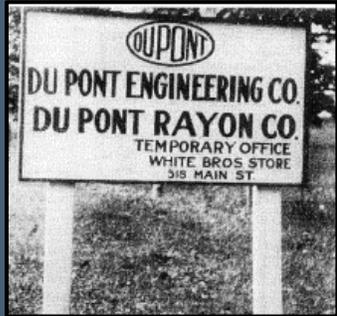


SOUTH RIVER, VA ADAPTIVE MANAGEMENT UNDER RCRA CA

- MIKE LIBERATI, CORTEVA AGRISCIENCE
- JOSH COLLINS, AECOM



THE SOUTH RIVER MERCURY STORY



1976:
Mercury discovered on-site and in fish; fish consumption advisory established



2001 - 2012:
Extensive field investigations

2014:
South River enters into regulatory process



1930 1940 1950 1960 1970 1980 1990 2000 ★ 2010 2016 2020 ★ 2022

1929-1950
Mercuric sulfate used in acetate rayon fiber production



1982-2001
MNA – Monitoring Period



2001:
DuPont and Virginia Department of Environmental Quality launch collaborative effort

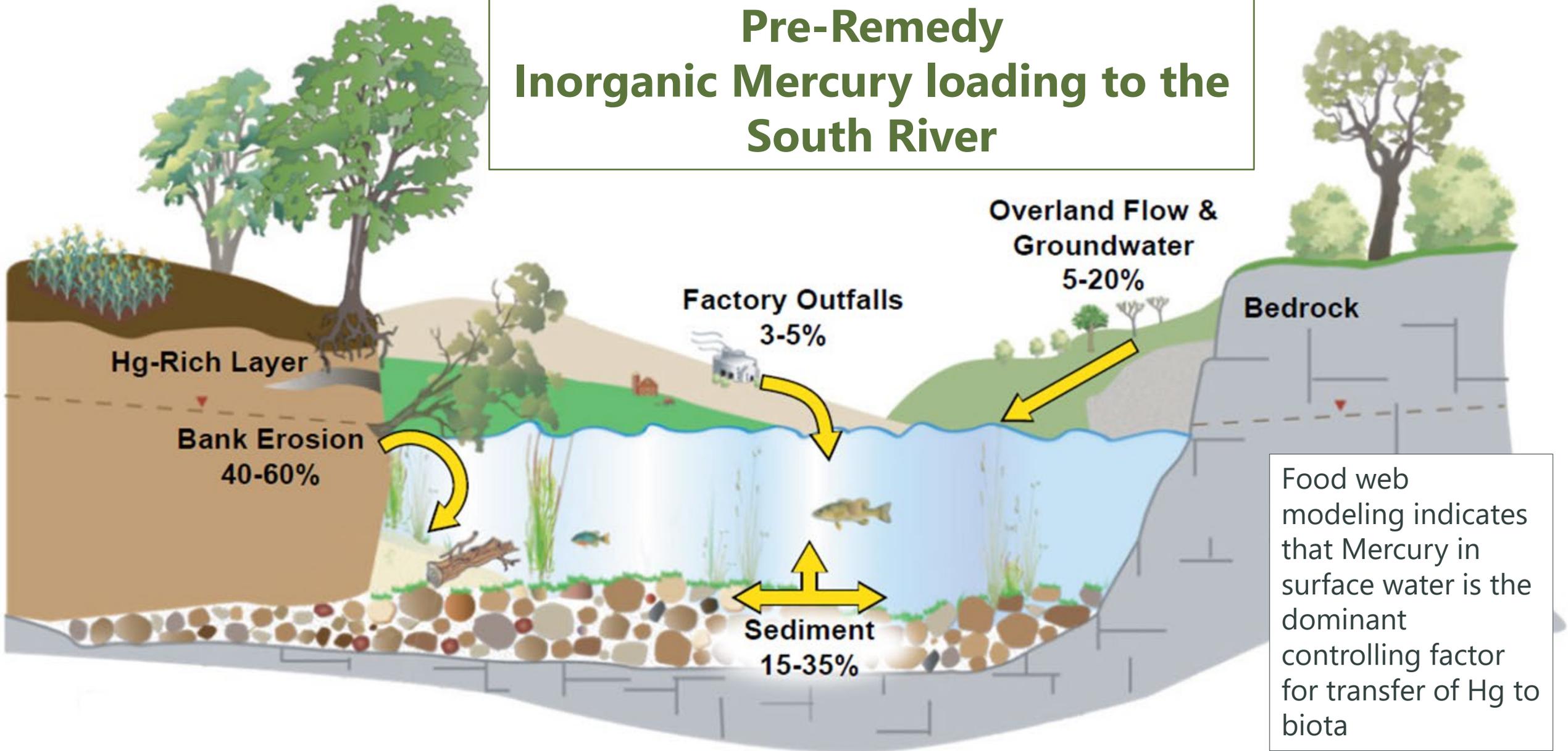
2014:
Baseline monitoring begins

2016-2020
Phase 1 Interim Measures Construction

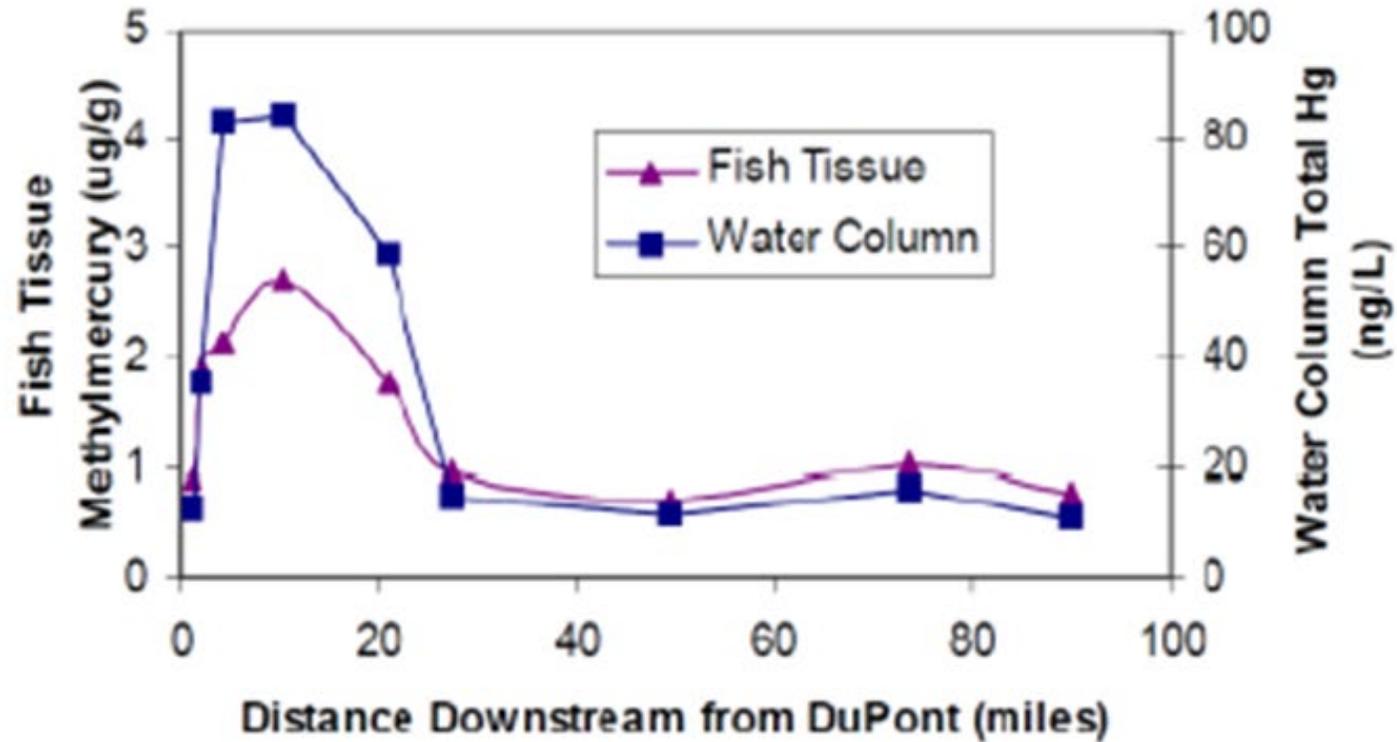
2020-2022+
Remedy Effectiveness Monitoring/Adaptive Management

