# Tap Water Analysis of Selected Areas of Ahmedabad City

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***Abstract* — Water is unavoidable necessity of each and every life. As it is said, "Health is Wealth", every person seeks good health. To have good health, good quality water is required because maximum diseases spread through poor quality or unpurified water. Water covers three-quarters of the earth's surface, but near to 1% of that is only potable. This study focuses on the quality analysis of drinking water of Ahmedabad city in 2012. There are mainly following sources of drinking water: Narmada Water, Tube well or Recycled water in the city. People get water from one or combination of above sources and thus drinking tap water samples were collected from different areas of the city. The samples were analyzed for their physical-chemical and microbiological quality in order to estimate water quality, the contamination problems and to suggest appropriate solutions.**

***Index Terms* — Water quality; Water analysis; Potable; Contamination**

## I. Introduction

The quality of water is available for human consumption is a direct measure of the human health. It is rightly equated with life because life is not possible without water. It circulates through the human body just like it does the land: transporting, dissolving and replenishing nutrients and organic matter, while carrying away waste material. Just a small loss of water in your body affects these functions, which is why dehydration causes you to experience fatigue, dizziness and headaches. This is tremendously significant when it comes to the efficiency of your children at school as well as for yourself in the workplace. Water is a natural substance with the chemical formula $H_2O$. A water molecule contains one oxygen and two hydrogen atoms connected by covalent bonds. It is a liquid at ambient conditions, but it often co-exists on Earth with its solid state, ice, and gaseous state (water vapor or steam). Water also exists in a liquid crystal state near hydrophilic surfaces. Environment is the representative of physical compounds of earth where in man is important factor influencing the environment. Environment mainly consists of land, water and air, which are necessary for survival of mankind. Water is vital substance on earth which is having unique and multiple properties and bears such a great significance for the existence of flora and fauna. As our health depends upon the quality of water we drink, with this research we have tried to estimate the quality of drinking water which will subsequently aid in bringing awareness among the local people.

Although statistics, the WHO reports that roughly 36% of urban and 65% of pastoral Indian were deprived of access to safe drinking water (Akoto and Adiyiah, 2007). It is even more important for the human being as they depend upon it for food production, industrial and waste disposal, as well as cultural requirement (Akpoveta *et. al.*, 2011). Today, water resources have been most exploited natural systems since man strode the earth. Pollution of water sources is growing gradually due to rapid pollution, development, industrial propagation, urban growth, enhancing living standards and wide spheres of human activities. The consequences of urbanization and industrialization leads to reduction in both quality and quantity of the water, for agricultural purposes ground water is explored in rural areas especially in those areas where other sources of water like dam, river or a canal is not considerable. Ahmedabad is the fast growing city in India and some of the areas of the city are getting affected by heavy contamination of biological waste, solids and chemicals that are responsible for the poor quality of water. Human alteration of the landscape has an extensive influence on watershed hydrology (Gurunathan and Shanmugam, 2006). In the city, people suffer with diseases like Cholera, Typhoid fever, Leptospirosis etc. that states the low quality or unclean water. The amplified demand of water supply has often lead to water that is unfit for human consumption, being inadvertently supplied to your tap. This is often the case in many smaller towns throughout Ahmedabad. Concerns about personal and family health may lead one to question the safety of the water that one is using. With the availability of modern water treatments and equipments, also often with aggressive marketing of these devices, one may wonder about the need to install such equipment in one's home. Nearly all water contains contaminants, even in the absence of nearby pollution-causing actions. Many dissolved minerals, organic carbon compounds, and microorganisms find their way into the drinking water as water comes into contact with air and soil. When pollutants and contaminants levels in drinking water are excessively high, they may affect certain household routines and these can be detrimental to human health. Obvious water problems, such as staining of plumbing faucets and laundry, as well as many objectionable tastes and odors, may be evidence of excessive levels of contaminants in the household water supply.

## II. Materials and Methods

2.1Water sampling techniques

The objective of sampling is to collect a portion of material small enough in volume to be transported conveniently and handled in the laboratory while still accurately presenting the material being sampled. The sampling method used should be the one that gives representative picture of the real stream of the drinking water that is being used for domestic purpose; otherwise the time and effects involved in analysis will be completely wasted. Separate samples must be collected for chemical and biological

analysis since the sampling and preservation techniques are quite different. For accurate analysis it is desirable to allow a short time interval between sampling and analysis.

