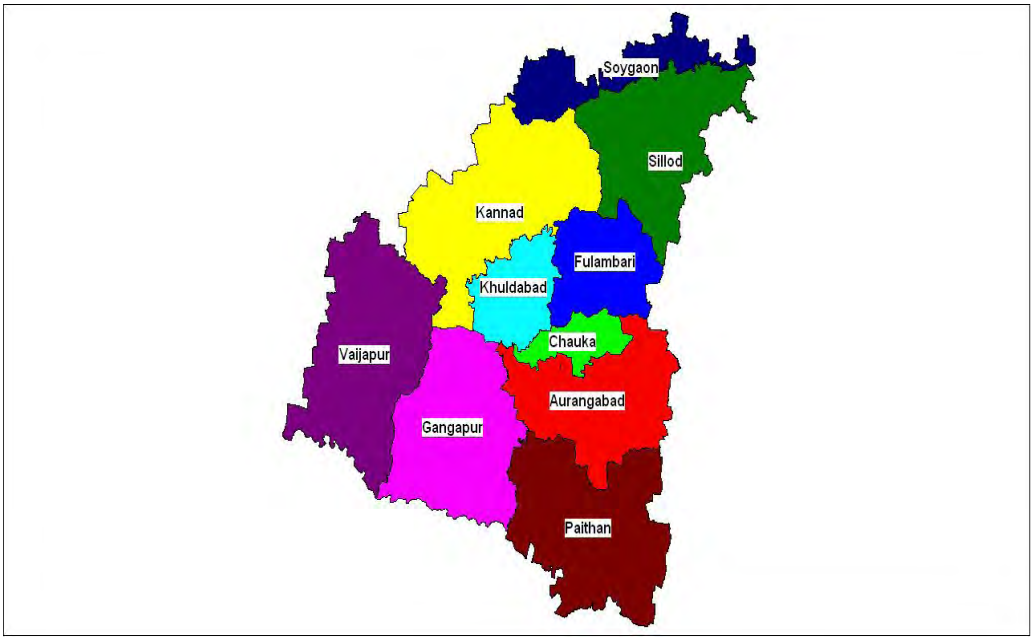
1791/DBR/2013

भारत सरकार
जल संसाधन मंत्रालय
केंद्रीय भूजल बोर्ड

GOVT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

महाराष्ट्र राज्य के अंतर्गत औरंगाबाद जिले की
भूजल विज्ञान जानकारी

GROUND WATER INFORMATION
AURANGABAD DISTRICT
MAHARASHTRA



By

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Scientist-C

द्वारा

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वैज्ञानिक-ग

CENTRAL REGION
NAGPUR
2013

AURANGABAD DISTRICT AT A GLANCE

1. GENERAL INFORMATION

Geographical Area	:	10,107 sq. km.
Administrative Divisions	:	Taluka-9; Aurangabad, Chaika, Kannad, Soygaon, Sillod, Phulambri, Khultabad, Vaijapur, Gangapur, Paithan
Villages	:	1344
Population (2011)	:	36,95,928
Average Annual Rainfall	:	705.08 mm

2. GEOMORPHOLOGY

Major Physiographic unit	:	3; Satmala hill range, Ajanta hill range and Godavari plain
Major Drainage	:	2; Godavari and Purna

3. LAND USE (2010)

Forest Area	:	726 sq. km.
Net Area Sown	:	6540 sq. km.
Gross cropped area	:	784 sq. km.

4. SOIL TYPE

: Deep and Medium black cotton soil

5. PRINCIPAL CROPS (2005-06)

Wheat	:	2381.70 sq. km.
Jowar	:	2301.33 sq. km.
Cotton	:	1329.16 sq. km.
Pulses	:	1189.30 sq. km

6. IRRIGATION BY DIFFERENT SOURCES (2006-07) - Nos. / Potential Created (ha)

Dugwells	:	101185/266139
Tubewells/Borewells	:	2336 / 4582
Tanks/Ponds	:	266/ 39791 (2001)
Other Minor Surface Sources	:	14/2748 (2001)
Net Irrigated Area	:	170569 ha (2001)

7. GROUND WATER MONITORING WELLS (As on 31/03/2012)

Dugwells	:	19
Piezometers	:	06

8. GEOLOGY

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

9. HYDROGEOLOGY

Water Bearing Formation	:	(Deccan Traps) Basalt weathered, vesicular fractured, jointed. Under phreatic semi-confined to and confined conditions.
Premonsoon Depth to Water Level (May-2011)	:	4.82 to 16.70 m bgl
Postmonsoon Depth to Water Level (Nov.-2011)	:	1.85 to 16.00 m bgl
Premonsoon Water Level	:	Rise: 0.08 to 0.79 m/year

Trend (2001-2010)		Fall: 0.03 to 2.48 m/year
Postmonsoon Water Level	:	Rise: 0.06 to1.29 m/year
Trend (2001-2010)		Fall: 0.04 to 0.27 m/year

10. GROUND WATER EXPLORATION (As on 31/03/12)

Wells Drilled	:	EW-64, OW-7, Total -71
Depth Range	:	16.25 to 200.00 m bgl
Discharge	:	Traces to 25.50 lps
Drawdown	:	0.80 to 72.10 m

11. GROUND WATER QUALITY

The potability is affected due to high concentration of nitrate. Hence water of these wells needs treatment for use of drinking purposes. The Ground water should be used for irrigation with proper soil and crop management practices.

12. DYNAMIC GROUND WATER RESOURCES- (March 2009)

Net Annual Ground Water Availability	:	1191.89 MCM
Annual Ground Water Draft (Irrigation+Domestic)	:	738.93 MCM
Projected demand for Domestic and Industrial requirement up to next 25 years	:	74.04 MCM
Stage of Ground Water Development		62 %

13. MAJOR GROUND WATER PROBLEMS AND ISSUES

There is rising trend of water levels.in canal command of major and minor irrigation projects in Paithan, Sillod, Aurangabad talukas. The ground water quality is adversely affected at many places due to high concentration of some parameters especially nitrate.

Ground Water Information
Aurangabad District

Contents

List of Figures

List of Tables

Ground Water Information
Aurangabad District

1.0 Introduction

Aurangabad district is situated in the north central part of Maharashtra between North Latitude 19° 15' and 20° 40, and East Longitude 74° 37' and 75° 52'. It covers an area of 10,107 sq. km falling in parts of Survey of India Toposheet No. 46 L & P and 47 I & M. The district is bounded by Jalgaon district in north by Nashik district in west, Ahmadnagar and Beed districts in south and Parbhani and Buldhana districts in east. The world famous Ajanta and Ellora caves are situated in Aurangabad district. There are also a few caves near Aurangabad City. Other monuments of national fame are Bibi-ka-Maqbara and Daulatabad fort.

