1606/DBR/2009

भारत सरकार

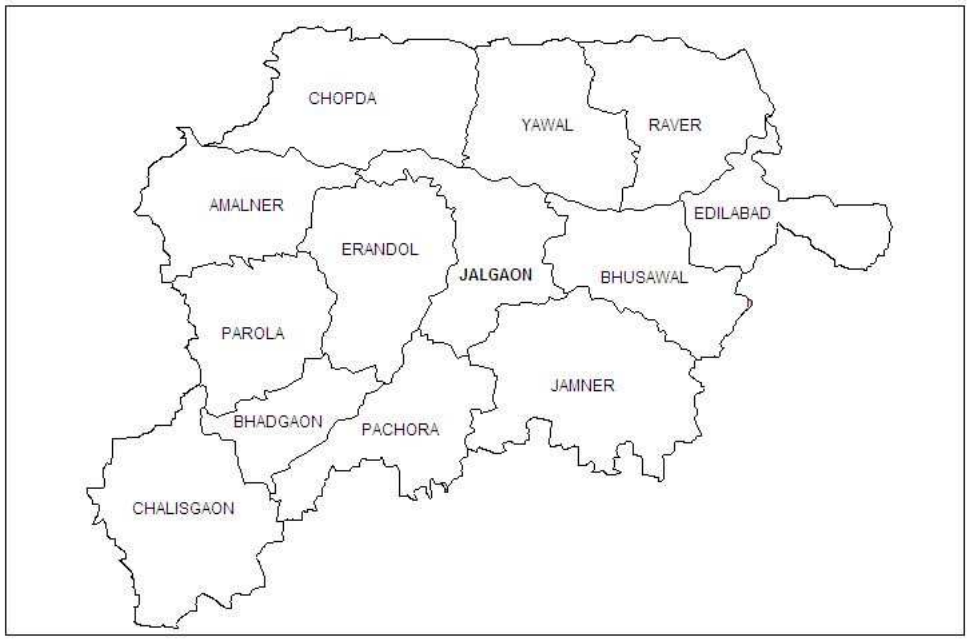
जल संसाधन मंत्रालय

केंद्रीय भूजल बोर्ड

GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

महाराष्ट्र राज्य क अंतर्गत जलगांव जिल की भूजल विज्ञान जानकारी

GROUND WATER INFORMATION
JALGAON DISTRICT
MAHARASHTRA



By
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Scientist-B

द्वारा
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वैज्ञानिक- ख

मध्यवर्ती क्षेत्र
नागपुर
CENTRAL REGION
NAGPUR
2009

JALGAON DISTRICT AT A GLANCE

1. GENERAL INFORMATION

Geographical Area	:	11,765 sq. km.
Administrative Divisions	:	Taluka-15; Jalgaon, Bhusaval, Yaval, Raver, Edilabad, Amalner, Chopda, Erandol, Palora, Chalisgaon, Jamner, Pachora, Bhadgaon, Dharangaon, Bodwad.
Villages	:	1519
Population (2001)	:	36,82,690
Average Annual Rainfall	:	669.86 mm

2. GEOMORPHOLOGY

Major Physiographic unit	:	Three; Satpuda hill range, Ajanta hill range and Tapi plain
Major Drainage	:	One; Tapi

3. LAND USE (2005-06)

Forest Area	:	1560 sq. km.
Net Area Sown	:	9710 sq. km.
Cultivable Area	:	1400 sq. km.

4. SOIL TYPE

	:	Deep black and Medium black soils

5. PRINCIPAL CROPS (2005-06)

Cotton	:	3330 sq. km.
Cereals	:	3350 sq. km.
Pulses	:	1850 sq. km.

6. IRRIGATION BY DIFFERENT SOURCES (2000-01) **- Nos. / Potential Created (ha)**

Dugwells	:	90398 / 221417
Tubewells and Borewells	:	7505 / 18641
Tanks and Ponds	:	186/ 533
Other Minor Surface Sources	:	56/2269
Net Irrigated Area	:	213570 ha

7. GROUND WATER MONITORING WELLS (As on 31/05/2007)

Dugwells	:	41
Piezometers	:	09

8. GEOLOGY

Recent	:	Alluvium
Quaternary to Recent	:	Bazada (Talus and Scree), Younger Alluvium, Older Alluvium
Upper Cretaceous-Lower Eocene	:	Basalt (Deccan Traps)

9. HYDROGEOLOGY

Water Bearing Formation	:	Basalt (Deccan Traps) weathered, vesicular fractured, jointed. Under phreatic and confined conditions. Alluvium- Coarse Sand, Pebble and Gravel, Under water table to confined conditions.
Premonsoon Depth to Water Level (May-2007)	:	2.05 to 56.20 m bgl

Postmonsoon Depth to Water Level (Nov.-2007)	:	0.15 to 52.90 m bgl
Premonsoon Water Level Trend (1998-2007)	:	Rise: Negligible to 1.75 m/year Fall: Negligible to 1.03 m/year
Postmonsoon Water Level Trend (1998-2007)	:	Rise: Negligible to 0.49 m/year Fall: Negligible to 1.03 m/year

10. GROUND WATER EXPLORATION (As on 31/03/07)

Wells Drilled	:	EW-63, OW-22, Pz-07, Total -92
Depth Range	:	22.70 to 318.45 m bgl
Discharge	:	0.14 to 47.00 lps
Storativity	:	1.65×10^{-2} to 1.05×10^{-4}
Transmissivity	:	82.5 to 2314 m^2/day

11. GROUND WATER QUALITY

The quality of ground water is alkaline and generally suitable for drinking and irrigation purpose, however localized nitrate contamination is observed in rural areas.

Type of Water	:	Ca-HCO_3 and Ca-Cl

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

Net Annual Ground Water Availability	:	1245.22 MCM
Annual Ground Water Draft (Irrigation+Domestic)	:	862.13 MCM
Allocation for Domestic and Industrial requirement up to next 25 years	:	87.18 MCM
Stage of Ground Water Development	:	69.24 %

13. AWARENESS AND TRAINING ACTIVITY

A	Mass Awareness Programme	:	One
	Date	:	16/02/2000
	Place	:	Yaval
B	Water Management Training Programme	:	Nil

14. ARTIFICIAL RECHARGE & RAINWATER HARVESTING

Projects Completed	:	Two, TE-11 and TE-17 watersheds
Projects under Technical Guidance	:	Nil

15. GROUND WATER CONTROL & REGULATION

Over-Exploited Taluka	:	Two, Raver and Yaval
Semi-Critical Taluka	:	Two, Pachora and Chopda
Notified Taluka	:	Two, Raver and Yaval

16. MAJOR GROUND WATER PROBLEMS AND ISSUES

Major part of the district, during both pre and postmonsoon periods show declining trends. Deeper water level areas have been observed in parts of Yaval, Raver and Chopda talukas. Ground water quality is adversely affected at many places due to high concentration of nitrate. Fluoride contamination is also observed at two places, i.e., Mondhale (2.24 mg/L) and Hingone (2.00 mg/L).

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Jalgaon District

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Jalgaon District

1.0 Introduction

Jalgaon district is one of the district of Khandesh region and situated in north western part of Maharashtra. It is situated in the northern part of the State abutting Madhya Pradesh and lies between north latitudes 20°15' and 21°25' and east longitudes 74°55' and 76°28'. The total area of the district is 11,765 sq.km. and falls in parts of Survey of India degree sheets 46 K, 46 L, 46 P, 55 C, 55 D, and 56 O. The district is bounded on the north by Madhya Pradesh State, on the east by Buldhana, on the west by Nashik and Dhule district and on the south by Aurangabad district.

The district headquarters is located at Jalgaon Town. For administrative convenience, the district is divided in 15 talukas viz., Jalgaon, Bhusaval, Yaval, Raver, Edilabad, Amalner, Chopda, Erandol, Palora, Chalisgaon, Jamner, Pachora, Bhadgaon, Dharangaon and Bodwad. It has a total population of 36,82,690 as per 2001 census. The district has 16 towns and 1519 villages. The major part of the district comes under Tapi basin. Tapi is the main river flowing through the district.

