Hydrogeology of the Quaternary unit at Ali Al-Gharbidistrictnortheast Missan Governorate, Iraq

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Abstract

Management of groundwater resources requires a comprehensive understanding of the hydrogeological characteristics of the water-bearing layers. Although, the importance of groundwater resources in the northeastern Missangovernorate, south of Iraq for growing agricultural activities and industrial purposes, there is no study so far to build the conceptual model of the aquifer system and estimate its hydraulic characteristics. This study aims to use the available well log records, field data and pumping test data to study the hydrogeological characteristics of the aquifer system in the Quaternary units which mainly consists of sand and gravel in addition to clay and silt. Several cross-sections were drawn based on the well logs and analysis of these cross-sections proved that the aquifer system in the Quaternary water-bearing layer is a single shallow unconfined aquifer with an average saturated thickness equals 42 m. The aquifer in the study area is mainly recharged by rainfall and the groundwater flow is from the northeast to southwest. Monitoring of groundwater level in thirty wells for six months indicated the groundwater level slightly fluctuates means that there is a balance between the applied stress on the aquifer system (recharge and discharge). Analysis of pumping test data in six wells showed that the hydraulic conductivity ranges 1.10 – 10.41 m/d, the transmissivity is between 34.01 to 426.9 m2/d, and the specific yield is between 0.01 to 0.12. The storage in stock and renewable storage were ($3*10^9 m^3$,$1*10^9 m^3$), respectively. Wise management of the aquifer system is urgent to prevent the minimizing of the resource and deterioration of its quality.

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Keywords: Pumping test, aquifer, transmissivity, specific yield,

Groundwater, wells,hydrogeological

1. Introduction

Water is a natural resource unique to the planet Earth. Water is life to usand all living things.Water is the elixir of life; without it life is not possible. Although many environment factors determine the density and distribution of vegetation, however, one of the most important is the amount of precipitation. Agriculture can flourish in some deserts, but only with water either pumped from the ground or imported from other areas civilizations have flourished with the development of reliable water suppliesand then collapsed as their water supplies failed. (Weight, 2001, .Fetter, 1994).Groundwater becomes an important source of water supply in many urban and rural areas of the world (Todd and Mays, 2005).

recent decades groundwater became one of the most important naturalwater resources as a result of increasing in water demand and decreasingrainfall amount and surface water supplies, particularly after the emergence of drought conditions in Iraq and water policies in neighboring countries, therefore, the management of this resource is very Important to meet the increasing demand of water (Al-Ghurabi, 2016, Maaroof 2012 , Abdullah, 2007, Saad,2014),(Al-Abadi et al,2017),(Ghalib et al,2019)most parts of the east and northeast of Missan governorate where the study area is located, the groundwater is the main source of water except the areas close to the Al-teeb and Al-duwirej rivers (Al-Jubouri, 2005, Al-Kaabi,2009,Al-Kubaisi and Al-Salih, 2016). Since the two rivers are seasonal and flow during rainfall time (winter and spring), all parts area will be in need of groundwater during the dry season.

For the past two decades, the investment of groundwater in the study area was very limited, itsonly used for household purposes and petroleum industries. Recently, the demand for groundwater has raised intensively due to increasing the agricultural lands. The excessive irrigation of agricultural fields can cause aquifer depletion and deterioration of water quality.

The current study would figure out the structure of the water-bearing layers by using a conceptual model of the aquifer system in the studied area, in addition to estimating the hydraulic characteristics of the aquifer using pumping test analysis.

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2. The Study area

The study area is located in the northeastern portion of Misan governorate of the Ali Al Gharbi district, lies between (32° 34′ 23.9 ” - 32° 48′ 23”) latitudes and (46° 53′ 47.4” – 46° 35′ 1.6”) longitudes, which cover an area of approximately (590 km²) as shown in the figure(1).

There are three main parts that represent the study area (Chlat, Al-Chafta, and Khazina). The topography of this area is mostly flat, just in the eastern parts where the Hamrin hills are located along the Iraqi-Iranian borders.

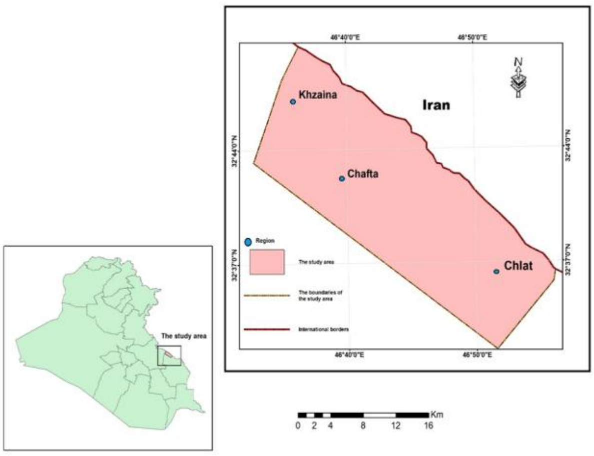
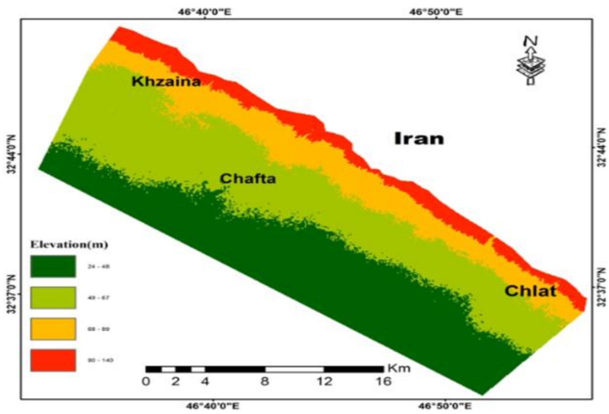


Fig. (1): location map of the study area.

The elevation ranged between (23-90)m (Al-Ali et al, 2019) as illustrated in the figure (2). The study area includes some valleys and that can be flooded during the rainfall periods, such as Chlat , Al-Chafta, Al-Talil, and Al-Jana, its depth and width ranged from (3-25m) , (20-40m),(10-



30m)and(3-20m) respectively. Therefore, its considered a source of groundwater recharge in the region (Al-Sam 1976). Some portions of the current area have been invested as quarries for sand and gravel because of the vast majority of this area is covered with Quaternary deposits (Barwari 1993).

Fig. (2): topographic map of the study area.

3. The geological setting of the study area

The study area is completely covered with sediments of the Quaternary period (Holocene - Pleistocene) (Barwary, 1993). Quaternary deposits can be found as an alluvial fan, floodplain, depression fill, or aeolian. Alluvial fan deposits mainly include gravel, sand, and silty sand as shown in Figure (3).

3.1Alluvial fans

It extends along the eastern parts of the study area at the Hamrin hills and consists of coarse deposits represented by gravel

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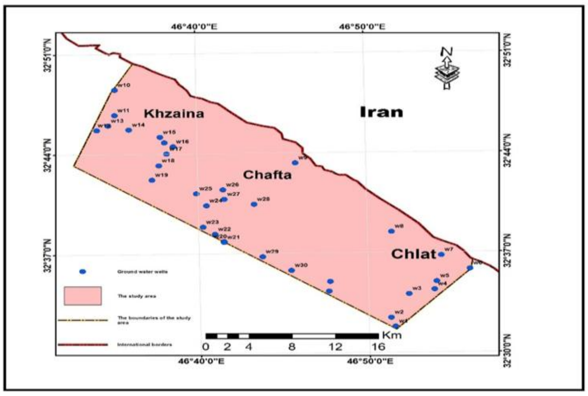
and coarse sand then gradually decreases until it reaches fine sand (Al-Jubouri 2005). These sediments constitute an important economic resource represented by gravel and sand quarries.

