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The Evaluation of Physical and Chemical characters for Water Wells in Al- Hamadanyah District and its Affiliated Villages

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ABSTRACT— This study is conducted in the environment laboratory for postgraduate studies of the Biology Department - College of Science at Tikrit University. It includes a field survey to estimate some of the physical and chemical aspects of water for the study area. The field study starts from the beginning of October 2021 until March 2022, and six sites for water wells are selected within the Al- Hamadanyah district and its affiliated villages. Water samples are taken from these sites monthly to determine some of their physical aspects such as (turbidity, total dissolved solids (TDS) and electrical conductivity EC) with some chemical aspects (pH, dissolved oxygen, total alkalinity, and total hardness). The results indicate high values of electrical conductivity, total dissolved solids, vital oxygen requirement and total hardness. The results also show that the pH values tend to be alkaline in some of the studied sites.

KEYWORDS: physical and chemical aspects, well water, Al-Hamadanyah sub-district.

1. INTRODUCTION

Water is an essential pillar that creates the appropriate conditions for life and its continuity, and it forms the backbone of all human activities. It is also the foundation upon which the city and civilization are based [1]. Groundwater can be used for domestic works, irrigation and industry according to its specifications, especially in rural areas where surface water is not available and is less affected by the drought conditions that prevail in some years [2].

The potable groundwater constitutes approximately 72% of the total drinking water resources in the world. Groundwater often contains relatively high concentrations of calcium and magnesium ions, etc., which makes it hard. This is due to the entry of some soluble compounds in the water, the transference of salts to it because of civilian, agricultural and animal activities, and the population increase around the wells areas. All of this has led to an increase in pollution problems and has become a threat to health and public interest, especially to the consumers of this water [3].

A research study is conducted for the groundwater of the village of Abu Maria, belonging to Tal Afar district by [4] to find out its suitability for human uses. The results have shown a high concentration of salts in this water, and thus considered very poor quality for drinking and household uses.

In their study on evaluating the quality of well water for drinking and irrigation in Al-Siddiq and Al-Hadba sectors in the left side of the city of Mosul, [5] also concluded, that all the studied samples are good for irrigation, but they were of poor quality for drinking and domestic uses. A field survey is also conducted by [6] on the fields, farms and villages in the district of Al-Hamdaniya (QaraQosh) and its outskirts, and a study of the quality of groundwater in it. The results indicate that the water quality index values fluctuated

between (6.36-107) due to the nature of the geological formations through which the water passes. The studied water is 50% of the excellent variety for irrigation, 40% of the good variety, and the rest is poor. As [7] they assessed the validity of groundwater for two areas in the north-eastern city of Mosul (Bashiqa and Alqosh) with the use of the water quality index (WQI) for drinking and irrigation purposes. The results show that the water quality of Bashiqa district is very poor to inadequate, while the second district is classified in its water between very poor in some wells and in others it is of the excellent water category. A research work has been conducted by [8] on the quality of groundwater in the Al-Kasak area in Nineveh Governorate. To demonstrate its suitability, the Water Quality Index (WQI) is applied to assess the quality of well water for irrigation according to international classifications. The results show that most of the measured standards are very high, and thus water is classified rom low restrictive (LR) to severely restrictive (SR) irrigation category.

2. Objective

Due to the importance of the issue, the current study aims at the following:

1. Identifying the physical and chemical aspects of well water in the study area.
2. Showing the effect of monthly and local changes in the study area.

3. Materials and Methods

3.1 Site Description

A number of (6) wells are selected in the Hamdaniya area as shown in Table (1) to collect samples. These wells are used to irrigate agricultural lands and livestock watering as shown in maps (1) and (2).

