Update on Anacostia River Comparative Validation of Innovative Capping Technologies

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Overall Project Objective

- The comparative effectiveness of traditional and innovative capping methods relative to control areas needs to be demonstrated and validated under realistic, well documented, in-situ, conditions at contaminated sediment sites
  - Better technical understanding of controlling parameters
  - Technical guidance for proper remedy selection and approaches
  - Broader scientific, regulatory and public acceptance of innovative approaches

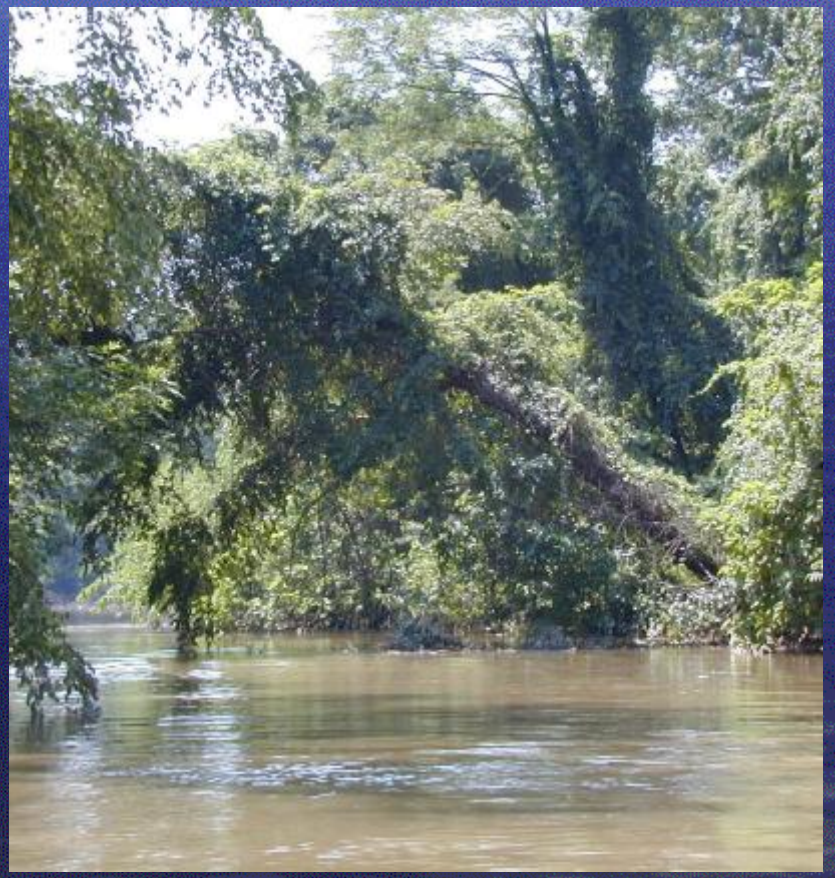
Overall Project Scope

A grid of capping cells will be established at a well characterized contaminated sediment site:

- Contaminant behavior before capping will be assessed
- Various capping types will be deployed within the grid evaluating placement approaches and implementation effectiveness
- Caps will be monitored for chemical isolation, fate processes and physical stability
- Cap types and controls will be compared for effectiveness at achieving goals

Demonstration Site – Anacostia River

- Anacostia River has documented areas of sediment contamination
- Anacostia Watershed Toxics Alliance (AWTA) offers unique opportunities
- Ultimate rehabilitation approaches uncertain
- Much of current focus on reducing contribution of sources
- Areas adjacent to Navy Yard are good candidate sites based on review of existing data



Proposed Demonstration Area

- The proposed demonstration areas are approximately 200 ft by 500 ft (approximately 2 acres) adjacent the shoreline upstream and downstream of the Navy Yard
- Each proposed pilot study cell is approximately 100 ft by 100 ft in size and two or three study cells per area will be implemented.

Demonstration Sites

Demonstration Sites

- First Site – old CSO outfall
  - South end of Navy Yard
  - PCBs: 6-12 ppm
  - PAHs: 30 ppm
  - Metals
    - Cd: 3-6 ppm
    - Cr: 120-155 ppm
    - Cu: 127-207 ppm
    - Pb: 351-409 ppm
    - Hg: 1.2-1.4 ppm
    - Zn: 512-587 ppm
- Second site – near old manufactured gas plant
  - North end of Navy Yard
  - PAHs up to 210 ppm

Potential Cap Technologies

- Five technologies undergoing bench scale testing and evaluation
- Bench scale testing objectives
  - Problems with physical placement?
  - Problems with contaminant or nutrient release during placement?
  - Problems with effectiveness with Anacostia contaminants?
  - What is appropriate cap design, homogeneous or layered composite?
  - What are key physical or chemical indicators of performance?

