



**केन्द्रीय भूमि जल बोर्ड**  
जल संसाधन, नदी विकास और गंगा संरक्षण  
विभाग, जल शक्ति मंत्रालय  
भारत सरकार

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

## **AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES**

**Chandrapura and Nawadih Blocksof  
Bokaro District  
JHARKHAND**

मध्य पूर्वी क्षेत्र, पटना  
Mid Eastern Region, Patna



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Central Ground Water Board

**AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN OF  
CHANDRAPURA AND NAWADIH BLOCKS OF BOKARO DISTRICT,  
JHARKHAND STATE**

जलभृत नक्शों तथा भूजल प्रबंधन योजना  
चंद्रपुरा और नावाडीह ब्लॉक, बोकारो जिला,  
झारखण्ड

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State Unit Office, Ranchi  
Mid- Eastern Region, Patna,  
September 2022

**REPORT ON AQUIFER MAPPING AND GROUND WATER MANAGEMENT PLAN  
OF CHANDRAPURA AND NAWADIH BLOCKS, BOKARO DISTRICT,  
JHARKHAND, 2021-22**

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# **REPORT ON AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN OF CHANDRAPURA AND NAWADIH BLOCKS OF BOKARO DISTRICT, JHARKHAND STATE**

## **1.0 INTRODUCTION**

The vagaries of rainfall, inherent heterogeneity & unsustainable nature of hard rock aquifers, over exploitation of once copious aquifers, lack of regulation mechanism etc has a detrimental effect on ground water scenario of the Country in last decade or so. Thus, prompting the paradigm shift from “**Traditional Groundwater Development concept**” to “**Modern Groundwater Management concept**”. Varied and diverse hydrogeological settings demand precise and comprehensive mapping of aquifers down to the optimum possible depth at appropriate scale to arrive at the robust and implementable ground water management plans. This leads to concept of Aquifer Mapping and Ground Water Management Plan. Aquifer mapping is a process wherein a combination of geologic, geophysical, hydrologic and chemical analyses is applied to characterize the quantity, quality and sustainability of ground water in aquifers. The proposed management plans will provide the “**Road Map**” for ensuring sustainable management and equitable distribution of ground water resources, thereby primarily improving drinking water security and irrigation coverage. Thus the crux of NAQUIM is not merely mapping, but reaching the goal-that of ground water management through community participation.

During XII five year plan (2012-17) National Aquifer Mapping (NAQUIM) study was initiated by CGWB to carry out detailed hydrogeological investigation. The Aquifer Mapping programme has been continued till 2023 to cover whole country. The present study of Chandrapura and Nawadih blocks of Bokaro district has been taken up during 2018-19 as a part of NAQUIM Programme. The aquifer maps and management plans will be shared with the administration of Bokaro district and other user agencies for its effective implementation.

## 1.1 Objective and Scope of the study:

The major objectives of aquifer mapping are

- Delineation of lateral and vertical disposition of aquifers and their characterization
- Quantification of ground water availability and assessment of its quality to formulate aquifer management plans to facilitate sustainable management of ground water resources at appropriate scales through participatory management approach with active involvement of stakeholders.

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

The main activities under NAQUIM are as follows:

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

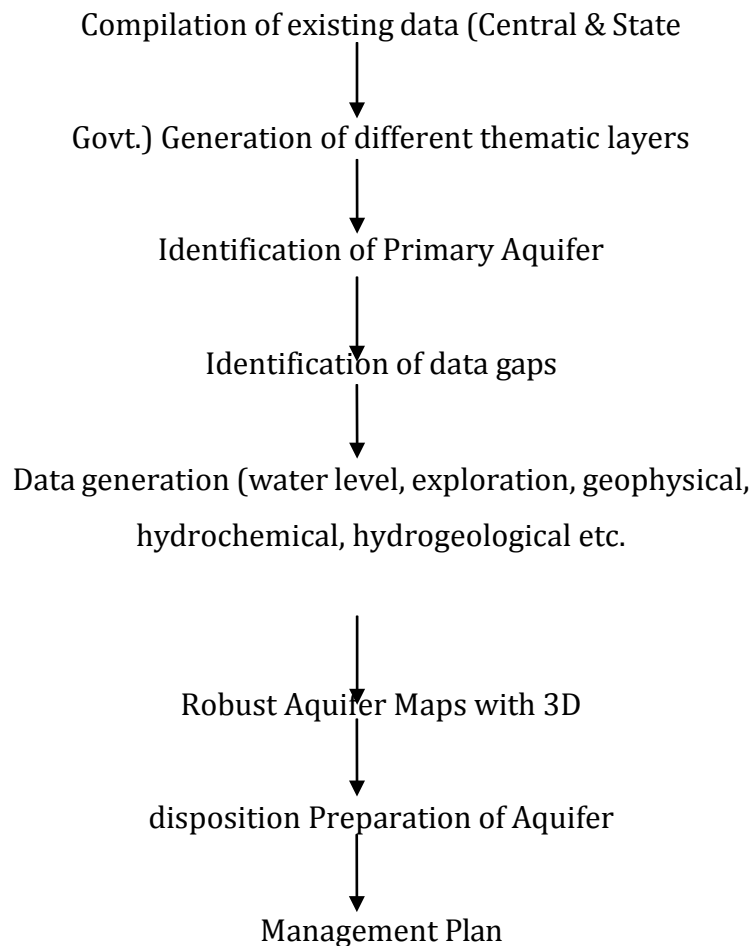
The demarcation of aquifers and their potential will help the agencies involved in water supply in ascertaining, how much volume of water is under their control. The robust and implementable ground water management plan will provide a “**Road Map**” to systematically manage the ground water resources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

## 1.2. Approach and methodology:

The ongoing activities of NAQUIM include hydrogeological data acquisition supported by geophysical and hydro-chemical investigations supplemented with ground water exploration down to the depths of 200 meters.