Sample sites

Map (1): collection

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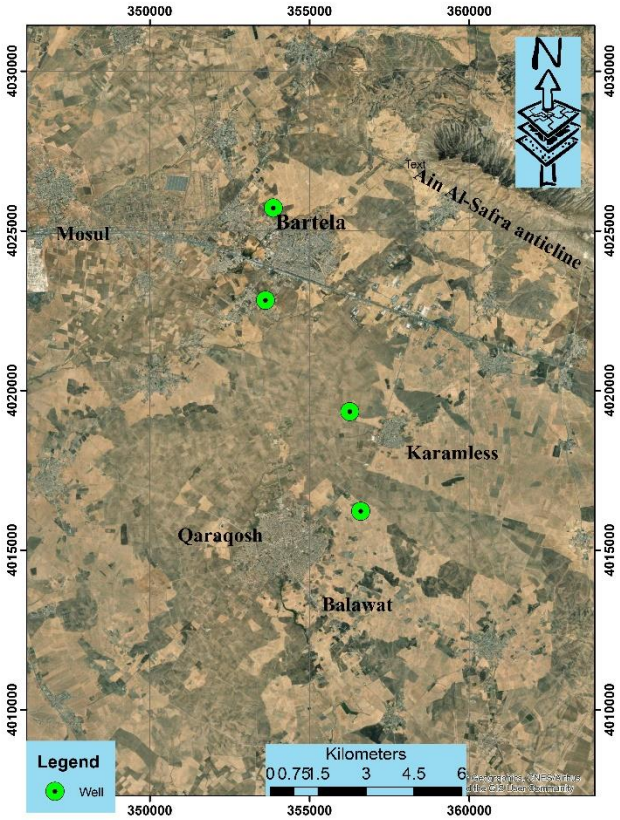

Figure (2): Locations of the wells

Table (1): The locations of wells in the Hamdaniya area

well age	well depth/meter	District name	well site	No.
2010	160	Bartella	Noah's Rafu Shaana farm	1
2007	28	Bartella	Ramy Shafu farm	2
2013	190	Karameles	St. Barbara's Church Farm	3
2019	49	Karameles	Jesus the Redeemer Monastery Farm	4
2010	100	Qaraqosh	Salem Hanna Butrus farm	5
2020	90	Qaraqosh	Adam Abdul Salam's farm	6

3.2 Sample Collection

Samples are collected from the sites shown above, starting from October (2021) until March (2022). The study period lasted for six months, using polyethylene bottles with a capacity of 2.25 liters, after washing them well with tap water several times to perform laboratory tests. Special water samples are also collected to measure dissolved oxygen (DO) and biological oxygen requirement (BOD5) in special bottles of (250)

ml each.

The following measurements are performed at each site with an average of three replicates, and according to the methods used by the American Public Health Authority [9], [10].

3.3 Physical examinations

3.3.1 Turbidity

The turbidity is measured upon direct arrival to the laboratory using the Turbidity meter, which shows the amount of turbidity measured in (NTU). The samples are shaken well until mixed and the measuring cell is filled up to the mark indicated. It is to be taken into account that traces of fingers are not left by wiping the measuring cell with a piece of cloth, the non-formation of air bubbles, as well as the stability of the device.

3.3.2 Electric Conductivity (EC)

The electrical conductivity is measured using the HANNA model H.199301 in micromosa/cm after regulating the device using distilled water with temperature adjustment to (25)°C.

3.3.3 Total dissolved solids (TDS)

The measurement is carried out with a TDS meter type YL-TDS2-A in units (ppm) (Patrs per million) after adjusting the device and calibrating it using distilled water.

3.4 Chemical Examinations

3.4.1 pH value

The measurement is performed with a pH meter model 210A Orion after adjusting the temperature of the device and model and calibrating with buffer solutions of different pH values (4, 7, 9).

3.4.2 Dissolved Oxygen (DO)

The Azide modification method is used after the oxygen stabilization process with standard solutions in the field. It is measured in the laboratory using special (250) ml bottles without creating air bubbles.

3.4.3 3 Biochemical Oxygen Demand (BOD5)

The organic loading (BOD5) is estimated by using a device to measure the biological requirement of a water sample with an incubator of the German origin (Lovibond oxidirect).

