



## केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय

भारत सरकार

**Central Ground Water Board**

Ministry of Water Resources, River Development and Ganga

Rejuvenation

Government of India

**Report**

**on**

# **AQUIFER MAPPING AND GROUND WATER MANAGEMENT**

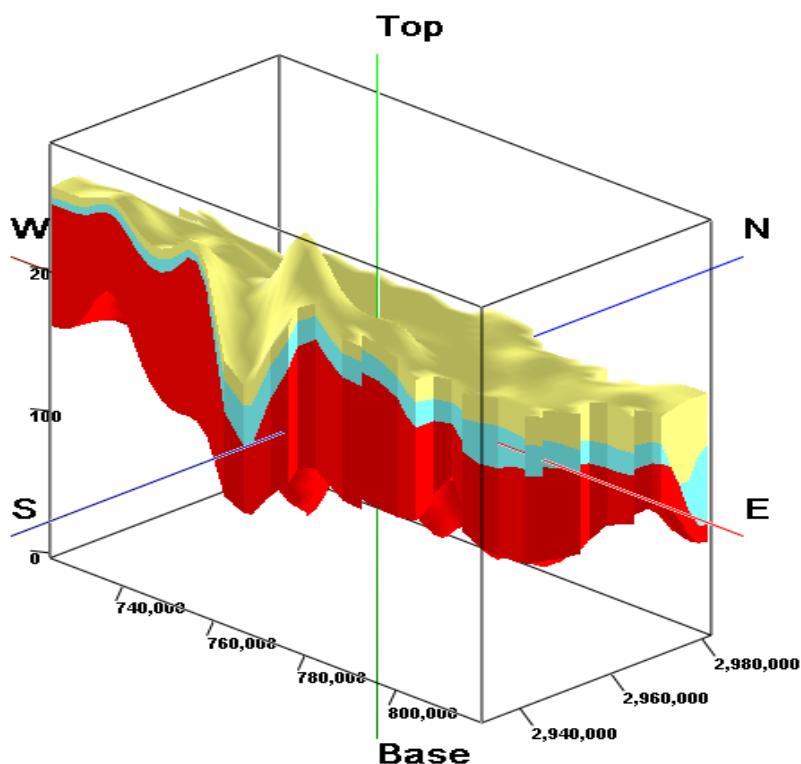
**Dholpur District, Rajasthan**

पश्चिमी क्षेत्र जयपुर

Western Region, Jaipur



**Report on  
AQUIFER MAPPING AND GROUND WATER  
MANAGEMENT  
DISTRICT DHOLPUR, RAJASTHAN  
(UNDER XII PLAN)**



**CENTRAL GROUND WATER BOARD  
MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVANATION  
GOVERNMENT OF INDIA  
WESTERN REGION, JAIPUR**

**JULY, 2017**

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### Block wise Aquifer Maps and Management Plans

25-27

# **Report on National Aquifer Mapping Programme**

(Based on Available Data)

## **District Dholpur, Rajasthan**

### **1. Introduction**

#### **1.1 Objectives**

Various developmental activities over the years have adversely affected the groundwater regime in the state. There is a need for scientific planning in development of groundwater under different hydrogeological situation and to evolve effective management practices with involvement of community for better ground water governance. In view of emergent challenges in the ground water sector in the state there is an urgent need for comprehensive and realistic information pertaining to various aspects of groundwater resource available in different hydrogeological setting through a process of systematic data collection, compilation, data generation, analysis and synthesis. Hence, aquifer mapping of the study area is the need of the hour.

#### **1.2 Scope of the study**

Aquifer mapping can be understood as a scientific process wherein a combination of geological, Geophysical, hydrological and chemical fields and laboratory analyses are applied to characterized the quantity, quality, and sustainability of ground water in aquifers. Aquifer mapping is expected to improve our understanding of the geological framework of aquifer, their hydrologic characteristics, water level in aquifer and how they changes over time and space and the occurrence of natural and anthropogenic contaminants that affect the portability of groundwater. Results of these studies will contribute significantly to resource management tools such as long term aquifer monitoring network and conceptual and quantitative regional groundwater flow models to be used by planners, policy makers and other stake holders. Aquifer mapping at appropriate scale can help to prepare, implement, and monitor the efficacy of various management interventions aimed at long term sustainability of our precious groundwater recourses, which in turn will help to achieve drinking water scarcity, improved irrigation facilities and sustainability of water resource in the state.

#### **1.3 Approach & Methodology**

As mentioned above, aquifer mapping is an attempt to integrate the geological, Geophysical, hydrological and chemical field and laboratory analyses are applied to characterize the quality, quantity and sustainability of groundwater in aquifer. Under the National aquifer Programme, it is proposed to generate Aquifer maps on 1:50000 scale, which basically aims at characterizing the aquifer geometry, behavior of groundwater levels and status of groundwater development in various aquifer system to facilitate planning of their suitable management. The major activities involved in this process include compilation of existing data, identification of data gaps, generation of data for filling data gaps and preparation of different aquifer layers.

#### **1.4 Data availability**

Groundwater availability, monitoring (water level and chemical quality), exploration had been carried out by CGWB and state Ground water Department. A total of 18 nos of NHS has been monitored by CGWB, WR, Jaipur and 114 Key observation wells have been monitored by State GWD, Government of Rajasthan. A total of 33 nos. of EW & OW have been constructed by CGWB and 33 nos. have been constructed by State GWD, Rajasthan.

### 1.5 Data Adequacy

The data collected from State GWD and CGWB WR Jaipur have been compiled and analysed. It has been observed that validation and georeferncing of the location coordinates, lithologs and hydrogeological data is needed and State GWD data is lacks in aquifer parameters. Geophysical data collected needs georeferncing of the hydrogeological interpretations. It has been observed that available data are limited largely to State highways and main roads only. Hence, to get a clear 3D hydrogeological geometry of the aquifer system and its behaviour, we need to generate data by Groundwater Exploration and to establish more numbers of monitoring stations for better understanding of the groundwater regime behavior in terms of both quantity and quality.

### 1.6 Data Gap Analysis

Data collected from State GW agencies and CGWB has been brought to a standard format and integrated location maps has been prepared regarding groundwater monitoring, exploration, surface water and agriculture data. Based on these maps and hydrogeological conditions in the area. Dholpur district further needs generation of data in the gap areas.

### 1.7 Area details

Dholpur district comprises of 3033 sq km geographical area having 54.30 sq km hilly area and 2486 sq.km. mappable area. Administratively, the district comprises of 4 blocks and 805 villages. It is located in the easternmost side of the state of Rajasthan and is situated within 26°21'19" and 26°57'33" North latitudes and 77°13'06" and 78°16'45" East longitudes. It is bounded by Bharatpur district in the northwest, Sawai Madhopur and Karauli districts in southwest and rest of the boundaries are bordered by Agra district of Uttar Pradesh and Bhind & Morena districts of Madhya Pradesh. The administrative set up of the district is given in Table 1 and map showing administrative divisions is presented in Figure 1.

**Table 1: Administrative set up of Dholpur district**

Name of Block	Geographical area (sq.km.)	Tehsil covered (Area in sq.km.)
Baseri	1001.42	Baseri/ 998.04
Rajakhera	583.07	Raja Khera 387.02, Sepau/ 304.06
Dholpur	609.32	Dholpur/ 509.71
Bari	816.24	Bari / 810.61

The population of the district as per 2011 census is 1206516 persons including 653647 males and 552869 females.



**Figure 1: Administrative Divisions**

Ground water investigations were carried out for the first time by S.K. Sinha, Geological Survey of India in the year 1969-70 in Rajakhera Panchayat Samiti. Systematic Hydrogeological surveys to map the district on the scale of 1": 4 miles was carried out in the district by Shri S.K. Jain, N.H. Reddy and S. Datta of Central Ground Water Board during 1979 – 81. Based on the results of hydrogeological mapping, ground water exploration in alluvial part of the district was taken up by CGWB during 1983 to 1985. Between 1969 and 1972, water levels from National Hydrograph Stations in the district were monitored by GSI and since 1973; these are being monitored by CGWB four times in a year.

As on date, 5 exploratory wells, 5 observation wells, 4 slim holes and 11 piezometers have been drilled in the district. Salient features of ground water exploration in the district are given in Table 2.

**Table 2: Salient features of ground water exploration**

Type of well	No.	Depth drilled (m)	SWL (m)	Transmissivity (m <sup>2</sup> /day)	Discharge (lpm)	EC (micromhos/cm) at 25°C
EW	5	39.5 – 159.55	4.13 – 19.10	70 – 277	440 – 727	620 - 1995
PZ	11	19.78 – 126.7	3.5 – 37.27	-	234 – 1200	665 - 7680
SH	4	52.50 – 110	-	-	120 – 300	1145 - 6225

### 1.8 Rainfall and Climate

Climate of the district can be classified as semi arid type. The summers are very hot & dry and winters are very cold. The summer season prevails from March to mid June after which the rainy

season starts with the onset of monsoon rains lasting till the end of September. During May/ June months, the mean daily temperature is about 40°C. The potential evapotranspiration is 1780.0 mm annually.

