Egyptian Geophysical Society
EGS Journal, Vol. 13, No. 1, 67-82 (2015)

GEOELECTRICAL CONTRIBUTION FOR SOLVING WATER LOGGING PROBLEM IN SELECTED SITES, KILOMETER 35, CAIRO-ISMAILIA DESERT RODE, EGYPT

M.S. Barseem, T.A. Abd El Lateef, H.M. Ezz El Deen

Geophysical Exploration Department, Desert Research Center
1 St. Matahaf El Matariya, El Matariya, Cairo, Egypt.
Barseem2002@hotmail.com, dr.talaat41@yahoo.com, ezhosny@yahoo.com.

مساهمة جيوكهربية لحل مشكلة غدق المياه فى بعض المواقع-
الكيلو ٣٥ طريق القاهرة الاسماعلية الصحراوى- مصر

الخلاصة: يعتبر غدق المياه من أكبر المشاكل التى تعوق التنمية الزراعية حيث تظهر فى الأماكن المنخفضة على هيئة سبخات تتحول مع مرور الوقت الى برك و مستنقعات. و هذه الدراسة هى لفهم الأوضاع الجيولوجية التحتسطحية التى تساعد فى إيجاد الحلول المناسبة للتخلص من تجمع المياه على السطح أو قريباً منه فى منطقة جمعية عرابى التى تقع شمال شرق القاهرة مما تهدد سبل التنمية الزراعية فيها. و اختيرت مزرعتان كنموذج للتعرف على أسباب هذه المشكلة وإيجاد الحلول المناسبة لها و يصلح تنفيذها على المستوى الفردى، و لقد تم إجراء استكشاف جيوكهربى باستخدام إحدى عشرة جسة جيوكهربية عمودية بتوزيع شلمبرجير. وتعتبر هذه الدراسة نموذجاً يمكن تطبيقه على المناطق المجاورة والتى لها نفس الظروف. وتغطى هذه المنطقة برواسب تتبع عصرى الثلاثى و الرباعى ويتراوح ارتفاع سطحها عن مستوى سطح البحر من ٣٨ الى ٧٧م.

اسفرت نتائج التحليل للقياسات الجيوكهربية عن تحديد ثلاث طبقات جيوكهربيه "A" , "B", "C" تتكون من تتابعات لرواسب الرمل و الحجر الجيرى وتداخلات من الطين. كما تم تحديد طبقات من الطين فى الطبقه الثانيه "B" فى المزرعتين بقيم مقاومة نوعية منخفضة اقل من ٤,٥ اوم.متر و هى غير منفذة وتلعب دوراً أساسياً فى ظهور مشكلة غدق المياه. وأظهرت القطاعات الجيوكهربية زيادة فى قيم المقاومة الكهربية النوعية كلما اتجهنا الى أسفل و يدل ذلك على زيادة رواسب الرمل والحجر الجيرى و قلة تداخلات الطين و يؤدى هذا إلى ارتفاع فى قيم المسامية وقلة فى النفاذية. و توجد محاولات لحفر آبار فى تلك المزارع أسفرت عن وجود بئر لا يتجاوز عمقه عن ١٠ م و لم يخترق طبقة الطين السفلى وفى المزرعة الثانية توجد حفرة يصل عمقها حوالى ٨.م و تعتمد هذه المزارع على مياه ترعة الإسماعيلية تصل إليها من خلال خطوط مياه. و يتراوح عمق سطح غدق المياه فى المزرعتين من أوم . متر واحد إلى ١٢,٥ أوم . متر وتصل ملوحة المياه فى المزرعة الأولى الى ٢٥٩٠جزء فى المليون وهذه الملوحة صالحة لزراعة الأشجار. بينما ملوحة عينة المياه السطحية المأخوذة من قناة الرى القريبة منها حوالى ٣٢٢ جزء فى المليون. أما ملوحة غدق المياه فى المزرعة الثانية فتصل لحوالى ٣٠٠٠ جزء فى المليون بينما عينة المياه السطحية المأخوذة من مضخة الرى تصل الى ٢٨١ جزء فى المليون ويعنى هذا انه كلما اتجهنا جنوبا تقل ملوحة المياه.

وبناءا على ما سبق من نتائج أمكن التوصية لحل تلك المشكلة فى المزرعة الأولى" بحفر بئرين يدويين بمواصفات خاصة فى التصميم عند الجسة ٥ و٨ أو تصميم بئر حقن عند الجسة ٦ لتصريف المياه إلى أسفل. و بالنسبة للمزرعة الثانية فيمكن حفر قناة صرف حول المزرعة واستخدام مياهها فى رى الأشجار التى تعمل كسوراً حولها أو حفر بئر حقن عند الجسة رقم ٣ كحل لهذه المشكلة بها. و بالفعل تم تطبيق الحل الثانى وهو حفر بئر حقن فى المزرعة الثانية و كانت النتيجة ايجابية وأسفرت عن هبوط عمق سطح الماء الى حوالى ٤م.

ABSTRACT: *Water logging is considered one of the great problems that suppressing agricultural development. It appears in the land as patches that change to lakes, with time, in some parts. The present study concentrates on the reasons of source water logging and suggesting solving methods. The study area at the kilometer 35 at Cairo - Ismailia desert road (i.e Orabi society) which suffered from this problem. The present study is carried out on two farms to solve this problem as a case study that can be applied in other areas. The geoelectrical technique such as Vertical Electrical Soundings (VES) is a suitable tool for this study. This area is occupied mainly by sedimentary deposits belonging to the Tertiary and Quaternary ages. The interpretation of the vertical electrical soundings led to detection of three geoelectrical layers "A", "B" and "C". Generally, these layers are composed of alternative sand, limestone and clay intercalation. It is noticed that the resistivity values of geoelectrical layers increase downwards in the two farms due to increasing in sand and limestone and decreasing of clay intercalation. There is a clay layer inside layer "B" in the two farms having low resistivity values (<1.5 to 4.5 Ohm.m). This clay layer is acting as impervious layer and plays a basic role to prevent the sewage or seepage water to pass downward causing phenomena of water logging. The depth to water (sewage or seepage water) in both farms ranges from 1.25 to 2.2m as interpreted from the Vertical Electrical*

Sounding curves. The salinity value of water (sewage or seepage water) from test well in farm (I) is about 2590ppm. This water salinity is suitable for irrigation of some trees, while the salinity of surface water sample taken from irrigation beside farm (I) is 320 ppm. The salinity value of a test hole in farm (II) is about 3000 ppm, while the salinity of surface water sample taken from irrigation pump is 280 ppm. The clay contents in subsurface sediments have an effect on the salinity values. It is recommended for solving the phenomenon of water logging according to the geoelectrical results in the farm (I) to drill two hand dug water wells with special casing at sites of VES'es stations 5 and 8 or drill a drainage well (injection well) at the site of VES No. 6 to inject water downward. Drilling a hole (main drainage) around farm (II) or drilling a drainage well at site of VES No. 3 is suitable solutions for this farm. According to this study, the applied solution of drilled injection well in the farm (II) reduces the water logging level for about 4m.

INTRODUCTION

The reclamation desert lands have numerous geological and hydrological problems suppressing their development. One of these major problems is water logging appearing on the surface as patches changed to lakes with time in some parts and acts as a perched aquifer on the subsurface due to the presence of impermeable layer such as clay layer or lenses. The area around Cairo - Ismailia desert road is subjected to reclamation activities from investors and government. The area specially at kilometer 35 (Orabi Society), is suffered from this problem. The present study is carried out on two farms (I&II) to solve this problem as a case study that can be applied in other areas. These areas are irrigated by surface water coming from water line and sometimes well. The geoelectrical technique such as Vertical Electrical Soundings (VES) is a suitable tool for this study. It can be used to recognize the subsurface geological and hydrogeological settings affecting the sewage or seepage water in the area of study to solve the problem of water logging and defining the geometry of clay lenses (depth, thickness and its extension) which act as the main reason of this problem. In addition to find out whether there is a lateral and vertical change in the lithologic section from one place to another along the study areas. It can also be used to find out a better solution for dewatering or drainage sewage or seepage water that affects the surface layers and causes the problem of water logging. There are many attempts deal with the problem of water logging as Al Abaseiry 2012, Mostafa et al, 2009, Al Abaseiry et al, 2012 and Ayman et al, 2008. All trials concentrate on the reasons of source water logging and solving methods to suppress of its harmful effects. The reasons of this phenomenon related to geologic and hydrologic setting. The geologic setting related to sedimentary successions and structure also, hydrologic setting related to source of sewage water and different aquifers are clarified. The solving methods for water logging depend on getting rid of the source of sewage water.

The studied area lies at an average distance of about 35 km northeast of Cairo. It is closed to Cairo-Ismailia desert Highway as shown in Figure (1).

It lies between Latitudes 30º 11' & 30º 15' N and Longitudes 31° 27' & 31° 31' E. The present study is carried out on two farms (I&II) lying in Orabi Society at about 7 km from Cairo-Ismailia desert road and about 13km south of Ismailia Canal. The farm (II) lies south to the farm (I) and the distance between them is about 5km. These farms suffer from water logging appearing as patches at different sites.

