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BULLETIN
ON
TREND AND HOT SPOT ANALYSIS OF GROUND WATER QUALITY IN SHALLOW AQUIFERS OF NCT OF DELHI DURING MAY 2024 (AAP: 2024-25)

GOVERNMENT OF INDIA
MINISTRY OF JAL SHAKTI
CENTRAL GROUND WATER BOARD
STATE UNIT OFFICE, NEW DELHI

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Government of India

Ministry of Jal Shakti

CENTRAL GROUND WATER BOARD

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Ministry of Jal Shakti
Govt. of India
2024

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

FOREWARD

Water is an indispensable resource for sustaining life and fostering growth, and the quality of our groundwater is paramount in ensuring the well-being of our communities. The NCT of Delhi, being a densely populated region with a burgeoning urban landscape, faces unique challenges in maintaining the quality of its water resources. Recognizing the significance of the shallow aquifers, this report delves into a thorough analysis to provide a comprehensive understanding of the ground water quality in the region.

This report is the culmination of extensive fieldwork, data collection, and rigorous analysis of chemical data during the month of May, 2024. The objective was to assess the current state of the shallow aquifer along with the temporal analysis that sheds light on the dynamic nature of groundwater quality, revealing changes and trends that are crucial for understanding the system's behaviour. This temporal perspective allows us to identify trends that may be indicative of anthropogenic activities, climatic influences, or other environmental factors affecting the groundwater quality.

As we delve into the contents of this report, it is my hope that the information presented will catalyze meaningful conversations and actions. Also, the inclusion of the temporal dimension in our report underscores the dynamic nature of the groundwater system and reinforces the need for ongoing monitoring and adaptive management strategies. It is my sincere hope that this temporal analysis will serve as a foundation for developing proactive measures to address emerging challenges and ensure the continued availability of high-quality groundwater for the residents of the National Capital Territory of Delhi.

I extend my heartfelt gratitude to the team members who contributed to this endeavour. It is my sincere belief that this report will serve as a valuable reference and guide for all those committed to preserving and enhancing the groundwater quality in the National Capital Territory of Delhi.

S.K Mohiddin 21/1/25

Regional Director

1. INTRODUCTION

Ground water is an important resource widely used for drinking, irrigation and industrial purpose. Ground Water plays an important role in the sustainable socio-economic development. In regions with scarcity of fresh surface water sources dependence on ground water increases exponentially. They fulfill substantial proportions of irrigation and drinking water needs. However, heightened reliance on groundwater across various sectors has resulted in declining water quality and dwindling water levels. The ground water quality is dependent upon chemical characteristic of rocks and minerals composition of aquifer material. Due to redox reaction, ions can be dissolved from minerals by dissolution and crystallization within aquifer and concentrate beyond permissible limits. Poor ground water quality can also be due to excessive use of fertilizers, urbanization and industrial effluent discharge.

According to UNESCO more than 80% of health issues are caused due to consumption of poor- quality water. Inorganic contaminants including Salinity, Fluoride, Nitrate, Arsenic, Iron and Uranium are important in determining the suitability of ground water for drinking purposes.

Therefore, periodic ground water quality assessment is important to alert people who utilize it for domestic and irrigation purpose. Numerous studies have been carried out on the poor quality of ground water. Earlier ground water quality is being monitored once in a year i.e. pre-monsoon in each year but 2023 onward, chemical quality of shallow ground water is being monitored twice in a year (Pre-monsoon and Post-monsoon). Based on 2023 monitoring of ground water quality, 38 trend monitoring stations and 16 hot spot were identified. During Pre-monsoon 2024 season, 38 samples from trend monitoring station and 58 samples from 16 hot spot were collected and analyzed in which four heavy elements Iron (Fe), Uranium (U)), Manganese (Mn) and Lead (Pb) were occurred. Our efforts in the present study are to fulfill the following objectives:

I. To present current GW quality scenario, parameter wise for each district

II. To analysis ground water quality of Trend locations, Parameter wise for 38 locations

III. To analysis present day hot spots of poor-quality ground water through spatial variation analysis of latest 2024 quality data.

2. STUDY AREA

The National Capital Territory of Delhi, occupying an area of 1483 sq.km., lies between latitudes 28°24’15” and 28°53’00” N and longitudes 76°50’24” and 77°20’30” E. For administrative purposes, NCT Delhi is divided into 11 districts. Each district is further sub-divided into 3 tehsils. There are total 33 Tehsils, with 112 villages, 110 Census Towns and 3 Statutory Towns. As per 2024 Groundwater resource assessment, Total Annual Ground Water Recharge of the State has been assessed as 0.38 bcm and Annual Extractable Ground Water Resource is 0.34 bcm. The Total Current Annual Ground Water extraction is 0.34 bcm and Stage of Ground Water extraction is 100.77 %.

The landforms of NCT, Delhi can be grouped into three broad geomorphic units: namely

rocky surface, Older Alluvial Plain and Flood Plain of Yamuna River. The rocky surface represents structurally controlled relict linear ridges and isolated hillocks comprising of rocks of Delhi Super group.

This distinct landform comprising of isolated hills is most prominent in the South-and South-Central parts, extends from Mahipalpur to Wazirabad in the north. Towards south of Mahipalpur the ridge gets bifurcated, one arm extends towards Mandi and further south whilethe other arm takes a turn towards southeast and extends up to Tughlakabad- Greater Kailash- Nehru Place and Okhla. It attains a maximum elevation of 362 mamsl which gradually diminishes towards north where rocks are exposed on the western bank of Yamuna near Wazirabad.

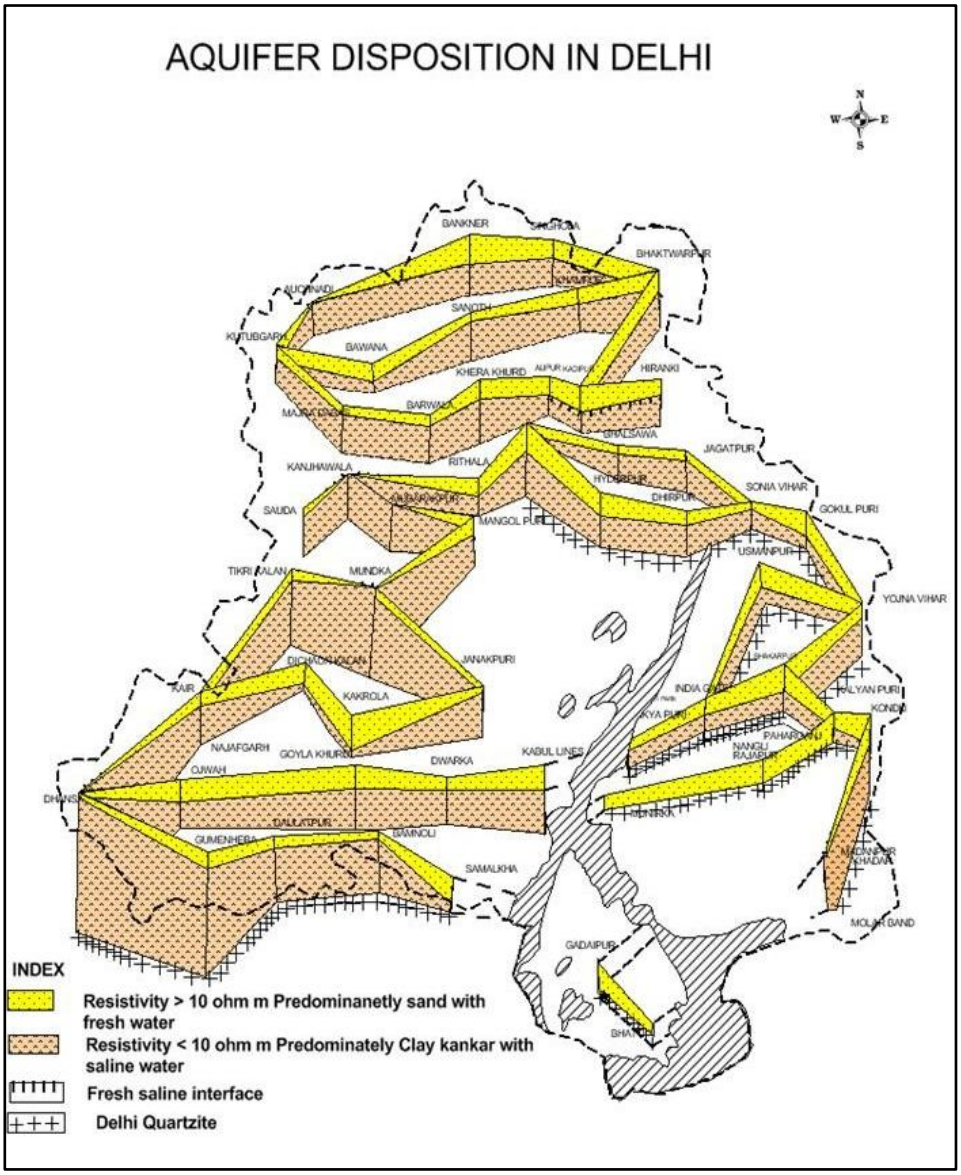

Figure 1 Panel Diagram showing Aquifer Disposition in NCT of Delhi

The rock formations exposed in the National Capital Territory of Delhi are mainly quartzite of Alwar series of the Delhi Super group that are interbedded with thin micaceous schist bands. Proterozoic rocks occur along the ridge, extending from Harchandpur (Haryana) in the South to Wazirabad (Delhi) in the North. Quaternary sediments directly overlie the Proterozoic rocks.

The Delhi Quartzite ridge acts as the recharge zone. The Quaternary deposits in the form of aeolian and alluvial deposits constitute the major repository of ground water in the area. In

the East of the ridge, the thickness of unconsolidated sediments gradually increases away from the ridge, with the maximum reported thickness being 170 m.

