

Preliminary Assessment of Sewage Pollution along the Coast of Kuwait

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A sewage outlet at Shuwaikh Area (Kuwait) which opens into the Kuwait Bay was monitored every 2 hr for a 12 hr period to study the effects of solar radiation, other climatic factors and tides on the fecal coliform counts in the sewage. Extremely high levels of coliform bacteria were recorded throughout the 12 hr study. The results showed an inverse relationship between bacterial counts and solar radiation. Changes in the tidal height also had some effect on the bacterial counts.

Along the coast of Kuwait, between Sulaibikhat and Feheheel, there are approximately 28 storm drain outlets. Most of these are found to be polluted with fecal coliform bacteria¹⁻³. This can be correlated to illegal disposal of partially treated sewage. Such chronic inputs of partially treated sewage into coastal waters is hazardous and therefore undesirable.

Micro-organisms form an important biological component of sewage, particularly the *Salmonella* group of bacteria present in fecal material which has been found to survive for 9 days in sea water⁴. These pathogens are responsible for a variety of diseases such as food poisoning, enteric infections, typhoid and para typhoid fever⁵.

The fecal coliform bacteria are widely used as bioindicators for the assessment of water quality⁶.

During the regular monitoring of storm drains and other outfalls along the Kuwaiti coast for sewage pollution, several chronic inputs of untreated sewage have been identified, (Table 1).

The fecal coliforms which comprise a portion of the total coliform group are able to grow at 44.5°C and ferment lactose producing acid and gas. Use of fecal coliform bacteria has proven to be of more sanitary significance than the use of total coliform bacteria, because they are restricted to the intestinal tract of the warm blooded animals and are now used to define water quality and sewage pollution.

At Shuwaikh area one storm drain outfall (No. 4) was chosen for study. Two sites for sampling were selected, one exactly at the mouth of the storm drain outfall (A), and the other (B) to the right of the outfall, approximately 5-6 m landward of the opening (Fig. 1).

Water samples were collected at 2 hr intervals starting at 0800 hrs. All samples were analysed using the bacteriological monitors, (Millipore Corp.)⁸.

Measured volumes of samples (dilutions) were filtered through these monitors coupled to a vacuum pump. The polluted water analysis required the preparation of the dilutions 1:100, 1:1000 and 1:10,000, depending on the probable degree of pollution. MFC

broth containing lactose, protein digest, vitamins, selected chemicals and aniline blue dye medium was used for culture.

The membrane was incubated for 24 hr at $44.5 \pm 0.2^\circ\text{C}$, allowing only coliforms of fecal origin to grow into visible bluish colonies.

Viability of aquatic bacteria, particularly in the marine environment may depend not only on the presence of nutrients in the water but also on the tidal height and the amount of solar radiation received.

Data obtained from previous studies are presented

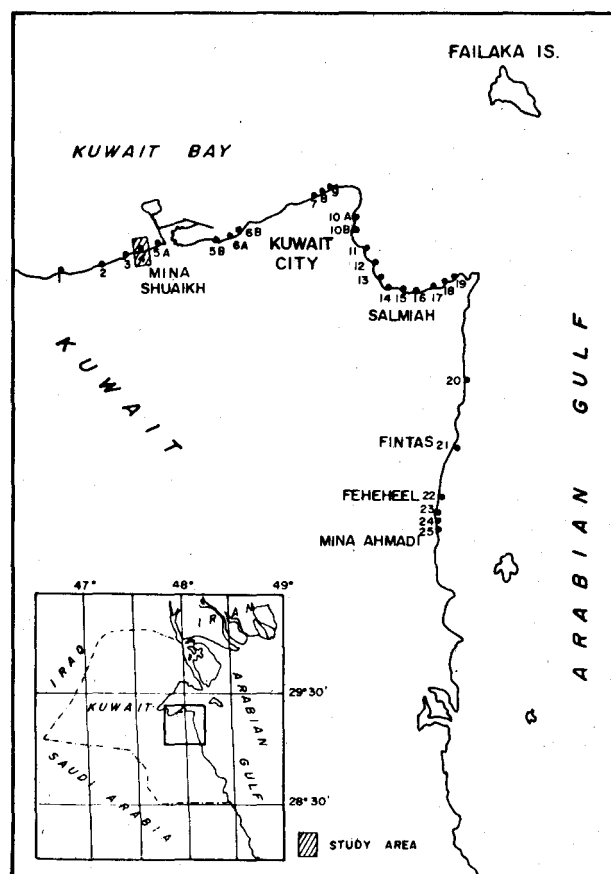


Fig. 1—Locations of storm drain outfalls along the coast of Kuwait, and the area studied for sewage pollution

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Table 1—Average Number of Fecal Coliform/100 ml of Waste Water Collected from Storm Drain Outfalls in Different Areas in Kuwait Coastal Waters during 1978

