GROUND WATER QUALITY OF GREATER GUWAHATI IN ASSAM WITH SPECIAL REFERENCE TO PHYSICAL AND REDOX PARAMETERS

S.R. Kumar , B.C. Patwary
National Institute of Hydrology, North Eastern Regional Centre
Dispur, Guwahati-781006 (Assam)

ABSTRACT

This paper provides information on different physical and redox parameters like pH, temperature, light transmitivity, oxidation reduction potential, conductivity and dissolved oxygen on ground water samples from 23 dug wells, representing the shallow unconfined aquifer. Ground water samples were collected in pre and post monsoon seasons of 1994 & 1995 and tested for various physical and redox parameters. The paper aims at analyzing the ground water quality scenario of Greater Guwahati, Assam and to see the variation in time and space. In general, it is found that ground water quality of the study area is in acidic nature.

1.0 INTRODUCTION

Water quality has been one of the important water resources issues since 1970. With the population explosion and rapid industrialisation there is continuous adverse effects on the sources of water and hence on its quality. It is global phenomena that due to human influence and ever increasing pressure on the resources for fulfilling demands, the quality of water is deteriorating day by day. polluted and unpotable water has creating many health hazards to the living beings and often cause many water born diseases in the country. Oflate, scientists, technocrats and planners have engaged serious attention to the water quality problems. The water quality study has therefore been presently regarded as one of the thrust areas in the water resources sector as envisaged in the national water policy that *".. Both surface and ground water should be regularly monitored. A phased programme should be undertaken for improvements of water quality".*

Ground water is one of the major source for meeting the domestic needs for the people. So ground water quality studies are not only essential for critical evaluation of its standards for the purposes such as domestic, agricultural and industrial supplies etc. but also required in many cases to ascertain geological history of the area where it occurs. For proper utilisation of water for various purposes, understanding geochemical controls on it and the extent of pollution, is of paramount importance to carry out systematic monitoring of ground water quality to suggest suitable remedial measures.

Water is liquid of life, as there can be no life without water. Pure water is an animating fluid while polluted water is real curse for living beings. Man during course of his civilization has settled in places where plenty of water was available. But with the increase of population and in exploitation of natural resources for his own benefit, he has behaved in a wild manner by creating problem of pollution hazardous not only to aquatic life but also to his own life. While developed countries have become quite sensitive to this problem, India is still continuing because of irresponsible behavior of its citizens, in rendering water polluted day by day and the situations is deteriorating progressively.

The ground water problems are more acute in the areas which are densely populated, are thickly industrialized and have shallow ground water table. Some of major, minor and trace constituents present in circulating waters give idea about the influence of soil and rocks through which these waters have passed and may not be known earlier. With the advent of industrialization and inadequate attention paid to protect the environment, degradation in water quality including that of ground water has become one of the challenges of modern times.

2.0 STUDY AREA

The city of Guwahati is bounded by 26°5' N to 26°12' N latitudes and 91°34' E to 91°51' E longitudes (Fig. 1). Structurally, the region is situated on a 50 meter thick alluvium bed of middle Brahmaputra valley underable granitic rocks of the Shillong Plateau, the outcrops of which may be seen in various parts of the city and neighbourhood. The area covered by the city is about 313 Sq.Km. with a population of about 5,77,591 according to 1991 census.

The Guwahati city which has been selected for ground water quality study saw its first phase of expansion during the period 1960-1965 with the setting up of the Oil refinery, the New Guwahati Goods Yard, the Army Cantonment and the Oil India Campus. The second burst of explosion witnessed by the city was in 1972, when the State Capital was shifted to Dispur, on the South-Eastern tip of the city. within a very short time, the city's population, at a conservative estimate, incremented by a lakh, creating a tremendous pressure on housing, office space and other infrastructural facilities. These expansions did not see any commensurate expansion of the city's infrastructural facilities and basic needs. At this time, the water supply system was extended to serve only the Capital Complex of perhaps 15,000 people, while the rest of the city continued to be starved for drinking water.

The two problems amongst many, that are affecting the lives of the city dwellers are drinking water and water logging. These two problems prevail in each and every corner of the city under the governance of Guwahati Municipal Corporation (GMC). This premier city of Assam, provides piped drinking water to only 20% of its population, leaving the rest to fend for themselves with tube wells, shallow wells, ponds and so on.