Considering the objectives of the NAQUIM, the data on various components was segregated, collected and brought on GIS platform by geo-referencing the available information for its

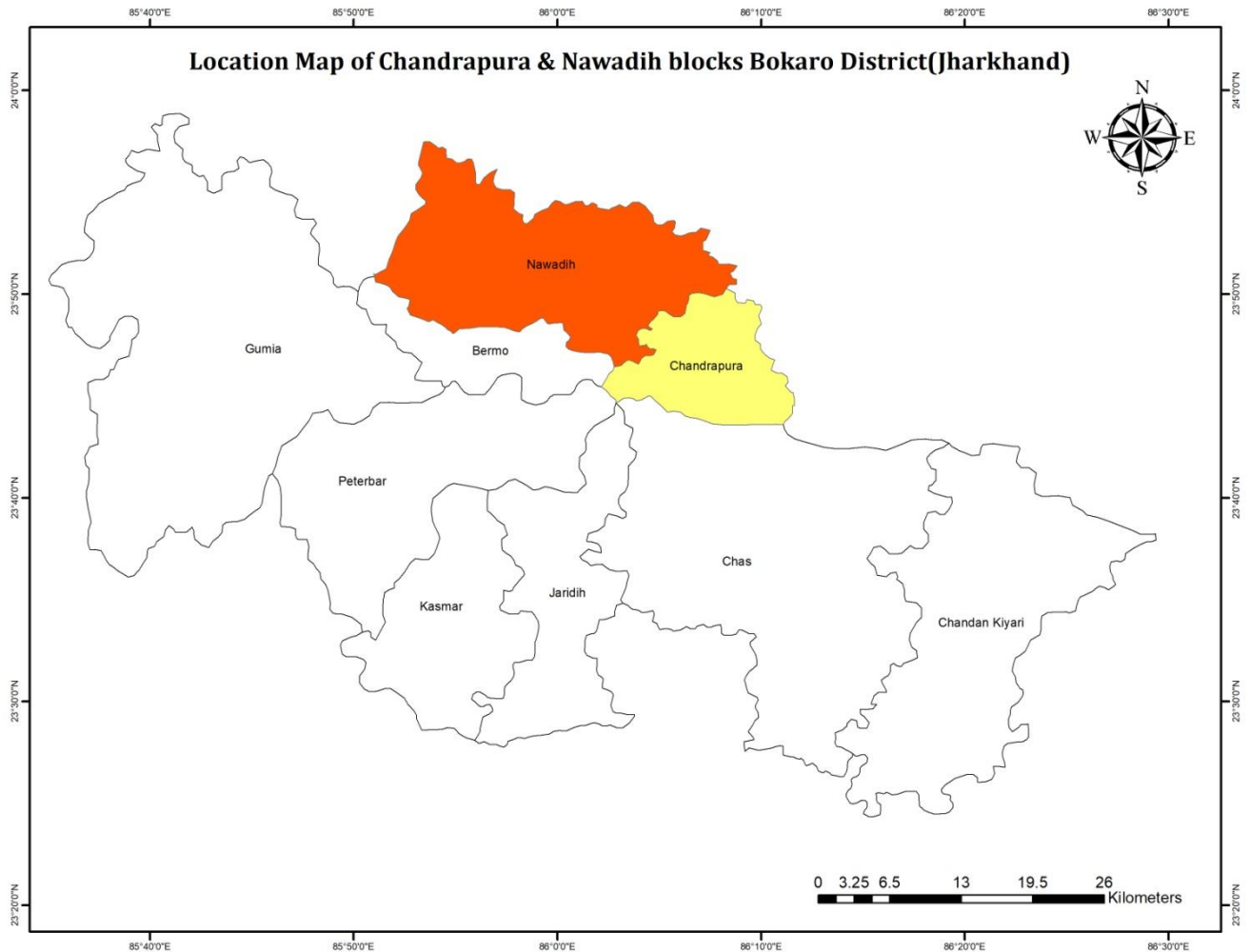
utilization for preparation of various thematic maps. The approach and methodology followed for Aquifer mapping is as given below:



Capacity building in all aspects of ground water through IEC Activities



**1.3 Area details:** The district of Bokaro was created on 1st April, 1991 by taking out Chas and Chandankiyari C.D.Blocks of Dhanbad district and the entire Bermo Subdivision of Giridih district and then merging them to form a new district. The district extends between 23°26" to 23°57" North Latitude and 85°34" to 86°26" East Latitude. The district is located at an elevation of 200-546 m. from mean sea level. The district is divided into 9 blocks namely i) Bermo ii) Chandan Kiyari iii) Chandrapura iv) Chas v) Gumia and vi) Jaridih vii) Kasmar viii) Nawadih and ix) Peterbar. ( Fig-1) Bokaro district is bounded on the east by Dhanbad district and some portion of West Bengal State, on the west by Ramgarh district, on the south by Purulia district of West Bengal and on the north by parts of Giridih, Hazaribag and Dhanbad districts. The Chandrapura block is located in North-eastern part while the Nawadih block is located in northern part of the Bokaro district. The total geographical area of the Chandrapura block is 124.24Sq. km. and Nawadih block is 286Sq.km. The location map of Chandrapura and Nawadih blocks is shown in figure – 1.



**Figure 1. Location map of Chandrapura and Nawadih Block of Bokaro District**

## 1.4 Data Availability, Data Adequacy and Data Gap Analysis

**1.4.1. Data availability:** Central Ground Water Board has carried out exploratory drilling in the Chandrapura block and drilled one exploratory wells while one exploratory wells has been drilled in Nawadih block through outsourcing drilling activity during the year 2020-2021. At least three exploratory and one observation wells are to be drilled in each block to know the sub – surface geology, depth and thickness of water bearing formation with their yield and determine the different aquifer parameters.

