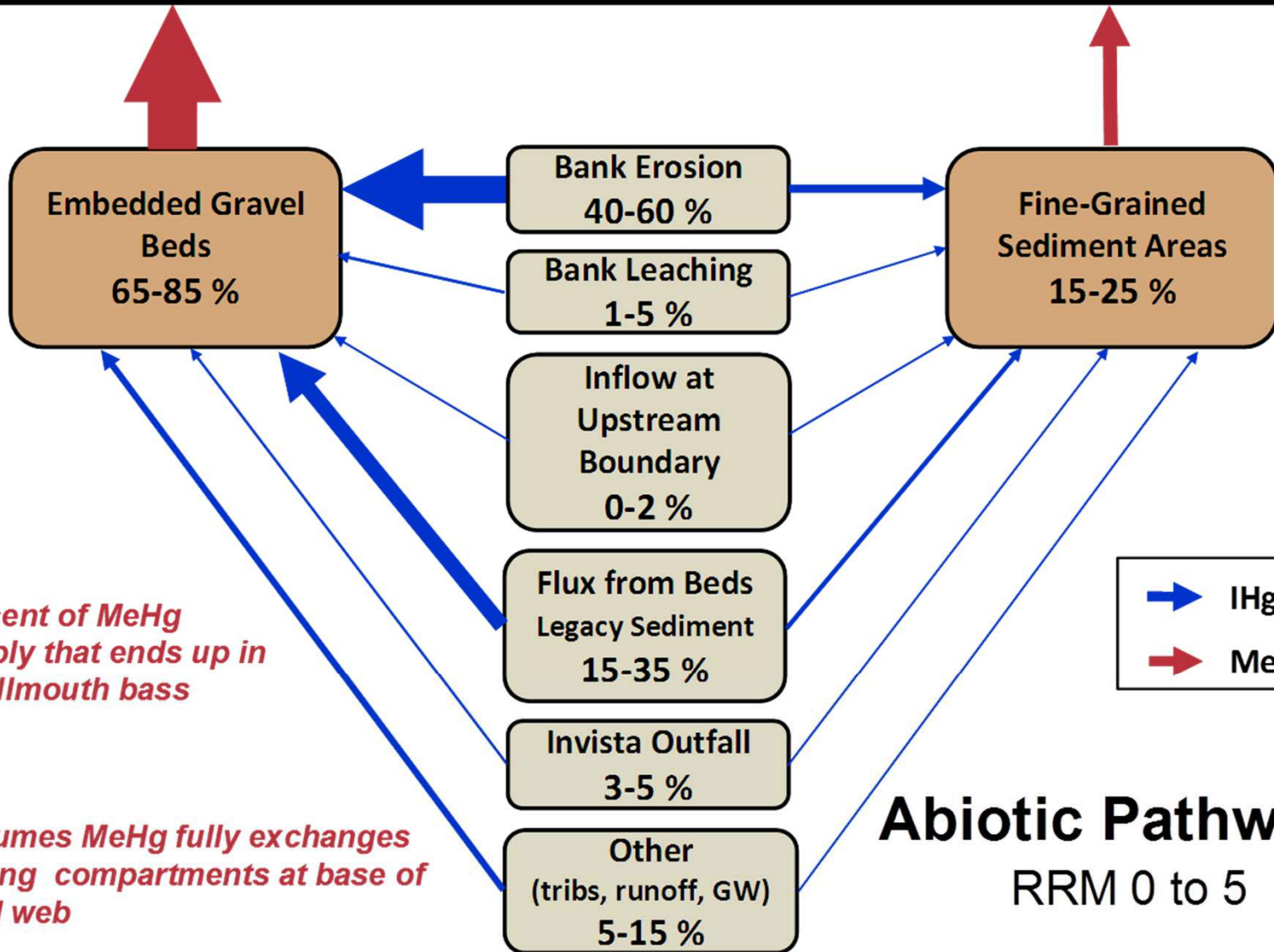
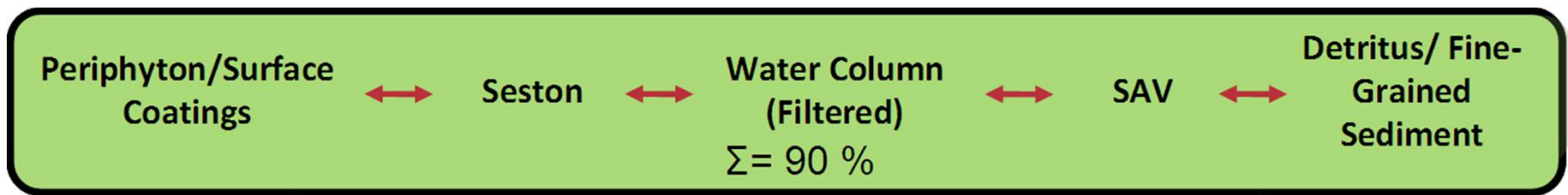


