



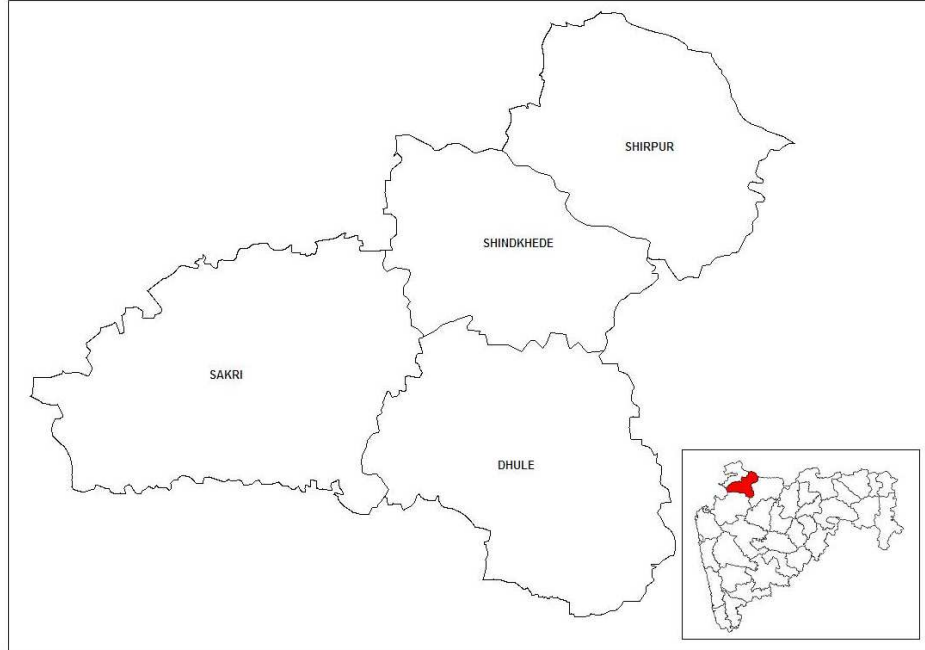
**भारत सरकार
जल संसाधन मंत्रालय
केंद्रीय भूजल बोर्ड**

**GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD**

महाराष्ट्र राज्य के अंतर्गत धुले जिले की

भूजल विज्ञान जानकारी

**GROUND WATER INFORMATION
DHULE DISTRICT
MAHARASHTRA**



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**द्वारा
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**मध्यवर्ती क्षेत्र
नागपुर
CENTRAL REGION
NAGPUR
2009**

DHULE DISTRICT AT A GLANCE

1. GENERAL INFORMATION

Geographical Area	: 8061 sq. km.
Administrative Divisions (As on 31/03/2008)	: Taluka- 4, Dhule, Sakri, Shirpur and Shindkheda.
Villages	: 681
Population	: 17,08,000
Normal Annual Rainfall	: 500 mm to 655 mm

2. GEOMORPHOLOGY

Major Physiographic unit	: 2; Tapi valley proper and the region of the dykes and residual hills of the Sahayadri Spurs
Major Drainage	: 1; Tapi River

3. LAND USE (2006-07)

Forest Area	: 2090 sq. km.
Cultivable Area	: 4160 sq. km.
Net Area Sown	: 3940 sq. km.

4. SOIL TYPE

3; Deep fertile soils in Alluvial areas and medium deep coarse soils to shallow stony soils away from Tapi River in Basaltic areas.

5. PRINCIPAL CROPS (2005-06)

Bajra	: 1013 sq. km.
Jowar	: 368 sq. km.
Total Pulses	: 474 sq. km.
Cotton	: 1179 sq. km.
Groundnut	: 323 sq. km.

6. IRRIGATION BY DIFFERENT SOURCES (2000-01) - Nos./Potential Created (sq.km.)

Dugwells	: 19089/470
Borewells	: 2382/57
Tanks/Ponds	: 294/5
Other Minor Surface Sources	: 48/0.71
Net Irrigated Area	: 149 sq.km

7. GROUND WATER MONITORING WELLS (As on 30/11/2007)

Dugwells	: 32
Piezometers	: 5

8. GEOLOGY

Recent	: Alluvium
Upper Cretaceous-Lower Eocene	: Deccan Trap Basalt
Middle - Upper Cretaceous	: Bagh Beds

9. HYDROGEOLOGY

Water Bearing formation	: Basalt-Weathered/fractured/ jointed vesicular/massive, under phreatic and semi-confined to confined conditions. Alluvium- Sand and Gravel under phreatic and semi- confined to confined conditions.
Premonsoon Depth to Water Level	: 3.10 to 21.00 m bgl (May-2007)
Postmonsoon Depth to Water Level	: 1.10 to 18.55 m bgl (Nov-2007)

Premonsoon Water Level Trend : Rise:0.03 to 0.29 m/year
(1998-2007) Fall: 0.01 to 0.59 m/year
Postmonsoon Water Level Trend : Rise: 0.02 to 0.54 m/year
(1998-2007) Fall: Negligible to 0.79 m/year

10. GROUND WATER EXPLORATION (As on 31/03/08)

Wells Drilled : EW-5, OW-03, Pz-1
Depth Range : 36.7 to 104.25 m bgl
Discharge : 1.5 to 6.00 lps

11. GROUND WATER QUALITY

Good and suitable for drinking and irrigation purpose, however localized nitrate and fluoride contamination is observed.

Type of Water : Ca-HCO₃ and Ca-Cl

12. DYNAMIC GROUND WATER RESOURCES- (As on 31/03/2004)

Net Annual Ground Water : 1220.19 MCM

Availability

Annual Ground Water Draft : 639.46 MCM

(Irrigation + Domestic)

Allocation for Domestic and : 21.18 MCM

Industrial requirement up to next 25
years

Stage of Ground Water : 53.55 %

Development

14. GROUND WATER CONTROL & REGULATION

Over-Exploited Taluka : None

Critical Taluka : None

Notified Taluka : None

16. MAJOR GROUND WATER PROBLEMS AND ISSUES

The drought area has been observed in western and southern parts of the district occupying parts of Sakri and Dhule talukas. The moderate to deeper water levels of 10 to 20 m bgl (parts of Shirpur and Sindkheda talukas) and falling water level trends are observed in most parts of the district, occupying Dhule and Shirpur talukas and eastern parts of Sindkheda and parts of Sakri talukas. Ground water quality is adversely affected by nitrate contamination in 56% of the samples and Fluoride contamination in 12% of samples collected in May 2007.

