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Memorandum

November 6, 2018

To: Kristen Keene, Maryland Department of Transportation Maryland Port Administration
Cassandra Carr, Maryland Environmental Service

From: Karin Olsen, PG, Anchor QEA, LLC

Re: Elk River Sampling – River Beach Samples

Program Overview

On behalf of the Maryland Department of Transportation Maryland Port Administration (MDOT MPA) and the Maryland Environmental Service (MES), sampling was conducted at two River Beach locations in the nearshore Elk River to assess the environmental conditions in the vicinity of the Pearce Creek Dredged Material Containment Facility (DMCF) Exterior Monitoring Area (Figure 1). The River Beach sampling efforts were initiated based on environmental concerns expressed by citizen members of the Pearce Creek Implementation Committee. The purpose of this Memorandum is to summarize the results of the spring 2018 sediment quality characterization, water quality characterization, benthic community sampling, and benthic bioassay sampling for each of the two locations (Figure 2).

Technical Approach

The data collection and analytical approach for the River Beach locations was consistent with the Pearce Creek DMCF Exterior Monitoring Program (Anchor QEA 2016a, 2016b, 2017a, and 2017b). The River Beach samples function as a discrete sample set and will be evaluated independently from the samples collected in conjunction with the Pearce Creek DMCF Exterior Monitoring Program. Data collected during previous sampling events in spring 2016, fall 2016, and spring 2017 are presented on the results tables for comparison to data collected during the spring 2018 sampling event.

Sediment Quality Characterization

Undisturbed sediments were collected from the sediment-water interface to a depth of 6 inches using a Ponar grab sampler. Samples were submitted for metals, grain size, moisture content, specific gravity, total organic carbon (TOC), nitrate + nitrite, total Kjeldahl nitrogen (TKN), ammonia, total phosphorus, and sulfide. Chemical concentrations in bulk sediment samples were compared to sediment quality guidelines for freshwater samples (MacDonald et al. 2000).

Water Quality Monitoring

Surface water samples were collected from the mid-depth of the water column. Samples were submitted for dissolved metals, total suspended solids (TSS), phosphorus, hardness, ammonia, nitrate, and TKN analysis. Physical parameters, including temperature, dissolved oxygen (DO), pH, and salinity, were also recorded at each sampling location. Chemical concentrations in the surface water samples were compared to the U.S. Environmental Protection Agency (USEPA) *National Recommended Water Quality Criteria* (2018) and the State of Maryland Code of Regulations (COMAR 26.08.02.03-2) freshwater acute water quality criteria for aquatic life.

Benthic Community Sampling

Benthic community (bottom-dwelling organisms) samples were collected to determine community composition, abundance (number of benthic organisms), and diversity (number of different types of species). The results were used to calculate benthic community metrics, including the number of unique taxa, species abundance, Shannon-Wiener Species Diversity Index, abundance of pollution-indicative taxa, abundance of pollution-sensitive taxa, abundance of carnivore and omnivore taxa, tolerance, evenness, species richness, and Simpson's Dominance Index.

Benthic Bioassays

Sediment from one location was submitted for benthic bioassay testing. Benthic bioassays were used to evaluate if the sediments were acutely toxic to organisms living in the sediments. Bioassays were 10-day whole sediment tests using the freshwater amphipod *Hyalella azteca*. Testing was conducted according to the USEPA's *Methods for Measuring the Toxicity and Bioaccumulation of Sediment Associated Contaminants with Freshwater Invertebrates* (USEPA 2000). *Hyalella azteca* survival data for the whole sediment bioassays were statistically compared to the survival data in control sediment. A control sediment is a non-impacted sediment sample that is used to evaluate the results of a test.

