Analysis of Metal Concentrations in Water Samples Collected February 28 – March 1, 2000 from the Bayou Creek System

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INTRODUCTION

Samples were taken for metal analyses from the water column of Big and Little Bayou Creeks on February 28 and March 1, 2000. Sampling stations BB1 through BB9 on Big Bayou Creek and LB1 through LB4 on Little Bayou Creek were included in this survey. The new reference station, upstream of BB1 and designated BB1A, also was collected. In addition, Massac Creek (MC) was sampled and served as a reference station independent of the Bayou Creek system. Two samples were collected for metal assays for each of the sampling stations. A total of 9 metals of concern (*i.e*. Ag, Be, Cd, Cr, Cu, Fe, Ni, Pb and Zn) were analyzed.

METHODS

Metal Determinations

Water samples for metal assays were collected in acid-cleaned 250-mL polyethylene bottles. Samples were preserved with concentrated HNO_3 upon collection and analyzed for total recoverable (TR) metals. Eight metals, including silver (Ag), beryllium (Be), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), nickel (Ni), and zinc (Zn), were determined. Additionally, Iron (Fe) was included in the metal survey. Metal analysis were performed by atomic absorption spectrophotometry (AAS) using either graphite furnace atomization or flame atomization techniques (U.S. EPA 1997). The instruments were a Varian AAS (Model Spectra AA-20), equipped with a GTA-96 graphite furnace and a Perkin-Elmer (Model 603), equipped with an air-acetylene flame. All gases used were ultra pure carrier grade. Calibration curves were based on five standards. The instrument was programmed to take three readings per sample and average the absorbance. Sample concentrations were then corrected for deviations from the standards and sample weights were factored into calculation of final values. Instrument blanks (0.5 % HNO_3) and check standards were processed with all samples.

Quality Assurance

Permanent bench records were kept of all assays and annotated as required under Good Laboratory Practices (*Federal Register*, 40 CFR, Part 160, August 17, 1989). All printouts and graphic recordings were filed. These bench records will be archived within two years after the close of the project. Chain of Custody was maintained for all samples collected.

RESULTS

Metals assay of water samples are presented in Tables 1 and 2 for Big Bayou and Little Bayou Creeks, respectively. Two independent samples were taken at each collecting station. Stream conditions were stable and no turbidity was evident. Silver (Ag) was not detected either in Massac Creek (MC) samples or those taken from stations BB1A through BB5 on Big Bayou Creek (Table 1). However, Ag was found at BB6 and all stations downstream thereof (Figure 1). These values (µg/L) ranged from 1.17 at BB6 to 0.55 at BB9. The latter station is situated 7.6 Km downstream of the 001 effluent that discharges just upstream of station BB6. Toxic chronic effects from silver are possible at these concentrations.

Beryllium (Be) was not detected at stations MC or BB1A through BB2, but was observed at 0.30 to 0.38 µg/L at BB3 and BB4. Be concentrations further increased at and downstream of station BB6, ranging from 0.80 to 0.48 µg/L (Figure 2). As for Ag, the 001 effluent is the likely source of most of the Be contamination. Cadmium (Cd) displayed a profile similar to that of Ag. It was not detected in MC or at BB1A through BB5, but occurred at BB6, BB7, and BB8. Cd concentrations ranged from 7.00 µg/L at BB7 to 0.22 µg/L at BB8. Total chromium (Cr) was detected at 1.05 µg/L at BB1, an upstream station, and also was observed at stations BB5 through BB9 (Figure 3). At and below station BB6, Cr concentrations ranged from 1.21 to 2.09 µg/L.

