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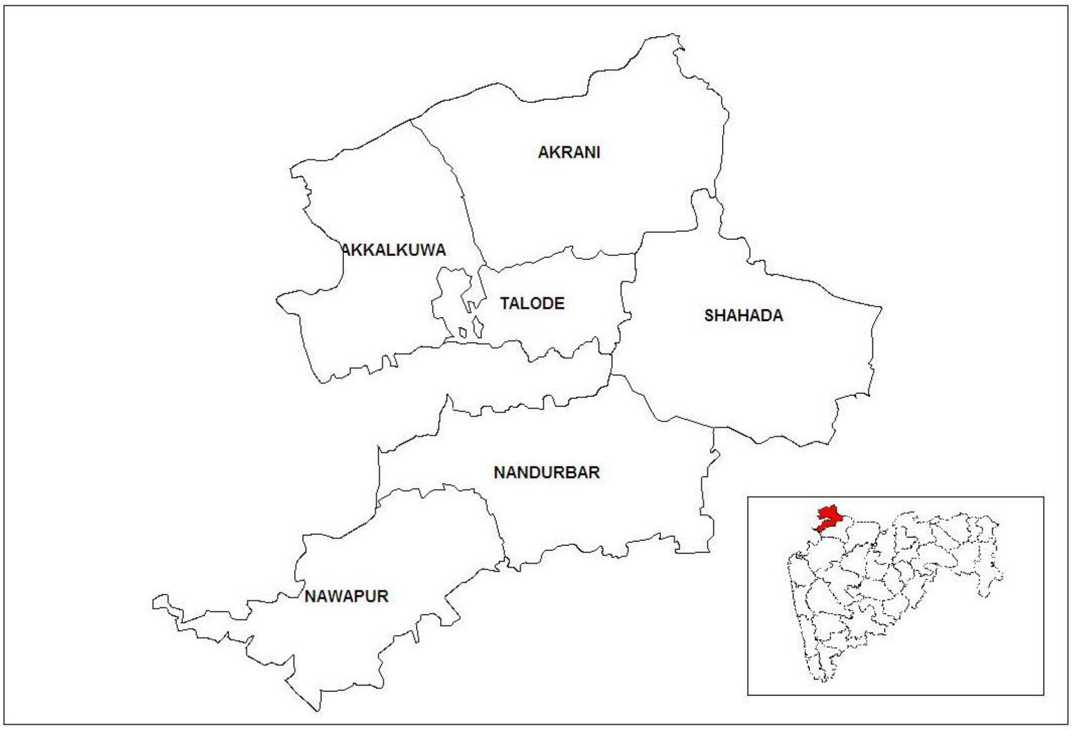
भारत सरकार
जल संसाधन मंत्रालय
केंद्रीय भूजल बोर्ड

GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

महाराष्ट्र राज्य के अंतर्गत नंदुरबार जिले की भूजल विज्ञान जानकारी

GROUND WATER INFORMATION NANDURBAR DISTRICT MAHARASHTRA



By द्वारा

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मध्य क्षेत्र, नागपुर

CENTRAL REGION
NAGPUR
2013

NANDURBAR DISTRICT AT A GLANCE

1. GENERAL INFORMATION		
Geographical Area	:	5034 sq. km.
Administrative Divisions (As on 31/03/2011)	:	Taluka- 6, Nandurbar, Nawapur, Shahada, Taloda, Akkalkuva and Akrani
Villages	:	864 mm
Population (2001 Census)	:	1,646,177
Average annual Rainfall	:	801 mm
2. GEOMORPHOLOGY		
Major Physiographic unit	:	4; Satpura Hilly Region, Tapi River Valley proper, Region of the dykes and residual hills of the Sahyadri Spurs.
Major Drainage	:	Two: **Tapi and Narmada**
3. LAND USE (2011)		
Forest Area	:	1040 Sq.km
Net Area Sown	:	840 Sq.km
Cultivable Area	:	4130 Sq.km
4. SOIL TYPE		
3; Coarse shallow soils, medium deep soils and deep black soils.		
5. PRINCIPAL CROPS (2011)		
Rice	:	218.96 Sq.km
Jowar	:	606.64 Sq.km
Total Pulses	:	1652.01 Sq.km
Cotton	:	461.96 Sq.km
6. IRRIGATION BY DIFFERENT SOURCES (2006-07)		
Nos./Potential Created (Sq.km)		
Dugwells	:	16939/444.75
Borewells (Deep and Shallow)	:	12696/339.80
Surface flow schemes	:	712/483.53
Surface Lift Schemes	:	14589/18.59
7. GROUND WATER MONITORING WELLS (As on 31/05/2011)		
Dugwells	:	14
Piezometers	:	0
8. GEOLOGY		
Recent	:	Alluvium
Upper Cretaceous-Lower Eocene	:	Deccan Trap Basalt
Middle-Upper Cretaceous	:	Bagh Bed
9. HYDROGEOLOGY		
Water Bearing formation	:	**Basalt**-Weathered/fractured/ jointed vesicular/massive, under phreatic and semi-confined to confined conditions. **Alluvium**- Sand and Gravel under semi-confined to confined conditions.
Premonsoon Depth to Water Level	:	6.20 to 13.6 m bgl (May-2011)
Postmonsoon Depth to Water Level	:	0.90 to 15.20 m bgl (Nov-2011)
Premonsoon Water Level Trend	:	Rise:0.0039 to 2.76 m/year

(2001 to 2010)		Fall: Negligible (0.01 to 0.97 m/year)
Postmonsoon Water Level Trend	:	Rise: 0.0064 to 0.39 m/year
(2001 to 2010)		Fall: 0.02 to 0.47 m/year

