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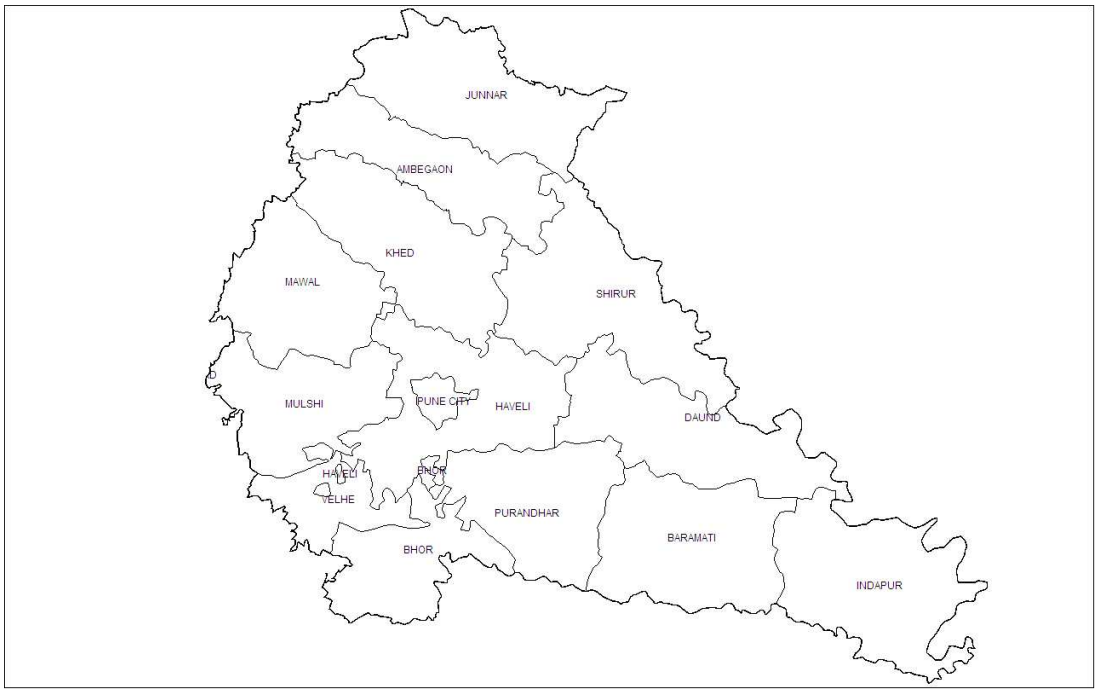
भारत सरकार
जल संसाधन मंत्रालय
केंद्रीय भूजल बोर्ड

GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

महाराष्ट्र राज्य के अंर्तगत पुना जिले की भूजल विज्ञान जानकारी

GROUND WATER INFORMATION
PUNE DISTRICT
MAHARASHTRA



By

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Scientist-D

द्वारा

डा. प्रभात कुमार जैन

वैज्ञानिक- घ

मध्यवर्ती क्षेत्र
नागपुर
CENTRAL REGION
NAGPUR
2009

PUNE DISTRICT AT A GLANCE

1. GENERAL INFORMATION

Geographical Area	:	15642 sq. km
Administrative Divisions (As on 31/03/2007)		Taluka – 14; Baramati, Haveli, Indapur Ambegaon, Shirur, Khed, Purandhar Daund, Junnar, Maval, Mulshi, Velhe Bhor and Pune City.
Villages	:	1866
Population	:	72,33,000
Normal Annual Rainfall	:	468 mm to 4659 mm

2. GEOMORPHOLOGY

Major Physiographic unit	:	4; Western Ghats, Foothills, Central Plateau and Eastern Plains
Major Drainage	:	3 ; Bhima-Ghod, Mula-Mutha and Nira

3. LAND USE (2000-01)

Forest Area	:	1720sq. km.
Net Area Sown	:	7925 sq. km.
Cultivable Area	:	9798 sq. km.

4. SOIL TYPE : 2; Medium Black and Deep Black soil.

5. PRINCIPAL CROPS (2000-01)

Jowar	:	4158 sq. km.
Bajra	:	1603 sq. km.
Cereals	:	940 sq. km.
Oil Seeds	:	843 sq. km.
Sugar Cane	:	595 sq. km.

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

Dugwells	:	108997 / 314738
Tubewells/Borewells	:	5077 / 12314
Tanks	:	5122 / 13367
Other Minor Surface Sources	:	4661 / 11436
Net Irrigated Area	:	218677 ha

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

Dugwells	:	43
Piezometers	:	6

8. GEOLOGY

Recent	:	Alluvium
Upper Cretaceous-Lower Eocene	:	Deccan Trap Basalt

9. HYDROGEOLOGY

Water Bearing Formation	:	Basalt – Weathered / fractured / jointed vesicular / massive, under phreatic condition.
Premonsoon Depth to Water Level (May-2007)	:	0.20 to 12.30 m bgl
Postmonsoon Depth to Water Level (Nov.-2007)	:	1.00 to 15.60 m bgl
Premonsoon Water Level Trend (1998-2007)	:	Rise : Negligible to 0.97 m/year Fall : Negligible to 0.48 m/year
Postmonsoon Water Level Trend (1998-2007)	:	Rise : Negligible to 0.41 m/year Fall: Negligible to 0.44 m/year

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

Wells Drilled	:	EW-71, OW-33
Depth Range	:	25.50 to 201.30 m bgl
Discharge	:	Traces to 30.62 lps

11. GROUND WATER QUALITY

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

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

Net Annual Ground Water Availability	:	1442.87 MCM
Annual Ground Water Draft (Irrigation + Domestic)	:	1015.35 MCM
Allocation for Domestic and Industrial requirement up to next 25 years	:	43.34 MCM
Stage of Ground Water Development	:	70.37%

13. AWARENESS AND TRAINING ACTIVITY

Mass Awareness Programme	:	Nil
Water Management Training Programme	:	1
Date	:	19/11/03 to 21/11/03
Place	:	Department of Geology, Pune University, Pune.

14. GROUND WATER CONTROL AND REGULATION

Over-Exploited Taluka	:	None
Critical Taluka	:	None
Semi – Critical Taluka	:	4, Baramati, Ambegaon, Purandhar and Junnar
Notified Taluka	:	None

15. MAJOR GROUND WATER PROBLEMS AND ISSUES

Parts of Pune district fall under rain shadow zone of Maharashtra State. It is seen from long term rainfall data that the eastern, southern, south eastern, central and north western parts around Indapur, Baramati, Jujuri, Daund, Talegaon, Dhamdhare, Alandi, Shirur and Bhor covering around 50% area of the district are classified as drought areas. The premonsoon water level trend shows fall in water level up to 20 cm/year in major parts of the district, occupying north, central, western and southern parts of the district in entire Purandhar, Bhor, Haveli, Mulshi, Maval, Ambegaon and parts of Junnar, Khed, Shirur, Daund, Baramati and Indapur talukas. Similarly as per current assessment of ground water resources it is also seen that the ground water development in Baramati, Ambegaon, Purandhar and Junnar talukas have already reached up to 100% and these talukas fall under “Semi-Critical” category. The ground water quality is mainly affected by localized nitrate contamination as 35% of samples are having high nitrate concentration.

