rocks, showing lava tunnels, flow structure and crater facies sequence. The Aeolian sequence is represented by unconsolidated sand. The area has active mining pits for lignite and Bentonite clay and is known for its oil field. Hydro geologically the Aeolian sand is largely unsaturated and forms

parts of the vadose zone. Underlaying semi-consolidated formation of Cenozoic and Mesozoic age forms the primary aquifer in the area where water levels vary from 60 to 110 mbgl and are unconfined to confined in condition and are taped through open well and tube well. Deep open wells are a peculiarity of this dry region. Depth varies in range of 50 to 100 mbgl. Groundwater quality is mainly brackish to saline where EC range from 1600 to 12000 us/cm.

ACKNOWLEDGMENT

The Center for Advance Water Technology and Management (CAWTM) is thankful to Dr Prashant Bhalla, Chancellor, MRIIRS, and Dr Amit Bhalla Vice President Manav Rachna International Institute of Research and Studies for their continuous encouragement to take up environmentally challenging projects for research and development and for the betterment of society**.** The CAWTM is very thankful to Dr NC Wadhwa, Director General and Dr Sanjay Srivastava, Vice Chancellor, MRIIRS for their support in all stages of the project and providing all facilities and logistics in this regard. Thanks to CAIRN Oil & Gas Vedanta for contract with MRIIRS. A special thanks to Mr Ranjan Sinha-DGM Subsurface for their support. Thanks to MRIIRS faculties Dr H S Saini, Ms Sneha Rai, Researchers Mr. Sandeep Kumar and Ms Alifia Ibkar and students Mr. Anuj Soni and Ms. Khushboo for their help in finalization and miscellaneous support in preparation of this DPR. Thanks to the hired manpower, Mr Hanuman and Imran Khan for their technical support during field work. The conceptualization of plan and preparation of DPR is the effort of CAWTM under the guidance of Chair Professor Dr Dipankar Saha.

1. Introduction:

1.1 Project description

CAIRN oil & gas, Vedanta limited a company incorporated in India and Manav Rachna International Institute of Research and Studies Faridabad have a contract with contract no 4600008827 on 9th July 2018. Main purpose of the contract is to provide groundwater level data and samples collection for groundwater monitoring in Barmer, Rajasthan for 3 Years. The contractor (MRIIRS) agreed to perform the services according to the terms and conditions of this contract. The contract shall be valid for a period of three years from 9th July 2018 to 30th June 2021. The company has issued the callout order to the contractor for each monitoring work.

1.2 Objective

Purpose of the study is to monitor the impact of groundwater development in the area on the shallow low TDS zones and produce a significant data set for long term groundwater modelling of the semi-consolidated and unconsolidated aquifer system of this extreme arid region.

1.3 Background

The discovery of oil and gas in the Barmer Basin in northwest India was one of the most significant global discoveries in the decade 2001–2010. The basins presence was suspected from gravity and magnetic data in the late 1980s but not confirmed until 1999 from seismic and drilling. The basin is a lacustrine failed rift. However, bio stratigraphic data indicate that it was intermittently connected to marine waters via either the Cambay Basin, the Kutch Basin, or across the Devikot high, temporarily forming a large, shallow estuary. At least six major tectono-stratigraphic events have caused relative lake level falls and translation of clastic reservoirs basin ward. Upward of 6 km (~20,000 ft) of Cenozoic and Mesozoic sedimentary rocks have been preserved. Prolific source rocks occur in the Mesozoic through Eocene strata. Tectonically, the basin is divided into a northern and a southern province. The north province continues to undergo inversion and erosion and has not been buried as deeply as the south. Kinetics of the major source facies in the north are substantially different from those in the south, as well as the present-day and paleo-heat flow. These differences have made the northern part of the basin predominantly an oil province and the southern part a mixed oil and gas province. The prolific Palaeocene Fatehgarh Formation contains the bulk oil identified to date, but other reservoirs from the Mesozoic to the late Cenozoic are common and may yield significant future resource additions.

1.4 Location

The total area of Barmer district is 28,387 square kilometres and the study area is about 5800 Sq km. Barmer district is located between 24^0 58′ to 26^0 32'N Latitudes and 70^0 05′ to $72^0$52′ E Longitudes. Barmer district is the third largest district of Rajasthan State. It is situated in the western side of Rajasthan with a part of the Thar Desert. Barmer has an arid and semi-arid type of climate. The longest river in Barmer district is the Luni River. There are eight blocks in the district namely Baetu, Balotra, Barmer, Chohtan, Dhorimanna, Siwana, Sheo and Sindhari with 2460 villages. Total population (as per 2011 census) of the district is 2,603,751 out of which 2,421,914 is rural population and 181,837 is urban population.

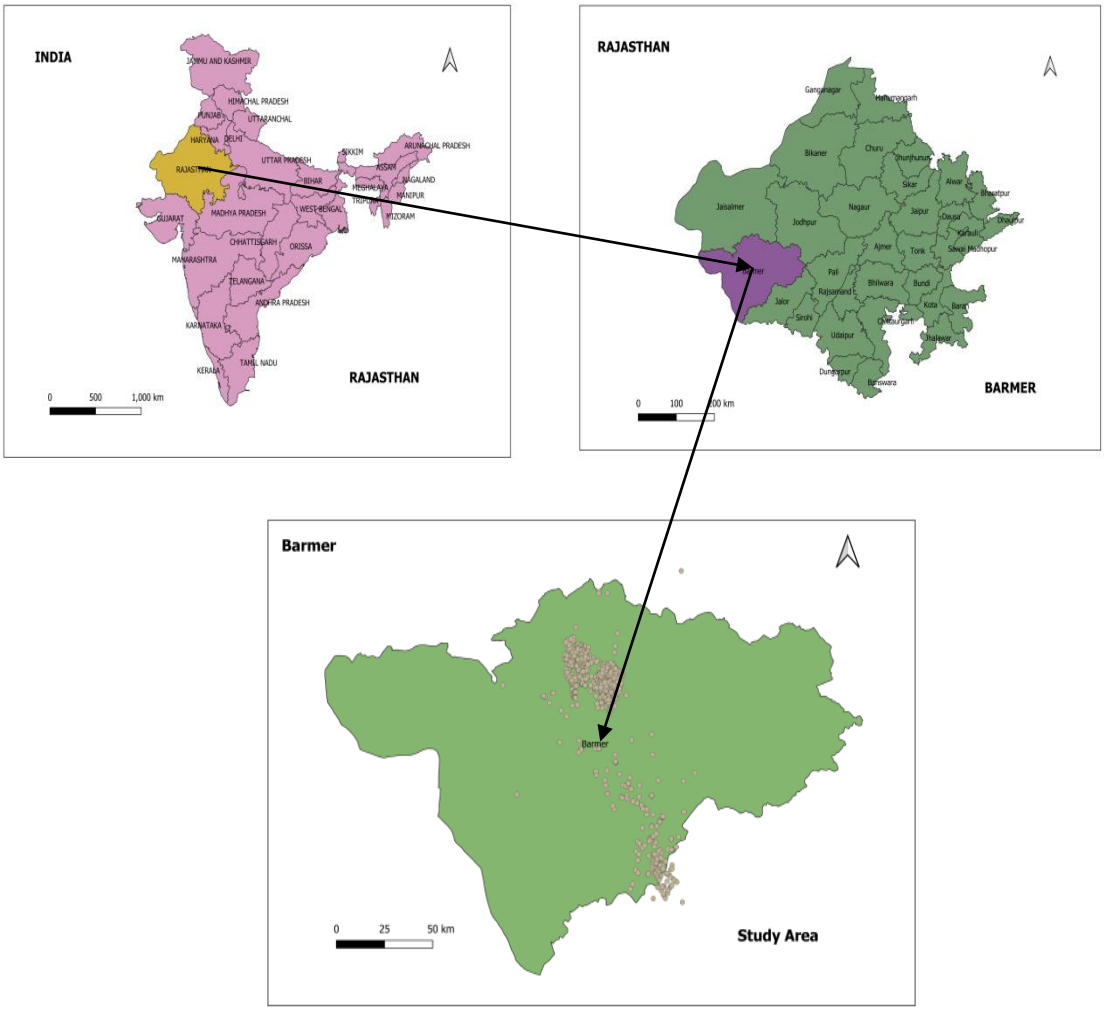

Figure 1.1: Location map of the study area in Barmer, Rajasthan

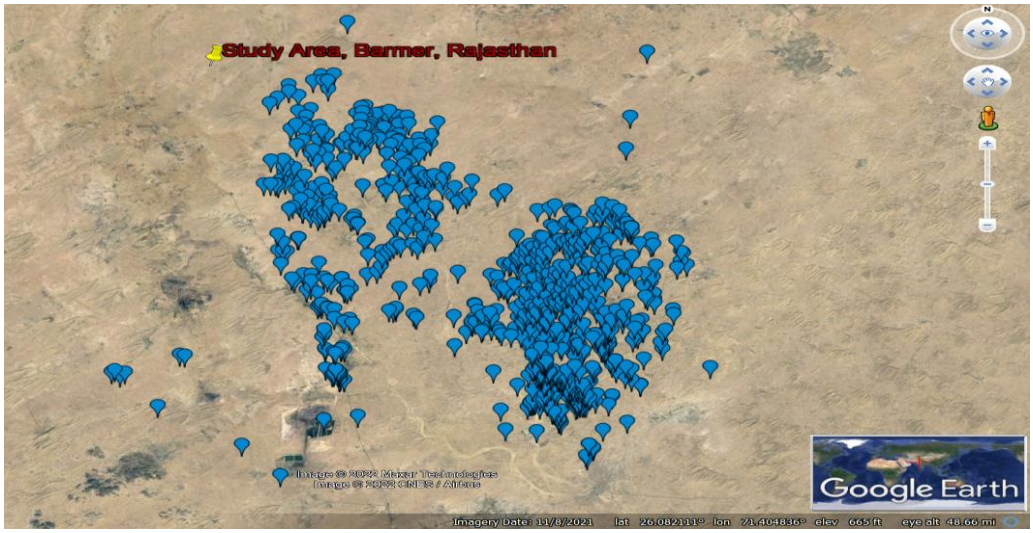

Figure 1.2: Location of data collection points, Barmer, Rajasthan

2. Geomorphology and Soil Types

2.1 Geomorphology

Geographically the Barmer District is part of the Thar Desert. The area is covered with a small offset of Aravalli Hills in the East with Sand Dunes. In the west, the Luni River represents a sandy plain dotted with bold hills. A well-defined valley is observed along the Barmer-Gadra road to the east of Kharin, Pachpadra. Sanwarla and Thob are the major salt lakes in the district.

2.2 Soil and its type

- **Desert soil:** Desert soil area is occupied by alluvium and wind-blown sand, yellowish brown, sandy to sandy loam, loose, structure less, well drained with high permeability and lies in northern, western, and central parts of the district.

- **Sand Dunes:** Is non-calcareous soil, sandy to loamy sand, loose, structure, well drained. Sand dunes lie in the northern, western, and central parts of the district.

- **Red Desertic soil:** These are pale brown to reddish brown soils, structure less, loose, and well drained. Texture varies from sandy loam to sandy clay loam. These soils occupy the eastern and south-eastern parts of the district.

- **Saline soil:** This type of soil is found in salt lakes. They are dark grey to pale brown, heavy soils with a water table very near the surface and are distinctly saline.

Fig 2.1: Sand dune in northern area of Barmer and Granite hills showing wind-blown erosion

- **Multani Mitti**

  Multani Mitti is a type of soil with economic importance which is locally found in some areas of Barmer and Jaisalmer in Rajasthan and is commercially mined by the local miners. **It is found only in small patches of Rajasthan and Pakistan.**

Fig 2.2: Extraction site of Multani Mitti in the Barmer area

3. Geology

3.1 Regional Geology

In the Northwest side of Barmer Basin there have been many discoveries of hydrocarbons. The onshore rift valley on the Western side of India includes Kutch, Cambay and the Narmada basin. Barmer basin is a northern rift, long narrow and deep (200km) linked with Cambay basin to the South. In the North, Barmer Basin is connected to Jaisalmer Basin. Extension within the West Indian Rift System may have begun as

early as the Triassic Period in the Kutch Basin (Biswas, 1982, 1987). It trends roughly NNW-SSE, fault-bounded on both flanks.

3.2 Barmer Basin

Structure and Geology of the Barmer Basin was poorly constrained as only subsurface data were available over the last decade. The basement of Barmer Basin comprises Precambrian Malani Igneous suite. The Malani Rocks are overlying by the exposure of the Jurassic Lathi formation in the North of Barmer Basin. Lower Cretaceous Ghaggar-Hakra Formation lies along the Central part of Barmer Basin. (Sarnoo Hills; Sisodia & Singh, 2000; Dolson et al., 2015). These formations are overlain by Pleistocene to recent alluvium consisting mainly of clay, sand, and silt. Braided stream gravel deposits, floodplain clays and meandering channel sands are the likely depositional products.

3.3 Malani Rhyolite

The Malani was introduced by Blanford (1877) for a volcanic series of pyroclastic lava and ash bed occurring in Barmer district, Rajasthan. There are many names for Malani such as Malani series, Malani system, Malani Granite and volcanic suite. Murthay (1961) described the rhyolite and associated granite as the Malani Igneous suite (MIS). Malani igneous suite are residual hills, tors, inselbergs, hummocks covering an area of 51000 sq.km in western Rajasthan covering part of Jalore, Jaisalmer, Barmer, Jodhpur, Pali, Bikaner, and Sirohi districts. More than 95% area is covered with wind-blown sand and sand dunes of the Thar Desert leaving a small portion of outcrop. The origin of the Malani beds of India has been construed to an event of anorogenic felsic magmatism that began at ~750 Ma (Neoproterozoic) and ended at 650 Ma. The ‘Malani Group’ is an ensemble of several types of lithology, viz. Sedimentary rocks, lava flows, tuffs, pyroclastic material, granitoids and dyke rocks.

Malani Rhyolite was formed mainly in 3 Phases:

- Extrusive phase: mafic and felsic flows.
- Intrusive phase: felsic plutonism.
- Hypabyssal phase: felsic and basic dikes.

Malani activity began with mafic lava flows as well as a large volume of felsic flow. Malani outcrops are covered with the quaternary sand of the Thar Desert in western Rajasthan. Granite plutonism occurred at Siwana, Jalore and other places. These granites are generally alkaline in nature. The end of Malani activity was marked by

dyke intrusions. The term Malani magmatism is more appropriate for the Neoproterozoic igneous activity that gave rise to these outcrops, which comprises volcanic, plutonic, and hypabyssal phases along with associated volcanic-sedimentary sequences that postdate the Sirohi Group (830 Ma) and predate the Marwar Supergroup (680 Ma).

Table 1. Generalized classification of Malani Igneous Suite.

Super Group	Group	Formation	Mode of Magmatism	Lithology
Marwar Supergroup (Vendian to lower Cambrian)				Sandstone, shale, limestone and evaporites
	~~Unconformity ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~			
Malani Igneous Suite (upper Proterozoic)	Dyke swarms	Basic dykes; Acid dykes; Trachyte porphyry, Andesite and porphyry dykes Aplite and Diorite plugs.	Intrusive dyke Phase-III	Gabbro, dolerite, basalt, granite; rhyolite porphyry Trachyte porphyry andesite porphyry porphyritic/non-porphyritic dykes & boss and aplite veins.
	Granitoid plutonism	Malani granite Siwana granite Jalore granite	Intrusive phase-II	Hornblende granite riebeckite/ aegirine granite biotite/ hornblende granite
	Bimodal volcanism	Rhyolite, Trachyte and Basalt flows	Extrusive phase-I	Rhyolite, dacite, trachyte and rhyodacite flows. Basalt and trachyandesite flows
	~~Unconformity ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~			
Pre Malani basement (middle to lower Proterozoic)	Aravalli and Delhi Supergroup			

Table 3.1 Generalized classification of Malani Igneous suite (Cozzi et al, 2012)

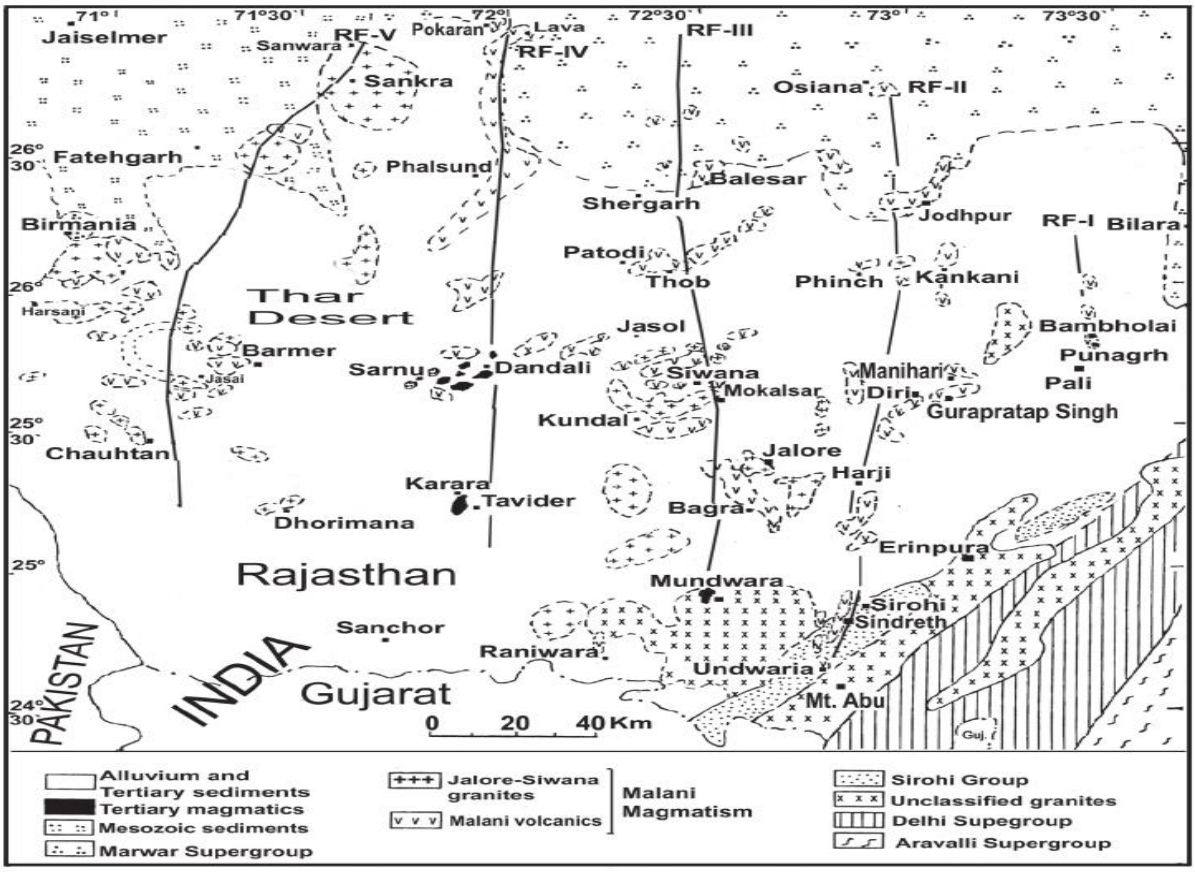

Figure. 3.1. Geological map of the area showing extent of the Malani volcanic rocks (updated from Dolson et al., 2015)

3.4 Stratigraphic Succession

The rocks of the Malani group are underlain by metasediments or granitoids of the Mesoproterozoic of the Delhi Supergroup. Malani group is unconformably overlain by Pokhran boulder bed of glacial origin or by sediment of Marwar supergroup (680-580 Ma.)

Marwar Supergroup	
Malani Group (Volcanics)	−780 to 680 Ma[1]
Erinpura granite	−850 Ma[2]
Sirohi Group	
Intrusives (Gabbro, Diorite)	−1000 Ma[3]
Synorogenic granites	−1450 Ma[2]
Delhi Supergroup	
Metamorphics	−1725 to 1625 Ma[4,5]
Intrusives (Darwal granite)	−1850 Ma[2]
Aravalli Supergroup	
Archean–Proterozoic Boundary	
Intrusives (Granites: Untala, Berach, Gingla etc)	−2500 Ma[6]
Pre-Aravalli Basement (Mewar Gneiss or Banded Gneissic Complex	2600 Ma to −3300 Ma[7,8,9]

Table 3.2: Stratigraphic succession of Barmer (Cozzi et al, 2012)

Felsic Volcanism

Pyroclastic and acid lava flow constitutes the most voluminous unit of the Malani igneous suite representing the second largest volcanic suite in India after the Deccan trap. The acid volcanism is represented by Rhyolite, Rhyodacite, Dacite and Trachyte.

The acid volcanism occurs in three stages.

Stage: 1 - Pyroclastic Explosion

Stage: 2 - Acid Lava Flow

Stage: 3 - Violent phase of pyroclastic ash fall

The Rhyolite flow sequence of stage 2 is the principal member of the acid volcanic rocks.

Acid Lava Flow

Glassy lava is evident. Some of them show excellent flow structure, and in many cases, the original glassy texture has been retained. Columnar jointing is observed occasionally. They are dark grassy green, light blue, yellow and white in colour.

Structure in Rhyolite

On the basis of primary flow structure, the flow layer varies in thickness from 1mm to 1cm. They are defined by variation in colour. The flow layer at places displays primary folding characterized by disharmonic fold pattern, rounded hinge, variation in wavelength, amplitude and in the thickness of the individual layer.

Petrography

In hand specimens, rhyolite is characterized by phenocryst of quartz, feldspar and occasionally of ferromagnesium in a fine-grained or glassy matrix. Under microscope study alkali feldspar is found as K feldspar and Sanidine and anorthoclase. Hornblende and biotite are present in some peraluminous rhyolite.

3.5 Marwar Supergroup

Marwar group overlies Malani group with a time gap of 100 My (650 Ma). Basal Marwar Supergroup lithologies vary in character and are probably of different ages in various localities, infilling an extensional and incised upper Proterozoic topography. The fluvial and shallow marine deposits of the basal **Jodhpur Sandstones** overlap onto the Malani erosional surface and cover a large geographic area across northern and western Rajasthan, known as the Bikaner–Nagaur Basin (Pandey and Bahadur, 2009).

3.6 Lathi Formation

The Jurassic Lathi Formation unconformably overlies the Malani and Marwar Supergroup. It is suspected of presence in the basin based on seismic data and known to be present at outcrop in the northern edge of the basin along the Fatehgarh Ridge. It is exposed around Jaisalmer to the north of the Barmer Basin. This formation includes porous sandstones with significant reservoir quality, which in the Bhuana-1 well north of Jaisalmer are 500 m (1640 ft) in thickness.

4 Local Geology

4.1 Ghaggar-Hakra Formation

Ghaggar-Hakra Formation comprises three sandstone-dominant successions of varying fluvial style, with interbedded floodplain deposits. The base of the formation comprises mud- to very fine-grained, paedogenic sand and unconformable overlies the Precambrian Malani Igneous Suite (750 Ma, Dolson et al., 2015) or, in places, the Lower Cretaceous Karentia Volcanic Formation (120 Ma, Sharma, 2007). The Ghaggar-Hakra Formation has been dated to the **Upper Jurassic – Lower Cretaceous** periods.

4.2 Darjaniyon-ki Dhani Sandstone

Darjaniyon-ki Dhani Sandstone comprises granule to large pebble-grade quartzitic and basaltic conglomerates that are the product of migrating braid bars (2 m high and ≤50 m long), overlain by coarse-grained quartz arenites in planar and trough cross-bedded sets

(95 cm high) representing the amalgamated fill of channels which are ≤2 m high and ≥5 m wide. Finally, the succession is capped with silt to fine-grained sands which are heavily bioturbated and form a floodplain element (≥30 m thick)

4.3 The Sarnoo Hills

Sarnoo Hills are a prominent series of northeast-trending ridges in the vicinity of the village of Sarnoo (alternatively spelt 'Sarnu'or 'Saranu'). Sarono hills are mainly composed of Sands and silts with interbedded of different thickness. The Sarnoo hills are exposed on mafic crystalline rocks. The uppermost surface is very coarse-grained quartz-arenites in cosets of planar cross-bedding (90 cm high) represent the amalgamated channel fill element of in-channel migrating bar forms (10 m high and 15 m wide). The succession then passes upwards into fine-grained rippled-laminated sandstones which are laterally extensive (≤1.5 m high and ≤2 km long) and formed through sheetfloods.

4.4 Nosar Sandstone

Nosar Sandstone comprises medium- to very coarse- grained quartz-arenites, arranged in planar and trough cross-bedded cosets (25 cm high), and representing the amalgamated fill of channels at least 10 m high and 25 m wide. Interbedded with the channel fill are granule-grade quartz conglomerates arranged into localized planar coset packages (≤30 cm high) and representing braid bars (≤4 m high and ≤25 m long). The top of the exposed Nosar Sandstone displays fine- to medium-grained quartz-arenites with ripple lamination, formed in a sheetflood environment (3 m high and ≤2 km in lateral extent).

	Average grainsize	Average sorting	Average roundness	Average porosity
Darjaniyon-ki Dhani Sandstone	0.594 mm	Moderately sorted	Subrounded	5.5%
Sarnoo Sandstone	0.297 mm	Moderately well sorted	Rounded	8.2%
Nosar Sandstone	0.401 mm	Moderately sorted	Rounded	4.5%

Table 1. Textural characteristics of the Darjaniyon-ki Dhani, Sarnoo, and Nosar sandstones within the Ghaggar-Hakra Formation. Data based upon fifty samples in total.

Table 4.1: Average grain size of the local area of Barmer.

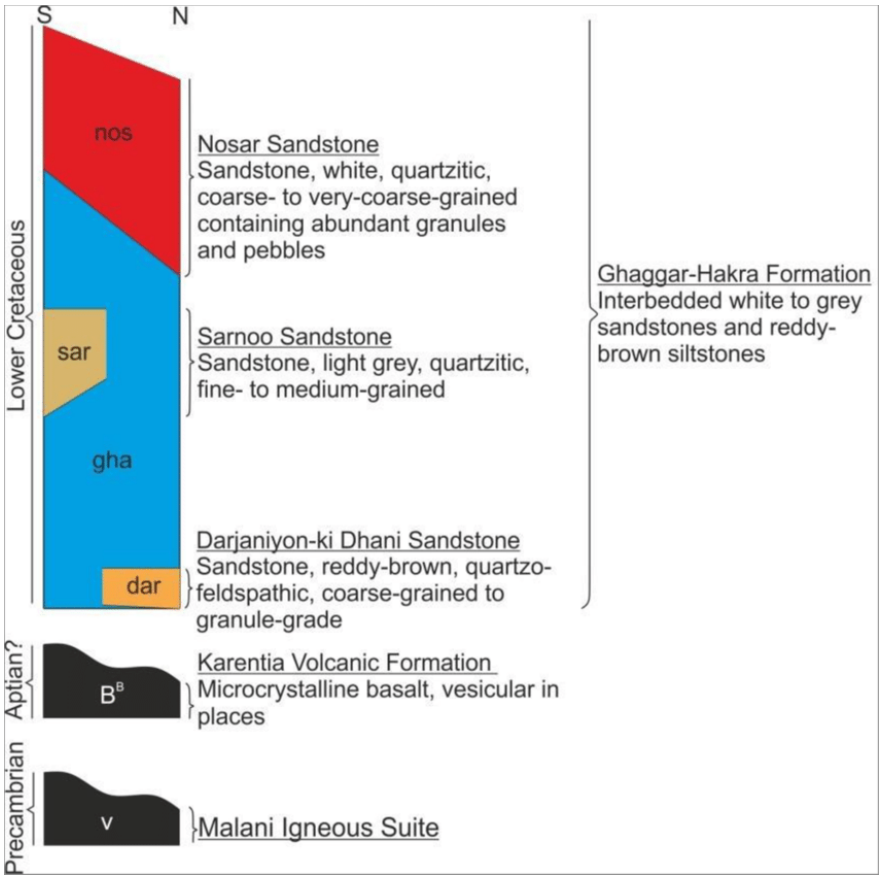

Fig 4.1: Vertical section of the Ghaggar-Hakra Formation, displaying each Sandstone succession and the background sedimentation of the formation (adapted from Bladon et.al 2015).

4.5 Fatehgarh Formations

The well-developed Fatehgarh Formation reservoirs are recognized mostly in the northern part of the basin and contain the bulk of the oil discovered in the basin. Fatehgarh Formation northern facies have porosities varying from 17 to 33% and permeability's of 200 mD to 20 Darcy's. They were deposited as both braided and meandering channels, but have transitional shoreface sandstones grading upward into the overlying Barmer Hill Formation. Mangala field Fatehgarh Formation reservoirs are oil-wet, with API gravities varying from 18 to 20°API near the oil–water contact to 29°API at the crest (O'Sullivan et al., 2008b). The crude is waxy, with viscosities in the range 9–22 cP. Gas–oil ratios are about 160 scf/bbl.

4.6 Barmer Hill Formation

The Barmer Hill Formation transitionally overlies the Fatehgarh Formation and contains the thickest and best-developed lacustrine shales. The Barmer Hill Formation contains a wide variety of facies, and basal, widespread black shale. High structural blocks in the

Barmer Hill Formation are generally devoid of clastic reservoirs in the north, where they consist of microporous porcellanitic with significant oil in place volume.

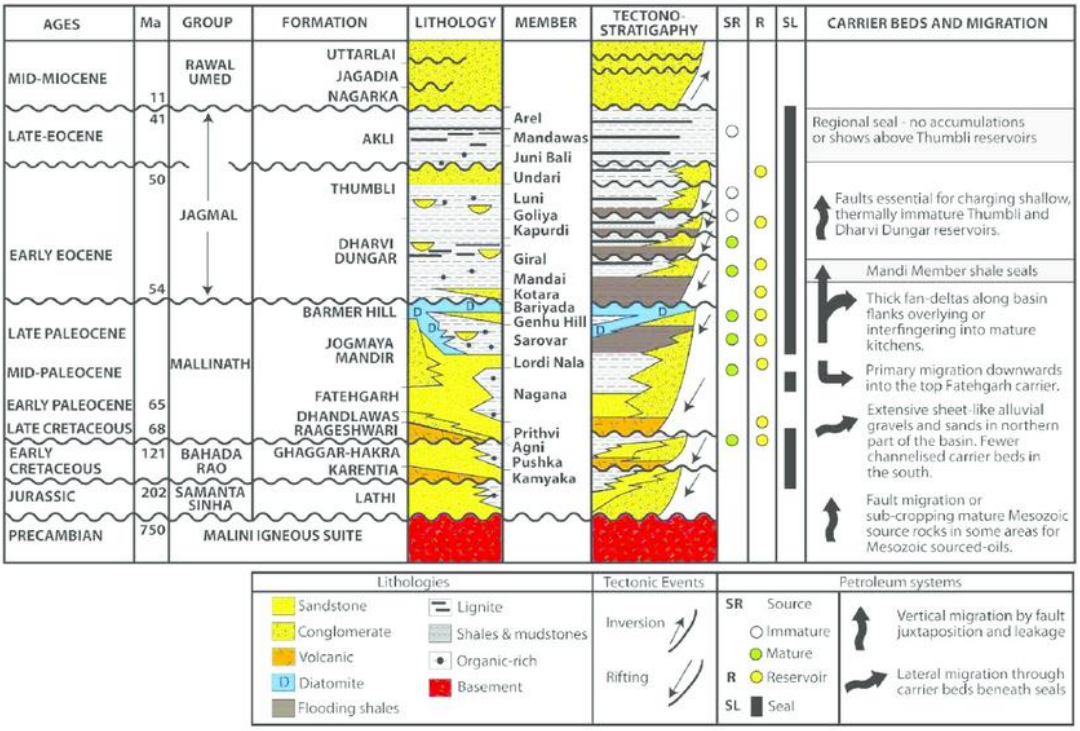

Fig 4.2: Detailed Stratigraphy of Barmer Basin (fig. modified and updated from Dolson et al., 2015)

4.7 Synrift Dharvi Dungar and Thumbli Formations

Dharavi Dunger and Thumabli formation comprise Eocene strata with lacustrine shale fluvial sandstone, and swamp lignite. In the basin there have many angular or erosional unconformity. Most of the shales are freshwater lacustrine, but the occasional presence of dinoflagellates indicates that marine incursions entered the basin from either the south (via a connection with the Cambay or Kutch Basins), or across the Devikot high from the north as the Jaisalmer Basin maintained marine connections until Tethys closed in the late Eocene. The Dharvi Dungar and Thumbli Formations have generally commercial oil only on the Central Basin high in the Rajeshwari and Guda fields. Both formations are sand poor where proven productive, with reservoirs being restricted to fine- grained, low-sinuosity channels and crevasse splays.

Fig 4.3: Thumbli Lignite coal mine field in Barmer.

4.8 Akli and Younger Formations

The Akli formation contains intervals of lacustrine black shale and is interlayered with coaly and silty facies, culminating in the geographically widespread Guda Member coals. Oil shows are largely absent above the Thumbli Formation, supporting the Akli Formation as the regional seal. Akli coals onlap and cover most of the basin margin faulting in the south, supporting a near-rift depositional setting. Oligocene rocks are absent and the Miocene Nagarka and Jagadia Formations are unproductive.

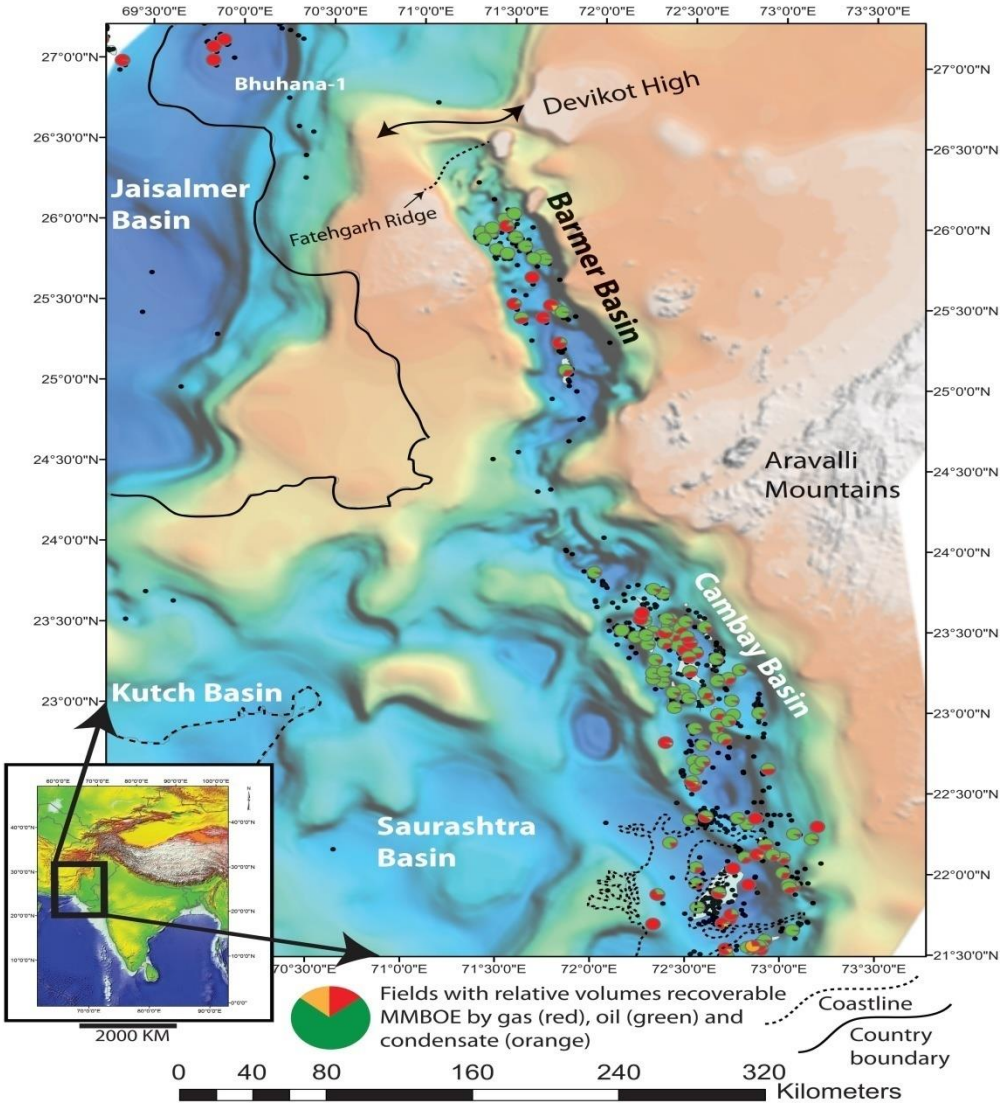

Fig 4.4: Barmer Basin (modified after John et al. 2015)

5. Climate and Rainfall

Barmer district experiences an arid type of climate with mean annual rainfall (1971 to 2005) is 281.85 mm, while normal rainfall (1901–1971) is 277.5 mm which is less than average rainfall (CGWB Report). During the southwest monsoon, from the first week of July till mid of September, nearly 90 percent of the total annual rainfall is received. This shows that it experiences extremes of heat in summer and cold in winter as the area is in the desert region. Temperature also rises during day and night but gradually reaches to the maximum value in the May and June month. In summer the range of temperature varies from 48°Cin summer to 2°C in winter. Even during the monsoon period, the atmosphere is generally dry. With a mean daily relative humidity of 43%, humidity is at its peak in the month of August.

