DETERMINATION OF PHYSICAL AND CHEMICAL PROPERTIES FOR DRINKING WATER IN AL-SAMAWAH CITY, IRAQ

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Abstract: The present paper investigates the study of physical and chemical properties of the Euphrates River water, purification station water and network water (drinking water) in Al-Samawah city. In this study ten sites have been selected in January, 2019. The parameters measured were temperature, color, taste and smell, turbidity, total solids, dissolved solids, suspended solids, electrical conductivity, PH, total hardness, calcium, magnesium, free chlorine, chlorides, sulfates, total phosphates and Biochemical oxygen demand (BOD). The results of the study showed that the pH tends to be neutral in river, purification station and network water. The water is colorless and tasteless and odorless, and the values of total and dissolved solids and turbidity have decreased significantly in the water of the purification station and the network compared to the raw water of the river. The sulfate also decreased from 250 mg/L in river water to between (239-242, 235-246) mg/L for water of station and network, respectively, and the concentration values of total hardness, calcium, magnesium and chloride showed a differential change between river water, station and the network. The values of free chlorine were between (2.3-1.3) mg/L in the network water. The values of pH, solids, turbidity, calcium, magnesium, chloride, sulfates and phosphates were within the permitted standard specifications of the World Health Organization, while the values of electrical conductivity, total hardness and free chlorine, and the biochemical oxygen demand for oxygen in water of station and the network were slightly higher. The values of the BOD fall within the good classification of drinking water and household uses defined by the Iraqi standards and the World Health Organization (WHO).

Keywords: Purification station water, network water, Al-Samawah city, physical and chemical properties, BOD.

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INTRODUCTION

Pollution is one of the major global problems that peoples and authorities seek to combat. There are three types of pollution, namely air, water and soil pollution. Water pollution is considered one of the most dangerous, because many diseases that affect humans are transmitted by sewage, which is the main cause of diseases transmitted through water to humans and livestock. and poultry.

Also, the cause of water pollution of all kinds is due to population growth and technological progress compatible with the discharge of huge amounts of liquid and solid pollutants into water sources as a result of industrial and agricultural use and human uses, especially the establishment of a number of industrial projects in places close to water bodies, which resulted in the leakage of their waste to water pollution is increasing in severity in proportion to the industrial development and the population gathering on the banks of the rivers, as these types of pollution contribute to reducing the quality of water.

When the pollution in the water becomes severe, it is due to three pollutants: dirty water sewage, industrial waste, and more recently, organic and inorganic pesticides (Saleh et al., 1982; Ansari et al.,2022). The disposal of waste causes many water environmental harms in addition to severe economic losses, starting with the lack of fisheries and ending with raising and doubling the economic cost of the water purification process to make it suitable for drinking and other daily uses. In this regard, (Al-Imarah and Najwa 1995; Sarhan et al., 2000; Bokov et al.,2022; Abed Ali et al., 2000 and Al-Mashkoor,2002) indicated to the strict treatment of excreta before dumping it into river waters. for emphasizing the treatment of waste before it is thrown into river water because of its bad effects on water pollution, especially dirty sewage, industrial waste and organic and inorganic pesticides. Great for the water environment, the simplest of which is the loss of the aesthetic quality of the rivers and lakes in which they are thrown. This may cause pollution of drinking water as a result of major sabotages due to irresponsible human actions such as breaking water pipes used for drinking.

The specifications of water suitable for human use is that it be colorless, tasteless and odorless, and free of bacteria and suspended matter. Therefore, the presence of bacteria, germs, salts, dissolved mineral substances, tree leaves and plants give water an undesirable color, taste and smell, and there are many common standards and specifications for assessing the suitability of water for purposes Drinking, such as the European specifications for drinking water 1987, the specifications of the

World Health Organization (WHO) 1980 and the specifications of the Iraqi standardization and quality control 1974. From this we conclude that the use of water for human purposes without purification leads to the spread of many diseases, especially transitional ones because of what unpurified water contains from Bacteria, germs and parasites that cause these diseases. Water purity depends on several factors, including the length of the river's path, the areas it passes through, and the industrial, agricultural and human activities on both banks of the river in these areas.

