Environmental and Biological study of Arab - Kand waste water channel in Erbil Governorate Kurdistan Region - Iraq

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Abstract

The studied area is located between Latitude 36° 03' 29"E to 36°10' 45" E and Longitude 43° 30' 29" N to 43° 56' 11" N at south west of Erbil province and extend to north east of Guer town within total length area about (50 km). The drainage patterns are of dendritic type. In present study 48 water samples were collected and analyzed during two periods. 24(20 water samples in Arab-Kand and 4 samples in Greater-Zab river) water samples belonging to the first period (Nov. 2005), and 24(20 water samples in Arab-Kand channel and 4 samples in Greater-Zab river) water samples belonging to the second period (May 2006) in order to calculate biological properties of sewage water along Arab-Kand channel and then determined the effect on Greater-Zab river. The study also includes determination of biological parameters are DO, (was low especially in second period because of high temperature in comparison with the first period)COD (recorded in both season and also BOD5 are high in both periods because they content high amount of organisms and organic matter)and BOD5(considered as a weak domestic wastewater). Biological indicators are (Coliform and fecal coliform), with huge account of bacteria number in coliform and fecal coliform. Generally the sewage water is unsuitable for human consumption but suitable for building and industries purposes. It is also suitable for irrigation and agriculture with regarding the plant type, and suitable for livestock purposes but in some station unsafe for this purpose due to rising in total account of bacteria.

Introduction

Population growth and activities in the Erbil City area over the last 15 years have resulted in increasing in water uses, changes in distribution and timing of flow, and deterioration of water quality. The changes threaten both remaining natural ecosystem and growing human population. Wastewater is generated from human activities in Erbil Governorate. This water comes from, discharge of domestic sewage which originated from kitchens and bathrooms of dwelling public building as well as street wash water, industrial waste region from north and south industrial region, and storm water flowing in sewers during or following periods of rain fall water. Pollution is one of the major sorts of pollution in the environment; it comes about with industrial an urban growth. Along Arab-Kand valley (channel) wastewater used for irrigation by farmers in rural area. It may generate negative impact on environment and health risks for community. The farms situated in south west of the city .Mainly those located between Toraq and till to Greater-Zab River they are depended on large scale up on the Erbil wastewater taken from sewer outfall. Municipal sewage contains human faces and contaminated with these effluents may contain pathogenic (disease-causing) organisms and, consequently, may be hazardous to human health if it used as drinking-water or in food preparation (Table 1). Fecal contamination of water is routinely detected by microbiological analysis (Bertrram and Balance,1996). Microorganisms found in wastewater include bacteria, viruses and protozoa excreted by diseased person or animal, when discharged into surface water, they make the water unfit for drinking uses involving the occurrence of protozoan pathogen Cryptosporidium, Giardia and resulting out breaks of gastrointestinal infection (Davis et.al, 2004) and (Al – Saadi, 2006). Variety of pathogens are present in domestic wastewater, there are major four groups of pathogen (table 1) (pathogen and disease), viruses, bacteria, protozoan and helminthes (worms) (Pandey et al., 2005). The present of micro–organism as a good indicator for contamination especially coliform and fecalcoliform (E.Coli) causing a risks for life and occurred in intestinal tract (Gasselin et al., 1997). Micro – organism (bacteria) can pent rated soil (Coarse texture) and reaches into ground water then causing ground water pollution, these cases are happened in studied area according to Shekha (2001). It favor to occurrence in fine texture high moisture, high organic matter and anaerobic condition soil (Radang & simpkins, 2001). Philip part (1981) imply the source of bacteriological pollutant come from agriculture, microbial, human, animal urint, and then affected on aquatic environment. Increasing in E.Coli associated with increase in viruses in water samples (Araujo et al., 1989). Some pathogen may re – infect by in halation of dust or aerosol drops (Hammer & Warren, 2005). Kachan (1976) mentioned that micro – organisms depend on nature of discharged organic matter for degradation (or to disengage). Identification urint contamination and effluent water by rising in total number of bacteria indicate high organic matter content in help for grow thing of bacteria.

