A STUDY FOR ABILITY OF WELLS WATER AS A SOURCE FOR POTABLE WATER

Haider Hussein Alwan
Engineering college
Kerbala University

Abstract

The well waters are important source to provide potable water by using storage water under ground level, it important source to provide potable water in desired.
In this study, 14 wells has been driven in some of villages Dyala governmental. A study has been selected samples from well waters, it tested chemically & physically especially (Total Dissolved Solids TDS) in Central Organization for Standardization & Quality Control in Baghdad.
A study has been drawing necessary graphs between salinity concentrations ratios in well waters & the standard limits in Iraqi standards for potable water No. 417, Also the study has been taken suitable photos for drilling, putting filter pipe screen & gravel filter pack & isolated matter between ground water and shallow water.
By this study, we can depend on the wells to provide potable water. From test results, just two wells are passing all important lab. Tests, it clean water no pollution & depend on it directly to provide potable water after disinfection stage, while the rest required to desalinate by (Reverse Osmosis system) & disinfection processes, a few of wells doesn't desalinate because high cost.

دراسة إمكانية اعتماد الآبار المائية كمصدر لمياه الشرب

حيدر حسين علوان
كلية الهندسة
جامعة كربلاء

المستخلص
تعد مياه الآبار مصدر مهم من مصادر التزود بالمياه عن طريق الاستفادة من المياه المخزونة تحت سطح الارض وهي المصدر الوحيد للماء في المناطق الصحراوية النائية.
تم دراسة (١٤) بئرا مائيا حفرت في قرى محافظة ديالى، حيث جمعت عينات من مياه هذه الآبار وفحصت مختبريا في الجهاز المركزي للتقييس والسيطرة النوعية وأهمها نسبة المواد الصلبة الذائبة الكلية (TDS) وهي مقياس تركيز الملوحة في مياه البئر. تم عمل المخططات المقارنة بين نسب تراكيز الاملاح في المياه والحدود العليا في المواصفة القياسية العراقية رقم (٤١٧)، كذلك أخذت الصور المناسبة لآلية الحفر وطريقة وضع المرشح وتحديد مكان وضع حصى الفلتر والمادة العازلة بين المياه السطحية والجوفية.
بينت الدراسة امكانية الاعتماد على الآبار كمصدر حيوي وفعال من مصادر التزود بالمياه الصالحة للشرب. أظهرت نتائج الفحوصات ان بئرين أثنين فقط تحتوي على مياه عذبة لا تحتاج الى تحلية، بل تصفية وتعقيم اما الآبار المتبقية فتحتاج الى تحلية وتصفية وتعقيم، وعدد قليل من الآبار عالي الملوحة لا يصلح للتحلية لارتفاع الكلف.

Introduction

The water area cover three quarters of global but a few percent from it is benefit for life.
Salt water ratio which is (97.47%) from total ratio doesn't benefit uses for agricultural, industrial & environmental fields, the rest ratio (2.53%) represent potable water, (1.97%) frozen water & (0.77%) storage ground water that can not benefit from it, (0.01%) from total water is the potable water which represent rivers & some lakes, i.e. the ratio which benefit equal 0.26% from potable water. This ratio represent important ground water sources to development & industrial, agricultures & environmental uses.[1]
From old years, human beings depends on wells water as a suitable manner to supply potable water for various sues as drinking, washing & cleaning & so on. This way is very important providing a water in living faraway from rivers, a well becomes the only solution for supplying water & irrigation.
The ground water is the only solution in the areas which dose not contains surface water from rivers or canals like rural & desired.
Figure (1) distribution ground water in Iraq, it is capable to classify to three zones, the first in Zagrous mountains, it is boundary with second zone by interlock each with other in these zones, either the third zone fro ground water which begin from North east Euphrates river near it interest with Iraqi boundary & extend south parallel Euphrates river till Nasiriya west to continues boundaries with some of the cavities in Southern area. Water in this area lie within aquifers from lime & dolomite rocks which less salinity.
Ground water feeding mainly from rains water except high mountains regions which it feeding from ices dissolved.[2]
Many of searches & engineering was study the well water management & how keep the wells for a long period, also detection from pollution & so on, from these researches & studies as shown below:

