# AN ANALYSIS OF DRINKING WATER QUALITY, SELECTED DELINEATING WATER SOURCES OF KOZHIKODE CORPORATION, KERALA

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*Abstract*
*Water quality refers to the chemical physical and biological characteristics of water. It is measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose. Kozhikode Corporation located in northern part of Kerala. The area is between $11^0$ 15' 35'' north to $75^0$ 56' 55'' east. The paper aims to classify both biological status and chemical status of water. Both primary and secondary data are used for the fulfilment of this paper. Primary data are collected by water sampling and survey method. Secondary data are collected from various Govt. departments. By analysing the data and then find out the quality of water with the help of diagrams and thematic map using GIS. Investigator also tries to identify the areas where the waterborne diseases are occurred.*

*Keywords: Chemical, biological, water sampling, GIS.*

## Introduction

Water is odorless, tasteless, transparent liquid that is colorless in small amount but exhibits a blush tinge in large quantity. It is the most familiar and abundant in liquid on the earth. It is solid form (ice) and liquid form it covers about 70% of the earth surface. Clean, safe and adequate fresh water is vital to the survival of all organisms and the smooth functioning of ecosystem, communities and economies. Drinking water quality standards describe the quality parameters set for drinking water. Delimiting water quality has become a global issue of concern as human population grow, industrial and agriculture activity expands and climate change threatens to cause major alterations to the hydrological cycle. In recent time the deterioration of the water quality in the surface water bodies due to anthropogenic activities like rapid urbanization and increased agriculture runoff has become a world wide problem. This has resulted in the dicers in the quality of drinking water available. Basically the quality of water is described according to its physical, chemical and biological parameters."Water quality" is a term used here to express the suitability of water to sustain various uses or processes. The quality of water may be described in terms of the concentration and state (dissolved or particulate) of some or all of the organic and inorganic material present in the water, together with certain physical characteristics of the water The complexity of water quality as a subject is reflected in the many types of measurements of water quality indicators. The most accurate measurements of water quality are made on-site, because water exists in equilibrium with its surroundings. Measurements commonly made on-site and in direct contact with the water source in question include temperature, pH, dissolved oxygen, conductivity, oxygen reduction potential (ORP), turbidity, and depth. Biological indicators of water quality include algae and phytoplankton. These parameters are relevant not only to surface water studies of the ocean, lakes and rivers, but to groundwater and industrial processes as well. Biological water characteristics are used to describe the presence of microbiological organisms and water-borne pathogens. Many organisms can cause illness when consumed by humans and animals. Micro-organisms and waterborne

pathogens enter rivers and lakes either naturally or via the release of untreated or partially treated sewage.

Water and water quality is very important element for human health. Water quality is determined by comparing the physical, chemical and biological characteristics of water sample with water quality guidelines or standards. Drinking water with an elevated pH above 11 can cause skin, eye and mucous membrane irritation. On the opposite end of the scale, pH values below 4 also cause irritation due to the corrosive effects of low pH levels. In general, sodium salts are not acutely toxic because of the efficiency with which mature kidneys excrete sodium. Water contaminated with iron and manganese often contains iron or manganese bacteria. These bacteria feed on the minerals in the water. They do not cause health problems, but do form a reddish brown (iron) or brownish-black (manganese) slime in toilet tanks and can clog water systems. Chronic iron overload results primarily from a genetic disorder (haemochromatosis) characterized by increased iron absorption and from diseases that require frequent transfusions. Nitrates and nitrites are because several health issues such as vitamin A shortage decreased the functioning of the thyroid gland. The United States Environmental Protection Agency (EPA) has determined that the presence of total coli forms is a possible health concern. Total Coli forms are common in the environment and are generally not harmful themselves. The presence of these bacteria in drinking water, however, generally is a result of a problem with water treatment or the pipes which distribute the water, and indicates that the water may be contaminated with organisms that can cause disease. Disease symptoms may include diarrhea, cramps, nausea, and possibly jaundice, and any associated headaches and fatigue. These symptoms, however, are not just associated with disease-causing organisms in drinking water, but also may be caused by a number of factors other than your drinking water. EPA and the state have set an enforceable drinking water standard for total coli forms to reduce the risk of these adverse health effects. Under this standard, no more than 5.0 percent of the samples collected during a month can contain these bacteria, except that systems collecting fewer than 40 samples/month that have one total coli form-positive sample per month are not violating the standard. Drinking water which meets this standard is usually not associated with a health risk from disease-causing bacteria and should be considered safe. The United States Environmental Protection Agency (EPA) has determined that the presence of fecal coli forms or E. coli is generally not harmful themselves, but their presence in drinking water is serious because they are usually associated with sewage or animal wastes. EPA and the state have set an enforceable drinking water standard for fecal coli forms and E. coli to reduce the risk of these adverse health effects. Under this standard all drinking water samples must be free of these bacteria. Drinking water which meets this standard is associated with little or none of this risk and should be considered safe.