**1.4.2 Data Adequacy and Data Gap Analysis:** The available data of the Exploratory wells drilled by Central Ground Water Board, State Unit Office, Ranchi, Geophysical Survey carried out in the area, ground water monitoring stations and ground water quality stations monitored by Central Ground Water Board were compiled and analyzed for adequacy of the same for the aquifer mapping studies. The summarized details of required, existing and data gap of exploratory wells, a ground water monitoring and ground water quality station is given below in table-1 & 2.

**Table – 1: Data adequacy and data gap analysis of Chandrapura block, Bokaro district**

Exploration data			Geophysical data			GW monitoring data (HNS)			GW quality data		
Req.	Exist	Gap	Req.	Exist	Gap	Req.	Exist	Gap	Req.	Exist	Gap
3	1	2	5	0	5	3	1	2	3	1	2

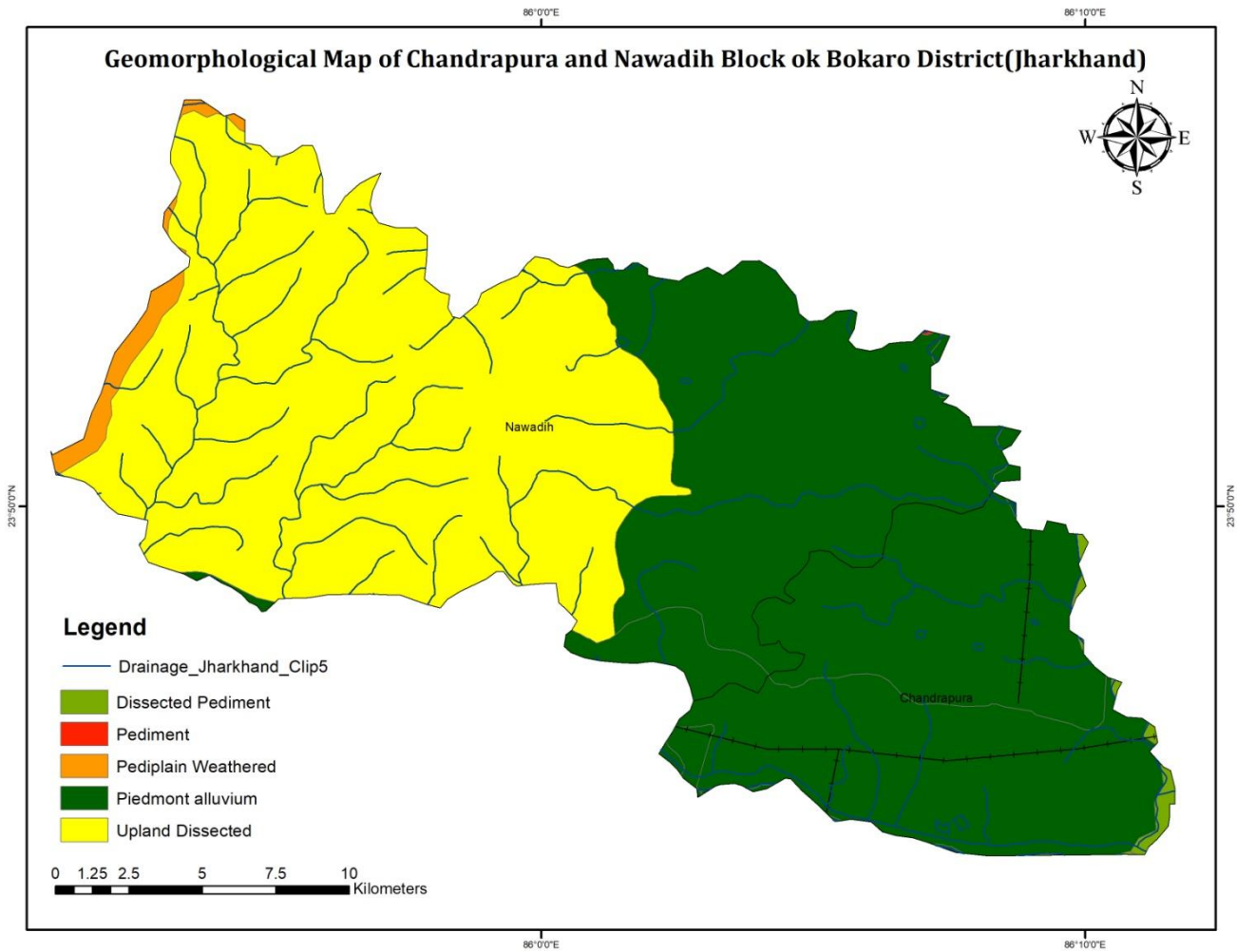
**Table – 2: Data adequacy and data gap analysis of Nawadih block Bokaro district**

Exploration data			Geophysical data			GW monitoring data (HNS)			GW quality data		
Req.	Exist	Gap	Req.	Exist	Gap	Req.	Exist	Gap	Req.	Exist	Gap
3	1	2	5	0	5	3	1	2	3	1	2

The data adequacy as discussed above indicates that the existing data is not sufficient for preparation of aquifer maps; hence data gap has been identified for Exploratory Wells, Geophysical Survey (VES), Ground Water Monitoring Wells and Ground Water Quality. However, based on available existing data block wise aquifer maps and management plan of Chandrapura and Nawadih blocks of Bokaro district is being prepared.

