Federal Remediation Technologies Roundtable

FRTR Web Updates

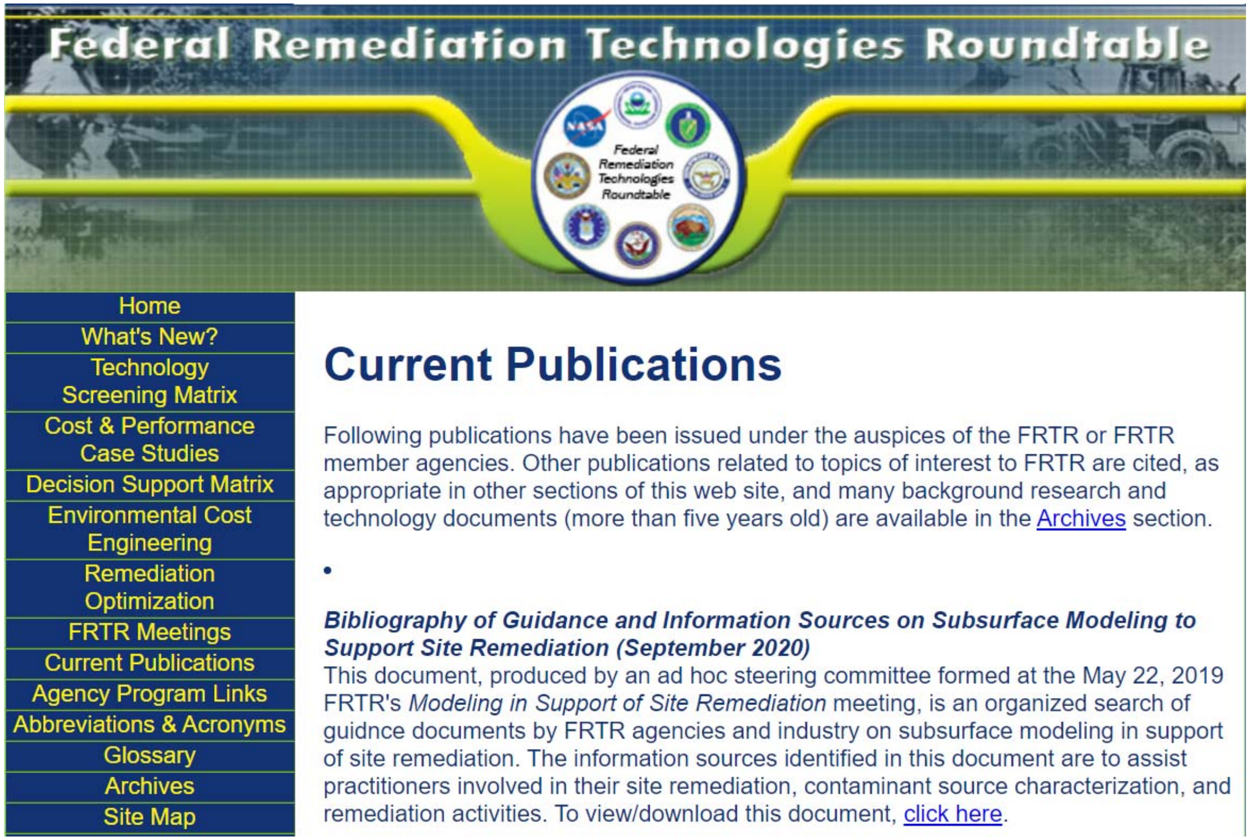
FRTR 2020 Fall Meeting

Presentation Summary

Federal Remediation Technologies Roundtable

- FRTR Updates
  - FRTR (Remediation) Technology Matrix
  - Remediation Optimization
  - Recent Additions: Bibliography
  - Updated Template

- CLU-IN Resources and Events



Federal Remediation Technologies Roundtable

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Current Publications

Following publications have been issued under the auspices of the FRTR or FRTR member agencies. Other publications related to topics of interest to FRTR are cited, as appropriate in other sections of this web site, and many background research and technology documents (more than five years old) are available in the Archives section.