10. GROUND WATER EXPLORATION- (As on 31/3/2011)

Wells Drilled	:	EW-22, OW-11, PZ-4
Depth Range	:	16.70 to 165.50 m bgl
Discharge	:	0.27 to 7.40 lps
Transmissivity (m^2/day)	:	210 to 6394 m^2/day
Storativity	:	1.05×10^{-1}

11. GROUND WATER QUALITY

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

Type of Water	:	$Ca\text{-}HCO_3$

12. DYNAMIC GROUND WATER RESOURCES- (As on 31/03/2009)

Net Annual Ground Water Availability	:	72660.2 Ham
Annual Ground Water Draft (Industrial + Domestic)	:	2372.664 Ham
Allocation for Domestic and Industrial requirement up to next 25 years	:	4745.33 Ham
Stage of Ground Water Development	:	37.55 %

13. GROUND WATER CONTROL & REGULATION

Over-Exploited Taluka	:	Nil
Critical Taluka	:	Nil
Notified Taluka	:	Nil

14. MAJOR GROUND WATER PROBLEMS AND ISSUES

Almost entire Akkalkuwa taluka and parts of Akrani, Nawapur and Nandurbar talukas are categorized as drought area. The deeper water levels are observed in southern part of the district. Ground water quality is adversely affected by nitrate contamination in 10% of the samples collected in May 2011. However, general groundwater quality of the district is potable as per the analysis of the samples.

Ground Water Information
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Nandurbar District

1.0 Introduction

Nandurbar district was derived from Dhule district on 1st July 1998 and it lies between north latitude 21°00’00” to 22°00’30” and east longitude 73°31’00” to 74°45’30”. The district covers a total geographical area of 5034 sq.km. It is surrounded by Dhule district in the south and east, Gujarat State in the west and Madhya Pradesh State in the north.

The district headquarters is Nandurbar. For administrative convenience, the district is divided in 6 talukas viz, Nandurbar, Nawapur, Shahada, Taloda, Akkalkua and Akrani. The population of Nandurabar district is 16,46,177 and the population density is 276 persons/sq.km. as per the 2011 census. Agriculture is the main occupation of the people. The district forms part of Tapi and Narmada basins.

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

Table 1: Studies Undertaken by CGWB.

S. No.	Year	Area Surveyed	Type of Survey/Study
1.	1965-66	Covering parts of Top sheet No’s 46 K/3,46,K7, and K/11	Systematic Hydrogeological Survey
2.	1986-87	Covering parts of Top sheet No’s 46 K/4,46,K8, and K/12	Systematic Hydrogeological Survey
3.	1988-89	Covering parts of Top sheet No’s 46 G/11 and 12.	Systematic Hydrogeological Survey
4.	1997-98	Tapi Basin, Dhule district,	Reappraisal Hydrogeological Study

Apart from above studies, ground water exploration in the Tapi Alluvial areas of the district has also been taken up during 1982-87. The status and salient features of ground water exploration as on March 2011 are given in Table-2.

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

S. No.	Taluka	Wells			Depth (mbgl)	SWL (mbgl)	Discharge (lps)	Draw-Down (m)	Zones (mbgl)
		EW	OW	PZ					
1	Akkalkuwa	3	1	-	16.70-26.60	2.27-7.95	1.86-7.40	1.25-8.05	5.18-18.40
2	Shahada	7	5	1	26.50-165.50	1.50-36.20	1.10-4.00	1.06-19.02	5.00-63.00
3	Taloda	11	5	1	26.60-162.50	5.23-16.27	0.27-6.10	4.05-5.52	5.30-66.44

4	Nandurbar	1	-	1	-	-	-	-	-
5	Navapur	-	-	1	-	-	-	-	-
6	Total	22	11	4	16.70-165.50	1.50-36.20	0.27-7.40	1.06-19.02	5.18-66.44

In Alluvial areas of the district 22 exploratory wells (EW), 11 observation wells (OW) were constructed. In addition to these 4 Pizometers were also drilled in the district under Hydrology Project. The depth of these wells ranged from 16.70 to 165.50 metres below ground level (m bgl). The discharge from these wells varied from 0.27 to 7.40 litres per second (lps), and 4 exploratory wells were found to be high yielding with discharge of more than 3 lps. Static water levels ranged from 1.50 to 36.20 m bgl. Aquifer zones have been encountered in most of the wells within 65 m depth.

