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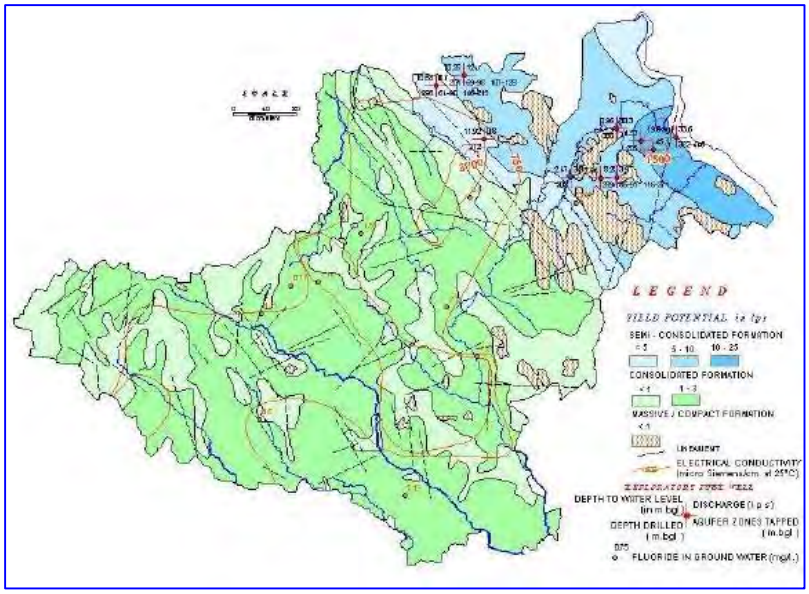
CENTRAL GROUND WATER BOARD
MINISTRY OF WATER RESOURCES
GOVERNMENT OF INDIA

GROUND WATER BROCHURE
WARANGAL, ANDHRA PRADESH



SOUTHERN REGION
HYDERABAD
September 2013

CENTRAL GROUND WATER BOARD

MINISTRY OF WATER RESOURCES
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GROUND WATER BROCHURE

WARANGAL ANDHRA PRADESH
(AAP-2012-13)

BY

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GROUND WATER BROCHURE
WARANGAL DISTRICT, ANDHRA PRADESH

CONTENTS

WARANGAL DISTRICT AT A GLANCE

1**. GENERAL FEATURES:**

i. **Location**	:	North Latitude 17^0 19' and 18^0 36'
	:	East Longitude 78^0 49' and 80^0 43'
ii. Geographical area	:	12846 Sq Kms
iii**.** Dist head quarters	:	Warangal
iv**.** No. of Rev.Mandals	:	Fifty One (51)
v. No. of Rev. villages	:	One thousand ninety eight (1098).

vi**.** Population (2011 Census)

a) Total	:	3522644
b) Urban	:	998146
c) Rural	:	2524498

vii**.** Population density : 274/ sq.km

2**. RAINFALL** (mm):

i. Normal Annual Rainfall	:	955 mm
ii) Annual rainfall (2012)	:	1232 mm

3. LAND USE (2012) (Area in ha)

i. Forest	:	3,71,014
ii. Barren and uncultivable land	:	51,363
iii. Cultivable waste	:	10,940
iv. Current fallows	:	58,080
v. Net area sown	:	5,30,401

4. IRRIGATION (2012) (Area in ha)

i. Area irrigated under canals	:	12,264
ii. Area irrigated under tanks	:	56,176
iii. Area irrigated under dug wells	:	1,68,377
iv. Area irrigated under tube wells	:	98,753
v. Area irrigated under other sources	:	3,196
vi. Net area irrigated	:	1,09,203
vii. Gross area irrigated	:	4,47,969

viii. Medium irrigation (Aycut area in Ha)

a) Phakal lake	:	21225
b) Laknavaram lake:		12400
c) Ramappa lake:		4860
d) Chalivagu project:		3246
e) Ghanpur tank:		3156

5. GEOLOGY

Granites and Gneisses, Schists,
Conglomerates, Sandstone,
Limestone, Shale,
Quartzites, Clays

6. GROUND WATER

Exploration by CGWB

Number of wells drilled : 32 EW, 15 OW,PZ 89 as on 2012.

Monitoring

Number of Observation wells :	Dug wells	: 25
	Piezometers	: 48
Range of water levels (meters below ground level May 2012)		
	Minimum	: 2.71
	Maximum	: 20.74
(meters below ground level Nov 2012)		
	Minimum	: 0.49
	Maximum	: 15.89

7. GROUND WATER RESOURCES (MCM)

Net annual Ground water Resources	:	1854.18
Net Annual Ground water Draft	:	1376.45
Balance Ground water resource	:	511.39

8. GROUND WATER DEVELOPMENT CATEGORY

No. of mandals categorized as		
Safe (<70% of net available resource)	:	22 mandals
Semi Critical (70-90%)	:	9mandals
Critical (90-100%)	:	3mandals
Over Exploited (>100%)	:	16 mandals
Stage of Ground Water Development	:	74%

9. CHEMICAL QUALITY

i. Electrical Conductivity (micro Siemens/cm at 250 C)	: 1020 to 1900.
ii. Chloride (mg/l)	: 48 to 241.
iii. Fluoride (mg/l)	: 0.52 to 0.55
iv. Nitrate (mg/l)	: 20 to 140.

GROUND WATER BROCHURE
WARANGAL DISTRICT, ANDHRA PRADESH

1.0 INTRODUCTION

Warangal district with a total geographical area of 12,846 sq km is one of the ten Telangana districts of Andhra Pradesh. The district is mainly agrarian and agriculture is the main stay of the population. Population density 274 person per sq km as per 2001 census.

The district falls in the drainage basins of both Godavari and Krishna rivers. The river Godavari, the largest river in the peninsular India flows along the eastern boundary of the district in south easterly direction (Fig.1). Pedavaguand Lakhnavaram are the two main tributaries of the Godavari. In the southern and south western part of the district the streams flow towards south and south easternly direction and finally fall into the Krishna river. The important tributaries of river Krishna are Akeru, Paleru and Muneru. The entire district is divided into 58 minor basins.

Table-1: Source Wise Area Irrigated (Ha)

S. No.	Source of irrigation	2012
1	Canals	12,264
2	Tanks	56,176
3	Tube Wells & filter points	98,753
4	dug wells	1,68,377
5	Other Sources	3,196
6	Net Area Irrigated	1,09,203
7	Gross area Irrigated	4,47,969

2.0 RAINFALL

The average annual rainfall of the district is 955 mm, which ranges from nil rainfall in December to January to 272 mm in July. July and august are the wettest months of the year. The mean seasonal rainfall distribution is 797 mm in southwest monsoon (June-September), 115 mm in northeast monsoon (Oct-Dec), nil rainfall in winter (Jan-Feb) and 43mm in summer (March–May). The percentage distribution of rainfall, season-wise, is 83% in southwest monsoon, 12 % in northeast monsoon, nil percentage in winter and 5 % in summer. The mean monthly rainfall distribution is given in the Table-1 and shown in Fig. 2. The

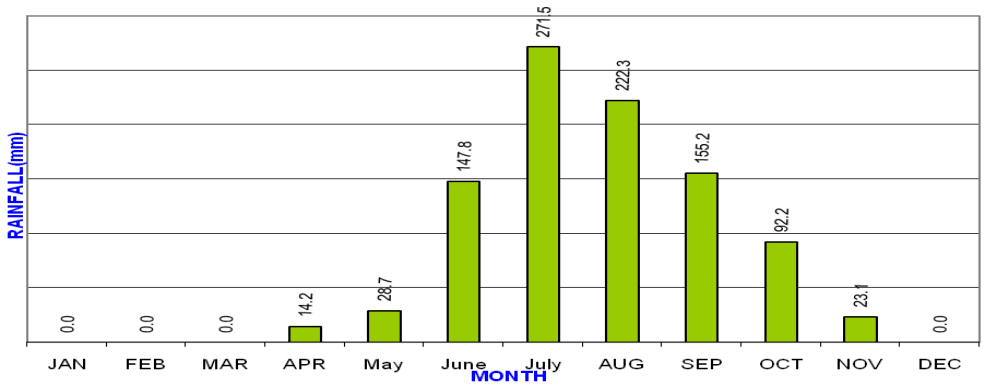
YEAR	ANNUAL	SWM	NEM	WINTER	SUMMER	SWM (%)	NEM (%)	WINTER (%)	SUMMER (%)	DEP FROM LPA(%)
1999	855.0	720.0	43.0	0.0	92.0	84.21%	5.03%	0.00%	10.76%	-10%
2000	1133.0	1046.0	12.0	17.0	58.0	92.32%	1.06%	1.50%	5.12%	19%
2001	807.9	648.0	117.9	0.0	42.0	80.21%	14.59%	0.00%	5.20%	-15%
2002	661.5	524.5	88.0	15.0	34.0	79.29%	13.30%	2.27%	5.14%	-31%
2003	902.2	728.6	161.0	1.0	11.6	80.76%	17.85%	0.11%	1.29%	-6%
2004	934.7	717.3	98.1	39.7	79.6	76.74%	10.50%	4.25%	8.52%	-2%
2005	1051.8	890.4	128.8	7.6	25.0	84.65%	12.25%	0.72%	2.38%	10%
2006	1229.8	1021.7	82.9	0.0	125.2	83.08%	6.74%	0.00%	10.18%	29%
2007	1030.2	921.6	70.2	8.8	29.6	89.46%	6.81%	0.85%	2.87%	8%
2008	1326.6	1060.2	49.1	32.2	185.1	79.92%	3.70%	2.43%	13.95%	39%
2009	655.2	503.9	128.4	0.0	22.9	76.91%	19.60%	0.00%	3.50%	-31%
2010	1353.3	1122.8	160.8	13.5	56.2	82.97%	11.88%	1.00%	4.15%	42%
2011	861.5	795.3	17.3	0.0	48.9	92.32%	2.01%	0.00%	5.68%	-10%
Long Period Average		796.7	115.3	0.0	42.9	83.43%	12.07%	0.00%	4.49%	

annual rainfall during 2012 is 1232mm.