2.2 Storage/ Container for water sample

The type of sample container used is of at most importance. Container may be of glass or polythene bottles. When physico-chemical analysis was carried out, polythene bottles were used for sampling or storage. And for biological analysis; Water samples were usually collected in a clean, sterile, 300-500 ml glass stoppered or screw cap bottles. After collection of water sample, it should be processed within one hour, in case of delay, the sample should be stored below 10$^{o}$C and must be analyzed and processed within 2-5 hours.

2.3 Sample collection**:** target source was drinking water

Sample of different sites were collected at a particular time and place. After the collection, they were brought immediately to laboratory for analysis to measure the water quality. Below image showed the sampling sites within Ahmedabad city which were selected randomly. Here, the sampling sites were pointed out by using Google earth software to understand sample distribution (Fig-1).

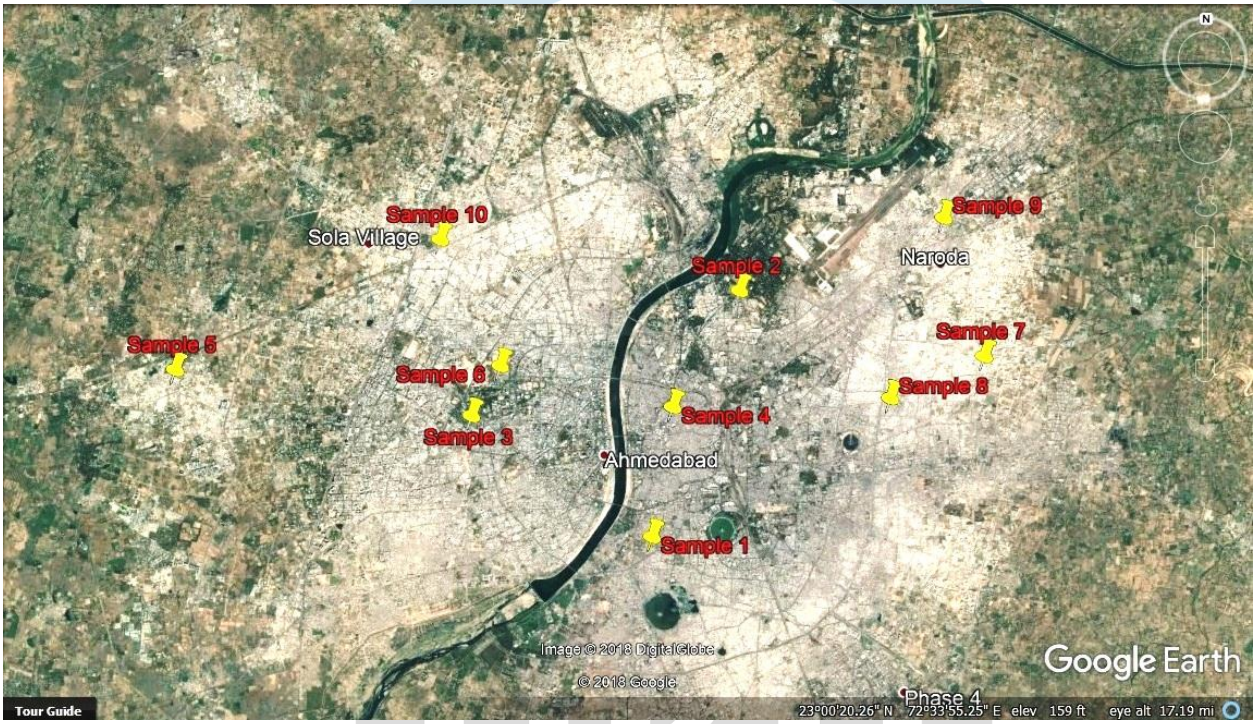



Figure-1: Sample sites within Ahmedabad city

2.4 Assessment of the samples

In physical analysis, Taste (applicable to only water not for waste water), Odour (by smelling), Colour (Platinum-Cobalt Method), Temperature (by thermometer), pH (Electrometric method using pH meter), Hardness (EDTA method) and Total Solids (Gravimetric method) were analysed. While chemical analysis included Chloride (Volhard's method), Dissolved Oxygen (Winkler's method) and Fluoride (Spectrophotometric method) content of the water. In microbiological characterization study, samples were decimally diluted and aliquots plated on nutrient agar media. After incubation at 25 or 30$^{o}$C, for up to 2 days, the colony forming units (CFU) were counted by Standard Plate Count or Total Viable Count method (Rakesh and Kiran, 2006). Aseptic and proper techniques have taken care into the consideration while performing the microbiological tests.

