ABSTRACT: In the early and mid decades of the previous century, the lack of a simple and economic option for the offsite conveyance and treatment of domestic sewage in Egyptian rural areas lead to the sole dependence on septic tanks for the onsite disposal of domestic sewage. As time went on the unpredicted demographic reshaping that had undergone in all Egyptian rural areas coupled with the un-engineered guidance in the construction of almost all the septic tanks has lead to a failing system of septic tanks. Currently almost all Egyptian rural areas are already facing environmental degradation. This is a result of the overload on the existing onsite septic tanks that resulted in frequent streets overflow, potential health hazards, high ground water level, contamination of ground waters, rivers and streams together with a long list of service management deficiencies. In this study a survey was conducted on existing septic tanks. Ground water samples were collected from around septic tanks to a diameter of 40 meters. The effect of the septic tanks was monitored during three operational conditions. The first condition when the tank in its ordinary operational sequence. The second when the tank fully emptied and the third when the tank connected to a small bore sewer system. The second operational condition gave the best results as the surrounding water seeped back into the tank. The third operational condition showed that by connecting the septic tanks to small bore sewers the pollution area of the septic tank dropped by about 50%. The first operational condition was the worst case. The study achieved its aim by indicating that the pollution effects of septic tanks can be reduced by connecting it to a small bore sewer system or by rehabilitating it or by both because it is virtually illogic to demolish the thousands of septic tanks currently existing and operating in Egyptian rural areas for new watertight tanks. Thus by reducing the pollution effects of septic tanks, all the rural populations in Egypt will benefit.

KEYWORDS: Domestic sewage; Rural areas; Ground water; Small bore sewers system; Septic tanks.

INTRODUCTION

In 1860 Jean Louis Mouras, built a brick tank in order to collect and treat the domestic wastewater of a residence. Mouras cesspit consisted of a simple tank of a single chamber with an entrance and an exit, Metcalf 1901. As time went by, modifications occurred and new conceptions of septic tanks were implemented, such as Travis tanks in 1903, from which later on Imhoff's tanks were developed. In Egypt, and from the early nineties, septic tanks provide the only means for domestic wastewater collection before the subsequent evacuation by special trucks. Almost all Egyptian unsewered villages are being served with a failing system of septic tanks. These septic tanks were/are usually constructed without any engineering guidance and in most cases are constructed bottomless with untight walls. As a result, wastewater seeped from these tanks to the ground water and thus contaminating it. Apart from the pollution effects of these septic tanks, the ground water table rouse to a critical extent of endangering the existing buildings.

On the other hand, groundwater represents one of the most important sources of freshwater in Egypt, especially with regards to villages and cities located far away from the river Nile, Amgad and Mohesn, 1996. In Egyptian unsewered areas, septic tanks provide a direct pollution source to ground water. The small bore sewers system that was introduced in the early 1990s as a means for wastewater collection, Fadel 2001, uses existing septic tanks as a main component of the system. In the small bore sewer system, all the household wastewater is collected in the septic tank were it is retained and allowed to settle for a period of 24-36 hrs. After that the liquid portion of the wastewater is trapped by means of special inlet and outlet configurations. The trapped liquid wastes are carried via a network of small bore sewers to the pumping stations.
Concurrently, with the widespread of this system in the Egyptian rural areas, there was a great controversy between both the Egyptian professionals and laymen about the success of this system. Of the few disadvantages mentioned was that these septic tanks provide a current or a potential source of pollution to ground water. Thus the need for a thorough research work to asses the pollution effects of septic tanks on ground water arised. This paper discusses the mode of operation of septic tanks together with corresponding pollution effects of each mode.

MATERIALS AND METHODS

In the course of this study, three septic tanks were selected for undertaking the research work. The experimental setup was carried out in a village called Nawag. This village is situated about 10 kms away from Tanta city on the Tanta-Kafr Elshiekh highway. This village experienced the first pilot and large small bore sewer system constructed in Egypt. These tanks were chosen to represent a category of the existing tanks in use. Table (1) shows the description of the three tanks understudy, while figures (1) to (3) show details of these tanks.

Table (1): Septic tanks understudy

No.	Dimensions (l*b*d)m	Materials of construction	Remarks
1	4.0*2.0*2.5	Brick walls and bottomless	Existing septic tank monitored in ordinary operation mode and empty mode with no any rehabilitation.
2	6.0*3.5*2.25	Brick walls and bottomless	Existing septic tank monitored before and after connection to the small bore sewers with rehabilitation conducted before connection.
3	8.0*3.0*3.0	Plain concrete	Newly constructed water tight septic tank monitored before and after connection to the small bore sewers.

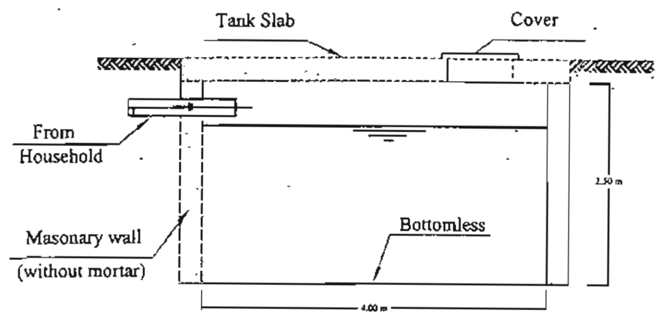
Soil borings were conducted at different locations and depth around the tanks. The distance of the borings from the tanks ranged from 1.0 ms to 18 ms and this was the maximum mid span distance between the tank under study and any nearby tank. The depth of borings reached to a maximum depth of 20 meters from the ground level at the site of the tanks under study. Table (2) shows nomenclature used from the sampling process.

