

Low-impact Delivery System for In Situ Treatment of Sediments Contaminated with Methylmercury

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DOE Mercury Summit

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UMBC

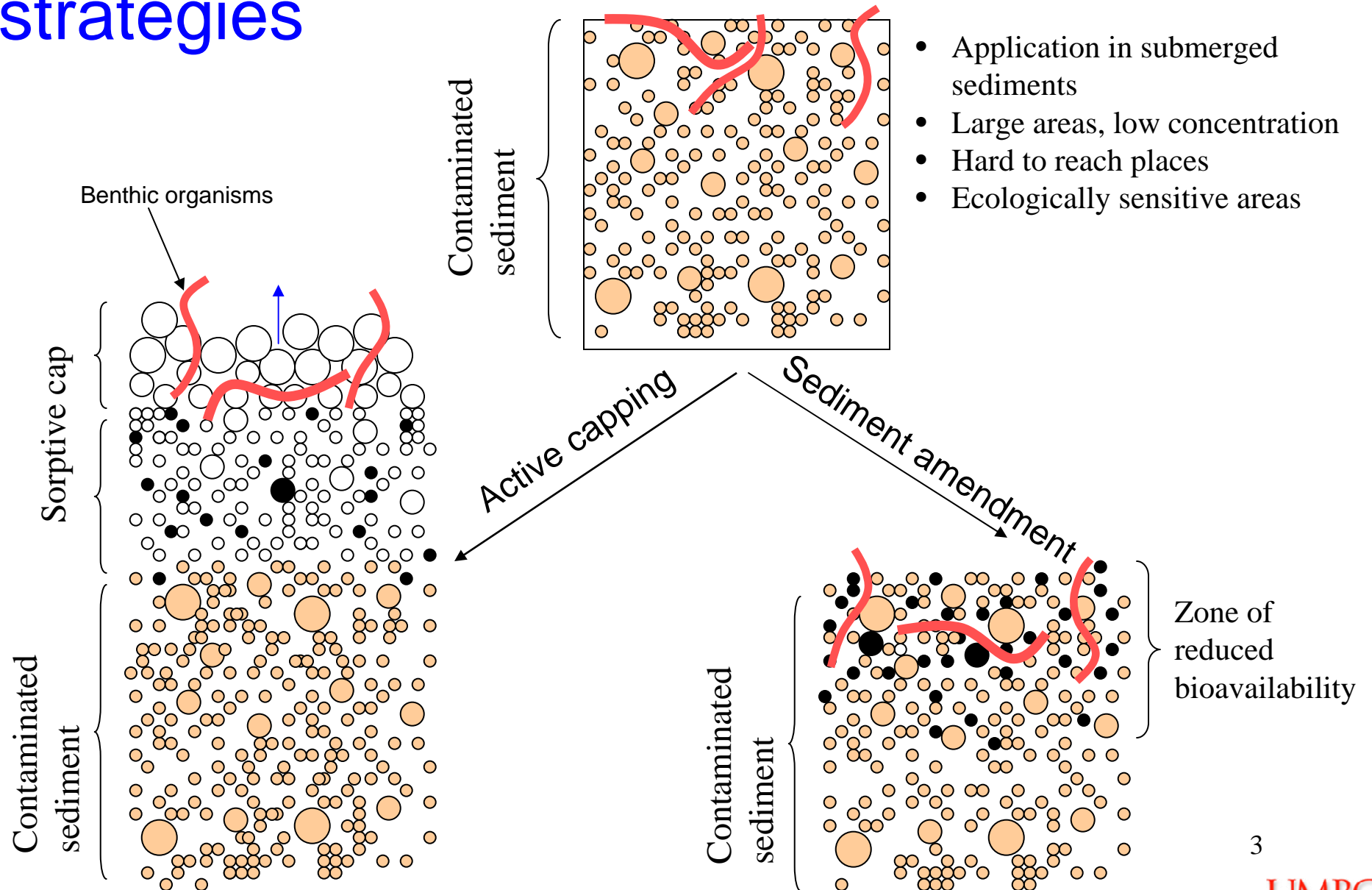
AN HONORS UNIVERSITY IN MARYLAND

How do you remediate a sensitive wetland without destroying it?



US Army Base, VA

Contaminant bioavailability manipulation strategies



Application in a River

(Participants: Alcoa, EPA, UMBC, Stanford University, Anchor Env., Brennan, Tetra Tech, Arcadis-BB&L, QEA)



- L-shaped silt screen to minimize suspended particle transport
- Equipment mobilized on barges
- Target dose of activated carbon = 2.5% in surficial sediments
- No measurable change in water-column PCBs downstream
- Post-treatment monitoring to continue for 2-3 years

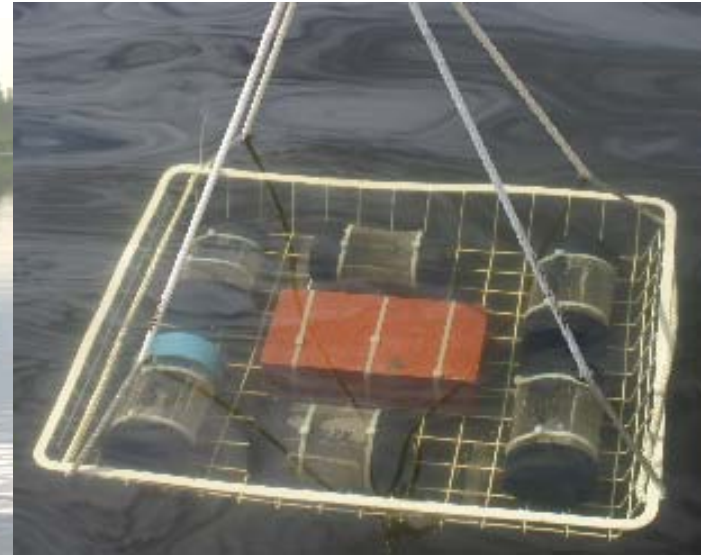
Mixed Tiller
(75' x 100')

