Progress on Treatment of PCB-Impacted Sediments with Bioamended Activated Carbon

Kevin R. Sowers
University of Maryland – Institute of Marine & Environmental Technology

Rayford Payne, Upal Ghosh and Harold May

International Conference on Remediation and Management of Contaminated Sediments
February 11-14, 2019
New Orleans, Louisiana
How bioaugmentation works

**Aroclor 1260**

- **Anaerobic Dechlorination**
  - $\text{CO}_2 + \text{H}_2\text{O}$

- **Aerobic Degradation**
Why Natural Attenuation is Slow

• Low rates in environment due to low cell numbers

See Needham et al B6, Poster 76
Technology/Methodology Description

1. Dehalococcoides
   - Dehalococcoides DHC-cc
   - Dehalococcoides DHE-bil
   - Dehalococcoides PL2
   - Dehalococcoides CBDB1
   - Dehalococcoides RAV1

2. Extraction
   - Sediment/Water Samples
   - DNA Extraction
   - Gas Chromatography
   - Detoxification Activity
   - High Throughput PCB Reducing Microbial Analysis/Monitoring

3. Confirmed PCB Dechlorinating Bacteria
   - O.17
   - SF-1
   - clone 10B.f
   - 161f
   - clone H3.93

4. IMET Institute of Marine and Environmental Technology

4
Application of Bioamended AC
Abraham’s Creek is an 8 acre/32,000 m² watershed outflow
Original contaminant likely A1260
Currently contaminated with an average 5 ppm PCB
Treatments in four 400 sq. m plots
Load rate = 1 ton SediMite + $10^{12}$ cells/400 sq. m
Treatability Study – Results

- Bioamending with $10^5$ cell/g yielded greatest reduction of PCBs after 375 days
- DF1 and LB400 were most robust bioamendments
- Addition of carbon source slightly stimulated PCB degradation
- Mono- to nona-chlorobiphenyls were reduced indicating both anaerobic & aerobic activity
Abraham’s Creek VA – Results

- 52% reduction in total mass of PCBs after 409 days
- 80% reduction in total mass of coplanar PCBs
- 95% reduction in dissolved PCBs
- All homolog groups dechlorinated or degraded
In Situ Treatment of High PCB Concentrations

- Waste Water Emergency Overflow Pond primary treatment until mid-70’s
- Area 6 acres/24,000 m²
- Aroclor 1248 (<17,000 ppm) from glass fabric production
- Adjacent to Roanoke River
- Site is currently in VA DEQ voluntary remediation program
WWTP Emergency Overflow Pond

Draper Aden & Assoc. 2002
Treatment Goals

- VA DEQ voluntary remediation program requires reduction of PCBs to <50 PPM

- Of currently accepted technologies: dredging is expensive and does not eliminate liability; capping does not remove or reduce levels of PCBs at site

- *In situ* treatment with Bioamended Activated Carbon:
  - cost-effective for town
  - degradation of PCBs
  - negates requirement for extensive waste management
  - maintains function of WWTP as an emergency overflow basin
In Situ Study - Deployment
Effect of Treatment
PCB Depth Profile

PCB Conc increases with depth

ca. 10-100 PPM

12-18 in

14-16 in

4-6 in

c. 100-1000 PPM

Bioaugmentation Treatment

Caisson 4 Top

- Day 0
- Day 519 total PCB 66 PPM
- Day 992 total PCB 49 PPM

Caisson 4 Bottom

- Day 0
- Day 519 total PCB 775 PPM
- Day 992 total PCB 761 PPM
Conclusions – *In Situ* Test

2.5 years after initial treatment

- PCBs in upper 14 inches of sediment degraded below 50 PPM
- PCBs in 0-4 inch bottom layer of sediment reduced 45%
- Mixing sediments during application increases activity
Pilot-Scale Field Study

- Four - 80 sq. ft (7.4 sq. m.) caissons
- PCB levels 500 – 1500 PPM
Pilot-Scale Field Study – Deployment of BAC

18 March 2015
Pilot-Scale Field Study

- Applied approximately 1200 lbs bioamended SediMite
- Sump pump used to homogenize sediments
Mixing alone has some stimulatory effect (Caisson 1)
• Treatments with bioamendment continue to degrade
• Treatments without bioamendment have leveled off
Conclusions – Pilot Study

2.3 years after initial treatment

• Mixing alone has some stimulatory effect (Caisson 1)
• Treatments with bioamendment continue to degrade PCBs
• Treatments without bioamendment leveled off after 1 year
Full-Scale Treatment - Approaches

Approach I - Tilling in Bioamended SediMite to access PCBs at bottom

Approach II - Mix Bioamended SediMite with circulation pumps
Questions