

Barton Creek Sediment Toxicity Evaluation to Aquatic Life July 29, 2004

Background

As a follow-up to the sediment toxicity assessment of Barton Springs Pool conducted in February 2003 to address concerns of elevated concentrations of polycyclic aromatic hydrocarbons (PAHs) found in the watershed, TCEQ collected ten sediment samples from five areas in Barton Creek in June 2003. These samples were submitted to the same toxicity testing laboratory that conducted the pool tests. Unfortunately, due to a malfunctioning water bath, the water temperature in some of the testing vessels exceeded the test protocols. Although a draft report of the testing results was prepared by the laboratory, TCEQ rejected the report and the results because of the temperature protocol violations. This action was supported by conversations staff had earlier with toxicity testing experts at EPA and the U.S. Geological Survey who said that elevated water temperatures could stress the test organisms and result in growth and survival effects. Because of low flow conditions in the creek, TCEQ was unable to collect additional sediment samples until May 2004. The collection of these samples along with the analytical and toxicological testing results are discussed below.

Sample Collection and Analyses

On May 4 and 6, 2004, ten composite sediment samples were collected from Barton Creek (Figure1) by staff from the TCEQ and City of Austin. The samples were cold-stored at the Lower Colorado River Authority (LCRA) laboratory which analyzed subsamples of each of the ten composites for physico-chemical parameters including: grain size, texture, total organic carbon, metals, pesticides, polychlorinated biphenyls (PCBs), and semivolatile organics. These types of analyses are usually conducted in conjunction with the toxicity tests and may help explain any impacts to aquatic life observed in the toxicity tests. On May 10, 2004 the ten composite samples were shipped to Aqua Survey Inc. in Flemington, New Jersey for toxicity testing using standard EPA and American Society for Testing and Materials (ASTM) protocols. These protocols included the 10-day exposure of the amphipod, *Hyalella azteca*, and the larvae of the midge, *Chironomus tentans*, to the sediment samples. Both lethal (i.e., survival) and sublethal (i.e., growth - indicated by weight) endpoints were measured.

Data Assessment

Unlike surface water, numerical standards have not been adopted for contaminants in sediment. Therefore, TCEQ relies on a variety of sediment screening levels to evaluate concentrations of contaminants that may be of concern. As described below, sediment screening levels used include those developed by the National Oceanic and Atmospheric Administration (NOAA), those from TCEQ's Surface Water Quality Monitoring (SWQM) Program, and those from TCEQ's Ecological Risk Assessment (ERA) Program.

NOAA's probable effects levels (PELs) are used to identify specific compounds that are likely to

be elevated to toxic concentrations. PELs are based on benthic invertebrate community characteristics and toxicity tests. The PEL is the geometric average of the 50th percentile of impacted, toxic samples and the 85th percentile of non-impacted samples and is the level above which adverse biological effects are frequently expected.

The SWQM sediment screening levels are derived from long-term data collected statewide from freshwater streams, reservoirs, tidally influenced streams, and estuaries. The 85th percentile values for each parameter in the four different water body types are not based on toxicity but are used as comparative screening levels for sediment contaminant concentrations in state waters. These values are updated every two years.

The ERA benchmarks are derived from a compendium of screening levels and are based on a consensus generally agreed upon by a multi-stakeholder ecological workgroup. These screening levels include threshold effect concentrations (TEC) and probable effect concentrations (PEC) and are intended to be protective of benthic communities. TECs and PECs represent the geometric means of groups of similarly-based sediment quality guidelines. TECs identify contaminant concentrations below which harmful effects on sediment-dwelling organisms are unlikely to be observed. PECs identify contaminant concentrations above which harmful effects on sediment-dwelling organisms are likely to be observed. The ERA program also uses a midpoint between the TEC and PEC as a protective concentration level (PCL) for benthic invertebrates for non-bioaccumulative compounds. For purposes of this study, the sediment screening benchmarks from the ERA Program are used when neither a PEL nor an 85th percentile value are available for a particular contaminant or a class of contaminants.

Physico-chemical Results

Grain size/texture:

- All percent composition results fell into the following ranges:
Clay: 10.1 - 23.9%
Silt: 14.0 - 50.5%
Sand: 31.2 - 58.9%
Gravel: 0.66 - 25.0%

Total organic carbon:

- Sample results were as expected and ranged from 59300 mg/kg at BC-06 to 101,000 mg/kg at BC-09.

Metals:

- None of the samples exceeded the PEL concentrations for any metal. There was a slight exceedance of the silver 85th percentile value of 0.52 mg/kg for Texas freshwater streams at BC-01 with an estimated (J flag) concentration of 0.60.

Chlorinated Pesticides/Benzenes:

- None of the samples exceeded the PEL concentrations for any chlorinated

pesticide/benzene. The beta-BHC concentrations of 72.0 and 65.3 ug/kg at BC-02 and BC-09, respectively, did exceed the 85th percentile value of 6.1 ug/kg. Also, the hexachlorobenzene concentration of 902 ug/kg (BC-8) exceeded the 85th percentile value of 473.55 ug/kg. The only other pesticide detected in any of the samples was DDE at 4.17 ug/kg (BC-07) but this was below the 85th percentile value of 13.35 ug/kg.

PCBs:

- No PCBs were detected in any of the samples.

