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

Lohardaga District
Jharkhand

मध्य पूर्वी क्षेत्र, पटना
Mid Eastern Region, Patna

भारत सरकार

Government of India

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Central Ground Water Board

AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN , LOHARDAGA DISTRICT, JHARKHAND STATE

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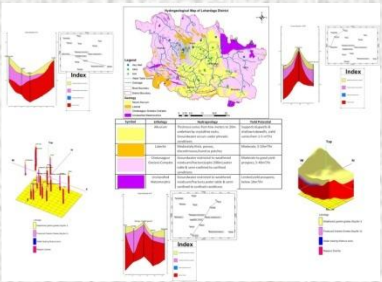

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REPORT ON AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN OF LOHARDAGA DISTRICT, JHARKHAND, 2020-21

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REPORT ON AQUIFER MAPS AND MANAGEMENT PLAN OF LOHARDAGA DISTRICT, JHARKHAND STATE (2020 - 2021)

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AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN OF LOHARDAGA DISTRICT, JHARKHAND STATE

1.0 INTRODUCTION

The vagaries of rainfall, inherent heterogenity & 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 implement table 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 studies of Lohardaga district have been taken up in AAP 2020-21 as a part of NAQUIM Programme. The aquifer maps and management plans will be shared with the administration of Lohardaga 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:

Compilation of existing data (Central & State Govt.)

↓

Generation of different thematic layers

↓

Identification of Primary Aquifer

↓

Identification of data gaps

↓

Data generation (water level, exploration, geophysical, hydrochemical, hydrogeological etc.

↓

Aquifer Maps with 3D disposition

↓

Preparation of Aquifer Management Plan

↓

Capacity building in all aspects of ground water through IEC Activties

1.3 Area Details: The district Lohardaga was taken for aquifer mapping study during 2020-21. The district is spread over 1491 Sq. km of geographical area. Latehar district is situated in the south-western part of the Jharkhand state. The district is bounded by Latehar district in the north, Ranchi in the east and Gumla in south and west. Lohardaga district is spread over 1491 Sq. Km., lying between north latitude $23^{0}30'$ to $23^{0}45'$ and East longitude $84^{0}15'$to$84^{0}50'$. Lohardaga district came into existence after Ranchi district split into three districts namely Ranchi, Lohardaga and Gumla way back in 1983. Lohardaga district has seven

blocks: Lohardaga, Kuru, Bhandra, Kairo, Kisko, Peshrar and Senha which contains 354 villages spread over in 66 Gram Panchayats (Fig-1). According to 2011 census, the total population of the district is 4,61,790 (Male- 232629, Female-229161) constituting 1.40 % of the total population of Jharkhand. The rural and urban population of the district is 4,04,379 and 57,411 respectively.
The location map of the study area is shown in figure – 1.

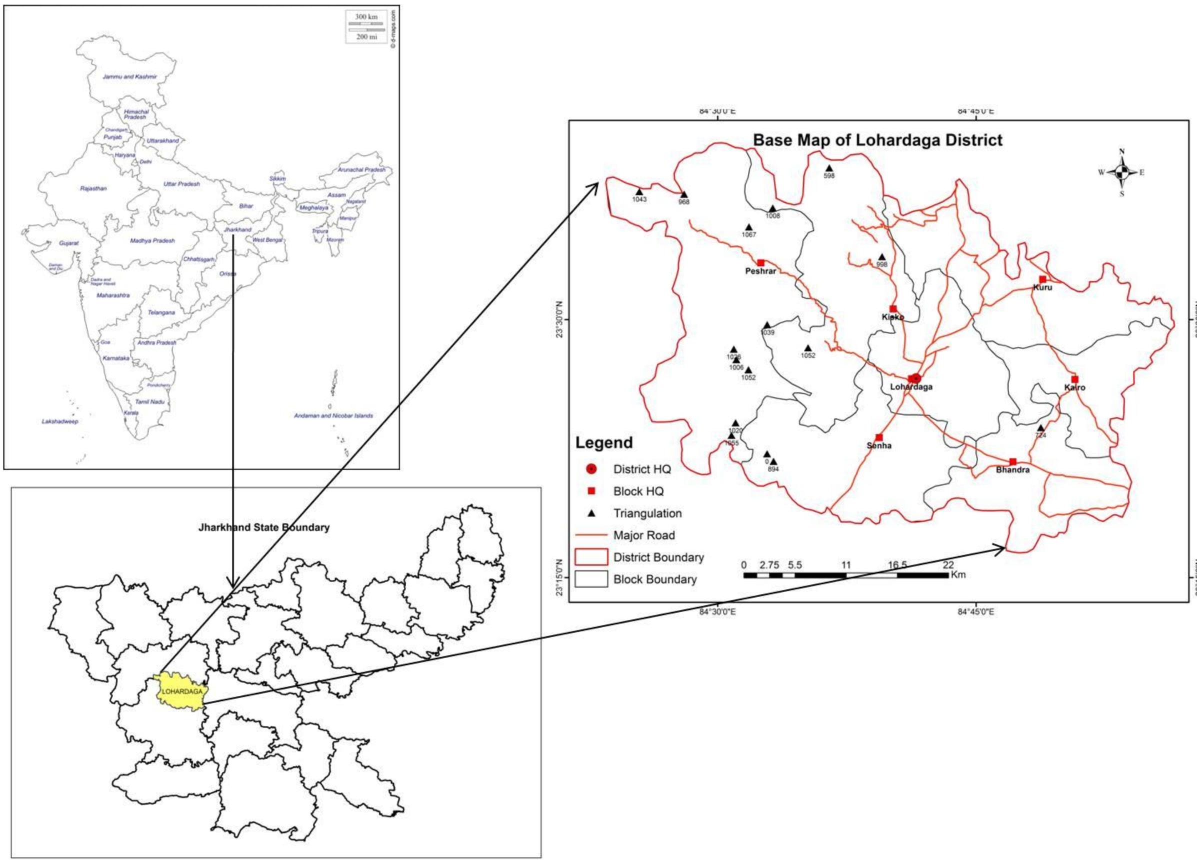


Figure 1: Location map of Lohardaga district

Table-1: Block wise Area of Lohardaga District, Jharkhand

Sr. No.	Block	Area in (Hectare)
1	Lohardaga	16168
2	Kuru	21741
3	Bhandra	16066
4	Kairo	10228
5	Kisko	25330
6	Peshrar	38467
7	Senha	21246
Total		149246

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 district and drilled 16 exploratory and 10 observation wells in hard rock formation by departmental rig during the year 1992-2005. In addition 4 exploratory and 2 Observation wells drilled through outsourcing (WAPCOS). In addition ten numbers of permanent observation well (HNS) of Central Ground Water Board located in the district are being monitored for ground water regime and to assess the chemical quality of ground water.

***1.4.2 Data Adequacy and Data Gap Analysis*:** The available data of the Exploratory wells drilled by Central Ground Water Board, Mid–Eastern Region, Patna, 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.

After taking into consideration, the available data of ground water exploration, geophysical survey, ground water monitoring and ground water quality, the data adequacy has been compiled. The summarised details of required, existing and data gap of exploratory wells, ground water monitoring and ground water quality stations are given in table–2.

Table – 2: Data adequacy and data gap analysis

Exploratory data			Geophysical data			GW monitoring data			GW quality data		
Req.	Exist.	Gap	Req.	Exis.	Gap	Req.	Exist.	Gap	Req.	Exis.	Gap
18	20	0	54	27	27	21	18	3	21	18	3

The data adequacy as discussed above indicates that the existing data is 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. Based on the data gap identification, the data generation activity was planned and completed in 2020-21. In addition 4 no of EW and 2 no of OW has been drilled through outsourcing through WAPCOS.

1.5 Climate and Rainfall:

The district experience humid climate with three well defined seasons i.e. summer, winter and monsoon. The winters commence from middle November and extend up to middle of March. December is the coldest month. During winterthe temperature goes down to 40C. Summer starts from middle of March and continues upto middle of June, when the temperature shoots up 42^0C. The monsoon sets in by the middle of June and continue till the middle of October. The annual normal rainfall in the district is 1137 mm. 83.5% of total rainfall occurs during the monsoon months only i.e., middle of June to middle of October.

Table – 3:Average annual Rainfall (2020-21) of Lohardaga district

Sr. No.	Block	Average annual rainfall in (mm)
1	Lohardaga	1307.3
2	Kuru	1367.9
3	Bhandra	1557.5
4	Kairo	1224.4
5	Kisko	1394.8
6	Peshrar	1511.2
7	Senha	1598.4

1.6 Physiography: Lohardaga district is divided into two broad physical divisions namely (i) The Hilly Tract and (ii) The Mapau Region

The hilly tract is spreaded in the west and northwestern parts of the district, which includes the parts of Kisko, Senha and Kuru blocks. The high hill tops of this region are known as Pat Plateau. The region is covered mainly with sal forests. The Mapau region is a part of the Gumla Mapau, comprised with entire part of Lohardaga and Bhandra blocks and some parts of Senha, Kuru and Kisko blocks. This region has a number of small hill blocks covered with forests. The general slope of the district is from west to east and general height ranges from 402 meter to 1120 meters. The Digital elevation model of Lohardaga district has been presented in Figure-2

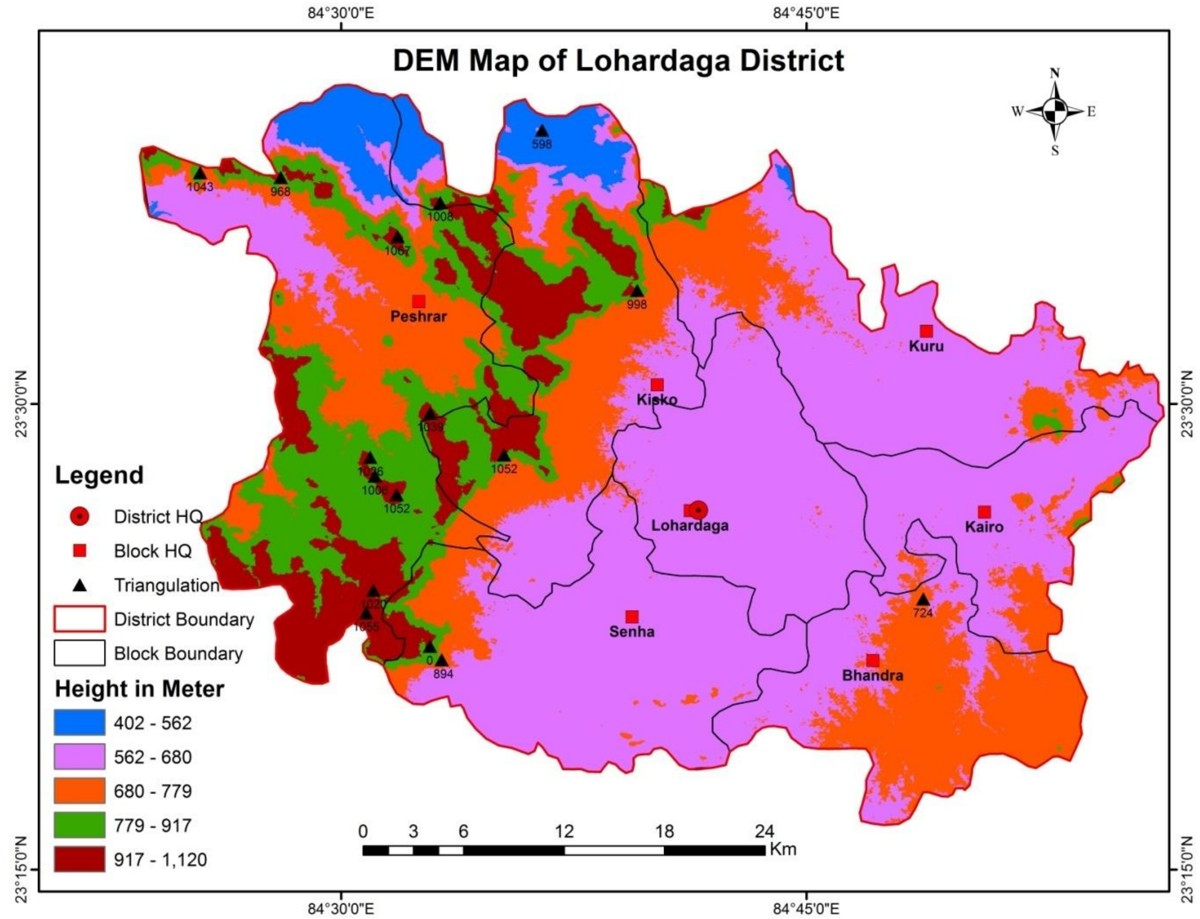


Figure – 2: Digital elevation model of Lohardaga district

1.7 Geomorphology:

Lohardaga district is a part of the Chhotanagpur plateau which is situated in the western part of the plateau. The terrain is highly undulating in nature. The plateaus are covered with laterite having the average thickness of 50m. In some places the laterites are enriched with aluminium and contain huge amount of bauxite. The average elevation of the district vary between 610 to 640masl . The Lohardaga district is divisible into following two physiographic unit .

i) **Plateau region:-** The average height of such plateau is 1000 m above mean sea level. The plateaus are covered with laterite having the average thickness to the tune of 50 m.

ii) **Peneplain area:-** The average altitude of the peneplain area is around 600 mamsl. Residual hills of different altitudes dot the peneplain area.

The geomorphological map of Lohardaga district have been presented in Fig-3

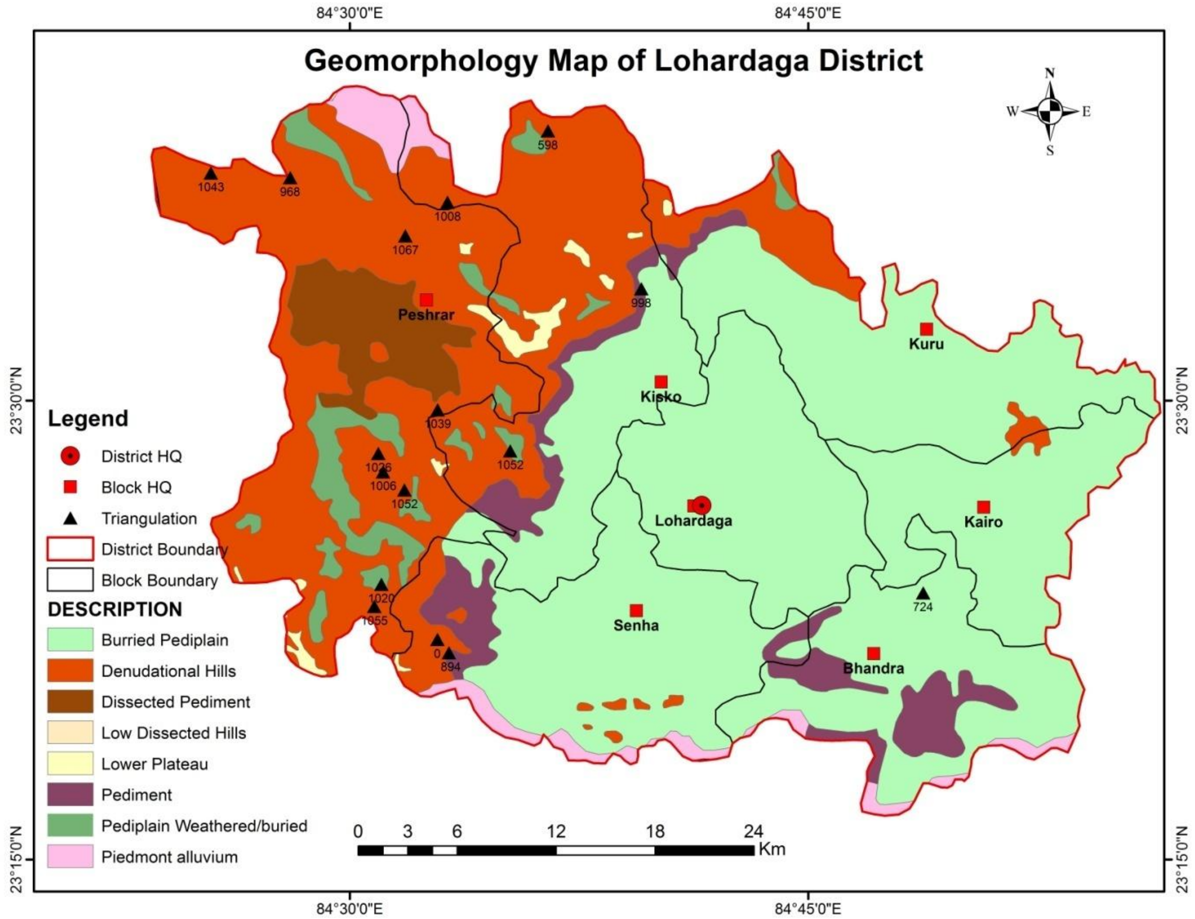


Figure – 3: Geomophology of Lohardaga district

1.8 Land Use: Geographical features play a major role in information of land use pattern. Out of total geographical area of the district i.e 1492 Sq. km, nearly 17 % area comes under net sown area, 26% under forests and the rest area falls under barren, cultivable waste, pasture and other agricultural use. The land use pattern data of the area for the year 2013 – 14 is given below in table-4. The Land use map of the Lohardaga district has been prepared and shown in figure – 4.

Table: 4: Land use pattern of Lohardaga district (2015– 2016) (Source: Lohardaga DIP report of PMKSY area in hectares)

sl.no	Block	Total Geographical Area	Gross Cropped Area (1)	Net Sown Area (2)	Area sown more than once (1-2)	Cropping Intensity (%)	Area under Forest	Area under Wasteland	Ares under other uses
1	Kairo	10540.72	8052.2	6722.5	1329.7	2168.21	307.1	969.09	1212.33
2	Kisko	24974.602	6918.672	4867.674	2376.922	1752.76	11145.8	948.112	1779.684
3	Kuru	43483.98	28981.8	25911.64	3070.16	0	7963.44	1895.82	4484.68
4	Bhandra	39319.76	25118.67	18487.59	6631.12	0	237.81	13743.72	205
5	Lohardaga	15369.41	8471.34	12198.15	3933.36	2147	135.91	2683.25	12548.82
6	Senha	107757.83	77061.05	29962.36	10018.34	0	18484.28	9905.66	9472.3

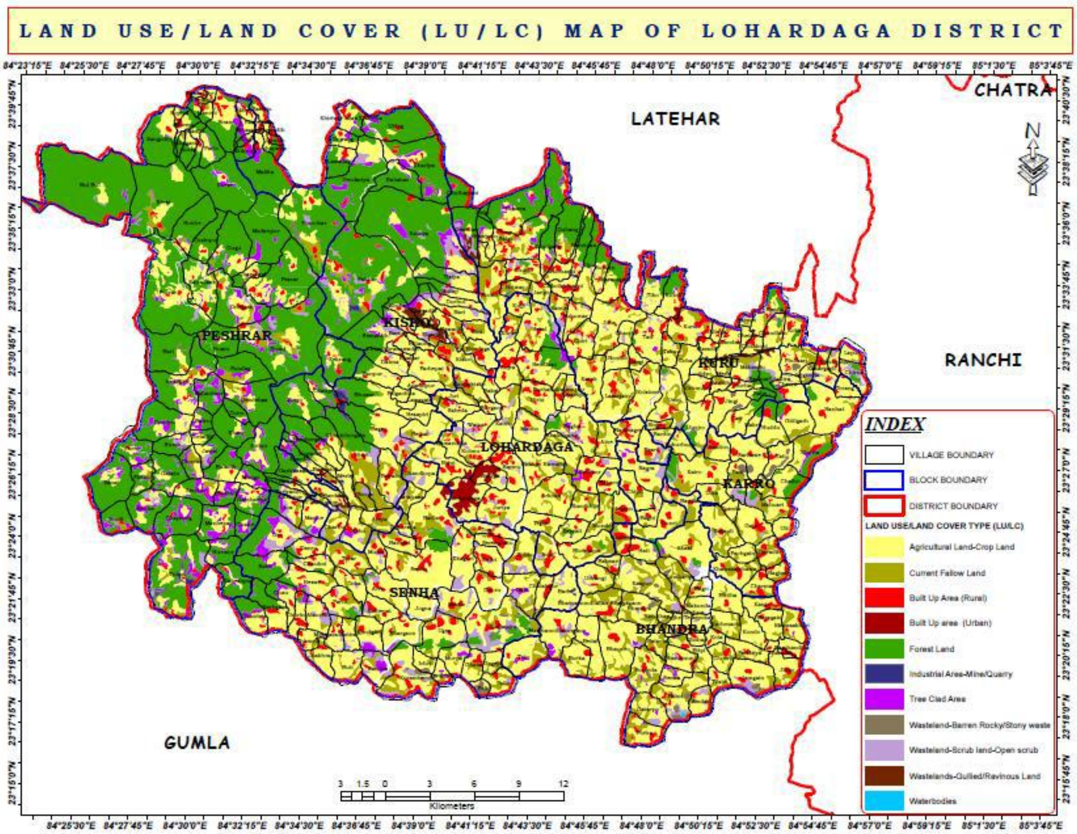


Figure – 4: Land Use Map of Lohardaga district
Source: PMKSY DIP Report of Lohardaga District

1.9 Soils

The soils occurring in different landforms have been characterised during soil resource mapping of the state on 1:250,000 scale (Haldar et al. 1996) and three soil orders namely Entisols, Inceptisols and Alfisols were observed in Lohardaga district (Fig.5) Alfisols were the dominant soils covering 52.60 percent of TGA followed by Inceptisols (25.0 %) and Entisols (21.1 %).

Soils of the district and their extent

Map unit	Taxonomy	Area ('00ha)	% of the TGA
15	Loamy-skeletal, mixed, hyperthermic Lithic Ustorthents Fine loamy, mixed, hyperthermic Ultic Haplustalfs	394	26.43
19	Loamy-skeletal, mixed hyperthermic Lithic Ustorthents Fine loamy, mixed, hyperthermic Typic Haplustepts	10	0.67
21	Coarse loamy, mixed, hyperthermic Typic Ustorthents Fine, mixed, hyperthermic Rhodic Paleustalfs	64	4.29
22	Fine, mixed, hyperthermic Typic Paleustalfs Fine, mixed, hyperthermic Typic Rhodustalfs	21	1.41
33	Fine, mixed, hyperthermic Typic Paleustalfs Fine, mixed, hyperthermic Typic Rhodustalfs	8	0.54
34	Fine loamy, mixed, hyperthermic Typic Paleustalfs Fine-loamy, mixed, hyperthermic Typic Rhodustalfs	445	29.84
37	Loamy, mixed, hyperthermic Lithic Haplustalfs Fine, mixed, hyperthermic Typic Paleustalfs	8	0.54
39	Fine, mixed, hyperthermic Rhodic Paleustalfs Fine-loamy, mixed, hyperthermic Typic Haplustepts	25	1.68
40	Fine loamy, mixed, hyperthermic Typic Haplustepts Fine loamy, mixed, hyperthermic Typic Haplustalfs	134	8.99
42	Fine, mixed, hyperthermic Typic Rhodustalfs Fine loamy, mixed, hyperthermic Typic Ustorthents	83	5.56
44	Fine, mixed, hyperthermic Aeric Endoaquepts Fine, mixed, hyperthermic Typic Haplustepts	280	18.78
Miscellaneous		19	1.27
Total		1491	100.00

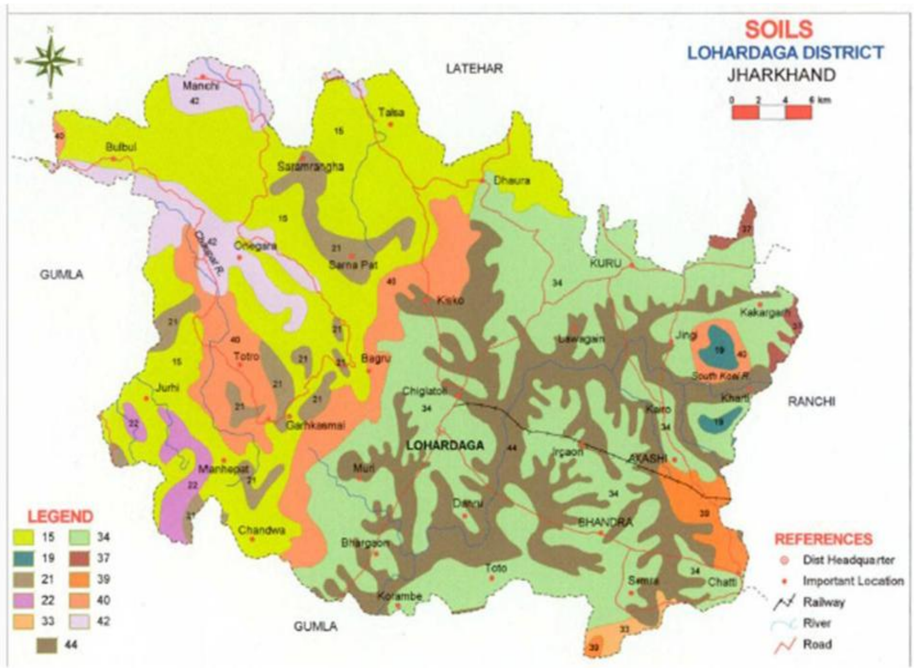


Figure 5 : Soil map of Lohardaga District

(Source) ***National Bureau of Soil Survey and Land Use Planning (ICAR), Regional Centre, Kolkata And Deptt. Of Soil Science & Agricultural Chemistry, BAU, Ranchi, Jharkhand*****)**

1.10 Hydrology and Drainage:

Lohardaga district covers the south - western part of Chhotanagpur plateau.The topography of the district is undulating and rugged. District has a number of small hillocks covered with forests. In general half part of the district slope from west to east and rest of the part east to west.Lohardaga district is drained by the tributaries of two major river of the state viz. North Koel & South Koel. The plateau region of the district is highly dissected by down cutting of the tributaries of these rivers.

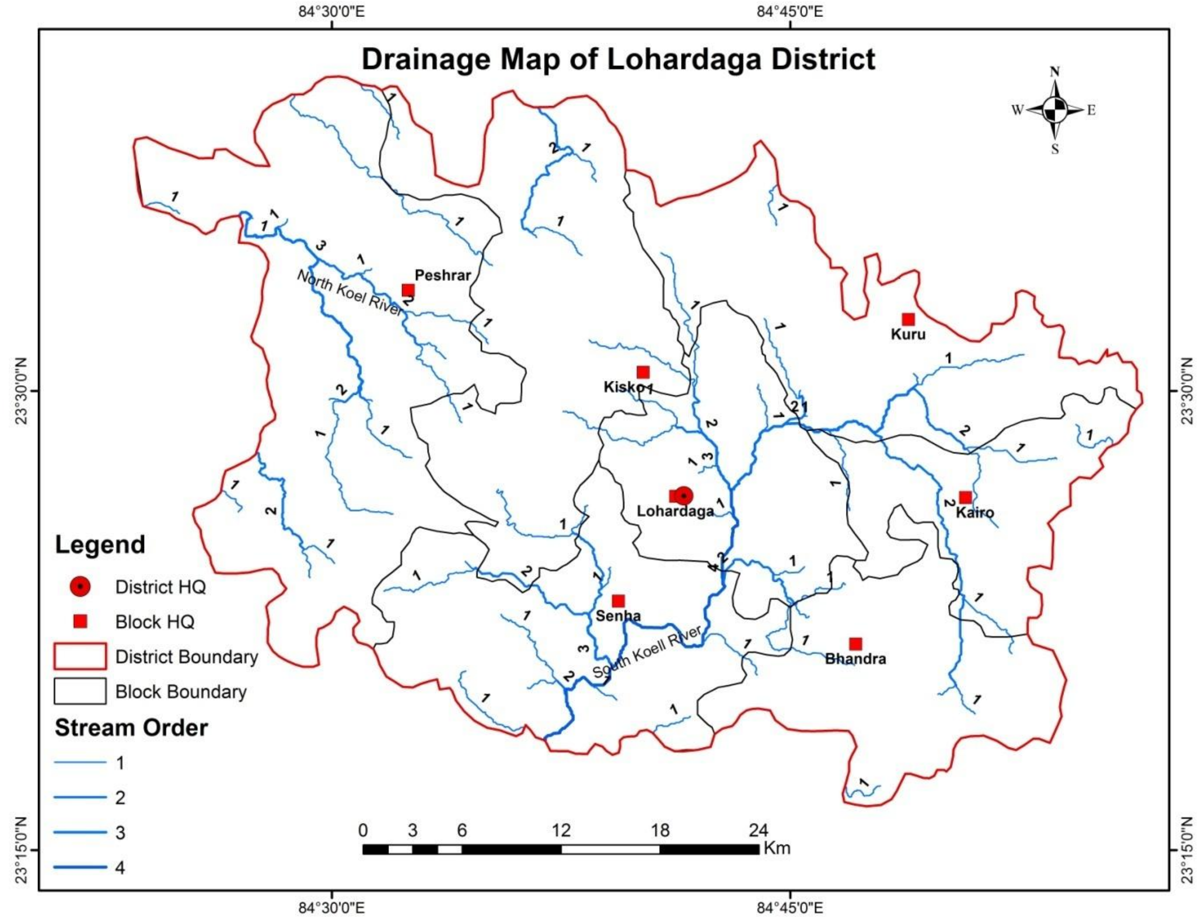


Figure – 6: Drainage Map of Lohardaga district

1.11 Agriculture and Irrigation Practices:

The local population of the district mostly depends on agriculture and forestry for their sustenance. The agriculture activity of the area is solely dependent upon the monsoon rainfall. Paddy is the main crop of the district. Wheat, Maize, Gram, Mustard oil Potato are other crops grown widely in Latehar and its adjoining areas. Irrigational facilities are not adequate in this district. The most common source is the dug well, but this is not a very dependable source of irrigation. The undulating nature of land makes it possible to store rain water by bunding. Apart from being dependent upon rains, these are by no means adequate. The result is that failure of rains invariably involves failure of crops except in small pockets. Minor irrigation structures like surface water, tanks and ponds are the other source for irrigation. Available source wise irrigation for the 2013-14 is given in table - 5.

Table 5: Block wise number of irrigation structure of Lohardaga district (2015-16)

Block	Surface water			Ground water			Other sources
	Canal	Tank	LI	DTW	STW	DW	
Peshrar		50		0	0	432	7
Lohardaga		6		0	8	1455	16
Kuru		14		0	2	1193	25
Kairo		12		0	0	636	4
Kisko		5			1	960	10
Senha		7		1	24	1039	18
Bhandra		13		1	1	1243	11
Total		**107**		**2**	**34**	**6958**	**91**

Source PMKSY DIP report

1.12 Cropping Pattern:

The major crops cultivated in the area are **paddy, wheat, maize, gram, pulses and vegetable.** But the land available for cultivation is very limited because of the hilly and rugged topography. Area under different crops for the year 2015 – 16 of the district is presented in table – 6.

Table – 6: Cropping pattern of Lohardaga district (2015-16)

Sl.no.	Block	Paddy	Coarse Cereals	Pulses	Oil Seeds	Fibre	Any other crops
1	Lohardaga	5935.83	676.79	443.6	116.36	8.35	1674.17
2	Senha	3251.94	672.26	712.65	168.42	29.26	2183.41
3	Bhandra	5220.6	1233.02	2008.25	346.24	45.43	6089.01
4	Kuru	3203.73	472.51	723.76	411.73	-	1646.57
5	Kairo	3043.08	369.46	883.41	236.1	8.34	2676.45
6	Peshrar	3050.51	601	517.39	289.54	32.94	1631.16

(Area in ha)

1.13 Geological set up

Lohardaga district occupies the south western part of the Chotanagpur Plateau. The district is underlain by Chotanagpur Granite-gneiss of Archean age forming the basement rock. Patches of mica schists also occur within the granite and gnessic country rocks. Laterite of Pleistocene age is found to occur as cap over granite gneiss in plateau region. Recent alluvium sediments are found to occur along the present-day river channels.