Potential Cap Technologies Anacostia Demonstration

- Aquablok for control of seepage and advective contaminant transport
- Zero-valent iron to encourage dechlorination and metal reduction
- Phosphate mineral (Apatite) to encourage sorption and reaction of metals
- BionSoil to encourage degradation of organic contaminants
- Natural organic sorbent to encourage sorption-related retardation (reduction in advective-diffusive transport)

AquaBlok™

- Gravel/rock core covered by clay layer
- Expands in water decreasing permeability
- Applicable to seep locations (Site 2)
- May be useful as funnel in "funnel and gate" reactive barrier design
- Semi-commercial technology
- Treatability evaluation underway Hull & Assoc

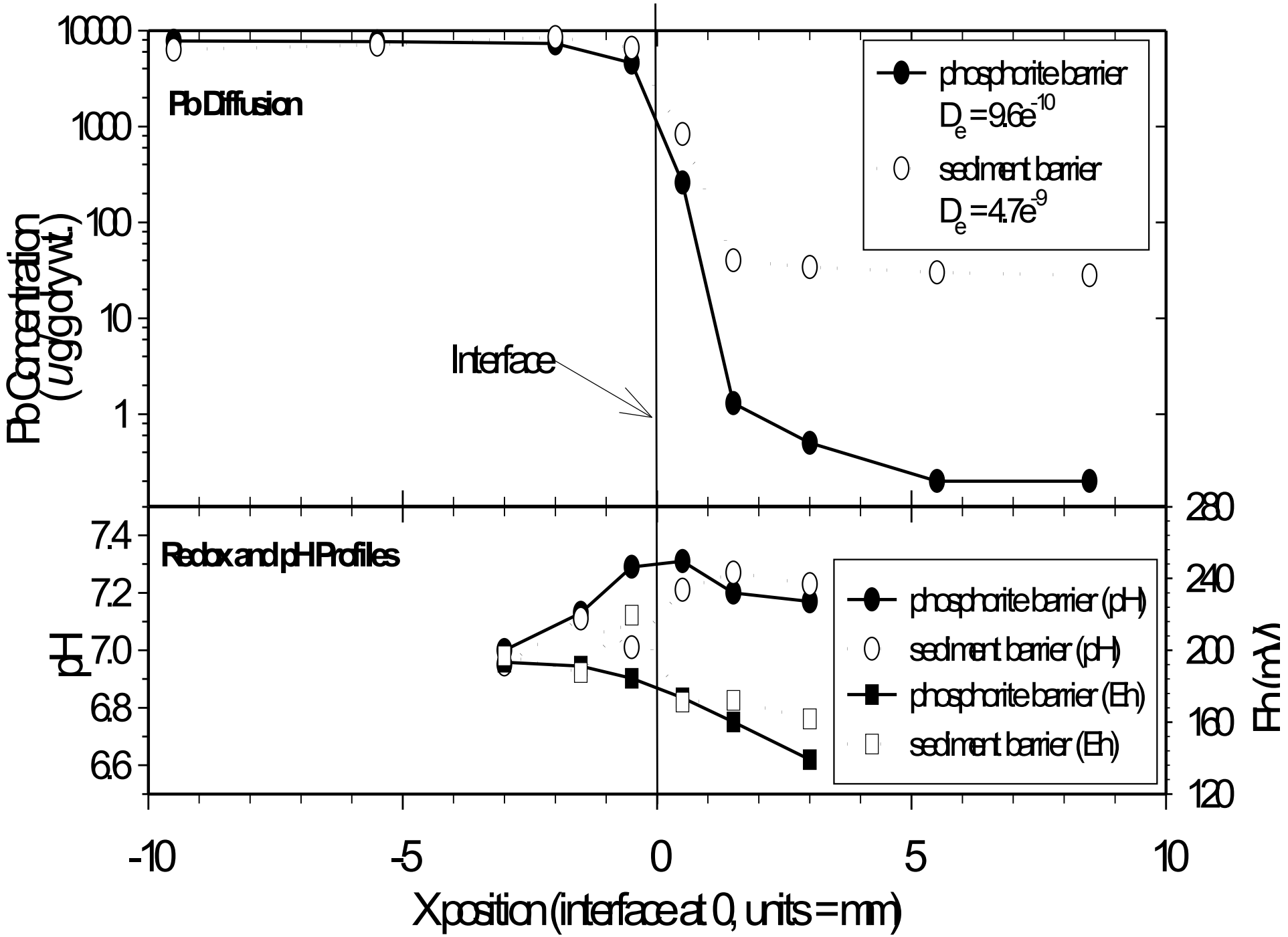
Zero-Valent Iron

- Fe(0), Fe-S, Pd/Fe(0) under consideration
  - Subject to cathodic reactions that yield hydrogen
    - Hydrogen can drive reductive biotic transformations
    - Reductive dechlorination
    - Metal reduction
  - Directly provide electrons for abiotic reduction
- Chlorinated Organic Compounds (PCBs)
  - Evaluation underway by Carnegie Mellon University
- Metals
  - Evaluation underway by Rice University

Apatite Barrier

Apatites – $Ca_5(PO_4)_3OH$

- Subject to isomorphic substitution
  - $Pb_5(PO_4)_3OH$
  - $Cd_5(PO_4)_3OH$
- Reduces migration of metal species
- Employing XRF and XAS for metal species dynamics and migration
- Evaluation underway with LSU/University of New Hampshire


Pb Diffusion
Pb Concentration (ug/g dry wt.)
10000
1000
100
10
1
Interface
phosphorite barrier
De = 9.6e-10
sediment barrier
De = 4.7e-9
Redox and pH Profiles
pH
7.4
7.2
7.0
6.8
6.6
Eh (mV)
280
240
200
160
120
phosphorite barrier (pH)
sediment barrier (pH)
phosphorite barrier (Eh)
sediment barrier (Eh)
-10
-5
0
5
10
X position (interface at 0, units = mm)

BionSoil™

- Manufactured soil from composting
- Hydrogen source
  - Enhancement of reductive dechlorination
  - Enhancement of anaerobic degradation of PAHs
- High organic content
  - Encourages sorption and retardation of transport
- Evaluation underway at LSU

OrganoClay Sorbent

- Candidate - Biomin EC-100 organo-modified clay
  - Low permeability
  - High organic content
  - Encourages retention of both non-aqueous and dissolved constituents
