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Impact of Abattoir Effluent on the Physico-Chemical Parameters of Gbagi Stream (Odo-Eran), Ibadan, Nigeria

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Abstract

The qualities of surface water bodies are being negatively impacted as untreated effluents are discharged into them through various sources. The effect of abattoir effluent on the physicochemical parameters of Gbagi stream, Ibadan, Nigeria was carried out bimonthly from March 2008 to January 2010. The physico-chemical qualities of water along the upstream and downstream sections of the river course were determined using standard methods. The results of the physicochemical parameters investigated were as follows: pH, 6.2-8.20; dissolved oxygen, below detection limit–4.67 mg/L; biochemical oxygen demand, 23.25–141.21 mg/L; chemical oxygen demand, 132.81–540 mg/L; chloride, 24.53–94.16 mg/L; phosphate, below detection limit–383.67 mg/L; sulphate, 100.00–2731.25 mg/L; lead, below detection limit–0.6355 mg/L; copper, below detection limit–0.4386 mg/L; iron, below detection limit–18.21 mg/L; zinc, below detection limit–18.9510 mg/L; nickel, below detection limit–0.2389 mg/L and cadmium, below detection limit–0.0910 mg/L. Compared to the limits set by National Environmental Standards and Regulatory Enforcement Agency (NESREA) in Nigeria, the mean values of physicochemical parameters were significantly higher ($p<0.05$) than the recommended limits set for effluent discharged into surface water bodies, except for pH that fell within the limits and dissolved oxygen that was lower than the limits. The need for treatment and monitoring of abattoir effluent before being discharged into water bodies and stringent enforcement of laws are recommended.

Key words: Gbagi stream, abattoir, effluent, physicochemical parameters, heavy metals.

1. Introduction

Incidences of water-borne diseases in developing countries leading to millions of death have been reported (United Nations University, Press (UNU), 1983). Some of these deaths have

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been traced to the use of water grossly polluted by untreated wastes (De Silva *et al.*, 1988; United Nations Environmental Protection (UNEP), 1991). Akpata and Ekundayo (1978) reported an increase in the number of total coliforms and of *E. coli* in particular when faeces were dumped into the Lagos Lagoon. Okoronkwo and Odeyemi, (1985) reported a similar trend in the pollution of a stream by wastewater from a sewage lagoon. Egborge and Benka-Coker (1986) also reported relatively higher faecal coliform loads in Warri River, Delta State that received faecal matter from slaughter houses and raw sewage from human sources. The discharge of wastewater from bathroom, laundry, slaughter houses have been used to explain the deterioration of most tropical rivers as they pass through inhabited places (Oluwande *et al.*, 1983). Human health and environmental quality are undergoing continuous degradation by the increasing amount of wastes being produced (Agenda 21, Earth Summit, 1992; Osibanjo 2001).

In Nigeria, environmental problems increase continually due to improper disposal of wastes. Abattoirs in the country have been generally known to dispose their wastes into surface water bodies without any prior treatment of the effluent. This impairs the surface of water bodies thus polluting the environment directly or indirectly. Abattoir wastes contain blood, grease, inorganic and organic solids, salts and chemicals added during the operation (Raheem and Morenikeji, 2008). Blood which is one of the major dissolved pollutants in slaughter effluent has a chemical oxygen demand value of 375,000 mg/L (Tritt and Schuchardt, 1992). This impacts high organic pollutants on receiving water and this value is far higher than the Nigerian National Environmental Standards and Regulatory Enforcement Agency's (NESREA) limit of 30 mg/L for effluent discharge. Abattoirs have also been known to transmit parasites helminthes and pathogens such as *E. coli* and *Brucella*, which causes the zoonotic diseases, *Brucellosis* (Cadmus *et al.,* 1999).

This study was aimed at assessing water quality of Gbagi stream and impact of the abattoir effluents on the water body.

2. Materials and Methods

Study Area

Gbagi upstream is located on longitude $2^0$57'20.1"" E and latitude $7^0$22'26.3" N while that of the downstream is on longitude $3^0$57'20.6" E and latitude $7^0$23'25.3" N. Gbagi abattoir is located very close to the popular New Gbagi market, Old Ife road in Egbeda local government area of Oyo state, Nigeria. The effluent from the abattoir is being discharged into the Gbagi stream.

