HYDRAULIC STUDY FOR THE SACRED LAKE POLLUTION AT ELKARNAK TEMPLE, EGYPT

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ABSTRACT:

After building the High Dam on the River Nile in Egypt, the sacred lake at Karnak Temple at Luxor City suffered from the concentration of salt and several organic reactions which had a negative effect on both the quality of the water and the air of the area .

This study outlines the background of the problem and the recommendations to develop an integrated hydraulic system to solve this problem .

1. INTRODUCTION:

Ancient Egyptians used to excavate a lake beside the Temples for the festivals during religious occasions, the studies proved the existence of several lakes around the Temples . The sacred lake at Karnak Temple at Luxor City, Egypt is the largest lake according to its size, the length is about 130m, the breadth is about 80m, and the depth reaches 4m .

The sacred lake lies south of the Ramses the Second statue fence, the sides have been covered with stones and the ruminants are clear on the Western, Southern and Northern sides where the stairs that were used to reach to the sacred lake are still there.

Boats for god Amoon, his wife Mote and their son Khonso have been floating on the surface of the sacred lake during the festivals of the God Amoon .

The priests of the great Temple -according to their beliefs- have to have a hair cut every three days and shower every day before the prayers using the sacred lake water .

The sacred lake supply of fresh water was from the underground water table which used to submerge the valley for several months during the flood of the River Nile before the High Dam at Aswan was built . This caused the rise of the underground water table level in the area, and accordingly the sacred lake to be filled with water and reaches its highest level during the month of November each year .

Then the dry period starts which lead to the lowering of the underground water table, and the sacred lake becomes almost dry during the month of July each year .

As a result of the change in the underground water table level, the water of sacred lake is refreshed annually .

After building the High Dam, which reserves the flood water upstream the River Nile and controls the discharge of water, the underground water table level became almost constant all year round . Since the annual change rate in the water level is about 0.8m, and the underground water level is stable, this prevented the sacred lake from refreshing its water . In addition, the high temperature in Luxor, Egypt, and the high rate of water evaporated from the surface of the sacred lake led to the concentration of salt and caused several organic reactions in the lake which had a negative effect on the quality of both the water and the air of the area .

The pollution of the scared lake water had a severe effect on the tourism industry for one of the most important historical sites in the world . The World Bank decided to fund the necessary projects to solve this problem taking into effect the safety and security of the Temple and the surrounding area .

This study recommended two pump stations to be installed -with separate discharge line for each pump- at both the River Nile bank and the sacred lake bank and to be connected, so that they can work and stop simultaneously . This method is simple, doesn’t need any technical operators, cost effective and allows providing the sacred lake with fresh water from the Nile, at the same time and the same discharge rate the polluted water is discharged from the lake to the River Nile . This will also keep the water table level stable to prevent any possible damage to the Temples' foundation due to soil settlements .

This study was of greats importance to develop an integrated hydraulic system and provide clean environment without scarifying the safety of one of the world's most admired old Egyptian treasures .

2. SITE ENVIRONMENTAL INVESTIGATIONS:

2.1. The Sacred Lake Information:

2.1.1. The site:

The sacred lake lies south of the surrounding fence of Ramsis the second statue inside the Karnak Temple in Luxor . Figure (1) shows the general site layout of the temple and the site of the sacred lake inside.