3.4.4 Total Alkalinity

Total alkalinity is measured by taking (50) ml of the sample, and sweeping it against a standard (0.02N) sulfuric acid solution using orange methylation index. The color change occurs when the pH reaches (4.2), and the total alkalinity is calculated from the equation: -

$$\text{T.ALK } CaCO_3 \text{ mg/L} = \frac{N \times V \times 50000 \times 1000}{\text{ml of sample}}$$

where:
N = Normality of Acid used by titration
V = Volume of Acid
50 = Equivalent weight of calcium carbonate

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3.4.5 Total Hardness

It is measured using the EDTA Titration Method, by taking 50 ml of sample water, adding an appropriate amount of buffer solution to regulate the pH of the sample, then adding a small amount of the indicator (Erichrom Black T) to give us a burgundy red color to the sample. It is titrated with a (Na2EDTA) standard solution until it changes to blue color and the hardness is calculated from the following equation:

$$\text{T.H.mg/L as } CaCo_3 = \frac{N \times V \times eq.wt \times 1000}{\text{ml of sample}}$$

where:
V = volume of measured solution
N = Normality of Standard Solutions
eq.wt = Equivalent weight of calcium carbonate

4. Results and Discussion

4.1 Physical Aspects

4.1.1 Turbidity

The turbidity value in the water of the current study ranges between (0.00-59.33) mg/liter as in Table (2). The highest value is in the fourth site in October and the lowest value in the second site for the month of November. The reason for the higher turbidity values may be due to rainfall in the studied areas, which cause the formation of suspended particles in the water wells. According to the study sites, the lowest rate recorded is (3.12) mg / liter in the fifth site and the highest rate (15.31) mg / liter in the fourth site. As for the months, the lowest rate recorded (0.09) mg/liter in November, and the highest rate (16.26) mg/liter in January. The results of the current study are higher than the results obtained by [11], whose rates range between (0.57-4.37) mg / liter and higher than the results obtained by [12] in the study of groundwater salinity treatment and evaluation of its physical and chemical properties in the city of Tikrit, in which the rates range between (0.19-0.55) mg/L.

Table (2): Turbidity (mg/L) in well water for the studied sites

month / site	October	November	December	January	February	March	Average
1	3.20	0.48	3.97	9.69	10.18	0.41	4.66
2	1.94	0.00	6.16	39.40	14.63	4.27	11.07
3	0.00	0.00	10.26	15.66	11.36	0.31	6.28
4	59.33	0.00	4.17	11.48	10.17	6.71	15.31
5	0.00	0.00	0.97	8.29	8.07	1.39	3.12
6	0.00	0.05	6.47	13.06	9.15	3.21	5.32
Average	10.75	0.09	5.33	16.26	10.59	2.73	

4.1.2 Total Dissolved Solids (TDS)

The value of TDS in the water of the current study ranges between (408.00-3757.67) mg / liter as in Table (3). The highest value is in the second site in January and the lowest value in the fourth site in December. The reason for the high values of total dissolved solids may be due to the rapid melting of the rocks through which the groundwater passed and the geological nature of the study area. As for the study sites, the lowest rate recorded is (473.00) mg / liter in the sixth site and the highest rate (3196.83) mg / liter in the second site. According to the months, the lowest rate recorded is (991.06) mg / liter in the month of October and the highest (1382.28) mg / liter in the month of January. The results of the current study are relatively close to the results obtained by [11], whose rates range between (707.80-1205.50) mg / liter and higher than the results obtained by [12], whose rates range between (2037.92-1440.84) mg / liter.