Sample collection and analysis

Surface water samples were collected from the upstream and downstream of Gbagi stream (Figure 1). This was done bimonthly from March 2008 to January 2010. The physicochemical parameters measured in-situ were, pH using a Kent EIL pH meter, Electrical Conductivity (EC) and Total Dissolved Solids (TDS) using EC/TDS meter model Exstik EC 400, Dissolved oxygen (DO) using DO meter model Acorn DO. The water samples for the other analyses except biochemical oxygen demand were preserved at 4^oC prior to analysis. In the laboratory, the water samples were subjected to standard procedures following the methods of American Public Health Association (APHA, 1998). Biochemical Oxygen Demand (BOD) was determined after incubation for five days at 20^0C, while the Chemical Oxygen Demand (COD) was determined by the heptaoxochromate (VI) test which involved titration. Chloride was determined by the Argentometric method which also involved titration. The determination of phosphate-phosphorus was done using ultraviolet spectrophotometric screening method at a wavelength of 470 nm using a Cecil ultraviolet visible spectrophotometer, while nitrate-nitrogen was estimated using same method as phosphate-phosphorus at 220 nm wavelengths in order to determine nitrate reading and at 270 nm wavelengths to evaluate any interference due to organic matter. The absorbance reading at 220 nm was subtracted from the absorbance reading at 270 nm to obtain absorbance due to nitrate. The same screening method was used for the determination of sulphate-sulphur and the absorbance was measured at 425nm.

For calcium and magnesium cations, trace and heavy metals, the samples were digested using the nitric acid digestion method using the Alpha Atomic Absorption Spectrophotometer (AAS) at the Central Science Laboratory, Obafemi Awolowo University, Ile–Ife.
Microsoft Excel 2007 was used for graphical illustrations. T-test was used to compare the means of the physico-chemical parameters obtained from upstream and downstream results.

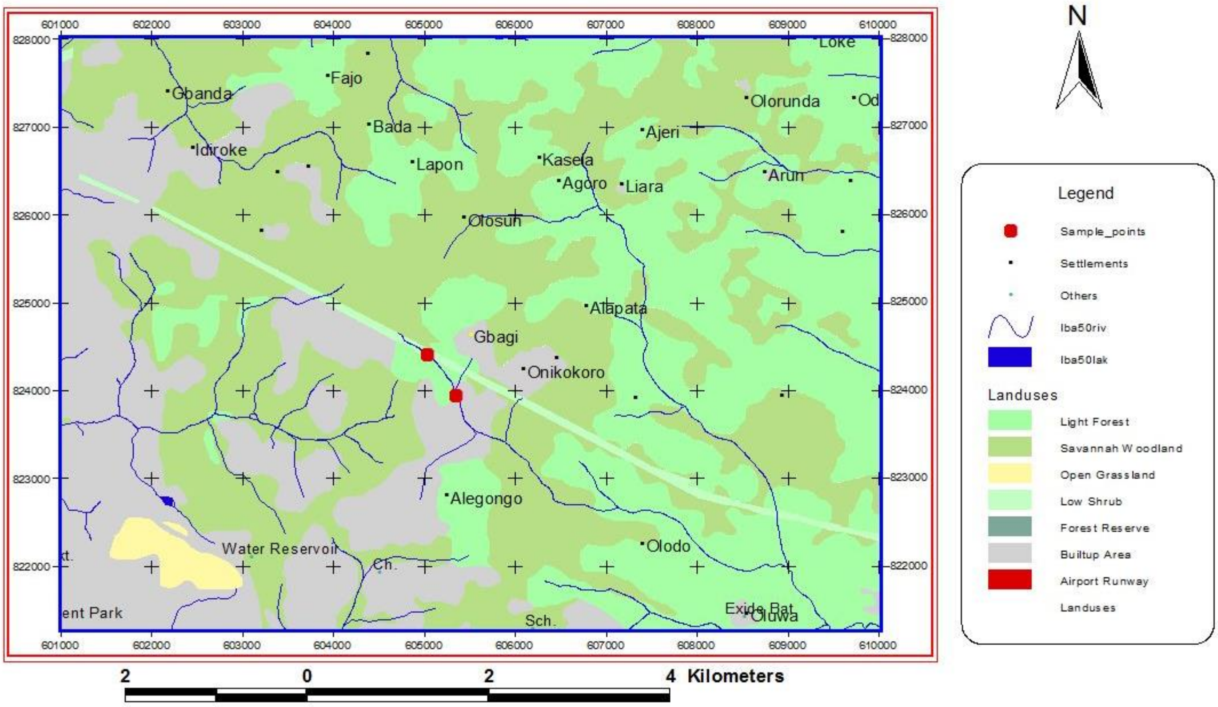

Figure 1: Map of the study area showing the sampling points on the field

3. Results and Discussion

pH is the measure of acidity or alkalinity of water. Most of the metabolic activities of aquatic organisms are pH-dependent (Chen and Lin, 1995; Wang *et. al.*, 2002). Using the standard set by National Environmental Standards and Regulatory Enforcement Agency (NESREA, 2011), all the pH values recorded during the study period were within the range of 6.5 to 8.5 limit specified for effluent discharge in surface waters except for the ones observed at the downstream in the months of March and May 2008 and at the upstream in May and November, 2008 and also May 2009 (Figure 2a). The pH values tended towards alkaline while the mean values (6.94 ± 0.47) and (7.00 ± 0.50) observed at the upstream and downstream sections respectively showed that the samples were neutral (Table 1).