The generalized geological succession as encountered in Loharadaga district is given below: -

Geological Formation	**Age**
Alluvium	Recent to sub-Recent
Laterite	Pleistocene
---------------Unconformity---------------------	
Schist and Phyllite Chotanagpur Granite-Gneiss	Proterozoic to Archaean

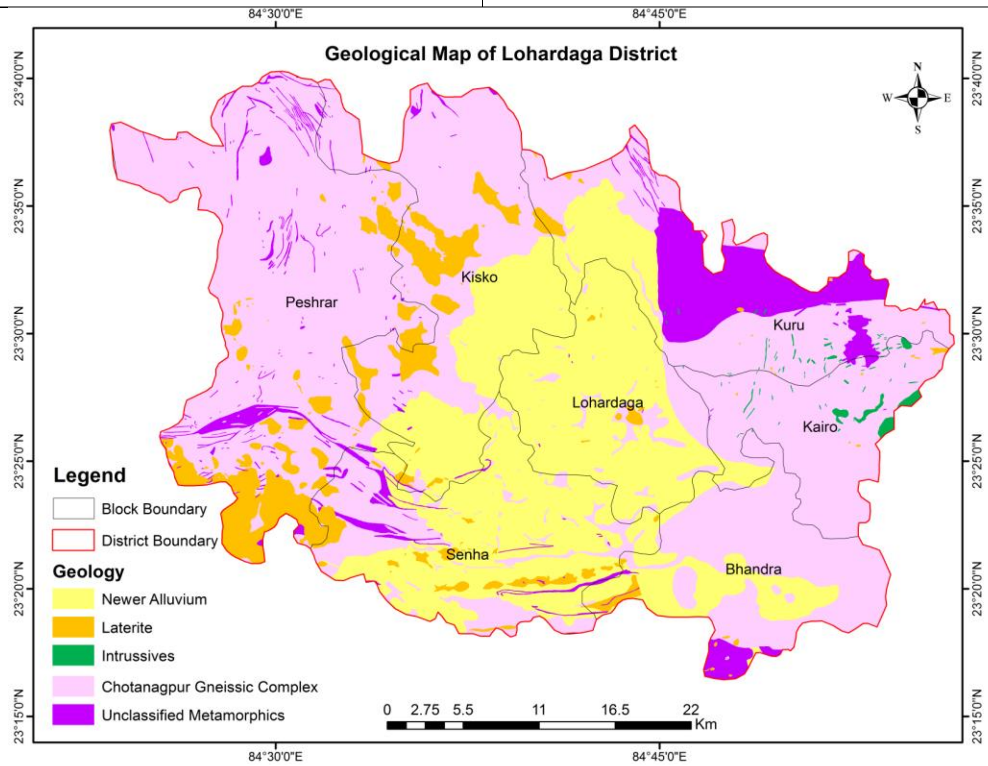


Figure – 7: Geological map of Lohardaga district (source GSI)

2.0 DATA COLLECTION AND GENERATION

The primary Data such as water level, quality, geophysical data and exploration details available with CGWB has been collected and utilised as baseline data. The Central Ground Water Board has established a network of observation wells under National Hydrograph Network programme to study the behavior of ground water level and quality of ground water in the district. To understand the sub–surface geology, identify the various water bearing horizons including their depth, thickness and compute the hydraulic characteristics such as transmissivity and storativity of the aquifers, exploratory drilling programme was carried out by Central Ground Water Board. For other inputs such as hydrometeorological, Landuse, cropping pattern etc. were collected from concerned state and central govt departments and compiled.

2.1 Data collection, Compilation & Data Generation

2.1.1 Data collection Compilation

The data collection and compilation for various components was carried out as given below

i. Hydrogeological Data: Water level data of 18 key wells and historical water level trend of monitoring wells were collected and compiled representing Aquifer-I.

ii. Hydrochemical Data: To evaluate the quality of ground water, 18 samples were collected from dug wells

iii. Exploratory drilling**:** 15 exploratory and 4 observation wells are existing in hard rock area and 06 exploratory well and 2 observation well were drilled through departmental rigs and 09 exploratory wells and 2 Observations drilled through Outsourcing (WAPCOS).

iv. Hydrometeorological Data: Last five years (2016-2020) monsoon rainfall data for each of the block from the office of District Agriculture Department, Lohardaga.

v. Land use and cropping pattern data**:** The data of land use and cropping pattern obtained from the office of Director Statistics, Ranchi.

vi. Thematic Layers: The following thematic layers were also generated which supported the primary database and provided precise information to assess the present ground water scenario and also to propose the future management plan.

1. Drainage
2. Geomorphology
3. Elevation
4. Land use
5. Geology & structure

The thematic layers such as drainage, geomorphology, DEM and land use have been described in Chapter – I.

2.1.2 Data Generation:

After taking into consideration, the data available with CGWB on ground water monitoring wells (GWMW), ground water quality, geophysical survey and ground water exploration, the data adequacy was compiled. The requirement, availability and gap of major data inputs i.e., exploratory wells, geophysical data, ground water monitoring wells and ground water quality data are detailed in the table – 2.

2.2 Hydrogeology:

The occurrence and movement of ground water in the area is variable, which is broadly governed by geological frameworks i.e., nature of rock formations including their porosity (primary and secondary) and permeability. The principal aquifer in the area is Chhotanagpur Gnesiss Complex, where the occurrence and movement of ground water primarily depends on the degree of interconnection of secondary pores/voids developed by fracturing and weathering.Based on morpho-genetic, geological diversities and relative ground water potentialities of the aquifers, the district can be broadly divided into two Hydrogeological units: Consolidated or Fissured formations, and unconsolidated or porous formations.

1. Consolidated or Fissured formations - Precambrians formation
2. Unconsolidated or Porous formations - Laterites and Alluvium

In major part of this district, hard rock form the principal aquifers, which includes mainly Chotanagpur gneissic complex,However, laterites at isolated patches as well as alluvium al materials along the vicinity of the rivers also form potential aquifers.

Hydrogeological map of Lohardaga district has been prepared (Fig-9)

2.2.1 *Ground water in Aquifer-I (Weathered Granite Gneisses, Laterites and alluvium): -*

The Aquifer-I is represented by weathered Granite- Gneisses, Laterites and alluvium. Within the depth zone of dug wells, the weathered zone influences to a greater extent in the hard rock formation constituting potential phreatic shallow aquifer. Laterites occur as cappings over granite-gneiss. Ground water occurs within the weathered residuum at favorable locations.The average thickness of the weathered residuum of the districtvariesfrom 15-30 m. Besides, the patches of laterite deposits contain goodamount ofground water within its primary porosityin the western part of the district. Thevalley has beenformed mainly by South Koel andits tributaries like Sankh.Ground water also occurs in the unconsolidated sediments deposited by theserivers.Potential aquifer exists at shallow to moderate depth. Ground water occurs in unconfined to semi-confined state in Aquifer-I (upto the depth of 30m). Yield of the wells in Aquifer-I is very poor restricted to 5-10 m3/hr in laterites/weathered Granite-Gneiss. These aquifers are generally tapped by the dugwells or shallow borewells.

2.2.2 *Ground Water in Aquifer – II (Fractured Granite Gneiss): -*

The Chotanagpur granite-gneiss, belonging to Precambrian age constitutes the group of Fissured formation hydrogeological units as an Aquifer-II i.e. Deeper Aquifer in the area. The aquifers in these rocks lack the primary porosity and occurrence and movement of ground water is to a large extent controlled by the extent and development of secondary porosity like joints, fissure planes etc. These rocks are the part of Chotanagpur Craton of Indian Shield. They contain hard rocks of different age, grade of metamorphism and structure. Many orogenic movements have affected the shields. Some rock types are extensively fractured; while others are almost undisturbed, even though they belong to the same tectonic environment. Based on exploratory drilling by CGWB, Moderate to good yield has been obtained in the wells upto the depth of 200m.

2.2.2.1 Potential Fractures: Potential Fractures have been identified based on exploratory drilling in Lohardaga district as under Table-7

Table-7.Potential Fractures identified based on exploratory drilling in Lohardaga district

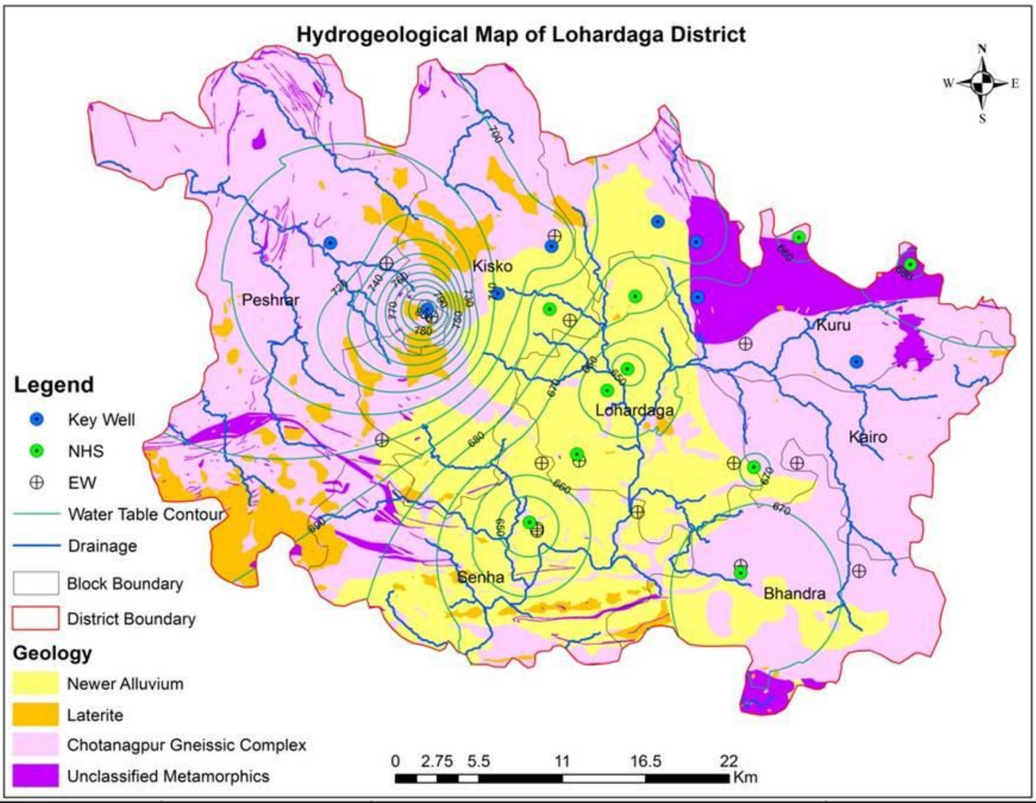
Sl No	Location	Block	Co-ordinate	Depth Drilled m	Casing Depth m	Granular Zone / fracture Tapped m	Discharge m^3/hr	Formation
1	Senha EW -2	Senha	$23^0$23’05’’ $84^0$39’30’’	176.26	18.15		7.2	Granite gneiss
2	Irgaon EW	Bhandra	$23^0$25’25’’ $84^0$46’30’’	199.12	19		6.45	Granite gneiss
3	Gangupara EW	Lohardaga	$23^0$27’04’’ $84^0$39’17’’	138.56	13.0	44.0-45.0 121-122 126-127 131-132	5.23	Granite gneiss
4	Gangupara	Lohardaga	$23^0$27’04’’ $84^0$39’17’’	135.54	13	130-132	14.40	Granite Gneiss
5	Rampur EW	Lohardaga	$23^0$26’21’’ $84^0$45’08’’	153.80	11.50	27-28 42-44	20.52	Granite Gneiss
6	Bhandra EW	Lohardaga	$23^0$21’30’’ $84^0$46’45’’	153.8	28	46-47 54-56	14.04	Granite Gneiss
7	Kujra EW	Lohardagga	23^0 30’ 30” 84^0 40’ 40”	116.85	42.42	33.88-39.50 45.11-50.64 74.97-80.56 92.80-98.56	28.8	Granite gneiss
8	Badla EW	Senha	23^0 25’ 25” 84^0 39’ 40”	132.39	22.57	25-28, 85-88	24	Granite gneiss
9	Shah Booty/Lohardaga EW		$23^0$25′51″ $85^0$20′13″	144.05	18.6		44.28	
10	Kuru/ Lohardaga	Kuru	$23^0$32′12″ $84^0$49′11.7″	200.0	31.0		7.92	
11	Murappa/ Lohardaga EW		$23^0$20′8.2″ $84^0$40′31.7″	134.76	35.45		80.28	
12	Jawakheda	Peshrar	$84^0$34'08.8" $23^0$30'37.7"	201	24.5	75.0-76.0	18.828	Granite Gneiss
13	Garahkasmar	Peshrar	$84^0$33'59.1" $23^0$26'13.8"	138	34.5	115.2-115.5	18	Granite Gneiss

Source: CGWB Compile all the wells previous plus NAQUIM plus outsourcing

On the basis of field investigations and results of exploratory wells drilled in the district, salient findings are summarized as:-

- In general in fissured formations, discharge of well has been found upto 80.28 m^3/hr.
- Overall in the district the major potential fractures zones are found between 25-130 m.
- First potential fracture zone encountered in the district widely varies from 11-108 m depth.
- Sometimes the potential fractures were encountered at very shallow level upto 55m with very high yielding wells(Rampur-20.52 m3/hr, Bhandra-14.04m3/hr), between 50-100m (Murappa-80.28m3/hr, Sneha-24m3/hr).
- Some of high yielding well where multiple fractures were encountered at deeper level more than 100 m (Gangupara-14.4 m3/hr, Garhkashmar-18 m^3/hr)

The hydrogeological map of area is prepared and presented in figure -8.



Symbol	Lithology	Hydrogeology	Yield Potential
	Alluvium	Thickness varies from few meters to 20m underlain by crystalline rocks. Groundwater occurs under phreatic conditions	Supports dugwells & shallow tubewells, yield varies from 1-5 m³/hr
	Laterite	Moderately thick, porous, discontinuous,found as patches	Moderate, 5-10m³/hr
	Chotanagpur Gneissic Complex	Groundwater restricted to weathered residuum/fractures(upto 200m),water table & semi-confined to confined conditions	Moderate to good yield prospecs, 5-40m³/hr
	Unclassified Metamorphic	Groundwater restricted to weathered residuum/fractures,water table & semi-confined to confined conditions	Limited yield prospects, below 10m³/hr

Figure – 8: Hydrogeological Map of Lohardaga district

2.2.3 Ground water Dynamics:-

2.2.3.1 Ground water Monitoring Wells: 09 key wells were established and 09 NHNS monitored to assess the ground water scenario of shallow aquifer (Aquifer-I) of the area. The depth of these dug well varies from 7.50 to 13.80 mbgl. Similarly, the diameters of key wells (dug wells) ranges from 2.10 to 4.60m. During 2020, the pre monsoon (May) depth to water level in these wells was between 4.60 to 11.10 mbgl. The post monsoon depth to water level (Nov. 2020) in the dug wells ranges from 0.01 to 7.72 mbgl. Average pre-monsoon water level was calculated 7.96 mbgl and in post monsoon 4.23 mbgl respectively.

A detail of key wells and water level data is presented in Annexure – I & II. Location of key wells and exploratory wells are shown in figure –9.

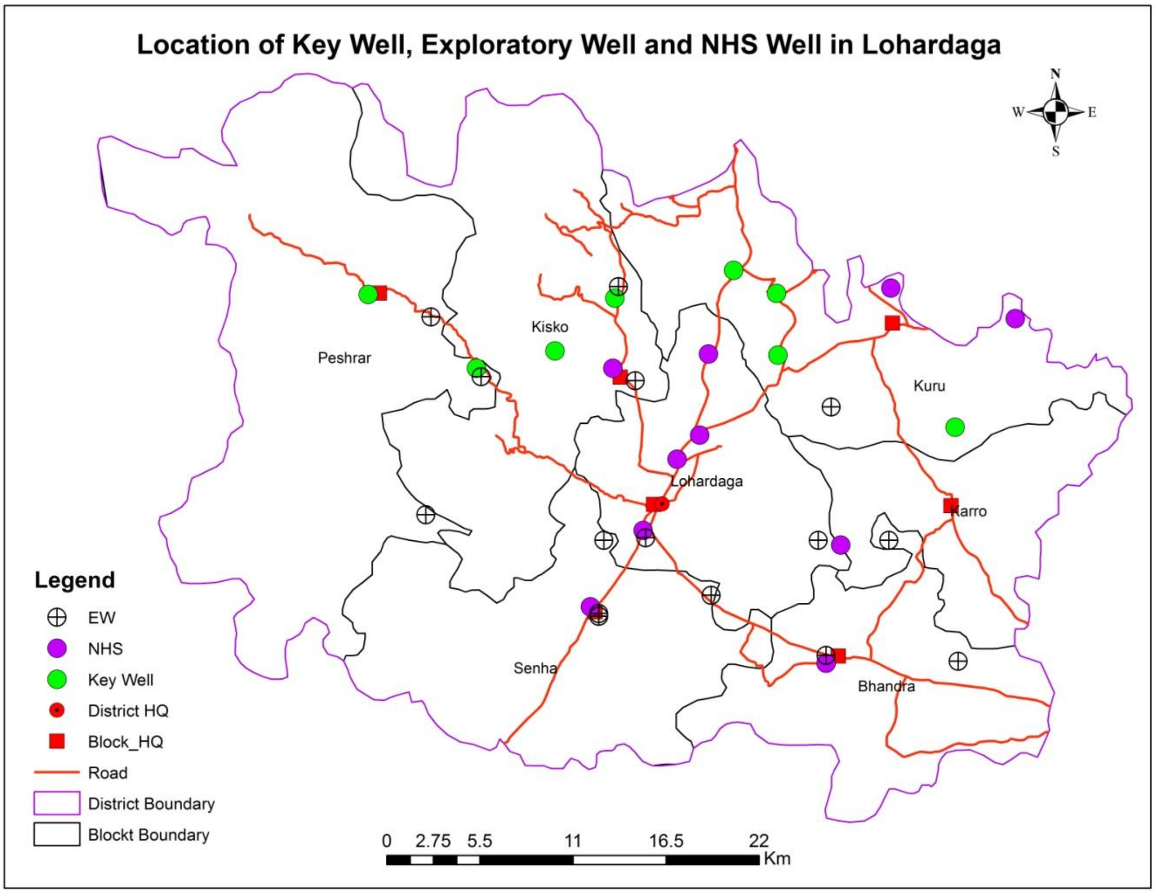
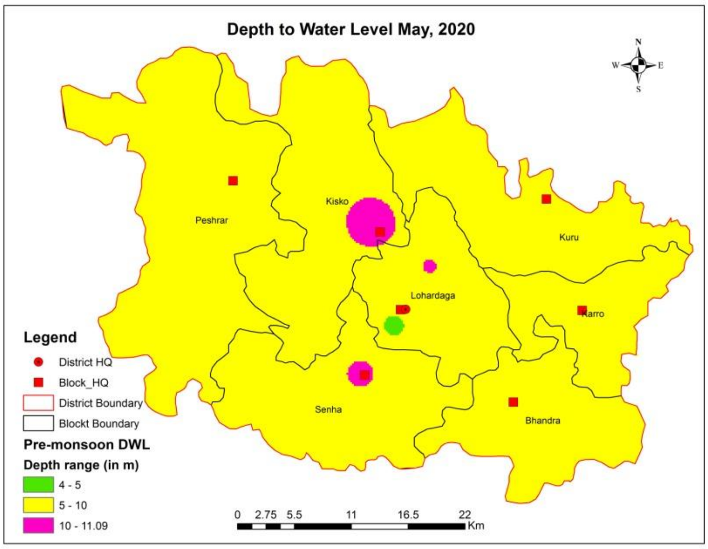
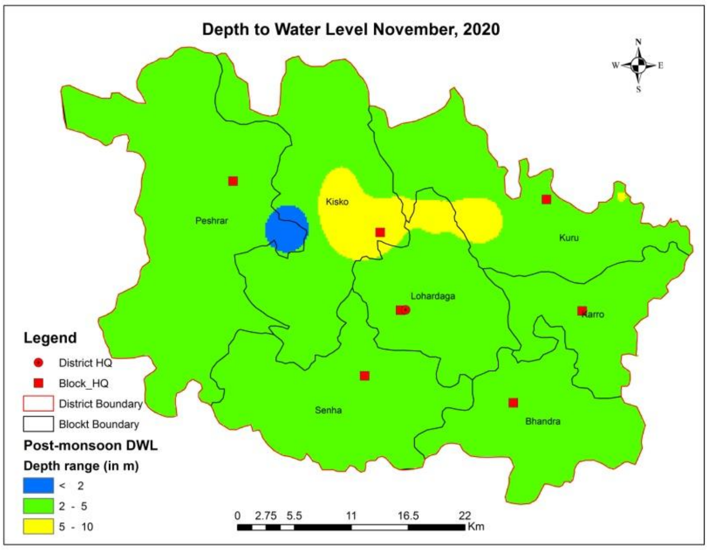


Figure –9: Location of Key wells NHNS and Exploratory wells

2.2.3.2 ***Water Level Scenario – Aquifer – I (Shallow Aquifer):*** water level scenario of shallow aquifer was generated by utilizing water level data of 18 monitoring wells representing shallow aquifer. The pre monsoon (May 2020) depth to water level monitored between 4.6 to 11.10 mbgl and average 7.96m bgl. The post monsoon depth to water level (Nov. 2020) in the dug wells ranges from 0.01 to 7.72 mbgl and average 4.23 m bgl respectively. Pre and post monsoon depth to water level maps were prepared for the year 2020 and shown in figure – 10, 11.

 **Figure – 10: Pre monsoon (May 2019) depth to water level map of Aquifer – I (shallow aquifer)**	 **Figure – 11: Post monsoon (Nov. 2020) depth to water level map of Aquifer – I (shallow aquifer)**

The water level monitored during pre and post monsoon period 2020 and 2020 was used to compute the seasonal fluctuation.

2.2.3.3 Water level fluctuation:

The seasonal water level fluctuation was observed between 1.20 to 8.35m for the period between pre monsoon and post monsoon 2020.

2.2.3.4 Ten years Long Term Water Level Trend (2012-2021):

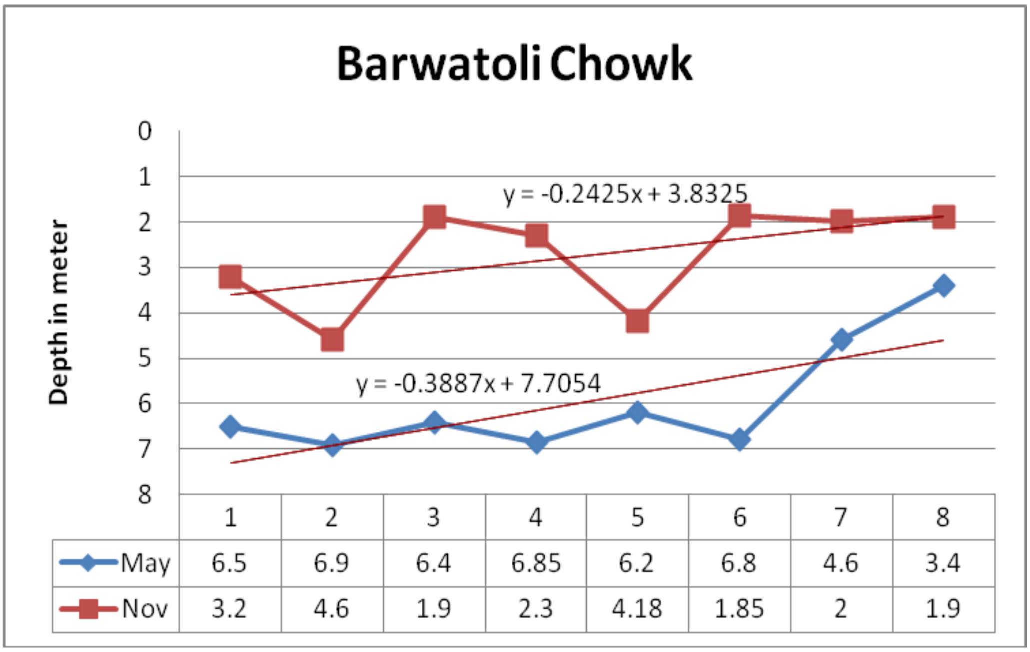
In order to study long term behavior of the water levels and also the effect of various developmental activities with time, the data for the period 2012-2021 have been computed and analyzed which is presented in table - 8. The annual decadal water level of the district was observed rising trend in 3 stations and declining trend in 4 staqtions.

Table:8 Last ten years long term water level trend of Lohardaga district (2011 – 2020)

	Lohardaga		
		Annual	
Sl No.	**Location**	**Rise (m/year)**	**Fall (m/year)**
1	Bhandara		0.027
2	Senha Bdo		0.0632
3	Lohardaga(pwdib	0.0668	
4	Lohardaga(Patra Toli)		0.0701
5	Hinjla		0.0087
6	Kuru1	0.1217	
7	Rudh1	0.2546	

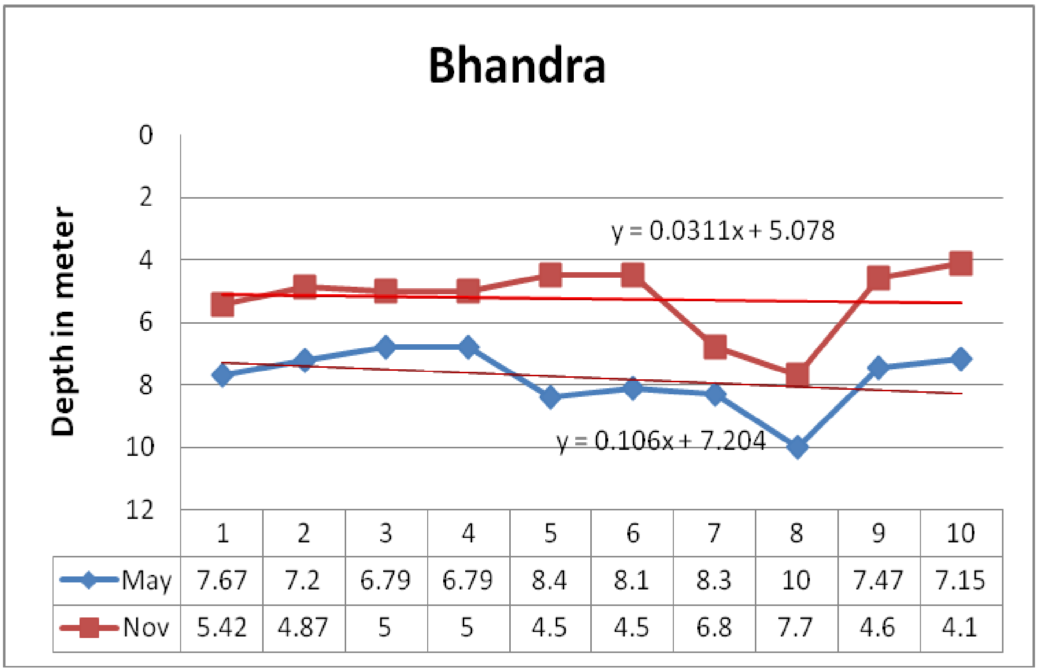
2.2.3.5 Hydrograph Analysis:

Analysis of five (05) hydrograph network stations, were carried out using Excel software (Figure-12-15) and analysed for the period from 2012-2021. It is observed that the long-term water level trends during pre and post-monsoon seasons are declining trend in one station and four station are rising in shallow aquifer-I represented by dug wells.



