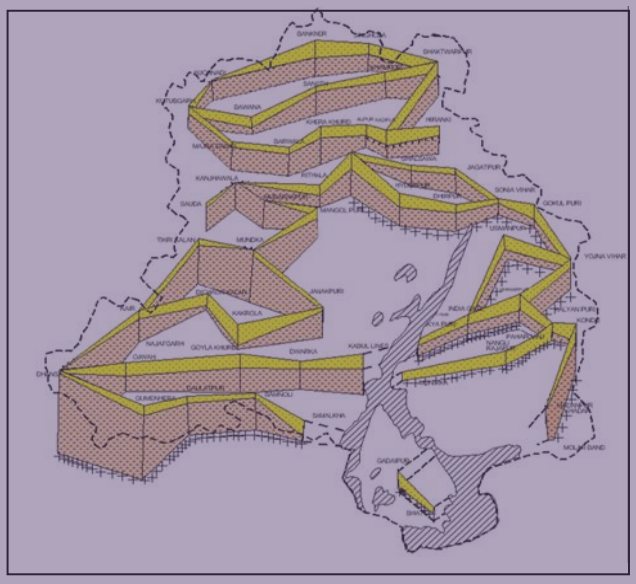
Ground Water Year Book

भू जल वार्षिक पुस्तिका

National Capital Territory, Delhi

राष्ट्रीय राजधानी क्षेत्र, दिल्ली

2021-2022



GOVERNMENT OF INDIA

भारत सरकार

CENTRAL GROUND WATER BOARD

केंद्रीय भूमि जल बोर्ड

STATE UNIT OFFICE, DELHI

राज्य एकक कार्यालय,दिल्ली

DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVENATION

जल संसाधन, नदी विकास और गंगा संरक्षण विभाग

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Foreword

Ground Water Year Book is based on the information generated through field studies. The data has been analyzed by officers of Central Ground Water Board, State Unit Office, Delhi and presented in the report. The maps have been generated using ARC GIS, Surfer software and Map info.

Depiction of ground water condition in Delhi provides information on availability of ground water in terms of quantity and quality, development prospects and management options. I am happy to note that the scientific information in this report is presented in a simplified form. I sincerely hope this report will be of immense help not only to planners, administrators, researchers and policy makers in formulating development and management strategy but also to the common man in need of such information to make himself aware of the ground situation in NCT Delhi.

The untiring efforts made by Sh. V. Praveen Kumar, STA-HG, Sh. Faisal Abrar, Assistant Hydrogeologist for bringing out this report are highly appreciated.

(S. K Mohiddin)
Head of Office,
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EXECUTIVE SUMMARY

GROUND WATER YEAR BOOK 2021-2022: NCT DELHI

National Capital Territory (NCT) of Delhi occupies an area of 1483 sq. km. and lies between 28° 24' 15'' to 28° 53' 00'' N latitudes and 76° 50' 24" to 77° 20' 30" E longitudes. The population of NCT Delhi, as per the census 2011 is 167.87 lakhs with a density of 11320 persons / Sq.km area.

The normal rainfall of NCT Delhi is 794mm. The rainfall increases from west to east. About 80% of the annual rainfall is received during the monsoon months July, August and September. The rest of the annual rainfall is received in the form of winter rain. Long- term rainfall data 1984 to 2021 shows that the rainfall in Delhi is highly variable and which in turn affects the natural recharge to ground water from year to year. The probability of rainfall exceeding normal rainfall of 794 mm is up to 62% whereas there are 90% chances that rainfall would limit to 450mm.

The ground water availability in NCT Delhi is controlled by the hydrogeological characteristics of its varied geological formations namely Delhi Quartzite, Older & Younger Alluvium. Central Ground Water Board (CGWB) is monitoring groundwater levels and quality through its monitoring stations spread over both Alluvial as well as quartzitic area of NCT of Delhi. Total 128 hydrograph monitoring stations data (2021-2022) have been analyzed for this report, out of which 26 are dug wells and 102 are Piezometers.

District wise distribution of hydrograph network stations is highly uneven and varies from one monitoring station per 1.4 Sq.km in New Delhi district to one monitoring station per 30 sq. km in North East district. Considering this unevenness in distribution of monitoring stations, Central Ground Water Board is striving to increase the number of stations for better monitoring of the ground water regime in the diverse Hydrogeologicalterrain.

An analysis for numbers of monitoring wells in the different categories of the water levels for all four monitoring periods of year 2021-2022 reveals that water level depth up to 5 mbgl varies considerably over two monitoring periods (May & other months) which shows that dynamic changes in ground water levels are conspicuously deciphered in shallow water zones. For depth range of 5 to 10mbgl and 10 to 20mbgl and more at few locations ground water levels in August, November & January compared to May period is not prominent. This may be interpreted as stressed water level conditions suppressing dynamic fluctuation in water levels. Whereas number of monitoring stations showing water level below 40mbgl remain almost same in all four-monitoring periods indicate stressed water conditions in deep aquifers of NCT, Delhi.

The depth to water level recorded in NCT Delhi during 2021-2022, in general varies from less than 2 mbgl in areas of Yamuna Flood plain and parts of Northwest & West district to more than 65mbgl, mainly in areas underlain by Delhi Quartzite in Central, New Delhi and South districts. The water level during **May-2021** range from 0.5 to 64.85mbgl and around 11% of area have shallow water level up to 5 m bgl while deep water levels of 20 to 65m are observed in around 24% of area. In rest of NCT Delhi, 65% of areas water level range from 5 to 20 m bgl. In **August-2021** water level range from 0.12 to 65.48mbgl and around 22% of NCT Delhi areas have shallow water level up to 5 m bgl while deep water levels of 20 to 66 m observed in around 23% of NCT Delhi. In rest of NCT Delhi, 55% areas have water level in range of 5 to 20 mbgl. In **November-2021** water level range from 0.19 to 65.67 mbgl and around 26% of NCT Delhi areas have shallow water level up to 5 m bgl while deep water

levels of 20 to 66mbgl observed in around 18% of NCT Delhi. In rest of NCT Delhi, 56% areas have water level in range of 5 to 20 m bgl. In **January-2022** water level range from 0.6 to 67.64mbgl and around 24% of NCT Delhi areas have shallow water level up to 5 m bgl while deep water levels of 20 to 68 mbgl observed in around 19% of NCT Delhi. In rest of NCT Delhi, 57% of areas have water level in range of 5 to 20 m bgl.

Analysis of seasonal water level fluctuation comparing **May 2021** period show rise in range of >0 to 2m in 71% monitoring stations during **August 2021**, 44% in **November 2021** and 70% in **January 2022**. Very few monitoring stations, 11% to 38% shows rise in range of 2 to 11 m. whereas nearly 5% to 11% monitoring stations show decline in range of 0 to 2 m and 0% in range of 2 to 4m, which reflect over stress conditions.

The fluctuation of water level between **May-2020 and May-2021** of NCT Delhi shows rise up to 4m in 56% of wells and 2% of wells show rise more than 4m while other 40% of monitoring wells show fall in range of 0 to 2 m; rest of 2% monitoring stations shows fall up to 4 m. Similarly, comparing **August-2020** water level with **August-2021** reveals that rise in the range of 0 to 2m in nearly 58% of the wells, while 28 % wells shows fall in range of 0 to 2 m. Wells showing more than 2m rise are about 12% and fall are about 2%. Comparing water level data of **November 2020** with **November 2021**, it is revealed that 51% wells shows rise in range of 0 to 2 m whereas 43% of wells show rise more than 2 m. Rest 6 % wells shows fall, mostly in range of 0 to 2 m. Comparing water level data of **January 2021** with **January 2022**, it is revealed that 83% wells shows rise, mostly in range of 0 to 2 m whereas small pockets in South East, New Delhi& South district has risen up more than 2m is about 41%; whereas rest 12% wells shows fall in range of 0 to 2m and 1% wells shows more than 2m..

Long-term behavior of water levels was studied by comparing water level data of May-2021 with 10 year mean water level of May (2011 to 2020) reveals change in water level range from -7.83 m to 17.24 m. Nearly 51% of monitoring wells show fall in water level whereas rest 49% wells show in rise of water levels. Comparing water level data of August-2021 with 10 year mean water level of August (2011 to 2020) reveals change in water level range from -8.26 m to 16.76 m. Nearly 61% of monitoring wells show rise in water level whereas rest 39 % monitoring wells show fall in water level. Comparing water level data of November-2021 with 10 year mean water level of November (2011 to 2020) reveals change in water level range from -9.44 m to 20.07 m. Nearly 74% of monitoring wells shows rise in water level whereas rest 26% monitoring wells show fall in water level. Comparing water level data of January-2022 with 10 year mean water level of January (2012 to 2021) reveals change in water level range from -16.11 m to 18.61m. Nearly 70% of monitoring wells show rise whereas rest 30% monitoring wells show fall.

Most of eastern part of NCT Delhi, in areas around Yamuna flood plain and Delhi Quartzite Ridge zones has EC within permissible range of 0 to 2250 µS/cm at 25°C whereas rest of NCT Delhi, except some pockets of South West, North West and West District, has EC value of more than 3000 µS / cm at 25 °C. It is also observed that water from deeper aquifers have greater EC value than the water from shallow aquifer. The EC value increases with depth.

Chloride concentration in groundwater of NCT Delhi is related with EC content. It is observed that in areas having EC values within permissible limits (2250 to 3000 µS/cm), the chloride

content also lies within permissible limit of 250 mg/l. In areas having high EC more than 3000 µS/cm, chloride value is also high up to a maximum of3000 mg/l.

Chemical analysis of ground water samples collected during May 2021 shows that nitrate content in groundwater is within permissible limit of 45 mg/l in most of the state and the concentration in Northeastern parts of Delhi shows higher nitrate content. Similarly, except 13 locations in Northern & Western half of NCT Delhi, all 66 locations show fluoride concentration within permissible limit of 1.5 mg /l.

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1. INTRODUCTION

The State Unit Office of Central Ground Water Board Delhi has jurisdiction over the National Capital Territory (NCT) of Delhi, covering an area of 1483 Sq.km and lies between 28°24'15'' & 28°53'00'' *North Latitudes* and 76°50'24" & 77°20'30" *East Longitudes*, covered under Survey of India Toposheet Nos. 53D and 53H. The NCT of Delhi is surrounded on three sides by two States, i.e., on North, West and South by Haryana and in the East across the river Yamuna by Uttar Pradesh.

1.1 Administrative Setup of NCT Delhi

NCT of Delhi is divided in 11 Revenue District and one non-revenue unit along river Yamuna, named as *Nazul Land*. Each district is headed by District Magistrate and assisted by 1 Additional District Magistrate &3 Sub Divisional Magistrates. The District Administration in Delhi is the *de-facto* enforcement department for all kinds of Government Policies and exercises supervisory powers over numerous other functionaries of the Government of NCT, Delhi. As per District Census Hand Book, 11 districts of NCT of Delhi are further subdivided into 3 Tehsils for each district and there are total 33 Tehsils, with 112 villages, 110 Census Town and 3 Statutory Towns. Administrative map of NCT of Delhi is shown in Fig. 1 and list of districts, tehsils is presented in table 1 and detailed list of urban / rural areas given in annexure I.

Fig. 1

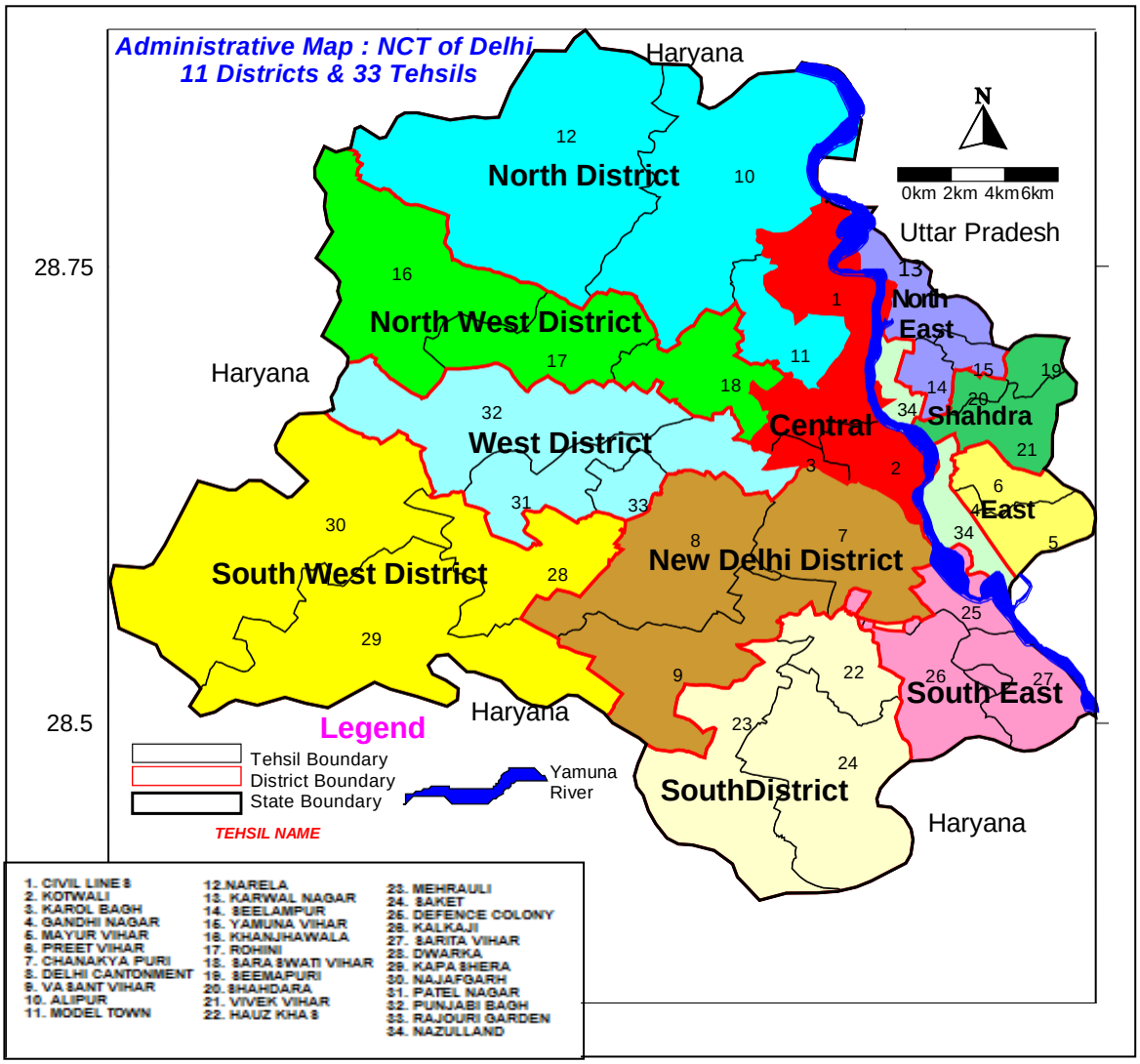


Table 1: Details of Administrative Units - NCT of Delhi

S. No.	District Name	Tehsil Name
1	CENTRAL	CIVIL LINES
		KOTWALI
		KAROL BAGH
2	EAST	GANDHI NAGAR
		MAYUR VIHAR
		PREET VIHAR
3	NEW DELHI	CHANAKYA PURI
		DELHI CANTONMENT
		VASANT VIHAR
4	NORTH	ALIPUR
		MODEL TOWN
		NARELA
5	NORTH EAST	KARAWAL NAGAR
		SEELAMPUR
		YAMUNA VIHAR
6	NORTH WEST	KHANJHAWALA
		ROHINI
		SARASWATI VIHAR
7	SHAHDARA	SEEMAPURI
		SHAHDARA
		VIVEK VIHAR
8	SOUTH	HAUZ KHAS
		MEHRAULI
		SAKET
9	SOUTH EAST	DEFENCE COLONY
		KALKA JI
		SARITA VIHAR
10	SOUTH WEST	DWARKA
		KAPASHERA
		NAJAFGARH
11	WEST	PATEL NAGAR
		PUNJAB BAGH
		RAJOURI GARDEN
Non-Revenue Unit Area		NAZUL LAND

1.2 Population & Land Use

As per Census of India Report 2011total population of NCT of Delhi is 167,87,944 persons. Out of total 1483 sqkm areas, only 25 % constitutes rural areas spread in 112 villages [Annexures I(A) & I(B)], which is sparsely populated having population density of 1135 persons / sqkm, whereas rest 75 % is urban areas spread in 110 Census Towns and 3 Statutory Towns and it is densely populated with population density of 14,698 persons / Sqkm. Details of villages and towns and its area & populations and land use pattern is given in table 2a & 2b respectively.

Population of Delhi has increased at a rate of 2.1% per annum during the decade 2001- 2011. Considering the same growth rate for the present decade, it is estimated that the population of Delhi in 2023 will be about 192lakhs and it would be about 196 lakhs in 2025, 208 lakhs by 2031. In order to evaluate the changes in ground water regime due to ever growing demand for ground water and the increasing numbers of abstraction

structures in the city, CGWB has been continuously monitoring the water level variation from its own monitoring network stations spread over the entire area of NCT Delhi.

Table 2a: Area, Population & Details of Towns and Villages: NCT of Delhi

Area & Population

Total Area: 1483 sqkm **Total Population 167,87,941persons**

- Urban Area: 1136.5 sqkm(75 %) Urban Population: 163,68,899 (98%)
- Rural Area: 369.35 sqkm(25%) Rural Population: 4,19,042 (2%)

Details of Towns - Urban Area

- Statutory Towns :3
  - New Delhi Municipal Council: Area 42.74 sqkm; Population:2,57,803
  - Delhi Cantonment Board : Area 42.97 sqkm; Population: 1,10,351
  - Delhi Municipal Corporation: Trifurcated into
    - North Delhi Municipal Corporation (NDMC)
    - South Delhi Municipal Corporation(SDMC)
    - East Delhi Municipal Corporation (EDMC)
- Census Towns: 110 - (List – Details Annexure I)

  DMC & Census Town Area: 1028 sqkm: Population 160,00,745

Details of Villages - Rural Area

- Villages: 112 (List – Details Annexure I)Village Area: 363.35 sqkm: Population 4,19,042

Source: Delhi Statistical Handbook-2021: www.delhigovt.nic.in

Land utilization data for year 2020-21 reveals that out of 1474.8sqkm areas accounted for Land Records in NCT of Delhi, more than 57 % area is not available for cultivation whereas only 192.25sqkm is available for cultivation and nearly 435sq km is gross cropped / agriculture areas. Nearly 6 % of total area is under forest, covering mostly notified ridge areas and other forest pockets under DDA & government forest land. Break up of land utilization is presented in Table 2b and depicted graphically in Fig.2a Fig 2b.

Table: 2b Utilisation of Land in Delhi (2020-21) Area in Hectares

Area according to Land use Records (Exclude Forest)		147488
Area not Available for Cultivation		92700
(a) Land Put to Non-Agriculture Use -	76218	
(b) Barren and Uncultivated Land	16482	
Other Uncultivated Land		11124
(a) Permanent Pasture & Other Grazing Land	61	
(b) Land Use Under Miscellaneous Uses	1170	
(c) Cultivable Waste Land	9893	
Fallow Land		19225
Net Area Sown		29241
Area Sown more than once		14328
Total Cropped Area		43569
Area Under Forest		9453
(a) Forest Under DDA	1281	
(b) Notified Ridge Forest	7784	
(c) Other Forest Area	388	

Source: Joint Director of Agriculture, Govt of NCT,Delhi

Table: 3 Sources of Irrigation and Irrigated Area 2020-21

Source		Area Irrigated (in Hectare)	
Canals			2235
Tanks			
Wells	TWs	21477	22465
	Others	988	
Net Area Irrigated			24700
Area Irrigated More Than Once			14328
Gross Area Irrigated			39028

Source: Joint Director of Agriculture, Govt of NCT of Delhi

Main source for irrigation in NCT of Delhi is groundwater whereas surface water is also available from Trans Yamuna Canal Network. Details about sources of irrigation and areas under irrigation is presented in Table 3.

Fig. 2a

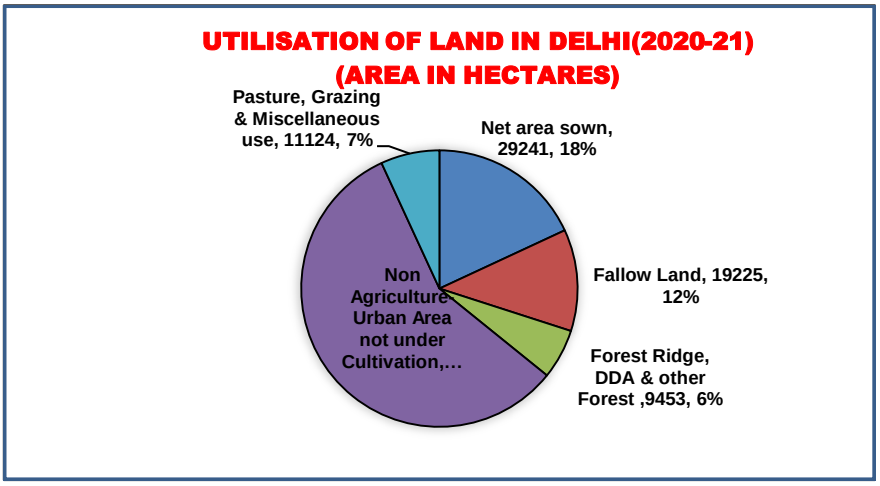
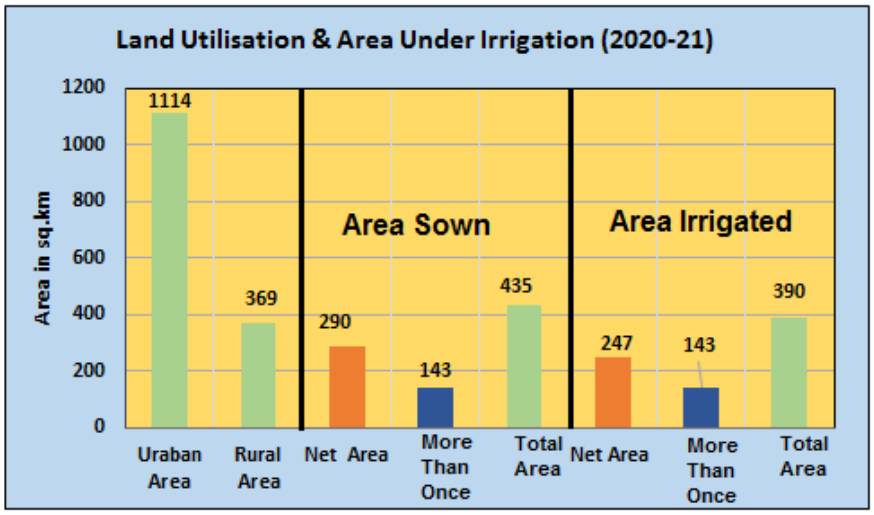


Fig. 2b



1.3 Climate and Rainfall

1.3.1 Climate

The climate of NCT Delhi is mainly influenced by its inland position and the prevalence of air of the continental type during the major part of the year. Extreme dryness with the intensely hot summer and cold winter are the characteristics of the climate. Only during the three-monsoon months July, August, and September does air of oceanic origin penetrate to this state and causes increased humidity, cloudiness and precipitation. The year can broadly be divided into three seasons (Table 4). Data on long-term average climatologic parameters covering monthly maximum / minimum temperature, relative humidity, evaporation and rainfall for NCT of Delhi is given in Table 5 and presented graphically in Fig 3.

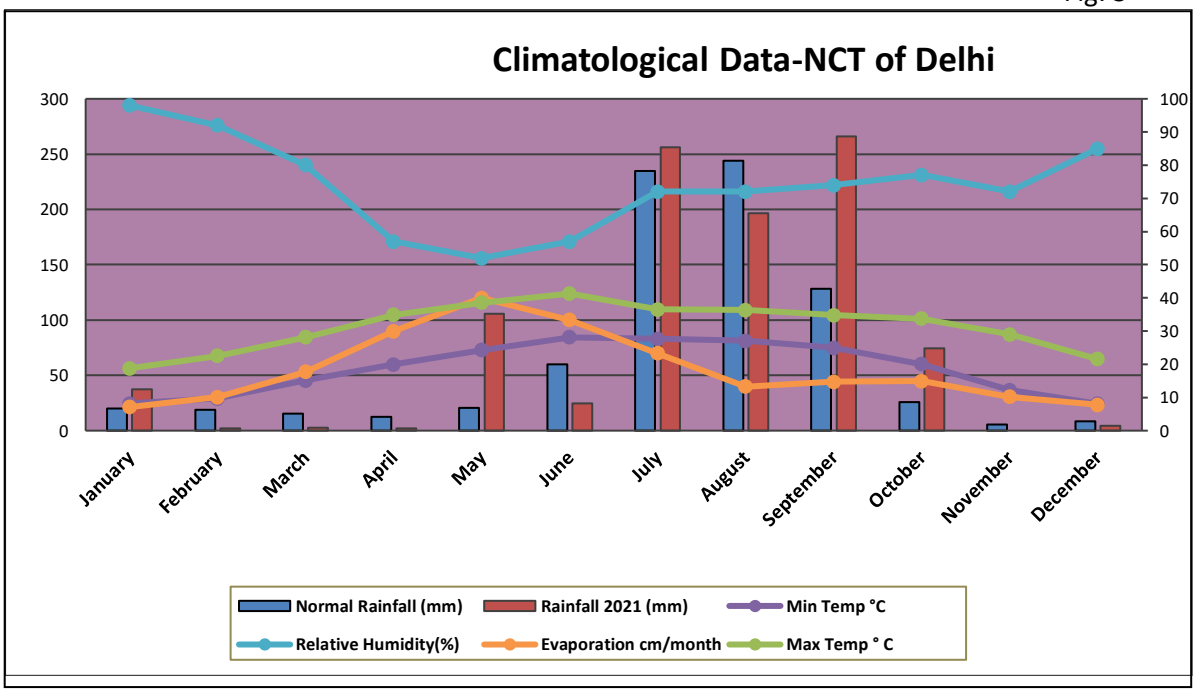
Table 4: Climate Seasons in NCT of Delhi

Season	Begin	End
Cold/Winter	End of November	Middle of March
Summer	Middle/End of March	End of June
Rainy season	Early July	September

Table: 5 Climatological Parameters – NCT of Delhi

Month	Max Temp (°C)	Mini Temp (°C)	Relative Humidity (%)	Rainfall (mm) Normal	Rainfall (mm) 2021	Rainy Days	Eto (mm/d)
January	18.8	8.2	98.0	19.9	37.11	4.0	7.1
February	22.5	9.7	92.0	18.6	2.18	0.0	10.1
March	28.1	15.1	80.0	15.5	2.93	6.0	17.7
April	34.9	19.9	57.0	12.7	2.16	2.0	30.0
May	38.6	24.3	52.0	20.8	105.62	0.0	40.0
June	41.3	28.1	57.0	59.9	24.88	4.0	33.3
July	36.5	27.7	72.0	234.7	255.94	10.0	23.3
August	36.3	27.1	72.0	244.2	196.74	9.0	13.3
September	34.8	25.0	74.0	128.3	265.95	1.0	14.7
October	33.7	20.0	77.0	25.9	74.34	0.0	14.9
November	29.0	12.2	72.0	5.3	0	0.0	10.2
December	21.6	8.1	85.0	8.2	4.49	0.0	7.8
Total	**-**	**-**	**-**	**794**	**972.34**	**36.0**	**222.4**
Average	**31.3**	**18.8**	**74.0**				

Fig. 3



1.3.2. Rainfall

The normal rainfall in NCT Delhi is 794mm. The rainfall in NCT Delhi increases from the southwest to the northwest (Fig. 4). About 81% of the annual rainfall is received during the monsoon months July, August and September. The rest of the annual rainfall is received as winter rains and as thunderstorm rain in the pre and post monsoon months. The variation of rainfall from year to year is large.

1.3.3. Rainfall Analysis

Rainfall analysis of 34 years annual rainfall of data and probability analysis data is plotted in figure 5 & 6 and its finding, about probability of occurrence of quantum of rainfall with various probability is presented in Table 6. (Data analyzed for probability graph Annexure II).

Fig. 4

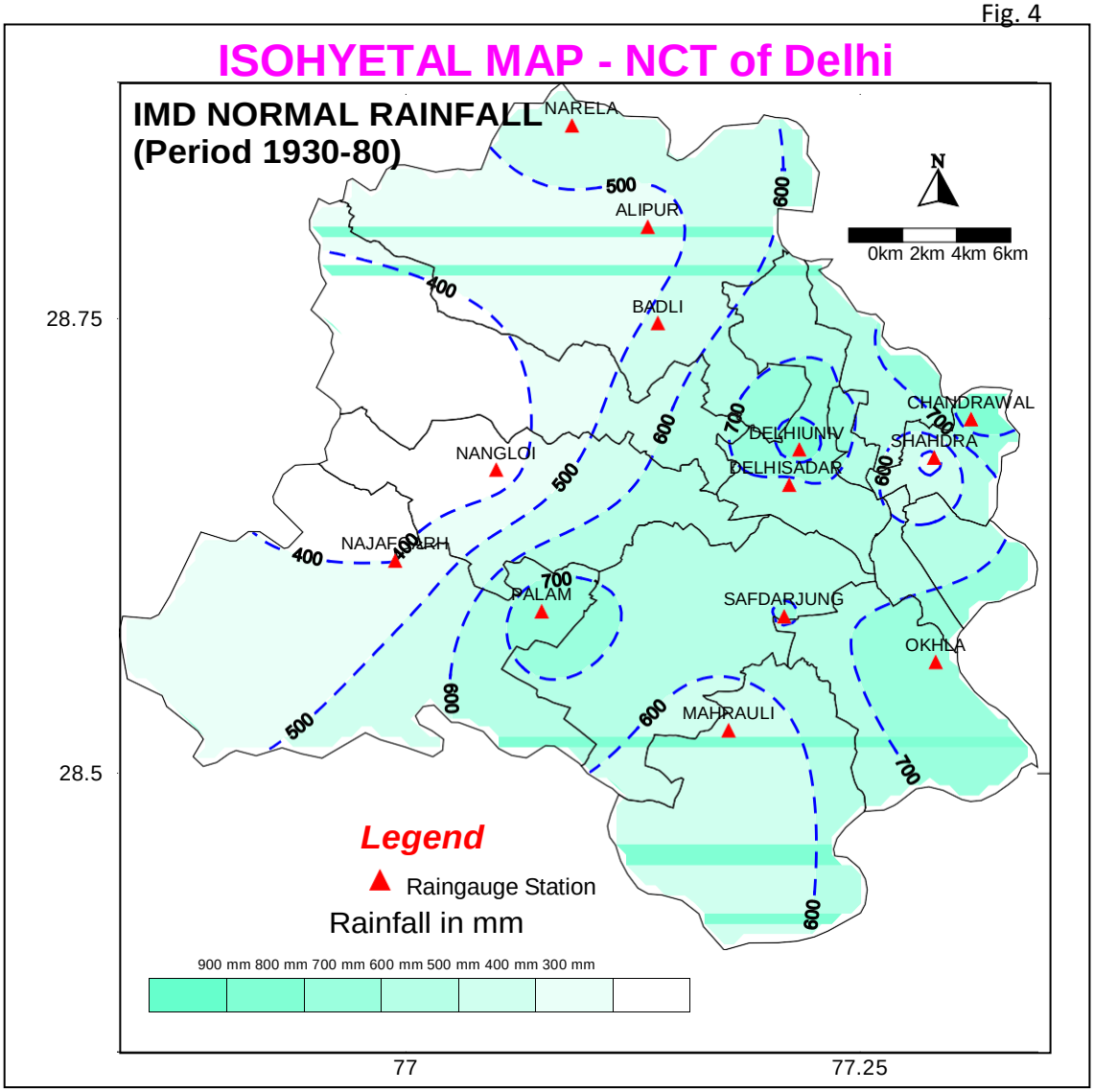

ISOHYETAL MAP - NCT of Delhi
IMD NORMAL RAINFALL
(Period 1930-80)
NARELA
ALIPUR
BADLI
NANGLOI
NAJAFGARH
PALAM
DELHIUNIV
DELHISADAR
CHANDRAWAL
SHAHDRA
SAFDARJUNG
OKHLA
MAHRAULI
500
600
400
700
N
0km 2km 4km 6km
28.75
28.5
77
77.25
Legend
Raingauge Station
Rainfall in mm
900 mm 800 mm 700 mm 600 mm 500 mm 400 mm 300 mm

Fig. 5

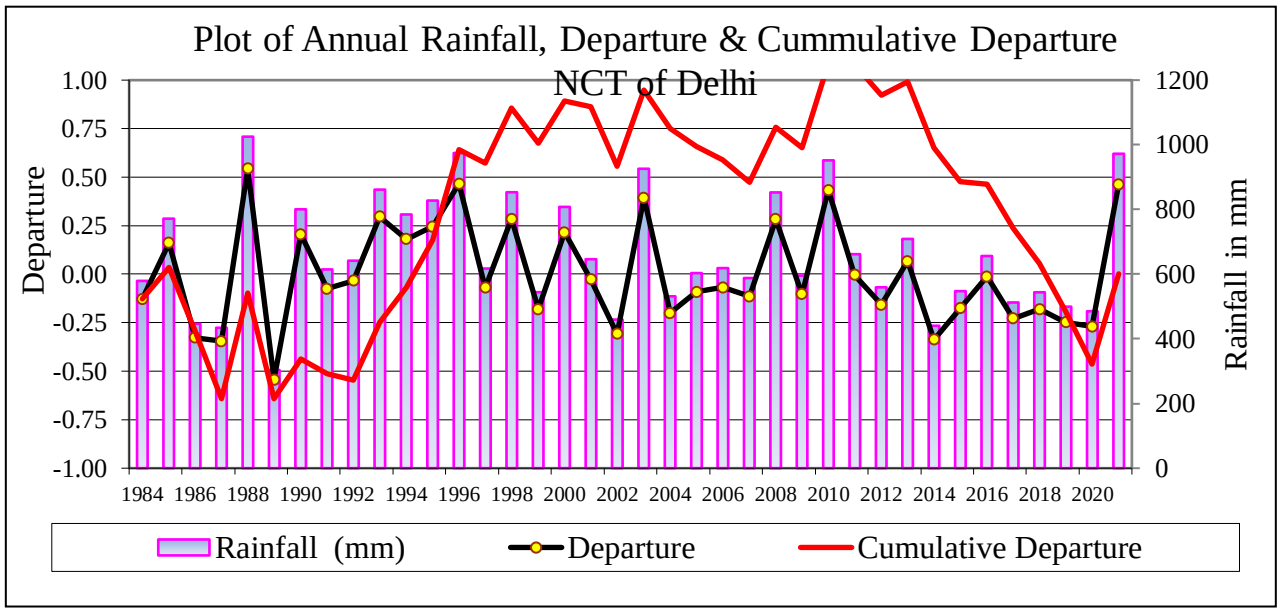

Plot of Annual Rainfall, Departure & Cummulative Departure
NCT of Delhi
Departure
Rainfall in mm
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
1200
1000
800
600
400
200
0
1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020
Rainfall (mm)
Departure
Cumulative Departure

Fig.6

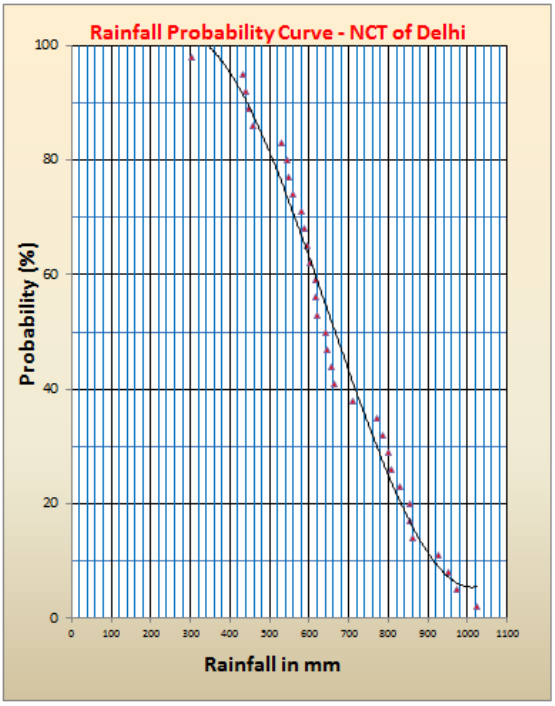


Table 6: Rainfall Probability	
Probability %	Annual Rainfall in mm
10%	922
20%	840
30%	778
40%	718
50%	664
60%	618
70%	562
80%	520
90%	476
Probability of exceeding of Normal RF	58%

A perusal of rainfall data from 1984 to 2021 shows that NCT Delhi received deficient rainfall during last 21 years corresponding to mild to severe drought conditions (Annexure-II). Severe drought with departure of 50 % was experienced in the year 1989. Normal drought, departure 25 to 50 % was experienced during year 1986,1987,2002 and recently during 2014. Whereas, Mild drought, departure up to 25 %, was experienced during the year 1984,1991,1992,1997,1999, 2001, 2004 to 2007, 2009, 2010, 2012 and 2015 to 2021. The probability analysis shows that probability of rainfall exceeding normal rainfall of 669 mm is up to 48 % whereas there are 90 % chance that rainfall would limit to 476 mm. Overall, the rainfall in Delhi is highly variable and which in turn affects the natural recharge to ground water from year to year. The effect of climate change is visible since 2019 onwards. The rainfall events are intense & more frequent during monsoon months with less no. of rainy days.

1.3.4. Other Climatic Parameters

- Temperature:

The cold season starts after second week of November when both day and night temperature drop rapidly with the advance of the season. January is the coldest month during which mean daily maximum and minimum temperature varies between 21.3°C to 7.3°C. In the winter months when western disturbances pass over North India, minimum temperatures may sometimes go down to the freezing point of water. From about the middle of March, temperature begins to rise rapidly. May and June are the hottest months. While day temperature is higher in May the nights are warmer in June. From April the hot wind known locally as *'loo'* blows and the weather is unpleasant. In May and June maximum temperature may sometimes reach 46 or 47°C. With the advance of the monsoon

into the area towards the end of June or the beginning of July day temperatures drop appreciably while the night temperatures remain high. In October the day temperatures are as in the monsoon months, but the nights are cooler.

- Humidity:

The air over Delhi is dry during the greater part of the year. Humidity is high in the monsoon months. April and May are the driest months with relative humidity of about 30% in the morning and less than 20% in the afternoons.

- Cloudiness:

During the monsoon especially in July and August skies are heavily clouded and often overcast. In the rest of the year skies are clear or lightly clouded. But in the months January, February and early March skies become cloudy by western disturbances.

- Winds:

Winds are generally light during the post monsoon and winter months. They strengthen during the summer and monsoon months. Except during the monsoon months, winds are predominantly from a westerly or northwesterly direction and tend to be more northerly in the afternoon. Easterly and southeasterly winds are more common in the monsoon months.

2. GROUND WATER REGIMEMONITORING

Central Ground Water Board is monitoring the ground water regime through the length and breadth of the country since the year 1969 through a network of (National Hydrograph Station) NHS. As on January 2022 a total of 118 NHS which included 97 Piezometers and 21 Dug wells were established in NCT Delhi. Monitoring of ground water levels is an effort to obtain information on variation in ground water regime and chemical quality through representative sampling, both in time and space. Systematic and regular monitoring of groundwater levels and quality brings out various information about the changes taking place in the groundwater regime due to change in climate, demography, usage, agriculture pattern and infrastructure development.

2.1. Monitoring Objective and Method

Main objective is to record the response of ground water regime to the natural and artificial conditions of stresses with reference to geology, climate, physiography, land-use pattern and other hydrologic characteristics. The database generated, in forms of reports and maps, are of immense help for regional groundwater flow modeling which serves as a groundwater management tool to provide the necessary advance information to the stakeholders to prepare contingency plans in case of unfavorable groundwater recharge situation. The data also has immense utility in deciding the legal issues arising out of conflicting interests of groundwater users and also form the basis for ground water development and management programme.