The district headquarter is located at Aurangabad City. For administrative convenience, the district has been divided in 9 talukas viz., Aurangabad, Kannad, Soygaon, Sillod, Phulambri, Khuldabad, Vaijapur, Gangapur and Paithan talukas. The district has geographical area of 10,107 sq.km. out of which 726 sq.km is occupied by forest whereas cultivable area is 8135.57 sq.km and net area sown is 6540 sq.km in 2010. Agriculture is the main occupation of the rural people.

A map showing taluka boundary, taluka head quarters physical features and location of monitoring wells is presented as figure 1.

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

Table 1: Studies Undertaken by CGWB (March 2012).

S. No.	Officer	AAP	Type of Survey/Study	Area Covered
1.	V.V Rane	1969-70	SHS	Toposheet No. 47 M/6 and M/7.
2.	V.V Rane	1970-71	SHS	Toposheet No. 47 M/1 and M/5.
3.	K. Shrinivasan	1972-73	SHS	Toposheet No. 46 P/11 and P/12.
4.	M.R. Kulkarni	1974-75	SHS	Extreme southern part.
5.	V.V Rane and M.R. Kulkarni	1975-76	SHS	Toposheet No. 46 P/4, 47 M/1 and M/2.
6.	Dr. S. Shrihari Rao	1975-76	SHS	Toposheet No. 47 I/9, 10, 13 and 14.
7.	M.R. Kulkarni	1976-77	SHS	Toposheet No. 47 M/9, 10, 13

				and 14 (Parts).
8.	M.R. Kulkarni	1978-79	SHS	Toposheet No. 46 P/3, 4, 7 and 8.
9.	D.Y. Sirsikar	1981-82	SHS	Extreme southern part.
10.	S. K. Bhatnagar	1992-93	RHS	Northern part.
11.	A. Suresha	1992-93	RHS	Northern part.
12.	B. K. Kallapur	1992-93	RHS	Southern part.
13.	K.B Sahoo	2000-01	RHS	Southern and south western parts.
14.	S.K Jain	2001-02	RHS	Urban Hydrogeology of Aurangabad city
15.	Binoy Ranjan & U.S. Balpande	2009-10	RHS	Part of Aurangabad and Jalgaon district

SHS : Systematic Hydrogeological Survey, RHS: Reappraisal Hydrogeological Survey

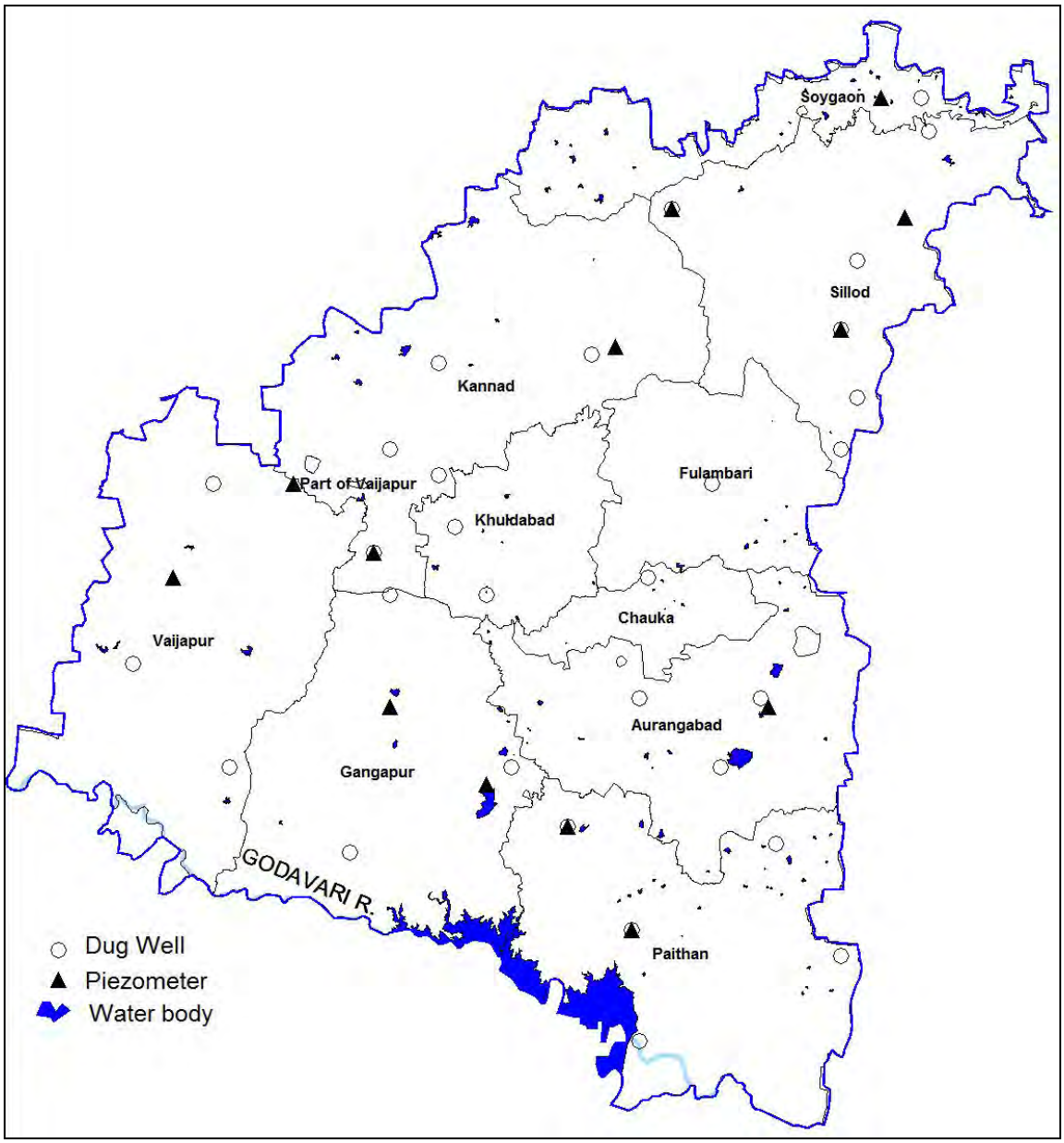

Figure-1: Location

Ground water exploration in the district has been taken up in different phases since 1985-86. The ground water exploration has been done in hard rock areas occupied by Deccan Trap Basalt and disconnected alluvial patches. A total of 64 exploratory wells (EW) and 10 Observation Wells (OW) have been constructed till March 2012.