In the Southwestern, Western and Northern parts of the area, the thickness of sediments is more than 300 m except at Dhansa where the bedrock has been encountered at 297 m below land surface. In Chhattarpur basin, the maximum thickness of sediments is 116 m. The aeolian deposits are mainly comprised of loam, silty loam and sandy loam. The bedrock is overlain by these deposits. Older alluvial deposits consist mostly of interbedded, lenticular and inter fingering deposits of clay, silt, and sand along with kankar. These deposits overlay the aeolian deposits and are in turn overlain bythe newer alluvium, which occurs mostly in the flood plains of river Yamuna.

3. GROUND WATER QUALITY MONITORING

Monitoring of ground water quality is an effort to obtain information on chemical quality through representative sampling in different hydrogeological units. Ground Water is commonly tapped from phreatic aquifers. The main objective of ground water quality monitoring programme is to get information on the distribution of water quality (**Figure-2**) on a regional scale as well as create a background data bank of different chemical constituents in ground water.

The quality of groundwater in NCT of Delhi for 2024 has been evaluated by sampling and analysis of water samples collected from Groundwater Trend Samples (38) and Hot Spot samples 57 (16 Main hot spot + 41). About 95 samples were collected for water quality during May 2024 representing pre- monsoon water quality. The district-wise distribution of water Quality Monitoring Stations of CGWB in the NCT of Delhi is given in **Table 1**.

Table 1 District-wise distribution of Water Quality Monitoring Station

S. No.	District	No. of Water Quality Monitoring Station
1	**Central**	**9**
2	**East**	**8**
3	**New Delhi**	**3**
4	**North**	**19**
5	**North East**	**3**
6	**North West**	**15**
7	**Shahdara**	**1**
8	**South**	**4**
9	**South East**	**5**
10	**South West**	**18**
11	**West**	**7**
	Najul Land (Administrated by DDA)	**3**
Total		**95**

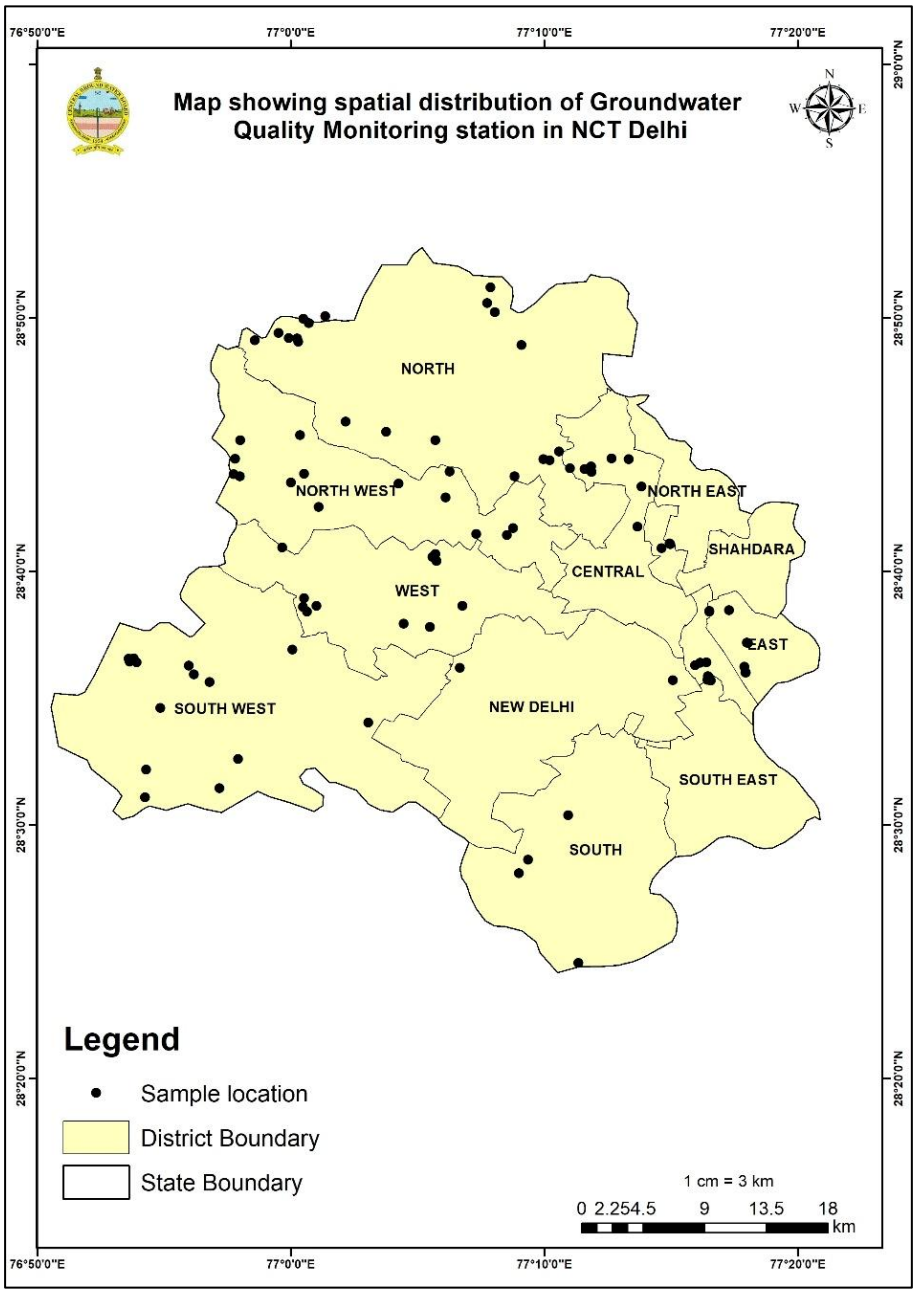

Figure 2 Map showing spatial distribution of water quality monitoring station in NCT of Delhi (May 2024)

The present bulletin is based on the changing scenario in water quality in trend analysis and hot spot sampling of ground water in shallow aquifers of NCT of Delhi for 2024.

4. GROUND WATER QUALITY SCENARIO

The groundwater samples collected from submersible pumps and hand pumps tapping phreatic aquifers are analyzed for all the major inorganic parameters. Based on the results, it is found that ground water in the NCT of Delhi is mostly of calcium bicarbonate (Ca-Mg-HCO3) type when the total dissolved solids of water is below 500 mg/L (corresponding to electrical conductance of 750 µS/cm at 25˚C). They are of mixed cations and mixed anion type when the electrical conductance is between 750 and 3000 µS/cm and waters with electrical conductance above 3000 µS/cm are of sodium chloride (Na-Cl) type.

However, other types of water are also found among these general classifications, which may be due to the local variations in hydro- chemical environments due to anthropogenic activities.

Nevertheless, occurrence of high concentrations of some water quality parameters such as salinity, chloride, fluoride, iron, arsenic and nitrate have been observed in some pockets in few districts of Delhi.

4.1 QUALITY ASSESSMENT OF GROUNDWATER IN UN-CONFINED AQUIFERS

Unconfined aquifers are extensively tapped for water supply and irrigation across the state therefore, its quality is of paramount importance. The chemical parameters like TDS, Fluoride, Nitrate, Iron, Arsenic and Uranium etc. are main constituents defining the quality of ground water in unconfined aquifers. Therefore, presence of these parameters with their range during NHS monitoring 2024 are discussed below.

1. Electrical Conductivity (> 3000 µS/cm)
2. Nitrate (>45 mg/liter)
3. Fluoride (>1.5 mg/liter)
4. Iron (>1.0 mg/liter)
5. Uranium (>30 ppb)
6. Manganese (> 0.3 mg/liter)
7. Lead (> 0.01 mg/liter)

4.1.1 Electrical Conductivity

Electrical conductivity or Total dissolved solids or Salinity is the dissolved salt content in a water body. Different substances dissolve in water giving it taste and odor. Electrical conductivity represents total number of cations and anions present in groundwater, indicating ionic mobility of different ions, total dissolved solids and saline nature of water.

In general water having EC < 1500 µS/cm, is considered as fresh water, EC 1500 –15000 µS/cm, is considered as brackish water and >15000 µS/cm is considered as saline water. Salinity always exists in ground water but in variable amounts. It is mostly influenced by aquifer material, solubility of minerals, duration of contact and factors such as the permeability of soil, drainage facilities, quantity of rainfall and above all, the climate of the area. BIS has recommended a drinking water standard for total dissolved solids a limit of 500 mg/I corresponding to EC of about 750 µS/cm at 25°C) that can be extended to a TDS of 2000 mg/I (corresponding to EC of about 3000 µS/cm at 25°C) in case of no alternate source. Water having TDS more than 2000 mg/liter are not suitable for drinking purposes.

PRESENT DAY SCENARIO IN NCT OF DELHI W.R.T ELECTRICAL CONDUCTIVITY (EC)

Distribution of Electrical Conductivity (EC) value of ground waters in the State varies from 234 µS/cm at Baprola of West district to 16780 µS/cm at Peeragarhi of West district at 25°C. Grouping water samples based on EC values, it is found that 8.42 % of them have EC less than 750µS/cm, 48.42 % have between 750 and 3000 µS/cm and the remaining 43.16 % of the samples have EC above 3000 µS/cm. The map showing aerial distribution of EC (**Figure-3**) with intervals corresponding to limits as above indicates that less than 750 µS/cm of water occur throughout the state in patches. The ground water occurring in the South West, West, North West and part of North districts is mostly saline and is not suitable for drinking purpose interms of Electrical Conductance.

