In Situ Technologies for the Remediation of Contaminated Sediments

Federal Remediation Technologies Roundtable Meeting
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In Situ Treatment and Reactive Capping

- Advantages
- Challenges
- Status
- Trends

In Situ Treatment – Continued Interest

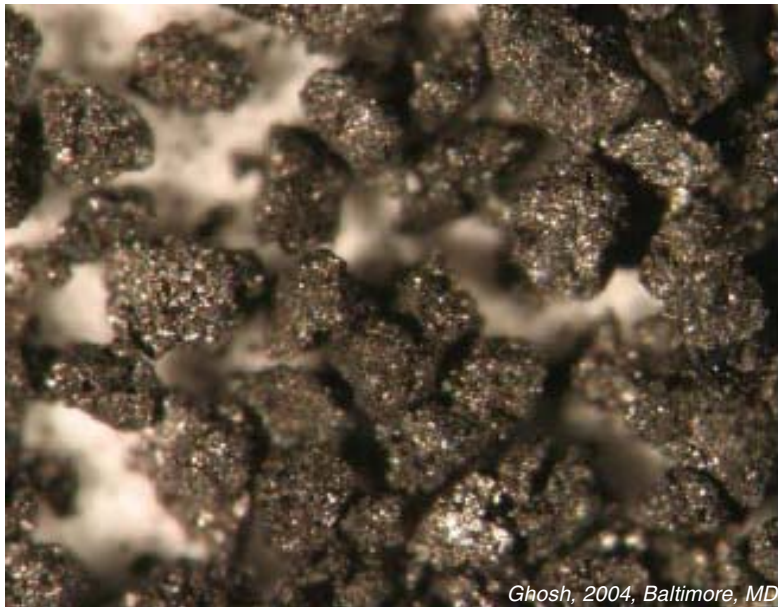
- Permanence and preference for treatment
- Perceived cost advantages and implementation time

- 2006 National Institute of Environmental Health Sciences (NIEHS) Funding Opportunity – Superfund Basic Research Program
- 2004 SERDP/ESTCP Expert Panel Workshop (Charlottesville, VA)
- 2004 EPA Remediation Technologies Development Forum Workshop (Baltimore, MD)

Means of Achieving Treatment

Based on mechanism

- **Sequestration**
  - **Reducing contaminant exposure (bioavailability)**
  - **Focus on Activated Carbon**
  - **Hunters Point Naval Shipyard, San Francisco Bay, CA**
  - **Grasse River, Massena, NY**
- **Biological and Abiotic Degradation**
  - **Destroying/transforming contaminants**
  - **Biological**
  - **Abiotic degradation**



Ghosh, 2004, Baltimore, MD

Challenges – Emplace, Contain, Assess

Engineering

- Deliver amendments/reagents
- Ensure adequate mixing
- Keep amendments/reagents in place