Field Investigation

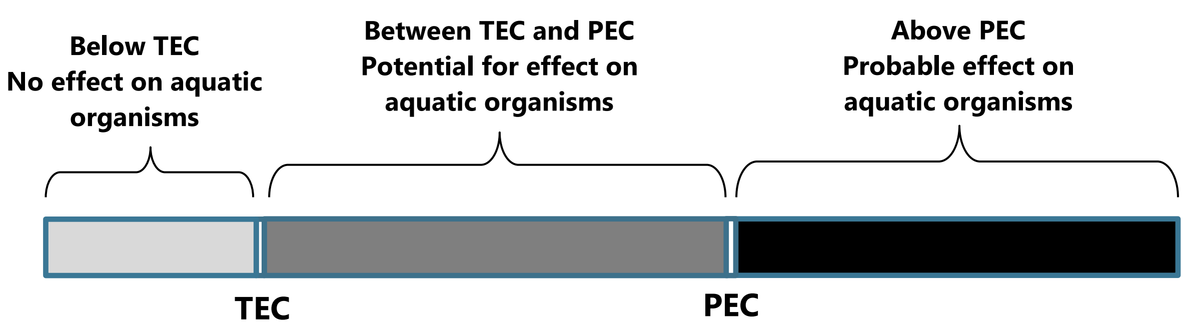
The methods and procedures for the collection of field samples, sampling schedule, rationale for the sampling design, and design assumptions for locating and selecting environmental samples were carried out in accordance with the Sampling and Analysis Plan (Anchor QEA 2015) and the methods used for the Pearce Creek DMCF Exterior Monitoring Program (Anchor QEA 2016a, 2016b, 2016c). Sampling procedures were consistent with USEPA protocols or other approved sample collection standards. A complete list of analytes, target detection limits, and analytical methodologies is provided in the Sampling and Analysis Plan (Anchor QEA 2015).

Two River Beach (RB) sampling locations were included in this investigation. One location was near the dredged material inflow location for the Pearce Creek DMCF (location RB-01), and one location (location RB-02) was near the area where Stemmers Run discharges into the Elk River. Sampling locations were determined in the field using a Trimble ProXRS Differential Global Positioning System (DGPS) with an accuracy of 1 to 3 meters (m). Northing and easting coordinates for the sampling locations are provided in Table 1 and shown on Figure 2.

Sediment Quality Characterization

Concentrations of detected analytes in sediment samples were compared to consensus-based sediment quality guidelines for freshwater sediment, where available (MacDonald et al. 2000). Threshold effect concentrations (TECs) and probable effect concentrations (PECs) are derived based on empirical data from laboratory and field studies (MacDonald et al. 2000). The TEC values represent concentrations below which adverse biological effects are unlikely, and PEC values represent concentrations above which adverse biological effects are probable (MacDonald et al. 2000). Concentrations that are between the TEC and PEC represent the concentrations at which adverse biological effects might occur, as shown below:

Data Evaluation Using Sediment Quality Guidelines



Results of the sediment quality characterization are summarized in Table 2. Sample RB-01 was composed of 0.8% gravel, 97.2% sand, and 2% silts and clays. Sample RB-02 was composed of 15% gravel, 84% sand, and less than 1% silts and clays. TOC and nutrient concentrations were low at both locations. TOC was detected at concentrations of 0.33% at RB-01 and 0.23% at RB-02. Nitrate + nitrite was detected at a concentration of 1.5 milligrams per kilogram (mg/kg) at RB-01 and 2 mg/kg at RB-02. TKN concentrations at RB-01 and RB-02 were 200 mg/kg and 540 mg/kg, respectively. Ammonia was detected at RB-01 (8.9 mg/kg) but not at RB-02. Total phosphorus was 51 mg/kg at RB-01 and 33 mg/kg at RB-02. Sulfide concentrations were similar at both locations, with concentrations reported at 25 mg/kg at RB-01 and 22 mg/kg at RB-02. Nutrient concentrations in the spring 2018 sampling event fall within the range of concentrations from the previous three sampling events (spring 2016, fall 2016, and spring 2017) at RB-01. Nutrient concentrations at RB-02 are slightly greater than those observed in the previous three sampling events.

Of the 13 tested metals, 12 were detected in at least one sample. Mercury was the only metal not detected at either location. Metal concentrations at both locations were low and well below the TECs. Concentrations in both samples generally fell within the range of, or were less than, concentrations reported in the previous three sampling events (Table 2).

Water Quality Characterization

Analytes detected in the surface water were compared to the USEPA and State of Maryland freshwater acute and chronic water quality criteria. Criteria were derived from the USEPA *National Recommended Water Quality Criteria* (USEPA 2018) and the Code of Maryland Regulations (COMAR 26.08.02.03-2). For dissolved metals, the State of Maryland freshwater water quality criteria for the protection of aquatic life are the same as the USEPA criteria (Table 3) and are directly comparable to the results.