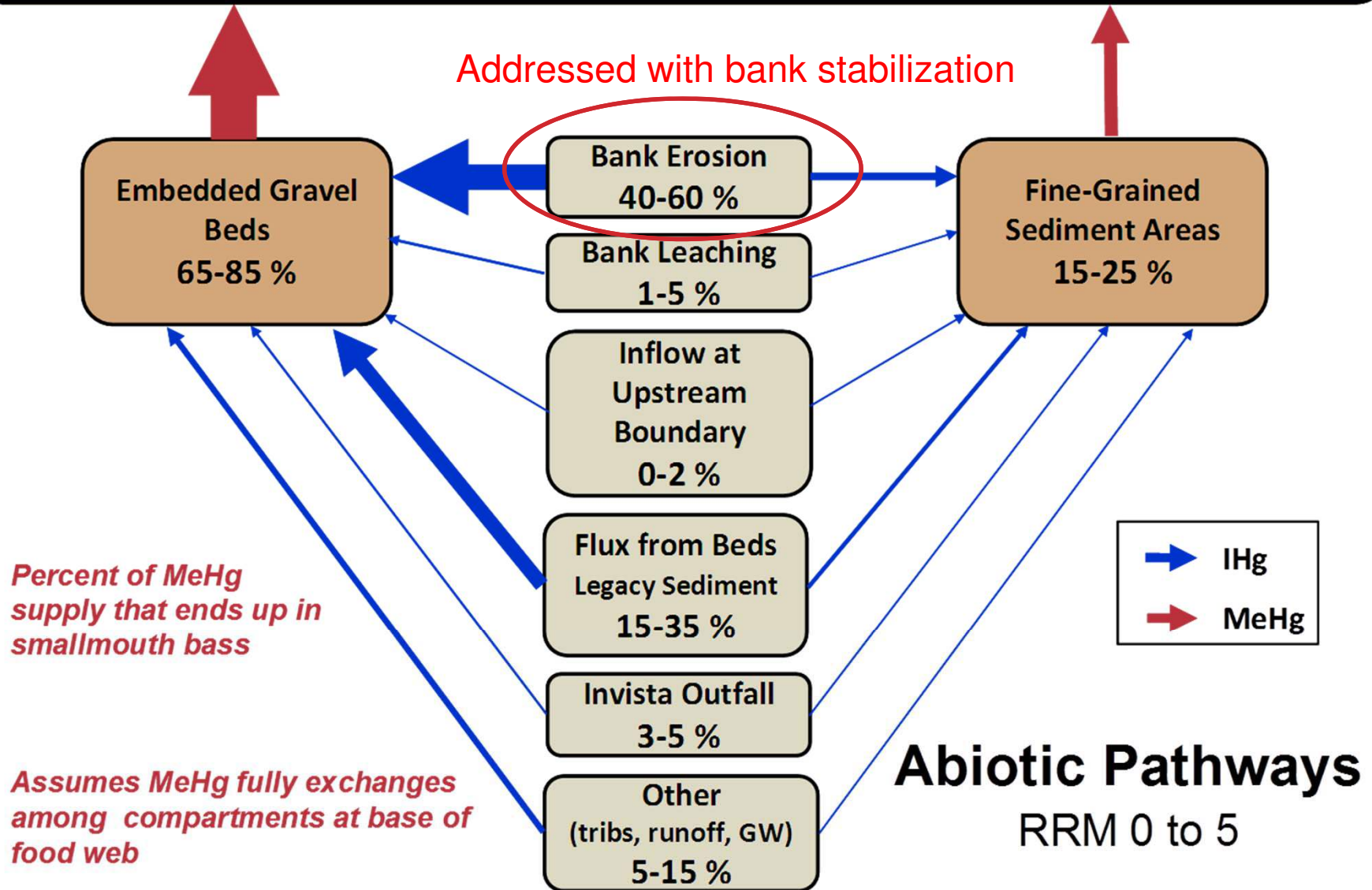
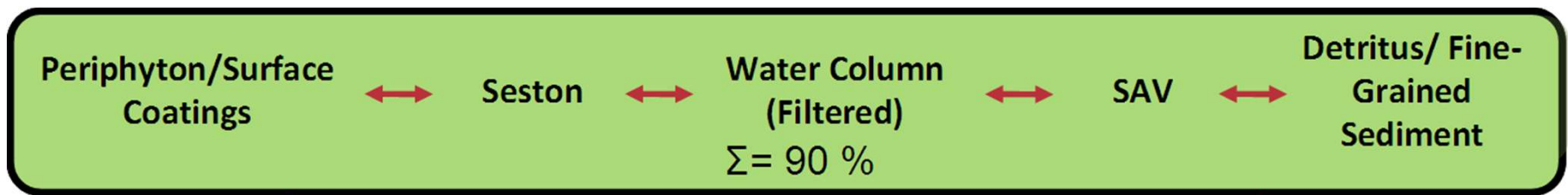
Biochar Amendment Discussion

