ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

ERC Hydro-Cracking Complex Project at Mostorod

FINAL VERSION

Appendix 5.3 – Surface and Groundwater Analysis

51287-1

December 2008

Infrastructure & Environment

10th Floor
21, Misr Helwan Agriculture Road
Maadi, Cairo, Egypt
Telephone: +202 2359 5628 / 1487 / 1576 / 3819
Facsimile: +202 2359 1038
www.worleyparsons.com

© Copyright 2008 WorleyParsons Infrastructure and Environment Limited

Introduction

Concerns with water quality have increased in recent years, in part due to frequent contamination of inland water resources by waterborne bacterial, viral and protozoan pathogens. Faecal pollution could lead to the transmission of pathogens and therefore, waterborne diseases. This faecal material can be originated from point source discharges such as raw sewage, storm water, effluent from wastewater treatment plants and industrial sources (Seurick *et al*., 2005).Thus, identification of pathogenic bacteria in water resources is important for controlling and prevention of infectious diseases.

Materials and methods

Determination of the most probable number (MPN) of total coliforms (TC), faecal coliforms (FC) in water and sediment samples was carried out using 3 decimal concentrations (10, 1 and 0.1 ml) from water and sediment samples (using 0.1% peptone water as diluent). Triplicate tubes containing MacConkey broth media were used for each sample. Double and single strengths media were used for 10, (1, 0.1)ml, respectively. All tubes were provided with durham tube. The inoculated tubes were incubated at 37^{o}C for 48 hr for TC. Positive tubes were indicated by acid and gas production. Positive tubes were confirmed by sub-culturing on Eosin-Methylene Blue (EMB) medium where coliform bacteria gave defined colonies with metallic sheen character (APHA, 1998).

For MPN of faecal coliforms, from positive tubes in total coliform MPN test , inoculate fresh single strength MacConkey broth media using sterilized loop. The inoculated tubes were then incubated at 44^{o}C (in water-bath). Gas and acid production within 24 hr., indicating positive reaction for FC. The MPN- index per 100ml water or 100g sediment was determined using the statistical tables (APHA, 1998).

National Research Centre
Environmental Consultation
&
Water Quality Unit

المركز القومى للبحوث
الوحدة الاستشارية للبيئة المائية

Table (1): The most probable number (MPN) of total coliform (TC), faecal coliform (FC) /100 ml water or / 100g sediment of the examined samples.

Sample		TC	FC	Sample		TC	FC
Water	A_1	350	0	Sediment	S_1	280	0
	A_2	90	0		S_2	210	0
	S_1	930	0		S_3	430	0
	S_2	210	0		S_4	470	10
	S_3	190	0		S_6	750	30
	S_4	200	0		S_7	150	30
	S_5	150	0				
	S_6	210	0				
	S_7	90	0				

Table 1: The biota of the investigated sites represented as no/100 cm^3

	S1	S2	S3	S4	S6	S7
Fauna						
Gnathostomulida						

Tahrir Street – Dokki – Giza
Phone & Fax: 33371479

شارع التحرير – الدقى - الجيزة
ت : ٣٣٧١٤٧٩

Gnathostomula paradoxa	0	0	0	0	23	18
Nematoda						
Rhabditis sp.	52	110	0	0	60	50
Vasostoma sp.	44	70	0	0	73	65
Oligochaeta						
Aktedrilus sp.	8	0	0	0	5	4
Polychaeta						
Triblodrilus sp.	39	7	0	0	3	2
Potamodrilus fluviatilis	33	5	0	0	3	2
Flora						
Oscillatoria sp.	37	28	0	0	20	25
Spirulina sp.	11	9	0	0	4	5
Melosira sp.	52	60	0	0	30	34
Pediastrum sp.	40	35	0	0	21	21
Total no. of individuals	316	324	0	0	242	226
Total no. of species	9	8	0	0	10	10

Table 2: Results for Parasites

Parasites

	S1	S2	S3	S4	S6	S7
Parasites	NON	NON	NON	NON	NON	NON
intermediate host for disease	NON	NON	NON	NON	NON	NON

Heavy Metals

Methodology

Total dissolved solids were measured after filtered known volume of well mixed sample by a glass fiber filter paper 0.045mm and then was transferred to a weighed evaporating dish and evaporate to dryness on a drying oven at 180 ^{0}C, cool in desiccator to balance temperature and TDS was calculated.

