REMEDIATION PROPOSAL SOUTH RIVER AND A SEGMENT OF THE SOUTH FORK SHENANDOAH RIVER, VIRGINIA

Briefing Paper

October 2013

OVERVIEW

A Remediation Proposal, in preparation, provides a framework for undertaking remedial actions in the South River and a segment of the South Fork Shenandoah (SFS) River, Virginia to comply with the final requirements of the 2005 Consent Decree between DuPont and the Virginia Chapter of the Sierra Club/Natural Resources Defense Council (NRDC). A draft document was distributed to the SRST Remedial Options Program Work Group, the SRST Monitoring Sub-team, VADEQ, USEPA, the City of Waynesboro and other interested parties for review and comment, in addition to submission to the NRDC.

As part of the Consent Decree, DuPont had previously conducted an Ecological Study (URS 2012b), which concluded that the majority of mercury loaded to the South River begins at the former DuPont facility in Waynesboro (site) and subsides approximately 10 to 12 relative river miles downstream. The Ecological Study found that a primary mechanism for the continued loading to the South River in this segment is through the erosion of river bank soils that contain mercury released from the site. It is estimated that between 40 and 60% of the mercury loaded to the river originates from eroding bank soils.

Owing to the size, linear nature, complexity and spatial variability of the South River system, remediation will be conducted utilizing an adaptive management approach. This type of approach requires that the river system be divided into manageable segments, and that remediation occur in an upstream-to-downstream fashion, with components of each segment (e.g., banks and in-channel bed sediments) addressed in an appropriate sequence. Conducting work on discrete segments of the river system allows the work to proceed safely and in a timely manner. Parallel efforts, including ecological and human health risk assessments in the South River watershed, may identify other remedial targets.

As a consequence of the adaptive management approach, remediation will be conducted in phases. Phase 1 of remediation will focus on relative river mile 0 to 2. This is based on a reasonable construction season of one to two years and the number of river banks that have been identified as significant mercury sources to the river. Short-term remedial action objectives were developed for Phase 1 and will be applied to subsequent reaches as appropriate (i.e. subsequent phases). A detailed monitoring and adaptive management approach will be used to measure effectiveness of Phase I and integrate lessons learned. Parallel efforts, such as interim remedial measures (IRM) at the former Waynesboro facility, will be integrated with the monitoring results. If monitoring results indicated that assumptions made in the Conceptual System Model are incorrect or inaccurate, adjustments to the remediation approach will be implemented.

The Proposal provides detailed technology options for the Phase 1 initial management option: bank stabilization. Based on evaluations, vegetative and/or structural stabilization of banks that contribute

disproportionately to mercury loading to the river achieve greater protectiveness with far less short-term impact on the environment during remedy implementation, less impact on the community, and less impact on sustainability core elements, compared to more invasive removal options and less invasive institutional control options. The recommended phase 1 remedy for the South River banks thus 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. However, as detailed remedy design proceeds all technologies will be considered to ensure optimal balancing of the alternatives evaluation criteria.

The Remediation Proposal forms the basis for more detailed work plans for design, construction, monitoring, and adaptive management in the South River and a segment of the SFS River, in multiple phases of remediation. The remediation program will be performed under regulatory oversight by the Virginia Department of Environmental Quality in collaboration with the U.S. Environmental Protection Agency. During remedial design, additional investigations and evaluations will be performed to further assess which remediation technologies are most appropriately applied to a given bank based on landowner preferences, site characteristics, regulatory requirements, and other factors. As it did with the Ecological Study, DuPont intends to fully engage the South River Science Team in the final design, implementation, monitoring and adjustments to the river remedy.

DuPont will 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. Examples of this education and outreach include continuation of *Promotores de Salud*, a public health program for the Hispanic community, the conduct of angler surveys to monitor adherence to the existing fish consumption advisory, and communicating with local health clinics and physicians regarding prevention of potential human exposure to mercury in fish.

PARALLEL REMEDIAL EFFORTS

The scope of this Remediation Proposal addresses the remedial strategy for the aquatic portion of the South River and a portion of the SFS River with greater detail provided for Phase 1 of the remedy. For the floodplain portion of the system, a risk assessment is currently being developed under regulatory agency oversight, and will include a conceptual site model (CSM) specific to potential ecological and human receptors and relevant exposure pathways associated with the floodplain. Remedial strategies for the floodplain continue to be investigated and, upon completion of the risk assessment for the floodplain, a remediation approach will be developed and integrated into the adaptive management strategy for the South River and SFS River system.

At the former DuPont plant site, a RCRA CA investigation has been completed. As a result of the RCRA Facility Investigation, three units that managed mercury, outfall discharges and groundwater beneath the former mercury area were identified for evaluation of remedial alternatives in the CMS, which is currently under development. Remediation of units that impact the river through IRM will be conducted prior to implementing the actions proposed in the South River Remediation Proposal. Post remedial monitoring of the IRMs will be implemented to assess effectiveness.

