International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2163
Volume 1 Issue 6 (July 2014) http://ijirae.com

Ground Water Quality Analysis for construction of Part of Mumbai Metropolitan Region (MMR)

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***Abstract*: Groundwater quality in the study area has been analysed in the present work. For this study, a part of Mumbai Metropolitan Region were selected which covers almost the entire area. Fifteen water samples, from various bore wells covering the study area during post monsoon season 2013 were collected to find out the values of different parameters in the groundwater so as to check the suitability for construction. The tests for different parameters like, chloride, Sulphates, suspended solids, Inorganic material, organic material, limits of acidity and, limits of alkalinity were performed by using Standard procedures and the results were compared with IS456 guidelines. All samples, except two (In Virar and Vasai' where sulphate' content was more than 1600 mg/l.) are suitable for construction. Samples from 'Old Panvel', 'Virar' and 'Nalasapora' were tested for the suitability for irrigation also, since the ground water is used for irrigation in those areas. The important parameters affecting for irrigation purposes are: Electrical Conductivity (EC), Sodium adsorption ratio (SAR), Sodium percentage (Na %) and Residual sodium carbonate (RSC). All the parameter values were within the permissible range, hence the ground water from the said areas is suitable for irrigation.**

***Key words*. Electrical Conductivity, Sodium adsorption ratio, Sodium percentage and Residual sodium carbonate**.

I. INTRODUCTION

Of the available global water supply, 97.2% is saline water in oceans. This water is unsuitable for drinking or agricultural uses. 2.14% is in ice caps and glaciers, 0.61% is groundwater. Much of this water is too deep for extraction. 0.009% is found in surface water. This is where most drinking water comes from.0.005% makes up soil moisture.0.001% of water is found in the atmosphere (10).Rapid urbanization, growing population and speedy industrialization have led to the pressure on demand for water. Ground water is used for domestic, industrial and irrigational purposes all over the world. In the last few decades there has been a tremendous increase in the demand for fresh water due to rapid growth of population and the accelerated pace of industrialization (7). The quality of ground water varies from place to place, with the depth of water table, and from season to season and is primarily governed by the extent and composition of dissolved solids present in it (5). The quality of ground water is of great importance in determining the suitability of particular ground water for a certain use such as for public water supply, irrigation, toilet flushing, industrial applications, constructional use etc. (2) The study area, i.e. Part of Mumbai Metropolitan Region (MMR), is highly urbanized, densely populated and is industrialized, hence there is a high demand for water. Since the demand for water is not met through other resources; the need for clean groundwater is very high and is an alternative solution.

II. STUDY AREA.

The study area is located on the western most periphery of the Maharashtra State. The coordinates of the study area are Virar on the north, Kalyan on north east and Panvel on south east. Arabian Sea lies on the southern side of the area.