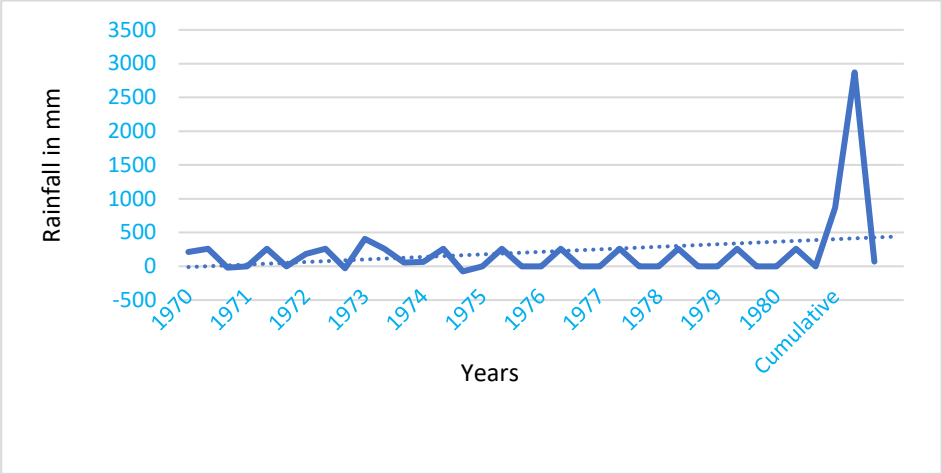

Fig 5.1: Mean annual rainfall at Barmer district (1970 to 1980).

6 Hydrogeology of the Barmer Area

The main water bearing formations in the district are rhyolites and granites of post Delhi; Lathi sandstone, Tertiary sandstone and Quaternary alluvium. In Quaternary alluvium, ground water occurs under semi-confined to unconfined conditions. In semi-consolidated Tertiary and Mesozoic formations, it occurs under unconfined to confined conditions and in weathered and fractured zones in hard rock's under phreatic conditions. Though ground water occurs in all the formations, the most productive aquifers are the Lathi sandstone, Barmer sandstone and Quaternary sediments. The Tertiary formation, which is predominantly clayey and argillaceous, is not found as productive except locally in the sandstone horizon. In general, the fractured and weathered zones in hard rock's form poor aquifers. Consolidated formations include intrusive of Malani rhyolite and granite.

6.1 Consolidated formations: Consolidated formations include Malani rhyolite and granite and Siwana granites of Post Delhi. These formations are found in the North-Western part of the Barmer district. These types of formation lie under the poor aquifer category because groundwater is found in small fracture and weathered conditions up to a depth of 100m. The Rhyolite is impervious in nature having very low water yielding capacity. Yield of dug wells tapping rhyolites is the lowest and ranges from 15 to 50 m3/day.

Fig.6.1: Rhyolitic grain.

6.2 Semi-consolidated formations: Semi-consolidated formation rocks of the Tertiary period, having an alternate bed of clay and shale. Lathi sandstone is the most potential aquifer having medium to coarse grain with a small amount of gravel. The aquifer portion of the Lathi formation ranges in thickness from less than 100 m in the east to over 800 m in the northern part, east of Jaisalmer. The ground water in Lathi formation occurs under perched as well as main water table conditions and under confined conditions.

6.3 Unconsolidated Formations: Unconsolidated formation includes Quaternary alluvium that is most extensive, is the potential aquifer and covers the entire southern part and extreme western portion of the Barmer district. The drilling data indicate that alluvium is composed of sand, silt, clay and kankar with lenses of gravel and cobbles. All types of desert landforms can be seen in the area, dominated by Dunes of permanent and migratory nature, ripples, barcons and Padestral rocks. The area has active mining pits of Lignite and Bentonite clay and is known for its oil fields. 6Km thick Cenozoic and Mesozoic sedimentary rocks have been preserved as a prolific source; rocks occur from the Mesozoic through Eocene strata. The Paleocene Fatehgarh Formation contains the bulk of oil but other reservoirs from the Mesozoic to the late Cenozoic are common and may yield significant future resource additions.

6.4 Study Area: The Hydro Census field work is to be conducted twice a year for the Pre-Monsoon and Post-Monsoon period in Barmer, Rajasthan. Duration of Pre-Monsoon and Post-Monsoon monitoring work is 40 days. The total monitoring area of Barmer and Jalore is divided into two parts, North and South to cover an entire area of 5800 sq. Km. Two field monitoring teams have been constituted each comprising two field label data collectors and a supervisor.

Each team has been provided with a covered AC vehicle with 4*4 drive and fitted with a vehicle tracking system. Each field team is equipped with water level indicator, EC, pH, TDS combo meter, handheld GPS and baller for sampling. Each team carries an ice box for collection of samples. Groundwater samples are collected in a one-litre polyvinyl alcohol bottle. To calibrate the combo EC pH meter standard solutions were provided. Each team at the beginning of field work on an everyday basis work, calibrates their combo meter for EC, pH and TDS. Predefined printed templates are given to each team. Groundwater data and groundwater samples so collected each day were handed over to the local office of CAIRN OIL and GAS Barmer. The data so collected were computed and analysed for aquifer monitoring and impact assessment. Location of all wells are listed in table no…1

Fig 6.2: Instruments used during field work in Barmer such as GPS, EC- Ph combo meter, water level meter and baller for samples collection.

6.5 Methodology

- Handle automatic water level recorder (Transducer/CTD) - set up instruments, downloading of data and transmission and handling related software.
- Measuring/ collection of field Hydrogeological data by GPS, dip meter, EC, pH, TSS and turbidity device, its calibration and maintenance activity
- Handling equipment's for land subsidence study-setting up of land subsidence instrument and downloading of data and handling related software.
- Supervision of drilling & development and pumping test of water wells
- Collection of water samples as per protocol.
- Working with computers- MS Office, email/internet etc
- Other field work related support.

7. Schedule of Field Monitoring

7.1 1st Monitoring- Post Monsoon 2018: The first Post Monsoon monitoring was started from 1 November 2018. During the fieldwork we collected 1050 pre-identified well data and more than 100 groundwater samples for lab analysis.

7.2 2nd Monitoring- Pre-Monsoon 2019: As per the call out order received from Cairn oil and Gas Vedanta Pvt. Ltd. the Pre-Monsoon hydro census work was conducted in the month of May-June, 2019. We collected approximately 1050 pre-identified well data and 100 groundwater samples.

7.3 3rd Monitoring – Post Monsoon 2019: As per the Call out order received from Cairn Oil and Gas Vedanta Pvt. Ltd. the Post Monsoon survey for the 2nd Year was conducted from November - December 2019 in Barmer District, Rajasthan and continued for 40 days. As per the pre-described data we collected more than 1050 well data and more than 100 water samples for lab analysis.

7.4 4th Monitoring –Pre-Monsoon 2020: The Pre-Monsoon Hydro census at Barmer was due in April but due to COVID 19 it was delayed. After the declaration of the Green Zone of Barmer area, Rajasthan, the 4th Hydro- Census work was started on the date of June- July 2020. As per the pre-described data we collected more than 1050 well data and more than 100 water samples for lab analysis.

7.5 5th Monitoring- Post Monsoon 2020: As per the Call out order received from Cairn Oil and Gas Vedanta Pvt. Ltd., the Post Monsoon survey for the 3rdYear was conducted on November-December 2020 in Barmer District, Rajasthan. During the monitoring work we collected more than 1050 well data and more than 100 water samples for lab analysis.

7.6 6th Monitoring- Pre-Monsoon 2021: Due to COVID-19 pandemic situation all over India, the last monitoring work was delayed. As per the call out order received from Cairn Oil and Gas Vedanta Pvt. Ltd., the Pre-Monsoon survey for the 3rdYear was conducted on May- June 2021 in Barmer District, Rajasthan. As per the pre-described data we collected more than 1050 well data and more than 100 water samples for lab analysis.

Fig 7.1: EC pH combo Meter showing pH reading

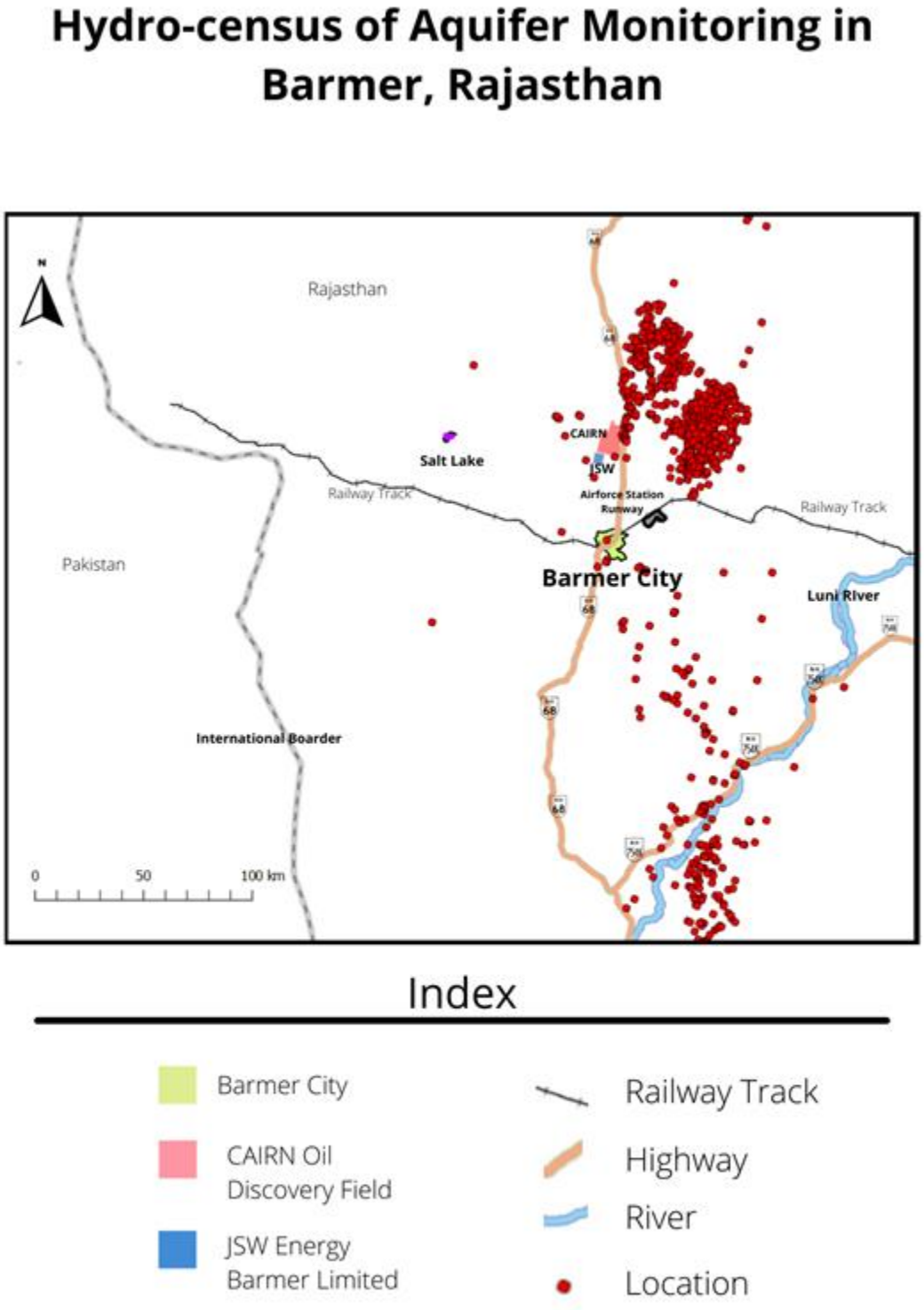

Fig: 7.2 Hydro census aquifer monitoring pre monsoon 2021 at Barmer area, Rajasthan

8. Groundwater Quality Analysis

8.1 Piper Trilinear Diagram

Different graphical methods can be adopted for representing geochemical variation which gives a better insight into the groundwater quality monitoring. One such efficient method of representation is plotting of Hill Piper Trilinear diagram in which data are plotted in two triangle fields and one diamond field. The diamond is then classified under various categories emphasizing their characteristics.

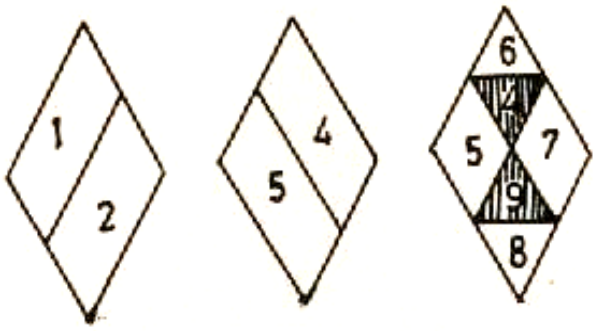

Fig 8.1: Sub-divisions of the diamond field

On the basis of samples collected from the study area, it can be observed that out of 90 Samples most of the samples are concentrated in **Area 6** indicating that: Non-carbonate hardness exceeds 50% i.e., Ca + Mg - (SO_4 + Cl + NO_3). Few samples come under **Area 4** representing strong acids (SO_4 + Cl + NO_3) exceed weak acids (CO_3 + HCO_3). Only 2 samples can be noticed under **Area 7**: Non-carbonate alkali exceeds 50% i.e., Na + K- (SO_4 + Cl + NO_3).

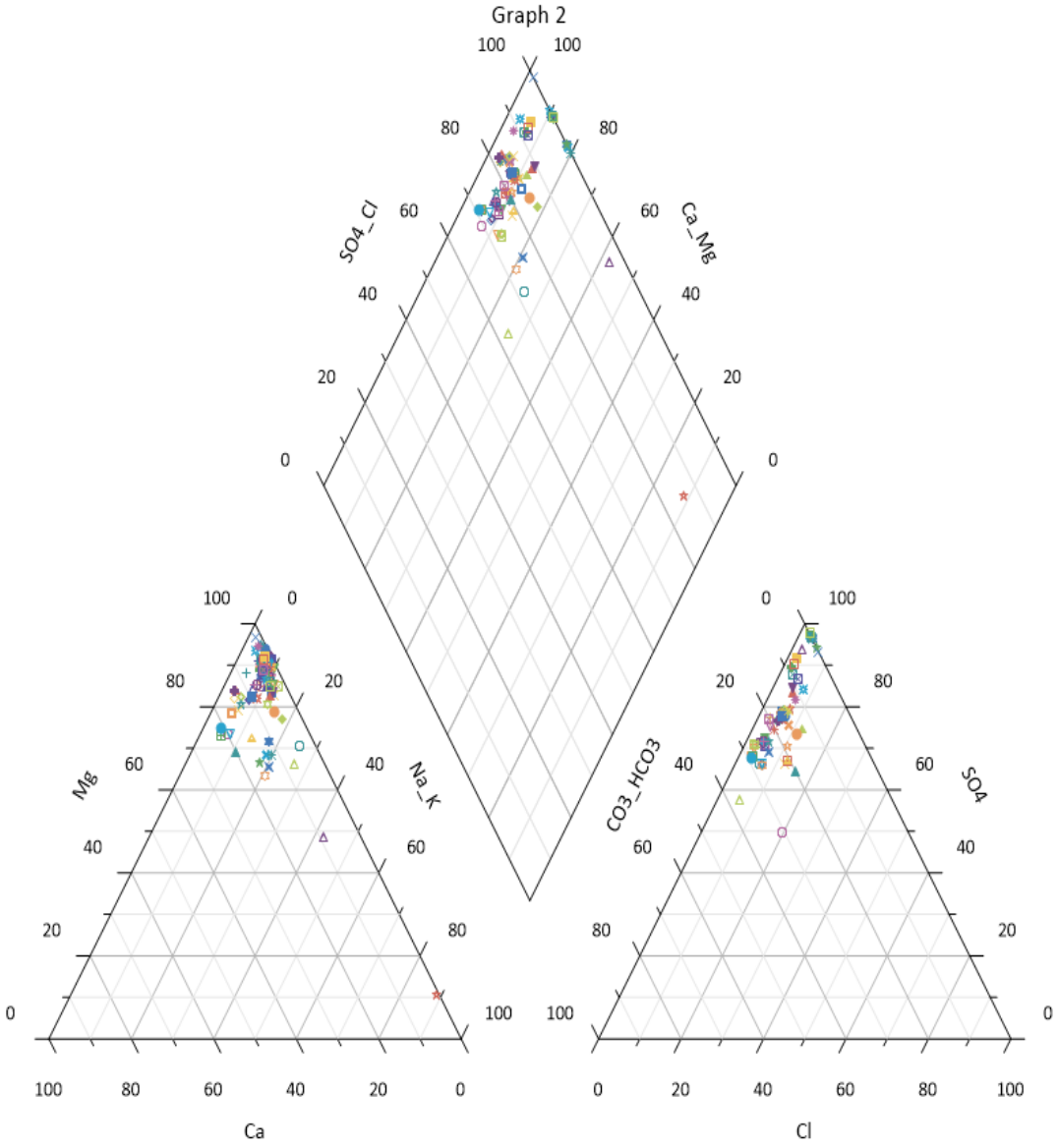

Fig 8.2: Distribution of Water Samples on Piper diagram.


Legend
Bhadka_PU1212NT-2
Bhadka_PU0513NT-1
Bhimda Rewali_PU1212 NT-12
Bhimda_PU0512NT-5
Bothiya 1
Bothiya_PU1218NT-8
Bothiya_PU0519NT3
Bhimda_PU1212 NT-41
Bhimda Rewali_PU1212 NT-31
Bisala Bhagyam_PU1212 NT-02
Khan ji ka Tala_PU1212 NT-20
Bothiya_PU1118NT-1
Bothiya _PU1212 NT-1
Bhimda Rewali_PU1212 NT-5
Bhadka_PU1218NT-20
Bhadka_PU1218NT-8
Bhimda 104
Bhimda rewali -2
Bhimda _PU1218NT-15
Tambo ka Dhora PHED NT-1
Jogasariya_PU1212 NT-25
Dabli 2
Jogasariya_PU1118NT-5
Jogasaria_PHED0509NT2
Chokhla_PU1218NT-13
Hudon ki Dhani_PHED0514NT-2
Nagurda _PU1212 NT-37
Khanji ka Tala 102
Sajitra_PU1218NT-10
Sajitra _PU0513NT-10
Nagana PHED-30
Chokhla_PU0509NT2
Chittarka ka par_PU0509NT14
Adel NT-2
Adel_PU0519NT-1
Kharwa_PU062020NT-2
Garal PHED_PU0513NT-2
Chittar Ka Par 13
Bhimda -112
Nagurda _PU1212 NT-187
Chittar ka Par 1
Nagurda _PU1212 NT-73
Battadu_PU0513NT-5
Jhab Luni River NT-1
Amba Ka Goliya NT-2
Bhimda _PU1118NT-9
Mahabar 7
Panchaniyon Ki Dhani -103
Dedawas ka Goliya NT-1
Mukonion ki dhani_PU1111NT1
Hemaguda fanta NT-1
Gangasar PHEDNT-1
Bhimda Rewali_PU0519NT-3
Bhimda_PU0513NT-14
Kawas PU1214NT-2
Panchaniyo ki Dhani _PU1212 NT-2
Teja ki Dhani
Adel
Battadu 9
Jogasariya PHEDc
Adel 1
Mulaniyo ki Dhani _PU0512NT-9
Bhimda Rewali_PU1212 NT- 6
Kawas PU1214NT-3
Chittar Ka Par_PU1218NT-4
Nagurda_PU1212 NT-129
Nagurda PHED7
Nimabalkot-1
Amba Ka Goliya NT-1
Chittar ka Par 8
Battadu_PU0511NT2
Nagana_PU1213NT-6
Nagurda 114
Nagurda _PU0512NT-27
Hemanada_PU062020NT-2
Huddo Ki Dhani_PU062020NT-1
Kawas PU1214NT-4
Morsim_PU062020NT-7
Battadu_PU062020NT-4
Bhimda Rewali_PU062020NT-17
Nagurda_PU0514NT-4
Nagurda _PU1212 NT-173
Koslu PU1214NT-1

8.2 USSL Diagram: The United States Salinity Laboratory (USSL) (1954) and Wilcox (1955) established standards for irrigation water quality classification. The Fig.7.5 is a simple scatter chart of sodium hazard (SAR) on the Y-axis versus salinity hazard (EC) on the X-axis. Using the SAR and the EC value of 90 water samples of Barmer area determines the quality classification of the water.

Based on the EC, irrigation water can be classified into four categories; include:

I. Low-salinity water (C_1) can be used for irrigation with most crops on most soils with little likelihood that soil salinity will develop.

II. Medium-salinity water (C_2) can be used if a moderate amount of leaching occurs. Plants with moderate salt- tolerance can be grown in most cases without special practices for salinity control.

III. High-salinity water (C_3) cannot be used on soils, special management for salinity control may be required and plants with good salt tolerance should be selected.

IV. Very high salinity water (C_4) is not suitable for irrigation under ordinary conditions.

Sodium Adsorption Ratio: High sodium in irrigation water reduces the permeability of soil. The USSL diagram based on SAR divided to four categories included:

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

I. Low-sodium water (S_1) can be used for irrigation on almost all soils.

II. Medium-sodium water (S_2) will present an appreciable sodium hazard in certain fine-textured soils. This water may be used on coarse-textured or organic soils with good permeability.

III. High-sodium water (S_3) may produce harmful levels of exchangeable sodium in most soils and will require special soil management.

IV. Very high sodium water (S_4) is generally unsatisfactory for irrigation unless special action is taken, such as addition of gypsum to soil (Lyerly and Longenecker, 1957).

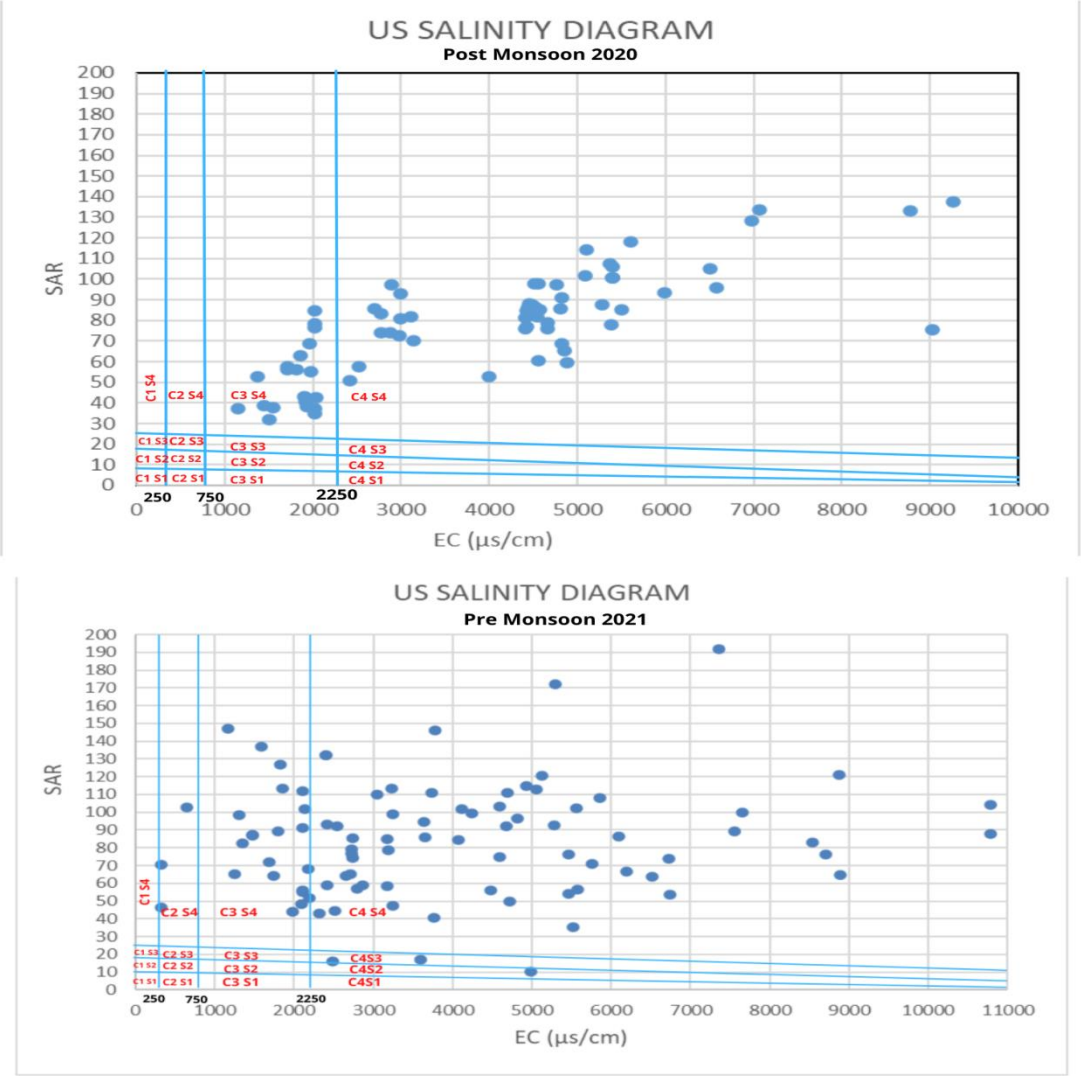

Fig 8.3: US Salinity diagram of Post Monsoon 2020 and Pre Monsoon 2021, Barmer

Interpretation: On the basis of samples collected from the study area, it can be observed that out of 82 samples of Post Monsoon 2020 and 90 samples of Pre Monsoon 2021, most of the samples are concentrated under C3S4 and C4S4 categories indicating very high sodium hazards with high to very high salinity. Out of these, few samples are scattered under C2S4, C4S3 and C4S2 categories representing very high sodium hazards with medium salinity, high sodium hazard with very high salinity and medium sodium hazard with very high salinity respectively. The main objective of this monitoring is to observe the variation in ground water recharge. Analysis of collected samples of pre and post monsoon shows that there is not any significant variation in groundwater recharge and groundwater quality due to monsoonal rainfall or other sources.

8.3 Pumping Test

A pumping test is a test in which groundwater is pumped from a localized well at a constant rate and the groundwater level is measured during and after pumping. A pump test has been operated at Khanji ka Tala village, during post monsoon hydro census aquifer monitoring 2020, Barmer. Main purpose of conducting a pumping test in the study area is to determine the different parameters of the aquifer.

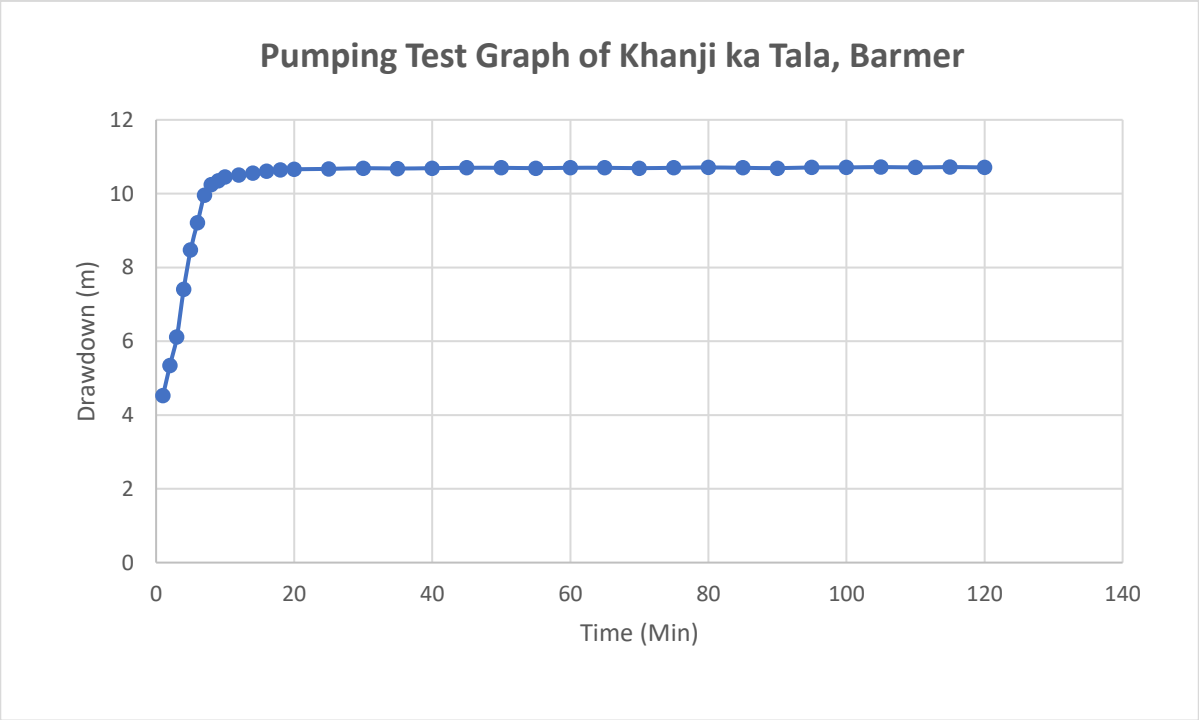

Fig 8.4: Drawdown curve during pump test in the study area

8.4 Field Observation

Quality of ground water in shallow aquifer varies widely from saline in Pachpadra Salt Lake to fresh close to the hilly tract in Barmer area. Analytical results of ground water samples collected during aquifer monitoring indicate that specific conductance (EC) varies from 747 to 27500 µS/cm at 25°C. By and large, EC conforms broadly to chloride concentration. Higher values of EC have been observed in the eastern part of the district around Jasol, central part around Hathi Tala and Sanwara, in the northern part around Bisukallan and in the north-western part around Napat. In general, the quality of ground water deteriorates from upland and hilly tracts towards the Luni River and its tributaries in the lower reaches and in depressions in the vicinity of the saline lake.