Central Ground Water Board has taken up several studies in the district. A list of studies conducted in the district is presented in **Table-1**.

Table 1: Studies undertaken by CGWB.

S. No.	Officer	AAP	Type of Survey/Study
1.	Gajbhiye, N.G.	1971-72	Systematic Hydrogeological Survey
2.	Bhatnagar, S.K.	1987-88	Systematic Hydrogeological Survey
3.	Sahoo, K.B.	1990-91	Systematic Hydrogeological Survey
4.	Naik, P.K.	1995-96	Reappraisal Hydrogeological Studies
5.	CGWB	1994-97	Artificial Recharge Project, W/s TE-17
6.	Sahoo, K.B.	1997-98	Reappraisal Hydrogeological Studies
7.	CGWB	1998-02	Artificial Recharge Project, W/s TE-11
8.	Toppo, Sunil	2003-04	Reappraisal Hydrogeological Studies
9.	Davithuraj, J	2003-04	Reappraisal Hydrogeological Studies
10.	Jain, S. K.	2004	Ground water utilization in Yaval taluka
11.	Naik, P.K.	2004	Ground water utilization in Raver taluka.

Shri S.K. Jain (2001) compiled the report on Hydrogeology of the district. Ground water exploration in the district has been taken up in different phases since 1957-58. The ground water exploration has been done in Alluvial and hard rock areas occupied by Deccan Trap Basalt. A total of 63 Exploratory Wells (EW), 22 Observation Wells (OW) and 07 Piezometers (Pz) have been constructed till March 2007.

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

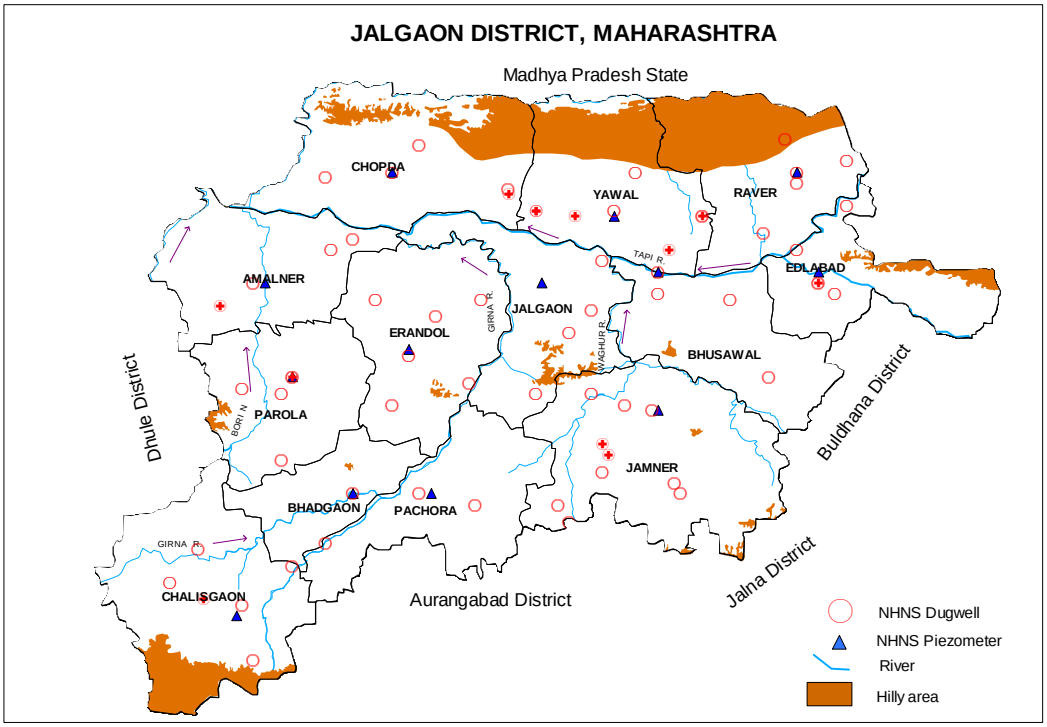

Figure 1: Location

Table 2: Salient Features of Ground Water Exploration.

S. No.	Taluka	Forma-tion	Wells			Depth (mbgl)	SWL (mbgl)	Dis-charge (lps)	Draw-Down (m)	Zones (mbgl)
			EW	OW	Pz					
1	Jalgaon	Basalt	3	--	--	198-67-204.75	62.00-88.00	0.38-20.00	--	12.00-197.00
2	Bhusawal	Basalt	5	--	--	168.35-204.35	6.50-140.00	1.37-7.76	--	9.00-200.00
3	Yaval	Alluvium	18	9	4	45.50 -318.45	18.00-46.00	0.14-38.00	0.87-8.26	10.36-271.00
4	Raver	Alluvium	12	5	1	22.70-229.00	7.6-45.00	0.30-47.00	3.02-17.68	10.00-68.00
5	Chopda	Alluvium	12	8	2	56.00-300.00	9.00-30.20	0.81-30.50	2.18-27.06	7.00-74.00
6	Chalisgaon	Basalt	4	--	--	200.20	45.00-99.40	--	--	--
7	Pachora	Basalt	5	--	--	175.95-204.75	5.20-100.00	0.14-29.16	--	9.00-175.00
8	Bhadgaon	Basalt	3	--	--	200.20	6.40-7.14	0.38-1.41	--	50.00-177.00
9	Dharan-gaon	Basalt	1	--	--	204.75	8.00	0.78	--	18.2-143.00
Total			**63**	**22**	**7**	**22.70-318.45**	**6.50-140.00**	**0.14-47.00**	**0.87-27.06**	**7.00-271.00**

In Basalt 21 exploratory wells were drilled and their depth ranged from 168.35 to 204.75 metres below ground level (m bgl). The discharge from these wells varied from 0.14 to 29.16 litres per second (lps). Static water levels ranged from 5.20 to 140.00 m bgl. The potential aquifer zones have been encountered from 9 to 200.0 m bgl.

In Tapi Alluvium, 42 exploratory wells, 22 observation wells and 7 Piezometers were constructed. The depth of the wells ranged from 22.70 to 318.45 m bgl. Static water levels vary from 7.6 to 46.00 m bgl. Discharge from exploratory wells ranged from 0.14 to 47.00 lps for drawdowns ranging from 0.87 to 27.06 m. Granular zones have been encountered and screened at various depths. In most of the wells, potential aquifers were restricted to the top 100m depths whereas in 4 wells, the granular zones were found upto 300m. The first aquifer was encountered upto 100m while the second potential aquifer was below 250 m depth. The intervening formation between 100 to 250 m is generally clayey and devoid of any significant granular zones with few exceptions.

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 mean minimum temperature is 10.8℃ and mean maximum temperature is 42.2℃.

The normal annual rainfall over the district varies from about 660.40 mm to 763.40 mm. The average annual rainfall for the last ten years 1998-2007 ranges from 667.19 mm (Amalner) to 830.84 mm (Jamner) and the same is presented in **Table-3**.

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

S. No.	Taluka	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Avg.
1	Jalgaon	803.40	606.60	740.00	772.00	939.70	1192.20	531.50	506.52	1444.10	674.23	821.03
2	Bhusawal	954.00	486.20	707.90	574.20	788.90	873.90	586.80	535.20	1420.60	565.02	749.27
3	Yaval	1056.00	369.00	569.80	557.00	744.80	970.00	694.00	573.00	1458.40	777.50	776.95
4	Raver	867.50	726.00	335.00	508.60	826.20	800.30	728.00	449.00	1232.00	747.30	721.99
5	Edlabad	1019.60	597.50	495.10	607.50	939.50	705.00	732.00	508.00	1306.00	569.70	747.99
6	Amalner	1023.00	628.00	321.20	598.30	530.00	826.00	717.00	398.20	950.80	679.40	667.19
7	Chopda	1013.00	430.00	475.20	548.80	877.40	1064.20	622.00	443.00	1457.00	747.00	767.76
8	Erandol	1010.00	717.10	515.20	701.00	825.40	950.00	589.00	509.00	1334.10	637.00	778.78
9	Parola	1036.80	802.00	520.00	824.60	691.40	956.30	611.00	562.10	1441.60	627.30	807.31
10	Chalisgaon	1183.00	632.00	336.40	666.00	925.80	1158.00	506.00	379.40	1039.00	531.60	735.72
11	Jamner	1104.30	695.00	620.00	857.00	770.70	994.00	722.00	607.60	1103.60	834.20	830.84
12	Pachora	1215.50	553.00	384.00	588.00	587.20	985.60	566.00	588.90	984.00	536.36	698.86
13	Bhadgaon	1137.90	659.00	480.00	644.30	605.10	1067.00	628.00	662.20	1033.80	481.60	739.89
14	Dharangaon	1010.00	NA	490.00	617.00	651.50	924.00	745.00	633.80	1425.80	676.10	717.32
15	Bodhwada	954.00	NA	435.70	839.30	663.80	765.10	815.50	481.50	1277.20	543.70	677.58
	Average	1025.87	526.76	495.03	660.24	757.83	948.77	652.92	522.49	1260.53	641.87	749.23