If the account of pathogens is sufficiently high the water may also unsafe for summing and fishing (Davis & Masten, 2004). According to WHO (2004) water must be empty from total coliform and E.Coli in 100ml of samples, but Abbawi and Hassan (1990) 1/100ml of samples 0/100ml of two samples respectively. E.Coli less 1/100ml total account 50 unit/1ml for drinking purpose. These study focused on two important type of bacteria coliform and fecal coliform (E.Coli).

The aims of this study are determine biological properties of waste water, Determine the effect of waste water discharge on Greater-Zab River, and comparing between discharged waste water with international standard for waste water discharging to river and exploring bacteriological effect of waste water.

Table 1: Water – borne pathogens and disease caused by them in humans (Pandey et al., 2005).

Sl. No.	pathogen	Disease
1	Bacteria Bacillus typhsum B. paratyphsum B.dysenteriae Vibrio cholere	 Typhoid fever Paratyphoid fever Bacillary dysentery
2	Protozoa Entamoeba histolytica Giardia lambia	 Amebic dysentery Giardiasis
3	Viruses Liver-infecting virus Polio virus Viruses(spread by water born mosquitoes)	 Infectious hepatitis Poliomyelitis Yellow fever
4	Helminthes Tapeworms Schistosoma	 Teniasis Bilharziasis
5	Algae Blue green algae	Toxic effects on human health

Site and description of the area

The study focuses on Arab-Kand channel which extend from SW of Erbil City to NS of Guer town, which its length about 50 km. 24 stations are taken along the channel with about 2 km spacing between adjacent station (Fig.1).The total elevation difference between 1st stations and 24th is about 160m/50000. The soil is brown soil. This type of soil occurs in areas where there is hot dry summer and cold wet winter (Guest, 1966).The thickness of surface layer is about 42-57 cm, and total soil depth is about 42-141 cm. Soil texture ranges from silty clay to sandy clay, high clay content, and the organic matter content ranges from 0.15 to 1.26 this ratio regarded less than the other nearby areas which has less vegetate cover (Kahraman, 2004). The climate of studied area is most closely approaches the Irano-Turanian type. Characterized by occurrences of three season, cold winter, mild grow period of spring and hot dry summer. The period from June to end of September is without rainfall; where as wettest months are between December and May.

Table 2: GPS data of each waste water sample location (station).

Station No	location	X(UTM)	Y(UTM)	Elevation (m.a.s.l)
1	Toraq	404348	40043436	367
2	Swery (village)	401712	4001759	354
3	Swery (bridge)	400541	4001279	339
4	Jimka	396754	3999034	327
5	Yarimja	394664	3996982	305
6	Ghzna	391473	3996126	298
7	Unknown	389851	3995785	287
8	Tarzan	388492	3996481	286
9	Sahdawa	387628	3996796	284
10	Unknown	386470	3997380	272
11	Unknown	385214	3997670	274
12	Unknown	384246	3997857	273
13	Unknown	382850	3998164	275
14	Pemarabra	382111	3998480	264
15	Qadrya	379609	3998922	255
16	Shamshula	377327	3998166	246
17	Hawera	373688	3997723	237
18	Um Rigeba	371771	3996899	234
19	Gameshtapa(village)	36877	3995888	227
20	Unknown	367540	3996273	220
21	Greater-Zab	366665	3996283	216
22	Unknown	365876	3995217	210
23	Unknown	366219	3994069	212
24	Unknown	365628	3992042	205
25	Saylow	409581	4004950	401
26	Ainkawa	409315	4008285	411