Ground Water Information
Pune District

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Pune District

1.0 Introduction

Pune is the second largest district of Maharashtra State in respect of area. The district has a geographical area of 15642 sq.km., which is 5.08% of the total area of State. It is situated in the western part of the State and lies between north latitude 17°54' and 19°24' and east longitudes 73°2 9' and 75°10' and falls in parts of Survey of India degree sheets 47-E, 47-F, 47-I, 47-J, 47-K, 47-N and 47-O. It is bounded by Ahmadnagar district in the north and east. Satara and Solapur districts in south and south east respectively and Thane and Raigarh districts in north west and west respectively. For administrative convenience it is divided in 14 talukas namely Pune City, Haveli, Khed, Ambegaon, Junnar, Shirur, Daund, Indapur, Baramati, Purandhar, Bhor, Velhe, Mulsi and Maval. The population of the district is 72,33,000 as per 2001 census with density of 462 persons/sq.km. There are 25 towns and 1866 villages in the district, out of which 18 villages one not habited. The district has 14 Panchayat Samitis, 11 Nagar Parishads, 1 Municipal Corporation and 1401 Gram Panchayats.

As per land use details (2000 – 01) the district has an area of 1720 sq.km occupied by forest. The gross cultivable area of district is 9978 sq.km whereas net sown area is 7925 sq.km.

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

Table 1: Studies undertaken by CGWB.

S. No.	Officer	AAP	Type of Survey / Study
1.	V. V. Sable	1964 – 65	Systematic Hydrogeological Surveys in parts of Pune district.
2.	V. V. S. Mani	1966 – 67	Systematic Hydrogeological Surveys in parts of Pune and Ahmadnagar districts.
3.	J. P. Dias	1969 – 70 1970 – 71 1971 – 72 1973 – 74 1974 – 75 1975 – 76	Systematic Hydrogeological Surveys in parts of Pune district.
4.	S. S. Rao	1977 – 78	Systematic Hydrogeological Surveys in parts of Pune district.
5.	S. V. Chougala	1982 – 83	Systematic Hydrogeological Surveys in parts of Pune district.
6.	D. K. Rai	1982 – 83	Systematic Hydrogeological Surveys in parts of Pune district.
7.	P. K. Jain	1989 – 90	Systematic Hydrogeological Surveys in parts of Pune district.
8.	S. N. Ramaih	1989 – 90	Systematic Hydrogeological Surveys in parts of Pune district.
9.	S.K. Bhatnagar	1991-92	Reappraisal Hydrogeological Studies in parts of Pune district.

10.	S.K. Verma	1991-92	Reappraisal Hydrogeological Studies in parts of Pune district.
11.	V.M. Halyal	1994-95	Reappraisal Hydrogeological Studies in parts of Pune district.
12.	D. Saha	1994-95	Reappraisal Hydrogeological Studies in parts of Pune district.
13.	A.B. Kawade	2004-05	Reappraisal Hydrogeological Studies in parts of Pune district.

In addition to the above a report on "Ground Water Resources and Development Potential of Pune District, Maharashtra" was compiled during year 1993 by Shri D. B. Shetye, Scientist- C. Ground water exploration in the district has been taken up since 1994 and total of 71 Exploratory Wells (EW) and 33 Observation Wells (OW) have been drilled. The taluka wise salient features of ground water exploration are given in **Table-2**.

Table–2: Salient Features of Ground Water Exploration.

S. No.	**Taluka**	**Wells Drilled**	**Drilled Depth (m bgl)**	**Zones (m bgl)**	**Discharge (lps)**	**SWL (m bgl)**
1	Shirur	5 EW 1 OW	171.10 to 200.50	6.40 to 13.00 161.00 to 171.00	Traces to 3.40	1.80 to 2.87
2	Daund	4 EW 3 OW	103.80 to 180.00	5.00 to 178.00	Traces to 12.18	3.41 to 19.00
3	Indapur	4 EW	200.00	5.00 to 10.00	Traces to 0.56	1.87 to 2.05
4	Ambegaon	5 EW	195.30 to 200.00	9.00 to 15.00 184.50	Traces to 1.05	7.95 to 14.15
5	Junnar	5 EW 2 OW	43.00 to 200.00	6.00 to 10.00 180.00 to 189.00	Traces to 10.45	2.50 to 6.00
6	Khed	4 EW 2 OW	115.90 to 200.00	15 to 24.00 161 to 167.00	Traces to 4.07	5.00 to 103.00
7	Purandhar	8 EW	73.20 to 200.00	18.00 137 to 152.00	Traces to 2.34	1.50 to 50.00
8	Baramati	3 EW 3 OW	24.50 to 200.00	9.20 to 15.30 167 to 174.00	Traces to 8.24	2.19 to 30.00
9	Haveli	20 EW 12 OW	31.50 to 201.30	4.50 to 158.00	Traces to 12.88	2.54 to 22.52
10	Mulshi	3 EW 4 OW	75.00 to 200.00	6.50 to 66.00	Traces to 30.68	2.95 to 8.90
11	Bhor	6 EW 4 OW	60.00 to 200.00	2.50 to 83.00	Traces to 8.25	5.85 to 30.00
12	Velhe	2 EW 2 OW	30.00 to 200.00	8.00 to 84.00	Traces to 1.50	3.80 to 50.00
13	Maval	4 EW	180.00 to 200.00	14.00 to 103.00	Traces to 3.00	4.30 to 50.00
14	**Total**	**EW-71 OW-34**	**24.50 to 201.30**	**2.50 to 184.50**	**Traces to 30.62**	**1.50 to 103.00**

It is observed from Table–2 that 71 EW and 33 OW were drilled in Deccan Trap basaltic area of the district. These wells are ranging in depth from 24.50

meters below ground level (m bgl) to 201.30 m bgl and the zones have been encountered in the depth range of 2.50 m bgl to 184.5 m bgl. The discharge of these wells varies from < 0.14 lps to 30.62 liters per second (lps) and static water level varies from 1.50 m bgl to 103.00 m bgl. The deeper zones below 50 m bgl have also been encountered in the district with the deepest zone being encountered at 184.50 m bgl. The discharge of the wells show wide variation and it varies from traces to 30.62 lps (Lavle) a seen from CGWB exploration data.

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

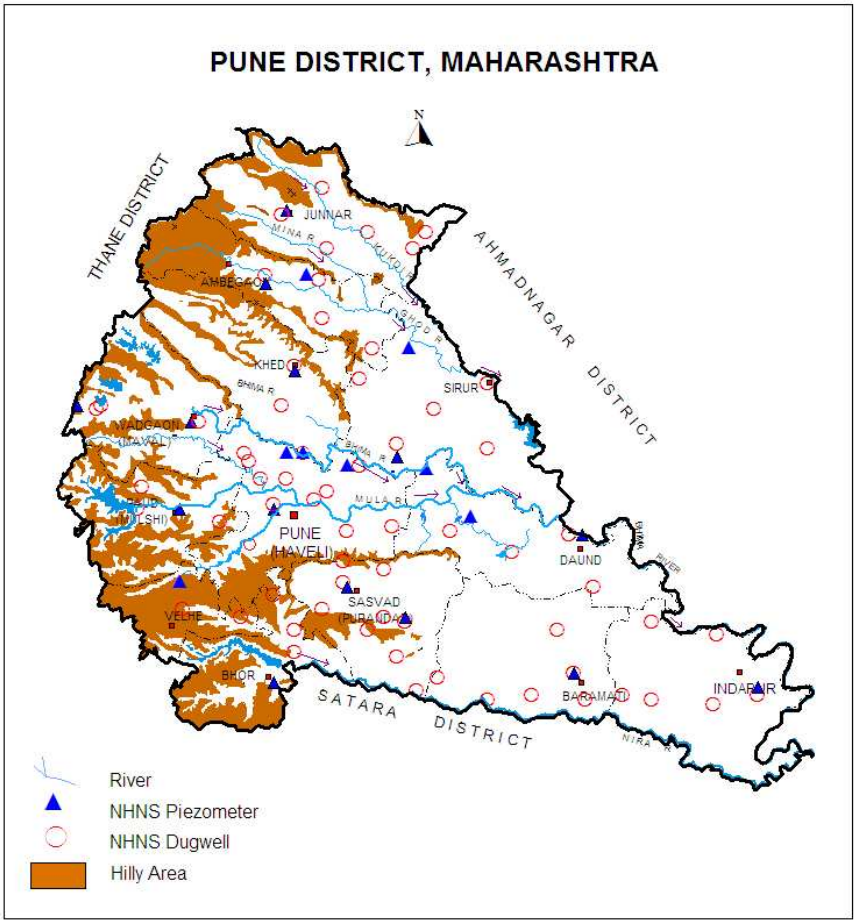

Figure-1: Location

2.0 Climate and Rainfall

The climate of the district is on the whole is agreeable. The winter season is from December to about the middle of February followed by summer season which last up to May. June to September is the south-west monsoon season, whereas October and November constitute the post-monsoon season. The mean minimum temperature is about 12℃ and mean maximum temperature is about 39℃.