South River: CONCEPTUAL SITE
MODEL SCHEMATIC

Pre-Remedy
Inorganic Mercury loading to the
South River



Food web modeling indicates that Mercury in surface water is the dominant controlling factor for transfer of Hg to biota



BASELINE SPATIAL TRENDS IN SW QUALITY AND FISH TISSUE

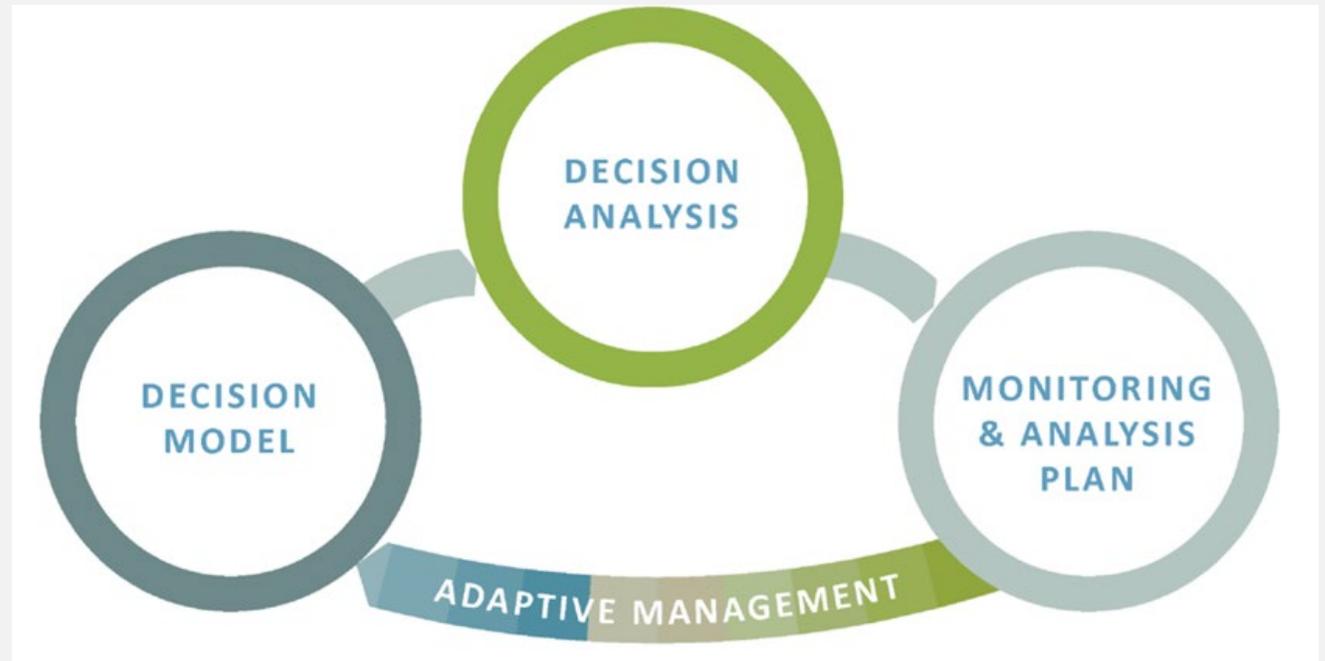
EXTERNAL SOURCES: CHARACTERIZING AND ADDRESSING

- Evaluation of other Potential Sources in the watershed was conducted early in the characterization 2001-2013
- Former Plant Site – ~5% loading to river. Species of Hg potentially more bioavailable
 - Former Plant Site Remediation from 2010 to 2021
 - Removal
 - Capping
 - Sewer cleanout



ADAPTIVE MANAGEMENT REMEDIAL APPROACH

- Control significant loading from banks and base of banks
- Restore banks
- Monitor for natural recovery of gravel/cobble bed
- Monitor system improvement and recalibrate models
- Adjust remedial approach and monitoring program based on data evaluation



