GROUND WATER INFORMATION BOOKLET

SEHORE DISTRICT
MADHYA PRADESH

Ministry of water Resources
Central Ground Water Board
North Central Region
BHOPAL
2013

SEHORE DISTRICT AT A GLANCE

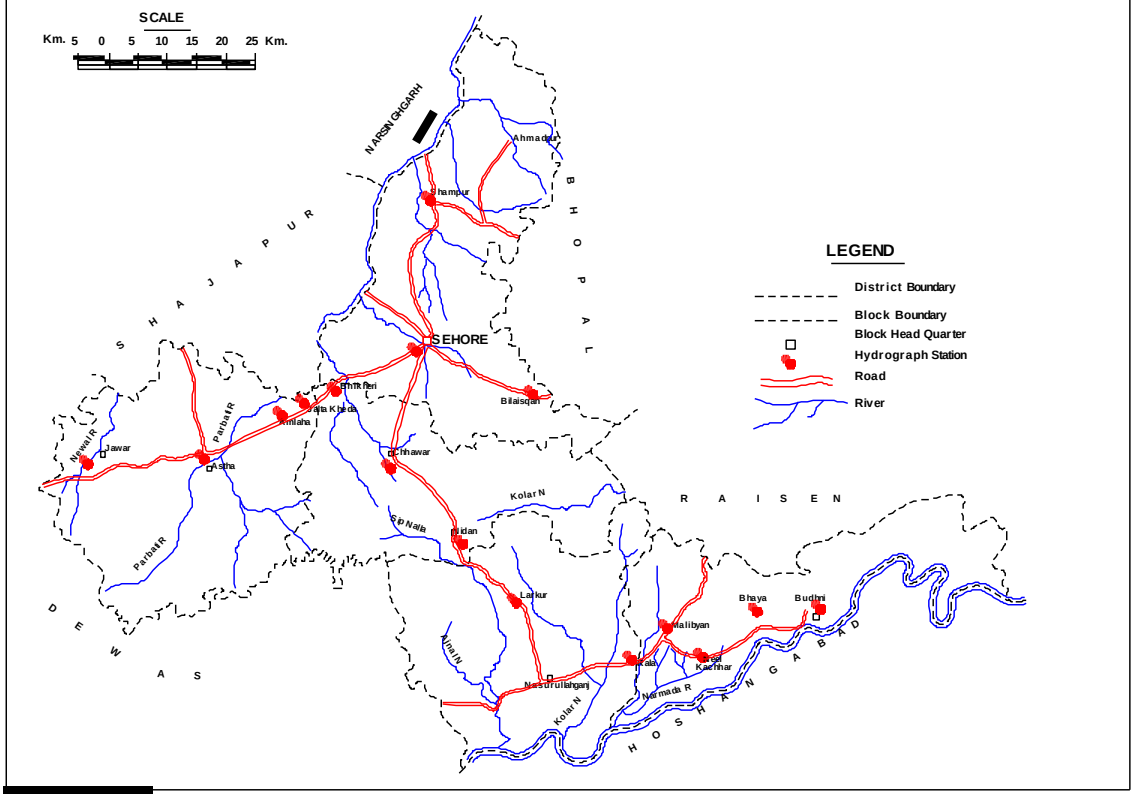
S.No.	ITEMS	STATISTICS	
1.	**General Information**		
	i) Geographical area	6578 Km^2	
	ii) Administrative Divisions (As on 2012) Number of Tehsil/Blocks No of Villages	8/5 1. Sehore 2. Ashta, 3. Budni 4. Ichhawar, 5. Nasrullaganj 1084	
	iii)Population (Census 2011)	1311008	
	iv)Average Annual Rainfall (mm)	1217.7 mm	
2.	**Geomorphology**		
	1. Major Physiographic Units 2. Major Drainage	- Narmada Basin Valley - Chambal Basin Valley - Betwa Basin Ajnal, Newaj, Paru, Papnas, Parva, Sewan, Utooli, Babbar, Dobi, Kolar and Sip	
3.	**Land Use (Km^2)**		
	i) Forest area:	1725.39	
	ii) Net area sown:	6289	
	iii) Cultivable area:	3968.7	
4.	**Major Soil Types**	Black Cotton	
5.	**Area Under Principal Crops**		
6.	**Irrigation By Different Sources**	**Nos.**	**Irrigated area km^2**
	Dugwells	33647	834
	Tube wells/Bore wells	20877	539
	Tanks/Ponds	64	63
	Canals	94	412
	Other Sources		947
	Gross Irrigated Area		2297
7.	**Number of Ground Water Monitoring Wells of CGWB(As on 31.3.2012)**		
	No. of Dug Wells No. of Piezometers	14 12	
8	**Predominant Geological Formations**	Deccan Trap basalts underlained by Vindhyan sandstone and alluvium	
9	**Hydrogeology** Major Water Bearing Formation (Pre-monsoon depth to water level during 12) (Post-monsoon depth to water level during 06) Long Term water level trend in 10 years (2003-2012) in m/yr	Weathered/vesicular basalt, flow contacts, fractured sandstone and granular sand 4.30 – 16.86 m/annum fall 4.01-11.95 m/annum rise Pre-monsoon 0.1-5.22 m/annum fall Post-monsoon 0.01-2.18 m/annum rise	