	1	2	3	4	5	6	7	8
May	6.5	6.9	6.4	6.85	6.2	6.8	4.6	3.4
Nov	3.2	4.6	1.9	2.3	4.18	1.85	2	1.9

Figure 12: Hydrograph (2012-2021), Barwatoli Chowk, Lohardaga



	1	2	3	4	5	6	7	8	9	10
May	7.67	7.2	6.79	6.79	8.4	8.1	8.3	10	7.47	7.15
Nov	5.42	4.87	5	5	4.5	4.5	6.8	7.7	4.6	4.1

Figure-13: Hydrograph (2012-2020), Bhandra block, Lohardaga district

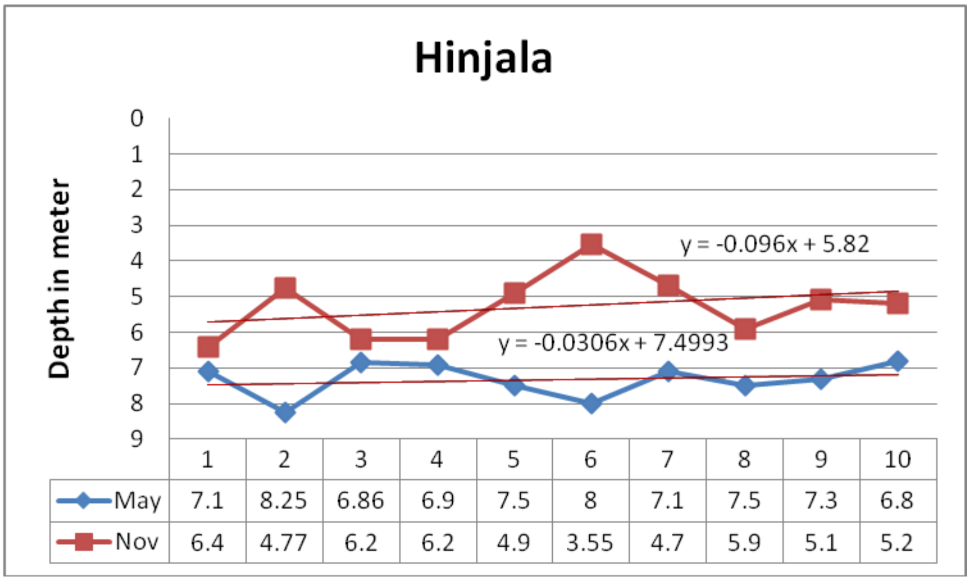


Figure- 14: Hydrograph (2012-2020), Hinjla, Kuru block, Lohardaga district

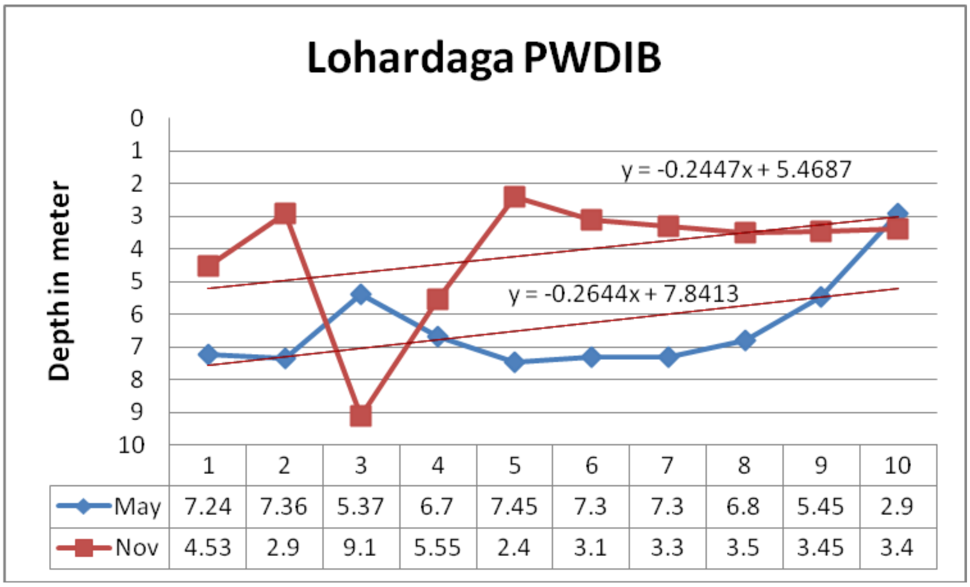


Figure- 15: Hydrograph (2012-2020), Lohardaga PWDIB, Lohardaga block, Lohardaga district

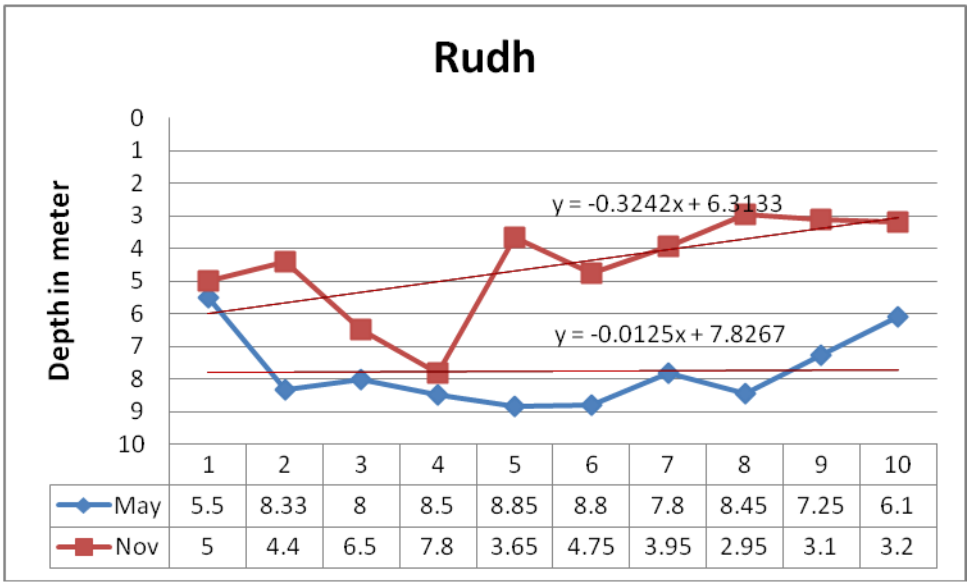


Figure- 16: Hydrograph (2012-2020), Rudh, Kuru block, Lohardaga district

2.3 Geophysical Survey:

54 VES is required in the district each block only 27 nos. of VES have been done by WAPCOS in Lohardaga district. The district has 7 blocks, and geophysical surveys were carried out in 4 blocks. Lohardaga district is mainly occupied by Archaean granite gneiss and patches of Older alluvium in the western part and quartzite, schist and phyllite in the northeastern part. A total of 27 VES were carried out in granite gneiss in 4 blocks of Lohardaga district. Details of VES location is given in Annexure-V

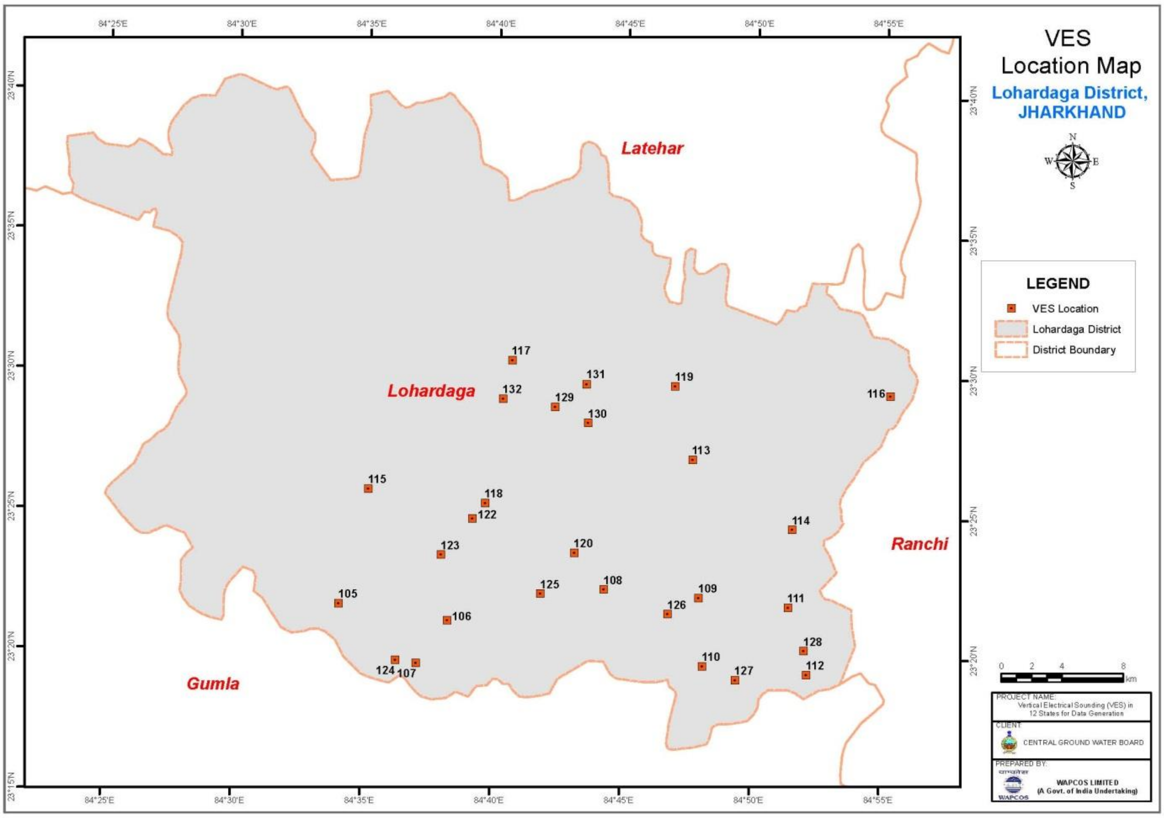


Figure 17: Map of Lohardaga district showing VES locations

Interpreted Results of VES

Interpreted results of VES are given in Annexure-I. The geoelectrical characteristics of the weathered and semi-weathered zones are given in Table 10.0. Based on the results of the VES conducted, it can be said that in Lohardaga district the weathered zone in granite gneiss terrain extends maximum up to 33 m depth. The resistivity of the weathered zone ranges from 15 to 70 ohm.m. Out of 27 VES sites at 8 VES sites the depth to the bottom of the weathered zone exceeds 10 m. The semi-weathered zone extends to a maximum depth of 94m at VES 115. The resistivity of semi weathered zone varies from 88 to 258 ohm.m. The fractured zones have been delineated empirically.

2.4 Ground Water Quality:

The quality of water plays prominent role in promoting both the standards of agriculture production and human health. To evaluate the quality of ground water, samples have been collected from 19 dug wells. The analytical results of water samples dug wells are given in Annexure-IV. The ground water samples were analyzed for major chemical constituents by using standard procedure at chemical laboratory in CGWB, MER, Patna. These samples have been considered to assess the chemical quality of ground water and its suitability for drinking and irrigational purposes. Since the samples are collected from the dug wells, they represent the quality of Aquifer I (phreatic/ shallow zone) and four no. of bore wells.

2.4.1 Chemical Parameters Of Aquifer I :-

Evaluation of ground water suitability in relation to its different purposes has been classified for drinking / domestic and irrigation. Water is very essential for life. Many a times it has raw consumption or indirectly (in food). Hence, it should be free from turbidity, odor, bacterial and poisonous contents and also chemically soft, low T.D.S value and other chemical constituents should range within low to tolerable limits. Excessive and longer use of water beyond these limits may endanger to many health problems. The variation range of the concentration in ppm of different chemical constituents and quality parameters of Aquifer I (dug wells samples) in table-11.

The distribution of different constituent in ground water can be described as follows:-

Hydrogen ions activity:

It is expressed in terms of pH and shows the acidity & basicity of the solution. Natural water reacts with H^+ & H^- ions and forms H_3O or ions. The recommended limit (6.5 to 8.5) by BIS, 2012 is base on taste, corrosion and scale formation criteria. The pH value in Aquifer-I ranges from 7.04 to 8.31 mg/l.

Electrical Conductivity:

Generally, the water's electrical conductivity increases in the dry periods because of evaporation and decreases in the rainy days because of the precipitation and also to the surface runoff flow into reservoir. The EC value in Aquifer-I ranges from 123 to 787 Microsemen at 25^{0c}.

Carbonate & bicarbonate:

Naturally occurring carbondioxide is the foremost source of carbonate and bicarbonate ions in ground water along with the carbon cycle and carbonaceous rocks. Leaching of calcite or dolomite bearing rocks (mainly carbonate) is also a principal source of these ions at places. Carbonate content of the area is not detectable. The bicarbonate concentration ranges between 30.50 to 219.60 mg/l.

Chloride:

The chloride anions in a certain water environment are characterized by a high stability. Thus, the concentration of chlorides shows little change after long flow distance because the dissolution of chloride is greater in water and the reaction between Cl- and other ions in stratum is insignificant. The Chloride concentration ranges between 7.09 to 63.90 mg/l.

Fluoride:

Its low solubility in water makes it different form the rest of halogen family. Fluoride geochemistry is mainly governed by fluoride bearing minerals found in Chotanagpur Gneissic complex.The main sources are fluorite (CaF_2), fluorapatite & other minerals present in rocks contributing the ion in water. The Flouride concentration ranges between 0.03 to 2.29 mg/l.

Sulphate

Sources of sulphate are minerals pyrite (FeS_2), anhydrite ($CaSO_4$). Under some conditions considerable quantities of sulphate may be obtained from organic Sulphur compounds. The generalized formulae for sulphate reaction is;

$$SO_4^{2-} + 2CH_2O \rightarrow 2HCO_3^{-} + H_2S$$

The Sulphate value ranges between 0.00 to 32mg/l.

Sodium

Sources of sodium are halite, sea spray, brines and some silicates. Common sodic silicates include plagioclase. The only common sink for sodium is reverse ion exchange that occurs when highly saline waters come in contact with calcium rich clays.

The Sodium concentration ranges between 3.20 to 65 mg/l.

Calcium:

In mineral form, it is found as Calcite, aragonite, gypsum, anhydrite, anorthite, diopside etc. The Calcium concentration ranges between 10 to 84 mg/l.

Magnesium:

The most common source of large quantities of magnesium in natural waters is dolomite. Magnesium is also derived from the silicates olivine, pyroxene and amphibole. The main sink is montmorillonite. The Magnesium concentration ranges between 3.64 to 21.87 mg/l.

Total Hardness:

It is expressed in terms $CaCO_3$ and it is equal to Calcium + Magnesium equivalent per litre. It can be classfied as under:-

Hardness range (mg/l $CaCO_3$) -	Class	
0- 60	-	Soft
61-120	-	Moderately hard
121-180	-	Hard
>180	-	Very Hard

In the study area, the total hardness value ranges from 43.76 to 300 mg/l.

Table - 9: Ranges of chemical constituents of Aquifer – I

Chemical Constituents and quality parameters	**Aquifer – I (Dug well samples)**
pH	7.04- 8.31
EC (micro siemens/cm at 25^0c)	123 - 787
TDS (ppm)	97.95 – 511.60
TH as $CaCo_3$ (ppm)	73.76 - 300
Ca (ppm)	10 - 84
Mg (ppm)	3.64 – 21.87
Na (ppm)	3.20 - 65
K (ppm)	0.06 - 24
HCO_3 (ppm)	3.50 – 219.6
Cl (ppm)	7.09 – 63.9
SO_4 (ppm)	0.00 - 32
NO_3 (ppm)	1.20 - 86
F (ppm)	0.03 -2.29

The ground water of Aquifer – I (shallow aquifers) in the area is alkaline in nature. On the perusal of table - 11, the pH value of the area is 7.04- 8.31. The TDS value is varies between 97.95 to 511.60 mg/l. Overall values of Calcium and Magnesium varies between 10 to 84 mg/l and 3.64 – 21.87 mg/l in the area respectively. Nitrate concentration is observed between 1.20 to 86 mg/l while the Fluoride value varies from 0.03 to 2.29 mg/l within the area.

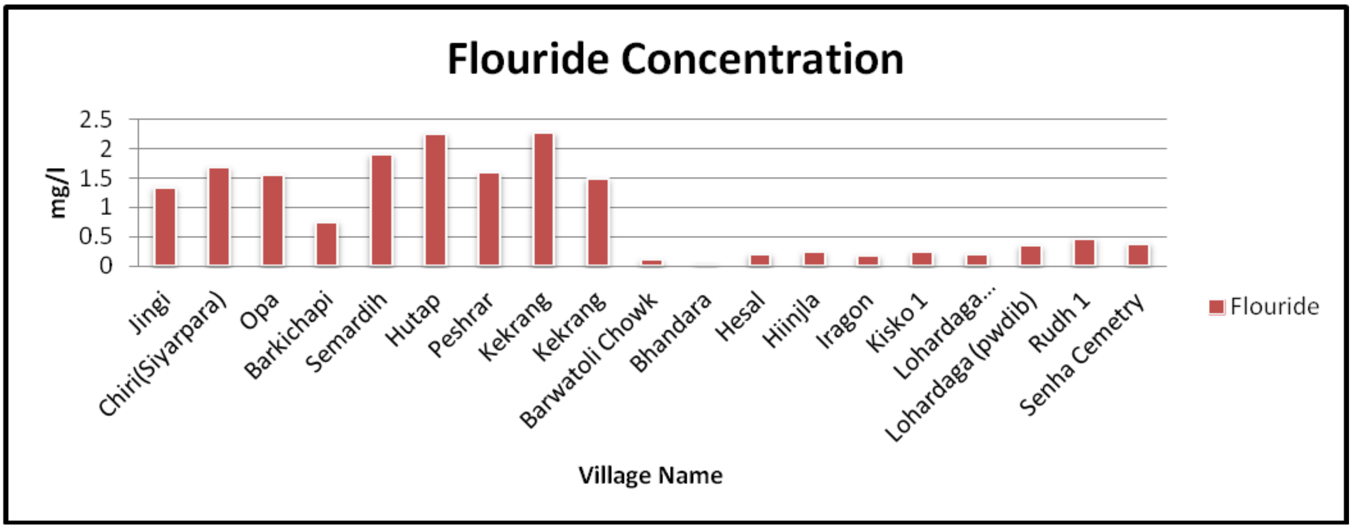


Figure 18. Flouride Concentration in Lohardaga district

2.4.1.1 Suitability of Ground Water of Aquifer – I for Drinking Purposes: -

The suitability of ground water for drinking purposes is determine on the basis of drinking water specification adopted by the Bureau of India Standards IS 10500 – 91 Revised 2012 and approved by World Health Organization (WHO). The number of water samples falling under various categories of permissible and desirable limits of various constituents and its percentage are given in table – 10 Aquifer – I.

Table-10: Suitability of ground water of Aquifer- I for drinking purposes

Chemical constituents and quality parameters	Ranges Desirable		No. of samples under desirable limits	No. of samples under permissible limit	No. of samples under excessive limits
	Desirable limit	Permissible limits in the absence of alternate source			
Ph	6.5 to 8.5	No relaxation	19 (100%)	Nil	Nil
TDS (ppm)	500	2000	18 (95%)	1(5%)	Nil
TH as $Caco_3$ (ppm)	200	600	18 (95%)	1(5%)	Nil
Ca (ppm)	75	200	19 (100%)	Nil	Nil
Mg (ppm)	30	100	19 (100%)	Nil	Nil
Cl (ppm)	250	1000	19 (100%)	Nil	Nil
SO_4 (ppm)	200	400	19 (100%)	Nil	Nil
HCO_3 (ppm)	200	600	19 (100%)	Nil	Nil
NO_3 (ppm)	45	No relaxation	12 (63%)	Nil	7(37%)
F (ppm)	1.0	1.5	11(58%)	1(5%)	7 (37%)

The table - 10 indicates that all the water samples are falling in desirable to permissible category except Nitrate and Flouride. The value of Nitrate observed beyond permissible limit (mg/l) in 07 samples. Similarly, the value of in 1 Sample of Flouride were found within permissible limit and 07 samples are found beyond permissible limit.

2.4.1.2 Suitability of Ground Water of Aquifer – I Irrigation Purposes:

Apart from domestic consumption, irrigation is consuming a major share of ground water for agricultural activities. The quality of water used for irrigation is an important factor in productivity and quality of irrigated crops. The suitability of water for irrigation purpose depends upon the Total Dissolved Solid in terms of EC value, concentration of Na, bicarbonate and its relative proportion to Mg and Ca. All these mentioned above either individual or with combination create concentration of Sodium (salinity) bicarbonate and alkalis type of hazard.

To better understanding the suitability of ground water for irrigation purpose chemical result of collected water samples have been analyzed and described the different classifications. Various parameters viz. Total Dissolved Solids (TDS), Sodium Adsorption Ratio (SAR), Residual Sodium Carbonate (RSC), Salt Index (SI), Soluble Sodium Percentage (SSP) & Water Class have been evaluated to assess the suitability of ground water for irrigation purposes.

Sodium Percentage classification: - EC and sodium concentration are very important in classifying irrigation water. The salts, besides affecting the growth of the plants directly, also affect soil structure, permeability and aeration, which indirectly affect plant growth.

Sodium is a major ion used for the classification of irrigation water due to its reaction with soil that reduces its permeability. Percentage of Na is generally used for assessing the suitability of water for irrigation purposes. Na is expressed as percent sodium or soluble-sodium percentage (Na %) using equation.

$$\text{Sodium Percentage (Na \%)} = \frac{(Na^+ + K^+) \times 100}{(Ca^{2+} + Mg^{2+} + Na^+ + K^+)} \quad \text{Wilcox (1955)}$$

Table- 11: Classification of ground water of Aquifer - I based on sodium percent

Sl No.	Water class or category	Sodium percent	No. of samples falling	Percentage of samples
1	Excellent	< 20 %	00	
2	Good	20 – 40 %	02	10%
3	Permissible	40 – 60 %	14	74%
4	Doubtful	60 – 80 %	03	16%
5	Unsuitable	> 80 %		

(Where all ions are expressed in epm)

On the perusal of table 74% of water samples of aquifer – I (dug wells) falling under permissible 16% doubtfull and 10% good category.

Sodium adsorption ratio (SAR): -In assessment of the quality of water used for irrigation, sodium adsorption ratio (SAR) is a vital parameter. Enhanced salinity decreases the osmotic activity of plants as well as stops water to reach to the branches and leaves of plants resulting in inferior production. Moreover, irrigation water with high sodium and low calcium favors ion exchange by saturation of Na and is detrimental to the soil structure due to scattering of clay particles resulting in minor production because of difficulty in cultivation. The sodium adsorption ration is calculated from the ionic concentration of Sodium, calcium and magnesium according the following relationship:

$$\mathrm{SAR} = \frac{\mathrm{Na}^{+}}{\sqrt{\frac{(\mathrm{Ca}^{2+}+\mathrm{Mg}^{2+})}{2}}}$$

where Na^{+}, Ca^{2+} and Mg^{2+} are in meq/l.

SAR values can be used to predict the degree to which irrigation water tends to enter into cation exchange section in soil. The higher value of SAR indicates damage of soil. Based on the SAR value the groundwater suitability classification is shown in Table-14 which is showing that all the water samples (100%) of aquifer – I (dug wells) pertain to excellent class. In Lohardaga district all all 19 water samples collected during the field falls in the (0-10) C1 category, ground water is excellent for irrigation.

Table: 12 Sodium Adsorption Ratio

Sodium Hazards Class	SAR (meq/L)	Remarks	Study area quality
C1	0-10	Excellent	All (19 sample)
C2	10-20	Good	-
C3	20-26	Doubtful	-
C4	>26	Unsuitable	-

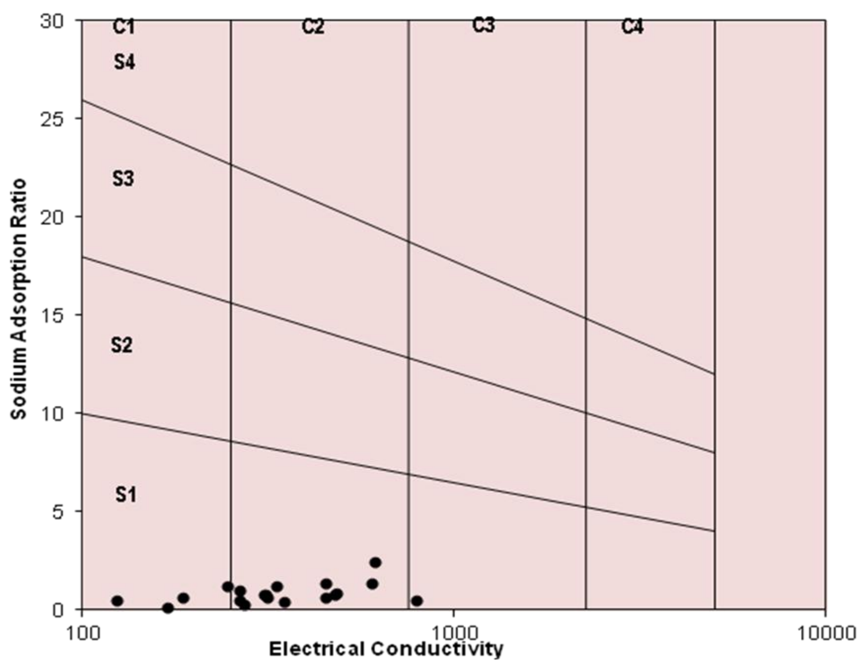


Figure:-19 U.S. salinity Hazards for Aquifer – I

Residual Sodium Carbonate (RSC)

The potential for a sodium hazard and Residual sodium carbonate (RSC) are directly proportional, and much of the calcium and magnesium are precipitated out of solution when water is supplied to the soil. Calculation of RSC is given below.

Residual sodium carbonate (RSC)	$(HCO_3^- + CO_3^{2-}) - (Ca^{2+} + Mg^{2+})$	Eaton (1950); Richards (1954)

In study area 19 water samples of shallow Aquifer-(dug wells) collected for analysis and are safe for all type of crops for irrigation.

On The perusal of table-15, about 100 % of water samples of Aquifer – I (dug well) falling under good water class.

Table: 13 Residual Sodium Carbonate (RSC)

Parameter	Range	Irrigation Suitability	Sample	Percentage
Residual Sodium Carbonate **(RSC)**	< 1.25	Safe for all type of crops	19	100
	1.25 – 2.50	Safe for semi-tolerant to tolerant crops		
	>2.50	Safe with application of gypsum of the rate of 8.5g/ham of irrigation water applied for 1.0 ml/liter RSC		

(All the values are expressed in epm.)

Suitability of ground water based on Electrical Conductivity (EC):

To better understanding the suitability of ground water for irrigation purpose chemical result of collected water samples have been analyzed and described the different water class based on Electrical Conductivity (EC) which is presented in table – 14.

Table- 14: - Classification of ground water of Aquifer – I based on EC

Sl. No.	Water Class	Rages of EC	No. of samples falling and their percentage
			Aquifer – I
1	Excellent	< 250	4 (21%)
2	Good	250 – 750	15 (79%)
3	Permissible	750 – 2250	Nil
4	Unisuitable	>2250	Nil

Piper Diagrame for Classification of Irrigation Water:-

The Piper diagram is used to categorize the type of water. It comprises of three parts: one diamond shaped diagram in the middle and two trilinear diagrams sideways in the bottom. The comparative concentrations of cations (left diagram) and anions (right diagram) in each sample is depicted in the trilinear diagram. For presenting ions in a piper diagram, the cations are clustered into three major divisions: sodium (Na) plus potassium (K), calcium (Ca), and magnesium (Mg). The anions are likewise grouped into three main categories: bicarbonate (HCO_3^{2-}) plus carbonate (CO_3^{2-})), chloride (Cl^-), and sulfate (SO_4^{2-}). Each sample is denoted by a point in each trilinear diagram; the type of water samples will make the grade according to the symbolic area in piper diagram.

Based on the major cation and major anion content in the water samples and plotting them in the trillinear diagram, hydrochemical facies could be identified. In Aquifer I cation chemistry out of samples, 1 sample is no dominant type 18 samples are Sodium and Potassium dominant. In anion part 17 samples are Bicarbonate dominant, 2 samples are Chloride dominant. In the dimond part plotted chemical falling 15 samples are Sodium bicarbonate type (Na-HCO_3) and 1 sample is mixed typeand 3 samples are Sodium Cloride type.

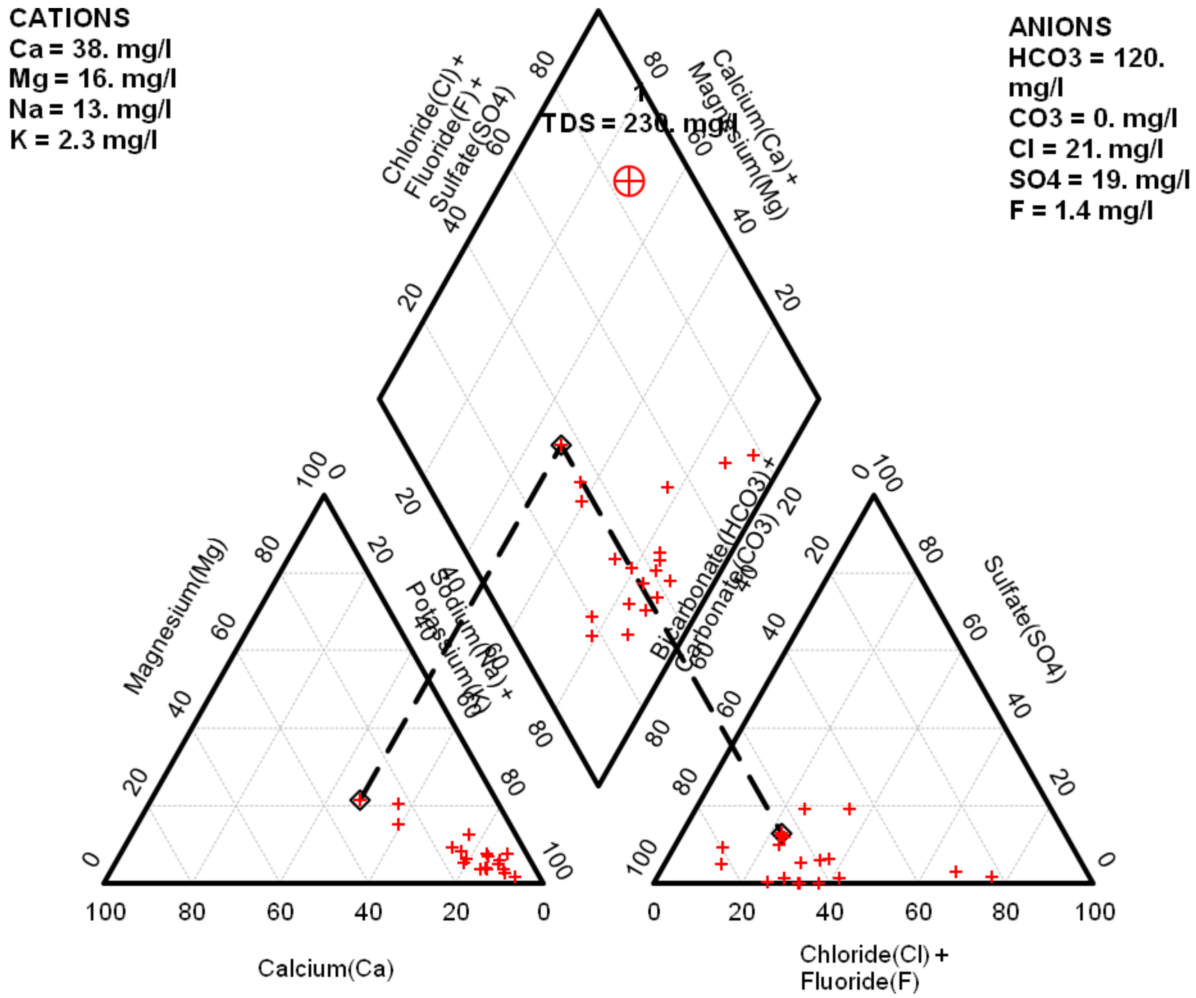


Figure:-20 Piper Diagrame for Aquifer – I

2.5 Ground Water Exploration

The exploratory data particularly includes the information on sub–surface geology, hydrogeological information and geometry of aquifer in Alluvium as well as in hard rocks. Based on exploration data, prepared litholog of EW & OW, in hard rock area depth of fractured/joints encountered within 200m depth formation has been presented in **Annexure III**.

3.0 DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

The data collected and generated on various parameters viz., water levels, water quality, exploration, aquifer parameters, geophysical, hydrology, hydrometeorology, irrigation, thematic layers was interpreted and integrated. Based on this the various aquifer characteristic maps on hydrogeology, aquifer wise water level scenario both current and long term scenarios, aquifer wise ground water quality, 2-D and 3-D sub surface disposition of aquifers by drawing fence and lithological sections, aquifer wise yield potential, aquifer wise resources, aquifer maps were generated which has been discussed in details.

3.1 Aquifer Disposition:

3.1.1 Hydrogeological Cross Section:-

To study the aquifer disposition in detail, various hydrogeological cross section indicating aquifer geometry has been prepared viz. A-A' (NW to SE direction), B-B' (N-S direction) and C-C' (West to East Direction).

3.1.1.1 Hydrogeological cross section A-A':

Hydrogeological cross section A-A' represents the area in Central part NE to SE direction of Lohardaga district. Cross section covers exploratory wells of Kuru, Lawangi, Rampur football ground, Sethio and Murapa. The Aquifer- I ranges 11- 33.40 m representing weathered Granite gneiss, while Aquifer-II ranges from 13-109 m representing fractured granite gneiss. Generally 1-3 fracture zones were encountered. Maximum discharge found at Murappa (80.28 m^3/hr).

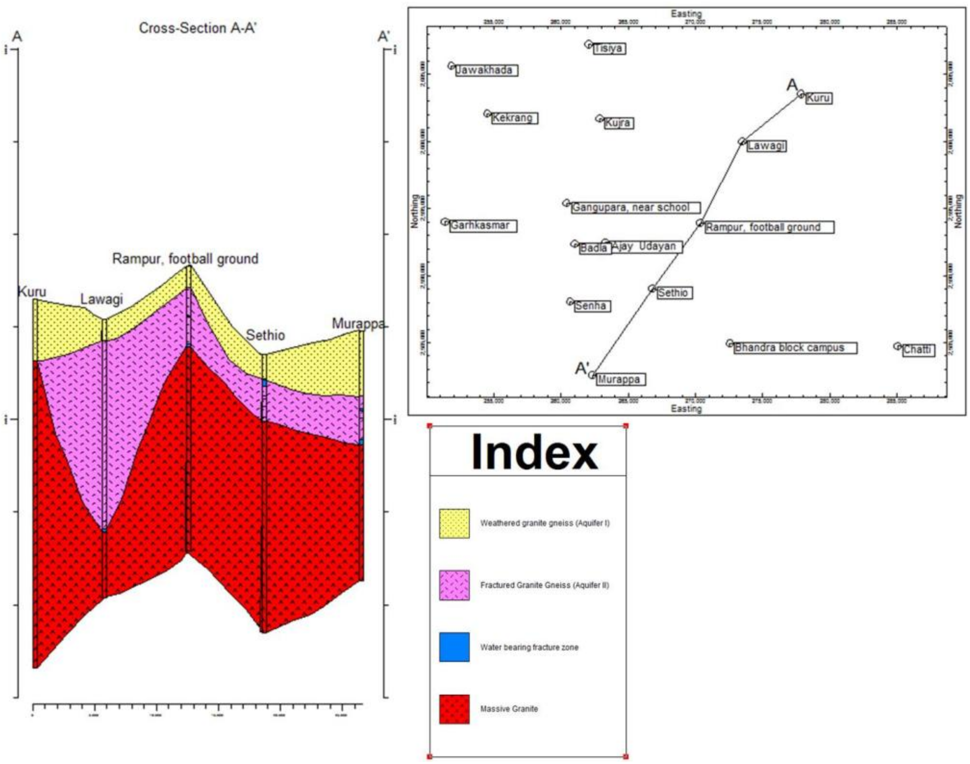


Figure-21: Hydrogeological cross section along A-A'

3.1.1.2 Hydrogeological cross section B-B’: -

Hydrogeological cross section B-B’ represents the area in NE and SE direction in north-western part of Lohardaga district. Cross section covers exploratory wells of Tisiya, Kekrang and Garhkashmar. The Aquifer- I ranges 18.30-35m representing weathered Granite gneiss, while Aquifer-II ranges from 35-200m representing fractured granite gneiss. Generally 1-3 fracture zones were encountered. Discharge ranges from 1-18 m^3/hr. Maximum discharge found at Garhkashmar -18 m3/hr.