## Study area

Kozhikode is a city in the state of Kerala in southern India on Malabar Coast. Kozhikode Corporation established in 1866. The area is between 11 15 35 north 75 56 55 east. It is bordered by Chemanjeri, Thalakkulathur, Kakkodi, and KuruvatturPanchayat in the north by Kunamangalam Perumanna and Olavanna panchayat in the East and kadalundi and ferok Panchayat in northern side. The total geographical area is 128.312 sq. km. The city is about 450 km far from the capital of Kerala. Location of the study area is given Fig.1.
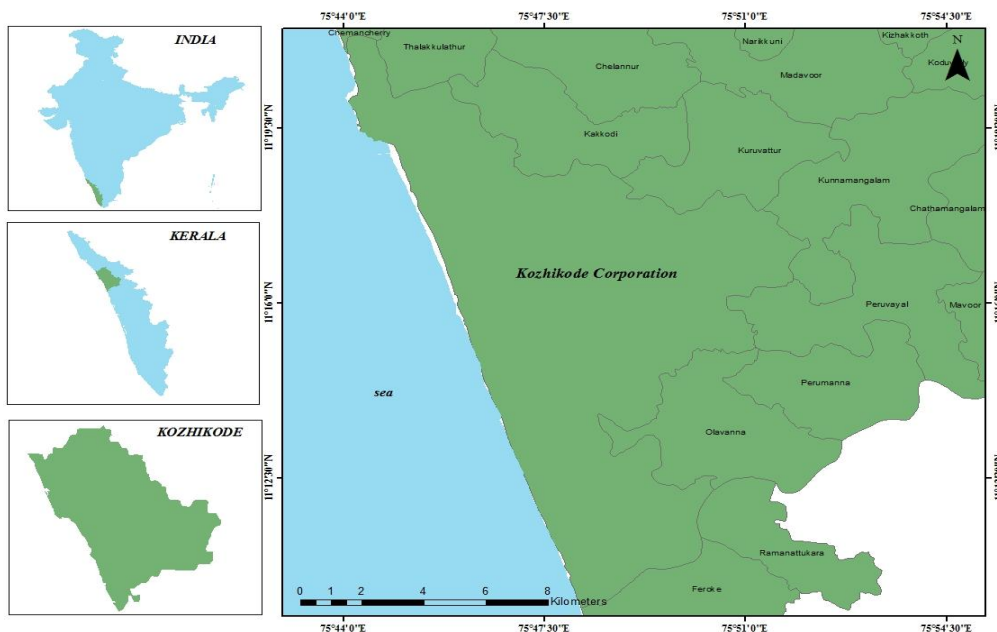
Figure 1. Location Map of the study area

Table 1. Water sampling stations of Kozhikode Corporation

| SAMPLE | LOCATION | SAMPLE STATION |
|--------|----------|----------------|
| WELL 1 | N 11 20.754'- E 75 44.408' | Elathur |
| WELL 2 | N 11 20.338'- E 75 44.675' | Chettikkulam |
| WELL 3 | N 11 19.462'- E 75 44.301' | Puthiyappa |
| WELL 4 | N 11 20.063'- E 75 45.098' | Eranjikkal |
| WELL 5 | N 11 19.353' – E 75 46.501' | Mokavoor |
| WELL 6 | N 11 19.094' – E 75 45.628' | Puthur |
| WELL 7 | N 11 18.72' – E 75, 45.639' | East Pavagad |
| WELL 8 | N 11 18.476' – E 75 46.941' | Kolakkattuvayal |
| WELL 9 | N 11 17.713' – E 75 47.348 | Karuvassery |
| WELL 10 | N 11 18.602'- E 75 47.810' | Vegeri |
| WELL 11 | N 11 17.905' – E 75 48.112' | Thadambattuthazham |
| WELL 12 | N 11 17.890' – E 75 50.044' | Moozhikkal |
| WELL 13 | N 11 17.533'- E 75 50.205' | Chilavoor |
| WELL 14 | N 11 18.152' – E 75 49.318' | Poolakkadavu |
| WELL 15 | N 11 14.880' – E 75 48.541' | Kommeri |
| WELL 16 | N 11 14.554' – E 75 48.943' | Kuttiyilthazham |
| WELL 17 | N 11 16.044' – E 75 49.123' | Nellikkode |
| WELL 18 | N 11 15.347'- E 75 49.052' | Pottammal |
| WELL 19 | N 11 12.242' – E 75 48.301' | Arakkinar |

