



स्वच्छ सुरक्षित जल – सुन्दर खुशहाल कल

CONSERVE WATER - SAVE LIFE

**CENTRAL GROUND WATER BOARD**  
Ministry of Water Resources  
Government of India

## GROUNDWATER SCENARIO

# BHARATPUR DISTRICT, RAJASTHAN



Western Region  
Jaipur  
March, 2009

## DISTRICT AT A GLANCE – BHARATPUR, RAJASTHAN

S No	Item	Statistics	
<b>1</b>	<b>GENERAL INFORMATION</b>		
	(i) Geographical area (sq km)	5066 sq. km.	
	(ii) Administrative Division (As on 31.3.2008)		
	Number of Tehsils	10	
	Number of Blocks	9	
	Number of Villages	1472	
	(iii) Population (As per 2001 Census)	2101000	
	(iv) Average Annual Rainfall (1977-2006) in mm	612.4mm	
<b>2</b>	<b>GEOMORPHOLOGY</b>		
	Major Physiographic Units	Alluvial Plains, Valley Fills, Ravines and Flood Plains	
	Major Drainage	Banganga, Gambhiri and Ruparel	
<b>3</b>	<b>LAND USE (sq km) (2005)</b>		
	(a) Forest Area	30334 ha	
	(b) Net Sown Area	393000 ha	
	(c) Cultivable Area	573000 ha	
<b>4</b>	<b>MAJOR SOIL TYPE</b>		
<b>5</b>	<b>AREA UNDER PRINCIPAL CROPS (As on 2005)</b>	Crops	Area in ha
		Foodgrains	306000
		Oil Seeds	194000
		Pulses	32000
		Cottian	900
		Sugarcane	50
<b>6</b>	<b>IRRIGATION BY DIFFERENT SOURCES</b>		
	Source	No of structure	Area in ha
	Dug wells	22331	306185
	Tube wells/Bore wells	33886	
	Tanks/Ponds	93	Nil
	Canals	-	
	Other Sources	-	
	Net Irrigated Area (ha)		295939
Gross Irrigated Area (ha)		306185	

7	<b>NUMBER OF GROUND WATER MONITORING WELLS OF CGWB</b> (As on 31. 03.2008)	
	Number of Dug wells	26
	Number of Piezometers	18
8	<b>PREDOMINANT GEOLOGICAL FORMATIONS</b>	Bhilwara & Aravalli, Delhi Super group, Vindhyan Super group and Quaternary Alluvium
9	<b>HYDROGEOLOGY</b>	
	Major Water bearing formation	Quaternary Unconsolidated formation & Hard Rocks
	Depth to water level (Pre-monsoon, 2008) (mbgl)	3.56 – 22.07
	Depth to water level (Post-monsoon, 2008) (mbgl)	2.19 – 25.35
	Long term decline water level trend (1999-2008) in m/yr	0.39
10	<b>GROUNDWATER EXPLORATION BY CGWB</b> (As on 31.3.2008)	
	Number of wells drilled (EW, OW, Total)	E W – 47 OW – 24 SH – 6 PZ – 25 Total – 102
	Depth Range (m)	30 – 210
	Discharge (liter per minute)	22 - 2200
	Transmissivity (m <sup>2</sup> /day)	6 – 787
	<b>GROUND WATER QUALITY</b>	
Presence of chemical constituents more than permissible limit (TDS>2000 ppm, F>1.5 mg/l, Nitrate>100.0mg/l)	EC - 46.15 % F - 46.15 % Nitrate- 15.81 %	
12	<b>DYNAMIC GROUND WATER RESOURCES (March, 2004) in mcm</b>	
	Annual Replenishable Ground Water Resources	453.6358
	Net Annual Ground Water Draft	453.1589
	Projected Demand for Domestic and Industrial Uses up to 2025	78.38
	Stage of Ground Water Development	99.89
13	<b>MAJOR GROUND WATER PROBLEMS AND ISSUES</b>	Limited fresh water Resources, with declining ground water trend and about 46% saline area.

## **GROUND WATER SCENARIO DISTRICT BHARATPUR, RAJASTHAN**

### **1.0 Introduction**

Bharatpur district is located between 26° 40' and 27° 50' latitude and 76° 53' and 77° 45' longitude covering an area of 5066 sq.km. The district is part of Bharatpur Division and is divided into 9 sub-divisions. Administratively the district is divided into 10 tehsils and 9 development blocks.

Total number of villages in the district is 1472 and it also has 9 urban towns. Rural and Urban population of the district is 1,692,182 and 434,939 respectively.

Systematic hydrogeological survey in the district was carried out by Central Ground Water Board from 1975 to 1979. Reappraisal hydrogeological survey in parts of district was carried out during 1994-95. Under exploratory programme 47 exploratory wells in Soft rock and 11 in Hard rock, 24 observation wells, 6 slim holes and 25 peizometers were constructed during 1976 – 2008. Since 1973, monitoring of water level is being carried out four times a year from National Hydrograph Network Stations in which 26 Dug Well & 18 Tube wells are monitored.

### **2.0 Rainfall & Climate**

Average annual rainfall (1977-06) of the district is 612.4mm. However normal rainfall for the period 1901 to 1970 is 675.1mm. This indicates that the rainfall has decreased over the years. The maximum average rainfall is 509.0mm at Kama and minimum average rainfall is 353.0 mm at Deeg in 2007-08.

The climate of the district is being dry becomes extremely hot during summer and extremely cold during winter. The cold season is from December to February and is followed by summer from March to June. From mid of September to end of November constitute post monsoon season.

The district experiences either mild or normal drought once in two years. Severe type of drought has been recorded in 1979. Most severe type of drought has occurred only in Nadbai subdivision in 1979 and Deeg subdivision in 1986.