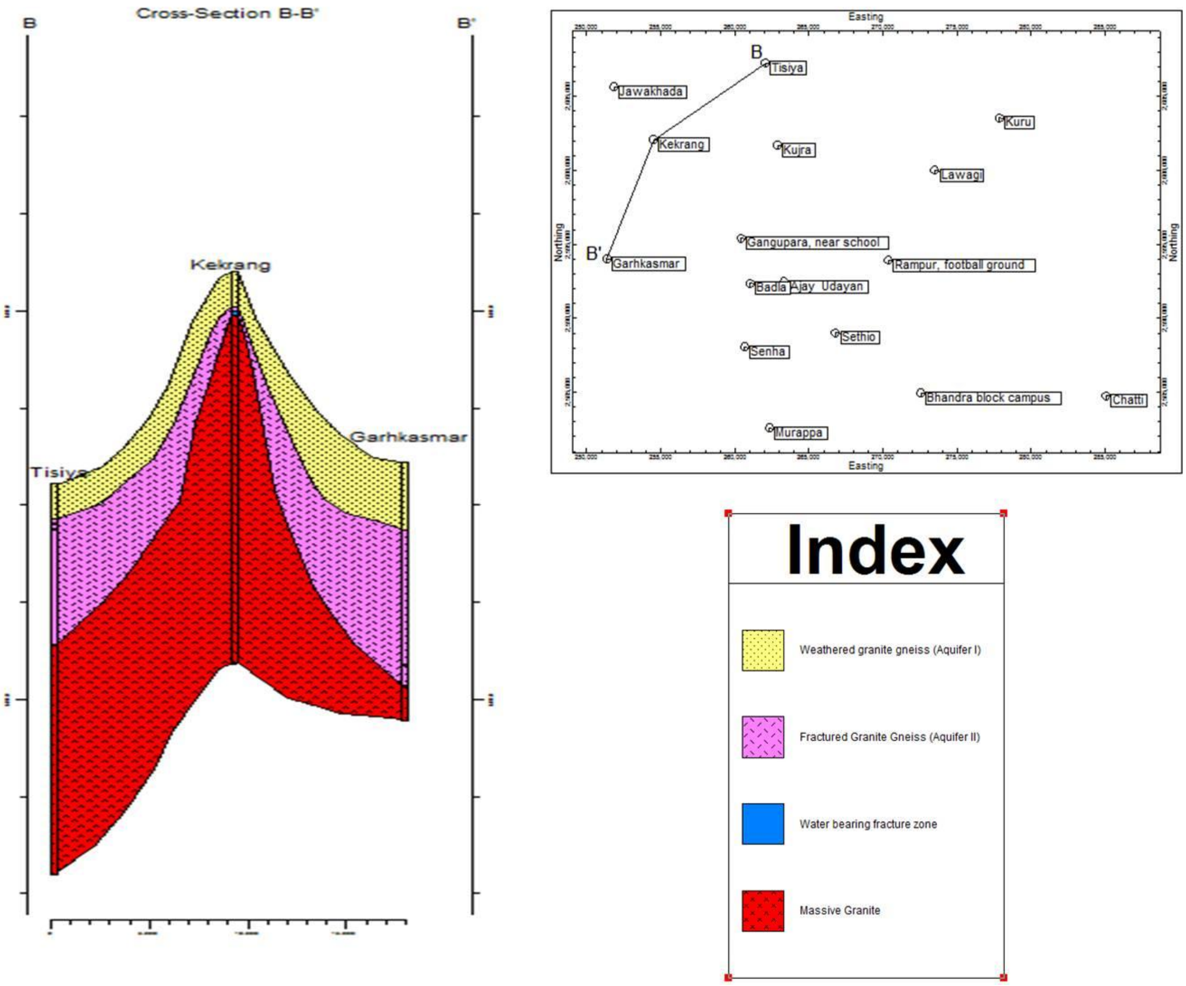


Figure-22: Hydrogeological cross section along B-B’

3.1.1.3 Hydrogeological cross section C-C’:-

Hydrogeological cross section C-C’ represents the area in West to East of Lohardaga district. Cross section covers exploratory wells of Garhkashmar, Badla, Sethio and Chatti. The Aquifer- I ranges 10-35 m representing weathered Granite gneiss, while Aquifer-II ranges from 35-133 m representing Fractured in granite gneiss. Generally 0-3 fracture zones were encountered. Discharge ranges from 2-24 m^3/hr. Maximum discharges found at Badla-24m3/hr.

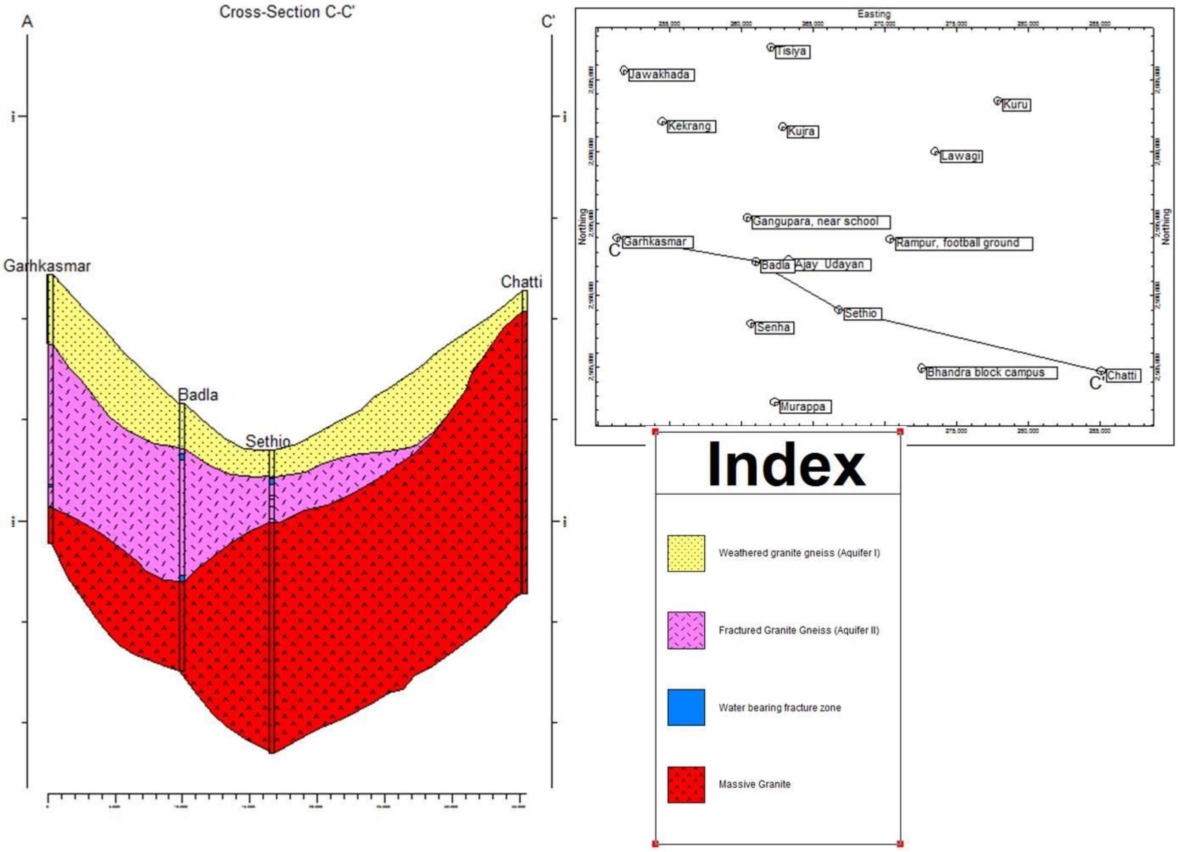


Figure -23: Hydrogeological cross section along C-C'

3.1.2 3-D Aquifer Disposition

The 3-D map in hard rock area of the district showing spatial disposition and vertical extent of Aquifer-I indicating its depth of weathering while the Aquifer – II showing occurrence of fractured rock thickness is presented in figure – 20. Based on the drilling data of exploratory wells maximum thickness of Aquifer - I (weathered zone) in hard rock area is 30.0 m. The depth of Aquifer – II (fracture zone) ranges from 13.00 to 140.00 mbgl.

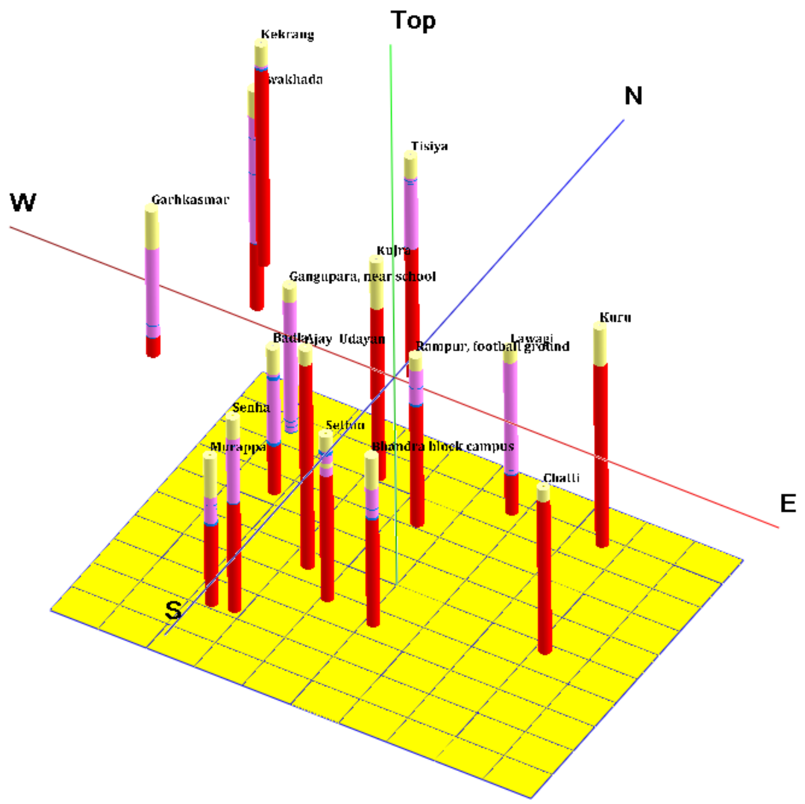


Figure –24: Three dimensional strip-log of EW drilled in Lohardaga district

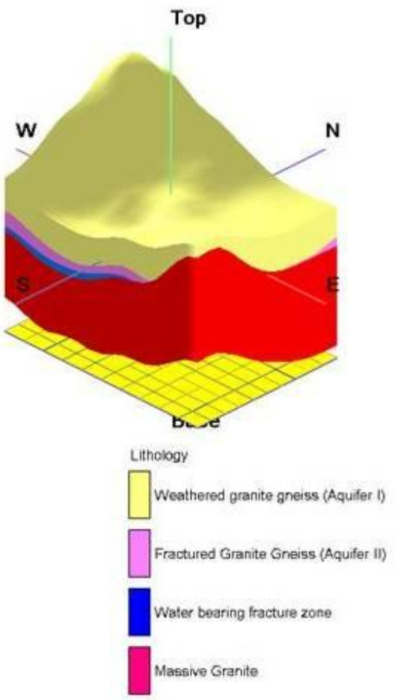


Figure –25: 3D subsurface lithological models with Aquifer Disposition in Lohardaga district

3.2 Aquifer Charcteristics:-

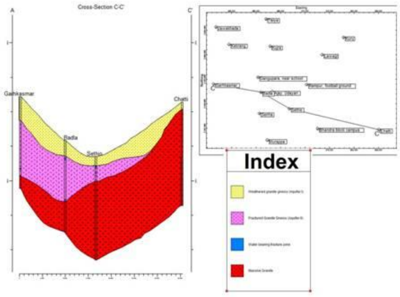
To know the aquifer Characteristics, Step Drawdown test (SDT) and Aquifer Performamce Tests (APT) were earlier conducted by CGWB is considered. Granite, Granite Gneiss forms the main aquifer of the area and comprises two distinct units viz, weathered zone and hard rock fractured zones. Granite gneiss is hard, compact and does not have primary porosity and hence impermeable. Weathering, jointing and fracturing induces secondary porosity in massive unit of granite gneiss. Average thickness of fractures in Aquifer-II is about 1-2 m. Along with yield potential, the aquifer parameters viz., transmissivity and storativity also form an important aquifer characteristic and provide valuable input on sustainability of the aquifers. The transmissivity of Aquifer-II ranges from 1.32 – 91.04 m^2/day, whereas storativity of the aquifer ranges from $2.22x10^{-4}$ to $4.78x10^{-5}$.

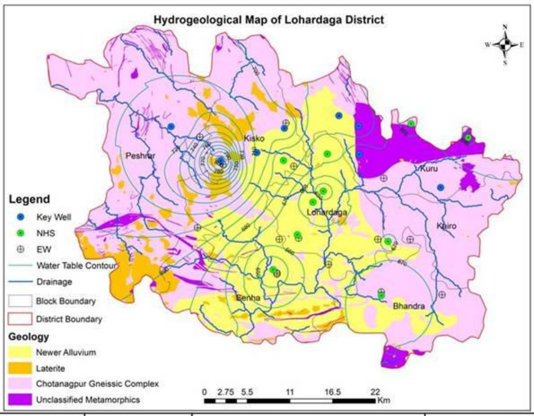
Table 15: Aquifer characteristics in hard rock areas of Lohardaga district

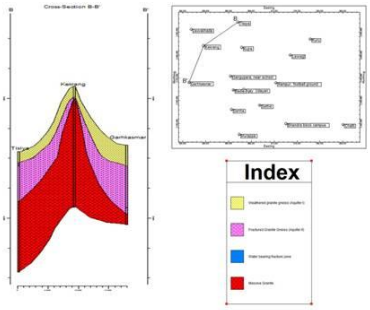
Type of aquifer	**Formation**	**Depth range of the aquifer**	**SWL (mbgl)**		**Thickness**	**Yield (m3/hr)**	**Aquifer parameter**	
			Pre Monsoon (2019)	Post Monsoon (2019)			**T (m^2/day)**	**Sy/S**
Aquifer - I	Weathered Granite-Gneiss	9-35.00 m	4.60 – 11.10	0.01 – 7.72	5- 10 m	5-10	-	-
Aquifer - II	Jointed/ fractured Granite Gneiss	35-133 m	-	-	1-2 m	Upto 80.28	1.32 – 91.04	$2.22x10^{-4}$ to $4.78x10^{-5}$.

3.3 Aquifer Maps

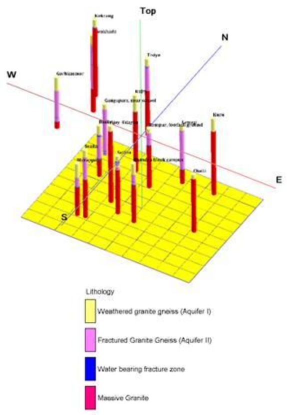
Based on Aquifer Disposition, Aquifer Geometry, Aquifer Characteristics, Aquifer Maps of Lohardaga district have been prepared as under

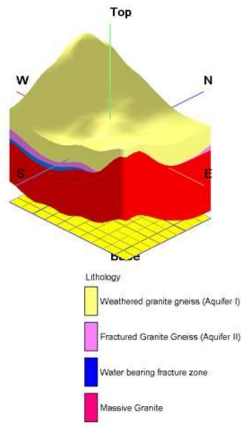






Symbol	Lithology	Hydrogeology	Yield Potential
	Alluvium	Thickness varies from few meters to 20m underlain by crystalline rocks. Groundwater occurs under phreatic conditions	Supports dugwells & shallow tubewells, yield varies from 1-5 m³/hr
	Laterite	Moderately thick, porous, discontinuous,found as patches	Moderate, 5-10m³/hr
	Chotanagpur Gneissic Complex	Groundwater restricted to weathered residuum/fractures(upto 200m),water table & semi-confined to confined conditions	Moderate to good yield prospecs, 5-40m³/hr
	Unclassified Metamorphic	Groundwater restricted to weathered residuum/fractures,water table & semi-confined to confined conditions	Limited yield prospects, below 10m³/hr





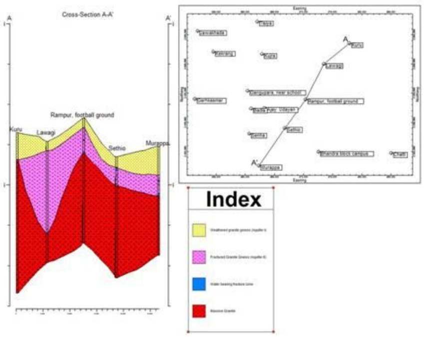


Figure -26 Aquifer maps of Lohardaga district

4.0 GROUND WATER RESOURCE

Ground Water Resource of the area has been estimated block wise based on as on 2020 water year. In the present report GEC 2015 methodology has been used and based on the assessment has been made using appropriate assumptions. This methodology recommends aquifer wise ground water resource assessment of both the Ground water resources components, i.e., Replenishable ground water resources or Dynamic Ground Water Resources and In-storage Resources or Static Resources. The assessment of ground water includes assessment of dynamic and in-storage ground water resources, but the development planning should mainly depend on dynamic resource only as it gets replenished every year. Changes in static or in-storage resources reflect impacts of ground water mining. Such resources may not be replenishable annually and may be allowed to be extracted only during exigencies with proper recharge planning in the succeeding excess rainfall years.

4.1 Assessment of Annually Replenishable or Dynamic Ground Water Resources (Unconfined Aquifer i. e Aquifer-I)

The methodology for ground water resources estimation is based on the principle of water balance as given below –
Inflow – Outflow = Change in Storage (of an aquifer)
The equation can be further elaborated as

4.1.1 Recharge Component

ΔS= RRF+RSTR+RC+RSWI+RGWI+RTP+RWCS±VF ± LF -GE-T-E-B

Where,
ΔS – Change is storage, RRF – Rainfall recharge, RSTR- Recharge from stream channels
RC – Recharge from canals, RSWI – Recharge from surface water irrigation
RGWI- Recharge from ground water irrigation, RTP- Recharge from Tanks & Ponds
RWCS – Recharge from water conservation structures, VF – Vertical flow across the aquifer system, LF- Lateral flow along the aquifer system (through flow), GE-Ground Water Extraction, T- Transpiration, E- Evaporation, B-Base flow

4.1.2 Ground Water Availability, Draft and Stage of GW development

Dynamic Ground Water Resource of Lohardaga district area has been estimated block wise with base year as on March-2020, based on GEC 2015 methodology. The dynamic Ground Water Resources as on 2020 has been assessed by CGWB, SUO, Ranchi in association with State Ground Water Directorate, Jharkhand. Out of Annual Extractable ground water recharge of 17052 Ham, current annual ground water extraction is only for 680 ham. The stage of ground water development is 14.79%. The Block wise details of Annually Replenishable or Dynamic Ground Water Resources of Loharadaga district is as under: -Table-18.

Table- 16: Dynamic Ground Water Resources Availability, Draft and Stage of GW Development 2020

Sl. No.	Adm Units	Annual Extractable Ground Water Recharge	Current Annual Ground Water Extraction for irrigation	Current Annual Ground Water Extraction for domestic	Current Annual Ground Water Extraction for industrial	Current Annual Ground Water Extraction for All uses	Annual GW Allocation for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(%)
1	Bhandra	2395.01	332.25	75.62	0	407.86	76.14	1986.63	17.03
2	Kairo	1486.77	159	49.97	0	208.97	50.32	1277.45	14.06
3	Kisko	2914.65	241.5	72.52	13.077	327.09	73.03	2587.05	11.22
4	Kuru	1698.31	301.25	111.94	0	413.18	112.71	1284.36	24.33
5	Loharadaga	2957.49	375.75	232.57	0	608.32	234.18	2347.56	20.57
6	Peshrar	2180.54	108	40.98	0	148.98	41.27	2031.27	6.83
7	Senha	3419.58	315.75	92.06	0.263011	408.07	92.7	3010.87	11.93
		17052.35	**1833.50**	**675.66**	**13.34**	**2522.47**	**680.35**	**14525.19**	**14.79**

4.2 Assessment of In-Storage Ground Water Resources or static Ground Water Resources (Unconfined Aquifer i.e. Aquifer – I)

The computation of the static or in-storage ground water resources is done after delineating the aquifer thickness and specific yield of the aquifer material. The computations can be done as follows:-

SGWR = A *(Z2 - Z1) * SY

Where, SGWR = Static or in-storage Ground Water Resources

A = Area of the Assessment Unit, Z2 = Bottom of Unconfined Aquifer, Z1 = Pre-monsoon water level, SY = Specific Yield in the In storage Zone

Table 17: Assessment of In-storage ground water resource of hard rock

AQUIFER I	
Area (A) (sq km)	1491
Pre-monsoon (average) depth to water level (mbgl) (Z1)	7.98
Bottom of Unconfined Aquifer (mbgl) (Z2)	21.41
Specific yield (Sy)	3%
Saturated zone thickness (Z2-Z1) of aquifer (ST)	13.43
SGWR = A *(Z2 - Z1) * SY	mcm
instorage	600.72 mcm

4.3 Assessment of Total Ground Water Availability in Unconfined Aquifer (Aquifer-I)

The sum of Annual Extractable Ground Water Recharge and the in storage ground water Resources of an unconfined aquifer are the Total Ground Water Availability of that aquifer.

Total Availability (unconfined Aquifer. i.e Aquifer-I) = Annual Extractable Ground Water Recharge + In-Storage Ground Water Resource
Total Availability (Mcm) = **170.52** *mcm +* **600.72** *mcm =* ***771.24****mcm*

5. GROUND WATER RELATED ISSUES

The Lohardaga district forms part of predominantly tribal belt wherein villagers have got very small land holdings and they do not find it economical to engage in agricultural activity in comparison to the earning, they earn by working as labourer in industrial units and Govt. Deprtments. Further, the cultivators are illiterate tribal and are ignorant of improved agricultural practices. By and large the district is not favoured with surface water irrigation system because of hilly and undulating geographical setting. The major ground water related issues are:-

5.1 Low Ground Water Development:

One major issue of the area that is low ground water extraction due to various socio-hydrogeological reasons. At present the overall stage of ground water extraction is only around 14.79 % Block wise stage of ground water extraction varies from 6.83 (Peshrar)-24.33(Kuru) percent.
Graphical presentation of SOD is shown in figure – 27.

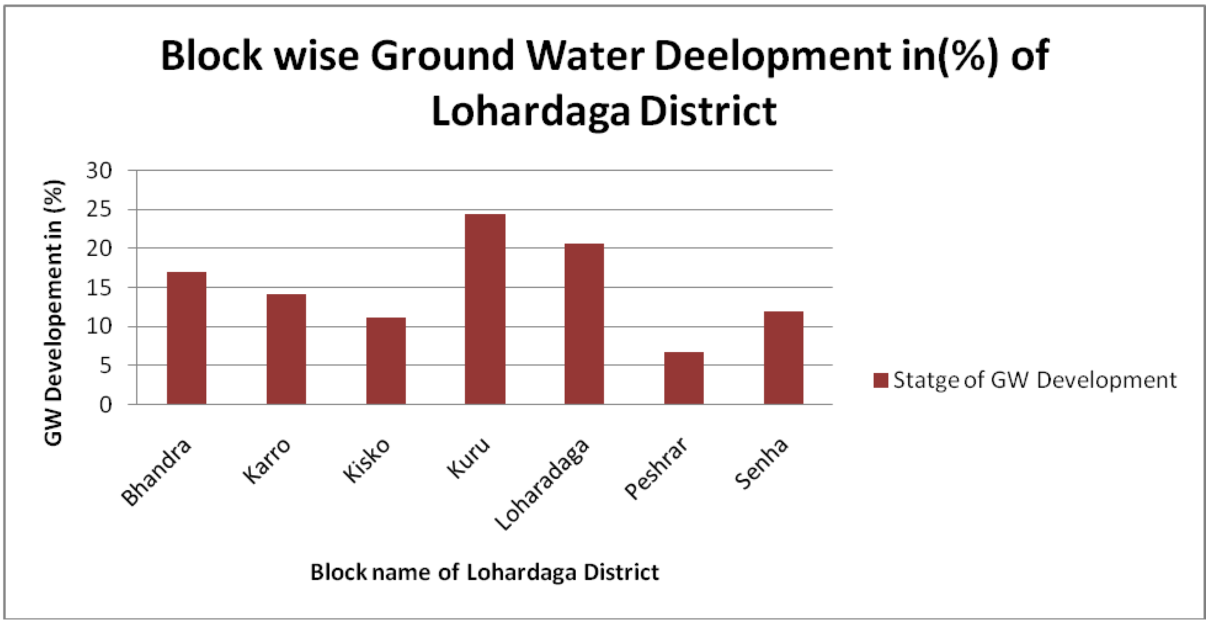


Figure 27 Block wise Ground Water Developement

5.2 Low Ground Water Potential / Limited Aquifer Thickness / Sustainability: The occurrence and movement of ground water depends in the hydrogeological characteristics of the sub surface rock formations. Ground water potential at any area mainly depends on the topography, rainfall and geology. Because of varied topography and hydrogeological condition in the district, the ground water potential is not uniform and it changes from one area to another. The majority of the area of Lohardaga district is covered by hard rock. Therefore, the quantity of which can be stored in sub surface as ground water is limited and quantity of water can be extracted from any area which depends on the thickness of aquifer and specific yield of aquifers. Thus, the availability of water resources is not uniformly distributed over time. This resource depletes often in summer or lean period.Central Ground Water Board has constructed exploratory wells at 14 locations in hard area of the district.

The percentage of successful bore wells (more than 3 lps discharge) is less. Out of 14 exploratory wells only 4 exploratory well having more than 3lps discharge. Average thickness of weathering is 25 m and fracture zone is 2-3 m only.

The fracture encountered of bore wells drilled in the area is classified and presented below in figure – 28.

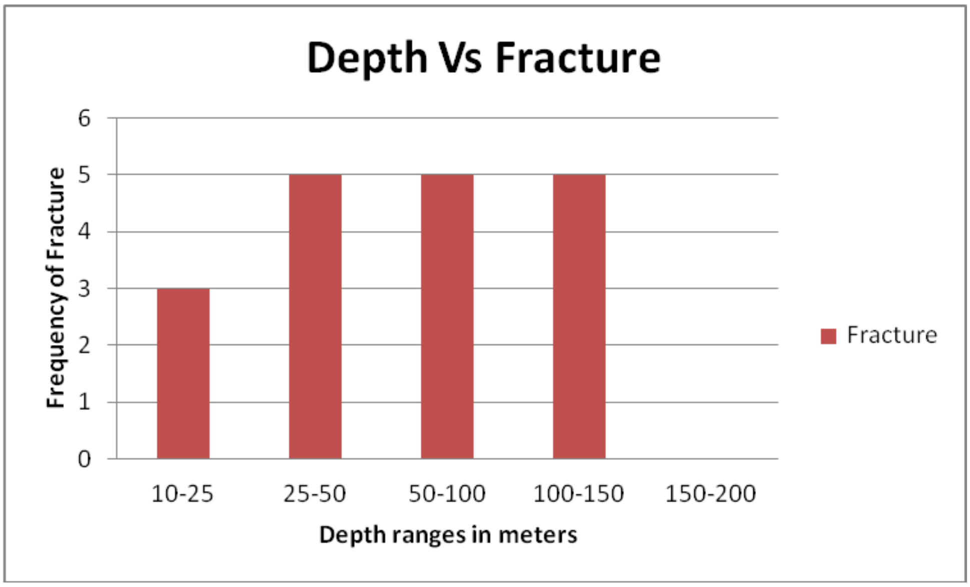


Figure – 28: Depth vs Frequency of fracture encountered in bore wells drilled in Lohardaga district

5.3 Ground water contamination:-

Analytical result of water samples collected from the district, it is found the Nitrate concentration is beyond permissible limit in 7 samples of shallow aquifer (dug well) Similarly, Fluoride concentration is found beyond permissible limit in 6 samples of shallow aquifer. In addition, high EC value 787 µ S/cm has been observed in dug well sample existing at Senha in Senha block. Location details of Nitrate and Fluoride concentration found beyond permissible limit are given in table 21 and 22 respectively and also represented in figure – 26.

5.3.1. Nitrate contamination: -

A variety of chemical constituents including Nitrate can pass through the soil and potentially contaminate ground water. Nitrate comes from the nitrogen, plant nutrient supplied by inorganic fertilizer and animal manure. Beneath agriculture land, nitrate is primary form of Nitrogen. It is soluble in water and can easily pass through soil to the ground water table. Nitrate can persists in ground water for decades and accumulated to high levels as more nitrogen is applied to the land surface every year. Nitrate is one of the most common ground water contaminations in rural areas. It is regulated in drinking water primarily because excess level can cause methemoglobinemia or blue baby disease. Nitrate can be removed from drinking water by distillation, reverse osmosis or ion exchange.

In shallow aquifer of Lohardaga ditrict 7 water samples out of 19 have been found more than the permissible limit of NO_3 (45mg/l). Location details of NO_3 concentration found beyond permissible limit is given in table 20.

Table 18: Nitrate concentration found beyond permissible limit

Sl. no	Village	Block	Concentration NO_3
1	Lohardaga (pwdib)	Lohardaga	86
2	Rudh 1	Kuru	74
3	Senha Bdo	Senha (Sneha)	86
4	Chiri(Siyarpara)	Kuru	68.56
5	Semardih	Kisko	48.17
6	Hutap	Kisko	47.99
7	Peshrar	Peshrar	47.93

5.3.2 Fluoride contamination:

Consumption of water with fluoride concentration above 1.5 mg/l is harmful which results in acute to chronic dental fluorosis where the tooth become coloured from yellow to brown. Skeletal fluorosis which causes weakness and bending of the bones also results due to long term consumption of water containing high fluoride. Presence of low or high concentration of fluoride in groundwater is because of geogenic or anthropogenic causes or a combination of both.

In shallow aquifer 6 samples, out of 19 have F concentration more than the desirable limit of 1.5mg/l. Location details of F concentration found beyond permissible limit is given in table-21 and sample wise Fluoride concentration is shown in figure-29 for shallow aquifer.