10.	**Ground Water Exploration By CGWB (As on 31.3.2013)**	
	No of wells drilled (EW,OW,PZ,SH, Total)	37 EW, 10 OW, 13 PZ
	Depth Range (m)	48.0 – 290.41 mbgl
	Discharge (litres per second)	0.7 – 12.18
	Storativity (S)	
	Transmissivity (m^2 /day)	0.94 m^2 /day
11.	**Ground Water Quality**	
	Presence of Chemical constituents more than permissible limit (eg EC, F, As,Fe)	Nitrate
	Type of Water	Alkaline
12	**Dynamic Ground Water Resources (2011) In MCM**	
	Net Ground Water available	771.72
	Gross Annual Ground Water Draft	573.94
	Projected Demand for Domestic and Industrial uses up to 2035	32.37
	Stage of Ground Water Development	74%
13	**Awareness and Training Activity**	
	Mass Awareness Programmes Organised Date: Place: No. of Participant:	Nil
	Water Management Training Programmes Date:13-12-2001 Place: Jawaher Lal Nehru Agriculture Coolege No. of Participant: 55	One
14	**Efforts of Artificial Recharge & Rainwater Harvesting**	
	Projects completed by CGWB (No. & Amount Spent)	Nil
	Projects under technical guidance of CGWB (Numbers)	Dugwell recharge
15	**Ground Water Control and Regulation**	
	Number of OE Blocks	Nil
	Number of Sem Critical Blocks	2
	Number of Notified Blocks	Nil
16	**Major Groundwater Problems and Issues**	Depletion in groundwater level and deterioration of Groundwater quality

1.0 INTRODUCTION

Sehore district is lying in the central part of Madhya Pradesh. It is in Bhopal commissioner's division and is well connected by roads and railway. National Highway 67, connecting Bhopal and Dewas passes through the district. There are 5 tehsils and 5 blocks in the district. The block headquarters are Ashta, Sehore, Ichhawar, Budhni and Nasrullaganj. Sehore district with an area of 6579 km^2 lying between the North Latitudes 22^0 33' 30" and 23^0 40' 25" and East Longitudes 78^0 26' 00" and 78^0 02' 00" and falls under the Survey of India toposheet No. 55A, 55B, 55F and 55F. The district is encircled by Guna district in the North, Vidisha and Raisen in the east, Hoshangabad and Dewas in the South and Shajapur and Rajgarh in the west (figure 1).

Fig. - 1 INDEX MAP, DISTRICT SEHORE (M.P.)



Administrative Division

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

Table – 1: Administrative Division, District Sehore, M.P.

District/ Block	Area Sq.km

District Sehore	**6578**
1. Sehore	1584.25
2. Ashta	1454.57
3. Ichhawar	1110.85
4. Budhni	1075.11
5. Nasrullaganj	1353.22

Sehore district forms the part of Malwa plateau with an undulating topography. Sehore 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.

Out of total 1810.23 hectares irrigated land, 1128.48 hectares was irrigated from ground water sources. There were 14698 tube wells and 33048 dug wells up to the year 2006 for irrigation purpose.

The statistical data of land use and Irrigation pattern of Sehore district has been extracted from the district statistical booklet, Sehore district 2006. The land use for the district is given in Table – 2. The irrigation details for the district are given in table – 3.

Land Use (Km^2)		
i) Forest area	333.7	
ii) Net area sown	5619	
iii) Cultivable area	4445.36	
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

2.0 RAINFALL AND CLIMATE

Climatology

The Climate of Sehore district can be divided into four seasons. The winter season commences from end of November and lasts till the end of Feb. The period from March to about the middle of June is the hot season. The south west monsoon

season from middle of June to end of September, October & end of November constitute the post monsoon or retreating monsoon season.

Rainfall

There are five rain gauge stations in Sehore district namely Astha, Ichhawar, Nasrullaganj, Budhni and Sehore itself. The normal rainfall of Sehore district is 1217.7 mm. The highest rainfall i.e. 1412.3mm received at Sehore and minimum at Astha i.e. 1054.9 mm. July is the wettest month of the year and about 36% of the annual rainfall takes place during this month only. About 92.4% of the annual rainfall takes place during the southwest monsoon period i.e. between June to September. About 6.2% and 1.4% rainfall received during winter and summer season respectively. Hence only 7.6% of the annual rainfall takes place from October to May months.

