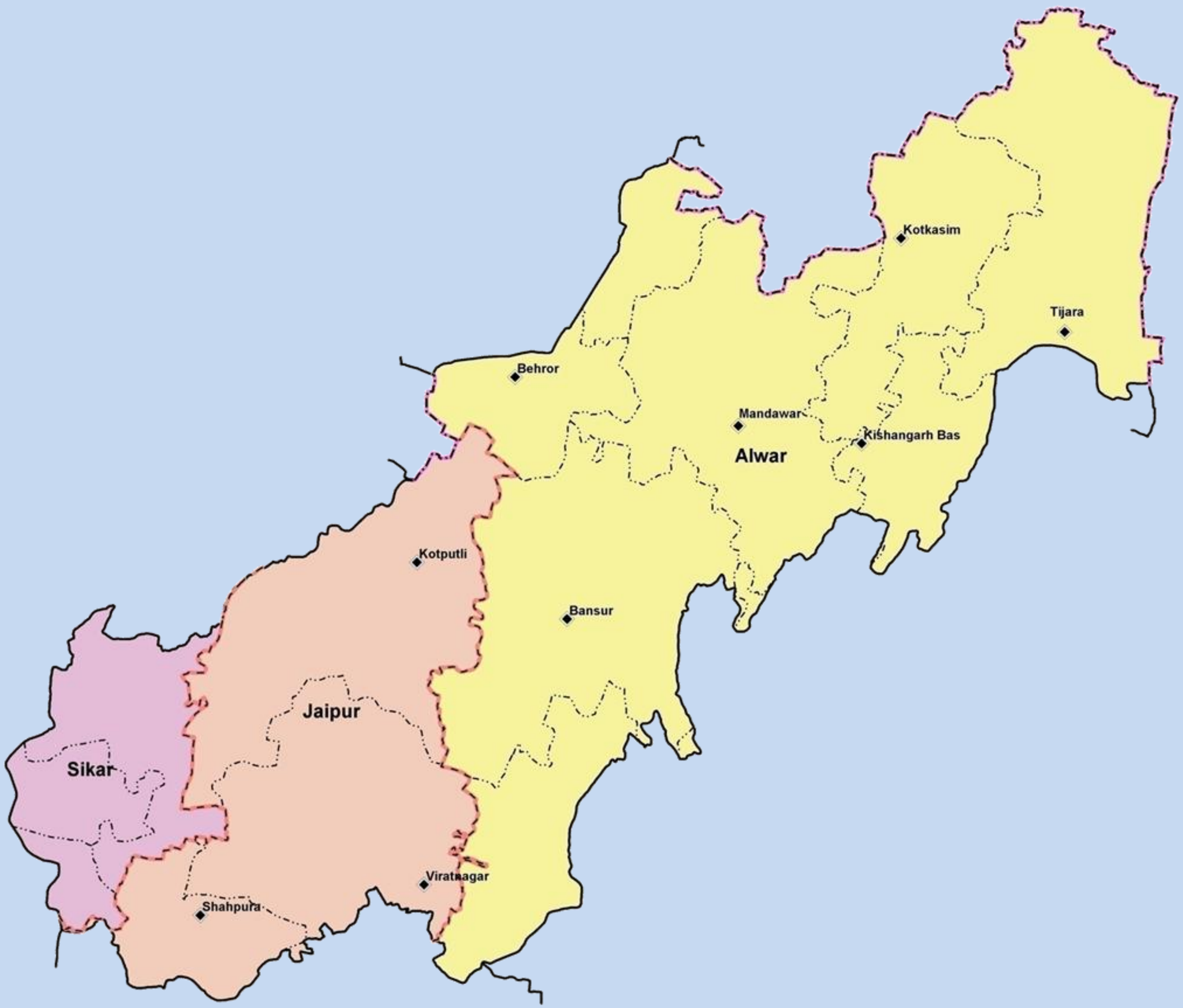
Ground Water Department, Rajasthan

Hydrogeological Atlas of Rajasthan

Sabi River Basin

European Union
State Partnership Programme

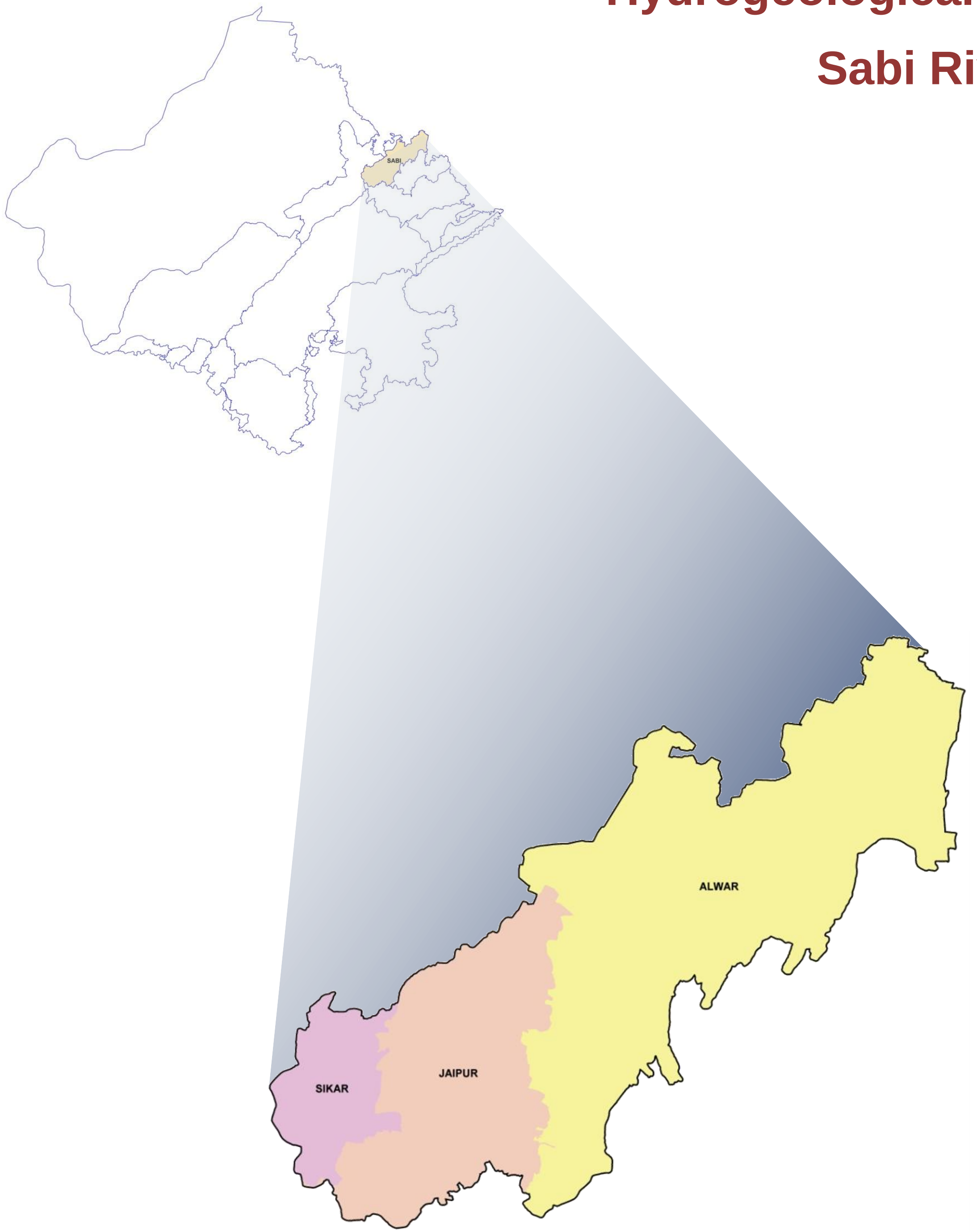


2013

ROLTA
Rolta India Limited

Hydrogeological Atlas of Rajasthan

Sabi River Basin



Contents:

2013

ADMINISTRATIVE SETUP

Location:

Sabi (also called Sahibi) River Basin is located in the mid north eastern part of Rajasthan. It stretches between 27° 18' 39.13” to 28° 13' 55.10” North latitude and 76° 58' 21.09’’ to 75° 45' 35.05’’ East longitude. It is bounded in the northwest by Shekhawati River Basin and Ruparail and Banganga River Basins in the southeast. The northern boundary is shared administratively with Haryana State. The Basin extends over parts of Alwar, Jaipur and Sikar districts. The total catchment area of the Basin is 4607.9 km2.

The Sabi River originates in the eastern slopes of the Saiwar Protected Forest (PF) hills in Sikar District, enters Jaipur district near the foot of these hills, and after initially flowing southeast and east turns northeastwards near Shahpura and continues further till it exits the State to enter Haryana. Important left bank tributary is Sota River and there are numerous right bank tributaries that originate in the hills of Alwar district. It flows in Rajasthan for a distance of about 157 km before entering Haryana State.

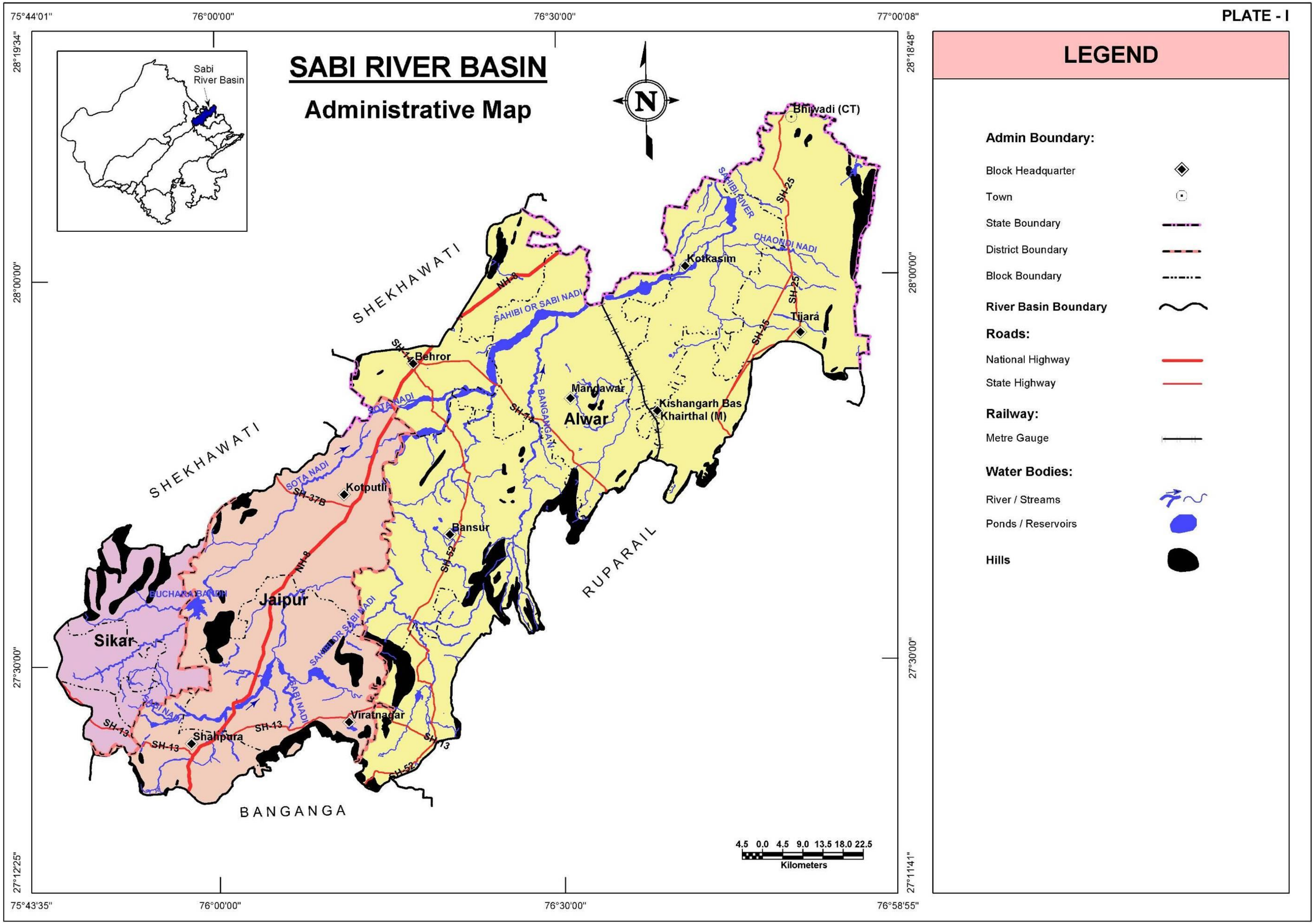
Administrative Set-up:

Administratively, Sabi River Basin extends over parts of Alwar, Jaipur and Sikar districts through 16 blocks and encompassing 1,013 towns and villages. Major part of the basin area lies in Alwar district which accounts for about 64% of its catchment area and Sikar the least with just about 9% of the basin area.

S. No.	District Name	Area (sq km)	% of Basin Area	Total Number of Blocks	Total Number of Towns and Villages
1	Alwar	2,937.8	63.8	10	745
2	Jaipur	1,249.2	27.1	3	225
3	Sikar	420.9	9.1	3	43
	Total	**4,607.9**	**100.0**	**16**	**1,013**

Climate:

The climate of the Sabi River Basin is semi-arid with very hot summers and extremely cold winters. The monsoon season is of very short duration. The cold season starts by the middle of November and continues up to the beginning of March. The summer season follows thereafter and extends up to the end of the June. The south-west monsoon continues from July to mid-September. The mean annual rainfall over Sabi basin is 616mm, of which about 91% falls during the four monsoon months. The period from mid-September to mid-November forms the post-monsoon season.



ROLTA
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TOPOGRAPHY

The general topographic map presented in Plate – II reveals that the southern, south eastern and eastern fringes are hilly whereas the general slope of the terrain is towards north to northwest. Aravali ridges constitute the hills and give rise to ridge and valley topography in hilly areas. The maximum elevation (791m amsl) is found in Sikar district where the Sabi River originates. The maximum elevation found in other districts is also at comparable levels (760m in Jaipur district and 770m in Alwar district). The lowest elevation in the basin is 191m in Alwar district is at the point where the river Sabi exits Rajasthan and enters Haryana.