The normal annual rainfall over the district varies from about 500 mm to 4500 mm. It is minimum in the eastern part of the district around Daund (468 mm), Baramati (486 mm) and Jujuri (494 mm). This increases towards west and reaches a maximum around Khandala (4659 mm) in the western ghat. The

chances of receiving normal rainfall are maximum (50 to 55%) in the eastern part around Indapur and Daund, in the central part around Pune city and small area around Junnar in northern part of the district. The rainfall analysis also indicates drought area in the eastern, southern, south eastern, central and north western parts around Indapur, Baramati, Jujuri, Daund, Talegaon, Dhamdhare, Alandi, Shirur and Bhor covering around 50% area of the district.

The average annual rainfall for the period 1998 to 2007 ranges from about 603 mm (Daund) to 2604 mm (Velhe) and 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	Average
Ambegaon	1105.40	794.30	552.30	832.10	351.20	421.80	753.10	1025.00	1338.30	830.90	800.44
Baramati	1263.00	751.00	413.40	478.80	262.40	NA	521.00	711.00	567.00	622.00	621.07
Bhor	1169.00	1335.60	838.20	906.10	1090.90	712.00	1380.10	1714.00	1762.00	1429.40	1233.73
Daund	793.00	720.60	319.00	527.20	NA	NA	522.00	742.20	594.00	604.80	602.85
Haveli (Pune)	857.50	679.90	403.40	546.50	762.50	452.10	390.60	1250.30	1247.50	859.60	744.99
Indapur	1421.30	445.60	425.30	621.00	336.40	163.30	651.90	696.10	668.00	640.30	606.92
Junnar	NA	784.10	401.30	676.90	605.50	648.20	771.80	1344.40	1237.00	880.00	816.58
Khed	688.50	455.40	533.50	478.80	513.70	386.20	775.00	973.10	1461.10	756.50	702.18
Maval	1141.00	1078.50	906.00	1039.40	1357.00	1062.00	1466.00	2561.00	2252.00	1442.60	1430.55
Mulsi	1640.00	1403.00	1000.10	1062.70	825.60	1251.00	1878.00	2875.80	2804.00	1834.00	1657.42
Pune City	NA	NA	1060.80	NA	NA	335.30	652.40	1239.50	1246.00	779.40	885.57
Purander	885.00	505.00	310.00	529.60	NA	NA	710.00	1158.00	1476.00	519.00	761.58
Shirur	598.00	528.40	394.40	422.80	520.20	NA	374.00	460.00	760.00	674.00	525.76
Velhe	2456.00	2314.00	1330.00	1931.00	952.30	1420.00	2054.40	6320.60	3997.00	3263.00	2603.83

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

3.0 Geomorphology and Soil Types

The district forms part of Western Ghat and Deccan Plateau. Physiographically the district can be divided in to three distinct belts i.e., (1) The western belt stretching from 16 to 31 km. east of Sahayadri – an extremely rugged country cut by deep valleys, divided and crossed by hill ranges. (2) The central belt extending for about 30 km. east of the western belt across the tract whose eastern boundary is roughly marked by a line drawn from Pabal in the north, southwards through Pune to Purandhar. In this belt a series of small hills stretch in to valleys and large spurs from Plateaux and (3) The eastern belt with a rolling topography and the low hills sinking slowly in to the plains with relatively broader valleys. Therefore, the physiography of the district has given rise to four major characteristic land forms namely; (1) The hills and ghats (2) the foot hills (3) the plateau and (4) the plains.

The district has three major drainage system namely (i) The Bhima – Ghod River system in the northern, north eastern and eastern part, of which Bhima River has a total length of about 355 km. and Ghod River has a drainage of about 196 km. in the district – (ii) Mula – Mutha River system covering the central part and have a total length of 242 km. in the district. (iii) Nira River system covering the south, south east and eastern part and has a total length of about 231 km. in the district The other Important rivers that are flowing through the district are

Bhima, Andhra, Karna, Shivganga, Pushpavati, Pauna and Indrayani. All the rivers have most semi-dendritic drainage pattern and the drainage density is quite high. Based on geomorphological setting and drainage pattern the district is divided into 71 watersheds.

4.0 Ground Water Scenario

4.1 Hydrogeology

The entire area of the district is underlain by the basaltic lava flows of upper Cretaceous to lower Eocene age. The shallow alluvial formation of Recent age also occurs as narrow stretch along the major rivers flowing in the area. A map depicting the hydrogeological features is shown as **Figure–2**.

