

MINOR RESEARCH PROJECT

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TITLE

“PHYSICO-CHEMICAL ANALYSIS OF BORE-WELLS
DRINKING WATER IN MORBI-MALIA TERRITORY”

NAME OF THE INSTITUTE

MAHARAJA SHREE MAHENDRASINHJI SCIENCE
COLLEGE
MORBI, DIST-RAJKOT
(GUJARAT)

PRINCIPAL INVESTIGATOR

Dr. B. M. BHESHDADIA
DEPARTMENT OF CHEMISRTY
MAHARAJA SHREE MAHENDRASINHJI SCIENCE
COLLEGE
MORBI, DIST-RAJKOT
(GUJARAT)

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INTRODUCTION

India has a rich water resource including a wide network of rivers and vast alluvial basins to hold ground water. In spite of the availability of approximately 1100km³ water for meeting all kind of needs there are severe problems of water scarcity, primarily due to non-uniformity in availability. The problem has been further aggravated by the rapid increase in population thereby increasing the demand of water supply for irrigation, human and industrial consumption. Surface and ground water are major sources of drinking water in urban and rural India. In urban area water for drinking and various domestic purposes is supplied by municipal authorities, which supply it after a thorough treatment. However despite the treatment the water gets contaminated during the distribution process either due to leakage from water pipes or escape of protozoa and enteric virus through filters or formation of bio-film in storage and distribution systems or even seepage of soil nutrients and soil particles through breakage in supply system.

In fact industrial waste and the municipal solid waste have emerged as one of the leading causes of pollution of surface and ground water. In many part of the country available water is rendered non-potable because of presence of iron, nitrate, arsenic or heavy metals and pesticide used in farm excess. The situation gets worsened during the summer season due to water scarcity and rainwater discharge. Contamination of water resources available for household and drinking purposes with heavy elements, metal ions and harmful microorganisms is one of the serious

major health problems. As a result huge amount of money is spent for chemical treatment of contaminated water to make it potable. Thus there is a need to look for some useful indicators, both microbiological and physical, which can be used to monitor both drinking water system operation and performance. The problem of water contamination and scarcity are very severe in Morbi-Malia territory where there has been a rapid increase in population due to increase urbanization and industrialization. While the condition of water contamination and scarcity is very severe in Morbi-Malia city and rural area of both taluka. Both city and rural area are experience very frequent episodes of cholera and jaundice. A study has attempted to assess the physical and chemical properties of bore-wells drinking water being used in different parts of the Morbi-Malia city and rural area.

In continuation of earlier studies on bore-well water¹⁻³, here we have investigated intensively the Physico-Chemical analysis of drinking water of Morbi-Malia territory, located in Rajkot district of Gujarat state. Bore-well water is generally used for drinking and other domestic purposes in this area. The use of fertilizers and pesticides, manure, lime, septic tank, refuse dump etc. is the major sources of bore-well water pollution⁴. In the absence of fresh water supply people residing in this area use bore-well water for their domestic and drinking purpose. In order to assess water quality index, we have conducted the physico-chemical analysis of bore-well drinking water.

We have measured the some parameters of the collected water sample like temperature, salinity, alkalinity, total hardness, phosphate, sulphate, nitrate, pH, electrical conductivity, T.D.S., turbidity, dissolved oxygen, fluoride etc.

All above mentioned parameters and elements are found in all bore-well water at some concentration, due to some pollutants and nature

of rocks. For example in ground water low and high concentration of fluoride may occur on the base of the nature of rocks and the occurrence of the fluoride-bearing minerals. Low concentration of fluoride prevents dental caries. However it has been observed that when fluoride intake through water, food and air increases to a specific level (1.0mg/l to 1.5mg/l) the beneficial effect is lost and harmful effect is seen with increasing concentration (above 1.5 mg/l). Excess intake of fluoride beyond permissible limit brings out dental and skeleton fluorosis along with some neurological disorder. Higher concentration of fluoride also causes respiratory failure, fall of blood pressure and general paralysis. Fluoride ions inhibit a variety of enzymes - often by forming complexes with magnesium ion and other metal ions.

According to water and river commission Western Australia, ground water occupies the pores and crevices in sand, sand stone and other rocks. The crucial role which ground water plays as decentralized source of drinking water for millions of rural and urban families can not be undermined.

EXPERIMENTAL

In the present study bore-well water samples from twenty five different areas located in and around Morbi-Malia territory were collected in brown glass bottle with necessary precautions⁵.

All the chemicals were used of AR grade. Double distilled water was used for the preparation of reagents and solution. The major water quality parameters considered for the examination in this study are temperature, pH, D.O., turbidity, electrical conductivity, T.D.S., salinity, alkalinity, phosphate, sulphate, nitrate, fluoride, total hardness and chloride contents⁶.

Temperature, pH, D.O., turbidity, electrical conductivity, T.D.S., salinity, phosphate, nitrate and fluoride value were measured by water analysis kit, portable D.O. meter and manual methods. Total hardness of water was estimated by complexometric titration methods⁷. Chloride content was determined volumetrically by silver nitrate titrimetric method using potassium chromate as an indicator and was calculated in terms of mg/l. Alkalinity of water samples were measured volumetrically by titrimetric method⁷. Sulphate content was determined by volumetric method⁷.

RESULTS AND DISCUSSION

Temperature : In the present study, temperature in May-2009 ranged from 29.8 to 32.8⁰C and temperature in October-2009 ranged from 29.0 to 31.7⁰C.