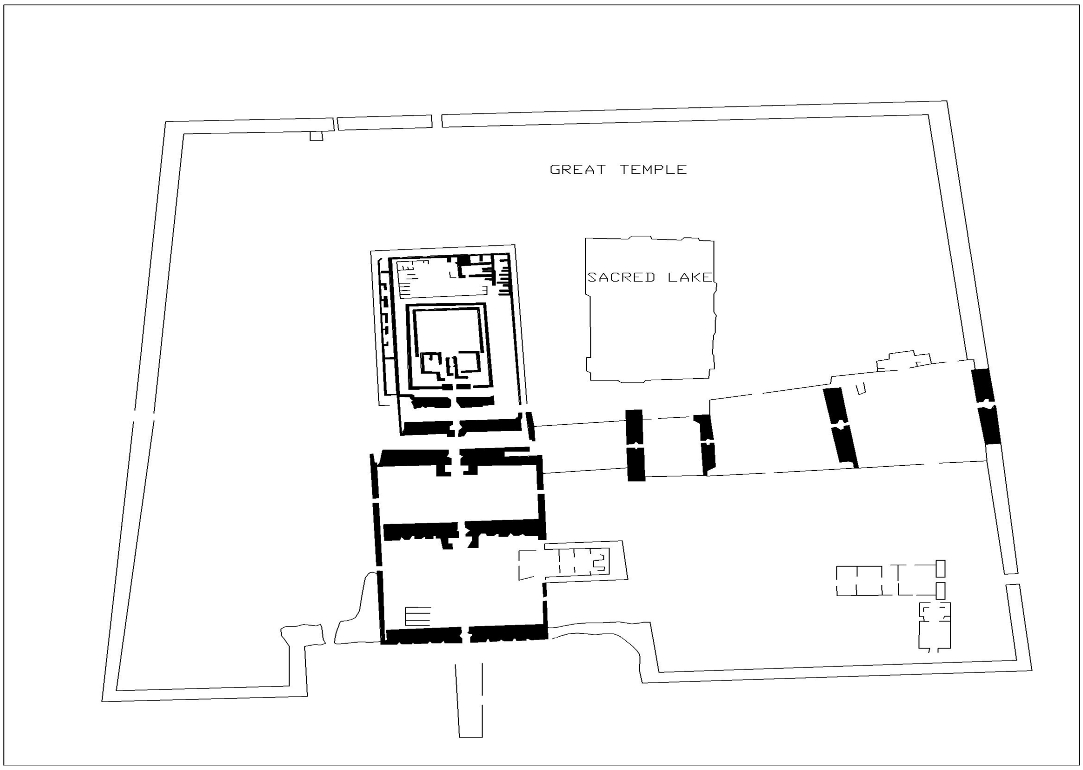

Fig. (1) General layout of the Karnak Temple

(Location of sacred lake)

2.1.2. The site topography:

The sacred lake is a rectangle trench with length of about 130m, breadth is about 80m and the depth is about 4m . The lake depth was measured in several points by dividing the lake into grid . Figure (2) shows the network of the leveling points, and Figure (3) shows the contour lines of the lake bed .