Objectives of Remediation

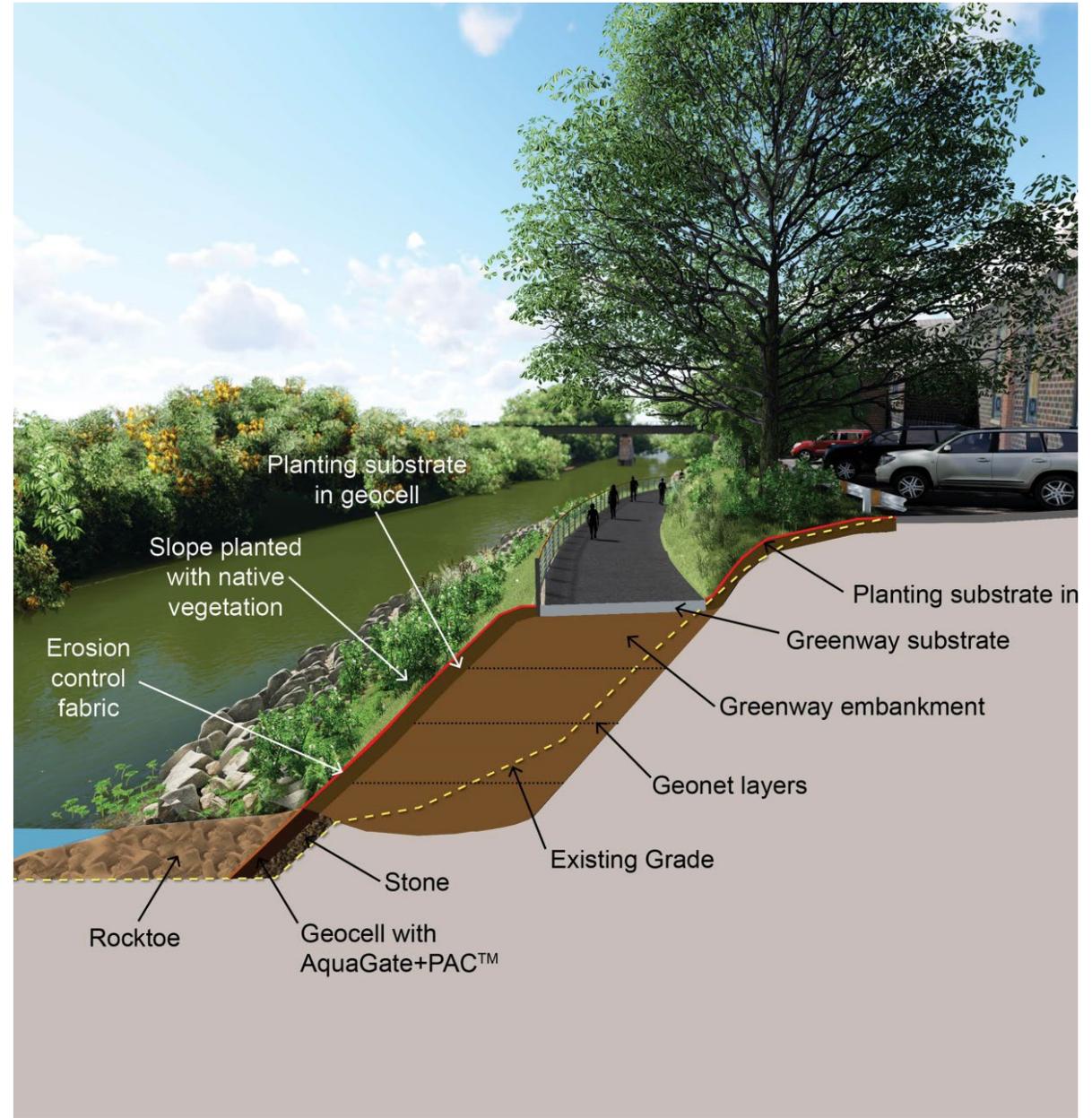
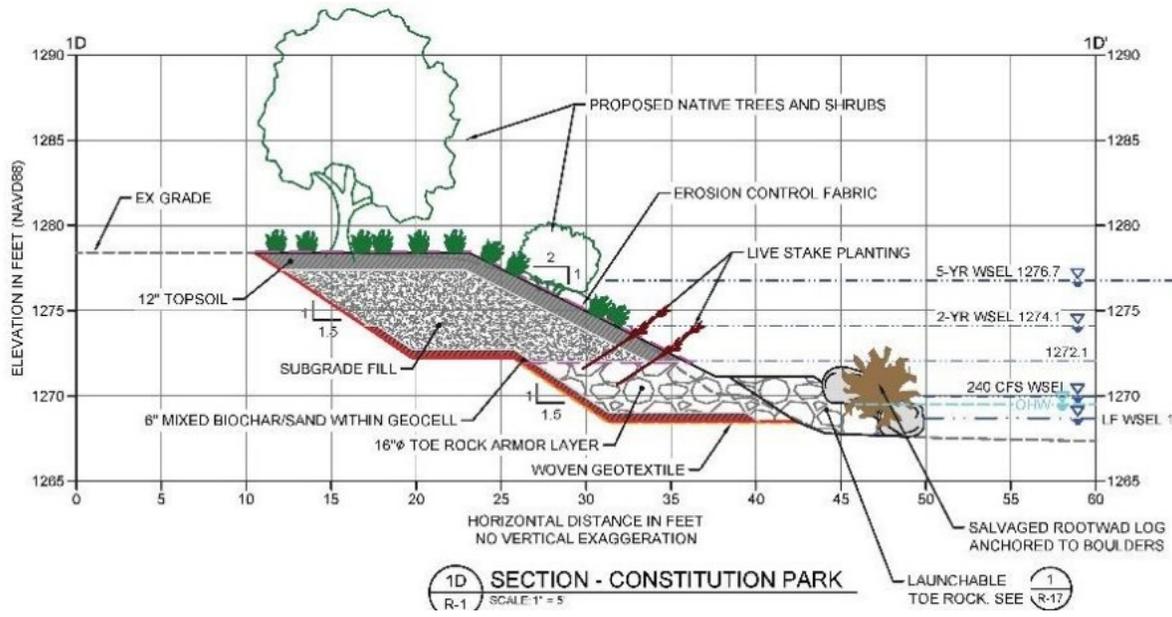
- Cleanup Goals
 - Determined by RCRA and adaptive management processes
- Short-Term RAOs (Phase 1 Interim Measure)
 - Reduce mercury transport and exposure
 - Improve bank habitat in the first two miles downstream of the plant
- Long-Term RAOs
 - Reduce methylmercury exposure
 - Improve habitat conditions throughout the South River and South Fork Shenandoah River

PHASE I INTERIM MEASURES

- Onsite Remediation of potential source areas including sewer systems (implemented 2010 through 2021)
- Six bank remediation projects (BMAs) conducted in Phase 1 in the first two miles downstream of the plant – Starting with the Pilot demonstration project in 2009, followed by remaining BMAs 2016-2020



REMEDIAL DESIGN ELEMENTS



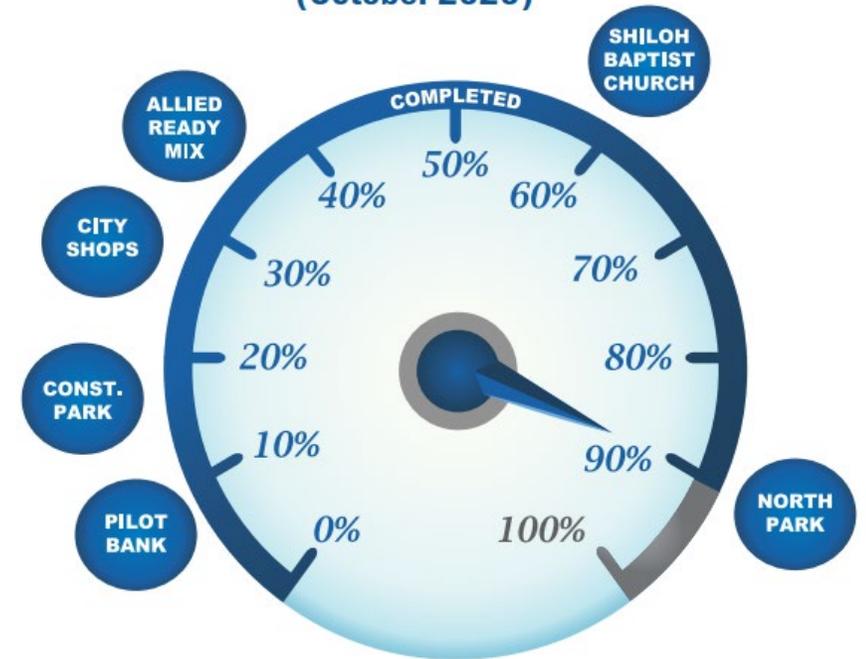


Phase 1 Interim Remedy Scope / Schedule Deviations

- Construction methods modified based on implementability and durability
- Original scope / schedule anticipated to last 2 construction seasons; agreements with stakeholders / landowners on design took considerably longer
- Access Agreements were a challenge to acquire
- City's desire to allow normal access to parks limited construction windows.
- Upland structures close to BMAs (e.g.. historic church; irrigation infrastructure) necessitated specialized design and required more design and construction time
- High value trees on and near banks necessitated design modifications
- Invasive species management