Copper (Cu) was not detected in MC samples but was observed at all stations on Big Bayou Creek (Figure 4). Cu values (µg/L) ranged from 1.07 to 3.78 at the upstream stations (BB1A, BB1, BB2). Station BB2 is just downstream of the abandoned bridge on the unnamed tributary to Big Bayou Creek. In and below the effluent receiving zone, Cu also was found at all stations (*i.e.* BB3 – BB9). The highest concentrations were detected at stations BB6 (4.80 µg/L) and BB7 (5.56 µg/L). Effluent 001 likely was the major source of Cu. Compared with MC and BB1, Cu was still elevated at station BB9 (*i.e*. 2.59 – 2.69 µg/L). Results for iron (Fe) were variable, with maximum concentrations occurring at stations BB3 and BB5 (Figure 5). In eight water samples taken at upstream stations (*i.e.* MC, BB1A, BB1, BB2), lead (Pb) was detected in only one sample from MC (0.91 µg/L). However, Pb was detected at BB3 and at all downstream stations on

Big Bayou Creek (Figure 6). The higher values (µg/L) were 1.91, 3.03, 3.12, 2.56, and 2.53 at stations BB3, BB6, BB7, BB8, and BB9, respectively. Nickel (Ni) was not detected at or upstream of station BB5, but was found in all but one sample from stations BB6 through BB9 (Figure 7). The maximum values (µg/L) were 12.85, 8.04, and 7.53 at stations BB6, BB7, and BB8. Zinc (Zn) occurred in samples from all stream stations (Figure 8). Maximum values (µg/L) were 16.17, 8.34, 236.4, 4.57, and 7.90 for stations BB3, BB6, BB7, BB8, and BB9, respectively.

In summary, metals in stream water samples were elevated substantially within the effluent receiving zone of Big Bayou Creek (*i.e.* stations BB3 – BB6) and, in most cases, metals remained above reference values at downstream stations, including station BB9. It appeared that effluent 001 was a major source for Ag, Be, Cd, Cr, Cu, Pb, and Ni. It was possible that 009 and other effluents contributed to contamination of Be, Cu, Pb, and Zn (Figures 2, 4, 4, and 8). Runoff from and around the plant site also may have been a factor.

Results for metal assays of water samples taken from Little Bayou Creek are given in Table 2 and Figures 1 through 8. Silver was not detected at any of the five sampling stations. The upstream site (LB1) exhibited conditions similar to stations located at and below the PGDP installation. The major exception was observed for Pb, which was undetected at LB1 but present at concentrations (µg/L) of 1.98 to 0.50 at stations LB2 – LB4. Copper also was somewhat elevated at these stations. Based on metal values for Massac Creek, metal contamination in Little Bayou Creek is appreciable, especially for Be, Cr, Pb, and Zn.

The above results support the need to continue monitoring the Bayou Creek system. It is noteworthy that metal pollutants appear to have extended down to station BB9 situated only 2.8 Km from the Ohio River. Upstream collecting stations used as reference sites also may have suffered from some contamination. A graphic summary of the results are given in Figure 9.

Table 1. Metal concentrations in water samples from Massac (MC) and Big Bayou Creeks collected February 29 and March 1, 2000.

			Water Metal Conc. (µg/L)								
Sample Name			Ag	Be	Cd	Cr	Cu	Fe	Pb	Ni	Zn
MC	30100	MWS1	<0.25	<0.25	<0.25	<1.00	<1.00	<200.0	0.91	<3.00	<1.00
MC	30100	MWS2	<0.25	<0.25	<0.25	<1.00	<1.00	268.8	<0.50	<3.00	2.12
BB1A	22900	MWS1	<0.25	<0.25	<0.25	<1.00	1.07	981.1	<0.50	<3.00	3.37
BB1A	22900	MWS2	<0.25	<0.25	<0.25	<1.00	1.36	751.2	<0.50	<3.00	2.63
BB1	22900	MWS1	<0.25	<0.25	<0.25	1.10	1.15	<200.0	<0.50	<3.00	1.35
BB1	22900	MWS2	<0.25	<0.25	<0.25	1.05	1.14	405.9	<0.50	<3.00	2.16
BB2	30100	MWS1	<0.25	<0.25	<0.25	<1.00	1.31	858.2	<0.50	<3.00	1.93
BB2	30100	MWS2	<0.25	<0.25	<0.25	<1.00	3.78	930.7	<0.50	<3.00	3.88
BB3	30100	MWS1	<0.25	0.36	<0.25	<1.00	<1.00	1171.1	1.91	<3.00	6.33
BB3	30100	MWS2	<0.25	0.38	<0.25	<1.00	1.01	1192.8	1.26	<3.00	16.17
BB4	30100	MWS1	<0.25	0.31	<0.25	<1.00	1.62	856.4	0.74	<3.00	3.15
BB4	30100	MWS2	<0.25	0.30	<0.25	<1.00	1.50	704.5	0.68	<3.00	3.55
BB5	30100	MWS1	<0.25	<0.25	<0.25	0.92	1.48	1076.8	0.62	<3.00	3.35
BB5	30100	MWS2	<0.25	<0.25	<0.25	0.86	1.22	1018.9	0.51	<3.00	2.32

