Barton Springs Pool Sediment Toxicity Evaluation to Aquatic Life
May 28, 2003

Background

Over the last few months, the public has expressed concern over City of Austin sampling data that found environmental contaminants in Barton Springs Pool and Barton Creek. These concerns prompted the TCEQ to conduct soil, sediment, and water sampling in the area and prompted the City to close the pool during the investigations. TCEQ sampling results indicated elevated levels of polycyclic aromatic hydrocarbons (PAHs) in sediment and soil samples. The pool remained closed for ninety days while the TCEQ, the Texas Department of Health (TDH), the Environmental Protection Agency (EPA), and other experts evaluated all of the data for potential human health effects. On March 27, 2003 a joint panel of experts from TDH, EPA, and TCEQ announced in a public meeting that the pool was safe for swimmers. Pursuing further investigation, the TCEQ, in consultation with EPA, conducted sediment toxicity tests in Barton Springs Pool. The purposes of these tests, which were funded by EPA, were:

, to assess pollutant levels to determine the potential impacts to aquatic life in the pool,
, to determine the need to reduce pollutant inputs,
, to determine if the pool should be placed on the State's 303(d) list of impaired water bodies scheduled for cleanup, and
, to determine the need for future monitoring.

TCEQ will soon initiate similar tests for Barton Creek sediment.

Sample Collection and Analyses

On February 15, 18, and 19, 2003, ten composite sediment samples were collected from Barton Springs Pool (Figure 1) 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 February 26, 2003 the ten composite samples were submitted through the EPA to Aqua Survey Inc.[1] 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 sediment samples to the amphipod, *Hyalella azteca*, and the larvae of the midge, *Chironomus tentans*. Both lethal (i.e., survival) and sublethal (i.e., growth - indicated by weight) endpoints were measured.

[1]Aqua Survey is under contract to the EPA Emergency Response Team.

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 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. 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.

Physico-chemical Results

Grain size/texture:

- All percent composition results were within the expected ranges.

Total organic carbon:

- All sample results were within the expected ranges.

Metals:

- None of the samples exceeded the PEL concentrations for any metal, with one exception. The copper concentration of 712 mg/kg (BSP-2, near the diving board) exceeded the PEL of 197 mg/kg.

Pesticides:

- None of the samples exceeded the PEL concentrations for any pesticide, with one exception. The dieldrin concentration of 17.4 ug/kg (BSP-6) exceeded the PEL of 6.67 ug/kg. The only other pesticide detected in any of the samples was DDE at a concentration of 8.13 ug/kg (BSP-8), but this was below the 85th percentile value of 13.35 ug/kg for Texas freshwater streams.

PCBs:

- None of the samples exceeded the 85th percentile of Texas freshwater streams for aroclors, with one exception. The Aroclor 1260 concentration of 250 ug/kg (BSP-6) exceeded the 85th percentile concentration of 33.2 ug/kg; however, this concentration is below the PEL for total PCBs of 277 ug/kg and there were no other aroclors detected in this or any other sample.

Semivolatile organics:

- The benzo(a)anthracene concentration of 439 ug/kg (BSP-8) exceeded the PEL of 385 ug/kg.
- The pyrene concentration of 934 ug/kg (BSP-8) exceeded the PEL of 875 ug/kg.
- The total PAH concentrations of 4.08 (BSP-4), 5.12 (BSP-5), 1.85 (BSP-6), 5.15 (BSP-7), and 6.16 mg/kg (BSP-8) exceeded the threshold effects concentration (TEC) of 1.60 mg/kg but were well under the PEC of 22.80 mg/kg used in TCEQ's ERA program.
- Concentrations of benzo(b)fluoranthene at 866 (BSP-5), 862 (BSP-7), and 1150 ug/kg (BSP-8) exceeded the 85th percentile of Texas freshwater streams of 750 ug/kg.

Toxicity Testing Results

Chironomus tentans:

- Control organism survival was 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 different from the control.
- Statistical analysis run on the ash-free dry weight of the organisms in the samples compared to the control indicated that none were statistically significantly different from the control with respect to growth.

