DISTRICT GROUND WATER INFORMATION BOOKLET

ANUPPUR DISTRICT

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Ministry Of water Resources
Central Ground Water Board
North Central RegionBHOPAL
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ANUPPUR DISTRICT AT A GLANCE

S.No	ITEMS	STATISTICS
1	General Information	
	i) Geographical Area (Sq.Km)	3669
	ii) Administrative Divisions (as on year 2006) Number of Tehsil / Block Number of Panchayats/ Villages	 4/4 282/578
	iii) Population (Census 2001)	6,67,155
	iv) Average Annual Rainfall (mm)	1235.00
2	**GEOMORPHOLOGY**	
	Major Physiographic Units	1Pushprajgarh Plateau 2 Son River Plateau area 3 Narmada Valley area
	Major Drainage	Johila sub-basin Son sub-basin Narmada basin
3	**Land Use (Sq. Km.)** i) Forest area : ii) Net sown area : iii) Cultivable area :	 764.48 1616.25 267.92
4	**Major Soil Types**	Black Cotton, Sandy-Loamy and Clayey-Loamy
5	**Area under principle crops (2006)**	Paddy, Wheat, Maize and Gram
6	**IRRIGATION BY DIFFERENT SOURCES**	
	Structures	**No Area (Sq. Km.)**
	Dug wells Tube wells/ Bore wells Tanks/ ponds Canals Other Sources Net Irrigated Area. Gross Irrigated Area	1992 15.14 56 2.46 156 0.78 80 7.26 10.95 36.59 36.59
7	**Number of Ground Water Monitoring Wells of CGWB (As on 31-03-2007)**	
	No. of Dug Wells No. of piezometers	13 05
8	**PREDOMINANT GEOLOGICAL**	Archaeans,

	FORMATIONS	Gondwanas, Lameta Beds and Basalts.
9	**HYDROGEOLOGY**	
	Major water bearing formation (Pre-monsoon DWL during 2006) (post-monsoon DWL during 2006) Long term water level trend in10 yrs (1997-2006) in m/year	Archaeans, Gondwana , Lameta & Bagh Beds 3.70-14.82 1.40-14.18 +0.24 to –0.76(Pre) +0.22 to –0.12(post)
10	**GROUND WATER EXPLORATION BY CGWB (as on 31.03.2007)**	
	No of wells drilled (EW, OW, PZ, SH, Total)	12 EW+ 05 PZ
	Depth Range (m)	30.99-232.00
	Discharge (litres per second)	0.20-25
	Storativity (S)	5.0 X $10^{-}4$
	Transmissivity (m^2 / day)	175
11	**GROUND WATER QUALITY**	
	Presence of Chemical constituents more than permissible limit (EC, F,AS, Fe etc.)	Nitrate more than 45 mg/l is recorded at Deohara, Kotma and Anuppur
12	**DYNAMIC GROUND WATER RESOURCES (2004) in MCM**	
	Net Ground Water Availability	408.80
	Gross Annual Ground Water Draft	57.31
	Projected demand for Domestic and Industrial Uses up to next 25 Years	5.86
	Stage of Ground Water Development	14.02
!3	**EFFORTS OF ARTIFICIAL RECHARGE & RAIN WATER HARVESTING**	
	Projects completed by CGWB	Nil
	Projects under technical guidance of CGWB	Nil
14	**GROUND WATER CONTROL AND REGULATION**	
	Number of OE Blocks	Nil
	Number of Critical Blocks	Nil
	Number of Notified Blocks	Nil
15	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	Depletion of water levels near Coal mines is reported.

1.0 INTRODUCTION

Anuppur is a newly formed district, situated in eastern corner of Madhya Pradesh. It came into existence on 15th August 2003, by reorganization of Shahdol district. The Anuppur is one of the tribal district of Madhya Pradesh and it is having 46.41 % tribal population to the total population of the district. Anuppur is also famous for **Amarkantak** hill and pilgrim station, where from two important rivers namely, Narmada and the son originates. District Anuppur is surrounded by Shahdol district in north, Umariya and Dindori districts in west and south-west, Bilaspur and Korea districts of Chhattishgarh State in south and east sides. The district lies between North latitude 22º 7' and 23º25' and East longitude 81º10' and 82º 10',falling in Survey of India toposheet nos. 64E, 64F and 64 I. It extends for about 86 Km from north to south and 117 Km from east to west.

The area of district is 3669 Sq. Km, and it has been divided into four tehsils and blocks (Fig-1).There are 578 villages and 6 towns in the district .Details of administrative divisions of the district is given in Table-1.

Table-1 : Administrative divisions, Anuppur district, M.P.