- **Occurrence of selected pesticides and their metabolites in Near-surface aquifers of the Midwestern United states** by Dana W. Kolpin & E. Michael Thurman & Donald A. Goolsby ((The occurrence and distribution of selected were investigated through the collection of 837 water-quality samples from 303 wells across the Midwest. Results of this study showed five of the six most frequently detected compounds were pesticide metabolites. Thus, it was common for a metabolite to be found more frequently in ground water than its parent compound.[3]
- **Reducing the sampling frequency of groundwater monitoring wells** by Virginia M. Johnson, R. Cary Tuckfield, Maureen N. Ridley & Rachel A. Anderson ((Increasing budgetary pressures are forcing organizations involved environmental detection and monitoring to look at every potential sources of cost savings, including those associated with sampling groundwater over time. The method was applied to a 1992 benchmark VOC data set from 296 wells at LINL s main site. The analytic data in LINL s groundwater monitoring database is subject to extensive quality control procedures that range from field sampling protocols, through chain-of-custody procedures.[4]
- ((**Determination of fluid flow properties from the response of water levels in wells to atmospheric loading**)) by Stuart Rojstaczer, ((the water level in a well that taps a partially confined aquifer if often sensitive to atmospheric loading. The magnitude and character of this response is partly governed by the well radius, the lateral hydraulic diffusivity of the aquifer, the thickness and vertical pneumatic diffusivity of the unsaturated zone, and the thickness and vertical hydraulic diffusivity of the saturated zone overlying the aquifer. These key elements can be combined into five dimensionless parameters that partly govern the phase and attenuation of the

response. In many cases, the response of a well to atmospheric loading can be broken up into a high, intermediate, and low-frequency response.[5]

Ground water consists of all kinds for water under ground surface like suspended water & ground water. Ground water features are decrease pollution degree, this feature capable us use it in houses especially in small cities & solitary areas, ground water is only source for irrigation in desired. Many countries are depend of ground water like USA, where (one) fifth total water from ground water. **Figure (2)** kinds of zones water under ground surface. It contains two kinds zones for ground water, zone of aeration & zone of saturation, the divider level between two zones is water surface called water table or phreatic surface.

In some cases, zone of saturation is confined by impermeable layer from top, ground water in this case called artesian water or confined ground water as shown in **figure (3)** kinds of aquifers.

Construction Of Wells

Before construction a well, it is necessary study the area by water bacteria pollution, one of important water pollution is exist septic tank or sewers line or so on, it must be away at least 25m towards in front to words it.

It capable to verify kinds of wells construction depend on many parameters like purpose of well, demand discharge quantity, ground water depth, earth geology & other economical parameters, wells divided into many kinds respect to construction method like Dug wells, bored wells, drivel wells, shallow wells with big diameter & deep wells which used to drilling of wells in this study, it construct using by hydraulic-rotary method as shown in **figure (4)**, in this method, drilling pipe end rotary by bit in same time which contains pumps mud slurry inside pipe well which collect in tanks, it aids well walls & support well collapse in addition to rise drilling cuts up to surface. Diameter & depths of this kind are 1.5m, 150m respectively.

Wells Water Filtration & Disinfection

Almost wells water clearance because it is filtered water by gravel layer which exist around the perforated filter pipes, either if pumped water from well high turbidity, then must be contains operation with high discharge till water clearance.

Water disinfection must be done after pump it from well by one of disinfection methods is chlorine disinfection in case of domestic uses. In case of high salinity wells water, to decrease this salinity must be install Reverse Osmosis (R.O. units), then through it to treatment water plant efficiency & well age depend on multi parameters as follow:

A. Execute engineering advisory especially the right drilling manner, method of filter putting & filter kinds where are two kinds of filters, the first made in site & the second made in a special factory, the second is the best because high accuracy in making perforated pipes also well age reaches to (50 year) with high pump efficiency.
B. Well age depend on the drilling & exist wells in same regions, i.e. same aquifer, this causes drop in ground water level, then well dryness.

Experimental Works (Drilling The Wells & Its Results)

A study execute on 14 wells which drilling in Dyala villages with high distance between one to others, so as to select a group from it to become a source for potable water & irrigation activities as shown in **Figure (5)** pump station for a well after success water samples from it in laboratory.