Table.1monthly Rainfall Distribution (1999-2011)

Source: Indian Meteorological Department and Directorate Of Economics And Statistics

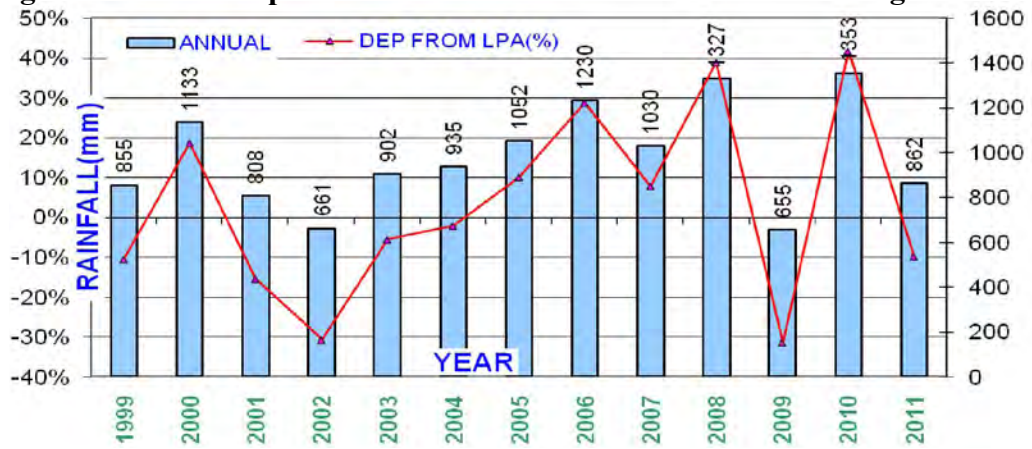
Fig.2 Mean monthly rainfall distribution - Warangal district



The annual rainfall ranges from 655.2 mm in 2009 to 1353.3 mm in 2010. The annual rainfall departure ranges from -31 % in 2002 and 2009 to 42 % in 2010. The southwest monsoon rainfall contributes about 83 % of annual rainfall. It ranges from 504 mm in 2009 to 1123 mm

in 2010. The year 2002 and 2009 experienced drought conditions in the district as the annual rainfall recorded in these two years is 31 % less than the long period average (LPA). The annual and seasonal rainfall distribution with its departure from mean along with year-wise percentage distribution is given in Fig.3. It indicates that, the rainfall departure as on 2011 is positive i.e. 41%, showing excess rainfall.

Fig.3 Cumulative departure of annual rainfall from LPA - Warangal district

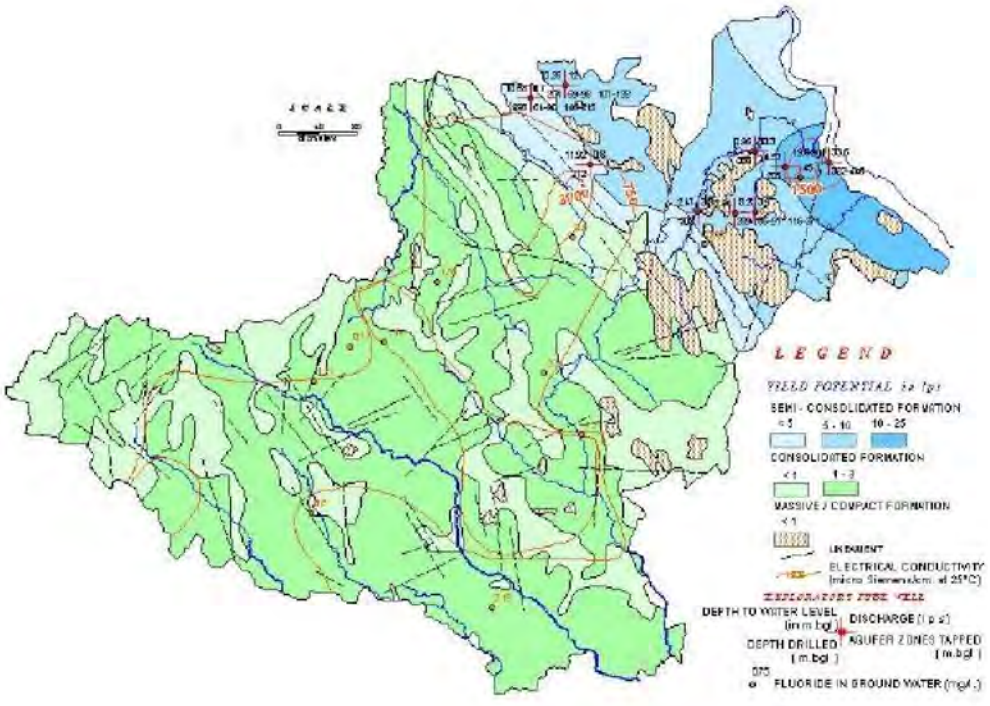


3.0 GROUND WATER SCENARIO

3.1 Hydrogeology

Ground water occurs in all the geological formations in the district. The major rock types occurring in the district are granites, gneisses, sandstone, limestone, shale, quartzite's etc. The occurrence and movement of the ground water is a consequence of a finite combination of topographical, climatological, hydrological, geological, structural and pedagogical factors, which together form integrated dynamic system. All these factors are interrelated and inter dependent, each providing a insight into the total functioning of this dynamic system. Hydrogeological conditions of the district are shown in the Fig.4. The yields of the wells depend on the recharge conditions and spacing of the wells. The nature of occurrence and behaviour of ground water in different water bearing formations are given

Fig.4 Hydrogeology of Warangal district



3.1.1 Ground Water in Crystalline Rocks

These rocks types occupy about 60% area of the district. The crystalline rocks like granite and gneisses lack primary porosity. They develop secondary porosity through fracturing and weathering over ages and thus become water bearing. The movement of ground water is controlled by the degree of inter-connection of secondary pores/voids. The depth to bed rock varies from few meters to 30 m bgl. Ground water occurs under unconfined conditions in weathered zone and under semi confined conditions in the fractures and fissures.

The shallow water table or phreatic aquifers are developed through large diameter irrigation dug wells and small diameter domestic wells. The irrigation wells are generally rectangular in shape with an open area ranging from 40 to 100 m2 with length of sides ranging from 4 to 10 m and diameter of circular wells varies from 6 to 10 m. The depth of the wells range from 6 to 15 m bgl. Depth to water in the wells vary from 5 to 20 m bgl during summer and < 2 to 5 m bgl during post monsoon. The yield ranges from 20 to 60 m3/day and specific capacity ranges from 0.002 to 0.324 m3/mdd.

The deeper fractured aquifer is developed through bore wells. The fractured aquifers are potential upto 100 m depth in general, the occurrence of fractures decreases drastically beyond 100m depth. Potential fractures are encountered only along the lineaments and at other favourable location. The discharge of the successful bore wells ranges from 0.5 lps to 4 lps. The transmissivity values range from 2.36 to 12.65 m2/day.

3.1.2 Ground Water in Pakhals and Sullavais

The Pakhals and Sullavais the oldest sedimentary rocks occupy an area of 1500 and 700 sq.km respectively in north eastern part of the district. They comprise mainly sandstones, quartzite, limestones, shales and phyllites. They are hard, compact and possess limited primary porosity. However, subsequent fracturing and fissuring followed by weathering enabled them to form aquifers locally. The thickness of weathered zone varies from 8 to 20m. The depth ranges of the dug wells vary from 6 to 10 m bgl. The premonsoon water levels vary from 5 to 20 m bgl and the post monsoon water levels vary from <2 to 10 m bgl. The yields of the dug wells range between 20 to 60 m3/day. In general they form poor aquifers except wells tapping weathered shales and sandstones.

The shallow fractured aquifer is tapped through bore wells. The discharges in Pakhal dolomitic limestones range from 6 to 32 m3/hr for drawdowns of 6 to 12 m. The specific capacity ranges from 24 to 76 lpm/mdd and the transmissivity from 168 to 834 m2/day. The discharges in the phyllitic shales ranges from 19 to 33 m3/hr, the specific capacity from 12.5 to 36 lpm/m/mdd and the transmissivity ranges from 33.9 to 35 m2/day. The discharges in the quartzite and shales ranges from 5 to 60 m3/hr, the transmissivity varies between 140 to 202 m2/day and the storage coefficient is about 3.4 x 10-3. The discharges in the Sullavai quartzite sandstones ranges from 15 to 42 m3/hr at draw downs varying from 1.1 to 6.6 m. The aquifer transmissivity ranges from 25 to 988 m2/day and the storage coefficient ranges from 1.6 x 10-4 to 2 x 10-4.