This research work lasted for a period of six months during which samples were collected monthly in accordance with the procedure stated in table (2). For each sample two borings were done at different locations but from the same distance from the tank. Both samples were mixed and a composite sample was taken. The parameters monitored in the collected samples were analyzed in the laboratories of the Faculties of Engineering and Science, University of Mansoura; according to the procedures stated in the Standard Methods, 1992.

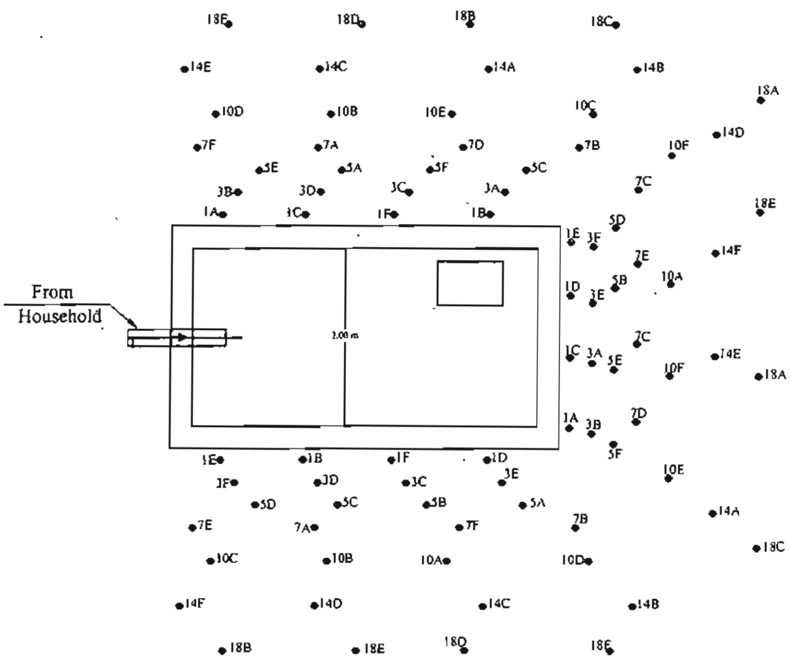
*Table (2): Samples nomenclature **

Depth of boring (m) / Distance from septic tank (m)	1	3	5	8	10	14	18	20
1.0	1A1	1A3	1A5	1A8	1A10	1A14	1A18	1A20
3.0	3A1	3A3	3A5	3A8	3A10	3A14	3A18	3A20
5.0	5A1	5A3	5A5	5A8	5A10	5A14	5A18	5A20
7.0	7A1	7A3	7A5	7A8	7A10	7A14	7A18	7A20
10.0	10A1	10A3	10A5	10A8	10A10	10A14	10A18	10A20
14.0	14A1	14A3	14A5	14A8	14A10	14A14	14A18	14A20
18.0	18A1	18A3	18A5	18A8	18A10	18A14	18A18	18A20

* The middle alphabet is for the month (A for first month and F for the sixth month). The number to the left is for distance from the septic tank and the number to the right is for the depth of boring.

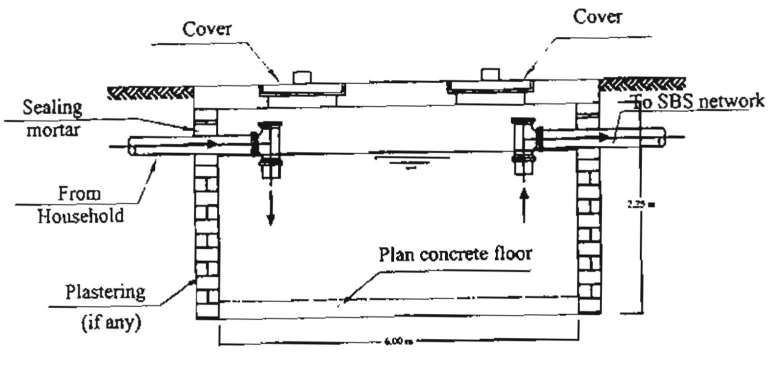


Section elevation

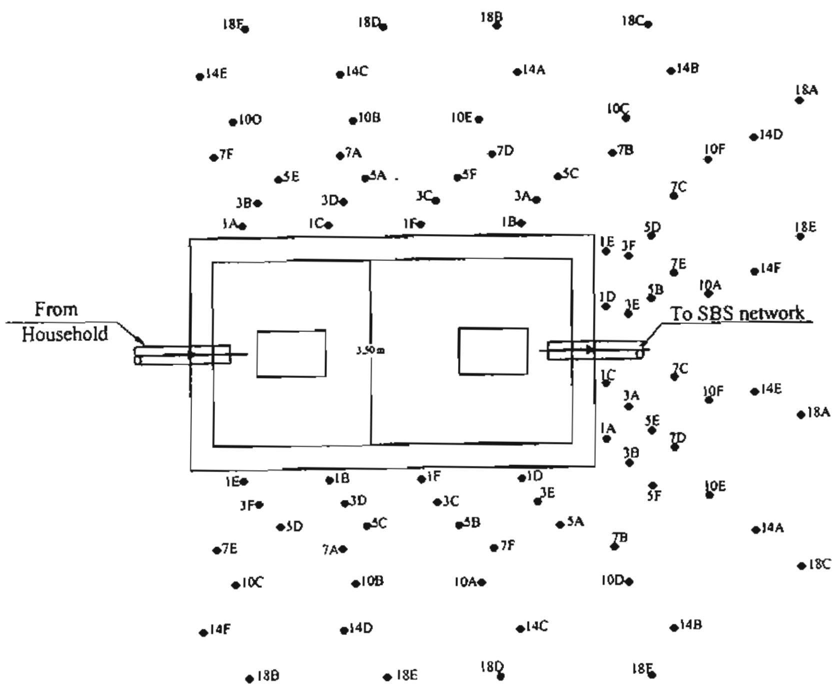


Plan showing the sampling points

Figure (1) : Existing septic tank monitored in ordinary operation and empty modes

