Recent ISS Activities for the Treatment of Organics

Paul R. Lear, Ph.D.

Note: Not all jobs depicted were completed by Envirocon – Dr. Lear brings experience from previous employers.
PRESENTATION OUTLINE

- Technology Description
- Stabilization of Organics (Theory and Practice)
- Leaching Criterion
- Full-Scale Examples of ISS of Chlorinated Solvents
- Conclusion
“In situ Stabilization/Solidification (ISS) is the mixing of impacted soils with reagents (such as Portland cement and/or slag) to reduce the leachability of contaminants while decreasing the permeability of the stabilized materials.”

ISS can be applied using “auger-based” and “excavator-based” soil mixing approaches.

“Auger-based” ISS mixing has been practiced for many years, primarily in the geotechnical and deep foundations arenas.

“Excavator-based” ISS mixing has been practiced for many years, primarily at waste impoundments and sites with subsurface obstructions.
Reactions which can alter the organic contaminant in a stabilized matrix

- Hydrolysis
- Oxidation
- Reduction
- Compound Formation
Physical processes which immobilize the organic contaminant in a stabilized matrix

- Adsorption
- Encapsulation

Typically both the chemical and physical processes occur simultaneous, though the relative effect of each may vary with the contaminant

- The more recalcitrant the organic contaminant, the more prevalent the physical processes
• **Sorbents**
  - Activated carbon
  - Organoclays/Bentonite
  - Rice hull ash
  - High carbon fly ash

• **Reactants**
  - Persulfate
  - Permanganate
  - Calcium peroxide
  - Zero valent iron (with and without bentonite)

• **Used alone or in conjunction with traditional alkaline S/S reagents**
<table>
<thead>
<tr>
<th>Project Name</th>
<th>Contaminants</th>
<th>Project Name</th>
<th>Contaminants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Umatilla Army Depot</td>
<td>Explosives, metals</td>
<td>Hercules Brunswick</td>
<td>Toxaphene</td>
</tr>
<tr>
<td>Camp Pendleton</td>
<td>Pesticides, PCBs, dioxins, metals</td>
<td>Orkin Dettlebach</td>
<td>Chlordane</td>
</tr>
<tr>
<td>American Creosote</td>
<td>PAHs, dioxins, metals</td>
<td>Geiger Oil</td>
<td>Benzene, TPH, metals</td>
</tr>
<tr>
<td>Roma Street</td>
<td>PAHs</td>
<td>Sunflower AAP</td>
<td>Explosives, propellants, metals</td>
</tr>
<tr>
<td>X-31, Portsmouth GDP</td>
<td>TCE, radionuclides</td>
<td>Docklands Development Site</td>
<td>PAHs</td>
</tr>
<tr>
<td>Selma Wood</td>
<td>PAHs, PCP, metals</td>
<td>GM Fisher Guide</td>
<td>Organometalics</td>
</tr>
</tbody>
</table>

**Note:** Many of the emerging contaminants should be amenable to stabilization treatment.
No regulatory leaching criteria are typically available for the organic contaminants of concerns:
- PAHs
- BTEX
- CVOCs

How do you develop these?
- ITRC Guidance
- Risk-Based Site Clean-up Approach

Available at http://www.itrcweb.org/Guidance
Leaching tests provide an estimate at the source of contamination.

Leaching test results should not be:
- Considered to directly represent POC value unless source is at the POC.
- Compared directly to water quality standards for purposes other than screening.

A Dilution-Attenuation Factor (DAF) relates concentration at source to that at POC.
- “Use and Measurement of Mass Flux and Mass Discharge” (ITRC 2010).
The EPA and many states utilize a risk-based approach to calculate standards for site remediation.

The Risk-based Impact to Groundwater Standards establish a Leachate Criterion:
- The quantity of a contaminant that the soil can leach and still be protective of human health and the environment at the POC.
Site-Specific Leachate Criterion
- The higher of the health-based water quality standard x site-specific dilution attenuation factor or the aqueous practical quantitation level (PQL) for the analyte

Default Leachate Criterion
- Higher of health-based water quality standard x a default dilution attenuation factor (13 to 20) or aqueous PQL
- Can be set at water quality standard multiplied by an appropriate DAF
  - Represent how much of a contaminant the ISS treated material can leach to groundwater and still be protective of human health and the environment
- Should not be set below the aqueous PQL
  - Laboratories typically will not quantify below the PQLs
Consistent with both

- The ITRC guidance, and
- the existing use of Leaching Criterion for calculating site-specific Impact to Groundwater Remediation Standards

Protective of human health and the environment
AER Superfund Site, Augusta, GA

- Solvent recycling operations results in chlorinated solvent contamination
- ISS treatment depths ranged from 4 to 35 feet bgs
FULL-SCALE ISS TREATMENT