Fig 8.5: Measurement of pH, EC, and Temperature by EC pH meter

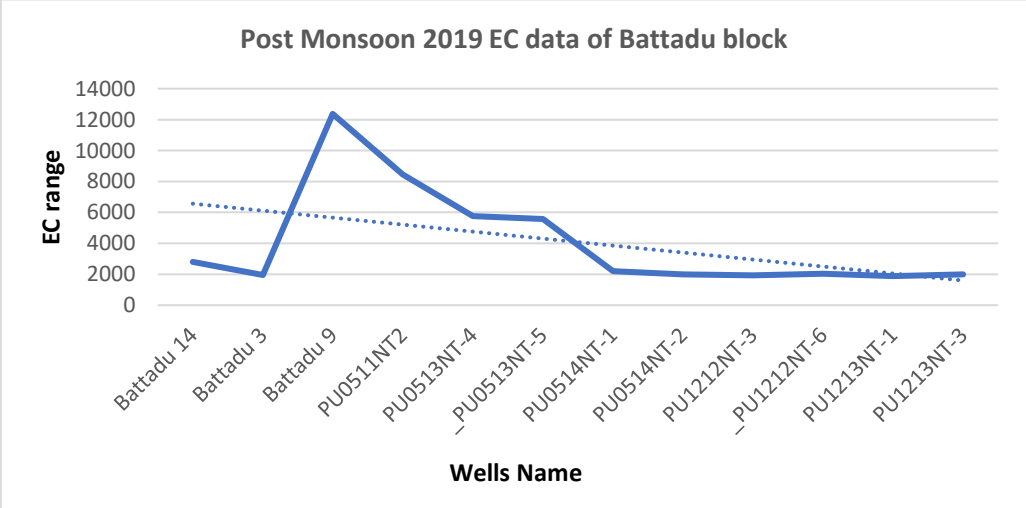

Fig 8.6: Post monsoon 2019, EC graph of Battadu wells

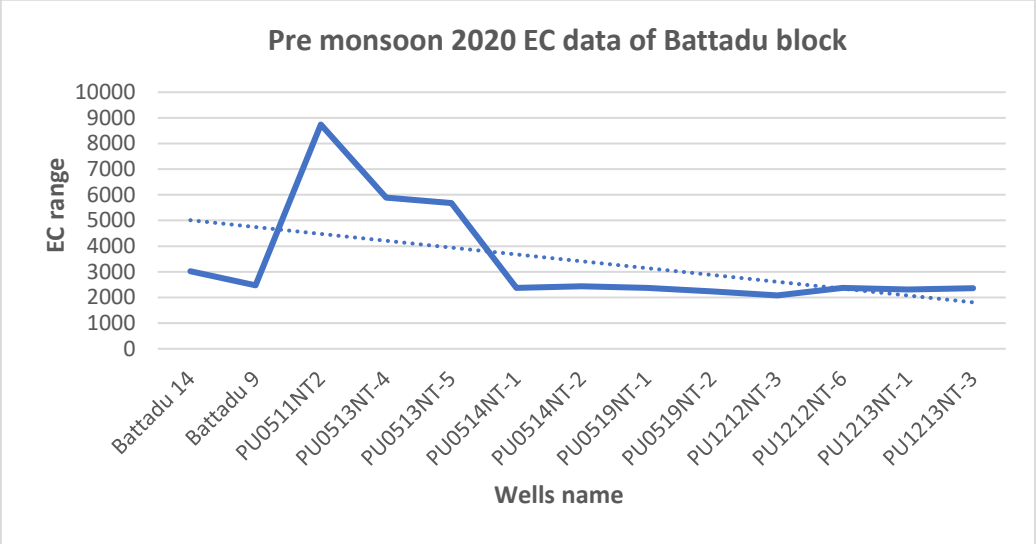

Fig 8.7: Pre monsoon 2020, EC graph of Battadu wells

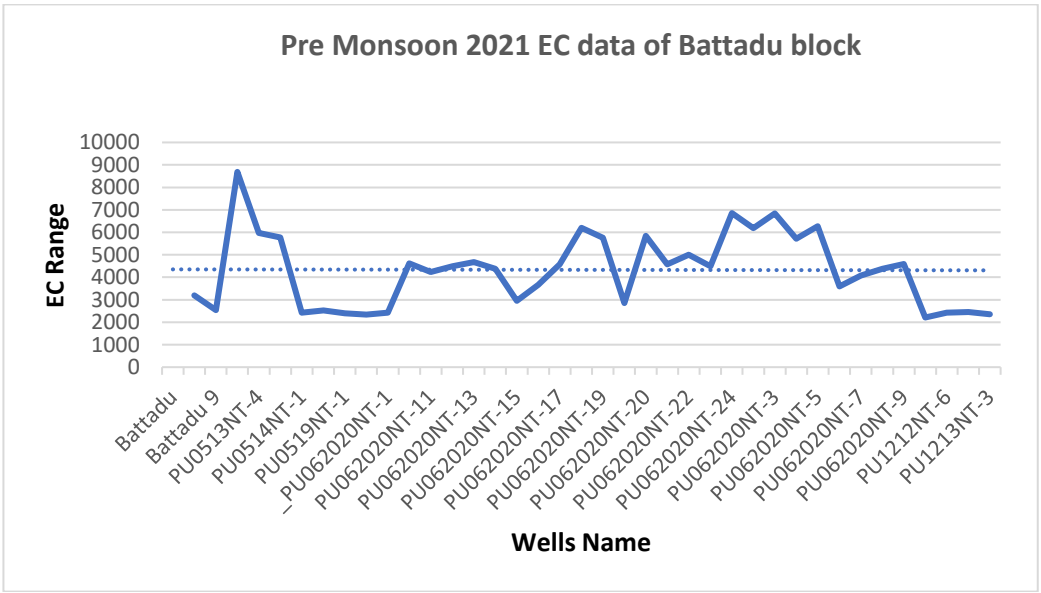

Fig 8.8: Pre monsoon 2021, EC graph of Battadu wells

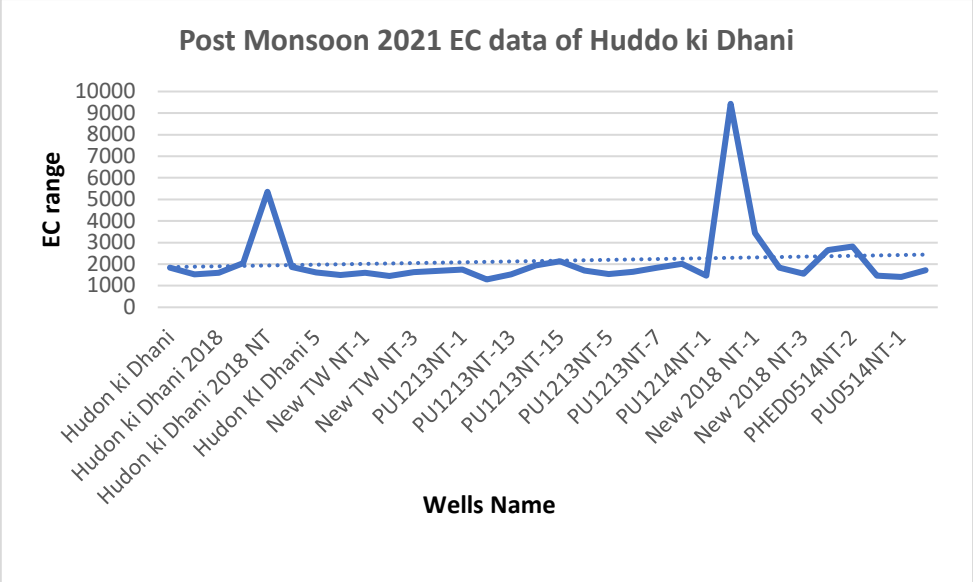

Fig 8.9: Post monsoon, 2021 EC graph of Huddo Ki Dhani well

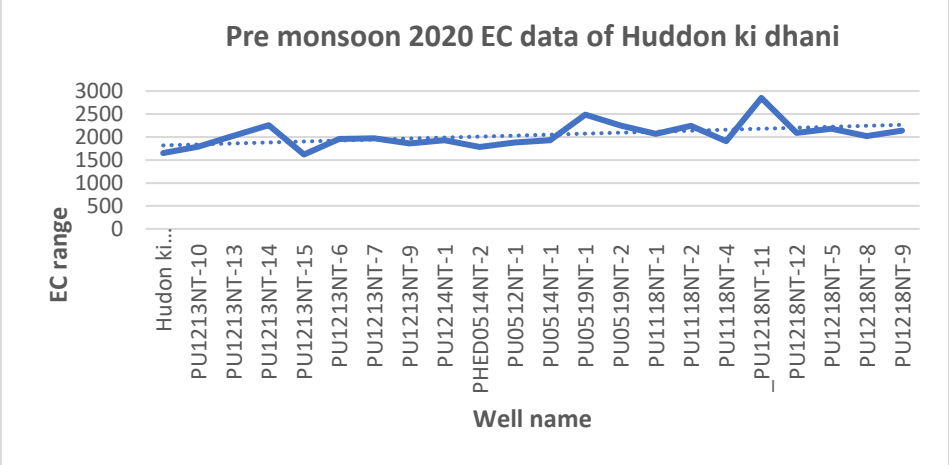

Fig 8.10: Pre monsoon 2020, EC graph of Huddo Ki Dhani well

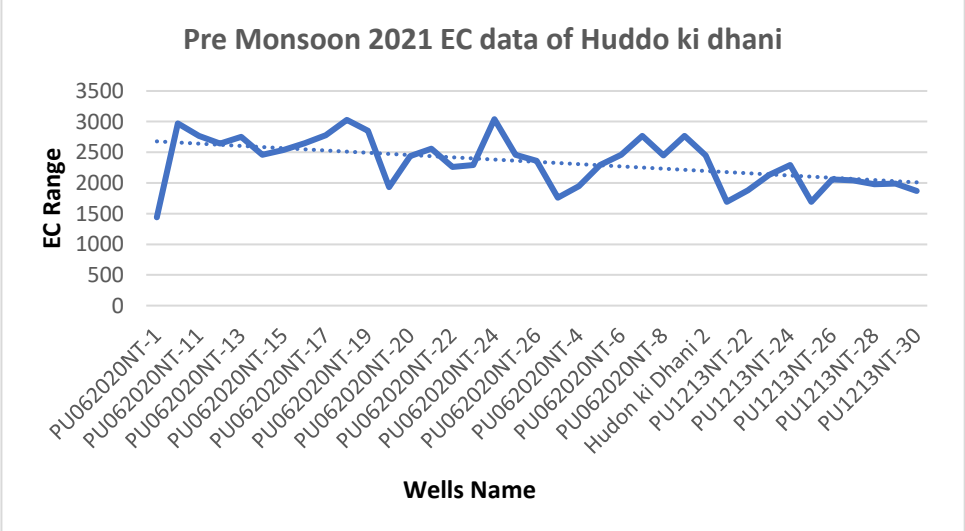

Fig 8.11: Pre monsoon 2021, EC graph of Huddo Ki Dhani well

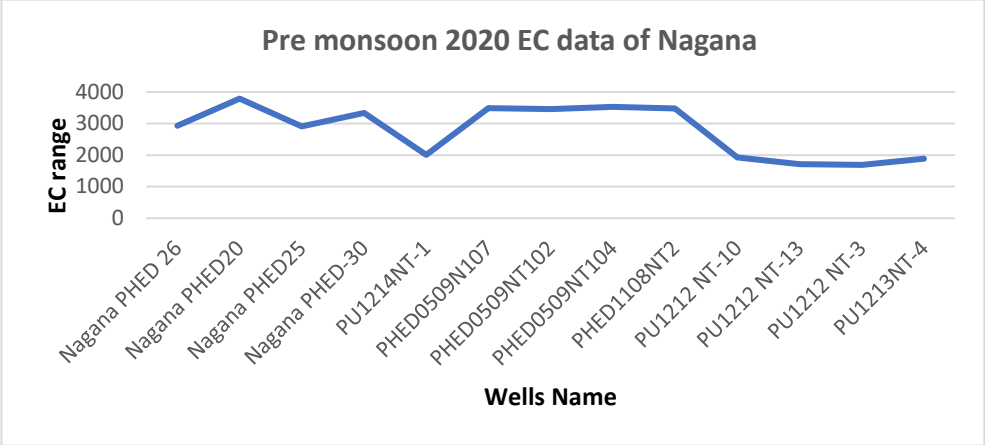

Fig 8.12: Pre monsoon 2020, EC graph of Nagana well

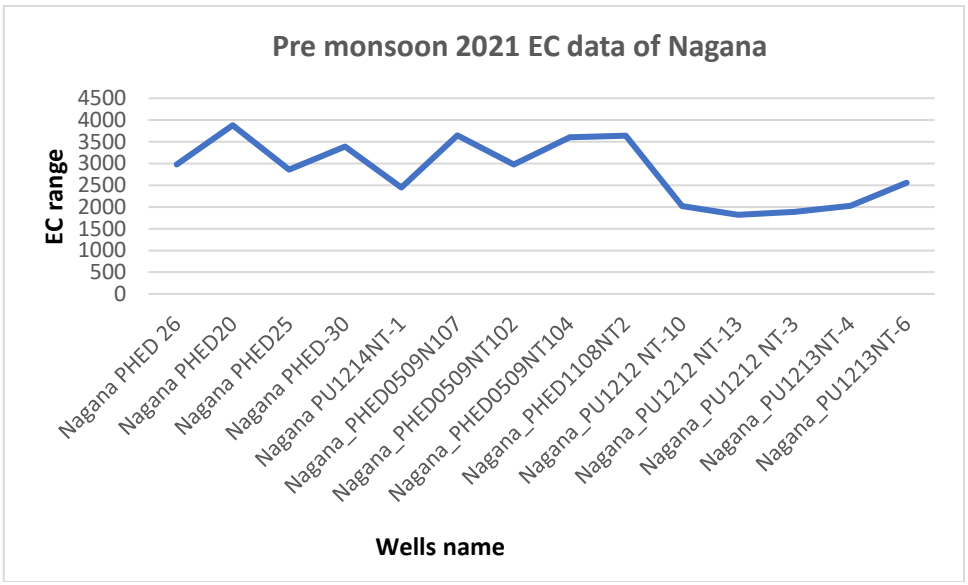

Fig 8.13: Pre monsoon 2021, EC graph of Nagana well

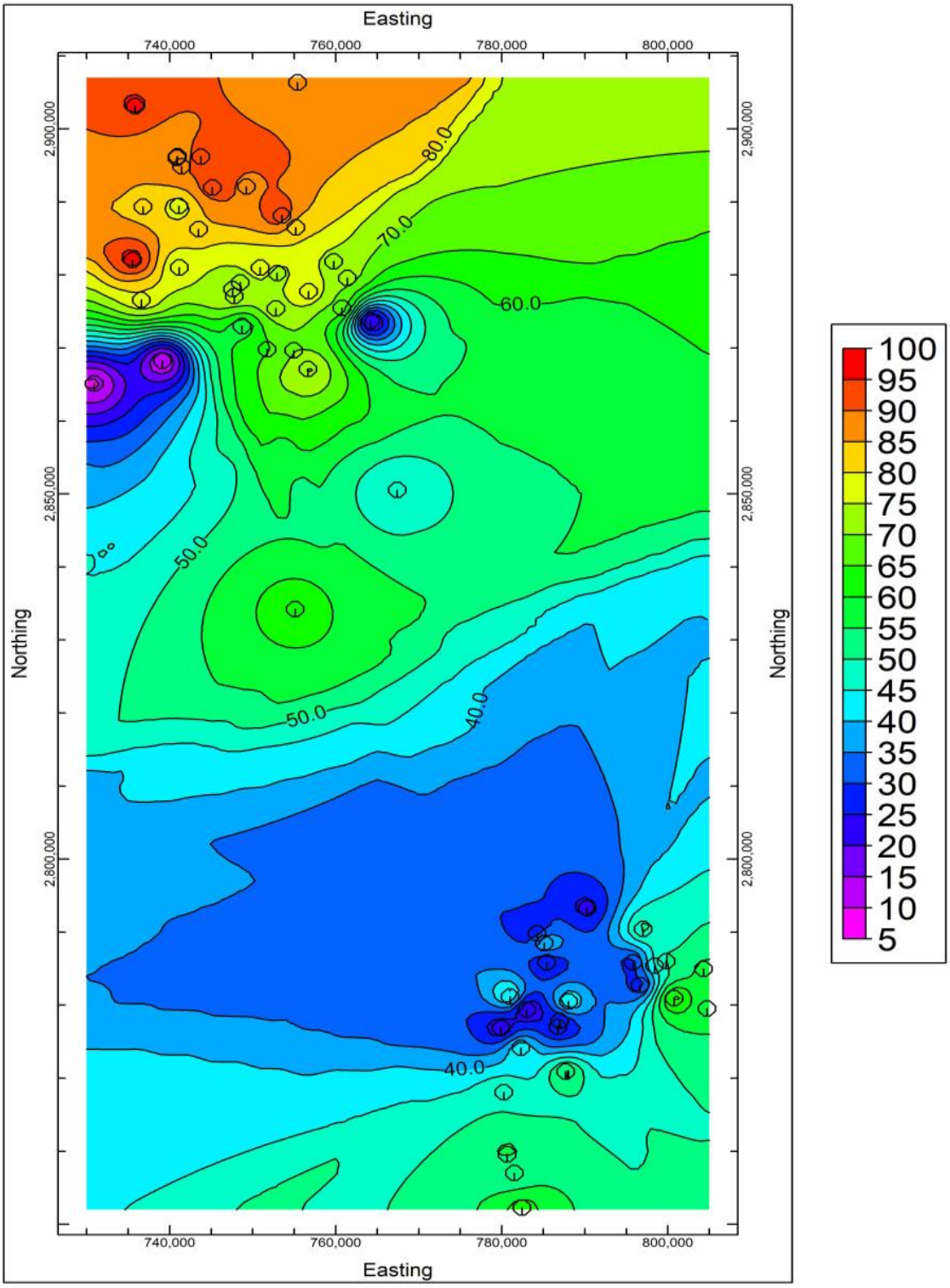

Fig. 8.14: Contour map showing depth of the water level in pre-monsoon 2021 in study area.

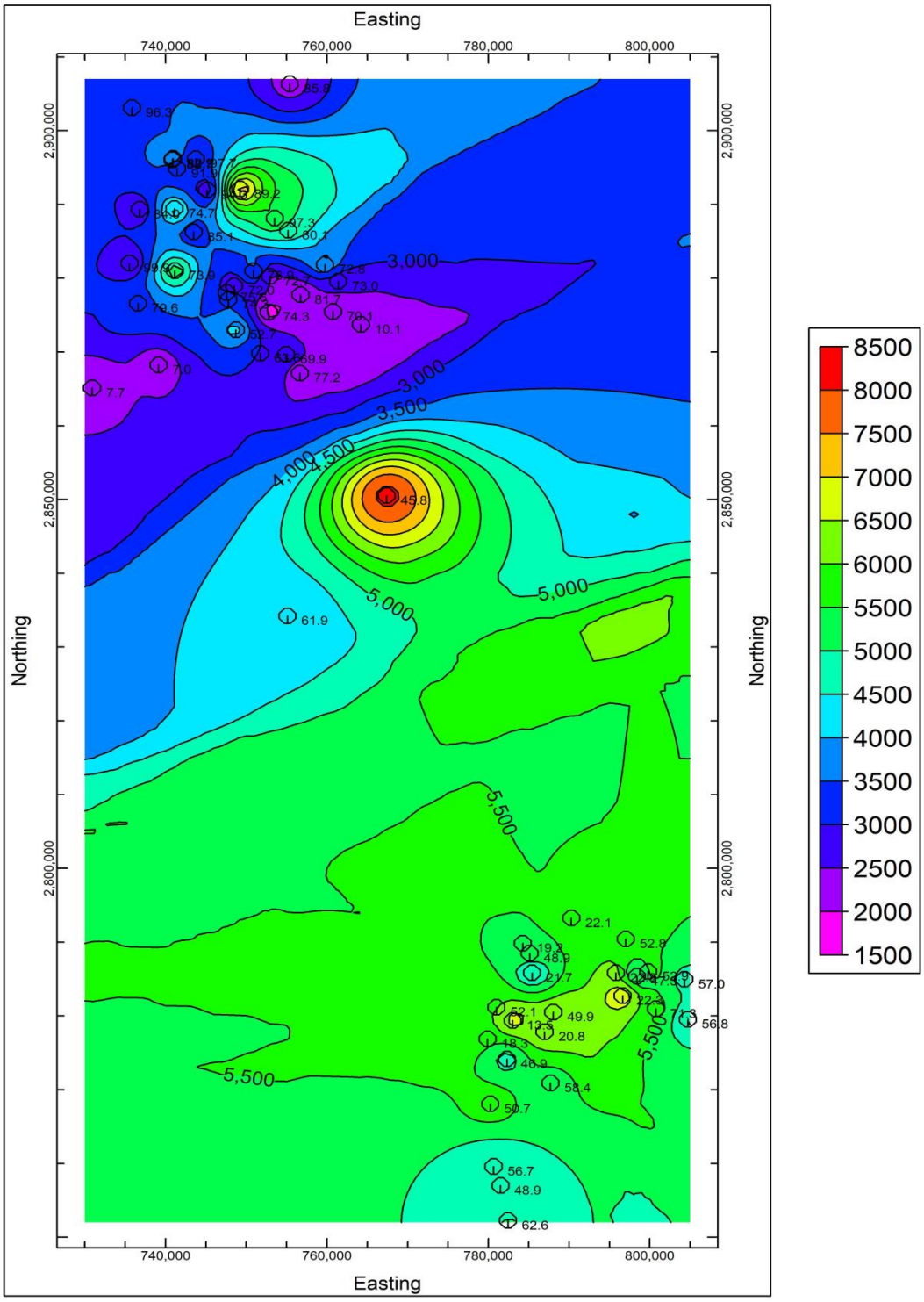

Fig. 8.15: Contour map showing variation in EC in the study area pre monsoon 2021

9 Urban Hydrogeology

The Hydro census field work of pre monsoon and post monsoon has been conducted for Barmer city also. The Barmer urban area is occupied by an Aeolian sandy plain and Malani Rhyolite hills as depicted on the Google map. Rainfall in the town is around 157mm/annum. No surface water body or natural drainage exists within the urban area. The urban area is divided into 40 wards and has about 1 lakh population. Barmer Municipality has total administration over 17,553 houses. The total water requirement of township is catered for through abstraction of groundwater. For Barmer town the water is drawn from 28 tube wells located near NH-15 at Bhadka situated 38 km from Barmer city. The total production is 9 MLD and per capita supply is about 100 litters. Out of the 9 MLD available from current sources, PHED supplies around 0.22 MLD to Commercial Consumers, 0.88 MLD to Industrial consumers and 7.90 MLD to Domestic consumers. The remaining part is supplemented by local abstraction of groundwater. Both open wells and tube wells exist within the urban area. Dig wells are located in the foothill region. 23 wells are identified for urban monitoring in 2019. Groundwater level ranges from 21 to 33m bgl and EC values range from 2700 to 5300 µs/cm. Interestingly there exist very little annual fluctuations in the groundwater levels between pre- and post-monsoon or even in the subsequent year data. On the front of water conservation roof top rain water harvesting and tanks are seen in the area in a few places, however no massive effort to conservation of rain water is evident and needs to be promoted. For the evaluation of Hadrochemical status in groundwater in Barmer city, more than 25 wells are analysed and post-monsoon period of 2018 to 2021. All the wells are analysed for EC, pH, Temperature and groundwater level.

9.1 Electrical Conductance (EC): Electrical Conductance is the ability of a substance to conduct an electric current. Chemically pure water in liquid form has a very low conductance. The presence of dissolved ions in solution makes it conductive. Distribution of Electrical Conductance of 25 analysed wells of pre monsoon and post monsoon 2020 and pre monsoon 2021 are represented by graphs. The change in EC over different periods is presented graphically in Figure 25. Based on EC graphs given below of 25 samples, it is observed that Barmer city has high EC values ranging from 2400 to 5300 µS/cm). Highest value of EC (5300 µS/cm) observed in well name Adersh Vidhya Mandir and lowest EC value (1650 µS/cm) observed in well name Barmer Lift canal water. High EC range is because a major part of the district is covered by hard rock formations such as Malani rhyolite and granite and Jalore & Siwana granites of Post Delhi. These have poor water yielding capacity.

9.2 Ground water level: To study the effect of monsoon on the groundwater regime and various other needs like agriculture, irrigation, domestic etc., changes in depth to water levels with respect to pre-monsoon and post-monsoon period were analysed. Based on the 25 wells analysis it is observed that the groundwater level of Barmer city ranges between 21m to 33m. Highest ground water level has been recorded in Tensing circle (32.82m) and lowest ground water level has been observed in Rishab Resort (21.54m).

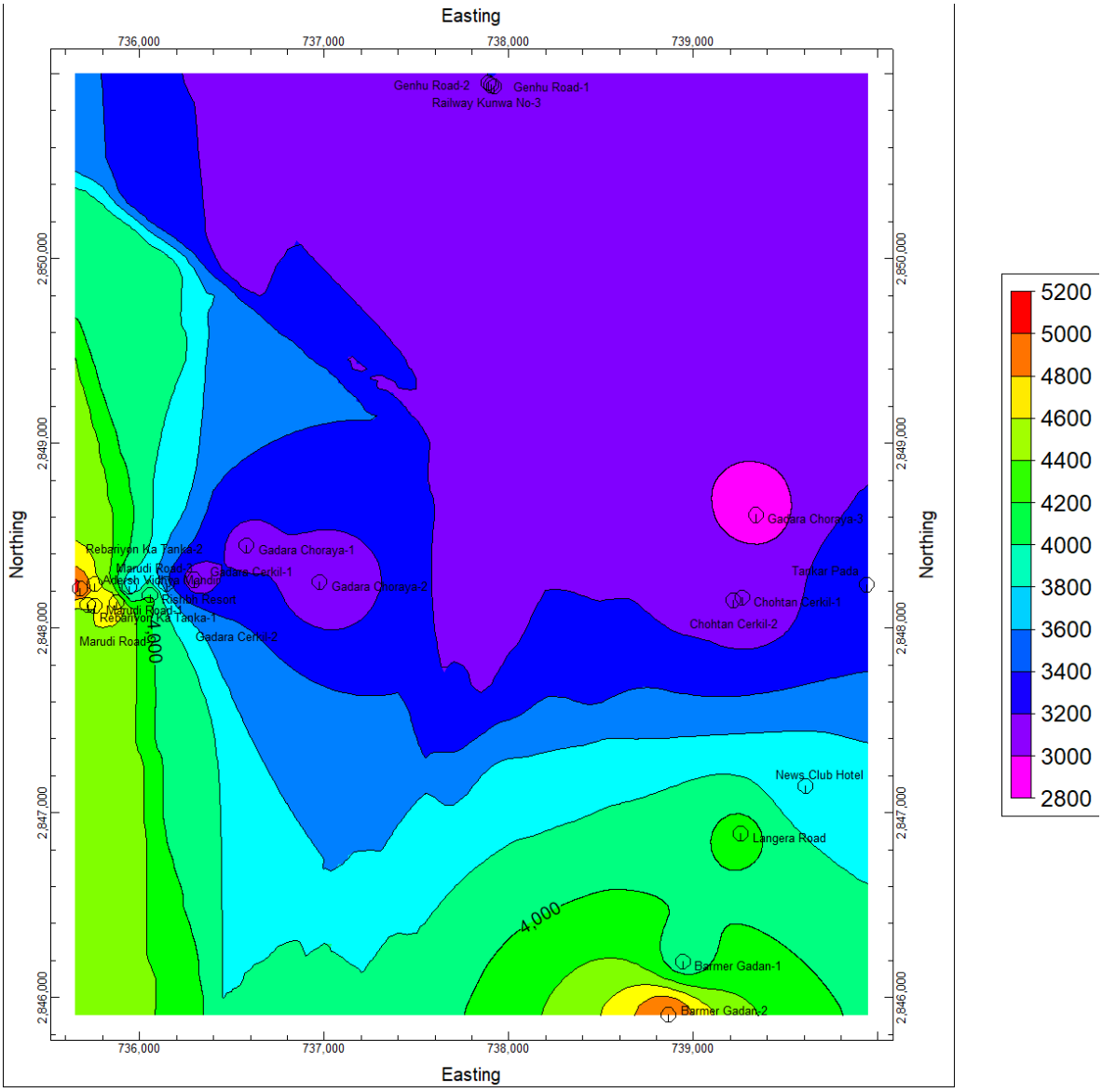

Fig 9.1: Contour map showing EC value of pre monsoon 2020 of Barmer city

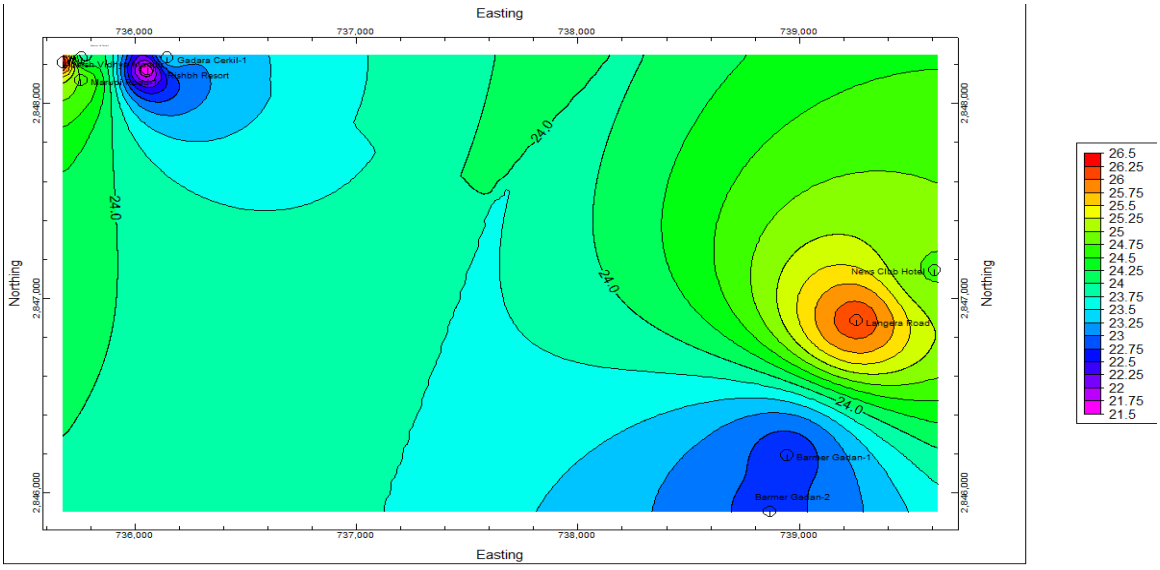

Fig 9.2: Contour map showing water level value of pre monsoon 2020 of Barmer city

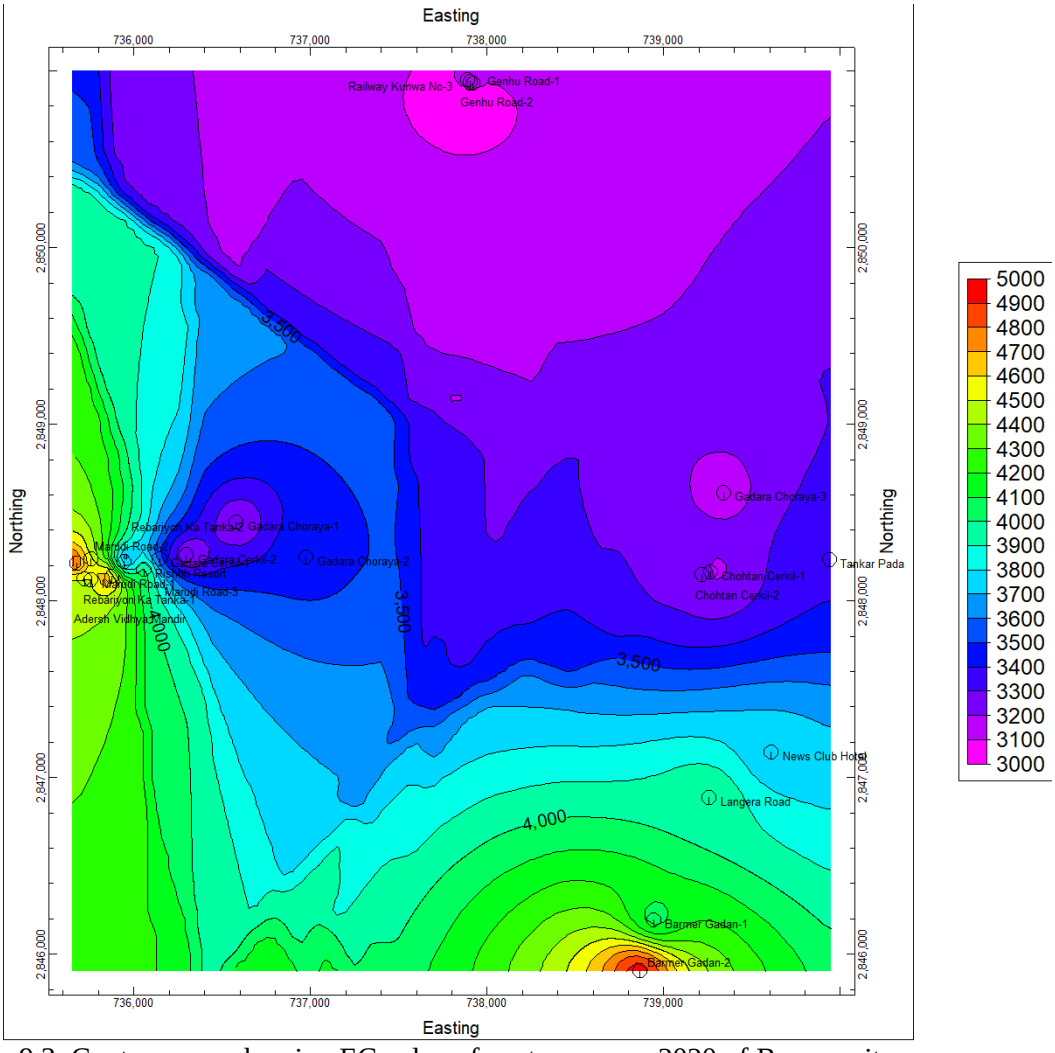

Fig 9.3: Contour map showing EC value of post monsoon 2020 of Barmer city

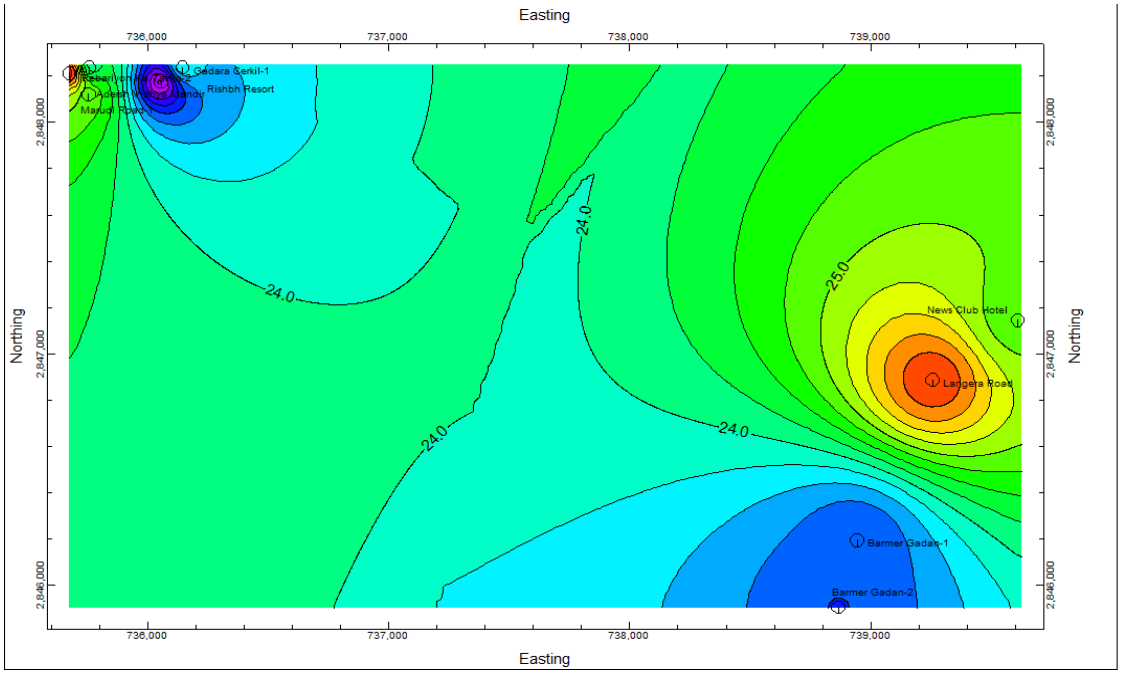

Fig 9.4: Contour map showing water level value of post monsoon 2020 of Barmer city

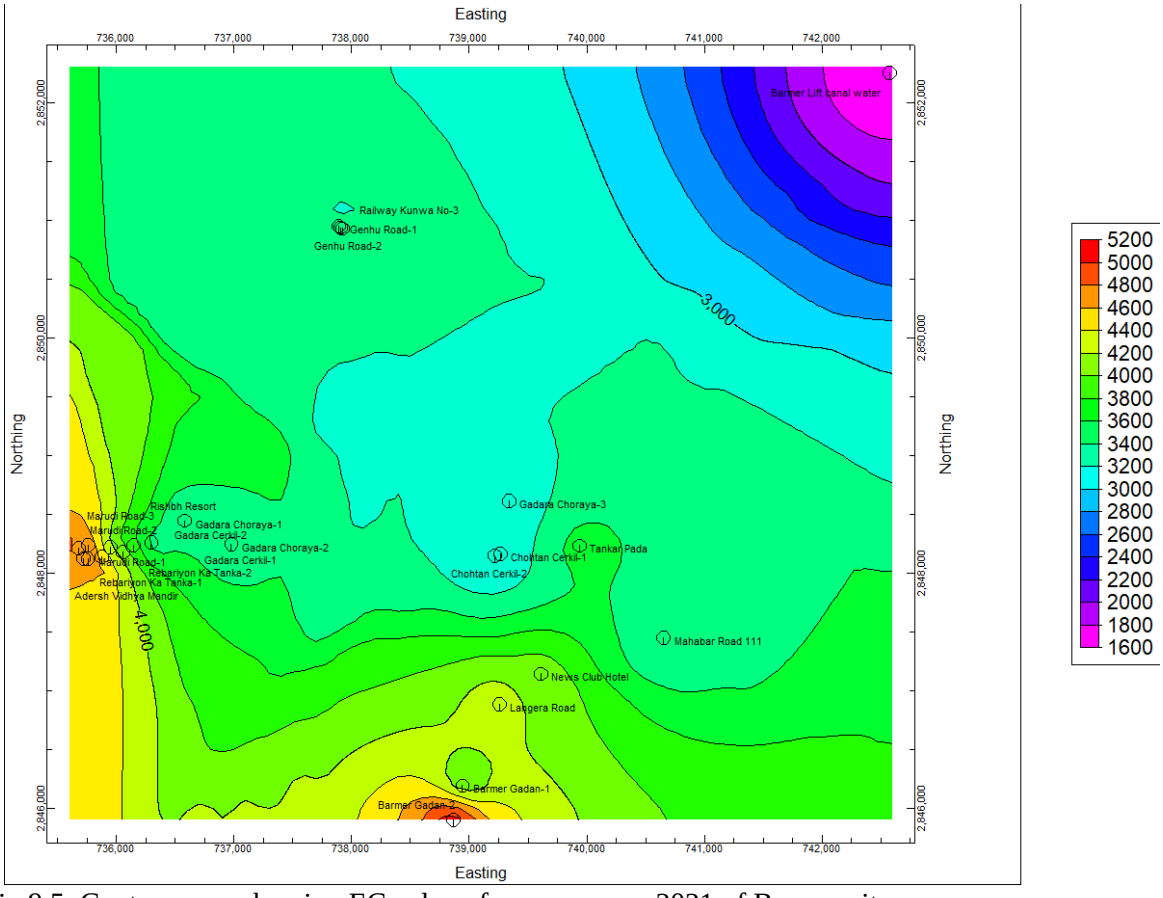

Fig 9.5: Contour map showing EC value of pre monsoon 2021 of Barmer city

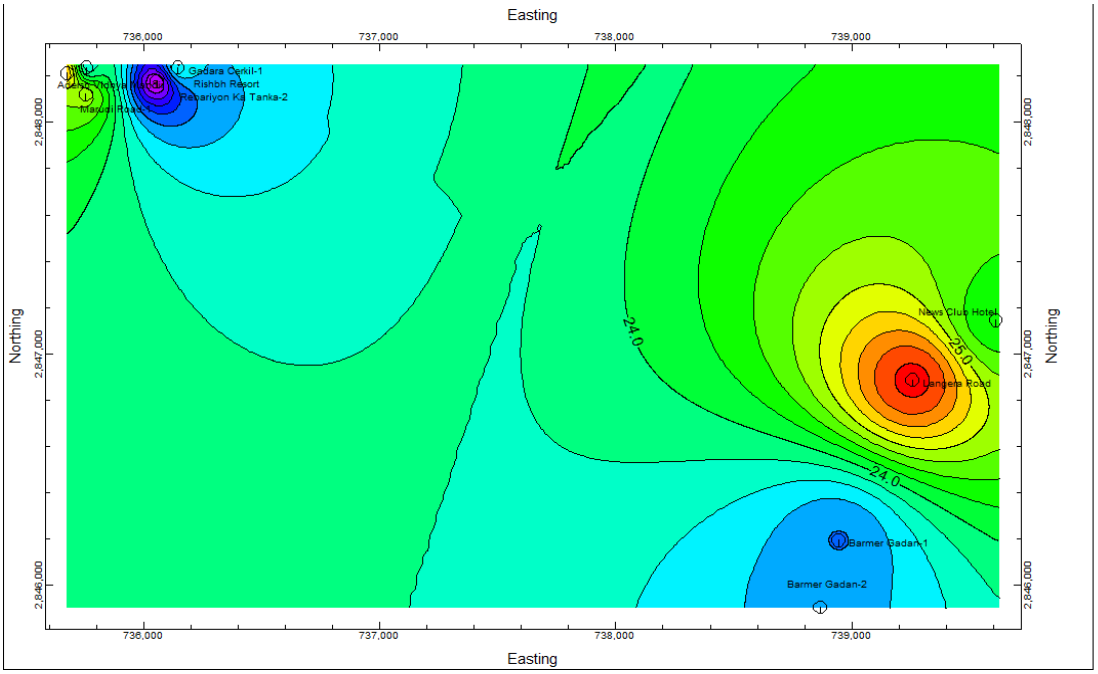

Fig 9.6: Contour map showing water level value of pre monsoon 2021 of Barmer city

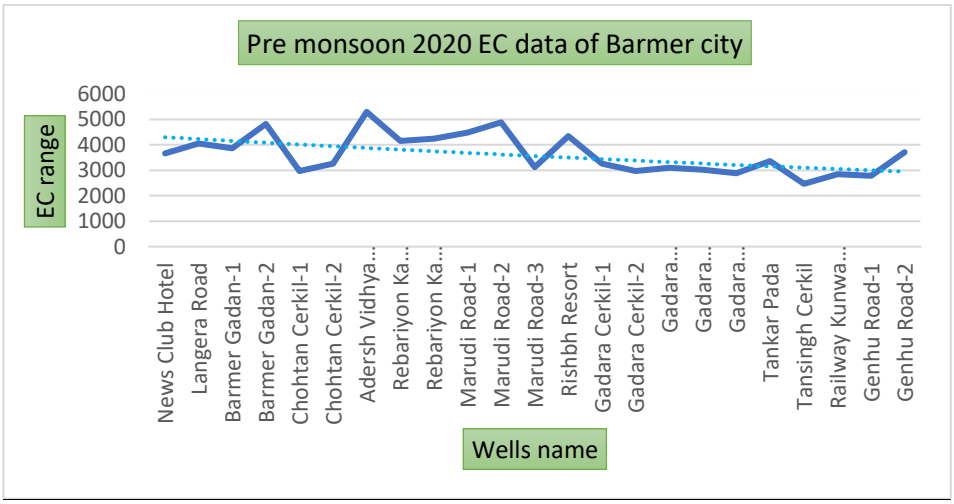

Fig 9.7: EC graph of pre monsoon 2020 data for Barmer city

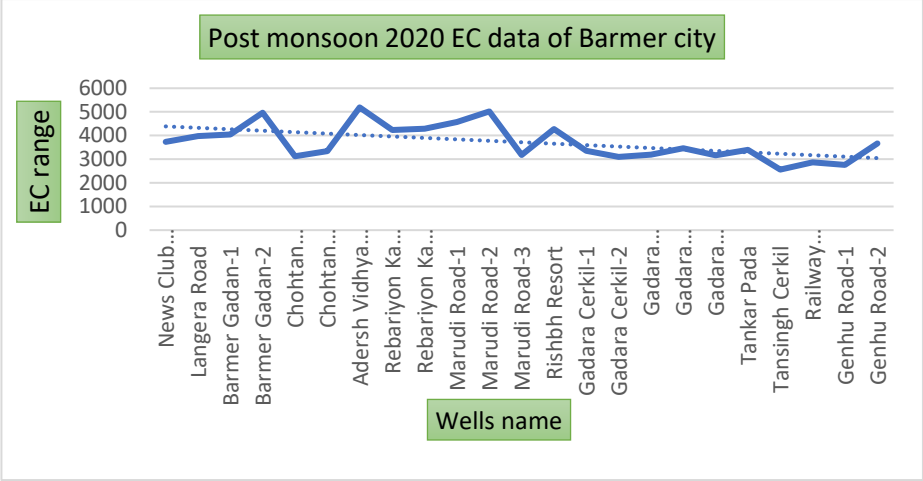

Fig 9.8: EC graph of post monsoon 2020 data for Barmer city

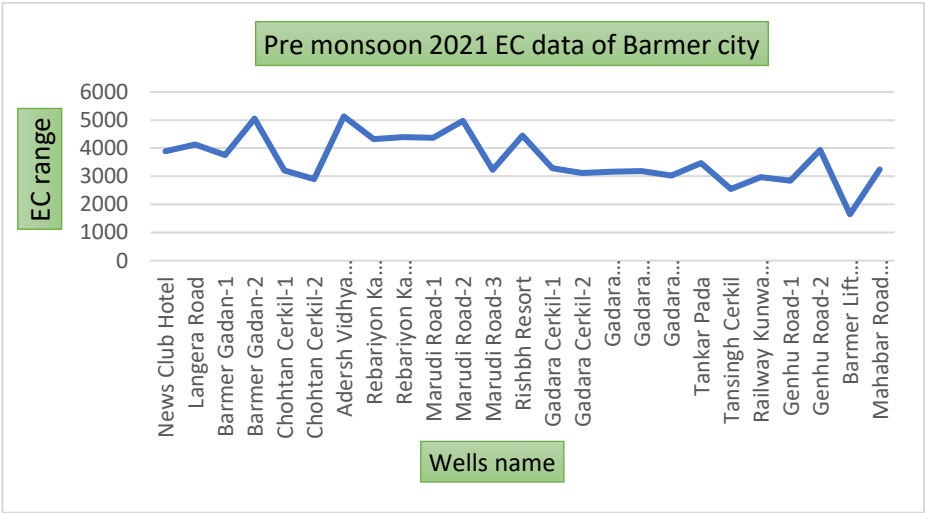

Fig 9.9: EC graph of pre monsoon 2021 data for Barmer city.