Ground Water Information Dhule District

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Ground Water Information Dhule District

1.0 Introduction

Dhule district, formerly known as west Khandesh is located in northern part of Maharashtra State. It is bounded between north latitude 20°38' to 21°61' and east longitude 73°50' to 75°11'. The district is bounded by Nandurbar district in the north west, Nashik district in south and Jalgaon district in east. The district headquarters is located at Dhule town. For administrative convenience, the district is divided in 4 talukas viz, Dhue, Sakri, Shirpur, Shindkheda. The district has a geographical area of 8061 sq. km. out of which 2090 sq.km. is covered by forest, whereas cultivable area is 3092 sq. km. and net sown area is 1930 sq. km. Agriculture is the main occupation of the people. The major part of the district comes under Tapi basin.

The population of Dhule district is 17,08,000 persons and the population density is 211.88 persons/sq.km. as per the 2001 census. Central Ground Water Board has taken up several studies in the district. A list of studies conducted in different parts of the district is presented in Table-1.

Table 1: Studies undertaken by CGWB.

S. No.	Year	Surveyed area	Type of Survey/Study
1.	1965-66	Covering parts of Toposheet No's 46-K/3,46-K7, and 46-K/11	Systematic Hydrogeological Survey
2.	1986-87	Covering parts of Toposheet No's 46-K/4,46-K8, and 46-K/12	Systematic Hydrogeological Survey
3.	1988-89	Covering parts of Toposheet No's 46-G/11 and 46-G/12	Systematic Hydrogeological Survey
4.	1997-98	Entire district	Reappraisal Hydrogeological Studies

A report on hydrogeology of the district entitled "Ground Water Resources and Development Potential of Dhule District, M.S." was compiled by Shri D.B. Shetye Scientist-C in the year 1996.

Apart from above studies, ground water exploration in the Tapi Alluvial areas of the district has also been taken up during 1982-87. Apart from this under Hydrology Project 5 Piezometer was constructed at Dhavda, Laling, Gothni, Ner2 and Kalamsare in 1997-98. The salient features of ground water exploration are given in Table-2.

Table 2: Salient Features of Ground Water Exploration.

S. No.	Taluka	Formation	Wells			Depth (m bgl)	SWL (m bgl)	Discharge (lps)	Draw-Down (m)	Zones (m bgl)
			EW	OW	PZ					
1	Shirpur	Alluvium	5	3	1	36.70 - 104.25	15.55 - 30.00	1.50 - 6.00	0.78- 13.00	30.00- 99.00

In Alluvial area of the district, 5 exploratory wells (EW), 3 observation wells (OW) and 5 Piezometer (PZ) were constructed. The depth of the wells ranged from 36.70 to 104.25 metres below ground level (m bgl). The discharge from these wells varied from 1.50 to 6.00 litres per second (lps), among 2 EW's were

found to be high yielding with discharge > 3 lps, whereas static water levels ranged from 15.55 to 30.00 m bgl. Deeper aquifer zones have been encountered in most of the wells 30.00 to 99.00 m bgl.

A map of the district showing the taluka boundaries, taluka headquarters, and location of monitoring wells is presented as Figure-1.

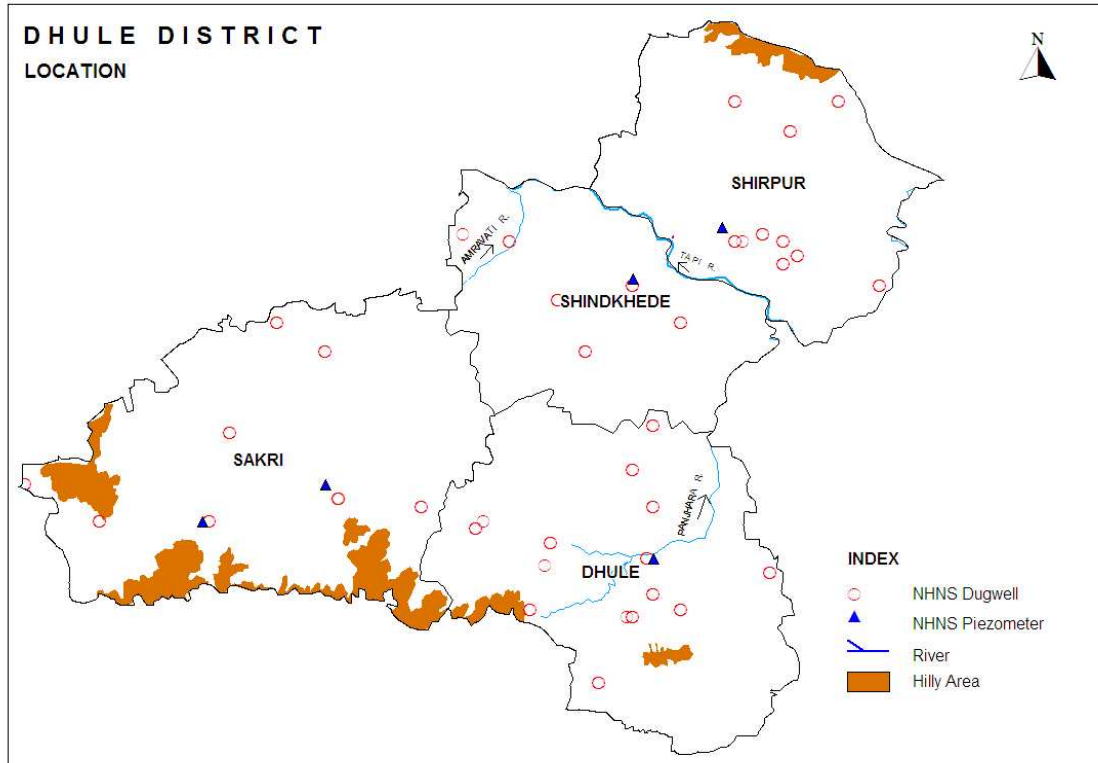


Figure-1: Location

2.0 Climate and Rainfall

The Climate of the district is characterized by a hot summer and general dryness throughout the year except during the south-west monsoon season, i.e., June to September. The daily mean minimum temperature was 16°C and mean maximum temperature was 45°C.

The normal annual rainfall over the district ranges from about 500 mm to 655 mm. It is the minimum in the central parts of the district around Dhule and Sakri (576 mm) and Sindkhed (566 mm) and increases northwards and westwards. The study of negative departures of the annual rainfall over normal reveals that western and southern parts of the district experienced moderate and severe drought conditions for more than 20% of years. Hence this parts occupying parts of Sakri and Dhule talukas can be categorized as drought area. The average annual rainfall of last ten years (1998-2007) in the district varied from 543 mm (Dhule) to 769 mm (Shirpur) and the same is presented in Table-3.