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Temperature

There is no meteorological observatory at Sehore district. The nearest meterological observatory is at Bairagarh where similar conditions prevail. The winter season starts from end of November & ends till last week of February. The January is the coldest month of the year. The average normal minimum temperature during the month is about 10.4%. The individual day temperature comes as low as 1 or 2^0C. From March onwards, the temperature starts rising and maximum temperature observed during the month of May.

The average normal maximum temperature is 40.7^0C. The individual day temperature as high as 45 or 46^0C. On the arrival of monsoon the weather became pleasant. In October, the retreating of monsoon the temperature rises slightly during the day time and nights become pleasant. The average annual normal temperature of Sehore district is 31.4^0C.

During the southwest monsoon the relative humidity are generally high exceeding about 88% in August. Humidity decreases in the post monsoon season. In the cold season it is fairly good over the district. The driest part of the year is the summer season with the humidity going down to 26% or less. The annual normal relative humidity of the district is 57%.

Winds are generally light to moderate in the district with some slight strengthening in force during the monsoon season. The wind velocity in the post monsoon or during the winter season is, in general, low as compared to Premonsoon or summer season. The normal average and wind velocity of the district is about 8.3 Km/hr.

CGWB ACTIVITE

Shri G.M. Reddy, Hydro geologist, carried out systematic Hydrogeological Surveys in part of the district during 1986-87, Shri M.L. Parmar, Hydro geologist and Shri S. Brahma Hydro geologist, CGWB, NCR in 1990-91. S/Shri S.C. Paranjpe and A. Srinivas carried out reappraisal Hydrogeological surveys during AAP 1994-1995 in the district.

Under the World Bank assisted Hydrology Project- I, 13 shallow and deep piezometers have been drilled by the Central Ground Water for water level and quality monitoring.

In Sehore district, 23 boreholes were drilled under Accelerated drilling programme in basaltic formation 7 boreholes were drilled up to the depth of 200 mbgl and remaining B/wells drilled up to the depths ranges from 101.14 (Jatakhera) to 196.85 mbgl (Bhankheri). The maximum numbers of exploratory borholes have been logged by natural gamma logging. Static water level of boreholes ranges from 1.63 mbgl. (Amajher) to 80 mbgl (Mahodia) and yield potential of boreholes varies from 0.70 lps (Jalki) to 12.18 lps (Hakimabad and Maina) Pachama and Khanelwa).

In Sehore district groundwater management-training programme have been organized by CGWB at Jawaher Lal Nehru Agriculuture College, Sehore.

3.0 GEOMORPHOLOGY & SOIL TYPES

Physiographically the district has been divided into three units based on the valleys formed by the major rivers i.e. Narmada basin, Chambal basin and Betwa basin.

Narmada Basin Valley

In the district the Narmada basin valley comprises an area of about 3295 Km^2. The surface water divide running between Ichhawar and Bilkishganj roughly marks the northern boundary of the basin. The northern boundary is marked by low-lying hills and or high grounds. The basin area is highly undulating with isolated hills and plains. The ground elevation ranges between 300 m and 667 m. above m.s.l. The ground slopes from north to south and east to west.

Chambal Basin Valley

The Chambal basin valley constituents an area of about 3108 Km^2 falling in the entire Ashta block and the area north of Ichhawar in the district. The hilly area high grounds occupying the eastern boundary of the district forms the surface water divide. The area along the western boundary of district, along which Parbati river flows, forms a valley. The southern boundary is also bounded by semi hilly area, high ground that forms the surface water divide. The interior area of the basin is undulating with isolated hills and elevated plains. The ground elevation in the basin vary between a minimum elevation in the basin vary between a minimum of about 455 m in the North/North west to about 545m above m.s.l. in the South/Southwest. The land in the basin slopes from south to north in Ashta area, and from north to west in the remaining area.

Betwa Basin

A small part of the district, measuring about 175 Km^2 is located in the east central part of the district forming the Betwa river basin, drained by its tributary the Kolinos nadi. The presence of elevated ground on all the three sides of the basin marks the surface water divide. The interior area of the basin is marked by undulating topography with elevated plains with very few low altitude isolated hills. The ground

elevations in the area vary between about 545/550 m in the south and west and about 520 in the east. The hydrological features of district are given in table 4.