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

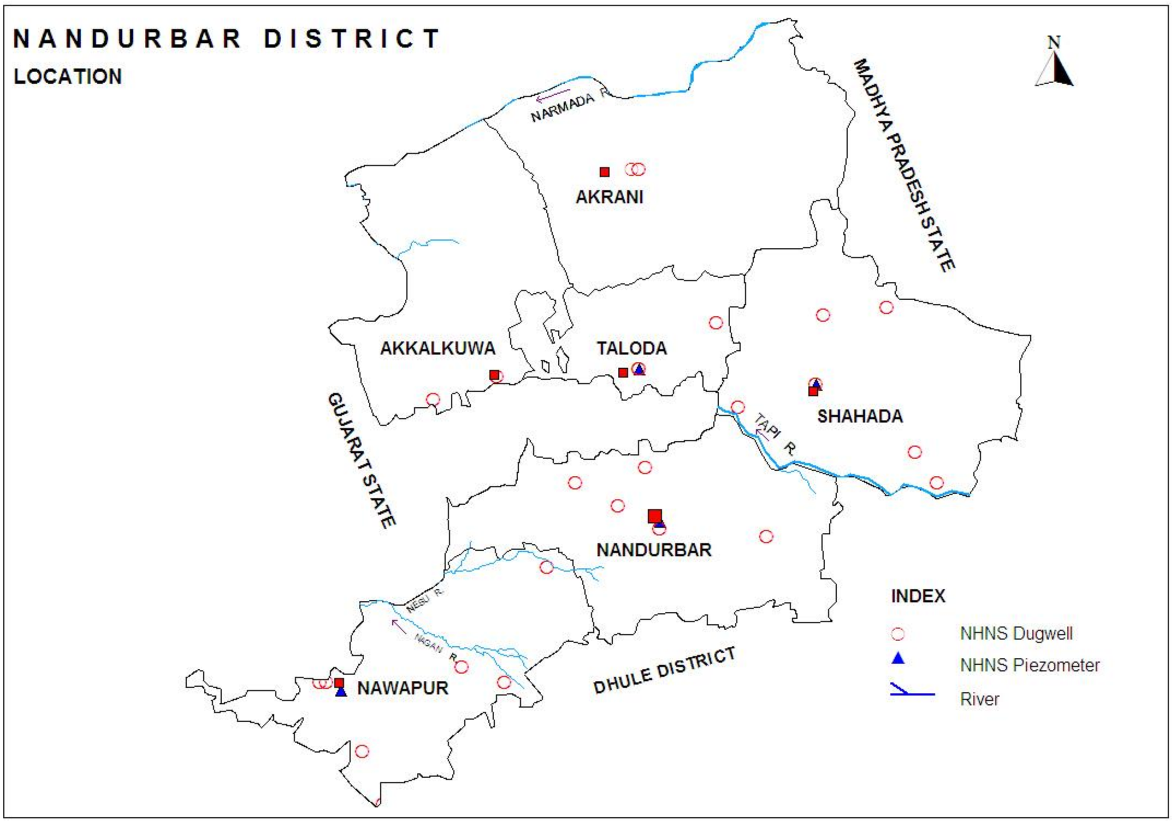

Figure-1: Location

2.0 Climate and Rainfall

The climate of the district is characterized by a hot summer and general dryness throughout the year except during the south-west monsoon season, i.e., June to September. The daily mean minimum temperature is 15.8°C and mean maximum temperature is 40.7°C.

The average annual rainfall over the district is about 801 mm. It is the minimum in the eastern part of the district and increases westwards towards Nawapur and Akkalkuwa. The study of negative departures of the annual rainfall over normal reveals that north western and south western parts of the district experienced moderate and severe drought conditions for more than 20% of years. Hence this parts occupying almost entire Akkalkuwa taluka and parts of Akrani, Nawapur and Nandurbar talukas can be categorized as drought area. The average annual rainfall of last ten years (2002-2011) in the district varied from 645 mm (Shahada) to 1192 mm (Nawapur) and the same is presented in Table-3.

Table 3: Annual Rainfall Data (2002-2011) **(in mm)**

Taluka	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
Nandurbar	969	1265	956	1284	1386	988	759	721	753	619	929.7
Nawapur	764	1255	1720	2103	1456	1504	1269	828	1043	860	1191.93
Shahada	405	887	604	571	1223	810	724	627	623	573	644.93
Taloda	572	1065	880	1099	1653	1156	945	783	900	827	901.79
Akrani	943	1118	1354	924	2003	1088	924	611	705	797	938.71
Akkalkuwa	667	1024	1035	1170	1764	1682	1512	905	915	1128	1068.93

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

3.0 Geomorphology and Soil Types

The district can be broadly divided into four distinct physiographic units i.e., Satpura Hilly Region, Tapi River Valley proper, Region of the dykes and residual hills of the Sahyadri Spurs with eastward trending streams in between and Nawapur and Western Nandurbar Region with a westerly aspect below the Sahyadri Scarps.

North of Tapi River, the whole length of the rich alluvial plain is bounded by the steep southern face of the Satpudas, a belt of mountain land about 30 km broad. Satpudas rise from the first range of hills, ridge behind ridge to the central ridge to a height of about 600 metres above mean sea level (m amsl) and then slope down rather steeply towards the Narmada. The Tapi River valley is observed on both sides of Tapi River in parts of Nandurbar, Shahda and Taloda talukas and Sindkhed talukas. The region of dykes and residual hills of the Sahyadri Spurs comprises southern part of Nandurbar taluka. Nawapur and western Nandurbar region with a westerly aspect below the Sahyadrian scarps, is full of steep hill ranges covered with forests.

Mainly three types of soils are observed in the district i.e., coarse shallow soils, medium deep soils and deep black soils. The soils of the district are basically derived from Deccan Trap Basalt to the south of Tapi River. North of Tapi River the soils are from Deccan Trap Basalt as well as from Alluvial formations. The northern part of the district has dark brown to yellowish brown coarse shallow to medium deep soils, with clayey loamy deep soils of Tapi River and Narmada River valley to its south and north respectively. Below the Tapi River valley comes the belt of medium deep soils mostly with interception of medium and shallow soils in scattered patches, depending on the local conditions.

Except the northern part drained by Narmada River and its tributaries such as Kanni, Devnad/Devganga and Udai, the entire district is mainly drained by Tapi River and its tributaries such as Nagan, Shivan, Gomai and Dehli.

4.0 Ground Water Scenario

4.1 Hydrogeology

The major part of the district is covered by basaltic flows commonly known as Deccan Traps and dykes of Upper Cretaceous-Lower Eocene age. Tapi Alluvial deposits are observed in Tapi River valley occupying parts of Taloda, Shahada and Nandurbar talukas. Along the north-western corner of the district, pre-trappean Bagh Beds of Middle to Upper Cretaceous age are exposed over a small area along the valley of the Devganga River. A map depicting the hydrogeological features is shown in **Figure-2**.