### 1.5 Geomorpholgy:

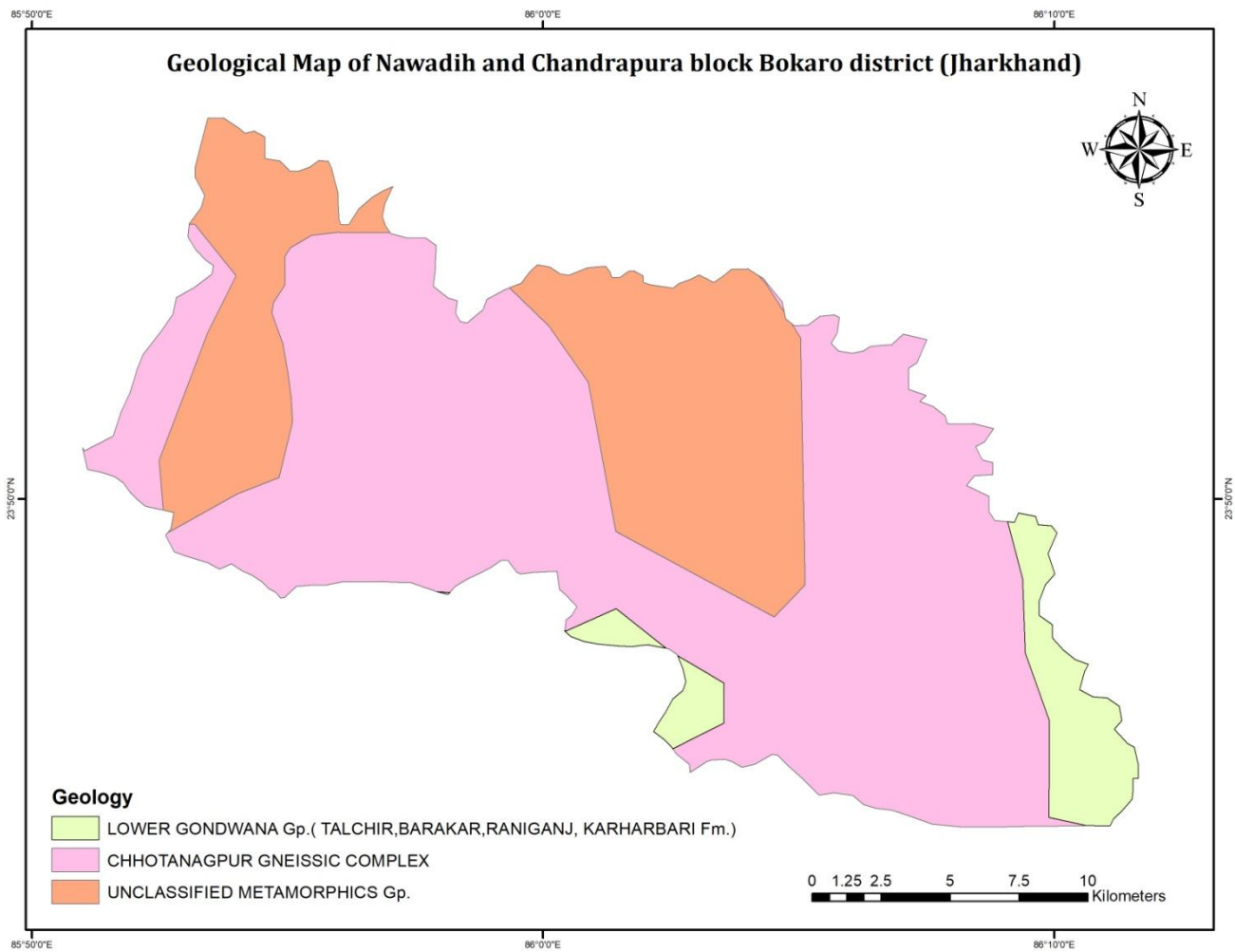
The area is undulating and has piedmont alluvium in north, eastern ,southern and central part, pediplain weathered in found in extreme western part, dissected pediment in south western part. The geomorphological map is given in the figure 2.



**Figure 2. Geomorphological Map of Chandrapura and Nawadih Block of Bokaro District District**

### 1.6 Geology:

Geologically the area is comprised with Archean rocks of metasediments, , Chotanagpur granite gneisses. In eastern, and some part of southern has Gondwana rock formation of occur in patches. Major part of the area covers granite gneiss and unclassified metamorphic rocks.. Geological map of the area is shown in fig.3