Table- 4 : Hydrological Features

Basin	Name of the river	Catchments area in Km^2	Total length in km	Total yield at 75% dependability
CHAMBAL	Ajnal	410.00	30.0	142.56
	Newaj	410.00	28.0	68.47
	Paru	392.00	46.0	136.30
	Papnas	250.00	35.0	71.27
	Parva	205.00	32.0	86.98
	Sewan	164.00	26.0	57.02
	Utooli	174.00	34.0	60.50
	Independent	1270.00	N.A.	444.01
	Total	**3285.00**	**-**	**1067.11**
NARMADA	Babbar	287.0	38.0	124.84
	Dobi	152.0	25.0	66.12
	Kolar	960.0	103.0	417.60
	Sip	796.0	72.0	320.16
	Independent	908.0	-	394.38
	Total	**3103.0**	**-**	**1323.70**
BETWA	Independent		-	41.64
	Catchment	175.7		
	Grand Total	**6563.7**	**-**	**2432.45**

The district is generally covered with black cotton soils covering almost three fourths of the area. This part is occupied by Deccan Basalts. The rest part has red-yellow mixed soils derived from sandstone, shale, gneiss. The alluvial soils are found along the river courses. The higher elevations i.e. the hilly regions have a cover of murum, which is made up of small rounded pieces of weathered trap. The Vindhyans and Bijawars have a thin cover of sandy loams. The soils in granitic area are clayey. The schist has a thin capping of loam with lot of quartz grains. The alluvium is derived from hill slopes by numerous streams and watercourses.

4.0 GROUND WATER SCENARIO

Over 85% of the area is occupied by Deccan trap, about 10% by alluvium and about 5% of the area by Vindhyan formations. The generalized geological succession is given below in table 5 and the hydrogeological map of district is shown in figure 2.

Table-5: General geological succession of Sehore district.

Age	Formation	Lithology
Quaternary	Alluvium	Clay, Sand, Silt, Gravel
	Laterite	Soil
Lower Eocene To	Deccan Trap	Lava flows of basalt

Upper Cretaceous		
Pre-Cambrian	Vindhyans	Quartzitic sandstone with intercalated shales.

Vindhyan Formations

Upper Vindhyan formations comprising of sandstone shales and breccias are exposed in the northern and eastern part of the district. The small patch of the area falling in the northern part is exposed in the form of hills. It occupies an area of about 50 Sq.km and comprises of sandstones. A major part of Budhni block, except east and western parts, is occupied by Vindhyan formation and comprises of sandstone and shales. The sandstones are normally hard, Quartzitic, massive and compact. However, they are jointed at the surface level.

Deccan trap formations

Deccan trap formations occupy over 85% of the total area of the district. The general flow is characteristic of lava flows in the area are the most of the flows are of 'Aa' type in nature being disposed in a three-fold system along a vertical column. Each flow normally consists of an upper fragmentary zone, a middle massive part and an impersistent thin layer of basalt clinkers. The fragmentary top zone presents a brecciated look. It is very often highly vesicular and amygdular. The vesicles are generally sub- rounded to irregular in shape. The middle part comprises of massive basalt, which is aphanitic to highly porphyritic.

Basalt clinker & horizon is impersistent and often absent. The thickness of this horizon where ever present varies between a few centimeters to about 0.50 m. This zone is analogous to top vesicular amygdular horizons in physical characters. Variation in thickness of different flows is also evident in the area. Most of the flow contacts can be demarcated by the presence of a red bole horizon. About 12 flows of Deccan trap can be identified in the district between the altitudes 435 and 533 m above msl. In general the thickness of the individual flows range between 5 and 10m. However, the older flows seems to have more thickness compared to the younger ones as indicated by flow numbers, 0 and 1.

Alluvium

Recent to sub-recent alluvial formations of significant extension occur in the southeastern part of the district falling in Budhni block. The alluvial formation in this part occurs along the Narmada River. The other patches of alluvial formation, though insignificant in both aerial extension and thickness occur along the major rivers and streams flowing in the area. The alluvial formations comprises of Silt, Clay, Sand, Gravel and Pebbles Cobbles etc. with Kankar. The district is covered mostly with Deccan trap formation deposited over the rocks of Vindhyan system. The alluvial area in the district occurs mainly along Narmada and Parbati rivers.

Description of rocks and their water bearing properties

Vindhyan System

A major portion of Budhni block falling in the southeastern part of the district is covered with Vindhyan formations comprising sandstones, shales, quartzite and breccia. The Vindhyans are, in general, poor aquifers, however, these formations

when subjected to weathering or jointing and fracturing gives rise to moderately yielding aquifers. The depth to water level in this formation varies from 4.86 m to 9.50 m.bgl. and season water level fluctuation ranges from 0.85 to 3.00 metres. The yield of wells in this formation varies from 1 to 3 lps.