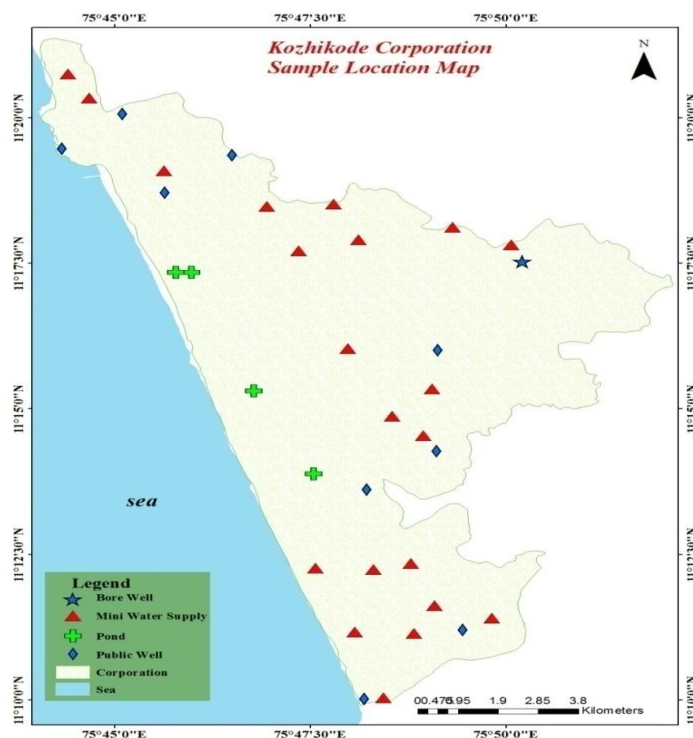| WELL 20 | N 1109.878' – E 75 48.250' | Beypore |
|---------|---------------------------|---------|
| WELL 21 | N 11 10.041' – E 75 48.427' | Beypore port |
| WELL 22 | N 11 11.149' – E 75 48.824' | Kizhakkumpadam |
| WELL 23 | N 11 11.203' – E 75 49.443' | Cheruvannur East |
| WELL 24 | N  11 11.410'- E 75 49.088' | Cheruvannur west |
| WELL 25 | N  11  11.625' – E 75 49.088' | Kudaithodu |
| WELL 26 | N  11 12.345' – E 75 48.065' | Kolathara |
| WELL 27 | N 11 11.173' – E 75 48.065' | Naduvattam |
| WELL 28 | N 11 12.271' – E 75 47.567' | Manthottam |
| WELL 29 | N 11 13.610' – E 75 48.219' | Nellikkode |
| WELL 30 | N 11 14.272' – E 75 49.109' | Pottammal |
| WELL 31 | N 11 16.037' – E 75 47.973' | Pottammal |
| POND 1 | N 11 17.344' – E 75 45.981' | Garudankulam |
| POND 2 | N 11 17.341' – E 75 45.785' | Thamarakkulam |
| POND 3 | N 11 15.309' – E 75 46.773' | Manachira |
| POND 4 | N 11 13.883' – E 75 47.539' | Neelichira |



Figure  2.  Location of map of samples

## Materials and methods

The study area is Kozhikode Corporation in Kerala. Primary data regarding water quality was collected by using sampling method and chemical and biological analysis of water. Secondary data collected from census report Govt. departments and literature review.

Primary data: The water source of Kozhikode Corporation divided in to surface water and ground water. Surface water includes ponds and rivers. And ground water includes wells. 31 samples from public well and 4 samples from ponds are taken from the study area. Location of samples is given Fig.2.The collected samples were analyzed for chemical parameters namely PH, TDS, EC, Salinity, TH, CaH, TA, Chloride, Sulphate, Nitrate, Sodium, Potassium, Phosphorous, Iron, Magnesium and Calcium. The procedure used for chemical analysis was American Public Health Association (APHA) used. For analyzing microbiological aspects namely total coli form, faucal coli form, E-coli MPN method was used. Arc GIS software was used to prepare location map, land use map, geomorphology map, and drainage map.

## Physico-Chemical And Bacteriological Charactoristics Of Groundwater Sample

Table 2. Physico-chemical characteristics of groundwater samples of Kozhikode Corporation