Table-2: Salient Features of Ground Water Exploration (As on March 2012).

S. No.	Taluka	Forma-tion	Wells		Depth (m bgl)	SWL (m bgl)	Discharge (lps)	Draw-Down (m)	Zones (m bgl)
			EW	OW					
1	Aurangabad	Basalt	10	1	70.00-200.00	5.00-17.80	Traces to 1.86	6.50-15.70	6.50-13.50, 30.70-34.80
2	Kannad	Basalt	9	2	36.70-200.00	3.50-8.00	Traces to 0.78	2.95-30.90	3.50-6.50, 124.00-148.00
3	Soygaon	Basalt	2	1	98.00-200.00	5.60	3.17-25.50	16.32-34.45	15.00-18.10, 90.0-107.10
4	Sillod	Basalt	7	1	125.50-200.00	5.25-16.50	0.02-3.17	1.88 to 72.10	3.10-6.20, 95.90-93.00
5	Phulambri	Basalt	4	0	200.00	5.25-10.00	Traces to 1.73	3.22 to 21.82	5.50-9.70, 41.00
6	Khultabad	Basalt	2	0	200.00	5.60-18.10	0.38-0.78	14.80-15.70	19.60-28.80
7	Vaijapur	Basalt	8	1	183.50-200.00	5.60-10.40	Traces to 9.84	0.80 to 25.50	3.50-12.70, 76. 40
		Alluvium	3	2	16.25-25.50	10.00 to 15.00	0.20 to 4.50	-	13.00 -16.00, 21.00-23.50
8	Gangapur	Basalt	9	0	200.00	4.50 to 19.00	Traces to 1.80	5.40 to 48.70	7.40 to 10.40, 56.20-59.30
		Alluvium	4	1	24.40-28.50	8.00 to 18.00	0.01 to 1.73	-	17.50 -18.50, 24.00-25.00
9	Paithan	Basalt	6	1	26.00 - 200.00	5.60-9.00	Traces to 4.43	6.90 to 10.40	7.00 - 27.10
	Sub-Total	Basalt	57	7	26.00 – 200.00	3.50-19.00	Traces to 25.50	0.80 – 72.10	3.10 – 148.00
	Sub-Total	Alluvium	7	3	16.25-28.50	8.00 to 18.00	0.01 to 4.50	-	13.00 – 25.00
	Total		**64**	**10**	**16.25 – 200.00**	**3.50 – 19.00**	**Traces to 25.50**	**0.80 – 72.10**	**3.10 – 148.00**

In Basalt 57 exploratory wells were drilled and their depth ranged from 26.0 to 200.0 metres below ground level (m bgl). The discharge from these wells varied from traces to 25.50 litres per second (lps). The static water levels (SWL) ranged from 3.50 to 19.00 m bgl. The potential aquifer zones have been encountered from 3.10 to 148.00 m bgl.

Apart from this, 7 shallow EW and 3 OW were constructed in Shivna alluvial area in the depth range of 16.25 to 28.50 m bgl in disconnected alluvial patches occurring along the Godavari and its tributaries. The phreatic and semi-confined aquifers tapped in these

EW in the depth range of 13-25 meters have yielded 0.01 to 4.50 lps of discharge. The static water levels in these wells ranged between 8.00 and 18.00 m bgl.

2.0 Climate and Rainfall

The climate of the district is characterized by a hot summer and a general dryness throughout the year except during the south west monsoon season, which is from June to September while October and November constitute the postmonsoon season.

The winter season commences towards the end of November when temperatures begin to fall rapidly. December is the coldest month with the mean maximum temperature of 28.9° C, while the mean minimum temperature is 10.3°C. From the beginning of March, the daily temperature increases continuously. May is the hottest month with the mean maximum temperature of 39.8°C and the mean minimum temperature of 24.6° C. With the onset of the south-west monsoon by about the second week of June, the temperature falls appreciably.

Except during the southwest monsoon season, when the relative humidity is high, the air is generally dry over the district. The summer months are the driest when the relative humidity is generally between 20 and 25% in the afternoon. Winds are generally light to moderate with increase in speed during the latter half of the hot season and in the monsoon season. The winds flow predominantly from directions between west and north during the hot season. They are mostly from directions between south west and northwest during the south west monsoon season. They blow mostly from the directions between northeast and southeast during the rest of the year becoming southwesterly to north westerly in January and February.

The average annual rainfall of the district for the period 2002 to 2011 is 705 mm (Table 3).

Table 3: Rainfall, Aurangabad district.

Taluka	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
Aurangabad	629.0	792.7	711.6	677.2	937.4	552.4	746.62	731.7	802.9	668.8	737.51
Gangapur	440.3	203.3	657.4	499.9	918.2	619.8	533.55	539.2	721.2	491.3	571.31
Kannad	594.7	440.8	496.2	506.4	971.1	537.7	626.09	621.8	839.9	535.4	655.80
Khuldabad	932.9	761.3	717.9	481.1	963.8	562.9	614.73	635.6	868.5	523.6	660.61
Paithan	586.9	578.6	787.6	512.3	873.2	545.1	672.67	755.8	967.1	694.6	772.54
Phulambri	497.0	603.2	445.4	494.2	681.8	627.9	841.46	670.1	1136.4	580.5	807.12
Sillod	758.6	648.9	624.7	482.2	1085.6	644.5	501.82	750.8	961.7	709.6	730.98
Soygaon	814.2	1035.3	694.6	651.2	1010.4	682.9	669.1	872.5	917.1	644	775.68
Vaijapur	405.0	255.0	484.4	445.8	843.1	538.0	658.7	650.1	773.4	454.7	634.23

3.0 Geomorphology and Soil Types

Geomorphologically, the district comprises of varied topographic features and landscapes consisting of high hills and plains and low lying hills. Most of the hill ranges are located in the northern part of the district. The Satmala hills and Ajanta hills extend from east to west. The hills near Verul in Khuldabad taluka are part of these ranges which extend to Chawaka ranges and Aurangabad hills. The Satmala range encompasses several hills overlooking the Tapi valley. From west to east they are Antur (826 m amsl), Satonda (552 m amsl), Abasgand (671 m amsl) and Ajantha (578 m amsl). The Satmala hill (493 m amsl) from which name of the range is derived, is situated north to Kannad town.