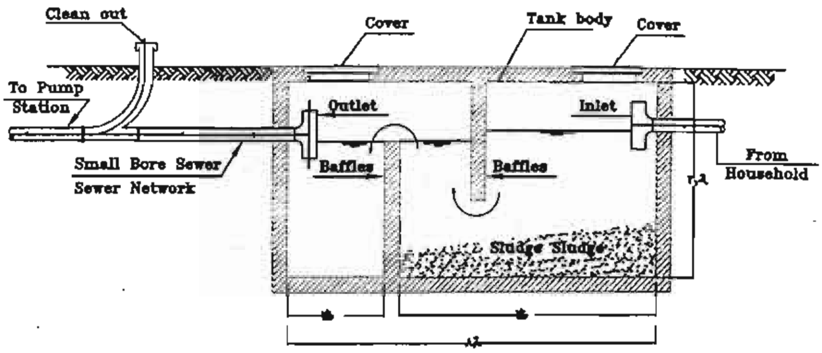


Section elevation of tank after rehabilitation

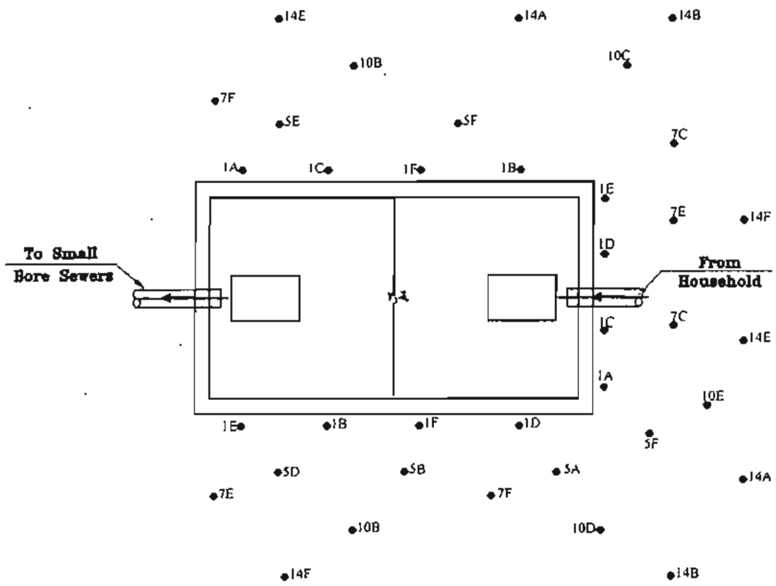


Plan showing the sampling points

Figure (2) : Existing septic tank monitored before and after connection to the small bore sewer system



Intercreptor Tank



Plan showing the sampling points

Figure (3) : Newly constructed septic tank

RESULTS AND DISCUSSIONS

CASE ONE: EXISTING SEPTIC TANK IN ORDINARY OPERATION AND EMPTY MODES

During the operational period of this case the best and worst results were obtained. Best results were obtained with samples collected when the septic tank was daily evacuated. In this situation the water seeped back into the tank through the walls from the surrounding high ground water table. The worst results were obtained during the normal operation mode of the septic tank. The normal operating mode of the septic tank was monitored for three months and almost all the three samples collected gave identical results. The empty operation mode was monitored for three months and the results were gradually improving, month after month. This is not strange as this mode of operation not only resembles the removal of the pollution source, but it also removes part of the surrounding ground waters that are heavily polluted.

Table (3) shows the summary of the average results obtained during the first mode of operation (A, B and C) while table (4) shows the third and final sample (F) tested as it gave the best results; identical samples were omitted from both tables. While figures (4) and (5) show the profiles of the COD and total coliform count values vs sample points. From the tables and curves it is obvious that the pollution is at its highest near the tank and it drops as we proceed away from the tank both vertically and horizontally. The highest COD value recorded was 165 mg/lit and it dropped to about 5.0 mg/lit down deep and away from the tank. Total coliform count was at its highest value near the tank (475 MPN/100 ml) and it dropped to 3 MPN/100 ml as we move away from the tank. It was also noticed that the movement and behavior of bacteria from the source of pollution to the point measurement is similar to that stated in literature, Romero 1970. pH values where almost the same in both operational modes. Turbidity values were found to drop by about 20% in the upper soil layers and increased to about 50% in the lower soil layers under study. The characteristic rotten egg smell of hydrogen sulfide was noticed in sub-surface samples collected from near the tank in the first mode of operation. This smell ceased in deeper samples and in those of the second mode of operation.

The other parameters monitored as shown, in tables (3) and (4), showed the pollution effect of septic tanks on the surrounding ground water. Some parameters showed a marked drop in the pollution effect after removing the source of pollution as in second operational mode. The highest COD value recorded was 45 mg/l and it decreased to 5 mg/l down deep and away from the tank. (Fig. 6 and Fig. 7). Other parameters on the contrary showed a slight change after the removal of the pollution source. However, in general, it can be deduced that the characteristics of the ground water were enhanced after the removal of the pollution source.

CASE TWO: EXISTING SEPTIC TANK BEFORE AND AFTER CONNECTION TO THE SMALL BORE SEWERS

The first mode of operation in this case resembled the first mode of case one discussed earlier. Thus after the first sample was collected, the tank was rehabilitated as shown in figure (2) and the tank was directly connected to the small bore sewer system. In the subsequent five months of operation, the samples collected showed a gradual marked decrease in pollution; a slight reduction in the ground water level was also recorded. This was attributed to the fact that no wastewater is passed to the groundwater. The phenomena lies in the fact that in the ordinary mode of operation, the tanks were pumped once or twice weekly and thus due to the difference in water level, groundwater enters the tank. As the tank gets filled by both the groundwater and incoming raw wastewater, the water level rises in the tank and wastewater, once again, is reversed back to the surrounding groundwater. The connection of the septic to the small bore sewer system maintained the water level in the tank at a constant fixed level. This made a sort of equilibrium between the groundwater level and the wastewater level in the tank and together with the slight rehabilitation that was conducted; virtually the wastewater seepage was terminated.