| Water quality parameters | Sample number | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Ph | 7.75 | 5.54 | 7.24 | 6.00 | 4.75 | 5.69 | 6.22 | 6.24 |
| TDS mg/l | 283.0 | 86.30 | 934.0 | 86.50 | 299.0 | 161.0 | 138.0 | 93.30 |
| EC, µS/cm | 399.0 | 121.50 | 1316.0 | 122.20 | 422.0 | 227.0 | 193.0 | 131.50 |
| Salinity(ppt) | 171.0 | 55.70 | 577.0 | 56.10 | 180.0 | 98.60 | 85.20 | 59.60 |
| Sulphate mg/l | 13.0 | 5.84 | 40.08 | 5.28 | 3.80 | 13.88 | 13.28 | 5.56 |
| Sodium mg/l | 14.72 | 12.82 | 28.14 | 11.45 | 36.08 | 23.74 | 18.42 | 12.74 |
| Potassium mg/l | 6.36 | 0.82 | 4.66 | 0.64 | 0.86 | 2.68 | 0.77 | 1.37 |
| Nitrate –N, mg/l | 2.32 | 1.20 | 6.74 | 0.90 | 6.73 | 3.37 | 1.58 | 1.26 |
| Phosphate-P,(mg/l) | 0.05 | BDL | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Iron mg/l | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.01 | 0.01 | 0.11 |
| Total Hardness mg/l | 240.0 | 28.0 | 360.0 | 36.0 | 40.0 | 56.0 | 44.0 | 28.0 |
| Calcium Hardness mg/l | 124.00 | 20.00 | 96.00 | 28.00 | 28.00 | 52.00 | 32.00 | 20.00 |
| Chloride mg/l | 42.73 | 27.19 | 240.87 | 194.20 | 66.04 | 38.85 | 34.96 | 23.31 |
| Total Alkalinity mg/l | 129.0 | 16.10 | 185.80 | 36.30 | 12.10 | 12.10 | 40.40 | 24.20 |
| Magnesium  mg/l | 28.18 | 1.94 | 64.15 | 1.94 | 2.91 | 0.97 | 2.91 | 1.94 |
| Calcium mg/l | 49.60 | 8.00 | 38.40 | 11.20 | 11.20 | 20.80 | 12.80 | 8.0 |
| Total Coliform,MPN/100ml | 240 | 21 | 72400 | 7240 | 7240 | 7240 | 7240 | 460 |
| Faecal Coliform, MPN/100ml | 240 | 7 | 1100 | 240 | 93 | 460 | 1100 | 75 |
| E-Coli | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |

Table 4. Physico-chemical characteristics of water samples of Kozhikode Corporatio

| Water quality parameters | Sample number | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| pH | 5.84 | 6.96 | 6.06 | 7.11 | 6.48 | 5.81 | 6.10 | 6.40 |
| TDS mg/l | 80.40 | 183.0 | 295.0 | 435.0 | 282.0 | 187.0 | 91.30 | 202.0 |
| EC, µS/cm | 112.70 | 258.0 | 415.0 | 612.0 | 397.0 | 263.0 | 128.0 | 285.0 |
| Salinity(ppt) | 52.50 | 111.0 | 178.0 | 263.0 | 170.0 | 113.0 | 58.70 | 123.0 |
| Sulphate mg/l | 1.12 | 10.88 | 38.04 | 311.82 | 19.24 | 31.0 | 1.96 | 20.0 |
| Sodium mg/l | 13.70 | 24.31 | 39.84 | 44.70 | 38.20 | 28.10 | 14.80 | 15.0 |
| Potassium mg/l | 1.27 | 5.11 | 7.04 | 10.88 | 3.62 | 3.11 | 1.33 | 5.90 |
| Nitrate –N, mg/l | 4.48 | 1.76 | 5.20 | 4.79 | 2.52 | 1.32 | 4.35 | 1.20 |
| Phosphate-P,(mg/l) | 0.01 | 0.01 | 0.02 | 0.03 | 0.22 | 0.02 | 0.01 | 0.01 |
| Iron mg/l | 0.04 | 0.02 | 0.03 | 0.02 | 0.04 | 0.06 | 0.02 | 0.10 |
| Total Hardness mg/l | 60.0 | 96.0 | 176.0 | 92.0 | 36.0 | 20.0 | 84.0 | 84.0 |
| Calcium Hardness mg/l | 12.0 | 48.0 | 72.0 | 148.0 | 64.0 | 20.0 | 8.0 | 60.0 |
| Chloride mg/l | 19.40 | 34.90 | 50.50 | 58.20 | 66.00 | 38.80 | 27.10 | 34.0 |
| Total Alkalinity mg/l | 4.04 | 52.50 | 48.80 | 149.40 | 56.50 | 16.10 | 12.10 | 60.0 |
| Magnesium  mg/l | 2.92 | 2.92 | 5.82 | 6.80 | 6.80 | 3.88 | 2.91 | 5.50 |
| Calcium mg/l | 4.80 | 19.20 | 28.80 | 59.60 | 25.60 | 8.0 | 3.20 | 24.0 |
| Total Coliform,MPN/100ml | 11 | 724 | 724 | 724 | 724 | 110 | 23 | 28 |
| Faecal Coliform, MPN/100ml | 11 | 11 | 110 | 460 | 240 | 110 | 7 | 7 |
| E-Coli | Absent | Absent | Present | AAbsent | Absent | Present | Absent | Absent |

