Active Cap Materials & Placement at East Branch Grand Calumet River: Evaluation of Sorption Characteristics of Sediment Capping Materials

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Presentation Outline

I. Amendments – Regulatory Acceptance
II. Case Study: East Branch Grand Calumet River
III. Summary/Q & A
The appropriate use of amendments has much potential to limit exposure to contaminants and, thus, to reduce risks.

- Less obtrusive than dredging
- Focused on reducing bioavailability
- Shorten recovery time
- Less costly and more expedient
Grand Calumet River
Legacy Act Cleanup
Grand Calumet River Area of Concern

Inland Steel Manufacturing Complex, circa 1909 – Looking to Lake Michigan

Indiana Harbor, 1969
East Branch (Zone B) of the Grand Calumet River:

• 1.8-mile stretch of the river from Indianapolis Boulevard to Holhman Avenue
• 350,000 cubic yards of sediment are slated to be removed
• A cap will be placed over the dredged sediment.
• Near shore habitats will be restored with native plants
• Completion expected in 2015.
Reactive Cap Design

Two Cap Designs:

1. 6-inch mixture of sand / AquaGate+Organoclay at a ratio of 2/3 Sand 1/3 AquaGate – in thickness

2. 6-inch AquaGate+Organoclay layer
Critical Aspects of Reactive Cap Design: Treatment Through A Permeable Treatment Layer

- **Uniform Distribution** of Treatment Material within Layer is Most Critical.

- Increased Thickness is often Required to Provides More **Residence Time** for Adsorption AND Capacity

- Larger Quantity of Treatment Material is Often Required to Protect Against Breakthrough from Higher Concentration Areas or an **Isolated Seep Zone**

- Must consider potential for long-term **Reduction in Permeability**

- Use of Powder Materials **Improves Rate of Sorption** over Granular Material
Overview of Capping Material

**Aggregate:** Nominal AASHTO #8 (1/4-3/8") or custom-sized to meet project-specific need. Limestone or non-calcareous substitute, as deemed project-appropriate.

**Binder:** Cellulosic polymer

**Permeability:** $1 \times 10^{-2}$ to $1 \times 10^{-5}$ cm/sec

**Dry Bulk Density:** 65 – 85 lbs/ft³

**Moisture:** 10 – 20% (maximum)

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**Product Description:**
Organoclay® P is a proprietary powder adsorption media effective in removing oils, greases, and other non-aqueous phase liquids (NAPL) and other dissolved high molecular weight/low solubility organic contaminants.

**Characteristics:**
- Hydrophobic; will not absorb water or swell when wetted
- Non-toxic to marine and benthic organisms
- High adsorption capacity of oils, greases and other NAPL
- Demonstrates noncompetitive sorption—can sorb multiple contaminants

**Properties:**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle Size</td>
<td>70% Min. passing 200 mesh sieve</td>
<td>CETCO Test Method</td>
</tr>
<tr>
<td>Bulk Density</td>
<td>50-54 lbs/ft³</td>
<td>CETCO Test Method</td>
</tr>
<tr>
<td>Oil Adsorption Capacity</td>
<td>0.5 lb/lb Min.</td>
<td>CETCO Test Method</td>
</tr>
<tr>
<td>Quaternary Amine Content</td>
<td>25% Min.</td>
<td>CETCO Test Method</td>
</tr>
</tbody>
</table>
## Why AquaGate+Organoclay?

A Comparison of AquaGate to Bulk Organoclay & RCM Approaches

<table>
<thead>
<tr>
<th>Product Characteristic</th>
<th>Mat/RCM</th>
<th>Sand/Granular OC</th>
<th>AquaGate+OC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Settling Velocity/Density</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Adsorptive Capacity</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Uniform Delivery</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Mixing – Active Cap</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Residence Time</td>
<td>-</td>
<td>+</td>
<td>+</td>
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<tr>
<td>Surface Preparation</td>
<td>-</td>
<td>+</td>
<td>+</td>
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<tr>
<td>Slopes</td>
<td>+</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Erosion Resistance</td>
<td>+/-</td>
<td>-</td>
<td>+/-</td>
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<tr>
<td>Initial QC – Placement</td>
<td>+</td>
<td>-</td>
<td>+/-</td>
</tr>
<tr>
<td>Long-term Monitoring</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Costs</td>
<td>?</td>
<td>+</td>
<td>+/-</td>
</tr>
</tbody>
</table>
Uniform Distribution of Low Concentration of In-Situ Treatment Material Placed in a Single Lift

Column Test with Organoclay

Column 1
Granular Organoclay Blend

Column 2
AquaGate+Organoclay Blend

Column Test with Activated Carbon

Graded AquaGate+PAC
AquaGate+PAC
GAC

Red Circles Indicate the Location of Organoclay within the Reactive Cap Layer

Red circles indicate relative location of particles within the as-placed cap. They do not denote the number of particles in a given location.
On-Site Production and Operations

Full-Scale Remote Manufacturing Performed at Multiple Locations
This Project is Believed to be the Largest Installation of an Organoclay-Based Active Cap for Contaminated Sediment Remediation

- Deliveries in 2,500lb Bulk Bags
- Approximately 4-5 Trucks/Day – at 22 tons
- Stockpile protected During Storage
- Placement Began in August – Completed November
- Production = + **16,600** tons
J.F. Brennan – Broadcast Capping System (BCS™)

- Able to accurately place over soft sediment with limited intermixing
- Limits resuspension of in-situ sediments
- Onboard tracking system records thickness, volume, and position of material placement
- Can accurately spread materials in very thin lifts, while achieving even distribution.
### Manufacturing & On-Site QA/QC