S.No	Tehsil / Block	Area in Sq. Km	No of villages	No of towns
1	Pushprajgarh	1764	271	1
2	Anuppur	573	139	2
3	Jaithari	921	99	1
4	Kotma	411	69	2
	Total	**3669**	**578**	**6**

Drainage: Anuppur district falls under two river basins i.e. the Ganga and the Narmada. Excepting small and narrow belt along the south-west boundary, in Pushprajgarh tehsil, which is drained by the river Narmada, entire Anuppur district forms the part of the Ganga river system.The river Son is an important tributary of the Ganga river, drains major part of the district. Both rivers the Narmada and Son originates from Amarkantak hill of Maikal Range (1057 m. a.m.s.l.) at 22º40' N 81º46'E from Anuppur district. The river Narmada flows in west word direction in the district, while the river Son flows from south-east to north-west direction. The important tributaries of Son river in the district are Johila, Gujar Kewai and Tipan rivers. The Samrar nadi is only important tributary of river the Narmada in the district.

Irrigation: Irrigation facilities in Anuppur district is minimum. Only 2.26 % of net sown area is irrigated, and rest is rain-fed area. Surface water irrigation in the district is in developing stage. Ground water is main source of irrigation in the district. Out of total 3829 hectares irrigated land, 1743 hectares was irrigated from ground water sources, which is about 45.42 % of total irrigation in the district. There were 248 tube wells and 1495 dug wells in the district for irrigation.

CGWB Activities: Systematic hydrogeological surveys of the district was carried out by Shri R.N.Sharma and Shri A.K.Budhauliya, then Junior Hydrogeologists, during year 1987-88.Shri A.K.Jain, Junior Hydrogeologist carried out Reappraisal hydrogeological surveys of the district during year 1998-99. Exploratory drilling in the district started in year 1979-80, to study inflow of water in Jamuna coal field area of Kotma block Subsequently CGWB had taken up regular ground water exploration during period 1988-93 and total 11 exploratory wells were drilled, at

various places in different geological formations of the district. Under the World Bank assisted Hydrology Project, 3 shallow and 2 deep Piezometers were constructed by CGWB at Anuppur, Kotma and Rajendragram.

2.0 RAINFALL AND CLIMATE

For description of meterological parameters , data of nearest I.M.D. Observatory located at Umariya has been used.

The normal annual rainfall of the district is 1235.0 mm. The district receives maximum rainfall during south-west monsoon period from June to September. About 89.3 % of annual rainfall is receieved during monsoon season. Only 10.7 % of the annual rainfall occurs during non-monsoon period, from October to May. Thus maximum water available for ground water recharge is during south-west monsoon season.

The normal maximum temperature recorded during the month of May is 41.3º C, and minimum during the month of December is 8.4º C. The normal annual means maximum and minimum temperatures of Anuppur district are 31.6º C and 18.2º C respectively.

During the south-west monsoon, the relative humidity generally exceeds 88 % during month of August. Relative humidity decreases during non-monsoon season. In summer season, relative humidity's are less than 38 %. May is the driest month of the year.

The wind velocity in the area is higher, during pre-monsoon period as compared to post-monsoon season. The maximum wind velocity 6.8 Km/hr is observed during the month of June and minimum 2.3 Km/hr is recorded during month of November. The average normal annual wind velocity of Anuppur district is 4.3 Km/hr

The climate of Anuppur district, is characterized by a hot summer and general dryness during the south-west monsoon season. The year may be divided into four seasons. The cold season is December to February and followed by the hot season from March to about the middle of June. The period from middle of June to September is the south-west monsoon season. October and November form the post-monsoon or transition period.

Normal climatological parameters of Anuppur district is given below in Table-2

Table-2 : Normal Climatological Parameters

S.No	Climatological Parameter	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual
1	Maximum Temp. (ºc)	24.8	28.0	33.2	38.4	41.3	37.7	30.9	29.7	30.7	31.0	28.2	25.2	31.6
2	Minimum Temp. (ºc)	8.5	11.0	15.6	21.6	26.2	26.7	24.0	23.5	22.8	18.1	11.9	8.4	18.2
3	Relative Humidity(%)	73	64	50	39	38	61	85	88	82	71	67	73	66
4	Rainfall (mm)	22.8	19.9	17.1	6.4	7.5	122.7	369.2	424.7	186.4	37.3	8.5	13.1	1235.0
5	Wind Speed (Km/hr)	2.8	3.3	4.1	5.0	5.6	6.8	6.2	5.7	4.4	2.8	2.4	2.3	4.3

3.0 GEOMORPHOLOGY AND SOIL TYPES

3.1 Geomorphology :

Anuppur is predominantly hilly and forested district. It is picturesque with certain pockets and belt of Sal and mixed forest. From Geomorphological point of view, the district consists of series of mountain ranges and rivers. It can be divided into three geographical divisions :

1. High land of mountain ranges
2. The central plateau and
3. Low land of valley areas.

In general, Anuppur district is characterized by hilly to undulating terrain with altitude ranging between 470 m and 1170 m, above mean sea level. The main high relief features of the area are the Maikal Range and Maikal Plateau (Amarkantak Plateau) in south-east part of the district covered with deccan Trap Basalts. Some denudational hills/ hillocks are at foot hills of Rajendragram plateau. Linear ridges of intrusives (Dolerites) at northern and north-eastern part, and Plateaus in remaining part of the district The river Son is forming valley in the district.