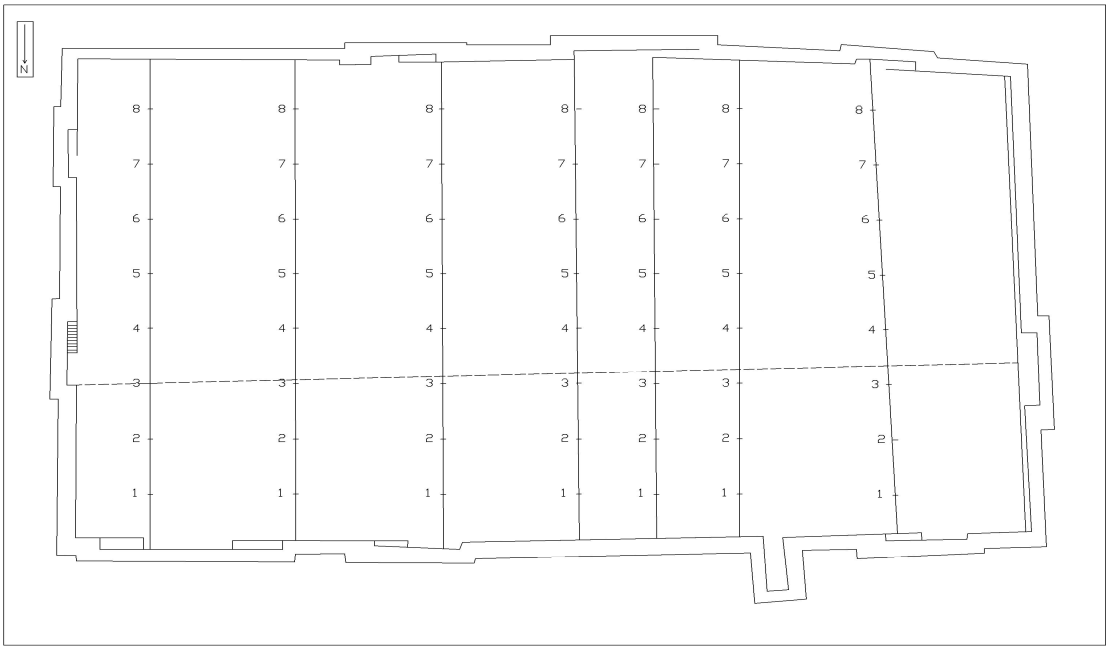

Fig. (2) Plan of the network of the leveling points

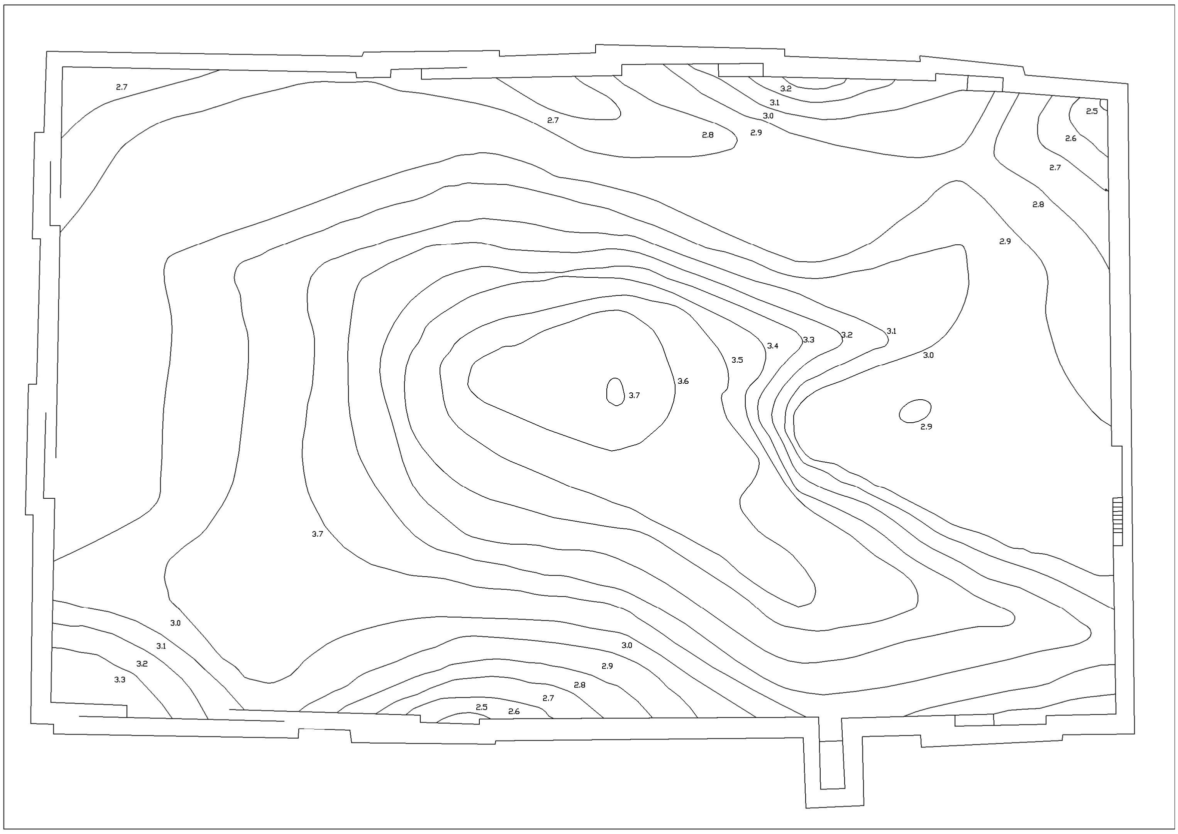

Fig. (3) Contour lines of the bed of the lake in meters

2.1.3. The nature of soil:

Seven borings were executed in the lake's bottom, Figure (4) shows the location of the borings, while Figure (5) shows the borings logs, which indicate that the bottom of the sacred lake consists of three layers as follows:

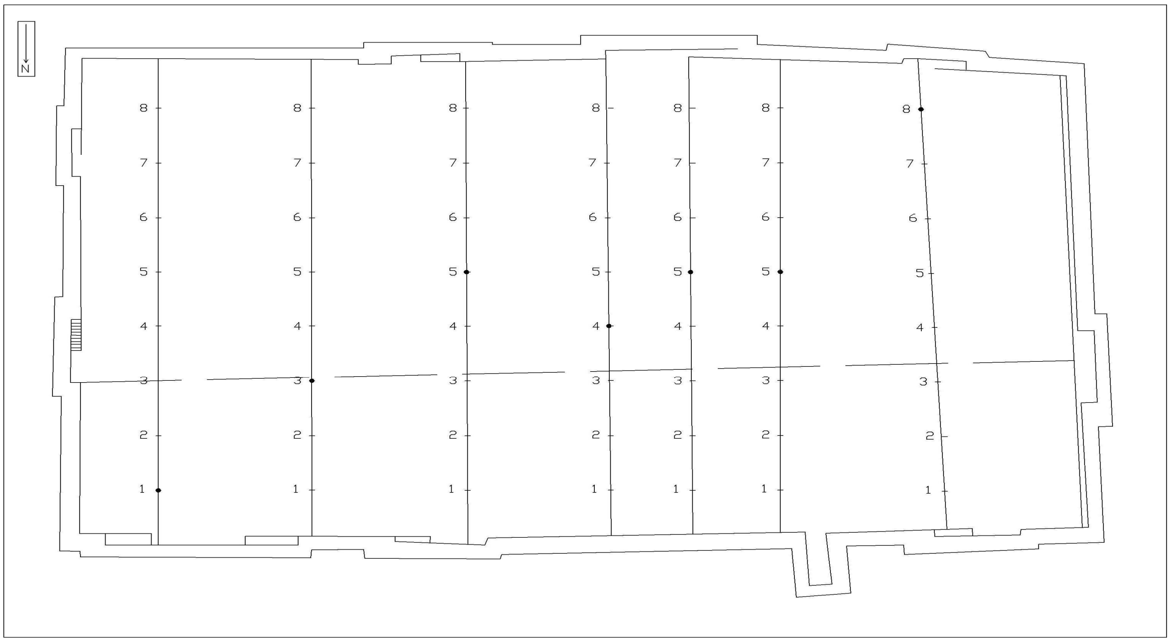

Fig. (4) The location of borings

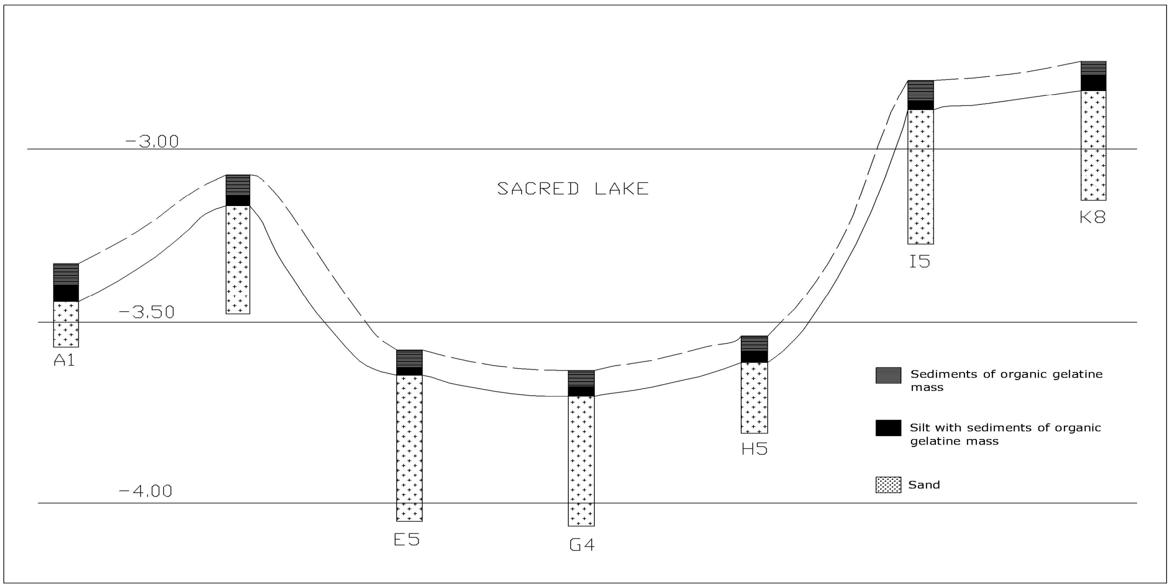

Fig. (5) Boring logs

A. The first layer:

Gelatinous organic sedimentation with different colours rosy brown, yellow, green and grey bacillus can be seen on the layer surface. The thickness of this layer ranges from 3cm to 8cm at the sides as shown in Figure (6).