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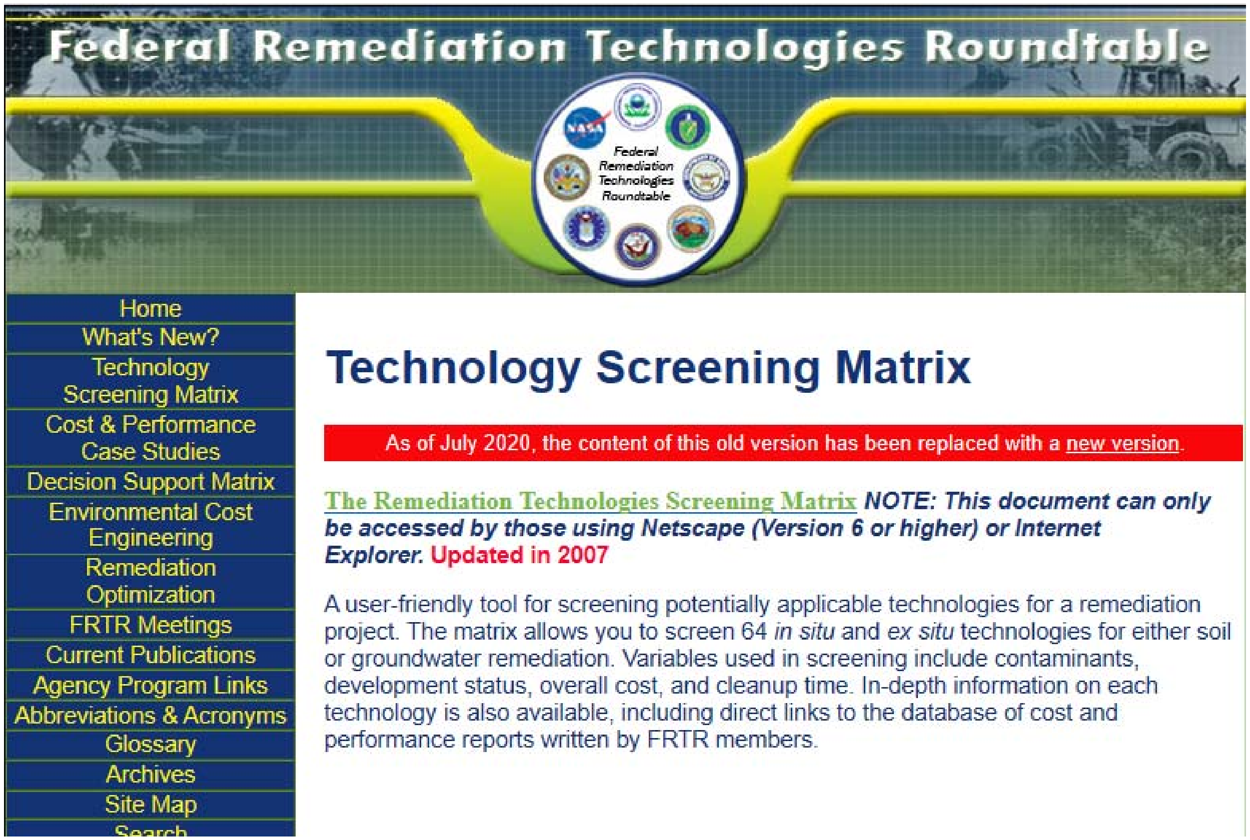
Bibliography of Guidance and Information Sources on Subsurface Modeling to Support Site Remediation (September 2020)
This document, produced by an ad hoc steering committee formed at the May 22, 2019 FRTR's *Modeling in Support of Site Remediation* meeting, is an organized search of guidnce documents by FRTR agencies and industry on subsurface modeling in support of site remediation. The information sources identified in this document are to assist practitioners involved in their site remediation, contaminant source characterization, and remediation activities. To view/download this document, click here.

