



Mercury Remediation of the South River, Virginia

Mike Liberati

DuPont Corporate Remediation

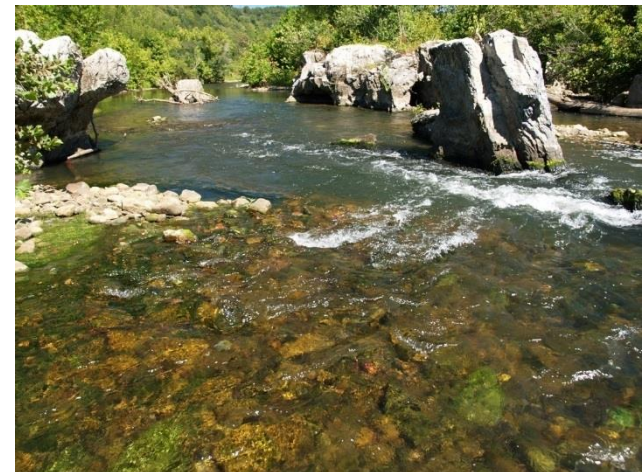
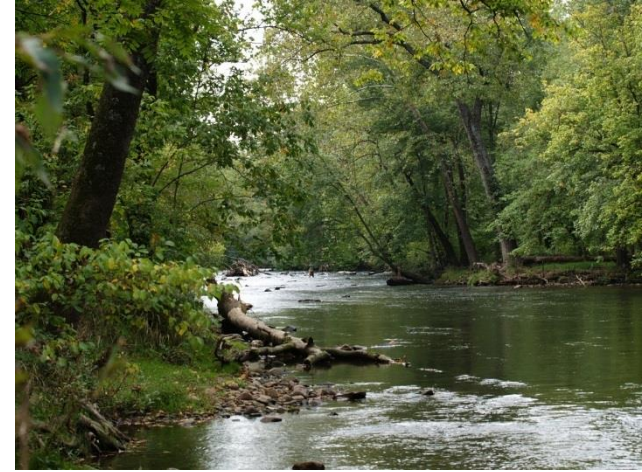
James Gaspard

Biochar Now

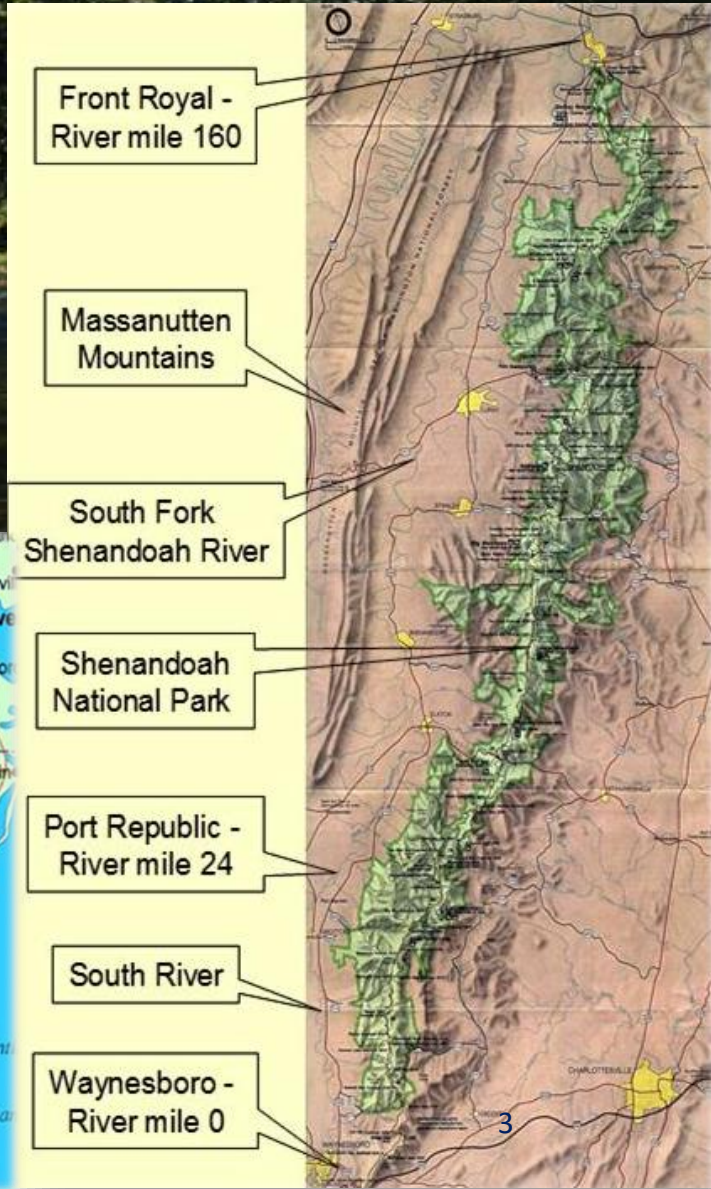
USBI Biochar 2018 Conference-August 22, 2018