Table – 19: Location details of Fluoride concentration found beyond permissible limit

Sl. no	Village	Block	Concentration F
1	Chiri(Siyarpara)	Kuru	1.69
2	Opa	Kuru	1.57
3	Semardih	Kisko	1.91
4	Hutap	Kisko	2.27
5	Peshrar	Peshrar	1.6
6	Kekrang	Peshrar	1.5

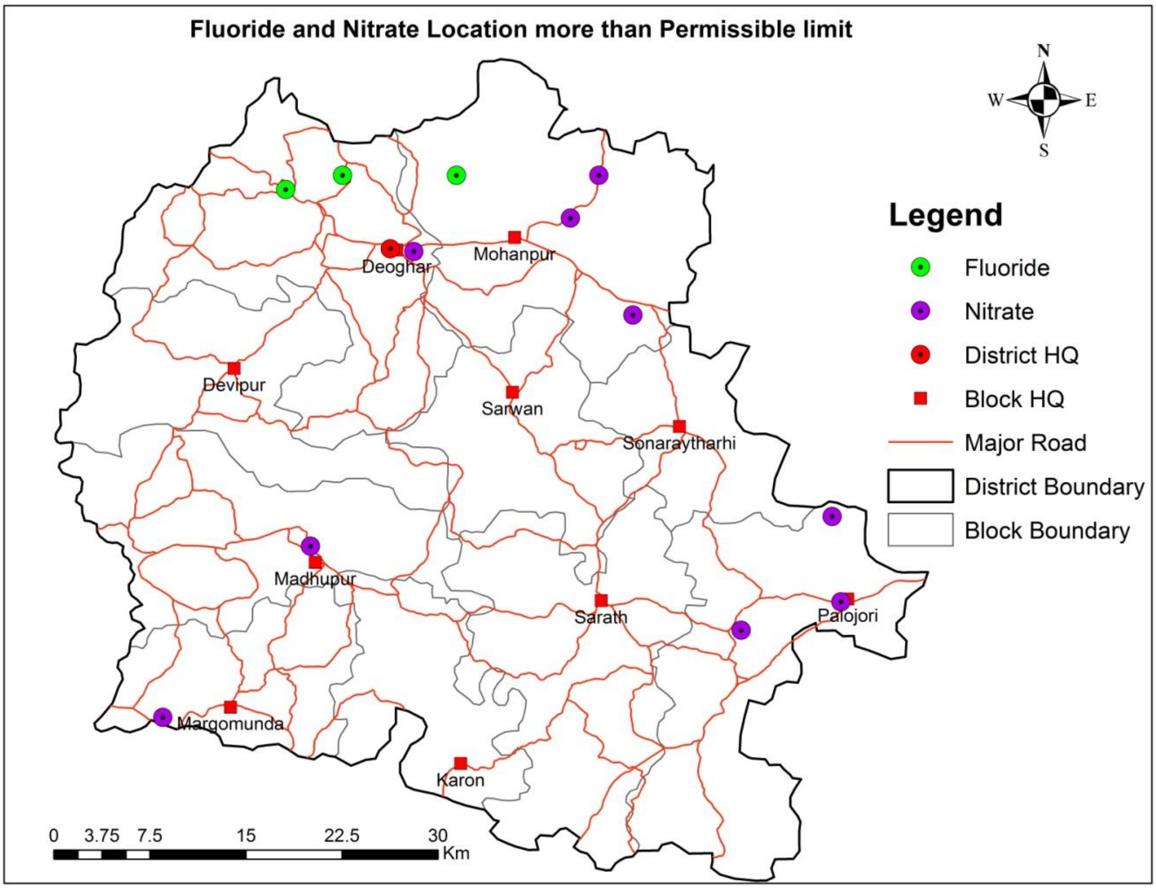


Figure – 29: Location map of NO_3 and F concentration found beyond permissible limit in ground water, Lohardaga district.

5.3.3 Uranium Contamination

Total 11 samples were analysed for uranium concentration in Lohardaga district. Uranium concentrations in Lohardaga district were found to be in the range of -0.03 ppb to 1.21 ppb. Out of 11 samples, at all sample the uranium concentration was found within permissible limit. The detail results of chemical analysis for uranium are in Annexure-VI.

6. MANAGEMENT STRATEGIES

As discussed in previous chapter, the major ground water related issue in Loharadaga, low ground water development and low ground water potential owing to many socio-economic and hydrogeological reasons. To overcome these, it is imperative to have a robust ground water resource development plan for the district. Various Management strategies to overcome the ground water related issues are;

6.1 Supply side Interventions:

At present as per Ground Water Resource Estimation 2020, the stage of ground water extraction is very low i.e., 14% and all the block of the district comes under safe category. However, in some parts of the district long term declining trend has been noticed. Therefore, the ground water development should also be coupled with ground water augmentation, so that there is no stress on ground water regime of the area.

The supply side interventions envisage Ground Water Resource Development Strategy & construction of Rainwater Harvesting and Artificial Recharge structures in the areas feasible for construction of recharge structures based on the long-term water level scenario and recharge potential of the aquifer.

6.1.1 Ground Water Resource Development Strategy:

The present status of ground water extraction for the whole district is only 14.79%. Therefore, there is ample scope of ground water extraction in the district. Block-wise balance ground water for future irrigation potential is determined for all availability. Considering the net ground water availability for future use, unit draft of different structures like Dug wells/Shallow Tubewell/Borewell, feasible structure has been determined for further ground water development in the district

Table – 20: Proposed number of Abstraction Structures

Block	Net GW Availability for Future use	future irrigation potential available (ha) considering (Δ) 0.45m	70% of future irrigation potential to be created (ha)	Proposed number of ground water structure (Dug wells)	Proposed number of ground water structure (Shallow TW/BW*)
Bhandra	1987	4415	3090	687	258
Kairo	1277	2839	1987	442	166
Kisko	2587	5749	4024	894	335
Kuru	1284	2845	1998	444	167
Loharadaga	2348	5217	3652	812	304
Peshrar	2031	4514	3160	702	263
Senha	3011	6691	4684	1041	390
Total	**14525**	**32278**	**22595**	**5021**	**1883**

*TW-Tubewell, BW-Borewell

It is necessary that proposed Additional ground water abstraction structure may be constructed in phases with proper site selection. The results of the first phase of ground water development together with studies of the behavior of ground water regime will guide futher ground water development to achieve 100% utlisation. Dug well, Shallow bore well and tube wells are feasible ground water structures for the district.

6.1.2 Artificial recharge to Groundwater -Master plan 2020

Recently in 2020, artificial recharge to Ground Water master plan 2020 of Jharkhand state has been prepared. The identification of feasible areas (shown in figure 29) for artificial recharge to ground water in Loharadagadistrict 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 Lohardaga district has been worked out. Based on the study 544 No of Nala Bund/Check Dam/Gully Plus and 83 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. It will ensure that the wells don't go dry during summer/lean/stress period in the areas of implementation and sufficient ground water availability is there in the wells even during the summer season. Thus, not only the drinking and domestic water sources will be strengthened but additional irrigation potential can be created through artificial recharge structures.

Table -21: Artificial recharge structures feasible in Lohardaga district

Sl. No.	District	Volume of unsaturated zone available for recharge (MCM	Total volume of Available Water for Recharge (MCM)	Percolation Tank	NalaBund/ Check dam / Gully Plug	Recharge Shaft
1	Lohardaga	655.47	32.64	86	544	0
Total Structures				**86**	**544**	**0**

6.2 Demand side Management:-

It is always essential to address the issue of constraining demand for groundwater abstraction since this will normally contribute more to achieving the groundwater balance. The concept of real water savings is critical in this regard. The main demand side interventions may be: -

1. Promote improved irrigation technologies (drip or sprinkler irrigation, etc.)
2. Crop choice management and diversification (promote less intensive crops like pulses and horticulture)
3. Promote treated municipal waste water for irrigation and construction use.
4. Managing energy and irrigation nexus (provide quality power supply when needed through separate feeders, high voltage distribution lines, solar pumps, etc.)

6.3 Ground water management strategy for Nitrate and Fluoride affected areas

Nitrate and Flouride is the most pollutant in some part of the Lohardaga district Nitrate can be removed from drinking water by distillation, reverse osmosis or ion exchange. several methods are available for the removal of fluoride from groundwater which is insitu or exsitu. To dilute the groundwater contaminated with fluoride, artificial recharge structures can be constructed at suitable places which will decrease its concentration. Rainwater harvesting through existing wells will also prove effective to reduce the groundwater fluoride concentration. Exsitu methods which are conventional treatment methods like adsorption, ion exchange, reverse osmosis etc can be practiced at community level or at households to reduce fluoride concentration before ingestion.

6.4 Stress aspect against future demand (2021, 2031): Demand of water is increasing day by day against the increasing population. The detail demographic particular of the Lohardaga district and water requirement for domestic purpose is worked out for the year 2031 and 2031 is presented in table – 22,23,24.

6.4.1 Urban Water Supply

Requirement of water for drinking and domestic use will be 18737030 per day in urban area. Due to increase in population of Lohardaga district.

6.4.2 Rural Water Supply

Requirement of water for drinking and domestic use will be 143489610 Liter per day in Rural area area. Due to increase in population of Lohardaga district.

Table 22: Detail demographic particular of Lohardaga district

Population as per census			
2001		2011	
Rural	Urban	Rural	Urban
318325	46196	404379	57411

Table – 23: Projected population

Projected population			
2021		**2031**	
Rural	Urban	Rural	Urban
640722	90965	1594329	144131

Table – 24: Requirement of water for domestic use

	Water requirement (assuming 90 liters per day per person for rural population and 130 liters per day per person for urban population)			
	2021		2031	
	Rural (Litres/day)	Urban (Litres/day)	Rural (Litres/day)	Urban (Litres/day)
	57664980	11825450	143489610	18737030
Total	69490430 **litres / day**		162226640 **litres / day**	

On perusal of table – 24, the requirement of water will be 162226640 litres per day in 2031. The demand of water is increasing due to highly increasing of population. Thus, recommended for alternate surface water supply from river to reduce the stress of ground water.

7.0 Sum-up

1. The district Loharadaga is spread over 1491 Sq. km area consisting of 7 blocks situated in the South Western part of the Jharkhand state. As per census of 2011, total population of the district is 1313551 with rural population of 1249132 and urban population 64419.

2. Lohardaga district covers the south-western part of Chhotanagpur plateau. The topography of the district is undulating and rugged. District has a number of small hill blocks covered with forests. It is drained by the tributaries of two major river of the state viz. North Koel & South Koel.

3. Lohardaga district occupies the south western part of the Chotanagpur Plateau. The district is underlain by Chotanagpur Granite-gneiss of Archean age forming the basement rock. Patches of mica schists also occur within the granite and gnessic country rocks. Laterites of Pleistocene age is found to occur as cap over granite gneiss in plateau region. Recent alluvium sediments are found to occur along the present-day river channels.

4. Based on morpho-genetic, geological diversities and relative ground water potentialities of the aquifers, the district can be broadly divided into two Hydrogeological units: Consolidated or Fissured formations (Precambrians), and unconsolidated or porous formations (Laterites& Alluvium).

5. Ground water occurs under unconfined to semi-confined state in Aquifer-I (upto the depth of 30m). Yield of the wells in Aquifer-I is very poor restricted upto 10 m3/hr in laterites/weathered Granite-Gneiss. These aquifers are generally tapped in the dugwells or shallow borewells.

6. In fissured formations of the district the major potential fractures zones are found in Aquifer-II between 35-130 m. In general, discharge of well has been found in the range of 1-13 LPS. Ground Water occurs under semi-confined to confined state in Aquifer-II.

7. Ground Water quality is generally potable, except few patches of high Flouride and Nitrate in Ground Water.

8. The stage of ground water development in Loharadaga district is 14.79% and all the block comes under safe category.Therefore, there is sufficient scope for further ground water development.

9. The major ground water related issues in Loharadaga district are Low ground water development, Low ground water potential/ sustainability etc.

10. To suggest a sustainable ground water management plan there are two options-Supply Side Management Options & Demand Side Management Options

11. The supply side interventions-I envisages Ground Water Management strategy through construction of 5021 dug wells and 1883 shallow bore wells in the feasible areas in the district. Rain water harvesting and artificial recharge to be encouraged in feasible areas for

ground water augmentation. In additional purification/filtration of Fluoride may also be adopted.

12. The supply side interventions-II also envisages construction of feasible artificial recharge structures - 86 percolation tank, 544 Nala Bund/Check Dam/Gully Plug Lohardaga district, which is Based on Artificial recharge to Ground Water master plan 2020 of Jharkhand state

13. The demand side intervention envisages the real water savings. 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 like pulses and horticulture), iii) Promoting treated municipal waste water for irrigation and construction use, and iv) Managing energy and irrigation nexus (provide quality power supply when needed through separate feeders, high voltage distribution lines, solar pumps, etc.) The government should encourage and provide incentive the use of drip irrigation and sprinkler system.

8.0 BLOCK-WISE AQUIFER MAPS AND MANAGEMENT PLAN

8.1 BHANDRA BLOCK

1. Salient Information

1.	Name of the block and area		Bhandra, Area:160.66 sq.km
2.	District/State		Lohardaga
3.	Population (2011)	Total	57303
		Urban	0
		Rural	57303
4.	Average annual Rain fall		1137.4 mm
5.	Agriculture and irrigation		Paddy, Coarse Cereal, Pulses, Oils Seeds etc. Tank-13, Deep tube well-1, Shallow tube well-1, DW-1243 and other -11
6.	Ground water resource availability and extraction		Available: 2395.01 Ham and extraction: 407.86 Ham
7.	Existing and future water demand		407.86 ham and for Domestic Use as on 2025 (Ham) is 75.14 ham
8.	Water level behaviour		Pre-monsoon DWL 7.95 and Post-monsoon 4.6 mbgl, fluctuation of pre and post monsoon is 3.35m

The block is bounded in north by, Lohardaga block and south by Berro block of Ranchi District and east by Kairo block and south by Senha block of Lohardaga district. The block headquarter is Bhandra. There is one main district road passes through the block.

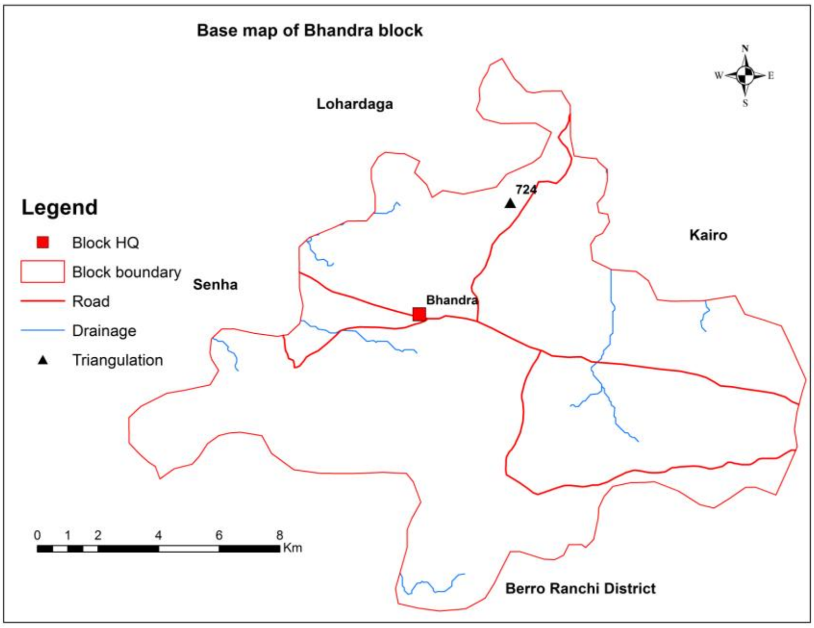


Figure: Base map of Bhandra block

2. Geomorphology:

The Bhandra block is a part of Lohardaga district. The block mainly made up of Piedmont, buried pediplain and piedmont alluvium. General slope have toward north part. Height ranges from msl 562 m to 724m.

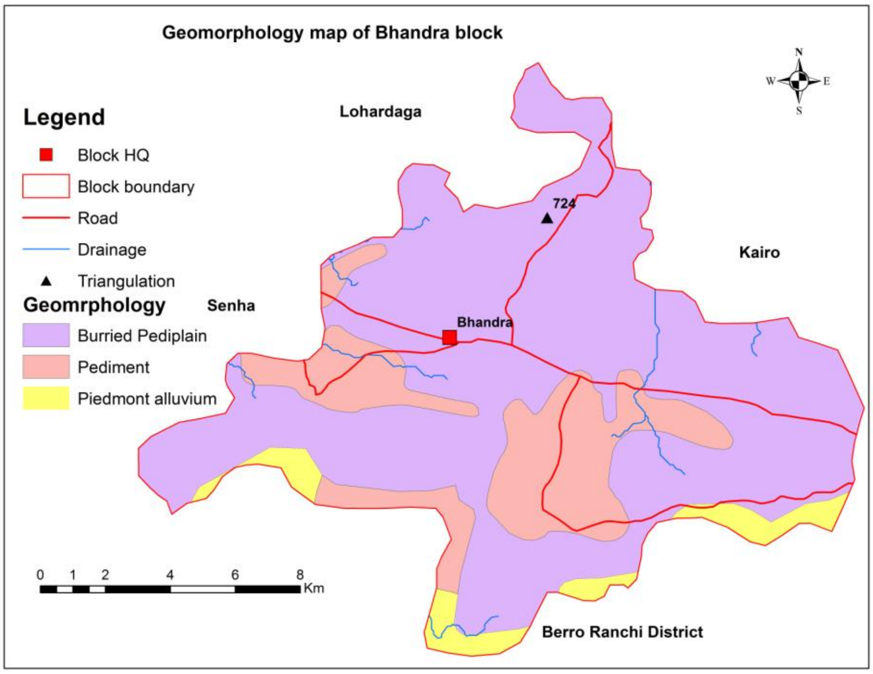


Figure: Geomorphology map of Bhandra block

3. Geology

The maximum part of the block is covered by Chhotanagpur Gneissic Complex and newer alluvium. Lateritic and unclassified rocks are also found in the block.

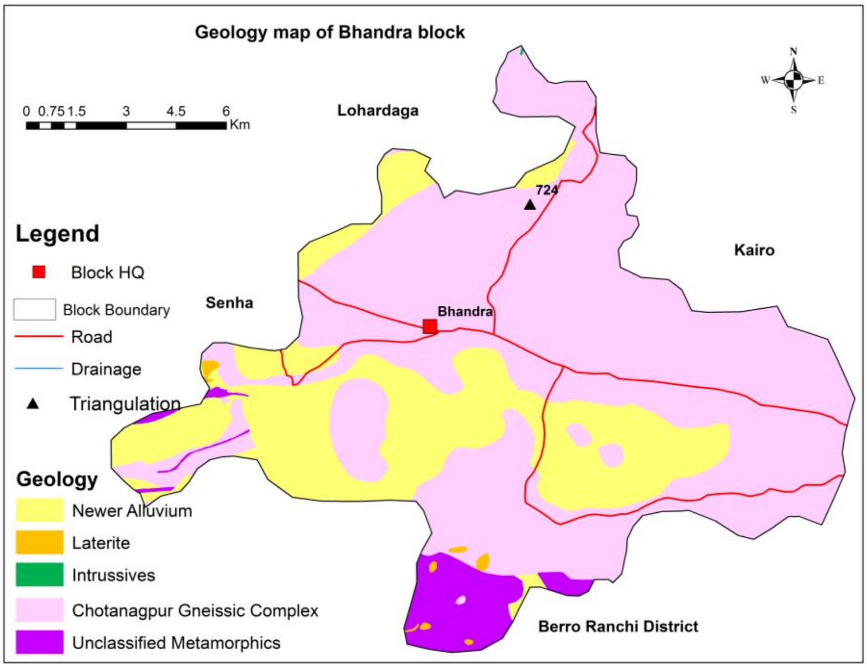


Figure: Geology map of Bhandra block

4. Depth to Water Level

There are 2 NHS monitoring stations in Bhandra block. CGWB NHS monitoring data shows that during the pre-monsoon period (2020-21), the whole block was under the depth to water level within 5 to 10 m bgl. During the post-monsoon period, maximum part of the block was under 2 to 5 m bgl depth to water level range.

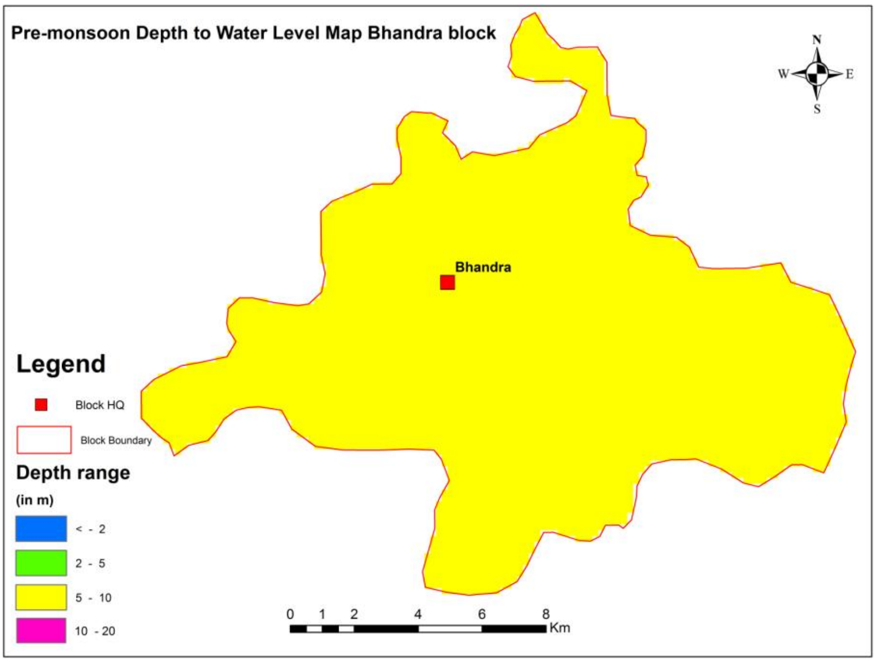


Figure: Pre-monsoon depth to water level map of Bhandra block

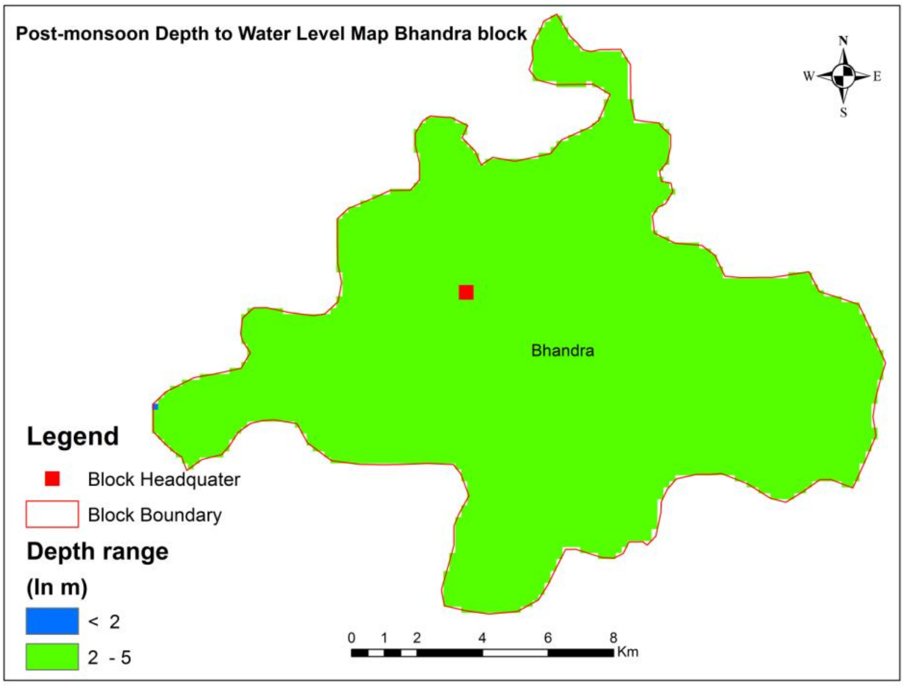


Figure: Post-monsoon depth to water level map of Bhandra block

5. Aquifer Disposition and Characteristics

In the Bhandra block 3 bore wells have been drilled to know the aquifer characteristics. Depth of the wells ranges 150m to 199 meters. Weathered depth ranges 10.00m to 23.00m. out of 3 wells two wells are dry and one well have very low discharge 6.45 m3/hour.

6. Ground water Resource, Extraction, Contamination and other issues

Extractable ground water recharge is 2395.01 ham, net ground water available for future us is 1986.63 ham. The SOD is 17.03 % only whereas of the district SOD is 14.79 %. It shows ample scope for further development of ground water.

Table: Ground Water Resources – 2020 of Bhandra block

Sl. No.	Adm Units	Annual Extractable Ground Water Recharge	Current Annual Ground Water Extraction for irrigation	Current Annual Ground Water Extraction for domestic	Current Annual Ground Water Extraction for industrial	Current Annual Ground Water Extraction for All uses	Annual GW Allocation for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(%)
1	Bhandra	2395.01	332.25	75.62	0	407.86	76.14	1986.63	17.03

Chemical quality of Ground Water:

Result of chemical analysis of ground water of shallow aquifer is given in the table below. The TDS ranged from 109 to 202 ppm and fluoride concentration is below the acceptable limit of 1 mg/l. In general Chemical quality of shallow aquifer is potable and also suitable for irrigation Purpose. Result of chemical analysis is given in the table below.

Table – Ground Water quality of of Bhandra block

Sl.No	LOCATION	pH	EC	TH	Ca	Mg	Na	K	CO32-	HCO3-	Cl-	NO3-	SO42-	F	PO43-	TDS
1	Bhandara	7.84	168	75	20	6.075	3.2	0.06	0	61	21.3	1.2	0	0.03	0	109.2
2	Iragon	8.31	312	115	28	10.935	16	0.9	0	48.8	63.9	19	3.7	0.18	0	202.8

7. Supply side management

Dynamic Ground water resource of Bandra block has been assessed as 2395.01 ham. The stage of Development 17.03%. Therefore there is scope of ground water development. Additional ground water abstraction structure (687 Dug well and 258 Shallow Borewell) may be constructed at favourable sites for irrigation purposes. In addition Artificial Recharge structure like Percolation tank and check Dam/Nala bund can be constructed. The implementation of water conservation through artificial recharge measures will have a positive impact on drinking water sources of the area.

8. Demand side management Plan

The main demand side interventions may be: -

i) Promote improved irrigation technologies (drip or sprinkler irrigation, etc.)

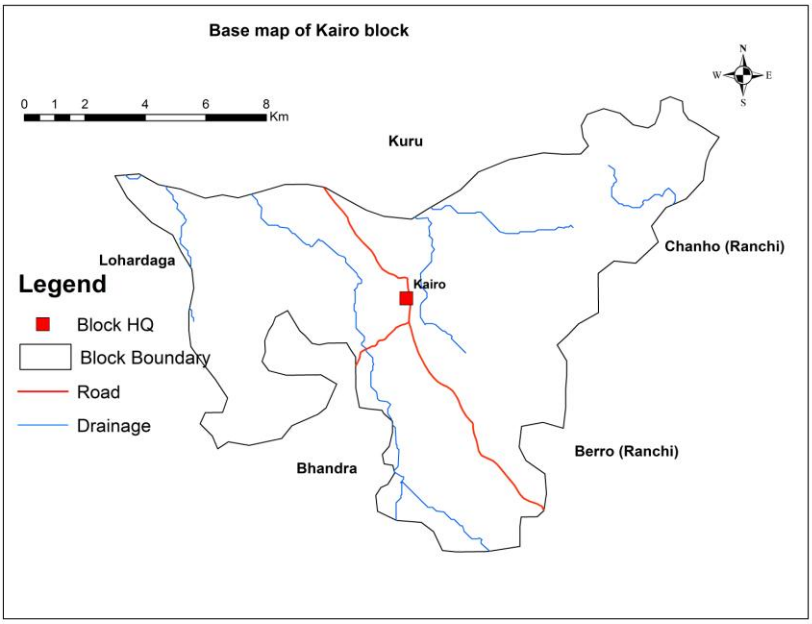
ii) Crop choice management and diversification (promote less intensive crops)

8.2 KAIRO: BLOCK

1. Salient Information

1.	Name of the block and area		Kairo and Area:102.28 sq.km
2.	District/State		Lohardaga
3.	Population (2011)	Total	37867
		Urban	0
		Rural	37867
4.	Average annual Rain fall		1394.8mm
5.	Agriculture and irrigation		Paddy, Coarse Cereal, Pulses, Oils Seeds etc. Tank-12, Deep tube well-0, Shallow tube well-0, DW-636 and other - 4
6.	Ground water resource availability and extraction		Available: 1486.77Ham and extraction: 208.97 Ham
7.	Existing and future water demand		208.97ham and for Domestic Use as on 2025 (Ham) is 50.32ham
8.	Water level behaviour		Pre-monsoon DWL varies from 5 to 10mbgl and Post-monsoon 2 to 5 mbgl mbgl.

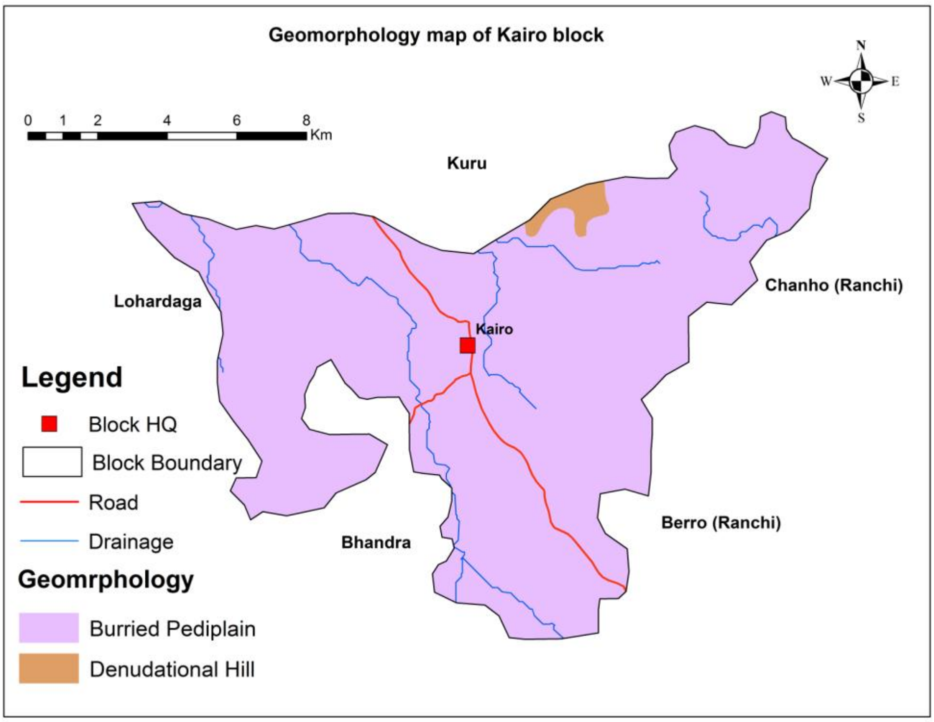
The block is bounded in north by Kuru block and south by Bhandra block and east by Chanho and Berro blocks of Ranchi district and south by Lohardaga and Bhandra blocks of Lohardaga district. The block headquarter is Kairo. There is one main district road passes through the block.