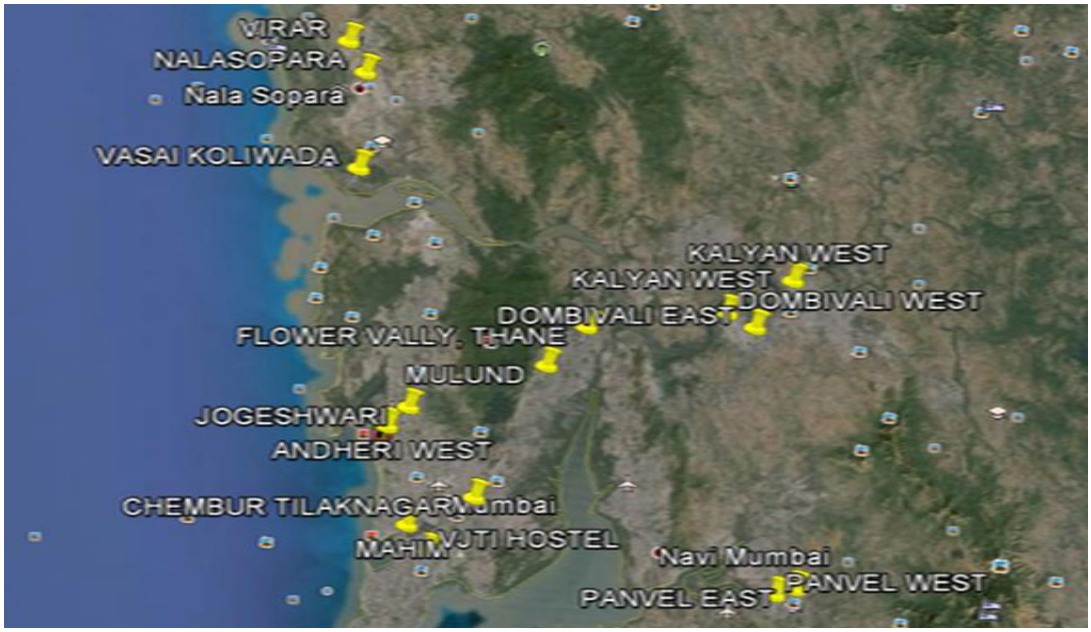

Fig 1.Sampling locations.

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III. SAMPLING.

Fifteen water samples, were collected in polyethylene bottles from various bore wells covering the study area during post monsoon 2013 and pre monsoon 2014, which were cleaned with acid water, followed by rinsing twice with distilled water. The water samples were chemically analyzed on the same day. At the sampling points, the boreholes were purged the aquifer of stagnant water to acquire fresh samples for analysis, purging lasted for 5–10 minutes. The analysis of water were done by using procedure of 'standard method'. Utmost care was taken during the collection of samples to avoid any kind of contamination.

IV. RESULTS AND DISCUSSIONS.

A. Suitability of ground water for construction

TABLE.1 VARIOUS PARAMETERS AND ITS VALUES TO CHECK THE SUITABILITY FOR CONSTRUCTION

Sr.no	Place of tube well	Limits of Acidity(ml)	Limits of Alkalinity(ml)	Chloride(mg/l)	Sulphate(mg/l)	Inorganic matter(mg/l)	Organic matter(mg/l)	Suspended Solids(mg/l)
1	MATUNGA	i.8	22	107	<200	540	40	40
2	JOGESHWARI	2.3	5.9	105	<200	510	20	70
4	MULUND	0.9	15.7	55	<200	320	40	35
3	THANE	0.6	5.9	97	<200	710	80	60
5	MAHIM	1.0	12.4	42	<200	435	30	30
6	NEW PANVEL	0.7	24.6	61	<200	340	80	100
7	DOMBIVALI(west)	1.8	53	49	<200	360	100	15
8	CHEMBUR	0.9	23.8	241	<200	830	40	35
9	ANDHERI	5.6	24.1	112	<200	455	40	65
10	KALYAN	0.5	4.6	43	<200	535	200	25
11	VIRAR	0.2	6.8	386	>1600	1500	80	180
12	VASAI	1.2	20	47	>1600	725	130	140
13	NALASAPORA	1.8	22	266	<200	955	115	120
14	DOMBIVALI(east)	2.0	15.0	79	<200	380	30	110
15	OLD PANVEL	2.0	20	52	<200	350	50	60
	LIMITSAS PER IS:456:-2000	5.0ml	25ml	500mg/l for RCC mg/l	400 mg/l	3000mg/l	200 mg/l	2000 mg/l

The parameters to check the suitability of ground water for construction purposes are tested and compared with IS456 guidelines. Among the samples, except the two samples (In Virar and Vasai,'sulphate' content is more than 1600 mg/l.), all others are suitable for construction.

B. Groundwater for Irrigation Purpose:

The water quality used for irrigation is essential for the crop yield and quantity, maintenance of soil productivity and protection of the environment. The quality of irrigation water is very much influenced by the land constituents of the water source. The important parameters affecting the suitability of groundwater for irrigation purposes are: Electrical Conductivity (EC), Sodium adsorption ratio (SAR), Sodium percentage (Na %) and Residual sodium carbonate (RSC).

The various cations like calcium, magnesium, sodium, potassium and anions like carbonate and bicarbonate were tested and the values are given in the table 2and table3.Electrical conductivity in the entire study area is given in table4.