The "Bibliography"



FRTR.gov/scrntools

FRTR.gov/matrix

Technology Screening Matrix

Search:

		Development Status								Availability			Contaminant Classes (Rating codes: ● Demonstrated Effectiveness, ◐ Limited Effectiveness, ○ No Demonstrated Effectiveness, ◊ Level of Effectiveness dependent upon specific contaminant and its application/design, I/D Insufficient Data, N/A Not Applicable)								
Profile	Treatment Type	Laboratory/ Bench Scale	Pilot Studies	Full Scale	Remediate an Entire Site	Remediate Source Only	Part of a Technology Train	Final Remedy at Multiple Sites	Attain Cleanup Goals in Multiple Sites	Commercially Available Nationwide	Limited Commercial Availability	Research Organizations and Academia	Nonhalogenated VOC	Halogenated VOC	Nonhalogenated SVOC	Halogenated SVOC	Fuels	Inorganics	Radionuclides	Munitions	Emerging Contaminants
Vapor Treatment Technologies	Air emission/off-gas	☐	☒	☒	☐	☐	☒	☐	☐	☒	☒	☒									
Biopiles	Ex situ biological	☐	☐	☒	☐	☒	☒	☐	☒	☒	☐	☐	●	◐	●	◐	●	○	○	◐	I/D
Landfarming	Ex situ biological	☐	☐	☒	☐	☒	☐	☐	☒	☒	☐	☐	●	◐	●	◐	●	○	○	◐	I/D
Composting	Ex situ biological	☐	☐	☒	☐	☒	☐	☐	☒	☒	☐	☐	●	◐	●	◐	●	○	○	◐	I/D
Bioreactors	Ex situ biological	☐	☐	☒	☒	☒	☒	☐	☐	☒	☐	☐	◐	●	◐	●	○	◐	○	●	I/D
Constructed Wetlands	Ex situ biological	☐	☐	☒	☒	☐	☒	☒	☒	☒	☐	☐	◐	◐	◐	◊	◐	●	○	●	I/D
Sediment Capping with Amendments	Ex situ physical/chemical	☒	☒	☒	☐	☒	☒	☐	☐	☐	☒	☒	◐	●	●	●	●	●	I/D	I/D	I/D
Air Stripping Ex Situ	Ex situ physical/chemical	☐	☐	☒	☒	☐	☒	☐	☐	☒	☐	☐	●	●	◐	◐	◐	○	○	○	●
Disinfection	Ex situ physical/chemical	☐	☐	☐	☐	☐	☒	☐	☐	☒	☒	☐	I/D	I/D	I/D	I/D	I/D	I/D	I/D	I/D	I/D
MEC Consolidated Detonation	Ex situ physical/chemical	☐	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	○	○	○	○	○	○	○	●	○
MEC Contained Detonation Chamber	Ex situ physical/chemical	☐	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	N/A	N/A	N/A	N/A	N/A	N/A	N/A	●	N/A

“Search All Profiles”