2.1.1. Monitoring Stations Status

Central Ground Water Board, as part of its national programme, has established network of observation wells in the NCT of Delhi for monitoring ground water regime. Number of wells monitored during 2021-22 in NCT of Delhi varies from 112 in May 2021 to 118 in January 2022 details of which with district wise breakup and types of wells (dug wells / piezometers etc) is given in Table 7. The distribution of monitoring wells in NCT of Delhi is shown in Fig 7. (Annexure III(A).)

Table:7Numbers of Stations Monitored by CGWB During 2021-22 – NCT Delhi

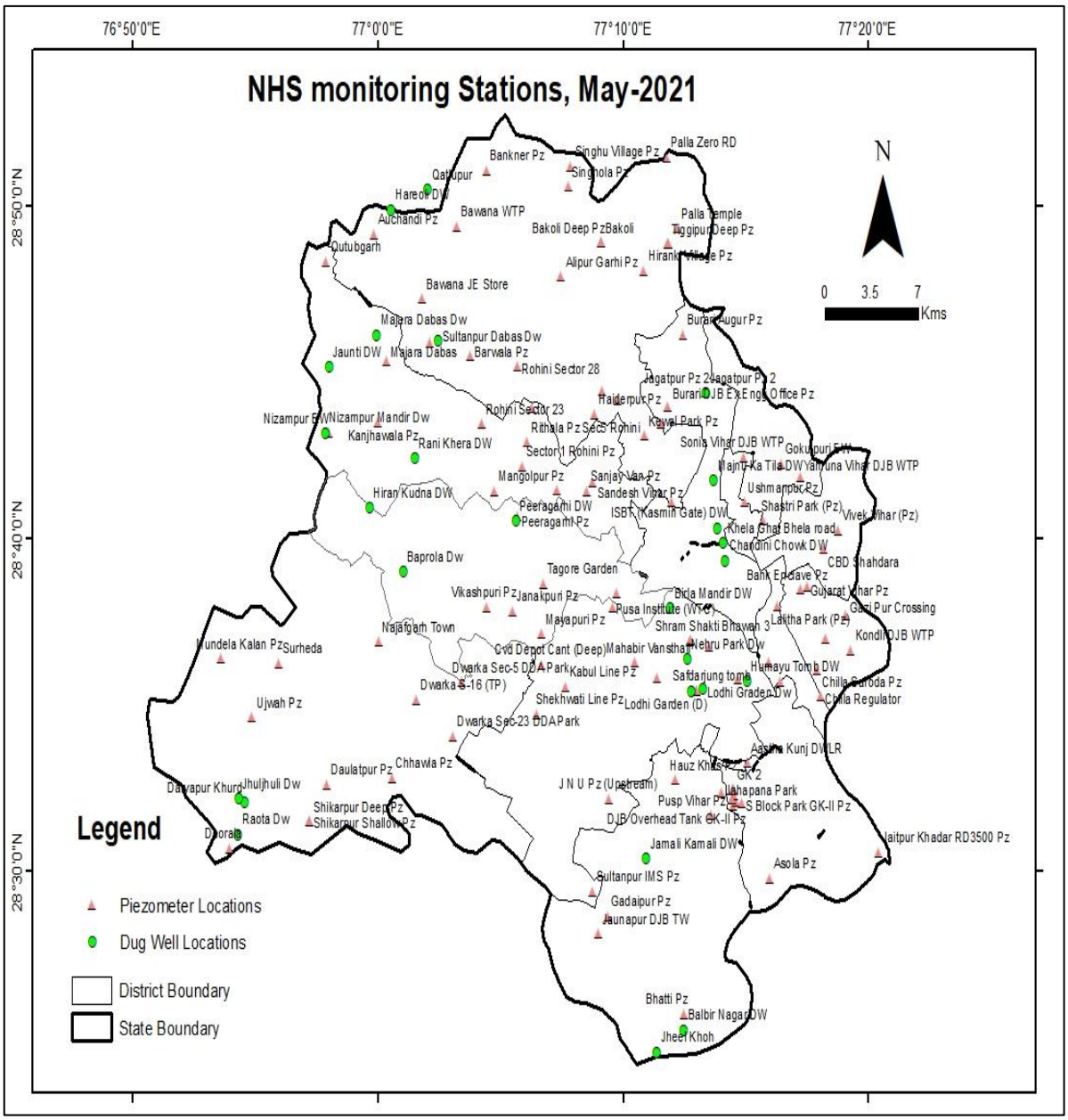
	May-21			**Aug-21**			**Nov-21**			**Jan-22**		
	Dw	Pz	**Total**	Dw	Pz	**Total**	Dw	Pz	**Total**	Dw	Pz	**Total**
Central	4	3	**7**	4	3	**7**	4	3	**7**	4	3	**7**
East	0	6	**6**	0	6	**6**	0	6	**6**	0	7	**7**
New Delhi	5	13	**18**	4	11	**15**	5	12	**17**	4	11	**15**
North	2	19	**21**	1	20	**21**	2	21	**23**	2	20	**22**
North East	0	1	**1**	0	1	**1**	0	3	**3**	0	4	**4**
North West	3	14	**17**	2	15	**17**	4	15	**19**	2	14	**16**
Shahdara	0	2	**2**	0	2	**2**	0	2	**2**	0	2	**2**
South	3	5	**8**	3	5	**8**	3	5	**8**	3	5	**8**
South East	0	5	**5**	0	6	**6**	0	11	**11**	0	11	**11**
South West	3	12	**15**	3	12	**15**	3	12	**15**	3	11	**14**
West	3	6	**9**	3	5	**8**	3	6	**9**	3	6	**9**
Nazul Land*	0	3	**3**	0	3	**3**	0	3	**3**	0	3	**3**
Total	23	89	**112**	20	89	**109**	24	99	**123**	21	97	**118**

DW: Dug well &Pz: Piezometer; * Non-Revenue Land Area – Yamuna Flood Plain Area

It is observed that at present district wise distribution of monitoring network stations is highly uneven. Some of these active monitoring stations have become defunct during same AAP largely due to corrosion of well assembly and at some places, destroyed / filled up due to other unavoidable urban development activities. During last two decade, at places, continuous decline in ground water level is observed. Such condition necessitates more attention and close monitoring at micro level. It

is fact that establishing of new Peizometers or identifying new working dug wells in metropolitan city of Delhi is very difficult due to non-availability of space, although Central Ground Water Board is striving to increase the number of monitoring stations in NCT Delhi to have close observation in the diverse hydrogeological domain. To ensure optimum network density of monitoring station for scientific analysis of the dynamics of ground water regime, in exceedingly developing areas of NCT Delhi is most inevitable. CGWB has taken up groundwater exploration programme to drill and construct new piezometers to replace existing defunct piezometers in NCT Delhi from the Annual Action Plan of year 2017-18 onwards. Map showing locations of existing monitoring stations of CGWB is presented in fig.7.

Fig. 7



2.1.2. Distribution of Monitoring Stations

Central Ground Water Board has carried out extensive hydrogeological mapping and groundwater exploration in NCT of Delhi and its surrounding States. The information generated from these studies has helped to figure out the subsurface disposition and inter-relationship of the aquifers spatially and depth wise. This information has enabled to decide grouping of interrelated aquifers into one aquifer system for the purpose of monitoring.

In alluvial areas of NCT of Delhi, number of sand zones constituting individual local aquifers is grouped into major one main aquifer system and piezometers have been installed accordingly. Three distinct potential aquifer groups within the depth of 450 m below ground level, identified and grouped on basis of various hydrogeological mapping and ground water exploration, are as follows.

1. Aquifer Group I - Down to 65 m below ground level(Un-confined)
2. Aquifer Group II- Between 65 to 200 m below ground level (Confined/Semi-Confined)
3. Aquifer Group III- Between 200 to >300 m below ground Level(Confined)

Separate piezometers are installed, tapping the two aquifer groups, the first one in the phreatic zone deep enough to accommodate long term fluctuation (i.e. up to 65 m deep) and the other one tapping the middle parts of the aquifer groups II, lying between 65 to 200 m. The Aquifer group III is not being monitored at present.

Similarly, hard rock area of NCT Delhi is being monitored through piezometric nests, which are installed in a single borehole tapping the weathered and fractured aquifers combined. Generally, the depth of the well goes up to 80 mbgl, but in some cases, it goes up to 140 mbgl.

Besides piezometers, many numbers of dug wells, tapping phreatic aquifer zone are included in monitoring network. Over the period, numbers of dug wells are becoming defunct due to lack of their use and maintenance. Still, there are 21 dug wells integrated with monitoring network of NCT Delhi (Fig. 7).

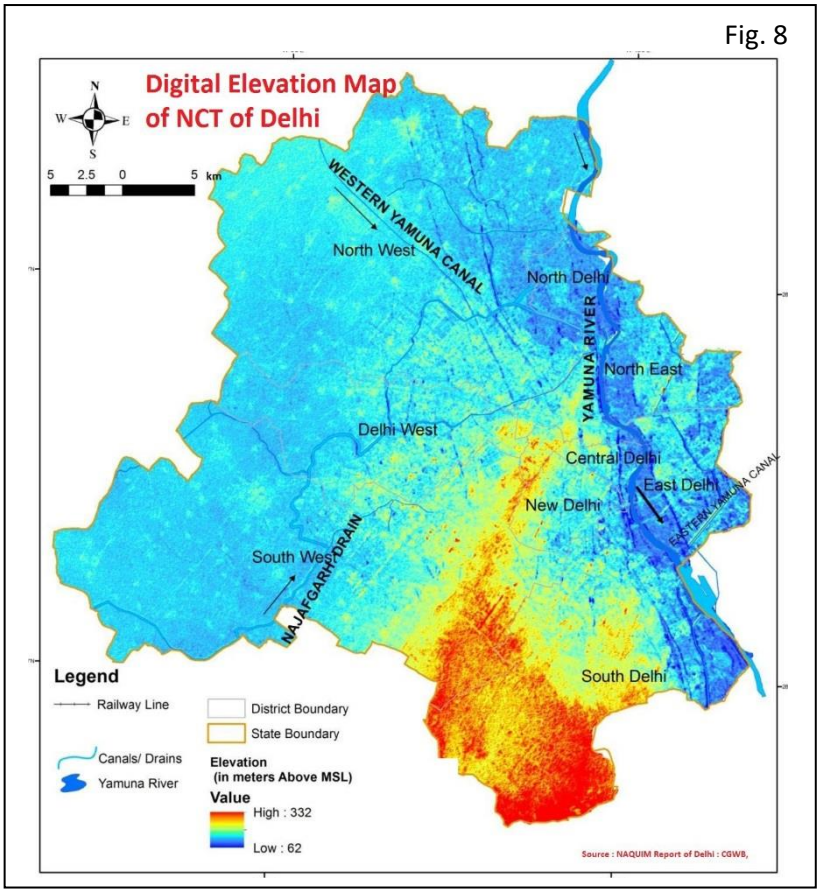
3. HYDROGEOLOGY

Occurrence and movement of groundwater in subsurface aquifer system depends upon topography, geology, climate, water yielding and water bearing properties of sub soils / rocks in the zones of aeration and saturation. The upper surface of the zone of saturation is the Water Table which is measured during water level monitoring. In case of wells penetrating confined aquifers, the water level represents the pressure or Piezometric Head at that point. For effective water level monitoring, it is essential to have a complete understanding of aquifer disposition and geometry in the area before establishing monitoring network.

3.1 Physiography & Drainage

NCT of Delhi represents a mature topography with vast, gently undulatory plains dominated by Yamuna River, low linear ridges and isolated hillocks. Physiography of Delhi is dominated by the Yamuna river, the Aravalli range, and the plains in between formed by alluvium deposits of Recent age. The SSW- NNE trending Aravalli Ranges are designated as *Delhi Ridge*, occupy the South-Central part of Delhi and extend up to western bank of Yamuna River near Okhla in the south and Wazirabad in the north-east. Ecologically, the Aravalli Ridge acts as a barrier between the Thar desert and the plains and slows down the movement of dust and wind from the desert. In NCT Delhi, the ridge area is covered with forests, acts as city's lungs and help maintain its environment. This green belt, a natural forest, has a moderate influence on temperature, besides bestowing other known benefits to the people.

Fig. 8

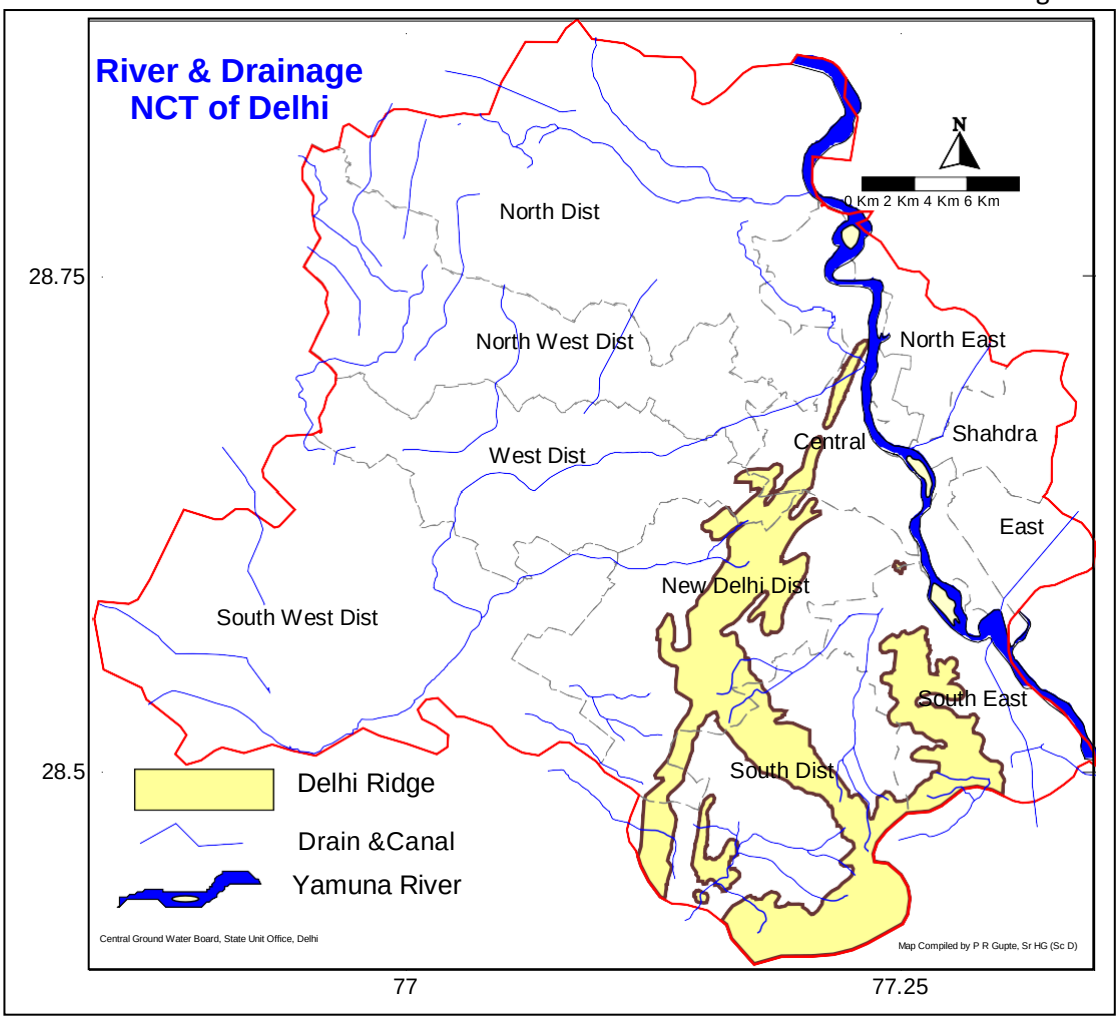


The area towards east of ridge has a gentle slope of 3.5 m/km towards Yamuna. The area towards west of ridge representing Older Alluvial Plain is mostly covered by sand dunes and has a westerly slope. Yamuna River flows across Delhi in a south-southeasterly direction with vast flood plain, marked by a bluff of 3 to 4 m on either bank. Digital Elevation Model Map of Delhi is presented in Fig. 8. Surface elevation varies from 332 m above mean sea level at the ridge to 62 m above mean sea level at river Yamuna. The low-lying Yamuna flood plains, with an elevation as low as 198 m amsl, provide fertile alluvial soil suitable for agriculture but are prone to recurrent floods.

The Yamuna river flowing in a southernly direction in the eastern part of the NCT of Delhi is the only perennial river in the area besides the number of micro watersheds originating from the quartzite ridge. The drainage on the East of the ridge enters river Yamuna, whereas on the West, it enters natural depressions located in Najafgarh Tehsil of South-West district. The NCT of Delhi can be

divided into seven sub basins, ultimately discharging into the Yamuna (Fig. 9), namely (I) The Najafgarh Drain is about 39 Km long, flows North-Easterly and joins Yamuna River at Wazirabad in North Delhi. (ii) Supplementary drain, (iii) Barapullah drain (iv) Wild life sanctuary area, (v) Drainage of Shahadra area, (vi) Bawana drain basin, (vii) Other drains directly out falling into river Yamuna on right bank. Swamp areas are common along the flood plains ofYamuna.

Fig. 9



3.2 Geomorphology

The ground water availability in NCT of Delhi indirectly relates with its distinct landform units, which in turn represent underlying intrinsic geological features. Map showing these landforms of NCT of Delhi are presented in Fig. 10. All these landforms of NCT, Delhi can be grouped into three broad geomorphic units: namely Rocky surface, Older Alluvial Plain and Flood Plain of Yamuna River.

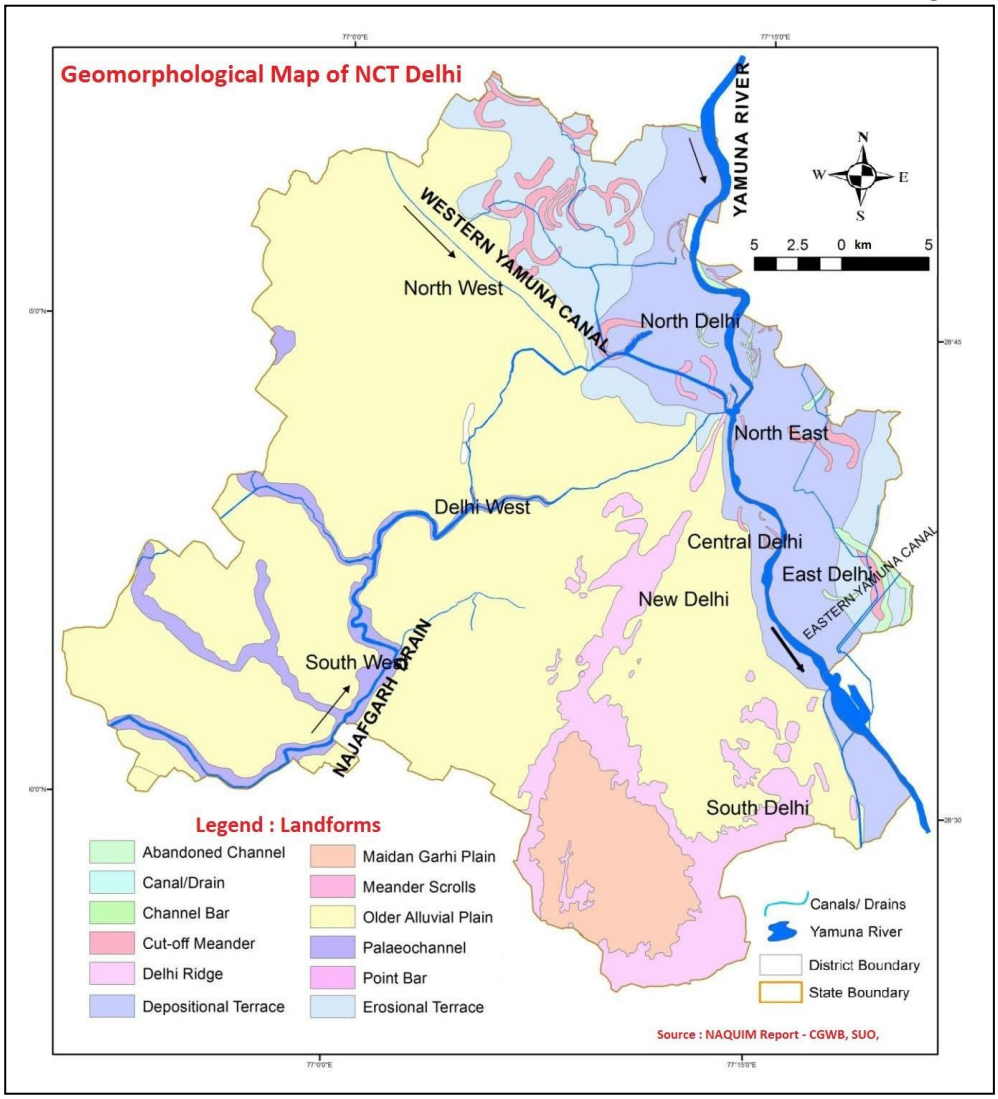
Rocky Surface: The rocky surface represents structurally controlled relict linear ridges and isolated hillocks comprising of rocks of Delhi Super group. This distinct landform comprising of isolated hills is most prominent in the South- and South-Central parts, extends from Mahipalpur to Wazirabad in the north. Towards south of Mahipalpur the ridge gets bifurcated, one arm extends towards Mandi and further south while the 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 m amsl which gradually diminishes towards north where rocks are exposed on the western bank of Yamuna near Wazirabad.

Older Alluvial Plain: The gently undulatory terrain on either side of the rocky surface is described as Older Alluvial Plain. This surface is separated from the Yamuna Flood Plain by a bluff. Depending upon

the morphological expressions / features, this unit is further divided into different subunits: namely, (i) Najafgarh Older Alluvial Plain, (ii) Delhi Older Alluvial Plain and (iii) Maidan Garhi Plain. Najafgarh Older Alluvial Plain occupying western and southwestern part of the region is partly covered by sand dunes and sandy sheets. The gently sloping surface including the covered pediment along the eastern flank of the ridge represents the Delhi Older Alluvial Plain. Maidan Garhi Plain is a relatively higher plain surface and forms part of Chhatarpur Basin. A narrow zone of badland has formed mostly along the western margins of structural ridges due to intense development of gullies and rills.

Flood Plain of river Yamuna: The low-lying flat surface representing the Flood Plain of river Yamuna occupying northern, northeastern and eastern parts of the NCT is an important geomorphic unit. North of Narela, the width of flood plain varies from 15 to 17 km. The wider Older Yamuna flood plain indicates lateral migration of river Yamuna over large areas. This belt has good potential for ground water development. It forms the erosional terrace. The Yamuna Active Flood Plain represents the wide belt bounded on both the sides by Eastern and Western bunds and is naturally prone to annual / periodic floods being in the flood way and flood fringe zone of river Yamuna. It forms depositional terrace and is characterized by abandoned channels, cut-off meanders, meander scrolls, point bars and channel bars. Presence of number of cut- off meanders in the Yamuna Flood Plain suggests oscillatory shifting of river. The lakes near Bhalsawa, Kondli and Khichdipur are remnants of large meanders.

Fig. 10



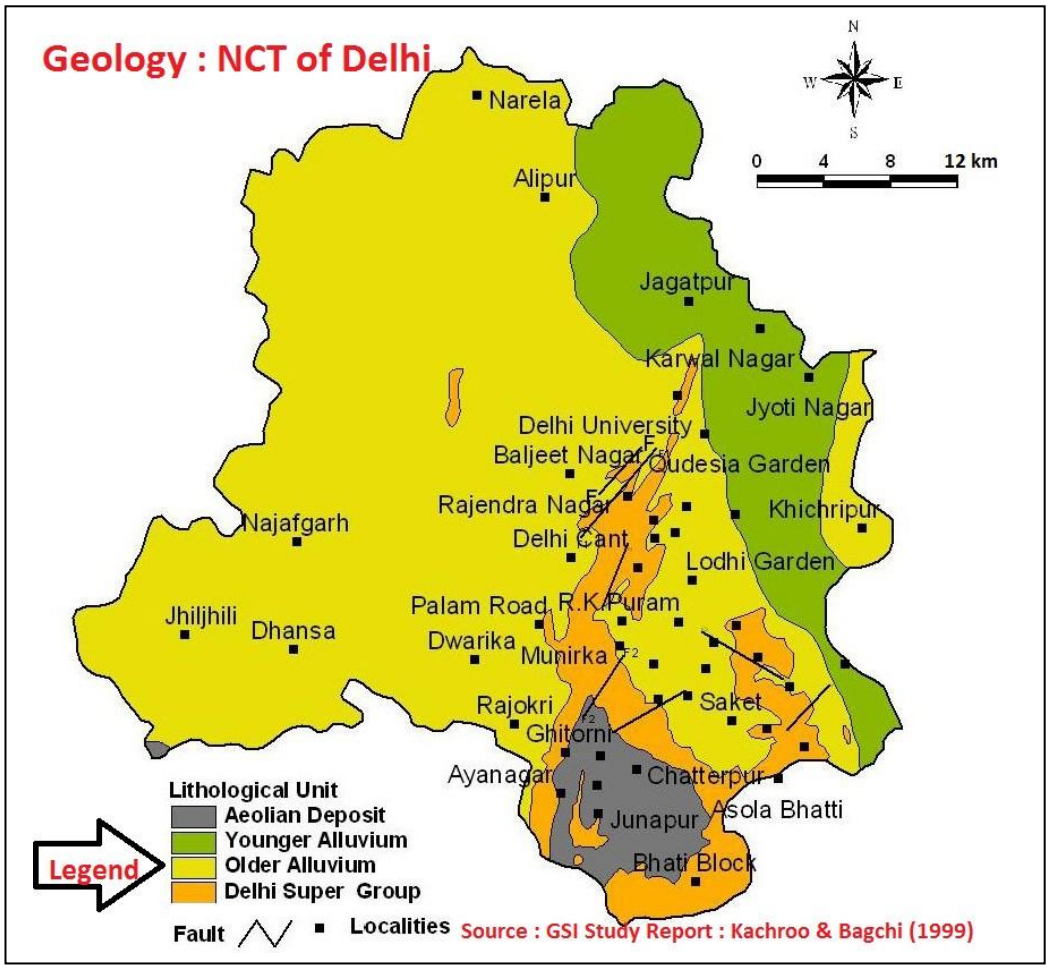
3.3 Geology

The rock formations exposed in the National Capital Territory of Delhi are mainly quartzite inter bedded with thin bands of micaceous schist. These Proterozoic age rocks occur along the ridge, extending from Harchandpur (Haryana) in the South to Wazirabad (Delhi) in the North. Quaternary sediments consisting alluvium deposit directly overlie the Proterozoic rocks. Systematic geological and geomorphologic studies carried out by the Geologists of Geological Survey of India has revealed three Stratigraphic horizons and underlying three distinct lithostratigraphic units of NCT Delhi. The highest of these is the erosional surface forming the top of denudational hills. The second surface is Older Alluvial plain and the third is depositional Younger Alluvial plain (Yamuna). All three lithostratigraphic units corresponding them have undergone changes due to widespread and uncontrolled urban activity over the period. The geological map of Delhi after Kachroo and Bagchi (1999), showing these main units is shown in Fig. 11 and generalized stratigraphy of NCT of Delhi is presented in Table 8.

Table: 8 Generalized Stratigraphic Units of NCT Delhi (compiled after GSI Study)

Alluvium	Newer Alluvium	Unconsolidated, inter-bedded lenses of sand, silt gravel and clay confined to narrow flood plains of Yamuna river and Aeolian deposit of South Delhi.
	Older Alluvium	Unconsolidated thickness varies up to 300m. Inter bedded, inter-fingering deposits of sand, clay and kankar, poor to moderately sorted.
Delhi Super Group	Alwar Quartzite	Well stratified, thick bedded, brown to buff colour, hard and compact, intruded locally by pegmatite and quartz veins inter bedded with mica schist.

Fig. 11



3.3.1. Alluvium Deposits

In NCT Delhi region, exposures of the oldest lithostratigraphic unit, the Delhi Quartzite ridge acts as main recharge zone to subsurface aquifer system. 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 of South Delhi 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 are overlain by the newer alluvium, which occurs mostly in the flood plains of river Yamuna.

3.3.2. Hard Rock Formation

Quartzite is one of the most physically durable and chemically resistant rocks found in NCT of Delhi. The suits of quartzite and associated mica schist /phyllite bands of Delhi system have undergone multiple folding and different phases of metamorphism. When the mountain ranges are worn down by weathering and erosion, less-resistant and less-durable rocks are destroyed, but the quartzite remains. Therefore Delhi Quartzite is so often the rock found as linear ridges ranges and covering their flanks as a litter of scree. One of the research study on weathering of Proterozoic quartzite in the semi-arid conditions around Delhisuggested that Quartzite being a resistant rock, dissolution of small amount of pyrites presence, by moving water produced a sulphate-bearing acidic solution and ferrous iron which reacted with aluminosilicate minerals and quartz respectively and has made the Delhi Quartzite porous and subsequent friable. The coupled weathering mechanism, from the core outward and also proceeded initially from fractures towards the inside, produced weathering rinds and subsequent physical erosion of loose sand, produced during rind development in the outermost zones, has given rise to features like tors, spheroids, gullies, cavities and small-scale caves on these quartzites. Thus, the terrain has acquired ruggedness in semi-arid conditions.

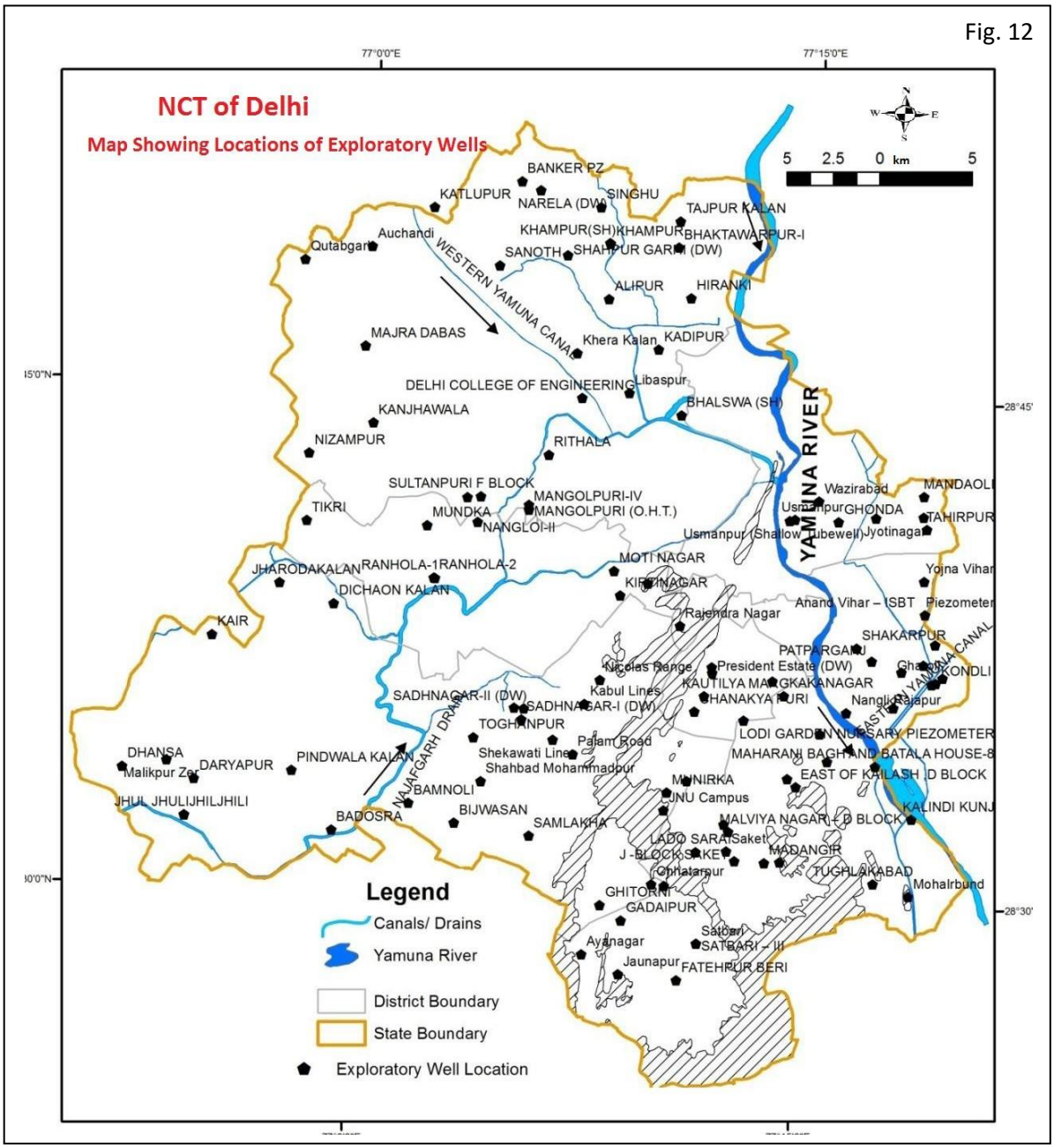
In one of the studies of GSI, it is reported three generations of folding in the rocks of Delhi. The fold axes of first-generation folds follow the trend of main ridge i.e. NNE-SSW, the second-generation folds trending NE-SW are observed at Tughlaqabad - Mehrauli area, and third generation fold trending NW-SE is observed at Anand Parbat. The rocks are highly jointed and two sets of conjugate vertical to sub-vertical joints have been reported. Another study of GSI has inferred several faults trending NNE-SSW, NE-SW and WNW-ESE.

3.3.3. Subsurface Aquifer Dispositions

Central Ground Water Board had been engaged in Ground Water Exploration in National Capital Territory of Delhi since its inception in 1972 and till date more than 327 boreholes are drilled out of which 151 are Exploratory Well (EW), 176 are Observation Well (OW) / Piezometers (Pz) / Slim holes. Locations of exploratory boreholes are shown in Fig. 12. All these boreholes were electrically logged to identify granular zones with fresh ground water and other lithological characteristics of subsurface litho units. All these studies have revealed that there is distinct variations in sub surface lithology characteristics and thickness of individual subunits of the main aquifer zone, within the Younger and Older alluvium deposits of NCT Delhi (refer Fig. 11) which make the aquifer geometry of Delhi complicated and complex. Younger Alluvium confined to the flood plains of Yamuna River and also along the courses of major streams, comprises of clay/silt mixed with small mica flakes, and medium to coarse-grained sand and gravel whereas Older Alluvium comprises interbedded and lenticular deposits of clay, silt and sand ranging from very fine to very coarse with occasional kankar. In general, the Younger alluvium, the disposition of different sediments particularly the pervious layer constituting the unconfined aquifer is well delineated in the Yamuna flood plain area while inthe

older alluvium, the disposition of different lithological units is not well defined, and they are heterogeneous in nature, making it difficult to identify the deep aquifer zones which are regionally extensive, both vertically and laterally. In the Yamuna flood plain, Younger Alluvium thickness is about 40m thick and underlain with silty clay with kankar whereas the thickness of the Older Alluvium, mainly west of Delhi Ridge is highly variable and is dependent mainly on the configuration of the basement; at Shahbad Mohammadpur near IGI airport the thickness of the older alluvium is 560 meters overlying the bed rock. Whereas in areas underlain by hard rock units, mainly South, South East, Parts of New Delhi and Central district of NCT of Delhi, the aquifers are defined by the presence of fractured zones at different depths. These fractured zones at places are locally well defined but not regionally extensive.

Fig. 12

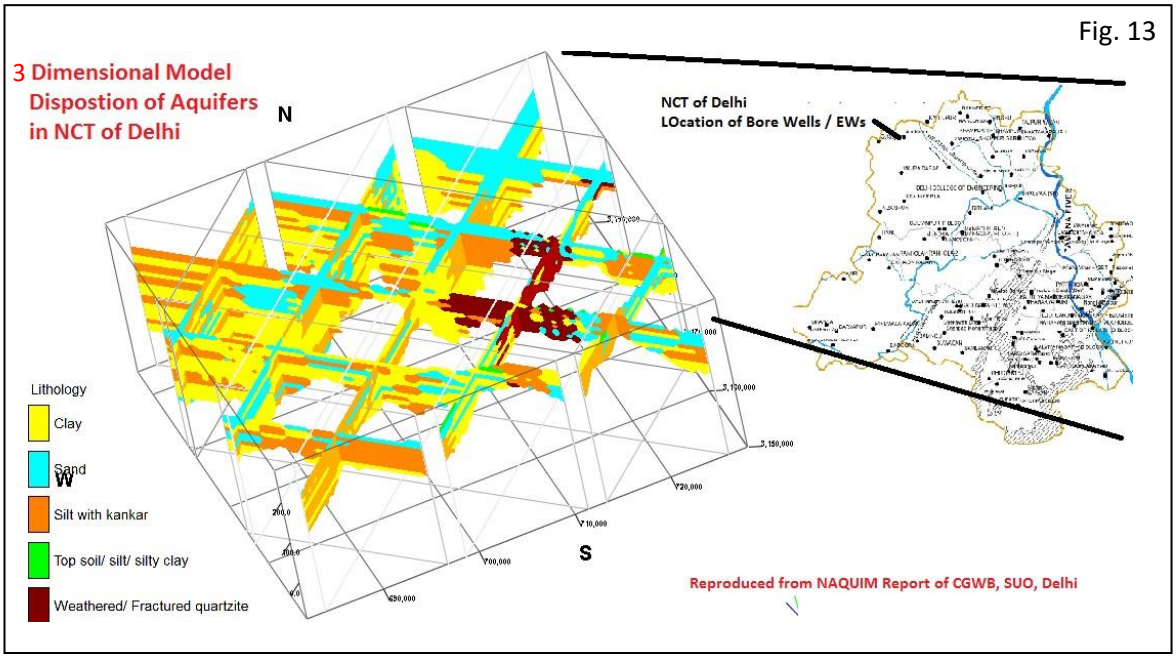


The subsurface configuration of aquifers, in entire NCT of Delhi has been deciphered on basis of available lithological and geophysical logs of exploratory wells drilled by Central Ground Water Board under the Ground Water Exploration Programme. To mark the aquifer geometry, on the basis of

these litholog data, the different sediments i.e. clay, silt, kankar and different grades of sand, and their admixture has been categorized as pervious (silt + kankar + sand) and impervious (mostly clay with some silt + kankar). In the areas underlain by hard rock formation, upper most wreathed regolith and quartzite with fractured zones at different depths and associated mica schist band constitutes unique hard rock aquifer system.

In recent study taken by CGWB under NAQUIM Project, the detailed aquifer geometry on regional scale has been established in the NCT, Delhi. All available information about subsurface aquifer configuration, deciphered on basis lithological and geophysical logs of exploratory wells drilled by Central Ground Water Board under the Ground Water Exploration Programme along with interpreted records of various geophysical studies etc., are integrated to prepare the aquifer map. From the geological sections and fence diagrams prepared, principal aquifers in the area have been delineated by grouping the fine, medium, coarse sand and sand with gravels as sand. Top soil and silty clay or silt at the surface have been grouped together. Weathered and fractured quartzite and the massive quartzite/ bedrock have been grouped together as weathered/ fractured quartzite (Fig.13).

Fig. 13



3.3.4. Fresh –Saline Ground Water Interface

Various hydrogeological and groundwater exploration studies in NCT of Delhi by CGWB has revealed that the thickness of fresh water in major part of the State varies from 20 to 40 m It is also observed that no fresh water is available in a few pockets in Narela and Alipurtehsils of North District, Saraswati Vihar tehsil of Northwest district, Punjabi Bagh and Patel Nagar tehsils of West District, Najafgarh tehsil of Southwest district and Kalkaji tehsil of Southeast District. (Fig. 14).

