Combining Engineering and Biology in a Low-Impact In-Situ Treatment System for Sediments

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Acknowledgments:

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Dr. Upal Ghosh

University of Maryland Baltimore County Department of Civil and Environmental Engineering

SBIR Project Goal (PHASE 1)

- Develop an agglomerate (SediMite) that can serve as a delivery system for in-situ treatment materials

- Initial focus of project is on treatment of low to moderate levels of:
  - PCBs
  - PAHs
  - DDT, Chlordane and other chlorinated pesticides
  - Other hydrophobic organic chemicals

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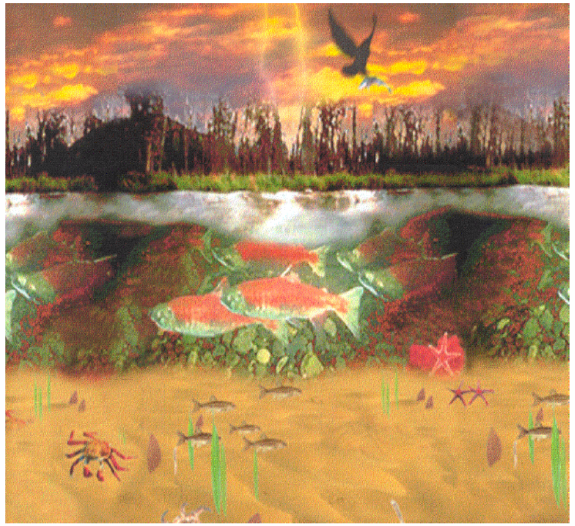
Extends from New Guidance:

United States
Environmental
Protection Agency

Contaminated Sediment Remediation
Guidance for Hazardous Waste Sites



- Sediment management will:
  - Be increasingly site-specific
  - Be guided by conceptual models
  - Be tied to overall management goals
  - Include a mix of methods (no-action, MNR, capping, treatment and/or removal)
  - Rely on decision approaches that incorporate a comparative analysis of remedial options

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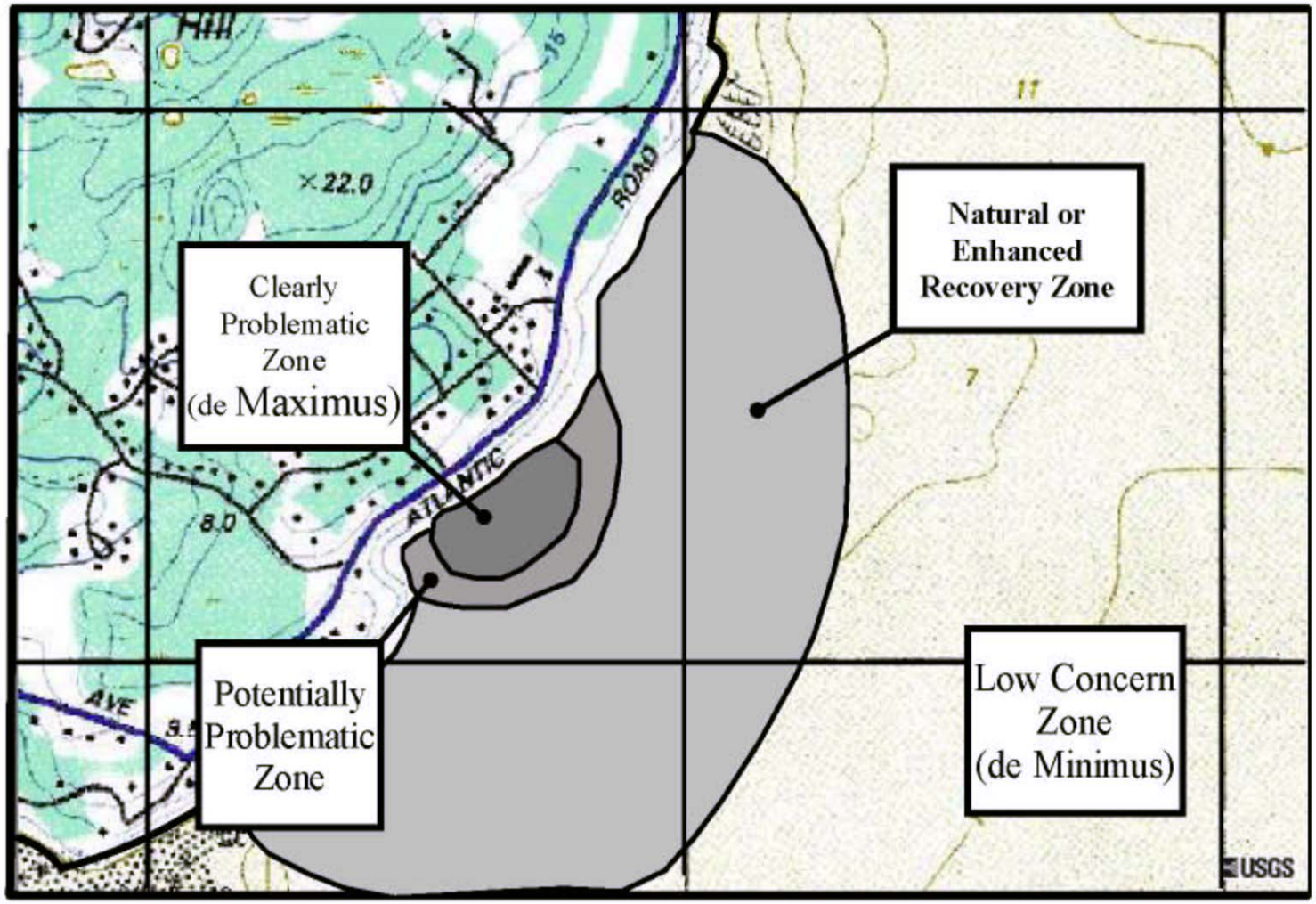
Approach intended for the grey (lower risk) zone