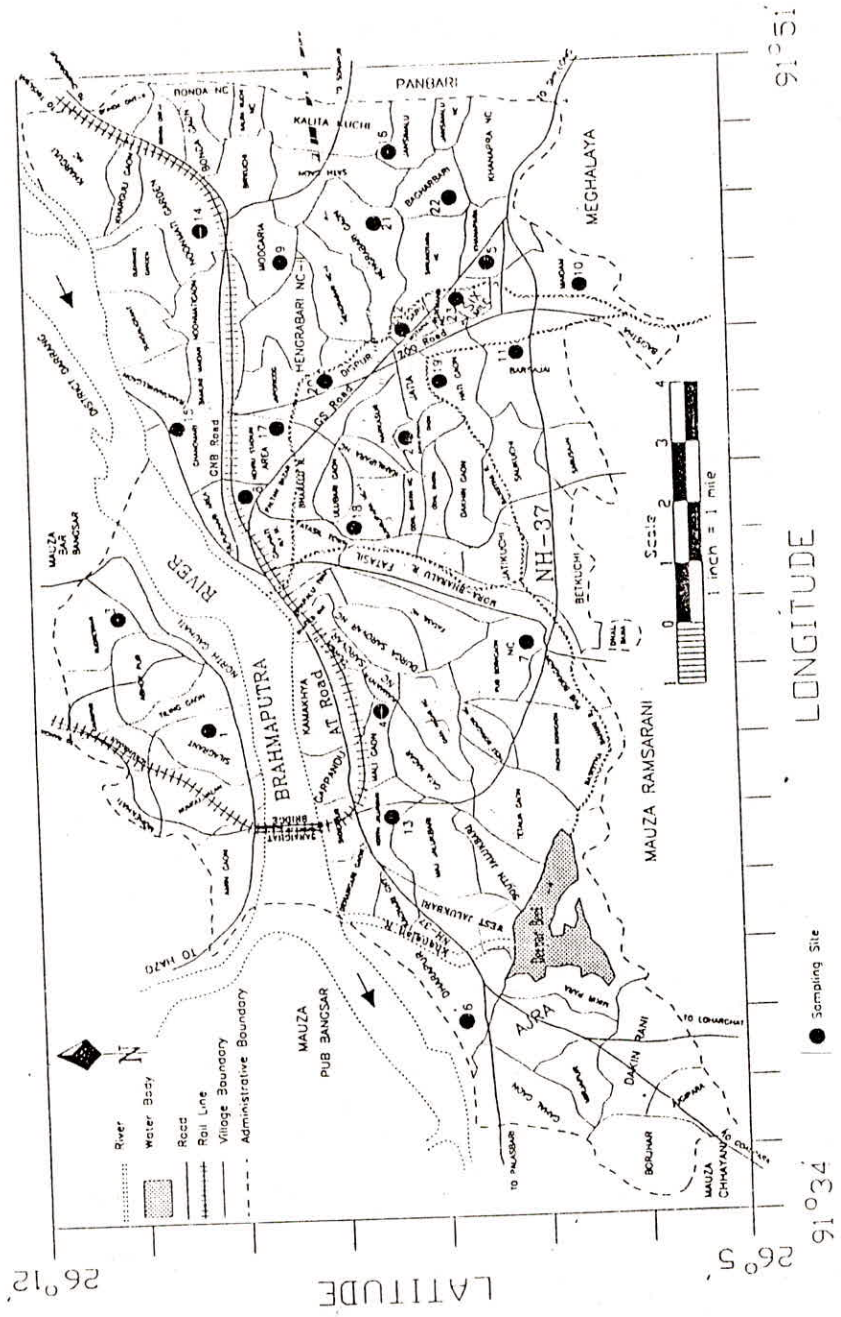

Fig. 1 Study Area Map Showing Sampling Sites

The phenomenal growth of Guwahati, bordering on an explosion, has created a myriad of problems of uncontrollable urban expansion. The city now suffers from an acute shortage of safe pipe water for drinking and lack of sanitation.

3.0 METHODOLOGY

Water samples from 23 observation wells (Fig. 1) were collected initially for a period of two years during 1994 and 1995 in pre and post monsoon season and was subjected to various physical and redox tests. Water samples were collected by grab sampling method using Standard Water Sampler (Hydro-Bios, Germany) in clean polyethylene bottles fitted with screw caps. Portable water testing kits were used for measurements of physical and redox parameters such as pH, temperature, conductance, oxidation reduction potential, light transmitivity and dissolved oxygen.

4.0 RESULTS AND ANALYSIS

The main objective of the study was aimed at (i) to see the regional variation in the quality of shallow ground water, (ii) to see the seasonal variation in the ground water quality.