With time and due to the effect of terminating or diminishing the pollution source, the pollutants in the groundwater began to degrade within the soil strata. It was also believed that the peculiar features inside the soil filter layers responsible for the ground water treatment are not only affected by the hydraulic stability of the system but also the inferior hydraulics that are thought to occur within the soil layers. The results

Table (3): Summary of average results obtained during the first mode of operation (Case one)

Parameter (mg/lit) / Samples	pH	Turbidity NTU	BOD mg/L	COD mg/L	Ammonia mg/L	Nitrates mg/L	Sulphates mg/L	Chlorides mg/L	Mg mg/L	Ca mg/L	Total hardness mg/L	Fe mg/L	Zn mg/L	Mn mg/L	P mg/L	Na mg/l	Total Bacterial Count	Total Coliform MPN/100ml	Fecal Coliform MPN/100ml
1 A 1	7.4	20.00	95.00	165.0	47.50	36.00	475	10.75	75.00	65.00	73.00	0.40	0.20	3.70	2.65	212	11.5	475	400
3A 1	7.3	18.00	80.00	137.0	40.00	34.25	375	8.35	60.00	55.00	70.00	0.30	0.15	2.90	3.25	185	10.7	310	225
3A 3	6.9	7.00	65.00	110.0	36.25	26.00	300	6.70	55.00	50.00	65.00	0.50	0.10	2.50	2.15	175	8.3	190	160
14A 10	6.8	5.00	22.00	32.00	23.75	17.35	195	3.75	37.00	30.00	55.00	---	---	2.00	1.9	140	1.0	18	15
18A 14	7.1	4.00	6..50	18.00	19.65	11.65	125	3.00	22.00	25.00	50.00	0.25	---	1.80	1.85	135	0.96	8	8
1B 3	7.3	12.00	90.00	165.00	39.60	30.00	275	9.00	70.00	60.00	71.00	0.30	0.08	1.70	2.25	250	2.3	455	375
1B 5	7.8	8.00	100.00	163.00	34.25	29.00	300	8.25	68.00	60.00	68.00	0.39	0.01	1.00	1.3	250	2.0	440	360
5B 8	7.4	9.00	48.00	95.00	27.35	20.00	260	7.35	57.00	57.00	65.00	0.15	---	0.80	1.5	155	1.5	155	100
10B 18	7.00	3.00	20.00	33.00	4.75	10.35	220	3.00	40.00	47.00	60.00	---	---	0.90	0.40	130	0.98	20	17
14 B 20	7.00	1.00	7.75	22.00	4.60	2.15	165	2.75	25.00	35.00	55.00	---	---	0.78	0.38	115	0.58	12.5	9
1C 1	6.9	28.00	80.00	165.00	49.00	35.00	330	9.75	70.00	30.00	71.00	0.20	0.01	3.00	3.0	230	12.5	460	400
1C 3	7.3	25.00	75.00	165.00	38.75	29.00	310	8.65	75.00	38.00	69.00	0.30	0.01	1.90	1.7	230	2.4	452	370
3C 5	7.3	17.00	39.00	130.00	31.00	27.00	300	6.50	45.00	49.00	65.00	0.19	0.01	1.50	1.2	115	2.0	330	250
5C 1	7.7	23.00	35.00	110.0	38.00	32.00	285	9.00	50.00	45.00	73.00	0.25	0.09	2.10	0.9	165	12.0	250	200
7C 20	7.0	2.00	6.75	35.00	8.00	6.75	210	4.75	40.00	20.00	55.00	---	---	0.70	0.40	145	0.62	25	20

Table (4): Summary of average results obtained during the second mode of operation (Case one)

Parameter (mg/lit) / Samples	pH	Turbidity NTU	BOD mg/L	COD mg/L	Ammonia mg/L	Nitrates mg/L	Sulphates mg/L	Chlorides mg/L	Mg mg/L	Ca mg/L	Total hardness mg/L	Fe mg/L	Zn mg/L	Mn mg/L	P mg/L	Na mg/L	Total Bacterial Count	Total Coliform MPN/100ml	Fecal Coliform MPN/100ml
1 F 3	7.5	18.00	27.00	55.00	31.35	23.75	300	8.75	45.00	45.00	65.00	0.35	0.01	2.90	2.25	160	1.98	170	150
1 F 5	7.2	16.00	25.00	50.00	22.00	17.00	210	6.35	40.00	36.00	50.00	0.25	0.09	2.00	3.0	160	2.3	160	125
1 F 10	7.8	6.00	18.00	40.00	18.00	10.00	175	5.35	38.00	45.00	45.00	---	---	0.90	0.93	135	1.2	138	120
3 F 3	7.1	12.00	19.00	47.00	26.00	12.00	195	6.65	40.00	36.00	40.00	0.18	0.03	2.00	1.9	130	1.0	145	95
3 F 8	7.4	8.00	15.00	37.00	20.00	10.00	165	6.00	40.00	40.00	51.00	0.16	0.02	1.50	1.0	147	0.95	110	100
5 F 14	6.8	3.00	13.00	27.00	12.00	6.75	155	5.25	35.00	30.00	53.00	---	---	1.60	0.4	125	0.63	60	40
5 F 20	7.1	1.00	3.75	17.00	---	---	100	2.65	25.00	20.00	50.00	---	---	0.08	--	105	0.04	27	20
7 F 5	7.3	10.00	12.00	33.00	14.00	10.75	185	5.85	20.00	15.00	51.00	0.29	0.01	1.00	0.7	135	0.75	90	65
7 F 8	7.5	7.00	15.00	32.00	11.00	9.00	155	6.35	20.00	27.00	53.00	0.23	---	1.80	0.5	130	0.7	70	47
7 F 10	7.3	6.00	11.00	30.00	8.75	5.45	160	6.85	8.75	33.00	40.00	0.27	---	1.20	0.31	120	0.8	65	50
10 F 14	7.6	6.00	6.75	22.00	6.75	3.50	145	3.00	6.50	21.00	38.00	---	---	0.09	0.09	115	0.6	30	20
10 F 18	7.5	4.00	4.35	17.00	3.75	---	120	2.75	4.76	25.00	45.00	---	---	0.01	0.05	120	0.05	17	13
14 F 14	6.4	4.00	4.25	16.00	2.75	---	110	2.85	3.75	20.00	49.00	---	---	0.01	0.3	125	0.09	16	10
14 F 18	7.3	3.00	3.00	12.00	1.75	---	105	1.85	3.75	20.00	55.00	---	---	0.01	0.01	100	0.06	12	10
18 F 20	7.2	1.00	2.00	3.75	---	---	95	---	2.75	26.00	50.00	---	---	0.01	--	90	0.03	2	2

