Porous Roughness Elements (Natural and Engineered)

Webinar to the Owens Lake Scientific Advisory Panel

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3-Dimensional Porous Roughness Element Testing

Purpose: Pursuit of a more optimal roughness element form to use in large arrays for dust control.

1. Wind tunnel testing conducted in 2015-2016
   - Tested performance of porous elements with well-defined geometry and porosity for increasing aerodynamic drag and sand-trapping potential

2. Field testing conducted at Mono Lake in 2017-2018
   - Field elements used were 1 m cubes with double walled mesh.
   - Mesh size varied between each element.

No testing has been conducted on natural porous roughness elements
Porous Element Wind Tunnel Testing

Wind tunnel testing occurred at University of Guelph, Ontario, Canada

Tested 5 nested porous cubes and cylinders

Sand feed used particle size of 0.19 mm

Elements tested with different volumetric porosity

FB

FB-SS

FB-SS-TB
Porous Element Wind Tunnel Results

• Porous elements are more effective at trapping and storing sand than solid elements.
• 2-walled form shows largest increase in trapping efficiency with little added effectiveness for more interior layers.

From: Gillies et al (2017)
PRE Testing at Mono Lake
Porous Element Test Results

- Pore geometry plays a key role in the magnitude of the amount of sand sequestered
- Permeable elements reduce sand flux more than solid elements due to the trapping of sand inside elements

\[ K' = \text{three dimensional permeability} \]
\[ H_d = \text{hydraulic diameter} \]
\[ \text{TE (trapping efficiency)} = \frac{\text{interior sand mass}}{\text{mean sand mass outside}} \]

**Figure 18 (Gillies et al. 2018)**
• Porous element array reduces distance to reach target control efficiency from ~137 ND to 72 ND.
• Permeable elements reduce sand flux more rapidly than solid elements due to the trapping of sand inside elements
## Porous Roughness Element Cost, Water Use, Energy Requirement

<table>
<thead>
<tr>
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<th>PRE</th>
<th>Notes</th>
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<tbody>
<tr>
<td><strong>Cost</strong></td>
<td>unknown</td>
<td>Engineered Porous Element cost would presumably be higher than solid elements due to more complex manufacturing.</td>
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<tr>
<td><strong>Water Use</strong></td>
<td>Engineered- None</td>
<td>Some natural PREs (live shrubs) would require some water</td>
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<td></td>
<td>Natural- Depends</td>
<td></td>
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<tr>
<td><strong>Energy</strong></td>
<td>unknown</td>
<td>Cost analysis could be conducted for engineered porous elements and natural porous elements.</td>
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Porous Roughness Elements
Applicability and Other Considerations

Applicability:
• Engineered Porous Roughness Elements (PREs) could be deployed quickly on most soil types and surface conditions.
• Engineered PREs could be used as a temporary control measure in transition or breakdown areas or for “hot spots” outside controlled areas.
• PREs could possibly be used in Environmental Sensitive Areas or Off-lake areas.

Other Considerations:
• Scouring appears to be reduced with use of porous elements.
• Project size should extend outside of delineated source due to edge effects.
• Type of material may have different implications for Tribal concerns, permitting issues, etc.
• Natural PREs would need a source of water for establishment. Shrubs may need protection to increase establishment success.
• Engineered PREs may require maintenance if trapping efficiency is reduced.

Unknown:
• PREs may need to be replaced as material degrades over time.