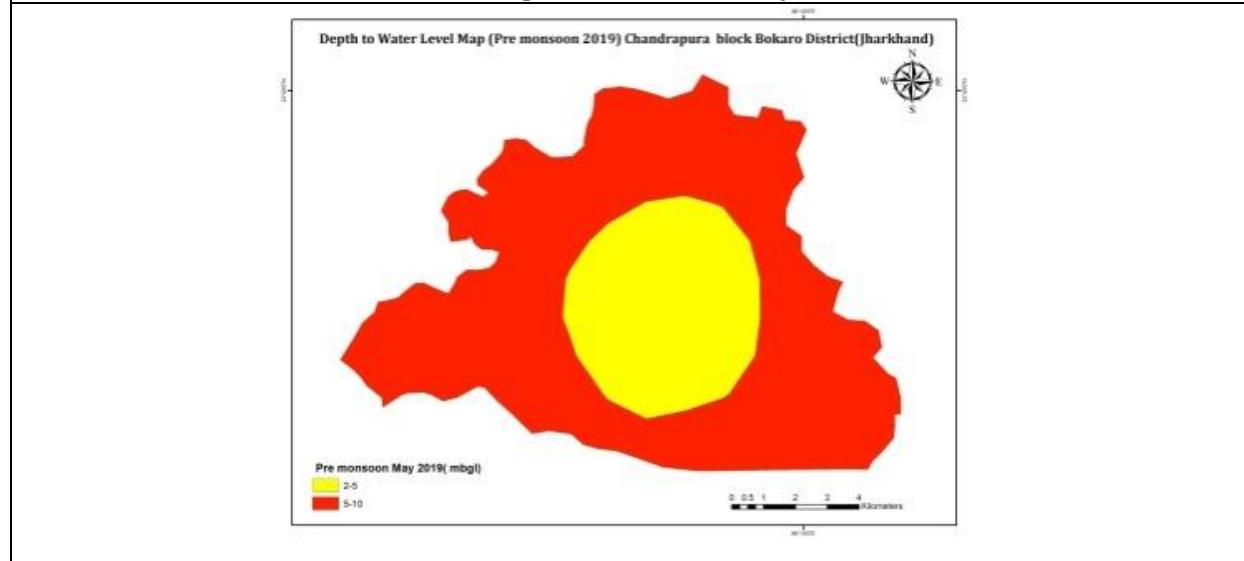


**Figure 3 Geological Map of Chandrapura and Nawadih Block of Bokaro District**

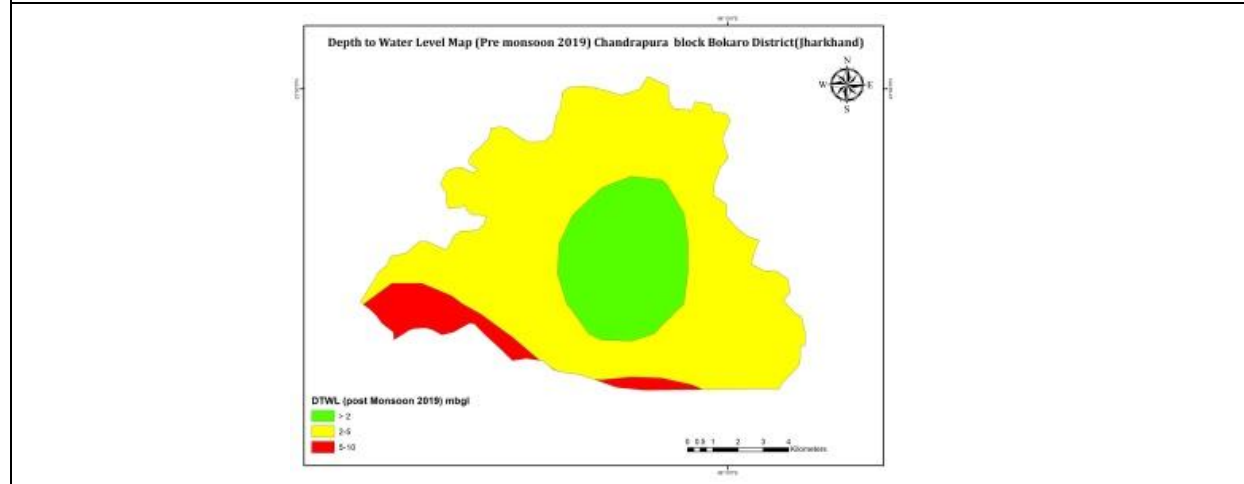
**2.0 BLOCK WISE AQUIFER MAPS AND GROUND WATER MANAGEMENT PLANS,  
2.1 AQUIFER MAPS AND GROUND WATER MANAGEMENT PLANS, CHANDRAPURA  
BLOCK, BOKARO DISTRICT, JHARKHAND**

<b>1.SALIENT FEATURES</b>	
• Block Name	Chandrapura
• Geographical Area (Sq. km.)	124.24 sqkm
• Population (2011)	<b>132,162</b>
• Rural	48,776
• Urban	83,386
• Rainfall Monsoon (mm)	748.60
• Rainfall Annual (mm)	829.20
• Water level behavior Pre monsoon 2019	Water level behavior Post monsoon 2019

**DTWL Map Pre-monsoon May 2019**

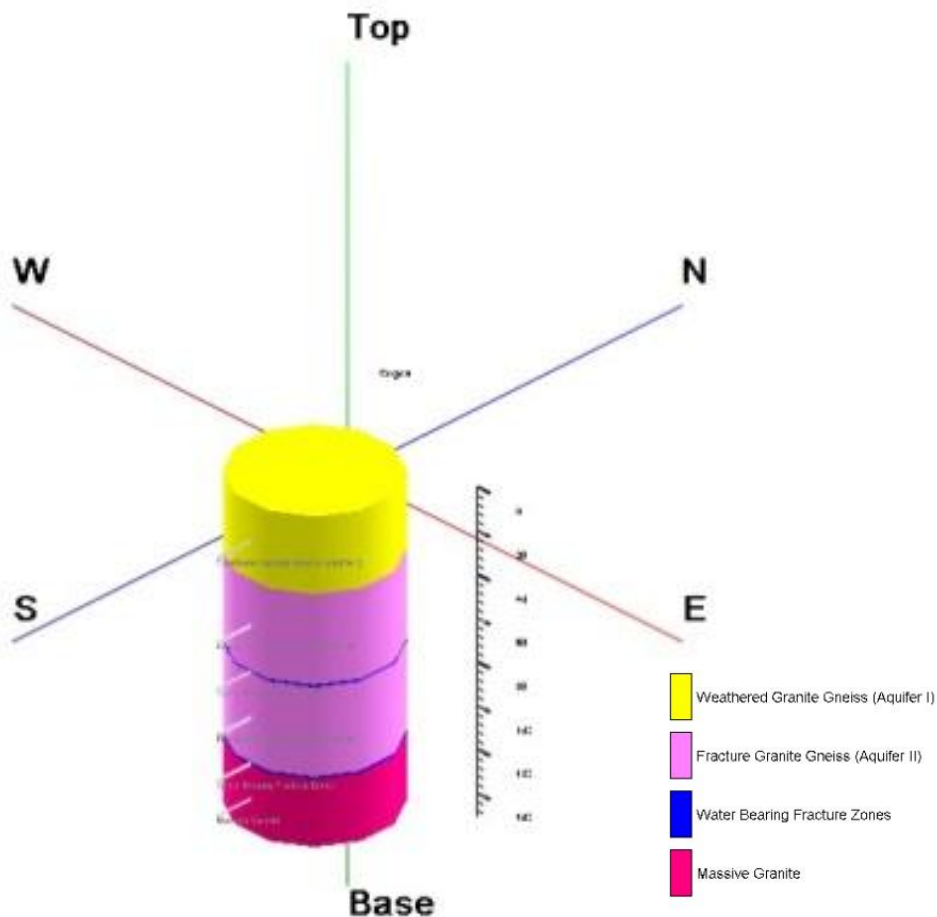


**DTWL Map Post-monsoon May 2019**



<b>2.0 AQUIFER DISPOSITION</b>	
<b>Major formation</b>	Granite gneiss,
<b>2.1 Numbers of aquifers</b>	Aquifer - I- Weathered Granite gneiss, Aquifer - II- Fractured Granite-Gneiss
<b>2.2 Number of EW constructed</b>	01

