Mercury Remediation of the South River, Virginia

Mike Liberati

DuPont Corporate Remediation

James Gaspard

Biochar Now

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Overview

- Background
- Remedial Concept
- BioChar Studies & Integration with Remedy

The South River Waynesboro, VA

south river SCIENCE TEAM

Front Royal - River mile 160

Massanutten Mountains

South Fork Shenandoah River

Shenandoah National Park

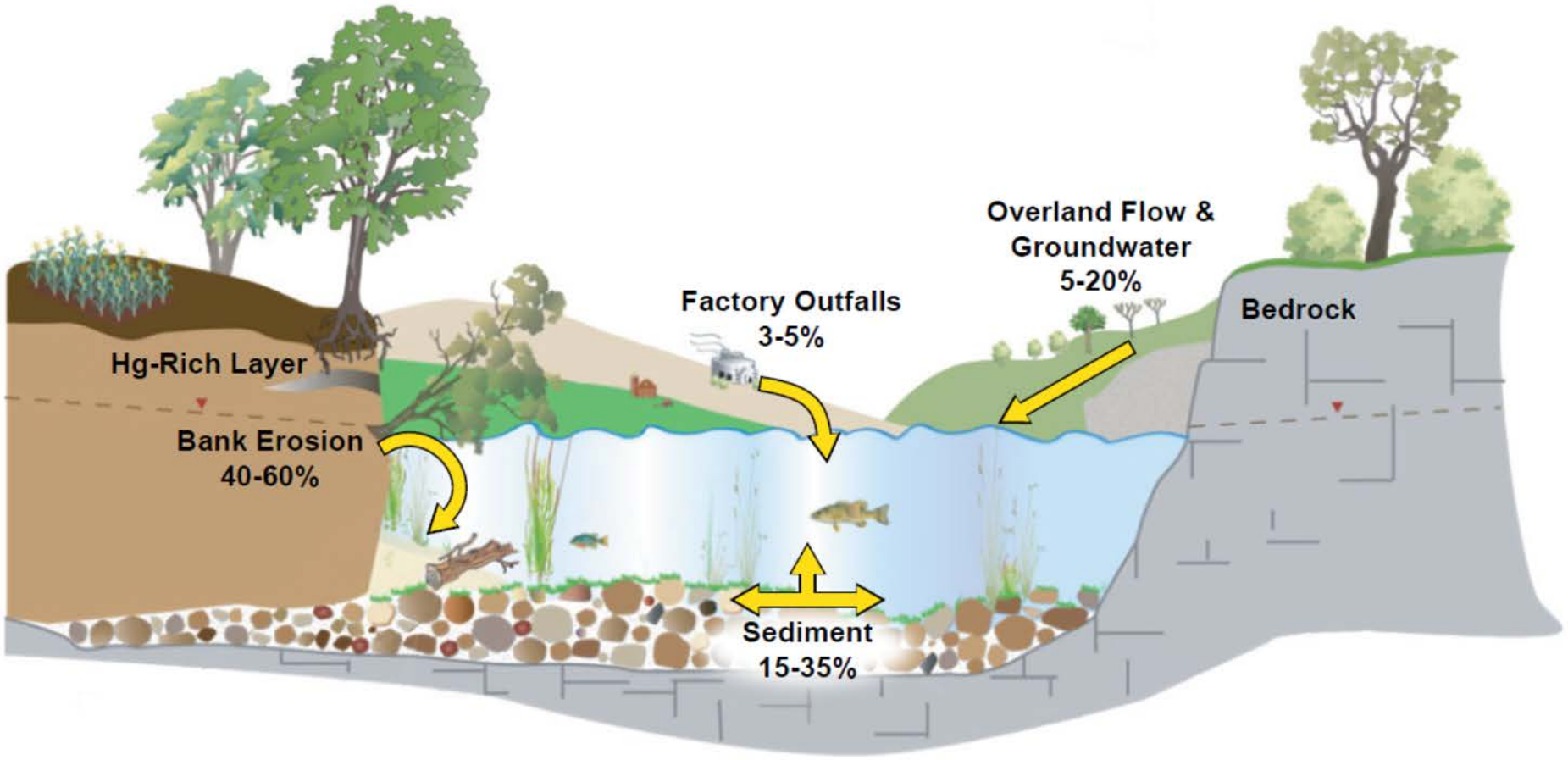
Port Republic - River mile 24

South River

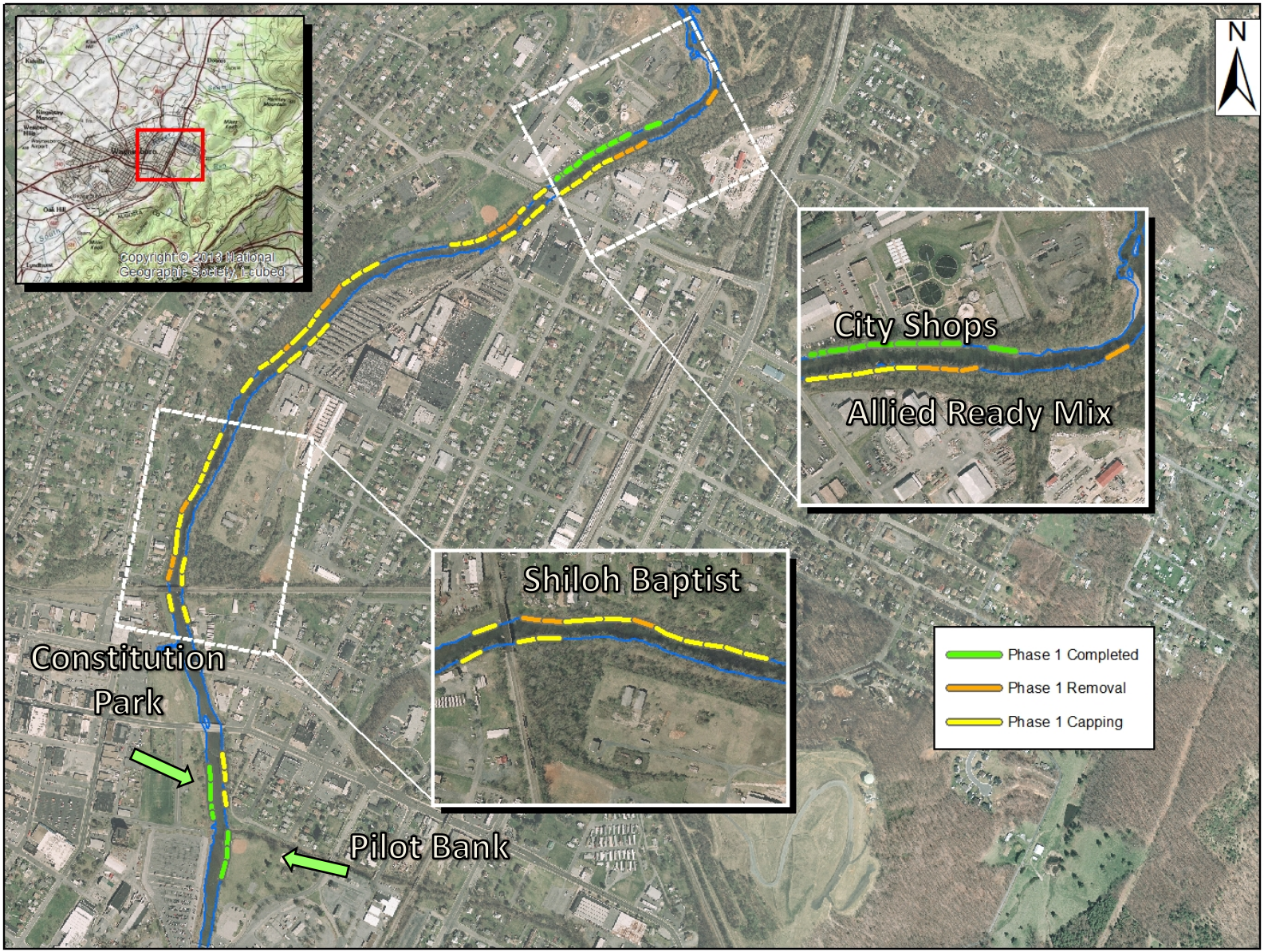
Waynesboro - River mile 0


Waynesboro, VA Fibers Plant
DuPont 1929 - 2004
INVISTA 2004 - present

South River: CONCEPTUAL SITE MODEL SCHEMATIC



Phase 1 - Bank Management Areas

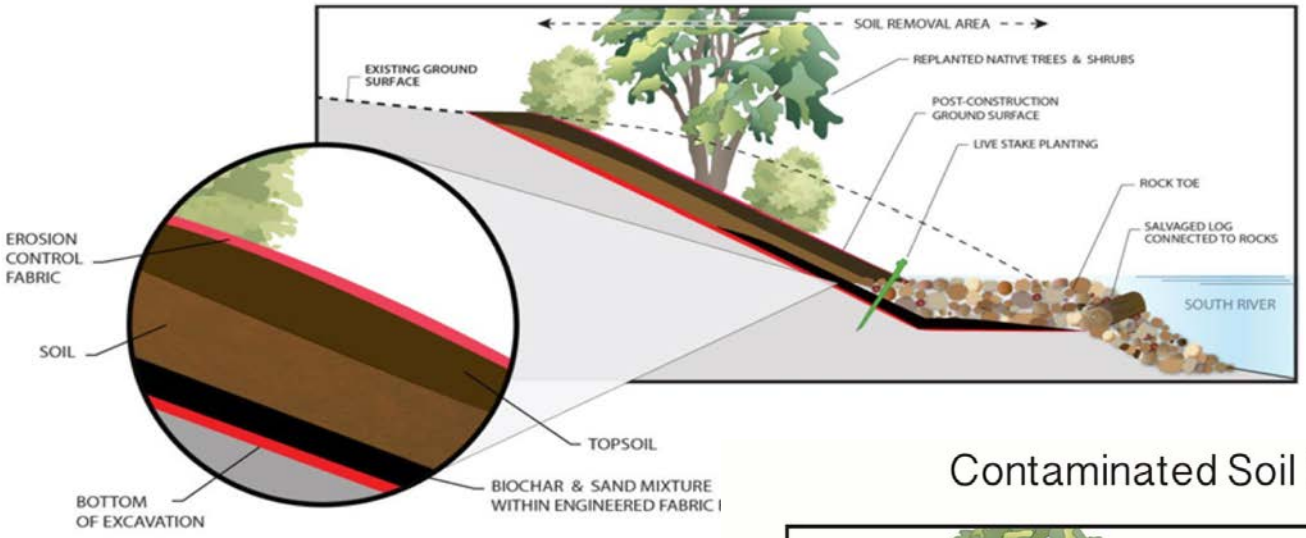