Wells drilling has been completed using Hydraulic-rotary method which use in deep wells, this method as shown in **Figure (4)**.
Wells locations study has been executed to prevent bacterial pollution & faraway from a septic tanks with distance varies between (100-150)m to guaranteed prevent transport bacterial pollution in future. Wells has been drilling using Hydraulic-rotary method as above mentioned, this capable to draw profile for all wells & know soil layers kinds, which through it determine well feeding layers & depth of aquifer also determine filter pipe length, perforated diameter, grain size distribution for gravel around filter & limitation isolated region ground water & surface water. Fig. (6) shows right drilling method, fig. (7) shows filter making in site, fig. (8) shows filter in special factory.
Table (1) show wells details & its coordinates by GPS appliance, also wells depths & profiles.
Wells water samples has been gave to laboratory tests physically & chemically, in Central Organization for Standardization & Quality Control in Baghdad as shown in table no. (2), the test includes seven tests as shown :

A. Total Hardness : This test give an indication of calcium & magnesium ratios.
B. Total Dissolved Solids (TDS): this test is very important because it good indication for salinity concentration in water, we didn't remove this ratio during flocculation, filtration & disinfection water process but we capable to reduce it to acceptance ratio which meat Iraqi standard through installation treatment plant for reverse osmosis units (R.O. units).
C. Calcium & Magnesium tests, these tests are give us as indication for water hardness.
D. Turbidity test, it is an indication for water pollution, it is indicate for sedimentation process, some times test results not accursed because error in sample giving, water pass through gravel filter pack causes water clearance from pollution like suspended solids, mud & clay.
E. Chlorine Ion test, it is indication for water salinity.
F. PH test, it is indication for alkalinities & acidity.

Table No. (2) shows test results on wells water samples where tested in Central Organization for Standardization & Quality Control in Baghdad.

<u>Result Discussion</u>

We have a high deviation in water laboratory tests for wells with respect to Iraqi standards as shown below:

Well No. (1) drilling in Maalla village, well water was failed in TDS, total hardness, calcium, turbidity & PH. Water well treatment is high cost, it required to install & built R.O. units to decrease TDS which equal to **3440 mg/l**, either PH = 3.5, we didn't solve it easily but we capable to decrease turbidity units by continues operation.

Well No. (2) drilling in Al Naqeeb village, well water was failed in TDS, total hardness, calcium, turbidity. Well water treatment is low cost, it required to install & built small R.O. units to decrease TDS which equal to **2206 mg/l**, it has small deviate from Iraqi standard therefore a small R.O.Units need. Turbidity units can be decreases by continues operation.

Well No. (3) drilling in Ali Al-Mutlaq village, well water was failed in TDS, calcium, magnesium, turbidity & Chloride salinity. Well water treatment is very high cost, it required to install & built R.O. units to decrease TDS which equal to **7644 mg/l**. from above mentioned of test results a very hard to obtain potable water from this well.

Well No. (4) drilling in Al-Essewor village, well water was failed in TDS, Total hardness, calcium, magnesium, & turbidity. Well water treatment is very high cost, it required to install & built R.O. units to decrease TDS which equal to **5279 mg/l**. from above mentioned of test results a very hard to obtain potable water from this well.
Well No. (5) drilling in Ashtoukan village, well water was failed in TDS, total hardness, calcium, & turbidity. Water well treatment is high cost, it required to install & built R.O. units to decrease TDS which equal to **3440 mg/l**.
Well No. (6) drilling in Cheft Al-Eisha village, well water was failed in TDS, total hardness & calcium. Well water treatment is low cost, it is required to install & built small R.O. units to decrease TDS which equal to **2311 mg/l**, it has small deviate from Iraqi standard therefore a small R.O.Units need.
Well No. (7) drilling in Gellabat village, well water was failed in TDS, total hardness, calcium & turbidity. Well water treatment is low cost, it required to install & built small R.O. units to decrease TDS which equal to **2549 mg/l**, it has small deviate from Iraqi standard therefore a small R.O.Units need. Turbidity units can be decreases by continues operation.
Well No. (8) drilling in Al -Ekhowaa village, well water was success in all important tests especially TDS, well water failed in Turbidity units, it very easily to reduce turbidity units by operation continues then we obtain clear water, therefore well water is succeed in tests & capable to install pump station & consider this well as a good source for potable water in the village.
Well No. (9) drilling in Ali Al Saadoun village, well water was failed in TDS, total hardness & calcium. Well water treatment is very low cost, TDS equal to **1529 mg/l**, it is very close from the standard & deviate by **(29 mg/l)**, i.e. it is capable to repeat TDS test or desalinate of water which low cost then complete ordinary process.
Well No. (10) drilling in Qurrameen village, well water was failed in TDS, total hardness, calcium & turbidity. Well water treatment is very low cost, TDS equal to **1745 mg/l**, it is close from the standard & deviate by **(275 mg/l)**, i.e. it is capable to repeat TDS test or desalinate of water which low cost & low area, then complete ordinary process.
Well No. (11) drilling in Jumaila village, well water was failed in TDS, total hardness & calcium. Well water treatment is low cost, it is required to install & built small R.O. units to decrease TDS which equal to (**2425 mg/l**), it has small deviate from Iraqi standard therefore a small R.O.Units need. Turbidity units can be decreases by continues operation.
Well No. (12) drilling in Fakka village, well water was success in all important tests especially TDS, well water failed in Turbidity units, it very easily to reduce turbidity units by operation continues then we obtain clear water, therefore well water is succeed in tests & capable to install pump station & consider this well as a good source for potable water in the village.
Well No. (13) drilling in Al-Himirat village, well water was failed in TDS, Total hardness, calcium, magnesium, & turbidity. Well water treatment is very high cost, it required to install & built R.O. units to decrease TDS which equal to **4619 mg/l**. from above mentioned of test results a very hard to obtain potable water from this well.
Well No. (14) drilling in Al-Assema village, well water was failed in TDS, total hardness, calcium & turbidity. Well water treatment is low cost, it is required to install & built small R.O. units to decrease TDS which equal to **2339 mg/l**, it has small deviate from Iraqi standard therefore a small R.O.Units need. Turbidity units can be decreases by continues operation.

