DISTRICT GROUND WATER INFORMATION BOOKLET

RAISEN DISTRICT

MADHYA PRADESH

Central Ground Water Board
North Central Region
Ministry of Water Resources
Government of India
BHOPAL
2013

RAISEN DISTRICT AT A GLANCE

S.No.	ITEMS	Statistics	
1.	**General Information**		
	i) Geographical area	8466 Km^2	
	ii) Administrative Divisions (As on 2013) Number of Tehsil/Blocks Number of Villages	8/7 (1.Raisen, 2. Gairatganj, 3. Begamganj, 4. Goharganj, 5. Bari, 6.Silwani and 7.Udaipura) 1500	
	iii)Population (Census 2011)	1331699	
	iv)Average Annual Rainfall (mm)	1207.3 mm	
2.	**Geomorphology**		
	1. Major Physiographic Units 2) Major Drainage	- Vindhyan Range - Narmada Alluvium Bewas, Dudhi, Bina, Nion, Betwa, Barna, Chamorsh, Ghogra,Tendoni, Begum and Nahar	
3.	**Land Use (Km^2)**		
	i) Forest area	333.7	
	ii) Net area sown	5619	
	iii) Cultivable area	4445.36	
4.	**Major Soil Types**	Black Cotton	
5.	**Area Under Principal Crops**		
6.	**Irrigation By Different Sources**		
	Type	No	Irrigated Area (Ha)
	Dugwells	11433	282
	Tube wells/Bore wells	15490	811
	Tanks/Ponds	129	20
	Canals	15	642
	Other Sources		146
	Net Irrigated Area		2101
	Gross Irrigated Area)		2101
7.	**Number Of Ground Water Monitoring Wells Of CGWB** (As on 31.3. 13)		
	No. of Dug Wells No. of Piezometers	20 6	
8	**Predominant Geological Formations**	Deccan Trap basalts, Vindhyan sandstone and alluvium	
9	**Hydrogeology** Major Water Bearing Formation	Weathered/vesicular basalt, flow contacts, fractured sandstone and granular sand	

	(Pre-monsoon) Depth to water level range during 2012) (Post-monsoon) Depth to water level range during 2012) Long Term water level trend in 10 years i.e. (1997-2006) in m/year	 4.07 m – 19.12 mbgl 2.23 m – 17.03 mbgl Pre-monsoon 0.05-0.39 m/annum fall Post-monsoon 0.02-2.53 m/annum rise
10.	**Ground Water Exploration By CGWB** (As on 31.3.2013)	
	No of wells drilled (EW,OW,PZ,SH, Total)	12 EW, 23 OW, 5 SH, 7 PZ
	Depth Range (m)	18 - 242
	Discharge (litres per second)	0.5 – 8.0
	Transmissivity (m^2/day)	0.56 – 30
11.	**Ground Water Quality**	
	Presence of Chemical constituents more than permissible limit (eg EC, F, As,Fe)	Chloride and Nitrate
	Type of Water	Alkaline
12	**Dynamic Ground Water Resources** (2009) in MCM	
	Net Ground Water available	752.09
	Gross Annual Ground Water Draft	381.65
	Projected Demand for Domestic and Industrial uses up to 2035	742.07
	Stage of Ground Water Development	51%
13	**Awareness and Training Activity**	
	Mass Awareness Programmes Organised Date:25-11-2002 & 07-02-2006 Place: Khurwai & Gouharganj No. of Participant:	Two 125 and 350
	Water Management Training Programmes	Nil
14	**Efforts Of Artificial Recharge & Rainwater Harvesting**	
	Projects completed by CGWB (No. & Amount Spent)	Nil
	Projects under technical guidance of CGWB (Numbers)	Nil
15	**Ground Water Control And Regulation**	
	Number of OE Blocks	Nil
	Number of Critical Blocks	Nil
	Number of Notifed Blocks	Nil
		All block are safe
16	**Major Groundwater Problems and Issues**	Depletion in groundwater level and deterioration of Groundwater quality

1.0 INTRODUCTION

Raisen district is lying in the central part of Madhya Pradesh. It comes in Bhopal commissioner's division and is well connected by roads and railway. National Highway 67, connecting Bhopal and Sagar passes through the district. There are 7 tehsils and 7 blocks in the district. The block headquarters are Sanchi, Gairat Ganj, Begamganj, Obedullahganj, Bareli, Silwani and Udaipur. Raisen district with an area of 16974 Km^2lying between the North Latitudes 22^0 45' 00" and 23^0 45' 00" and East Longitudes 77^0 21' 00" and 78^0 49' 00" and falls under the Survey of India toposheet No. 55 E, F, I and J. It is enclaved by Vidisha district in north, Sagar district in northeast, Narsinghpur, Hosangabad and Sehore district in south and Bhopal district in the west. The Narmada River flowing along the southeastern boundary of the district, detached it from the Narsinghpur and Hosangabad district boundaries.