In one of the recent studies undertaken under NAQUIM projects by WAPCOS, the granular zones (the aquifers) with varied resistivity were picked up from the combined interpretations of electrical resistivity (64 inches Normal) and gamma radioactivity logs of the boreholes drilled in the area. It shows that resistivity values greater than 10 ohm m to 50 ohm m represents predominately sand with fresh ground water. Resistivity less than 10 ohm m indicates predominately clay and kankar with saline water. Further lowering of resistivity values to 1 ohm m indicates further deterioration of water quality with depth. Resistivity of the order of 50 to 500 ohm m in hard rock (quartzite) area is represented by weathered/ fractured/ jointed quartzite which forms potential aquifer with potable water. In general, it is clear that fresh water sediments are followed by the saline water sediments in

all over NCT of Delhi. The thickness of fresh water sediments is limited in major parts of NCT, Delhi. The depth to fresh-saline water interface varies from 10 m bgl to 80 m bgl. Ground water quality below fresh saline water interface is saline all through up to the bedrock. At a few locations like Dhansa, Qutabgarh and Bankner, saline ground water is present at a very shallow depth. Panel diagram showing fresh-saline ground water interface in subsurface aquifer system of NCT of Delhi, is presented in Fig. 15.

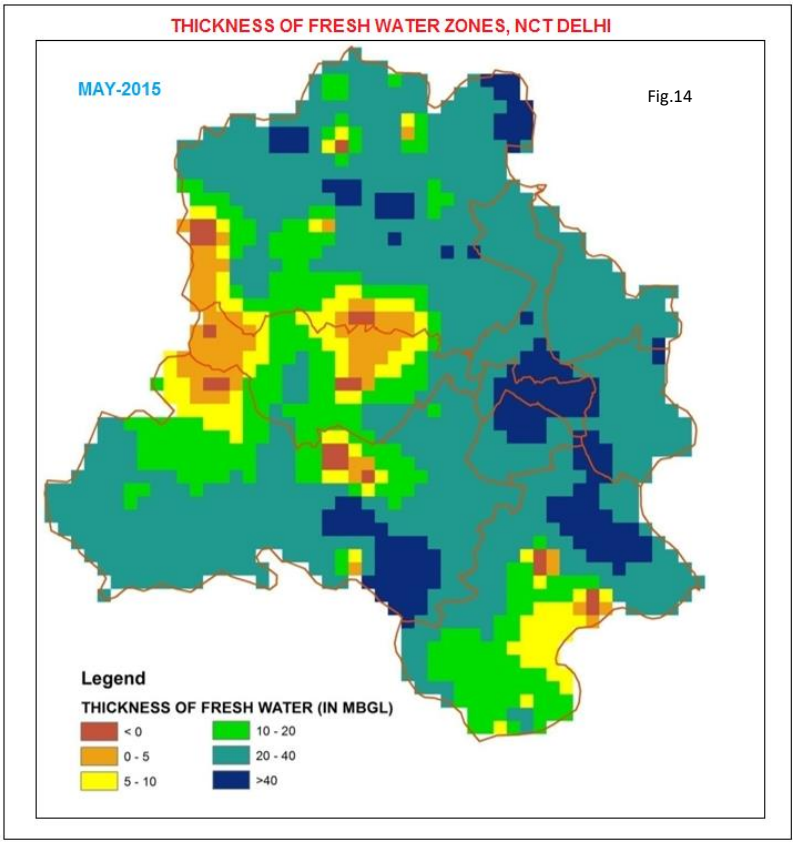


Fig.14

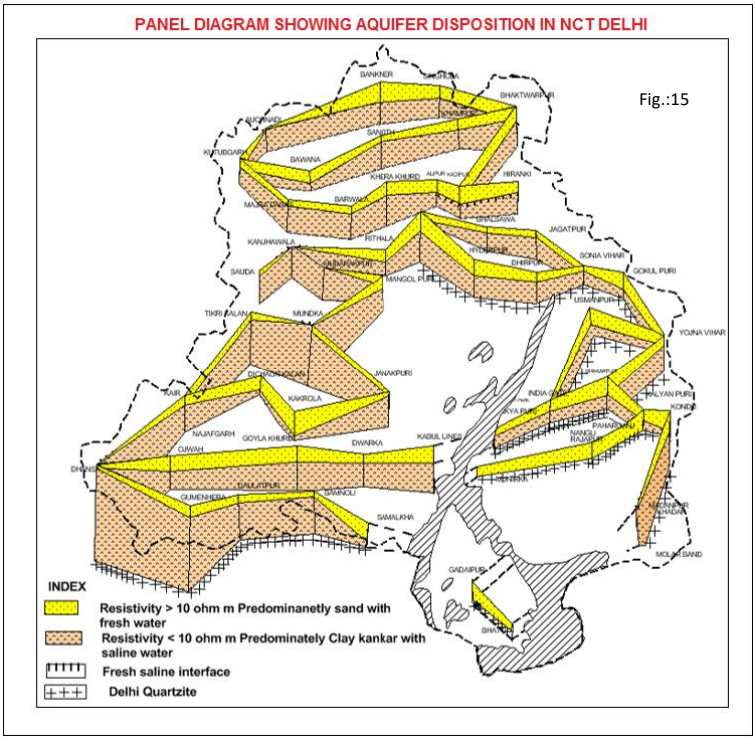


Fig.:15

Perusal of Fig. 15 shows that in the South West district of NCT Delhi, bedrock is encountered at many places i.e. in Dhansa, Samalkha, Kabul lines, Jhuljhuli where fresh/saline water interface also varies greatly in entire area. All along the Najafgarh Drain and two depressions i.e., Gummanhera & Pindwalan Kalan, fresh water layer is somewhat deeper i.e. up to 35 m bgl but rest of the area is having thin layer of fresh water i.e. up to the depth 25 to 28 m bgl only. In the western parts of the district, the thickness of fresh water zone is limited. At a few locations like Dhansa, the saline ground water is present at a very shallow depth and as we move towards areas in the eastern part of the district, where hard rock is present, the thickness of fresh water aquifers is more, and fresh-saline water interface occurs at deeper depth i.e. generally around 80 to 90 m bgl. At Rajokri, the depth of fresh-saline water interface has been observed to be 150 m bgl.

In West district, the depth of fresh-saline interface varies from 25 to 50 m bgl. The depth of fresh water zone varies from 10 to 45mbgl. The thickness of fresh water aquifers is more at places like Dichaon Kalan and Kakrola and fresh-saline interface is at deeper depths. While in the areas around Janakpuri, Mundka, the saline water is present at shallow depths.

In South district, depth of fresh-saline water interface varies from 75 to 100 mbgl. The thickness of fresh water zone varies from 30 to 85 m. At locations like Gadaipur, Bhatti and Munirka, fresh water aquifers are followed by hard rock (Delhi quartzite). In Southeast district, at places around Madanpur Khadar, the thickness of fresh water zones is limited. Here, fresh water aquifers are followed by saline water zone and bedrock is encountered at depth of around of 300 m.

In North West district, the depth of fresh-saline water interface varies greatly. The thickness of fresh water aquifers is limited in this district. At locations like Auchandi, Qutabgarh&Bankner, the saline water is present at shallower depths. In areas along Yamuna Flood Plain, fresh-saline water interface is at deeper depth i.e., around 40 to 70 m bgl, whereas in rest of the area it is 22 to 40 m. No bedrock has been observed up to the depth of 250 mbgl.

In Northeast district, thickness of fresh water aquifers is more in areas around Yamuna Flood Plain. The depth of fresh-saline water interface in Yamuna Flood Plain ranges between 32 and 50 mbgl whereas in rest of the area, it ranges from 25 to 38 m bgl.

In New Delhi and Central Districts, fresh water sediments are followed by saline water and then by quartzites (Delhi Ridge). In East & Shahdara districts, thickness of fresh water aquifers is more at locations like Kalyanpuri, Kondli and Shakurpur up to 60 mbgl.

3.1.1. Basement Topography

The Pre-Cambrian basement rocks are exposed in form of series of isolated hillocks with different dimension, usually termed as Ridge, trending almost in NNE- SSW direction in NCT of Delhi. Main exposures are Northern Ridge near Delhi University (0.87 Sq. Km), Central Ridge near Dhaula Kuan (8.69 Sq. Km), South Central Ridge near Vasant Kunj (6.26 Sq. Km) and Southern Ridge near Asola (62 Sq. Km). The strike of these rocks varies from north-east and south-west to north north-east and south south-west with steep dips towards east and south-east except for some local variation due to folding.

Central Ground Water Board carried out a regular programme to drill exploratory wells in NCT Delhi and its surrounding States, So far, in NCT of Delhi alone, nearly 327 wells have been drilled in various parts of Delhi, which covers diverse terrain i.e. Yamuna flood plain, older alluvium area, Chattarpur Enclosed Basin and Delhi Quartzite terrain, for their aquifer evaluation and quality determination of ground water. Moreover, as a short-term basis electrical resistivity survey was also carried out along Najafgarh Drain and along Rajpath (India gate) as well as in different parts of south district. All these has helped to configure extension of basement rock topography, below variable thickness of alluvium, from the land surfaces of exposed ridge in all the stretches in& around NCT of Delhi. Earlier, during 2000, bed rock configuration map prepared on the basis of subsurface geological data generated from exploratory drilling and supplementary geophysical data input, indicated that the contour of the bed rock up to 200 m almost follows the Ridge alignment indicating the slope of the bed rock to be uniform. As such, taking into consideration of geological and tectonic processes undergone by basement rocks during the Pre-Cambrian and subsequent periods, the basement topography of NCT, Delhi is presumed to be highly uneven with the presence of sub-surface ridges and valleys. A simplified basement topography map, an abridged information derived by all available explorations & survey reports, mainly by using exploratory data of NCT Delhi, reproduced from old report of CGWB is shown in Fig. 16. Taking into account of thickness of alluvium overburden, the area of NCT Delhi has been classified into three zones Viz, A, B, C, which is shown in the Table 9.

Fig. 16

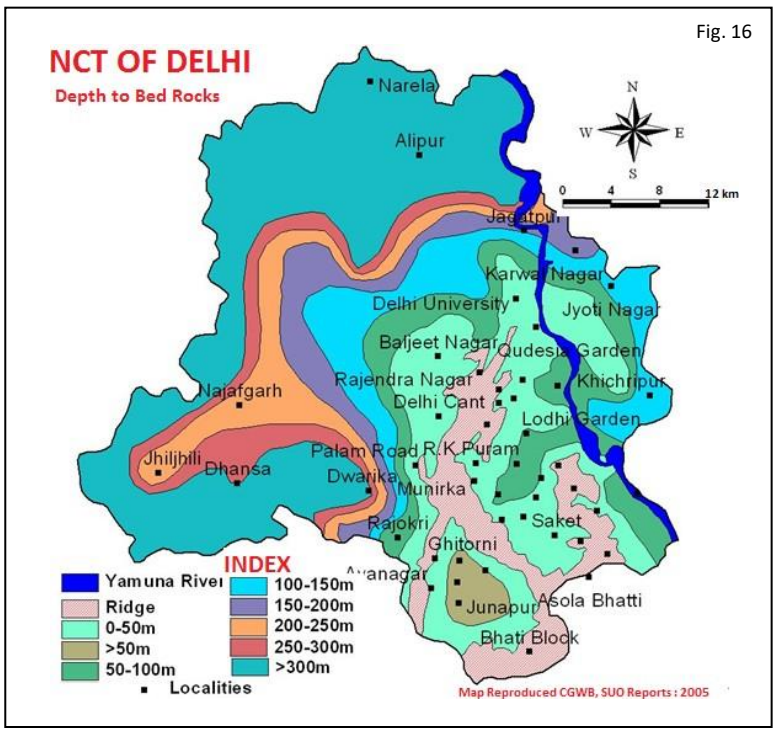


Table:9 Thickness of Alluvium overburden over Bed rock

Zone	Depth of Bed rock or overburden in mbgl	Area of NCT Delhi
Zone A	< 30	Lal Quila, Delhi Gate, Feroz Shah Kotla, Ramlila Ground, Ajmeri Gate, Sadar Bazar, Dhir-pur, Timarpur, Majnu Ka Tilla, Gandhi Nagar (Rail Bridge), Nehru Park, Sabji Mandi, Chandani Chowk- Sadar Bazar, GreaterKailash-Kalkaji, North of Connaught Place & Moti Bagh.
Zone B	30 to 100	Usmanpur, Loni border, Metro rail Depot, Mayur Vihar Phase-II (Block BD), Geeta colony, Khajuri Khas, Shakarpur Khas, Gadaipur, Jaunapur, Ayanagar,Hauz Khas, VayusenaBad.Jamia Univ. (Okhala), Arvindo Marg, Gulabi Bagh, Trilokpuri, Mayur Vihar-Ph-II,Ghazipur, Kondli (LoniBdr).
Zone C	> 100	Madanpur Khadar, Jagatpur, Jaitpur, West of Najafgarh Nala, Kirbi Place, Palam Village, Shastri Nagar, CBD Shahdara, Ananda Vihar, Dilshad Garden, Bawana,Nangloi,Tikri Kalan.

4. GROUND WATER BEHAVIOUR DURING 2021-22

The monitoring of ground water levels has been carried out four times in a year simultaneously throughout the NCT of Delhi during following periods.

a) May - 20th to 30th (water level of pre-monsoon period)
b) August - 20th to 30th (peak monsoon water level)
c) November - 1st to 10th (water levels of post-monsoon period)
d) January - 1st to 10th (the recession stage of water level)

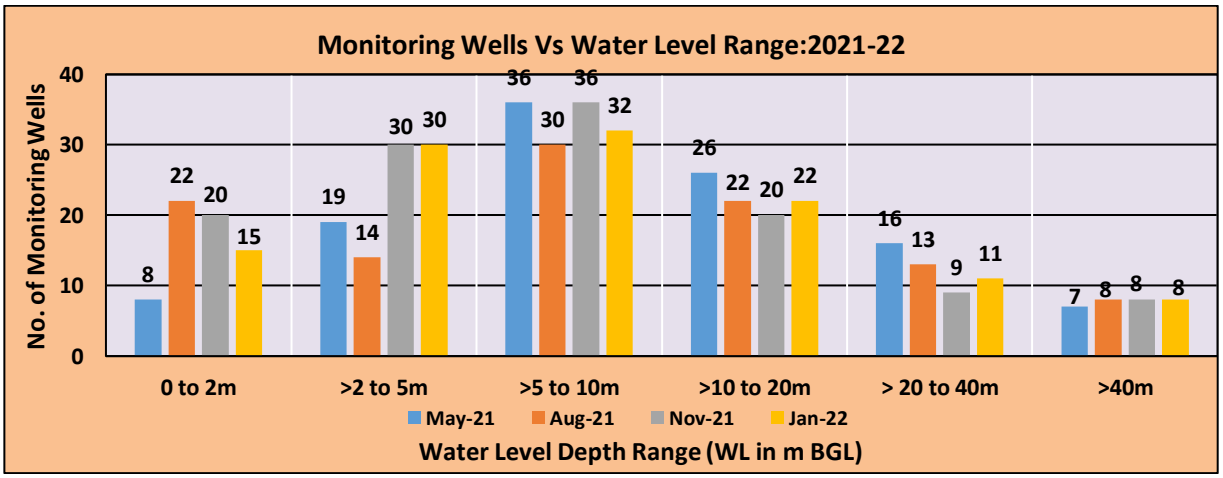
The data is analyzed for each set of measurement, and report prepared which include following maps to understand the groundwater regime in NCT of Delhi.

a) Depth to water level – water level with reference to ground level.
b) Seasonal fluctuation - water level fluctuation in comparison topre-monsoon.
c) Annual fluctuation - water level fluctuation in comparison to same month in the previous year.
d) Decadal fluctuation - water level fluctuation in the month of measurement with reference to the decadal average for the same month.
e) Ground Water Flow Net – water level with reference to mean sea level.

4.1 Depth to Water Level

The analysis of number of monitoring wells in the different categories of the water levels for all four monitoring periods of year 2021-22 (January, May, August & November) reveals that zone (shallow aquifer) having depth to water level up to 5 meters bgl varies considerably over two monitoring periods which shows that upper zone (shallow aquifer) is actively responding to stresses on ground water system. The changes in water levels in the depth range of 5mbgl to 10mbgland 10mbgl to 20mbgland> 20 mbgl, during 3 monitoring period as compared to May is not prominent. This may be interpreted as stressed water level conditions suppressing dynamic changes in water levels. Whereas number of monitoring stations showing water level below 40 m remain almost same in all four-monitoring period, indicating very high stressed water conditions in deep aquifers (Hard Rock Aquifer) of NCT Delhi Annexures IV(A,B,C,D).

Fig. 17



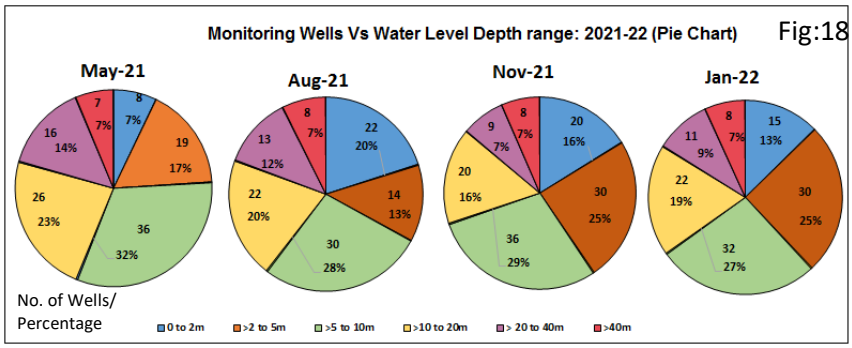


Fig:18

4.1.1. May 2021

The Depth to water level recorded in NCT Delhi during **May-2021** ranges from 0.5mbglat Deorala to 64.85m bgl at Gadaipur. A map showing May 2021 ground water levels in NCT of Delhi is given in Fig. 19 and areas under various depth zones is presented in Fig. 20. Around 11% of NCT Delhi have shallow water level up to 5 m bgl which falls in parts of North, North West, West, South West & Central districts. Deep water levels of 20m bgl to 65mbgl is observed in around 24% of NCT Delhi, which falls mainly in South & New Delhi districts & small pockets of South West, South East, North districts. In rest of NCT Delhi i.e. 65% of areas have water level ranging between 5m bgl to 20 m bgl.

Fig. 19

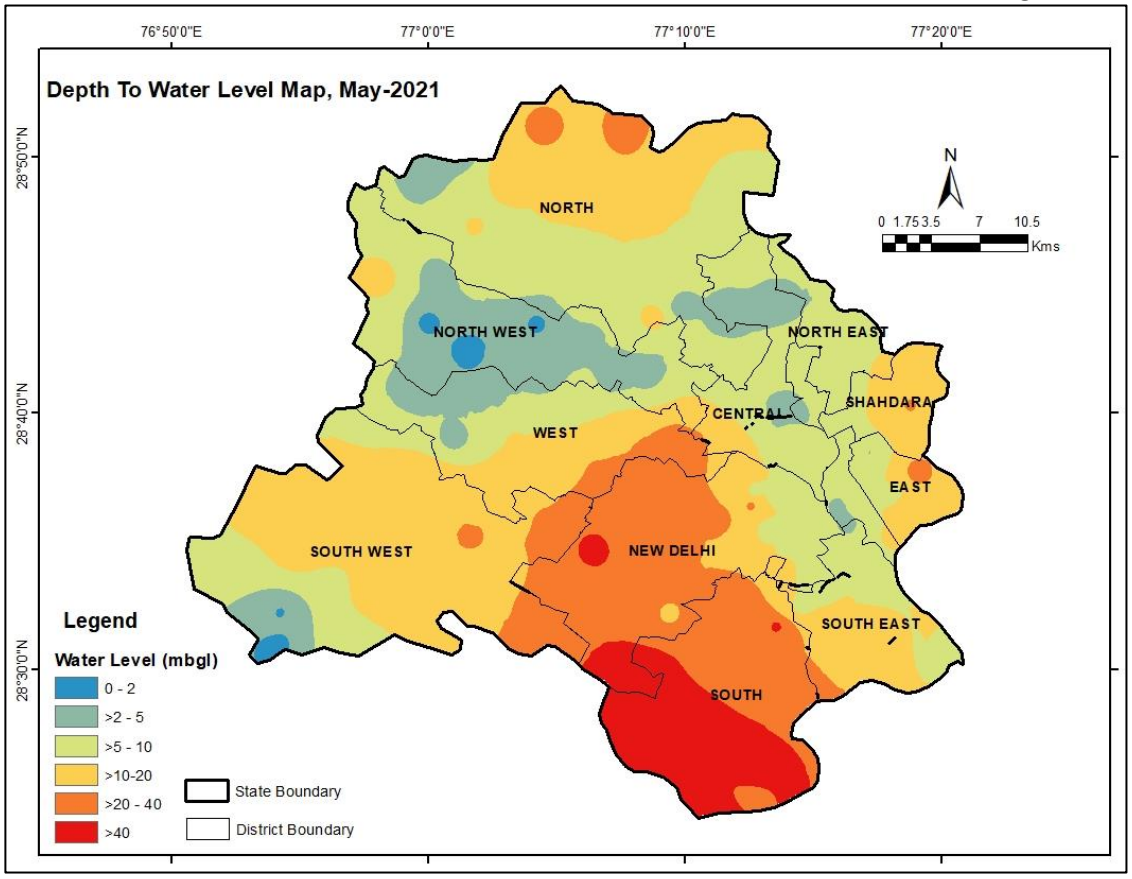
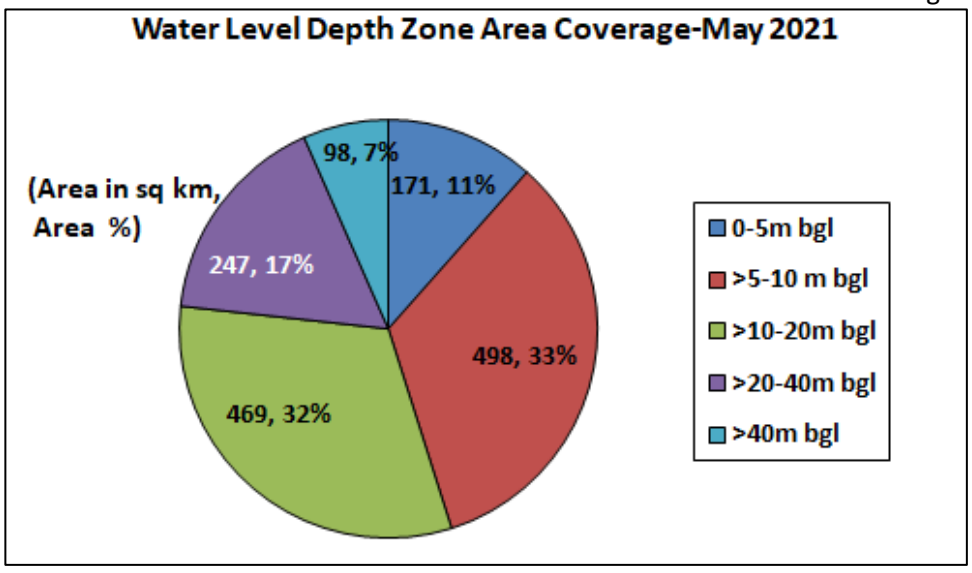


Fig. 20



4.1.2. August 2021

The Depth to water level recorded in NCT Delhi during **August-2021** ranges from 0.12mbglat Asthakunj Park to 65.48mbgl at Gadaipur. A map showing August 2021 ground water levels in NCT of Delhi is given in Fig. 21 and areas under various depth zones is presented in Fig. 22. Around 22% of NCT Delhi areas have shallow water level up to 5 m bgl which falls in parts of North, North West, North East, Central and South West districts. Deep water levels of 20 to 66 mbgl observed in around 23% of NCT Delhi, which falls in South, South East, New Delhi, North & South West districts. In rest of NCT Delhi, 55 % areas have water level in range of 5 to 20 mbgl.

Fig.21

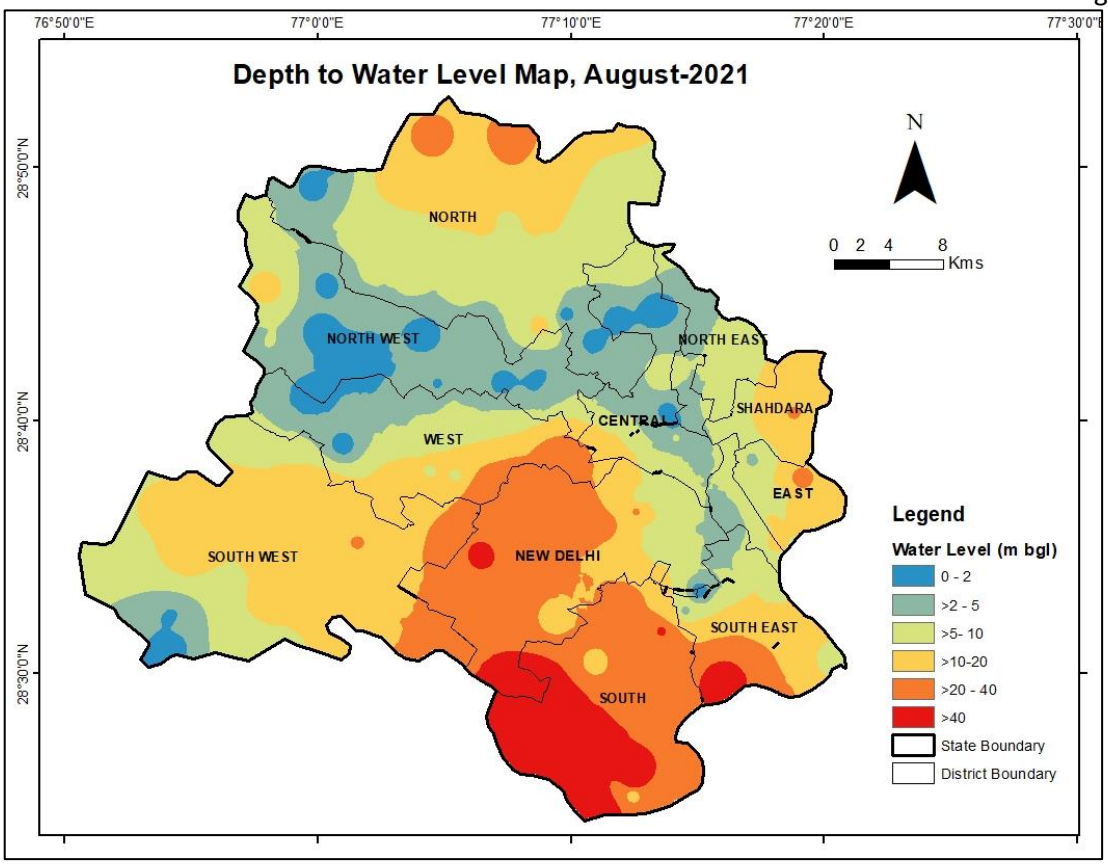
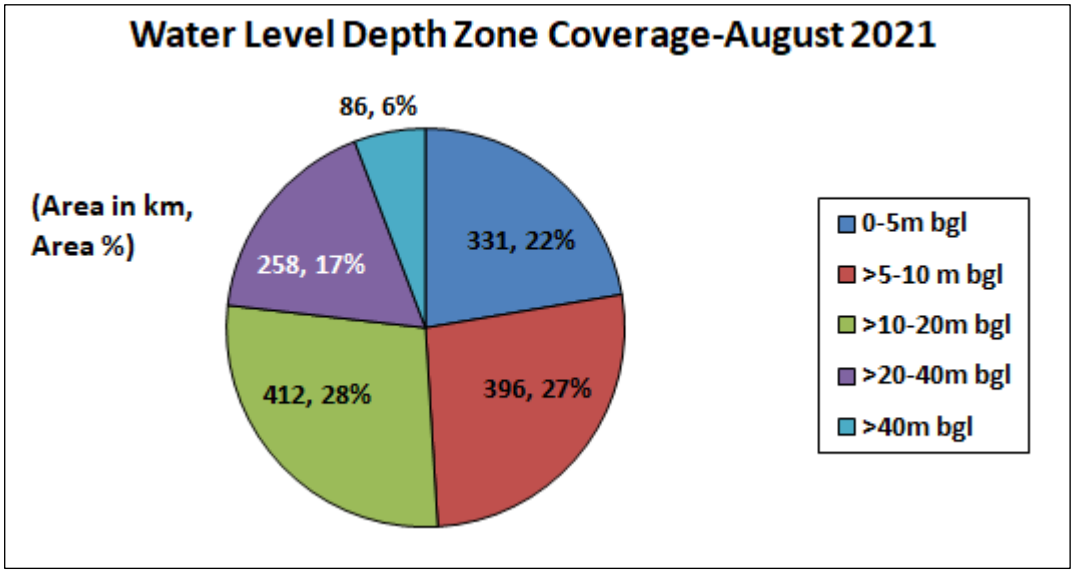


Fig. 22



4.1.2.November 2021

The Depth to water level recorded in NCT Delhi during **November-2021** ranges from 0.19m bgl at Asthakunj Park to 65.67mbgl at Gadaipur. A map showing November 2021 ground water levels in NCT of Delhi is given in Fig. 23 and areas under various depth zones presented in Fig. 24. Around 26% of NCT Delhi, which falls in parts of North, North West, Northeast, South East, Central, West and Southwest districts have shallow water level up to 5 m bgl. Deep water levels of 20 to 66 mbgl observed in around 18% of NCT Delhi, which falls in South, South East, New Delhi & South West districts. In rest of NCT Delhi, 56 % areas have water level in range of 5 to 20 mbgl.

Fig.23

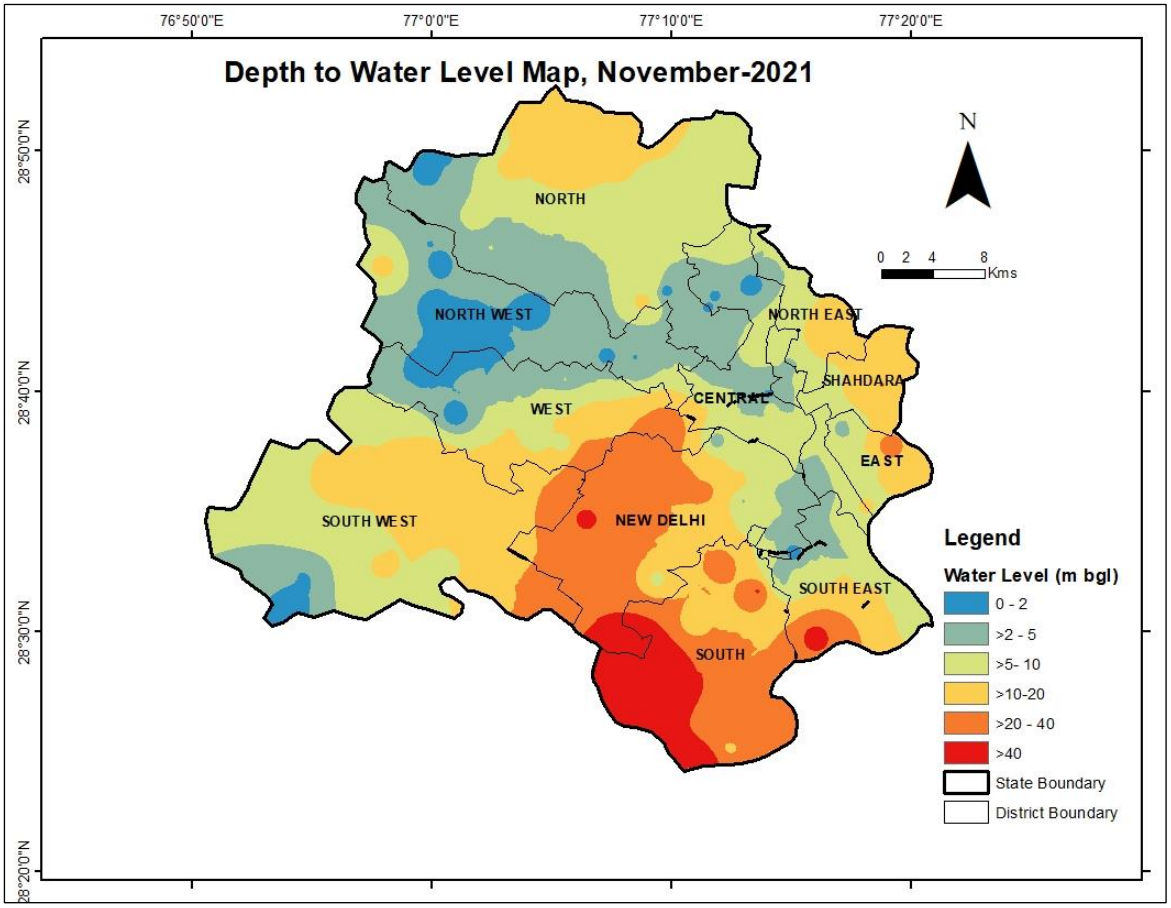
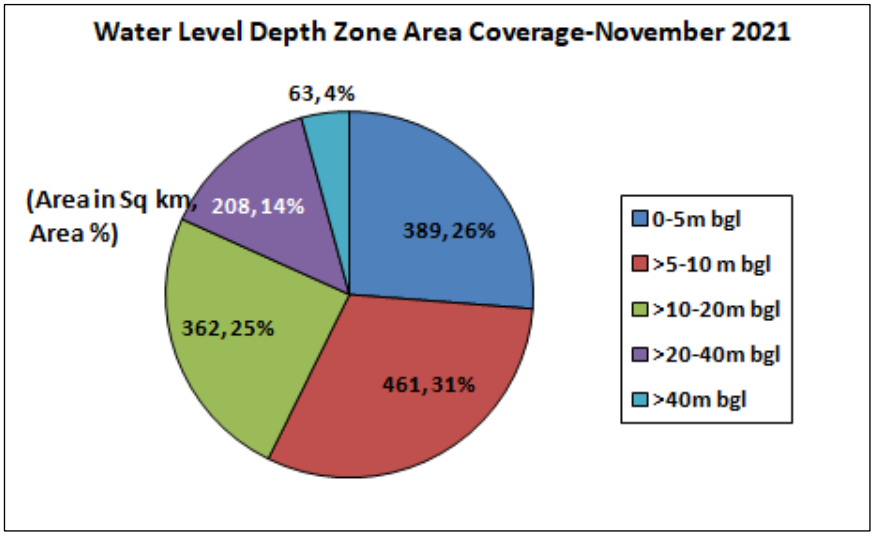


Fig.24



4.1.4. January 2022

The Depth to water level recorded in NCT Delhi during **January-2022** ranges from 0.6 mbgl at Hiran Kudna to 67.64mbgl at Jheel Khoh. A map showing January 2022 ground water levels in NCT of Delhi is given in Fig.25 and areas under various depth zones presented in Fig. 26. Around 24% of NCT Delhi, which falls in parts of North, North West and some small pockets of South East Central & Southwest districts have shallow water level up to 5 m bgl. Deep water levels of 20 to 68m bgl observed in around 19% of NCT Delhi, which falls in South, South East, New Delhi, West, North, East & South West districts. In rest of NCT Delhi, 57 % areas have water level in range of 5 to 20 m bgl.

Fig. 25

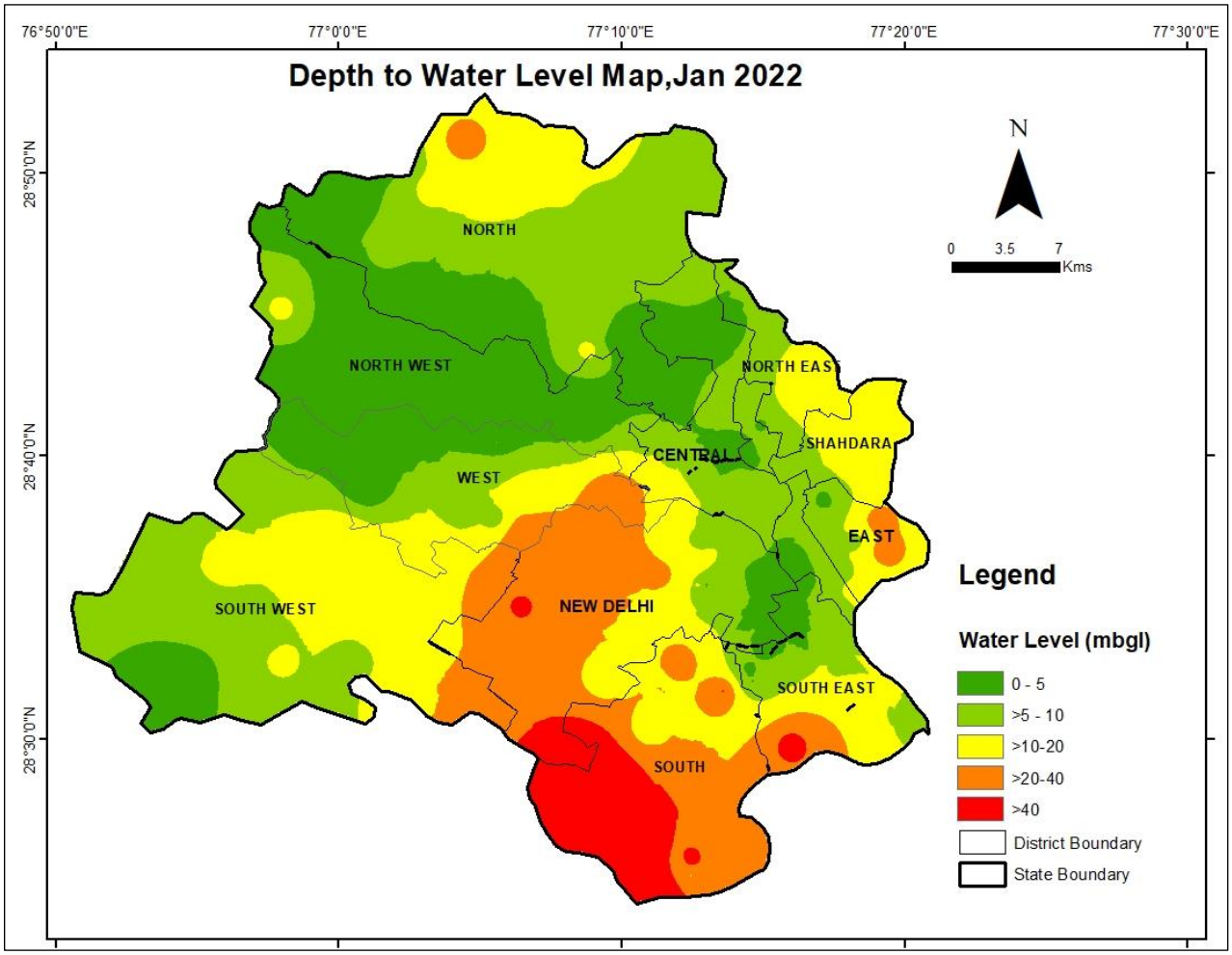
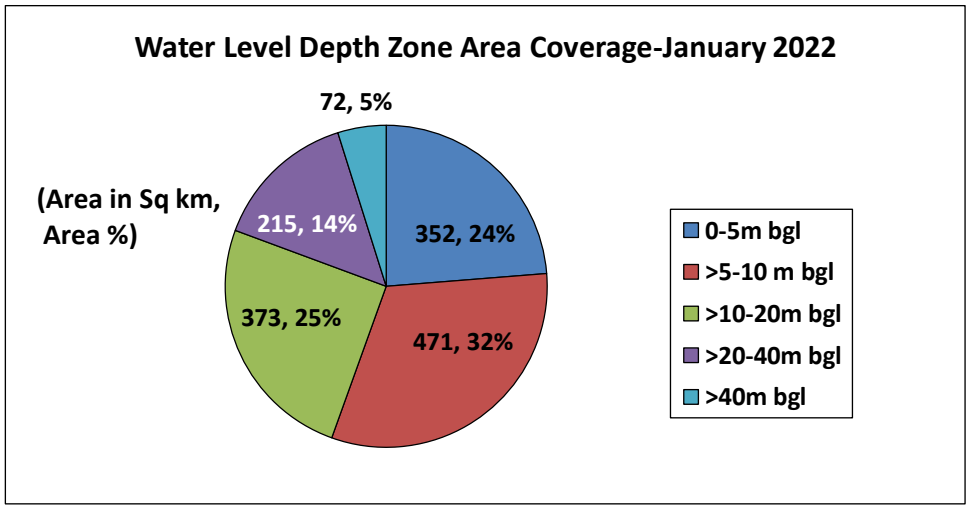


Fig. 26



4.2. Seasonal Water Level Fluctuation: 2021-22

The seasonal water level fluctuation, i.e. the changes in depth of water levels of August 21, November 21 and January 22 with respect to May 21 water level reveals the effect of subsequent utilization of groundwater for various needs like Industrial, Irrigation, Domestic etc., on overall groundwater regime of the area. Number of wells showing change in groundwater levels in the region over different periods is presented in Fig. 27 (a,b & c) and Table10.

