VARIATIONS OF GROUNDWATER QUALITY DURING PUMPING TEST IN JOLACK BASIN.N.IRAQ

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Introduction :المقدمـــــة

Abstract

The pumping test is done for seven location during (24) hours at Jolack basin to get the groundwater quality and their variation. The quality of water is termed as degree of salinity, PH and major ions.

Water analysis shows two kinds of water belongs for same family:

1-$CaHCO_3$ of west recharges area.

2-$CaSO_4$ of east recharges area.

The ionic concentration is different more than 10 %(significant change), but no change in water family.

All the values of ionic concentration and salinity are below the recommended suggested for human drinking, so these limits are within good water quality for irrigation.

INTRODUCTION

The situation of jolack basin is the lower east part of N-Iraq (Kirkuk governorate) (figure 1). It is surrounding by Khilkhalan Mountains east, Baba dome west and lower Zab River north. This boundary is not corresponding with divided boundary of surface water, this is meaning additional of surface topographic subdivisions areas for water recharge to the jolack basin.

The upper part of aquifer in jolack basin is consisting of gravel, sand and silt. These classtic materials are weathered products of Pliocene epoch. (Al-Syyab, Hassan 1983)

The aim of search is to find the quality changes of wells water during 24 hours pumping, then the good results is lead to ability of people and agriculture growth.

Seven wells in the basin are tested (figure1). The wells are-
1-Daraman. 2-Hassar al khaber. 3-Nabe awa. 4-Sakhisly. 5-Bebany al khaber. 6-Yarimja. 7-Kurzae.

(Table 1) is showing depth and discharge of wells.

MATERIALS AND METHODS

Many standard chemical methods are used to find the concentration of major ions for wells water (AWWA 1982,.APHA.1992 and WHO.2006). The pumping test for all wells is 24 hours, except Kuzae (well No 7) is 13 hours.

Tow equations are used to calculate the chemical change at the rang and average of chemical variables (Al Sinawa and Hassan 1982)

$$RR = \frac{\Delta R}{\text{Max-R}} \times 100 \quad \text{---------- (1)}$$

Whereas:
RR = Rang Variation Ratio.
ΔR = Difference between upper and lower limit.
Max–R = Upper limit.

$$RA = \frac{Ai - (Ai - 1)}{Ai} \times 100 \quad \text{---------- (2)}$$

RA = Average Variation Ratio.
Ai = Average Value for -i- Interval.

According to above equations, chemical variation is divided into three types: -
1- Not significant ---------- When the chemical variation during pumping test is between 1 – 5%.
2- Probably significant ---------- When the chemical variation during pumping test is between 5 – 10%.
3-Higly significant ---------- When the chemical variation during pumping test is more than 10%.

RESULTS AND DISCUSSION

A-Accuracy Of Chemical Analysis

The results of chemical analysis in (table 2) is showing the rang and average of salinity and the major ions (Potassium, Sodium, Magnesium, Calcium, Chloride, Sulphates, Bicarbonate).

The accuracy of water analysis is calculated by triple test for two random of water samples of wells (Nabe awa No 3, Yarimja No 6), by way of standard deviation method (Al Sinawa and Hassan 1982). The results of standard deviation are between 6-17⁄ 1000which is reflect good accuracy for the function of chemical analysis as shown in (table 3).

B-Chemical Variation During Pumping

The pumping time at jolack basin is depending on neediness for human, animal and agricultural activities.

The field observation is based on the highest neediness for water (upper limit for salinity) at June month

, thus, the pumping is doing in June month (Hassan and Zeki 1982).it is divided into three continues time interval as:-

1- (1 – 6) hours of pumping interval.

2- (7 – 12) hours of pumping interval.

3- (13 – 24) hours of pumping interval.

(Table 4) is show the percentage of chemical variation during three continuous time interval.

C-Average Of Chemical Variation During Time Interval

The average of chemical variation during pumping is divided into two-time interval of pumping to find the chemical variation during these intervals.

C-1- (1 – 6) hours.

C-2- (7 – 12) hours.

The results are showing in (Table 5).

D-Variation Of Upper-Lower Value During 24 hours pumping

(Table 6) is show highly significant variation in salinity for Daraman well no one, Hassar al khabir no 2, Nabe awa no 3 and Bebany al khaber no 5.