From the discussion above mentioned, almost wells are failed to provide potable water by directly method, therefore must install desalinate station working in (Reverse Osmosis) to become a good source for provide potable water & other uses. The drawing curves nos. (9-14) shown below the relationship between wells water tests results with Iraqi standards.

From this study, the factors which effective on well water quality are :

A. Well geographical, soil nature & soil stratum quality, i.e. soil profile like sand, mud, clay & gravel or mix.
B. Mix surface water with deep or ground water.
C. Ground water resources which established aquifers, for example in Dyala governorate (study place), villages which drilling wells in it near from Dyala river basin which is good quality & less TDS, in addition to heavy rains, i.e. when go on from Dyala river basin, water will be high TDS & hardness also decrease in water table.
D. Well drilling place is near from publishers especially septic tanks & sewer lines or sewer basins.

Conclusion

From this study which achieved on (14) wells in Dyala villages, it is capable to the following conclusions:

A. The wells are important source from potable water sources, it capable to construct a pump station for the village or city & distribution by elevated tank.
B. Construct a pump station by a group of wells commonly to provide city with high public.
C. Isolate shallow or surface water from deep ground water which begins from 25m & above till 114 m in this study.
D. Put the screen pipe filter in suitable layers with respect to soil profile & prefer put it in gravel layers or mix with gravel layers.
E. Well is successful technically from side of water quality & quantity & less turbidity, also economically (long age) in case of almost soil drilling profile are gravel layers.
F. Shallow wells which depth less than 25m are depended for general magazines irrigation with condition that laboratory test results are success.

Recommendations

From this study experimental works, a some recommendations as following below:

A. Select a suitable & right place for drilling a well, by apply the main conditions like avoid sewerage water collection & septic tanks by a minimum distance 100m.
B. Avoid shallow wells & depend on deep wells, because more clearance & less pollution.
C. Each three months or less, all must be select a random samples from wells water to check it in laboratory
D. Avoid children from the well so that don't put a strange details which caused water pollution.
E. Put a suitable plug which opened by same diameter for suction pipe, it is prefer pipe height above ground level between (1-1.5m)

References

1- البديري، نجاح كاظم عباس، **((الاحتياجات المائية لمنظومة شط الحلة))**، اطروحة ماجستير مقدمة الى كلية الهندسة – قسم هندسة الري والبزل- جامعة بغداد، ١٩٩٦.

2- د. نجيب خروفة وآخرون، **((الري والبزل في العراق والوطن العربي))**، وزارة التعليم العالي والبحث العلمي - جامعة بغداد – كلية الهندسة، ١٩٨٤ .

3- Dana W. Kolpin & E. Michael Thurman & Donald A. Goolsby, ((**Occurrence of selected pesticides and their metabolites in Near-surface aquifers of the Midwestern United states**)), Environmental Science & technology, Vol. 30, No. 1, January, 1996.

4- Virginia M. Johnson, R. Cary Tuckfield, Maureen N. Ridley & Rachel A. Anderson, ((**Reducing the sampling frequency of groundwater monitoring wells**)), Environmental Science & technology, Vol. 30, No. 1, January, 1996.

5- Stuart Rojstaczer, ((**Determination of fluid flow properties from the response of water levels in wells to atmospheric loading**)), water resources research, vol. 24, No.11, November 1988.