Figure: 27 a

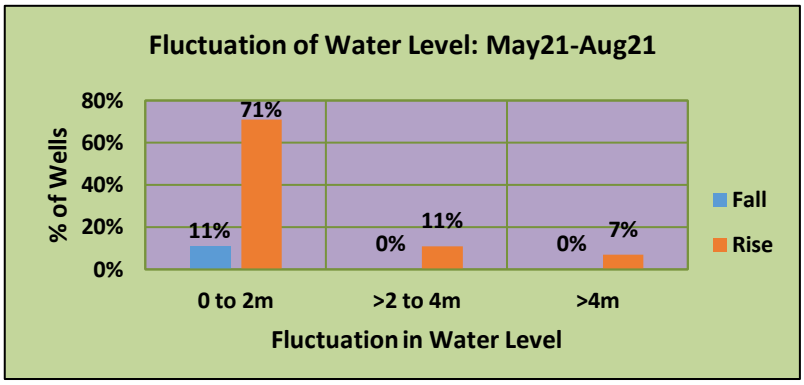


Figure 27b

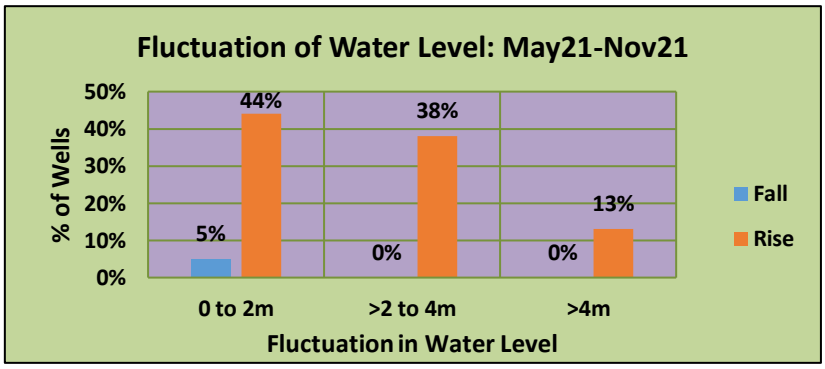


Figure: 27 c

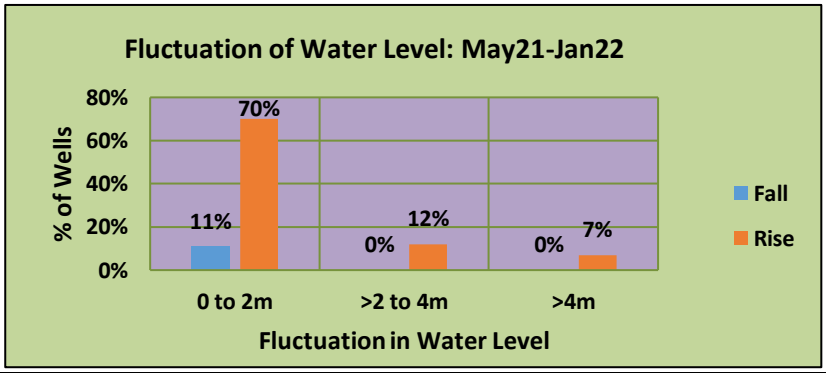


Table: 10 Monitoring Wells Showing Seasonal Fluctuation in Water Level

Water Level Fluctuation Range	May 21 -Aug 21		May 21-Nov 21		May 21 - Jan22	
	Rise	Fall	Rise	Fall	Rise	Fall
0 to 2 m	75	12	48	6	75	12
> 2 to 4 m	12	0	41	0	13	0
>4 m	7	0	14	0	7	0
Total	94	12	103	6	95	12
	106		109		107	

4.2.1. May 2021 to August 2021

A perusal of Fig. 27a and Table 11 reveals that comparing water levels of May 21 to August 21, total 94 (89%) of monitoring wells of the NCT Delhi show a rise in water level whereas rest 11% shows declining water level. The extent of rise and decline in water levels is shown in map presented in Fig. 28 and in pie chart (Fig.29).

Fig. 28

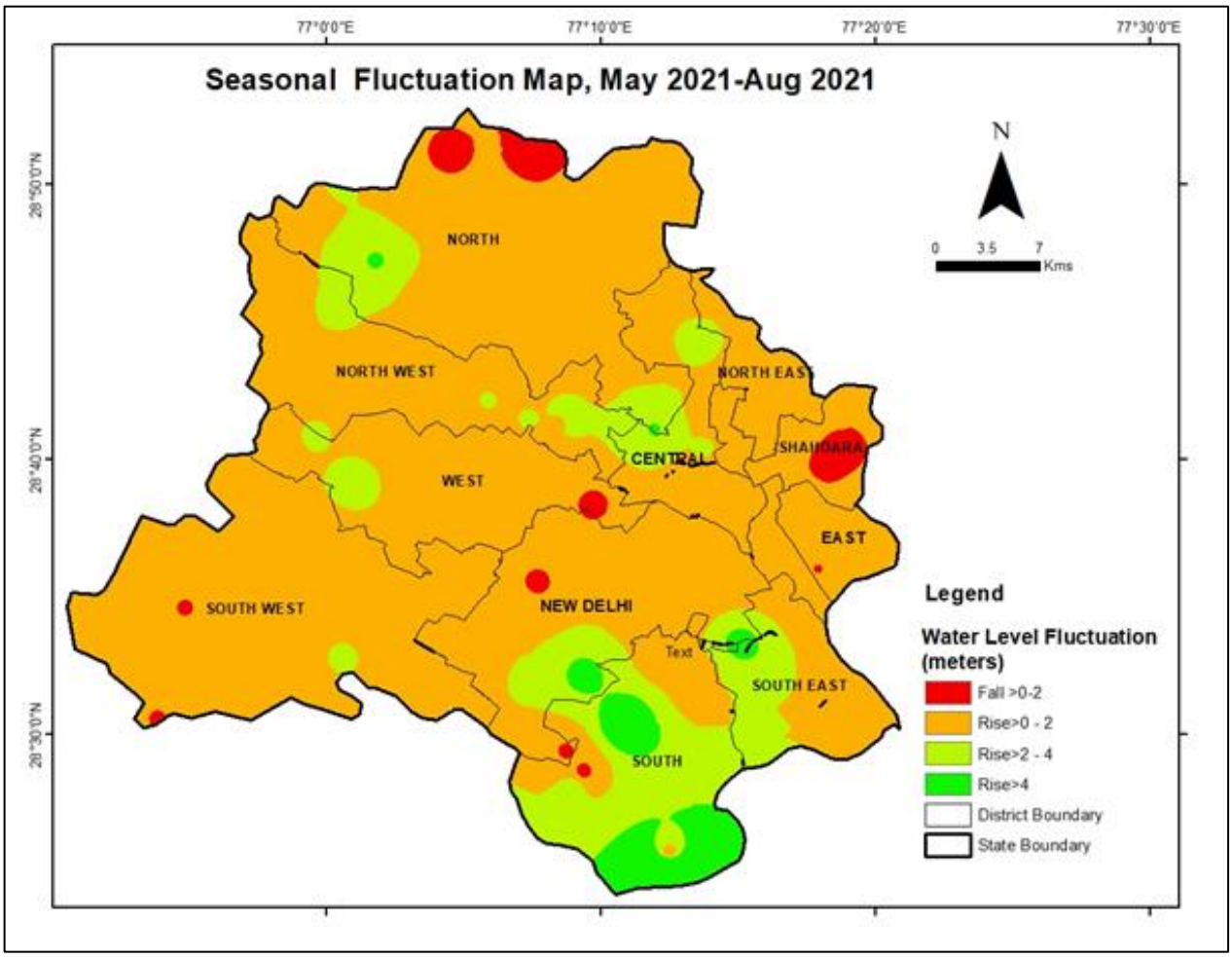
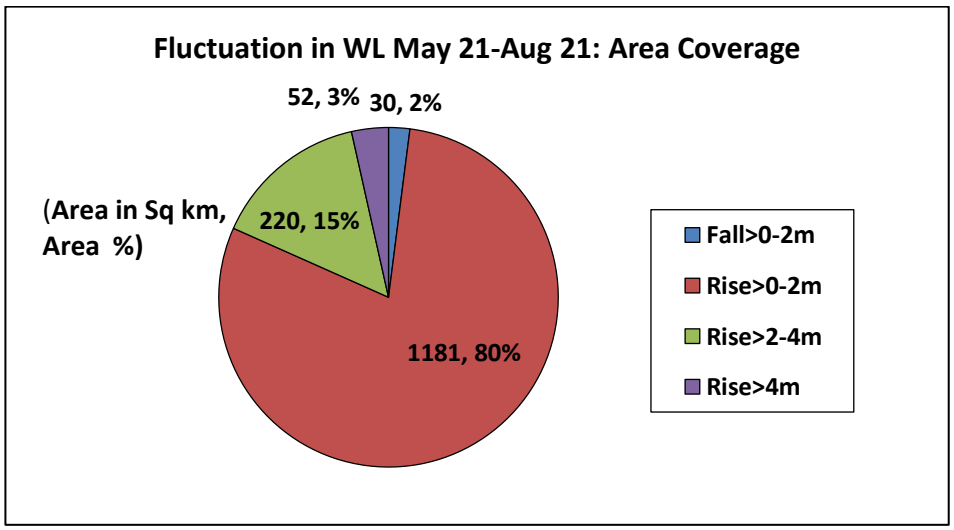


Fig. 29



4.2.2. May 2021 to November 2021 (Pre & Post Monsoon)

A perusal of Fig. 27(b) and Table 11 reveals that comparing water levels of May 21 to November 21, total 103(95%) of monitoring wells of the NCT Delhi show a rise in water level whereas rest 5% shows declining water level. The extent of rise and fall in water levels is shown in map presented in Fig. 30 and in pie chart (Fig. 31).

Fig. 30

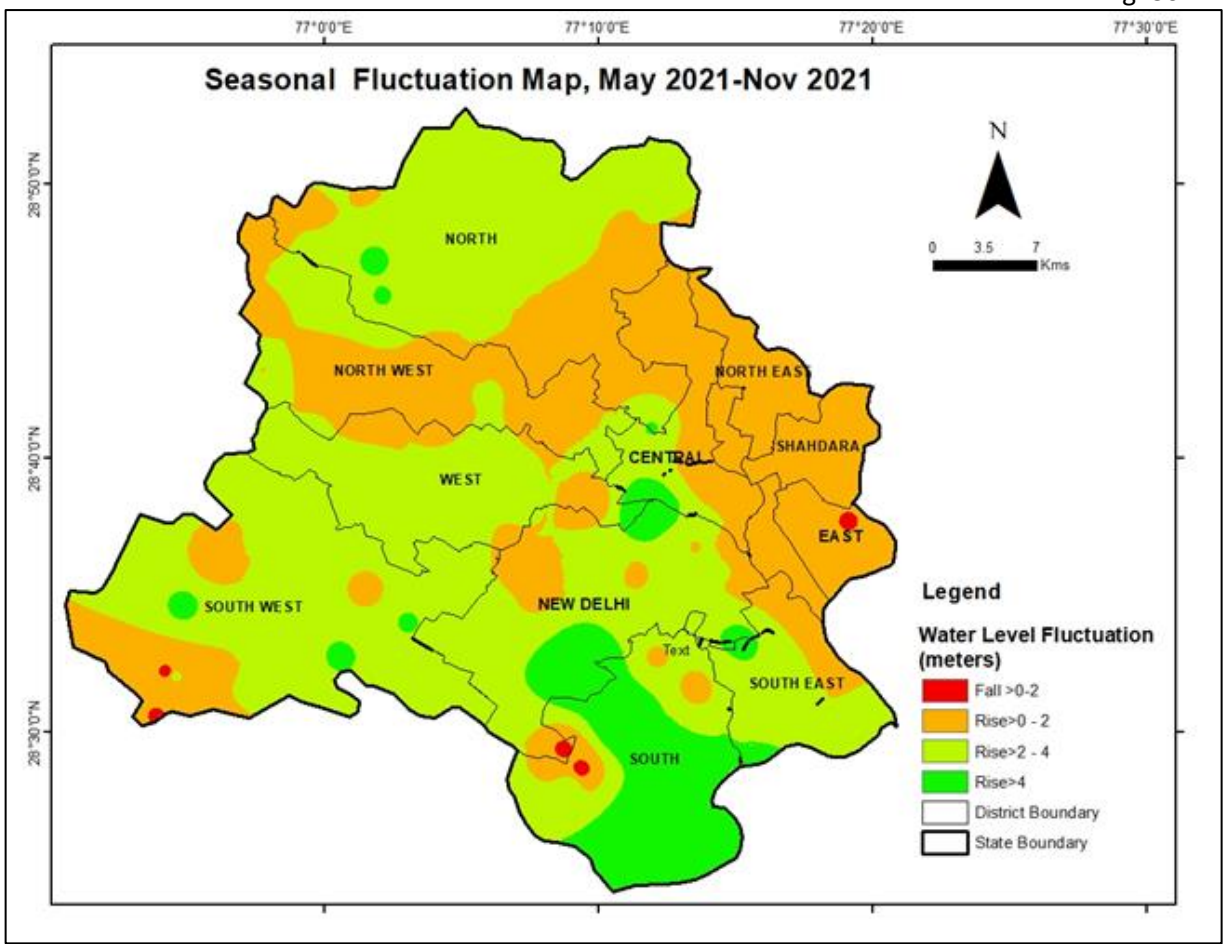
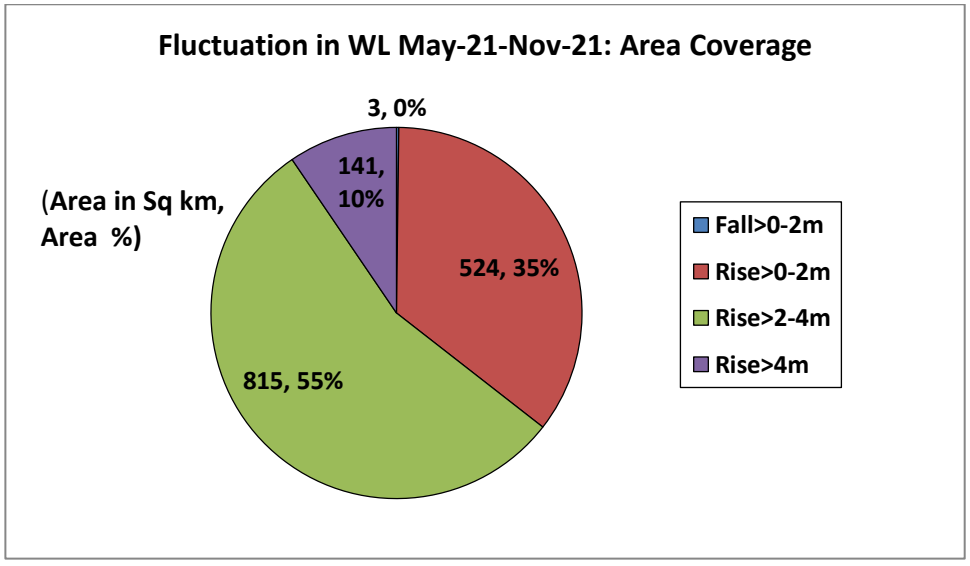


Fig. 31



4.2.3. May 2021 to January 2022

A perusal of Fig. 27(c) and Table 11 reveals that comparing water levels of May 21 to January 22, total 95 (89%) of monitoring wells of the NCT Delhi show a rise in water level whereas rest 11 % shows fall in water level. The extent of rise and fall in water levels is shown in map presented in Fig. 32 and in pie chart (Fig.33).

Fig. 32

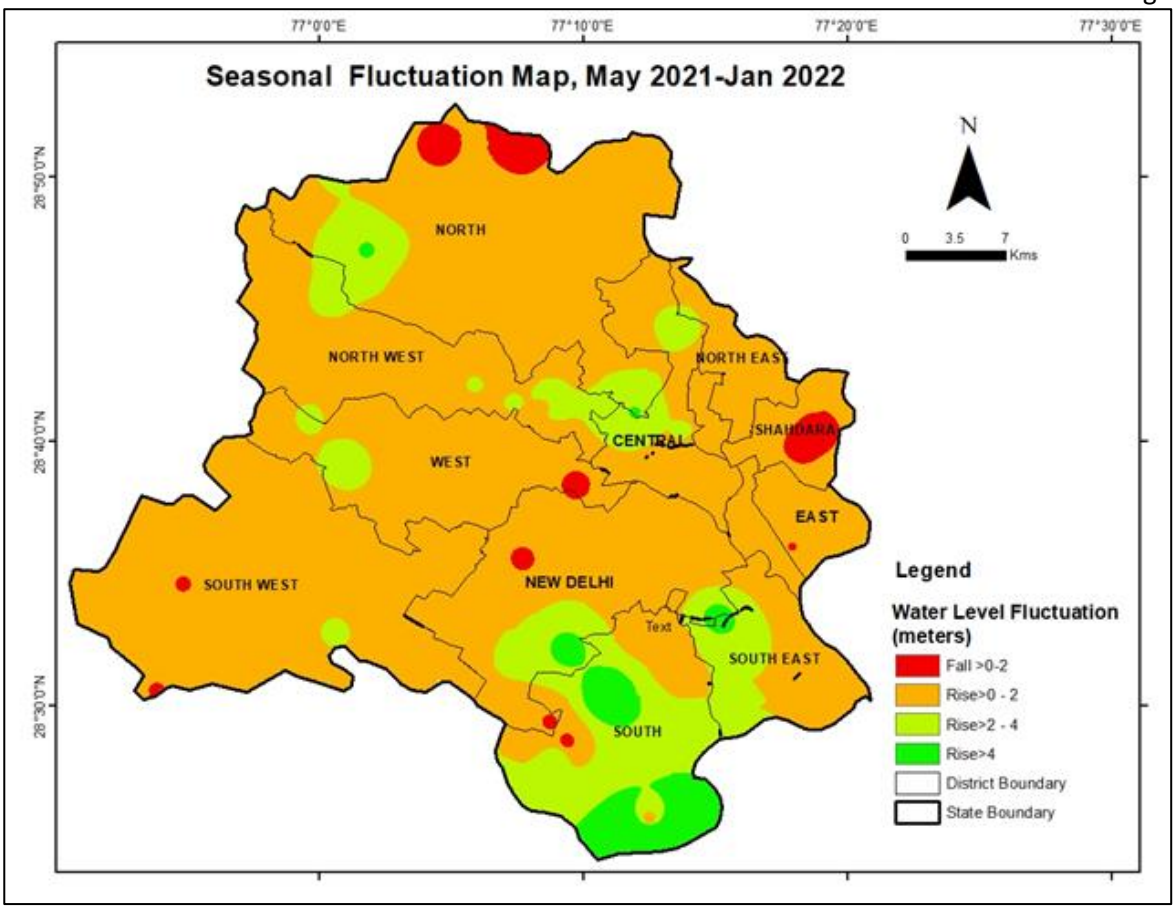
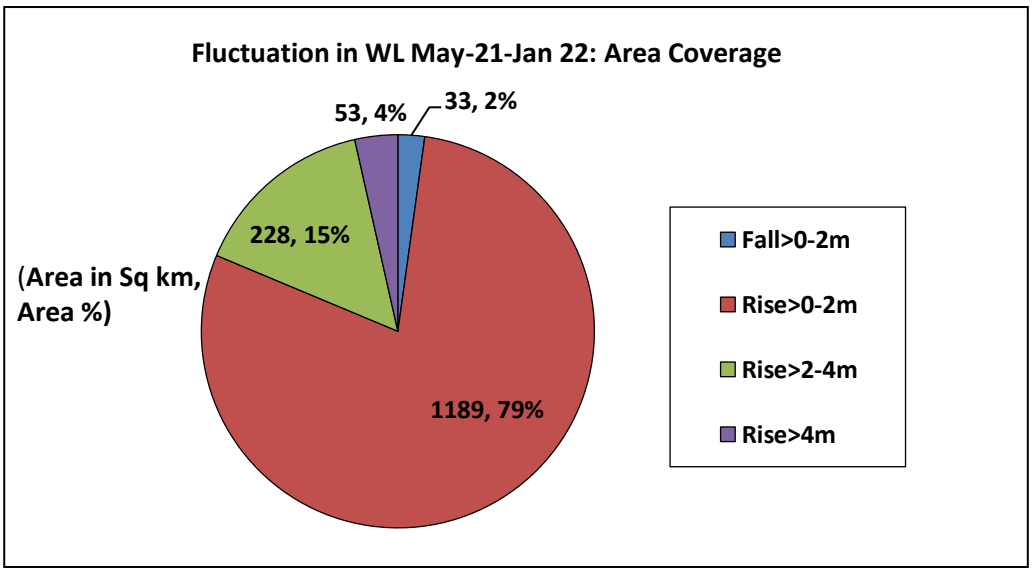


Fig. 33



4.3 Annual Water Level Fluctuation: 2021-2022

Annual Fluctuation in the water levels of the ground water monitoring wells during 2021-22 for different monitoring periods were compared with same period of 2020-21 and wells showing change in groundwater levels over different periods is presented in Fig. 34 (a,b,c & d) and Table 11.

Fig. 34(a)

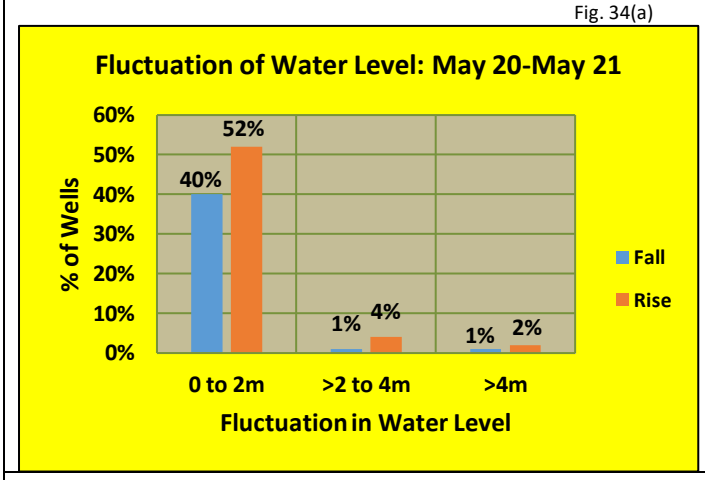


Fig. 34(b)

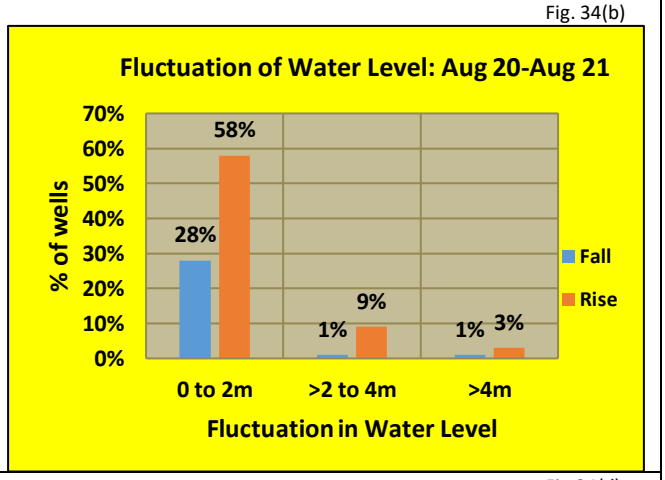


Fig. 34(c)

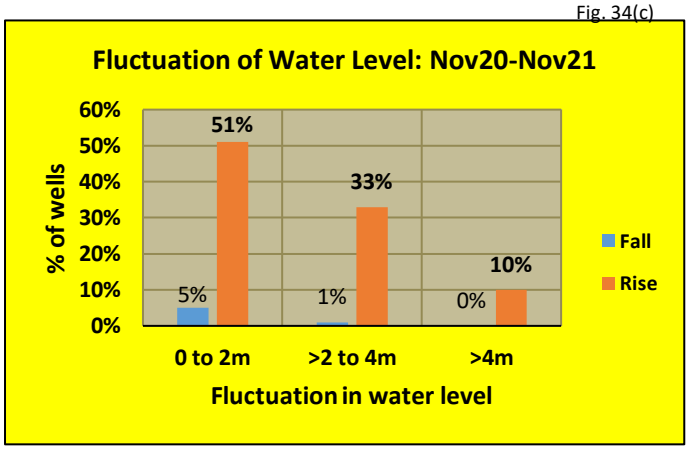


Fig.34(d)

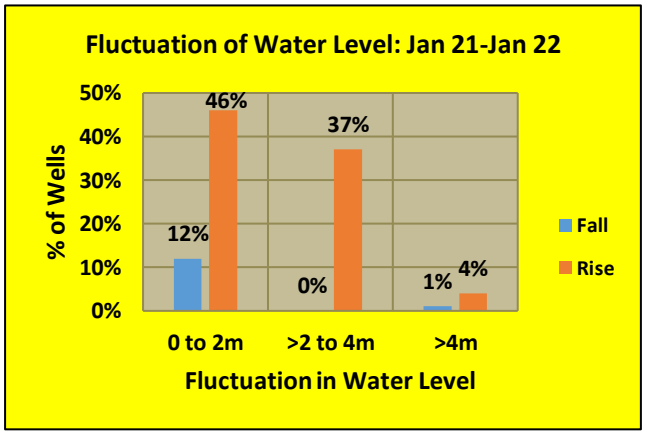


Table: 11 Monitoring wells showing Annual Fluctuation in Ground Water Level

WATER LEVEL FLUCTUATION	MAY 20-MAY 21		AUG 20- AUG 21		NOV 20-NOV 21		JAN 21-JAN 22	
	Rise	Fall	Rise	Fall	Rise	Fall	Rise	Fall
0 to 2 m	48	37	55	27	48	5	46	12
>2 to 4 m	4	1	8	1	31	1	37	0
>4 m	2	1	3	1	9	0	4	1
Total	54	39	66	29	88	6	87	13
	93		95		94		100	

4.3.1. Annual Fluctuation: May 2020 & May 2021

The fluctuation of water level between **May-2020** and **May-2021** of NCT Delhi shows that some part of New Delhi district and South district show a considerable rise of >4 m and rise >2-4m in water level whereas most of the state show water level rise between 0 m to 2m. Northeastern part of the state shows mostly fall in water level between 0 m to 2m.Nearly 66% of area of NCT Delhi shows rise in water level while 34 % of area shows fall in water level (Fig. 35)(Fig. 36).Out of all monitoring stations 42% shows fall in water level whereas 56% show rise in water level(Figure: 34(a)).

Fig.35

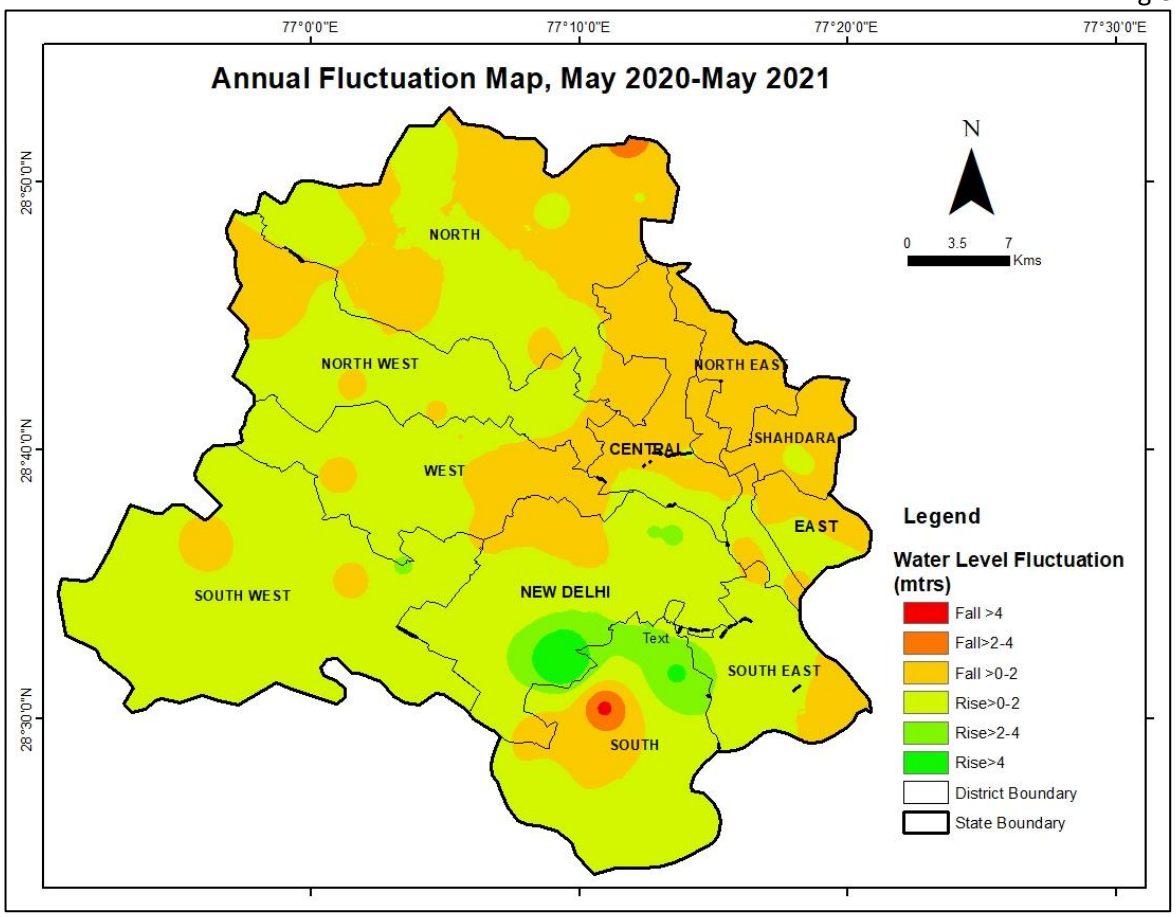
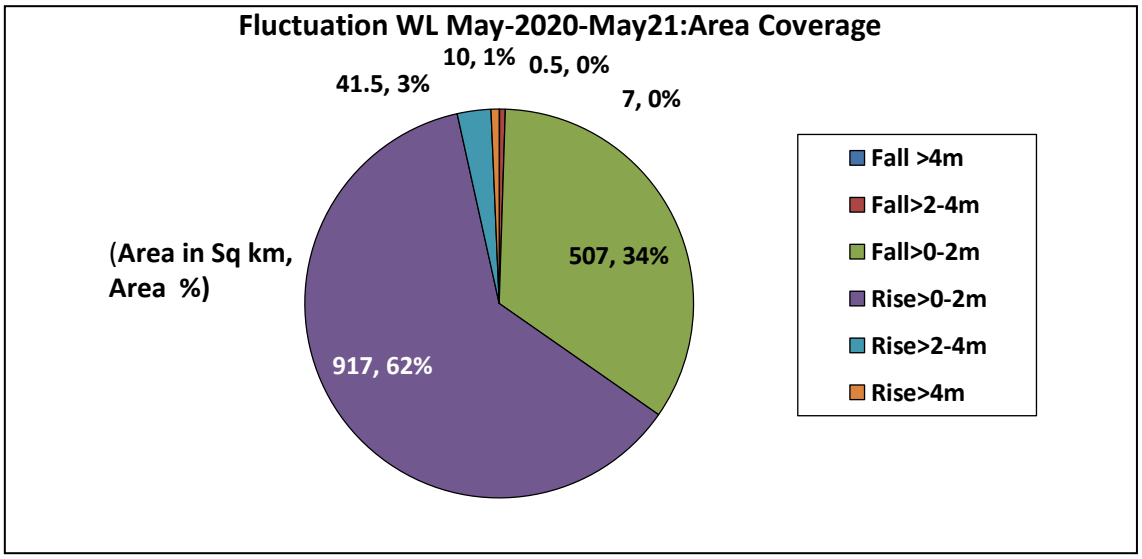


Fig.36



4.3.2. Annual Fluctuation: August 2020 & August 2021

The variation of water level between August-2020 and August-2021 reveals that 83% of area in NCT Delhi shows rise rest 17% of area shows fall(Fig. 37 & chart Fig. 38).Out of all monitoring stations 70% of wells shows rise in water level whereas 30% of wells shows fall in water level (Fig. 34(b)).

Fig. 37

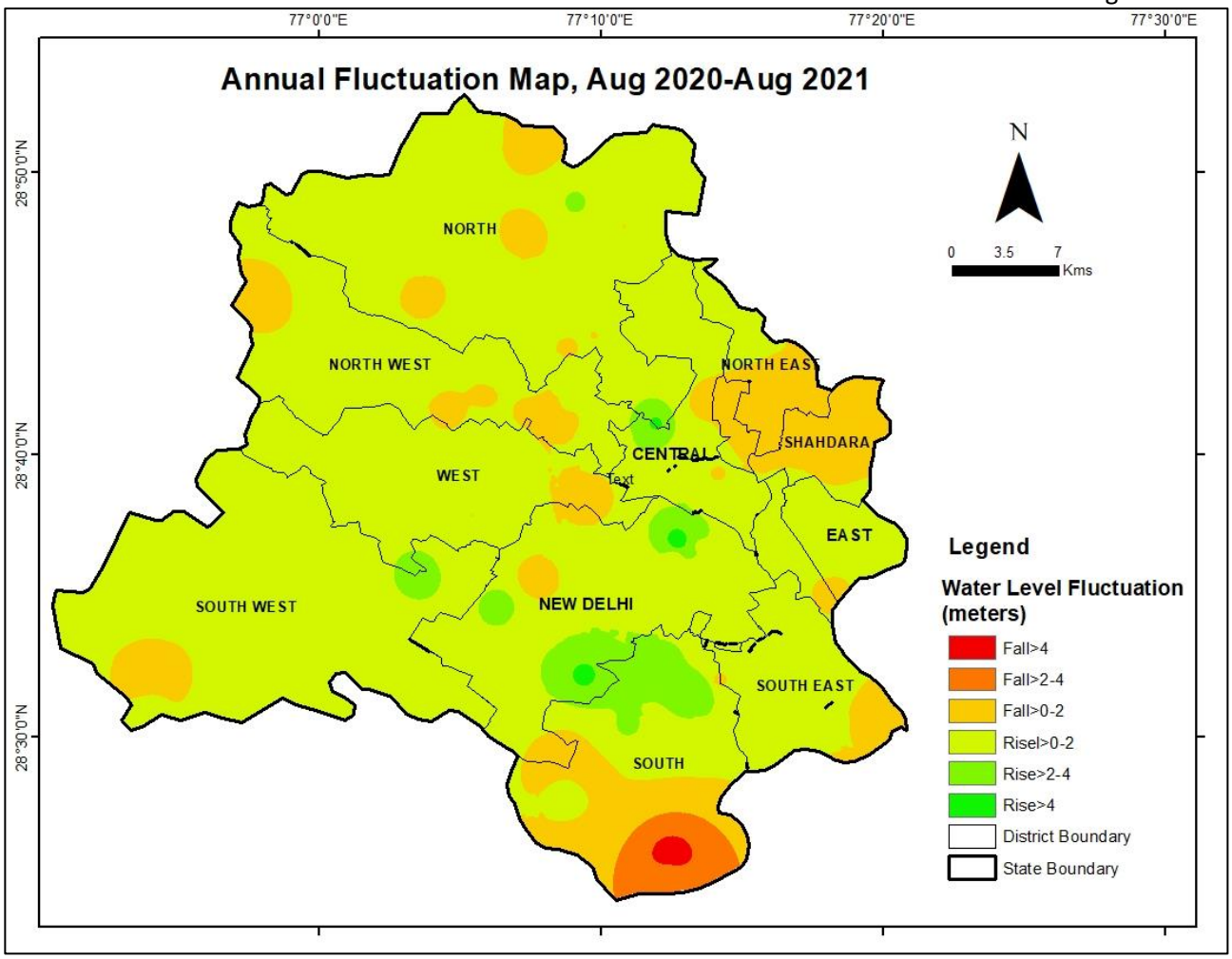
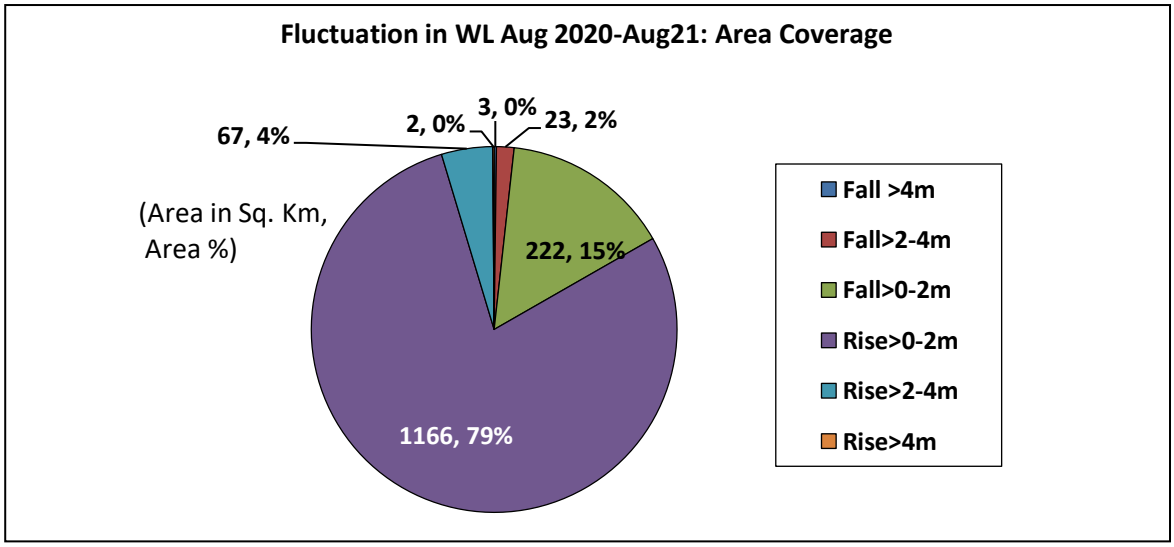


Fig. 38



4.3.3. Annual Fluctuation: November 2020 & November 2021

Comparing water level data of November 2020 to November 2021, it is revealed that 94% of monitoring stations show rise in water level. Rest 6% of monitoring stations shows fall in water level. Small pockets of East, New Delhi, South and South west districts show fall more than 2m (Fig. 34(c)). Nearly 49% of NCT Delhi areas show rise up to 2m while 1% of area shows fall in range of 0-2m, 50% of area shows rise more than 2m and 0% of area shows fall more than 2m (Fig. 39 & Fig. 40).

