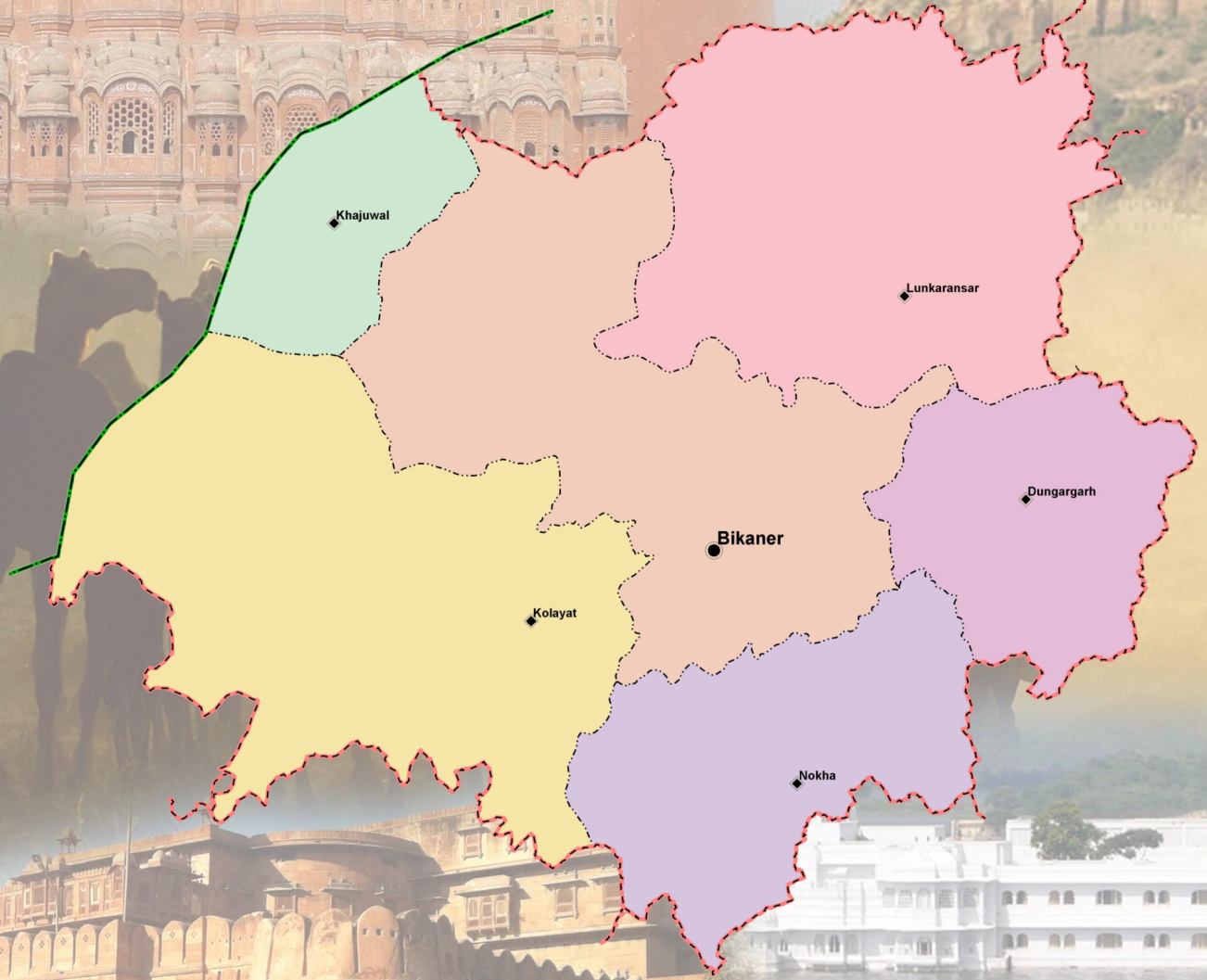
Ground Water Department,
Rajasthan

Hydrogeological Atlas of Rajasthan
Bikaner District

European Union
State Partnership Programme



2013

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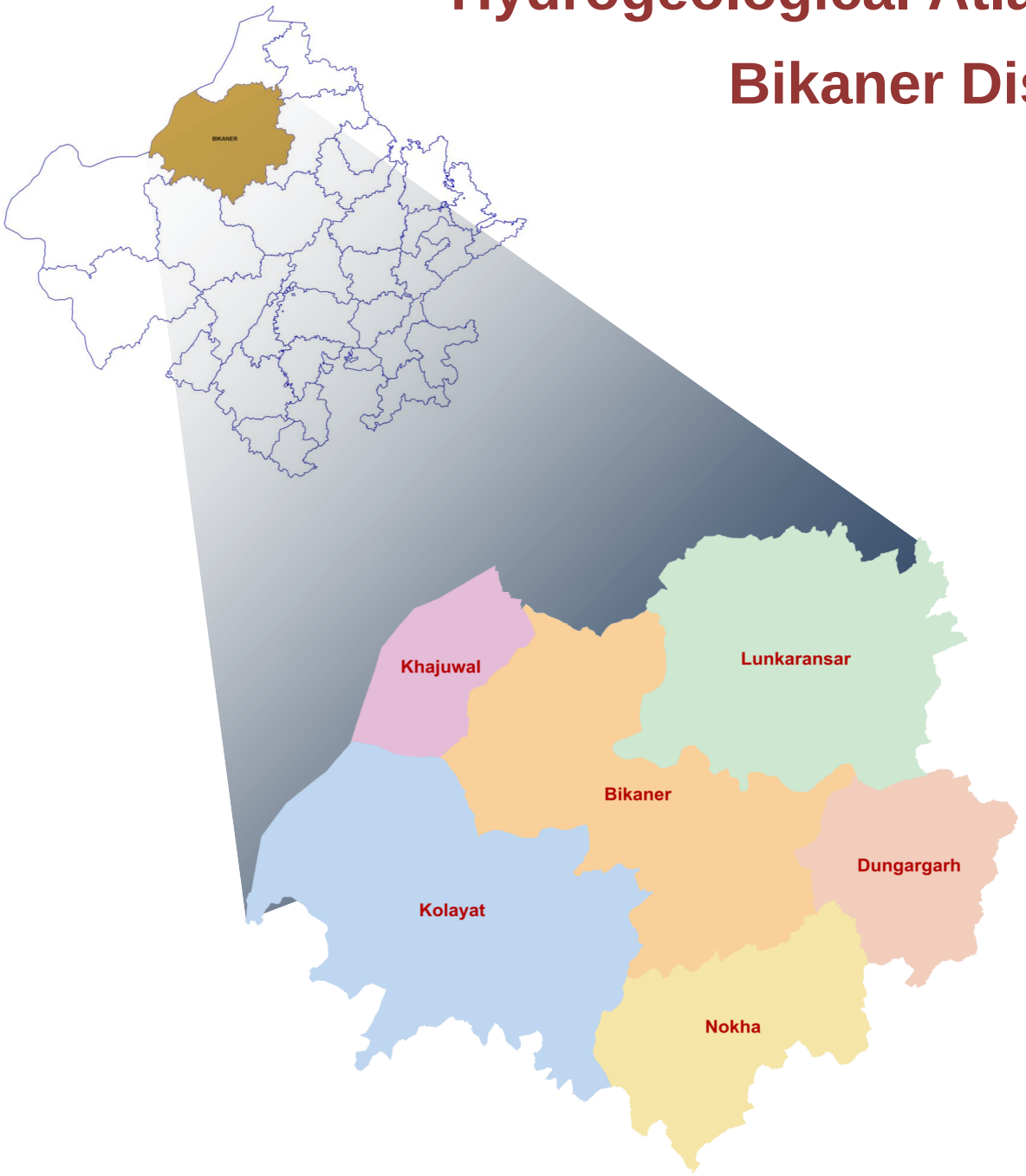
Hydrogeological Atlas of Rajasthan

Bikaner District



Contents:

2013

ADMINISTRATIVE SETUP

DISTRICT – BIKANER

Location:

Bikaner is located in the northwestern part of Rajasthan. It is bounded in the North by Ganganagar district, in the East by Hanumangarh, Churu and Nagaur districts, South by Jodhpur and Jaisalmer districts and Pakistan in the West. It stretches between 27^{o} 09' 31.05" to 29^{o} 03' 14.17" North latitude and 71^{o} 50' 59.01'' to 74^{o} 21' 59.21'' East longitude covering an approximate area of 30,279 sq kms. Systematically developed drainage system is lacking, so the district is identified as part of an 'Outside' Basin.

Administrative Set-up:

Administratively Bikaner district is part of Jodhpur division. This district is divided into 6 blocks. The following table summarizes the basic statistics of the district at block level.

S. No.	Block Name	Population (Based on 2001 census)	Area (sq km)	% of District Area	Total Number of Towns and Villages
1	Bikaner	8,28,379	7,006.0	23.1	201
2	Dungargarh	2,27,839	2,963.1	9.8	98
3	Khajuwal	91,771	1,914.6	6.3	45
4	Kolayat	2,07,749	7,965.7	26.3	221
5	Lunkaransar	2,17,341	6,579.7	21.7	176
6	Nokha	3,29,031	3,850.1	12.7	138
Total		**19,02,110**	**30,279.2**	**100.0**	**879**

Bikaner district has 879 towns and villages. Of these there are 6 towns are also block headquarters. Total population of the district is 19,02,110.

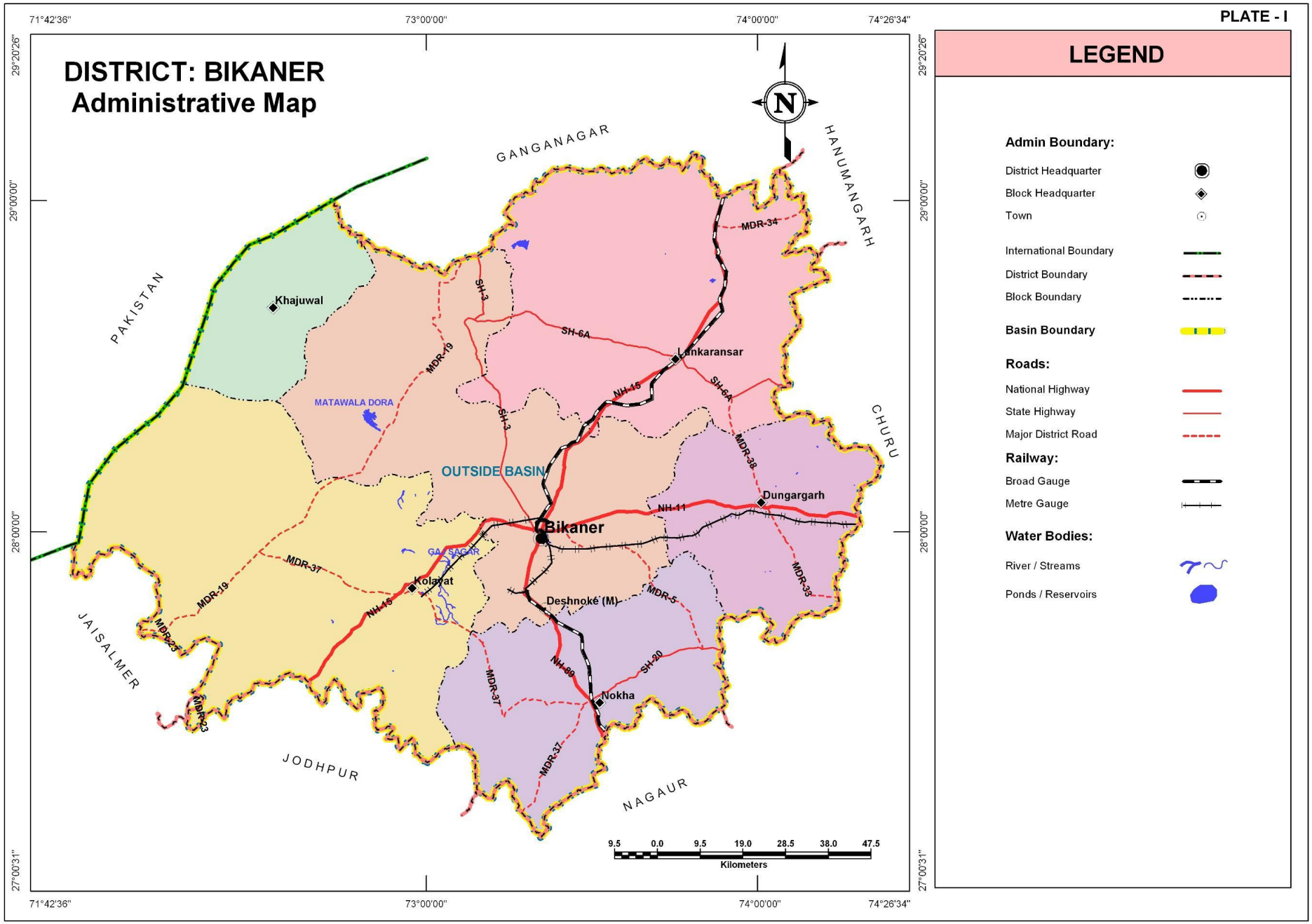
Climate:

The climate of the district is characterized by very high temperature, uncertain rainfall and dryness. The winter season which starts in November lasts till February, followed by summer lasting up to June. Period from July to mid-September is monsoon season. There is a large variation between maximum and minimum temperature within the district, while the average maximum temperature is about reaches up to 50^{o}C, the minimum is around 5^{o}C. The average total annual rainfall is approximately 455 mm.