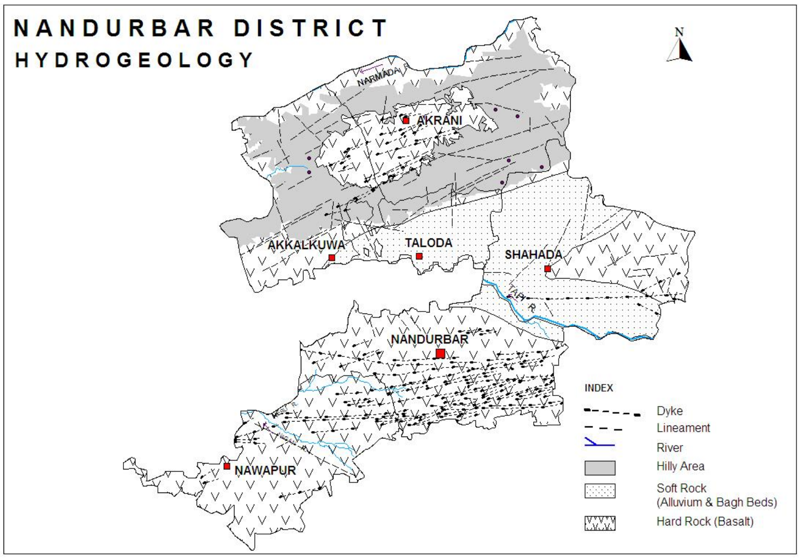

Figure-2: Hydrogeology

4.1.1 Hard Rock Areas

4.1.1.1 Deccan Trap Basalt

Deccan Trap includes several flows of basalt which are supposed to have extruded from fissure volcanoes. The flows are mainly of two types i.e., "Pahoehoe" and "aa" types, the former being very common. It is observed in north. The flows have been intruded by large number of doleritic dykes. The dykes are generally 1 m to 20 m in width. However, few dykes are as much as 50 m wide. The dykes are aligned in an ENE-WSW direction and a few gave N-S or WNE-ESE trends.

The ground water occurs under unconfined conditions in the near surface strata down to the depth of 20 m in the weathered zone of the vesicular/amygdaloidal Basalt, jointed and fractured units of massive Basalt. Ground water occurs under semi-confined to confined conditions generally below 40 m depth beneath the red bole and dense massive Basalt in the fractured or jointed massive/vesicular/amygdaloidal Basalt. On the elevated plateau tops having good areal extent, local water table develops in top most layers and the wells in such areas show rapid decline water levels in postmonsoon season and go dry during peak summer. In the foot hills zone the water table is relatively shallow near the water courses and deep away from it and near the water divides. In the valleys and plains of river basin the water table aquifer occurs at shallow depth and the wells in such areas do not go dry and sustain perennial yield except in extreme summer or drought conditions. The yield of the dugwells varies from 60 to 125 m^3/day, whereas that of borewells varies form 2 to > 20 m^3/hr, however in most of the borewells it ranges between 2 to 10 m^3/hr.

4.1.2 Soft Rock Areas

4.1.2.1 Bagh Beds

The oldest geological formation met within the north-western part of the district is the Bagh beds of Middle to Upper Cretaceous age. They occur as inliers within the Deccan Traps over an area 9 km in length and 5 km in width. These rocks are conspicuously exposed on the banks of Devganga river and its tributaries. The formation comprises of Nimar Sandstone, Shale, grey Limestone and upper Sandstone. The Sandstone beds are porous and permeable and the Limestone holds water in the joints, fissures and solution cavities

4.1.2.2 Alluvium

Alluvial deposits of Tapi River valley occurs in long narrow basin, which are probably caused by faulting. About a 15% of the district is occupied by Alluvium. It consists of clays, silt, sand, gravels and boulders etc. The beds of sand and gravels are discontinuous and lenticular and pinch out laterally within short distance. They are mixed with large proportions of clayey material rendering delimiting of individuals granular horizons difficult. As per ground water exploration data Alluvium is encountered down to 100 m depth. Ground water occurs under water table, semi-confined and confined conditions in inter granular pore spaces of gravel and sand. The yield of the dugwells varies between150 and 200 m^3/day, whereas that of exploratory wells varies form 0.27 to 7.40 lps as per exploration data. The yields of the tubewells drilled by State ground water department/agency ranges from 20 to 250 m^3/hr.

4.2 Water Level Scenario

Central Ground Water Board periodically monitors 14 National Hydrograph Network Stations (NHNS) in Nandurbar district, four times a year i.e. in January, May (Premonsoon), August and November (Postmonsoon).

4.2.1 Depth to Water Level – Pre monsoon (May-2011)

The premonsoon depth to water level in the district ranges between 6.20 and 13.6 mbgl. Depth to water level during premonsoon (May 2011) has been depicted in **Figure-3**.

Major part of the district is having water levels of 5-10 m bgl depth viz. Akkalkkuva, Akarni, Taloda, Shahada and almost all parts Nandurbar and small patched of Navapur. The moderately deeper water levels of 10 to 20 m bgl are observed in SW part of the district in Nawapur Taluka and in a small part of Nandurbar taluka in its southern part.

4.2.2 Depth to Water Level – Postmonsoon (Nov. 2011)

The depth to water level during postmonsoon period (Nov 2011) ranges between 0.90 to 15.2 m bgl. Spatial variation in post monsoon depth to water level is shown in **Figure-4**.

The shallow water levels of less than 2 m bgl are seen the hilly areas of Akkalkkuva, Akarni (extreme northern part of the district) and in few very small isolated patch of Navapur taluka in its southern part. The water levels of 2 to 5 m bgl are observed in parts of Akkalkkuva, Akarni (Northern part), Nandurbar (NW part) and Navapur talukas. Majot part of the district is having water levels of 5-10 m bgl depth viz. Akkalkkuva (southern part), Akarni (southern part), Taloda (SW and NE parts), Shahada (almost entire taluka), Nandurbar(primarily in southern part) and Navapur (almost entire taluka except some patches in southern part). The moderately deeper water levels of 10 to

20 m bgl are seen in alluvial parts of Taloda and Shahada talukas as a longitudinal patch.

