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Studies on Lyari River Effluent

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The study was aimed at determining the physical (TS, TSS, TDS, TVS) and chemical (Cl, SO_4, NH_3, BOD_5, COD, DO) characteristics as well as heavy metals present in the Lyari river effluent so as to identify the extent of pollution. The average results of each parameter of twelve different sites were compared with that of the National Environmental Quality Standards (NEQS). BOD_5 and COD levels were well above the NEQS while the NH_3-N concentration was low. Concentrations of Cd and Zn were within the range while that of Pb, Cr, Ni and Cu were higher than the NEQS at times. This indicates that heavy pollution load is entering into the Arabian Sea creating tremendous harm especially to marine life.

Key words: Pollution, Waste water, Lyari river.

Introduction

Environmental pollution develops and deepens whenever the volume of waste water flow exceeds the combined capacity of natural and man-made facilities developed to control, capture, convey and decompose the generated waste. The industrial and domestic wastewater discharged untreated into aquatic environment results in serious water pollution, causing deterioration of marine environment (Anon 1990).

Lyari river is primarily a seasonal river and has practically become a drainage system for the adjoining industries and localities. There are about 5,000 registered industrial units (and may unregistered ones) in Karachi and three fourth of them are discharging their effluents into the Lyari river. These industries include textile, paints, leather, pharmaceutical, oil, paper and food products. Apart from few well-established industries, which have installed preliminary treatment facilities, all other industrial units discharge their wastes directly or indirectly into the Lyari river without any treatment (ACE 1993).

The present study was aimed at the collection and analysis of wastewater samples from the Lyari river so as to identify the parameters causing pollution that is causing deterioration of marine environment and is harmful especially to marine life.

Materials and Methods

Samples were collected from 12 different sampling stations along the Lyari river as indicated in Fig 1. The river enters the city at L-1 and joins the sea at L-12. The present study was conducted from January to December 1993.

All along the Lyari river starting from the North in the outskirts of Karachi upto the Arabian Sea, 12 monitoring stations were established. Stations L-3, L-4, L-5 and L-7 were receiving wastewater purely of domestic origin while station L-1, L-2, L-6, L-8, L-9, L-10, L-11, L-12 received mixed wastewater of domestic, industrial and trade origin. All along the lower level of river-bed commercial laundry activity, agricultural activity and dairy activity were taking place.

Lyari river monitoring stations

Rashid Minhas Road bridge (L-1). Industrial effluents from industries along Rashid Minhas Road were collected in the sewer system and discharged into Lyari river at this point. The main flow here was fairly representable.

Culvert near Sir Shah Suleman Road bridge (L-2). Cattle farming was taking place along the riverside and vegetation was done by wells dug near the river. Squatter settlements were also seen along the riverside.

Nishtar Basti Road bridge (Behind Sabzi Mandi) (L-3). As reported by the workers KWSB water obtained through stand post was used for laundry purpose at this point. Other activities included cattle farming, solid waste dumping and sorting, dyeing and weaving.

Liaquatabad Road bridge (Teen Hatti) (L-4) Cattle farming and laundry activities were taking place there. Illegal settlements were found under the bridge.

Nawab Siddique Ali Khan Road bridge (Lasbella) (L-5). No activity was seen at that point.

Manghopir Road bridge (L-6). Cattle farming, marble crushing, dyeing were observed at that point. Marble crush