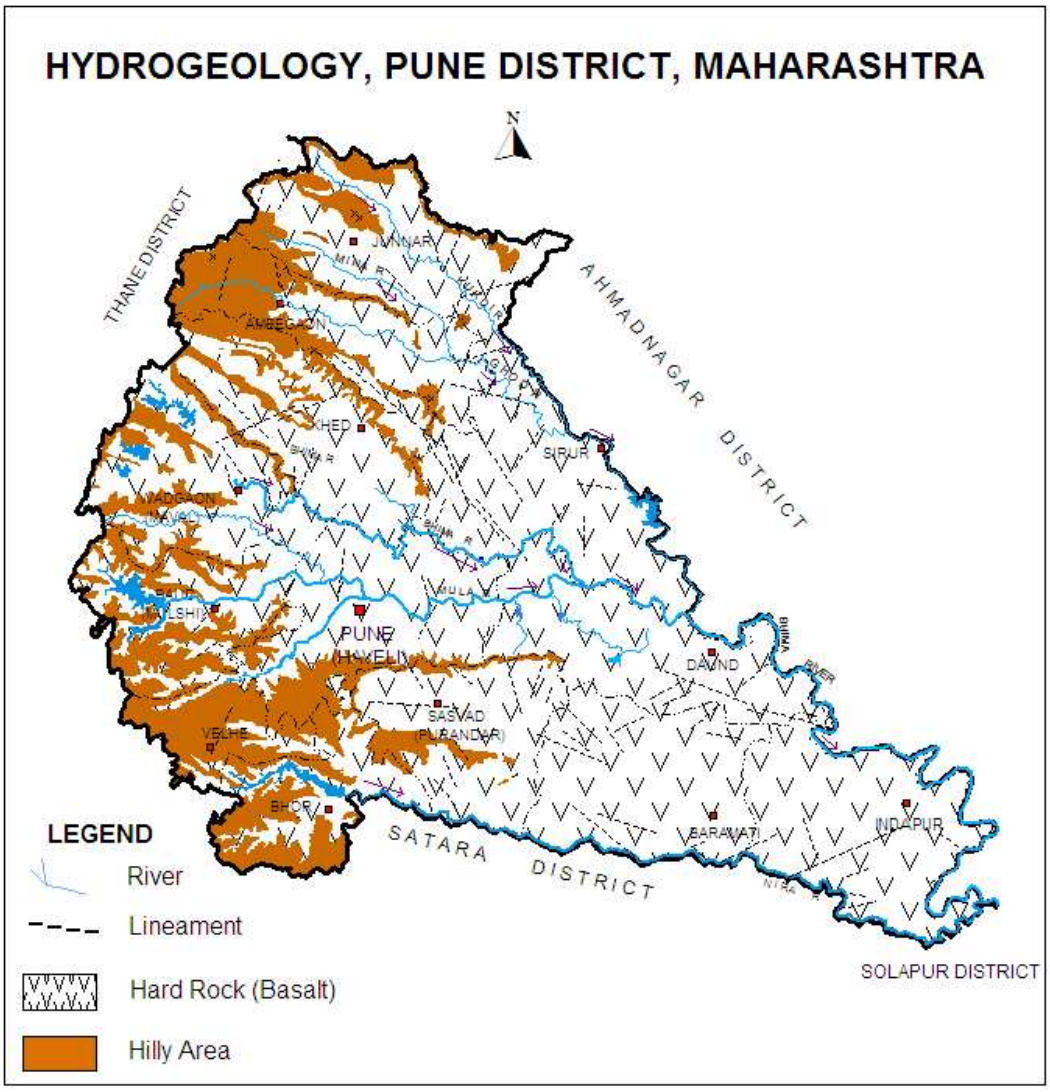

Figure-2: Hydrogeology

4.1.1 Hard Rock (Deccan Trap Basalt)

Basaltic lava flows occupies more than 95% of the area of the district. These flows are normally horizontally disposed over a wide stretch and give rise to table land type of topography also known a plateau. These flows occur in layered sequences ranging in thickness from 7 to 45 m and represented by

massive unit at the bottom and vesicular unit at the top of the flow. These flows are separated from each other by marker bed known as 'bole bed'.

The water bearing properties of these flows depend upon the intensity of weathering, fracturing and jointing which provides availability of open space within the rock for storage and movement of ground water. The thickness of weathering in the district various widely up to 20 m bgl. However, the weathered and fractured trap occurring in topographic lows forms the potential aquifer in the district.

The ground water in the district occurs under phreatic, semi – confined and confined conditions. Generally the shallower zones down to the depth of 20 to 22 m bgl form the phreatic aquifer. The water bearing zones occurring between the depth 20 and 40 m bgl when weathered or having shear zones yield water under semi-confined condition. The deep confined aquifers generally occur below the depth of 40 m bgl.

The vesicular unit of lava flow when exposed or lying just few meter below the surface forms a potential aquifer in the district. However, the vesicular portion of different lava flows varies in thickness from few m to 10 m and nature and density of vesicles, their distribution, interconnection, weathering are the decisive factors for occurrence and movement of water in these units. The massive portions of basaltic flows are normally devoid of water, but when it is weathered, fractured and jointed forms potential aquifer. In Deccan Trap Basalt, the yield of the dugwells in different formations ranges from 30 to 150 lpm/day depending upon the local hydrogeological conditions. The yields of borewells also show wide variations and it ranges from traces to 30.62 lps (Lavle) a seen from CGWB exploration data.

4.1.2 Soft Rock (Alluvium)

Alluvium occurs in small areas along banks and flood plains of major rivers like Bhima, Ghod, Mula, Mutha and their tributaries. In alluvium the granular detrital material like sand and gravel usually occurring as thin layer in the district yields water. But due to its limited extent the ground water potential in this formation is negligible.

4.2 Water Level Scenario

Central Ground Water Board monitors water levels in 49 National Hydrograph Network Stations (NHNS) stations in the district. These NHNS are measured four time in a year viz., January, May (Premonsoon), August and November (Postmonsoon).

4.2.1 Depth to Water Level – Premonsoon (May 2007)

The premonsoon depth to water levels monitored during May 2007 ranges between 0.20 m bgl (Bhadalwadi) and 12.30 m bgl (Otur). The depth to water levels during premonsoon has been depicted in **Figure-3**. It is observed from map that in major parts of the district the water levels are within 5 m bgl in almost entire western part and south eastern part of the district. The water levels in the range of 5 to 10 m bgl are observed in central, eastern and north eastern parts of the district. The deeper water levels of more than 10 m bgl have been observed around Otur village in northern part of the district where as at village Sirur in east and village Nimbgaon in south eastern part of the district.

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

The depth to water level during postmonsoon (Nov. 2007) ranges between 1.00 m bgl (Ranjangaon) and 15.60 m bgl (Otur). Spatial variation in postmonsoon depth to water level is shown in **Figure-4.** The water levels between 2 and 5 m bgl have been observed in major parts of the district in the south, south eastern, central and north western parts occupying almost entire Purandar, Bhor, Mulshi, Maval and Khed talukas and parts of Daund, Baramati, Velhe and Shirur. The water levels in 5 to 10 m bgl range are mainly seen in three isolated pockets i.e., in northern, central and south eastern parts of the district in parts of Junnar, Ambegaon, Haveli, Daund and Indapur talukas. Very shallow water levels of less than 2 m bgl are observed in isolated patch in central part of the district.

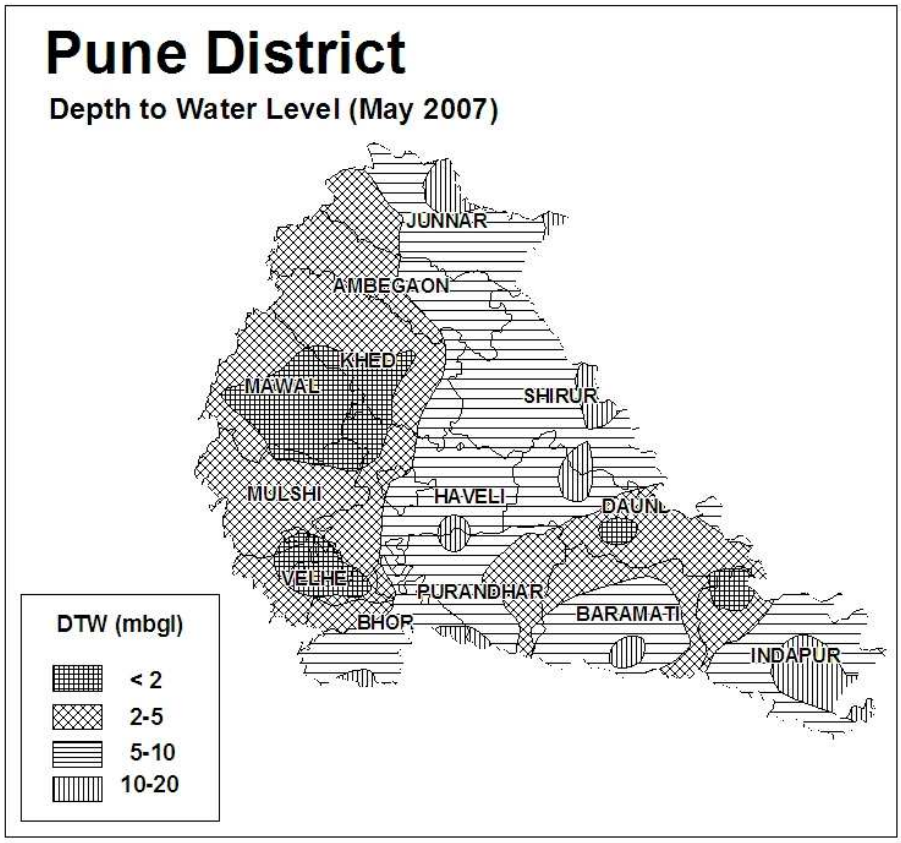

Figure-3: Depth to Water Level (Premonsoon- May 2007)

4.2.3 Seasonal Water Level Fluctuation (May to Nov. 2007)

Seasonal water level fluctuation between premonsoon and postmonsoon of 2007 have been computed. Rise in water level in range of 0.10 (Mulshi) to 8.00 m (Zendewadi) is observed in the district. However, fall in water level was also observed at 8 locations ranging between 0.05 (Kalamb and Kolwan) to 4.55 m (Bhadalwadi) in a longitudinal patch extending from north to central western part of the district in parts of Junnar, Ambegaon, Khed and Maval talukas and also in south eastern part covering parts of Daund and Indapur talukas. Rise in the water levels up to 4 m have been observed in major part of the district. While rise in water levels of more than 4 m is seen in isolated patches in southern part of the

district in parts of Purandhar taluka and in central eastern part of the district in parts of Shirur taluka.