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TABLE 2 CATIONS CONCENTRATION IN MEQ/L

Place	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}
	mg/l	mg/l	mg/l	mg/l	meq/l	**meq/l**	meq/l	meq/l
Panvel	56.1	173.9	29.64	0.92	2.800	14.310	1.289	0.024
Nalasapora	62.5	187.5	60.15	3.54	3.119	15.429	2.616	0.091
Virar	48	112	49.2	0.89	2.395	9.216	2.140	0.023
Sum					8.314	38.955	6.046	0.137

TABLE 3 ANIONS CONCENTRATION IN MEQ/L

Place	CO_3^{2-}	HCO^{3-}	CO_3^{2-}	HCO_3^{-}
	mg/l	mg/l	meq/l	meq/l
Panvel	0.493	199.49	0.016	3.269
Nalasapora	0.074	183.43	0.002	3.006
Virar	0.463	191.52	0.015	3.139
Sum			0.034	12.68

TABLE 4 ELECTRICAL CONDUCTIVITY

SR NO.	PLACE OF TUBEWELL	EC µS/cm
1	MATUNGA	523.0
2	JOGESWARI	400.0
4	MULUND	400.0
3	THANE	1076.9
5	MAHIM	615.0
6	NEW PANVEL	384.0
7	DOMBIVALI(west)	646.0
8	CHEMBUR	1261.0
9	ANDHERI	646.0
10	KALYAN	1076.0
11	VIRAR	1723.0
12	VASAI	1061.0
13	NALASAPORA	1353.0
14	DOMBIVALI(east)	415.0
15	OLD PANVEL	492.0

1) *Electrical conductivity (EC):* The total soluble salt content of irrigation water generally is measured by determining its electrical conductivity. Electrical conductivity in the study area, ranges from 384 to 1723 µmhos/cm. (µS/cm) during post monsoon season 2013. Normally, irrigation water with an EC<700 µmhos/cm causes little or no threat to most crops, while EC>3000 µmhos/cm may limit their growth (9). Hence the ground water in this area is suitable for irrigation.

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2) *Sodium Adsorption Ratio (SAR):* Sodium Adsorption Ratio (SAR) is a criterion for evaluating the sodium hazard in irrigation waters, determined by measuring the ratio of sodium to magnesium and calcium. The formula for calculating sodium adsorption ratio is:

$$S.A.R. = \frac{Na^{+}}{\sqrt{\frac{1}{2}(Ca^{2+} + Mg^{2+})}}$$

Where calcium, and magnesium are in milliequivalents/litre. With the proper amount of calcium and magnesium in the irrigation water, the irrigated soil will be granular in structure, easily worked, and permeable .With increasing proportions of sodium, the soil will tend to become less permeable and water logging may occur. (12) The SAR values for three representative water samples are shown below.

TABLE 5. SAR VALUES

PLACE	SAR
PANVEL	0.441
NALASAPORA	0.859
VIRAR	0.888

As per Richards's (6) classification, the SAR values of all samples fall in excellent category (<10). The calculated value of SAR in the study area ranges from 0.441 to 0.888. In general, the higher the sodium adsorption ratio, the less suitable the water is for irrigation.

3) Sodium %: Sodium is important cations which in excess deteriorates the soil structure and reduces crop yield. Sodium causes an increase in the hardness of soil as well as reduction in its permeability. The sodium in irrigation water is also expressed as percent sodium (%Na) and can be determined using the following equation . *(9)*

Na% = $(Na^{+} + K^{+})$ *100/ $(Ca^{2+} + Mg^{2+} + Na^{+} + K^{+})$.Where all ionic concentrations are expressed in meq/l. The values from the percent sodium in the study area ranges from 7-15% which is less than 60%, hence suitable for irrigation.

4) *Residual Sodium Carbonate (RSC):* The excess sum of carbonate and bicarbonate in groundwater over the sum of calcium and magnesium also influences the unsuitability of groundwater for irrigation. This is termed as residual sodium carbonate (RSC) .If RSC<1.25 meq/l, the water is considered safe. If RSC lies between 1.25-2.5 meq/l, the water is of marginal quality. If RSC>2.5 meq/l, the water is unsuitable for irrigation. Residual Sodium Carbonate (RSC) predicts the accumulation of sodium in the soil based on the potential precipitation of calcium/magnesium carbonate. The RSC is calculated using the formula given below: RSC = $(CO_3^{2-} + HCO_3^{-}) - (Ca^{2+} + Mg^{2+})$ Where the concentrations are expressed in meq/l (6).It is found that RSC of Panvel, Nalasapora and Virar are -13.83, -15.54and -8.5 respectively. A negative RSC indicates water is unlikely to cause structural degradation. .Thus, based on RSC criteria, the tested groundwater samples can be considered safe for irrigation purpose.

V. CONCLUSION:

In the study area, all the ground water samples except two (Virar and Vasai) are fit for construction as per IS: 456. 2000 and all the samples are suitable for irrigation.

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