PREFACE

National Capital Territory (NCT) of Delhi is one of the largest metropolises spread over an area of 1483 sq.km. Due to high water consumption of the urban populace, this is a water stressed state. It is the eighth largest metropolis in the world with a population of 16,753,235 inhabitants as per the 2011 Census. Around 75% of state area is urbanized and more than 97% of its population lives in urban area.

Ground water is one of the primary resources to meet the water requirements of our country as a whole. It is of vital importance for sustaining life. The water requirement in National Capital Territory of Delhi is increasing at a rapid pace mainly due to ever increasing population and its associated demands. Since the available surface water sources are inadequate to meet the increasing water demand of NCT Delhi, groundwater forms a vital part in augmenting the resource.

Ground water at deeper levels is brackish to saline in all the aquifers in NCT Delhi except in area underlain by hard rock aquifers. Nearly 89% of the total geographical area of the State is underlain by alluvial formations and the remaining part by quartzites. Increasing population, rapid urbanization, industrial development and human interventions in the ecosystem have resulted in increasing pressure on the limited ground water resources over the last few decades. This overexploitation of the aquifers is leading to decline in water levels and related quality issues. The deterioration of ground water quality due to up-coning of saline water and due to pollution of ground water by disposal of untreated urban waste into the natural drains is leading to further reduction in the available fresh water resources. Judicious and planned development of ground water and its scientific management have become imminent for long-term sustainability of this precious natural resource. This requires periodic and regular monitoring of ground water regime for better assessment and management of ground water resources.

Central Ground Water Board, State Unit Office, Delhi has stepped up its activities in this direction and the present report is an outcome of various studies undertaken by Central Ground Water Board in NCT Delhi from time to time. I appreciate the efforts of Shri Somnath Bhattacharya, Officer in Charge, CGWB, State Unit Office, Delhi and his team for bringing this excellent report in form of “Ground Water Year Book 2015-16, NCT Delhi”. I hope this report will facilitate scientist and planners in formulation of future strategies to tackle issues of sustainable development of water resources in Delhi.

(K.B.BISWAS)
CHAIRMAN

FOREWORD

Ground Water Year Book is based on the information generated by monitoring of ground water observation wells of NCT-Delhi during the field Season of 2015-16. The data has been analyzed by a team of Officers of State Unit Office, Delhi and presented in the report. The reports, annexure and maps have been generated using GEMS Software, Version-2.1 developed indigenously by Central Ground Water Board.

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

The untiring effort made by Shri Sanjay Kumar Naik, Assistant Hydrogeologist for bringing out this report is highly appreciated. The contributions made by Sh. N. Jyothi Kumar, Scientist-D, and Sh. Rajesh Chandra, Scientist-D are also commendable and duly acknowledged.

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Central Ground Water Board
Ministry of Water Resources,
River Development &
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New Delhi

EXECUTIVE SUMMARY

GROUND WATER YEAR BOOK 2015-16
NCT DELHI

National Capital Territory (NCT) of Delhi occupies an area of 1483 sq. km. and lies between 28^0 24' 15'' and 28^0 53' 00'' North latitudes and 76^0 50'24" and 77^0 20' 30" East longitudes. The total population of NCT Delhi, as per the census 2011 is 167.53 lakhs with a density of 11297 persons/sq. km.

The normal annual rainfall of NCT Delhi is 611.8 mm. The rainfall increases from the South-West to the North-East. About 81% 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.

The ground water availability in the territory is controlled by the hydrogeological conditions characterized by occurrence of different geological formations namely Delhi Quartzite, Older and Younger Alluvium. Central Ground Water Board (CGWB) has established 127 hydrograph monitoring stations till March 2016, out of which 24 are dug wells and 103 are Piezometers. The ground water monitoring stations are spread over both Alluvial and quartzitic area. Nearly 11 stations fall in Delhi quartzite and 116 stations fall in alluvial area including Yamuna Flood Plain.

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 Northeast district. Considering this unevenness, Central Ground Water Board is striving to increase the number of monitoring stations for better monitoring of the ground water regime in the diverse hydrogeological terrain.

The depth to water level recorded in NCT Delhi during **May 2015** ranges from 1.20 to 62.22 meter below ground level (m bgl). About 50% wells of South district show more than 40 m bgl water level and 19% wells have 20 to 40 m bgl water level. In New Delhi and Southwest districts, water level in the range of 10 to 20 m bgl is shown by 57% and 35% wells respectively. In North, East and Northwest districts, 29%, 40% and 46% wells show water levels in the range of 5 to10 m bgl respectively. In East, North, Northeast, Northwest, and West districts 30%, 57%, 50%, 29% and 12% of wells show water level in the range of 2 to 5 m bgl respectively. The entire Yamuna flood plain is also falling in the 2 to 5 m bgl category.

The fluctuation of water level between **May 2014** and **May 2015** of Delhi state shows rise in water level in the range of 0.02 m to 8.82 m in the districts of New Delhi, North, South, Northwest, Southwest and West. Whereas rest of the districts like Central, East, Northeast, West, South and Southwest shows fall in the range of 0.01 to 3.55 m. The overall data indicates that in South and Southwest districts the water levels are showing maximum fall.

A comparison of the water level data of **May 2015** with **10 year mean water level of May** shows that 63% of wells show a fall in the range of 0.24 to 10.10 m. In New Delhi, North, Northwest and Southwest districts 52% of wells show a rise in water level varying from 0.70 to 3.76 m. The maximum fall has taken place in Northwest, South and Southwest districts (i.e. 4.90 to 10.10 m).

The depth to water level recorded in NCT Delhi during **August 2015** ranges from 0.51 to 61.84 m bgl. About 44% wells of South district show more than 40 m bgl water level and 19% wells have 20 to 40 m bgl water level. In New Delhi and Southwest district 50% and 31% wells have shown 10 to 20 m bgl water level, respectively.

The water level fluctuation between **May 2015 (Pre-monsoon)** and **August 2015** for Delhi indicates that 19% wells show a fall in the range of 0 to 2 m and 23% depict a fall ranging from 0.06 m to 9.92 m.

The hydrograph analyses of **August 2014** and **August 2015** water level reveals that 65% of wells show rise in the range of 0.03 to 8.92 m while in few districts like East, New Delhi, Northeast, South and Southwest show localized fall in ground water level in the range of 0.09 to 3.09 m. In totality 34% wells show a fall in water level.

The depth to water level recorded in NCT Delhi during **November 2015** ranges from 0.72 to 61.13 m bgl. About 50% wells of South district shown more than 40 m bgl water level and in 12% of the wells the water level varies between 20 to 40 m bgl. In Southwest district 35% and 38% wells show fall in the water level category of 10 to 20 and 20 to 40 m bgl respectively. The depth to water level of East, Northeast, Northwest and West districts show 40%, 25%, 34% and 33% in the range of 5 to 10 m bgl whereas in East, North, Northeast, Northwest and West districts the water levels are in the range of 2 to 5 m bgl in 30%, 57%, 25%, 24% and 22% respectively. In the entire Yamuna flood plain the water level are falling between 2 to 5 m bgl during this period.

The fluctuation of water level between **May 2015 (Pre-monsoon)** and **November 2015 (Post Monsoon)** of Delhi state shows 0.01 to 8.82 m rise in 67% of the wells. Some wells of East, New Delhi, Northwest, South and Southwest district shows fall in the range of 0 to 4 m.

When the data of **November 2015** is compared with **10 year mean for the month of November** it is seen that 63% of the wells show a fall of water level in the range of 0.01 to 7.27 m.

The depth to water level recorded during **January 2016** ranges from 0.74 to 59.51 m bgl. South district alone shows 47% wells in the category having more than 40 m bgl depth to water level and 20% in the range of 20 to 40 m bgl depth to water level. 35% and 57% wells in Southwest and New Delhi districts have water levels in the range of 10 to 20 m bgl respectively. A few patches of 20 to 40 m bgl water level are also seen in these districts. Rest of the districts fall under the category of 2 to 10 m bgl water level. Some of the monitoring stations viz. Palam, Godaipur, Sultanpur, Jaunapur and PushpVihar show depth to water level in the range of 56 to 59 m bgl, which is maximum in Delhi state.

The fluctuation of water level between **May 2015 (Pre-monsoon)** and **January 2016** of Delhi state reveals that 43% wells of Northeast, Northwest, South and Southwest districts record fall in the range of 0.78 to 9.52 m and 62% wells show rise in the range of 0.97 to 6.38 m in East, New Delhi, North, Northwest & Southwest districts.

When the data of **January 2016** was compared with **10 year mean water level of January,** it has been observed that 67% of monitoring wells of New Delhi and Northwest districts show a fall in water levels, the maximum being 4.23 m and 4.03 m respectively. The same conditions prevail in South and Southwest districts where 54% of the wells show fall in water level with the maximum being 7.20 m and 7.65 m respectively. East and Northeast districts have also shown decline in water table in the range of 5.09 to 5.40 m. The overall observation of the state shows that the southern districts of Delhi state are showing declining condition.

In almost 17% ground water samples of NCT Delhi mostly from the district of Northwest, West, North and Southwest reveal high concentration of fluoride (F') beyond prescribed maximum permissible limit of 1.5 mg/l. Some more sites are also affected by F' content in ground water which are sporadically located. On perusal of data and affected locations, it is observed that wherever existence of Saline/Brackish water is at shallow depth the F' concentration are higher.

The Nitrate (NO_3') concentration in ground water of NCT Delhi shows a wide range (i.e. 1.01mg/l to 710 mg/l). The NO_3' concentration in ground water is generally spread out over the entire state but is more significant in parts of Northwest, Southwest and some pockets of New Delhi districts. The NO_3' pollution in the ground water is mostly anthropogenic and may be due to improper disposal of sewage and unhygienic conditions around the well.

GROUND WATER YEAR BOOK

NCT DELHI

2015-16

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Chapter - 1

INTRODUCTION

National Capital Territory of Delhi occupies an area of 1483 sq. km and lies between 28° 24’ 15’’ & 28° 53’ 00’’N latitudes and 76° 50’24” & 77° 20’ 30” E longitudes. Area is covered under Survey of India Toposheet Nos. 53D and 53H. For administrative purposes NCT Delhi is divided into 11 districts and 33 Tehsils/Sub-divisions. NCT Delhi has three Statutory Towns, viz., the Municipal Corporation of Delhi (MCD), New Delhi Municipal Council (NDMC) and Delhi Cantonment Board (DCB), 110 Census Towns and 112 Villages as per the census of 2011. 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 2019 will be about 184 lakhs and 188 lakhs in 2021, 208 lakhs by 2031. In order to evaluate the changes in ground water regime effect 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 with its own network stations spread over the entire area of NCT Delhi.

1.1 Ground Water Regime Monitoring

Monitoring of ground water regime is an effort to obtain information on variation in ground water levels and chemical quality through representative sampling both in time and space. The important attributes of ground water regime monitoring are:

a) Ground Water Level

b) Ground Water Quality, and

c) Temperature.

The primary objective of establishing the ground water monitoring network stations is to record the response of ground water regime to the natural and artificial conditions of recharge and discharge with reference to geology, climate, physiography, land-use pattern and hydrologic characteristics. The natural conditions affecting the regime involve climatic parameters like rainfall; evapo-transpiration etc. and the artificial conditions include pumpage from the aquifer, recharge due to irrigation system and other man made causes like waste disposal etc. The database generated can form the basis for ground water development and management programme. The objectives of the Ground Water Observation Network may be broadly summarized as below:

Collection of basic data on ground water conditions for:

- Study of inter-relationship between ground water and climatic parameters,
- Study the influence of geology, topography, land-use on ground water regime,
- Understanding the role of ground water in the hydrologic cycle and influence of the recharge on ground water storage changes, chemistry and temperature.

Application of ground water monitoring data for:

a. Reference purposes

b. Prediction measures

c. Environmental evaluation

d. Estimation of resources

Monitoring may come under two categories:

i) Background monitoring to characterize the initial stage of a system.

Background monitoring commences with inventory of existing information like land-use, topography, extent, thickness, structure of the geological units and their hydraulic properties. Based on the analysis of the data, different ground water systems can be identified.

ii) Specific monitoring to deal with systems, where significant changes have taken place. This functions as an early warning system and provides information for remedial actions.

Ground water levels:

The configuration of the water table depends upon topography, geology, climate, water yielding and water bearing properties of rocks in the zones of aeration and saturation which controls the ground water recharge. The upper surface of the zone of saturation is the **Water Table**. In case of wells penetrating confined aquifers, the water level represents the pressure or **Piezometric Head** at that point.

Hydrograph network planning is basic to ground water assessment and development programme. The ground water, being subterranean resource can only be assessed through indirect reflection in the form of water level changes. The systematic and regular monitoring of ground water levels can bring out the changes taking place in the regime. The data so generated is of immense help for regional

ground water flow modeling to serve as a ground water management tool and to provide the necessary advance information to the user agencies to frame contingency plans in case of unfavorable ground water recharge situation. The data also has immense utility in settling the legal issues arising out of conflicting interests of ground water users.

Geologically, Delhi state is occupied by Quartzite interbedded with Mica-Schist belonging to Delhi Super Group, unconformably overlain by unconsolidated Quaternary to Recent sediments. The ground water availability in the territory is controlled by the hydrogeological situation characterized by occurrence of alluvial formation and quartzite hard rocks. The hydrogeological set up and the following distinct physiographic units influence the ground water occurrence: -

1. Alluvial plain on eastern and western sides of the ridge.
2. Yamuna flood plain deposits.
3. Isolated and nearly closed Chattarpur alluvial basin.
4. NNE-SSW trending Quartzitic Ridge.

The basic activities pertaining to monitoring well design and construction are as follows:

a. Suitable locations for installation of piezometer, working out optimal depth and diameter of piezometer.

b. Appropriate drilling technique and suitable drilling rig for piezometer construction.

c. Installation of suitable well assembly to tap the aquifer proposed to be monitored, i.e. casing, screen etc.

d. Maintenance of well.

It is essential to have a complete understanding of aquifer disposition and geometry in the area before the piezometers are designed and installed. The hydrogeological mapping in the area may indicate the disposition and inter-relationship of the aquifers spatially and depth wise. The information generated from ground water surveys and exploration would enable one to decide grouping of interrelated aquifers into one aquifer system for the purpose of monitoring. The decision to install piezometers monitoring phreatic and deeper confined aquifers would be dependent on the nature of aquifer system viz., alluvial aquifers or hard rock aquifers.

Alluvial aquifers:

In Delhi state, alluvial areas are characterized by occurrence of number of sand zones constituting the aquifers, it may not be essential to install piezometers for each sand zone. Based on inter-relationship and behavior, these aquifers are grouped into major aquifer systems and piezometers have been installed accordingly.

In National Capital Territory of Delhi and adjoining, the hydrogeological mapping and ground water exploration indicates the presence of three distinct potential aquifer groups within the depth of 450 meter below ground level (m bgl). Each of these aquifer groups comprises of number of individual sandy horizons. The grouping of aquifers was done as follows:

Aquifer Group I - Down to 65 m bgl (Un-confined)

Aquifer Group II - Between 65 to 200 m bgl (Confined/ Semi-Confined)

Aquifer Group III - Between 200 to >300 m bgl (Confined)

Separate piezometers were 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 bgl) and the other one tapping the middle parts of the aquifer groups II lying between 65 to 200 m bgl. The Aquifer group III is not being monitored at present.

Hard rock aquifers:

The 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 composedly. Generally, the depth of the well goes up to 80 m bgl, but in some cases it even goes up to 140 m bgl.

1.2 Distribution of Hydrograph Network Stations

Central Ground Water Board has established a network of 127 hydrograph monitoring stations (Plate-1), of which 24 are dug wells and 103 are piezometers till March, 2016. District wise details of National Hydrograph Network Monitoring Stations (NHNS) for the last four years are given in following Table 1.1.

Table-1.1

Status National Hydrograph Monitoring Stations in NCT Delhi

Name of the district	Number of NHNS as on 31-3-2013	Number of NHNS as on 31-3-2014	Number of NHNS as on 31-3-2015	Number of NHNS as on 31-3-2016
North-West	32	30	29	33
North	08	08	07	09
North-East	05	04	04	05
East	09	10	10	11
New Delhi	16	15	14	14
Central	01	01	01	01
West	13	11	09	11
South-West	33	29	26	28
South	22	17	16	15
Total	**139**	**125**	**116**	**127**

Central Ground Water Board is striving to increase the number of monitoring stations in NCT, Delhi to monitor and have close observation in the diverse hydrogeological domain. In the recent years Delhi is facing rapid decline in ground water levels, which calls for attention and close watch through monitoring. The establishment of Peizometer in metropolitan city of Delhi is very difficult due to non-availability of space. However, efforts are on for increasing the number of monitoring stations gradually for the precise observations of ground water conditions.

District wise distribution of hydrograph network station is highly uneven and varies from one monitoring station per 2.50 sq. km in the New Delhi district to one monitoring station per 25 sq. km in the Central district. Table-1.2 shows the density distribution of hydrograph stations in NCT Delhi.

Table-1.2

Density distribution of National Hydrograph Monitoring Stations in NCT Delhi

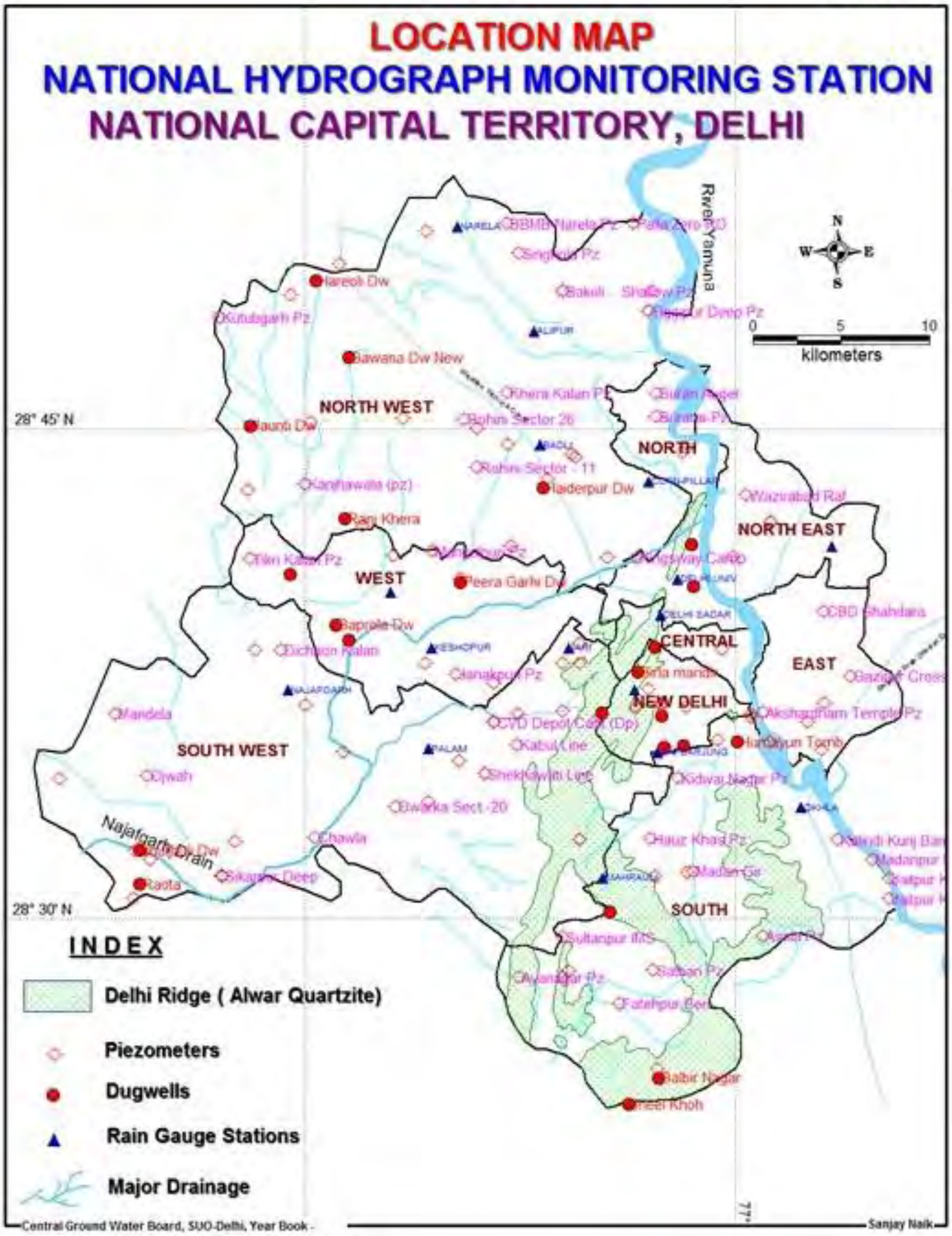
Name of the district	Area in sq. km	No. of NHNS	Density sq. km per well
North-West	440	33	13.13
North	60	09	6.66
North-East	60	05	12
East	64	11	5.81
New Delhi	35	14	2.50
Central	25	01	25
West	129	11	11.72
South-West	420	28	15
South	250	15	16.66
Total	**1483**	**127**	**11.67**

1.3 Periodic Analysis:

Analysis is normally done immediately after each phase of ground water monitoring; viz. May, August, November and January. The water level data generated are utilized to prepare (i) depth to water level maps and (ii) fluctuation maps, to bring out the prevailing status of ground water regime. The depiction of the data through maps on district wise basis is presented below:

I. **Depth to water table map**:

Depth to water table maps usually presented for Delhi State on appropriate scale bringing out suitable depth ranges say; 0-2 m, 2-5 m, 5-10 m, 10-20 m, 20-40 m & >40 m. The depth ranges are categorized considering prevailing water levels, depth zone of water logging, depth zone of prone to water logging, centrifugal pumping depths, etc.



LOCATION MAP
NATIONAL HYDROGRAPH MONITORING STATION
NATIONAL CAPITAL TERRITORY, DELHI
River Yamuna
N
W
E
S
0
5
10
kilometers
28° 45' N
28° 30' N
NORTH WEST
NORTH
NORTH EAST
WEST
CENTRAL
EAST
NEW DELHI
SOUTH WEST
SOUTH
Najafgarh Drain
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Delhi Ridge (Alwar Quartzite)
Piezometers
Dugwells
Rain Gauge Stations
Major Drainage
Central Ground Water Board, SUO-Delhi, Year Book -
Sanjay Naik

Plate 1.

II. Water level fluctuation map:

The ground water level fluctuation is usually depicted through a set of maps showing the status of the water levels under observation as compared to the levels of the same period of the previous year and to the decadal mean water levels etc. These maps prepared are as follows:

a. Fluctuation map comparing the water levels monitored with the corresponding water levels in the preceding *year.*

b. Fluctuation map comparing the Post-monsoon water level monitored with Pre-monsoon water level of the same water *year.*

c. Fluctuation map comparing the water level monitored with the mean water levels of the period *for* at least a decade. This map would bring out departures *from* normal ground water storage situations during the period under consideration.

III. Ground water quality map:

Sample collection for chemical analysis of ground water quality is done once in a *year.* Only major constituents analyzed are used in preparation of the maps. The following maps are prepared:

a. Map showing EC variation in the ground water
b. Map showing Nitrate distribution in the ground water
c. Map showing high point values of Fluoride, Nitrate and other pollutants.

After each measurement, a comprehensive report is prepared, which include the following:

a. Brief write-up supported by water level data, maps of depth to water, and rise and fall of ground water levels and ground water quality maps etc.
b. Effects of various factors on ground water regime like rainfall, ground water pumpage, irrigation practices, etc.
c. Departure in the normal behavior of water levels bringing out the factors responsible.

Chapter - 2

CLIMATE

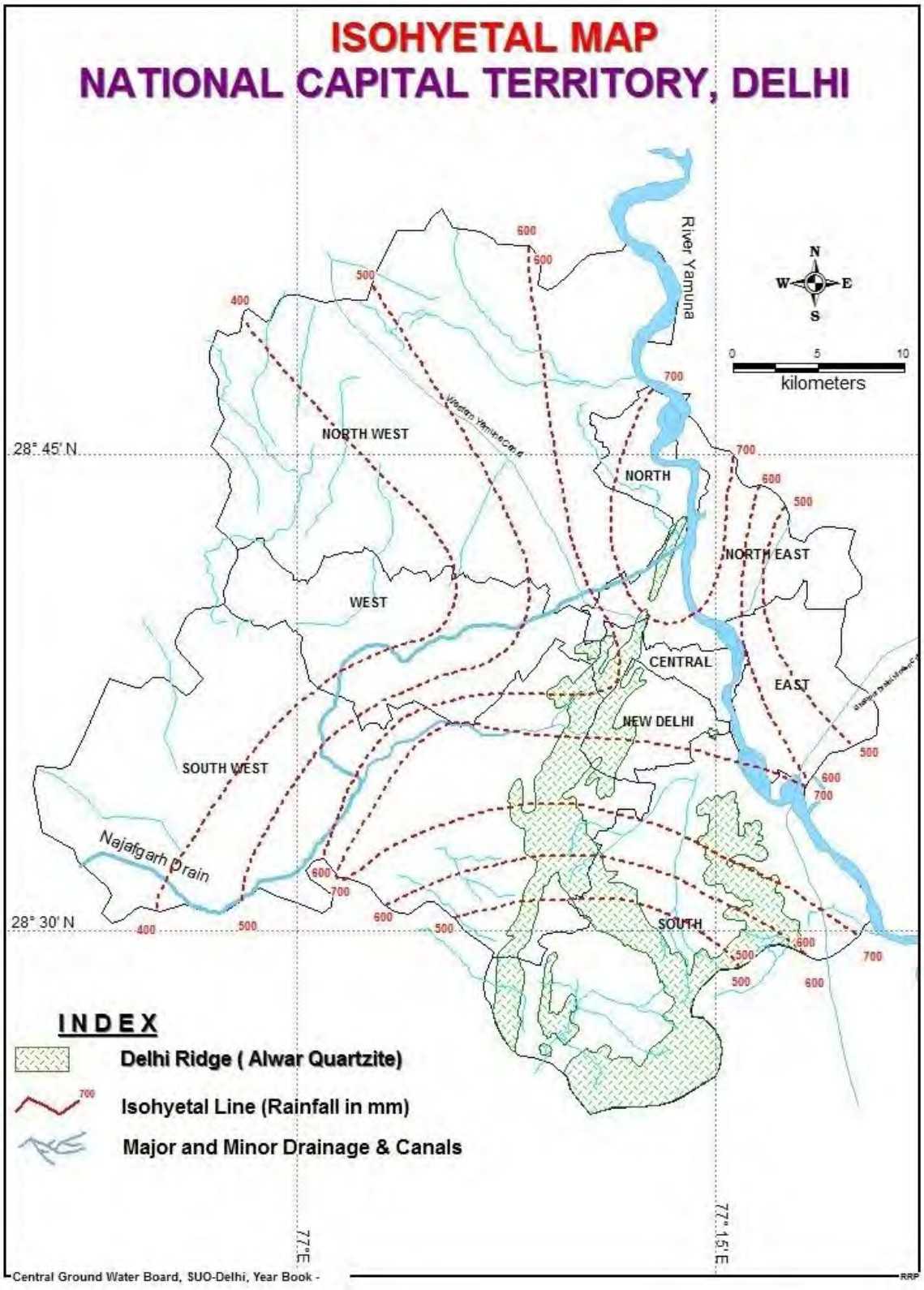
The climate of NCT Delhi is mainly influenced by its inland position and the prevalence of air of the continental type during the major part of the year. Extreme dryness with the intensely hot summer and cold winter are the characteristics of the climate. Only during the three-monsoon months July, August, 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 four seasons. The cold season starts in late November and extends up to the beginning of March. This is followed by the hot season, which lasts till about the end of June when the monsoon arrives over the state. The monsoon continues to the last week of September. The two post monsoon months October and November constitute a transition period from the monsoon to winter condition.