3.1.3 Ground Water in Gondwanas

Shallow Phreatic Aquifers

The Talchir boulder bed is favourable for sinking open wells, the depth of wells varies from 8 to 13 m in general and the yields ranges from 15 to 30 m3/day. The depth of the dug wells in Barakars 12 to 17 m bgl. They form poor aquifers and are tapped only for domestic needs. The depth of the dug wells tapping Kamthi sand stones vary from 4 to 15 m bgl and the have yields of 20 to 40 m3/day. The Maleri and Chikiala formations are predominantly clayey and form poor aquifers.

Deeper Confined Gondwana Aquifers

The yields of the bore wells tapping the Talchir formation (depth 100 m) ranges from 5 to 20 m3/hr and the specific capacity of the wells ranges from 10 to 55 lpm/mdd. The Barakar formation form poor aquifers. The sandstone horizons of 50 to 80 m tapped in the wells have discharges of 56 to 72 m3/day at draw down 19 to 23 m. The specific capacity of wells ranges from 27 to 330 lpm/mdd and the aquifer transmissivity ranges between 128 and 396 m2/day. The Kamthi sandstones extend upto 446 m bgl, the potential zones can be classified in to three groups top upto 100m, middle between 100 to 250 m and bottom beyond 250 m bgl. The lower group comprising of gritty sandstones have low to moderate yields of 324 to 1936 m3/day, transmissivity ranging from 70 to 135 m2/day and storage coefficient of 3.7 x 10-4. The middle group consisting of coarse to medium grained sandstones with intercalation of clays have moderate yields of 1180 m3/day with a transmissivity value of 70 m2/day and storage coefficient of 1.6 x 10-4. The upper Kamthi sandstones comprising of coarse to gritty sandstones have very high yields ranging from 1909 to 3896 m3/day, transmissivity ranging from 225 to 740 m2/day and storage coefficient varying from 2.6 x 10-4 to 8.4 x 10-5. The deeper sandstone aquifers of Maleri and Chikiala extending down to 220 m bgl occur under highly confined conditions. The discharges are around 2615 m3/day at drawdown of 22 m. The transmissivity and storage coefficient are around 126 m2/day and 7.98 x 10-4 respectively and many of them become artesian flowing wells.

3.1.4 Ground Water in Laterites and Alluvium

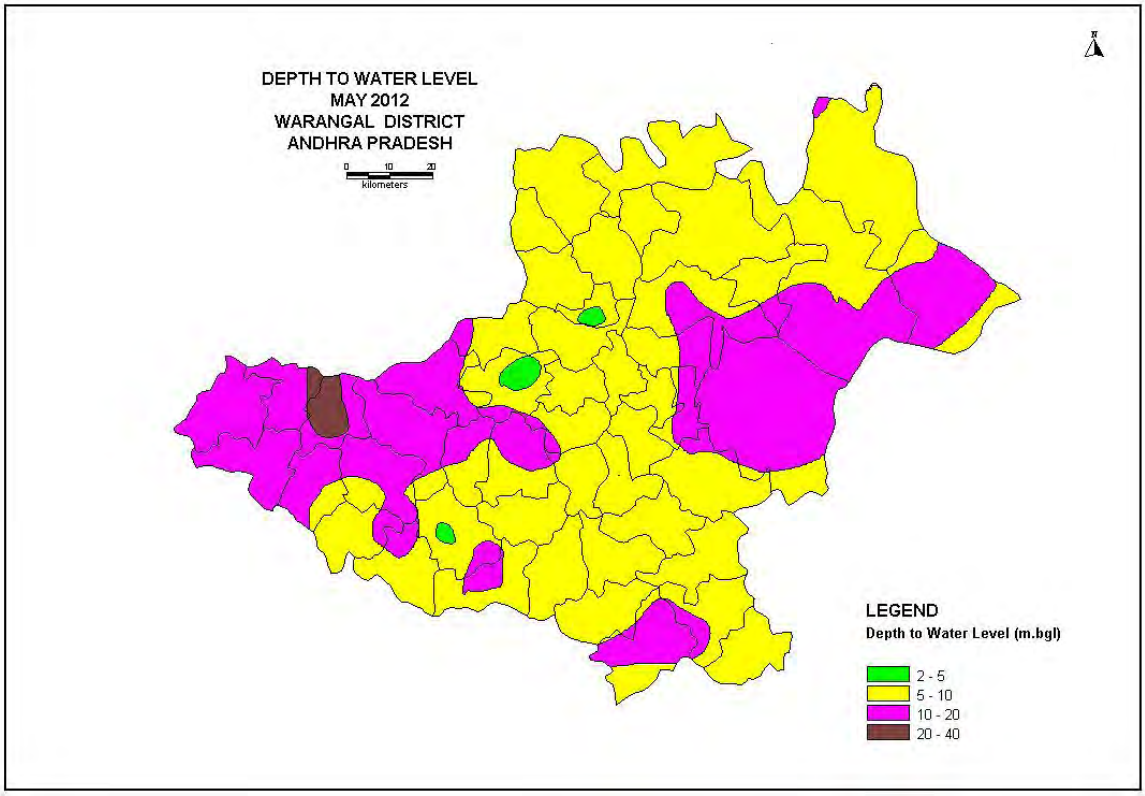
The yields of dug wells and dug-cum-bore wells are as high as 300 m3/day. Alluvium occurs either as terrace deposits or flood plains in about 125 sq km area along the western bank of the Godavari River. The depth of the alluvial sands varies from 5 to 20 m bgl. The yields of the shallow wells tapping alluvium vary from 30 to 60 m3/day and that of the filter point wells from 720 to 960 m3/day for a drawdown of 1 to 15 m.

4.0 DEPTH TO WATER LEVEL

4.1 Pre-monsoon

The depth to water levels range from 2.71 meters bgl to 20.74 m.bgl. The shallow water level of <5 m is observed as isolated patches in the district. The deeper water levels of more than 20 m bgl are observed in north-western part of the district. In rest of the area it varies from 5 to 20 m bgl. Majority of the area shows water level range of 5 to 10 m bgl. (Fig.4)

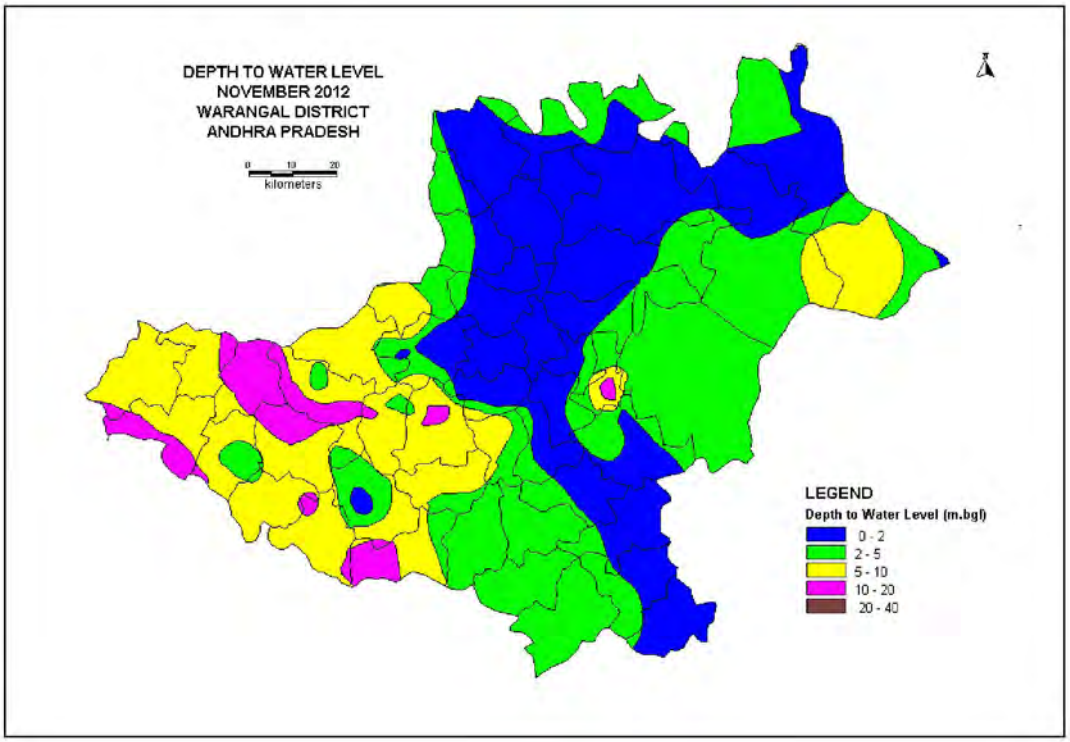
Fig.4 Depth to Water Level – Pre-monsoon 2012-Warangal district



4.2 Post-monsoon

The depth to water level range from 0.49 to 15.89 m bgl. In general the water levels are between 2 and 10 m bgl during the post monsoon period 2012 (Fig.5). The area under < 2 m bgl occurs in the central, northern and north-eastern part of the district. Water levels of more than 10 m bgl are seen only in very small isolated patches in the western and southern part. The water levels are between 0 and 5 m bgl in the central part from south to north and it varies from 5 to 10 m bgl all along the western part. In general the water levels are deep in the western part and shallow in eastern parts of the district.