#### Bulk Density

<table>
<thead>
<tr>
<th>Sample Number (each sample represents forty-four bags)</th>
<th>Minimum Moving Average</th>
<th>LCL</th>
<th>Moving Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk Density (lbs/cu ft)</td>
<td></td>
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<tr>
<td>50 - 70</td>
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<tr>
<td>70 - 90</td>
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<td>90 - 110</td>
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<td>110 - 130</td>
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<td>130 - 150</td>
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<td>270 - 290</td>
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<tr>
<td>290</td>
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</tr>
</tbody>
</table>

#### As-Placed Coating Content

- **As-Manufactured Bulk Density**
- **As-Manufactured Moisture Content**
- **As-Manufactured Coating Content**

### Table: B-Cap

<table>
<thead>
<tr>
<th>Bucket Number</th>
<th>ID #</th>
<th>Fines %</th>
<th>Ave. Fines</th>
<th>lb/cu ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>092514465</td>
<td>12.79%</td>
<td>14.38%</td>
<td>14.04</td>
</tr>
<tr>
<td>2</td>
<td>09261474</td>
<td>6.37%</td>
<td>4.91%</td>
<td>5.36%</td>
</tr>
<tr>
<td>3</td>
<td>092914549</td>
<td>7.34%</td>
<td>8.82%</td>
<td>8.61</td>
</tr>
<tr>
<td>4</td>
<td>092914557</td>
<td>6.38%</td>
<td>12.75%</td>
<td></td>
</tr>
</tbody>
</table>

### Table: A-Cap

<table>
<thead>
<tr>
<th>Bucket Number</th>
<th>ID #</th>
<th>Fines %</th>
<th>Ave. Fines</th>
<th>lb/cu ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>100214689</td>
<td>39.63%</td>
<td>31.08%</td>
<td>25.64</td>
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<tr>
<td>6</td>
<td>100814783</td>
<td>27.49%</td>
<td>26.12%</td>
<td>25.78%</td>
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<tr>
<td>7</td>
<td>110614534</td>
<td>28.10%</td>
<td>31.15%</td>
<td>25.70</td>
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<tr>
<td>8</td>
<td>111114665</td>
<td>28.03%</td>
<td></td>
<td>23.13</td>
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<tr>
<td>9</td>
<td>111814798</td>
<td>26.78%</td>
<td></td>
<td>22.09</td>
</tr>
</tbody>
</table>

#### Moving Average Shoveling

<table>
<thead>
<tr>
<th>Sample Number (each sample represents forty-four bags)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moving Average Shoveling</td>
</tr>
<tr>
<td>----------------------------</td>
</tr>
<tr>
<td>50 - 70</td>
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<td>70 - 90</td>
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<td>270 - 290</td>
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<tr>
<td>290</td>
</tr>
</tbody>
</table>

#### Moving Average Adsorption Testing

- **Ave. Fines**
- **lb/cu ft**

<table>
<thead>
<tr>
<th>Sample Number (each sample represents forty-four bags)</th>
<th>Average Fines</th>
<th>Target lb/cu ft</th>
<th>Actual lb/cu ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 - 70</td>
<td>9.36%</td>
<td>7.0 - 7.2</td>
<td>9.14</td>
</tr>
</tbody>
</table>

**Post-Placement Adsorption Testing Confirmed As-Placed Treatment Capacity**
Step #1 As-Placed Active Cap Bucket Samples Recovered from River and Coating Material Dried and Removed from Cap Material

Step #2 Active Coating Material Samples (Post Placement, As-Manufactured Coating Samples and Raw Organoclay Samples Prepared for Lab Testing (3 replicates each of 3 samples)

Step #3 Samples Sent to CETCO Lab for DNAPL Adsorption Test and Dr. Danny Reible at Texas Tech University for Dissolved Phase PAH Adsorption Testing

Figure 1. CETCO Lab oil sorption capacity (% dry wt.) for samples. Error bars represent the 95% confidence interval (CI) around respective mean values; n = 4 for each material type.

Figure 2. Texas Tech University Lab derived partition coefficients on samples. #1 – As Received, #2 – As Manufactured #3 – As Placed. Measured partition coefficients as a function of Kow.
Post-Placement Active Material Testing & Analysis: Conclusions

- Ability to confirm the quantity of high-value amendment material (organoclay coating weight) being supplied and placed.
- Confirmation of material properties such as bulk density (determines layer thickness) which is critical to demonstration that this key design parameter is met.
- Verification of uniform distribution of active-treatment materials is achieved through the thickness of the capping layer.
- Enables ability to perform post-placement confirmation of active-treatment material testing of adsorption capacity (partition coefficient) that satisfies the specification.
- Modeling output can be confirmed through comparison of input/assumptions to post-placement physical and material property data.
- Results can support modeling assumptions and be used to reduce costs associated with excessive factors of safety due to lack of certainty of achievement of a design / specification as well as the ability to provide post-placement verification.

The approach enabled full-scale verification of quantity and post-placement material properties relative to project material specifications, design standards, performance goals, and objectives.
Summary – Q&A

AquaBlok as a Low-Permeability Material for Remediation & Geotechnical Applications:

Permeable Treatment Material for Remediation Applications:

Permeable Treatment Material for Sediment Remediation Applications

- Provides Uniform Delivery of Small Quantities of a High Value Treatment Material
- Use of Powder Treatment Materials = Faster Adsorption Rates
- Creates Thicker (uniform) Layers with Less Material Usage
- Ability to Mix Treatment Materials with other Granular Capping Materials and Provide Uniform Delivery in a Single Lift - Less Risk of Material Separation Wide Range of Treatment Materials

- Rapid Installation – Using Conventional Equipment
- Proven Full-Scale Production – On-Site Manufacturing