The highly significant variation in potassium ion also in water of Daraman well no one, Hassar al khaber no two, And Kurzae no 7. The highly significant variation in sodium ion at Daraman no I, Hassar al khaber no two, Nabe awa no three and Bebany al khaber. The highly significant variation in magnesium at Daraman no 1, Hassar al khaber no two and Nabe awa no three. The highly significant variation in calcium at Hassar al khaber no two and Nabe awa.

The highly significant variation in chloride and sulphates at Daraman no 1, Hassar al khaber no two, Nabe awa no three and Bebany al khaber no five.

Bicarbonate is highly significant variation at Nabe awa well no three, while probably significant at Hassar al khaber well no two.

E-Groundwater Quality

There are many methods to find the groundwater quality. The important method is that of (Scholler 1962), which is deal with all cations and anions andtheir concentration in groundwater. By looking at (Table 2), all the water wells type are calcium bicarbonate ($CaHCO_3$) during 24 hours pumping, except (kurzae well no 7), since it changes into Calcium Sulphates ($CaSO_4$) during first time interval (1 – 6 hours).

The actual reason of this difference is that all water wells are present at the side of khilkhalan mountains (figure 1) at the east side of Jolack basine, whereas Kurzae well no seven at left side of basine, near Baba dome.

Results is reflecting, no quality variation of groundwater during pumping, which is mean aquifer is homogenous and has good natural extend.

F-Water Evaluation For Drinking

The chemical variables of water wells shows at (figure 2). All the cations and anions are within allowable limit for drinking water according to world health organization (WHO 2006).

G-Water Evaluation For agriculture

The evaluation of groundwater in jolack basin for culture is done by method of (Willcox 1955). (figure 3)

Is represent the relationship between sodium as epm percentage (equivalent weight / million) and electrical conductivity as micromhos / centimeter. In order to be united scale for (figure 3), electrical conductivity is divided on 10.

The value of sodium for all water walls is between (5 – 18) and for electrical conductivity is between (26 – 72). This result is meaning that water wells are excellent for agriculture regard to sodium concentration, while it is good for electrical conductivity.