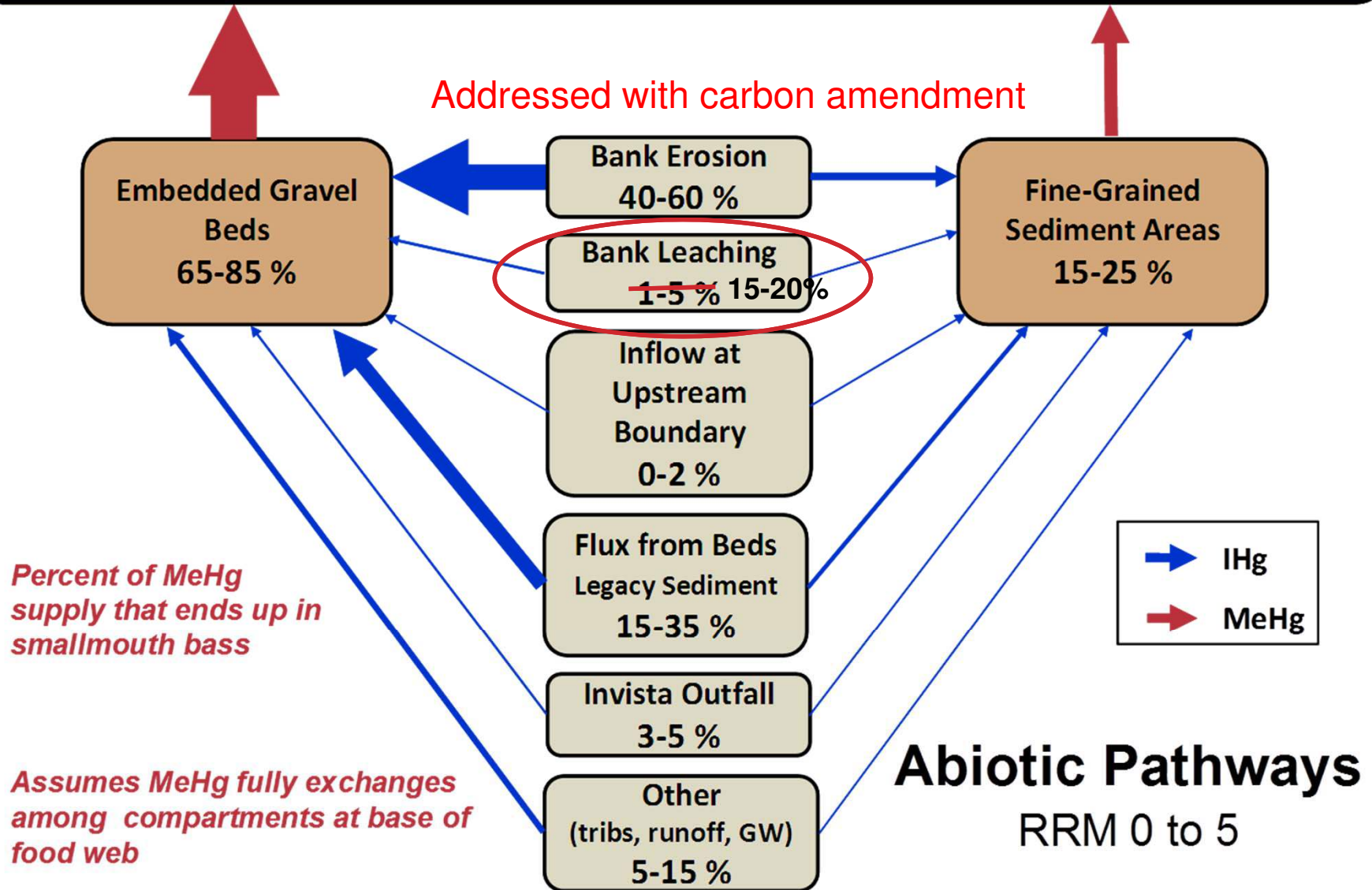
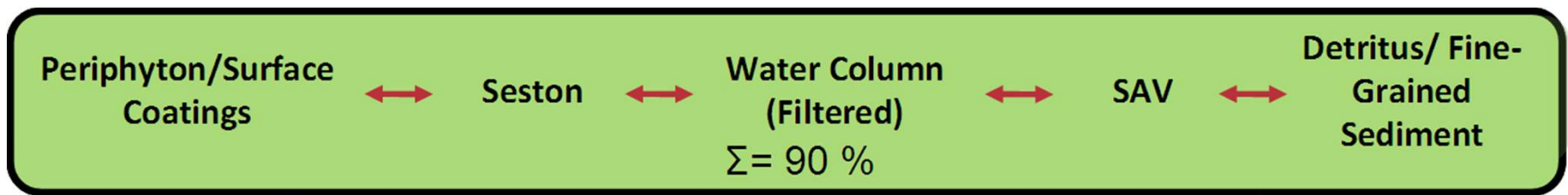
- Action Item from October Expert Panel Meeting
 - Hold a workshop to discuss the possibility of adding biochar to bank stabilization remediation designs
 - Goals:
 - Identify potential pros and cons
 - Identify possible unintended consequences
 - Approach
 - Jim Dyer presented a summary of carbon adsorption studies
 - Clay Patmont presented summary of carbon amendment applications worldwide
 - Group participated in a facilitated discussion to reach consensus