Studies conducted in various countries, including Iraq, have indicated that attention to the processes of filtering, sterilizing and distributing water correctly has led to a decrease in the incidence of these diseases and that the validity of drinking water is determined by a set of physical, chemical and bacteriological tests that reveal contamination with chemicals or contamination with pathogenic bacteria. Attention to water sources, both surface and underground, in order to exploit them to meet the daily needs of people, especially after the increasing shortage in the amount of water needed to meet the needs of the population due to the increase in their numbers and the rise in the standard of living, as the water consumption rate per capita in some areas of Iraq reached (180 liters/day) in the sixties and rose to (300 liters/day) in the eighties, and the proportion of urban population in 1950 did not exceed (30%) of the total population of the earth and increased to (60%) at the end of the twentieth century, and we expect a further increase in the current and subsequent centuries, which will lead to an increase in water consumption.

Through this introduction to the importance and sensitivity of the topic at the present time, and as a result of Iraq's exposure to three wars in the last three decades that led to the destruction of the country's infrastructure and the use of various types of weapons in it, it made a lot of human and material sacrifices, as well as the collapse of the country's economic structures, which negatively affected the creation of an environment Clean and free from the remnants of those wars, and the decline in research and applied scientific experiments, which would reduce the risks of pollution, prevented the achievement of the desired goal.

The city of Al-Samawah relies on the Euphrates River as a main source for preparing raw water for the purpose of purification and sterilization of water at the station on the river.

In the network, plastic and ductile pipes are used, and given the current conditions that the country is going through, the increase in population, and population and industrial waste, and its pollutant impact on water and thus on public health (Zadeh et al.,2022). Therefore this study aimed to evaluate the specifications of drinking water from a physical and chemical aspects in the city of Al-Samawah and its comparison with the standard specifications approved by international organizations for the purpose of ensuring the suitability of water for human consumption. Figure (1) a typical scheme of the stages of purification and sterilization of river water in the station of purification water.

MATERIALS AND METHODS

A. Method of sampling

Ten samples were collected from several sites in the station and its network in Al-Samawah city in clean glass containers of one liter for each sample, where the first sample was taken from the pumps withdrawing raw water from the river and the second sample from the sedimentation basins after being treated with alum and first sterilization with chlorine and the third sample after filtration and second sterilization with chlorine, it represents the water pushed into the network (drinking water), the fourth sample from the Al-Muallimeen site, the fifth sample from Al-Garbi site, the sixth sample from Old Kasbah site, the seventh sample from Al-Judayyida site, the eighth sample from the Al-Elam site, and the nine sample from Al-Qishla site, and the tenth sample from Al-Risala site (Figure 2).

B. Examination of environmental variables

The samples were collected according to the specifications and the common standard methods of analysis were adopted to estimate and measure the physical and chemical determinants according to the American Public Health Association (APHA) 1985 and these variables include:

Temperature: The temperature was measured using a mercury thermometer at the sampling sites.

2- Color, taste and smell: The visual comparison method was used in measuring color and depending on the sense of taste and smell in determining the taste and smell of water.

3- pH: measured using a PH meter as soon as the samples reach the laboratory.

4- Total solids: The total solids (T.S) were determined by drying, expressed in units (mg/L).

5- Dissolved solids: Total Dissolved solids (T.D.S) were determined by filtering and drying the filtrate, expressed as (mg/L).

6- Electrical conductivity (EC): The electrical conductivity was measured using an (Electrical conductivity meter 31A) µmhos/cm at 25°C.

7- Turbidity: Turbidity was measured, expressed in NTU, using a device (Turbid meter model 2100A).

8- Total Hardness: Total Hardness salts (T.H.S) were estimated in the form of calcium carbonate.