Show All

Show All

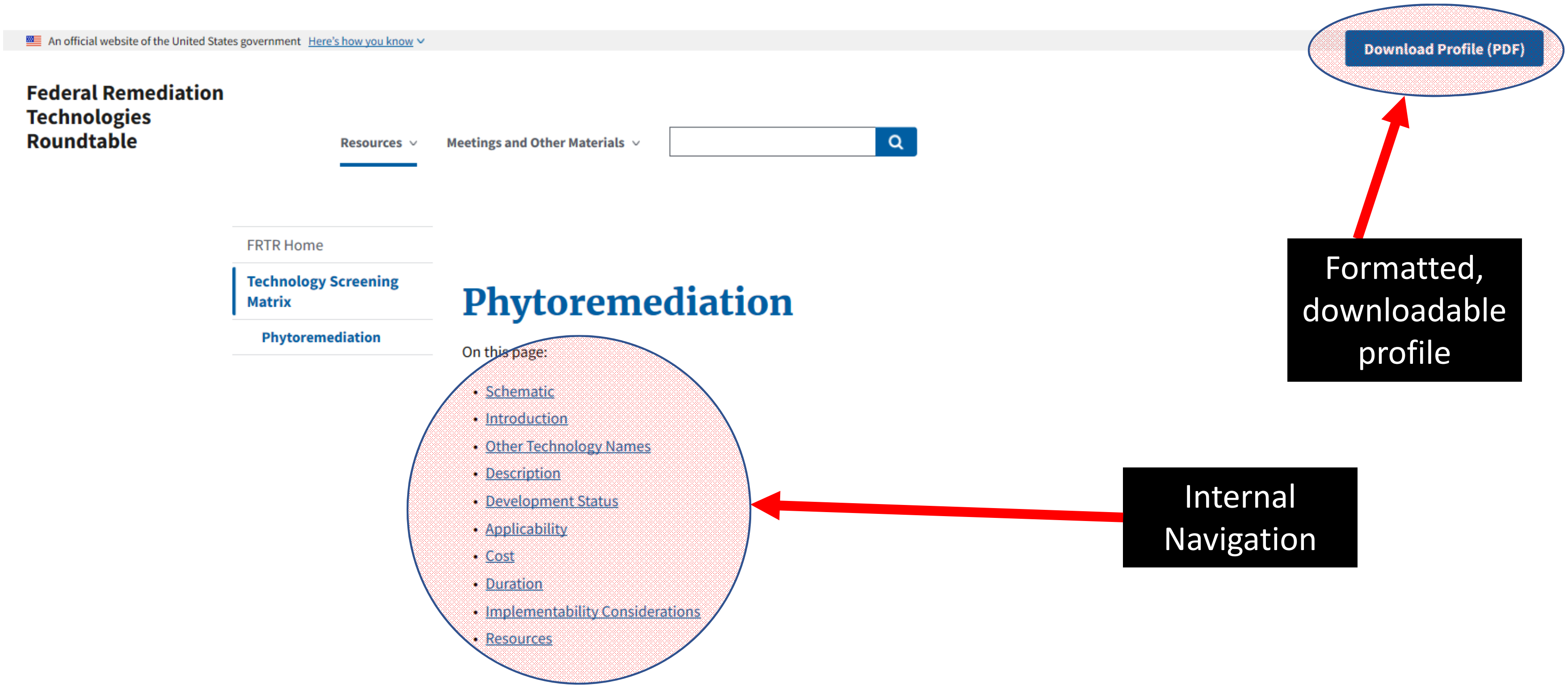
Contaminant Class Effectiveness

Show All

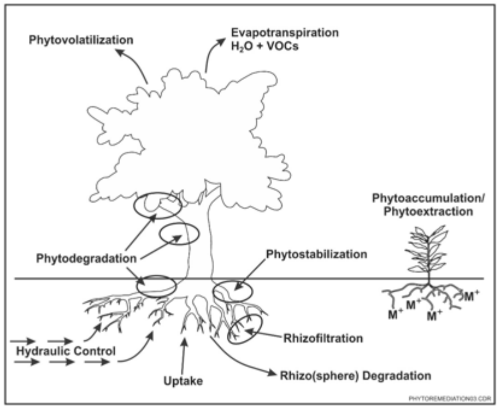
Profile	Treatment Type
Vapor Treatment Technologies	Air emission/off-gas
Biopiles	Ex situ biological
Landfarming	Ex situ biological
Composting	Ex situ biological
Bioreactors	Ex situ biological
Constructed Wetlands	Ex situ biological
Sediment Capping with Amendments	Ex situ physical/chemical
Air Stripping Ex Situ	Ex situ physical/chemical
Disinfection	Ex situ physical/chemical
MEC Consolidated Detonation	Ex situ physical/chemical
MEC Contained Detonation Chamber	Ex situ physical/chemical
MEC Screening	Ex situ physical/chemical
Sediment Capping	Ex situ physical/chemical
Soil Washing	Ex situ physical/chemical
Environmental Dredging	Ex situ physical/chemical
Landfill and Soil Capping	Ex situ physical/chemical
Groundwater Pump and Treat	Ex situ physical/chemical

Profile Example

[Federal Remediation Technologies Roundtable]



Schematic



Schematic of Phytoremediation Processes

Introduction

Phytoremediation is a treatment technology that uses vegetation and its associated microbiota, soil amendments, and agronomic techniques to remove, contain, or reduce the toxicity of environmental contaminants. Phytoremediation is most commonly applied to shallow soil and groundwater, but is also applicable to sludge, sediments, surface water, stormwater, and waste water. It is generally used as an in situ technology, but can also be used as an ex situ technology using hydroponics and/or constructed wetlands (see separate profile).