Overview

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



The South River Waynesboro, VA



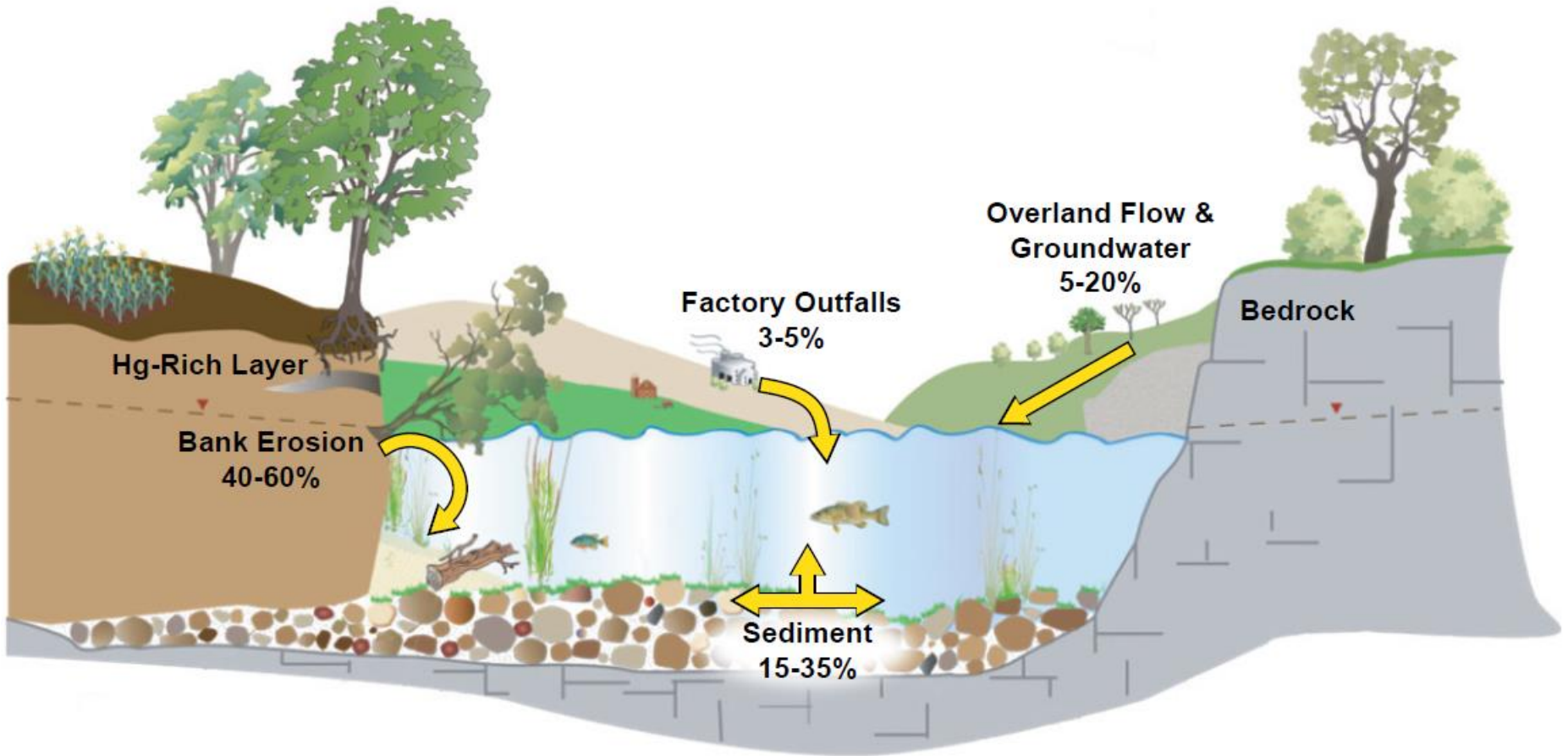
Waynesboro, VA Fibers Plant

DuPont 1929 - 2004

INVISTA 2004 - present

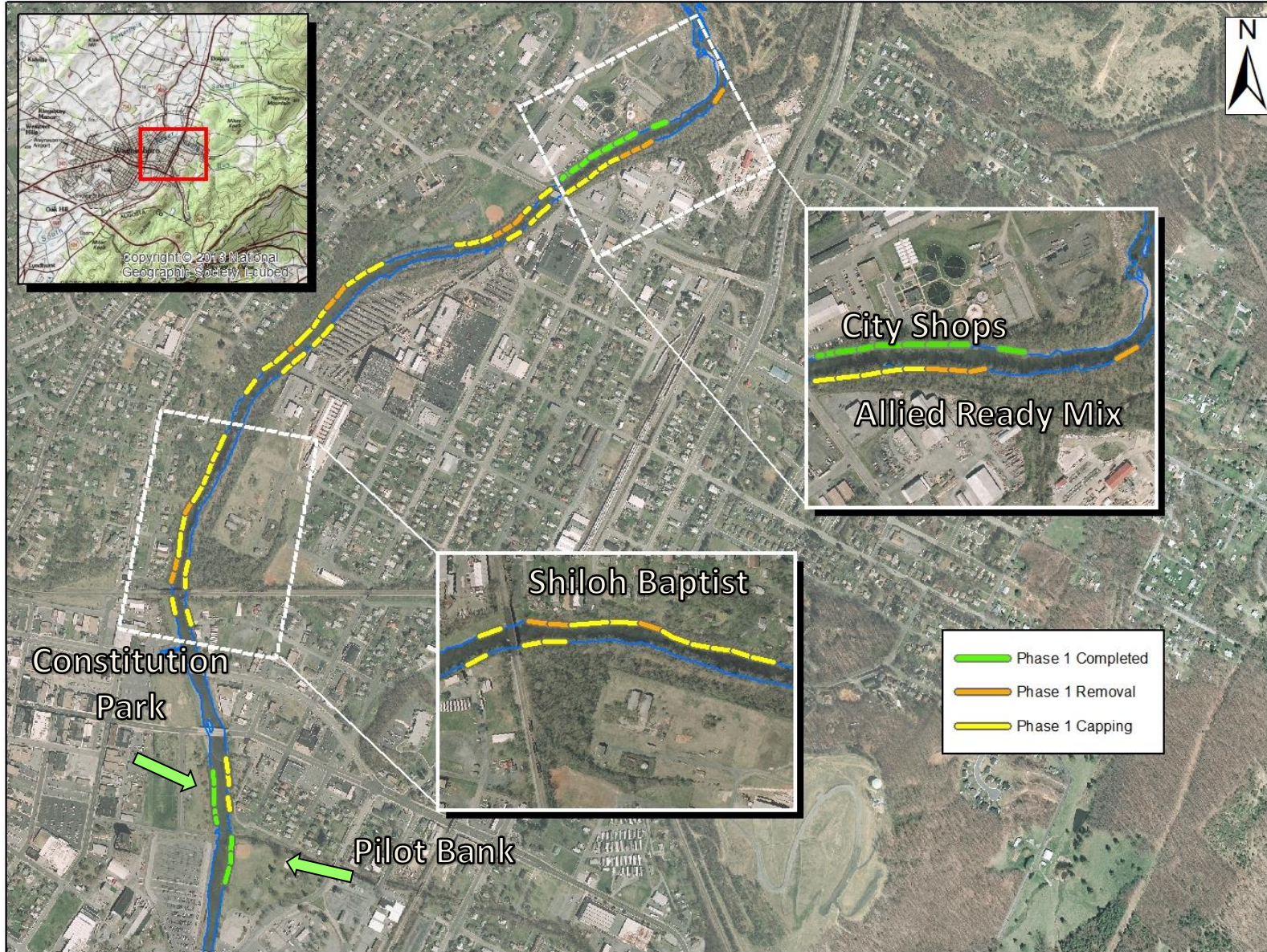


**South River: CONCEPTUAL SITE
MODEL SCHEMATIC**





Phase 1 - Bank Management Areas



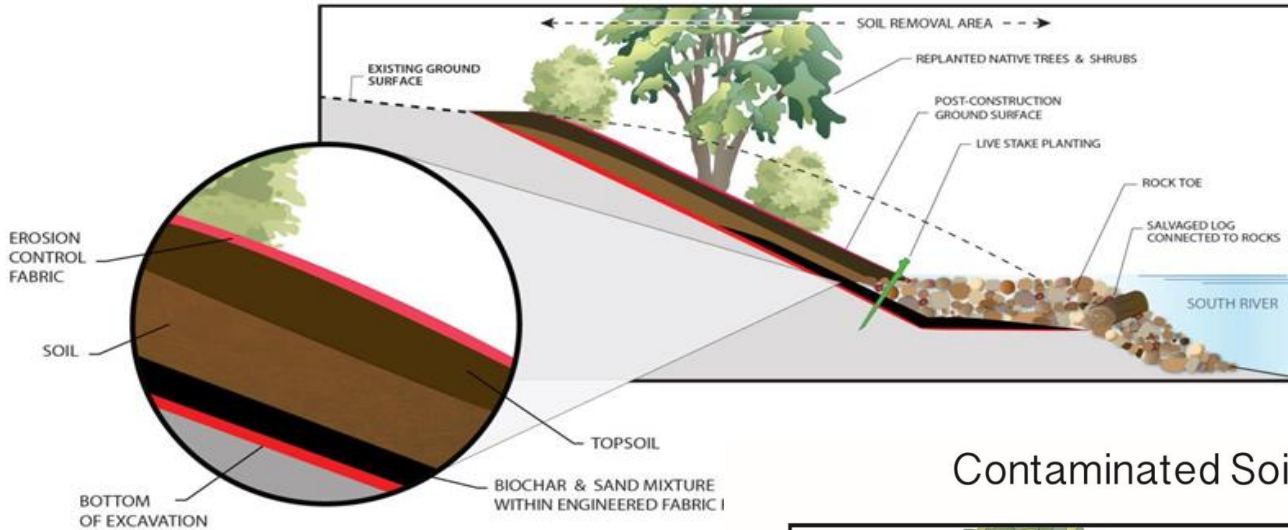