GEOMORPHOLOGICAL, GEOLOGICAL AND HYDROGEOLOGICAL BACKGROUND

The two farms (I&II) and surrounding areas have been investigated by many authors to delineate the geomorphological, geological and hydrological setting as follows:

a. Geomorphological aspect:

The area east of the Nile Delta slopes northwards and is characterized by several types of land forms (Fig. 2). Different geomorphologic studies were carried in the eastern part of the Nile Delta, among them El Fayoumy (1968), El Shazly, et.al (1975), Hefney, et.al (1983) and Moussa, (1990). According to El-Shazly, et.al (1975), the main geomorphic units within the area lies northeast Cairo city and its surroundings from north to south are: Gebel Umm Qamar, Gebel Al-Hamza ridge, Heliopolis Basin, El Khanka and Gebel Asfer dunes, drainage lines (Wadis) and Nile Flood Plain.

The area of study includes two farms (I&II) and lies on the low land of Heliopolis Basin having general slope southeastwards towards the Cairo-Ismailia desert Highway. The average of ground elevation ranges from 38 to 77 m above the mean sea level.

b. Geological aspect:

The studied farms (I&II) and its surrounding are stratigraphically occupied mainly by sedimentary deposits belonging to the Tertiary and Quaternary. The Tertiary and Quaternary succession in the area has been discussed by several authors as Sadek, (1926), shukri and Akmal, (1953), Said, (1962), Said et.al., (1961), Sadek, (1965), El Fayoumy, (1968), Ismail et.al., (1968), Barakat et al., (1970), Soliman and Korany, (1972), El-Shazly, (1975), Youssef, (1980), El Badrawy and Soliman (1997), Hefny, (1983), El Ahwani, M.M, (1982) Helmy et.al., (1986), Helmy, (2002) and Zaghloul et.al., (1990).

The surface exposures and the subsurface succession are shown in Figs. (3&4). The Tertiary deposits are composed of sand, gravel, clay with interbeds of limestone. These deposits are varied in thicknesses increasing toward the Nile Delta reaching to more than 1000m. The Pliocene deposits outcrop NE of Cairo along the margin of Umm Gidam gravely plain. It is composed of fine sand with streaks of clay wedging

eastwards (Ezz El-Deen, 1993). The Quaternary deposits about 200m. (Pleistocene and Holocene deposits) cover a great part of the area east of the Nile Delta. They are formed from sand and gravel with clay intercalations. Aeolian sands are widely distributed over a large part of the area in the form of sand dunes (El-Khanka sand dunes) and sand sheets in the form of a huge accumulation of sand of about 120m thick. It must be noticed that the clay intercalation exhibited in the Quaternary deposits acting as reason of the water logging in the studied farms (I&II).

Structurally, according to (Sadek, 1965) and (El-Fayoumy, 1968) the area at southeast of the Nile Delta was affected by normal faults and few folds (Fig. 5), these faults striking in the E-W and NW-SE trends.

c. Hydrogeological aspect:

Several hydrogeological studies have been carried out in the eastern part of the Nile Delta that including the studied farms. These studies were discussed by Hefney et.al. (1983), El Dairy (1980), Kotb (1987), Mousa (1988), El Hadad, (1996), Ezz El Deen (1993), Hefny (1980), Sallouma, et. al. (1997) and Ahmed, et.al. (2006). The results of these studied refer to the Pleistocene and the Miocene aquifers forming the two main aquifers along the area east of the Nile Delta

Geoelectrical field survey:

Most of the electrical resistivity techniques require injection of electrical currents into the subsurface via a pair of electrodes planted on the ground. By measuring the resulting variations in electrical potential at other pairs of electrodes, it is possible to determine the variations in resistivity (Dobrin, 1988; Ozcep et al., 2009; Alile et al., 2011).

A conventional vertical electrical sounding (VES) survey is used for quantitative interpretation where the center point of the array remains fixed and the electrode spacing is increased for deeper penetration (Loke, 1999). The ultimate aim of the resistivity survey is to determine the resistivity distribution with depth on the basis of surface measurements of the apparent resistivity and to interpret it in terms of geology or hydrogeology. It is necessary to interpret the soundings data taking parameters from other sources like geological and hydrological information into consideration (Kumar et al., 2007, Yilmaz, 2011). The present study deals with the shallow successive layers to recognize the reason of the water logging problem.

The Schlumberger four electrodes array was used in carrying out the field measurements with a current electrode separation (AB) ranging from 400 to 600m. The "Terrameter SAS 1000" resistivity meter was used for measuring the apparent resistance with a high accuracy at different electrode spacing. For each of the sounding stations, the calculated apparent resistivity was plotted against the corresponding half the electrode separation (AB/2) on a bio-logarithmic scale (cycle 6.25cm).

A total of thirteen Vertical Electrical Sounding stations (VES stations) are carried out in the study areas. Eight of them at first farm (I) and five at the second farm (II). Some of these stations were measured near to the test wells to estimate the geophysical parameters available for verifying the geoelectrical interpretation. The distribution of the sounding stations and the trend of geoelectrical profiles are shown in Figure (1).

The topographic survey is carried out to determine the locations (latitudes and longitudes) of the sounding stations on that represent on the contour map of elevation values (Fig. 6) by using the GPS apparatus (Trimble type) contact with nine satellites. These maps shows elevation values ranges from 73 to 77m at farm (I) and in the farm (II) ranges from 38 to 47m.

INTERPRETAION AND DISCUSSION OF RESULTS

The sounding curves are interpreted qualitatively and quantitatively. The qualitative interpretation gives a rather descriptive analysis about the range of the measured resistivity values and the significance of such values, the approximate number of the geoelectrical layers and the relative physical relationship between the successive layers as reflected by the type of the sounding curves. The quantitative interpretation, on the other hand, involves the determination of the number of the geoelectrical layers as well as the true depth, thickness and resistivity of each layer.

a. Qualitative interpretation:

It includes comparison of the relative changes in the apparent resistivity and thickness of the different layers in the sounding curves as in Figure (7) for the two farms (I&II). It gives information about the number of layers, their continuity throughout the area or in a certain direction and it reflects the degree of homogeneity or heterogeneity of the individual layer. Qualitative interpretation of the field VES curves in the present study indicates the following:

1- The general types of the sounding curves in the two farms (I&II) are characteristic by KQH and QQH types curve of three geoelectrical layers of high resistivity with depth due to increment of sand and limestone content (VES No.3) in farm (II).

2- The variation in the resistivity values on the first and second cycles of the resistivity curves represents the surface and near surface variations. However, they reflect heterogeneity characterizing the first layers and the low values of resistivity reflect the presence of clay content. In going downwards on the curves (The third cycles) terminate with H type reflecting homogeneity and continuous aerial extension of the deep layers.

3- From a visual inspection of these type curves, it is noticed that the resistivity of the clay lens has low resistivity and lying on different depth. These lenses play a basic role to prevent the sewage or seepage water to pass downward.

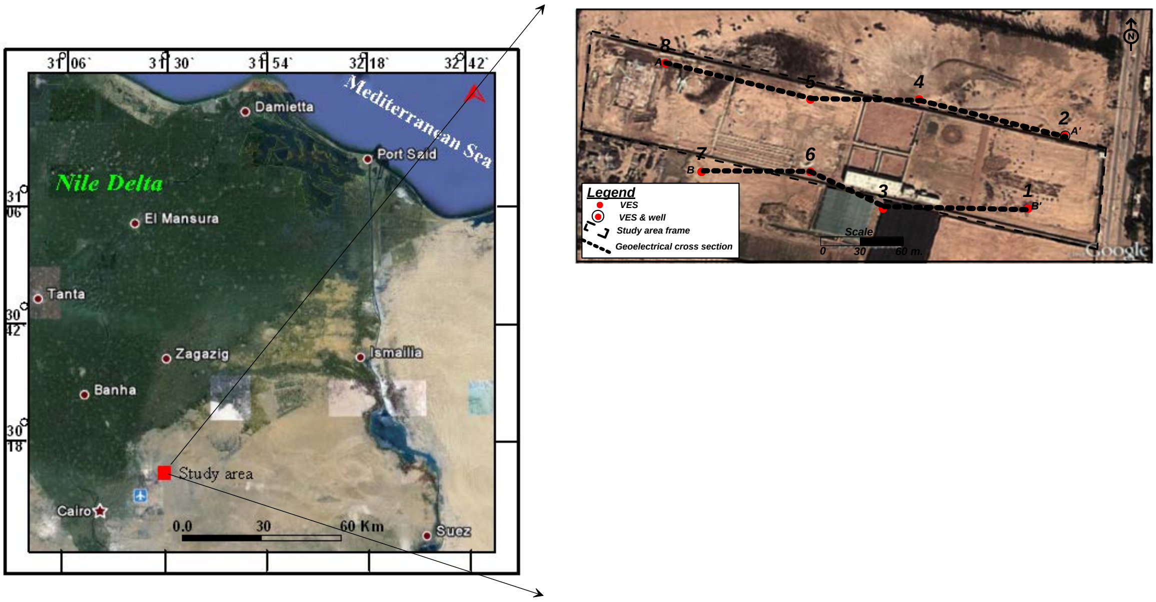


Fig. (1): The location map of Vertical Electrical Sounding (VES) stations and geoelectrical cross sections in the two study farms (I & II).