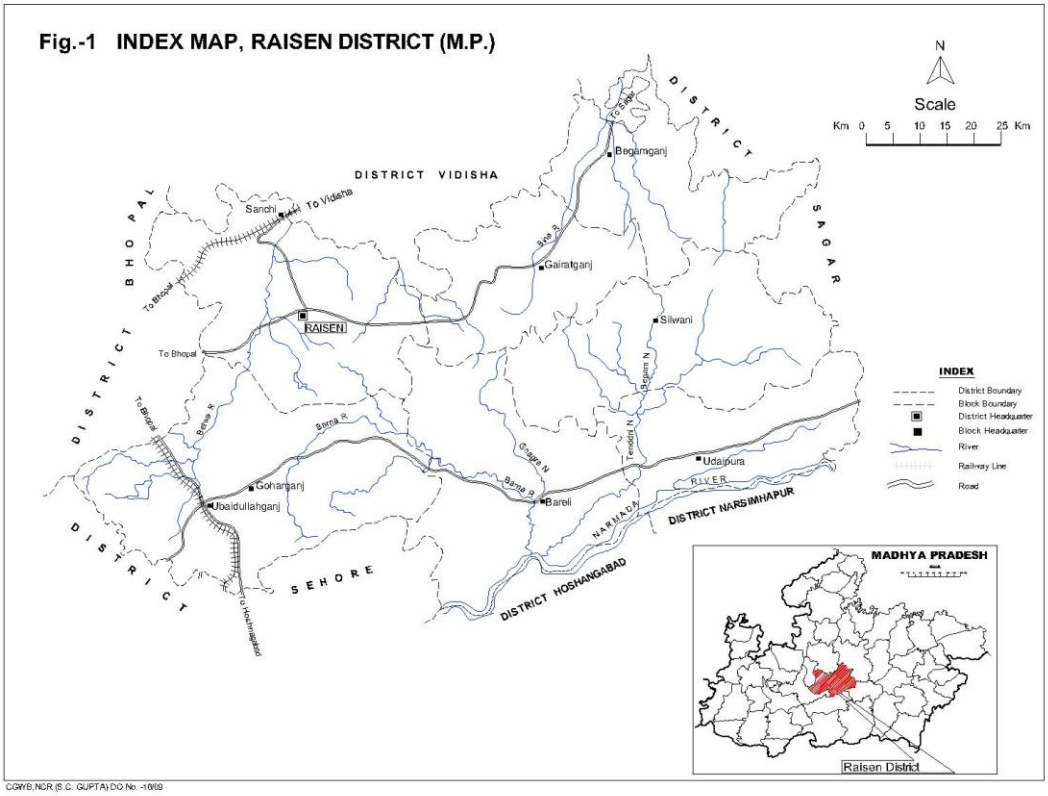
Administrative Division

The district is sub divided into seven administrative blocks and seven tehsils. The administrative divisions are shown in figure-1 and given in table–1.

Table – 1:Population in different administrative Division, District Raisen, M.P.

District/ Block	Area km^2	Population 2001
District Raisen	6317.45	11,20,159
1. Raisen / Sanchi	763.88	1,93,118
2. Gairat/ Gairat Ganj	825.67	1,04,760
3. Begamganj / Begamganj	897.42	1,26,743
4. Goharganj/ Obedullahganj	745.43	2,13,415
5. Bari/ Bareli	1305.88	2,18,944
6. Silwani/ Silwani	1084.22	1,25,992
7. Udaipur / Udaipur	694.95	1,37,187

Raisen district forms the part of Vindhyan range with an undulating topography. Raisen district is primarily an agricultural district occupying the Chambal and Narmada basin valley, having predominantly an agricultural economy. Agriculture is the main occupation of the people in the district. Wheat, Rice, Jawar, Maize and Soyabean are the major crops sown in the district. Ground water has an important role to play for irrigation.



2.0 RAINFALL AND CLIMATE

The climate of Raisen district characterized by a hot summer and general dryness except during the south west monsoon season. The year may be divided into four seasons. The cold season, December to February is followed by the hot season from March to about the middle of June. The period from the middle of June to September is the southwest monsoon season. October and November form the post monsoon or transition period.

The normal rainfall of Raisen district is 1207.3 mm. It receives maximum rainfall during southwest monsoon period. About 92.2% of the annual rainfall received during monsoon seasons. Only 7.8 % of the annual rainfalls take place during October to May period. The surplus water for groundwater recharge is available only during the southwest monsoon period. The maximum rainfall received in district at Udaipura i.e. 1389.8 mm and minimum at Bareli i.e. 1150.3 mm.

The normal maximum temperature received during the month of May is 41.5 ^{o}C and minimum during the month of January is 6.8 ^{o}C. The normal annual means maximum and minimum temperature of Raisen district is 32.0 ^{o}C and 17.5 ^{o}C respectively. During the southwest monsoon season the relative humidity generally exceeds 87% (August month). In rest of the year is drier. The driest part of the year is the summer season, when relative humidity is less than 29%. April is the driest month of the year.

The wind velocity is higher during the pre-monsoon period as compared to post monsoon period. The maximum wind velocity 10.8 km/hr observed during the month of June and is minimum 2.2 km/hr during the month of December. The average normal annual wind velocity of Raisen district is 5.9 km/hr.

CGWB ACTIVITES

In many parts of the district the Systematic Hydrogeological surveys were conducted during Indo-British Betwa groundwater project in 1975-1980. During this project study 4 exploratory boreholes were also drilled in the district.

Before that during 1959-61 Mr. A S M Rao has carried out systematic hydrogeological surveys in the southern fringe the district.

Under the World Bank assisted Hydrology Project- I, 7 shallow and deep piezometers have been drilled by the Central Ground Water for water level and quality monitoring.

In Raisen district two mass-awareness programme have been organized by CGWB at Khurwai and Gouharganj.

3.0 GEOMORPHOLOGY & SOIL TYPES

Physiographically the area in the district has NE-SW trending elevated spurs ranging in the altitude from 414 m to 719 m a msl and belonging to the north-eastern limb of the Vindhyan range, which forms the two physiographic divisions of the district area, the northern part constituting the undulating terrain in higher altitude sloping down gently towards northwest sparsely dotted with isolated knolls/hills as erosional remnants and forming the table land away from the escarpment and ultimately a plain terrain. The southern half constitute the hilly and rugged terrain at higher elevation and slopes down gently towards south forming a very gentle sloping or plain terrain in the vicinity of the westerly flowing Narmada river which forms the southern boundary of the district.

