AOC 4 RFI Report: Technical Briefing Paper

This briefing paper summarizes the findings of the Resource Conservation and Recovery Act (RCRA) Facility Investigation Report (RFI Report) for the Area of Concern (AOC) 4. It provides an introduction, summary of results and investigations, and a description of the anticipated future course of action. The information reviewed and presented herein is not comprehensive; additional details are provided in the AOC 4 RFI Report (URS, 2014).

Introduction

The AOC 4 RFI Report documents the results of a number of investigative activities conducted to characterize the nature and extent of mercury in environmental media in an off-site portion (AOC 4) of the former E.I. du Pont de Nemours and Company (DuPont) Plant (the site), in Waynesboro, Virginia. It was prepared pursuant to a modification to permit VAD003114832, and issued to DuPont by the Commonwealth of Virginia, Department of Environment Quality (VDEQ) in February 2014 under the corrective action provision of RCRA.

References

- ✓ Anchor QEA, LLC and URS Corporation. 2013. Remediation Proposal South River and a Segment of the South Fork Shenandoah River, Virginia. October 2013.
- ✓ Anchor QEA, LLC and URS Corporation. 2014. Phase 1 Interim Measures Design, Implementation and Monitoring Work Plan. Area of Concern 4. Former DuPont Waynesboro Site.
- ✓ URS Corporation. 2012. Final Report: Ecological Study of the South River and a Segment of the South Fork Shenandoah River, Virginia. September 2012.
- ✓ URS Corporation. 2014. RCRA Facility Investigation (RFI) Report Former DuPont Waynesboro site, Area of Concern (AOC) 4, South River and a Segment of the South Fork Shenandoah River, Virginia. August 15, 2014. Submitted to VDEQ.
- ✓ VDEQ. 2009. Bacteria and Benthic Total Maximum Daily Load Development for South River. Prepared by Engineering Concepts, Inc. July.

The AOC 4 RFI Report relies on data provided in the Ecological Study Report (URS, 2012) and the Remediation Proposal (Anchor QEA and URS, 2013) to document the nature, extent, fate, and transport of mercury that has historically migrated from the site into the surface water, sediments, floodplain soils, and biota within AOC 4. Both the Ecological Study Report and the Remediation Proposal were prepared pursuant to the June 2005 Consent Decree (CD) among DuPont, the Natural Resources Defense Council (NRDC), and the Sierra Club (Virginia Chapter).

Summary of Results and Investigations

DuPont and others have extensively investigated the physical, chemical, and biological components of off-site portions of the South River, SFS River, and associated floodplain areas within AOC 4. The Ecological Study Report (URS, 2013) integrated the findings of various studies and concluded that the largest mercury sources are river banks, outfalls from the former Waynesboro facility, and sediment, and they primarily occur in the first 12 river miles. Another important finding was that concentrations of total mercury (THg) in the riverbanks of the South River downstream of relative river mile (RRM) 12 and the upper segment of the SFS River are generally low, but biota inhabiting these areas such as birds and fish, have elevated mercury concentrations. The following paragraphs summarize the chemical/mass balance, physical/geomorphological, and biological characteristics of AOC 4. Also provided is a summary of the Mercury Conceptual

System Model that was developed as a framework to better understand linkages in the aquatic and terrestrial systems. Detailed information can be found in the RFI or source documents cited above.

Chemical/Mass Balance Characteristics

The concentrations of mercury in various media within AOC 4 have been documented through various studies that have occurred over the past two decades. Key findings from the studies are summarized below.

- ***Floodplain Soils***: The concentrations of THg in floodplain soils decrease with increasing distance to the floodplain from the river and increasing distance downstream, but were highest in the two- and five-year floodplains and within forested areas. The majority (89%) of soil samples were below the human health screening level of 17 mg/kg.

- ***Bank Soils:*** A total of 207 river bank transects was sampled from RRM 0.1 to 23.5. The vertically averaged THg concentration in the river bank soils range from 1 to 140 mg/kg, and the maximum concentrations in discrete samples range from 3 to 515 mg/kg. Concentrations of THg vary spatially, but highest concentrations occur between RRM 0 and 11.6.

- ***Surface Water:*** Under baseline (or non-storm) conditions, the concentration of inorganic mercury (IHg) on particles in surface water generally increases immediately downstream of the outfall (at RRM 0) and reaches a maximum at RRM 5.2. Particulate IHg concentrations remain relatively constant until approximately RRM 12, then decrease.