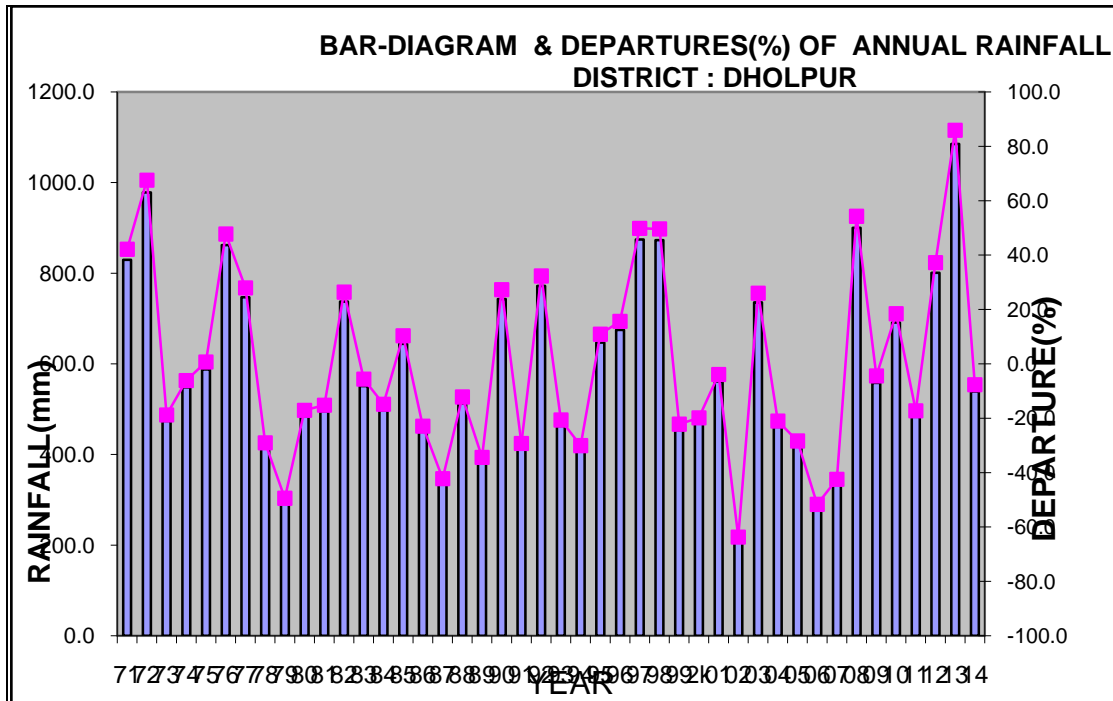
The mean annual rainfall of the district is 563.94 mm (2001-2011). The long term normal annual rainfall (1951-2000) is 722.1mm. The occurrence of mild droughts is highest in the district. Normal drought occurs sometimes where as severe type of drought occurs rarely. The rainfall data of Dholpur district is shown in Table 3 and the Bar diagram is presented in Figure 2.

**Table 3: Annual Rainfall and Departure (%) From Mean**

YEAR	Dholpur	Dep(%)	Sepau	Dep(%)	Rajakhera	Dep(%)	Bari	Dep(%)	Baseri	Dep(%)	Sarmathra	Dep(%)
71	771.0	16.2	720.0	14.2	881.5	35.5	886.5	16.8	617.0	12.8	829.4	42.1
72	494.0	-25.5	458.0	-27.3	417.7	-35.8	1190.0	56.7	565.7	3.4	978.0	67.6
73	631.7	-4.8	739.1	17.3	624.9	-4.0	940.0	23.8	607.6	11.0	474.0	-18.8
74	428.0	-35.5	455.0	-27.8	724.2	11.3	734.0	-3.3	612.0	11.8	548.0	-6.1
75	543.0	-18.2	749.0	18.8	486.9	-25.2	998.1	31.5	739.1	35.1	587.8	0.7
76	759.4	14.5	1168.0	85.3	763.5	17.3	1114.3	46.8	662.8	21.1	862.0	47.7
77	540.0	-18.6	1064.2	68.8	936.1	43.9	1148.2	51.2	530.8	-3.0	746.8	28.0
78	629.5	-5.1	648.0	2.8	416.0	-36.1	914.8	20.5	338.0	-38.2	414.4	-29.0
79	171.8	-74.1	138.6	-78.0	399.6	-38.6	534.0	-29.7	349.8	-36.1	295.0	-49.5
80	491.9	-25.9	515.0	-18.3	412.5	-36.6	874.8	15.2	491.6	-10.2	484.0	-17.1
81	432.4	-34.8	434.0	-31.1	840.8	29.2	752.5	-0.9	448.0	-18.1	495.0	-15.2
82	744.5	12.2	471.0	-25.3	551.8	-15.2	773.8	1.9	517.3	-5.5	737.4	26.4
83	736.6	11.0	675.0	7.1	506.0	-22.2	553.2	-27.1	428.2	-21.7	551.0	-5.6
84	553.7	-16.5	1063.0	68.6	331.3	-49.1	366.0	-51.8	292.4	-46.6	497.1	-14.8
85	897.9	35.3	1044.0	65.6	775.0	19.1	628.0	-17.3	381.0	-30.4	644.0	10.3
86	266.0	-59.9	513.0	-18.6	394.0	-39.4	529.0	-30.3	361.0	-34.0	450.0	-22.9
87	371.0	-44.1	474.5	-24.7	268.0	-58.8	469.5	-38.2	283.5	-48.2	337.5	-42.2
88	835.8	26.0	574.0	-8.9	459.0	-29.5	772.5	1.8	310.0	-43.3	512.4	-12.2
89	521.6	-21.4	377.0	-40.2	322.0	-50.5	503.0	-33.7	178.0	-67.5	383.0	-34.4
90	836.1	26.0	739.0	17.2	586.0	-9.9	889.3	17.1	576.5	5.4	743.0	27.3
91	360.8	-45.6	323.0	-48.8	647.0	-0.6	588.2	-22.5	255.5	-53.3	413.0	-29.2



<b>YEAR</b>	<b>Dholpur</b>	<b>Dep(%)</b>	<b>Sepau</b>	<b>Dep(%)</b>	<b>Rajakhera</b>	<b>Dep(%)</b>	<b>Bari</b>	<b>Dep(%)</b>	<b>Baseri</b>	<b>Dep(%)</b>	<b>Sarmathra</b>	<b>Dep(%)</b>
92	992.7	49.6	644.0	2.2	1511.0	132.2	754.0	-0.7	564.5	3.2	772.0	32.3
93	429.7	-35.2	484.0	-23.2	720.0	10.7	704.6	-7.2	254.0	-53.6	463.0	-20.7
94	612.4	-7.7	467.0	-25.9	481.0	-26.1	565.0	-25.6	422.3	-22.8	408.0	-30.1
95	1008.3	52.0	805.0	27.7	677.0	4.0	1145.9	50.9	652.0	19.2	647.0	10.9
96	993.2	49.7	950.0	50.7	959.0	47.4	1104.9	45.5	764.0	39.6	675.0	15.7
97	915.2	37.9	668.0	6.0	675.0	3.7	704.1	-7.3	467.0	-14.7	874.5	49.8
98	884.5	33.3	781.0	23.9	818.0	25.7	811.0	6.8	556.0	1.6	873.0	49.6
99	698.1	5.2	768.0	21.8	635.0	-2.4	636.1	-16.2	529.0	-3.3	454.0	-22.2
2k	549.6	-17.2	451.0	-28.4	415.0	-36.2	555.0	-26.9	448.0	-18.1	468.0	-19.8
01	409.0	-38.4	695.5	10.3	669.0	2.8	939.0	23.7	717.0	31.0	561.0	-3.9
02	454.2	-31.5	446.0	-29.2	703.0	8.0	576.0	-24.1	404.0	-26.2	212.0	-63.7
03	728.1	9.7	552.1	-12.4	521.0	-19.9	705.0	-7.1	525.0	-4.1	735.5	26.0
04	773.0	16.5	633.0	0.4	1086.0	66.9	877.0	15.5	711.0	29.9	461.0	-21.0
05	784.1	18.2	673.0	6.8	754.0	15.9	607.5	-20.0	609.0	11.3	418.0	-28.4
06	301.4	-54.6	394.0	-37.5	466.0	-28.4	513.0	-32.4	455.0	-16.8	282.0	-51.7
07	620.0	-6.6	357.0	-43.4	475.0	-27.0	598.0	-21.2	472.0	-13.7	336.0	-42.4
08	1319.6	98.9	804.0	27.6	1080.0	66.0	1047.0	37.9	1093.0	99.7	900.1	54.2
09	495.0	-25.4	433.0	-31.3	511.0	-21.5	472.0	-37.8	457.0	-16.5	558.0	-4.4
10	978.5	47.5	693.0	9.9	798.0	22.6	712.0	-6.2	566.0	3.4	691.0	18.4
11	751.0	13.2	646.0	2.5	610.0	-6.3	633.0	-16.6	658.0	20.2	483.0	-17.2
12	728.0	9.7	744.0	18.0	839.0	28.9	826.0	8.8	1167.0	113.3	801.0	37.3
13	1133	70.8	880	39.6	984	51.2	1105	45.5	1171	114.0	1085	85.9
14	620	-6.6	424	-32.7	502	-22.9	652	-14.1	867	58.4	539	-7.6
Mean	663.5	0.0	630.3	0.0	650.7	0.0	759.2	0.0	547.2	0.0	583.6	0.0



**Figure 2: Bar Diagram of Rainfall Data, Dholpur district**

### 1.9 Physiography, Drainage and Soils

#### Physiography:

The district comprises of alluvial plains and ravines in the eastern part and small flat topped hills in the western part. These hills are spread over 378.33 sq km area attaining altimetric variation of about 174 m from plains. The district is also known for ravines covering about 272 sq km area developed mainly on the banks of Chambal river.