Table (1) wells details (coordination, length & its profile)

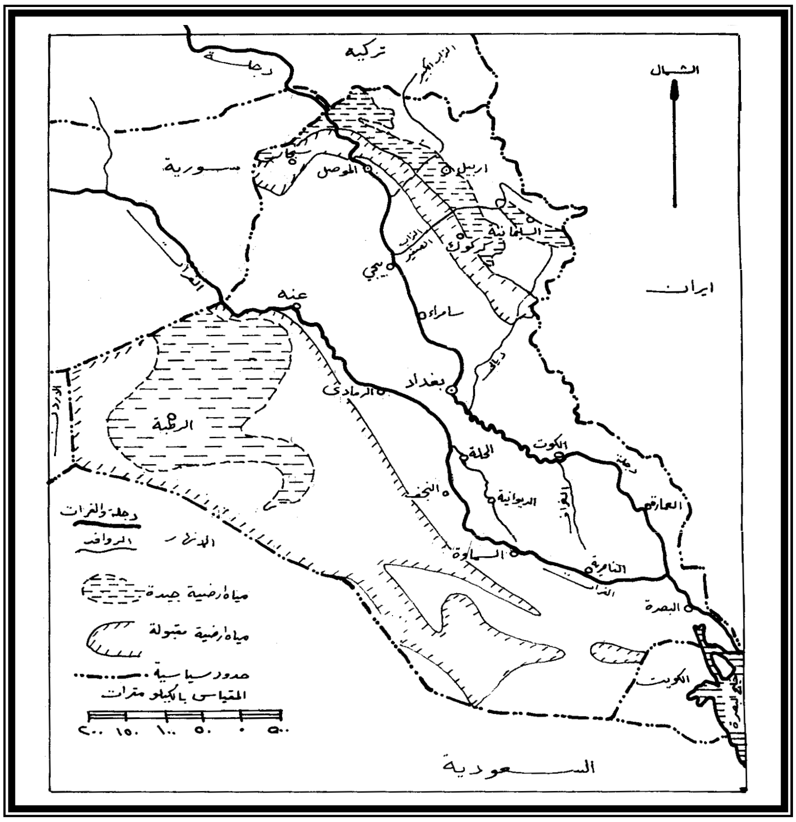
No.	Well Name (Village)	Coordinate	Depth(m)	Profile
1	Maulla	Lat N 33° 31' 34.90" Lon E 45° 45' 08.09"	85	(0-30)m clay, (30-50)m sand, (50-63)m sandy clay, (63-85) gravely clay
2	Al Naqaib	Lat N 33° 52' 41.9" Lon E 45° 17' 21.1"	40	(0-3)m clay, (3-36)m gravel, (36-40)m rocks, 40 m Artesian aquifer
3	Ali Al-Mutlaq	Lat N 33° 44' 27.9" Lon E 45° 34' 16.9"	93	(0-13)m sand, (13-16)m sandy clay (16-20)m clay, (20-23)m sandy clay (23-27)m lime, (27-30)m clay (30-37)m sand clay, (37-41)m lime (41-55)m sand clay, (55-58)m lime (58-62)m clay, (62-93)m sandy clay
4	AlEseawor	Lat N 34° 02' 52.88" Lon E 45° 15' 25.58"	90	(0-15)m clay, (15-23)m sandy clay (23-36)m clay, (36-85)m sandy clay (85-90)m clay
5	Ashtoukan	Lat N 34° 38' 40.51" Lon E 44° 50' 51.46"	100	(0-2)m clay, (2-6)m sand (6-27)m clay, (27-35)m sand (35-47)m clay, (47-72)m sandy gravel (72-82)m sand clay, (82-100)m clay
6	Cheft AlEisha	Lat N 34° 41' 31.1" Lon E 44° 47' 35.9"	114	(0-14)m clay, (14-19)m gravel (19-34)m gravely clay, (34-50)m clay (50-53)m gravel, (53-91)m gravely clay (91-99)m gravel, (99-104)m clay (104-106)m gravely clay, (106-114)m clay