  - Evaluated for control of active hydrocarbon seeps in Thea Foss Waterway, WA
- Treatability testing underway with Hart-Crowser

Other Potential Cap Materials

- Ambersorb commercial sorbent
- Coal-based sorbents
- Undergoing initial review/feasibility evaluation

Prime Field Contractor

- Horne Engineering
  - Project Lead – YueWei Zhu
  - Site Characterization Plan (Summer 2002)
  - Site Characterization (Fall 2002)
  - Cap Design (Winter 2003)
  - Cap Placement projected for Spring 2003

Project Plans June-Dec 2002

- Develop site characterization workplan
- Distribute workplan for review and comment
- Initiate site characterization
- Reporting of preliminary conclusions on lab treatability studies
- Preliminary field construction design
- Coordinate with cooperating sources of support
  - EPA SITE program (3rd party evaluation)

Site Characterization Objectives

- Establish the contamination baseline at demonstration areas
  - Define contaminant variability
  - Identify and confirm appropriate areas for cap demonstration
- Determine the geotechnical characteristics of the sediment
- Provide necessary baseline data for future evaluation of effectiveness of capping placement and capping technologies

Sampling Approach

A two-staged sampling approach is planned for site characterization:

- Stage 1 sampling will be implemented in 2002 to provide a representative assessment of demonstration site conditions and to provide necessary information to refine the subsequent sediment coring and benthic community sampling.
- Stage 2 sampling will be implemented in the spring of 2003 to accommodate the biological parameter sampling such as submerged aquatic vegetation (SAV) and benthic community due to reduced biological activities in the winter season as well as provide opportunity for supplemental sampling to respond to issues raised during Stage 1

Stage 1 Sampling

- Preliminary physical assessment
  - Bathymetry measurement and side scan and sub-bottom profiling
- Surficial sediment sample collection
- Sediment coring sample collection
- Sediment radionuclide characterization
  - Historical deposition
  - Average rate and extent of bioturbation
- Geotechnical data for the cap design
- Historical Data Collection (groundwater seepage, flow velocity, and etc.)