The district lies in the drainage basins of the Ganga and Narmada rivers. The NE-SW trending Vindhyan range forms major water divide in the district. The northern portion of the district is drained by the perennial Betwa and Bina rivers and their tributaries while the southern part of the district is drained by the southerly flowing Sindori, Tendani, and Barna rivers and their tributaries ultimately joining the Namad river which carries large volume of water through out the year and forms about half of the southern boundary of the district.

The soils of the district are locally classed into six types depending upon their appearance and crop bearing. The superior Kalmat a loamy soil of

black colour, when dry is become very hard and developed craks, but when wet it is soft and clayey. It remains moist for a considerable period. This soil is found on hillsides and in the areas occupied by the Deccan Lava flows. It is suited to wheat, masur and gram. Bhanwar is a gray coloured soil, mixture of Kalmat and Soyar soils. It is loose textured retains moisture considerably. Soyar or Pitula is yellow or brownish colour, shallow in thickness, large to small pebbles and is found on the slop of hills. Siari is a poor soil of grey yellowish or reddish black colour. It is loose and sandy in constitution. If irrigated, it suits to grow rice. It is shallow and does not retain much moisture. Bharwa is a light, sandy shallow soil of black or brown color. It is found mostly on the foothills. It grows only the inferior crops. Kachar or Chap is an excellent loamy soil found in the banks and beds of streams. It grows fine crops of wheat, jawar and vegetable.

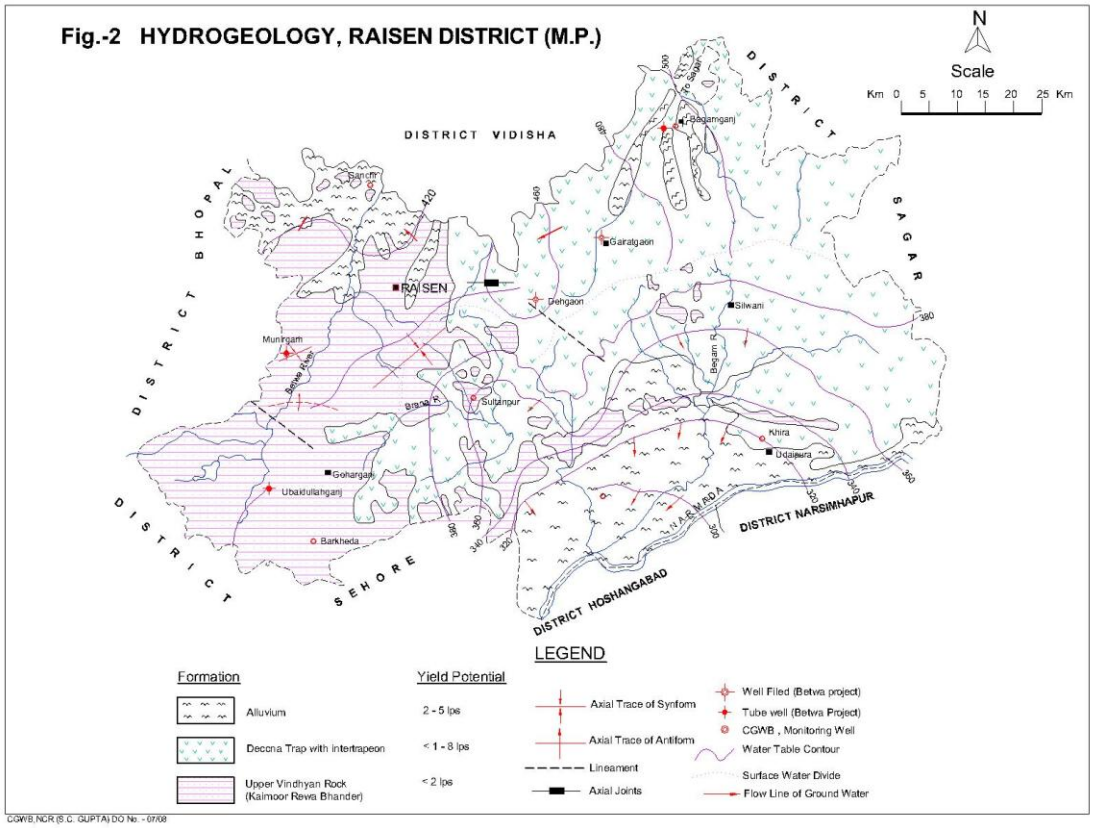
4.0 GROUND WATER SCENARIO

The geology of the district comprises “The Vindhyans are exposed in the southern and western part and Deccan trap flows in the eastern part of district. The generalized geological succession is given below-

Age	Formation		Lithology
Recent to Pleistocene	Alluvium		Clay with kankar Sand and river alluvium
	Laterite		Small capping of lateritic soil on hills and patches in river valley
Upper Cretaceous to Lower Eocene	Deccan Trap		Lava flows of basalt with red bole and intertrappean beds
	Lametas		Small irregular patches in the Vindhyan
Upper Pre-Cambrian to lower Paleozoic	Upper Vindhyan System	Upper Bhander series	Upper Bhander sandstones Sirbu shales at the base of scarps.
		Lower Bhander series	Lower Bhander sandstone but intercalated bands of shales known as Sanchi shale, Bhander limestone and ganurgarh shale

4.1 Hydrogeological Units and Their Water Bearing Properties

The different lithological units occures within the district area, depending upon their water bearing and retaining properties, control, occurrence, movement and recharge of groundwater in the area. The hydrogeological map of the district is shown in figure-2. The hydrogeological characteristics of different lithological units are as under:



Upper Kaimurs

This group comprising sandstones and conglomerate at the base, forms hilly areas and scarps. The sandstones are hard compact, quartzitic with in frequent joints and have occasional beds of shales hence possess less porosity and permeability. Secondary porosity is not very well developed in these rocks. The thin bed of conglomerate at the base does not bear any significance as an aquifer. Thus the components of the Kaimur Series are not good repository of groundwater.