The State of Maryland allows, but does not require, that freshwater criteria be adjusted based on water hardness. The freshwater water quality criteria for the protection of aquatic life for cadmium, chromium, copper, lead, nickel, and zinc were calculated using the minimum hardness value (86 milligrams per liter [mg/L]), which was applied to both samples as a conservative evaluation of water quality. The hardness-adjusted criteria were more conservative than the non-adjusted values for the surface water samples.

Results of the water quality characterization are summarized in Table 3. Hardness and nutrients were reported at similar concentrations between both surface water samples. The total phosphorus concentration was reported at 0.11 mg/L at RB-01 and was not detected at RB-02. The TSS concentration was 39 mg/L at RB-01 and 29 mg/L at RB-02, and ammonia was 0.38 mg/L at RB-01 and 0.21 mg/L at RB-02. TKN was reported at 1.7 mg/L at RB-01 and was not detected at RB-02. Nitrate was 0.69 mg/L at RB-01 and 0.95 mg/L at RB-02. Nutrient concentrations in the spring 2018 sampling event generally fall within the range of concentrations from the previous three sampling events (spring 2016, fall 2016, and spring 2017) at RB-01. Nutrient concentrations at RB-02 are slightly greater than those observed in the previous three sampling events.

Of the 16 tested metals, nine were detected in one or both surface water samples (aluminum, arsenic, chromium, copper, iron, lead, manganese, nickel, and zinc). Metals were detected at similar concentrations at RB-01 and RB-02, with the exception of aluminum and iron, which were detected at higher concentrations at RB-01 compared to previous years. However, this is likely attributable to higher TSS concentrations in the 2018 surface water samples compared to previous sampling events.

Aluminum exceeded the chronic freshwater criteria for the protection of aquatic life at RB-01 but was substantially less than the acute freshwater criteria. There were no other exceedances of either the acute or chronic freshwater criteria. Metal concentrations in both samples generally fell within the range of, or were less than, concentrations reported in the previous three sampling events (Table 3) with two exceptions.

Benthic Community

Benthic (or bottom dwelling) organisms are important indicators of stress in aquatic systems because they can integrate the effects of environmental conditions during long periods of time. Benthic organisms are also important food for many fish, providing an important link to higher trophic levels. Most benthic organisms tend to thrive only in some habitats (for example, sandy versus muddy sediments), and groups of benthic organisms collected at sampling locations are generally comprised of species that are adapted to a specific habitat. Sampling locations are considered "normal" or "healthy" when the benthic organisms collected from that location are primarily the species that are specifically adapted to live in that particular habitat.

Results of the benthic community sampling are summarized in Tables 4 and 5. The bottom salinity was 0.23 parts per thousand (ppt; Table 1); therefore, both locations were classified as freshwater habitats (bottom salinity ranging from 0 to 0.5 ppt). A taxonomic list and mean abundance of the benthic fauna collected are presented in Table 4. A list of the benthic fauna collected in individual replicates collected at each location is provided in Table 5. Benthic metrics are summarized in Table 6.

Total benthic abundance (total number of organisms per square meter [m^2]) was 3,509 organisms/m^2 at RB-01 and 7,024 organisms/m^2 at RB-02 (Table 6). Twenty-one benthic taxa were collected from the River Beach locations (Table 5). Nineteen taxa were collected at RB-01: Diptera (9 taxa), Isopoda (1 taxa), Polychaete (1 taxa), Oligochaeta (4 taxa), Bivalves (2 taxa), Amphipoda (1 taxa), and Crustacea (1 taxa). Sixteen taxa were collected at RB-02: Diptera (9 taxa), Crustacea (2 taxa), Bivalves (1 taxa), Polychaete (1 taxa), and Oligochaeta (3 taxa). *Tubificidae* (with capilliform) were the dominant taxa at RB-01 and RB-02 (Table 4).