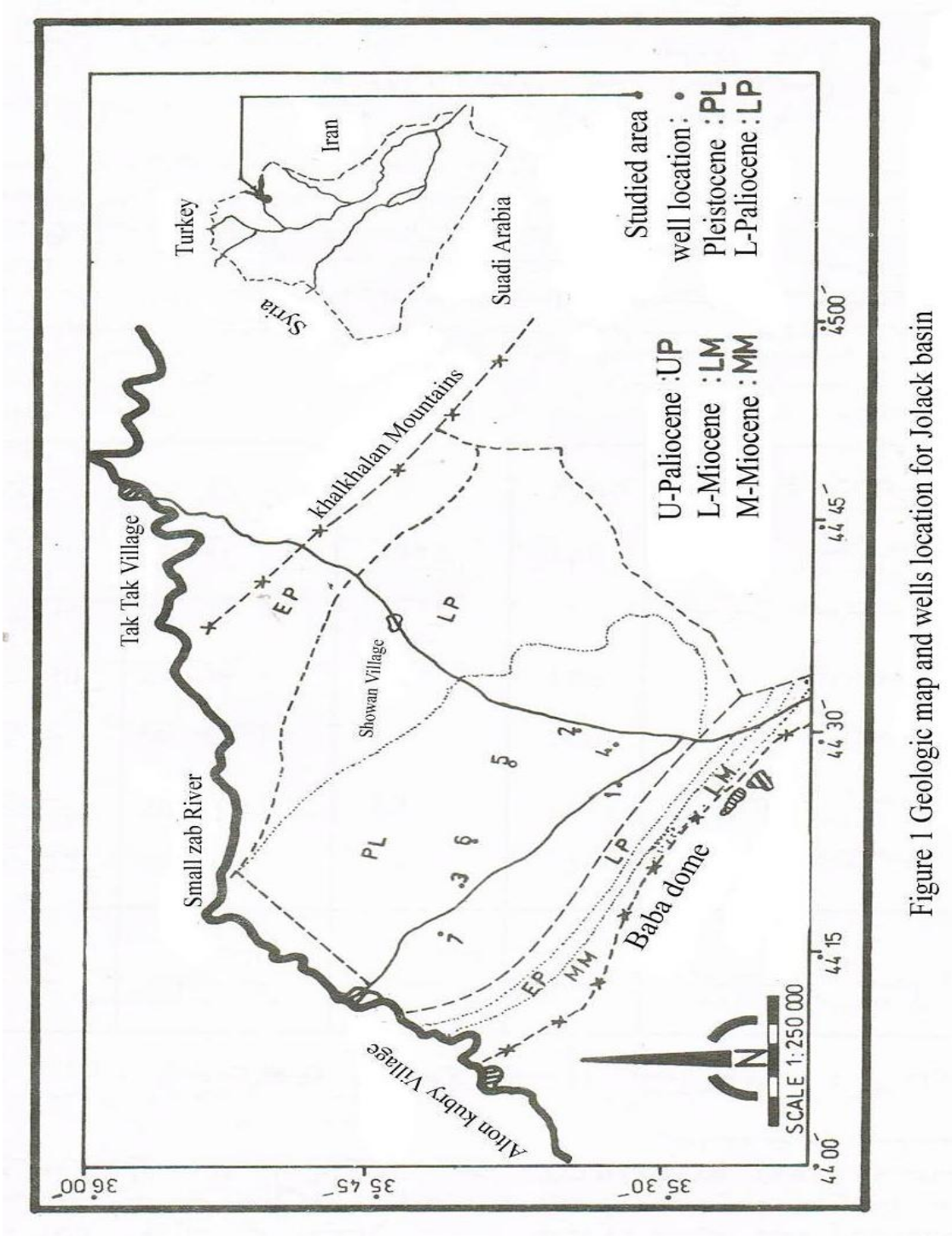

Figure 1 Geologic map and wells location for Jolack basin

Well name	Discharge-litter / second	Depth-meter
1- Daraman	8	76
2- Hassar al khaber	15	120
3- Nabe awa	18	100
4- Sakhisly	13	136
5- Bebany al khaber	15	120
6- Yarimja	10.5	110
7 -Kurzae	8	100

Table 1 discharge and depth of water wells

Table 2 upper -lower and avarage of chemical varaibles for water wells epm (equivalent per miflion)