Profile Example Sections

Profile Example Sections (Cont'd)

Other Technology Names

Phytotechnologies
Vegetation-enhanced Bioremediation
Dendroremediation (when trees are used)
Evapotranspiration/Botic/Phyto Cover (landfill applications for methane)

Description

Phytoremediation is implemented by establishing a plant or community of plants that have been selected to provide the required remediation mechanisms. The technology exploits the natural hydraulic and metabolic processes of plants, and thus is solar driven. The technology can be applied either in situ where the technology is passive or ex situ where contaminated groundwater is extracted and treated with engineered systems (hydroponics or constructed wetlands) to treat the groundwater utilizing natural plant processes. Since the ex situ phytoremediation applications are more expensive, have a narrower focus, and are less commonly used than the in situ applications, they are not covered further here. For more information, the reader is referred to the resource section and separate profile for constructed wetlands. The remainder of the technology description is focused on in situ applications of phytoremediation.

The phytoremediation mechanisms that are applicable to contaminated media are described in the paragraphs that follow.

Stabilization/Containment Mechanisms

- **Phytostabilization (phytosequestration):** Phytostabilization is the use of plants to increase sequestration of contaminants (usually metals) in the soil and/or the plant root. Soil sequestration occurs as plants alter water flux and reduce contaminant mobility. Plants and microbial enzymes bind contaminants into soil (humification). Plants also incorporate free contaminants into plant roots (lignification) and prevent wind and water erosion.
- **Hydraulic Control:** Hydraulic control is the use of plants, more specifically tree

Development Status and Availability

The following checklist provides a summary of the development and implementation status of phytoremediation:

☐ At the laboratory/bench scale and shows promise

☐ In pilot studies

☒ At full scale

☒ To remediate an entire site (source and plume)

☐ To remediate a source only

☒ As part of a technology train

☐ As the final remedy at multiple sites

☐ To successfully attain cleanup goals in multiple sites

Phytoremediation is available through the following vendors:

☒ Commercially available nationwide

☐ Commercially available through limited vendors because of licensing or specialized equipment

☐ Research organizations and academia

Profile Example Sections (Cont'd)

Applicability

Contaminant Class Applicability Rating for Phytoremediation

(Rating codes: ● Demonstrated Effectiveness, ◐ Limited Effectiveness, ◌
Demonstrated Effectiveness,
◊ Level of Effectiveness dependent upon specific contaminant and its applicati
I/D Insufficient Data)

Nonhalogenated VOC	Halogenated VOC	Nonhalogenated SVOC	Halogenated SVOC	Fuels	Inorganics	Radionuclides	Munitions
◐	●	◐	●	●	◐	◐	●

Phytoremediation can be used to treat a wide range of inorganic and organic contaminants in shallow groundwater and soil, and is applicable to sites where water uptake is desirable for hydraulic/migration control or treatment. Contaminant classes for which phytoremediation has been applied include nonhalogenated and halogenated VOCs, fuels, inorganics, radionuclides, munitions, polychlorinated biphenyls (PCBs), and pesticides (ITRC, 2009). Full-scale implementation has been documented for phytoremediation for all of these contaminant classes (ITRC, 2009).

Profile Example Sections (Cont’d)

Cost

In situ phytoremediation is a passive technology that typically requires little equipment installation (except in some cases where elaborate irrigation systems are required), and the implementation cost is typically low compared to other more aggressive technologies. Phytoremediation is typically selected when a longer treatment time can be tolerated, and when starting concentrations are relatively low or as part of a treatment train as a polishing step. Grid planting of a large number of tree stands is a typical approach for using phytoremediation to provide groundwater hydraulic/migration control. As with all in situ technologies, application costs vary according to site conditions and contaminants. The labor and equipment associated with site preparation and planting represent the primary capital costs for phytoremediation. The cost of the plants themselves can also be a cost driver, although not in all cases. For instance, when planting 9-inch hardwood cuttings of hybrid poplars, the cost of the cuttings themselves is typically just a few hundred dollars. Major cost drivers include:

Upfront Costs

- Degree to which existing infrastructure (e.g., buildings, pavement, and utilities) must be removed in order to plant
- Need for pilot studies or bench-scale tests to demonstrate effectiveness at a particular site
- Need for, and complexity of, irrigation and monitoring systems
- Site climate
- Selected species of plant and growth stage (e.g., hardwood cuttings versus whips)
- Size of treatment area, topography, soil type, and drainage requirements
- Degree of growing media amendments and support materials required

Operation and Maintenance Costs

- Level of plant maintenance, including irrigation, fertilization, pest control, pruning and thinning
- Need for harvesting and disposal (for phytoaccumulation)

Profile Example Sections (Cont'd)

Cost Section

Includes a General Cost Discussion.