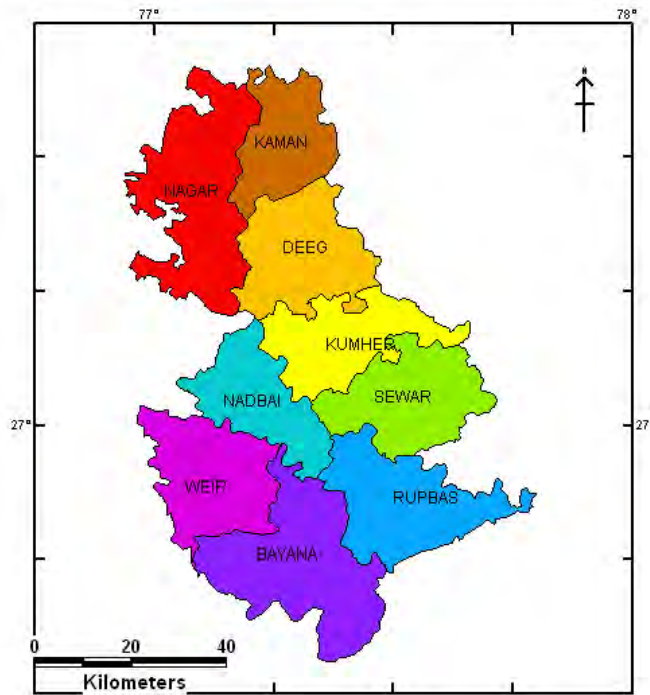
### **3.0 Geomorphology & Drainage**

The district is characterized by isolated hillocks in the northern part, vast plain occupied by alluvium and windblown sand in central part and low lying flat topped hills in southern part of the area the main physiographic units. The master slope of the district is easterly towards Yamuna River.

Geomorphologically the district is divided into following units:

Origin	Land Forms	Occurrence in the District
Fluvial Origin	Alluvial Plain	Formed due to fluvial activity, consisting of gravels, sand, silt and clay. Terrain mainly undulating.
	Valley Fills	Formed by fluvial activity at lower topographic level
	Ravines	Small, narrow, deep depression usually carved by running water.
	Flood Plain	Surface of relatively smooth land adjacent to a river channel. Subjected to periodic flooding.
Structural Origin	Plateau	Extensive flat landscape, bordered by escarpment on all sides. Formed over horizontally layered rock formation with steep slopes.
	Dissected plateau	Plateau, criss-crossed by fractures forming deep valleys.
Hills	Linear Ridges	Long narrow ridges having high run-off
	Structural Hills	Linear to arcuate hills associated with folding
	Denudational Hills	Steep sided comprising of varying lithology with joints, fractures and lineaments.

### INDEX MAP OF BHARATPUR DISTRICT



## Drainage:

Bharatpur district falls in parts of Ruparel, Banganga and Gambhiri river basins. Tehsil wise distribution of basin area is given below

S. No.	Name of Tehsil	Area in river basin (sq. km)		
		Banganga	Gambhiri	Ruparel
1	Pahari	3		483
2	Kaman	119		314
3	Nagar	162		308
4	Deeg	398		
5	Nadbai	439	0.4	
6	Kumher	508		
7	Bharatpur	468		
8	Weir	508	274	
9	Bayana	48	483	
10	Roopwas	61	466	

All the rivers in the district are ephemeral in nature. River Banganga, which passes through the south-central part of the district, disappears in the sandy tract near Ghana. Gambhiri River flows in the southern part, where as Ruparel flows in the northern part. Drainage density in the northern and central part varies between 0.2 and 0.3 km/Km<sup>2</sup> where as in the southern part varies from 0.3 to 0.5km/k

There are four important lakes in the district. These are Moti Jheel, Keola Deo Jheel (Ghana Bird Sancturay), Model Jheel and Jheel Ka Bara.

## 4.0 Soils & Irrigation Practices

The soils of the Bharatpur district are greyish brown and yellowish brown with wide variation in texture from sandy loam to clay loam. The soils at some places are affected by salinity/ alkalinity. The soils of Bharatpur, Bayana and Deeg subdivision is fertile. In NE part of the district the soils are compact and have low permeability, which causes water to stagnate on upper surface during rainy season.

### Irrigation:

The principal means of irrigation in the district are wells/tube wells and though some areas are irrigated by canals. Groundwater is the main source of irrigation and is utilized through dug wells, DCB's, and tube wells. Canals form the second most important source of irrigation in the district. Details of the gross irrigated area by different sources and number of structures have been given below:

(Area in Ha)

Sl. No	Tehsil	Total Irrigated Area	Irrigated Area				Number of structures		
			Tube wells / wells	Ponds / Tanks	Canals	Others	Dug Well	Tube Well	Pond
1	Bharatpur	34510	34510	-	-	-	19	4089	-
2	Nadbai	38621	38621	-	-	-	81	6524	-
3	Deeg	26403	25329	-	1074	-	814	3509	-
4	Nagar	28837	28837	-	-	-	317	2227	-
5	Kama	19513	19053	-	460	-	1039	1417	4
6	Bayana	30319	30139	-	180	-	3534	2618	18
7	Weir	37333	37333	-	-	-	1952	4238	24
8	Rupbas	33891	2694	-	1197	-	1445	4160	40
9	Kumher	29039	28512	-	527	-	5	3117	6
10	Pahari	17473	17473	-	-	-	61	1987	1

## 5.0 GROUNDWATER SCENARIO

### Geological Framework

Different formations belonging to Bhilwara super group, Delhi super group, Vindhyan group and Quaternary alluvium forms the geological frame work of the district. About 85% area of the district is occupied by alluvium & wind blown sand. The geological sequence in Bharatpur district is as follows