Species richness is a comparison of how many taxa are in a sample compared to how many individuals are in a sample. Lower values indicate that the total benthic abundance at a location is dominated by a few taxa and does not represent a diverse benthic community. Lower species richness was observed at RB-02 when compared to RB-01, with values of 1.9 and 2.9, respectively (Table 6).

Evenness is a measure of how evenly the individuals collected at a location are distributed among the taxa collected at that location, with a value of 1 indicating that the individuals are distributed as evenly as possible. Evenness values were similar between locations RB-01 and RB-02, with values of 0.778 and 0.769, respectively (Table 6).

The Shannon-Wiener Species Diversity Index takes into account species richness and species evenness, with higher values indicating a more diverse benthic community. Location RB-01 had a Shannon-Wiener Species Diversity Index of 3.1 and the value at RB-02 was 2.8, indicating that these locations have diverse benthic communities (Table 6).

Simpson's Dominance Index measures the diversity of a sample, with a lower value indicating a more diverse community. Simpson's Dominance Index was 0.15 at RB-01 and 0.19 RB-02 (Table 6). The low Simpson's Dominance Index value is indicative of high species diversity.

Results for the benthic community evaluation for spring 2018 were generally consistent with the results for the previous three sampling events (spring 2016, fall 2016, and spring 2017; Table 6). Total abundance in both samples was substantially greater in the spring 2018 sampling event than in the previous years, but the majority of the other benthic metrics were similar or fell within the range of those observed in the previous three sampling events (Table 6). This indicates that while the species composition of the benthic community changes seasonally in response to temperature, salinity, and dissolved oxygen fluctuations, the overall health of the benthic community is stable.

Benthic Bioassays

Benthic bioassays with whole sediment are designed to determine whether the sediment from each sampling location is likely to produce unacceptable adverse effects on benthic organisms by exposing the organisms to the whole sediment for 10 days. A freshwater amphipod (*Hyalella azteca)* was used in the whole-sediment bioassay.

Hyalella azteca is adapted to live in silty environments, so the toxicity tests are only applicable for fine-grained sediments comprised mostly of silts and clays. For the spring 2018 sampling event, both locations were primarily comprised of coarse grained sands and gravel. Bioassay testing was only conducted at one River Beach location (RB-01), because location RB-02 was comprised almost entirely of sand and gravel (99%). Even though the RB-01 location was also composed primarily of coarse-grained sands (97%), the bioassay was still run for consistency with data from previous sampling events.

Results of the benthic bioassays were compared to the results in the control (Table 7). A control sediment is a non-impacted sediment sample that is used to evaluate the results of a test. Mean survival of *Hyalella azteca* exposed for 10 days to the River Beach sediment was 81%. The survival result was not statistically different ($p=0.05$) from the mean survival in the control sediment (91%). Therefore, the sediment sample collected from location RB-01 was unlikely to cause adverse effects to benthic organisms.

Benthic bioassay results for the spring 2018 samples were comparable with the results for spring 2016, fall 2016, and spring 2017, with samples from each event indicating that the sediment sample collected from location RB-01 was unlikely to cause adverse effects to benthic organisms.

Summary

Sampling was conducted for two River Beach locations in the nearshore Elk River to evaluate existing conditions for sediment quality, surface water quality, benthic community, and benthic bioassays. Data collected during this investigation was compared to three previous sampling events (spring 2016, fall 2016, and spring 2017) to identify any trends or changes in sediment quality, surface water quality, benthic community, and benthic bioassays. The data collected as part of this investigation will also be compared to future data collection.

References

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MacDonald, D.D., C.G. Ingersoll, and T.A. Berger, 2000. Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. *Archives of Environmental Contamination and Toxicology* 39:20-31.

USEPA, 2000. *Methods for Measuring the Toxicity and Bioaccumulation of Sediment Associated Contaminants with Freshwater Invertebrates, Second Edition.* EPA 600/R-99/064. March 2000.

USEPA, 2018. National Recommended Water Quality Criteria. Accessed: August 28, 2018. Available at: http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm.

Figures

LEGEND:

Exterior Monitoring Area

Pearce Creek DMCF

NOTE:
1. Base map courtesy of ESRI and its data suppliers (2017).