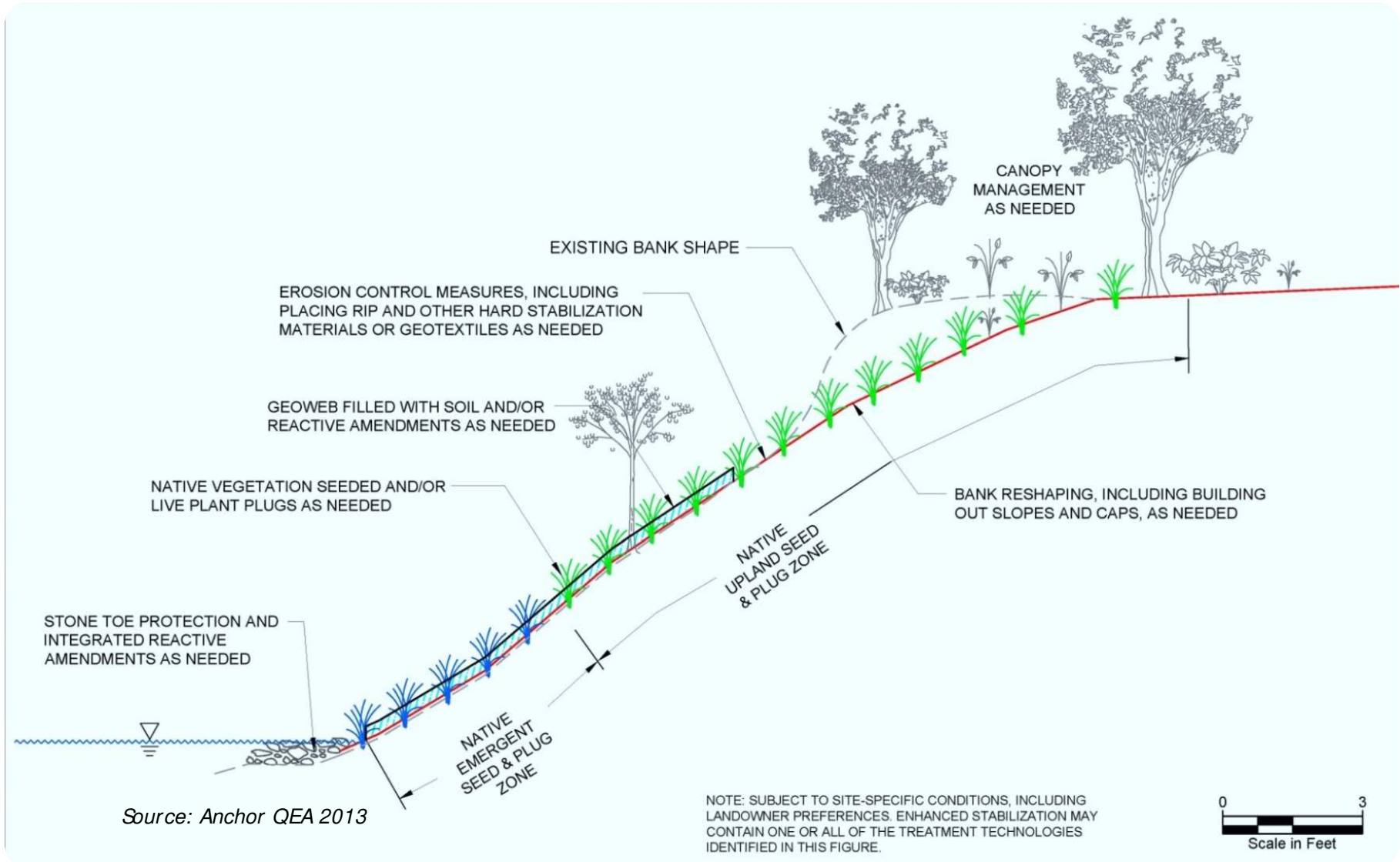
Percent of MeHg supply that ends up in smallmouth bass