9- Calcium and Magnesium: Calcium and magnesium elements (mg/L) were measured by following the lubrication method with the chelating reagent (EDTA).

10- Free chlorine : The measurement of free chlorine (chlorine) was carried out locally using the comparison device (Lovibond comp rotor 200).

11- Chlorides: The amount of chloride is mixed with silver nitrate.

12- Sulfates: It was estimated according to the method mentioned by the World Health Organization (WHO)1980 by purifying the gravimetric precipitate in the form of barium sulfate.

13- Phosphates: The method mentioned in the report of the British Health Association 1960 was used by taking (50 ml) of the filtered form, adding to it (0.1) ml of tin chloride and adding (2 ml) ammonium molybdate, then measuring the intensity of the blue color formed with a standard solution of phosphates.

14- Biological oxygen demand (BOD): It was estimated in mg/L and using Winkler's method mentioned by the American Public Health Association (APHA) 1985 and by following the increment modulation after incubating the model for five days (DO_5) at a temperature of 20) ± 1°C and subtracting it from the dissolved oxygen measurement D_1 on the first day.

RESULTS AND DISCUSSION

1. Physical properties of water

It is evident from Table (1) that the water temperature for all sites ranged between (16-17) °C. The temperature is one of the factors affecting bacterial growth and has an effect on dissolved oxygen, biochemical oxygen demand, pH (Brock 1967 and chlorine activity (WHO) 1980 Which increases with the increase in water temperature while reducing the period of its stay in the water in contrast to the decrease in temperature.

As for the color, the water was colorless and tasteless and odorless. The highest value of turbidity was in raw water (60 NTU), and this is due to the rapid drainage of river water and its load of clay and silt. This value is lower than that of the Euphrates River water in the city of Al-Samawah (NTU170) (Al-Mashkoor, 2002; Hafsan et al.,2022) and the water of the Diwaniyah River (NTU89) (Sarhan et al., 2000), but it is more than in Al-Diwaniyah River before Al-Diwaniyah city (NTU29) (Hassan et al., 2019), then the turbidity values gradually decreased in the purification station until it reached its value for drinking water after sterilization (NTU9). The turbidity value has increased in the two sites (8 and 9) to (NTU12) and this may be due to the presence of some sediments in these two sites. One of the effectiveness of the added chlorine when sterilization because it provides protection for microorganisms and bacteria from its influence, as it provides good conditions for bacterial growth in the distribution network (WHO) 1995.

The value of the total solids decreased from 1500 mg/L in river water to 850 mg/L in site (3) (after filtration and second sterilization) due to filtration operations. It is noted that the value is 1200 mg/L in site (2) (after sedimentation and first sterilization) and this is due to increase the amount of dissolved salts due to the addition of alum. The effect of sedimentation, filtration and sterilization processes on the values of total solids and dissolved solids and suspended solid led to their reduction from (1500, 600, 450) mg/L, respectively, for raw river water to (850 and 400, 401) mg/L, respectively, for propulsion water of station after sterilization (site 3). The values of total solids within the standard specifications for drinking water (WHO 1980 which specified a value ranging between (500-1500) mg/L of total solids.

It is evident from Table (1) that the electrical conductivity values of water of River, purification station, and network are (1200, 1000-1250, 1050-1250) µmhos/cm respectively, which are close to values of Euphrates River, purification station, and network in Hilla city (1130, 1134-1142, 1120-1150) µmhos/cm, respectively (Hassan and Ashwaq 2021). The electrical conductivity value of the push water decreased to 1000 µmhos/cm due to the decrease in the amount of total dissolved salts (dissolved solids) from 600 mg/L in river water to 400 mg/L in propulsion (drinking) water.