Rewa Series

Comprises Rewa sandstone and Jhiri Shales, which mostly are exposed at the base of scarps forming, scarp ridges. These sandstones also are hard and compact with a few joints and fractures. The soil and weathered profile developed on these rocks is thin and hence the occurrence of groundwater at shallow depth is confined to joints and weathered zone only.

Bhander Series

Comprises upper Bhander sandstones, Sirbu shales, and lower Bhander sandstones with intercalated bands of Sanchi shales, Bhander limestone and Ganurgarh shales. Although Ganurgarh shale has poor permeability, it is very much susceptible to weathering and therefore has developed sizable weathered zone, which yield limited quantity of water at shallow depth under phreatic conditions. Groundwater also occurs along the bedding planes in theses rocks. Bhander limestones are hard compact but jointed and fractured and developed sizable thick zone of weathering upto 5 m

in topographic lows. Solution cavities are developed along the stratification and joint planes. There is a copious chance to get groundwater in these rocks, particularly in low-lying areas. Bhander sandstones are fine to medium grained compact and indurate and highly jointed developing considerable secondary porosity and permeability and yield limited quantity of groundwater.

Lametas

Occur in the form of small irregular patches above the Vindhyan rocks and does not have much significance as an aquifers.

Deccan Traps

Deccan traps are of Upper Cretaceous to Eocene age and occupy the central and eastern part of the district infilling the valleys of the pre-existing Vindhyan topography. Individual lava flows varying in thickness from 10 to 30 m comprise two distinct units i.e. (i) the upper most vesicular/amygdolidal basalt with upper mantle weathered and (ii) the lower massive and compact basalts, often fractured and at places with columnar jointing. They occasionally are seen overlying the thin amygdular layer with pipe amygdule. The soils derived from the weathered mantle of traps are conspicuously dark colored and are popularly known as “black cotton soil”. Vesicular traps particularly when with well defined density and size of vesicles and if the vesicles are interconnected, prove to be good aquifers, next to alluvium in yield, but the in filled of the vesicles by zeolites and other secondary minerals diminish their water bearing and yielding capacities. The massive basalts if jointed and fractured and if occupy the area in favourable geomorphic setup yield moderately good amount of water due to the secondary porosity developed in them. Weathered zone in trappeans terrain is quite porous and permeable and can yield sufficient amount of water required for domestic uses.

Alluvium

It is predominantly silty and clayey, fine to medium grained with an admixture of clay and minor amount of kanker, 0 to 25 m in thickness is developed along the major river courses and a few sandy or gravel zones which may be worthy of groundwater development, occur in Bari, Bareli and Obedullahganj areas. These alluvium pockets form the repository of groundwater in the area.