7	Gallabat	Lat N 34° 35' 25.57" Lon E 44° 52' 29.53"	108	(0-5)m sand, (5-10)m clay (10-15)m clayey gravel, (15-20)m sandy clay (20-29)m clay, (29-96)m clay (96-108)m gravely clay
8	Al-Ekhowaa	Lat N 34° 19' 25.5" Lon E 45° 16' 42.5"	82	(0-14)m clay, (14-36)m sandy clay (36-52)m gravel, (52-62)m clay (62-82)m gravel
9	Ali Al Saadoun	Lat N 34° 23' 02" Lon E 45° 17' 30.4"	72	(0-23)m clay, (23-64)m gravel (64-72)m clay
10	Qurramean	Lat N 34° 25 ' 19.6" Lon E 45° 17' 30.3"	70	(0-70)m gravel
11	Jumaila	Lat N 34° 19' 35.5" Lon E 45° 03' 19.3"	101	(0-20)m sand clay, (20-52)m gravel (52-101)m gravely clay
12	Fakka	Lat N 34° 31' 24.8" Lon E 44° 55' 12.7"	90	(0-20)m clay, (20-35)m sand (35-37)m clay, (37-89)m gravel (89-90)m clay
13	Al-Humairat	Lat N 33° 51' 07.9" Lon E 45° 14' 56.3"	92	(0-5)m clay, (5-15)m sandy gravel (15-35)m sand, (35-52)m sandy clay (52-60)m gravely clay, (60-84)m gravel (84-92)m clay.
14	AL Assema	Lat N 33° 51' 20.3" Lon E 45° 23' 21.8"	102	(0-2)m clay, (2-91)m sandy clay (91-102)m gravely clay.

Table No. (2) Lab. Tests results for a random samples from (14) wells

Well No.(7)	Well No.(6)	Well No.(5)	Well No. (4)	Well No.(3)	Well No.(2)	Well No.(1)	Test / Max. limit
١٠٣٢	٩٣٣	١٠٣٦	١٧٨٨	٢٣٥	٩٤٥	١٧٢٥	**Total Hardness −500 mg /l**
٢٥٤٩	٢٣١١	٣٦٩١	٥٢٧٩	٧٦٤٤	٢٢٠٦	٣٤٤٠	**TDS – 1500 mg/l**
٢٨٤	٢١٨	٣٠٠	٤٤٢	٢٨٩	٢٦٨	٥٧٩	**Calcium − 200 mg/l**
٧٩	١٠٩	٧٠	١٦٦	٢٦٨	٦٧	٦٨	**Magnesium – 150 mg/l**
٤٢	٤.٥	٤٠	١٨	٢٤	٧٥	٣٥	**Turbidity – 5 NTU**
٢٤١	٢٩٨	٤٥٤	٥٥٤	٩٢٣	١٢٨	٥٧	**Chlorine – 600 mg/l**
٧.٤	٧.٩	٧.٨	٧.٧	٧.٦	٦.٧	٣.٧	**PH – (6.5-8.5**

Well No.(14)	Well No.(13)	Well No.(12)	Well No.(11)	Well No.(10)	Well No.(9)	Well No.(8)	Test / Max. limit
١٢٠٥	٢٣٥٨	٣٥٢	١٥٦١	٩٣٢	٦٠٠	٤٢٠	**Total Hardness −500 mg /l**
٢٣٣٩	٤٦١٩	٥٨٦	٢٤٢٥	١٧٤٥	١٥٢٩	٩٣٣	**TDS – 1500 mg/l**
٤١٠	٦٢٥	٧٧	٣٨٠	٢٨٧	٢٠٧	١٢٣	**Calcium − 200 mg/l**
٤٤	١٩٤	٣٩	١٤٩	٥٣	٢٠	٢٧	**Magnesium – 150 mg/l**
١٨	٤٠	٢٨	٣.٥	٢٧	٢.٤	٣٢	**Turbidity – 5 NTU**
١٨٥	١٩٩	٥٧	١٧٠	٨٥	٨٥	٧١	**Chlorine – 600 mg/l**
٨.٢	٨.٢	٨.١	٧.٩	٨	٧.٧	٧.٧	**PH – (6.5-8.5**