3.2 Soils :

The anuppur district is mainly occupied by four types of rocks, namely Basalts, Lametas, Gondwanas and Archaeans. Soils are also depending upon lithology of the area. Hence soils of the area has been classified in following four groups:

(A) Soil of rocks
(B) Soils of Lameta Rocks
(C) Soils of Gondwana rocks
(D) Soils of Archaean Rocks

Soils of Basaltic rocks are occupying, major hilly and forested area of Rajendragram plateau on south-west part of Anuppur district. Soils of Lameta rocks are reported in isolated patches in south-west corner of the district, surrounded by basaltic soils. Soils of Gondwana rocks are covering major north and north-eastern part of the district. Soils of Archaeans (Crystalline Rocks) are occurring in South-east part of the district in Jaithari Block area. Soils of the area are categorized as loamy to fine loamy and loamy-skeletal soils.

4.0 GROUND WATER SCENARIO

4.1 Hydrogeology:

Anuppur district is underlain by various geological formations, forming different types of aquifers in the area. Main lithological units of the area are, Archaeans, Gondwanas, Lametas and Basalts. Occurrence and movement of ground water in hard rocks is essentially by development and nature of secondary porosity through joints and fractures. Primary porosity in Gondwana rocks and vesicularity in basalts play and important role. Lametas are also potential aquifers made up of relatively loose and friable material. Ground water in general occurs under unconfined to semi-confined conditions. The occurrence and movement of ground water in different lithological units is described below:

Archeans :

Granites and Granitic-Gneisses are main rock types, occurring in south-east part of the district. They are crystalline hard rocks, forming basement in the district. They yield water through fractures, joints and secondary porosity developed in weathered portions. In Jaithari block area, quite many dug wells exists in these formations and wells yield moderate quantity of ground water. The yield depends upon the saturated thickness of the weathered mantle overlying the massive rock. The open wells that exists in these formations, range in depth from 8m to 20m. b.g.l. Generally the column of water available during pre-monsoon season varies between 2m to 4m. The general yield potential of Archeans is less than 180 L.P.M..

Gondwanas :

The semi-consolidated Gondwana group of rocks, that bears coal deposits are forming main ground water reservoir in this district. The felspathic, medium to coarse grained sand stone, bears ground water in the interconnected primary pores in the formation, as well as the contact planes between shales and sand stones. Coal seams in Gondwana formations are acting as confining layers giving rise to artesian conditions at several places. Ground water is also mined out along with the coal in almost all coal fields of the district. Ground water occurs in unconfined, semi-confined and confined conditions in the Gondwana formations of the district. It is reported that due to excessive pumpage of ground water from the underneath coal mines, there has been appreciable lowering of water levels in the phreatic ground water regime overlying the coal field area, particularly in Kotma block area. Gondwana formation particularly the upper part of Barakar Sandstone support development of phreatic aquifers, which extends from few metres below ground level to 25 m below land surface. The ground water moves over laterally in the area following gradient It also moves downward from phreatic aquifer into the deeper section up to the coal seams. The Talchir formation of lower Gondwana group, comprising of well sorted sandstone, olive green shales and basal conglomerates are forming poor aquifer in the area. These formations are occurring southwards of Anuppur town. Exploratory well drilled by CGWB in Anuppur town has yielded only 15 L.P.M.discharge in Talchir formation. The Barakar formations which are upper part of lower Gondwanas are forming potential aquifers in the area. These formations are covering north and eastern part of Anuppur district. The yield of Barakar formations in the district is recorded between 150 and 960 L.P.M.

Lametas :

These are sedimentary deposits resting over Archeans /Gondwana formations and are overlain by Basalts. siliceous Lime stones of Lametas are compact and impervious in nature. Nodular lime stone and poorly consolidated sand stone of Lametas are forming good aquifers in the area. Lametas occurring below Basalts, are under semi-confined to confined conditions. Lametas are occupying hilly and forested area, where population and habitation is rather poor. Dug wells in this formation is generally used for drinking/domestic purposes by tribal population. It is observed that 80 % of dugwells are within the depth range of 8 m to 16 m, below ground level; with diameter of 3-4 m. CGWB had taken up exploratory drilling in Rajendragram plateau of Pushprajgarh Block, where Lameta beds are occurring below Basalts at deeper level. Since lametas are relatively loose and friable rocks found below Basalts at depth (more than 100 m), there is difficulty in drilling in this formation deploying DTH or DTH-Rotary Combination rigs. After penetrating basalts, drilling in loose and friable Lameta beds at depth more than 100 m becomes unserviceable using these rigs, because available rigs can not function to operate using rotary system at depth. Because of this reason CGWB had abandoned many exploratory

wells in Rajendragram plateau area , where Lametas are occurring below Basalts. Thickness of Lameta Beds is recorded as 80 m at Keolari exploratory well site. Yield of Lameta beds recorded during exploratory drilling vary from 180 to 1500 L.P.M.

