



ASSESSMENT OF GROUNDWATER QUALITY AND IT'S SUITABILITY FOR DRINKING IN ADARSHNAGAR AREA, VISAKHAPATNAM, A.P.

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ABSTRACT

The principal sources of water supply to Visakhapatnam Municipal Corporation are the reservoirs constructed across the stream courses in watershed areas. The city's population also depends on groundwater, to meet its demands. The present study incorporates the assessment of groundwater quality in Adarshnagar. The samples are analysed for important physical and chemical parameters such as pH, Electrical conductivity, total dissolved solids, total hardness, nitrate, sulphates, chlorides, alkalinity, iron, calcium and magnesium, using standard methods. Evaluation of water quality index is done by weighted arithmetic index method.

Key Words: Groundwater, Water Quality, Water Quality Index

I. INTRODUCTION

Sources of water to Visakhapatnam are Mehadrigedda reservoir, Thatipudi reservoir, Gosthani reservoir, Mudasarlova reservoir, Raiwada reservoir and Yeleru canals, Gambheeram gedda. The total demand of VMC is 533.5 MLD and the total supply is 440 MLD. The deficiency in VMC is 93.5 MLD. The city's population also depends on groundwater to meet its demands. The groundwater samples have been collected from ten borewells in Adarshnagar area, and analysis was done in eight batches from December 2014 to March 2015. The samples are analysed for important physical and chemical parameters such as pH, Electrical conductivity, total dissolved solids, total hardness, nitrate, sulphates, chlorides, alkalinity, iron, calcium and magnesium, using standard methods. The water quality index is evaluated using weighted arithmetic index method to assess the suitability for drinking.

II. METHODOLOGY

Initially a reconnaissance survey is conducted over the entire study area. Sampling wells have been identified and latitude and longitude noted through GPS Survey



Table 1: Details of sampling locations of study area:

Sampling station no:	Latitude N	Longitude E
1	17.761279	83.333706
2	17.763629	83.332901
3	17.763363	83.332027
4	17.764661	83.331737
5	17.764702	83.331421
6	17.764477	83.331040
7	17.764925	83.328940
8	17.763162	83.329403
9	17.763162	83.330699
10	17.763364	83.330888

Table 2: Analytical methods adopted for physico-chemical analysis

S.no.	Parameter	Analysis method/ instrument
1	pH	DIGITAL pH meter
2	EC	DIGITAL CONDUCTIVITY METER
3	TDS	INDIRECT METHOD 0.65* ECmicro S/cm
4	alkalinity	Titrimetry
5	Total hardness	EDTA - titrimetry
6	chloride	Mohr's titrimetry
7	Nitrate	SPECTROPHOTOMETRY
8	Iron	1, 10, Phenathroline spectrophotometry
9	Calcium hardness	EDTA titrimetry
10	Magnesium hardness	Indirect method(total hardness - calcium hardness)
11	sulphates	Barium sulphate gravimetric method

Evaluation of water quality index by weighted arithmetic index method

To determine suitability of ground water for drinking purposes, water quality index shall be computed.

$$WQI = \frac{\sum Q_i W_i}{\sum W_i}$$

Where i = 1 to n

Where W_i is a weightage factor Q_i is quality rating for i^{th} water quality parameter

$$W_i = K/S_i$$

Where S_i is standard value of i^{th} water quality parameter

K is a proportionality constant = 1.0 (Ravi Chandra babu et al., 2006)

N is the total number of water quality parameters.

$$Q_i = \frac{(V_a - V_i)}{(S_i - V_i)} * 100$$

Where V_a is actual value of i^{th} parameter obtained from analysis

V_i is the ideal value of i^{th} water quality parameter, which is 7 for p h and zero for other parameters



Table 3: Standard values and weightage factor W_i

Parameter	BIS standard value	Weightage factor
Ph	8.5	0.1176
EC	-	-
TOTAL DISSOLVED SOLIDS mg/l	500	0.002
Total alkalinity as Ca Co ₃ mg/l	200	0.005
Total hardness as Ca Co ₃ mg/l	200	0.005
Sulphates	200	0.005
Chloride mg/l	250	0.004
Nitrate mg/l	45	0.0222
Iron mg/l	0.3	3.3333
Calcium mg/l	75	0.0133
Magnesium mg/l	30	0.0333

