Open Water Placement Demonstration of Amended Dredged Material for Bioaccumulation Control

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14 June 2016

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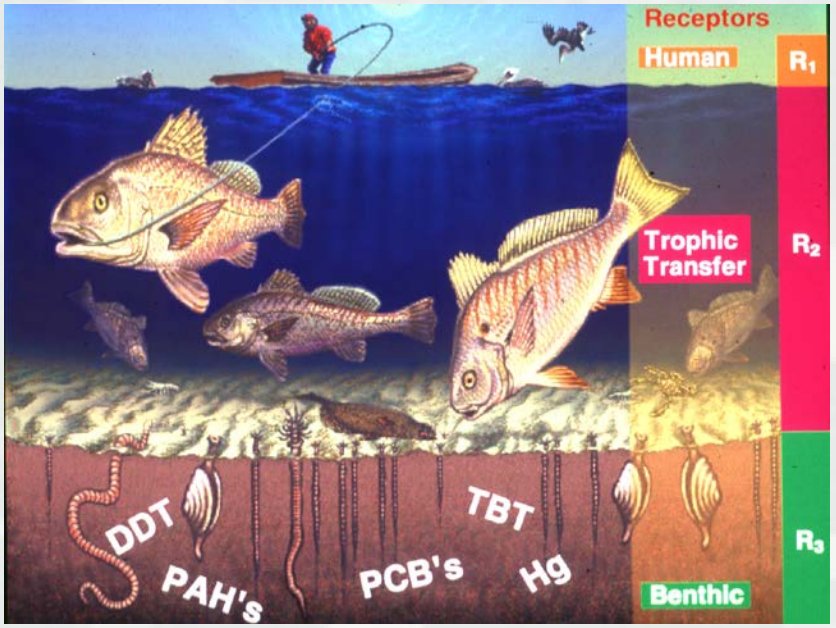
Problem

- Historic contamination poses ecological and human health concerns from potential bioaccumulation of contaminants placed dredged material placed in an aquatic environment for disposal or beneficial use
- Limiting placement alternatives and increasing costs
- Need for cost-effective, implementable bioaccumulation control technology



Past Applications of Activated Carbon in Sediments

- Activated carbon has been applied directly to sediment only about a dozen times, mostly in small pilot demonstrations
- Additionally, activated carbon has been applied in caps at contaminated sediment sites at about a dozen sites, also mostly in small field demonstrations
- Only a few of these applications were larger than our current demonstration and half of the applications were much smaller.
- All of the applications were intended to remediate in situ contaminated sediment by reducing contaminant exposure/flux and limiting bioaccumulation.

Past Applications of Activated Carbon in Sediments

- None of the applications used a technique similar to our method of applying activated carbon except two applications in Norway that applied carbon as a blended cover with clean dredged clay; however, the carbon was placed as pumped slurry from a hopper dredge with a tremie (Cornelissen et al. 2012 and Eek et al. 2012).
- Carbon has been applied directly to the surface of the sediment without mixing in test plots at Grasse River, and Upper Canal Creek near Aberdeen, MD (USEPA 2013) while activated carbon within a delivery system such as SediMite® and AquaGate™ have been applied at about a dozen sites (Patmont et al. 2015).
- Prior to this study, an application of activated carbon in a conventional mechanical dredging operation has never been demonstrated in a navigation dredging project.