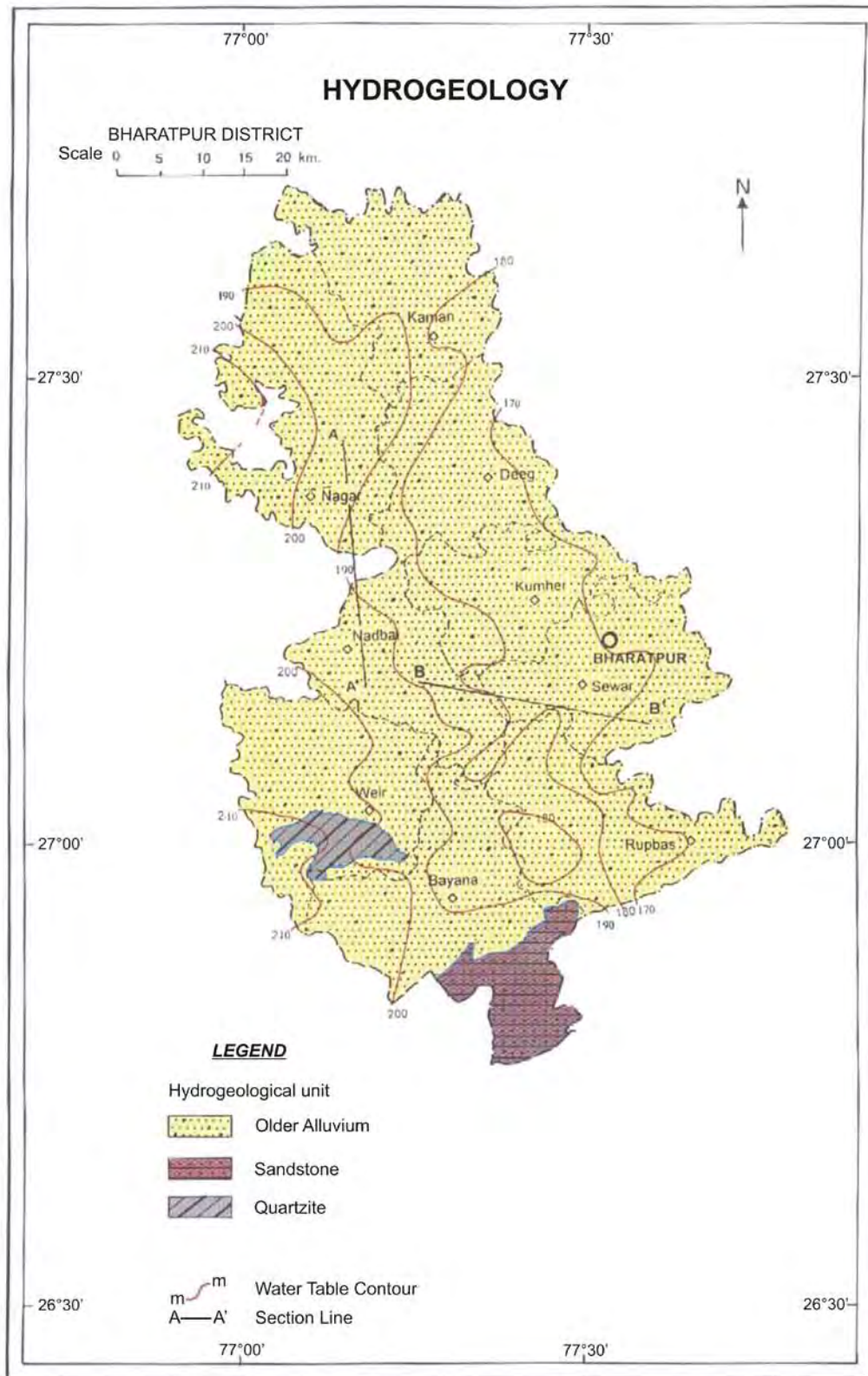
SUPER GROUP	GROUP	FORMATION
Quaternary		Alluvium, wind blown sand.
VINDHYAN	Bhander	Sandstone, Shales & Limestone.
DELHI (Proterozoic)	Ajabgarh	Argilaceous meta sediments
	Alwar	Arenaceous meta sediments
BHILWARA & ARAVALLI (Archaen)		Granites, Granitic Gneisses

### Hydro-geological Condition:

Groundwater within the district usually occurs at shallow depths ranging from 25 – 30m to less than 5m and at places almost at ground level after rainy season. In most of the area groundwater is phreatic, but semi-confined conditions occur in the central and eastern part of the district. In Kumher area confining conditions are prevailing till today.

Groundwater is mainly found in the quaternary, unconsolidated beds. However weathered zones, fracture, joints and fissure system in hard rock belonging to Vindhyan group also yield considerable amount of groundwater. Favorable groundwater exploitation areas in hard rock terrain occur in fractures and talus along subsurface contact of alluvium and quartzite ridges.

# HYDROGEOLOGICAL MAP OF BHARATPUR DISTRICT



## **Quaternary Unconsolidated Formation**

The unconsolidated sediments cover the greater part of the district and consist of sand, gravel, silts clays and Kankar within the flood plain province. The piedmont zone is characterized by talus & scree and fault debris material. These groundwater potential zones have favorable hydraulic properties and receive a major part of the surface run-off.

The alluvial flood plain (Banganga River Basin) is composed mostly of aeolian sand gravel, silt and clay. The coarser component predominates in the western side of the district, while gradually decreasing in the east ( direction of low energy flow regime) the proportion of finer clastics in the profile increases giving rise to semi-confined to confined conditions. In the west only single, phreatic aquifer is encountered. In the central part of the district semi confined unit exist, where as in the east where alluvium complex attains its maximum thickness giving rise to third lower most mainly confined unit. These major ground water potential units separated by two major aquicludes are referred as 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> aquifers. The thickness of alluvium in Banganga basin greatest and varies from 120 to 180m. The basement of the alluvium is formed by gneiss, sandstone and quartzites.

The lithological disposition along Nadbai, Ludhawai, Mallah and Chiksana shows that the maximum alluvium thickness (160m) is encountered at Chiksana and minimum at Nadbai. The quantity of clay increases from Nadbai to Chiksana. Occurrence of clay and silt at various depths give rise to multiple aquifer system. The basement rock at all the boreholes is limestone.

In the northern part of the district (Ruparel Basin) basement is encountered at shallow depth as compared to central part. The thickness of alluvium is about 100m at Kaman and sau. There is predominance of clay mixed with kankar and gravel thus gives rise to poor aquifers. The yield of wells varies from 6 to 25m<sup>3</sup>/hr.

