SUSTAINABLE SEDIMENT MANAGEMENT AND DREDGING SEMINAR
28-30 NOVEMBER 2018
GALVESTON, TX

Pathway Assessment
Susan Bailey
Upland placement alternatives

- Confined disposal
- Beneficial use
  - Habitat development
  - Beach nourishment
  - Parks & recreation
  - Agriculture, forestry, horticulture, aquaculture
  - Strip-mine reclamation/Solid waste management
  - Construction/Industrial development
  - Multipurpose
Regulatory concerns and available guidance

- Regulatory
  - CWA Section 404

- Guidance
  - USACE/EPA Technical Framework
  - Upland Testing Manual
  - Draft – Great Lakes Regional BU Manual
Upland pathways

- Effluent
- Runoff
- Volatilization
- Leachate
- Plant/Animal Uptake

Disposal vs. BU
Upland pathways – Unconfined / BU

- Effluent
- Runoff
- Volatilization
- Leachate
- Plant/Animal Uptake

- Disposal vs. BU

Birds/Wildlife
Precipitation
Volatilization
Plant/Animal Uptake
Runoff
Effluent
Surface Water
Unsaturated
Saturated
Infiltration
Seepage
Ground Water
Leachate
Air Quality
Pathway evaluation

- **Tier I – Existing info**
- **Tier II - Screening**
  - calculate concentrations
    - conservative assumptions
    - bulk sediment concentrations
    - equilibrium partitioning
  - spreadsheet available
  - consider initial mixing/dilution
  - compare to appropriate criteria
- **Tier III – Laboratory testing**
  - used to generate pathway concentrations
- **Tier IV – Case specific**
Effluent

Receptors:
Aquatic species

Criteria:
State/Federal
WQS/WQC
**Effluent**

- Compare predicted effluent concentration with WQC/WQS

- Consider initial mixing

- Tier II – Screening
  - Effluent concentration predicted based on equilibrium partitioning ($K_d$) and bulk sediment properties

- Tier III – Testing
  - Modified Elutriate Test
    - EFQUAL model
  - Column Settling
    - SETTLE model
  - Toxicity Evaluation (procedure in ITM)
    - LAT-E model (or EFFLUENT)

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**Diagram:**

- **Tier I**
  - Conduct Screening Evaluations
  - Evaluate Initial Mixing
  - Effluent WQS Decision
  - Information Sufficient For a Decision?
    - Yes
      - Conduct Water Column Toxicity Tests with EET
    - No
      - Follow Both Pathways as Needed

- **Tier II** Screening
  - COCs with WQS
  - COCs with No WQS or Interactive Effects of Concern

- **Tier III** Testing
  - Conduct EET and LTCST
  - Evaluate Initial Mixing
  - Effluent WQS Decision
  - Information Sufficient For a Decision?
    - Yes
      - Effluent Toxicity Decision
    - No
      - Conduct Water Column Toxicity Tests with EET

- **Tier IV**
  - EET = Effluent Elutriate Test
  - LTCST = Long Tube Column Settling Test
  - Information Sufficient For a Decision?
    - Yes
    - No
Effluent – Modified Elutriate Test

1. Mix sediment and water to expected influent concentration\(^1\)
2. Aerate in 4L cylinder for 1 hr
3. Settle for expected mean field retention time up to 24 hr maximum
4. Extract sample and split
5. Centrifugation or 0.45 µm filtration

\(\text{Csi} = \% \text{Fines} + 3 \times \% \text{Coarse}\)

Suspended Solids Determination
Chemical Analysis Total Concentration
Chemical Analysis Dissolved Concentration

\(^1\)
Effluent – Column Settling Test

- **Column**
  - 8-in diameter, > 6-ft tall
  - Ports every 6 in.
- **Fill column with slurry at expected influent solids concentration**
  - \( C_{sl} = \% \text{Fines} + (3 \times \% \text{Coarse}) \)
- **15 day test**
  - Sample supernatant TSS
  - Record interface height
- **Predict rate of settling and effluent TSS**
  - SETTLE model

\[
C = 262.6 \times T^{0.1361}
\]
Initial Mixing

40 CFR § 230.3 (m) The term *mixing zone* means a limited volume of water serving as a zone of initial dilution in the immediate vicinity of a discharge point where receiving water quality may not meet quality standards or other requirements otherwise applicable to the receiving water.

<table>
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<tr>
<th>Model/Technique</th>
<th>Hydrodynamics</th>
<th>Conditions</th>
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<td>Steady Uniform</td>
<td>General</td>
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<tr>
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</table>
Runoff

Receptors:
Aquatic species

Criteria:
State/Federal WQS/WQC
Runoff

- Compare predicted runoff concentration with WQC/WQS
- Consider initial mixing
- Tier II – Screening
  - Effluent concentration predicted based on equilibrium partitioning ($K_{d,ox}$ and $K_{d,unox}$) and bulk sediment properties
- Tier III – Testing
  - Simplified Laboratory Runoff Procedure (SLRP)
    - Wet (unoxidized) and Dry (oxidized)
  - Rainfall Simulator/Lysimeter System (RSLS)
    - RUNQUAL model
  - Toxicity Evaluation (procedure in ITM)
    - LAT-R model (or RUNOFF)

**Diagram:**

1. Conduct Screening Evaluations
2. Evaluate Initial Mixing
3. Conduct SLRP and/or RSLS Runoff Tests
4. Evaluate Initial Mixing
5. Runoff WQS Decision
6. Conduct Water Column Toxicity Tests with Runoff Medium
7. Runoff Toxicity Decision
8. Information Sufficient For a Decision?
9. COCs with WQS
10. COCs with No WQS or Interactive Effects of Concern
11. Follow Both Pathways as Needed
12. Tier I
13. Tier II
14. Tier III
15. Tier IV