The highest peak (the Gurjar Pahar) in the district is about 357 m above mean sea level (amsl) and is located in the southwest of the district. The eastern plain lies at altitude between 163 and 171 m amsl. The central part of the district lies between altitude of 232 and 177 m amsl.

Geomorphologically, the district can be divided into following four main morphological units:

- Western hilly areas.
- Central undulating plains.
- The eastern plain (east of Dholpur - Maina) alignment.
- About 3 to 10 km wide strip of plateau about the southern boundary demarcated by Chambal River. Ravines are very common and prominent physiographic features in the district.

#### Drainage:

Dholpur district is covered in part by three river basins namely Parbati, Chambal and Gambhiri. The river Parbati flows from west to east and is located in the central part of the district whereas

river Chambal and river Gambhiri flow in the southern and northern extremities of the district respectively. Both these rivers flow in the southwest - northeast direction.

Drainage system of the district is quite well developed and is represented by Chambal, Gambhir and Parbati rivers and their various tributaries. The entire district falls under the Yamuna basin as both Chambal and Gambhir rivers are the tributaries of Yamuna river. Major part of the district comes under Gambhir and Parbati sub basins and a narrow strip of the plateau part of the district running in NE-SW direction falls under Chambal sub basin. The details of basin wise area covered in the district are given in Table 4.

**Table 4: Basin wise area covered**

Basin	Area sq. km	% of district	% of Basin
Parbati	1950.70	64.50	81.70
Gambhir	203.50	17.80	4.90
Chambal	869.40	28.80	2.80

#### Soil Types:

Soils of the district have been classified into the following six categories:

- Sandy soil: It is restricted within a small NE-SW trending lenticular patch in the western part of the district.
- Loamy sandy soil: This type of soil occurs in a very small patch of the area in the western vicinity of Bari town.
- Sandy loamy soil: It occurs in two small patches, one located to the west of the district adjoining the sandy soil patch and the other around Turripura village in the western part of the district.
- Clayey soil : This variety of soil occurs in the eastern part of the district about 5 km southwest of Rajakhera and in the northwestern part about 5 km north of Turripura village.
- Sandy clayey loam soil: This type of soil occurs in four isolated patches, two in northwestern part and two in the central part of the district.
- Sandy clayey soil: This type of soil is the most prevalent in the district.

#### 1.10 Landuse and irrigation practices

The land use statistics of the district are furnished in Table 5. Out of total reporting area of 300913 ha, 27173 ha (9%) is covered by forests. Fallow lands cover 5.25% of the total area occupying 15795 ha and other uncultivated land occupy 26728 ha area covering 8.9% of the total area. About 74744 ha (24.84%) land is not available for cultivation.

**Table 5: Land use pattern (2010-11)**

Particulars	Area (in ha)
Area not available for cultivation	74744
Forest	27173
Other uncultivated land excluding fallow land	26728
Fallow land	15795
Net area sown	156473
Total cropped area	226210

Area sown more than once	69737
Total reporting area	300913

The total sown area is 226210 has (including area sown more than once) and net sown area is 156473 ha out of which net irrigated area is 110900 ha forming nearly two third of the net area sown. Agriculture activity is spread over both Kharif and Rabi cultivation. Kharif cultivation is rain fed and Rabi cultivation is mostly based on ground water. Details of source wise area irrigated in the district are given in Table 6.

**Table 6: Source wise area irrigated (2010-11)**

Source	Net irrigated area (ha)	Gross irrigated area (ha)
Canal	6634	6641
Tank	128	2312
Tubewells	98478	99027
Other wells	566 0	5660
Total	110900	111456

## 2. Aquifer System

### 2.1 Geology

The rock formations exposed in Dholpur district are sedimentary in nature belonging to Vindhyan Super Group and are overlain in most part of the district by the Quaternary alluvium. The stratigraphic succession of different types of formations in the district is as follows:

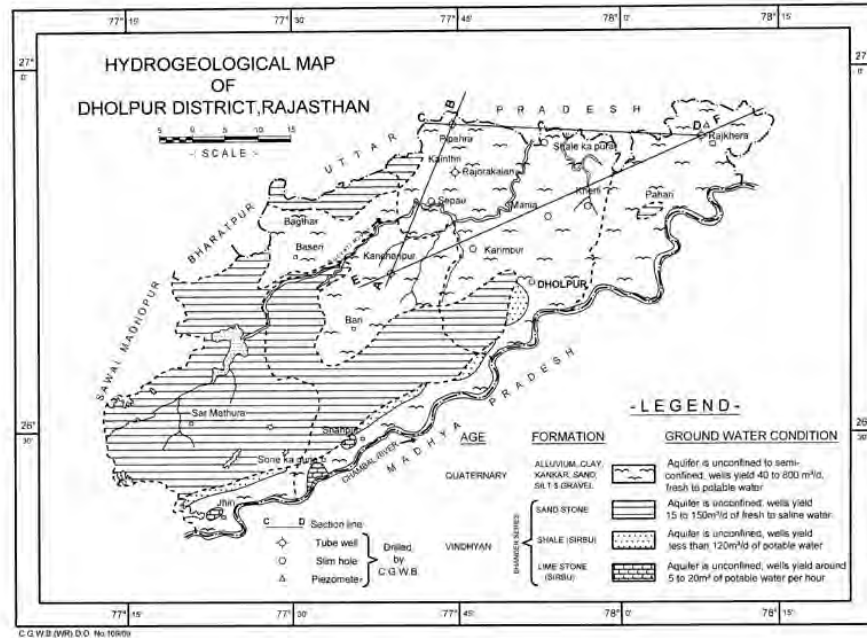
Quaternary	Recent to sub recent	Alluvium	Clay, silt, sand, kankar, gravel and rock fragments
Upper Proterozoic	Vindhyan Super Group	Bhander Group	Upper Bhander sandstone. Sirbhu shale with bands of siltstone and limeStone

### 2.2 Hydrogeology

In Dholpur district, ground water occurs in mainly four hydrogeological formations. These hydrogeological formations are alluvium, sandstone, shale and limestone and among these formations, alluvium is the most important formation as it covers the maximum area and also it is the most potential among different hydrogeological formations. Hydrogeological map of the district is shown in Figure 3. The ground water bearing characteristics of the various formations are described below:

#### *Sirbhu shale*

Sirbhu shales occur as water bearing formation in isolated patches located along the southern contact of upper Bhander sandstone with alluvium. As shale gets easily weathered into clayey products, its water storing capacity is very poor. Within shales generally ground water moves



**Figure 3: Hydrogeological map of Dholpur district**

through joints and fractures, which do not persist much downwards or laterally and further the joints are filled with secondary materials making the shales a poor aquifer.

### *Sirbhu limestone*

Sirbhu limestone as a hydrogeological formation occurs in the extreme corner of the district near Chambal river. The investigation indicates that the cavernous nature of limestone is not properly developed and aerial distribution of this formation is very limited. Ground water occurs under water table conditions and yield from the open wells ranges from 5 to 20 m<sup>3</sup>/hr individually.