The district is a part of the Deccan Plateau. In general, the slopes in the district are towards south and southeast. The average elevation of the district is in the order of 500 m amsl. Within it there are flat topped hill ranges extending over wide area and also hills separated by broad valleys.

Major part of the district falls in Godavari basin with a small area in north eastern parts falling Tapi Basin. The major river in the district is the Godavari with its tributaries namely; Purna, Dudhna and Shivna rivers. The other important tributaries are Sukna, Khelna, Kham, Gulathi, Shivbhadra and Girija rivers. Depending on the drainage and geomorphology, the district has been divided into 52 watersheds.

Soil plays a very important role in the agricultural activities and forest growth of the area. The fertility of the soil from agricultural point of view depends upon the texture and structure which controls the retaining and transmitting capacity of moisture and various nutrients such as nitrogen, phosphorous and potassium present in the soil. The formation of the soil in the area is influenced by the climate, geology, vegetation and topography. The major part of the district is covered by black cotton soil or ‘Regur’ formed by the weathering of Deccan Trap Basalt. It is rich in plant nutrients such as lime, magnesia, iron and alkalies on which cotton and dry crops like Jowar, Bazra and tur etc flourish. It swells and becomes sticky on watering while on drying it contracts and develops many cracks. The soil varies both in texture and depth. In northern portion of the district the soils are shallow and relatively poor while in south they become deep and fairly rich in nutrients.

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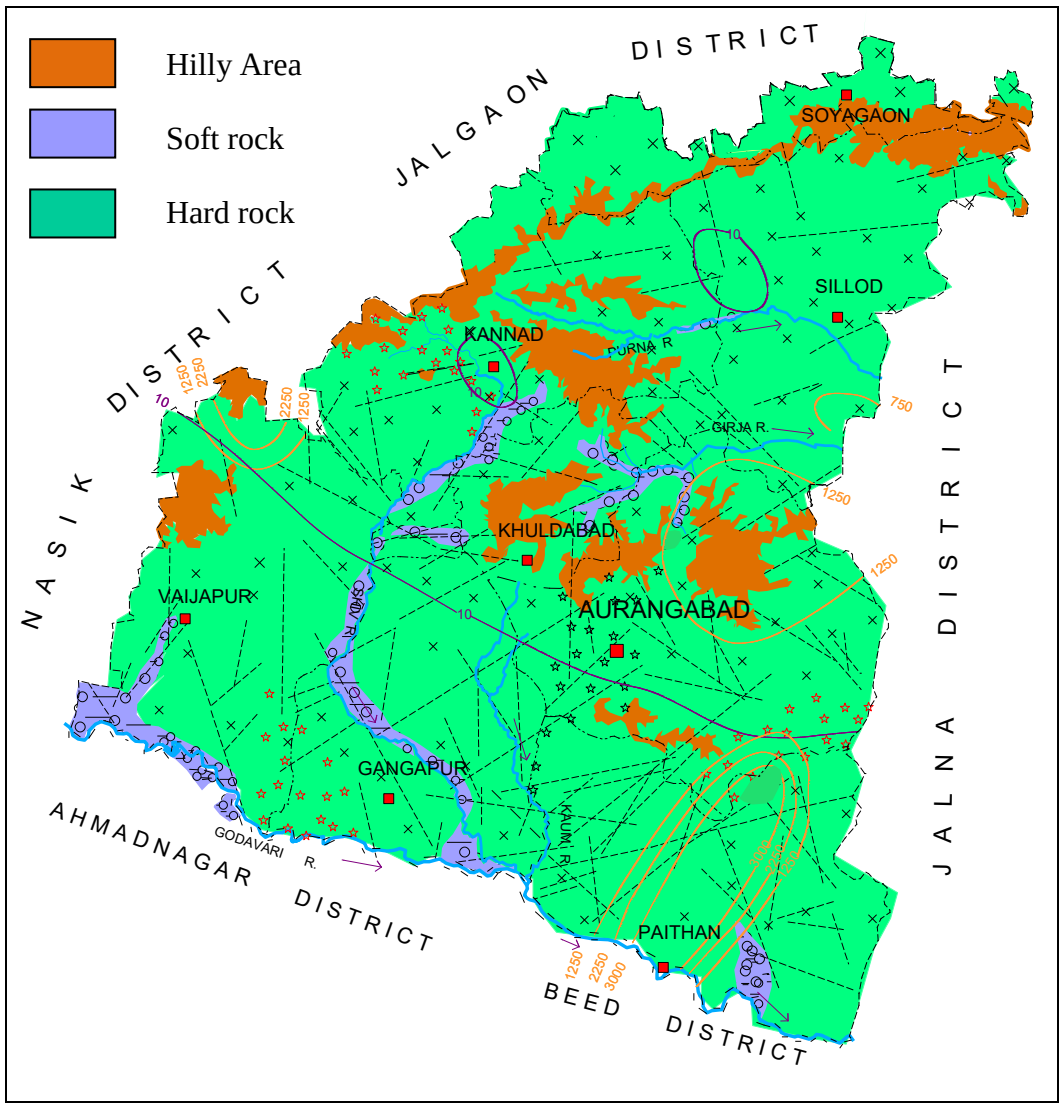

Figure 2: Hydrogeology

4.1.1 Hard Rock Areas

4.1.1.1 Deccan Trap Basalt

Deccan traps are a thick pile of basaltic flows, horizontally disposed and apparently more or less uniform in composition. Each individual flow is a typical section, which varies from porous weathered base to a massive middle unit, becoming increasingly vesicular towards the top. The ground water occurs under water table and semi confined to confined conditions in Deccan Trap Basalt. The vesicular units in different trappean flows range in thickness from 2-8 meters and have primary porosity. However, the nature and density of the vesicles, their distribution, interconnection between the vesicles, depth of weathering and topography of the area are the decisive factor for occurrence and movement of ground water in these units. Since the zeolitic units in vesicular traps are highly susceptible to weathering, the vesicular units comprising weathered zeolitic traps occurring in topographic lows are the main water bearing formation in hard rock terrain of the district.