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

3.0 Geomorphology and Soil Types

The district can be divided into three main physiographic divisions i.e.,

Satpura hill ranges in the northern part with dense forest; Tapi valley consisting of alluvial plain in the central part of the district and Ajanta hill ranges, flanking the hill ridges and small valley in the southern part of the district.

Tapi is the main river flowing through the district and its major tributaries are Purna in the south and Bhokar, Suki, Morna, Harki, Manki and Gul in the north.

The soils in Jalgaon district are essentially derived from the basaltic lava flows and are classified as, a) Deep black soils, b) Medium black soils, c) Loamy and sandy soils and d) Forest soils. Deep black soils are observed in northern part of Amalner, Erandol, Jalgaon, Bhusaval and Edilabad talukas. Medium black soils occur over large areas in the district viz.; the central belt of the wide Tapi valley and southern hills. In Tapi alluvial basin soils are black alluvial clay occurs in the southern parts of Yaval, Raver, Chopda, Jalgaon, Bhusaval, Chalisgaon, Amalner, and Bhadgaon. Loamy soils are observed in the southern-most part of Amalner, Erandol, Jalgaon and Bhusaval. Sandy soils observed on the foothills of Satpura ranges and near southern hillocks. Forest soils are dark brown and occur on slopes mainly in the Satpura ranges.

4.0 Ground Water Scenario

4.1 Hydrogeology

Deccan Trap Basalt of upper Cretaceous to lower Eocene age is the major rock formation, covering about 8040 sq. km. area in central and the southern parts of the district. These rocks are intruded by the dykes of the same period. Alluvium occurs over an area of 3600 sq. km. in the northern part of the district below the Satpura ranges. A map depicting hydrogeological features is presented as **Figure-2**.

4.1.1 Deccan Trap Basalt

Ground water in Deccan Trap Basalt occurs mostly in the upper weathered and fractured parts down to 20-25 m depth. At places potential zones are encountered at deeper levels in the form of fractures and inter-flow zones. The upper weathered and fractured parts form phreatic aquifer and ground water occurs under water table (unconfined) conditions. At deeper levels, the ground water occurs under semi-confined conditions.

The yield of dugwells tapping upper phreatic aquifer ranges between 21 and 337 m^3/day, which have 5-15 m bgl depth range. Borewells drilled down to 60-150 m depths, tapping weathered and vesicular basalt are found to yield 1.8 to 52 m^3/day.

4.1.2 Alluvium

Northern part of the district is underlain by Tapi Alluvium. Tapi Alluvium can be subdivided into two sub units, i.e., the upper younger Alluvium extending down to 70-80 m depth and the deeper older Alluvium attaining a maximum depth of 450 m. However, only upper 70-80 m of younger Alluvium having 2 to 5 layers of granular zones of sand and gravel ranging in thickness from 2 to 20 m forms the potential aquifer. At deeper levels the Alluvium is mostly clayey and does not form potential aquifer.

Ground water in Alluvium occurs under water table, semi-confined and confined conditions. The dugwells are deep ranging from 25 to 50 m bgl in depth with yield varing from 120 to 200 m^3/day in winter and from 100 to 150 m^3/day in summer. In bazada aquifers yield of dugwells varies from 160 to 200 m^3/day in winter and 100 to 180 m^3/day in summer.

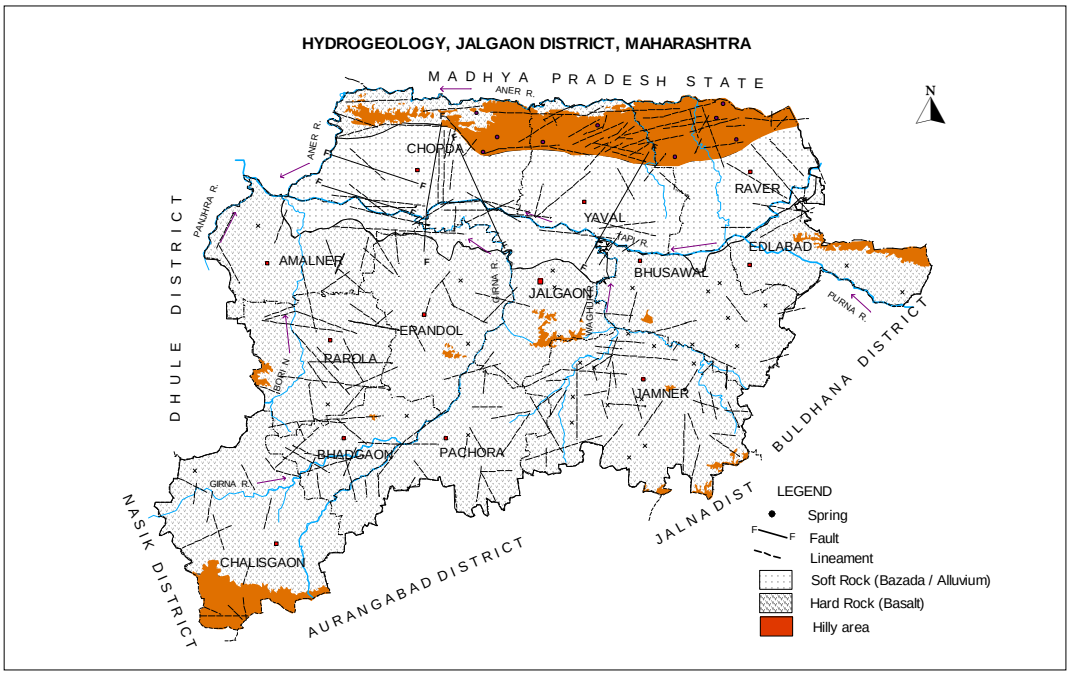

Figure 2- Hydrogeology

4.1.3 Water Level Scenario

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

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

The depth to water levels in the district during May 2007 ranges between 2.05 (Varkhedi) and 56.20 (Faizpur) m bgl. Depth to water levels during premonsoon (May 2007) has been depicted in **Figure-3**. Shallow water levels, within 5 to10 m bgl are seen in the southern and central parts of the district, i.e., Amalner, Palora, Bhadgaon, Chalisgaon, Pachora, Erandol, Jamner and South of Bhusaval taluka. Deeper water levels of more than 40 m bgl are observed in some part of Chopda, Raver, Yaval and Jalgaon talukas. The central part of Jamner taluka, northeastern and north part of the district shows water level between 10 and 20 m bgl.

4.1.4 Depth to Water Level – Postmonsoon (Nov-2007)

The depth to water levels during postmonsoon (Nov. 2007) ranges between 0.15 (Varkhedi) and 52.90 (Faizpur). Spatial variation in postmonsoon depth to water levels is shown in **Figure-4**. Shallow water levels within 5 m bgl are observed in southwestern part of the district in parts of Amalner, Palora, Pachora, north part of Chalisgaon, south part of Erandol, and west and eastern part of Jamner talukas and as a small patch in northern

Yaval taluka. Water levels are between 5 and 10 m bgl in south central parts of the Chalisgaon, Bhadgaon, Jamner, and a small strip running from Amalner-Erandol-Jalgaon-Bhusaval-Edilabad Taluka and as a small patch in northern Yaval and Raver taluka. North western, central and eastern parts of the district covering parts of Chopda, Yaval, Jalgaon, Bhusaval and Raver talukas have water levels between 10 and 20 m bgl. Deeper water levels of more than 20 m bgl are observed as isolated patches in Chopda, Yaval, Jalgaon, Bhusaval and Raver talukas. Only in southwestern part of Raver taluka around Faizpur water level observed are more than 40 m bgl.