Table-2.1 Seasons in NCT, Delhi

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

2.1 Rainfall:

For calculation of normal rainfall of NCT Delhi, rainfall records from 1930-1980 for 13 stations (Table-2.4) were considered. The normal annual rainfall in NCT Delhi is 611.8 mm. The rainfall in NCT Delhi increases from the southwest to the northeast (Plate-2). 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.


ISOHYETAL MAP
NATIONAL CAPITAL TERRITORY, DELHI
River Yamuna
N
W
E
S
0
5
10
kilometers
NORTH WEST
NORTH
NORTH EAST
WEST
CENTRAL
EAST
NEW DELHI
SOUTH WEST
SOUTH
Najafgarh Drain
28° 45' N
28° 30' N
77° E
77° 15' E
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Delhi Ridge (Alwar Quartzite)
Isohyetal Line (Rainfall in mm)
Major and Minor Drainage & Canals
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Plate 2

Table-2.2: Rainfall received and deviations from Normal in Delhi

Year 2012		Year 2013		Year 2014	
rainfall received (mm)	Deviation from Normal rainfall	rainfall received (mm)	Deviation from Normal rainfall	rainfall received (mm)	Deviation from Normal rainfall
321	-47.53%	708.9	+15.87%	440.4	-28.01%

A perusal of rainfall data from 2012 to 2014 shows that NCT Delhi received deficient rainfall of -28.01% in 2014 and -47.53% during 2012. Year 2013 has surplus rainfall of (+) 15.87%. Comparison of annual rainfall of 2012, 2013 and 2014 has been done with that of Normal rainfall of NCT Delhi and presented in Table-2.2. Month-wise Normal Rainfall with Rainy days and Evaporation losses are given in Table-2.3. The average annual evaporation losses are 2224 mm.

Table 2.3 Rainfall and Evaporation Losses

Month	Jan	Feb	Mar	Apr.	May	Jun	July	Aug	Sep	Oct	Nov.	Dec.	Annual
Rainfall (in mm)	14.5	13.2	9.9	5.5	9.2	38.8	191.6	197.4	105.3	19.3	2.8	4.3	611.3
Rainy days	1.2	1.0	0.8	0.5	0.8	2.1	7.4	7.9	4.0	0.8	0.1	0.4	27.0
Evaporation (in mm)	71	101	177	300	400	333	233	133	147	149	102	78	2224
Source: Indian Meteorological Department													

Rainfall in Delhi is thus highly variable with deviations ranging from (–) 47.53% to (+) 15.87% from normal rainfall which in turn affects the natural recharge to ground water from year to year. The details of the Normal and the Extreme Rainfall are tabulated in Table-2.4.

Table 2.4 - Normal and Extremes of Rainfall

Stations	No. of Years of DATA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	HIGHEST ANNUAL AS % OF (YEARS)**	LOWEST RAINFALL NORMAL &	HEAVIEST RAINFALL In 24 HOURS * Amount (mm)	Date
Chandrawal (obsy)	20 a	8.5	15.3	16.7	5.5	18.2	47.6	329.8	308.4	102.3	14.4	8.2	11.6	886.5	163	64	171.0	1976 Aug 08
	b	0.6	1.2	1.2	0.5	1.5	2.2	10.5	10.4	3.9	0.9	0.2	0.8	33.9	(1977)	(1969)		
New Delhi (Safd)	79 a	20.5	20.1	13.3	7.8	12.5	62.2	203.2	202.2	137.6	21.7	3.1	8.0	712.2	215	43	495.3	1875 Sep 09
	b	1.8	1.5	1.2	0.8	1.4	3.6	9.2	9.5	5.1	1.0	0.2	0.7	36.0	(1933)	(1905)		
Delhi (University obsy)	29 a	20.7	18.3	19.1	5.1	16.4	62.2	281.6	263.5	147.4	41.6	4.1	7.6	887.6	209	52	250.0	1963 Sep 16
	b	1.6	1.4	1.5	0.7	1.5	2.8	10.3	10.5	5.2	1.6	0.2	0.8	38.1	(1957)	(1974)		
New Delhi Palam	22 a	14.7	14.1	9.3	6.1	18.9	54.2	241.1	284.3	119.4	16.8	6.4	8.6	793.9	164	51	265.8	1972 Jul 09
	b	1.3	1.5	1.0	0.6	1.5	3.5	10.9	10.7	4.9	1.4	0.2	0.6	38.3	(1967)	(1965)		
Okhala (obsy)	21 a	9.6	11.9	14.7	2.6	17.1	66.9	212.5	296.3	124.6	23.2	5.7	7.3	792.4	159	66	190.0	1967 Aug 26
	b	0.9	1.3	0.9	0.3	1.4	3.4	9.3	10.7	5.1	0.9	0.3	0.6	35.1	(1964)	(1974)		
Mahruali	33 a	13.9	10.1	7.3	9.4	3.6	28.3	159.9	152.5	98.7	11.5	1.5	2.3	499.0	197	42	177.8	1911 Sep 28
	b	1.1	0.7	0.6	0.6	0.3	1.5	5.8	5.9	3.0	0.3	0.2	0.3	20.3	(1944)	(1954)		
Delhi Sadaer	38 a	22.6	17.5	13.0	8.8	9.6	44.8	184.3	180.0	132.3	26.1	3.5	5.1	647.6	194	42	224.8	1942 Sep 05
	b	1.9	1.4	1.4	0.6	0.9	2.4	7.6	8.9	4.7	1.0	0.3	0.6	31.7	(1964)	(1903)		
Nangloi	25 a	8.5	4.6	1.1	4.0	2.4	19.8	100.3	121.6	69.0	5.0	0.4	0.5	337.2	246	21	120.0	1964 Aug 14
	b	0.8	0.3	0.2	0.2	0.3	1.1	4.6	5.4	3.1	0.4	0.0	0.0	16.4	(1964)	(1950)		
Sahadra	12 a	15.5	17.9	5.6	5.3	2.8	24.8	170.7	125.8	74.9	7.9	0.0	0.6	451.9	206	42	129.5	1944 Sep 04
	b	0.7	0.8	0.7	0.3	0.5	1.4	6.1	5.0	2.8	0.3	0.0	0.1	18.7	(1944)	(1948)		
Najafgarh	23 a	8.9	8.2	4.7	4.2	3.0	25.1	122.0	122.8	75.9	21.7	0.5	1.8	398.9	171	10	139.7	1954 Oct 01
	b	0.8	0.7	0.2	0.4	0.4	1.3	5.5	5.6	3.2	0.8	0.0	0.2	19.1	(1942)	(1959)		
Badli	23 a	13.7	8.6	9.6	3.6	1.4	21.8	154.2	181.3	88.2	32.9	0.8	0.0	516.1	257	37	205.7	1962 Jul 17
	b	1.0	0.7	0.6	0.4	0.2	1.1	5.8	6.4	3.7	0.8	0.0	0.0	20.7	(1961)	(1951)		
Alipur	21 a	11.7	10.6	3.3	3.6	6.0	26.7	146.1	137.1	87.7	13.7	1.3	1.1	448.9	202	12	162.1	1961 Jul 17
	b	1.3	0.7	0.4	0.4	0.4	1.5	4.7	6.0	2.9	0.7	0.1	0.1	19.3	(1961)	(1959)		
Narela	19 a	19.9	14.5	10.6	4.9	7.2	20.6	184.7	190.4	111.2	14.8	1.1	1.4	581.3	196	29	184.1	1947 Sep 15
	b	1.5	0.9	1.1	0.6	0.4	1.6	6.4	8.2	4.0	0.5	0.1	0.2	25.3	(1961)	(1965)		
Delhi (District)	a	14.5	13.2	9.9	5.5	9.2	38.8	191.6	197.4	105.3	19.3	2.8	4.3	611.8	251	44		
	b	1.2	1.0	0.8	0.5	0.8	2.1	7.4	7.9	4.0	0.8	0.1	0.4	27.0	(1933)	(1951)		

(a) Normal rainfall in mm.

(b) Average number of rainy days (i.e. days with rainfall of 2.5 mm or more)

* Based on all available data up to 1980.

** Years given in brackets.

2.2 Temperature:

The cold season starts towards the later half of November when both day and night temperature drop rapidly with the advance of the season. January is the coldest month with the mean daily maximum temperature at 21.3ºC and the mean daily minimum at 7.3ºC. In the winter months during cold waves which affect the area in the wake of western disturbances passing across north India, minimum temperatures may sometimes go down to the freezing point of water. From about the middle of March, temperature begins to rise fairly 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 47ºC. 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.

2.3 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.

2.4 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 and overcast when the area is affected by western disturbances.

2.5 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.

Chapter - 3

HYDROGEOLOGICAL FRAMEWORK

3.1 Physiography

The National Capital Territory of Delhi has four distinct physiographic units characterised as follows:

1. Delhi (Quartzitic) Ridge
2. Older alluvium on both sides of the Delhi Ridge
3. Younger Alluvium –Along Yamuna Flood Plain
4. Alluvium Deposits of Chattarpur basin

The quartzitic ridge enters the area from the South-western part extending up to the western bank of river Yamuna near Wazirabad. The ridge has a length of about 35 km and trends in a NNE-SSW direction. Isolated exposures of the quartzite are found in the Western part of the area. The elevation of the crest of the ridge varies from 213 to 314 m above mean sea level with an average elevation of 40 m from the surrounding plain. The land surface on the Eastern side of ridge slopes towards the river Yamuna with a general gradient of 3.3 m/km. On the West side of the ridge the ground slopes towards the Najafgarh *Jheel* in the South-West.

The alluvial plain in the area is almost flat and is interrupted by cluster of sand dunes and quartzite ridges. The sand dunes which are more prominent in the western part of the area are of varying dimensions and have North-East to South-West trend. The crests of these dunes generally lie between 3 to10 meters above the surrounding plains. The dunes in the area are more area less static with vegetation cover. The dunes are mostly longitudinal in nature.

Younger alluvium (Flood Plain) deposits are confined all along the river Yamuna, which are presently demarcated by embankment on both sides of the river. Virtually, this is an active flood plain domain covering an area of nearly 97 sq. km, characterized by granular deposits with shallow depth to water level. Presently, the entire flood plain area is protected by constructing embankment running all through Dahia Border to Badarpur border on Western bank and Loni border to Mayur Vihar border on the Eastern bank of Yamuna River within National Capital Territory.

The river Yamuna is the only perennial river flowing in the Southerly direction. Either side of the river Yamuna is marked by the extensive alluvial flood plain. The flood plains towards the North falls in Narela and Civil-lines tehsils of North District, the Central parts fall in North-East district and Daryaganj tehsil of Central district and the Southern most part falls in Saidabad and Kalkaji tehsil of South district. In general, the alluvial flood plain slope is towards South. The average slope of the Yamuna River bed from North to South is 0.4 m/km. Eastern and Western Yamuna Canal and Agra Canal are the three major canals originating from the river with Bawana, Rajpur and Lampur distributaries. A dense network of lined canals system exists in the North-Western part of the state.

The nearly closed alluvial basin of Chattarpur (28^0 25' 30 " to 28^0 32' 30" N Longitudesw and 77^0 07 ' 30" to 77^0 13' 00" E Latitudes) in South Delhi occupies an area of about 78 km^2. This is a closed inland basin, the boundary of which is marked by the quartzite ridges. The general slope of the land is towards the center of the basin from the surrounding ridges. The slope in the southern part of the basin is towards south. The maximum land altitude in the basin is about 259 m amsl whereas the land at the ridges is about 274 m amsl.

A number of micro watersheds originate 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 geographical area of NCT Delhi, is broadly divided into seven drainage basins, ultimately discharging into the Yamuna – (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 falling into river Yamuna on right bank. Swamp areas are common along the flood plains of Yamuna.

3.2 Geology:

The rock formations exposed in the National Capital Territory of Delhi are mainly quartzite of the Alwar series of the Delhi Supergroup that are interbedded with thin micaceous schist bands. Srivatava et al. (1980) grouped these rocks of Delhi area as the Alwar formation of Delhi Super group while Kachroo and Bagchi (1999) have classified them as Barkhol formation of the Ajabgarh Group of the Delhi Supergroup. Proterozoic rocks occur along the ridge, extending from Harchandpur (Haryana) in the South to Wazirabad (Delhi) in the North. Quaternary sediments directly overlie the Proterozoic rocks. The stratigraphic succession of these rocks reviewed by Kachroo and Bagchi (1999) is given in Table 4.1.

Table 4.1: Stratigraphic succession of rocks in Delhi area (modified after Kachroo and Bagchi, 1999).

Holocene	Yamuna channel alluvium	Grey, fine to medium sand, grit with coarse sand, silt and clay	Point bars, channel deposits
	Yamuna Older Flood Plain & Terraces	Grey sand, coarse grit, pebble beds and minor clays	Palaeochannels, meander scrolls, ox-bow lakes
	Older Alluvium	Sequence of sand-silt-clay with yellowish brown medium sand with silt, kankar with brown Aeolian sand	Abandoned channels, meander scrolls
~~ Unconformity ~~~~~~~~~~~~~~~~~~~~~~~~~~~~			
Neo-proterozoic	Post Delhi Intrusives	Pegmatitic, tourmaline-quartz veins and quartz veins	
Meso-proterozoic	Delhi Supergroup	Ajabgarh Group – Bharkol Formation	Quartzite with minor schist, tuff and ash beds

Srivastava et al. (1974) and Kachroo and Bagchi (1999) have carried out systematic geological and geomorphological mapping of Delhi and identified three distinct surfaces. The highest 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). The geomorphologic features have undergone changes due to widespread and uncontrolled urban activity. The geological map of Delhi after Kachroo and Bagchi (1999) is shown in Figure 4.1. The Delhi Quartzite ridge acts as the recharge zone. The Quaternary deposits in the form of aeolian and alluvial deposits constitute the major repository of ground water in the area. In the East of the ridge, the thickness of unconsolidated sediments gradually increases away from the ridge, with the maximum reported thickness being 170 m. In the Southwestern, Western and Northern parts of the area, the thickness of sediments is more than 300 m except at Dhansa where the bedrock has been encountered at 297 m below land surface. In Chhattarpur basin, the maximum thickness of sediments is 116 m.

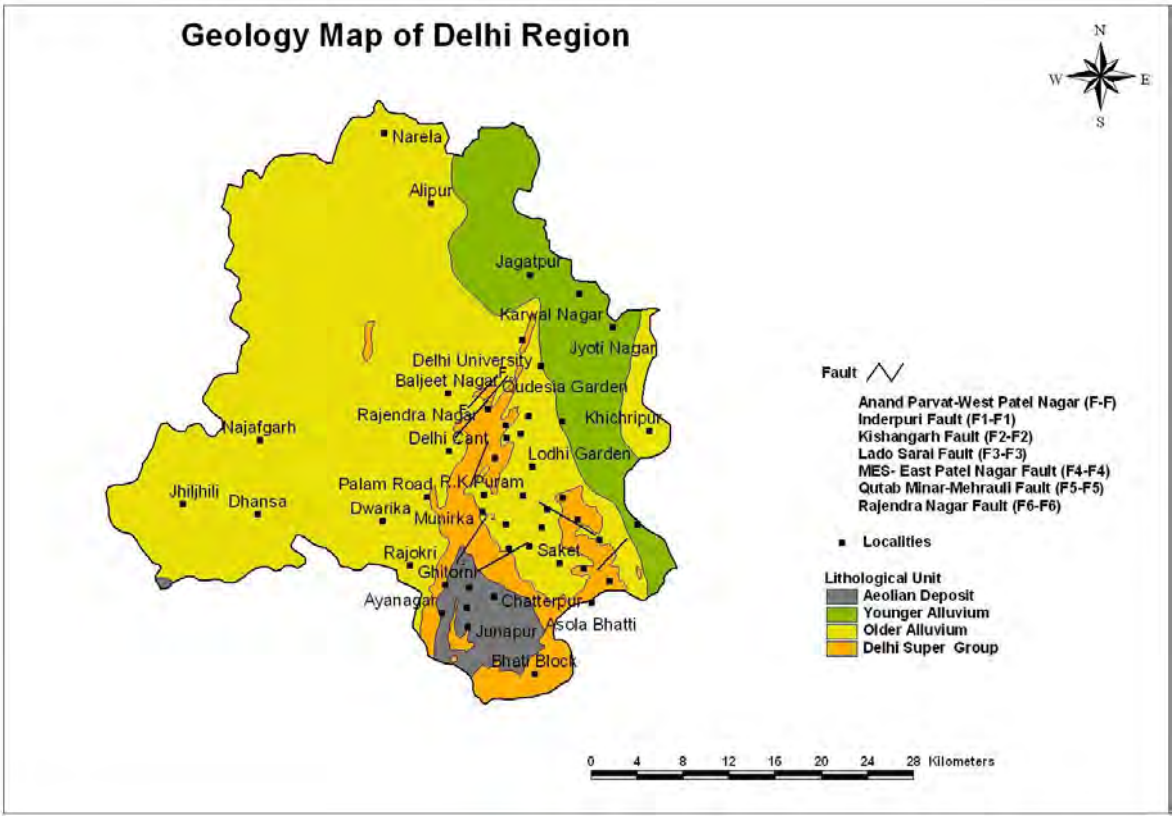

Fig 4.1: Geological map of NCT Delhi

The aeolian deposits are mainly comprised of loam, silty loam and sandy loam. The bedrock is overlain by these deposits. Older alluvial deposits consist mostly of interbedded, lenticular and inter fingering deposits of clay, silt, and sand along with kankar. These deposits overlay the aeolian deposits and are in turn overlain by the newer alluvium, which occurs mostly in the flood plains of river Yamuna.

The rocks of Delhi system have undergone multiple folding and different phases of metamorphism with time. Three generations of folding have been found in the rocks of Delhi (Gangopadhyay and Sen, 1968). 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. Two sets of conjugate vertical to sub-vertical joints have been reported (Kachroo and Bagchi, 1999). These are NNE-SSW and WNW-ESE joints conforming to the older and newer structural trends. Srivastava et al. (1980) have inferred a number of faults trending NNE-SSW, NE-SW and WNW-ESE.

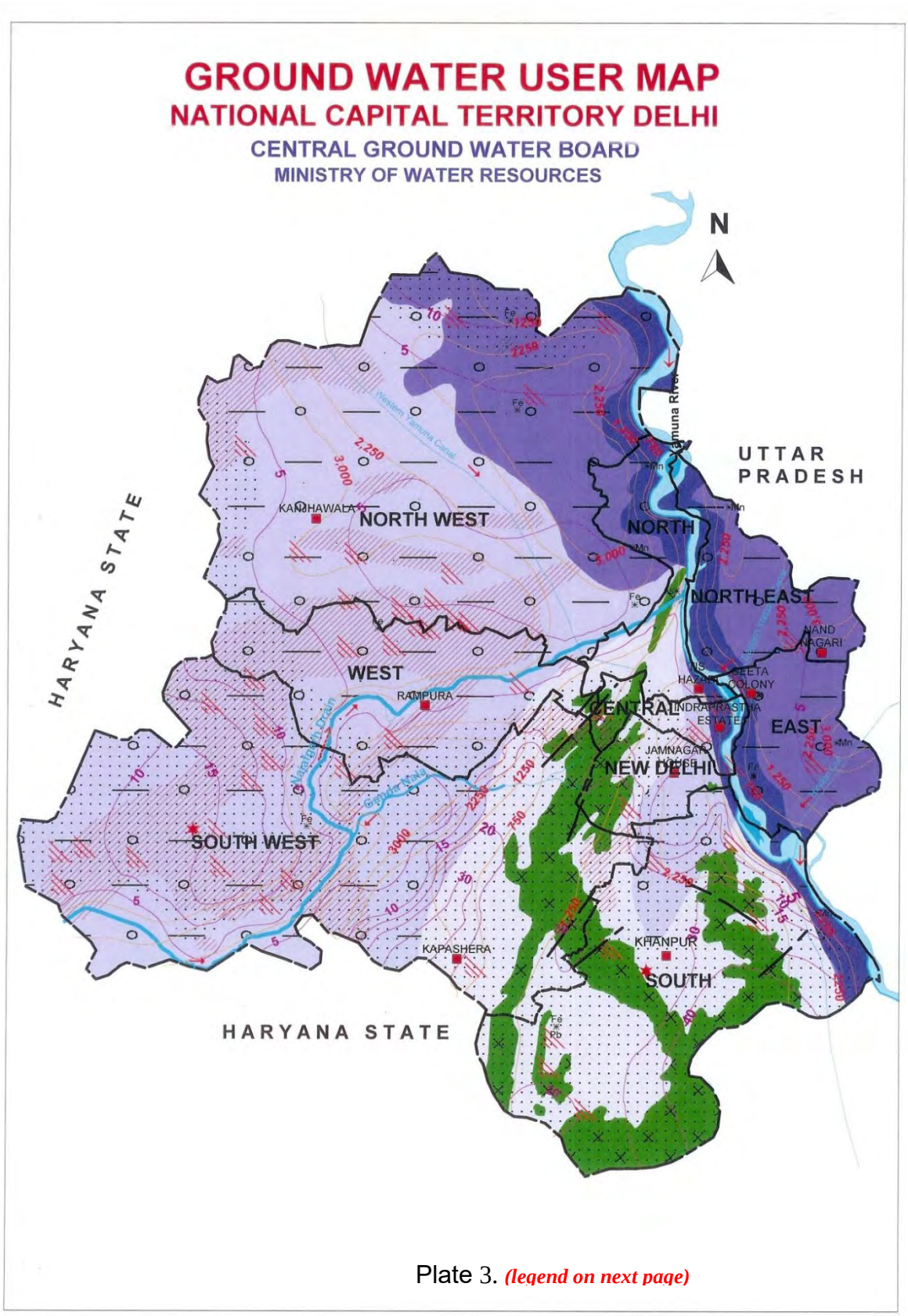

Plate 3. *(legend on next page)*

NATIONAL CAPITAL TERRITORY DELHI

LEGEND

Rock Types	Wells feasible & Formation	Rigs suitable	Depth of Well (m)	Discharge (lpm)	Suitable Artificial Recharge Structures **
Soft Rock	Tube Wells Yamuna Flood Plain	Reverse / Direct Rotary	25-65*	300-2400	Not Feasible
Soft Rock	Tube wells Younger Alluvium	Reverse /Direct Rotary	25-45*	300-1500	Shaft/Trench with recharge well, Recharge Pit with/without bore
Soft Rock	Tube Wells Older Alluvium	Reverse / Direct Rotary	25-90*	120-600	Shaft/Trench with recharge well, Recharge Pit with/without bore
Hard Rock	Tube Wells Quartzites	DTH / Rotary cum DTH	60-120*	90-240	Shaft/Trench with recharge well

Depth to Water level in m (Pre-monsoon decadal mean, 1993-2002) 5	Electrical Conductivity (Micro mhos/cm at 25° C) 3000	Major river / Drain	Faults/Lineaments
Fluoride > Permissible limit (1.5 ppm)	Nitrate > Permissible limit (100 ppm)	Iron > Permissible Limit (1.0 ppm) / * Fe	
State boundary	District boundary	Tehsil boundary	
District head quarter	Over exploited block	Area feasible for Artificial recharge structures	

* Depth of the well is restricted to the availability of fresh water. ** Feasible in areas where depth to water level is more than 8 m below ground level.

OTHER INFORMATION

Name of State	Delhi
Number of Districts	9
Geographical Area	1483 Sq. Km
Major Geological Formation	Soft Rock-Yamuna/Older Alluvium Hard Rock-Quartzites
Major Drainage System	Yamuna
Population (as on 2011)	167.87 Lakhs
No. of Tehsils	27
Existing Major/Medium Irrigation Projects	-
Replenishable Ground Water Resources	28712.29 Hac.m. or 0.28 BCM
Total Ground Water Draft	39215.31 Hac.m. or 0.39 BCM
Stage of Ground Water Development	136.58%
Average Annual Rainfall	Safdarjung-712 mm Palam-794 mm
Range of Mean Daily Temperature	18-32^{O}C
Tehsils Showing Intensive Ground Water Development	All tehsils except Darya Ganj & Civil Lines

3.3 Basement Topography

The basement topography of NCT Delhi is highly uneven depicting the presence of sub-surface ridges and valleys because of folding of the geological formations during the Pre-Cambrian and subsequent periods. Thickness of alluvium overlying the quartzites increases away from the outcrops. The thickness of alluvium is 300 m or more in most parts of South West, West and North West districts. The depth to bed rock is within 30 m on the east side of the ridge with a gradual downward slope towards river Yamuna. On the west of ridge near Mall road and Vikramaditya Marg, the depth to bed rock varies from 1 to 30 m. bgl. Further west of it and East of Najafgarh drain, there is a sudden increase in depth to 100 m. Near Sabjimandi, Rani Jhansi Road, Aram bagh, Paharganj, Chandani Chowk and Sadar Bazaar areas, thickness of alluvium is of the order of 10 to 20 m whereas near Roshanara Garden the thickness is about 200 m.

In the Central part of the city area near Dayabasti railway station, Karanpura, Patel Nagar Railway Station, the bedrock occurs within 30 m depth. But a little east of Karanpura, in DCM Chemical works, the bedrock has not been touched down to a drilling depth of 182.88 m. Such sharp and sudden change in thickness of alluvium may be due to faulting. In the Irwin Hospital, Delhi Gate, Daryaganj, Vijay Chowk and Pusa road areas the depth to bedrock varies from 5 to 10 m. bgl. In Lal Quila and Rajghat areas the depth to bedrock varies between 40 to 60 m. bgl. In Shantivan area bedrock is encountered at a depth of 23 m. bgl. In Nangla Machi and Zoo complex, bedrock exposures are present on surface. In Okhla village bedrock is exposed on surface within the Jamia Milia Islamia campus. The thickness of alluvium is about 30 m at rail Bhawan and is about 100 to 150 m around India Gate. In Trans Yamuna area the thickness of alluvium varies from less than 20 (near Kailash colony) to more than 150 m away from Yamuna. In Ushmanpur area bedrock is encountered at a depth of about 60 m. In Sonia Vihar area bedrock is encountered at a depth of 50 m. bgl. In Chattarpur basin of Mehrauli block, the alluvial thickness varies from a few meters near periphery to 115m around Satbari bund.

3.4 Aquifer Disposition

3.4.1 Central District:

Central district of NCT Delhi is located in hard rock terrain of Delhi quartzite at one end while alluvium is underlain by Delhi quartzite at another end. Nearly 25 sq km area covered in the district which is extending east to west, where eastern part is just terminating along Yamuna Flood Plain. Depth to bedrock in the eastern part is ranging from 10 to 60 m. bgl. In the western part some of the rock exposures of Delhi ridge are also seen, sporadically covering 1.91 sq km area. Quaternary alluvium is

comprised of fine sand, silt, clay along with the occurrence of kankars. The sub surface geology comprise of top soil which is silty clay and sand, sand which is medium grained, sub-angular to sub rounded, grey in colour, composed of quartz grains and mica flakes which occurs as massive as well as fractured, admixed with calcareous matters and mica schist, alternate bands of light greyish to whitish in colour. The aquifer system consists of sand which is fine to medium grained, yellowish in colour, kankars medium to high grade. The depth to water level varies from 2 to 7 m. The quality of water down to 31 m bgl is found to be fresh.

3.4.2 North District:

North District of NCT Delhi just lying all along Yamuna River covering 60 sq. km areas. Its 40% area is under Yamuna Flood Plain. The Southern part of the District have a thin veneer of alluvium cover over quartzitic rock which is an extension of Delhi Ridge (Strike-SSW to NNE), near Wazirabad Barrage. The slope of the surface in the district is towards south by 0.40 m/km, but at the place of concealed Delhi Ridge it gets elevated. Due to this reason it forms a depression at the northern part of the upland area of the ridge leading to water logging conditions. Some of the exploratory wells Drilled by CGWB falling in this area are Delhi University, Dhirpur and Jagatpur encountered with bed rock at the depth of 32 m, 28 m and 167 m respectively. The alluvium covers are dominant with the clayey-silt followed by buff coloured semi plastic clay and on the margin of bedrock angular gravels with fine to coarse sand occur. The bedrock encountered have suffered moderate to high weathering in this area. The borehole logs of the Yamuna Flood Plain are characterized by the granular zones consisting of fine to medium Yamuna sand. The Percentage of Silt and Clay in flood plain are in lower side than sand.