Table 1, continued. Metal concentrations in water samples from Massac (MC) and Big Bayou Creeks collected February 29 and March 1, 2000.

Sample Name			Water Metal Conc. (µg/L)								
			Ag	Be	Cd	Cr	Cu	Fe	Pb	Ni	Zn
BB6	30100	MWS1	1.17	0.74	0.38	1.95	4.80	552.3	3.03	12.28	8.34
BB6	30100	MWS2	1.14	0.80	0.35	2.03	4.66	519.3	2.24	12.85	7.81
BB7	22900	MWS1	0.87	0.64	7.00	1.88	5.56	278.9	2.99	7.84	236.40
BB7	22900	MWS2	0.89	0.65	3.78	2.09	4.37	274.2	3.12	8.04	10.08
BB8	22900	MWS1	0.78	0.63	0.22	1.34	3.41	997.4	1.77	7.53	4.57
BB8	22900	MWS2	0.80	0.61	<0.25	1.36	3.70	589.1	2.56	7.21	4.41
BB9	30100	MWS1	0.55	0.48	<0.25	1.50	2.59	768.6	<0.50	<3.00	3.27
BB9	30100	MWS2	0.56	0.48	<0.25	1.21	2.69	374.0	2.53	5.51	7.90

Table 2. Metal concentrations in water samples from Little Bayou Creek collected February 29 and March 1, 2000.

			Water Metal Conc. (µg/L)								
Sample Name			Ag	Be	Cd	Cr	Cu	Fe	Pb	Ni	Zn
LB1	30100	MWS1	<0.25	0.47	<0.25	2.59	1.36	843.1	<0.50	3.34	11.44
LB1	30100	MWS2	<0.25	0.40	<0.25	2.51	1.36	511.9	<0.50	3.52	10.46
LB2	30100	MWS1	<0.25	0.30	<0.25	2.52	1.96	285.2	1.75	<3.00	12.00
LB2	30100	MWS2	<0.25	0.27	<0.25	2.34	2.31	250.0	1.98	4.78	15.01
LB2A	30100	MWS1	<0.25	0.34	<0.25	1.44	1.40	677.8	1.07	<3.00	8.72
LB2A	30100	MWS2	<0.25	0.33	<0.25	1.38	1.39	720.4	0.81	<3.00	8.18
LB3	30100	MWS1	<0.25	0.38	<0.25	3.00	2.21	537.0	0.91	<3.00	11.67
LB3	30100	MWS2	<0.25	0.27	<0.25	2.48	1.89	370.3	1.29	<3.00	9.54
LB4	30100	MWS1	<0.25	0.60	<0.25	2.18	2.34	442.2	0.50	<3.00	11.13
LB4	30100	MWS2	<0.25	0.37	<0.25	2.03	1.72	524.6	0.62	<3.00	10.34

Figure 1. Mean Silver Concentrations in Stream Surface Water from Bayou Creek System Collected February 29 and March 1, 2000.