Most In-Situ Approaches Rely on Mechanical Mixing

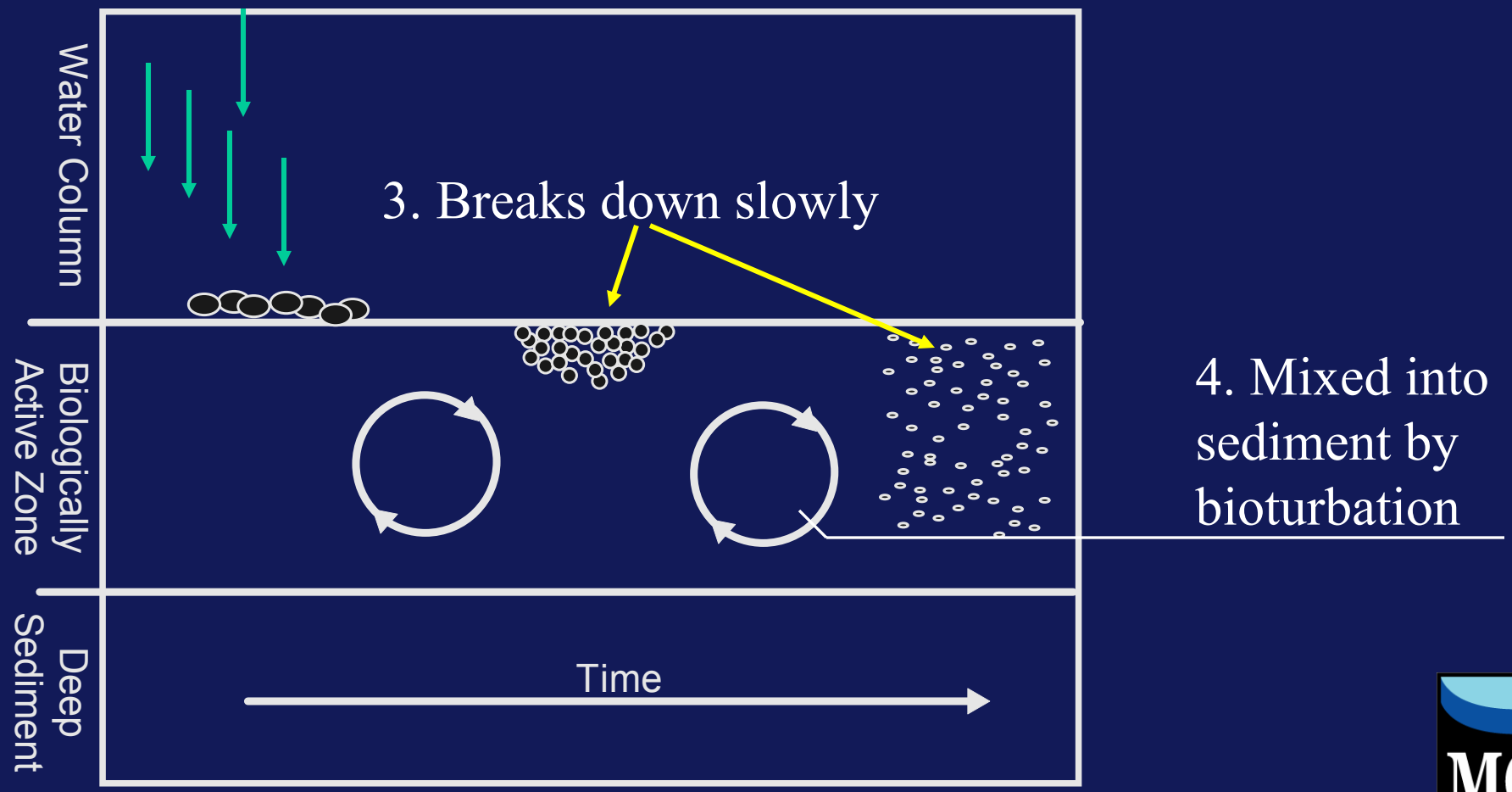
Slurry injection system
(Williams Environmental Services, Stone Mountain,GA)