Remedial Design Criteria

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

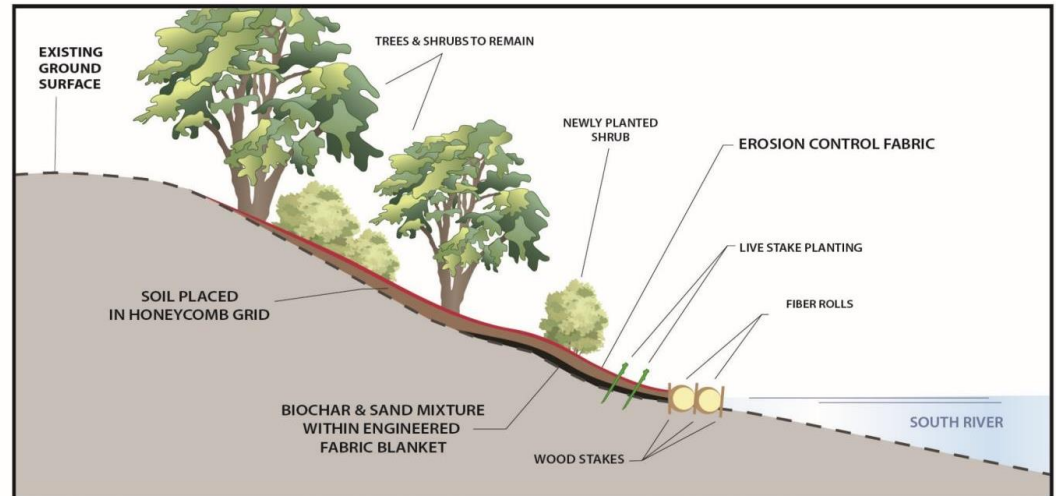


Phase 1 Design Concepts

Contaminated Soil Removal Approach



Contaminated Soil Capping Approach



Evaluation of BioChar as Remedial Option

Technology Evaluation

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

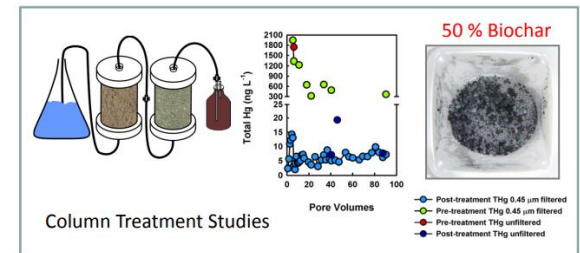
Laboratory Evaluation