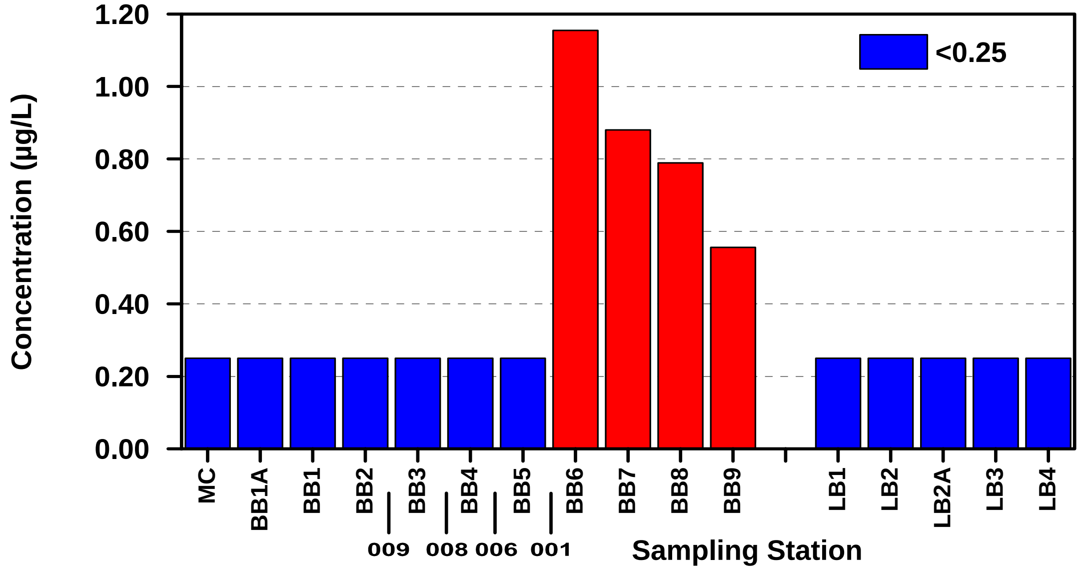


Figure 2. Mean Beryllium Concentrations in Stream Surface Water from Bayou Creek System Collected February 29 and March 1, 2000.

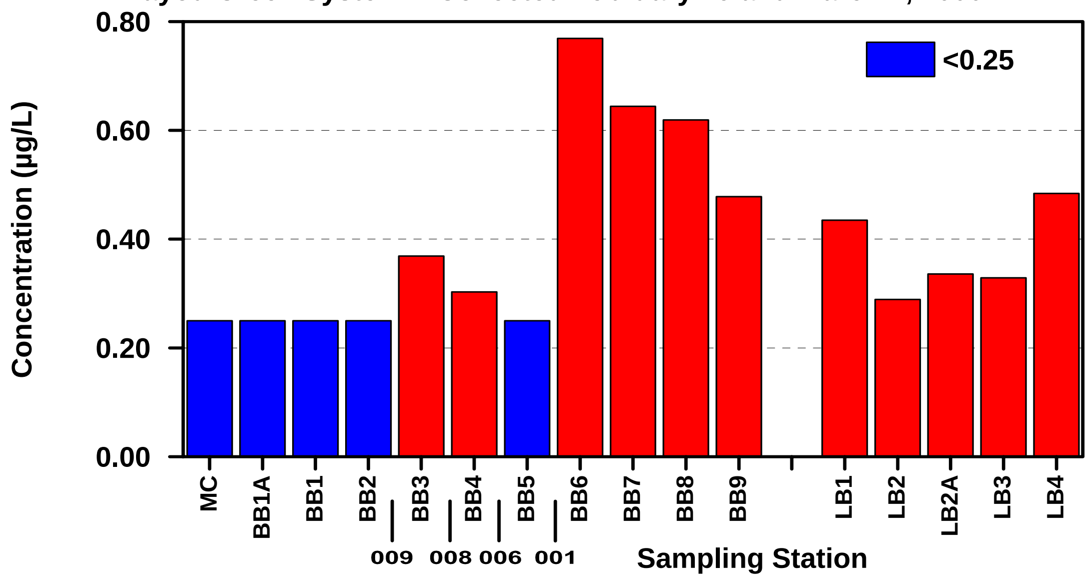


Figure 3. Mean Chromium Concentrations in Stream Surface Water from Bayou Creek System Collected February 29 and March 1, 2000.