Name of well	Time Interval		T.S.S ppm	Elect Cond mhos/cm	pH	K	Na	Mg	Ca	Cl	SO_4	HCO_3
1- Daraman	1-6	R	390-442	581-664	7.7-8.0	0.02-0.03	1.21-1.37	2.3-2.6	2.80-2.90	0.48-0.54	2.02-2.29	3.9-4.00
		A	410.2	613.88	7.78	0.026	1.28	2.41	2.85	0.50	2.13	3.94
	7-12		440-445	661-670	8.0-8.0	0.03-0.03	1.37-1.37	2.6-2.6	2.90-2.90	0.54-0.54	2.28-2.31	4.0-4.0
			442.5	665.5	7.98	0.03	1.37	2.6	2.9	0.54	[illegible]	4.0
	13-24		442-448	661-674	8.0-8.02	0.03-0.03	1.37-1.39	2.6-2.63	2.90-2.91	0.54-0.55	2.29-2.33	4.01-4.02
			444.4	668.6	7.99	0.03	1.38	2.61	2.9	0.54	2.30	4.01
2- Hassar al Khaber	1-6		172-194	261-297	6.8-7.0	0.02-0.02	0.37-0.40	0.92-1.03	2.13-2.20	0.23-0.23	0.22-0.22	3.29-3.49
			177.6	270.2	6.82	0.02	0.38	0.95	2.15	0.23	0.22	3.41
	7-12		170-192	261-294	6.9-7.0	0.02-0.02	0.36-0.41	0.91-1.02	2.13-2.20	0.22-0.25	0.22-0.24	3.38-3.46
			178.7	272	6.85	0.02	0.38	0.96	2.15	0.24	0.23	3.42
	13-24		194-268	237-422	7.1-7.4	0.02-0.03	0.41-0.57	1.03-1.43	2.20-2.37	0.26-0.35	0.24-0.34	3.49-3.76
			227	352.6	7.22	0.025	0.48	1.21	2.27	0.30	0.29	3.61
3- Nabe Awa	1-6		350-360	448-458	6.8-6.9	0.02-0.02	1.54-1.58	1.58-1.62	2.10-2.16	0.46-0.47	2.42-2.48	2.45-2.52
			355.4	454.3	6.85	0.02	1.56	1.6	2.13	0.46	2.45	2.46
	7-12		354-358	453-458	6.8-6.9	0.02-0.02	1.56-1.58	1.59-1.61	2.12-2.15	0.46-0.47	2.44-2.47	2.48-2.51
			356	455.6	6.85	0.02	1.57	1.6	2.14	0.26	2.46	2.49
	13-24		350-404	448-520	6.8-7.1	0.02-0.02	1.54-1.78	1.65-1.82	2.10-2.42	0.46-0.53	2.42-2.79	2.45-2.83
			374.5	480.3	6.94	0.02	1.64	1.63	2.25	0.49	2.58	2.62
4- Sakhisly	1-6		332-346	506-530	7.13-7.4	0.04-0.04	1.15-1.26	1.86-1.91	2.37-2.44	0.46-0.51	0.69-0.77	4.47-4.59
			340.2	502.8	7.18	0.04	1.18	1.88	2.39	0.47	0.71	4.50
	7-12		344-354	509-525	7.24-7.3	0.04-0.04	1.19-1.31	1.88-1.90	2.40-2.41	0.48-0.48	0.72-0.74	4.51-4.55
			349	516.7	7.28	0.04	1.21	1.89	2.40	0.48	0.73	4.53
	13-24		352-363	521-539	7.30-7.40	0.04-0.04	1.22-1.26	1.89-1.91	2.41-2.43	0.5-0.5	0.73-0.76	4.54-4.58
			359.5	533	7.37	0.04	1.25	1.90	2.42	0.50	0.75	4.56
5- Bebany al khaber	1-6		220-302	321-450	6.86-7.2	0.04-0.04	0.59-0.81	1.46-1.57	2.35-2.53	0.35-0.47	0.66-0.90	3.42-3.68
			236.1	346	6.61	0.04	0.63	1.48	2.39	0.37	0.71	3.47
	7-12		254-272	374-406	6.79-6.97	0.04-0.04	0.68-0.73	1.51-1.53	2.43-2.47	0.40-0.43	0.76-0.82	3.53-3.60
			264.3	390.5	6.88	0.04	0.71	1.52	2.45	0.42	0.78	3.57
	13-24		270-284	400-422	6.94-7.06	0.04-0.04	0.72-0.76	1.53-1.53	2.46-2.48	0.42-0.45	0.81-0.85	3.58-3.63
			274.3	406.3	6.98	0.04	0.73	1.53	2.47	0.43	0.82	3.60
6- Yarimja	1-6	A	260-366	408-569	7.84-8.22	0.03-0.04	1.04-1.42	1.77-1.83	2.55-2.68	0.32-0.44	1.30-1.77	3.78-4.07
		R	304.2	483.6	7.87	0.036	1.22	1.80	1.61	0.38	1.52	3.92
	7-12		260-264	408-415	7.44-7.49	0.03-0.03	1.04-1.06	1.77-1.77	2.55-2.55	0.32-0.32	1.30-1.32	3.78-3.78
			261.3	410.2	7.46	0.03	1.05	1.77	2.55	0.32	1.31	3.78
	13-18		260-268	408-422	7.44-7.53	0.03-0.03	1.04-1.07	1.77-1.78	2.55-2.55	0.33-0.33	1.30-1.34	3.78-3.80
			264.6	415.7	7.49	0.03	1.06	1.78	2.55	0.33	1.33	3.79
7- Kurzae	1-6		532-538	715-723	7.50-7.53	0.03-0.03	3.08-3.08	2.19-2.19	2.98-2.99	0.68-0.68	3.88-3.89	3.67-3.67
			355.8	719.9	7.52	1.03	3.08	2.19	2.985	0.68	3.886	3.67
	7-12		537-541	722-727	7.52-7.54	0.03-0.04	3.08-3.08	2.19-2.20	2.99-3.00	0.68-0.69	3.89-3.90	3.67-3.69
			539.5	725.1	7.53	0.036	3.080	2.196	2.996	0.686	3.896	3.685