Fig.39

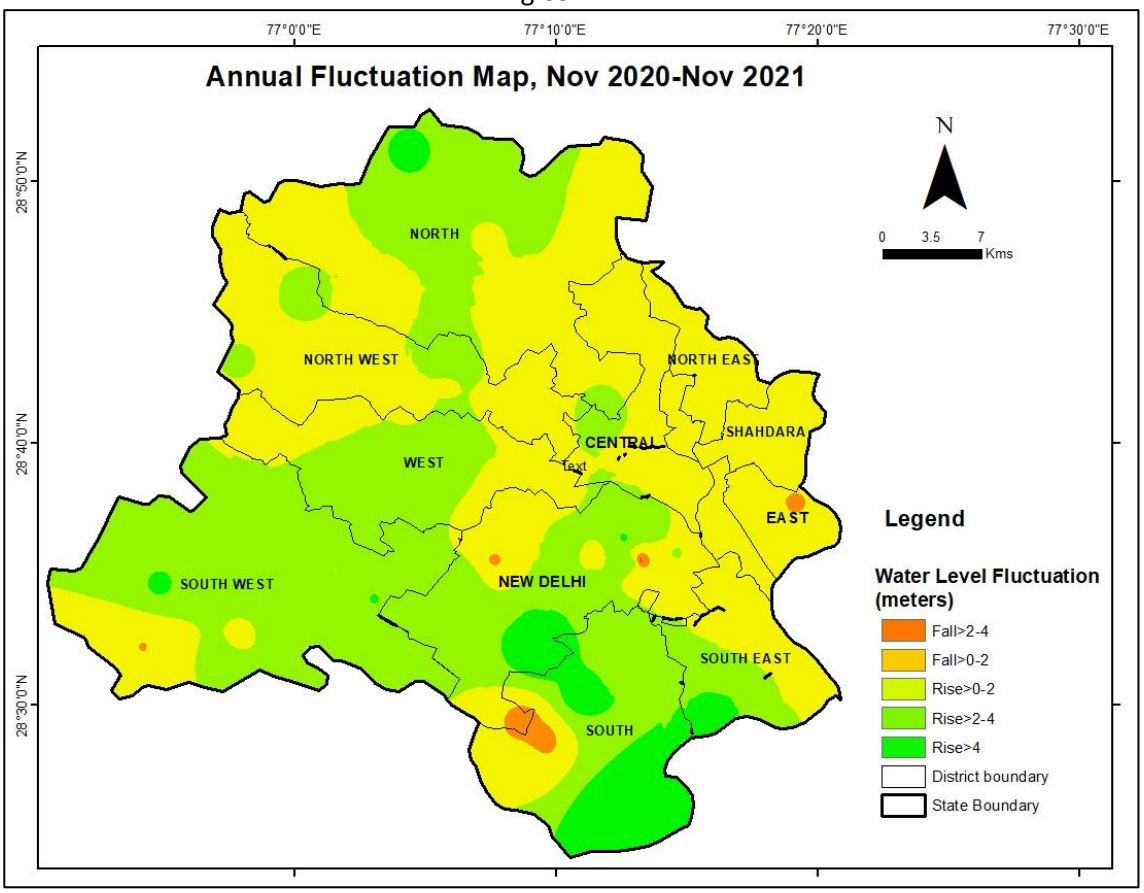
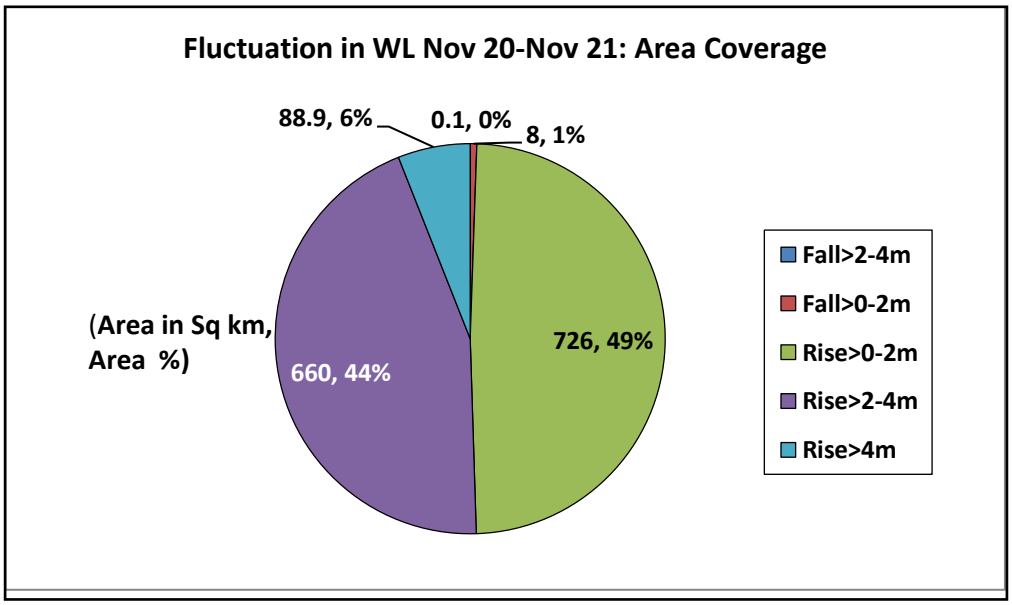


Fig. 40



4.3.4. Annual Fluctuation: January 2021 & January 2022

Comparing water level data of January 2021 to January 2022, it is revealed that 87% monitoring stations shows rise whereas rest 13% of monitoring stations show fall (Fig. 34(d)).Nearly 58% of areas show rise up to 2m, 2% area shows fall in range of 0-2m while 0% area has fall more than 2m and 40% area has risen more than 2m (Fig. 41) & (Fig. 42).

Fig. 41

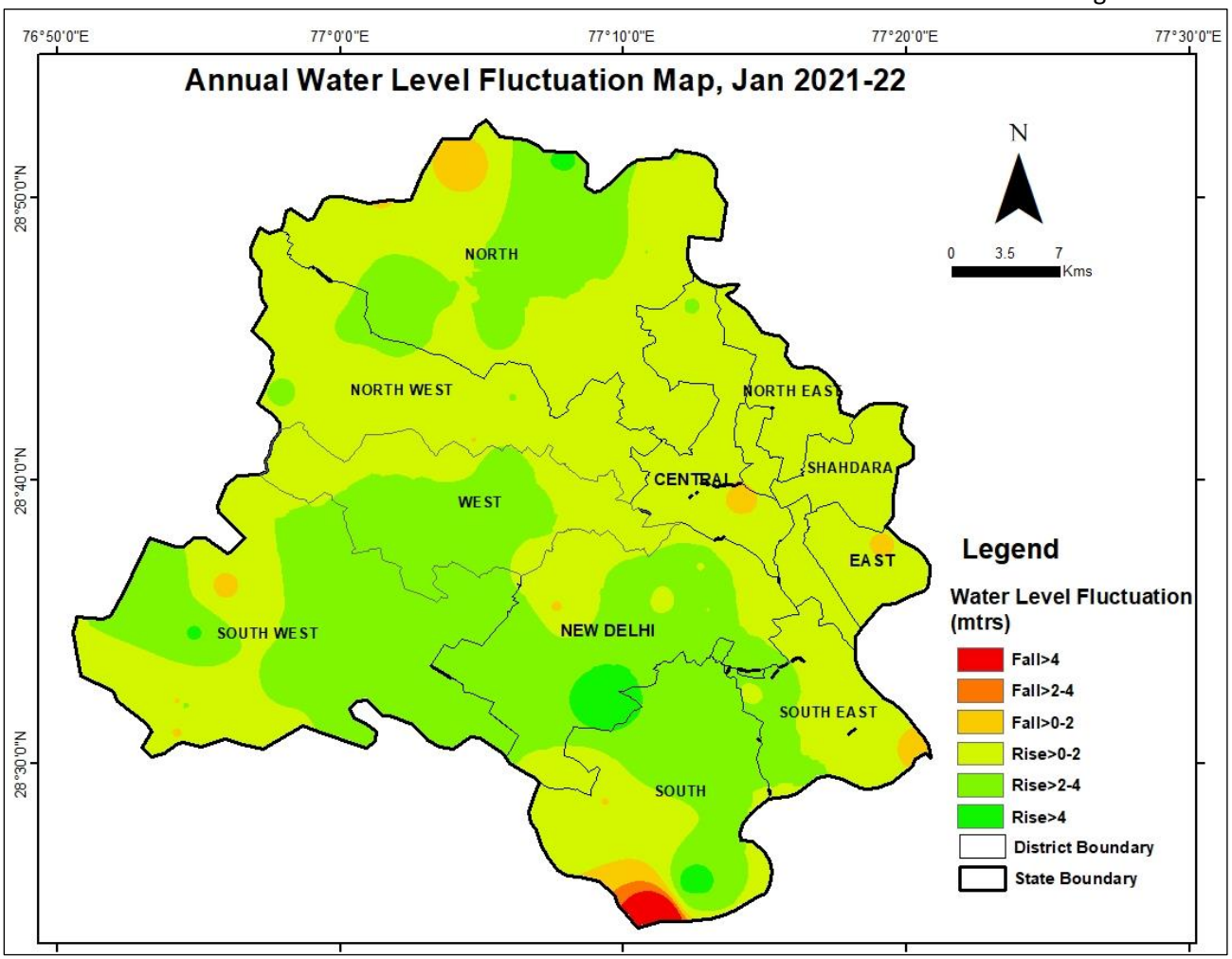
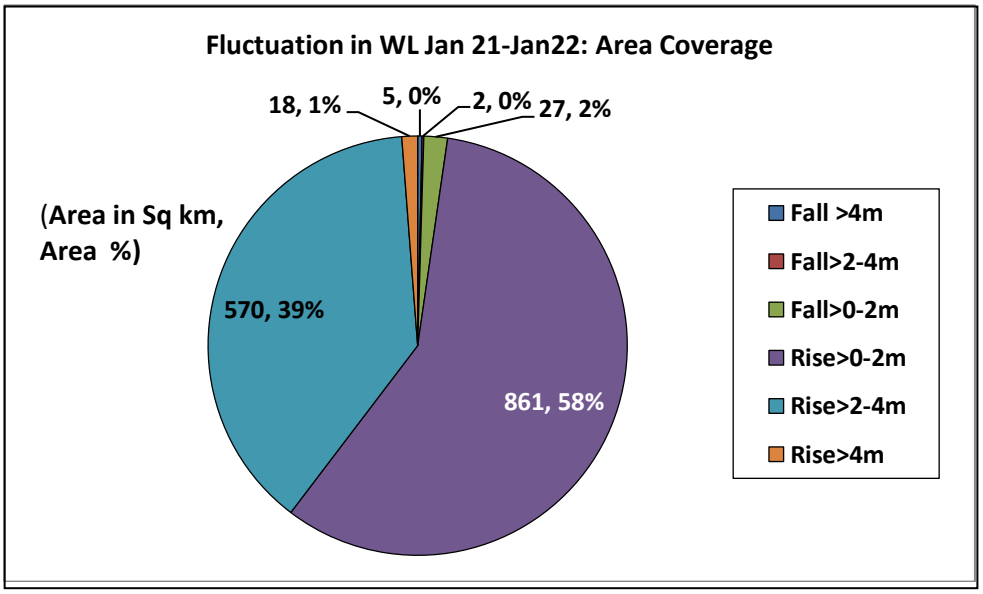


Fig. 42



4.4 Long Term Ground Water Scenario

Long-term behavior of water levels was studied by analyzing water level change of decadal mean water levels data of 2011-20 for May, August & November and 2012-21 decade for January month with corresponding water level data of 2021-22. Statistical analysis of numbers of monitoring wells and range of water levels showing decadal change is presented as charts in Fig. 43 (a, b, c & d) and in Table 13. The decadal water level mean data and fluctuation data is given in Annexure III(B) and Annexure V(A), V(B) respectively.

Fig.43(a)

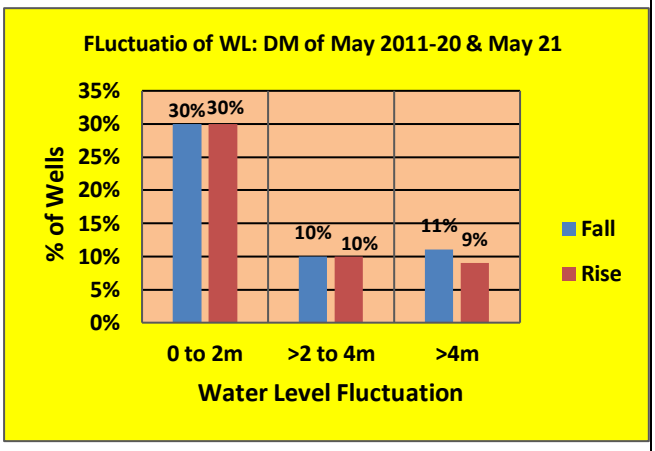


Fig.43(b)

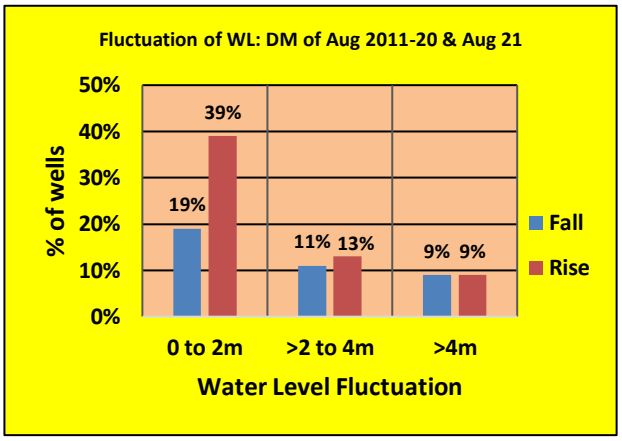


Fig.43(c)

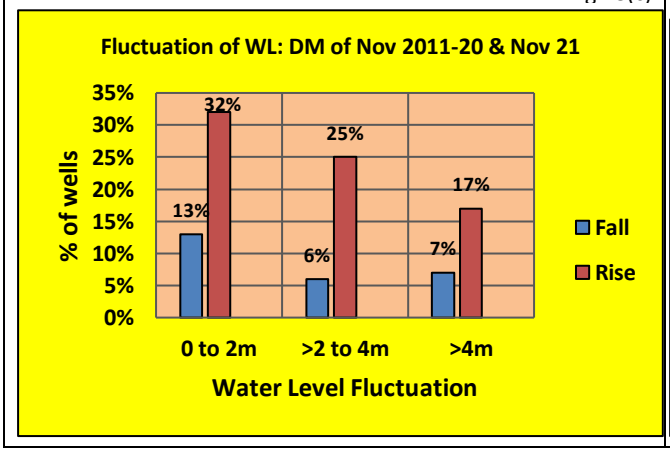


Fig.43(d)

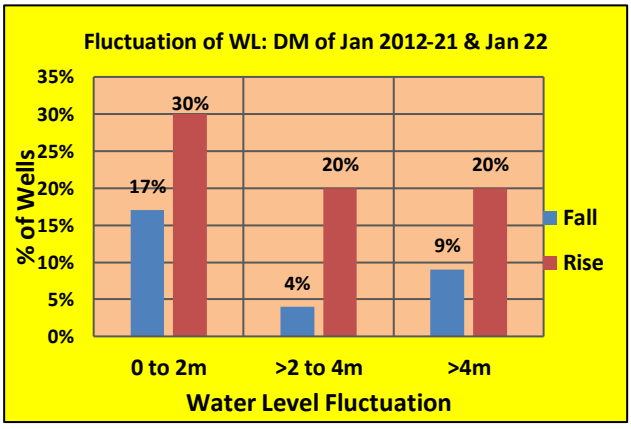


Table:12 monitoring wells showing change in water levels comparing with decadal mean

Water Level Fluctuation Range	DM of May 2011-20 &may 21		DM of Aug 2011-20 & Aug 21		DM of Nov 2011-20 & Nov 21		DM of Jan 2012-21 & Jan 22	
	Rise	Fall	Rise	Fall	Rise	Fall	Rise	Fall
0 to 2 m	25	25	31	15	27	11	24	13
> 2 to 4 m	8	8	11	9	21	5	16	3
>4 m	8	9	7	7	15	6	16	7
Total	41	42	49	31	63	22	56	23
	83		80		85		79	

Maps showing change in water level scenario over May, August, November and January for year 2021-22 with decadal mean of May, August & November for 2011-20 and January 2012-21 respectively are presented in figure 44, 46, 48 and 50 and pie diagrams showing areas under different ranges of water level change are presented in Fig. 45, 47, 49 and 51 respectively for month corresponding May, August, November and January of 2021-22.

4.4.1. Decadal Fluctuation: (DM of May 2011-20 & May 2021)

Comparing water level data of May-2021 with 10 year mean water level of May (2011 to 2020), the change in water level ranges from -7.83 m to 17.24 m. Nearly 51 % of monitoring wells show fall in water level of May 2021 when comparing decadal mean of May water level of 2011-20, whereas rest 49 % wells show rise in water levels(Fig. 43a). The rise mainly confined to western parts of South-West, West, North West and some parts New Delhi, Central, South, Central and South East (Fig. 44). Nearly 36% areas show fall up to 2 m, 13% more than 2m. Similarly rise up to 2m is recorded in 38% areas, 6% areas show rise in range 2 to 4 m and 7% of areas show more than 4 m. Chart showing extent of areas having change in rise and fall, computed from map grid, is presented in Fig. 44 & 45.

Fig. 44

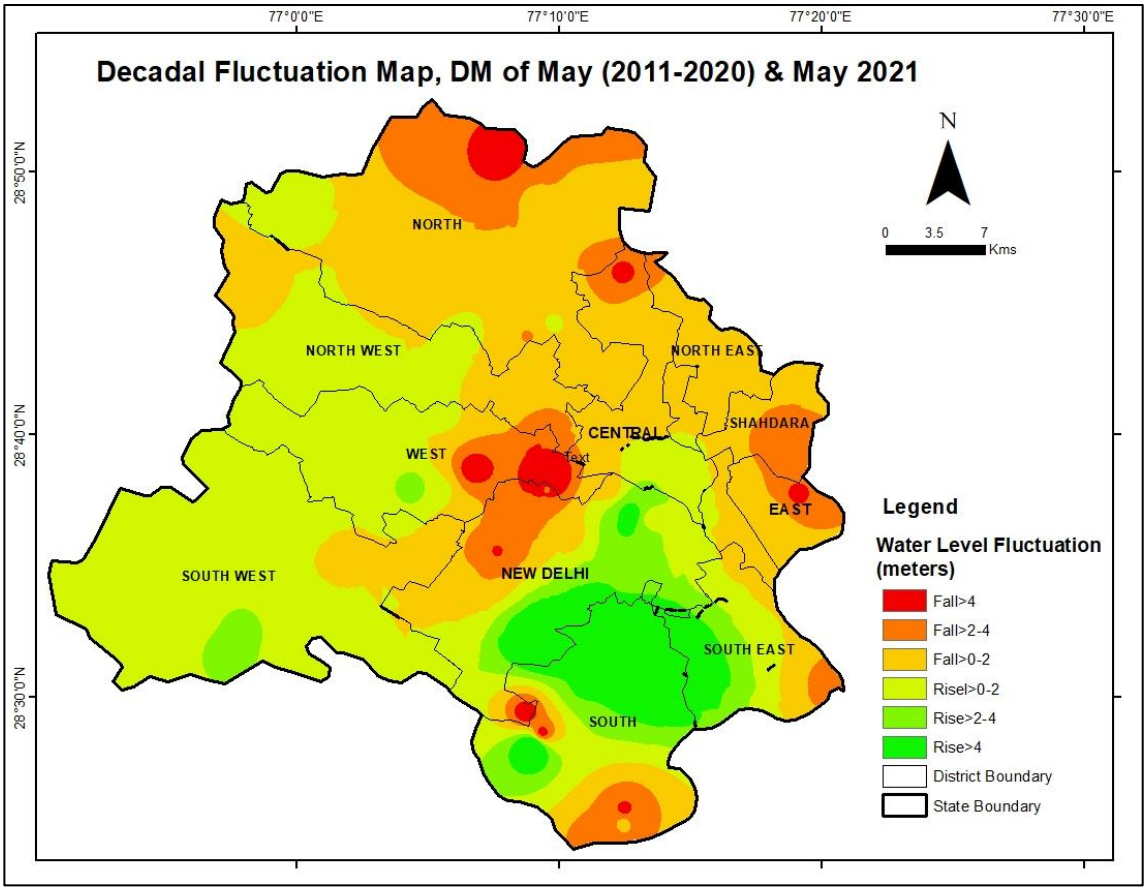
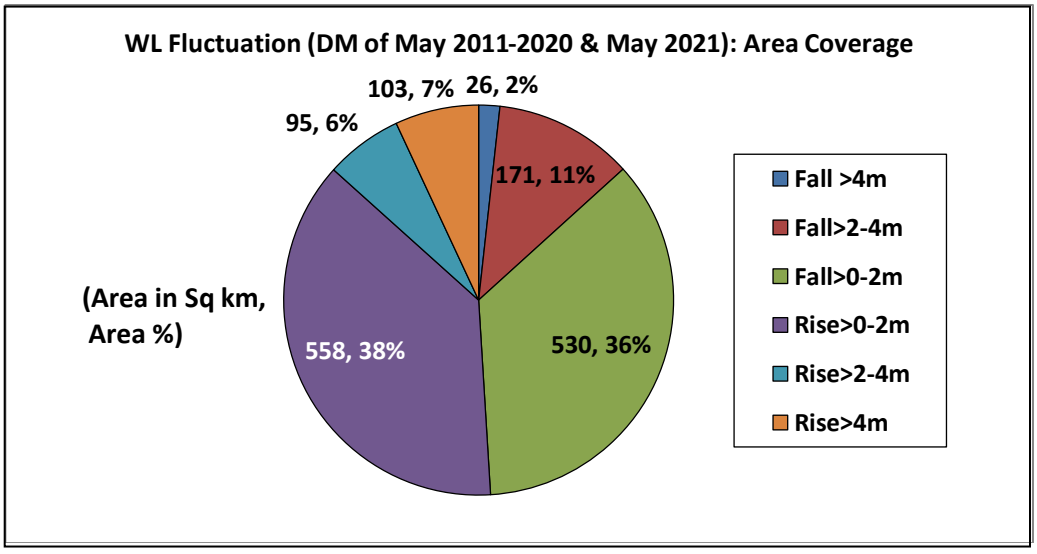


Fig. 45



4.4.2. Decadal Fluctuation: (DM of August 2011-20 & August 2021)

Comparing water level data of August-2021 with 10 year mean water level of August (2011 to 2020), the change in water ranges from –8.26 m to 16.76 m. Nearly 61 % of monitoring wells show rise in water level of August 2021, comparing decadal mean of August water level of 2011-20, whereas rest 39% monitoring wells show fall in water level(fig. 43b). The rise mainly confined to some parts of western and Southern Delhi (Fig. 46). Nearly 46% areas show rise up to 2 m, 16% of areas show more than 2m. Similarly fall up to 2 m is recorded in 30% areas and 8% in the areas above 2m. Chart showing extent of areas having change in rise and fall, computed from map grid is presented in Fig. 47.

Fig. 46

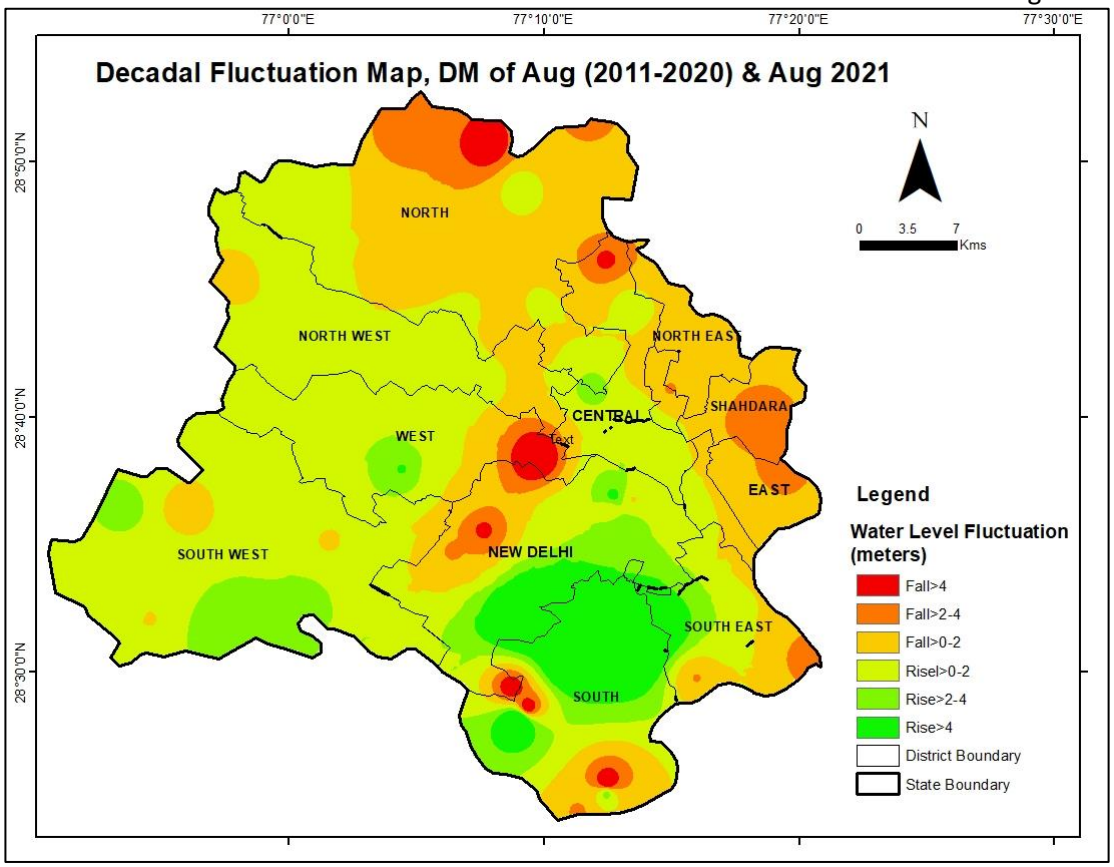
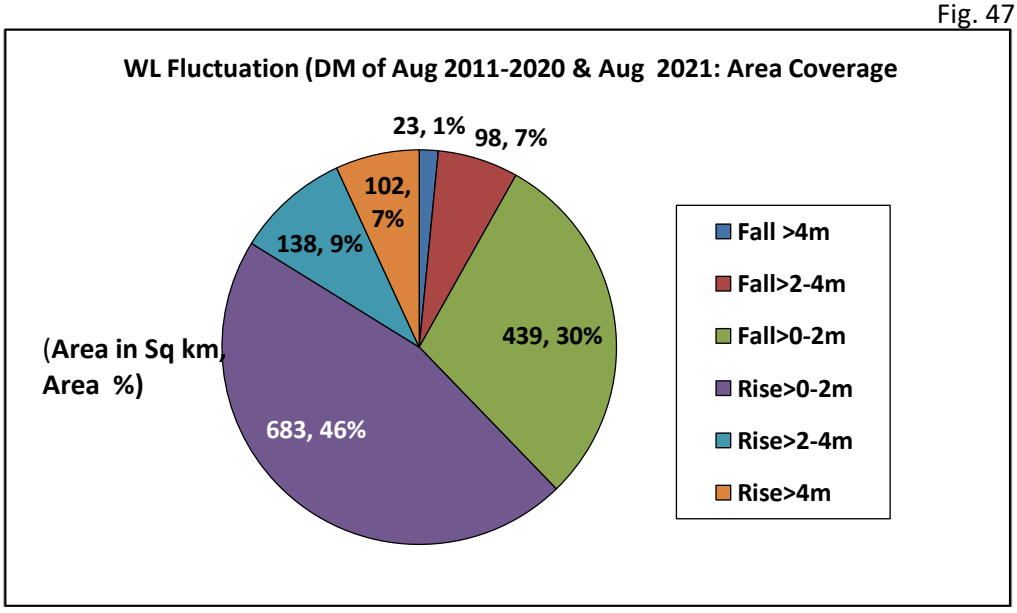


Fig. 47



4.4.3. Decadal Fluctuation: DM of Nov 2011-20 & Nov 2021

Comparing water level data of November-2021 with 10 year mean water level of November (2011 to 2020), the change in water level ranges from -9.44 m to 20.07 m. Nearly 74% of monitoring wells show in rise of water level of November 2021, comparing decadal mean of November water level of 2011-20, whereas rest 26 % monitoring wells show fall of water level (Fig. 43c). This rise shows most of the state except eastern part of the state and small patches of West, New Delhi, South and North Districts (Fig. 48). Nearly 12% areas show fall up to 2 m, 6% area 2 to 4 m and 2% area more than 4m. Similarly rise up to 2 m is recorded in 39% area and 43% area shows rise more than 2m. Chart showing extent of areas having change in rise and fall, computed from map grid, is presented in Fig. 49.

Fig. 48

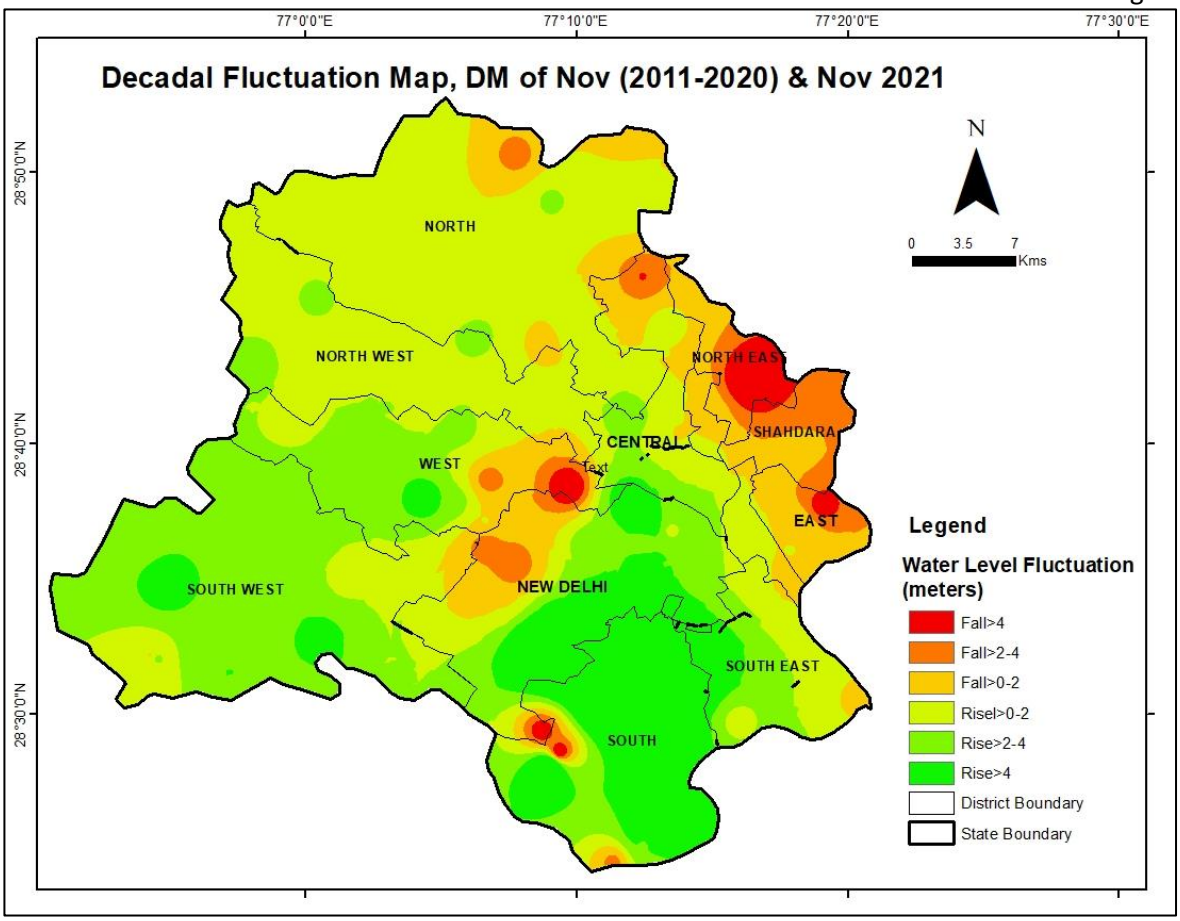
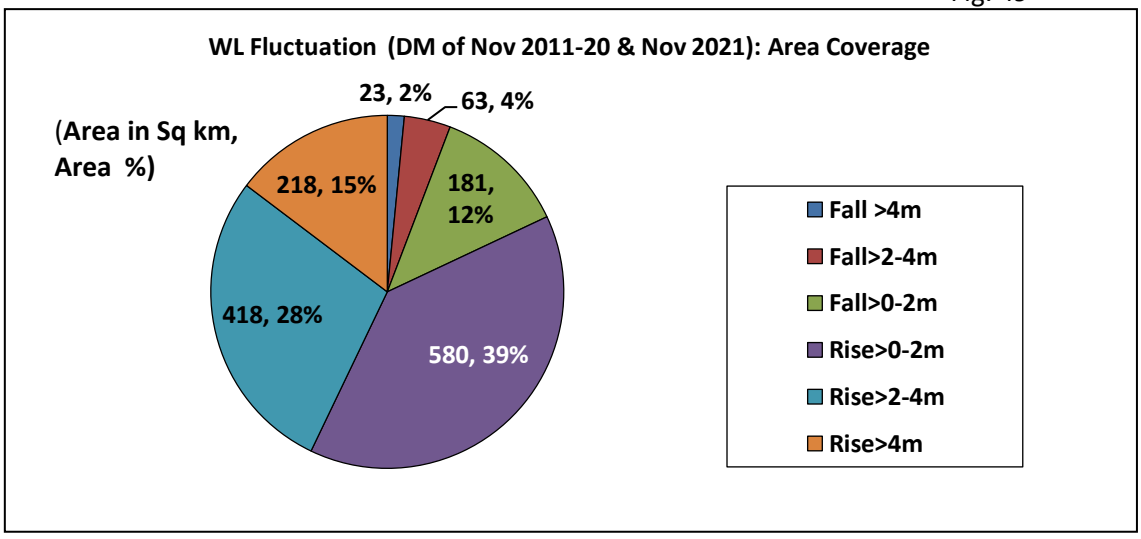


Fig. 49



4.4.4. Decadal Fluctuation: DM of January 2012–21 & January 2022

Comparing water level data of January-2022 with 10 year mean water level of January (2012 to 2021), the change in water level ranges from –16.11m to 18.61m. Nearly 70% of monitoring wells show rise whereas rest 30% monitoring wells shows fall (Fig. 43d). This rise mainly confined to western half of NCT Delhi covering parts of Southwest, West, Northwest and North districts. Similarly, parts of Southeast, South, Central and New Delhi districts also shows rise (Fig. 50). Nearly 20% areas show fall up to 2 m, 7% more than 2m. Similarly rise up to 2m is recorded in 31% area and 42% area shows rise more than 2m. Chart showing extent of areas having change in rise and fall, computed from map grid, is presented in Fig. 51.

Fig. 50

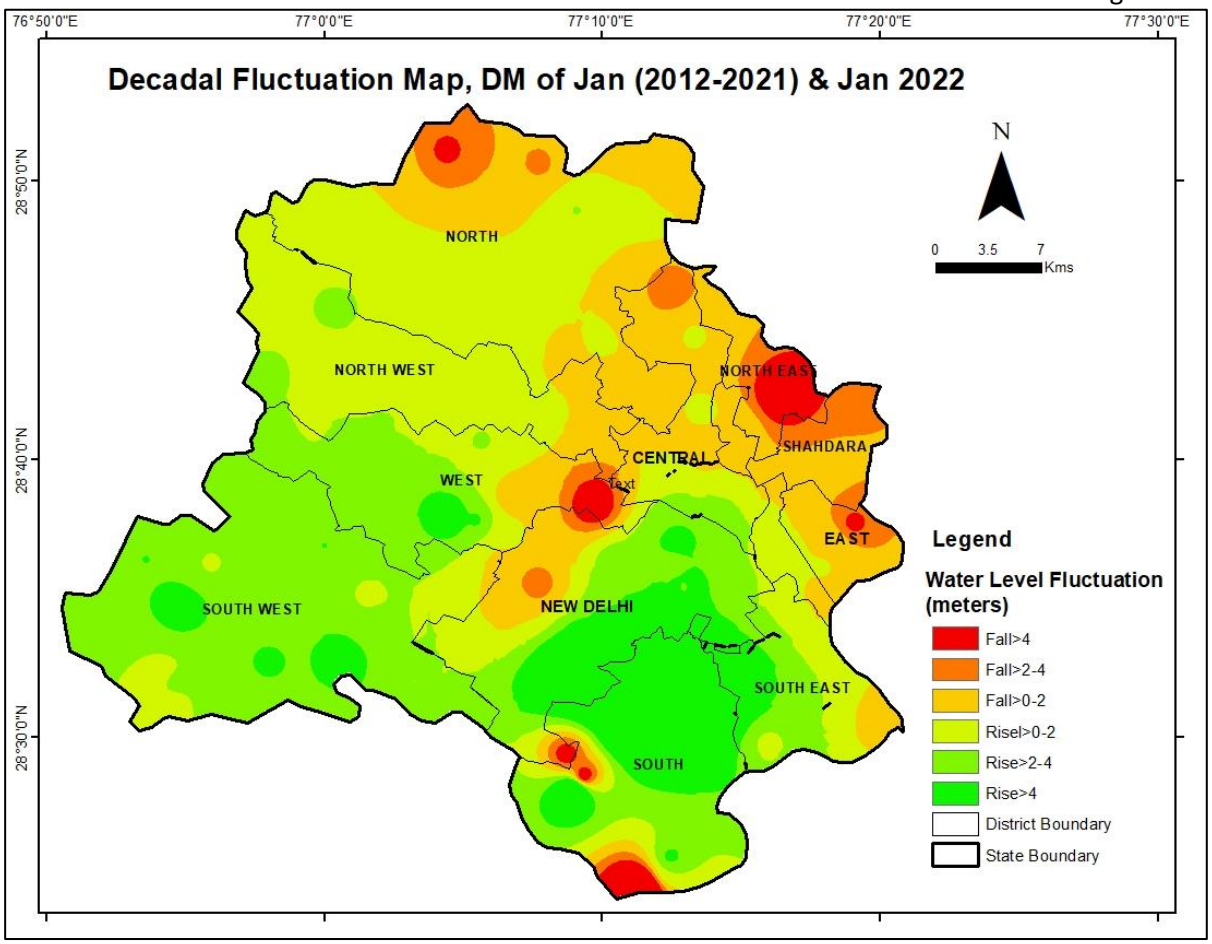
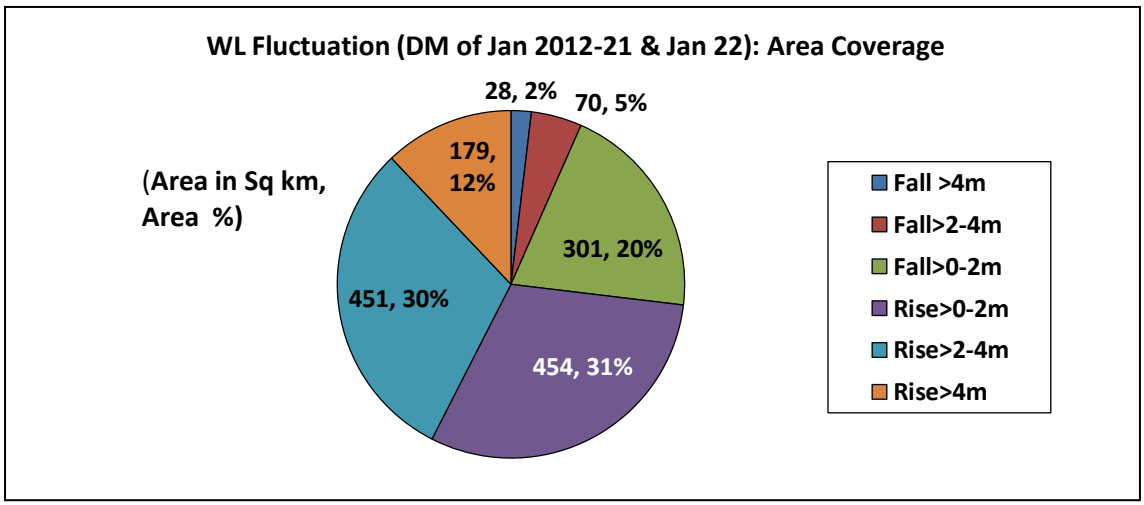


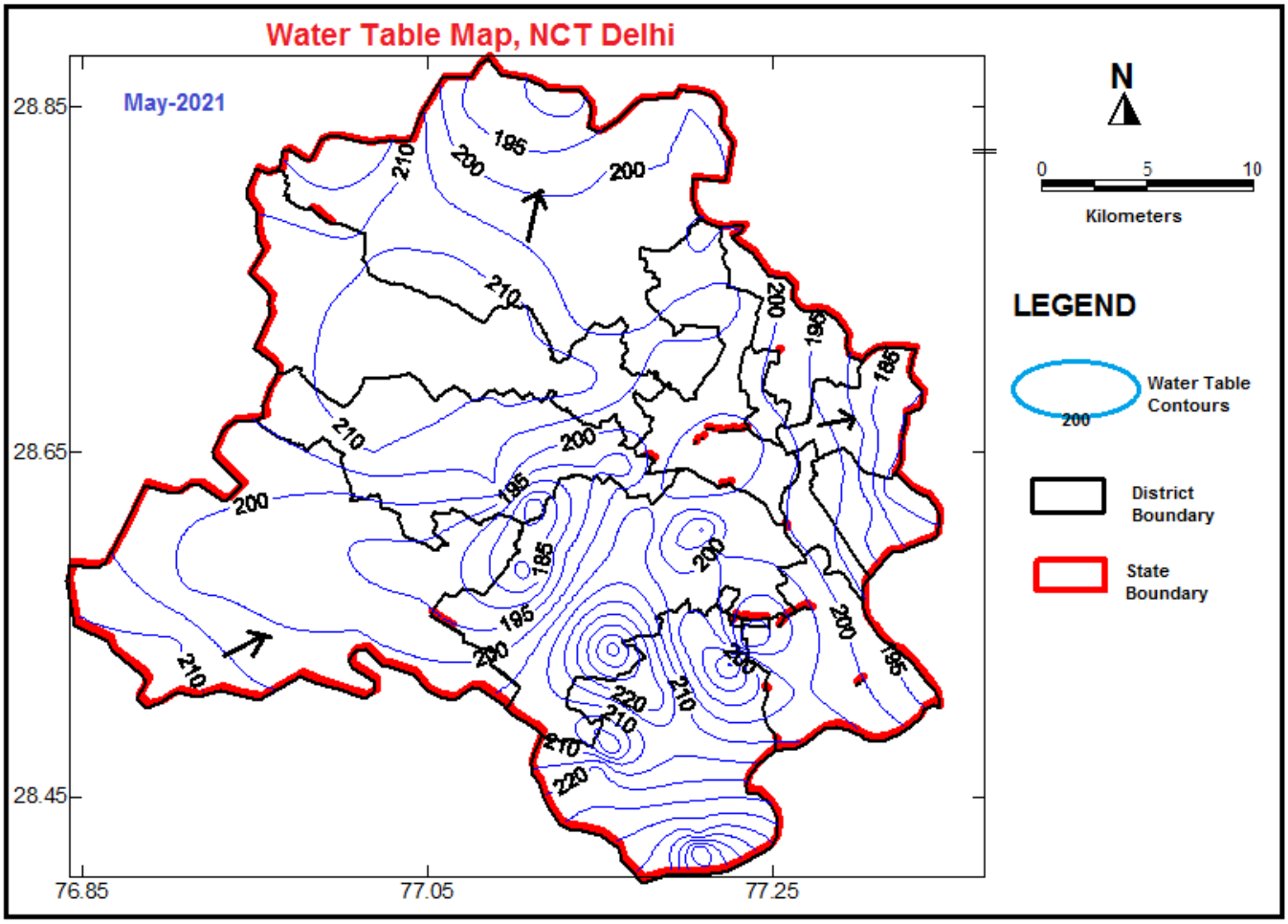
Fig. 51



4.5 Water Table Scenario

Water table contour map of May 2021 is presented in Fig. 52. The perusal of the map shows that the water table elevation ranges from 175.74m amsl at Mayapuri in Rajouri Garden Tehsil to 261m amsl at Balbir Nagar in Saket tehsil in south part of NCT Delhi. Aravalli Ridge areas is main recharge zones for NCT Delhi. In these areas water table ranges from 210 to 240 m amsl. Closely spaced contours on the eastern side of the ridge indicate steep gradient and high rate of flow of ground water, while widely spaced contours on the western side of the ridge indicate gentle gradient. Two trough of lowest water table observed indicate high development of groundwater; one is around Pushp Vihar in Hauz Khas tehsil and another is in Chanakyapuri tehsil. In remain part of NCT Delhi, water table contour follows general topography of the areas. Yamuna river flood zone shows water table in range of 185 to 200 m amsl. Major parts of Yamuna flood zone in NCT of Delhi, on either bank, water table configuration indicate influent nature of river Yamuna while in small section passing through South East district it shows effluent nature on right bank, however left bank area, bordering Uttar Pradesh it shows influent nature.