The results of physical and redox properties in ground water of Greater Guwahati at different places in pre and post monsoon period of 1994 and 1995 are shown in Fig. 2. The results of analysis of physical and redox parameters in ground water samples are presented in Table 1 and Fig. 3 to 4 and are discussed below.

pH

pH is a measure of the concentration of hydrogen ions (H^+) and indicates the degree of acidity or alkalinity of the water. The permissible pH range for public water supplies is 6.5 to 8.5 (WHO). Lower pH cause tuberculation and corrosion while the higher value produce incrustation, sediment deposit, difficult in chlorination, certain physiological effects on human systems etc.

pH of Guwahati during the month of July 1994 varied between 7.43 to 5.74 with an average value of 6.550 and the variation was found to be ±0.845. Maximum value of 7.43 was measured at Lachit Nagar and minimum of 5.74 at Noonmati.

During the month of December 1994 the pH varied between 7.38 to 5.24 with an average of 6.410 and the variation was found to be ±1.07. Maximum of 7.38 measured at Maligoan and a minimum of 5.24 at Noonmati. During the month of April 1995, the pH varied between 6.99 to 4.87 with an average value of 6.06 and variation was ±1.06. Maximum value of 6.99 was measured at Jalukbari and a minimum of 4.87 at Noonmati.

During the month of October 1995, the pH varied between 7.03 to 5.47 with an average value of 6.376 and the variation was found to be ±0.78. Maximum value of 7.03 measured at Maligaon and minimum of 5.47 at Noonmati. From the results it is found that the pH of Noonmati almost remained the same compared to other sampling sites. From Fig. 2 and 4, it can be seen that overall average pH value is higher at Maligaon site (7.14) and lowest at Noonmati site (5.33).