The dissolved oxygen (DO) values obtained were lower than the limit of 4.0 mg/L set by NESREA (2011) (Table 1; Figure 2b). This indicated that the aquatic organisms found in this receiving stream may likely be stressed and eventually die since dissolved oxygen value set to sustain aquatic life is 5 mg/L (Horne and Goldman, 1994). DO concentrations in natural waters depend on the physical, chemical and biochemical activities in the water body (Raheem and Morenikeji, 2008). The zero DO values recorded at both sampling stations in September 2009 and at the downstream in January 2010 could be as a result of organic pollution. This is because the rate of deoxygenation depends on dilution that occur when effluents mix with the stream, the biochemical oxygen demand of the discharge, temperature of the discharge and streams' DO (Raheem and Morenikeji, 2008). This is reflected from the results of biochemical oxygen demand (BOD) and chemical oxygen demand (COD). Chapman (1997) reported that both parameters are very essential in water quality assessment. The high COD observed (Figure 2d) could be as a result of high organic load since abattoir effluent is rich in blood signifying high organic content. The COD at the two points were higher than the 30 mg/L standard set by NESREA (2011). Since blood has been observed to have a COD value of 350, 000 mg/L (Tritt and Schuchardt, 1992), it follows that this may impact high organic pollutants on any receiving water body, thus leading to environmental stress.

Phosphorus occurs almost solely as dissolved phosphates and it is the most significant form of phosphorus in natural waters (Fadiran, *et al.,* 2008). Excessive amounts of phosphate in natural water bodies can lead to eutrophication. The high values of phosphate (Figure 3a) may be attributed to probably much detergent that was used to wash the roasted carcass and in washing the slaughter houses. The periods when phosphate was below detection limit may be due to its low solubility in water and also its poor mobility in soil as at the time of sampling.

The chloride sources could be soluble salts (NaCl and KCl) from blood discharged into the effluent (Atuanya *et. al.,* 2012). However, the chloride contents in the samples were not up to the specified limits (Figure 3b).

The results of the sulphate (Figure 3c) indicated high pollution load of the stream since sulphate is one of the major components of the effluent (Haslam, 1990).

Table 1 shows the mean values of cations, trace and heavy metals of the samples from the upstream and downstream of the stream. Results of cations were far less than the set limit by NESREA (2011) while all the results of trace and heavy metals indicated that the values were higher than the set limit. The high heavy metal load of the water body is attributable to bioaccumulation in the blood and fat of the slaughtered cattle. This corroborates the position of Osibanjo and Adie (2007) that animals bioaccumulate heavy metals. From the results, though heavy metal load was higher in the downstream samples than the upstream samples, there was however no significant difference between the two.

4. Conclusion and Recommendation

From the results, it could be seen that the effluents are not treated before their discharge into the Gbagi surface water. This could affect the distribution and diversity of the aquatic biota inhabiting the stream and the larger surface water bodies that the stream feed are also at a disadvantage. It could also encourage the spread of zoonotic diseases.

Based on the results, there is the need for enlightenment for abattoir workers on proper and safe disposal methods. This it is believed will help reduce the incidence of washing blood and disposal of bones and other materials into such water bodies. To reduce the incidence of zoonotic diseases, users of such water bodies should attempt treating water collected before use.

Table 1: Mean values of physico-chemical parameters of Gbagi stream, Ibadan, Nigeria

Parameters	Upstream (mg/L)	Downstream (mg/L)	t	df	Sig. (2-tailed)	NESREA Limit (mg/L)
pH	6.94±0.49	7.00±0.60	-.258	22	.799	6.5 – 8.5
DO	1.89±1.42	2.53±1.32	-1.06	19	.302	4.0
BOD	82.44±34.49	90.46±37.98	-.541	22	.594	6.0
COD	338.42±102.80	382.09±109.42	-1.008	22	.325	30.0
PO_4^{2-}	168.04±72.73	257.63±104.24	-1.865	12	.087	3.50
Cl^-	47.31±15.54	53.10±14.36	-.949	22	.353	350.0
SO_4^{2-}	614.00±553.21	863.59±752.68	-.937	22	.359	500.0