Ground Water Department, Rajasthan

European Union
State Partnership Programme

PLATE - I



LEGEND

Admin Boundary:

- District Headquarter
- Block Headquarter
- Town
- International Boundary
- District Boundary
- Block Boundary

Basin Boundary

Roads:

- National Highway
- State Highway
- Major District Road

Railway:

- Broad Gauge
- Metre Gauge

Water Bodies:

- River / Streams
- Ponds / Reservoirs

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TOPOGRAPHY

DISTRICT – BIKANER

Bikaner district is conspicuous of vast sandy areas and lack of hills. The topography is undulating interspersed with dunes of eolian origin. The table below reveals that the minimum elevation in the district is 103.7m above mean sea level (amsl) as found in Kolayat block whereas the maximum elevation is 349.1 m amsl in Nokha block where rocks of Tertiary sandstone are exposed. General slope of the terrain is from southeast to northwest.

Table: Block wise minimum and maximum elevation

S. No.	Block Name	Minimum Elevation (m amsl)	Maximum Elevation (m amsl)
1	Bikaner	123.2	298.6
2	Dungargarh	200.2	347.3
3	Khajuwal	107.9	163.0
4	Kolayat	103.7	315.3
5	Lunkaransar	149.5	246.8
6	Nokha	261.6	349.1

RAINFALL

The rainfall is very limited and erratic. The general distribution of rainfall across can be visualized from isohyets presented in the Plate III where major part of the district has received average rainfall less than 500mm in the year 2010. Most of the rainfall, i.e., approximately 90% of the total annual rainfall or more, is received during monsoon period and non-monsoon rainfall is very limited or negligible. The annual average rainfall was 458.2 mm based on the data of available blocks while highest average annual rainfall is 595.4 mm in Dungargarh block. Lowest of minimum average annual rainfall was in Khajuwal block (288.0 mm). Lunkaransar block has received highest maximum annual rainfall of about 781.2 mm.

Table: Block wise annual rainfall statistics (derived from year 2010 meteorological station data)

Block Name	Minimum Annual Rainfall (mm)	Maximum Annual Rainfall (mm)	Average Annual Rainfall (mm)
Bikaner	325.4	707.2	435.6
Dungargarh	499.0	688.6	595.4
Khajuwal	288.0	345.3	315.7
Kolayat	310.9	416.5	369.4
Lunkaransar	385.1	781.2	592.4
Nokha	400.0	538.9	440.9

PLATE - II

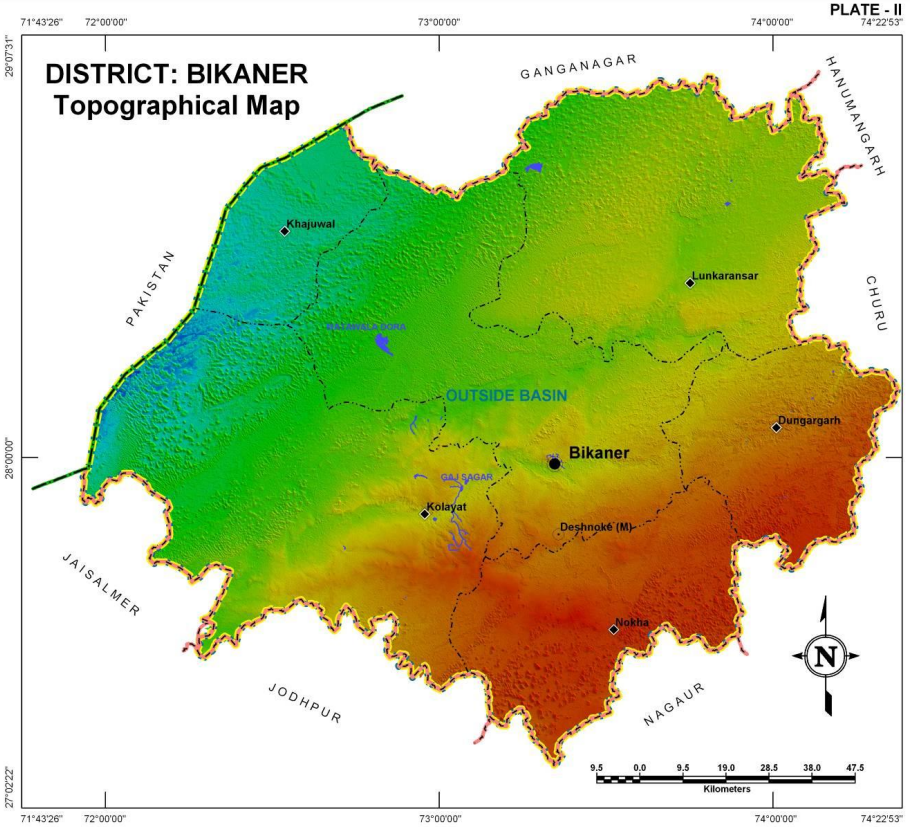
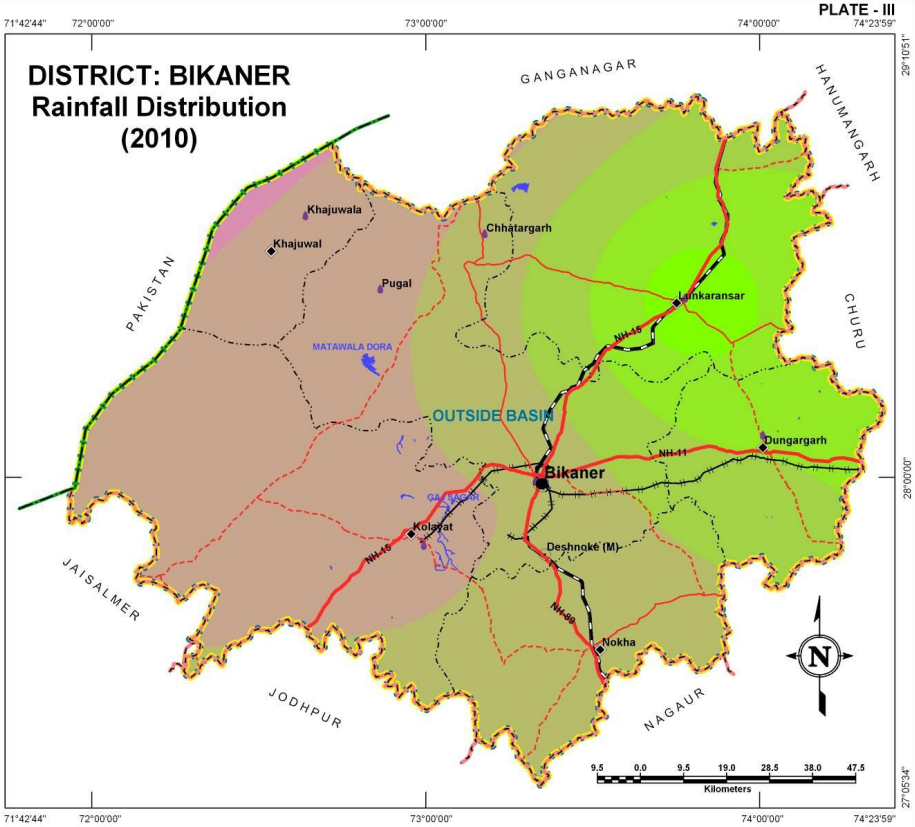


PLATE - III



LEGEND

Admin Boundary:
- District Headquarter
- Block Headquarter
- Town
- International Boundary
- District Boundary
- Block Boundary

Basin Boundary

Water Bodies:
- River / Streams
- Ponds / Reservoirs

Elevation (m amsl):

349
300
250
200
150
104

Source : SRTM DEM

LEGEND

Admin Boundary:
- District Headquarter
- Block Headquarter
- Town
- Raingauge Stations
- International Boundary
- District Boundary
- Block Boundary

Basin Boundary

Roads:
- National Highway
- State Highway
- Major District Road

Railway:
- Broad Gauge
- Metre Gauge

Water Bodies:
- River / Streams
- Ponds / Reservoirs

Isohyets (mm):
- 200-300
- 300-400
- 400-500
- 500-600
- 600-700
- 700-800

GEOLOGY

DISTRICT – BIKANER

The Bikaner district is predominantly covered (about 80%) by alluvial and eolian sand. Most of the eolian sand is seen as sand dunes of variable heights. Otherwise, the geologic succession of the area is represented by rocks of Palaeosoic to Recent age. The next group of formations (after eolian and alluvial sand) is that of Tertiary Group of rocks represented by Sandstones of variable grain size. These are also exposed in Bikaner- Kolayat region. Marwar Super Group represented by Nagaur Sandstones and Bilara limestone occupies southeastern part of the district.

Table: Geologic succession

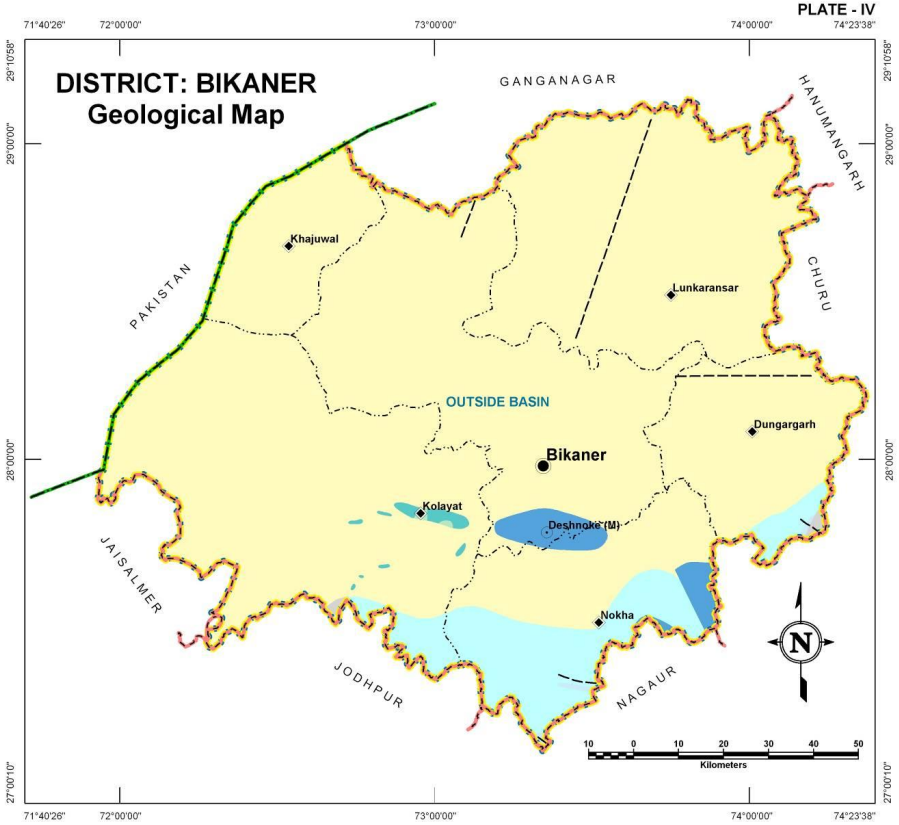
Group	Series/Super Group	Geological Unit	Formation
Quaternary	Recent	Wind-blown Sand	Very fine, buff to grey sand, well rounded to sorted by wind action
	Pleistocene	Alluvium	Unconsolidated to loosely consolidated sand, find to medium, silty clays and kankar with occasional horizons of gravel and coarse sand.
Tertiary	Eocene	Sandstone	Coarse and gritty sandstone usually consolidated, porous, within intercalated clays and gravel, fuller's earth (Bentonite) and Lignite also occur in thin sequences.
Palaeozoic	Marwar Super Group	Nagaur Sandstone	Hard compactly consolidated, reddish sandstone Interbedded with red shales.
		Bilara Limestone	Limestone, hard, massive grey to blackish in colour with occasional cavities.