### *Upper Bhandar sandstone*

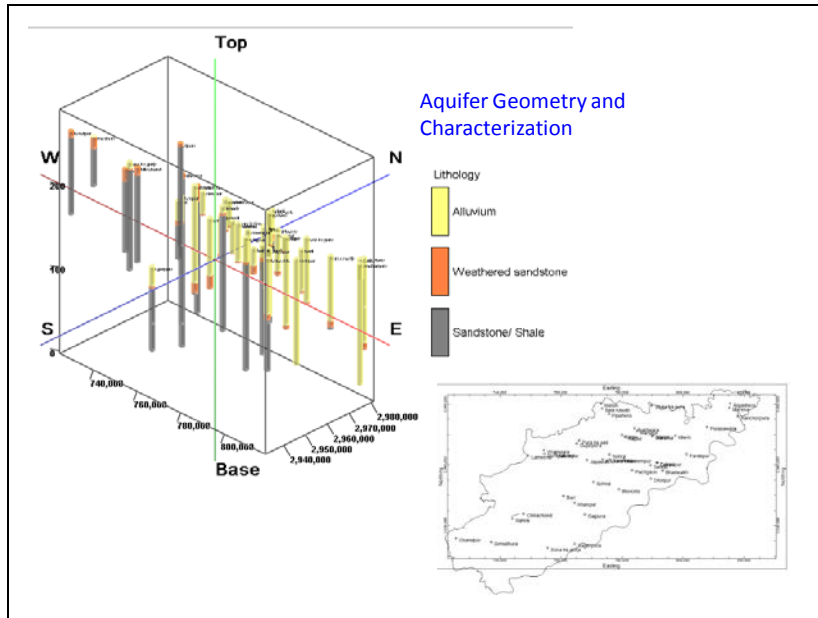
Upper Bhandar sandstone occurring in the central, southern and western part of the district is the second important hydrogeological formation in the district and in the aerial coverage it is next to alluvium. Ground water occurs under water table conditions. Sandstone is very hard compact, fine grained, devoid of secondary porosity and very much resistant to weathering and as such water holding capacity of sandstone is very poor. In general, the yield of wells tapping this aquifer is very poor. However, good yielding wells have been observed where extent and spacing of joints and fractures are more. The yield of wells tapping sandstone ranges from 15 to 150 m<sup>3</sup>/day and recuperation is markedly slow.

### *Alluvium*

Alluvium is the most important hydrogeological formation in the district and it covers maximum area. Ground water occurs under unconfined condition. In the district mainly sandy clay, silty clay, sand and gravel type of aquifers have been observed. In some of the area clay with kankar also forms aquifers, which is generally very poor aquifer. Whenever, aquifers contain mainly sand/ sand and gravel, it becomes the potential aquifer and yield from open wells ranges from

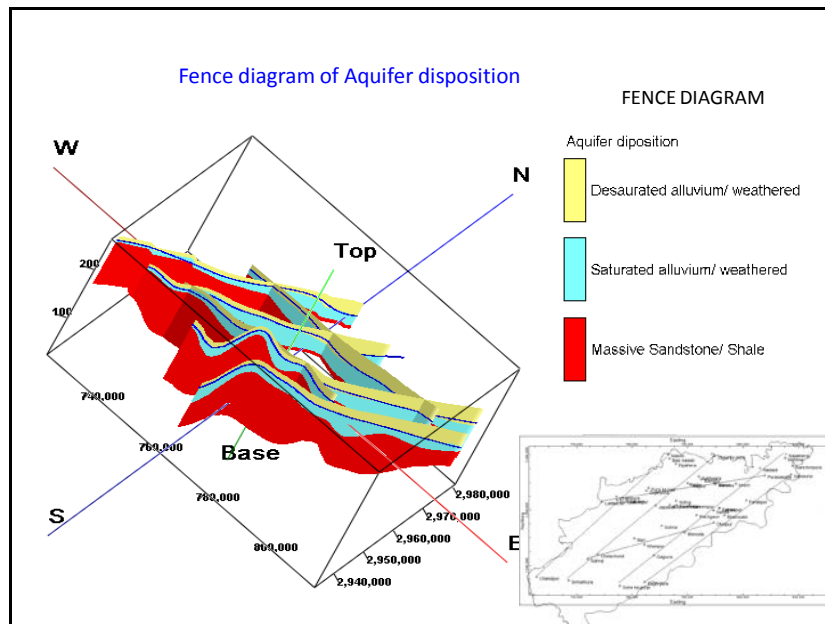
200 to 800 m<sup>3</sup>/day and discharge from tubewells as high as 726 lpm (Piphera) and 632 lpm (Rajakhera). The open wells tapping clay and kankar as aquifer have poorest yield and recuperation is also slow in these wells. The intermediate yields are obtained from the aquifer comprised of silty clay and sandy clay.

Three dimension aquifer geometry and characterization model has been prepared using Rock Works Software which is given in Figure 4.



**Figure 4: Aquifer Geometry and Characterization Model**

The 3-D Fence diagram has been prepared using the said software given in Figure 5.



**Figure 5: Fence Diagram of Aquifer Disposition**

The hydrogeological sections showing aquifer disposition have been prepared and depicted in Figures 7A to 7C and cross section is given in Figure 6.

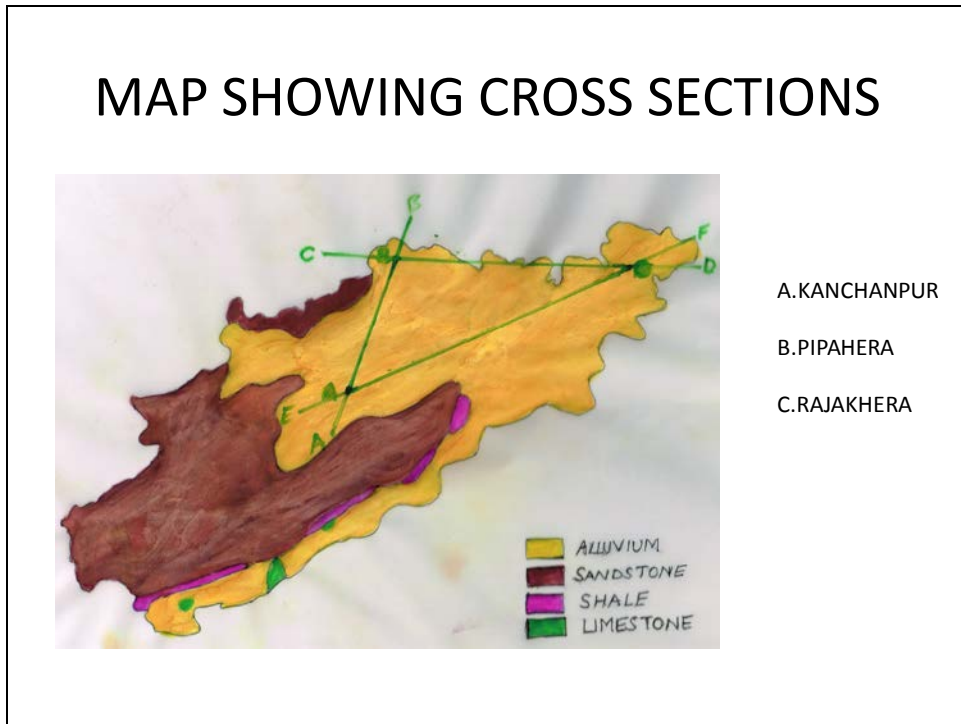


Figure 6: Map showing Cross Sections

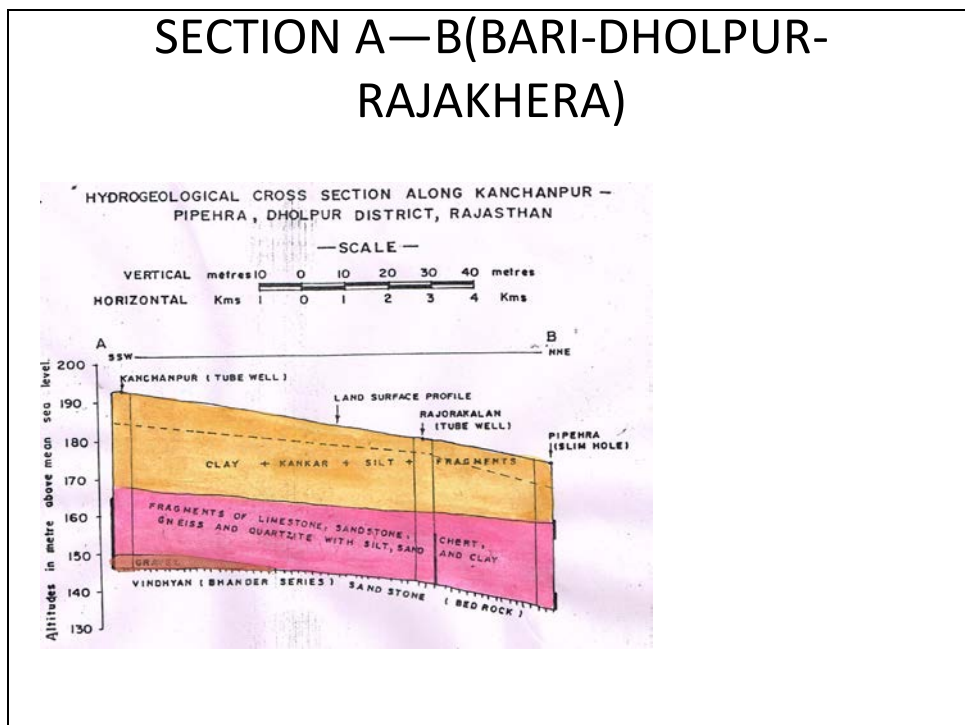
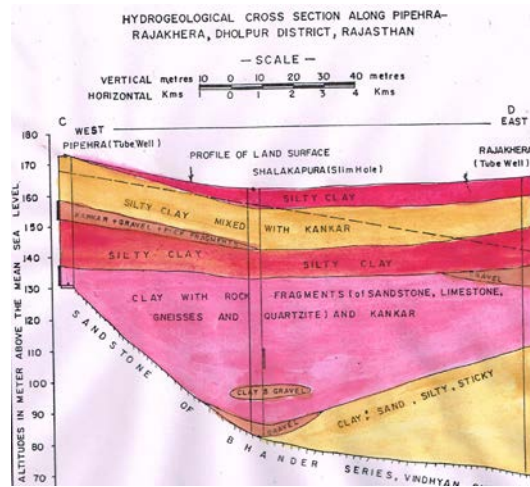


