

Phase I System Characterization: Year Two Findings and Phase II Direction

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Introduction

This briefing paper provides a summary of the results of Phase I, Year two studies conducted during 2008 and outlines activities planned for 2009. Data collection activities are based on the overall project objectives for the ecological study as well as information acquired from ongoing and historic studies, such as those conducted by the South River Science Team. The 2009 studies will begin Phase II of the ecological study, the goal of which is to assess impacts to the environment.

Year Two Studies

Year two studies focused on refining the study area and providing additional data to characterize the potential sources of mercury and methylmercury in the South River. The emphasis for year two included geospatial analysis of the geomorphic, hydrologic, and loading data collected in year one. These activities are discussed briefly in the following sections, they include:

- Targeted storm loading study for the upper 10 miles of the South River (RRM 0 to 10)
- Identification and characterization of a reference area(s) on the Middle River
- Characterization of fine-grained sediment deposits and floodplain soils
- Integrated MeHg studies
- Development of a short-term mercury budget for a targeted area along the South River

Targeted Loading Study

A targeted loading study was developed for the upper 10 miles of the South River study area (RRM 0 to 10) based on data collected during various studies including river geomorphology, characterization of sources (historic sediment and floodplain soils sampling), and year one loading studies. The sampling plan included data collections for tributaries, direct floodplain runoff points, and bridge crossings on the mainstem river between RRM 0 and 10. It was designed to evaluate total mercury loading during the rising discharge and total and methylmercury loading over seven days during the falling discharges (post-storm runoff) at targeted bridges and various points within the floodplain.

Two separate storm events were sampled including a rising limb storm in October 2007 and a falling limb storm in April/May 2008. The conclusions are briefly summarized below.

Data Findings for the October 2007 Storm Event:

- October storm sampling provided THg loading estimates for first flush conditions in tributaries following prolonged dry period; though flow conditions were lower than prior storm sampling events
- Data collected indicated measurable differences between THg loading estimates at bridge and confluence locations on tributaries
- Tributaries and floodplain features accounted for minor percentage of THg loading to the South River (<3% contribution of total load)

Data Findings for the April/May 2008 Storm Event:

- April/May falling limb storm sampling provided MeHg and THg loading estimates for post-storm conditions in tributaries/floodplain
- Tributaries and floodplain features accounted for minor percentage of total MeHg and THg loads to the South River
- Tributaries contribute MeHg and THg loads to South River generally at several orders of magnitude below mainstem loads
- Among tributaries and floodplain features, Steele Run generally shows the highest loading rates; data is consistent with floodplain soils findings for oxbow area
- Overall, tributaries and floodplain features accounted for minor percentage of total MeHg loads (<2%) to the South River suggesting this pathway is of secondary importance for input of MeHg

Reference Area Development for the Middle River

Potential reference areas on the Middle River were evaluated in October 2007, in accordance with the recommendations provided in the Phase I Year 1 Report. River habitats were characterized at two locations along with mercury in sediment, surface water and crayfish tissue. Mercury concentrations in media at these stations were comparable to the reference locations on the South and North Rivers.

Source Characterization

Year two investigations focused on characterizing the floodplain and depositional features. An evaluation of floodplain soils with various land uses (including wetlands) and river channel banks were conducted with VADEQ and the greater South River Science Team. The floodplain soils results are discussed in other briefing documents. Fifteen additional FGCM deposits were selected for additional characterization in October 2007. Core depth ranged from 30 cm to 75 cm; samples were collected at 5 cm intervals and analyzed for THg and grain size. One surface (0 to 5 cm) sample was analyzed for MeHg. The results of the study include:

- Eleven (11) of 15 cores have THg concentrations below 25 ug/g with occasional peaks between 50 ug/g and 100 ug/g
- Three cores with peak concentrations between 100 ug/g and 300 ug/g; one core with peak concentrations <880 ug/g

- MeHg concentrations in the surficial interval of each core were similar to other baseline monitoring locations in the river co-sampled in October 2007 (conc. ranged from 9-98 ng/g)

Integrated MeHg Studies

The goal of the integrated MeHg study is to begin to understand what habitat types are important sources of MeHg, what metabolic pathways are important for MeHg production, and how IHg bioavailability differs among sources. The MeHg study is comprised of four main components lead by various SRST members (in parentheses):