Unmixed
(50' x 50')

Tine Sled
(50' x 60')

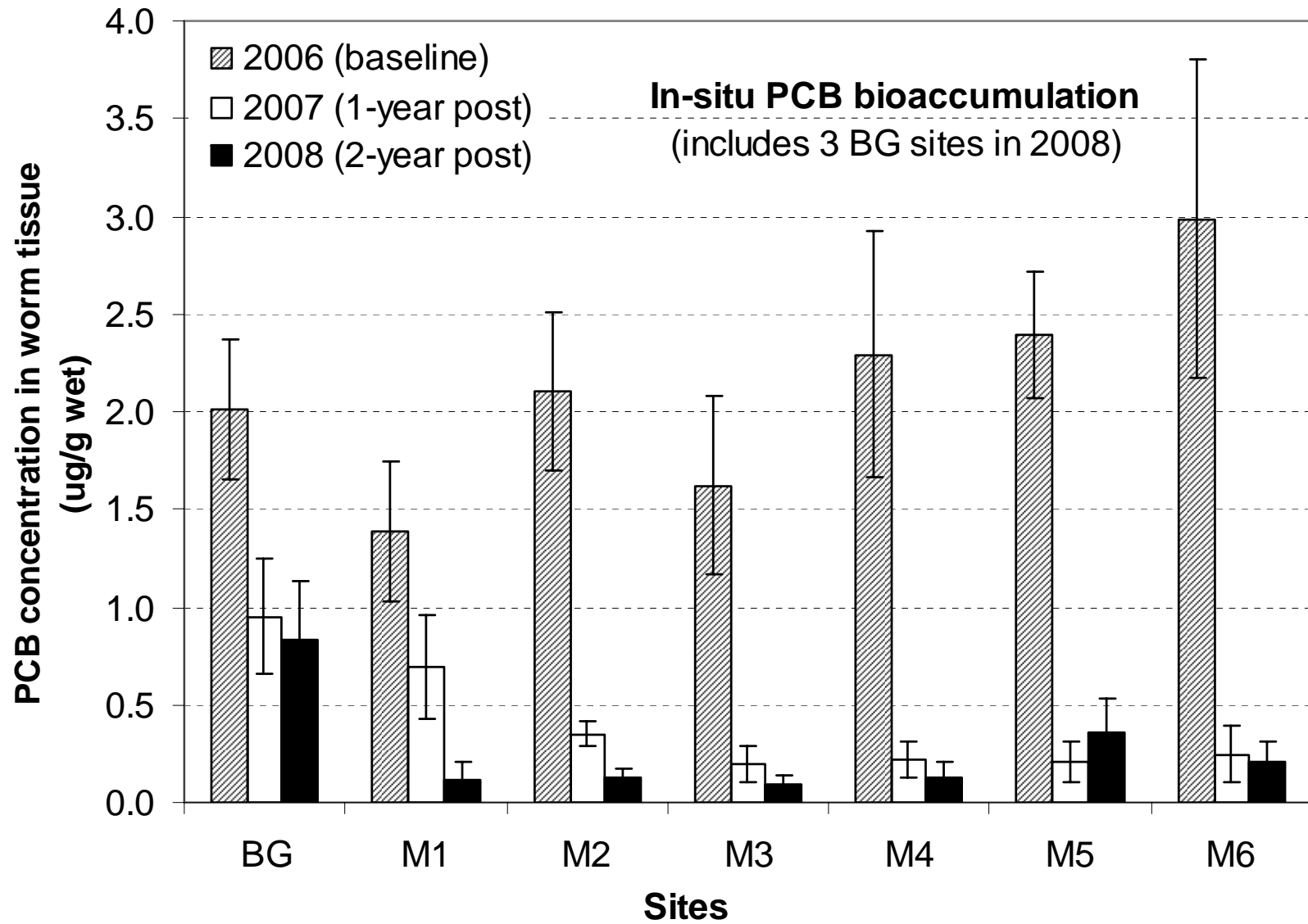
Initial testing
area
(50' x 100')