Figgure: Base map of Kairo block

2. Geomorphology:

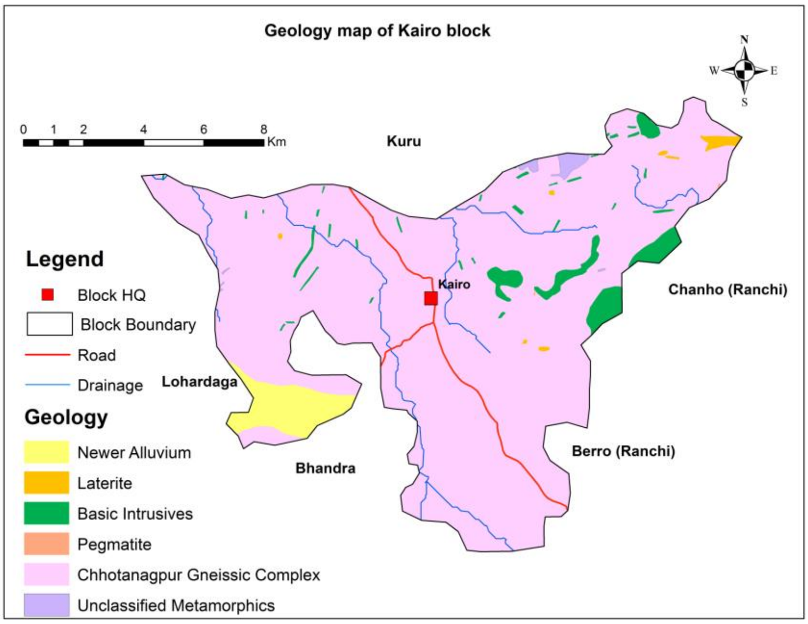
The Kairo block is a part of Lohardaga district. The block mainly made up of Buried pediplain and denudational hills. General slope have toward west part. Height ranges from msl 562 m to 680m.



Figgure: Geomorphology map of Kairo block

3. Geology

The maximum part of the block is covered by Chhotanagpur Gneissic Complex, newer alluvium and Basaltic intrusive. Lateritic, Pegmatite and unclassified rocks are also found in the block.



Figgure: Geology map of Kairo block

4. Depth to Water Level

One key well is monitored in Kairo block and monitoring data shows that during the pre-monsoon period (2020-21), the whole block was under the depth to water level within 5 to 10 m bgl. During the post-monsoon period, maximum part of the block was under 2 to 5 m bgl depth to water level range.

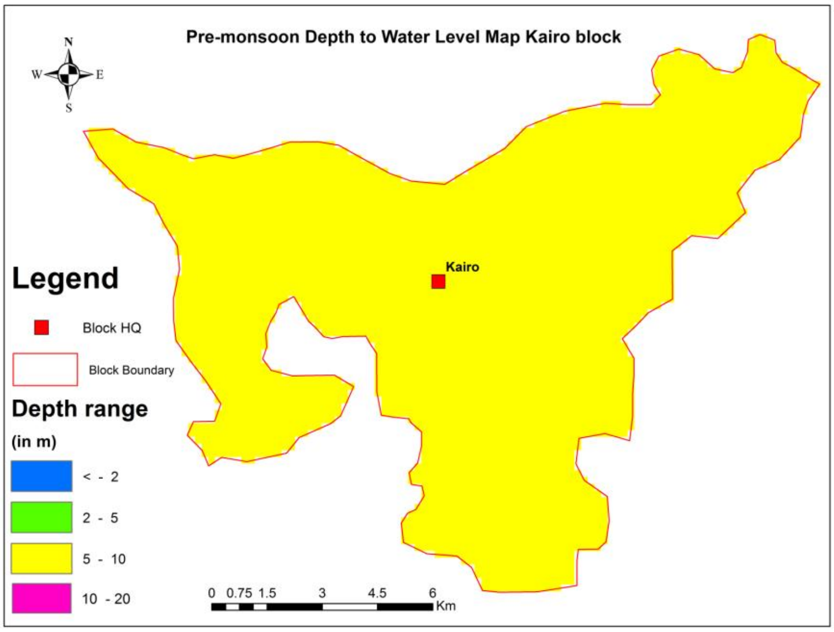
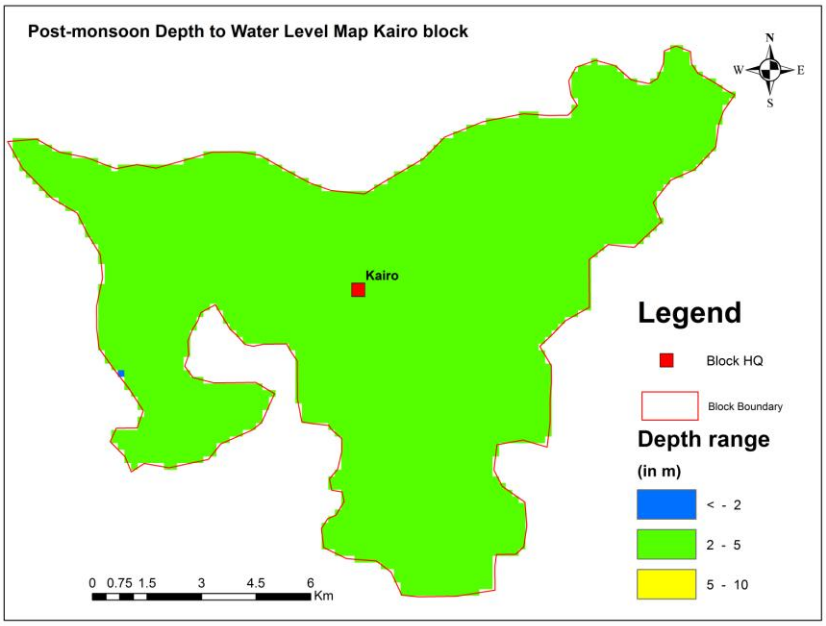


Figure: Pre-monsoon depth to water level map of Kairo block



Figgure: Post-monsoon depth to water level map of Kairo block

5. Aquifer Disposition and Characteristics

In the Kairo block no bore well has been drilled however near block Kuru and Bhandra hsve 5 bore wells have been drilled to know the aquifer characteristics. Depth of the wells ranges 150m to 199 meters. Weathered depth ranges 10.00m to 33.00m. out of 5 wells three wells are dry and two wells have very low discharge 0.288 m3/hour.

6. Ground water resource, extraction, contamination and other issues

Extractable ground water recharge is 1486.77 ham, net ground water available for future us is 1277.45 ham. The SOD is 14.06 % only whereas of the district SOD is 14.79 %. It shows ample scope for further development of ground water.

Table –Ground Water Resources – 2020 of Kairo block

Sl. No.	Adm Units	Annual Extractable Ground Water Recharge	Current Annual Ground Water Extraction for irrigation	Current Annual Ground Water Extraction for domestic	Current Annual Ground Water Extraction for industrial	Current Annual Ground Water Extraction for All uses	Annual GW Allocation for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(%)
1	Kairo	1486.77	159	49.97	0	208.97	50.32	1277.45	14.06

Chemical quality of Ground Water :

Result of chemical analysis of ground water of shallow aquifer is given in the table below. The TDS ranged up to 225 ppm and fluoride concentration is below the acceptable limit of 1 mg/l. In general Chemical quality of shallow aquifer is potable and also suitable for irrigation Purpose. Result of chemical analysis is given in the table below.

Table - Ground Water quality of of Kario block

Sl.No	BLOCK	LOCATION	pH	EC	TH	Ca	Mg	Na	K	CO32-	HCO3-	Cl-	NO3-	SO42-	F	PO43-	TDS
1	Kuru/ Kairo	Jingi	7.4	347	160	38	15.795	13.17	2.264	ND	116.85	21.27	26.77	18.51	1.35	BDL	225.55

7. Supply side management

Dynamic Ground water resource of Kairo block has been assessed as 1486.77 ham. The stage of Development 14.06%. Therefore there is scope of ground water development. Additional ground water abstraction structure (442 Dug well and 166 Shallow Borewell) may be constructed at favourable sites for irrigation purposes. In addition Artificial Recharge structure like Percolation tank and check Dam/Nala bund can be constructed. The implementation of water conservation through artificial recharge measures will have a positive impact on drinking water sources of the area.

8. Demand side management Plan

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)

8.3 KISKO: BLOCK
1 Salient Information

1.	Name of the block and area		Kisko and Area:253.30 sq.km
2.	District/State		Lohardaga
3.	Population (2011)	Total	54959
		Urban	0
		Rural	54959
4.	Average annual Rain fall		1394.8 mm
5.	Agriculture and irrigation		Paddy, Coarse Cereal, Pulses, Oils Seeds etc. Tank-5, Deep tube well-10 Shallow tube well-1, DW-1243 and other -10
6.	Ground water resource availability and extraction		Available: 2914.65 Ham and extraction: 327.09 Ham
7.	Existing and future water demand		327.09 ham and for Domestic Use as on 2025 (Ham) is 73.03 ham
8.	Water level behaviour		Pre-monsoon DWL 11.1 and Post-monsoon 6.8 mbgl fluctuation of pre and post monsoon is 4.30m

The block is bounded in north by, Latehar and Chandwa block and south by Senha block east by Kuru and Lohardaga block and in the west by Peshrar block. The block headquarter is Kisko. There is one main district road passes through the block.

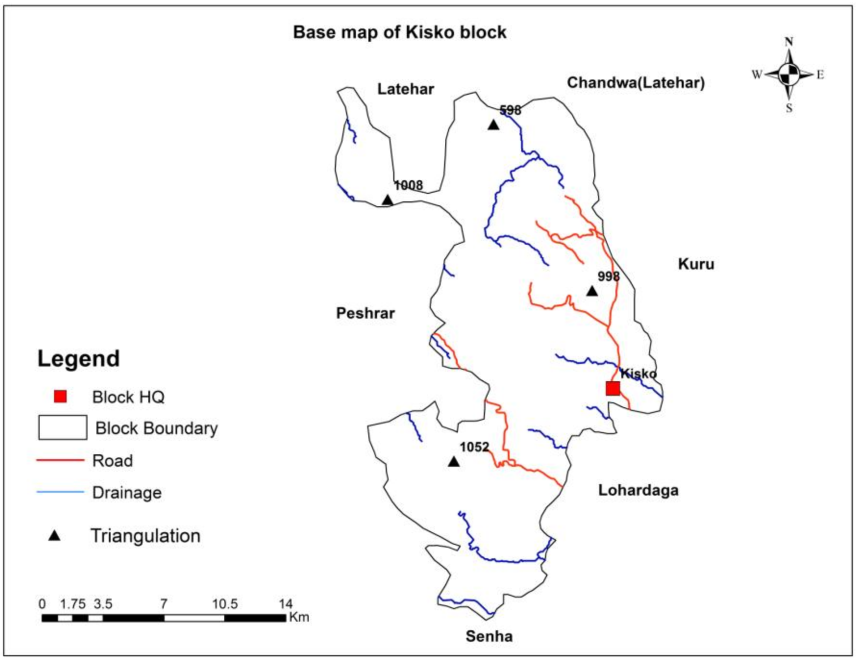


Figure: Base map of Kisko block

2. Geomorphology:

The Bhandra block is a part of Lohardaga district. The block mainly made up of Piedmont, buried pediplain and piedmont alluvium. General slope have toward north part. Height ranges from msl 598 m to 1052m.

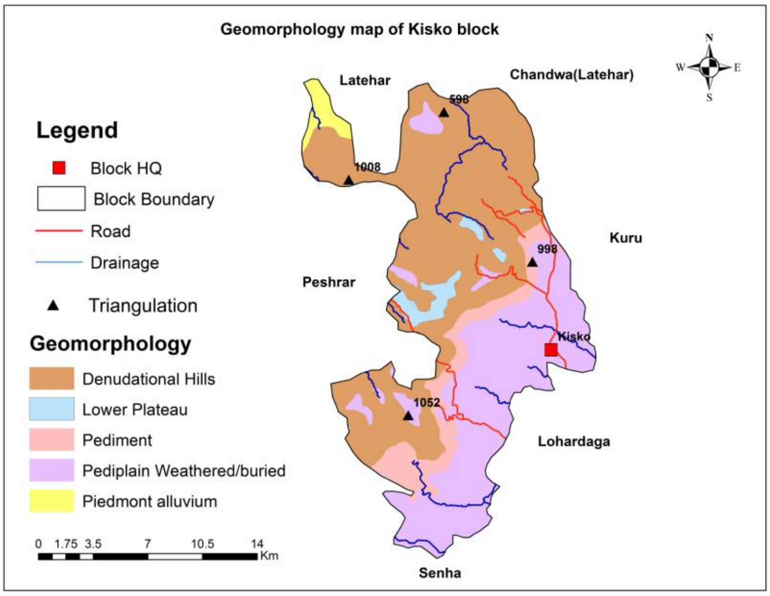


Figure: Geomorphology map of Kisko block

3. Geology

The maximum part of the block is covered by Chhotanagpur Gneissic Complex and newer alluvium. Lateritic and unclassified rocks are also found in the block.

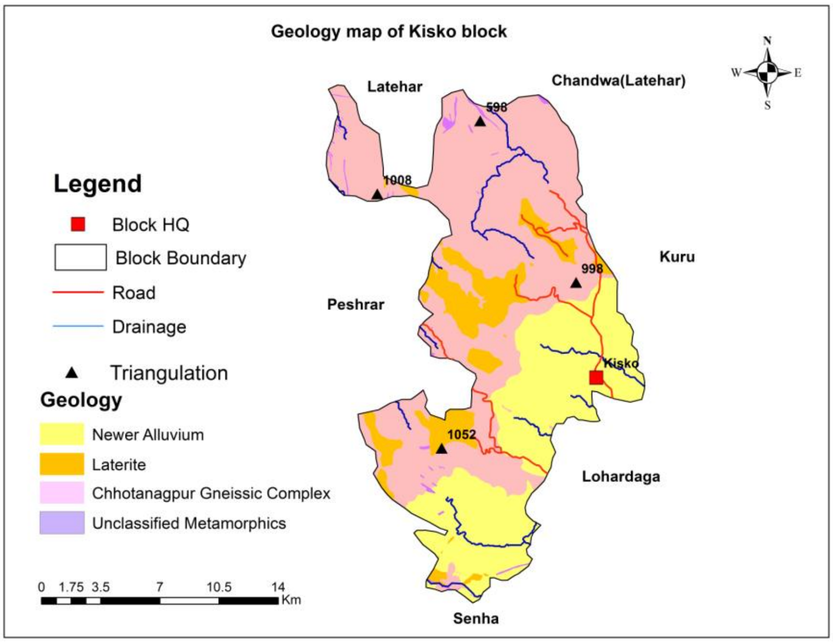


Figure: Geology map of Kisko block

4. Depth to Water Level

There are 1 NHS monitoring station and one key well in Kisko block. CGWB NHS monitoring data shows that during the pre-monsoon period (2020-21), the whole block was under the depth to water level within 5 to 10 m bgl. During the post-monsoon period, maximum part of the block was under 2 to 5 m bgl depth to water level range.

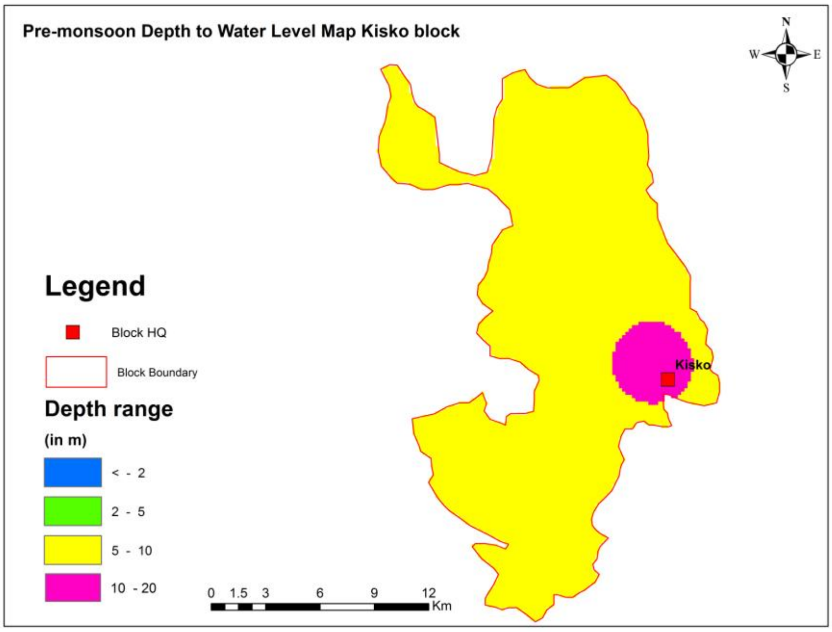


Figure: Pre-monsoon depth to water level map of Kisko block

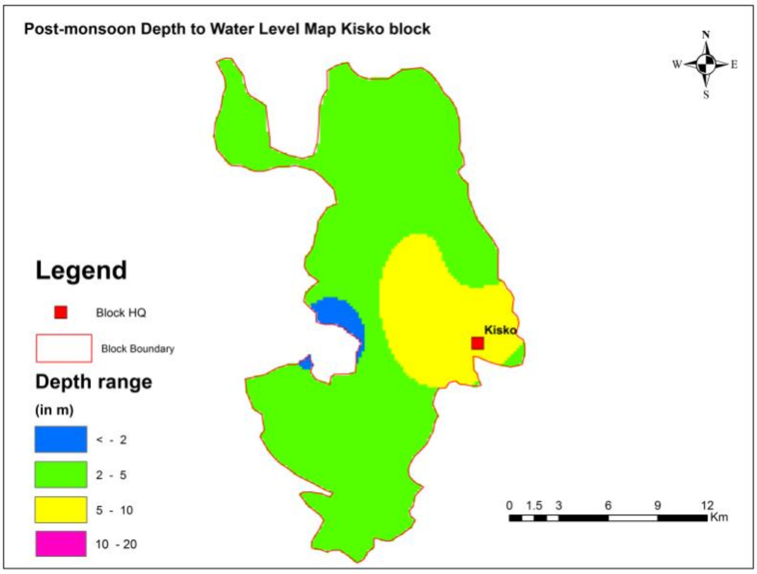


Figure: Post-monsoon depth to water level map of Kisko block

5. Aquifer Disposition and Characteristics

In the Kisko block one bore well has been drilled to know the aquifer characteristics. Bore well has been drilled up to 200m depth. Weathered depth encounter up to 17.80m depth and very low discharge measured 0.72 m3/hour.

6. Ground water resource, extraction, contamination and other issues

Extractable ground water recharge is 2914.65 ham, net ground water available for future us is 2587.05 ham. The SOD is 11.22 % only whereas of the district SOD is 14.79 %. It shows ample scope for further development of ground water.

Table - Ground Water Resources – 2020 of Kisko block Ground Water Resources – 2020

Sl. No.	Adm Units	Annual Extractable Ground Water Recharge	Current Annual Ground Water Extraction for irrigation	Current Annual Ground Water Extraction for domestic	Current Annual Ground Water Extraction for industrial	Current Annual Ground Water Extraction for All uses	Annual GW Allocation for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(%)
1	Kisko	2914.65	241.5	72.52	13.077	327.09	73.03	2587.05	11.22

Chemical quality of Ground Water :

Result of chemical analysis of ground water of shallow aquifer is given in the table below. The TDS ranged from 199 to 202 ppm and fluoride concentration is1.91 to 2.27 beyond the acceptable limit of 1 mg/l. In general Chemical quality of shallow aquifer is potable except some places and suitable for irrigation Purpose. Result of chemical analysis is given in the table below.

Table –Ground Water quality of of Kairo block

Sl.No	BLOCK	LOCATION	pH	EC	TH	Ca	Mg	Na	K	CO32-	HCO3-	Cl-	NO3-	SO42-	F	PO43-	TDS
1	Kisko	Semardih	7.04	307	110	28	9.72	18.67	13.96	ND	98.40	24.815	48.17	BDL	1.91	BDL	199.55
2	Kisko	Hutap	7.07	311	110	28	9.72	18.57	3	ND	73.80	28	47.99	24.41	2.27	BDL	202.15

7. Supply side management

Dynamic Ground water resource of Kisko block has been assessed as 2914.65ham. The stage of Development 11.22%. Therefore there is scope of ground water development. Additional ground water abstraction structure (894 Dug well and 335 Shallow Borewell) may be constructed at favourable sites for irrigation purposes. In addition Artificial Recharge structure like Percolation tank and check Dam/Nala bund can be constructed. The implementation of water conservation through artificial recharge measures will have a positive impact on drinking water sources of the area.

8. Demand side management Plan

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)

8.4 KURU: BLOCK

1 Salient Information

1.	Name of the block and area		Kuru and Area:217.41 sq.km
2.	District/State		Lohardaga
3.	Population (2011)	Total	84827
		Urban	0
		Rural	84827
4.	Average annual Rain fall		1367.9 mm
5.	Agriculture and irrigation		Paddy, Coarse Cereal, Pulses, Oils Seeds etc. Tank-14, Deep tube well-1, Shallow tube well-2, DW-1193 and other -25
6.	Ground water resource availability and extraction		Available: 1698.31 Ham and extraction: 413.18 Ham
7.	Existing and future water demand		413.18 ham and for Domestic Use as on 2025 (Ham) is 112.71 ham
8.	Water level behaviour		Pre-monsoon DWL 7.40 and Post-monsoon 3.45 mbgl fluctuation of pre and post monsoon is 3.95m

The block is bounded in north by Chandwa block of Latehar district and south byLohardaga and Kairo blocks and east by Chanho block of Ranchi district and south by Kisko block of Lohardaga district. The block headquarter is Kuru. There is one main district road passes through the block.

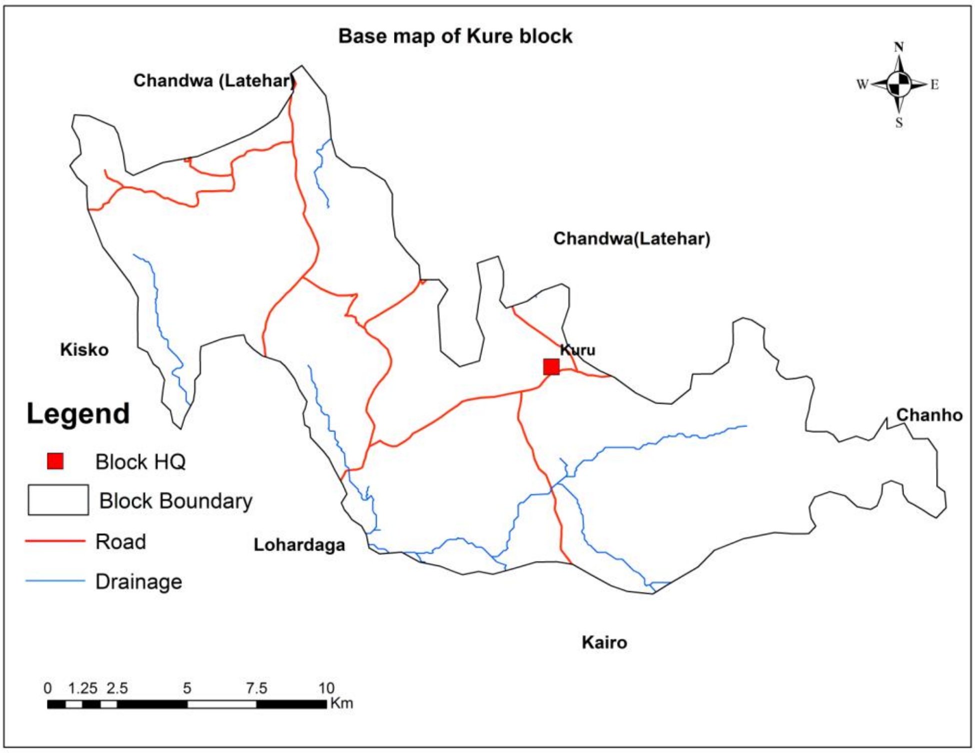


Figure: Base map of Kuru block

2. Geomorphology:

The Kuru block is a part of Lohardaga district. The block mainly made up, buried pediplain and pediment. General slope have toward north part. Height ranges from msl 562 m to 779m.

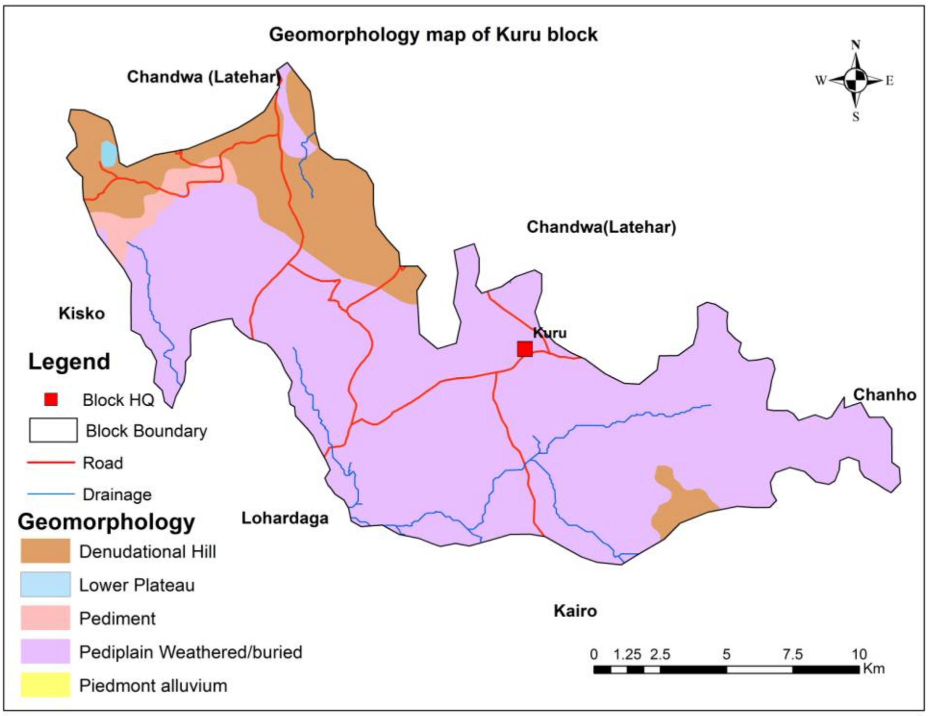


Figure: Geomorphology map of Kuru block

3. Geology

The maximum part of the block is covered by Chhotanagpur Gneissic Complex and newer alluvium. Lateritic and unclassified rocks are also found in the block.

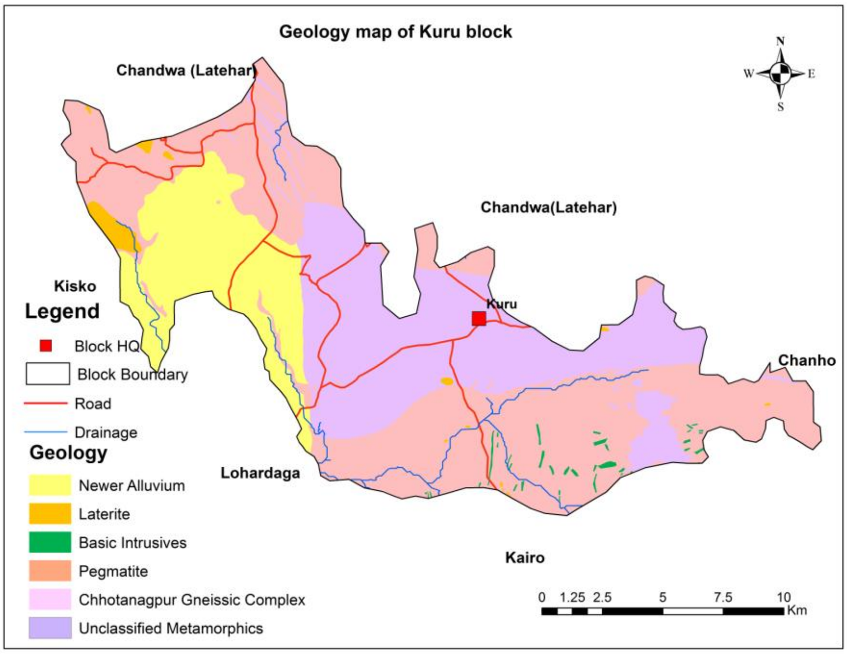


Figure: Geology map of Kuru block

4. Depth to Water Level

There are 2 NHS and 3 key wells were monitored in Kuru block. monitored data shows that during the pre-monsoon period (2020-21), the whole block was under the depth to water level within 5 to 10 m bgl. During the post-monsoon period, maximum part of the block was under 2 to 5 m bgl depth to water level range.

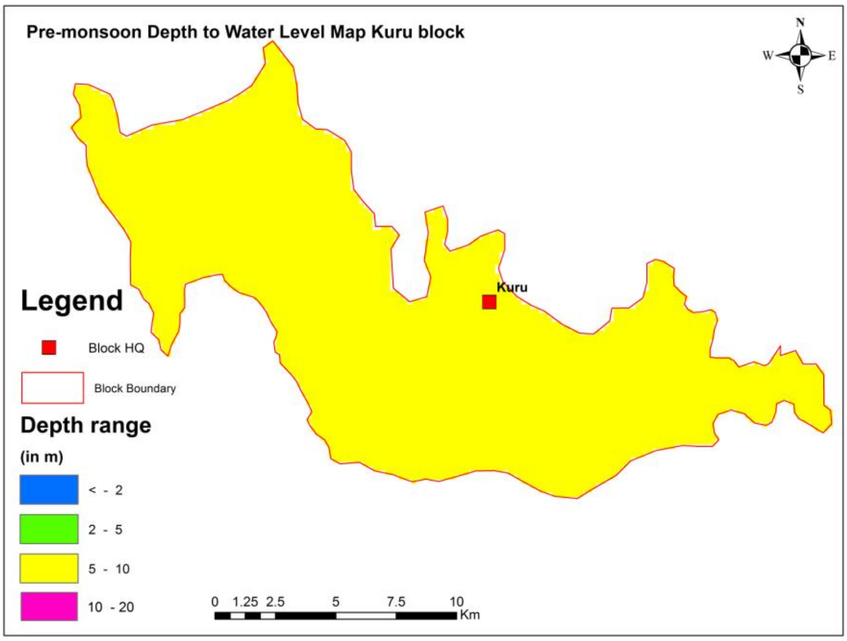
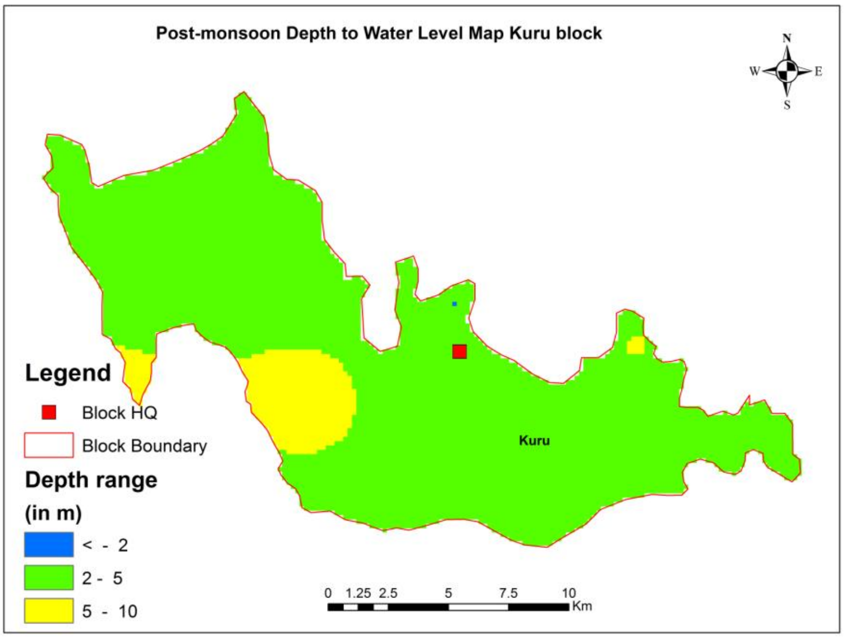


Figure: Pre-monsoon depth to water level map of Kuru block



Figgure: Post-monsoon depth to water level map of Kuru block

5. Aquifer Disposition and Characteristics

In the Kuru block 3 bore wells have been drilled to know the aquifer characteristics. Depth of the wells ranges 150m to 200 meters. Weathered depth ranges 10.00m to 33.00m. discharge is very low ranges from seepages to 7.92 m3/hour.