Remedial Design Criteria

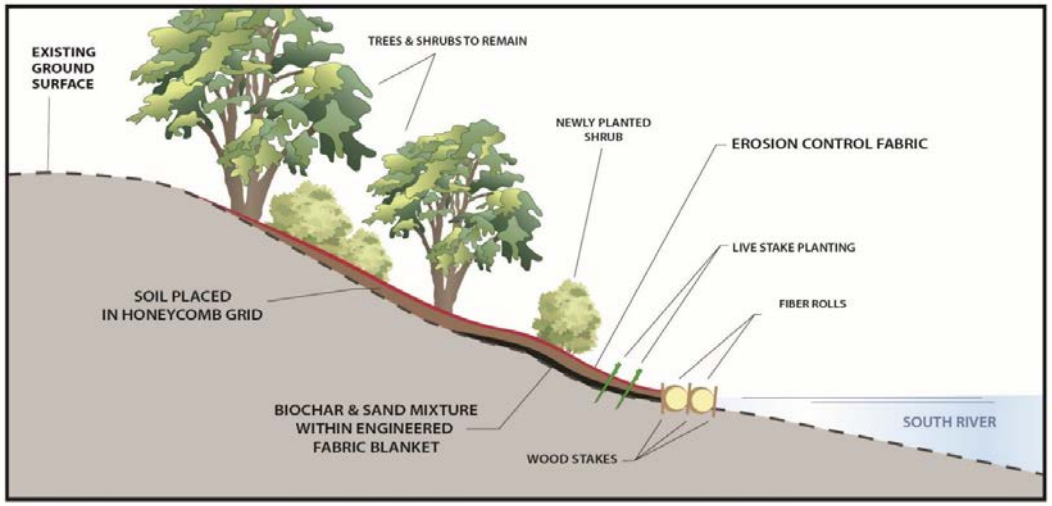
- Reduce mercury loading
- Maintain/improve habitat
- Minimize disruption
- Use proven/effective methods
- Address landowner concerns

Phase 1 Design Concepts

Contaminated Soil Removal Approach



Contaminated Soil Capping Approach



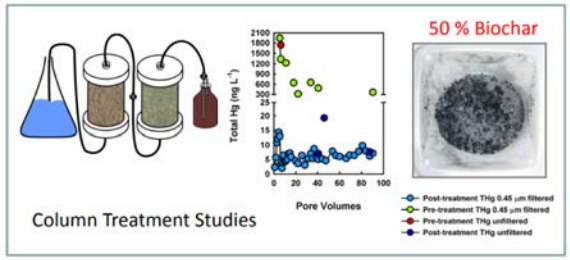
Evaluation of BioChar as Remedial Option