SLRP = Simplified Laboratory Runoff Procedure
RSLS = Rainfall Simulation/Lysimeter System
Runoff – SLRP Procedures

**Unoxidized (Wet)**

- **Sediment**
  - 500 mg/L
  - 5000 mg/L
  - 50,000 mg/L
- **DI Water**
- **Agitate 1 hr**
- **Filter**
- **Split Sample**
- **Dissolved Chemical Analysis**
- **Total Chemical Analysis**
- **TSS Analysis**

**Oxidized (Dry)**

- **Sediment**
- **Air dry Grind**
- **Dried Sediment**
- **Add H₂O₂ Dry, Regrind**
- **Oxidized Sediment**
- **Dried Sediment¹ or Oxidized Sediment²**
  - 50 mg/L
  - 500 mg/L
  - 5000 mg/L
- **Agitate 1 hr**
- **Filter**
- **Split Sample**
- **Dissolved Chemical Analysis**
- **Total Chemical Analysis**
- **TSS Analysis**

¹For Nutrients/Organics; ²For Metals

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Runoff – SLRP predicted copper

This is why we do both wet, and dry SLRP tests

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Runoff – RSLS Procedure

• Specialized equipment
• 60 gal sediment
• Conduct on wet; allow to dry 6 months, repeat on oxidized sediment
• Test specifics
  • Rainfall
    • 2 in/hr, 30 min events, 3 events
  • Sample
    • Runoff rate – every minute
    • pH, TSS, EC
      • Every minute up to 15 min, then every 5
    • Chemical analysis
      • Composite of 5, 15, 25 minutes after runoff begins
      • Dissolved and total
Leachate

Receptors:
- GW supply (freshwater)
- Benthic zone receptors (marine)

Criteria:
GW or surface water standards
Leachate

- Tier II – Screening
  - Equilibrium partitioning
    - Laboratory determination of sediment chemical properties
  - Attenuation
  - Compare to applicable GW or surface water standards

- Tier III – Testing
  - Freshwater sediments
    - Sequential Batch Leach Test (SBLT)
  - Marine (saline) sediments
    - Pancake Column Leach Test (PCLT)
  - Groundwater modeling
    - HELPQ
    - MultiMed/IWEM
    - GMS
Leachate - Sequential Batch Leach Test (SBLT)

• Load sediment in a 4:1 water-to-sediment ratio under anaerobic (nitrogen atmosphere) conditions (for unoxidized dredged materials).

• Shake for 24 hours, centrifuge, and filter leachate.

• Add water to sediment to make up that removed. Repeat steps 1 and 2.

• Repeat procedure for at least four cycles.
Leachate - Pancake Column Leach Test (PCLT)

- Laboratory-scale physical model of contaminant elution from dredged material
- Thin layer column to maximize the number of pore volumes eluted
- Testing conducted in up-flow mode
- Pore water velocity limited to $1 \times 10^{-5}$ cm/sec
- Elution of 30 pore volumes recommended
Volatilization

- Not regulated under Clean Air Act. Evaluation designed to meet exposure standards under OSHA.

Receptors:
Humans working on site or adjacent

Criteria:
OSHA Human Exposure Standards
Volatilization

- **Tier II – Screening**
  - Equilibrium partitioning based on Henry’s Law, bulk sediment properties
- **Tier III – Testing**
  - Laboratory and field procedures to quantify volatile losses
- **Dispersion**
  - Predictive models
    - Gaussian models
    - More sophisticated, e.g. AERMOD
      - [https://www.epa.gov/scram/air-quality-dispersion-modeling](https://www.epa.gov/scram/air-quality-dispersion-modeling)
Volatilization – Tier III – Volatile Flux Chamber Test

- Load dredged material into flux chamber
- Attach COC-specific air sampling tube (traps)
  - Arrange in series for multiple COCs
- Apply air - 1.7 L/min
  - “House” air, compressed gas, or vacuum pump
  - Flow meter at entrance, traps to remove contaminants
- Sample air passed over DM surface
  - Sampling intervals depends on concentration
  - E.g. 6, 24, 48, 72 hours, 5, 7, 10, and 14 days
- Flux determination: \( N_A(t) = \frac{\Delta m}{\Delta t / A_c} \)
## Summary

- **Upland placement**
  - Disposal in CDFs
  - Beneficial use alternatives
- **Tiered screening process**
- **Pathways**
  - Effluent
  - Runoff
  - Leachate
  - Volatilization
  - Plant & Animal uptake

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<th>Effluent</th>
<th>Runoff</th>
<th>Leachate</th>
<th>Volatilization</th>
<th>Plant Uptake</th>
<th>Animal Uptake</th>
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<tr>
<td>Tier I</td>
<td>Existing Info</td>
<td>Existing Info</td>
<td>Existing Info</td>
<td>Existing Info</td>
<td>Existing Info, conceptual site model, complete exposure routes</td>
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</tr>
<tr>
<td>Tier II</td>
<td>Total release screen and/or Solubility partitioning screen</td>
<td>Solubility partitioning screen</td>
<td>Solubility partitioning screen</td>
<td>Volatility partitioning screen</td>
<td>DTPA Extract, COC elimination</td>
<td>TBP Calculation, COC elimination</td>
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<tr>
<td>Tier III</td>
<td>LTCST turbidity/TS EET EET toxicity</td>
<td>SLRP and/or RSLS chemistry SLRP and/or RSLS toxicity</td>
<td>SLRP and/or RSLS chemistry SLRP and/or RSLS toxicity</td>
<td>VFC chemistry</td>
<td>Plant bioaccumulation test</td>
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<td>Tier IV</td>
<td>Case specific study or risk assessment</td>
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