EVALUATING EFFICACY OF PHASE 1 INTERIM MEASURES

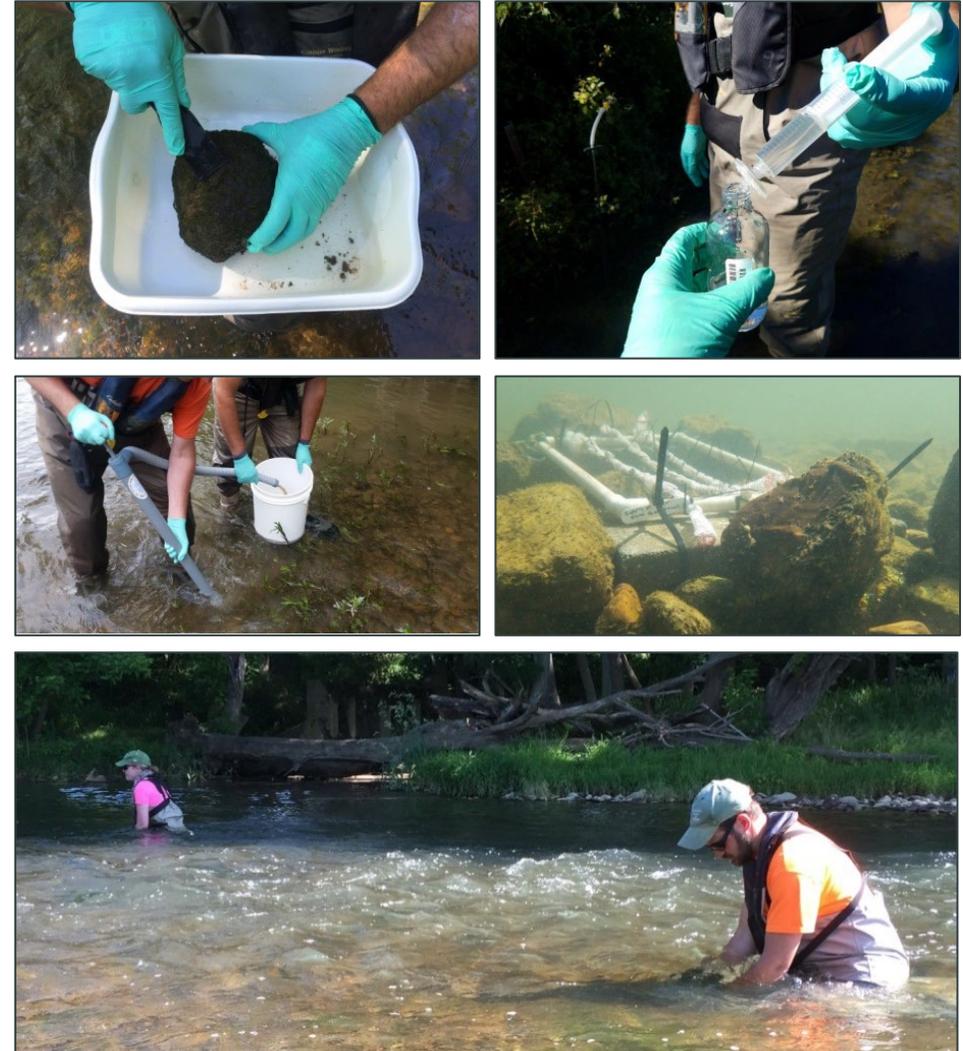
**Estimated Percent of Mercury
Input Reduced to Date
(October 2020)**



It is estimated that the erosion of six South River riverbanks contributes appreciable mercury to the river each year. The goal of the remediation work is to stop the erosion of these riverbanks and, in doing so, reduce the mercury input into the South River by 90%.

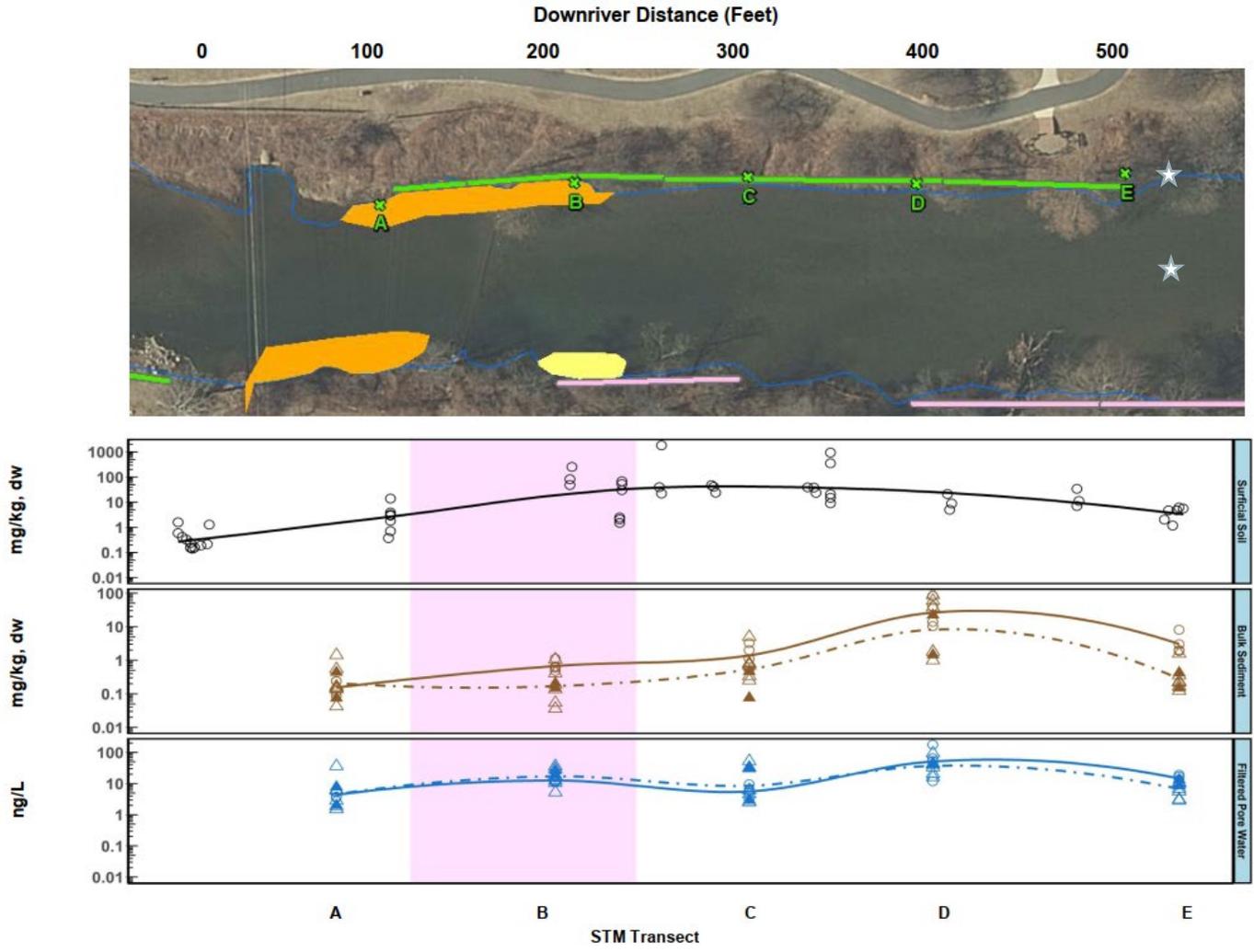
Primary Pre- and Post-Remedy Effectiveness Monitoring Elements

- Short-term and long-term monitoring programs
- Inorganic mercury and methylmercury in biotic and abiotic compartments pre- and post-remedy and at background station(s)
- Bank stability monitoring
- Riparian and aquatic habitat monitoring



Short-term Monitoring Elements and Frequency

- Data collected biannually
 - Sediment
 - Pore water
 - Periphyton
 - Clams (discontinued)
- Abiotic data collected at transects along BMA
- Biotic data collected immediately downstream of BMA