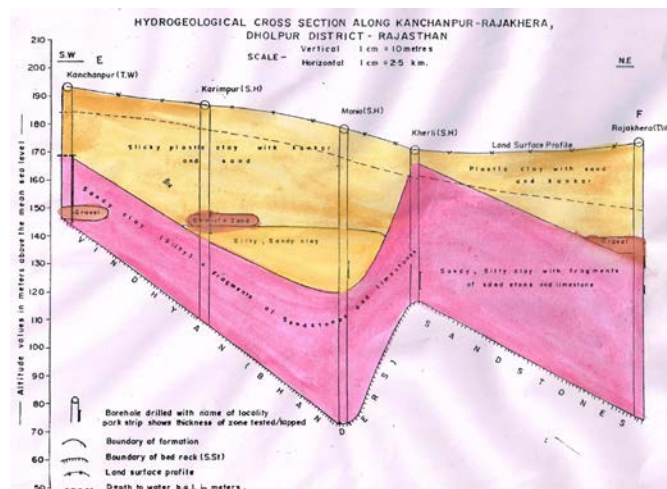
Figure 7A: Section A - B

# SECTION C—D(RAJAKHERA)



**Figure 7B: Section C - D**

# SECTION E—F(BARI-DHOLPUR-RAJAKHERA)



**Figure 7C: Section E-F**



### 2.3 Ground Water Scenario

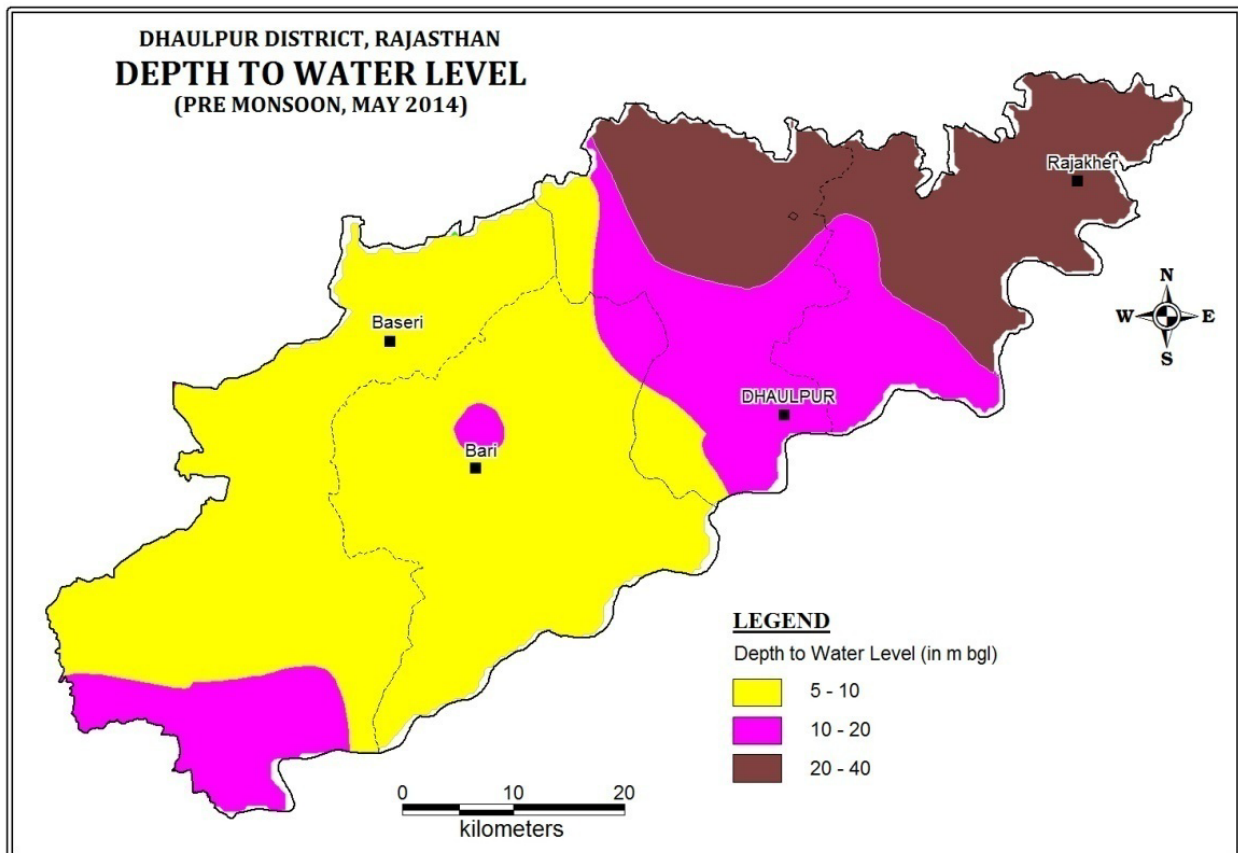
Central Ground Water Board periodically monitors the National Hydrograph Network Stations (NHNS) in the district, four times a year i.e. in January, May (Premonsoon), August and November (Postmonsoon).

#### *Depth to Water Level – Pre-monsoon (May-2014):*

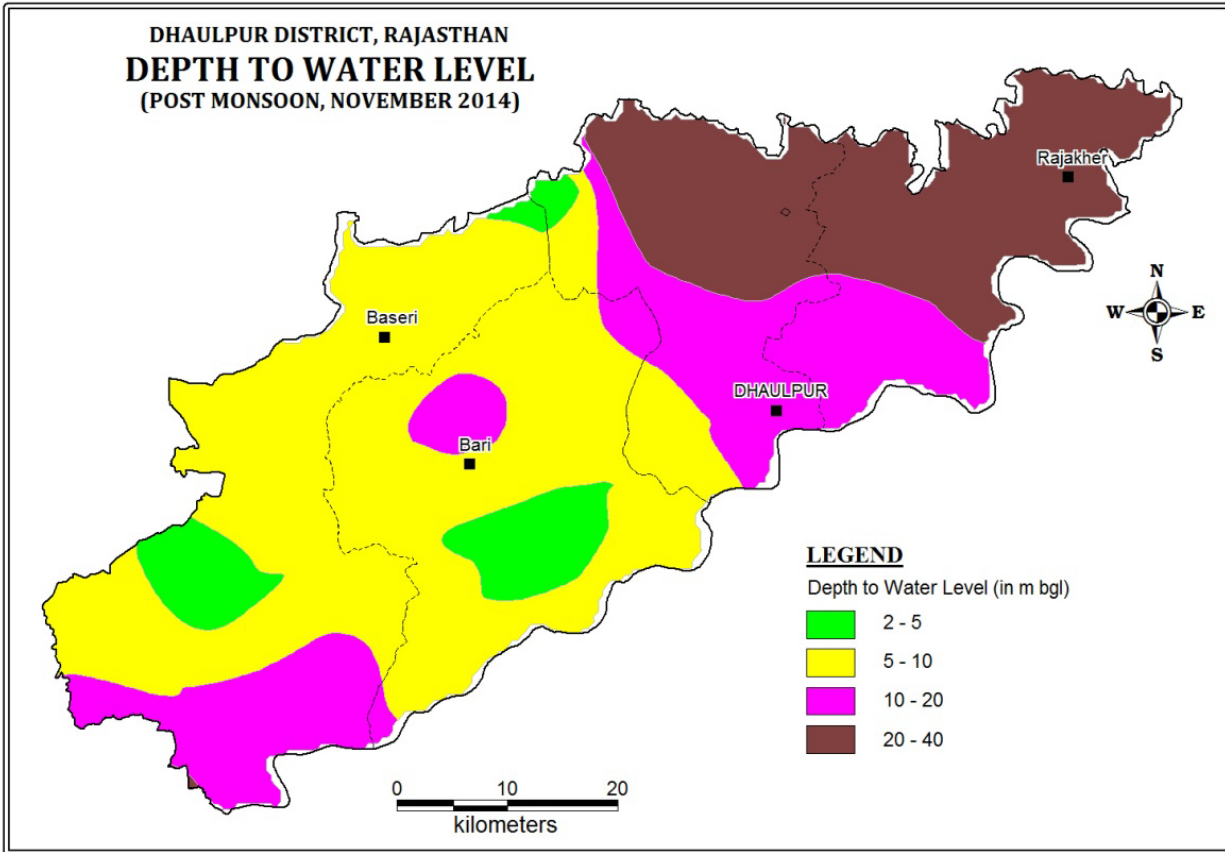
During pre-monsoon (May, 2014), the depth to water level in the district varied from 4.97 to 35.10 mbgl. Majority of wells monitored (64.29%) have registered water levels in the range of 5 to 20 mbgl. Deeper water levels (> 20 mbgl) were recorded in 28.57% wells monitored in northern and northwestern parts of the district. The Depth to water level map for pre-monsoon 2014 is given in Figure 8.