In the southern part (Gambhiri River basin) generally single phreatic aquifer is encountered. The thickness of alluvium ranges from 60 to 100m. The maximum thickness of aquifer tapped is 18m in the depth range of 36 to 100m. Aquifer under pressure is found in limited area (Pachuna) and peizometric head ranges from 1m to 9m bgl.

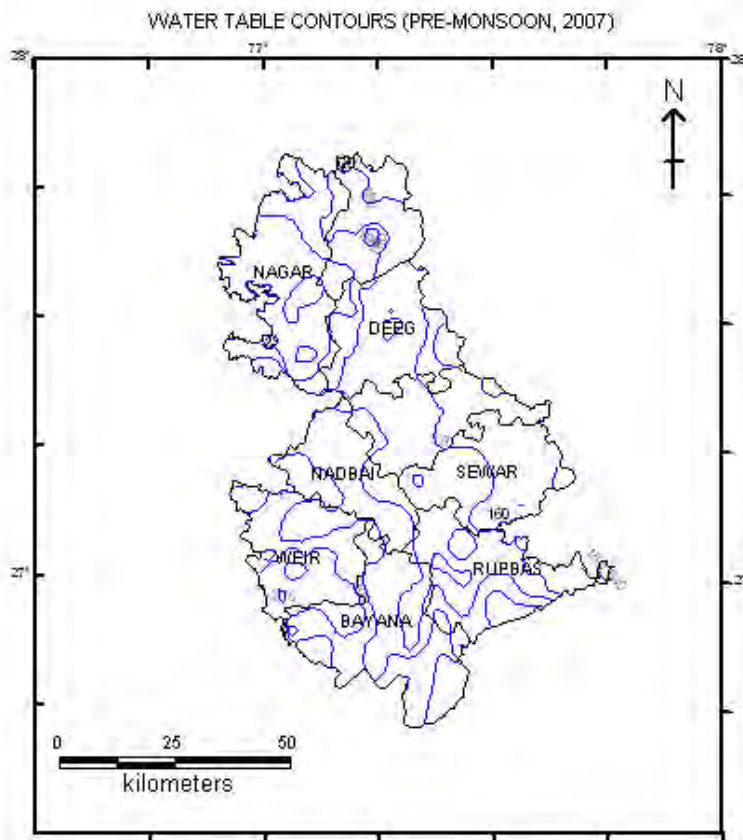
## **Hard Rocks**

Sedimentary and meta-sedimentary consolidated formation belonging to Vindhyan, Delhi and Bhilwara super groups forms poor aquifer in the district. The groundwater occurs in the weathered zones and in secondary openings under unconfined conditions.

Occurrence of groundwater in these aquifers is not inter-connected hydraulically. Hard rock aquifer occurs in parts mainly in Roopwas, Bayana and

Weir blocks. The consolidated water bearing formations are sandstone, quartzite, schist, gneisses and phyllites. The depth of wells constructed in these formations range from 85m to 160m. High yielding wells in Vindhyan sandstone has been constructed at Malpura Kachhi, Bakholi, and Ghantoli. Summarized block wise groundwater condition and development possibilities is given below:

## GROUND WATER MOVEMENT



Perusal of the counter map show that water table contour follow the topography of the district reaching the highest elevation in the hills. The absolute ground water level in the district during pre-monsoon 2007 ranged from 217m amsl in the west to 163m amsl in the east. The average hydraulic gradient changes from 5m/km in the hilly area to 1m/8km in the eastern most part (Sewar Block) of the district. The eastern most part of the district is almost equipotential hydraulic plain which behaves like a hydrologic trough for all practical purposes (SE of Sewar Block). Minor out flows may take place after monsoon rains but greater

part of the outflow from this area is apparently by evaporation from water table.

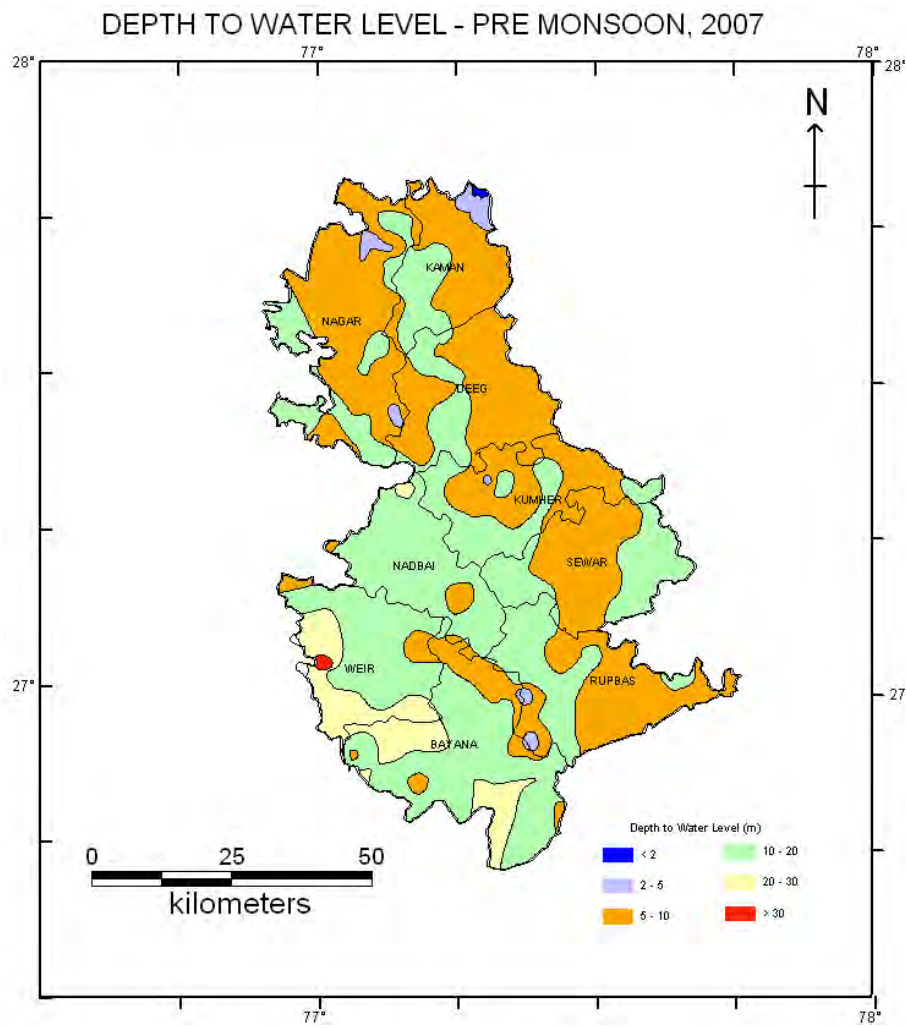
A similar situation exists along the boundary of Banganga and the Ruparel River in Nagar and Kaman block. The Ruparel dries up and disappears in Sikri Bund. No hydrogeological discontinuity appears to cause the discontinuation of Ruparel River. This area is also an internal drainage basin and is also affected by ground water quality deterioration. In the extreme southern part of the district (Bayana Block) elevation of water table is more than 200m and slope of the water table is northerly which gradually turns easterly.