Table 3: Annual Rainfall Data (1998-2007). (mm)

Taluka	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Avg.
Dhule	772	490	339	546	412	718	851	318	727	668	543
Sakri	762	468	319	513	457	701	633	687	880	798	576
Shirpur	1172	749	372	475	702	1175	889	605	1195	1061	769
Shindkheda	862	579	447	452	513	863	762	386	970	747	607

(Source: www.agri.mah.nic.in)

3.0 Geomorphology and Soil Types

The district can be broadly divided into 2 physiographic units namely Tapi valley proper and the region of the dykes and residual hills of the Sahyadri Spurs with eastward trending streams in between. The Tapi River valley is observed on both sides of Tapi River in parts of Shirpur and Sindkhed talukas, whereas the region of dykes and residual hills of the Sahyadri Spurs comprises southern part of Shindkheda and entire Sakri and Dhule talukas. The district is drained by Tapi River and its tributaries. Tapi River flows westward through the central part of the district. Panjra and Aner rivers are the main tributaries of Tapi flowing northward and southward respectively to join Tapi River

In the Tapi valley proper, the soils are deep black and extremely fertile except in some portions near the main river and its tributaries, which have cut down the land very badly and removed the top soil. Otherwise the soils grade from the deep fertile soils to coarse shallow to stony soils away from the river either northwards towards the Satpudas or south ward towards the residual hills and dykes.

4.0 Ground Water Scenario

4.1 Hydrogeology

The major part of the district occupying northern parts of Shirpur, southern parts of Sindkhed and entire Dhule and Sakri talukas is covered by Basaltic flows commonly known as Deccan Traps intruded by dykes of Upper Cretaceous-Lower Eocene age. Tapi Alluvial deposits are observed in Tapi River valley occupying parts of Sindkhed and Shirpur talukas. A map depicting the hydrogeological features is shown in **Figure-2**.

4.1.1 Hard Rock Areas

4.1.1.1 Deccan Trap Basalt

The Deccan Trap includes several flows of Basalt which are supposed to have extruded from fissure volcanoes. The flows have been intruded by large number of dykes of doleritic composition. The dykes are aligned in an ENE-WSW direction and a few gave N-S or WNE-ESE trends. Basalt includes the "pahoehoe" and the "aa" types of flows, the former being very common.

The ground water occurs in the near surface strata down to the depth of 20 m under unconfined conditions in the weathered zone, vesicular/amygdaloidal Basalt, jointed and fractured massive Basalt. The water bearing strata occurring below 30 m depth, beneath the redbole and dense massive Basalt exhibit semi-confined to confined conditions. On the elevated plateau tops having good areal extent, local water table develops in top most layers and the wells in such areas show rapid decline water levels in postmonsoon season and go dry during peak summer. In the foot hills zone the water table is relatively shallow near the water courses and deep away from it and near the water divides. In the valleys and

plains of river basin the water table aquifer occurs at shallow depth and the wells in such areas do not go dry and sustain perennial yield except in extreme summer or drought conditions. The yield of the dugwells varies from 60 to 125 m³/day, whereas those of borewells varies form 2 to > 20 m³/hr, however in most of the borewells it ranges between 2 to 10 m³/hr.

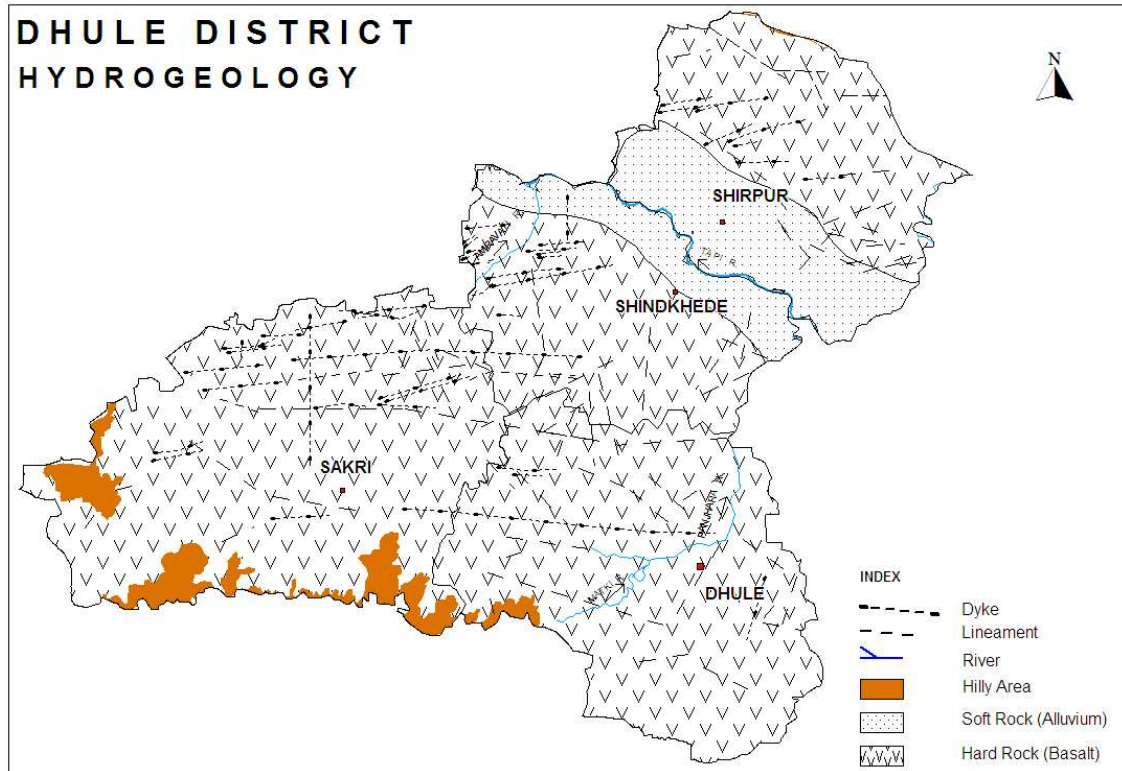


Figure-2: Hydrogeology

4.1.2 Soft Rock Areas

4.1.2.1 Alluvium

Alluvial deposits of Tapi River valley occurs in long narrow basin, which are probably caused by faulting. About a 15% of the district is occupied by Alluvium. It consists of clays, silt, sand, gravels and boulders etc. The beds of sand and gravels are discontinuous and lenticular and pinch out laterally within short distance. They are mixed with large proportions of clayey material rendering delimiting of individuals granular horizons difficult. As per ground water exploration data Alluvium is encountered down to 100 m depth. Ground water occurs under water table, semi-confined and confined conditions in inter granular pore spaces of gravel and sand. The yield of the dugwells varies between 150 and 200 m³/day, whereas that of exploratory wells varies form 1.50 to 6.00 lps as per exploration data. The yields of the tubewells drilled by State ground water department/agency ranges from 20 to 250 m³/hr.