- Column Studies
- Leachability Testing
- Ecological Impact
























Field Pilots

- Pond
- Floodplain
- Surface Water

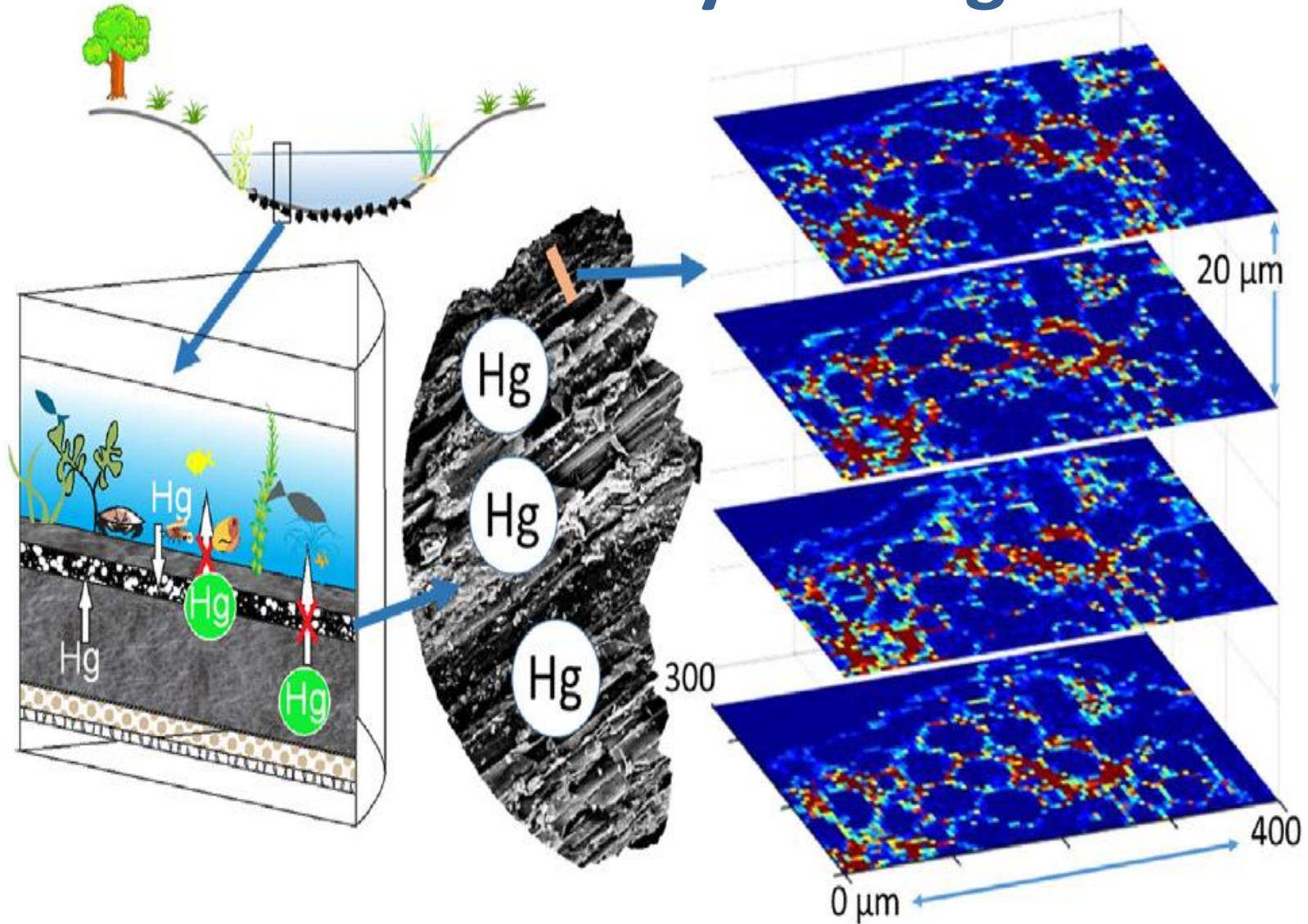
Remedy Implementation



Technology Evaluation

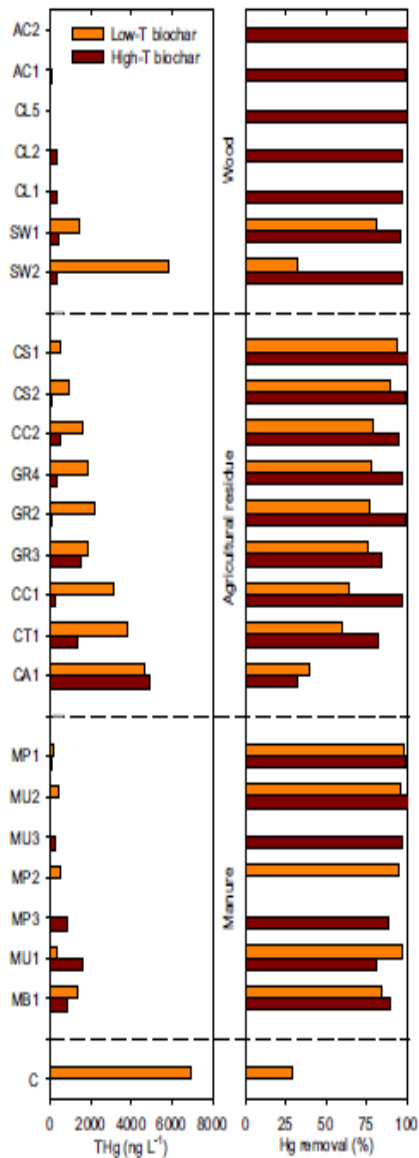
	Potential Sources	Remediation Target	Remedial Priority ¹	Remedial Alternatives / Remedial Approach	Status	Notes
External Sources	Site Outfalls	Reduce mercury loading to compartments in the aquatic environment	High: -Most upstream source -Relatively large inorganic mercury load -IHg from outfalls may 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				--	--	
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 shear 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 shear 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