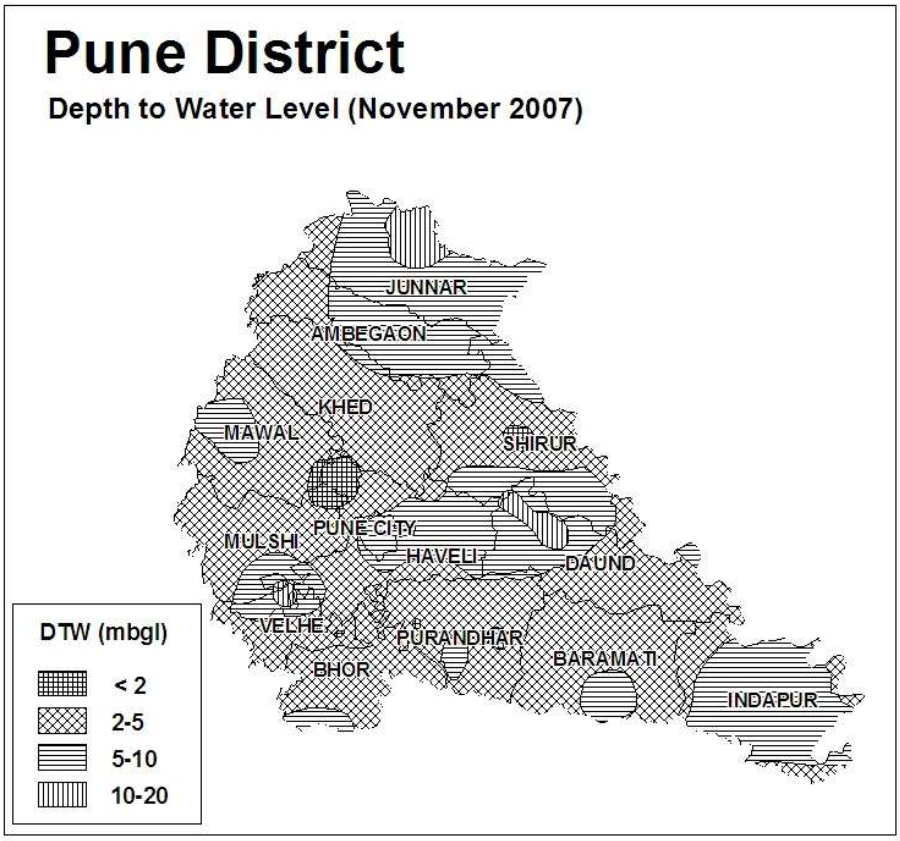

Figure-4: Depth to Water Level (Postmonsoon- Nov. 2007)

4.2.4 Water Level Trend (1998-2007)

Trend of water levels for premonsoon and postmonsoon periods for last ten years (1998-2007) have been computed for 42 NHNS. Analysis of long term trend water level data indicates that rise in water levels in premonsoon period has been recorded at 18 NHNS and its ranges from negligible to 0.97 m/year (Otur) and fall in water levels has been observed in 24 NHNS and it ranges between negligible to 0.48 m/year (Zendewadi). During postmonsoon period rise in water levels has been recorded at 12 NHNS ranging from negligible to 0.41 m/year (Ale) while at 30 NHNS fall in water level have been recorded and it ranges between negligible to 0.44 m/year (Otur). Thus in major parts of the district, both during premonsoon and postmonsoon seasons declining water level trend has been recorded.

The premonsoon trend map was also prepared and the same is presented in **Figure-5**. It shows that the fall in water level trend of up to 20 cm/year is observed in major parts of the district, occupying north, central, western and southern parts of the district in entire Purandhar, Bhor, Haveli, Mulshi, Maval, Ambegaon and parts of Junnar, Khed, Shirur, Daund, Baramati and Indapur talukas. Thus the situation is quite critical in almost entire district and the future ground water conservation and recharge structures needs to be prioritized in these areas.

The rise of up to 20 cm/year has been observed in 2 to 3 isolated patches in south eastern, southern and northern parts occupying parts of Indapur, Baramati and Daund talukas entire Velhe and parts of Junnar taluka.

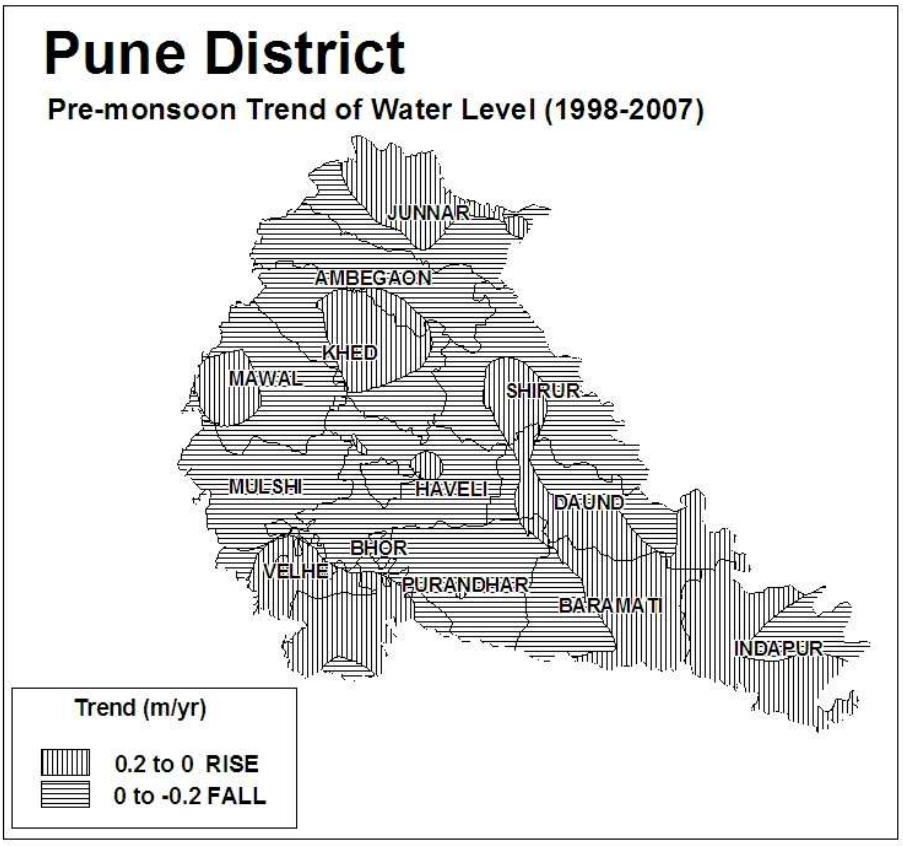

Figure-5: Water Level Trend (Premonsoon- 1998-2007)

4.3 Aquifer Parameters

The aquifer parameters of phreatic aquifer are available from systematic hydrogeological surveys conducted by CGWB. In Deccan Trap Basalt, the unit area specific capacity of dugwells ranges from 0.77 to 18.9 lpm/dd/sq.m. While the permeability ranges from 12 to 65 m/day. The transmissivity of phreatic aquifer ranges between 18 and 89 m^2/day. While the specific yield ranges between 1.7 to 9.7 % in the district. In Alluvium, the unit area specific capacity ranges from 5.95 to 32.00 lpm/dd/sq.m, transmissivity ranges between 97 and 248 m^2/day and specific yield ranges between 5 to 19 %.