Figure(1) Ground water distribution in Iraq

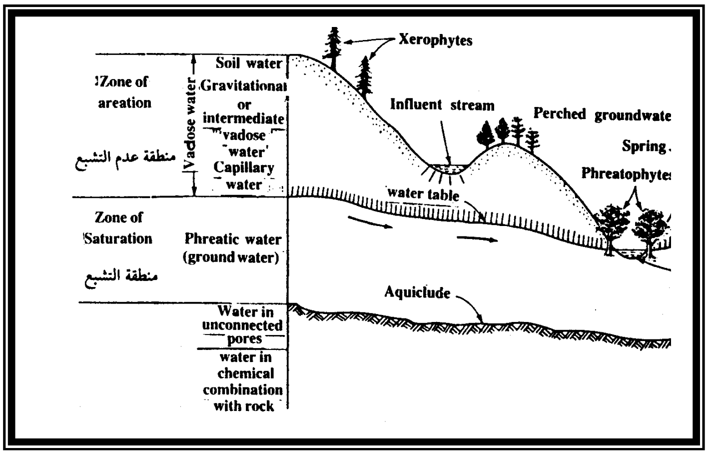


Figure (2) Shapes of exist ground water

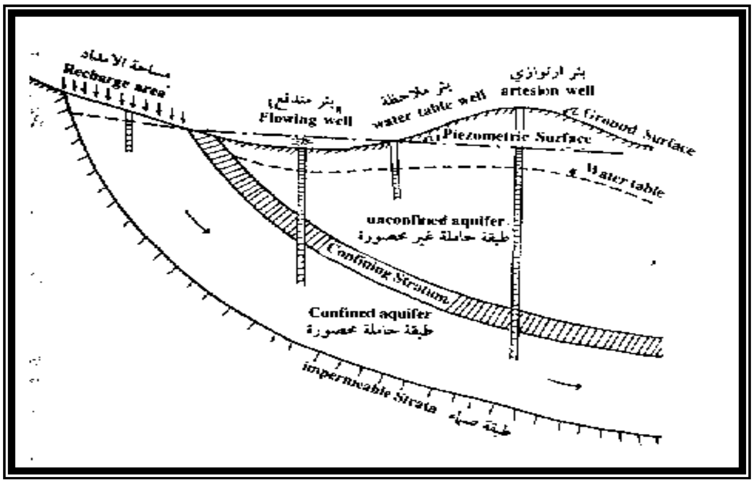


Figure (3) kinds of aquifers.

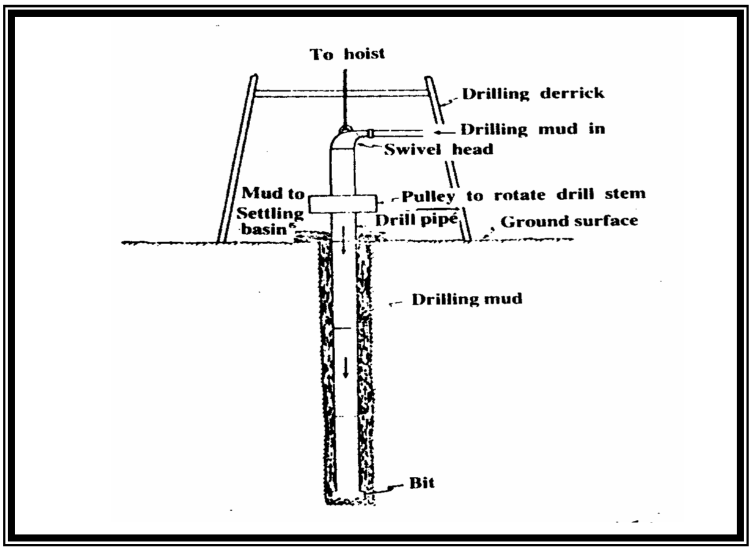


Figure (4) Deep well construction using by Hydraulic-rotary Method

Figure (5) Pump station close a well (water source)