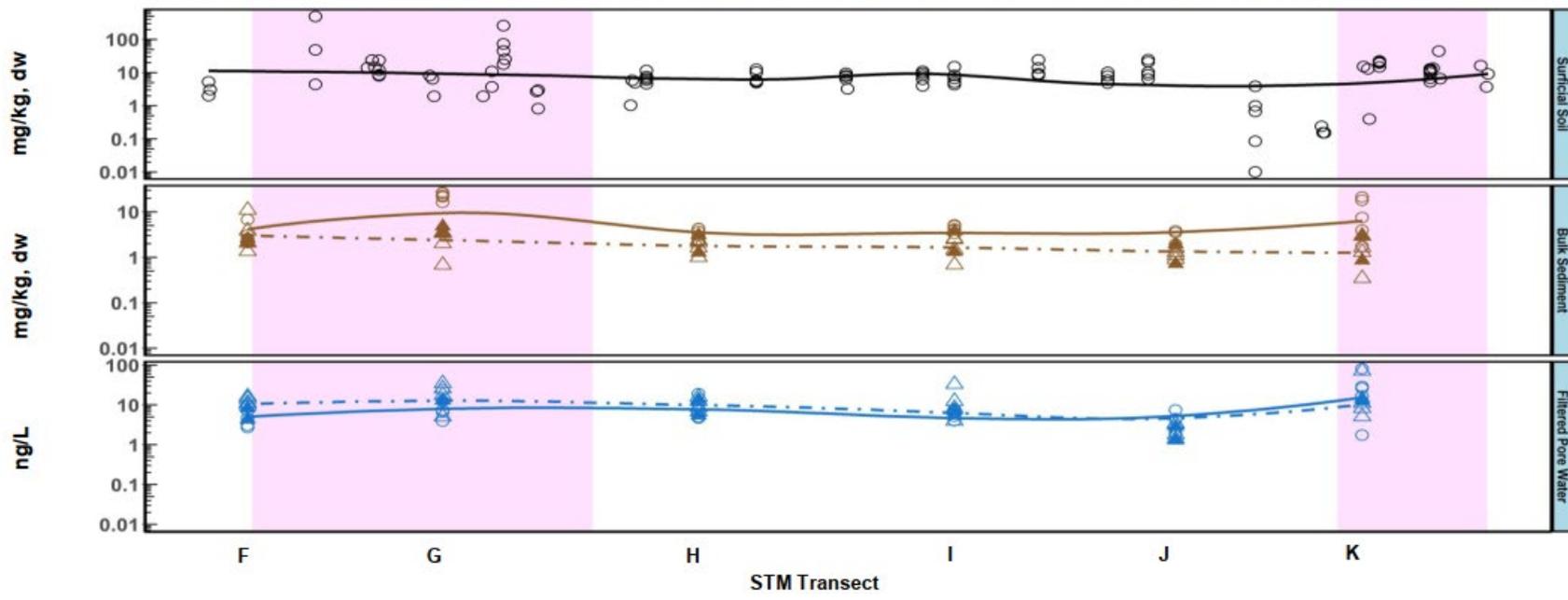
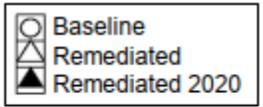
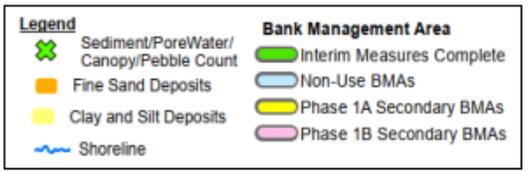
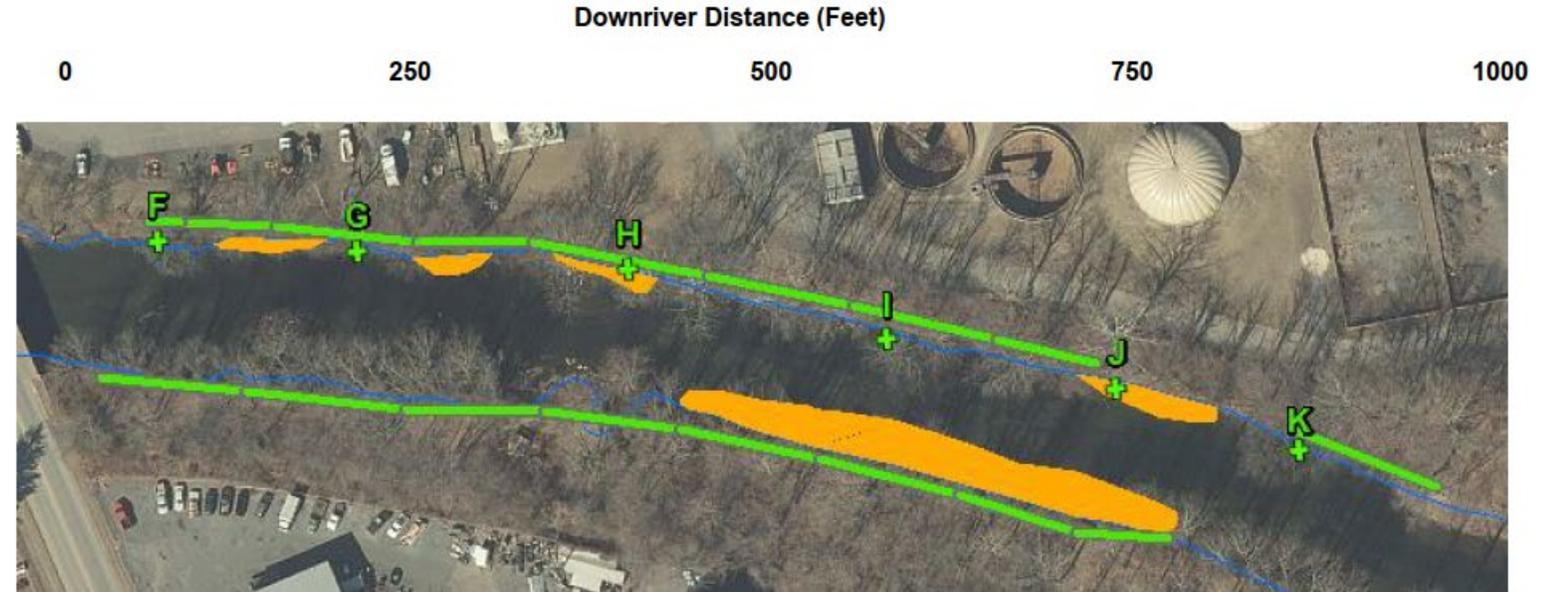


LONG-TERM MONITORING ELEMENTS AND FREQUENCY

- Hg exposure >160 miles of river and floodplain
- Data collection focused on three potential receptor groups:
 - Human
 - Adult Bass
 - Aquatic Ecological
 - Asiatic Clams, sediment, mayflies, young-of-year Smallmouth Bass, surface water
 - Terrestrial Ecological
 - Carolina Wren, Wolf Spiders