4.2 Water Level Scenario

Central Ground Water Board periodically monitors 33 National Hydrograph Network Stations (NHNS) stations in the Dhule district, four times a year i.e. in January, May (Premonsoon), August and November (Postmonsoon).

4.2.1 Depth to Water Level – Premonsoon (May-2007)

The depth to water level in the district during May 2007 ranges between 3.10 (Pimpalner) and 21.00 m bgl (Gotane). Depth to water level during premonsoon (May 2007) has been depicted in **Figure-3**. Shallow water levels within 5 m bgl are observed in 2-3 small isolated patches in south eastern and southern parts. The water levels between 5 and 10 m bgl are observed in major parts of the district in southern parts and extreme north eastern parts. The moderate to deeper water levels of 10 to 20 m bgl are observed in elongated patch extending from northeastern to south western part of the district, occupying major parts of Shirpur and Sindkheda talukas. The water levels between 20 to 40 m bgl are observed in small rounded patch in southern part of the district.

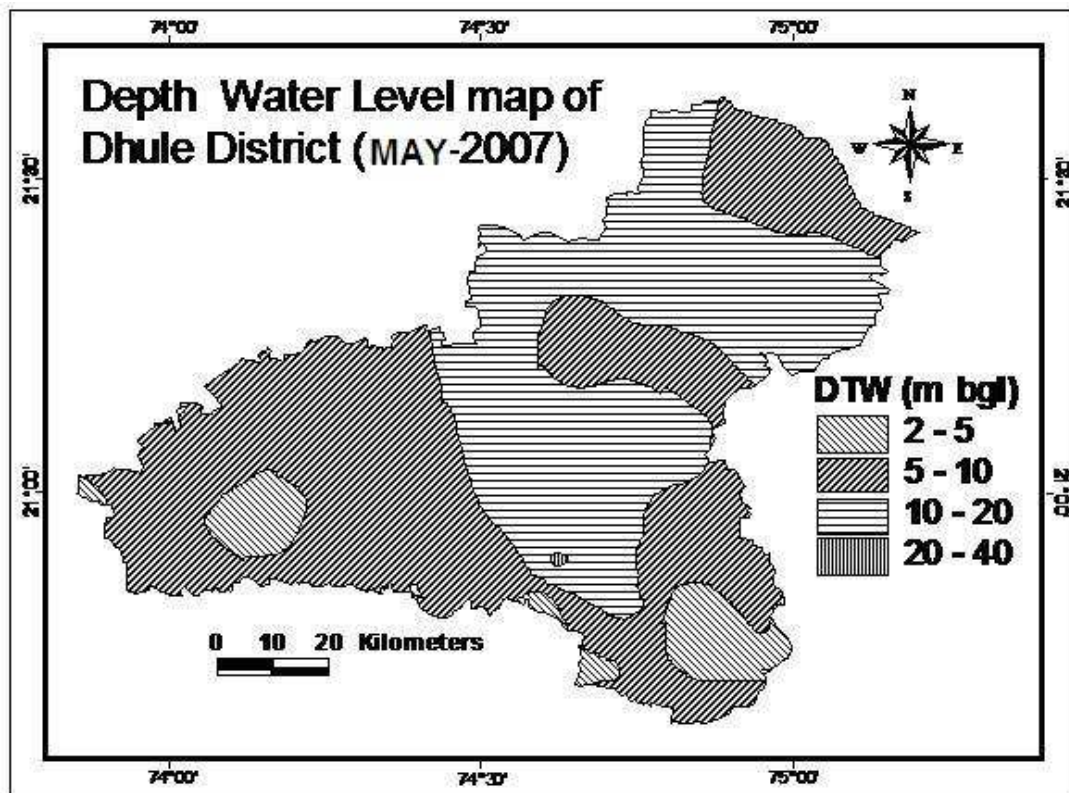


Figure-3: Depth to Water Level (Premonsoon- May 2007)

4.2.2 Depth to Water Level – Postmonsoon (Nov.-2007)

The depth to water level during postmonsoon (Nov. 2007) ranges between 1.10 m bgl (Charanmal) and 18.55 m bgl (Gotane). Spatial variation in postmonsoon depth to water level is shown in **Figure-4**. In major parts of the district water levels are between 5 and 10 m bgl. Shallow water levels, within 5 m bgl are seen south eastern and south western parts of the district. The moderate to deeper water levels of 10-20 m bgl are observed in most of northern Alluvial part of the district i.e., in parts of Shirpur and Dhule talukas.

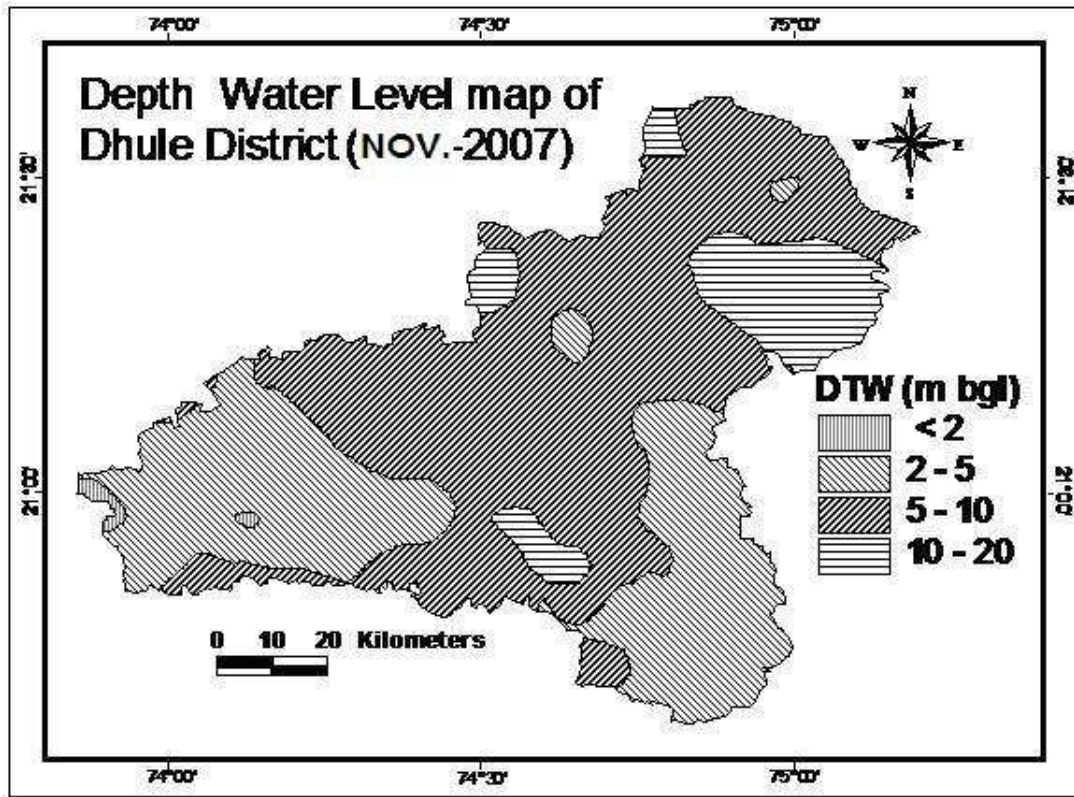


Figure-4: Depth to Water Level (Postmonsoon- Nov. 2007)