Table: District wise minimum and maximum elevation

S. No.	District Name	Min Elevation (m amsl)	Max. Elevation (m amsl)
1	Alwar	190.8	769.7
2	Jaipur	317.6	760.4
3	Sikar	406.3	791.5

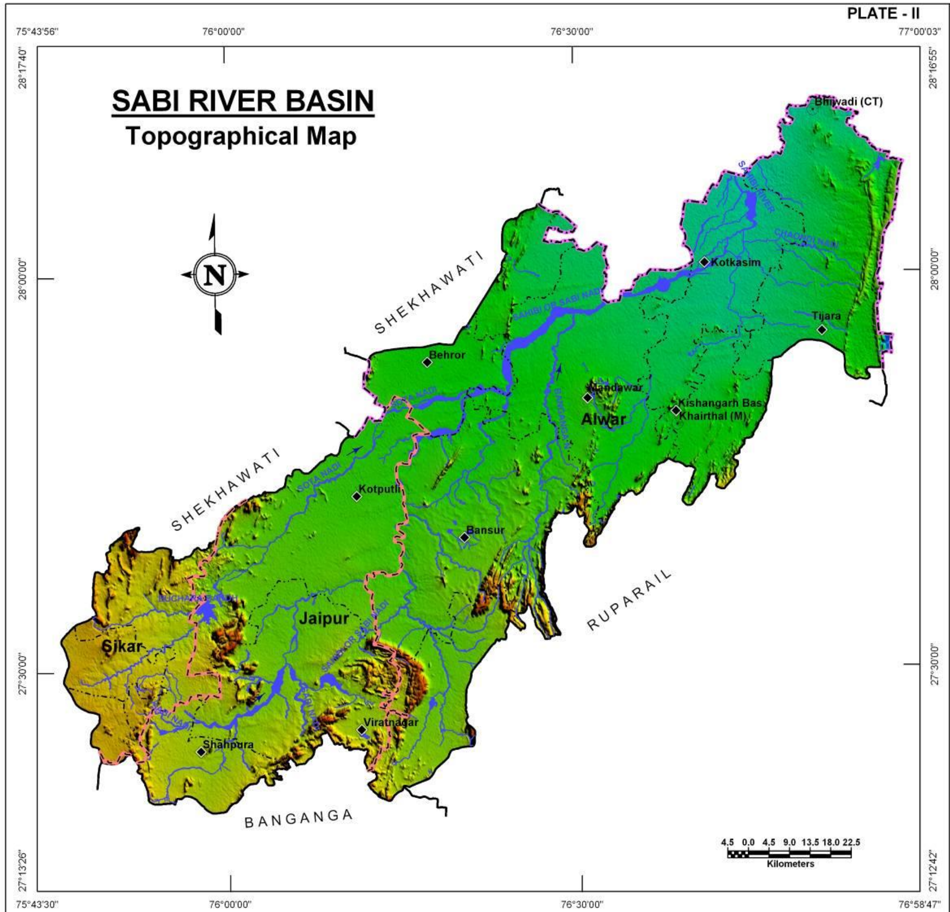
RAINFALL

The general distribution of rainfall across the Luni River Basin can be visualized from isohyets presented in the Plate III where except for the area around Behror and in the Bhiwandi – Tapukara – Tijara region (total annual rainfall received is less than 600mm), most of the basin receives good rainfall (total annual rainfall >800mm) especially hills and in their vicinity. Highest rainfall was recorded by the Kotkasim rain gauge station which measured total annual rainfall of 1,013mm in the year 2010.

Table: District wise total annual rainfall (based on year 2010 meteorological station recordings (http://waterresources.rajasthan.gov.in)

S. No.	Rain gauge Stations	Total Monsoon Rainfall (mm)	Total Non-Monsoon Rainfall (mm)	Total Annual Rainfall (mm)
1	Bairath	829.0	94.0	923.0
2	Bansur	678.0	40.0	718.0
3	Behrod	381.0	36.0	417.0
4	Kotkasim	936.0	77.0	1,013.0
5	Kotputli	757.0	59.0	816.0
6	Mundawar	707.0	59.0	766.0
7	Tapukara	495.0	-	495.0
8	Thanagaji	832.0	70.0	902.0
9	Tijara	618.0	61.0	679.0

PLATE - II



LEGEND

Admin Boundary:

- Block Headquarter
- Town
- State Boundary
- District Boundary
- Block Boundary

River Basin Boundary

Water Bodies:

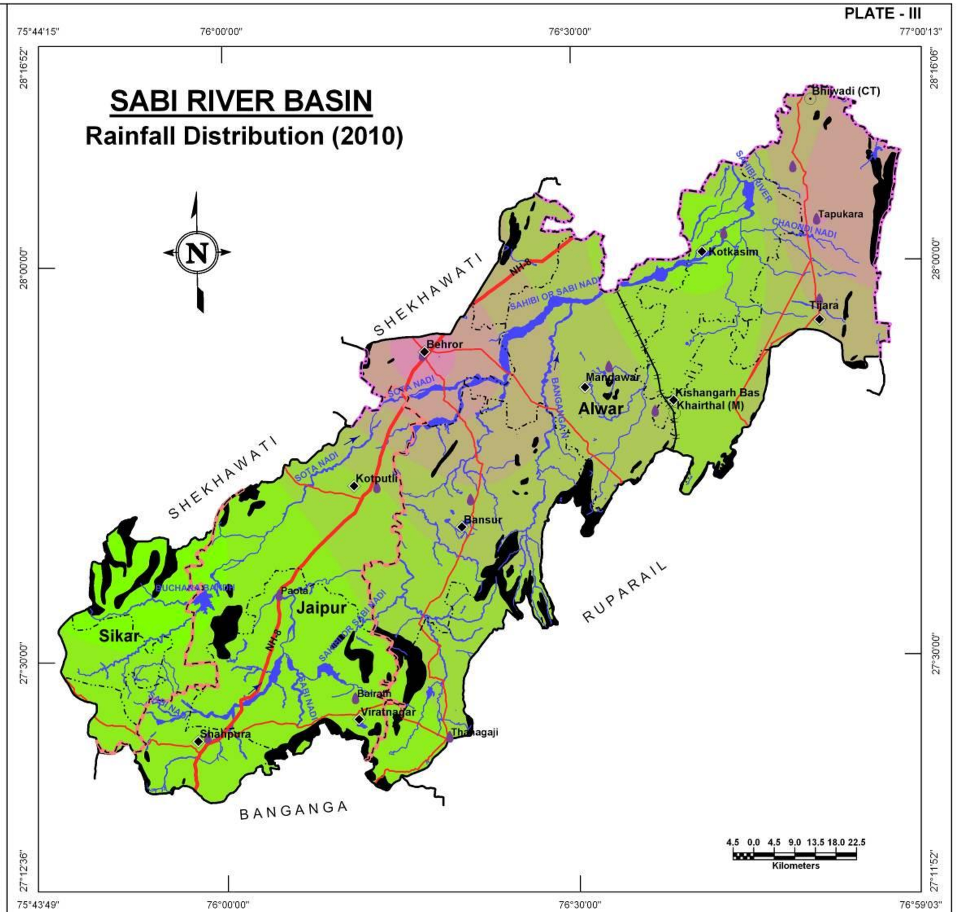
- River / Streams
- Ponds / Reservoirs

Elevation(m amsl):

716 m, 625 m, 500 m, 375 m, 250 m, 179 m

Source : SRTM DEM

PLATE - III



LEGEND

Admin Boundary:

- Block Headquarter
- Town
- Raingauge
- State Boundary
- District Boundary
- Block Boundary

River Basin Boundary

Roads:

- Natoinal Highway
- State Highway

Railway:

- Metre Gauge

Water Bodies:

- River / Streams
- Ponds / Reservoirs

Hills

Isohyets (mm):

- 400-500
- 500-600
- 600-700
- 700-800
- 800-900
- 900-1000
- > 1000

GEOLOGY

The Sabi River Basin is covered mainly by rocks belonging to the Pre-Cambrian rocks (Delhi Super-Group) to Aeolian and Fluvial deposits of Recent to Sub-Recent age. The hilly areas are primarily the areas where Delhi Super Group rocks are exposed in the form of ridges and valleys whereas the alluvium is deposited in the broad intervening valleys and regional depressions. Quartzites, schists, marbles are most prominent and other lithologies encountered are Granites, Pegmatites, Calc-silicates, Gneisses etc.

Age	Super-Group	Group/ Formation	Rock Types
Sub-Recent To Recent	Alluvium	Alluvium	Alluvial sand, Clays, Kankar, Gravel, Pebble beds, Colluvial cobbles and boulders, Wind-blown sand
----------x----------x----------x----------Unconformity----------x----------x----------x----------			
Lower Precambrian To Upper Precambrian	(Post-Delhi Intrusives)	--	Granites, pegmatites and amphibolites
Middle Precambrian	Delhi Super Group	Ajabgarh	Schists, Calc-schists, Phyllites, marbles and quartzites, gneisses, meta basics
		Alwar	Quartzites, Conglomerates, Schists

GEOMORPHOLOGY

Origin	Landform Unit	Description
Aeolian	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.
	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.
	Intermontane Valley	Depression between mountains, generally broad & linear, filled with colluvial deposits.
	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.
Fluvial	Alluvial Plain	Mainly undulating landscape formed due to fluvial activity, comprising of gravels, sand, silt and clay. Terrain mainly undulating, produced by extensive deposition of alluvium.
	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.
	Flood Plain	The surface or strip of relatively smooth land adjacent to a river channel formed by river and covered with water when river over flows its bank. Normally subject to periodic flooding.
	Valley Fill	Formed by fluvial activity, usually at lower topographic locations, comprising of boulders, cobbles, pebbles, gravels, sand, silt and clay. The unit has consolidated sediment deposits.
	Ravine	Small, narrow, deep, depression, smaller than gorges, larger than gulley, usually carved by running water.
Hills	Denudational, Structural Hill, Linear Ridge	Steep sided, relict hills undergone denudation, comprising of varying lithology with joints, fractures and lineaments. Linear to arcuate hills showing definite trend-lines with varying lithology associated with folding, faulting etc. Long narrow low-lying ridge usually barren, having high run off may form over varying lithology with controlled strike.

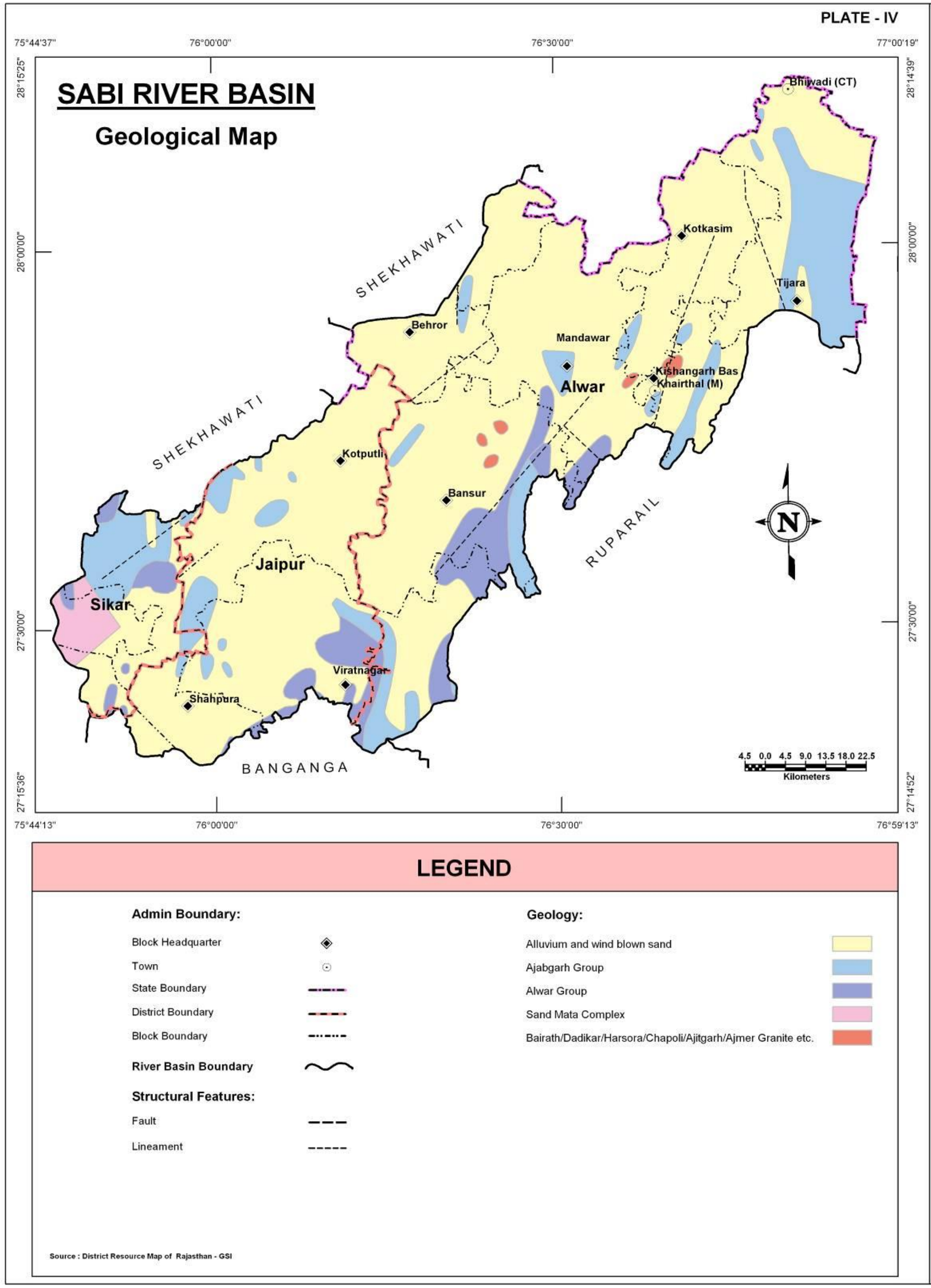


PLATE - IV
SABI RIVER BASIN
Geological Map
SHEKHAWATI
SHEKHAWATI
RUPARAIL
BANGANGA
Bhiwadi (CT)
Kotkasim
Tijara
Behror
Mandawar
Alwar
Kishangarh Bas
Khairthal (M)
Kotputli
Bansur
Jaipur
Sikar
Viratnagar
Shahpura
N
4.5 0.0 4.5 9.0 13.5 18.0 22.5
Kilometers
LEGEND
Admin Boundary:
Block Headquarter
Town
State Boundary
District Boundary
Block Boundary
River Basin Boundary
Structural Features:
Fault
Lineament
Geology:
Alluvium and wind blown sand
Ajabgarh Group
Alwar Group
Sand Mata Complex
Bairath/Dadikar/Harsora/Chapoli/Ajitgarh/Ajmer Granite etc.
Source : District Resource Map of Rajasthan - GSI