3.4.3 East District:

East district of Delhi is located in the East of Yamuna River and extends up to the borders of Gaziabad and Noida ares of Uttar Pradesh. Covering a total area of 64 sq. km. Virtually, East district of NCT Delhi is a domain lying in between two rivers i.e. Yamuna in the West to Hindon in the East (6 Km eastward from the Delhi border).

The sub-surface material along Yamuna flood plain and along eastern border (proximity of Hindon River) shows thick fine sand and sandy-silt strata at shallower depth i.e. up to 60 m. bgl. The finer sediments like clayey-silt, silty-clay and buff coloured clay along with Kankars also do exists, as parting between granular zones. The deeper zones beyond 60 m depth are characterized by fine material and lacking in granular zone. The basement rock condition in East district area is moderately uneven with gentle slopping towards East. It is unlike from western flank of NCT Delhi. At Ghazipur, Kalyanpuri and Mayur Vihar a mound like basement rock

prevails in the depth range of 54 to 79 m. bgl. The basement rock situation around Yamuna flood plain in East Delhi District is ranging from 28 to 204 m. bgl. Especially around Akhsardham temple it ranges from 88 to 120 m.

The depth to water level in this district varies from 5 to 8 m. bgl and the discharge of tube well in Flood Plain is in the range of 600 to 1800 LPM and in the rest of the area it is 300 to 900 LPM with a draw-down of 6 to 13 m.

The Fresh–Saline water interface in Yamuna Flood Plain is ranging from 32 to 50 m whereas in rest of the area it is ranging from 25 to 38 m.

3.4.4 New Delhi District:

New Delhi district is located centrally in the state occupying an area of 35 sq. km. with varied surface altitude due to Delhi Ridge. Nearly 10 sq. Km. area falls within ridge area having a height of 225 to 255 m Above Mean Sea Level (AMSL). The surface is sloping gradually towards east up to the Yamuna river course where altitude is 210 m AMSL. The sub-surface configuration of New Delhi is different at various places, the western part which is adjoining to Delhi ridge is characterized by marginal alluvium of 0 to 30 m thickness overlain on weathered and fractured quartzite rocks (Delhi Ridge). The alluvium consists with clay, silt and fine to medium sand. A substantial amount of *Kankar*s also admixed with the clayey-silt below 20 m depth. This is the main aquifer material found in these areas. The top soil zone is predominantly consists of silty-clay material followed by thin partings of clayey-silt, sandy-silt and clay layers alternatively. Sandy-silt strata behave as favorable aquifer zone with a substantial discharge. In the western part of New Delhi district covering area of Rashtrapati Bhavan, Chanakyapuri, Shantipath, South and North Avenue and Connaught Place, tubewells are tapping both prevailing formation i.e. alluvium as well as hard rock, whereas in the eastern part only alluvial aquifers are tapped with yield ranging from 200 to 500 LPM. The extreme eastern part of New Delhi District bounded by river Yamuna where a domain of Yamuna Flood Plain exists in a linear fashion along river Yamuna .The potentiality of Ground water in this formation is relatively high i.e. ranging from 500 to 1600 LPM.

Ground water in the area occurs both under water table as well as under semi-confined conditions in the alluvium. The depth to water level in the district ranges from 5 to 25 m below ground level. The depth to water level varies widely depending upon the topographic elevation; it varies from 5 to 8 m in Yamuna flood plain and increases to 10 to 25 m towards the Delhi ridge. The tubewells usually tap *kankar* zone admixed with clayey-silt and sandy-silt aquifer zone. These aquifer zones are generally encountered alternatively below the depth of 20 m. bgl and onward up to the basement rock.

3.4.5 North-East District:

North-East district is located east of Yamuna River and bordering to Gaziabad district in the east and Merrut district in the north of Uttar Pradesh. It covers 60 sq. km of area. Virtually, North-East district of NCT Delhi is a domain lying in between two rivers i.e. Yamuna in the west to Hindon in the east (6 Km eastward from the Delhi border).

The sub-surface material along Yamuna flood plain and along eastern border (proximity of Hindon River) shows thick fine sand and sandy silt strata at shallower depth i.e. up to 60 m. bgl. The finer sediments like clayey–silt, silty-clay and buff coloured clay along with Kankars also do exists, as parting between granular zones. The deeper zones beyond 60 m depth are characterized by fine material and lacking in granular zone. Basement rock condition along the Yamuna Flood Plain in this district is shallower because Delhi central ridge which is running NNE to SSW diminishes at Wazirabad Barrage and protruding further in the same direction resulting to shallower depth of basement condition in sub-surface–horizon. In this district the depth is ranging from 54 m. bgl (Mandoli) to 67 m. bgl (Ushmanpur). Further east the depth of basement rock increases.

The depth to water level in this district is 5 to 8 m.bgl and the discharge of tube well in Flood Plain is in the range of 600 to 1800 LPM and in the rest of the area it is 300 to 900 LPM with a draw-down of 6 to 13 m.

The Fresh –Saline water interface in Yamuna Flood Plain is ranging from 32 to 50 m whereas in rest of the area it is ranging from 25 to 38 m.

3.4.6 North-West District:

The North-West district of NCT Delhi covers 440 Sq. km. area characterized by unconsolidated quaternary alluvium deposits. So for 250 m depth has been explored without encountering bed rock. The expected depth of bed rock is about 300 m or beyond. Thick pile of alluvium over the basement rock possesses varied sediment strata in an alternate fashion of geological setting. Nearly fine to medium and silt grade of sediment are frequent up to the depth of 50 m along with buff coloured clayey bed admixed with Coarse kankars. On the other hand after the depth of 50 m, silty–clay and clay (Light yellow) beds with Kankars increases with depth. The semi-plastic and plastic clay beds are also common at deeper depth i.e. 80 m. bgl to 250 m. bgl. The granular zone (Fine sand and silty–sand) at deeper depth are not so frequent as in the shallower depth.

In large part of the district the water levels are shallow ranging from 2 to 8 m. bgl, whereas in a limited area towards the northern border (Narela) the water levels are somewhat deeper ranging from 6 to 12 m. bgl.

The line of fresh-saline water interface also varies greatly in entire area. All along the western Yamuna Canal and along Yamuna Flood Plain it shows deeper existence that is between 40 to 70 m, whereas in rest of the area it is at 22 to 40 m deep. It was also observed from the exploratory well data that salinity of water increases with depth and there are no fresh water aquifers in between the saline zone.

3.4.7 South District:

The South district of NCT Delhi covers 250 sq. km. of area of which 45.2 sq. km area shows mountainous undulating terrain exposed with Delhi quartzite. The district is also characterized by a saucer shaped vast alluvium field in the central part of the district popularly known as Chattarpur Basin. Virtually this is valley fill deposit, the alluvium thickness varies from 0.0 m to 140.00 m.bgl (Satbari village), below which quartzitic basement rock prevails. Some of the villages like Chattarpur, Gadaipur, Mandi, Ghitorni, Ayanagar, FatehpurBeri and Satbari fall within this area. The overburden composed of unconsolidated clay, silt, sand and varying proportions of Kankars. In the deep basin area, depth zone of 38 m to 55 m is characterized as prominent gravel zone admixed with silt and fine sand followed by clayey-silt and fine sand with occasional kankar nodules. Near to basement somewhat medium sands and angular gravels (ferruginous and gritty types quartzites) are also encountered. At some places viz. Aya Nagar &FarehpurBeri at depth near to the basement rock, lenses of sticky yellowish clay also are encountered. The area across southern Delhi Ridge which falls in South District namely Hauj-khas, Saket, Khanpur, Pushpvihar, Lal-kunwa and Saritavihar are underlain by marginal alluvium deposits with a thickness ranging from 60 m to 94 m below which Quartzitic basement rock prevails.

The bore hole constructed in Quartzites (Jaunapur, Asola, Mandi, Tughlakabad) reveals that moderately fractured zones are prevalent in the depth of 30 m to 90 m and their fractured density gradually decreasing as depth increases. The weathered zone is found at every place above hard rock but their thickness varies from place to place.

The depth to water level varies widely in this district and is ranging from 8 m to 65 m. In the eastern tract of the district where Yamuna Flood Plain occur, depth to water level varies from 8 m to 22 m.bgl but in rest of the area it ranges from 30 to 65 m.bgl. The fresh/Saline water interface depth varies from 75 m to 100 m. The thickness of the fresh water zone varies from 30 m to 85 m.

3.4.8 South-West District:

The South-West district of NCT Delhi covers 420 Sq. km. Majority of the area characterized by unconsolidated quaternary alluvium deposits and about 18 sq. km area is covered by denudation hills especially in the eastern part of the district. Exploration upto a depth of 302 m was done to study the hydrogeological condition. The bed rock was encountered at different depth i.e. in Dhansa (297 m), Pindwalakala (300 m), Toghanpur (298 m) and Jhul-jhuli (251 m) Thick pile of alluvium over the basement rock possesses varied nature of sediment strata in an alternate fashion of geological setting. Nearly fine to medium and silt grade of sediment are frequent up to the depth of 50 m along with buff coloured clayey bed admixed with coarse kankars. On the other hand after the depth of 50m, silty–clay and clay (Light yellow) beds with Kankars increases with depth. The semi-plastic and plastic clay beds are also common at deeper depth i.e. 80 m .bgl to 250 m.bgl. The granular zone (Fine sand and silty–sand) at deeper depth are not so frequent as in the shallower depth.

In major part of the district the depth to water level ranges from 5 to 28 m.bgl where as in rocky area which are lying in the eastern part of the district (Central Delhi Ridge) the depth to water level is in the range of 22 m to 50 m.

The line of Fresh-Saline water interface also varies greatly in entire area. All along the Najafgarh Drain and Two Depression (Gumanhera Village & PindwalanKalan) possesses somewhat deep fresh water layer i.e. up to 35 m. bgl but on the other hand 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 Eastern rocky area the fresh–saline Interface lies at greater depths i.e. around 80 to 90 m.bgl.

3.4.9 West District:

West district is occupied by unconsolidated Quaternary alluvium underlain by Precambrian meta-sediments of Delhi System. Quaternary alluvium comprises of sand, clay, silt, gravels/pebbles, kankars. The aquifer system include sand fine to coarse grained admixed with kankars with little amount of clay and silt. Clay is sticky and plastic in nature, light grayish in colour, admixed with a little sand and kankars, fine to medium grained. The depth of water level varies in the district, 2 m to 15 m. The depth of fresh saline interface also varies from 25 m to 50 m at different places. The depth of fresh water zone varies from 10 m to 45 m.

Chapter 4
WATER LEVEL BEHAVIOUR OF HYDROGRAPH STATIONS

4.1. May- 2015:

4.1.1 Depth to water level: The Depth to water level recorded in NCT Delhi during May-2015 ranges from 1.20 to 62.22 m. bgl. The total 114 stations of Delhi state have been analyzed district wise where 50% wells of South district shown more than 40 m.bgl water level and 19% wells have 20 to 40 m.bgl water level. In New Delhi and South-West district 57% and 35% of the wells show water levels ranging from 10 to 20 m.bgl, (Plate-4, Annexure-1& 3, Table- 4.1). In 29%, 40% and 45% of the wells in North, East and North West districts the water level ranges from of 5 to10 m.bgl respectively. The entire Yamuna flood plain the water levels are between 2 to 5 m. Area wise analysis of water level data of May, 2015 *for* 114 stations is shown in table 4.1.

4.1.2 Annual Fluctuation: The fluctuation of water level between May-2014 and May-2015 of Delhi state shows a fall in the range of 0.01 to 3.55 m in nearly 87% of wells. The overall data indicates that South and Southwest districts are showing a continuous fall in comparison to other areas. (Plate-5, Annexure-4).

4.1.3 Decadal Fluctuation: When the water level data of May-2015 is compared with 10 year mean of the month of May, about 63% of the wells indicate fall in the range of 0.24 to 10.10 m. Only 36% wells of the East, New Delhi, North and Northwest have shown rising water level condition in the range of 0 to 2 m. The maximum fall has taken place in South and Southwest districts (i.e. 7.15 to 10.10 m) (Plate-6, Annexure-5)

Table-4.1 Area under various Depth to Water Level

DTW (m bgl)	Area (sq km)	Location	Districts
0-2	5	Raj Ghat, Jagat Pur-2, Balswa Lake	Central, N, NW.
2-5	270	Jagat Pur-1, Nangli Rajapur, Burari, Kanjawala, Auchandi, Majra Dabus, Deorala, Hiran Kudna etc.	E, N, NW, SW, W
5-10	401	Indiagate, Chilla, Bakoli, Palla, Peeragarhi etc	New Delhi, E, NW, W.
10-20	383	Birla Mandir, Kichner Road, Shram Shakti Bhavan, Chawla, Daulatpur etc.	SW, New Delhi,
20-40	195	Mahavir Banasthali, Nehrupark, JamaliKamali etc.	SW, S, New Delhi
> 40	229	PushpVihar, Bhatti, Asola Jaunapur, Satbari Sultanpur etc	S

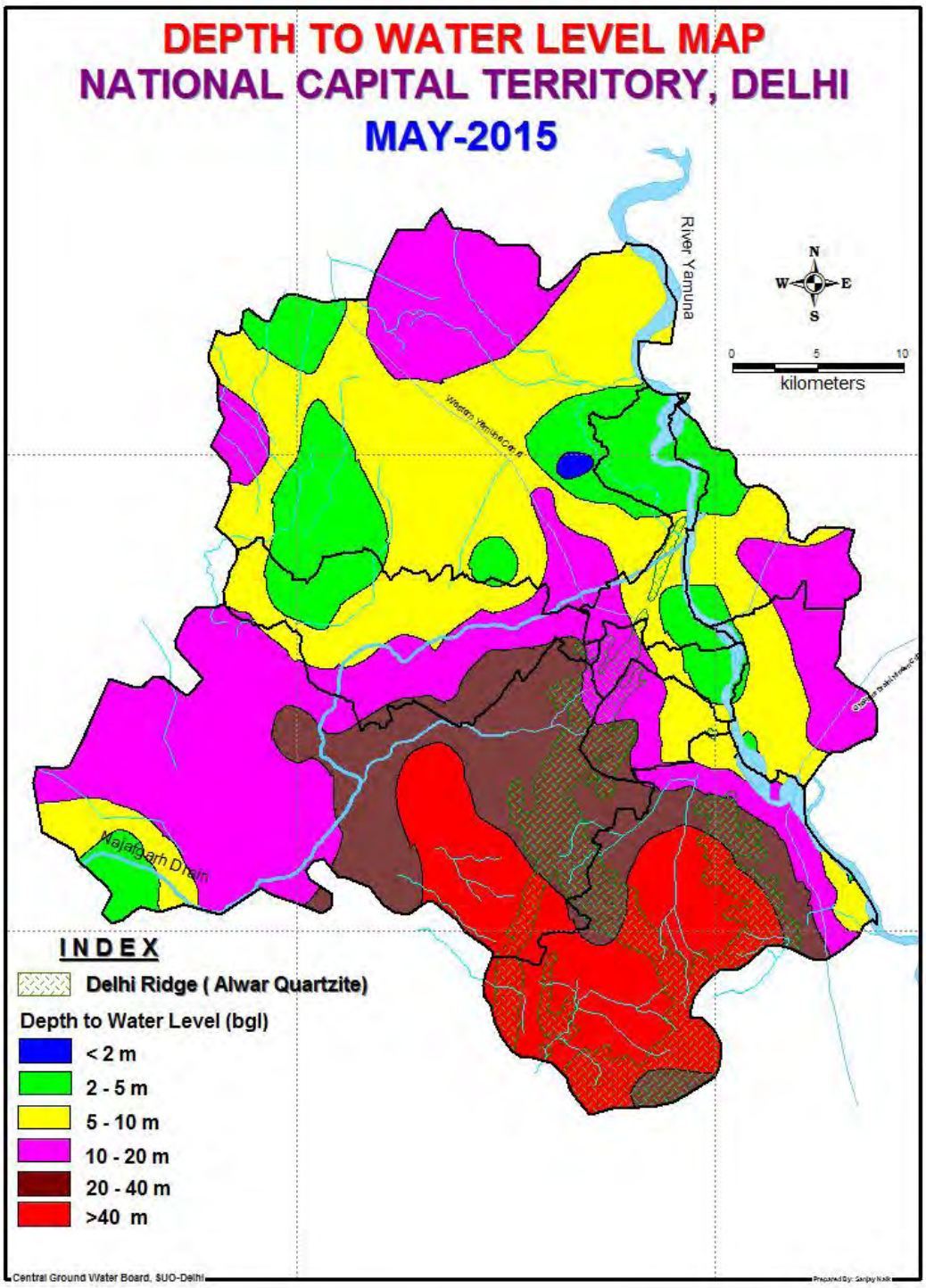
DEPTH TO WATER LEVEL MAP
NATIONAL CAPITAL TERRITORY, DELHI
MAY-2015
River Yamuna
N
W
E
S
0
5
10
kilometers
Najafgarh Drain
INDEX
Delhi Ridge (Alwar Quartzite)
Depth to Water Level (bgl)
< 2 m
2 - 5 m
5 - 10 m
10 - 20 m
20 - 40 m
>40 m
Central Ground Water Board, SUO-Delhi

Plate 4

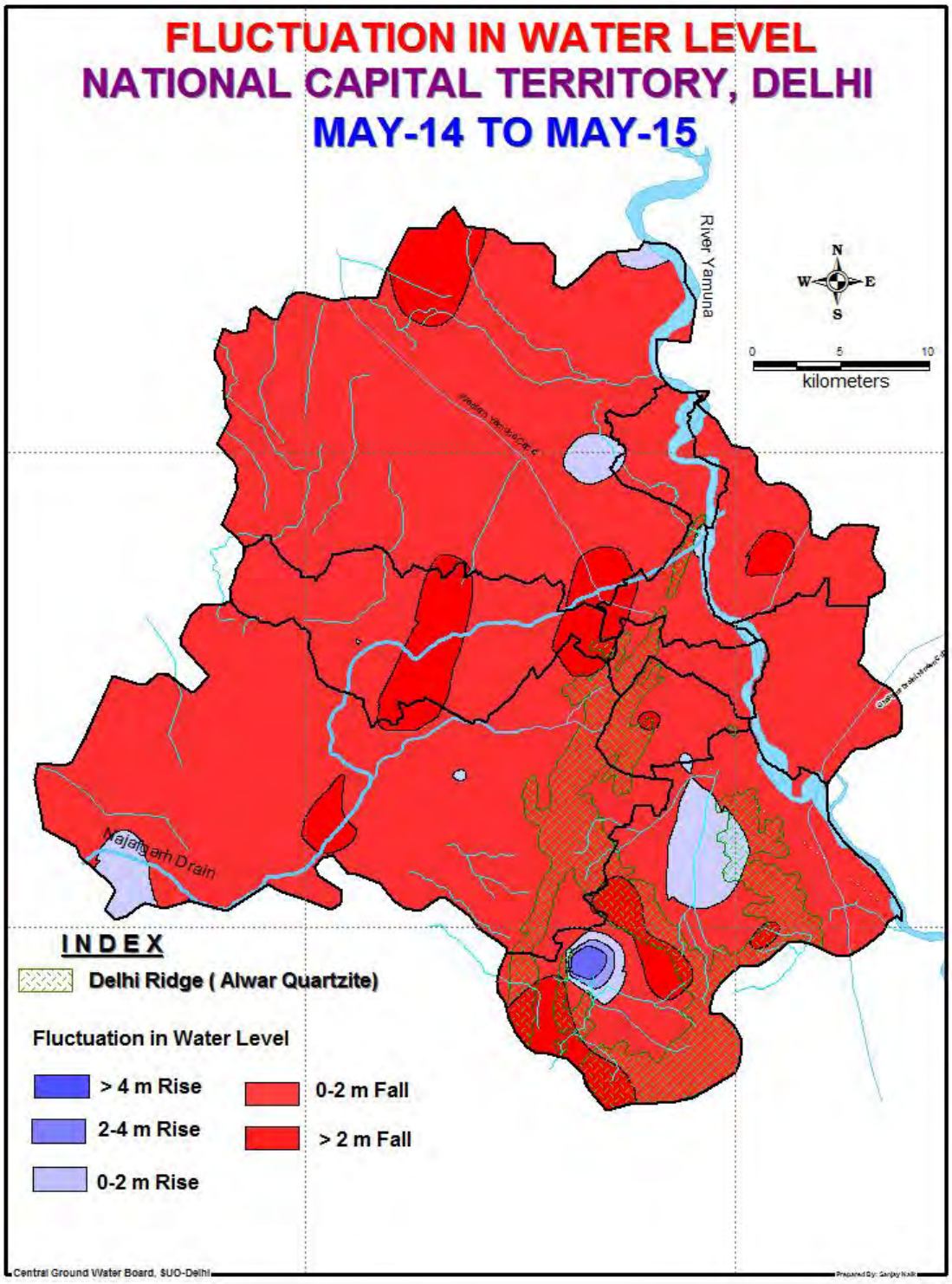
FLUCTUATION IN WATER LEVEL
NATIONAL CAPITAL TERRITORY, DELHI
MAY-14 TO MAY-15
River Yamuna
N
W
E
S
0
5
10
kilometers
Najafgarh Drain
INDEX
Delhi Ridge (Alwar Quartzite)
Fluctuation in Water Level
> 4 m Rise
2-4 m Rise
0-2 m Rise
0-2 m Fall
> 2 m Fall
Central Ground Water Board, SUO-Delhi

Plate 5

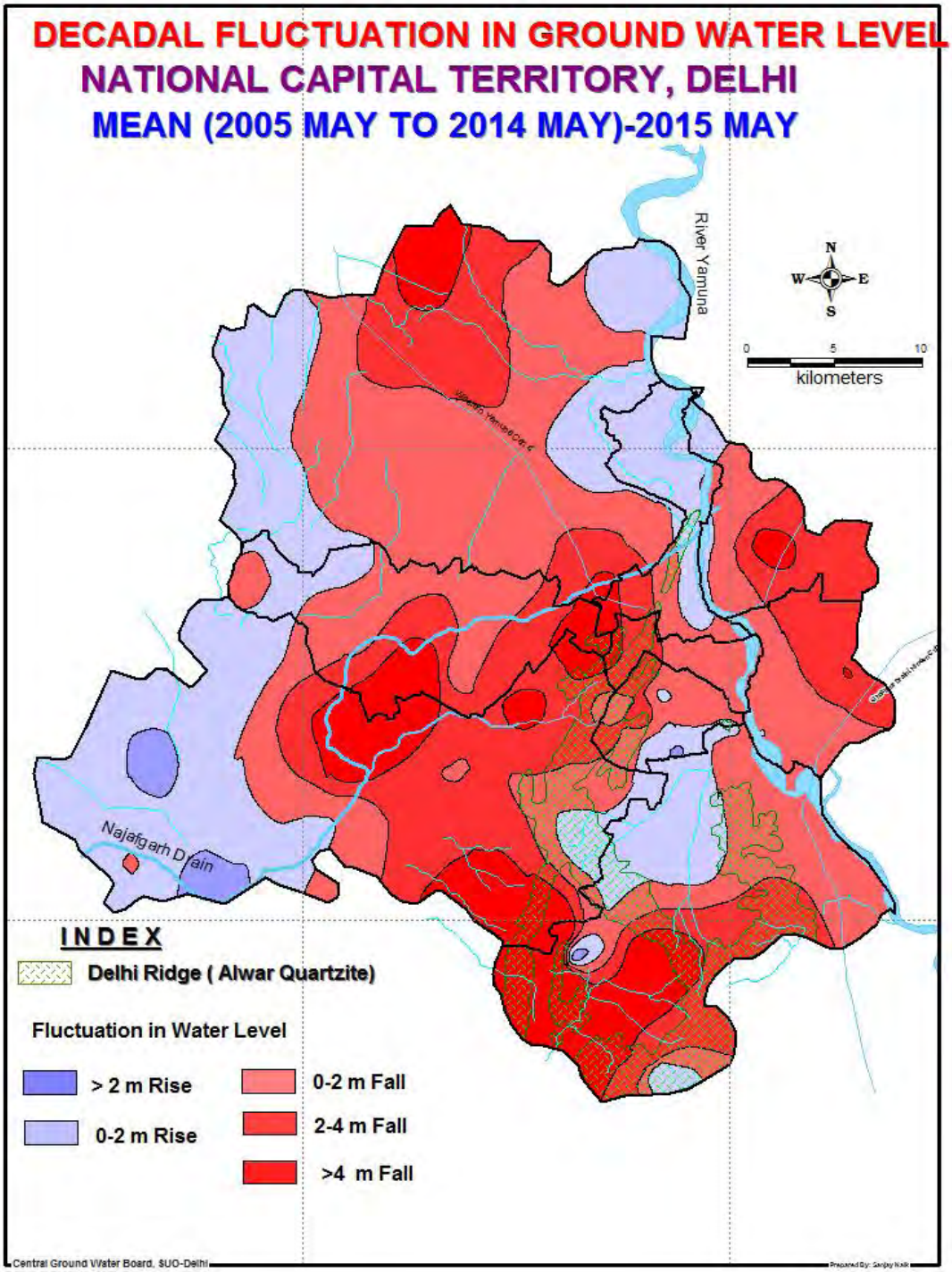
DECADAL FLUCTUATION IN GROUND WATER LEVEL
NATIONAL CAPITAL TERRITORY, DELHI
MEAN (2005 MAY TO 2014 MAY)-2015 MAY
River Yamuna
N
W
E
S
0
5
10
kilometers
Najafgarh Drain
INDEX
Delhi Ridge (Alwar Quartzite)
Fluctuation in Water Level
> 2 m Rise
0-2 m Rise
0-2 m Fall
2-4 m Fall
>4 m Fall
Central Ground Water Board, SUO-Delhi

Plate 6

4.2. August 2015:

4.2.1 Depth to water level: The depth to water level recorded in NCT Delhi during Aug-2015 ranges from 0.51 to 61.84 m. bgl. Data from 114 stations have been analyzed district wise in which, 44% wells of South district show more than 40 m bgl water level and 19% wells have 20 to 40 m bgl water level. In Southwest district water levels in 38% of the monitored wells range between 20 to 40 m bgl. In New Delhi district 50% of the wells have 10 to 20 m bgl water level. (Plate-7, Annexure-1 & 6). The depth to water level in East and Northwest district range between 5 to 10 m bgl in 40% and 29% of the district whereas in East, North and West districts the water levels in 30%, 29%, and 13% wells range between 2 to 5 m bgl respectively. The entire Yamuna flood plain is also falling in this category.

4.2.2 May (2015) – August (2015) Fluctuation: The fluctuation of water level between Pre-monsoon (May-2015) and August-2015 indicate that 60% wells shows rise in the range of 0 to 2m, 17% show rise in the range of 2 to 4 m and the rest show a fall in water level. The fall condition has been observed in Southwest, South, Northwest and Northeast districts. The maximum fall of 2.81 m and 9.92 m is observed in the district of Northwest and South respectively. This may be the result of heavy withdrawal locally during the period (Annexure-1 & 7).

4.2.3 Annual Fluctuation: The variation of water level from August 2014 and August 2015 reveals that there is a rise in the range of 0 to 2 m in nearly 52% of the wells (only in pockets). In the districts like New Delhi, Southwest and South district the range of fall in water level in between 1.11 to 3.09 m. In totality, 34% wells shows fall in the range of 0 to more than 4 m. The rise of more than 4 m is recorded in New Delhi, South and South West districts. The overall analysis indicates a rising situation in the state (Plate-8, Annexure-8).