3.2 Aeolian deposits

These sediments appear after alluvial fan deposits especially in the central and southern parts of the study area in the form of sand sheets and sand dunes. The sediments can be observed in the south of the Chlat, Al-Jana, and the northeast of the Khazina region (Al-Shammary, 2011).

3.3 Floodplain sediments

These sediments consist of silt and clay that cover the western and southwestern parts of the study area. These areas have assigned as pasturelands and an important agricultural area where most of the groundwater wells have been used for irrigation



formation of these sediments with water flow.

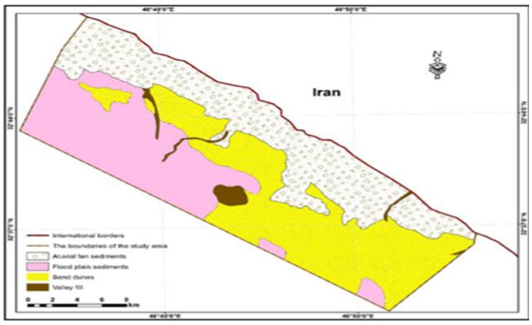


Fig. (3): geological map of the study area (modified after Barwary (1993)).

4. Methodology and materials

4.1 Field works

The fieldwork has been started in July 2020.In the first trip, (30) existing wells have been selected during the field surveys to represent all the study area as shown in Figure (4). Among those wells, six observation wells were drilled nearby pumping wells in order to implement the pumping test. A global position system (GPS) was used to identify the exact location of each well based on the latitude and longitude. Furthermore, the static water levels (S.W.L) :It is thelevel that the well water reaches in the state of still of wells were monitored and recorded for the period of (6) months started in July 2020 until December 2020.

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Fig. (4): Map of the study area showing wells location

Table (1): Data of Selected wells to monitoring groundwater levels in the study area

Well no.	Northing	Easting	Depth(m)(	s.w.l month 7	s.w.l month8	s.w.l month 9	s.w.l month 10	s.w.l month 11	s.w.l month 12	E.V(m)
W1	3600369.5	674609.5	72	5.4	5.5	5.63	5.68	5.57	5.5	23
W2	3600019	674297.19	65	2.1	2.11	2.11	2.51	2.35	2.5	30
W3	3605384.7	675286.27	72	10.75	12.19	11.16	11	10.48	11	46
W4	3605571.8	678024.74	70	13.12	14.27	14.62	31.52	12.75	12.54	58
W5	3606326.6	678350.39	70	15.6	15.57	15.51	15.8	15	14.9	57
W6	3608131.9	681440.04	88	45.4	45.46	45.62	45.69	45.75	45.8	91
W7	3609695.6	678801.29	60	31	31.1	31.11	31.17	31.17	31	93
W8	3612292.6	674265.54	85	16.65	17.13	17.54	17.8	18	17.75	62
W9	3621785.4	665281.04	70	27.2	27.1	27.1	27.13	27.7	27	85
W10	3630934.1	648280.07	60	11.28	11.66	12	12	12	12	75
W11	3627945	648629.3	60	4.9	4.92	5	5	4.97	4.9	70
W12	6326442.7	646626.93	60	5.9	6	6	11.3	6.3	6.22	56
W13	6327039	647367.64	70	6.5	12	10	10.6	7.41	8	60
W14	3626127.5	651277.6	60	14.3	14.45	16.77	16.63	14.35	14.34	58
W15	3625143.4	652594.18	65	16.38	17	17.62	16.21	15.85	17.47	65
W16	3624693.8	653440.29	70	15.4	16.55	18.5	15.83	16.15	17.89	65
W17	3623637.7	653236.98	60	15.75	16.2	16	15	15.26	15.35	63
W18	3622663.8	652410.99	65	12.48	12.64	12.45	12.4	12.73	13	61
W19	3620556.9	652018.83	70	9.6	9.5	9.2	9.52	9.85	10.6	48
W20	3609840.8	658416.37	80	11	13.84	6.76	13.3	7.15	6.6	26
W21	3610318	657230.38	120	6.82	6.47	4.19	8.5	5.17	8	26
W22	3611930.4	657507.32	70	5.58	5.88	5.65	5.85	6.58	8.45	34
W23	3615484.2	656255.08	75	14.2	12.87	15.17	13.3	13	14	43
W24	3614894.9	658151	70	14.47	15	18	17.66	12.75	17	45
W25	3613859.2	658688.7	60	11.32	11.25	11.48	11.8	10.47	14.65	55
W26	3616549.8	661063.72	82	16.84	18.31	16.84		15.64	15.8	48
W27	3607723.3	659892.12	70	2.6	3	2.4	2.78	2.55	2.4	20
W28	3606419.1	665309.4	36	4.94	4.94	5	5	5	4.87	26
W29	3605435.6	668761.15	50	5.16	6.78	6.67	5.89	5.55	5.3	30
W30	3604144	667068.92	75	8	8	7.93	7.83	7.94	7.8	26

5. Type of aquifer

Depending on the analysis of the records of wells taken from the General commission for Groundwater Misan Branch, as well as the wells that were drilled and selected in the study

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area and distributed in three regions, Figure (5) and table (2). Showed that the Quaternary age sediments (gravel, sand) are the only reservoir in the region, as shown in Figure (6) of the unconfined type, it depends on rainfall for recharge, and through the stratigraphic section of the drilled wells, secondary gypsum deposits appear as clay deposits which negatively affected the water quality (Al-Jabouri, 2005).This type of reservoir is heterogeneous in the thickness of the aquifer and the lithological nature of the sediments. It is consist of coarse sediments (gravel) along the eastern parts of the study area. After that, the sediments of a mixture of gravel and sand are converted, especially in the central, southeastern and northeastern parts. In the western parts, it is a mixture of fine sand, silt and clay. The emergence of secondary gypsum deposits and this has negatively affected the quality of water and the efficiency of wells. Because the reservoir is unconfined and most of its upper layers of sediments are characterized by high permeability, it made it completely dependent on rainwater and flood coming from the eastern side for its recharge.

Table (2): Data of selected wells

Well no.	region	x	y	Depth(m)	Elevation(m)
W1	Chlat	674609.50	3600369.52	72	23
W2	Chlat	678024.72	3605571.76	60	58
W3	Chafta	656255.08	3615484.18	66	43
W4	Serkhaton	661063.72	3616549.75	66	48
W5	Garataba	668761.15	3605435.57	50	30
W6	Al-Jana	670871.83	3612874.66	60	54
W7	Khzaina	648280.07	3630934.07	54	69