Table (3): Total dissolved solids TDS (mg/L) in well water for the studied sites

Month / Site	October	November	December	January	February	March	Average
1	606.67	461.00	692.67	508.00	519.67	490.33	546.39
2	2302.33	2910.33	3388.67	3757.67	3285.67	3536.33	3196.83
3	1522.33	1442.00	1475.00	2541.33	2003.33	1815.67	1799.94
4	615.00	503.33	408.00	417.33	538.33	653.00	522.50
5	465.00	491.33	571.00	567.33	615.33	608.33	553.06
6	435.00	461.00	495.00	502.00	473.00	472.00	473.00
Average	991.06	1044.83	1171.72	1382.28	1239.22	1262.61	

4.1.3 Electrical Conductivity (EC)

It is a measure of the liquid's ability to conduct electric current, which is directly proportional to the temperature and the concentration of dissolved ions in it. As for the water of wells in the Hamdania region, which is represented in Table (4), the values range between (7995.00-860.00) micromhoz/cm. The lowest values are recorded in the fourth site for the month of December, and the highest values are recorded in the second site for the month of January. The reason for this is due to the differences in geological formations between regions, as well as the proximity of wells and their distance from water sources. The rates of electrical conductivity values for the water wells according to the site range between (6492.00-982.33) micromhoz/cm, with the lowest rate (982.33) micromhos/cm recorded in the sixth site and the highest rate (6492.00) micromhos/cm in the second site. As for the averages of the months, they range between (1888.83_2948.72) micromhoz/cm for the months of October and January, respectively. The results of the study are relatively close to what is found by [13] for Al Rashidiya wells, north of the city of Mosul, as the values are between (1040.00-3712.00) micromhoz/cm. The results of the study are also higher than the results reached by [14] when studying some wells of Laylan sub-district in Kirkuk governorate, which range between (475.00-1581.00) micromhoz/cm.

Table (4): Electrical conductivity (EC) (micromhos/cm) for well water of the studied sites

month	October	November	December	January	February	March	Average

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site							
1	1212.00	918.67	1464.00	1063.00	1105.00	1043.00	1134.28
2	3980.00	6030.67	6416.00	7995.00	7006.67	7523.67	6492.00
3	3048.33	2957.67	3127.00	5406.67	4262.00	3862.67	3777.39
4	1255.33	1013.67	860.00	887.33	1145.00	1388.67	1091.67
5	944.67	985.67	1185.33	1276.00	1308.67	1293.67	1165.67
6	892.67	904.00	1023.67	1064.33	1005.67	1003.67	982.33
Average	1888.83	2135.06	2346.00	2948.72	2638.83	2685.89	

4.2 Chemical Aspects

4.2.1 pH value

The results of the current study in Table (5) indicate that the pH rates range between (7.03-9.80) and the highest pH value is recorded in the first site in January, reaching 9.80, while the lowest value is recorded in the third site in October reaching 7.03. The reason for this is due to the water's distance from direct weather changes which cause the dissolution of carbon dioxide in the water. According to the study sites, the lowest rate (7.22) is recorded in the third site and the highest rate (8.41) in the second site. According to the months, the lowest rate of (7.53) is recorded in October and the highest (8.19) in January. The results are higher than what is reached by [12] in his study, which ranged between (7.35-7.45) and also higher than the results reached by [15] during his study of the water wells of the University and Agricultural sectors in Nineveh Governorate, as the average values range between (7.08-7.53). In general, the pH values are within the permissible limits [16].

Table (5): pH values of well water in the studied sites

month site	October	November	December	January	February	March	Average
1	7.87	8.00	8.17	9.80	8.40	8.20	8.41
2	7.10	7.20	7.47	7.60	7.27	7.60	7.37
3	7.03	7.20	7.30	7.40	7.10	7.33	7.22
4	8.13	8.30	8.50	8.67	8.40	8.30	8.38
5	7.80	7.97	7.73	7.80	7.70	7.70	7.78
6	7.27	7.47	7.70	7.90	7.40	7.50	7.54
Average	7.53	7.69	7.81	8.19	7.71	7.77	