4.2.4 Decadal Fluctuation: The water level data of August-2015 when compared with 10 year mean for the month of August indicate that in 54% of the wells the water levels are falling in the range of 0.01 to 8.39. In the districts like East, New Delhi, North East, North West, South and South-West 49% of the wells show decline in water level behavior (Plate-9, Annexure-9).

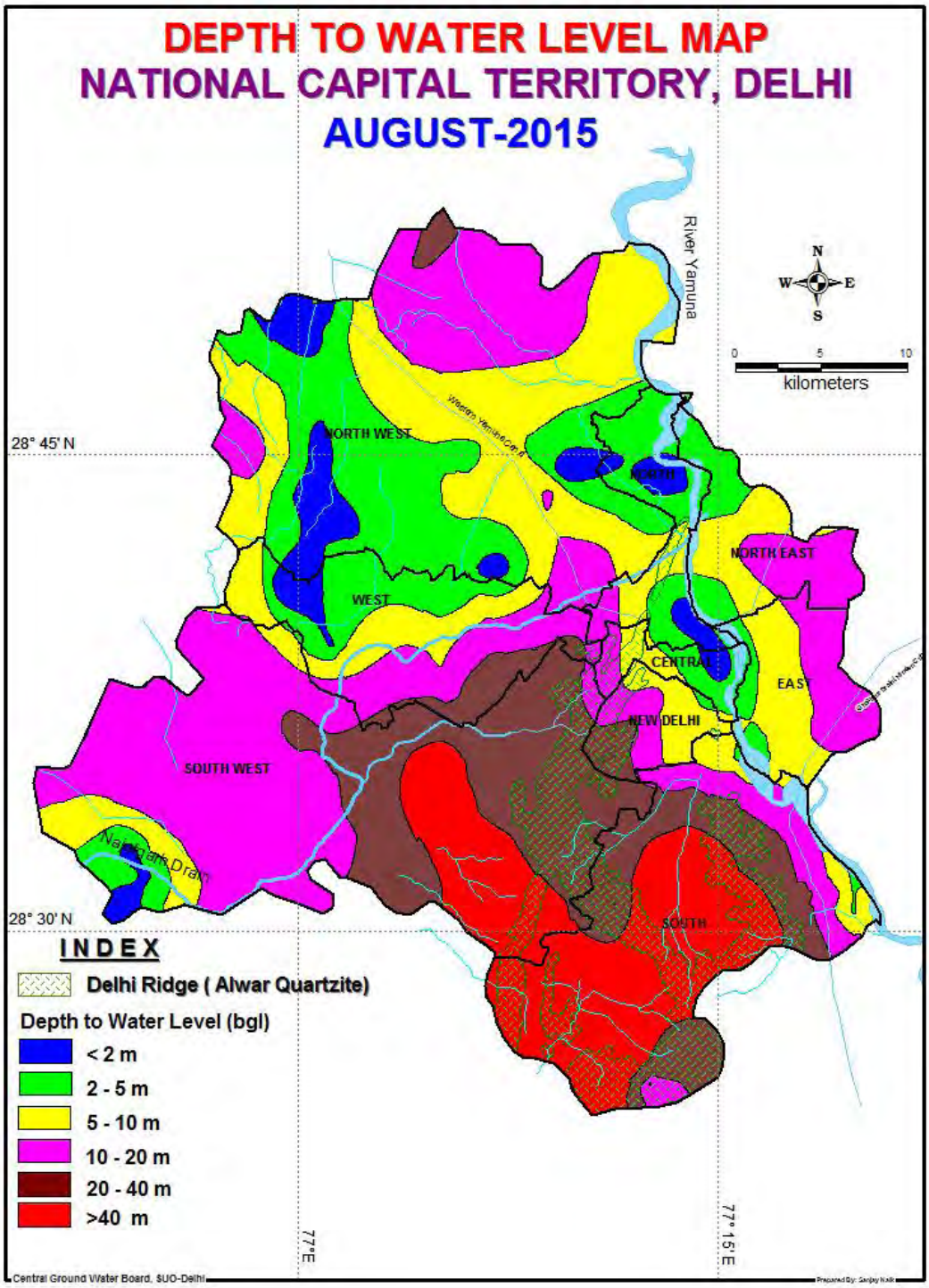
DEPTH TO WATER LEVEL MAP
NATIONAL CAPITAL TERRITORY, DELHI
AUGUST-2015
River Yamuna
N
W
E
S
0
5
10
kilometers
28° 45' N
NORTH WEST
NORTH
NORTH EAST
WEST
CENTRAL
EAST
NEW DELHI
SOUTH WEST
SOUTH
28° 30' N
77° E
77° 15' E
INDEX
Delhi Ridge (Alwar Quartzite)
Depth to Water Level (bgl)
< 2 m
2 - 5 m
5 - 10 m
10 - 20 m
20 - 40 m
>40 m
Central Ground Water Board, SUO-Delhi

Plate 7

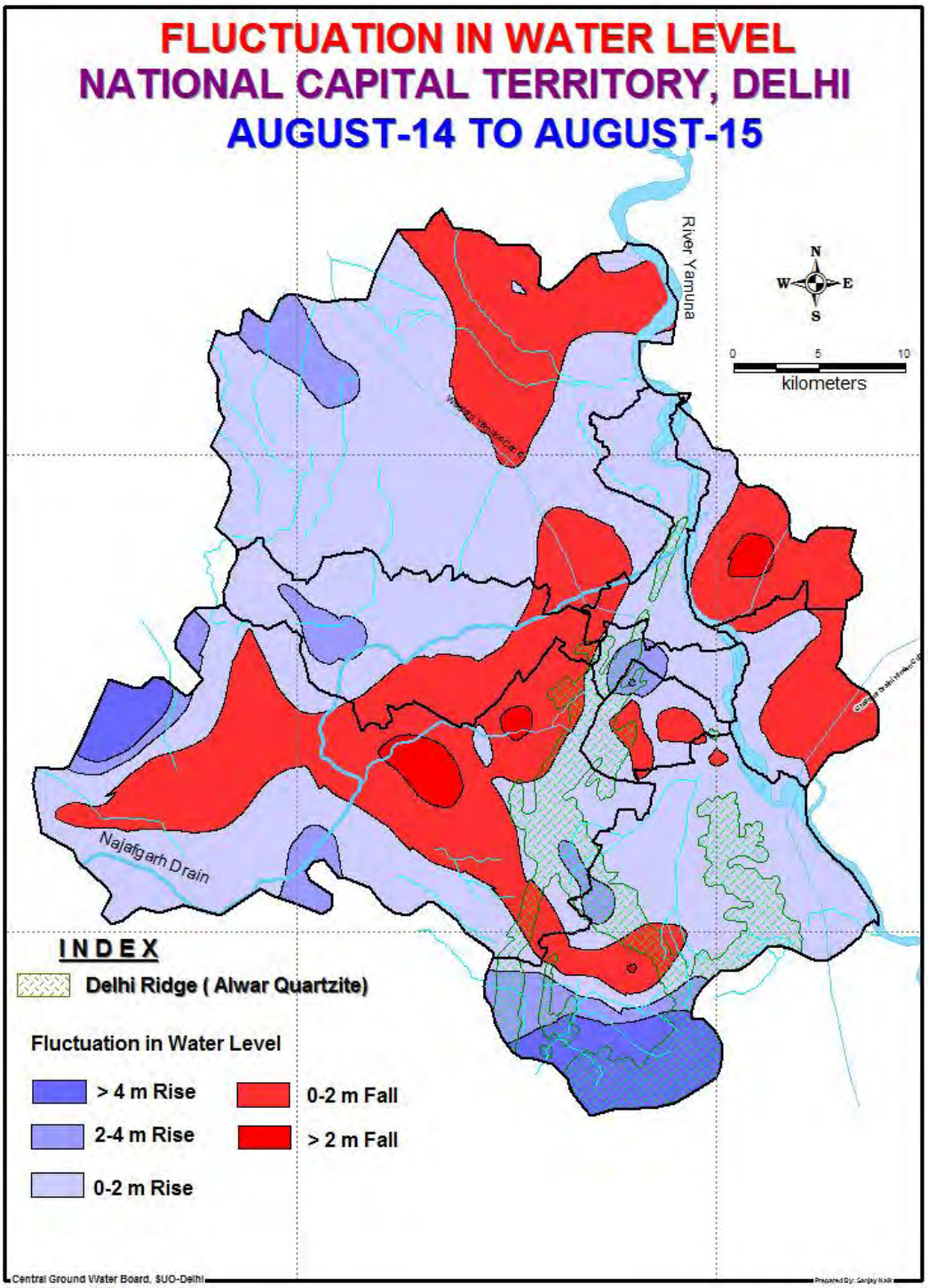
FLUCTUATION IN WATER LEVEL
NATIONAL CAPITAL TERRITORY, DELHI
AUGUST-14 TO AUGUST-15
River Yamuna
N
W
E
S
0
5
10
kilometers
Najafgarh Drain
INDEX
Delhi Ridge (Alwar Quartzite)
Fluctuation in Water Level
> 4 m Rise
2-4 m Rise
0-2 m Rise
0-2 m Fall
> 2 m Fall
Central Ground Water Board, SUO-Delhi

Plate 8

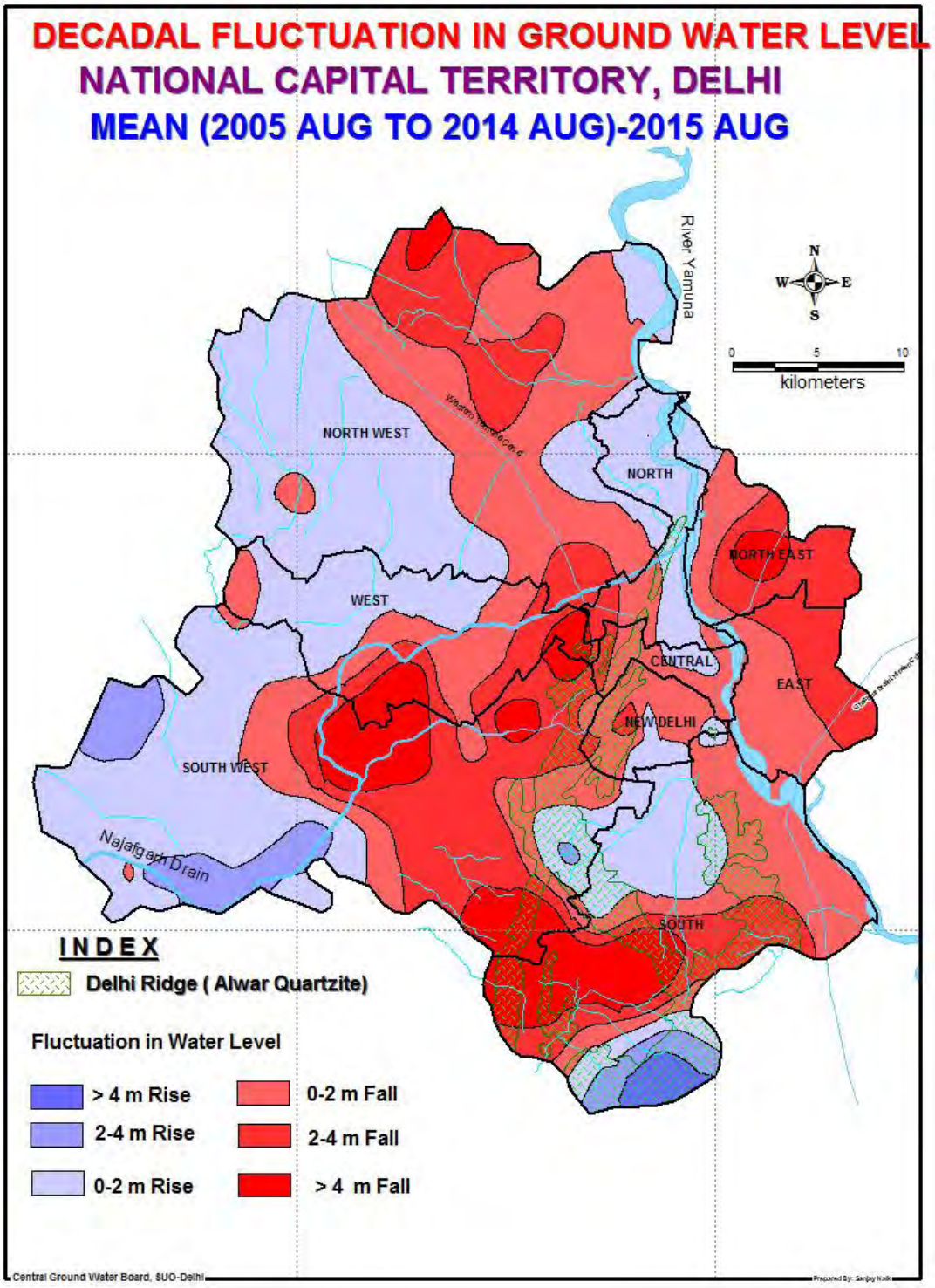
DECADAL FLUCTUATION IN GROUND WATER LEVEL
NATIONAL CAPITAL TERRITORY, DELHI
MEAN (2005 AUG TO 2014 AUG)-2015 AUG
River Yamuna
N
W
E
S
0
5
10
kilometers
NORTH WEST
NORTH
NORTH EAST
WEST
CENTRAL
EAST
NEW DELHI
SOUTH WEST
SOUTH
Najafgarh Drain
INDEX
Delhi Ridge (Alwar Quartzite)
Fluctuation in Water Level
> 4 m Rise
2-4 m Rise
0-2 m Rise
0-2 m Fall
2-4 m Fall
> 4 m Fall
Central Ground Water Board, SUO-Delhi

Plate 9

4.3. November 2015:

4.3.1 Depth to water level: The depth to water level recorded in NCT Delhi during November-2015 ranges from 0.72 to 61.13 m bgl. The data from 116 stations (Plate-10, Annexure-1 & 10) has been analyzed district wise. 50% wells of South district shown more than 40 m bgl water level and 12% wells have 20 to 40 m bgl water level. In Southwest district 38% wells have water level between 20 to 40 m bgl. The depth to water level of East, Northeast and Northwest districts are in the range of 5 to10 m bgl in 40%, 25% and 34% respectively whereas in North and South districts 57% and 15% wells are showing water level in the range of 2 to 5 m bgl respectively. The water levels of entire Yamuna flood plain are in the range of 2 to 5 m bgl.

4.3.2 Pre-Post Monsoon Fluctuation: The fluctuation of water level between Pre-monsoon (May-2015) and Post Monsoon (Nov-2015) of Delhi state shows 0.01 to 8.82 m rise in 66% of the wells. Few wells of New Delhi, Northwest, South and Southwest districts show fall in water level in the range of 0 to 2 m. An analysis of the data indicates that the declining trend is continuing in the South and Southwest districts (Plate-11, Annexure-1 & 11).

4.3.3 Annual Fluctuation: The hydrograph analyses of Nov-2014 and Nov-2015 water levels of 115 wells reveals that 58% of the wells shows rise in the range of 0 to more than 4 m whereas rest of the wells show fall in water level. The rise of more than 4 m is recorded only in South and Southwest districts. The overall analysis indicates a rising water level situation in the state (Plate-12, Annexure-12).

4.3.4 Decadal Fluctuation: When the data of Nov 2015 was compared with 10 year mean for November, it shows that the water levels in 63% of the wells have recorded a fall in the range of 0.01 to 7.27 m. Only 23% wells of the New Delhi, Northwest and Southwest districts have a rising condition of water level in the range of 0 to 2 m (Plate-13, Annexure-13).

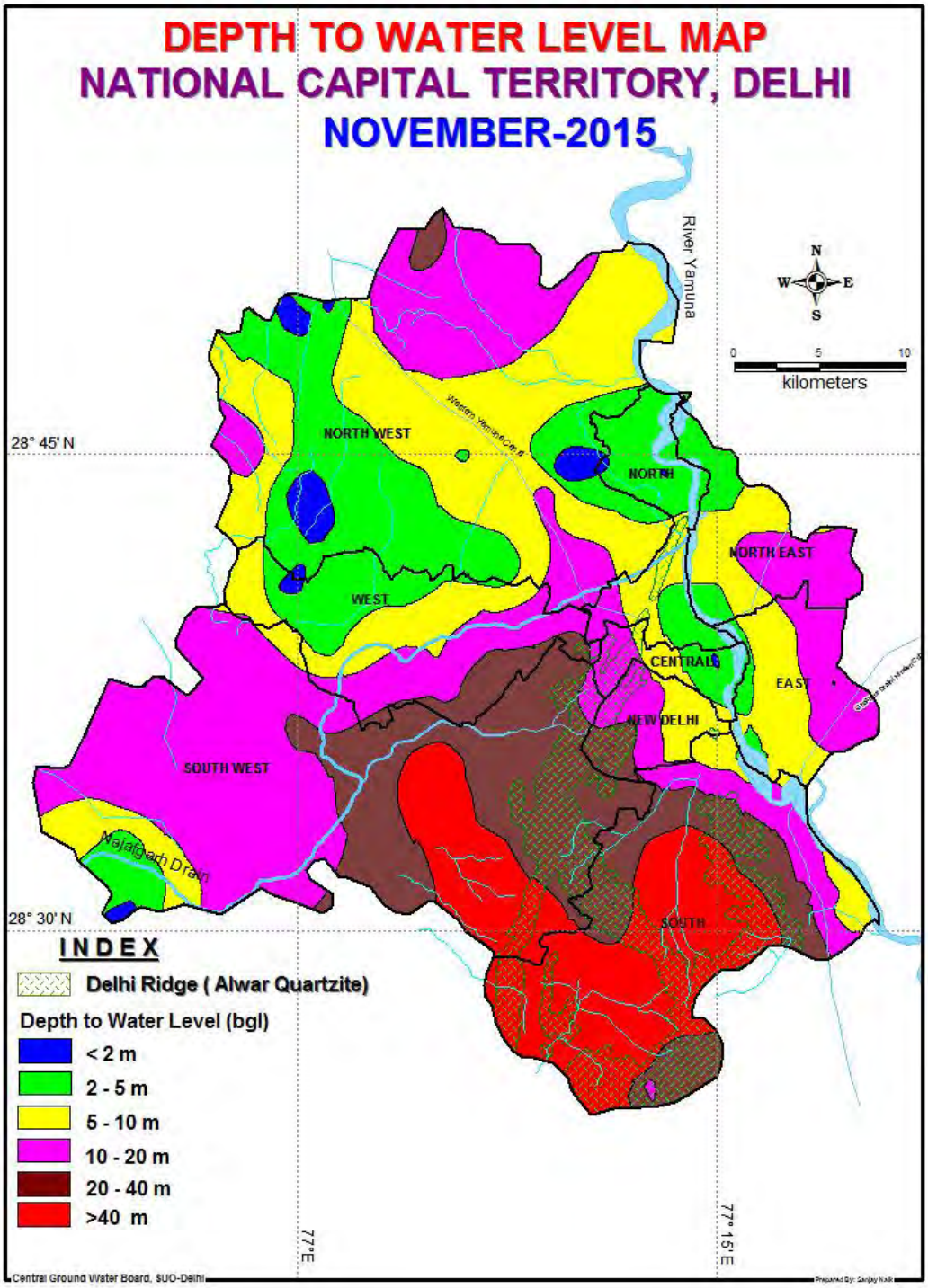
DEPTH TO WATER LEVEL MAP
NATIONAL CAPITAL TERRITORY, DELHI
NOVEMBER-2015
River Yamuna
N
W
E
S
0
5
10
kilometers
28° 45' N
NORTH WEST
NORTH
NORTH EAST
WEST
CENTRAL
EAST
NEW DELHI
SOUTH WEST
SOUTH
Najafgarh Drain
28° 30' N
77°E
77° 15' E
INDEX
Delhi Ridge (Alwar Quartzite)
Depth to Water Level (bgl)
< 2 m
2 - 5 m
5 - 10 m
10 - 20 m
20 - 40 m
>40 m
Central Ground Water Board, SUO-Delhi

Plate 10

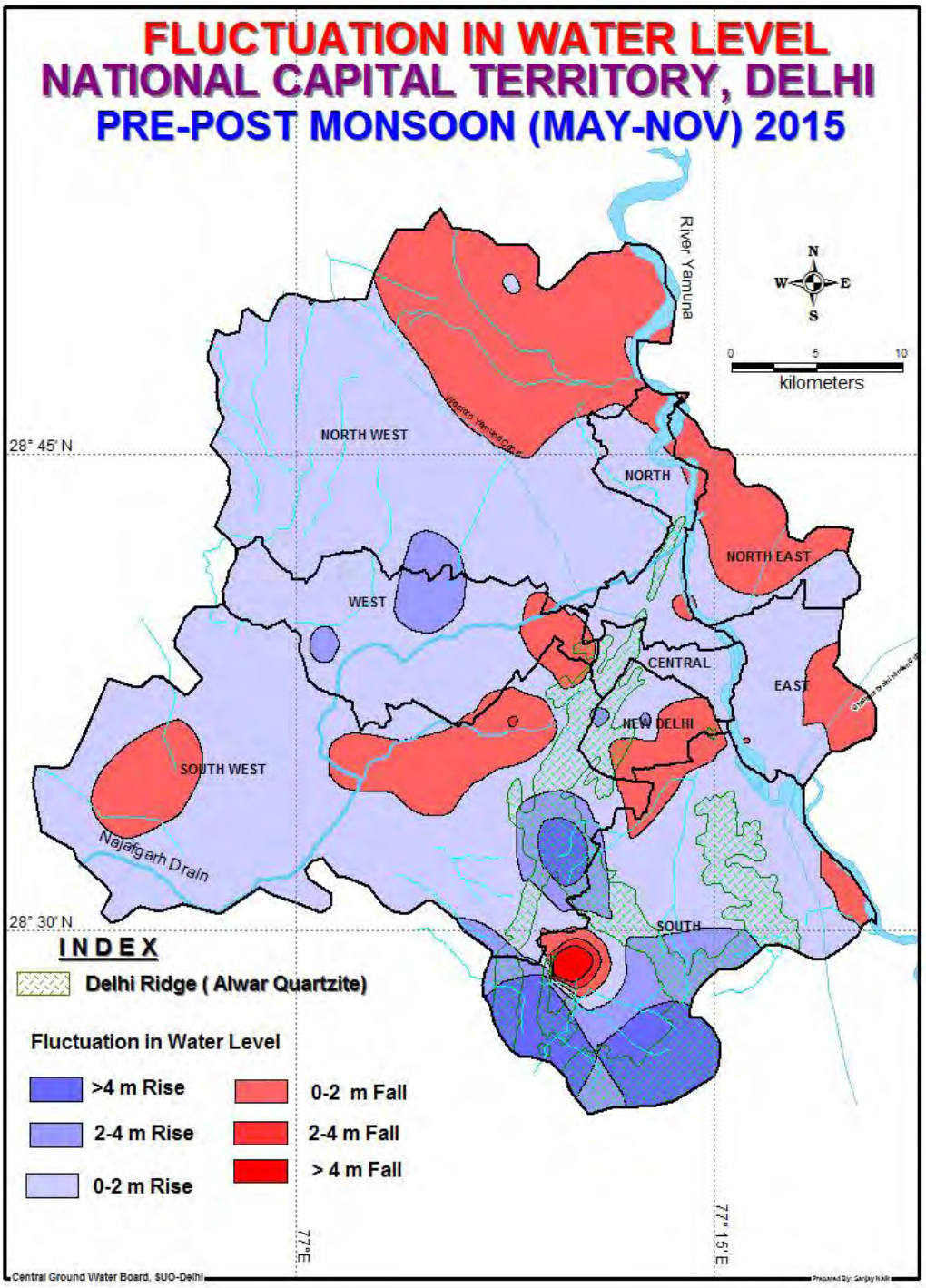
FLUCTUATION IN WATER LEVEL
NATIONAL CAPITAL TERRITORY, DELHI
PRE-POST MONSOON (MAY-NOV) 2015
River Yamuna
N
W
E
S
0
5
10
kilometers
28° 45' N
NORTH WEST
NORTH
NORTH EAST
WEST
CENTRAL
EAST
NEW DELHI
SOUTH WEST
SOUTH
Najafgarh Drain
28° 30' N
INDEX
Delhi Ridge (Alwar Quartzite)
Fluctuation in Water Level
>4 m Rise
2-4 m Rise
0-2 m Rise
0-2 m Fall
2-4 m Fall
> 4 m Fall
77° E
77° 15' E
Central Ground Water Board, SUO-Delhi

Plate 11

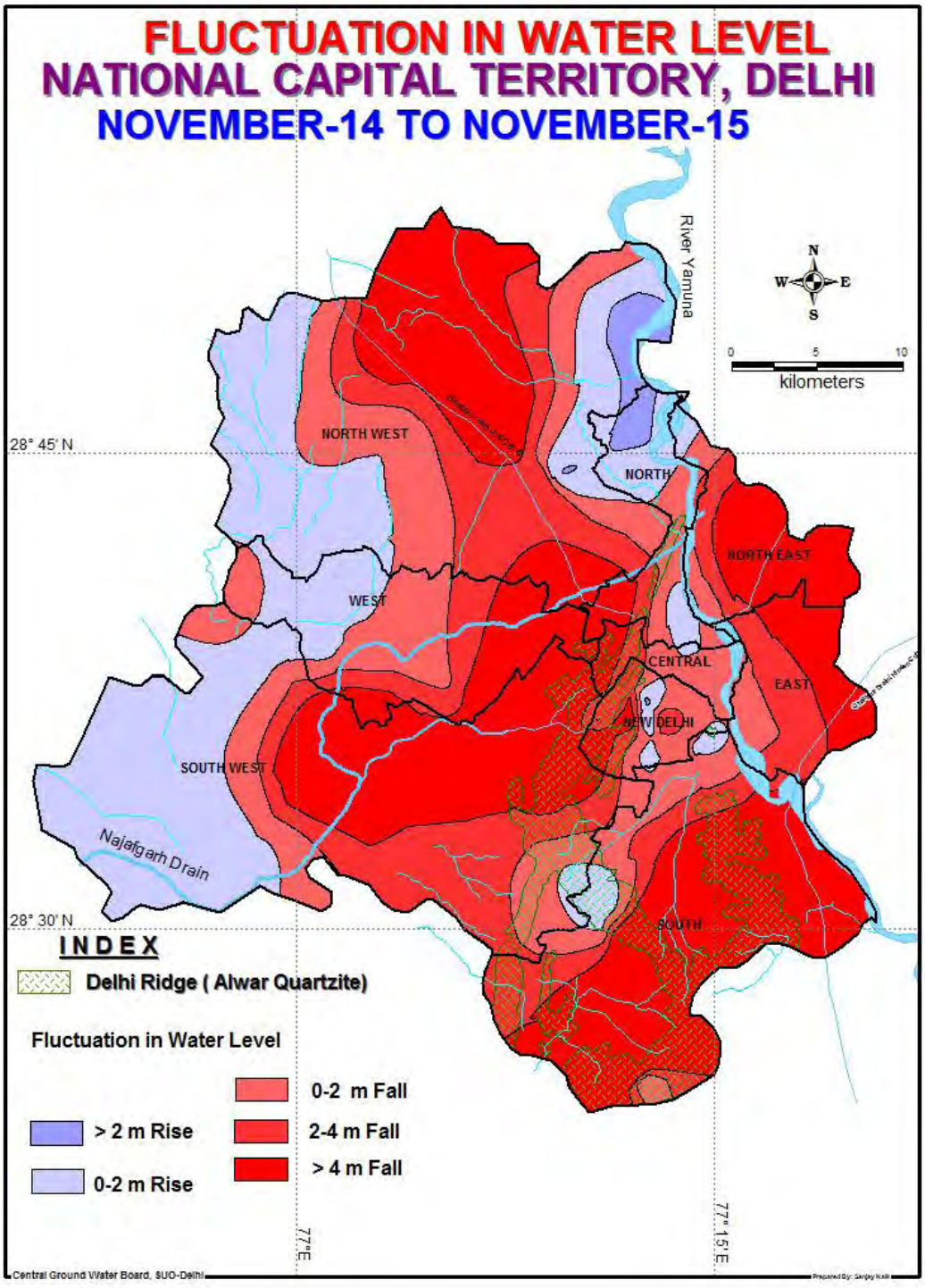
FLUCTUATION IN WATER LEVEL
NATIONAL CAPITAL TERRITORY, DELHI
NOVEMBER-14 TO NOVEMBER-15
River Yamuna
N
W
E
S
0
5
10
kilometers
28° 45' N
NORTH WEST
NORTH
NORTH EAST
WEST
CENTRAL
EAST
NEW DELHI
SOUTH WEST
Najafgarh Drain
28° 30' N
SOUTH
77°E
77° 15'E
INDEX
Delhi Ridge (Alwar Quartzite)
Fluctuation in Water Level
0-2 m Fall
2-4 m Fall
> 4 m Fall
> 2 m Rise
0-2 m Rise
Central Ground Water Board, SUO-Delhi