6. Ground water resource, extraction, contamination and other issues

Extractable ground water recharge is 1698.31 ham, net ground water available for future us is 1284.36 ham. The SOD is 24.33 % only whereas of the district SOD is 14.79 %. It shows ample scope for further development of ground water.

Table –Ground Water Resources – 2020 Kuru Block

Sl. No.	Adm Units	Annual Extractable Ground Water Recharge	Current Annual Ground Water Extraction for irrigation	Current Annual Ground Water Extraction for domestic	Current Annual Ground Water Extraction for industrial	Current Annual Ground Water Extraction for All uses	Annual GW Allocation for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(%)
1	Kuru	1698.31	301.25	111.94	0	413.18	112.71	1284.36	24.33

Chemical quality of Ground Water :

Result of chemical analysis of ground water of shallow aquifer is given in the table below. The TDS ranged from 79 to 395 ppm and fluoride concentration is 0.24 to 1.67 ppm. 2 places are recorded more than permissible limit. In general Chemical quality of shallow aquifer is potable and also suitable for irrigation Purpose. Result of chemical analysis is given in the table below.

Table – Ground Water quality of of Kuru block

Sl.No	BLOCK	LOCATION	pH	EC	TH	Ca	Mg	Na	K	CO32-	HCO3-	Cl-	NO3-	SO42-	F	PO43-	TDS
1	Kuru	Hiinjla	8.12	264	80	24	4.86	21	4.2	0	85.4	35.5	17	1.5	0.24	0	171.6
2	Kuru	Rudh 1	8.19	608	130	20	19.44	65	24	0	195.2	39.05	74	23	0.47	0	395.2
3	Kuru	Chiri (Siyarpara)	7.16	265	120	30	10.935	12.07	0.07	ND	73.80	17.72	68.56	BDL	1.69	BDL	172.25
4	Kuru	Opa	7.2	481	190	40	21.87	26.83	9.35	ND	209.10	39.985	2.49	30.96	1.57	BDL	312.65
5	Kuru	Barkichapi	7.33	123	44	10	4.56	7.18	5.16	ND	43.05	9.72	5.18	11.5	0.76	BDL	79.95

7. Supply side management

Dynamic Ground water resource of Kuru block has been assessed as 1698.31 ham. The stage of Development 24.33%. Therefore there is scope of ground water development. Additional ground water abstraction structure (444 Dug well and 167 Shallow Borewell) may be constructed at favourable sites for irrigation purposes. In addition Artificial Recharge structure like Percolation tank and check Dam/Nala bund can be constructed. The implementation of water conservation through artificial recharge measures will have a positive impact on drinking water sources of the area.

8. Demand side management Plan

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)

8.5 LOHARDAGA BLOCK
1. Salient Information

1.	Name of the block and area		Lohardaga and Area:161.68 sq.km
2.	District/State		Lohardaga
3.	Population (2011)	Total	126009
		Urban	57411
		Rural	68598
4.	Average annual Rain fall		1307.3 mm
5.	Agriculture and irrigation		Paddy, Coarse Cereal, Pulses, Oils Seeds etc. Tank-6, Deep tube well-0, Shallow tube well-8, DW-1455 and other -16
6.	Ground water resource availability and extraction		Available: 2957.49 Ham and extraction: 608.32 Ham
7.	Existing and future water demand		608.32 ham and for Domestic Use as on 2025 (Ham) is 234.18 ham
8.	Water level behaviour		Average Pre-monsoon DWL is 8.46 and Post-monsoon 4.47 mbgl fluctuation of pre and post monsoon is 3.99m

The block is bounded in north by, Kuru block and south by Bhandra block and east by Kairo and Kuru blocks and south by Senha and Kisko blocks of Lohardaga district.
The block headquarter is Lohardaga. There is one main district road passes through the block.

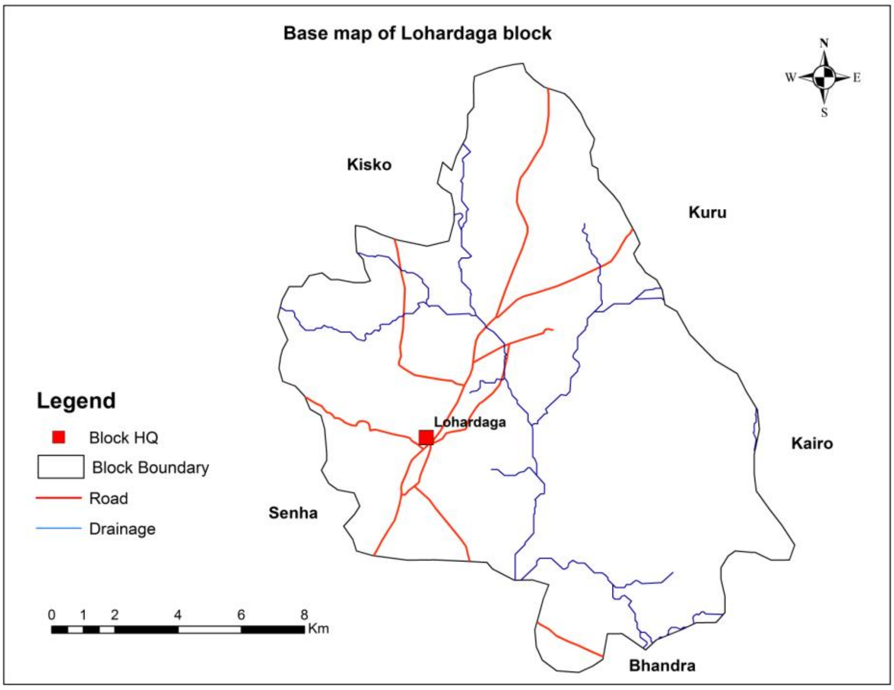


Figure:Base map of Lohardaga block

2. Geomorphology:

The Lohardaga block is a part of Lohardaga district. The block mainly made up of Burried pediplain. General slope have toward north part. Height ranges from msl 562 m to 779m.

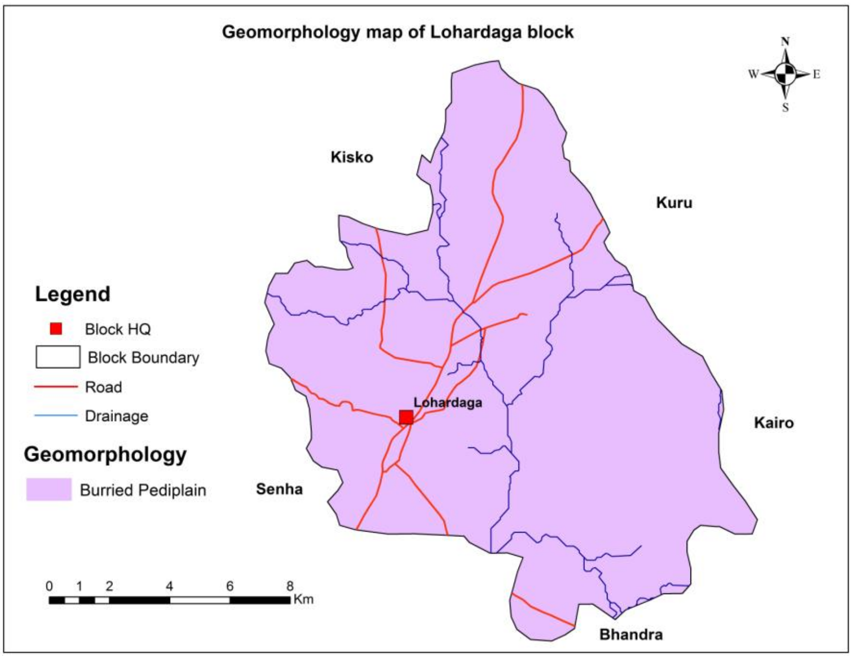


Figure: Geomorphology map of Lohardaga block

3. Geology

The maximum part of the block is covered by Newer alluvium and Chhotanagpur Gneissic Complex. Lateritic and unclassified rocks are also found in the block.

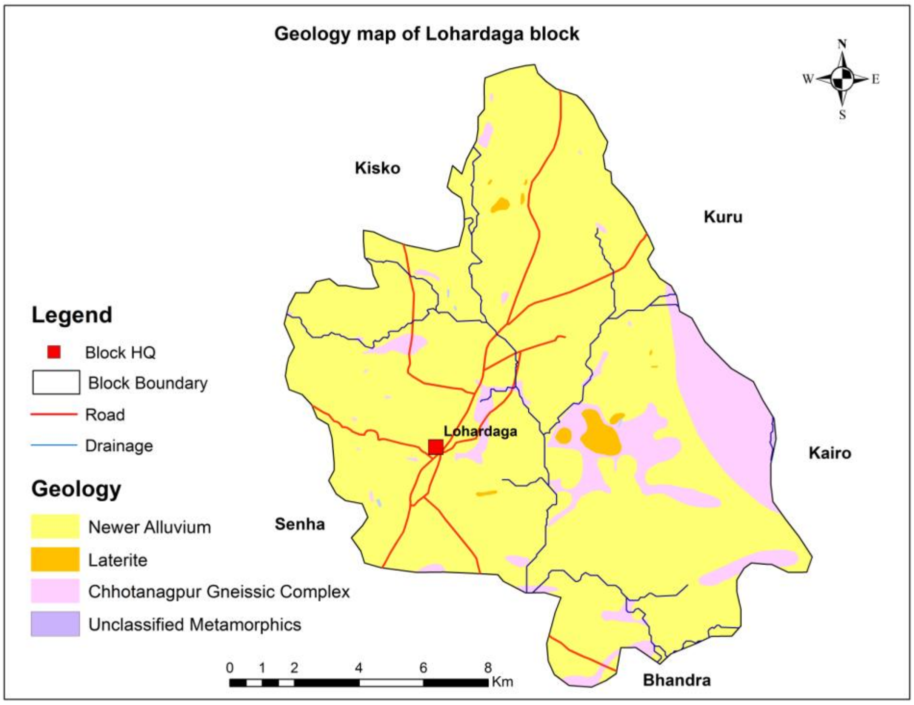


Figure: Geology map of Lohardaga block

4.Depth to Water Level

There are 5 NHS monitoring stations in Bhandra block. CGWB NHS monitoring data shows that during the pre-monsoon period (2020-21), the whole block was under the depth to water level within 5 to 10 m bgl. During the post-monsoon period, maximum part of the block was under 2 to 5 m bgl depth to water level range.

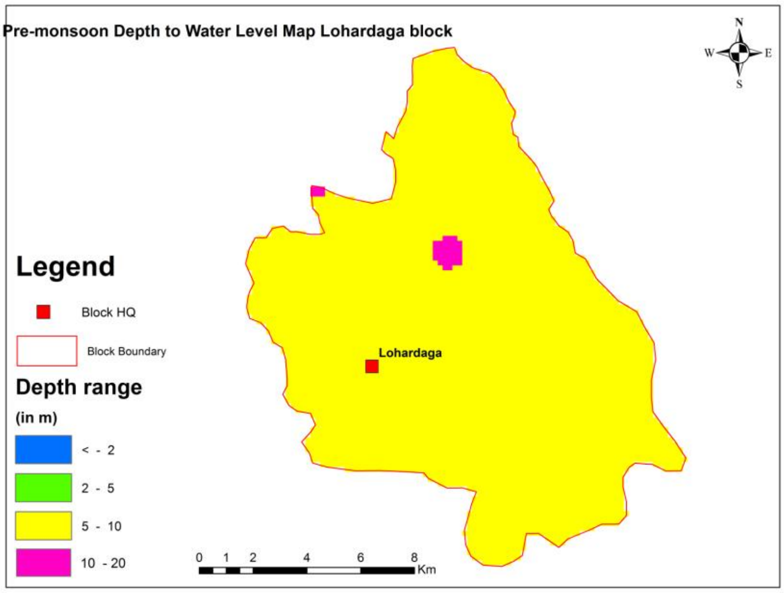


Figure: Pre-monsoon depth to water level map of Lohardaga block

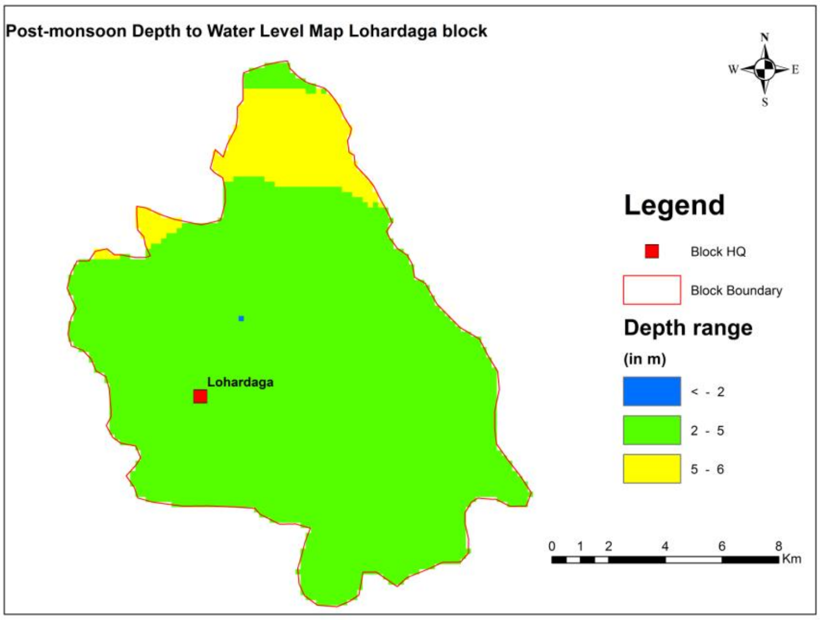


Figure: Post-monsoon depth to water level map of Lohardaga block

5. Aquifer Disposition and Characteristics

In the Lohardaga block 2 bore wells have been drilled to know the aquifer characteristics. Depth of the wells ranges 116m to 199 meters. Weathered depth ranges 13.00m to 42.00m. out of 2 wells one well is dry and one well have discharge 28.80 m3/hour.

6. Ground water resource, extraction, contamination and other issues

Extractable ground water recharge is 2957.49 ham, net ground water available for future us is 2347.56 ham. The SOD is 20.57 % only whereas of the district SOD is 14.79 %. It shows ample scope for further development of ground water.

Table – Ground Water Resources – 2020 of Lohardaga Block

Sl. No.	Adm Units	Annual Extractable Ground Water Recharge	Current Annual Ground Water Extraction for irrigation	Current Annual Ground Water Extraction for domestic	Current Annual Ground Water Extraction for industrial	Current Annual Ground Water Extraction for All uses	Annual GW Allocation for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(%)
1	Loharadaga	2957.49	375.75	232.57	0	608.32	234.18	2347.56	20.57

Chemical quality of Ground Water :

Result of chemical analysis of ground water of shallow aquifer is given in the table below. The TDS ranged from 202 to 388 ppm and fluoride concentration is below the acceptable limit of 1 mg/l. In general Chemical quality of shallow aquifer is potable and also suitable for irrigation Purpose. Result of chemical analysis is given in the table below.

Table – Ground Water quality of of Lohardaga block

Sl.No	BLOCK	LOCATION	pH	EC	TH	Ca	Mg	Na	K	CO32-	HCO3-	Cl-	NO3-	SO42-	F	PO43-	TDS
1	Lohardaga	Barwatoli Chowk	7.91	332	100	30	6.075	29	2.4	0	103.7	35.5	25	8.2	0.11	0	215.8
2	Lohardaga	Hesal	7.98	449	135	42	7.29	37	6.9	0	152.5	42.6	33	9.7	0.2	0	291.85
3	Lohardaga	Iragon	8.31	312	115	28	10.935	16	0.9	0	48.8	63.9	19	3.7	0.18	0	202.8
4	Lohardaga	Lohardaga (Patra Toli)	8.1	474	180	40	19.44	25	0.13	0	176.9	42.6	29	2.3	0.21	0	308.1
5	Lohardaga	Lohardaga (pwdib)	8.15	597	175	52	10.935	42	14	0	152.5	56.8	86	13	0.35	0	388.05

7. Supply side management

Dynamic Ground water resource of Lohardaga block has been assessed as 2957.49ham. The stage of Development 20.57%. Therefore there is scope of ground water development. Additional ground water abstraction structure (812 Dug well and 304 Shallow Borewell) may be constructed at favourable sites for irrigation purposes. In addition Artificial Recharge structure like Percolation tank and check Dam/Nala bund can be constructed. The implementation of water conservation through artificial recharge measures will have a positive impact on drinking water sources of the area.

8. Demand side management Plan

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)

iii) Promote treated municipal waste water for irrigation and construction use.

8.6 PESHRAR: BLOCK

1 Salient Information

1.	Name of the block and area		Peshrar and Area: 384.67 sq.km
2.	District/State		Lohardaga
3.	Population (2011)	Total	31057
		Urban	0
		Rural	31057
4.	Average annual Rain fall		1511.2 mm
5.	Agriculture and irrigation		Paddy, Coarse Cereal, Pulses, Oils Seeds etc. Tank-50, Deep tube well-0, Shallow tube well-0, DW-432 and other -60
6.	Ground water resource availability and extraction		Available: 2957.49 Ham and extraction: 608.32 Ham
7.	Existing and future water demand		608.32 ham and for Domestic Use as on 2025 (Ham) is 234.18 ham
8.	Water level behaviour		Pre-monsoon DWL 6.60 and Post-monsoon 5.00mbgl fluctuation of pre and post monsoon is 1.60m

The block is bounded in north by, Latehat District of Garu block, south by Ghaghara block of Gumla District and east by Kisko and Senha blocks and west by Bishunpur block of Gumla district. The block headquarter is Peshrar. There is one main district road passes through the block.

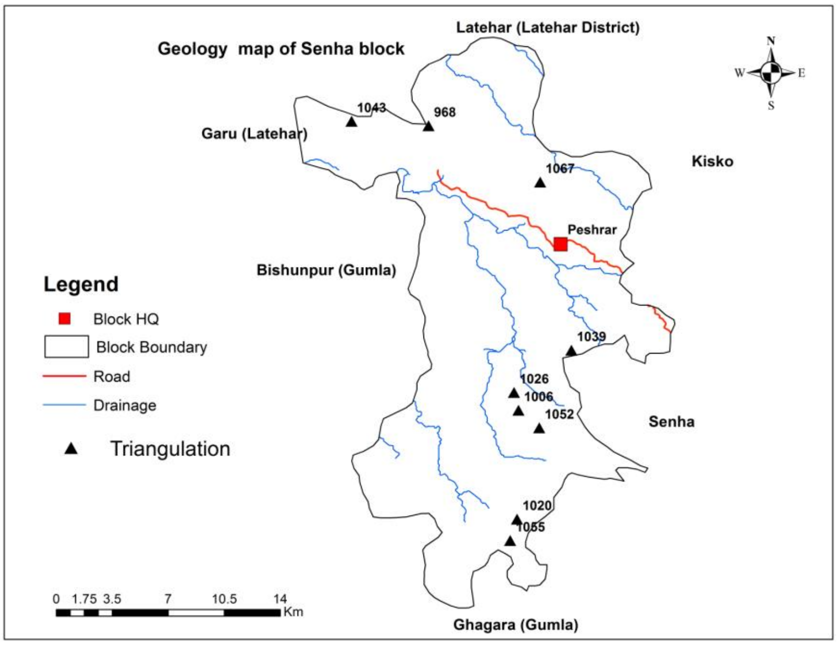


Figure: Base map of Peshrar block

2. Geomorphology:

The Peshrar block is a part of Lohardaga district. The block mainly made up of Denudational hills, dissected pediment, pediplain weathered and piedmont alluvium. General slope have toward north part. Height ranges from msl 968 m to 1055m.

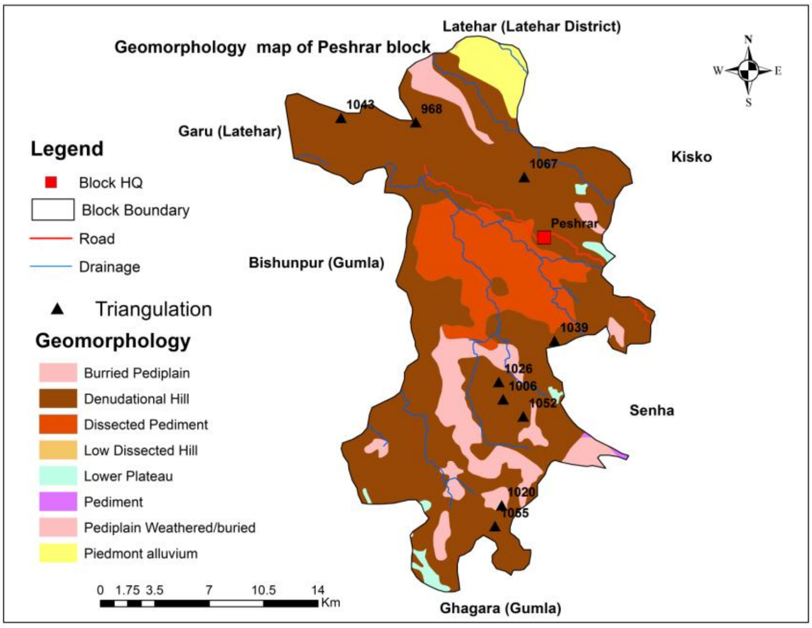


Figure: Geomorphology map of Peshrar block

3. Geology

The maximum part of the block is covered by Chhotanagpur Gneissic Complex and newer alluvium. Lateritic and unclassified rocks are also found in the block.

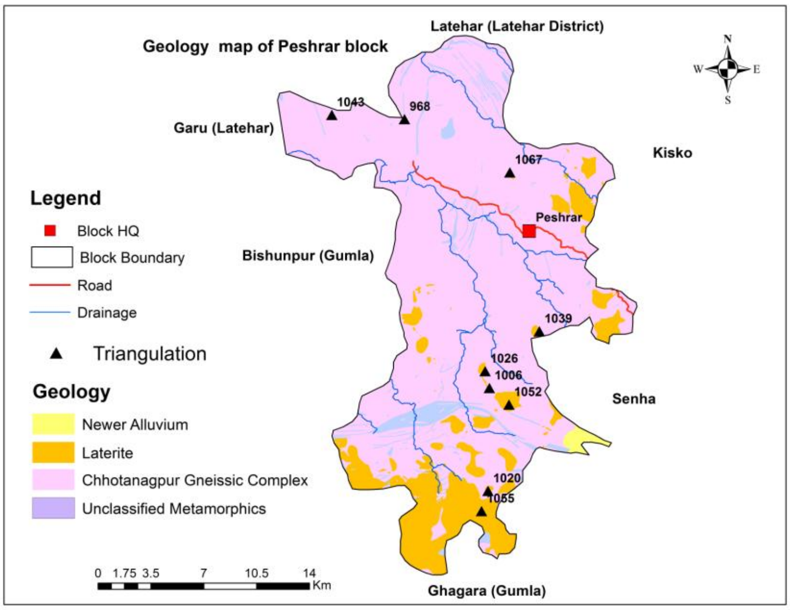


Figure: Geology map of Peshrar block

4. Depth to Water Level

1 NHS and 2 key wells monitored in Peshrar block, data shows that during the pre-monsoon period (2020-21), the whole block was under the depth to water level within 5 to 10 m bgl.

During the post-monsoon period, maximum part of the block was under 2 to 5 m bgl depth to water level range.

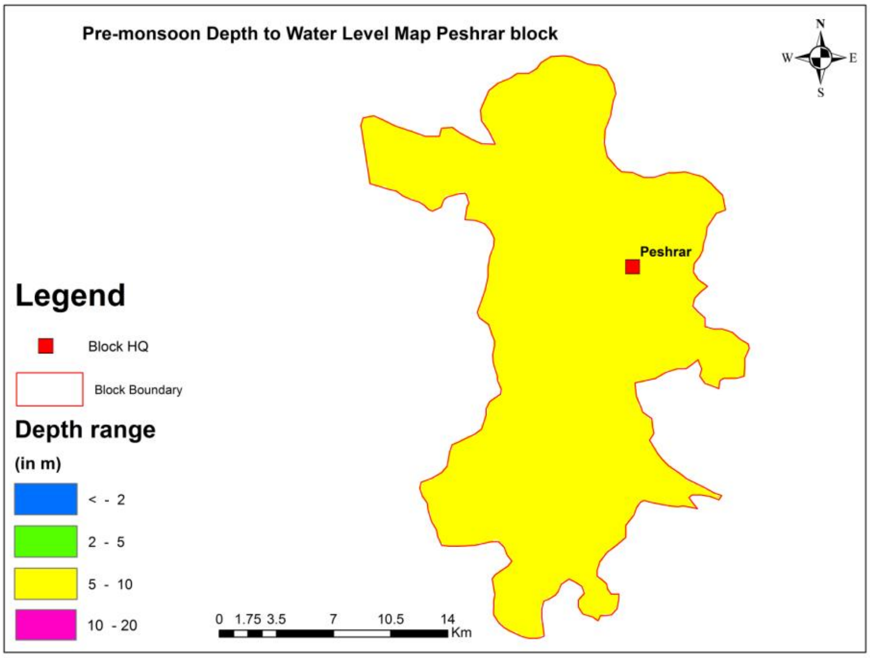


Figure: Pre-monsoon depth to water level map of Peshrar block

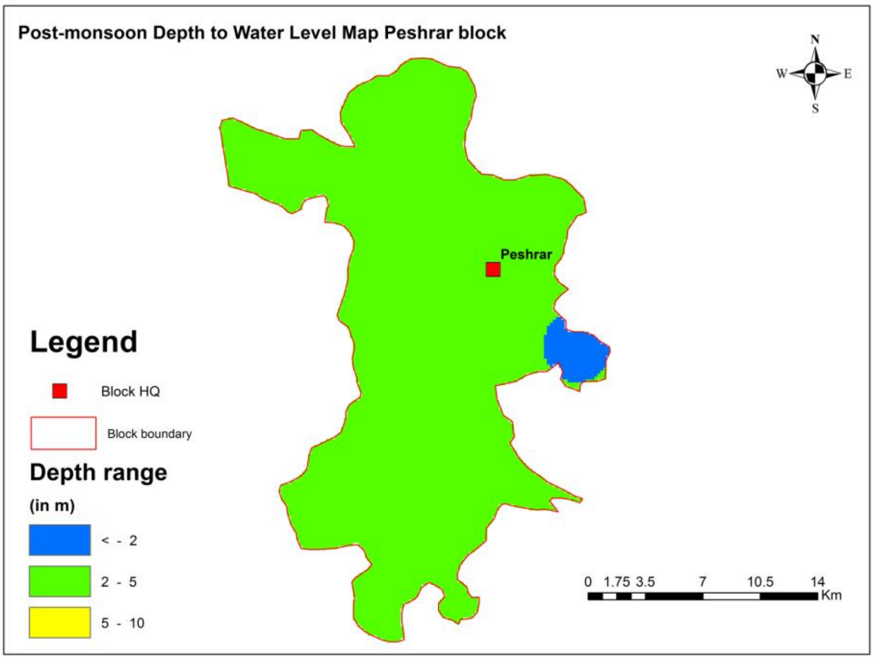


Figure: Post-monsoon depth to water level map of Peshrar block

5. Aquifer Disposition and Characteristics

In the Peshrar block 3 bore wells have been drilled to know the aquifer characteristics. Depth of the wells ranges 138m to 201 meters. Weathered depth ranges 18.00m to 35.00m. discharge ranges 5 m3/hour to 18 m3/hour

6. Ground water resource, extraction, contamination and other issues

Extractable ground water recharge is 2180.54 ham, net ground water available for future use is 2031.27 ham. The SOD is 6.83 % only whereas of the district SOD is 14.79 %. It shows ample scope for further development of ground water.

Table – Ground Water Resources – 2020 of Peshrar Block

Sl. No.	Adm Units	Annual Extractable Ground Water Recharge	Current Annual Ground Water Extraction for irrigation	Current Annual Ground Water Extraction for domestic	Current Annual Ground Water Extraction for industrial	Current Annual Ground Water Extraction for All uses	Annual GW Allocation for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(%)
1	Peshrar	2180.54	108	40.98	0	148.98	41.27	2031.27	6.83

Chemical Quality of Ground Water :

Result of chemical analysis of ground water of shallow aquifer is given in the table below. The TDS ranged from 120 to 291 ppm and fluoride concentration is beyond the acceptable limit of 1 mg/l ranges 1.50 to 2.29. In general Chemical quality of shallow aquifer is potable and also suitable for irrigation Purpose. Result of chemical analysis is given in the table below.

Table – Ground Water quality of of Peshrar block

Sl.No	Block	Location	pH	EC	TH	Ca	Mg	Na	K	CO32-	HCO3-	Cl-	NO3-	SO42-	F	PO43-	TDS
1	Peshrar	Peshrar	7.28	272	115	34	7.219	7.84	7.39	ND	110.70	7.09	47.93	5.15	1.6	BDL	176.8
2	Peshrar	Kekrang	7.49	185	65	14	7.29	12.41	5.27	ND	73.80	10.635	25.87	0.28	2.29	BDL	120.25
3	Peshrar	Kekrang	7.31	448	160	30	20.655	18.34	8.19	ND	209.10	14.18	23.97	19.17	1.5	BDL	291.2

7. Supply side management

Dynamic Ground water resource of Peshrar block has been assessed as 2180.54 ham. The stage of Development 6.83%. Therefore there is scope of ground water development. Additional ground water abstraction structure (702 Dug well and 263 Shallow Borewell) may be constructed at favourable sites for irrigation purposes.

8. Demand side management Plan

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)

8.7 SENHA: BLOCK

1 Salient Information

1.	Name of the block and area		Senha and Area: 212.46 sq.km
2.	District/State		Lohardaga
3.	Population (2011)	Total	69768
		Urban	0
		Rural	69768
4.	Average annual rain fall		1307.3mm
5.	Agriculture and irrigation		Paddy, Coarse Cereal, Pulses, Oils Seeds etc. Tank-7, Deep tube well-1, Shallow tube well-24, DW-1039 and other -18
6.	Ground water resource availability and extraction		Available: 3419.58 Ham and extraction: 408.07 Ham
7.	Existing and future water demand		408.07 ham and for Domestic Use as on 2025 (Ham) is 92.7 ham
8.	Water level behaviour		Pre-monsoon DWL 10.40 and Post-monsoon 42.05mbgl fluctuation of pre and post monsoon is 8.53m
9.	Basin / Sub-basin		

The block is bounded in north by Kisko and Lohardaga blocks, south by Ghaghara and Sisai blocks of Gumla District and east by Bhandra block and south by Peshrar block of Lohardaga district. The block headquarter is Senha. There is one main district road passes through the block.