4.2.2 Dissolved Oxygen (DO)

Dissolved oxygen (DO) is one of the most important criteria for evaluating water quality and the degree of its pollution. Low DO is evidence of water pollution [17]. Table (6) shows the dissolved oxygen (DO) values for the wells' water of the of Al-Hamdaniya area, which ranges between (2.13-8.17) mg/l. The highest value of 8.17 mg/l is recorded in the water of the first site for the month of January, while the lowest value is recorded at 2.13 mg/l in the third site for the month of March. The reason for the difference in

dissolved oxygen values may be due to the depth of the wells, the proximity of the water level to the surface of the earth, and the weather conditions to which the wells are exposed in the studied sites, such as temperature and rain. The dissolved oxygen rates of the wells water range according to the site between (3.23-5.72) mg/L, where the lowest rate is 3.23 mg/L in the third site, while the highest rate is recorded at 5.72 mg/L in the first site. As for the monthly average values, they are between (3.08-6.82) mg/L in the months of February and October, respectively. The current results are higher than those reached by [18] when they studied the physical and chemical aspects of a number of wells in the village of Samra belonging to the Al-Alam sub-district within Salah Al-Deen governorate, as the dissolved oxygen values range between (2.75-5.37) mg / liter. These are higher than the results reached by [19] when studying the physical, chemical and biological aspects and the possibility of treating water from some wells within Kirkuk governorate, as the dissolved oxygen concentration rates range between (5.23-6.4) mg / liter.

Table (6): Values of dissolved oxygen (DO) (mg/L) in well water for the studied sites

month / site	October	November	December	January	February	March	**Average**
1	7.37	8.17	6.53	4.20	3.20	4.87	5.72
2	6.20	5.17	3.87	2.70	2.73	3.00	3.94
3	5.53	3.37	2.90	2.73	2.70	2.13	3.23
4	6.67	7.00	4.23	3.67	3.17	2.70	4.57
5	7.80	7.77	4.40	3.60	3.77	3.10	5.07
6	7.33	7.50	4.77	3.77	2.90	2.87	4.86
Average	6.82	6.49	4.45	3.44	3.08	3.11	

4.2.3 Total Alkalinity

The main source of alkalinity in well water is the weathering process of rocks caused by the presence of carbonate, bicarbonate and hydroxide ions [10]. It is noted from Table (7) that the total alkalinity values range between (3.27-9.80) mg/L, where the highest value is recorded at 9.80 mg/L in the water of the third site well for the month of December, while the lowest value is recorded at 3.27 mg/L in the well of the fifth site for the month of October. The relative decrease in the concentration of the water alkalinity of the studied wells may be due to the dry season and the consumption of bicarbonate, while the relative increase in the alkalinity may be due to the geological nature of the wells of the studied sites and the nature of the rocks that make up the soils of those wells. The total alkalinity rates of well water for the studied sites range between (5.01- 6.86) mg/L. The lowest rate of 5.01 mg/l is recorded in the second site, while the highest rate is recorded at 6.85 mg/l in the water wells of the fourth site. As for the monthly rates of well water, it ranges between (4.79-8.02) mg / liter during the months of October and December, respectively. The results of this study are lower than the results reached by [20] when they studied the evaluation of the validity of well water for a number of uses in the area between the Tigris River and the Lower Zab, in which the values range between (130.00-417.00) mg / liter. Moreover, the results obtained by [21] in the Nimrud district, south of Mosul, are less than the studied results, as the values range between (123.00-648.00) mg / liter.