Area	Storm drain outfall included	Av. No./100 ml throughout the whole year	Av. No./100 ml through Sept. to Nov.	Av. No./100 ml through Dec. to Feb.	Av. No./100 ml through March to May
Sulibikhat	1, 2, 3	11,540	18,494	14,388	1,744
Al-Shuwaikh & City Center	4, 5A, 5B, 6A, 6B, 7, 8, 9	1,140,101	160,252	2,354,549	163,082
Benid Al-Khar	10A, 10B, 11, 12, 13	298,635	9,925	672,095	33,893
Al-Shaab & Al-Salimiah	14, 15, 16, 17, 18, 19	27,018	16,454	53,887	7,627
Al-Bide, Fintas and Fehhehel	20, 21, 22, 23, 24, 25	6,539	1,056	15,246	617

Table 2—Effects of Solar Radiation, pH and Temperature on the Total Fecal Coliform during 12 hr Period

Sample No.	Time hrs	Tide	Solar radiation cal/cm ² /min	pH		Temp. °C		Sample A	Sample B
				Sample A	Sample B	Sample A	Sample B	Fecal coliform Count/100 ml	Fecal coliform Count/100 ml
1	0800	LT	0.27	7.72	7.7	26.5	19	4.9 × 10 ⁵	7 × 10 ³
2	1000	LT	0.78	7.52	7.8	27.6	19.5	3.9 × 10 ⁵	20 × 10 ³
3	1200	HT	0.98	8	7.8	28	20.5	3.4 × 10 ⁵	8 × 10 ²
4	1400	HT	0.8	8.27	8.2	19.5	20	1.9 × 10 ⁵	0.8 × 10 ⁵
5	1600	HT	0.32	7.55	8.7	24	18	0.9 × 10 ⁵	6.3 × 10 ²
6	1800	HT	0	8.1	8.1	21.5	15.9	10.2 × 10 ⁵	3.5 × 10 ⁵
7	2000	LT	0	8.24	8	27.5	15	5.6 × 10 ⁵	1.3 × 10 ⁵

LT = low tide and HT = high tide

in Table 1, which reveal that all the outfalls monitored have been used for discharging the raw or partially treated sewage and waste waters directly to the natural waters of Kuwait³. Further, it is clear that the outfalls in the Shuwaikh and Kuwait City areas were highly polluted with an average number of fecal coliform exceeding a million cells/100 ml. of waste water. The average number of fecal coliform counted during that period decreased from Shuwaikh and Kuwait City Center area towards the northern and southern coasts of Kuwait.

In Shuwaikh area there are 2 main outfalls (No. 4 and 5A) which are highly polluted throughout the year, except during September 1978 (Table 1).

Bacterial counts observed during this study showed an obvious decline which may be attributed to the dilution occurring during high tide period (Table 2).

The solar radiation showed a steady increase till noon when it reached its maximum level and declined thereafter. It could be noted that the bacterial counts decreased by the increase of solar radiation. Fecal coliform counts were consistently higher at st A than at st B, this could be probably explained in terms of the location of A and dilution effect. As both sts A and B showed a decreased rate of bacterial growth as solar

radiation increased and tidal height changed. The highest count of fecal coliform was at 1800 hrs, when the water began to ebb towards low tide and the flow of effluent was high. The solar radiation reading at this time was zero, which means that, at that time a great deal of raw sewage was being dumped. From the study, it may be concluded that raw sewage is continuously being channelled through the specified storm drain (No. 4) since relatively high counts of fecal coliforms were recorded in every sample of the 12 hr study. Such introduction of raw sewage presents a great hazard to the local environment by contributing to the destruction of ecosystem and also by the possible transmission of infectious diseases⁷.

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References

- 1 Al-Zaher A A, *Report on beaches regarding water quality and meteorology* (Ministry of Public Health, State of Kuwait) 1974.
- 2 Salama M, Awadh A & Anderlini V, *Sewage pollution project final report* (MPP Phase I, EES Division, KISR, Kuwait) 1978, 28 pp.

- 3 Al-Mossawi M, Salama M & Awadh A, *Interim Report* (KISR/EES-RT-R-7921) 1979, 40 pp.
- 4 McKee J E & Wolf H W, *Water quality criteria* Vol.1 (The Resources Agency of California, State Water Quality Control Board Publication No. 3-A, USA) 1963.
- 5 Cruickshank R, Duguid J P, Marmion B P & Swain R H A, *Medical microbiology* Vol.1 (Churchill and Livingston, Edinburg & London) 1973, 667 pp.
- 6 McCoy J H, *Sanitarian*, 74 (1965), 79.
- 7 Grabow W O K, *Literature survey: The use of bacteria as indicators of fecal pollution in water* (CSIR Special Report O/WAFI) 1970, 27 pp.
- 8 American Public Health Association, *Standard methods for the analysis of water and waste water* (APHA, New York) 1971 874 pp.