## III. Results and Discussion

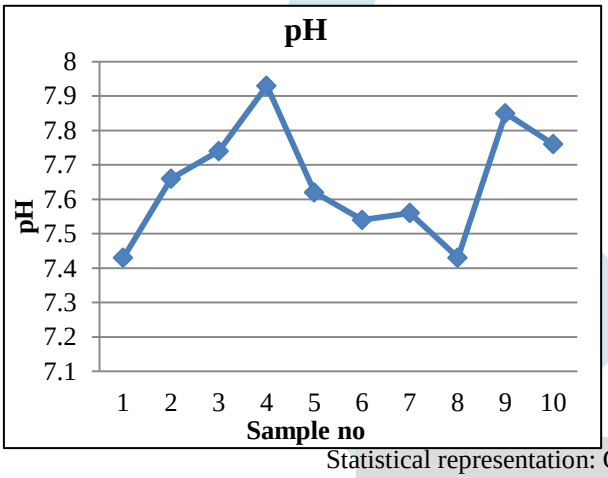
3.1 Physical and Chemical Analysis

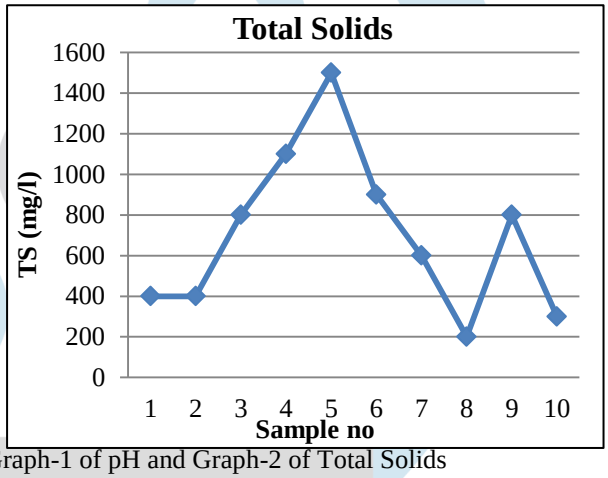
Water samples collected from different areas and analyzed for various Physical and Chemical Characteristics are depicted in results (Table-1 and Table-4). As seen from the data, the Taste, Colour and Odour were agreeable. The pH is a measure of the hydrogen ion concentration in water. Drinking water with a pH in between 6.5 to 8.5 is generally considered satisfactory. Acid water tend to be corrosive to plumbing and faucets, particularly, if the pH is below 6. Alkaline waters are less corrosive; water with a pH above 8.5 may tend to have a biter or soda-like taste. In this study, pH was recorded slightly alkaline range. That was in between the 7.43 to 7.93 and all the water samples analyzed have concentration within the safe limit of 6.5 to 8.5 standards set by the WHO. Thus indicated that the measured pH values of the drinking water samples were within permissible value of WHO; which will not cause any harmful effect to the consumers (Graph-1). Temperature data was also recorded at the time of sampling and that was not showing big differences.

Table-1: Water analysis data table of Physical parameters

| Sample no | Taste | Odour | Colour | pH | Temp.($^oC$) | Total Solids (mg/l) |
|---|---|---|---|---|---|---|
| Sample 1 | Agreeable | Agreeable | Agreeable | 7.43 | 28.0 | 400 |
| Sample 2 | Agreeable | Agreeable | Agreeable | 7.66 | 27.0 | 400 |
| Sample 3 | Agreeable | Agreeable | Agreeable | 7.74 | 28.0 | 800 |
| Sample 4 | Agreeable | Agreeable | Agreeable | 7.93 | 29.0 | 1100 |
| Sample 5 | Agreeable | Agreeable | Agreeable | 7.62 | 26.0 | 1500 |
| Sample 6 | Agreeable | Agreeable | Agreeable | 7.54 | 26.0 | 900 |
| Sample 7 | Agreeable | Agreeable | Agreeable | 7.56 | 27.0 | 600 |
| Sample 8 | Agreeable | Agreeable | Agreeable | 7.43 | 28.0 | 200 |
| Sample 9 | Agreeable | Agreeable | Agreeable | 7.85 | 30.0 | 800 |
| Sample 10 | Agreeable | Agreeable | Agreeable | 7.76 | 29.0 | 300 |

Total Solids (TS) values of water samples were ranging from 200.00 to 1500.00 mg/l. According to the WHO guide line, permissible limit is 500 mg/l. Sampling site 1, site 2, site 8 and site 10 were in the WHO limits while other sample showed higher values of total solids which was very near to maximum permissible limits of WHO (Graph-2). In Physical analysis, all the parameters were in acceptable limits but the TS values were near the maximum limits.