- 5 to 20% Other

BASIS FOR REMEDIATION

A present-day mass balance for mercury in the aquatic system was developed for the first 10 river miles (south River from Waynesboro to Crimora) and is summarized in the Ecological Study (URS 2012b). 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 occur primarily in the first 10 to 12 river miles of the South River.

Mass Loading of Hg to Fish Tissue

- **3 to 5%** **Plant Site Outfalls**
- **40 to 60%** **Eroding Banks (historic deposits)**
- **15 to 35%** **In-stream Beds**
- **5%** **Bank Leaching**
- **5 to 15%** **Other**

Eroding banks are the largest current single source of THg loading to RRMs 0 to 10 of the South River, accounting for 40 to 60% of the THg loading to the river channel system (URS 2012b). Controlling bank erosion is thus a primary focus of initial remediation efforts. However, there are other mechanisms by which THg stored in banks could potentially be transported to the water column, such as soil-water and other biogeochemical interaction within the bank (i.e. bank leaching). Ongoing SRST studies continue to assess these mechanisms (see Biogeochemical Dynamics in the Bank – Surface Water Zone briefing paper).

The facility outfalls continue to be a source of mercury to the South River (URS 2012b). Unintended mercury releases through the facility outfalls have also recently occurred as a result of on-site remediation actions, including sewer cleaning. As discussed above, DuPont is evaluating alternatives jointly with USEPA for the remediation of upland mercury sources; these actions will be coordinated with in-river remedial activities.

In-channel sediments in RRMs 0 to 12 are both a potential exposure medium and a source of MeHg to the South River. Mercury is distributed throughout the channel bed: in deposits along the channel margin and behind obstructions and mixed within the gravel matrix of the streambed. Although a relatively small source of THg to the South River, in-channel sediment is estimated to account for approximately 74% of the MeHg loading between RRMs 0 and 2.7 (URS 2012b). THg concentrations in finer sediment deposits along the channel margin and THg attached to fine sediment that occurs within the interstices of the gravel-cobble matrix are sufficient to maintain ongoing methylation of THg throughout the system. It is possible that with control of mercury loading from bank soils, mercury already residing in the channel bed may undergo an aging process whereby bioavailability of mercury to methylating bacteria is reduced. This is one potential mechanism of natural recovery within the channel bed. There are uncertainties associated with the conceptual model and the quantitative mercury mass balance described above. It is anticipated that these uncertainties will be reduced as part of an adaptive management approach to remediation.

Therefore, elevated Hg in bank soils, and to a lesser degree, near bank in-channel sediments within the upper 12 miles of the South River, are the primary media of concern and form the basis for remediation. This Remediation CSM focuses on the three pathways relevant to understanding the need for a response action: 1) the source of mercury to the South River and the extent to which sources are controlled; 2) the mercury-impacted media—in this case, bank soils and near bank in-channel sediments; and 3) potential receptors. The potential for mercury exposure between sediments and fish and between fish and consumers of fish is depicted in the figure below.