Table 3. Physio-chemical characteristics of water samples of Kozhikode Corporation

| Water quality parameters | Sample number | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| pH | 7.04 | 6.54 | 6.78 | 7.06 | 7.54 | 7.38 | 6.96 | 5.73 |
| TDS mg/l | 124.0 | 64.30 | 180.0 | 38.0 | 227.0 | 37.90 | 59.20 | 199.0 |
| EC, µS/cm | 174.0 | 90.60 | 253.0 | 53.60 | 322.0 | 53.60 | 83.50 | 280.0 |
| Salinity(ppt) | 77.30 | 43.60 | 109.0 | 20.60 | 138.0 | 29.50 | 40.90 | 120.0 |
| Sulphate mg/l | 5.96 | 4.04 | 13.52 | 2.80 | 9.92 | 3.16 | 4.56 | 4.0 |
| Sodium mg/l | 12.73 | 9.31 | 14.96 | 4.83 | 24.60 | 6.08 | 10.80 | 3.64 |
| Potassium mg/l | 0.97 | 0.80 | 3.50 | 0.42 | 3.67 | 0.72 | 1.26 | 0.24 |
| Nitrate –N, mg/l | 0.77 | 0.62 | 0.31 | 0.51 | BDL | 0.46 | 0.20 | 6.09 |
| Phosphate-P,(mg/l) | 0.01 | 0.01 | 0.01 | 0.01 | 0.03 | 0.01 | 0.04 | 0.01 |
| Iron mg/l | 0.02 | 0.11 | 0.02 | 0.03 | 0.02 | 0.01 | 0.03 | 0.01 |
| Total Hardness mg/l | 48.0 | 20.0 | 72.0 | 16.0 | 92.0 | 12.0 | 44.0 | 24.0 |
| Calcium Hardness mg/l | 46.0 | 12.0 | 60.0 | 12.0 | 44.0 | 10.0 | 10.0 | 28.0 |
| Chloride mg/l | 23.31 | 23.30 | 23.30 | 7.77 | 15.50 | 11.60 | 15.50 | 46.60 |
| Total Alkalinity mg/l | 80.80 | 16.10 | 92.90 | 16.60 | 137.00 | 76.70 | 24.20 | 16.10 |
| Magnesium  mg/l | 0.48 | 1.94 | 2.91 | 0.97 | 11.60 | 0.48 | 0.48 | 3.88 |
| Calcium mg/l | 18.84 | 4.80 | 24.0 | 4.80 | 176.0 | 4.0 | 4.0 | 11.20 |
| Total Coliform,MPN/100ml | 7240 | 4 | 7240 | 112 | 3 | 724 | 112 | 21 |
| Faecal Coliform, MPN/100ml | 43 | 3 | 460 | 64 | 0 | 120 | 120 | 9 |
| E-Coli | Absent | Absent | Absent | Present | Absent | Present | Absent | Absent |

BDL: Below Detection Limit

Table 5.  Physico-chemical characteristicsof water samples of Kozhikode Corporation

| Water quality parameters | Sample number | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| pH | 5.80 | 6.10 | 6.20 | 6.60 | 6.93 | 6.92 | 6.20 | 7.77 |
| TDS. mg/l | 428.0 | 234.0 | 215.0 | 360.0 | 359.0 | 158.0 | 169.0 | 95.0 |
| EC, μS/cm | 606.0 | 303.0 | 304.0 | 506.0 | 508.0 | 224.0 | 239.0 | 134.0 |
| Salinity(ppt) | 259.0 | 141.0 | 130.0 | 217.0 | 217.0 | 96.60 | 103.0 | 60.70 |
| Sulphate, mg/l | 27.0 | 46.0 | 30.90 | 43.20 | 21.60 | 33.60 | 9.68 | 5.60 |
| Sodium mg/l | 71.0 | 18.0 | 19.50 | 32.70 | 38.60 | 7.28 | 19.26 | 6.19 |
| Potassium mg/l | 2.20 | 6.10 | 1.07 | 8.13 | 11.80 | 1.61 | 1.77 | 0.33 |
| Nitrate –N, mg/l | 6.20 | 3.50 | 3.93 | 6.32 | 3.46 | 0.86 | 3.89 | 0.38 |
| Phosphate-P,(mg/l) | 0.01 | 0.03 | 0.01 | 0.02 | 0.02 | 0.02 | 0.04 | BDL |
| Iron mg/l | 0.10 | 0.08 | 0.09 | 0.01 | 0.01 | 0.18 | 0.05 | 0.01 |
| TH mg/l | 96.0 | 88.0 | 72.0 | 132.0 | 120.0 | 80.0 | 80.0 | 40.0 |
| Calcium Hardness mg/l | 48.0 | 68.0 | 48.0 | 116.0 | 92.0 | 64.0 | 36.0 | 40.0 |
| Chloride mg/l | 128.0 | 23.0 | 34.0 | 54.0 | 77.70 | 34.90 | 15.54 | 27.19 |
| Total Alkalinity mg/l | 16.0 | 44.0 | 36.30 | 60.60 | 109.0 | 44.44 | 40.40 | 48.48 |
| Magnesium  mg/l | 11.00 | 4.80 | 5.80 | 3.88 | 6.80 | 3.40 | 10.69 | 0.97 |
| Calcium mg/l | 19.00 | 27.0 | 19.20 | 46.40 | 36.80 | 25.60 | 14.40 | 16.0 |
| Total Coliform,MPN/100ml | 21 | 724 | 724 | 724 | 724 | 724 | 724 | 724 |
| Faecal       Coliform, MPN/100ml | 11 | 21 | 110 | 460 | 1100 | 1100 | 460 | 240 |
| E-Coli | Absent | Absent | Absent | Absent | Present | Absent | Absent | Absent |