Publish Date: 2018/11/06, 11:29 AM | User: ckiblinger
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Figure 1
Site Location Map
Spring 2018 Monitoring Report

LEGEND:

Sample Locations

Pearce Creek Dredged Material Containment Facility

NOTE:
1. Aerial imagery: NAIP 2017.

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Figure 2
River Beach Sampling Locations
Spring 2018

Tables

Table 1
Sample Collection and Water Quality Parameters

Location	Date	Time (EST)	Northing[a]	Easting[a]	Water Depth (feet)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	pH
RB-01	5/23/2018	13:55	645662.04	1599539.27	4	23.7	0.23	8.67	21.2	7.75
RB-02	5/23/2018	12:22	645037.92	1598008.27	4	21.5	0.23	8.59	13	7.67

Notes:

a: Coordinates are in Maryland State Plane, North American Datum of 1983.

EST: Eastern Standard Time

mg/L: milligram per liter

NTU: Nephelometric Turbidity Unit

ppt: part per thousand

Table 2
Analytical Results for Sediment Samples

				River Beach Location 1				River Beach Location 2			
Analyte	**Units**	**Threshold Effect Concentration (TEC)**	**Probable Effect Concentration (PEC)**	**Spring 2016**	**Fall 2016**	**Spring 2017**	**Spring 2018**	**Spring 2016**	**Fall 2016**	**Spring 2017**	**Spring 2018**
Physical Characteristics											
Gravel	%	--	--	**9.4**	**40.4**	**1.4**	**0.8**	**7.8**	**17.0**	**9.6**	**15.1**
Sand	%	--	--	**20.7**	**59**	**97**	**97.2**	**91**	**81.5**	**87.1**	**84.1**
Silt	%	--	--	**37**	**0.4**	**0.02**	**0.4**	**0.4**	**0.9**	**1.7**	**0**
Clay	%	--	--	**32.9**	**0.2**	**1.6**	**1.6**	**0.8**	**0.6**	**1.6**	**0.8**
Specific Gravity	--	--	--	**2.64**	**2.67**	**2.68**	**2.67**	**2.69**	**2.66**	**2.67**	**2.67**
Nutrients											
Total Organic Carbon	%	--	--	**2.9**	**0.17**	**0.62**	**0.33**	**0.15**	**0.15**	0.13 U	**0.23**
Nitrate + Nitrite	mg/kg	--	--	**4.2**	1.3 U	**1.3 J**	**1.5**	**1.6**	**0.58 J**	1.2 U	**2**
Total Kjeldahl Nitrogen	mg/kg	--	--	**2,200**	**140 J**	390 U	**200 J**	**210**	**96 J**	200 U	**540**
Ammonia	mg/kg	--	--	**150**	**10**	**20**	**8.9 J**	12 U	**8.2**	**10.0**	8.2 U
Total Phosphorus	mg/kg	--	--	**620**	**31**	**78**	**51**	**42**	**31**	**30**	**33**
Sulfide	mg/kg	--	--	**460**	38 U	73 U	**25 J**	**9.8 J**	**9.1 J**	38 U	**22 J**
Metals											
Antimony	mg/kg	--	--	**0.29**	**0.11 J**	**0.11 J**	**0.3**	**0.077 J**	**0.05 J**	**0.029 J**	**0.061 J**
Arsenic	mg/kg	9.79	33	**7.1**	**1.9**	**1.3**	**1.1**	**0.82**	**0.50**	**0.47**	**0.45**
Beryllium	mg/kg	--	--	**1.3**	**0.4**	**0.21**	**0.14**	**0.08**	**0.059 J**	**0.054 J**	**0.066 J**
Cadmium	mg/kg	0.99	4.98	**0.31**	**0.21**	**0.043 J**	**0.042 J**	**0.013 J**	**0.21**	**0.017 J**	**0.014 J**
Chromium	mg/kg	43.4	111	**29**	**7.4**	**8.6**	**5.7**	**4.3**	**4.7**	**3.5**	**3.8**

