जल वर्ष 2007 Water Year 2007

स्वच्छ सुरक्षित जल – सुन्दर खुशहाल कल

CONSERVE WATER - SAVE LIFE

CENTRAL GROUND WATER BOARD

Ministry of Water Resources

Government of India

GROUNDWATER SCENARIO

BHILWARA DISTRICT, RAJASTHAN

Western Region

Jaipur

June, 2008

DISTRICT AT A GLANCE – BHILWARA DISTRICT, RAJASTHAN

S No	Item	Statistics	
1	**GENERAL INFORMATION**		
	(i) Geographical area (sq km)	10,455	
	(ii) Administrative Division (As on 31.3.2007)		
	Number of Tehsils	12	
	Number of Blocks	11	
	Number of Villages	1745	
	(iii) Population (As per 2001 Census)	23,35,611	
	(iv) Average Annual Rainfall (1986-2005) in mm	633.9	
2	**GEOMORPHOLOGY**		
	Major Physiographic Units	Pediment, Buried Pediment, Intermontane Valley, Plataeu, Sandy Plain	
	Major Drainage	Banas River	
3	**LAND USE (ha)**		
	(a) Forest Area	74221	
	(b) Net Sown Area	332196	
	(c) Cultivable Area	753818	
4	**MAJOR SOIL TYPE**	Loam, Clay loam, Sand Loam pebbly & stony and sandy loam	
5	**AREA UNDER PRINCIPAL CROPS** *(As on 2004-05)*	**Crops**	**Area in ha**
		Maize	180927
		Oil Seeds	122771
		Wheat	83389
		Pulses	55217
		Jowar	38671
		Barley	10666
		Spices	7650
		Bajra	2265
6	**IRRIGATION BY DIFFERENT SOURCES**		
	Source	**No of structure**	**Gross Irrigated Area in ha**
	Dug wells	126164	94991
	Tube wells/Bore wells	2184	4371
	Tanks/Ponds	2137	10692
	Canals	79	9735
	Net Irrigated Area (ha)	94850	
	Gross Irrigated Area (ha)	119789	

7	**NUMBER OF GROUND WATER MONITORING WELLS OF CGWB** (As on May 2007)	
	Number of Dug wells	32
	Number of Piezometers	5
8	**PREDOMINANT GEOLOGICAL FORMATIONS**	Rock types belonging to Bhilwara Super group, Aravallis & Vindhyan Super group
9	**HYDROGEOLOGY**	
	Major Water bearing formation	Gneiss, Schist/phyllite, Sandstone, Limestone
	Depth to water level (Pre-monsoon, 2006) (mbgl)	5 – 24
	Depth to water level (Post-monsoon, 2006) (mbgl)	0.5 – 16.0
	Long term water level trend (1997-2006) in cm/yr	< 10
10	**GROUNDWATER EXPLORATION BY CGWB** (As on 31.3.2007)	
	Number of wells drilled (EW, OW, PZ, SH, Total)	EW - 30 & SH -1
	Depth Range (m)	13 – 200
	Discharge (liter per second)	Negligible – 35
	Storativity	-
	Transmissivity (m^2/day)	8 – 230 (Hard Rock) 200 – 3000 (Alluvium)
11	**GROUND WATER QUALITY**	
	Presence of chemical constituents more than permissible limit (EC>1500 mmhos/cm at 25^0 C, F>1.5 mg/l, Fe>1.0mg/l) in parts of district	EC – 4021 sq. km. F – 4825 sq. km. Fe – 4825 sq. km.
	Type of water	Chloride type
12	**DYNAMIC GROUND WATER RESOURCES (March, 2004) in mcm**	
	Annual Replenishable Ground Water Resources	390.3628
	Net Annual Ground Water Draft	452.8714
	Projected Demand for Domestic and Industrial Uses up to 2025	75.9095
	Stage of Ground Water Development	116.01%
13	**GROUND WATER CONTROL AND REGULATION**	
	Number of Over-exploited blocks	8
	Number of Critical Blocks	3
	No of Blocks Notified	Nil
14	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	Scarcity of water

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GROUND WATER SCENARIO
BHILWARA DISTRICT, RAJASTHAN

1.0 INTRODUCTION

The district is situated between 25^0 01' & 25^0 58' North latitude and 74^0 01' & 75^0 28' East longitude covering geographical area of 10,455 sq km. Bhilwara district is part of Ajmer Division. The district is divided into 4 sub-divisions namely Bhilwara, Gulabpura, Mandalgarh & Shahpura and comprises of 12 tehsils & 11 blocks. Total number of villages in the district is 1745 (2001 census). Rural & Urban population of the district is 19,33,149 & 4,02,462 respectively. Decennial population growth rate of the district is 21.58% since 1991. The district is known for its textile industries and mineral wealth.

Systematic Hydrogeological survey in the district was carried out by Central Ground Water Board from 1978 to 1980. Reappraisal hydroeological survey of entire district was carried out during 2000-2001. Under exploratory programme 30 exploratory boreholes and 1 slim hole have been drilled. Since 1973, monitoring of water level is being carried out and presently four times a year from 37 National Hydrograph Network Stations.