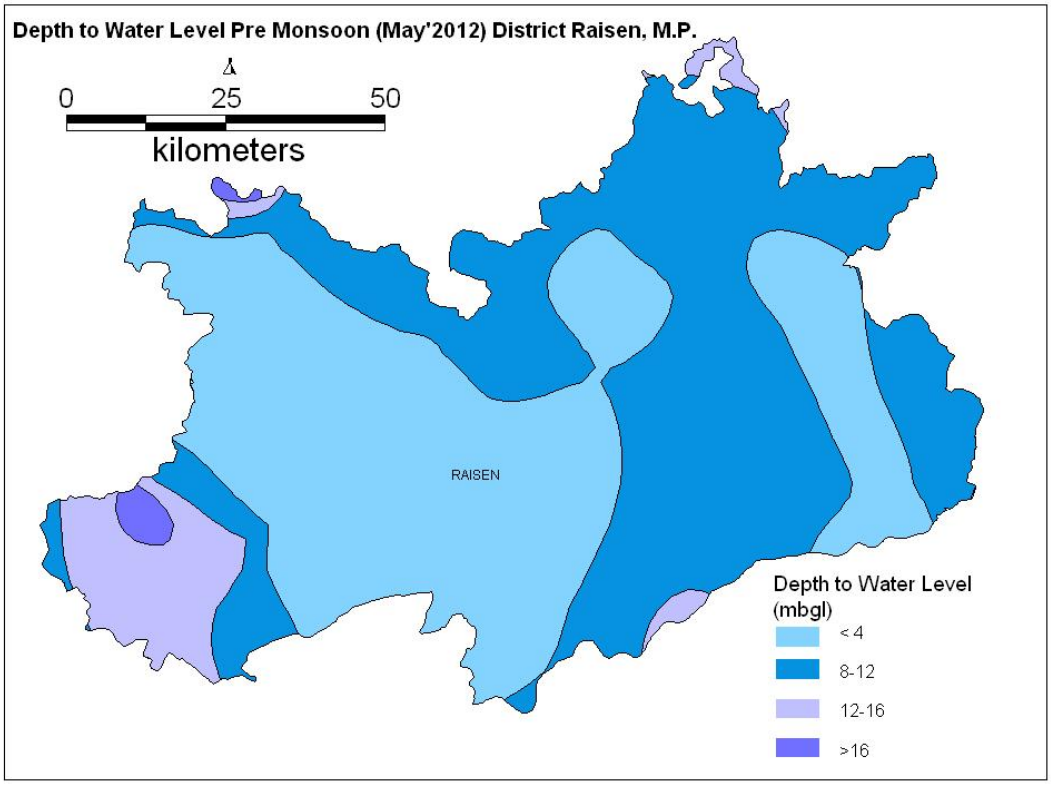
WATER LEVELS

A scientific database of groundwater levels is essential for assessing the regional groundwater scenario to reliably estimate the groundwater resources for long term planning and judicious use of available groundwater resources. Variation in groundwater levels in an area is an important component of the hydrological cycle because it is a physical reflection of aquifer systems. As change in groundwater level is directly related to groundwater balance its continuous records provide direct information to geo-environmental changes due to withdrawal of groundwater. To monitor the seasonal and year by year change in quantity and quality of groundwater, Central Ground Water Board (CGWB) has established 20 National Hydrograph Stations (NHS) and 6 Piezometers in Raisen district. It is felt that

due to large-scale ground water development in the district the phreatic aquifers are overexploited and resulting erratic water level record from monitoring dug well.

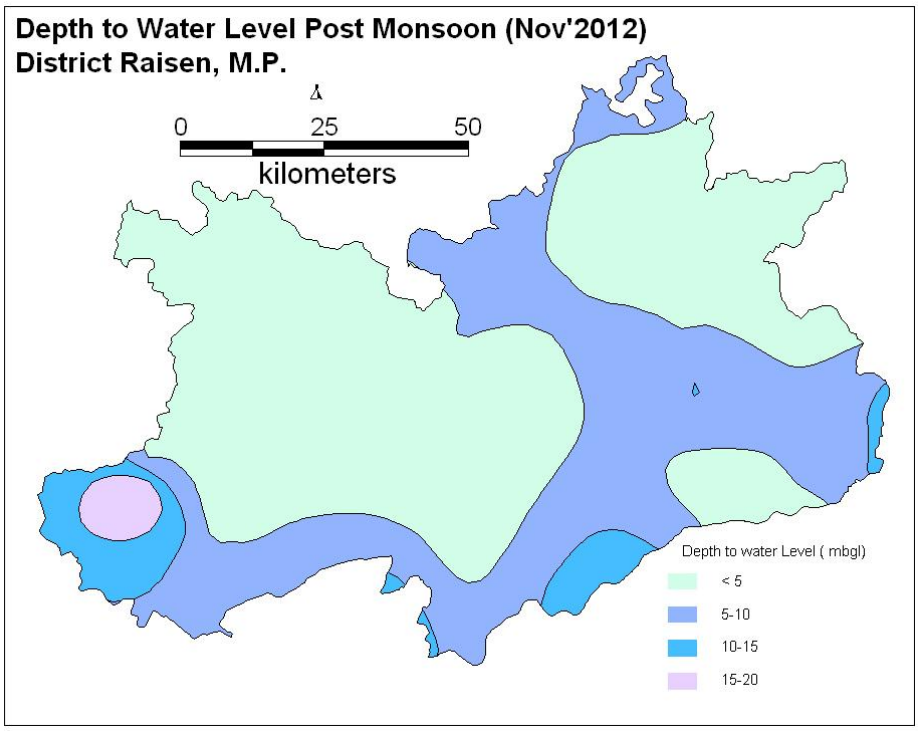
Pre-monsoon (May 2012)

During May 2006, pre-monsoon the depth to water level (fig-3) in Raisen district ranged between 4.07 m bgl at Sultanpur and 19.12 m bgl at Mandideep. During the pre monsoon period the most part of the district have water level in the range of 3-9mbgl.



Post-monsoon (November 2012)

During post-monsoon period of the same year, November 2006, (fig-4), the water levels varied from 2.23 m bgl at Sultanpur and 17.03 m bgl at Mandideep.. It is observed that in most part of the district the water level lies between 6 to 12 m bgl during this period.



Decadal Average Water Level (May 2003-2012)

Decadal average water level is an average of water levels of a particular monitoring station for the last 10 consecutive years. This gives a more realistic picture of the area as the water level of any particular year depends on rainfall and draft and may vary widely during the particular year. It is noticed that there is a fall of 0.05-0.39 m/annum fall in Post-monsoon and rise of 0.02-2.53 m/annum rise in pre monsoon. It is evident from the analysis of the data that the unplanned groundwater abstraction is going on in the district.

Aquifer Parameters

The exploratory drilling has been carried out mainly in areas occupied by Deccan Traps underlain by Vindhyan shale and sandstone. In Basalt, the vesicular, weathered and fractured basalt form the aquifers while in Vindhyan, fractured sandstones are aquifer. These exploratory wells were drilled down to a depth of 242 m bgl, yielding upto 14 lps discharge. The piezometers were restricted to the depth of. 30 m, 60 m, 90 m and 120 m bgl. The transmissivity of hard rock aquifer varies between 0.35 m^2/day to 30 m^2/day while in alluvium formation it varies between 20 to 125 m^2/day.

4.2 Ground Water Resources

Dynamic Ground water resource estimation of the district has been computed for Base Year-2008/09, on block wise basis. All blocks of the district are categorized. as safe. The highest stage of ground water development is computed as 70 % in Obaidullahganj block. The net ground water availability in the district 75,209 ham and ground water draft for all uses is 38165 ham, making stage of ground water development 51 % (34 % in 2003/04) as a whole for district. After making allocation for future domestic and industrial supply for next 25 years, balance available ground water for future irrigation would be 35863 ham.