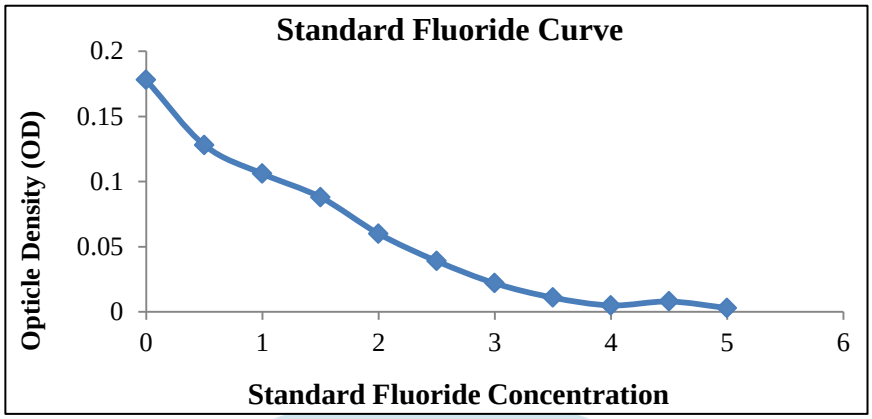




Statistical representation: Graph-1 of pH and Graph-2 of Total Solids

Following Table-2 shows the optical density for standard Fluoride solution that were recorded and plotted in the graph which is called standard Fluoride curve (Graph-3). Now, optical densities for all the water samples were recorded (Table-3) and plotted on this standard curve. Fluoride content of the samples was noted on the basis of this standard curve.

Table-2: Optical Density (OD) of standard Fluoride Solution

| NO. | Standard Fluoride Solution | OD |
|---|---|---|
| **1** | 0.0 | 0.178 |
| **2** | 0.5 | 0.128 |
| **3** | 1.0 | 0.106 |
| **4** | 1.5 | 0.088 |
| **5** | 2.0 | 0.060 |
| **6** | 2.5 | 0.039 |
| **7** | 3.0 | 0.022 |
| **8** | 3.5 | 0.011 |
| **9** | 4.0 | 0.005 |
| **10** | 4.5 | 0.008 |
| **11** | 5.0 | 0.003 |




Graph-3: Standard Fluoride Curve of the water sources in the study area

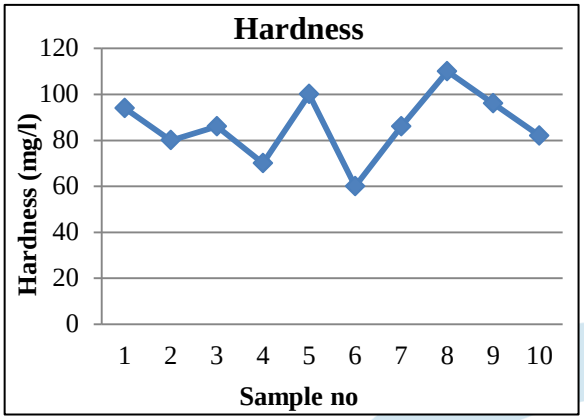
Table-3: Optical Density (OD) for Fluoride for Samples

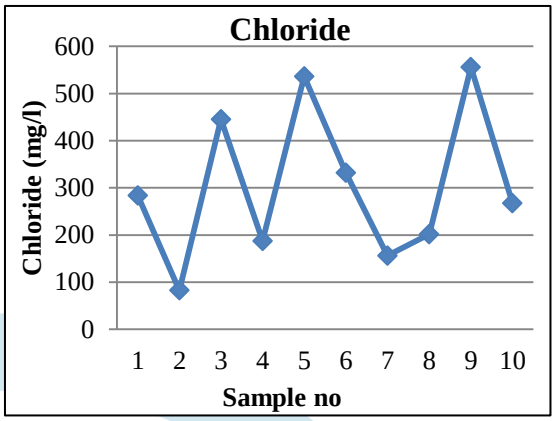
| Sample no | OD |
|---|---|
| Sample 1 | 0.166 |
| Sample 2 | 0.173 |
| Sample 3 | 0.142 |
| Sample 4 | 0.176 |
| Sample 5 | 0.163 |
| Sample 6 | 0.147 |
| Sample 7 | 0.124 |
| Sample 8 | 0.174 |
| Sample 9 | 0.133 |
| Sample 10 | 0.166 |