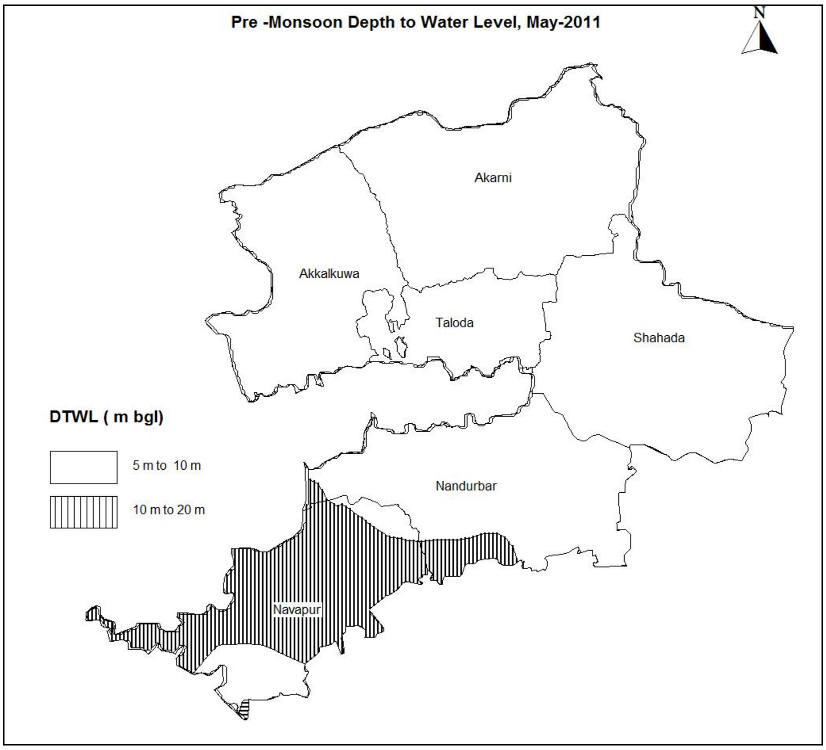

Figure-3: Depth to Water Level (Premonsoon- May 2011)

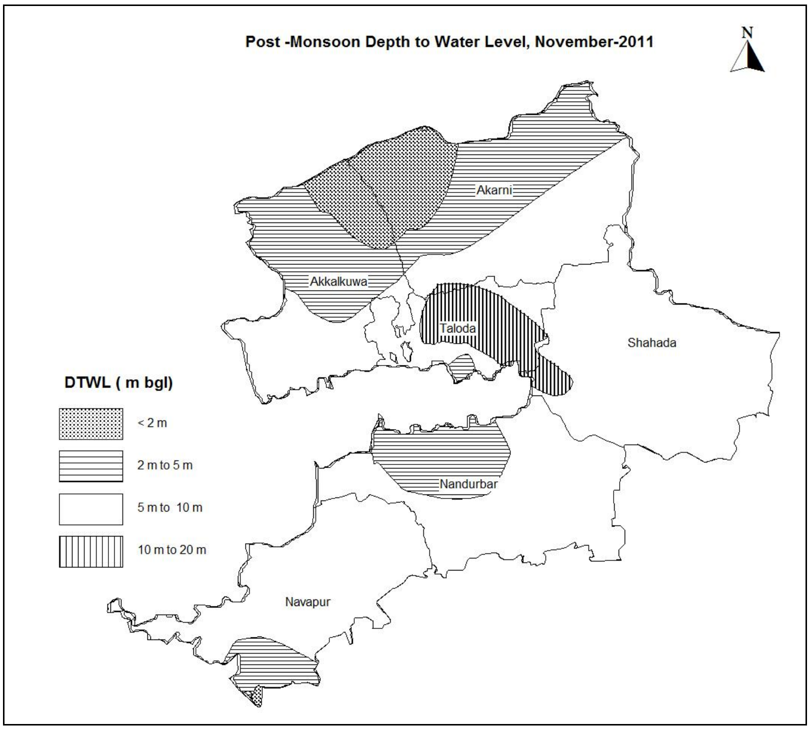

Figure-4: Depth to Water Level (Postmonsoon- Nov. 2011)

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

Major parts of the district is characterised with fluctuation range of 2-4 m viz.

Akkalkkuva, Akarni, Taloda, Shahada and a major part of Nandurbar taluka and a small patch of Nawapur taluka. Fluctuation of more than 4 m is seen in parts of Nawapur taluka (N and NE parts) and in parts of Nandurbar taluka (SE part).

4.2.4 Water Level Trend (2001 to 2010)

Trend of water levels for premonsoon and postmonsoon period for last ten years (2001 to 2010) have been computed for 14 NHNS. Rising trend of premonsoon water level varying from 0.0039 to 2.76 m/year in major part of the district whereas, in small area falling trend has been observed ranging from 0.01 to 0.97 m/year.

During post monsoon rise is recorded in the range of 0.0064 to 0.39 m/year and fall is observed in the range of 0.02 to 0.47 m/year.

Out of the 14 wells analysed 10 wells have shown rising trend during premonsoon and post monsoon whereas, in 4 wells falling trend in premonsoon and post monsoon period.

4.3 Aquifer Parameters

The aquifer parameters of shallow aquifer as determined during previous studies carried out by the Board are presented in Table-4. In Basalt transmissivity ranges from 6 to 96 m^2/day, the storativity varies between 0.017 to 0.0429 and the specific capacity ranges from 41 to 220 lpm/m of drawdown, whereas in Alluvium transmissivity is about 70 m^2/day and the specific capacity ranges from 173 to 616 lpm/m of drawdown.