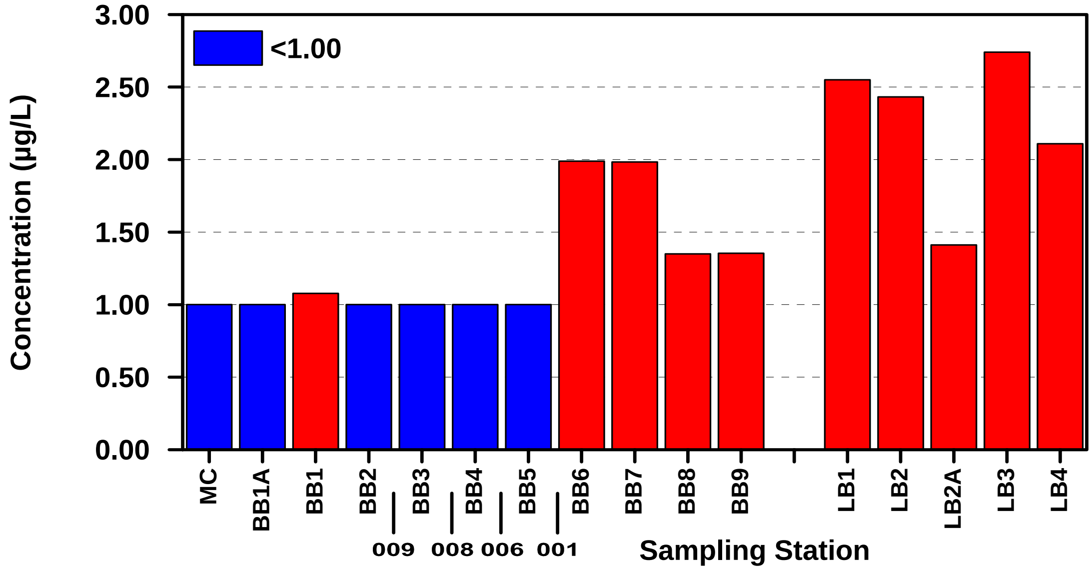


Figure 4. Mean Copper Concentrations in Stream Surface Water from Bayou Creek System Collected February 29 and March 1, 2000.