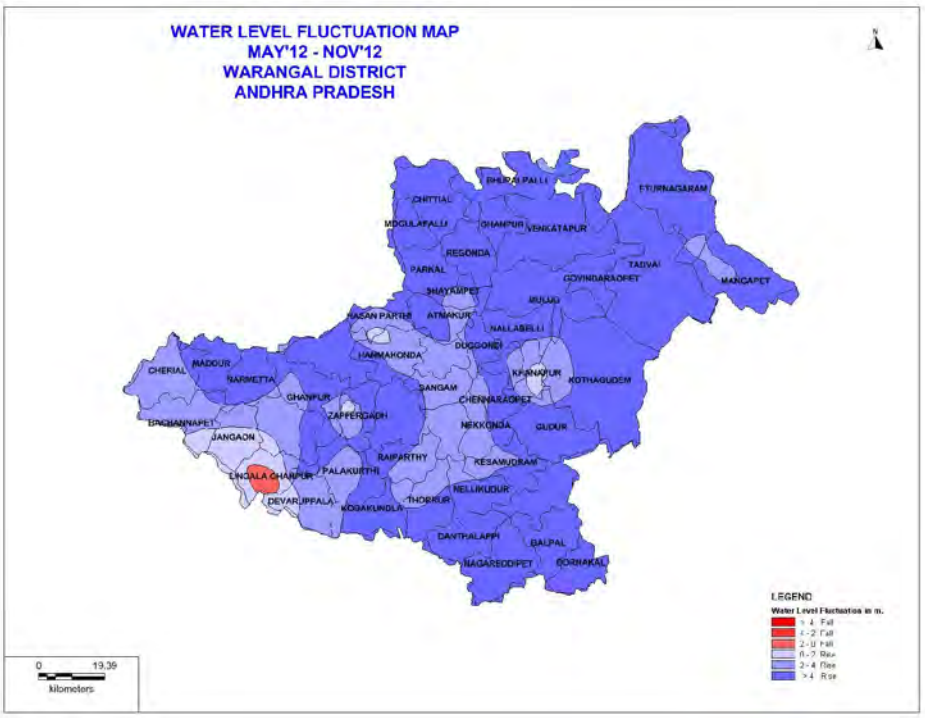
Fig.5 Depth to Water Level – Post monsoon 2012



4.3 Water Level Fluctuation:

The rise in water level between pre and post monsoon period of 2012 is more than 4 m in the entire district except in small pockets in central and western part of the district, where it is between 0-2 and 2-4 m (Fig 6). Fluctuation of water level shows a general rise.

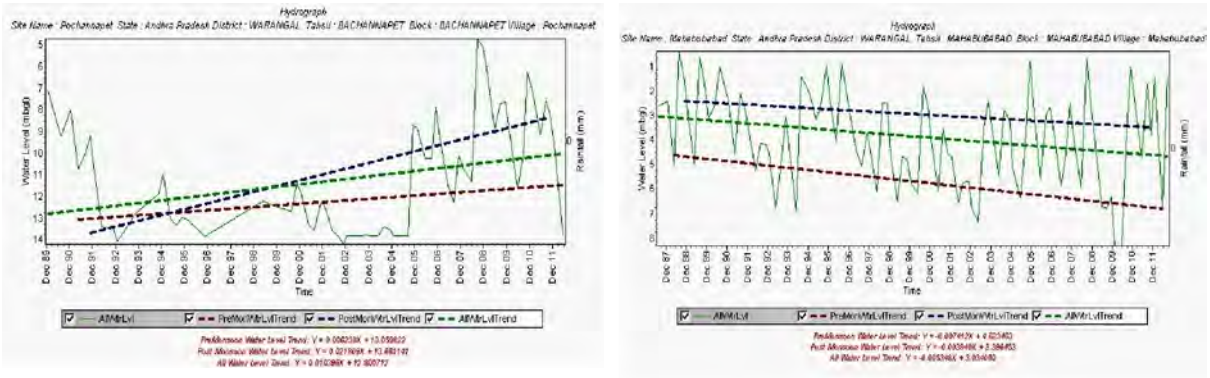
Fig.6 Water level Fluctuation 2012- Warangal District



4.4 Long Term Water Levels

Depth to water level data of observation wells (CGWB) for the period 1993 to 2011 has been considered for long term trend analysis. 46 records are showing annual rising trends, and the 22 records of the wells are showing falling trends. The hydrographs showing rising and declining trends are presented in the Fig.7.

Fig.7 Hydrographs showing rising and declining trends – Warangal district



5.0 GROUND WATER RESOURCES

The mandal wise ground water assessment, based on Ground Water Estimation Committee (GEC-97) norms, is presented in the Table 2. The total ground water resource available is 1854.18 MCM, Ground water draft is 1376.45 MCM and the ground water balance is 511.39 MCM in command and non command areas respectively. Based on present stage of development 22 mandals are categorized as safe, 9 semi-critical, 3 critical and 16 over exploited (Fig.8). The overall stage of ground water development of the district is 74%.

Fig.8 Mandal wise categorization of ground water resources – Warangal district

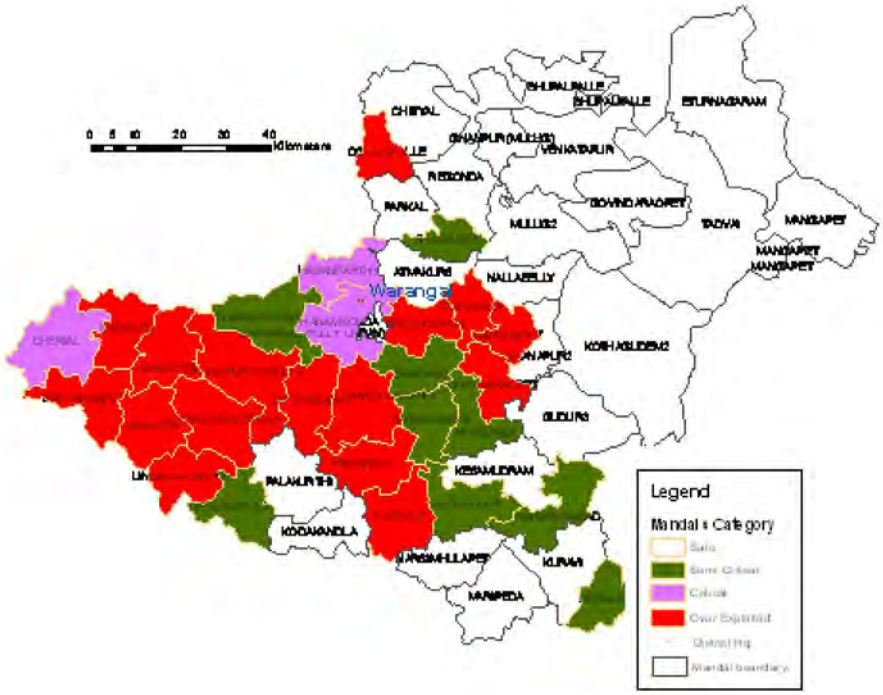


Table.2 Mandal Wise Dynamic Groundwater Resources Assessment Warangal District, Andhra Pradesh[2008-2009] [in ha.m.]

Sl.No	Mandal	C/ NC/ T	Recharge from rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total annual ground water recharge [4+5+ 6+7]	Provision for natural discharge	Net annual ground water availability
1	2	3	4	5	6	7	8	9	10
1	Atmakur	C	1507	1962	561	1082	5112	511	4601
		NC	0	0	0	0	0	0	0
		T	1507	1962	561	1082	5112	511	4601
2	Bachannapet	C	0	0	0	0	0	0	0
		NC	1752	355	380	869	3356	336	3020
		T	1752	355	380	869	3356	336	3020
3	Bhupalpally	C	263	63	52	63	441	44	397
		NC	2302	139	423	244	3108	311	2797
		T	2565	202	475	307	3549	355	3194
4	Chennaraopet	C	1026	597	267	886	2776	278	2498
		NC	0	0	0	0	0	0	0
		T	1026	597	267	886	2776	278	2498
5	Cherial	C	0	0	0	0	0	0	0
		NC	2240	212	564	914	3930	393	3537
		T	2240	212	564	914	3930	393	3537
6	Chityal	C	1938	2593	391	1165	6087	609	5478
		NC	480	44	77	77	678	67	611
		T	2418	2637	468	1242	6765	676	6089
7	Devaruppula	C	0	0	0	0	0	0	0
		NC	1541	430	450	795	3216	322	2894
		T	1541	430	450	795	3216	322	2894
8	Dharmasagar	C	0	0	0	0	0	0	0
		NC	1761	721	505	1278	4265	426	3839
		T	1761	721	505	1278	4265	426	3839
9	Dornakal	C	993	491	332	766	2582	258	2324
		NC	0	0	0	0	0	0	0
		T	993	491	332	766	2582	258	2324
10	Duggondi	C	459	530	182	371	1542	154	1388
		NC	306	78	142	153	679	68	611
		T	765	608	324	524	2221	222	1999
11	Eturnagaram	C	0	0	0	0	0	0	0
		NC	5903	112	1375	179	7569	757	6812
		T	5903	112	1375	179	7569	757	6812
12	Geesugonda	C	234	416	122	181	953	95	858
		NC	780	226	331	423	1760	176	1584
		T	1014	642	453	604	2713	271	2442
13	Govindraopet	C	0	0	0	0	0	0	0
		NC	3649	247	832	408	5136	514	4622
		T	3649	247	832	408	5136	514	4622
14	Gudur	C	707	305	177	600	1789	179	1610
		NC	1306	177	322	462	2267	227	2040
		T	2013	482	499	1062	4056	406	3650
15	Hanamkonda	C	21	6	7	12	46	5	41
		NC	2127	317	654	620	3718	372	3346
		T	2148	323	661	632	3764	377	3387
16	Hasanparthy	C	1205	801	295	969	3270	327	2943
		NC	0	0	0	0	0	0	0
		T	1205	801	295	969	3270	327	2943
17	Jangaon	C	0	0	0	0	0	0	0
		NC	1277	373	426	813	2889	289	2600