Total fixed (ashes of TDS) and volatile solids (ashes of TSS) were measured by ignite residue produced by method of total dissolved and total suspended solids to a constant weigh in a muffle furnace at a 550 ± 50 ^{0}C for 30 minute, respectively.

Dissolved oxygen was measured using modified Winkler method. BOD was determined by using 5 days method. COD was carried out using potassium dichromate method. Water alkalinity was determined using phenolphthalein and methyl orange indicators. Determination of fluoride carried out using SPANDS method. Sulphide determined by Iodometeric method. sodium was determined using flame photometer model (Jenway Felsted Gi Dunmow Essex)

Total organic nitrogen (TON) was determined by the Kjeldahl technique as reported in **APHA, (1992)**. A known volume of samples were subjected to ammonia removal by adding 10 ml of "11 N NaOH" and then digested using the digestion mixture of mercuric sulphate, potassium sulphate and Conc. H_2SO_4 in a digestion unit, until formation of clear liquid. The digested samples were left to cool, then 2ml DW were added. The digested samples were transferred to Kjeldahl unit which adjusted for 2-3 minutes to neutralize the sample using 10 N NaOH in micro-Kjeldahl model BUCHI 316. The liberated fumes from digested samples in Kjeldahl unit were received in a flask contain Boric acid and mixed indicator (Bromocrysol green + methyl red indicators) till the color changed from pale red to blue.

Then the mixture were titrated against H_2SO_4 (0.005 N) till color changed from blue to pale violet. Blank sample contain D.W. was treated as a sample as the same above procedure. Ammonia was determined by phenate method. Nitrite was determined using colorimetric method. Nitrate determined by reduction method as described by Mullin and Riley (1956). Orthophosphate was determined by using stannous chloride and acid molybdate method. Hexavalent Chromium was measured using colorimetric method using diphenylcarbazide in acid solution, the developed pink color was measured at wavelength 540 nm.

1.2. Recorded levels of studied parameters

Table (1): Recorded level of different parameters in the investigated samples

	S1	S2	S3	S4	S5	S6	S7	A1	A2
TDS mg/l	375	369	415	379	415	468	389	420	389
TSS mg/l	53	68	125	71	63	68	57	71	69
Ashes TDS (Fixed Solids) mg/l	281	273	302	272	306	329	287	305	287
Ashes TSS (Volatile solids) mg/l	21	19	52	21	20	24	19	23	21
DO mg/l	6.2	5.8	7.2	4.6	6.1	7.2	4.8	6.2	6.2
BOD mg/l	3.5	3.8	6.2	3.2	4.1	6.9	4.8	3.6	4.2
pH								8.35	8.07
Vanadium µg/l								2.35 ± 0.08	3.6 ± 0.1
Vinyl Chloride								ND	ND
COD (dichromate) mg/l	9.6	10.2	13.6	8.5	6.7	12.6	14.3	6.5	7.8
COD (permanganate) mg/l	12.2	13.5	18.9	10.2	9.6	17.2	17.6	8.9	10.4
T. Alk. mg/l	215	225	265	226	202	182	195	195	195
Fluoride mg/l	0.82	0.78	0.61	ND	ND	0.91	0.87	0.71	0.9
sulphide µg/l	290	360	560	410	310	612	560	330	396
Sulphate mg/l	24.0	24.6	22.8	25.3	31.8	31.1	22.7	27.9	25.6
NO_2 µg/l	4.3	4.3	10.8	4.9	3.8	5.1	4.1	4.9	3.8

NO_3 µg/l	43.2	46.4	79.9	44.6	36.0	45.4	36.7	41.8	33.1
NH_3 µg/l	151	120	245	149	128	68	62	140	130
PO_4 µg/l	53	86	175	151	82	163	119	117	143
TP µg/l	152	235	456	405	256	435	305	306	377
TON µg/l	885	753	1058	993	718	935	1060	836	739

Table (1): Continued

	G1	G2	G3	G4
Na	850	560	650	485
NO_2 µg/l	475.2	32.1	8.4	7.8
NO_3 µg/l	1180	325	89	73
NH_3 µg/l	1560	1152	130	157
PO_4 µg/l	931	419	239	281

Table (1) shows that both TDS and TSS were varied in a wide range with respect to different localities. The highest TDS value (485 mg/l) was recorded at station S6 while minimum value (369 mg/l) was recorded at station S2. The maximum TSS value was recorded at S3 while minimum one was recorded at S1.