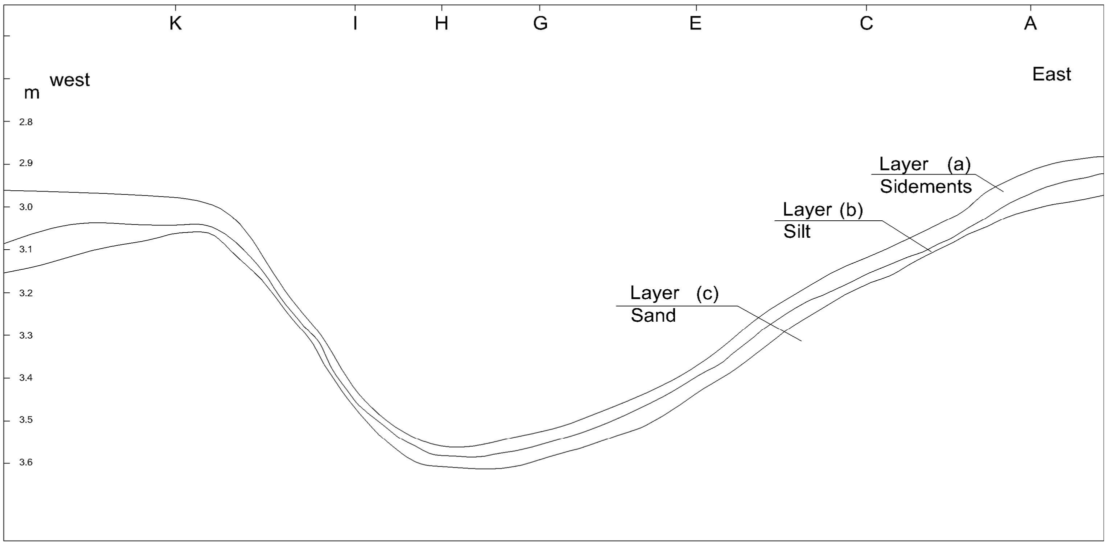

Fig. (6) West – East section

B. The second layer:

Silt having the same components of the first layer but black in colour, the thickness of the this layer ranges from 1cm at the west side to 9.50cm at the north east part of the sacred lake as shown in Figure (6) .

The thickness of the first and second layers are shown in Figure (6) .

The thickness ranged from 6 cm to 16 cm at the north east of the lake side.

C. The third layer:

The third layer is sand which forms the natural soil at the bottom of the sacred lake, Figure (6) shows the longitudinal cross-section for the three layers at the bottom of the lake.

2.1.4. The natural hydrological system of the sacred lake:

The natural hydrological system of the lake consists of two stages as follows:

2.1.4.1. Before the construction of the High Dam at Aswan:

During the flooding period of the River Nile, the underground water level is raised and the lake was filled with water, reaching its highest level during the month of November as shown in Figure (7) and reaches its lowest level during the month of July just before the start of the flood of the Nile, this was a natural refreshing of the water of the lake .