In massive unit of Deccan Trap Basalt, ground water occurs in soil cum weathered mantle, joints, cracks and other weaker zones. The upper portion of the massive traps show persistent spheroidal weathering and exfoliation which helps in retaining more ground water in these rocks in comparison to compact massive unit. The storage of ground water in compact massive unit totally depends upon the presence of joints and their nature, distribution and interconnection. The average depth range of dugwells is 12.00 m to 15.00 m and that of borewells is 50.00 to 60.00 m in hard rock areas, whereas the yield ranges from 0.60 to 3.10 lps.

4.1.2 Soft Rock Areas

4.1.2.1 Alluvium

The ground water in isolated alluvial pockets in the Godavari, Shivna, Purna and their tributaries occur under both water table and semi-confined conditions. The exploration of shallow alluvial area of the Shivna basin reveals that the saturated thickness of the alluvial material comprising silty clay, sand and gravel ranges from 1-7 meters. The depth to basement ranges between 16.25 to 26.45 m bgl. The aquifer horizons were encountered as coarse sand mixed with clay and silt between 15.00 and 26.00 m bgl, which constitute the potential aquifer in the area with discharge of up to 4.50 lps. The dugwells are generally down to 20 m depth and yields varying between 0.5 and 0.8 lps.

4.2 Water Level Scenario

Central Ground Water Board monitors 25 National Hydrograph Network Stations (NHNS) stations in the Aurangabad district of which 19 are dugwells and 6 are piezometers four times a year i.e. in January, May (Premonsoon), August and November (Postmonsoon).

4.2.1 Premonsoon Depth to Water Level (May-2011)

Depth to water level map of Aurangabad district for the period May 2011 reveals that in most of the area, depth to water level is between 5 to 10 m bgl. Depth to water level in the range of 2 to 5 m bgl is observed in north eastern part of the district in Sillod and Soygaon talukas. Depth to water level between in the range of 10 to 20 m bgl is observed in parts of Vaijapur and Gangapur talukas and Khuldabad and Chauka talukas. The depth to water level map is shown in Fig. 3.

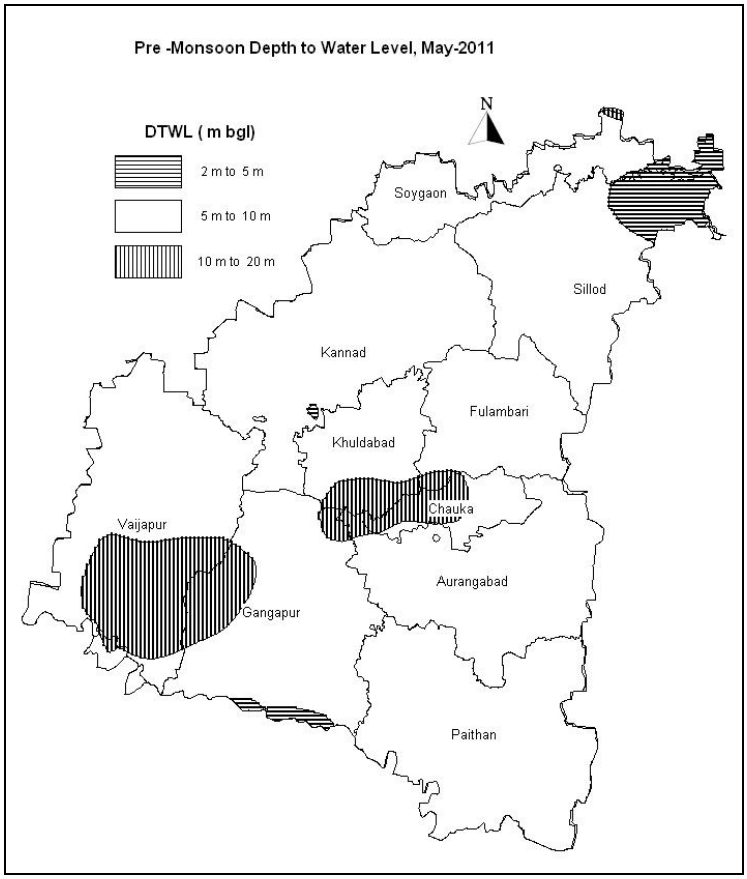

Figure-3: Pre-monsoon Depth to Water Level Map (May-2011)

4.2.2 Post-monsoon Depth to Water Level (Nov 2011)

Depth to water level map of Aurangabad district for the period November 2011 reveals that in major part f the area, depth to water level is between 0 to 5 m bgl covering

northern, central and southern part of the district. Depth to water level between 5 to 10 m bgl is observed in western and eastern part of the district. Depth to water level in the range of 10 to 20 m bgl is observed in the eastern part of Aurangabad Taluka. The depth to water level map is shown in Fig. 4.

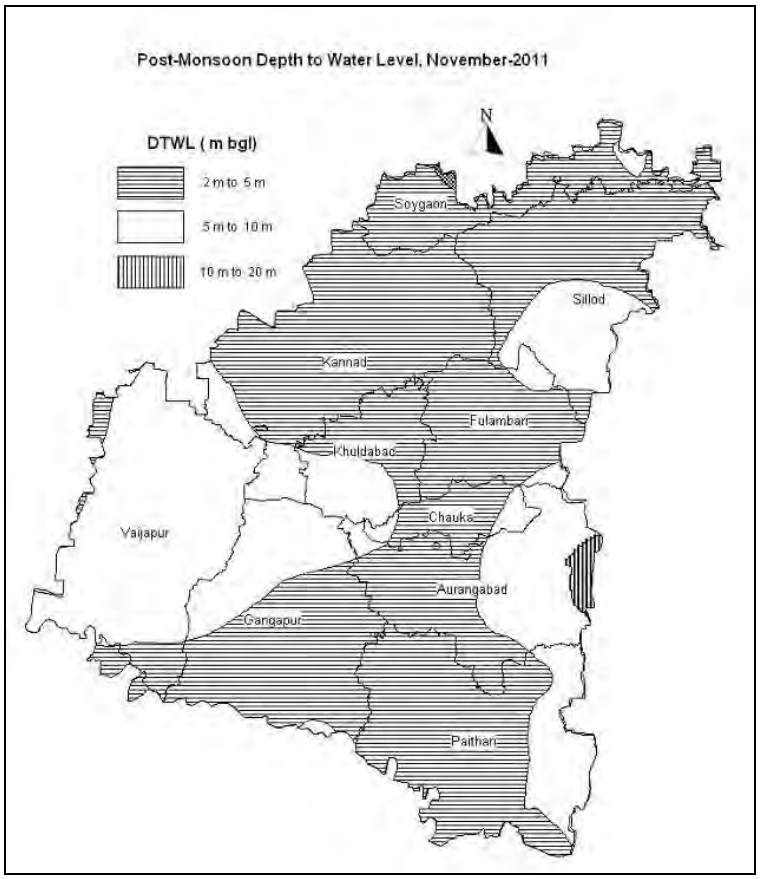

Figure-4: Post-monsoon Depth to Water Level Map (November-2011)