Table 2
Analytical Results for Sediment Samples

				River Beach Location 1				River Beach Location 2			
Analyte	**Units**	**Threshold Effect Concentration (TEC)**	**Probable Effect Concentration (PEC)**	**Spring 2016**	**Fall 2016**	**Spring 2017**	**Spring 2018**	**Spring 2016**	**Fall 2016**	**Spring 2017**	**Spring 2018**
Copper	mg/kg	31.6	149	**21**	**1.8**	**2.3**	**1.8**	**1.6**	**1.1**	**0.93**	**1.2**
Lead	mg/kg	35.8	128	**32**	**1.5**	**5.1**	**3.7**	**2**	**1.6**	**1.6**	**1.7**
Mercury	mg/kg	0.18	1.06	**0.08**	0.019 U	0.041 U	0.025 U	**0.0042 J**	0.02 U	0.02 U	0.022 U
Nickel	mg/kg	22.7	48.6	**33**	**3.1**	**4.1**	**2.7**	**1.4**	**1.1**	**1.2**	**1.4**
Selenium	mg/kg	--	--	**1.6**	**0.5**	**0.25 J**	**0.087 J**	**0.091 J**	**0.19 J**	**0.12 J**	**0.07 J**
Silver	mg/kg	--	--	**0.25**	**0.008 J**	0.12 U	**0.038 J**	**0.0053 J**	**0.008 J**	0.063 U	0.071 U
Thallium	mg/kg	--	--	**0.15**	**0.0049 J**	**0.012 J**	**0.018 J**	**0.0063 J**	**0.0036 J**	**0.0036 J**	0.071 U
Zinc	mg/kg	121	459	**120**	**13**	**19**	**9.7**	**5.1**	**5.2**	**5.1**	**5.1**

Notes:

Bold indicates detected constituents.

--: no value

J: estimated value; result is less than the reporting limit but greater than the method detection limit

mg/kg: milligram per kilogram

U: compound not detected

Table 3
Analytical Results for Surface Water Samples

				River Beach Location 1				River Beach Location 2			
Analyte	**Unit**	**Acute**	**Chronic**	**Spring 2016**	**Fall 2016**	**Spring 2017**	**Spring 2018**	**Spring 2016**	**Fall 2016**	**Spring 2017**	**Spring 2018**
Hardness	mg/L	--	--	**86**	**880**	**72**	**86**	**86**	**940**	**70**	**86**
Total Phosphorus	mg/L	--	--	**0.049 J**	**0.14**	0.1 U	**0.11**	0.1 U	**0.1**	**0.037 J**	0.1 U
Total Suspended Solids	mg/L	--	--	**11**	**40**	**8.9**	**39**	**8.4**	**22**	**7.1**	**29**
Ammonia	mg/L	--	--	**0.2**	**0.21**	**0.18**	**0.38**	**0.15**	**0.16**	**0.16**	**0.21**
Total Kjeldahl Nitrogen	mg/L	--	--	5 U	**2.2 J**	**11**	**1.7 J**	5 U	**2.2 J**	**3.4 J**	5 U
Nitrate	mg/L	--	--	**0.85**	**0.41**	**0.66**	**0.69**	**0.83**	**0.25**	**0.65**	**0.95**
Metals											
Aluminum	µg/L	750	87	**19 J**	**33**	30 U	**190**	**16**	**48**	**16 J**	**22 J**
Antimony	µg/L	--	--	**0.27 J**	**0.61 J**	**1.5 J**	2 U	**0.26 J**	**0.93 J**	**0.98 J**	2 U
Arsenic	µg/L	340	150	**0.83 J**	**0.77 J**	**0.34 J**	**1.4**	**0.77 J**	**1.3**	**0.41 J**	**1.2**
Beryllium	µg/L	--	--	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Cadmium[a]	µg/L	1.6	0.64	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chromium[a]	µg/L	503	65.5	**1.3 J**	**0.39 J**	2 U	**2.2**	**1.2 J**	**0.55 J**	2 U	**1.9 J**
Copper[a]	µg/L	12	7.9	**1.2 J**	**1.9 J**	2 U	**2**	**1.3 J**	**2.4**	2 U	**1.7 J**
Iron	µg/L	--	1,000	**31 J**	**88**	50 U	**460**	**28 J**	**51**	**23 J**	**37 J**
Lead[a]	µg/L	55	2.13	1 U	**0.25 J**	1 U	**0.38 J**	1 U	**0.35 J**	1 U	1 U
Manganese	µg/L	--	--	**3.9 J**	**810**	5 U	**260**	**4 J**	**43**	**3.2 J**	**5.4**
Mercury	µg/L	1.40	0.77	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Nickel[a]	µg/L	412	46	**1.2**	**4.6**	**1**	**3.5**	**1.2**	**2.6**	**0.69 J**	**1.6**
Selenium	µg/L	20	5	5 U	**0.57 J**	5 U	5 U	5 U	**0.96 J**	5 U	5 U
Silver[a]	µg/L	2.48	--	1 U	1 U	1 U	1 U	1 U	**0.3 J**	1 U	1 U
Thallium	µg/L	--	--	1 U	1 U	**0.054 J**	1 U	1 U	1 U	1 U	1 U
Zinc[a]	µg/L	103	104	**4.2 J**	**4.2 J**	5 U	**3.9 J**	**3.4 J**	**3.5 J**	5 U	5 U