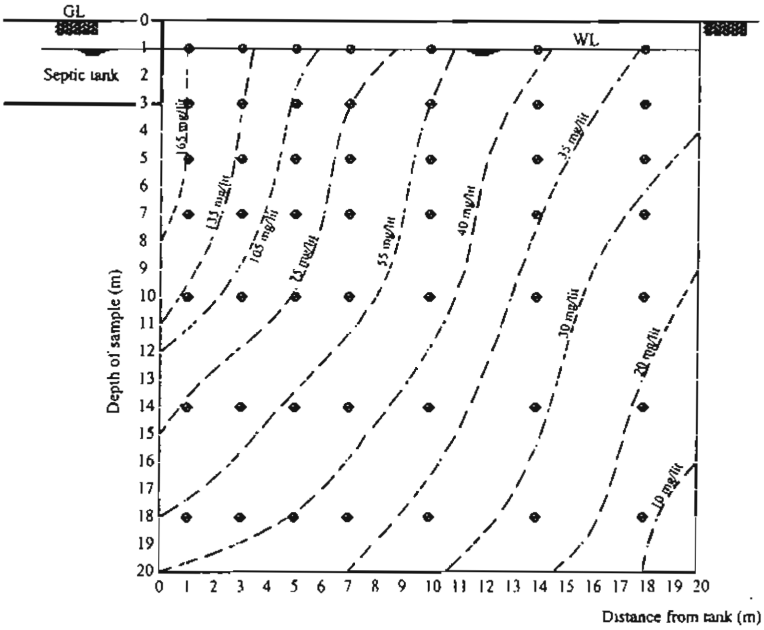


Figure (4): Profile of the COD values recorded for case one (first operation mode)

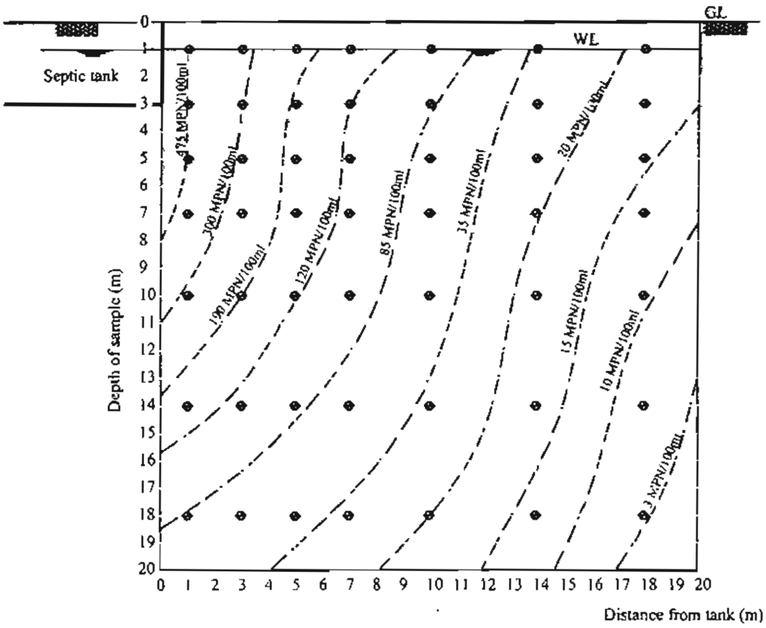


Figure (5): Profile of the total coliform count values recorded for case one (first operation mode)

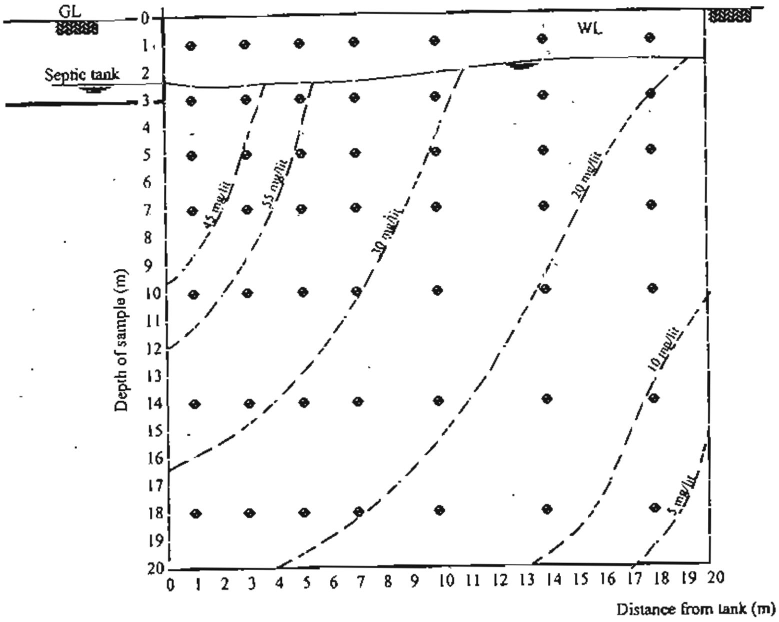


Figure (6): Profile of the COD values recorded for case one (second operation mode)