Assumes MeHg fully exchanges among compartments at base of food web





Engineering Options for Incorporating Carbon into SR Bank Stabilization Designs



SR Carbon Amendment Studies (from Jim)



Jim summarized findings from various SRST studies

- University of Waterloo
- Pond Pilot
- Floodplain Pilot
- James Madison University
- Smithsonian Environmental Research Center
- Virginia Institute of Marine Science

Key Carbon Learnings To Date (from Jim)

- Source material, pyrolysis temperature and particle size important considerations
- Carbon quite effective at removing IHg & MeHg from aqueous phase regardless of speciation
- Carbon amendments generally reduce MeHg uptake by invertebrates
- “Spent” carbon resistant to desorption by SR water and acid rain

Key Carbon Learnings To Date (from Jim)



- Column studies suggest steep breakthrough curve, meaning that shallow beds of carbon may be effective
- However, in aquatic environment, carbon susceptible over time to biological fouling and reduced effectiveness
- Adsorptive structures tested so far limited by reactive surface area exposed to flow and contact time
- Varied results to date on carbon impacts on invertebrate communities

Clay Summarized Findings at Carbon Amendment Application Sites (from Clay)

- More than 25 field application sites worldwide
- Used for a variety of contaminants (PCBs, PAHs, Dioxin, etc.)
- Show promise for reducing fluxes to water column and biological uptake