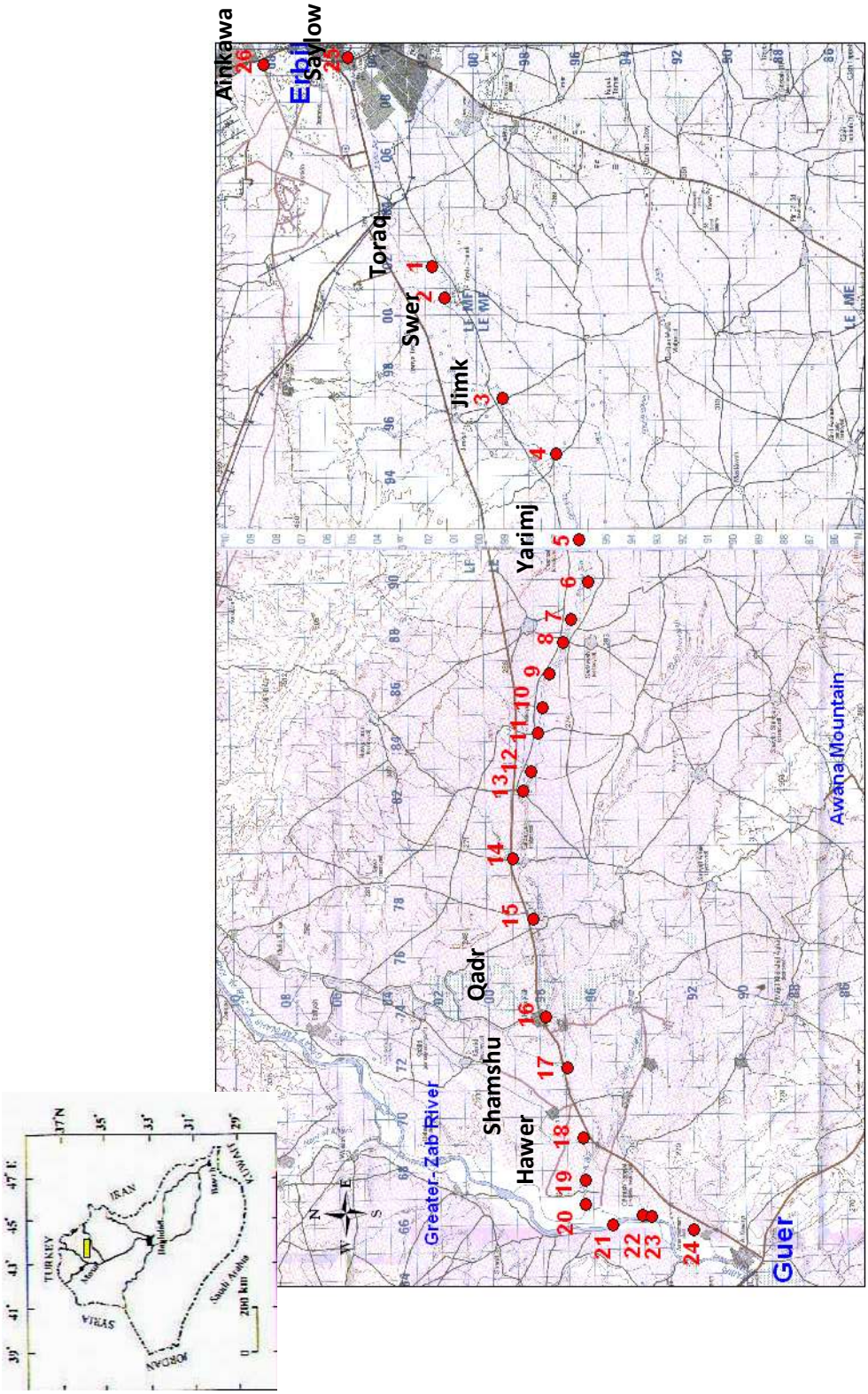

Figure 1-2: Topographic Map of studied area and position of water samples (stations).

Materials and methods

A total of 48 waste water samples were collected during two different periods: The first period (water deficit) was from 18-11-2005 to 24-11-2005, and the second period (water surplus) was from 1-5-2006 to 8-5-2006 (24 sample of each season). The samples were collected from 20 stations along Arab-Kand channel and 4 stations from the Greater-Zab River (Fig 1) the first station is selected before connection of Greater-Zab River with polluted water discharge, while the other three station after the connection of polluted channel with Greater Zab river to determine the effect of polluted water on Greater-Zab River. Chemical analyses of water samples for the first period were carried out in laboratories of Erbil Water Directorate, Geochemistry laboratories of the department of Geology, and environmental lab of the Ecology department. While for the second period the chemical analysis were carried out at University of Salahaddin, department of Biology and Geology.