D.O. : In the present study, D.O. in May-2009 ranged from 3.7 to 7.3 ppm. The minimum tolerance range is 4.0 ppm for drinking water. But the D. O. was found lower in sample station Nos. 1 and 8. In October-2009 D.O. ranged from 3.9 to 8.1 ppm. But the sample station No. 1 showed lower range.

pH : In the present study, pH in May-2009 ranged from 7.09 to 8.89. The tolerance pH limit⁸ is 6.5 to 8.5. The sample station No. 1, 3, 5, 6, 8, 11, 12, 13, 15, 16, 17, 21, 23, 24 and 25 showed higher pH than prescribed range. In October-2009 pH ranged from 7.58 to 9.06. The sample station No. 8, 12, 15, 16, 17, 20, 21 and 23 showed higher pH than the prescribed range.

Turbidity : In the present study, Turbidity in May-2009 ranged from 0.06 to 2.50 NTU and in October-2009 Turbidity ranged from 0.10 to

4.70. The tolerance range for Turbidity is 5 NTU¹⁰. So all the sample station Nos. have shown lower NTU values than the prescribed range.

Electrical conductance : In present study, Electrical conductance in May-2009 ranged from 0.78×10^{-3} to 6.10×10^{-3} mho/cm, while in October-2009 Electrical conductance ranged from 0.47×10^{-3} to 4.94×10^{-3} mho/cm.

T.D.S. : In the present study, TDS in May-2009 ranged from 397 to 3090 ppm. According to WHO⁹ and Indian standards¹⁰, TDS value should be less than 500 ppm for drinking water. The sample station Nos. 1 to 25 except 10 showed higher range compare to prescribed WHO and Indian standards. In October-2009 TDS ranged from 237 to 2490 ppm. But sample station Nos. 1 to 25 except 7, 10, 20 and 21 showed higher range than prescribed range.

Salinity : In the present study, Salinity in May-2009 ranged from 390 to 3080 ppm and in October-2009 Salinity ranged from 240 to 2470 ppm.

Alkalinity : In the present study, Alkalinity in May-2009 ranged from 100 to 660 ppm while in October-2009 Alkalinity ranged from 120 to 700 ppm.

Phosphate : In the present study, Phosphate in May-2009 ranged from 11 to 42 mg/l and in October-2009 Phosphate ranged from 10 to 31 mg/l. The evaluated value of phosphate in the present study is higher than the prescribed value¹³. The higher value of phosphate is mainly due to the use of fertilizers and pesticides by the people residing in this area. If phosphate is consumed in excess, phosphine gas is produced in gastrointestinal tract on reaction with gastric.

Nitrate : In the present study, Nitrate in May-2009 ranged from 84 to 447 mg/l and in October-2009 Nitrate ranged from 90 to 415 mg/l. The tolerance range for Nitrate is 20-45 mg/l. Nitrate nitrogen is one of the

major constituents of organism along with carbon and hydrogen as amino acids proteins and organic compounds in the bore-well water¹⁴. If the nitrate reduces to nitrite then it causes methaemoglobinaemia in infants^{15,16} and also diarrhea.

Sulphate : In the present study, Sulphate in May-2009 ranged from 125.29 to 365.08 mg/l and in October-2009 Sulphate ranged from 105.15 to 355.08 mg/l. The tolerance range of Sulphate is 200-400 mg/l¹².

Total hardness : In the presence study, Total hardness in May-2009 ranged from 110 to 980 ppm and in October-2009 Total hardness ranged from 80 to 810 ppm. The tolerance range for Total hardness¹¹ is 300-600 ppm.

Chloride : In the present study, Chloride in May-2009 ranged from 120.2 to 1469.7 mg/l and in October-2009 Chloride ranged from 63.9 to 1180.9 mg/l. While the tolerance range for chloride is 200-1000 mg/l¹⁰.

Fluoride : In the present study, Fluoride in May-2009 ranged from 0.9 to 1.2 mg/l and in October-2009 Fluoride ranged from 0.9 to 1.2 mg/l. While the tolerance range for Fluoride is 1.0 to 1.5 mg/l¹⁰.

In the next year in same season no major change is seen in all the parameters.

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TABLE - 1 ANALYSIS RESULT OF THE SAMPLES COLLECTED FROM MORBI CITY IN MAY - 2009

| S.St. No: | Name of Sample Station | Temp (°C) | D.O. (ppm) | pH | Turb. (NTU) | Conduct. (mho/cm) | T.D.S. (ppm) | Salinity (ppm) | Alkalinity (ppm) | Phosphate (mg/l) | Sulphate (mg/l) | Nitrate (mg/l) | Flouride (mg/l) | Total Hardness (ppm) | Chloride (mg/l) |
|-----------|------------------------|-----------|------------|------|-------------|-----------------------|--------------|----------------|------------------|------------------|-----------------|----------------|-----------------|----------------------|-----------------|
| 1 | SHRI RAM SOCIETY | 30.6 | 3.9 | 8.69 | 0.17 | 2.00X10 ⁻³ | 1020 | 1000 | 660 | 15 | 155.15 | 445 | 1.1 | 110 | 166.1 |
| 2 | YADUNANDAN SOCIETY | 30.3 | 5.3 | 7.09 | 0.12 | 2.55X10 ⁻³ | 1290 | 1270 | 500 | 20 | 298.23 | 88 | 1.0 | 310 | 293.9 |
| 3 | PANCHAVATY SOCIETY | 31.5 | 4.3 | 8.52 | 0.06 | 1.69X10 ⁻³ | 850 | 840 | 260 | 22 | 262.31 | 426 | 0.9 | 630 | 309.2 |
| 4 | JAIN DERASAR | 29.8 | 4.4 | 8.38 | 0.36 | 2.17X10 ⁻³ | 1100 | 1090 | 260 | 32 | 273.01 | 255 | 1.2 | 522 | 281.2 |
| 5 | GAYATRI NAGAR | 31.3 | 6.6 | 8.69 | 0.13 | 6.10X10 ⁻³ | 3090 | 3080 | 380 | 21 | 233.58 | 196 | 1.2 | 980 | 1469.7 |
| 6 | BHAGVATI PARK | 31.1 | 6.4 | 8.80 | 0.09 | 3.32X10 ⁻³ | 1680 | 1660 | 620 | 42 | 146.12 | 407 | 1.1 | 448 | 447.3 |
| 7 | SCIENCE COLLEGE | 32.8 | 4.8 | 8.47 | 0.32 | 1.87X10 ⁻³ | 950 | 930 | 100 | 21 | 163.72 | 447 | 1.0 | 744 | 393.7 |
| 8 | RELIF NAGAR | 30.9 | 3.7 | 8.73 | 0.15 | 2.41X10 ⁻³ | 1220 | 1210 | 360 | 17 | 216.37 | 125 | 0.9 | 362 | 391.1 |
| 9 | BHUVNESHWER PARK | 31.3 | 5.2 | 8.30 | 0.12 | 2.28X10 ⁻³ | 1160 | 1150 | 100 | 18 | 311.44 | 409 | 1.2 | 710 | 457.6 |
| 10 | KENAL ROAD | 30.2 | 7.3 | 8.30 | 0.27 | 0.92X10 ⁻³ | 465 | 460 | 160 | 38 | 193.15 | 340 | 1.1 | 310 | 140.6 |