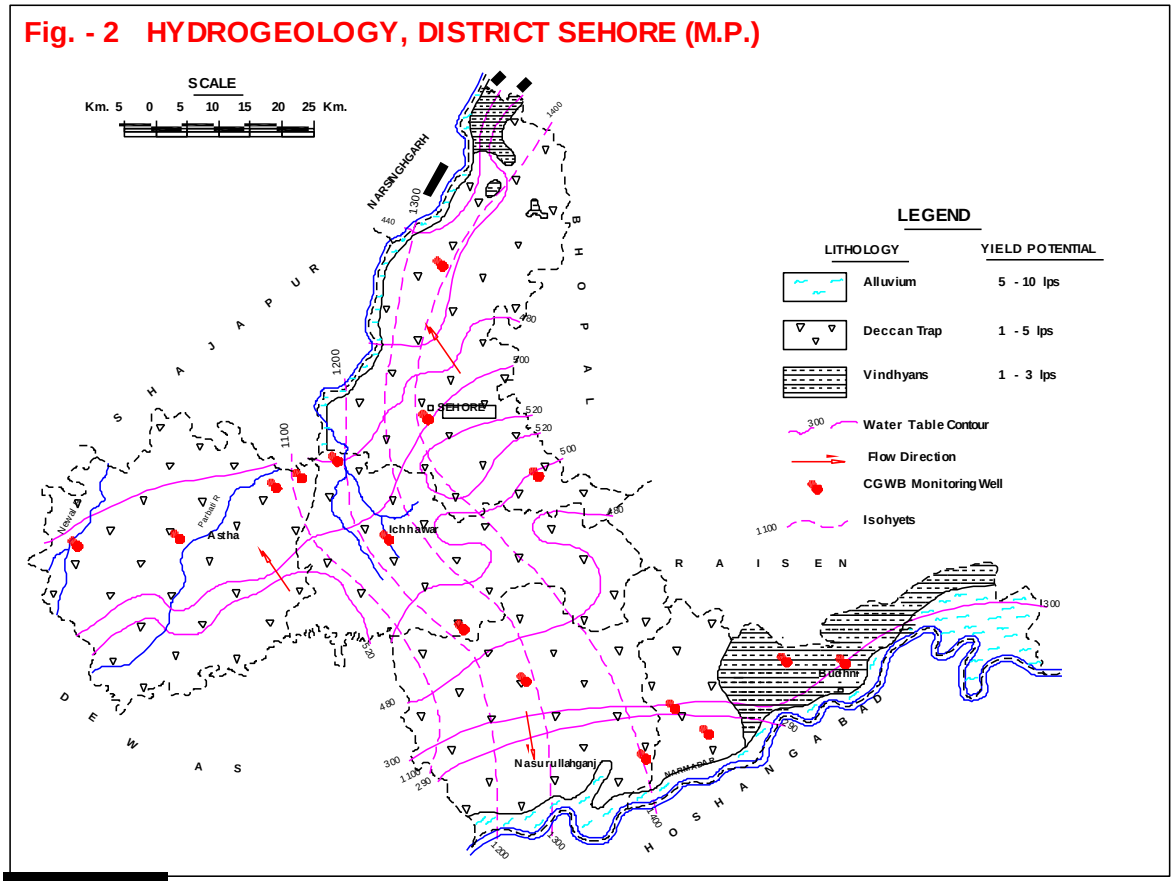
Deccan trap formations

The Deccan trap formation occupies about 85% of the total area of the district. The main aquifer systems in the formation are the weathered, vesicular flow contacts jointed, fractured zones etc. The ground water occurs mainly under phreatic conditions the red bole horizon generally confined conditions the red bole horizon generally act as semi-confining and confining layers in the deep aquifers. The yield of wells in this formation varies from 1 to 5 lps.

Alluvium

Alluvial area in the district occurs mainly along Narmada and Parbati River. A major pertain of alluvial patch occurs along Narmada river falling in Budhni block small linear patches of alluvium also occur along Parbati river in the western side of the district. The alluvium consists of clay, silt, sand, gravels and pebbles. The sandy gravelling zones when saturated form very good aquifers. The yield of the formation depends upon the ranges from 5 to 10 lps.

Fig. - 2 HYDROGEOLOGY, DISTRICT SEHORE (M.P.)