The aquifer parameters for deeper alluvial aquifer are also available from the pumping tests conducted by CGWB on exploratory wells. The results show that transmissivity ranges from 210 to 6394 m^2/day m^2/day, the storativity value was observed as 1.05×10^{-1} and the permeability ranges from 12.00 to 606.76 m/day, whereas the specific capacity ranges form 0.45 to 7.02 lpm/m of drawdown.

Table 4: Aquifer Parameters.

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

4.4 Yield of Dugwells and Borewells

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

The borewells drilled by State ground water department/agency in Deccan Trap Basalt indicate wide variation of discharge in the range of 2 to > 20 m^3/hr, however in majority of the borewells it ranges between 2 to 10 m^3/hr. The yield of exploratory wells constructed by CGWB ranges from 0.27 to 7.40 lps as seen from exploration data. The yields of the tubewells drilled by State ground water department/agency ranges from 20 to 250 m^3/hr.

Table 5: Yield of Dugwells.

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

4.5 Ground Water Resources

Central Ground Water Board and Ground Water Survey and Development Agency (GSDA) have jointly estimated the ground water resources of Dhule district based on GEC-97 methodology. The same is presented in Table-6. Taluka wise ground water resources are shown in **Figure-5.**

As per the estimation, net annual ground water availability comes to be 72660.20 Ham. The gross draft for all uses is estimated at 27281.10 Ham with irrigation sector being the major consumer having a draft of 24908.44 Ham. The allocation for domestic and industrial requirements for the next 25 years are worked out at 4745.33 Ham, whereas the net ground water availability for future irrigation is estimated at 43006.43 Ham.

Table 6: Ground Water Resources (March 2009).

District	Administrative Unit	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}%
Nandurbar	Akkalkuva	7120.11	1045.60	372.98	1418.58	745.96	5328.56	19.92
Nandurbar	Akrani	7862.88	660.76	292.80	953.56	599.21	6615.56	12.13
Nandurbar	Nandurbar	16129.88	9969.88	403.72	10373.59	822.70	5417.06	64.31
Nandurbar	Nawapur	22486.14	5276.70	514.30	5791.00	1013.34	16116.34	25.75
Nandurbar	Shahada	13842.57	6232.26	529.48	6761.73	1093.72	6548.91	48.85
Nandurbar	Taloda	5218.62	1723.25	259.39	1982.64	470.41	2980.00	37.99
Total		**72660.20**	**24908.44**	**2372.66**	**27281.10**	**4745.33**	**43006.43**	**37.55**

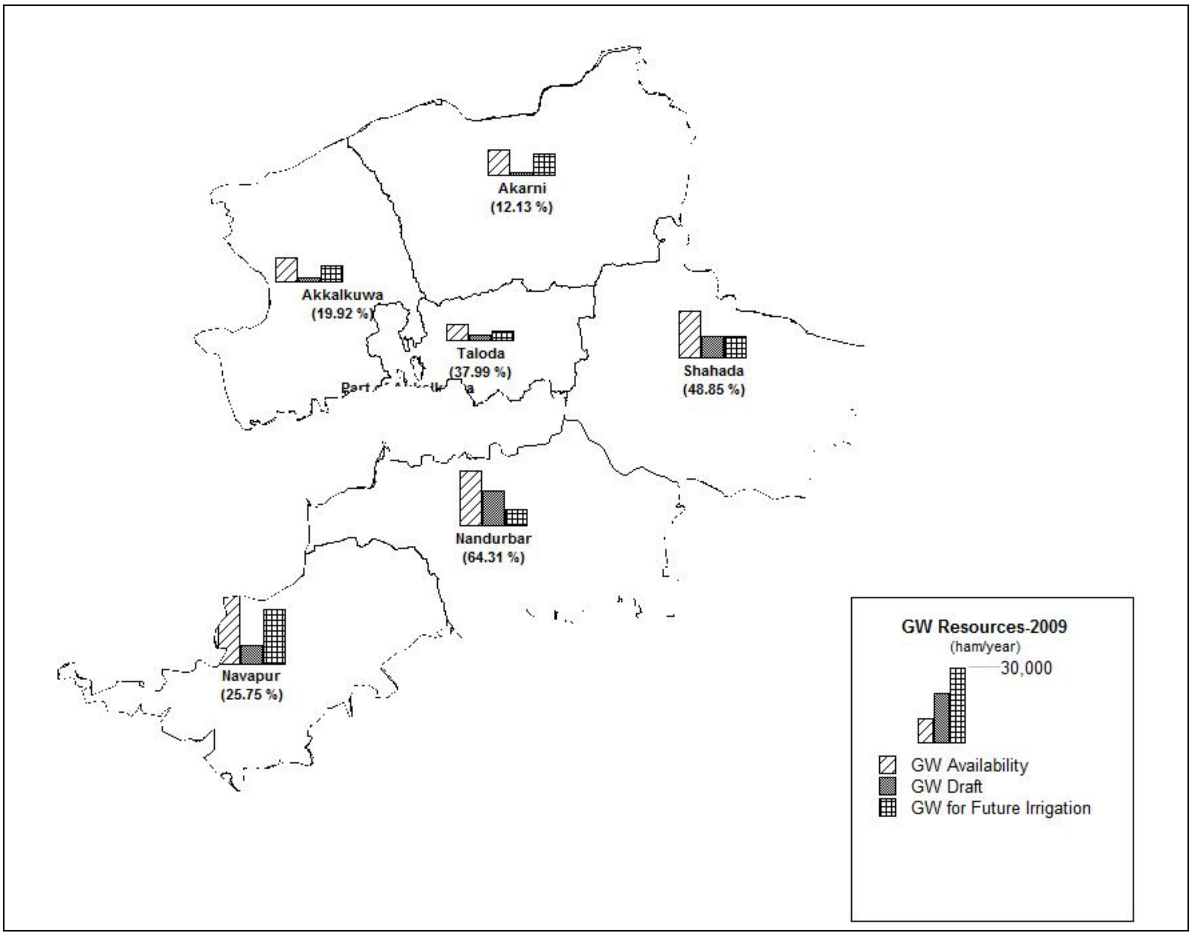

Figure-5: Ground Water Resources (March 2009)

The stage of ground water development varies from 12.13% (Akrani) to 64% (Nandurbar) and all the talukas come under "Safe" category. The overall stage of ground water development for the district is 37%.