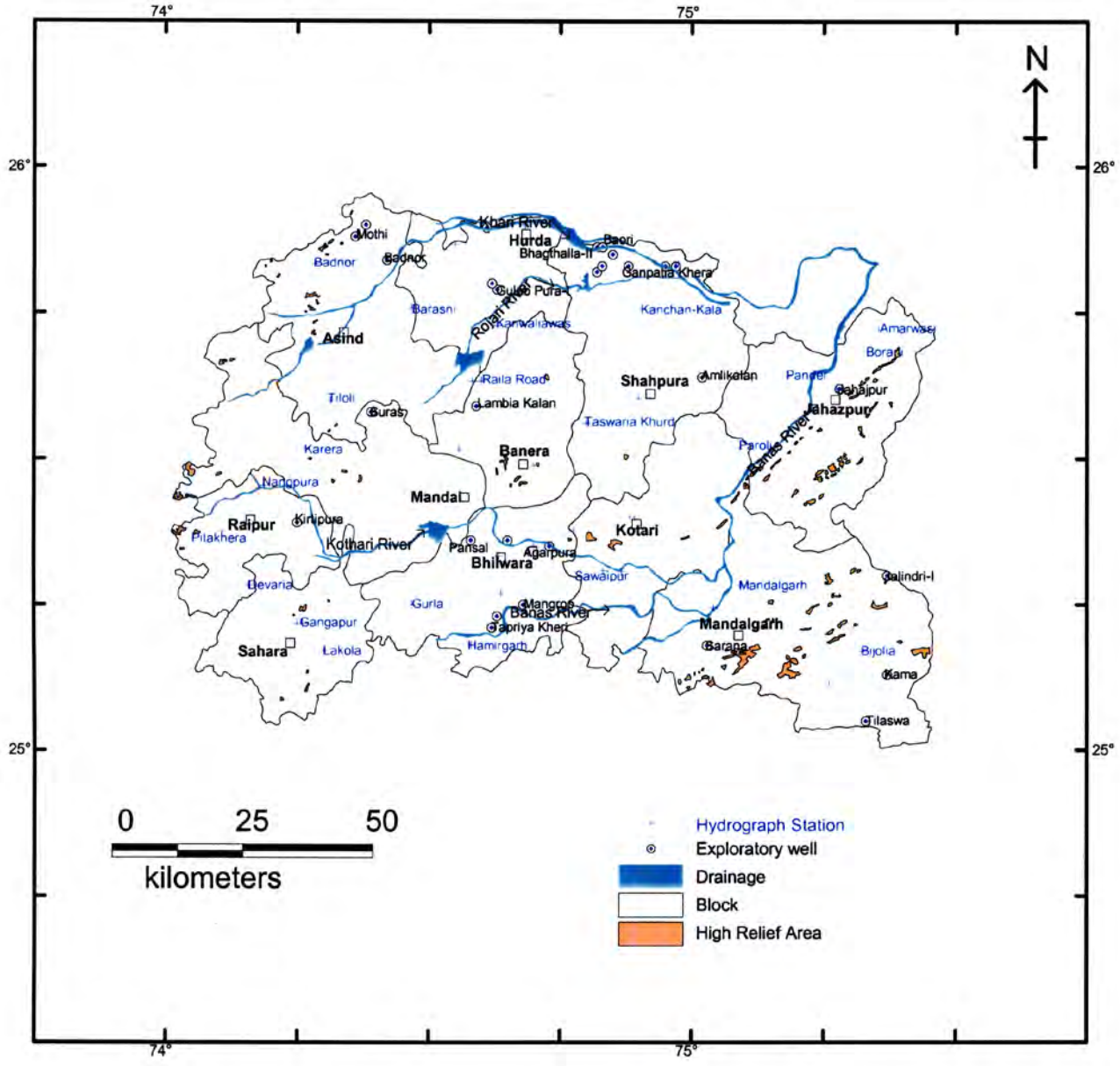
2.0 RAINFALL & CLIMATE

Mean annual rainfall (1986-2005) of the district is 633.9 mm whereas normal rainfall (1901-70) is lower than average rainfall and placed at 603.3. Almost 95% of the total annual rainfall is received during the southwest monsoon, which enters the district in the last week of June and withdraws in the middle of September. Probability of average annual rainfall exceeding 900 mm is only 10%. However, there is 90% probability that the average rainfall will be more than 400 mm. The probability of occurrence of mean annual rainfall is 45%. Drought analysis based on agriculture criteria indicates that the district is prone to mild and normal type of droughts. Occurrence of severe and very severe type of drought is very rare.

January is the coldest month with mean maximum and minimum temperatures being lowest at 22.2^0 C & 7.3^0 C. Temperature in summer month, June, reaches up to 46^0 C. There is drop in temperature due to onset of monsoon and rises again in the month of September.

Atmosphere is generally dry except during the monsoon period. The humidity is highest in August with mean daily relative humidity 80%. The annual potential evapotranspiration in the district is 1495 mm and is the highest in the month of May (228 mm).

Index map of Bhilwara District, Rajasthan



3.0 GEOMORPHOLOGY & DRAINAGE

Bhilwara district consist of fairly open plains in the north and southeast with a few hillocks and undulating plains & hills in the south and northeastern part. Occasional inselberg, low-lying hillocks and chains of ridges break the monotony of peneplained tract. The area of the district is generally slopes gently except in western & northwestern part where it is high. Geomorphologically, the district is divided into following units:

Origin	Landform Unit	Occurrence
Fluvial	Alluvial Plain	Along rivers- Khari, Masi, Banas, Kothari
	Valley Fill	Small scattered patches in east & west
	Ravine	Along Berach River in south
Denudational	Pediment	Scattered in entire district, mainly in east & west
	Buried Pediment	Almost entire district except in east, southeast & north
	Intermontane Valley	Scattered in east & southeast
Aeoline	Sandy Plain	North
Structural	Plataeu	Southeast
Hills	Linear Ridges	Near Jahazpur town
	Structural Hill	In northwest & eastern part of the district and Bhilwara town

Bhilwara district falls in the Banas (9157.2 sq km), Chambal (1164.9 sq km) & Luni basin (133.0 sq km). Breakup of the basin area falling in various tehsil is as follows:

S No	Block	Area in sq km		
		Banas Basin	Chambal Basin	Luni Basin
1	Asind	1161.3	0	133.0
2	Banera	725.3	0	0
3	Suwana	674.8	0	0
4	Hurda	962.2	0	0
5	Jahazpur	779.8	468.8	0
6	Kotri	686.8	0	0
7	Mandal	1156.5	0	0
8	Mandalgarh	668.4	696.1	0
9	Raipur	533.5	0	0
10	Sahara	494.9	0	0
11	Shahpura	1313.6	0	0
Total		**9157.1**	**1164.9**	**133.0**

Major River of the district is Banas, which flows in northeast to easterly direction. It enters near village Doodiya in Bhilwara tehsil in the west flowing towards east and takes an abrupt turn towards north-northeastern direction near Bigod downstream of the confluence with Berach River and again takes an easterly turn near Kanti and finally flows towards northeast till it enters Tonk district. Total length of the Banas River is 142 km in Bhilwara district. Channel pattern of Banas is sinuous and changes to more or less straight between Bigod and Rajamahal indicating structural control on the drainage pattern. Important tributaries are Berach, Kothari, Unli, Mendi, Nakadi, Chandrabhaga and Khari River. All these are ephemeral.

4.0 SOIL, LAND USE & IRRIGATION PRACTICES

Soils of the district are classified as follows:

Clay loam or medium black*:* This type of soil is found in the hilly areas in the central parts of the district.

Loam**:** This type of soil is found in the entire district.

Sand and sandy loam**:** This type of soil is found mostly near the banks of rivers and nallahs.

Loam pebbly & stony**:** These types of soils are met within the hilly areas of the eastern blocks of the district.

Total forest area is 794.18 sq km (7.59 %) mainly confined to Jahazpur & Mandalgarh blocks due to comparatively higher rainfall in the eastern and southeastern parts of the district. Cultivable area of the district is 7538.18 sq km (72.11%) whereas uncultivable area is 2916.82 sq km (27.89%).

The total area under *Kharif* crop is 3,19,540 ha and *Rabi* crop is 90,018 ha. In Raipur, Sahara, Hurda and Banera blocks, total sown area is very less due to poor groundwater availability whereas it is high in Jahazpur and Mandalgarh due to sufficient ground water potential.

Net area under irrigation is 119789 ha (11.45% of the total geographical area). Important medium irrigation projects are Mandal (Mandal block), Sareri, Arwar, Maharsagar, Umedsagar (All in Shahpura block), Jethpura, Govia, Panchanpura (All in Mandalgarh block) Jhadol and Kothari (All in Kotri block). Besides these, dug wells are the main source of irrigation. Bore wells and tube wells are limited due to low discharge. Irrigated area and number of structures according to source is as follows:

S No	Tehsil	Net Irrigated Area	Gross Irrigated area	Gross Irrigated area (ha) & Number						
				Bore well		Dug well		Ponds		Canal
		(ha)	(ha)	Area	No	Area	No	Area	No	
1	Asind	6694	8739	22	17	8366	13033	351	267	
2	Banera	4143	5177	0	42	4385	6682	792	177	
3	Bhilwara	8825	11716	129	202	10905	12287	682	65	
4	Hurda	3719	4628	23	22	4261	4852	344	88	
5	Jahazpur	13290	17095	311	27	14111	9991	2293	184	380
6	Kotri	12540	15360	855	62	12423	8196	2082	121	
7	Mandal	5986	7457	0	39	6465	11801	992	384	
8	Mandalgarh	17597	23925	2819	181	14650	8086	1272	18	5184
9	Raipur	1990	2547	2	10	2509	5930	36	70	
10	Sahara	2768	3309	0	22	3044	6265	265	135	
11	Shahpura	12657	14650	1	2	10936	9539	1583	164	2130
12	Bijolia	4641	5186	209	82	2936	2471	0	6	2041
TOTAL		**119789**	**94850**	**4371**	**708**	**94991**	**99133**	**10692**	**1679**	**4171**