The obtained results revealed that, stations S3, S6 and S7 have the highest nutrient salts in the studied samples, these results indicate that these sites were influenced by a source of pollution and mainly domestic sewage. On the hand, site G1 and G2 showed an abrupt increase of nutrient salts

more than other two sites (G3 and G4). These stations undergo sever status of a pollutant source certainly domestic sewage.

Table (2): Recorded level of heavy metals in the water samples

	S1	S2	S3	S4	S5	S6	S7	A1	A2
Fe µg/l	195 ± 9.5	210 ± 10.1	285 ± 12.9	235 ± 12.3	261 ± 11.6	281 ± 13.1	269 ± 12.6	221 ± 12.1	221 ± 10.1
Mn µg/l	41 ± 1.6	36 ± 1.8	45 ± 2.1	32 ± 1.4	39 ± 1.6	52 ± 2.3	59 ± 2.4	45 ± 2.1	51 ± 2.3
Zn µg/l	48 ± 1.5	51 ± 2.1	82 ± 3.1	54 ± 2.5	61 ± 3.1	78 ± 3.6	67 ± 3.2	41 ± 2.1	39 ± 1.1
Cu µg/l	5.1 ± 0.22	4.8 ± 0.21	6.8 ± 0.26	5.1 ± 0.23	4.5 ± 0.21	6.1 ± 0.23	5.8 ± 0.23	4.8 ± 0.21	5.2 ± 0.25
Pb µg/l	16.1 ± 0.66	17.2 ± 0.81	23.7 ± 0.85	18.5 ± 0.87	15.1 ± 0.74	18.9 ± 0.81	13.6 ± 0.61	14.2 ± 0.65	15.8 ± 0.71
Cd µg/l	1.2 ± 0.05	1.6 ± 0.07	2.5 ± 0.09	1.8 ± 0.08	1.7 ± 0.08	1.9 ± 0.08	1.8 ± 0.06	1.1 ± 0.05	1.3 ± 0.06
Cr^{+6} µg/l	14.6 ± 0.55	15.6 ± 0.71	21.3 ± 0.91	20.8 ± 0.90	18.9 ± 0.86	22.6 ± 0.98	21.6 ± 0.93	17.1 ± 0.87	18.2 ± 0.82
Cr µg/l	22.1 ± 1.01	24.5 ± 1.1	37.6 ± 1.3	25.6 ± 1.2	29.1 ± 1.3	36.1 ± 1.6	35.9 ± 1.6	25.1 ± 1.3	26.9 ± 1.4
Ni µg/l	14.2 ± 0.65	15.2 ± 0.69	21.1 ± 0.87	16.5 ± 0.67	17.1 ± 0.71	19.9 ± 0.95	20.6 ± 0.98	14.5 ± 0.92	15.8 ± 0.72
Ag µg/l	1.12 ± 0.06	1.47 ± 0.07	2.32 ± 0.08	1.65 ± 0.07	1.56 ± 0.06	1.75 ±0.08	1.65 ± 0.07	1.01 ± 0.04	1.02 ± 0.04
Hg µg/l	1.16 ± 0.04	1.23 ± 0.04	1.56 ± 0.06	1.1 ± 0.05	0.98 ± 0.03	1.21 ± 0.05	1.35 ±0.06	1.01 ± 0.04	0.96 ± 0.03
As µg/l	1.75 ± 0.08	1.87 ± 0.09	2.5 ± 0.11	1.91 ± 0.09	2.01 ± 0.10	2.3 ± 0.11	2.4 ± 0.11	1.52 ± 0.12	1.61 ± 0.13

Se µg/l	ND	ND	0.95 ± 0.03	0.84 ± 0.03	0.74 ± 0.02	1.01 ± 0.05	0.97 ± 0.04	ND	ND

ND : Not Detected

Table (2) Continued

	G1	G2	G3	G4
Iron µg/l	485 ± 22	325 ± 17	315 ± 15	325 ± 16
Zinc µg/l	115 ± 5.5	98 ± 4.6	72 ± 3.8	63 ± 2.5
Copper µg/l	13.5 ± 0.8	9.12 ± 0.7	6.8 ± 0.5	7.1 ± 0.5
Lead µg/l	26.5 ± 1.1	21.5 ± 1.2	17.6 ± 0.95	18.9 ± 0.87
Cadmium µg/l	2.5 ± 0.11	2.1 ± 0.12	1.8 ± 0.13	1.4 ± 0.11
Chromium µg/l	29 ± 1.4	24 ± 1.2	25 ± 1.5	28 ± 1.3
Nickel µg/l	19.8 ± 0.9	20.6 ± 0.95	17.8 ± 0.87	16.9 ± 0.87
Mercury µg/l	2.6 ± 0.11	2.01 ± 0.09	1.1 ± 0.06	0.98 ± 0.05
Arsenic µg/l	4.2 ± 0.15	3.1 ± 0.13	2.6 ± 0.13	2.4 ± 0.11

The studied heavy metals concentrations varied in slight range and exceed the permissible levels at sites G1, G2 and S3 for some elements.