4.2.3 Seasonal Water Level Fluctuation– (May-Nov. 2007)

In major parts district rise in water levels in the range of 1.05 (Hisala) to 10.75 m (Songir), however fall is also observed at 6 NHNS and it ranges from 0.01 (Ner) to 1.35 m (Ajnale). The rise of more than 2 m being the most dominant range observed in entire southern, central and north western areas occupying major parts of district.

4.2.4 Water Level Trend (1998-2007)

Trend of water levels for premonsoon and postmonsoon period for last ten years (1998-2007) have been computed for 28 NHNS. The analysis of trend indicates that during premonsoon period, rise in water level has been recorded at 8 stations and it ranges between 0.03 m/year (Pimpalner) and 0.29 m/year (Methi). The fall in water level trend has been observed at 19 stations and it ranges between 0.01 at Ajnale and 0.59 m/year at Deobhane. During postmonsoon period, rise in water levels has been recorded at 13 stations and it ranges from 0.02 m/year (Sangivi) to 0.54 m/year (Sindkheda), whereas at 15 stations, fall in water level ranging between negligible at Hisala and 0.79 m/year at Purnepada(pur) is observed. Thus in major part of the district, both during pre and postmonsoon periods declining trends of water levels have been observed.

The premonsoon trend map was also prepared and the same is presented in **Figure-5**. It shows that during premonsoon the rise in water level trend of up to 20 cm/year is observed in 2-3 patches in southern and north western parts occupying parts of Sakri and Sindkheda talukas. In major parts of the district fall in water level trend of up to 20 cm/year is observed in almost entire Dhule and Shirur talukas and eastern parts of Sindkheda and parts of Sakri talukas. Thus

the future ground water conservation and recharge structures need to be prioritized in these areas.

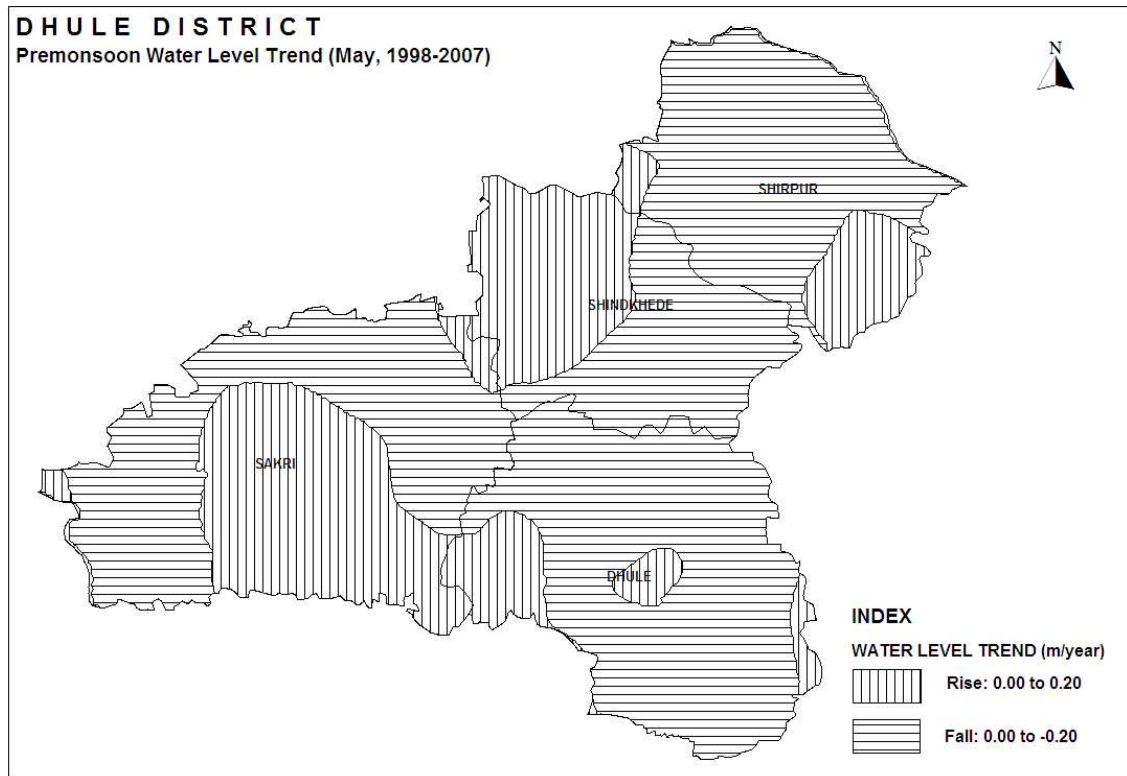


Figure-5: Premonsoon Water Level Trend (May, 1998-2007)

4.3 Aquifer Parameters

The aquifer parameters of shallow aquifer as determined during previous studies carried out by the Board are presented in Table-4. In Basalt transmissivity ranges from 6 to 96 m²/day, the storativity varies between 0.017 to 0.0429 and the specific capacity ranges from 41 to 220 lpm/m of drawdown, whereas in Alluvium transmissivity is about 70 m²/day and the specific capacity ranges from 173 to 616 lpm/m of drawdown.

Table 4: Aquifer Parameters.

S. No.	Aquifer	Specific Capacity (lpm/m of drawdown)	Transmissivity (m ² /day)	Storativity
1.	Fractured and moderately weathered Massive Basalt	80 - 220	5.70 – 88.50	0.017 – 0.048
2.	Moderately to highly weathered Basalt	48 – 155	77 – 96	-
3.	Vesicular Amygdaloidal Basalt	41 – 112	11 – 56	0.0429
4.	Alluvium	173 – 616	70	-

4.4 Yield of Dugwells and Borewells

The yields of the wells are function of the permeability and transmissivity of aquifer encountered and it varies with location, diameter and depth of wells etc. There are mainly two types of ground water abstraction structures in the district i.e., dugwells and borewells/tubewells, however the yield of wells also vary according to nature of formation tapped and its saturated thickness. Therefore, the dugwells located in the topographic lows, morphological depressions and on or near the lineaments yield comparatively more water than the located elsewhere, which is particularly true in basaltic terrain. The yield of dugwell also varies depending on the season. The yields of dugwells for different formations are presented in Table-5.