TABLE - 2 ANALYSIS RESULT OF THE SAMPLES COLLECTED FROM MALIA CITY IN MAY-2009

| S.St. No: | Name of Sample Station | Temp (°C) | D.O. (ppm) | pH | Turb. (NTU) | Conduct. (mho/cm) | T.D.S. (ppm) | Salinity (ppm) | Alkalinity (ppm) | Phosphate (mg/l) | Sulphate (mg/l) | Nitrate (mg/l) | Flouride (mg/l) | Total Hardness (ppm) | Chloride (mg/l) |
|-----------|------------------------|-----------|------------|------|-------------|-----------------------|--------------|----------------|------------------|------------------|-----------------|----------------|-----------------|----------------------|-----------------|
| 11 | MATAM CHOCK | 31.5 | 6.8 | 8.65 | 0.14 | 6.00X10 ⁻³ | 3050 | 3040 | 370 | 20 | 233.58 | 195 | 1.2 | 960 | 1460.7 |
| 12 | BHISTI VAD | 30.8 | 5.2 | 8.80 | 0.19 | 4.25X10 ⁻³ | 2120 | 2110 | 620 | 36 | 223.21 | 293 | 0.9 | 195 | 678.4 |
| 13 | RAIL. STATION ROAD | 31.2 | 6.5 | 8.75 | 0.09 | 3.30X10 ⁻³ | 1680 | 1670 | 610 | 40 | 145.12 | 406 | 1.1 | 445 | 442.8 |
| 14 | KHARIVADI | 31.6 | 5.9 | 8.20 | 0.11 | 5.11X10 ⁻³ | 2600 | 2580 | 120 | 15 | 266.48 | 124 | 1.0 | 345 | 1314.5 |
| 15 | RAMJI MANDIR CHOCK | 31.3 | 5.7 | 8.88 | 0.44 | 3.56X10 ⁻³ | 1810 | 1800 | 320 | 21 | 291.23 | 84 | 1.1 | 245 | 666.5 |

TABLE - 3 ANALYSIS RESULT OF THE SAMPLES COLLECTED FROM MORBI-MALIA RURAL IN MAY - 2009

| S.St. No: | Name of Sample Station | Temp (°C) | D.O. (ppm) | pH | Turb. (NTU) | Conduct. (mho/cm) | T.D.S. (ppm) | Salinity (ppm) | Alkalinity (ppm) | Phosphate (mg/l) | Sulphate (mg/l) | Nitrate (mg/l) | Flouride (mg/l) | Total Hardness (ppm) | Chloride (mg/l) |
|-----------|------------------------|-----------|------------|------|-------------|-----------------------|--------------|----------------|------------------|------------------|-----------------|----------------|-----------------|----------------------|-----------------|
| 16 | JETPAR | 30.9 | 5.1 | 8.83 | 0.18 | 4.21×10^{-3} | 2130 | 2120 | 620 | 37 | 221.21 | 291 | 0.9 | 192 | 677.3 |
| 17 | ANIYARI | 31.2 | 5.6 | 8.89 | 0.45 | 3.57×10^{-3} | 1810 | 1800 | 320 | 22 | 293.23 | 85 | 1.2 | 240 | 662.0 |
| 18 | KHAKHARECHI | 31.6 | 6.1 | 8.21 | 0.15 | 1.43×10^{-3} | 720 | 720 | 220 | 21 | 125.29 | 395 | 1.1 | 276 | 153.4 |
| 19 | SARVAD | 31.7 | 5.7 | 8.20 | 0.11 | 5.13×10^{-3} | 2600 | 2570 | 120 | 16 | 267.48 | 125 | 1.0 | 342 | 1316.3 |
| 20 | MOTA DAHISHARA | 31.2 | 5.2 | 8.48 | 1.70 | 1.72×10^{-3} | 870 | 860 | 440 | 14 | 269.01 | 420 | 0.9 | 122 | 150.8 |
| 21 | KHAKHARADA | 32.0 | 5.7 | 8.53 | 0.46 | 0.78×10^{-3} | 397 | 390 | 160 | 11 | 134.51 | 360 | 1.2 | 196 | 130.3 |
| 22 | JODHAPAR NADI | 30.9 | 6.1 | 7.95 | 0.27 | 1.82×10^{-3} | 920 | 910 | 200 | 12 | 269.01 | 317 | 0.9 | 554 | 391.1 |
| 23 | CHACHAPAR | 31.1 | 5.3 | 8.60 | 2.50 | 1.98×10^{-3} | 1000 | 990 | 440 | 20 | 365.08 | 403 | 1.0 | 176 | 301.6 |
| 24 | NANI VAVADI | 32.1 | 6.2 | 8.79 | 0.30 | 1.01×10^{-3} | 510 | 500 | 240 | 27 | 278.23 | 390 | 1.2 | 194 | 120.2 |
| 25 | NICHI MANDAL | 31.8 | 5.5 | 8.63 | 0.12 | 1.30×10^{-3} | 660 | 650 | 300 | 14 | 146.12 | 419 | 1.1 | 216 | 199.4 |