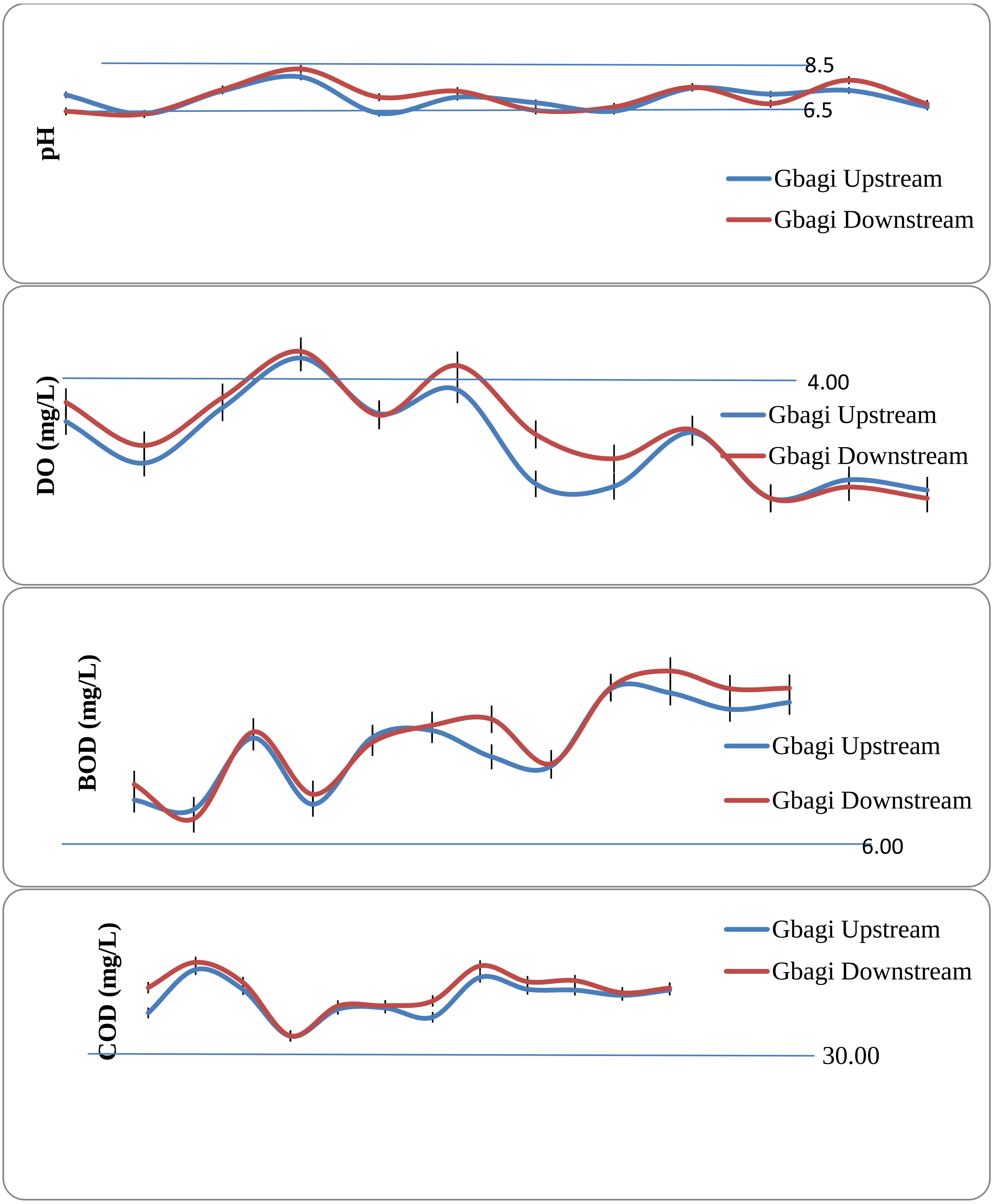

Figure 2: Effects of abattoir effluent on the physico-chemical parameters of Gbagi stream, Ibadan, Nigeria