#### *Depth to Water Level – Post-monsoon (November, 2014):*

During post-monsoon period (November, 2014), the depth to water level varied from 3.07 to 39.90 mbgl. Depth to water level in the range of 2 to 5 mbgl was recorded in 30.77% of the wells monitored in parts of Bari, Baseri and Dholpur blocks. Depth to water level in the range of 5 to 20 mbgl were recorded in 45.45% wells in the district. Deeper water levels (>20mbgl) were reported from southwestern, northern and northeastern parts of the district. Depth to water level map of the district during post-monsoon period is shown in Figure 9.



**Figure 8: Depth to Water Level Map (May 2014)**

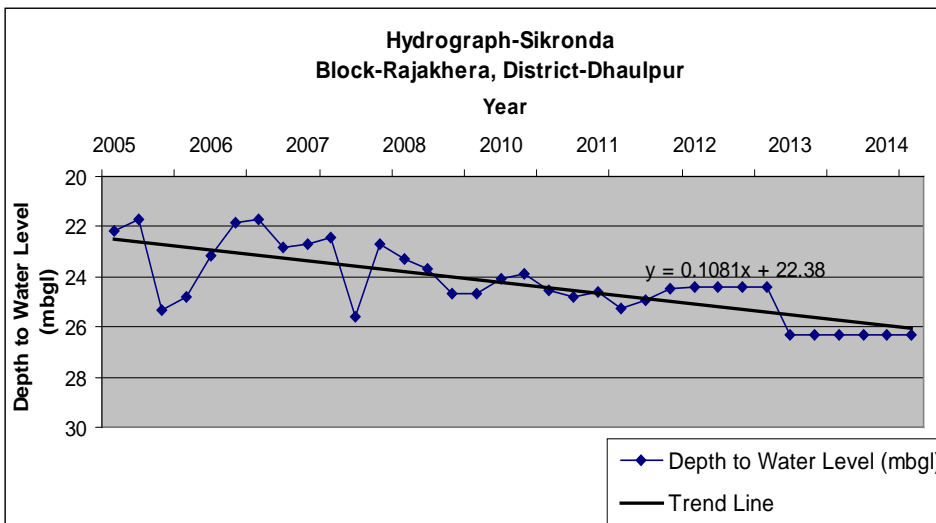
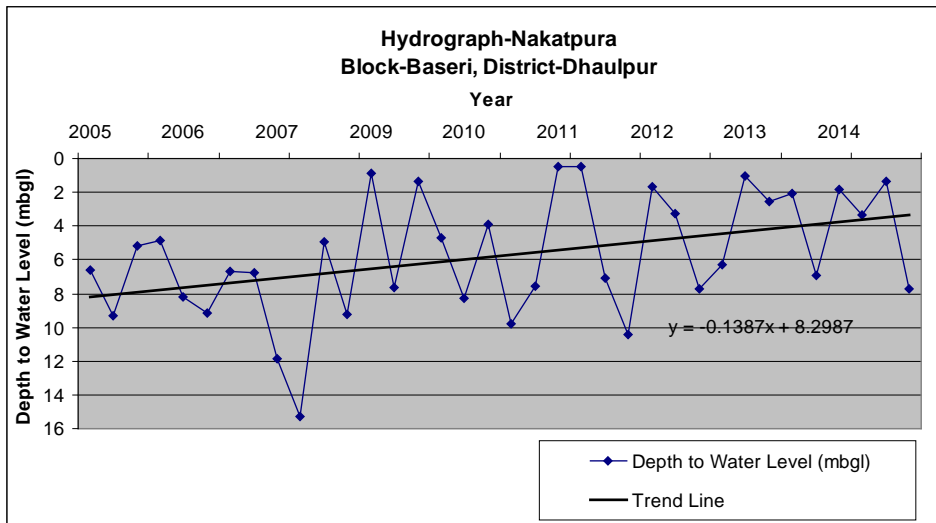
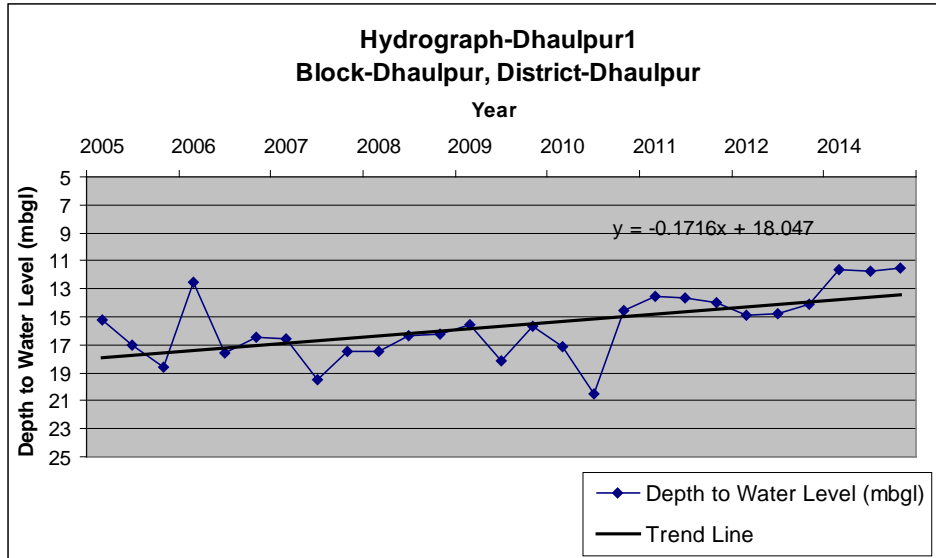


**Figure 9: Depth to Water Level Map (November, 2014)**

Analysis of long term water level data of selected hydrograph stations for the last ten years (2005-2014) indicates that most of the selected representative wells from each block have shown rising water levels. The Badh Gajpura station of Bari Block, Nakatpura station of Baseri Block and Dholpur1 station of Dholpur Block have shown water level rises of 0.09, 0.14, 0.17 m/year, respectively. The water level falls of 0.36 m/year at Pipehera station of Dholpur Block and 0.11 m/year at Sikronda station of Rajakhera Block have been observed during this period. The long term trends of selected stations are given below in table 7 and hydrographs for these are given in Figure 10.

**Table 7: Long term trends (2005-2014) for selected hydrograph stations**

Name of Station	Block	Trend (m/year)
Gajpura	Bari	-0.09
Nakatpura	Baseri	-0.14
Dholpur1	Dholpur	-0.17
Pipehera	Dholpur	0.36
Sikronda	Rajakhera	0.11



**Figure 10: Hydrographs of Dholpur district**

### 3. Chemical Quality of Ground Water

The range of chemical constituents of ground water in Dholpur district during pre-monsoon 2014 is furnished in Table 8.

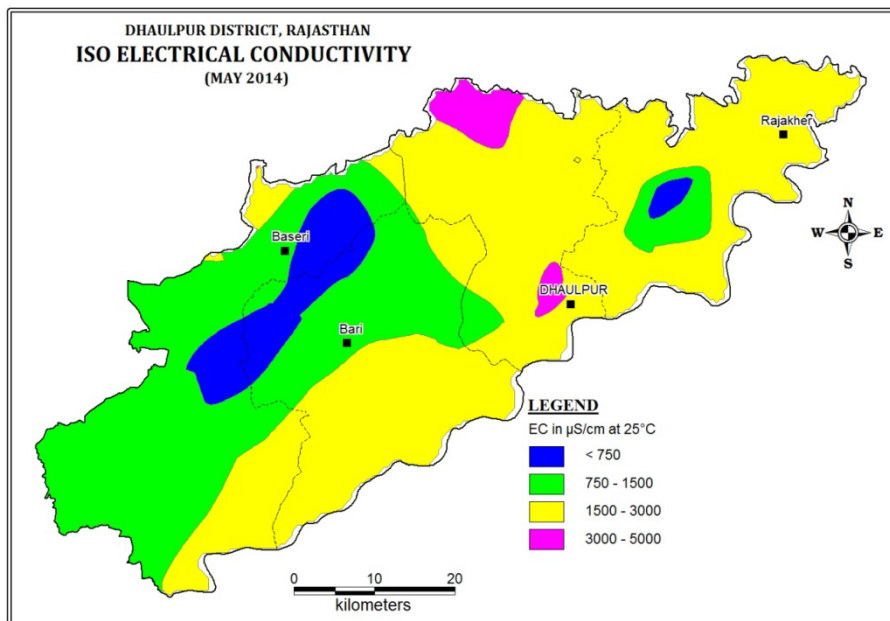
**Table 8: Chemical constituents in ground water**

Chemical constituent	Range
pH	7.60-8.48
EC in $\mu\text{S}/\text{cm}$ at $25^\circ\text{C}$	150-3200
Bicarbonate $\text{HCO}_3$ in $\text{mg}/\text{l}$	207-927
Chloride in $\text{mg}/\text{l}$	43-426
Nitrate $\text{NO}_3$ in $\text{mg}/\text{l}$	5.1-202.5
Fluoride in $\text{mg}/\text{l}$	0.35-2.93

In general, quality is good for drinking, irrigation and industrial use in the shallow water. The deeper aquifer also shows that quality is good except at localized places and there is little change in the quality of ground water with depth.