Table-4: Water analysis data table of Chemical parameters

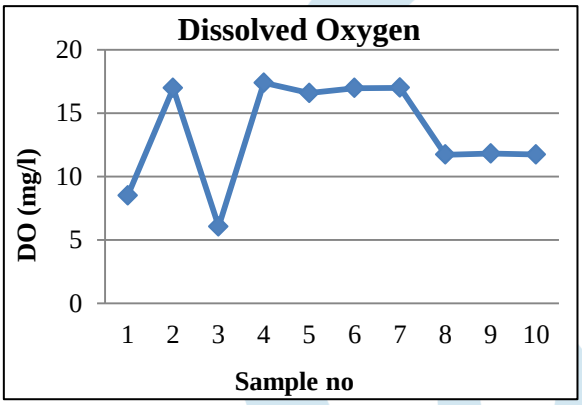
| Sample no | Hardness (mg/l) | Chloride (mg/l) | DO (mg/l) | Fluoride (mg/l) |
|---|---|---|---|---|
| Sample 1 | 94 | 283.656 | 8.505 | 0.25 |
| Sample 2 | 80 | 82.260 | 16.984 | 0.15 |
| Sample 3 | 86 | 445.340 | 6.067 | 0.65 |
| Sample 4 | 70 | 187.219 | 17.393 | 0.07 |
| Sample 5 | 100 | 536.110 | 16.584 | 0.30 |
| Sample 6 | 60 | 331.878 | 16.984 | 0.60 |
| Sample 7 | 86 | 156.011 | 17.009 | 0.90 |
| Sample 8 | 110 | 201.395 | 11.727 | 0.15 |
| Sample 9 | 96 | 555.966 | 11.819 | 0.85 |
| Sample 10 | 82 | 266.925 | 11.745 | 0.25 |

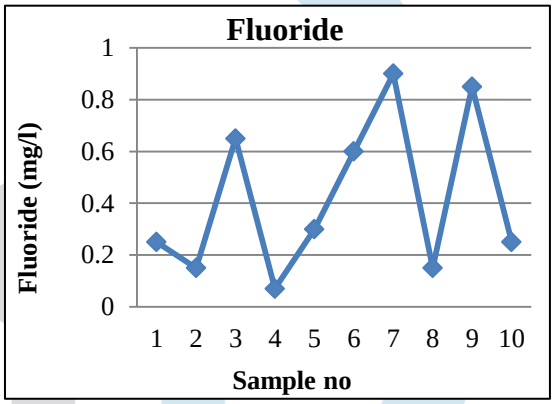
In groundwater hardness is mainly contributed by bicarbonates, carbonates, sulphates and chlorides of calcium and magnesium. So, the principal hardness causing ions are calcium and magnesium. The acceptable limit of total hardness is 300 mg/l whereas the maximum limit is 600 mg/l. The hardness of analyzed water samples varied from 60.00 to 110.00 mg/l as $CaCO_3$ (Graph-4). The highest value of total hardness was observed at sample 8 site while lowest in sample 6. On the basis of BIS (300 mg/l) and WHO (500 mg/l) standards, all the measured values were within the acceptable limit. The concentration of chloride is the indicator of sewage pollution and also imparts laxative effect. Atmospheric sources or sea water contamination is reason for bulk of the chloride concentration in groundwater which may exceed due to base-exchange phenomena, high temperature, domestic effluents, septic tanks and low rainfall (Venkateswara, 2011). Porosity soil and permeability also plays a key role in building up the chlorides concentration (Chanda, 1999). The chloride content of studied water samples were within permissible limit of 250 mg/l prescribed by (Arghyam, 1991). In present study, the results of chlorides in all sampling sites ranged from 82.260 to 555.966 mg/l. The chloride level recorded in sample 2,4,7,8 and 10 sampling sites were within the drinking water quality of WHO (250 mg/l) whereas rest of the sample showed higher chloride but it was within the maximum limit of BIS which is 1000 mg/l (Graph-5). Dissolved oxygen was recorded low in sample 3 and 1 while high in sample 4 followed by 7, 6 and 2 (Graph-6). It was due to the ground water contamination that will not affect the health of consumer. Fluoride value was ranged between 0.07 to 0.90 mh/l, that was in permissible limit according to WHO standards which is 1.5 mg/l (Graph-7).