Fig. 52



5. DEEP AQUIFERS IN NCT, DELHI

5.1 Depth to Water Level

In NCT of Delhi, five no. of monitoring wells are used to monitor deep aquifer systems for all four monitoring periods of year 2021-22 (May, August, November & January,) (Annexure-IIIA).The monitoring wells are namely 1) Bakoli Deep Pz 2) Lodhi Garden Deep 3) Tiggipur Deep 4) Shikarpur Deep 5) CVD Depot Cant (deep).

5.1.1 May 2021

The depth to water level of deeper aquifers in NCT Delhi during May-2021 was 12.38m bgl at Bakoli Deep Pz, 9.86m bgl at Tiggipur deep, 6.13m bgl at Lodhi Garden Deep and 8.72m bgl at Shikarpur Deep.

5.1.2 August 2021

The depth to water level of deeper aquifers in NCT Delhi during August-2021 was 10.79m bgl at Bakoli Deep Pz, 9.18m bgl at Tiggipur deep, 5.03m bgl at Lodhi Garden Deep and 8.1m bgl at Shikarpur Deep.

5.1.3 November 2021

The depth to water level of deeper aquifers in NCT Delhi during August-2021 was 8.41m bgl at Bakoli Deep Pz, 7.76m bgl at Tiggipur deep, 3.77m bgl at Lodhi Garden Deep, 6.7m bgl at Shikarpur Deep and 24.98m bgl at CVD Depot Cant (Deep).

5.1.4 January 2022

The depth to water level of deeper aquifers in NCT Delhi during August-2021 was 8.43m bgl at Bakoli Deep Pz, 7.89m bgl at Tiggipur deep, 4.09m bgl at Lodhi Garden Deep, 7.38m bgl at Shikarpur Deep and 24.8m bgl at CVD Depot Cant (Deep).

5.2 Seasonal Water Level Fluctuation: 2021-22

The seasonal water level fluctuation, i.e. the changes in depth of water levels of August 21, November 21 and January 22 with respect to May 21 water level reveals the effect of subsequent utilization of groundwater for various needs like Industrial, Irrigation, Domestic etc., on overall groundwater regime of the area.

5.2.1 May 2021 to August 2021

The water level fluctuation between May-2021 and August-2021 shows rise of 1.59 m at Bakoli Deep Pz, 1.1m at Lodhi Garden Deep, 0.68m at Tiggipur Deep and 0.62 m at Shikarpur Deep. The analysis for these monitoring stations for all the four monitoring periods reveals that water level varies considerably.

5.2.2 May 2021 to November 2021

The water level fluctuation between May-2021 and Nov-2021 shows rise of 3.97 m at Bakoli Deep Pz, 2.36m at Lodhi Garden Deep, 2.10m at Tiggipur Deep and 2.02 m at Shikarpur Deep. The analysis for these monitoring stations for all the four monitoring periods reveals that water level varies considerably.

5.2.3 May 2021 to January 2022

The water level fluctuation between May-2021 and Nov-2021 shows rise of 3.95 m at Bakoli Deep Pz, 2.04m at Lodhi Garden Deep, 1.97m at Tiggipur Deep and 1.34m at Shikarpur Deep. The analysis for these monitoring stations for all the four monitoring periods reveals that water level varies considerably.

5.3 Annual Water Level Fluctuation: 2021-22

Annual Fluctuation in the water levels of the ground water monitoring wells during 2021-22 for different monitoring periods were compared with same period of 2020-21 and wells showing change in groundwater levels over different periods.

5.3.1 Annual Fluctuation: May 2020 & May 2021

The water level fluctuation between May-2020 and May-2021 shows rise of 0.28 m at Bakoli Deep Pz, 1.33m at Lodhi Garden Deep, 0.7m at Shikarpur Deep and shows fall of 1.34m at Tiggipur Deep. The analysis for these monitoring stations for all the four monitoring periods reveals that water level varies considerably.

5.3.2 Annual Fluctuation: August 2020 & August 2021

The water level fluctuation between August-2020 and August-2021 shows rise of 2.4 m at Bakoli Deep Pz, 1.56m at Lodhi Garden Deep, 1.38m at Shikarpur Deep and 0.68m at Tiggipur Deep. The analysis for these monitoring stations for all the four monitoring periods reveals that water level varies considerably.

5.3.3 Annual Fluctuation: November 2020 & November 2021

The water level fluctuation between November-2020 and November-2021 shows rise of 3.58 m at Bakoli Deep Pz, 2.73m at Lodhi Garden Deep, 2.35m at Shikarpur Deep and 1.19m at Tiggipur Deep. The analysis for these monitoring stations for all the four monitoring periods reveals that water level varies considerably.

5.3.4 Annual Fluctuation: January 2021 & January 2022

The water level fluctuation between January-2021 and January-2022 shows rise of 2.99 m at Bakoli Deep Pz, 1.86m at Lodhi Garden Deep, 1.18m at Shikarpur Deep and 1.08m at Tiggipur Deep. The analysis for these monitoring stations for all the four monitoring periods reveals that water level varies considerably.

5.4 Long Term Ground Water Scenario

Long-term behavior of water levels was studied by analyzing water level change of decadal mean water levels data of 2011-20 for May, August & November and 2012-21 decade for January month with corresponding water level data of 2021-22 (Annexure-IIIB).

5.4.1 Decadal Fluctuation: (DM of May-2011-20 & May 2021)

Comparing water level data of May-2021 with 10 year mean water level of May (2011 to 2020) shows rise of 2.51m at Lodhi Garden Deep, 2.19m at Shikarpur Deep and fall of 1.79m at Bakoli Deep, 0.81m at Tiggipur Deep.

5.4.2 Decadal Fluctuation: (DM of Aug-2011-20 & Aug-2021)

Comparing water level data of August-2021 with 10 year mean water level of August (2011 to 2020) shows rise of 3.15m at Lodhi Garden Deep, 3.2m at Shikarpur Deep, 1.48m at Bakoli Deep and 0.19m at Tiggipur Deep.

5.4.2 Decadal Fluctuation: (DM of Nov-2011-20 & Nov- 2021)

Comparing water level data of November-2021 with 10 year mean water level of November (2011 to 2020) shows rise of 4.4m at Lodhi Garden Deep, 3.94m at Shikarpur Deep, 2.37m at Bakoli Deep, 0.19m at Tiggipur Deep and fall of 3.41m at CVD Depot Cant..

5.4.2 Decadal Fluctuation: (DM of January-2012-21 & January- 2022)

Comparing water level data of January-2022 with 10 year mean water level of January (2012 to 2021) shows rise of 3.73m at Lodhi Garden Deep, 2.83m at Shikarpur Deep, 2.11m at Bakoli Deep, 0.77m at Tiggipur Deep and fall of 1.63m at CVD Depot Cant..

6. HYDROGEOCHEMISTRY

The water that falls as rain and snow infiltrates into the subsurface soil and rock. Some water remains in the shallow soil layer whereas large portion infiltrate deeper and becomes part of groundwater system. The chemical characteristics of groundwater are mainly based on the surface and subsurface environment, such as the chemical composition of rain, composition of infiltrating surface water, properties of soil and rock in which the groundwater moves. It varies as per duration of contact time and contact surface between groundwater and geological material along its flow path, rate of geochemical (oxidation/reduction ion exchange, dissolution, evaporation, precipitation) process and microbiological process.

Hydrochemistry is an interdisciplinary science that deals with all these aspects responsible for the chemical composition of the groundwater and as such, it is helpful in knowing about residence time, flow path and aquifer characteristics, as the chemical reactions are time and space dependent. The classical use of chemical characteristics in hydrochemistry is to provide information about the regional distribution of water qualities. At the same time, hydrochemistry has a potential use for tracing the origin and history of water. The hydrochemistry can also be of immense help in yielding information about the environment through which water has circulated.

6.1 Hydrogeochemistry of NCT Delhi

The diverse physiographic, topographic and geologic conditions have given rise to diversified groundwater situations and groundwater quality of NCT of Delhi and it varies with depth and space. It is mainly influenced by local geology and inherent salinity, and uneven development of groundwater.

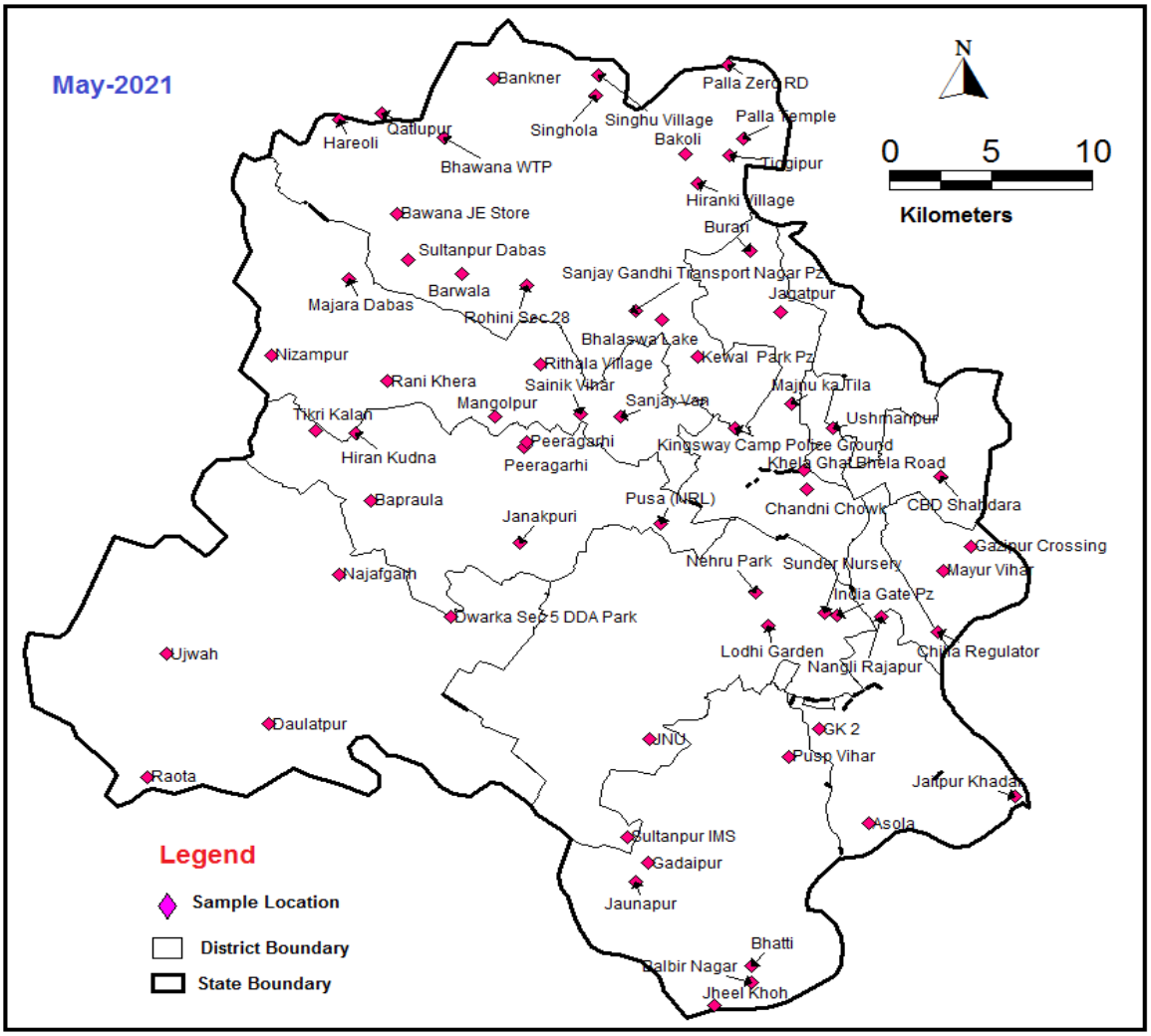
In alluvial formations, in general, the quality of ground water deteriorates with depth, which is variable in different areas. The fresh ground water aquifers mainly exist up to a depth of 25 to 35 m in North West, West and parts of South west districts and in minor patches in North and Central districts. In South, Southeast & Southwest district, especially in Najafgarh *Jheel*area the fresh water occurs up to a depth of 30 to 45 mbgl. A localized area located just north of Kamala Nehru Ridge (part of Delhi ridge falling in Central District) covering area of Dhirpur, Wazirabad and Jagatpur are characterized by shallow depth of fresh water aquifers that is in the range of 22 to 28mbgl, regardless of proximity to River Yamuna. In the flood plains of Yamuna, in general, fresh water aquifers exist down to depth of 30-45mbgl and especially in Palla it reaches to the depth of 60 to 75mbglbelow which brackish and saline water exists. The ground water is fresh at all depths in the areas around the ridge falling in Central, New Delhi, South and eastern part (Ridge Area) of South-West districts and also in Chattarpur basin. In the areas west of the ridge, in general, the thickness of fresh water aquifers decreases towards North-West, the thickness of fresh water zone is limited in most parts of west and southwest districts.

6.2 Groundwater Quality Monitoring

Monitoring of groundwater quality is an effort to obtain information on chemical quality through representative sampling in different parts of NCT Delhi. Groundwater is commonly tapped from phreatic aquifers through representative dug well / bore wells or hand pump located nearest to the monitoring station. A total number of 79 water samples were collected from NCT of Delhi, as part of groundwater quality monitoring work, during May 2021. List of locations and result of chemical analysis for its basic parameters such as pH, EC, TDS, CO3, HCO3, Cl, NO3, SO4, F, Ca, Mg, TH, is presented in annexure IV. Map showing locations of water sample locations is presented in Fig. 53.

Ground Water Quality Samples, NCT Delhi

Fig. 53



The overall results of hydro chemical analysis are attached in Annexure VI(a) and Annexure VI(b) whereas distribution of major groundwater quality parameters in NCT of Delhi are described as under.

6.2.1. Electrical Conductance

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. Electrical Conductivity (EC) is a measure of salinity of the groundwater in terms of saltiness, calculated as Micro Siemen / cm at 25°C. Similar expression is Total Dissolved Solid (TDS), a measure of total dissolved salt contents in mg / liter of groundwater. Different substances dissolve in groundwater giving it taste and odour. In fact, human beings have developed senses, which are able to evaluatethe potability of water. In general water having EC < 1500 uS/cm, is considered as fresh water, EC 1500 – 15000 uS/cm is considered as brackish water and EC > 15000 uS/cm is considered as saline water.

Map showing distribution of electrical conductance in groundwater of NCT Delhi is presented in Fig.54. Most of eastern part of NCT Delhi, in areas around Yamuna in districts of Central, North East, East, South East, New Delhi, South Delhi and few parts of North Delhi and South West Delhi districts has EC within permissible range, upto to 2250 µS/cm at 25°C. The area of Tagore Garden, Nizampur, Jharoda Kalan, Hiran Kudna and some pockets of Shahdara are showing exceptionally high EC Values, even in shallower depth. It is also observed that deeper aquifer water has greater EC value than the shallow aquifer, value increases with increase in depth. The major part of the area underlain by Delhi quartzite ridge has EC values in range of 600 µs/cm to 2000 µs/cm.

Fig. 54

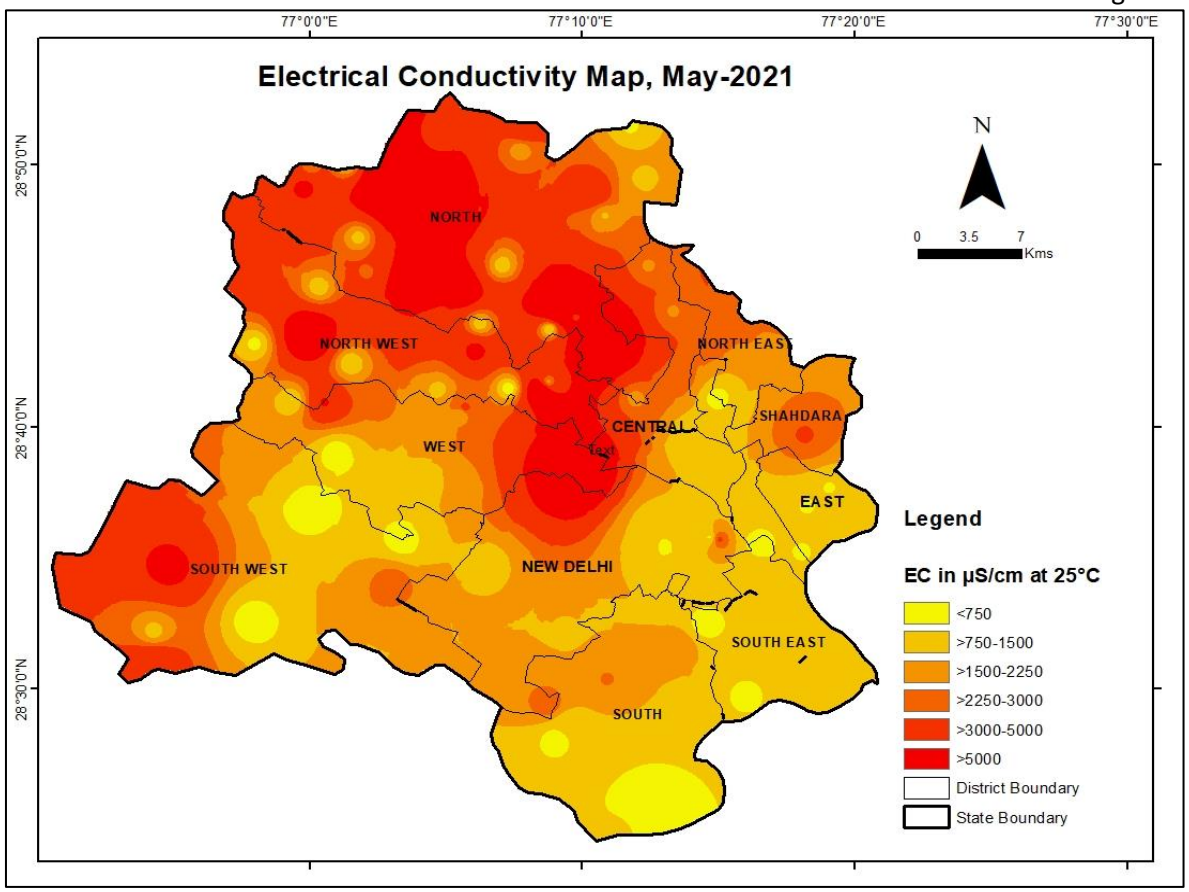
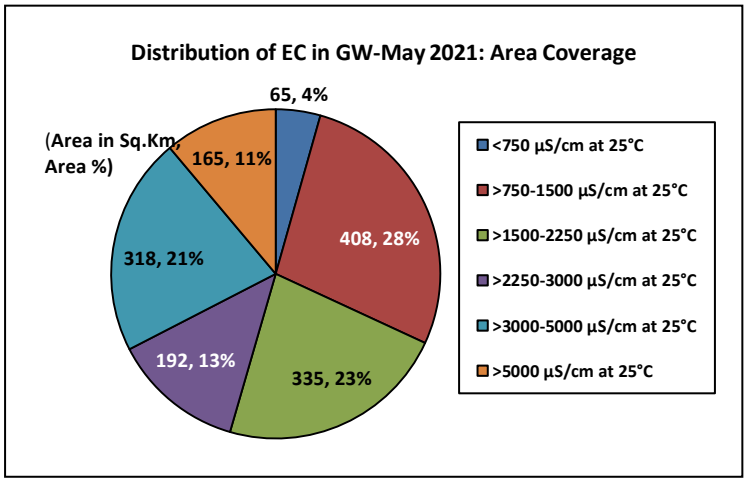


Fig. 55

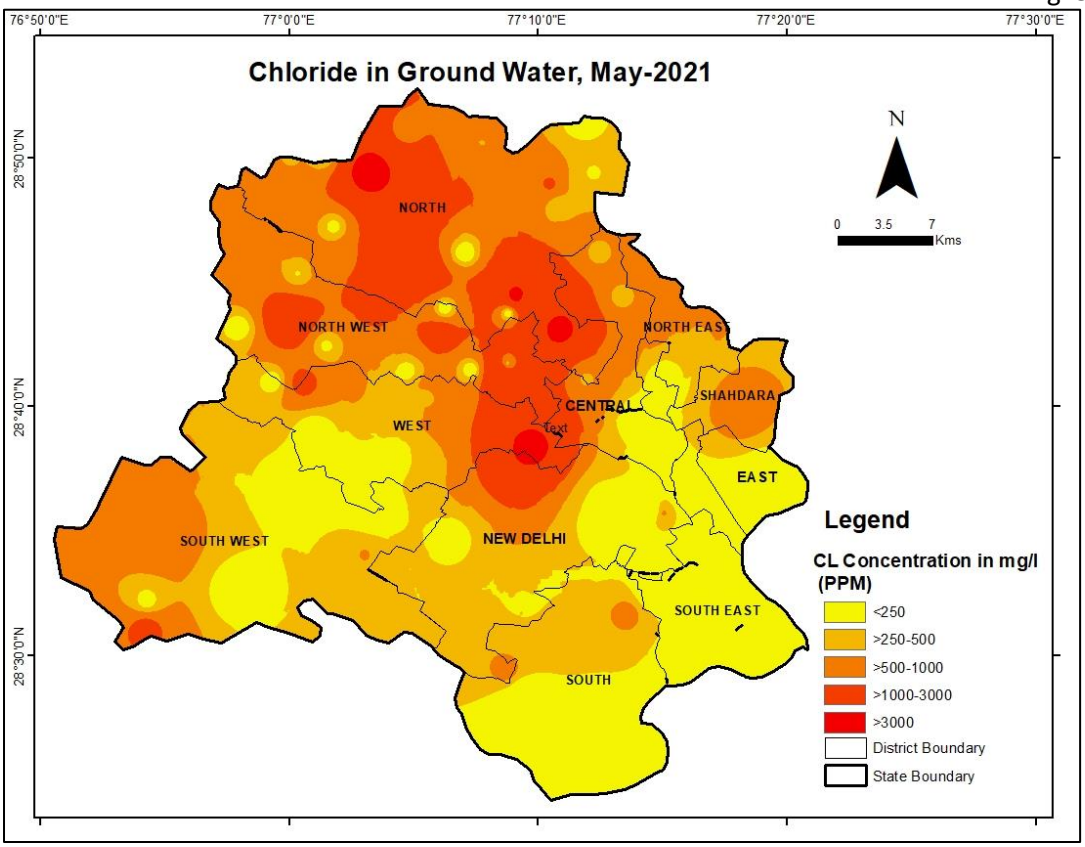
It is observed that nearly 39.3% areas of NCT Delhi falling in North, North West, West and South West districts show EC more than 3000 µS/cm at 25°C whereas rest 60.7 % area has EC in range from 0 to 3000 µS/cm at 25°C. Nearly 3.8% (55.96sqkm) areas of North, New Delhi, South East & South district has EC of 0 to 750 µS/cm at 25°C (Fig. 55).



6.2.2. Chloride

Chloride is present in all-natural waters being highly soluble and moves freely through soil and rock. In groundwater Chloride content is mostly below 250 mg/l except in cases where inland salinity is prevalent. BIS have recommended a desirable limit of 250mg/l of chloride in drinking water; this concentration limit can be extended to 1000 mg/l of chloride in cases where no alternative source of water with desired concentration is available. The map showing distribution of Chloride in NCT Delhi is presented in Fig. 56.

Fig. 56



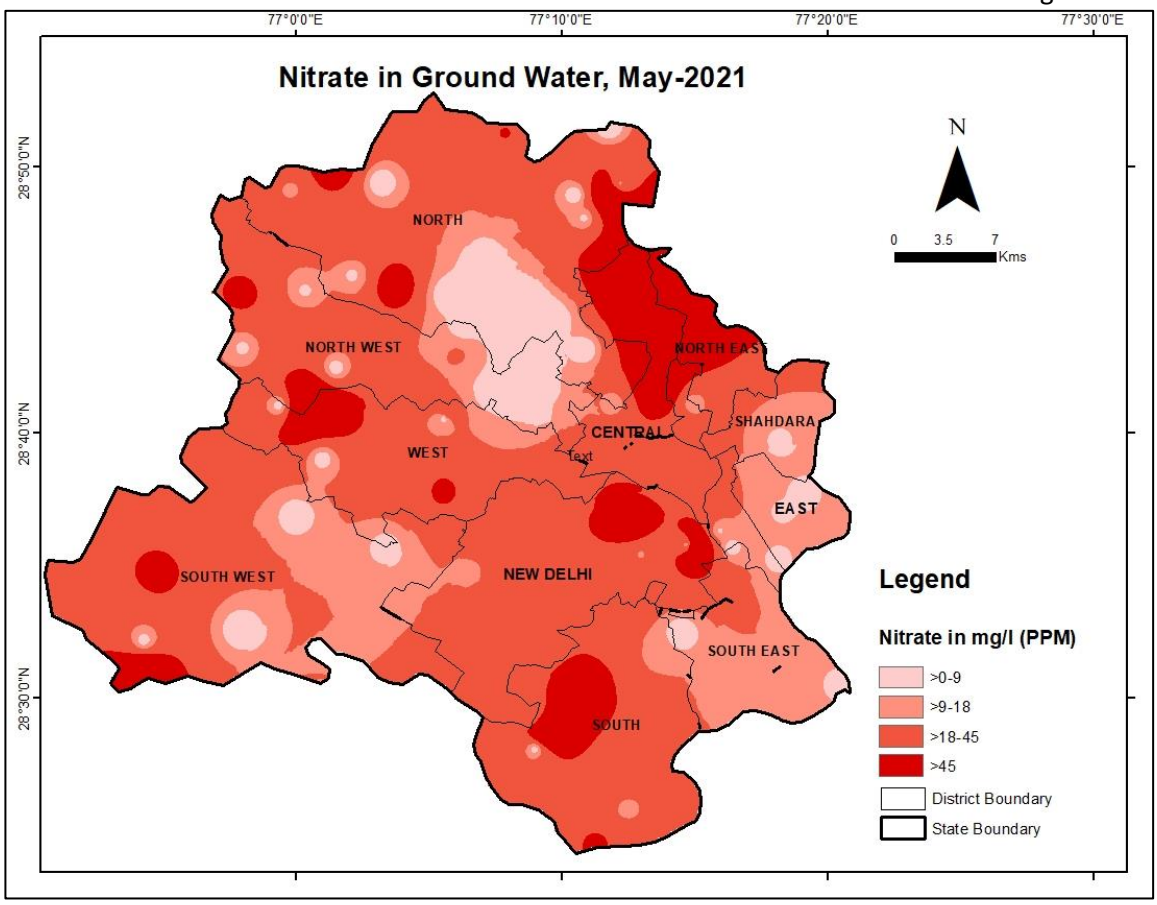
It is observed major part of NCT Delhi, in areas having EC within permissible limits i.e., 2250 to 3000 µS/cm, has chloride also within permissible limit of 250 mg/l. In areas having high EC values i.e., >3000 µS/cm, chloride value is more than 1000 mg /l (Fig. 56).

6.2.3. Nitrate

Nitrate is a naturally occurring compound that is formed in the soil when nitrogen and oxygen combine. The primary source of all nitrates is atmospheric nitrogen gas. This is converted into organic nitrogen by some plants by a process called nitrogen fixation. Dissolved nitrogen in the form of nitrate is the most common contaminant of groundwater. Nitrate in groundwater generally originates from non-point sources such as leaching of chemical fertilizers and animal manure, groundwater pollution from septic and sewage discharges etc. It is difficult to identify the natural and man-made sources of nitrogen contamination of ground water. Some chemical and microbiological processes such as nitrification and denitrification also influence the nitrate concentration in ground water.

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 methemoglobinemia particularly to infants.

Fig. 57



The map (Fig. 57) shows NHS having nitrates in ground water of Delhi, as point source of pollution, within permissible and beyond permissible limit of 45 mg /ltr.

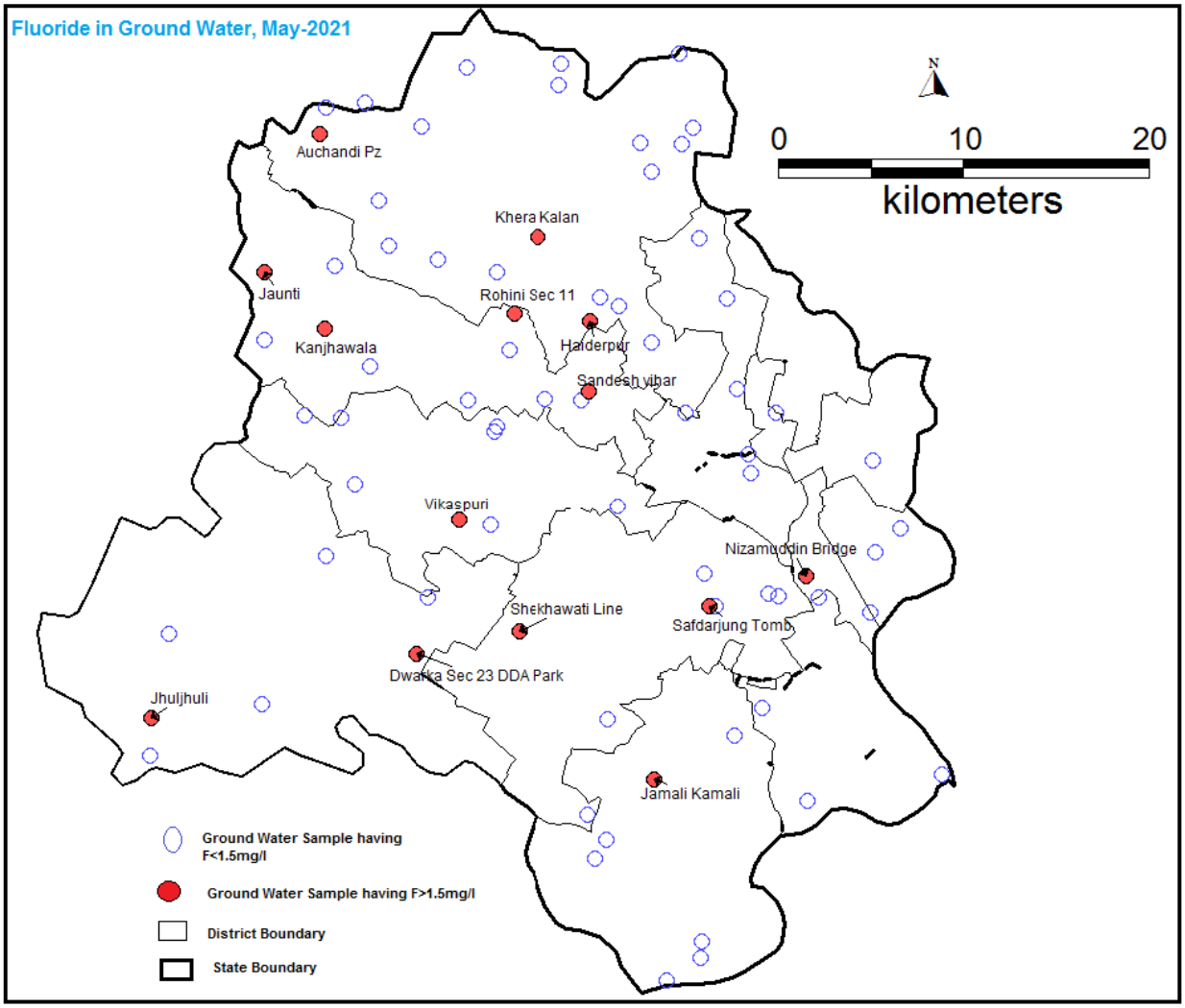
6.2.4. Fluoride

Fluorine is a common element, but it does not occur in the elemental state in nature because of its high reactivity. Fluorine is the most electronegative and reactive of all elements that occur naturally within much type of rocks. 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 map showing distribution of Fluoride in NCT Delhi is presented in Fig. 58.

It is well known that small amount of fluoride (>1.0 mg/l) have proven to be beneficial in reducing tooth decay. Community water supplies commonly are treated with sodium fluoride or fluorosilicates to maintain fluoride level ranging from 0.8 to 1.2 mg/l to reduce the incidents of dental carries. 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.

BIS has recommended an upper desirable limit of 1.0 mg/l of fluoride concentration in drinking water, which can be extended to 1.5 mg/l in case no alternative source of drinking water is available. Water having fluoride concentration more than 1.5mg/l is not suitable for drinking purposes.

Fig. 58



The map (Fig. 58) shows NHS locations having fluoride in ground water of Delhi, within permissible limits & beyond permissible limit of 1.5 mg /litre.

5.2.5 Heavy metal analysis

The heavy metal analysis of ground water was determined from 77 nos. of water samples collected from the National Hydrograph Stations distributed throughout NCT, Delhi. These samples were collected during the month of May 2021 in the pre-monsoon period, when the concentrations of ions were maximum. The water samples were analyzed for the major ions viz Cr, Mn, Fe, Ni, Cu, Zn, As, Se, Ag, Cd, Pb & U. The obtained heavy metal analysis results are computed and given in Annexure: VI(B).

Out of 77 locations the highest concentration of manganese i.e. 2.293 mg/l was recorded at Jagatpur. The iron concentrations were recorded high (>1mg/l) at 4 locations viz Rohini sec-11, Nangli Rajapura, Bhalaswa Lake and Burari DJB Ex Engg Office. The uranium concentrations were found beyond the permissible limit (30.00ppb) in locations viz., Kanjhawala, jaunti and Nizampur.