Thus it seems that the flow of both surface and phreatic aquifer terminates in an inland drainage basin encompassing Bhartpur-Nadbai area with Kumher as it center. This conclusion is based on (i) Shape of static ground water level

contours, (ii) Disappearance of Banganga river SW of Bharatpur, (iii) Presence of saline soils & water logged areas and (iv) Deterioration of Groundwater Quality

## GROUND WATER REGIME BEHAVIOUR

A contour map of phreatic aquifer was prepared based on the data of NHS of CGWB and key wells of RGWD. The objective in preparing this map was to depict the regional behavior of water level and depth to water level, A perusal of the map indicates that during pre-monsoon07' DTW in the district varies from 3.0m to 37.0 m bgl. In flat areas and pediments ground water is perched over impermeable rocks and is encountered at shallow depths. In eastern most part of the district from Uchain in south to Kaman in the north is known to have been occasionally at places under water logging conditions and is suffering from salinity problems. In the eastern plain from Weir block in the south to Deeg and Nagar blocks in north the average water level is in the range of 8-14m.

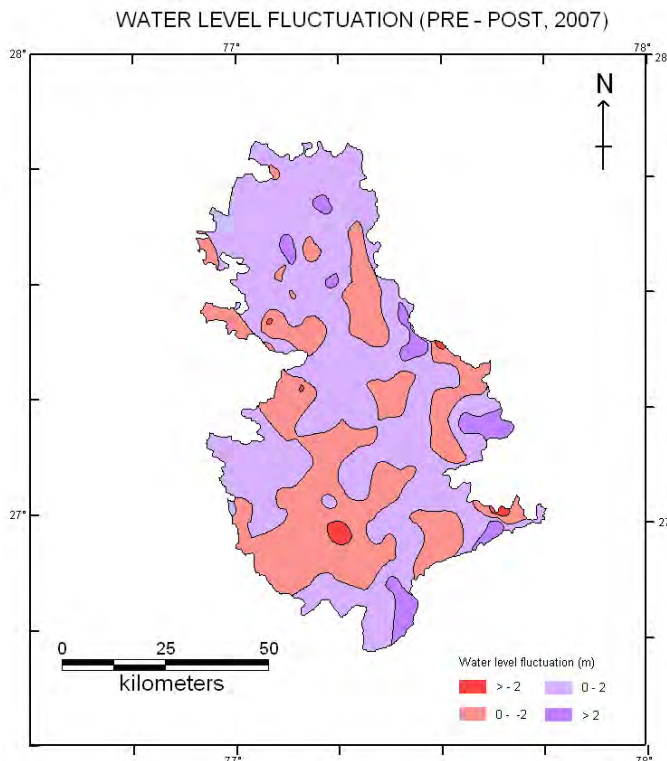


Generally, over major part of the district the depth to water varies between 5m to 10m bgl. In the south – western part of the district depth to water varies from 10 to 15m bgl. During post-monsoon period the water level are comparatively shallow and generally range from 2m to 16m bgl. Range of water levels block-wise during pre & post monsoon, 2007 is shown in the table given below:

Block	Pre Monsoon 07		Post Monsoon 07	
	Min	Max	Min	Max
Bayana	3.05	23.80	3.10	24.40
Deeg	5.20	13.33	2.90	11.90
Kaman	1.70	18.50	0.07	16.00
Kumher	4.50	14.60	4.35	13.90
Nadbai	7.80	23.30	6.40	21.60
Nagar	4.60	11.80	4.15	11.70
Roopwas	3.30	17.40	2.30	16.35
Sewar	2.60	15.50	2.00	15.60
Weir	5.95	37.00	6.20	45.60

The piezometric regime of the units underlying the phreatic aquifer is similar. An area of about 700km<sup>2</sup> east of Ludhawai is under confining condition. Flowing wells were observed at Kumher in the past but due to lowering of the head artesian condition no longer exist in the area.

## WATER LEVEL FLUCTUATION



**Seasonal fluctuation** in water level based on Pre and Post Monsoon, 2007 indicate that there has been post monsoon rise in water level in major part of the district. Perusal of the fluctuation data indicates that major part of the district has recorded rise in water level up to 2m. Decline in water level is also observed in Nagar, Weir and Bayana blocks.

Block	Water level fluctuation (Pre– Post)			
	Rise		Fall	
	Min	Max	Max	Max
Bayana	0.10	3.80	0.05	2.55
Deeg	0.45	1.90	0.05	1.35
Kaman	0.30	1.90	0.15	0.50
Kumher	0.10	3.20	0.10	2.25
Nadbai	0.80	2.00	0.10	0.65
Nagar	0.10	3.40	0.05	2.20
Roopwas	0.20	3.15	0.10	2.55
Sewar	0.15	2.85	0.10	0.20
Weir	0.10	1.10	0.15	8.60

### Long Term Water Level Decline:

Water level declined in the entire district during last decade. In the eastern plain from weir block in the south to Kaman in the north show decline of 3-5m over the last decade. The decline in water level is accompanied by consistent deterioration of ground water quality.