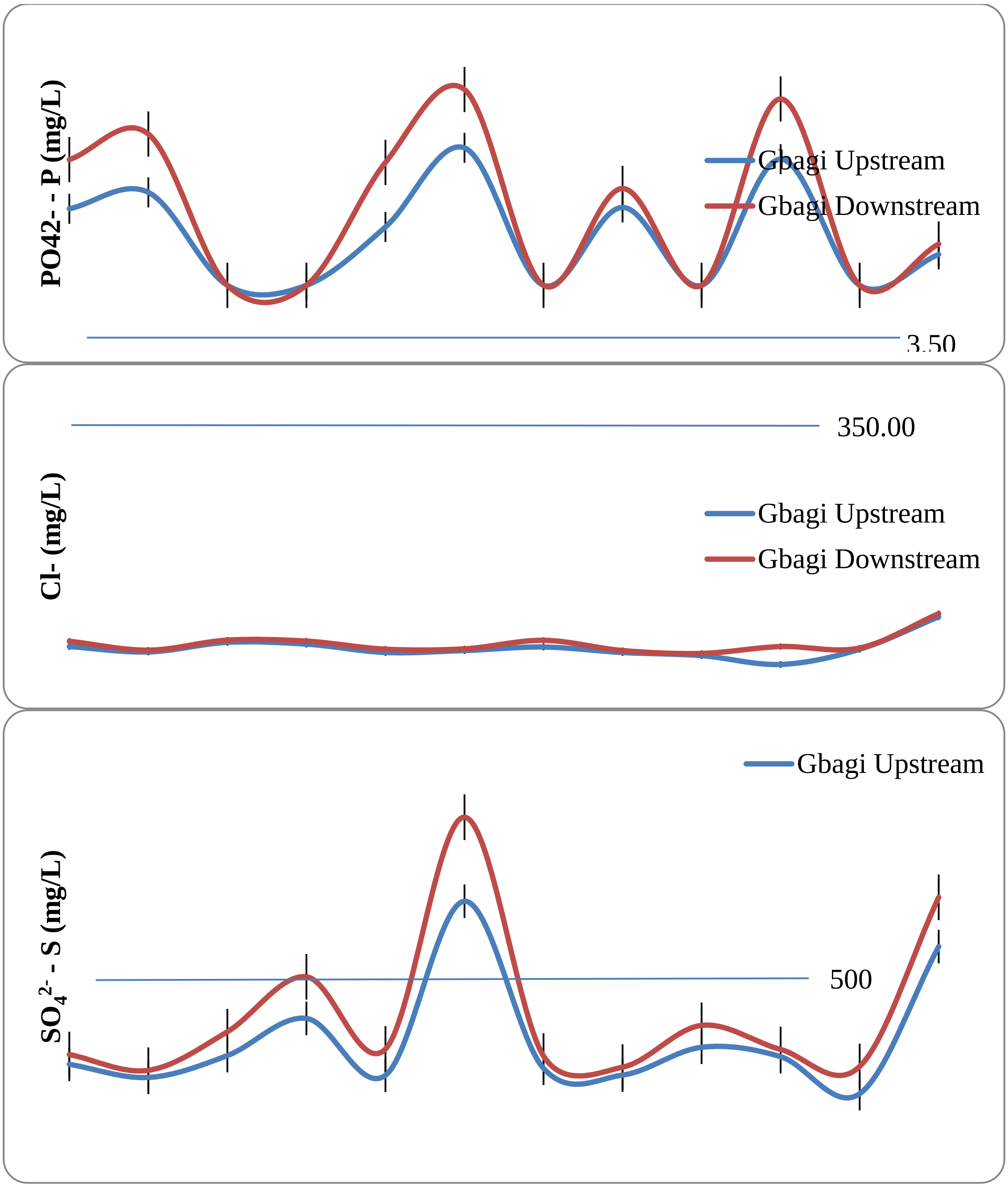

Figure 3: Effects of abattoir effluent on the physico-chemical parameters of Gbagi stream, Ibadan, Nigeria

Table 2: Mean values of cations, trace and heavy metals of Gbagi stream, Ibadan, Nigeria

Elements	Upstream (mg/L)	Downstream (mg/L)	t	df	Sig. (2-tailed)	NESREA Limit (mg/L)
Pb	0.19±0.18	0.44±0.17	-1.527	15	.148	0.1
Cu	0.20±0.08	0.18±0.15	.134	15	.895	0.01
Fe	1.79±1.51	4.84±5.72	-.604	15	.555	0.5
Zn	0.87±0.96	4.43±7.15	-.894	15	.385	0.2
Ni	0.02±0.01	0.07±0.10	-1.012	15	.328	0.1
Mg	16.24±11.36	17.92±11.63	.224	15	.826	40
Ca	42.25±9.42	45.15±10.26	-.624	7	.552	180
Cd	0.01±0.004	0.02±0.01	.746	13	.469	0.01
Mn	0.49±0.71	1.23±1.01	.459	11	.655	
Cr	0.03	0.09	-.414	11	.687	0.5

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