Plate 12

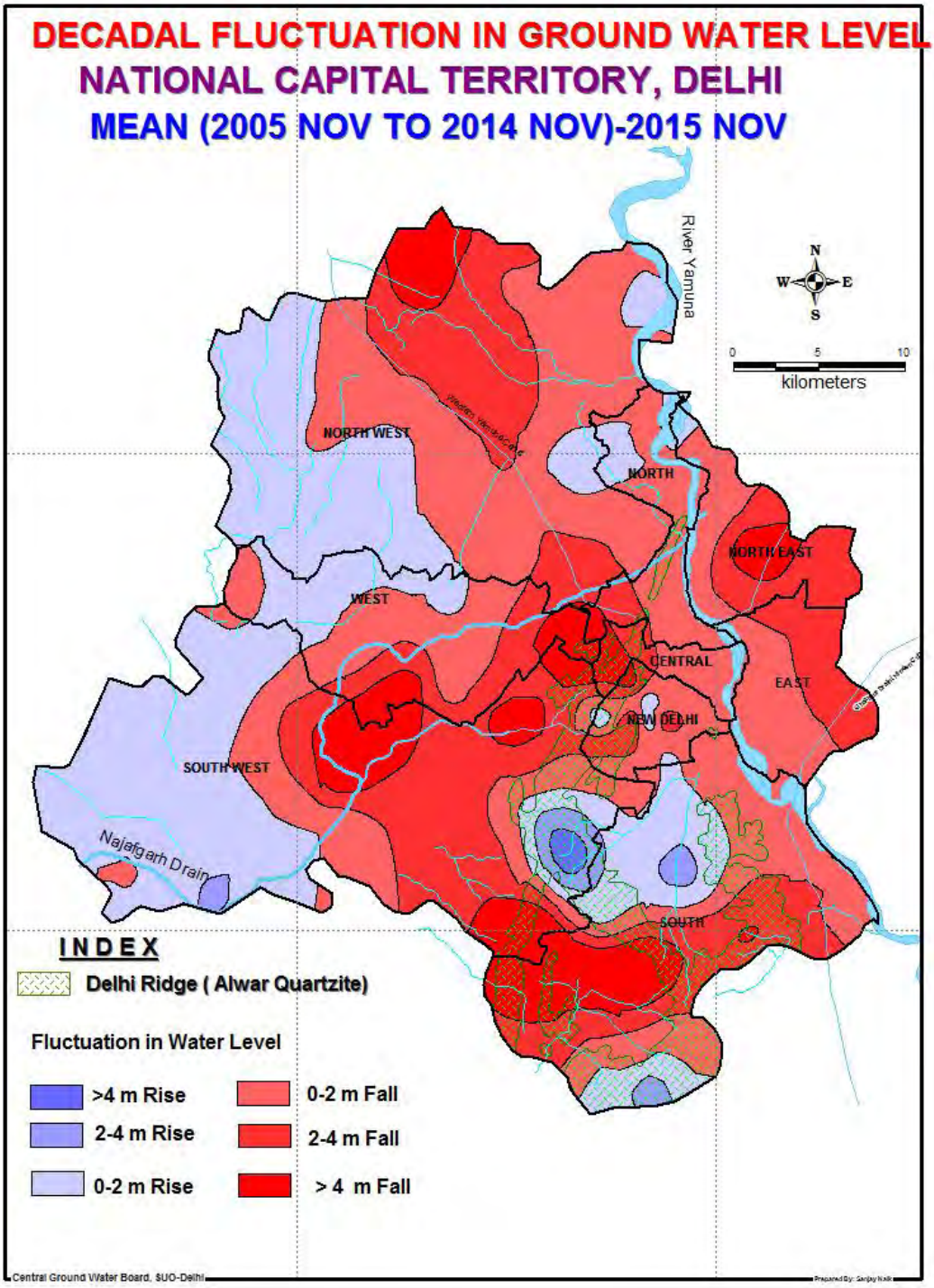
DECADAL FLUCTUATION IN GROUND WATER LEVEL
NATIONAL CAPITAL TERRITORY, DELHI
MEAN (2005 NOV TO 2014 NOV)-2015 NOV
River Yamuna
N
W
E
S
0
5
10
kilometers
NORTH WEST
NORTH
NORTH EAST
WEST
CENTRAL
EAST
NEW DELHI
SOUTH WEST
SOUTH
Najafgarh Drain
INDEX
Delhi Ridge (Alwar Quartzite)
Fluctuation in Water Level
>4 m Rise
2-4 m Rise
0-2 m Rise
0-2 m Fall
2-4 m Fall
> 4 m Fall
Central Ground Water Board, SUO-Delhi

Plate 13

4.4. January 2016:

4.4.1 Depth to water level: The depth to water level recorded in NCT Delhi during January 2016 ranges from 0.74 to 59.51 m bgl. A total of 115 stations have been analyzed district wise. An analysis of the data reveal that in South district 47% of the wells have water levels of more than 40 m bgl and 20% in the range of 20 to 40 m bgl. The water levels in the districts of Southwest and New Delhi are in the range of 10 to 20 m bgl in 42% of the area and a few patches of 20 to 40 m bgl water levels are also observed in New Delhi, South and Southwest districts. In rest of the districts the water level ranges between 2 to 10 m bgl indicating that, only in 50% of the State the water levels are below 10 m bgl (Plate-14, Annexure-1 & 14) covering entire Yamuna Flood Plain and East, Northeast, Northwest and North districts. Maximum water levels in the states are observed in the monitoring wells at Godaipur, Jaunapur, Palam, and Pushp Vihar ranging between of 56 to 59 m bgl.

4.4.2 May 15 – January 16 Fluctuation: The fluctuation of water level between Pre-monsoon (May-2015) and January-2016 have been analyzed for 113 wells in which it has been found that 40% wells register a fall in water level in the range of 0.11 to 9.52 m mostly in Northwest, South and Southwest districts and 60% area show rise in water level in the range of 0.01 to 6.38 m. (Annexure-1 & 15).

4.4.3 Annual Fluctuation: The hydrograph analyses of January 2015 and January 2016 reveals that in 49% of the wells the water level is falling and in 47% of the wells there is a rise in the range of 0 to 2 m. The overall data indicates that New Delhi, Northwest, South and Southwest districts are showing a continuous fall in comparison to other areas (Plate-15, Annexure-16).

4.4.4 Decadal Fluctuation: When the data of January-2016 has compared with 10 year mean of January, it has been observed that 67% of monitoring stations of New Delhi and Northwest show a fall in water level where the highest fall is 4.23 m and 4.03 m respectively. The same condition prevails in South and Southwest districts in 54% of the area where the highest depletion is 7.20 m and 7.65 m respectively. Northeast and East have also suffered depletion of water table in the range of 5.09 to 5.40 m. The overall observation of water levels in the state indicates that the southern districts are facing maximum declining conditions (Plate-16, Annexure-17).

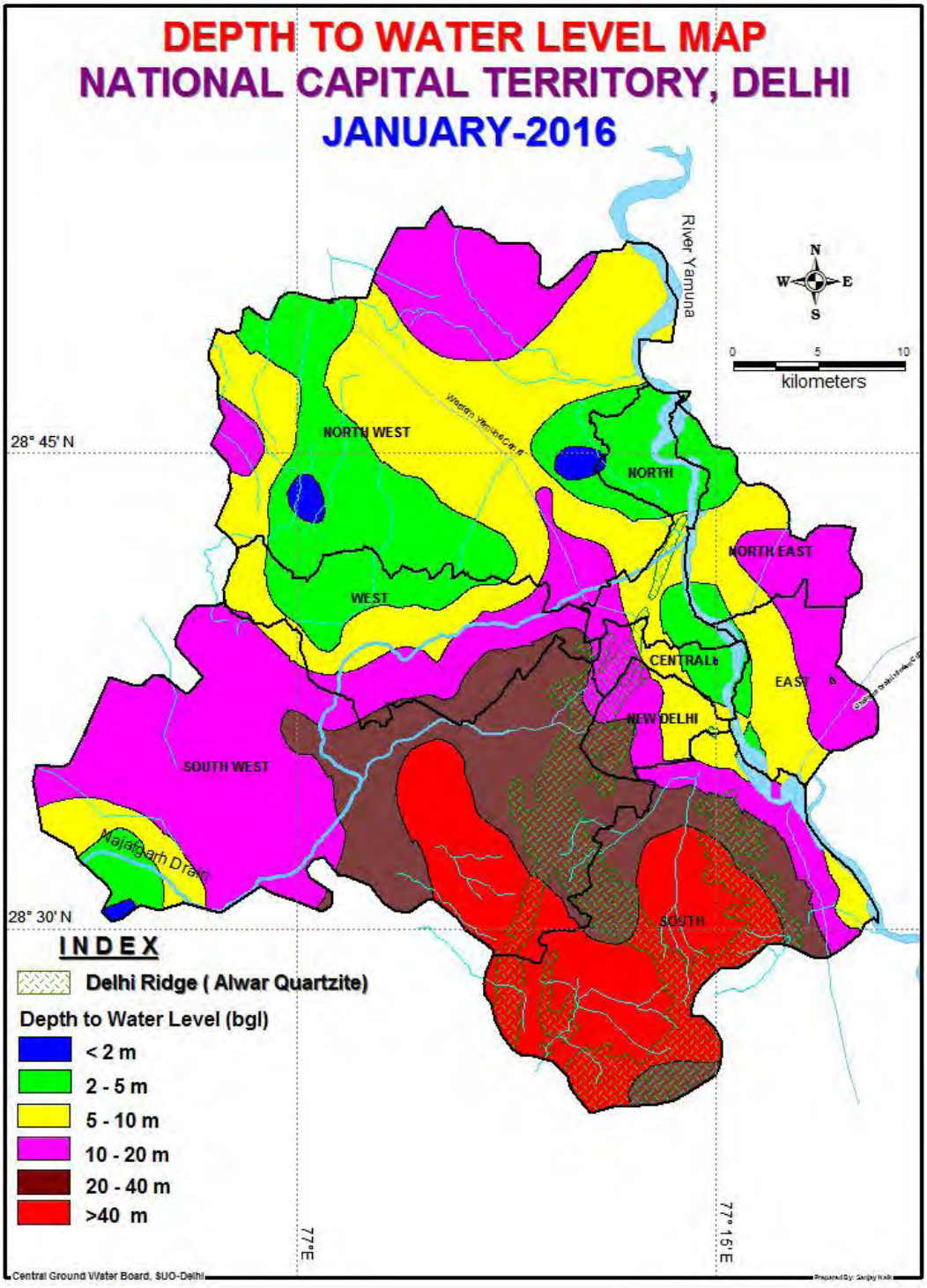
DEPTH TO WATER LEVEL MAP
NATIONAL CAPITAL TERRITORY, DELHI
JANUARY-2016
River Yamuna
N
W
E
S
0
5
10
kilometers
28° 45' N
NORTH WEST
NORTH
NORTH EAST
WEST
CENTRAL
EAST
NEW DELHI
SOUTH WEST
SOUTH
Najafgarh Drain
28° 30' N
77° E
77° 15' E
INDEX
Delhi Ridge (Alwar Quartzite)
Depth to Water Level (bgl)
< 2 m
2 - 5 m
5 - 10 m
10 - 20 m
20 - 40 m
>40 m
Central Ground Water Board, SUO-Delhi

Plate 14

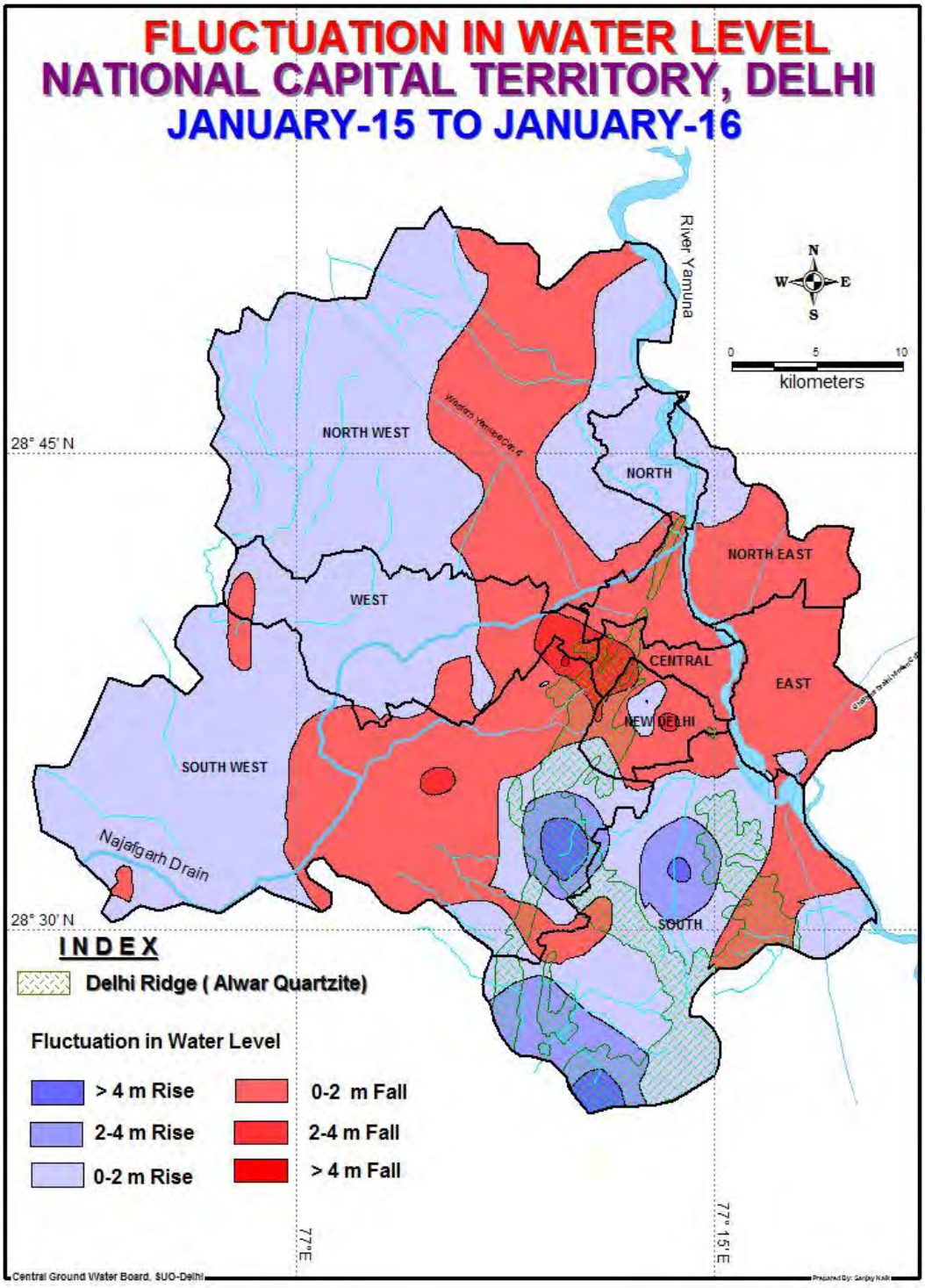
FLUCTUATION IN WATER LEVEL
NATIONAL CAPITAL TERRITORY, DELHI
JANUARY-15 TO JANUARY-16
River Yamuna
N
W
E
S
0
5
10
kilometers
NORTH WEST
NORTH
NORTH EAST
WEST
CENTRAL
EAST
NEW DELHI
SOUTH WEST
SOUTH
Najafgarh Drain
28° 45' N
28° 30' N
77°E
77° 15' E
INDEX
Delhi Ridge (Alwar Quartzite)
Fluctuation in Water Level
> 4 m Rise
2-4 m Rise
0-2 m Rise
0-2 m Fall
2-4 m Fall
> 4 m Fall
Central Ground Water Board, SUO-Delhi

Plate 15

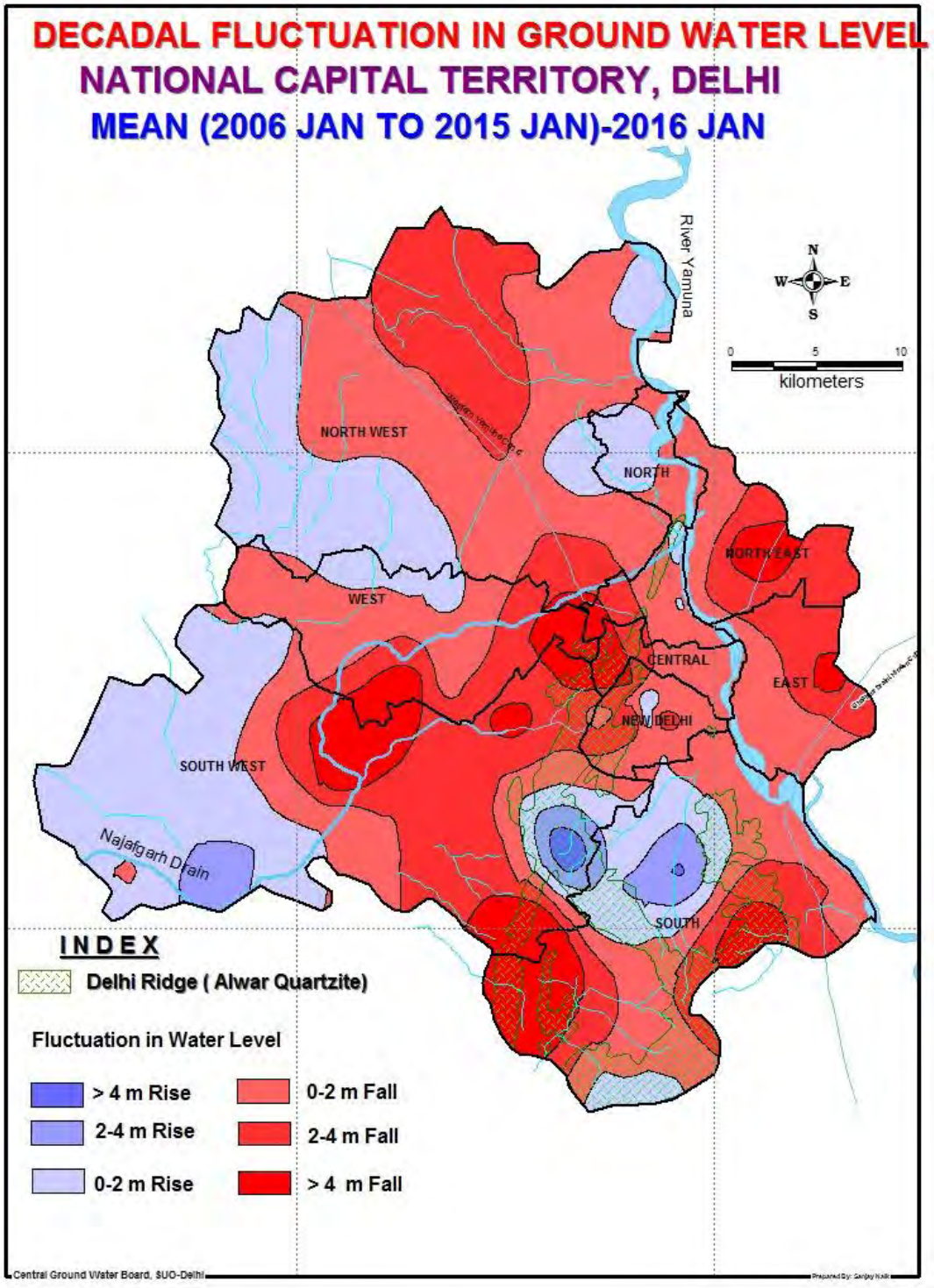
DECADAL FLUCTUATION IN GROUND WATER LEVEL
NATIONAL CAPITAL TERRITORY, DELHI
MEAN (2006 JAN TO 2015 JAN)-2016 JAN
River Yamuna
N
W
E
S
0
5
10
kilometers
NORTH WEST
NORTH
NORTH EAST
WEST
CENTRAL
EAST
NEW DELHI
SOUTH WEST
Najafgarh Drain
SOUTH
INDEX
Delhi Ridge (Alwar Quartzite)
Fluctuation in Water Level
> 4 m Rise
2-4 m Rise
0-2 m Rise
0-2 m Fall
2-4 m Fall
> 4 m Fall
Central Ground Water Board, SUO-Delhi

Plate 16

Chapter – 5

HYDROGEOCHEMISTRY

Chemical quality of ground water in NCT Delhi varies with depth and space. The fresh ground water aquifers mainly exist up to a depth of 25 to 35 m bgl in Northwest, West and Southwest districts and in minor patches in North and Central districts. In Southwest district, especially in Najafgarh *Jheel* area the fresh water occurs up to a depth of 30 to 45 m bgl. 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 28 m, regardless of proximity to River Yamuna.

In alluvial formations, the quality of ground water deteriorates with depth, which varies in different areas. 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 Southwest districts and also Chattarpur basin. In the areas west of the ridge, in general, the thickness of fresh water aquifers decreases towards Northwest, the thickness of fresh water zone is limited in most parts of west and southwest districts. In the flood plains of Yamuna, in general, fresh water aquifers exist down to depth of 30 to 45 m and especially in Palla and zero RD area it reaches to the depth of 60 to 75 m below which brackish and saline water exists.

5.1 Electrical Conductivity in Ground Water

Electrical conductivity (EC) of water is measured to get an idea about the extent of mineralization of ground water. It also gives idea of total dissolved salts in a water sample. Out of the total 89 analyzed samples (Annexure-2) of NCT Delhi 33 samples have high EC value that is in the range of 513 to 24240 µs/cm (Hirankudna). Most of the higher values are falling in western part of Delhi, especially towards west of Delhi Ridge. The area around Najafgarh, Singhola, Balswa and Shahdara are showing exceptionally high EC Values, even in shallower depth of tube wells (i.e. up to the depth of 25 to 30 m bgl). While carrying out exploratory programme, it has been found that deeper aquifer water have greater EC value than the shallow aquifer. Value increases with increase in depth.

South district and Delhi quartzite ridge area have EC values lower than 2000 µs/cm (Plate-17).

5.2 Fluoride in Ground Water:

Out of 89 analyzed samples fifteen samples are showing higher value of Fluoride concentration i.e. more than 1.5mg/l which is the permissible limit of fluoride. The data indicate that Southwest and Northwest districts are the only affected areas of NCT Delhi. Rest of the samples show values well within the permissible limit. The fluoride minerals present in soil strata have mostly contributed fluoride pollution (geogenic). High fluoride levels are mostly found in the areas where ground water is brackish to saline in nature. Human activities like use of fluoride salts in steel, aluminum, bricks and tile industries and also agricultural discharges, can also be attributable to fluoride pollution in ground water (Plate-18).

5.3 Nitrate in Ground Water:

The studies carried out by CGWB indicate that nitrate concentrations in ground water of Delhi have wide range (1.01mg/l in Qatlupur to 710 mg/l in Hauz Khas). The higher nitrate concentration may be attributed due to combined effect of contamination from domestic sewage, livestock rearing, landfills, run off from fertilized fields, unlined drains and cattle sheds. The perusal of data indicates that higher concentration of nitrates are found at the places where domestic effluent is discharged into open unlined drains and usually this places are densely populated settlements. Mainly the higher concentration is due to point source of contamination.

Delhi's ground water has more nitrate contents at shallow levels but decrease with depth. Well depth was found to be a dominant factor affecting nitrate concentrations. This is mainly due to the sub-standard well construction and location factor of wells near potential source of contamination like domestic effluent (Plate-19).