The Net annual ground water available in the Raisen District and draft from all uses for all the blocks is given in table.

Table: Ground Water Resources & Stage of Development in Raisen District.

S. No	District/ Assessment Unit	Sub-unit Command/ Non-Command/	Net Annual Ground water Availability (ham)	Existing Gross Ground water Draft for Irrigation (ham)	Existing Gross Ground water Draft for Domestic & Industrial water Supply (ham)	Existing Gross Ground water Draft for All uses (ham)	Provision for domestic, and industrial requirement supply to next 25 year (2033) (ham)	Net Ground water Availability for future irrigation d development (ham)	Stage of Ground water Development (%)
	Raisen								
1	Badi	Command	7507	199	167	366	273	7036	5
		Non-Command	5026	1163	264	1427	409	3454	28
		Block Total	**12533**	**1363**	**431**	**1793**	**681**	**10489**	**14**
2	Begam Ganj	Command							
		Non-Command	10457	4477	241	4718	378	5602	45
		Block Total	**10457**	**4477**	**241**	**4718**	**378**	**5602**	**45**
3	Gairatganj	Command							
		Non-Command	8847	4011	255	4266	**461**	4375	48
		Block Total	**8847**	**4011**	**255**	**4266**	**461**	**4375**	**48**
4	Obedulla Ganj	Command							
		Non-Command	9947	5868	1054	6921	1338	2742	70
		Block Total	**9947**	**5868**	**1054**	**6921**	**1338**	**2742**	**70**
5	Sanchi	Command							
		Non-Command	10951	6890	392	7282	413	3649	66
		Block Total	**10951**	**6890**	**392**	**7282**	**413**	**3649**	**66**
6	Silwani	Command							
		Non-Command	12033	7368	348	7716	596	4069	64
		Block Total	**12033**	**7368**	**348**	**7716**	**596**	**4069**	**64**
7	Udaipura	Command							
		Non-Command	10440	5164	304	5468	340	4936	52
		Block Total	**10440**	**5164**	**304**	**5468**	**340**	**4936**	**52**
		District Total	**75209**	**35139**	**3025**	**38165**	**4207**	**35863**	**51**

4.3 Ground Water Quality

Ground Water quality of Raisen district is assessed by CGWB on the basis of water samples collected from fifteen numbers of hydrograph (ground water) stations for the year 2011.

The hydrogen ion concentration i.e. pH in groundwater of Raisen district ranges 7.3 to 8.85. The pH of ground water shows neutral to alkaline in nature. As per BIS recommendation the pH ranges in between 6.5 to 8.5. In Raisen district the Begumganj village pH has been recorded more than BIS recommendation i.e. 8.85. According to Electrical conductivity the ground water of Raisen district shows low to high saline in nature. The electric conductivity value varies in between 448 to 2312 µS/ cm at 25°C. As per BIS recommendation the EC value in drinking water towards Total Dissolve Solids (TDS) i.e. 750 µS/cm at 25°C is minimum desirable limit and 3000 µS/cm at 25°C is maximum permissible limit for drinking purposes. If the EC values more than 3000 µS/cm at 25°C; the water are not suitable for drinking purposes. The EC of ground water of Raisen district does not exceeded maximum permissible limit. The highest EC was recorded at Gairatganj village i.e. 2312 µS/cm at 25°C.

Constituents like Carbonate, Bi-carbonate, Chloride, Sulphate and Calcium were within the safe limit for drinking water as per BIS standards. Nitrate concentration in the ground water of Raisen district varies from 4 to 106 mg/l. As per BIS recommendation nitrate more than 45mg/l were found in seven villages namely Begumganj (49 mg/l), Gairatganj (58 mg/l), Deori (67 mg/l), Khiria (72 mg/l), Barkheda (75 mg/l), Paloha (76 mg/l) and Dehgaon (106 mg/l). High nitrate in ground water may be due to the excessive use of fertilizers or anthropogenic activities etc. The fluoride concentration in the ground water of Raisen district recorded in the ranges 0.09 to 2.10 mg/l. The maximum concentration of fluoride i.e. 2.10 mg/l recorded in the ground water of Begumganj village which is more than maximum permissible limit recommended by BIS i.e. 1.50 mg/l. The Total Hardness of ground water has been recorded in the range of 105 to 730 mg/l. The maximum Total Hardness 730 mg/l was recorded at Gairatganj village which is more than BIS recommendation i.e. 600 mg/l. The magnesium concentration was recorded in the range of 6 to 55 mg/l. As per BIS recommendation the maximum permissible limit of magnesium concentration in drinking water is 30 mg/l. The villages namely: Khiria and Dehgaon (39 mg/l), Barkheda (46 mg/l) and Gairatganj (55 mg/l) have been recorded magnesium concentration more than BIS recommendation.

Quality of water for Irrigation:-

High SAR is not good for irrigation as it lead to sodium hazards. Water samples falls in C_2S_1, C_3S_1 and C_4S_1 classes of US Salinity classification.

The ground water in the district is safe for irrigation purpose but proper drainage system is required where EC is high i.e. more than 1500 µS/ cm at 25°C.

5.0 GROUND WATER MANAGEMENT STRATEGY

It is felt that the overexploitation, indiscriminate development of groundwater, anthropogenic and irrigation practices have led to many

groundwater related problems, which need proper management of groundwater resources. These problems are being discussed below.

5.1 Groundwater Depletion

It is observed that in Raisen district, the stage of groundwater development is not very high (51%). In certain areas the withdrawal of groundwater is more than recharges causing depletion in groundwater level.