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 2010, CGWB has carried out the ground water quality monitoring at 11 NHNS.

The results of chemical analysis show that the ground water in the district is alkaline in nature.

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, NO_3 and F prescribed in the standards and is given in Table-7.

Table 7: Classification of Ground Water Samples based on BIS Drinking Water Standards (IS-10500-91, Revised 2003).

Parameters	**DL** (mg/L)	**MPL** (mg/L)	**Samples with conc. < DL**	**Samples with conc. in DL-MPL**	**Samples with conc. >MPL**
TDS	500	2000	4	6	Nil
TH	300	600	9	1	0
NO_3	45	No relaxation	9	-	1
F	1.0	1.5	10	Nil	Nil

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

Ground water quality is adversely affected by nitrate contamination in only one sample collected from Bhadwad. Overall, the ground water quality scenario of the wells monitored in the district is bright and it is suitable for drinking in most of the district except where localised nitrate contamination is observed.

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

4.6.2.1 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 RSC values for its suitability for irrigation purpose is shown below in Table-8.

The perusal of Table-8 indicates that the RSC values of all ground water samples collected from the district is less than 1.25 meg/l suggesting that the quality of ground water in the monitoring wells is good for irrigation purpose.

Table 8: Classification of Ground water for Irrigation based on RSC.

RSC (meg/l)	**<1.25**		**1.25-2.50**		**>2.50**	
Category	**Good**		**Doubtful**		**Unsuitable**	
Total Samples	No. of Samples	%	No. of Samples	%	No. of Samples	%
12	10	100	Nil	Nil	Nil	Nil

4.7 Status of Ground Water Development

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

As per Minor Irrigation Census 2006-07, the district had 16939 irrigation dugwells, which create an irrigation potential of about 444.75 sq.km. In addition to this about 339.80 sq.km, of irrigation potential is created through 12696 shallow and deep borewells/tubewells.

State Government agencies have drilled number of borewells/tubewells fitted with hand pumps and electric motors for rural drinking water purposes in the district. In all till March 2007, GSDA, Government of Maharashtra is operating 4931 successful borewells/tubewells for rural water supply under various schemes in the district, out of which 4439 wells are fitted with hand pumps and the rest 492 are fitted with electric pumps.

5.0 Ground Water Management Strategy

Ground water has special significance for agricultural development in the district. The ground water development in almost entire district is on lower side, thus presenting plenty of scope for further development. However, in some parts of the district declining water level trends have been observed. Thus, there is a need to adopt an integrated approach of development of ground water resources dovetailed with ground water augmentation to provide sustainability to ground water development.

5.1 Ground Water Development

Major part of the district, particularly the southern part, is underlain by Deccan Trap Basalt. The development potential of ground water in Deccan Trap Basalt is low to medium in entire Akkalkuva, Dhadgaon Akrani and Navapur talukas and parts of Shahada, Nandurbar and Taloda talukas. The ground water in these parts can be developed through dugwells and dug-cum-bored wells (DCB) and borewells. However, the dugwells are the most feasible structures and borewells should normally be avoided as they generally tap deeper fractures, which may not be sustainable. Besides, the borewells should only be used for drinking water supply and not for irrigation. The sites for borewells also need to be selected only after proper scientific investigation so as to minimise the rate of failure. In the hilly areas of Dhadgaon Akrani, Taloda and Shahada talukas rocks are hard and compact, resistant to weathering with steep gradient causing rapid runoff and low infiltration and such areas are not feasible for ground water development.

In the Alluvium part of the district occupying southern parts of Shahada and Taloda and northern part of Nandurbar taluka, the groundwater potential is medium to high and groundwater can developed through dugwells, dug-cum-bored wells (DCB) and tubewells. The aquifer zones within 65 m bgl can be used for agricultural purposes by means of shallow tubewells constructed down to the depth of 60-65 m and yielding up to 5 lps for 30 m lift.

The nature and yield potential of the aquifers occurring in different areas is given below in Table-9.

Table 9: Nature and Yield Potential of Aquifers.

S. No	Taluka	Main Aquifer	Yield Potential	Type of wells Suitable
1.	Nandurbar	Basalt	Low to Medium	Dugwell, DCB and Borewell
		Alluvium	Medium to High	Dugwell, DCB and Tubewell
2.	Shahada	Basalt	Low to Medium	Dugwell, DCB and Borewell
		Alluvium	Medium to High	Dugwell, DCB and Tubewell
3.	Taloda	Basalt	Low to Medium	Dugwell, DCB and Borewell
		Alluvium	Medium to High	Dugwell, DCB and Tubewell
4.	Navapur	Basalt	Low to Medium	Dug Well, DCB, Borewell
5.	Akrani	Basalt	Low to Medium	Dug Well, DCB, Borewell
6.	Akkalkuva	Basalt	Low to Medium	Dug Well, DCB, Borewell

5.2 Water Conservation and Artificial Recharge

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

6.0 Ground Water Related Issues and Problems

Almost entire Akkalkuwa taluka and parts of Akrani, Nawapur and Nandurbar talukas are categorized as drought area. The deeper water levels are also observed in southern part of the district i.e., in parts of Navapur and Nandurbar talukas during premonsoon seasons. The water level trends are also observed declining as seen from premonsoon trend map. Thus future water conservation and artificial recharge structures in the district may be prioritised in these parts of the district. In the hilly areas of Dhadgaon, Akrani, Taloda and Shahada talukas rocks are hard and compact, resistant to weathering with steep gradient causing rapid runoff and low infiltration and such areas are not feasible for ground water development.