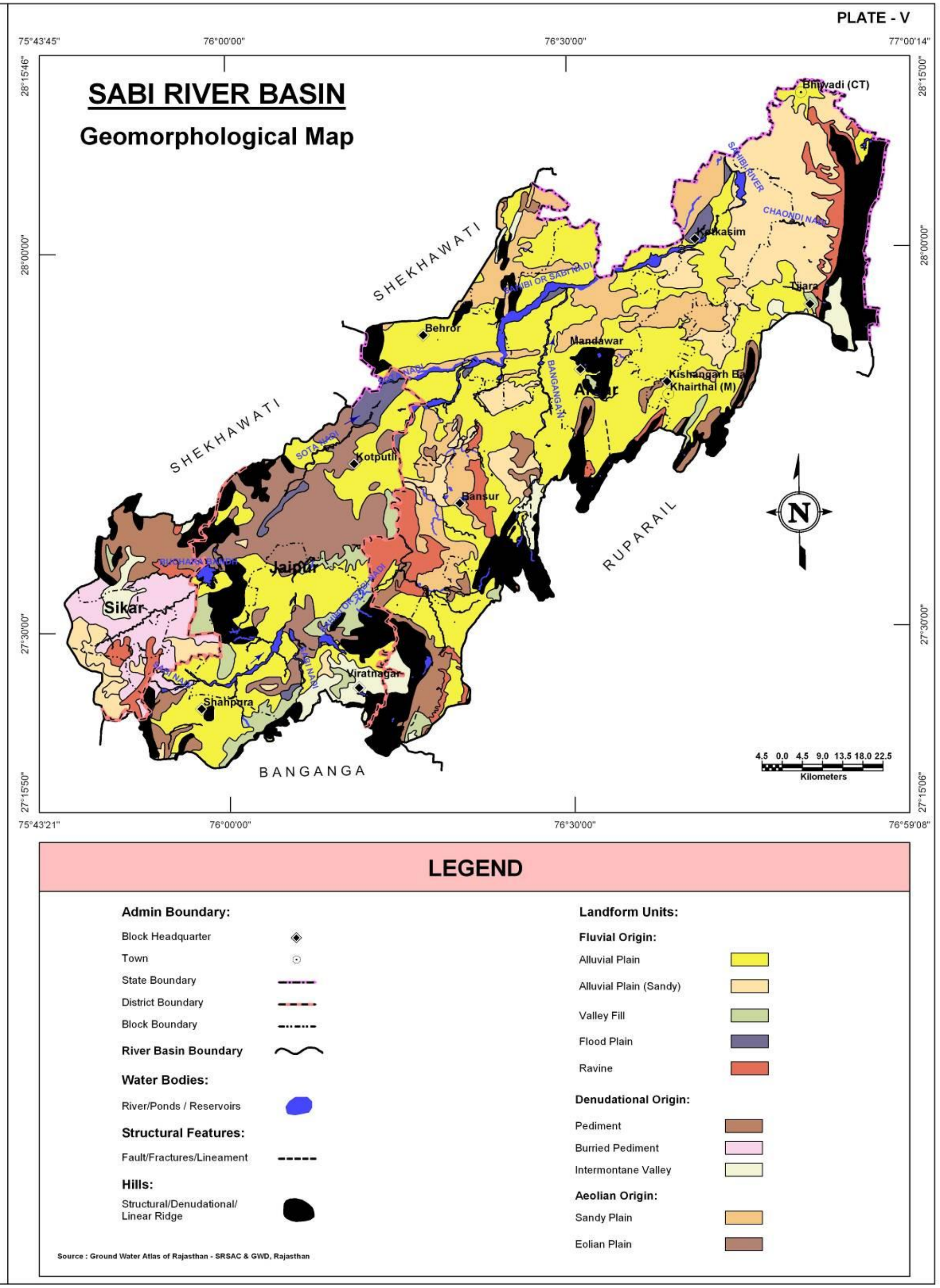


PLATE - V
SABI RIVER BASIN
Geomorphological Map
SHEKHAWATI
SHEKHAWATI
RUPARAIL
BANGANGA
Bhiwadi (CT)
Kotkasim
Tijara
Behror
Mandawar
Alwar
Kishangarh Bas
Khairthal (M)
Kotputli
Bansur
Jaipur
Sikar
Viratnagar
Shahpura
CHAONDI NADI
SOTA NADI
N
4.5 0.0 4.5 9.0 13.5 18.0 22.5
Kilometers
LEGEND
Admin Boundary:
Block Headquarter
Town
State Boundary
District Boundary
Block Boundary
River Basin Boundary
Water Bodies:
River/Ponds / Reservoirs
Structural Features:
Fault/Fractures/Lineament
Hills:
Structural/Denudational/
Linear Ridge
Landform Units:
Fluvial Origin:
Alluvial Plain
Alluvial Plain (Sandy)
Valley Fill
Flood Plain
Ravine
Denudational Origin:
Pediment
Burried Pediment
Intermontane Valley
Aeolian Origin:
Sandy Plain
Eolian Plain
Source : Ground Water Atlas of Rajasthan - SRSAC & GWD, Rajasthan

AQUIFERS

Younger and Older alluvium together form the predominant aquifer type in the Basin and also among these the Older alluvium is more prominent. While all the alluvium together account for about 82% of the basin area, the older alluvium alone occupies about 59%. The alluvium is both of fluvial and aeolian origin constituted of sand, silt, clay and gravel and at times Kankar too. The weathered and fractured quartzite contributes to rest of the aquifer area forming 13% of Sabi river basin.

Aquifer in Potential Zone	Area (sq km)	% of Basin Area	Description of the unit/Occurrence
Younger Alluvium	1,007.6	21.9	It is largely constituted of Aeolian and Fluvial sand, silt, clay, gravel and pebbles in varying proportions.
Older Alluvium	2,733.7	59.3	This litho unit comprises of mixture of heterogeneous fine to medium grained sand, silt and kankar.
Quartzite	597.5	13.0	Medium to coarse grained and varies from feldspathic grit to sericitic quartzite.
Non Potential Zone	269.1	5.8	Hills
Total	**4,607.9**	**100.0**	

LOCATION OF GROUND WATER MONITORING WELLS

The basin has a well distributed network of large number of ground water monitoring stations (114) in the basin owned by RGWD (76) and CGWB (38); and an additional 120 wells have been recommended to be added to network to effectively monitor ground water level (5 additional wells in Alwar district) and quality (15 additional wells) in the basin.

District Name	CGWB	RGWD	Total	Recommended additional wells for optimization of monitoring network	
				Water Level	Water Quality
Alwar	31	50	81	5	103
Jaipur	7	17	24	-	2
Sikar		9	9	-	10
Total	**38**	**76**	**114**	**5**	**115**

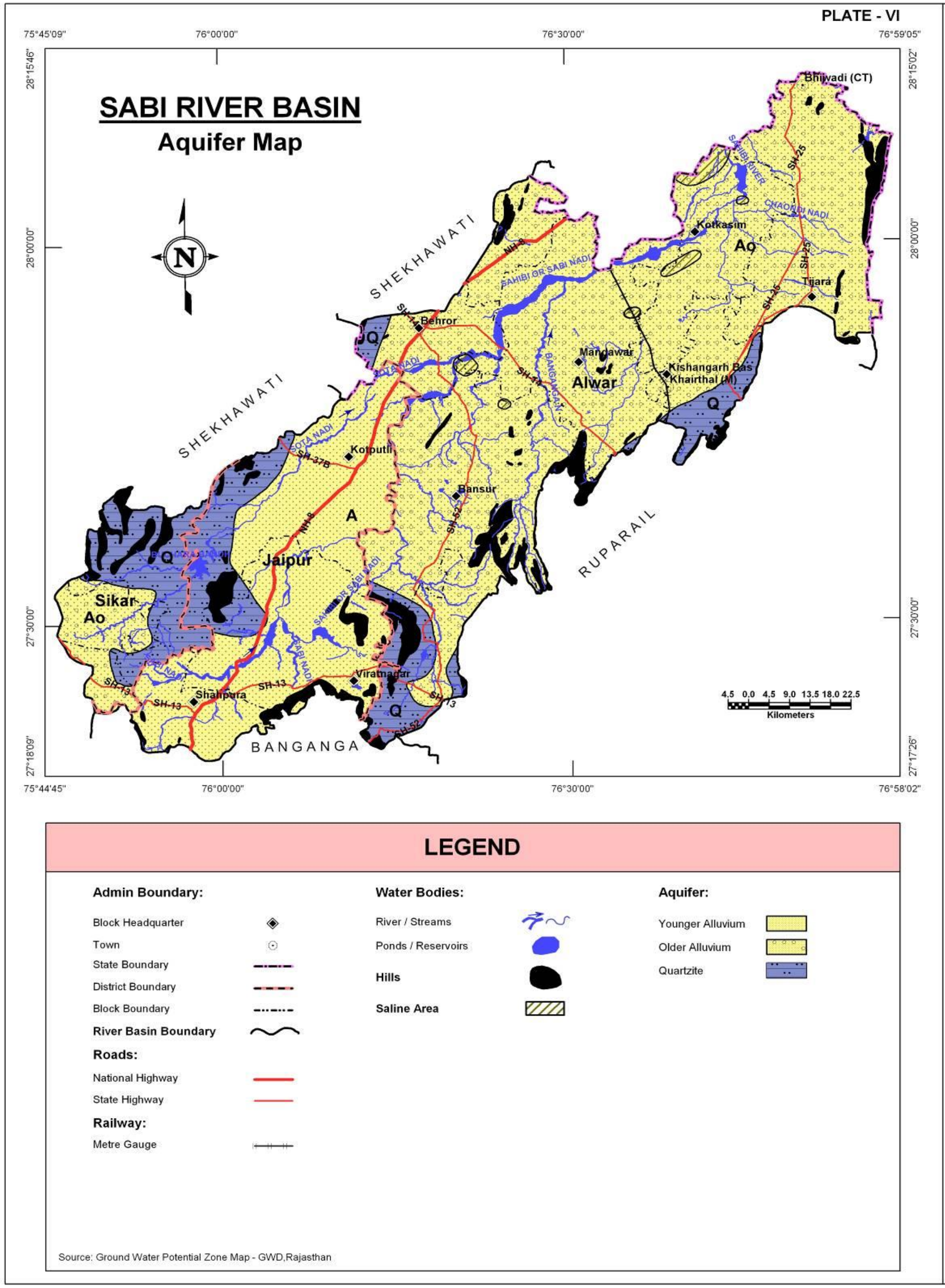


PLATE - VI
SABI RIVER BASIN
Aquifer Map
N
SHEKHAWATI
SHEKHAWATI
RUPARAIL
BANGANGA
Bhiwadi (CT)
Kotkasim
Tijara
Behror
Mandawar
Alwar
Kishangarh Bas
Khairthal (M)
Kotputli
Bansur
Jaipur
Sikar
Viratnagar
Shahpura
Ao
A
Q
Kilometers
LEGEND
Admin Boundary:
Block Headquarter
Town
State Boundary
District Boundary
Block Boundary
River Basin Boundary
Roads:
National Highway
State Highway
Railway:
Metre Gauge
Water Bodies:
River / Streams
Ponds / Reservoirs
Hills
Saline Area
Aquifer:
Younger Alluvium
Older Alluvium
Quartzite
Source: Ground Water Potential Zone Map - GWD,Rajasthan

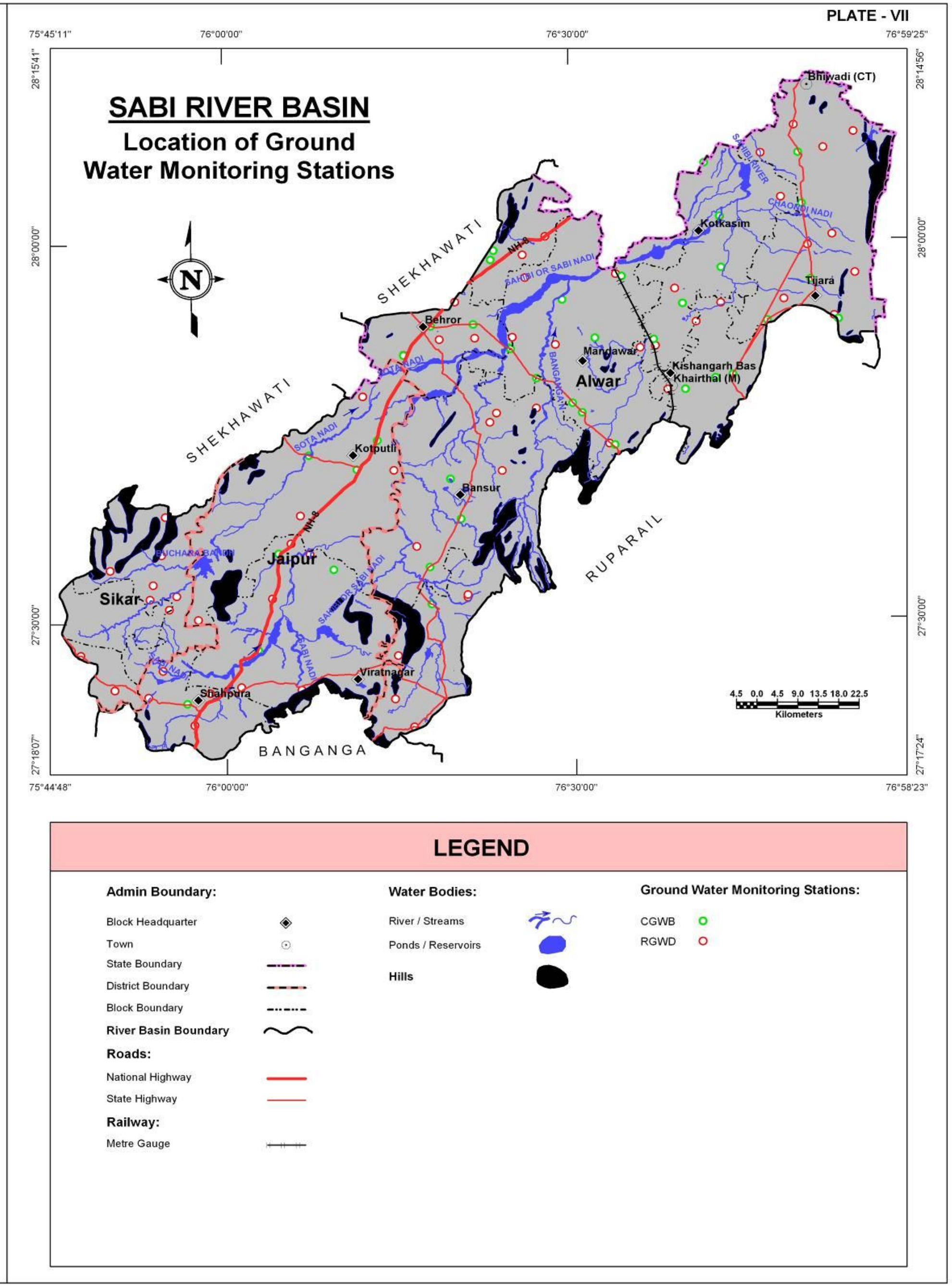


PLATE - VII
SABI RIVER BASIN
Location of Ground
Water Monitoring Stations
N
SHEKHAWATI
SHEKHAWATI
RUPARAIL
BANGANGA
Bhiwadi (CT)
Kotkasim
Tijara
Behror
Mandawar
Alwar
Kishangarh Bas
Khairthal (M)
Kotputli
Bansur
Jaipur
Sikar
Viratnagar
Shahpura
Kilometers
LEGEND
Admin Boundary:
Block Headquarter
Town
State Boundary
District Boundary
Block Boundary
River Basin Boundary
Roads:
National Highway
State Highway
Railway:
Metre Gauge
Water Bodies:
River / Streams
Ponds / Reservoirs
Hills
Ground Water Monitoring Stations:
CGWB
RGWD

LOCATION OF EXPLORATORY WELLS

In all there are 134 exploratory wells present in the basin drilled in the past by RGWD (107) and CGWB (27) that form basis for interpretation and understanding of sub-surface aquifer distribution. The exploratory wells are well distributed all over the basin.