Frtr.gov/matrix/cost

Duration

Operation and maintenance duration for phytoremediation will range from 1 to 30+ years. In contrast to active mechanical treatment systems, selection and operation and maintenance activities require expertise in agriculture and silviculture. The duration of operation and maintenance is dependent on the following conditions:

- Cleanup goals
- Volume of in situ media requiring treatment
- Contaminant concentrations and distribution
- Growth rate and characteristics of remediation plantings
- Climate (i.e., temperature, winds, and rain).

Implementability Considerations

The following are key considerations associated with implementing phytoremediation:

- Employing specific plant species to target particular contaminants at a site can be difficult because of species adaptability problems.
- Climatic or seasonal conditions may interfere with or inhibit plant growth, slow remediation efforts, or increase the length of the treatment period.
- In addition to climate, site soil type, lithology, and hydrogeology characteristics may not be conducive to needed plant/tree species (e.g., insufficient groundwater yield or transmissivity for tree root systems).
- The transpiration mechanisms of phytoremediation function almost entirely during the active growing season, and during daylight hours when solar

Profile Example Sections (Cont’d)

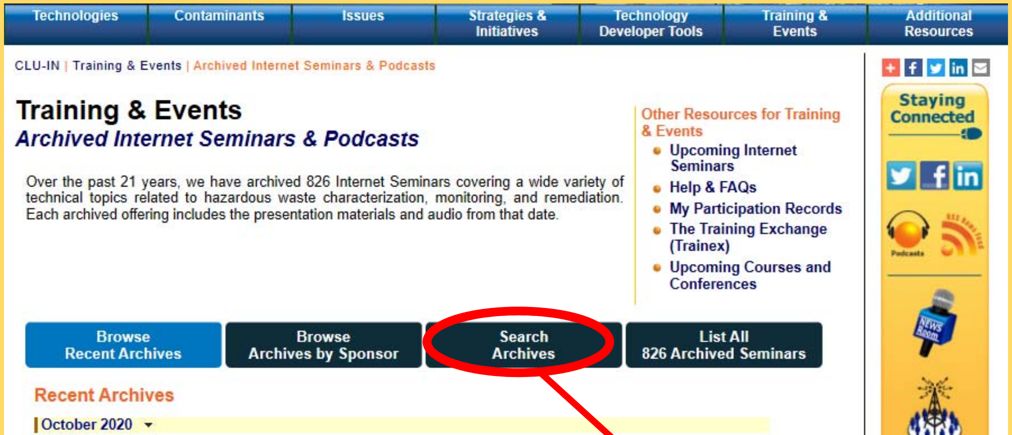
FRTR Matrix Conclusion

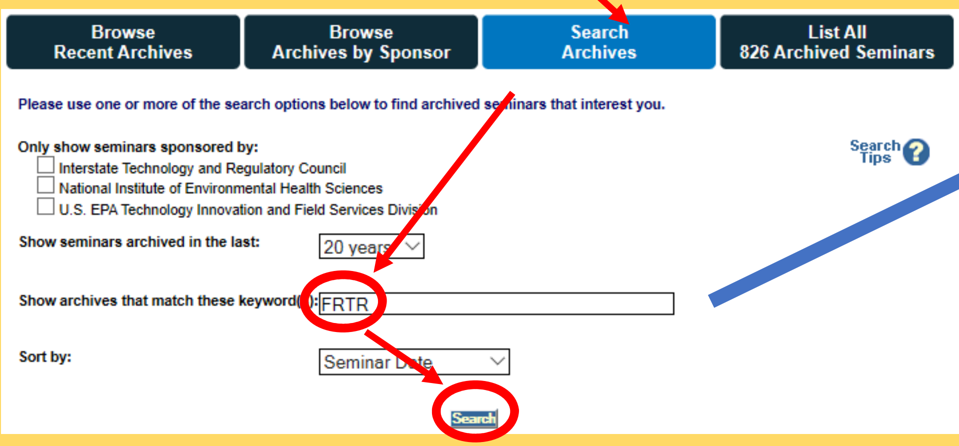
[Federal Remediation Technologies Roundtable]