4.1.5 Seasonal Water Level Fluctuation (May-Nov. 2007)

In major part of the district rise in water level in the range of 0.05 (Mondhale) to 12.15 m (Raver) is observed. In entire district rise in water level has been observed. Rise in water level in the range of 0 to 2 m is observed in Parola, Bhadgaon, Pachora, Chalisgaon, south central part of Jalgaon, southeastern part of Bhusaval, and Edilabd. Rise of 2 to 4 m is observed in most of the part of the district covering, Amalner, Chopda, Yaval, Raver, Jalgaon, Bhusaval, Jamner and Chalisgaon Taluka. Rise of more than 4 m is observed in isolated and scattered patches in Amalner, Chopda, Yaval, Raver, and Jamner Taluka. Fall in water level is observed as abnormally in two places i.e. Hingone and Talwade as exception.

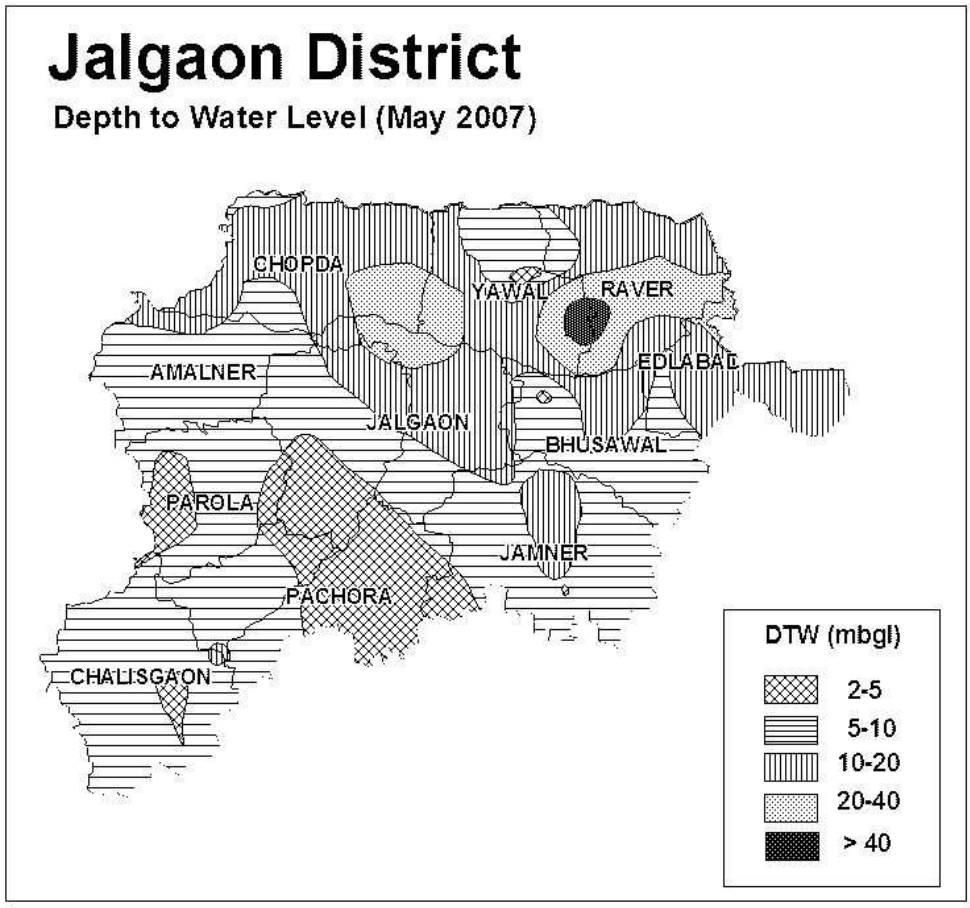

Figure 3- Depth to Water Level (Premonsoon- May 2007)

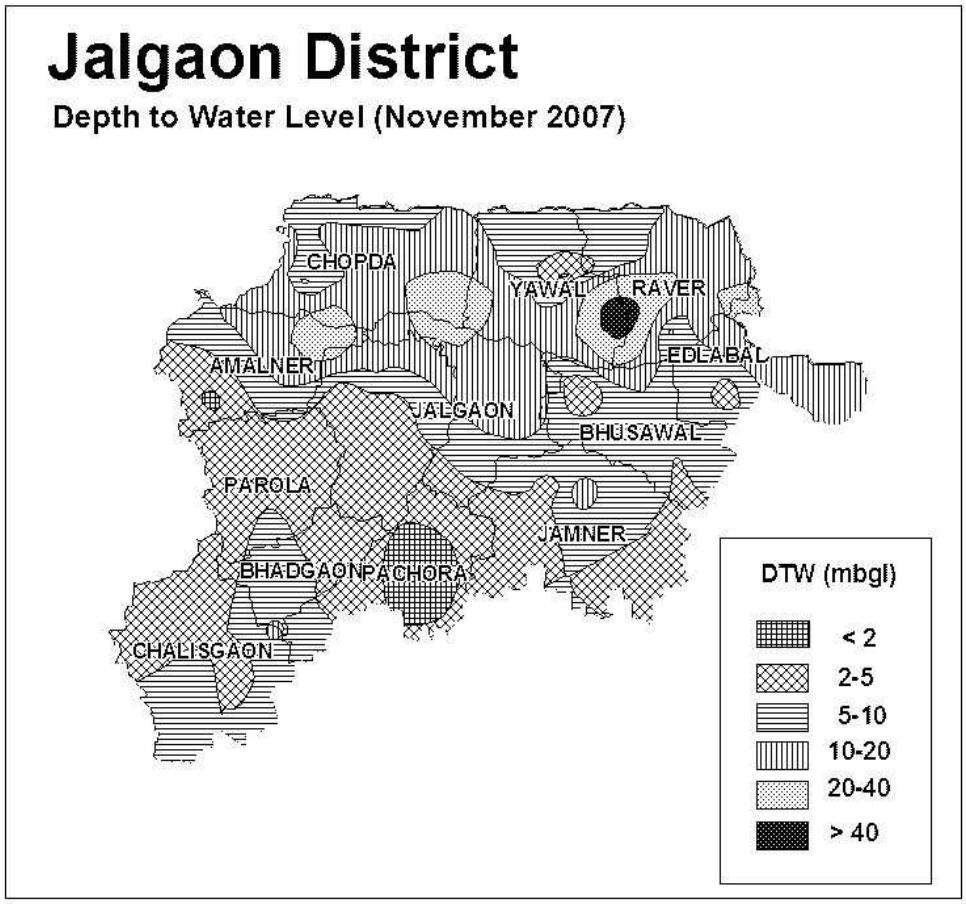

Figure 4- Depth to Water Level (Post Monsoon- Nov. 2007)

4.1.6 Water Level Trend (1998-2007)

Trend of water levels for pre-monsoon and post-monsoon periods for last ten years (1998-2007) have been computed for 44 NHNS. Analysis of trend indicates that during premonsoon period, rise in water levels has been recorded at 19 stations and it ranges between 0.008 (Bhadgaon) and 1.75 m/year (Shendurni). Fall in water levels has been observed at 19 stations and ranges between 0.005 (Nagduli) and 0.86 m/year (Abhora Bk). During postmonsoon period, rise in water levels has been recorded at 20 stations and it ranges from 0.002 (Bodwad) to 0.49 m/year (Sadwan), whereas at 19 stations, fall in water levels ranging between 0.001 (Pahur) and 1.03 m/year (Abhora Bk) is observed. Thus in major part of the district, both during pre and postmonsoon periods declining trends have been observed.

The premonsoon trend map was also prepared and the same is presented in **Figure-5**. It shows that the rise and fall in water level trend is almost equallydistributed. The rise of up to 20 cm/year is observed mainly in central north, central west and in southwestern parts of the district. The fall of up to 20 cm/year has been observed mainly in eastern and northwestern parts of the districts covering major parts of Raver, Bhusaval, Jamner, Chopda and Amalner talukas.