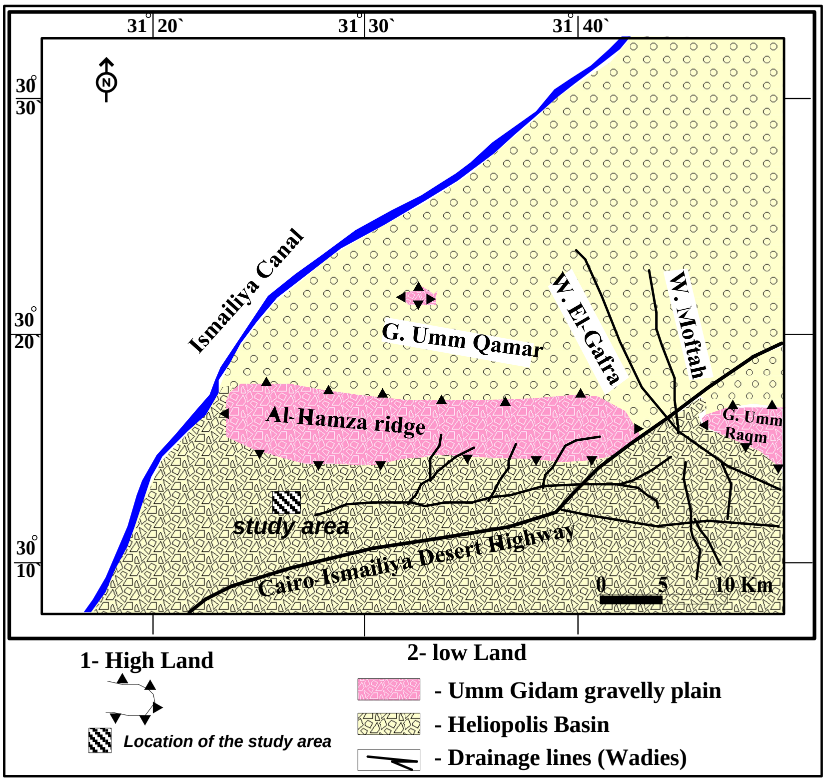


Fig. (2): Geomorphic map of the southeastern part of the Nile Delta (after El-Shazly et. al. 1975).

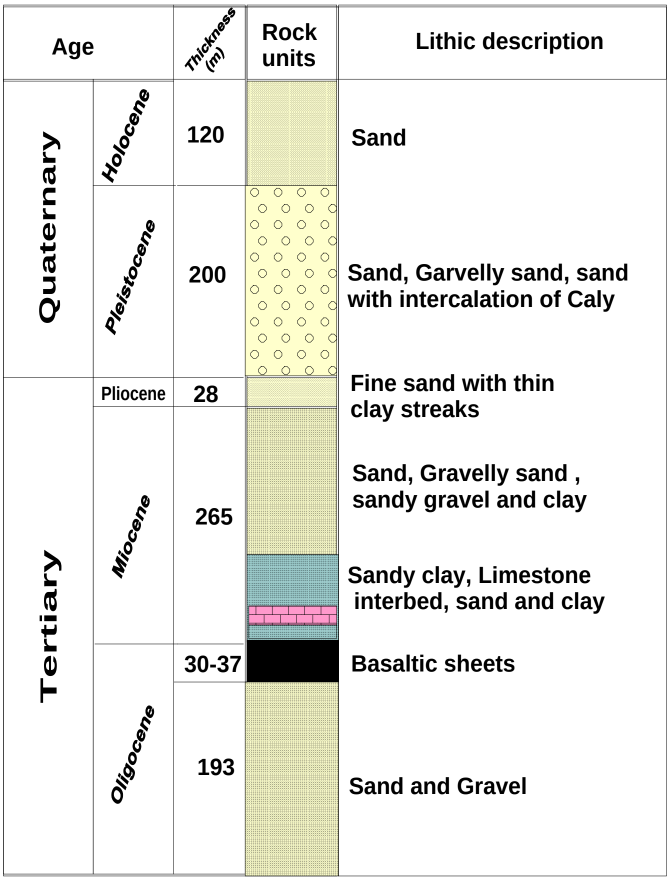


Fig. (3): Compiled stratigraphic columnar section in the southern part of Nile Delta (after El- Shazly et . al. 1975).

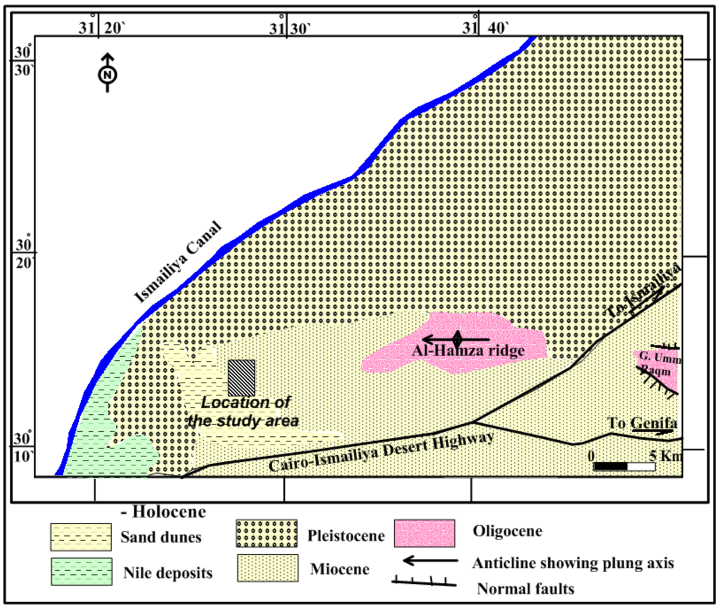


Fig. (4): Compiled geological map of the southeastern part of the Nile Delta (after El- Shazly et. al. 1975).

b. Quantitative interpretation:

It involves the determination of the number of the geoelectric layers as well as the true depth, thickness and resistivity of each layer. The computer programs "RESIST" (Van Der Velpen, 1988) and RESIX-PLUS, ver.2.39 (Interpex, 1996), are used for the quantitative interpretation of the Vertical Electrical Sounding (VES) curves. The initial model has constructed in view of the lithologic data of the existing test wells being available in the study farms (I&II). The available information about the regional and local geologic setting of the area is taken into consideration in assigning the lithology to the resulting resistivities. The interpreted data of each curve represent the geoelectrical layers with their corresponding thicknesses and resistivities. The geologic setting and relevant information are visualized and described in view of a number of generated geoelectrical cross sections crossing the concerned sites in different directions and contour maps. The detailed interpretation results of the geoelectrical resistivity sounding measurements in the two farms (I&II) are discussed as follows:

1. The subsurface geoelectrical succession:

The quantitative interpretation of the field curves of the two farms (I&II) revealed that the geoelectrical succession is formed of a number of layers being grouped together in three main layers.

The first layer is surface layer "A" and the second is layer "B", while bottom layer is "C". Detailed description of these geoelectrical layers is as follows:

i. Surface layer "A":

This layer represents the surface cover and has a wide range of resistivity varying from 6.6 to 253 Ohm.m. (Farm (I)), and 2.1 to 114 Ohm.m. (Farm (II)). It is composed of sand, gravelly sand and clay. This wide range of resistivity is due to different composition whereas the low resistivity values reflect clay content and the effect of water logging. The thickness of this layer in the two farms does not exceed 2.5m.

ii. Layer "B":

This layer in both farms (I&II) has resistivity values varying from 6 to 32 Ohm.m and its thickness ranges from 25 to 47 m. It is composed of sand, sandy clay, clayey sand and clay. According to the resistivity values, this layer can be differentiated into three parts (B1, B2 &B3). B1 is saturated with water and acts as perched aquifer. It was appeared as water logging on the surface of the two farms (I&II) as patches at VES No. 5 & 6 in farm (I) and at VES No. 3 in farm (II). B2 consists of clay and shale and has a thickness ranges from 8 to 17m with low resistivity values (<1.5 to 4.5 Ohm.m). This clay layer acts as impervious layer and plays a basic role to prevent the sewage or seepage water to move downwards causing the phenomena of water logging. B3 is saturated clay and sandy clay deposits.

iii. Layer "C":

This layer consists of sand, clayey sand intercalated with limestone and shale in both farms (I&II) and saturated with water. It has a resistivity value varying from 17.2 to 51.7 Ohm.m in the farm (I) and 8.5 to 20 Ohm.m in the farm (II). It must be noticed that the high resistivity values represents sand intercalated with limestone, while a low resistivity value is mainly corresponding to clay deposits.