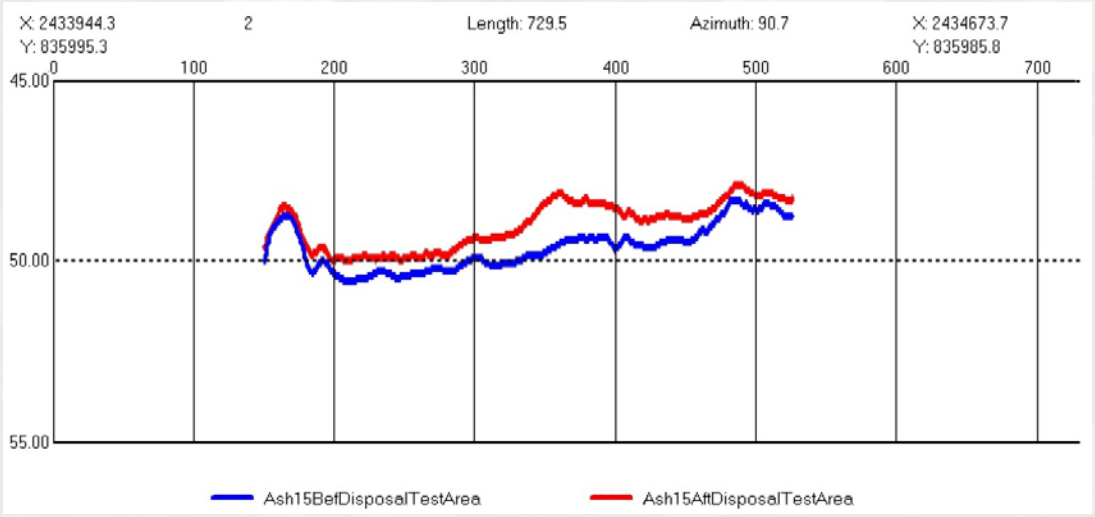
Objectives

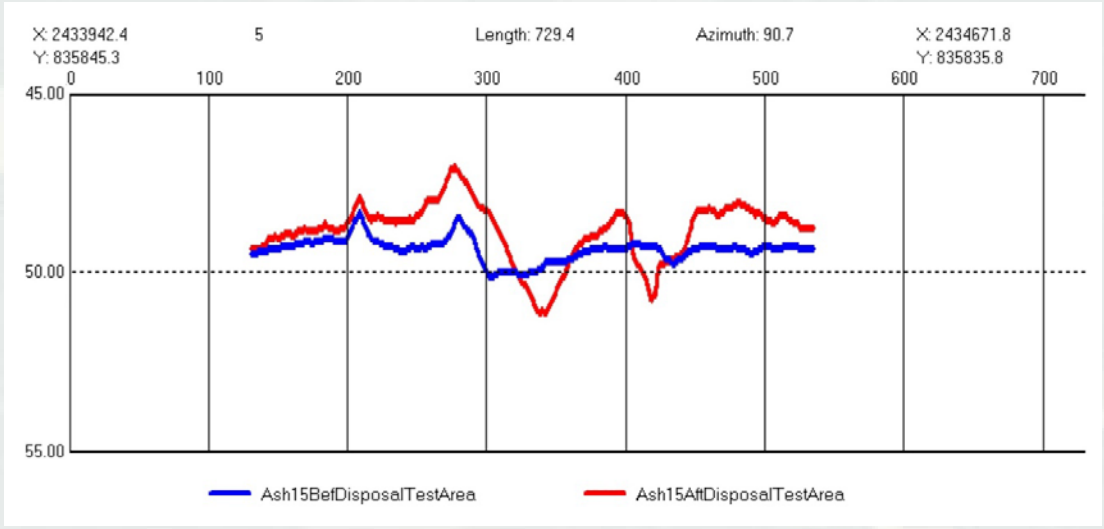
- Determine the efficacy of mixing activated carbon (both powdered and granular) within the barge using conventional dredging equipment
- Determine the potential loss of activated carbon (powdered and granular) during conventional placement through 15 meters (50 feet) of water and during the long term after placement
- Determine the extent of replacement or coverage of the bioactive zone with activated carbon amended dredged material
- Determine the long-term reduction in PCB bioavailability and bioaccumulation in the bioactive zone of the demonstration site
- Evaluate the dosage screening protocols and volume requirements for amended dredged material to adequately treat the bioactive zone

Approach

- Place four barges of unamended mechanically dredged material at a point in the open water placement site in 50 ft of water (about 6000 cy to form a 1-ft high mound); sample the barges to characterize the unamended dredged material in August 2015