Statistical representation: Graph-4 of Hardness and Graph-5 of Chloride




Statistical representation: Graph-6 of Dissolved Oxygen and Graph-7 of Fluoride

Table-5: Standard Plate Count (SPC) results

| Sample no | Colonies per 0.5 ml inoculation from: | | |
|---|---|---|---|
| | Dilution $10^{-1}$ | Dilution $10^{-2}$ | Dilution $10^{-3}$ |
| Sample 1 | 30 | 19 | 18 |
| Sample 2 | 24 | 13 | 10 |
| Sample 3 | 23 | 15 | 6 |
| Sample 4 | 26 | 19 | 7 |
| Sample 5 | 8 | 5 | 4 |
| Sample 6 | 29 | 22 | 16 |
| Sample 7 | 27 | 23 | 18 |
| Sample 8 | 22 | 19 | 14 |
| Sample 9 | 17 | 9 | 3 |
| Sample 10 | 25 | 12 | 6 |

3.2 Microbial Analysis

There were less than 30 colonies counted which indicated standard plate count of microorganism was safe for water sample (Table-5). And in the presumptive test all the test were negative. Total number of bacteria will be extensively high in the tap water that could be due to growth of microorganism in the collection tank. However, microbiological analysis was not showing any statistical value of data. That might be due to the Chlorination of water or Chlorine present in water. Because of that, Chlorine does not allow the growth of the microbiological growth. That might be the reason in microbial test. Hence, there is no growth of organisms on N-agar plate in SPC.

3.3 Statistical summary

Table-6: Statistical summary of Physico-chemical analysis data for Ahmedabad city

| Sr no | Parameter | Descriptive Statistics | | | | |
|---|---|---|---|---|---|---|
| | | Number of samples | Maximum value | Minimum value | Mean | Std. Deviation |
| 1 | pH | 10 | 7.930 | 7.430 | 7.652 | 0.1688 |
| 2 | Temperature | 10 | 30.000 | 26.000 | 27.800 | 1.3166 |
| 3 | Hardness | 10 | 110.000 | 60.000 | 86.400 | 14.5999 |
| 4 | Total Solids | 10 | 1500.000 | 200.000 | 700.000 | 402.7682 |
| 5 | Chloride | 10 | 555.966 | 82.260 | 304.676 | 161.6357 |
| 6 | Dissolved Oxygen | 10 | 17.009 | 6.067 | 13.482 | 4.0893 |
| 7 | Fluoride | 10 | 0.900 | 0.070 | 0.417 | 0.3057 |

In the overall statistics of Physico-Chemical water analysis of Ahmedabad city (Table-6), all the parameters were in the acceptable range according to the WHO standards. The pH varies in 7.43 to 7.93 and average pH was 7.652 with 0.1688 std. deviation. At the time of sample collection, temperature was not high. Mean Hardness value was 86.400 mg/l and difference between observed value and the mean was 14.5999. Average value of Total Solids was 700.00 mg/l and 402.7682 std. deviation. In chemical parameter, mean Chloride content was 304.676±161.6357, DO was 13.482±4.0893 and Fluoride was 0.417±0.3057. Comparison of all data given in the table above in results, ensures that the water of all 10 sites were safe to drink as according to the WHO. There were some differences in TS, Chloride, Hardness and Fluoride but all these were in maximum permissible limits. Moreover, there were not harmful Coliforms in the water. So, it also permitted the potability of water.
So, all the sample sites of water were safe to drink in Ahmedabad city.

## IV. Conclusion

From the research work of the Ahmedabad city, it had been proved that the water of the Ahmedabad city was not bad. In addition, the municipal water supply for drinking purpose from the Narmada water or Bore well water was good. Physical parameter and chemical parameter both were in the normal range according to the WHO (World Health Organization, 2006) standards. So, it had been proved that the water was not hard and not contain the excess Fluorine. And the microbial analysis concluded that the water was potable for drinking purpose. The bacterial count were not high that might be due to the chlorination of water which was for the drinking purpose. In short, the water quality of Ahmedabad city was good enough and safe to drink and was not harmful for other human use.

## V. Acknowledgments

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