2. The geoelectrical cross sections:

These sections illustrate the geoelectrical sequence, lateral and vertical variation for different layers along the profile direction. In the farm (I), two geoelectrical cross sections AA' and BB' in (NW-SE) direction are crossing the area (Fig. 1). In the farm (II), two geoelectrical cross sections A-A' and B-B' have been constructed (Fig. 1) in (SW – NE) and (NW - SE) directions respectively from the interpreted data of the soundings and the information from the available water points. Detailed description of the geoelectrical layers from top to bottom for two farms (I&II) can be described as follows:

Farm (I):

To avoid unnecessary repetition, the geoelectrical cross section would facilitate comparisons among these sections. Such geoelectrical cross sections (A-A') and (B-B') in NW –SE direction would complete the picture and determine the thickness and extension of the subsurface layers. The data of the geoelectrical cross sections such as thickness and resistivities of every layer along these cross sections are summarized in Table (1). The main observations and conclusions from these sections are:

1- Generally, the geoelectrical cross sections (A-A') and (B-B') consist of three geoelectrical layers "A", "B", and "C" (Figs.8 & 9).
2- The depth to water (sewage or seepage water) as recorded from the test well and the interpreted geoelectrical data ranges between 1.6m and 2.5m.
3- The resistivity values of geoelectrical layers increase with depth due to the increment of sand and limestone contents and decreases of clay intercalation.
4- The depth of clay layer ranges from 3 to 23m and it thickness varies from 8 to 17m.
5- The brackish sewage or seepage water considered as the strategic water supply to the area and has a suitable saturated thickness reached up to about 17m.

Farm (II):

The geoelectrical cross sections (A-A') and (B-B') in the SW –NE and NW-SE directions would complete the picture in farm (II) and determine the thickness and extension of the subsurface layers. The interpreted data of the Vertical Electrical Soundings along five profiles are shown in Table (2). The main observations and conclusions from these results are as follows:

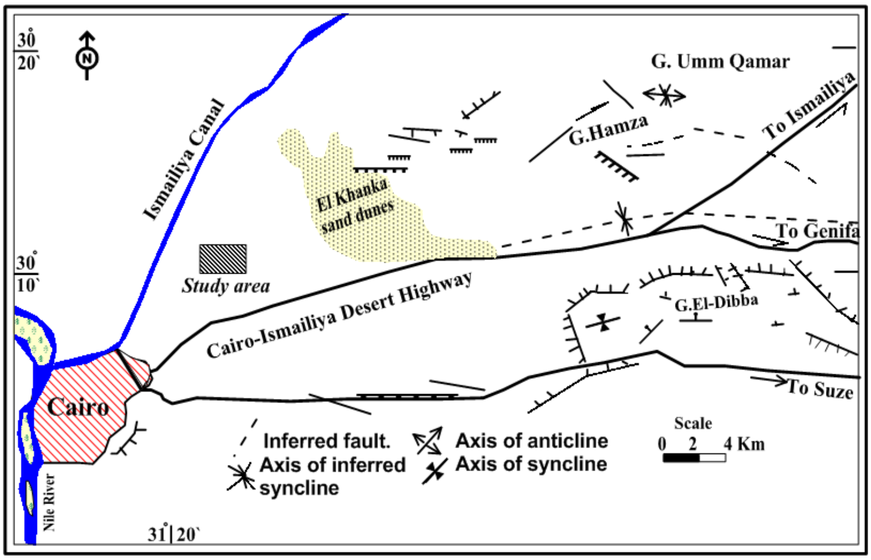


Fig. (5): Compiled structural map of the southeastern part of the Nile Delta. (El- Fayoumy, 1968).

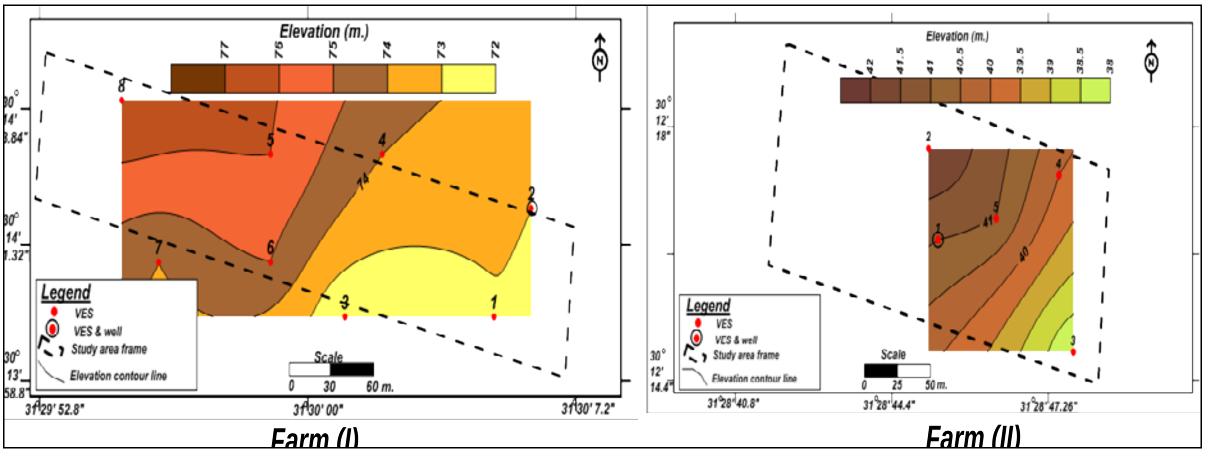


Fig. (6): Contour map of the elevation values for the two farms (I & II).

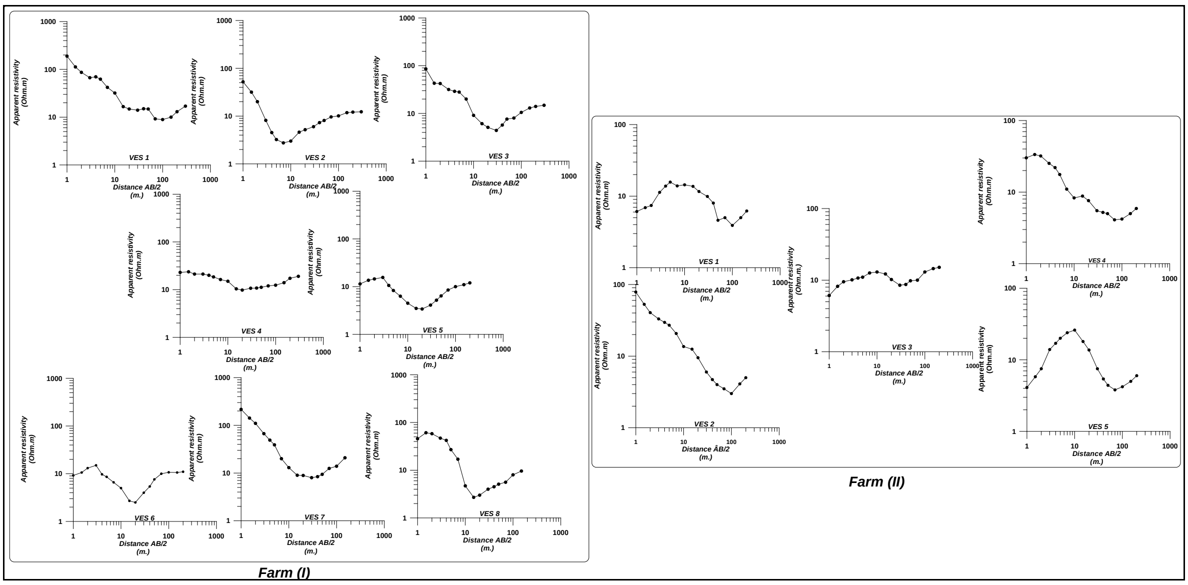


Fig. (7): Vertical Electrical sounding curves of the two farms (I & II).

1- Generally, the geoelectrical cross sections consist of three geoelectrical layers "A", "B", and ”C” (Figs. 10 & 11).

2- The depth to water (sewage or seepage water) as recorded from the drilled test well and the interpreted from the geoelectrical measurements ranges between 1.25m and 2.3m.

3- The resistivity values of geoelectrical layers increases downwards in the study farm due to increase in sand and limestone and decrease due to the presence of clay intercalations.

4- The depth of clay layer ranges from 10 to 20m and its thickness varies from 7 to 18m**.**

Solving the problem of shallow seepage water or dewatering the soil in the study farms (I&II) is based on the aforementioned results of geoelectrical exploration and main conclusions. This phenomena exhibited obviously at VES,es No 5& 6 in farm (I) and at VES No. 3 in farm (II) due to low topographic land and surface deposits. Also, capillary action is important for moving water which defined as the movement of water within the spaces of a porous material due to the forces of a adhesion, cohesion, and surface tension.