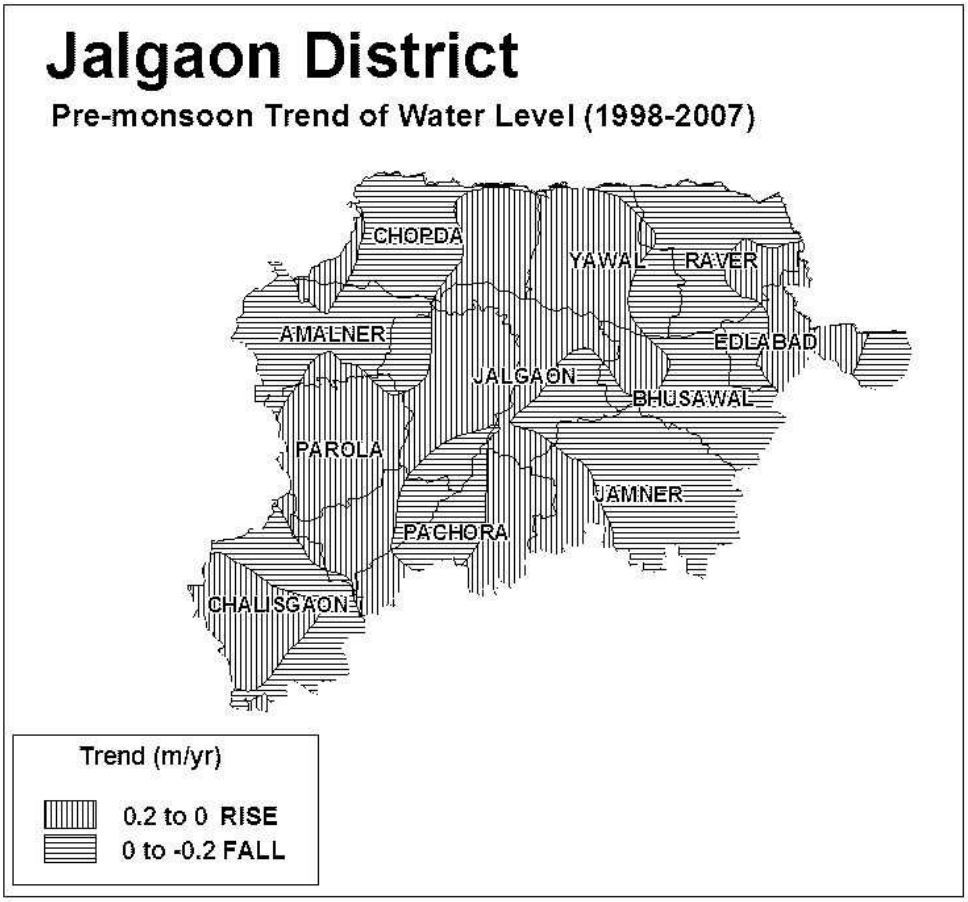

Figure 5- Water Level Trend (Premonsoon- 1998-2007)

4.1.7 Aquifer Parameters

Aquifer parameters are available from ground water exploration carried out in the alluvial area of the district. The specific capacity ranges between 0.07.and 21.6 lps/m of drawdown and the transmissivity ranges from 82.5 to 2314 m^2/day. The storativity varied from $1.6x10^{-2}$ and $1.057x10^{-4}$ while permeability varied from 0.19 and 154.62 m/day.

The results of pumping test analysis of dugwells in basalt show that the permeability and specific capacity ranges from 1.104 to 274.08 m/day and 12.14 to 1818.18 lpm/m respectively, whereas the permeability is ranging from 1.00 to 142.88 m/day.

4.2 Ground Water Resources

Central Ground Water Board and Ground Water Survey and Development Agency (GSDA) have jointly estimated the ground water resources of Jalgaon district based on GEC-97 methodology. The same are presented in **Table-4**, whereas the graphical representations of the resources on the map are shown in **Figure-6**. Ground Water Resources estimation was carried out for 11378.83 sq. km. area out of which 1635.84 sq. km. is under command and 9742.99 sq. km. is non-command.

As per the estimation the total annual ground water recharge is 1310.76

MCM with the natural discharge of 65.53 MCM, thus the net annual ground water availability comes to be 1245.22 MCM. The annual ground water draft for all uses is estimated at 862.13 MCM with irrigation sector being the major consumer having a draft of 806.17 MCM. The allocation for domestic and industrial requirement up to next 25 years is 87.18 MCM. The net ground water availability for future irrigation is estimated at 438 MCM.

Stage of ground water development varies from 40.27 % (Bhadgaon) to 133.37 % (Raver). The overall stage of ground water development for the district is 69.24 %, which is borderline high for "Semi-Critical" category. Taluka wise assessments indicate that two talukas namely Yaval and Raver fall under "Over- Exploited" category while Pachora and Chopda talukas fall under "Semi-Critical" category. Watershedwise, out of 66 watersheds, 38 watersheds fall under "Safe category" while 9 watersheds fall under "Over-Exploited" category, namely, TE-2, TE-2', TE-7, TE-15A, TE-17, TE-22, TE-25, TE-36, and TE-59. 17 watersheds fall under "Semi-Critical" category, namely, TE-1, TE-3, TE-11, TE-19A, TE-21, TE-24, TE-30, TE-37A, TE-41, TE-43, TE-48, TE-49, TE-50, TE-51, TE-60, PT-13 and PTW-1. Only two watersheds are falling under "Critical" category, namely, TE-4' and TE-18.

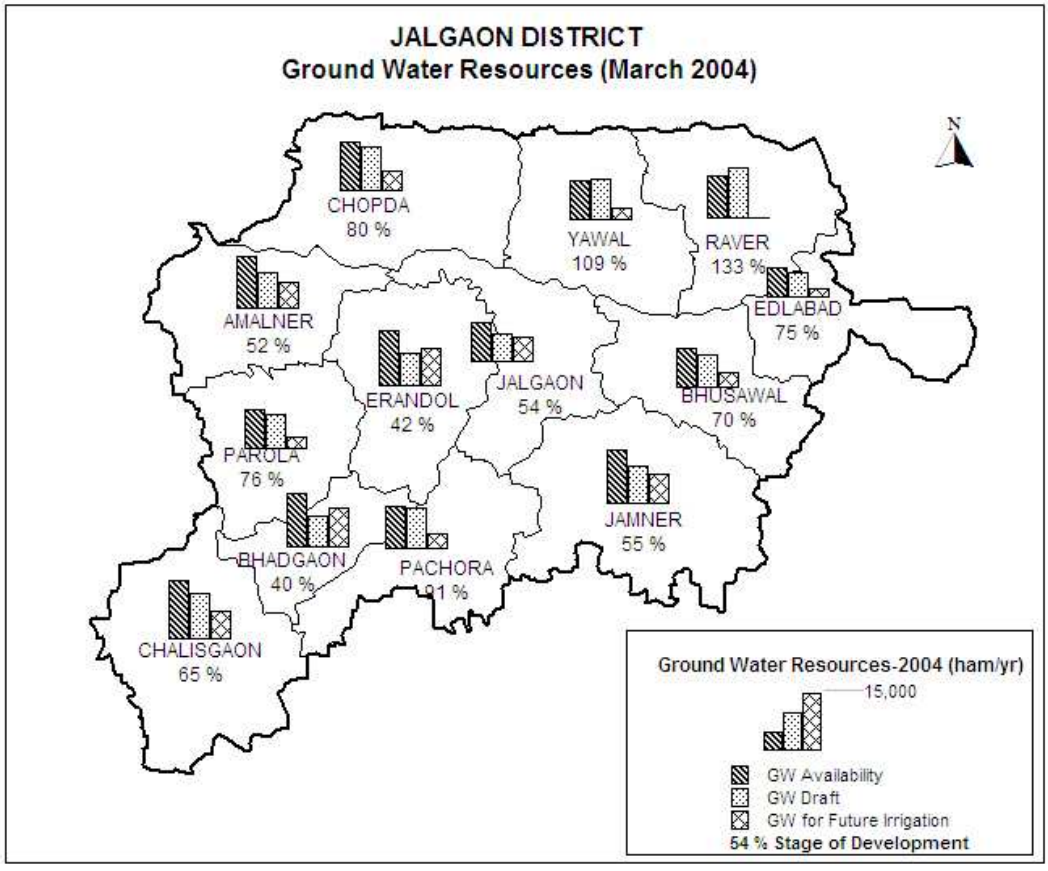

Figure 6 – Ground Water Resources (March 2004)