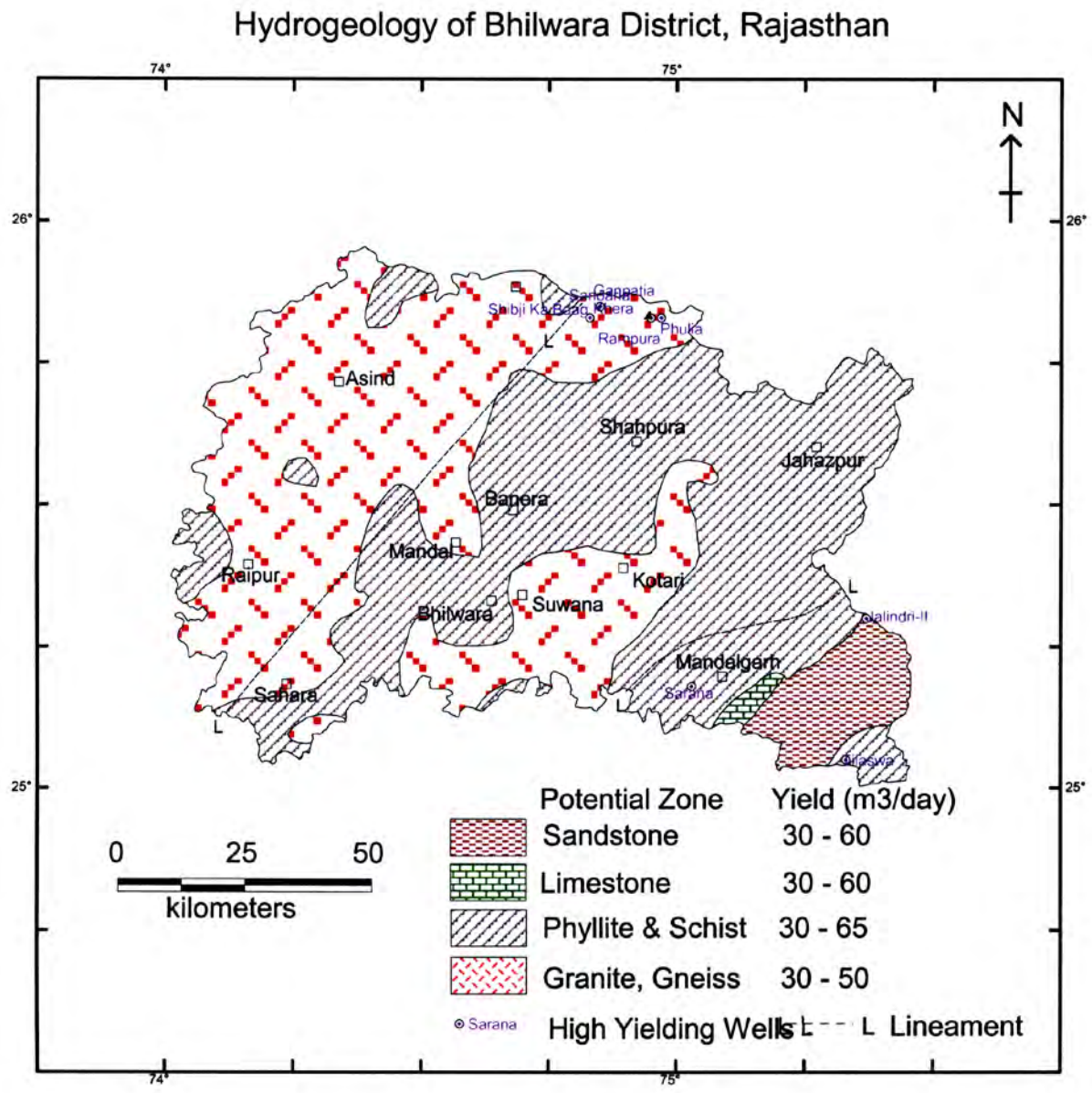
5.0 Ground Water Scenario

5.1 Hydrogeology

Major water bearing formations are gneiss and schist (Bhilwara Supergroup); gneiss, schist, phyllite, slate and limestone (Aravalli Supergroup); sandstone, shale and limestone (Vindhyan Supergroup) and alluvium. Ground water occurs under unconfined to semi-confined condition. Weathered zone below the water table acts as a good storage. The joints, fissures and other plains of structural weakness as well as their extent, size, opening and inter connection control occurrence & movement of ground water.

Weathered gneiss forms upper part of the bedrock in central part. Weathered gneiss with schist occupies most of the northern part under thin cover of alluvium. In schists, phyllites and slates, weathered zone extends to depth greater than in granites and gneisses. Muscovite schist often grade into gneiss. These have well-developed foliation and irregular joints and are intruded by granite, amphibolite, pegmatite and quartz vein. The contact between these intrusives and schist, provide good channel for ground water circulation. Dug wells in Gangapur and Bhilwara area tapping gneiss and mica schist yield between 25 & 50 m^3/day.

Phyllites and schists are predominating in the eastern parts of the district near Shakargarh, Amalda and Kachola towards north of Great Boundary Fault. These formations are intercalated with dolomitic limestone, quartzite and basic intrusives. Depth of wells tapping these formations varies from 15 to 50 m. Yield of wells vary from 30 to 45 m^3/day.