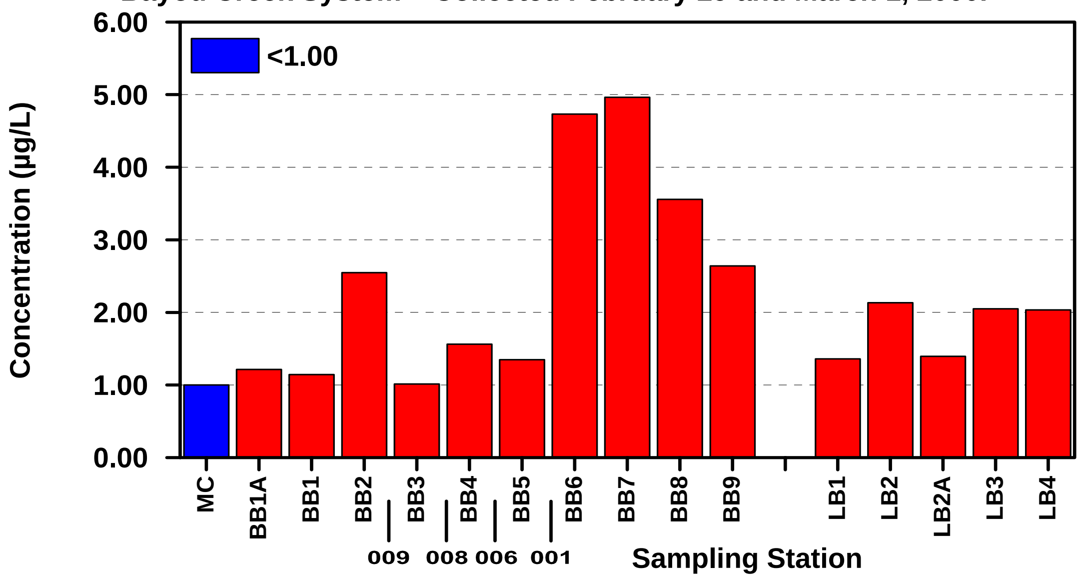


Figure 5. Mean Iron Concentrations in Stream Surface Water from Bayou Creek System Collected February 29 and March 1, 2000.

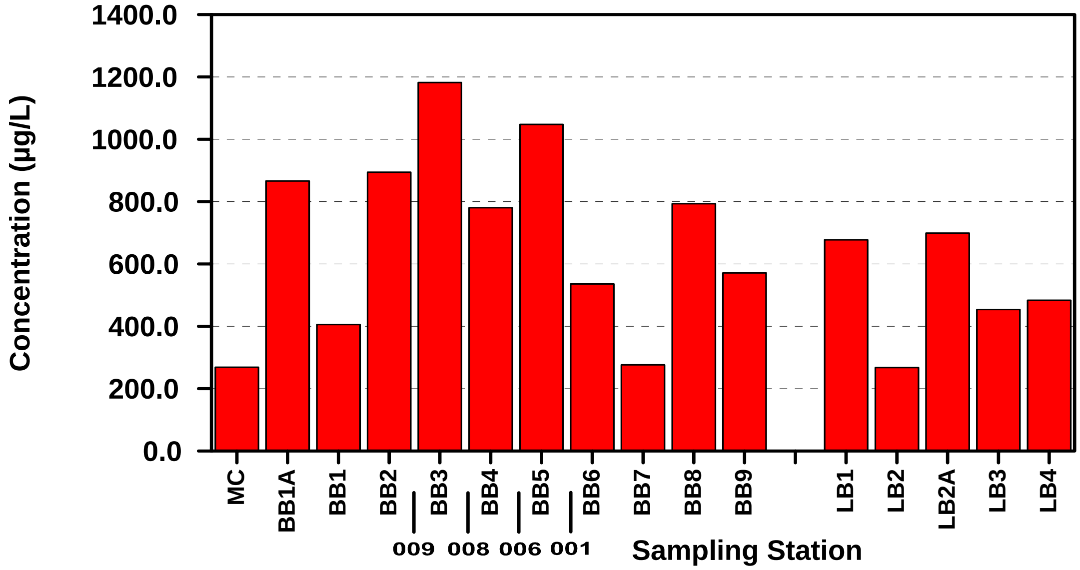


Figure 6. Mean Lead Concentrations in Stream Surface Water from Bayou Creek System Collected February 29 and March 1, 2000.