Table 3: Results for organic pollutants in Surface water

Sample no.	Oil and grease (mg/l)	Detergents (mg/l)	Phenols (mg/l)	Benzo (a) pyrene (ug/l)
S 1	0.5	N.D	N.D	N.D

S 2	**1.1**	**N.D**	**N.D**	**N.D**
S 3	**0.3**	**N.D**	**N.D**	**N.D**
S 4	**1.25**	**N.D**	**N.D**	**N.D**
S 5	**0.27**	**N.D**	**N.D**	**N.D**
S 6	**3.01**	**N.D**	**N.D**	**N.D**
S 7	**1.35**	**N.D**	**N.D**	**N.D**
A 1	**1.7**	**N.D**	**N.D**	**N.D**
A 2	**0.7**	**N.D**	**N.D**	**1.26**

Table 4: Results of organic pollutants in ground water samples

Sample	**G 1**	**G 2**	**G 3**	**G 4**
Phenol (mg/l)	**ND**	**ND**	**ND**	**ND**
Pesticides (ng/l)	**ND**	**ND**	**ND**	**ND**
BTEX(ug/l)	**ND**	**ND**	**ND**	**ND**
Dichloroethylene(ng/l)	**ND**	**ND**	**ND**	**ND**
Dichloroethylene(ng/l)	**ND**	**ND**	**ND**	**ND**
Trichloroethylene(ng/l)	**ND**	**ND**	**ND**	**ND**
Tetrachloroethylene (ng/l)	**ND**	**ND**	**ND**	**ND**

PCBs (ng/l)	**1271.63**	**1091.33**	**754.815**	**1343.65**

Continued Table 4: results of organic pollutants in ground water samples

Parameters	G 1	G 2	G 3	G 4
Naphthalene	**ND**	**ND**	**ND**	**ND**
Acenaphthylene	**ND**	**7.152**	**ND**	**ND**
Acenaphthene	**ND**	**ND**	**2.156**	**3.83**
Fluorene	**ND**	**9.00**	**1.996**	**ND**
Phenanthrene	**ND**	**6.914**	**ND**	**ND**
Anthracene	**ND**	**11.164**	**4.358**	**32.43**
Fluoranthene	**ND**	**7.942**	**5.048**	**7.51**
Pyrene	**ND**	**6.21**	**2.45**	**2.3**
Benzo (a) Anthracene	**ND**	**2.03**	**ND**	**ND**
Chrysene	**ND**	**0.39**	**1.214**	**2.01**
Benzo (k) Fluoranthene	**ND**	**ND**	**ND**	**ND**
Benzo (b) Fluoranthene	**ND**	**ND**	**ND**	**ND**
Benzo (a) Pyrene	**ND**	**ND**	**ND**	**ND**
Dibenzo (a, h) anthracene	**ND**	**ND**	**ND**	**ND**
Indeno (1, 2, 3- cd) pyrene	**ND**	**ND**	**ND**	**ND**
Benzo (ghi) perylene	**ND**	**ND**	**ND**	**ND**
Total 16 EPA PAHs	**ND**	**50.802**	**17.22**	**47.63**

Table 5: Organic pollutants in sediment

Sample no.	PAHs (ug/kg)	Pesticides (ug/kg)
S 1	**698.4**	**423.69**
S 2	**2412.6**	**343.22**
S 3	**1284**	**285.296**
S 4	**135.1**	**457.63**
S 6	**1662.52**	**383.91**
S 7	**ND**	**871.95**