Table4: Assessment of water quality based on WQI

SL.NO.	WATER QUALITY INDEX	STATUS OF WATER
1	0-25	EXCELLENT
2.	26-50	GOOD
3.	51-75	POOR
4.	76-100	VERY POOR
5.	100 AND ABOVE	UNSUITABLE FOR DRINKING

RESULTS

Table 5: Analysis results for ten sampling stations / bore wells during December first and second weeks

STA TIO N NO.	pH	EC micromhos/cm	TDS mg/l	TH as cacoco 3 mg/l	Ca mg/l	Mg mg/l	Sulphate s mg/l	Cl mg/l	Fe mg/l	NO ₃ mg/l	Alkalinity mg/l
1	6.85	1.79	1010	400	104	33.6	90	300	0.3	2.7	200
2	6.67	1.48	860	340	80	33.6	68	220	0.21	4.8	152
3	6.65	1.39	816	310	76	28.8	60	210	0.15	3.1	140
4	6.66	1.03	590	260	64	24	54	50	0.19	3.8	131
5	6.78	1.09	678	100	28	7.2	15	200	0.21	2.6	148
6	6.72	1.43	840	330	79.2	31.6	64	250	0.13	5.6	160
7	6.66	1.61	980	360	72	43.2	86	400	0.14	2.9	128
8	6.63	1.86	1350	520	112	57.6	116	410	0.21	3.1	119
9	6.37	2.05	1390	540	108	64.8	120	410	0.15	4.8	122
10	6.71	1.77	1000	380	84	40.8	84	290	0.1	5.3	120



Table6: Analysis results for ten sampling stations/ bore wells during December third and fourth weeks

STATION NO.	pH	EC micromhos/cm	TDS mg/l	TH as CaCO_3 mg/l	Ca mg/l	Mg mg/l	Sulphates mg/l	Cl mg/l	Fe mg/l	NO_3 mg/l	Alkalinity mg/l
1	6.94	1.31	780	442	110	40	94	180	0.29	2.8	210
2	6.74	1.08	620	380	96	33.6	66	150	0.26	4.9	160
3	8.82	1.02	612	340	80	33.6	64	160	0.19	3.3	122
4	6.55	0.68	408	265	72	20.4	56	110	0.20	3.9	141
5	6.71	1.03	618	218	36	30.7	22	140	0.24	2.8	150
6	6.82	1.07	642	360	84	36	62	144	0.10	4.9	164
7	6.64	1.17	692	400	78	49.2	80	160	0.15	2.8	155
8	6.89	1.41	846	520	116	55.2	112	186	0.21	3.2	120
9	6.61	1.44	834	560	112	67.2	100	184	0.20	4.9	122
10	6.80	1.33	798	390	96	36	80	180	0.15	5.5	140

Table 7: Analysis results for ten sampling stations/ bore wells during January first and second weeks

STATION NO.	pH	EC micromhos/cm	TDS mg/l	TH as CaCO_3 mg/l	Ca mg/l	Mg mg/l	Sulphates mg/l	Cl mg/l	Fe mg/l	NO_3 mg/l	Alkalinity mg/l
1	6.73	1.33	798	550	96.0	74.4	63	420	0.15	2.54	198
2	6.54	1.09	654	446	92.8	51.3	59	340	0.19	4.10	170
3	6.63	0.99	594	436	72.0	61.4	52	360	0.12	2.90	145
4	6.34	0.65	390	308	79.2	26.4	48	280	0.10	3.10	140
5	6.48	1.07	642	478	60.0	78.7	56	310	0.21	2.40	160
6	6.41	1.08	648	612	84.0	96.4	57	480	0.21	5.50	175
7	6.40	1.12	672	528	108	61.9	60	410	0.30	2.80	160
8	6.63	1.45	870	592	104	79.6	66	430	0.32	3.10	160
9	6.72	1.49	894	532	116	58.0	68	400	0.29	4.60	120
10	6.92	1.2	720	500	80.0	72.0	61	390	0.42	5.20	130