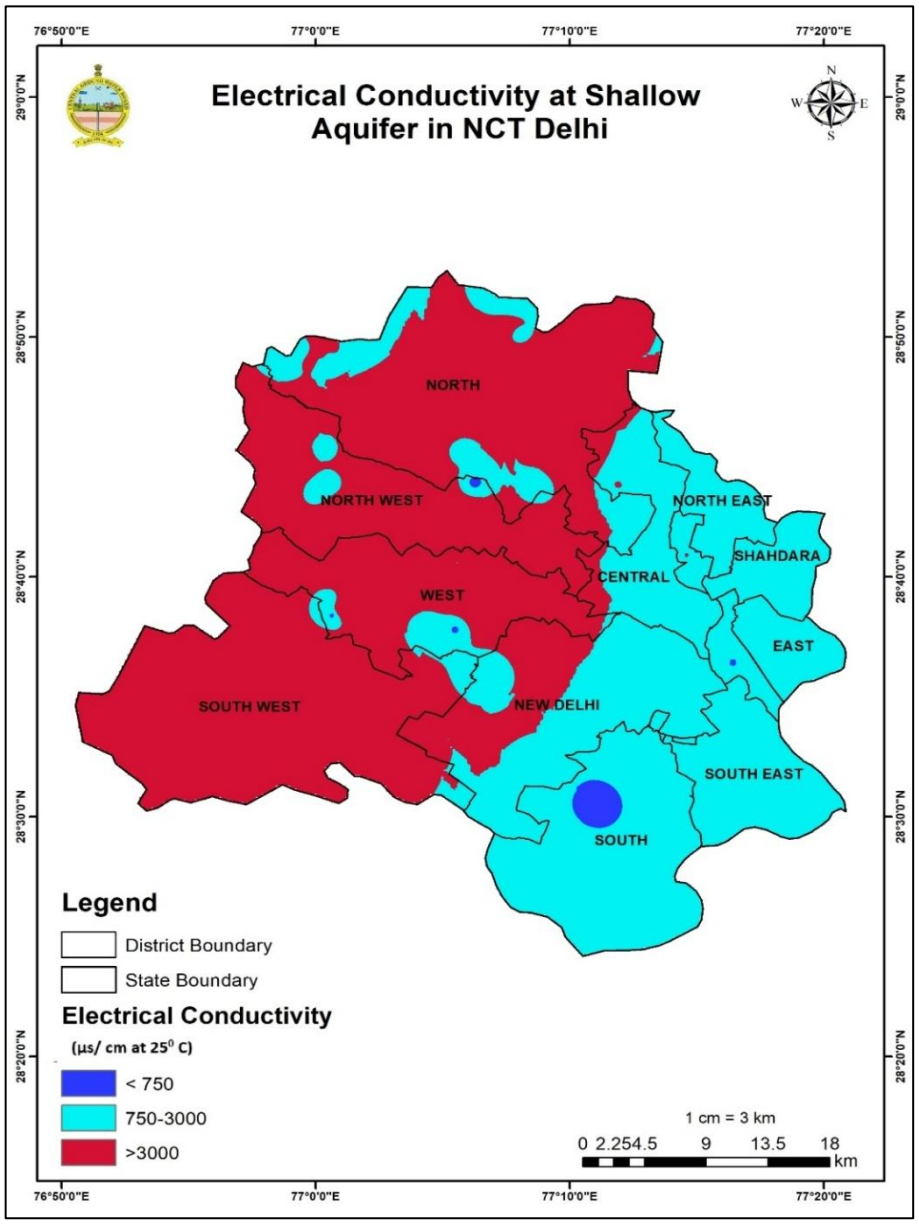

Figure 3 Spatial distribution of Electrical Conductivity during May 2024

Table 2 District wise Range and distribution of EC in shallow GW of NCT of Delhi

S. No.	District	No of samples	Min	Max	% of samples		
					< 750	750 - 3000	>3000
1	Central	9	575.3	2720	22.2	77.8	0
2	East	8	750	1490	0	100	0
3	New Delhi	3	1090	2160	0	100	0
4	North	19	773	10620	0	47.4	52.6
5	North East	3	580	3220	33.3	33.3	33.4
6	North West	15	243.3	10940	6.7	20	73.3
7	Shahdara	1	-	2400	0	100	0
8	South	4	406	2600	25	75	0
9	South East	5	1120	1660	0	100	0
10	South West	18	234	12810	5.6	11.1	83.3
11	West	7	575.8	16780	14.3	28.6	57.1
	Najul Land	3	440	1320	33.3	66.7	0
Total		95			8.42	48.42	43.16

TEMPORAL VARIATION OF EC IN GROUND WATER DURING THE PERIOD FROM 2020 TO 2024

In comparison to 2020 **(Table 3),** it has been observed that there is a marginal decrease in the number of Districts having EC more than 3000 µS/cm in 2024.

Table 3 Comparative change in number of locations having EC > 3000 µS/cm in various Districts

S. No	District	No. of locations having EC>3000 µS/cm in various districts				
		2020	2021	2022	2023	2024
1	Central	0	0	0	0	0
2	East	0	0	0	0	0
3	New Delhi	0	2	0	0	0
4	North	4	9	9	4	10
5	North East	0	0	0	0	0
6	North West	4	5	3	5	11
7	Shahdara	2	1	0	1	0
8	South	1	0	0	0	0
9	South East	0	0	0	0	0
10	South West	7	2	9	9	15
11	West	3	3	3	5	4
	Najul Land	1	0	0	0	0
Total		22	22	24	24	40

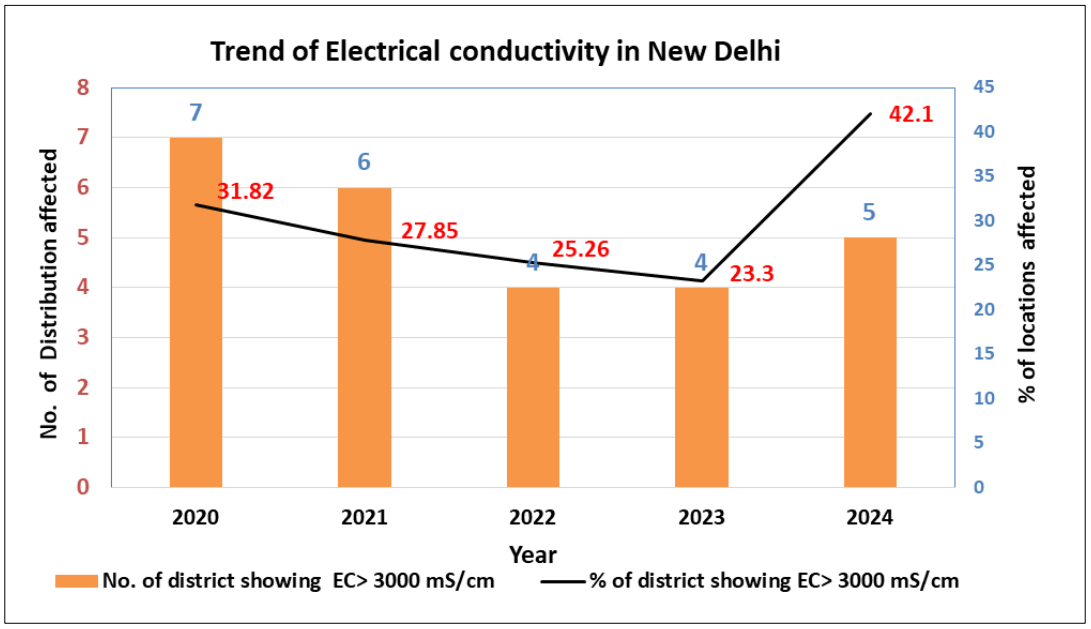

Figure 4 Trend of Electrical Conductivity in NCT of Delhi

4.1.2 Nitrate

Naturally occurring nitrate forms when nitrogen and oxygen combine in soil, primarily sourced from atmospheric nitrogen. Groundwater nitrate mainly comes from chemical fertilizers, animal manure leaching, and sewage discharge. Identifying natural vs. man-made sources is challenging. Chemical and microbiological processes like nitrification and denitrification also affect groundwater nitrate levels.

As per the BIS standard for drinking water the maximum desirable limit of nitrate concentration in groundwater is 45 mg/l.

Though nitrate is considered relatively non-toxic, a high nitrate concentration in drinking water is an environmental health concern arising from increased risks of methaemoglobonaemia particularly to infants. Adults can tolerate little higher concentration.

PRESENT DAY SCENARIO IN NCT OF DELHI W.R.T NITRATE (NO_3)

The probable sources of nitrate contamination of ground water are through excessive application of fertilizers, bacterial nitrification of organic nitrogen, and seepage from animal and human wastes and atmospheric inputs. In the NCT of Delhi, nitrate in ground water samples varies from 0 to 480 mg/L. BIS permits a maximum concentration of 45 mg/L nitrate in drinking water. Considering this limit, it is found that 72.63 % of the samples, spread over theentire State, have nitrate below 45 and 27.37 % have more than 45 mg/L. Spatial distribution of Nitrate (**Figure 5**) indicates a considerable area of the western and southern part of NCT of Delhi have nitrate concentration exceeding 45 mg/L.