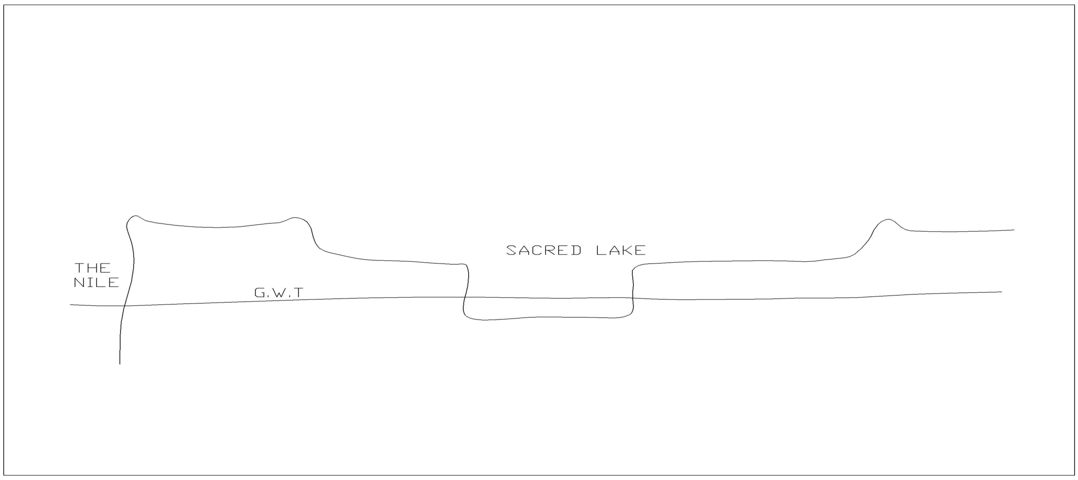

Fig. (7) Hydraulic system during the Nile flood (Before the High Dam)

2.1.4.2. After the construction of the High Dam at Aswan:

The High Dam controlled the discharge of water in the Nile and holds flood water upstream the dam . This led to the stability of the under ground water almost all year round at level higher than the lowest level and less than the highest level before construction of the Dam as indicated in Figure (8). The water of the lake became stationary and the water level ranges within 0.80m only .

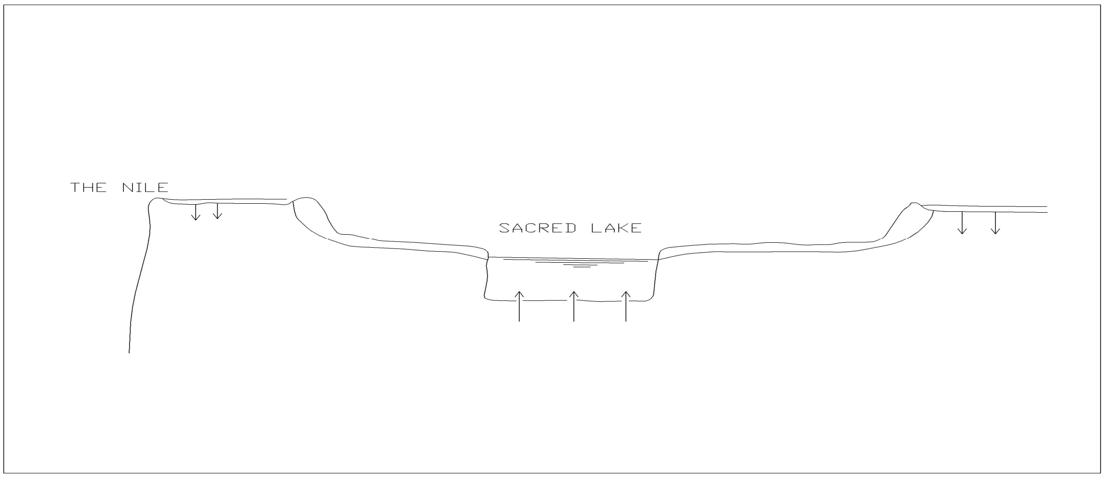

Fig. (8) Hydraulic system after the High Dam

2.1.5. The water depth:

On January, 1980 the depth of the lake was measured at several points as shown in Figure (2), the deepest was 3.70m at the middle and the shallowest was 3.50m at both the eastern side and the western south part from the lake . The lake depth ranged from a maximum of 3.95m to a minimum of 2.20m.

2.1.6. The water properties:

Three samples were taken from the lake's water of volume 1 liter each . The first sample was taken from a depth of 30cm, the second sample was taken from a depth of 150cm below the water surface and the third sample was taken at 30cm .
The three samples were analyzed, and the results were as follows:

2.1.6.1. The chemical properties:

The salts are concentrated in the lake's water . It contains a high percentage of sodium and chloride salts . The PH value is almost constant (10) and the change in the mineral content is small ranging between 10-11 gram/liter.