Deccan Traps :

These are Basaltic flows, forming hill ranges in south-west part of the district. Rajendragram plateau of Pushprajgarh Block is fully occupied by basaltic rocks. In basaltic terrain , ground water generally occurs under phreatic conditions in shallow weathered, jointed and fractured horizons. Basalt does not exhibit uniform nature, both vertically and laterally. Physiographic locations, thickness of weathered mantle, degree of joints, fractured or sheared zones, characteristics of vesicular horizons and their inter-connections are important factors, that play a decisive role in the yield capacity of open wells, tapping shallow aquifers. The deeper aquifer system appears to be under semi-confined conditions. While visualizing lava flow sequence (Which shows alternative units of vesicular and massive horizons), the hydrogeological regime in different tiers, deeper aquifer is more likely to be governed by secondary porosity. Jointed/fractured form of massive unit is creating possibility of their acting as leaky confining bed, consequently resulting into semi-confined conditions for water bearing vesicular unit occurring beneath it. On the other hand if massive unit is compact and have not developed fractured porosity, then under favourable conditions they may act as a confining bed for the water bearing vesicular horizon, occurring below it and thus leading to confined conditions. Dugwells in basaltic flows of Deccan Traps vary in depth from 6 to 15 m, below ground level and diameter ranges between 2 m to 3 m. CGWB had drilled number of tube wells in Rajendragram plateau of Anuppur district, and thickness of Basalt vary from 1 m (at Keolari) to 127 m (at Karanpathar). Yield of exploratory wells ranges between 60 to 240 L.P.M.

Depth to water Level : Central Ground Water Board has been carrying out water level monitoring of Ground Water Monitoring Wells (GWMW), since year 1990 in the district. Water levels of these monitoring wells are being monitored four times in a year; Viz during the month of January, May, August and November. A hydrogeological map (Fig-2) of Anuppur district has been prepared on the basis of available data. To study ground water regime of the area, pre-monsoon and post-monsoon depth to water level maps of the district has been prepared. South-west part of Anuppur district is highly undulating and forest covered. In that area there are no Ground water Monitoring Well for observation and preparation of maps.

Pre-monsoon (May 2006) :

In general depth to water level in the district , ranges between 3.70 m, below ground level at Pipraha in Pushprajgarh Block and 14.82 m, below ground level at Venkatnagar in Jaitahari block area.In Major part of the district, depth to water level is occurring between 5 to 10 m b.g.l., recorded at Basaniha, Kirar anuppur, Kotma, Dhangawan and Lapta (Fig-3). Depth to water level between 10 to 15 m, b.g.l. is recorded in northern part of the district at Deohara, Phunga and Jhiriyatola and also as isolated patches at Amarkantak and Venkatnagar on Southern part of the district.

Post-monsoon (November 2006) :

During post-monsoon season of year-2006, depth to water level varies from 1.40 m, b.g.l. at Anuppur to 14.18 m, b.g.l. at Venkatnagar in granitic terrain (Fig-4).Shallow water levels of less than 5 m, b.g.l. are observed in central part of the district at Phunga, Anuppur, Kirar, Dhangawan and Lapta. Depth to water level between 5 to 10 m, b.g.l. is recorded at Deohara,

Kotma , Jhiriyatola and Rajendragram. Depth to water level of more than 10 m, b.g.l. is reported at Venkatnagar and Amarkantak Ground Water Monitoring Wells.

Water level fluctuation between pre and post-monsoon season (Year 2006) :

In entire Anuppur district, rise in water levels between pre and post-monsoon seasons have been recorded. Rise in water levels is ranging from 0.64 m at Venkatnagar in southern corner of the district to 9.00 m at Phunga on northern part of the district. Rise in water levels of less than 2m is observed at Kotma, Dhangawan, Lapta, Venkatnagar, Pipraha and Amarkantak on south-eastern and southern part of the district. Water level rise between 2m and 4m is recordrd at Anuppur, Kirar and Basaniha in central part of the district. Rise in water level more than 4m is reported at Deohara, Phunga and Rajendragram.

Long-term water level trend in last 10 years (year 1997 to 2006) :

To study change in ground water regime of the area over last one decade, from year 1997 to 2006 water level data of CGWB Ground Water Monitoring Wells have been used. For long term trend analysis, pre and post-monsoon water levels of these wells have been analyzed. Long term trend analysis results are summarized below in Table-3.