In-Situ PCB Bioaccumulation Studies

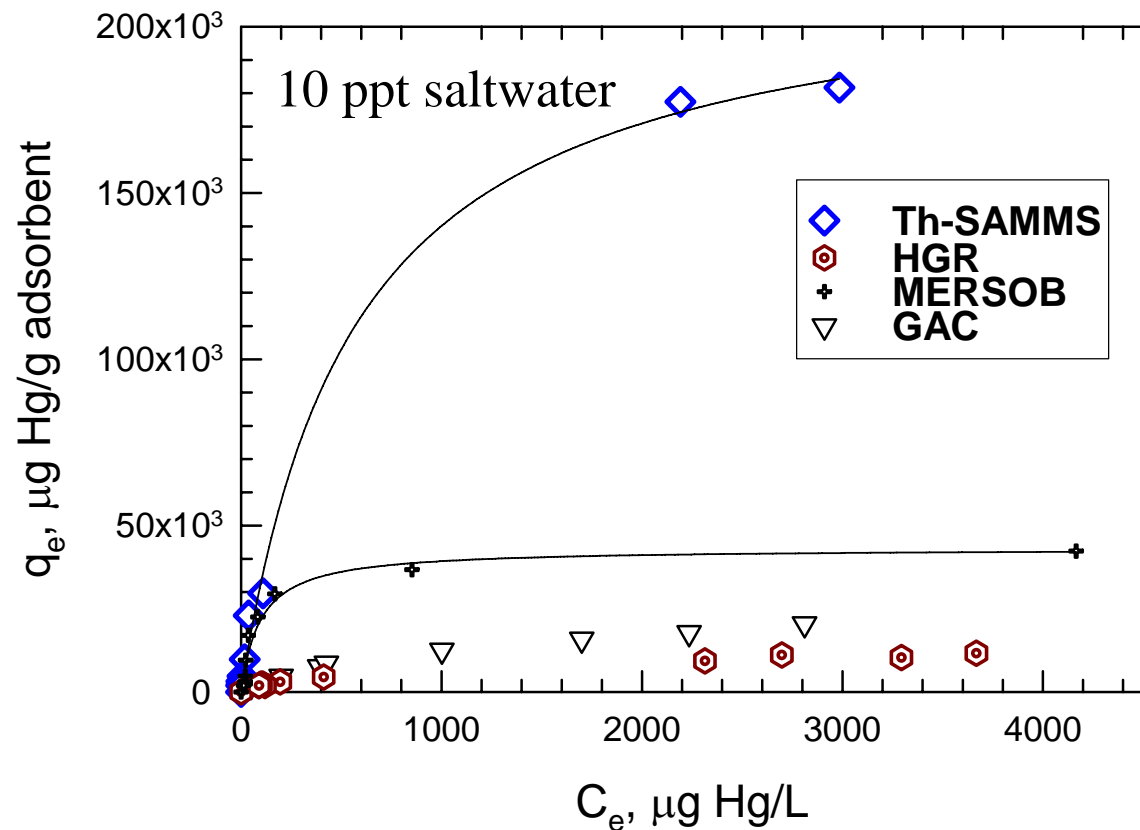


In-river deployment of field exposure cages with *L. variegatus* for baseline study⁵ using a modified ASTM draft method (Burton et al. 2005)

Ex-situ PCB Bioaccumulation at Mixed Treatment Area sites



Mercury isotherm studies of selected metal sorbents in different water matrices



Sorbents:

Thiol-SAMMS: Thiol amended mesoporous silica

HGR: sulfur impregnated activated carbon

MERSORB: sulfur impregnated activated carbon

GAC: granular activated carbon TOG 75-300 μm

Th-SAMMS outperforms other potential Hg sorbents
Kinetics for Th-SAMMS is fast

Biouptake study on with mercury contaminated sediments

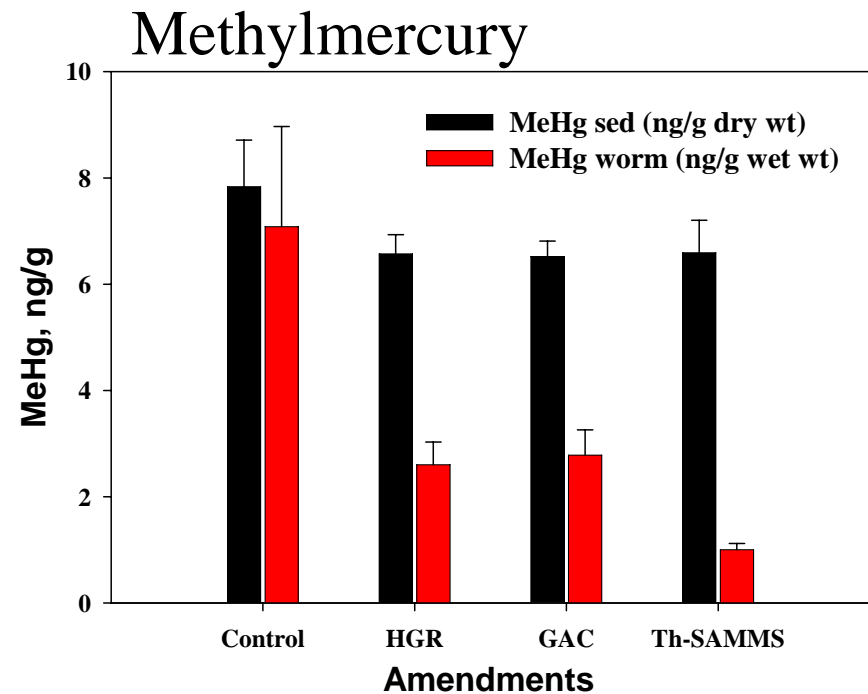
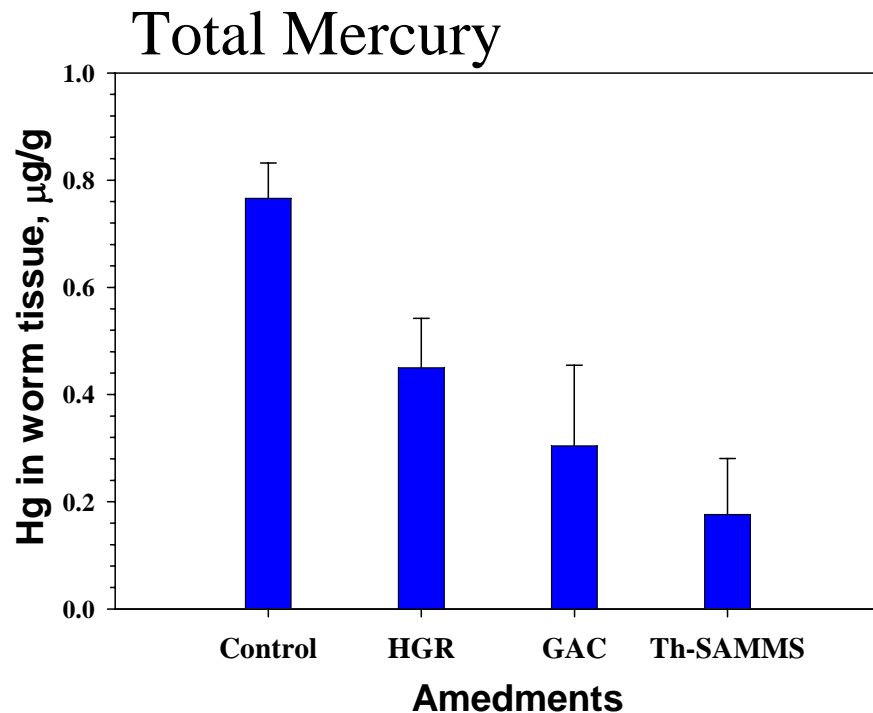
Mesocosm Design