United States

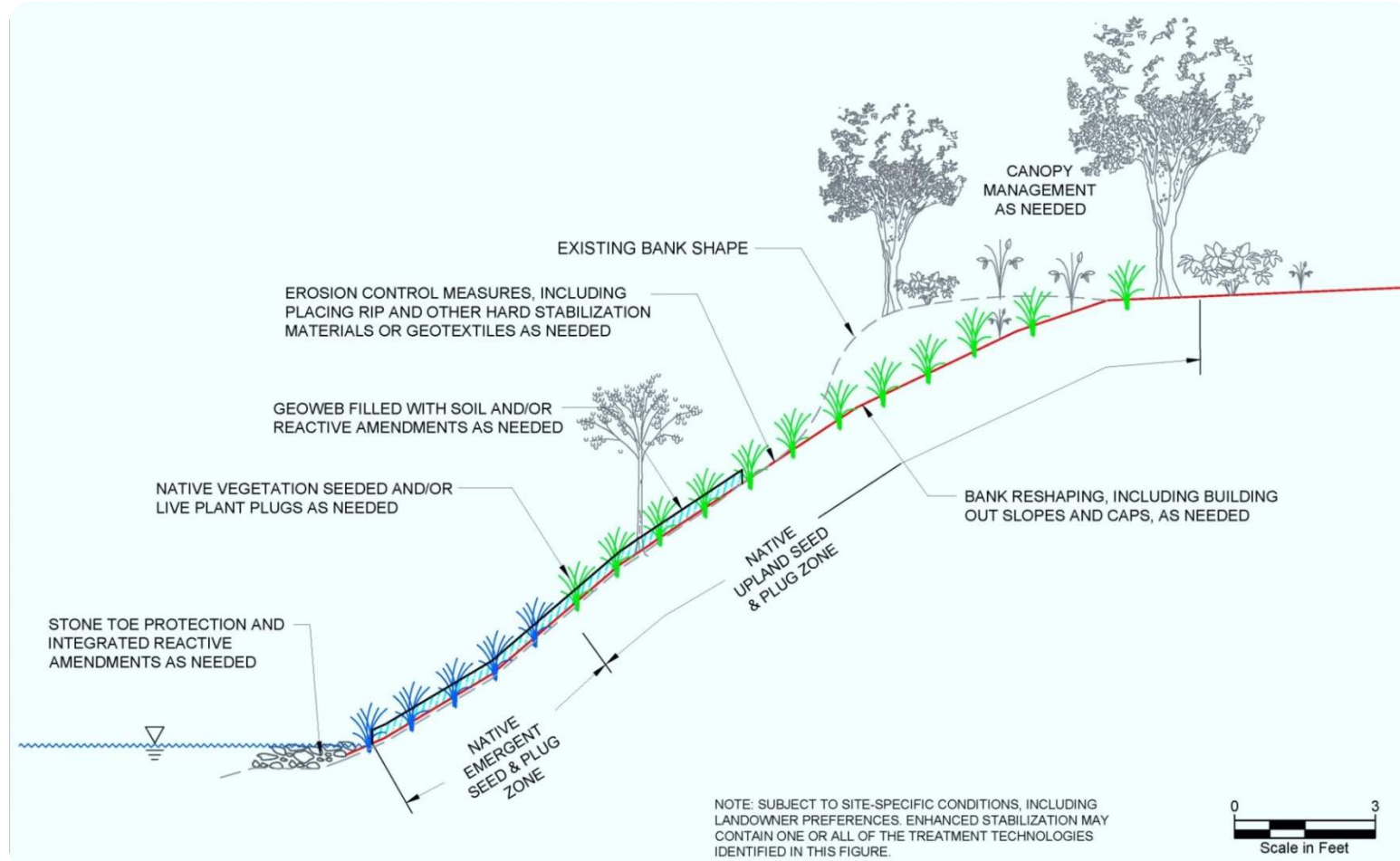


Europe



Source: Patmont et al. 2014

Engineering Options for Incorporating Carbon into SR Bank Stabilization Designs (from Clay)



Source: Anchor QEA 2013

Reactive Core Mat and Geoweb® Options for Placing Carbon Amendments on Slopes (from Clay)

Source: Mahoney et al. 2014

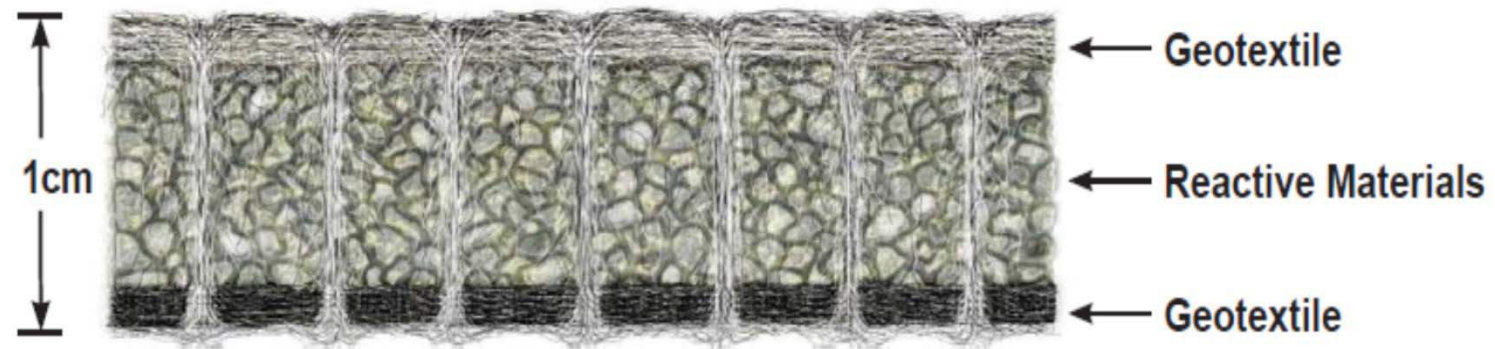


Reactive Core Mat



Geoweb®

Reactive Core Mat Installation Example (from Clay)



Source: Mahoney et al. 2014



Placing Reactive Core Mat

Geoweb® Installation Example (from Clay)

Source: Mahoney et al. 2014



Placing Geoweb®



Backfilling with Blended Cover

Summary of Discussion

- Pros
 - Potential to limit the Hg flux from bank leaching
 - Potential to increase overall success of remediation approach
 - Hedge against uncertainty in bank leaching estimate
 - Small additional cost
 - May improve public perception
 - In concert with bank stabilization, requires only one-time impact
 - Relatively flexible remedy
 - Carbon shown to exhibit chemical stability
 - Why not, if risk of cons are acceptable

Summary of Discussion

- Cons
 - Complicates engineering
 - Possible vegetation limitations (with reactive core mat)
 - Cost of construction complexity
 - Difficulty maintaining reactive surface area of carbon
 - Possible plugging of mats, backing up groundwater and compromising structural design of bank stabilization
 - Questionable long-term effectiveness
 - Difficulty in monitoring success or failure
 - Possibility for enhancing methylation

Summary of Discussion



- Consensus Reached
 - Move ahead with incorporation of carbon into bank stabilization designs within first 2 miles of remediation effort
 - » Location specific engineering designs will address most of the cons identified
 - » DEQ approval of remediation design required