Mound Dimensions





Approach

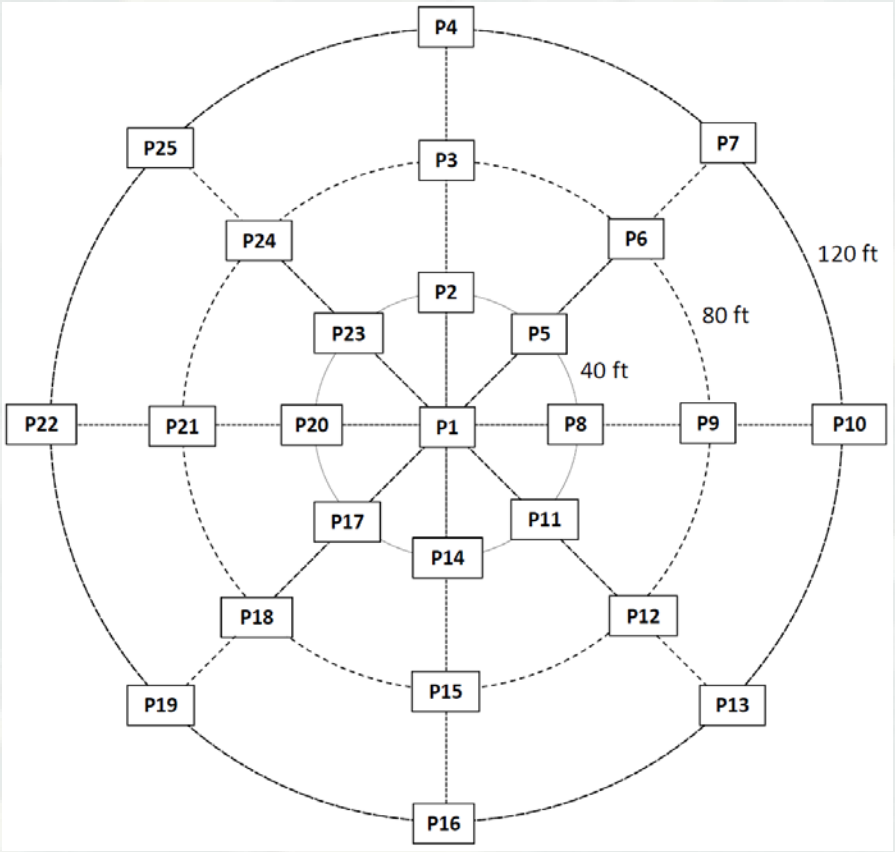
- Mix both PAC and GAC in two layers of dredged material in the dump scow using a small conventional dredge bucket; sample the amended dredged material from each hopper of the dump scow to characterize the activated carbon distribution

Carbon Addition

Mixing

Approach

- Disperse GAC on the surface of the amended dredged material in the dump scow
- Bottom dump the amended dredged material on the placement mound
- Sample the top two inches of the placement mound to characterize the activated carbon distribution three weeks after placement at end of August 2015