Technology Evaluation

- BioChar
- Activated Carbon
- Thiol SAMMS
- Polymeric Adsorption Resins

Laboratory Evaluation

- Column Studies
- Leachability Testing
- Ecological Impact



Field Pilots

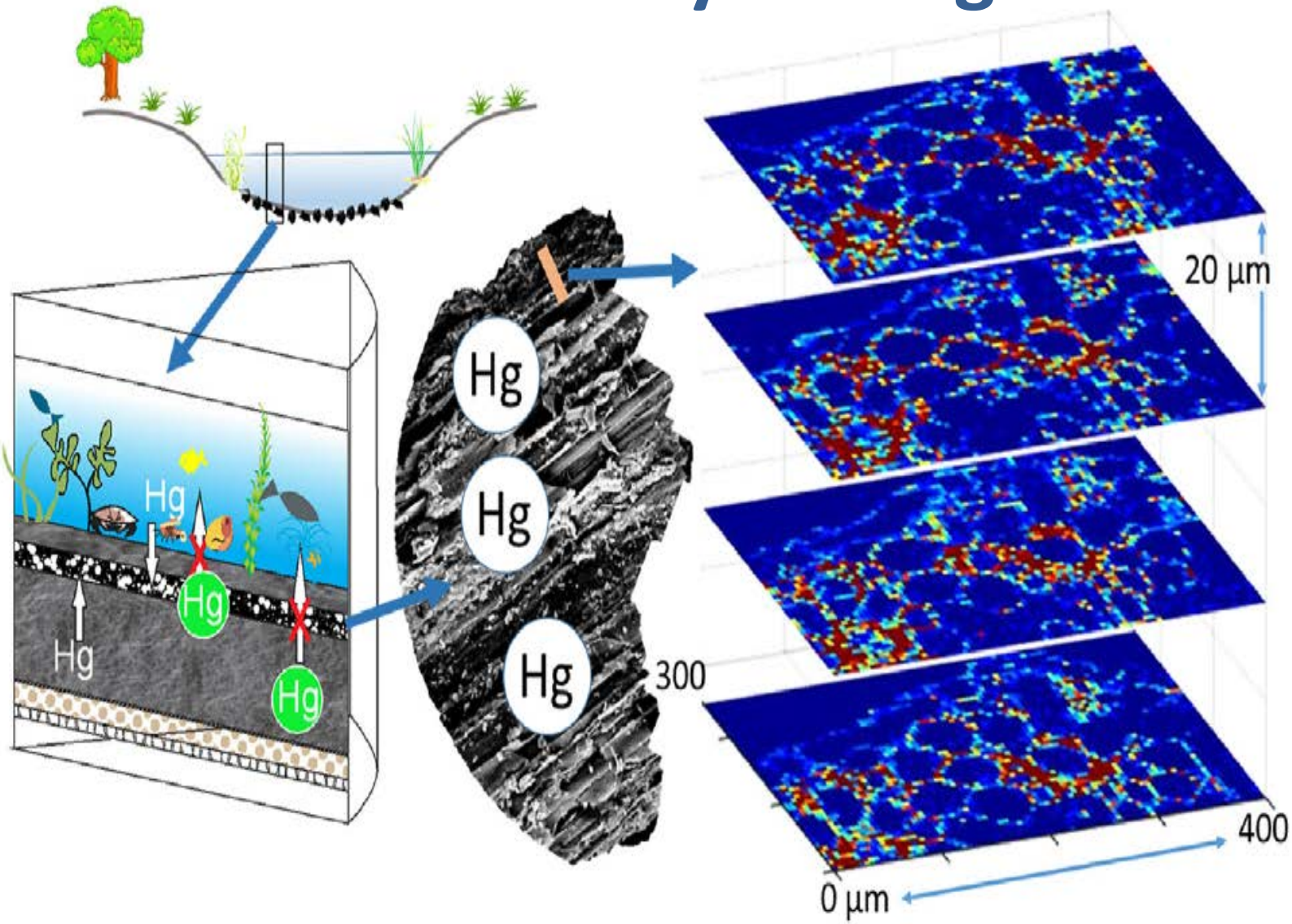
- Pond
- Floodplain
- Surface Water

Remedy Implementation

Technology Evaluation

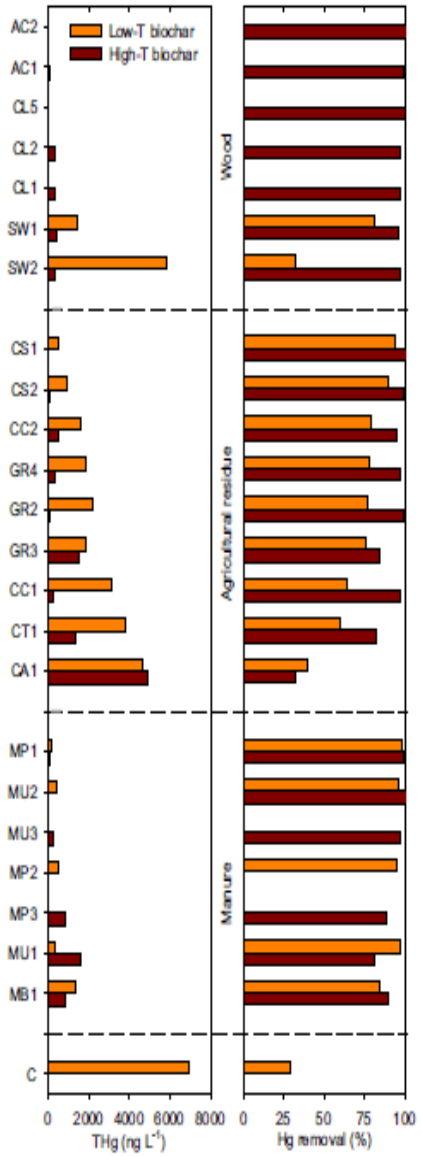
	Potential Sources	Remediation Target	Remedial Priority[1]	Remedial Alternatives / Remedial Approach	Status	Notes
External Sources	**Site Outfalls**	Reduce mercury loading to compartments in the aquatic environment	High: -Most upstream source -Relatively large inorganic mercury load -IHg from outfalls may be more available for methylation than other sources of IHg -May confound potential downstream remedies	On-Site source remediation (Sewers, sumps, soil)	Interim measures complete	-Mass load and variation are quantified. -Relative bioavailability of source is assumed to be high. -Time required for interim remedial measure success is not known.
				-Filtration	--	
				-Chemical manipulation: -Nalco Nalmet polymers -Thiol SAMMS -Activated carbon -Polymeric adsorption resins	--	
				-$SnCl_2$ reduction and air stripping	--	
	River Banks	Reduce mercury loading to compartments in the aquatic environment	High: -Potentially most significant source of mercury to the river system -Soil-derived IHg may be more available for methylation than sediment-derived IHg	Physical stabilization	Planned/ongoing ROP activity for 2012-2013	-Length of time to achieve desired objective is uncertain -Longevity of stabilization
				Chemical Stabilization: -Carbon amendment	--	Length of time to achieve desired objective uncertain
				Best Management Practices: -Livestock management	--	--
				Removal		Soil may be removed as part of physical stabilization
				Increase sorption capacity: -Clay minerals -Modified organoclays -Thiol SAMMS		-Behavior/efficacy of amendments if eroded/inundated not known -Potential for deleterious ecological effects unknown