Results and Discussions

Dissolved Oxygen is necessary for living organisms in aquatic system to maintain the metabolic process that produces energy for growth and respiration (Zab – Center, 2002). Oxygen enters water by photosynthesis of aquatic biota (Plant and by transfer of oxygen across the air – water interface, the amount of oxygen that held by water depend on the water temperature, salinity and pressure (Leggett et al., 2001). All gasses of atmosphere are dissolved in water but to different degree. There are four factors controlling the solubility of oxygen in water Water interface contact with air, photosynthesis, respiration and Oxidation waste. In this study dissolved oxygen ranges between 0 – 7.6 ppm (on average 4.81ppm) during first period, and 0 – 6.3 ppm (on average 2.85ppm) during second period (Table 3) and Figure (2) show DO variation in first and second period. In Greater-Zab River ranges between6.9-7.6ppm (on average 7.3ppm) during first period and 5.85-6.3ppm (on average 6ppm) during second period. According to DO content it can be discharged into Greater-Zab River Table (4). The results of second period are lower than the first period, attributed to increase in temperature in second period as well as the low discharges compared with that of first period, in some stations reaches zero in the second season effected by sewage discharged with organic matter content .The variation in dissolved oxygen during the seasons at the studied period may closely related with the temperature of dissolved salt, partial pressure of gasses, input of organic matter, climatic factor, light transparency, photosynthesis, wind action, and rainfall. DO is in a very significant correlation coefficient (inverse proportional) with temperature in studied area.

Table 3: DO, BOD_5, and COD in first and second period

station	First period			Second period		
	DO	BOD5	COD	DO	BOD_5	COD
1	0	170	195	0	110	132
2	2.1	45	60	0.9	55	92
3	4.2	40	48	3.4	50	72
4	4.5	35	56	3.8	60	80
5	4.3	30	48	4.2	45	88
6	3.9	48	52	5.8	30	84
7	4.85	52	67	1.9	15	20
8	5.3	55	68	2.3	35	64
9	4.2	48	54	2	20	24
10	4	53	73	1.85	40	52
11	5.1	65	76	1.9	25	28
12	5	32	59	1.85	10	16
13	4.8	40	50	1.95	30	44
14	5	20	48	2.3	20	40
15	5.25	5	24	2.25	25	32
16	5.2	15	16	1.85	10	28
17	5	25	26	1.9	10	40
18	5.7	11	18	1.35	30	36
19	3.1	16	23	0.75	25	64
20	4.8	7.3	17	1.95	35	40
21	7.2	1.2	8.4	5.85	25	32
22	7.6	3	6.2	6.16	65	68
23	7.6	1.8	4	6.3	40	48
24	6.9	1	3	6	15	44.8

Table 4: The maximum biological limits of pollution parameters for discharge in the water environment (M.E.A.S., 2007).

parameters	Type of recipients River (recipient water environment)	Water of studied area	
		First period	Second period
DO	4	4.3	2.9
BOD_5	40	41	34
COD	150	54	54
Total account of bacteria	2500	16000	16000