2. Chemical properties of water

It is noted that the pH ranges between (7.1-7.3) (Table 1) and these readings are more than what it is in the waters of the Tigris River in the city of Kut (PH = 6.9) (Al-Mashkoor 2006), and they fall within the permissible standards specified by the European Union 1987 and the WHO 1980 (PH ranges between (6.5-9.5) and the American Public Health Association (APHA) 1985 and Iraqi environmental legislation 1988 that allowed the PH value ranging between (6.5-8.5) in drinking water and household uses. This was in accordance with what was indicated by Blum 1976 that the PH of most rivers in temperate regions tends to be weakly basal. The reason for the lack of noteworthy changes in the PH of the sites' water may be due to the low water temperature at the beginning of January 2019, which caused an obstruction to the growth of micro-organisms and plankton, and consequently, the amount of CO_2 released from the breathing of these organisms decreased, and finally, the decrease in the amount of carbonates and bicarbonates resulting from the dissolution of this gas and its interaction with Salts of calcium, magnesium, sodium, etc., and Abu Giedria 1988 indicated that the solubility of CO_2 in water is an important factor in increasing alkalinity.

One study (CEHA) 1996 showed that (0.5 mg/L) residual chlorine and turbidity of NTU (1) at pH equal to 8 are sufficient to destroy 99% of colon bacteria.

As for the chloride values, for river, purification station, and network water, they were (250, 240-245, 228-243) mg/L respectively, and for propulsion water of station 240 mg/L, it lies within the international standards (WHO) 1980 and its amount is (200-600) mg/L, while the average chloride concentration in the drinking water of purification station of Kut (Al-Mashkoor 2006), Baghdad (Khorshid 1988), Basrah (Abaychi and Al-Obaidy 1982), and Hilla city (Hassan and Ashwaq 2021) (214, 86.5, 324, and 94) mg/L, respectively, while the value of chloride in the Euphrates River in the city of Nasiriyah, it ranges between (555-400) mg/L, due to the effect of saline groundwater, saline soil and rice sewage water (Ali,2001).

The value of sulfates for water of river, purification station, and network in this study was between (250, 260-265, 248-256) mg/L, respectively (Table 1), and lies within the permissible limits according to the European specifications for drinking water 1987 of (25-250) mg/L and within the limits of the World Health Organization (WHO) 1980 of (200-400) mg/L and more than it is according to Iraqi environmental legislation 1988 (200) mg/L. The values of this study were close to what it is in the water of Al-Diwaniyah River (Sarhan et al., 2000) (264) mg/L and the purification station is between (207-225) mg/L and the network is between (217-236) mg/L, and it close to values of Euphrates River in Hilla city (250) mg/L and the purification station is between (260-265) mg/L and the network is between (248-256) mg/L respectively (Hassan and Ashwaq 2021). Al-Saadi 1986 indicated that the source of sulfates in Iraqi Rivers is a number of industries whose waste seeps into the Rivers, such as the manufacture of fertilizers, paper and oil refining, and that in the natural conditions of River water the amount of sulfate does not exceed (12) mg/L.

The concentration values of the total hardness, calcium and magnesium showed a differential change between the river water and for propulsion water of station after sterilization (site 3). Their values were recorded in the range of (600,141, and 60) mg/L respectively, for river water, and the values of (580, 125, and 60) mg/L, respectively, for propulsion water of purification station. These values were more than for Baghdad purification station water (Khorshid 1988) (300, 71 and 31) mg/L for total hardness, calcium and magnesium, respectively, and less than it for each of the value of the hardness of purification station of Basrah city (Abaychi and Al-Obaidy, 1982) (616) mg/L and its value of calcium and magnesium (141 and 63) mg/L, respectively, as the values of the current study were more than it is for water of Al-Diwaniyah River (Sarhan et al., 2000) (202, 30, 32) mg/L for total hardness, calcium and magnesium, respectively, and for the same factors for propulsion water (196,

26, 33) mg/L respectively as well.