	Floodplain Runoff	Reduce mercury loading to compartments in the aquatic environment	Low: -Floodplain (adjacent to eroding banks) contributes less than 10% of total load between RRM 0 and 10	Sediment traps	--	-The importance of floodplain runoff is not known but considered low based on CSM
				Rerouting river/runs	--	
				Flood control measures (e.g., increase storage capacity)	--	
Internal Sources	**Fine-grained Sediment Deposits**	Reduce importance as MeHg source to aquatic environment	High: -Areas support high potential rates of mercury methylation	Monitored natural recovery[2]	Planned/ongoing ROP activity for 2012-2013	Importance of MeHg produced in bulk sediment vs. other habitats to overall food web burden not known
				-(Im)permeable and/or reactive cap: -carbon amendment and/or coagulant	Planned/ongoing ROP activity for 2012-2013	Changes in hydraulic sheer stress over time could destabilize cover
				Removal	--	Removal may expose higher mercury concentrations buried at depth
				Large woody debris management	--	--
				Maintenance/filling ditches/millraces	--	Account for very small proportion of MeHg to system
				Aeration/oxidation	--	-Effectiveness questionable uncertain -Bioavailability of IHg in sediment over time
	Interstitial sediment	Reduce importance as MeHg source to aquatic environment	Moderate: -Areas support high potential rates of mercury methylation	Monitored natural recovery[2]	Planned/ongoing ROP activity for 2012-2013	Reduced bioavailability of IHg over time unknown
				-(Im)permeable and/or reactive cap: -carbon amendment and/or coagulant	Planned/ongoing ROP activity for 2012-2013	Change in hydraulic sheer stress may occur over time
				Aeration/oxidation	--	--
	Water Column	Reduction in mercury concentrations	Moderate -Important exposure medium for base of the food web -Water column is an important transport pathway	Monitored natural recovery[2]	Planned/ongoing ROP activity for 2012-2013	Length of time to achieve desired objective unknown
				Chemical treatment: -e.g., carbon sorbent	Planned/ongoing ROP activity for 2012-2013	-Proportion of volume that must be treated unknown -Longevity of treatment unknown
				Phytoremediation	--	--
				Aeration/oxidation	--	Unlikely that areas of methylation will respond to water column treatment