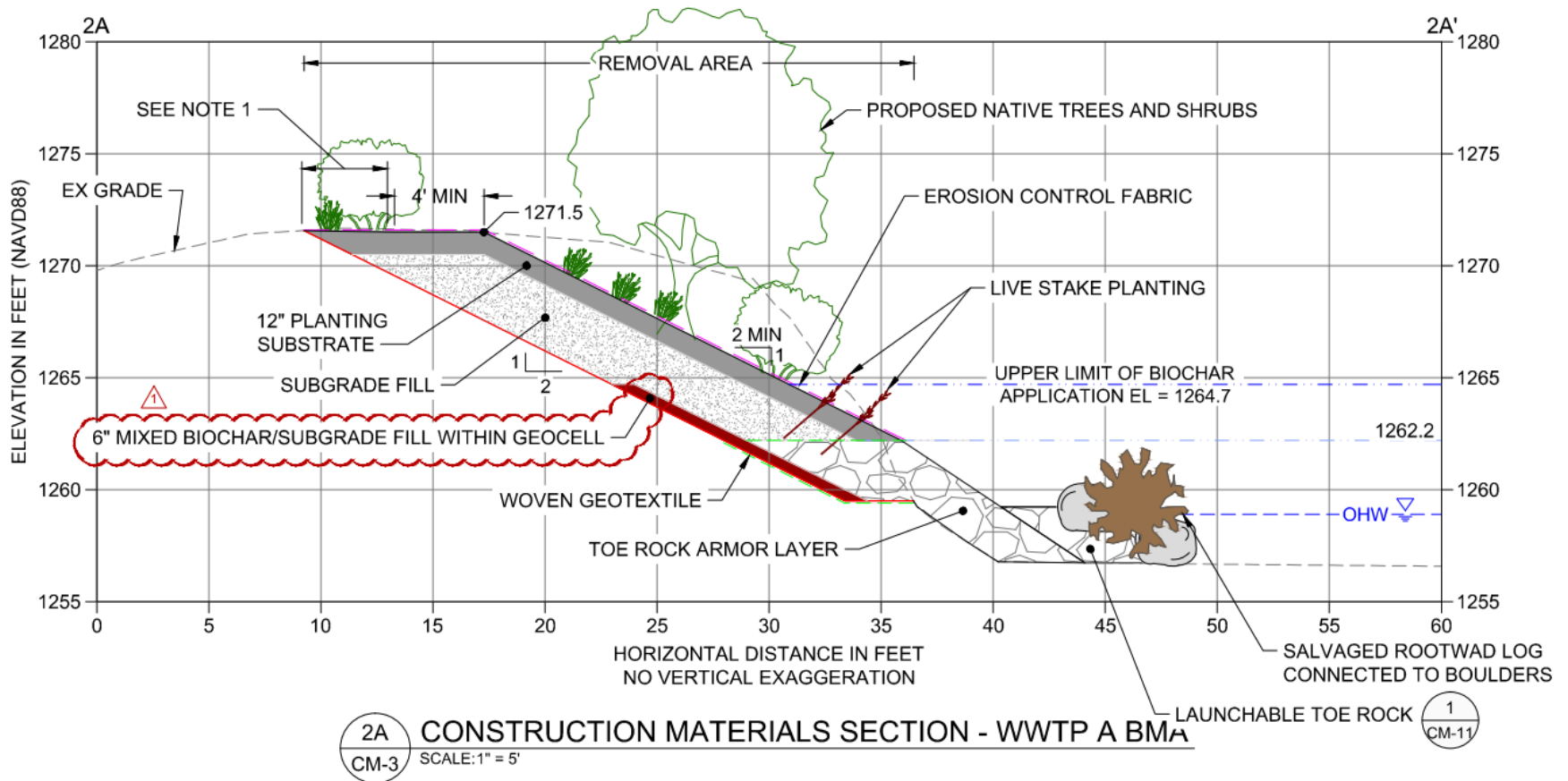
Floodplain Pilot



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

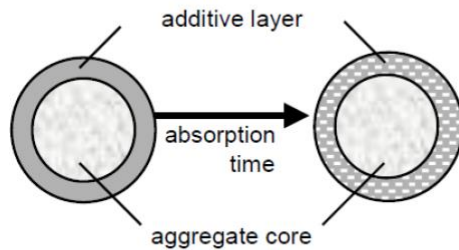


Figure 1. Configuration of PAC-coated particle.