  MeHg concentrations in surface water were generally the highest between RRM 10 and 12, but the areas with the highest surface water MeHg concentrations were more widely dispersed. Surface water MeHg concentrations exhibit strong seasonality, generally increasing when surface water temperatures reach approximately 12 degrees Celsius (^{o}C) and low flow conditions. Surface water MeHg loading is generally higher at temperatures greater than 12 ^{o}C compared to temperatures below 12 ^{o}C, suggesting a role of methylation at higher temperatures.

- ***In-Channel Sediment:*** Fine-grained sediment in the South River occurs primarily as channel margin deposits and as interstitial sediment within the coarser substrates of the streambed. THg concentrations were highly variable in the channel margin deposits. Higher concentrations were found at depth, buried below fine sediment with lower concentrations relative to subsurface sediments. THg concentrations in interstitial sediment generally increase between RRM 0 and 8.7 and decline farther downstream.

- ***Biological Tissues:*** Extensive sampling and analysis of biological tissues across the range of aquatic and terrestrial trophic levels has been performed in AOC 4.

Higher trophic levels tend to have higher concentrations (e.g., smallmouth bass). Areas with relatively high MeHg concentrations in environmental media (e.g., surface water) and biological tissue (e.g., fish) were observed at distances greater than approximately 12 miles from the site.

- ***Mercury Mass Balance*:** A present-day mass balance for mercury was developed for the first 10 river miles of the South River. Several different lines of evidence—including incremental loading rates and concentration gradients in surface water, sediment, and pore water—strongly suggest that non-channel (e.g., bank) sources of THg were primarily limited to the first 10 to 12 river miles of the South River. Additionally,
  - Eroding banks were the largest current single source of THg loading to RRM 0 to 10, accounting for 40 to 60% of the THg loading.
  - Site outfalls continue to be a source of mercury to the South River.
  - Although a relatively small source, in-channel sediments in RRM 0 to 12 are both a potential MeHg source to the South River and an exposure medium.

Physical/Geomorphological Characteristics

- ***Sediment and Mercury Transport:*** At RRM 0, the South River carries an estimated 54 to 92 metric tons of suspended sediment per year. As suspended sediment is transported downstream, an average of approximately 6% of the annual load is deposited per mile on the floodplain. In addition, approximately 3% of the annual sediment load is deposited as fine-grained sediment deposits in eddies and other low energy areas near the banks, such as behind large woody debris and other obstructions. Newly deposited sediment originates mostly from the eroded banks but also from re-suspended surficial sediments of fine-grained sediment deposits. Bank soil erosion is a relatively small portion of the total sediment budget, but is important for mercury transport.
- ***In-Channel Bed Stability:*** The South River bed is stable with no discernible scour. Approximately 80% of the stored sediment in gravel beds and interstices is estimated to be less than 50 years old and the median age of stored sediment is estimated to be about 32 years, indicating that the bed is relatively stable and that sediment residence time in the coarse-grained beds is on the order of a few decades.
- ***Bank Erosion:*** Bank erosion rates on the South River average approximately 4 cm/yr throughout the system. Present-day bank erosion rates tend to be higher near islands and at migrating bends.

Biological Conditions

The South River is a generally functional ecological system supporting diverse land types and biological communities. A number of studies on biological conditions are summarized below:

- ***Benthic Community:*** Benthic and epibenthic communities were found to be similar in the South River and reference areas based on several widely applied

metrics. These comparisons indicate that that mercury is not adversely affecting benthic community structure in AOC 4 relative to the reference areas.

- ***Bank Habitat:*** Riverbanks and the surrounding riparian zones also represent ecologically important habitats of the South River. These areas provide foraging, nesting/burrowing, and refugia opportunities for numerous species of songbirds, piscivorous birds, small mammals, and reptiles/amphibians. The extent and quality of bank and riparian habitats of the South River vary extensively with surrounding land use. For example, the first two miles of the river are mostly surrounded by a mixture of commercial, industrial, and residential land uses with minimal riparian habitats.

Mercury Conceptual System Models

DuPont and others have investigated the physical, chemical and biological components of off-site portions of the South River, SFS River, and associated floodplain areas. The legacy mercury issue at the site was discovered in 1976. A review of VDEQ monitoring data in 2000 showed that mercury remained elevated in the South River fish species, with potential implications for human and ecological exposure. After over three decades of investigation, mercury biomagnification in the aquatic and terrestrial food webs, rather than direct toxicity to existing ecological receptors, has been identified as the primary pathway of exposure within AOC 4. Figures 1 and 2 provide the mercury conceptual system models for AOC 4. These models describe the unique set of conditions within the South River aquatic system and terrestrial systems of AOC 4.