Table8: Analysis results for ten sampling stations/ bore wells during January third and fourth weeks

STATION NO.	pH	EC micromhos/cm	TDS mg/l	TH as CaCO_3 mg/l	Ca mg/l	Mg mg/l	Sulphates mg/l	Cl mg/l	Fe mg/l	NO_3 mg/l	Alkalinity mg/l
1	7.0	1.40	840	406	107	33.1	76	310	0.2	2.6	189
2	6.93	1.12	672	360	104	24	62	220	0.9	4.6	180
3	7.03	1.03	618	740	100	117	60	220	0.12	3.0	150
4	6.97	0.67	402	512	92	67.6	50	180	0.08	3.6	145
5	6.93	1.07	642	368	104	25.9	57	220	0.12	2.4	150
6	6.95	1.08	648	300	102	10.5	59	230	0.22	5.4	160
7	6.95	1.13	678	200	64	9.6	64	400	0.4	2.6	140
8	6.90	1.84	1104	224	57.6	19.2	84	390	0.32	3.9	150
9	6.86	1.5	900	186	52	13.4	72	410	0.2	4.6	110
10	6.95	1.3	780	192	52	14.8	66	280	0.41	5.2	120



Table 9: Analysis results for ten sampling stations/ bore wells during February first and second weeks

STATION NO.	pH	EC micromhos/cm	TDS mg/l	TH as cacO3 mg/l	Ca mg/l	Mg mg/l	Sulphates mg/l	Cl mg/l	Fe mg/l	NO ₃ mg/l	Alkalinity mg/l
1	6.90	1.44	864	300	88	19	86	390	0.2	2.62	194
2	6.81	1.17	702	224	80	5.7	62	240	0.16	4.6	144
3	6.90	1.06	636	212	60	14	58	220	0.10	3.0	138
4	6.82	0.69	414	340	37	59	54	180	0.12	3.6	128
5	6.90	1.07	642	206	70	7.2	15	70	0.14	2.4	146
6	6.95	1.14	684	202	62	11	60	240	0.21	5.3	158
7	6.92	1.16	696	222	70	11	82	240	0.16	2.6	128
8	6.98	1.68	1008	300	92	16	110	410	0.18	3.0	152
9	6.94	1.56	936	384	84	41	105	430	0.22	4.4	116
10	6.95	1.36	816	300	79	24	90	300	0.40	5.2	116

Table 10: Analysis results for ten sampling stations/ bore wells during February third and fourth weeks

STATION NO.	pH	EC micromhos/cm	TDS mg/l	TH as cacO3 mg/l	Ca mg/l	Mg mg/l	Sulphates mg/l	Cl mg/l	Fe mg/l	NO ₃ mg/l	Alkalinity mg/l
1	7.9	1.37	822	280	52.0	36.0	89	330	0.22	2.64	196
2	7.95	1.17	702	298	52.0	40.3	64	260	0.29	4.5	160
3	7.92	1.01	606	216	50.4	21.6	56	240	0.18	3.0	144
4	7.86	0.67	402	288	69.6	27.4	54	190	0.16	3.5	136
5	7.89	1.08	648	238	48.8	27.8	28	80	0.2	2.8	152
6	7.9	1.16	696	189	39.2	21.8	62	260	0.18	5.4	160
7	7.83	1.54	924	202	64.0	10.0	80	260	0.21	2.9	162
8	7.89	1.75	1050	280	56.8	33.1	122	410	0.30	3.8	164
9	7.85	1.60	960	296	51.2	40.3	115	440	0.26	4.6	124
10	7.88	1.37	822	240	40.8	33.1	100	290	0.3	5.2	118

Table 11: Analysis results for ten sampling stations/ bore wells during March first and second weeks