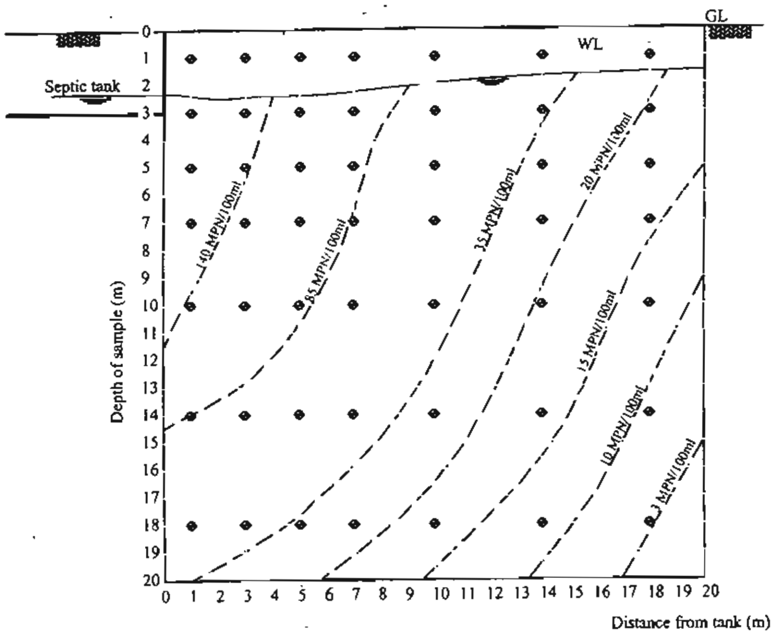


Figure (7): Profile of the total coliform count values recorded for case one (second operation mode) obtained in the five months subsequent to the connection to the small sewers, showed a gradually progress in the characteristics of the ground water. Figures (8) and (9) show the profiles of COD and total coliform count values recorded in the sixth and final measurement, while table (5) shows some of the results monitored after the connection to the small bore sewers. A marked drop in turbidity was recorded during this case of operation and this was attributed to the stability that has occurred to the system after the connection to the small bore sewer system. In almost all the parameters that were monitored during this period, the samples that were collected from the deep layers showed better results compared with those collected from the upper layers.

Generally, we can deduce that the pollution effect was reduced by about (60 – 70) % after the connection to the small bore sewers and this in the circumstantial point of view is a great achievement as 80 % of the Egyptian rural dwelling areas are provided with septic tanks and with a slight modification and rehabilitation it can be used in the small bore sewer system instead of constructing a new tank or demolishing it as with the case of the conventional system of sewers.

CASE THREE: NEWLY CONSTRUCTED SEPTIC TANK

This case of operation gave the best and ideal results. The constructed tank was water tight thus no any water seeped in nor out of the tank during the different operational phases prior to and after the connection to the small bore sewers. With the presence of the tank no any pollution effects were recorded. This dropped the need for the numerous samples that were recorded. The flow lines as shown in figures (9) and (10) are almost horizontal compared with those discussed earlier. This shows that newly constructed septic tanks that are water tight have no any effect on the ground water. From the figures and table (6) we can deduce that the ideal solution is to construct water tight tanks. But on the contrary, this solution is not economic and it will lead to a more economic burden on the low cost small bore sewer project which in either case remains cost effective compared with other wastewater collection systems. During this case of operation, the ground water level recorded a slight drop due to the cease of seepage water and some of the deeper samples recorded during this phase of experimental work were fit for potable water consumption.

Table (5): Summary of average results obtained during the second mode of operation (Case two)

Parameter (mg/lit) / Samples	pH	Turbidity NTU	BOD mg/L	COD mg/L	Ammonia mg/L	Nitrates mg/L	Sulphates mg/L	Chlorides mg/L	Mg mg/L	Ca mg/L	Total hardness mg/L	Fe mg/L	Zn mg/L	Mn mg/L	P mg/L	Na mg/L	Total Bacterial Count [illegible]	Total Coliform MPN/100ml	Fecal Coliform MPN/100ml
1 F 1	7.0	12.00	65	90	38.0	30	265	8.35	38	43	65	0.49	0.15	3.2	2.0	170	1.57	200	110
3F 1	7.6	9.00	53	80	32.0	27	220	7.15	35	37	65	0.30	0.13	3.2	2.2	165	1.23	180	95
5F 3	6.9	7.00	47	70	30.0	27	195	7.00	30	33	60	0.39	0.1	3.0	2.1	143	1.0	148	100
14A 10	6.8	5.00	10	17	23.0	28	185	7.00	22	23	55	0.28	0.08	2.0	1.9	75	0.1	18	10
18A 14	7.5	3.00	3	8	19.0	20	125	6.5	25	17	27	0.22	--	1.7	1.8	65	1.68	190	105
1B 3	7.4	10.00	29	75	35.0	23	130	6.0	23	26	38	0.32	0.09	2.9	2.0	85	1.93	187	123
1B 5	7.9	6.00	33	70	33.0	27	125	6.0	21	28	55	0.31	0.1	2.7	2.1	78	1.1	160	85
3B 8	7.5	5.00	39	60	29.0	20	165	4.75	27	23	30	0.29	0.06	2.0	--	70	0.63	90	49
10B 18	7.10	3.00	6	17	17.0	18	150	3.75	16	20	24	0.23	0.03	1.5	1.6	60	0.69	20	15
14 B 20	7.00	2.00	--	8	16.0	12	100	--	5	18	20	--	—	1.0	1.4	55	0.5	12	10
1C 1	6.9	7.00	63	95	31.0	30	120	3.5	18	29	45	0.37	0.13	2.5	2.3	165	1.75	195	95
1C 3	7.3	5.00	49	80	27.0	29	135	3.0	26	30	38	0.36	0.1	2.4	2.1	160	1.85	165	87
3C 5	7.5	4.00	37	70	33.0	25	115	3.1	22	30	32	0.3	0.12	2.2	1.8	80	1.1	160	73
5C 1	7.8	6.00	43	70	32.0	20	195	2.8	23	27	26	0.3	0.11	2.9	2.3	160	0.97	163	95
7C 20	6.5	1.00	6	17	20.0	17	95	2.0	20	20	31	0.2	--	0.6	1.0	48	0.67	23	10