GEOMORPHOLOGY

Table: Geomorphologic units, their description and distribution

Origin	Landform Unit	Description of Lithology
Aeolian	Dune Complex	An undulating plain composed of number of sand dunes of crescent shape.
	Dune Valley Complex	Cluster of dunes and interdunal spaces with undulating topography formed due to wind-blown activity, comprising of unconsolidated sand and silt.
	Eolian Plain	Formed by aeolian activity, with sand dunes of varying height, size, slope. Long stretches of sand sheet. Gently sloping flat to undulating plain, comprised of fine to medium grained sand and silt. Also scattered xerophytic vegetation.
	Eolian Plain (Reclaimed)	Gently sloping with sheet of sand or sand dunes, scattered xerophytic vegetation.
	Interdunal Depression	Slightly depressed area in between the dunal complex showing moisture and fine sediments.
	Interdunal Flat	Flat, narrow land between dunes.
	Sandy Plain	Formed of aeolian activity, wind-blown sand with gentle sloping to undulating plain, comprising of coarse sand, fine sand, silt and clay.
Denudational	Buried Pediment	Pediment covers essentially with relatively thicker alluvial, colluvial or weathered materials.
	Pediment	Broad gently sloping rock flooring, erosional surface of low relief between hill and plain, comprised of varied lithology, criss-crossed by fractures and faults.
	Pediplain	Coalescence and extensive occurrence of pediment.
Fluvial	Alluvial Plain (Sandy)	Flat to gentle undulating plain formed due to fluvial activity, mainly consists of gravels, sand, silt and clay with unconsolidated material of varying lithology, predominantly sand along river.
Hills	Structural Hills	Linear to arcuate hills showing definite trend-lines with varying lithology associated with folding, faulting etc.

PLATE - IV



LEGEND

Admin Boundary:
- District Headquarter
- Block Headquarter
- Town
- International Boundary
- District Boundary
- Block Boundary

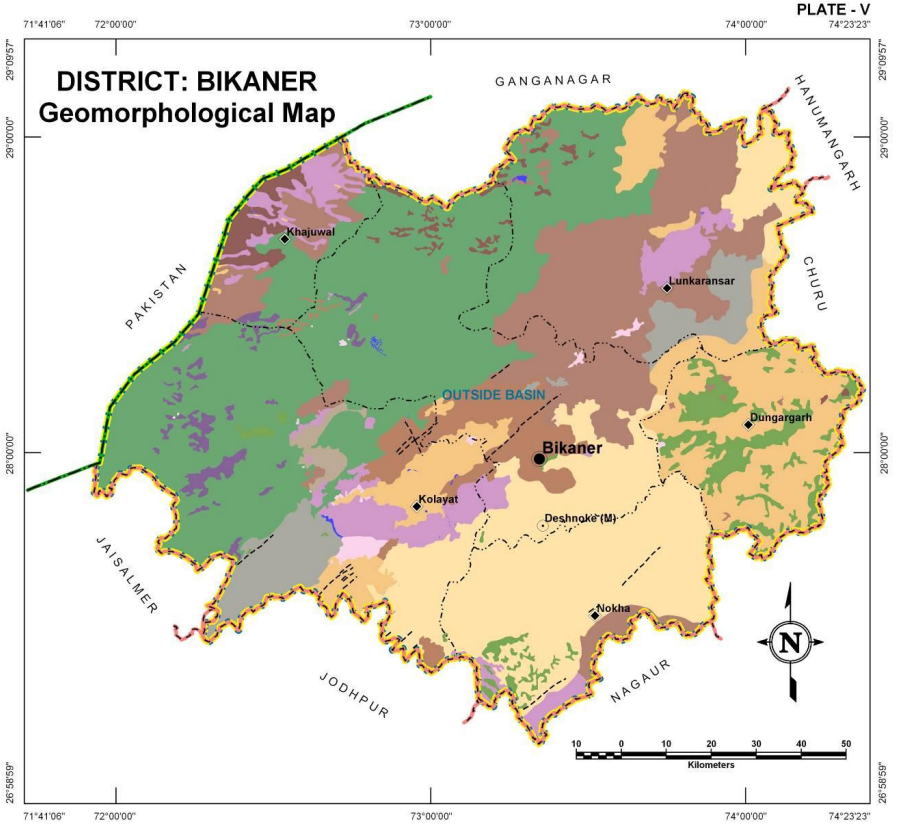
Basin Boundary

Structural Features:
- Fault

Geology:
- Alluvium and Wind blown sand
- Jogira Formation
- Marh Formation
- Palana Formation
- Bap Boulder Bed
- Nagaur Group
- Bilara Group
- Jodhpur Group

Source: District Resource Map of Rajasthan - GSI

PLATE - V



LEGEND

Admin Boundary:
- District Headquarter
- Block Headquarter
- Town
- International Boundary
- District Boundary
- Block Boundary

Basin Boundary

Water Bodies:
- River/Ponds/Reservoirs

Structural Features:
- Fault/Fractures/Lineament

Landform Units:

Fluvial Origin:
- Alluvial Plain (Sandy)

Denudational Origin:
- Pediment
- Buried Pediplain
- Buried Pediment
- Pediplain

Aeolian Origin:
- Sandy Plain
- Eolian Plain
- Eolian Plain (Reclaimed)
- Dune Complex
- Interdunal Depression
- Interdunal Flat
- Dune Valley Complex

Source: Ground Water Atlas of Rajasthan - SRSAC & GWD, Rajasthan

AQUIFERS

DISTRICT – BIKANER

Variety of rock-types constitute aquifers in Bikaner district. While Older alluvium forms most widespread aquifer material but most of it contains saline water rendering it not very useful and only about 8% of the district's aquifers contain fresh water in alluvial aquifers. Tertiary sandstones are also very good aquifers both in spatial distribution as well as in ground water quality within them because it occupies about 31% of the district area of which about 24% is fresh water aquifer. Also important are Nagaur and Jodhpur sandstone and partly the Bilara limestone.

Table: Block wise area of aquifer potential zones and their description

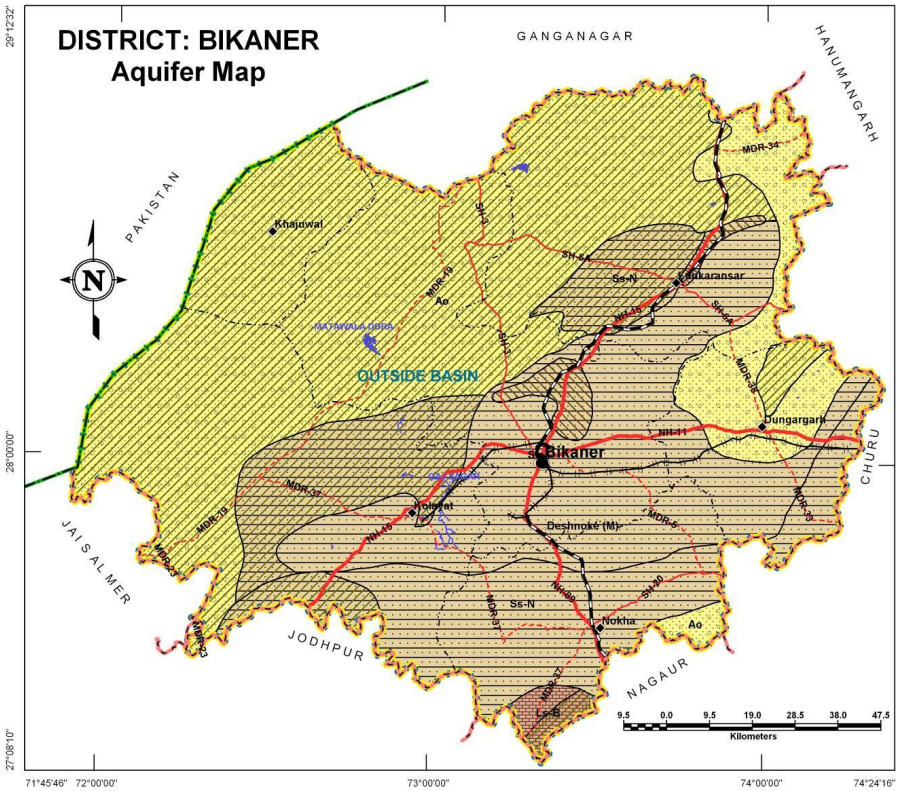
Aquifer in Potential Zone	Area (sq km)	%age of district	Description of the unit/Occurrence
Older Alluvium	2,353.6	7.8	Older Alluvium mainly composed of unconsolidated to semi consolidated clay, sand gravel, pebble in varying proportions. Thickness of the litho unit varies considerably due to undulating bed rock topography. It occurs along the stream courses and flood plains of rivers. While older alluvium occupies large tracts in west, north and eastern parts, major part of it is saline and only narrow tracts in eastern fringe contains fresh water constituting potential zone.
Older Alluvium Saline Areas	13,067.8	43.2	Except for the Nokha block, alluvium found in rest of the blocks is either partially or whole of it contains non-potable ground water categorized as non-potential area (Saline area).
Bilara Limestone	156.1	0.5	The Bilara limestone is potential source of ground water. These are mostly dolomitic, grey or dark grey to black. The litho unit occupies small area in southern most part of Nokha block. Half of it contains freshwater and the rest is Saline.
Bilara Limestone Saline Areas	161.7	0.5	It is grey to buff coloured hard and compact in southern most part of Nokha block.
Tertiary Sandstone	7,209.3	23.8	Medium to coarse grained, consolidated to semi consolidated sandstone occupy area in Bikaner – Kolayat region.
Tertiary Sandstone Saline Areas	2,132.4	7.0	Part of the tertiary sandstone contains saline ground water
Nagaur & Jodhpur Sandstone	3,788.7	12.5	The major aquifer in the district is formed in Sandstone; it belongs to Marwar Super Group. The Sandstone of this Group forms the chief source of ground water which occurs under confined to semi-confined conditions. Sandstone is red to pink or buff coloured, very hard and compact. It occupies blocks in order of area encompassed by the aquifer in potential area.
Nagaur & Jodhpur Sandstone Saline Areas	1,409.6	4.7	The saline ground water containing parts of Nagaur and Jodhpur sandstones fall in this catergory
Total	**30,279.2**	**100.0**	

STAGE OF GROUND WATER DEVELOPMENT

Categorization on the basis of stage of development of ground water	Block Name
Safe	Kolayat, Lunkaransar
Over Exploited	Nokha, Dungargarh, Khajuwal, Bikaner

Basis for categorization: Ground water development <= 70% - Safe and >100% - Over-Exploited.

PLATE - VI



LEGEND

Admin Boundary:
- District Headquarter
- Block Headquarter
- Town
- International Boundary
- District Boundary
- Block Boundary
- **Basin Boundary**

Roads:
- National Highway
- State Highway
- Major District Road

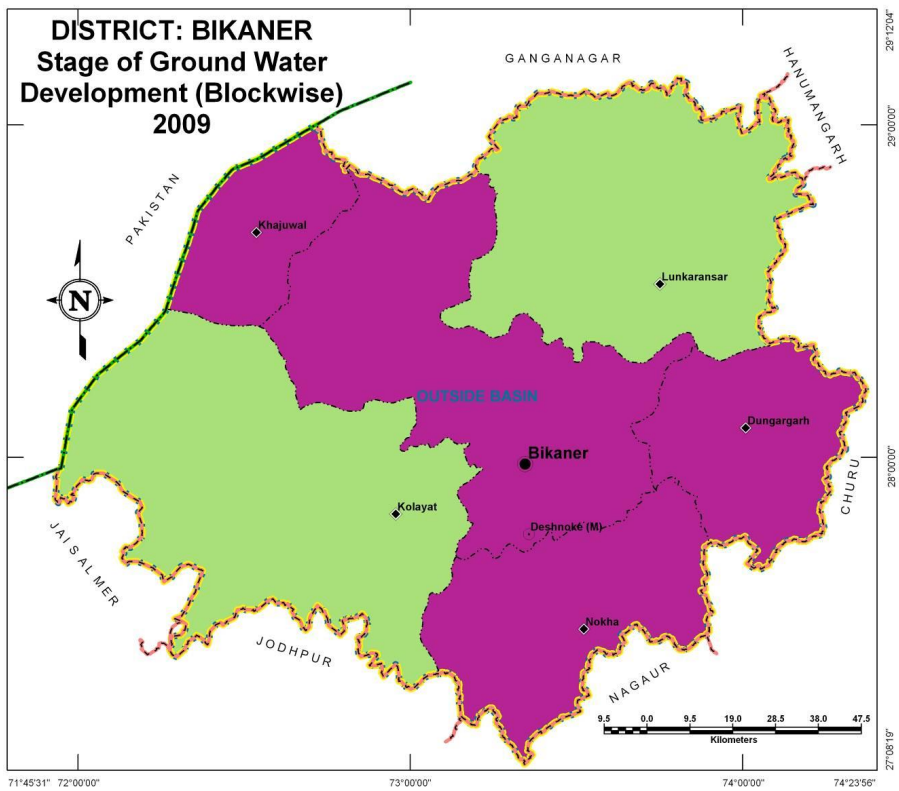
Railway:
- Broad Gauge
- Metre Gauge

Water Bodies:
- River / Streams
- Ponds / Reservoirs
- **Saline Area**
- **Command Area**

Aquifer:
- Older Alluvium
- Bilara Limestone
- Tertiary Sandstone
- Nagaur & Jodhpur Sandstone

Source: Ground Water Potential Zone Map - GWD, Rajasthan

PLATE - VII



LEGEND

Admin Boundary:
- District Headquarter
- Block Headquarter
- Town
- International Boundary
- District Boundary
- Block Boundary
- **Basin Boundary**

***Stage of Ground water Development:**
- Safe
- Over-Exploited

Source: Ground Water Department, Rajasthan

LOCATION OF EXPLORATORY AND GROUND WATER MONITORING WELLS DISTRICT – BIKANER

Bikaner district has a well distributed network of exploratory wells (194) and ground water monitoring stations (444) in the district owned by RGWD (145 and 338 respectively) and CGWB (49 and 106 respectively). The exploratory wells have formed the basis for delineation of subsurface aquifer distribution scenario in three dimensions. Benchmarking and optimization studies suggest that ground water level monitoring network is sufficiently distributed for appropriate monitoring but for water quality 148 additional wells in different blocks are recommended to be added to existing network for optimum monitoring of the aquifers.