Table-4: Taluka wise 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.)	Groundwater availability for future irrigation (ham/yr.)	Stage of groundwater development (%)	Category
			Irrigation	Domestic & industrial uses	Total				
Jalgaon	Command	619.95	500.74	30.39	531.13	24.59	291.36	85.67	**Safe**
	Non Command	6618.86	3194.55	218.68	3413.24	437.36	2986.94	51.57	
	Total	**7238.82**	**3695.29**	**249.07**	**3944.37**	**461.95**	**3278.30**	**54.49**	
Yawal	Command	1067.21	2125.48	34.86	2160.34	21.23	149.83	202.43	**Over-Exploited**
	Non Command	5957.45	5409.00	152.47	5561.47	112.51	962.59	93.35	
	Total	**7024.66**	**7534.47**	**187.33**	**7721.80**	**133.74**	**1112.42**	**109.92**	
Raver	Command	1218.05	3352.46	43.28	3395.74	0.00	0.00	278.78	**Over-Exploited**
	Non Command	7218.07	7656.09	199.54	7855.63	141.64	706.39	108.83	
	Total	**8436.12**	**11008.55**	**242.82**	**11251.37**	**141.64**	**706.39**	**133.37**	
Muktainagar	Command	80.75	116.95	6.59	123.54	0.00	0.00	152.99	**Safe**
	Non Command	4303.92	2863.45	339.71	3203.16	676.05	764.42	74.42	
	Total	**4384.67**	**2980.40**	**346.29**	**3326.70**	**676.05**	**764.42**	**75.87**	
Bhusawal	Command	218.63	260.85	13.36	274.21	7.32	23.60	125.42	**Safe**
	Non Command	7149.46	4407.04	537.27	4944.31	954.19	1788.23	69.16	
	Total	**7368.09**	**4667.89**	**550.63**	**5218.52**	**961.51**	**1811.83**	**70.83**	
Chalisgaon	Command	3653.99	3218.03	133.03	3351.06	121.96	1073.44	91.71	**Safe**
	Non Command	10685.29	5745.11	328.11	6073.21	595.85	4504.69	56.84	
	Total	**14339.28**	**8963.13**	**461.14**	**9424.28**	**717.81**	**5578.13**	**65.72**	
Pachora	Command	2042.58	1650.90	76.20	1727.10	80.65	593.73	84.55	**Semi-Critical**
	Non Command	6365.75	5581.56	362.03	5943.58	365.37	1289.67	93.37	
	Total	**8408.34**	**7232.46**	**438.22**	**7670.68**	**446.02**	**1883.40**	**91.23**	
Jamner	Command	777.69	820.47	115.11	935.58	83.93	46.17	120.30	**Safe**
	Non Command	11621.61	5251.35	677.20	5928.55	1156.02	5297.02	51.01	
	Total	**12399.30**	**6071.82**	**792.30**	**6864.13**	**1239.95**	**5343.19**	**55.36**	
Bhadgaon	Command	10639.83	3817.67	173.45	3991.12	346.89	6475.26	37.51	**Safe**
	Non Command	1855.31	1000.79	39.46	1040.25	17.05	957.33	56.07	
	Total	**12495.14**	**4818.47**	**212.91**	**5031.37**	**363.94**	**7432.59**	**40.27**	

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.)	Groundwater availability for future irrigation (ham/yr.)	Stage of groundwater development (%)	Category
			Irrigation	Domestic & industrial uses	Total				
Amalner	Command	3592.33	898.07	118.08	1016.15	196.66	2500.86	28.29	**Safe**
	Non Command	8010.63	4509.41	588.97	5098.38	1177.94	2323.27	63.65	
	Total	**11602.95**	**5407.48**	**707.05**	**6114.53**	1374.60	4824.13	**52.70**	
Parola	Command	2287.25	1549.20	261.68	1810.88	296.85	463.00	79.17	**Safe**
	Non Command	5133.78	3565.18	292.42	3857.60	464.54	1141.16	75.14	
	Total	**7421.04**	**5114.38**	**554.10**	**5668.48**	761.39	1604.16	**76.38**	
Chopda	Command	5256.63	4142.76	131.94	4274.70	222.16	905.06	81.32	**Semi-Critical**
	Non Command	5397.97	4074.97	199.01	4273.97	328.46	1590.88	79.18	
	Total	**10654.60**	**8217.72**	**330.95**	**8548.67**	550.62	2495.94	**80.23**	
Erandol	Command	7102.46	2510.06	241.89	2751.95	458.82	4144.92	38.75	**Safe**
	Non Command	5646.87	2395.72	280.91	2676.63	430.39	2820.76	47.40	
	Total	**12749.34**	**4905.78**	**522.81**	**5428.59**	889.21	6965.68	**42.58**	
District Total	**Command**	**38557.36**	**24963.64**	**1379.86**	**26343.50**	**1861.06**	**16667.23**	**68.32**	
	Non Command	**85964.97**	**55654.22**	**4215.77**	**59869.99**	**6857.37**	**27133.35**	**69.64**	
	Total	**124522.33**	**80617.86**	**5595.63**	**86213.49**	**8718.43**	**43800.58**	**69.24**	

4.3 Ground Water Quality

In the district, 30 water samples were collected during May 2007. The samples were broadly classified into four classes as given in **Table-5**.

Table-5: Geochemical Classification of Ground Water Samples.

S. No.	Classification	Type	No. of Samples	% of Samples
1	Alkaline earths (Ca+Mg > 50%) exceeds alkali metals and weak acids (CO_3+HCO_3 > 50%) exceeds strong acids	Ca-HCO_3	14	47
2	Alkali metal (Na+K > 50%) exceeds alkaline earths and weak acids (CO_3+HCO_3 > 50%) exceeds strong acids.	Na-HCO_3	1	3
3	Alkaline earths (Ca+Mg > 50%) exceeds alkali metals and strong acids (Cl+SO_4+NO_3 > 50%) exceeds weak acids	Ca-Cl	14	47
4	Alkali metal (Na+K > 50%) exceeds alkaline earths and strong acids (Cl+SO_4+NO_3 > 50%) exceeds weak acids	Na-Cl	1	3
	Total		**30**	**100**

In Alluvium aquifer, it was found that the water is mainly of of Ca-HCO_3 type with only one sample showing Ca-Cl and Na-Cl type of ground water. As majority of the samples are from Basaltic aquifer, the type of water present in these samples should be of Ca-HCO_3 type. But the classification shows that 47% samples are having Ca-Cl type of water and same percentage are of Ca- HCO_3 type indicating that the type of water in these samples have been changed from Ca-HCO_3 type to Ca-Cl type. This may be because of percolation of waste and wastewater containing high concentration of strong acid ions (Cl+NO_3+SO_4) to ground water.

4.3.1 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, SO_4 and NO_3 prescribed in the standards and is given in **Table-6**.

The perusal of **Table-6** shows that concentration of TDS, TH, Ca, Mg, Cl, SO_4 NO_3 is above MPL at Sadavan Bk. Apart form this, high TH and Mg concentration is observed at Jamner, Chalisgaon, Dharangaon, Nasirabad, Kasoda and Varkhedi. The concentration of nitrate is found beyond MPL at 18 locations viz., Raver, Sadawan Bk, Pimpalkhuta, Mendholda, Narvel, Nagalwadi, Bodar, Varkhedi, Wakdi, Parsodi, Kasoda, Shendurni, Dharangaon, Nasirabad, Mahunbare, Bodwad, Chalisgaon, Jamner. Fluoride contamination of ground

water is observed at two places, i.e., Mondhale (2.24 mg/L) and Hingone (2.00 mg/L).