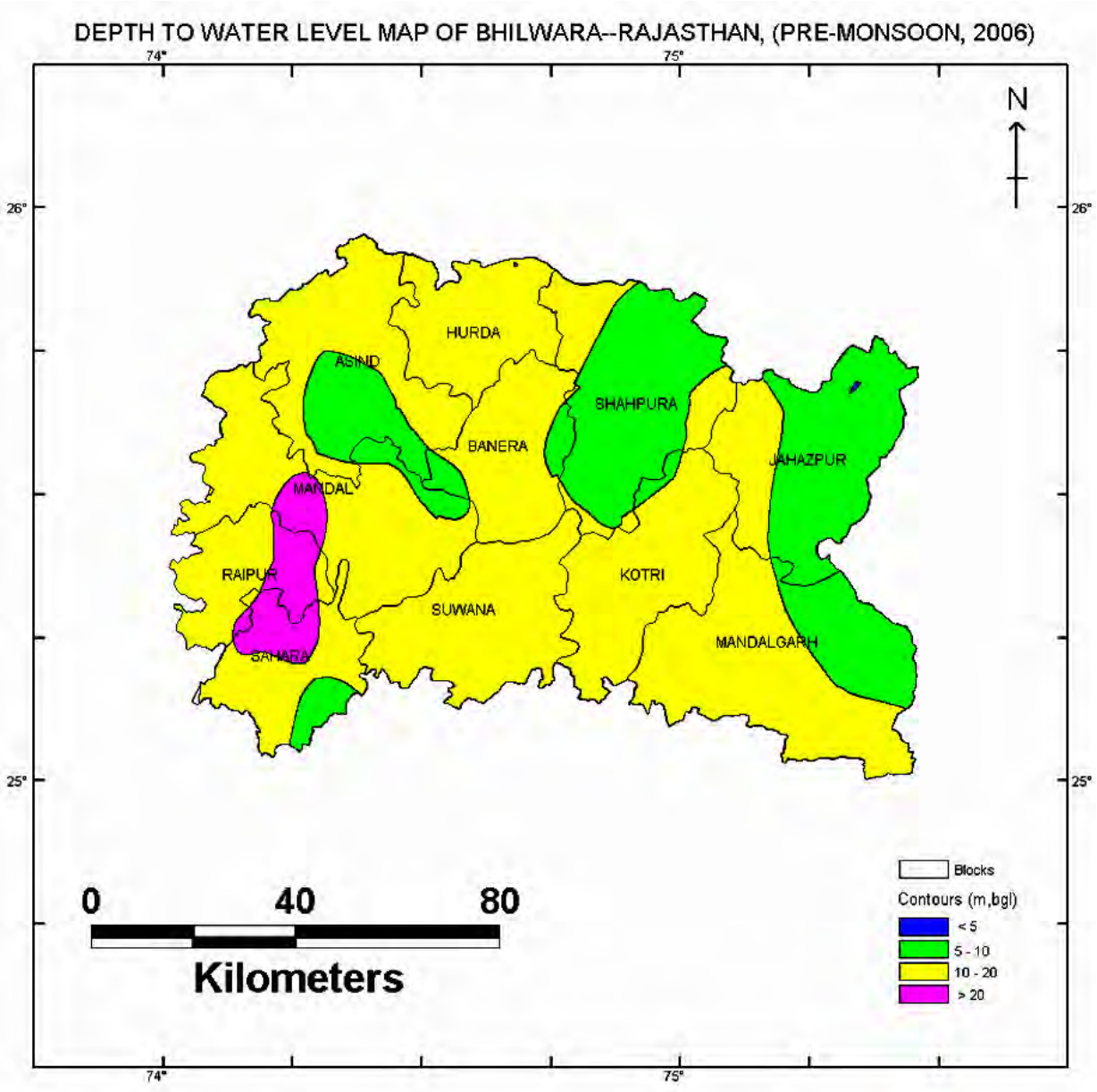
Dolomitic limestone is grey to light brown and compact at the surface. It forms aquifer in intercalations with slates and phyllites around Bagota, Laxmipura, Rampura, Amargarh, Dolpura, Kishangarh, Bakli, Bhajgarh, west of Banakhera, Mal Ka Khera, northeast of Mohanpura, Ladpura and Ratiya Khera. Depth of wells generally ranges from 15 to 35 m with yield from 50 to 60 m^3/day.

Quartzite generally intercalated with phyllite and slate. These are brown coloured, hard and jointed. Thickness of weathered and fractured zone ranges from 10 to 30 m. Depth of dug wells is generally more than 20m. Yield of dug wells varies from 15 to 25 m^3/day.

The hard metamorphic rocks have been intruded by amphibolite, granite, pegmatite and quartz vein. Joints are well developed in amphibolites and in some porphyritic granites. Dug wells tapping amphibolite yield more (average yield 30 m^3/day) as compared to wells in granitic gneiss.

Sandstone and shale are confined to Mandalgarh block. Dug wells are 3 to 30 m deep and yield water between 40 & 50 m^3/day.

Quaternary alluvium is confined to narrow valleys along the river and stream courses. The alluvium is generally shallow but whenever saturated forms good aquifer. Yield of the wells in alluvium ranges from 75 to 100 m^3/day.



Depth to water level as recorded in 37 NHS (2006) ranges from 4.94 to 23.21 and 0.52 to 16.2 mbgl during pre-monsoon and post monsoon respectively. Block-wise depth to water level is as follows:

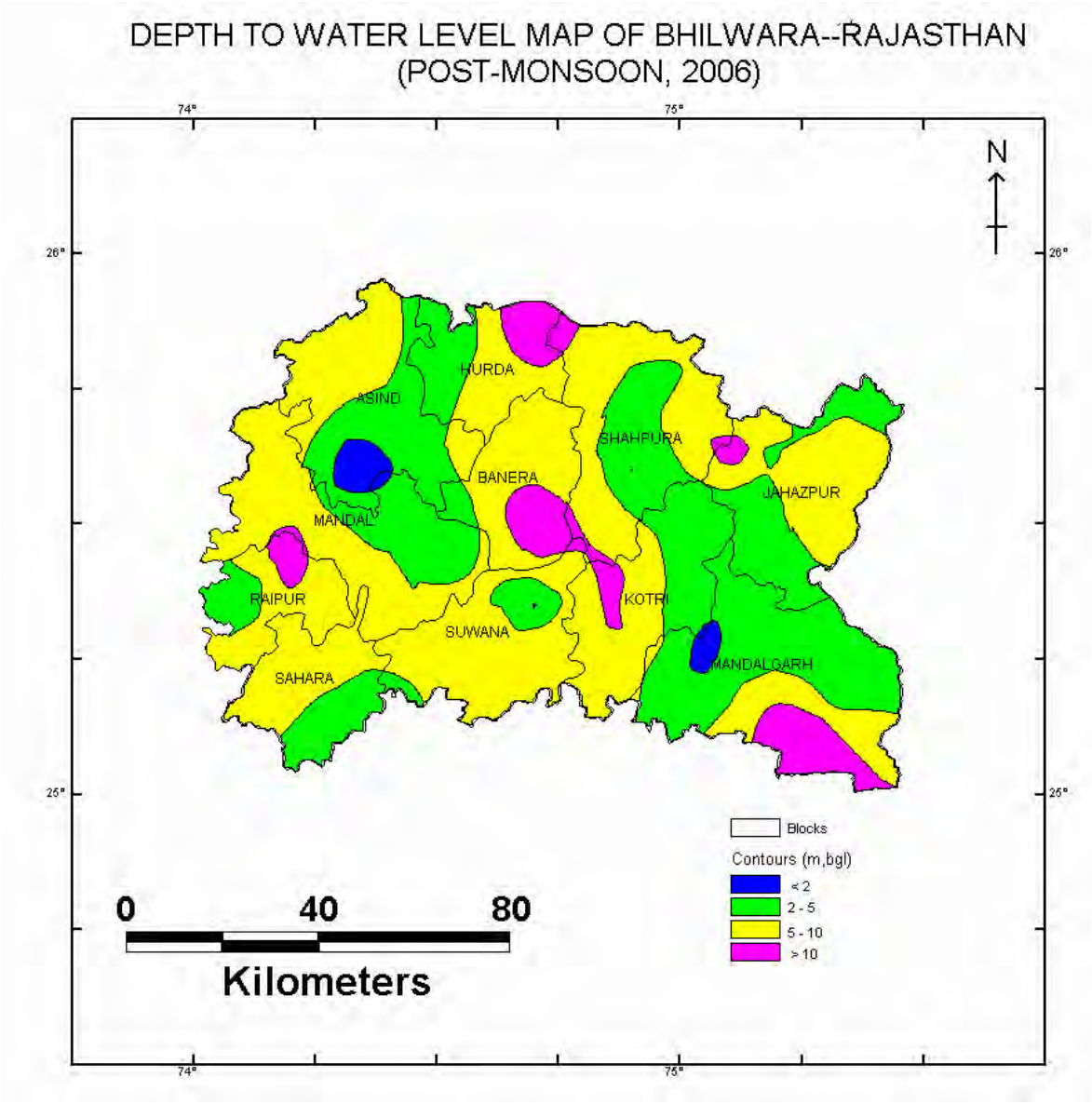
Block	Pre Monsoon		Post Monsoon		Water level fluctuation (Pre– Post)			
					Rise		Fall	
	Min	Max	Min	Max	Min	Max	Min	Max
Asind	5.05	12.03	0.52	9.40	2.63	4.53	-	-
Banera	8.66	18.26	4.36	13.66	4.40	9.64	-	-
Hurda	12.69	20.05	3.09	13.01	7.04	9.60	-	-
Jahazpur	4.94	12.5	2.59	12.24	0.26	2.50	0.30	2.13
Kotri	10.48	15.40	2.59	11.12	2.73	7.88	0.64	0.64
Mandal	22.46	22.46	-	-	-	-	-	-
Mandalgarh	9.23	18.7	1.50	16.2	2.50	10.40	-	-
Raipur	13.60	20.65	2.22	11.81	11.38	12.64	-	-
Sahara	8.14	23.21	2.83	7.64	5.31	15.57	-	-
Sahapura	5.85	7.68	1.97	8.30	3.48	4.00	2.45	2.45
Suwana	12.55	14.15	1.87	6.75	5.81	10.68	-	-
District	**4.94**	**23.21**	**0.52**	**16.2**	**0.26**	**15.57**	**0.3**	**2.45**