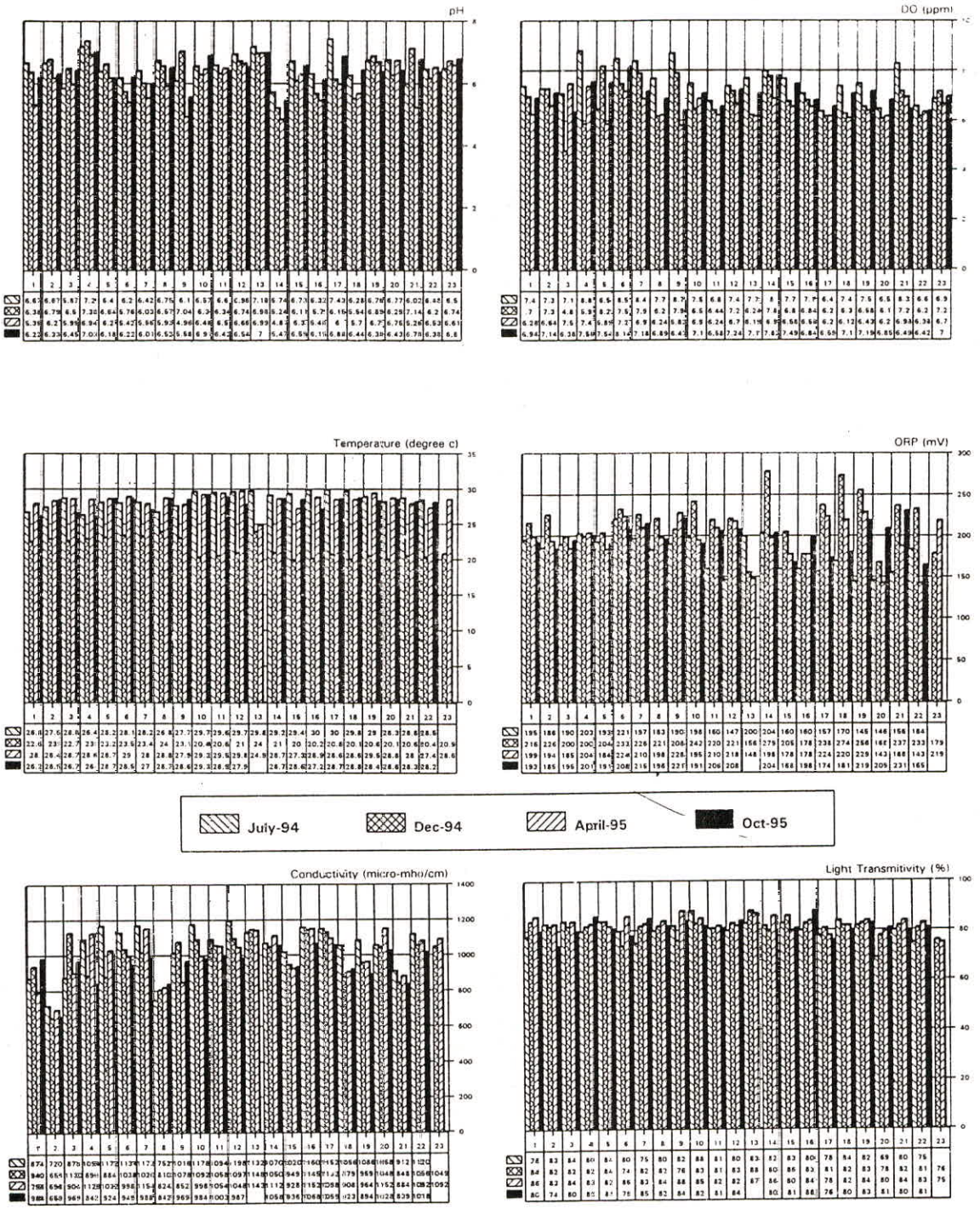

Fig. 2 Seasonal Variation of Physical and Redox Parameters

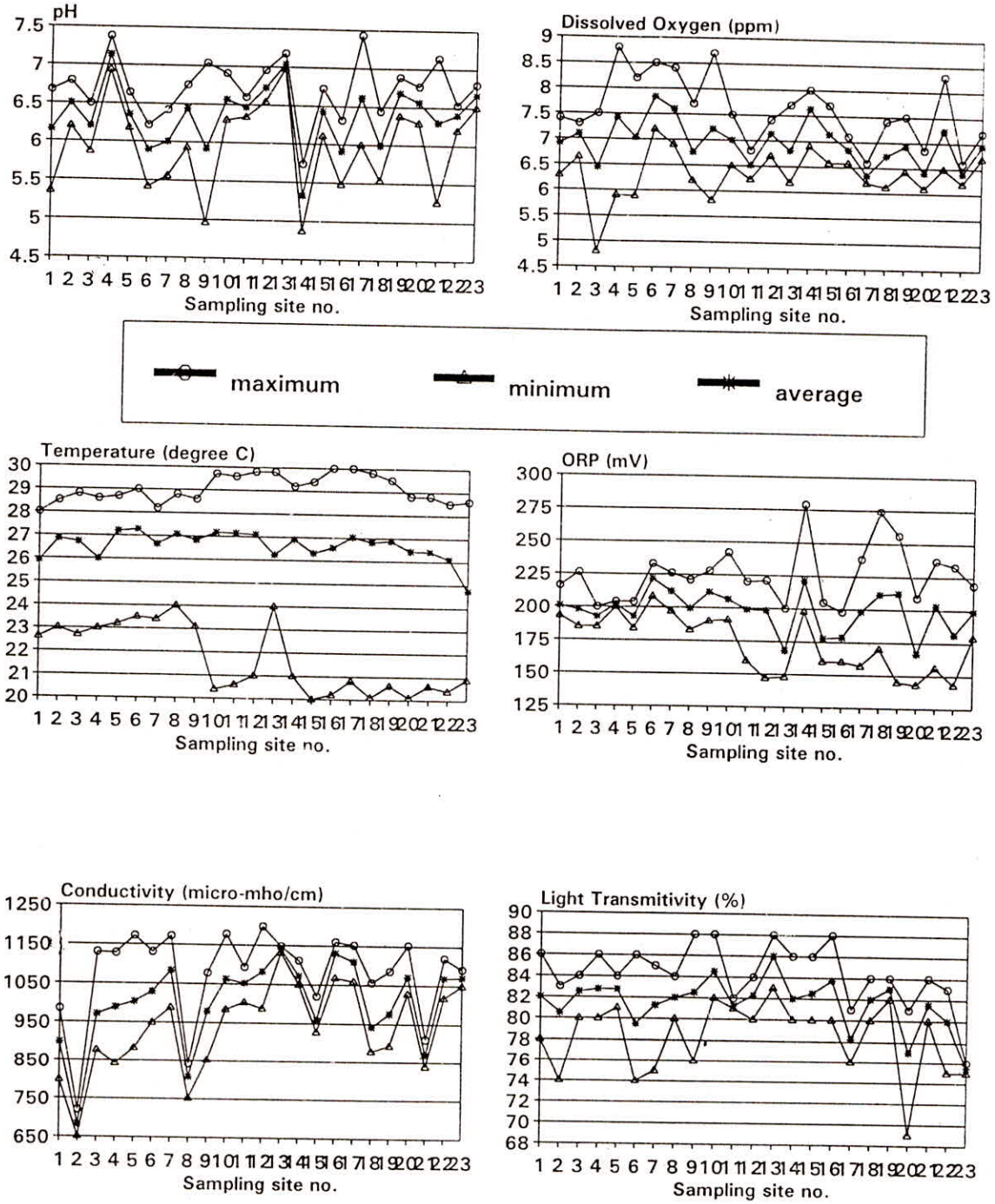