**2.3 Litholog:**



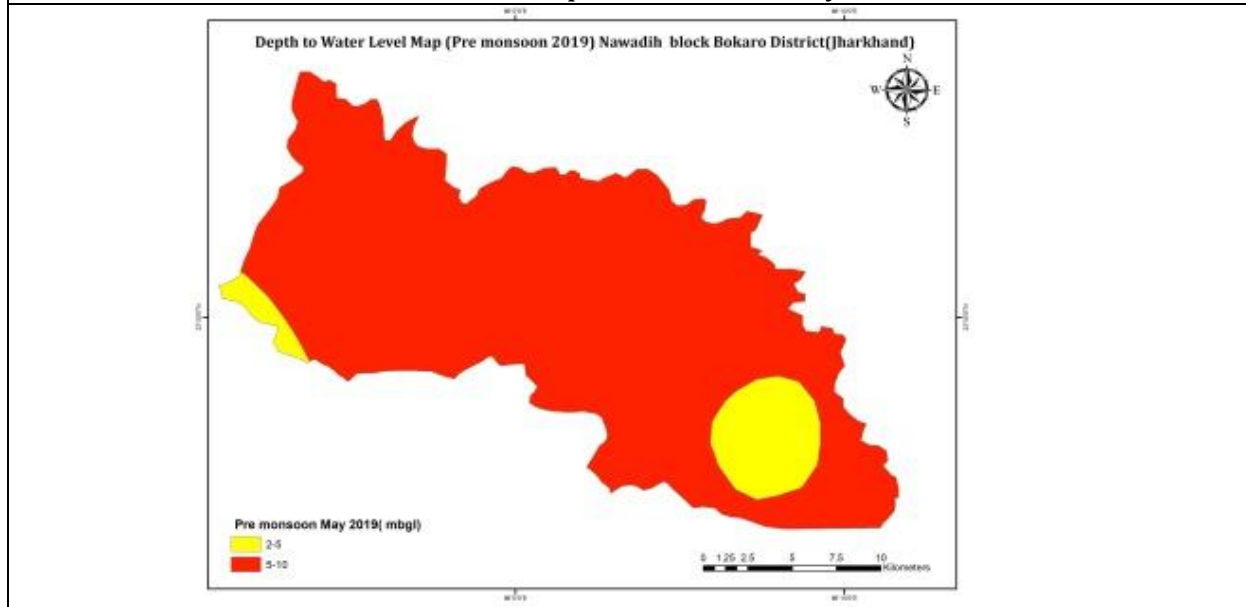
<b>3. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES</b>	
<b>3.1 Aquifer wise resource availability and extraction</b>	
<b>Phreatic Aquifer (Aquifer - I)</b>	
Ground water resource estimation (As on 31 <sup>st</sup> March 2020)	
Annual extractable ground water for recharge (ham)	863.74
Current annual ground water extraction for irrigation (ham)	106.5
Current annual ground water extraction for domestic (ham)	270.6
Current annual ground water extraction for industrial (ham)	100
Current annual ground water extraction for all uses (ham)	477.18
Net ground water availability for future use (ham)	384.68
Stage of ground water extraction (%)	55.2
Category	safe
<b>3.2 Chemical quality of ground water and contamination</b>	

<b>3.2.1 Variation in Major and Minor elements</b>
Phreatic Aquifer (Aquifer - I)
The EC value of the phreatic aquifer found from 335 $\mu\text{S}/\text{cm}$ . TDS has been observed 217.75 mg/l. Total hardness value found 135 mg/l. Similarly, the Chloride value observed 25 mg/l while the Sulphate value found 76.76 mg/l. Nitrate value observed 1.98 mg/l. Fluoride value found 1.12 mg/l. Overall ground water quality of shallow aquifer (Aquifer - I) is suitable for domestic purpose.
<b>3.3 Other issues</b>
3.3.1 Low ground water Potential/Sustainability:- Based on exploration and field studies there is issue of Low ground water Potential/Ground Water Sustainability in the area
<b>4. SUPPLY SIDE MANAGEMENT</b>
<b>4.1 Ground Water Development Strategies-Construction of Tube well/Bore well based on available safe resources:</b> As per Dynamic Ground Water Resource estimation 2020, the stage of ground water development is only 55.2%. There is little scope for further ground water development. The Construction of 25 numbers dug wells (10 -20 m depth; 2 to 4 m diameter) and 03 bore wells ( up to 100 m) are proposed
<b>4.2 Artificial recharge to ground Water:</b> The identification of feasible areas for artificial recharge to ground water in Chandrapura block, Bokaro district has been carried out based on depth to water level (post-monsoon) and ground water level trend. The computation of unsaturated zone available, surface water requirement and source water availability for Artificial recharge and proposed numbers of different types of artificial recharge structures feasible in Chandrapura block, Bokaro district has been worked out. Based on the study 20 No of Nala Bund/Check Dam/Gully Plus and 03 No of Percolation tanks can be constructed. In addition, Roof Top rainwater harvesting system may also be installed in buildings. The implementation of water conservation through artificial recharge measures will have a positive impact on drinking water sources of the area.
<b>5. DEMAND SIDE MANAGEMENT</b>
The main demand side interventions may be: - i) Promote improved irrigation technologies (drip or sprinkler irrigation, etc.) ii) Crop choice management and diversification (promote less intensive crops)