Table 3 Accuracy of chemical analysis

Ions	Nabe awa Well	Average	Standard Deviation	Yarimja Well	Average	Standard Deviation
K	0.02 0.02 0.02	0.02	0	0.03 0.03 0.03	0.03	0
Na	1.56 1.56 1.57	1.563	0.006	1.04 1.04 1.05	1.043	0.006
Mg	1.58 1.59 1.61	1.593	0.015	1.77 1.77 1.78	1.773	0.006
Ca	2.12 2.14 2.15	2.136	0.015	2.55 2.55 2.55	2.55	0
Cl	0.46 0.46 0.47	0.463	0.006	2.32 2.33 2.32	2.323	0.006
SO_4	2.44 2.44 2.46	2.446	0.011	1.31 1.32 1.31	1.313	0.006
HCO_3	2.48 2.48 2.51	2.49	0.017	3.78 3.79 3.78	3.783	0.006

Table 4 The percentage of chemical variation during three continuous time interval

well name	Hours	TDS	EC mhos/cm	PH	K	Na	Mg	Ca	Cl	SO_4	HCO_3
1-Daraman	1- 6	11.8	12.5	3.8	33.3	11.7	11.5	3.4	11.1	11.8	2.5
	7-12	1.1	1.3	0	0	0	0	0	0	1.3	0
	13-24	1.3	1.9	0.25	0	1.43	1.1	0.7	1.8	1.7	0.25
2-Hassar al khaber	1- 6	11.3	12.5	2.9	0	7.5	10.7	3.2	0	0	2.9
	7-12	11.5	11.2	4.3	0	12.2	10.8	3.2	12	8.3	2.9
	13-24	27.6	29.6	1.4	33.3	28	28	7.2	25.7	29.4	7.2
3- Nabe awa	1- 6	2.8	2.1	1.4	0	2.5	2.5	2.8	2.12	2.4	2.8
	7-12	1.1	1.1	1.4	0	1.3	1.24	1.4	2.12	1.1	1.2
	13-24	13.24	13.8	4.2	0	13.5	13.2	13.2	13.2	13.3	13.4
4- Sakhisly	1- 6	4	4.2	4.2	0	10.2	2.6	2.9	9.8	10.4	2.6
	7-12	2.8	3	1.1	0	9.2	1.1	0.4	0	2.7	0.9
	13-24	3	3.3	1.4	0	3.2	1.6	0.8	0	3.9	0.9
5-Bebany al khaber	1- 6	25.6	28.7	4.9	0	27.2	7	7.1	25.5	26.7	7.1
	7-12	6.6	7.9	2.6	0	6.8	1.3	1.6	6.9	7.3	1.9
	13-24	4.9	5.2	1.7	0	5.3	0	0.8	6.7	4.7	1.4
6-Yarimja	1- 6	29	28.3	4.6	25	26.8	3.3	4.9	27.3	27	7.1
	7-12	1.5	1.7	0.66	0	1.9	0	0	0	1.5	0
	13-24	3	3.3	1.2	0	2.8	0.6	0	0	3	0.5
7-Kurzae	1- 6	1.1	1.1	0.4	0	0	0	0.3	0	0.3	0
	7-12	0.7	0.7	0.3	25	0	0.5	0.3	1.4	0.3	0.5

Tabler 5 The average percentage of chemical variation during continuity time interval