- Revised baseline monitoring of surface water and sediment (URS)
- BFC sampling (DuPont, URS)
- Mercury methylation and bioavailability study (Rutgers University)
- Tributary and floodplain loading study (URS)

The integrated MeHg study includes baseline sediment monitoring at five South River habitat types. The area on the South River were monitored for MeHg concentration and ancillary parameters on a bimonthly basis from October 2007 to October 2008; the habitat types included were:

- Main channel pools with low and high embedded substrates
- FGCM deposits along the edges of pools
- Pools in island side channels and mill races
- Open water wetlands within the 0.3-yr floodplain

Samples were analyzed for MeHg, LOI, THg, acid volatile sulfide (AVS), and ferrous iron [Fe(II)] and ferric iron [Fe(III)]. The inclusion of AVS and Fe(II)/Fe(III) was intended to provide basic information about the presence of sulfate reducing bacteria or iron-reducing bacteria, respectively, which are important groups of mercury methylating bacteria. From the data collected thus far, we have concluded that:

- The MeHg concentrations in the varied habitat types had similar maximum MeHg concentrations as observed in previous studies during 2006 – 2007 (i.e. the monthly baseline study in Phase I)
- Low detection rates of AVS in all habitat types and high Fe(II):Fe(III) ratios indicate that iron reduction may be an important methylation pathway in the South River
- Areas in the floodplain with an overt wetland appearance may have low THg and MeHg concentrations and are not an important source of MeHg to the main channel

These sediment-sampling locations also serve as locations for BFC deployments, which will determine areas of high MeHg flux. Additional sediment samples are collected for methylation and bioavailability studies, including the measurement of radiotracer based mercury methylation potentials and 16S ribosomal RNA based microbial community structures. The BFC and methylation studies are ongoing and will be presented as separate studies to the expert panel.

Development of a Short-term Mercury Budget

Data sets from various studies were integrated to develop a short-term filter-passing inorganic mercury (FIHg) and methylmercury (FMeHg) mass balance for reaches between RRM -2.7 and RRM 9.9 along the South River. Studies included the surface water baseline monitoring program, BFC study, tributary and floodplain loading study, and other historic SRST data. Data from Spring 2008 sampling (during April/May) form the basis for the mercury budget. The following methods and data sets were used:

- Calculated discharge (Q) and measured IHg and MeHg concentrations at tributaries and bridges (May 2008) to determine load
- Calculated median concentrations from groundwater data set and combined result with discharge estimate to calculate groundwater contribution (RT Geosciences, EPA)
- Calculated median flux data from FGCM deposits and gravel beds data sets (from May and June 2008) and combined result with area estimates for in-river habitats within the reach
- Determined discharge (Q) and median IHg and MeHg concentration values or assigned values for select point sources (Invista, Waynesboro STP, Genicom outfall) based on data from NPDES permits or South River TMDL work

Results of Water Balance:

- Able to account for discharge increases from tributaries
- Solved for groundwater and estimated this source accounts for 33% of discharge in river
- Estimate for groundwater consistent with previously developed water budget monograph for South River (groundwater accounts for approximately 30-70%)

Results of FMeHg Budget:

- Can account for 64% of FMeHg
- Groundwater accounts for 1.1% of FMeHg load
- Flux from gravels the largest contributor (57%)
- Wetlands and millraces contribute <1%

Results of FIHg Budget:

- Account for 10% of FIHg
- Groundwater <1%
- Point sources accounted for the largest percentage (5.1%) in the analysis but this is still small by comparison to the mass unaccounted for in the budget
- Near bank inputs and porewater diffusion not estimated here; previous studies indicates this is a potentially important source of FIHg

Phase II Studies

The 2009 studies will begin Phase II of the ecological study. The scope of work is currently being developed with the Natural Resource Defense Council. The first step will

be to conduct a comprehensive data evaluation using the numerous data sets available in order to guide the development of Phase II studies and selection of potential study areas.

Several areas of focus will include:

- Develop a study to characterize near-bank loading processes and address potential gaps in short-term mercury budgets
- Confirm previous benthic flux chamber results for MeHg in various in-river habitats
- Develop a study to evaluate potential effects of mercury on the aquatic invertebrate community
- Continue to support other South River Science Team activities related to foodweb models and biological investigations