Table 6: cyanide

Cyanide	S1	S2	S3	S4	S5	S6	S7
	ND	ND	ND	ND	ND	ND	ND

Cyanide	A1	A2	G1	G2	G3	G4
	ND	ND	ND	ND	ND	ND

	S1	S2	S3	S4	S5	S6	S7
Turbidity(NTU)	3	29	6	5	2	4	3
Color (TCU)	5	30	5	5	3	3	3

	A1	A2
Benzene	ND	ND
Benzo (a) Pyrene (ug/l)	**ND**	**1.26**

The pesticides content in Groundwater

Sample	G 1	G 2	G 3	G 4
α-HCB	**ND**	**ND**	**ND**	**ND**
β-HCB	**ND**	**ND**	**ND**	**ND**
γ-HCB	**ND**	**ND**	**ND**	**ND**
δ-HCB	**ND**	**ND**	**ND**	**ND**
Heptachlor	**ND**	**ND**	**ND**	**ND**
Aldrin	**ND**	**ND**	**ND**	**ND**
Heptachlor-epoxide	**ND**	**ND**	**ND**	**ND**

Endosulfan I	**ND**	**ND**	**ND**	**ND**
p-p-DDE	**ND**	**ND**	**ND**	**ND**
Dieldrin	**ND**	**ND**	**ND**	**ND**
Endrin	**ND**	**ND**	**ND**	**ND**
p-p-DDD	**ND**	**ND**	**ND**	**ND**
Endosulfan II	**ND**	**ND**	**ND**	**ND**
p-p-DDT	**ND**	**ND**	**ND**	**ND**
Endrin aldehyde	**ND**	**ND**	**ND**	**ND**
Endosulfan sulphate	**ND**	**ND**	**ND**	**ND**
MethoxyChlor	**ND**	**ND**	**ND**	**ND**
Total pesticides	**ND**	**ND**	**ND**	**ND**

SEDIMENT ANALYSES

1. Heavy metals

Heavy metals (Fe, Mn, Cu, Zn, Cd, Pb, Ni, Cr, Co, Al, Ag, Ba, B and Mo) were determined in sediment samples after complete digestion was done according to Kouatio and Trefy (1987). The step of completely digestion can be summarized as following:

1. 10ml concentrated nitric acid and 10ml hydrofluoric acid were added to 0.5g of the finely powdered sediment into Teflon bottles.
2. The Teflon bottles were covered and set a side for overnight.
3. 5ml perchloric acid was added and the bottles were heated in sand bath on hot plate and evaporated to about 3ml.

4. The bottles were cooled and washed down the side with a little deionized water, then add 5ml $HClO_4$ and evaporate just to dryness.
5. Add 10ml of concentrated HCl and the bottles were placed back on hot plate until the solution was clear and the fumes ceased.
6. The digest material was filtered and the residue was washed several times with deionized water.
7. The filtrate was then diluted by deionized water to 100ml in volumetric flask.

1.2. Method for determination of As & Hg

Method used for determination total arsenic involve two step procedure namely (1): the conversion of all forms of As (organic and inorganic forms) to As(V) by various digestion/oxidation procedures, and (2) the reduction of solution As(V) to As(III) by using sodiumboro hydride according to (American Society of Agronomy, 1982).

1.3. Method for determination of Hg

Method used for determination total mercury involve two step procedure namely (1): the conversion of all forms of Hg to Hg(II) by various digestion/oxidation procedures, and (2) the reduction of solution Hg(II) to Hg^0 vapor for analysis. This technique called cooled vapor method according to (American Society of Agronomy, 1982)

B. Measurement of elements

The samples were analyzed by using Perkin Elmer Atomic Adsorption Spectroscopy Model (Analyst 2000) with Graphite furnace Model (GA-2). For mercury, Hydride Generation Unit was used for determination of As. Each sample measured three times (triplet) for Q.A. The concentrations of these elements were determined by using standard calibration curve from a series of different standard concentrations of each element. Blank sample was prepared using De-ionized distilled water acidified by conc. nitric acid and treated as previous samples.

Table (3): Recorded level of total phosphorus and some heavy metals in the sediment samples

	S1 ± SD	**S2± SD**	**S3 ± SD**	**S4 ± SD**	**S6 ± SD**	**S7 ± SD**
TP mg/g	2.5 ± 0.1	2.6 ± 0.11	3.1± 0.12	2.8 ± 0.13	3.5 ± 0.12	3.6 ± 0.11
Iron mg/g	2.85 ± 0.12	2.46 ± 0.11	3.32 ± 0.13	2.31 ± 0.11	3.45 ± 0.11	3.15 ± 0.1
Manganese µg/g	245 ± 10	287 ± 13	365 ± 14	267 ± 15	348 ± 12	323 ± 16
Zinc µg/g	51 ± 2.1	48 ± 2.3	62 ± 2.8	43 ± 1.3	58 ± 2.0	49 ± 2.1
Copper µg/g	8.2 ± 0.41	7.9 ± 0.35	11.2 ± 0.4	6.8 ± 0.31	9.4 ± 0.41	10.5 ± 0.5
Lead µg/g	12.5 ± 0.55	13.9 ± 0.51	15.6 ± 0.62	11.4 ± 0.45	16.8 ± 0.61	17.9 ± 0.62
Cadmium µg/g	2.05 ± 0.1	1.96 ± 0.09	3.21 ± 0.1	1.78 ± 0.09	2.15 ± 0.09	2.45 ± 0.11
Chromium µg/g	16.2 ± 0.81	13.8 ± 0.71	17.6 ± 0.75	14.6 ± 0.62	18.9 ± 0.8	20.6 ± 0.92