During pre monsoon, shallow (<10 m) water levels exist in Shahpura, Mandalgarh, Jahajpur and Asind blocks. In the remaining area water level was between 10 & 20m except in central part of Sahara, Raipur & Mandal blocks where water level is more than 20m.

Post monsoon data shows depth to water level below 2m in the Mandal block, 2 to 5m in Mandalgarh, Asind, Mandal, Shahpura and Jahazpur blocks. South of Mandalgarh, northwest of Kotri, southeast of Banera, north of Hurda and Raipur shows water level more than 10m. Rest of the area falls under 5 to 10m category.

Broadly, water table slopes follows drainage direction. Nature of Banas River is effluent. Water table elevation & gradient ranges from 360 to 260 meter above mean sea level (mamsl) & 2.5 to 3.02m/km respectively in the eastern part, Jahazpur block and northern part of Manadalgarh block. In the rest of Mandalgarh block water table elevation ranges from 540 to 340 mamsl.

Seasonal fluctuation of pre & post monsoon, 2006 indicates rise in about 8000 sq km due to widespread and good rainfall. Out of this, rise in water level more than 4m was observed in 5800 sq km area falling in Banera, Hurda, Raipur, Sahara, Suwana, Mandalgarh, Asind and parts of Kotri blocks. Jahazpur, Shahpura and Kotri blocks show decline at isolated locations.



Long term pre monsoon (1997-2006) water level data of Hydrograph Stations show declining trend of 0.029 m/year due to 6 low rainfall monsoon years when rainfall was below average. During post monsoon decadal trend shows rise & decline of 0.40 & 0.037 m/year respectively. Block-wise pre & post monsoon decadal trend is as follows:

Block	Pre Monsoon Trend (m/yr)		Post Monsoon Trend (m/yr)	
	Rise	Fall	Rise	Fall
Asind		0.043	0.030	0.036
Banera		0.016	0.139	0.037
Hurda		0.052	0.006	0.075
Jahazpur	0.005	0.008	0.011	0.021
Kotri	0.001	0.048	0.025	0.045
Mandal		0.000	-	-
Mandalgarh		0.030	0.021	0.028
Raipur		0.005	0.068	0.034
Sahara		0.056	0.082	-
Sahapura	0.012	0.015	0.016	0.033
Suwana		0.049	0.003	0.020
Total	**0.0058**	**0.029**	**0.040**	**0.037**

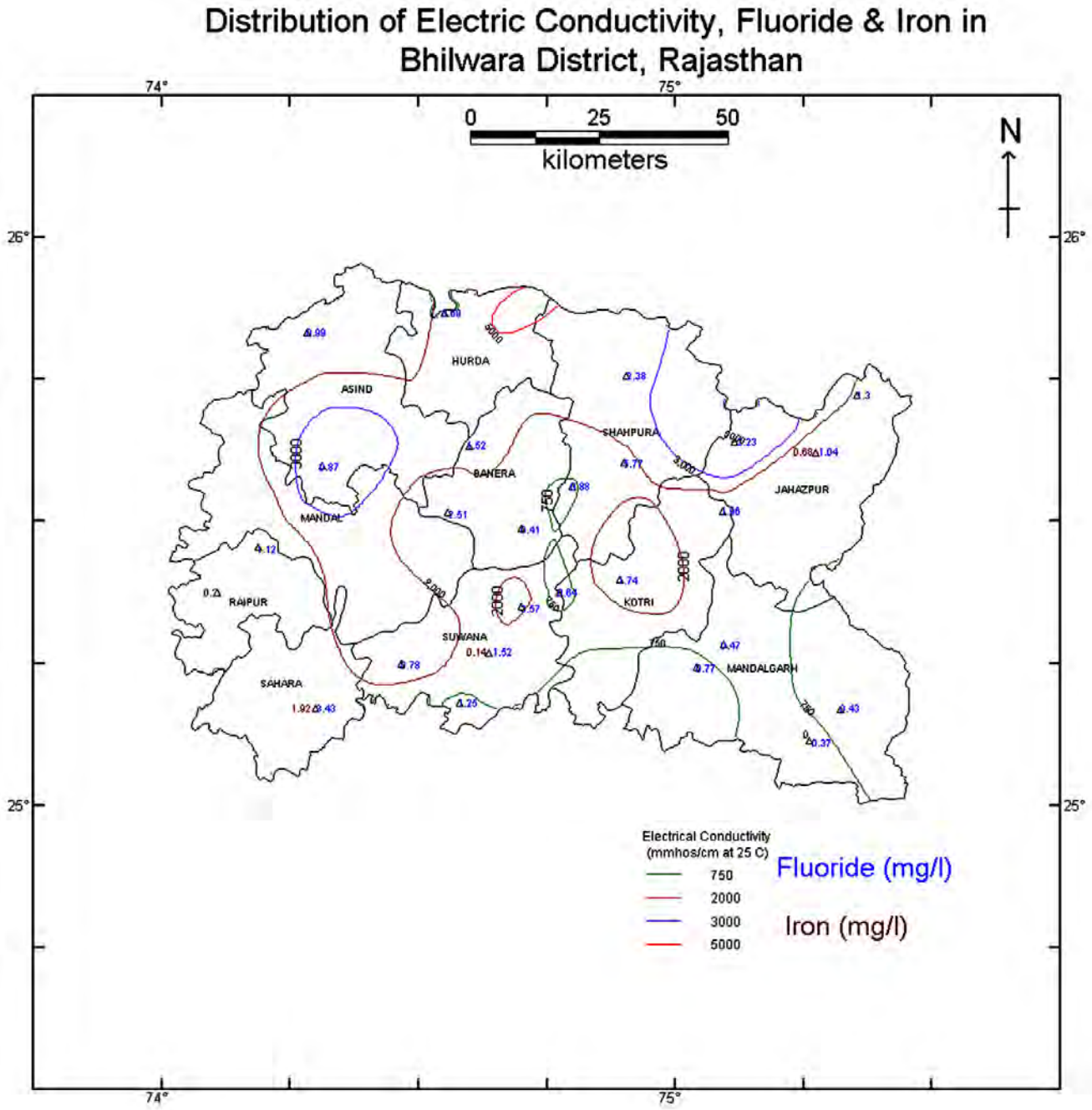
Specific yield of schist/phyllite is 1.75%, gneiss – 1.5%, sandstone- 1.0% and limestone-2.5% *(Reappraisal of ground water resources of Bhilwara district, 2004)*. The transmissivity of aquifer tapping alluvium confined to Banas River varies from 499 to 3108 m^2/day whereas in hard rock areas in the district it varies from 8.08 & 230 m^2/day.