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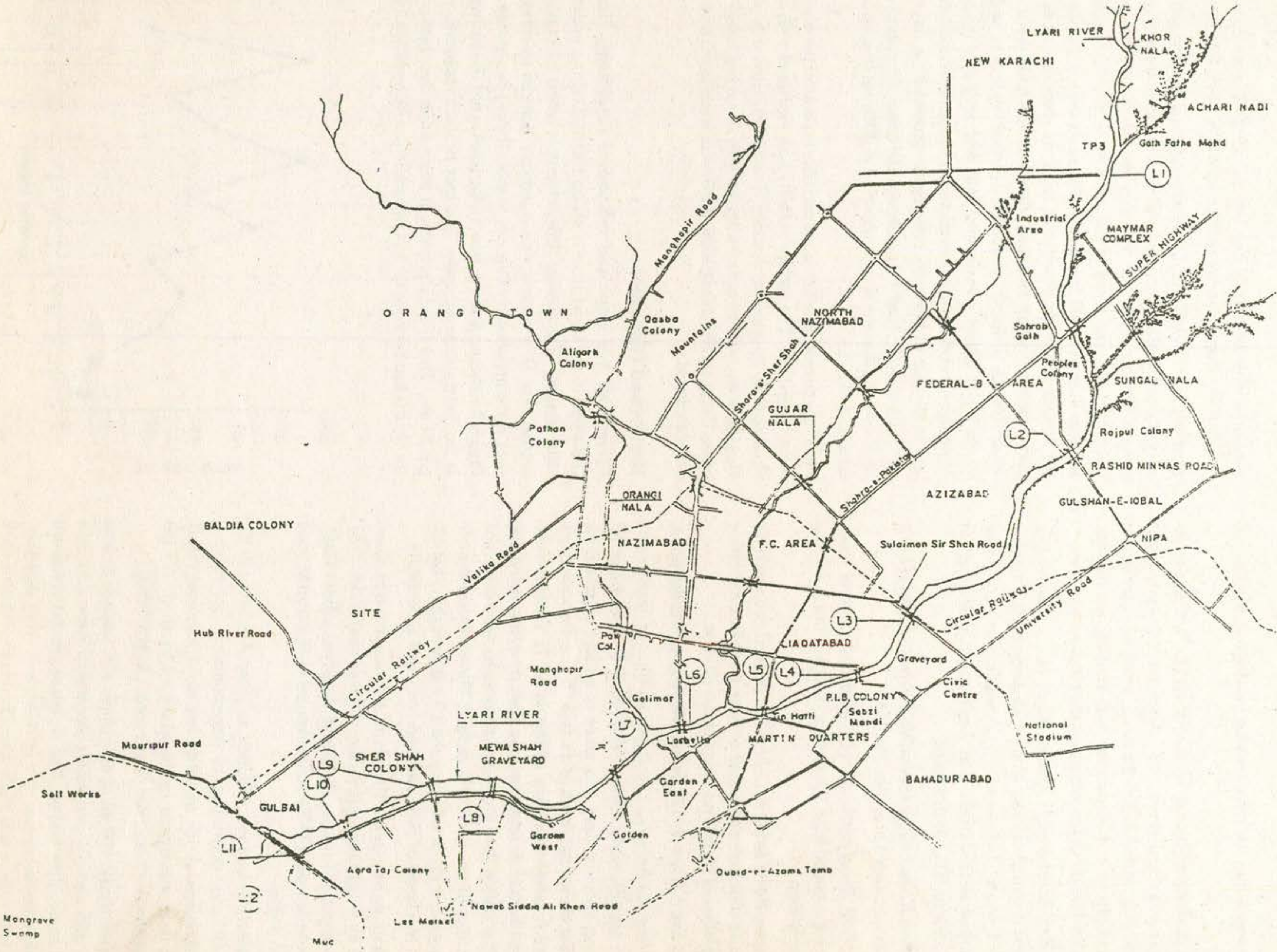

Fig 1. Sampling stations of Lyari river.

was dumped into the river causing blockage in the flow of water.

Mewashah Road bridge (Bakra Piri) (L-7). Cattle farming was observed there. A6" diameter drinking water pipeline was passing across the river, which was corroded at different places and wastewater was entering the pipeline contaminating the water whenever the pressure was low.

Shershah Road bridge (point No.1) (L-8). Automobile junk was disposed off here along with dumping and burning of solid waste. Industrial liquid waste was also being discharged at this point. The Lyari river also received effluents from TP-1 at that point.

Shershah Road bridge (point No.2 down stream) (L-9). Same as mentioned in station No. L-8.

Mira Naka Road causeway (L-10). Industrial solid waste was being dumped here. Level of pollution at this point was extremely high.

Mauripur Road bridge (L-11). The channel of Lyari river was quite wide here and colour of river was black indicating the initiation of high level of industrial effluent.

End of Lyari river (L-12). No activity was seen at that point.

Sampling technique. The depth of flow of wastewater varied significantly from 1 foot to 3 feet at different sampling stations. Care was taken to collect sample from midpoint of the total depth of the flow. 6 samples were taken from each sampling station so that in all 72 samples were obtained from 12 different stations. Each time from individual sampling station flow proportionate samples were taken and mixed to make one composite sample. The composite sample representing a given sampling station was brought to the lab within two hours of collection and processed accordingly.

Physical parameters. The pH of the samples was determined by using Orion pH meter, whereas total solids (TS), total suspended solids (TSS), total dissolved solids (TDS), total volatile solids (TVS) were measured by Standard Method (APHA 1980).

Chemical parameters. Chloride, sulphate, Ammonia, BOD_5 and COD were determined by Argentometric, Gravimetric, Nesslerization, Azide modification and Dicromate reflux methods as mentioned in the Standard Methods for the Examination of Water and Wastewater (APHA 1980).