4.4 Yields of Dugwells and Borewells

The yields of the wells are the functions of the permeability and transmissivity of aquifer encountered. This varies with location, diameter and depth of wells. There are mainly two types of ground water structures in the district i.e., dugwells and borewells. Yield of dugwells varies according to the nature of formations tapped. In Deccan Trap Basalt, the yield of the dugwells in different formations and its ranges are given in Table–4. The yields of borewells also show wide variations and it ranges from traces to 30.62 lps (Lavle) a seen from CGWB exploration data. This variation of yields in the single type of aquifer is due to lateral/spatial variation in permeability of the formation/aquifer material.

Table-4: Yields of Dugwells.

Formation	Yield Range (lpm/day)	Elevation Range (m amsl)
Massive basalt poorly weathered / jointed with thin vesicular zone.	30 – 60	787 – 838
Weathered and highly jointed massive basalt with thick vesicular zones.	90 – 150	721 – 787
Weathered, fractured and jointed massive basalt with thick vesicular zone.	60 – 120	651 – 721
Highly weathered and moderate to poorly jointed basalt.	40 – 80	560 – 651

It is clear from Table-4 that at higher elevations the yields of the wells are low in the range of 30 to 60lpm/day. The maximum yield in the range of 90 to 150 lpm/day is observed in weathered and highly jointed massive basalt with thick vesicular zones, followed by 60 to 120 lpm/day in weathered, fractured and jointed massive basalt with thick vesicular zone and 40 to 80 lpm/day in highly weathered and moderate to poorly jointed basalt.

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 Satara district based on GEC–97 methodology and the same are presented in Table–5. Ground water resources estimation was carried out for 13072.60 sq.km. area out of which 2436.60 sq.km. is under command and 10351.78 sq.km. is non command, whereas 284.22 sq.km. area is of poor ground water quality. Taluka wise ground water resources are shown in **Figure-6.**

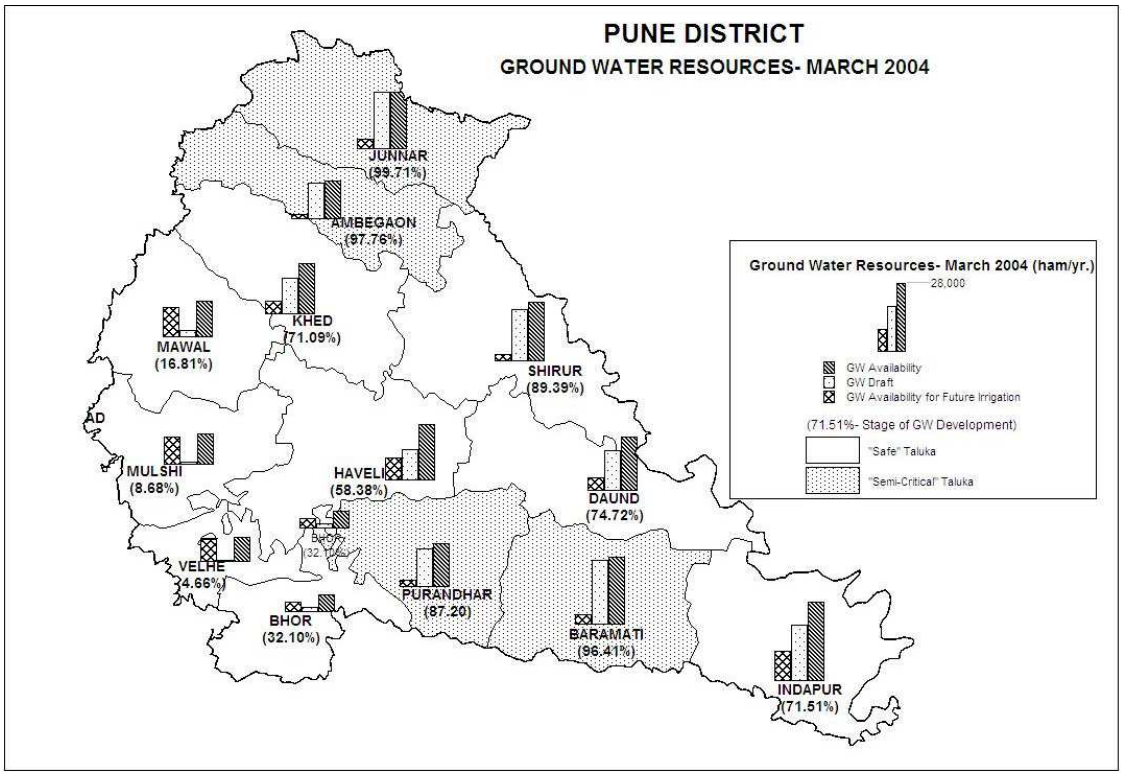

Figure-6: Ground Water Resources (March 2004)

Table-5: 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				
MAVAL	C	457.21	53.53	16.03	69.56	32.05	371.62	15.21	**Safe**
	NC	8136.56	1251.58	123.15	1374.73	246.31	6638.67	16.90	
	TOTAL	**8593.76**	**1305.11**	**139.18**	**1444.29**	278.36	7010.29	**16.81**	
MULSHI	C	600.10	87.14	14.75	101.89	29.51	483.46	16.98	**Safe**
	NC	6638.69	433.26	93.40	526.66	186.81	6018.63	7.93	
	TOTAL	**7238.80**	**520.39**	**108.16**	**628.55**	216.32	6502.09	**8.68**	
VELHE	C	51.03	4.85	0.63	5.48	1.27	44.91	10.75	**Safe**
	NC	5519.84	207.94	46.11	254.05	92.22	5219.67	4.60	
	TOTAL	**5570.86**	**212.79**	**46.74**	**259.53**	93.49	5264.58	**4.66**	
BHOR	C	408.97	12.95	5.45	18.40	10.89	385.13	4.50	**Safe**
	NC	3614.88	1164.70	108.54	1273.24	217.08	2233.10	35.22	
	TOTAL	**4023.84**	**1177.65**	**113.99**	**1291.63**	227.97	2618.23	**32.10**	
HAVELI	C	2387.58	1749.22	39.39	1788.60	78.78	559.59	74.91	**Safe**
	NC	10598.57	5588.93	203.24	5792.17	396.27	4693.80	54.65	
	TOTAL	**12986.15**	**7338.14**	**242.63**	**7580.77**	475.05	5253.39	**58.38**	
BARAMATI	C	7236.94	5094.88	104.84	5199.72	209.68	1932.38	71.85	**Semi-Critical**
	NC	8723.14	10056.02	131.63	10187.65	102.54	524.30	116.79	
	TOTAL	**15960.08**	**15150.90**	**236.47**	**15387.37**	312.22	2456.68	**96.41**	
INDAPUR	C	14374.32	7814.63	245.61	8060.24	377.41	6283.58	56.07	**Safe**
	NC	4234.49	5204.09	43.35	5247.44	29.57	631.51	123.92	
	TOTAL	**18608.81**	**13018.72**	**288.96**	**13307.68**	406.98	6915.09	**71.51**	