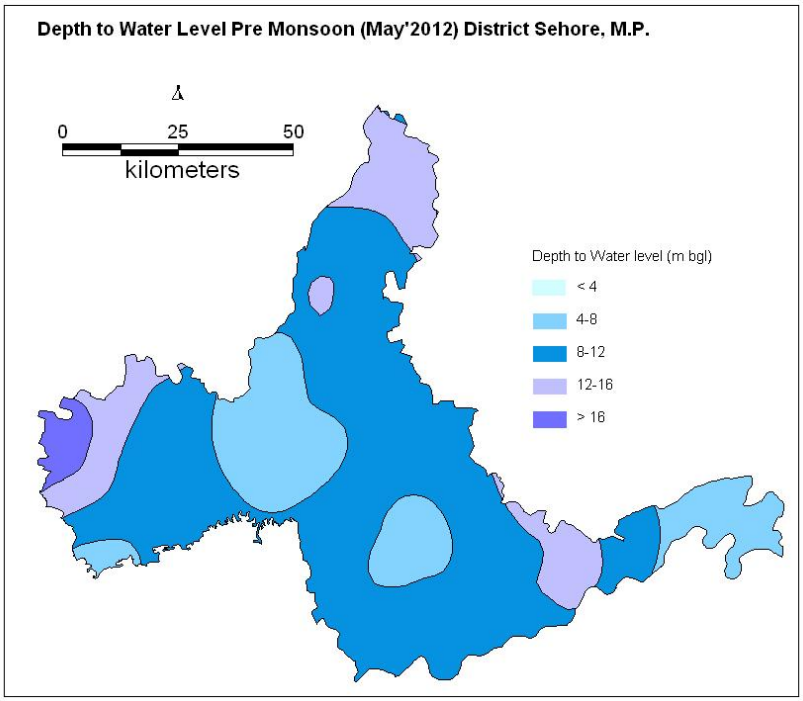


WATER LEVELS

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 20National Hydrograph Stations (NHS) and 6 Peizometers in Sehore 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.

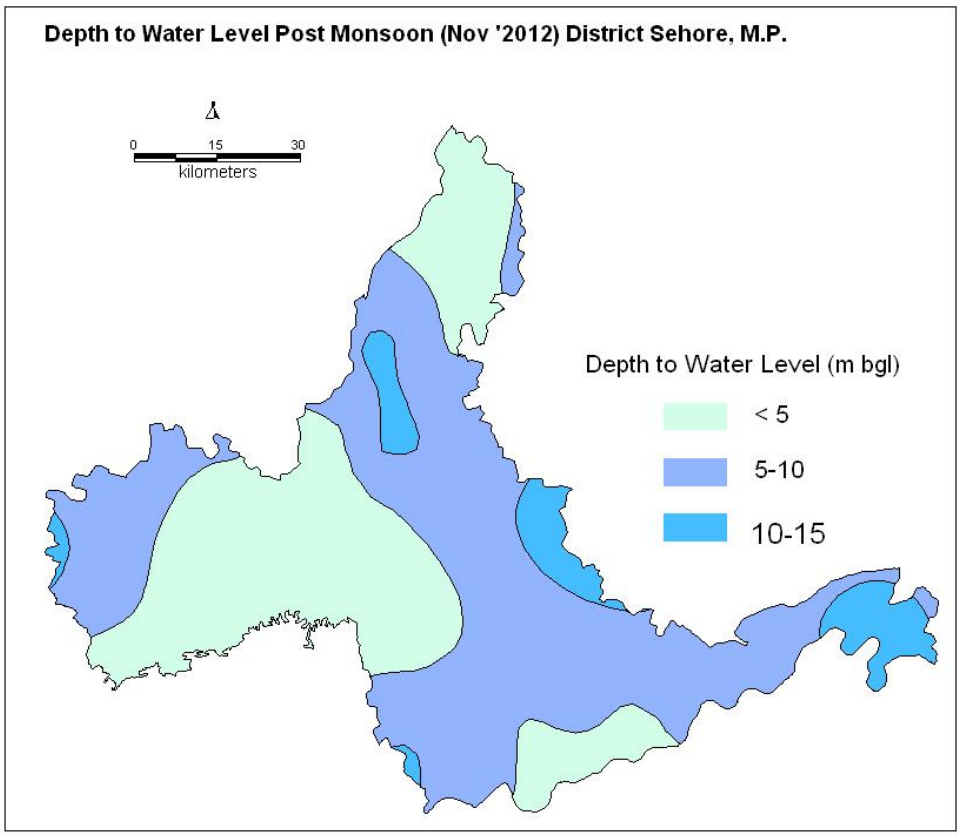
Pre-monsoon (May 2012)

During May 2012, pre-monsoon the depth to water level (figure-3) in Sehore district ranged between 4.3 m bgl at Jatakheda and 16.86 m bgl at Jawar. During the pre monsoon the central part of the district have water level in the range of 6 – 12 mbgl. The northeastern part of district in Sehore block and eastern part of district in Budhni block have the water level in the range of > 20 mbgl.



Post-monsoon (November 2012)

During post-monsoon period of the same year, November 2012, (figure-4) the water levels varied from 4.01 m bgl at Neelkachhar to 11.95 mbgl at Chandbar in Sehore block. It is observed that in most part of the district have shallow water level in comparison to other part of the district.



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 observed that there is a fall of 0.1-5.22 m/annum during premonsoon and rise of 0.01-2.18 m/annum during post monsoon.