Table (7): Total alkalinity values (mg/L) of well water for the studied sites

month / site	October	November	December	January	February	March	**Average**

1	5.33	7.23	9.57	5.83	6.00	5.53	6.58
2	5.03	6.43	9.57	7.13	6.70	6.27	6.86
3	5.37	5.63	9.80	6.97	7.17	5.37	6.72
4	5.80	5.60	5.70	4.20	4.60	4.13	5.01
5	3.27	6.80	6.37	4.67	5.10	4.37	5.09
6	3.93	7.63	7.10	4.30	5.30	5.03	5.55
Average	4.79	6.56	8.02	5.52	5.81	5.12	

4.2.4 Total Hardness

The total hardness of the wells' water range between (553.33-4053.33) mg/L (See Table 8). The lowest value of 553.33 mg/L is recorded in the well of the first site during the month of March, and the highest value of 4053.33 mg/L is recorded in the well of the second site during the month of January. The reason for the variation in the concentration of total hardness from one region to another may be due to the effect of these concentrations in the processes of withdrawal and pumping of groundwater and its uses in irrigation and animal watering. As for the total hardness rate according to the sites, it ranges between (663.33-3693.33) mg/L, with the lowest rate 663.33 mg/L recorded in the well of the first site and the highest rate 3693.33 mg/L recorded in the well of the second site. As for the monthly rates of well water, it ranges between (1197.78-1717.78) mg / liter during the months of November and January, respectively. The results of the study are higher than the results obtained by [22] in her study of the physical, chemical and biological aspects of the water wells in Nineveh Governorate, as its rates are between (436.00-1655.00) mg / liter. It is also higher than the results reached by [23] when studying the environment on the water of some wells in the Al-Zab district, as the rates of total hardness values in the well water samples are between (239.50-3199.00) mg / liter.

Table (8): Values of total hardness (mg/L) in the well water of the studied sites

Month site	October	November	December	January	February	March	Average
1	580.00	606.67	606.67	880.00	753.33	553.33	663.33
2	3093.33	3546.67	3913.33	4053.33	3506.67	4046.67	3693.33
3	1873.33	913.33	2320.00	2460.00	2206.67	2120.00	1982.22
4	626.67	566.67	560.00	820.00	693.33	786.67	675.56
5	680.00	680.00	820.00	993.33	846.67	960.00	830.00
6	833.33	873.33	1026.67	1100.00	833.33	886.67	925.56
Average	1281.11	1197.78	1541.11	1717.78	1473.33	1558.89	

5. Conclusions

1- Well water tends to be alkaline in some sites and in the other sites it is neutral.

2- High value of electrical conductivity, total dissolved solids, dissolved oxygen and total hardness of wells.

3- Conducting periodic studies and checks to monitor the suitability of well water for irrigation and animals watering.

6. References

[1] Al-Saady, H.A.(2017). Water Environment. Al-Bazoory Publishing House, No. of pages (300).

[2] Jen,T.(2020). Water Encyclopedia.Grade5,ISBN:978-1-945192-74-6.

[3] Al-Mashhadany, M. H. S. (2021). Assessment The Suitable of The Groundwater for Civil uses in Kakhirta Village, Al-Ayadiyah Sub-district, Iraq. In Journal of Physics: Conference Series (Vol.1879, No. 2, p. 022060). IOP Publishing.

[4] Al-Safawi, A. Y., Al-Shannouna, R. A. A. and Al-Sardar, N. M. (2018). Evaluation of water quality characteristics and calculation of the WQI coefficient for some water sources in Abu Maria village, Tal Afar District, Nineveh Governorate. Journal of Education and Science for Pure Sciences, 27(3),pp.81-98.

[5] Kabalan, A. Y. H. (2018). Assessment of the qualitative reality of water from some wells from the city of Mosul using water quality models (WQI). M.Sc. Thesis, College of Science, Department of Biology, Tikrit University.

[6] Al-Safawi, A. Y. T., Ayad,R. (2019). Using a water quality model (WQI) to assess the water condition of the wells of Hamdaniya district in Nineveh governorate for the purposes of irrigation and watering animals. International Assembly on Environment and Water, 8(4): pp.75-84.

[7] Al-Youzbakey, K. T. and Sulaiman, A. M. (2020) Ground Water Quality ofSelected Areas in the Northeastern Mosul City and their Assessments for Domestic and Agricultural Usage. Iraqi National J. of Earth Sci., 20(1):107-126 .