The increase in the concentration of magnesium in the treated water is due to the quality of the alum used in the sacrifice, which contains large amounts of magnesium, while the decrease in calcium and the total hardness reflects the efficiency of the purification station in reducing the hardness of drinking water. Outside the permissible limits for drinking water specifications according to the (WHO) 1980 which allowed (50-100) mg/L, while the calcium and magnesium values came within (75-200, 30-150) mg/L for calcium and magnesium values, respectively, and this is due to the limestone nature that the Euphrates River passes through with the water scarcity on the one hand, and the inefficiency of the purification station water in reducing hard salts for drinking water. This may be due to the old network water pipes and the large number of sediments in them over the past years, which led to an increase in the value of the total hardness.

The values of free chlorine were between (1.3-2.3) mg/L and the globally accepted value in drinking water is (1.0) mg/L (WHO, 1980), and the increase in the amount of chlorine in some sites may be due to its proximity to the purification station also, the decrease in concentration in some sites may be due to the occurrence of perfusion in the tubes. Note that this quantity is related to the temperature of the water.

The values of total phosphates (orthophosphate, organophosphate, and polyphosphate) for river water, purification station and network water are equal 1.4, 1.3, and 1.3-1.5 mg/L, respectively, the value in river is equal to in Euphrates River before the city of Al-Samawah (Al-Mashakoor 2002), but these values come more than the determinants of maintaining Iraqi Rivers and public waters from pollution for the year 1967, which allowed phosphate of (1.4 and 3.0) mg/L in river water and water discharged to the river, respectively (Abawi and Hassan, 1990), and the values is more than the Euphrates River and the purification plant and network in Hilla (0.9, 0.8, 5.0-0.9) mg/L, respectively (Hassan and Ashwaq, 2021) and more than in water of Al-Diwaniyah River before and after of al-Diwaniyah city (0.03 and 0.05) mg/L (Hassan et al., 2019), but thy fall within the limits of the values mentioned by (Peavy et al., 1987) in the American public water between (1-50) mg/L and an ideal value of 20 mg/L.

The Iraqi draft standard for drinking water of 1986 referred to an organic phosphorous value of 0.01 mg/L (Cited from Abawi and Hassan, 1990). The presence of phosphorous in water along with a high concentration of nitrogen causes the phenomenon of eutrophication that affects the quality of water and the livelihood of living organisms (Saleh et al., 1980; Huldani et al.,2022).

3. Biochemical properties of water

It is clear from Table (1) that the highest value of the biochemical oxygen demand (BOD) is 2.9 mg/L in raw river water, and the (BOD) values for purification station, network water, it ranged between (2.2-2.5 and 1.8-2.1) mg/L, respectively and these values are within or close to the values for Tigris River, purification station, and network water of Kut city (Al-Mashkoor, 2006) 2.5, 1.5-2.0 and 1.5-1.8) mg/L, respectively and of Hilla city, which is located on the Euphrates River (Hassn and Ashwaq 2021) (2.5, 1.5-2.3 and 1.1-1.5) mg/L, respectively.

BOD value of River water limits of clean rivers specifications referred to by (Al-Saadi et al., 1986) (2.0-2.5) mg/L, and it lies within the limits of the good classification (1.9-3.0) mg/L for drinking water and household uses determined by the Iraqi specifications (Ali, 1987).

CONCLUSIONS AND RECOMMENDATIONS

We conclude from this study in general that the water of the Euphrates River, the purification station, and the network of the city of Al-Samawah are considered a brackish water and contained a concentration of total hardness salts slightly more than the upper limits allowed according to WHO 1980.

The water is suitable for drinking, and the river water is better than the water of the Euphrates River, the average salinity in the city of Nasiriyah (Ali 2001), but it is of lower quality than that of the water of the Diwaniyah River in the city of Al-Diwaniyah (Sarhan et al., 2000) ,and drinking water in the purification stations of Baghdad (Khorshid 1988) and Kut (Al-Mashkoor 2006).

The above-mentioned concentration of salts of total hardness reflects the inefficiency of purification station of the city of Al-Samawah in reducing hardness salts coming from rice troughs, the quality of the soil through which the Euphrates River water passes, and the reason for the old network pipes that contain such sediments, in addition to the water scarcity in this season. Therefore, we recommend replacing the old pipes in some areas of the network, and stressing the necessity of developing a treatment for industrial waste before putting it in the river water, in order to preserve public health.