		T	1277	373	426	813	2889	289	2600
18	Kesamudram	C	1501	1488	488	1242	4719	472	4247
		NC	0	0	0	0	0	0	0
		T	1501	1488	488	1242	4719	472	4247
19	Khanapur	C	0	0	0	0	0	0	0
		NC	910	128	227	334	1599	159	1440
		T	910	128	227	334	1599	159	1440
20	Kodakandla	C	0	0	0	0	0	0	0
		NC	1534	430	459	682	3105	155	2950
		T	1534	430	459	682	3105	155	2950
21	Korivi	C	1644	1501	552	1410	5107	511	4596
		NC	0	0	0	0	0	0	0
		T	1644	1501	552	1410	5107	511	4596
22	Kothaguda	C	0	0	0	0	0	0	0
		NC	4459	179	1352	262	6252	626	5626
		T	4459	179	1352	262	6252	626	5626
23	Lingala ghanpur	C	0	0	0	0	0	0	0
		NC	1293	392	439	820	2944	295	2649
		T	1293	392	439	820	2944	295	2649
24	Maddur	C	0	0	0	0	0	0	0
		NC	1314	279	331	653	2577	257	2320
		T	1314	279	331	653	2577	257	2320
25	Mahabubabad	C	1456	1839	469	1216	4980	499	4481
		NC	266	37	66	98	467	47	420
		T	1722	1876	535	1314	5447	546	4901
26	Mangapet	C	0	0	0	0	0	0	0
		NC	5042	177	969	302	6490	649	5841
		T	5042	177	969	302	6490	649	5841
27	Maripeda	C	452	834	150	402	1838	184	1654
		NC	1889	433	465	662	3449	344	3105
		T	2341	1267	615	1064	5287	528	4759
28	Mogullapally	C	1075	1256	275	890	3496	350	3146
		NC	0	0	0	0	0	0	0
		T	1075	1256	275	890	3496	350	3146
29	Mulug	C	655	872	272	439	2238	200	2038
		NC	3498	140	680	241	4559	456	4103
		T	4153	1012	952	680	6797	656	6141
30	MulugGhanpur	C	0	0	0	0	0	0	0
		NC	1225	182	247	286	1940	194	1746
		T	1225	182	247	286	1940	194	1746
31	Nallabelly	C	454	765	225	350	1794	180	1614
		NC	550	130	147	215	1042	105	937
		T	1004	895	372	565	2836	285	2551
32	Narmetta	C	0	0	0	0	0	0	0
		NC	2102	588	455	993	4138	413	3725
		T	2102	588	455	993	4138	413	3725
33	Narsampet	C	602	429	157	468	1656	165	1491
		NC	149	28	39	57	273	27	246
		T	751	457	196	525	1929	192	1737
34	Narsimhulapet	C	130	274	43	115	562	56	506
		NC	1396	461	425	730	3012	150	2862
		T	1526	735	468	845	3574	206	3368
35	Nekkonda	C	1204	1440	391	1079	4114	411	3703
		NC	136	40	42	75	293	15	278
		T	1340	1480	433	1154	4407	426	3981
36	Nellikudur	C	1542	1884	500	1214	5140	515	4625
		NC	81	27	32	47	187	18	169
		T	1623	1911	532	1261	5327	533	4794
37	Palakurthy	C	0	0	0	0	0	0	0
		NC	2311	562	671	871	4415	434	3981
		T	2311	562	671	871	4415	434	3981
38	Parkal	C	1352	1321	361	1089	4123	412	3711
		NC	0	0	0	0	0	0	0
		T	1352	1321	361	1089	4123	412	3711
39	Parvatagiri	C	1019	1023	282	697	3021	150	2871

		NC	325	65	66	126	582	58	524
		T	1344	1088	348	823	3603	208	3395
40	Raghunathpally	C	0	0	0	0	0	0	0
		NC	2005	579	581	1035	4200	420	3780
		T	2005	579	581	1035	4200	420	3780
41	Rayaparthy	C	0	0	0	0	0	0	0
		NC	1995	395	409	782	3581	358	3223
		T	1995	395	409	782	3581	358	3223
42	Regonda	C	1401	1664	291	825	4181	419	3762
		NC	260	37	77	64	438	44	394
		T	1661	1701	368	889	4619	463	4156
43	Sangem	C	522	874	172	480	2048	205	1843
		NC	843	253	263	497	1856	93	1763
		T	1365	1127	435	977	3904	298	3606
44	Shayampet	C	844	1006	286	578	2714	271	2443
		NC	0	0	0	0	0	0	0
		T	844	1006	286	578	2714	271	2443
45	Stn Ghanpur	C	0	0	0	0	0	0	0
		NC	3994	891	706	1532	7123	713	6410
		T	3994	891	706	1532	7123	713	6410
46	Tadvai	C	0	0	0	0	0	0	0
		NC	6040	122	1300	212	7674	767	6907
		T	6040	122	1300	212	7674	767	6907
47	Thorrur	C	0	0	0	0	0	0	0
		NC	1399	454	474	778	3105	292	2813
		T	1399	454	474	778	3105	292	2813
48	Venkatapur	C	0	0	0	0	0	0	0
		NC	2463	265	530	416	3674	337	3337
		T	2463	265	530	416	3674	337	3337
49	Wardhannapet	C	522	372	132	304	1330	132	1198
		NC	1633	342	432	920	3327	285	3042
		T	2155	714	564	1224	4657	417	4240
50	Zaffergadh	C	0	0	0	0	0	0	0
		NC	1418	243	365	694	2720	273	2447
		T	1418	243	365	694	2720	273	2447
	District Total	C	24728	26606	7432	18893	77659	7592	70067
		NC	75954	11290	18730	21619	127593	12242	115351
		T	100682	37896	26162	40512	205252	19834	185418

C= Command; NC=Non-command; T=Total

ASSESSMENT OF MANDAL WISE DYNAMIC GROUNDWATER RESOURCES (Table.2 cont)
OF THE WARANGAL DISTRICT, ANDHRA PRADESH [2008-2009] [in ha.m.]

Sl.No	Mandal	C/ NC/ T	Net annual ground water availability	Existing gross ground water draft for irrigate-on	Existing gross GW 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 GW availability for future irrigation develop-ment [10-11-14]	Stage of ground water development {(13/10*100)} [%]
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	Atmakur	C	4601	2374	68	2442	203	2024	53
		NC	0	0	0	0	0	0	0
		T	4601	2374	68	2442	203	2024	53
2	Bachannapet	C	0	0	0	0	0	0	0
		NC	3020	2900	66	2966	120	0	98
		T	3020	2900	66	2966	120	0	98
3	Bhupalpally	C	397	176	0	176	22	199	44
		NC	2797	490	412	902	412	1895	32
		T	3194	666	412	1078	434	2094	34
4	Chennaraopet	C	2498	3054	61	3115	61	0	125
		NC	0	0	0	0	0	0	0
		T	2498	3054	61	3115	61	0	125
5	Cherial	C	0	0	0	0	0	0	0
		NC	3537	3148	98	3246	250	139	92
		T	3537	3148	98	3246	250	139	92
6	Chityal	C	5478	4012	70	4082	191	1275	75
		NC	611	151	1	152	25	435	25
		T	6089	4163	71	4234	216	1710	70
7	Devaruppula	C	0	0	0	0	0	0	0
		NC	2894	2217	67	2284	153	524	79
		T	2894	2217	67	2284	153	524	79
8	Dharmasagar	C	0	0	0	0	0	0	0
		NC	3839	3359	79	3438	257	223	90
		T	3839	3359	79	3438	257	223	90
9	Dornakal	C	2324	2136	105	2241	174	14	96
		NC	0	0	0	0	0	0	0
		T	2324	2136	105	2241	174	14	96
10	Duggondi	C	1388	1361	40	1401	40	0	101
		NC	611	959	44	1003	44	0	164
		T	1999	2320	84	2404	84	0	120
11	Eturnagaram	C	0	0	0	0	0	0	0
		NC	6812	525	30	555	138	6149	8
		T	6812	525	30	555	138	6149	8
12	Geesugonda	C	858	734	15	749	47	77	87
		NC	1584	1933	73	2006	73	0	127
		T	2442	2667	88	2755	120	77	113
13	Govindraopet	C	0	0	0	0	0	0	0
		NC	4622	417	35	452	109	4096	10
		T	4622	417	35	452	109	4096	10
14	Gudur	C	1610	1190	32	1222	107	313	76
		NC	2040	1049	43	1092	94	897	54
		T	3650	2239	75	2314	201	1210	63
15	Hanamkonda	C	41	0	0	0	0	41	0
		NC	3346	2800	433	3233	546	0	97
		T	3387	2800	433	3233	546	41	95
16	Hasanparthy	C	2943	2797	92	2889	146	0	98
		NC	0	0	0	0	0	0	0
		T	2943	2797	92	2889	146	0	98
17	Jangaon	C	0	0	0	0	0	0	0
		NC	2600	3111	127	3238	127	0	125
		T	2600	3111	127	3238	127	0	125
18	Kesamudram	C	4247	2540	370	2910	370	1337	69
		NC	0	0	0	0	0	0	0
		T	4247	2540	370	2910	370	1337	69
19	Khanapur	C	0	0	0	0	0	0	0
		NC	1440	855	25	880	115	470	61
		T	1440	855	25	880	115	470	61