Laboratory Testing



P. Liu, C. J. Ptacek, D. W. Blowes, Y. Z. Finfrock, R. A. Gordon (2017) Stabilization of mercury in sediment by using biochars under reducing conditions. Journal of Hazardous Materials 325:120-128

Laboratory Testing



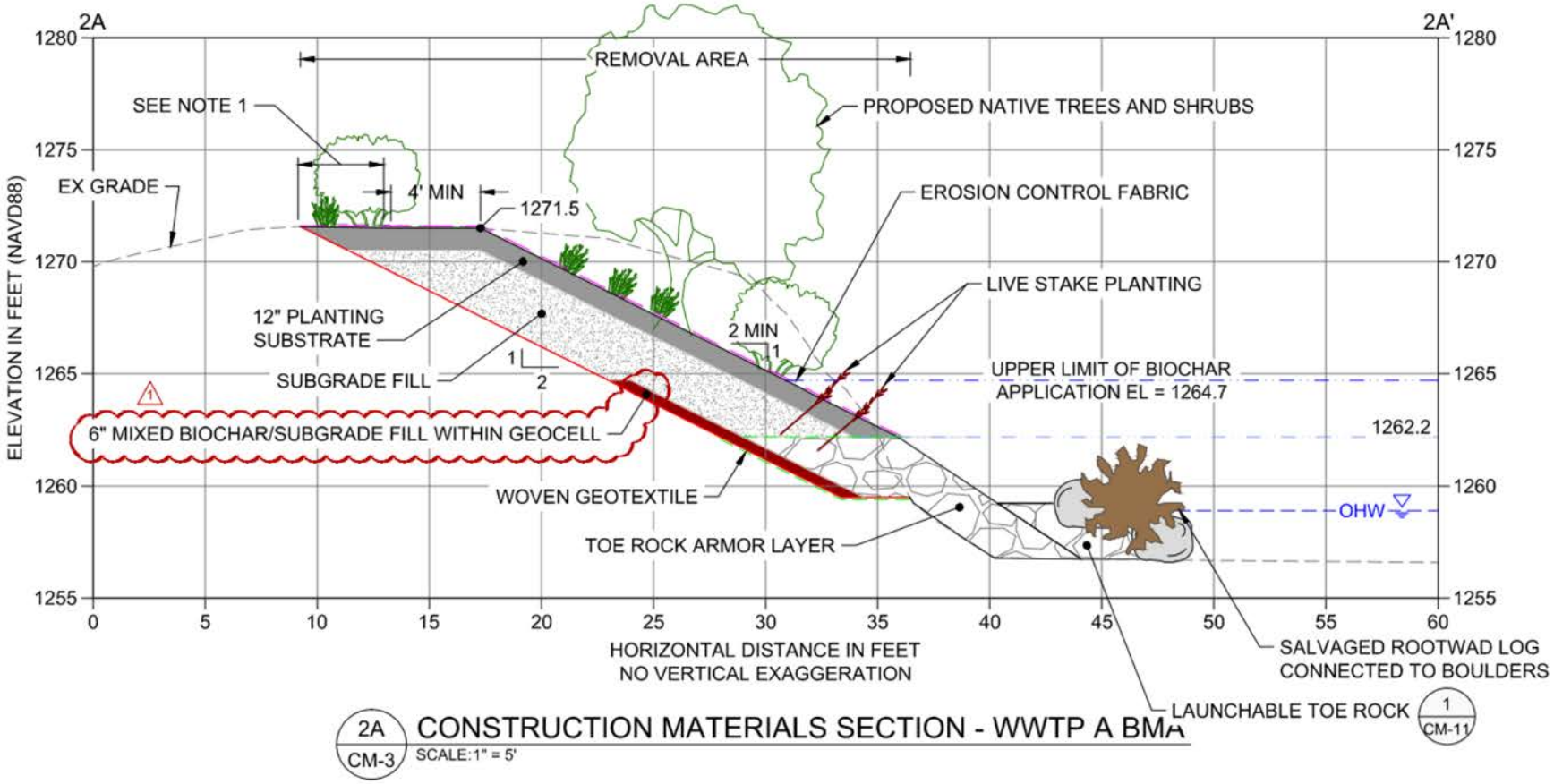
Total Hg concentrations and %Hg removal from aqueous solution in batch tests containing biochar and river water spiked with Hg. C represents the control containing Hg-spiked river water with no biochar added.