Electrical Conductivity in Ground Water

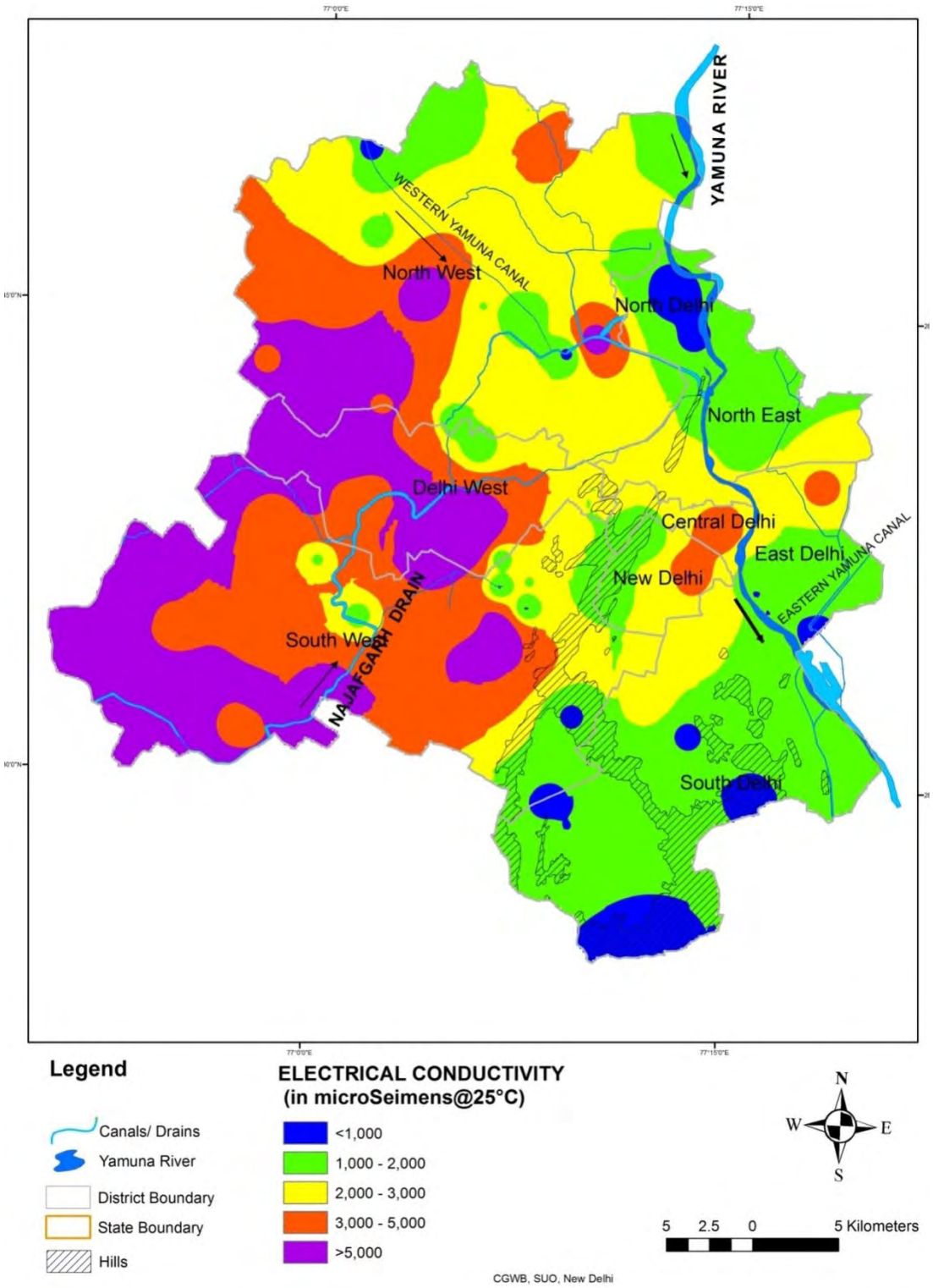

Plate 17

Fluoride(>1.5 mg/l) in Ground Water

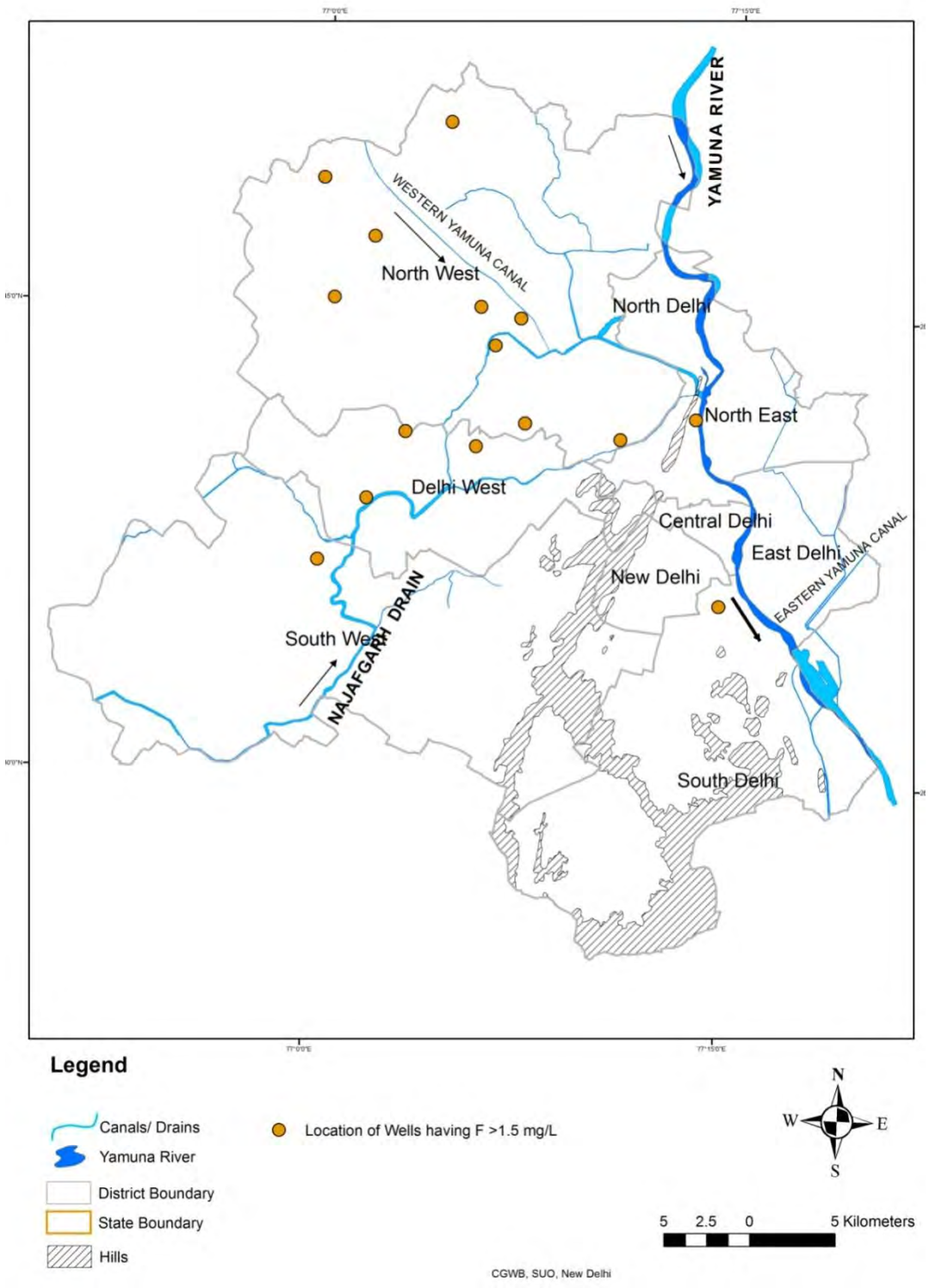

Plate 18

Nitrate (>45 Mg/L) in Ground Water

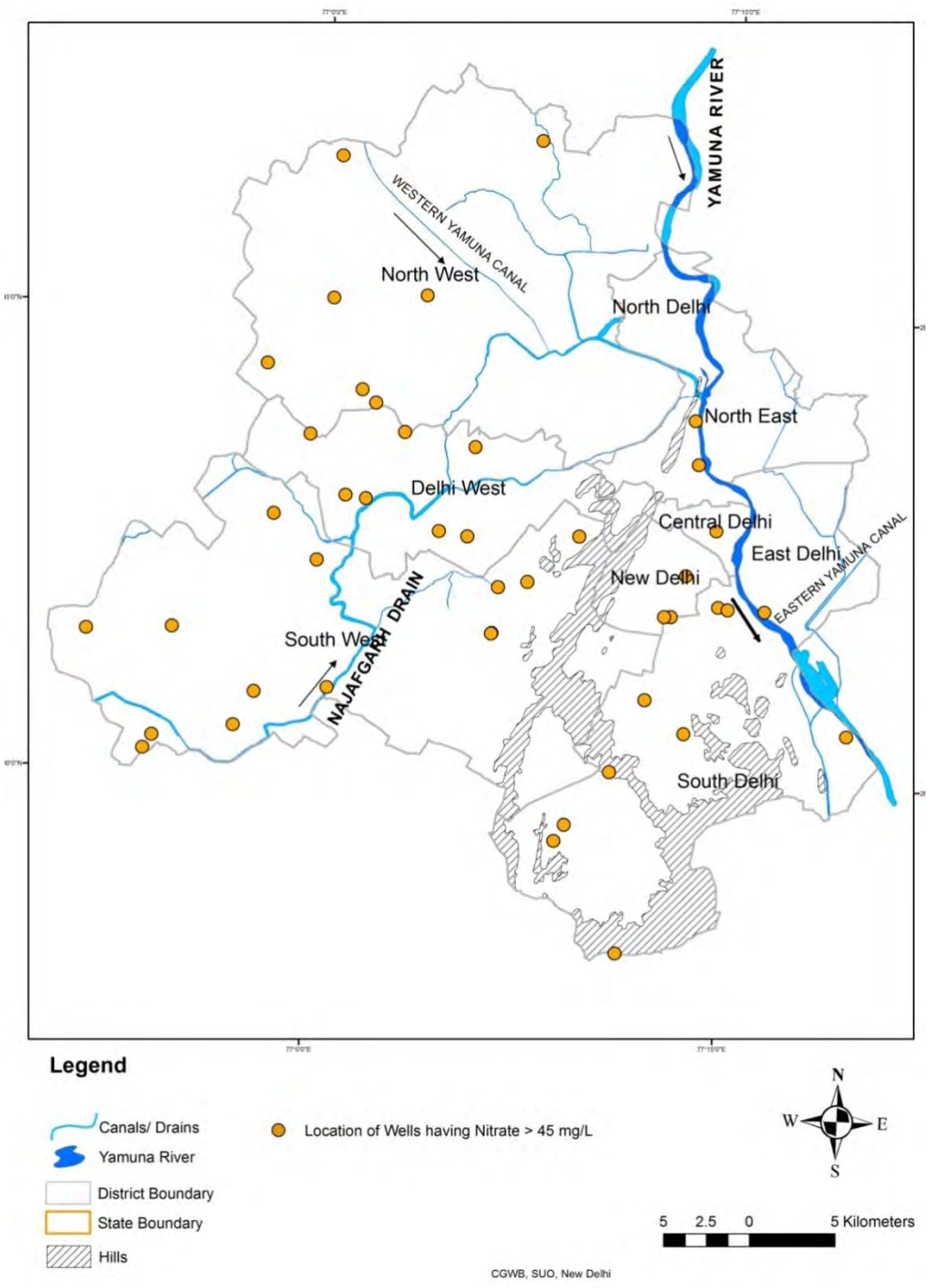

Plate 19

5.4 Hydrochemical Facies

The concept of hydro-chemical facies can be used to denote the diagnostic chemical characteristics of water in hydrological systems. The facies reflect the effect of chemical processes occurring between the mineral within the lithologic framework and ground water. The flow pattern based on the geology of the area controls the type of facies and its distribution. The difference in hydro-chemical facies in the same group of formations may be caused by characteristics of ground water flow and the dilution effect of local recharge.

Hydrochemical facies or hydrochemical zonation for 89 analyzed data has been carried out by plotting percentage reacting values of major ions in trilinear diagrams. Trilinear diagram (Hill piper) which adds to the original two triangles is a diamond shaped area in which two points plotted with triangles are projected into diamond and plotted as a single point. The analyzed data on the hydrochemical facies of ground water in NCT Delhi has been presented in trilinear diagrams (Plate-20) which indicate distribution of hydro-chemical types present in respective area.

5.4.1 Formation of Various Chemical Type of Ground Water and Hydro-Chemical Zones:

The plot of chemical data of ground water from more than 25 m deep wells from Southwest, West and Northwest district indicates that the water is predominantly of Calcium-Bicarbonate type (temporary hardness) and Sodium-Chloride Type (Saline) whereas water from aquifer from less than 25 m shows mixed water type. Virtually, this is the end product of exchange reactions of facies like Na-Ca-HCO_3-Cl, Ca-Mg-HCO_3-SO_4, Na-Ca-Cl-HCO_3, Na-Mg-HCO_3-SO_4, Na-SO_4-HCO_3, Na-CO_3–Cl, Ca-Na-HCO_3, and Na-SO_4-Cl.

In case of South and New Delhi districts where majority of samples have been collected from deeper levels in Delhi Ridge areas are falling in the category of Calcium Chloride Type (Permanent Hardness) and calcium Bicarbonate type. But few samples also fall in the range of mixed type.

In East Delhi most of the samples collected from the Akshardham and Ghazipur Border area comes under the zone of Calcium Bicarbonate type and mixed type.

At a few places in North district, ground water at depth of about 10 to12 m is of Ca-CO_3 type, which is in confirmation of general characteristic of ground water in the recharge areas. In some of the tube wells such as Jagatpur and King'sway camp ground water is of mixed facies, i.e. SO_4-Cl, HCO_3-Cl, Cl-HCO_3, type with predominance of sodium cations.

5.4.2 US salinity diagram.

The total dissolved solid content, measured in terms of specific electrical conductance gives the salinity hazard of irrigation waters. Beside the salinity hazard, excessive sodium content in water renders it unsuitable for soils containing exchangeable Ca^{++} and Mg^{++}ions. If the percentage of Na to Ca + Mg + Na is considerably above 50 in irrigation waters, soil containing exchangeable Calcium and Magnesium takes up Sodium and in exchange for Calcium and Magnesium causing deflocculation and impairment of filth and permeability of soils. The Sodium Hazard in irrigated waters is expressed by determining the sodium adsorption ratio (SAR) by the relation:

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

Out of 89 ground water samples 58% falls in the category of C2 & C3 type of salinity hazard, which is medium and high salinity (EC < 2250). A few sites of South West district and South district fall in very high salinity category.

In case of Sodium hazard, the ground water of NCT Delhi covers low and medium Hazard that means this kind of water contain appreciable Sodium hazard in fine-textured soils having high cation-exchange capacity, especially under low-leaching condition. A few samples of South and Southwest districts are placed under high sodium hazard condition (Plate-21).

5.4.3 Percent Sodium (Wilcox Diagram)

Majority of the sample analysed shows water falling under the good to permissible category and even better. Nearly 11 samples show a deterioration and comes under permissible to doubtful category. But the samples from Khera Kalan, Barwala, Nagloi, Mandela Kalan, Ashok Vihar and Tikri Kalan localities are showing unsuitable conditions in the Wilcox diagram. Some of the samples from Shekhawati Line, Hareoli, Tiggipur, Palla, Rohini, Nizampur, Dwarka Sector-16 and Chawla locality also show doubtful to unsuitable category (Plate-22).

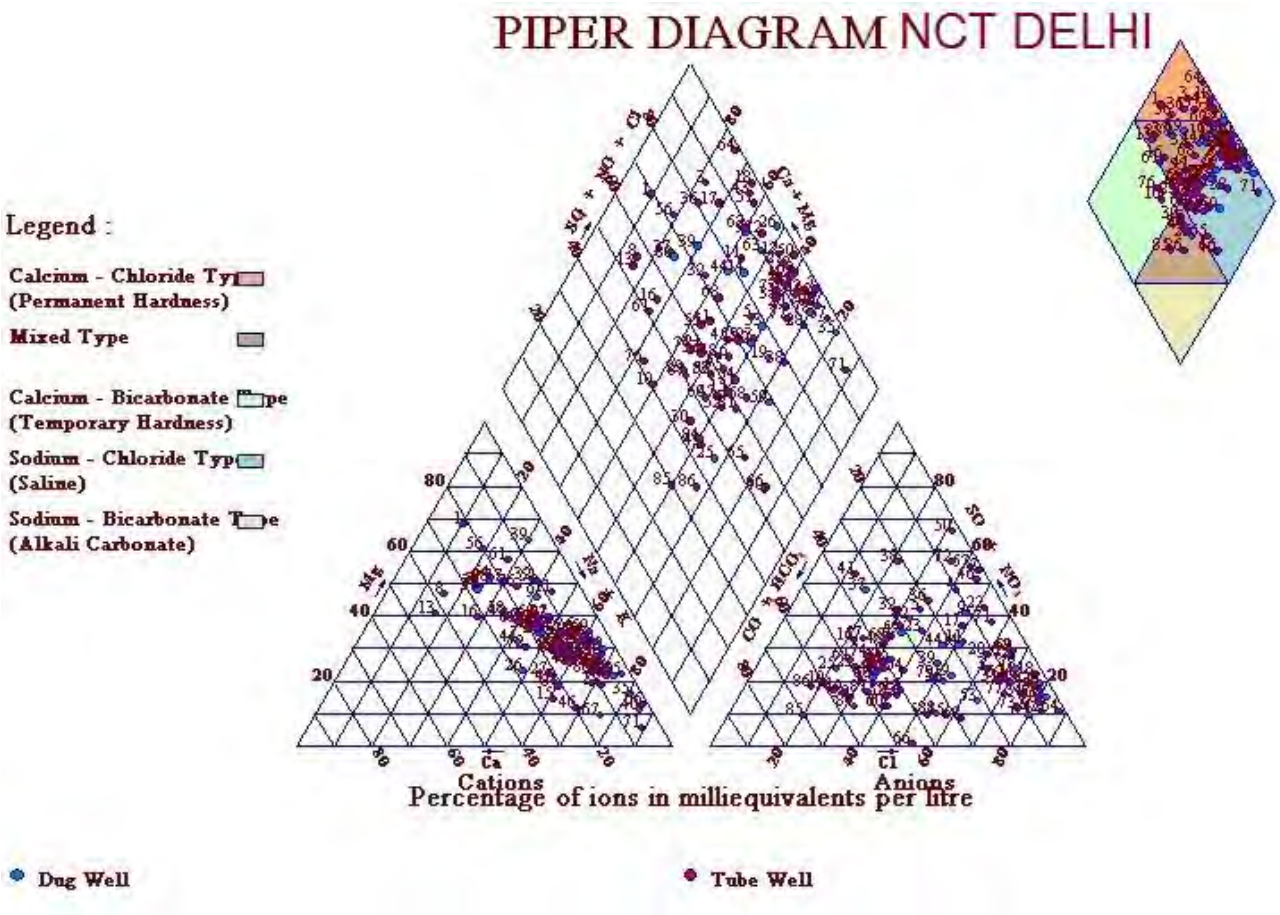
PIPER DIAGRAM NCT DELHI
Legend :
Calcium - Chloride Type
(Permanent Hardness)
Mixed Type
Calcium - Bicarbonate Type
(Temporary Hardness)
Sodium - Chloride Type
(Saline)
Sodium - Bicarbonate Type
(Alkali Carbonate)
Cations
Anions
Percentage of ions in milliequivalents per litre
Dug Well
Tube Well

Plate 20

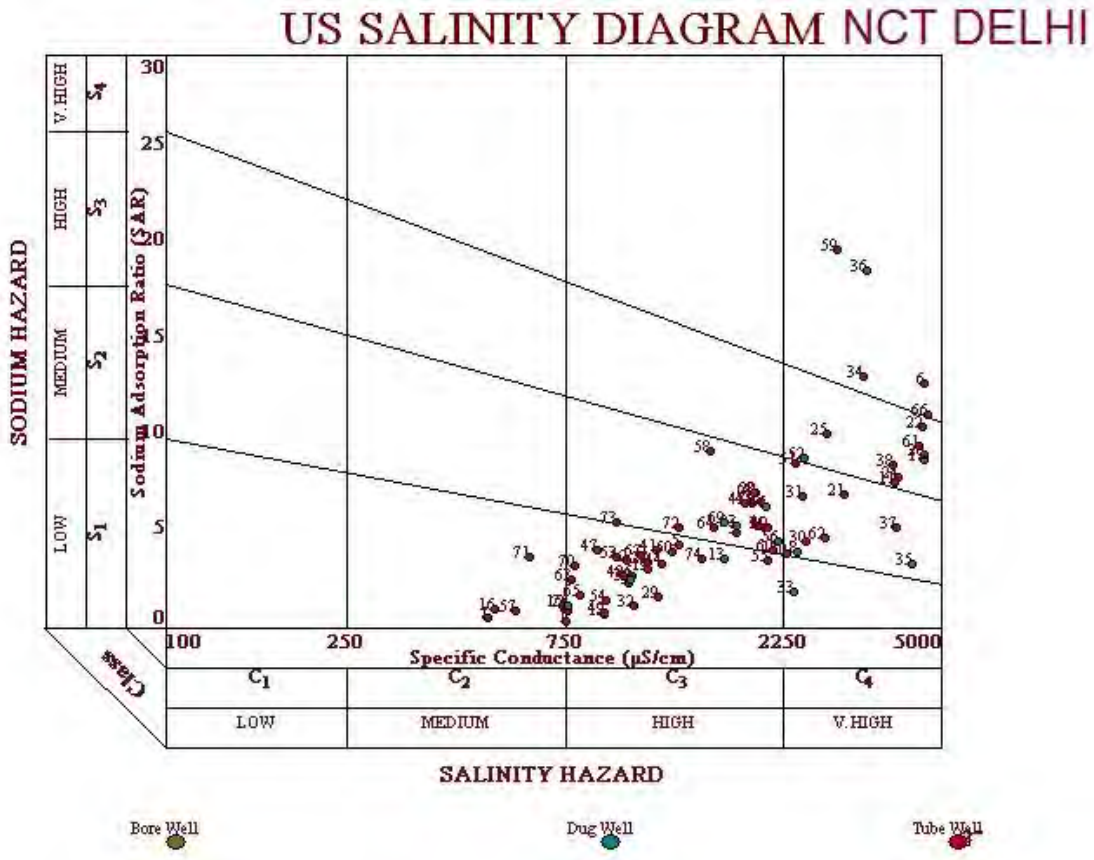
US SALINITY DIAGRAM NCT DELHI
SODIUM HAZARD
V. HIGH
HIGH
MEDIUM
LOW
S4
S3
S2
S1
Sodium Adsorption Ratio (SAR)
30
25
20
15
10
5
0
100
250
750
2250
5000
Specific Conductance (µS/cm)
Class
C1
C2
C3
C4
LOW
MEDIUM
HIGH
V.HIGH
SALINITY HAZARD
Bore Well
Dug Well
Tube Well

Plate 21

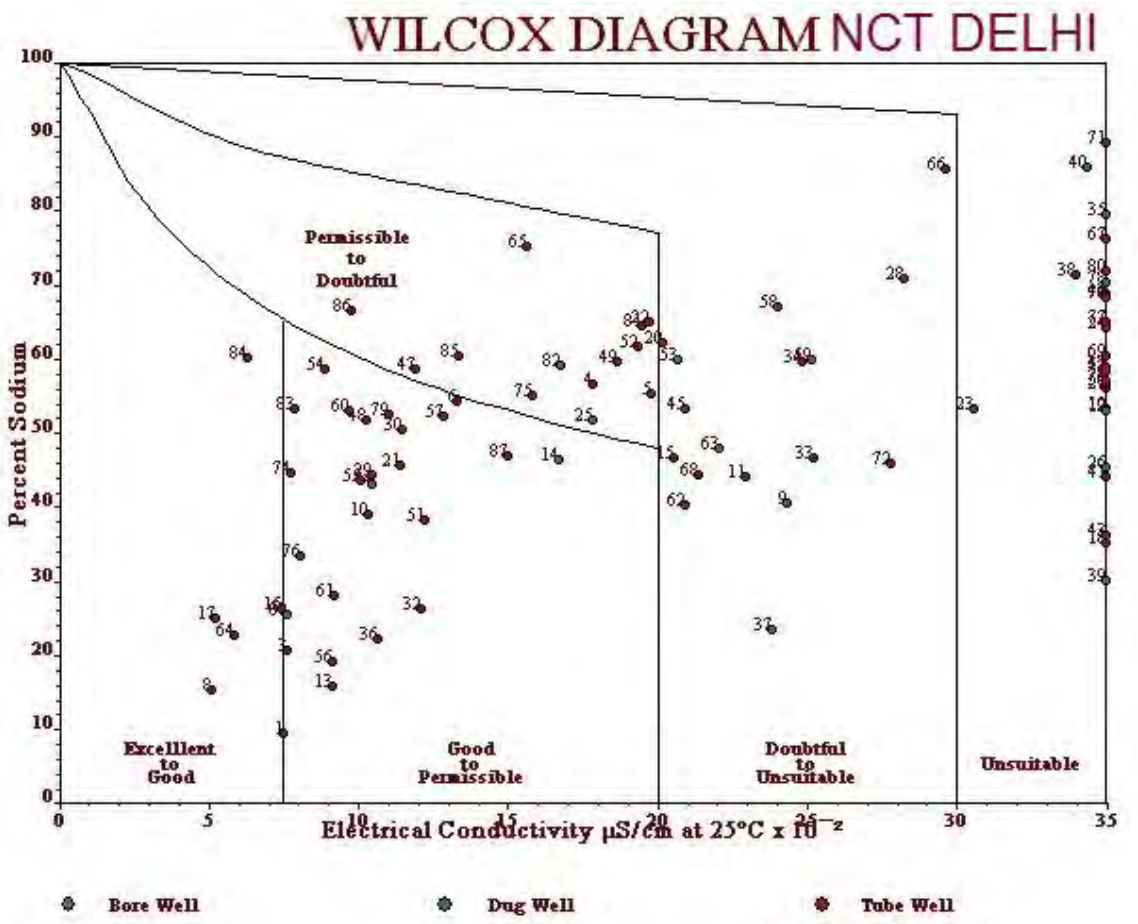
WILCOX DIAGRAM NCT DELHI
Percent Sodium
Electrical Conductivity µS/cm at 25°C x 10⁻²
Permissible to Doubtful
Excelllent to Good
Good to Permissible
Doubtful to Unsuitable
Unsuitable
Bore Well
Dug Well
Tube Well

Plate 22

Annexure – 1

DEPTH TO WATER LEVEL / FLUCTUATION DATA OF NCT-DELHI

	Depth to Water Level									Water Level Fluctuation w.r.t 2015/May			Annual Fluctuation of May-2015 w.r.t May-14
	2014/May (mbgl)	2014/Aug (mbgl)	2014/Nov (mbgl)	2015/Jan (mbgl)	2015/May (mbgl)	2015/Aug (mbgl)	2015/Nov (mbgl)	2016/Jan (mbgl)	2016/May (mbgl)	2015/Aug (mbgl)	2015/Nov (mbgl)	2016/Jan (mbgl)	
State : Delhi													
District : CENTRAL													
1 Rajghat Pz	1.99	2.12	1.88	1.8	2	1.02	1.82	1.9	1.84	0.98	0.18	0.10	-0.01
District : EAST													
2 Akshardham Temple Pz	5.05	6.05	5.34	5.46	6.77	6.19	6.44	6.27	6.74	0.58	0.33	0.50	-1.72
3 Cbd Shahdara Pz	10.42	10.45	10.44	10.3	10.79	10.15	10.27	10.67	11	0.64	0.52	0.12	-0.37
4 Chilla Regulator	8.23	8.63	8.71	8.53	9.05	8.59	8.51	8.4	8.92	0.46	0.54	0.65	-0.82
5 Chillasaroda Pz	8.11	8.97	9.2	9.26	9.72	9.69	9.7	9.51	10.04	0.03	0.02	0.21	-1.61
6 Ghazipur Crossing Pz	18.4	18.97	19.18	19.04	19.68	19.95	20.27	20.47	21.05	-0.27	-0.59	-0.79	-1.28
7 Kondli	12.88	13.18	13.09	13.48	14.11	14.37	14.38	14.45	14.68	-0.26	-0.27	-0.34	
8 Mayur Vihar B Block, Ph-II	6.69	7.07	6.94	6.64	7.9	7.58	7.84	8.08	7.79	0.32	0.06	-0.18	-1.21
9 Nangali Rajapur Pz	3.16	3.15	3.47	3.38	3.99	2.98	3.37	3.46	4.13	1.01	0.62	0.53	-0.83
10 Nizamuddin Bridge-1	3.69	4.13	4.29	4.31	4.73	3.86	4.32	4.39	4.9	0.87	0.41	0.34	-1.04
11 Nizamuddin Bridge-2	3.24	3.58	3.82	3.84	4.26	3.19	3.71	3.76	4.36	1.07	0.55	0.50	-1.02
District : NEW DELHI													
12 Birla mandir	13.3	12.53	10.78	9.24	13.5	8.32	11.95	11.86	14.9	5.18	1.55	1.64	-0.2
13 India gate	5.98	6.07	6.88	5.47	7.44	6.85	8.15	8.13	8.04	0.59	-0.71	-0.69	-1.46
14 Kitchner road	17.71	18.61	16.41	16.75	18.7	18.23	16.15	18.9	20.71	0.47	2.55	-0.20	-0.99
15 Lodhi Garden (D)	8.6	8.67	8.72	8.03	7.92	7.55	8.12	8.31	9.76	0.37	-0.20	-0.39	0.68
16 Lodhi Garden (SH)	7.9	8.34	8.47	7.73	7.55	7.23	7.8	8.12	9.57	0.32	-0.25	-0.57	0.35
17 Lodhi Graden Dw	11.36	12.04	12.61	11.6	12.1	11.8	12.05	11.53	12.58	0.3	0.05	0.57	-0.74
18 Mahabir Vansth.	26.97	27.43	27.79	27.3	27.08	26.46	26.83	27.19	27.8	0.62	0.25	-0.11	-0.11
19 Nehru Park Dw	20.57	21.53	22.36	23.23	24.12	21.4	20.06	21.9	24.14	2.72	4.06	2.22	-3.55
20 Presidents Estate-1	18.37	19.67	20.49	20.56	21.05	20.78	20.26	20.59	22.9	0.27	0.79	0.46	-2.68
21 Presidents Estate-2	12.84	12.59	13.03	13.14	13.31	13.08	12.16	12.78	13.2	0.23	1.15	0.53	-0.47
22 Safdarjung tomb	14.25	14.4	18.01	14.47	14.86	14.63	16.53	15.59	18.77	0.23	-1.67	-0.73	-0.61
23 Shram Shakti Bhawan 1	13.97	14.5	13.83	14.06	14.58	11.94	12.35	12.05	12.13	2.64	2.23	2.53	-0.61
24 Shram Shakti Bhawan 2	12.95	11.48	13.72	13.9	14.11	12.13	12.54	12.36	12.99	1.98	1.57	1.75	-1.16
25 Shram Shakti Bhawan 3	13.84	14.78	14.91	15.14	14.97	13.52	13.46	13.09	14.01	1.45	1.51	1.88	-1.13
District : NORTH													
26 Burarai-Pz	3.31	3.53	3.66	3.81	3.8	3.24	3.42	3.53	3.51	0.56	0.38	0.27	-0.49
27 Burari Auger Pz	3.14	2.97	3.44	3.53	3.26	2.54	3.41	3.51	4.01	0.72	-0.15	-0.25	-0.12
28 ISBT (Kashmiri Gate) Dw	2.56	1.71	2.63	2.57	2.65	1.28	2.74	3.51	3.11	1.37	-0.09	-0.86	-0.09
29 Jagatpur Pz-1	2.3	2.25	2.51	2.42	2.48	1.23	2.22	2.33	2.87	1.25	0.26	0.15	-0.18
30 Jagatpur Pz-2	1.68	1.56	1.82	1.68	1.82	0.65	1.59	1.63	2.26	1.17	0.23	0.19	-0.14
31 Kingsway Camp Police Groun	6.17	6.46	7.29	7.33	7.73	6.29	7.12	7.61	8.55	1.44	0.61	0.12	-1.56
32 Majanu Ka Tila Dw	8.27	7.6	8.11	7.42	8.17	6.72	7.77	7.53	9.44	1.45	0.40	0.64	0.1
District : NORTH EAST													
33 Gokulpuri E Pz	8.73	9.05	10.22	10.27	11.29	11.76	12.01	12.03	13.04	0	0.00	0.00	0
34 Gokulpuri W Pz	8.41	8.77	9.97	10.08	11.12	11.61	11.85	11.9	12.89	-0.47	-0.72	-0.74	-2.56
35 Ushmanpur Pz	2.89	2.41	4.01	4.19	4.77	4.22	4.68	4.9	8.43	-0.49	-0.73	-0.78	-2.71
36 Wazirabad Raf	4.25	4.77	5.04	5.55	4.72	4.86	5.09	5.32	5.44	0.55	0.09	-0.13	-1.88
										-0.14	-0.37	-0.60	-0.47