Table: Block wise count of wells (existing and recommended)

Block Name	Exploratory Wells			Ground Water Monitoring Stations			Recommended additional wells for optimization of monitoring network	
	CGWB	RGWD	Total	CGWB	RGWD	Total	Water Level	Water Quality
Bikaner	13	38	**51**	34	89	**123**	0	37
Dungargarh	8	41	**49**	15	64	**79**	0	56
Khajuwal	1	-	**1**	3	3	**6**	0	0
Kolayat	7	24	**31**	21	57	**78**	0	4
Lunkaransar	10	17	**27**	24	55	**79**	0	39
Nokha	10	25	**35**	9	70	**79**	0	12
Total	**49**	**145**	**194**	**106**	**338**	**444**	**0**	**148**

DEPTH TO WATER LEVEL (PRE MONSOON – 2010)

Depth to water level shows variation from less than 10m below ground level to about 120m below ground level. The alluvial aquifers in the west have shown a general shallower ground water occurrence i.e., upto 30m of depth from ground level whereas the hardrock areas in the south eastern parts within Sandstone aquifers have shown very deep water levels reaching upto 120m below ground level.

Block Name	Block wise area coverage (sq km) within depth water level range (m bgl) *													Total Area (sq km)
	< 10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-110	110-120	> 120	
Bikaner	-	773.2	1,613.1	367.9	1,762.6	616.9	509.6	372.7	408.6	360.1	178.1	43.2	-	**7,006.0**
Dungargarh	-	-	-	44.5	280.5	592.1	583.0	532.1	416.9	176.6	148.0	142.7	46.8	**2,963.2**
Khajuwal	-	306.4	1,608.2	-	-	-	-	-	-	-	-	-	-	**1,914.6**
Kolayat	-	1,491.2	2,255.0	-	1,178.9	563.8	757.9	566.6	490.7	438.1	185.0	38.4	-	**7,965.6**
Lunkaransar	216.5	628.6	807.9	177.2	2,678.3	1,459.3	593.8	18.1	-	-	-	-	-	**6,579.7**
Nokha	-	0.7	11.1	58.0	81.8	151.9	204.3	482.1	646.0	970.0	911.4	332.8	-	**3,850.1**
Total	**216.5**	**3,200.1**	**6,295.3**	**647.6**	**5,982.1**	**3,384.0**	**2,648.6**	**1,971.6**	**1,962.2**	**1,944.8**	**1,422.5**	**557.1**	**46.8**	**30,279.2**

* The area covered in the derived maps is less than the total district area since the hills have been excluded from interpolation/contouring.

PLATE - VIII

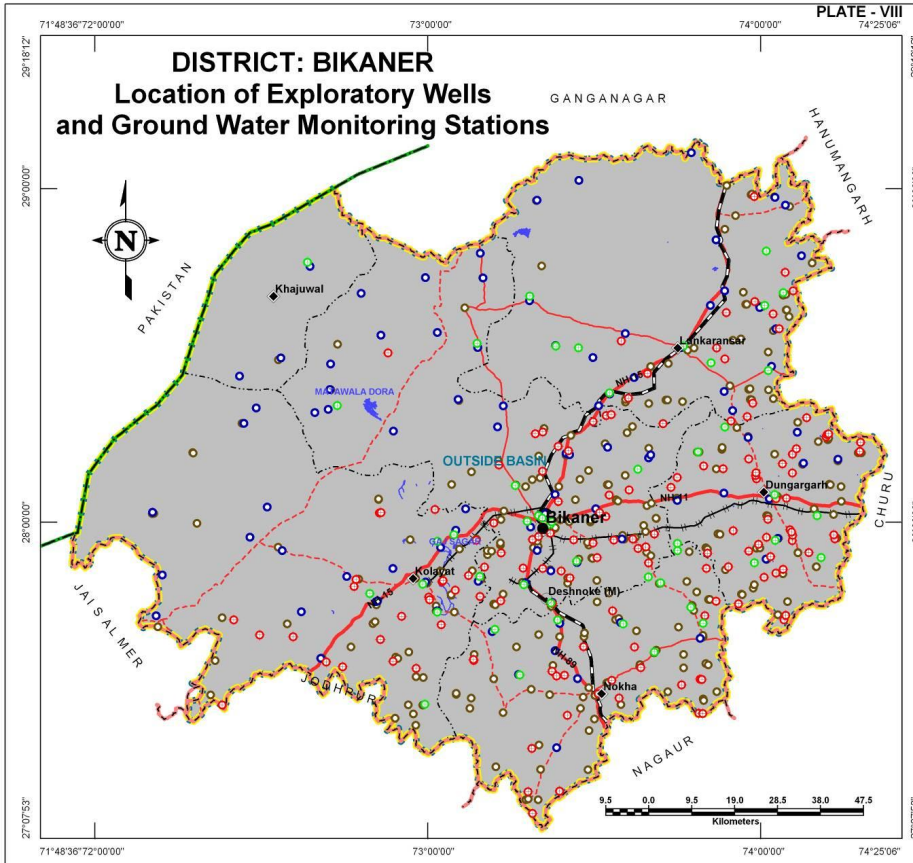
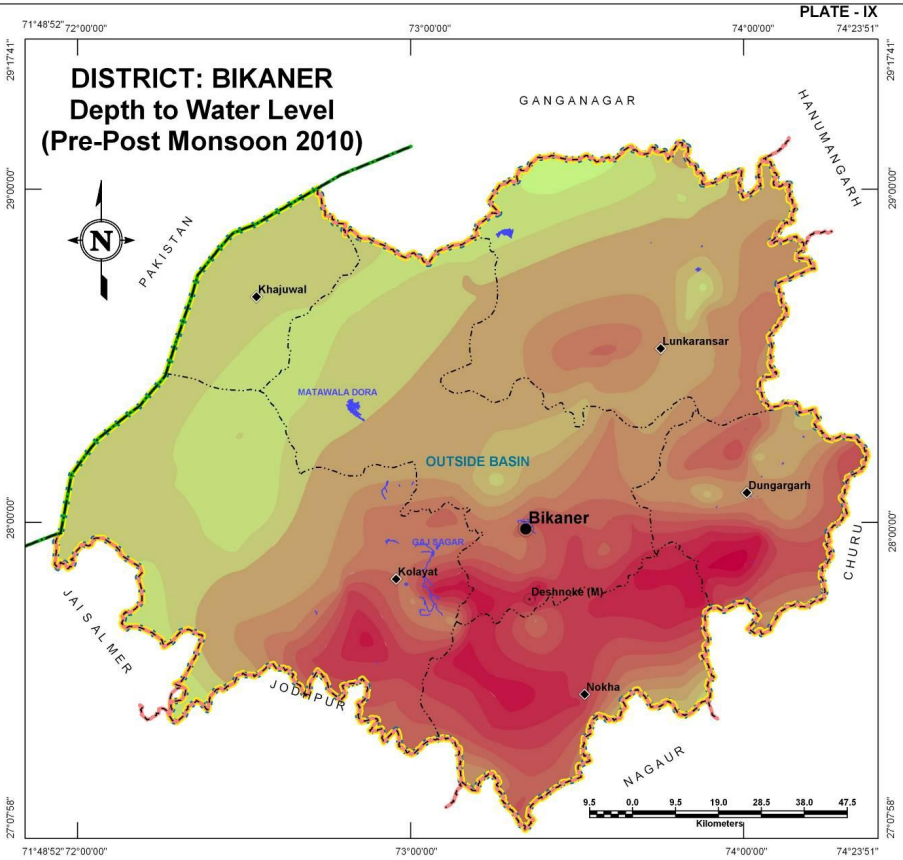


PLATE - IX



LEGEND

Admin Boundary:
- State Capital
- Block Headquarter
- Town
- International Boundary
- District Boundary
- Block Boundary

Basin Boundary

Roads:
- National Highway
- State Highway
- Major District Road

Railway:
- Broad Gauge
- Metre Gauge

Water Bodies:
- River / Streams
- Ponds / Reservoirs

Exploratory Wells:
- CGWB
- RGWD

Ground Water Monitoring Stations:
- CGWB
- RGWD

LEGEND

Admin Boundary:
- State Capital
- Block Headquarter
- Town
- International Boundary
- District Boundary
- Block Boundary

Basin Boundary

Water Bodies:
- River / Streams
- Ponds / Reservoirs

Depth to Water Level (m bgl):
- < 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- 90 - 100
- 100 - 110
- 110 - 120
- >120

WATER TABLE ELEVATION (PRE MONSOON – 2010) DISTRICT – BIKANER

Marginal fringe in the south eastern part of the district, within Dungargarh and Nokha blocks the elevation of water table is highest reaching upto 280m above sea level. The water table gradually lowers towards northwest reaching a minimum elevation in the western most part of the district in Kolayat block. Most of the central part of the district has a general water table elevation of 120m to 160m above mean sea level.

Table: Block wise area covered in each water table elevation range (20m interval)

Water table elevation range (m amsl)	Block wise area coverage (sq km)						Total Area (sq km)
	Bikaner	Dungargarh	Khajuwal	Kolayat	Lunkaransar	Nokha	
<60	-	-	-	740.8	-	-	**740.8**
80-100	-	-	408.7	846.1	-	-	**1,254.8**
100-120	68.5	-	1,258.5	871.7	-	-	**2,198.7**
120-140	3,090.6	-	247.5	2,131.4	1,270.7	-	**6,740.2**
140-160	3,087.6	177.8	-	1,726.2	4,726.0	-	**9,717.6**
160-180	709.7	381.7	-	1,200.4	583.0	321.2	**3,196.0**
180-200	49.6	755.9	-	383.0	-	1,027.0	**2,215.5**
200-220	-	830.2	-	66.1	-	990.9	**1,887.2**
220-240	-	676.8	-	-	-	1,036.3	**1,713.1**
240-260	-	105.2	-	-	-	324.8	**430.0**
>280	-	35.5	-	-	-	149.8	**185.3**
Total	**7,006.0**	**2,963.1**	**1,914.7**	**7,965.7**	**6,579.7**	**3,850.0**	**30,279.2**

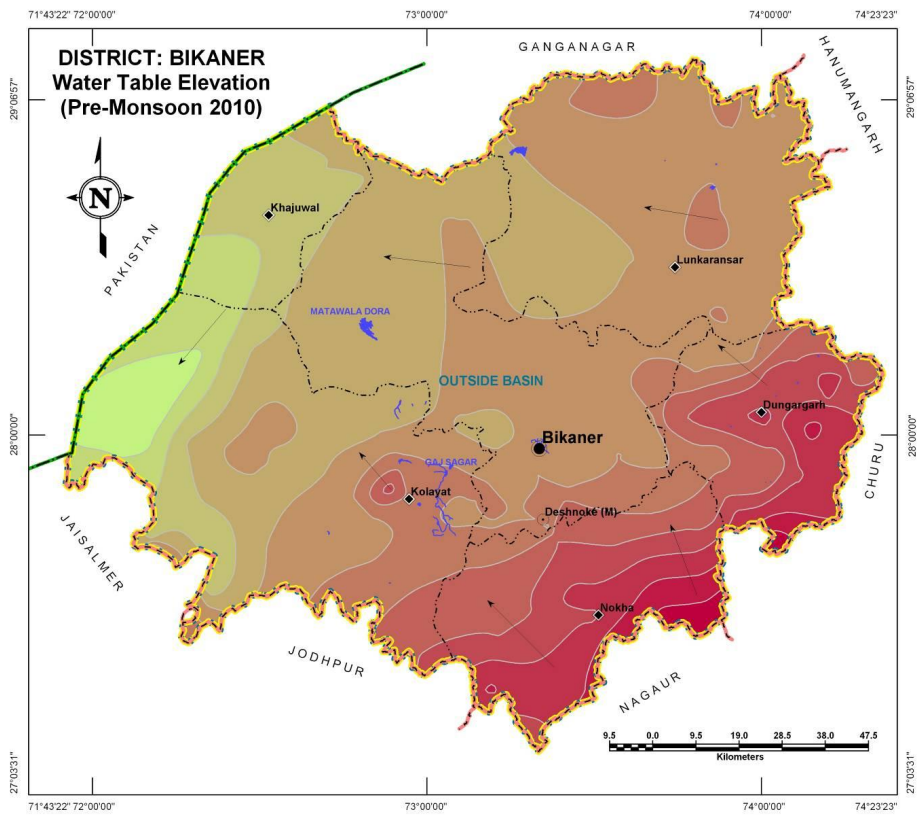
WATER LEVEL FLUCTUATION (PRE TO POST MONSOON 2010)

Central part of the district largely shows upto 2m rise in water table in post monsoon season. Rest of the district has shown a depletion of 2m with respect to Pre-monsoon water levels which is alarming. Block Nokha has registered very high variation where in one part (around Nokha city) the water table has gone down significantly (>6m), in the other part, quite adjacent to it, the water table has risen by more than 6m.