1	2	3	4	5	6	7	8	9	10
20	Kodakandla	C	0	0	0	0	0	0	0
		NC	2950	2212	89	2301	183	555	78
		T	2950	2212	89	2301	183	555	78
21	Korivi	C	4596	3546	60	3606	297	753	78
		NC	0	0	0	0	0	0	0
		T	4596	3546	60	3606	297	753	78
22	Kothaguda	C	0	0	0	0	0	0	0
		NC	5626	501	83	584	143	4982	10
		T	5626	501	83	584	143	4982	10
23	Lingala ghanpur	C	0	0	0	0	0	0	0
		NC	2649	2930	47	2977	47	0	112
		T	2649	2930	47	2977	47	0	112
24	Maddur	C	0	0	0	0	0	0	0
		NC	2320	2714	65	2779	65	0	120
		T	2320	2714	65	2779	65	0	120
25	Mahabubabad	C	4481	3464	227	3691	356	661	82
		NC	420	804	3	807	3	0	192
		T	4901	4268	230	4498	359	661	92
26	Mangapet	C	0	0	0	0	0	0	0
		NC	5841	777	38	815	175	4889	14
		T	5841	777	38	815	175	4889	14
27	Maripeda	C	1654	1108	14	1122	55	491	68
		NC	3105	2472	104	2576	240	393	83
		T	4759	3580	118	3698	295	884	78
28	Mogullapally	C	3146	3475	41	3516	41	0	112
		NC	0	0	0	0	0	0	0
		T	3146	3475	41	3516	41	0	112
29	Mulug	C	2038	943	38	981	67	1028	48
		NC	4103	707	64	771	153	3243	19
		T	6141	1650	102	1752	220	4271	29
30	MulugGhanpur	C	0	0	0	0	0	0	0
		NC	1746	1007	91	1098	124	615	63
		T	1746	1007	91	1098	124	615	63
31	Nallabelly	C	1614	1351	36	1387	99	164	86
		NC	937	449	13	462	32	456	49
		T	2551	1800	49	1849	131	620	72
32	Narmetta	C	0	0	0	0	0	0	0
		NC	3725	3746	64	3810	64	0	102
		T	3725	3746	64	3810	64	0	102
33	Narsampet	C	1491	1431	43	1474	60	0	99
		NC	246	320	12	332	12	0	135
		T	1737	1751	55	1806	72	0	104
34	Narsimhulapet	C	506	245	0	245	13	248	48
		NC	2862	1881	86	1967	197	784	69
		T	3368	2126	86	2212	210	1032	66
1	2	3	10	11	12	13	14	15	16
35	Nekkonda	C	3703	3317	63	3380	158	228	91
		NC	278	234	2	236	24	20	85
		T	3981	3551	65	3616	182	248	91
36	Nellikudur	C	4625	4559	79	4638	79	0	100
		NC	169	114	0	114	13	42	67
		T	4794	4673	79	4752	92	42	99
37	Palakurthy	C	0	0	0	0	0	0	0
		NC	3981	2998	118	3116	202	781	78
		T	3981	2998	118	3116	202	781	78
38	Parkal	C	3711	3016	196	3212	282	413	87
		NC	0	0	0	0	0	0	0
		T	3711	3016	196	3212	282	413	87
39	Parvatagiri	C	2871	2254	76	2330	76	541	81
		NC	524	564	10	574	10	0	110
		T	3395	2818	86	2904	86	541	86
40	Raghunathpally	C	0	0	0	0	0	0	0
		NC	3780	3845	95	3940	95	0	104
		T	3780	3845	95	3940	95	0	104
41	Rayaparthy	C	0	0	0	0	0	0	0
		NC	3223	3110	97	3207	97	16	100
		T	3223	3110	97	3207	97	16	100
42	Regonda	C	3762	3129	76	3205	76	557	85
		NC	394	276	5	281	26	92	71
		T	4156	3405	81	3486	102	649	84

1	2	3	4	5	6	7	8	9	10
43	Sangem	C	1843	1309	37	1346	84	450	73
		NC	1763	1376	54	1430	112	275	81
		T	3606	2685	91	2776	196	725	77
44	Shayampet	C	2443	2281	95	2376	154	8	97
		NC	0	0	0	0	0	0	0
		T	2443	2281	95	2376	154	8	97
45	Stn Ghanpur	C	0	0	0	0	0	0	0
		NC	6410	7230	90	7320	90	0	114
		T	6410	7230	90	7320	90	0	114
46	Tadvai	C	0	0	0	0	0	0	0
		NC	6907	1159	18	1177	80	5668	17
		T	6907	1159	18	1177	80	5668	17
47	Thorrur	C	0	0	0	0	0	0	0
		NC	2813	2917	90	3007	90	0	107
		T	2813	2917	90	3007	90	0	107
48	Venkatapur	C	0	0	0	0	0	0	0
		NC	3337	549	79	628	136	2652	19
		T	3337	549	79	628	136	2652	19
49	Wardhannapet	C	1198	1494	23	1517	23	0	127
		NC	3042	2809	84	2893	207	26	95
		T	4240	4303	107	4410	230	26	104
50	Zaffergadh	C	0	0	0	0	0	0	0
		NC	2447	3685	58	3743	58	0	153
		T	2447	3685	58	3743	58	0	153
	District	C	70067	57296	1957	59253	3281	10822	85
		NC	115351	75300	3092	78392	5141	40317	68
		T	185418	132596	5049	137645	8422	51139	74

Mandal Wise Categorization (2008-09) – Warangal District(Table.2 cont.)

Sl. No	Mandal name	C/ NC/ T	Stage of ground water develop ment [%]	Pre-monsoon		Post monsoon		Category [safe/ semicritical/ Critical/ Over exploited]
				Water level trend cm/yr	Is there a significant decline [YES/NO]	Water level trend cm/yr	Is there a significant decline [YES/NO]	
1	Atmakur	C	53	-47	No	1	No	Safe
	Atmakur	NC	0					
	Atmakur	T	53	-47	No	1	No	Safe
2	Bachannapet	C	0					
	Bachannapet	NC	98	98	Yes	-21	No	Over Expoloited
	Bachannapet	T	98	98	Yes	-21	No	Over Expoloited
3	Bhupalpally	C	44	6	No	-1	No	Safe
	Bhupalpally	NC	32	6	No	-1	No	Safe
	Bhupalpally	T	34	6	No	-1	No	Safe
4	Chennaraopet	C	125	9	No	64	Yes	Over Expoloited
	Chennaraopet	NC	0					
	Chennaraopet	T	125	9	No	64	Yes	Over Expoloited
5	Cherial	C	0					
	Cherial	NC	92	27	Yes	29	Yes	Critical
	Cherial	T	92	27	Yes	29	Yes	Critical
6	Chityal	C	75	-19	No	-70	No	Safe
	Chityal	NC	25	-19	No	-70	No	Safe
	Chityal	T	70	-19	No	-70	No	Safe
7	Devaruppula	C	0					
	Devaruppula	NC	79	-18	No	13	Yes	Semi-Critical
	Devaruppula	T	79	-18	No	13	Yes	Semi-Critical
8	Dharmasagar	C	0					
	Dharmasagar	NC	90	-117	No	55	Yes	Semi-Critical
	Dharmasagar	T	90	-117	No	55	Yes	Semi-Critical
9	Dornakal	C	96	13	Yes	-10	No	Semi-Critical
	Dornakal	NC	0					
	Dornakal	T	96	13	Yes	-10	No	Semi-Critical