District Name	CGWB	RGWD	Total
Alwar	22	91	113
Jaipur	5	13	18
Sikar	-	3	3
Total	**27**	**107**	**134**

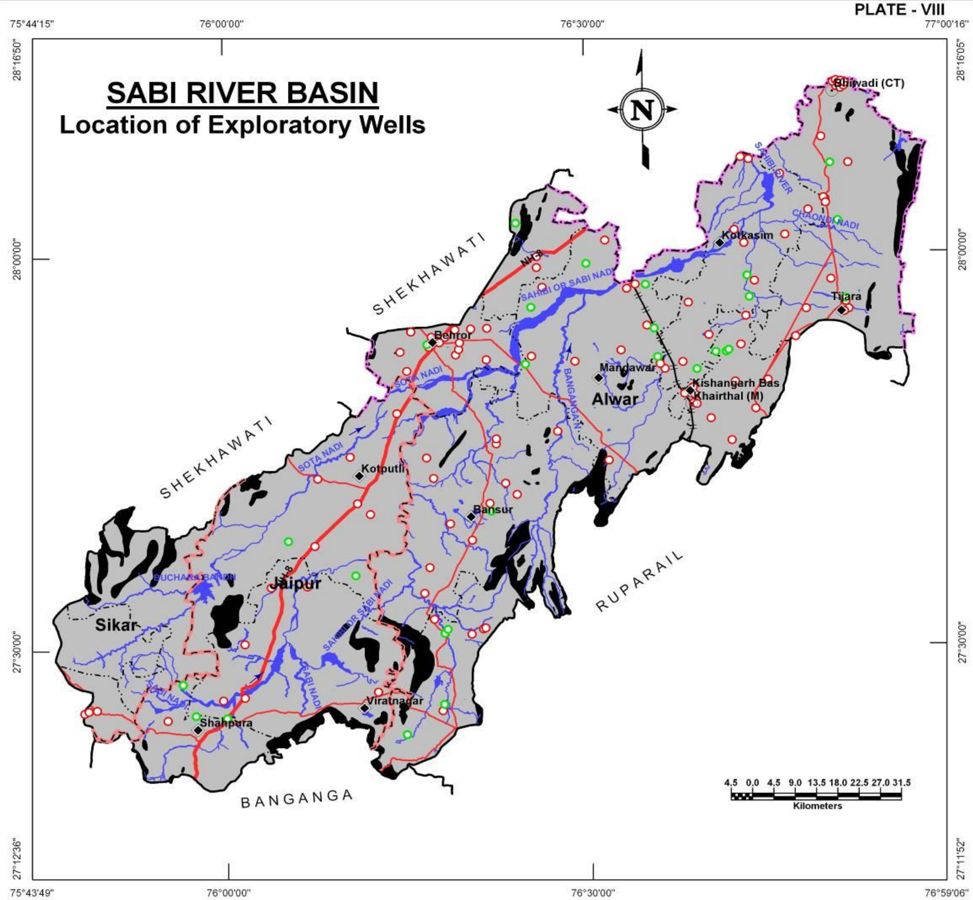
DEPTH TO WATER LEVEL (PRE MONSOON – 2010)

The map showing depth water level contours is presented in Plate – IX. Most of the river basin shows general water level depth in the range of 10 – 40m bgl. There are three prominent isolated pockets in the southwest, southeast and northwestern part of the basin which show deeper water levels about 60m bgl incidentally, these areas also correspond to hilly parts of the basin. The broad patch in the Kotkasim – Tijara – Bhiwandi region, the ground water occurs at shallow depths of less than 20m bgl.

Depth to water level (m bgl) Pre Monsoon - 2010	District wise area coverage (sq km)*			Total Area (sq km)
	Alwar	Jaipur	Sikar	
< 10	1.9	-	-	**1.9**
10 - 20	820.2	15.5	56.4	**892.1**
20 - 30	1,074.9	873.0	144.5	**2,092.4**
30 - 40	640.9	271.2	74.2	**986.3**
40 - 50	155.9	21.4	81.2	**258.5**
50 - 60	66.5	-	23.9	**90.4**
> 60	17.2	-	-	**17.2**
Total	**2,777.5**	**1,181.1**	**380.2**	**4,338.8**

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

PLATE - VIII



LEGEND

Admin Boundary:

- Block Headquarter
- Town
- State Boundary
- District Boundary
- Block Boundary

River Basin Boundary

Railway

- Metre Gauge

Roads

- Natoinal Highway
- State Highway

Water Bodies:

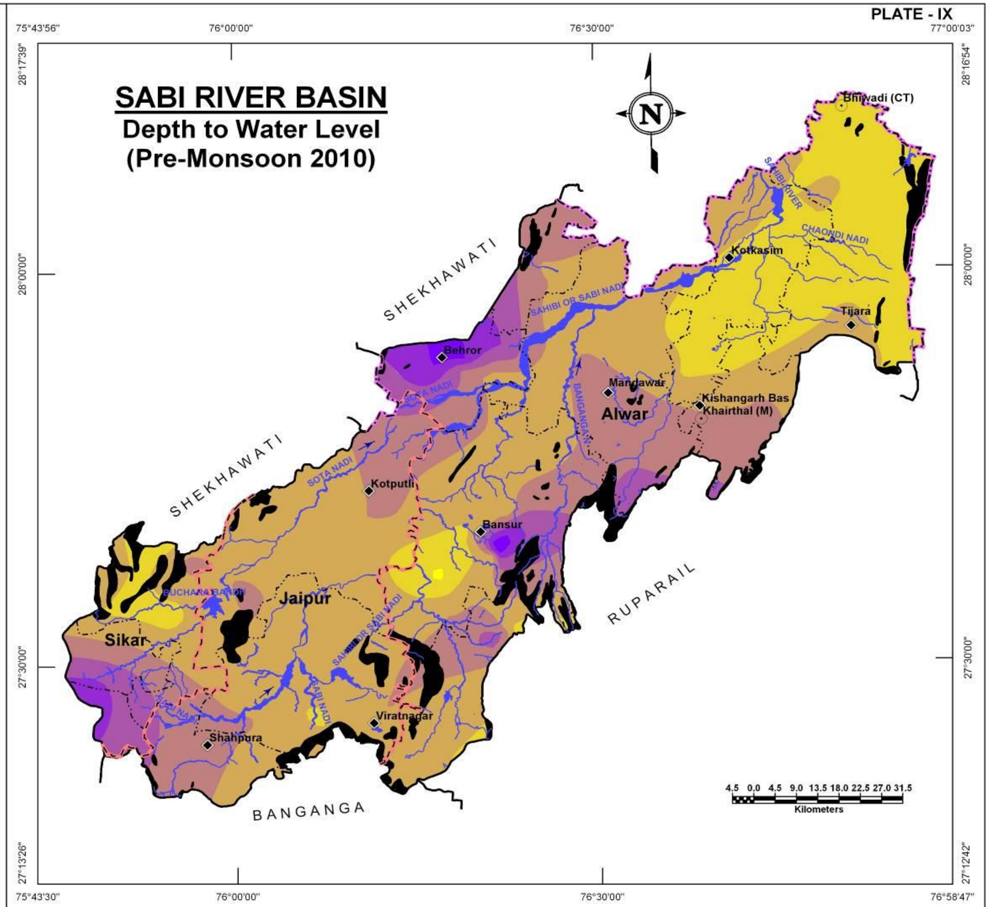
- River / Streams
- Ponds / Reservoirs

Hills

Exploratory Wells:

- CGWB
- RGWD

PLATE - IX



LEGEND

Admin Boundary:

- Block Headquarter
- Town
- State Boundary
- District Boundary
- Block Boundary

River Basin Boundary

Water Bodies:

- River / Streams
- Ponds / Reservoirs

Hills

Depth to Water Level (m bgl):

- < 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- > 60

WATER TABLE ELEVATION (PRE MONSOON 2010) SABI RIVER BASIN

Water table elevation map is important in order to visualize the ground water flow directions in the river basin. The map is presented in Plate – X and reveals that the highest ground water elevation is seen in the hilly areas of Sikar district and the lowest elevation corresponding to the exit point of Sabi River from the State. The overall flow of the ground water thus is from southwest to northeast following the general topographic trend in the basin. The total fall in water level head across the basin is about 240m and the gradient is higher in the hilly areas as suggested by closely spaced contours but a relatively sluggish flow in the flatter parts of the basin beyond Alwar, northwards indicated by widely spaced contours.

Water Table Elevation (m amsl) Pre Monsoon - 2010	District wise area coverage (sq km)			Total Area (sq km)
	Alwar	Jaipur	Sikar	
< 240	76.1	-	-	**76.1**
240 - 260	666.2	-	-	**666.2**
260 - 280	844.2	-	-	**844.2**
280 - 300	354.3	13.1	-	**367.4**
300 - 320	257.5	61.1	-	**318.6**
320 - 340	147.0	108.9	-	**255.9**
340 - 360	226.4	174.2	-	**400.6**
360 - 380	103.3	190.4	-	**293.7**
380 - 400	64.4	220.2	-	**284.6**
400 - 440	38.1	401.9	85.3	**525.3**
440 - 480	-	11.3	293.4	**304.7**
> 480	-	-	1.5	**1.5**
Total	**2,777.5**	**1,181.1**	**380.2**	**4,338.8**

WATER LEVEL FLUCTUATION (PRE TO POST MONSOON 2010)

The Basin area is a mixture of hardrock aquifers and those formed within thick cover of alluvium as can be seen from aquifer distribution map in Plate – VI. Therefore, wide fluctuations in water levels are seen which ranges broadly from -8m to +16m. Unusually high water level rise is seen in Sikar area which was recorded in quartzite aquifer measuring the highest in the basin (rise of about 16m). Similarly a localized high extraction is indicated in the well near Bansur in Alwar district. Apart from these two extremities which together occupy no more than 4% of the basin area, the general ground water level fluctuation has been in the range of -2m to +4m.

District Name	District wise area coverage (sq km) within fluctuation range (m)												Total Area (sq km)
	-8 to -6	-6 to -4	-4 to -2	-2 to 0	0 to 2	2 to 4	4 to 6	6 to 8	8 to 10	10 to 12	12 to 14	14 to 16	
Alwar	0.8	2.8	9.9	421.3	1,975.3	297.5	50.8	19.1	-	-	-	-	**2,777.5**
Jaipur	-	-	-	237.0	733.7	143.4	40.2	18.4	7.3	1.1	-	-	**1,181.1**
Sikar	-	-	-	2.5	71.8	77.0	63.7	51.3	48.8	38.5	26.4	0.2	**380.2**
Total	**0.8**	**2.8**	**9.9**	**660.8**	**2,780.8**	**517.9**	**154.7**	**88.8**	**56.1**	**39.6**	**26.4**	**0.2**	**4,338.8**

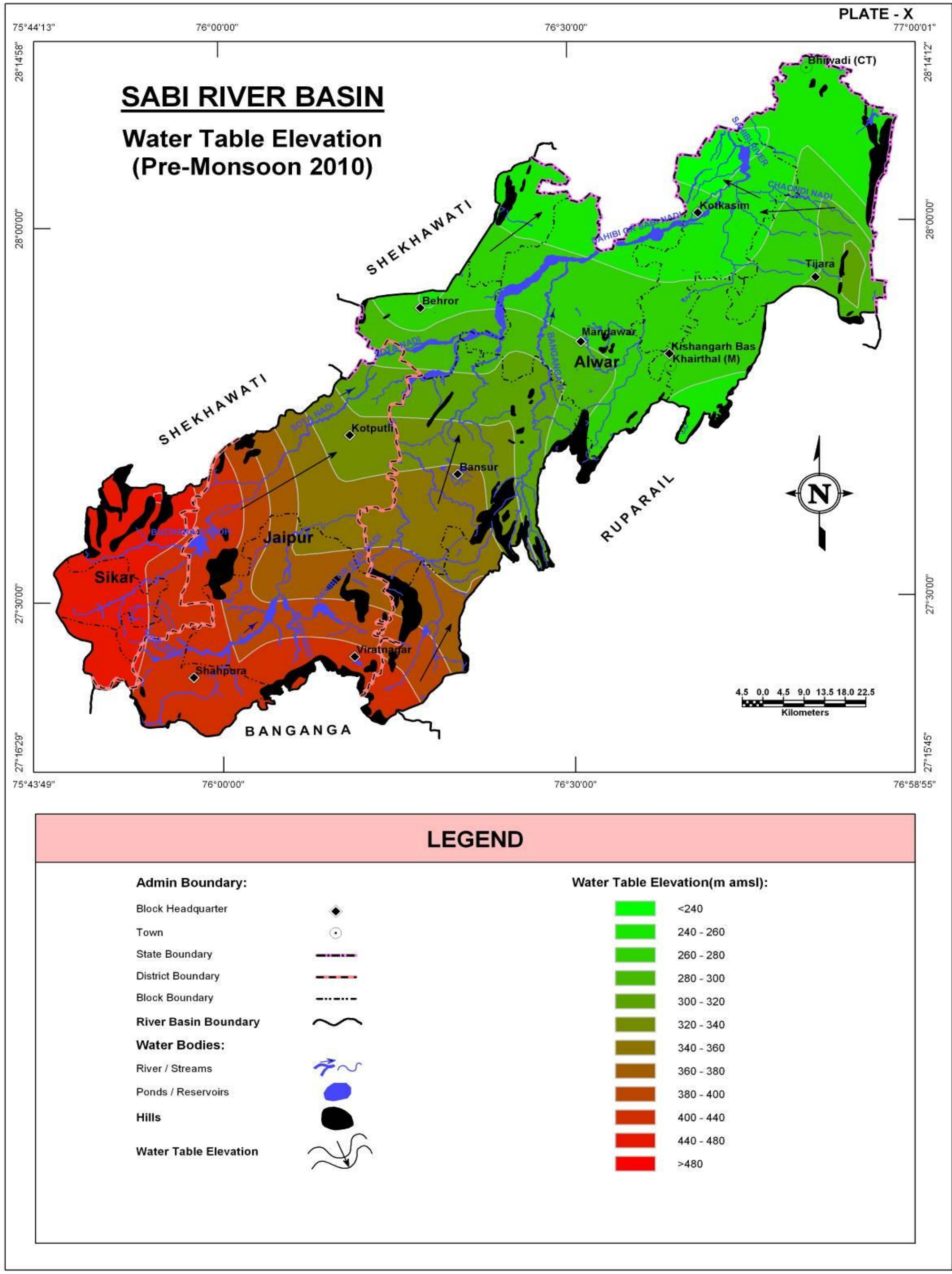


PLATE - X
SABI RIVER BASIN
Water Table Elevation
(Pre-Monsoon 2010)
SHEKHAWATI
SHEKHAWATI
RUPARAIL
BANGANGA
Bhiwadi (CT)
Kotkasim
Tijara
Behror
Mandawar
Alwar
Kishangarh Bas
Khairthal (M)
Kotputli
Bansur
Jaipur
Sikar
Viratnagar
Shahpura
N
4.5 0.0 4.5 9.0 13.5 18.0 22.5
Kilometers
LEGEND
Admin Boundary:
Block Headquarter
Town
State Boundary
District Boundary
Block Boundary
River Basin Boundary
Water Bodies:
River / Streams
Ponds / Reservoirs
Hills
Water Table Elevation
Water Table Elevation(m amsl):
<240
240 - 260
260 - 280
280 - 300
300 - 320
320 - 340
340 - 360
360 - 380
380 - 400
400 - 440
440 - 480
>480