4.2.3 Seasonal Water Level Fluctuation (May-Nov. 2011)

The seasonal water level fluctuation for the year 2011 reveals that in most of the area of the district, water level fluctuation is less than 4 m. Rise in water level of less than 2 m is observed in northern, southern and western part of the district. The northern part covers parts of taluka Sillod, Soygaon, Kannad and Fulambri. The southern part covers part of Paithan and Gangapur. The western part of the district covers areas of taluka Vaijapur and Kannad. Rise in water level between 2 to 4 m is observed in parts of Kannad, Fulambri, Aurangabad, Khuldabad, Chauka, Paithan, Gangapur, Vaijapur and a small part of Sillod taluka. Rise in water level of more than 4 m is observed in parts of Vaijapur, Gangapur, Chauka, Khuldabad, Fulambri and Aurangabad talukas. Water level fall of less than 2 m is observed in Aurangabad, Gangapur and Paithan talukas. Water level fall of more than 4 m is observed in Aurangabad taluka.

4.2.4 Water Level Trend (2001 - 2010)

Trend of water levels of 19 NHNS for pre-monsoon and of 20 NHNS for post-monsoon periods for last ten years (2001-2010) have been computed.

Analysis of trend indicates that during premonsoon period, rise in water levels has been recorded at 10 stations and it ranges between 0.08 and 0.79 m/year. Fall in water levels has been observed at 9 stations and it ranges between 0.03 and 2.48 m/year During post-monsoon period rise in water levels has been recorded at 18 stations and it ranges from 0.06 to 1.29 m/year, whereas at 2 stations, fall in water levels ranging between 0.04 and 0.27 m/year is observed. Thus in major part of the district, both during pre and postmonsoon periods declining trends have been observed.

4.3 Yield of Wells

The yields of the wells are function of the permeability and transmissivity of aquifer encountered and it varies with location, diameter and depth of wells etc. There are mainly two types of ground water abstraction structures in the district i.e., dugwells and borewells/tubewells, however the yield of wells also vary according to nature of formation tapped and its saturated thickness. Therefore, the dugwells located in the topographic lows, morphological depressions and on or near the lineaments yield comparatively more water than the wells located elsewhere, which is particularly true in basaltic terrain. The yield of dugwells also varies depending on the season. The yields of dugwells for different formations are presented in Table-4.

Table-4: Yield of Wells

S. No.	Formation	G.W Structures	Depth Range (m bgl)	Yield Range (lps)
1	Alluvium (Porous)	Dugwell Tubewell	7-20 20-30	0.5-0.8 0.1-4.5
2	Basalt (Fissured)	Dugwell DCB Borewell	12-15 12-40 50-60	1.5-3.1 0.6-3.0 0.6-2.4

4.4 Aquifer Parameters

Aquifer parameters are available from ground water exploration carried out in the alluvial area of the district as well as from the pumping tests carried out on dugwells in Basaltic and Alluvial terrain. The transmissivity of shallow basaltic aquifers in the district is generally less than 80 m^2/day. The specific capacity of well also gives an idea about the productivity of well and is controlled by diameter and depth. In basaltic formation the

specific capacity of dugwells is generally less than 200 lpm/m of drawdown with an average of 110 lpm/m of drawdown. In Alluvium, it ranges from 130-2043 lpm/m of drawdown. The pumping tests conducted on 2 shallow exploratory wells of Alluvium indicates that transmissivity ranges from 369 to 757 m^2/day, storativity ranges from 3.3 x 10^{-5} to 1.7 x 10^{-3} whereas specific capacity ranges between 0.7 and 3.2 lps/m of drawdown.

4.5 Ground Water Resources

Central Ground Water Board and Ground Water Survey and Development Agency (GSDA), Govt of Maharashtra have jointly estimated the ground water resources of the district based on GEC-97 methodology as on March 2009. The same are presented in Table 5, whereas graphical representation is presented in Figure-5.

As per the estimation, the annual replenishable groundwater resource is 125631 ha. m with the natural discharge of 6442 ha.m. The net annual ground water availability is 119189 ha.m The annual gross draft for all uses is estimated at 73893 ha.m with irrigation sector being the major consumer having an annual draft of 70131 ha.m. The allocation domestic and industrial water requirement is at 7404 ha.m for next 25 years. The net annual ground water availability for future irrigation is estimated at 42220 ha.m. The stage of groundwater development in the district is 62 % and it falls under “Safe” category. The watershed wise resource estimation was also done and it indicated that 47 watersheds out of 52 fall under “Safe” category. The 4 watersheds that fall under “Semi-Critical category” are GP-11, GP-15, GP-9 and TE-36B whereas 1 watershed i.e., GV-41 falls under “Critical” category. In all these watersheds, future ground water development is not recommended without adhering to the precautionary measures i.e., artificial recharge to ground water resources and adoption of ground water management practices.