On the basis of average rate of decline for the year (1984-2006) the blocks have been further classified as high, moderated and marginal decline.

**High:** In this category average rate of decline is between 0.20 & 0.40m/yr. All together three blocks namely Bayana, Nadbai and Weir fall under this category.

Affected Blocks	Average Decline (m)	Avg. rate of decline (m/yr)
Bayana	5.25	0.24
Nadbai	6.98	0.32
Weir	5.29	0.24

**Moderate:** In this category average rate of decline is between 0.10 & 0.20m/yr. All together two blocks namely Nagar and Roopwas fall under this category.

Affected Blocks	Average Decline (m)	Avg. rate of decline (m/yr)
Nagar	3.14	0.14
Roopwas	3.13	0.14

**Marginal:** In this category average rate of decline is between <0.10 m/yr. All together four blocks namely Deeg, Kaman, Kumher and Sewar fall under this category.

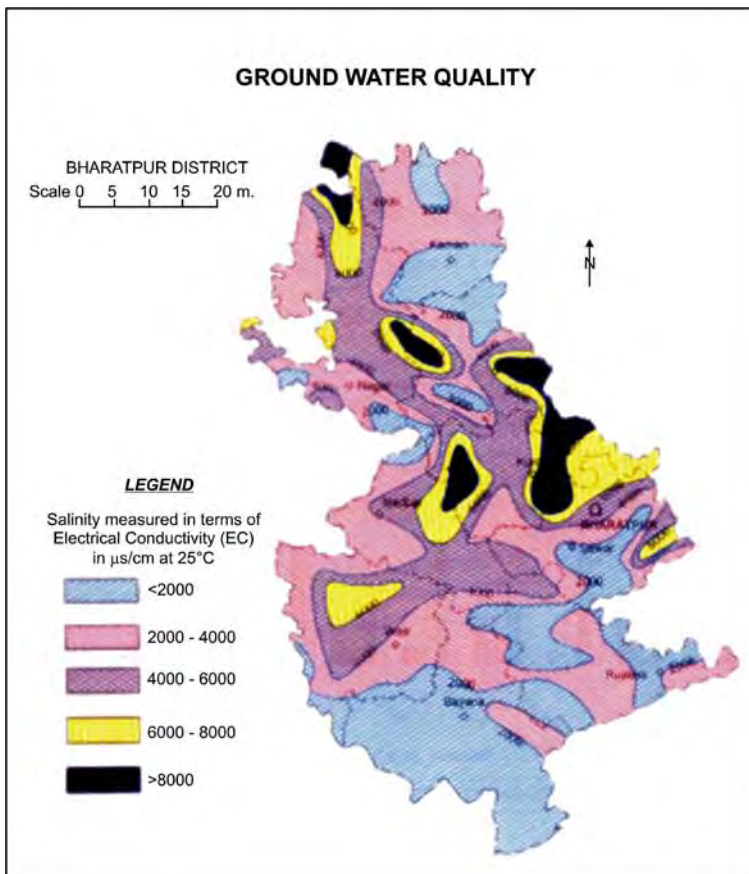
Affected Blocks	Average Decline (m)	Avg. rate of decline (m/yr)
Deeg	1.80	0.08
Kaman	1.03	0.05
Kumher	1.96	0.09
Sewar	1.47	0.07

These trends are a result of over-exploitation of the aquifer coupled with apparent downward departures of annual rainfall from long term average. Average rate of decline of the whole district is 0.15m/yr.

## GROUND WATER QUALITY

Groundwater quality in the district is presented in the form of iso-conductivity map. Variation in ground water quality is observed both in shallow and deep aquifer. At present the greater part of the district contains groundwater with EC > 3000 mmhos/cm. Ground water quality deteriorates consistently from west to east i.e. upstream terrain to low lying clayey and flat alluvial plain in the east of Weir-Nadbai-Nagar.

In southern and southeastern parts (Bayana & Roopwas block) ground water is generally fresh with EC less than 2000 mmhos/cm at 25°C. In eastern most parts of Deeg Block similar situation prevails. In most part of Roopwas, Nadbai, Sewar and Weir block EC of shallow ground water varies from 2000 to 4000 mmhos/cm at 25°C. The villages Fatehpur, Dhilwati, Dhimas, Garh Ajan, Nayam (Kaman Block)



Gazipur, Baraulichhar (Nadbai Block), Ajau, Dhamnr, Rarah (Kumhar Block) and Basichak, Bharsauri, Hingota (Weir Block) fall in this range. The medium to high salinity (EC 4000 – 6000 mmhos/cm) water is observed in villages Januthar, Mabai, Malipura (Deeg Block) and Awar, Pichunar, Saint (Kumhar Block). The next range of saline water (EC 6000 – 8000) is observed at Gopalgargh, Nakatpur,

Pahari, villages (Nagar Block) and Dhurmai, Rampura, Uchanagla of Sewar block. The maximum salinity (EC=15,000) in shallow aquifer is observed at Kanauli village (Sewar) and minimum value (EC=390) occurs at Thanasong of Bayana Block.

In Deeg and Nagar blocks in the north potable water is skimmed in places from above saline groundwater bodies by means dug wells. Some pockets of potable water are also known to have been formed beneath and along ponds and canals fed by monsoon waters.

Ground water quality in shallow **hard rocks** aquifers overlain by thin alluvial mantle is suitable for all purposes.

Block	% OF SAMPLES IN DIFFERENT RANGE OF SALINITY (EC, mmhos/cm)				
	0 – 2000	2000– 4000	4000– 6000	6000-8000	>8000
Bayana	68	29	-	-	3
Kaman	38	47	5	5	5
Roopwas	43	50	7	-	-
Weir	35	35	15	10	5
Nadbai	13	53	20	7	7
Deeg	24	14	33	10	19
Kumher	15	25	30	10	20
Nagar	32	18	21	11	18
Sewar	27	23	23	18	9

Salt accumulation in the area is prevented by continuous inflow of upstream groundwater. However impoundment of surface water in tanks and ponds have locally changed subsurface ground water flow regime by creating ground water mounds in the alluvial over burden, which is manifested by appearance of water logging and salinity problem.