	S1 ± SD	S2± SD	S3 ± SD	S4 ± SD	S6 ± SD	S7 ± SD
Nickel µg/g	10.8 ± 0.41	9.7 ± 0.42	13.6 ± 0.51	11.4 ± 0.52	15.4 ± 0.62	16.3 ± 0.75
Cobalt µg/g	7.9 ± 0.31	8.1 ± 0.41	8.6 ± 0.35	8.4 ± 0.31	10.6 ± 0.31	11.2 ± 0.36
molybdenum µg/g	0.71 ± 0.03	0.81 ± 0.03	0.67 ± 0.03	0.53 ± 0.02	0.69 ± 0.03	0.71 ± 0.04
Aluminum µg/g	83 ± 4.1	91 ± 4.2	102 ± 5.1	79 ± 3.5	110 ± 4.1	107 ± 4.2
Silver µg/g	3.12 ± 0.15	2.89 ± 0.12	3.54 ± 0.13	2.47 ± 0.11	3.14 ± 0.13	2.78 ± 0.14
Mercury µg/g	0.84 ± 0.02	0.73 ± 0.01	0.91 ± 0.03	0.65 ± 0.02	0.82 ± 0.02	0.89 ±0.03
Arsenic µg/g	2.63 ± 0.11	2.16 ± 0.1	3.15 ± 0.13	2.47 ± 0.11	2.67 ± 0.12	3.01 ± 0.13
Boron µg/g	11.5 ± 0.51	13.5 ± 0.55	10.1 ± 0.59	12.8 ± 0.61	9.6 ± 0.42	8.4 ± 0.39
Barium µg/g	13.6 ± 0.62	15.2 ± 0.69	12.4 ± 0.67	11.6 ± 0.59	12.8 ± 0.61	13.4 ± 0.63

Total petroleum Hydrocarbons in sediment

Parameters	S 1	S 2	S 3	S 4	S 6	S 7
Total petroleum Hydrocarbons (ug/g)	**1.34**	**3.68**	**1.97**	**0.75**	**2.54**	**0.85**

References:

1. Tarek S. J., **(2008)** Development of water treatment technologies for the removal of hazardous pollutants, Ph.D thesis, Cairo University jointly with Van Hall institute – part of Wagningen University, the Netherlands.
2. Tarek S. J., Osama, A. Ali,(2007) The effect of Industrial Waste of Oil companies on the Distribution of Organic Pollutants in Ismailia Canal Water. Bull. NRC., Egypt, Vol 32, 6: 647-659.
3. **Kornmuller, A., Wiesmann, U., (2003)** Ozonation of polycyclic aromatic hydrocarbons in oil/water-emulsions: mass transfer and reaction kinetics , Water Research **37**:1023–1032.
4. **Daboor, S.M (2006)** .Studies on Bacterial flora and its role in the clean up of hazardous pollutants in the River Nile,PhD thesies Fac. Sci Zagazeag University .
5. A.P.H.A. (1992): Standard methods for the examination of water and wastewater. 18th ed AWWA.WPCF. American Public Health association, 1015pp. Washington D.C., 20005
6. Mullin, J. B. and Riely, J. P. (1956): The spectrophotometric determination of nitrate in natural waters, with particular references to see water; Bull. Analytica, chemica ACTA Vol. 12 p 479-480.
7. American public Health Association (APHA) (1998). Standard Methods for the Examination of Water and Wastewater, 20th ed. APHA, Washington, D. C.
8. Seurinck, S.; Defoirdt, T.; Verstraete, W.; Siciliano, A. D. (2005). Detection and quantification of the human-specific HF183 Bacteroides 16s rRNA genetic marker with real-time PCR for assessment of human fecal pollution in freshwaters. Microbiol., 7:5279-5288.