well name	T.S.S.	EC mhos/ cm	PH	K	Na	Mg	Ca	Cl	SO_4	HCO_3	Time interval / hour
1-Daraman	7. 3 0.42	7. 5 0.46	2. 5 0.13	13.3 0	6. 6 0.72	7. 3 0.38	1. 7 0	7.4 0	7. 0 0.43	1. 5 0.24	(1– 6) ---- (7–12) (7–12) ---- (13–24)
2-Hassar al khaber	0. 6 21. 3	0. 7 22.9	0.43 4	0 20	0 20. 8	0 21. 5	0 5. 3	4.2 20	4. 3 20. 7	0. 3 5. 3	(1– 6) ---- (7–12) (7–12) ---- (13–24)
3-Nabe awa	0.17 4. 9	0.18 4. 8	0.14 1. 2	0 0	0. 6 4. 3	0 1. 8	0.47 4. 7	0 6.1	0. 4 4. 7	0 4. 9	(1– 6) ---- (7–12) (7–12) ---- (13–24)
4-Sakhisly	2. 5 2. 9	2. 7 3. 1	1. 4 1. 2	0 0	2. 5 3. 2	0. 5 0. 5	1 0. 4	2.8 4	2. 7 2. 7	0. 7 0. 7	(1– 6) ---- (7–12) (7–12) ---- (13–24)
5-Bebany al khaber	10. 6 3. 6	11.4 3. 9	3. 9 1. 4	0 0	11. 3 2. 7	2. 6 0. 7	2. 4 0. 8	11.9 2.3	8. 9 4. 8	2. 8 0. 8	(1– 6) ---- (7–12) (7–12) ---- (13–24)
6-Yarimja	−16 1. 2	−18 1.3	−5.5 0. 7	−20 0	−16 0. 9	−1. 8 0. 6	−2.4 0	−19 3	−16 0. 8	−3.7 0. 3	(1– 6) ---- (7–12) (7–12) ---- (13–24)
7-Kurzae	0. 7	0. 7	0.13	16.7	0	0. 3	0. 4	0.9	0. 3	0. 4	(1– 6) ---- (7–12)

Table 6 chemical variation percentage for upper lower value during 24 hours pumping

well name	T.S.S.	EC mhos/cm	PH	K	Na	Mg	Ca	Cl	SO_4	HCO_3	well name
1-Daraman	7. 3 0.42	7. 5 0.46	2. 5 0.13	13.3 0	6. 6 0.72	7. 3 0.38	1. 7 0	7.4 0	7. 0 0.43	1. 5 0.24	(1- 6) --- (7-12) (7-12) --- (13-24)
2-Hassar al khaber	0. 6 21. 3	0. 7 22.9	0.43 4	0 20	0 20. 8	0 21. 5	0 5. 3	4.2 20	4. 3 20. 7	0. 3 5. 3	(1- 6) --- (7-12) (7-12) --- (13-24)
3-Nabe awa	0.17 4. 9	0.18 4. 8	0.14 1. 2	0 0	0. 6 4. 3	0 1. 8	0.47 4. 7	0 6.1	0. 4 4. 7	0 4. 9	(1- 6) --- (7-12) (7-12) --- (13-24)
4-Sakhisly	2. 5 2. 9	2. 7 3. 1	1. 4 1. 2	0 0	2. 5 3. 2	0. 5 0. 5	1 0. 4	2.8 4	2. 7 2. 7	0. 7 0. 7	(1- 6) --- (7-12) (7-12) --- (13-24)
5-Bebany al khaber	10. 6 3. 6	11.4 3. 9	3. 9 1. 4	0 0	11. 3 2. 7	2. 6 0. 7	2. 4 0. 8	11.9 2.3	8. 9 4. 8	2. 8 0. 8	(1- 6) --- (7-12) (7-12) --- (13-24)
6-Yarimja	-16 1. 2	-18 1.3	-5.5 0. 7	-20 0	-16 0. 9	-1. 8 0. 6	-2.4 0	-19 3	-16 0. 8	-3.7 0. 3	(1- 6) --- (7-12) (7-12) --- (13-24)
7-Kurzae	0. 7	0. 7	0.13	16.7	0	0. 3	0. 4	0.9	0. 3	0. 4	(1- 6) --- (7-12)