BDL: Below Detection Limit

Table 6. Physico-chemical characteristics of grounwater samples of Kozhikode Corporation

| Water quality parameters | Sample number | | |
|---|---|---|---|
| | 33 | 34 | 35 |
| pH | 8.68 | 8.83 | 7.62 |
| TDS mg/l | 159.0 | 49.30 | 267.0 |
| EC, μS/cm | 226.0 | 69.40 | 37.60 |
| Salinity(ppt) | 97.10 | 36.0 | 171.0 |
| Sulphate mg/l | 13.88 | 4.64 | 35.20 |
| Sodium mg/l | 11.80 | 13.53 | 25.30 |
| Potassium mg/l | 2.11 | 1.11 | 2.24 |
| Nitrate –N, mg/l | 0.14 | 0.16 | 4.48 |
| Phosphate-P,(mg/l) | 0.03 | 0.04 | 0.05 |
| Iron mg/l | 0.11 | 0.05 | 0.02 |
| Total Hardness mg/l | 56.0 | 12.0 | 84.0 |
| Calcium Hardness mg/l | 56.0 | 12.0 | 84.0 |
| Chloride mg/l | 11.65 | 15.54 | 38.80 |
| Total Alkalinity mg/l | 60.60 | 36.36 | 64.60 |
| Magnesium  mg/l | 2.91 | 2.91 | 2.91 |
| Calcium mg/l | 2.40 | 4.80 | 33.60 |
| Total Coliform,MPN/100ml | 110 | 43 | 724 |
| Faecal Coliform, MPN/100ml | 1100 | 7 | 64 |
| E-Coli | Absent | Present | Absent |

Sample 1 is taken from Elathur in Kozhikode Corporation. In this sample the chemical parameters are normal and bacteriological contamination is very low. Elathur region depend on this public well for drinking and other purpose. Sample 2 is drawn from chetikulam ward of Kozhikode Corporation. This public well is located in parammel region. The pH level of this water is 5.54 and other chemical parameters are lies in normal range. Biological contamination is very low in this well. Sample 3 is from puthiyappa region. This well located in a colony. TDS is very high in this water. And the level of Magnesium is higher than the level of Calsium.The people mainly depend this well for their daily purpose. Bacteriological contamination is very high in this well due to the presence of human waste and animal waste entered through different channels.  So total coliform and faecal coliform are very high in this sample.  Sample 4 is taken from Cherukadu in Eranjikkal ward. This well is located in the border of Kozhikode Corporation. The total coliform is present in this well and faecal coliform is very low. There is no presence of E-coli. Sample 5 is taken from mokavoor ward. pH level of the sample is low compared to its minimum range.  Other chemical parameters are in normal range. Presence of total coliform is identified in this sample and faecal coliform is very low level. Sample 6 is taken from Kizhvalathuthazham in puthur ward of Kozhikode Corporation. Chemical parameters of water are normal and the presence of total coliform and fecal coliform in this water. Sample 7 is taken from puthiyappa in East Pavagad. Biological contaminations such as total coliform and faecal coliform are identified in this water sample. Other chemical parameters are in normal range. Sample 8 is taken from Parambathu. The well is used as a mini water supply scheme project of the Kozhikode Corporation.  Total coliform are identified in this water sample and very small amount of fecal coliform are also identified. But the levels of these two parameters are not harmful for the human health. Other chemical parameters are normal in range. Sample 9 is taken from karuvassey. This is a mini drinking water supply. Chemical and bacteriological parameter of this water sample is normal. Sample 10 is drawn from Thannerpandhal in Vegery ward. The quality of water is very high in this sample because chemical and bacteriological contamination is in normal range.  Sample 11 is taken from Thadambattuthazham region. The chemical parameters are normal in this water sample. But the presence of biological contamination such as total coliform and faecal coliform are in this water sample. Sample 12 is taken from Moozhikkal. Medical college treatment plan is located in this region. In this water sample, chemical parameters are normal in range. Bacteriological parameters such as total coliforms and E coli are found in this sample. This is the only water source for the medical college and its surroundings. Presence of E coli in this sample is very harmful for human health. The people of this region used this source of water. Sample 13 is taken from Chilavoor.  The chemical and bacteriological parameters are normal in this region. So the quality of water is very high. Sample 14 is taken from Poolakkaavu. This is a public well. Chemical parameters are normal in this water sample. Total coliform, fecal coliform and E.coli presence are present in this sample. Sample 15 is taken from Kommery.  Chemical parameters are normal in nature. Total coliform and faecal coliform are present in this water sample. Sample 16 is taken from Kuttiyilthazham. Chemical parameters and bacteriological parameters are normal in nature. Sample 17 is taken from Nellikkode. This is a colony region. The people of this region mainly depend on this well for their purpose. Chemical parameters and biological parameters are normal in this well. Because they always keep this well very clean. Sample 18 is taken from Pottammal region. Total coliform are present in this water sample. Sample 19 is taken from Arakkinar. This is a mini water supply project of Kozhikode Corporation, named as Chakkaarikad mini water supply. Chemical parameters are normal. Bacteriological contamination is very high. Total coliform, faecal coliform and E.coli are present in this water sample. This well is located very near to aganavdi. The