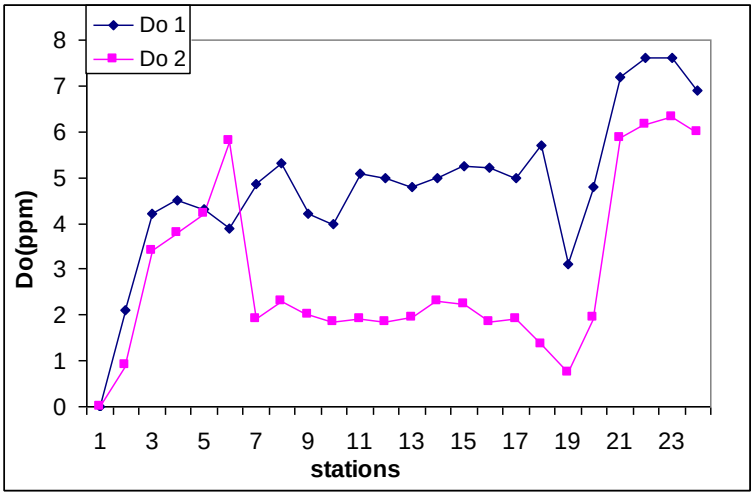

Figure 2: DO variation in first and second period

BOD_5 is a measure of the amount of oxygen required by aerobic micro – organism to break down the organic compound to less harmful substances such as carbon dioxide (Kehew, 2000); it is the quantity of oxygen used by micro – organisms in the aerobic stabilization of waste water and polluted water. The standard 5-days at 20°C BOD_5 value is commonly used to define the strength of polluted municipal waste water (Hammer and Viessman, 2005).

Table 5: BOD_5 as index of water quality (Pandey, et al, 2005).

General condition of water	BOD_5(ppm)
Pure water	1
Clean water	2
Moderately clean water	3
Of doubtful clean lines	4
Poor	5
Untreated city sewages	100-400
Complex industrial wastes	1000 – 10 000

BOD_5 in clean water is less than 1ppm, 3 ppm is acceptable range, when 5ppm are critical limits, but more than 10ppm the water are polluted according to Al – Saadi (2006) (Table 6). In sometimes it exceeds 1000ppm especially in waste of food industry, food preservation industry, effected high risks on water when discharged in river and lakes when not treated (Table 5). In sometimes it exceeds 1000ppm especially in waste of food high risks on water when discharged in river and lakes without treating (Al – Saadi, 2006). The sample must be diluted if the BOD_5 exceeds 8 mg/l.

Table 6: water type based on BOD_5 according to AL-Saadi (2006)

BOD_5 (ppm)	Water type
<1	Very clean
2	Clean
3	May be clean(fairly clean)
5	Critical (doubtful)
>10	Polluted(bad)

In present study BOD_5 concentration ranges between 5 – 170 ppm (on average 41ppm) during first period, and 10 – 110ppm (on average 34ppm) during second period (Table 3) and Figure (3) BOD_5 fluctuation in first and

second period. In Greater-Zab River ranges 1-3ppm (on average 2ppm), and 15-65ppm (on average 33ppm) during first and second period respectively. High BOD5 in second period in Greater-Zab River is caused by weathering process it generate best condition to growing of organisms (nutrient more available).

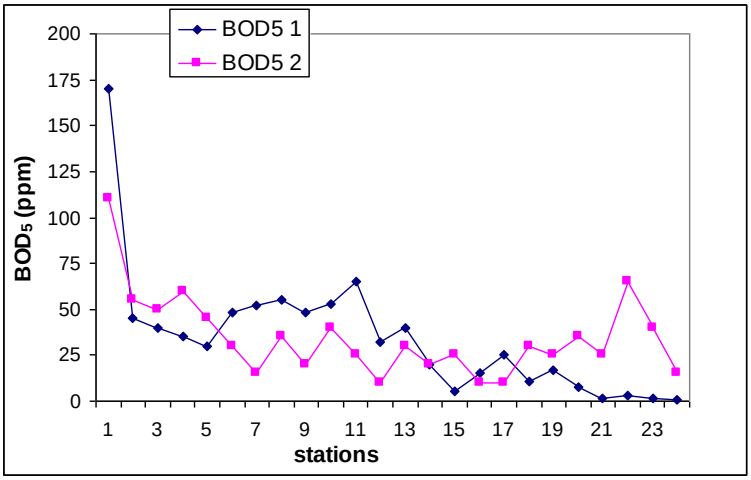

Figure 3: BOD_5 variation in first and second period

High BOD_5 level in Arab-Kand channel due to the oxygen consumption by the micro – organisms suspended in water which resulted as a response to high nutrient level, BOD_5 value observed occasional during winter were partly due to relatively low current which caused more nutrient load concentration. The BOD_5 of wastes is an important consideration in the design of treatment facilities; it is the factor in the choice of treatment method. According to Bitton (2005) the waste water of Erbil city is weak domestic waste water (Table 7).waste water cannot discharged into Greater-Zab River due to High BOD_5 more than standard limits Table (3).