Table-3 : Long term trend analysis of CGWB Ground Water Monitoring Wells

S.No	Ground Water Monitoring well	Block	Pre-monsoon			Post-monsoon		
			Data Set	Rise	Fall	Data Set	Rise	fall
			No	m/year	m/year	No	m/year	m/year
1	Deohara	Anuppur	10	-	0.37	10	-	0.10
2	Kirar	-do-	10	-	0.19	10	-	0.09
3	Anuppur	-do-	9	0.017	-	10	0.05	-
4	Phunga	-do-	10	0.122	-	10	0.07	-
5	Kotma	Kotma	10	-	0.03	10	-	0.04
6	Jhiriyatola	-do-	10	-	0.14	10	-	0.12
7	Dhangawan	Jaithari	7	-	o.17	10	-	0.05
8	Lapta	-do-	9	-	0.07	10	-	0.02
9	Venkatnagar	-do-	9	-	0.05	10	0	-
10	Rajendragram	Pushprajgarh	7	-	0.76	10	-	0.05
11	Basaniha	-do-	10	0.14	-	10	-	0.01
12	Pipraha	-do-	10	0.24	-	10	0.22	-
13	Amarkantak	-do-	5	0.13	-	6	-	0.125

Perusal of above table indicate that, out of 13 Ground Water Monitoring wells of the district , 8 are showing falling trend during pre-monsoon seasons. Average rate of decline is varying from 0.03 m/ year at Kotma to 0.76 m/ year at Rajendragram. During pre-monsoon period 5 Ground Water Monitoring Wells of the district are showing rising trend and an average rate of rise in water level is ranging between 0.017 m/ year at Anuppur and 0.24 m/year at Pipraha. Post-monsoon long term water level trend analysis reveals that out of 13 Ground Water Monitoring Wells, 9 are indicating falling trend and average rate of decline vary from 0.01 m/year at Basaniha to 0.125 m/year at Amarkantak. An average rate of rise in water level ranges from 0.05 m/year at Anuppur to 0.22 m/ year at Pipraha during post-monsoon season .No change is observed in water levels of Venkatnagar Ground Water Monitoring Well during post-monsoon period. Ground Water Monitoring Wells Located close to Coal Mines, at Deohara, Kotma and

Jhiriyatola are showing declining water level trends during both pre-monsoon and post-monsoon seasons.

Aquifer Parameters :

CGWB had drilled 12 Exploratory Wells in the district. Hydrogeological data of exploratory wells in the district is given below in Table-4.

Table-4: Hydrogeological details of CGWB exploratory wells drilled in Anuppur district

S.No	Name of site	Depth Drilled (m)	Aquifer zones	SWL (m) b.g.l.	Yield (L.P.M.)	Draw-down (m)	E.C. (Micro-mhos /cm)	Aquifer
1	Bakho	232.00	35.00-38.00 59.00-66.00 69.00-74.00 105.00-113.00 139.00-150.00	12.36	151	10.00	------	Barakar Sandstone
2	Anuppur	166.81	36.00-46.00 85.00-95.00 99.00-108.00	4.66 (S) 70.43(D)	10 / 15	39.54/ 22.31	950	Talchir Sandstone
3	Karanpat-har	153.13	10.50-14.50 32.00-35.00 48.00-53.00 61.00-70.00 103.00-108.00 131.83-151.00	7.44	180	-----	-----	Basalt/ Lameta
4	Ghoghari	158.16	18.00-20.00	8.00	204	11.0	193	Basalt
5	Benibari	104.10	73.70-104.10	39.60	240	0.98		Basalt
6	Khetgaon	111.32	60.00-72.00	21.10	954			Basalt/Lameta
7	Keolari	83.00	48.00-75.00	17.43	1500	6.00		Lameta
8	Basaniha	171.50	134.00-170.00	39.38	Negli.	----		Basalt/Lameta
9	Karaundi	106.50	43.44-52.63 61.73-70.93 88.00-93.00	14.10	60	20.0	------	Basalt
10	Pipraha	122.16	60.00-70.00	>30.00	240	20.00	453	Basalt/ Lameta
11	Bhejri	122.10	62.65-68.00	31.68	282	-dry	------	Basalt/ Lameta
12	Jamuna Colliery	90.40	38.00-41.00 45.50-50.50 53.50-56.50 59.00-63.50 65.50-69.50 71.50-74.00 76.00-82.00 83.50-87.00	13.65	840	13.40	122	Barakar Sandstone

Perusal of above table reveals that, yield of Gondwana formations vary from 10 LPM to 840 LPM, and draw down ranges between 13.4 m and 39.54 m. Yield of Lameta formations of the district vary from 240 to 1500 LPM and draw down was recorded between 6.00 to 20.00 m. Yield of Deccan Trap basalts was recorded between 60 to 240 LPM, and draw down was observed between 11.00 to 20.00 m .Long duration pumping tests (APT) were conducted only at Jamuna Colliery, for determination of aquifer parameters of coal bearing Barakar formation. At this site **well field** , consisting of one pumping well, 5 observation wells and 2 piezometers was constructed , in which Step Drawdown and long duration Aquifer Performance Tests were conducted. Analysis of A.P.T. results reveals that regional transmissivity of barakar sediments is estimated to be 175 m²/ day, while the hydraulic conductivity is 5 m/day. The specific yield of the dewatered material has been computed as 0.038. Co-efficient of storage was computed as 5.0 x 10^{-4}.