It is observed that the fluctuation in water table is mainly due to rainfall and withdrawal of groundwater. The study on the long term analysis of water level, conducted by CGWB, indicate that water level in Raisen district have shown a steady decline of 0.05 to 0.39 m during past one decade. The incidence of rainfall remaining more or less same in the period of question the only possible reason for the decline in groundwater level appears to be over development of groundwater resources indiscriminately through ever increasing number of tube wells tapping the confined and unconfined aquifers for agricultural, industrial and domestic uses. To remedy for the ill effects, the following steps are required to be taken for effective groundwater management in Raisen district.

5.1.1 Groundwater recharge

Due to fast industrialization and urbanization in Raisen district, there is a reduction in open green areas resulted in substantial decrease in natural recharge to groundwater. Also, the improvement in drainage pattern has caused reduction in percolation of rainwater to the groundwater thereby affecting the natural recharge. It is reported that huge amount of surface water available during rainy season goes as runoff. Hence it can be harnessed through suitable artificial recharge techniques to groundwater. Construction of various suitable artificial groundwater recharge structures will result in augmentation of the groundwater aquifers and arrest further decline of groundwater level. As the area is urban, the roof top rainwater harvesting technique should be adopted in a big way. As the geology of the area along with climatological and pedalogical parameters provide the hydrogeological environment which governs the groundwater recharge, modern techniques like remote sensing and geophysics should be applied for finalization of location, extent and design of artificial groundwater recharge structures.

5.1.2 Water conservation

It is evident that to solve the problem of depletion in groundwater level, it is necessary that the groundwater withdrawal should be reduced substantially. Some of the options available are:

5.1.2.1 Recycling of water

Due to limited groundwater resources and increased demand of water there is a need of recycling of water for its conservation. The treated sewage water can judiciously be utilized to reduce stress on exploitation of groundwater for various purposes including domestic, industrial and horticultural needs.

5.1.2.2 Change in cropping pattern

In last few decades the cropping pattern in Raisen district has

changed substantially. In some parts of district, the farmers have started multi crop cultivation due to profitability which will caused extensive development of groundwater resources. There is a need to change the cropping pattern in the area and adopt cultivation of those crops, which require less irrigation.

5.1.2.3Change in irrigation policy and power pricing

It is observed that in many parts of Raisen district the complete irrigation is being done through flooding. As the district is covered with hard rock terrain and is water scare, the flooding practice of irrigation requires change. Sprinkler and drip irrigation should be adopted in the area wherever feasible. In this regards the government should come forward and provide infrastructure and other benefits. In most parts of district the irrigation is being done through dugwell and tubewells using power pump. Rates of power for tube well irrigation are irrational and require modification. There should be no free power for irrigation so the consumers should take due cares for its economic and judicious use. Instead of flat rates, metering may be introduced.

5.1.2.4 Mass awareness program

The management of groundwater resources cannot be successful without public participation. It requires educating the public regarding judicious use of water. To make the public aware, it is necessary to educate the people through mass awareness program at grass root level and impart training on rainwater harvesting and artificial recharge techniques for groundwater augmentation.

5.1.2.5 ***Groundwater regulation***

As the groundwater condition in Raisen district is in alarming stage, groundwater regulation may be enforced for its judicious exploitation and use.

5.2 Groundwater Pollution

Due to increasing industrialization and fast population growth in Raisen district, anthropogenic activities have led to pollution of groundwater in certain areas. The main sources of pollution are domestic and municipal waste, agricultural practices and industrial activities. Most of the localities/villages in Raisen district do not have proper sewage treatment system; the groundwater gets polluted with variety of nutritional constituents and pathogenic microbes. Use of various chemical fertilizers and pesticides has led to increase of nitrates, phosphates and other organic component in groundwater. Untreated effluents discharged in/on ground has caused increased level of heavy metals. Some organic compounds have also led to deterioration of quality of groundwater.

5.2.1 ***Action Plan***

It is fact that the groundwater pollution in the area increasing day by day there is a need to take up the comprehensive groundwater pollution studies in the Raisen district township. It is necessary to initiate measures to control further groundwater pollution. Dilution of pollutant concentration through groundwater recharge can be effective to mitigate the hazards of high

concentration of chemical constituents. It is also desirable to formulate water supply schemes utilizing such water for purpose other than drinking.

6.0 RECOMMENDATIONS

1. Raisen district is presenting a sensible picture from ground water point of view. Though, presently ground water is meeting the most water needs of the district but it may not go very long in future. The average water levels of the district are deep, the decadal fluctuations and the long-term trends are showing a decline, and the water balance left is limited. The population and progress coupled with poor aquifers are responsible for this alarming situation. Thus special caution is to be observed while developing this natural resource.

2. The groundwater development in Raisen district, both for irrigation and domestic purposes, is being done on need basis without proper backup of scientific investigations. Some times failure of monsoon led to crisis of even drinking water in district. A serious thought should be given to plan future development of groundwater on scientific lines. For a planned and coordinated development of groundwater resources it is essential that detailed hydrogeological, remote sensing and geophysical investigation should be carried out before taking decision on finalization of sites for drilling wells for irrigation and domestic use. The lithological details along with aquifer wise yield records should be maintained for future inferences.

3. The groundwater resource evaluation for year 2011 indicates that the stage of groundwater development in district has reached to 45%. The Net annual ground water available in the Raisen District is 902.62 MCM and draft from all uses is 402.63 MCM, Net ground water available for future irrigation use is 487.75 MCM only. Thus it has become imperative for further detailed hydrogeological investigation in district for water balance studies making watershed as a unit.