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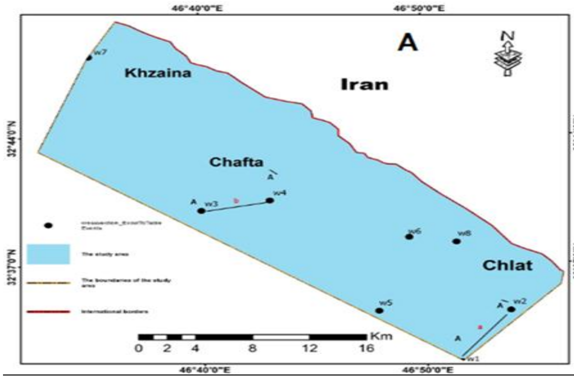
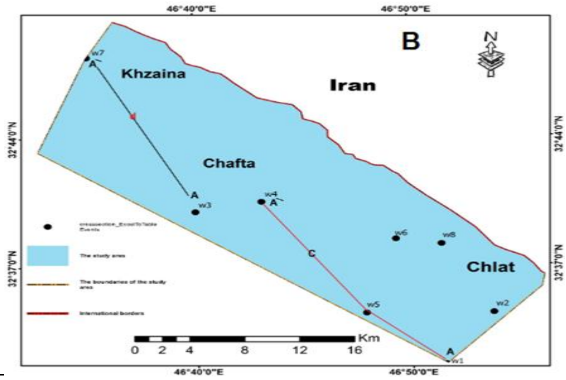
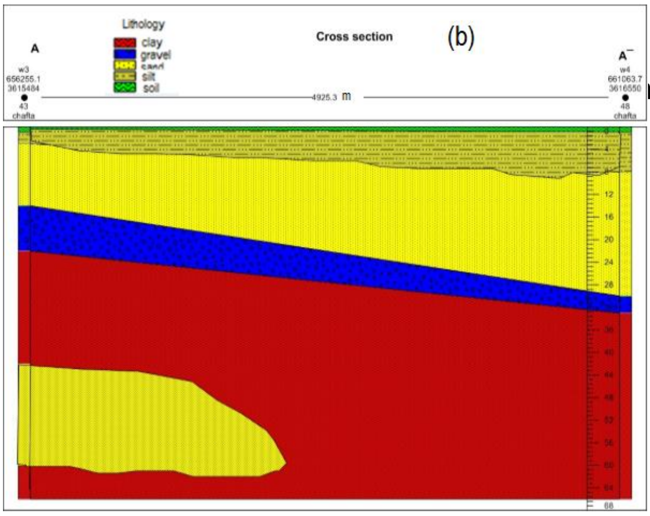
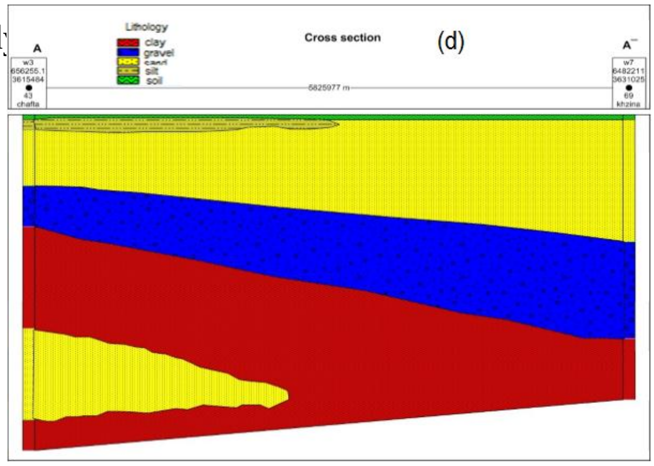
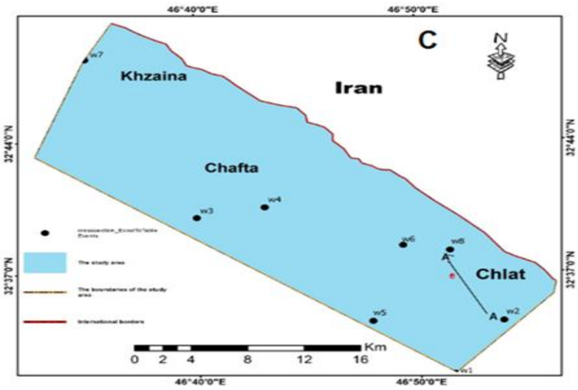
W8	Al-Jana	674187.56	3612418.49	85	70

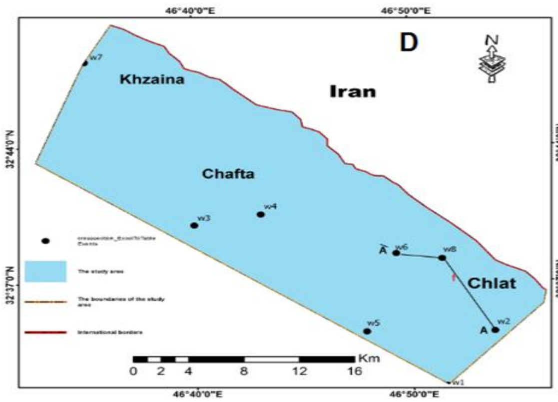












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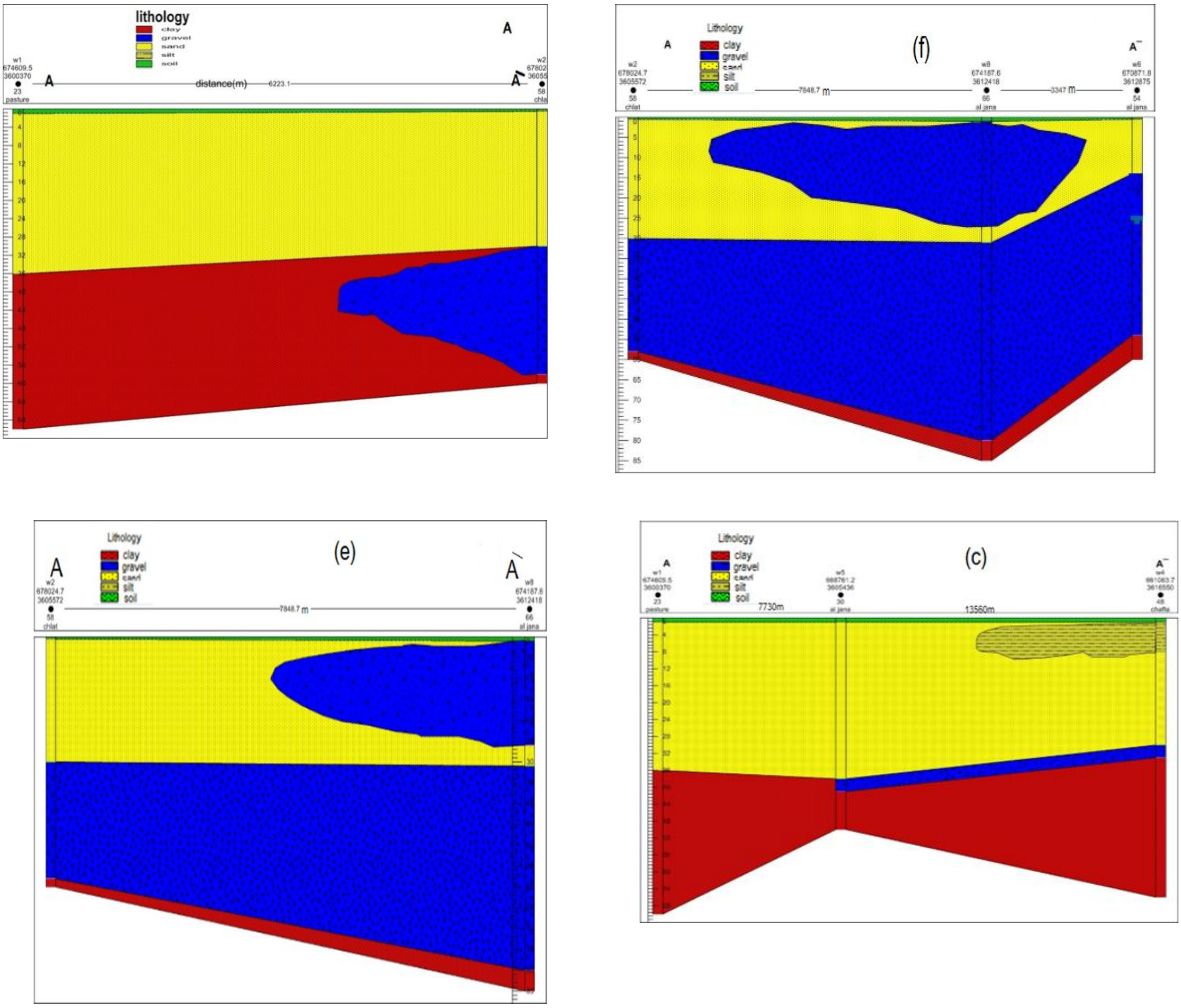

Fig. (6) :(A, B, C, D, E, F) cross- sectionshowing lithology of the drilled wells in the study area.