Metal analysis. 100 ml of the sample was taken in a clean China dish and digested with concentrated nitric acid on a hot plate avoiding boiling. The digestion process continued until the sample became pale or colourless. After digestion, the sample volume was made upto 25 ml in a volumetric flask with deionized water and metal content in the sample was measured with the help of Pye Unicam SP 2900 atomic absorption spectrophotometer (APHA, AWWA, WPCF 1980).

Hydrological profile of Lyari river. Since Karachi gets very scarce rain therefore, the Lyari river remains dry during most of the time of the year. The river gets rain water from its catchment area and flows at full capacity which may be at times as deep as 50-60 feet and finally enters the sea. During dry season and in the absence of rains the river acts as an open sewer receiving industrial, domestic and trade wastewater through different tributaries, overflowing gutters and storm water drains transformed into and acting as open sewerage network. Due to variations in industrial production and in the use of water by different communities, a large variation in the hydraulic flow regime and hence the concentration of pollutants is always observed at different locations from L-1 to L-12.

Flow measurements before noon and after noon at all the sites were carried out. The surface velocity was measured with a floating body for a known distance. The cross section area of flowing water was recorded with the help of survey equipment. Using continuity equation, the flow of water in the river was calculated.

Results and Discussion

River flow, bed slope and subsurface conditions. The bed slope of the Lyari river is about 1 in 600 falling under mild category. The average flow velocity is below 2 feet per second. The flow measurements indicate that the morning peak in the upper parts of the city reaches the sea by evening. Figure 2 indicates that the flow in the river is not increasing in the down stream direction. This may be due to subsurface conditions. This is very prominent when more than half of the flow is lost between the last two stations which are hardly

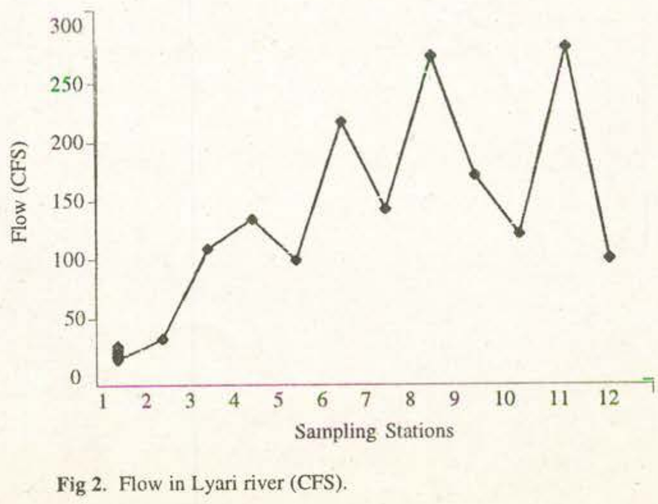

Fig 2. Flow in Lyari river (CFS).

half a kilometer away from the sea. This may be due to the presence of thick deltaic soil which is absorbing a large amount of flow of the river with the capillary action and also supporting a sizeable layer of the grass. The extent of the delta is several thousand square meters.

pH, temperature, colour. A pH range of 4.5 to 7.9 is observed indicating that the river effluent is neither too acidic nor basic (Table 1). Water temperature varies from 29°C to 34°C. The colour of the Lyari river is greyish black which gives an anaesthetic appearance to the river and also hampers the natural purification of water via photosynthesis.

Total solids, total dissolved solids, total suspended solids and total volatile solids. Approximately 75% of the municipal TSS are organic in nature and approximately half of the organic solids are settleable. Therefore, the distribution of these solids is not uniform (Defrain and Schmidt 1992). The variations in the amount of TS, TDS and TSS at various stations are given in Table 2. There is a drop of about 8 fold in the amount of total solids and suspended solids between the first two stations, i.e., as the river approaches city limits and is almost constant at the last three points. The flow in the river also increases successively during the first three stations. This indicates that the effluent from the industries contains solid mostly in the soluble from rather than in suspended from. The amount of total dissolved solids increases as the river passes through the city while there is no much change in the amount of suspended solids. The solid contents are compared with NEQS (1993) in Table 1. Total volatile solids indicate the strength of wastewater in terms of organic matter content, which is directly related to BOD_5. The concentration of TVS varies from 156 to 2039 mg l^{-1}.

Salt contents. Chloride and sulphate contents were beyond the NEQS (1993) range as indicated in Table 1. The sulphate content of river water is an important consideration in determining the magnitude of problems that can arise from reduction of sulphates to hydrogen sulphide. Thus presence of sulphate in river water may create odour problems in the absence of oxygen.