Preliminary Physical Assessment

- Wide-area coverage/rapid assessment surveys of gross topography, sediment texture and depositional history.
- Bathymetry and sidescan profiling for depths and surficial sediment texture
- Sub-bottom profiling.
- Rapid photographic (planview with sediment interface camera) survey in order to map in detail the top 6" of sediment for grain size, benthic habitat type and stability
- Currently negotiating with potential subcontractors

Chemical Sampling

- Surficial sediments
  - ~40 surficial sediment samples will be collected from each site four (4) inch and up to six (6) inch thick at each grid point using a stainless steel Van Veen grab sampler or Petite Ponar grab sampler.
- Core sediments
  - 8 cores will be collected from each site to a depth of 3 ft
    - Samples collected from 0-6", 6"-12" and 12"-36"
  - Additional deeper cores will be used to assess underlying stratigraphy and provide geotechnical information for design
    - One water sample from underlying sand unit
  - Additional shallow cores (gravity corer) employed to supplement baseline sampling
- Water sampling
  - To define chemical baseline in water and potential for recontamination of caps

Physical, Chemical, and Biological Parameters

Parameter	Surficial Sediment	Core Sediment Sample	Water Column/ Pore-water
PCBs	X	X	X
PAHs	X	X	X
8 RCRA Metal & Mercury	X	X	X
Total Organic Carbon	X	X	
Water Contents	X	X	
Total Kjeldahl Nitrogen	X	X	
pH			X
Total Suspended Solids			X
Salinity			X
DO			X
Conductivity			X
Benthic Macroinvertebrate	X		
SAV Survey	X		

Analytical Methods

Analytical Parameter	Aqueous Methodology	Solid Methodology*
Chemical		
PAHs	SW-846 5030B/8270C	SW-846 8270C
TCL Pesticides/PCBs	SW-846 5030B/8180A	SW-846 8180A
PCBs	SW-846 5030B/8082	SW-846 8082
8 RCRA Metals	7060A/7421/7740/7061/ 7131A/7191	7060A/7421/7740/7061/ 7131A/7191
Total Suspended Solids- (TSS)	EPA 160.2	Not Applicable
Total Kjeldahl Nitrogen	EPA 351.3	EPA 351 modified
Phosphorus	EPA 365	EPA 365 modified
Total Organic Carbon	EPA 415, SW-846 9060	EPA 415 modified
Biological		
Benthic Macroinvertebrate		EPA/600/4-90/030
SAV Survey		General Acceptable Method

Geotechnical Parameters

Parameter	Number of Sample	Method
Grain Size Distribution	10	ASTM D421/422
Specific Gravity	4	ASTM D854
Atterberg Limits	10	ASTM D4318
Classification	10	ASTM D2487
In-Situ Vane Shear Test (Shear Test)	20	ASTM D2573
Unconsolidated, Undrained Strength	4	ASTM D 2850
Permeability*	4	ASTM D 2434
Consolidation**	4	ASTM D2435 USACE VIII
Moisture Content	40	ASTM D2216
Bearing Capacity	Calculated	
Slope Stability	Calculated	

Note:

* One value of permeability must be calculated from the self-weight consolidation test.

** Use the Modified standard consolidation test and self-weight consolidation test as described in USACE 1987 (Department of Army Laboratory Soils Manual EM 1110-2-1906 - USACE 1970).

Stage 2 Sampling

- Benthic community sampling collection
- Submerged aquatic vegetation (SAV) sampling
- Supplemental sampling as identified by Stage 1 sampling

Sampling after cap placement

- Approach
  - Employ cores and dialysis samplers to define placement and cap effectiveness
    - Bottom of core – undisturbed sediment
    - Middle of core – cap/sediment interface
      - Examine interlayer mixing
      - Examine contaminant migration/fate processes
    - Top of core – cap/water interface
      - Examine recontamination
      - Examine recolonization
  - Supplement with physical monitoring
    - Water column (flow, suspended sediment and chemical)
    - Non-invasive (sonar, bathymetry)
    - Invasive (sediment profiling camera)

Summary

- Capping technologies undergoing bench-scale evaluation and testing
- Site characterization efforts in final planning stages for field deployment within a month
- Additional site characterization, cap design and implementation slated for next spring
- Additional information www.hsrc-ssw.org