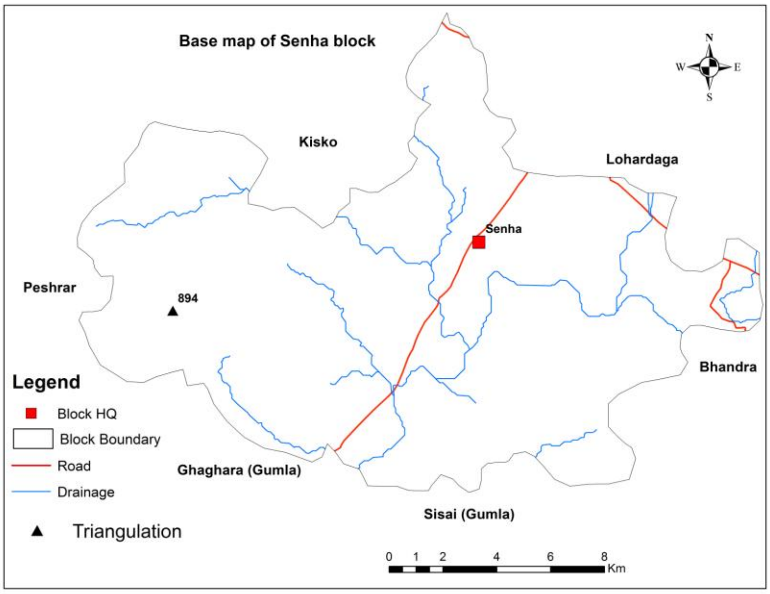


Figure: Base map of Senha block

2. Geomorphology:

The Senha block is a part of Lohardaga district. The block mainly made up of Pediplain buried, Pediment, Denudational hills and piedmont alluvium. General slope have toward south western part. Height ranges from msl 562 m to 680m.

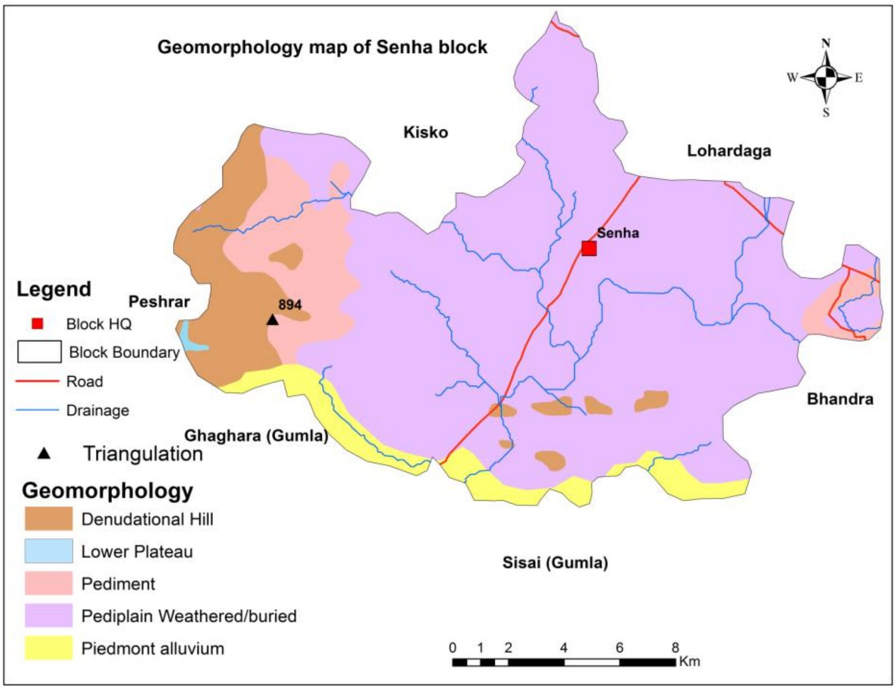


Figure: Geomorphology map of Senha block

3. Geology

The maximum part of the block is covered by Chhotanagpur Gneissic Complex and newer alluvium. Lateritic and unclassified rocks are also found in the block.

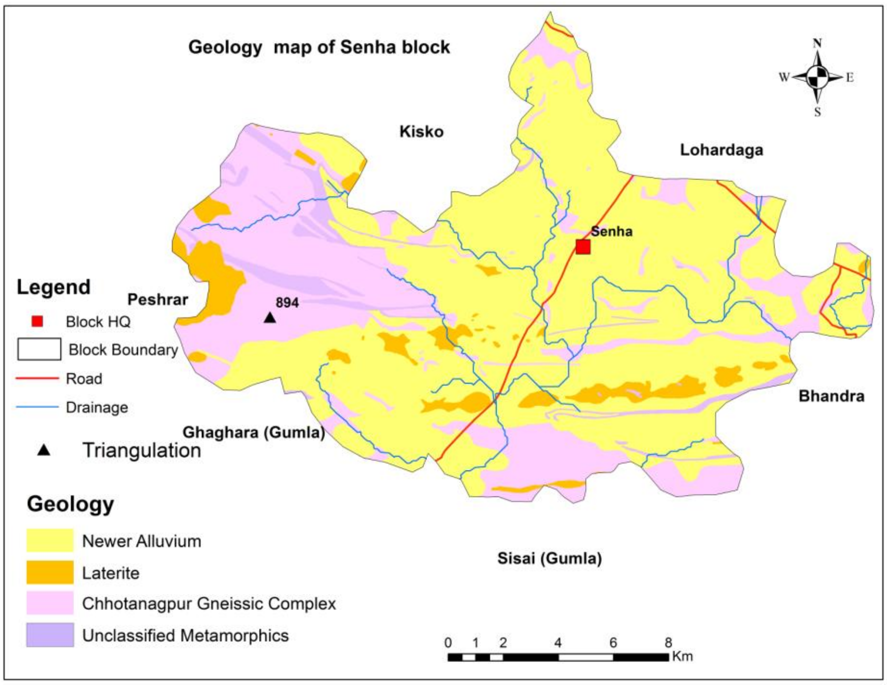


Figure: Geology map of Senha block

4. Depth to Water Level

There are 1 NHS monitoring stations in Senha block. CGWB NHS monitoring data shows that during the pre-monsoon period (2020-21), the whole block was under the depth to water level within 5 to 20 m bgl. During the post-monsoon period, maximum part of the block wasunder 2 to 5 m bgl depth to water level range.

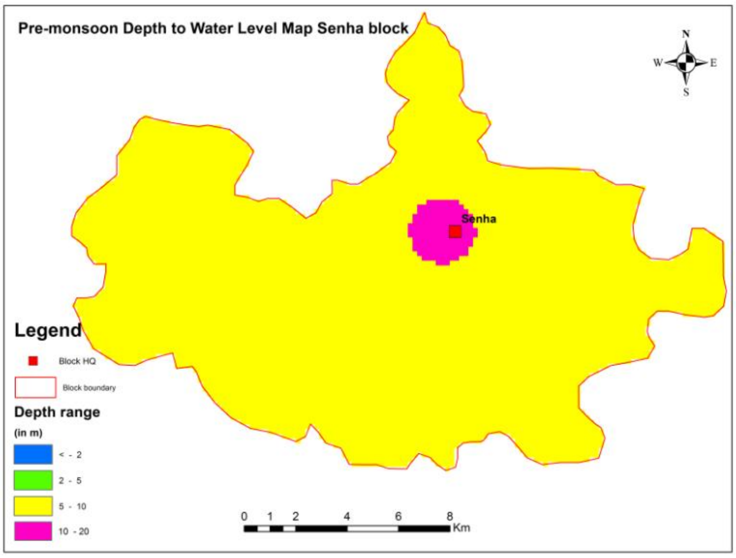


Figure: Pre-monsoon depth to water level map of Senha block

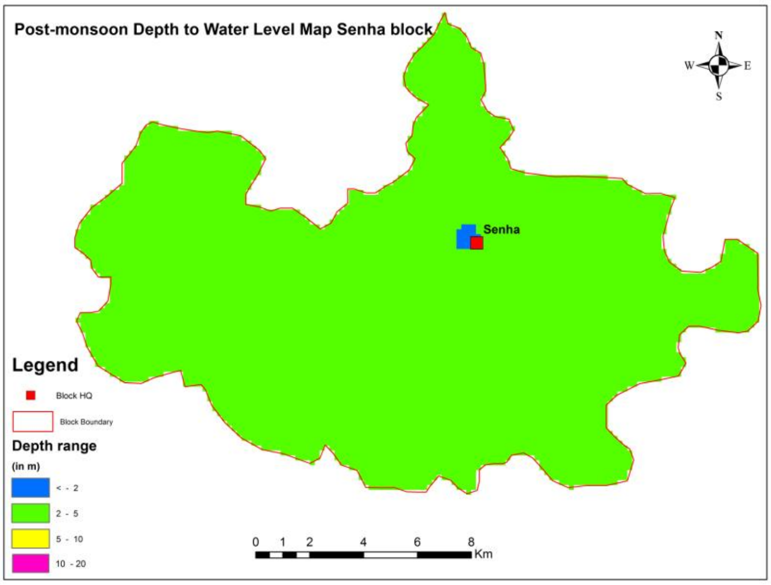


Figure: Post-monsoon depth to water level map of Senha block

5. Aquifer Disposition and Characteristics

In the Bhandra block 4 bore wells have been drilled to know the aquifer characteristics. Depth of the wells ranges 132m to 199 meters. Weathered depth ranges 13.00m to 23.00m. out of 4 wells one wells are dry and rest well have very low discharge 6.48 m3/hour.

6. Ground water resource, extraction, contamination and other issues

Extractable ground water recharge is 3419.58 ham, net ground water available for future us is 3010.87 ham. The SOD is 11.93 % only whereas of the district SOD is 14.79 %. It shows ample scope for further development of ground water.

Table – Ground Water Resources – 2020 of Senha block

Sl. No.	Adm Units	Annual Extractable Ground Water Recharge	Current Annual Ground Water Extraction for irrigation	Current Annual Ground Water Extraction for domestic	Current Annual Ground Water Extraction for industrial	Current Annual Ground Water Extraction for All uses	Annual GW Allocation for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(%)
1	Senha	3419.58	315.75	92.06	0.263011	408.07	92.7	3010.87	11.93

Chemical quality of Ground Water :

Result of chemical analysis of ground water of shallow aquifer is given in the table below. The TDS 511 ppm and fluoride concentration is below the acceptable limit of 1 mg/l. In general Chemical quality of shallow aquifer is potable and also suitable for irrigation Purpose. Result of chemical analysis is given in the table below.

Table – Ground Water quality of of Senha block

BLOCK	LOCATION	pH	EC	TH	Ca	Mg	Na	K	CO32-	HCO3-	Cl-	NO3-	SO42-	F	PO43-	TDS
Senha	Senha Bdo	8.17	787	300	84	21.87	19	4.6	0	219.6	46.15	86	32	0.39	0	511.55

7. Supply side management

Dynamic Ground water resource of Senha block has been assessed as 3419.58 ham. The stage of Development 11.93%. Therefore there is scope of ground water development. Additional ground water abstraction structure (1041 Dug well and 390 Shallow Borewell) may be constructed at favourable sites for irrigation purposes. In addition Artificial Recharge structure like Percolation tank and check Dam/Nala bund can be constructed. The implementation of water conservation through artificial recharge measures will have a positive impact on drinking water sources of the area.

8. Demand side management Plan

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)

DETAILS OF KEY WELLS ESTABLISHED FOR NATIONAL AQUIFER MAPPING STUDY OF LOHARDAGA DISTRICT, 2019 –20

Well No.	Village	Block	Owner	Location	Type of well	Geology	Lifting device	MP (magl)	Depth (mbgl)	Dia. (m.)
1	Jingi	Kuru	Govt. Kaleshwari Bhagat	Near Anganbari Kendra, Jingi	DW	CGC	Rope & Bucket	00.00	7.50	4.30
2	Chiri(Siyarpara)	Kuru	Shamsher Ansari	LHS after crossing High School Chiri	DW	CGC	Rope & Bucket	0.40	9.05	4.50
3	Opa	Kuru	Pachu Oraon	Near Trijuction of Opa villge	DW	CGC	Rope & Bucket	.10	10	3.10
4	Barkichapi	Kuru	Govt.	Near Essar Petrol pump Barki Chapi	DW	CGC	Rope & Bucket	.40	9.10	4.60
5	Semardih	Kisko	Charwa Bhat	In the campus of Cherwa bhagat, near Primari School Semardih	DW	CGC	Rope & Bucket	.35	13.45	3.30
6	Hutap	Kisko	Govt.	In the Land of Kudrat ansari	DW	CGC	Rope & Bucket	.50	8.40	4.60
7	Peshrar	Peshrar	Govt.	Opposite to weekly market Peshrar, Near Block office Peshrar	DW	CGC	Rope & Bucket	.40	7.90	3.90
8	Kekrang	Peshrar	Govt.	Near Middle School Kekrang, Peshrar	DW	CGC	Rope & Bucket	.40	1.80	2.10
9	Kekrang	Peshrar	Govt.	In the Campus of Middle School Kekrang, Peshrar	HP	CGC	Hand pump			

Annexure – II

WATER LEVEL DATA OF KEY & NHNS WELLS OF NAQUIM STUDY AREA OF LOHARDAGA DISTRICT, JHARKHAND, 2020-21

Sl No	Village	Block	District	May 2020 DWL(inmbgl)	Nov. 2020 DWL(inmbgl)	Pre-post Fluctuation
1	Jingi	Kuru	Lohardaga		3.7	
2	Chiri(Siyarpara)	Kuru	Lohardaga		5.9	
3	Opa	Kuru	Lohardaga		4.9	
4	Barkichapi	Kuru	Lohardaga		4.2	
5	Semardih	Kisko	Lohardaga		7.72	
6	Hutap	Kisko	Lohardaga		4.6	
7	Peshrar	Peshrar	Lohardaga		5	
8	Kekrang	Peshrar	Lohardaga		0.01	
9	Barwatoli Chowk	Lohardaga	Lohardaga	4.6	3.4	1.2
10	Bhandara	Bhandara	Lohardaga	7.95	4.6	3.35
11	Hesal	Lohardaga	Lohardaga	8.63	5.4	3.23
12	Hinjla	Kuru	Lohardaga	7.15	5.1	2.05
13	Irgaon	Lohardaga	Lohardaga	5.95	3.55	2.4
14	Kisko1	Kisko	Lohardaga	11.1	6.8	4.3
15	Lohardaga(Patra Toli)	Lohardaga	Lohardaga	10.5	3.7	6.8
16	Lohardaga(pwdib	Lohardaga	Lohardaga	6.15	2.9	3.25
17	Rudh1	Kuru	Lohardaga	7.4	3.45	3.95
18	Senha Bdo	Senha	Lohardaga	10.4	2.05	8.35

Hydrogeological Details of Exploratory Borewells in Lohardaga District
Wells drilled through Department Rings

Sl No	Location	Block	Co-ordinate	Depth Drilled	Casing Depth	fracture encountered between	Static Water level	Discharge	D/Dn	Specific Capacity	Dia. of assembly	Formation	Year
				m	m	m	m bgl.	m^3/hr	m	$m^3/hr/m$	mm		
1	**Bhandra EW**	Bhandra	$23^0$21'45'' $84^0$46'45''	199	23.1			Dry				Granite gneiss	
2	**Senha** EW -1	Senha	$23^0$23'00'' $84^0$39'30''	199.12	20.2			Dry				Granite gneiss	
3	**Senha** EW -2	Senha	$23^0$23'05'' $84^0$39'30''	176.26	18.15			7.2				Granite gneiss	
4	**Kuru EW**	Kuru	$23^0$25'25'' $84^0$48'45''	199.12	33.4			0.29				Granite gneiss	
5	**Irgaon EW**	Bhandra	$23^0$25'25'' $84^0$46'30''	199.12	19			6.45				Granite gneiss	
6	**Gangupara EW**	Lohardaga	$23^0$27'04'' $84^0$39'17''	138.56	13.0	44.0-45.0 121-122 126-127 131-132		5.23	16.20			Granite gneiss	2014-15
7	**Ajay Udayan EW**	Lohardagga	$23^0$25'30'' $84^0$41'00''	199.12	13			2.63				Granite gneiss	
8	**Gangupara OW**	Lohardaga	$23^0$27'04'' $84^0$39'17''	135.54	13	130-132		14.40				Granite Gneiss	2015-16
9	**Rampur EW**		$23^0$26'21'' $84^0$45'08''	153.80	11.50	27-28 42-44		20.52				Granite Gneiss	2015-16
	OW-1			54.74	12.0	40-42 52-54		20.52					

Sl No	Location	Block	Co-ordinate	Depth Drilled	Casing Depth	fracture encountered between	Static Water level	Discharge	D/Dn	Specific Capacity	Dia. of assembly	Formation	Year
				m	m	m	m bgl.	m^3/hr	m	m^3/hr/m	mm		
	OW-II			54.47	12.0	40-42 52-54		20.52					
10	**Gudi**	Lohardaga	$23^0$24'57'' $84^0$48'30''	153.8	12			Dry				Granite Gneiss	2015-16
	OW			153.8	11			Dry					
11	**Bhandra EW**	**Lohardaga**	$23^0$21'30'' $84^0$46'45''	153.8	28	46-47 54-56		14.04				Granite Gneiss	2015-16
	OW-I			153.8	28	46-47 54-56		14.04				Granite Gneiss	2015-16
	OW-II			153.8	28	46-48 56-57		9.0				Granite Gneiss	2015-16

Wells drilled through Out-Sourcing

Sl No	Location	Block	Co-ordinate	Depth Drilled	Casing Depth	fracture encountered between	Static Water level	Discharge	Drawdown	Specific Capacity	Dia. of assembly	Formation	Year
				m	m	m	m bgl.	m^3/hr	m	m^3/hr/m	mm		
12	**Kujra** EW	Lohardagga	23^0 30' 30" 84^0 40' 40"	116.85	42.42	33.88-39.50 45.11-50.64 74.97-80.56 92.80-98.56	4.6	28.8	7.1		203	Granite gneiss	02/2005
13	**Badla** EW	Senha	23^0 25' 25" 84^0 39' 40"	132.39	22.57	25-28 85-88	5.6	24	6.1		203	Granite gneiss	02/2005
14	**Chatti** **EW**	Bhandra	23^0 21' 30" 84^0 53' 50"	150	10.4		7.9				203	Granite gneiss	02/2005
15	**Lawagi**	Kuru	23^0 29' 40"	150	11.4	108.78-114.40	5.1	LOW			203		2005
	EW		84^0 46' 55"									Granite gneiss	

Sl No	Location	Block	Co-ordinate	Depth Drilled	Casing Depth	fracture encountered between	Static Water level	Discharge	Drawdown	Specific Capacity	Dia. of assembly	Formation	Year
				m	m	m	m bgl.	m^3/hr	m	$m^3/hr/m$	mm		
16	**Sethio** EW	Senha	23^0 23' 40" 84^0 43' 05"	150	13.08	13.82-16.82 22.45-28.05 33.73-35.73	5.3	2.46	20.9		203	granite gneiss	2005
17	Shah Booty/Lohardaga EW		$23^0$25'51" $85^0$20'13"	144.05	18.6			44.28					2012
	OW			139.7	18.9			43.2					2012
18	Kuru/ Lohardaga		$23^0$32'12" $84^0$49'11.7"	200.0	31.0			7.92					2012
19	Murappa/ Lohardaga EW		$23^0$20'8.2" $84^0$40'31.7"	134.76	35.45			80.28					2012
	OW			85.42	35.6			80.28					2012

Through Outsource Drilling (WAPCOS)

Sl. No.	Location	Block	Co-ordinate	Depth Drilled	Casing Depth/Dia.	fracture encountered between	Static Water level	Discharge (Comp)	Discharge (Pumping Test)	Draw down	Specific Capacity	T	S	Formation	Year
				m	m/mm	m	m bgl.	m^3/hr	m^3/hr	m	$m^3/hr./m.$	m^2/day			
20	Kakrang	Peshrar	$84^0$35'45.0" $23^0$30'37.7"	201	17.8	20.0-22.0	9.9		4.968(PYT)	**14.3**		6.07		Granite Gneiss	**2020-21**
21	Jawakheda	Peshrar	$84^0$34'08.8" $23^0$30'37.7"	201	24.5	75.0-76.0	0.08		18.828	43.17		28.27	$2.22 X10^{-4}$	Granite Gneiss	**2020-21**
	OW	Peshrar	$84^0$34'08.8" $23^0$30'37.7"	201	23.9	75.5				6.54					
22	Tisiya	Kisko	$84^0$40'07.8" $23^0$33'30.1"	201	17.8	20.0-21.0 83.0-83.5	2.32	0.72				1.32(slug		Granite Gneiss	**2020-21**

												test)			
23	Garahkasmar	Peshrar	84^{0}33'59.1" 23^{0}26'13.8"	138	34.5	115.2-115.5	**11.69**		**18**	**13.8**		91.04	4.78 x10^{-5}	**Granite Gneiss**	**2020-21**
	OW	Peshrar	84^{0}33'59.1" 23^{0}26'13.8"	115	37.0	109.0-109.4	**12.15**			**6.3**					

Piezometers

Sl No	Location	Block	Co-ordinate	Depth Drilled	Casing Depth	Granular Zone / fracture Tapped	Static Water level	Discharge	D/Dn	Specific Capacity	T	S	Dia. of assembly	Formation	Year
				m	**m**	**m**	**m bgl.**	**m^3/hr**	**m**	**m^3/hr/m**	**m^2/day**		**mm**		
1	**Gangupara Pz**	Lohardaga	23^{0}27'04'' 84^{0}39'17''	62.36	16.5	44.0-44.5	5.80	1.368						Granite Gneiss	2014-15

Annexure - IV

Water quality data of aquifer – I (dug well samples) of aquifer mapping study area of Lohardaga district

Sl.No	District	BLOCK	LOCATION	pH	EC	TH	Ca	Mg	Na	K	CO32-	HCO3-	Cl-	NO3-	SO42-	F	PO43-	TDS
1	Lohardaga	Lohardaga	Barwatoli Chowk	7.91	332	100	30	6.075	29	2.4	0	103.7	35.5	25	8.2	0.11	0	215.8
2	Lohardaga	Bhandara	Bhandara	7.84	168	75	20	6.075	3.2	0.06	0	61	21.3	1.2	0	0.03	0	109.2
3	Lohardaga	Lohardaga	Hesal	7.98	449	135	42	7.29	37	6.9	0	152.5	42.6	33	9.7	0.2	0	291.85
4	Lohardaga	Kuru	Hiinjla	8.12	264	80	24	4.86	21	4.2	0	85.4	35.5	17	1.5	0.24	0	171.6
5	Lohardaga	Lohardaga	Iragon	8.31	312	115	28	10.935	16	0.9	0	48.8	63.9	19	3.7	0.18	0	202.8
6	Lohardaga	Kisko	Kisko 1	8.29	244	65	20	3.645	23	3.6	0	30.5	60.35	11	1.8	0.24	0	158.6
7	Lohardaga	Lohardaga	Lohardaga (Patra Toli)	8.1	474	180	40	19.44	25	0.13	0	176.9	42.6	29	2.3	0.21	0	308.1
8	Lohardaga	Lohardaga	Lohardaga (pwdib)	8.15	597	175	52	10.935	42	14	0	152.5	56.8	86	13	0.35	0	388.05
9	Lohardaga	Kuru	Rudh 1	8.19	608	130	20	19.44	65	24	0	195.2	39.05	74	23	0.47	0	395.2
10	Lohardaga	Senha (Sneha)	Senha Bdo	8.17	787	300	84	21.87	19	4.6	0	219.6	46.15	86	32	0.39	0	511.55
11	Lohardaga	Kuru	Jingi	7.4	347	160	38	15.795	13.17	2.264	ND	116.85	21.27	26.77	18.51	1.35	BDL	225.55
12	Lohardaga	Kuru	Chiri(Siyarpara)	7.16	265	120	30	10.935	12.07	0.07	ND	73.80	17.72	68.56	BDL	1.69	BDL	172.25
13	Lohardaga	Kuru	Opa	7.2	481	190	40	21.87	26.83	9.35	ND	209.10	39.985	2.49	30.96	1.57	BDL	312.65
14	Lohardaga	Kuru	Barkichapi	7.33	123	44	10	4.56	7.18	5.16	ND	43.05	9.72	5.18	11.5	0.76	BDL	79.95
15	Lohardaga	Kisko	Semardih	7.04	307	110	28	9.72	18.67	13.96	ND	98.40	24.815	48.17	BDL	1.91	BDL	199.55
16	Lohardaga	Kisko	Hutap	7.07	311	110	28	9.72	18.57	3	ND	73.80	28	47.99	24.41	2.27	BDL	202.15
17	Lohardaga	Peshrar	Peshrar	7.28	272	115	34	7.219	7.84	7.39	ND	110.70	7.09	47.93	5.15	1.6	BDL	176.8
18	Lohardaga	Peshrar	Kekrang	7.49	185	65	14	7.29	12.41	5.27	ND	73.80	10.635	25.87	0.28	2.29	BDL	120.25
19	Lohardaga	Peshrar	Kekrang	7.31	448	160	30	20.655	18.34	8.19	ND	209.10	14.18	23.97	19.17	1.5	BDL	291.2

Annexure-V

Uranium concentration of Water quality data of aquifer – I (dug well samples) of aquifer mapping study area of Lohardaga district

Sample no.	District	Block	Well Name	Type of Well	Uranium Concentration (ppb)
1	Lohardaga	Kuru	Hinjala	D/W	0.10
2	Lohardaga	Kuru	Rudh	H/P	0.04
3	Lohardaga	Kuru	Kuru	H/P	1.21
4	Lohardaga	Lohardaga	Hesal	H/P	0.11
5	Lohardaga	Lohardaga	Lohardaga (PatraToli)	H/P	0.09
6	Lohardaga	Kisko	Kisko	D/W	0.06
7	Lohardaga	Lohardaga	Lohardaga (PWD IB)	H/P	-0.03
8	Lohardaga	Senha	Senha	H/P	0.00
9	Lohardaga	Lohardaga	Barwatolichowk	H/P	0.13
10	Lohardaga	Bhandra	Bhandra	H/P	-0.02
11	Lohardaga	Lohardaga	Irgaon	D/W	0.03

Annexure-VI

Results of Geophysical Survey in Lohardaga district(by WAPCOS)

VES No.	Village/Location	Weathered zone (WZ)			Semi-weathered zone(SWZ)/Less compact formation or different lihounit			Fractured zone(FZ)	Recommendations for borehole drilling	Remarks
		Resistivity (ohm.m)	Depth to bottom (m)	Bottom depth of probable WZ aquifer (m)	Resistivity (ohm.m)	Depth to bottom (m)	Bottom depth of probable SWZ aquifer / (Depth to compact formation) (m)	Probable occurrence of thin fractured zone aquifer in the depth range (m)		
105	Churku	15 64	5 33	33	NA	NA	NA (33)	30-50, 100-110, 150-170	120 m	WZ aquifer up to 33 m depth. FZs are feeble. (Low Priority)
106	Berotoli	70	7	max up to 10 m depth	NA	NA	NA (7-10)	45-55, 65-70, 75-95, 11 110-140	150 m	WZ aquifer max. up to 10 m depth. FZs may form aquifer
107	Kandra	18	3	NA	NA	NA	NA (3)	NA	NA	Vey high resistivities
108	Chatakpur	18	3	NA	NA	NA	NA (3)	NA	NA	Vey high resistivities
109	Damatoli	26	5	NA	88	12	12 (12)	NA	NA	Only possibility of WZ and SWZ aquifer up to 12 m depth
110	Soranda	20	5	NA	150	12	12 (12)	15-20, 45-55, 60-	130 m	FZs are feeble

VES No.	Village/Location	Weathered zone (WZ)			Semi-weathered zone(SWZ)/Less compact formation or different lihounit			Fractured zone(FZ)	Recommendations for borehole drilling	Remarks
		Resistivity (ohm.m)	Depth to bottom (m)	Bottom depth of probable WZ aquifer (m)	Resistivity (ohm.m)	Depth to bottom (m)	Bottom depth of probable SWZ aquifer / (Depth to compact formation) (m)	Probable occurrence of thin fractured zone aquifer in the depth range (m)		
								65, 120-130		(Low Priority)
111	Bhitha	NA	NA	NA	148	29	29 (29)	30-40, 100-130	130 m	SWZ aquifer up to 29 m depth. FZs are feeble. (Low Priority)
112	Jamgain	36	10	10	NA	NA	NA (10)	15-20	NA	WZ aquifer up to 10 m depth
113	Nagra	59	6	NA	NA	NA	NA (6)	55-60, 110-120	120 m	WZ aquifer max. up to 8 m depth. FZs are feeble. (Low Priority)
114	Narauli	NA	NA	NA	181 255	19 19-57	57 (57)	20-25, 35-45, 85-90	100 m	FZs may form aquifer
115	Utka	36	14	14	206	94	94 (94)	35-45, 60-70, 85-90, 130-140	150 m	WZ aquifer. FZs may form aquifer
116	Keratoli	NA	NA	NA	102	38	38 (38)	50-55, 95-110	110 m	SWZ up to 38 m may form aquifer. FZs are feeble
117	Kujra	8 45	4 24		NA	NA	NA (24)	40-50, 100-120, 170-180	120 m	FZ indications are feeble

VES No.	Village/Location	Weathered zone (WZ)			Semi-weathered zone(SWZ)/Less compact formation or different lihounit			Fractured zone(FZ)	Recommendations for borehole drilling	Remarks
		Resistivity (ohm.m)	Depth to bottom (m)	Bottom depth of probable WZ aquifer (m)	Resistivity (ohm.m)	Depth to bottom (m)	Bottom depth of probable SWZ aquifer / (Depth to compact formation) (m)	Probable occurrence of thin fractured zone aquifer in the depth range (m)		
118	Badla	NA	NA	NA	189 380	12 12-87	12 (87)	20-40, 70-80, 130-140	140 m	SWZ up to 12 m depth may form aquifer. FZ may form aquifer
119	Lawagi	NA	NA	NA	89	8	NA (8)	75-85, 110-120	120 m	The top 8 m may form near surface aquifer. FZ may form aquifer
120	Sethio	26	7	NA	NA	NA	NA (7)	NA	NA	Very high resistivities
122	Bodhatoli	21 57	5 32	32	NA	NA	NA (32)	40-80, 100-110	110 m	WZ aquifer up to 32 m depth. FZs may form aquifer
123	Koenartoli	24	5	NA	316	3-23	NA (	100-120	120 m	FZ aquifer (Low Priority)
124	Buti	NA	NA	NA	148	8	(8)	35-45, 100-110	110 m	FZ indications are feeble
125	Danru	37	15	15	NA	NA	NA (15)	NA	NA	WZ aquifer up to

VES No.	Village/Location	Weathered zone (WZ)			Semi-weathered zone(SWZ)/Less compact formation or different lihounit			Fractured zone(FZ)	Recommendations for borehole drilling	Remarks
		Resistivity (ohm.m)	Depth to bottom (m)	Bottom depth of probable WZ aquifer (m)	Resistivity (ohm.m)	Depth to bottom (m)	Bottom depth of probable SWZ aquifer / (Depth to compact formation) (m)	Probable occurrence of thin fractured zone aquifer in the depth range (m)		
										15 m depth
126	Bhainomundu	NA	NA	NA	203	14	14 (14)	NA	NA	SWZ up to 14 m depth may hold GW
127	Semera	58	7		258	39	39 (39)	45-55, 130-140	140 m	High resistivities. FZ indications are feeble
128	Pondariya	NA	NA	NA	126 306	1 1-19	NA (Near surface)	NA	NA	Very high resistivities
129	Kaimo	NA	NA	NA	105	10	10 (10)	60-65, 100-120	120 m	FZ indications are feeble
130	Manho	52	15	15	NA	NA	NA (15)	35-45, 95-100	100 m	WZ aquifer. FZ indications are feeble
131	Hirhi	6 54	4 4-13	13	NA	NA	NA (13)	NA	NA	WZ aquifer up to 13 m depth
132	Saheda	35	5		150 261	5-11 11-49	11 (49)	60-70, 120-140	140 m	FZ indications are feeble