Future Course of Action in AOC 4

The findings summarized in the preceding sections formed the basis for the Remediation Proposal and the Phase 1 Interim Measures Design Implementation and Monitoring Plan (Anchor QEA and URS, 2013 and 2014). The remedy includes site-specific remedial action objectives (RAOs), and evaluates a range of bank remediation alternatives, first to be applied to the upper reach of the South River in a logical upstream-to-downstream implementation sequence. In addition to ongoing efforts to control limited on-site mercury releases, the primary recommended remedy for AOC 4 includes enhanced vegetative and structural stabilization of target banks to substantively reduce mercury loading to the South River and accelerate natural recovery processes within channel areas.

Given the complexity, extent, and the uncertainty of the system(s) involved, an Enhanced Adaptive Management (EAM) approach is proposed to address ongoing mercury exposures in AOC 4. SRST studies will also continue to provide information relevant to the RFI. In addition, the results of the proposed EAM process may warrant investigative work. Resulting additional information will be evaluated as part of the RCRA process. Proposed human and ecological exposure monitoring (short-term and long-term) plans will also generate environmental data used for hypothesis testing within the EAM approach to track potential system responses to remedial actions and effectively integrate lessons learned.

DuPont will also continue to work closely with the various state and federal governmental agencies to conduct education and other outreach efforts for the communities along the South River and SFS River (e.g., via continued collaboration with *Promotores de Salud*, a public health program for the Hispanic community).

Figure 1
Aquatic Mercury Conceptual System Model (HgCSM)
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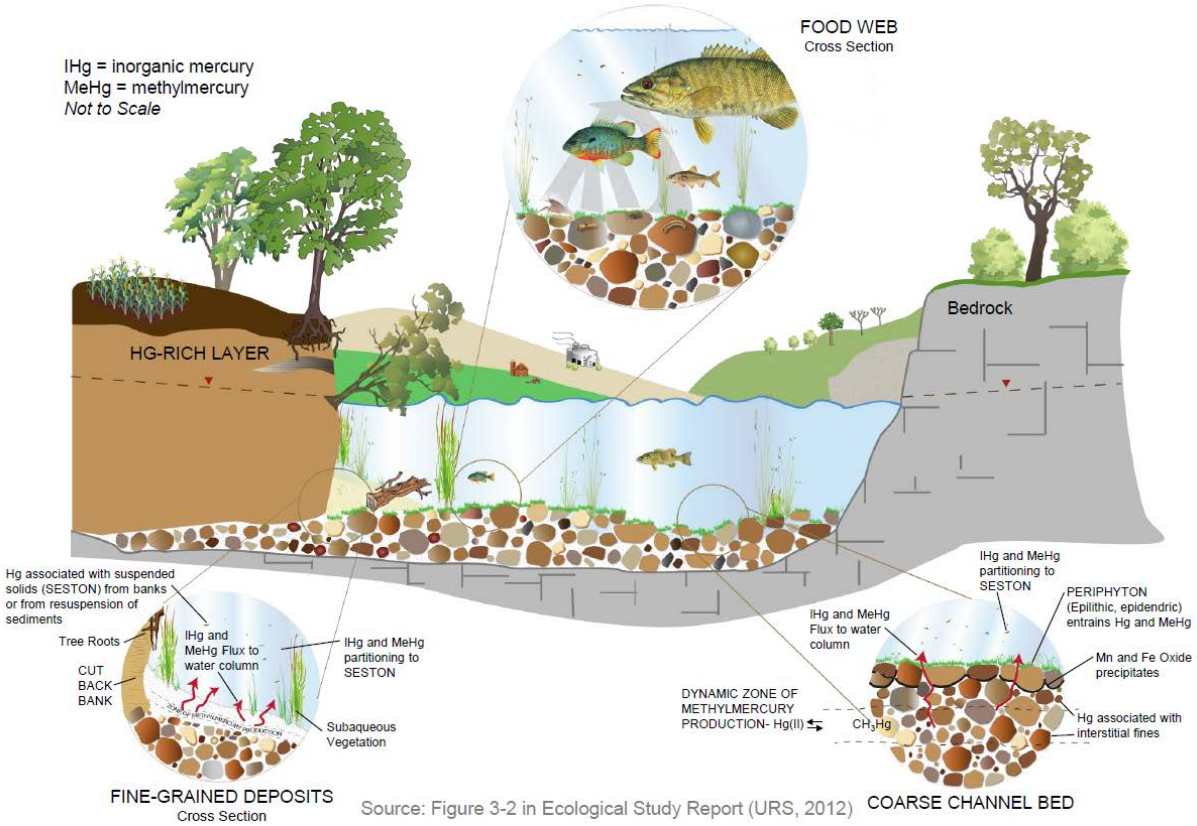

Source: Figure 3-2 in Ecological Study Report (URS, 2012)

Figure 2
Terrestrial Mercury Conceptual System Model (HgCSM)
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