5.2 Ground Water Quality

The greater part of the district covering mainly the southern, eastern & western part, ground water quality in shallow aquifer is fresh with electrical conductance less than 2000 mmhos/cm at 25^0 C. Here water of high electrical conductance occurs in small isolated patches. In the northern parts groundwater is comparatively more saline (Gulabpura block) with electrical conductivity 2000 to 3000 mmhos/cm at 25^0 C or higher. Variation in conductivity is confirmed by presence of chloride. Electrical conductivity at Naya Laxmipura has been recorded as high as 11,400 micromhos/cm at 25^0 C. Bore wells drilled at Vijay Singh Pathik Nagar (Bhilwara City), Gulabpura and Mangrop show EC values 5640, 5430 & 36,280 micromhos/cm at 25^0 C respectively. Groundwater is brackish (EC more than 3000 to 18,030 micromhos/cm) at Bhilwara – Ajmer border along the Khari River. High conductivity in groundwater makes the area unfit for non-salt tolerance crops. Salt tolerant crops are suggested in these areas.

Fluoride concentration in groundwater exceeding permissible limit (1.5 mg/l) has been reported from all the blocks. Higher values of fluoride have been observed at Sopura 5.77), Shibji Ka Bagh (3.4), Ganpatia Ka Khera (2.3) & Kanechhan Kalan (3.01) (Shahpura block); Gageda (3.69), Moti (2.88), Patan (2.83) (Asind block); Suwana (3.57) (Suwana block); Lakola (Sahara block); Lambia Kalan (2.4) (Banera block), Jiwanliyan (2.51) (Mandal block) and Gulabpura (2.23) (Hurda block).

Higher concentration of Iron (permissible limit 1.0 mg/l) were observed in hydrograph stations at Bijolia (9.3), Kanechhan Kalan (3.01), Lakola (1.92), Badnor (1.7), Amarwasi (1.5), Taswairya Khurd (1.42), Suwana (1.32), Raila Road (1.2), Mandalgarh (1.08), Sopura (1.07), Jiwanliyan (1.04) and Gageda (1.02).