4.2 Ground Water Resources :

Ground water resource estimation of Anuppur district has been computed for Base Year-2004, on block wise basis. Entire Blocks of this district are falling under non-command category, as there are no major irrigation projects in the district, and medium irrigation project is not irrigating the area to its desined capacity. All blocks of Anuppur district are categorized as **safe** blocks, and highest stage of ground water development is computed as 25.74 % for Kotma Block.

As per Ground water resource estimation figures, Net Ground Water availability in Anuppur district is **408.81MCM** and Ground Water Draft for all uses **is 57.33 MCM**, making Stage of Ground water development **14.02 %** as a whole for district. After making allocation for future domestic and industrial supply for next 25 years, balance available ground water for future irrigation would be **168.90MCM**, at 50 % stage of ground water development's safe limits, in Anuppur district. Block wise ground water resource estimation data of Anuppur district is given below in Table-5 and data is also presented in Fig-5

Table-5 : Block Wise Ground Water Resource Estimation Data of Anuppur District (Base Year-2004)

S.No	Block	Net Ground Water Availability (MCM)	Gross Annual Ground Water Draft For All Uses (MCM)	Current Stage of Ground Water Development (%)	Allocation For Domestic & Industrial Supply for next 25 years (MCM)	Balance Ground Water available for Future Irrigation (MCM)
1	Pushprajgarh	96.76	6.35	6.56	6.21	42.17
2	Anuppur	101.59	8.25	8.12	20.24	30.55
3	Kotma	80.34	20.68	25.74	4.46	35.72
4	Jaithari	130.12	22.05	16.94	4.62	60.46
	District Total	**408.81**	**57.33**	**14.02**	**60.53**	**168.9**

4.3 Ground Water Quality of Anuppur district :

Quality of Ground water for Drinking :

Ground water quality of the district, is accessed annually by CGWB on the basis of water samples collected from Ground Water Monitoring Wells. Ground water in the district is generally low to medium saline, as electric conductivity values vary between 259 to 966 µs/cm at 25º C. High EC was recorded in dug well of Deohara (966 µs/cm) village. Constituents like chloride, fluoride, sulfate, calcium and magnesium are within safe limits for drinking purposes as per BIS standards. Total Hardness of ground water in the district, is ranging between 85 to 260 mg/l, which is well within permissible limits. Nitrate content in groun waters of phreatic aquifers is varying between 3 to 99 mg/l. From dugwells water samples, nitrate more than 45 mg/l was reported in only one village at Deoraha (99 mg/l). However water samples collected from CGWB piezometers located at Anuppur and Kotma are having nitrate concentration 125 and 52 mg/l respectively, which in excess to permissible limits of 45 mg/l, thus rendering the water unsuitable for drinking purpose. Excessive nitrate content in water causes " Blue Baby Syndrome" disease. Excessive nitrate content in ground water system, may be because of seepage from sewage waste or due to high uses of nitrate fertilizers.

Quality of water for irrigation :

High SAR is not good for irrigation, as it leads to sodium hazards. Ground water in the district is in general safe for irrigation, and water samples fall in C1S1, C2S1, and C3S1 classes of US Salinity diagram.

Geogenic Problems :

Geogenic problems are not reported in the district. Fluoride in ground water is recorded within safe limits of 1.5 mg/l. Fluoride more than 1.5 mg/l in water is causing " fluorisis disease"including bones deformities.

4.4 Status of Ground Water Development :

Ground water is main source for drinking and irrigation in the Anuppur district. About 45.52% of irrigation in the district is from ground water sources, though level of irrigation in the district is very low i.e. only 2.26%. There are 246 tubewells and 1557 dug wells for irrigation in the district .In Anuppur district there are 6514 Electric connections for agriculture purposes. Depth of dug wells in the district ranges from 5 to 20 m. Yield of bore wells/ tube wells vary from 10 to 1500 liters/ minute, depending on hydrogeological situations in the area. High yielding tube wells are found at Jamuna colliery, Khetgaon and Keolari, and their yield was recorded as 840, 954 and 1500 liters/minute respectively. Apart from private sources, Hand Pumps are main source of Rural water supply in the district There are total 4408 hand pumps in the district for rural water supply, out of which 4099 hand pumps are operational making success percentage 93% as a whole for district. It is reported that out of 1575 hand pumps installed in Pushprajgarh block area, 219 hand pumps are non-operative, making highest failure rate of 14 % in this block.Perhaps due to collapsible nature of Lameta formation occurring below Basalts in Pushprajgarh block area, bore holes are filled. As far as Urban water supply is concerned there are 6 towns in the district, namely Anuppur, Kotma, Jaithari,Bijuri, Pasan and Amarkantak. Urban water supply of Anuppur and Amarkantak towns are based on bore wells/ tube wells. Water supply of Kotma and Jaithari towns are from Kewai and Tipan rivers. Bijuri and Pasan towns are getting water supplies from Coal Mines water/ tube wells.