Limnofix In-Situ Sediment Treatment Technology (LIST)
(Golder Associates)

Concept for Low-Impact Delivery System

1. Agglomerate containing treatment agent delivered from water surface or above the sediment

2. Sinks to sediment surface and resists resuspension



The biologically active zone is the upper most layer of sediment and varies in depth among water bodies (e.g., Passaic and Upper Hudson vs. Puget Sound or Coastal Oregon)

The biologically active zone can range from under an inch to a few feet

This zone is relevant for exposures to most biota

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The workers
(burrowing depth increases left to right)

Anticipated Benefits

- Targets biologically active zone
- Little disruption of benthic habitat
- Little disturbance of in-place sediments
- Can be used at various water depths
- Can be applied using available dispersive methods (agriculture, thin-layer caps)
- Can be used in sensitive environments (e.g., grass beds)

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Possible Limitations

- Limited to biologically active zone and requires biota for mixing
- Requires production and shipment of large volumes of agglomerate
- Higher energy environments might affect applications (currents, bottom shear stress)

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Project Elements: Phase 1

1. Agglomerate Development

2. Evaluation of Efficacy

3. Evaluation of Mixing via Bioturbation

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Production methods for agglomerates

1. *Pressure extrusion (Phase 1)*
2. *Tumble/growth (Phase 2)*
3. Heat/sintering
4. Atomization

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Step-Wise Approach Toward Agglomerate Development

1. Binder Evaluation
2. Mixtures Testing
3. Component Selection
4. Evaluation of Mixtures
5. Evaluation of Post Treatment
6. Evaluation of Encapsulation
7. Evaluation of Friability

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SediMite
Produced by Pressure Extrusion Process

SediMite
Major Components

- Primary binder
- Secondary binder (to reduce friability)
- Weighting agent
- Treatment agent (powered activated Carbon)
- Coating (does not appear needed but will be further evaluated)

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Evaluation of Efficacy

Toxicity of agglomerate

Acute toxicity tests indicate no toxicity
(chronic tests still needed)
30-day microcosm tests show that benthic communities remain established