TABLE - 4 ANALYSIS RESULT OF THE SAMPLES COLLECTED FROM MORBI CITY IN OCT - 2009

| S.St. No: | Name of Sample Station | Temp (°C) | D.O. (ppm) | p ^H | Turb. (NTU) | Conduct. (mho/cm) | T.D.S. (ppm) | Salinity (ppm) | Alkalinity (ppm) | Phosph. ate (mg/l) | Sulphate (mg/l) | Nitrate (mg/l) | Flourid e (mg/l) | Total Hardness (ppm) | Chloride (mg/l) |
|-----------|------------------------|-----------|------------|----------------|-------------|-----------------------|--------------|----------------|------------------|--------------------|-----------------|----------------|------------------|----------------------|-----------------|
| 1 | SHRI RAM SOCIETY | 29.4 | 3.9 | 8.10 | 0.25 | 1.97X10 ⁻³ | 1000 | 990 | 700 | 11 | 105.15 | 345 | 1.0 | 90 | 230.0 |
| 2 | YADUNANDAN SOCIETY | 29.2 | 5.3 | 7.58 | 0.56 | 2.28X10 ⁻³ | 1160 | 1150 | 660 | 13 | 188.23 | 92 | 1.0 | 280 | 242.8 |
| 3 | PANCHAVATY SOCIETY | 30.6 | 5.6 | 8.41 | 0.94 | 1.39X10 ⁻³ | 710 | 700 | 420 | 20 | 182.31 | 401 | 0.9 | 500 | 212.1 |
| 4 | JAIN DERASAR | 29.0 | 5.3 | 8.38 | 0.42 | 1.78X10 ⁻³ | 900 | 890 | 360 | 29 | 223.01 | 235 | 1.1 | 400 | 240.2 |
| 5 | GAYATRI NAGAR | 30.4 | 7.7 | 8.21 | 0.49 | 4.94X10 ⁻³ | 2490 | 2470 | 580 | 19 | 203.58 | 176 | 1.1 | 810 | 1180.9 |
| 6 | BHAGVATI PARK | 30.3 | 7.4 | 8.45 | 0.15 | 2.30X10 ⁻³ | 1390 | 1380 | 680 | 36 | 136.12 | 377 | 1.0 | 350 | 347.6 |
| 7 | SCIENCE COLLEGE | 31.7 | 5.9 | 8.25 | 0.55 | 1.21X10 ⁻³ | 500 | 490 | 580 | 17 | 143.72 | 402 | 0.9 | 624 | 303.7 |
| 8 | RELIF NAGAR | 29.8 | 4.8 | 8.96 | 0.53 | 1.51X10 ⁻³ | 770 | 770 | 440 | 15 | 196.37 | 105 | 0.9 | 160 | 173.8 |
| 9 | BHUVNESHWER PARK | 30.5 | 6.1 | 8.30 | 0.50 | 1.16X10 ⁻³ | 590 | 580 | 220 | 16 | 281.44 | 369 | 1.1 | 320 | 168.7 |
| 10 | KENAL ROAD | 29.4 | 8.1 | 8.44 | 0.30 | 0.89X10 ⁻³ | 450 | 450 | 320 | 34 | 173.15 | 305 | 1.0 | 310 | 120.2 |

TABLE - 5 ANALYSIS RESULT OF THE SAMPLES COLLECTED FROM MALIA CITY IN OCT-2009

| S.St. No: | Name of Sample Station | Temp (°C) | D.O. (ppm) | p ^H | Turb. (NTU) | Conduct. (mho/cm) | T.D.S. (ppm) | Salinity (ppm) | Alkalinity (ppm) | Phosph. ate (mg/l) | Sulphate (mg/l) | Nitrate (mg/l) | Flourid e (mg/l) | Total Hardness (ppm) | Chloride (mg/l) |
|-----------|------------------------|-----------|------------|----------------|-------------|-----------------------|--------------|----------------|------------------|--------------------|-----------------|----------------|------------------|----------------------|-----------------|
| 11 | MATAM CHOCK | 30.5 | 7.8 | 8.20 | 0.48 | 4.90X10 ⁻³ | 2460 | 2450 | 580 | 18 | 205.58 | 175 | 1.0 | 810 | 1181.8 |
| 12 | BHISTI VAD | 30.0 | 6.4 | 8.61 | 0.33 | 2.03X10 ⁻³ | 1030 | 1010 | 420 | 37 | 201.21 | 290 | 0.9 | 190 | 343.3 |
| 13 | RAIL. STATION ROAD | 30.4 | 7.5 | 8.44 | 0.14 | 2.29X10 ⁻³ | 1380 | 1370 | 680 | 35 | 136.12 | 375 | 1.0 | 355 | 346.7 |
| 14 | KHARIVADI | 30.8 | 6.7 | 8.26 | 1.22 | 4.30X10 ⁻³ | 2180 | 2170 | 120 | 14 | 236.48 | 127 | 1.1 | 300 | 1267.0 |
| 15 | RAMJI MANDIR CHOCK | 30.6 | 6.6 | 8.53 | 0.50 | 3.00X10 ⁻³ | 1550 | 1540 | 460 | 20 | 274.23 | 92 | 1.0 | 240 | 608.2 |