5.0GROUND WARER MANAGEMENT STRATEGY

5.1**Ground Water Development :**

As per Ground Water Resource Estimation of Anuppur district for the year –2004, the available ground water resources and gross annual ground water drafts are 408.80 MCM and 57.31 MCM respectively, making stage of ground water development 14.02 % as a whole for district. Thus there is ample scope for future development of ground water resources in the district. All four blocks namely Pushprajgarh, Anuppur, Kotma and Jaithari are falling under Safe categories. Decadal water level trend analysis, reveals mixed trend of water levels during pre and post-monsoon seasons After making allocation for future domestic and industrial supply up to next 25 years, balance Available ground water at 50 % stage of ground water development safe limits in Anuppur district would be 169.88 MCM. .If 70% of balance available ground water resources is to be developed through dugwells and 30 % through tubewells, then at suitable hydrogeological locations tentatively 11,820 new dug wells and 1266 new tube wells for irrigation can be constructed in the district, considering unit draft of dug wells and tube wells 1.0 and 4.0 Ha-m respectively. Area recommended for future development is given in Fig-6. Dug wells are feasible structures for Granitic area, where as shallow tube wells are recommended in weathered/ jointed Archaeans and Talchir formations og Gondwana group. Deep tube wells with proper well assembly are suitable in coal bearing Barakar formations. In Basalts, overlying Lameta beds drilling may be taken up with DTH Rigs, but further drilling in Lameta formations becomes difficult , due to its loose and friable nature, if these rocks are occurring below depth 100 m, for drilling technology is to be developed to negotiate these formations at deeper level.

5.2 Water Conservation and Artificial Recharge :

Considering hydrogeological situation of the area, there is tremendous scope for artificial recharge work, specially in water depleting areas around coal mines, in Kotma block. Coal bearing Gondwana rocks are, porous and permeable semi-consolidated formations. Coal India Ltd. is mining out important ground water resources of the area. It will be appreciated, if Coal India Ltd is making master plan for artificial recharge in water depleting areas around various coal mines specially in Kotma block, as a social responsibility for misusing ground water resources of the area. Plan may be adopted using hill to valley approach in a watershed. At origin of the streams structures like Gully Plugs and Contour Trenches may be constructed to arrest surface runoff and same water may be useful for soil moisture retention and development of vegetation cover in the area. Gabion structures may be constructed at down streams of these structures, across the stream using local boulders and wire mess to check the velocity of flowing water, and to store water in up stream direction of these structures. Percolation tanks are most important structures from ground water recharge point of view. Percolation tanks are recommended in second and third order streams on porous and permeable formations. Foundation of these structures should not rest on hard and compact or on impermeable formations and water should be allowed to seep below stream bed to recharge ground water body at sub-surface. Percolation tanks should not hold water beyond month of January, because these are not water storage structures. It is quite possible that in due course of time infiltration of water from percolation tanks is reduced due to silt deposition inside the structures. To over come this problem, Recharge Shafts may be constructed inside percolation tanks to allow continues seepage of water from the structures to ground water system of the area. Recharge shafts can be

constructed using hume pipes of the diameter from 1 to 3 metres and graded filter medium is filled in the structures. At bottom boulders, gravels at middle and coarse sand at top is filled and periodical cleaning of upper layered coarse sand is required to avoid silt layer deposited over sand bed. Another advantage of recharge shafts is that, water may be allowed to hold in tanks up to required level for local use by earmarking height of the shaft inside the tank Recharge shafts can also be constructed in those places where impervious formations are occurring at surface and below shallow depths porous and permeable rocks are found, which may accept water for recharge. By constructing recharge shafts inside water bodies of this type of situation, inter connection is made to reach water in underlying porous and permeable formations occurring below impervious formation at shallow depth. Properly designed tube wells also act as recharge shafts , if recharge of water is needed in deeper aquifers overlain by impervious rocks. Sub-Surface Dykes are water conservation structures constructed at suitable hydrogeological locations across the river beds at end of watershed to check sub surface flow of water along streams beds. Trench is dug, down to impervious horizon across the stream and filled with local clay balls over high density polythene, making sub-surface barrier for flow of water from stream beds. Dugwells recharge is also applicable in rural areas. In this system water from fields is diverted in to recharge well passing through de-siltation chamber and filer media. Filtered water reaches in to recharge well through delivery pipe, lowered below water level or at bottom of the well to avoid chocking of aquifer by entry of air bubbles.