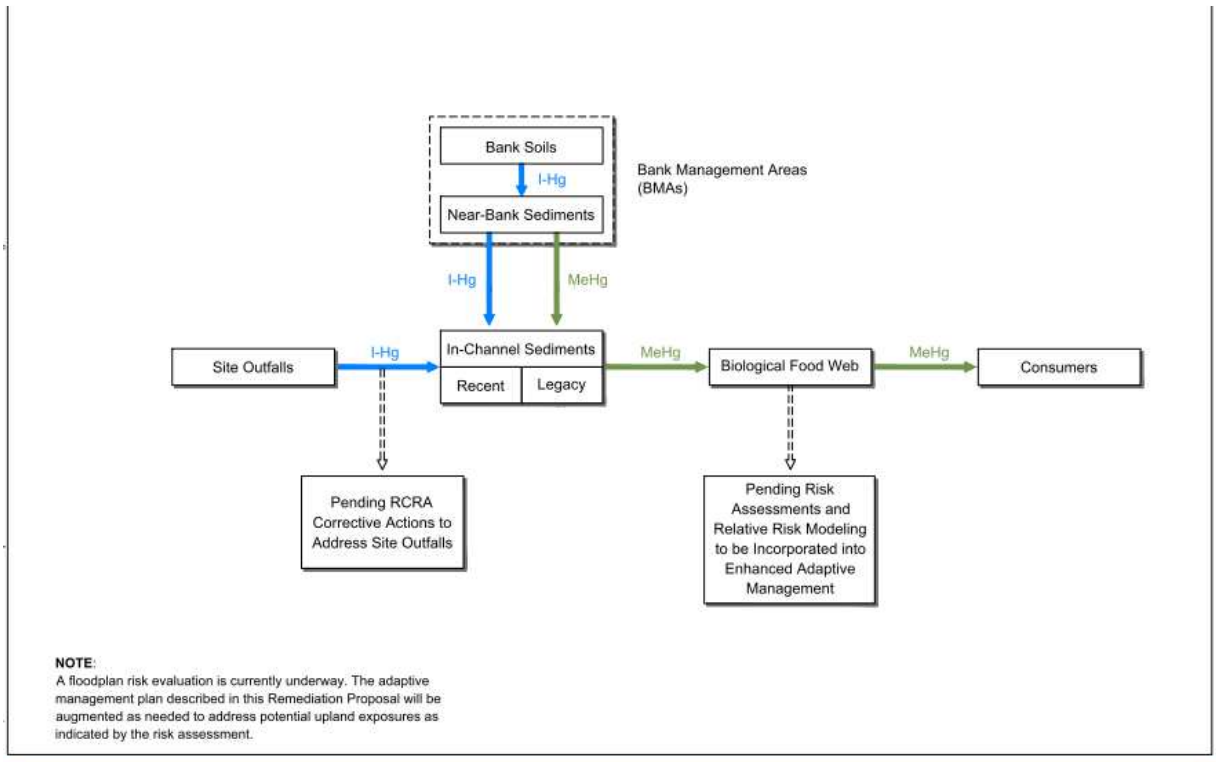

Figure 3-1
Basis for Remediation Conceptual Site Model
Draft Remediation Proposal
South River and a Segment of the South Fork Shenandoah River

MONITORING AND ADAPTIVE MANAGEMENT

Successful remediation of mercury-impacted aquatic and terrestrial systems has been a challenge at other sites. These difficulties are largely due to the chemical nature of mercury and the complexity of mercury cycling. In the South River system, reduced exposure of humans and ecological receptors, and subsequent overall risk reduction, will be best achieved by ensuring that the remedial action objectives (RAOs) are used in an adaptive management approach. An adaptive management approach requires making and implementing response decisions based on monitoring results, and informing future response decisions by these results. An Enhanced Adaptive Management Model will be developed and will be coupled with the relative risk model to provide quantitative feedback on the effectiveness of remedial actions.

Short-term and long-term monitoring plans are provided in the Remediation Proposal. The overall goal of the effort is to provide data to assess the efficacy of the remedy in addressing both migration and potential exposure pathways. Specific objectives of the monitoring are to provide data to:

- Monitor system responses to remediation
- Monitor the integrity of the remedial action
- Monitor human and ecological exposure to mercury
- Provide input to the adaptive management framework and relative risk model to determine whether any aspect of the remedial action, monitoring strategy, remedial design, or conceptual model needs to be modified

The short-term monitoring plan is designed to measure improvements over relatively rapid timeframes (e.g., 2 to 10 years) and small spatial scales (e.g., adjacent to a particular BMA). First and foremost, the short-term monitoring will assess whether the physical specifications of the remedy are being met, and ensure that the physical integrity of the remedy is repaired should it be affected by flooding or other events. (Routine inspection of remediated areas will be conducted to ensure the continued integrity and performance of the remedy, and to maintain and/or repair a remedy as necessary). Secondly, the short-term monitoring will provide chemical and biological information that will feed into the relative risk model and the adaptive management approach. Combined, these sets of information will allow for rapid feedback on the efficacy, integrity, and performance of the remedy, and whether or not the RAOs are being met.

The long-term monitoring program addresses changes in potential mercury exposures of humans and ecological receptors, as well as habitat improvements in the South River and SFS River over longer timeframes and larger spatial scales. While the short-term monitoring will be focused primarily in the South River at or near those areas where remedies are being implemented, the long-term plan is designed to cover a timeframe of many years to decades, and a much larger area, including the South River and SFS River and associated floodplain or riparian zone.

It is expected that once remedial actions have been implemented, over time the mercury loading to the South River and SFS River should decline and be accompanied by a concomitant reduction in potential mercury exposures and potential risks to humans and ecological receptors.

The monitoring plan included in the Proposal is subject to review and potential modification by regulatory agencies and the SRST. Under regulatory agency oversight, the detailed specifics of the monitoring and adaptive management program will be developed during remedial design. Because the outputs from the relative risk model can be applicable to understanding net risk reduction from the implementation of a remedial action, it will be coupled to the monitoring and adaptive management process to provide a more holistic view of the benefits from implementing specific elements of the Remediation Proposal.

NEXT STEPS

The final Remediation Proposal will be distributed to the SRST in the latter part of October, 2013. DuPont will implement this Remediation Proposal under the federal RCRA framework; therefore, the final designs for remediation and monitoring will be developed in collaboration with the appropriate regulatory agencies. As the monitoring plan is implemented, there will be frequent and open communication with those involved with the existing monitoring efforts to share data and experience, and where possible, avoid duplication of effort. The Phase 1 remedial design work plan which will address critical data gaps in RRM 0 to 2 is anticipated to be the first deliverable under the forthcoming Agreement between DuPont and the regulatory agencies, and is currently scheduled to be developed in early 2014.