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 mostly drilled down to a depth of 290.41 m bgl, yielding upto 15 lps discharge. The piezometers were restricted to the depth of. 30 m, 60 m, 90 m and 120 m bgl. The specific capacity, as determined in a few wells in basalt area, ranged from 3.5 to 61.23 lpm/m of draw down while in alluvium areas it varies from 15 to 120 lpm/m. The transmissivity of basaltic aquifer varies between 0.94 m^2/day to 28.9 m^2/day while in alluvium formation it varies between 32.31 to 137.87 m^2/day.

4.2 Ground Water Resources

The entire command area in all blocks of district are in safe categories while the non-command area of Sehore and Ashta blocks fall under critical category. The

stage of ground water development has reached to 98% and 89 % in Sehore and Astha block respectively of district.

The Net annual ground water available in the Sehore District is 749.99 MCM and draft from all uses is 576.99 MCM, Net ground water available for future irrigation use is 141.06 MCM. The Net annual ground water available in the Sehore District and draft from all uses for all the blocks is given in table.

Table: Ground Water Resources & Stage of Development in Sehore 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 (11+12) (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 {(13/10)*100} (%)
	Sehore								
	Ashta	Command							
		Non-Command	21648	18602	661	19263	836	2209	89
		Block Total	**21648**	**18602**	**661**	**19263**	**836**	**2209**	**89**
	Budhni	Command	3677	687	217	904	230	2760	25
		Non-Command	6399	3469	247	3716	913	2017	58
		Block Total	**10077**	**4157**	**464**	**4621**	**1143**	**4777**	**46**
	Ichawar	Command							
		Non-Command	7530	4248	305	4553	407	2876	60
		Block Total	**7530**	**4248**	**305**	**4553**	**407**	**2876**	60
	Nasrulla Ganj	Command	3442	363	98	461	106	2973	13
		Non-Command	9329	4192	349	4542	498	4638	49
		Block Total	**12770**	**4556**	**448**	**5003**	**604**	**7611**	**39**
	Sehore	Command							
		Non-Command	25147	23709	246	23955	246	**1192**	95
		Block Total	**25147**	**23709**	**246**	**23955**	**246**	**1192**	95
		District Total	**77172**	**55271**	**2124**	**57394**	**3237**	**18664**	**74**

4.3 Ground Water Quality

Ground water quality to be contiguous to Sehore district is assessed annually by CGWB on the basis of analysis of ground water samples collected from 8 No. of hydrograph stations in the district. On the basis of the data for the year 2011, the water quality is described as follows:

Quality of Ground Water for Drinking Purpose: The pH values of all the water samples varied in between 7.20 to 7.80 hence proved alkaline in nature and were within permissible limit (6.50 to 8.50) as described by BIS (IS: 10500: 2009). The EC values were found to be in the range of 786 and 1762 µS/cm at 25 ^{0}C (Larkui, highest) with an average of 1098 µS/cm at 25 ^{0}C and were underneath of permissible limit (3000 µS/cm at 25 ^{0}C) as described by BIS (IS: 10500: 2009). The anion chemistry shows that the chloride concentration ranged 35 - 305 mg/l in the area surveilled and two locations namely Larkui (305 mg/l, highest) and Astha (252 mg/l) reported to have chloride concentration more than desirable safe limit of 250 mg/l as set by BIS (IS: 10500:2009). The concentration of NO_3^- exceeding 45 mg/l (BIS, IS: 10500: 2009) were reported in 50% wells with highest as 97

mg/l of Bhaya. This higher concentration of NO_3^- can be attributed from anthropological sources. A scrutiny of data shows that none well of the district was reported having fluoride greater than 1.5 mg/l of BIS (IS: 10500: 2009) permissible limit

Quality of Ground Water for Irrigation: The chemical quality of water is an important factor to be considered in evaluating its suitability for irrigation purpose. The parameters such as Electrical conductance (EC), Sodium adsorption ratio (SAR), percent sodium (% Na), and Residual sodium carbonate (RSC) are used to classify the water quality for irrigation purpose. A diagram for classifying waters for irrigation purpose was suggested by the U.S. Salinity Laboratory in 1954. The plot of U.S. Salinity Laboratory diagram suggested that all the studied 100 % wells of district shorted under C_3-S_1 (High Salinity & Low Sodium) class. This water can be used for irrigation purpose applying restriction on drainage.

4.4 Status of Ground Water Development

Ground water is the main source for drinking and irrigation in the Sehore district. About 74% of irrigation in the district is from ground water, though the level of irrigation in the district is very low, only 27.5% of total geographical area is being irrigated. The total number of dug wells and tube wells in the district were 33647 and 20877 respectively. On the drinking water front, Sehore city have entire supply from ground water, while the outskirts of Sehore city is totally dependent on groundwater. There has been a steady rise in ground water development in the district. The Stage of Development in the district during 2011 was 77%, which has increased considerably from 1997 estimates.