District : NORTH WEST													
37 Ashok Vihar - IV	12.47	12.93	13.14	14.58	15.43	14.75	14.6	14.62	15.42	0.68	0.83	0.81	-2.96
38 Auchandi Pz	2.56	3.02	3.5	3.76	3.02	0.51	1.46	2.57	3.59	2.51	1.56	0.45	-0.46
39 Bakoli - Shallow Pz	8.68	11.91	9.85	9.43	9.51	11.91	10.35	10.11	10.82	-2.4	-0.84	-0.60	-0.83
40 Bakoli- Deep Pz	8.7	12.17	9.86	9.5	9.57	12.38	10.58	10.22	10.95	-2.81	-1.01	-0.65	-0.87
41 Balsawa Landfill										0	0.00	0.00	0
42 Balswa Lake	1.61	1.62	2.16	1.68	1.2	0.78	0.72	0.74	2.33	0.42	0.48	0.46	0.41
43 Bankner-Pz	16.6	20.33	20.63	20.72	19.65	20.29	20.47	19.2	19.54	-0.64	-0.82	0.45	-3.05
44 Barwala Pz	5.38	5.61	6.03	6.36	6.39	4.85	5.44	5.93	6.2	1.54	0.95	0.46	-1.01
45 Bawana Dw New	6.85	6.78	7.16	7.53	7.64	4.52	6.13	6.53	7.27	3.12	1.51	1.11	-0.79
46 BBMB Narela Pz	16.98	18.76	21.03	18.1	18.63	19.76	19.17	19.16	19.96	-1.13	-0.54	-0.53	-1.65
47 Delhi College of Engineering	5.72	6	6.38	6.35	6.82	6.04	6.68	6.95	7.62	0.78	0.14	-0.13	-1.1
48 Haiderpur Pz	9.86	10.49	10.84	10.53	10.95	10.41	10.85	10.62	11.38	0.54	0.10	0.33	-1.09
49 Harcoli Dw	3.87	3.71	3.41	4.3	4.73	2.08	2.69	3.82	4.74	2.65	2.04	0.91	-0.86
50 Jaunti Dw	11.84	12.43	12.42	12.37	12.77	12.14	11.82	11.75	12.41	0.63	0.95	1.02	-0.93
51 Kanjhawala (pz)	1.19	1.74	2.8	1.7	2.42	1.68	1.06	1.12	1.85	0.74	1.36	1.30	-1.23
52 Khera Kalan Pz	5.52	6.1	5.92	6.09	6.9	6.98	7.79	7.95	8.53	-0.08	-0.89	-1.05	-1.38
53										0	0.00	0.00	0
54 Majara Dabas	3.27	3.29	3.94		4.01	1.59	3.01	3.51	3.77	2.42	1.00	0.50	-0.74
55 Mangolpuri Pz	2.76	2.95	2.71	2.82			2.86	2.72	2.97	0	-2.86	-2.72	2.76
56 Mubarakpur	3.08	3.51	3.13	3.83	3.1	2.58	2.69	2.77	3.18	0.52	0.41	0.33	-0.02
57 Nizampur	7.03	7.23	7.56	7.77	7.95	6.97	6.99	7.35	7.77	0.98	0.96	0.60	-0.92
58 Palla Temple	5.29	5.81	7	7.04	5.98	6.51	6.28	6.22	7.86	-0.53	-0.30	-0.24	-0.69
59 Palla Zero RD	6.93	8.26	7.81	7.78	6.66	8.06	8.01	8.07	8.63	-1.4	-1.35	-1.41	0.27
60 Qatlupur Pz	2.54	1.82	2.01	2.14	2.64	1.69	1.65	1.84	3	0.95	0.99	0.80	-0.1
61 Rani Khera	2.58	3.28	3.71	3.6	3.9	1.7	2.22	2.53	3.22	2.2	1.68	1.37	-1.32
62 Rohini Sec-28	4.43	6.05	5.64	5.35	5.94	4.3	4.84	5.43	6.28	1.64	1.10	0.51	-1.51
63 Rohini Sector - 11	6.26	6.2	6.37	6.05	7.27	5.78	5.98	5.7	6.54	1.49	1.29	1.57	-1.01
64													
65 Sainik Vihar Pz	2.3	2.03	2.02	1.7	2.59	0.91	2.48	2.91	2.92	1.68	0.11	-0.32	-0.29
66 Singhola Pz	14.11	14.12	14.03	14.06	14.11	14.09	13.99	14.1	14.12	0.02	-0.12	0.01	0
67 Tiggipur Deep Pz	8.02	9.46	8.81	8.78	8.61	8.88	8.34	7.96	9.21	-0.27	0.27	0.65	-0.59
68 Tiggipur Shallow Pz	6.3	6.98	6.9	6.91	6.78	11.91	6.94	6.93	7.48	-5.13	-0.16	-0.15	-0.48
District : SOUTH													
69 Asola Pz	49.72	50.3	50.62	50.86	51.83	50.2	49.84	51.76	52.12	1.63	1.99	0.07	-2.11
70 Ayanagar Pz	45.72	47.32								0	0.00	0.00	45.72
71 Balbir Nagar	22.79	17.19	19.77	22.23	22.83	9.41	16.62	20.82	25.04	13.42	6.21	2.01	-0.04
72 Bhatti-Pz	48.07	48.18	48.16	48.05	49.18	39.32	43.01		48.74	9.86	6.17	49.18	-1.11
73 Fatehpur Beri Pz										0			0
74 Gadaipur Pz	57.37	57.99	58.38	58.25	48.55	58.47	58.7	58.07	58.89	-9.92	-10.15	-9.52	8.82
75 Hauz Khas Pz	33.37	34.82	33.97	35.44	34.54	34.78	34.59	34.28	35.03	-0.24	-0.05	0.26	-1.17
76 Humayun Tomb	6.2	6.87	6.93	6.9	7.4	6.97	7.41	7.65	8.17	0.43	-0.01	-0.25	-1.2
77 Jaitpur Khadar RD-2600	5.4	5.54	5.1	7.6	5.46	4.84	5.55	5.88	6.24	0.62	-0.09	-0.42	-0.06
78 Jaitpur Khadar RD-3500	6.26	6.36	6.38	8.95	6.65	6.14	6.73	7.04	7.52	0.51	-0.08	-0.39	-0.39
79 Jamali Kamali	27.2	30.75	27.65	27.51	30.25	28.2	28.12	28.1	30.49	2.05	2.13	2.15	-3.05
80 Jaunapur DJB	58.49	59.34	59.63	59.54	60.6	56.18	55.38	56.81	58.84	4.42	5.22	3.79	-2.11
81 Jheel Khoh	50.56	54.18	55.09	52.92	52.66	46.45	49.23	48.36	52	6.21	3.43	4.30	-2.1
82 Kalindi Kunj Barrage Pz										0	0.00	0.00	0
83 Madan Gir										0	0.00	0.00	0
84 Madanpur Khadar	4.59	4.64	4.46	4.58	4.8	4.51	5.22	5.75	6.18	0.29	-0.42	-0.95	-0.21
85 Pusp Vihar Pz	63.97	63.7	63.63	64	62.66	61.84	61.13	59.51	58.39	0.82	1.53	3.15	1.31
86 Saket D Block Pz										0	0.00	0.00	0
87 Satbari Pz	45.25	46.95	46.6	47.64	47.78	49.12	45.5			-1.34	2.28	47.78	-2.53
88 Sultanpur IMS	55.75	56.19	56.48	56.59	56.97	57.37	57.57	57.79	58.12	-0.4	-0.60	-0.82	-1.22
89 Sundar Nursery Pz	7.25	7.48	7.62	7.65	7.94	7.44	8.08	8.22	8.75	0.5	-0.14	-0.28	-0.69

District : SOUTH WEST													
90 Chawla	12.53	13.68	14.13	13.42	14.74	11.32	13.79	13.97	15.5	3.42	0.95	0.77	-2.21
91 CVD Depot Cant (Dp)		21.67	22.06	22.31	22.57	21.22	22.62	22.69	23.94	1.35	-0.05	-0.12	-22.57
92 CVD Depot Cant (Md)										0	0.00	0.00	0
93 CVD Depot Cant (Sh)										0	0.00	0.00	0
94 Daryapur Khurd	4.01	3.48	3.98	4.5	4.02	1.7	3.28	3.83	4.28	2.32	0.74	0.19	-0.01
95 Daulatpur Pz	15.48	15.49	15.54	16.18	16.85	15.04	15.07	15.32	16.15	1.81	1.78	1.53	-1.37
96 Deorala Pz	2.24	1.09	1.85	1.66	2.14	1.02	1.58	1.54	2.23	1.12	0.56	0.60	0.1
97 Dichaon Kalan										0			0
98 Dwarka Sec-16 (Tp)	19.48	20.03	20.39	20.68	21.46	21.82	21.88	21.95	22.18	-0.36	-0.42	-0.49	-1.98
99 Dwarka Sect.-20										0	0.00	0.00	0
100 Issapur Khera Pz	9.97	9.89	10.1	10.35	10.3	9.98	10.05	10.27	10.38	0.32	0.25	0.03	-0.33
101 Jharoda Kalan Pz	13.89	13.85	14.1	14.2	14.56	14.39	14.21	14.22	14.59	0.17	0.35	0.34	-0.67
102 Jhuljhuli Dw	2.47	1.2	2.06	2.21	2.2	0.87	2.01	1.99	2.44	1.33	0.19	0.21	0.27
103 Jhuljhuli Pz	3.53	2.97	2.85	2.96	3.38	2.66	2.99	3.02	3.43	0.72	0.39	0.36	0.15
104 JUN Pz-13 Upstreem	35.29	35.1	36.38	37.62	35.97	31.55	27.15	29.59	31.07	4.42	8.82	6.38	-0.68
105 JUN Pz-3 (D) Downstream	27.04	26.88	26.84	27.9	27.02	26.05	23.93	24	24.66	0.97	3.09	3.02	0.02
106 Kabul Line Pz	26.02	26.52	26.75	26.72	27.17	27.34	27.37	27.53	27.79	-0.17	-0.20	-0.36	-1.15
107 Kirbi Place Pz	24.69	24.22	25.21	25.37	26.31	27.31	28.54	26.75	30.19	-1	-2.23	-0.44	-1.62
108 Mandela Khurd Pz	11.71	20.57	11.98	12.94	12.46	11.65	11.85	12.65	13	0.81	0.61	-0.19	-0.75
109 Najafgarh Town	20.16	20.89	20.88	21.02	21.64	21.09	20.66	20.92	22.11	0.55	0.98	0.72	-1.48
110 Nicolsan Range Pz										0			0
111 Ojwah Pz	13.45	14.06	14.69	15.96	14.84	15.35	15.77	15.63	15.87	-0.51	-0.93	-0.79	-1.39
112 Palam Signal Camp Pz	55.01	54.18	54.07	53.92	54.92	57.02	55.23	56.12	57.86	-2.1	-0.31	-1.20	0.09
113 PUSA (NRL)	20.19	22.17	23.11	21.15	23.1	23.73	24.51	25.42	26.6	-0.63	-1.41	-2.32	-2.91
114 PUSA (WTC)	20.32	21.33	21.78	21.51	22.15	22.25	22.44	22.58	23.29	-0.1	-0.29	-0.43	-1.83
115 PUSA Indrapuri Gate	22.67	23.86	23.24	23.07	24.25	24.31	23.43	22.98	24.43	-0.06	0.82	1.27	-1.58
116 Raota	2.69	1.92	2.23	2.15	2.61	1.45	2.26	2.3	2.98	1.16	0.35	0.31	0.08
117 Shekhawati Line Pz	40.07	40.39	40.62	40	40.45	40.27	40.18	40.84	41.32	0.18	0.27	-0.39	-0.38
Sikarpur Deep		12.7	11.45	11.05	11.88	11.32	11.17	10.7	11.26	0.56		1.18	
118 Sikarpur Shallow	10.35	12.9	11.22	10.76	10.68	11.2	11.03	10.42	11.1	-0.52	-0.35	0.26	-0.33
119 Tagore Garden Pz	9.93	10.51	10.47	10.6	11.12	10.98	11.5	11.54	12.53	0.14	-0.38	-0.42	-1.19
District : WEST													
120 Baprola Dw	3.76	4.32	4.49	4.46	5.48	1.8	3.12	3.65	5.12	3.68	2.36	1.83	-1.72
121 Hiran Kudna Dw	2.19	2.77	2.88	3.4	2.84	0.7	1.81	3.04	3.33	2.14	1.03	-0.20	-0.65
122 Janakpuri Pz	10.47	10.97	11.59	11.7	12.02	11.51	11.77	12.13	12.83	0.51	0.25	-0.11	-1.55
123 Mayapuri Pz	35.68	36.19	36.63	36.52	36.91	36.69	36.9	36.38	36.76	0.22	0.01	0.53	-1.23
124 Nangloi Pz	4.36	4.23	4.08	3.9						0	0.00	0.00	4.36
125 Peera Garhi Pz	4.64	5.15	5	5.25	7.1	3.47	4.09	4.11	4.78	3.63	3.01	2.99	-2.46
126 Tikri Kalan Pz	8.56	8.61	8.68	8.7	8.8	8.58	8.76	8.78	8.84	0.22	0.04	0.02	-0.24
127 Tilangpur Kotla Dw	7.36	7.73	7.41	7.17	7.3	5.25	5.52	6.08	6.61	2.05	1.78	1.22	0.06
128 Vikashpuri Pz	14.3	16.22	17.24	17.59	17.67	17.28	16.58	16.48	17.24	0.39	1.09	1.19	-3.37

Annexure - 2

Ground Water Quality of NCT Delhi, May 2015																
Sl No	District	Location	Latitude	Longitude	pH	EC (uS/cm)	Ca	Mg	CO3	HCO3	Cl	NO3	F	SO4	Na	K
1	Central	Rajghat Pz	28.64	77.24	7.76	3989.00	141.00	174.00	0.00	807.90	178.00	655.00	0.79	491.00	394.00	27.00
2	East	Chilla Regulator	28.59	77.30	8.14	589.00	27.00	38.00	0.00	2.80	158.00	4.60	0.31	23.00	31.00	8.00
3	East	Nagali Rajapur Pz	28.59	77.27	7.92	977.00	28.00	40.00	0.00	273.00	139.00	68.20	0.88	3.00	129.00	14.00
4	East	Chillasaroda Pz	28.60	77.30	8.39	1289.00	32.00	57.00	9.59	336.30	121.00	4.55	0.49	220.00	162.00	10.00
5	East	Nizamuddin Bridge-2	28.60	77.27	8.43	891.00	22.00	31.00	4.73	195.80	134.00	37.50	0.35	75.00	126.00	10.00
6	East	Akshardham Temple Pz	28.61	77.27	8.32	1228.00	50.00	148.00	4.32	57.98	754.00	4.65	0.75	187.00	210.00	7.00
7	East	Mayur Vihar B Block, Ph-II	28.62	77.30	8.45	1032.00	31.00	46.00	7.70	229.20	119.00	2.66	0.23	163.00	134.00	6.00
8	East	Cbd Shahdara Pz	28.66	77.30	8.07	3400.00	92.00	111.00	0.00	192.80	122.00	14.60	0.55	407.00	792.00	11.00
9	New Delhi	Safdarjung tomb	28.59	77.21	7.96	2211.00	79.00	99.00	0.00	141.00	688.00	62.40	0.21	66.00	254.00	4.00
10	New Delhi	Lodhi Garden (D)	28.59	77.22	7.82	2095.00	98.00	106.00	0.00	131.80	499.00	100.00	0.34	134.00	209.00	1.00
11	New Delhi	Mahabir Vansth.	28.60	77.18	8.45	1011.00	44.00	49.00	4.19	223.60	196.00	3.96	0.77	45.00	110.00	2.00
12	New Delhi	Nehru Park Dw	28.61	77.21	8.35	2073.00	53.00	77.00	7.84	248.70	478.00	28.20	0.76	119.00	307.00	4.00
13	New Delhi	India gate	28.61	77.23	7.84	5107.00	115.00	185.00	0.00	45.28	589.00	499.00	0.46	1261.00	640.00	26.00
14	New Delhi	Birla mandir	28.63	77.20	8.21	1050.00	51.00	40.00	0.00	125.60	160.00	7.13	0.56	138.00	100.00	0.00
15	North	ISBT (Kashmiri Gate) Dw	28.67	77.23	8.12	2390.00	136.00	144.00	0.00	489.80	153.00	125.00	0.87	451.00	132.00	10.00
16	North	Kingsway Camp Police Ground Pz	28.68	77.20	8.34	2528.00	64.00	118.00	6.62	592.80	296.00	29.20	0.74	257.00	264.00	14.00
17	North	Majanu Ka Tila Dw	28.70	77.23	8.56	1786.00	21.00	56.00	14.05	499.00	126.00	52.70	1.85	143.00	207.00	110.00
18	North	Jagatpur Pz-2	28.74	77.22	8.19	764.50	41.00	45.00	0.00	65.77	172.00	3.14	0.19	87.00	35.00	7.00
19	North	Burarai-Pz	28.76	77.21	8.04	529.40	22.00	35.00	0.00	40.07	85.00	1.61	0.34	85.00	32.00	11.00
20	North	Burari Auger Pz	28.77	77.21	7.77	748.30	46.00	35.00	0.00	180.30	53.00	2.44	0.35	102.00	43.00	6.00
21	North East	Ushmanpur Pz	28.68	77.25	8.34	1211.00	28.00	74.00	7.03	205.70	136.00	12.90	0.29	247.00	71.00	52.00
22	North East	Wazirabad Raf	28.72	77.26	8.37	1053.00	33.00	49.00	8.51	294.80	101.00	8.96	0.73	117.00	107.00	9.00
23	North West	Ashok Vihar - IV	28.68	77.18	7.83	2490.00	31.00	113.00	0.00	124.60	681.00	21.60	2.18	170.00	368.00	5.00
24	North West	Mangolpuri Pz	28.69	77.08	8.19	1148.00	30.00	38.00	0.00	344.80	110.00	10.30	0.38	68.00	120.00	21.00
25	North West	Sainik Vihar Pz	28.69	77.12	8.29	2826.00	39.00	80.00	9.05	155.80	747.00	30.20	4.07	256.00	480.00	6.00
26	North West	Mubarakpur	28.70	77.03	7.65	4051.00	189.00	120.00	0.00	138.00	987.00	125.00	0.36	461.00	563.00	0.00
27	North West	Rani Khera	28.71	77.03	7.94	8900.00	521.00	263.00	0.00	88.33	2,511.00	363.00	0.62	562.00	959.00	131.00
28	North West	Nizampur	28.72	76.97	7.83	4570.00	96.00	152.00	0.00	202.30	1,148.00	62.20	1.28	425.00	708.00	5.00
29	North West	Haiderpur Pz	28.73	77.15	8.15	755.50	33.00	64.00	0.00	150.80	94.00	12.30	1.15	136.00	16.00	3.00
30	North West	Rohini Sector - 11	28.73	77.10	8.73	2020.00	18.00	81.00	7.70	132.50	458.00	23.60	3.13	272.00	294.00	13.00
31	North West	Balswa Lake	28.74	77.16	7.79	6686.00	203.00	213.00	0.00	177.60	1,564.00	35.40	0.59	909.00	897.00	14.00

Ground Water Quality of NCT Delhi, May 2015																
Sl No	District	Location	Latitude	Longitude	pH	EC (uS/cm)	Ca	Mg	CO3	HCO3	Cl	NO3	F	SO4	Na	K
32	North West	Delhi College of Engineering	28.75	77.12	8.77	1145.00	41.00	53.00	14.59	271.90	150.00	19.50	3.60	135.00	126.00	8.00
33	North West	Jaunti Dw	28.75	76.97	8.11	4600.00	31.00	170.00	0.00	702.10	921.00	2.13	0.31	498.00	565.00	250.00
34	North West	Rohini Sec-28	28.75	77.10	8.40	1975.00	40.00	63.00	5.67	42.50	355.00	13.00	2.37	382.00	308.00	5.00
35	North West	Majara Dabas	28.76	77.01	8.36	3063.00	61.00	132.00	18.24	506.80	494.00	190.00	2.52	462.00	420.00	92.00
36	North West	Barwala Pz	28.76	77.06	7.55	7208.00	368.00	387.00	0.00	73.44	2,056.00	132.00	0.20	713.00	623.00	7.00
37	North West	Khera Kalan Pz	28.77	77.12	8.85	2062.00	120.00	44.00	0.00	556.90	343.00	1.45	0.83	188.00	263.00	142.00
38	North West	Bawana Dw New	28.79	77.03	8.10	1677.00	58.00	68.00	0.00	184.00	318.00	38.50	1.91	231.00	170.00	6.00
39	North West	Tiggipur Deep Pz	28.81	77.20	7.77	917.00	81.00	47.00	0.00	262.30	115.00	1.44	0.75	88.00	34.00	3.00
40	North West	Bakoli - Shallow Pz	28.81	77.20	8.13	3971.00	165.00	172.00	0.00	150.10	1,134.00	16.00	1.23	617.00	586.00	8.00
41	North West	Auchandi Pz	28.82	77.00	8.39	2296.00	37.00	127.00	5.81	217.60	435.00	38.30	1.97	332.00	221.00	3.00
42	North West	Palla Temple	28.82	77.20	8.19	1040.00	48.00	53.00	0.00	404.80	86.00	2.65	0.76	104.00	100.00	5.00
43	North West	Hareoli Dw	28.83	77.01	8.21	2435.00	76.00	164.00	0.00	178.40	462.00	56.30	0.77	489.00	271.00	10.00
44	North West	Qatlupur Pz	28.83	77.02	8.14	513.00	39.00	30.00	0.00	125.70	53.00	1.01	0.58	56.00	18.00	2.00
45	North West	Singhola Pz	28.84	77.13	7.93	4590.00	128.00	131.00	0.00	24.58	848.00	62.90	0.53	1320.00	860.00	2.00
46	North West	Bankner-Pz	28.85	77.07	8.34	1336.00	23.00	63.00	0.00	295.70	161.00	18.90	1.76	213.00	178.00	11.00
47	North West	BBMB Narela Pz	28.86	77.12	8.34	1986.00	42.00	88.00	5.54	281.70	273.00	30.60	1.23	416.00	266.00	6.00
48	North West	Palla Zero RD	28.86	77.20	8.31	1790.00	50.00	59.00	0.00	107.80	273.00	5.25	0.51	418.00	220.00	4.00
49	South	Jheel Khoh	28.41	77.19	8.10	829.20	35.00	36.00	0.00	242.30	91.00	64.60	0.76	31.00	102.00	1.00
50	South	Balbir Nagar	28.42	77.21	8.23	768.10	35.00	47.00	0.00	160.30	155.00	18.90	0.46	24.00	44.00	2.00
51	South	Jaunapur DJB	28.47	77.15	8.09	1506.00	42.00	78.00	0.00	476.30	195.00	60.00	0.53	84.00	173.00	4.00
52	South	Gadaipur Pz	28.48	77.16	8.63	978.80	22.00	31.00	11.89	398.10	71.00	87.20	0.65	31.00	170.00	4.00
53	South	Satbari Pz	28.48	77.20	8.70	1340.00	20.00	60.00	18.91	586.80	110.00	37.00	0.77	38.00	207.00	1.00
54	South	Sultanpur IMS	28.49	77.15	8.31	631.10	32.00	17.00	8.92	227.20	85.00	10.30	0.39	36.00	105.00	3.00
55	South	Asola Pz	28.50	77.27	8.35	793.00	28.00	32.00	6.89	189.60	120.00	16.50	0.72	46.00	106.00	3.00
56	South	Jamali Kamali	28.51	77.18	8.50	1678.00	23.00	72.00	9.19	272.90	218.00	114.00	0.96	254.00	237.00	5.00
57	South	Jaitpur Khadar RD-3500	28.51	77.34	8.62	1950.00	28.00	70.00	13.78	505.10	256.00	6.80	0.24	267.00	308.00	13.00
58	South	Jaitpur Khadar RD-2600	28.52	77.34	7.85	1107.00	37.00	40.00	0.00	192.70	190.00	6.91	0.00	104.00	140.00	17.00
59	South	Pusp Vihar Pz	28.53	77.23	8.25	812.60	29.00	52.00	0.00	302.10	75.00	47.20	0.28	35.00	66.00	2.00
60	South	Madanpur Khadar	28.53	77.33	8.16	1589.00	37.00	85.00	0.00	434.80	238.00	50.90	0.55	202.00	255.00	13.00