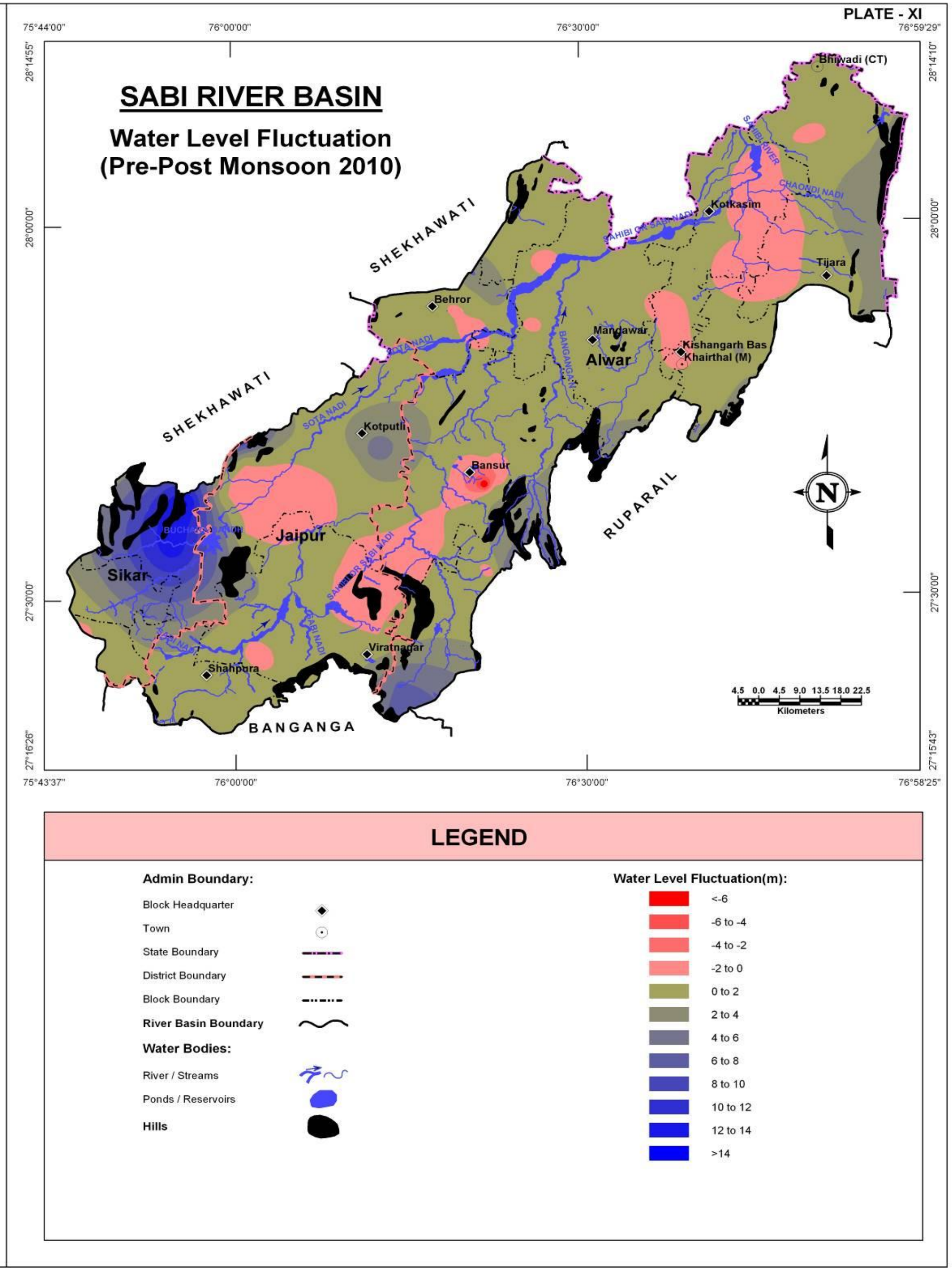


PLATE - XI
SABI RIVER BASIN
Water Level Fluctuation
(Pre-Post Monsoon 2010)
SHEKHAWATI
SHEKHAWATI
RUPARAIL
BANGANGA
Bhiwadi (CT)
Kotkasim
Tijara
Behror
Mandawar
Alwar
Kishangarh Bas
Khairthal (M)
Kotputli
Bansur
Jaipur
Sikar
Viratnagar
Shahpura
N
4.5 0.0 4.5 9.0 13.5 18.0 22.5
Kilometers
LEGEND
Admin Boundary:
Block Headquarter
Town
State Boundary
District Boundary
Block Boundary
River Basin Boundary
Water Bodies:
River / Streams
Ponds / Reservoirs
Hills
Water Level Fluctuation(m):
<-6
-6 to -4
-4 to -2
-2 to 0
0 to 2
2 to 4
4 to 6
6 to 8
8 to 10
10 to 12
12 to 14
>14

ELECTRICAL CONDUCTIVITY DISTRIBUTION

The Electrical Conductivity (at 25^{o}C) distribution map is presented in Plate – XII reveals that the overall quality of ground water in the basin from EC point of view is good as indicated by yellow coloured region (EC < 2000 µS/cm) occupying most part of the basin. This region encompasses all the districts and aquifer types and covers about 90% of the basin area. There is a small patch north of Alwar where the EC values in ground water are very high (EC >4000 µS/cm). The moderate EC region (EC between 2000 – 4000 µS/cm) surrounds the high EC area and also occurs as isolated patches in southern part of basin within alluvial aquifers.

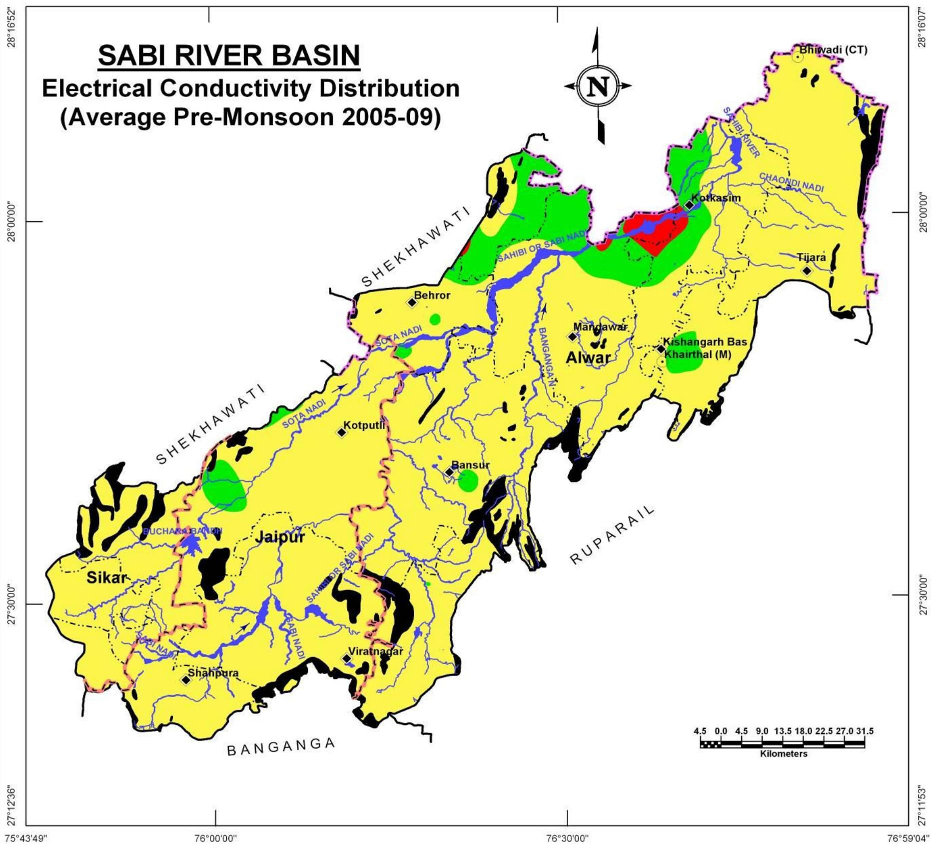
Electrical Conductivity Ranges (µS/cm at 25^{o}C) (Ave. of years 2005-09)	District wise area coverage (sq km)						Total Area (sq km)
	Alwar		Jaipur		Sikar		
	Area	% age	Area	% age	Area	% age	
< 2000	2,394.1	86.2	1,142.3	96.7	380.2	100.0	**3,916.6**
2000-4000	338.1	12.2	38.8	3.3	-	-	**376.9**
> 4000	45.3	1.6	-	-	-	-	**45.3**
Total	**2,777.5**	**100.0**	**1,181.1**	**100.0**	**380.2**	**100.0**	**4,338.8**

CHLORIDE DISTRIBUTION

The yellow coloured region (Chloride <250mg/l) in Plate – XIII indicates the areas that have ground water suitable for domestic purposes. The green coloured region (Chloride 250 – 1000 mg/l) defines the area where ground water is still within tolerable limits for domestic consumption and on adding these two regions together, these occupy 99.4% of the basin area that leaves only very small part of the basin in the northwestern part which is unsuitable because of high Chloride concentration (>1000 mg/l) in ground water.

Chloride Ranges (mg/l) (Ave. of years 2005-09)	District wise area coverage (sq km)						Total Area (sq km)
	Alwar		Jaipur		Sikar		
	Area	% age	Area	% age	Area	% age	
< 250	2,178.2	78.4	895.0	75.8	339.7	89.4	**3,412.9**
250 - 1000	573.9	20.7	286.1	24.2	40.5	10.6	**900.5**
> 1000	25.4	0.9	-	-	-	-	**25.4**
Total	**2,777.5**	**100.0**	**1,181.1**	**100.0**	**380.2**	**100.0**	**4,338.8**

PLATE - XII



LEGEND

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

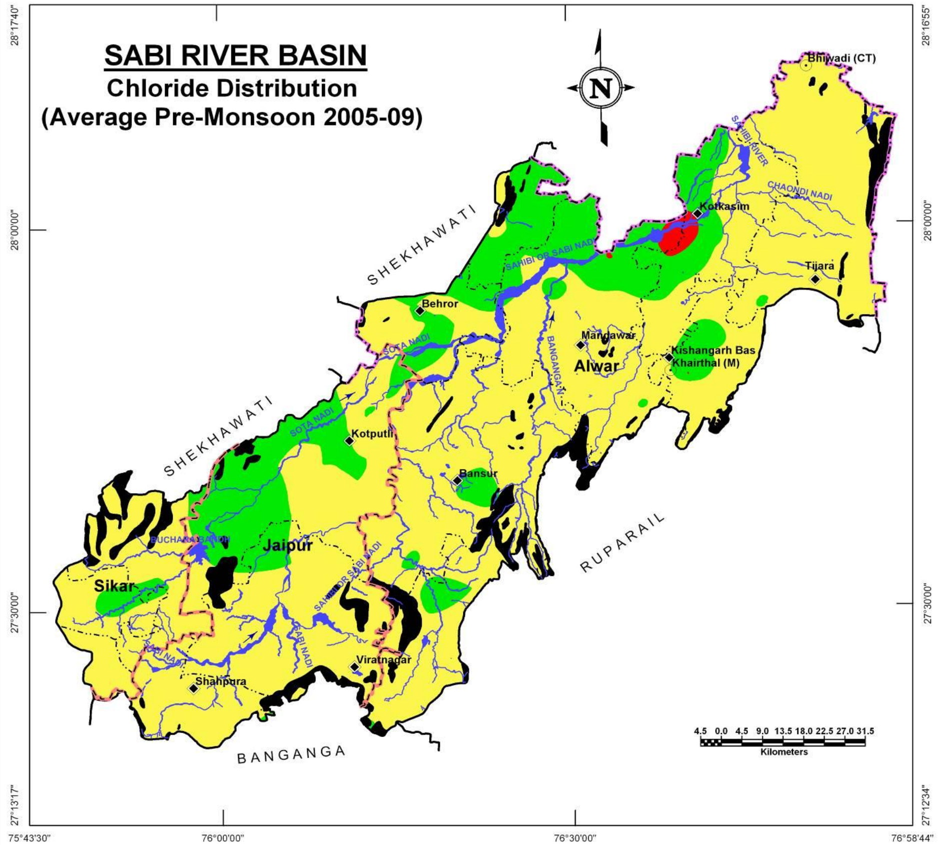
River Basin Boundary

Water Bodies:
- River / Streams
- Ponds / Reservoirs

Hills

Electrical Conductivity (μS/cm at 25°C):
- < 2000
- 2000-4000
- > 4000

PLATE - XIII



LEGEND

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

River Basin Boundary

Water Bodies:
- River / Streams
- Ponds / Reservoirs

Hills

Chloride Concentration (mg/l):
- < 250
- 250 - 1000
- > 1000

FLUORIDE DISTRIBUTION

The Fluoride concentration map (Plate – XIV) displays a large patch of high fluoride concentration (>3 mg/l) in the northern part of Alwar district and close to the exit of Sabi River from Rajasthan. This is about 74 sq km in area and constitutes less than 2% of the basin area which is unsuitable for domestic purposes. Another small area of high Fluoride concentration is seen in the south of Bansur which also is within Alwar district. Rest of the 97% of the basin area is either very low in Fluoride concentration (F <1.5 mg/l) or has moderately high (F between 1.5 – 3.0 mg/l).

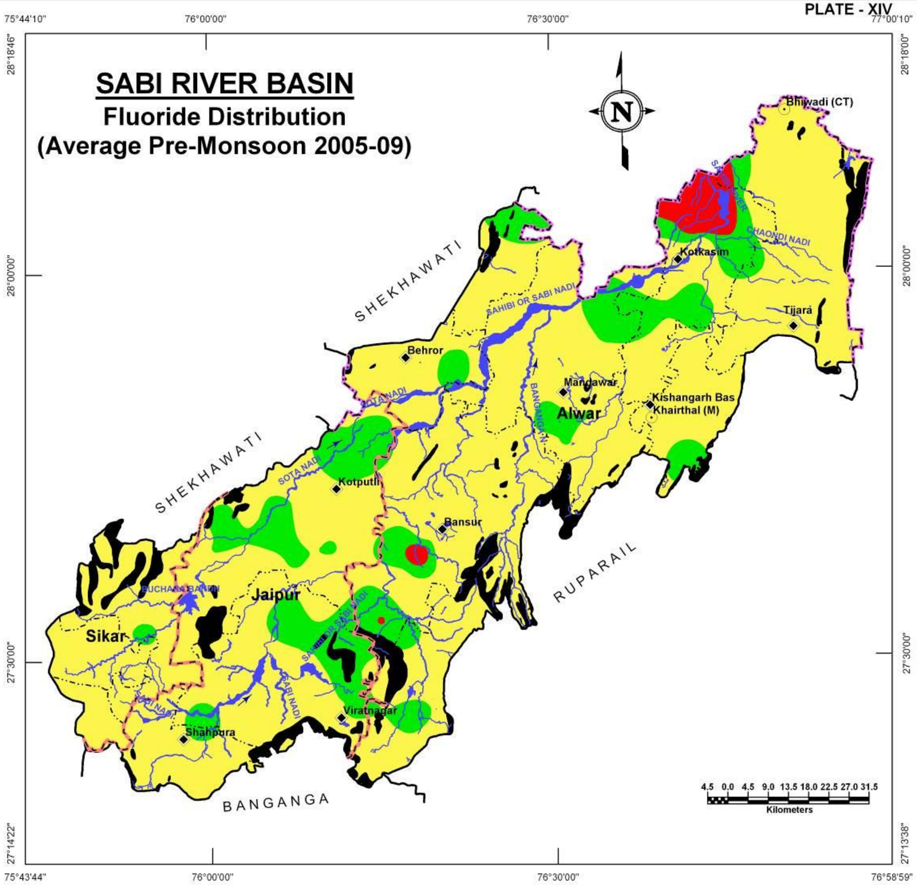
Fluoride Ranges (mg/l) (Ave. of years 2005-09)	District wise area coverage (sq km)						Total Area (sq km)
	Alwar		Jaipur		Sikar		
	Area	% age	Area	% age	Area	% age	
< 1.5	2,285.5	82.3	887.8	75.2	372.0	97.9	**3,545.3**
1.5-3.0	405.9	14.6	293.3	24.8	8.2	2.1	**707.4**
> 3.0	86.1	3.1	-	-	-	-	**86.1**
Total	**2,777.5**	**100.0**	**1,181.1**	**100.0**	**380.2**	**100.0**	**4,338.8**

NITRATE DISTRIBUTION

High nitrate concentration in ground water renders it unsuitable for agriculture purposes. Plate – XV shows distribution of Nitrate in ground water wherein there are several isolated patches distributed all over the basin. The distribution is seen both in quartzite and alluvial aquifers alike. Northern alluvial part is seen to have more patches of high Nitrate concentration in ground water (Nitrate >100 mg/l). These areas occupy about 10% of the basin area while rest of the basin either falls within low (Nitrate <50 mg/l) or moderately high (Nitrate 50-100 mg/l) category rendering the ground water bye and large suitable for agriculture.