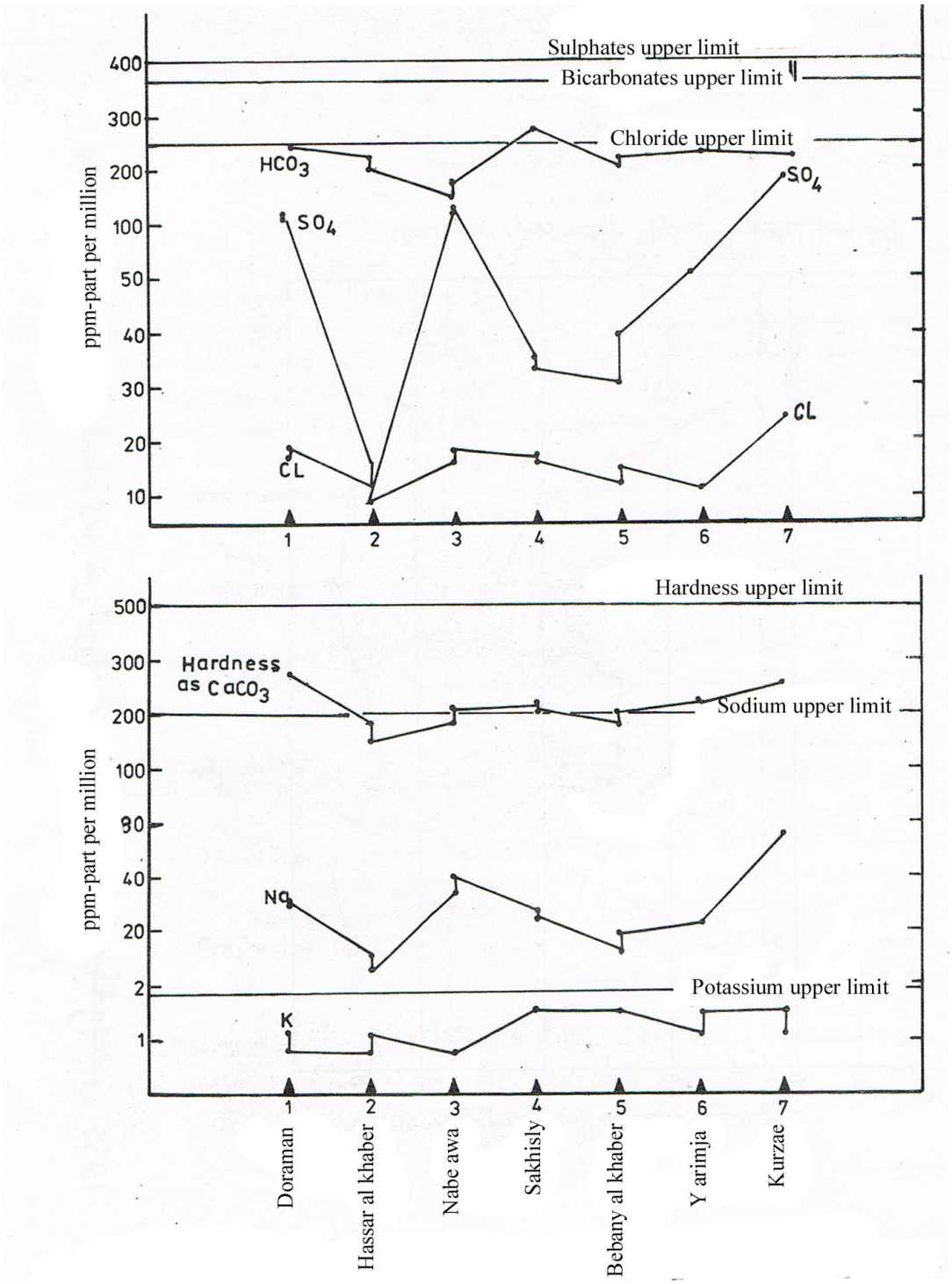

Figure.2 Chemical variation of water wells and upper-lower limit
For drinking water (WHO 2006).