Table (6): Summary of average results obtained during operation of the newly constructed tank (Case three)

Parameter (mg/lit) / Samples	pH	Turbidity NTU	BOD mg/L	COD mg/L	Ammonia mg/L	Nitrates mg/L	Sulphates mg/L	Chlorides mg/L	Mg mg/L	Ca mg/L	Total hardness mg/L	Fe mg/L	Zn mg/L	Mn mg/L	P mg/L	Na mg/L	Total Bacterial Count [illegible]	Total Coliform MPN/100ml	Fecal Coliform MPN/100ml
1 A 1	7.0	9.00	21	40	31	27	250	6.35	34	36	55	0.35	0.01	2.5	2.2	150	1.2	175	165
1 A 5	7.2	7.00	17	30	27	23	210	4.15	29	32	50	0.3	0.02	2.3	2.3	160	1.0	110	101
3D 8	6.7	6.00	12	25	22	20	175	3.8	26	38	38	0.19	0.03	2.0	2.0	125	0.98	80	65
7B 14	7.1	12.00	2	9	15	11	75	1.75	20	29	41	0.28	0.07	1.8	1.9	95	0.09	22	20
1 C 8	7.4	8.00	13	25	17	14	75	3.35	23	25	33	0.23	0.09	1.75	1.3	100	0.6	80	60
5 C 14	6.8	1.00	--	9	1.2	1.05	65	--	17	15	25	—	--	1.0	0.95	85	0.06	22	20
5-C 20	7.1	0.8	--	3	—	—	60	--	--	10	30	--	--	0.9	0.01	75	1.0	170	100
7C 1	7.3	7.00	25	38	8.5	6.3	63	2.75	6.79	12	21	0.20	0.01	1.2	0.5	65	0.85	105	75
7 D 5	7.7	7.00	14	30	9.5	7.5	70	--	8.3	13	35	0.19	0.04	0.8	0.31	85	0.7	50	41
7 D 10	7.3	5.00	10	21	6.5	4.35	90	--	3.65	4.7	30	--	0.01	0.5	0.09	75	0.65	47	40
10 E 10	7.6	6.00	7	20	5.45	4.75	105	1.0	4.45	7.3	26	0.1	0.05	0.03	0.27	70	0.03	21	11
10 E 14	7.5	4.00	--	8	3.25	2.5	80	--	1.75	5.35	33	—	0.06	0.01	0.1	69	1.1	70	60
14 F 8	6.4	3.00	6	23	15	10	85	--	1.5	4.7	22	0.13	0.01	0.02	0.15	50	0.63	230	20
14 F 18	7.3	1.00	--	3	--	—	55	--	—	6.9	20	--	0.03	--	0.01	65	0.015	1	--
18 F 20	7.2	0.5	--	—	0.9	—	50	--	1.0	3.4	29	--	--	0.01	—	38	0.01	--	--

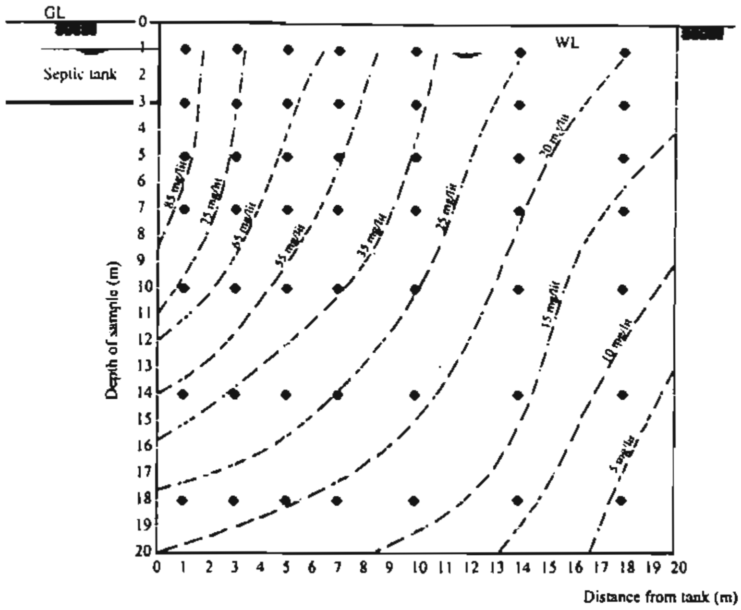


Figure (8): Profile of the COD values recorded for case two (second operation mode)

