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DuPont | south river SCIENCE TEAM | AECOM

Development of a Short-term Monitoring Strategy for Evaluation of Remedy Effectiveness in a Mercury Impacted River

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Background

Historical mercury (Hg) releases at a textile manufacturing facility on the South River, Virginia, resulted in increased Hg concentrations in biotic and abiotic media, which have not declined over the past forty years as originally expected. Introduction of legacy Hg impacted soils, through bank erosion, is the most significant source of Hg loading to the system (Figure 1). Key learnings from monitoring a Pilot Bank Stabilization project were included in the short-term monitoring (STM) program. Interim remedial measures began in 2016, targeted at reducing this Hg source within the first few river miles.

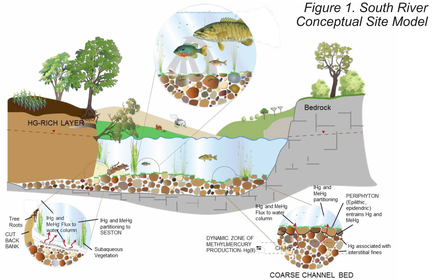


Figure 1. South River Conceptual Site Model

Pilot Bank Stabilization Project

Sediment

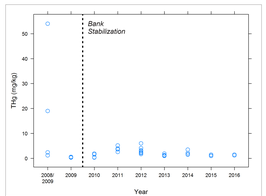


Figure 2. Near-bank sediment

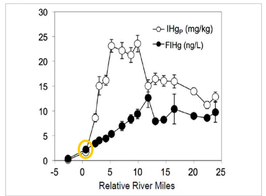


Figure 3. Inorganic mercury in surface water

Pore Water

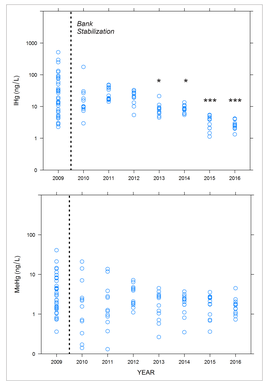


Figure 4. THg and MeHg in near-bank pore water.

Transplanted Asiatic Clams

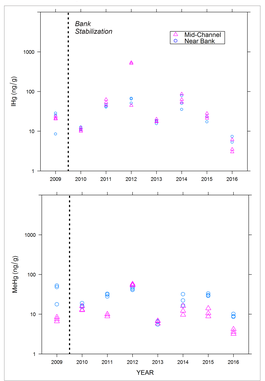


Figure 5. THg and MeHg concentrations in transplanted Asiatic clam. Clams tagged and seeded in near bank and mid-channel environments for a 5-week exposure period.

- **Figure 2.** Post-stabilization sediment total mercury (THg) < pre-stabilization data.
- **Figure 3.** Inorganic mercury concentrations on suspended solids in surface water; location of Pilot Bank Stabilization project highlighted with yellow circle.
- **Figure 4.** Statistically significant reductions ($\alpha = 0.05$) in filtered pore water inorganic mercury (IHg) observed within four years post-stabilization. A nearly significant reduction ($p=0.069$) in methylmercury (MeHg) was observed in 2016.
- **Figure 5.** Transplanted Asiatic clams responsive to increased Hg concentrations in surface water (2011/2012) associated with on-site remedial actions (Figure 8A).

Short-Term Monitoring Approach

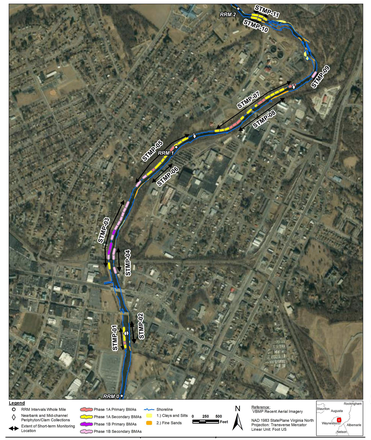


Figure 6. STM BMAs

- Comprised of multiple lines of evidence.
- Aims to document changes in Hg in biotic and abiotic endpoints at given bank management areas over 2-10 yrs (BMA; Figure 6).
- Intended to evaluate post-remediation changes in Hg concentrations and habitat quality (Figure 7).
- Co-located near-bank sediment and filtered pore water (0.45 µm) samples collected at transects spaced 100'-200' apart (Figure 6 and Figure 7).
- Periphyton collected from native substrates adjacent to the bank and from the middle of the channel (Figure 8).
- Reference Asiatic clams (*Corbicula fluminea*) exposed for a 5-week period. Seeded and caged exposures evaluate dietary vs. aqueous exposure pathways (Figure 8).
- All samples analyzed for THg (EPA Method 1631) and MeHg (EPA Method 1630).