P. Liu, C. Ptacek, D. W. Blowes, R.C. Landis (2016) Mechanisms of mercury removal by biochars produced from different feedstocks determined using X-Ray absorption spectroscopy. Journal of Hazardous Materials 308:233-242

Floodplain Pilot

Pond & Surface Water Pilots

Remedy Implementation



Remedy Implementation

Evolution of BioChar Implementation

- Initially 50/50 Mix BioChar/Soil
- Reduced to 15% by weight using new source of BioChar
- Identified more cost effective delivery mechanism

AquaGATE+

BioChar

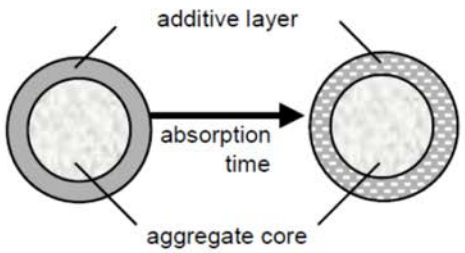
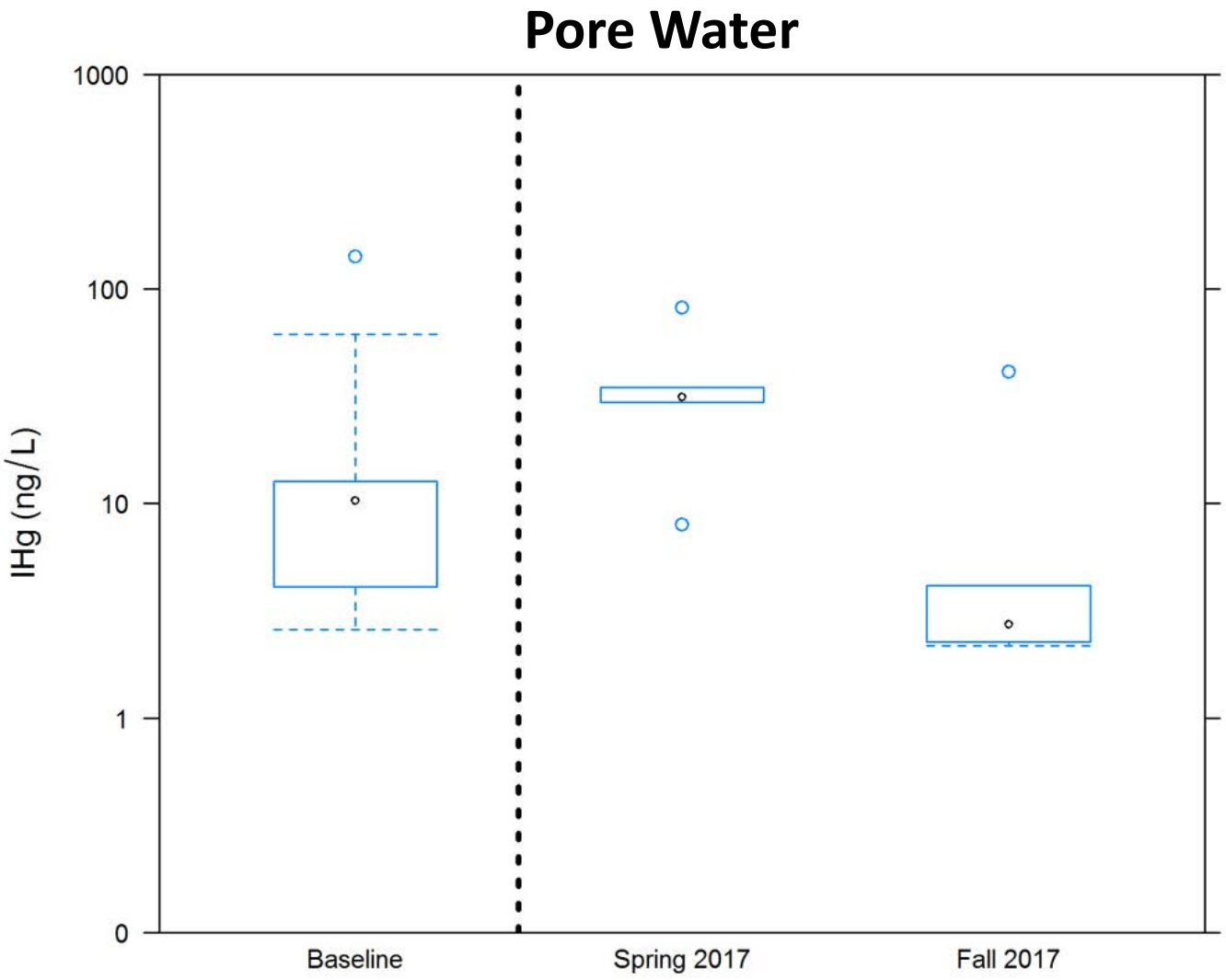