Nitrate Ranges (mg/l) (Ave. of years 2005-09)	District wise area coverage (sq km)						Total Area (sq km)
	Alwar		Jaipur		Sikar		
	Area	% age	Area	% age	Area	% age	
< 50	1,407.6	50.7	904.0	76.5	122.5	32.2	**2,434.1**
50-100	1,021.1	36.7	236.3	20.0	202.6	53.3	**1,460.0**
> 100	348.8	12.6	40.8	3.5	55.1	14.5	**444.7**
Total	**2,777.5**	**100.0**	**1,181.1**	**100.0**	**380.2**	**100.0**	**4,338.8**

PLATE - XIV



LEGEND

Admin Boundary:

- Block Headquarter
- Town
- State Boundary
- District Boundary
- Block Boundary

River Basin Boundary

Water Bodies:

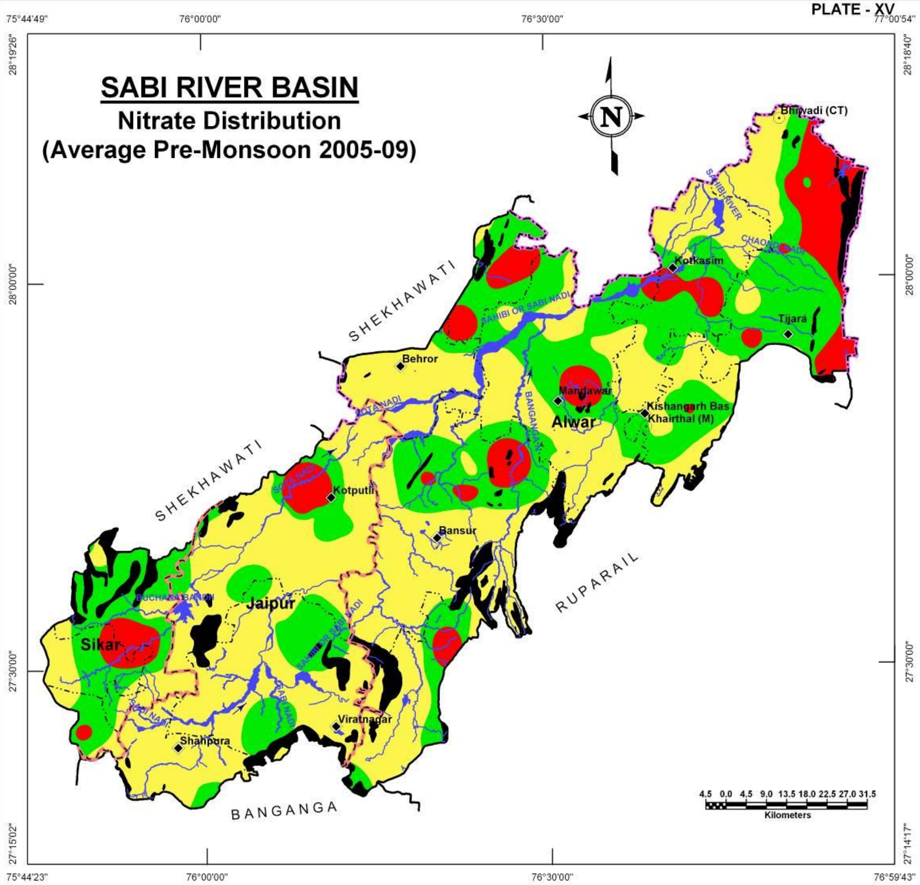
- River / Streams
- Ponds / Reservoirs

Hills

Fluoride Concentration(mg/l):

- < 1.5
- 1.5-3.0
- > 3.0

PLATE - XV



LEGEND

Admin Boundary:

- Block Headquarter
- Town
- State Boundary
- District Boundary
- Block Boundary

River Basin Boundary

Water Bodies:

- River / Streams
- Ponds / Reservoirs

Hills

Nitrate Concentration (mg/l):

- < 50
- 50-100
- > 100

DEPTH TO BEDROCK

The hilly areas expose the bedrock and gradually into the plains, the thick alluvial pile conceals the bedrock under sand, clay and mix. From an aquifer perspective, the beginning of massive bedrock is taken to mark the start of bedrock and thus the weathered and fractured part of bedrock and alluvial cover constitutes the material above the bedrock. Plate XVI represents depth to bedrock in meters below ground level (bgl).

Steeply dipping bedrock surface is indicated in the depths of about 40m bgl in the vicinity of hills which gradually but consistently deepens towards the northeastern part to reach the maximum of about 120m bgl as seen around Tijara and Kotkasim. The bedrock is primarily made up of quartzites and slates.

Depth to Bedrock (m bgl)	District wise area coverage (sq km)			Total Area (sq km)
	Alwar	Jaipur	Sikar	
< 40	18.3	0.3	47.5	**66.1**
40-60	445.4	987.3	332.7	**1,765.4**
60-80	971.4	163.0	-	**1,134.4**
80-100	758.3	30.5	-	**788.8**
100-120	366.9	-	-	**366.9**
> 120	217.2	-	-	**217.2**
Total	**2,777.5**	**1,181.1**	**380.2**	**4,338.8**

UNCONFINED AQUIFER

Hydrogeological properties are different for alluvial and hard rock aquifers and therefore, this aquifer has been mapped as two separate regions viz, unconfined aquifers in alluvial and in hard rock areas.

The alluvial material is predominantly eolian or fluvial origin sand, clay and gravel. The thickness of this aquifer depends on the thickness of saturation zone within aquifer material and in turn on depth to water level. Generally deeper water levels leave lesser thickness of aquifer zones. The Plate – XVII and table below reveals a generally less than 20m thickness of unconfined aquifer zone in alluvial areas, occasionally reaching higher thicknesses of 50m and rarely 70m bgl. In hardrock areas also the general thickness of unconfined aquifers is low i.e., below 20m only.

Alluvial areas:

`Unconfined aquifer Thickness (m)	District wise area coverage (sq km)			Total Area (sq km)
	Alwar	Jaipur	Sikar	
< 10	1,421.0	696.0	33.0	**2,150.0**
10-20	777.6	248.0	112.5	**1,138.1**
20-30	287.8	56.3	24.7	**368.8**
30-40	88.0	5.3	-	**93.3**
40-50	31.0	-	-	**31.0**
50-60	2.5	-	-	**2.5**
60-70	1.1	-	-	**1.1**
> 70	0.5	-	-	**0.5**
Total	**2,609.5**	**1,005.6**	**170.2**	**3,785.3**

Hardrock areas:

Unconfined aquifer Thickness (m)	District wise area coverage (sq km)			Total Area (sq km)
	Alwar	Jaipur	Sikar	
<10	31.9	84.7	101.3	**217.9**
10-20	128.6	81.9	108.7	**319.2**
> 20	7.5	8.9	-	**16.4**
Total	**168.0**	**175.5**	**210.0**	**553.5**

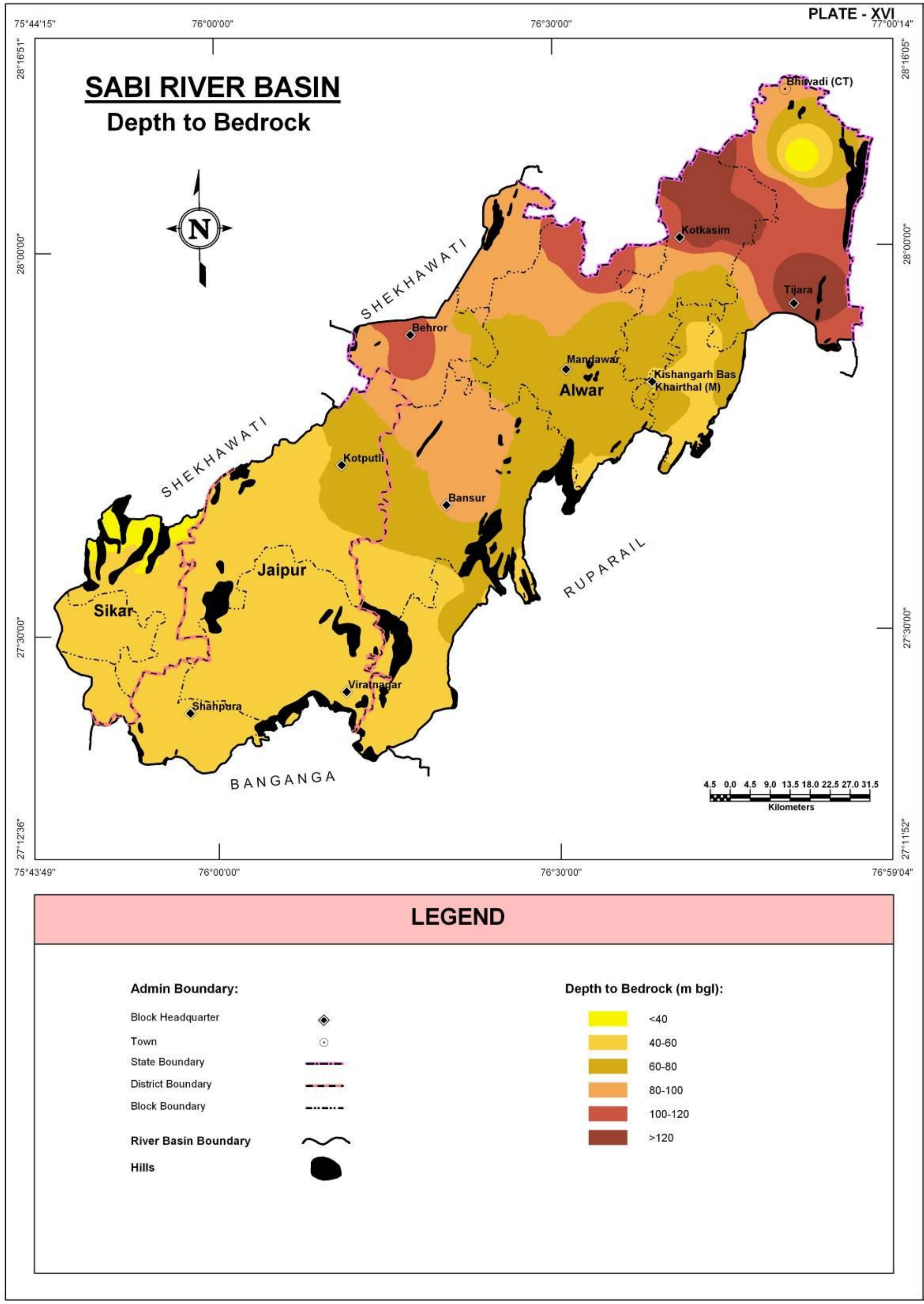


PLATE - XVI
SABI RIVER BASIN
Depth to Bedrock
N
SHEKHAWATI
SHEKHAWATI
RUPARAIL
BANGANGA
Bhiwadi (CT)
Kotkasim
Tijara
Behror
Mandawar
Alwar
Kishangarh Bas
Khairthal (M)
Kotputli
Bansur
Jaipur
Sikar
Viratnagar
Shahpura
Kilometers
LEGEND
Admin Boundary:
Block Headquarter
Town
State Boundary
District Boundary
Block Boundary
River Basin Boundary
Hills
Depth to Bedrock (m bgl):
<40
40-60
60-80
80-100
100-120
>120