6. Depth of groundwater

Through monthly monitoring of the water levels of wells, which have been regularly determined in the region for a period of six months and for the period from July to December. The depths of the groundwater were not constant in most of the wells, as shown in the table (1). As a result of agricultural use in the area, but in some wells it is somewhat constant, especially in wells (w1, w2, w7, w9, w10, w11, w28) in which the water is used for specific purposes (animals, uses household) in the southwestern of the study area. the depths of ground water increase from the south-west towards the east and north-east as shown in the figure (7) for wells(w6,w7,w8,w9,w10,w14,w15,w16,w17).

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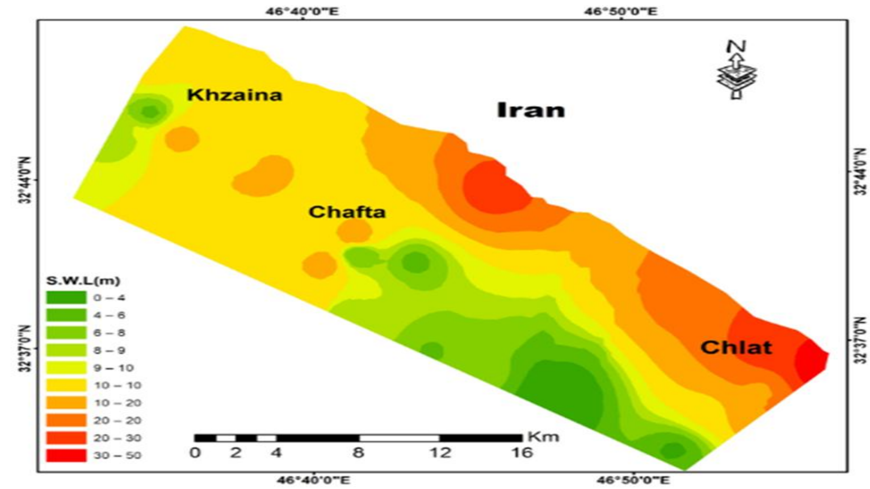
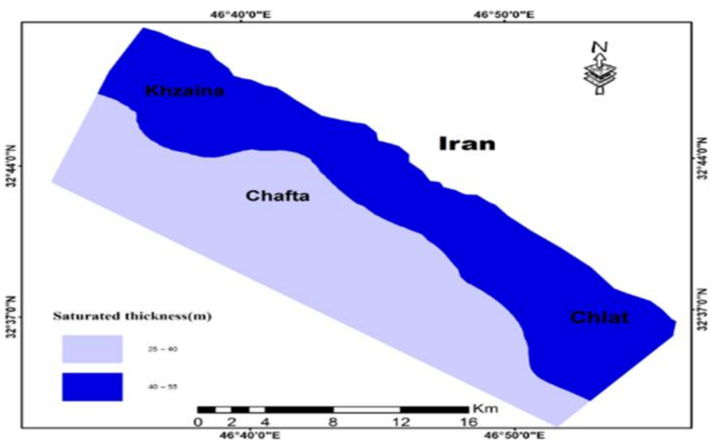


Fig. (7): Static water level in the study area.

7. Thickness of aquifer (b)

The stratigraphic sequence of these wells shows that coarse sediments (gravel, sand) extend along the eastern and northeastern parts of the study area and gradually decrease towards the



western and southern parts. Therefore, the thickness of the aquifer (b) in the eastern and northeastern parts is higher than the rest of the study area. Through Table (3), the thickness of the reservoir, by analyzing the records of wells dug by the General commission for Groundwater - Missan Branch, ranges between (25 m to 55 m) in the eastern and northeastern parts whilefor the southern and western parts and some central parts of the region, the thickness of the reservoir ranges between 15 m to 29 m, as shown in figure (8). The average thickness of the reservoir reached (42) m.

Fig. (8): Saturated thickness in the study area.

Table (3): Thickness of aquifer in the study area.

well no.	X	Y	Depth(m)	S.W.L(m)	b(m)
w1	674609.50	3600369.52	72	4.70	34
w2	678024.74	3605571.76	70	13	44.53
w3	681440.04	3608131.93	88	45.62	41
w4	670412.79	3608162.39	70	4.50	40.50
w5	658312.72	3614885.18	70	11.25	33
w6	659750.87	3616528.58	70	15.42	25
w7	655819.75	3616826.65	75	13.50	33
w8	652098.22	3620644.37	75	9	35
w9	656255.08	3615484.18	70	12	33
w10	652182.30	3622805.12	75	13	35
w11	653446.23	3624753.02	75	17	43
w12	652519.18	3624942.04	75	17	43
w13	651277.60	3626127.53	70	14	41
w14	650191.74	3627361.72	70	15	40
w15	665187.86	3621907.04	90	27	53
w16	674214.30	3612390.32	80	17.75	55
w17	646613.92	3626442.53	60	6	34
w18	648426.26	3622209.16	48	9	29
w19	648231.69	3631038.08	60	12	42
w20	656552.61	3629983.22	80	25	55
W21	669816.35	3609036.41	50	6	30
W22	679496.47	3608740.69	85	40	44
W23	650220.52	3633027.31	80	26	52
W24	681495.53	3608665.95	88	41	47

8. Groundwater recharge

The groundwater reservoirs in the study area are directly affected by climatic factors, the most important of which is rainfall, which is the main source of recharge. Groundwater

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recharge depends on the direct infiltration of water downward through the soil, as the quality of the soil has a direct effect on recharge (Al-Abadi, 2011).

On the other hand,the movement of water from the ground surface through the soil pores, passing through the unsaturated zone to the saturated zone. Therefore, the eastern and northeastern parts are the most important places for recharge, since soils are composed of coarse sediments (gravel and sand). Determining recharge areas is very important in studying the quality of groundwater, the prevailing chemical elements and the other pollutants in order to determine the areas for investment.

9. The Hydraulic properties

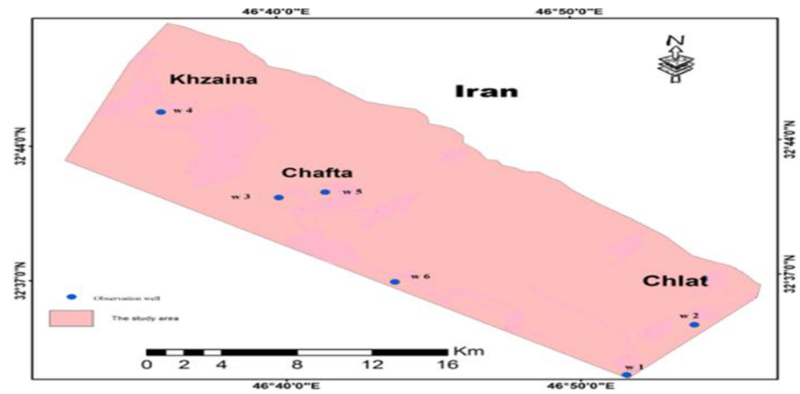
The hydraulic properties of groundwater reservoirs are very important in the study management and investment of groundwater and development projects in any region(Kruseman, and de Ridder, 1990), as well as important in the process of locating wells (Saab etal, 2015).