Table: Block wise area covered in each water fluctuation range

Water level fluctuation range (m)	Block wise area coverage (sq km)						Total Area (sq km)
	Bikaner	Dungargarh	Khajuwal	Kolayat	Lunkaransar	Nokha	
<-6	-	-	-	-	-	78.4	**78.4**
-6 to -4	-	-	-	-	-	168.4	**168.4**
-4 to -2	8.6	11.3	-	-	109.1	488.8	**617.8**
-2 to 0	1,799.2	2,773.7	1,518.3	4,596.6	3,233.8	1,663.4	**15,585.0**
0 to 2	5,097.5	178.1	396.4	3,369.1	3,164.5	983.0	**13,188.6**
2 to 4	78.0	-	-	-	60.1	344.7	**482.8**
4 to 6	18.7	-	-	-	12.2	121.3	**152.2**
>6	4.0	-	-	-	-	2.0	**6.0**
Total	**7,006.0**	**2,963.1**	**1,914.7**	**7,965.7**	**6,579.7**	**3,850.0**	**30,279.2**

PLATE - X



LEGEND

Admin Boundary:

- District Headquarter
- Block Headquarter
- Town
- International Boundary
- District Boundary
- Block Boundary

Basin Boundary

Water Bodies:

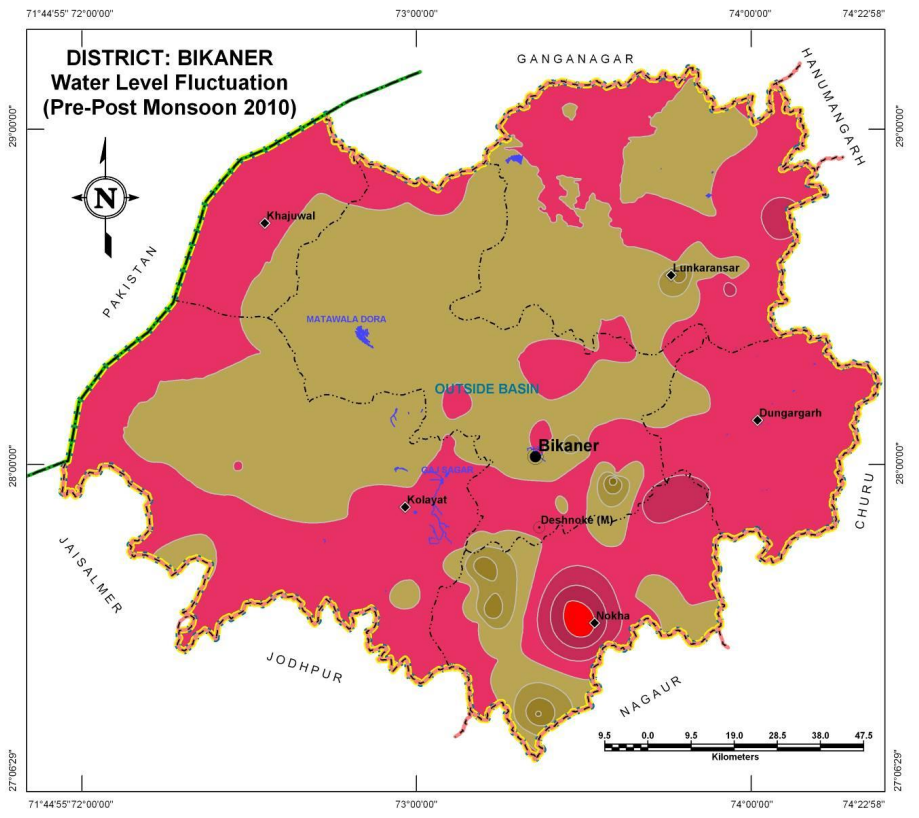
- River / Streams
- Ponds / Reservoirs

Water Table Elevation

Water Table Elevation (m amsl):

- < 80
- 80 - 100
- 100 - 120
- 120 - 140
- 140 - 160
- 160 - 180
- 180 - 200
- 200 - 220
- 220 - 240
- 240 - 260
- > 260

PLATE - XI



LEGEND

Admin Boundary:

- District Headquarter
- Block Headquarter
- Town
- International Boundary
- District Boundary
- Block Boundary

Basin Boundary

Water Bodies:

- River / Streams
- Ponds / Reservoirs

Water Level Fluctuation (m):

- < -6
- -6 to -4
- -4 to -2
- -2 to 0
- 0 to 2
- 2 to 4
- 4 to 6
- > 6

GROUND WATER ELECTRICAL CONDUCTIVITY DISTRIBUTION — DISTRICT – BIKANER

The electrical conductivity of ground water ranges from less than 2000 µS/cm at 25° C to more than 10,000µS/cm 25° C. Fresh water (<2000 µS/cm) occurs largely in hardrock aquifers of Dungargarh, southeastern part of Bikaner and northern part of Nokha blocks. A large area in the northwestern part of Bikaner block and adjoining parts of Khajuwal and Lunkaransar blocks where aquifer is formed in older alluvium also has low EC. Saline patches are quite prominent and occupy nearly whole of Kolayat block and a significant patch around Lunkaransar. Some high salinity pockets are also seen in the northwestern fringe, and extreme southern part of Nokha block. The analysis is based on average of EC values observed during Pre-Monsoon between years 2005-09.

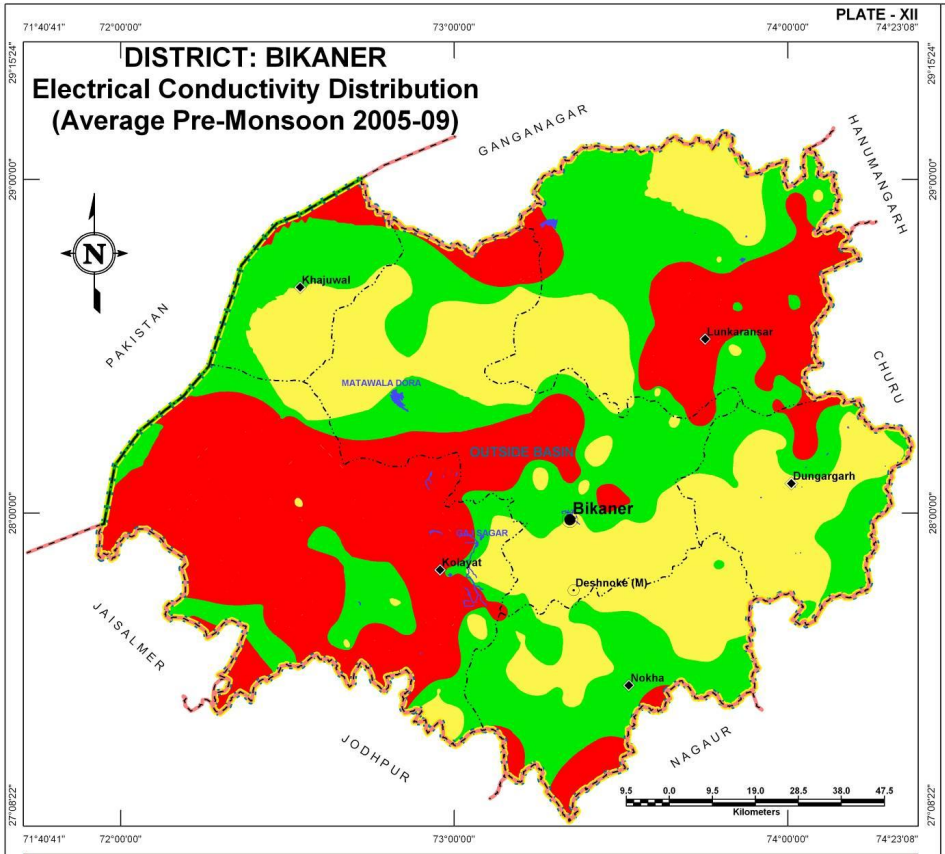
Electrical Conductivity Ranges (µS/cm at 25°C) (Ave. of years 2005-09)	Block wise area coverage												Total Area (sq km)
	Bikaner		Dungargarh		Khajuwal		Kolayat		Lunkaransar		Nokha		
	Area	%age	Area	%age	Area	%age	Area	%age	Area	%age	Area	%age	
< 2000	2,911.4	41.6	1,746.1	58.9	641.1	33.5	477.1	6.0	1,696.6	25.8	1,441.7	37.4	**8,914.0**
2000-4000	2,613.7	37.3	1,053.1	35.6	1,053.3	55.0	1,582.1	19.8	2,718.2	41.3	1,989.9	51.7	**11,010.3**
> 4000	1,480.8	21.1	163.9	5.5	220.2	11.5	5,906.6	74.2	2,164.9	32.9	418.5	10.9	**10,354.9**
Total	**7,005.9**	**100.0**	**2,963.1**	**100.0**	**1,914.6**	**100.0**	**7,965.8**	**100.0**	**6,579.7**	**100.0**	**3,850.1**	**100.0**	**30,279.2**

GROUND WATER CHLORIDE DISTRIBUTION

Red colored zones indicating very high chloride concentration (>1000 mg/l) are seen in Southwest and northeastern parts of the district. Almost all of Kolayat block has high chloride concentration in excess of 1000 mg/l. Ground water in Khajuwal, Nokha and Dungargarh blocks has moderately high chloride concentration. Patches along the tri junction of Dungargarh, Bikaner and Nokha blocks; and that along Lunkaransar Bikaner border have low chloride concentration.