#### *Electrical Conductivity*

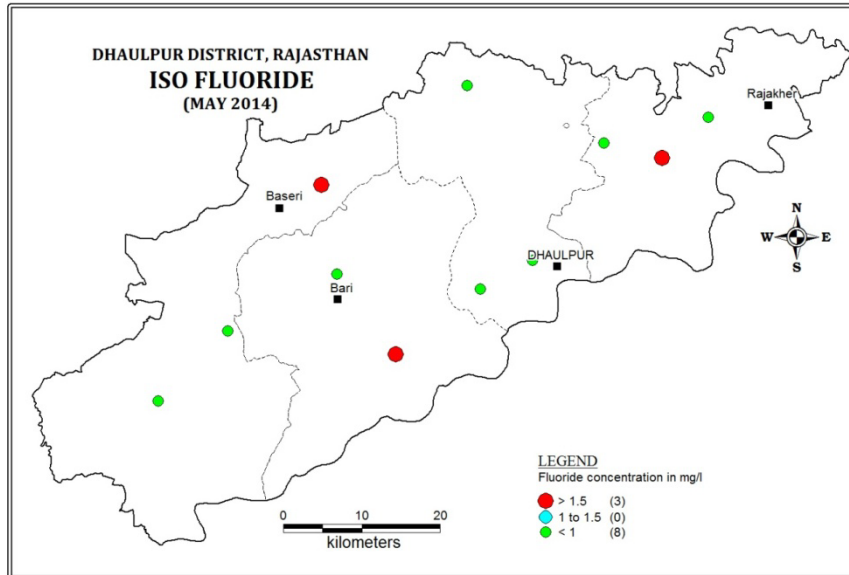
The electrical conductivity (EC) of ground water in the district varies from 150-3220  $\mu\text{S}/\text{cm}$  at  $25^\circ\text{C}$ . Quality of ground water is generally fresh with EC below 3000  $\mu\text{S}/\text{cm}$  at  $25^\circ\text{C}$  in major parts of the district (Figure 11). EC above 3000  $\mu\text{S}/\text{cm}$  at  $25^\circ\text{C}$  has been observed in some localised pockets in Dholpur block.



**Figure 11: Iso Electrical Conductivity Map (May, 2014)**

*Fluoride*

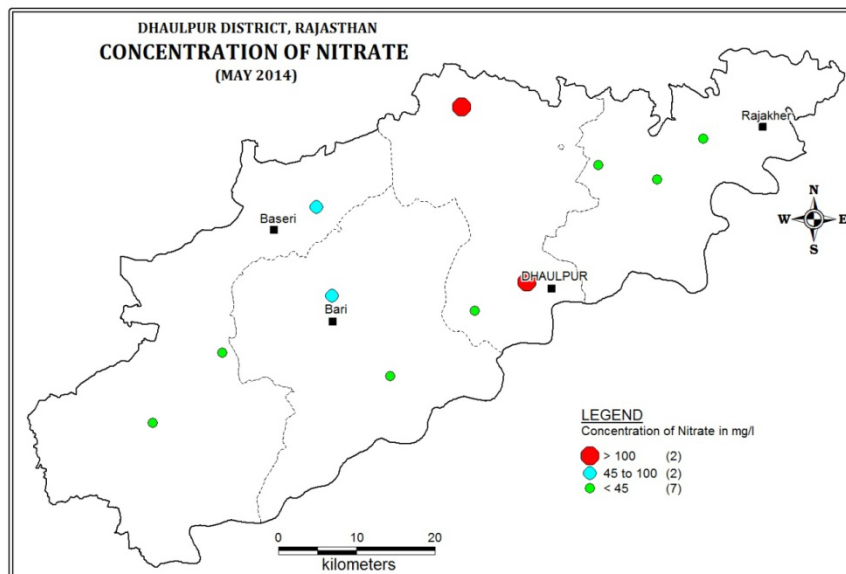
Fluoride concentration in ground water has been found to vary from 0.33 to 2.93 mg/l. Fluoride above its permissible limit of 1.5 mg/l has been observed in Bari, Baseri and Rajakhera Blocks (Figure 12).



**Figure 12: Fluoride Map (May, 2014)**

*Nitrate*

Nitrate concentration in ground water varies from 5.1 to 202.5 mg/l. Nitrate concentration in excess of maximum permissible limit of 45 mg/l prescribed by BIS in drinking water has been reported from Bar, Baseri and Dholpur Blocks (Figure 13). In rest of the blocks, nitrate content in ground water is well within the maximum permissible limit.



**Figure 13: Nitrate Distribution Map (May, 2014)**

## 4. Ground Water Resources

Central Ground Water Board and Rajasthan State Ground Water Department have jointly estimated the ground water resources of Dholpur district as on 31.03.2013 based on GEC-97 methodology (Table 9). Ground Water Resource estimation was carried out for 2486.14 sq.km. area, out of which 51.5% area comprises of older alluvium as aquifer and in the remaining area, sandstone forms the potential aquifer. The potential zone of command area in the district is around 81.11 sq km covering about 36.44 sq km area under dams and bundhs. The area in command is well connected by about 95.99 km length of main and about 67.48 km length of minor canals. The rest of the area falls under non-command area.

**Table 9: Block wise ground water resources (As on 31.03.2013)**

Block	Total Annual Ground Water Recharge	Natural Discharge During Non-Monsoon Season	Net Annual Ground Water Availability	Existing Gross Ground Water Draft For All Uses	Allocation For Dom. & Ind. Requirement	Net G.W. Availability For Future Irrigation Dev.	Stage Of G.W. Development	Category Of Block
Bari	74.4954	5.1386	69.3568	63.4091	8.3457	6.8405	91.42	Semi critical
Baseri	82.4505	5.5754	76.8751	73.1102	7.7803	10.6754	95.1	Semi critical
Dholpur	77.5335	6.9686	70.5649	126.0141	13.4111	0	178.58	Over Exploited
Rajakhera	65.0262	6.5026	58.5236	76.1335	6.24	0	130.09	Over Exploited
Total	299.5056	24.1852	275.3204	338.6669	35.7771	17.5159	123.01	Over Exploited

The total annually replenishable resource of the district has been assessed to be 299.505 MCM and net annual ground water availability has been estimated to be 275.3204 MCM. The Gross annual ground water draft for all uses has been estimated to be 338.6669 MCM. The overall stage of ground water development in the district is 123.01%. Out of total 4 Blocks, 2 fall under Overexploited category and 2 under Semi critical category. The block wise details of replenishable ground water resource assessment in the district are given in Table 10.

## 5. Ground Water Related Issues

Out of total 4 blocks, 2 blocks in the district are over-exploited, where stage of ground water development has exceeded 100%, leaving no further scope for ground water development. These blocks require judicious development of ground water. Quality of ground water is generally potable, except for a few pockets, where high Electrical Conductivity, Nitrate and Iron have been reported.

## 6. Management Strategy

Out of total 4 blocks, 2 no. of blocks of this district are over exploited, thereby, leaving limited scope of further ground water development for various consumptions and area is devoid of sustained surface water bodies. In order to manage the ground water resources and to control further decline in water levels, a management plan has been proposed. In order to manage the ground water resources and to control further decline in water levels, a management plan has been proposed. The management plan comprises two components- supply side management and demand side management. Since there is very little surplus surface water available in this district, very little intervention in the form of supply side management could be proposed.

### 6.1 Supply Side Management

The supply side management of ground water resources can be done through the artificial recharge of surplus runoff available within river sub basins and micro watersheds. Also it is necessary to understand the unsaturated aquifer volume available for recharge. The unsaturated volume of aquifer for the Dholpur district is computed based on following; the area feasible for recharge, unsaturated depth below 5 m bgl and the specific yield of the aquifer.

#### 6.1.1 Artificial recharge to ground water through interventions of various structures

The following parameters are inevitable for planning of artificial recharge to ground water.

- Availability of sufficient storage space to accommodate recharged water
- Availability of surplus water to recharge
- Feasibility of sub-surface geological formations

In case of Dholpur district, sufficient sub-surface storage space is available to accommodate the recharged water. Details of feasible recharge structures to recharge the surplus water in respective block are given in Table 10.