[8] Al-Saffawi, A. Y. T., Abubakar, B. I., Abbas, L. Y., and Monguno, A. K.(2020a). Assessment of groundwater quality for irrigation using water quality index (WQI index) in Al-kasik subdistrict northwestern, Iraq.Nigerian J. of technology., 39(2): 632-638.doi.org/10.4314/njt.v39i1.35.

[9] APHA, (2005). "Standard Methods for examination. of water and wastewater", American public Health Association, Edition: 21th ed.,Washington DC, USA .

[10] APHA, AWWA and WCPE (2017). "Stand Method for Examination of waterand wastewater American public Health Association , 23 ed.,Washington DC, USA.

[11] Fattah, S. H. S. (2015). Assessment of the water quality of some wells in Kirkuk Governorate. PhD dissertation, Tikrit University - College of Education for Pure Sciences - Department of Biology.

[12] Tarshan, Z. Kh. J. (2017). Treating groundwater salinity and assessing its physical and chemical properties in the city of Tikrit / Iraq. A M.Sc. thesis, College of Education for Women - University of Tikrit.

[13] Jaafer, A.J., and AL-Saffawi, A.Y.T.(2020). Application the logarithmic water quality index(WQI) to evaluate the wells water in AL-Rashidiya area, north Mosul for drinking and civilan uses:Plant Archives,20(1):3221-3228 .

[14] Al-Jubouri, A. M. H. (2017). An environmental study of some artesian wells in Laylan district in

Kirkuk governorate. M.Sc. thesis, College of Education for Pure Sciences, Tikrit University.

[15] Talat, R. A. Al-Assaf, A. Y.R. and Al-Saffawi, A. Y.T. (2019) Valuation ofwater quality for drinking and domestic purposes using WQI: acasestudy for groundwater of Al-Gameaa and Al-Zeraee qaurters inMosul city/Iraq. In J. of Physics: Conf Series., 1294 (7):1-10doi:10.1088/1742-6596/1294/7/07201.

[16] WHO, (2004) guidelines for drinking water quality' World Health Organization, Geneva.

[17] Madan, R. Chaudhry, S. Sharma, M. and Madan, S. (2018) Determination of water quality index of Indraprastha estate region and the vicinity areain Delhi, India. ESSENCE Int. J. Env. Rehab. Conserv., IX (1): 89-100. DOI:10.31786/09756272.18.9.1.126.

[18] Dalaas, I.S. and Abduljabar, R..A. (2018).Studying the physical and chemical properties of groundwater in the AL-Alam within the province of Salah Al-Deen. Tikrit journal for pure sciences, 23(3),pp.1-5.

[19] Mansour, A. H. M. (2021). A study of the physical, chemical and biological properties and the possibility of treating water from some wells in Kirkuk Governorate. A M.Sc. thesis, College of Education for Women – Biology Dept., Tikrit University.

[20] Saleh, R. A., Ghadban, I. I., Abdul Wahed, AR. Kh. and Faris, M. A. (2016). Assessment of the validity of well water for different uses of the area between the Tigris and Lower Zab rivers,.Tikrit Journal of Engineering Sciences, 23 (4): pp.109 - 121.

[21] Al-Saffawi, A. A. Y. (2019). Water quality of Nimrud district wellssoutheast of Mosul city for drinking and civil purpose using the canadian model of water quality. Pak J. of Anal andEnvironChem.,20(1):7581.doi.org/10.21743/pjaec/2018.06.01 .10.

[22] Al-Badrany, H. H. F. (2017). A study of the physical and chemical properties of the water of two selected wells from southwest Mosul and the use of ion exchangers for treatment. M. Sc. Thesis, College of Environment - University of Mosul.

[23] Al-Janabi, M. A. J. (2020). An environmental study on the water of some wells and the Lower Zab River in the Zab district, comparing its effect on the quality and quantity of sheep's milk. A M.Sc. Thesis, College of Education for Pure Sciences – Biology Dept., Tikrit University.