Semivolatile organics:

- The benzo(a)anthracene concentrations of 400, 594, and 387 ug/kg at BC-02, BC-03, and BC-04, respectively, exceeded the PEL of 385 ug/kg.
- The fluoranthene concentration of 2890 ug/kg (BC-02) exceeded the PEL of 2355 ug/kg.
- The pyrene concentrations of 1900 (BC-02) and 1375 ug/kg (BC-03) exceeded the PEL of 875 ug/kg.
- The benzo(a)pyrene concentration of 854 ug/kg (BC-03) exceeded the PEL of 782 ug/kg.
- The chrysene concentration of 1080 ug/kg (BC-03) exceeded the PEL of 862 ug/kg.
- Concentrations of benzo(b)fluoranthene at 949 (BC-02), 1470 (BC-03), and 937 ug/kg (BC-04) exceeded the 85th percentile of Texas freshwater streams of 750 ug/kg.
- The concentration of benzo(g,h,i)perylene at 823 ug/kg (BC-03) exceeded the 85th percentile of 862 ug/kg.
- The total PAH concentrations of 4916 (BC-01), 9110 (BC-02), 9483 (BC-03), 5726 (BC-04), 2429.8 (BC-07), and 2282.6 ug/kg (BC-08) exceeded the TEC of 1610 ug/kg but were well under the PEC of 22800 ug/kg and the PCL (midpoint) of 12205 ug/kg all used in TCEQ's ERA program.

Toxicity Testing Results

Chironomus tentans:

- Control organism survival was 93 %, which is above the survival percentage for an acceptable test.
- Statistical analysis run on the percent survival of organisms in the samples compared to the control indicated that none were statistically significantly lower than the control.
- Statistical analysis run on the ash-free dry weight of the organisms in the samples compared to the control indicated that one sample (BC-04) was statistically significantly lower than the control with respect to growth.

Hyalella azteca:

- Control organism survival was 95%, which is above the survival percentage for an acceptable test.
- Statistical analysis run on the percent survival of organisms in the samples compared to that of the control indicated that none were statistically significantly lower than the control.
- Statistical analysis run on the dry weight of the organisms in the samples compared to

that of the control indicated that one sample (BC-07) was statistically lower than the control with respect to growth.

Discussion

Physico-chemical analyses:

With few exceptions, the results of the physico-chemical analyses of Barton Creek sediment indicate that the quality of the creek is better than that expected from typical water bodies in urbanized areas. None of the metal concentrations exceeded their respective PELs and therefore it is unlikely that metals caused the observed sublethal toxicity.

The use of DDE is prohibited by EPA and is no longer produced in the U.S. The single detected concentration of 4.17 ug/kg (BC-07) is likely from historical use and its presence can be explained by the persistence of chlorinated pesticides. Although this concentration is below the 85th percentile, it is slightly above the TEC of 3.16 ug/kg used in the ERA program, but still well below the PEC of 31.3 ug/kg. There is a slight possibility that this concentration of DDE could have caused the sublethal effects to *Hyaella* observed from this sample. Other chlorinated compounds were detected at BC-02, BC-08, and BC-09; however, no toxicity of any kind was observed at these locations.

Concentrations of individual PAHs exceeded PELs and 85th percentiles at BC-02, BC-03, and BC-04. These locations are immediately below (BC-02) and above (BC-03, BC-04) the Barton Springs Pool. Of these locations, only sublethal effects to the chironomid at BC-04 were observed. However, the concentrations of benzo(a)anthracene and benzo(b)fluoranthene detected at BC-04 were less than those detected at BC-02 and BC-03 where no toxicity was observed. Also, since none of the samples exceeded the recommended PCL value of 12205 ug/kg total PAH, it is unlikely that PAHs caused the sublethal effects to *Chironomus*.

Toxicity tests:

There were no lethal effects observed to either species of test organisms compared to their respective controls. There were sublethal effects observed for the growth of *Chironomus tentans* and *Hyaella azteca* compared to the controls at BC-04 and BC-07, respectively. In a review of ambient toxicity testing methods, Palachek et al. (2002) recommended that, because of a lack of data, sublethal effects should not be used to assess attainment of aquatic life uses and subsequent decisions regarding placement on the 303(d) list. This recommendation is supported by a statement in EPA's freshwater sediment toxicity testing manual (U.S. EPA, 2000) indicating that additional studies are needed to more thoroughly evaluate the relative sensitivity between lethal and sublethal endpoints. The debate over the use and reliability of sublethal data is currently being discussed by the SWQM Guidance Advisory Work Group. However, even if sublethal data were used to assess use attainment in the creek, the reported toxicity does not exceed the 10% criterion cap for determining if a water body is fully supporting its aquatic life uses. The physico-chemical analyses support the lack of mortality observed in the test organisms but, with the possible exception of DDE at BC-07, there is no apparent correlation between these analyses and the recorded sublethal effects. Neither is there any obvious correlation between the toxicity

testing results and the overlying test water conditions (including DO, pH, temperature, and total ammonia) recorded during these laboratory tests.

Conclusions and Recommendations

- Although growth effects to both test species were observed, these observations were at single and different locations. The 10% occurrence of these growth effects combined with the lack of good correlation with the physico-chemical data suggests that the aquatic life uses in Barton Creek are not impaired by sediment toxicity.
- Barton Creek should not be placed on the State's 303(d) list for ambient sediment toxicity at this time, but the growth effects observed in the toxicity tests do warrant continued contaminant monitoring and toxicity testing.
- Sediment samples from Barton Creek should be collected, analyzed, and submitted for toxicity testing on a routine basis.
- Sediment data should be collected routinely from Barton Creek (and Barton Springs Pool) to help evaluate the effectiveness of control measures implemented by the City of Austin to address sources of toxic contaminants.

References

Palachek, R., A. Sullivan, and S. Manning. 2002. Recommended assessment protocols for use with ambient toxicity tests in the 305(b) reporting and 303(d) listing process. National TMDL Science and Policy Water Environment Federation Specialty Conference. Phoenix, Arizona. November.

U.S. Environmental Protection Agency. 2000. Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates. Second Edition. EPA/600/R-99/064. March.

Figure 1. Barton Creek Sediment Sampling Sites