TABLE - 6 ANALYSIS RESULT OF THE SAMPLES COLLECTED FROM MORBI-MALIA RURAL IN OCT - 2009

| S.St. No: | Name of Sample Station | Temp (°C) | D.O. (ppm) | p ^H | Turb. (NTU) | Conduct. (mho/cm) | T.D.S. (ppm) | Salinity (ppm) | Alkalinity (ppm) | Phosphate (mg/l) | Sulphate (mg/l) | Nitrate (mg/l) | Flouride (mg/l) | Total Hardness (ppm) | Chloride (mg/l) |
|-----------|------------------------|-----------|------------|----------------|-------------|-----------------------|--------------|----------------|------------------|------------------|-----------------|----------------|-----------------|----------------------|-----------------|
| 16 | JETPAR | 30.1 | 6.2 | 8.63 | 0.34 | 2.02X10 ⁻³ | 1030 | 1020 | 420 | 38 | 201.21 | 295 | 0.9 | 190 | 345.1 |
| 17 | ANIYARI | 30.5 | 6.4 | 8.52 | 0.50 | 3.08X10 ⁻³ | 1560 | 1550 | 460 | 21 | 273.23 | 90 | 1.1 | 230 | 610.9 |
| 18 | KHAKHARECHI | 30.5 | 7.0 | 8.20 | 0.10 | 1.44X10 ⁻³ | 730 | 720 | 280 | 22 | 118.29 | 397 | 1.1 | 260 | 143.1 |
| 19 | SARVAD | 30.9 | 6.5 | 8.27 | 1.20 | 4.32X10 ⁻³ | 2190 | 2170 | 120 | 15 | 237.48 | 127 | 1.1 | 300 | 1265.2 |
| 20 | MOTA DAHISHARA | 30.4 | 6.1 | 8.69 | 0.36 | 0.86X10 ⁻³ | 434 | 430 | 220 | 15 | 239.01 | 415 | 0.9 | 110 | 145.7 |
| 21 | KHAKHARADA | 31.0 | 6.8 | 8.52 | 0.85 | 0.47X10 ⁻³ | 237 | 240 | 160 | 10 | 134.51 | 355 | 1.2 | 150 | 69.0 |
| 22 | JODHAPAR NADI | 30.0 | 7.0 | 8.17 | 0.68 | 1.27X10 ⁻³ | 640 | 640 | 200 | 12 | 249.01 | 313 | 0.9 | 370 | 250.5 |
| 23 | CHACHAPAR | 30.2 | 5.9 | 9.06 | 4.70 | 1.62X10 ⁻³ | 820 | 820 | 520 | 21 | 355.08 | 401 | 1.0 | 80 | 242.8 |
| 24 | NANI VAVADI | 31.3 | 7.1 | 8.19 | 0.53 | 0.74X10 ⁻³ | 374 | 370 | 360 | 26 | 270.23 | 391 | 1.1 | 140 | 63.9 |
| 25 | NICHI MANDAL | 31.1 | 6.3 | 8.10 | 0.58 | 1.75X10 ⁻³ | 890 | 880 | 360 | 15 | 145.12 | 414 | 1.2 | 290 | 337.4 |

TABLE - 7 ANALYSIS RESULT OF THE SAMPLES COLLECTED FROM MORBI CITY IN MAY - 2010

| S.St No: | Name of Sample Station | Temp (°C) | D.O. (ppm) | pH | Turb. (NTU) | Conduct. (mho/cm) | T.D.S. (ppm) | Salinity (ppm) | Alkalinity (ppm) | Phosphate (mg/l) | Sulphate (mg/l) | Nitrate (mg/l) | Flouride (mg/l) | Total Hardness (ppm) | Chloride (mg/l) |
|----------|------------------------|-----------|------------|------|-------------|-----------------------|--------------|----------------|------------------|------------------|-----------------|----------------|-----------------|----------------------|-----------------|
| 1 | SHRI RAM SOCIETY | 30.4 | 4.1 | 8.70 | 0.22 | 2.10X10 ⁻³ | 1010 | 1000 | 650 | 16 | 158.18 | 441 | 1.1 | 115 | 162.5 |
| 2 | YADUNANDAN SOCIETY | 30.2 | 5.5 | 7.10 | 0.23 | 2.47X10 ⁻³ | 1280 | 1270 | 510 | 20 | 292.25 | 87 | 1.0 | 305 | 298.9 |
| 3 | PANCHAVATY SOCIETY | 31.7 | 4.4 | 8.42 | 0.08 | 1.71X10 ⁻³ | 855 | 845 | 250 | 21 | 265.33 | 420 | 0.9 | 610 | 305.2 |
| 4 | JAIN DERASAR | 29.6 | 4.5 | 8.48 | 0.39 | 2.20X10 ⁻³ | 1110 | 1090 | 250 | 30 | 275.02 | 265 | 1.1 | 512 | 285.2 |
| 5 | GAYATRI NAGAR | 31.5 | 6.8 | 8.59 | 0.15 | 6.15X10 ⁻³ | 3070 | 3060 | 370 | 20 | 230.55 | 191 | 1.2 | 960 | 1465.7 |
| 6 | BHAGVATI PARK | 31.0 | 6.6 | 8.75 | 0.10 | 3.37X10 ⁻³ | 1670 | 1660 | 600 | 41 | 142.18 | 417 | 1.1 | 438 | 440.3 |
| 7 | SCIENCE COLLEGE | 32.6 | 4.9 | 8.56 | 0.35 | 1.82X10 ⁻³ | 940 | 930 | 100 | 20 | 168.62 | 445 | 1.0 | 734 | 398.7 |
| 8 | RELIF NAGAR | 30.8 | 3.9 | 8.66 | 0.18 | 2.37X10 ⁻³ | 1225 | 1210 | 350 | 18 | 220.47 | 135 | 0.9 | 360 | 395.1 |
| 9 | BHUVNESHWER PARK | 31.5 | 5.4 | 8.37 | 0.15 | 2.23X10 ⁻³ | 1165 | 1150 | 110 | 19 | 321.44 | 415 | 1.2 | 690 | 452.6 |
| 10 | KENAL ROAD | 30.1 | 7.3 | 8.39 | 0.31 | 0.98X10 ⁻³ | 460 | 455 | 150 | 36 | 198.21 | 330 | 1.0 | 305 | 145.6 |