1	2	3	4	5	6	7	8	9
10	Duggondi	C	101	41	Yes	100	Yes	Over Exploited
	Duggondi	NC	164	41	Yes	100	Yes	Over Exploited
	Duggondi	T	120	41	Yes	100	Yes	Over Exploited
11	Eturnagaram	C	0					
	Eturnagaram	NC	8	-21	No	-13	No	Safe
	Eturnagaram	T	8	-21	No	-13	No	Safe
12	Geesugonda	C	87	-38	No	-51	No	Safe
	Geesugonda	NC	127	10	Yes	-2.57	No	Over Exploited
	Geesugonda	T	113	10	Yes	-2.57	No	Over Exploited
13	Govindraopet	C	0					
	Govindraopet	NC	10	-19	No	-11	No	Safe
	Govindraopet	T	10	-19	No	-11	No	Safe
14	Gudur	C	76	9	No	64	Yes	Semi-Critical
	Gudur	NC	54	-31	No	-17.53	No	Safe
	Gudur	T	63	-31	No	-17.53	No	Safe
15	Hanamkonda	C	0					
	Hanamkonda	NC	97	11	Yes	16	Yes	Critical
	Hanamkonda	T	95	11	Yes	16	Yes	Critical
16	Hasanparthy	C	98	11	Yes	16	Yes	Critical
	Hasanparthy	NC	0					
	Hasanparthy	T	98	11	Yes	16	Yes	Critical
17	Jangaon	C	0					
	Jangaon	NC	125	28	Yes	-69	No	Over Exploited
	Jangaon	T	125	28	Yes	-69	No	Over Exploited
18	Kesamudram	C	69	-95	No	-86	No	Safe
	Kesamudram	NC	0					
	Kesamudram	T	69	-95	No	-86	No	Safe
19	Khanapur	C	0					
	Khanapur	NC	61	-71	No	-73.04	No	Safe
	Khanapur	T	61	-71	No	-73.04	No	Safe
20	Kodakandla	C	0					
	Kodakandla	NC	78	3	No	-7	No	Safe
	Kodakandla	T	78	3	No	-7	No	Safe
21	Korivi	C	78	-15	No	-14	No	Safe
	Korivi	NC	0					
	Korivi	T	78	-15	No	-14	No	Safe
22	Kothaguda	C	0					
	Kothaguda	NC	10	-31	No	-18	No	Safe
	Kothaguda	T	10	-31	No	-18	No	Safe
23	Lingala ghanpur	C	0					
	Lingala ghanpur	NC	112	27	Yes	-1	No	Over Exploited
	Lingala ghanpur	T	112	27	Yes	-1	No	Over Exploited
24	Maddur	C	0					
	Maddur	NC	120	11	Yes	10	Yes	Over Exploited
	Maddur	T	120	11	Yes	10	Yes	Over Exploited
25	Mahabubabad	C	82	13	Yes	-10	No	Semi-Critical
	Mahabubabad	NC	192	13	Yes	-10	No	Over Exploited
	Mahabubabad	T	92	13	Yes	-10	No	Semi-Critical
26	Mangapet	C	0					
	Mangapet	NC	14	4	No	-27	No	Safe
	Mangapet	T	14	4	No	-27	No	Safe
27	Maripeda	C	68	-15	No	-14	No	Safe
	Maripeda	NC	83	-15	No	-14	No	Safe
	Maripeda	T	78	-15	No	-14	No	Safe
28	Mogullapally	C	112	54	Yes	77	Yes	Over Exploited
	Mogullapally	NC	0					
	Mogullapally	T	112	54	Yes	77	Yes	Over Exploited
29	Mulug	C	48	2	No	-19	No	Safe
	Mulug	NC	19	2	No	-19	No	Safe
	Mulug	T	29	2	No	-19	No	Safe
30	MulugGhanpur	C	0					
	MulugGhanpur	NC	63	-27	No	-61	No	Safe
	MulugGhanpur	T	63	-27	No	-61	No	Safe
31	Nallabelly	C	86	-24	No	-25	No	Safe
	Nallabelly	NC	49	-24	No	-25	No	Safe
	Nallabelly	T	72	-24	No	-25	No	Safe
32	Narmetta	C	0					
	Narmetta	NC	102	62	Yes	-13	No	Over Exploited
	Narmetta	T	102	62	Yes	-13	No	Over Exploited
33	Narsampet	C	99	41	Yes	100	Yes	Critical
	Narsampet	NC	135	41	Yes	100	Yes	Over Exploited

1	2	3	4	5	6	7	8	9
	Narsampet	T	104	41	Yes	100	Yes	Over Exploited
34	Narsimhulapet	C	48	-71	No	-73	No	Safe
	Narsimhulapet	NC	69	-71	No	-73	No	Safe
	Narsimhulapet	T	66	-71	No	-73	No	Safe
35	Nekkonda	C	91	-1	No	12	Yes	Semi-Critical
	Nekkonda	NC	85	-1	No	12	Yes	Semi-Critical
	Nekkonda	T	91	-1	No	12	Yes	Semi-Critical
36	Nellikudur	C	100	18	Yes	7	No	Over Exploited
	Nellikudur	NC	67	3	No	-6.75	No	Safe
	Nellikudur	T	99	18	Yes	7	No	Semi-Critical
37	Palakurthy	C	0					
	Palakurthy	NC	78	3	No	-7	No	Safe
	Palakurthy	T	78	3	No	-7	No	Safe
38	Parkal	C	87	10	No	-3	No	Safe
	Parkal	NC	0					
	Parkal	T	87	10	No	-3	No	Safe
39	Parvatagiri	C	81	36	Yes	-2	No	Semi-Critical
	Parvatagiri	NC	110	36	Yes	-2	No	Over Exploited
	Parvatagiri	T	86	36	Yes	-2	No	Semi-Critical
40	Raghunathpally	C	0					
	Raghunathpally	NC	104	33	Yes	-16	No	Over Exploited
	Raghunathpally	T	104	33	Yes	-16	No	Over Exploited
41	Rayaparthy	C	0					
	Rayaparthy	NC	100	-138	No	21	Yes	Over Exploited
	Rayaparthy	T	100	-138	No	21	Yes	Over Exploited
42	Regonda	C	85	-19	No	-70	No	Safe
	Regonda	NC	71	-19	No	-70	No	Safe
	Regonda	T	84	-19	No	-70	No	Safe
43	Sangem	C	73	18	Yes	7	No	S.C.
	Sangem	NC	81	3	No	-6.75	No	Safe
	Sangem	T	77	18	Yes	7	No	S.C.
44	Shayampet	C	97	11	Yes	-3	No	Semi-Critical
	Shayampet	NC	0					
	Shayampet	T	97	11	Yes	-3	No	Semi-Critical
45	Stn Ghanpur	C	0					
	Stn Ghanpur	NC	114	-42	No	21	Yes	Over Exploited
	Stn Ghanpur	T	114	-42	No	21	Yes	Over Exploited
46	Tadvai	C	0					
	Tadvai	NC	17	-1	No	-10	No	Safe
	Tadvai	T	17	-1	No	-10	No	Safe
47	Thorrur	C	0					
	Thorrur	NC	107	-159	No	14	Yes	Over Exploited
	Thorrur	T	107	-159	No	14	Yes	Over Exploited
48	Venkatapur	C	0					
	Venkatapur	NC	19	-4	No	0	No	Safe
	Venkatapur	T	19	-4	No	0	No	Safe
49	Wardhannapet	C	127	36	Yes	-2	No	Over Exploited
	Wardhannapet	NC	95	36	Yes	-2	No	Semi-Critical
	Wardhannapet	T	104	36	Yes	-2	No	Over Exploited
50	Zaffergadh	C	0					
	Zaffergadh	NC	153	45	Yes	29	Yes	Over Exploited
	Zaffergadh	T	153	45	Yes	29	Yes	Over Exploited

6.0 GROUND WATER QUALITY

The ground water in the district is in general suitable for both domestic and irrigation purpose. PH is well within the prescribed limits in the district. Total Hardness values are beyond permissible limits in about 28% of the samples.12% of samples are beyond permissible limits with respect to Bicarbonate, whereas about 80% samples falls beyond the permissible limits, in case of Nitrates. This may be attributed to anthropogenic activities going on thought the district. Fluoride is excess as per the BIS permissible limits at one place ie., Narampet in the district.

The electrical conductivity is defined as reciprocal of electrical resistance and it measures the ability of water to conduct electric current. The distribution of EC in Warangal

district ranges from 750 to 3000 (Siemens/cm at 25 c). Ec values more than 3000 (Siemens/cm at 25 c) are observed in Raghinathapalli and Janagoan villages. The distribution of electrical conductivity in ground water is presented in Fig.7 and the chemical analysis data of ground water collected from observations wells is presented in the Table.3.

Fig.9 Distribution of electrical conductivity in ground water – Warangal district