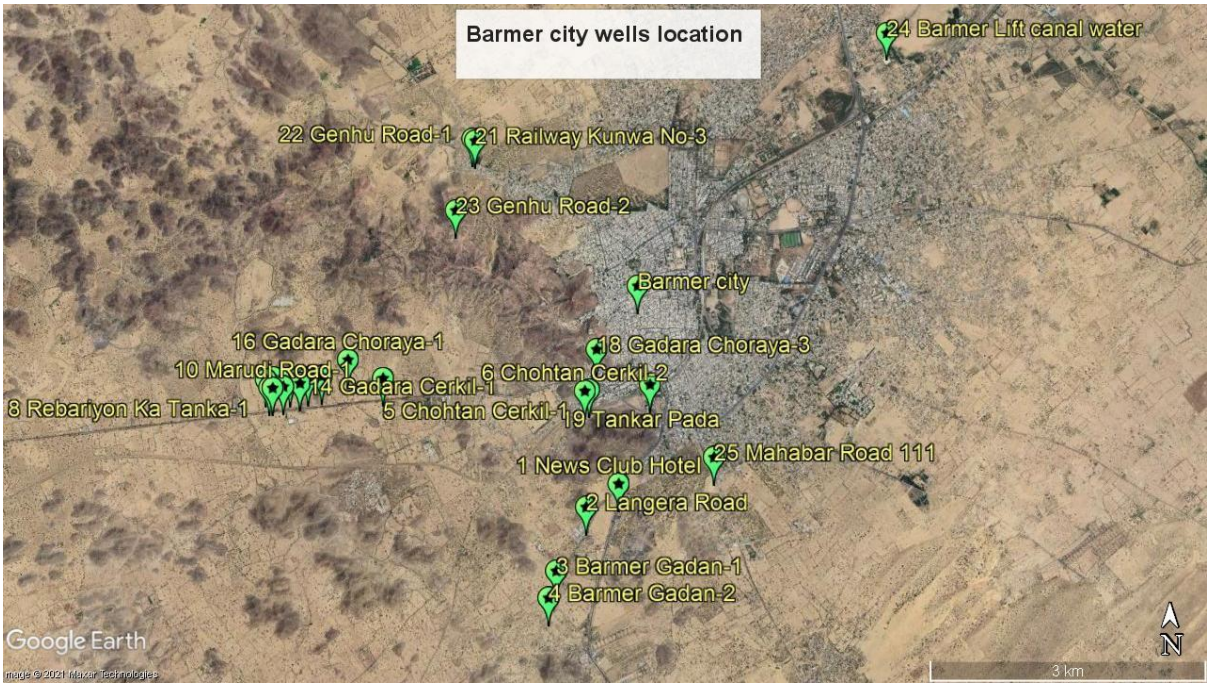

Fig 9.10: Location of 25 local wells of Barmer city

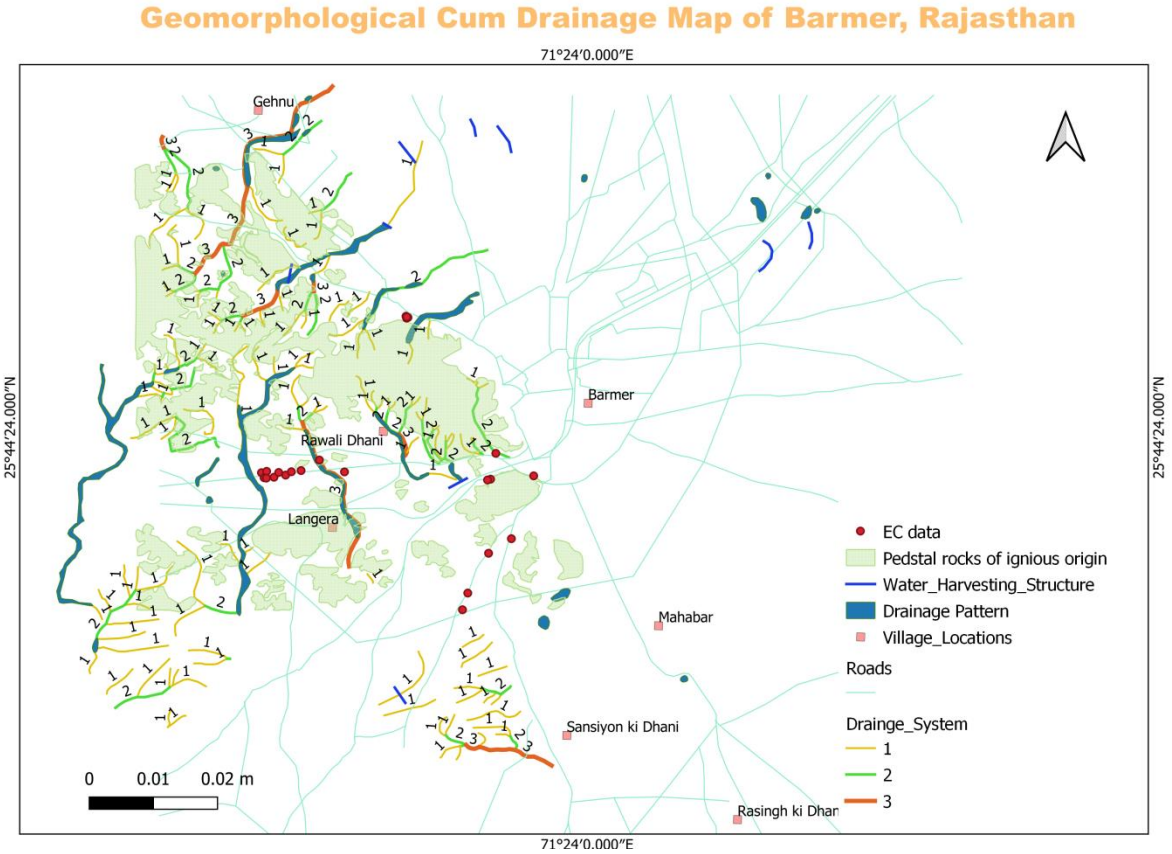

Fig 9.11: Geomorphological cum drainage map of Barmer city

10. Water well construction

Water well is a hole, shaft, or excavation used for the purpose of extracting groundwater from the subsurface. Water may flow to the surface naturally after excavation of the hole or shaft. Such a well is known as a flowing artesian well. More commonly, water must be pumped out of the well.

10.1 Well Design: The Barmer area of Rajasthan is situated in the central part of the Thar Desert and is represented by extreme arid conditions. Ground water exploitation in the area is unique in many senses and is sustaining the Kharif & Rabi crop in the area. The Late Cretaceous to Early Palaeocene sandstone forms an aquifer in the area. The wells are 100 to 200m in depth having discharge in the range of 110 – 220 m^3/day for a moderate draw down of 20-30m. However, field investigation showed that the well construction practice in the area is very poor and not much scientific thus the well efficiency in the area always remains on the lower side. Water well drilling is through deploying rotary drilling rigs with circulating mud in the area. At many places instead of Bentonite mud local mud is being used. In place of quartz pea gravel, crusher stones are largely used. Many a time it has been found that the material used as gravel is oversize and basaltic in composition.

Fig 10.1: Construction of a new tube well by rotary drilling rig

10.2. Type of Well: There are mainly two types of wells which are used in Barmer for irrigation and drinking purposes.

10.2.1 Tube well: The Central Ground Water Board has taken up a ground water exploration programme since 1957 in the Barmer district. Tube well consists essentially of a hole bored into the ground for tapping groundwater from a deep pervious zone. Compared to open wells, tube wells have a small diameter (8cm to 60cm). During the field observation most of the wells have been drilled between 300 to 450 m. More than 1050 tube well data collection, it is found that the water level of most wells is from 100 to 150 m. Diameters of the well are in the range from 10 to 12 m and cemented material is used for construction. Most tube wells are drilled in a confined type of aquifer, and some are in semi-confined (Tertiary Sandstone & Lathi Sandstone) with a 25 to 30 HP pump.

Fig 10.2: Measurement of open tube well depth by water level meter and visit of a new construction site of tube well

10.2.2 Dug Well: Dug wells are operated in the area where the ground is soft, and the aquifer is in shallow depth. During field observation in Barmer we found many ancient dug wells. The casing was used with stones, brick, tile, or other material to prevent collapse, and was covered with a cap of wood, stone, or concrete. They cannot be dug much deeper than the water table and the depth of the well is approximately 70 to 90m.

Fig 10.3: Measurement of water level in an open well by water level meter.

10.3 Casing: Consisting of steel pipe that is joined together to make a continuous hollow tube, the casing is run into the well. The different levels of the well define what diameter of casing will be installed. Referred to as a casing program, the different levels include production casing, intermediate casing, surface casing and conductor casing.

10.3.1 Casing Material: During aquifer monitoring in the Barmer area cemented material are used for casing. Here, a well is drilled to a certain depth, cased, and cemented, and then the well is drilled to a deeper depth, cased and cemented again, and so on. Each time the well is capped, a smaller diameter casing is used.

Fig 10.4: Casing Pipe used in Barmer for Tube well construction.

10.4 Water Storage Structure: Traditional rainwater harvesting structures which are used in rural areas, such as surface water storage tanks, irrigation tanks and temple tanks. In ancient times houses in western Rajasthan were built so that each had a roof top water harvesting system. Rainwater from these was directed into underground tanks. This system can be seen even today in all forts, places, and houses of the region.

10.4.1 Taanka: In the Thar Desert, Taanka is mainly used for harvesting rainwater throughout the dry season. The taanka is a cylindrical paved well-like structure that can collect rainwater from courtyards and rooftops.

Fig 10.5: Rainwater harvesting structure as Taanka in the Barmer area.

10.4.2 Kunds or **kundis:** In Western Rajasthan and Gujarat harvest rainwater for drinking in the sandy tracts of the Thar Desert. Rainwater collected through artificial catchments diverted to underground storage tanks. Groundwater in Barmer, for instance, 76% of the district area, has total dissolved salt (TDS) ranging from 1500-10000ppm. Under such conditions Kunds provided convenient, clean and sweet water for drinking. The Kunds are the structures which are connected by a pipe line attached to the roof top.

Fig 10.6: Rain water harvesting structure as Kund in western Barmer.

11 References: -

- Beaumont, H., Clarke, S. M., Burley, S. D., Taylor, A., Gould, T., & Mohapatra, P. (2015, April). Deciphering tectonic controls on fluvial sedimentation within the Barmer Basin India: The Lower Cretaceous Ghaggar–Hakra Formation. In *AAPG Annual Convention and Exhibition*.
- Bhushan, S. K. (2000). Malani rhyolites—a review. *Gondwana Research*, *3*(1), 65-77.
- CGWB (2020) Ground Water Year Book Rajasthan, Department of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti
- CGWB (2013) Ground Water Information Barmer district Rajasthan, Central Ground Water Board Ministry of Water Resources, and Government of India.
- Dolson, J., Burley, S. D., Sunder, V. R., Kothari, V., Naidu, B., Whiteley, N. P., ... & Ananthakrishnan, B. (2015). The discovery of the Barmer Basin, Rajasthan, India, and its petroleum geology. *AAPG Bulletin*, *99*(3), 433-465.
- Mirabbasi. R, S.M. Mazloumzadeh and M.B. Rahnama, 2008. Evaluation of Irrigation Water Quality Using Fuzzy Logic. *Research Journal of Environmental Sciences, 2: 340-352.*
- Pandey, A., Dasgupta, S., Yadav, R. K., Kuila, U., Mishra, P., & Mohapatra, P. Various Characteristics of Deccan Lava flow sequences identified in Core, Wireline and Seismic in Barmer Basin.
- Sharma, K. K. (2005). Malani magmatism: an extensional lithospheric tectonic origin. *SPECIAL PAPERS-GEOLOGICAL SOCIETY OF AMERICA*, *388*, 463.
- Sisodia, M. S. (2011). Malani rhyolite: highly eroded complex crater. *Current Science*, 946-951.


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Sector-43, Delhi - Surajkund Road, Aravali Hills, Faridabad - 121004

Comprehensive Report on:

Groundwater Condition in both core and buffer zone of Raikela Iron Ore Mining Project of M/s. Geetarani Mohanty Koira Tehsil, Sundargarh District, Odisha.

[Report submitted for renewal of NOC form CGWA under Section 5 of the Environment (Protection) act, 1986 (29 of 1986) as per the new notification no 2941 of 24th Sept 2020]

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House No – 96, Station Road,
Keonjhar, Odisha, Pin-758035
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Comprehensive Report on:

Groundwater Condition in both core and buffer zone of Raikela Iron ore Mining Project of M/s. Geetarani Mohanty, KoiraTehsil, Sundargarh District, Odisha.

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E-MAIL ID: geetarani.mines@gmail.com
By MRCAWTM – November, 2022

Executive summary

Raikela Iron ore Mining Project of M/s. Geetarani Mohanty spread over an area of 67.586 Ha is under operation with the production capacity of Iron Ore @ 0.864 MTPA in village Raikela under Bonai Sub-Division of Sundargarh district was initially executed for a period of 20 years w.e.f. 02.07.1991 in favour of Smt. Geetarani Mohanty.As per the Supplementary lease deed, the validity of the lease period is now extended up to 01.07.2041. The study area falls under survey of Indiatoposheet no F45N1 (73G/1).The existing iron Ore Mining project is in running condition and consent to operate has been obtained from State Pollution Control Board (SPCB) Govt. of Odisha. The Ministry of Environment and Forest has granted the Environmental Clearance for the production capacity of 0.864MTPA capacity vides the letter No-J- 11015/380/2006-IA.II dated 02.07.2008.

The lessee has obtained all the statutory clearances like Mining Plan approval from IBM, Forest and Environment Clearance from MoEF, Consent to Operate from SPCB.

The mine has been developed by opencast mining method with mechanized means deploying machinery like wagon drill machine, rock breaker, hydraulic / diesel operated shovel, dumper/tipper etc.

The present production capacity of the Iron Ore Mine is @ 2.99 MTPA will increase upto 4.99.The present study is made for renewal of NOC from CGWA for extraction of maximum 170KLD of groundwater during mining operation as per the approved mine plan and previous NOC. The present report is based on the Hydrogeological investigation made within core zone and its 10km radius i.e buffer zone for assessment of impact of dewatering of groundwater by the mine and will be submitted to CGWA for obtaining NOC. The area is drained by IB and Brahmani River and its tributaries. The easterly flowing Sankh and westerly flowing Koel River join at Vedavyas near Rourkela to form the Brahmani River. The river, IB a tributary of Mahanadi controls the drainage of the western parts of the district. The drainage pattern of the area is dendritic. The study area is located in Koira Tehsil of Sundargarh District, Odisha which falls under **safe blocks** as per the report on Dynamic Groundwater Resource of India, published by CGWB in 2019-20. The study area is having largely one geological formation name Singbhum-Keonjhar-Bonai group of iron ore of Precambrian age. These constitute hard rock's includes schist, tuffs, phyllite, basic rock, BHQ/BHJ have been classified as Iron Ore Series (IOS). Aquifers are developed only in the low lying area and valley parts of the study area. Groundwater quality is fresh and potable in both core and buffer zone area and EC remains below 1900 ppm and TDS varies from 10 to 310 ppm in the core zone & buffer zone both. As per the approved mine plan the dewatering of groundwater is maximum 170KLD is required for mining operations. Rainwater is harvested within the ML area through construction of water conservation pond, and earth bunds to meet the complete requirement. There is no long term impact on groundwater because the area is under safe zone. For the running of mine 281.30KLD water is required, 170KLD from ground water and 98 KLD will be from RWH and 13.3 from recycle water from ETP& STP. Thus, the study recommends NOC may be provided for next 5 yr with maximum 170 KLD extractions from groundwater.

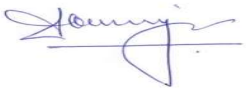
Acknowledgments and Certificate

Impact assessment and report preparation work as per the CGWA guideline is carried out by Manav Rachna Centre for Advance water Technology and Management (MRCAWTM), an accredited Groundwater Institution of CGWA. The work order is provided by **My world consultancy services (WCS), Bhubaneswar.**

Discussions with Mr. Pradeept Mohapatra, Director WCS, regarding the geology of lease area and plan our investigations according to scope of work is gratefully acknowledged. Help rendered by Mr. Pradeept Mohapatra and Diganta Ray, WCS in every stage of planning and Field verification, investigations in and around lease area and report preparation is thankfully acknowledged. He also provided all the available relevant data and records; many of them are reproduced in this report and forms part of annexure section.

The report has been prepared by Ms. ShehaRai, Assistant Professor and Sandeep Kumar Research Assistant, MRCAWTM under the supervision of Prof. (Dr) Arunangshu Mukherjee, Director MRCAWTM.

It is to certify that MRCAWTM have investigated the area of Raikela Iron ore Mining Project of M/s. Geetarani Mohanty, village Raikela of Koira Tehsil of Sundargarh District, Odisha. Based on actual data collected from field, available documents and literature survey done, has prepared the report as per the format of CGWA.



(Dr Arunangshu Mukherjee)
Director, MRCAWTM

MR Centre for Advance Water Technology & Management
Manav Rachna International Institute of Research & Studies
(Deemed to be University under section 3 of the UGC Act, 1956)
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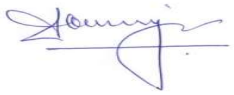
Report on
Hydrogeological Investigation and Impact Assessment for Raikela Iron ore Mining, village Raikela, KoiraTahasil of Sundergarh District, Odisha.

1. SALIENT FEATURES OF THE PROPOSAL

1.1	Application No	
1.2	Accredited by	CGWA
1.3	Date of Accreditation	01/10/2021
1.4	Validity upto	30/09/26
1.5	Work Order Date (Attach copy of the Work Order with masking details of charges)	8/10/2022, Attached as annexure 3.
1.6	New/ Existing Project	Existing Project
1.7	CTE issued date	19-08-2022
1.8	Alluvium/ Non-alluvium	Non-Alluvium
1.9	Block Name & Category (GWRA, 2020)	**Koira Block,** Safe category
1.10	Ground water requirement	170KLD
1.11	Date of NOC issued & Authority	31/01/2021, CGWA
1.12	Date of NOC validity	30/01/2023, Annexure 1
1.13	Ground water Modelling Required (Yes/No)	NO
1.14	In case the report is prepared jointly by accredited Institute and Individual consultant, name/details of chapters prepared by the Individual consultant	NO
1.15	Signature of the Consultant(s)	 (Dr Arunangshu Mukherjee) Director, MRCAWTM

2.0 ABOUT THE PROJECT

Raikela Iron ore Mining Project of M/s. Geetarani Mohanty spread over an area of 67.586 Ha is under operation with the production capacity of Iron Ore @ 0.864 MTPA located in Raikela village in Koira Tahasil of Bonai sub-division in Sundergarh district of Odisha. The lessee is a partnership firm. The latest lists of partners areas 1.Sri Srinibash Sahoo, 2.Duhshasan Sahoo, and 3.Smt Suprassana Sahoo. The existing iron Ore Mining projects was executed for a period of 20 years w.e.f. 02.07.1991 in favour of Smt. Geetarani Mohanty and as per the Supplementary lease deed, the validity of the lease period is now extended up to 01.07.2041. The Mine is in running condition and consent to operate has been obtained from State Pollution Control Board (SPCB) Govt. of Odisha. The lessee has applied for enhancing production capacity EC for a capacity of 4.99 MTPA, which is in due process.

Out of the 67.586Ha of Mining Lease area, forest land under DLC category is 66.671Ha and 0.915Ha is non-forest land. Out of the 66.671Ha, DLC Forest land, 43.033Ha had been broken prior to 12.12.1996 and mining operation in this area was being continued. Ministry of Environment and Forest, Govt of India has accorded the Stage-II Forest Clearance over an area of 66.671Ha vide letter No. F No.8-37/2007-FC dated 22.10.2014.

There is no environmental sensitive zone in core and buffer zone. There is no reserve forest in the core zone. However, the reserve forest found in the buffer zone is as follows:
Sarkunda R.F - 2.5 Km (South), Tohra R.F - 3.3km (South),Tohra R.F - 5.9km (North), Karo R.F - 9.5km (North-east) Kathmal R.F - 8.2km(East)

The Review of Mining Plan under Rule 17(2) of MCR 2016 was approved vide letter no MRMP/A/05-ORI/BHU/2021-22 dated.01.07.2021 for the production capacity of 4.99 MTPA. The validity of the Review of the Mining plan is up to dt.31.03.2026.

As per the approved mining plan, the mineral processing like screening and crushing will be suggested by deploying mobile screening and crushing plant for future. Now the lessee proposed a fixed 1000TPH Central processing unit (CPU) for screening and crushing of iron ore of required sizes. As a result of installation of CPU the mining operation will be in a systematic and scientific manner.

In present there is no beneficiation proposal. The lessees will directly sale the product in open market. Total mineral reserve is 74455138 T, mineral resource is 13980220 T and total reserve resource is 88435358 T.

NOC for withdrawal of 64.5 m3/day of Ground water has been obtained from CGWA vide ltr no 21-4(83/3ER/CGWA/2008-1723 dt 18.12.2008.

NOC for drawl of 180 m3/day of Ground water has been obtained from CGWA vide ltr no CGWA/NOC/MIN/ORIG/2021/10588 dt 31.01.2021 **(Annexure 1).** The water requirement will be met from own bore wells situated in the lease area. The area falls under safe category as far as stage of development is concerned.

The mining lease area is approachable from Koira town covering a distance of 8 km by Bhadrasahi – Rourkela NH–215. The area can also be approachable from Tensa town ship which is on NH – 215 at a distance of 2 km. Nearest Rail Head is at Barsuan (both Passenger and goods train) located adjacent to several working mines connected by road from Bhadrasahi-Koira-Rajamunda NH-215. District headquarter is at Sundergarh – 110 km from lease area.

The lease area comes under the toposheet no F45N1 (73 G/1) is delineated between latitude 21^0 51' 54.47556'' to 21^0 52 35.39676"N and longitude 85^0 10'32.27952" to 85^0 11'05.16660"E. List of the co-ordinates of the pillars are shown in table no 2.1.

DGPS SURVEYED CO-ORDINATES OF ML PILLARS					
SL.NO.	PILLAR NO.	LONGITUDE	LATITUDE	UTM COORDINATE	
		DD-MM-SS	DD-MM-SS	EASTING	NORTHING
1	1	85°10'43.50432"	21°52'35.39676"	311823.778	2420271.88
2	2	85°10'39.17784"	21°52'29.73648"	311697.506	2420099.257
3	3	85°10'37.58988"	21°52'26.27508"	311650.661	2419993.342
4	4	85°10'38.32032"	21°52'23.63160"	311670.664	241991.785
5	5	85°10'34.63140"	21°52'19.69536"	311563.326	2419791.972
6	6	85°10'32.83140"	21°52'14.74932"	311509.848	2419640.454
7	7	85°10'32.27952"	21°52'10.05348"	311492.283	2419496.223
8	8	85°10'33.52152"	21°52'06.88260"	311526.783	2419398.267
9	9	85°10'34.38336"	21°52'04.17540"	311550.546	2419314.709
10	10	85°10'36.46488"	21°52'02.64468"	311609.746	2419266.922
11	11	85°10'39.38772"	21°51'58.90212"	311692.296	2419150.811
12	12	85°10'41.23128"	21°51'57.16728"	311744.587	2419096.834
13	13	85°10'44.15304"	21°51'54.47556"	311827.492	2419013.045
14	14/1	85°10'45.80220"	21°51'56.04840"	311875.406	2419060.887
15	14/2	85°10'53.13144"	21°52'02.65296"	312088.239	2419261.509
16	14/3	85°10'54.26796"	21°52'03.72828"	312121.256	2419294.194
17	14/4	85°10'57.69120"	21°52'07.64724"	312220.964	2419413.570
18	14/5	85°10'58.70136"	21°52'08.72364"	312250.350	2419446.339
19	14/6	85°11'01.76964"	21°52'11.13960"	321339.315	2419519.603
20	14/7	85°11'05.16660"	21°52'14.84508"	312438.184	2419632.414
21	15	85°11'03.56748"	21°52'13.55592"	312391.814	2419593.315
22	16	85°11'02.36508"	21°52'13.99512"	312357.453	2419607.226
23	17	85°11'01.46004"	21°52'14.17908"	312331.528	2419613.191
24	18	85°11'01.24008"	21°52'14.68596"	312325.402	2419628.856
25	19	85°11'04.52400"	21°52'19.85520"	312421.555	2419786.728
26	20	85°11'03.56640"	21°52'20.56224"	312394.325	2419808.807
27	20/1	85°10'58.73592"	21°52'24.30696"	312257.012	2419925.620
28	21	85°10'54.24600"	21°52'27.80904"	312129.385	2420034.856
29	22	85°10'49.64196"	21°52'31.53756"	311998.567	2420151.094

Table-2.1: Pallor coordinates of the lease boundary

Location:

Raikela Iron ore Mining Project of M/s. Geetarani Mohanty spread over an area of 67.586 Ha is under operation, located in Raikela village in Koira Tahasil of Bonai sub-division in Sundergarh district of Odisha. Location Map and Satellite Image of the Project area is shown in Figure no.2.1 &2.2.

The mining lease area is approachable from Koira town covering a distance of 8 km by Bhadrasahi – Rourkela NH–215. Tensa Township by NH – 215 at a distance of 2 km. Nearest Railway station is at Barsuan (both Passenger and goods train) located adjacent to several working mines connected by road from Bhadrasahi-Koira-Rajamunda NH-215. District headquarters is at Sundergarh – 110 km from lease area.

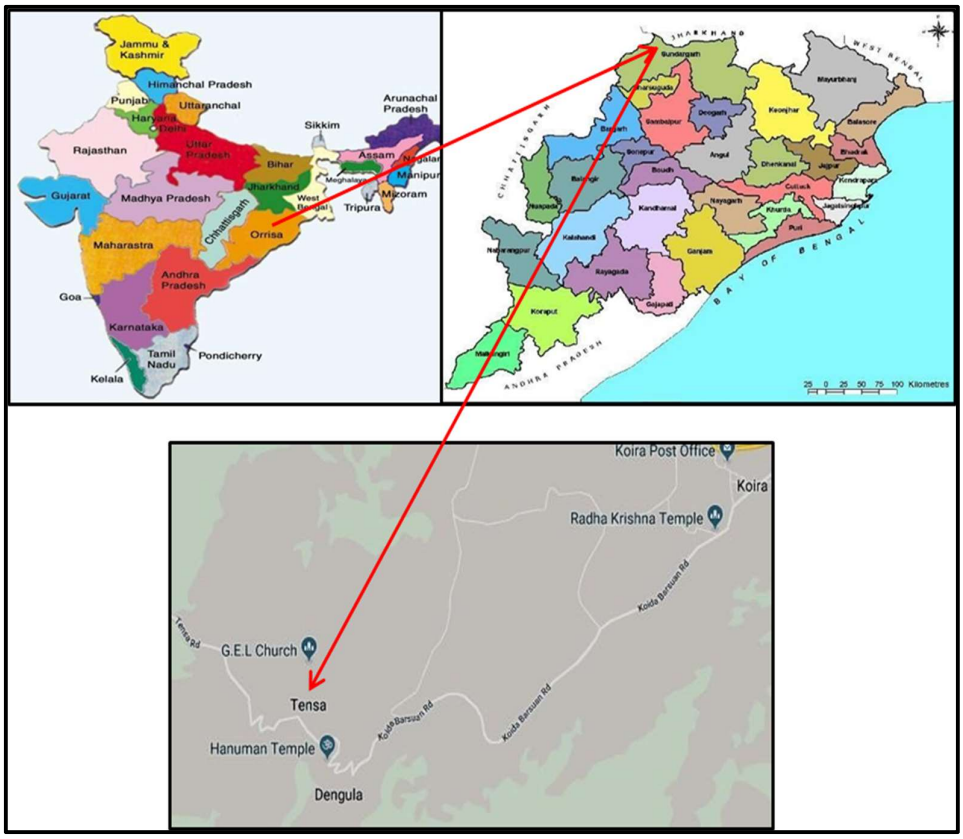


Fig-2.1. Location Map of Raikela Iron ore mine, Sundergarh district, Odisha

Fig-2.2. Satellite Image of the Project area

2.1Land Use Land Cover of surrounding area

"Land use" is the term used to describe the human use of land. It represents the economic and cultural activities (e.g., agricultural, residential, industrial, mining, and recreational uses) that are practiced at a given place. Land use and land management practices have a major impact on natural resources including water, soil, nutrients, plants and animals. Land use information can be used to develop solutions for natural resource management issues. The major effect of land use on land cover is deforestation more recent significant effects of land use include urban sprawl, soil erosion, soil degradation, salinization, and desertification. Land-use change, together with use of fossil fuels, is the major anthropogenic sources of carbon dioxide, a dominant greenhouse gas. In the present study, land use and land cover within 10Km buffer area covering area is 347.16 sq.km, using remote sensing satellite data and LULC within the Core Zone (CZ) has been carried out for obtaining environmental clearance for Iron ore mining lease (66.587 Ha) of M/s Geetarani Mohanty near Raikela village of Sundargarh district, Odisha. 3.4.3.1 Terrain Description of the study area. The study area is mostly an undulating rugged mountain terrain except a relatively flat and gently undulating terrain in the northwestern part. The hills are trending from northeast to southwest. Most of the terrain is covered with forest ranging from dense through open and degraded forest cover. The rugged terrain has the highest elevation range of approximately 1000m above MSL and 400m above MSL as the lowest elevation. Plains are also seen, which are narrow and very small in spatial extent. Such places are inhabited with settlements that are scattered in nature and seasonal agricultural activities are seen. There are many first order nallas are seen in the hilly area which act as overland flow of precipitation. These seasonal nallas join to form minor streams and later confluence with major rivers. There are two major nallas flowing in the study area are Kuradhi Nadi, Karo river and Sarkanda nalla with former flowing in the northeast and latter in southwest direction. Villages are scattered and seen along the foothills and along the narrow valleys between the hills. Because of the natural constraints on land availability and lack of proper storage mechanism for water, only seasonal agriculture cropping is practiced in this area.

2.1.1 LULC Pattern within 10 Km Radial Buffer around the ML

Map showing various LULC categories is prepared using visual interpretation technique based on image elements such as spectral band width colour, tone, texture, size, shape and association of elements. Categorization of LULC and their nomenclature is based on the national level land use classification system, which is adopted for the entire country as recommended by National Remote Sensing Centre (NRSC), Department of Space, and Government of India. Also as mentioned in the previous section, LULC , LISS IV image thus prepared for 10 Km radial buffer of the ML area is finalized after carrying out limited field checks for accuracy of classification. Post field visit of the study area includes incorporation of necessary corrections and modification of boundary elements wherever required. The geo-referenced LULC map in GIS environment has the advantage of updating information temporally to locate changes around specific locations and features within the study area apart from acting as base reference for periodical monitoring for EIA studies

Sl.No	Major LULC Category	Land use unit
1.	Built-up Land Settlement	Industries / Mining, Infrastructures
2.	Agricultural Land Crop land	Plantation
3.	Forest Dense Forest	Open Forest, Scrub Forest
4.	Waste Land Land with Scrub	Land without scrub
5.	Water bodies Tanks / Ponds	Rivers / Streams

LULC map showing 10 Km radial buffer around the mining lease (ML) area and major LULC categories such as built-up, agriculture, forest, and wasteland and water bodies along with their spatial estimation are discussed below. Settlements: About 18.06 km2 is under habitation comprising villages, settlements. Since, the buffer area is mostly a rugged mountainous terrain, habitation settlements – villages - are numerous, small in size and scattered in nature. From the satellite image, built-up / settlements are identified by their typical image elements such as light grayish green color, medium to coarse tone, medium to coarse texture and close association with vegetative cover (red color). They are small and scattered in nature and there is one larger settlement Koida town in the study area. There are some mining related industrial activities in the buffer area apart from some infrastructure buildings such as temporary shelters - camps and schools). Agricultural Land Agricultural land covers of 55.65 Sq.km. Cultivation is seasonal, Kharif crops, are grown along with maize, pulses like Ragi, Mango, Biri are grown to substantiate the household requirements and provide some form of earning to the local people. Owing to mountainous terrain, cultivation practice is limited and restricted to a few pockets in the study area. Plantation Area is very meagre with presence of teak, mango, neem trees occupying an area of 0.24 Sq.km of the buffer area. Forest is the major land cover in the study area and most of the area is covered with forest of varying density covered with deciduous trees, shrubs and scrubs with trees such as Sal, Sidha, Mahula, kendu Champa. Based on the image elements such as colour, tone and textural variations, forest is delineated qualitatively as “dense forest”, “open forest” and “scrub forest” cover. Cumulatively, LULC of forest category covers an area of 203.92 Sq.km of the study are.

Wasteland is another important LULC where land lie unproductive in terms of agricultural activity even after sustained conservation practices but could be used for other land utilization or land use such industrial activities and mining activities. Some of the category that comes under this LULC is “land with scrub”, “land without scrub”. The total wasteland is 43.42sq km. Water bodies Water bodies include features such as tanks, ponds, streams and rivers. This is an important LULC that indicates the terrain condition and agricultural resource of an area. There are many ponds and tanks

existing near settlements. They are identified by their typical blue colour. The water bodies cover 1.59sq km.

Sl No	Landuse Category	Area In Sq.Km
1	Settlement	4.66
2	Road	0.19
3	Railway	0.33
4	Mining / Industries	12.88
5	Agricultural land	55.43
6	Land with Scrub	24.49
7	Land without Scrub	43.42
8	Dense Forest	116.31
9	Open Forest	73.63
10	Scrub Forest	13.99
11	Plantation	0.24
12	River / Stream	1.44
13	Reservoir / Tank / Pond	0.15
	Total Area	347.16

Table-2.2: LULC units within 10 Km Buffer zone and their Spatial Extent

2.1.2 LULC Pattern within core zone

Total ML area covers 67.586Ha. Out of the 67.586Ha of Mining Lease area, forest land under DLC category is 66.671Ha and 0.915Ha is non-forest land. Out of the 66.671Ha, DLC Forest land, 43.033 Ha had been broken prior to 12.12.1996 and mining operation in this area was being continued. In present, during mining land use pattern is given in table 2.3.

Table-2.3: A Present Land use of the ML area

Sl No	Patternofutilization	Area put on use at start of Plan period (Ha)
1	Mining	33.593
2	Overburden dump	2.000
3	Mineral storage	3.799
4	Infrastructure	0.200
5	Road	1.900
6	Mineralseparationplant	0
7	Greenbelt	2.477
Subtotal		**43.054**
8	Safetyzone	2.523
9	Area undisturbed	21.094
Total		**67.586**

2.2 DEM / TOPOGRAPHY

M/s Geetarani Mohanty Raikela iron ore mine of over an area of 67.586 hectares is located in village Raikela, PO-Tensa in the district of Sundergarh of Odisha state. The area contains both forest and non-forest land. Out of total lease area, 66.671 ha come in forest land which is falls under in "DLC Forest" and rest 0.915 ha area is under non-forest area. The mining lease area is approachable from Koira town covering a distance of 8 km by Bhadrasahi – Rourkela NH – 215. The leasehold area falls under Survey of India Toposheet No. 73 G/1 and is delineated between latitude 21^0 51' 54.47556'' to 21^0 52 35.39676" N and longitude 85^0 10'32.27952" to 85^0 11'05.16660" E.Topography map including core zone and Buffer Zone is shown in Fig-3.4.

The lease area presents an undulating topography. The highest and lowest elevation is 845m and 625m above M.S.L. respectively. Digital elevation map of the area is showing in Fig-2.3.