When studying the hydraulic properties, there are a set of questions about the condition of the aquifer and the nature of the wells drilling or drilling in the future. Among the most important of these characteristics are (hydraulic conductivity, transmissvity, storativity, specific storage). These characteristics are obtained by analyzing the results of the pumping test according to certain interpretation methods are:(Neuman's method (1974), Cooper-Jacob’s (1946) method,Moench (1997) method,Tratakovsky- Neuman method (2007)

10. Pumping test

Pumping test is a pumping a well for a period of time and observing the change in hydraulic head in the aquifer pumping test may be used to determine the capacity of the well. and the hydraulic properties of the aquifer (Fetter, 1994).

In order to apply the pumping test procedure, (6) wells were selected from the total of the wells drilled in the study area as illustrated in the figure (9), to identify the stratigraphy sequence and thickness of the reservoir. These wells were near previously drilled pumping wells distributed regularly in the study area. The results were obtained and interpreted according to the (Neuman method), (Cooper-Jacob method), (Moench), and (Tartakovsky-Neuman) using AQTESOLV software version 4.50 for 6 observation wells were classified



as unconfined aquifer The available results were through a pumping test to the 6 wells distributed in the study area with monitoring wells of the same depth that completely penetrated the groundwater reservoir and submersible Pumps of type (S.P125-3, S.P95-3, S.P46-6and S.P17.4) with electric Motor (40KW, 7.5 KW) and productivity (34.7, 26, 12.7and4 l/sec).

Fig. (9): Location of observation wells in the study area.

and discussions11. Results

11.1 Pumping test analysis

After the pumping test process for groundwater reservoirs and recording the pumping results, then the pumping data are analyzed according to scientific methods. The analyzed data includes: Measurements of the water levels in the pumping well and observation well, in addition to themeasurements of the discharge rate of the pumping well.As well as, the measurements of the recovery to water levels in the pumping well and observation well.

1-Well no. 1

The duration of pumping test process and monitoring of water level lasted for (150) minutes in the pumping well and the observation well with a constant discharge rate (8 l/sec) when using a submersible electric pump of the type (S.P30-6) and a total drawdown (33.35) meters. The drawdown settled in the minute (15). After the end of the pumping period and shut down the pump at minute (150) the water level in the observation well began to recovery to the static water level before pumping (4.70)meters (.specific capacity (SC) is (18.92m2/day). The hydraulic properties (T, S, K, Ss and Sy) of this well as analyzed according to (Neuman method, Moench method and Tartakovsky method) as shown in the

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figure (10) and specific capacity (SC) is (18.92m²/day).and saturation thickness of aquifer is (b) 34m.

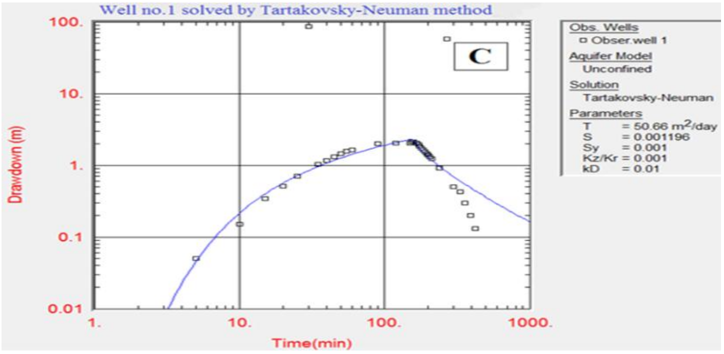

Fig. (10): A) Neuman (1974) solution,B) Monech (1997) solution, C) Tratakovsky-Neuman (2007) to observation well no. 1

Table (4) Result Solution methods for observation well no.1

Result Solution method	T(m²/d)	K(m/d)	S	Sy	Ss
Neuman	51.68	1.49	$1.082x10^{-2}$	$1x10^{-2}$	$3.136\ x10^{-5}$
Moench	48.67	1.41	$1.082x10^{-2}$	$1x10^{-2}$	$3.136\ x10^{-5}$
Tartakovsky-Neuman	50.66	1.46	$1.196x10^{-2}$	$1x10^{-2}$	$3.467\ x10^{-5}$

2-Well no. 2

The well is located in the Chlat region. The duration of pumping test process and monitoring of water level lasted for (360) minutes in the pumping well and the observation well with a constant discharge rate (34.7 l/sec) when using a submersible electric pump of the type (S.P125-3) and a total drawdown (8.46) meters. The drawdown settled in the minute (300). After pumping stopped at the minute (360), the water level in the observation well began to recovery to the static water level before pumping (13) meters at a time (660) minutes. Specific capacity (SC) is (354.60m²/day). The well results were analyzed to find the hydraulic parameters (T, S, K, Ss and Sy) according to (Neuman method, Moench method and Tartakovsky method) as in the figure (11) and saturation thickness of aquifer is (b) 44m.

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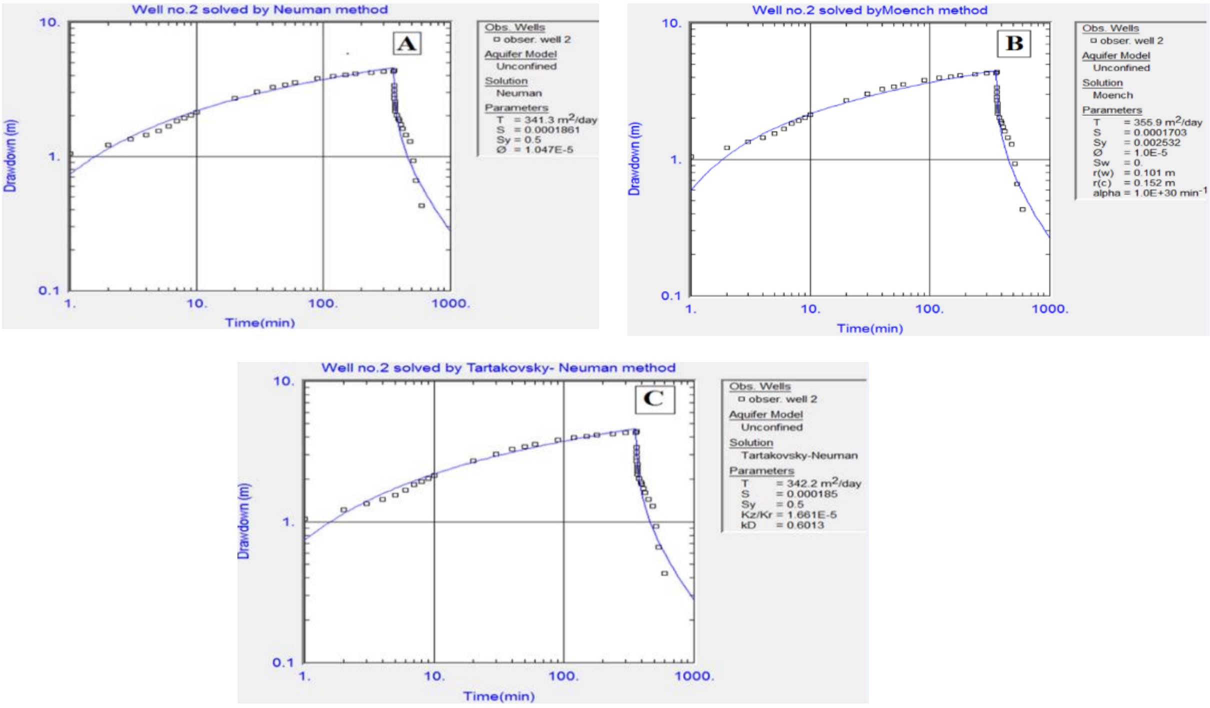