TABLE - 8 ANALYSIS RESULT OF THE SAMPLES COLLECTED FROM MALIA CITY IN MAY-2010

| S.St No: | Name of Sample Station | Temp (°C) | D.O. (ppm) | pH | Turb. (NTU) | Conduct. (mho/cm) | T.D.S. (ppm) | Salinity (ppm) | Alkalinity (ppm) | Phosphate (mg/l) | Sulphate (mg/l) | Nitrate (mg/l) | Flouride (mg/l) | Total Hardness (ppm) | Chloride (mg/l) |
|----------|------------------------|-----------|------------|------|-------------|-----------------------|--------------|----------------|------------------|------------------|-----------------|----------------|-----------------|----------------------|-----------------|
| 11 | MATAM CHOCK | 31.7 | 6.9 | 8.62 | 0.18 | 6.06X10 ⁻³ | 3040 | 3030 | 390 | 20 | 230.48 | 205 | 1.2 | 950 | 1450.7 |
| 12 | BHISTI VAD | 30.7 | 5.5 | 8.77 | 0.17 | 4.35X10 ⁻³ | 2110 | 2100 | 600 | 34 | 229.28 | 285 | 0.8 | 205 | 688.4 |
| 13 | RAIL. STATION ROAD | 31.3 | 6.7 | 8.71 | 0.11 | 3.33X10 ⁻³ | 1690 | 1680 | 600 | 38 | 151.12 | 416 | 1.1 | 440 | 445.7 |
| 14 | KHARIVADI | 31.8 | 5.8 | 8.29 | 0.13 | 5.10X10 ⁻³ | 2610 | 2595 | 130 | 16 | 261.36 | 129 | 1.0 | 350 | 1324.5 |
| 15 | RAMJI MANDIR CHOCK | 31.5 | 5.9 | 8.78 | 0.41 | 3.46X10 ⁻³ | 1820 | 1810 | 310 | 20 | 290.21 | 85 | 1.2 | 250 | 666.6 |

TABLE - 9 ANALYSIS RESULT OF THE SAMPLES COLLECTED FROM MORBI-MALIA RURAL IN MAY - 2010

| S.St. No: | Name of Sample Station | Temp (°C) | D.O. (ppm) | pH | Turb. (NTU) | Conduct. (mho/cm) | T.D.S. (ppm) | Salinity (ppm) | Alkalinity (ppm) | Phosphate (mg/l) | Sulphate (mg/l) | Nitrate (mg/l) | Flouride (mg/l) | Total Hardness (ppm) | Chloride (mg/l) |
|-----------|------------------------|-----------|------------|------|-------------|-----------------------|--------------|----------------|------------------|------------------|-----------------|----------------|-----------------|----------------------|-----------------|
| 16 | JETPAR | 30.8 | 5.3 | 8.81 | 0.17 | 4.11X10 ⁻³ | 2110 | 2100 | 640 | 35 | 225.25 | 299 | 0.9 | 197 | 667.3 |
| 17 | ANIYARI | 31.4 | 5.8 | 8.90 | 0.40 | 3.49X10 ⁻³ | 1820 | 1810 | 330 | 21 | 283.23 | 87 | 1.2 | 255 | 667.2 |
| 18 | KHAKHARECHI | 31.5 | 6.4 | 8.28 | 0.21 | 1.37X10 ⁻³ | 730 | 720 | 240 | 20 | 130.28 | 400 | 1.0 | 270 | 151.4 |
| 19 | SARVAD | 31.9 | 5.8 | 8.28 | 0.18 | 5.21X10 ⁻³ | 2580 | 2570 | 130 | 17 | 260.48 | 135 | 1.0 | 340 | 1326.3 |
| 20 | MOTA DAHISHARA | 31.4 | 5.2 | 8.58 | 1.75 | 1.78X10 ⁻³ | 880 | 870 | 430 | 16 | 259.01 | 430 | 0.9 | 125 | 155.8 |
| 21 | KHAKHARADA | 32.2 | 5.6 | 8.58 | 0.49 | 0.74X10 ⁻³ | 399 | 390 | 150 | 13 | 138.51 | 350 | 1.1 | 200 | 135.3 |
| 22 | JODHAPAR NADI | 30.8 | 6.3 | 7.85 | 0.29 | 1.87X10 ⁻³ | 940 | 930 | 210 | 15 | 264.41 | 307 | 0.9 | 560 | 394.1 |
| 23 | CHACHAPAR | 31.3 | 5.5 | 8.68 | 2.35 | 1.88X10 ⁻³ | 1020 | 1010 | 430 | 20 | 362.07 | 413 | 1.0 | 175 | 306.6 |
| 24 | NANI VAVADI | 32.3 | 6.5 | 8.69 | 0.37 | 1.11X10 ⁻³ | 515 | 510 | 230 | 26 | 275.28 | 380 | 1.2 | 198 | 122.2 |
| 25 | NICHI MANDAL | 31.9 | 5.4 | 8.69 | 0.17 | 1.39X10 ⁻³ | 670 | 660 | 290 | 17 | 149.32 | 415 | 1.0 | 221 | 196.4 |