Fig. 3 Maximum, Minimum and Average Values

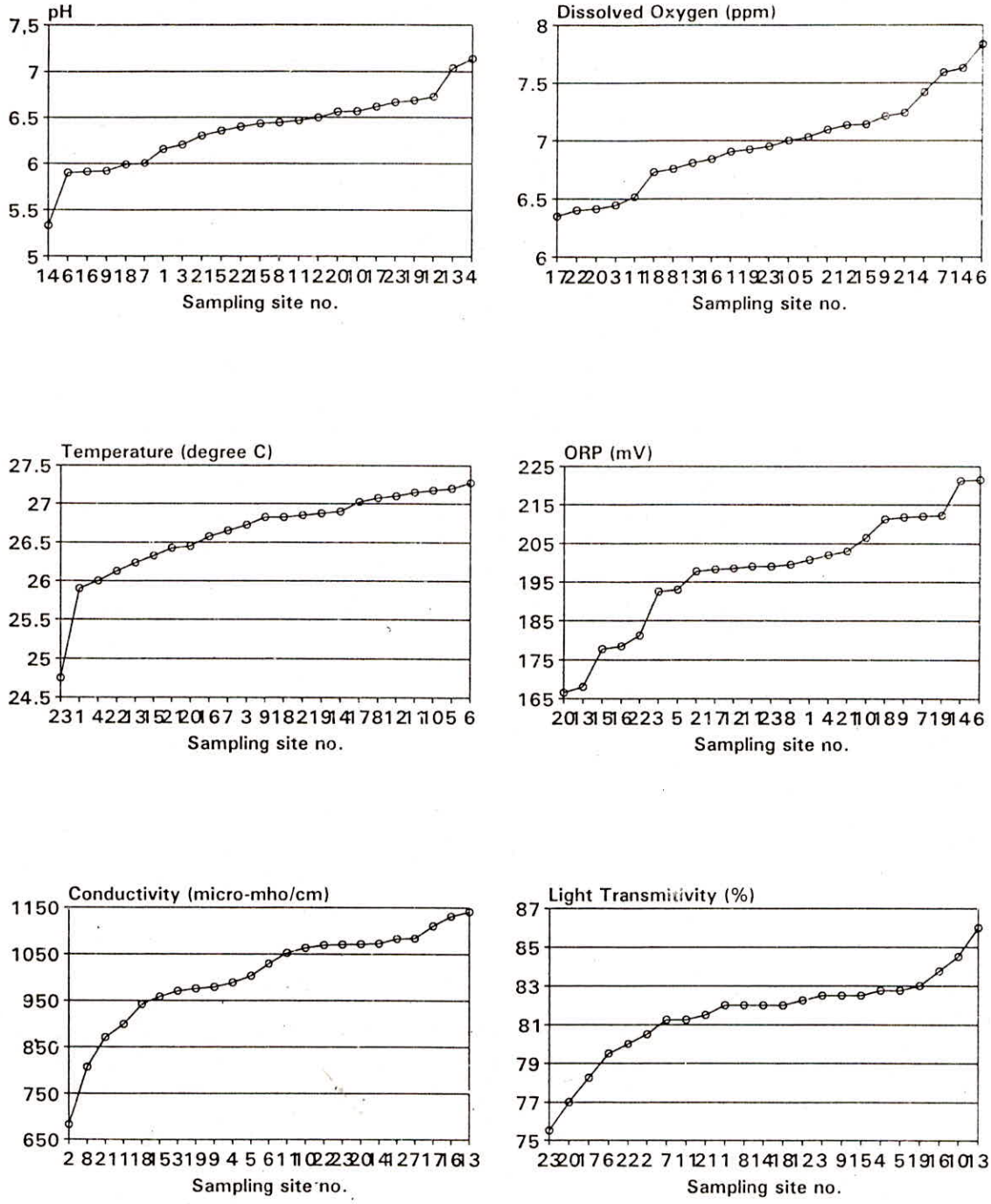

Fig. 4 Increasing Trend of Parameters (Average)