- Lumbriculus exposure studies
- 300 or 750 cc sediment and 200 or 500 cc of overlying water
- Amendments 5 % by sediment dry wt
- Treatments: Thiol SAMMS, GAC, MRM, HGR + Control (5 replicates)
- Incubated at 20~25⁰ C, 12 h light; 12 h dark
- Examine contaminant concentrations in worm tissue and partitioning, and sediment geochemistry



Mercury and methylmercury biouptake in worms

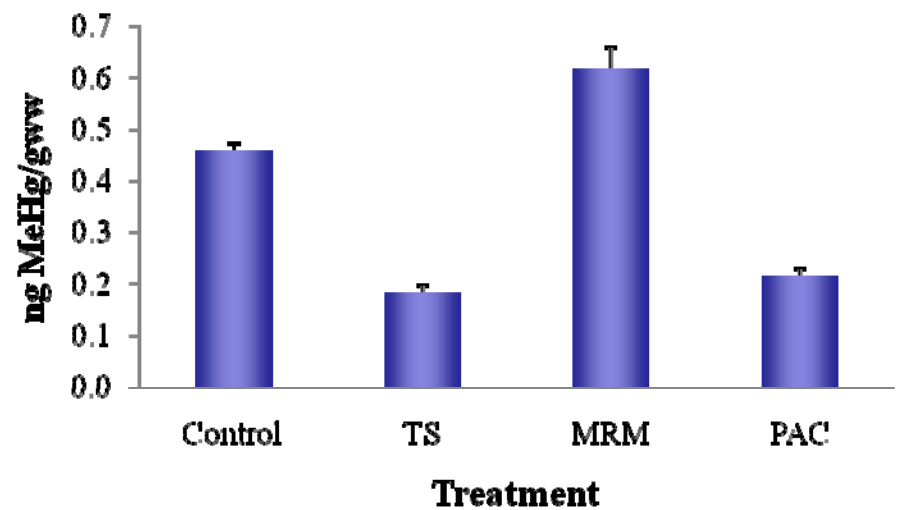
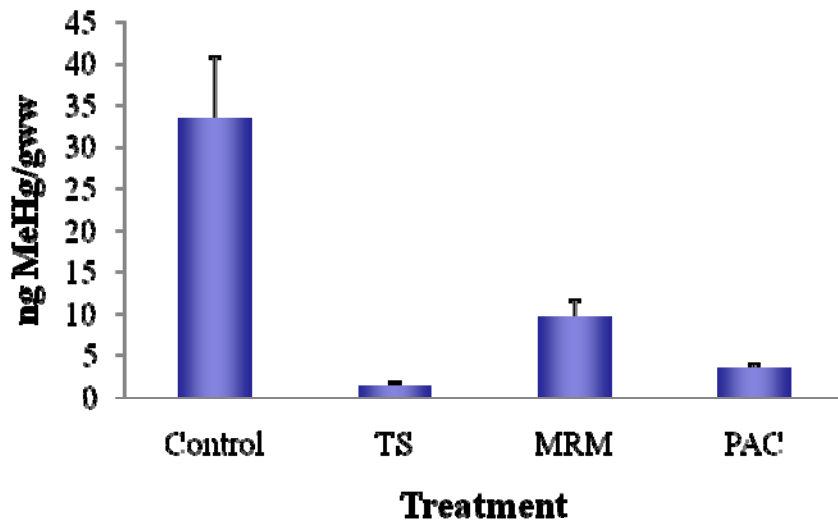
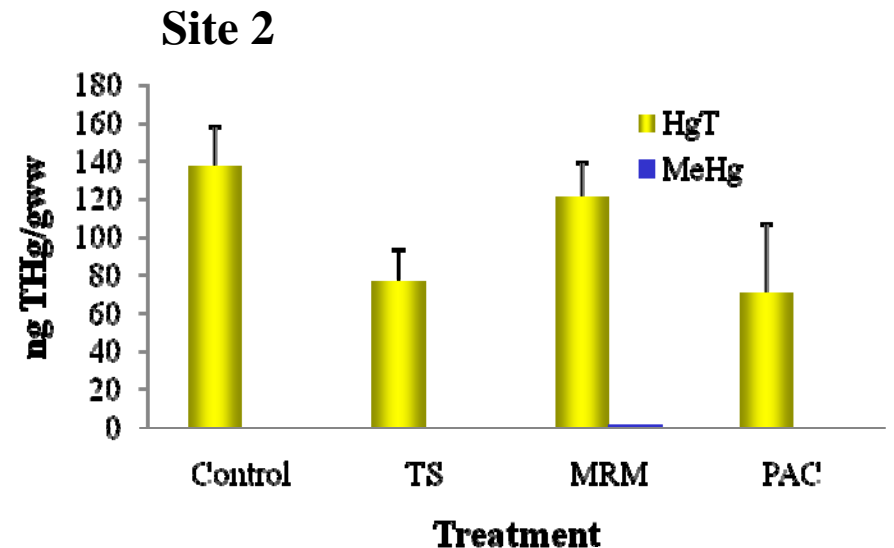
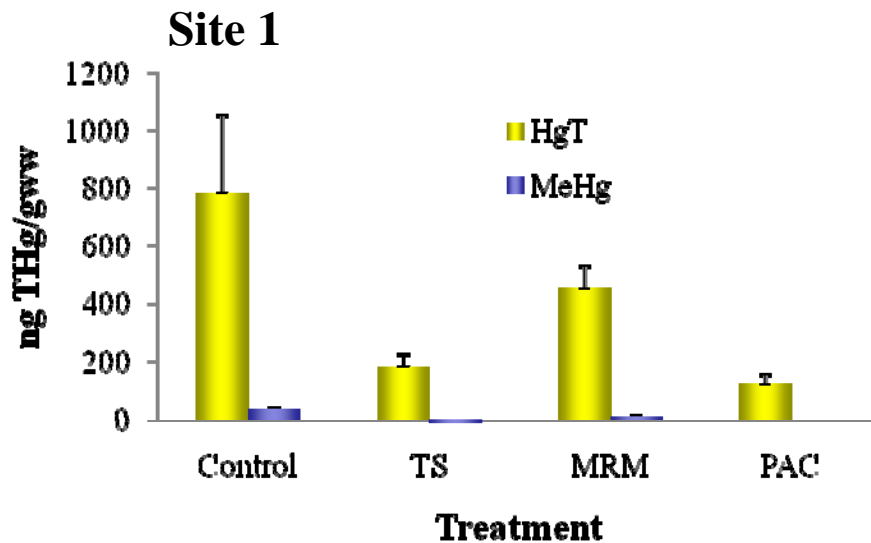
Spiked Anacostia River sediment – 50 mg/Kg)