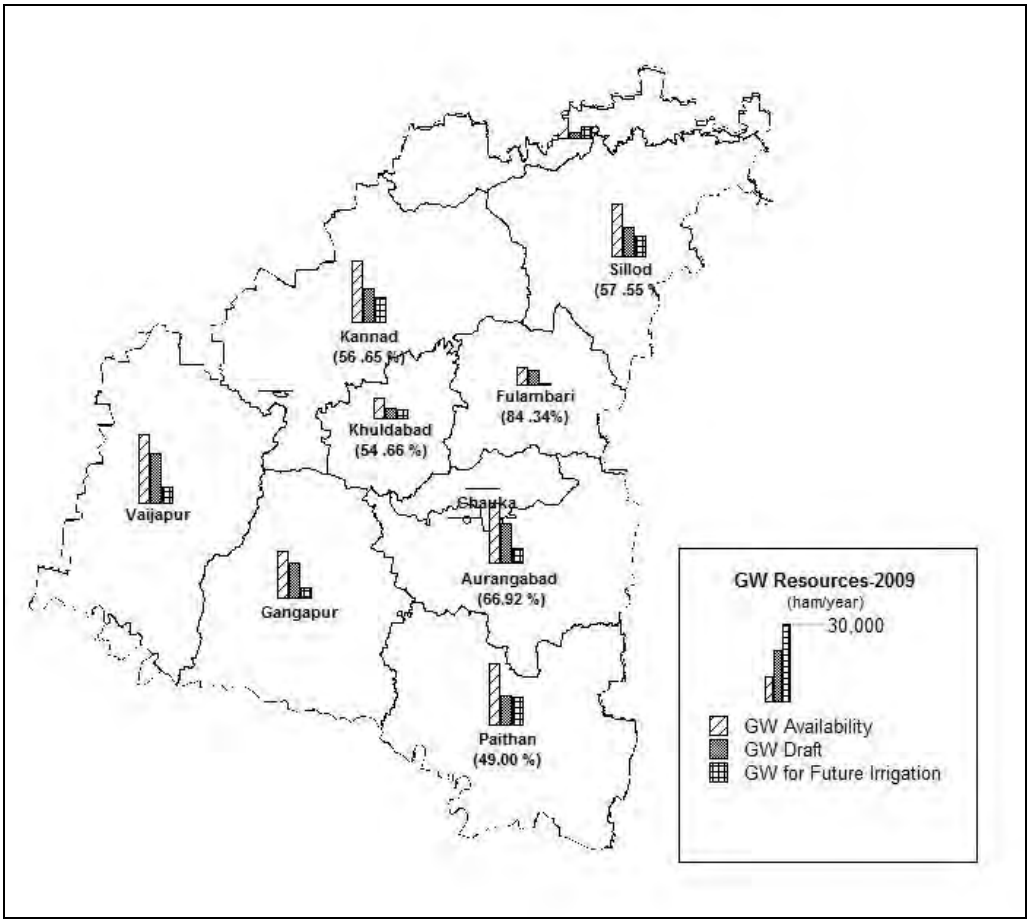

Figure-5: Ground Water Resources (March 2009)

Table-5 Taluka wise Ground Water Resources (March 2009).

S. No	Administ-Rative Unit (Taluka)	Command / Non-Command / Total	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground Water Draft for domestic and industrial water supply	Existing Gross Ground Water Draft for All uses (11+12)	Provision for domestic and industrial requirement supply to 2025	Net Ground Water Availability for future irrigation development (10-11-14)	Stage of Ground Water Development {13/10 * 100}%
1	Aurangabad	Command	5947.46	2642.13	113.05	2755.18			
	Aurangabad	Non Command	11257.00	8222.11	536.32	8758.43			
	Aurangabad	**Total**	**17204.47**	**10864.24**	**649.37**	**11513.61**	**1268.38**	**4645.63**	**66.92**
2	Fulambre	Command	568.19	226.06	7.94	234.00			
	Fulambre	Non Command	4735.48	4144.92	94.01	4238.94			
	Fulambre	**Total**	**5303.68**	**4370.98**	**101.95**	**4472.94**	**206.67**	**1013.38**	**84.34**
3	Gangapur	Command	4348.00	2404.05	103.69	2507.74			
	Gangapur	Non Command	9205.17	7508.91	363.74	7872.66			
	Gangapur	**Total**	**13553.17**	**9912.96**	**467.43**	**10380.40**	**846.33**	**3457.95**	**76.59**
4	Kannad	Command	3847.08	2175.71	54.64	2230.35			
	Kannad	Non Command	13957.93	7425.17	430.91	7856.08			
	Kannad	**Total**	**17805.01**	**9600.88**	**485.56**	**10086.44**	**972.93**	**7168.51**	**56.65**
5	Khuldabad	Command	1573.33	1046.21	31.87	1078.08			
	Khuldabad	Non Command	4649.52	2157.76	165.57	2323.34			

	Khuldabad	**Total**	**6222.85**	**3203.97**	**197.45**	**3401.42**	**391.90**	**2791.64**	**54.66**
6	Paithan	Command	7145.19	2120.92	124.98	2245.90			
	Paithan	Non Command	10750.58	5744.87	777.81	6522.68			
	Paithan	**Total**	**17895.77**	**7865.78**	**902.79**	**8768.58**	**1810.12**	**8144.32**	**49.00**
7	Sillod	Command	3476.60	1430.59	34.75	1465.35			
	Sillod	Non Command	11581.59	6871.32	329.91	7201.23			
	Sillod	**Total**	**15058.19**	**8301.91**	**364.67**	**8666.58**	**739.05**	**6305.13**	**57.55**
8	Soyegaon	Command	2841.85	387.68	19.04	406.73			
	Soyegaon	Non Command	3492.67	1720.52	82.26	1802.79			
	Soyegaon	**Total**	**6334.52**	**2108.21**	**101.31**	**2209.52**	**197.72**	**3737.25**	**34.88**
9	Vaijapur	Command	6888.15	4832.38	158.39	4990.77			
	Vaijapur	Non Command	12923.08	9069.20	333.79	9402.99			
	Vaijapur	**Total**	**19811.23**	**13901.57**	**492.18**	**14393.75**	**971.10**	**4956.59**	**72.65**
		Dist Total	**119188.9**	**70130.5**	**3762.71**	**73893.24**	**7404.2**	**42220.4**	**91.99**

Here C-Command, NC-Non-Command.

4.6 Ground Water Quality

CGWB is monitoring the ground water quality of the Aurangabad district since the last four decades through its established monitoring wells. The objectives behind the monitoring are to develop an overall picture of the ground water quality of the district. During the year 2011, the Board has carried out the ground water quality monitoring of 10 monitoring wells. These wells mainly consist of the dug wells representing the shallow aquifer. The sampling of ground water from these wells was carried out in the month of May 2011 (pre-monsoon period). The water samples after collection were immediately subjected to the analysis of various parameters in the Regional Chemical Laboratory of the Board at Nagpur. The parameters analysed, include pH, Electrical Conductivity (EC), Total Alkalinity (TA), Total Hardness (TH), Nitrate (NO_3) and Fluoride (F). The sample collection, preservation, storage, transportation and analysis were carried out as per the standard methods given in the manual of American Public Health Association for the Examination of Water and Wastewater (APHA, 1998). The ground water quality data thus generated was first checked for completeness and then the validation of data was carried out using standard checks. Subsequently, the interpretation of data was carried out to develop the overall picture of ground water quality in the district in the year 2011.