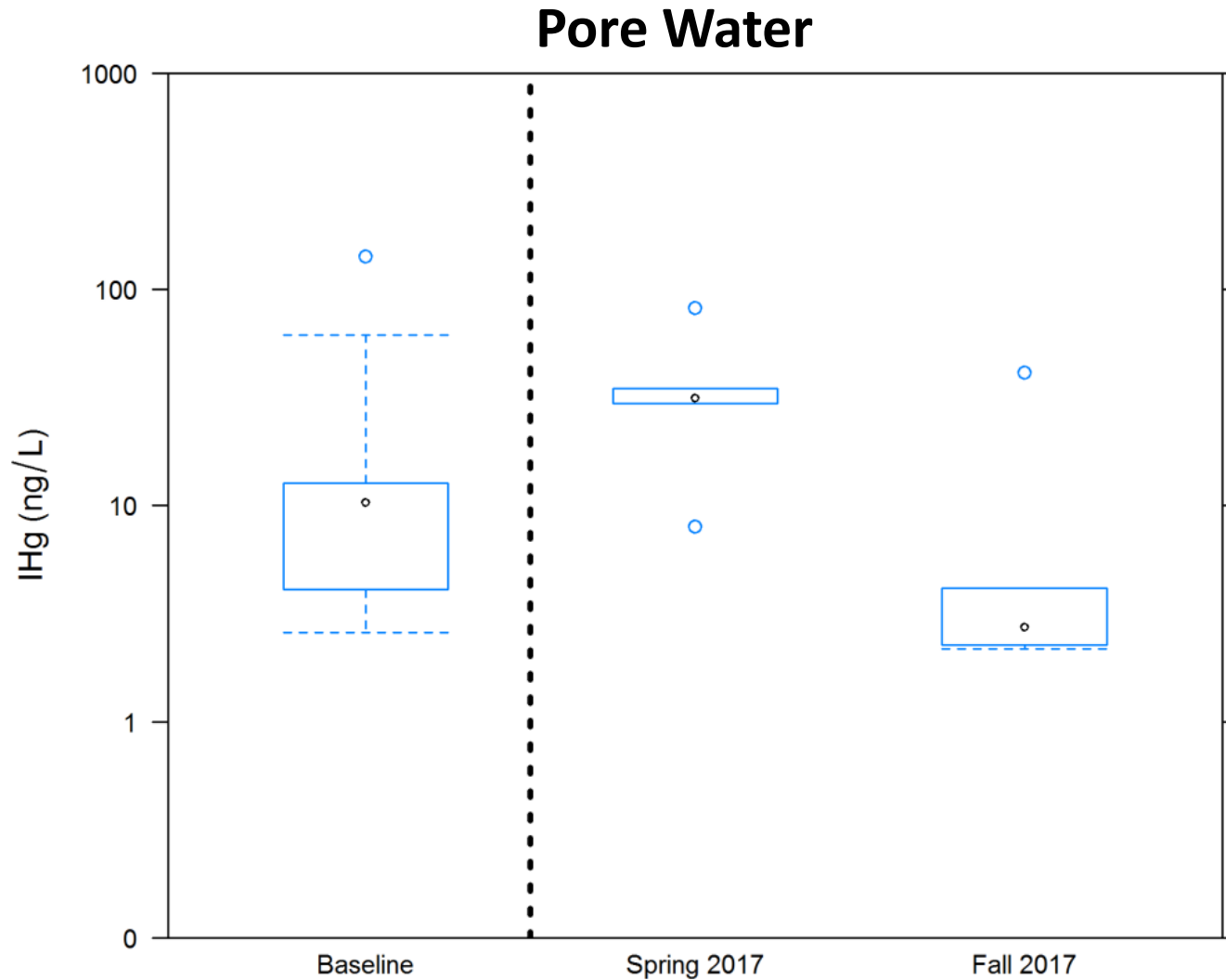
AquaGate+PAC serves as a delivery mechanism to reliably place reactive capping materials into aquatic environments.