2.1.6.2 The water temperature:

The water temperature doesn't change a lot from the surface to the bottom, where the difference in the water temperature is 1° degree (at 16° Celsius at 10:00a.m at the end of January 1980).

2.1.6.3. The suspended materials:

Most of the suspended materials in the water were green carrageen and thread germs, some organic materials were found close to the lake's bottom . These materials mix with water when in motion, the ratio ranging between 80-85mlgram/litre, and increases by depth . The distribution of the suspended materials are even excluding the green carrageen which are floating on the surface in a conical shape towards the depth .

Table (1) shows the distribution of the suspended materials in the lake water:

Table(1)

	At the water surface	30cm below the water surface	150cm below the water surface	30cm above the bed level	Average
A1	81	82	67	153	96
C3	82	123	117	152	113
E5	793+	614+	70	84+554	77
G4	77	75	75	107	83
I5	78	75	60	1006+1046	71
K8	78	92	73	100	86
Average	79	89	77	115	

2.1.7. Pollution:

The bottom of the sacred lake is covered with about 15cm-thick layer of organic sediments which is the main source of the pollution . Moreover, the stationary water in the lake helps the foresees to grow on surface which causes the rotten smell .

It is clear that the sacred lake's water should be renewed continuously with fresh water and the sediments layer at the bottom must be removed to prevent contamination.

2.2. The River Nile:

The River Nile is the main source which provides the sacred lake with fresh water, also it is the drain for discharging the lake's water .

2.2.1. The water properties :

Table (2) shows the Biologic Oxygen Demand (BOD) :

Table (2)

Content (Part/ Million)	Date
14.0	0
13.0	1
12.0	2
10.5	3
10.0	4
8.5	5

2.2.2. The water level:

The average water level in the River Nile during the month of June 1981 was (78.320m) with respect to the fixed point no (1) which is placed at the lake's North East corner .

3. THE PROPOSED SOLUTION TO THE PROBLEM:

The proposed hydraulic system to clean the lake and prevent the pollution as follows:

The main purpose of the hydraulic system is to replace the sacred lake's water frequently by discharging its water to the Nile and replacing it at the same time and with the same rate by fresh water from the Nile water . This system to be constructed using two pipe line systems with pumps from the lake to the Nile for the discharge and from the Nile to the lake . Figure (9) shows a sketch of this system which has several advantages as follows:

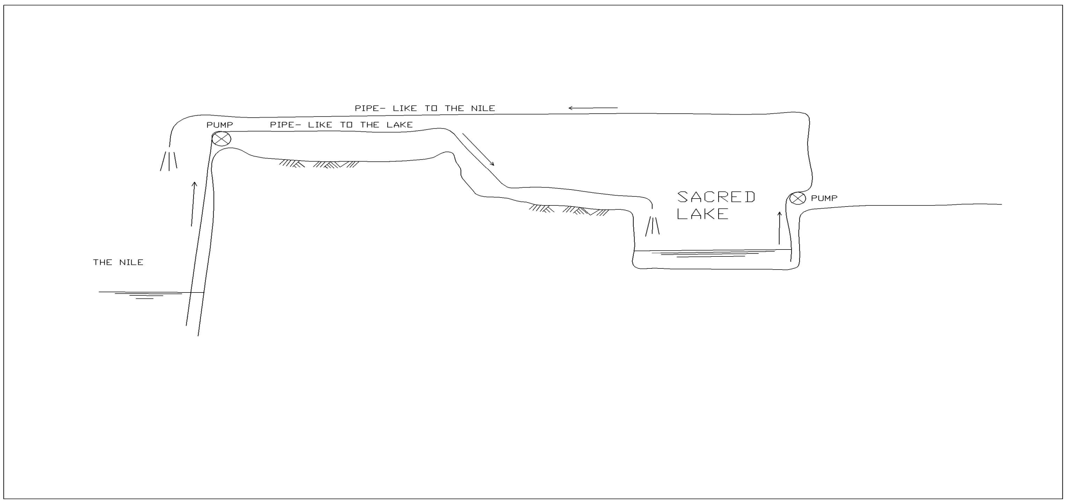

Fig. (9) Proposed hydraulic system for cleansing the sacred lake

3.1. Simple operation:

The usage of two separate pipes, one for the discharge and one for the supply with a pump station on each pipe line need a limited technical staff for both the operation and maintenance for the system .