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., TH, 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
TH (mg/L)	300	600	0	9	1
NO_3 (mg/L)	45	No relaxation	0	-	10
F (mg/L)	1.0	1.5	10	-	-

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

The perusal of **Table-6** shows that the concentrations of all the parameters except nitrate in most of the samples are the within maximum permissible limit of the BIS standards. It is also seen from the **Table-6** that the potability of ground water in the wells is mainly affected due to the Nitrate (NO_3) as its concentration exceeds more than MPL in 100% of samples. Overall, it can be concluded that the ground water quality in the wells monitored in the district is affected because of high NO_3 concentrations.

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. Electrical Conductivity (EC) and Residual Sodium Carbonate (RSC) are the most important quality criteria, which influence the water quality and its suitability for irrigation.

Electrical Conductivity (EC)

The amount of dissolved ions in the water is best represented by the parameter electrical conductivity. The classification of water for irrigation based on the EC values is as follows.

Low Salinity Water (EC: 100-250 µS/cm): This water can be used for irrigation with most crops on most soils with little likelihood that salinity will develop.

Medium Salinity Water (EC: 250 – 750 µS/cm): This water can be used if moderate amount of leaching occurs. Plants with moderate salt tolerance can be grown in most cases without special practices for salinity control.

High Salinity Water (EC: 750 – 2250 µS/cm): This water cannot be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected.

Very High Salinity Water (EC: >2250 µS/cm): This water is not suitable for irrigation under ordinary condition. The soils must be permeable, drainage must be adequate, irrigation water must be applied in excess to provide considerable leaching and very salt tolerant crops should be selected.

The classification of ground water samples collected from monitoring wells for was carried out irrigation purpose and given below in **Table-7**.

It is clear from the **Table-7** that maximum number of samples (90%) fall under the category of high salinity water while nearly 10% of samples fall in very high salinity water category. This shows that the ground water in the pre-monsoon season from shallow aquifer in the district should be used for irrigation with proper soil and crop management practices..

Table-7: Classification of Ground Water for Irrigation Based on EC.

Type	EC (µS/cm)	No. of Samples	% of Samples
Low Salinity Water	<250	Nil	Nil
Medium Salinity Water	250-750	Nil	Nil
High Salinity Water	750-2250	9	90
Very High Salinity Water	>2250	1	10
Total		**10**	**100.0**

5.0 Ground Water Management Strategy

Ground water has special significance for agricultural development in the district as 71% of irrigation is ground water based. The ground water development in some parts of the district has reached a critical stage resulting in decline of 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

The present average stage of ground water development in the district is 62%. Thus there is scope for further ground water development in the district. However, cautious groundwater development is necessary. 4 watersheds that fall under “Semi-Critical category” are GP-11, GP-15, GP-9 and TE-36B whereas 1 watershed i.e., GV-41 fall under “Critical” category. In all these watersheds, future ground water development is not recommended without adhering to the precautionary measures i.e., artificial recharge to ground water resources and adoption of ground water management practices.

5.2 Water Conservation and Artificial Recharge

CCT, nala bunding, gabion structures, vegetative bunds, terracing etc are suitable for the Satpuda hill range. In the Basaltic area, the 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 structures suitable for alluvial area, 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. Such areas are available throughout the district except in Soygaon taluka, where water levels are shallow.

6.0 Ground Water Related Issues and Problems

In major parts of the district falling water level trend is observed in southern, south western and central parts occupying almost entire Paithan, Gangapur, Vaijapur and Khuldabad talukas and parts of Kannad and Sillod talukas. Thus the future water conservation and artificial recharge structures needs to be prioritized in these areas. Although a considerable area in Aurangabad district is under canal command of various major and minor irrigation projects but major parts the district is showing declining trend of

water levels due to exploitation of ground water for irrigation and other purposes at a faster rate. There is not much scope for conjunctive use in such areas. But an area of about 61,300 ha falling under canal command of major and minor irrigation projects in Paithan, Sillod and Aurangabad talukas is showing rising trend. The conjunctive use of water is recommended in this area.

Ground water quality is adversely affected at many places due to high concentration of some parameters especially nitrate. Adequate sanitary protection to the wells may be provided to control the nitrate contamination.

7.0 Areas Notified by CGWA/SGWA

As per ground water resource estimation all the talukas fall under 'Safe' category, hence till March 2012 no area has been notified either by CGWA or SGWA.

8.0 Recommendations

1. Before deciding to develop ground water potential of Aurangabad district it is of prime importance to consider the stage of ground water development so that the system is not damaged and no adverse effects like over exploitation, deterioration of water quality etc., happen.
2. The design of ground water structures depends upon geological formation. In basaltic area, dugwells of 5-6 meter diameter and 12-15 m depth, and borewells of 50-60 meters depth are recommended while in alluvial area, the dugwells of 2-4 meter diameter and 7-20 m depth and shallow tubewells of 20-30 meters depth are recommended to be constructed.
3. Major part of the district is underlain by Deccan Trap Basalt, where only dugwells are the most feasible structures for ground water development.
4. The sites for borewells need to be selected only after proper scientific investigation. Borewells generally tap deeper fractures, which may not be sustainable. Besides, the borewells should only be used for drinking water supply and not for irrigation.

5. As per the estimation, the annual replenishable groundwater resource is 125631 ha. m with the natural discharge of 6442 ha.m. The net annual ground water availability is 119189 ha.m. The annual gross draft for all uses is estimated at 73893 ha.m with irrigation sector being the major consumer having an annual draft of 70131 ha.m. The allocation domestic and industrial water requirement is at 7404 ha.m for next 25 years. The net annual ground water availability for future irrigation is estimated at 42220 ha.m. The stage of groundwater development in the district is 62 % and it falls under “Safe” category. The watershed wise resource estimation was also done and it indicated that 47 watersheds out of 52 fall under “Safe” category. The 4 watersheds that fall under “Semi-Critical category” are GP-11, GP-15, GP-9 and TE-36B whereas 1 watershed i.e., GV-41 fall under “Critical” category. In all these watersheds, future ground water development is not recommended without adhering to the precautionary measures i.e., artificial recharge to ground water resources and adoption of ground water management practices.
6. The concentration of nitrate is found more than MPL in all the wells indicating high Influence of anthropogenic activity in the vicinity of the wells, causing nitrate contamination. It may cause toxic effect on young infants. Ground water from these areas may be used only after proper treatment or demineralization. Adequate sanitary protection to the wells may be provided to control nitrate contamination.
7. CCT, nala bunding, gabion structures, vegetative bunds, terracing etc are suitable for the Satpuda hill range. In the Basaltic area, the 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.
8. The existing village ponds/tanks need to be rejuvenated to act both as water conservation and artificial recharge structures.