Table 5: Yield of Dugwells.

S. No.	Aquifer	Depth Range (m bgl)	Yield Range (m ³ /day)
1	Predominantly Amygdaloidal Basalt	10 – 15	75 – 95
2	Predominantly Vesicular/Zeolitic Basalt	9 – 12	100 – 125
3	Predominantly Massive Basalt	10 – 14	60 - 75
4	Alluvium	25 - 30	150 - 200

The borewells drilled by State ground water department/agency in Deccan Trap Basalt indicate wide variation and it varies from 2 to > 20 m³/hr, however in most of the borewells it ranges between 2 to 10 m³/hr. The yield of exploratory wells constructed by CGWB ranges from 1.50 to 6.00 lps as seen from exploration data. The yields of the tubewells drilled by State ground water department/agency ranges from 20 to 250 m³/hr.

4.5 Ground Water Resources

Central Ground Water Board and Ground Water Survey and Development Agency (GSDA) have jointly estimated the ground water resources of Dhule district based on GEC-97 methodology. The same is presented in Table-6. Ground Water Resources assessment was done for 6368.19 sq. km. area of which 479.16 sq. km. is under command and 5889.03 sq. km. is non-command. Taluka wise ground water resources are shown in **Figure-5**.

As per the estimation, the total annual ground water recharge is 1302.23 MCM with the natural discharge of 82.04 MCM, thus the net annual ground water availability comes to be 1220.19 MCM. The gross draft for all uses is estimated at 639.46 MCM with irrigation sector being the major consumer having a draft of 624.03 MCM. The allocation for domestic and industrial requirements for the next 25 years are worked out at 21.18 MCM, whereas the net ground water availability for future irrigation is estimated at 620.17 MCM. The stage of ground water development varies from 36.45% (Shirpur) to 78.73% (Sindkheda) and all the talukas falls in “Safe” category. The overall stage of ground water development for the district is 53.55%. Similarly, the ground water resources were also assessed for all the 37 watersheds and 5 watersheds (TE-63, TE-64, TE-88, TE-100 and TE-101) have been categorised as “Semi-Critical”, 1 watershed i.e., TE-105A have been categorised as “Critical” and 5 watersheds (TE- 50B, TE-65, TE-76, TE-99 and TE-124) have been categorised as “Over-Exploited”.

In all these “Semi-Critical”, “Critical” and “Over-Exploited” watersheds and

in Sindkheda taluka where the stage of ground water development has already reached 78% but has been categorised as “Safe”, future ground water development is not recommended without adhering to the precautionary measures i.e., artificial recharge to augment the ground water resources and adoption of ground water management practices.

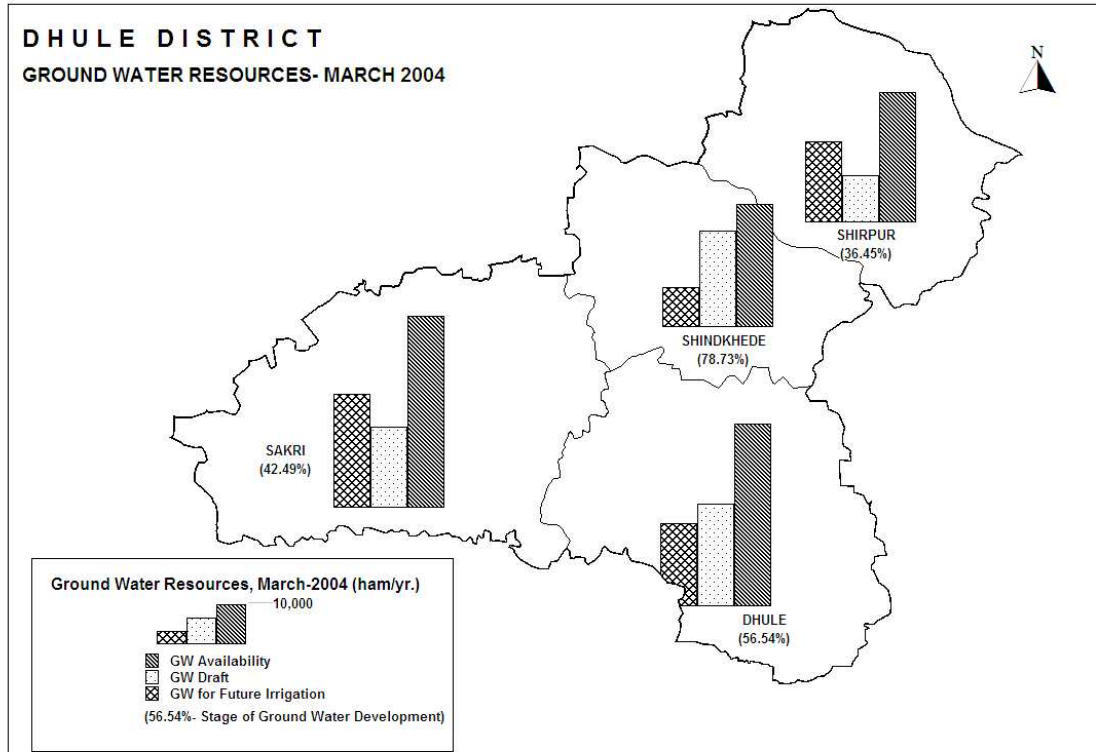


Figure 5: Ground Water Resources (March 2004)

4.6 Ground Water Quality

Central Ground Water Board monitors the ground water quality of the district through analysis of water samples collected from its National Hydrograph Network Stations (NHNS) which represent the shallow aquifer of the district only. The objective behind quality monitoring is to understand an overall picture of ground water quality of the district. During year 2007, CGWB has carried out the ground water quality monitoring at 16 NHNS out of which 15 samples represent Basaltic aquifer and 1 sample represent Alluvium.

The results of chemical analysis show that the ground water in the district is alkaline in nature. The geochemical classification of ground water samples is given in Table-7. It is clear from the Table-7 that the ground water in the district is mainly dominated by Ca-HCO₃ type of water followed by Ca-Cl. However the groundwater in the Basalt is generally of Ca-HCO₃ type, the change in the type of water may be due to the excess amount of strong acids ions getting percolated to ground water from anthropogenic sources. In 3 sample of Basaltic aquifer, the ground water was found to be of Na-Cl type.

Table 6: Ground Water Resources (March 2004).