Chloride Concentration Range (mg/l) (Ave. of years 2005-09)	Block wise area coverage (sq km)												Total Area (sq km)
	Bikaner		Dungargarh		Khajuwal		Kolayat		Lunkaransar		Nokha		
	Area	%age	Area	%age	Area	%age	Area	%age	Area	%age	Area	%age	
< 250	1,226.9	17.5	1,090.1	36.8	0.3	0.0	163.4	2.0	1,070.2	16.3	411.6	10.7	**3,962.4**
250-1000	4,558.6	65.1	1,799.4	60.7	1,837.9	96.0	2,093.2	26.0	4,039.6	61.4	3,159.4	82.1	**17,488.0**
> 1000	1,220.5	17.4	73.6	2.5	76.5	4.0	5,709.1	72.0	1,470.0	22.3	279.1	7.3	**8,828.8**
Total	**7,006.0**	**100.0**	**2,963.1**	**100.0**	**1,914.6**	**100.0**	**7,965.7**	**100.0**	**6,579.7**	**100.0**	**3,850.1**	**100.0**	**30,279.2**

PLATE - XII



LEGEND

Admin Boundary:

- District Headquarter
- Block Headquarter
- Town
- International Boundary
- District Boundary
- Block Boundary
- **Basin Boundary**

Water Bodies:

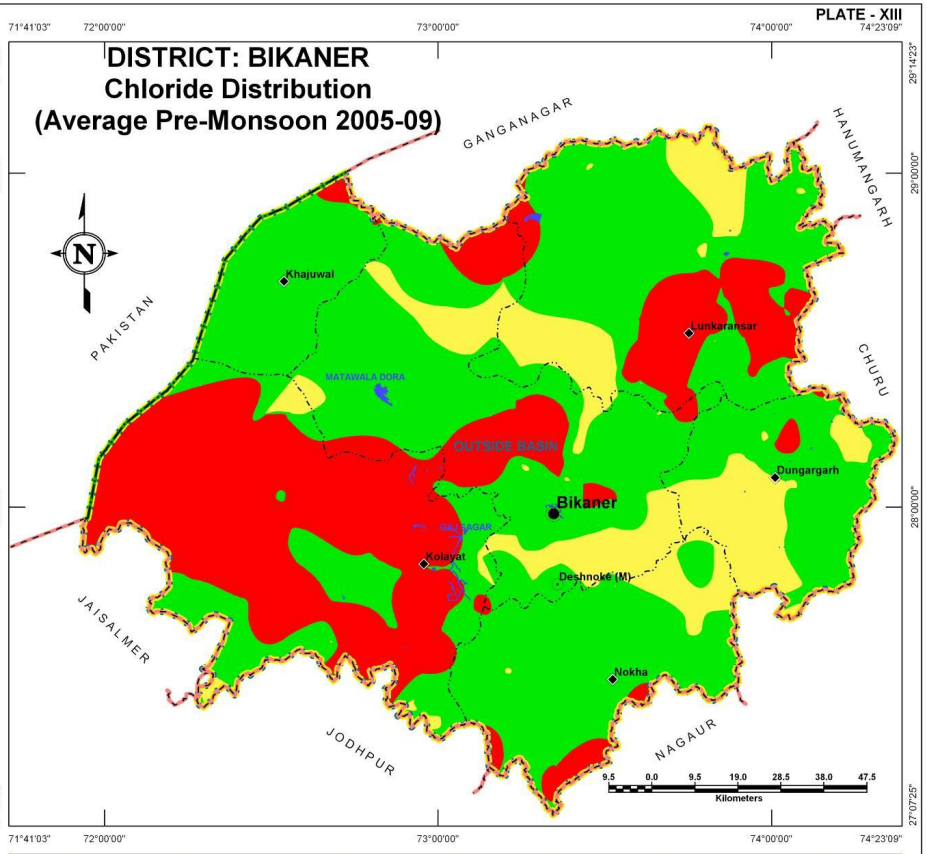
- River / Streams
- Ponds / Reservoirs

Electrical Conductivity (µS/cm at 25°C):

- < 2000
- 2000-4000
- >4000

Source: SRTM DEM

PLATE - XIII



LEGEND

Admin Boundary:

- District Headquarter
- Block Headquarter
- Town
- International Boundary
- District Boundary
- Block Boundary
- **Basin Boundary**

Water Bodies:

- River / Streams
- Ponds / Reservoirs

Chloride Concentration (mg/l):

- < 250
- 250 - 1000
- > 1000

GROUND WATER FLUORIDE DISTRIBUTION

DISTRICT – BIKANER

Three broad patches extending in Northwest-southeast direction, first one in the western part of Kolayat block, second one in Khajuwal-Bikaner region and the third one northwards of Lunkaransar have high Fluoride concentration i.e., in excess of 3.0 mg/l. Most of the remaining area has low to moderately high Fluoride concentration.

Fluoride concentration Range (mg/l) (Ave. of years 2005-09)	Block wise area coverage (sq km)												Total Area (sq km)
	Bikaner		Dungargarh		Khajuwal		Kolayat		Lunkaransar		Nokha		
	Area	%age	Area	%age	Area	%age	Area	%age	Area	%age	Area	%age	
< 1.5	2,788.9	39.8	2,839.4	95.8	-	-	3,698.8	46.4	1,740.4	26.5	3,786.1	98.3	**14,853.6**
1.5-3.0	2,006.7	28.6	123.7	4.2	157.1	8.2	2,467.8	31.0	1,961.5	29.8	63.6	1.7	**6,780.4**
> 3.0	2,210.4	31.6	-	-	1,757.5	91.8	1,799.1	22.6	2,877.8	43.7	0.4	-	**8,645.2**
Total	**7,006.0**	**100.0**	**2,963.1**	**100.0**	**1,914.6**	**100.0**	**7,965.7**	**100.0**	**6,579.7**	**100.0**	**3,850.1**	**100.0**	**30,279.2**

GROUND WATER NITRATE DISTRIBUTION

Low ground water Nitrate concentration (<50 mg/l) areas are distributed in the southwest and northwest of Nokha-Kolayat-Bikaner-Lunkaransar region and a broad patch in the western part of the district falling within Khajuwal and parts of Bikaner and Kolayat blocks. Rest of the district has high Nitrate concentration i.e., above 100 mg/l. The area in between the two, however very limited in extent has moderately high Nitrate concentration (i.e., between 50-100 mg/l.

Nitrate concentration Range (mg/l) (Ave. of years 2005-09)	Block wise area coverage (sq km)												Total Area (sq km)
	Bikaner		Dungargarh		Khajuwal		Kolayat		Lunkaransar		Nokha		
	Area	%age	Area	%age	Area	%age	Area	%age	Area	%age	Area	%age	
< 50	1,743.8	24.9	599.6	20.2	125.0	6.5	1,215.8	15.3	875.2	13.3	770.8	20.0	**5,330.2**
50-100	3,243.8	46.3	2,154.1	72.7	474.3	24.8	3,560.2	44.7	5,000.6	76.0	2,016.7	52.4	**16,449.7**
> 100	2,018.4	28.8	209.4	7.1	1,315.3	68.7	3,189.7	40.0	704.0	10.7	1,062.5	27.6	**8,499.3**
Total	**7,006.0**	**100.0**	**2,963.1**	**100.0**	**1,914.6**	**100.0**	**7,965.7**	**100.0**	**6,579.8**	**100.0**	**3,850.0**	**100.0**	**30,279.2**

PLATE - XIV

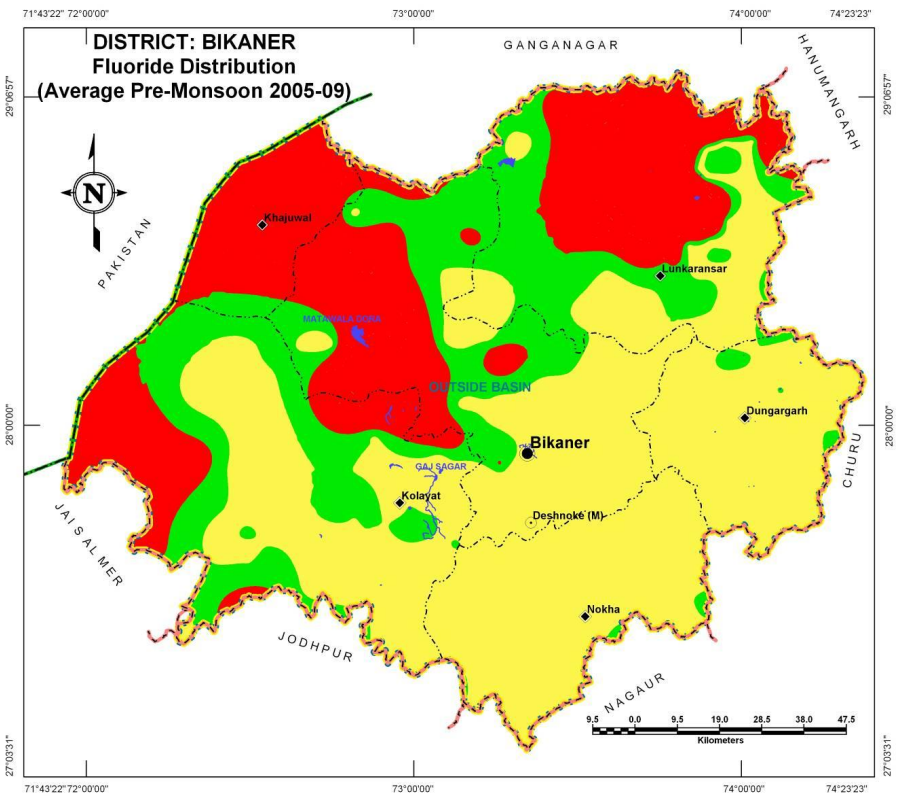
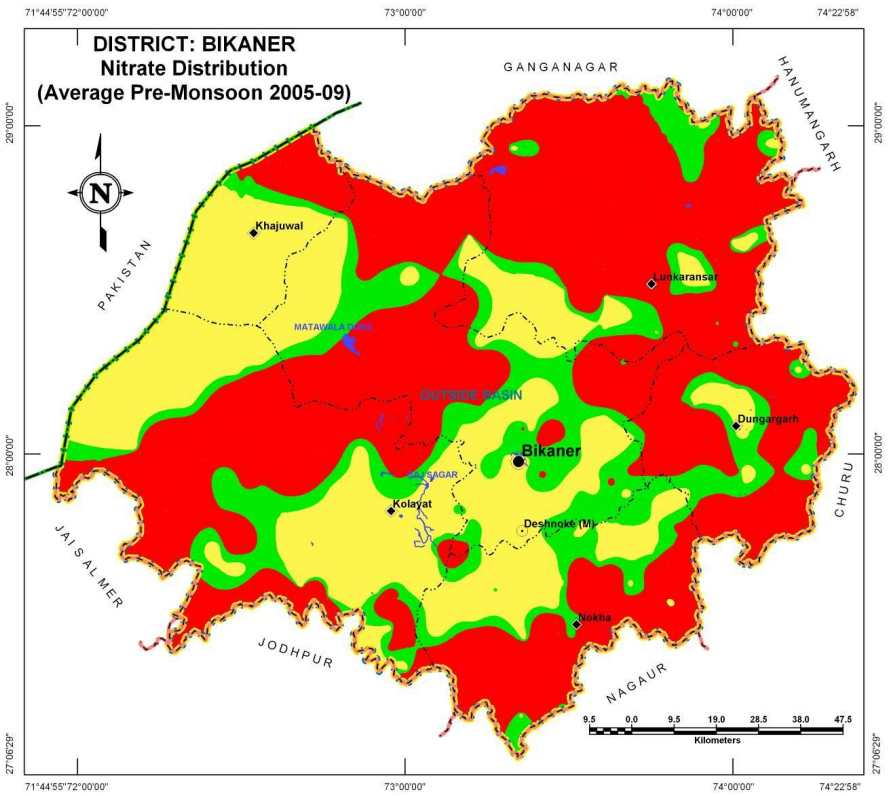


PLATE - XV



LEGEND

Admin Boundary:

- District Headquarter
- Block Headquarter
- Town
- International Boundary
- District Boundary
- Block Boundary

Basin Boundary

Water Bodies:

- River / Streams
- Ponds / Reservoirs

Fluoride Concentration (mg/l):

- < 1.5
- 1.5-3.0
- >3.0

LEGEND

Admin Boundary:

- District Headquarter
- Block Headquarter
- Town
- International Boundary
- District Boundary
- Block Boundary

Basin Boundary

Water Bodies:

- River / Streams
- Ponds / Reservoirs

Nitrate Concentration (mg/l):

- < 50
- 50-100
- >100

DEPTH TO BEDROCK

DISTRICT – BIKANER

The thick alluvial deposits are underlain by bedrock of different lithology and age. Plate XVI depicts the distribution of bedrock depth from ground level. The beginning of massive bedrock has been considered for defining top of bedrock surface. The major rocks types occurring in the district are Sandstones and Limestones. These rocks are overlain by alluvial deposits of sand, clay, silt and admixture of these in different proportions and thicknesses. The map of Depth to bed rock in meters below ground level reveals that the bedrock surface is highly undulating in the eastern part whereas is relatively even northwestwards. It varies from upto 60m bgl to more than 260m. Shallow bedrock depth is found in the southernmost part of Nokha block and in the northeast of Lunkaransar and Kolayat blocks. Deepest occurrence of bedrock (indicating high alluvial thickness) is found in east and west of Bikaner city, around Dungargarh and Lunkaransar; and to the southwest of Kolayat and Nokha. The areas in the west have moderately deep bedrock at around 200m of depth.