TABLE - 10 ANALYSIS RESULT OF THE SAMPLES COLLECTED FROM MORBI CITY IN OCT - 2010

| S.St. No: | Name of Sample Station | Temp (°C) | D.O. (ppm) | p ^H | Turb. (NTU) | Conduct. (mho/cm) | T.D.S. (ppm) | Salinity (ppm) | Alkalinity (ppm) | Phosphate (mg/l) | Sulphate (mg/l) | Nitrate (mg/l) | Flouride (mg/l) | Total Hardness (ppm) | Chloride (mg/l) |
|-----------|------------------------|-----------|------------|----------------|-------------|-----------------------|--------------|----------------|------------------|------------------|-----------------|----------------|-----------------|----------------------|-----------------|
| 1 | SHRI RAM SOCIETY | 29.2 | 4.1 | 8.15 | 0.30 | 1.88X10 ⁻³ | 990 | 980 | 710 | 10 | 109.25 | 341 | 0.9 | 95 | 240.2 |
| 2 | YADUNANDAN SOCIETY | 29.1 | 5.4 | 7.67 | 0.59 | 2.35X10 ⁻³ | 1140 | 1130 | 650 | 13 | 180.23 | 95 | 1.0 | 270 | 245.8 |
| 3 | PANCHAVATY SOCIETY | 30.6 | 5.8 | 8.49 | 0.97 | 1.32X10 ⁻³ | 720 | 710 | 430 | 22 | 187.32 | 411 | 0.9 | 480 | 211.1 |
| 4 | JAIN DERASAR | 29.2 | 5.5 | 8.48 | 0.49 | 1.88X10 ⁻³ | 910 | 900 | 350 | 27 | 222.30 | 232 | 1.0 | 390 | 245.3 |
| 5 | GAYATRI NAGAR | 30.3 | 7.6 | 8.31 | 0.44 | 4.97X10 ⁻³ | 2460 | 2450 | 590 | 19 | 208.57 | 179 | 1.1 | 820 | 1170.7 |
| 6 | BHAGVATI PARK | 30.1 | 7.5 | 8.40 | 0.17 | 2.25X10 ⁻³ | 1380 | 1370 | 670 | 35 | 139.35 | 367 | 1.0 | 330 | 341.5 |
| 7 | SCIENCE COLLEGE | 31.8 | 5.8 | 8.35 | 0.52 | 1.28X10 ⁻³ | 510 | 490 | 590 | 18 | 141.72 | 412 | 0.9 | 614 | 308.7 |
| 8 | RELIF NAGAR | 29.6 | 4.9 | 8.90 | 0.51 | 1.58X10 ⁻³ | 780 | 770 | 450 | 15 | 192.37 | 110 | 1.0 | 150 | 177.8 |
| 9 | BHUVNESHWER PARK | 30.2 | 6.3 | 8.35 | 0.57 | 1.27X10 ⁻³ | 580 | 570 | 210 | 19 | 285.45 | 359 | 1.1 | 320 | 178.7 |
| 10 | KENAL ROAD | 29.2 | 8.3 | 8.47 | 0.38 | 0.95X10 ⁻³ | 460 | 450 | 330 | 32 | 175.25 | 318 | 1.0 | 320 | 130.2 |

TABLE - 11 ANALYSIS RESULT OF THE SAMPLES COLLECTED FROM MALIA CITY IN OCT-2010

| S.St. No: | Name of Sample Station | Temp (°C) | D.O. (ppm) | p ^H | Turb. (NTU) | Conduct. (mho/cm) | T.D.S. (ppm) | Salinity (ppm) | Alkalinity (ppm) | Phosphate (mg/l) | Sulphate (mg/l) | Nitrate (mg/l) | Flouride (mg/l) | Total Hardness (ppm) | Chloride (mg/l) |
|-----------|------------------------|-----------|------------|----------------|-------------|-----------------------|--------------|----------------|------------------|------------------|-----------------|----------------|-----------------|----------------------|-----------------|
| 11 | MATAM CHOCK | 30.7 | 7.9 | 8.27 | 0.44 | 4.85X10 ⁻³ | 2440 | 2430 | 570 | 20 | 200.48 | 172 | 1.0 | 800 | 1161.5 |
| 12 | BHISTI VAD | 30.2 | 6.6 | 8.66 | 0.36 | 2.12X10 ⁻³ | 1020 | 1010 | 430 | 35 | 211.25 | 290 | 0.9 | 195 | 348.9 |
| 13 | RAIL. STATION ROAD | 30.2 | 7.4 | 8.49 | 0.20 | 2.24X10 ⁻³ | 1360 | 1350 | 670 | 34 | 131.15 | 370 | 1.0 | 347 | 342.5 |
| 14 | KHARIVADI | 30.6 | 6.5 | 8.29 | 1.20 | 4.40X10 ⁻³ | 2190 | 2180 | 110 | 16 | 239.48 | 117 | 12.0 | 320 | 1257.5 |
| 15 | RAMJI MANDIR CHOCK | 30.4 | 6.5 | 8.58 | 0.54 | 3.10X10 ⁻³ | 1560 | 1550 | 470 | 20 | 271.72 | 94 | 1.0 | 250 | 612.2 |