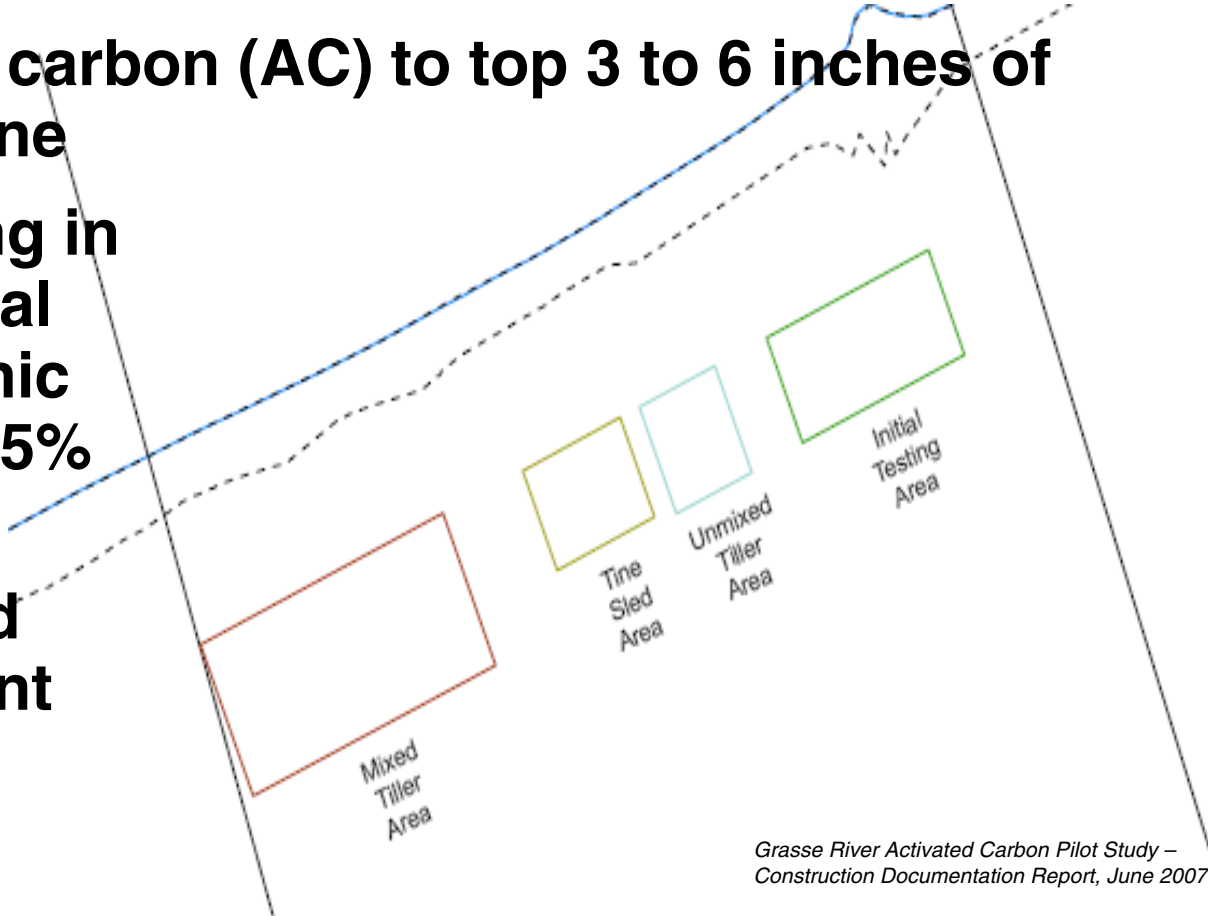
"Process Level" Challenges

- Strong Adsorption
  - High organic content
  - Hydrophobic chemicals
- Low permeability
  - High percentage of silts/clays

http://www.stanford.edu/group/luthygroup/cei.htm

Grasse River, NY Demonstration

- PCB contamination (4-13 ppm) in 0.5 acre demonstration area
- Applied activated carbon (AC) to top 3 to 6 inches of biologic active zone
- PCB uptake testing in lab showed optimal reduction in benthic organisms with 2.5% AC (dry weight)
- Test roto-tiller and tine sled placement equipment



Grasse River Activated Carbon Pilot Study – Construction Documentation Report, June 2007

Grasse River Demonstration

- AC dosage ranged 3.2% to 5% (dry weight) in top 3 inches
- 18,000 lbs of AC applied
- Water column PCB data indicated small increases adjacent and downstream of pilot study
- Greater small-scale variability observed with tiller than tine sled
- 2 year post monitoring

PRP sponsored web link:
http://www.thegrasseriver.com/2006_ActCarbon_Pilot.htm

Status and Trends

- Research efforts are underway (e.g., NIEHS SBRP and SERDP/ESTCP)
- Multiple field tests will continue to be necessary
- Questions (inevitable) on long-term performance
- Low-impact delivery systems being developed (e.g., SediMite™)
  - Menzie, Ghosh, et al.
  - Agglomerate containing treatment reagents
  - Conceptually, sinks to sediment surface and resists resuspension