In Kotma block area where maximum coal mines are operative, " Kewai Watershed" may be taken up for implementation of artificial recharge project at large scale. The Kewai watershed may be divided into micro watersheds for implementation of various artificial recharge structures, according to hydrogeological feasibility and adopting hill to valley approach in the watershed. All kinds of artificial recharge structures may be implemented in this watershed. For sub-surface dykes and check dams, impervious foundation is required to prevent leakage/seepage from base of the these structures .Benefit zones of percolation tanks is at down stream direction, where as sub-surface dykes and check dams will recharge upstream part of structures. Area recommended for artificial recharge is shown in Fig-6.

6.0 GROUND WATER RELATED ISSUES AND PROBLEMS

Long term water level trend analysis shows mixed results. But depletion in water levels is observed during both pre and post-monsoon seasons in Ground Water Monitoring Wells located close to coal mines, at Deoraha, Kotma and Jhiriyatola. In Kotma block area number of coal mines are located, where from ground water is pumped continuously for making mines operational. Though stage of ground water development of Kotma block is only 25.73 %, even though depletion of water levels indicate mining of ground water resources of the area. Perhaps depletion of water level of the area is due to heavy pumping of ground water from different coal mines of the area. Analysis of ground water draft figures are also supporting, huge ground water draft from coal mines in Kotma block. In Kotma block area, annual ground water draft for irrigation and industrial water supply during year 2004 was only 0.69 and 2.47 MCM respectively, where as ground water draft from various coal mines was 17.52 MCM , which is 87.71 % of the gross annual draft. Coal India Ltd. should provide real data regarding actual ground water draft from various coal mines, so that actual picture of ground water resources of the block is obtained.

Drilling problem is also reported in Pushprajgarh block area of Anuppur district. In this area Basaltic rocks are forming Rajendragram plateau having thickness of basalts more than 100

meters. Below basalts, Lameta beds of sedimentary origin are occurring which are comparatively loose and friable in nature and forming potential aquifers in the area. By deploying available drilling rigs (DTH-Rotary Combination), drilling in Lameta beds occurring below basalts at more than 100 m b.g.l. becomes difficult, because rotary system of these rigs are not operative below depth 100m to drill in Lameta rocks found below hard and compact basalts at deeper levels.

Though ground water pollution is not reported in the area, even then pollution studies around Amarkantak Thermal Power station at Chachai is suggested to study ground water pollution around the plant , if any due Ash-dust. Ground Water Pollution from thermal power ash-dust is reported at many places in the country by Central Pollution Control Board. At Chachai , Thermal power ash-dust was dumped near thermal power station, which needs scientific studies to ascertain possible pollution in ground water systemof the area.

7.0 AWARENESS AND TRAINING ACTIVITY

7.1 Mass Awareness Programme (MAP) & Water Management Training Programme (WMTP) by CGWB :

CGWB has not carried out Mass Awareness Programme and Water Management Training Programme in Anuppur district.

7.2 Participation in Exhibition, Mela, Fair etc :

In Anuppur district, paricipation in exibition, mela and fair etc.by CGWB was not done.

7.3 Presentation & lectures delivered in public forum / Radio / T.V. etc. :

CGWB has not done any activity in the district, under items mentioned above.

8.0 AREAS NOTIFIED BY CGWA / SGWA

In Anuppur district , no area is notified by CGWB / SGWA

9.0 RECOMMENDATIONS

(1) The Stage of ground water development of Anuppur district as a whole is only 14.04 %, which reveals adequate scope for future development of ground water for irrigation. After making allocation for future domestic and industrial water supply up to next 25 years in the district, balance available ground water at 50 % stage of ground water development's safe limits would be 169.88 MCM. If 70 % of balance available ground water is to be developed through dug wells and 30 % through tube well/ bore wells, then tentatively 11,820 new dug wells and 1266 new tube wells can be constructed for irrigation.

(2) Depletion of water levels is recorded near coal mines area, specially in Kotma block. Continuous pumping from ground water regime of the area is perhaps causing depletion of water levels. Coal India Ltd. should prepare and implement master plan for artificial recharge in coal mining areas, so that important natural resource is again put into ground water system through feasible techniques.

(3) Drilling problem in Pushprajgarh block area is reported , where Lametas are overlain by hard and compact Basalts. Drilling in Lametas after crossing basalts at depth, becomes difficult.

Proper drilling techniques is to be adopted for drilling in first hard and compact basalts, there after in loose and friable lametas at deeper levels.

(4) Conjunctive use of surface and Ground water is recommended in the area.

(5) Nitrate content in ground water samples collected from Ground Water Monitoring Well at Deoraha and from CGWB Piezometers located at Anuppur and Kotma are indicting much higher than permissible limits. Higher nitrate content in ground water is indicating sewage pollution in ground water system of the area. Water from these stations should not be used for drinking purpose.

(6) Ground water pollution studies are suggested around Amarkantak Thermal Power station, Chachai to ascertain any possible pollution through Ash-dust dumped in the area.

(7) Roof top rain water harvesting project should be implemented in urban areas of Anuppur district.

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