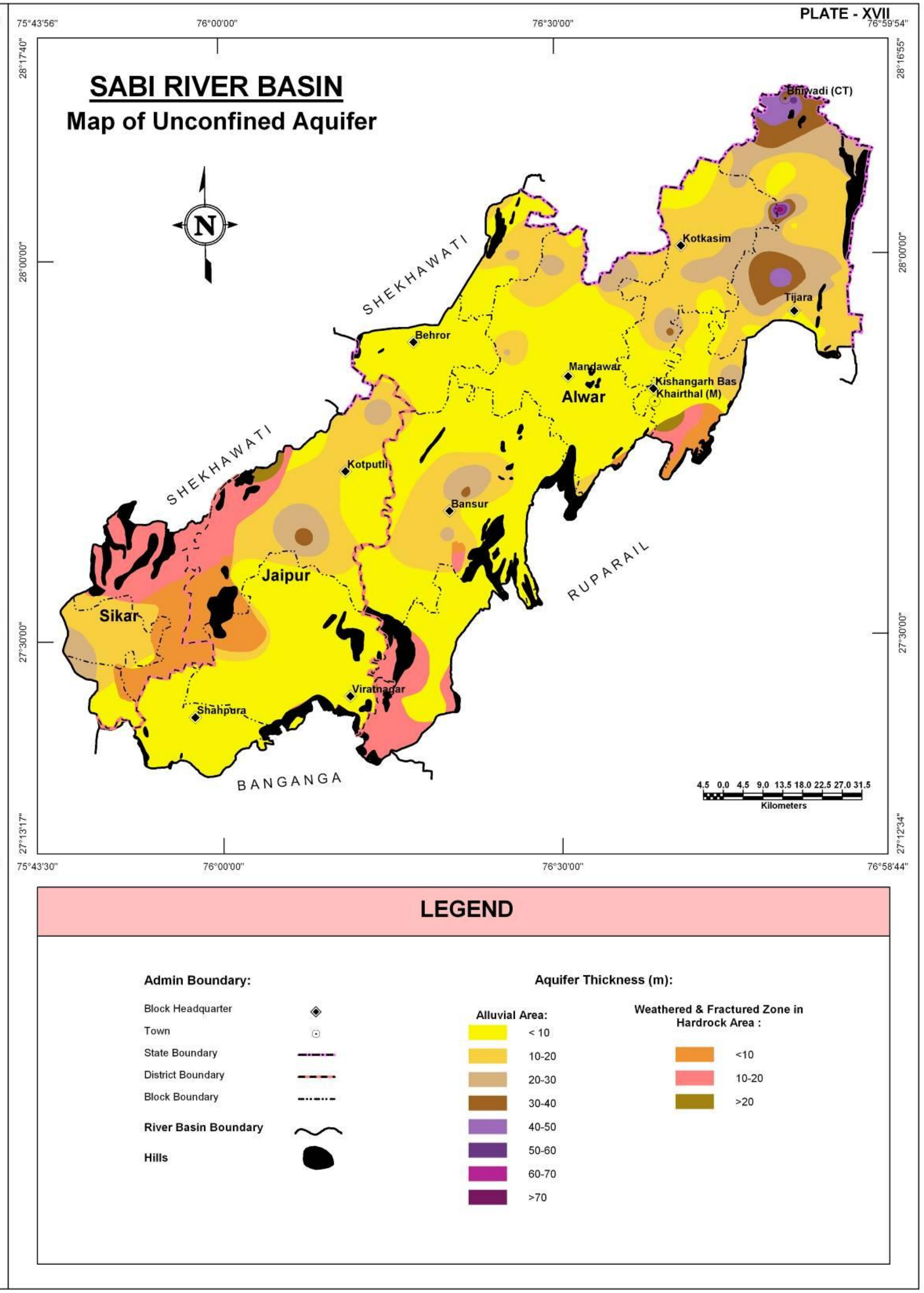


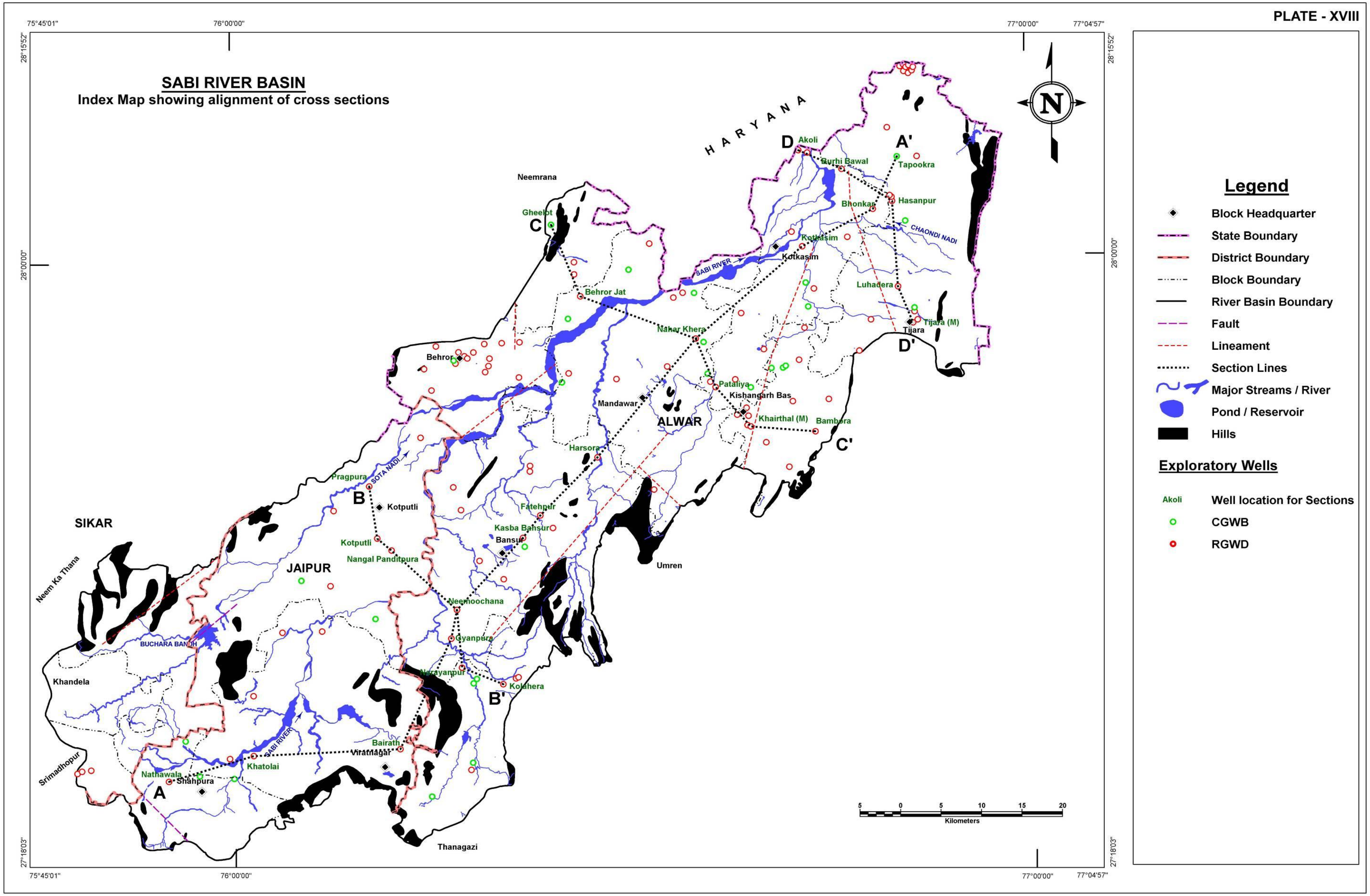
PLATE - XVII
SABI RIVER BASIN
Map of Unconfined Aquifer
N
SHEKHAWATI
SHEKHAWATI
RUPARAIL
BANGANGA
Bhiwadi (CT)
Kotkasim
Tijara
Behror
Mandawar
Alwar
Kishangarh Bas
Khairthal (M)
Kotputli
Bansur
Jaipur
Sikar
Viratnagar
Shahpura
Kilometers
LEGEND
Admin Boundary:
Block Headquarter
Town
State Boundary
District Boundary
Block Boundary
River Basin Boundary
Hills
Aquifer Thickness (m):
Alluvial Area:
< 10
10-20
20-30
30-40
40-50
50-60
60-70
>70
Weathered & Fractured Zone in Hardrock Area :
<10
10-20
>20

CROSS SECTIONS

Several hydrogeologic cross sections have been drawn to better decipher the sub-surface distribution of lithology. These sections have been overlaid with geological maps and structural faults if there are any have been transferred for verification of their impact on sub-surface material disposition. The alignment of the cross sections is shown in Plate XVIII and corresponding sections are presented in Plates XIX to XXII. The broad alignment of the sections is as given below:

Name of Section Line	Orientation
Section AA’	SW – NE
Section BB’	NW – SE
Section CC’	NW – SE
Section DD’	NW – SE

PLATE - XVIII


SABI RIVER BASIN
Index Map showing alignment of cross sections
Legend
Block Headquarter
State Boundary
District Boundary
Block Boundary
River Basin Boundary
Fault
Lineament
Section Lines
Major Streams / River
Pond / Reservoir
Hills
Exploratory Wells
Akoli
Well location for Sections
CGWB
RGWD
HARYANA
SIKAR
JAIPUR
ALWAR
Neemrana
Behror
Kotputli
Mandawar
Kishangarh Bas
Kotkasim
Tijara
Umren
Thanagazi
Khandela
Neem Ka Thana
Srimadhopur
Shahpura
Viratnagar
Bansur
SABI RIVER
SOTA NADI
CHAONDI NADI
BUCHARA BANDH
A
A'
B
B'
C
C'
D
D'
Kilometers

Section A-A':

This section is the longest of the sections plotted (Plate – XIX) in the basin and trends in SW-NE direction, extending along the length of the basin and alongside the Sabi river. The data pertaining to 10 boreholes has been plotted and interpreted for this cross section. It is interesting to note that as one moves from A to A' (i.e., from southwest to northeast) not only the topography is lowered by also the water levels, while the thickness of alluvial cover shows marked increase. The section depicts the disposition of different layers of sand and clay along with weathered and fractured zones in quartzite. While clay lenses are seen all around, the thickness significantly increases northwards to about 100m towards A'.

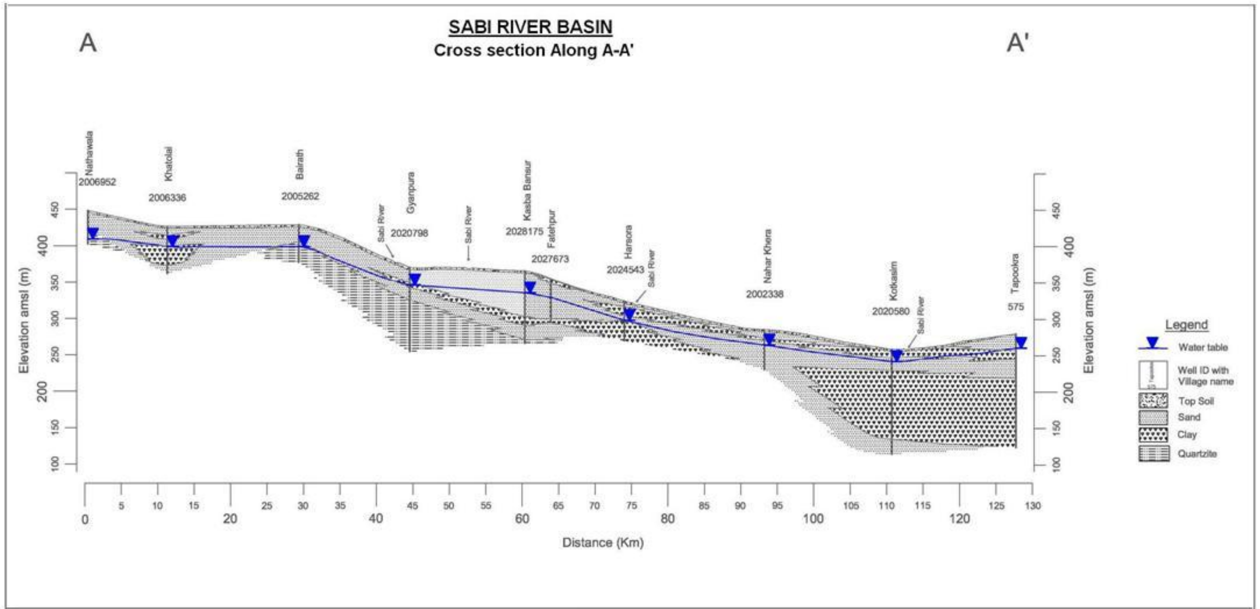
Ground water occurs at an elevation of 250 m amsl to 410 meter amsl in the section and generally follows the surface topography.

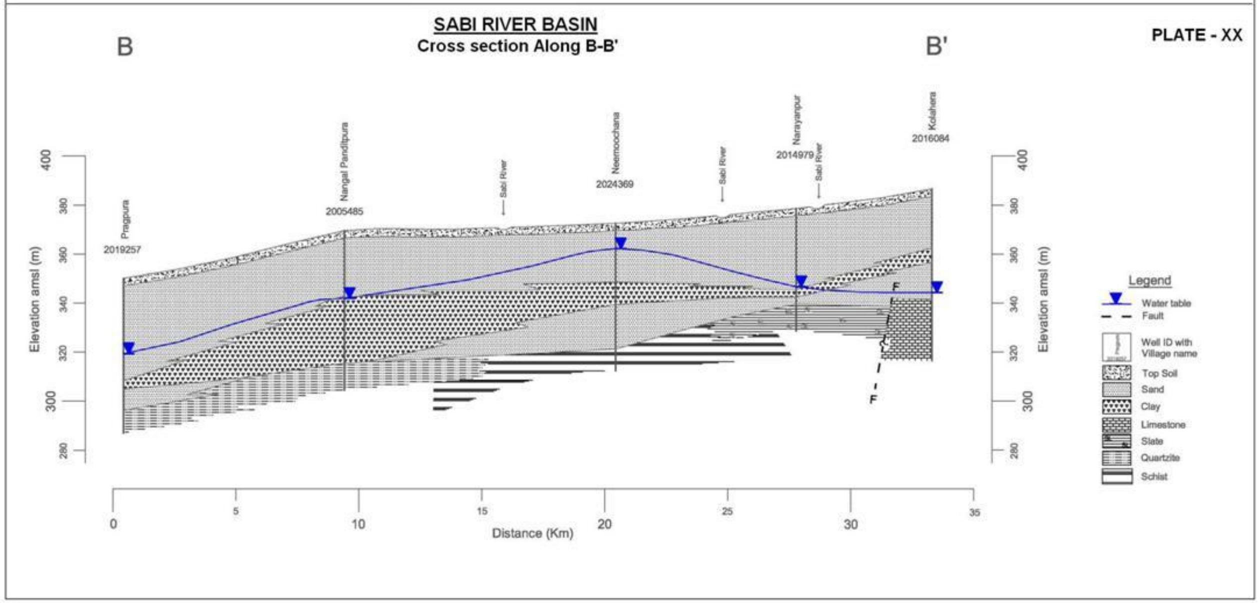
Section B-B':

Section B-B' (Plate – XX) is considered from NW to SW direction of the basin, covering a distance of about 34 km in the southern part of the basin roughly cutting across the river Sabi and basin. The lithologs of 5 boreholes along with surrounding well information has been considered for the section. Schist (0-15 km), Quartzite (14 - 28), Slate (28 – 32 km) and Limestone (32 – 34 km) forms the bedrock in the section; overlain by clay and sand. There is rise in topography eastwards and so is the bedrock level. The first layer below soil cover is thick and continuous sand followed by variable thickness clay layer and another set of sand lenses between the clay and bedrock giving rise to somewhat confined aquifer situation. A tentative fault is indicated near B' where the limestones rest against slates.

Ground water occurs at an elevation of 320m amsl to 365m amsl in the section. It is shallower in the centre of the section but goes deeper on either side towards B and B'.

PLATE - XIX


SABI RIVER BASIN
Cross section Along A-A'
A
A'
Nathawala
2006952
Khatolai
2006336
Bairath
2005262
Sabi River
Gyanpura
2020798
Sabi River
Kasba Bansur
2028175
Fatehpur
2027673
Harsora
2024543
Sabi River
Nahar Khera
2002338
Kotkasim
2020580
Sabi River
Tapookra
575
Elevation amsl (m)
Distance (Km)
Legend
Water table
Well ID with Village name
Top Soil
Sand
Clay
Quartzite


SABI RIVER BASIN
Cross section Along B-B'
PLATE - XX
B
B'
Pragpura
2019257
Nangal Panditpura
2005485
Sabi River
Neemoochana
2024369
Sabi River
Narayanpur
2014979
Sabi River
Kolahera
2016084
F
F
Elevation amsl (m)
Distance (Km)
Legend
Water table
Fault
Well ID with Village name
Top Soil
Sand
Clay
Limestone
Slate
Quartzite
Schist

Section C-C':

The section C-C' (Plate – XXI) has been selected across the basin trending NW-SE direction for a distance of about 47km in the centre of the basin. The lithologs of 7 boreholes have been used for interpretation and preparation of this section along with surrounding data. Bedrock is formed by Phyllites and Quartzites and the alluvial cover is quite thick in the centre of the section. The section is predominantly sandy in nature with some discontinuous clay lenses are present at shallow depths leaving the lower layer of sand in semi confined state.