Capillary action occurs because water is sticky water molecules stick to each other and to other substances such as organic tissues, and soil. The water logging has harmful effect on the surface water and soil. To reduce the effect of water logging, it must be known the boundary of clay layer especially depth and level that prevent water to infiltrate downward. The contour maps of both values (depth and level) of clay layer become more suitable. The depth contour map used to delineate the less thickness above the clay layer but the level contour map used to delineate the slope of the upper surface of clay layer. The suggested solutions in the study farms (I&II) are discussed as follows:

Farm (I):

A shallow well with a depth of about 10m reaches to the layer of clay in the farm (I) and having water salinity reaching 2590ppm. The salinity of irrigation water comes from water line is about 320ppm. The salinity increases due to clay content, substance of chemical fertilizer and evaporation. Already, the water logging appears in two sites at VESes No 5& 6. The results obtained from the contour maps (Figs. 12&13) of both depth and level of clay layer helped in suggesting solutions for the water logging problem in this farm as follows:

The sites of VES’es stations 5 and 8 are the first priority of solution and are recommended for drilling two hand dug water wells according to less depth of clay which reach to 4m. The type of suggested wells have an internal diameter of about 3m and a total depth of about 10m or stops on clay layer. The wall sides of this well is about 50cm thick, covered with gravel back as illustrated in Figure (14a). The water logging (sewage and seepage water) will collected in the two hand dug wells. The collected water can be extract by discharge and used with the irrigation net around the farm to irrigate some wood trees around the farm. It can also collect this water in a reservoir and mix it with surface water (320ppm) to decrease the total salinity and then used the mixed water in irrigation.

1. The second priority of solution is drilling a drainage well (injection well) at site of the VES No. 6 to depart or inject water downward. Although, the site of VES No.1 has the largest value of depth to clay layer reaching about 22m. and the value level records 51m. with a large slope. It permits to collect more water but not recommended for building at this location. According to the above mentioned results of this study, the total depth of this well should be 50m. with internal diameter is about 10 inch. The whole well should be cased by screen 10” and making gravel back around the filter "Screen". Then, drill a hand dug well with the internal diameter about 3m and a total depth of less than 10m around the injection well (Fig. 14b) to collect the water and injected it under clay layer throughout the injection well in sand layer as mention above in previous lithological study.
2. In view of geoelectrical study, the site of VES No.1 is recommended for building due to the increase in sand and decreases of clay intercalation.

Farm (II):

This farm has a length of about 150m and a width 100m. The water logging appears at the site of VES No.3. There is one water point as test well with water salinity reaching 3000ppm. The salinity of irrigation water comes from water line reaches 281ppm. This means that the salinity of water line decreases in the south direction. The contour maps (Figs. 15 &16) of both depth and level of clay layer make the picture more obvious for suggesting solutions to the water logging in this farm as follow:

1. Drilling a hole (main drainage) around the farm with diameter of about (0.7m) and depth of about 2 m and drilling other hole or drainage in the central part of the farm. The central drainage must be connected with the main drainage as on Figure (17). This solution is preferred for small area and the water can be used twice for irrigation purposes.
2. The second priority is drilling a drainage well (injection well) at the site of VES No. 3 to depart or injected water downward. The depth to clay layer at this site reaches about 10m. and the record level 28m. This site is more suitable to drill injection well where the depth to the groundwater in the main aquifer reaches more than 100m.

Table (1): Interpreted geoelectrical data in the farm (I).

Cross section	Trend and Length	VES'es No and wells included	Geoelectrical Layers Resistivity and Thickness				
			Layer "A"	Layer "B"			Layer "C"
				B1	B2	B3	
A-A'	NW-SE	8,5,4 &2 Test well 2	6.6-96 Ω.m 1.6-2.1m	6.5 -16Ω.m 2-4m	1.1 -5.5Ω.m 6-14m	11.7 -12.5Ω.m 12-20m	17.2 - 25Ω.m ------
B-B'	NW-SE	7,6,3 &1	9-253 Ω.m 1-3.5m	8.5-14Ω.m 2-18m	2.2 -4.4Ω.m 10-12m	9.6 -15.4Ω.m 10-14m	20 - 51.7Ω.m ------

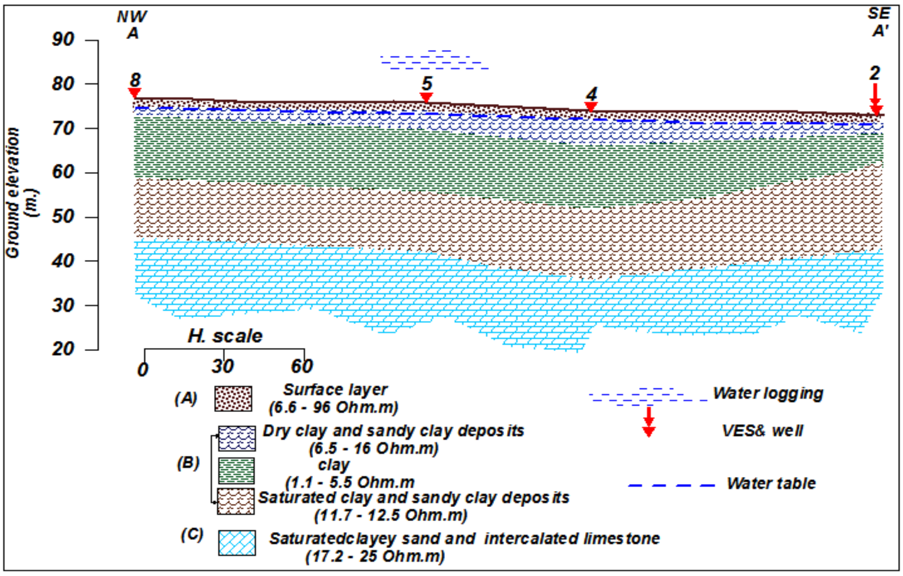


Fig. (8): Geoelectrical cross section AA' in farm (I).

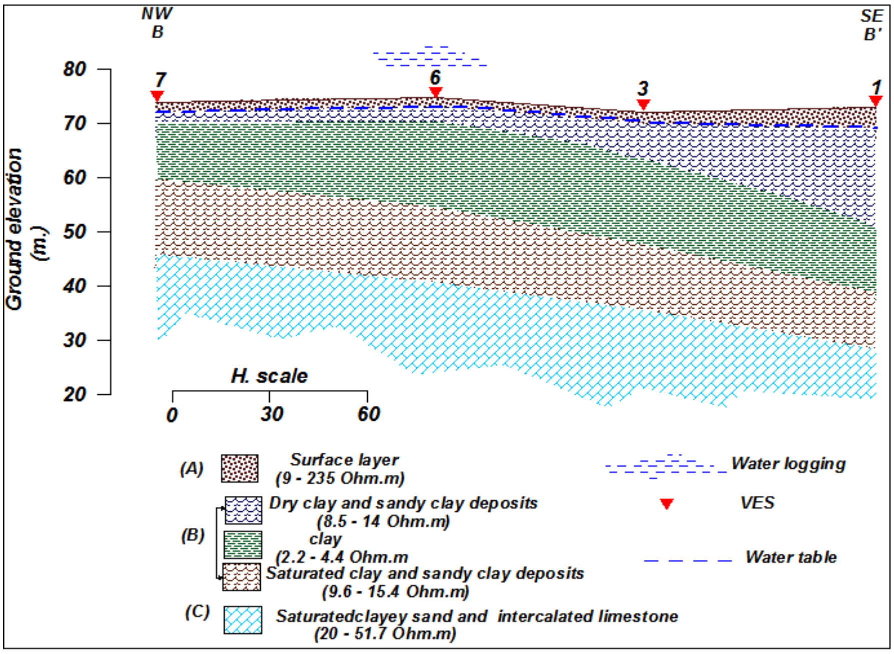


Fig. (9) Geoelectrical cross section BB' in the farm (I).

Table (2): Interpreted geoelectrical data in the farm (II).

Cross section	Trend and length	VES'es No and wells included	Geoelectrical Layers (Resistivity and Thickness)				
			Layer "A"	Layer "B"			Layer "C"
				B1	B2	B3	
A-A'	SW-NE	1,5&3 Test well 1	2-114 Ω.m 1.6-2.3m	8–31Ω.m 6.6-13.3m	1.4–5Ω.m 7.5-16.6m	6–8Ω.m 5-13.3m	8.5-20Ω.m ------
B-B'	NW-SE	2,5 &3	4-45 Ω.m 1.6-2.3m	6–27Ω.m 6.6-27.5m	1–3.6Ω.m 7.5-16.6m	6–7.5Ω.m 7.5-13.3m	8.5-20Ω.m ------

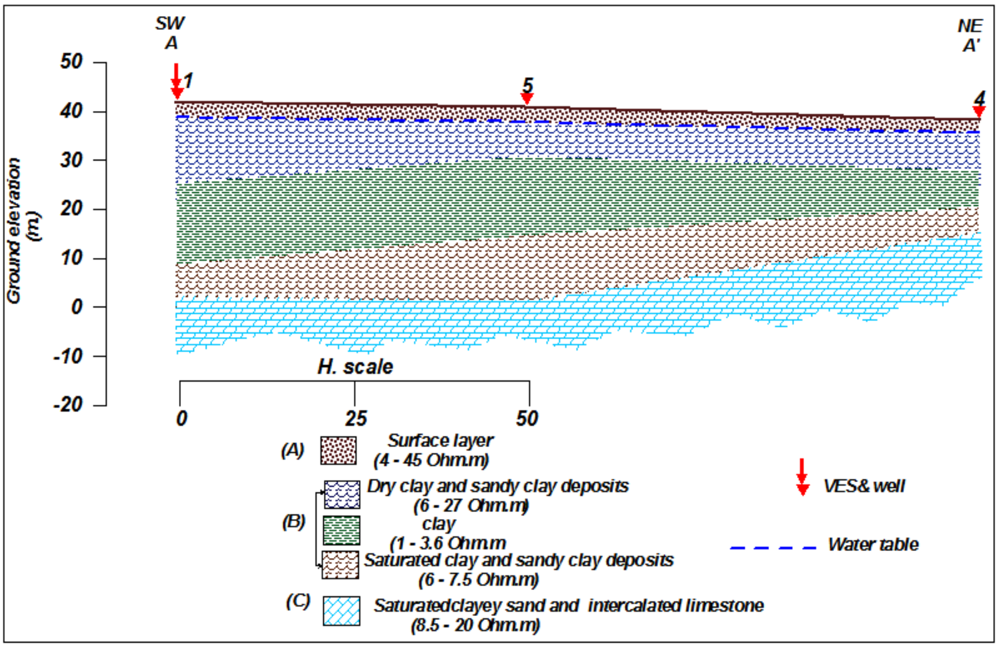


Fig. (10): Geoelectrical cross section AA' in the farm (II).