Dredged Material Characteristics

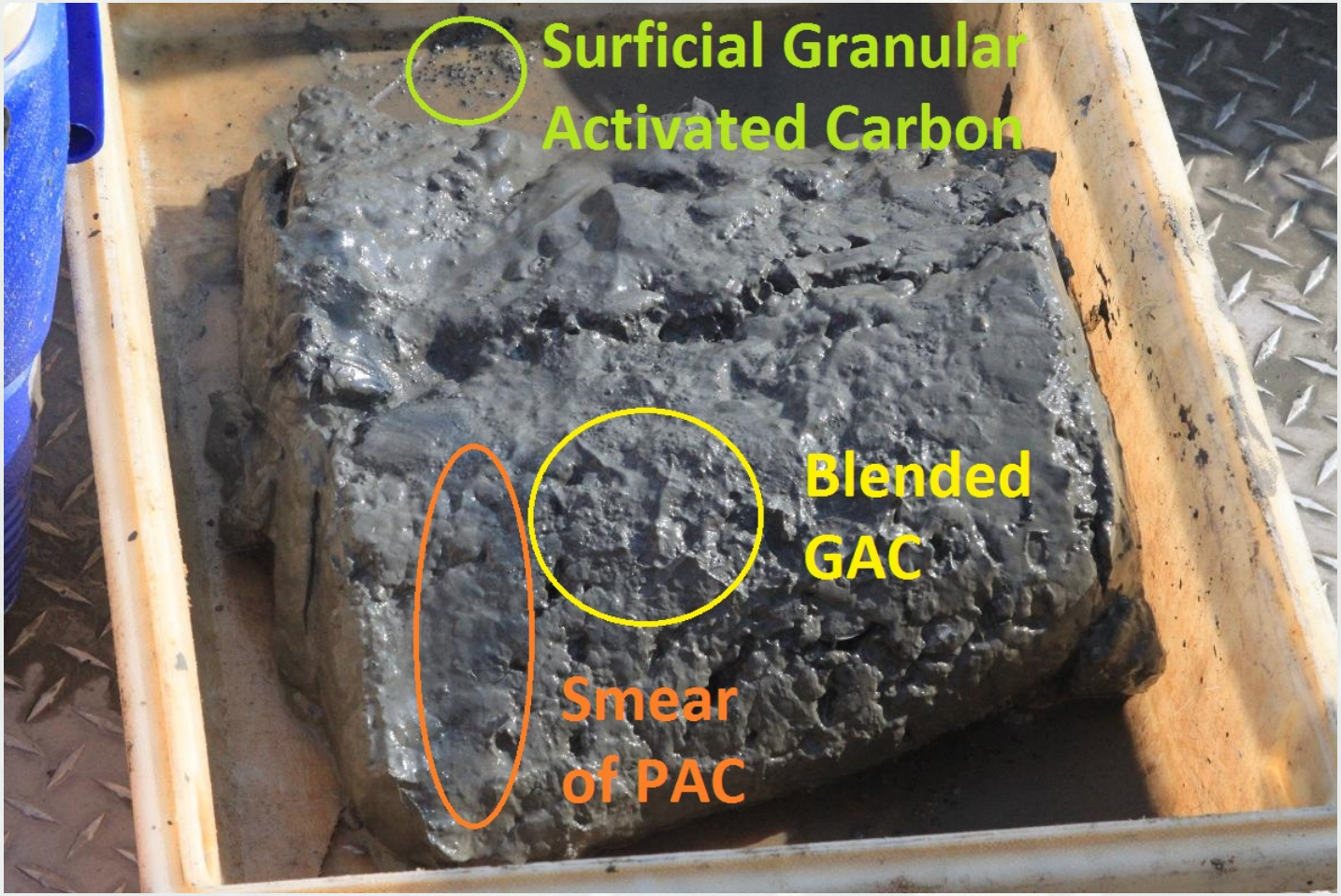
- Classified as CL (lean clay of low plasticity)
- Liquid Limit of 37, Plastic Limit of 22 and Plasticity Index of 15
- Water content ranging from 65 to 67% and a solids content of 60%
- Liquidity Index ranged from 2.7 to 3.0
- Toughness Index ranged from 1 to 1.3
- Amended dredged material: 0.934 g/cc dry bulk density in barge
  0.947 g/cc dry at placement site

Barge AC Content

SAMPLE	PAC Content	GAC Content	Total AC Content*
Average	1.50%	2.20%	3.70%
Maximum	2.60%	4.00%	6.60%
Median	1.60%	2.10%	3.70%
Minimum	0.60%	0.80%	1.50%
Std. Dev.			1.10%
CV			32.00%

0.3% GAC added to surface also.

Placement Site Sample



Placement Site AC Content

SAMPLE	PAC Content	GAC Content	Total AC Content*	Thickness of Amended Dredged Material	
				cm	inches
Average	0.47%	2.33%	2.69%	5	2
Maximum	0.99%	4.86%	5.12%	10	4
Median	0.42%	2.51%	2.80%	5	2
Minimum	0.01%	0.27%	0.56%	2.5	1
Std. Dev.	0.25%	1.09%	1.10%	2.5	1
CV	52.90%	46.70%	41.00%	48.40%	

Measured by differential combustion and sieving

Other Measurements

- PCBs in dredged material
- Bioaccumulation of PCBs from unamended dredged material
- Losses of PAC and fines in laboratory tank tests
- Carbon content at placement site after 1 year
- Bioaccumulation of PCBs from amended dredged material from placement site 1 year after placement

Conclusions

- Activated carbon can be added and mixed using conventional dredging equipment
- Amended dredged material can be deliver by conventional dump scows to form a cover for bioaccumulation control
- PAC needs to be pre-wetted to prevent losses during addition
- PAC content was unexplicably less than measured in the barge
- Further investigation is needed using laboratory dump tests

Acknowledgements

- Support was provided by the USACE Buffalo District
- Additional on-going support is being provided by the USACE Engineering with Nature (EWN) Program and the Dredging Operations and Environmental Research (DOER) Program