Treatment effectiveness upon release from agglomerate

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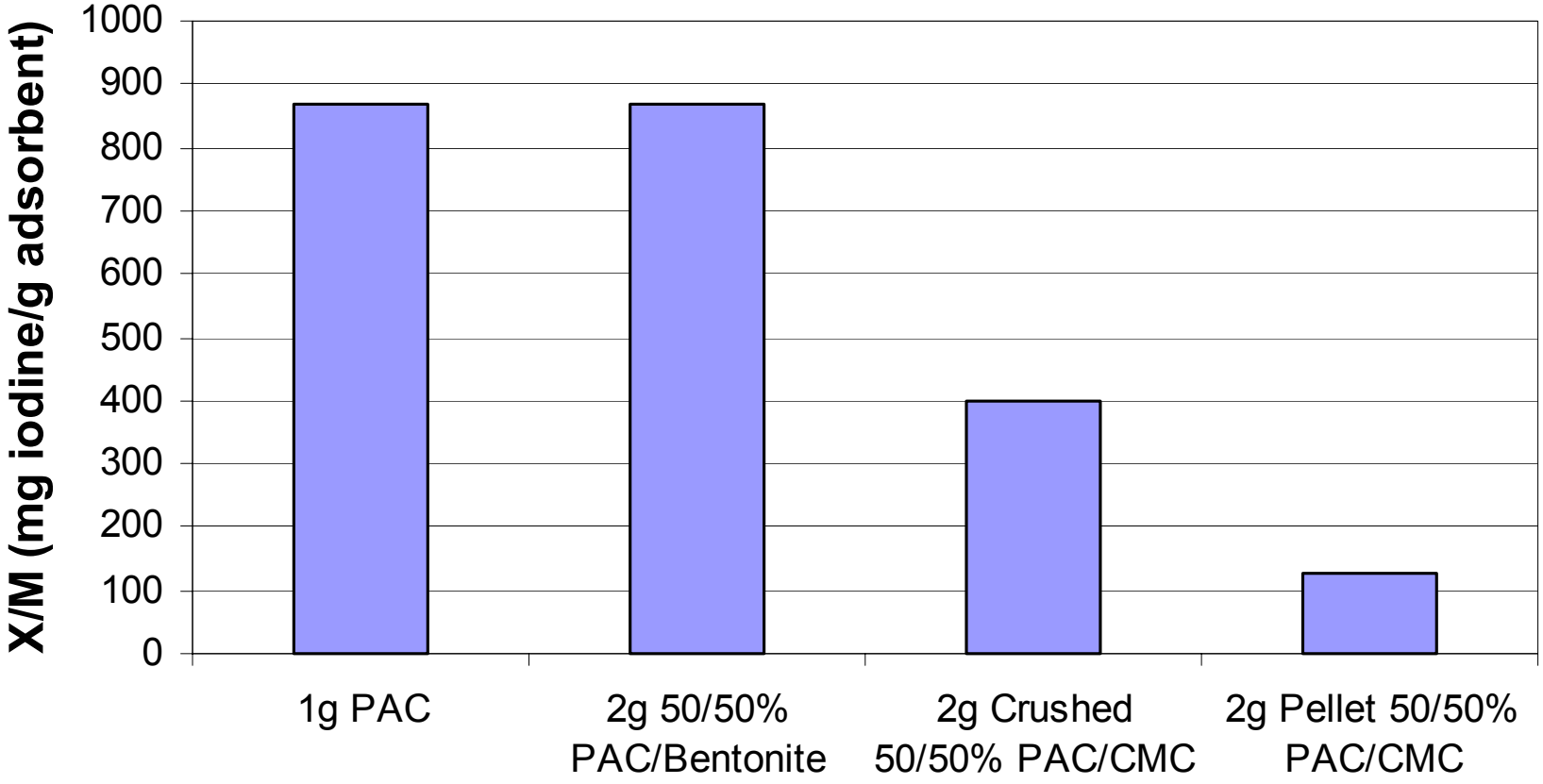
Iodine Test
(Adsorptive Capacity)