4. Raisen district is mainly a hard rock area and the decision for the type of groundwater structures for groundwater development is dictated by local hydrogeological situation. Figure-5 shows the areas recommended for future groundwater development in Raisen district.

    a. In areas of phreatic aquifers with low permeability large diameter dugwells is the only suitable groundwater structure. The dugwell should be located as for as possible in topographic depressions, nearer to rivers and streams and if possible nearer to zone of structural disturbances. In Deccan trap areas of the district, instead of increasing the diameter of dugwells drilling of horizontal bore into the dugwell should be preferred to increase the yield of dugwell.
    b. In certain areas of district where dugwell do not penetrate fully to the aquifer, it is recommended that dug cum bore wells may be constructed.

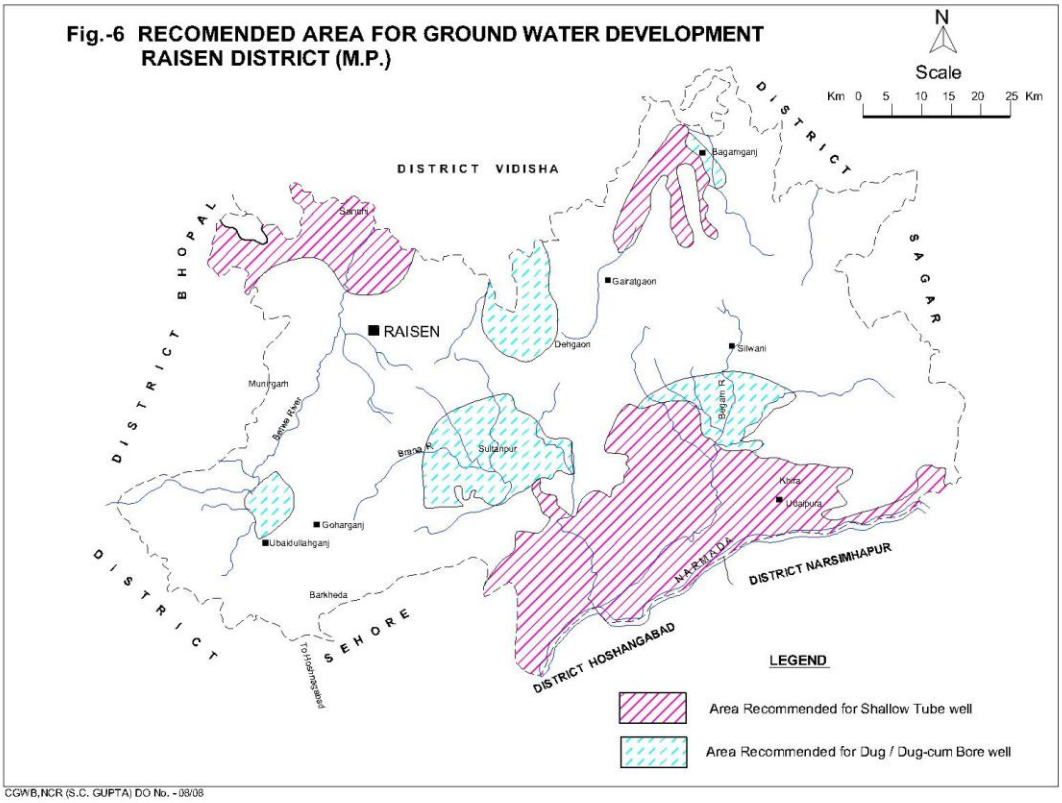
c. As the intertrapens are present between two flows and are collapsible in nature, telescopic drilling should be adopted for screening/casing the collapsible strata to increase the longevity and yield of boreholes.
d. In view of the limited regional extent of joints/fracturing, it is possible to miss a good water bearing horizons in a small diameter borehole during the drilling. It is recommended that technique of hydro-fracturing/bore blasting should be tried to enhance the yield of boreholes.
e. For wells constructed for drinking water it is much more important to ensure that the intake section of tubewell is not directly in connection with pollution from ground surface.

5. It is observed that in most part of the district there is an ample fluctuation in depth to water level during pre and post monsoon period. Also, there is substantial surplus monsoon run off going as unutilized needs to be conserved through artificial recharge techniques. In order to get sustainable yield from groundwater structures the need for augmentation of groundwater resources through artificial recharge structure is imperative. Artificial Recharge practices in rural areas should be taken up earnestly to improve the ground water quantity and quality. The selection of sites should be done on scientific basis by conducting hydrogeological and geophysical investigations.

6. The Roof Top Rainwater Harvesting technique has wide scope in the areas covered with weathered basalt. In Vindhyan rock formation, tubewells can be used for this purpose. Roof top rainwater harvesting should be made mandatory considering the water scarcity in urban areas. This would mitigate the situation.

7. Unscientific use of fertilizer/pesticides for agriculture and disposal of untreated industrial effluents through unlined drain in most of the industrial areas of district will be very dangerous for groundwater quality in near future. There is a urgent need to control such type of activities to check the groundwater pollution.

8. The deforestation of forestland to accommodate the population growth causes heavy run off and insufficient subsurface recharge to groundwater storage in foothill zone. Afforestation programme in such areas need to be taken up. This would not only check soil erosion and improve the environment but also conserve surface runoff and recharge the phreatic aquifers in the area.



9. Change in cropping pattern is another measure, which will relieve the situation. Presently Soya bean crop is being grown in large areas, which has a high water requirement. There is a need to change the cropping pattern in the area and adopt cultivation of those crops, which require less irrigation.