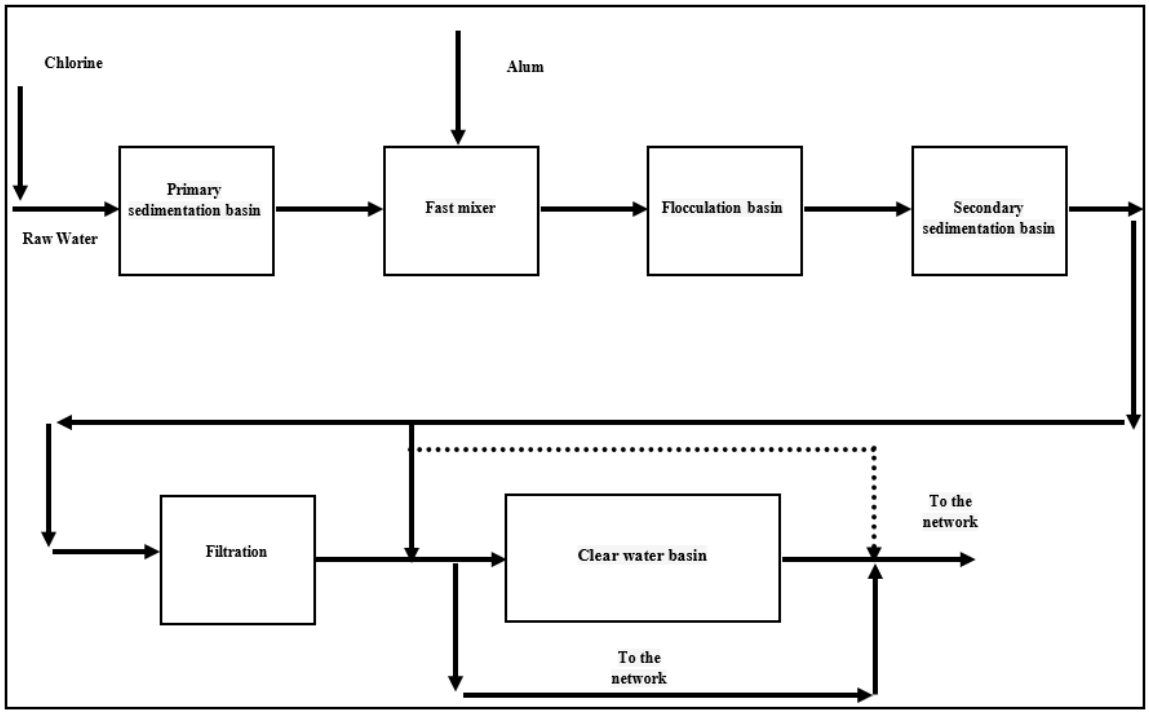

Figure 1. A typical diagram of a river water purification project.