Ammonia. Ammonia is produced by the hydrolysis of urea and by biological degradation of organic compounds in the wastewater. The concentration of ammonia in all the samples was below the NEQS (1993) (Table 1). However, even this much concentration is toxic to some of the marine life forms.

Dissolved oxygen. Dissolved oxygen is the factor that determines whether biological changes are brought about by aerobic or by anaerobic organisms. Its measurements are vital for maintaining aerobic conditions in natural water that receive pollution matter. The dissolved oxygen levels in all the sampling stations were below detectable limit.

Biochemical oxygen demand. BOD_5 level of the Lyari river is much higher than the NEQS (1993) (Table 1), which indicates the presence of heavy organic load in the Lyari river. The variation of BOD_5 at different sampling stations is shown in Table 2. BOD_5 has an inverse relationship with the dissolved oxygen (Bian and Li 1992). The absence of DO in all sampling stations further confirms the presence of heavy organic load of both industrial and domestic origin in the Lyari river.

Chemical oxygen demand. COD level of the Lyari river is also much higher than the NEQS (1993) (Table 1). The variation of COD at different sampling stations is shown in Table 2. High COD level in the samples indicate the presence of compounds of industrial origin that are resistant to biological oxidation.

Metal content. Metals in different state and in different situations have been found to be essential and toxic (Mastin and Coughtruj 1975; Davis and Beckett 1978; Hambridge 1981; Nelnon 1982; Fischer 1985) and the extent of damage done to the physiological system of living beings depends upon bioavailability and absorbability of metals (Catlado *et al* 1983; Bushnell and Joeger 1986; Misra and Mani 1992).

Table 1
Lyari river effluent characteristics

Parameters	Results (mg l^{-1})	NEQS
pH	4.5-7.9	6-10
Temperature °C	29-34	40
Total solids	198-3935	---
Total suspended solids	58-540	150
Total dissolved solids	908-2630	3500
Total volatile solids	156-2039	--
Ammonia	8.4-10.3	40
Biochemical oxygen demand	30-329	80
Chemical oxygen demand	112-980	150
Chloride	202-1603	1000
Sulphate	398-1973	600
Cadmium	BDL-0.048	0.1
Chromium	BDL-2.00	1.0
Copper	BDL-10.69	1.0
Lead	BDL-0.68	0.5
Nickel	BDL-2.28	1.0
Zinc	BDL-0.84	5.0

BDL, Below Detectable Limit (<0.001 mg l^{-1}); NEQS, National Environmental Quality Standards.

Table 2
Pollution profile of Lyari river

Parameters (mg l^{-1})	L-1	L-2	L-3	L-4	L-5	L-6	L-7	L-8	L-9	L-10	L-11	L-12
pH	7.7-7.9	7.5-7.5	7.7-7.9	7.2-7.5	6.8-7.2	6.5-7.4	7.2-7.6	7.1-7.4	4.5-7.1	6.6-7.1	6.9-7.1	6.9-7.2
Temp. °C	31-34	29-32	30-33	30-33	30-33	30-34	31-33	29-32	30-34	30-33	30-33	30-34
TSS	302-540	120-174	62-410	142-182	72-184	236-324	60-218	138-360	152-228	58-262	126-270	88-332
TDS	1806-2246	1044-2630	1080-1490	908-1398	1002-1188	1128-1278	998-1226	1144-1264	1021-1294	1316-1462	1262-1462	1278-1439
TS	3024-3935	2052-3152	1214-2175	1690-2650	1339-1881	1470-2533	1490-3042	306-3690	228-2974	216-2337	198-2895	265-2161
TVS	620-1541	309-980	223-733	399-421	240-804	467-778	245-413	491-2039	156-429	374-737	386-431	224-361
Ammonia	10.2-10.3	10.2-10.3	10.0-10.2	10.1-10.2	10.0-10.3	10.2-10.3	9.5-10.0	10.0-10.2	8.4-10.2	10.2-10.3	10.0-10.3	10.2
BOD_5	200-225	150-308	173-230	120-280	127-313	150-259	160-329	200-311	73-230	30-275	112-225	110-305
Chlorides	546-1603	419-1521	230-810	224-641	202-625	214-585	233-665	230-641	219-593	293-294	261-665	277-761
COD	400-512	296-610	448-590	208-580	240-656	304-650	312-868	336-795	348-980	112-805	240-751	192-856
DO	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sulphates	1387-1962	1788-1970	479-1427	398-903	573-1001	481-791	590-1810	1014-1973	904-1472	1449-1644	1449-1503	921-1332
Cadmium	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL.048	BDL	BDL	BDL
Chromium	BDL	BDL-1.66	BDL-2.00	BDL-1.39	BDL-1.66	BDL-1.66	BDL	BDL	BDL	1.33-1.66	BDL-2.00	BDL
Copper	0.125-0.38	BDL-0.21	BDL-0.57	0.14-0.95	0.17-1.54	0.27-1.66	0.14-2.16	0.21-2.05	0.2-2.30	0.11-5.68	0.17-3.68	0.18-10.69
Lead	BDL-0.50	BDL-0.55	BDL-0.57	BDL-0.55	BDL-0.27	BDL-0.20	BDL-0.45	BDL-0.52	BDL.068	BDL-0.42	BDL-0.45	BDL-0.50
Nickel	0.41-1.89	BDL-0.58	0.22-0.45	BDL-2.28	BDL-1.90	0.41-2.14	BDL-0.50	BDL-0.62	BDL-0.58	BDL-0.54	BDL-0.54	BDL-0.54
Zinc	0.37-0.84	BDL-0.58	0.02-0.34	0.21-0.40	0.27-0.39	0.56-0.64	0.34-0.44	0.53-0.64	0.43-0.72	0.40-0.58	0.58-0.62	0.40-0.63