**Table 10: Block-wise details of feasible recharge structures**

Block	Usable Surplus Water (MCM)	Recharge Shafts proposed	Percolation Tanks Proposed	Recharge from Recharge Shaft (MCM)	Recharge from Percolation Tanks (MCM)	Total Recharge (MCM)	Effective Recharge (MCM)
Bari	44.16	76	66	2.28	13.20	15.48	12.38
Baseri	30.32	72	38	2.16	7.60	9.76	7.81
Dhaulpur	29.52	53	22	1.59	4.40	5.99	4.79
Rajakhera	49.66	41	45	1.23	9.00	10.23	8.18

It can be observed that 33.168 MCM of effective recharge is possible through Supply side Management.

## 6.2 Demand Side Management

Though not much augmentation can be done through supply side management due to less availability of surplus water, applying the techniques of demand side management can save large amount of water. Demand side management has been proposed through two interventions – changing the more water intensive wheat crop to gram (chick pea) and use of sprinkler irrigation in the areas where rabi crop is being irrigated through ground water.

### 6.2.1 Change in cropping pattern

In view of the alarming decline of water level, drastic reduction in saturated thickness of aquifer and resulting of depletion of aquifer, there is need to bring paradigm change/shift in cropping pattern in the area. It is proposed to grow low water requirement crop like gram in the instead of wheat. Growing of gram will save the water to the tune of about 100 mcm per annum @ 0.1m (Table 11).

### 6.2.2 Adoption of modern practice of sprinkler irrigation/improved irrigation practices

Data indicate that flooding method of irrigation is still in practice in many parts of the district which causes wastage of ample quantity of water. In view of this, it is proposed to bring about 50% of total irrigated area under sprinkler irrigation which may save water to the tune of about 64.67mcm/annum @0.08m (Table 11).

**Table 11: Block-wise water saving through change in cropping pattern and irrigation practice**

Block	Irrigated Area (ha)	Irrigated Area proposed for irrigation through sprinkler (ha)	Water Saving by sprinkler in MCM (@0.08 m)	Irrigated Area (ha)	Irrigated Area under wheat proposed for Gram cultivation (ha)	Water Saving by change in cropping pattern in MCM @0.1 m	Total Water saving in MCM
Bari	18325	9163	7.33	18325	4348	4.35	11.68
Baseri	20180	10090	8.07	20180	5069	5.07	13.14
Dholpur	29107	14554	11.64	29107	6072	6.07	17.71
Rajakhera	34758	17379	13.9	34758	8077	8.08	21.98

Considerable saving of ground water can be achieved if the proposed supply side and demand side management plans are implemented. With the implementation of supply side management, additional 33.168 MCM/year can be recharged. It can be seen that not much augmentation in ground water resources can be achieved through artificial recharge due to constraints of availability of surplus/non-committed surface water. However, considerable improvement in ground water situation can be achieved with implementation of demand side management plans.



With the proposed use of sprinkler irrigation in the areas where rabi crop is being irrigated through ground water it is expected that 40.94 MCM/year can be saved due to reduction in pumping. The water saving under change in cropping pattern is expected to be 23.57 MCM/year. Therefore, total water saving through demand side management is 64.51 MCM/year. Block wise details of ground water recharged and saved along with expected improvement in stage of ground water development is given in Table 12.

**Table 12: Summary of expected benefit of management strategies, Dholpur district**

Block	Net Annual Ground Water Availability	Additional recharge from RWH & conservation (mcm)	Total net GW availability after intervention (mcm)	Existing Gross Ground Water Draft for all uses	Saving of GW through projects (mcm)	Net GW draft after interventions (mcm)	Present stage of GW development (%)	Projected stage of GW development (%)
Bari	69.3568	12.38	81.7368	63.4091	11.68	51.7291	91.42	63.29
Baseri	76.8751	7.81	84.6851	73.1102	13.14	59.9702	95.1	70.82
Dholpur	70.5649	4.79	75.3549	126.0141	17.71	108.3041	178.58	143.73
Rajakhera	58.5236	8.18	66.7036	76.1335	21.98	54.1535	130.09	81.19
Total	275.3204	33.16	308.4804	338.6669	64.51	274.1569	123.01	88.87

## Part B

### Block wise Aquifer Maps and Management Plans

Name Of The Block	BASERI	BARI	DHOLPUR	RAJAKHERA
Geographical Area (Km2 )	816.24	1001.42	609.32	582.07
Rainfall (1971-2014)	435.8289474	616.478947	531.186842	690.013158
Groundwater Resource Availability And Extraction				
Net G.W. Availability (Mcm)	69.3568	76.8751	70.5649	58.5236
Irrigation Draft	55.508382	66.546	118.1673	69.3
Existing Water Demand	7.90079	6.56416	7.84677	6.83353
Future Water Demad For Domestic & Industries	6.8405	10.6754	0	0
Water Level Behaviour, DTW (M)	13.03	12.2	11.6	11.39
Trend (M/Yr)	25	0.5	0.64	0.56
<b>Aquifer Disposition</b>				
Geology	Ao/Sc	Ao/Sc	Ao/Sc	Ao
Depth Of Occurrence	80	80	85	60
Type Of Aquifer	Unc	Unc	Unc	Unc
Thickness Of Aquifer (Utilisable)	5.2	5.13	6.75	4.29
Hydraulic Characters (Sp.Yield%)	0.006	0.006	0.006	0.0100
<b>Groundwater Resource Extraction, Contamination And Other Issues</b>				
Aquifer Wise Resource Availability And Extraction	33.5979	31.8262	23.6474	49.0335

<b>Name Of The Block</b>	<b>BASERI</b>	<b>BARI</b>	<b>DHOLPUR</b>	<b>RAJAKHERA</b>
Whether Significant Decline Pre Monsoon/ Post Monsoon	Yes	Yes	Yes	Yes
Categorisation	Semi Critical	Semi Critical	Over Explo.	Over Explo.
Chemical Quality Of Groundwater In General	Fresh	Fresh	Fresh	Fresh
Other Issues	Inadequate Space For Groundwater	Inadequate Space For Groundwater	Inadequate Space For Groundwater	Inadequate Space For Groundwater
<b>Groundwater Resource Enhancements</b>				
Aquifer Wise Space Available For Recharge And Proposed Interventions	150.352	33.195	17.004	25.846
Other Interventions Proposed, If Any				
Surplus Available In The Zone (In Mm3)	0		0.10701256	1.2458
Surplus Available Ins Zone As Per The Water Level (In Mm3)	0		0.107	1.2458
No. Of RS 0.03 MCM/RS	0		0.10701256	0.872727
No Of RS Possible In Block (As Per Water Bodies)	0	0	3	29
<b>Demand Side Interventions</b>				
Advanced Irrigation Practices				
Irrigated Area (Ha) Proposed For Irrigation Through Sprinkler	10090	9162.5	14553.5	17379
Change In Cropping Pattern				
Irrigated Area Under Wheat (Ha)	20180	18325	29107	34758
Irrigated Area (Ha) Under Wheat Proposed For Gram Cultivation	5069	4348	6072	8077
Alternate Water Sources	NA	NA	NA	NA

<b>Name Of The Block</b>	<b>BASERI</b>	<b>BARI</b>	<b>DHOLPUR</b>	<b>RAJAKHERA</b>
Regulation And Control	To Be Notified	To Be Notified	To Be Notified	To Be Notified
Other Interventions Proposed, If Any				
Surplus Available In The Zone (In Mm3)	0		0.10701256	1.2458
Surplus Available Ins Zone As Per The Water Level (In Mm3)	0		0.107	1.2458
No. Of RS 0.03 MCM/RS	0		0.10701256	0.872727
No Of RS Possible In Block (As Per Water Bodies)	0	0	3	29
Net G.W. Availability (Mcm)	74.6204	45.1397	41.0252	52.4579
Additional Recharge From RWH & Conservation (Mcm)	0.00	0.00	0.07	0.87
Total Net G.W. Availability After Intervention (Mcm)	74.62	45.14	41.10	53.33
Existing G.W Draft For All Purpose (Mcm)	194.56	77.41	100.29	88.38
Saving Of Ground Water Through Projects (Mcm)	13.5446	12.0445	18.29694	22.67536
Net GW Draft After Interventions (Mcm)	181.0144	65.3701	81.99516	65.70894
Present Stage Of G.W. Development (%)	91.42	95.1	178.58	130.09
Projected Stage Of G.W. Dev. (In %)	63.29	70.89	143.73	81.19
Irrigated Area Under Wheat (Ha)	20180	18325	29107	34758
Irrigated Area (Ha) Under Wheat Proposed For Gram Cultivation	5069	4348	6072	8077
Water Saving By Change In Cropping Pattern In Mcm @0.1 M	5.07	4.35	6.07	8.08
Water Saving By Sprinkler In Mcm @0.08 M	8.072	7.33	11.6428	13.9032
Water Saving By Land Levelling In Mcm @0.02 M	0.4036	0.3665	0.58214	0.69516