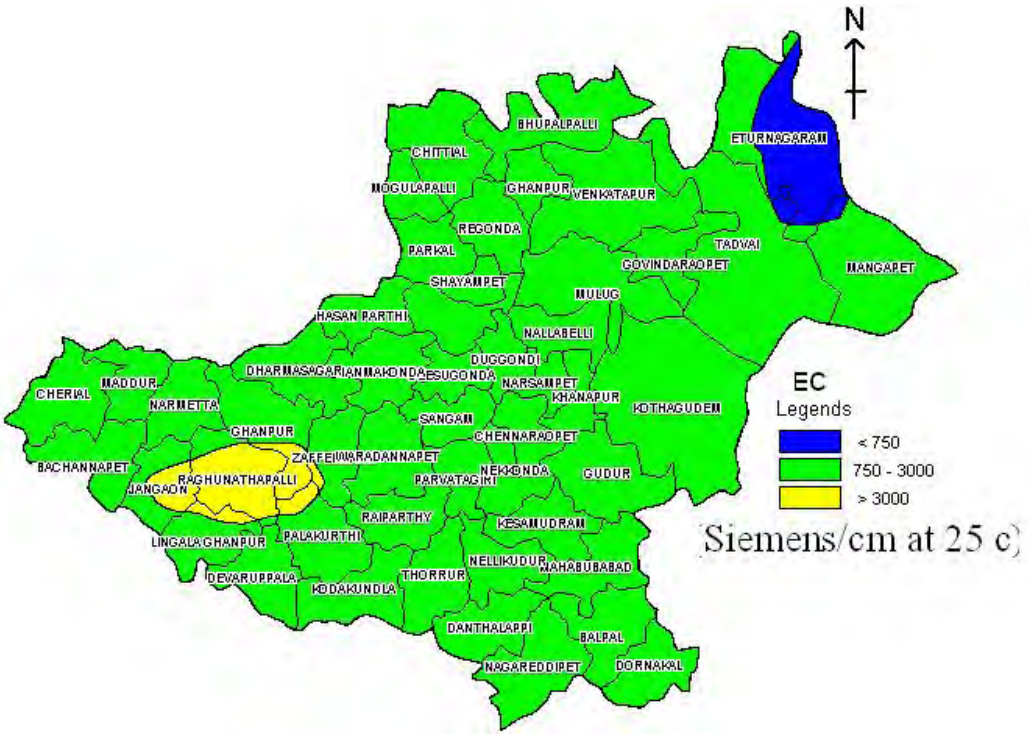


Table.3 Chemical analysis data of ground water collected from observation wells

Location	pH	EC	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	F
		in uS/cm	---------- ------ppm----------										
Mulug	6.65	2992	1100	256	112	158	33	0	488	482	141	320	0.31
Tadvai-new	6.82	1162	453	148	20	53	2.2	0	360	138	4.8	105	0.35
Kamalapuram-new	6.61	1133	295	96	13	59	107	0	342	110	23	130	0.31
Urugonda	7.20	2018	500	92	66	234	6.9	0	634	255	2.1	160	1.20
Kazipet-alt	7.23	1164	415	78	53	77	1.3	0	421	96	6.4	115	0.80
Narsampet	7.11	1476	545	74	87	88	3.2	0	555	135	2.1	100	2.04
Mahabubabad	6.78	1910	569	130	59	170	5.2	0	659	230	14	90	0.50
Mallampalli	6.88	2461	777	212	60	203	1.9	0	488	440	85	140	1.10
Govindaraopet	7.25	776	328	88	26	29	0.4	0	372	43	18	2.0	0.42
Lakhmidevpet-1	6.93	2421	968	184	124	106	1.3	0	500	475	44	100	0.32
Pochannapet	6.70	2870	1018	176	140	185	3.9	0	561	362	127	400	0.44
Parakal	7.18	990	355	86	34	65	1.3	0	467	41	0.8	65	1.28
Warangal	7.45	2025	428	144	17	260	6.9	0	537	305	97	40	0.79
Gudur2	7.14	1480	385	88	40	158	2.6	0	598	138	3	60	1.20
Mylaram	6.76	2490	734	192	62	226	7.9	0	512	390	100	200	1.18
Jangalapalli	7.22	1383	415	80	52	125	1.6	0	598	92	40	30	1.03
Chinaboyanapali	6.60	68	30	10	1.0	4.0	0.7	0	24	11	1.4	1.0	0.04
Nekkonda	7.31	2050	455	64	72	268	2.9	0	781	213	5.8	110	1.05
Ingurti	7.35	2070	390	120	22	285	11	0	415	255	176	170	0.61
Kesamudram	7.38	1456	505	76	77	98	2.9	0	488	170	9.2	85	0.51
Pedda Pendyal	6.80	1353	501	102	60	74	3.9	0	439	170	8.7	80	0.96
Ippagudem	6.84	4961	1410	368	119	484	6.9	0	537	787	219	850	0.53
Palakurthi	7.76	1020	165	56	6.0	111	89	0	515	48	2.6	20	0.55
Alimpuram	7.15	2140	400	128	19	203	165	0	549	255	41	240	0.44
Cherial	6.82	1900	640	140	71	130	13	0	512	241	63	140	0.52
Max:	**7.76**	**4961**	**1410**	**368**	**140**	**484**	**165**	**0**	**781**	**787**	**219**	**850**	**2.04**
Min:	**6.60**	**68**	**30**	**10**	**1**	**4**	**0.36**	**0**	**24**	**11**	**0.82**	**1**	**0.04**
Avg:	**7.04**	**1831**	**551**	**128**	**56**	**154**	**19**	**0**	**494**	**235**	**50**	**150**	**0.74**
>BIS		**1**	**7**						**3**	**0**	**0**	**20**	**1**

7.0 STATUS OF GROUND WATER DEVELOPMENT

Ground water development in the district is through bore well of 60 to 100 m depth in the non-command areas and through dug wells and shallow bore wells in the command area. In the sedimentary terrain ground water development is through deep tube wells tapping the Gondwana sandstones. Alluvial aquifers are developed through filter point wells of 10 to 20 depths. The district is mainly dependant on ground water for its irrigation and domestic needs. 87% of the irrigated area is dependent on ground water and to cater to this need 196007ground water extraction structures exist. 98.5% of the drinking water needs are met from ground water sources. To meet the domestic water needs of the 1003habitations 2459 ground water extraction structures are constructed. The details of the drinking water facilities are presented in Table 4.Large diameter dug wells piercing the weathered rock exist in the area for irrigation purpose; they are either in rectangular or circular shape. The sides of the rectangular wells are usually between 4 to 10 m, similarly the diameter of the circular wells is between 6 to 10 m. The depth of the dug wells varies from 6 to15 m bgl in crystalline areas and between 8 to 13 m in sedimentary terrain. Most of the wells in the non-command dry up in summer. The wells have 1-2 m of water column and sustain pumping by 5 HP motors for 2 to 5 hrs in two spells ina day. The yields of the wells vary from 20 to 60 m3/day in crystalline rocks and15 to 40 m3/day in sedimentary rocks.

The fractured aquifers in crystalline rocks are tapped by bore wells of 100 to 159 mm dia with a depth range of 60 to 100 m bgl in general. The discharge of the bore wells varies from 0.5 to 4 lps. The sedimentary aquifers are tapped by tube wells, the discharges of the sedimentary formation vary widely ranging from 56.5 to 3896.6 m3/day.

8.0 GROUND WATER MANAGEMENT STRATEGY

The ground water management strategy should be such that there is optimal utilisation of ground water resource and it should also take into consideration the well spacing norms. Based on the well spacing of 250 m on an average for shallow bore wells in hard rocks and sedimentary rocks, the optimal well density per sq.km comes to 16, whereas presently the well density in the district is 19 per sq. km leaving little scope for further development of the groundwater. Based on the above norm ground water development is possible only in 22 mandals of the district which are falling under safe category.

The district is having limited command area and the entire command area is falling under safe category with a balance resource of 2060 MCM available for development. In view of this situation conjunctive use of surface and groundwater is the only alternative available. Ground water development in the command area through construction of dug wells/bore wells may be taken up for utilization of ground water resource available and use it in conjunction with surface water to increase the irrigation potential.

The southwestern and central part of the district is highly over developed and all the 16 over exploited mandals are located in this area. It is necessary to augment the ground water resource by taking up artificial recharge to ground water on a large-scale to sustain the existing ground water extraction structures. Further construction of bore wells needs to be stopped by strictly implementing APWALTA act. There is an urgent need in this area to motivate the farmer's for changing the cropping pattern. Less water consuming crops and modern irrigation methods are to be encouraged in the area in lieu of the present practice of double crop of paddy and flood irrigation.

9.0 GROUND WATER DEVELOPMENT

Ground water development should be restricted to the command area and sedimentary terrain. In command area dug wells of 10 to 15 m depth having a radius of 5 m may be constructed in areas having water levels below 5 m bgl or shallow bore wells of 165 mm dia up to a depth of 40 m may be constructed. The selection of bore well sites should be done based on the geophysical and hydrogeological studies.

Deeper aquifer in the Gondwana formations has good potential, which can be developed by deep tube wells up to a depth of 60 to 450 m bgl. Tube wells with 254 mm housing; 152 mm casing with slotted pipes again the productive aquifer zones may be constructed. The selection of bore well sites should be done based on the geophysical and hydrogeological studies. The tube well construction and maintenance may be taken up by Government agencies and irrigation may be taken up on co-operative basis.

10.0 WATER CONSERVATION & ARTIFICIAL RECHARGE

Ground water conservation and artificial recharge works have been taken up on a large scale in the district since 2002 under Neeru-Meeru, Water shed,RIDF and other programmes. So far 1791 number of structures has been constructed. The structures constructed under these schemes are percolation tanks, check dams and farm ponds. Apart from these structures contour trenching has been done by the Forest department in number of

places. Artificial recharge works in the district should be taken up on priority basis in the 18 over exploited mandals of the district. Artificial recharge works should be avoided in command area and sedimentary terrain. Most ideally suited artificial recharge structure in the area is the percolation tank. Further modifying the percolation tank with construction of recharge bore will help very much as the weathered thickness is high and the water levels are very deep. Desalting of all the existing tanks in OE mandals need to be taken up. Apart from this check dams/gully plugs may be taken up where the slope is considerable. All the works have to be taken up on water shed basis and after careful assessment of the available surface run off and after meeting the needs of the existing structures. Rooftop harvesting both in urban and rural areas should be made mandatory to enhance the ground water recharge.

11.0 RECOMMENDATIONS

Construction of very deep bore wells beyond 80-100 m in hard rocks where the success rate is very limited leads to high cost investments and loan burdens. This can be addressed by restriction of further ground water development in then on-command area and over exploited mandalas by strict implementation ofAPWALTA act. The strategies for ground water management have to be different for different areas in the district. In Command area conjunctive use practice has to be adopted by developing ground water through dug wells/shallow bore wells and using it in conjunction with surface water to increase the irrigation potential within the command area. In sedimentary terrain by construction of tube wells of 60–450 m depth to tap the potential Gondwana sandstone. As the cost of the tube wells is quite high the development has to be undertaken by Government agencies and co-operative farming adopted by involving the stakeholders. In over exploited areas large scale artificial recharge needs to be encouraged on water shed basis. Care has to be taken in assessing the source water availability and the needs of the existing structures. Site selection needs to be done on scientific lines. Annual maintenance of the artificial recharge structure is very essential for its effective functioning. A corpus fund has to be created for the maintenance of the structure at the time of construction from the cost of the structure or contribution from the beneficiaries. Involvement of the stakeholders in the maintenance of the structure has to be made mandatory.

Acknowledgements

The author has sincerely thanks to Shri G. Sudarshan, Regional Director, CGWB,SR, Hyderabad, for giving timely guidance to complete of this report. The data provided by the State Ground Water Department and Directorate of Economics & Statistic's, Govt.of Andhra Pradesh, for preparation of the report, is gratefully acknowledged.