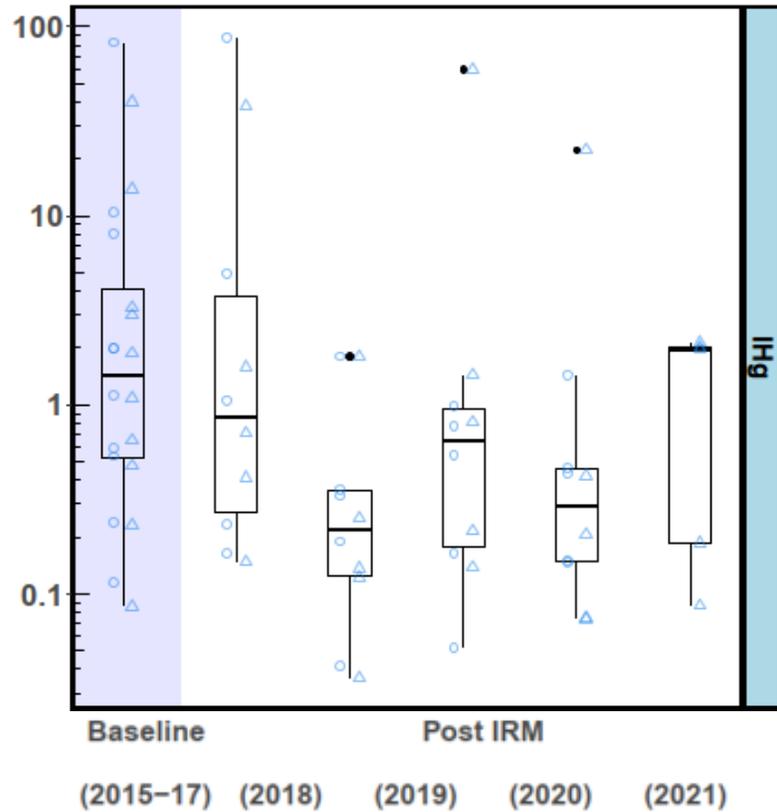


City Shops BMA

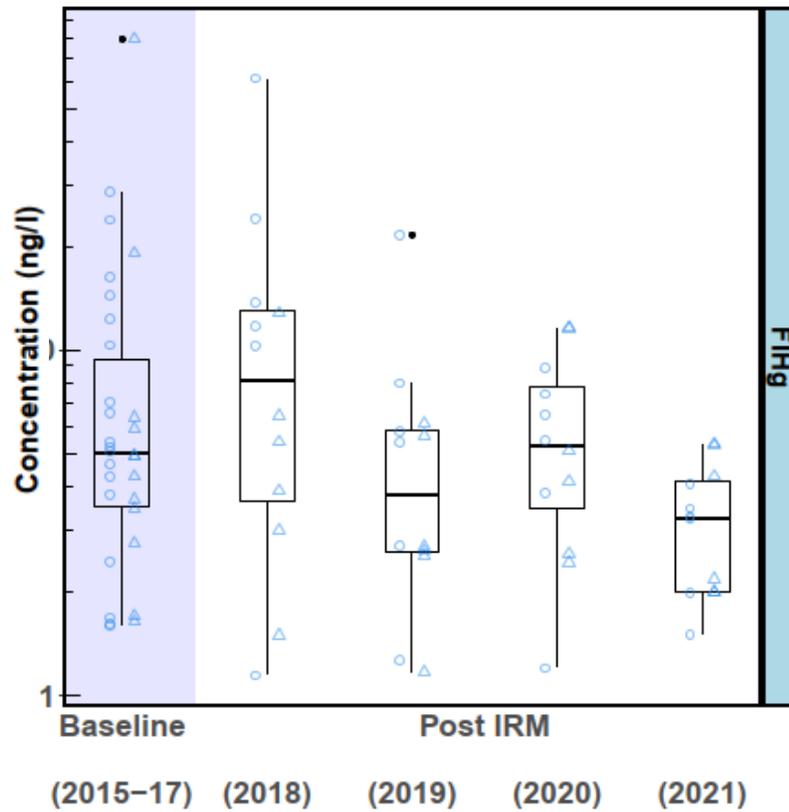


City Shops BMA

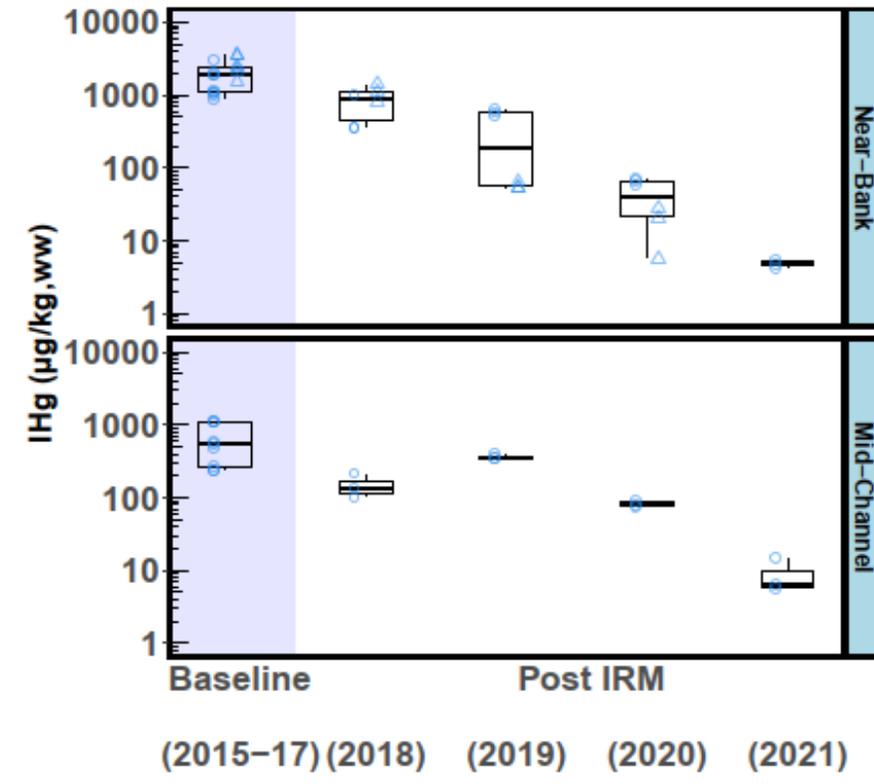
Sediment



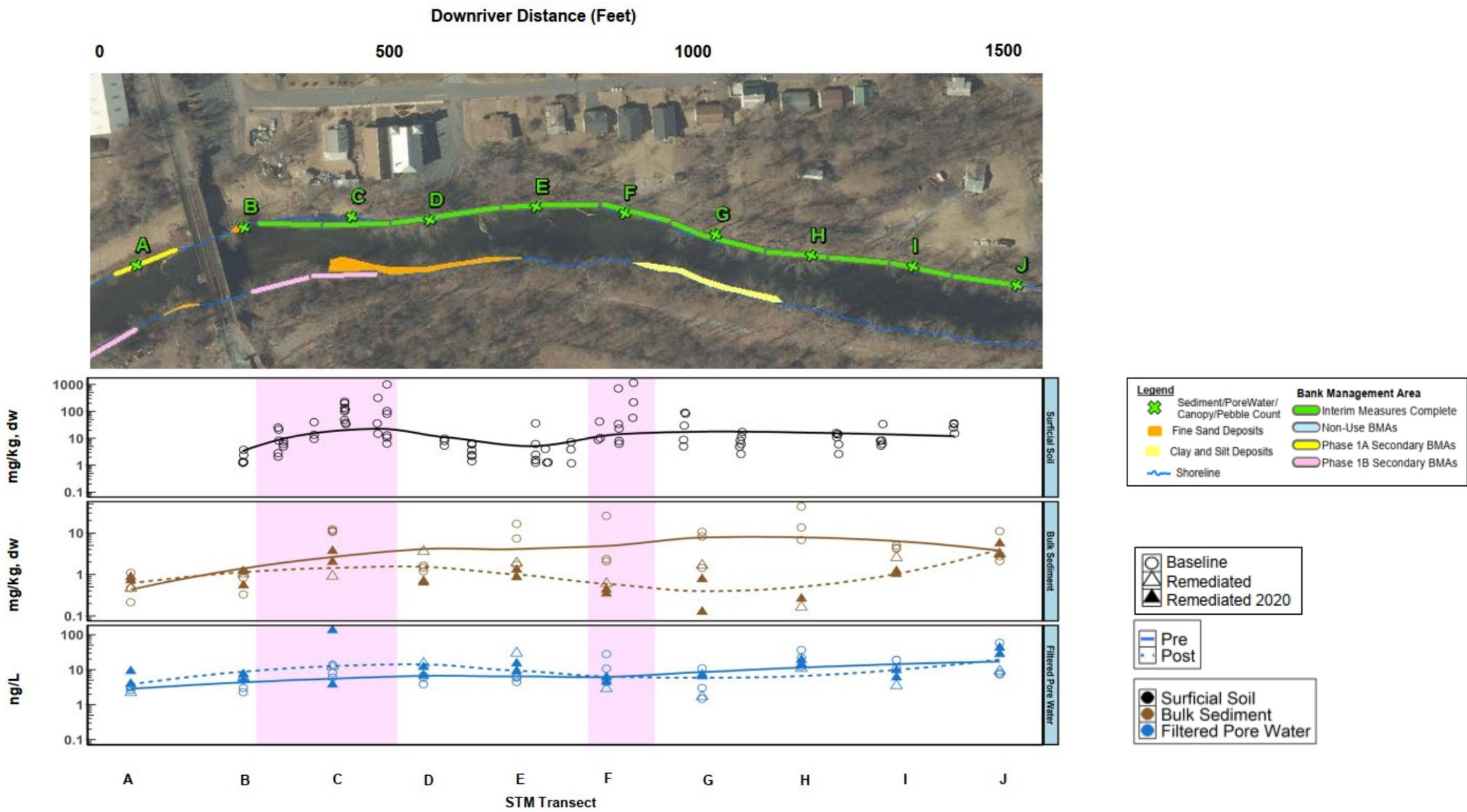
Pore Water



Periphyton

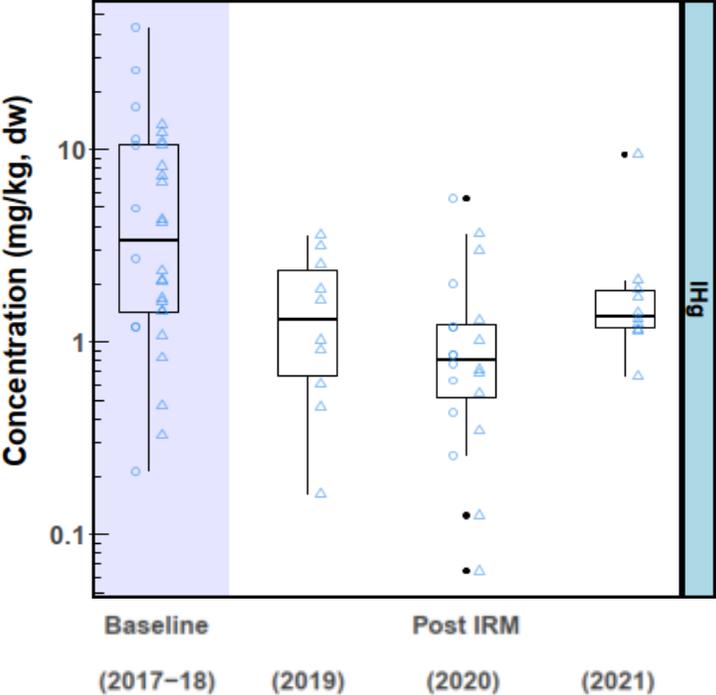


Shiloh Baptist Church BMA

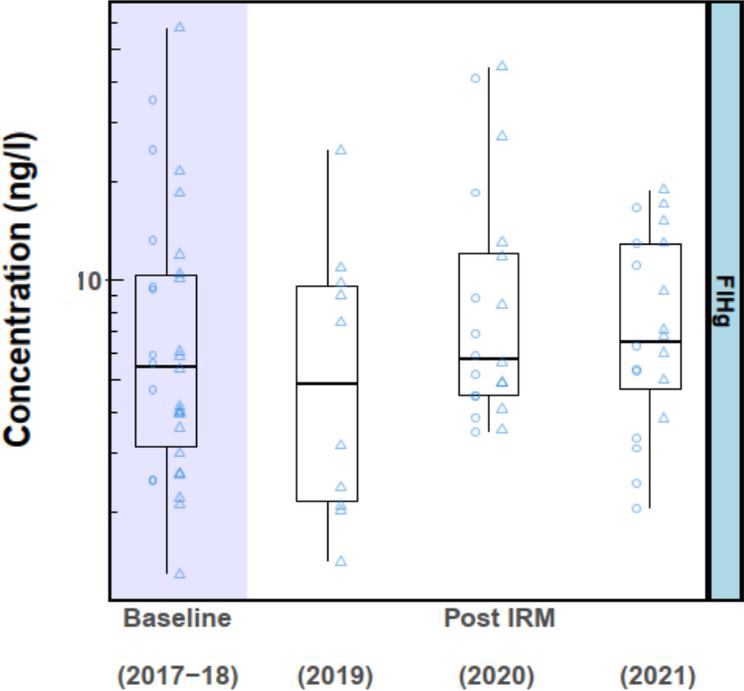


Shiloh Baptist Church BMA

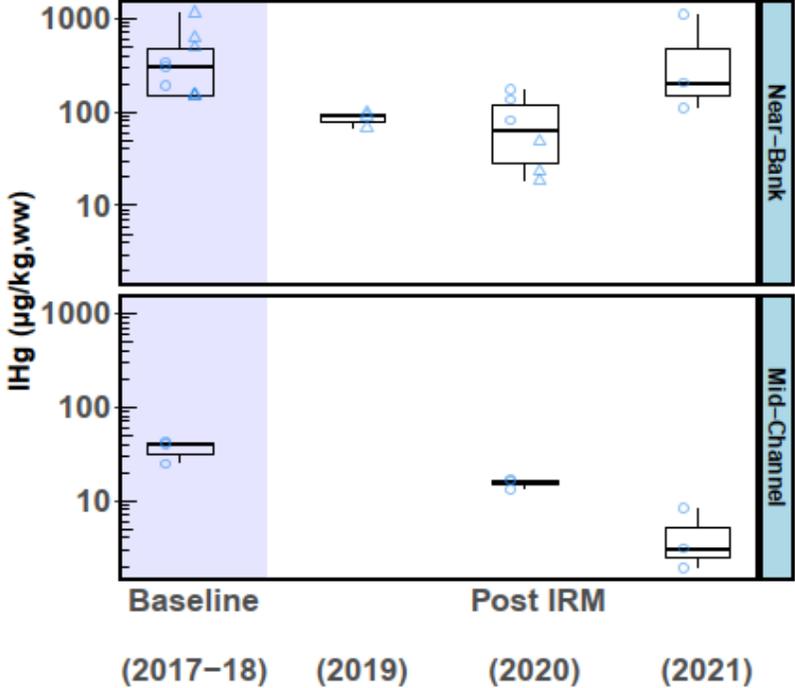
Sediment



Pore Water



Periphyton

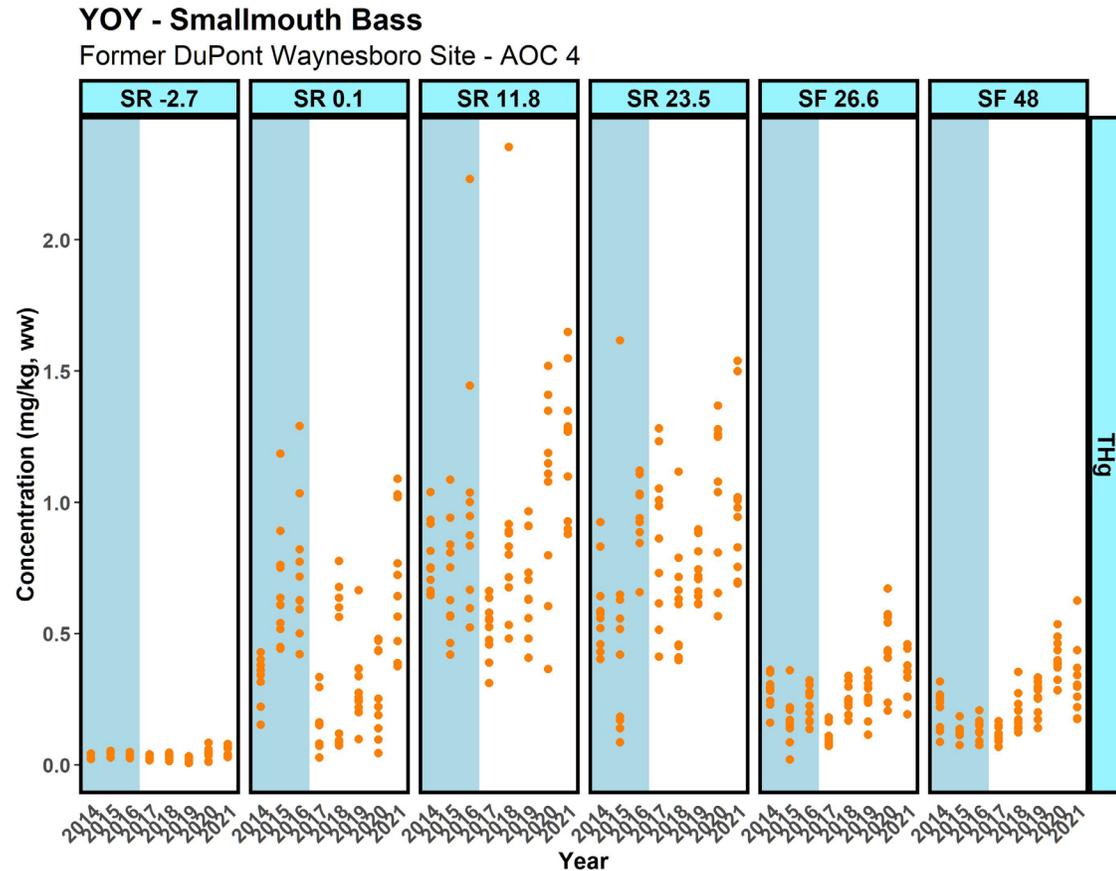


Did the Remedy Achieve Short-term Remediation Objectives?

- Preliminary short-term success criteria were achieved in some compartments – lower concentrations and less variability
 - Bulk sediment and periphyton data are encouraging
 - Pore water data are variable and may reflect bank design features

Is the Remedy on Track to Achieve Long-Term Remediation Objectives for Water and/or Biota?

- TBD – possible trends
- System needs element of natural recovery of channel bed in addition to the active remediation that's been performed