**2.2 AQUIFER MAPS AND GROUND WATER MANAGEMENT PLANS, NAWADIH BLOCK, BOKARO DISTRICT, JHARKHAND**

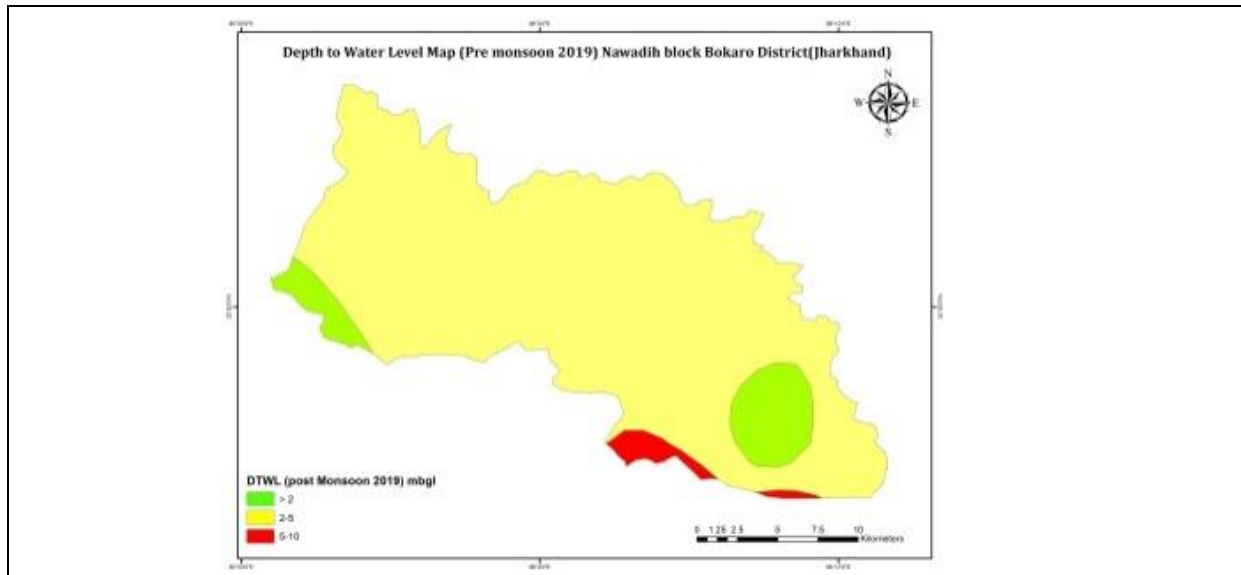
<b>1.SALIENT FEATURES</b>	
• Block Name	Nawadih
• Geographical Area (Sq. km.)	286 sqkm
• Population (2011)	138,454
• Rural	133,848
• Urban	4,606
• Rainfall Monsoon (mm)	888.60
• Rainfall Annual (mm)	996.20
• Water level behavior Pre monsoon 2019	Water level behavior Post monsoon 2019

**DTWL Map Pre-monsoon May 2019**



**DTWL Map Post-monsoon Nov 2019**

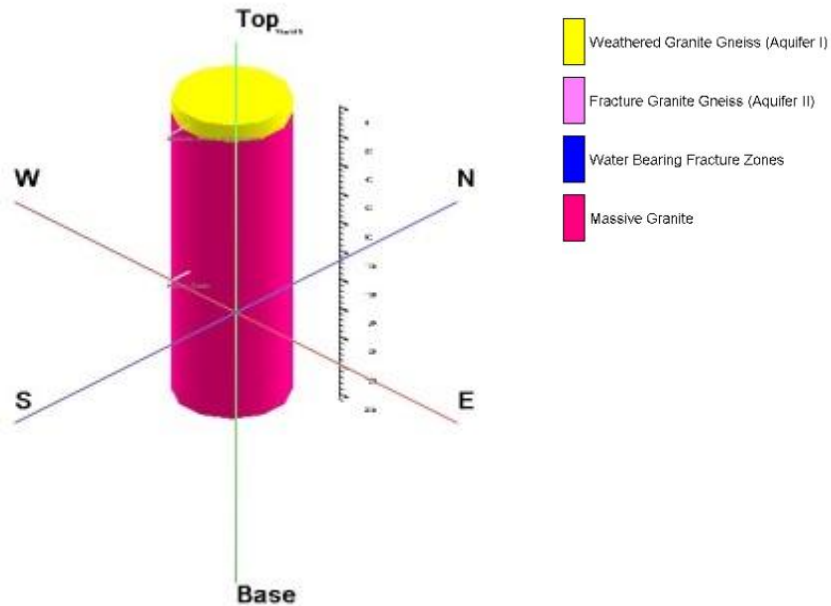




## 2.0 AQUIFER DISPOSITION

<b>Major formation</b>	Granite gneiss, and Shale sandstone with coal
<b>2.1 Numbers of aquifers</b>	Aquifer – I- Weathered Granite gneiss, Aquifer – II- Fractured Granite-Gneiss
<b>2.2 Number of EW constructed</b>	01

### 2.3 Litholog:



## 3. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES

### 3.1 Aquifer wise resource availability and extraction

#### Phreatic Aquifer (Aquifer - I)

Ground water resource estimation (As on 31 <sup>st</sup> March 2020)	
Annual extractable ground water for recharge (ham)	2839.51
Current annual ground water extraction for irrigation (ham)	285
Current annual ground water extraction for domestic (ham)	188.0