Evaluation of Mixing by Bioturbation

Microcosm tests

- Freshwater
- Coastal marine

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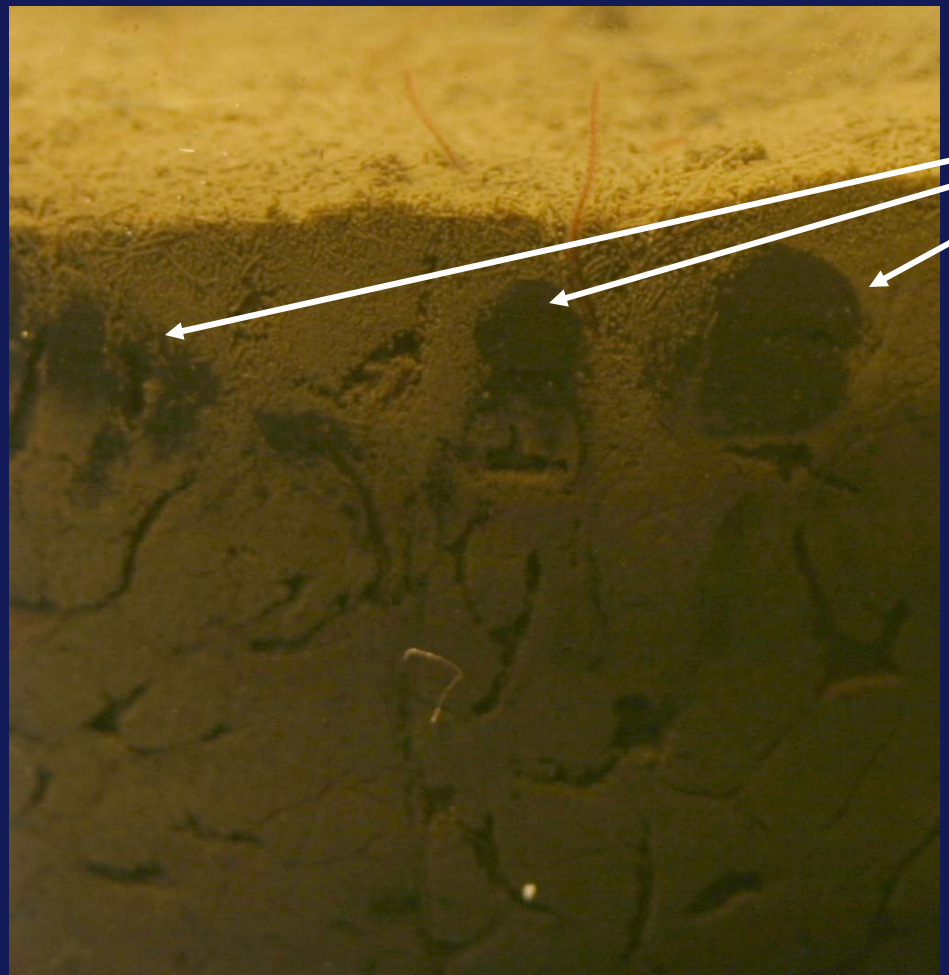
Freshwater microcosms

Freshwater Microcosm
SediMite has been incorporated into sediment by tubificid worms



SediMite agglomerates

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Marine Microcosms

- Natural benthic communities typical of coastal Chesapeake Bay were established at Wye Research Institute
- SediMite was augmented with fluorescent particles in addition to PAC
- SediMite was added to sediment surface
- Monitoring occurred for 30 days