Key Take-Home Messages

Technical

- Year to year weather variability (ppt/flow and temp) continue to show a strong influence on both total Hg and methylmercury concentrations
- Short-term monitoring shows that locally remediation objectives were generally achieved
- More time is needed to gage longer term remediation effectiveness with respect to channel improvement (Pizzuto, University of Delaware) and higher trophic fish
- Machine Learning Model is an important tool for identifying controlling factors in the aquatic environment (temp, flow); recalibration as data is collected will enhance predictability
- **Adaptive Management allows for optimization of both monitoring program and remedy design**

Key Take-Home Messages

Stakeholders and Landowners

- Early establishment of a technical team of diverse stakeholders increased soundness of remedy recommendations. *South River Science Team*
- But...ensure that stakeholders are fully engaged in the process
- Inclusion of co-benefits in the remedy increases community acceptance and shortens time for approvals and access agreements (City Greenway Project, infrastructure for church)
- Public river access can result in alterations to rock toe and erosion due to foot traffic – regular inspection/repair necessary
- Communication and outreach to local residents required extra effort but well worth it
- Restoration can be challenging due to invasive species/public

QUESTIONS / DISCUSSION

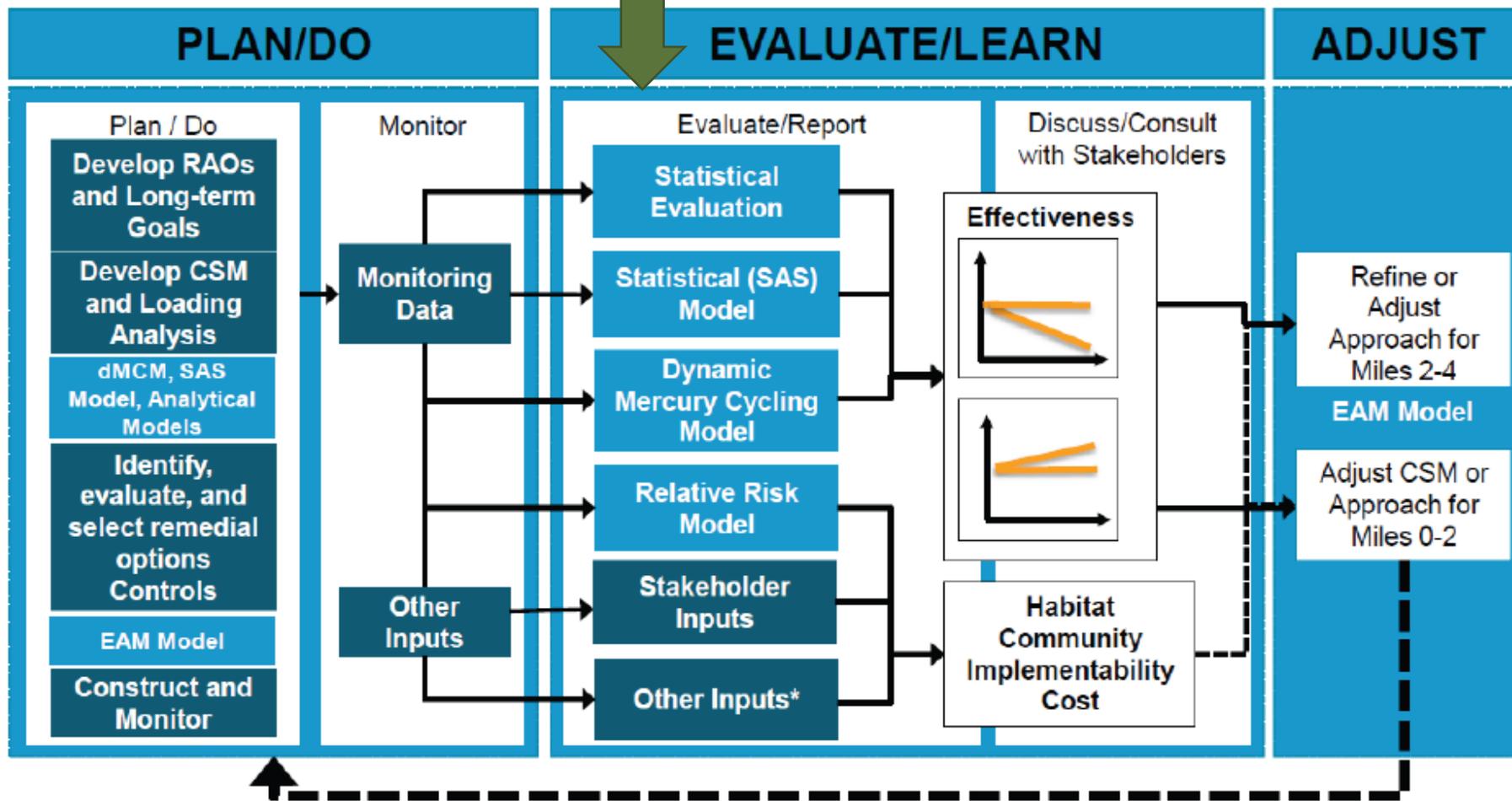
South River Science Team

2022 transitioned to SR Watershed Coalition

- Formed in 2001
- Technical focal point of extensive scientific studies and pilots
- Collaborative – Commonwealth of Virginia, federal agencies, national experts, academia, NGOs, consultants, and DuPont



We are here in 2022



Enhanced Adaptive Management (EAM)

*Other Inputs include: Habitat condition improvements, permitting and implementation issues encountered and actual costs

Machine Learning Model Inputs