ANNEXURE IA: LIST OF CENSUS TOWNS – NCT OF DELHI

District	Tehsil	Town Name Name
CENTRAL	Civil Lines	Burari (CT)
CENTRAL	Civil Lines	JharodaMajraBurari (CT)
CENTRAL	Civil Lines	Kamal PurMajraBurari (CT)
CENTRAL	Civil Lines	Mukund Pur (CT)
EAST	Gandhi Nagar	ShakarPurBaramad (CT)
EAST	Mayur Vihar	ChillaSarodaBangar (CT)
EAST	Mayur Vihar	ChillaSaroda Khadar (CT)
EAST	Mayur Vihar	Dallo Pura (CT)
EAST	Mayur Vihar	Gharoli (CT)
EAST	Mayur Vihar	GharondaNeemkaBangar alias Patpar Ganj (CT)
EAST	Mayur Vihar	Kondli (CT)
NEW DELHI	Delhi Cantonment	Moradabad Pahari (CT)
NEW DELHI	VasanatVihar	Ghitorni (CT)
NEW DELHI	VasanatVihar	Kusum Pur (CT)
NEW DELHI	VasanatVihar	Malik PurKohi alias Rang Puri (CT)
NEW DELHI	VasanatVihar	Rajokri (CT)
NEW DELHI	VasanatVihar	Sambhalka (CT)
NORTH	Alipur	Ali Pur (CT)
NORTH	Alipur	Bakhtawar Pur (CT)
NORTH	Alipur	Bankauli (CT)
NORTH	Alipur	Ibrahim Pur (CT)
NORTH	Alipur	Khera Kalan (CT)
NORTH	Alipur	LibasPur (CT)
NORTH	Alipur	MukhmelPur (CT)
NORTH	Alipur	Qadi Pur (CT)
NORTH	Alipur	Sahibabad DaulatPur (CT)
NORTH	Alipur	SirasPur (CT)
NORTH	Model Town	Bhalswa Jahangir Pur (CT)
NORTH	Narela	Bankaner (CT)
NORTH	Narela	Barwala (CT)
NORTH	Narela	Bawana (CT)
NORTH	Narela	BhorGarh (CT)
NORTH	Narela	Darya Pur Kalan (CT)
NORTH	Narela	Khera Khurd (CT)
NORTH	Narela	PehladPurBangar (CT)
NORTH	Narela	POOTH KHURD
NORTH	Narela	Tikri Khurd (CT)
NORTH EAST	Karwal Nagar	Baqiabad (CT)
NORTH EAST	Karwal Nagar	JiwanPur alias Johri Pur (CT)
NORTH EAST	Karwal Nagar	Karawal Nagar (CT)
NORTH EAST	Karwal Nagar	Sadat PurGujran (CT)
NORTH EAST	SeelamPur	DayalPur (CT)
NORTH EAST	SeelamPur	Khajoori Khas (CT)
NORTH EAST	SeelamPur	Khan PurDhani (CT)
NORTH EAST	SeelamPur	Mir Pur Turk (CT)
NORTH EAST	SeelamPur	TukhmirPur (CT)
NORTH EAST	Yamuna Vihar	GokalPur (CT)
NORTH EAST	Yamuna Vihar	Mustafabad (CT)
NORTH EAST	Yamuna Vihar	Ziauddin Pur (CT)
NORTH WEST	Kanjhawala	Gheora (CT)
NORTH WEST	Kanjhawala	Kanjhawala (CT)
NORTH WEST	Kanjhawala	Karala (CT)
NORTH WEST	Kanjhawala	Lad Pur (CT)
NORTH WEST	Kanjhawala	Mohammad PurMajri (CT)
NORTH WEST	Kanjhawala	Qutab Garh (CT)
NORTH WEST	Rohini	Begum Pur (CT)

District	Tehsil	Town Name Name
SHAHDARA	Seema Puri	Mandoli (CT)
SHAHDARA	Shahdara	Babar Pur (CT)
SHAHDARA	Shahdara	Jaffrabad (CT)
SOUTH	Mehrauli	Aya Nagat (CT)
SOUTH	Mehrauli	Chandan Hola (CT)
SOUTH	Mehrauli	Dera Mandi (CT)
SOUTH	Mehrauli	Fateh Pur Beri (CT)
SOUTH	Mehrauli	JonaPur (CT)
SOUTH	Mehrauli	Sultan Pur (CT)
SOUTH	Saket	Asola (CT)
SOUTH	Saket	Bhati (CT)
SOUTH	Saket	ChhatarPur (CT)
SOUTH	Saket	Deoli (CT)
SOUTH	Saket	Maidan Garhi (CT)
SOUTH	Saket	Neb Sarai (CT)
SOUTH	Saket	Raj Pur Khurd (CT)
SOUTH	Saket	SaidulAzaib (CT)
SOUTH	Saket	Tigri (CT)
SOUTH EAST	Defence Colony	Saidabad (CT)
SOUTH EAST	Kalkaji	PulPehlad (CT)
SOUTH EAST	Sarita Vihar	Aali (CT)
SOUTH EAST	Sarita Vihar	Jaitpur (CT)
SOUTH EAST	Sarita Vihar	KotlaMahigiran (CT)
SOUTH EAST	Sarita Vihar	MithePur (CT)
SOUTH EAST	Sarita Vihar	Molar Band (CT)
SOUTH EAST	Sarita Vihar	Taj Pul (CT)
SOUTH WEST	Dwarka	NangliSakrawati (CT)
SOUTH WEST	Kapeshera	Chhawla (CT)
SOUTH WEST	Kapeshera	DindarPur (CT)
SOUTH WEST	Kapeshera	Kapas Hera (CT)
SOUTH WEST	Najafgarh	Jaffar Pur Kalan (CT)
SOUTH WEST	Najafgarh	Jharoda Kalan (CT)
SOUTH WEST	Najafgarh	Kair (CT)
SOUTH WEST	Najafgarh	Khera (CT)
SOUTH WEST	Najafgarh	Mitraon (CT)
SOUTH WEST	Najafgarh	Roshan Pura alias Dichaon Khurd (CT)
SOUTH WEST	Najafgarh	Ujwa (CT)
WEST	Patel Nagar	Hastsal (CT)
WEST	Patel Nagar	Raja Pur Khurd (CT)
WEST	Punjabi Bagh	Bakkar Wala (CT)
WEST	Punjabi Bagh	Bapraula (CT)
WEST	Punjabi Bagh	Mundaka (CT)
WEST	Punjabi Bagh	NangloiJat (CT)
WEST	Punjabi Bagh	Nilothi (CT)
WEST	Punjabi Bagh	Quammruddin Nagar (CT)
WEST	Punjabi Bagh	ShafiPurRanhola (CT)
WEST	Punjabi Bagh	Tikri Kalan (CT)
WEST	Punjabi Bagh	TilangPurKotla (CT)
NORTH WEST	Rohini	Kirari Suleman Nagar (CT)
NORTH WEST	Rohini	Mubarak PurDabas (CT)
NORTH WEST	Rohini	Nithari (CT)
NORTH WEST	Rohini	Pooth Kalan (CT)
NORTH WEST	Rohini	Rani Khera (CT)
NORTH WEST	Rohini	Sultan PurMajra (CT)

ANNEXURE IB: LIST OF VILLAGES – NCT OF DELHI

District	Tehsil	Village Name
CENTRAL	Civil Lines	BadarPurMajraBurari
CENTRAL	Civil Lines	Jagat Purilaqa Delhi
CENTRAL	Civil Lines	Jagat Purilaqa Shahdara (un-inhabited)
CENTRAL	Civil Lines	Salem PurMajraBurari
EAST	Mayur Vihar	ShamasPur
NORTH	Alipur	Akbar PurMajra
NORTH	Alipur	Bodh PurBijaPur
NORTH	Alipur	Fateh PurJat
NORTH	Alipur	GarhiKhasru
NORTH	Alipur	Hamid Pur
NORTH	Alipur	Hiranki
NORTH	Alipur	Jhangola
NORTH	Alipur	Kham Pur
NORTH	Alipur	Mohd. Pur Ramzan Pur
NORTH	Alipur	Nangli Poona
NORTH	Alipur	Palla
NORTH	Alipur	QullakPur
NORTH	Alipur	Singhola
NORTH	Alipur	Singhu
NORTH	Alipur	SungerPur Delhi
NORTH	Alipur	SungerPur Shahdara (un-inhabited)
NORTH	Alipur	Taj Pur Kalan
NORTH	Alipur	Tehri DaulatPur (Un-inhabited)
NORTH	Alipur	TigiPur
NORTH	Alipur	ZindPur
NORTH	Model Town	ShanjarPur(un-inhabited)
NORTH	Narela	BazidPurThakran
NORTH	Narela	Ghoga
NORTH	Narela	Hareoli
NORTH	Narela	Holambi Kalan
NORTH	Narela	Holambi Khurd
NORTH	Narela	Iradat Nagar alias Naya Bans
NORTH	Narela	KankarKhera
NORTH	Narela	Katewara
NORTH	Narela	Kureni
NORTH	Narela	Lam Pur
NORTH	Narela	MamoorPur
NORTH	Narela	MungeshPur
NORTH	Narela	Ochandi
NORTH	Narela	Pansali
NORTH	Narela	Raja Pur Kalan (Un-inhabited)
NORTH	Narela	Sanoth
NORTH	Narela	Shah PurGarhi
NORTH	Narela	Sultan PurDabas
NORTH EAST	Karwal Nagar	BadarPur Khadar
NORTH EAST	Karwal Nagar	Bihari Pur
NORTH EAST	Karwal Nagar	Pur Delhi
NORTH EAST	Karwal Nagar	Pur Shahdara
NORTH EAST	Karwal Nagar	Saba Pur Delhi
NORTH EAST	Karwal Nagar	Saba Pur Shahdara
NORTH EAST	Karwal Nagar	Sadat PurMusalmanan (un-inhabited)
NORTH EAST	SeelamPur	GarhiMendu
NORTH EAST	SeelamPur	Sher Pur
NORTH WEST	Kanjhawala	BudhanPur
NORTH WEST	Kanjhawala	Chand Pur
NORTH WEST	Kanjhawala	Chatesar
NORTH WEST	Kanjhawala	GarhiRindhala
NORTH WEST	Kanjhawala	Jat Khor
NORTH WEST	Kanjhawala	Jonti
NORTH WEST	Kanjhawala	Nizam Pur Rashid Pur
NORTH WEST	Kanjhawala	Punjab Khor
NORTH WEST	Kanjhawala	Salah PurMajra
NORTH WEST	Rohini	Madan PurDabas
NORTH WEST	Rohini	Rasool Pur
NORTH WEST	SaraswatiVihar	Saoda
SOUTH	Mehrauli	GadaiPur
SOUTH	Saket	Satberi
SOUTH	Saket	ShahurPur
SOUTH WEST	Kapeshera	AsalatPurKhawad
SOUTH WEST	Kapeshera	Badhosra
SOUTH WEST	Kapeshera	Darya Pur Khurd
SOUTH WEST	Kapeshera	DaulatPur
SOUTH WEST	Kapeshera	Deorala
SOUTH WEST	Kapeshera	Goela Khurd
SOUTH WEST	Kapeshera	Goman Hera
SOUTH WEST	Kapeshera	Hasan Pur
SOUTH WEST	Kapeshera	Jain Pur(Un-inhabited)
SOUTH WEST	Kapeshera	Jhatikra
SOUTH WEST	Kapeshera	KanganHeri
SOUTH WEST	Kapeshera	KharkhariJatmal
SOUTH WEST	Kapeshera	KharkhariRond
SOUTH WEST	Kapeshera	Nanak Heri
SOUTH WEST	Kapeshera	Paprawat
SOUTH WEST	Kapeshera	Pindwala Kalan
SOUTH WEST	Kapeshera	Pindwala Khurd
SOUTH WEST	Kapeshera	Qutab Pur
SOUTH WEST	Kapeshera	Raghu Pur
SOUTH WEST	Kapeshera	Raota
SOUTH WEST	Kapeshera	Rewla Kham Pur
SOUTH WEST	Kapeshera	Salah Pur
SOUTH WEST	Kapeshera	Shikar Pur
SOUTH WEST	Kapeshera	Taj Pur Khurd
SOUTH WEST	Najafgarh	BaqarGarh
SOUTH WEST	Najafgarh	Dhansa
SOUTH WEST	Najafgarh	Dichaon Kalan
SOUTH WEST	Najafgarh	Ghalib Pur
SOUTH WEST	Najafgarh	Isa Pur
SOUTH WEST	Najafgarh	Jhuljhuli
SOUTH WEST	Najafgarh	Kharkhari Nahar
SOUTH WEST	Najafgarh	KheraDabar
SOUTH WEST	Najafgarh	Malik Purzer-Najafgarh
SOUTH WEST	Najafgarh	Mundhela Kalan
SOUTH WEST	Najafgarh	Mundhela Khurd
SOUTH WEST	Najafgarh	Qazi Pur
SOUTH WEST	Najafgarh	SamasPur Khalsa
SOUTH WEST	Najafgarh	Sarang Pur
SOUTH WEST	Najafgarh	Sher Pur Deri
SOUTH WEST	Najafgarh	SurakhPur
SOUTH WEST	Najafgarh	Surera
WEST	Punjabi Bagh	Jaffar Pur alias HiranKudna
WEST	Punjabi Bagh	Neel Wal

ANNEXURE II: RAINFALL DATA & PROBABILITY ANALYSIS

Rainfall, Departure and Cumulative Departure & Occurrence of Drought - NCT of Delhi

Year	Rainfall (mm)	Departure	Cumulative	Type of Drought
1984	579.2	-0.13	-0.13	Mild
1985	771.6	0.16	0.03	
1986	446.4	-0.33	-0.30	Normal
1987	434.2	-0.35	-0.64	Normal
1988	1025.2	0.54	-0.10	
1989	303.6	-0.54	-0.64	Severe
1990	800.6	0.20	-0.44	
1991	614.7	-0.07	-0.51	Mild
1992	641.6	-0.03	-0.55	Mild
1993	861.4	0.30	-0.25	
1994	784.6	0.18	-0.07	
1995	827.6	0.25	0.18	
1996	974.6	0.47	0.64	
1997	617.4	-0.07	0.57	Mild
1998	853.3	0.28	0.86	
1999	544.2	-0.18	0.68	Mild
2000	808.0	0.22	0.89	
2001	646.2	-0.03	0.86	Mild
2002	459.5	-0.31	0.56	Normal
2003	925.9	0.39	0.95	
2004	531.5	-0.20	0.75	Mild
2005	603.3	-0.09	0.66	Mild
2006	618.7	-0.07	0.59	Mild
2007	588.0	-0.12	0.47	Mild
2008	852.8	0.28	0.76	
2009	595.6	-0.10	0.65	Mild
2010	951.9	0.43	1.09	
2011	661.8	0.00	1.08	Mild
2012	559.4	-0.16	0.92	Mild
2013	708.9	0.07	0.99	
2014	440.4	-0.34	0.65	Normal
2015	547.5	-0.18	0.48	Mild
2016	656.1	-0.01	0.46	Mild
2017	512.49	-0.23	0.24	
2018	543.97	-0.18	0.05	
2019	499.44	-0.25	-0.19	
2020	485.4	-0.27	-0.46	
2021	972.34	0.46	0.00	

Rank	Probability in %	ARF in decresing order
1	2.03	1025.2
2	5.09	974.6
3	8.08	951.9
4	11.08	925.9
5	14.07	861.4
6	17.07	853.3
7	20.06	852.8
8	23.05	827.6
9	26.05	808.0
10	29.04	800.6
11	32.04	784.6
12	35.03	771.6
13	38.02	708.9
14	41.02	661.8
15	44.01	656.1
16	47.01	646.2
17	50.00	641.6
18	52.99	618.7
19	55.99	617.4
20	58.98	614.7
21	61.98	603.3
22	64.97	595.6
23	67.96	588.0
24	70.96	579.2
25	73.95	559.4
26	76.95	547.5
27	79.94	544.2
28	82.93	533.7
29	85.93	531.5
30	88.92	459.5
31	91.92	446.4
32	94.91	440.4
33	97.90	434.2
34	100.90	303.6

ANNEXURE IIIA: WATER LEVEL MONITORING DATA(2021-22)

List of NHS/ Monitoring Stations Monitored During 2021-22, NCT of Delhi (Water Level in mbgl)							
DISTRICT	**TEHSIL NAME**	**SITE_NAME**	**May-21**	**Aug_21**	**Nov-21**	**Jan-22**	**Pz/DW**
North	ALIPUR	AlipurGarhiPz	10.99	9.51	7.88	7.54	Pz
North	ALIPUR	Bakoli	12.21	10.56	8.18	8.23	Pz
North	ALIPUR	HaiderpurPz	13.37	12.9	12.22	11.92	Pz
North	ALIPUR	Hiranki Village Pz	9.33	9.1	7.95	7.64	Pz
North	ALIPUR	Palla Temple	9.29	7.72	7.2	7.98	Pz
North	ALIPUR	Palla Zero RD	12.01	11.7	9.8	9.5	Pz
North	ALIPUR	Rohini Sector 28	7.17	6.4	4.52	4.37	Pz
North	ALIPUR	SingholaPz	21.68	21.78	19.41	18.29	Pz
North	ALIPUR	Singhu Village Pz	22.64	23.44	19.66	18.52	Pz
North	ALIPUR	Tiggipur Shallow Pz	8.21	7.58	6.27	6.54	Pz
New Delhi	CHANAKYAPURI	Birla Mandir DW	13.97	NA	3.38	NA	DW
New Delhi	CHANAKYAPURI	Humayu Tomb DW	5.72	4.78	4.88	3.85	DW
New Delhi	CHANAKYAPURI	India Gate Pz	7.79	7.27	6.01	NA	Pz
New Delhi	CHANAKYAPURI	Lodhi Garden.(SH)	6.04	4.9	3.65	3.96	Pz
New Delhi	CHANAKYAPURI	Lodhi GradenDw	8.69	8.01	6.66	6.54	DW
New Delhi	CHANAKYAPURI	MahabirVansthali	27.09	25.23	23.49	22.76	Pz
New Delhi	CHANAKYAPURI	Nehru Park Dw	22.95	22.02	19.09	19.07	DW
New Delhi	CHANAKYAPURI	Safdarjung tomb	13.71	12.52	10.58	10.57	DW
New Delhi	CHANAKYAPURI	Shanti Path American Embassy	25.16	25.14	24.31	23.99	Pz
New Delhi	CHANAKYAPURI	Shram Shakti Bhawan 2	8.9	7.32	6.28	6.7	Pz
New Delhi	CHANAKYAPURI	Shram Shakti Bhawan 3	8.23	NA	NA	NA	Pz
New Delhi	CHANAKYAPURI	Sunder Nursery Pz	6.53	5.53	4.09	4.4	Pz
Central	CIVIL LINES	Burari Augur Pz	8.59	7.82	8.06	7.46	Pz
Central	CIVIL LINES	Burari DJB Ex.Engg Office Pz	2.45	1.01	1.82	2.46	Pz
Central	CIVIL LINES	ISBT (Kasmiri Gate) DW	3.47	1	2.6	3.37	DW
Central	CIVIL LINES	JagatpurPz 2	2.95	0.31	0.98	1.35	DW
Central	CIVIL LINES	KhelaGhatBhela road	1.87	0.57	1.29	1.93	DW
Central	CIVIL LINES	Majnu Ka Tila DW	9.81	8.07	8.26	7.79	DW
South East	DEFENCE COLONY	NangliRajapurPz	4.09	2.63	3.74	2.9	Pz
New Delhi	DELHI CANTONMENT	Kabul Line Pz	32.63	33.05	32.54	32.06	Pz
New Delhi	DELHI CANTONMENT	Pusa Institute (WTC)	25.73	NA	NA	NA	Pz
New Delhi	DELHI CANTONMENT	Shekhwati Line Pz	46.7	44.86	44.37	43.79	Pz
South West	DWARKA	Dwarka S-16 (TP)	20.82	20.34	19.39	18.73	Pz
South West	DWARKA	Dwarka Sec-23 DDA Park	17.57	15.84	13.3	14.21	Pz
South West	DWARKA	Dwarka Sec-5 DDA Park	19.26	18.34	17.03	16.4	Pz
South	HAUZ KHAS	Hauz Khas Pz	28.32	27.68	26.72	25.49	Pz
South	HAUZ KHAS	PuspViharPz	43.43	43.05	42.3	41.1	Pz
South East	KALKAJI	Aastha Kunj DWLR	6.27	0.12	0.19	1.98	Pz
South East	KALKAJI	AsolaPz	NA	51.7	47.84	47.56	Pz
South East	KALKAJI	DJB Overhead Tank GK-II Pz	NA	NA	7.43	8.4	Pz
South East	KALKAJI	GK 2	6.35	3.61	3.73	4.15	Pz

DISTRICT	TEHSIL NAME	SITE_NAME	May-21	Aug_21	Nov-21	Jan-22	Pz/DW
South East	KALKAJI	Jahapana Park	11.8	10.53	NA	NA	Pz
South East	KALKAJI	Gurudwara GK-II Pz	NA	NA	3.14	3.39	Pz
South East	KALKAJI	M-Block Park GK-II Pz	NA	NA	3.36	3.87	Pz
South East	KALKAJI	S Block Park GK-II Pz	NA	NA	7.88	8.93	Pz
South East	KALKAJI	Sehgal Market-1 GK-II Pz	NA	NA	3.65	2.63	Pz
South East	KALKAJI	Sehgal Market-2 GK-II Pz	NA	NA	6.25	12.13	Pz
North West	KANJHWARIA	Jaunti DW	13.9	13.3	12.1	11.43	DW
North West	KANJHWARIA	KanjhawalaPz	1.09	0.38	0.63	0.72	Pz
North West	KANJHWARIA	Nizampur EW	7.17	5.46	4.39	4.7	Pz
North West	KANJHWARIA	Nizampur Mandir Dw	5.85	4.39	4.01	4.29	DW
South West	KAPASHERA	Deorala	0.5	0.82	0.85	NA	Pz
South West	KAPESHERA	ChhawlaPz	12.94	10.67	8.56	8.35	Pz
South West	KAPESHERA	DaulatpurPz	13.34	12.36	11.31	11.06	Pz
South West	KAPESHERA	RaotaDw	1.65	0.6	0.88	1.45	DW
South West	KAPESHERA	Shikarpur Shallow Pz	8.56	7.93	6.44	7.42	Pz
North East	KARAWAL NAGAR	Gokulpuri EW	NA	NA	18.67	17.95	Pz
North East	KARAWAL NAGAR	Sonia Vihar DJB WTP	NA	NA	9.21	9.35	Pz
Central	KOTWALI	Chandini Chowk DW	6.39	5.3	5.77	6.13	Dw
East	MAYUR VIHAR	Chilla Regulator	10.88	10.79	10.51	10.25	Pz
East	MAYUR VIHAR	ChillaSarodaPz	10.2	10.27	9.58	9.34	Pz
East	MAYUR VIHAR	Kondli DJB WTP	NA	NA	NA	26.17	Pz
East	MAYUR VIHAR	Mayur Vihar B Block Ph II	9.18	8.67	8.21	8.13	Pz
South	MEHRAULI	GadaipurPz	64.85	65.48	65.67	65.54	Pz
South	MEHRAULI	Jamali Kamali DW	22.83	15.2	13.6	12.54	Dw
South	MEHRAULI	Jaunapur DJB TW	43.91	40.76	41	41.13	Pz
South	MEHRAULI	JheelKhoh	58	53.6	53.88	67.64	DW
North	MODEL TOWN	Bhalaswa Lake Pz	1.9	0.5	0.9	1.41	Pz
North	MODEL TOWN	Coronation Pillar Pz DJB RWTP	NA	NA	1.83	2.33	Pz
North	MODEL TOWN	Kewal Park Pz	NA	1.24	2.19	2.73	Pz
South West	NAJAFGARH	Daryapur Khurd	3.95	3.03	1	1.02	DW
South West	NAJAFGARH	JhuljhuliDw	1.28	0.9	2.4	1.85	Dw
South West	NAJAFGARH	Mundela Kalan Pz	11.52	10.27	8.7	8.64	Pz
South West	NAJAFGARH	Najafgarh Town	19.86	19.28	17.35	16.72	Pz
South West	NAJAFGARH	Surheda	13.74	12.76	12.67	11.3	Pz
South West	NAJAFGARH	UjwahPz	13.78	13.87	8.9	9.46	Pz
North	NARELA	AuchandiPz	2.51	0.66	0.94	1.39	Pz
North	NARELA	BanknerPz	23.25	23.8	19.78	24.75	Pz
North	NARELA	BarwalaPz	6.99	6.26	4.79	4.62	Pz
North	NARELA	Bawana JE Store	10.63	6.3	6.09	6.5	Pz
North	NARELA	Bawana WTP	14.68	13.3	11.83	11.37	Pz
North	NARELA	Hareoli DW	3.92	1.78	1.3	2.03	DW
North	NARELA	Kingsway Camp Police Ground	7.92	3.74	3.73	NA	Pz
North	NARELA	Qatlupur	2.89	NA	2.13	2.46	DW

DISTRICT	TEHSIL NAME	SITE_NAME	May-21	Aug_21	Nov-21	Jan-22	Pz/DW
NAZUL LAND	NAZUL LAND	Lalitha Park (Pz)	5.64	5.6	5.05	5.25	Pz
NAZUL LAND	NAZUL LAND	Nizamuddin Bridge 2 Pz	4.33	2.69	2.55	3.2	Pz
NAZUL LAND	NAZUL LAND	Shastri Park (Pz)	6.38	5.82	5.35	5.44	Pz
West	PATEL NAGAR	JanakpuriPz	10.05	8.99	7.35	6.86	Pz
West	PATEL NAGAR	PUSA (NRL) Pz	31.93	32.39	31.94	31.46	Pz
West	PATEL NAGAR	VikashpuriPz	10.77	9.58	7.73	7.11	Pz
East	PREET VIHAR	Bank Enclave Pz	4.69	3.2	2.77	3	Pz
East	PREET VIHAR	Gazi Pur Crossing	25.74	24.48	26.03	25.77	Pz
East	PREET VIHAR	Gujarat ViharPz	7.93	7.12	6.22	6.2	Pz
West	PUNJABI BAGH	BaprolaDw	3.71	0.9	0.71	0.89	DW
West	PUNJABI BAGH	HiranKudna DW	2.84	0.66	0.65	0.6	DW
West	PUNJABI BAGH	Peeragarhi DW	8.49	6.99	5.43	5.22	DW
West	PUNJABI BAGH	PeeragarhiPz	5.09	3.77	2.6	2.76	Pz
West	RAJOURI GARDEN	MayapuriPz	38.26	36.95	36.66	35.95	Pz
West	RAJOURI GARDEN	Tagore Garden	17.89	NA	14.43	13.43	Pz
North West	ROHINI	MangolpurPz	2.72	1.78	2.02	2.24	Pz
North West	ROHINI	Rani Khera DW	1.06	0.52	0.22	NA	DW
North West	ROHINI	RithalaPz Sec5 Rohini	4.17	2.45	2.17	2.05	Pz
North West	ROHINI	Rohini Sec 11 Pz	5.33	4.3	3.42	4.06	Pz
North West	ROHINI	Rohini Sector 23	1.34	0.37	0.56	0.76	Pz
North West	ROHINI	Samaypur Badli Pz	9.12	8.59	8.32	8.02	Pz
North West	ROHINI	Sector 1 Rohini Pz	4.97	2.745	2.675	3.255	Pz
North West	ROHINI	Sultanpur Dabas	7.49	5.45	3.24	3.4	Pz
South	SAKET	Balbir Nagar DW	24.8	11.45	14.44	19.27	DW
South	SAKET	Bhatti Pz	54.72	54.61	40.55	43.89	Pz
North West	SARASWATI VIHAR	MajaraDabas	3.57	1.03	0.93	0.77	Pz
North West	SARASWATI VIHAR	Qutubgarh	6.04	5.24	4.37	4.57	Pz
North West	SARASWATI VIHAR	Sainik Vihar(Pz)	3.03	0.93	1.44	1.74	Pz
North West	SARASWATI VIHAR	Sandesh ViharPz	4.4	1.67	2.61	2.49	Pz
North West	SARASWATI VIHAR	Sanjay Van Pz	3.46	1.64	1.89	1.9	Pz
South East	SARITA VIHAR	Jaitpur Khadar RD3500 Pz	9.13	8.57	6.76	8.4	Pz
North East	SEELAM PUR	UshmanpurPz	5.48	4.91	4.39	4.63	Pz
Shahdara	SHAHDARA	CBD Shahdara	13.68	14.34	12.9	12.9	Pz
New Delhi	VASANT VIHAR	J N U Pz (Upstream)	17.65	12.83	7.94	10.1	Pz
New Delhi	VASANT VIHAR	Sultanpur IMS Pz	63.3	63.61	63.78	63.88	Pz
Shahdara	VIVEK VIHAR	Vivek Vihar (Pz)	20.96	21.25	20.32	20.1	Pz
North East	YAMUNA VIHAR	Yamuna Vihar DJB WTP	NA	NA	NA	19.45	Pz

List of Deep Aquifer monitoring stations monitored during 2021-22, NCT Delhi (Water Level in m bgl)							
DISTRICT	TEHSIL NAME	SITE_NAME	May-21	Aug_21	Nov-21	Jan-22	Pz/DW
North	ALIPUR	Bakoli Deep Pz	12.38	10.79	8.41	8.43	Pz
North	ALIPUR	Tiggipur Deep Pz	9.86	9.18	7.76	7.89	Pz
New Delhi	CHANAKYAPURI	Lodhi Garden (D)	6.13	5.03	3.77	4.09	Pz
New Delhi	DELHI CANTONMENT	Cvd Depot Cant (Deep)	NA	NA	24.98	24.8	Pz
South West	KAPESHERA	Shikarpur Deep Pz	8.72	8.1	6.7	7.38	Pz

ANNEXURE IIIB: DECADAL MEAN WATER LEVEL DATA

List of NHS/Monitoring wells monitored during 2011-2020 and Decadal mean				
	Decadal Mean Water Level in mbgl			
Site Name	DM (2011-20) May	DM (2011-20) Aug	DM (2011-20) Nov	DM (2012-21) Jan
AsolaPz	NA	49.61	49.19	49.15
AuchandiPz	3.23	1.34	2.11	2.5
Bakoli	10.54	11.96	10.64	10.29
Balbir Nagar DW	23.34	14.27	18.25	21.28
Bankner Pz	19.51	20.9	21.06	20.25
Baprola Dw	3.99	2.7	2.87	3.28
Barwala Pz	5.93	5.49	5.88	5.86
Bhalaswa Lake Pz	2.19	1.23	1.78	1.66
Bhatti Pz	49.98	47.49	47.25	48.72
Birla Temple	11.94	NA	9.98	NA
Burari Augur Pz	4.04	3.3	3.96	4.04
CBD Shahdara	10.91	11.02	11.36	11.45
Chandini Chowk DW	7.28	6.5	7.05	NA
Chhawla Pz	14.52	13.33	13.31	13.12
Chilla Regulator	9.22	8.91	9.11	9.02
Chilla Saroda Pz	9.75	9.61	9.68	9.63
Daryapur Khurd	4.34	2.74	3.49	4.29
Daulatpur Pz	15.6	14.81	15.03	15.55
Deorala	1.79	1.72	1.1	NA
Dwarka S-16 (TP)	19.98	20.11	20.52	20.47
Gadaipur Pz	59.71	59.02	59.22	59.35
Gazi Pur Crossing	21	21.24	20.52	21.03
Gokulpuri EW	NA	NA	9.23	9.51
Haiderpur Pz	11.21	10.92	11.21	11.01
Hareoli DW	4.52	3.6	2.71	3.39
Hauz Khas Pz	33.81	33.76	33.5	33.28
HiranKudna DW	3.01	1.68	2.31	2.58
Humayu Tomb DW	6.59	6.24	6.91	6.95
India Gate Pz	8.05	7.04	7.33	NA
ISBT (Kasmiri Gate) DW	2.74	1.4	2.45	2.75
J N U Pz (Upstream)	29.99	27.45	28.01	28.71
Jagatpur Pz 2	2.35	1.01	1.74	1.6
Jaitpur Khadar RD3500 Pz	6.25	5.81	6.48	6.99
Jamali Kamali DW	27.23	25.65	26.18	25.41
Janakpuri Pz	11.21	10.82	11.03	11.13
Jaunapur DJB TW	55.03	53.04	53.15	53.86
Jaunti DW	12.63	12.27	12.47	11.9
Jheel Khoh	54.55	51.34	51.17	51.53
Jhuljhuli Dw	2.44	0.98	2.17	2.04
Kabul Line Pz	28.45	28.46	28.67	28.47
Kanjhawala Pz	1.86	0.96	2.27	1.32
Kingsway Camp Police Ground Pz	7.69	6.92	7.39	NA

	Decadal Mean Water Level in mbgl			
Site Name	DM (2011-20) May	DM (2011-20) Aug	DM (2011-20) Nov	DM (2012-21) Jan
Lodhi Garden.(SH)	8.35	7.94	7.95	7.51
Lodhi Graden Dw	11.43	11.72	10.59	11.4
Mahabir Vansthali	26.16	26.11	26.65	26.39
Majara Dabas	3.58	2.5	3.21	3.34
Majnu Ka Tila DW	9.46	7.81	8.48	8.32
Mangolpur Pz	3.34	2.48	2.89	2.92
MayapuriPz	36.59	36.44	36.72	36.47
Mayur Vihar B Block Ph II	7.63	7.53	7.91	7.82
Mundela Kalan Pz	12.98	13.14	12.03	12.65
Najafgarh Town	20.78	21	20.72	20.73
Nangli Rajapur Pz	3.69	2.83	3.88	3.43
Nehru Park Dw	27.85	22.46	21.91	22.1
Nizampur EW	7.59	7.06	7.06	7.35
Nizamuddin Bridge 2 Pz	4.26	3	3.92	3.76
Palla Temple	7.63	6.33	7.26	7.03
Palla Zero RD	8.48	9.03	8.92	8.5
PeeragarhiPz	5.67	4.89	4.98	4.97
PUSA (NRL) Pz	24.1	24.13	24.87	24.22
Pusa Institute (WTC)	21.89	NA	NA	NA
Pusp Vihar Pz	60.67	59.81	58.63	57.72
Qatlupur	2.75	NA	1.74	1.85
Rani Khera DW	2.59	1.42	2.07	NA
RaotaDw	2.82	1.6	2.11	2.17
Rohini Sec 11 Pz	6.48	5.95	6.17	5.98
Rohini Sector 28	5.86	5.13	5.58	5.66
Safdarjung tomb	16.25	14.7	15.97	14.75
SainikVihar(Pz)	2.9	1.58	2.38	2.37
Shekhwati Line Pz	44.77	42.7	42.86	43.19
Shikarpur Shallow Pz	10.96	11.48	10.53	10.44
Shram Shakti Bhawan 2	13.24	12.39	12.56	12.12
Shram Shakti Bhawan 3	14.41	NA	NA	NA
Singhola Pz	15.9	15.82	16.69	16.03
Sultanpur IMS Pz	57.33	57.32	57.66	57.94
Sunder Nursery Pz	7.73	7.35	7.4	7.33
Surheda	NA	11.15	NA	13.12
Tagore Garden	11.91	NA	11.26	11.83
Tiggipur Shallow Pz	7.37	7.2	7.06	7.23
Ujwah Pz	15.24	15.3	14.65	15.07
Ushmanpur Pz	4.68	2.7	3.32	4.43
Vikashpuri Pz	14.11	13.76	14.1	13.71

List of Deep Aquifer NHS/Monitoring wells monitored during 2011-2020 and Decadal mean				
	Decadal Mean Water Level in mbgl			
Site Name	DM (2011-20) May	DM (2011-20) Aug	DM (2011-20) Nov	DM (2012-21) Jan
Bakoli Deep Pz	10.59	12.27	10.78	10.54
Cvd Depot Cant (Deep)	NA	NA	21.57	23.17
Lodhi Garden (D)	8.64	8.18	8.17	7.82
Shikarpur Deep Pz	10.91	11.3	10.64	10.21
Tiggipur Deep Pz	9.05	9.37	8.74	8.66

Annexure IV(A): Ground Water Level Depth Range of Monitoring Stations, May-2021, NCT Delhi

Ground Water Level Depth Range of Monitoring Stations, NCT Delhi														
District Name	Tehsil Name	Total no. monitoring wells	Water Level, May-2021											
			0-2 mbgl		>2-5 mbgl		>5-10 mbgl		>10-20 mbgl		>20-40 mbgl		>40 mbgl	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
New Delhi	Chanakyapuri	13	0	0.0	0	0.0	8	61.5	2	15.4	3	23.1	0	0.0
	Delhi Cantonment	3	0	0.0	0	0.0	0	0.0	0	0.0	2	66.7	1	33.3
	Vasant Vihar	2	0	0.0	0	0.0	0	0.0	1	50.0	0	0.0	1	50.0
North	Alipur	12	0	0.0	0	0.0	5	41.7	5	41.7	2	16.7	0	0.0
	Narela	8	0	0.0	3	37.5	2	25.0	2	25.0	1	12.5	0	0.0
	Model Town	1	1	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
North West	SaraswatiVihar	5	0	0.0	4	80.0	1	20.0	0	0.0	0	0.0	0	0.0
	Khanjhawala	9	1	11.1	4	44.4	3	33.3	1	11.1	0	0.0	0	0.0
	Rohini	8	2	25.0	3	37.5	3	37.5	0	0.0	0	0.0	0	0.0
North East	Yamuna Vihar	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Karawal Nagar	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Seelampur	1	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0
Central	civil Lines	6	1	16.7	3	50.0	2	33.3	0	0.0	0	0.0	0	0.0
	Kotwali	1	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0
	Karol Bagh	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
South	Mehrauli	4	0	0.0	0	0.0	0	0.0	0	0.0	1	25.0	3	75.0
	Saket	2	0	0.0	0	0.0	0	0.0	0	0.0	1	50.0	1	50.0
	Hauz Khas	2	0	0.0	0	0.0	0	0.0	0	0.0	1	50.0	1	50.0
South West	Dwarka	3	0	0.0	0	0.0	0	0.0	2	66.7	1	33.3	0	0.0
	Najafgarh	6	1	16.7	1	16.7	0	0.0	4	66.7	0	0.0	0	0.0
	Kapashera	6	2	33.3	0	0.0	2	33.3	2	33.3	0	0.0	0	0.0
East	Preet Vihar	3	0	0.0	1	33.3	1	33.3	0	0.0	1	33.3	0	0.0
	Mayur Vihar	3	0	0.0	0	0.0	1	33.3	2	66.7	0	0.0	0	0.0
	Gandhi Nagar	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
West	Patel Nagar	3	0	0.0	0	0.0	0	0.0	2	66.7	1	33.3	0	0.0
	Punjabi Bagh	4	0	0.0	2	50.0	2	50.0	0	0.0	0	0.0	0	0.0
	Rajouri Garden	2	0	0.0	0	0.0	0	0.0	1	50.0	1	50.0	0	0.0
Shahdara	Shahdara	1	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0
	Vivek Vihar	1	0	0.0	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0
	Seemapuri	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
South East	Defence Colony	1	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0	0	0.0
	Kalkaji	3	0	0.0	0	0.0	2	66.7	1	33.3	0	0.0	0	0.0
	Sarita Vihar	1	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0
Nazul Land	Nazul Land	3	0	0.0	1	33.3	2	66.7	0	0.0	0	0.0	0	0.0
Total		**117**	**8**	**6.8**	**23**	**19.7**	**37**	**31.6**	**26**	**22.2**	**16**	**13.7**	**7**	**6.0**

Annexure IV(B): Ground Water Level Depth Range of Monitoring Stations, August-2021, NCT Delhi

Ground Water Level Depth Range of Monitoring Stations, NCT Delhi														
District Name	Tehsil Name	Total no. monitoring wells	Water Level, Aug-2021											
			0-2 mbgl		>2-5 mbgl		>5-10 mbgl		>10-20 mbgl		>20-40 mbgl		>40 mbgl	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
New Delhi	Chanakyapuri	11	0	0.0	2	18.2	5	45.5	1	9.1	3	27.3	0	0.0
	Delhi Cantonment	2	0	0.0	0	0.0	0	0.0	0	0.0	1	50.0	1	50.0
	Vasant Vihar	2	0	0.0	0	0.0	0	0.0	1	50.0	0	0.0	1	50.0
North	Alipur	12	0	0.0	0	0.0	6	50.0	4	33.3	2	16.7	0	0.0
	Narela	7	2	28.6	1	14.3	2	28.6	1	14.3	1	14.3	0	0.0
	Model Town	2	2	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
North West	SaraswatiVihar	5	4	80.0	0	0.0	1	20.0	0	0.0	0	0.0	0	0.0
	Khanjhawala	4	1	25.0	1	25.0	1	25.0	1	25.0	0	0.0	0	0.0
	Rohini	8	3	37.5	3	37.5	2	25.0	0	0.0	0	0.0	0	0.0
North East	Yamuna Vihar	0	0	0	0	0	0	0	0	0	0	0	0	0
	Karawal Nagar	0	0	0	0	0	0	0	0	0	0	0	0	0
	Seelampur	1	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0	0	0.0
Central	civil Lines	6	4	66.7	0	0.0	2	33.3	0	0.0	0	0.0	0	0.0
	Kotwali	1	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0
	Karol Bagh	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
South	Mehrauli	4	0	0.0	0	0.0	0	0.0	1	25.0	0	0.0	3	75.0
	Saket	2	0	0.0	0	0.0	0	0.0	1	50.0	0	0.0	1	50.0
	Hauz Khas	2	0	0.0	0	0.0	0	0.0	0	0.0	1	50.0	1	50.0
South West	Dwarka	3	0	0.0	0	0.0	0	0.0	2	66.7	1	33.3	0	0.0
	Najafgarh	6	1	16.7	1	16.7	0	0.0	4	66.7	0	0.0	0	0.0
	Kapashera	6	2	33.3	0	0.0	2	33.3	2	33.3	0	0.0	0	0.0
East	Preet Vihar	3	0	0.0	1	33.3	1	33.3	0	0.0	1	33.3	0	0.0
	Mayur Vihar	3	0	0.0	0	0.0	1	33.3	2	66.7	0	0.0	0	0.0
	Gandhi Nagar	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
West	Patel Nagar	3	0	0.0	0	0.0	2	66.7	0	0.0	1	33.3	0	0.0
	Punjabi Bagh	4	2	50.0	1	25.0	1	25.0	0	0.0	0	0.0	0	0.0
	Rajouri Garden	1	0	0.0	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0
Shahdara	Shahdara	1	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0
	Vivek Vihar	1	0	0.0	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0
	Seemapuri	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
South East	Defence Colony	1	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0	0	0.0
	Kalkaji	4	1	25.0	1	25.0	0	0.0	1	25.0	0	0.0	1	25.0
	Sarita Vihar	1	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0
Nazul Land	Nazul Land	3	0	0.0	1	33.3	2	66.7	0	0.0	0	0.0	0	0.0
Total		**109**	**22**	**20.2**	**14**	**12.8**	**30**	**27.5**	**22**	**20.2**	**13**	**11.9**	**8**	**7.3**