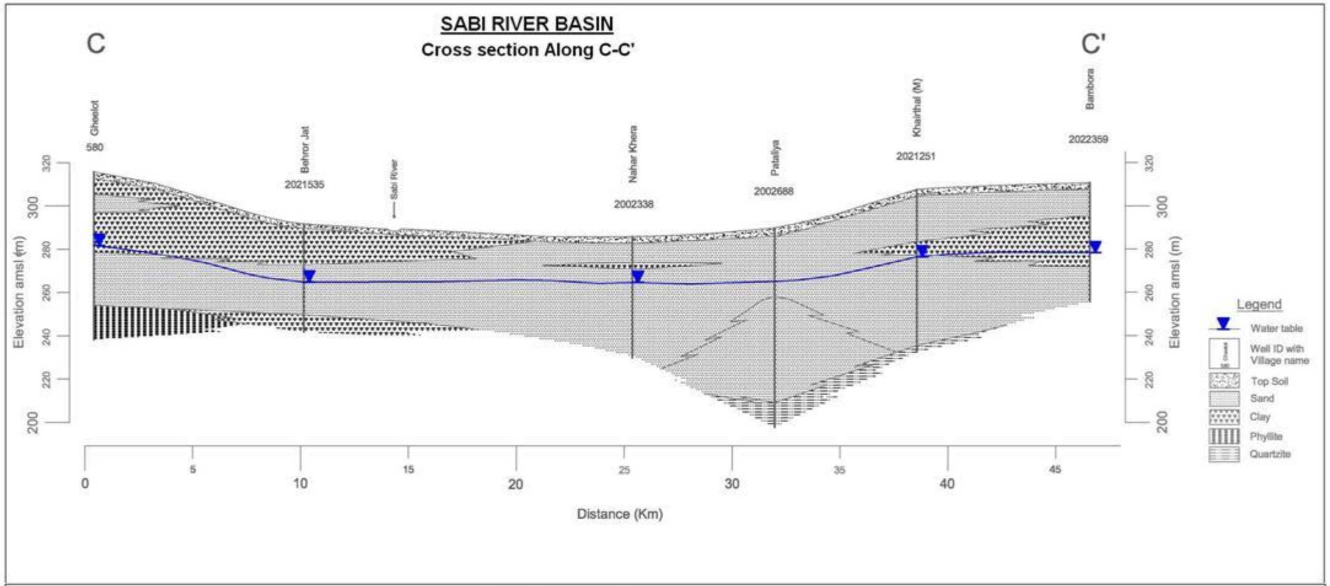
Ground water occurs at an elevation of 260m amsl to 280m amsl in the section following the surface topography, is often quite deep reaching a general depth of 40m bgl.

Section D-D':

The D-D' (Plate – XXII) section is selected across the basin trending NW-SE direction in the northern part of the basin for short a length of 30 km. The lithologs of 5 boreholes are interpreted and presented in the section along with surrounding data. The alluvial column is quite thick in this section and while the central part has thick sand in the subsurface (reaching thickness of >100m) clay predominates on either side of it. Quartzite is the only hardrock encountered in this section forming bedrock.

Ground water occurs at an elevation of 230m amsl to 275m amsl in the section following the surface topography. The depth of ground water level is shallow and often seen to occur at less than 20m of depth below ground level.

PLATE - XXI


SABI RIVER BASIN
Cross section Along C-C'
C
C'
Gheelot
580
Behror Jat
2021535
Sabi River
Nahar Khera
2002338
Pataliya
2002688
Khairthal (M)
2021251
Bambora
2022359
Elevation amsl (m)
Distance (Km)
Legend
Water table
Well ID with Village name
Top Soil
Sand
Clay
Phyllite
Quartzite

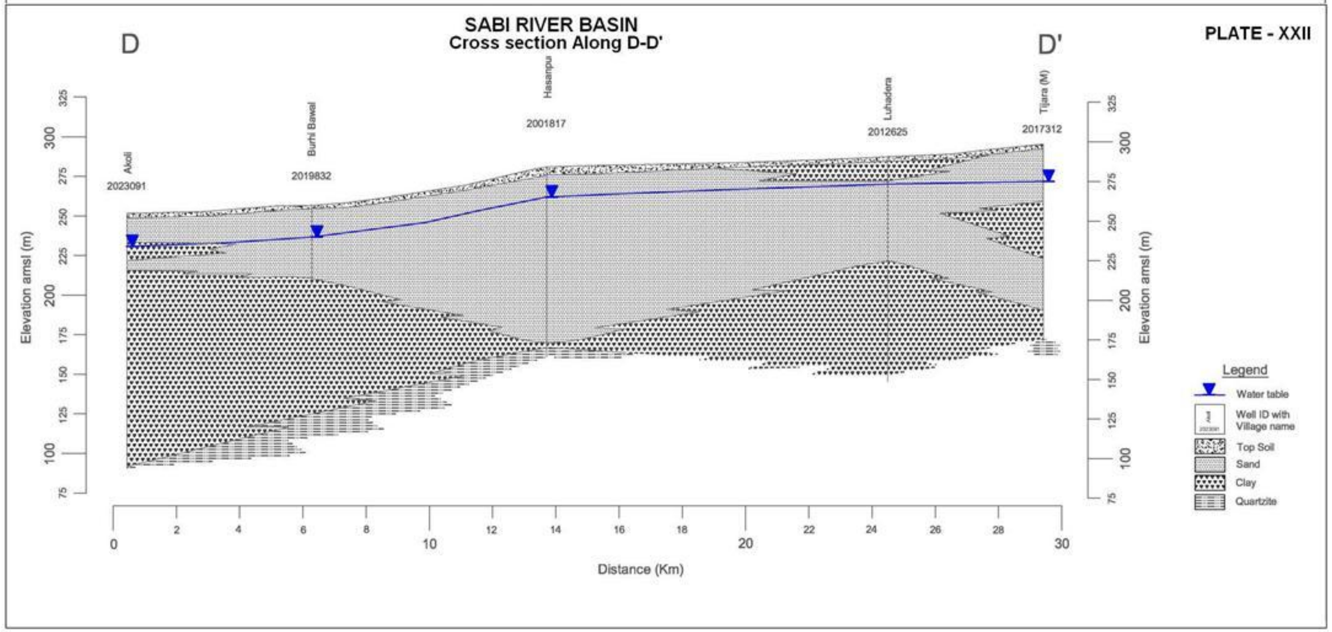


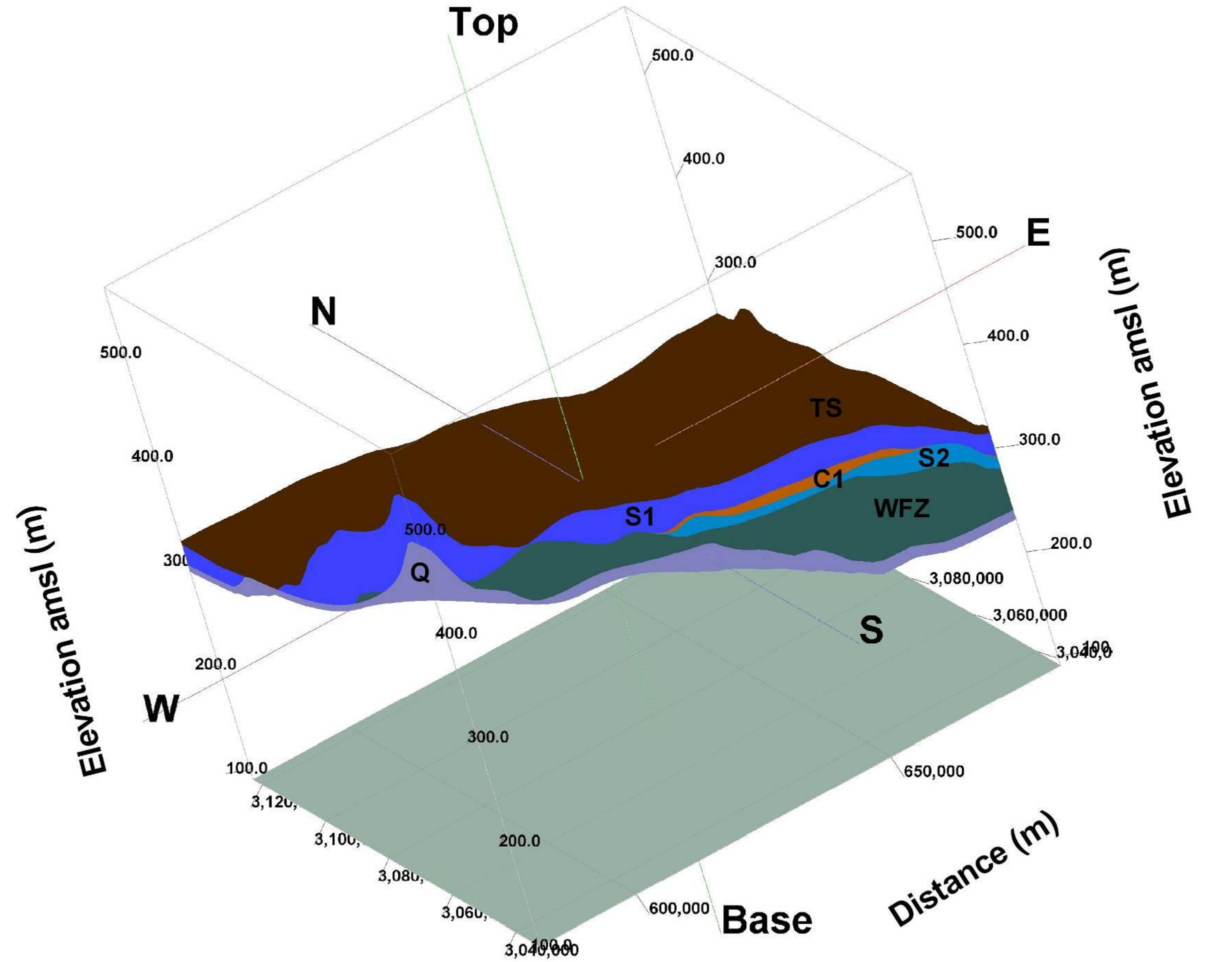
PLATE - XXII
SABI RIVER BASIN
Cross section Along D-D'
D
D'
Akoli
2023091
Burhi Bawal
2019832
Hasanpur
2001817
Luhadera
2012625
Tijara (M)
2017312
Elevation amsl (m)
Distance (Km)
Legend
Water table
Well ID with Village name
Top Soil
Sand
Clay
Quartzite

The continuous litho-stratigraphic model has been developed for the Sabi River Basin using the data of scattered exploratory boreholes as input. 3D model depicts the sub-surface aquifer disposition of litho-stratigraphic units forming aquifers, aquicludes and aquitards in the area. Plate – XXIII presents 3D model depicting the various litho-stratigraphic units in the entire river basin.

From this model it is apparent that beneath the top soil there is persistent sand horizon forming unconfined aquifer, it seems that beneath the there are two persistent clay horizons (2nd one not extending in the west) in the region separating two sandy aquifers. The second sandy aquifer is found only in the northeastern part of the basin within alluvium. The confined sandy aquifer is found in the eastern and southeastern part of the basin within alluvium. Weathered and fractured quartzite underlying the alluvium is more persistent in the west and southern part forming the unconfined aquifer. The depth of weathered and fractured rock is shallow in the western part as compared to the northeastern part of the basin. However the quartzite, below the weathered and fractured rock is appearing as almost continuous layer in the model.

PLATE - XXIII

SABI RIVER BASIN
3D Model



Legend

TS	Top Soil
S1	Sand
C1	Clay
S2	Sand
C2	Clay
WFZ	Weathered and Fractured Bedrock
Q	Quartzite

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 its 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
- सोडियम-हृदय, गुर्दा व रक्त परिसंचरण रोगों से ग्रसित लोगों को हानिकारक
- क्लोराइड-सोडियम के साथ मिलकर उच्च रक्त चाप
- नाइट्रेट-नवजात शिशुओं में ब्लू बेबी बीमारी (मेथमोग्लोबिनिमिया)
- कैल्शियम-जोड़ों में कड़ापन
- 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
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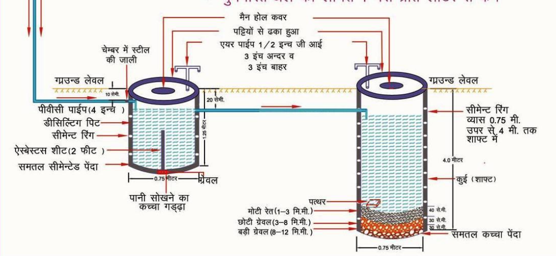
भूजल अमूल्य है इसे प्रदूषित न करें।

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.व्यासx 1.25 मी.गहरा)
- सीमेन्ट रिंग से निर्मित शाफ्ट (0.75 मी व्यासx 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

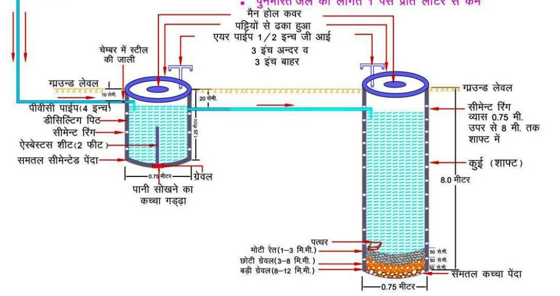



चित्र–2

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.व्यासx 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

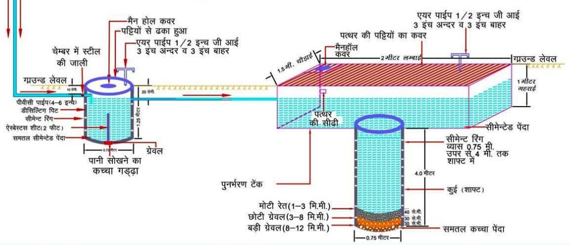



चित्र–3

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.व्यासx1.25 मी.गहरा)
- रीचार्ज टेंक 1.5 मी.चौड़ाx2 मी.लम्बाx1 मी.गहरा
- सीमेन्ट रिंग से निर्मित शाफ्ट (0.75 मी.व्यासx4 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

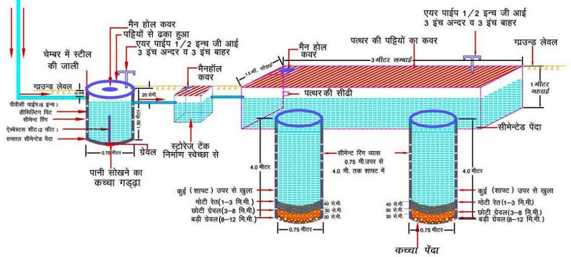



चित्र–4

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.व्यासx1.50 मी.गहरा)
- रीचार्ज टेंक 1.5 मी.चौड़ाx3 मी.लम्बाx1 मी.गहरा
- सीमेन्ट रिंग से निर्मित शाफ्ट (0.75 मी.व्यासx4 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
- पुर्नभरित 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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