contributors of bacteriological contaminators in a small quantity are from the human waste disposal of anganvadi. Sample 20 is taken from Beypore.

Table 7. Health zones of Kozhikode Corporation

| SL NO | Health zone |
|-------|-------------|
| 1 | West hill |
| 2 | Vellayil |
| 3 | New busstand |
| 4 | Karaparmbu |
| 5 | Vellimadukkunnu |
| 6 | Palayam |
| 7 | Francis road |
| 8 | Civil station |
| 9 | Kaloor road |
| 10 | Panniyankara |
| 11 | Mankavu |
| 12 | Thondayadu |
| 13 | Malaparmbu |
| 14 | Puthiyangadi |
| 15 | Medical college |
| 16 | Central market |
| 17 | Thangals Road |
| 18 | Elathur |
| 19 | Nallalam |
| 20 | Beypore |

*(Source: Health department, Kozhikode Corporation-2016)*

This is a coastal region and public well is located very near to the sea. Chemical parameters are normal in this region. Total coliform is present in this water sample. Sample 21 is taken from Beypore port. This is a public well and this water is used by the surrounding people. Total coliform and faecal coliform are present in this region. Sample 22 is taken from Kizhakkumpadam region. Bacteriological contamination is high in this water sample. Total coliform and faecalcoliform are very high in this sample and E.coli is also present. Sample 23 is taken from Cheruvannur East. The chemical and biological parameters are in the normal range. The water is used by aganavadi and schools. Sample 24 is taken from Cheruvannur East. The chemical and biological parameters are normal in range. This water is pure and clean for drinking purpose. Sample 25 is taken from Kundaithodu. In this sample there were no pollutants. Because the water quality parameter of the sample in normal condition. Sample 26 is taken from Kolathara. In this sample total coliform is identified. Presence of Fecal coliform is very low and E.coli does not present in this water sample.

Sample 27 is taken from Naduvattam.  Same as sample 26, the total coliform is higher compared to other parameters of water. Sample 28 is taken from Mathottam. Bacteriological parameters such as total coliform and faecal coliform are present in this water sample. Other chemical parameters and ecoli are not present in this water sample. Sample 29 is taken from Nellikkode region. This well is situated along the road side. It is the pumping source for the colony located in Nellikkode region. Chemical contamination is normal in this water sample. But bacteriological contamination is very high. E.coli is present in this region. Sample 30 is taken from Naduvattam ward in Kozhikode Corporation. In this public well chemical parameters are normal. Total coliform and faecal coliform are identified in this water sample. Sample 31 is taken from pottammal ward. Similar to the sample 30, both chemical and biological parameters are normal except total coliform and faecal coliform. Sample 32 is taken from Garudankulam. This is a pond situated in westhill of Kozhikode Corporation. Chemical parameters are normal in this sample. Total coliform and fecal coliform are found in this sample.  Sample 33 is taken from Thamarakkulam it is another pond located in the westhill region. Chemical parameters and biological parameters are normal in range. Sample 34 is taken from Manachira square. Chemical parameters are normal in this sample. Total coliform and faecal coliform are found in low level.  But presence of E.coli is very high in this water sample. And it is the major source of drinking water supply in urban region of Kozhikode city. The last water sample (35) collected from Neelichira. The pond is situated in Kallai region. It is another source of drinking water supply for urban centres of Kozhikode city. The chemical parameters are normal in this pond and total coliform are also found in this water sample. Kozhikode corporation health service divided the corporation area in to 20 different health zones.