At **deeper levels** ground water is fresh in northwest – southeast trending belt in parts of Weir and Bayana blocks. Marginal quality of water occurs in most part of Roopwas and Sewar blocks. In western part of Nadbai and northern part of Kumher block deeper ground water is saline. It is observed that areas with fresh water at all levels extend from Weir, Hingota to Bayana and Samogar. Depth wise variation in chemical quality of water is also observed in some areas. In parts of Sewar and Roopwas blocks fresh water is overlain by saline water. In very small area marginal to fresh water overlying the saline water occurs in Sewar and Kumher blocks. List of places where extremely high salinity has been recorded in exploratory wells is given below:

Name	EC	Cl (ppm)
Gangrauli	15980	4325
Halena	23300	7516
Kamalpura	19115	6275

Kumher	13248	4325
Sahari	22240	6887
Bahai	22180	6133
Nadbai	8420	1828

The principal reasons for the severe groundwater quality problem are

- The Banganga and Ruparel terminate in an internal drainage basin. It is estimated that flood water of these river carry 100,000 tons of solute load annually (Water Resources Planning For Banganga River Basin-1998) which are concentrated by evaporation and seep into shallow ground water.
- Further, concentration is brought about by evaporation from the water table i.e. by capillary rise due to shallow water table and clayey lithology of formations.
- All solutes transported to this area by means of surface of subsurface flow remains in-situ as there seems to be no flushing out of salts from the closed basin.

#### **GROUND WATER RESOURCES:**

Ground water resources have been estimated as per norms recommended by GEC 97. While assessing the ground water resources saline and hilly areas have not been considered. Total groundwater resources based on water level fluctuation is estimated to be 453.6358 mcm. Draft for all uses is 453.1589 mcm and over all stage of development is 99.89%.

Sl. No.	Assessment Unit	Net Annual Ground Water Availability (mcm)	Gross Ground Water Draft for All uses (mcm)	Stage of Ground Water Development	Category
1	Bayana	86.7803	75.9698	87.54	Semi Cr
2	Kaman	60.8526	46.9640	77.18	SAFE
3	Roopwas	78.2141	66.7324	85.32	SAFE
4	Weir	43.5555	64.1868	147.34	O E
5	Nadbai	42.6915	65.9995	154.57	O E
6	Deeg	41.8133	36.3389	86.92	SAFE
7	Kumher	16.1859	14.0890	87.08	SAFE
8	Nagar	45.8593	34.2664	74.72	SAFE
9	Sewar	37.6833	48.6121	129.00	O E
<b>DISTRICT TOTAL</b>		<b>453.6358</b>	<b>453.1589</b>	<b>99.89</b>	<b>CRITICAL</b>

## **WATER RESOURCES MANAGEMENT PLAN**

Due to pressure of population and improvement in the standard of living the demand of fresh water for both agriculture and domestic use has substantially increased. As surface flow is available only for a limited period ground water withdrawal has sharply increased. The top layer of fresh ground water is also reducing every year. Artificial recharge serves as a means for restoring the depleted ground water storage, slow down the quality deterioration and put back into operation many groundwater abstraction structures.

Availability of groundwater in the district is estimated to be 453.6358mcm. Draft for all uses is 453.1589 mcm. Out of which 412.1820 mcm is used for agriculture and 40.9769mcm is used for domestic needs. It is expected that by 2025 the demand of groundwater will increase by 78mcm. As per ground water resource estimation 2004 stage of ground water development is 99.89%. At present there are 42,656 tube wells/open well used for irrigation and 3,273 wells for domestic use and 4025 hand pumps and 350 tube wells are used for domestic water supply. Rainfall in the district is the main source of ground water recharge. Due to less rainfall and increased ground water withdrawal the groundwater level is depleting at a rate of 0.12m/yr, as a result of which salinity in ground water is also increasing. High salinity is observed in the downstream areas of Banganga and Ruparel River falling in parts of Deeg, Kumher, Nadbai and Sewar blocks.

In the back drop of the above situation it is need of the hour restore and increase storage capacity of our traditional water conservation structures viz. village ponds, ani-cuts, earthen dams, tanks and canals to meet the future domestic, agriculture and industrial demands.

In the realm of water resources it is recommended to carry out the works, described below, as a part of desirable comprehensive groundwater and surface water development plan:

### **Rejuvenation & Restoration of Reservoir and Canals:**

District Bharatpur encompasses world famous water conservation and surface water inundation irrigation system built on three rivers flowing through the district. The inundation irrigation system includes diversion of surplus river flow from the river through canals, inundation of large area and storage of water in small and medium shallow reservoirs. The surface water conservation is done through 197 no. of earthen dams with total storage capacity of about 226.7047 mcm. There are total 90 canals with 650km length. This unique system withstood test of time as it provided agricultural base to large population. It also helped in replenishing the phreatic aquifer with fresh water and suppressing groundwater salinity.

The current inundation irrigation is regarded more as groundwater recharge method than an irrigation method. Off late farmers are providing irrigation through open wells which are constructed near to canals, tanks and ponds. These wells are also used as the source for drinking water. Such wells use the recharged groundwater for irrigation which is bound to raise irrigation efficiencies. The existing system is not operating properly because of inadequate capacity of diversion channels, silting of canals, river beds and detention reservoirs.

It is recommended to improve the system for the entire area from Weir block in the south to Deeg and Nagar block in the north. The average phreatic water level is in the range of 15 to 20m bgl, constituting a cumulative decline of 3-5m over past decade which has created better condition for aquifer recharge. However, favorable condition for artificial recharge by extensive spreading grounds at a single site do not seems to exist in the district. The most effective solution appears to be network of unlined canals which also serves as irrigation canals. This pattern is likely to minimize local effects like water level mounding and ensure distribution of recharge water in alluvial aquifer over wide area as possible. The exact alignment should be determined on the basis of (i) necessary alluvial thickness (ii) sufficient ground water level depth and (iii) adequate permeability and non-existence of subsoil clay horizon.