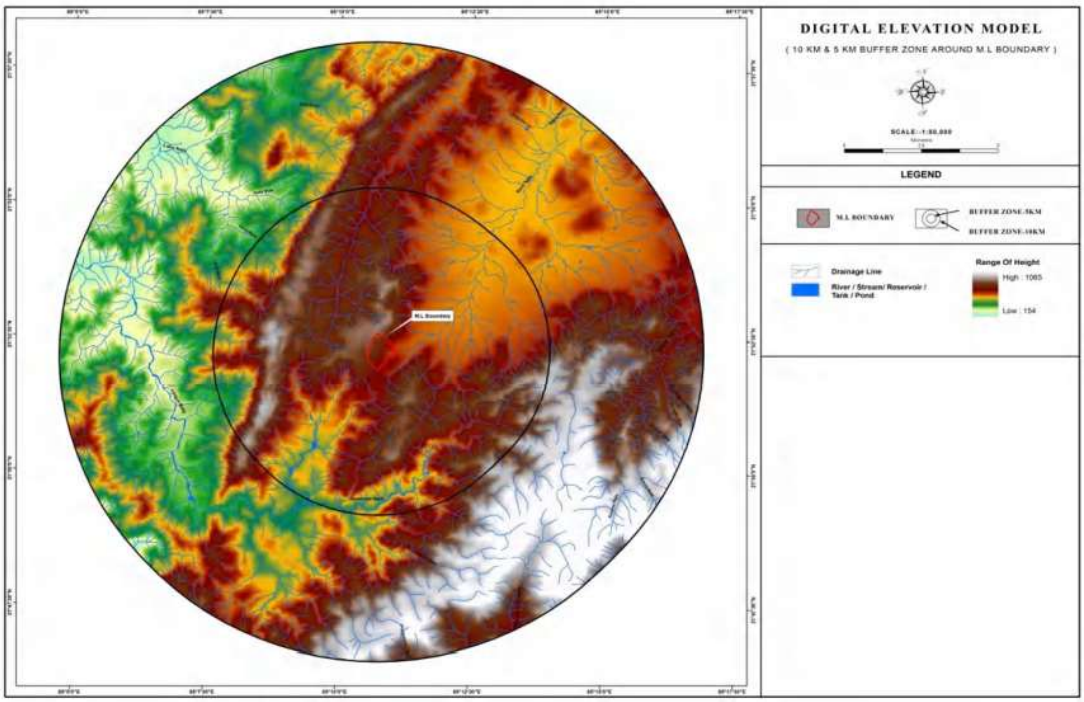


Fig-2.3: Digital Elevation Model of the Study area showing highest and lowest altitudes

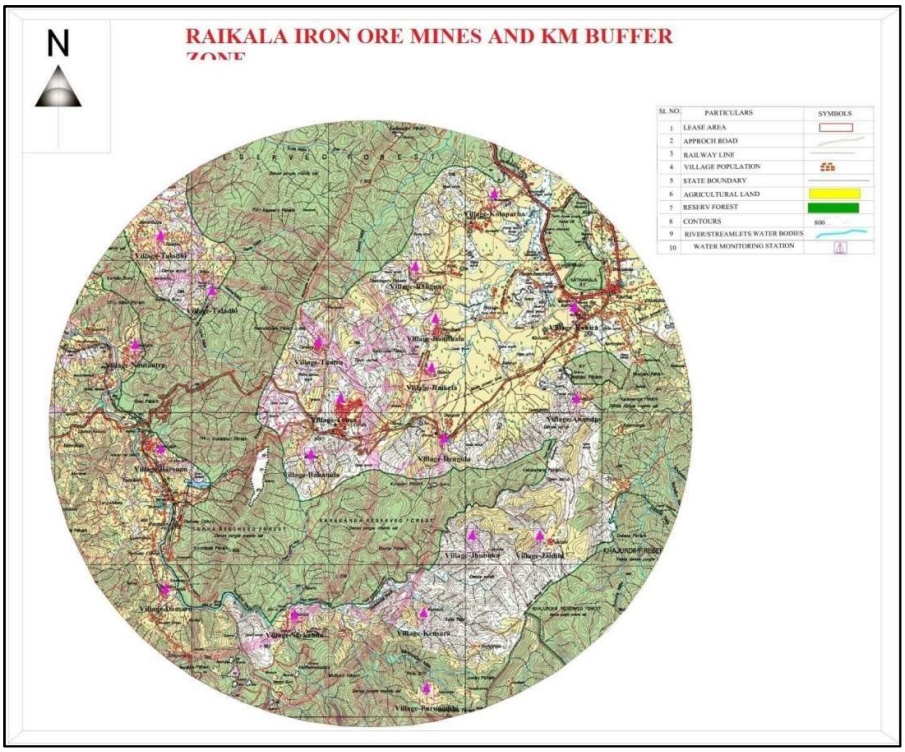


Fig-2.4:. Topography map including core zone and Buffer Zone

2.3 GEOMORPHOLOGY AND DRAINAGE

As far as drainage pattern is concerned, dendritic pattern can be observed regionally in the lease area and its surrounding area. There is no perennial nala flowing within the lease area. Only some seasonal nala flowing due east along the valley. The KurahiNadi is flowing due North West in the western part of the lease area at a distance of 8km. Geomorphological map of the buffer zone is shown in fig-2.5.

Drainage system of the area is dendritic type controlled river Baitarani (outside the buffer zone) andits tributaries like Kuarhi Nadi, Marda Nadi, Burghar Nadi, Kiri Nadi etc. Kuarhi Nala a perennial source, starting near village Basada, drains the north-western part of the buffer zone similarly, southeastern and southwestern part of the buffer zone is drained by MardaNadi and Burgharnadi respectively. Drainage density is very high indicating the hilly nature of the land-form.

The rainfall runoff is generated through drainage of different orders, which flows in general from north-west towards south-east. Besides there are other prominent seasonal nallas, the whole area dendritic drainage pattern can be observed that generally follows physiography as shown in Drainage map (Fig. 2.6). Vegetation is sparse with deep-rooted trees at number of places especially along the nallas. The area has deciduous forest which spread over hills. The area comes within Micro-watershed of sub basin is given in fig 2.7.

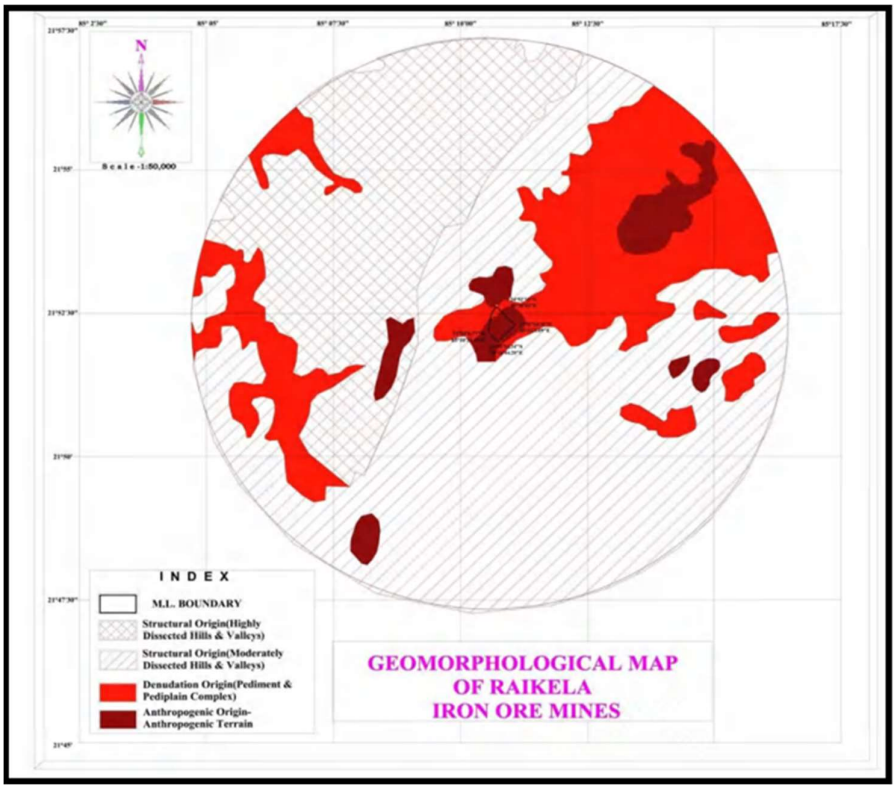


Fig-2.5:. Geomorphological Map of the study area

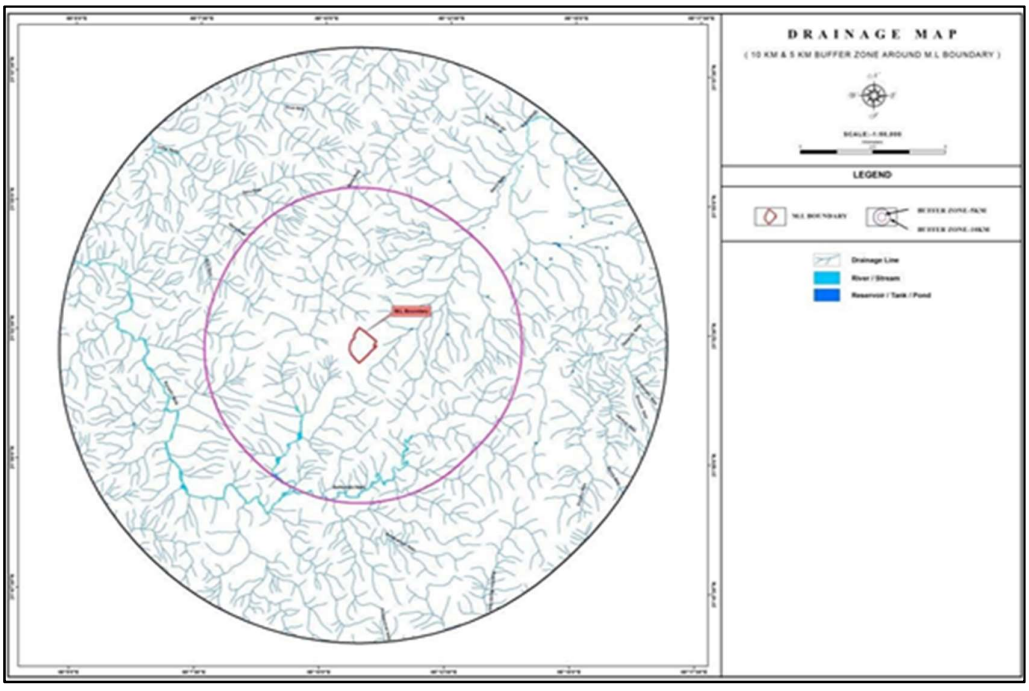


Fig-2.6:. Drainage map of core Zone and buffer Zone

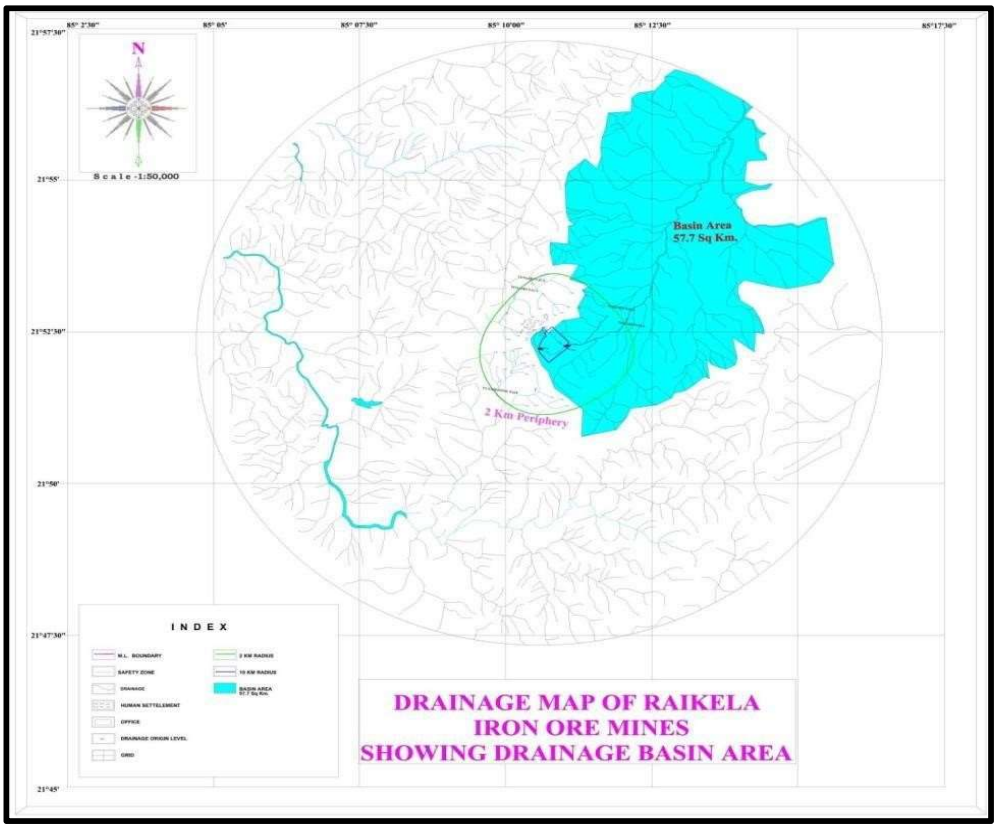


Fig-2.7:. Drainage Map showing drainage basin area

2.4 DETAILS OF WETLANDS/ MAJOR WATER BODIES

The drainage pattern is dendritic generally but since the region is fracture controlled, trellis pattern is also observed. The drainage density is moderately high indicating more run-off than infiltration. The drainage system is predominately controlled by Karo River flowing at a distance of 7km in North eastern side and Kurahi Nadi, flowing due North West in the western part of the lease area at a distance of 8km. Similarly, Sarkunda Nala flowing at a distance of 4.20 km in the southern side joins Kuradi Nadi at a distance of 5.0 km in the southwestern direction. Drainage density is moderate indicating the hilly nature of the land-form. The slope is generally towards west and southwest. The drainage map of the study area is shown in Fig- 2.6.

3. HYDROGEOLOGY

Sundergarh district is North Western part of Odisha state. Sundargarh is recognized as an industrial district in the map of Odisha. Steel Plant, Fertilizer Plant, Cement factory, Ferro Vanadium Plant, are some of the major industries of this District.Large part of the study area belongs to Raikela Village, Koira Tehsil of Sundargarh District, Odisha. Ground water is the main source of drinking as well as industrial and domestic purpose. However, the requirement of water in irrigation and agriculture is

fulfilled mainly by river, canals as well as by rainwater. The rainwater also is the main source for recharge of groundwater of the area. The following major subtopics that are covered in this particular chapter are:

3.1 GEOLOGICAL SETUP

3.2 HYDROGEOLOGICAL SETUP

3.2.1Aquifer characteristics

3.2.2 Groundwater flow & aquifer interaction with surface water bodies.

3.2.3. Depth of water level

3.2.4Long term water- level data analysis

3.2.5 Groundwater quality

3.1GEOLOGICAL SETUP

3.1.1. Regional Geology

Sundergarh district is rich in Iron ore, limestone, manganese, dolomite, and fire clay. Banded Iron Formation (BIF) and Iron ore deposit occupy three distinct provinces surrounding the North Odisha Iron Ore Craton (NOIOC). They are Bonai-Keonjhar belt in the western side of the Craton, Badampahar Gorumahisani- Suleipat belt in the eastern flank and Daitari-Tomka belt in the southern side of the Craton. All of these three belts having best preserved basin of Precambrian age that form Iron Ore Super Group (IOSG) of Odisha. Sundergarh district lies under Western flank by the Bonai – Keonjhar (BK) belt forming U shaped synclinorium which is known as the Horseshoe belt. Iron Ore Super Group (IOSG) Odisha, rock assemblages is belonging to Singhbhum – North Odisha Iron Ore Craton. There are three or more Iron Ore Group existing in the IOSG such as Badampahar Group, Noamundi Group and Koira Group. These groups are separated by unconformity, different metamorphic grade, distinct sedimentary and igneous assemblages and ore types (Fig: 2.1).

The Mayurbhanj granite occurring along the eastern fringe of the Singhbhum granite was dated to be 3100Ma. The A type Mayurbhanj Granite Pluton (3.09Ga) occurring along the eastern margin of the Singhbhum – OdishaCraton, eastern India, represent the final phase of acid plutonism in this crustal block of Archaean age.

I. BIF-1: Badampahar – Gorumahisani – Sulpet Belt

The BIF-1 comprising of iron formation of Badampahar- Gorumahisani – Sulpet (BGS) Belt. The litho assemblage of this oldest Iron Ore Group consists of banded cherty quartzite, tremolite-actinolite schist and fuchsite quartzite. The Badam Quartzite is well exposed in the western side of BGS. Banded magnetite quartzite is the dominant litho unit in the BIF-1. The major mineral

constituents are Magnetite, martite, hematite, specularite, goethite, grunerite, and quartz. The BIF-1 has suffered amphibolitesfacies of metamorphism.

II. BIF – II: Daitari- Tomka Belt

The BIF-II lying in the southern portion of the North Odisha Iron Ore Craton is confirmed to Daitari – Tomka belt. It is underlain and overlain by Badampahar quartzite and Dhanjori quartzite. The litho assemblage of this belt consists of banded magnetite/hematite quartzite, banded magnetite/hematite jasper, quartz sericite schist, phyllite, slate and banded chert. The rocks of BIF –II attain green schist facies of metamorphism.

III. BIF – III: Bonai- Keonjhar Belt:

BIF-III is a U- shaped pattern in the western flank of the NOIOC that rests over the Dhanjori Quartzite. The litho association of this area forms the youngest Iron Ore Group comprising of banded hematite jasper, banded hematite quartz/cherty, banded shale, banded manganese formation and ferruginous shale. The banded iron formation consists of predominantly iron oxide mineral such as hematite, martite, specularite, and magnetite. The litho assemblage of this youngest iron ore belt is un-metamorphosed and lack of intrusive Fig (3.1).

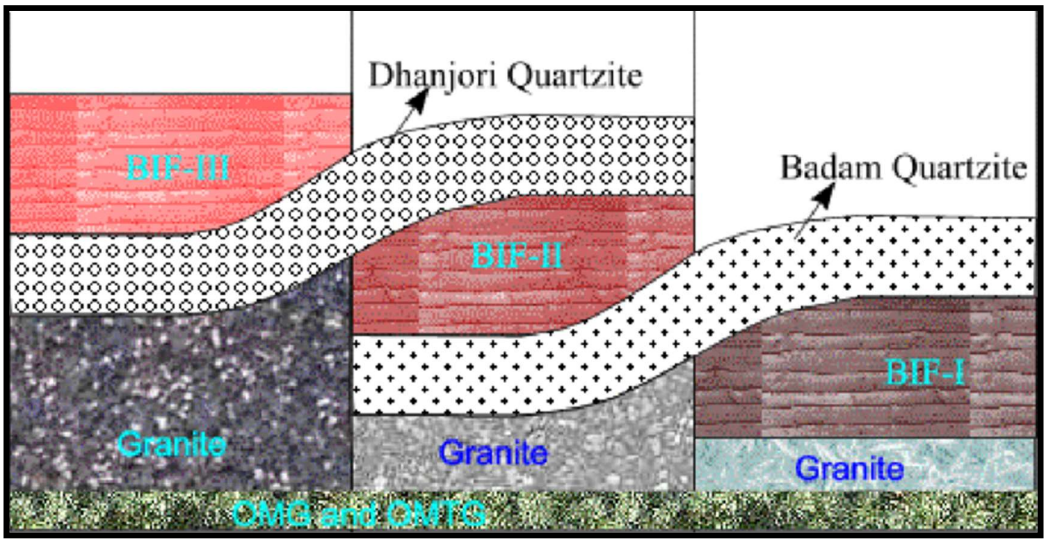


Fig -3.1: Schematic diagram of stratigraphic setting of three BIF of IOSG (Beura et al.2016)

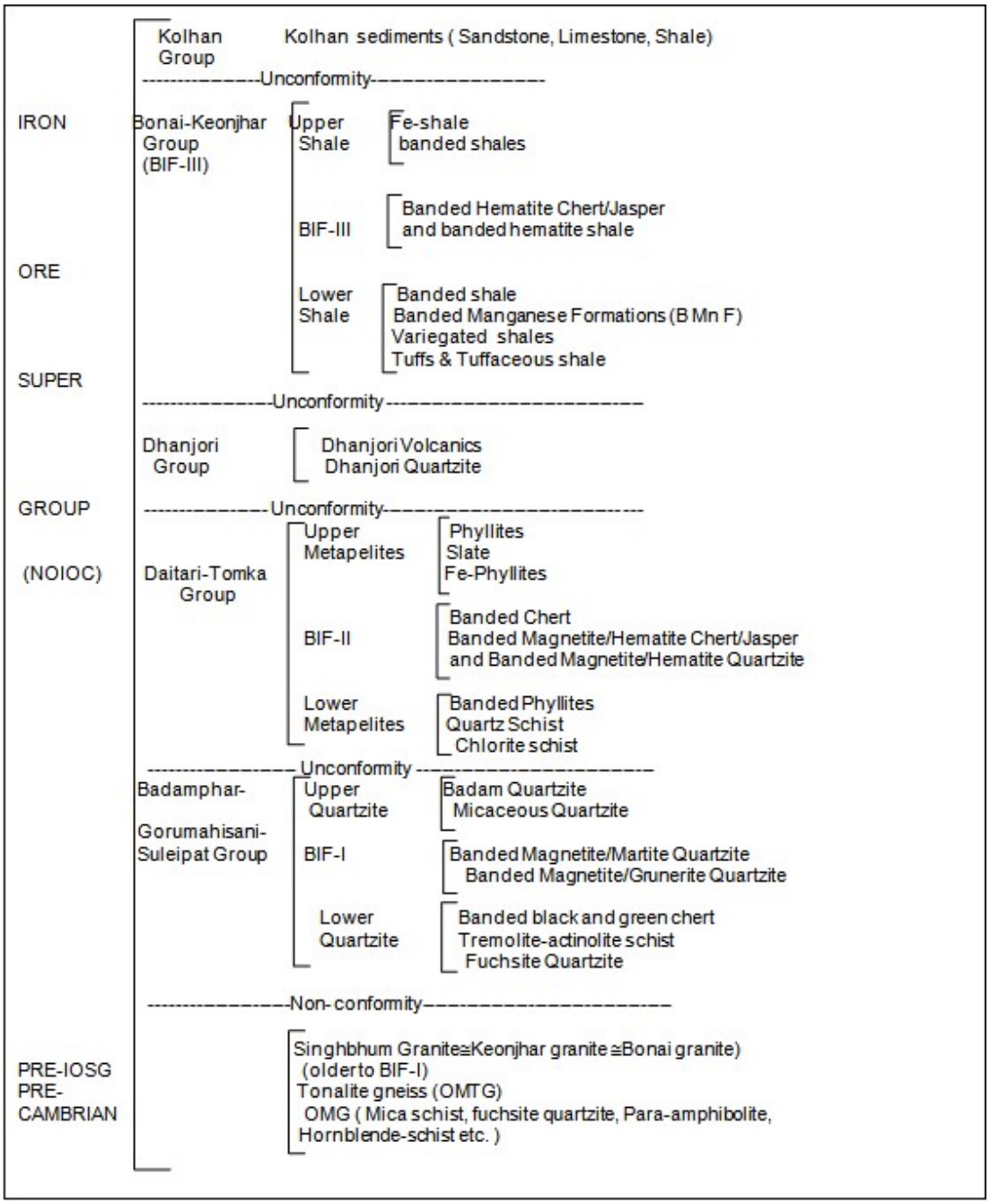


Fig 3.2: Stratigraphic Succession of Iron Ore Super Group of Odisha (Beuraet al.2016).

3.1.2. Local Geology

The study area is occupied by the rock of Koira group Table (2.1). This belt is 60km long and 25 km wide extending from south of Malangtoli in Keonjhar district up to Chakra Dhrampurin West Singhbhum district (Jharkhand). The western syncline known as Koira syncline, due to steep dip and overturned nature of its limb form a deeper basin with thick sequence of younger shales in the core region. On the other hand, the eastern syncline known as Bamberi syncline is a shallower basin and exposes younger litho members within the core region as outliers. The Upper shale unit within the Koira syncline is more or less continuous. The general strike of the beddings in N100W- S100E direction with occasional swings to N300E-S300W and having 20° - 40° dip towards west in the area. The area under investigation lies within the Upper Shale Formation of the Koira group described by Murthy & Acharya (19975)

Table 2.3: Startigraphy of Koira Group in Sundergarh district, Odisha		
Soil Laterite		
Koira Group	Upper Shale Formation	Shale's of different color like purple, yellow with inter beds of Iron ore
	Banded Iron Formation	Coarsely banded BHJ followed up by finely banded BHJ and iron ore in the eastern block.

M/s Geetarani-Mohanty-Raikela iron ore mine is belonging to Singhbhum iron ore series and main rock type in the study area are Laterite, Hematite, and Shale. Geologically, the area is underlain by Pre – Cambrian crystalline rocks like Granite, Granitic Gneiss, Banded Hematite Jasper, Quartzite, Slate, Phyllite, and Mica Schist.

Laterite

Laterites are observed in the study area including ML area that has been the resulted from a process of residual weathering. Laterite has been developed mostly over the shale unit or low grade iron ores of the area. The shale rich in alumina has given rise to aluminous laterite and those rich in iron have developed ferruginous laterites. Ferruginous laterite occupies most of the high lands in the vicinity of iron ore of central ridge while aluminous laterite occurs in the extreme east of the area.

Shale

Western side study area has occupied with fine laminated rock having different shades of colors ranging from brownish to purple grey. Different colors of the Shale are largely dependent of minerals compositions. It is mostly composed of clayey micaceous minerals, with lenses of chert.

Iron Ore

Iron ore formation are economically important meta sedimentary rocks that occur most commonly in Precambrain sedimentary succession Based on surface exposures and sub-surface geology 4 (four) types of iron ore are recorded in the explored block.(Fig 2.1).These are Hard Laminated Ore (HLO), Soft Laminated Ore (SLO), blue dust (powdery ore), lateritic ore and float ores. . The general strike of the beddings in N100W- S100Edirection with occasional swing to N300E-S300W, having 20° - 40° dip towards west in the study area

3.1.3 Geomorphology & Soil Type

Geomorphology: The district has varied geomorphological features. The geomorphic units are (I) Plain (ii)Deep Buried Pediment (iii) Shallow buried pediment (iv) Intermontane valley (v) Inselberg, (vi) Mesa & Butte, (vii) Residual Hills, (viii) Intermontane Valleys, (ix) Structural hills. The soil characteristics of the district show wide variation depending upon their occurrence, physical and chemical properties. The soil of the district is broadly grouped into (I) Alfisols (II) Ultisols (CGWB Report).

I. Alfisol and Red Soil

The study area is covered with red sandy soils and red loamy soils. These soils predominantly occupy high and medium land throughout the Sundargarh district. The characteristics feature of Red soil is porous and fragile in structure. These are usually deficient in nitrogen, phosphate, organic matter and lime. These soils are suitable for cultivation of paddy and other crops.

II. Ultisols

The ultisols comprises mainly of lateritic soils and red and yellow soils. These soils are mildly acidic in nature and deficient in nitrogen, phosphorous and potassium and organic matters. Soils of the district are generally having average to good fertility status. All common types of crops can be grown in the district.

3.2 HYDROGEOLOGICAL SETUP

The climate of the district is sub-tropical climate characterized with hot and dry summer, cold winter and erratic in rainfall. The winter season extends from November to end of February, which is followed by summer season from March to the middle of June, and rainy season from middle of June to middle of October. During summer months the maximum temperature rises up to 43° C and May is the hottest month. December is the coldest month of the year when the average daily temperature drops down to 8° C. Relative humidity is around 60-70% throughout the year. The highest and lowest monthly mean relative humidity so far recorded is 97% (Dec) and 26% (April). The annual rainfall of last decade is given in Table 2.2.

Table 3.1Decadal Rainfall in Sundergarh District (Source: WRIS online portal) 2011-2020

Year	Actual Rainfall (mm)	Deviation (%)	Year	Actual Rainfall (mm)	Deviation (%)	Average Rainfall (mm)
2011	1788.35	20.87	2016	1098.51	-28.82	1415.126
2012	1435.18	1.39	2017	1323.91	-6.8	
2013	1537.77	7.97	2018	1396.59	-1.32	
2014	1335.09	-5.99	2019	1387.02	-2.02	
2015	1286.6	-9.9	2020	1562.24	9.4	

3.2.1Aquifer Characteristics

The study area comprises 10km radius zone in Raikela iron ore Mines, located in Koira Tehsil of Sundargarh district of Odisha.Detailed hydrogeological study of both core and buffer zone of mine area is carried out.The hydrogeological condition varied from place to place due to different litho unit of aquifer.The hydrogeological units of the study area are broadly categorized into twogroups namely.

1. Consolidated formations.
2. Unconsolidated formations
3. Semi-consolidated

1. Consolidated formations

The study areais occupied by the consolidated formations comprising of Precambrian metasediments of Gangpur series and Iron ore series and also granite gneiss, metasediments like amphibolite, epidiorite etc. Ground water is stored mainly in the secondary porosity resulting from weathering and fracturing of the rocks. Ground water occurs under confined to semi-confined condition in the deeper fractured zones. Wateryielding capacity is mainly depend on the extent of fracture, depth, opening and size of fracture. Mica schist, quartzite and phyllite are the formation in the study area.

2. **Unconsolidated formations-** Unconsolidated sand and gravel aquifers are characterized by intergranular porosity and all contain water primarily under unconfined, or water-table, conditions. They are grouped into four categories: basin-fill, blanket sand and gravel, glacial-deposit, and stream-valley aquifers. All four types have intergranular porosity, and all contain water primarily under unconfined or water-table conditions. The hydraulic conductivity of the aquifers is variable, depending on the sorting of aquifer materials and the amount of silt and clay present, but generally it is high. Aquifer thickness ranges from a few meters or tens of meters. Groundwater in these aquifers flows along relatively short flow paths typical of local flow systems.

3. **Semiconsolidated aquifers** consist of semiconsolidated sand interbedded with silt, clay, and minor carbonate rocks. Porosity is intergranular, and hydraulic conductivity is moderate to high.

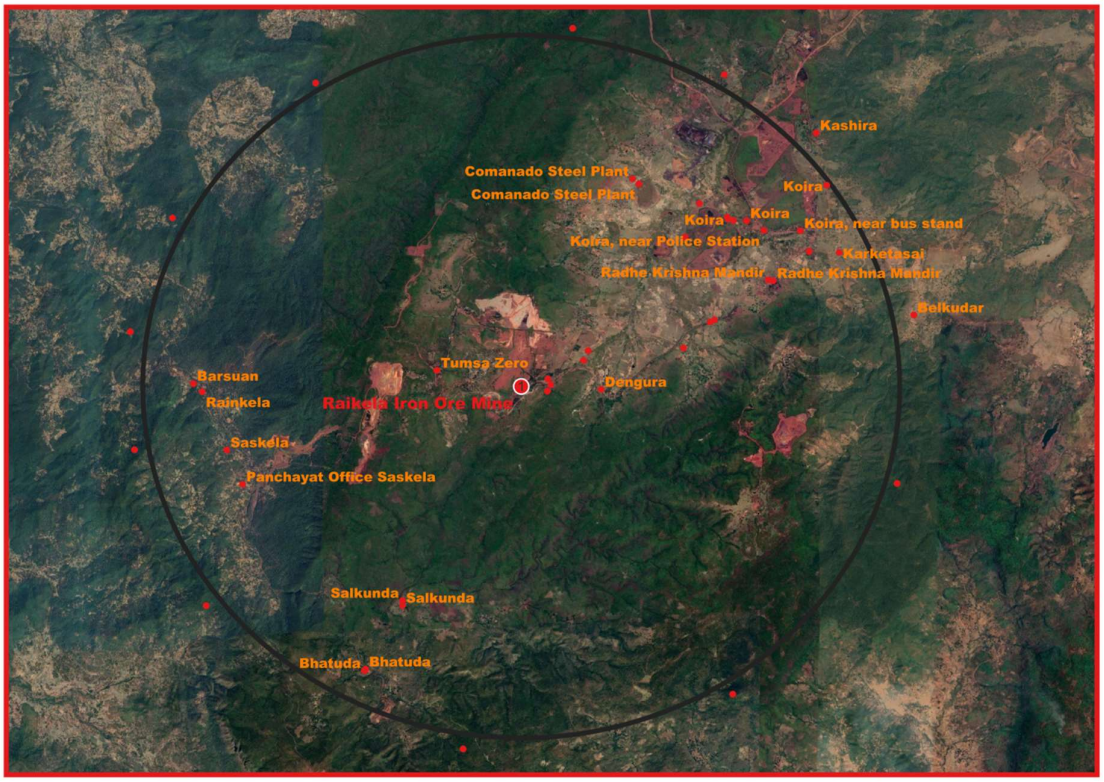


Fig-3.3: Map showing Location of groundwater Monitoring

3.2.2 Ground water flow and aquifer interaction with surface water bodies

As per the field investigation it has been observed that the main source of water is from River and groundwater. Groundwater is withdrawal from bore well as well as from hand pump (Fig-2.4). Most of dug well having water level from 3.7 to 7.5m in pre monsoon period. Total depth of dug well is from 9 to 12m. It has been observed that the bore wells are often from 16 to 30m in depth. Ground water is lying in weathered part of hard rock aquifer (2.5). Hard rock

comprises Precambrian met sediments like Mica schist, quartzite, phyllite, conglomerate along with granite. The movement of the ground water in deeper rocks is controlled by the nature, size opening and continuity of joints & fracture present in them. Wells in hard rock generally yield 50 to 70 m3 /day of all the rock types. Schist, phyllite and their variants form very poor aquifers yielding 10 to 30 m3 /day for heavy drawdown. Well inventory of study area (Fig:2.5) in Pre Monsoon (April 2022) period showing ground water level varies within the range from 3.7 m to 36.3m bgl (Table 2.3). In Post Monsoon water level rises up to 2-3m and some places it is 5m.

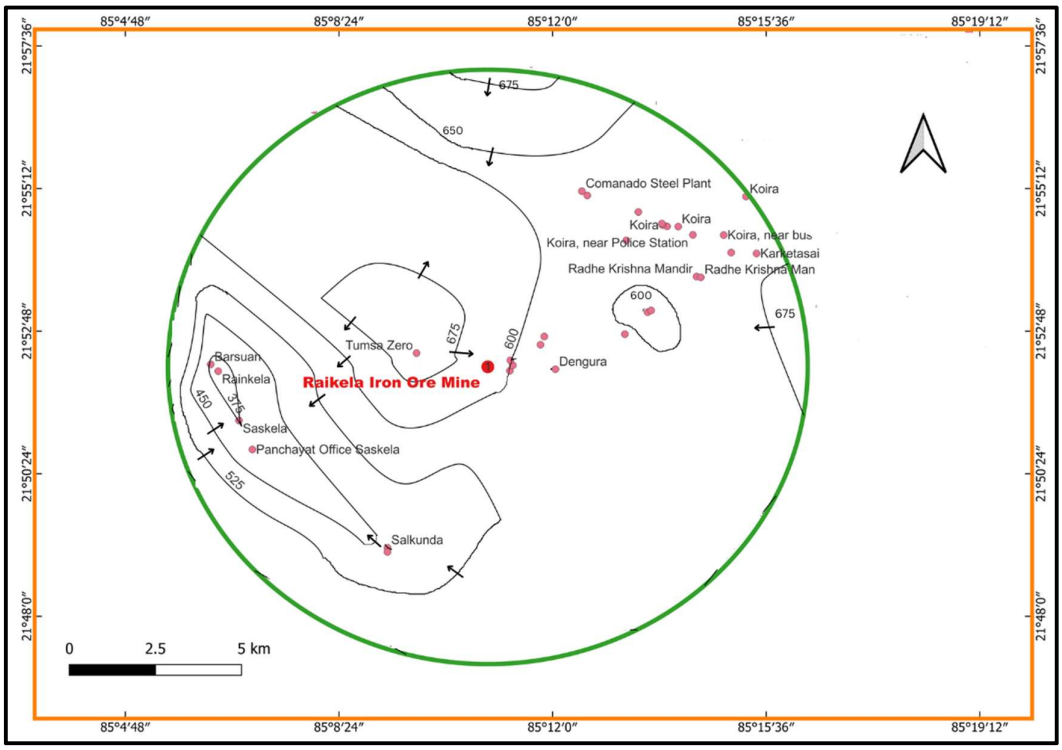


Fig3.4: Natural groundwater flow Direction's in Buffer Zone

3.2.3 Depth of water Level

Various location points have been selected for groundwater data collection in Buffer zone and core zone, some points from outside of the boundary were also taken for clear picture and modelling purpose. The details of quality and water level are given below.