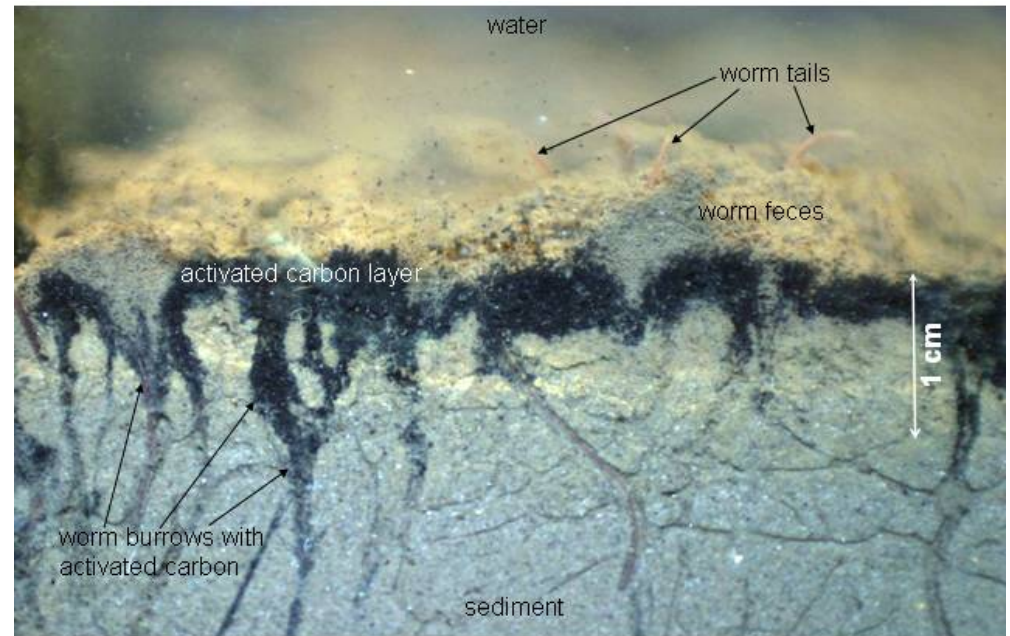
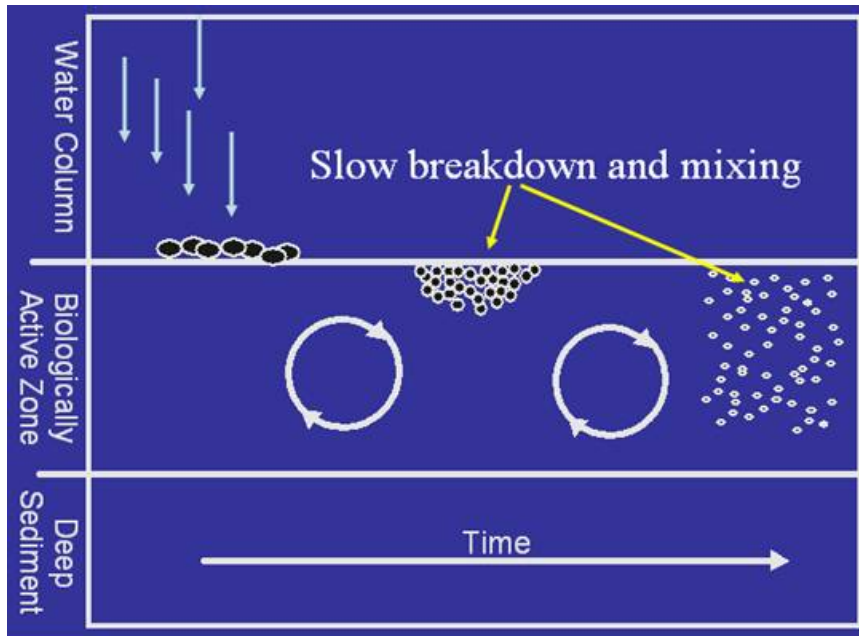
Biouptake of mercury and methylmercury in Hg-spiked sediment was reduced after amendment