TABLE - 12 ANALYSIS RESULT OF THE SAMPLES COLLECTED FROM MORBI-MALIA RURAL IN OCT - 2010

| S.St. No: | Name of Sample Station | Temp (°C) | D.O. (ppm) | p ^H | Turb. (NTU) | Conduct. (mho/cm) | T.D.S. (ppm) | Salinity (ppm) | Alkalinity (ppm) | Phosphate (mg/l) | Sulphate (mg/l) | Nitrate (mg/l) | Fluoride (mg/l) | Total Hardness (ppm) | Chloride (mg/l) |
|-----------|------------------------|-----------|------------|----------------|-------------|-----------------------|--------------|----------------|------------------|------------------|-----------------|----------------|-----------------|----------------------|-----------------|
| 16 | JETPAR | 30.3 | 6.3 | 8.69 | 0.37 | 2.12X10 ⁻³ | 1050 | 1040 | 430 | 39 | 210.21 | 291 | 1.0 | 180 | 349.1 |
| 17 | ANIYARI | 30.4 | 6.5 | 8.58 | 0.52 | 3.14X10 ⁻³ | 1550 | 1540 | 450 | 22 | 278.23 | 92 | 1.1 | 220 | 620.9 |
| 18 | KHAKHARECHI | 30.4 | 7.2 | 8.30 | 0.15 | 1.48X10 ⁻³ | 740 | 730 | 290 | 23 | 115.39 | 377 | 1.1 | 260 | 141.1 |
| 19 | SARVAD | 30.7 | 6.7 | 8.35 | 1.27 | 4.38X10 ⁻³ | 2195 | 2180 | 130 | 17 | 232.58 | 137 | 1.1 | 310 | 1245.2 |
| 20 | MOTA DAHISHARA | 30.5 | 6.3 | 8.73 | 0.31 | 0.88X10 ⁻³ | 444 | 440 | 220 | 15 | 235.11 | 423 | 1.0 | 130 | 148.7 |
| 21 | KHAKHARADA | 31.2 | 6.7 | 8.55 | 0.82 | 0.51X10 ⁻³ | 247 | 240 | 170 | 13 | 138.51 | 345 | 1.2 | 170 | 71.5 |
| 22 | JODHAPAR NADI | 30.3 | 7.2 | 8.27 | 0.65 | 1.25X10 ⁻³ | 650 | 640 | 210 | 15 | 245.12 | 333 | 0.9 | 350 | 259.5 |
| 23 | CHACHAPAR | 30.3 | 5.8 | 9.02 | 4.60 | 1.70X10 ⁻³ | 830 | 820 | 520 | 25 | 359.55 | 421 | 1.0 | 85 | 248.8 |
| 24 | NANI VAVADI | 31.1 | 7.2 | 8.23 | 0.58 | 0.77X10 ⁻³ | 384 | 380 | 350 | 29 | 276.38 | 371 | 1.2 | 135 | 68.9 |
| 25 | NICHI MANDAL | 31.2 | 6.4 | 8.19 | 0.59 | 1.80X10 ⁻³ | 890 | 870 | 370 | 18 | 148.21 | 401 | 1.2 | 295 | 342.4 |

REFERENCES

1. A.K. Rana, M.J. Kharodawala, J. M. Patel, R.K. Rai, B.S. Patel and Dabhi, Asian J.Chem., 14, 1209 (2002).
2. A.K. Rana, M.J. Kharodawala, H.R. Dabhi, D.M. Suthar, D.N. Dave, B.S. Patel and R.K. Rai, Asian J. Chem., 14, 1178 (2002).
3. D.K. Bhoi, D.S. Raj, Y.M. Mehta, M.B. Chauhan and M.T.Machhar, Asian J.Chem., 17, 404 (2005).
4. P.A. Hamilton and D.K. Helsel, Ground Water, 33, 2 (1995)
5. E. Broun, M.W. Skovgstd and M.J. Fishman, Method for Collection and Analysis of water Samples for Dissolved Minerals and Gases, Vol.5 (1974)
6. N. Manivasagam, Physico-chemical Examination of water, Sewage And Industrial Effluents, Pragati Prakashan, Meerut (1984).
7. A.I. Vogel, Text Book of Quantitative, Inorganic Analysis, 4th Edn., ELBC, London (1978).
8. APHA: American Public Health Association, Standard Methods for Examination of water and Wastewater, 16th Edn., APHA-WPCF-AWWA, Washington (1985).
9. International Standard for Drinking Water, 3rd Edn., WHO, Geneva (1971)
10. The Gazette of India: Extraordinary, Part-II, 3, 11 (1991).
11. A.J. Dhembare, G.M. Pondhe and C.R. Singh, poll. Res., 17, 87 (1998).
12. J.E. Mekee and H.W. Wolf, Water Quality Criteria. The Resources Agency of California State Water Quality Control Board (1978).
13. APSFSL, Andhra Pradesh State Forensic Science Laboratories, Annual Report (1988).

14. D.G. Miller, Nitrate in Drinking Water, Water Research Centre, Medmenham (1981).
15. NEERI: National Environment Engineering Research Institute, Disinfection of Small Community Water Supplies, Nagpur (1972).
16. J.W. White, J.Agric. Food Chem., 23, 886 (1975).
17. Fluoride in Drinking Water, WHO/IWA, (2001).



Principal Investigator
Dr. B. M. Bhoshdadia
UGC MRP F.No. 47-550/88(WRO)
M. M. Science College, Morbi (Guj)