Current annual ground water extraction for industrial (ham)	3.6
Current annual ground water extraction for all uses (ham)	476.68
Net ground water availability for future use (ham)	2361.53
Stage of ground water extraction (%)	16.78
Category	safe
<b>3.2 Chemical quality of ground water and contamination</b>	
<b>3.2.1 Variation in Major and Minor elements</b>	
Phreatic Aquifer (Aquifer - I)	
The EC value of the phreatic aquifer found from 997 $\mu\text{S/cm}$ . TDS has been observed 648.05 mg/l. Total hardness value found 375 mg/l. Similarly, the Chloride value observed 156 mg/l while the Sulphate value found 73.51mg/l. Nitrate value observed 68.8 mg/l. Fluoride value found 0.59 mg/l. Overall ground water quality of shallow aquifer (Aquifer – I) is suitable for domestic purpose.	
<b>3.3 Other issues</b>	
<b>3.3.1 Low ground water development:</b> Low ground water development is the one major issue of the block. Based on Ground water resource assessment as on 2020 stage of ground water development is only 16.78%.	
Ground water exploration: Only one exploratory well is located in the block. At least three more exploratory wells may be drilled in the block.	
<b>4. SUPPLY SIDE MANAGEMENT</b>	
<b>4.1 Ground Water Development Strategies-Construction of Tube well/Bore well based on available safe resources:</b> As per Dynamic Ground Water Resource estimation 2020, the stage of ground water development is only 16.78%. There is large scope of further Ground water Development. To enhance the ground water development, construction of 30 dug wells (10 -20 m depth; 2 to 4 m diameter) and 3 bore wells ( up to 100 m) are proposed	
<b>4.2 Artificial recharge to ground Water:</b> The identification of feasible areas for artificial recharge to ground water in Nawadih block, Bokaro district has been carried out based on depth to water level (post-monsoon) and ground water level trend. The computation of unsaturated zone available, surface water requirement and source water availability for Artificial recharge and proposed numbers of different types of artificial recharge structures feasible in Nawadih block, Bokaro district has been worked out. Based on the study 47No of Nala Bund/Check Dam/Gully Plus and 07 No of Percolation tanks can be constructed. In addition, Roof Top rainwater harvesting system may also be installed in buildings. The implementation of water conservation through artificial recharge measures will have a positive impact on drinking water sources of the area.	
<b>5. DEMAND SIDE MANAGEMENT</b>	
The main demand side interventions may be: -	
i) Promote improved irrigation technologies (drip or sprinkler irrigation, etc.)	
ii) Crop choice management and diversification (promote less intensive crops)	

**Annexure - I**

**DETAILS OF WELLS CONSTRUCTED IN HARD FORMATION OF CHANDRAPURA AND NAWADIH BLOCKS OF BOKARO DISTRICT (2021-22)**

Sl. No.	Location with coordinates	Block	District	Depth drilled (m)	Depth of Well (m)	Thickness of weathering (m)	Length of casing lowered with dia. (m)	Fractures Encountered (mbgl)		Aquifer	SWL (mbgl)	Discharge (lpm)	D.D. (m)	T (m <sup>2</sup> /d)	S (Storativity)
								From	To						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Dugda EW 23.750611 86.1478055	Chandrapura	Bokaro	151.00	151.00	35.5	235.5	77 119	78 120	Fractured Granite gneiss	-	60	-	41.69	-
2	Nawadih EW 23.85722 86.043333	Nawadih	Bokaro	204	204	11.68	11.68			Granite gneiss	--	dry	--	--	--

**Annexure - II**

**WATER QUALITY DATA OF AQUIFER - I (DUG WELL SAMPLES) OF AQUIFER MAPPING STUDY OF CHANDRAPURA AND NAWADIH BLOCKS OF BOKARO DISTRICT (2021-22)**

Sl.No	District	Block	Location	E.C. micro	TDS	pH	CO <sub>3</sub> <sup>2-</sup>	HCO <sub>3</sub> <sup>-</sup>	Cl <sup>-</sup>	F <sup>-</sup>	NO <sub>3</sub> <sup>-</sup>	SO <sub>4</sub> <sup>2-</sup>	TH	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Na	K	SiO <sub>2</sub>	PO <sub>4</sub>
				Siemens/cm	mg/L		mg/l						as CaCO <sub>3</sub>			mg/L			
				at 25o C			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
1	Bokaro	Chandrapura	Chandrapura	335	217.75	7.9	0	86.1	25	1.12	1.98	76.76	135	38	9.72	4.86	17.97	NA	0.3
2	Bokaro	Nawadih	Nawadih	997	648.05	8.25	0	276.75	156	0.599	68.8	73.51	375	120	18.225	62	5.18	NA	0

### Annexure-III

Details of weathered and semi weathered zones and possible presence of thin fractured zones in Chandrapura Block, , Bokaro district( by WAPCOS)

VE S No.	Village/ Location	Weathered /Semi Weathered Zone (WZ/SWZ)		Compact Rock Formation (CR)				Fractured zone (FZ)	Bed Rock	GW Quality (GWQ)	Recommendations		
		Resistivity (ohm.m)	Depth(m) to bottom of WZ/SWZ aquifer & /probable depth to (“groundwater first strike”)	Less Compact (Resistivity less than compact, could be due to variations in rock composition also)		Compact					Probable occurrence of thin fractured zone aquifer in compact rock in the depth range (m)	Depth (m) to Compact Rock (DCR)	Tentative in terms of salinity
<b>CHANDRAPURA BLOCK</b>													
42	Chandrapura	23-57	32(10)	Absent		VH	32	40-60, 75-80, 160-170	32	Potable	SBW	WZ is prominent and thick. Thin FZ in different depth ranges up to 80 m depth	80 m Priority
88	Nawadih	Absent (10)		158-251	3 to 49	VH	49	15-20, 35-55,95-100,150-180	3	Potable	SBW	WZ is up to 49 m depth FZ in the depth ranges 35-55 m and 95-100 m appear promising	100 m Low Priority
89	Manjitola	Absent (8)		155	1 to 20	VH	20	Feeble FZ indications at 45-50, 65-70 and 110-120 m depth	1	NA	NR	WZ is absent. FZ indications are feeble	NA