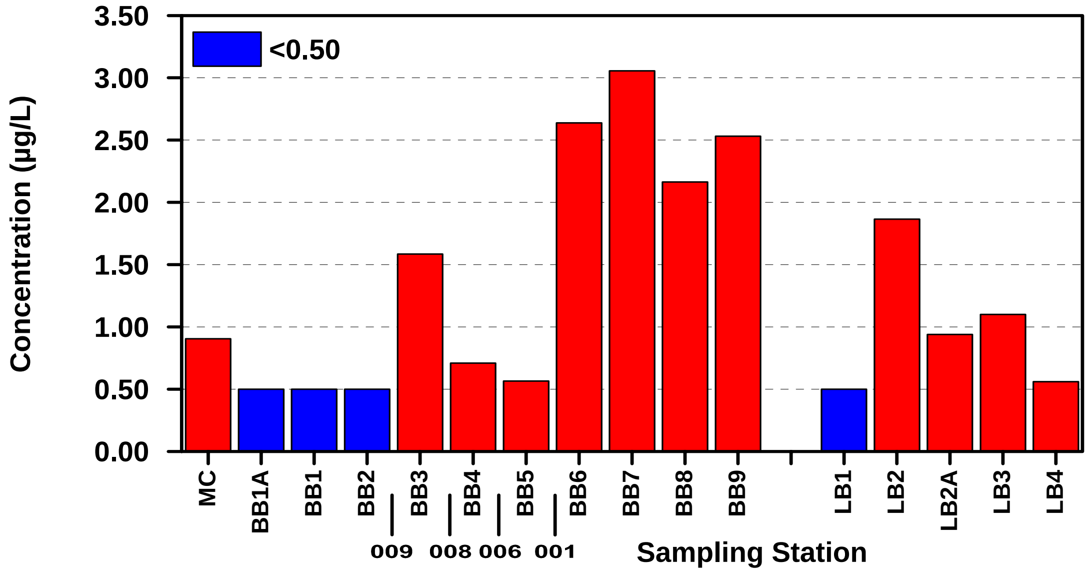


Figure 7. Mean Nickel Concentrations in Stream Surface Water from Bayou Creek System Collected February 29 and March 1, 2000.

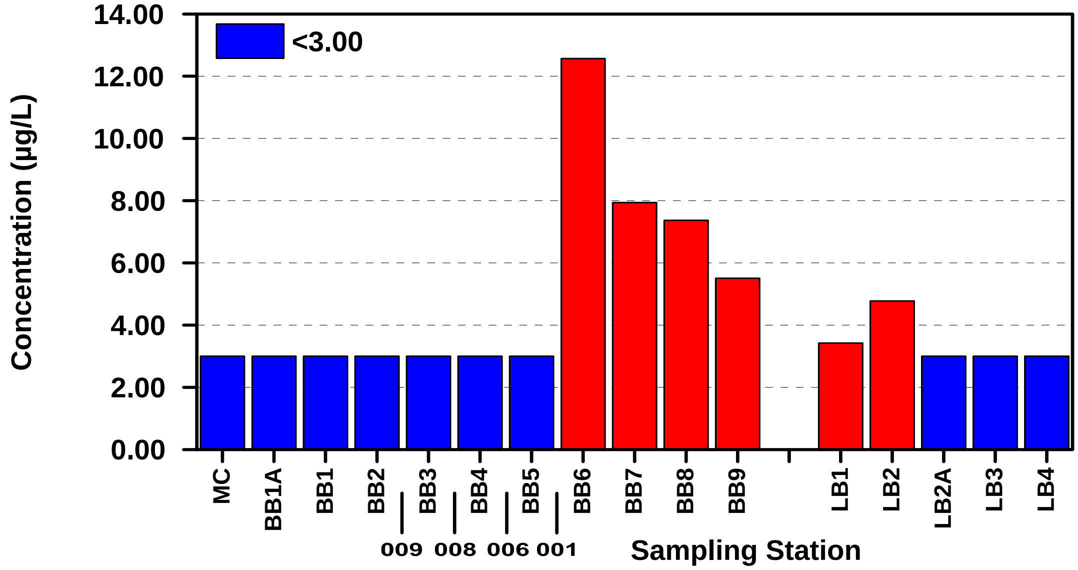


Figure 8. Mean Zinc Concentrations in Stream Surface Water from Bayou Creek System Collected February 29 and March 1, 2000.