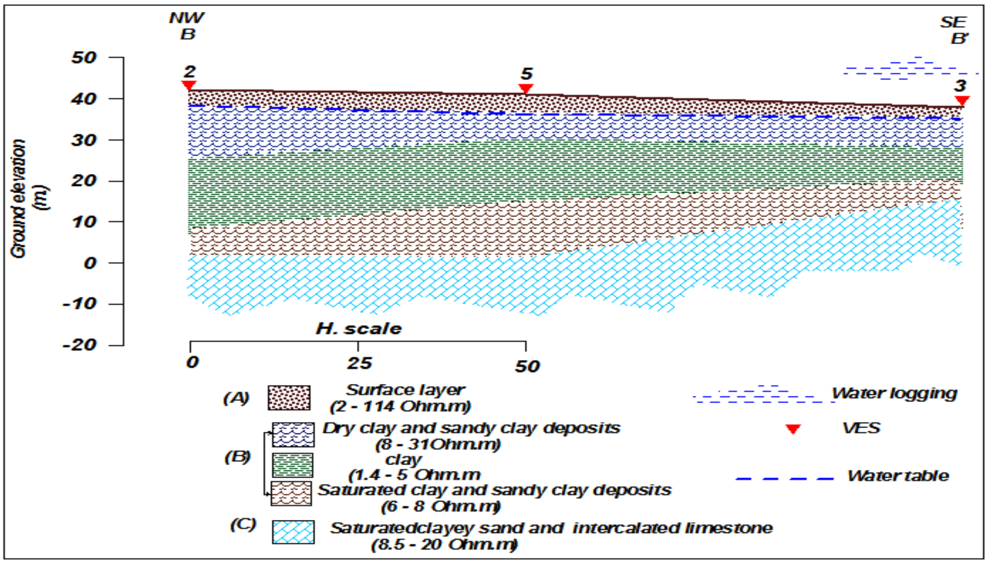


Fig. (11): Geoelectrical cross section BB' in the farm (II)
hydroGEOlogical problems and Suitabile solution.

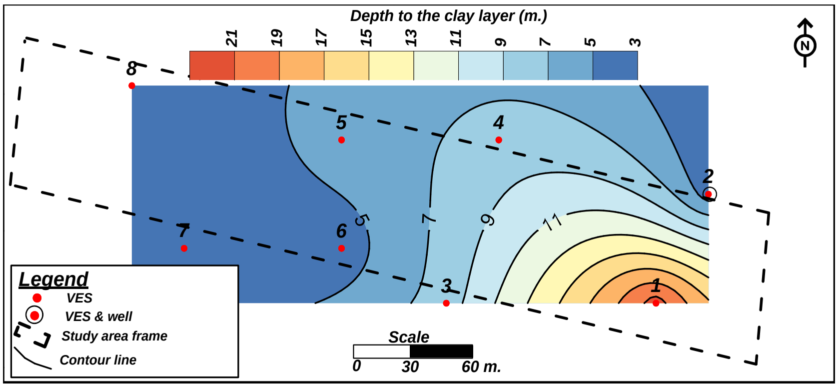


Fig. (12): Depth contour map of the clay layer in the farm (I).

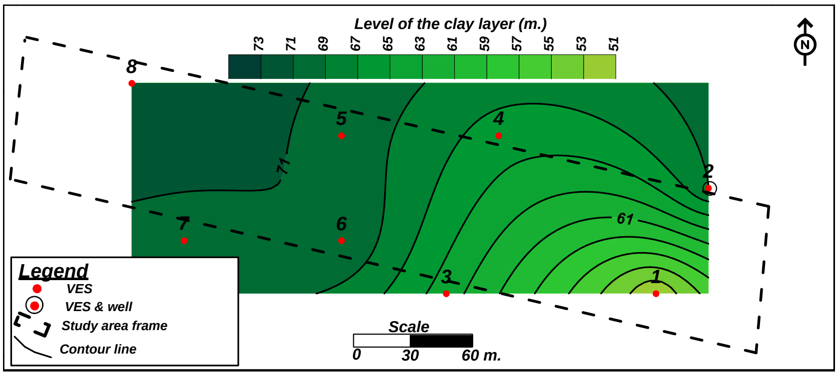
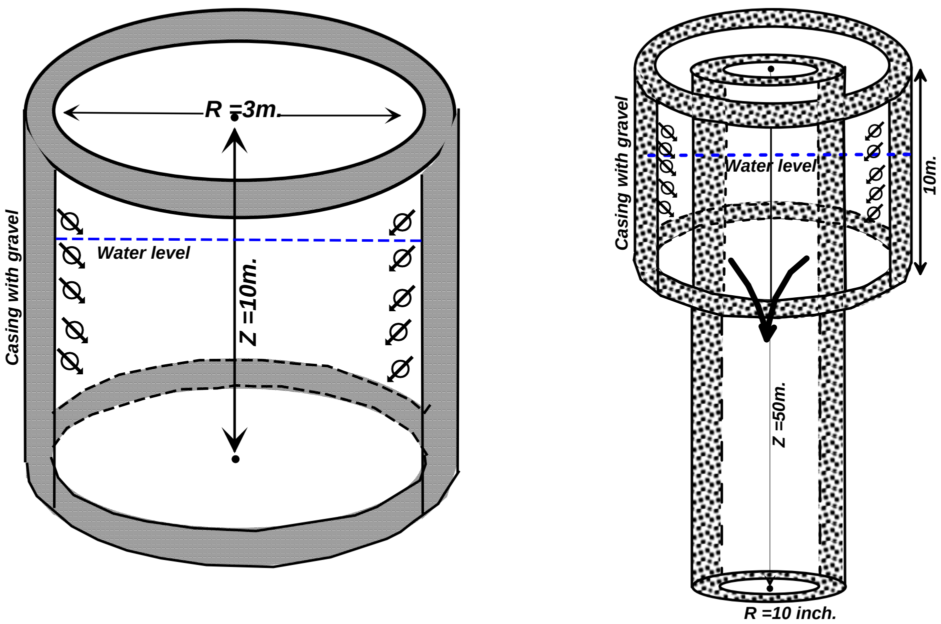


Fig. (13): Level contour map of the clay layer in the farm (I).



(a) Hand dug well **(b) Injection well**

Fig. (14): The design of proposed well in the farm (I).

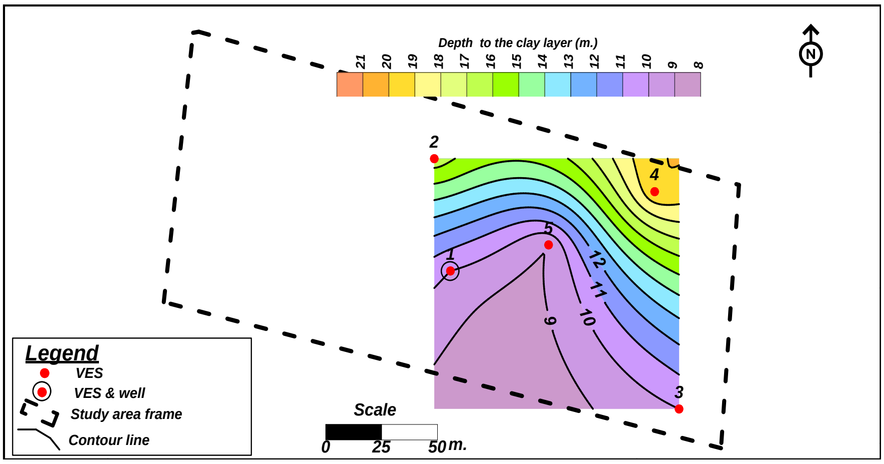


Fig. (15): Depth contour map of the clay layer in the farm (II).