The following table shows the details of water borne diseses identified in the Kozhikode Corporation;

Table 8.  Water borne diseses identified in Kozhikode Corporation

| SL.NO | WATERBORNE DISESES | NO. OF CASES | PLACES |
|---|---|---|---|
| 1 | Viral Hepatitis A | 82 | Kolathara, Chevayoor, Kallai, Nallalam, Areekkad, Malapparmbu |
| 2 | Typhoid | 13 | Kallai, Puthiyappa, Nadakkavu, Elathur, Areekkad, Vegeri |

*(Source: Health department, Kozhikode Corporation- 2016)*

**Table 9.** Water borne diseses identified

| Sl no | Places | Viral hepatitis | Typhoid |
|---|---|---|---|
| 1 | Kolathra | 18 | 0 |
| 2 | Chevayoor | 14 | 0 |
| 3 | Kallai | 13 | 6 |
| 4 | Nallalam | 13 | 0 |
| 5 | Areekkad | 13 | 1 |
| 6 | Malaparmbu | 11 | 0 |
| 7 | Puthiyappa | 2 | 0 |
| 8 | Nadakkavu | 2 | 0 |
| 9 | Elathur | 1 | 0 |
| 10 | vegery | 1 | 0 |

*(Source: Health department, Kozhikode Corporation-2016)*

The table shows the number of cases identified the Kozhikode corporation area. Viral hepatitis and typhoid are the major waterborne diseases in this area. Diharria also seen almost all part of Kozhikode Corporation. 82 viral hepatitis cases are identified.  In Kolathara ward, 18 cases are reported and this region included in urban area zone. The major water

source of uran area zone is ponds such as Manachira and Neelichira. Chevayoor located in medical college area zone and the river is the major source of water availability. Samples collected from the medical college area shows that there is an imbalance in the biological parameters.  14 viral Hepatitis cases are identified there. In kallai, viral hepatitis (13 cases) and typhoid (6) were identified. 13 viral Hepatitis cases are reported in Nallalam.  It is also situated in urban area zone. In the last year Areekkad, 13 Viral Hepatitis and 1 typhoid were reported. This is also coming under the urban area zone. Malapparmbu and Nadakkavu are two urban centres of Kozhikode corporation area. Viral hepaatitis reported in these regions. The ponds are the major water availability sources in these regions. Puthiyappa and Elathur wards are located in coastal area. Individual wells and public wells are the major water source of these wards. In Puthiyappa 2 viral Hepatitis cases and 1 viral Hepatitis case reported. Vagary is another ward, where 1 viral Hepatitis case was reported. This is the region coming under the medical college area zone.

## Conclusion

By analysing the physical chemical and biological parameters of water quality in Kozhikode corporation, it shows the chemical parameters pH, TDS, EC, salinity, sulphate, sodium, potassium, nitrate, phosphate, iron, TH, CaH, Chloride, TA, Mg and Ca are normal. Biological contamination such as total coliform, faecal coliform, E.coliare not in a good condition these leads to some serious health issues.Most of the cases were reported in urban area of Kozhikode Corporation. The major water availability sources are ponds such as Manachira and Neelichira in this area. Most of the people depending on Corporation water for their purpose, collected from these two sources. In manachira, chemical and physical parameters are normal but the presence of E.coli is identified. So this is main reason behind the waterborne diseases in this area.

## Reference

**Abdul khayum, N. Nadhini, J.S.Chandrashekar and R.** Durgesh-"assessment of drinking water quality, Baglore, West zone-a case study.

**AnjanaDesi and AvantikaPrajapathi** in "Drinking water and water borne diseases in urban environment; a case study of Ahmadabad'.

**Ashwani Kumar Tiwari, Prasoon Kumar Singh and Mukesh Kumar Mahato** says that Water Quality Index (WQI).

**Chadedrik Rout and Arbindha Sharma**., 2011.,  "assessment of drinking water quality, a case study on an Ambalacontonment area, Hariyana India.

**Chelsea core**., 2012., spatial assessment and analysis of pollution sources and water quality in the BougeFalaya River and Ambitha river watersheds, St Thammany Parish, la.

**Dhinedra Mohan Joshi, et.**al., 2009., studied on the "physico chemical parameters to asses the water quality of river Ganga for drinking purpose in Haridwar districts."

**Jeena T. Sreenivasan and V. Rathna Reddy,** "impact on irrigation water quality on human health, a case study in India".

**K. sundara Kumar** assessed the ground water quality in Rajam, Andhra Pradesh**.**

**Muhammad mohasin et.al,** drinking water quality and its impact on resident's health in Bahawalpur City.

Naheedhakidhar et.al. The impact of water pollution on human health in Fisalabad city, Pakistahan.

**National Water Quality Handbook.,** 2002., by Natural Resource Conservation Service.