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				
PURANDHAR	C	1624.38	171.48	15.27	186.76	30.55	1422.35	11.50	**Semi-Critical**
	NC	8566.95	8525.46	175.11	8700.57	219.77	349.50	101.56	
	TOTAL	**10191.32**	**8696.94**	**190.39**	**8887.33**	250.32	1771.85	**87.20**	
DAUND	C	7245.71	4388.79	83.70	4472.49	167.40	2689.52	61.73	**Safe**
	NC	5354.24	4857.10	85.27	4942.37	137.32	638.29	92.31	
	TOTAL	**12599.95**	**9245.89**	**168.97**	**9414.86**	304.72	3327.81	**74.72**	
KHED	C	603.25	224.84	20.37	245.22	40.75	337.66	40.65	**Safe**
	NC	11370.28	7946.51	320.19	8266.70	614.52	2915.54	72.70	
	TOTAL	**11973.53**	**8171.35**	**340.56**	**8511.91**	655.27	3253.20	**71.09**	
JUNNAR	C	3169.43	1402.26	124.27	1526.54	248.55	1518.62	48.16	**Semi-Critical**
	NC	10415.75	11770.35	249.20	12019.54	243.48	781.21	115.40	
	TOTAL	**13585.18**	**13172.61**	**373.47**	**13546.08**	492.03	2299.83	**99.71**	
AMBEGAON	C	693.90	452.07	44.53	496.60	89.06	152.77	71.57	**Semi-Critical**
	NC	8325.70	8174.86	145.74	8320.60	131.47	1144.57	99.94	
	TOTAL	**9019.60**	**8626.93**	**190.27**	**8817.20**	220.53	1297.34	**97.76**	
SHIRUR	C	1462.49	1376.13	56.33	1432.46	56.28	76.87	97.95	**Safe**
	NC	12473.55	10783.47	242.11	11025.59	344.44	1749.52	88.39	
	TOTAL	**13936.04**	**12159.61**	**298.44**	**12458.05**	400.72	1826.39	**89.39**	
DISTRICT TOTAL	C	**40315.30**	**22832.79**	**771.17**	**23603.96**	**1372.18**	**16258.46**	**58.55**	
	NC	**103972.62**	**75964.24**	**1967.06**	**77931.31**	**2961.80**	**33538.31**	**74.95**	
	TOTAL	**144287.92**	**98797.04**	**2738.23**	**101535.27**	**4333.98**	**49796.77**	**70.37**	

(Here, C- Command, NC- Non-Command)

As per the estimation, the total annual ground water recharge is 1519.79 MCM with natural discharge of 76.91 MCM. The net annual ground water availability comes to be 1442.87 MCM. The annual draft for all uses is estimated at 1015.35 MCM with irrigation sector being the major consumer having a draft of 987.97 MCM while the draft for domestic and industrial uses was estimated at 27.38 MCM. The net annual ground water availability for future irrigation is 497.96 MCM, whereas the allocation for domestic and industrial requirements is 43.33 MCM. The stage of ground water development in the district varies from 4.66% at Velhe to 99.71% at Junnar. The over all stage of ground water development in the district is 70.37%. Out of 14 talukas, 4 talukas viz., Baramati, Ambegaon, Purandhar and Junnar have been categorized as "Semi-Critical" whereas remaining talukas fall in "Safe" category. Similarly the watershed wise assessment has also been done for the district and out of 71 watersheds assessed, 44 watersheds fall under "Safe" category, 11 fall in "Semi-Critical" (BM-13, BM-17, BM-19, BM-27, BM-35, BM-49, BM-50, BM-51, BM-52, BM-60 and BM-74); 2 in "Critical" (BM-58 and BM-70); 14 in "Over-Exploited" (GV-114, BM-1, BM-4, BM-5, BM-6, BM-9, BM-12, BM-18, BM-26, BM-59, BM-69, BM-75, BM-76 and BM-77).

In all these "Semi-Critical", "Critical", "Over-Exploited" watersheds and 4 "Semi-Critical" talukas viz., Baramati, Ambegaon, Purandhar and Junnar 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.

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 39 NHNS. All the parameters analysed are expressed in mg/L except pH and EC. The EC is expressed in Micro Siemens (µs) per centimeter at 25°C.

The results of chemical analysis shows that the ground water in the district is alkaline in nature, while EC and TDS values shows that the ground water in the district is mineralized to medium extent. The concentration of major ions indicates that among the cations, the concentration of magnesium ion is highest followed by and sodium and calcium, while among the anions the concentration of bicarbonate ion is highest, followed by chloride, sulphate and nitrate ions.

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

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	25	14	Nil
TH (mg/L)	300	600	20	15	4
Ca (mg/L)	75	200	35	4	Nil
Mg (mg/L)	30	100	7	27	5
Cl (mg/L)	250	1000	34	5	Nil
SO_4 (mg/L)	200	400	37	2	Nil
NO_3 (mg/L)	45	No relaxation	25	-	14
F (mg/L)	1.0	1.5	37	1	1

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

The Table-6 shows that out of the 39 ground water samples, 14 samples (35%) have Nitrate (NO_3) concentration more than MPL (>45 mg/L). The concentrations of most of the other parameters are less than MPL except Total Hardness (TH) at 4 NHNS (Shirur, Otur, Wagholi and Karanje) and Magnesium (Mg) at 5 NHNS (Dhumalwadi, Parne, Otur, Wagholi and Karanje). The potability of ground water in 1 sample collected from Uruli Kanchan is also affected due to high concentration of Fluoride (F). This indicates that the potability of ground water is mainly affected due to NO_3.

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-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 Permissible**		**Doubtful**		**Unsuitable**	
Total Samples	No. of Samples	%	No. of Samples	%	No. of Samples	%	No. of Samples	%
39	39	100	-	-	-	-	-	-
RSC	**<1.25**		**1.25-2.50**		**>2.50**			
Category	**Good**		**Doubtful**		**Unsuitable**			
Total Samples	No. of Samples	%	No. of Samples	%	No. of Samples	%		
39	37	96	1	2	1	2		

The **Table-7** shows that SAR and RSC values of majority of ground water samples are less than 10 and 1.25 respectively indicating ground water is good for irrigation purposes. However, the RSC values of ground water sample collected from the well located at Uruli Kanchan is between 1.25 and 2.50, whereas at Kalamb it is more than 2.50 suggesting that the ground water from these wells is doubtful to unsuitable for irrigation purposes. Overall, the ground water quality in the wells monitored is good for irrigation purpose and there is a less possibility of developing sodium hazard.

4.7 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 district is predominantly used for irrigation as it is the major ground water utilizing sector. The minor irrigation census data of 2000-01 indicates that the area irrigated by ground water is 1578 sq.km., whereas surface water accounts for only 609 sq. km. of the area and the net irrigated area stand at 2187sq. km. Thus it is clear that ground water is the major source of irrigation as it accounts for 72% of the net irrigated area.. There are about 1,08,997 dugwells in use in the district which create an irrigation potential of 3147 sq. km. out of which 2775 sq. km. of irrigation potential is utilized, whereas 5077 borewells create an irrigation potential of 123 sq. km. out of which 112 sq. km. of irrigation potential is utilized.

In addition to this, till March 2007 GSDA and other State Govt. agencies have drilled 10,390 borewells for rural water supply out of which 416 borewells are fitted with electric pumps and the rest with hand pumps.