Mercury and methylmercury biouptake in worms

Field sediments with native Hg:



Low-Impact Amendment Delivery System (*SediMite*)



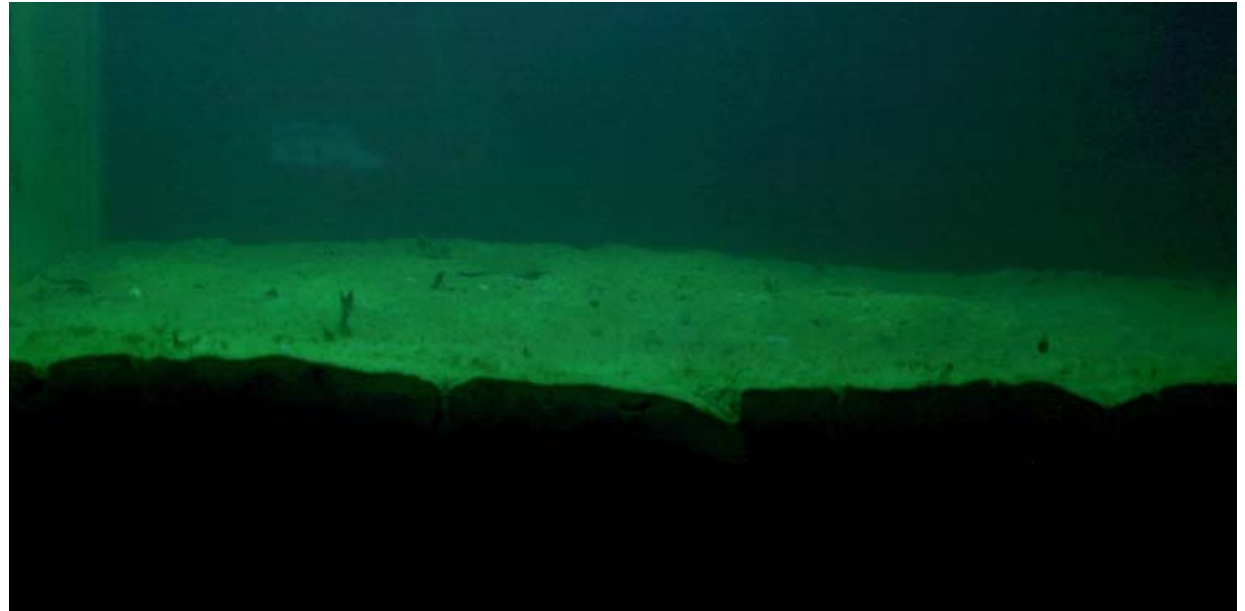
1. Agglomerates delivered from water surface
2. Sinks to sediment surface and resists resuspension
3. Breaks down slowly
4. Mixed into sediment by bioturbation
5. Developed at UMBC in collaboration with Dr. Charlie Menzie (Menzie Cura & Assoc.)