Sl No.	Location	Latitude	Longitude	Elevation (m)	EC (mS)	pH	TDS(ppt)	Water Level (m)	Type of water body
1	Barsuan	21.885964	85.304356	622.85	130	6.8	70	22	Dug well
2	Belkudar	21.886949	85.304342	623.11	120	6.8	60	16.5	Bore well
3	Bhatuda	21.881586	85.314718	614.34	240	6.7	130	8	Hand pump
4	Bhatuda	21.879735	85.314745	623.34	480	6.9	225	7	Hand pump
5	Comanado Steel Plant	21.87555	85.308419	617.73				8	Pond
6	Comanado Steel Plant	21.875081	85.308162	623.8	100	6.4	50	8.5	Bore well
7	Dengura	21.863644	85.293346	664.9				8	Pond
8	Karketasai	21.904283	85.305595	608.55	90	6.5	50	22	Hand pump
9	Kashira	21.904144	85.305645	607.9	95	6.5	45		Hand pump
10	Koira	21.952008	85.320045	567.21	450	7.2	220	8	Bore well
11	Koira	21.963844	85.317	577				5	Mine pit
12	Koira	21.950576	85.255734	562.95	40	7.6	20	22	Bore well
13	Koira, near bus stand	21.93019	85.251827	565.3	40	6.5	20	25	Hand pump
14	Koira, near Police Station	21.917759	85.2543	568.87	65	6.5	25	5	Hand pump
15	New Colony	21.871817	85.188111	611				4	Bore well
16	Panchayat Office Saskela	21.913434	85.224078	559.84	60	6.5	25	25	Hand pump
17	Radhe Krishna Mandir	21.886959	85.274977	646.48	340	6.9	180	22	Hand pump
18	Radhe Krishna Mandir	21.901799	85.257257	581.28	85	6.9	40	18	Hand pump
19	Rainkela	21.895306	85.240408	588.94	70	6.6	30	25	Hand pump
20	Rainkela Iron ore Mines	21.86858	85.17598	680	190	6.57	113	10	Borewell
21	Rengalbeda	21.868889	85.187991	619.85	20	5.9	10	surface	
22	Tumsa Zero	21.838361	85.336098	865.3	210	7.03	120	11	Hand pump
23	Salkunda	21.819241	85.153618	449.78	340	6.7	170	8	Hand pump
24	Salkunda	21.818068	85.153606	431.39	260	6.7	140	7.5	Bore well
25	Saskela	21.878866	85.314424	591.85	110	6.6	60	12	Hand pump
26	A1	21.84094	85.34045	867.2					Pond
27	A2	21.868772	85.10608	370.59	300	7.1	160	27.27	Bore well
28	A3	21.854939	85.111915	373.46	290	6.7	150		Hand pump
29	A4	21.846799	85.115667	379.11	190	6.9	100		Hand Pump
30	A5	21.876188	85.196579	572.02					Pond
31	A6	21.878495	85.197651	571.44	20	6.3	10	surface	
32	A7	21.909329	85.235269	574.88	20	6.4	10		Bore well
33	A8	21.910184	85.230684	578.12	120	6.5	60		Bore well
34	A9	21.918085	85.209714	573.27					Pond

Table3.2: Post monsoon Monitoring points in Buffer Zone

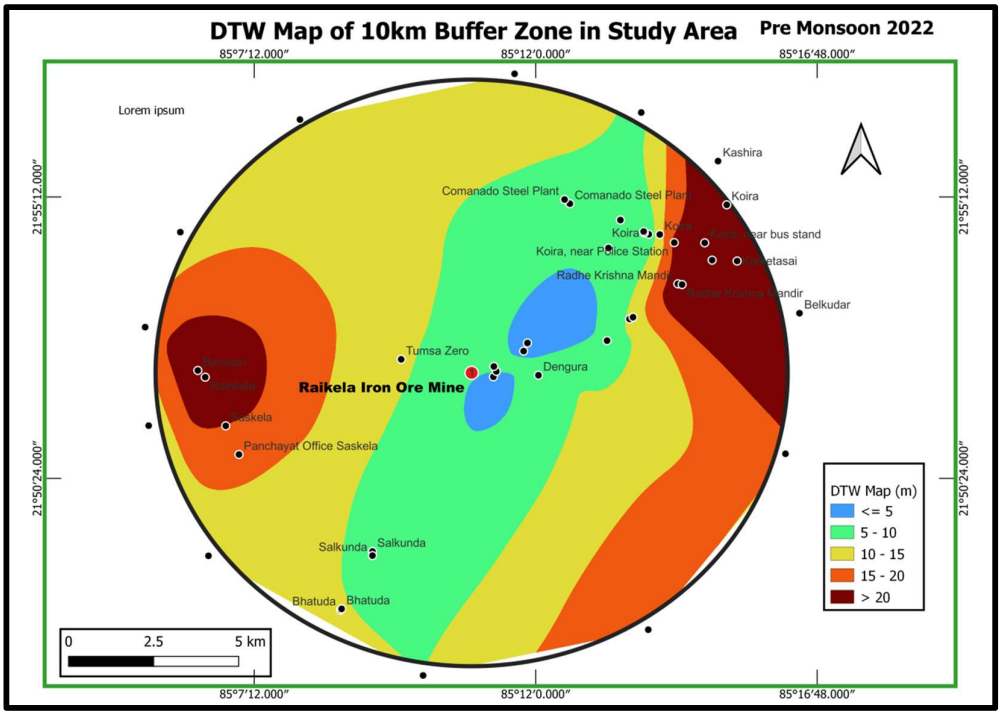


Fig3.5: DTW map of buffer zone of RaikelaIorn ore Mines (Pre- Monsoon)

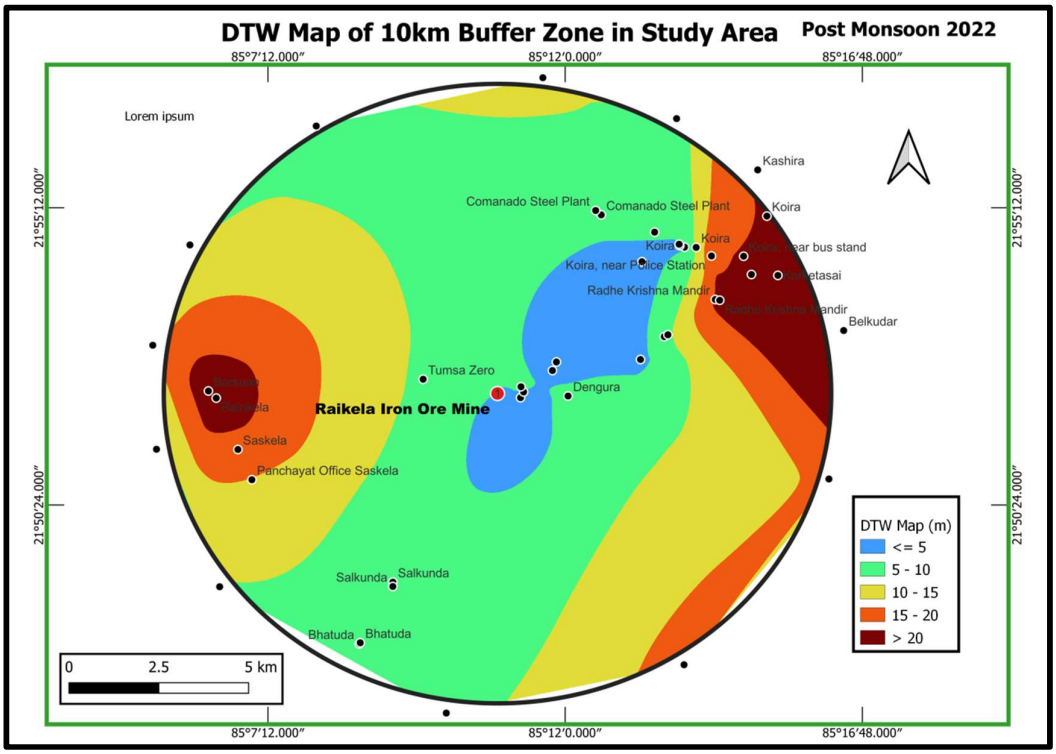


Fig 3.6: DTW map of buffer zone of RaikelaIorn ore Mines (Post Monsoon)

3.2.4 Long term water level data analysis

The study area comprises 10km radius zone in Raikela Iron Ore Mines that largely fall under Koira tehsil, Sundergarh district, Odisha. In the core zone village the source of ground water such as bore well; hand pump and pond are used for domestic, irrigation and drinking where out of 3 observation location of dug well, it has been observed that the water level (Pre monsoon 2022) varying from 3 to 7.5m bgl. Long term trend analysis of data obtained from WRIS shows no significant change-rise or fall as depicted in **Fig: 3.7.**

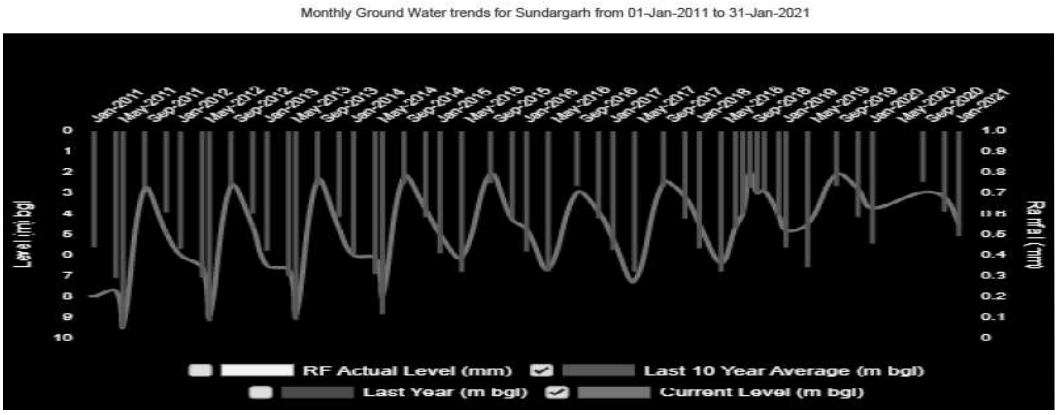


Fig 3.7: Long term well hydrograph of wells of Sundergarh district, Odisha (source: WRIS portal)

Dynamic Groundwater Resource of study area

The groundwater resource as estimated by CGWB (2020) is presented in the table 3.3 for Koira block of Sundargarh district Odisha and is in safe category.

Table: 3.3 Block wise Dynamic Groundwater Resources of Koira block, Sundergarh district

District	Block	Ground water Recharge (Ham)				Total Ground water Recharge (Ham)	Total Natural Discharge (Ham)	Annual Extractable ground water resources (Ham)
		Monsoon Season		Non Monsoon Season				
		Recharge from Rainfall	Recharge from other sources	Recharge from Rainfall	Recharge from other sources			
Sundergarh	Koira	4777.33	139.58	572.73	172.14	5661.78	283.09	5378.69
Annual Extractable Ground water Resources (Ham)	Annual Groundwater Draft (Ham)				Annual GW allocation for Domestic use as on 2025 (Ham)	Net Groundwater availability for future use (Ham)	Stage of Ground water Extraction (%)	Categorization (over exploited/ Critical/semi critical/ safe/ saline)
	Irrigation	Industrial	Domestic	Total Extraction				
5378.63	873.45	290.16	265.25	1428.8	304.71	3910.38	26.57	Safe

3.2.5 Groundwater Quality

Based on the above study, different ground water parameters were computed, which include pH, TDS, EC, and Temperature. Ground water in study area is potable with pH ranging 5.9 to 7.6 and total dissolved solid (TDS) ranging from 10 to 310 ppt and EC ranging from 20 to 600 µS. (Fig 2.9 and 2.10) Groundwater quality in the study area is fresh and all major and trace elements are found within the BIS 10500 permissible limit. Thus is suitable for all domestic, industrial and irrigational use. The general parameters of groundwater in study area as analyses are given in Table 3.2.The comparison of data reveals that the area mining (Project Area) is having less TDS.TDS and EC map of the Buffer zone is shown in Figure--3.8 & Figure 3.9.

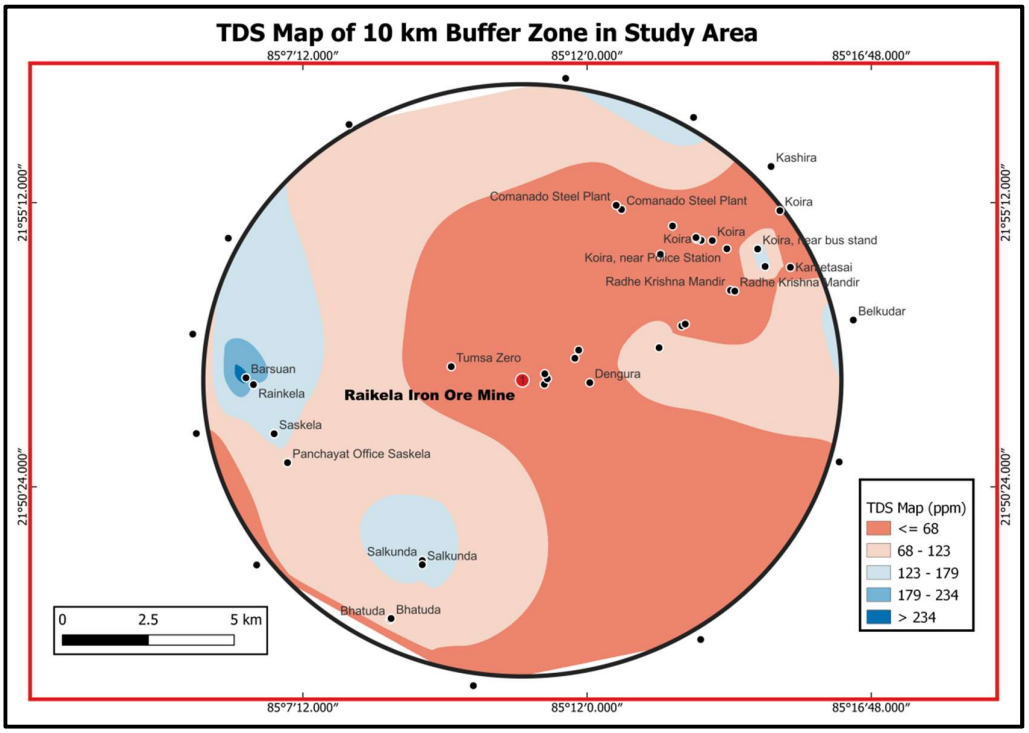


Fig 3.8: TDS map of Raikela Iron Ore mine

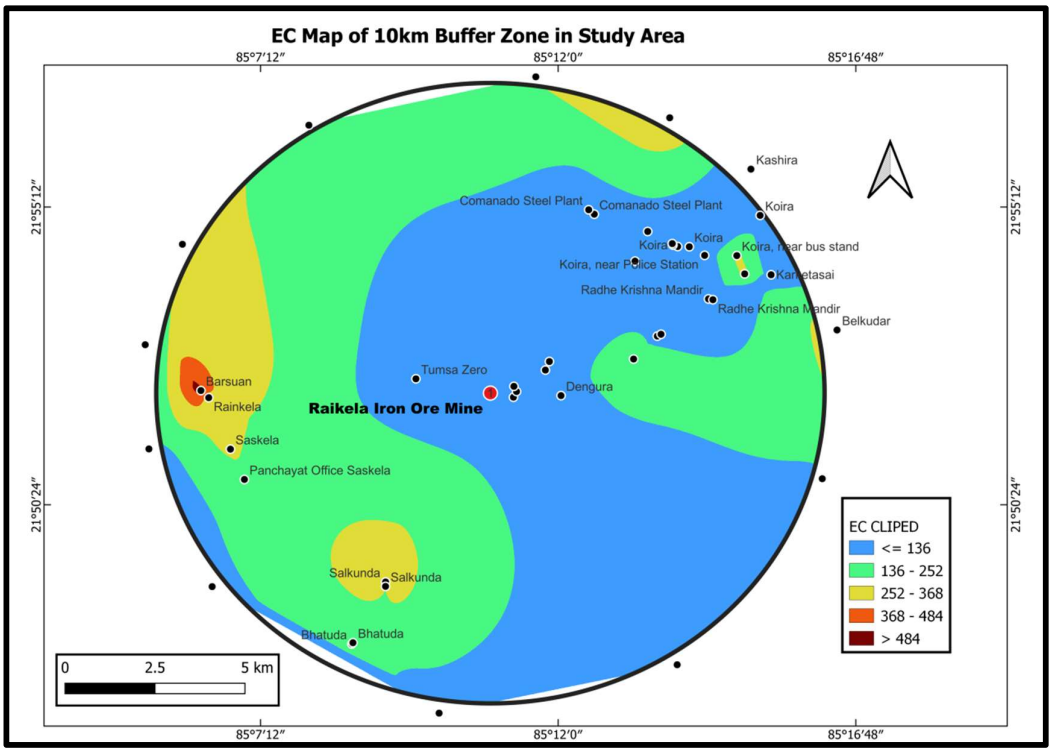


Fig-3.9: EC map of 10km of Buffer Zone of Raikela Iron Ore Mines

3.2.6 Water Quality of nearby water bodies

Data in Piper Trilinear Diagram: Different graphical methods can be adopted for representing geochemical variation which gives a better insight into the groundwater quality monitoring. One such efficient method of representation is plotting of Hill Piper Trilinear diagram in which data are plotted in two triangle fields and one diamond field. The diamond is then classified under various categories emphasizing their characteristics.

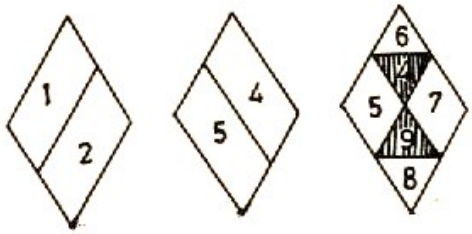


Fig 3.10: Sub-divisions of the diamond field

On the basis of data collection from CGWB report (2020-2021). It has been observed that out of 63 samples are concentrated in Area 6 indicating that: Non-

carbonate hardness exceeds 50% i.e., Ca + Mg - (SO4 + Cl + NO3). 50% samples are lies under area 4 representing strong acids (SO4 + Cl + NO3) exceed weak acids (CO3 + HCO3). Few samples can be noticed under Area 7: Non-carbonate alkali exceeds 50% i.e., Na + K- (SO4 + Cl + NO3).

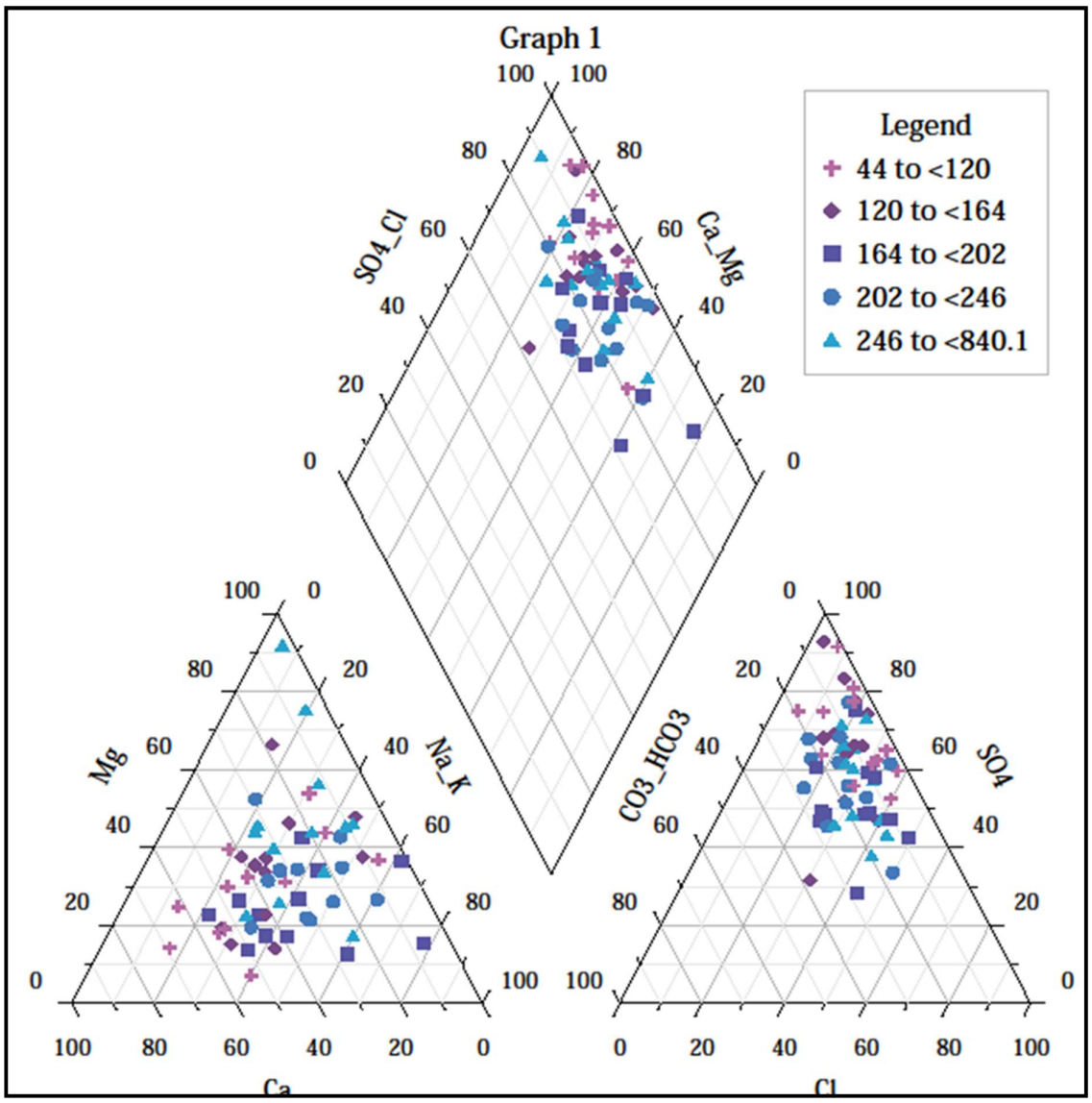


Fig 3.11 Piper Trilinear diagram

USSL Diagram: The United States Salinity Laboratory (USSL) (1954) and Wilcox (1955) established standards for irrigation water quality classification. The Fig.7.5 is a simple scatter chart of sodium hazard (SAR) on the Y-axis versus salinity hazard (EC) on the X-axis. Using the SAR and the EC value of 41 water samples of Balaghat area determines the quality classification of the water.
Based on the EC, irrigation water can be classified into four categories; include:

I. Low-salinity water (C_1) can be used for irrigation with most crops on most soils with little likelihood that **soil salinity** will develop.
II. Medium-salinity water (C_2) can be used if a moderate amount of leaching occurs. Plants with moderate salt- tolerance can be grown in most cases without special practices for salinity control.
III. High-salinity water (C_3) cannot be used on soils, special management for salinity control may be required and plants with good salt tolerance should be selected.
IV. Very high salinity water (C_4) is not suitable for irrigation under ordinary conditions.

Sodium Adsorption Ratio: High sodium in irrigation water reduces the permeability of soil.The USSL diagram based on SAR divided to four categories included:

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

I. Low-sodium water (S_1) can be used for irrigation on almost all soils.
II. Medium-sodium water (S_2) will present an appreciable sodium hazard in certain fine-textured soils. This water may be used on coarse-textured or organic soils with good permeability.
III. High-sodium water (S_3) may produce harmful levels of exchangeable sodium in most soils and will require special soil management.
IV. Very high sodium water (S_4) is generally unsatisfactory for irrigation unless special action is taken, such as addition of gypsum to soil (Lyerly and Longenecker, 1957).

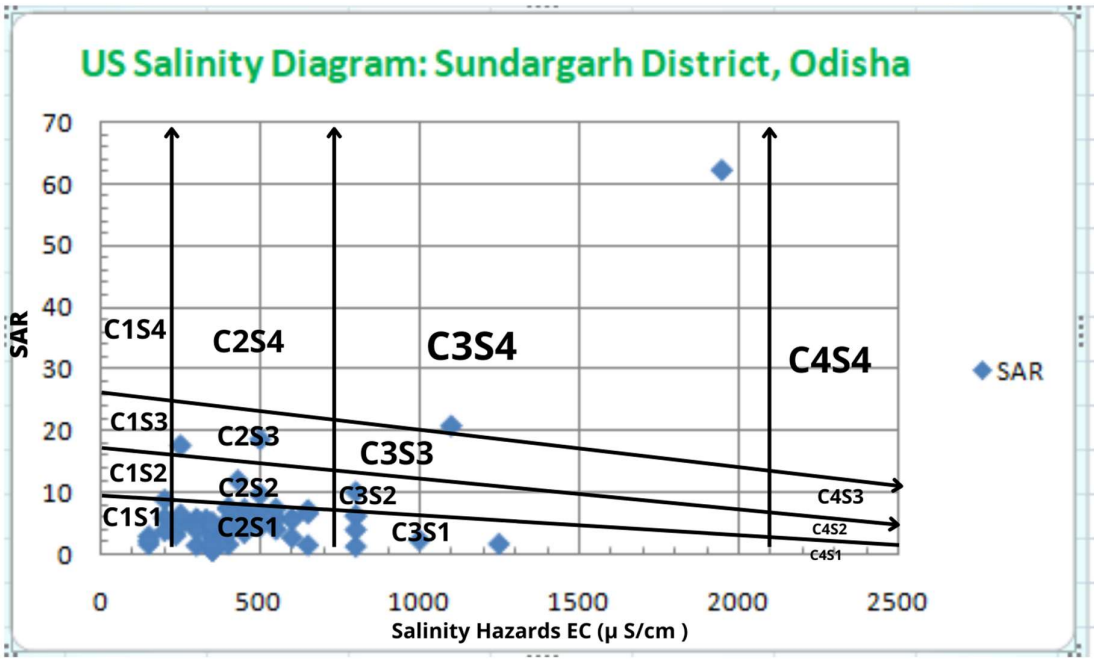


Fig 3.12: US Salinity diagram, Sundergarh district , Odisha

Data Analysis

On the basis of data collection from CGWB report (2020-2021). It has been observed that out of 63 sample, most of the samples are concentrated under C2S1, C2S2 and C3S2 categories indicating low to medium sodium hazards with medium salinity. Out of these, few samples are scattered under C3S1 and C3S2 categories representing high salinity with low to medium sodium hazard. Few samples are scattered in C1S1 indicating low sodium hazards with low salinity.

4. APPROVED MINE PLAN

4.1 DETAILS OF APPROVED MINING PLAN/SCHEME OF MINING.

Date and reference of earlier approved Mining Plan/Scheme of mining

The details of approved Mining Plan/Scheme of Mining in chronological order are as summarized in **Table 4.1.**

Documents approved	Under Rule	Period	Approval
Mining Plan	22 of MCR 1960	1993-94 to 1998-1999	Approved vide letter No RQP/ CAL/ 006/ 87/A/MO-94 dated 27.06.1990
1st Mining Scheme	12 of MCDR' 1988	1999-2000 to 2003-04	Approved vide their letter No BBS/SNG/Fe/MS-7 dated 11.10.1999.
Modification in the Approved Scheme of Mining	10 of MCDR' 1988	2002-2003 to 2003-04	Approved vide their letter No BBS/ SNG/Fe/MS-7 dated 08.05.2003.
2nd Mining Scheme	12 of MCDR' 1988	2004-05 to 2008-09	Approved vide letter No 314(3)/2004/MCCM(C)/MS-14 dated 17.02 .2005.
3rd Scheme of Mining	12 of MCDR' 1988	2009-10 to 2011 -12 (up to 01.07.11)	Approved vide letter No 314(3)/2009 /MCCM/ (CZ)/ MS / 36 dated 22.03.2010.
Mining Plan	24A of MCR 1960	01.07.2011- 2012 to 2015-16	Approved vide letter No 314(3)/ 2011/MCCM/(CZ)/MP/10 dated 03.08.2011.
1st Scheme of Mining	12 of MCDR' 1988	2016-17 to 2020-21	Approved vide letter No MPM / FM/07-ORI/BHU/2015-16 dated 15.06.2016.
Modification of Review of the Mining Plan	17(3) of MCR,M2016	2019-20 to 2020-21	Approved vide letter No. MSM/FM/10-ORI/BHU/2019-20/1087 dated 20.09.2019
Review of Mining Plan	17(2) of MCR,M2016	2021-22 to 2025-26	Approved vide letter No. RMP/A/30-ORI/ BHU/2020-21 dated 18.11.2020

Table 4.1: List of Approved Mine plans

4.2 Mining Method

Opencast fully mechanized method will be adopted to achieve the targeted production. The existing quarries namely Top quarry, Middle quarry and South Pit shall be developed by deploying shovel and dumper combination during the mining operation. Mining operation will be done on the Top quarry on the northern side, bottom quarry on the south eastern side and South pit on the South eastern side with lateral and depth ward extensions with top slicing method. The details of salient description of present mining method in table no 4.2.

Method of Mining	Opencast mechanized method (A-FM).
Type of ore	Laminated hard and soft ore, massive boulder type
Laminated hard and soft ore , massive boulder type	With the help of excavator and Dumper combination.
Bench height and width	10m height with 15m width.
Overall slope angle	28^{O}
Transportation of Ore	By dumper through haulage road to the Crusher at 1:16 gradient.
Blasting	Drilling of 11.0m drill holes with Crawler mounted DTH drill and blasting by using Class 3 explosives. Since the formations are mostly soft, drilling & blasting is done only for 75% of the volume. One hydraulic rock breaker is used for reducing the size of the large boulders instead of secondary blasting.

Table 4.2: Jest of Mining Method

The ROM produced is fed to the Screening unit for the production of 0-10mm, 10-30mm, and +30mm sized ore. The +30 mm ore sent to the crushing unit for production of 5-18mm, 0-5mm. So, the various finished products are 0-5mm, 0-10mm, 5-18mm and 10-30mm.

(i) Recovery factor:

Considering the available borehole data, different litho unit has been demarcated on the Geological section. Based on this updated geological sections different grade wise resource calculation i.e 45 to 55% Fe and +55% Fe has been made. Further waste as BHJ, Shale and Laterite has been demarcated in each geological section, which has been calculated separately. As the grade wise resource and waste calculation carried out separately for each section, 100% recovery factor has been considered for the estimation of resource.

(ii) Cutoff grade

The threshold value is considered at 45%Fe and calculation of reserves is done under different range of Fe% i.e. 45 to 55% Fe and +55% Fe. While above 55% Fe ore is termed as saleable iron ore, below that up to 45% Fe is termed as Mineral Reject. Ore containing less than 45% Fe is considered as mineral waste.

(iii) Ultimate pit depth proposed.

The maximum depth up to which the quarry can be developed economically is considered as the ultimate or conceptual extent of the quarry. Based on the present geological information and mine ability of ore the ultimate pit limit has been marked. The depth of ultimate pit limit has been shown up to the probable limit in the iron ore zone.

(iv) Mineral/ ore blocked dues to benches, safety zone:

During mining operation certain resources have been blocked under UPL, lease boundary safety zone and

blocked area within bench slope. The ore in these blocked areas are non-mineable. Although feasibility study has been carried out and the quantity is established, because of the above mentioned blockages the quantity falls under F-2 category. By considering these blockages, due to above mention various factors, the mineable resource has been estimated.

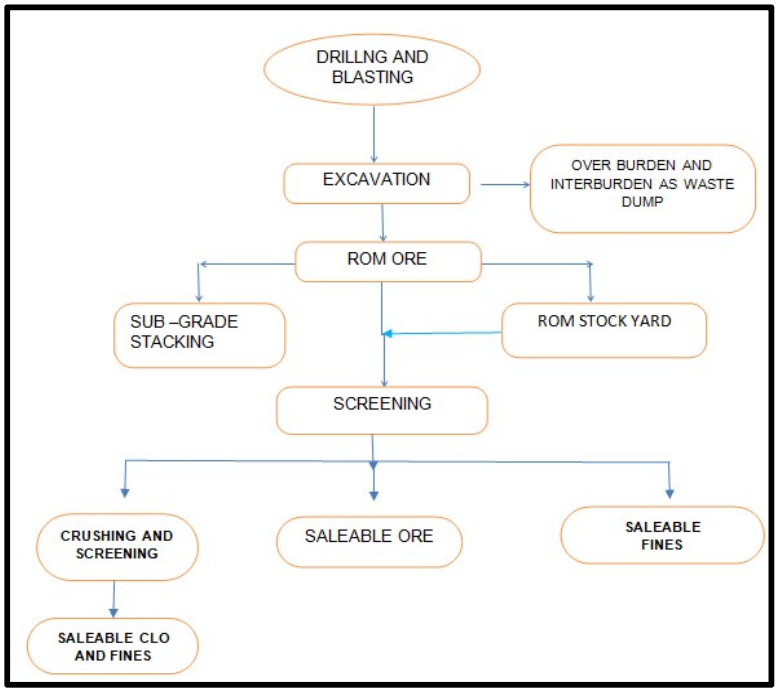
(v) Tonnage Factor

As per the approved Scheme of Mining, the tonnage factor of saleable ore has been considered as 3.0MT/m3 and for sub-grade ore as 2.5MT/m3. The tonnage factor of waste has been considered as 2.0MT/m3. For tonnage factor the lessee has undertaken a bulk density study through a NABL Accredited Laboratory. The copy of the report is enclosed as **Annexure- XXV.**

Sequence of mining operation

Based on earlier mining operation can be observed that three pits have been formed within the lease area. The dimension of the quarries has been mentioned in the table below in the next page. The following flow chart depicts the entire process of mining which is in-vogue at present in Raikela Iron ore Mine.

Fig 4.1: Flow chart of mining operation



As per guidelines of IBM threshold value of iron ore is considered as 45% Fe. While above 55 % Fe ore is termed as saleable iron ore (cutoff grade), and 45-55% Fe is termed as Mineral Reject iron ore. Ore containing less than 45% Fe is considered as waste.

4.3 PRODUCTION DETAILS.

As per guidelines of IBM threshold value of iron ore is considered as 45% Fe. While above 55 % Fe ore is termed as saleable iron ore (cutoff grade), and 45-55% Fe is termed as Mineral Reject iron ore. Ore containing less than 45% Fe is considered as waste.

Table 4.3: Details of production Plan of iron ore (+55%Fe and 45-55%Fe)

YEAR	IRON ORE(MT) (+55%Fe)	MINERAL REJECT (MT) (45-55%Fe)	ROM(MT) (+45%Fe)
2021-22	2023052	966948	2990000
2022-23	4411541	578459	4990000
2023-24	4598847	391153	4990000
2024-25	4680387	309613	4990000
2025-26	4990000	NIL	4990000
TOTAL	20703827	2246173	22950000

As per the approved mining plan total production of +55%Fe will be 20703827 T. Before dispatch to the consumers, grade wise stacking will be undertaken at specified location proposed in the mining plan. This product will be dispatched as per the requirement of consumers.

Table 4.4: Generation of off grade material/mineral reject (45 – 55 % Fe)

Year	Mineral rejects(MT)		
	Total Generation	Storage @ 30%	Blending@ 70% with high grade
2021-22	966948	290084	676864
2022-23	578459	173538	404921
2023-24	391153	117346	273807
2024-25	309613	92884	216729
2025-26	Nil	0	0
Total	**2246173**	**673852**	**1572321**

Beyond plan period about 5730731cum of Mineral Reject i.e. 45-55%Fe will be generated. The mineral reject generated will be stored for a short period as per requirement. Further, it is also planned to evacuate the mineral reject by blending with the high grade ore so that stacking of mineral reject during conceptual period will not arise.

5. ESTIMATION OF MINE SEEPAGE AND ADVANCED DEWATERING PLAN

Minimum and Maximum depth of water table based on observations from the nearby well-

The nearest habitations from the mine are Raikela, Dengula, Tantra, Tensa town etc. The wells at village Raikela, and Dengula is indicating that the water level is encountering at 610MRL.

Indicate Maximum and Minimum depth of working

Mining operation in this lease area is going on after the lease was executed. Continuation of mining operation in the area has opened up three quarries i.e. Top Quarry, Middle Quarry and South Pit. The detail of the quarry is as follows in Table no 5.1.

Nameofthe pit	Location	Length (m.)	Breadth (m.)	Depth(m)	Top RL(m.)	Botto mRL (m.)	No of Benches In Ore	No of Bencs In OB	Pit angle	Areaback filled	Areareclai med& rehabilitate d
TopQuarry	N2419636to 2420236 & E 311610to 312070	553.27 01	376. 502	115.778	843.944	728.166	15	0	37°	Nil	Nil
MiddleQuarr y	N2419500to 2420017 & E 311900to 312252	676.61 1	267. 964	90.197	728.685	638.488	16	0	37°	Nil	Nil
SouthPit	N2419237to 2419310 & E 311795to 311925	75.957	59.4 43	23.551	688.551	665.000	4	0	25°	Nil	Nil

Table 5.1:.depth of working in existing lease quarries

It has been proposed to develop the existing pits i.e. Top Quarry and Middle Quarry. At present the existing bottom RL of Top quarry is 730.497m and Middle quarry is 638.488m. During ensuing plan period the working will be done up to 690m.RL in Top quarry, 620m.RL in Middle quarry.

Table 5.2: Ultimate Pit limit within Plan Period

Name of the Quarry	At the end of plan period (m.RL)	
	Top	Bottom
Top Quarry	843.944	690
Middle Quarry	730.497	620

5.1 Rain water accumulation within Open Mine Pit Area

The open pit area in Raikela Mines is 33.593ha. The average rainfall receive in the area as per record is 1415.126mm, i.e. 1.415m (Table 3.1), that occurs in about 75days. The maximum daily rainfall ever recorded at Koida was 110 mm on 12.08.2022. The Iron ore Mines is located on the hill slop and

garland drains were constructed along the boundary of the Mine pit, hence no runoff water enters within the open pit area.

Considering above facts of rainfall, the total volume of water can be generated within the mine area has been calculated and present below.

Duration	Open Mine area in Ha	Rainfall in m	Volume in ham	Volume in m3	Considering Rainy days	Total volume in m3
Annual	33.593	1.415	47.5341	475341	75	6338
Max/day(110mm)	33.593	0.11	3.6952	36952	1	36952

Table 5.3. Rain water accumulation within the Pit area

As per the above table of calculation the maximum volume of water that can be generated within the open mine pit annually is about 47.53ham. However, the per day rain fall is 6338m3/d only and in extreme case it will be 36952m3.