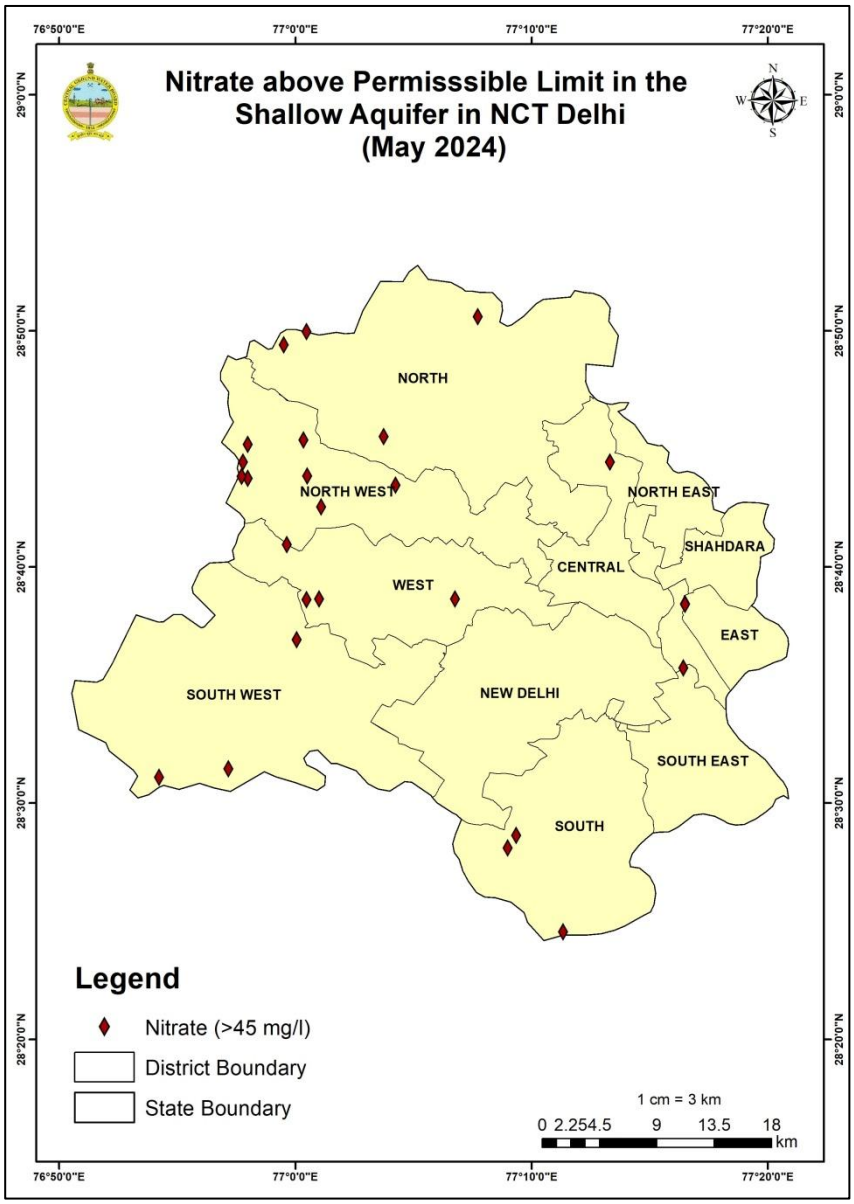

Figure 5 Locations having Nitrate concentration > 45 mg/L during May 24

Table 4 given below provides for the number of samples analyzed per district, along with their minimum and maximum Nitrate values based on Trend Monitoring wells and Hot spot wells of May 2024 Data

Table 4 District wise Range and distribution of Nitrate in shallow GW of NCT of Delhi

S. No.	District	No. of Samples analyzed	Min	Max	% of samples	
					< 45	> 45
1	Central	9	1	480	88.89	11.11
2	East	8	1	100	75	25
3	New Delhi	3	27	28	100	0
4	North	19	1	205	78.95	21.05
5	North East	3	1	3	100	0
6	North West	15	3	290	46.67	53.33
7	Shahdara	1	44	NIL	100	0
8	South	4	3	120	25	75
9	South East	5	11	50	80	20
10	South West	18	2	460	72.22	27.78
11	West	7	7	110	71.43	28.57
	Nazul land	3	1	10	100	0
Total		95			72.63	27.37

TEMPORAL VARIATION OF NO_3 IN GROUNDWATER DURING THE PERIOD FROM 2020 TO 2024

It has been observed **(Table 5)** that No. of Districts having high Nitrate (more than 45 mg/l) content in ground water has increased from 5 in the year 2020 to 8 in the year 2024.

Table 5 Comparative Change in number of locations having Nitrate > 45 mg/I

S. No	District	No. of locations having NO3 > 45 mg/l in various districts				
		2020	2021	2022	2023	2024
1	Central	0	3	1	0	1
2	East	0	0	1	0	2
3	New Delhi	2	2	3	1	0
4	North	0	4	6	1	4
5	North East	0	0	0	0	0
6	North West	3	1	8	3	8
7	Shahdara	0	0	1	0	0
8	South	2	3	4	6	3
9	South East	1	0	0	2	1
10	South West	0	2	5	4	5
11	West	2	2	3	4	2
	Nazul land	0	0	1	0	0
Total		10	17	33	21	26

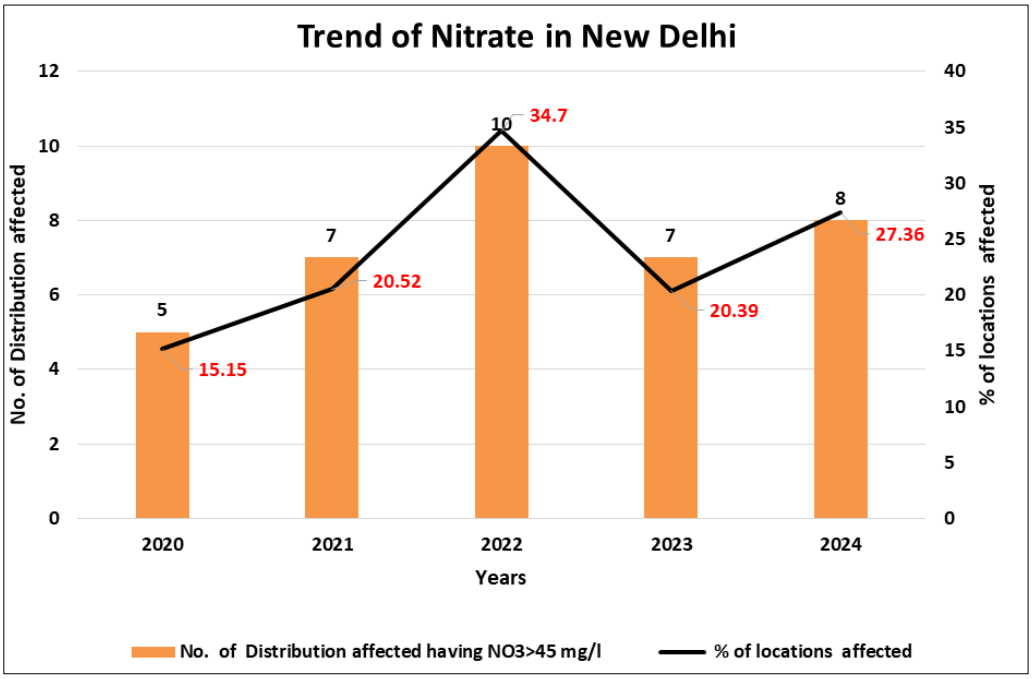

Figure 6 Trend of Nitrate in NCT of Delhi

4.1.3 Fluoride

Fluorine does not occur in the elemental state in nature because of its high reactivity. It exists in the form of fluorides in a number of minerals of which Fluorspar, Cryolite, Fluorite & Fluor-apatite are the most common. Most of the fluoride found in groundwater is naturally occurring from the breakdown of rocks and soils or weathering and deposition of atmospheric particles.

Most of the fluorides are sparingly soluble and are present in groundwater in small amount. The type of rocks, climatic conditions, nature of hydro geological strata and time of contact between rock and the circulating groundwater affect the occurrence of fluoride in natural water. BIS has recommended a desirable limit of 1.0 mg/l of fluoride concentration in drinking water and maximum permissible limit of 1.5 mg/l in case no alternative source of drinking water is available. It is well known that small amount of fluoride (upto1.0 mg/l) have proven to be beneficial in reducing tooth decay. However, high concentrations (>1.5mg/l) have resulted in staining of tooth enamel while at still higher levels of fluoride (> 5.0 mg/l) further critical problems such as stiffness of bones occur. Water having fluoride concentration more than 1.5mg/l is not suitable for drinking purposes. High Fluoride >1.5mg/l is mainly attributed due to geogenic conditions. The fluoride content in ground water from observation wells in a major part of the NCT of Delhi is found to be less than 1.0 mg/l.

PRESENT DAY SCENARIO IN NCT OF DELHI W.R.T FLUORIDE (F)

Fluoride in small amounts in drinking water is beneficial for the dental health while in large amounts it is injurious. The fluoride content in ground water ranges from 0.1 to 4.02 mg/L. BIS recommends that fluoride concentration up to 1.0 mg/L in drinking water is desirable, up to 1.50 mg/L it is permitted and above 1.50 mg/L is injurious. Classification of samples based on this recommendation, it is found that 63.16 % samples have fluoride in desirable range, 13.68 % in the permissible and the remaining 23.16 % have fluoride above 1.50 mg/L.

Map showing spatial distribution **(Figure-7)** of fluoride contents in ground water indicates that ground waters with fluoride above 1.50 mg/L are found mainly in North, North West, South West and West districts of the NCT of Delhi.