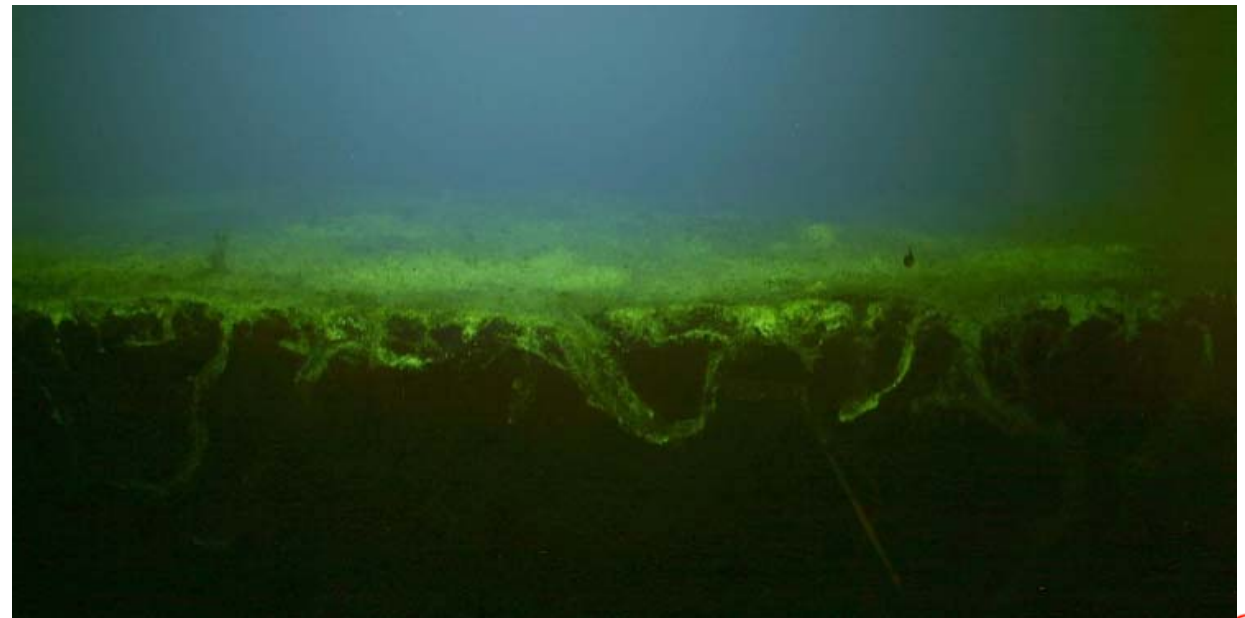
SediMite™ mixing by bioturbation

UV images of bioturbation of fluorescent-tagged SediMite

Marine microcosm without active population of benthic organisms show no mixing



Marine microcosm with an active population of benthic organisms show good mixing



Aberdeen Proving Ground Pilot Test Area

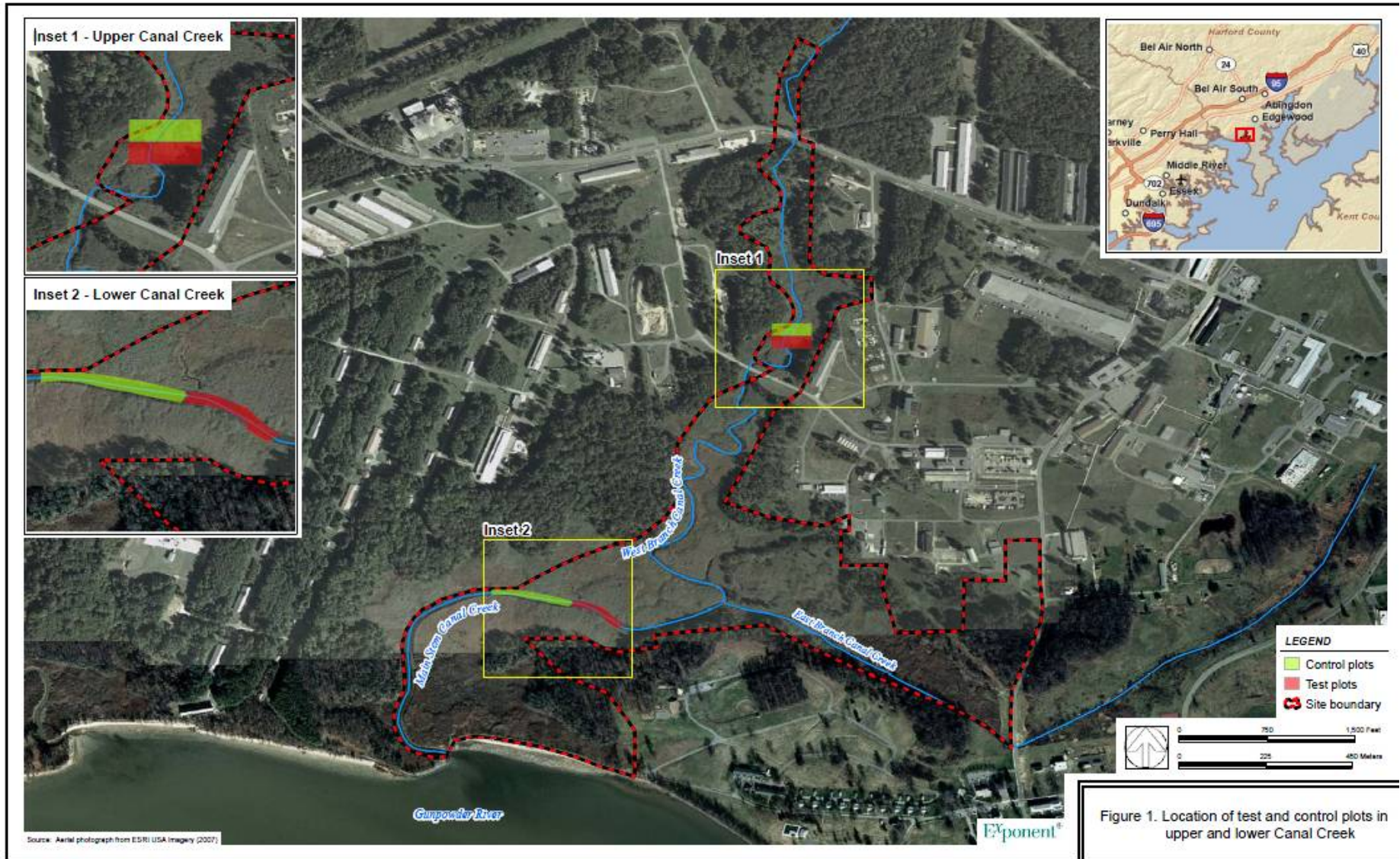
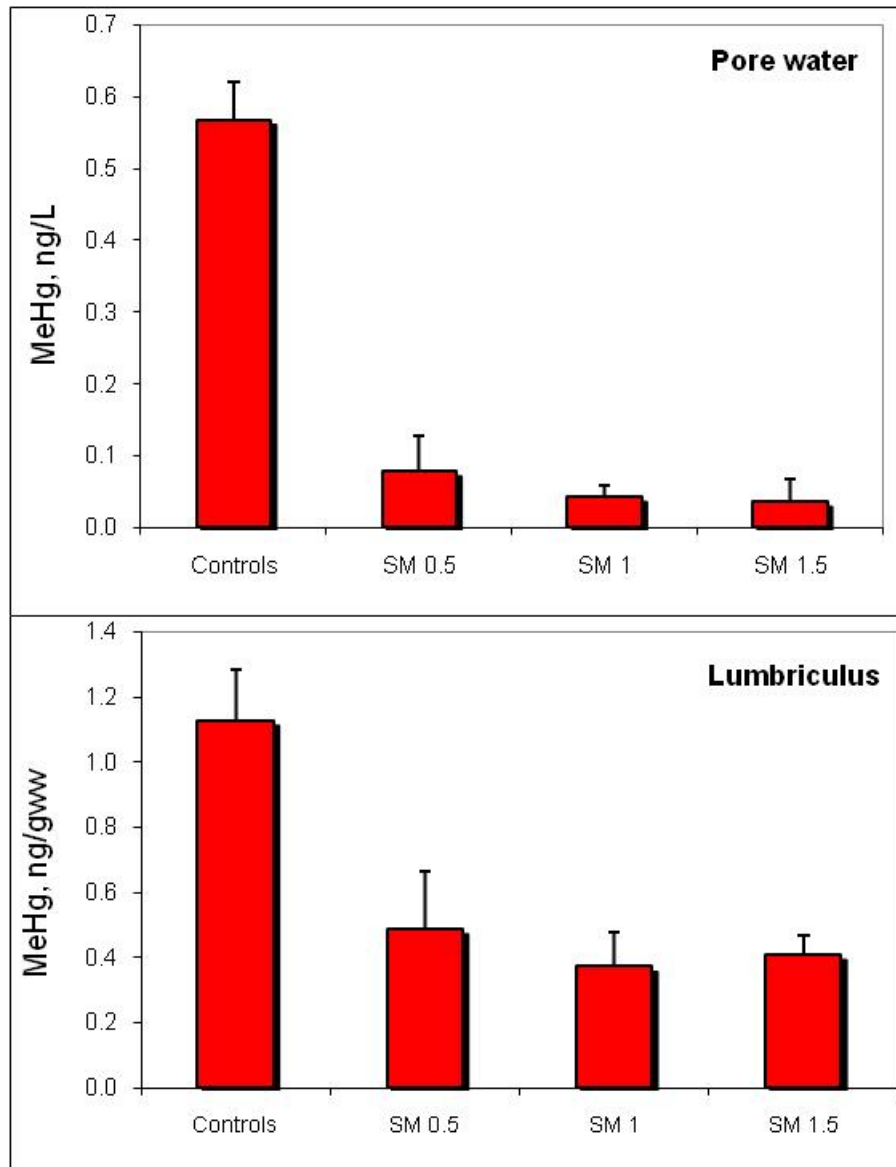