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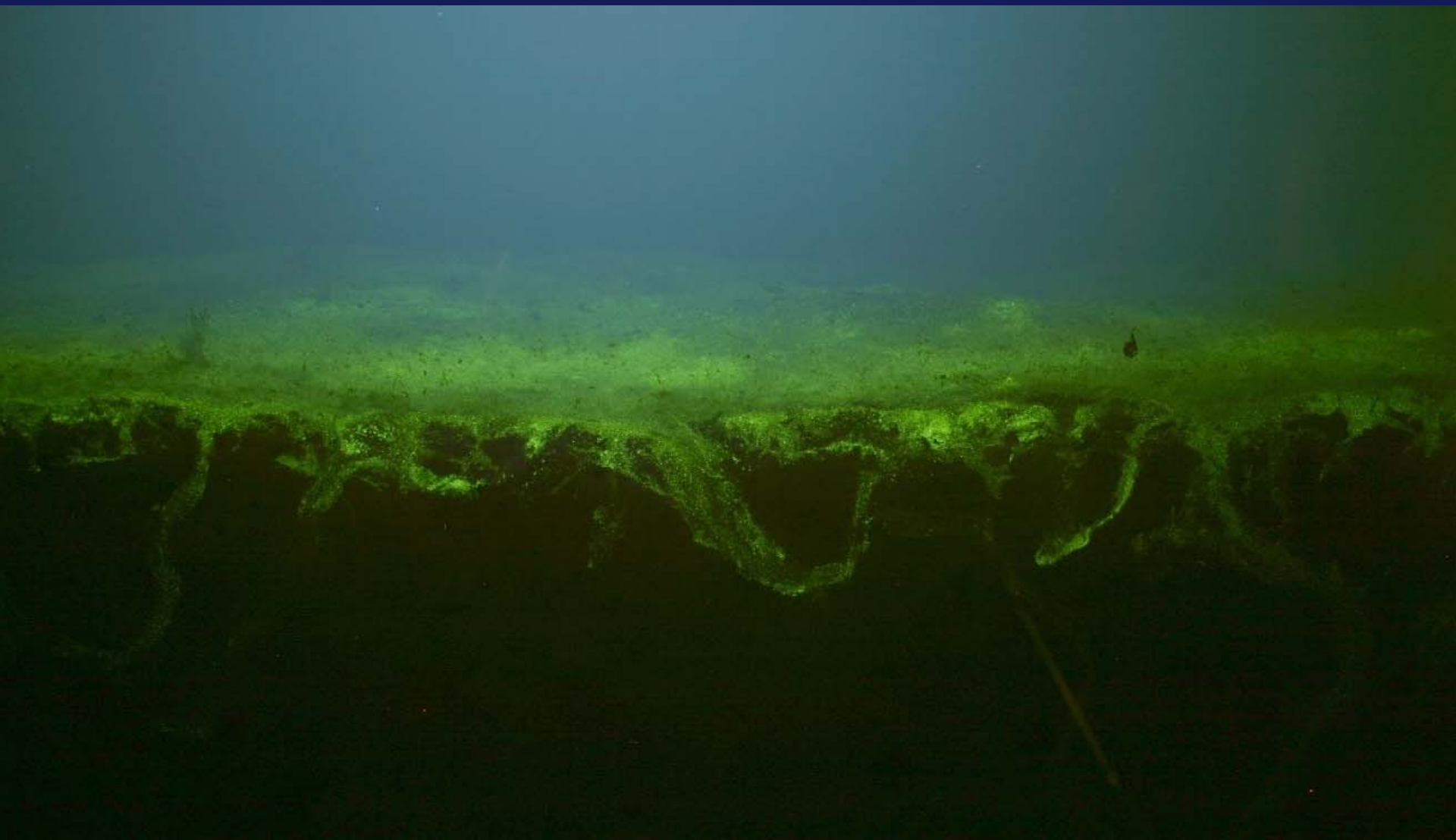
Mixing of treatment materials after 30 days



Comparison to a microcosm without benthic invertebrates

Planning an Application Requires Information on

- Management goals
- Contaminant distribution
- Sediment characteristics
  - Grain sizes
- Contaminant bioavailability
  - TOC, black carbon
  - Pore water (direct, SPME)
- Biology
  - Profile camera work (e.g., Germano)
  - Composition and perhaps vertical distribution of benthic fauna

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Insights from Vertical Profile Camera (courtesy of Joe Germano)

Example of profile

SBIR Phase 2 Goals

- Develop production capability (partners sought)
- Develop delivery capabilities (partners sought)
- Further evaluation of efficacy (treatment and potential for effects)
- Pilot and full-scale applications (candidate sites are being selected: PCBs and DDx)

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One thought is to place a broadcast spreader for granular agricultural products on a barge

Another possibility is to use a thin-layer sand cap applicator (courtesy RMT)

Invitation

- Phase 2 SBIR Proposal is being prepared
- Partners are sought for production and application elements
- Candidate PCB, Pesticide, or PAH sites being sought
- Contact Charlie Menzie: camenzie@menziecura.com

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