Annexure IV(C): Ground Water Level Depth Range of Monitoring Stations, November-2021, NCT Delhi

Ground Water Level Depth Range of Monitoring Stations, NCT Delhi														
District Name	Tehsil Name	Total no. monitoring wells	Water Level, Nov-2021											
			0-2 mbgl		>2-5 mbgl		>5-10 mbgl		>10-20 mbgl		>20-40 mbgl		>40 mbgl	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
New Delhi	Chanakyapuri	12	0	0.0	5	41.7	3	25.0	2	16.7	2	16.7	0	0.0
	Delhi Cantonment	3	0	0.0	0	0.0	0	0.0	0	0.0	2	66.7	1	33.3
	Vasant Vihar	2	0	0.0	0	0.0	1	50.0	0	0.0	0	0.0	1	50.0
North	Alipur	12	0	0.0	1	8.3	8	66.7	3	25.0	0	0.0	0	0.0
	Narela	8	2	25.0	3	37.5	1	12.5	2	25.0	0	0.0	0	0.0
	Model Town	3	2	0.0	1	0.0	0	0.0	0	0.0	0	0.0	0	0.0
North West	SaraswatiVihar	6	4	66.7	2	33.3	0	0.0	0	0.0	0	0.0	0	0.0
	Khanjhawala	4	1	25.0	2	50.0	0	0.0	1	25.0	0	0.0	0	0.0
	Rohini	9	2	22.2	5	55.6	2	22.2	0	0.0	0	0.0	0	0.0
North East	Yamuna Vihar	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Karawal Nagar	2	0	0.0	0	0.0	1	50.0	1	50.0	0	0.0	0	0.0
	Seelampur	1	0	0.0	1	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Central	civil Lines	6	3	50.0	1	16.7	2	33.3	0	0.0	0	0.0	0	0.0
	Kotwali	1	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0
	Karol Bagh	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
South	Mehrauli	4	0	0.0	0	0.0	0	0.0	1	25.0	0	0.0	3	75.0
	Saket	2	0	0.0	0	0.0	0	0.0	1	50.0	0	0.0	1	50.0
	Hauz Khas	2	0	0.0	0	0.0	0	0.0	0	0.0	1	50.0	1	50.0
South West	Dwarka	3	0	0.0	0	0.0	0	0.0	3	100.0	0	0.0	0	0.0
	Najafgarh	6	1	16.7	1	16.7	2	33.3	2	33.3	0	0.0	0	0.0
	Kapashera	6	2	33.3	0	0.0	3	50.0	1	16.7	0	0.0	0	0.0
East	Preet Vihar	3	0	0.0	1	33.3	1	33.3	0	0.0	1	33.3	0	0.0
	Mayur Vihar	3	0	0.0	0	0.0	2	66.7	1	33.3	0	0.0	0	0.0
	Gandhi Nagar	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
West	Patel Nagar	3	0	0.0	0	0.0	2	66.7	0	0.0	1	33.3	0	0.0
	Punjabi Bagh	4	2	50.0	1	25.0	1	25.0	0	0.0	0	0.0	0	0.0
	Rajouri Garden	2	0	0.0	0	0.0	0	0.0	1	50.0	1	50.0	0	0.0
Shahdara	Shahdara	1	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0
	Vivek Vihar	1	0	0.0	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0
	Seemapuri	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
South East	Defence Colony	1	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0	0	0.0
	Kalkaji	9	1	11.1	4	44.4	3	33.3	0	0.0	0	0.0	1	11.1
	Sarita Vihar	1	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0
Nazul Land	Nazul Land	3	0	0.0	1	33.3	2	66.7	0	0.0	0	0.0	0	0.0
Total		**123**	**20**	**16.3**	**30**	**24.4**	**36**	**29.3**	**20**	**16.3**	**9**	**7.3**	**8**	**6.5**

Annexure IV(D): Ground Water Level Depth Range of Monitoring Stations, January-2022, NCT Delhi

Ground Water Level Depth Range of Monitoring Stations, NCT Delhi														
District Name	**Tehsil Name**	**Total no. monitoring wells**	**Water Level, Jan-2022**											
			0-2 mbgl		**>2-5 mbgl**		**>5-10 mbgl**		**>10-20 mbgl**		**>20-40 mbgl**		**>40 mbgl**	
			No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
New Delhi	Chanakyapuri	10	0	0.0	4	40.0	2	20.0	2	20.0	2	20.0	0	0.0
	Delhi Cantonment	3	0	0.0	0	0.0	0	0.0	0	0.0	2	66.7	1	33.3
	Vasant Vihar	2	0	0.0	0	0.0	0	0.0	1	50.0	0	0.0	1	50.0
North	Alipur	12	0	0.0	1	8.3	8	66.7	3	25.0	0	0.0	0	0.0
	Narela	7	1	14.3	3	42.9	1	14.3	1	14.3	1	14.3	0	0.0
	Model Town	3	1	0.0	2	0.0	0	0.0	0	0.0	0	0.0	0	0.0
North West	SaraswatiVihar	5	3	60.0	2	40.0	0	0.0	0	0.0	0	0.0	0	0.0
	Khanjhawala	4	1	25.0	2	50.0	0	0.0	1	25.0	0	0.0	0	0.0
	Rohini	7	1	14.3	5	71.4	1	14.3	0	0.0	0	0.0	0	0.0
North East	Yamuna Vihar	1	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0
	Karawal Nagar	2	0	0.0	0	0.0	1	50.0	1	50.0	0	0.0	0	0.0
	Seelampur	1	0	0.0	1	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Central	civil Lines	6	2	33.3	2	33.3	2	33.3	0	0.0	0	0.0	0	0.0
	Kotwali	1	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0
	Karol Bagh	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
South	Mehrauli	4	0	0.0	0	0.0	0	0.0	1	25.0	0	0.0	3	75.0
	Saket	2	0	0.0	0	0.0	0	0.0	1	50.0	0	0.0	1	50.0
	Hauz Khas	2	0	0.0	0	0.0	0	0.0	0	0.0	1	50.0	1	50.0
South West	Dwarka	3	0	0.0	0	0.0	0	0.0	3	100.0	0	0.0	0	0.0
	Najafgarh	6	2	33.3	0	0.0	2	33.3	2	33.3	0	0.0	0	0.0
	Kapashera	5	1	20.0	0	0.0	3	60.0	1	20.0	0	0.0	0	0.0
East	Preet Vihar	3	0	0.0	1	33.3	1	33.3	0	0.0	1	33.3	0	0.0
	Mayur Vihar	4	0	0.0	0	0.0	2	50.0	1	25.0	1	25.0	0	0.0
	Gandhi Nagar	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
West	Patel Nagar	3	0	0.0	0	0.0	2	66.7	0	0.0	1	33.3	0	0.0
	Punjabi Bagh	4	2	50.0	1	25.0	1	25.0	0	0.0	0	0.0	0	0.0
	Rajouri Garden	2	0	0.0	0	0.0	0	0.0	1	50.0	1	50.0	0	0.0
Shahdara	Shahdara	1	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0
	Vivek Vihar	1	0	0.0	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0
	Seemapuri	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
South East	Defence Colony	1	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0	0	0.0
	Kalkaji	9	1	11.1	4	44.4	2	22.2	1	11.1	0	0.0	1	11.1
	Sarita Vihar	1	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0
Nazul Land	Nazul Land	3	0	0.0	1	33.3	2	66.7	0	0.0	0	0.0	0	0.0
Total		**118**	**15**	**12.7**	**30**	**25.4**	**32**	**27.1**	**22**	**18.6**	**11**	**9.3**	**8**	**6.8**

Annexure V(A): Decadal Water Level Fluctuation with Mean [Pre-monsoon (2011 to 2020) and Pre- monsoon 2021]

Tehsil-wise Decadal Water Level Fluctuation with Mean [Pre-Monsoon (2011 to 2020] and Pre-Monsoon 2021]																									
S. No.	Name of District	Name of Tehsil	No. of wells Analysed	Range in m				Rise						Fall						Rise		Fall		Wells showing no change	
				Rise		Fall		0-2 m		2-4 m		>4 m		0-2 m		2-4 m		>4 m							
				Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
1	CENTRAL	CIVIL LINES	4			0.35	4.55							3	75			1	25	0		4	100	0	0
2	CENTRAL	KAROL BAGH	0																	0		0		0	0
3	CENTRAL	KOTWALI	1		0.89			1	100											1	100	0		0	0
4	EAST	GANDHI NAGAR	0																	0		0		0	0
5	EAST	MAYUR VIHAR	3			0.45	1.66							3	100					0		3	100	0	0
6	EAST	PREET VIHAR	1				4.74											1	100	0		1	100	0	0
7	NAZUL LAND	NAZUL LAND	1				0.07							1	100					0		1	100	0	0
8	NEW DELHI	CHANAKYAPURI	10	0.26	6.18	0.93	2.03	3	37.50	4	50.00	3	37.50	1	50	1	50			8	80	2	20	0	0
9	NEW DELHI	DELHI CANTONMENT	3			1.93	4.18							1	33	1	33	1	33.333	0	0	3	100	0	0
10	NEW DELHI	VASANT VIHAR	2		12.3		5.97					1	100					1	100	1	50.00	1	50.00	0	0
11	NORTH	ALIPUR	9			0.81	5.78							6	66.67	2	22.22	1	11.11	0	0	9	100	0	0
12	NORTH	MODEL TOWN	1		0.29			1	100.00											1	100	0	0	0	0
13	NORTH	NARELA	6	0.6	0.72	0.14	3.74	2	100					3	75.00	1	25			2	33.33	4	66.67	0	0
14	NORTH EAST	KARAWAL NAGAR	0																	0		0		0	0
15	NORTH EAST	SEELAMPUR	1				0.8							1	100.00					0		1	100	0	0
16	NORTH EAST	YAMUNA VIHAR	0																	0		0		0	0
17	NORTH WEST	KANJHAWALA	3	0.42	0.77		1.27	2	100					1	100					2	67	1	33.33	0	0
18	NORTH WEST	ROHINI	3	0.62	1.53			3	100											3	100	0		0	0
19	NORTH WEST	SARASWATI VIHAR	2		0.01		0.13	1	100					1	100					1	50	1	50.00	0	0
20	SHAHDARA	SEEMAPURI	0																	0		0		0	0
21	SHAHDARA	SHAHDARA	1				2.77									1	100			0		1	100	0	0
22	SHAHDARA	VIVEK VIHAR	0																	0		0		0	0
23	SOUTH	HAUZ KHAS	2	5.49	17.2							2	100							2	100	0	0	0	0
24	SOUTH	MEHRAULI	4	4.4	11.1	3.45	5.14					2	100			1	50	1	50	2	50.00	2	50.00	0	0
25	SOUTH	SAKET	2			1.46	4.74							1	50			1	50	0		2	100	0	0
26	SOUTH EAST	DEFENCE COLONY	1				0.4							1	100					0		1	100	0	0
27	SOUTH EAST	KALKAJI	0																			0		0	0
28	SOUTH EAST	SARITA VIHAR	1				2.88									1	100			0		1	100	0	0
29	SOUTH WEST	DWARKA	1				0.84							1	100					0		1	100	0	0
30	SOUTH WEST	KAPASHERA	6	1.17	2.4			3	50	3	50									6	100	0		0	0
31	SOUTH WEST	NAJAFGARH	5	0.39	1.46			5	100											5	100.00	0		0	0
32	WEST	PATEL NAGAR	3	1.16	3.34		7.83	1	50	1	50							1	100	2	66.67	1	33	0	0
33	WEST	PUNJABI BAGH	3	0.17	0.58			3	100											3	100	0		0	0
34	WEST	RAJOURI GARDEN	2			1.67	5.98							1	50			1	50	0		2	100	0	0
Total			81					25		8		8		25		8		9		39		42		0	

Annexure V(B): Decadal Water Level Fluctuation with Mean [Post monsoon (2011 to 2020) and Post monsoon 2021]

Tehsil-wise Decadal Water Level Fluctuation with Mean [Post monsoon (2011 to 2020] and Post monsoon 2021]																									
S. No.	Name of District	Name of Tehsil	No. of wells Analysed	Range in m				Rise						Fall						Rise		Fall		Wells showing no change	
				Rise		Fall		0-2 m		2-4 m		>4 m		0-2 m		2-4 m		>4 m							
				Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
1	CENTRAL	CIVIL LINES	4	0.22	0.76	0.15	4.1	2	100					1	50			1	50	2	50	2	50	0	0
2	CENTRAL	KAROL BAGH	0																	0		0		0	0
3	CENTRAL	KOTWALI	1		1.28			1	100											1	100	0	0	0	0
4	EAST	GANDHI NAGAR	0																	0		0		0	0
5	EAST	MAYUR VIHAR	3		0.1	0.3	1.4	1	100					2	100					1	33.33	2	66.67	0	0
6	EAST	PREET VIHAR	1				5.51											1	100	0	0	1	100	0	0
7	NAZUL LAND	NAZUR LAND	1		1.37			1	100											1	100	0	0	0	0
8	NEW DELHI	CHANAKYAPURI	11	1.32	6.6			1	9.1	5	45	5	45							11	100	0	0	0	0
9	NEW DELHI	DELHI CANTONMENT	3			1.51	3.87							1	33.3	2	66.67			0	0	3	100	0	0
10	NEW DELHI	VASANT VIHAR	2		20.1		6.12					1	100					1	100	1	50.00	1	50.00	0	0
11	NORTH	ALIPUR	9	0.06	2.46	0.88	2.72	4	67	2	33			2	66.7	1	33.33			6	66.67	3	33.33	0	0
12	NORTH	MODEL TOWN	1		0.88		0	1	100											1	100	0	0	0	0
13	NORTH	NARELA	6	1.09	3.66	0	0.39	4	80	1	20			1	100					5	83.33	1	16.67	0	0
14	NORTH EAST	KARAWAL NAGAR	1				9.44											1	100	0		1		0	0
15	NORTH EAST	SEELAMPUR	1				1.07							1	100					0	0	1	100	0	0
16	NORTH EAST	YAMUNA VIHAR	0																	0		0		0	0
17	NORTH WEST	KANJHAWALA	3	0.37	2.67			2	67	1	33									3	100.00	0		0	0
18	NORTH WEST	ROHINI	3	0.87	2.75			2	67	1	33									3	100.00	0		0	0
19	NORTH WEST	SARASWATI VIHAR	2	0.94	2.28			1	50	1	50									2	100	0		0	0
20	SHAHDARA	SEEMAPURI	0																	0		0		0	0
21	SHAHDARA	SHAHDARA	1				1.54							1	100							1	100	0	0
22	SHAHDARA	VIVEK VIHAR	0																	0		0		0	0
23	SOUTH	HAUZ KHAS	2	6.78	16.3							2	100							2	100	0		0	0
24	SOUTH	MEHRAULI	4	12.2	12.6	2.71	6.45					2	100	1	50			1	50	2	50.00	2	50.00	0	0
25	SOUTH	SAKET	2	3.81	6.7					1	50	1	50							2	100	0		0	0
26	SOUTH EAST	DEFENCE COLONY	1		0.14			1	100											1	100	0		0	0
27	SOUTH EAST	KALKAJI	1		1.35			1	100											1	100	0		0	0
28	SOUTH EAST	SARITA VIHAR	1				0.28							1	100							1	100	0	0
29	SOUTH WEST	DWARKA	1		1.13			1	100											1	100	0		0	0
30	SOUTH WEST	KAPASHERA	6	0.25	4.75			3	60	2	40									5	83.33	0	0	0	0
31	SOUTH WEST	NAJAFGARH	5	2.49	5.75		0.23			3	75	1	25	1	100					4	80	1	20	0	0
32	WEST	PATEL NAGAR	3	3.68	6.37		7.07			1	50	1	50					1	100	2	66.67	1	33.33	0	0
33	WEST	PUNJABI BAGH	4	1.66	2.97			1	25	3	75									4	100	0		0	0
34	WEST	RAJOURI GARDEN	2		0.06		3.17	1	100							1	100			1	50	1	50	0	0
Total			85					28		21		13		12		4		6		62		22			

ANNEXURE: VI(A) LIST OF GROUNDWATER SAMPLES & CHEMICAL ANALYSIS (BASIC ELEMENTS): MAY 2021

S. No	Location	pH*	EC* in µS/cm at 25^0 C	CO_3	HCO_3	Cl*	SO_4	NO_3*	F*	PO_4	Ca*	Mg*	Na*	K*	SiO_2	TH *as $CaCO_3$
				mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
1	Bakoli	7.99	4808	0	156	1098	754	1.4	0.57	<0.01	128	202	620	14	21	1151
2	Haider pur	8.39	623	21	227	56	31	2.7	1.90	<0.01	52	22	51	4.1	21	220
3	Hiranki Village	8.42	1408	21	255	284	62	6.7	0.48	<0.01	36	51	189	9.4	21	300
4	Khera Kalan	9.24	1038	63	426	21	35	2.6	2.40	<0.01	16	15	115	2	28	100
5	Palla Temple	8.50	998	21	199	208	BDL	15.5	0.57	<0.01	24	32	140	8.7	22	190
6	Palla Zero RD	8.24	622	0	284	46	38	1	1.40	<0.01	24	24	85	2.8	18	160
7	Rohini Sec 28	8.33	7335	28	312	1604	1558	0.4	0.43	<0.01	36	212	1480	12	24	961
8	Singhola	8.20	1634	0	213	486	140	29	0.18	<0.01	16	58	255	1.7	19	280
9	Singhu Village	7.81	3955	0	298	736	728	47	0.21	<0.01	124	165	500	5.8	22	991
10	Tiggipur	8.34	1990	28	369	298	150	135	0.49	<0.01	60	34	345	3.2	15	290
11	India Gate Pz	8.33	3294	42	353	556	394	146	1.10	<0.01	24	102	511	26	22	480
12	Nehru Park	8.44	1068	14	206	194	BDL	86	0.66	<0.01	40	29	140	10	18	220
13	Lodhi Garden	8.52	519	14	113	83	31	16	0.51	<0.01	32	27	37	0.7	18	190
14	Safdarjung Tomb	8.73	885	42	355	26	50	19	2.20	<0.01	8	24	160	5.4	15	120
15	Sunder Nursery	8.68	619	28	327	35	5	9.9	0.45	<0.01	12	29	105	2.8	19	150
16	Burari	8.09	2160	0	184	396	271	146	0.28	<0.01	88	90	243	10	28	590
17	Burari DJB Ex Engg. Office	8.15	1254	0	253	201	134	6.0	1.40	<0.01	48	41	164	5	21	290
18	Jagatpur	8.10	2165	0	184	389	298	147	0.29	<0.01	112	83	118	178	21	620
19	KhelaGhatBhela Road	8.66	967	14	170	104	127	44	0.73	<0.01	32	46	87	20	21	270
20	Majnu ka Tila	8.05	2554	0	256	542	238	116	0.51	<0.01	80	71	310	120	19	490
21	NangliRajapur	8.27	256	0	121	14	BDL	3.3	0.39	<0.01	48	12	5.52	2.1	19	170
22	Shekhawati Line	8.32	993	21	298	111	60	16	1.70	<0.01	20	68	84	5.3	23	330

S. No	Location	pH*	EC* in µS/cm at 25^0 C	CO_3	HCO_3	Cl^*	SO_4	NO_3^*	F^*	PO_4	Ca^*	Mg^*	Na*	K*	SiO_2	TH *as $CaCO_3$
				mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
23	Dwarka Sec 23 DDA Park	8.91	2843	140	668	514	BDL	11	1.81	<0.01	16	39	620	8	19	200
24	Dwarka Sec 5 DDA Park	8.28	253	0	113	14	27	4	0.85	<0.01	28	17	3.5	1.3	14	140
25	PuspVihar	8.06	2142	0	170	656	10	13	0.19	<0.01	68	56	320	4.3	19	400
26	Asola	8.34	667	28	199	90	BDL	14	0.53	<0.01	24	22	92	3.9	13	150
27	GK 2	8.33	354	21	156	27	BDL	0	0.65	<0.01	40	24	2	0.5	14	200
28	Kanjhawala	8.44	10680	70	738	2598	894	29	2.30	<0.01	56	139	1980	25	34	710
29	Jaunti	8.96	3356	70	668	639	104	53	8.90	<0.01	20	29	694	7	26	170
30	Nizampur	8.22	517	0	149	69	BDL	7.0	0.39	<0.01	40	12	44	4.6	20	150
31	Daulatpur	8.17	269	0	156	21	BDL	3	0.76	<0.01	32	19	2	0.7	11	160
32	Raota	7.90	4823	0	1273	1273	510	95	0.12	<0.01	216	229	490	9.2	19	1481
33	Chandni Chowk	8.45	761	14	213	90	74	20	0.63	<0.01	28	27	91	38	17	180
34	Chilla Regulator	8.43	707	14	228	118	10	6.2	0.40	<0.01	16	39	84	8.8	22	200
35	Mayur Vihar	8.38	689	21	256	62	BDL	7.4	0.96	<0.01	28	19	92	1.2	21	150
36	Gadaipur	8.65	870	28	284	76	BDL	97	0.48	<0.01	16	41	113	3	20	210
37	Jamali Kamali	8.14	2309	0	870	298	14	67	1.50	<0.01	40	48	425	8.5	23	300
38	Jaunapur	8.36	350	0	56	41	53	4.8	0.33	<0.01	36	10	15	4.7	11	130
39	JheelKhoh	8.82	890	28	298	90	14	49	1.20	<0.01	20	36	130	1.6	22	200
40	Bhalaswa Lake	7.87	4744	0	171	1334	361	1.6	0.71	<0.01	224	168	561	11	21	1251
41	Kewal ParkPz	7.73	12140	0	113	3946	780	1.2	0.48	<0.01	292	227	2200	16	22	1666
42	Jhuljhuli	9.23	1180	77	369	132	12	5.3	3.2	<0.01	32	32	195	9	27	210
43	Najafgarh	8.24	269	0	99	27	62	3.3	0.44	<0.01	32	15	8.87	3.7	17	140

S. No	Location	pH*	EC* in µS/cm at 25^0 C	CO_3	HCO_3	Cl*	SO_4	NO_3*	F*	PO_4	Ca*	Mg*	Na*	K*	SiO_2	TH *as $CaCO_3$
				mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
44	Ujwah	7.94	5858	0	184	938	1450	50	0.3	<0.01	208	185	800	7.9	19	1281
45	AuchandiPz	8.13	5480	0	87	637	BDL	13	1.70	<0.01	68	129	112	14	17	701
46	Bankner	7.78	3936	0	199	806	584	25	0.48	<0.01	228	136	385	29	20	1131
47	Barwala	7.50	8243	0	71	2779	145	76	0.16	<0.01	801	80	790	9	19	2332
48	Bawana JE Store	8.54	1146	56	128	153	157	28	1.20	<0.01	32	54	134	5.2	17	300
49	Hareoli	8.23	2540	0	212	444	424	43	0.74	<0.01	88	143	240	8	23	810
50	Kingsway Camp Police Ground	8.64	1992	35	241	437	117	12	0.75	<0.01	96	58	226	6	21	480
51	Qatlupur	8.22	802	0	241	106	BDL	85	0.20	<0.01	12	41	94	1.8	22	200
52	Bhawana WTP	7.51	21200	0	497	4697	4790	0.4	0.38	<0.01	505	846	3350	23	25	2371
53	Nizamuddin Bridge	8.94	1196	56	611	55	BDL	7.6	3.10	<0.01	12	19	260	3.8	21	110
54	Janakpuri	8.88	1807	42	440	364	17	54	1.30	<0.01	24	83	268	1	29	400
55	Pusa (NRL)	7.64	13060	0	270	3871	35	35	0.33	<0.01	400	618	1860	32	29	3542
56	Vikaspuri	8.57	1135	28	341	118	70	25	1.60	<0.01	12	100	205	3.5	21	140
57	Gazipur Crossing	8.43	704	28	212	124	18	6.6	0.42	<0.01	28	34	95	8.8	15	210
58	Bapraula	8.32	250	14	71	14	31	4.3	0.61	<0.01	28	15	4.6	1.4	14	130
59	HiranKudna	7.87	5174	0	269	1340	281	196	0.36	<0.01	168	129	731	3	25	950
60	Peeragarhi	8.01	1319	0	554	206	5	0.5	0.39	<0.01	32	51	210	6.0	21	290
61	Peeragarhi	8.11	3680	0	341	908	330	40	0.63	<0.01	107	168	450	13	8	950
62	Tikri Kalan	8.21	723	0	270	83	55	5.1	0.41	<0.01	190	24	32	93	4.23	190
63	Mangolpur	8.85	1190	42	383	111	48	24	1.30	<0.01	12	34	150	98	23	170
64	Rani Khera	8.16	805	0	156	186	228	4.0	1.10	<0.01	64	68	25	4.0	20	440
65	Rithala Village	8.73	5808	77	341	1710	260	20	0.25	<0.01	136	194	890	28	22	1140
66	Rohini Sec 11	8.72	948	42	412	53	10	4.9	5.10	<0.01	32	15	170	4.5	21	140

S. No	Location	pH*	EC* in µS/cm at 25^0 C	CO_3	HCO_3	Cl*	SO_4	NO_3*	F*	PO_4	Ca*	Mg*	Na*	K*	SiO_2	TH *as $CaCO_3$
				mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
67	Sultanpur Dabas	8.07	2837	0	270	528	470	6.8	0.36	<0.01	100	88	390	4.8	24	610
68	Sanjay Gandhi Transport Nagar Pz	7.42	12780	0	312	3800	870	0.2	0.44	<0.01	629	314	1700	17	22	2812
69	Balbir Nagar	8.40	387	28	99	28	15	38	0.69	<0.01	52	15	11	0.8	18	190
70	Bhatti	8.44	303	28	128	21	BDL	8.4	0.93	<0.01	24	12	35	2.1	15	110
71	MajaraDabas	8.16	967	0	241	236	BDL	7.2	0.77	<0.01	52	9.7	170	2.37	17	170
72	SainikVihar	8.03	220	0	113	13	15	1.6	0.28	<0.01	12	22	3.46	3.3	23	120
73	Sandesh vihar	8.56	1829	42	312	345	150	2.0	3.20	<0.01	28	46	330	4.0	22	260
74	Sanjay Van	7.83	9168	0	270	3001	760	4.4	0.46	<0.01	140	299	1680	16	21	1581
75	Jaitpur Khadar	8.56	1404	21	241	229	174	8.1	0.25	<0.01	28	44	227	9.5	19	250
76	Ushmanpur	8.40	405	21	156	20	48	9.6	0.45	<0.01	32	29	11	23	20	200
77	CBD Shahdara	7.92	4928	0	440	1369	178	9.5	0.74	<0.01	152	112	769	10	25	841
78	JNU	8.40	1362	27	255	229	77	39	0.81	<0.01	24	58	188	1	27	300
79	Sultanpur IMS	8.41	3019	42	483	708	60	29	1.40	<0.01	44	58	550	5.7	22	350

ANNEXURE: VI(B) LIST OF GROUNDWATER SAMPLES & CHEMICAL ANALYSIS (HEAVY METALS): MAY 2021

S.No.	Location	Cr	Mn	Fe	Ni	Cu	Zn	As	Se	Ag	Cd	Pb	U
		Concentration in PPM						Concentration in PPB					
1	Asola	BDL	0.002	0.049	BDL	BDL	0.014	0.082	0.207	BDL	0.096	BDL	1.687
2	AuchandiPz	BDL	0.055	0.080	BDL	BDL	0.170	0.510	0.030	0.212	0.060	0.316	25.928
3	Bakoli	BDL	0.117	0.007	BDL	BDL	0.024	0.070	BDL	BDL	0.012	BDL	11.262
4	Balbir Nagar	BDL	0.096	0.012	0.001	BDL	0.052	0.111	0.007	BDL	0.185	BDL	0.053
5	Bankner	BDL	0.052	0.038	0.001	BDL	0.725	0.369	0.133	0.442	0.047	3.048	18.458
6	Bapraula	BDL	0.001	0.002	BDL	BDL	0.052	0.781	0.031	BDL	0.164	BDL	1.556
7	Barwala	BDL	0.703	0.587	0.001	BDL	0.167	0.054	0.009	0.087	0.005	BDL	0.877
8	Bawana JE Store	0.002	0.003	BDL	BDL	BDL	0.082	0.547	0.083	0.252	0.019	0.084	19.942
9	Bhalaswa Lake	BDL	0.252	3.392	BDL	BDL	1.575	0.134	0.085	BDL	0.035	BDL	4.543
10	Bhatti	BDL	0.003	0.011	BDL	BDL	0.037	0.088	0.035	BDL	0.095	BDL	0.586
11	Burari	BDL	1.424	0.359	0.001	BDL	0.152	0.249	0.017	BDL	0.108	BDL	9.311
12	Burari DJB Ex Engg. Office	BDL	0.533	2.360	BDL	BDL	0.073	7.109	0.004	BDL	0.034	0.069	5.386
13	CBD Shahdara	BDL	0.068	0.010	BDL	BDL	0.533	0.282	BDL	BDL	0.088	BDL	12.294
14	Chandni Chowk	BDL	0.003	0.015	0.004	0.025	0.151	0.431	0.094	BDL	0.107	0.360	2.367
15	Chilla Regulator	BDL	0.062	0.010	BDL	BDL	0.280	0.345	0.002	BDL	0.103	0.020	8.804
16	Daulatpur	BDL	0.002	0.009	BDL	0.001	0.051	1.109	0.015	BDL	0.169	BDL	2.113
17	Dwarka Sec 23 DDA Park	BDL	0.009	0.007	BDL	BDL	0.081	0.467	0.002	BDL	0.156	BDL	13.639
18	Dwarka Sec 5 DDA Park	BDL	0.003	0.006	BDL	BDL	0.047	1.251	0.048	BDL	0.155	BDL	2.517
19	Gadaipur	0.002	0.007	0.083	BDL	BDL	0.027	0.184	0.155	BDL	0.060	BDL	2.453
20	Gazipur Crossing	BDL	0.074	0.016	BDL	BDL	0.290	0.387	0.012	BDL	0.081	0.227	7.209

S.No.	Location	Cr	Mn	Fe	Ni	Cu	Zn	As	Se	Ag	Cd	Pb	U
		Concentration in PPM						Concentration in PPB					
21	GK 2	BDL	0.002	0.029	BDL	BDL	0.042	0.147	0.021	BDL	0.083	BDL	1.285
22	Haiderpur	BDL	0.005	0.015	BDL	BDL	0.007	0.616	0.043	0.815	0.016	BDL	7.670
23	Hareoli	0.002	0.003	0.083	BDL	BDL	0.832	0.391	0.040	1.005	0.097	4.086	22.605
24	HiranKudna	BDL	0.154	0.073	0.003	BDL	1.299	0.388	0.010	0.408	0.020	4.624	11.954
25	Hiranki Village	BDL	0.002	0.016	BDL	0.001	0.036	0.382	0.013	BDL	0.033	BDL	9.879
26	India Gate Pz	BDL	0.107	0.016	BDL	BDL	0.167	0.205	0.135	BDL	0.129	0.142	14.269
27	JNU	0.002	BDL	0.001	BDL	BDL	BDL	0.237	0.312	BDL	BDL	BDL	10.622
28	Jagatpur	BDL	2.293	0.217	BDL	BDL	0.073	0.437	0.145	BDL	0.053	BDL	6.366
29	Jaitpur Khadar	BDL	BDL	0.002	BDL	BDL	BDL	1.688	0.008	BDL	BDL	BDL	6.364
30	Jamali Kamali	0.004	0.028	0.025	BDL	BDL	BDL	0.475	0.480	BDL	0.067	BDL	12.991
31	Janakpuri	BDL	BDL	BDL	BDL	BDL	BDL	0.528	0.023	BDL	0.144	BDL	14.906
32	Jaunapur	BDL	0.002	0.018	BDL	BDL	0.049	1.490	0.035	BDL	0.127	BDL	1.135
33	Jaunti	BDL	0.002	0.019	BDL	BDL	0.620	4.401	0.124	0.390	0.163	2.005	39.810
34	Jheel Khoh	0.001	BDL	BDL	BDL	BDL	BDL	0.195	0.127	BDL	BDL	BDL	12.100
35	Jhuljhuli	0.006	0.003	0.021	BDL	0.003	0.039	5.172	0.243	BDL	0.152	BDL	6.314
36	Kanjhawala	BDL	0.030	0.622	BDL	BDL	0.035	0.259	0.154	0.079	0.315	BDL	34.902
37	Khela Ghat Bhela Road	0.004	0.001	0.016	BDL	0.003	0.009	3.731	0.210	BDL	0.060	BDL	6.447
38	Khera Kalan	BDL	0.010	0.011	BDL	0.002	0.042	1.816	0.041	BDL	0.471	BDL	19.238
39	Kingsway Camp Police Ground	BDL	0.113	0.480	BDL	0.068	0.042	1.758	0.054	2.322	0.013	2.604	2.624
40	Lodhi Garden	BDL	0.267	0.234	BDL	BDL	0.362	0.066	0.105	BDL	0.055	BDL	4.528
41	MahabirVansth.	BDL	0.012	0.142	0.001	BDL	0.033	0.059	0.109	BDL	0.063	BDL	2.168
42	MajaraDabas	BDL	0.071	0.044	BDL	BDL	0.418	0.255	0.093	0.252	0.029	0.091	12.955
43	Majnu ka Tila	0.003	0.055	0.029	0.005	0.002	0.009	0.641	0.239	BDL	0.042	BDL	9.599

S.No.	Location	Cr	Mn	Fe	Ni	Cu	Zn	As	Se	Ag	Cd	Pb	U
		Concentration in PPM						Concentration in PPB					
44	Mangolpur	BDL	0.139	0.264	BDL	BDL	0.030	0.329	0.006	BDL	0.042	BDL	0.665
45	Mayur Vihar	BDL	0.060	0.075	0.009	BDL	0.033	0.646	0.035	BDL	0.082	BDL	1.246
46	Najafgarh	BDL	0.006	0.020	BDL	BDL	0.260	1.179	0.034	BDL	0.106	BDL	1.690
47	Nangli Rajapur	BDL	0.949	4.583	BDL	BDL	0.050	84.055	BDL	BDL	0.042	BDL	BDL
48	Nehru Park	BDL	0.243	BDL	BDL	BDL	BDL	0.007	0.024	BDL	0.010	BDL	7.009
49	Nizampur	0.003	0.288	0.010	0.007	0.012	1.860	0.091	0.223	BDL	0.131	0.693	58.399
50	Nizamuddin Bridge	0.001	1.044	0.754	BDL	BDL	0.099	27.511	0.022	BDL	0.048	BDL	5.075
51	Palla Temple	0.004	0.327	0.016	BDL	BDL	0.014	0.110	0.111	BDL	0.008	BDL	9.400
52	Palla Zero RD	BDL	BDL	0.344	0.001	BDL	0.769	0.270	0.008	0.550	0.325	BDL	4.150
53	Peeragarhi	BDL	0.212	0.010	BDL	BDL	BDL	0.091	0.024	BDL	0.010	BDL	7.009
54	Peeragarhi	0.003	0.004	0.010	0.007	0.012	0.036	1.228	0.223	BDL	0.131	0.693	20.240
55	Pusa (NRL)	0.001	0.006	0.057	BDL	BDL	0.099	0.231	0.022	BDL	0.048	BDL	5.075
56	PuspVihar	0.004	0.001	0.016	BDL	BDL	0.014	0.179	0.111	BDL	0.008	BDL	11.289
57	Qatlupur	BDL	0.070	0.344	0.001	BDL	0.769	0.110	0.008	0.550	0.325	BDL	16.059
58	Rani Khera	BDL	0.162	0.044	0.001	BDL	0.027	0.270	0.009	0.192	0.010	BDL	12.812
59	Raota	BDL	0.028	0.013	BDL	BDL	0.010	0.251	0.014	BDL	0.031	BDL	0.350
60	Rithala Village	BDL	0.016	0.003	BDL	BDL	0.019	1.372	0.020	BDL	0.335	0.087	20.604
61	Rohini Sec 11	BDL	0.187	2.422	BDL	BDL	0.005	0.034	0.001	0.163	0.006	BDL	1.021
62	Rohini Sec 28	BDL	0.015	0.013	BDL	BDL	0.732	1.226	0.307	0.709	0.113	7.729	8.750
63	Safdarjung Tomb	BDL	0.002	0.019	BDL	0.005	0.088	0.915	0.033	BDL	0.080	BDL	1.395
64	SainikVihar	BDL	BDL	BDL	BDL	BDL	BDL	2.971	0.009	BDL	0.041	BDL	20.788
65	Sandesh vihar	BDL	BDL	BDL	BDL	BDL	BDL	0.187	0.001	BDL	0.042	BDL	7.761
66	Sanjay Van	BDL	BDL	BDL	BDL	BDL	0.017	0.391	0.003	BDL	0.042	BDL	12.159
67	Shekhawati Line	BDL	0.018	0.025	BDL	BDL	0.606	0.185	0.055	BDL	0.112	1.762	9.881

S.No.	Location	Cr	Mn	Fe	Ni	Cu	Zn	As	Se	Ag	Cd	Pb	U
		Concentration in PPM						Concentration in PPB					
68	Singhola	BDL	0.111	0.477	BDL	BDL	1.986	0.066	0.122	BDL	0.080	BDL	8.992
69	Singhu Village	BDL	0.003	0.016	BDL	BDL	0.007	0.787	0.056	BDL	0.014	BDL	6.388
70	Sultanpur Dabas	0.002	0.001	0.017	BDL	BDL	0.101	0.961	0.145	0.602	0.062	0.283	24.983
71	Sultanpur IMS	0.015	0.003	0.015	BDL	0.015	0.035	0.652	0.094	BDL	0.071	2.174	8.096
72	Sunder Nursery	BDL	0.061	0.028	BDL	BDL	0.019	0.243	0.083	BDL	0.067	BDL	10.900
73	Tiggipur	BDL	0.254	0.015	BDL	BDL	0.004	1.428	0.001	BDL	0.017	BDL	5.561
74	Tikri Kalan	BDL	0.003	0.043	0.001	BDL	1.267	0.114	0.105	0.389	0.033	6.212	8.232
75	Ujwah	0.002	0.003	0.013	BDL	0.001	0.018	0.610	0.138	BDL	0.087	BDL	13.253
76	Ushmanpur	BDL	1.421	0.511	BDL	BDL	0.075	41.208	0.010	BDL	0.117	BDL	3.193
77	Vikaspuri	BDL	BDL	BDL	BDL	BDL	BDL	0.407	0.043	BDL	0.184	BDL	20.735

REFERENCE

1. Delhi Statistical Hand Book - 2021, Directorate of Economics & Statistics, Government of NCT,Delhi
2. Census of India Report -2011; District Census Handbook, Directorate of Census Operations,Delhi
3. GSI Study Report: Kachroo and Baghchi,1999.
4. Jayant K. Tripathi & V. Rajmani: 'Weathering control over geomorphology of Supermature Proterozoic Delhi Quartzites of India' Earth Surface Processes & Landforms – Vol 28, Issue 13, Dec 2003.
5. GSI Study Reports: Naha et.al 1944 & 1987; Roy 1988; Gangopadhyay and Sen, 1968)
6. GSI Study Report: Srivastava et al. (1980)
7. NAQUIM Report – "Aquifer Mapping and Groundwater Management Plan of Delhi", CGWB, SUO, New Delhi, 2016.
8. Freeze R A & Cherry J A, "Groundwater Book"; 1979 Prentice Hall Inc.