Depth to bedrock range (m bgl)	Block wise area coverage (sq km)												Total Area (sq km)
	Bikaner		Dungargarh		Khajuwal		Kolayat		Lunkaransar		Nokha		
	Area	%age	Area	%age	Area	%age	Area	%age	Area	%age	Area	%age	
< 60	-	-	-	-	-	-	-	-	-	-	12.9	0.3	**12.9**
60-80	-	-	-	-	-	-	-	-	-	-	18.8	0.5	**18.8**
80-100	-	-	6.7	0.2	-	-	-	-	-	-	28.6	0.7	**35.3**
100-120	-	-	26.0	0.9	-	-	3.6	0.1	241.8	3.7	67.7	1.8	**339.1**
120-140	3.1	-	109.8	3.7	-	-	82.9	1.0	996.8	15.2	60.5	1.6	**1,253.1**
140-160	108.6	1.6	368.2	12.4	-	-	229.2	2.9	1,169.3	17.6	69.8	1.8	**1,945.1**
160-180	194.5	2.8	658.7	22.3	-	-	555.5	7.0	1,658.7	25.2	718.8	18.6	**3,786.2**
180-200	958.6	13.7	1,169.7	39.5	-	-	1,353.0	17.0	1,189.2	18.1	1,497.2	38.9	**6,167.7**
200-220	4,456.1	63.6	528.2	17.8	1,914.6	100.0	4,101.8	51.5	1,025.1	15.6	977.4	25.4	**13,003.2**
220-240	919.0	13.1	86.0	2.9	-	-	1,428.3	17.9	222.7	3.4	330.1	8.6	**2,986.1**
240-260	314.0	4.5	9.8	0.3	-	-	201.2	2.5	62.9	1.0	68.2	1.8	**656.1**
> 260	52.1	0.7	-	-	-	-	10.2	0.1	13.3	0.2	-	-	**75.6**
Total	**7,006.0**	**100.0**	**2,963.1**	**100.0**	**1,914.6**	**100.0**	**7,965.7**	**100.0**	**6,579.8**	**100.0**	**3,850.0**	**100.0**	**30,279.2**

UNCONFINED AQUIFER

Alluvial areas

Alluvial material forms aquifers in most of Northwestern half of the district and also around Dungargarh city. The thickness of unconfined aquifer varies from less than 10 m to about 80m with the thickest parts lying to the east of Dungargarh city and the northwestern part of Bikaner block. The general thickness is upto 40m.

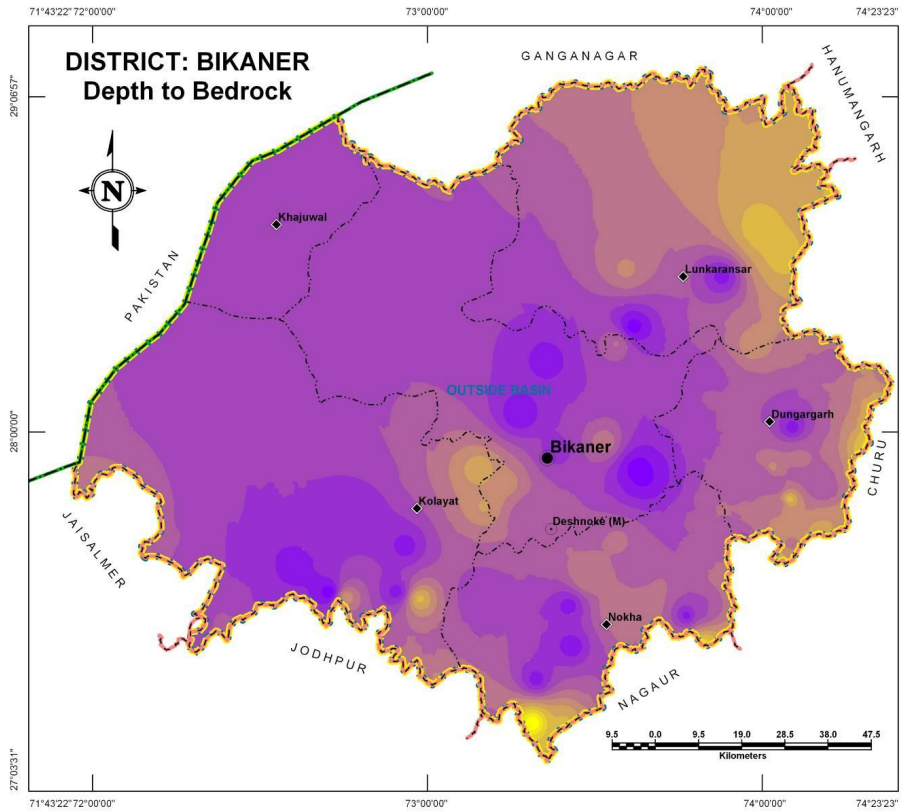
Unconfined aquifer Thickness (m)	Block wise area coverage (sq km)						Total Area (sq km)
	Bikaner	Dungargarh	Khajuwal	Kolayat	Lunkaransar	Nokha	
< 10	121.8	695.1	-	34.2	810.9	52.7	**1,714.7**
10-20	271.1	263.5	-	1,148.2	1,062.4	91.0	**2,836.2**
20-30	419.8	113.1	581.7	2,185.5	1,705.0	37.0	**5,042.1**
30-40	677.4	76.0	1,311.6	25.8	675.1	-	**2,765.9**
40-50	818.8	66.1	21.4	206.9	155.4	-	**1,268.6**
50-60	711.8	57.2	-	45.0	74.0	-	**888.0**
60-70	512.0	45.7	-	23.1	20.1	-	**600.9**
70-80	251.9	22.0	-	7.6	-	-	**281.5**
> 80	-	6.0	-	-	-	-	**6.0**
Total	**3,784.6**	**1,344.7**	**1,914.7**	**3,676.3**	**4,502.9**	**180.7**	**15,403.9**

Hardrock areas

Weathered, fractured and jointed rock formations occurring at shallower depths constitute good unconfined aquifers. Such zone ranges in thickness from less than 10 meter to around 50 meter throughout the central and southern part of the district. Southernmost part of the district in Nokha block has thickest zone of weathered/fractured hardrock thickness and the Bikaner –Kolayat- Nokha region has moderate thickness of upto 30m.

Unconfined aquifer Thickness (m)	Block wise area coverage (sq km)						Total Area (sq km)
	Bikaner	Dungargarh	Khajuwal	Kolayat	Lunkaransar	Nokha	
<10	82.3	575.8	-	390.7	-	10.3	**1,059.1**
10-20	1,230.6	450.9	-	3,247.7	6.0	723.4	**5,658.6**
20-30	1,232.6	392.2	-	405.3	1,044.6	1,395.5	**4,470.2**
30-40	675.9	199.5	-	156.4	1,026.2	712.8	**2,770.8**
40-50	-	-	-	88.8	-	523.3	**612.1**
> 50	-	-	-	0.5	-	304.0	**304.5**
Total	**3,221.4**	**1,618.4**	**-**	**4,289.4**	**2,076.8**	**3,669.3**	**14,875.3**

PLATE - XVI



LEGEND

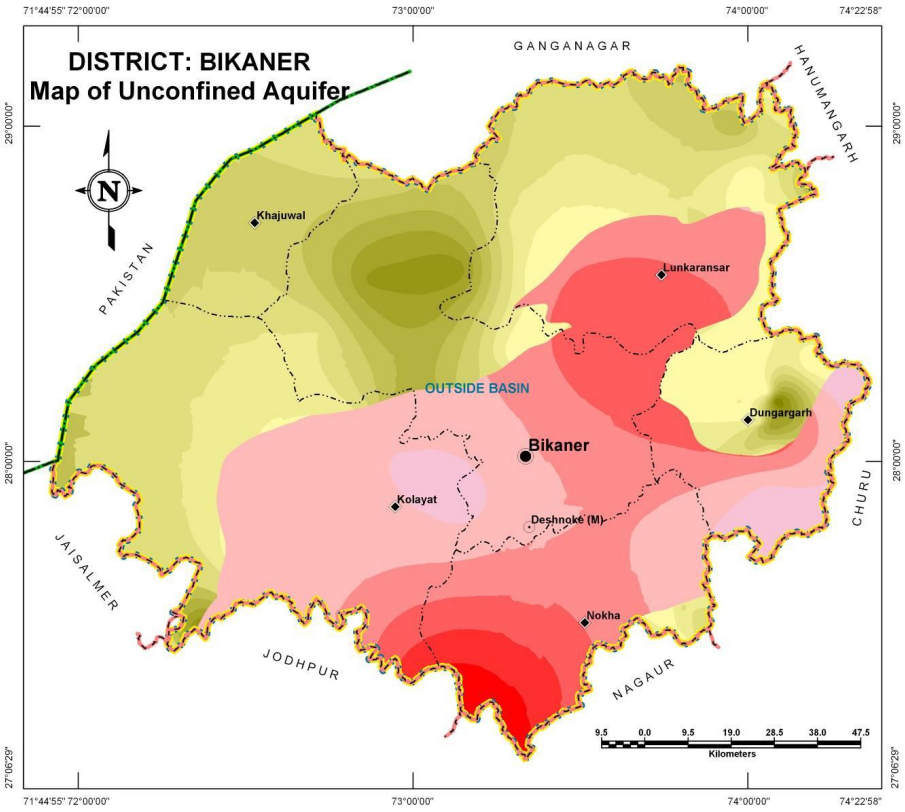
Admin Boundary:

- District Headquarter
- Block Headquarter
- Town
- International Boundary
- District Boundary
- Block Boundary
- **Basin Boundary**

Depth to Bedrock(m bgl):

- < 60
- 60-80
- 80-100
- 100-120
- 120-140
- 140-160
- 160-180
- 180-200
- 200-220
- 220-240
- 240-260
- > 260

PLATE - XVII



LEGEND

Admin Boundary:

- District Headquarter
- Block Headquarter
- Town
- International Boundary
- District Boundary
- Block Boundary
- **Basin Boundary**

Aquifer Thickness(m):

Alluvial Area	Weathered & Fractured Zone in Hardrock Area
< 10	<10
10-20	10-20
20-30	20-30
30-40	30-40
40-50	40-50
50-60	> 50
60-70	
70-80	
> 80	

Glossary of terms

S. No.	Technical Terms	Definition
1	AQUIFER	A saturated geological formation which has good permeability to supply sufficient quantity of water to a Tube well, well or spring.
2	ARID CLIMATE	Climate characterized by high evaporation and low precipitation.
3	ARTIFICIAL RECHARGE	Addition of water to a ground water reservoir by man-made activity
4	CLIMATE	The sum total of all atmospheric or meteorological influences principally temperature, moisture, wind, pressure and evaporation of a region.
5	CONFINED AQUIFER	A water bearing strata having confined impermeable overburden. In this aquifer, water level represents the piezometric head.
6	CONTAMINATION	Introduction of undesirable substance, normally not found in water, which renders the water unfit for its intended use.
7	DRAWDOWN	The drawdown is the depth by which water level is lowered.
8	FRESH WATER	Water suitable for drinking purpose.
9	GROUND WATER	Water found below the land surface.
10	GROUND WATER BASIN	A hydro-geologic unit containing one large aquifer or several connected and interrelated aquifers.
11	GROUND WATER RECHARGE	The natural infiltration of surface water into the ground.
12	HARD WATER	The water which does not produce sufficient foam with soap.
13	HYDRAULIC CONDUCTIVITY	A constant that serves as a measure of permeability of porous medium.
14	HYDROGEOLOGY	The science related with the ground water.
15	HUMID CLIMATE	The area having high moisture content.
16	ISOHYET	A line of equal amount of rainfall.
17	METEOROLOGY	Science of the atmosphere.
18	PERCOLATION	It is flow through a porous substance.
19	PERMEABILITY	The property or capacity of a soil or rock for transmitting water.
20	pH	Value of hydrogen-ion concentration in water. Used as an indicator of acidity (pH < 7) or alkalinity (pH > 7).
21	PIEZOMETRIC HEAD	Elevation to which water will rise in a piezometers.
22	RECHARGE	It is a natural or artificial process by which water is added from outside to the aquifer.
23	SAFE YIELD	Amount of water which can be extracted from ground water without producing undesirable effect.
24	SALINITY	Concentration of dissolved salts.
25	SEMI-ARID	An area is considered semiarid having annual rainfall between 10-20 inches.
26	SEMI-CONFINED AQUIFER	Aquifer overlain and/or underlain by a relatively thin semi-pervious layer.
27	SPECIFIC YIELD	Quantity of water which is released by a formation after it's complete saturation.
28	TOTAL DISSOLVED SOLIDS	Total weight of dissolved mineral constituents in water per unit volume (or weight) of water in the sample.