Figure (6) Right drilling process

Figure (7) Screen filter pipes making in site

Figure (8) Screen filter pipes making in a special factory

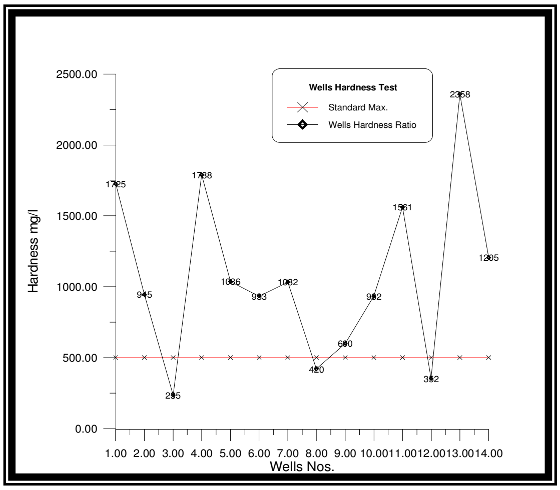


Figure (9) Total hardness results test with standards

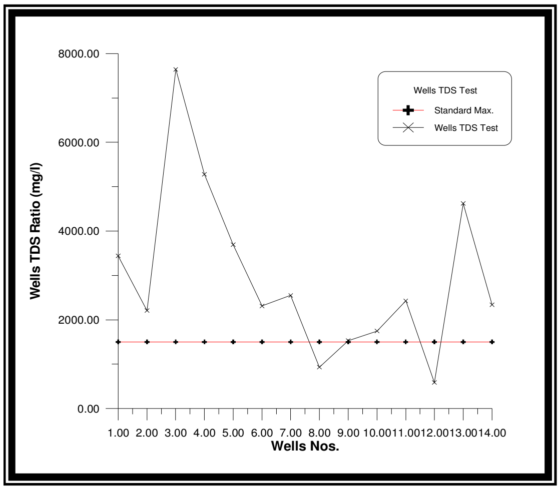


Figure (10) TDS results test with standards

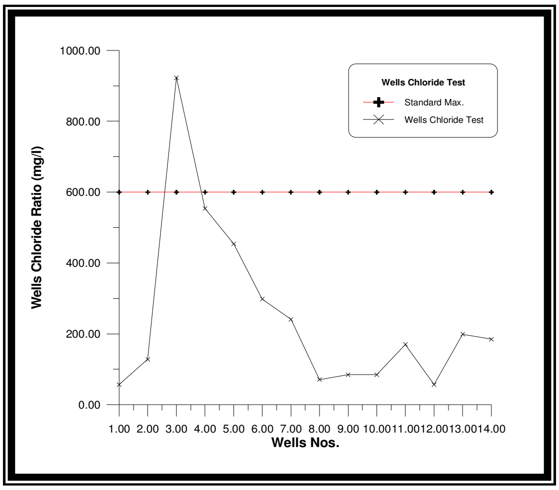


Figure (11) Chlorides results test with standards

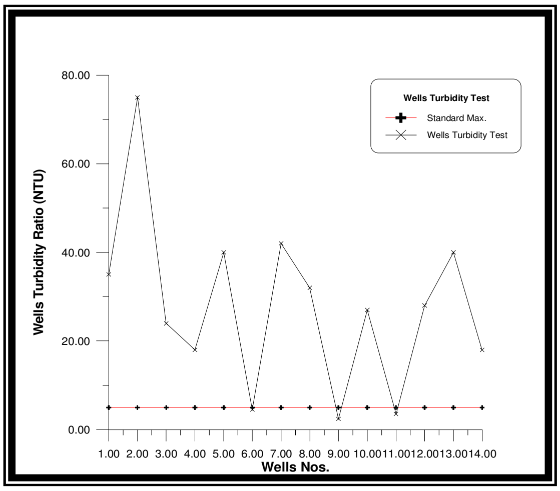


Figure (12) Turbidity results test with standards

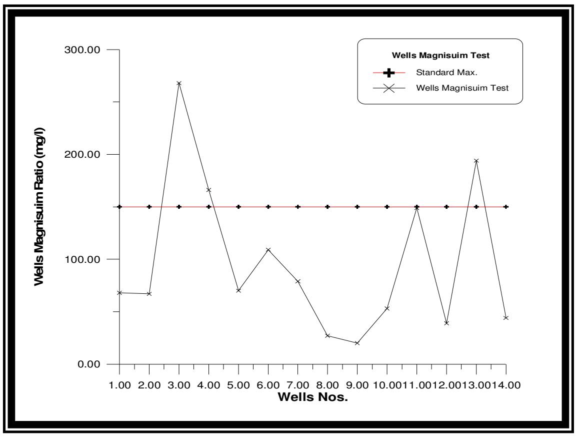


Figure (13) Magnesium results test with standards

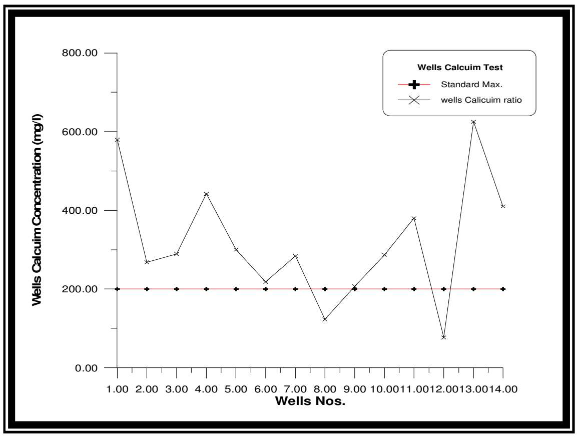


Figure (14) Calcium results test with standards