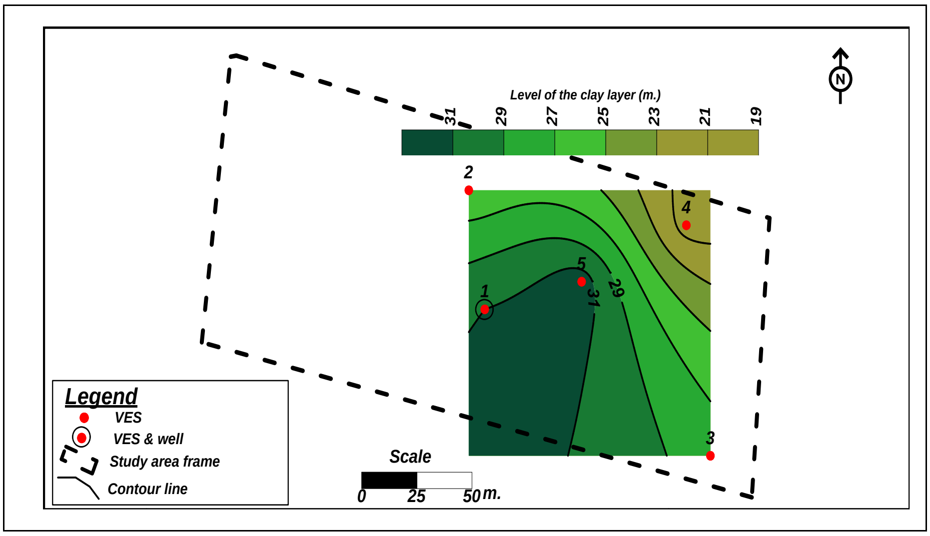


Fig. (16): Level contour map of the clay layer in the farm (II).

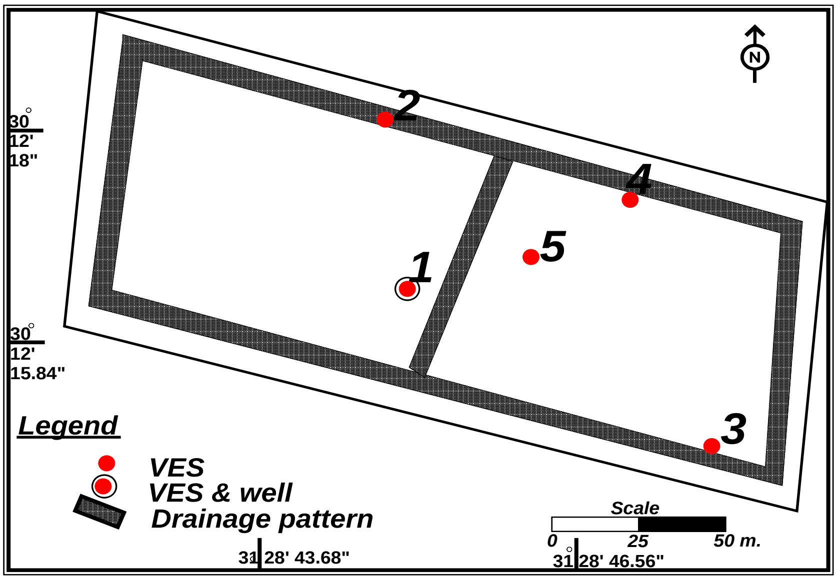


Fig. (17): The location of drainage pattern in farm (II).

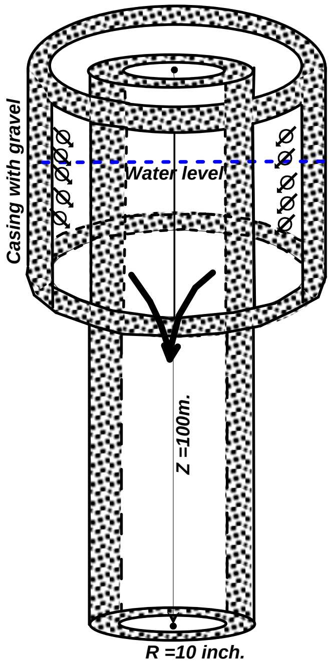


Fig. (18): Design of the proposed well in the farm (II).

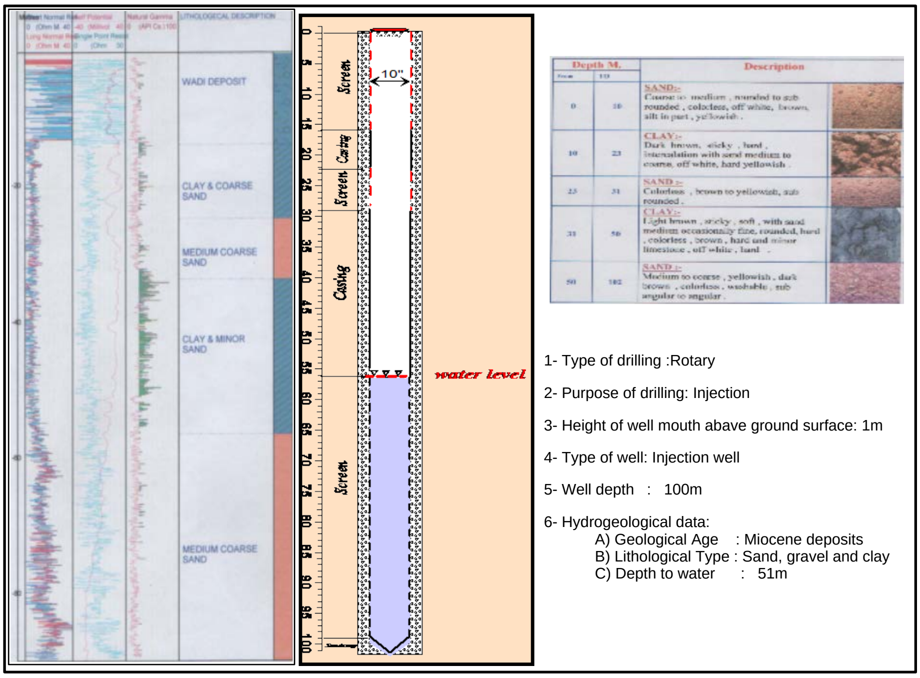


Fig. (19): Design the injection well and electrical log with lithological description at VES No. (3) in farm (II).

According to the above mentioned results of this study, the total depth of this well should be 100m, with an internal diameter of about 10” inch. The whole well should be cased by screen 10”inches and making gravel back around the filter “Screen”. Then, drill a hand dug well with an internal diameter of about 3m and a total depth of less than 5m around the injection well (Fig.18) to collect the water and inject it under clay layer throughout the injection well.

3. The above suggested solutions for this farm can be merged together by drain the collected water in the hole drainage around the farm (II) into the injected well at VS No.3.

The applied part in this study:

The second suggested solution was performed in the farm (II) for solving the problem of water logging based on the geoelectrical results. The drainage well (injection well) was drilled beside site of VES No.3

(Fig. 19) with reversed casing to achieve the purpose. The result exhibited drawdown of depth to water from 80cm to 4.6m and it can be notice the sound of the fall down of water inside the injected drilled well. Due to a little of finance possibilities no model of solutions problem of water logging preformed in farm (I).

CONCLUSION AND RECOMMENDATION

The present study deals with agriculture farms suffered from a water logging problem. Geoelectrical techniques have been used to recognize the subsurface geological and hydro-geological settings affecting the sewage or seepage water in the area and to solve this problem. The geometry of clay lenses (depth, thickness and extension) plays a basic role in this problem. This study concentrates on two farms (I&II) as a case for solving this problem and can be applied in the other surrounding farms.

The results obtained from the interpretation of the vertical electrical resistivity sounding revealed that the subsurface successions in the two farms consist of three main layers ("A", "B" and "C"). The surface layer "A" is composed of sand, gravely sand and clay and layer "B" is composed of sand, sandy clay, clayey sand and clay or shale. The layer (B) can be differentiated into three parts; the upper one is saturated with water but the bottom one is dry and the middle part consists of clay separating between them. The layer "C" consists of sand, clayey sand and intercalated limestone with shale and saturated with water. The depth to water (sewage or seepage) in both farms ranges from 1.25 to 2.2m as from interpreted Vertical Electrical Sounding curves. The salinity values of water logging in farm (I) is about 2590ppm. This water salinity is suitable for irrigating some trees, while the salinity of surface water sample taken from irrigation line beside farm (I) is 320 ppm (fresh water). The salinity value in test well of farm (II) is about 3000 ppm, while that of surface water sample taken from irrigation pump in the farm is 280 ppm (fresh water). Vertically, it is noticed that the resistivity values of geoelectrical layers increase downwards in the two farms due to the increase in sand and limestone and decrease of clay intercalation. There is a layer of clay or shale inside layer "B" in the two farms which has low resistivity values (<1.5 to 4.5 Ohm.m). This clay is acting as impervious layer and plays a basic role to prevent the sewage or seepage water to pass downwards causing the phenomenon of water logging.