Menzie et al, 2007

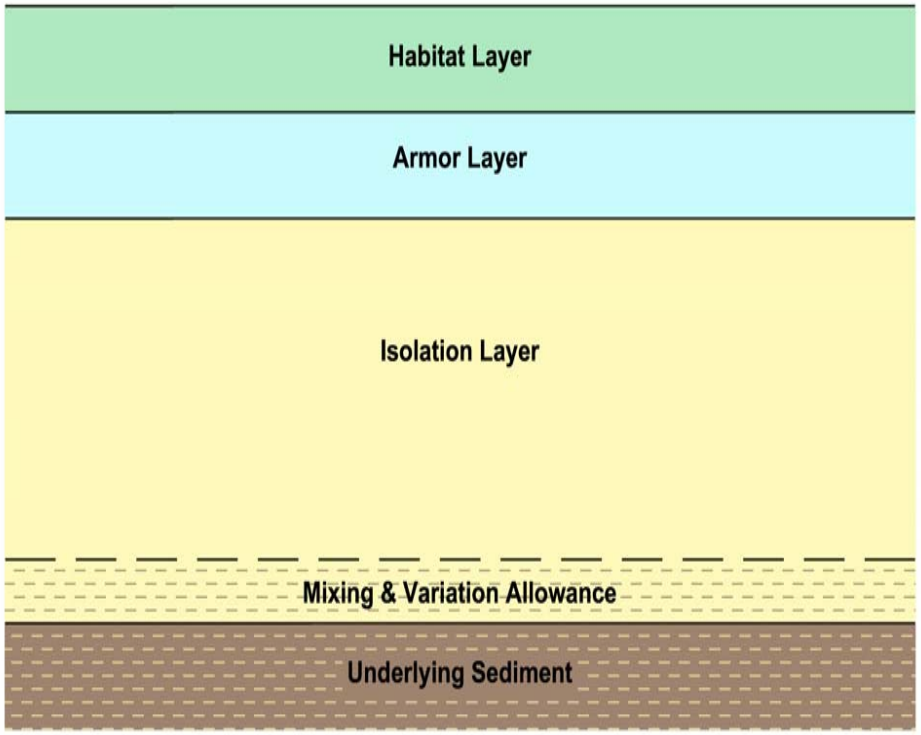
NIEHS – Superfund Basic Research Program

- Stanford: Activated Carbon as a Multifunctional Amendment to Treat PCBs and Mercury (Richard G. Luthy)
- UC Merced: Sequestration and Immobilization of Metal and Metalloid Contaminants in Sediments (Peggy A. O'Day)
- UM Baltimore County: Pilot-scale Research of Novel Amendment Delivery for In-situ Sediment Remediation (Upal Ghosh)
- UT Austin: Funnel and Gate Innovations - Stabilization and Treatment of Contaminated Sediments (Danny Reible)
- U Missouri Rolla: In-Situ Sediment Remediation Using Benthic Waterjet Amendment Placement (Joel G. Burken)
- Medical U South Carolina: Integrating microbial biostimulation and electrolytic aeration to degrade POPs (Harold May)
- Northeastern U: A reactive mat to remediate contaminated sediments and reduce health risks (Thomas Sheahan)

http://tools.niehs.nih.gov/sbrp/programs/index271.cfm

Capping

- **Functions**
  - **Physically isolate contaminated sediments**
  - **Stabilize sediments**
  - **Reduce chemical flux to benthic organisms and water column**



EPA Sediment Remediation Course 2005, Chicago, IL

- **Sand material typical design**
- **Applied at a number of sites http://www.sediments.org/capping-chart.html**

Why Reactive Caps?

- **Enhance control of contaminant migration (flux)**
  - **Increase sorption capacity**
  - **Facilitate degradation**
- **Deliver amendments in a controlled manner**
- **Potentially address**
  - **NAPL residual present or expected**
  - **Gas (NAPL) releases**
  - **Manage consolidation effects**
  - **Limit loss of water depth**

Second Five-Year Review Report
McCormick and Baxter, September 2006

Reactive (Treatment) Materials

Demonstrated

- **Activated Carbon or other carbon sources**
- **Organoclays**
  - **NAPL control**
- **Phosphate additives (Apatite)**
  - **Metals**
- **Zero valent iron**
- **Oxygen or hydrogen release compounds**
- **Biopolymers** *(Knox research)*
  - **Can bind metals and organics**