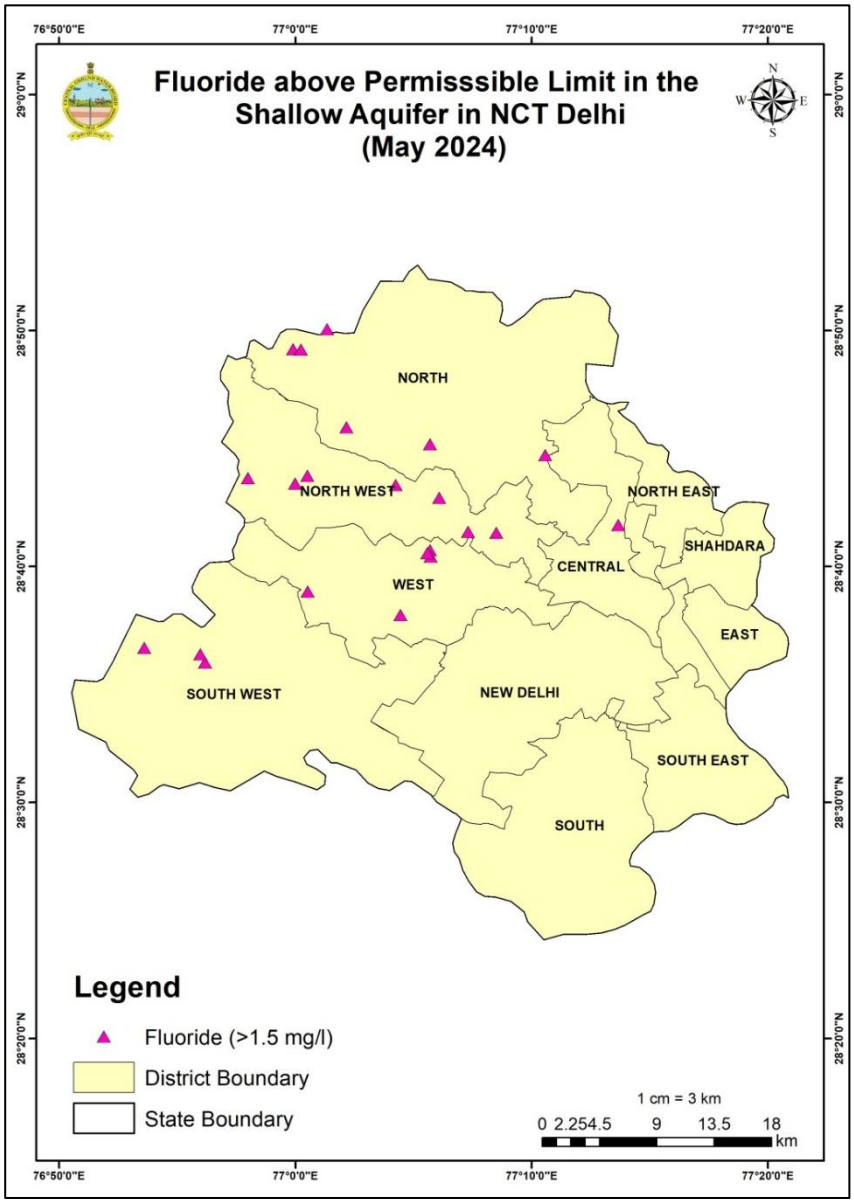

Figure 7 Locations having Fluoride concentration > 1.5 mg/L during May 24

Table 6 District wise Range and distribution of Fluoride in shallow GW of NCT of Delhi

S.No.	District	No of samples	Min	Max	% of samples		
					< 1.0	1.0-1.5	> 1.5
1	Central	9	0.1	1.9	88.89	0	11.11
2	East	8	0.1	0.55	100	0	0
3	New Delhi	3	0.25	0.9	100	0	0
4	North	19	0.15	2.1	63.16	10.53	26.32
5	North East	3	0.1	0.35	100	0	0
6	North West	15	0.25	4.02	40	6.67	53.33
7	Shahdara	1	0.89	NIL	100	0	0
8	South	4	0.2	1.29	75	25	0
9	South East	5	0.3	0.69	100	0	0
10	South West	18	0.59	2.2	33.33	44.44	22.22
11	West	7	0.35	3.1	28.57	14.26	57.14
	Nazul land	3	0.23	0.4	100	0	0
Total					63.16	13.68	23.16

Table 6 provides for the number of samples analyzed per district, along with their minimum and maximum Fluoride values based on Trend Monitoring wells and Hot spot wells of May 2024 Data.

TEMPORAL VARIATION OF FLUORIDE IN GROUNDWATER DURING THE PERIOD FROM 2020 TO 2024

It has been observed **(Table 7)** that total number of districts affected by high fluoride has increased from 3 in 2020 to 5 in 2024.

Table 7 Comparative Change in the number of locations having Fluoride > 1.50 mg/l

S. No	District	No. of locations having F >1.50 mg/l in various districts				
		2020	2021	2022	2023	2024
1	Central	0	0	1	0	1
2	East	0	0	0	0	0
3	New Delhi	0	2	0	1	0
4	North	2	3	4	6	5
5	North East	0	0	0	0	0
6	North West	2	4	5	5	8
7	Shahdara	0	0	0	1	0
8	South	0	0	1	1	0
9	South East	0	0	0	0	0
10	South West	0	2	2	3	4
11	West	1	1	2	0	4
	Nazul land	0	1	0	0	0
Total		5	13	15	17	22

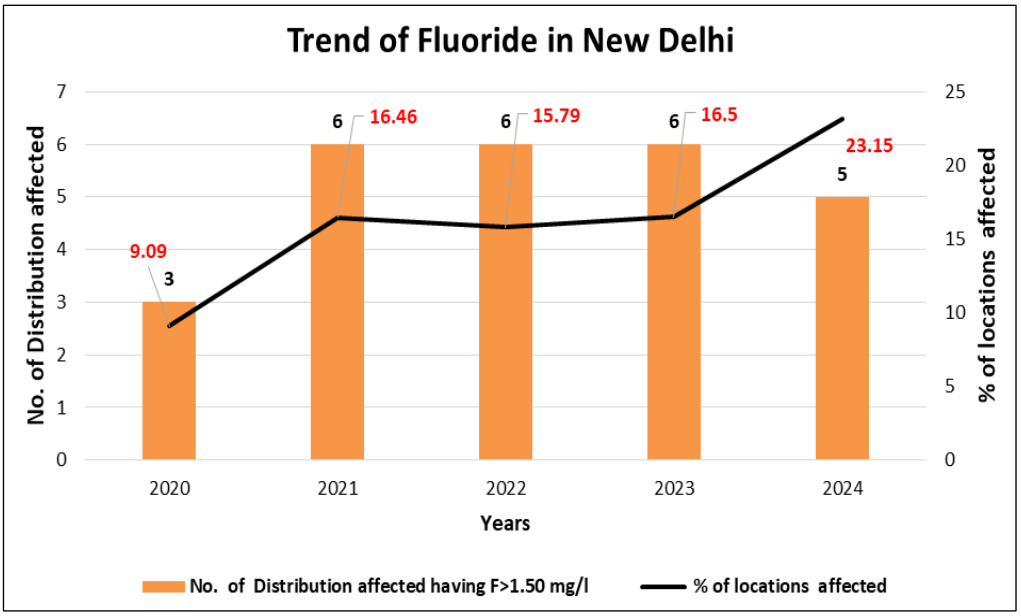

Figure 8 Trend of Fluoride in NCT of Delhi

5. HEAVY METALS -

5.1.1 Iron

Iron is a common constituent in soil and ground water. It is present in water either as soluble ferrous iron or the insoluble ferric iron. Water containing ferrous iron is clear and colorless because the iron is completely dissolved. When exposed to air, the water turns cloudy due to oxidation of ferrous iron into reddish brown ferric oxide.

The concentration of iron in natural water is controlled by both physico-chemical and microbiological factors. It is contributed to ground water mainly from weathering of ferruginous minerals of igneous rocks such as hematite, magnetite and sulphide ores of sedimentary and metamorphic rocks.

The permissible Iron concentration in ground water is less than 1.0 mg/liter as per the BIS Standard for drinking water.

PRESENT DAY SCENARIO IN NCT OF DELHI W.R.T IRON

The iron content in ground water ranges from BDL to 3.23 mg/L. BIS recommends that iron concentration up to 1.0 mg/L in drinking water is acceptable. Classification of samples based on this recommendation; it is found that 7.37 % samples have iron above 1.0 mg/L. Map showing spatial distribution (**Figure 9**) of iron content in ground water (2024) indicates that ground waters with iron above 1.0 mg/L are found mainly in South East, North East and North district of the NCT of Delhi.