It can be recommended for solving the phenomenon of water logging according to the geoelectrical results in the farm (I) by drilling two hand dug water wells with special casing at sites of VES'es stations 5 and 8 or drilling a drainage well (injection well) at the site of VES No. 6 to inject water downwards. Drilling a line drainage around the farm (II) or drilling a drainage well (injection well) at site of VES No. 3 are suitable solutions for this farm. Generally, water logging can be prevented or reduced by applying the following procedures:

- Using the drop irrigation method or other advanced irrigation methods in the new reclaimed lands, instead of flood irrigation method.
- Applying suitable biological drainage system in the logged areas by cultivating high consumptive plants e.g. acacias, etc.
- Using the drainage water in cultivating trees for wood or plants for organic fuel or decorating plant.
- The treatment of the drainage water and transfering it to the arid area may be a suitable solution.

Finally, the individual trials for solving the water logging problems must be organized by the government.

REFERENCES

Ahmed, S. El-Mahmoudi., El-Arabi H. Shendi and Saber M. Mohammed., (2006): "Groundwater Exploration with Schlumberger Soundings at Cairo- Bilbeis District, East Nile Delta, Egypt", UAEU Funded Research Publications, Vol. 15,p.108-121 .

Al-Abaseiry A. Abd El-Rahman, (2011): Contribution of the geoelectrical techniques to solve the problem of water logging in El Obour city, Cairo, Egypt, Egyptian Journal of Geology, v. 56(1), 2012, p. 101-119.

Al-Abaseiry A. Abd El Rahman and Ahmed. N. El Sayed, (2012): Study of the impact of the surface water on the groundwater using geoelectrical methods in El Salhyiah Gedidah, Egypt, Egyptian Geophysical Society EGS journal,vol. 10,1,129-138.

Alile OM, Ujuanbi O, Evbuomwan IA (2011): Geoelectric investigation of groundwater in Obaretin -Iyanomon locality, Edo state, Nigeria. J. G. Mining Res., 3(1): 13-20.

Ayman M. M. Al Temamy, Mohamed A. Khaled and Mostafa S. M. Barseem, (2008): Use of geoelectrical techniques TO determine the impact of facies changes on groundwater potentials and water logging in the area south of Lake Manzala, East Nile Delta, Egypt" Egyptian J. Desert Res., 58, No.2, 1-18

Barakat, M.G., and Abul Ela, N.M., (1970): "Microfacies and paleoecology of Middle Eocene and younger sediments in Genifa aream Cairo-Suez district, Egypt", Jour. Geol., Vol. 14, .23-34.

El-Ahwani, M.M, (1982): Geological and Sedimentological studies Shabraweet area , Suez Canal district, Egypt Ann.Geol Surv, Vol X,P 305-381

El- Badrawy and Soliman (1997): Evaluation of Subsurface Active Structures of El-Asher of

Ramadan Area using Gravity, Aeromagnitic and seismic Data Egypt. J.Geol . 817-837 pp.

El-Dairy (1980): Hydrological Studies On the Eastern Part of Nile Delta Using isotope techniques. MSc Thesis , Faculty of Science, El-Azhar Univ. Egypt.

El-Fayoumy, I.F., (1968): "Geology of ground water supplies in the region east of the Nile Delta", Ph.D.Thesis, Fac. Sci., Cairo Univ., Egypt, 207 pp.

El-Hadad, (1996): Ground water Sources and Soil evaluation for Tenth of Ramadan City and its surrounding ,Egypt M Sc, Thesis , Faculty of Science , El-Azhar Univ, Egypt

El-Shazly, E.M., Abdel Hady, M.A., El-Shazly, M.M., El-Ghawaby, M.A., El-Kassas, I.A., Salman, A.B.and Morsi, M.A. (1975): "Geological and groundwater potential studies of El-Ismailiya master plan study area", Remote Sensing Res. Project, Acad. Sci. Res. and Techn., Cairo, Egypt, 1- 24 pp.

Ezz El-Deen, H.M.M. (1993): "Sedimentological and geophysical studies of Heliopolis basin, Cairo-Ismailiya Desert Road, and their application", M.Sc. Thesis, Fac. Sci., Ain Shams Univ., Cairo, Egypt, 228 pp.

Hefny, K. (1980): "Groundwater in the Nile Valley." Ministry of Irrigation Water Research Center. Groundwater Research Inst.. (in Arabic); 120pp.

Hefny, K. Morsi, A., Khalil, J.B., Farid, M.S., El-Ridi, M.R. and Khater, A.R., (1983): "Groundwater study for El-Obour City area", Research Inst., for Groundwater, Giza, Egypt., 37pp.

Helmy, M.E., Hassan, F., and Mahmoud, A., (1986): "Exposed Quaternary sediments, East Nile Delta area, Egypt", 15th Symp., Quaternary Develop. in Egypt, El-Mansoura Univ., Egypt.

Helmy , E. M.A. (2002): "Geophysical evaluation of the groundwatyer resources of the area between Gabal Al-Hamza and Ismailia canal, east of the Nile Delta, Egypt ., ", M.Sc. Thesis, Fac. Sci., Ain Shams Univ., Cairo, Egypt, pp109.

Interprx Limited. (1996): "RESIX- PLUS". Resistivity data interpretation software, v. 2.39., Golden, Colorado, USA.

Ismail, M.M., and Selim, A.A., (1968): "A microfacies study of the Cretaceous and Eocene strata of Gebel Ataqa, Eastern Desert", Bull. Fac. Sci., Alex. Univ., Vol.8, No.2, pp.235-254.

Kumar D, Ahmed S, Krishnamurthy NS, Dewandel B (2007): Reducing ambiguities in vertical electrical sounding interpretations: A geostatistical application. J. A. Geophys., 62: 16-32.

Dobrin MB (1988): Introduction to Geophysical Prospecting. New York: McGraw-Hill, p. 867.

Loke MH (1999): Electrical imaging surveys for environmental and engineering studies. Apractical guide to 2D and 3D surveys: Austin, Texas, Advanced Geosciences Inc., p. 57.

Mostafa S.M, Sawsan M.M.I and Ahmed M.A.Y.,(2009): Groundwater management in Golf city area, east of Cairo city, Egypt, VI-International Conference on Environmental Hydrology, 28-30 September, 2009.

Mousa, B.M., (1990): "Petrology and soil genesis of the surface Quaternary deposits, East of Nile Delta", Ph. D., Thesis, Fac. Sci., Ain Shams Univ., Cairo, Egypt.

Mousa, S.A, (1988): "Geophysical and hydrogeological studies on the area north of El Mokattam Ataqa plateau and the south of El Ismailiya canal, Egypt", Ph.D. Thesis, Fac. Sci., Ain Shams Univ., Cairo, Egypt.

Ozcep F, Tezel O, Asci M (2009): Correlation between electrical resistivity and soil-water content: Istanbul and Golcuk. Int. J. Phys. Sci., (4)6: 362-365.

Sadek, A., (1965): "Geological studies on some Tertiary deposits south of the Cairo-Suez road, G.Homayira area", M.Sc. Thesis, Fac. Sci., Cairo, Univ., Egypt.

Sadek, H., (1926): "The geography and geology of the district between Gebel Ataqa and El-Galala El-Bahariya, Gulf of Suez", Geo. Surv. Cairo, Egypt, 122pp.

Said, R. (1962): " The geology of Egypt", Elsevier Amsterdam and New York, 377 pp.

Said, R. and Beheri, S., (1961):"Quantitative geomorphological of the area to the east of Cairo", Bull Soc Geogr., Egypt, Vol. 34, 125-150.

Sallouma, M.K. and Gomaa, M.A., (1997): "Groundwater quality in the Miocene aquifers east and west of the Nile Delta and in the North Western Desert, Egypt", Ain Shams Sci. Bull., Vol. 35, Fac. Sci., Ain Univ., Cairo, Egypt, 47-72 pp.

Shukri, N.M., and Akmal, M.G., (1953): "The geology of Gebel El- Nassuri and Gebel El-Anqabia district, Cairo, Suez belt", Bull. Soc. Geogr. Egypt, Vol.24, 243-276.

Soliman, S., M., and Korany, E., (1972): "Electrical resistivity investigation for prospecting groundwater in the area between Ismailiya Canal and Cairo-Ismailiya road, Egypt", Desert. Inst., Vol. 21, No.2, 285-295.

Velpen, V.D. (1988): "RESIST'; Version 1.0 a computer program for the interpretation of resistivity sounding curves. An ITC M.Sc. Research Project. ITC, Delft, the Netherlands.

Yilmaz S (2011): A case study of the application of electrical resistivity imaging for investigation of a landslide along highway. Int. J. Phys. Sci., 6(24): 5843-5849.

Youssef, M.H.M., (1980): "Geological studies on some Tertiary sediments of Gebel Umm Raqm area, Cairo- Suez district", M.Sc. Thesis, Fac. Sci, Cairo Univ.

Zaghloul, Z.M., Abdel Daiem, A., and Taha, A., (1990): "Geomorphologic, geologic evolution and subsidence of the Nile Delta during Quaternary", Bull. Fac. Sci., Mansoura Univ., Vol. 17, No.1, 471- 495.