Figure 7. STM Remedial Action Objectives

Short-Term Remedial Action Objectives				Monitoring Frequency
General Objective	Performance Objective	Metric	Success Criteria	
Reduce Mercury Transport and Exposure	Increase in Bank Stability	Topography	Continuous grade/bank angle	3 Years Annually Post-storm
		Vegetation	>80% Cover <10% Invasives	3 Years Annually Post-storm
		Design and Implementation	Landowner Approvals Permits	NA
	Reduce Mercury Loading from Bank	Surface Sediment	>75% Hg Reduction	3 Years Biannually
		Pore Water	>75% Hg Reduction	3 Years Biannually
		Periphyton	>75% Hg Reduction	3 Years Biannually
		Asiatic Clam Sampling	>75% Hg Reduction	3 Years Biannually
	Reduce In-Channel Mercury Exposure	Periphyton	>50% Hg Reduction	10 Years Annually
		Asiatic Clam Sampling	>50% Hg Reduction	10 Years Annually
Maintain or Improve Riparian and Aquatic Habitat	Improve Bank Vegetation	Vegetation	>80% Cover <10% Invasives	3 Years Annually
	Improve In-Stream Habitat	Rapid Bioassessment Protocols	Visual Stream Classification	Quarterly for First Year Biannually for Years 2-10

Figure 8A. Tagged Asiatic clam for seeded treatment

Figure 8B. Caged Asiatic clams suspended off of the stream substrate

Figure 8C. Periphyton collection

Figure 8D. Pore water collection using Henry Probe

Figure 8E. Field filtration with 0.45 polythylensulfone inline filter

Baseline STM Results

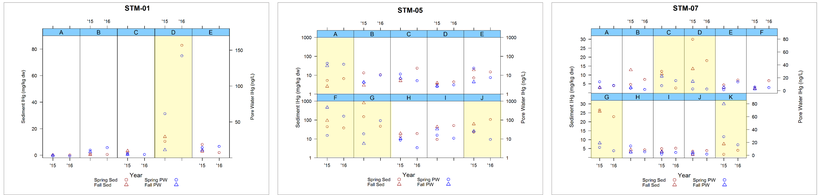
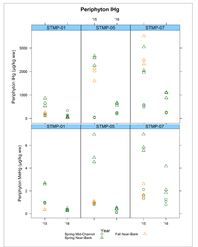
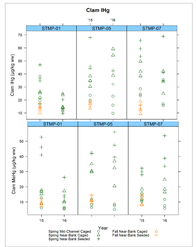


Figure 9. Inorganic mercury concentrations in near bank sediment and pore water. Yellow shaded transects are adjacent to, or downstream of river banks with elevated Hg concentrations.





- Hg concentrations in near-bank sediment and pore water were highest adjacent to/downstream of areas with elevated Hg in bank soil (Figure 9).
- IHg and MeHg in biotic media increase with distance downstream and were higher in near-bank environments (Figures 10 and 11).
- MeHg in biotic and abiotic media were higher in the spring (Figures 9, 10, and 11).

LEFT: Figure 10. IHg and in MeHg periphyton
RIGHT: Figure 11. IHg and MeHg in transplanted Asiatic clams

Discussion

- Pilot Bank learnings informed the Phase I – Interim Measures and associated monitoring programs.
- Pilot project confirmed bank stabilization could reduce Hg concentrations in biotic and abiotic media immediately adjacent to stabilized banks.
- Demonstrated utility of integrating multiple lines of evidence in a monitoring program; providing the ability to differentiate between changes attributable to remedial actions (i.e., Hg reductions in pore water) vs. those from another potential source (e.g., upstream perturbation to the system).

Baseline STM program data collected in 2015 and 2016 were consistent with historical data collected as part of the Pilot Bank stabilization project and other investigations. These data will be compared with post-interim remedial measures data, to assess the efficacy of the remedy at specific BMAs. STM program data will also be reviewed in concert with the long-term monitoring program data in adaptive management framework (Figure 12) to inform potential future remedial actions and the need for additional monitoring activities.

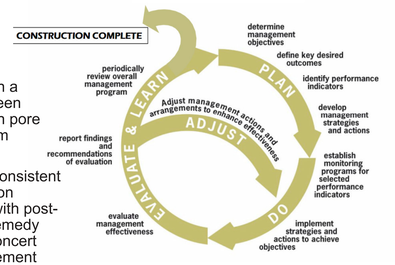


Figure 12. Adaptive Management Framework

The work described in this poster has been performed in conjunction with the South River Science Team (SRST), a multi-stakeholder group including representatives from local, state and federal governments, academia, environmental groups and DuPont. The SRST is a collaborative team created to provide input into the watershed-level, risk-based assessment framework to address mercury in the system.

For more information visit the South River Science Team website! ⇨