Speculative

Adapted from Reible 2008

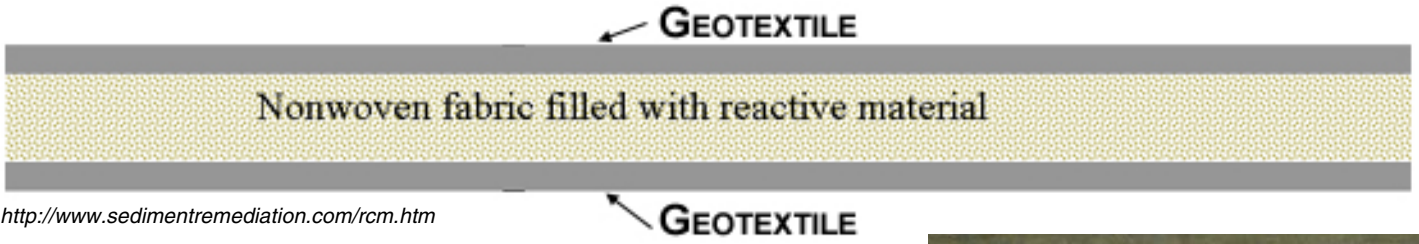
Installation

http://www.aquatechnologies.com/projects_sedimentcap.htm

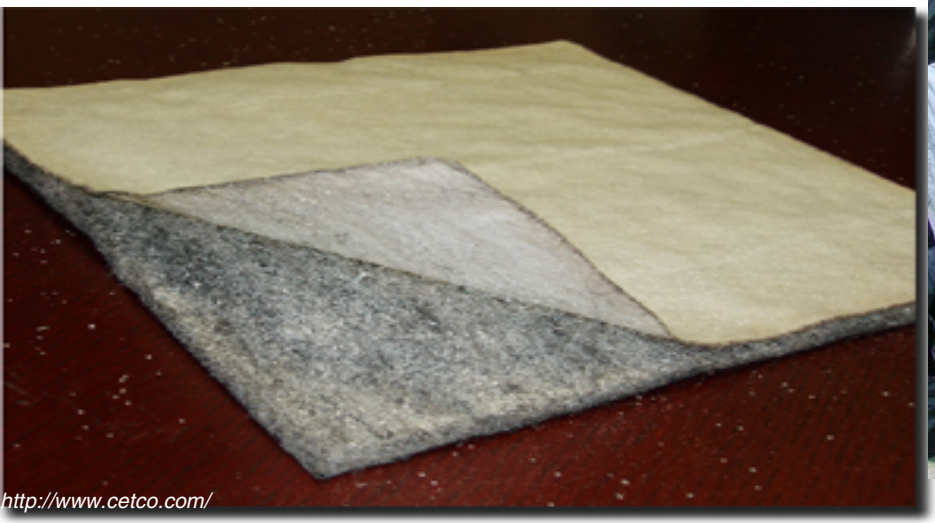
Cap Completion Report for Anacostia River, December 2004