Table 1 : Average Values of Physical and Redox Parameters

Site no.	Sampling source	Location	pH	DO	Temp.	ORP	Cond.	LT
1	dug well	Dol Govind	6.16	6.91	25.9	201	899	82
2	dug well	Kahilipara	6.50	7.10	26.9	198	682	81
3	dug well	Durgeswari	6.20	6.45	26.7	193	970	83
4	dug well	Maligaon	7.14	7.42	26.0	202	989	83
5	dug well	Khanapara	6.36	7.03	27.2	193	1003	83
6	dug well	Azra	5.90	7.84	27.3	222	1029	80
7	dug well	Bora Gaon	6.01	7.60	26.7	212	1084	81
8	dug well	Paltan Bazar	6.44	6.76	27.1	200	807	82
9	dug well	Zoo Narangi	5.92	7.21	26.8	212	979	83
10	dug well	Nutan Bazar	6.57	7.00	27.2	207	1063	85
11	dug well	Barsajai	6.47	6.52	27.2	199	1052	81
12	dug well	Rukmanigaon	6.73	7.14	27.1	199	1083	82
13	dug well	Jalukbari	7.04	6.81	26.2	168	1141	86
14	dug well	Noonmati	5.33	7.63	26.9	221	1073	82
15	dug well	Chandmari	6.43	7.14	26.3	178	958	83
16	dug well	Panjabari	5.91	6.84	26.6	179	1131	84
17	dug well	Lachit Nagar	6.62	6.35	27.0	198	1110	78
18	dug well	Bhangaghar	5.99	6.73	26.8	211	942	82
19	dug well	Hathi Gaon	6.68	6.93	26.9	212	976	83
20	dug well	Usha Nagar	6.56	6.41	26.5	167	1072	77
21	dug well	Hengrabari	6.30	7.24	26.4	203	871	82
22	dug well	Mathuranagar	6.40	6.40	26.1	181	1069	80
23	dug well	Rukmaninagar	6.66	6.95	24.8	199	1071	76
		maximum	7.1	7.8	27.3	221.5	1141	86.0
		minimum	5.3	6.3	24.8	166.5	682	75.5
		average	6.4	7.0	26.6	197.9	1002.2	81.5

Dissolved Oxygen

Dissolved oxygen (DO) plays a large part in the assessment of water quality, since it is an essential ingredient for the sustenance of fish and all other forms of aquatic life. It also affects the taste of water, and a high concentration of dissolved oxygen in domestic supplies is encouraged by aeration. Values of dissolved oxygen are given in ppm or mg/l.

During the month of July 1994 DO varied between 8.8 ppm to 6.4 ppm with an average value of 7.513 ppm. The variation was found to be ±1.2 ppm. Maximum value of 8.8 ppm measured at Maligaon and a minimum of 6.4 ppm measured at Lachit Nagar.

During December 1994, values of DO varied between 8.2 ppm to 4.8 ppm with an average value of 6.80 ppm. The variation was found to be ±1.7 ppm. Maximum value of 8.2 ppm was measured at Khanapara and a minimum of 4.8 ppm measured at Durgeswari.

During the period of April 1995. the value of DO varied between 7.5 ppm to 6.56 ppm with an average value of 5.82 ppm. The variation was found to be ±0.84 ppm. Maximum value of 7.5 ppm measured at Durgeswari and minimum of 5.82 ppm was measured at Zoo Narangi.

During October 1995, value of DO varied between 8.14 ppm to 6.38 ppm with an average value of 7.044 ppm. The variation was found to be ±0.88 ppm. Maximum value of 8.14 ppm measured at Azra and a minimum of 6.38 ppm measured at Durgeswari. In Lachit Nagar average DO is lowest (6.35) compared to other sites while highest at Azra (7.84) then other sites.

To see the seasonal variation in average values of DO, it can be seen from the results of pre and post monsoon season of 1994 and 1995 separately, that, post monsoon values of DO is lower than the pre monsoon values almost every sites.

Water Temperature

Temperature of surface and ground water varies with the climate and the season. Its measurement is useful to indicate the trend of various chemical, biochemical and biological activities. A rise in water temperature lead to the faster chemical and biochemical reactions. Biological activity is also enhanced by higher temperature upto 60° C. Kinetics of BOD is also regulated to some extent by water temperature. It may also affect some other characteristics of water like dissolution of gases, pH, conductivity etc. Temperature relation of water controls the structure and function of aquatic ecosystem in a significant way. Temperature is a standard physical characteristic that is important in the consideration of the chemical properties of water. The temperature of water depends on the season and the temperature of the ground with which it is in contact.