Taluka	Area type	Net annual ground water availability (ham/yr.)	Annual ground water draft (ham/yr.)			Allocation for domestic & industrial requirement supply up to next 25 years (ham/yr.)	Ground water availability for future irrigation (ham/yr.)	Stage of ground water development (%)	Category
			Irrigation	Domestic & industrial uses	Total				
Dhule	Command	6311.05	1176.16	25.28	1201.44	50.55	5084.34	19.04	Safe
	Non Command	29177.92	18083.46	779.16	18862.62	840.25	10960.48	64.65	
	Total	35488.97	19259.62	804.43	20064.06	890.80	16044.82	56.54	
Sakri	Command	9750.45	2337.69	59.18	2396.87	117.15	7501.29	24.58	Safe
	Non Command	27647.65	13278.73	216.07	13494.81	337.21	14770.05	48.81	
	Total	37398.10	15616.43	275.25	15891.68	454.36	22271.34	42.49	
Sindkheda	Command	4418.42	626.42	28.66	655.08	57.31	3734.69	14.83	Safe
	Non Command	19427.77	17950.39	168.58	18118.97	184.43	4162.44	93.26	
	Total	23846.20	18576.81	197.24	18774.05	241.74	7897.13	78.73	
Shirpur	Command	6381.36	2307.22	52.87	2360.09	105.74	3968.40	36.98	Safe
	Non Command	18905.00	6643.67	212.79	6856.47	425.58	11835.74	36.27	
	Total	25286.35	8950.89	265.66	9216.55	531.32	15804.14	36.45	
District Total	Command	26861.28	6447.50	165.98	6613.48	330.75	20288.72	23.86	
	Non Command	95158.34	55956.26	1376.60	57332.86	1787.47	41728.71	60.75	
	Total	122019.62	62403.75	1542.58	63946.33	2118.22	62017.43	53.55	

Table 7: Geochemical Classification of Ground Water Samples.

S. No.	Classification	Type	No. of Sample	% of Sample
1	Alkaline earths (Ca+Mg > 50%) exceeds alkali metals and weak acids (CO ₃ +HCO ₃ > 50%) exceeds strong acids	Ca-HCO ₃	7	44
2	Alkaline earths (Ca+Mg > 50%) exceeds alkali metals and strong acids (Cl+SO ₄ +NO ₃ > 50%) exceeds weak acids	Ca-Cl	6	37
3	Alkali metal (Na+K > 50%) exceeds alkaline earths and strong acids (Cl+SO ₄ +NO ₃ > 50%) exceeds weak acids	Na-Cl	3	19
	Total		16	100

4.6.1 Suitability of Ground Water for Drinking Purpose

The suitability of ground water for drinking purpose is determined keeping in view the effects of various chemical constituents in water on the biological system of human being. Though many ions are very essential for the growth of human, but when present in excess, have an adverse effect on human body. The standards proposed by the Bureau of Indian Standards (BIS) for drinking water (IS-10500-91, Revised 2003) were used to decide the suitability of ground water. The classification of ground water samples was carried out based on the desirable and maximum permissible limits for the parameters viz., TDS, TH, Ca, Mg, Cl, SO₄ and NO₃ prescribed in the standards and is given in Table-8.

Table 8: Classification of Ground Water for Drinking based on BIS Drinking Water Standards (IS-10500-91, Revised 2003).

Parameters	DL (mg/L)	MPL (mg/L)	Samples with conc. < DL	Samples with conc. in DL-MPL	Samples with conc. >MPL
TDS	500	2000	6	10	Nil
TH	300	600	5	8	3
Ca	75	200	14	2	Nil
Mg	30	100	1	12	3
Cl	250	1000	11	5	Nil
SO ₄	200	400	14	2	Nil
NO ₃	45	No relaxation	7	Nil	9
F	1.0	1.5	13	1	2

(Here, DL- Desirable Limit, MPL- Maximum Permissible Limit.)

The perusal of Table-8 shows that the potability of groundwater in 56% of wells monitored has been affected by the high concentration of nitrate present in ground water. The total hardness (TH) is beyond permissible limit in Avdhan, Nardana and Ner, magnesium (Mg) is beyond permissible limit in Avdhan, Nardana and Mukti, whereas concentration of fluoride (F) was beyond permissible limit in Dhule and Sakri. Overall, the ground water quality scenario of the wells monitored in the district is not bright.

4.6.2 Suitability of Ground Water for Irrigation Purpose

The water used for irrigation is an important factor in productivity of crop, its yield and quality of irrigated crops. The quality of irrigation water depends primarily on the presence of dissolved salts and their concentrations. Sodium Absorption Ratio (SAR) and Residual Sodium Carbonate (RSC) are the most important quality criteria, which influence the water quality and its suitability for irrigation.

4.6.2.1 Sodium Absorption Ratio (SAR)

Sodium Absorption Ratio (SAR) is an expression pertaining to cation make up of water and soil solution and is used for characterizing the sodium hazard of irrigation water. SAR value is used to calculate the degree to which irrigation water tends to enter into cation exchange section in the soil. The main problem with high sodium concentration is its effect on soil permeability. Sodium also contributes directly to the total salinity of the water and may be toxic to sensitive crops such as fruit trees. The higher value of SAR indicates soil structure damage.

4.6.2.2 Residual Sodium Carbonate (RSC)

Residual Sodium Carbonate (RSC) is considered to be superior to SAR as a measure of sodicity particularly at low salinity levels. The classification of ground water samples based on SAR and RSC values for its suitability for irrigation purpose is shown below in Table-9.

Table 9: Classification of Ground Water for Irrigation based on SAR and RSC.

SAR	<10		10-18		18-26		>26	
Category	Good		Good to Permissible		Doubtful		Unsuitable	
Total Samples	No. of Samples	%	No. of Samples	%	No. of Samples	%	No. of Samples	%
16	15	94	1	6	Nil	Nil	Nil	Nil
RSC	<1.25		1.25-2.50		>2.50			
Category	Good		Doubtful		Unsuitable			
Total Samples	No. of Samples	%	No. of Samples	%	No. of Samples	%		
16	14	88	1	6	1	6		

The perusal of Table-9 clearly indicates that the 94% and 88% of samples have SAR and RSC values respectively in Good category, suggesting that the quality of ground water in the monitoring wells is good for irrigation purpose. Only in 1 sample collected from Dhule town has RSC value more than 2.50 thereby rendering it unsuitable for irrigation.

4.7 Status of Ground Water Development

Ground water development depends on many factors viz., availability, crop water requirement, socio-economic fabric and on the yield of the aquifers existing in that area. Ground water in the area is being developed by three type of abstraction structures i.e., dugwells, borewells and tubewells. However dugwell is the main ground water abstraction structure in the district.