Notes:

a. Acute and chronic water quality criteria are adjusted for a hardness of 86 mg/L.

Bold indicates detected constituents.

[shaded box]: constituents that exceed chronic criteria

--: no value

µg/L: microgram per liter

J: estimated value; result is less than the reporting limit but greater than the method detection limit

mg/L: milligram per liter

U: compound not detected

Table 4

Mean Abundance of Benthic Macroinvertebrates

	River Beach Location 1				River Beach Location 2			
Species	**Spring 2016**	**Fall 2016**	**Spring 2017**	**Spring 2018**	**Spring 2016**	**Fall 2016**	**Spring 2017**	**Spring 2018**
Ameroculodes spp.	0	0	0	0	25	0	0	0
Anthuridae spp.	0	38	0	0	0	0	0	0
Apocorophium lacustre	178	108	6	0	0	229	114	89
Boccardiella ligerica	0	6	0	0	0	13	0	0
Chaoborus punctipennis	0	0	6	0	0	0	0	0
Chirodotea almyra	0	0	13	19	19	0	0	0
Chironomidae	0	0	0	445	0	0	0	477
Chironomini	0	0	0	0	0	0	0	13
Chironomus spp.	0	0	25	89	13	0	25	19
Cladotanytarsus spp.	0	0	**915**	426	70	0	**1,068**	1,074
Coelotanypus spp.	32	0	0	0	64	6	0	0
Corbicula fluminea	210	32	229	191	267	375	477	909
Cricotopus spp.	0	13	0	0	0	13	6	0
Cryptochironomus spp.	13	13	6	6	19	0	0	6
Cyathura polita	13	534	191	121	32	782	292	114
Dicrotendipes spp.	6	0	0	13	0	0	0	19
Ilyodrilus templetoni	0	0	267	0	0	0	0	0
Leptocheirus plumulosus	127	0	0	13	6	0	0	0
Limnodrilus hoffmeisteri	83	0	0	6	64	0	0	280
Marenzelleria viridis	0	0	64	369	292	114	254	197
Microtendipes spp.	0	0	0	0	6	0	0	0
Naididae spp.	0	6	0	6	0	0	0	0
Orthocladiinae spp.	0	19	0	0	0	0	0	0
Paratanytarsus sp.	0	0	0	32	0	0	0	0
Penaeidea spp.	0	6	0	0	0	0	0	0
Polydora cornuta	0	13	0	0	0	25	0	0
Polypedilum spp.	13	0	0	6	64	0	0	25
Procladius spp.	44	0	0	70	0	0	0	64
Rangia cuneata	483	0	57	70	0	57	13	0

Table 4
Mean Abundance of Benthic Macroinvertebrates

	River Beach Location 1				River Beach Location 2			
Species	**Spring 2016**	**Fall 2016**	**Spring 2017**	**Spring 2018**	**Spring 2016**	**Fall 2016**	**Spring 2017**	**Spring 2018**
Rheotanytarsus spp.	0	108	0	0	0	0	0	0
Rhithropanopeus harrisii	0	44	0	0	0	6	0	0
Saetheria spp.	6	0	0	0	0	0	0	0
Streblospio benedicti	0	**667**	0	0	0	559	0	0
Tanypus spp.	0	0	0	0	0	0	6	0
Tanytarsini	0	0	0	0	0	0	0	25
Tubificidae with capilliform	0	0	0	**966**	**706**	6	305	**2,244**
Tubificidae without capilliform	**642**	57	470	610	686	**1,328**	420	1,468

Note:
Bold values represent the dominant species at each location.

