Soil Washing of PFAS-Contaminated Soils
Agenda

• Who are Brice Engineering and ECT2?

• Introduction to soil washing

• Pilot-Scale Soil Washing – Peterson Air Force Base (2020)
  • Initial soil characterization
  • Source area excavation
  • Plant configuration
  • Treatment of coarse and fine fractions
  • Soil – PFAS removal efficiencies
  • Water treatment configuration and results
  • Applications

• Conclusions
Brice Engineering

- An environmental company that started as a small, family-owned construction company in Alaska
- An Alaska Native Corporation (ANC)
- Patented soil washing process:
  - Water-based
  - Segregation of soil fractions
  - Attrition and extraction
  - Flocculation and dewatering
  - Closed-loop water treatment
ECT2: Emerging Compounds Treatment Technologies, Inc.

- ECT2 is a solutions provider of cutting-edge technology solutions to remove emerging and difficult to treat contaminants, PFAS and 1,4-dioxane, from:
  - Investigation-Derived Waste
  - Groundwater
  - Surface Water
  - Construction Dewatering Liquids
  - Soil Washing Effluent
  - Drinking Water
  - Waste Water
  - Foam Spills
  - Landfill Leachate
Soil Washing and PFAS

Background

• Mature technology with proven track record
  • Complete treatment of soil mass
  • Beneficial re-use of soil
• Contaminant solubilizes rapidly with:
  • Retention time
  • Soil attrition
  • Water contact
• PFAS removal from process water
  • IX resins can be regenerated
  • Waste concentration
• Potential to combine with destruction technologies
# Pilot Soil Washing Project

**Peterson AFB, CO**

| PFAS Source: | Former Fire Training Area
Active 1996 - 2017 |
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>PFAS Concetration:</strong></td>
<td>3,200 – 12,000 ug/kg PFOS in loamy sands</td>
</tr>
</tbody>
</table>
| Soil Approach (Brice) | Baseline process testing
Source area excavation and characterization
Soil processing
Stockpiling and sampling
Dewatering |
| Water Approach (ECT2) | Pretreatment - sand filters and GAC
Treatment - SORBIX RePure Regenerable IX Resin |
Baseline Process Testing

- Collected representative soils from six borings on site
- Homogenize & run through standard protocol
- Pre-treatment:
  - 2,900 – 12,000 µg/kg PFOS
  - Water 0.023 µg/L PFOS
- Post treatment
  - 345 – 2,700 µg/kg PFOS
  - 78% - 88% RE
  - Water 280 µg/L PFOS
- Mass Balance:
  - 96.6% PFOS Recovered
Source Area Excavation

- Area of site with highest detected levels of PFOS
- 75’x 75’ at top of excavation
- Maximum depth 4’ w/ 1.5:1 side slopes
- 488 bank cubic yards (513 cy stockpile)
Stockpile Characterization

Pretreatment Soils
(μg/kg PFOS)

<table>
<thead>
<tr>
<th></th>
<th>Bulk Soil</th>
<th>Coarse Sands</th>
<th>Fine Sands</th>
<th>Silts &amp; Clays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration (μg/kg)</td>
<td>3,200</td>
<td>2,900</td>
<td>6,300</td>
<td>12,000</td>
</tr>
</tbody>
</table>
Factors Determining Plant Configuration

- Particle Size Distribution
- COCs Present and Concentrations
- Soil Mineralogy and Organic Matter

Old Guys.....
Size Segregation and Scrubbing/Attrition

- **Triple Deck Screen**
  - 1"
  - 3/8"
  - 1/4"

- **36” Sandscrew**
- **21” Sandscrew**
- **36” Sandscrew**
- **Material Feeder**
  - 170 gpm Overflow
  - Further Fines Treatment (< 200#)
- **Organics Screen**
  - 110 gpm Overflow
- **Conveyor**
  - Coarse Fraction Stockpile (> 200#)
  - Overflows

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What the Heck are Sandscrews?
Clarification and Thickening

Dewatering

Various technologies available for sediment dewatering depending on % and nature of fines, e.g.:

• Filter presses
• Centrifuges/cyclones
• Vacuum filters, etc.
System Setup and Outputs
Field Scale Removal Efficiencies (Coarse Fraction)

1\textsuperscript{st} wash: 110 – 140 ug/kg

2\textsuperscript{nd} wash: 7 – 10 ug/kg

93 – 96% RE

99% RE
Field Scale Removal Efficiencies (Fines Fraction)

1st wash: 2,000 – 2,100 ug/kg
MeOH addition: 1,300 ug/kg

82 – 83% RE
89% RE
Water Treatment Process

490 µg/L PFOS

< 70 ng/L PFOS
Single-Pass Results

490 µg/L PFOS Influent → 450 gpm Flow Rate → 0.087 µg/L PFOS Post-treatment
Final Water Treatment

• Use of IX resin tank array instead of larger tanks
• Allows for on-site regeneration during operations
• Reconfigured from single pass to lead/lag
• Treated process and decontamination water to 0.008 µg/L PFOS
• Discharge to storm water system
SORBIX RePURE™ Regeneration Technology

- 13x More effective treatment with PURE
- >99% Less waste generation with RePURE
- 67% reduction in treatment system size
- 50% reduction in lifecycle costs
### Case Study: Former Pease AFB Groundwater Treatment for PFAS

**Portsmouth, NH**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFAS Source:</td>
<td>Former Fire Training Area</td>
</tr>
<tr>
<td>PFAS Concentration:</td>
<td>50 – 100 ug/L</td>
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<tr>
<td>Project Approach:</td>
<td>Mitigate impact to off-site drinking water (120 - 200 gpm design flow)</td>
</tr>
<tr>
<td>Treatment:</td>
<td>SORBIX RePure regenerable IX resin; On-site regeneration</td>
</tr>
<tr>
<td>Effluent Concentration:</td>
<td>ND since startup</td>
</tr>
<tr>
<td>Groundwater Treated:</td>
<td>50 million gallons since 2018</td>
</tr>
<tr>
<td>Waste Generated</td>
<td>None taken off-site; <strong>50 gallons to date</strong></td>
</tr>
</tbody>
</table>
Full-Scale Regenerable IX System at Pease AFB

200 GPM Regeneration Facility

One Year of Waste

Single-Use GAC
185 drums

VS

Regenerable IX
< 1 drum
Pilot Soil Washing Project
Peterson AFB

Soil Quantity Treated: 500 bank cubic yards
Price per cubic yard treated: Highly-dependent upon volume
Cost Savings: > 50% vs. off-site incineration

Takeaways:

• Treated soil below EPA Risk Management Levels for PFOS/PFOA (1,280 µg/kg) from levels up to 12,000 µg/kg.
• Size segregation key to effective treatment
• Soil fractions reconstituted prior to return – potential for beneficial reuse
• Process water treated via single-pass; optimized to lead-lag configuration
Conclusions and Q&A

- Able to successfully treat PFOS/PFOA contaminated soils
- Applicable to a range of soil conditions/concentrations
- Can support both large scale construction projects as well as source area removal
- Process water can be treated and discharged on-site
- Potential for resin regeneration and PFAS destruction on larger projects

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