Cap Completion Report for Anacostia River, December 2004

Reactive Core Mat™



http://www.sedimentremediation.com/rcm.htm

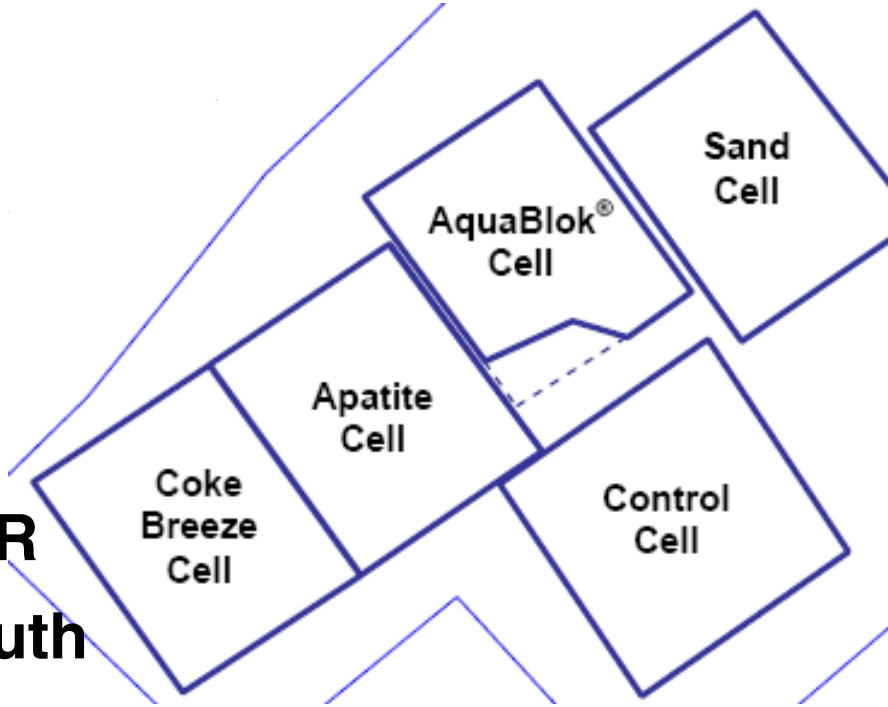


http://www.cetco.com/

Anacostia River March 31, 2004

Demonstrations and Applications

- **Anacostia River, Washington, DC**
  - Demonstration of several materials/designs
  - Implemented in 2004
  - PAHs and metal contamination
- **McCormick and Baxter Creosoting Site, Portland, OR**
- **St. Louis River/Interlake/Duluth Tar Site, Duluth, MN**



EPA SITE Report (540R07008)

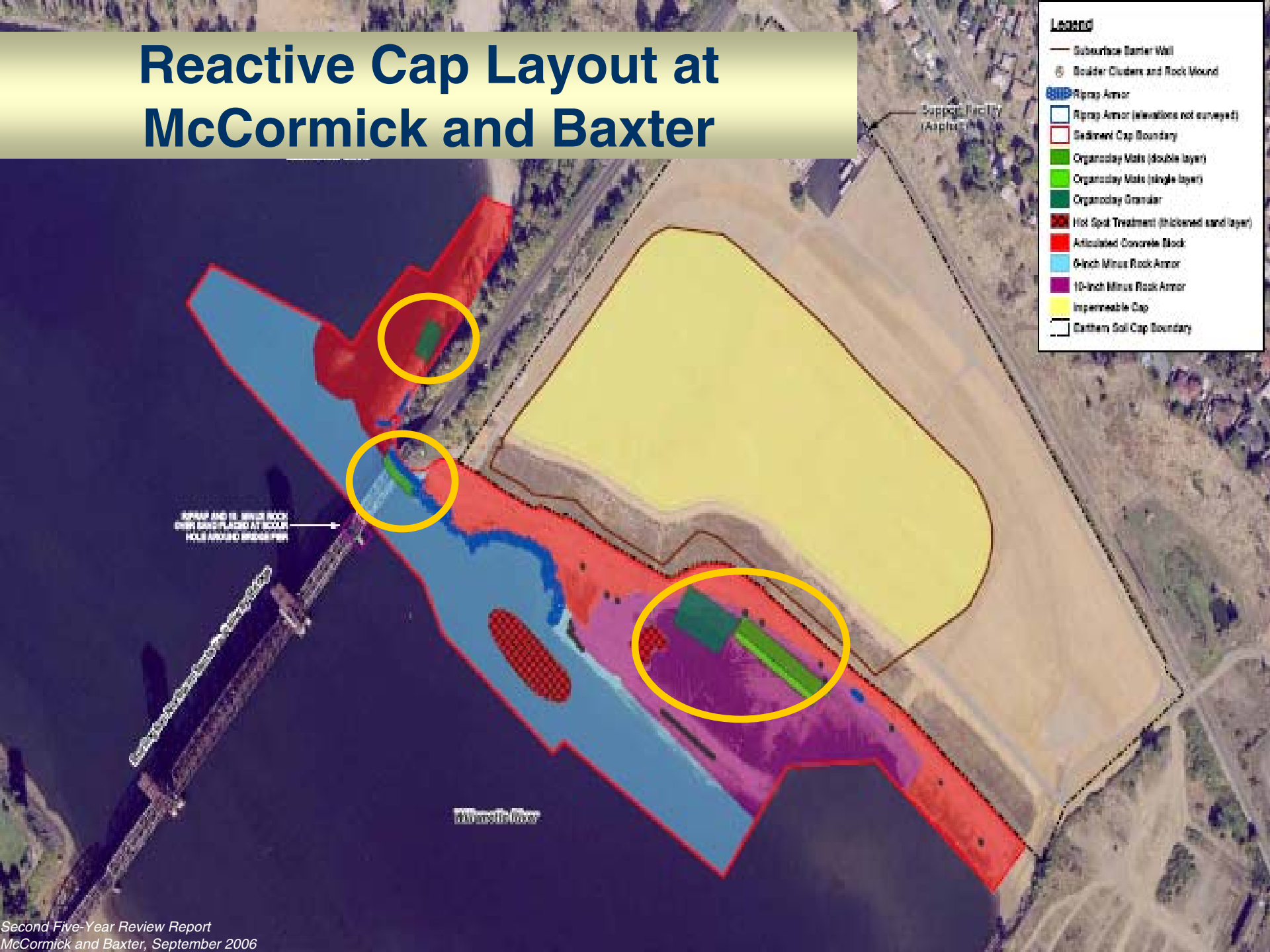
McCormick and Baxter Creosoting Company Superfund Site