Fig. (11): A) Neuman (1974) solution, (B) Monech (1997) solution, (C) Tratakovsky-Neuman (2007) to observation well no. 2

Table (5): Result Solution methods for observation well no.2

Result Solution method	T(m²/d)	K(m/d)	S	Sy	Ss
Neuman	341.3	7.664	$1.86x10^{-4}$	$5x10^{-1}$	$4.179\ x10^{-6}$
Moench	355.9	7.992	$1.70\ x10^{-4}$	$2.5x10^{-3}$	$3.825\ x10^{-5}$
Tartakovsky-Neuman	342.2	7.685	$1.85x10^{-4}$	$5x10^{-1}$	$4.154x10^{-5}$

3-Well no. 3

The well is located in the Chafta region. The duration of pumping test process and monitoring of water level lasted for (270) minutes in the pumping well and the observation well with a constant discharge rate (26.4 l/sec) when using a submersible electric pump of the type (S.P95-3) and a total drawdown (16.95) meters

The drawdown settled in the minute (150) After the end of the pumping period and shut down the pump at minute (270) the water level in the observation well began to recovery to the static water level before pumping (12)meters at a time (480)minutes .specific capacity

(SC) is (134.51m²/day). The hydraulic properties (T, S, K, Ss and Sy) of this well as analyzed according to (Neuman method, Moench method and Tartakovsky method) as in the figure (12).and a saturation thickness of aquifer is (b) 33m

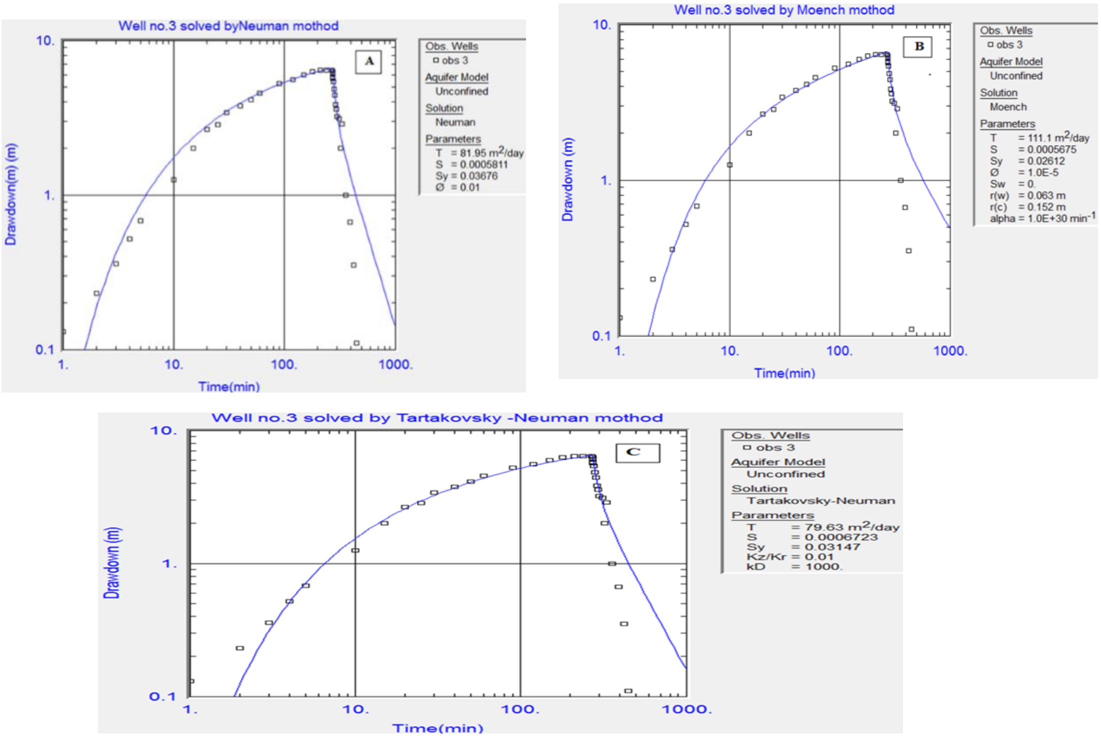

Fig. (12): A) Neuman (1974) solution,B) Monech(1997) solution ,C) Tratakovsky-Neuman (2007) to observation well no. 3

Table (6) Result Solution methods for observation well no.3

Result Solution method	T(m²/d)	K(m/d)	s	sy	Ss
Neuman	103.9	3.15	$5.796x10^{-4}$	$5x10^{-1}$	$1.756\ x10^{-5}$
Moench	110.1	3.335	$5.833\ x10^{-4}$	$5x10^{-1}$	$1.767\ x10^{-5}$
Tartakovsky-Neuman	104.1	3.153	$5.5x10^{-4}$	$5x10^{-1}$	$1.667x10^{-5}$

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4-Well no. 4

The duration of pumping test process and monitoring of water level lasted for (210) minutes in the pumping well and the observation well with a constant discharge rate (34.7 l/sec) when using a submersible electric pump of the type (S.P125-3) and a total drawdown (10.81) meters. The drawdown settled in the minute (150). After the end of the pumping period and shut down the pump at minute (210) the water level in the observation well began to recovery to the static water level before pumping (14)meters at a time (480)minutes. The hydraulic properties (T, S, K, Ss and Sy) of this well as analyzed according to (Neuman method, Moench method and Tartakovsky method) as in the figure (13) and specific capacity (SC) is (277.52m²/day).and saturation thickness of aquifer is (b) 41m.