Table 7: Typical Characteristic of Domestic Wastewater (Bitton, 2005).

parameter	Strong (mg/l)	Medium (mg/l)	Weak (mg/l)	Water in the studied area	
				First period	Second period
BOD_5	400	220	110	41	34
COD	1000	500	250	54	54
PO_4	15	8	4	34	25
NO_3	85	40	20	22	11
NO_2	35	15	8	0.88	0.32
Total solids	1200	720	350	weak domestic wastewater	
Suspended solids	350	220	100		

Chemical oxygen demand of waste water is a measure of the oxygen equivalent of organic matter, susceptible to oxidation by a strong chemical oxidation (Davis et.al, 2004), or is the amount of Oxygen necessary to oxidize the organic carbon completely to CO_2, H_2O, and ammonia (Bitton, 2005). In COD test all organic matter is oxidized by strong oxidizer (Soluble and insoluble organic matter), but in BOD_5 bacteria cannot oxidize all organic matter because of this reason COD value is higher than BOD_5 (Al – Saadi, 2006). If the COD value is much higher than the BOD_5 value, because the sample contains large amounts of organic compounds that are not easily biodegraded (Bitton, 2005). In present study COD ranges between 48 – 195 ppm (on average 54ppm) during first period, and 16 – 132 ppm (on average 54ppm) during second period, while in Greater-Zab River ranges 3-8.4ppm (on average 3.2ppm), and 32-68ppm (on average 48ppm) during first and second period (Table 3), and Figure (4) show COD fluctuation of first and second period. High COD value in second season is attributed to high temperatures which lead to activate and increasing in oxidation in both Arab-Kand channel and Greater-Zab River.

High COD value come coincided with annual report of (Directorate of Health of Erbil governorate, Health Preventive & Environmental Protection Department, Environmental Protection Branch) for year 2001, 2002 of BOD_5 and COD value that recorded (near Toraq and other station inside Erbil) for environmental indicator of pollution or degree of pollution.

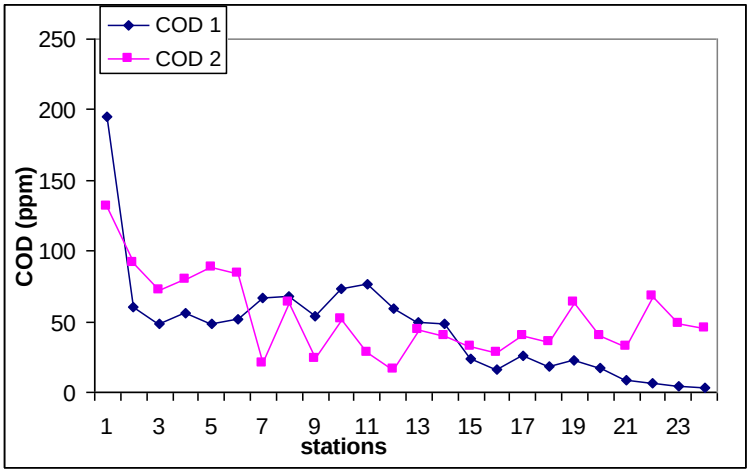

Figure 4: COD variation in first and second season

The coli form group of bacteria is defined as aerobic and facultative an aerobic non spore forming Gram's – stain negative roads that ferment lactose with gas production within 48hr. of incubation. The basic coli form analysis is a fermentation of bacteria in makonky bronth media based on gas production, is evidence that coli forms have converted the lactose sugar to lactic acid, thus lowering pH releasing gases, if no gases appear in the inverted vial test is negative (Hammer & warren, 2005). Non-acceptable water according to Abdul-redah 1984 in M.E.A.S, 2007) depend on ***coli form*** bacteria (Table 8). This group includes the aerobic and facultative anaerobic, gram-negative, nonspore-forming, rod-shaped bacteria (Bitton, 2005).