BDL, Below Detectable Limit (<0.001 mg l^{-1}).

The range of metal content at different sample stations is given in Table 2. The values of different metal contents are compared with NEQS (1993) in Table 1. Cadmium and zinc concentrations are within the range while that of chromium, lead, nickel and copper are higher than the NEQS (1993) at times. The presence of these heavy metals indicates the heavy pollution load from the industries that enters into the Lyari river.

Conclusion

The presence of pollutants in the Lyari river effluent, emphasizes the need for conducting further monitoring studies, in order to draw a clear picture of the overall situation. Furthermore, general public and the various industries located along the river side, which were targeted as the sample monitoring stations, must be properly educated on health hazards due to various pollutants discharged into these site and the effective treatment of the effluent before final discharge into the sea.

The Lyari river meets only some of the NEQS (1993). BOD_5 and COD are exceptionally higher. Till the industries around the river do not stop dumping their wastes untreated into the river, the unpleasant character of the river will remain and such water source cannot be used for irrigation and recreational activities.

References

ACE 1993 Lyari and Malir Rivers Pollution Study. Associated Consulting Engineers pp 1-24.

Anon 1990 World Resource Institute Report. *Oceans and Coasts.* **22** 179.

APHA, A WWA, WPCF 1980 Standard Methods for the Examination of Water and Wastewater. American Public Health Association (APHA), American Water Works Association (AWWA), Water Pollution Control Federation (WPCF) pp 89-550.

Bian J, Li X 1992 Research on the operational regularity and management technology of stabilization ponds. *Wat Sci Tech* **26** (7-8) 1749-1757.

Bushnell J P, Joeger J R 1986 Hazards to health from environmental lead exposure. *Vet Hun Toxicol* **28** (3) 255-261.

Cataldo D A, Garland T R, Wilding R E 1983 Cadmium uptake kinetics in intact soybean plants. *Plant Physiol* **73** 844-848.

Davis R D, Beckett P H T 1978 The use of young plants to detect metal accumulation in soils. *Wat Pollut Cont Fed* **77** (2) 193-205.

Defrain M, Schmidt F 1992 Solids concentrations in a treatment plant effluent. *Wat Sci Tech* **26** (9-11) 2543-2546.

Fischer A B 1985 Antagonistic effects of manganese on cadmium toxicity. In: *Trace Substances in Environmental Health-IXX*, ed Hemphill D H, University of Missouri, Columbia pp 228-237.

Hambridge K M 1981 Chromium. In: *Disorders of Mineral Metabolism,* eds Bronner T & Coburn J W. Vol 1. Trace Minerals. New York, Academic Press pp 271-273.

Mastin M H, Coughtruj P J 1975 Preliminary observation on the levels of cadmium in a contaminated environment. *Chromosphere* **3** 155-160.

Misra S G, Mani D 1992 *Metallic Pollution.* Ashish Publishing House. 8/81 Punjabi Bagh, New Delhi pp 13-15.

Nelnon F H 1982 Possible future implications of nickel, arsenic, silicon, vanadium and other ultra-elements in human nutrition. In: *Clinical Biochemical and Nutritional Aspects of Trace Elements.* ed Prasad A S, New York, Alan R. Liss pp 379.

NEQS 1993 National Environmental Quality Standards, Government of Pakistan, Environment and Urban Affairs Division L. 7646.