Table-6 Classification of Ground Water Samples for Drinking based on BIS Drinking Water Standards (IS-10500-91, Revised 2003)

Parameters	DL	MPL	Samples with conc. < DL	Samples with conc. in DL-MPL	Samples with conc. >MPL
TDS (mg/L)	500	2000	13	16	1
TH (mg/L)	300	600	12	11	7
Ca(mg/L)	75	200	22	5	3
Mg(mg/L)	30	100	1	22	7
Cl (mg/L)	250	1000	24	5	1
SO_4 (mg/L)	200	400	28	1	1
NO_3 (mg/L)	45	No relaxation	12	--	18
F (mg/L)	1.0	1.5	28	0	2

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

Therefore, it can be concluded that the ground water quality in above said areas is not suitable for drinking purpose. The ground water, in general, is potable with few exceptions and the potability of ground water is mainly affected due to NO_3.

4.3.2 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.

4.3.2.1 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.

4.3.2.2 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 in **Table-7**.

Table-7 Classification of Ground water for Irrigation based on SAR and RSC.

SAR	**<10**		**10-18**		**18-26**		**>26**	
Category	**Good**		**Good to**		**Doubtful**		**Unsuitable**	
Total Samples	No. of Samples	%	No. of Samples	%	No. of Samples	%	No. of Samples	%
30	29	97	1	3	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		%	
30	28	94	--	--	2		6	

The **Table-7** shows that out of 30 samples, 29 samples are having SAR values below 10 indicating that the possibility of sodium hazard is low if the water is used for irrigation purpose. The ground water sample collected from well located at Chopda is having SAR value in the range of 10 to 18 and is under the permissible category. The RSC values of 2 samples collected from the well located at Mondhale and Hingone was above 2.5 and the water in these wells is unsuitable for irrigation purpose. All the remaining samples were having RSC values less than 1.25.

Overall, the ground water quality in the wells monitored is good for irrigation purpose and there is a less possibility of developing sodium hazard.

4.4 Status of Ground Water Development

The yields of wells are functions of the permeability and transmissivity of aquifer encountered and vary with location, diameter and depth etc. There are three type of ground water structures i.e. dugwells, borewells and tubewells in the area. Their yield characteristics are described below.

Dugwells are generally used for both domestic water requirements and for irrigation purposes in this area. The depth of large diameter dugwells in Basaltic areas of the district ranges from 5 to 15 m. The reported yield of dugwells in Basalt for irrigation purposes varies from 21 to 337 m^3/day. Unit draft of dugwell in Basaltic areas is estimated to be around 1 ham / year. In Alluvial area, the dugwells are deep ranging from 25 to 50 m bgl in depth with yield varying from 120 to 200 m^3/day in winter and from 100 to 150 m^3/day in summer. In Bazada yield of dugwells varies from 160 to 200 m^3/day in winter and 100 to 180 m^3/day in summer. Unit draft of dugwell in Alluvial areas is estimated to be around 2.5 ham / year while Unit draft of dugwell in Bazada areas is estimated to be around 3.5 ham / year. The dugwells occurring in Yaval and Raver talukas are deeper than those of Chopda Taluka.

Many hot springs occur in Tapi basin along the foothills of Satpura Mountains. It is observed that hot springs of higher temperature occur near the junction of faults. The computed base temperature of these hot springs range upto 120 ^{o} C $\pm$ 10^{o} C.

Ground water is predominantly used for irrigation, as it is the major ground water utilising sector. As per the data available for year 1996-97, area irrigated by ground water is 889.61 sq. km., whereas the surface water accounts for only 7.23

sq.km with net irrigable area of 896.84 sq.km. The recent data (2000-01) indicates more than 100% increase in all figures with area irrigated by ground water increasing to 1821.59 sq.km., whereas surface water accounts for 293.04 sq.km. of area and net irrigated area stands at 2135.7 sq.km. Thus it is clear that ground water is the major source for irrigation purposes as it accounts for about 85.30 % of net irrigated area. As per 2000-01 data the district there are about 90398 dugwells in the district which create an irrigation potential of 2214.17 sq.km., out of which 2060.50 sq.km. of irrigation potential is utilised. In addition to this 185.66 sq.km of irrigation potential is utilised through 7505 borewells/tubewells.

State government has drilled large number of borewells and tubewells fitted with hand pumps and electric motors for rural drinking water purposes in the district. In all GSDA, Government of Maharashtra has drilled 1346 tubewells/borewells under various schemes for rural water supply in the district upto march 2006; of which 1263 are fitted with hand pump and 83 are fitted with power pump. The discharge of successful borewells ranged from 1 to 5 lps and yield ranged form 1.8 to 52 m^3/hour. Maximum high yielding borewells are encountered in Amalner taluka as 35%. The ground water development in the district is mostly through dugwells.

5.0 Ground Water Management Strategy

Ground water has special significance for agricultural development in the State of Maharashtra. The ground water development in some parts of the State has reached a critical stage resulting in decline in ground water levels. There is thus 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

Further ground water development in bazada zone is feasible at those sites wherever additional recharge from percolation tanks all along the foothills of Satpuda takes place. The ground water exploration may be taken up in this zone by percussion rigs keeping in view the Bouldary nature of this formation. Further ground water development in Tapi alluvial plains is not feasible, keeping in view the overall interest of future generation. Ground water augmentation in this area should be undertaken on large scale through people's participation by utilizing the surplus water, available in Hatnur canal and cooperative lift schemes operating in the area, using existing dugwells.

In parts of Amalner, Jalgaon, Bhusawal, Edilabad, Jamner, Erandol and Pachora talukas, the water levels are declining @ up to 20 cm/year. The aquifers are poor to moderately yielding having low storage capacity. Therefore, ground water development should be permitted very carefully in scarcity areas only. Yaval and Raver talukas and 9 watersheds falling under "Over- Exploited" category, whereas Chopda and Pachora talukas and 17 watersheds falling under "Semi-Critical" and two watersheds falling under "Critical" category are not recommended for any further ground water development except for drinking purpose.

In parts of Chalisgaon, Parola and Bhadgaon talukas it was observed that

the depth to water level has rising trend @ 0-20 cm/year during postmonsoon. These areas have shallow water levels and being hard rock areas, overall ground water availability is poor. The sites for further ground water development in these areas may be identified by applying proper scientific methods.

5.2 Water Conservation and Artificial Recharge

CCT, nala bunding, gabion structures, vegetative bunds, terracing etc., are the feasible water conservation structures in the Satpura hill range. In the Basaltic area, the water conservation and artificial recharge structures feasible are check dams, gully plugs, percolation tanks, nala bunds, etc. 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. The most feasible artificial recharge structure suitable for Alluvial areas, are shallow recharge wells/shafts on the river bed of the tributaries. 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.

Two artificial recharge schemes were taken up in the district in watershed TE-17 under VIIth 5 year plan and in watershed TE-11 under IXth 5 year plan as pilot projects under Central Sector Scheme.

The watershed TE-17 covers an area of about 235 sq.kms and is located in Yaval taluka. A total of 10 recharge structures have been constructed, which include 6 percolation tanks, 2 recharge shafts, 1 injection well and 1 dugwell recharge. The impact assessment studies indicated that 856 x 10^3 cubic meter of rain water was stored in 6 percolation tanks of the scheme and tanks were utilized at its maximum storage capacity. The recharge to ground water was more than 90% and evaporation losses were less than 10%. The percolation rate was 81-500 mm/day with rise of water level witnessed upto 5 meters. Total 120 dug wells were benefited and beneficiaries were mostly tribal villages over a land of around 1000 ha. Recharge shafts recharged 23.6 x 10^3 cubic meter. Total 5.9 ha of land of local farmers was benefited and rise of water level upto 12 meter in the mother wells was observed. Injection well recharge was 3.767 x 10^3 cubic meter and 1 ha of land was benefited with a water level rise of 1.25 m. Dug well experiment was very encouraging. A total 6.58 x 10^3 cubic meter of water was recharged at the rate of 60,000 – 70,000 litres per hour. A rise of 9.9 m was observed in the mother well, benefiting around 3 ha of additional land.