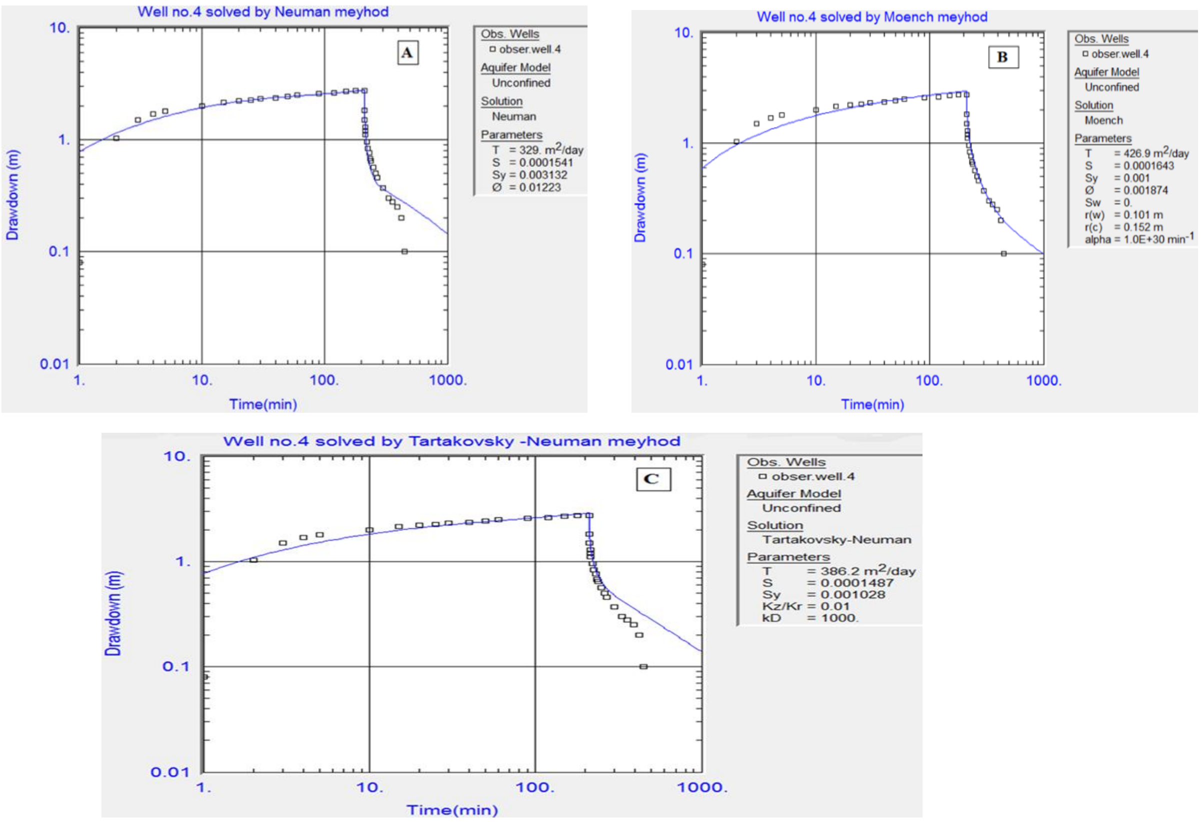

Fig. (13): A) Neuman (1974) solution,B) Monech(1997) solution ,C) Tratakovsky-Neuman (2007) to observation well no. 4

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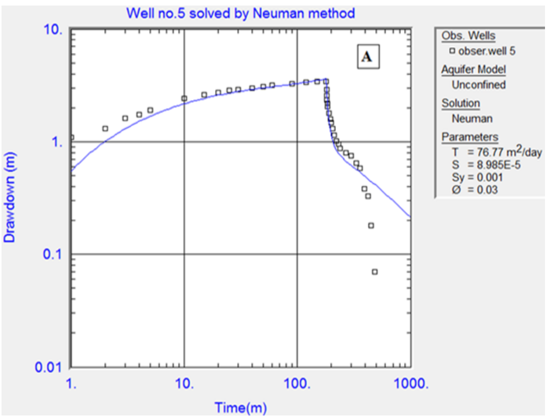
Table (7) Result Solution methods for observation well no.4.

Result method	Solution	/d) ²T(m	K(m/d)	S	Sy	Ss
Neuman		329	8.025	1.541 x10^{-3}	3.132x10^{-3}	3.758 x10^{-6}
Moench		426.9	10.41	1.643 x10^{-4}	1x10^{-3}	4.007 x10^{-6}
Tartakovsky-Neuman		386.2	9.419	1.487 x10^{-4}	1.028x10^{-3}	3.626x10^{-6}

5-Well no. 5

The duration of pumping test process and monitoring of water level lasted for (180) minutes in the pumping well and the observation well with a constant discharge rate (12.7 l/sec) when using a submersible electric pump of the type (S.P46-5) and a total drawdown (39.24) meters. The drawdown settled in the minute (25). After pumping stopped at the minute (180), the water level in the observation well began to recovery to the static water level before pumping (15.42) meters at a time (510) minutes. .specific capacity (SC) is (28.13m2/day). The well results were analyzed to find the hydraulic parameters (T, S, K, Ss and Sy) according to (Neuman method, Moench method and Tartakovsky method) as in the figure (14) and saturation thickness of aquifer is (b) 25.58m.



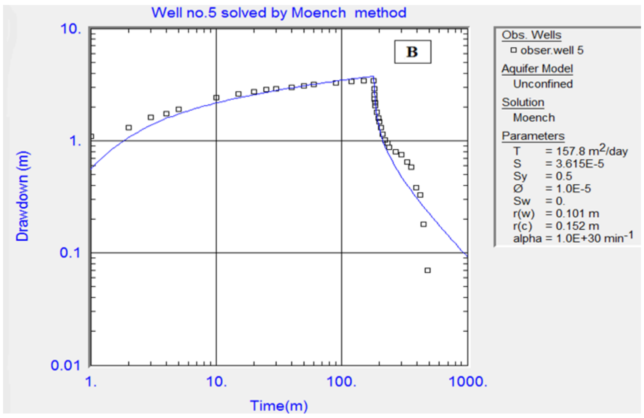


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Fig. (14): A) Neuman (1974) solution,B) Monech(1997) solution ,C) Tratakovsky-Neuman (2007) to observation well no. 5

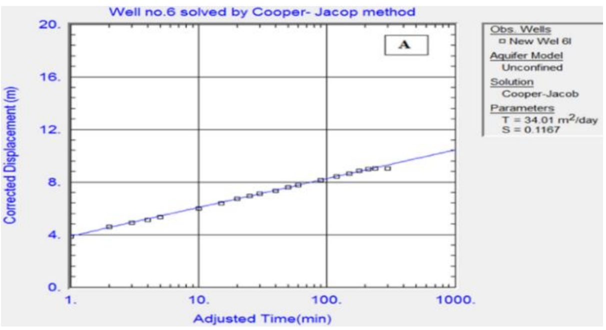
Table (8) Result Solution methods for observation well no.5

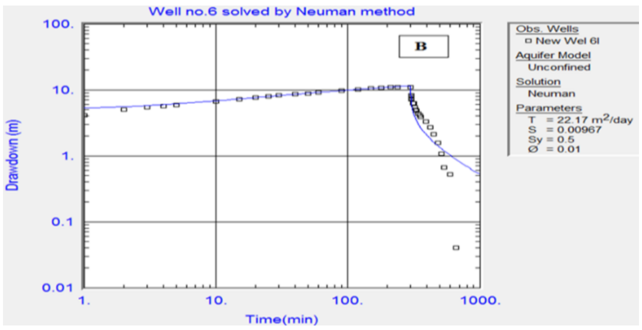
Result Solution method	T(m²/d)	K(m/d)	S	Sy	Ss
Neuman	76.77	3.001	$8.985x10^{-5}$	$1x10^{-3}$	$3.512\ x10^{-6}$
Moench	157.8	6.169	$3.615x10^{-5}$	$5x10^{-1}$	$1.413\ x10^{-6}$
Tartakovsky-Neuman	71.06	2.778	$7.452\ x10^{-5}$	$1x10^{-3}$	$2.913x10^{-6}$

6-Well no. 6

The duration of pumping test process and monitoring of water level lasted for (300) minutes in the pumping well with a constant discharge rate (4.7 l/sec) when using a submersible electric pump of the type (S.P17-4) and a total drawdown (11) meters. The drawdown settled in the minute (240).

After the end of the pumping period and shut down the pump at minute (300) the water level in the pumping well began to recoveryto the static water level before pumping (5.30)meters at a time (670)minutes. The hydraulic properties (T, S, K, Ss and Sy) of this well as analyzed according to (Cooper- Jacop method ,Neuman method, Moench method and Tartakovsky method) as in the figure (15) and specific capacity (SC) is (37.09m2/day).and saturation thickness of aquifer is (b) 30m.