Table 8: water type according to (Abdul redah, 1984 in M.E.A.S, 2007)

Account per 100 ml Of *coliform*	Water class	Water type
< 1	one	normal
1 – 2	two	acceptable
3 – 10	three	doubtful
>10	four	non-acceptable

This group of bacteria is to recur in human & animal gastroinfsestinas. Several factors affect the rate at which bacteria grow, including temperature, pH, and Oxygen levels. The warmer the environment, the faster the rate of growth. Generally, for each increase of 10°C, the growth rate doubles (Spellman, 2003), also they are influenced by water discharge, dust deposition, organic matter and incidence of human and animal pollution (Mutlak, et, al,1980). Total number of bacteria during first period ranged between 2200 - 16000/100 ml ,and 2200-16000/ 100 ml during second period (Table 3-8),while in Greater-Zab river ranges between 2200-9200/100ml during first period but during second period ranges between9200-1600/100ml. During second period in both Arab-Kand channel and Greater-Zab river total numbers of bacteria are more than first period; it referred to rising in temperature during second period created available condition for bacteria growth because bacteria growing under optimal conditions can double their number about every 20 to 30 min (Hunter et al., 2004). Decreasing in water level and loss dilution effect, organic matter for growth in addition to decrease in water discharge which needs more time purification of pollution. Also higher Turbidity during second period compared with that to first period leads to rising organic matter and prevent the organisms for sun light. *Escherichia coli* are non-spore-forming, Gram-negative bacteria, usually motile by peritrichous flagella. They are facultative anaerobic with gas usually produce from fermentable carbohydrates (Hunter et al., 2004). Coliform group was chosen as indicator for pollution; because it was found in human gastrointestinal tract at very high levels, because coliform have been shows to have resistance similar to most pathogens (Tate & Trussel, 1977). Fecal coliform in present study ranges between (0- 9200/100ml during first period, and 2200-16000/100ml during second season (Table 9),while in Greater-Zab river ranges between 2200-5100/100ml during first period, and 2200-5100/100ml during second period. The results shows that fecal coliform number in the second period greater than that first period, it referred to temperature and turbidity low in first period, high fecal coliform number recorded in both period at station one (Start point Toraq) and remained high number at station 20, that returned to huge pollutant source along channels and low distance approximate number of both *coliform* and *fecal coliform(E-coli)* in second period referred to high in temperature reached (30°C) and high amount of turbidity value in second period. . The primary source of bacteria in water are human and animal waste , these sources of bacterial contamination include runoff from feedlots, pastures dog runs, and other land areas where animal wastes are deposited (Hunter et al, 2003) .Sewage discharging in Greater-Zab river adding more pathogens to the river it can be generate a negative impact on Greater-Zab river .

Table 9: Coliform and E-coli in both seasons.

station	First period		Second period	
	Coliform 100 ml	Fecal coliform (E-coli)/100 ml	*Coliform* 100 ml	Fecal coliform (E-coli) 100 ml
1	16000	9200	16000	16000
2	16000	9200	16000	16000
3	9200	9200	9200	5100
4	9200	5100	9200	9200
5	9200	2200	16000	9200
6	16000	2200	16000	5100
7	16000	5100	16000	9200
8	9200	5100	9200	5100
9	9200	5100	9200	5100
10	5100	5100	9200	5100
11	9200	5100	16000	9200
12	5100	5100	9200	9200
13	9200	5100	9200	5100
14	5100	2200	5100	5100
15	5100	2200	2200	2200
16	9200	5100	16000	9200
17	9200	5100	16000	5100
18	5100	2100	5100	2200
19	2200	0	9200	2200
20	2200	0	2200	2200
21	5100	2200	9200	2200
22	9200	5100	16000	5100
23	2200	2200	9200	5100
24	2200	2200	9200	5100

Conclusion

Based on the results obtained from this study, the following conclusions can be made

1- Dissolved oxygen (DO) was low especially in second period because of high temperature in comparison with the first period.
2- High COD recorded in both season and also BOD_5 are high in both periods because they content high amount of organisms and organic matter.
3- According to biological indicators (BOD_5 and COD) for environment the waste water of Arab-Kand channel considered as a weak domestic wastewater.
4- In any way the waste water cannot be used for human consumption, but it can be used for livestock purposes with consideration of the number account of bacteria. Whereas it can be used for building and industrial purposes.

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