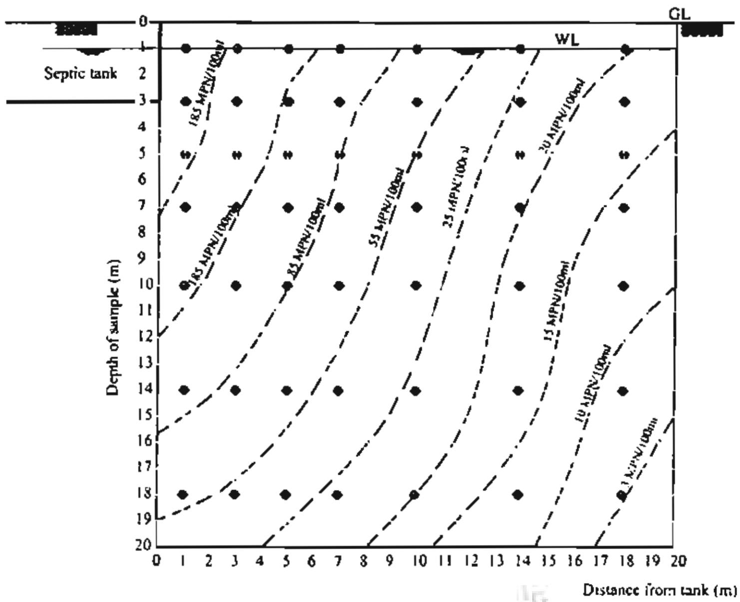


Figure (9): Profile of the total coliform count values recorded for case two (second operation mode)

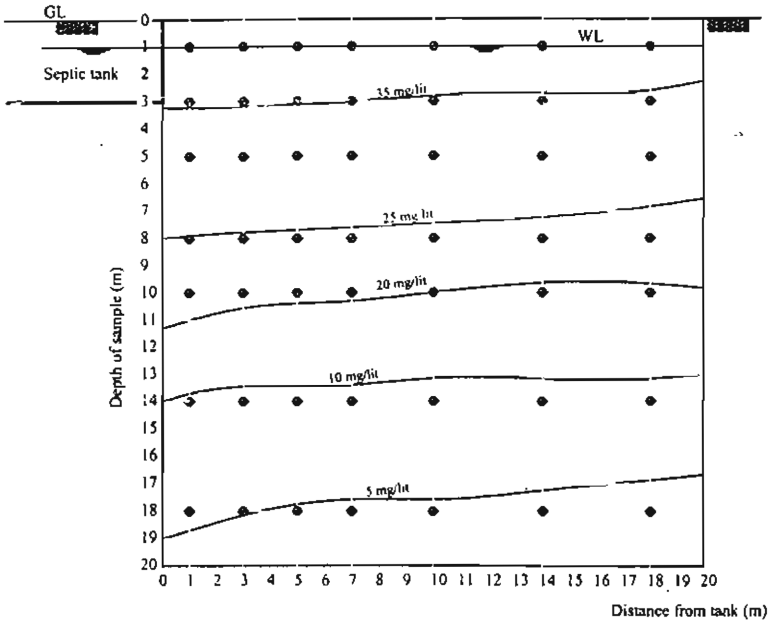


Figure (10): Profile of the COD values recorded for case three (newly constructic septic tank)

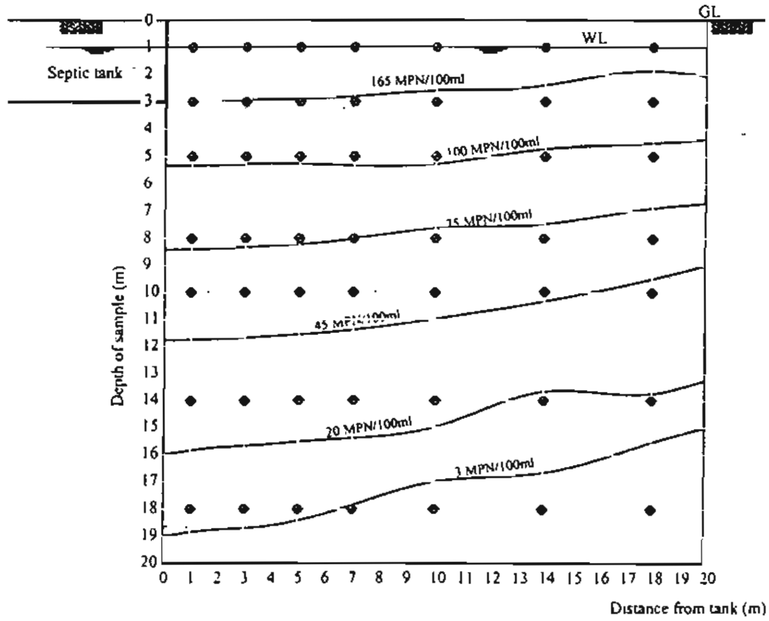


Figure (11): Profile of the total coliform count values recorded for case three (newly constructic septic tank)

GENERAL DISCUSSIONS

From the three cases discussed earlier, it is feasible that un-engineered poorly designed and constructed septic tanks represent a great pollution source to the surrounding ground water. They are also the main source responsible for the increase of ground water level in Egyptian rural areas. There presence represents a great menace to both the Egyptian rural populace and buildings. The Egyptian government has undertaken many projects to lower the ground water table, but to no avail. The main solution to the problem of the rise and pollution of ground water should come from the roots. This means proper sanitation facilities must be provided for all Egyptian villages starting from collection and ending with disposal via safe conveyance and treatment systems that suit their local environment. The rehabilitation of existing septic tanks and connecting it to the small bore sewers gave a dual promising result. Firstly, it provided a direct solution to the problem of wastewater collection and disposal in rural Egyptian areas. Secondly, it helped to reduce the pollution of the ground water by about 50 %.

CONCLUSIONS

The survey conducted on the effect of septic tanks on ground water characteristics in Egypt has revealed the dilemma and critical situation that is facing Egypt because the contamination of ground water is a problem of serious impact on the ecosystem, subsurface structures, water resources, public health and consequently the national economy. This paper is the first of its type in Egypt to discuss the pollution effect of septic tanks in Egypt and the results obtained from this study provide a glimpse of hope for the solution of the Egyptian groundwater pollution crisis and the findings of this paper are summarized as follows:-

* Newly constructed septic tanks have no any pollution effect on ground water.
* Existing poorly designed and constructed septic tanks are the main sources of ground water pollution in Egyptian rural areas.
* The rehabilitation of existing septic tanks and connecting it to small bore sewers reduced the pollution of the surrounding ground water by about 50%.

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