The temperature of Guwahati during the month of July 94 varied between 30 to 26.4°C with an average temperature of 28.7°C. The variance in temperature was found to be ± 1.8°C. Maximum temperature of 30°C was measured at Lachit Nagar and Panjabari and minimum of 26.4°C was measured at Maligaon.

During the month of December 1994 the temperature varied between 24 to 20°C with an average temperature of 21.7°C. the variance in temperature was found to be ± 2.5°C. Maximum of 24.9°C at Jalukbari.

During the month of October 1995 the temperature varied between 29.3 to 26°C with an average of 28.1°C. The variance was found to be ± 1.7°C. Maximum temperature of 29.3°C was measured at Nutan Bazar and a minimum temperature of 26.0°C measured at Maligoan.

In general the maximum temperature varied between 29.3 to 30°C and a minimum temperature between 26 to 26.4°C. The variance in temperature was maximum at Panjabari and Bhangagarh with a value of ± 2.4°C. During the sampling period maximum temperature of 30°C was

measured at Panjabari and Lachit Nagar during July 94 and a minimum of 20°C was measured at Chandmari during December 94.

Oxidation-Reduction Potential (ORP)

Chemical substance is oxidized by losing its electrons while a substance which acquires electrons is reduced. Both the processes always occur simultaneously. When any solution contains chemical substance in more than one state of oxidation or reduction, a particular potential is associated with each state. But the potential of any solution is the net of all these reactions and known Redox Potential of that solution (or water).

The redox potential is an indication of the energy state of water system, governed by the presence of oxidized and reduced chemical substances or their biological activities. As the oxidation and reduction reactions are accompanied by the transference of electron. The oxidized or reduced energy can be estimated by measuring emf capable of regulating this movement by electrons. The Redox potential can be quickly observed and is, therefore a valuable index to measure the conditions of water body.

ORP of Guwahati during the month of July 94, varied between 221mV to 145mV with an average value of 179mV. The variance was found to be ± 38mV. Maximum value of 221mV was measured at Azra and a minimum of 145mV was measured at Hatigoan. During the month of December 94, ORP varied between 279mV to 156mV with an average value of 218mV and the variance was ± 62mV. Maximum value of 179mV measured at Noonmati and a minimum of 156mV was measured at Jalukbari.

During the month of April 95, ORP varied between 229mV to 143mV with an average value of 196mV. the variance was found to be ± 43mV. Maximum value of 229mV measured at Hatigaon and a minimum of 143mV at Usha Nagar and Mathura Nagar.

During the month of October 95, ORP varied between 231mV to 165mV with an average value of 198mV. The variance was found to be ± 33mV with a maximum value of 231mV measured at Hengrabari and a minimum of 165mV at Mathura Nagar.

During the sampling period maximum ORP of 279mV was measured at Noonmati and a minimum of 143mV at Usha Nagar and Mathura Nagar.

Conductivity

Electrical Conductivity (EC) is a physical property of water that is dependent on the dissolved salts. Thus its measurements in micro-mho/cm gives a good estimate of the dissolved solids content of a sample. The conductivity of water depends upon the concentration of dissolved ions.

During July 1994 conductivity varied between 1198 to 720 micro-mho/cm with an average value of 1048 micro-mho/cm. The variance was found to be ± 339 micro-mho/cm. Maximum

conductivity of 1198 micro-mho/cm was measured at Rukmanigaon and a minimum of 720 micro-mho/cm at Kahilipara.

During the month of December 1994, the conductivity varied between 1148 to 651 micro-mho/cm with an average value of 998. The variance was found to be ± 249 micro-mho/cm. Maximum conductivity of 651 micro-mho/cm was measured at Kahilipara.

During the month of April 1995 the conductivity varied between 1154 to 698 micro-mho/cm. Maximum conductivity of 1154 micro-mho/cm was measured at Barasajai and a minimum of 698 micro-mho/cm was measured at Kahilipara.

During the month of October 1995, the conductivity varied between 1068 to 659 micro-mho/cm with an average value of 949 micro-mho/cm and the variance was found to be ± 205 micro-mho/cm. Maximum conductivity of 1068 micro-mho/cm was measured at Paniabari and a minimum of 659 micro-mho/cm measured at Kahilipara.