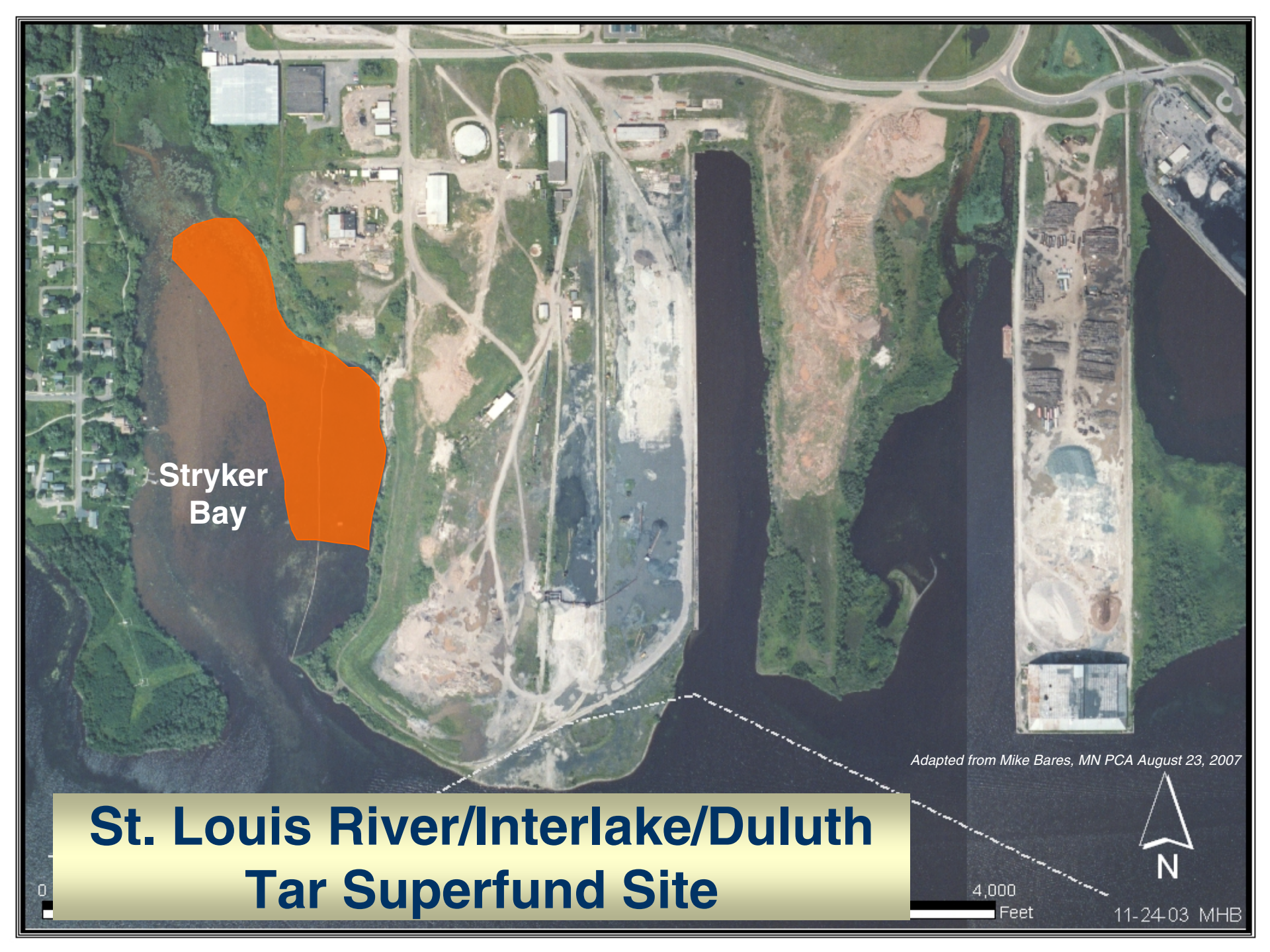
- **Creosote NAPL contamination in soils, groundwater, and sediments**