As per the data available for year 2000-01 (Minor Irrigation Census) the area irrigated by ground water is about 64 sq.km., whereas surface water is accounting for about 85 sq.km. of area and the net irrigated area stands at 149

sq.km. The district had 19089 irrigation dugwells, which create an irrigation potential of about 470 sq.km., out of which 408 sq.km. of irrigation potential is utilised. In addition to this about 57 sq.km, of irrigation potential is created through 2382 shallow and deep borewells/tubewells out of which about 46 sq.km. of irrigation potential is utilised during 2000-01.

State Government agencies have drilled number of borewells/tubewells fitted with hand pumps and electric motors for rural drinking water purposes in the district. In all till March 2007, GSDA, Government of Maharashtra is operating 2634 successful borewells/tubewells for rural water supply under various schemes in the district, out of which 2410 wells are fitted with hand pumps and the rest 224 are fitted with electric pumps.

5.0 Ground Water Management Strategy

Ground water has special significance for agricultural development in the district. The ground water development in some parts of the district has reached a critical stage resulting in decline of ground water levels over a period of time. Thus, there is a need to adopt an integrated approach of development of ground water resources dovetailed with ground water augmentation to provide sustainability to ground water development.

5.1 Ground Water Development

Major part of the district is underlain by Deccan Trap Basalt. The development potential of ground water in Deccan Trap Basalt is low to medium in parts of Sakri, Sindkheda and Dhule talukas and ground water in these areas can be developed through dugwells and dug-cum-bored wells (DCB) and borewells. However, the dugwells are the most feasible structures and borewells should normally be avoided as they generally tap deeper fractures, which may not be sustainable. Besides, the borewells should only be used for drinking water supply and not for irrigation. The sites for borewells also need to be selected only after proper scientific investigation so as to minimise the rate of failure.

In the southern parts of Shirpur taluka mainly occupied by Alluvium, the groundwater potential is medium to high and groundwater can developed through dugwells and shallow tubewells. However, the stage of ground water development has already reached 78%, hence future ground water development is not recommended without adhering to the precautionary measures i.e., artificial recharge to augment the ground water resources and adoption of ground water management practices in the taluka. Similar strategy also needs to be adopted in all the "Semi-Critical", "Critical" and "Over-Exploited" watersheds.

The overall stage of ground water development for the district is at halfway stage, i.e., 53.55% thus there is a scope for further development of ground water resources particularly in Dhule, Sakri and Sindkheda talukas. However, the ground water development needs to be carried out with proper care and planning, since in these areas falling water level trends are observed.

The nature and yield potential of the aquifers occurring in different areas is given below in **Table-10**

Table 10: Nature and Yield Potential of Aquifers.

S. No.	Taluka	Main Aquifer	Yield Potential	Type of Wells Feasible
1.	Dhule	Basalt	Low to Medium	Dugwell, DCB and Borewell
2.	Sakari	Basalt	Low to Medium	Dugwell, DCB and Borewell
3.	Sindkheda	Basalt	Low to Medium	Dugwell, DCB and Borewell
4.	Shirpur	Alluvium	Medium to High	Dugwell and Shallow Tubewell

5.2 Water Conservation and Artificial Recharge

A number of water conservation structures in the form of check dams, percolation tanks, and KT weirs have already been constructed in the district. In Basaltic area, the artificial recharge structures feasible are check dams, gully plugs, percolation tanks, nalla bunds, etc. The structures like gully plugs, contour bunds are most favourable in the hilly areas, occurring in the central part of the district. Existing dugwells can also be used for artificial recharge, however, the source water should be properly filtered before being put in the wells. The artificial recharge structures suitable for alluvial areas are percolation tanks and recharge wells/shafts. These sites need to be located where the hydrogeological conditions are favourable, i.e., where sufficient thickness of de-saturated/unsaturated aquifer exists and water levels are more than 5 m deep. Such areas are observed in almost entire district as seen from postmonsoon water level scenario.

6.0 Ground Water Related Issues and Problems

The drought area has been observed in western and southern parts of the district occupying parts of Sakri and Dhule talukas. The moderate to deeper water levels of 10 to 20 m bgl (parts of Shirpur and Sindkheda talukas) and falling water level trends are observed in most parts of the district, occupying Dhule and Shirpur talukas and eastern parts of Sindkheda and parts of Sakri talukas. Thus artificial recharge and water conservation structures needs to be prioritised in these areas.

Ground water quality is adversely affected by nitrate contamination in 56% of the samples and Fluoride contamination in 12% of samples collected in May 2007. Continues intake of high nitrate concentration water causes infant methaemoglobinemia, popularly known as Blue Babies, and high fluoride concentration causes the dental and skeletal fluorosis. Thus all the wells used for water supply should be first analysed for nitrate and fluoride contents and if the contents are found beyond permissible limits then the ground water may be used for other than drinking purpose. Adequate sanitary protection to the wells may be provided to control the nitrate contamination.

7.0 Areas Notified by CGWA/SGWA

As per ground water resource estimation all the talukas have been categorised as "Safe" and hence none of the taluka has been notified either by CGWA or SGWA.

8.0 Recommendations

1. Major part of the district is underlain by Deccan Trap Basalt, where only dugwells are the most feasible structures for ground water development.
2. The sites for borewells need to be selected only after proper scientific investigation. Borewells generally tap deeper fractures, which may not be sustainable. Besides, the borewells should only be used for drinking water supply and not for irrigation.
3. The overall stage of ground water development for the district is at halfway stage, i.e., 53.55% thus there is a scope for further development of ground water resources particularly in Dhule, Sakri and Sindkheda talukas. However, the ground water development needs to be carried out with proper care and planning, since in these areas falling water level trends are observed.
4. The stage of ground water development has already reached about 78% in Shirpur taluka, hence future ground water development is not recommended without adhering to the precautionary measures i.e., artificial recharge to augment the ground water resources and adoption of ground water management practices in the taluka. Similar strategy also needs to be adopted in all the "Semi-Critical", "Critical", "Over-Exploited" watersheds.
5. The scope exists for construction of suitable artificial recharge structures in the district. The structures recommended for the hilly- Deccan Trap Basalt area in the central part are: contour bunds, gully plugs, nala bunds and check dams. For other basaltic areas, the nala bunds, check dams and KT weirs are suggested. The existing dugwells may also be used for artificial recharge of ground water provided source water is free of silt and dissolved impurities.
6. In Alluvial area of the district, percolation tanks and recharge wells/shafts are suggested.
7. The existing village ponds/tanks need to be rejuvenated to act both as water conservation and artificial recharge structures.
8. Ground water quality is adversely affected by nitrate contamination in 56% samples and fluoride contamination in 12% of the samples collected in May 2007. Thus all the wells used for water supply should be first analysed for nitrate and fluoride contents and if the contents are found beyond permissible limits then the ground water may be used for other than drinking purpose. Adequate sanitary protection to the wells may be provided to control the nitrate contamination.