In watershed TE-11 scheme was taken up in IXth plan. The project was started in year 1998-99 and completed in 2001-02. The watershed TE-11 in Yaval taluka of Jalgaon district covering 28 villages has an area of 371 Sq.kms and falls in Tapi river basin. A total of 10 recharge structures have been constructed, which included 5 percolation tanks and 5 recharge shafts. The impact assessment studies indicated that 8.236 sq. km catchment was brought under rainwater harvesting. Catchment area of tanks varied from 0.425 to 4.2273 sq. km. The storage of 285.89 x 10^3 cubic meter of rainwater was created in the area. The recharge to ground water due to 5 percolation tanks was 211.19 x 10^3 cubic meter in spite of very low rainfall of 432.3 mm in 2001-02 against average rainfall of 674 mm. A rise of 2-10 meter water level in 30-50 ha of benefited area was observed. The beneficiaries of the schemes were mostly small and marginal

land holders dominated by local tribal population on the foot hills of the Satpura Hills. Five Recharge Shafts constructed at Wadri village in the watershed TE-11 were monitored and the impact of these was very encouraging. More than 30 wells over an area of 50 ha were benefited by a rise of up to 10 m in the water levels. Around 10.50 x 10^3 cubic metre of recharge was effected in one year in the area benefiting local farmers.

Earlier studies have shown that the 17 urban towns of Jalgaon district have total roof area of 7.85 sq. km. and are estimated to receive 5.42 MCM of rain during monsoon and 0.36 MCM during non-monsoon. Jalgaon city itself consists of 2.25 sq. km. roof area and 1.55 MCM rainwater is estimated to be available for harvesting during monsoon and 0.10 MCM during non-monsoon. Other 9 towns of the districts namely, Chopda, Yaval, Raver, Amalner, Edilabad, Bhusaval, Jamner, Chalisgaon and Bhadgaon may also have feasibility of rainwater harvesting for ground water augmentation. The existing dugwells, borewells or tubewells may also be used for recharging the ground water with proper filter media.

6.0 Ground Water Related Issues and Problems

Northern part of the district is underlain by Tapi Alluvium. Only upper 70-80 m of younger Alluvium having 2 to 5 layers of granular zones of sand and gravel ranging in thickness from 2 to 20 m, forms the potential aquifer. At deeper levels the older Alluvium is mostly clayey and does not form potential aquifer. The ground water levels are quite deep as the ground water is being withdrawn heavily for the banana cultivation. The regional water level is also declining. In addition to this, in major part of the district, declining water level trends have been observed both during pre and postmonsoon periods.

Ground water quality is adversely affected at many places due to high concentration of nitrate. Adequate sanitary protection to the wells may be provided to control the nitrate contamination. Likewise fluoride contamination of ground water is also observed at two places, i.e., Mondhale (2.24 mg/L) and Hingone (2.00 mg/L). Thus, in this area, all the wells used for water supply should be first analysed for fluoride and nitrate concentration.

7.0 Mass Awareness and Training Activities

7.1 M.A.P. and W.M.T.P.

Till March 2007, one Mass Awareness Programmes (MAP) have been organised in the district at Yaval whereas WMTP (Water Management Training Programme) is yet to be organised. The details are given in **Table-8**.

Table-8: Status of MAP

S. No.	Year	Programme	Venue	Date	No. of Persons Attended
1	2001-02	MAP	Yaval	16/02/2000	300

7.2 Participation in Exhibition, Mela, Fair etc.

During the MAP at Jalgaon, an exhibition depicting rainwater harvesting model, various ground water related posters, leaflets, literature and technical reports were displayed along with maps of Jalgaon district. The models, maps,

posters were explained to the visitors in details.

8.0 Areas Notified by CGWA/SGWA

The increase in area under banana cultivation has put undue pressure on the ground water resources due to withdrawal for irrigation purposes resulting in declining trends of ground water levels in Raver and Yaval talukas. Due to which the stage of ground water development reached up to 133.37 % and 109.92 % in Raver and Yaval taluka respectively. There is no ground water resources left for future domestic, industrial and irrigation purpose and both the talukas are categorized as “Over-Exploited”. Due to the over development of ground water resources, Raver and Yaval talukas of Jalgaon district were notified by Central Ground Water Authority (CGWA) vide Office Memorandum No. 28-2/CGWA/06-413 dated 16th March 2006 issued by Administrator, CGWA. A public notice dated 13th March 2006 was also published in the leading local and National newspapers regarding the ‘Declaration of “Over-Exploited Areas” for registration of ground water abstraction structures’. However the registration of ground water abstraction structures has been discontinued with effect from

9.0 Recommendations

1 Further ground water development in Bazada zone is feasible at those sites wher additional recharge from percolation tanks all along the foothills of Satpura takes place. Further ground water development in Tapi alluvial plains is not feasible, keeping in view the overall ground water availability scenario.

2 The ground water exploration in Bazada may be taken up in this zone by percussion rigs keeping in view the Bouldary nature of this formation.

3 Northern part of the district is underlain by Tapi Alluvium, which is about 450 m thick. However, upper 70-80 m of Alluvium, i.e., younger Alluvium comprises sand and gravel forming potential aquifer. The ground water in the Alluvium can be developed through dugwells and shallow tubewells.

4 Southern part of the district is occupied by Deccan Trap Basalt, where only dugwells are most feasible structures for ground water development. The sites for borewells need to be selected only after proper scientific investigation.

5 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.

6 In parts of Amalner, Jalgaon, Bhusawal, Edilabad, Jamner, Erandol, and Pachora talukas the water levels are declining @ up to 20 cm/year. The aquifers are poor to moderately yielding with low storage capacity. Therefore, ground water development should be permitted very carefully in scarcity areas only.

7 The overall stage of ground water development for the district is about 69.24%, which is borderline high for “Semi-Critical” category. Therefore, proper planning should be done for further development of ground water resources.

8 Yaval and Raver taluka fall under “Over- Exploited” category and Pachora

and Chopda taluka fall in “Semi Critical” category. Likewise, 8 watersheds fall under “Over- Exploited” category, namely, TE-7, TE-15A, TE-17, TE-22, TE-25, TE-36, and TE-59 and two watersheds are falling under “Critical” category, namely, TE-4 and TE-18. Therefore, further ground water development is not recommended in these talukas and watersheds except for drinking purpose.

9 Deeper water level areas have been observed in parts of Yaval, Raver and Chopda talukas, which are also categorised as “Over-Exploited” and “Semi-Critical” talukas. Thus future water conservation and artificial recharge structures needs to be prioritised in these parts as well as in the “Over-Exploited” and “Semi-Critical” watersheds of the district.

10 The scope exists for construction of suitable artificial recharge structures in the district. CCT, nala bunding, gabion structures, vegetative bunds, terracing etc and construction of minor and medium irrigation projects with lined or pipe canals may be feasible in the Satpuda hill range. The structures recommended for Basaltic areas are nala bunds, check dams and KT weirs. The existing dugwells may also be used for artificial recharge of ground water provided source water is free of silt and dissolved impurities.

11 In the Alluvial area of the district, percolation tanks and recharge wells/shafts are suggested. The most feasible artificial recharge structure suitable in such areas, are recharge wells/shafts on the river bed of the tributaries.

12 Jalgaon district has 17 urban towns, which have total roof area of 7.85 sq. km. and are estimated to receive 5.42 MCM of rainwater during monsoon and 0.36 MCM during non-monsoon. Jalgaon city itself consists of 2.25 sq. km. roof area and 1.55 MCM rainwater is estimated to be available for harvesting during monsoon and 0.10 MCM during non-monsoon. This huge amount of rainwater may be used for recharging the ground water by using the existing dugwells, borewells or tubewells with proper filter media.

13 The existing village ponds need to be rejuvenated to act both as water conservation and artificial recharge structures.

14 Ground water quality is adversely affected at many places due to high concentration of nitrate. Adequate sanitary protection to the wells may be provided to control the nitrate contamination. Likewise fluoride contamination of ground water is observed at two places, i.e., Mondhale (2.24 mg/L) and Hingone (2.00 mg/L). Thus, in this area, all the wells used for water supply should be first analysed for fluoride and nitrate concentration.