ISS Cross Sections

Figure 6.2
CROSS-SECTION B-B'
95% DESIGN REPORT - SOIL
ALTERNATE ENERGY RESOURCES SITE
Augusta, Georgia

Figure 6.3
CROSS-SECTION B-B'
95% DESIGN REPORT - SOIL
ALTERNATE ENERGY RESOURCES SITE
Augusta, Georgia
RELOCATION OF IMPACTED SOILS

Excavated and Placed in Soil Treatment Area GP-14 for ISS Treatment

Off-site removals
Auger ISS treatment

- Treatment depth greater than 16 feet bgs
- Daily production areas pre-excavated to accommodate swell
- Cement grout added to 10% by weight of soil
- Carbon added to grout where auger reached highly contaminated treatment zones (1% by soil weight)
- Total of 3 mixing passes were required
cavator ISS treatment

Treatment depth less than 16 feet bgs

Treatment cells (400 cy) bermed to accommodate swell

Cement grout added to 10% by weight of soil

Mixed until visibly homogeneous (no “bigger than fisted-sized” lumps)
### Performance Criteria

Risk-based SPLP Leachate Criteria

Calculated by MCL or groundwater quality standard times a site-specific DAF

Approved by GA EPD and USEPA Region IV

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#### SPLP Extract

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Criterion d.1</th>
<th>mg/L</th>
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<tbody>
<tr>
<td><strong>VOCs</strong></td>
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<tr>
<td>1,1,1-Trichloroethane</td>
<td>17.82</td>
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<tr>
<td>1,1-Dichloroethene</td>
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<td>Benzene</td>
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<td>cis-1,2-Dichloroethene</td>
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<tr>
<td>Methylene Chloride</td>
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<tr>
<td>Tetrachloroethene</td>
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<td>trans-1,2-Dichloroethene</td>
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<tr>
<td>Trichloroethene</td>
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<tr>
<td>Vinyl Chloride</td>
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<tr>
<td>Xylenes (Total)</td>
<td>65.5</td>
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#### SVOCs

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<th>Parameters</th>
<th>Criterion d.1</th>
<th>mg/L</th>
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</thead>
<tbody>
<tr>
<td>Benzo(a)anthracene</td>
<td>0.07</td>
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<tr>
<td>Benzo(a)pyrene</td>
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<tr>
<td>Benzo(b)fluoranthene</td>
<td>0.07</td>
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</tbody>
</table>
Performance Verification

Sampled every 500 cy for each mixing method

Sampling location determined by de maximis (Oversight Engineer)

3rd party analytical lab

Results

All samples met the leachate criteria
Most in 7 days after treatment, but all in 35 days
Mixing method irrelevant to performance
Aura Shopping Center, Jonesborough, GA

Dry cleaner disposed of solvents in a dry well, resulting in chlorinated solvent contamination in soil and groundwater.

Impacts to groundwater detected off-site.

Voluntary site cleanup to facilitate redevelopment.
S treatment depths ranged from 25 to 45 feet bgs.
**Soil ISS treatment**

Daily production areas pre-excavated to accommodate swell

Area 1 – 1.9% cement + 5.6% slag
+ 1% carbon added to the soil as a grout

Other Areas (1A, 1B, 2, and 3) – 1.9% cement + 5.6% slag added to the soil as a grout

Total of 3 mixing passes were required for each column
## Performance Criteria

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Method</th>
<th>Criteria</th>
<th>Tolerance</th>
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<tbody>
<tr>
<td>S</td>
<td>ASTM D1633</td>
<td>50 psi</td>
<td>No less than 40 psi</td>
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<tr>
<td>Permeability</td>
<td>ASTM D5084</td>
<td>5x10⁻⁷ cm/s</td>
<td>No more than 8x10⁻⁷ cm/s</td>
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<tr>
<td>LP Leachability</td>
<td>SW846 Method 1312</td>
<td>PCE, TCE, Cis 1,2DCE, Vinyl Chloride</td>
<td>5 µg/L, 5 µg/L, 70 µg/L, 2 µg/L</td>
</tr>
</tbody>
</table>

**Note:** Leachate criteria = MCL
Performance Verification

Sampled every 250 cy

Sampling location determined by ESH (Oversight Engineer)

Sample material placed into 3’x6” molds

3rd party analytical and geotechnical lab testing

Results

All samples met the ISS performance criteria
S can be applied to soils and diments contaminated with organics including many emerging contaminants achieving performance criterion (sked-based SPLP leachate criterion) can be calculated MCL or groundwater quality standard times a default or site-specific DAF
QUESTIONS OR COMMENTS?

plear@envirocon.com

865-919-5205