Traditional water conservation system of the district was built about 200 years ago by erstwhile rulers of Bharatpur. Due to natural degradation, water carrying & holding capacity of the system has reduced. Irrigation Department, Govt. of Rajasthan has identified 66 restoration works which will generate additional 70.7921 mcm of water. The estimated cost for above works is Rs. 673.00 lac.

### **Artificial Recharge of Groundwater by Imported Surface water**

Presently Bharatpur district receives its share of Yamuna water from Okhla barrage through Gurgaon Canal and Bharatpur feeder. Gurgaon canal has the supply capacity of 14.17 m<sup>3</sup>/sec while Bharatpur feeder has a supply capacity of 8.5 m<sup>3</sup>/sec. To utilize Rajasthan's entire share it is proposed to construct minor feeder channels from Bharatpur feeder and Gurgaon canal to fill the 23 village ponds located in Deeg & Kumher blocks and 20 village ponds located in Kaman & Pahari blocks. The infiltration capacity of the alluvial deposits ranges roughly from 10 – 15 cm/day depending upon the clay and silt content (Water Resources Planning For Banganga River Basin-1998). Assuming 100 days of operation annually it is assumed that 10 mcm of water can be recharged per sq.km per year.

Groundwater level is depleting in the alluvium potential zones of the mentioned blocks indicating artificial recharge to ground water is feasible in principal. For full utilization of surface water especially excavated skimming wells/ cavity bore

wells may also be constructed at base of canal, catchment of ponds or in low lying areas. These structures may be used to recharge groundwater during monsoon and as groundwater abstraction structures during lean period.

By adopting the above work surface water will be assured in the 43 village ponds. Filling of village ponds will ensure in-situ ground water recharge and will meet the needs of drinking water supply by tube wells / open wells. It is estimated that Rs 43.60 lac will be spent on construction of feeder channels and Rs 300.00 lac on construction of skimming wells and cavity bore wells.

### **Groundwater Recharge through Dug Wells:-**

Artificial recharge of groundwater is the most efficient groundwater management tools for ensuing sustainability of groundwater resources. Govt. of India is concerned about the problem of over exploitation of groundwater resources in the district. To ensure sustainable water management and assured irrigation facilities the dug well recharge scheme is implemented for accelerated groundwater recharge. Dug well located in the catchment area of dams, near canals, downstream of ani-cuts and low lying areas (depression) of the agricultural fields etc. forms the potential site for groundwater recharge, besides other open wells located in the area.

The Dug well recharge scheme is a state sector scheme taken in XI plan period. The scheme is being implemented by state government in over exploited, critical and semi-critical blocks in association with Non Government Organizations. Under this scheme farmers will be encouraged to install rainwater harvesting structure near the dug well in their agricultural field. The design of the structure may vary depending upon site condition. The rainwater harvesting structure may include a silting pit to retard the surface water flow and a filter pit to make water silt and contamination free. This scheme is being implemented in Bayana, Nadbai, Weir and Sewar blocks of the district. The Government of India will provide a subsidy of Rs 4000 to marginal and small farmers and Rs 2000 to other identified farmers.

### **Construction of Ani-cuts**

In Gambhiri river basin surplus surface water is available hence small scale, inexpensive flow retarding structures can be constructed at many places on the main river or on its tributaries. Suitable hydro-geological conditions for artificial recharge have been identified in Bayana, Roopwas, Weir, Deeg and Kaman tehsils. Technical and economic feasibility, site conditions etc. has been studied by Irrigation Department, Govt. of Rajasthan. Construction of ani-cuts in different hydrogeological and agro climatic conditions has reflected their importance in groundwater recharge, controlling decline in groundwater level and mitigation of groundwater quality problems. A total of 155 new ani-cuts have been proposed in the above mentioned tehsils by which an additional 13.1673

mcm of water can be stored. It is estimated that an amount of Rs. 2446.00 lac will be spent on construction of ani-cuts.

### **Conservation of Flood Water at 'K.P Drain'**

Kaman-Pahari Drain originates from Rajasthan – Haryana border. This drain is an inter-state flood water disposal system for Haryana, Up and Rajasthan. There are 19 low lying pockets where rain water is collected during monsoon season. Excess flood water is diverted into Yamuna River through this drain. It is proposed to construct gated system at chain 740/828 to conserve the excess monsoon flood water. It is estimated that by construction of gated system an additional 0.424 mcm of water can be conserved which can be utilized for artificial groundwater recharge. The estimated cost of the above work is Rs. 152.00 lac.

### **Prevention of Salinity Ingress**

Groundwater mining in the district is highly problematic. In the eastern part, down stream of Banganga and Ruparel River it is characterized by abundance of saline potential zones. A delicate hydraulic equilibrium exists between saline zones and pumped areas. Lowering of water level in the fresh water zones may trigger expansion of saline zones.

To counter act the salinisation process artificial recharge of fresh water in order to form a hydraulic barrier around the saline potential zones with a reverse water table gradient may be adopted. Suitable hydrogeological condition for artificial recharge lies between Toda-Bhim –Mandawar line in the east and Suri tributary in the west. In this part of the Banganga river basin the aquifer thickness is 50 – 70m and is predominately arenaceous and there is no saline patch. This area also serves as the feeder zone for 2<sup>nd</sup> and 3<sup>rd</sup> aquifer in the east which means that artificial recharge will affect the entire aquifer.

The Todana Dam is proposed as source of regulated water for the planned recharge grounds and utilization of recharged water by means of existing as well as additional wells in future. This proposal will also encourage conjunctive use of surface and groundwater where ever possible. The water intercept by Todana Dam is expected to greatly enhance aquifer recharge. This would be achieved by

1. Retention of water in reservoir
2. Specially excavated recharge ponds into which water would be released from the dam after some retention period.

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