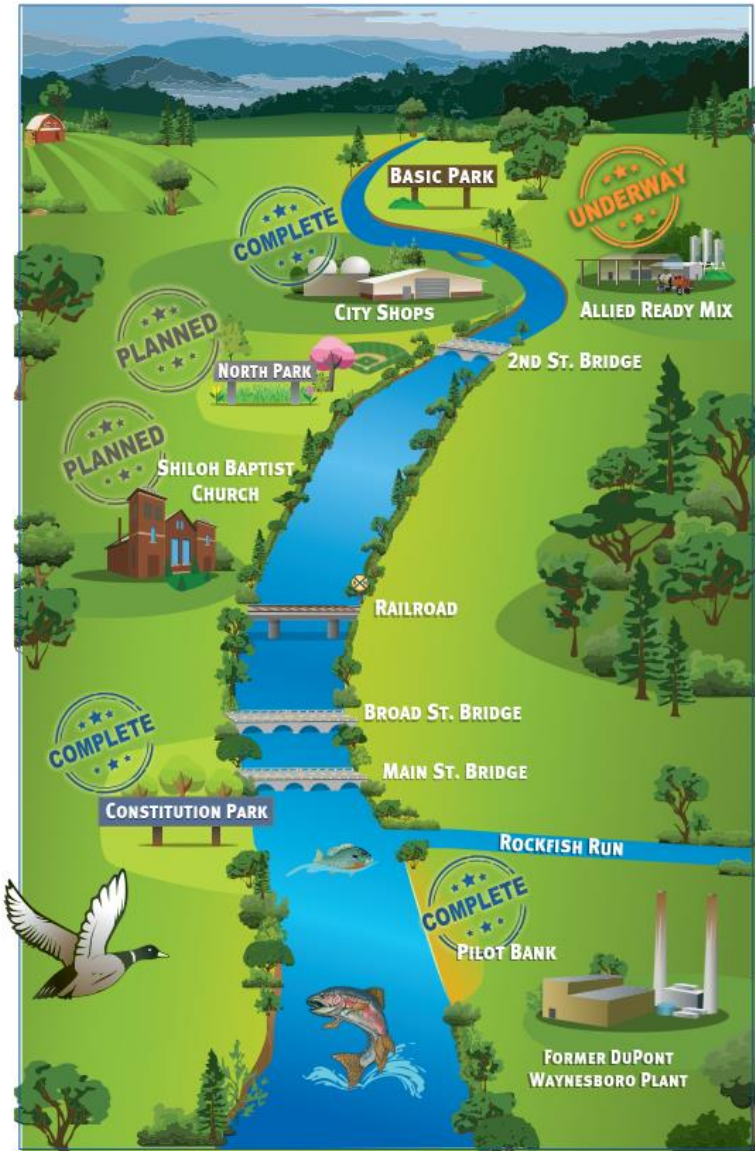
1st Completed Remedy



Monitoring Effectiveness



What's Next?



Estimated % of Mercury Input Reduced to Date (April 2018)