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 Sehore district, the stage of groundwater development is quite high (95%). 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 Sehore district have shown a steady decline of 0 to 2.49 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 unconfined and unconfined aquifers for agricultural, industrial and domestic uses. To remedy the ill effects, the following steps are required to be taken for effective groundwater management in Sehore district.

5.1.1 Groundwater recharge:

Due to fast industrialization and urbanization in Sehore 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 area 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 Sehore 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 Sehore 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 Sehore 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 Sehore 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 Sehore 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 have 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 Sehore 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

I. Sehore 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.

II. The groundwater development in Sehore 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.

III. The groundwater resource evaluation for year 2011 indicates that the stage of groundwater development in district has reached to 77%. The Net annual ground water available in the Sehore District is 749.99 MCM and draft from all uses is 576.99 MCM, Net ground water available for future irrigation use is 141.06 MCM only. Thus it has become imperative for further detailed hydrogeological investigation in district for water balance studies making watershed as a unit.

IV. Sehore 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 Sehore 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.

V. 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

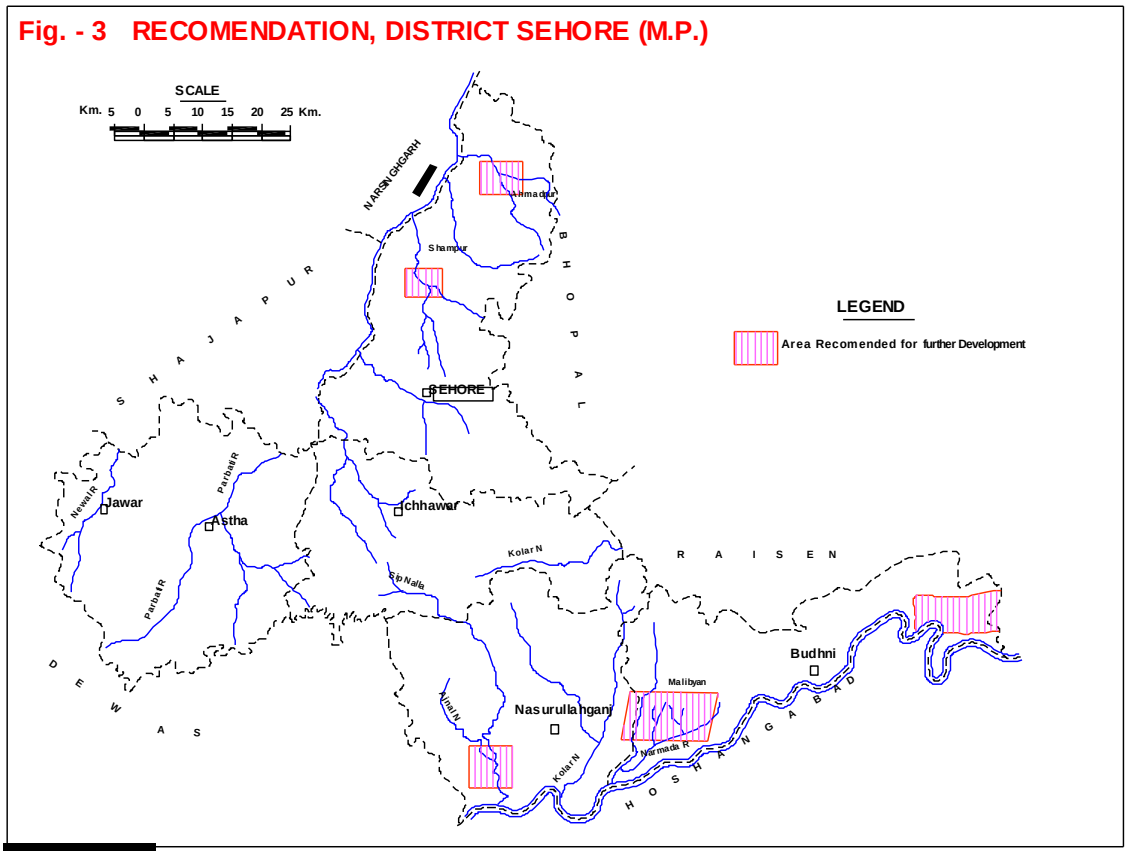
groundwater structures the need for augmentation of groundwater resources through artificial recharge structure is imperative. Artificial Recharge practices in rural areas should be taken up earnestly to improve the ground water quantity and quality. The selection of sites should be done on scientific basis by conducting hydrogeological and geophysical investigations.

VI. 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.

VII. 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.

VIII. 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.

Fig. - 3 RECOMENDATION, DISTRICT SEHORE (M.P.)



IX. 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.

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