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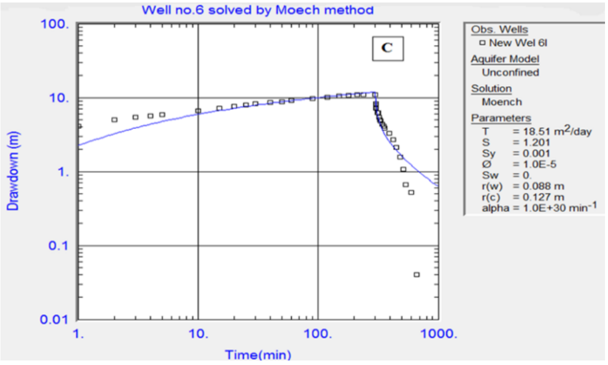

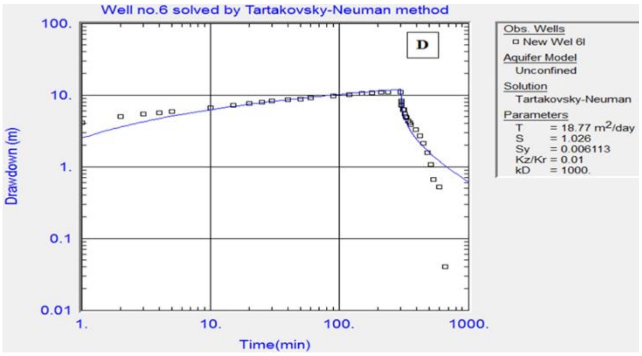

Fig. (15): A) Cooper- Jacop (1946),B) Neuman (1974) solution ,C)Moench(1997), D) Tratakovsky- Neuman (2007) to observation well no. 6

Table (9) Result Solution methods for observation well no.6

Result Solution method	T(m²/d)	K(m/d)	S	Sy	Ss
Neuman	22.17	0.722	$9.67x10^{-3}$	$5x10^{-1}$	$3.15\ x10^{-4}$
Moench	18.51	0.602	$12.01\ x10^{-1}$	$1x10^{-3}$	$3.91\ x10^{-2}$
Tartakovsky- Neuman	18.77	0.601	$10.26\ x10^{-1}$	$6.11x10^{-3}$	$3.34x10^{-2}$
Cooper- Jacop	34.01	1.108	$11.67\ x10^{-2}$		$3.80\ x10^{-3}$

10.2 Analysis Results of pumping test

The results of (T) obtained through test pumping ranged between (very low potential and moderate potential) According to (Gheorghe, 1978). The transmissivity values which are obtained from specific capacity classified as moderate potential and high potential, It Different from that obtained through pumping test because of the program of interpretation of pumping results, which depends on the values of the drawdown in the water level, discharge rate, pumping time, drilling diameter and pipe diameters for the well and pump. The coarse sediments cover the eastern and northeastern parts of the study area, where the permeability is very high. Therefore, high values of hydraulic conductivity (K) to obtained, especially in the well (2, 4) compared to the rest of the pumping test wells. Also, the specific capacity (SC) is high in the eastern

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and northeastern parts, as in the well (2, 4) due to the high productivity and low drawdown during pumping, table (10)

Table (10): Hydraulic properties values for wells in the study area by using four methods in pumping test

Well no.	Rate of discharge	Saturate d b	Neuman (1974) solution		Moench(1997)		Tratakovsky-Neuman (2007		Cooper-Jacop 1946		Specific capacity	$T=15.3*(\frac{Q}{sw})^{0.67}$
	Q (m³/d)	b(m)	T	K	T	K	T	K	T	K	SC. m²/d)	T (m²/d)
W 1	1944	34	51.6	1.4	48.6	1.4	50.6	1.4	__	__	18.9	110
W 2	3000	44	341.3	7.6	355.9	7.9	342.2	7.6	__	__	354.6	782
W 3	2880	33	103.9	3.1	110.1	3.3	104.1	3.1	__	__	134.5	408
W 4	3000	41	329	8	426.9	10.4	386.2	9.4	__	__	277.5	663
W 5	1097	25.5	76.7	3	157.8	6.1	71	2.7	__	__	28.1	143
W 6	408	30	22.1	0.7	18.5	0.6	18.7	0.6	34	1.1	37	172

Conclusions

The study showed that the sediments of the Quaternary cover all the study area, which represents the main reservoir in the region. The lithology sequence of the sedimentary showed that the reservoir is unconfined aquifer type where the thickness of the aquifer ranged between (25-55 m) and is greater in the eastern parts of the study area. Due to the exposure of coarse sediments with high permeability, in addition to runoff water coming from the Iranian borders, rainfall is the main source of recharge of reservoir in the eastern and northeastern parts of study area. The results revealed that the hydraulic conductivity, transmissivity, specific capacity and productivity of wells are high in the eastern and northeastern parts compared to the other parts of the study area.

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هيدروجيولوجيا العصرالرباعي في قضاء علي الغربي العراق,شمال شرق محافظة ميسان

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** الهيأة العامة للمياه الجوفية- وزارة الموارد المائية

الملخص

تتطلب إدارة مواردالمياه الجوفية فهماً شاملاً للخصائص الهيدروجيولوجية للطبقات الحاملة للمياه. على الرغم من أهمية المياه الجوفية في شمال شرق محافظة ميسان،جنوب العراق لتنمية الأنشطة الزراعية والأغراض الصناعية والاروائية،إلاأنه لاتوجد دراسة حتى الآن لبناء النموذج المفاهيمي لنظام الخزان الجوفي وتقدير خصائصه الهيدروليكية. تهدف هذه الدراسة إلى استخدام سجلات الآبارالمتوفرة والبيانات الميدانية وبيانات اختبارالضخ لدراسة الخصائص الهيدروجيولوجية لنظام الخزانالجوفي في ترسبات العصر الرباعي التي تتكون أساسًا من الرمل والحصى

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بالإضافة إلى الطين والطمي. تم رسم عدة مقاطع عرضية بناءً على سجلات الآبار المحفورة وأثبت تحليل هذه المقاطع العرضية أن نظام الخزان الجوفي في الطبقة الحاملة للمياه في رواسب العصر الرباعي عبارة عن طبقة مياه جوفية ضحلة واحدة غير محصورة بمتوسط سمك مشبع يساوي ٤٢ مترًا. يتغذى الخزان الجوفي في منطقة الدراسة بشكل أساسي عن طريق هطول الأمطار ويتدفق المياه الجوفية من الشمال الشرقي إلى الجنوب الغربي. أشارت مراقبة مستوى المياه الجوفية في ثلاثون بئرا لمدة ستة أشهر إلى أن مستوى المياه الجوفية يتقلب قليلاً مما يعني أن هناك توازنًا بين الضغط المطبق على نظام الخزان الجوفي (إعادة الشحن والتفريغ). أظهرتحليلبياناتاختبار الضخفيستةآبار أنالموصليةالهيدرولكيةتتراوحبين ١.١٠ - ١٠.٤١ م / يوم،وأن النفاية تتراوح بين ٣٤.٠١ إلى ٤٢٦.٩ م ٢ / يوم،وأن العائد النوعي يتراوح بين ٠.٠١ إلى ٠.١٢. كان التخزين الثابت والتخزين المتجدد (٣ * ١٠^{٦} م^{٣}، ١ *١٠^{٦} م^{٣}) على التوالي.

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