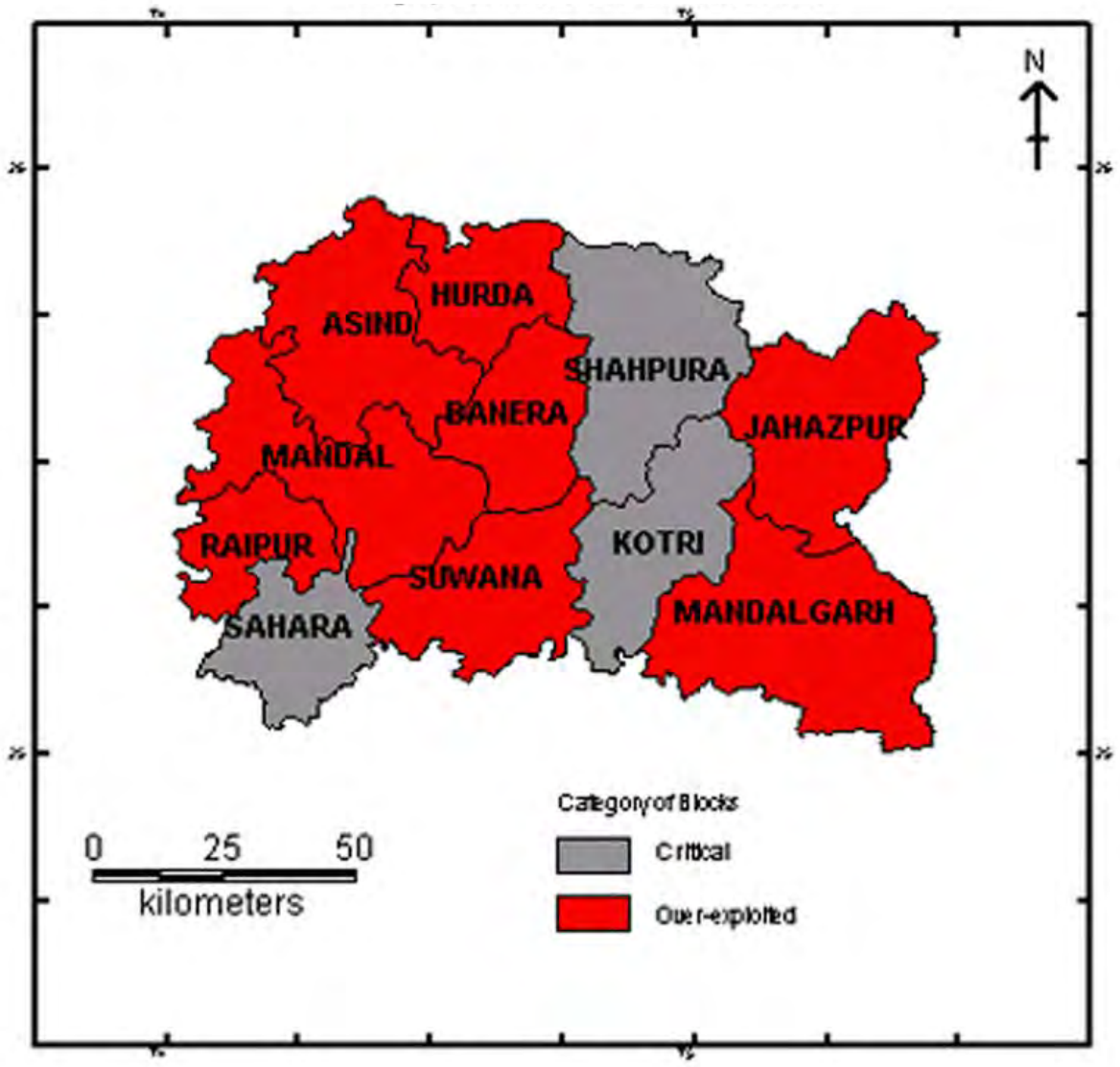


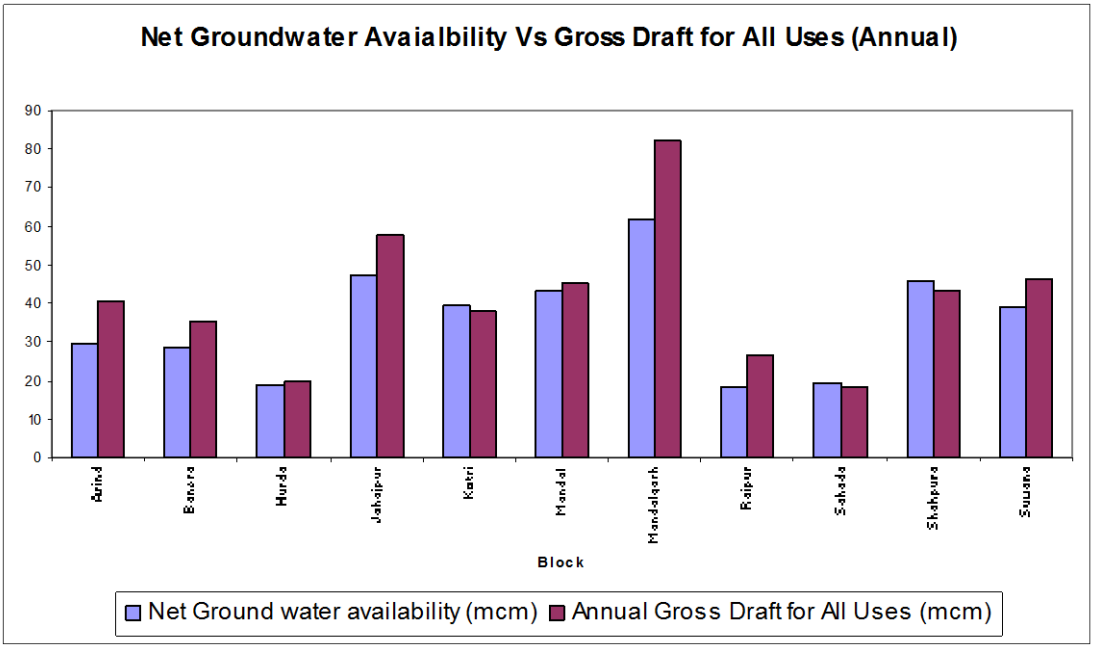
5.3 Ground Water Resources

Groundwater resources have been reassessed as on 31.3.2004 based on Ground Water Estimation Committee (1997) are given below:

Block	Area (Sq.Km)	Type of Area	Potential Zone Area (Sq.Km.)	Net Annual GW availability (mcm)	Agriculture Draft (mcm)	Dom. & Ind Draft (mcm)	Annual Gross Draft for All Uses (mcm)	Stage of GW Dev (%)	Category
Asind	1136.1	NC	908.04	26.8293	36.4908	1.5232	38.014	141.69	
		C	82.42	2.8174	2.6293	0.1872	2.8165	99.97	
BLOCK TOTAL			**990.46**	**29.6467**	**39.1201**	**1.7104**	**40.8305**	**137.72**	**O.E.**
Banera	687.8	NC	628.1	26.949	32.0113	1.7625	33.7738	125.32	
		C	34.48	1.4345	1.1828	0.2077	1.3905	96.93	
BLOCK TOTAL			**662.58**	**28.3835**	**33.1941**	**1.9702**	**35.1643**	**123.89**	**O.E.**
Hurda	621.8	NC	548.66	16.5221	14.0365	1.4008	15.4373	93.43	
		C	64.1	2.4187	4.2552	0.1942	4.4494	183.96	
BLOCK TOTAL			**612.76**	**18.9408**	**18.2917**	**1.595**	**19.8867**	**104.99**	**O.E.**
Jahajpur	1089.7	NC	865.87	47.3634	56.2524	1.5206	57.773	121.98	
BLOCK TOTAL			**865.87**	**47.3634**	**56.2524**	**1.5206**	**57.773**	**121.98**	**O.E.**
Kotri	934	NC	855.8	36.9399	34.6079	1.3741	35.982	97.41	
		C	42.51	2.3434	1.935	0.0415	1.9765	84.34	
BLOCK TOTAL			**898.31**	**39.2833**	**36.5429**	**1.4156**	**37.9585**	**96.63**	**Critical**
Mandal	1234.2	NC	1133.38	42.0191	42.0039	1.8659	43.8698	104.4	
		C	22.57	1.1011	0.4137	0.9416	1.3553	123.09	
BLOCK TOTAL			**1155.95**	**43.1202**	**42.4176**	**2.8074**	**45.225**	**104.88**	**O.E.**
Mandalgarh	1499.1	NC	963.44	53.4362	71.3663	2.0002	73.3665	137.3	
		C	69.29	8.3109	7.7351	1.0153	8.7504	105.29	
BLOCK TOTAL			**1032.73**	**61.7471**	**79.1014**	**3.0154**	**82.1168**	**132.99**	**O.E.**
Raipur	524.2	NC	486.36	18.1372	25.0938	1.2812	26.375	145.42	
BLOCK TOTAL			**486.36**	**18.1372**	**25.0938**	**1.2812**	**26.375**	**145.42**	**O.E.**
Sahara	**653.9**	**NC**	**634.69**	**19.0327**	**16.6673**	**1.6073**	**18.2746**	**96.02**	**Critical**
Shahpura	1159.3	NC	955.3	37.9018	34.1241	0.845	34.9691	92.26	
		C	169.83	7.8264	7.3735	0.6854	8.0589	102.97	
BLOCK TOTAL			**1125.13**	**45.7282**	**41.4976**	**1.5305**	**43.0281**	**94.1**	**Critical**
Suwana	914.9	NC	743.28	32.4622	33.9878	1.6247	35.6125	109.7	
		C	146.73	6.5175	7.0172	3.6091	10.6263	163.04	
BLOCK TOTAL			**890.01**	**38.9797**	**41.005**	**5.2338**	**46.2388**	**118.62**	**O.E.**
		NC	8722.92	357.5929	396.6421	16.8055	413.4476	115.62	
TOTAL		C	631.93	32.7699	32.5418	6.882	39.4238	120.3	
G.TOTAL	**10455**		**9354.85**	**390.3628**	**429.1839**	**23.6875**	**452.8714**	**116.01**	
O E – Over-exploited				*C – Command*				*NC – Non Command*	

Category of blocks, Bhilwara District (As on March, 2004)





5.4 Ground Water Development

The ground water development in the district is being done by dug wells, bore wells and dug cum bore wells. Dug wells with horizontal boring are very common. Diameter of dug well varies from 1 m to 6 m with depth ranging from 5 m to 40 m. The present stage of ground water development in the district is 116.01%, which indicates that the scope of ground water development is already exhausted. Out of 11 blocks, 8 fall under “Over-exploited” category and 3 under “Critical” category.