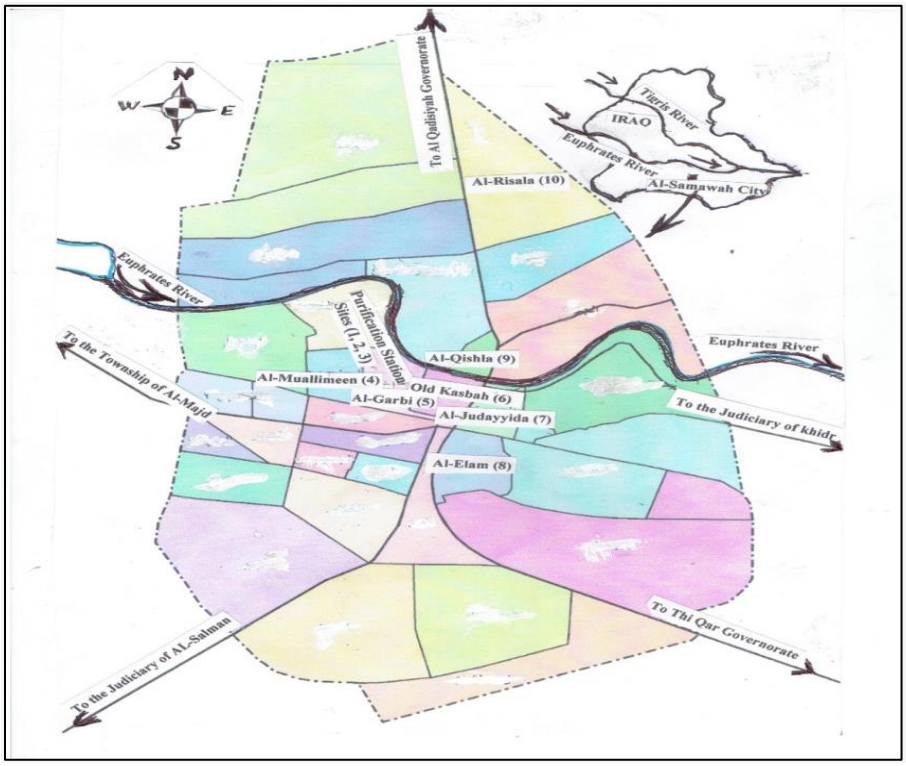

Figure 2. A map of the city of Al-Samawah showing the river, water purification station, and sample collection sites from network.

Table 1. Physical and chemical values of samples water at the different sites.

Site No.	Site Name	Temp. C°	pH	Total. Solid Materials	Dissolv. Solid Materials	Susp. Solid	Electr. Conduct.	Turbid.	Total Hard.	Ca	Mg	Free Chlorine	Clorides	Sulfates	Total phosph.	B.O.D
1	Raw Water	16	7.3	1500	600	450	1200	60	600	141	60	/	250	250	1.4	2.9
2	After Sedimentation and First Sterilization	16	7.2	1200	650	430	1250	30	580	130	58	/	245	242	1.3	2.5
3	After Filtration and Second Sterilization	16	7.3	850	400	401	1000	9	580	125	60	2.3	240	239	1.3	2.2
4	Al-Muallimeen	16	7.3	900	450	380	1050	9	581	130	58	2.1	237	235	1.3	2.1
5	Al-Garbi	17	7.2	1000	500	400	1100	10	575	135	55	1.7	243	242	1.4	2.0
6	Al-Old Kasbah	17	7.3	900	450	410	1050	11	570	140	57	1.5	238	235	1.5	1.9
7	Al-Judayyida	16	7.3	950	525	370	1075	11	581	133	50	1.6	246	246	1.3	1.8
8	Al- Elam	17	7.2	1100	550	420	1250	12	590	145	59	1.4	239	237	1.3	2.1
9	Al-Qishla	17	7.2	900	500	380	1150	12	580	138	60	1.3	241	240	1.4	2.0
10	Al-Risala	17	7.2	975	527	405	1143	10	591	129	63	1.4	228	236	1.3	1.9

The units of variables is mg/L except temperature C° and pH without unit, Turbidity (NTU), electrical conductivity (µmhos/cm).

COMPLIANCE WITH ETHICAL STANDARDS STATEMENTS

I. Ethical approval:

The manuscript is written in original and all the data, results pertaining to this manuscript are original according to the research performed. The authors followed academic integrity and have not copied any content/results from another source.

II. Funding details (In case of Funding):

The authors of this manuscript did not receive any funding to perform the present research

III. Conflict of interest

The authors of the study do not have any conflict of interest

IV. Informed Consent:

The authors of the manuscript agrees to publish this research in the journal if it's considerable by the editors of the journal. The authors provide full consent for reviewing and publishing this manuscript.

V. All the authors of this study contributed equally in terms of performing the research as well as in preparing the manuscript. All the authors of the study followed the guidelines of the corresponding author. Any query/suggestion related to the manuscript can be reached to the corresponding author

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