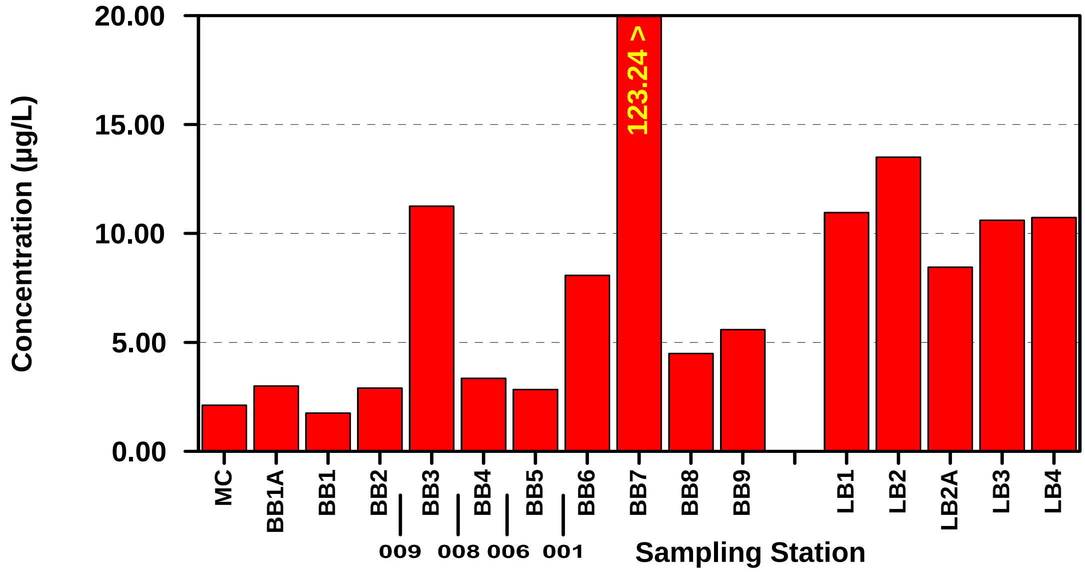
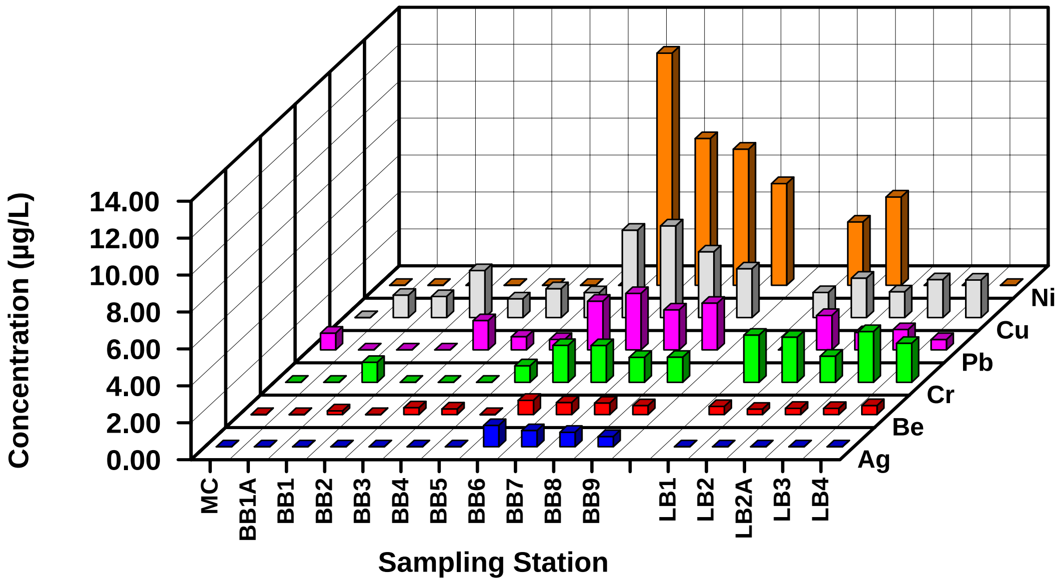


Figure 9. Mean Metal Concentrations in Stream Surface Water from Bayou Creek System Collected February 29 and March 1, 2000.



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