Table 5
Benthic Community Counts

	River Beach Location 1			River Beach Location 2		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Species	**RB-01A**	**RB-01B**	**RB-01C**	**RB-02A**	**RB-02B**	**RB-02C**
Apocorophium lacustre	0	0	0	4	3	7
Chirodotea almyra	2	1	0	0	0	0
Chironomidae	21	23	26	5	24	46
Chironomini	0	0	0	2	0	0
Chironomus sp.	2	9	3	2	1	0
Cladotanytarsus sp.	30	22	15	25	71	73
Corbicula fluminea	8	9	13	28	53	62
Cryptochironomus sp.	1	0	0	0	0	1
Cyathura polita	6	4	9	5	9	4
Dicrotendipes sp.	0	1	1	0	1	2
Leptocheirus plumulosus	0	1	1	0	0	0
Limnodrilus hoffmeisteri	0	1	0	7	31	6
Marenzelleria viridis	14	19	25	11	11	9
Naididae	0	1	0	0	0	0
Paratanytarsus sp.	0	5	0	0	0	0
Polypedilum sp.	0	1	0	0	2	2
Procladius sp.	2	5	4	3	4	3
Rangia cuneata	4	5	2	0	0	0
Tanytarsini	2	0	6	4	0	0
Tubificidae with capilliform setae	56	75	21	225	68	60
Tubificidae without capilliform setae	22	43	31	97	69	65

Table 6
Benthic Community Metrics

	River Beach Location 1				River Beach Location 2			
Metric	**Spring 2016**	**Fall 2016**	**Spring 2017**	**Spring 2018**	**Spring 2016**	**Fall 2016**	**Spring 2017**	**Spring 2018**
Total Abundance/m^2	1,907	1,773	2,250	3,509	2,333	3,502	2,981	7,024
Infaunal Taxa	14	15	12	16	15	12	11	12
Species Richness (Ludwig-Reynolds)	2.6	3.1	2.3	2.9	2.5	2.1	2.0	1.9
Evenness	0.739	0.67	0.689	0.778	0.732	0.68	0.760	0.769
Shannon-Wiener H' (log base 2)	2.7	2.6	2.5	3.1	2.7	2.4	2.6	2.8
Simpson's Dominance Index	0.21	0.25	0.24	0.15	0.21	0.24	0.20	0.19
Percent Abundance Pollution Indicative Species	38	43	21	18	32	66	14	3
Percent Abundance Deep Deposit Feeders	38	0	33	45	62	0	24	57
Tolerance Score	5.05	1.30	5.6	5.8	8.04	4.52	4.8	7.0

Note:

m^2: square meter

Table 7

Summary of Test Acceptability Endpoints for Whole Sediment Acute Bioassay for *Hyalella azteca*

			River Beach Location 1			
Endpoint/Measurement	**Protocol Criteria**	**Units**	**Spring 2016**	**Fall 2016**	**Spring 2017**	**Spring 2018**
Survival	Mean Laboratory Control	Mean Survival %	94%	94%	94%	91%
	≥ 80%	Protocol Met	Yes	Yes	Yes	Yes
Growth	Measure Positive Growth	Start Dry Weight (mg)	0.024	0.017	0.018	0.008
	End vs. Start of Assay	End Dry Weight (mg)	0.143	0.124	0.147	0.659
	Protocol Met		Yes	Yes	Yes	Yes
Temperature	Mean: 23 °C ± 1 °C	Daily/Hourly	22.8 / 22.8	21.3 / 21.6	23.3 / 23.4	22.0 / 21.9
	Minimum: 20 °C	Daily/Hourly	22.1 / 21.7	20.2 / 20.1	22.9 / 22.9	20.9 / 20.9
	Maximum: 26 °C	Daily/Hourly	23.4 / 23.4	22.4 / 22.5	23.6 / 23.9	22.5 / 23.2
	Protocol Met		Yes / Yes	No / Yes	Yes / Yes	Yes / Yes

Note:

mg: milligram