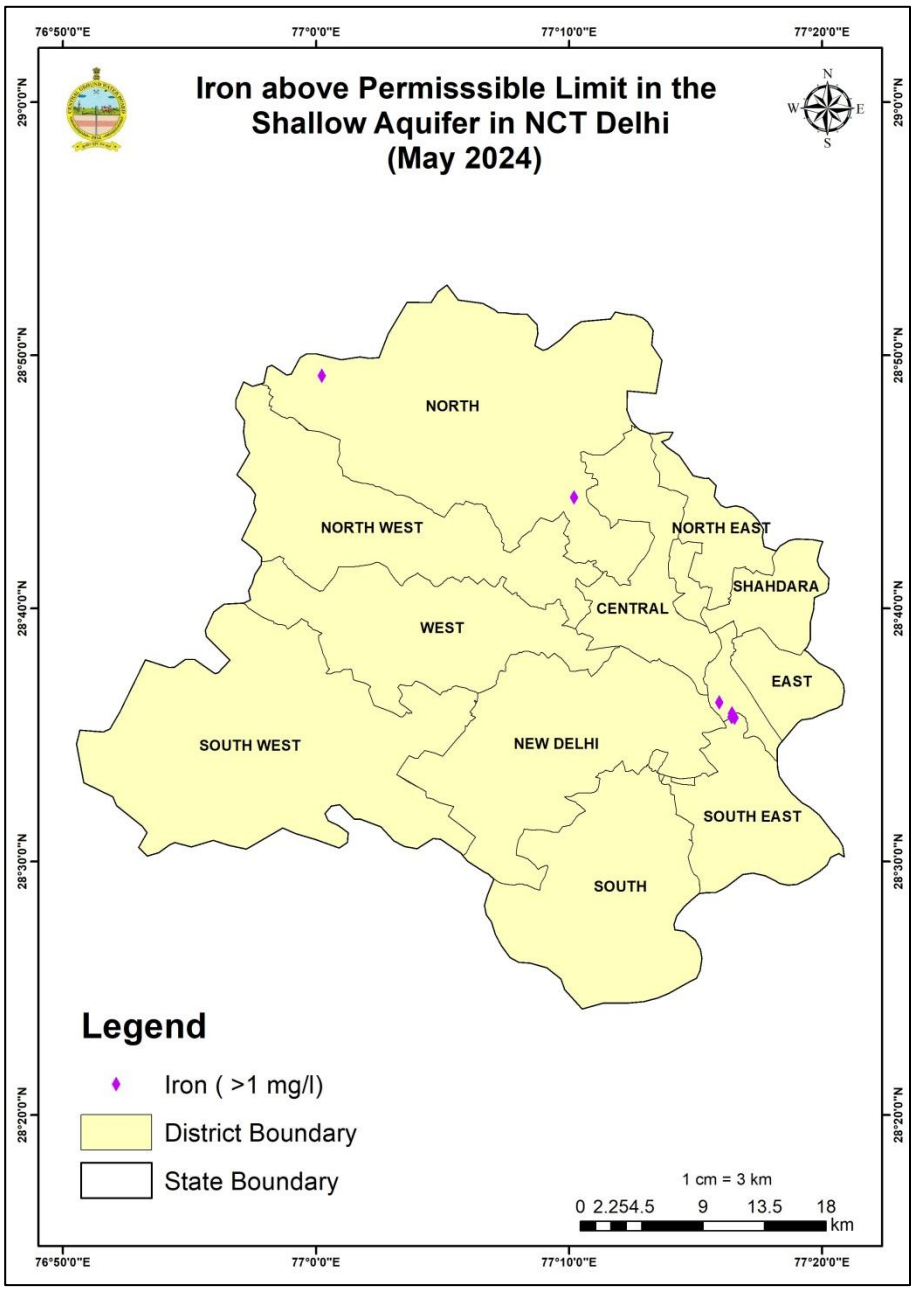

Figure 9 Locations having Iron concentration > 1.0 mg/L during May 24

Table 8 given below provides for the number of samples analyzed per district, along with their minimum and maximum Iron values based on Trend Monitoring wells and Hot spot wells of May 2024 Data.

Table 8 District wise Range and distribution of Iron in shallow GW of NCT of Delhi

S. No.	District	No of samples	Min	Max	% of Samples	
					<=1.0	> 1.0
1	Central	9	BDL	0.3346	100	0
2	East	8	BDL	0.9077	100	0
3	New Delhi	3	BDL	0.073	100	0
4	North	19	BDL	2.027	89.47	10.53
5	North East	3	BDL	0.0723	100	0
6	North West	15	BDL	0.122	100	0
7	Shahdara	1	Nil	0.1469	100	0
8	South	4	BDL	0.167	100	0
9	South East	5	0.0627	3.23	20	80
10	South West	18	BDL	0.1121	100	0
11	West	7	BDL	0.3556	100	0
	Najul land	3	0.138	1.2905	66.67	33.33
Total					92.63	7.37

TEMPORAL VARIATION OF IRON IN GROUND WATER DURING THE PERIOD FROM 2020 TO 2024

As compared to the data available in year 2020, the number of districts having Iron more than 1.0 mg/l in ground water samples have same (**Table-9**) during the year 2024.

Table 9 Comparative Change in number of locations having Iron > 1.00 mg/l

S. No	District	No. of locations having Fe >1.00 mg/l in various districts				
		2020	2021	2022	2023	2024
1	Central	0	1	0	0	0
2	East	0	0	0	1	0
3	New Delhi	0	0	0	0	0
4	North	1	1	1	0	2
5	North East	0	0	0	0	0
6	North West	0	1	0	0	0
7	Shahdara	0	0	0	0	0
8	South	0	0	0	0	0
9	South East	1	1	1	2	4
10	South West	2	0	0	0	0
11	West	0	0	0	0	0
	Nazul land	0	0	0	1	1
Total		4	4	2	4	7

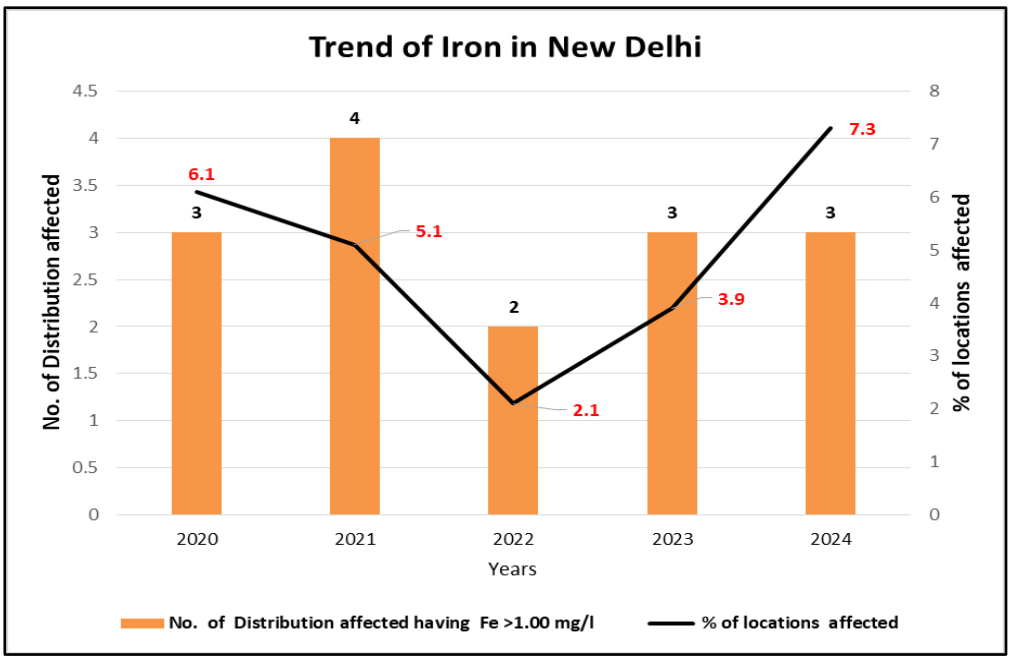

Figure 10 Trend of Iron in NCT of Delhi

5.1.2 Uranium

Uranium occurs naturally in groundwater and surface water. Being naturally occurring uranium in groundwater and surface water poses health risks due to its radioactive properties. Sources include natural deposits, nuclear industry emissions, coal combustion, and phosphate fertilizers. Human exposure occurs mainly through drinking water, food, air, and occupational hazards. Concentrations exceeding 30 ppb, according to BIS standards, can cause damage to internal organs with prolonged intake, necessitating caution in consumption.

PRESENT DAY SCENARIO IN NCT OF DELHI W.R.T URANIUM

The uranium content in ground water ranges from BDL to 59 ppb. BIS recommends that uranium concentration up to 30 ppb in drinking water is acceptable. Classification of samples based on this recommendation; it is found that 12.63 % samples have uranium above 30 ppb. Map showing spatial distribution (**Figure-11**) of uranium content in ground water (2024) indicates that ground waters with uranium above 30 ppb are found mainly in North, North West, West and South West districts of the NCT of Delhi.

Table 10 given below provides for the number of samples analyzed per district, along with Their minimum and maximum Uranium values based on Trend Monitoring wells and Hot spot wells of May 2024 Data.

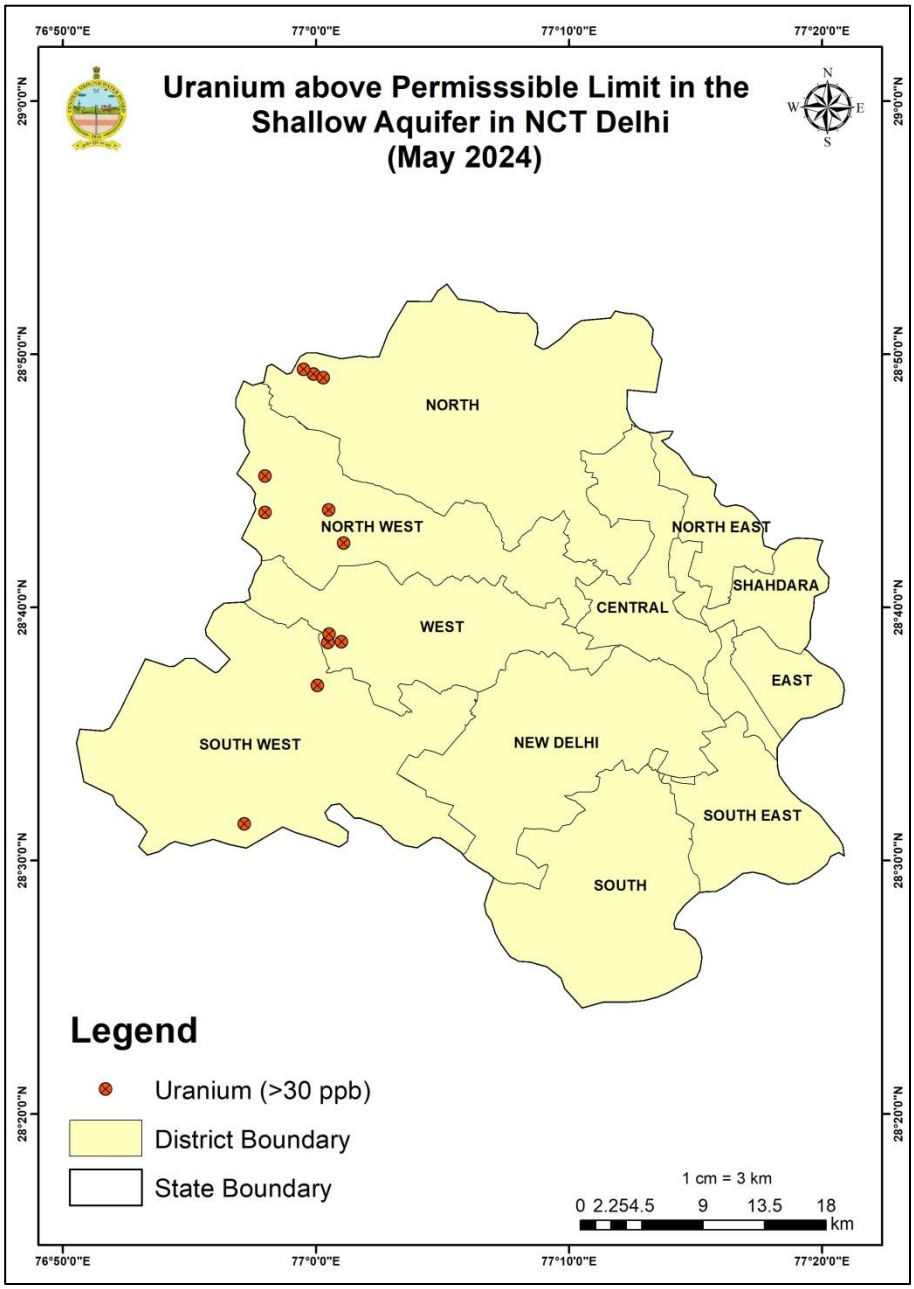

Figure 11 Locations having Uranium concentration > 30 ppb during May 24

Table 10 District wise Range and distribution of Uranium in shallow GW of NCT of Delhi