(Contd…)

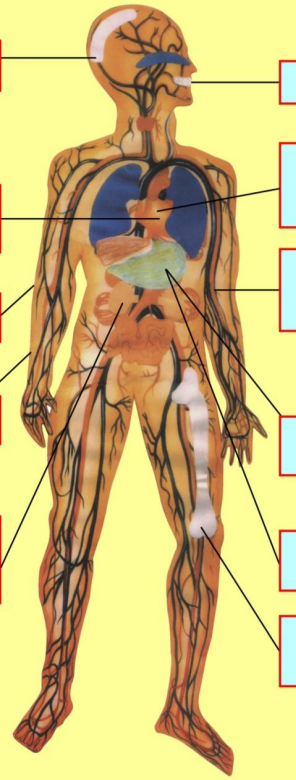
S. No.	Technical Terms	Definition
29	TRANSMISSIBILITY	It is defined as the rate of flow through an aquifer of unit width and total saturation depth under unit hydraulic gradient. It is equal to product of full saturation depth of aquifer and its coefficient of permeability.
30	UNCONFINED AQUIFER	A water bearing formation having permeable overburden. The water table forms the upper boundary of the aquifer.
31	UNSATURATED ZONE	The zone below the land surface in which pore space contains both water and air.
32	WATER CONSERVATION	Optimal use and proper storage of water.
33	WATER RESOURCES	Availability of surface and ground water.
34	WATER RESOURCES MANAGEMENT	Planned development, distribution and use of water resources.
35	WATER TABLE	Water table is the upper surface of the zone of saturation at atmospheric pressure.
36	ZONE OF SATURATION	The ground in which all pores are completely filled with water.
37	ELECTRICAL CONDUCTIVITY	Flow of free ions in the water at 25C mu/cm.
38	CROSS SECTION	A Vertical Projection showing sub-surface formations encountered in a specific plane.
39	3-D PICTURE	A structure showing all three dimensions i.e. length, width and depth.
40	GWD	Ground Water Department
41	CGWB	Central Ground Water Board
42	CGWA	Central Ground Water Authority
43	SWRPD	State Water Resources Planning Department
44	EU-SPP	European Union State Partnership Programme
45	TOPOGRAPHY	Details of drainage lines and physical features of land surface on a map.
46	GEOLOGY	The science related with the Earth.
47	GEOMORPHOLOGY	The description and interpretation of land forms.
48	PRE MONSOON SURVEY	Monitoring of Ground Water level from the selected DKW/Piezometer before Monsoon (carried out between 15th May to 15th June)
49	POST-MONSOON SURVEY	Monitoring of Ground Water level from the selected DKW/Piezometer after Monsoon (carried out between 15th October to 15th November)
50	PIEZOMETER	A non-pumping small diameter bore hole used for monitoring of static water level.
51	GROUND WATER FLUCTUATION	Change in static water level below ground level.
52	WATER TABLE	The static water level found in unconfined aquifer.
53	DEPTH OF BED ROCK	Hard & compact rock encountered below land Surface.
54	G.W. MONITORING STATION	Dug wells selected on grid basis for monitoring of state water level.
55	EOLIAN DEPOSITS	Wind-blown sand deposits

Ground Water Department,
Rajasthan

European Union
State Partnership Programme

भूजल में घुले मुख्य तत्वों की अधिकता का मानव शरीर पर दुष्प्रभाव

- बोरोन-स्नायु तन्त्र पर प्रभाव
- फ्लोराइड - दंत क्षरण
- क्लोराइड-सोडियम के साथ मिलकर उच्च रक्त चाप
- सोडियम-हृदय, गुर्दा व रक्त परिसंचरण रोगों से ग्रसित लोगों को हानिकारक
- कैल्शियम-जोड़ों में कड़ापन
- नाइट्रेट-नवजात शिशुओं में ब्लू बेबी बीमारी (मेथमोग्लोबिनिमिया)
- आर्सेनिक-त्वचा रोग, कैंसर
- सल्फेट-अधिकता में मैग्नेशियम के साथ मिलकर दस्तावर
- लेड-बच्चों के शारीरिक व मानसिक विकास में बाधा वयस्कों में गुर्दे के रोग
- आयरन-आयरन जीवाणु से आमाशय संबंधी रोग
- फ्लोराइड-जोड़ों में अकड़न, हड्डियों में मुड़ाव



केन्द्रीय भूमि जल बोर्ड,
पश्चिमी क्षेत्र, जयपुर
जल संसाधन मंत्रालय
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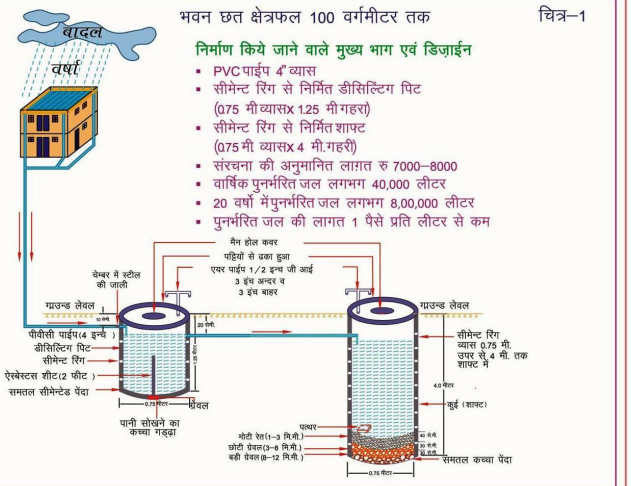
भूजल अमूल्य है इसे प्रदूषित न करें।

चित्र–1

भवन छत क्षेत्रफल 100 वर्गमीटर तक

निर्माण किये जाने वाले मुख्य भाग एवं डिज़ाईन

- PVC पाईप 4" व्यास
- सीमेन्ट रिंग से निर्मित डीसिल्टिंग पिट (0.75 मी.व्यास x 1.25 मी.गहरा)
- सीमेन्ट रिंग से निर्मित शाफ्ट (0.75 मी.व्यास x 4 मी.गहरी)
- संरचना की अनुमानित लाग़त रु 7000–8000
- वार्षिक पुनर्भरित जल लगभग 40,000 लीटर
- 20 वर्षों में पुनर्भरित जल लगभग 8,00,000 लीटर
- पुनर्भरित जल की लागत 1 पैसे प्रति लीटर से कम

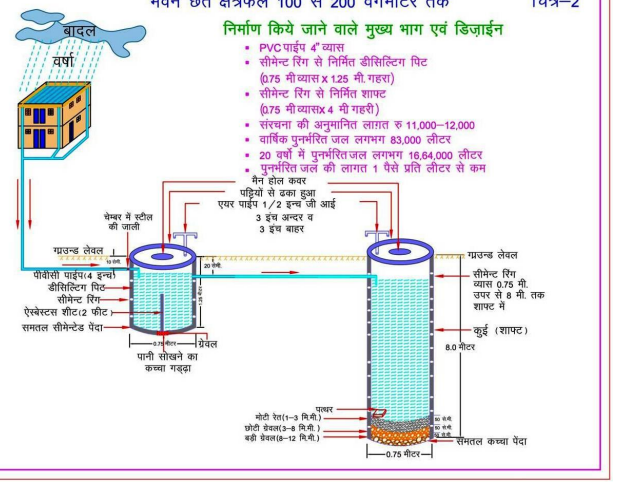


चित्र–2

भवन छत क्षेत्रफल 100 से 200 वर्गमीटर तक

निर्माण किये जाने वाले मुख्य भाग एवं डिज़ाईन

- PVC पाईप 4" व्यास
- सीमेन्ट रिंग से निर्मित डीसिल्टिंग पिट (0.75 मी.व्यास x 1.25 मी.गहरा)
- सीमेन्ट रिंग से निर्मित शाफ्ट (0.75 मी.व्यास x 4 मी गहरी)
- संरचना की अनुमानित लाग़त रु 11,000–12,000
- वार्षिक पुनर्भरित जल लगभग 83,000 लीटर
- 20 वर्षों में पुनर्भरित जल लगभग 16,64,000 लीटर
- पुनर्भरित जल की लागत 1 पैसे प्रति लीटर से कम

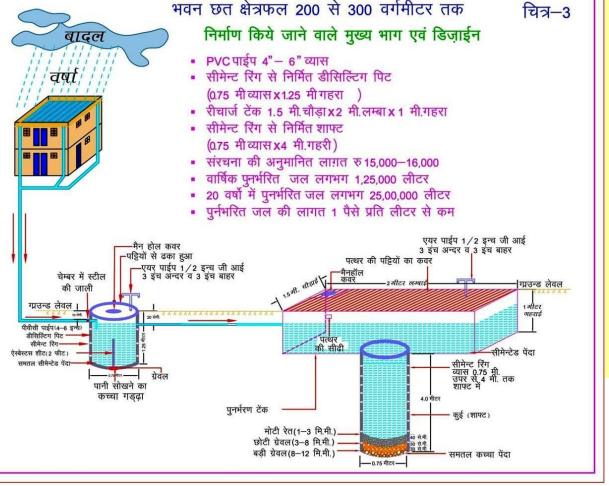


चित्र–3

भवन छत क्षेत्रफल 200 से 300 वर्गमीटर तक

निर्माण किये जाने वाले मुख्य भाग एवं डिज़ाईन

- PVC पाईप 4" – 6" व्यास
- सीमेन्ट रिंग से निर्मित डीसिल्टिंग पिट (0.75 मी.व्यास x 1.25 मी.गहरा)
- रीचार्ज टेंक 1.5 मी.चौड़ा x 2 मी.लम्बा x 1 मी.गहरा
- सीमेन्ट रिंग से निर्मित शाफ्ट (0.75 मी.व्यास x 4 मी.गहरी)
- संरचना की अनुमानित लाग़त रु 15,000–16,000
- वार्षिक पुनर्भरित जल लगभग 1,25,000 लीटर
- 20 वर्षों में पुनर्भरित जल लगभग 25,00,000 लीटर
- पुनर्भरित जल की लागत 1 पैसे प्रति लीटर से कम

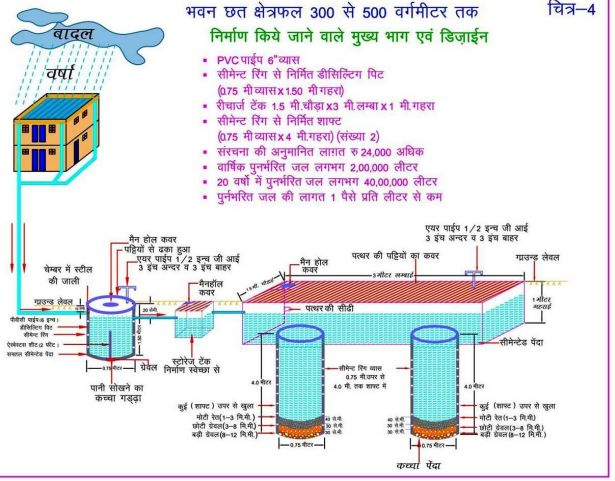


चित्र–4

भवन छत क्षेत्रफल 300 से 500 वर्गमीटर तक

निर्माण किये जाने वाले मुख्य भाग एवं डिज़ाईन

- PVC पाईप 6" व्यास
- सीमेन्ट रिंग से निर्मित डीसिल्टिंग पिट (0.75 मी.व्यास x 1.50 मी.गहरा)
- रीचार्ज टेंक 1.5 मी.चौड़ा x 3 मी.लम्बा x 1 मी.गहरा
- सीमेन्ट रिंग से निर्मित शाफ्ट (0.75 मी.व्यास x 4 मी.गहरा) (संख्या 2)
- संरचना की अनुमानित लाग़त रु 24,000 अधिक
- वार्षिक पुनर्भरित जल लगभग 2,00,000 लीटर
- 20 वर्षों में पुनर्भरित जल लगभग 40,00,000 लीटर
- पुनर्भरित जल की लागत 1 पैसे प्रति लीटर से कम



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Myths and Facts about Ground Water

S No	Myths	Facts
1	What is Ground Water • an underground lake • a net work of underground rivers • a bowl filled with water	Water which occurs below the land in geological formations/rocks is Ground water
2	Ground Water occurs everywhere beneath the Land Surface	Not really, it depends on the nature of rock formation
3	There is a relationship between ground water and surface water	Not all the places. Near streams/rivers there is relation
4	Groundwater is not renewable resource	It is renewable source and every year it is being recharged through rain/applied irrigation etc
5	Ground water is unlimited and deeper you drill more discharge	It is limited to annual recharge from rain/applied irrigation. The discharge may not increase if you go deeper
6	Ground Water moves rapidly	The movement of ground water is very slow
7	Ground water pumped from wells is thousands of years old	Generally the ground water being tapped through wells is a few years old
8	If water taste good—it is safe to drink	It may have other chemicals e.g. fluoride, nitrates etc which are harmful
9	Water from free flowing tube wells is very pure	This water can also be contaminated so test before use
10	If I recharge my TW/DW/HP it will not benefit me	It will also benefit you and also adjoing wells
11	There is no static ground water resources in Rajasthan	Rajasthan is also having Static GW resources, and being tapped in most of areas as GW annual withdrawal is more than annual recharge
12	I cannot meet annual cooking and drinking water requirement by rain water harvesting	The water requirement for drinking and cooking is only 8 lit/day. You can harvest this water for family of 5 persons from roof top or paved area of 75 Sq m to meet annual requirement
13	You can increase ground water recharge	This can be done by harvesting the rain water and storing in sub surface reservoir (GW) by constructing the recharge structures
14	You cannot use abandoned TW/HP/DW for ground water recharge	These should be used as recharge structures as harvested rain water is directly put into GW reservoir
15	Putting waste near HP/TW will not cause any problem	Such actions will pollute wells and water

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