Figure 1. Location of test and control plots in upper and lower Canal Creek

Mercury and methylmercury biouptake in worms: Canal Creek, Aberdeen



3 doses of SediMite: 0.5, 1, 1.5 times native TOC

Pore water Me-Hg reduction by 86-92%

Methylmercury reduction in worm tissue: 57-74%

SediMite demonstration project #1: (NIEHS) US Army installation in VA

Participants: UMBC, Exponent.

Site logistics: US Army, Malcolm Pirnie

1. Application of SediMite™ in Aug, 2009 in a tidal creek and marsh impacted with PCBs.
2. Application involved an air blown applicator that can distribute pellets over a wide area.
3. Performance monitoring 2 months and 1 year after application:
 - Sediment core AC profiles
 - Bioaccumulation of PCBs
 - Porewater PCB concentrations
 - Benthic community assessments

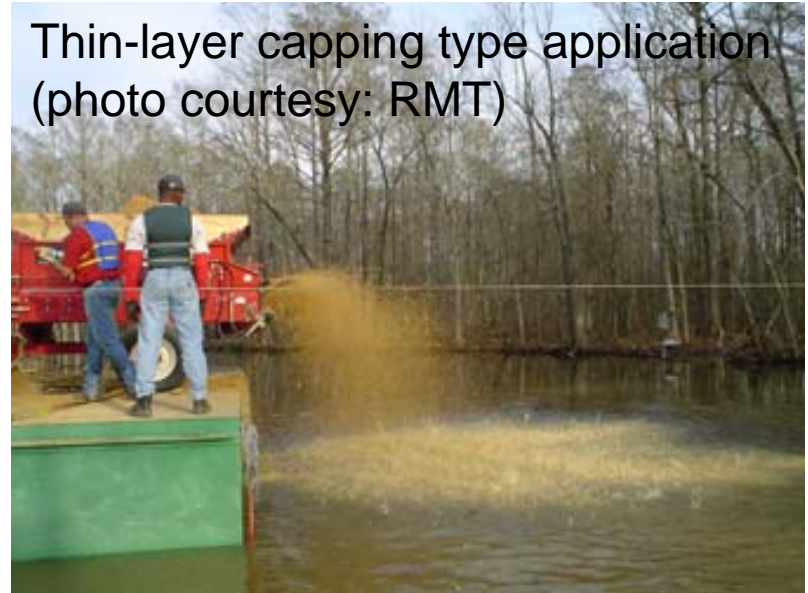


SediMite demonstration project #2:(ESTCP) Aberdeen Proving Grounds

(Participants: Exponent, UMBC, SERC)

1. Targeted application in December, 2009.
2. Two locations:
 1. Upper Canal Creek and marsh (DDT and PCBs)
 2. Lower Canal Creek and marsh (Hg and Me-Hg)
3. Demonstration project supported by the DoD ESTCP program.
4. Application will involve a pellet spreading device like a salt spreader or a vortex system.
5. Application areas will include a tidal creek and adjoining vegetated marsh area.
6. Performance monitoring will include benthic community, in-situ bioaccumulation, AC in sediment cores, and passive sampling.

Thin-layer capping type application
(photo courtesy: RMT)



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Current and Past Collaborators:

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