7.0 Areas Notified by CGWA/SGWA

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

8.0 Recommendations

1. Major part of the district is underlain by Deccan Trap Basalt, where only dugwells are the most feasible structures for ground water development.
2. The sites for borewells need to be selected only after proper scientific investigation. Borewells generally tap deeper fractures, which may not be sustainable. Besides, the borewells should only be used for drinking water supply and not for irrigation.

3. The overall stage of ground water development for the district is on lower side, i.e., 37.55 % thus there is a plenty of scope for further development particularly in Akkalkkuva (19.92%), Akarni (12.13 %) and Nawapur (25.75 %) Talukas. In Nandurbar Taluka development has reached up to 64%, so further development is not recommended in this taluka or development may be allowed with suitable measures of artificial recharge.
4. However, the ground water development needs to be carried out with proper care and planning, since in these areas falling water level trends are observed.
5. In the hilly areas of Dhadgaon, Akrani, Taloda and Shahada talukas rocks are hard and compact, resistant to weathering with steep gradient causing rapid runoff and low infiltration and such areas are not feasible for ground water development.
6. The scope exists for construction of suitable artificial recharge structures in the district. The structures recommended for the hilly- Deccan Trap Basalt area in the northern part is: contour bunds, gully plugs, nala bunds and check dams. For other basaltic areas, the nala bunds, check dams and KT weirs are suggested. The existing dugwells may also be used for artificial recharge of ground water provided source water is free of silt and dissolved impurities.
7. In Alluvial area of the district, percolation tanks and recharge wells/shafts are suggested.
8. The existing village ponds/tanks need to be rejuvenated to act both as water conservation and artificial recharge structures.

Table 7: Classification of Ground Water Samples based on BIS Drinking Water Standards (IS-10500-91, Revised 2003).

Parameters	**DL** (mg/L)	**MPL** (mg/L)	**Samples with conc. < DL**	**Samples with conc. in DL-MPL**	**Samples with conc. >MPL**
TDS	500	2000	4	6	Nil
TH	300	600	9	1	0
NO_3	45	No relaxation	9	-	1
F	1.0	1.5	10	Nil	Nil

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

Ground water quality is adversely affected by nitrate contamination in 10% of the samples (one sample at Bhadwad) collected in May 2011. Overall, the ground water quality scenario of the wells monitored in the district is bright and it is suitable for drinking in most of the district except where localised nitrate contamination is observed.

8.1.1 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. Residual Sodium Carbonate (RSC) is the most important quality criteria, which influence the water quality and its suitability for irrigation.

8.1.1.1 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 RSC values for its suitability for irrigation purpose is shown below in Table-8.

The perusal of Table-9 indicates that the RSC values of all ground water samples collected from the district is less than 1.25 meg/l suggesting that the quality of ground water in the monitoring wells is good for irrigation purpose.

Table 8: Classification of Ground water for Irrigation based on RSC.

RSC (meg/l)	**<1.25**		**1.25-2.50**		**>2.50**	
Category	**Good**		**Doubtful**		**Unsuitable**	
Total Samples	No. of Samples	%	No. of Samples	%	No. of Samples	%
12	10	100	Nil	Nil	Nil	Nil

8.2 Status of Ground Water Development

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9.0 Ground Water Management Strategy

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9.1 Ground Water Development

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9.	Taloda	Basalt	Low to Medium	Dugwell, DCB and Borewell
		Alluvium	Medium to High	Dugwell, DCB and Tubewell
10.	Navapur	Basalt	Low to Medium	Dug Well, DCB, Borewell
11.	Akrani	Basalt	Low to Medium	Dug Well, DCB, Borewell
12.	Akkalkuva	Basalt	Low to Medium	Dug Well, DCB, Borewell

9.2 Water Conservation and Artificial Recharge

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

10.0 Ground Water Related Issues and Problems

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11.0 Areas Notified by CGWA/SGWA

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

12.0 Recommendations

9. Major part of the district is underlain by Deccan Trap Basalt, where only dugwells are the most feasible structures for ground water development.
10. 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.
11. The overall stage of ground water development for the district is on lower side, i.e., 37.55 % thus there is a plenty of scope for further development particularly in Akkalkkuva (19.92%), Akarni (12.13 %) and Nawapur (25.75 %) Talukas. In

Nandurbar Taluka development has reached up to 64%, so further development is not recommended in this taluka or development may be allowed with suitable measures of artificial recharge.

12. However, the ground water development needs to be carried out with proper care and planning, since in these areas falling water level trends are observed.
13. In the hilly areas of Dhadgaon, Akrani, Taloda and Shahada talukas rocks are hard and compact, resistant to weathering with steep gradient causing rapid runoff and low infiltration and such areas are not feasible for ground water development.
14. The scope exists for construction of suitable artificial recharge structures in the district. The structures recommended for the hilly- Deccan Trap Basalt area in the northern part is: contour bunds, gully plugs, nala bunds and check dams. For other basaltic areas, the nala bunds, check dams and KT weirs are suggested. The existing dugwells may also be used for artificial recharge of ground water provided source water is free of silt and dissolved impurities.
15. In Alluvial area of the district, percolation tanks and recharge wells/shafts are suggested.
16. The existing village ponds/tanks need to be rejuvenated to act both as water conservation and artificial recharge structures.
17. Ground water quality is adversely affected by nitrate contamination in 9% of the samples collected in May 2011. Thus all the wells used for water supply should be first analyzed 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.