Figure 1. Configuration of PAC-coated particle.

AquaGate+PAC serves as a delivery mechanism to reliably place reactive capping materials into aquatic environments.

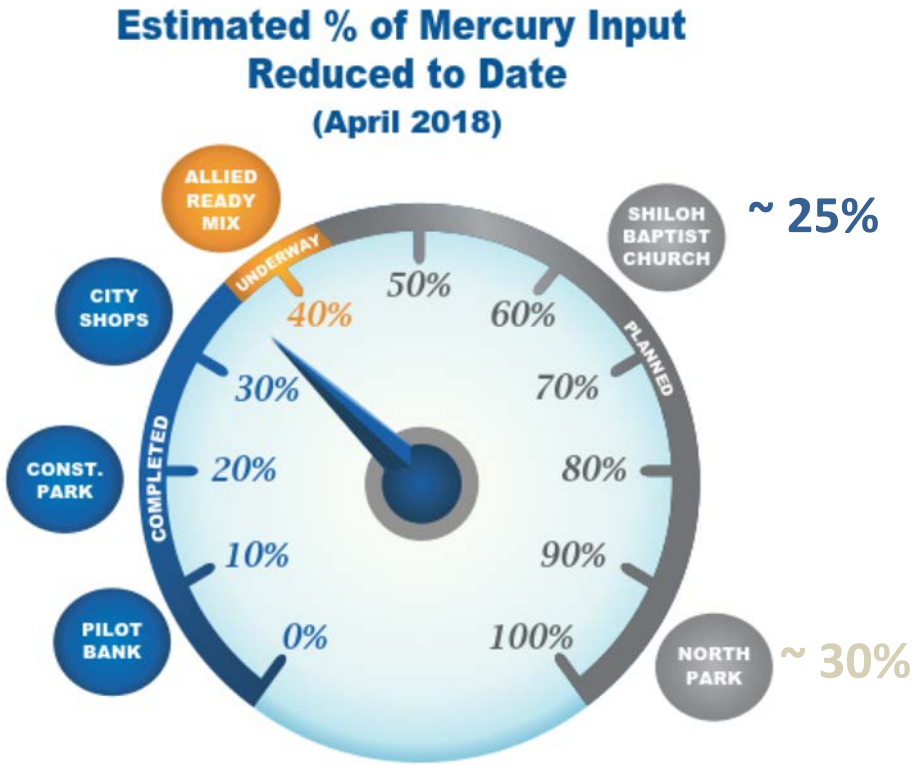
1st Completed Remedy

Monitoring Effectiveness



What's Next?


BASIC PARK
COMPLETE
CITY SHOPS
UNDERWAY
ALLIED READY MIX
PLANNED
NORTH PARK
2ND ST. BRIDGE
PLANNED
SHILOH BAPTIST CHURCH
RAILROAD
COMPLETE
BROAD ST. BRIDGE
MAIN ST. BRIDGE
CONSTITUTION PARK
ROCKFISH RUN
COMPLETE
PILOT BANK
FORMER DUPONT WAYNESBORO PLANT


Estimated % of Mercury Input Reduced to Date
(April 2018)
ALLIED READY MIX
SHILOH BAPTIST CHURCH
~ 25%
CITY SHOPS
UNDERWAY
PLANNED
CONST. PARK
COMPLETED
PILOT BANK
NORTH PARK
~ 30%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

Proven Manufacturing

Production kilns

Biochar Now

1200X