STATION NO.	pH	EC micromhos/cm	TDS mg/l	TH as cacO3 mg/l	Ca mg/l	Mg mg/l	Sulphates mg/l	Cl mg/l	Fe mg/l	NO ₃ mg/l	Alkalinity mg/l
1	7.0	1.32	792	340	84	31.2	90	360	0.29	2.7	189
2	6.89	1.12	672	300	88	19.2	66	230	0.21	4.9	140
3	6.9	1.04	624	316	64	37	60	210	0.17	3.3	135
4	6.99	0.68	408	260	80	14	59	195	0.20	3.6	128
5	7.0	1.07	642	246	48	30	30	90	0.21	2.4	144
6	7.02	1.14	684	198	61	10.5	66	220	0.16	5.3	156
7	6.52	1.70	1020	200	64	9.1	86	240	0.15	2.8	151
8	6.89	1.58	948	260	58	27	130	400	0.22	3.2	154
9	6.92	1.57	942	250	52	28.8	115	420	0.18	4.6	118
10	7.10	1.38	828	220	48	24.0	120	290	0.18	5.4	117



Table 12: Analysis results for ten sampling stations / bore wells during March third and fourth weeks

STATION NO.	pH	EC micromhos/cm	TDS mg/l	TH as CaCO_3 mg/l	Ca mg/l	Mg mg/l	Sulphates mg/l	Cl mg/l	Fe mg/l	NO_3 mg/l	Alkalinity mg/l
1	7.65	1.36	816	372	88.0	36.4	92	380	0.32	3.10	196
2	7.42	1.14	684	330	84.0	28.8	69	245	0.26	4.99	146
3	7.18	1.02	612	326	72.0	35.0	64	225	0.21	3.6	142
4	7.63	0.70	420	292	96.0	12.5	62	210	0.23	3.7	129
5	7.9	1.04	624	265	64.0	25.2	35	100	0.25	2.5	149
6	7.86	1.12	672	218	64.8	13.4	69	240	0.20	5.3	162
7	7.72	1.51	906	240	72.1	14.4	90	260	0.18	2.8	132
8	7.11	1.72	1032	272	64.0	26.8	145	420	0.42	3.4	156
9	7.54	1.59	954	262	58.0	28.0	122	440	0.20	4.8	220
10	7.62	1.36	816	240	54.0	25.2	128	310	0.21	5.56	121

TABLE NO.13 WATER QUALITY INDEX values from December to March

Sampling well no.	Latitude N	Longitude E	Average water quality index			
			December	January	February	March
1	17.761279	83.333706	94.4	58.23	67.99	85.87
2	17.763629	83.332901	75.3	79.06	72.44	75.5
3	17.763363	83.332027	55.14	41.58	45.46	61.7
4	17.764661	83.331737	62.2	30.88	52.3	69.0
5	17.764702	83.331421	71.3	54.55	54.8	73.9
6	17.764477	83.331040	37.6	71.72	62.7	57.9
7	17.764925	83.328940	47.2	94.92	59.44	53.1
8	17.763162	83.329403	68.2	103.3	78.98	86.5
9	17.763162	83.330699	57.3	79.3	77.88	61.6
10	17.763364	83.330888	40.9	112.5	94.63	62.9

Table no. 14 status of ground water quality based on wqi

WATERQUALITY INDEX	STATUS	SAMPLING WELLS
0-25	Excellent	None
26-50	Good	December:wells6,7,10 January:wells3,4 February: well 3 March: wells-none
51-75	Poor	Dec: wells 2,3,4,5,8,9 January: wells:1,5,6 Feb:wells 1,2,4,5,6,7 March: wells2,3,4,5,6,7,9.,10
76-100	Very poor	Dec:wells-1 Jan:wells-2,7,9 Feb-wells-8,9,10 March-1,8
100 and above	Unsuitable for drinking	Dec: none Jan: wells -8,10 Feb: wells-none March-none

CONCLUSIONS

The groundwater of entire study area is undoubtedly hard.

The total dissolved solids content of well no.8 is reported to be greater than 1000 mg/l. It cannot be regarded as fresh. The iron concentration is reported to be exceeding the standard value for well no.8 and 10., which affects the aesthetics. The groundwater is found to be of alkalinity of less than 250 mg/l and hence suitable for domestic consumption. In the samples analysed many of the samples exceed the standard of 250mg/l for chlorides. Salty taste may be imparted to such water in combination with sodium. Sampling wells 8 and 10 are of poor to very poor quality usually during the monitoring period, and especially during January, the sampling wells 8 and 10 have been found to have WQI values exceeding 100.