Hyalella azteca:

- Control organism survival was 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 different from the control.

- Statistical analysis run on the dry weight of the organisms in the samples compared to that of the control indicated that eight of the ten samples (all but BSP-10 and 11) were 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 Springs Pool sediment (combined with the water column data from previous sampling) indicate that the quality of the pool is better than that expected from typical water bodies in urbanized areas. The single elevated copper concentration was found in a sample located in the upper end of the pool near the diving board where, historically, the bedrock and boulders were painted with copper sulfate to minimize algal growth. However, given the suspected chelated form of this copper, it is unlikely to be bioavailable and would therefore not account for the sublethal effects to *Hyalella* observed at this location.

The use of dieldrin has been prohibited by EPA since 1974 and is no longer produced in the U.S. The single elevated concentration is likely from historical use and its presence can be explained by the persistence of chlorinated pesticides. This concentration of dieldrin could cause the sublethal effects to *Hyalella* observed from this sample; however, no other concentrations of dieldrin were detected.

Of the multiple aroclor analyses, the only detected concentration was that of Aroclor 1260 at BSP-6. This single concentration is insufficient to explain the sublethal effects to *Hyalella* from this sample.

Regarding PAHs, TCEQ's ecological risk assessment guidance document (TNRCC, 2001) recommends that because of the additive toxicity of PAHs, they should be evaluated individually, by low and high molecular weight classes (for marine sediments), and by totals whenever corresponding sediment quality guideline numbers are listed in the guidance. However, recent studies indicate that because PAHs are nearly always found in the environment as mixtures, they should be evaluated as such. TCEQ's multi-stakeholder ecological workgroup is currently evaluating the scientific literature to determine appropriate screening levels for total PAHs. In the interim, a total PAH number of 12.2 mg/kg has been recommended for the protection of benthic invertebrates in freshwater sediments. This number is a midpoint between the threshold effect concentration (TEC) of 1.6 mg/kg listed in MacDonald et al. (2000) and the probable effect concentration (PEC) of 22.8 mg/kg listed in Ingersoll et al. (2000). These two authors and their associates have been collaborating recently on developing consensus-based sediment quality guidelines and their efforts will likely be the primary sources from which the workgroup will update the benchmark tables in the ERA guidance document. Since none of the samples exceeded the recommended value of 12.2 mg/kg total PAH, and because some samples contained lower concentrations of total PAHs than the two samples that were not different from the control, it is unlikely that PAHs caused the sublethal effects to *Hyalella*.

Toxicity tests:

There were no lethal effects observed to either species of test organisms compared to their respective controls. There were also no sublethal effects observed for the growth of *Chironomus tentans* compared to the control. Sublethal effects were observed for *Hyalella azteca* in all samples except BSP-10 and 11 when compared to the control. However, 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. Furthermore, the physico-chemical analyses support the lack of mortality observed in the test organisms, but 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.

Recommendations

- Although growth effects to one (i.e., *Hyalella*) of two test species were observed, based on discussions with EPA about the lack of mortality in either test organism, the lack of growth effects to the other test organism (i.e., *Chironomus*), and the lack of correlation between the physico-chemical data and the *Hyalella* growth effects, the evidence suggests that the aquatic life use in Barton Springs Pool is not impaired by sediment toxicity.
- The pool should not be placed on the State's 303(d) list for ambient sediment toxicity but the growth effects observed in the tests with *Hyalella* do warrant continued contaminant monitoring and toxicity testing.
- Entire pool composite sediment samples should be collected, analyzed, and submitted for toxicity testing on a routine basis and could be scheduled to coincide with pool closure for cleaning purposes which would facilitate sample collection.
- The pool sediment results indicate the need to implement mechanisms to reduce pollutant inputs to Barton Springs and Barton Creek.
- These pool sediment results should be compared to those obtained from Barton Creek sediment in an upcoming TCEQ creek study.