3.2. The life span and the maintenance cost for the pipelines:

The usage of two pipelines extend the life span for each of the two pipe lines and decrease the necessary maintenance costs .

3.3. Monument protection:

This system permits the lake to be supplied by fresh water at the same time and with the same rate of the discharge of the lake's water, this ensures a stable underground water level at The Karnak Temple area, and prevents any possible damage to the Temple foundations due to soil settlements .

3.4. Field data collection and analysis:

To design the suitable hydraulic system, it is required to prepare two groups of technicians to collect the necessary field data for the two pipelines and the pumping station design.

The first group to identify the location of the pipe lines and survey the ground levels along the path of the two pipe lines, while the second group to make the soil borings along the pipe lines path.

Figure (10) indicates the general site layout and the path of the two pipelines and also the fixed points on the ground.

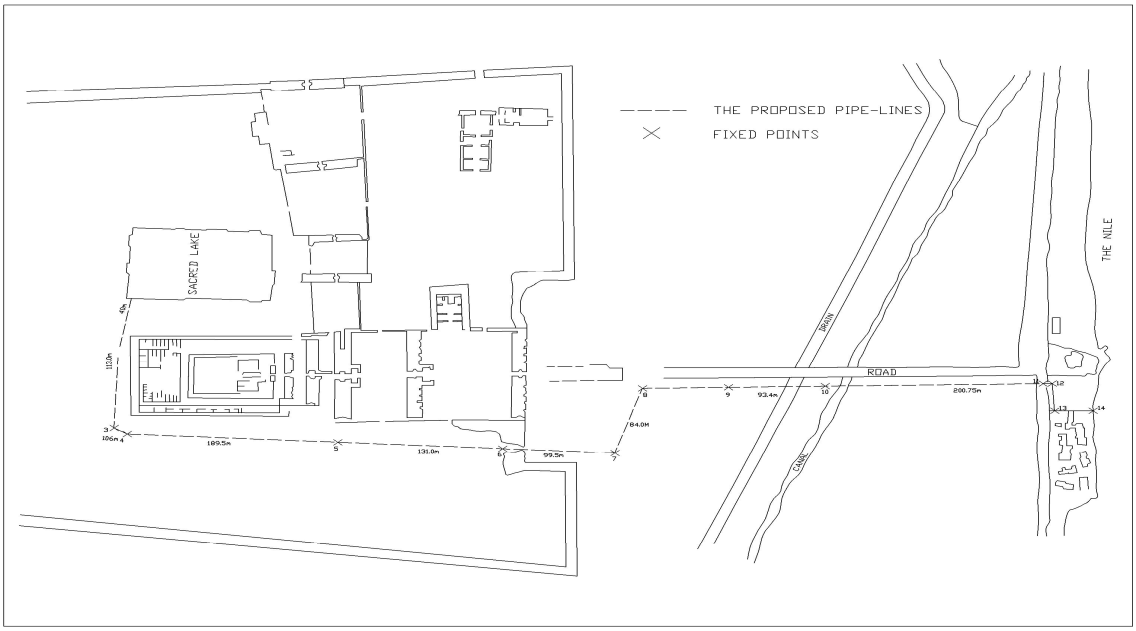

Fig. (10) Layout and location of the proposed pipe-lines

4. CONCLUSIONS:

a. The rate of supplying the sacred lake with fresh water must be simultaneously in the same time and discharge rate, so that the underground water table level in the area stay constant.

b. The suction point from the River Nile must be upstream the discharge point in the Nile by about 50m to avoid the resuction of the polluted water.

c. The discharge water from the discharge line at the point of exit will be equal to the atmospheric pressure . The end of the discharge line has to be higher than the surface water of the lake to ensure continuous flow of water in the discharge line.

d. Supplying the lake with fresh water through a perforated plate installed higher than the lake's water level to ensure water ventilation.

e. The organic sediments to be removed from the bottom of the lake by using a high pressure water jet then discharging the water with the suspended sediments and supplying in the same time and rate the fresh water from the River Nile .

5. REFRENCES:

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