Considering evaporation and percolation losses per day, it will insignificant quantity of water left for discharge by pumping.

It is therefore concluded that there is no adequate rain water accumulation in pit bottom nor it cut the groundwater table. Hence no mine water discharge generated from Raikela Iron Ore Mines.

5.2 Estimation of Mine seepage – NA

5.3 Advance Dewatering Plan in case of Coal/Lignite Mines – NA

5.4 GW modelling- NA

6.0Mine water Management

6.1 WATER REQUIREMENT:

The project proponent should submit the quantity of surface water or ground water to be used in this project. The complete water balance cycle needs to be used for this project. The complete water balance cycle needs to be submitted. In addition to this the project proponent should submit a detailed plan for rain water harvesting measures to be taken. PP should submit the year wise target for reduction in consumption of the ground/surface water by developing alternative source of water through rain water harvesting measures. The capital and recurring expenditure to be incurred need to be submitted.

The water requirement for the Project, its availability and source should be furnished. A detailed water balance should also be provided. Fresh water requirement for the project should be indicated.

Total water management including domestic use were sourcing from bore well, rain water harvesting and recycling of waste water from ETP/STP, both for monsoon and non-monsoon be submitted of the existing mines and propose expansion. Total makeup water requirement for production of 4.99 MTPA

Iron Ore is 281.3 KLD, 170KLD is sourced from bore well, and 98 KLD from rain water harvesting and 13.3 KLD recycling water from STP & ETP.

The water requirement for the Project, its availability and source should be furnished. A detailed water balance has been al provided in Table no 6.1. Fresh water requirement for the project should be indicated. Total water requirement for production of 4.99 MTPA of Iron Ore is281.3KLD. Out of this requirement from groundwater withdrawal is only 170KLD. The water required will be sourced from bore well existing within the lease area. The proponent has proposed to draw the required quantity from bore well for 8 months excluding summer season. During summer season the required quantity will be met from rain water harvesting pond. The details of breakup of 281.3 m3 /day are as follows:

Sl. No	Purpose	Ground Water (KLD)	RWH (KLD)	Recycled STP &ETP (KLD)	Total from all source (KLD)
1	Dust Suppression	127.4	90	5.1	222.5
2	Domestic Use	14.0			14.0
3	Plantation	16.3	8.0	8.2	32.5
4	ETP & Workshop, Wheel Washing System	12.3	-	-	12.3
Total		**170**	**98**	**13.3**	**281.3**

Table 6.1: Details of water requirement in mining operation

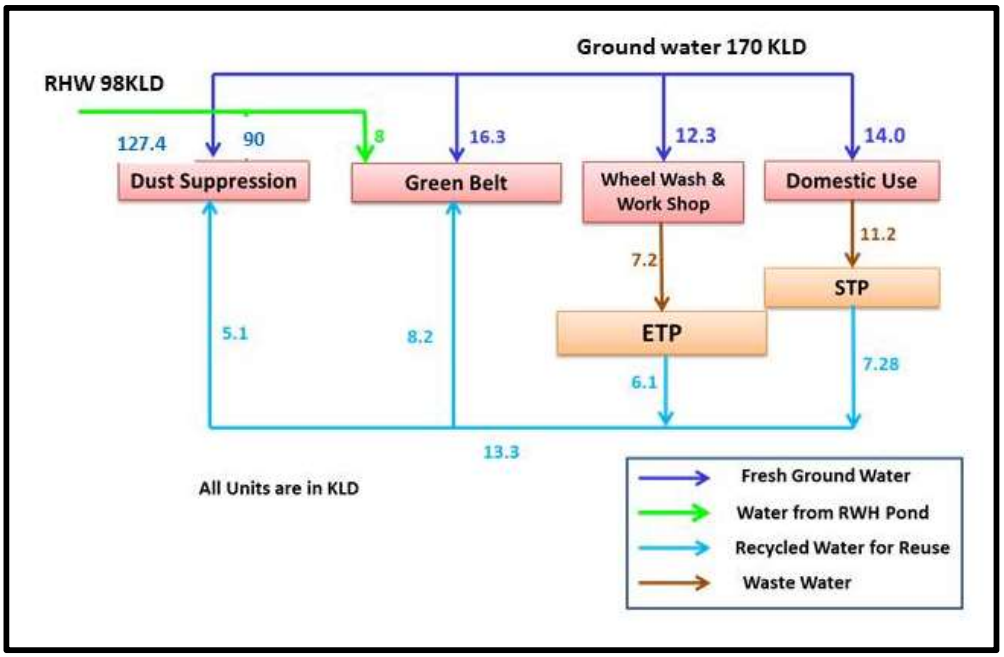


Fig- 6.1 Flowchart for Mine water utilization

There will be reduction of 10 KLD of groundwater in total consumption of water in the mining activates. The necessary requirement has been fulfilled through rain water harvesting and recycled water. The flowchart of water utilization is shown in Fig 6.1.

1st NOC for drawl of 64.5 m3/day of Ground water has been obtained from CGWA vide ltr no 21-4(83/3ER/CGWA/2008-1723 dt 18.12.2008. After that, NOC for drawl of 180 m3/day of Ground water has been obtained from CGWA vide ltr no CGWA/NOC/MIN/ORIG/2021/10588 dt 31.01.2021 **(Annexure 1)** for expansion of productivity**. The** water requirement will be met from own bore wells situated in the lease area. The area falls under safe category as far as stage of development is concerned.

7. Impact of mine Dewatering/ Abstraction and Mitigation Measures

Piezometric well has been established to monitor the ground water Table/water depilation in the lease area due to withdrawal of groundwater. After observing the detail Piezometric reading from April to July 2022 (Pre-monsoon) no Impact has been seen in water level in the area because of Abstraction of the ground water for the smooth running of the Mines in the lease (Shown in Table 7.1).Detail of the reading has been attached in Annexure5. Rain water harvesting and recharge structures were established for minimise the ground water extraction and recharge the area.

Sl. No	Date	Time	Water Level
1	30 March 2022	06:00 AM	10.61
2	30 May 2022	06:00 AM	10.74
3	30 June 2022	06:00 AM	10.74
4	30 July 2022	06:00 AM	10.74
5	August 2022	06:00AM	5.25
6	30 September 2022	06:00 AM	5.3
7	30 October 2022	06:00 AM	10.75

Table 7.1: Pre-monsoon and Post-monsoon water level within the lease area

7.1 Impact on ground water regime

As discuss above no major/Serious Impact has been reported in the area because of groundwater withdrawal. The lease area is lies within the Safe zone for groundwater. Groundwater flow is in the outside direction from the lease area hence no or very less effect of groundwater regime will be reported because of the mining activities.

7.2 Impact on Surface water sources

Retaining wall is already present partly around the existing waste dump. Further it is proposed to construct a retaining wall at the bottom periphery of the waste dump mineral reject stack followed by a garland drain during the plan period,showing in Fig 7.1.

Water during rainy season that percolates through the wastes in the waste/overburden dump shall be drained to the garland drain and the retaining wall shall help in arresting movement of waste materials. Garland drain shall be channelized in such a way that the water flows to an area which

should be on non-ore bearing and a wasteland. Regular cleaning of the drain shall be done for easy flow of water. Besides the garland drain and the retaining wall, six (6) settling pond of 10 m x 8 m x 2 m size will be constructed at the end of garland drain, which will accumulate water. Alum shall be added here for settlement of suspended solids. After suspended solids are settled, the water shall be discharged outside the lease area. In the rainy season the water from the pits shall be pumped out to the garland drain at the top of the quarry so that entire water flows to outside the working area keeping the bottom of the pit in dry condition. A rain water harvesting pond has been constructed and this pond water will be used for different purposes within the mines.

The proposed year wise protective measures are furnished in table no 7.2 & 7.3.

Location	Retaining wall			Garland drain			Settling pond			
	L(m)	W(m)	H(m)	L(m)	W(m)	D(m)	Nos	L(m)	W(m)	D(m)
Proposed Mineral reject stack -1	620	1.0	2.0	620	1.0	1.5	3	10	8	2
Proposed Mineral reject stack -2	188	1.0	2.0	468	1.0	1.5	1	10	8	2
Proposed Mineral reject stack -3	230	--	--	230	1.0	1.5	1	10	8	2
Total	1038	1.0	2.0	1318	1.0	1.5	5	10	8	2

Table 7.2: Protective Measures around the Mineral reject stack

Year	Retaining wall			Garland drain			Settling tank/Pond			
	L(m)	W(m)	H(m)	L(m)	W(m)	D(m)	Nos	L(m)	W(m)	D(m)
2021-22	888	1.0	1.5	1010	1.0	1.0	3	10	8	2
							1	200	30	5
2022-23	415	1.0	1.5	690	1.0	1.0	2	10	8	2
2023-24	500	1.0	1.5	670	1.0	1.0	2	10	8	2
2024-25	120	1.0	1.5	120	1.0	1.0	--	10	8	2
2025-26	Maintenance			Maintenance			Maintenance			
Total	1923	1.0	1.5	2490	1.0	1.0	8	10	8	2

Table 7.3: Year wise proposal of retaining wall, garland drain & settling pond

Coir matting over proposed dump: It has been proposed to prevent waste dump from water cutting in rainy season. Detail year wise construction shown in Table 7.4.

Period	Area of coir matting	No of sapling
2021-22	4000 sq.m	grass seedlings
2022-23	2500 sq.m	grass seedlings
2023-24	4100 sq.m	grass seedlings
2024-25	3700 sq.m	grass seedlings
2025-26	2900 sq.m	grass seedlings
Total	**17200** sq.m	

Table 7.4: Year wise proposal of coir matting

Fig 7.1: Retaining Walls and Garland Drain in Mining area

7.3 Impact on water quality

Continuous monitoring has been taken care by the mines authority. Quarterly ground water sample of the lease area and nearby places has been collected and send for testing at NABL aggregated Laboratory at Bhubaneswar. In Laboratory 43 parameters have tested. Till now no serious Impact/issues has been reported in the groundwater quality.

According to the Report Groundwater is safe for drinking and other activates. The test report of NABL accredited Laboratory, conducted in moth of October, 2022 is shown in Fig 7.2. Also the analysis report of surrounding three 3 wells is attached as Annexure4.

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(FORMERLY GLOBAL EXPERTS)
An ISO-9001:2008 Certified Company

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E-mail- globalexperts@rediffmail.com
visit us: www.globaltechenvexpt.com

GTEEPL/LQR/56

TEST REPORT

TC-10101

NABL ULR NO	:	**TC10101220000000203P**
Report No.	:	**GTEEPL/09/22/GW/203F**
Name of the Client	:	**Raikela Iron Ore Mines of M/s Geetarani Mohanty**
Address	:	**Raikela, Koira, Sundargarh, Odisha.**
Date of Sampling	:	06.09.2022
Date of Testing	:	08.09.2022 to 14.09.2022
Sampling Location	:	**Office Bore Well (Inside Mines Office)**
Identification of Sample	:	**Ground Water**
Quantity of Sample	:	1LTR X 2
Sampling procedure	:	GTEEPL/LSOP/09

Issue Date: 07.10.2022

Date of Receiving: 07.09.2022

Sl. No.	Parameters	Unit	Testing Method	Requirement as per IS 10500:2012RA 2018	Analysis Result
Physical Parameters					
1	pH	.....	IS 3025(Part-11)1983 RA 2017	6.5 to 8.5	6.57
2	Odour	....	IS 3025(Part 5) 2018	Agreeable	Agreeable
3	Colour	Hazen	IS 3025(Part 4) 2021	5(max)	<1.0
4	Electrical Conductivity	µs/cm	IS 3025(Part-14) :2021	.....	190
5	Total Dissolved solids	mg/l	IS 3025(Part-16)1984 RA 2017	500 (max)	113
6	Total Suspended Solids	mg/l	IS 3025(Part-17):1984 RA 2017	.....	<1.0
7	Turbidity	NTU	IS 3025(Part-10)1984 RA 2017	1.0(max)	<0.5
Chemical Parameters					
8	Total Hardness as $CaCo_3$	mg/l	IS 3025(Part-21)2009 RA 2019	200(max)	62.8
9	Calcium Hardness as $CaCO_3$	mg/l	IS 3025(Part-40)1991 RA 2019	---	40.2
10	Magnesium Hardness as $CaCO_3$	mg/l	IS 3025(Part-46)1994 RA 2003	-----	22.6
11	Total Alkalinity as CaCo3	mg/l	IS 3025(Part-23) 1986 RA 2019	200(max)	46.4
12	Calcium as Ca	mg/l	IS 3025 (Part-40) 1991 RA 2019	75(max)	16.12
13	Magnesium as Mg	mg/l	APHA 3500Mg B	30(max)	5.49
14	Chloride as Cl	mg/l	IS 3025(Part-32)1988 RA 2019	250(max)	9.8
15	Sulphate as SO4	mg/l	IS 3025(Part-24)1986 RA 2019	200(max)	2.1
16	Fluoride as F	mg/l	APHA F 4500 C-D	1.0(max)	0.34
17	Nitrate as NO3	mg/l	APHA 4500 NO3-B	45(max)	1.4
18	Total Ammonia	mg/l	IS 3025(Part-34)1988RA2019	0.5(max)	<0.3
19	Free Residual Chlorine	mg/l	IS 3025: (Part-26) 2021	0.2(min)	<0.1
20	Mineral Oil	mg/l	IS 3025(Part-39) 2021	0.5(max)	<0.4
21	Iron as Fe	mg/l	IS 3025(Part-53)2003 RA 2019	1.0(max)	0.45
22	Hexavalent Chromium as Cr^{+6}	mg/l	IS 3025(Part-52)2003 RA 2019	----	<0.01

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Report No: GTEEPL/0/22/GW/203F

23	Phosphate as PO_4	mg/l	APHA 23rd Ed (4500-P-D): 2017	----	<0.05
24	Silica	mg/l	APHA 23rd Ed (4500-SiO_2-C): 2017	-----	0.3
25	Sodium as Na	mg/l	IS 3025: (Part-45) 1993 RA 2019	-----	18.6
26	Potassium as K	mg/l	IS 3025: (Part-45) 1993 RA 2019	-------	4.9
27	Total Chromium as	mg/l	IS 3025(Part-52) 2003 RA 2009	0.05(max)	<0.01
28	Phenolic Compounds as C_6H_5OH	mg/l	IS 3025(Part-43)1992 RA 2019	0.001 (max)	<0.001
29	Sulphide as H_2S	mg/l	IS 3025(Part-29)1986 RA 2019	0.05(max)	<0.05
30	Aluminium as Al	mg/l	IS 3025(Part-55)2003 RA 2019	0.03 (max)	<0.02
31	Boron as B	mg/l	IS 3025(Part-57)2005 RA 2017	0.5 (max)	<0.1
32	Cyanide as CN	mg/l	IS 3025(Part-27)1986 RA 2019	0.05(max.)	<0.01
33	Arsenic as As	mg/l	IS 3025(Part-37)1988 RA 2019	0.01(max)	<0.01
34	Copper as Cu	mg/l	IS 3025(Part-42)1992 RA 2019	0.05(max)	<0.01
35	Manganese as Mn	mg/l	IS 3025(Part-59)2006 RA 2017	0.1(max)	<0.05
36	Lead as Pb	mg/l	IS 3025(Part-47)1994 RA 2019	0.01(max)	<0.01
37	Selenium as Se	mg/l	IS 3025(Part-56)2003 RA 2019	0.01(max)	<0.001
38	Nickel	mg/l	IS 3025(Part-54)2003 RA 2019	0.02(max)	<0.01
39	Zinc as Zn	mg/l	IS 3025(Part-49)1994 RA 2019	5 (max)	0.06
40	Cadmium as Cd	mg/l	IS 3025(Part-41)1992 RA 2019	0.003(max)	0.001
41	Mercury as Hg	mg/l	IS 3025(Part 48) 1994 RA 2009	0.001(max)	<0.001
42	Anionic detergent as MBAS	mg/l	Annex K of IS 13428	0.2(max)	<0.2
Bacteriological Quality					
43	Total Coliform Bacteria	MPN/100ml	IS 1622:1981 RA 2019	Shall not be detected in any 100 ml sample	< 2

-END OF REPORT-

Authorised Signatory
Global Tech Enviro Experts Pvt. Ltd

N.B.:
- The results relate to the sample received in respect to the Parameters tested.
- Liability for return of sample ceases after 15 days from the date of Test certificate.
- The report cannot be reproduced either in full or in part, without prior written consent of Director.
- In case of any complaint, Please mail us globalexperts@rediffmail.com

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Fig7.2: Quality Report from NABL accredited Lab for Office Bore-well in October, 2022

7.4 Mitigation Measures

The rain fall data has been obtained from WARIS online portal for the financial year 20011-2020. Based on the data the rain minimum Annual rainfall is 1098.51mm in 2016 and the maximum rain fall is 1562.24mm in 2020. However, the average rain fall data is calculated to be 1415.126 mm. Since the proposed waste dumps are located in areas which is a steep slope, maximum flow of water in rainy season will endanger the retaining walls. Therefore, concrete wall were construct along the toe of the proposed/existing dump. However, the following precautionary measures shall be taken while designing the retaining walls and garland drains.

Retaining Walls

Retaining boulder wall (2.0m high and 1.0m width) of substantial strength shall be constructed all around the bottom periphery of waste dumps with locally available boulders mixed with sand and cement, to arrest any rolling down of the dump materials. Perforation shall be left at around 10 m intervals to allow for passage of water.

Garland drains

Garland drains of 1.5 m deep and 1.0 m wide shall be constructed all along the bottom periphery of waste dumps followed by the retaining wall to prevent any wash off or leaching of dump materials during heavy rains. Side walls and the base shall be pitched with locally available boulders. Joints shall be filled up with cement and sand mixture so that water cannot percolate.

Settling Tank

The garland drain shall be channelized to settling tank of 10m long, 8m width and 2.0m deep. Side walls and base shall be packed with locally available boulders mixed with cement and sand.

RWH Ponds

Fig-7.3: Rainwater Harvesting Pond

Fig-7.4: Roof Top Rainwater Harvesting in Lease area.

Piezometric Well

Piezometric wells were established for continuous monitoring of groundwater level. It is helpful for keep an eye on ground water fluctuationdue to extraction for various mining activates. Day wise three readings has been collected i.e, at 00.00hrs, 06.00hrs, 12.00hrs and 18.00hrs Post Monsoon and Pre-monsoon is attached in Annexure 5.

Rainwater Harvesting Pond and Bunds

The average annual rainfall is around 1278 mm per annum. The maximum daily rainfall ever recorded at Koida was 110 mm on 12.08.2022. Out of which 36% is lost as the surface runoff, 44% is lost through evapotranspiration and only 20% is enter into the subsoil and recharge the aquifer. To harvest the rain water in the lease area, one Pond is constricted and one is proposed for future. Two nala bunds are also constricted for catch the flood and recharge the groundwater. Figure 7.3 and Fig 7.5 is showing the Pond in Lease area.

Roof Top Rainwater Harvesting in Lease area

To catch the roof top water during rainy days and roof top rain water harvesting structures has been established in the lease area to direct recharge the groundwater. The established structure is shown in Figure 7.4.

Regularly Plantation:

Regular plantation has been planned in lease area to protect forest, environment and soil cutting. After closer of the mines the complete leasehold will be afforested. As shown in fig. 7.6.

ETP/STP:

ETP is constricted within the lease hold to recycle the wastage water and again make it usable. Shown in Fig7.7.

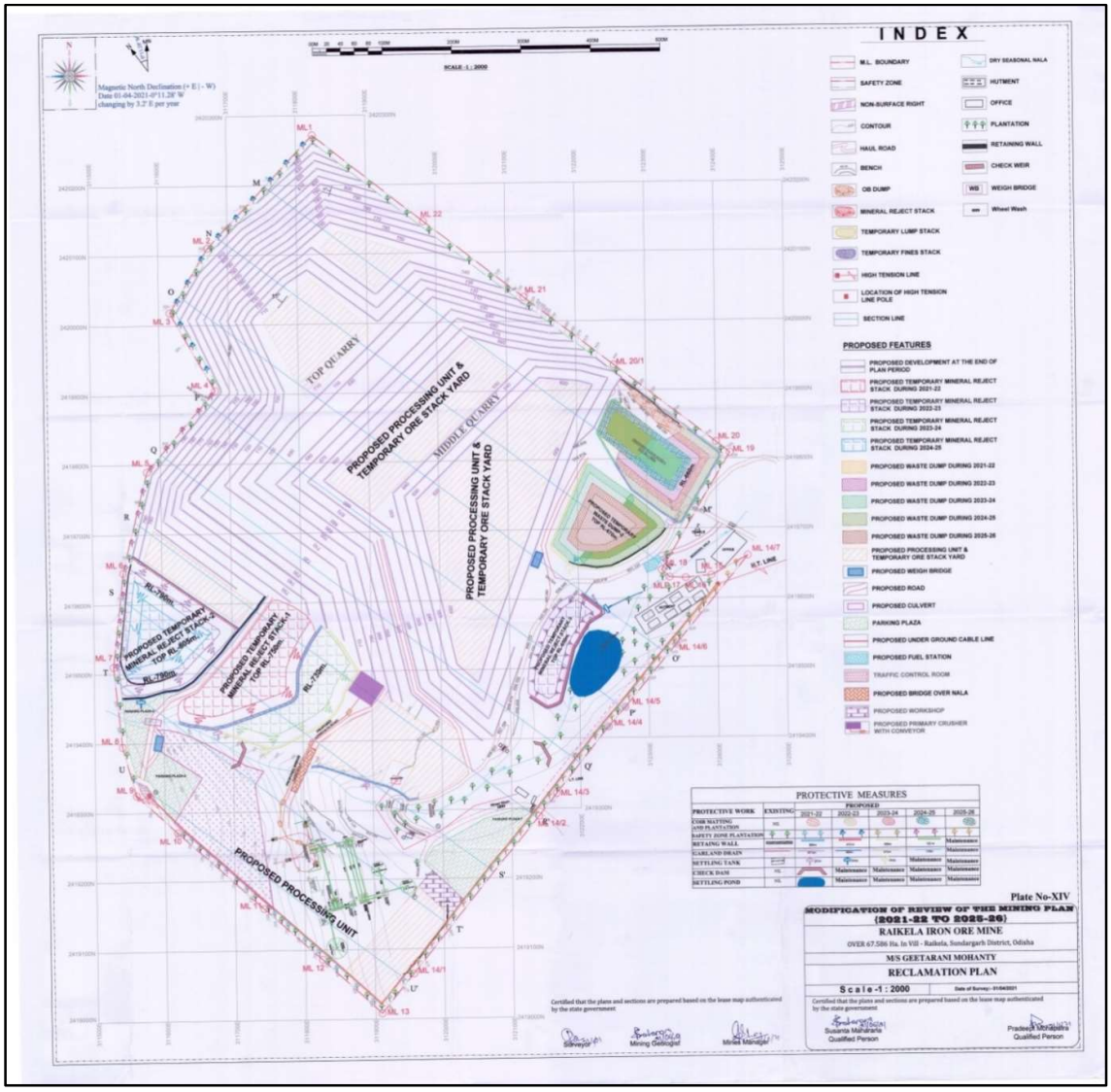


Fig 7.5: Section showing reclamation and restoration of mined out areas

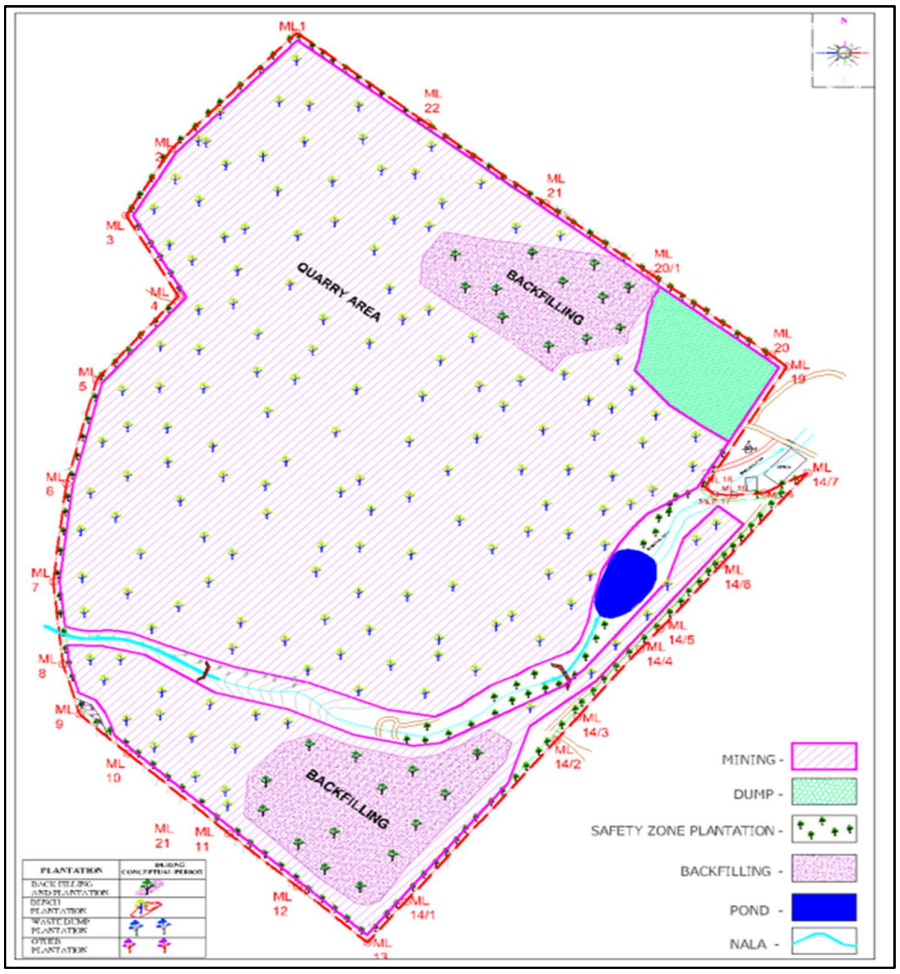


Fig 7.6: Post mining land use plan with reclamation and restoration of mined out areas

Fig 7.7:. ETP for recycle of water is established in Lease area.

7.5 Saline water Disposal- NA

8. Summery and conclusion

The groundwater resource as estimated by CGWB (2020) is presented in the table 3.3 for Koira block of Sundargarh district Odisha and is in safe category. The total estimated recharge in this block is 5661.78(Ham) and the Discharge is 283.09Ham. The total available extractable water is 5378.69 Ham. At present, area is having huge surplus reserves. Hence, no adverse impact on ground water regime of the area is envisaged. Further, area comes under safe category.

However, the RWH structure have been constructed and proposed to be constructed further to augment ground water resource of the area. It reduces the cost for pumping of ground water, reduces soil erosion in urban areas, and Provides self-sufficiency to your water supply.

The slope of groundwater flow is apart from the mine. Hence, with reference to our field study, earlier NOC and GCWB report, it has been safely concluded that the area is under safe zone and the extraction of water for the mining activates will not affect groundwater in adverse. The available and proposed measure of RWH and groundwater recharging also play the key role in fulfilling the requirement and sustain the groundwater.

Annexure 1: Copy of Present NOC for Groundwater Abstraction by CGWA

ANNEXURE 12

भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन, नदी विकास
और गंगा संरक्षण विभाग
केन्द्रीय भूमि जल प्राधिकरण
Government of India
Ministry of Jal Shakti
Department of Water Resources,
River Development & Ganga Rejuvenation
Central Ground Water Authority

(भूजल निकासी हेतु अनापत्ति प्रमाण पत्र)

NO OBJECTION CERTIFICATE (NOC) FOR GROUND WATER ABSTRACTION

Project Name:	Raikela Iron Ore Mine		
Project Address:	Village-raikela		
Village:	Raikela	Block:	Koida
District:	Sundargarh	State:	Odisha
Pin Code:			
Communication Address:	Bomikhal, Plot No 380, Rasulgarh, Bhubaneswar, Bhubaneswar, Khordha, Odisha - 751010		
Address of CGWB Regional Office :	Central Ground Water Board South Eastern Region, Bhujal Bhawan, Khandagiri Square, Nh-5, Bhubaneshwar, Khordha, Odisha - 750001		

1.	**NOC No.:**	CGWA/NOC/MIN/ORIG/2021/10588			
2.	Application No.:	21-4/2466/OR/MIN/2020	3.	Category: (GWRE 2017)	Safe
4.	Project Status:	Existing Project	5.	NOC Type:	New
6.	**Valid from:**	31/01/2021	7.	**Valid up to:**	30/01/2023

8. Ground Water Abstraction Permitted:

Fresh Water		Saline Water		Dewatering		Total	
m³/day	m³/year	m³/day	m³/year	m³/day	m³/year	m³/day	m³/year
180.00	55592.50						

9. Details of ground water abstraction /Dewatering structures

	Total Existing No.:2						Total Proposed No.:0					
	DW	DCB	BW	TW	MP	MPu	DW	DCB	BW	TW	MP	MPu
Abstraction Structure*	0	0	2	0	0	0	0	0	0	0	0	0

*DW- Dug Well; DCB-Dug-cum-Bore Well; BW-Bore Well; TW-Tube Well; MP-Mine Pit;MPu-Mine Pumps

10. Ground Water Abstraction/Restoration Charges paid (Rs.): 111185.00

11. Number of Piezometers(Observation wells) to be constructed/ monitored & Monitoring mechanism.

No. of Piezometers	Monitoring Mechanism		
	Manual	DWLR**	DWLR With Telemetry
1	0	1	0

**DWLR - Digital Water Level Recorder

(Compliance Conditions given overleaf)

This is an auto generated document & need not to be signed.

Validity of this NOC shall be subject to compliance of the following conditions:

Mandatory conditions:

1) Installation of digital water flow meter (conforming to BIS/ IS standards) having telemetry system in the abstraction structure(s) shall be mandatory for all users seeking No Objection Certificate and intimation regarding their installation shall be communicated to the CGWA within 30 days of grant of No Objection Certificate through the web-portal.

2) Proponents shall mandatorily get water flow meter calibrated from an authorized agency once in a year.

3) Construction of purpose-built observation wells (piezometers) for ground water level monitoring shall be mandatory as per Section 14 of Guidelines . Water level data shall be made available to CGWA through web portal. Detailed guidelines for construction of piezometers are given in Annexure-II.

4) Proponents shall monitor quality of ground water from the abstraction structure(s) once in a year. Water samples from bore wells/ tube wells / dug wells shall be collected during April/May every year and analysed in NABL accredited laboratories for basic parameters (cations and anions), heavy metals, pesticides/ organic compounds etc. Water quality data shall be made available to CGWA through the web portal.

5) In case of mining projects, additional key wells shall be established in consultation with the Regional Director, CGWB for ground water level monitoring four (4) times a year (January, May, August and November) in core as well as buffer zones of the mine.

6) In case of mining project the firm shall submit water quality report of mine discharge/ seepage from Govt. approved/ NABL accredited lab.

7) The firm shall report compliance of the NOC conditions online in the website (www.cgwa-noc.gov.in) within one year from the date of issue of this NOC.

8) The firm shall submit the water audit report in case of water requirement is in excess of 100 m3/day through certified auditors within three months of completion of the same to CGWA.

9) Application for renewal can be submitted online from 90 days before the expiry of NOC. Ground water withdrawal, if any, after expiry of NOC shall be illegal & liable for legal action as per provisions of Environment (Protection) Act, 1986.

10) This NOC is subject to prevailing Central/State Government rules/laws/norms or Court orders related to construction of tube well/ground water abstraction structure / recharge or conservation structure/discharge of effluents or any such matter as applicable.

General conditions:

11) No additional ground water abstraction and/or de-watering structures shall be constructed for this purpose without prior approval of the Central Ground Water Authority (CGWA).

12) The proponent shall seek prior permission from CGWA for any increase in quantum of groundwater abstraction (more than that permitted in NOC for specific period).

13) Proponents shall install roof top rain water harvesting in the premise as per the existing building bye laws in the premise.

14) The project proponent shall take all necessary measures to prevent contamination of ground water in the premises failing which the firm shall be responsible for any consequences arising thereupon.

15) In case of industries that are likely to contaminate the ground water, no recharge measures shall be taken up by the firm inside the plant premises. The runoff generated from the rooftop shall be stored and put to beneficial use by the firm.

16) Wherever feasible, requirement of water for greenbelt (horticulture) shall be met from recycled / treated waste water.

17) Wherever the NOC is for abstraction of saline water and the existing wells (s) is /are yielding fresh water, the same shall be sealed and new tubewell(s) tapping saline water zone shall be constructed within 3 months of the issuance of NOC. The firm shall also ensure safe disposal of saline residue, if any.

18) Unexpected variations in inflow of ground water into the mine pit, if any, shall be reported to the concerned Regional Director, Central Ground Water Board.

19) In case of violation of any NOC conditions, the applicant shall be liable to pay the penalties as per Section 16 of Guidelines.

20) This NOC does not absolve the proponents of their obligation / requirement to obtain other statutory and administrative clearances from appropriate authorities.

21) The issue of this NOC does not imply that other statutory / administrative clearances shall be granted to the project by the concerned authorities. Such authorities would consider the project on merits and take decisions independently of the NOC.

22) In case of change of ownership, new owner of the industry will have to apply for incorporation of necessary changes in the No Objection Certificate with documentary proof within 60 days of taking over possession of the premises.

23) This NOC is being issued without any prejudice to the directions of the Hon'ble NGT/court orders in cases related to ground water or any other related matters.

(Non-compliance of the conditions mentioned above is likely to result in the cancellation of NOC and legal action against the proponent.)

Annexure 2: Copy of Accreditation of MRCAWTM, Faridabad

Accreditation Board of CGWA

Certificate of Accreditation

M/s. Manav Rachna Centre for Advance Water Technology and Management, (MRCAWTM) of (MRIIRS)

Has been accredited as a Ground Water Professionals to prepare reports in the Functional Areas of

- *Impact Assessment Report without Modelling.*
- *Hydrogeological Report for mining projects.*

Valid from : 01.10.2021
Valid thru : 30.09.2026

Certificate No. : CGWA/RG1/025
Dated : 30.11.2021

क्षेत्रीय निदेशक
Regional Director
आरजीएनजीडब्ल्यूटीआरआई
RGNGWT&RI

सदस्य
Member
आरजीएनजीडब्ल्यूटीआरआई
RGNGWT&RI

Annexure 3: Work Order copy to MRCAWTM from Raikela Iron Ore Mines

WCS
World Consultancy Services

MY WORLD CONSULTANCY SERVICES PRIVATE LIMITED
GST NO: 21AADCT4043N1ZE

Ref No. WCS/44/2022-23/HG **Date.08.10.2022**

To

The Director,

Manav Rachna Centre for Advanced Water Technology & Management (CAWTM)

Manav Rachna International Institute of Research and Studies,

Faridabad 121004, Haryana

Subject: Work Order for carrying out hydrogeological study and preparation of Hydrological study report in respect of Raikela Iron ore mine of M/s Geetarani Mohanty in Koira Tahasil of Sundargarh district of Odisha.

Ref: "MOU" between My WCS and MRIIS, Dated. 01.03.2022

Dear Madam/Sir,

As per the discussion held with you, we are herewith authorizing your valued organization to carry out Hydrogeology Study of the above depicted subject with following scope of work.

Scope for MRIIS:

- Comprehensive report on ground water conditions in both core and buffer zones of the mine.
- Depth wise and year wise mine seepage calculations.
- Impact assessment of mining and dewatering on ground water regime and its socio-economic impact.
- Details of recycling reuse and recharge reduction of pumping with use of technology for mining and water management to minimize and mitigate the adverse.
- Report will comprise Introduction Project description Background Objectives and scope regional setting Location.
- Land use Climate.
- Topography and drainage Geology
- Regional and Local General Hydrogeology (aquifer types, aquifer depth, zone tapped etc.)
- Groundwater condition (In core and buffer zones)

WCS
World Consultancy Services

MY WORLD CONSULTANCY SERVICES PRIVATE LIMITED
GST NO: 21AADCT4043N1ZE

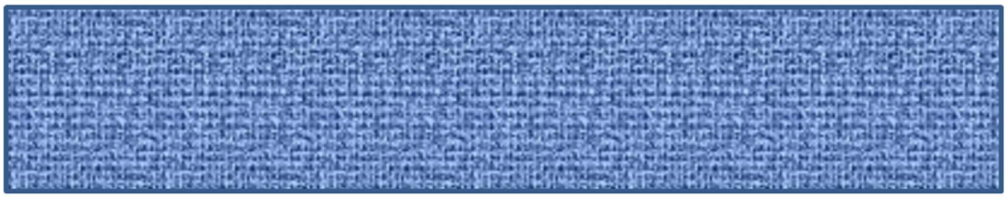
- Spatial and temporal variations in water levels Groundwater quality (Shallow and deep aquifer)
- Impact of groundwater extraction on local groundwater
- Hydrograph of water level/piezometer in monitoring wells
- Trend analysis of historical water levels
- Flow net analysis (groundwater flow direction) Year wise/ bench wise mine dewatering computation as per approved mine plan Conclusions.

Scope for WCS:

- Providing details of location, area, and brief description about the project
- Approved Mining Plan & Plates
- Maps and figures.
- Site Visit, conveyance, fooding & lodging for the experts

Completion Period:

Submission of Draft report - Within three months from issue of work order



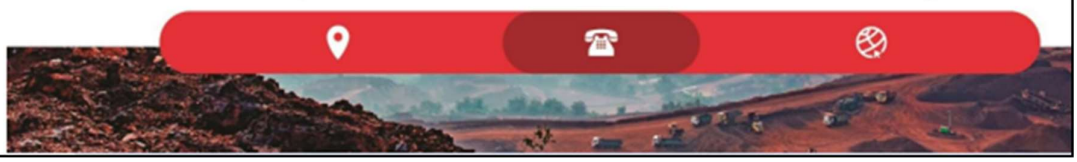
We believe this will be an opportunity for us to be associated with your esteemed organization and knowledge partner.