The maximum variance was at Maligaon and Khanapara with a variance of ± 143 micro-mho/cm and ± 144 micro-mho/cm respectively. During the sampling period maximum conductivity of 1198 micro-mho/cm was measured at Rukmanigaon during July 94 and a minimum of 651 micro-mho/cm was measured at Kahilipara during December 1994.

% Light Transmitivity

The suspended particles, soil, silt particles, decomposed, or undecomposed organic matter, total dissolved solids as well as microscopic organisms etc. one the main source of turbidity in water, which always interferes with the penetration of light. Hence % light transmission can give a rough idea about level of turbidity in water surface.

The % light transmission of ground water at Guwahati varied between 69 to 88% during the month of July 94, 74 to 88% during the month of Dec. 1994, 75 to 88% during April 1995 and 74 to 88% during the month of Oct. 1995. The maximum light transmission of ground water at Guwahati was 88% during the month of July 94, Dec. 94. April 95' and Oct. 95 for Nutan Bazar, Jalukbari Zoo Narangi and Panjabari respectively. The minimum light transmission of ground water at Guwahati was 74% during the month of dec. 94 at Azra.

5.0 CONCLUSIONS

Determination of chemical parameters needs systematic laboratory tests in a fulfledge water quality laboratory. Physical tests do not directly indicate the safety of a water supply system. However, they do give an indication of its acceptability. It is very costly affair to establish full fledge laboratory to test all water quality parameters like physical, biological, chemical, radiological etc. Water quality monitoring represents the most elaborate and potentially the most costly of the analytical programme required by regulating authorities. Because of the importance and cost factors the selection of analytical tests should be a cautious undertaking. The results of the analyses are the key to demonstrate the pollution environment. In the event of water

contamination, analyses can be used to determine the concentration, migration limit and migration rates of the constituents. Due to lack of funds always it is not possible to test all parameters in water samples to detect pollution level. The changing effect on composition of different chemical, biological and radiological parameters reflects the physical and redox properties of water bodies also. Hence, it is possible to judge the overall pollution level on water bodies by measuring the physical and redox parameters only.

ACKNOWLEDGEMENTS

Paper is based on the study conducted by NERC, NIH for "Ground Water Quality Monitoring and Evaluation of Greater Guwahati" during the period of 1994 to 1995. While completing this part of the paper acknowledgement is due to Sh. PK Sarkar (SRA), Sh. CS Chowhan (Tech.) and Sh. DM Rangan (Tech.) for their helps in water quality sampling and testing. Helps of other scientific staff and scientists of NERC are also acknowledge while participation in field trips.

REFERENCES

Agarwal, SK, Pollution Ecology, Himanshu Publications.

Bhatia, KKS and R Jaiswal, Water Quality Conservation and Need for Public Awareness, Proc. of Seminar on Water Conservation and Public Awareness, Sept. 25-26, 1992, Inst Engineers (India), Roorkee, pp. 276-280.

Jain, CK and KKS Bhatia, Physico-Chemical Analysis of Water and Waste Water, UM-26, NIH, Roorkee, 1987-88.

Jal Vigyan Sameeksha, (Hydrology Review), Theme Water Quality, Publication of High Level Technical Committee on Hydrology, NIH, Roorkee, June 1988.

Kumar, SR et al. (1996), Ground Water Quality Monitoring and Evaluation in and around Greater Guwahati (Part-I, Preliminary). CS(AR)-200, National Institute of Hydrology, Roorkee.

Sarma, C, and SK Sarma, A Study of Physico-Chemical Qualities of the Water of Three Ring Wells and Two Ponds in Guwahati area, Journal of Assam Science Society, Vol. 31, No. 1, Dec.1988, pp. 33-42.

Stednick, JD, Wild Land Water Quality Sampling and Analysis, Academic Press, Harcourt Brace Jovanovich, Publishers, San Diego.

Tripathi, AK, and SN Pandey, Water Pollution, Ashish Publishing House, New Delhi.

Tyagi, A, Automatic Water Quality Monitoring, TN-66, NIH., Roorkee. 1989-90.

APPENDIX : - Formula and subscripts

Cond.	= Conductivity in micro-mho/cm
DO	= Dissolved Oxygen in ppm
emf	= electro magnetic force
LT	= Light Transmitivity in %
mV	= milli Volt
ORP	= Oxydation Reduction Potential in milli-Volt
ppm	= parts per million
Temp.	= Temperature in degree centigrade
Variance	= ± [(maximum-average)+(average-minimum)]/2