Second Five-Year Review Report
McCormick and Baxter, September 2006

- **Control of NAPL groundwater seeps**
  - **Organoclay applied in bulk**
  - **600 tons in 2004**
- **Control of NAPL gas releases**
  - **Organoclay mats applied in 2005**
  - **35,000 square feet**

Reactive Cap Layout at McCormick and Baxter

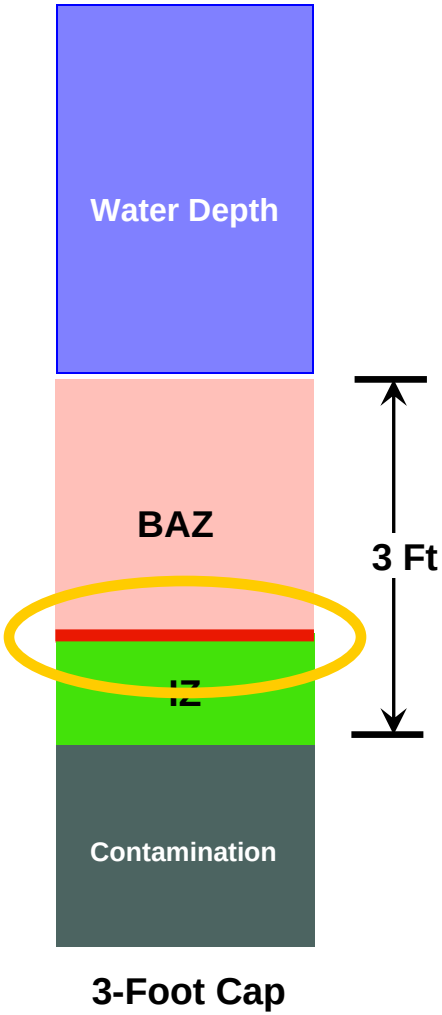




St. Louis River/Interlake/Duluth Tar Superfund Site

Reactive Cap Applied at Stryker Bay, MN

- **Activated Carbon**
- **550,000 ft²**



3-Foot Cap

Mike Bares, MN PCA August 23, 2007

Surcharge Cap Material Placement at Stryker Bay, MN

Mike Bares, MN PCA August 23, 2007

Status and Trends

- Number of field applications
  - <10 (Reactive Mats)
  - NAPL PAH contamination
  - Beach heads/shallower depths
- Research efforts underway
- Other "active" cap designs
  - Aquablok™ (SITE evaluation report)
  - Geocomposite material
  - Funnel and gate approach
- Concerns
  - Seepage (not a substitute for source control)
  - Monitoring/change out
- Start-up of EPA project to summarize applications