S. No.	District	No of samples	Min	Max	% of Samples	
					<=30	> 30
1	Central	9	0	12.8	100	0
2	East	8	BDL	0	100	0
3	New Delhi	3	2	10	100	0
4	North	19	BDL	42	84.21	15.79
5	North East	3	BDL	0	100	0
6	North West	15	BDL	59	73.33	26.67
7	Shahdara	1	5	Nil	100	0
8	South	4	0	10.1	100	0
9	South East	5	BDL	0	100	0
10	South West	18	4.2	52	72.22	27.78
11	West	7	6	28	100	0
	Najul Land	3	BDL	42	100	0
Total					87.37	12.63

TEMPORAL VARIATION OF URANIUM IN GROUND WATER DURING THE PERIOD FROM 2020 TO 2023

As compared to the data available in year 2020, the number of districts having Uranium more than 0.03 mg/l in ground water samples have decreased **(Table-11)** during the year 2024.

Table 11 Comparative Change in number of locations having Uranium > 0.03 mg/l

S. No	District	No. of locations having U >0.03 mg/l in various districts				
		2020	2021	2022	2023	2024
1	Central	0	0	0	0	0
2	East	0	0	0	0	0
3	New Delhi	0	0	0	0	0
4	North	1	0	2	3	3
5	North East	0	0	0	0	0
6	North West	1	3	2	3	4
7	Shahdara	0	0	0	0	0
8	South	0	0	0	1	0
9	South East	0	0	0	0	0
10	South West	1	0	2	2	5
11	West	1	0	2	1	0
	Nazul land	1	0	0	0	0
Total		5	3	8	10	12

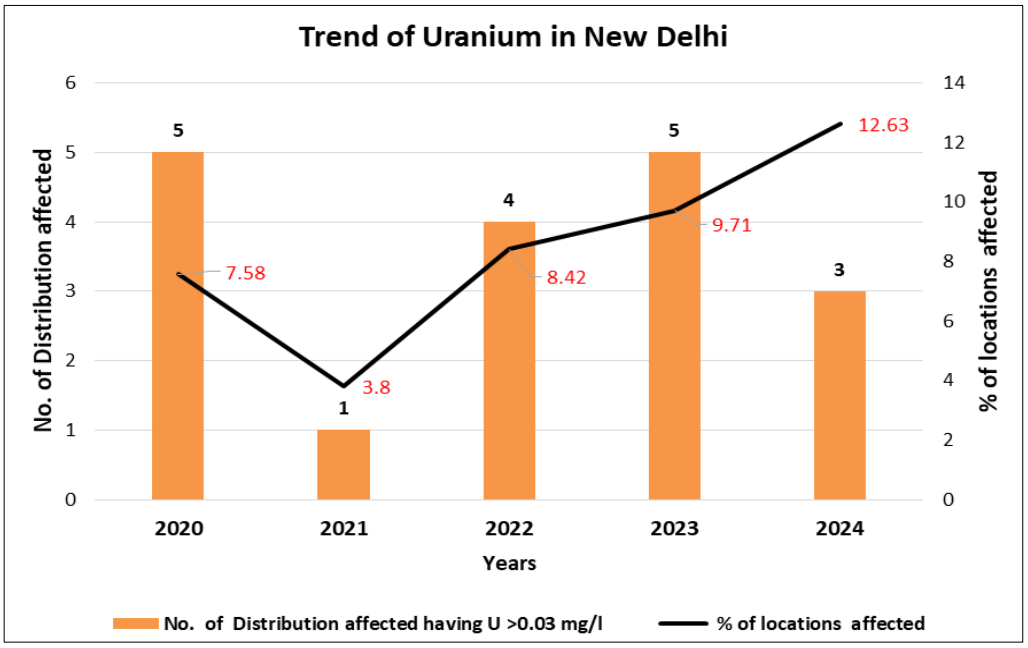

Figure 12 Trend of Uranium in NCT of Delhi

5.1.3 Manganese-

Manganese is an essential human dietary element, important in macronutrient metabolism, bone formation, and free radical defence systems. Manganese occurs in soils in three oxidation states. The most common sources of manganese in groundwater are naturally occurring from the weathering of iron and manganese-bearing minerals and rocks. Industrial effluent, acid-mine drainage, sewage, and landfill leachate may also contribute iron and manganese to local groundwater. Typically, manganese concentrations from natural processes are low but can range up to 1.5 mg/L or higher. Chronic manganese exposure has been shown to produce a parkinsonism-like illness characterized by movement abnormalities

PRESENT DAY SCENARIO IN NCT OF DELHI W.R.T MANGANESE

Manganese is an essential human dietary element. The manganese content in ground water ranges from 0.1289 to 0.5964 mg/L. BIS recommends that fluoride concentration up to 0.1 mg/L in drinking water is desirable, up to 0.3 mg/L it is permitted and above 0.3 mg/L is harmful. Classification of samples based on this recommendation, it is found that 65.26 % samples have manganese in desirable range, 16.84% in the permissible and the remaining 17.89 % have manganese above 0.3 mg/L. Map showing spatial distribution **(Figure -13)** of manganese contents in ground water indicates that ground waters with manganese above 0.3 mg/L are found mainly in North, North West, South West, West and Central districts of the NCT of Delhi.

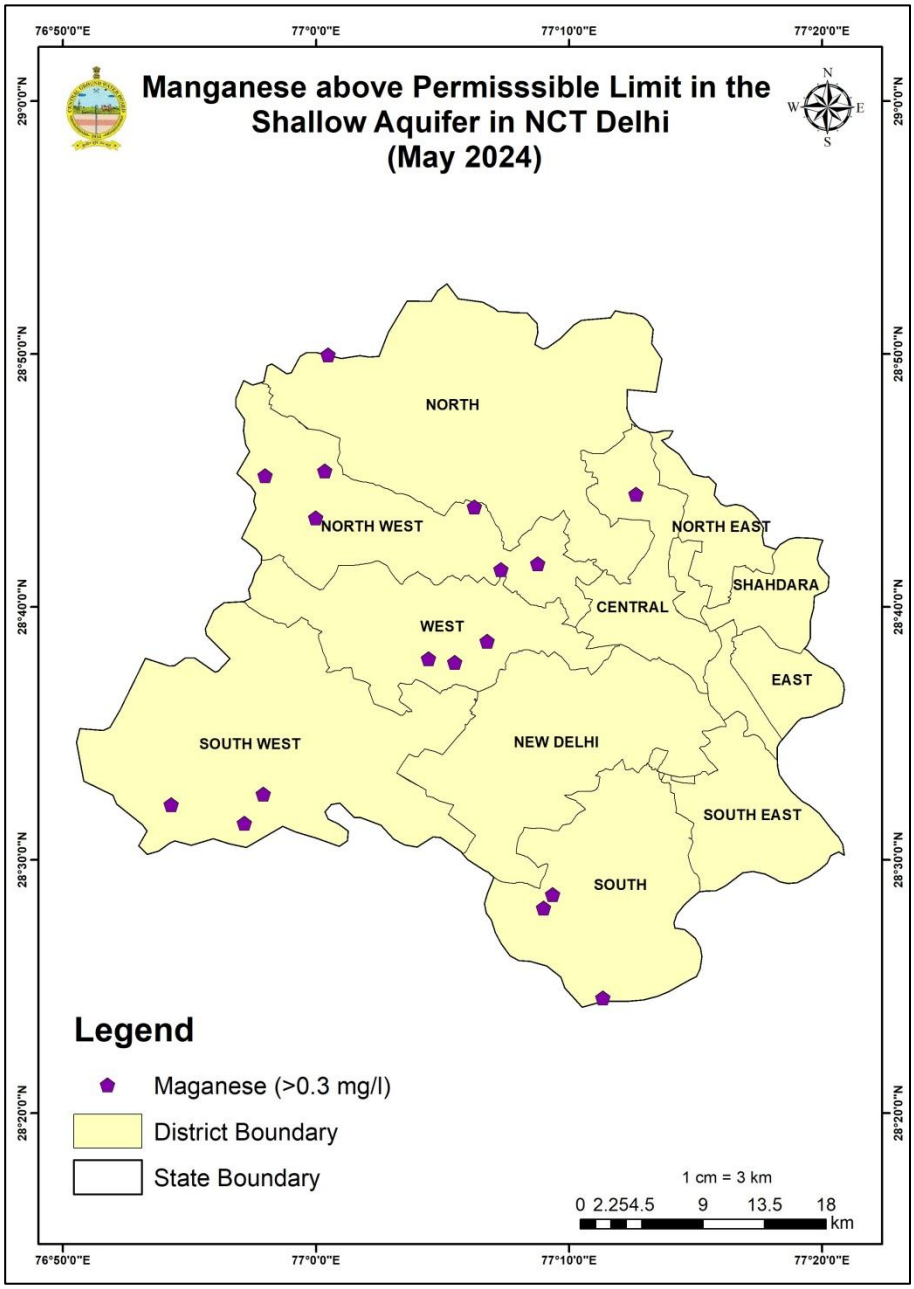

Figure 13 Locations having Manganese concentration > 0.3 mg/l during May 2024

Table 12 given below provides for the number of samples analyzed per district, along with Their minimum and maximum manganese values based on Trend Monitoring wells and Hot spot wells of May 2024 Data.