References

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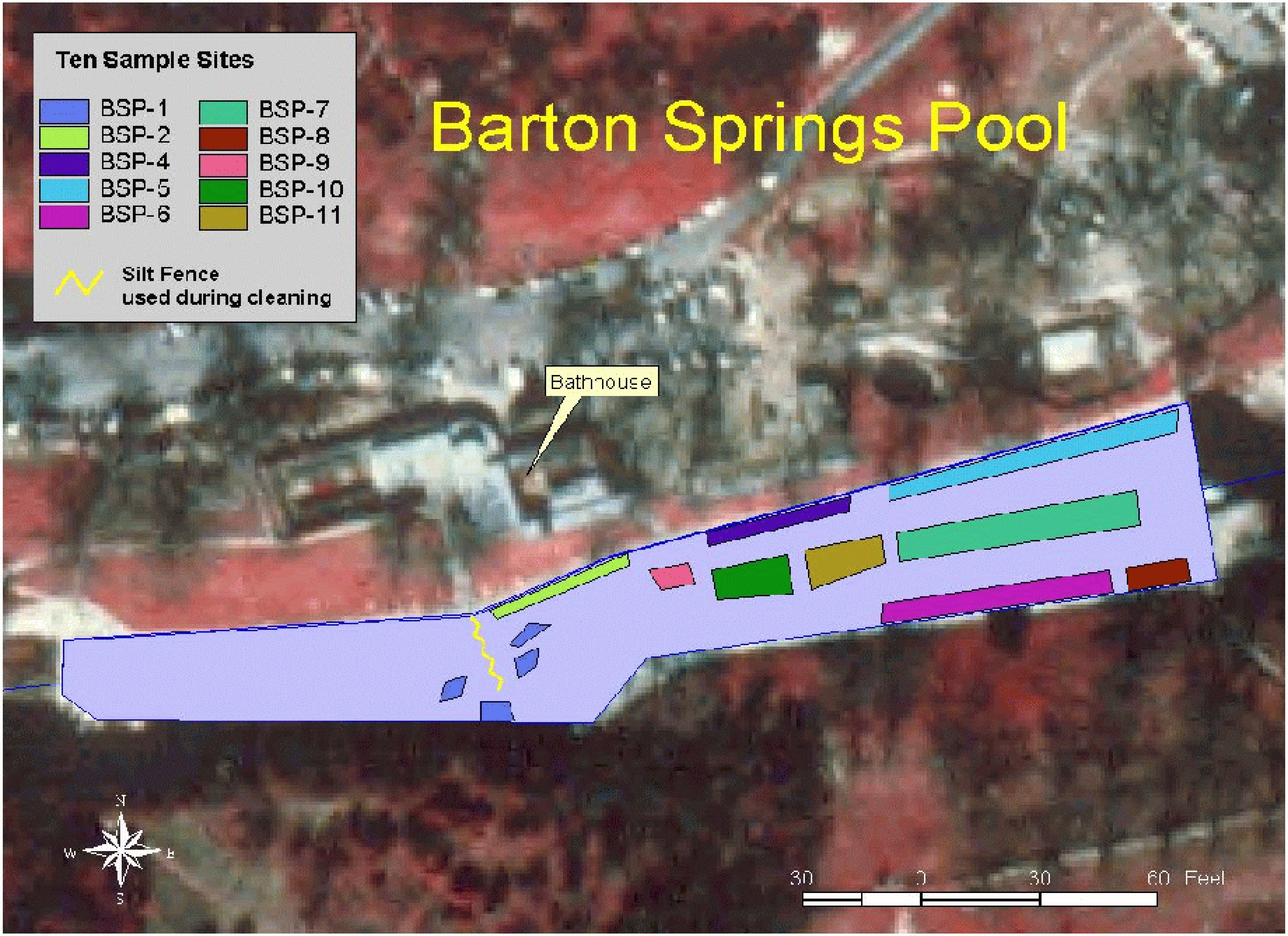

Figure 1. Barton Springs Pool Sediment Sampling Locations