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 part of the State has reached to a critical stage resulting in decline of ground water levels. Thus, there is need to adopt and 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

Almost entire district is underlain by Deccan Trap Basalt and major parts of the district adjoining the hilly areas as well as the entire northern, south

western and south eastern parts have low ground water development potential. Such areas occur in almost entire Junnar, Ambegaon, Maval, Mulshi, Velhe, Bhor and parts of Khed and Shirur talukas. The central part of the district is occupied by the areas with medium to high ground water potential. Such areas are observed in parts of Khed, Shirur, Haveli and Purandar talukas and almost entire Baramati and Daund talukas. In the hard rock areas of the district the ground water can be developed through dugwells, which are the most feasible structure for ground water development. The borewells generally tap deeper fractures thus selection of site for pinpointing of borewells need proper scientific investigation. The yield of dugwells in the district may be expected from 30 to 150 m^3/day depending on the local hydrogeological conditions.

The nature and yield potential of the aquifers occurring in different areas is given below in **Table-8**. A perusal of Table-8 shows that the 5 talukas i.e., Haveli, Shirur, Daund, Baramati and Purandar have medium to high yield potential and the suitable abstraction structures are dugwell, DCB and borewells. However in Baramati and Purandar talukas, which have been categorised as “Semi-Critical”, 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, so that the sustainable development is achieved.

Table-8: Nature and Yield Potential of Aquifers.

S. No.	Taluka	Aquifer	Yield Potential	Type of wells suitable
1	Pune City	Basalt	Medium	Dugwells and borewells
2	Haveli	- do -	Medium to high	Dugwells and borewells
3	Khed	- do -	Low and high	Dugwells, DCB and borewells
4	Ambegaon	- do -	Low	Dugwells
5	Junnar	- do -	Low	Dugwells
6	Shirur	- do -	Medium to high	Dugwells, DCB and borewells
7	Daund	- do -	Medium to high	Dugwells, DCB and borewells
8	Indapur	- do -	Low to Medium	Dugwells, DCB and borewells
9	Baramati	- do -	Medium to high	Dugwells, DCB and borewells
10	Purandhar	- do -	Medium to high	Dugwells, DCB and borewells
11	Bhor	- do -	Low to medium	Dugwells and borewells
12	Velhe	- do -	Low to medium	Dugwells and borewells
13	Mulshi	- do -	Low to medium	Dugwells and borewells
14	Maval	- do -	Low to medium	Dugwells and borewells

5.2 Water Conservation and Artificial Recharge

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 favorable in hilly areas, particularly in almost entire Mulsi, Velhe, Bhor and parts of Khed and Junnar talukas. Existing dugwells can also be used for artificial recharge, however, the source water should be properly filtered before being put in the wells. The most feasible artificial recharge structure suitable for Alluvial areas restricted along the banks of major rivers and their tributaries, are shallow recharge wells on the river bed of the tributaries. Percolation tanks are also suitable, wherever source water availability is there.

The sites for artificial recharge structures need to be located where the hydrogeological conditions are favorable, i.e., where sufficient thickness of de-saturated/unsaturated aquifer exists and water levels are more than 5 m deep.

6.0 Ground Water Related Problems

Parts of Pune district falls under rain shadow zone of Maharashtra State. It is seen from long term rainfall data that the eastern, southern, south eastern, central and north western parts around Indapur, Baramati, Jujuri, Daund, Talegaon, Dhamdhare, Alandi, Shirur and Bhor covering around 50% area of the district experiences drought conditions for more than 20% of the years. Therefore, these areas are classified as drought areas. The premonsoon water level trend shows fall in water level up to 20 cm/year in major parts of the district, occupying north, central, western and southern parts of the district in entire Purandhar, Bhor, Haveli, Mulshi, Maval, Ambegaon and parts of Junnar, Khed, Shirur, Daund, Baramati and Indapur talukas. . Similarly as per current assessment of ground water resources it is also seen that the ground water development in Baramati, Ambegaon, Purandhar and Junnar talukas have already reached up to 100% and these talukas fall under “Semi-Critical” category. Thus the situation is quite critical in almost entire district and the future ground water conservation and recharge structures needs to be prioritized in these areas.

The ground water quality is mainly affected by nitrate as 35% of samples are having high nitrate concentration. Continuous intake of high nitrate concentration water causes infant methaemoglobinamea, popularly known as Blue Babies disease. Thus all the wells used for water supply should be first analysed for nitrate contents and if the nitrate content is found beyond permissible limit the ground water may be used for other purposes than drinking. Adequate sanitary protection to the wells may be provided to control the nitrate contamination.

7.0 Mass Awareness and Training Activities

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

Till March 2007, 1 Water Management Training Programme (WMTP) had been organised in the district. The details are given in **Table-9**.

Table-9: Status of WMTP.

S. No.	Item	AAP	Venue	Date	Participants
1.	WMTP	2003-04	Department of Geology, Pune University, Pune.	19 to 21/11/03	30

7.2 Participation in Exhibition, Mela, Fair etc.

During the WMTP at Department of Geology, Pune University, an exhibition depicting rainwater harvesting model, various ground water related posters, leaflets, literature and technical reports were displayed along with maps of Pune district. The models, maps, posters were explained to the visitors in details.

8.0 Areas Notified by CGWA / SGWA

As per ground water resources estimation, four talukas viz., Baramati, Ambegaon, Purandhar and Junnar talukas fall under “Semi-Critical” category.

However, so far none of talukas have been notified either by CGWA or SGWA for ground water regulation in the district.

9.0 Recommendations

1. Almost entire district is underlain by Deccan Trap Basalt, where only dugwells are most feasible ground water abstraction structures for development. However the borewells are another alternative but their construction requires special technical and scientific attention while pin pointing of site.
2. Borewells generally tap deeper fracture which may not be sustainable throughout the year. Hence the borewell should only be used for drinking purpose, not for irrigation purposes.
3. The overall stage of ground water development for the district has already reached about 70%. Therefore, future development of ground water resources should be carried out with proper care and planning.
4. In the “Semi-Critical”, “Critical”, “Over-Exploited” watersheds and 4 “Semi-Critical” talukas viz., Baramati, Ambegaon, Purandhar and Junnar the stage of ground water development indicates a very limited scope for further ground water development unless ground water recharge exceeds the ground water draft by artificial means. Therefore 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 these areas.
5. Haveli, Shirur and Daund talukas have medium to high yield potential and the suitable abstraction structures recommended for ground water development are dugwell, DCB and borewells.
6. The ground water quality is mainly affected by nitrate as 35% of samples are having high nitrate concentration. Thus all the wells used for water supply should be first analysed for nitrate contents and if the nitrate content is found beyond permissible limit the ground water may be used for purposes other than drinking. Adequate sanitary protection to the wells may be provided to control the nitrate contamination.
7. The scope exists for construction of suitable artificial recharge structure in the district. The structure recommended particularly for the hilly area in the west and northwestern part are contour bunds, gully plugs, nala bunds and check dams etc. For other hard rock areas of the district, nala bunds, check dam, KT weirs and percolation tanks at suitable sites are suggested. The existing dugwells may also be used for artificial recharge of ground water by insuring that the water used for recharge should be free from silt and other impurities.
8. The existing percolation tanks and village ponds need to be rejuvenated to act both as water conservation and artificial recharge structure.
9. To enhance the ground water resources and for sustainable development, mass awareness programmes should be organized in large scale by district administration. Such programmes are necessary so as to educate the user regarding yielding capacity of aquifer and declining trend of water levels in the district. Similarly farmer should also be encouraged to adopt appropriate crop planning and irrigation practices.