Kindly acknowledge this work order as a token of acceptance.

Thanking You
Yours Faithfully

Pradeept Mohapatra
Authorized Signatory

Reach us at Telengapetha,
Cuttack, Odisha - 754001
+91 79787 24154
wcs@theworld.co.in
www.worldconsultancyservices.in



Annexure 4: Water Quality Analysis by NABL Accredited Laboratory

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(FORMERLY GLOBAL EXPERTS)
An ISO-9001:2008 Certified Company

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visit us: www.globaltechenvexpt.com

GTEEPL/LQR/56

TEST REPORT

TC-10101

NABL ULR NO	:	**TC101012200000203P**
Report No.	:	**GTEEPL/09/22/GW/203F**
Name of the Client	:	**Raikela Iron Ore Mines of M/s Geetarani Mohanty**
Address	:	**Raikela, Koira, Sundargarh, Odisha,**
Date of Sampling	:	06.09.2022
Date of Testing	:	08.09.2022 to 14.09.2022
Sampling Location	:	**Office Bore Well (Inside Mines Office)**
Identification of Sample	:	**Ground Water**
Quantity of Sample	:	1LTR X 2
Sampling procedure	:	GTEEPL/LSOP/09

Issue Date: 07.10.2022

Date of Receiving: 07.09.2022

Sl. No.	Parameters	Unit	Testing Method	Requirement as per IS 10500:2012RA 2018	Analysis Result
Physical Parameters					
1	pH	.....	IS 3025(Part-11)1983 RA 2017	6.5 to 8.5	6.57
2	Odour	....	IS 3025(Part 5) 2018	Agreeable	Agreeable
3	Colour	Hazen	IS 3025(Part 4) 2021	5(max)	<1.0
4	Electrical Conductivity	µs/cm	IS 3025(Part-14) :2021	.....	190
5	Total Dissolved solids	mg/l	IS 3025(Part-16)1984 RA 2017	500 (max)	113
6	Total Suspended Solids	mg/l	IS 3025(Part-17):1984 RA 2017	.....	<1.0
7	Turbidity	NTU	IS 3025(Part-10)1984 RA 2017	1.0(max)	<0.5
Chemical Parameters					
8	Total Hardness as $CaCo_3$	mg/l	IS 3025(Part-21)2009 RA 2019	200(max)	62.8
9	Calcium Hardness as $CaCO_3$	mg/l	IS 3025(Part-40)1991 RA 2019	---	40.2
10	Magnesium Hardness as $CaCO_3$	mg/l	IS 3025(Part-46)1994 RA 2003	-----	22.6
11	Total Alkalinity as CaCo3	mg/l	IS 3025(Part-23) 1986 RA 2019	200(max)	46.4
12	Calcium as Ca	mg/l	IS 3025 (Part-40) 1991 RA 2019	75(max)	16.12
13	Magnesium as Mg	mg/l	APHA 3500Mg B	30(max)	5.49
14	Chloride as Cl	mg/l	IS 3025(Part-32)1988 RA 2019	250(max)	9.8
15	Sulphate as SO4	mg/l	IS 3025(Part-24)1986 RA 2019	200(max)	2.1
16	Fluoride as F	mg/l	APHA F 4500 C-D	1.0(max)	0.34
17	Nitrate as NO3	mg/l	APHA 4500 NO3-B	45(max)	1.4
18	Total Ammonia	mg/l	IS 3025(Part-34)1988RA2019	0.5(max)	<0.3
19	Free Residual Chlorine	mg/l	IS 3025: (Part-26) 2021	0.2(min)	<0.1
20	Mineral Oil	mg/l	IS 3025(Part-39) 2021	0.5(max)	<0.4
21	Iron as Fe	mg/l	IS 3025(Part-53)2003 RA 2019	1.0(max)	0.45
22	Hexavalent Chromium as Cr^{+6}	mg/l	IS 3025(Part-52)2003 RA 2019	----	<0.01

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Report No: GTEEPL/0/22/GW/203F

23	Phosphate as PO_4	mg/l	APHA 23rd Ed (4500-P-D): 2017	----	<0.05
24	Silica	mg/l	APHA 23rd Ed (4500-SiO_2-C): 2017	-----	0.3
25	Sodium as Na	mg/l	IS 3025: (Part-45) 1993 RA 2019	-----	18.6
26	Potassium as K	mg/l	IS 3025: (Part-45) 1993 RA 2019	-------	4.9
27	Total Chromium as	mg/l	IS 3025(Part-52) 2003 RA 2009	0.05(max)	<0.01
28	Phenolic Compounds as C_6H_5OH	mg/l	IS 3025(Part-43)1992 RA 2019	0.001 (max)	<0.001
29	Sulphide as H_2S	mg/l	IS 3025(Part-29)1986 RA 2019	0.05(max)	<0.05
30	Aluminium as Al	mg/l	IS 3025(Part-55)2003 RA 2019	0.03 (max)	<0.02
31	Boron as B	mg/l	IS 3025(Part-57)2005 RA 2017	0.5 (max)	<0.1
32	Cyanide as CN	mg/l	IS 3025(Part-27)1986 RA 2019	0.05(max.)	<0.01
33	Arsenic as As	mg/l	IS 3025(Part-37)1988 RA 2019	0.01(max)	<0.01
34	Copper as Cu	mg/l	IS 3025(Part-42)1992 RA 2019	0.05(max)	<0.01
35	Manganese as Mn	mg/l	IS 3025(Part-59)2006 RA 2017	0.1(max)	<0.05
36	Lead as Pb	mg/l	IS 3025(Part-47)1994 RA 2019	0.01(max)	<0.01
37	Selenium as Se	mg/l	IS 3025(Part-56)2003 RA 2019	0.01(max)	<0.001
38	Nickel	mg/l	IS 3025(Part-54)2003 RA 2019	0.02(max)	<0.01
39	Zinc as Zn	mg/l	IS 3025(Part-49)1994 RA 2019	5 (max)	0.06
40	Cadmium as Cd	mg/l	IS 3025(Part-41)1992 RA 2019	0.003(max)	0.001
41	Mercury as Hg	mg/l	IS 3025(Part 48) 1994 RA 2009	0.001(max)	<0.001
42	Anionic detergent as MBAS	mg/l	Annex K of IS 13428	0.2(max)	<0.2
Bacteriological Quality					
43	Total Coliform Bacteria	MPN/100ml	IS 1622:1981 RA 2019	Shall not be detected in any 100 ml sample	< 2

-END OF REPORT-

Authorised Signatory
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GTEEPL/LQR/56

TEST REPORT

TC-10101

NABL ULR NO	:	**TC101012200000203P**
Report No.	:	**GTEEPL/09/22/GW/203G**
Name of the Client	:	**Raikela Iron Ore Mines of M/s Geetarani Mohanty**
Address	:	**Raikela, Koira, Sundargarh, Odisha,**
Date of Sampling	:	06.09.2022
Date of Testing	:	08.09.2022 to 14.09.2022
Sampling Location	:	**Tensa Tube Well**
Identification of Sample	:	**Ground Water**
Quantity of Sample	:	1LTR X 2
Sampling procedure	:	GTEEPL/LSOP/09

Issue Date: 07.10.2022

Date of Receiving: 07.09.2022

Sl. No.	Parameters	Unit	Testing Method	Requirement as per IS 10500:2012RA 2018	Analysis Result
Physical Parameters					
1	pH	.....	IS 3025(Part-11)1983 RA 2017	6.5 to 8.5	6.81
2	Odour	....	IS 3025(Part 5) 2018	Agreeable	Agreeable
3	Colour	Hazen	IS 3025(Part 4) 2021	5(max)	<1.0
4	Electrical Conductivity	µs/cm	IS 3025(Part-14) :2021	.....	178
5	Total Dissolved solids	mg/l	IS 3025(Part-16)1984 RA 2017	500 (max)	104
6	Total Suspended Solids	mg/l	IS 3025(Part-17):1984 RA 2017	.....	<1.0
7	Turbidity	NTU	IS 3025(Part-10)1984 RA 2017	1.0(max)	<0.5
Chemical Parameters					
8	Total Hardness as $CaCo_3$	mg/l	IS 3025(Part-21)2009 RA 2019	200(max)	54.6
9	Calcium Hardness as $CaCO_3$	mg/l	IS 3025(Part-40)1991 RA 2019	---	36.7
10	Magnesium Hardness as $CaCO_3$	mg/l	IS 3025(Part-46)1994 RA 2003	-----	17.9
11	Total Alkalinity as CaCo3	mg/l	IS 3025(Part-23) 1986 RA 2019	200(max)	41.8
12	Calcium as Ca	mg/l	IS 3025 (Part-40) 1991 RA 2019	75(max)	14.72
13	Magnesium as Mg	mg/l	APHA 3500Mg B	30(max)	4.35
14	Chloride as Cl	mg/l	IS 3025(Part-32)1988 RA 2019	250(max)	22.2
15	Sulphate as SO4	mg/l	IS 3025(Part-24)1986 RA 2019	200(max)	16.8
16	Fluoride as F	mg/l	APHA F 4500 C-D	1.0(max)	0.39
17	Nitrate as NO3	mg/l	APHA 4500 NO3-B	45(max)	3.7
18	Total Ammonia	mg/l	IS 3025(Part-34)1988RA2019	0.5(max)	<0.3
19	Free Residual Chlorine	mg/l	IS 3025: (Part-26) 2021	0.2(min)	<0.1
20	Mineral Oil	mg/l	IS 3025(Part-39) 2021	0.5(max)	<0.4
21	Iron as Fe	mg/l	IS 3025(Part-53)2003 RA 2019	1.0(max)	0.58
22	Hexavalent Chromium as Cr^{+6}	mg/l	IS 3025(Part-52)2003 RA 2019	----	<0.01

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Report No: GTEEPL/09/22/GW/203G

23	Phosphate as PO_4	mg/l	APHA 23rd Ed (4500-P-D): 2017	----	<0.1
24	Silica	mg/l	APHA 23rd Ed (4500-SiO_2-C): 2017	-----	<0.4
25	Sodium as Na	mg/l	IS 3025: (Part-45) 1993 RA 2019	-----	18.6
26	Potassium as K	mg/l	IS 3025. (Part-45) 1993 RA 2019	-------	6.2
27	Total Chromium as	mg/l	IS 3025(Part-52) 2003 RA 2009	0.05(max)	<0.01
28	Phenolic Compounds as C_6H_5OH	mg/l	IS 3025(Part-43)1992 RA 2019	0.001 (max)	<0.001
29	Sulphide as H_2S	mg/l	IS 3025(Part-29)1986 RA 2019	0.05(max)	<0.05
30	Aluminium as Al	mg/l	IS 3025(Part-55)2003 RA 2019	0.03 (max)	<0.02
31	Boron as B	mg/l	IS 3025(Part-57)2005 RA 2017	0.5 (max)	<0.1
32	Cyanide as CN	mg/l	IS 3025(Part-27)1986 RA 2019	0.05(max.)	<0.01
33	Arsenic as As	mg/l	IS 3025(Part-37)1988 RA 2019	0.01(max)	<0.01
34	Copper as Cu	mg/l	IS 3025(Part-42)1992 RA 2019	0.05(max)	<0.01
35	Manganese as Mn	mg/l	IS 3025(Part-59)2006 RA 2017	0.1(max)	<0.05
36	Lead as Pb	mg/l	IS 3025(Part-47)1994 RA 2019	0.01(max)	<0.01
37	Selenium as Se	mg/l	IS 3025(Part-56)2003 RA 2019	0.01(max)	<0.00]
38	Nickel	mg/l	IS 3025(Part-54)2003 RA 2019	0.02(max)	<0.01
39	Zinc as Zn	mg/l	IS 3025(Part-49)1994 RA 2019	5 (max)	0.05
40	Cadmium as Cd	mg/l	IS 3025(Part-41)1992 RA 2019	0.003(max)	0.001
41	Mercury as Hg	mg/l	IS 3025(Part 48) 1994 RA 2009	0.001(max)	<0.001
42	Anionic detergent as MBAS	mg/l	Annex K of IS 13428	0.2(max)	<0.2
Bacteriological Quality					
43	Total Coliform Bacteria	MPN/100ml	IS 1622:1981 RA 2019	Shall not be detected in any 100 ml sample	< 2

-END OF REPORT-

Authorised Signatory
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GTEEPL/LQR/56

TEST REPORT

TC-10101

NABL ULR NO : **TC101012200000203P**
Report No. : **GTEEPL/09/22/GW/203H** Issue Date: 07.10.2022
Name of the Client : **Raikela Iron Ore Mines of M/s Geetarani Mohanty**
Address : **Raikela, Koira, Sundargarh, Odisha.**
Date of Sampling : 06.09.2022 Date of Receiving: 07.09.2022
Date of Testing : 08.09.2022 to 14.09.2022
Sampling Location : **Tentulidihi Dug Well**
Identification of Sample : **Ground Water**
Quantity of Sample : 1LTR X 2
Sampling procedure : GTEEPL/LSOP/09

Sl. No.	Parameters	Unit	Testing Method	Requirement as per IS 10500:2012RA 2018	Analysis Result
Physical Parameters					
1	pH	.....	IS 3025(Part-11)1983 RA 2017	6.5 to 8.5	6.58
2	Odour	.....	IS 3025(Part 5) 2018	Agreeable	Agreeable
3	Colour	Hazen	IS 3025(Part 4) 2021	5(max)	<1.0
4	Electrical Conductivity	µs/cm	IS 3025(Part-14) :2021	.....	95
5	Total Dissolved solids	mg/l	IS 3025(Part-16)1984 RA 2017	500 (max)	57
6	Total Suspended Solids	mg/l	IS 3025(Part-17):1984 RA 2017	.....	<1.0
7	Turbidity	NTU	IS 3025(Part-10)1984 RA 2017	1.0(max)	<0.5
Chemical Parameters					
8	Total Hardness as $CaCo_3$	mg/l	IS 3025(Part-21)2009 RA 2019	200(max)	45.6
9	Calcium Hardness as $CaCO_3$	mg/l	IS 3025(Part-40)1991 RA 2019	---	29.6
10	Magnesium Hardness as $CaCO_3$	mg/l	IS 3025(Part-46)1994 RA 2003	-----	15
11	Total Alkalinity as CaCo3	mg/l	IS 3025(Part-23) 1986 RA 2019	200(max)	28.4
12	Calcium as Ca	mg/l	IS 3025 (Part-40) 1991 RA 2019	75(max)	11.87
13	Magnesium as Mg	mg/l	APHA 3500Mg B	30(max)	3.65
14	Chloride as Cl	mg/l	IS 3025(Part-32)1988 RA 2019	250(max)	11.9
15	Sulphate as SO4	mg/l	IS 3025(Part-24)1986 RA 2019	200(max)	26.2
16	Fluoride as F	mg/l	APHA F 4500 C-D	1.0(max)	0.17
17	Nitrate as NO3	mg/l	APHA 4500 NO3-B	45(max)	4.5
18	Total Ammonia	mg/l	IS 3025(Part-34)1988RA2019	0.5(max)	<0.3
19	Free Residual Chlorine	mg/l	IS 3025: (Part-26) 2021	0.2(min)	<0.1
20	Mineral Oil	mg/l	IS 3025(Part-39) 2021	0.5(max)	0.3
21	Iron as Fe	mg/l	IS 3025(Part-53)2003 RA 2019	1.0(max)	0.21
22	Hexavalent Chromium as Cr^{+6}	mg/l	IS 3025(Part-52)2003 RA 2019	----	<0.01

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Report No: GTEEPL/09/22/GW/203H

23	Phosphate as PO_4	mg/l	APHA 23rd Ed (4500-P-D): 2017	----	0.05
24	Silica	mg/l	APHA 23rd Ed (4500-SiO_2-C): 2017	-----	<0.4
25	Sodium as Na	mg/l	IS 3025: (Part-45) 1993 RA 2019	-----	13.7
26	Potassium as K	mg/l	IS 3025: (Part-45) 1993 RA 2019	-------	3.8
27	Total Chromium as	mg/l	IS 3025(Part-52) 2003 RA 2009	0.05(max)	<0.01
28	Phenolic Compounds as C_6H_5OH	mg/l	IS 3025(Part-43)1992 RA 2019	0.001 (max)	<0.001
29	Sulphide as H_2S	mg/l	IS 3025(Part-29)1986 RA 2019	0.05(max)	<0.05
30	Aluminium as Al	mg/l	IS 3025(Part-55)2003 RA 2019	0.03 (max)	<0.02
31	Boron as B	mg/l	IS 3025(Part-57)2005 RA 2017	0.5 (max)	<0.1
32	Cyanide as CN	mg/l	IS 3025(Part-27)1986 RA 2019	0.05(max.)	<0.01
33	Arsenic as As	mg/l	IS 3025(Part-37)1988 RA 2019	0.01(max)	<0.01
34	Copper as Cu	mg/l	IS 3025(Part-42)1992 RA 2019	0.05(max)	<0.01
35	Manganese as Mn	mg/l	IS 3025(Part-59)2006 RA 2017	0.1(max)	<0.05
36	Lead as Pb	mg/l	IS 3025(Part-47)1994 RA 2019	0.01(max)	<0.01
37	Selenium as Se	mg/l	IS 3025(Part-56)2003 RA 2019	0.01(max)	<0.001
38	Nickel	mg/l	IS 3025(Part-54)2003 RA 2019	0.02(max)	<0.01
39	Zinc as Zn	mg/l	IS 3025(Part-49)1994 RA 2019	5 (max)	<0.05
40	Cadmium as Cd	mg/l	IS 3025(Part-41)1992 RA 2019	0.003(max)	0.001
41	Mercury as Hg	mg/l	IS 3025(Part 48) 1994 RA 2009	0.001(max)	<0.001
42	Anionic detergent as MBAS	mg/l	Annex K of IS 13428	0.2(max)	<0.2
Bacteriological Quality					
43	Total Coliform Bacteria	MPN/100ml	IS 1622:1981 RA 2019	Shall not be detected in any 100 ml sample	< 2

-END OF REPORT-

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Annexure 5: Groundwater Level monitoring data of Pre-monsoon and Post Monsoon in Mining Lease Area

RAIKELA IRON ORE MINES OF M/S GEETARANI MOHANTY (Pre-Monsoom)				
PIEZOMETRIC DATA OF MAY-2022				
DATA	**TIME**	**Ground Water Level (m)**	**Water Temprature (degC)**	**Barometric Pressure (hPa)**
01-05-2022	06.00 AM	10.67	25.06	93.674
	12.00 PM	10.69	25.01	93.683
	06.00 PM	10.42	25.08	94.685
	00.00 AM	10.12	25.01	92.54
02-05-2022	06.00 AM	10.69	25.52	93.775
	12.00 PM	10.68	25.42	93.717
	06.00 PM	10.71	25.24	93.70
	00.00 AM	10.31	26.36	93.699
03-05-2022	06.00 AM	10.84	25.3	93.723
	12.00 PM	10.73	25.08	93.71
	06.00 PM	10.84	25.09	94.287
	00.00 AM	10.42	25.05	92.358
04-05-2022	06.00 AM	10.24	25.42	93.966
	12.00 PM	10.69	25.01	93.962
	06.00 PM	10.42	25.36	95.424
	00.00 AM	10.71	25.61	93.90
05-05-2022	06.00 AM	10.83	25.59	93.823
	12.00 PM	10.64	25.23	93.249
	06.00 PM	10.75	25.06	93.90
	00.00 AM	10.80	25.11	93.809
06-05-2022	06.00 AM	10.65	25.41	93.73
	12.00 PM	10.82	25.52	93.82
	06.00 PM	10.78	25.24	93.68
	00.00 AM	10.62	25.41	93.48
07-05-2022	06.00 AM	10.19	25.32	93.856
	12.00 PM	10.55	25.18	93.829
	06.00 PM	10.75	25.15	93.885
	00.00 AM	10.42	25.01	94.287
08-05-2022	06.00 AM	10.3	25.11	94.30
	12.00 PM	10.36	25.41	94.28
	06.00 PM	10.01	25.42	94.36
	00.00 AM	10.67	25.27	94.33
09-05-2022	06.00 AM	10.22	25.75	93.51
	12.00 PM	10	25.98	93.63
	06.00 PM	10.75	25.01	93.69
	00.00 AM	10.72	25.61	93.73
10-05-2022	06.00 AM	10.16	25.08	94.30

	12.00 PM	10.36	25.41	94.27
	06.00 PM	10.76	25.01	93.62
	00.00 AM	10.72	25.41	93.63
11-05-2022	06.00 AM	10.76	25.01	93.69
	12.00 PM	10.76	25.06	93.73
	06.00 PM	10.48	25.43	93.43
	00.00 AM	10.48	25.05	92.59
12-05-2022	06.00 AM	10.78	25.33	93.68
	12.00 PM	10.77	25.01	93.67
	06.00 PM	10.81	25.70	93.43
	00.00 AM	10.47	25.31	93.43
13-05-2022	06.00 AM	10.73	25.42	93.50
	12.00 PM	10.83	25.52	93.46
	06.00 PM	10.52	25.33	93.43
	00.00 AM	10.63	25.34	93.43
14-05-2022	06.00 AM	10.48	25.42	93.46
	12.00 PM	10.63	25.51	93.64
	06.00 PM	10.87	25.42	93.35
	00.00 AM	10.52	25.34	93.39
15-05-2022	06.00 AM	10.63	25.34	93.45
	12.00 PM	10.87	25.24	93.62
	06.00 PM	10.60	25.24	93.47
	00.00 AM	10.51	25.42	93.44
16-05-2022	06.00 AM	10.50	25.23	93.62
	12.00 PM	10.84	25.24	93.70
	06.00 PM	10.61	25.34	93.64
	00.00 AM	10.52	25.70	93.67
17-05-2022	06.00 AM	10.61	25.42	93.63
	12.00 PM	10.83	25.61	93.63
	06.00 PM	10.85	26.07	93.35
	00.00 AM	10.25	25.60	93.34
18-05-2022	06.00 AM	10.89	25.01	93.69
	12.00 PM	10.88	25.44	93.73
	06.00 PM	10.89	25.01	93.53
	00.00 AM	10.93	25.01	93.63
19-05-2022	06.00 AM	10.78	25.01	93.46
	12.00 PM	10.89	25.58	93.57
	06.00 PM	10.88	25.44	93.57
	00.00 AM	10.79	25.01	93.46
20-05-2022	06.00 AM	10.76	25.01	93.46
	12.00 PM	10.86	26.26	93.47
	06.00 PM	10.25	25.01	93.45
	00.00 AM	10.28	25.42	94.32
21-05-2022	06.00 AM	10.48	25.33	93.43
	12.00 PM	10.87	26.07	93.45

	06.00 PM	10.50	25.60	93.23
	00.00 AM	10.25	25.42	93.23
22-05-2022	06.00 AM	10.74	25.52	93.36
	12.00 PM	10.79	25.01	93.63
	06.00 PM	10.80	25.61	93.00
	00.00 AM	10.74	25.61	93.02
23-05-2022	06.00 AM	10.82	25.42	93.13
	12.00 PM	10.81	25.89	93.91
	06.00 PM	10.25	25.41	93.92
	00.00 AM	10.17	25.60	93.90
24-05-2022	06.00 AM	10.67	25.39	93.85
	12.00 PM	10.88	25.01	93.59
	06.00 PM	10.81	25.01	93.56
	00.00 AM	10.61	25.01	93.54
25-05-2022	06.00 AM	10.81	25.42	93.84
	12.00 PM	10.81	25.42	93.76
	06.00 PM	10.25	25.62	93.55
	00.00 AM	10.05	25.42	93.56
26-05-2022	06.00 AM	10.90	25.70	93.74
	12.00 PM	10.88	25.42	93.58
	06.00 PM	10.89	25.42	93.58
	00.00 AM	10.82	25.01	93.59
27-05-2022	06.00 AM	10.8	25.01	93.57
	12.00 PM	10.81	25.01	93.56
	06.00 PM	10.18	25.52	93.40
	00.00 AM	10.73	25.05	93.44
28-05-2022	06.00 AM	10.39	25.02	93.41
	12.00 PM	10.84	25.01	93.50
	06.00 PM	10.85	25.01	93.27
	00.00 AM	10.93	25.01	93.40
29-05-2022	06.00 AM	10.74	25.06	93.39
	12.00 PM	10.88	25.01	93.42
	06.00 PM	10.47	25.02	93.41
	00.00 AM	10.42	25.42	93.46
30-05-2022	06.00 AM	10.74	25.44	93.44
	12.00 PM	10.88	25.01	93.64
	06.00 PM	10.81	25.11	93.68
	00.00 AM	10.25	25.18	93.68
31-05-2022	06.00 AM	10.75	25.01	93.67
	12.00 PM	10.89	25.51	93.38
	06.00 PM	10.78	25.01	93.68
	00.00 AM	10.87	25.02	

RAIKELA IRON ORE MINES OF M/S GEETARANI MOHANTY PIEZOMETRIC DATA OF AUGUST 2022		
DATA	**TIME**	**Ground Water Level (m)**
01-08-2022	06.00 AM	5.04
	12.00 PM	5.11
	06.00 PM	5.15
	00.00 AM	5.22
02-08-2022	06.00 AM	5.29
	12.00 PM	5.40
	06.00 PM	5.05
	00.00 AM	5.02
03-08-2022	06.00 AM	5.08
	12.00 PM	5.07
	06.00 PM	5.14
	00.00 AM	5.16
04-08-2022	06.00 AM	5.10
	12.00 PM	5.20
	06.00 PM	5.03
	00.00 AM	5.08
05-08-2022	06.00 AM	4.99
	12.00 PM	5.01
	06.00 PM	4.99
	00.00 AM	5.26
06-08-2022	06.00 AM	5.00
	12.00 PM	5.02
	06.00 PM	5.04
	00.00 AM	5.01
07-08-2022	06.00 AM	5.13
	12.00 PM	5.02
	06.00 PM	5.07
	00.00 AM	5.09
08-08-2022	06.00 AM	5.05
	12.00 PM	5.09
	06.00 PM	5.12
	00.00 AM	5.06
09-08-2022	06.00 AM	5.08
	12.00 PM	5.12
	06.00 PM	5.18
	00.00 AM	5.13
10-08-2022	06.00 AM	5.06
	12.00 PM	5.07
	06.00 PM	5.11
	00.00 AM	5.13
11-08-2022	06.00 AM	5.01

	12.00 PM	5.05
	06.00 PM	5.08
	00.00 AM	5.26
12-08-2022	06.00 AM	5.11
	12.00 PM	5.07
	06.00 PM	5.10
	00.00 AM	5.01
13-08-2022	06.00 AM	5.03
	12.00 PM	5.11
	06.00 PM	5.12
	00.00 AM	5.15
14-08-2022	06.00 AM	5.09
	12.00 PM	5.05
	06.00 PM	5.13
	00.00 AM	5.02
15-08-2022	06.00 AM	5.04
	12.00 PM	5.10
	06.00 PM	5.14
	00.00 AM	5.12
16-08-2022	06.00 AM	5.09
	12.00 PM	5.10
	06.00 PM	5.21
	00.00 AM	5.13
17-08-2022	06.00 AM	5.10
	12.00 PM	5.15
	06.00 PM	5.13
	00.00 AM	5.11
18-08-2022	06.00 AM	5.11
	12.00 PM	5.13
	06.00 PM	5.10
	00.00 AM	5.11
19-08-2022	06.00 AM	5.10
	12.00 PM	5.14
	06.00 PM	5.21
	00.00 AM	5.34
20-08-2022	06.00 AM	5.15
	12.00 PM	5.20
	06.00 PM	5.18
	00.00 AM	5.13
21-08-2022	06.00 AM	5.08
	12.00 PM	5.18
	06.00 PM	5.18
	00.00 AM	5.09
22-08-2022	06.00 AM	5.09
	12.00 PM	5.13

	06.00 PM	5.04
	00.00 AM	5.11
23-08-2022	06.00 AM	5.25
	12.00 PM	5.38
	06.00 PM	5.03
	00.00 AM	5.09
24-08-2022	06.00 AM	5.04
	12.00 PM	5.40
	06.00 PM	5.28
	00.00 AM	5.37
25-08-2022	06.00 AM	5.14
	12.00 PM	5.34
	06.00 PM	5.25
	00.00 AM	5.17
26-08-2022	06.00 AM	5.15
	12.00 PM	5.25
	06.00 PM	5.28
	00.00 AM	5.23
27-08-2022	06.00 AM	5.20
	12.00 PM	5.26
	06.00 PM	5.27
	00.00 AM	5.39
28-08-2022	06.00 AM	5.16
	12.00 PM	5.35
	06.00 PM	5.32
	00.00 AM	5.38
29-08-2022	06.00 AM	5.14
	12.00 PM	5.33
	06.00 PM	5.28
	00.00 AM	5.37
30-08-2022	06.00 AM	5.24
	12.00 PM	5.28
	06.00 PM	5.31
	00.00 AM	5.40
30-08-2022	06.00 AM	5.25
	12.00 PM	5.29
	06.00 PM	5.30
	00.00 AM	5.41

RAIKELA IRON ORE MINES OF M/S GEETARANI MOHANTY PIEZOMETRIC DATA OF SEPTEMBER 2022		
DATA	**TIME**	**Ground Water Level (m)**

01-09-2022	06.00 AM	5.21
	12.00 PM	5.23
	06.00 PM	5.35
	00.00 AM	5.32
02-09-2022	06.00 AM	5.41
	12.00 PM	5.33
	06.00 PM	5.35
	00.00 AM	5.12
03-09-2022	06.00 AM	5.36
	12.00 PM	5.25
	06.00 PM	5.29
	00.00 AM	5.34
04-09-2022	06.00 AM	5.14
	12.00 PM	5.45
	06.00 PM	5.20
	00.00 AM	5.49
05-09-2022	06.00 AM	5.32
	12.00 PM	5.40
	06.00 PM	5.42
	00.00 AM	5.33
06-09-2022	06.00 AM	5.32
	12.00 PM	5.4
	06.00 PM	5.42
	00.00 AM	5.33
07-09-2022	06.00 AM	5.08
	12.00 PM	5.4
	06.00 PM	5.42
	00.00 AM	5.33
08-09-2022	06.00 AM	5.52
	12.00 PM	5.48
	06.00 PM	5.43
	00.00 AM	5.39
09-09-2022	06.00 AM	5.37
	12.00 PM	5.46
	06.00 PM	5.61
	00.00 AM	5.39
10-09-2022	06.00 AM	5.39
	12.00 PM	5.48
	06.00 PM	5.59
	00.00 AM	5.39
11-09-2022	06.00 AM	5.33
	12.00 PM	5.52
	06.00 PM	5.4
	00.00 AM	5.29
12-09-2022	06.00 AM	5.44

	12.00 PM	5.48
	06.00 PM	5.32
	00.00 AM	5.49
13-09-2022	06.00 AM	5.45
	12.00 PM	5.32
	06.00 PM	5.43
	00.00 AM	5.51
14-09-2022	06.00 AM	5.39
	12.00 PM	5.56
	06.00 PM	5.59
	00.00 AM	5.39
15-09-2022	06.00 AM	5.42
	12.00 PM	5.58
	06.00 PM	5.65
	00.00 AM	5.41
16-09-2022	06.00 AM	5.56
	12.00 PM	5.66
	06.00 PM	5.65
	00.00 AM	5.41
17-09-2022	06.00 AM	5.58
	12.00 PM	5.63
	06.00 PM	5.62
	00.00 AM	5.61
18-09-2022	06.00 AM	5.43
	12.00 PM	5.32
	06.00 PM	5.65
	00.00 AM	5.53
19-09-2022	06.00 AM	5.59
	12.00 PM	5.63
	06.00 PM	5.68
	00.00 AM	5.42
20-09-2022	06.00 AM	5.27
	12.00 PM	5.66
	06.00 PM	5.68
	00.00 AM	5.66
21-09-2022	06.00 AM	5.62
	12.00 PM	5.25
	06.00 PM	5.58
	00.00 AM	5.53
22-09-2022	06.00 AM	5.54
	12.00 PM	5.59
	06.00 PM	5.62
	00.00 AM	5.87
23-09-2022	06.00 AM	5.42
	12.00 PM	5.83

	06.00 PM	5.59
	00.00 AM	5.81
24-09-2022	06.00 AM	5.62
	12.00 PM	5.38
	06.00 PM	5.54
	00.00 AM	5.50
25-09-2022	06.00 AM	5.41
	12.00 PM	5.83
	06.00 PM	5.50
	00.00 AM	5.77
26-09-2022	06.00 AM	5.59
	12.00 PM	5.69
	06.00 PM	5.61
	00.00 AM	5.67
27-09-2022	06.00 AM	5.56
	12.00 PM	5.49
	06.00 PM	5.67
	00.00 AM	5.35
28-09-2022	06.00 AM	5.6
	12.00 PM	5.61
	06.00 PM	5.75
	00.00 AM	5.61
29-09-2022	06.00 AM	5.64
	12.00 PM	5.72
	06.00 PM	5.60
	00.00 AM	5.43
30-09-2022	06.00 AM	5.59
	12.00 PM	5.69
	06.00 PM	5.56
	00.00 AM	5.08

RAIKELA IRON ORE MINES OF M/S GEETARANI MOHANTY PIEZOMETRIC DATA OF OCTOBER 2022

DATA	TIME	Ground Water Level (m)
01-10-2022	06.00 AM	5.08
	12.00 PM	5.52
	06.00 PM	5.5
	00.00 AM	5.8
02-10-2022	06.00 AM	5.8
	12.00 PM	6.0
	06.00 PM	6.01
	00.00 AM	6.01
03-10-2022	06.00 AM	6.02
	12.00 PM	6.4
	06.00 PM	6.6
	00.00 AM	6.6
04-10-2022	06.00 AM	6.8
	12.00 PM	6.9
	06.00 PM	7.0
	00.00 AM	7.01
05-10-2022	06.00 AM	7.02
	12.00 PM	7.3
	06.00 PM	7.4
	00.00 AM	7.5
06-10-2022	06.00 AM	7.8
	12.00 PM	7.8
	06.00 PM	7.9
	00.00 AM	7.9
07-10-2022	06.00 AM	8.01
	12.00 PM	8.02
	06.00 PM	8.5
	00.00 AM	8.6
08-10-2022	06.00 AM	8.5
	12.00 PM	8.4
	06.00 PM	8.8
	00.00 AM	9.1
09-10-2022	06.00 AM	9.2
	12.00 PM	9.01
	06.00 PM	9.05
	00.00 AM	9.4
10-10-2022	06.00 AM	9.5
	12.00 PM	9.6
	06.00 PM	9.5
	00.00 AM	9.6
11-10-2022	06.00 AM	9.8
	12.00 PM	9.9
	06.00 PM	9.7

	00.00 AM	9.8
12-10-2022	06.00 AM	9.9
	12.00 PM	9.7
	06.00 PM	10
	00.00 AM	10.02
13-10-2022	06.00 AM	10.05
	12.00 PM	10.11
	06.00 PM	10.2
	00.00 AM	10.3
14-10-2022	06.00 AM	10.5
	12.00 PM	10.4
	06.00 PM	10.2
	00.00 AM	10.01
15-10-2022	06.00 AM	10.4
	12.00 PM	10.3
	06.00 PM	10.60
	00.00 AM	10.51
16-10-2022	06.00 AM	10.50
	12.00 PM	10.84
	06.00 PM	10.61
	00.00 AM	10.52
17-10-2022	06.00 AM	10.61
	12.00 PM	10.83
	06.00 PM	10.85
	00.00 AM	10.25
18-10-2022	06.00 AM	10.89
	12.00 PM	10.88
	06.00 PM	10.89
	00.00 AM	10.93
19-10-2022	06.00 AM	10.78
	12.00 PM	10.89
	06.00 PM	10.88
	00.00 AM	10.79
20-10-2022	06.00 AM	10.76
	12.00 PM	10.86
	06.00 PM	10.25
	00.00 AM	10.28
21-10-2022	06.00 AM	10.48
	12.00 PM	10.87
	06.00 PM	10.50
	00.00 AM	10.25
22-10-2022	06.00 AM	10.74
	12.00 PM	10.79
	06.00 PM	10.80
	00.00 AM	10.74

23-10-2022	06.00 AM	10.82
	12.00 PM	10.81
	06.00 PM	10.25
	00.00 AM	10.17
24-10-2022	06.00 AM	10.67
	12.00 PM	10.88
	06.00 PM	10.81
	00.00 AM	10.61
25-10-2022	06.00 AM	10.81
	12.00 PM	10.81
	06.00 PM	10.25
	00.00 AM	10.05
26-10-2022	06.00 AM	10.90
	12.00 PM	10.88
	06.00 PM	10.89
	00.00 AM	10.82
27-10-2022	06.00 AM	10.8
	12.00 PM	10.81
	06.00 PM	10.18
	00.00 AM	10.73
28-10-2022	06.00 AM	10.39
	12.00 PM	10.84
	06.00 PM	10.85
	00.00 AM	10.93
29-10-2022	06.00 AM	10.74
	12.00 PM	10.88
	06.00 PM	10.47
	00.00 AM	10.42
30-10-2022	06.00 AM	10.74
	12.00 PM	10.88
	06.00 PM	10.81
	00.00 AM	10.25
31-10-2022	06.00 AM	10.75
	12.00 PM	10.89
	06.00 PM	10.78
	00.00 AM	10.87