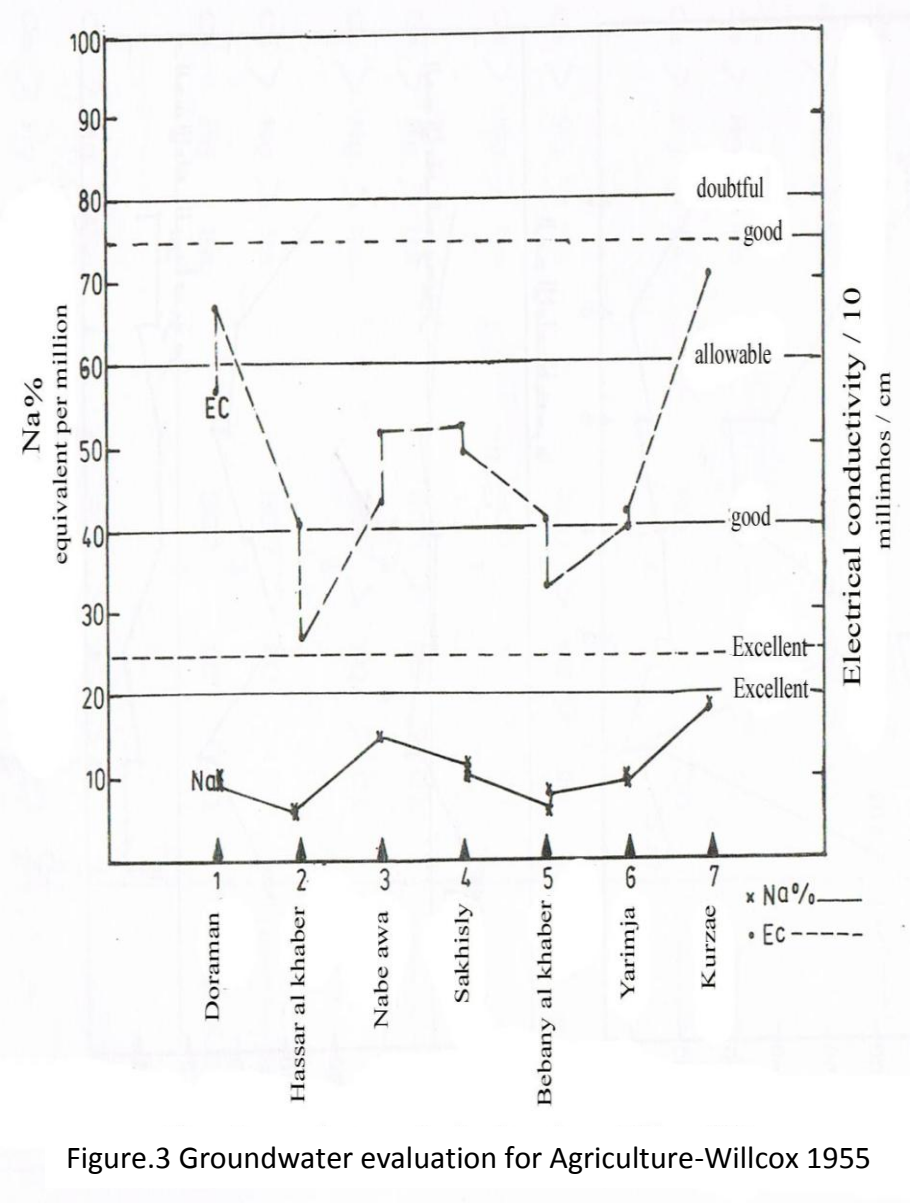

Figure.3 Groundwater evaluation for Agriculture-Willcox 1955

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التغيرات النوعية للمياه الجوفية مع الضخ الاختباري في حوض الجولاك شمال العراق

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المستخلص

تم قياس تركيز الأملاح المذابة الكلية وتركيز العناصر الرئيسة المكونة للمياه الجوفية والتوصيلية الكهربائية وكذلك الأس الهيدروجيني وذلك خلال 24 ساعة من الضخ الاختباري للمياه الجوفية في سبعة آبار (مواقع) لحوض الجولاك وذلك لغرض معرفة مدى صلاحية المياه لأغراض الشرب والزراعة .

بينت النتائج إن جميع مياه آبار الحوض هي ضمن الحدود المسموح بها لأغراض الشرب والزراعة.

وجد إن نوعية المياه الجوفية لأبار حوض الجولاك هي:

1- بيكربونات الكالسيوم ($CaHCO_3$).

2- كبريتات الكالسيوم ($CaSO_4$) .

إن نتائج عمليات الضخ الاختباري لأبار حوض الجولاك قد بينت إن نوعية المياه الجوفية لم تتغير إثناء عمليات الضخ مما يدل على سعة الخزان الجوفي وتجانسه النسبي من خلال التغيرات غير المعنوية في نوعية المياه الجوفية.