Ground Water Quality of NCT Delhi, May 2015																
Sl No	District	Location	Latitude	Longitude	pH	EC (uS/cm)	Ca	Mg	CO3	HCO3	Cl	NO3	F	SO4	Na	K
61	South	Hauz Khas Pz	28.55	77.20	7.95	2785.00	139.00	107.00	0.00	125.90	411.00	710.00	0.38	307.00	303.00	2.00
62	South	Humayun Tomb	28.60	77.25	8.76	2522.00	28.00	78.00	15.67	508.30	349.00	250.00	1.22	288.00	405.00	162.00
63	South	Sundar Nursery Pz	28.60	77.25	8.46	2406.00	25.00	95.00	20.94	574.70	310.00	276.00	1.97	229.00	422.00	2.00
64	South West	Deorala Pz	28.51	76.90	7.89	8596.00	151.00	302.00	0.00	202.50	3,023.00	343.00	1.00	619.00	1877.00	1.00
65	South West	Raota	28.52	76.90	7.78	7138.00	96.00	248.00	0.00	290.70	2,015.00	649.00	0.70	437.00	1389.00	22.00
66	South West	Sikarpur Shallow	28.52	76.95	8.09	4692.00	86.00	163.00	0.00	380.20	1,204.00	92.40	1.11	306.00	763.00	13.00
67	South West	JUN Pz-3 (D) Downstream	28.54	77.16	8.11	779.00	32.00	41.00	0.00	212.10	81.00	42.50	0.95	74.00	91.00	1.00
68	South West	Daulatpur Pz	28.54	76.97	7.91	5068.00	140.00	190.00	0.00	374.30	1,430.00	192.00	1.24	148.00	708.00	35.00
69	South West	Chawla	28.55	77.01	8.04	5826.00	63.00	43.00	0.00	187.20	1,203.00	64.70	0.87	1058.00	1264.00	6.00
70	South West	Issapur Khera Pz	28.57	76.86	8.07	8995.00	140.00	251.00	0.00	276.50	2,661.00	100.00	0.76	505.00	1376.00	17.00
71	South West	Ojwah Pz	28.58	76.91	8.11	4474.00	40.00	211.00	0.00	114.40	1,154.00	57.20	0.82	654.00	681.00	8.00
72	South West	Shekhawati Line Pz	28.58	77.11	7.92	2144.00	77.00	119.00	0.00	388.80	515.00	45.60	0.41	58.00	247.00	2.00
73	South West	Tagore Garden Pz	28.58	77.11	7.94	14470.00	412.00	162.00	0.00	214.80	2,204.00	97.50	0.54	3852.00	2477.00	6.00
74	South West	Palam Signal Camp	28.58	77.09	8.68	2967.00	10.00	62.00	28.37	1,095.00	812.00	18.40	0.32	5.00	759.00	2.00
75	South West	Dwarka Sec-16 (Tp)	28.59	77.03	8.72	1564.00	8.00	50.00	15.13	507.80	288.00	34.20	1.05	88.00	320.00	6.00
76	South West	Kabul Line Pz	28.59	77.13	8.09	925.00	28.00	66.00	0.00	300.50	88.00	40.00	0.50	100.00	60.00	0.00
77	South West	CVD Depot Cant (Dp)	28.60	77.11	7.94	919.30	33.00	61.00	0.00	144.70	162.00	54.20	0.51	42.00	36.00	1.00
78	South West	Kirbi Place Pz	28.61	77.13	8.42	1941.00	31.00	81.00	20.54	556.00	314.00	126.00	0.42	71.00	303.00	2.00
79	South West	Najafgarh Town	28.61	77.00	8.37	1869.00	28.00	88.00	129.70	582.00	249.00	82.80	2.06	136.00	311.00	24.00
80	South West	PUSA (WTC)	28.63	77.16	7.68	2099.00	53.00	99.00	0.00	465.20	494.00	51.70	0.89	71.00	280.00	1.00
81	South West	Jharoda Kalan Pz	28.64	76.97	7.80	3940.00	121.00	129.00	0.00	146.70	1,286.00	114.00	0.39	137.00	562.00	23.00
82	West	Mayapuri Pz	28.62	77.11	8.83	1197.00	42.00	24.00	26.61	209.90	117.00	29.40	1.34	86.00	132.00	2.00
83	West	Janakpuri Pz	28.63	77.09	7.84	13660.00	513.00	193.00	0.00	237.20	2,142.00	68.00	0.85	3224.00	2065.00	7.00
84	West	Vikashpuri Pz	28.63	77.07	7.84	8128.00	384.00	386.00	0.00	181.00	2,178.00	86.40	0.41	670.00	660.00	11.00
85	West	Tilangpur Kotla Dw	28.65	77.03	8.92	3438.00	18.00	47.00	46.74	827.30	393.00	199.00	2.18	185.00	660.00	3.00
86	West	Baprola Dw	28.65	77.02	8.18	4331.00	56.00	339.00	0.00	693.30	755.00	80.70	1.31	476.00	302.00	11.00
87	West	Peera Garhi Pz	28.68	77.09	7.94	1070.00	62.00	70.00	0.00	128.10	144.00	48.70	2.04	200.00	59.00	10.00
88	West	Hiran Kudna Dw	28.68	76.99	7.56	24240.00	142.00	502.00	0.00	327.30	7,409.00	350.00	0.47	1554.00	4607.00	150.00
89	West	Nangloi Pz	28.68	77.05	7.88	4618.00	129.00	160.00	0.00	356.60	1,100.00	156.00	1.72	322.00	653.00	21.00

Depth to Water Table
Distribution of Percentage of Observation Wells
2015/May

State : **Delhi**

District	No. of Wells Analysed	Depth to Water Table (mbgl)		No. / Percentage of Wells Showing Depth to Water Table (mbgl) in the Range of					
		Min	Max	0.0 - 2.0	2.0 - 5.0	5.0 - 10.0	10.0 - 20.0	20.0 - 40.0	> 40.0
CENTRAL	1	2.00	2.00	1 100.00%	0	0	0	0	0
EAST	10	3.99	19.68	0	3 30.00%	4 40.00%	3 30.00 %	0	0
NEW DELHI	14	7.44	27.08	0	0	3 21.43%	8 57.14 %	3 21.43%	0
NORTH	7	1.82	8.17	1 14.29%	4 57.14%	2 28.57%	0	0	0
NORTH EAST	4	4.72	11.29	0	2 50.00%	0	2 50.00 %	0	0
NORTH WEST	28	1.20	19.65	1 3.57%	8 28.57%	13 46.43%	6 21.43 %	0	0
SOUTH	16	4.80	62.22	0	1 6.25%	4 25.00%	0	3 18.75%	8 50.00%
SOUTH WEST	26	2.14	54.92	0	5 19.23%	0	9 34.62 %	10 38.46%	2 7.69%
WEST	8	2.84	36.91	0	1 12.50%	4 50.00%	2 25.00 %	1 12.50%	0
Total	114	1.20	62.22	3	24	30	30	17	10

District Wise - Fluctuation and Frequency Distribution From Different Ranges from One Period to Other

From Year: 2014/May - To Year: 2015/May

State : Delhi

District Name	No. of Wells	Range of Fluctuation (m)				No. of Wells/Percentage Showing Fluctuation						Total No. of Wells	
		Rise		Fall		Rise			Fall			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
CENTRAL	1	-	-	0.01	0.01	0	0	0	1 100.0 %	0	0	0	1
EAST	10	-	-	0.37	1.72	0	0	0	10 100.0 %	0	0	0	10
NEW DELHI	14	0.35	0.68	0.11	3.55	2 14.29%	0	0	10 71.43%	2 14.29%	0	2	12
NORTH	7	0.10	0.10	0.09	1.56	1 14.29%	0	0	6 85.71%	0	0	1	6
NORTH EAST	4	-	-	0.47	2.71	0	0	0	2 50.00%	2 50.00%	0	0	4
NORTH WEST	28	0.27	0.41	0.02	3.05	2 7.14%	0	0	23 82.14%	2 7.14%	0	2	25
SOUTH	16	1.75	8.82	0.04	3.05	1 6.25%	0	1 6.25%	9 56.25%	5 31.25%	0	2	14
SOUTH WEST	24	0.02	0.27	0.01	2.91	6 25.00%	0	0	16 66.67%	2 8.33%	0	6	18
WEST	8	0.06	0.06	0.24	3.37	1 12.50%	0	0	5 62.50%	2 25.00%	0	1	7

Total	112	1.75	0.06	0.01	3.55	13	0	1	82	15	0	14	97

District Wise - Fluctuation of Water Level with Mean and Selected Period

10 Years Mean (2005 May - 2014 May) - 2015/May

State : Delhi

District Name	No. of Wells	Range of Fluctuation				No. of Wells/Percentage Showing Fluctuation						Total No. of Wells	
		Rise (m)		Fall (m)		Rise (m)			Fall (m)			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
CENTRAL	1	-	-	0.42	0.42	0	0	0	1 100.0 %	0	0	0	1
EAST	10	0.05	0.05	0.36	4.15	1 10.00 %	0	0	6 60.00%	2 20.00 %	1 10.00%	1	9
NEW DELHI	14	0.24	3.03	0.30	3.64	5 35.71 %	1 7.14%	0	5 35.71%	3 21.43 %	0	6	8
NORTH	7	0.16	0.70	2.39	2.39	6 85.71 %	0	0	0	1 14.29 %	0	6	1
NORTH EAST	4	-	-	1.13	4.80	0	0	0	2 50.00%	0	2 50.00%	0	4
NORTH WEST	28	0.04	1.66	0.24	4.90	9 32.14 %	0	0	16 57.14%	1 3.57 %	2 7.14%	9	19
SOUTH	16	0.18	3.38	0.35	10.10	5 31.25 %	1 6.25%	0	4 25.00%	3 18.75 %	3 18.75%	6	10
SOUTH WEST	26	0.36	3.76	0.59	7.15	9 34.62 %	4 15.38%	0	4 15.38%	5 19.23 %	4 15.38%	13	13

WEST	8	0.37	0.37	0.60	6.64	1 12.50 %	0	0	5 62.50%	1 12.50 %	1 12.50%	1	7
Total	114	0.05	0.37	0.24	10.10	36	6	0	43	16	13	42	72

Depth to Water Table
Distribution of Percentage of Observation Wells
2015/Aug

State : Delhi

District	No. of Wells Analysed	Depth to Water Table (mbgl)		No. / Percentage of Wells Showing Depth to Water Table (mbgl) in the Range of					
		Min	Max	0.0 - 2.0	2.0 - 5.0	5.0 - 10.0	10.0 - 20.0	20.0 - 40.0	> 40.0
CENTRAL	1	1.02	1.02	1 100.00%	0	0	0	0	0
EAST	10	2.98	19.95	0	3 30.00%	4 40.00%	3 30.00 %	0	0
NEW DELHI	14	6.85	26.46	0	0	4 28.57%	7 50.00 %	3 21.43%	0
NORTH	7	0.65	6.72	3 42.86%	2 28.57%	2 28.57%	0	0	0
NORTH EAST	4	4.22	11.76	0	2 50.00%	0	2 50.00 %	0	0
NORTH WEST	28	0.51	20.29	7 25.00%	5 17.86%	8 28.57%	7 25.00 %	1 3.57%	0
SOUTH	16	4.51	61.84	0	2 12.50%	4 25.00%	0	3 18.75%	7 43.75%
SOUTH WEST	26	0.87	57.02	4 15.38%	1 3.85%	1 3.85%	8 30.77 %	10 38.46%	2 7.69%
WEST	8	0.70	36.69	2 25.00%	1 12.50%	2 25.00%	2 25.00 %	1 12.50%	0
Total	114	0.51	61.84	17	16	25	29	18	9

District Wise - Fluctuation and Frequency Distribution From Different Ranges from One Period to Other

From Year: 2015/May - To Year: 2015/Aug

State : Delhi

District Name	No. of Wells	Range of Fluctuation (m)				No. of Wells/Percentage Showing Fluctuation						Total No. of Wells	
		Rise		Fall		Rise			Fall			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
CENTRAL	1	0.98	0.98	-	-	1 100.00%	0	0	0	0	0	1	0
EAST	10	0.03	1.07	0.26	0.27	8 80.00%	0	0	2 20.00%	0	0	8	2
NEW DELHI	14	0.23	5.18	-	-	11 78.57%	2 14.29 %	1 7.14%	0	0	0	14	0
NORTH	7	0.56	1.45	-	-	7 100.00%	0	0	0	0	0	7	0
NORTH EAST	4	0.55	0.55	0.14	0.49	1 25.00%	0	0	3 75.00%	0	0	1	3
NORTH WEST	28	0.01	3.12	0.08	2.81	15 53.57%	5 17.86 %	0	6 21.43%	2 7.14%	0	20	8
SOUTH	16	0.29	13.42	0.24	9.92	7 43.75%	1 6.25 %	4 25.00%	3 18.75%	0	1 6.25%	12	4
SOUTH WEST	26	0.14	4.42	0.06	2.10	14 53.85%	2 7.69 %	1 3.85%	8 30.77%	1 3.85%	0	17	9
WEST	8	0.22	3.68	-	-	4 50.00%	4 50.00 %	0	0	0	0	8	0

Total	114	0.98	0.55			68	14	6	22	3	1	88	26

District Wise - Fluctuation and Frequency Distribution From Different Ranges from One Period to Other

From Year: 2014/Aug - To Year: 2015/Aug

State : Delhi

District Name	No. of Wells	Range of Fluctuation (m)				No. of Wells/Percentage Showing Fluctuation						Total No. of Wells	
		Rise		Fall		Rise			Fall			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
CENTRAL	1	1.10	1.10	-	-	1 100.00%	0	0	0	0	0	1	0
EAST	10	0.04	0.39	0.14	1.19	5 50.00%	0	0	5 50.00%	0	0	5	5
NEW DELHI	14	0.13	4.21	0.23	1.11	7 50.00%	1 7.14 %	1 7.14%	5 35.71%	0	0	9	5
NORTH	7	0.17	1.02	-	-	7 100.00%	0	0	0	0	0	7	0
NORTH EAST	4	-	-	0.09	2.84	0	0	0	2 50.00%	2 50.00%	0	0	4
NORTH WEST	28	0.03	2.51	0.04	1.82	19 67.86%	2 7.14 %	0	6 21.43%	0	0	21	6
SOUTH	16	0.04	8.86	0.10	2.17	7 43.75%	2 12.50 %	3 18.75%	3 18.75%	1 6.25%	0	12	4
SOUTH WEST	26	0.07	8.92	0.09	3.09	11 42.31%	2 7.69 %	1 3.85%	10 38.46%	2 7.69%	0	14	12
WEST	8	0.03	2.52	0.50	1.06	2 25.00%	3 37.50 %	0	3 37.50%	0	0	5	3

Total	114	1.10	0.39	0.00	3.09	59	10	5	34	5	0	74	39

District Wise - Fluctuation of Water Level with Mean and Selected Period

10 Years Mean (2005 Aug - 2014 Aug) - 2015/Aug

State : Delhi

District Name	No. of Wells	Range of Fluctuation				No. of Wells/Percentage Showing Fluctuation						Total No. of Wells	
		Rise (m)		Fall (m)		Rise (m)			Fall (m)			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
CENTRAL	1	0.08	0.08	-	-	1 100.0 %	0	0	0	0	0	1	0
EAST	10	-	-	0.11	3.39	0	0	0	7 70.00%	3 30.00 %	0	0	10
NEW DELHI	14	0.35	2.21	0.01	3.54	6 42.86 %	1 7.14%	0	5 35.71%	2 14.29 %	0	7	7
NORTH	7	0.65	0.90	0.01	1.41	5 71.43 %	0	0	2 28.57%	0	0	5	2
NORTH EAST	4	-	-	1.10	5.24	0	0	0	1 25.00%	1 25.00 %	2 50.00%	0	4
NORTH WEST	28	0.06	1.99	0.10	4.16	14 50.00 %	0	0	8 28.57%	5 17.86 %	1 3.57%	14	14
SOUTH	16	0.33	9.76	0.86	8.39	4 25.00 %	1 6.25%	2 12.50%	4 25.00%	1 6.25 %	4 25.00%	7	9
SOUTH WEST	26	0.45	3.32	0.54	7.40	7 26.92 %	7 26.92%	0	2 7.69%	7 26.92 %	3 11.54%	14	12

WEST	8	0.49	1.85	0.78	5.71	4 50.00 %	0	0	2 25.00%	1 12.50 %	1 12.50%	4	4
Total	114	0.08	0.65	0.00	8.39	41	9	2	31	20	11	52	62

Depth to Water Table
Distribution of Percentage of Observation Wells
2015/Nov

State : Delhi

District	No. of Wells Analysed	Depth to Water Table (mbgl)		No. / Percentage of Wells Showing Depth to Water Table (mbgl) in the Range of					
		Min	Max	0.0 - 2.0	2.0 - 5.0	5.0 - 10.0	10.0 - 20.0	20.0 - 40.0	> 40.0
CENTRAL	1	1.82	1.82	1 100.00%	0	0	0	0	0
EAST	10	3.37	20.27	0	3 30.00%	4 40.00%	2 20.00 %	1 10.00%	0
NEW DELHI	14	7.80	26.83	0	0	3 21.43%	8 57.14 %	3 21.43%	0
NORTH	7	1.59	7.77	1 14.29%	4 57.14%	2 28.57%	0	0	0
NORTH EAST	4	4.68	12.01	0	1 25.00%	1 25.00%	2 50.00 %	0	0
NORTH WEST	29	0.72	20.47	4 13.79%	7 24.14%	10 34.48%	7 24.14 %	1 3.45%	0
SOUTH	16	5.22	61.13	0	0	5 31.25%	1 6.25 %	2 12.50%	8 50.00%
SOUTH WEST	26	1.58	55.23	1 3.85%	4 15.38%	0	9 34.62 %	10 38.46%	2 7.69%
WEST	9	1.81	36.90	1 11.11%	2 22.22%	3 33.33%	2 22.22 %	1 11.11%	0
Total	116	0.72	61.13	8	21	28	31	18	10

District Wise - Fluctuation and Frequency Distribution From Different Ranges from One Period to Other

From Year: 2015/May - To Year: 2015/Nov

State : Delhi

District Name	No. of Wells	Range of Fluctuation (m)				No. of Wells/Percentage Showing Fluctuation						Total No. of Wells	
		Rise		Fall		Rise			Fall			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
CENTRAL	1	0.18	0.18	-	-	1 100.00%	0	0	0	0	0	1	0
EAST	10	0.02	1.02	0.06	0.59	7 70.00%	0	0	3 30.00%	0	0	7	3
NEW DELHI	14	0.05	4.06	0.20	1.67	7 50.00%	2 14.29 %	1 7.14%	4 28.57%	0	0	10	4
NORTH	7	0.23	0.61	0.09	0.15	5 71.43%	0	0	2 28.57%	0	0	5	2
NORTH EAST	4	0.09	0.09	0.37	0.73	1 25.00%	0	0	3 75.00%	0	0	1	3
NORTH WEST	28	0.10	2.04	0.16	1.35	19 67.86%	1 3.57 %	0	8 28.57%	0	0	20	8
SOUTH	16	1.09	6.21	0.01	10.15	2 12.50%	3 18.75 %	3 18.75%	7 43.75%	0	1 6.25%	8	8
SOUTH WEST	26	0.19	8.82	0.05	2.23	14 53.85%	1 3.85 %	1 3.85%	9 34.62%	1 3.85%	0	16	10
WEST	8	0.01	3.01	-	-	6 75.00%	2 25.00 %	0	0	0	0	8	0

Total	114	1.09	0.09			62	9	5	36	1	1	76	38

District Wise - Fluctuation and Frequency Distribution From Different Ranges from One Period to Other

From Year: 2014/Nov - To Year: 2015/Nov

State : Delhi

District Name	No. of Wells	Range of Fluctuation (m)				No. of Wells/Percentage Showing Fluctuation						Total No. of Wells	
		Rise		Fall		Rise			Fall			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
CENTRAL	1	0.06	0.06	-	-	1 100.00%	0	0	0	0	0	1	0
EAST	10	0.10	0.58	0.50	1.29	4 40.00%	0	0	6 60.00%	0	0	4	6
NEW DELHI	14	0.23	2.30	1.17	1.27	11 78.57%	1 7.14 %	0	2 14.29%	0	0	12	2
NORTH	7	0.03	0.34	0.11	0.11	6 85.71%	0	0	1 14.29%	0	0	6	1
NORTH EAST	4	-	-	0.05	1.88	0	0	0	4 100.0 %	0	0	0	4
NORTH WEST	29	0.04	2.04	0.01	1.87	18 62.07%	1 3.45 %	0	10 34.48%	0	0	19	10
SOUTH	16	0.78	5.86	0.32	1.09	2 12.50%	2 12.50 %	3 18.75%	9 56.25%	0	0	7	9
SOUTH WEST	26	0.05	9.23	0.03	3.33	11 42.31%	1 3.85 %	1 3.85%	12 46.15%	1 3.85%	0	13	13
WEST	8	0.66	1.89	0.08	0.27	5 62.50%	0	0	3 37.50%	0	0	5	3

Total	115	0.78	0.06	0.00	3.33	58	5	4	47	1	0	67	48

District Wise - Fluctuation of Water Level with Mean and Selected Period

10 Years Mean (2005 Nov - 2014 Nov) - 2015/Nov

State : Delhi

District Name	No. of Wells	Range of Fluctuation				No. of Wells/Percentage Showing Fluctuation						Total No. of Wells	
		Rise (m)		Fall (m)		Rise (m)			Fall (m)			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
CENTRAL	1	-	-	0.62	0.62	0	0	0	1 100.0 %	0	0	0	1
EAST	10	-	-	0.35	3.80	0	0	0	7 70.00%	3 30.00 %	0	0	10
NEW DELHI	14	0.39	1.81	0.34	4.43	7 50.00 %	0	0	3 21.43%	3 21.43 %	1 7.14%	7	7
NORTH	7	0.02	0.02	0.01	2.02	1 14.29 %	0	0	5 71.43%	1 14.29 %	0	1	6
NORTH EAST	4	-	-	1.52	5.38	0	0	0	1 25.00%	1 25.00 %	2 50.00%	0	4
NORTH WEST	29	0.06	1.04	0.09	5.12	12 41.38 %	0	0	12 41.38%	4 13.79 %	1 3.45%	12	17
SOUTH	16	0.39	3.15	0.47	7.27	4 25.00 %	2 12.50%	0	5 31.25%	1 6.25 %	4 25.00%	6	10
SOUTH WEST	26	0.10	6.67	0.75	7.13	11 42.31 %	1 3.85%	2 7.69%	1 3.85%	7 26.92 %	4 15.38%	14	12

WEST	9	0.62	0.73	0.05	4.60	3 33.33 %	0	0	4 44.44%	1 11.11 %	1 11.11%	3	6
Total	116	0.02	0.62	0.01	7.27	38	3	2	39	21	13	43	73

Depth to Water Table
Distribution of Percentage of Observation Wells
2016/Jan

State : Delhi

District	No. of Wells Analysed	Depth to Water Table (mbgl)		No. / Percentage of Wells Showing Depth to Water Table (mbgl) in the Range of					
		Min	Max	0.0 - 2.0	2.0 - 5.0	5.0 - 10.0	10.0 - 20.0	20.0 - 40.0	> 40.0
CENTRAL	1	1.90	1.90	1 100.00%	0	0	0	0	0
EAST	10	3.46	20.47	0	3 30.00%	4 40.00%	2 20.00 %	1 10.00%	0
NEW DELHI	14	8.12	27.19	0	0	3 21.43%	8 57.14 %	3 21.43%	0
NORTH	7	1.63	7.61	1 14.29%	4 57.14%	2 28.57%	0	0	0
NORTH EAST	4	4.90	12.03	0	1 25.00%	1 25.00%	2 50.00 %	0	0
NORTH WEST	30	0.74	19.20	3 10.00%	7 23.33%	12 40.00%	8 26.67 %	0	0
SOUTH	15	5.75	59.51	0	0	5 33.33%	0	3 20.00%	7 46.67%
SOUTH WEST	26	1.54	56.12	2 7.69%	3 11.54%	0	9 34.62 %	10 38.46%	2 7.69%
WEST	8	3.04	36.38	0	3 37.50%	2 25.00%	2 25.00 %	1 12.50%	0
Total	115	0.74	59.51	7	21	29	31	18	9

District Wise - Fluctuation and Frequency Distribution From Different Ranges from One Period to Other

From Year: 2015/May - To Year: 2016/Jan

State : Delhi

District Name	No. of Wells	Range of Fluctuation (m)				No. of Wells/Percentage Showing Fluctuation						Total No. of Wells	
		Rise		Fall		Rise			Fall			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
CENTRAL	1	0.10	0.10	-	-	1 100.00%	0	0	0	0	0	1	0
EAST	10	0.12	0.97	0.13	0.79	6 60.00%	0	0	4 40.00%	0	0	6	4
NEW DELHI	14	0.46	2.53	0.11	0.73	6 42.86%	2 14.29 %	0	6 42.86%	0	0	8	6
NORTH	7	0.12	0.64	0.16	0.25	5 71.43%	0	0	2 28.57%	0	0	5	2
NORTH EAST	4	-	-	0.13	0.78	0	0	0	4 100.0 %	0	0	0	4
NORTH WEST	28	0.01	1.57	0.13	1.41	19 67.86%	0	0	9 32.14%	0	0	19	9
SOUTH	15	0.07	4.30	0.25	9.52	2 13.33%	5 33.33 %	1 6.67%	6 40.00%	0	1 6.67%	8	7
SOUTH WEST	26	0.03	6.38	0.12	2.32	13 50.00%	1 3.85 %	1 3.85%	10 38.46%	1 3.85%	0	15	11
WEST	8	0.02	2.99	0.11	0.20	5 62.50%	1 12.50 %	0	2 25.00%	0	0	6	2

Total	113	0.46	0.10	0.00	9.52	57	9	2	43	1	1	68	45

District Wise - Fluctuation and Frequency Distribution From Different Ranges from One Period to Other

From Year: 2015/Jan - To Year: 2016/Jan

State : Delhi

District Name	No. of Wells	Range of Fluctuation (m)				No. of Wells/Percentage Showing Fluctuation						Total No. of Wells	
		Rise		Fall		Rise			Fall			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
CENTRAL	1	-	-	0.10	0.10	0	0	0	1 100.0 %	0	0	0	1
EAST	10	0.13	0.55	0.08	1.44	2 20.00%	0	0	8 80.00%	0	0	2	8
NEW DELHI	14	0.07	2.05	0.03	2.66	5 35.71%	2 14.29 %	0	4 28.57%	3 21.43%	0	7	7
NORTH	7	0.02	0.28	0.11	0.28	4 57.14%	0	0	3 42.86%	0	0	4	3
NORTH EAST	4	0.23	0.23	0.71	1.82	1 25.00%	0	0	3 75.00%	0	0	1	3
NORTH WEST	28	0.10	1.52	0.02	1.86	16 57.14%	0	0	12 42.86%	0	0	16	12
SOUTH	15	0.18	4.56	0.57	1.20	5 33.33%	2 13.33 %	2 13.33%	6 40.00%	0	0	9	6
SOUTH WEST	26	0.08	8.03	0.02	4.27	11 42.31%	1 3.85 %	1 3.85%	11 42.31%	1 3.85%	1 3.85%	13	13
WEST	8	0.14	1.14	0.08	0.43	6 75.00%	0	0	2 25.00%	0	0	6	2

Total	113	0.23	0.23	0.02	4.27	50	5	3	50	4	1	58	55

District Wise - Fluctuation of Water Level with Mean and Selected Period

10 Years Mean (2006 Jan - 2015 Jan) - 2016/Jan

State : Delhi

District Name	No. of Wells	Range of Fluctuation				No. of Wells/Percentage Showing Fluctuation						Total No. of Wells	
		Rise (m)		Fall (m)		Rise (m)			Fall (m)			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
CENTRAL	1	-	-	0.47	0.47	0	0	0	1 100.0 %	0	0	0	1
EAST	10	-	-	0.18	5.09	0	0	0	6 60.00%	3 30.00 %	1 10.00%	0	10
NEW DELHI	14	0.28	2.14	0.17	4.23	4 28.57 %	1 7.14%	0	5 35.71%	3 21.43 %	1 7.14%	5	9
NORTH	7	0.02	0.24	0.25	2.00	5 71.43 %	0	0	2 28.57%	0	0	5	2
NORTH EAST	4	-	-	1.75	5.40	0	0	0	1 25.00%	1 25.00 %	2 50.00%	0	4
NORTH WEST	29	0.06	1.17	0.09	4.03	9 31.03 %	0	0	15 51.72%	4 13.79 %	1 3.45%	9	20
SOUTH	15	0.80	4.51	0.62	7.20	4 26.67 %	0	1 6.67%	6 40.00%	0	4 26.67%	5	10
SOUTH WEST	26	0.14	5.80	0.57	7.65	9 34.62 %	3 11.54%	2 7.69%	2 7.69%	6 23.08 %	4 15.38%	14	12

WEST	8	0.71	0.71	0.31	4.79	1 12.50 %	0	0	5 62.50%	1 12.50 %	1 12.50%	1	7
Total	114	0.24	0.80	0.09	7.65	32	4	3	43	18	14	39	75