- 49 Profiles
- Consolidated Profiles
  - Vapor Treatment Technologies
  - Water Treatment Technologies

Meeting and Events Archives

Federal Remediation Technologies Roundtable





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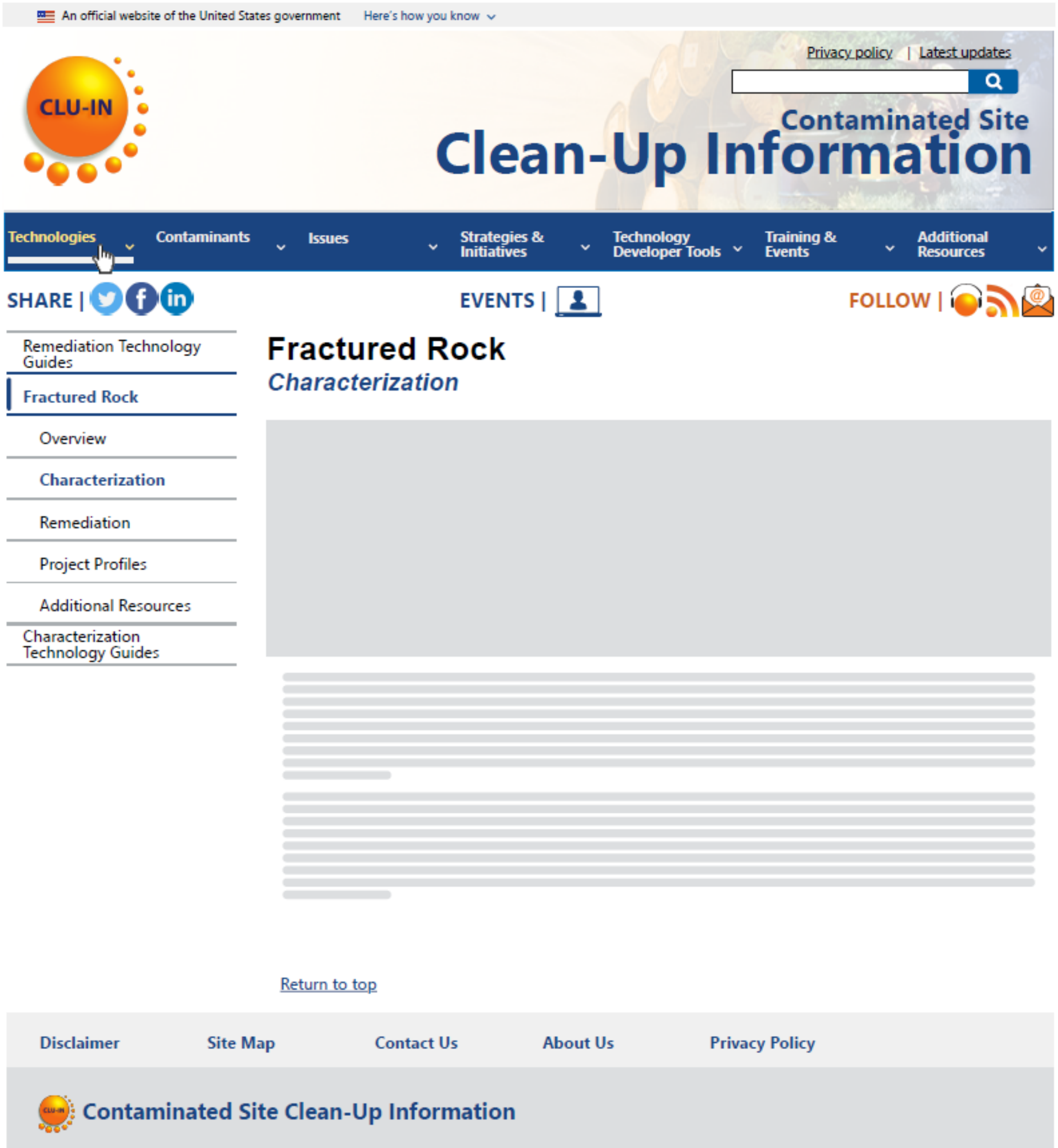

[Federal Remediation Technologies Roundtable]()

Coming Soon:
New Look CLU-IN