Table 12 District wise Range and distribution of Manganese in shallow GW of NCT of Delhi

S. No.	District	No of samples	Min	Max	% of samples		
					< 0.1	0.1 - 0.3	> 0.3
1	Central	9	BDL	0.5964	0	88.89	11.11
2	East	8	BDL	0	100	0	0
3	New Delhi	19	BDL	0.3873	66.67	33.33	0
4	North	3	BDL	0	78.95	15.79	5.26
5	North East	15	BDL	0.5964	100	0	0
6	North West	1	BDL	0	53.33	6.67	40
7	Shahdara	4	0.1779	0.52	100	0	0
8	South	5	BDL	0	0	25	75
9	South East	18	BDL	0.5391	100	0	0
10	South West	7	BDL	0.5582	77.78	5.56	16.67
11	West	3	BDL	0	42.86	14.29	42.86
	Najul land	3	BDL	0.1433	100	0	0
Total					65.26	16.84	17.89

5.1.4 Lead

Lead naturally occurs in rocks and mineral deposits that have varying degrees of solubility. Leaching of those rocks and minerals can cause elevated lead concentrations in groundwater. Much of our exposure comes from human activities including the use of fossil fuels including past use of leaded gasoline, some types of industrial facilities, and past use of lead-based paint in homes. Lead can enter drinking water when plumbing materials that contain lead corrode, especially where the water has high acidity or low mineral content that corrodes pipes and fixtures. The most common sources of lead in drinking water are lead pipes, faucets, and fixtures. The natural presence of lead in groundwater tends to be very small and generally non-detectable. Even small amounts of lead can cause serious health problems. The maximum allowable concentrations of lead in drinking water are 0.01 mg/l.

PRESENT DAY SCENARIO IN NCT OF DELHI W.R.T LEAD

Lead in small amounts in drinking water is not beneficial for the human health. The lead content in ground water ranges from 0.01 to 0.0648 mg/L. BIS recommends that lead concentration up to 0.01 mg/L in drinking water is desirable, and above 0.01 mg/L is harmful. Classification of samples based on this recommendation, it is found that 92.63 % samples have lead in the permissible and the remaining 7.37 % have lead above 1.50 mg/L. Map showing spatial distribution (**Figure-14**) of lead contents in ground water indicates that ground waters with lead above 0.01 mg/L are found mainly in North, North West, South West, Central and West districts of the NCT of Delhi.

Table 13 given below provides for the number of samples analyzed per district, along with Their minimum and maximum lead values based on Trend Monitoring wells and Hot spot wells of May 2024 Data.

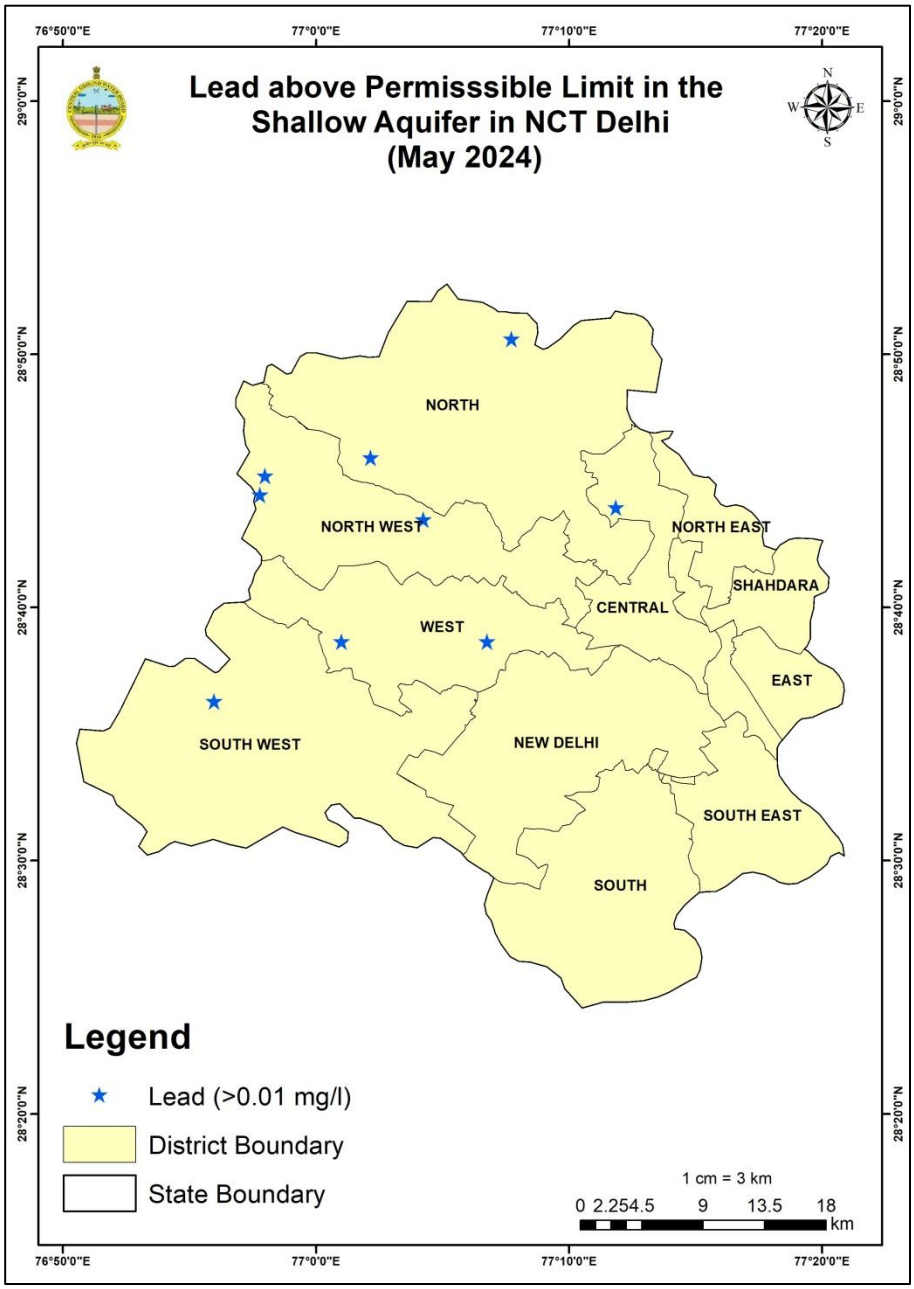

Figure 14 Locations having Lead concentration > 0.01 mg/l during May 24

Table 13 District wise Range and distribution of Lead in shallow GW of NCT of Delhi

S. No.	District	No of samples	Min	Max	% of samples	
					<=0.01	> 0.01
1	Central	9	BDL	0.01	100	0
2	East	8	BDL	Nil	100	0
3	New Delhi	3	BDL	Nil	100	0
4	North	19	BDL	0.0556	89.47	10.53
5	North East	3	BDL	Nil	100	0
6	North West	15	BDL	0.0556	86.67	13.33
7	Shahdara	1	BDL	Nil	100	0
8	South	4	BDL	Nil	100	0
9	South East	5	BDL	Nil	100	0
10	South West	18	BDL	0.0648	88.89	11.11
11	West	7	BDL	0.0556	85.71	14.29
	Najul land	3	BDL	Nil	100	0
Total					92.63	7.37

6. SUMMARY

The analytical results of Trend Monitoring wells and Hot spot wells of May 2024 Data shows NCT of Delhi had groundwater samples exceeding permissible limits for EC, NO_3 and F for basic parameters by 2024 and for heavy metals Iron, Uranium, Manganese and Lead had exceeding from permissible limits.

While most samples from Central Ground Water Board observation wells meet drinking water standards for basic parameters and heavy metals, some exceed permissible limits, posing health risks with prolonged use.

Table 14 provides a summary of groundwater quality in the NCT of Delhi, broken down by the number of samples collected and the percentage of those samples that are contaminated with various parameters.

Table 14 Summary of groundwater quality in NCT of Delhi: samples collected and Contamination percentage

NCT of Delhi Summary	**Total no. of Basic samples**	**Number of samples contaminated (% age of samples contaminated)**			
		EC	**NO_3**	**F**	
	95	41 (43.16 %)	26 (27.37%)	22 (23.16 %)	
	Total no. of HM samples	**Fe**	**U**	**Mn**	**Pb**
	95	7 (7.37 %)	12 (12.63%)	17 (17.89%)	7 (7.37 %)

7. RECOMMENDATIONS

- In hot spot area, piped water supply will be must and also closing of hot spot tube wells is recommended.

- Recharge measures need to be taken in large scale for improvement of Ground Water quality.

- Ground water is highly polluted and is not fit for drinking and irrigation purposes along the Najafgarh drain, landfill sites and industrial belts. It is recommended that ground water should be used only after proper treatment.

- In Delhi, fresh ground water is underlain by saline/ brackish water. Over-exploitation of ground water in certain areas has not only resulted in depletion of fresh ground water resources but has also led to gradual up-coning of saline water. It is recommended to withdraw poor quality water, which can be used for growing salt tolerant crops like cotton, wheat, guar, chickpea, soyabean, sugarcane, sunflower etc. in agricultural belts. In rest of the areas, saline water can be used after blending for uses other than drinking. Withdrawal of saline water will lead to void space in the aquifer, which when recharged during subsequent monsoon, will help in improving the water quality.

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