Gneiss, schist, phyllite, slate, dolomitic limestone, sandstone, shale and alluvium form the aquifers in different parts of the district. Alluvium area is restricted to riverbeds. Ground water occurs under unconfined to semi-confined conditions. Depth and diameter of the dug wells and bore wells depend on formation and geomorphology. However, general depth of dug well and bore wells ranges from 10 to 30m and 150m respectively except in alluvial aquifer where depth of dug well ranges from 15 to 20m. Details of groundwater abstraction structures is as follows:

Formation	Yield of Dug well (m^3/day)	Discharge of Bore well (lpm)	Depth (m)		Diameter		Type of pump/Water lifting devices
			Dug well	Bore well	Dug well (m)	Bore well (mm)	
Alluvium (Tube well)	45-55	250-1500	20-25	15-20	4-5	200	Submersible /Centrifugal pump/ Bullock
Granite Gneiss	30-40	60-100	40-55	150-175	4-5	200	
Phyllite/ Schist	30-45	20-450	15-50	150	4-5	200	
Dolomitic Limestone	50-60	20-500	15-25	150	4-5	200	
Quartzite	15-25	20-600	10-30	150	4-5	200	
Sandstone Shale	40-50	20-500	3-30	150	4-5	200	

Bhilwara district comprises 9 urban areas and each of them is facilitated with piped water supply. In all 1745 villages the drinking domestic water requirements are being met with piped water supply. Status of urban and rural water supply is as follows:

S No	Town	Population	Source of drinking water		Water Demand (in K liter)	Supply (in K liter)	Daily/ capita Demand (liter)	Daily/ capita supply (liter)	Interval of water supply once (in hr)
			Bore well	Dug well					
1	Bhilwara	280128	36	48	28013	10000	100	40	72
2	Asind	14123	21	27	989	600	70	46	24
3	Mandal	197500	18	55	13825	800	70	40	48
4	Gangapur	24362	11	33	1705	576	70	32	48
5	Mandalgarh	20169	44	1	1412	1408	70	70	24
6	Bijolia	14570	N A	N A	1020	770	70	70	24
7	Shahpura	27792	6	33	2779	1700	100	61	24
8	Jahazpur	18815	19	14	1311	1250	70	69	24
9	Gulabpura	24362	7	24	1705	480	70	21	36

Major part of the district (about 90%) is covered by hard formation where success failure ratio is 73:27. High yield i.e. more than 1000 lpm was recorded in 27% of wells, yield between 500 & 1000 in 9% wells, between 100 & 500 lpm in 32% whereas yield less than 100 lpm was registered in 41% of wells. About 27% wells have yielded negligible quantity of water. Success –failure ratio of wells falling in alluvium is 87:13. High yield (>1000 lpm) was recorded in 50% wells, yield between 500 & 1000 lpm in 12%, between 100 & 500 lpm in 25% wells whereas 12% has negligible discharge.

6.0 GROUND WATER DEVELOPMENT STRATEGY

6.1 Ground Water Development

Stage of ground water development in the district is 116.01%, which indicate that the scope of ground water development is already exhausted in 8 blocks where groundwater development has already exceeded 100% and categorized as “Over-exploited”. Only 3 blocks fall under “Critical” category where ground water development is approaching 100%. Most of the boreholes have been drilled in the northern part of district falling in Shahpura, Hurda, Asind blocks and southern part in Suwana block. There is no scope for further development in the district for irrigation or industrial use. However, exploratory drilling can be taken up in unexplored area for estimation of aquifer parameters.

6.2 Water Conservation and Artificial Recharge

Due to over development, further exploitation of precious resource must be checked. For sustainable development of ground water, artificial recharge measures to be employed to augment ground water and surface water resources. M/s Hindustan Zinc Limited (HZL) has constructed collector well in

Banas River, in the downstream side of Ghewaria mines, which is being recharged after dewatering of soapstone mine at Ghewaria, whenever the dewatering stops, discharge of collector well reduces drastically. Exploratory drilling results show potential zone having inferior quality water, which can be blended with fresh water for irrigation use.

Since the stage of ground water development has already crossed 100%, artificial recharge is the only solution to augment ground water through construction of bunds, anicuts, and rooftop harvesting structures. The area has undergone polyphase deformation in geological past, which has resulted in a complex structure (folded, faulted and jointed) that may not be conducive for such structures. Therefore, site of these structures should be selected carefully.

Watershed Development & Soil Conservation Department has constructed permanent (masonry) check dams under Irrigated Watershed Development Project to harvest rainwater, reduce soil erosion and check runoff velocity. In the district 285 check dams covering an area of 108962 ha have been constructed.

Impact assessment of check dams revealed that increase in water level, cropping area, cropping intensity, crop production and labor employment observed in the project area. Erosion from nalah bank minimizes. Cropping pattern and cropping intensity changed. Harvested water provides supplementary irrigation during long dry spell. In view of the above, such artificial recharge programmes may be taken up in the district for further development of surface water and ground water resources to enhance agricultural production. Details of masonry structures (1999) constructed are as follows:

S No	Watershed in block	No of check dams	Capacity in ha-m	No of well recharged	Cultivated area increased due to lift irrigation
1	Shahpura	45	58.66	368	243
2	Suwana	173	229.06	1406	1176
3	Kotri	15	26.12	124	52
4	Banera	53	39.7	382	201
Total		**286**	**353.54**	**2280**	**1672**

7.0 GROUND WATER RELATED ISSUES & PROBLEMS

Almost entire district is facing problem of ground water scarcity. Over the greater part of the district occupied by hard formation the well yields are very poor. As such the depth of weathered zone is generally restricted up to 30m, which control the occurrence and movement of groundwater. Deep-seated fractures below 100m are very rare. This causes reduction in the well yield drastically during the summers creating acute water shortage of domestic water supply. However, in selective areas located on structural weak planes connected to some recharge source wells continue to yield moderate quantity of water. Deeper levels are

either devoid of water or of poor quality of ground water (brackish to saline). Alluvium occurs at limited places along the major drainage/ valley fill but has very shallow thickness. The well yield varies considerably year to year in different parts of the district and over the season. Thus the availability of surface as well as ground water is very scarce in low rainfall years & specially in summer months.

8.0 Recommendations

1. Ground water draft is very high in Hurda, Kotri, Suwana, Sahara, Asind & Banera blocks. Stage of ground water development in the district has reached 116% due to indiscriminate use. It has to be controlled by preventing further development.
2. Revival of traditional ground water storage system i.e. *Baori*, open wells, *Tanka* etc for rainwater conservation for use in day to day life will reduce ground water draft.
3. There are 352 textile related industries located in Bhilwara and Gulabpura town. These industries consume huge quantity of water resulting in drinking water problem. Effluent is left untreated and allowed to mingle with ground water. Regular monitoring and check on untreated disposal of waste can prevent ground water to get polluted.
4. Awareness programmes and training on rainwater harvesting will be beneficial to check the decline in water level and justified use.
5. Taking advantage of uneven topography of the area, small check dams or earthen dams, upstream of irrigation commands, at suitable sites, may be constructed to store rainwater. This will increase recharge to ground water which ultimately result in increase of yield of wells.
6. An area of 794.18 sq km is occupied by forest. To protect the area from environmental degradation, extensive programme of aforestation and soil conservation measures may be taken up.
7. Modern agricultural management techniques have to be adopted for effective and optimum utilization of the water resources. Maintaining irrigation through minimum pumping hours as per minimum requirement of water by the crop and also selecting most suitable cost effective cropping pattern can achieve this.
8. Alluvial tracts along river channels of Banas, Kothari, Khari, Manusi and Chandrabhaga are most feasible locations where shallow wells can be constructed to harness the shallow water table aquifers being potentially recharged by the flash flood and surface runoff. These wells can be used for water supply, wherever feasible.
9. Surface runoff can be harnessed by constructing tanks at feasible sites in the area occupied by the hard rock terrain for supplementing irrigation potential to increase the agricultural production.
10. High water requirement crops be discouraged. Proper agriculture extension services should be provided to the farmers so that they can go for alternate low water requirement economical crops.