ITRC DRAFT Document: Optimizing Injection Strategies & In Situ Remediation Performance

ITRC is a state-led coalition working to advance the use of innovative environmental technologies and approaches to translate good science into better decision-making.

Our Unique Network

State/City/Local Government: 44%
Federal Government: 10%
Private Sector: 4%
Academia: 5%
Stakeholders: 3%
International Organizations: 2%

Federal Government Participants

Benefits to DOD and DOE

- Facilitate interactions between federal managers and state regulators
- Increase consistency of regulatory requirements for similar environmental problems in different states
- Provide harmonized approaches to using innovative technology across the nation
- Reduce review and approval times for those innovative approaches

ITRC Accomplishments

Educates state regulators on the use of innovative technologies
Promotes the use of innovative technologies
Unites state approaches to complex topics
Inspires collaboration over adversarial relationships
Optimizing Injection Strategies and In Situ Remediation Performance

DRAFT
INTERNET BASED DOCUMENT & TRAINING
(GOING PUBLIC IN APRIL 2020)

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What is Optimization?

Optimization is the effort (at any clean-up phase) to identify and implement actions that improve effectiveness and cost-efficiency of that phase.

Foundation of this Document

► 2011 Integrated DNAPL Site Strategy (IDSS)
► 2015’s IDSS Site Characterization and Tool Selection Document
► Optimization addressed in other contexts
  ► Performance-Based Environmental Management (ITRC-RPO-2, 2007)
  ► Geospatial Analysis for Optimization (2016) (GRO-1, 2016)

Purpose of this Document

High Resolution Site Characterization Tools:
- Downhole geophysics, HHPT/LIDAR
- LIDAR, ER, tracer test, GPR, Packer testing
- Remedi Design Characterization
- Amendment Selection Table
- Delivery Factsheets
- Bench or Pilot Test
- Performance Monitoring

OPTIMIZATION TOOL BOX
The remediation manager who has had a failure of some type:
- Remedial Design Characterization (Ch 2)
- Amendment, Delivery, Dose Design (Ch 3)
- Implementation & Feedback (Monitoring) Optimization (Ch 4)
- Regulatory Perspectives (Ch 5)
- Community & Tribal Stakeholder Considerations (Ch 6)

Amendment is reacting with the geochemistry

Implementation & Feedback (Monitoring) Optimization (Ch 4)
- Have successfully cleaned up 50% of the mass and but stalled out for the rest
- The practitioner who is just about to start an in situ remediation project and wants to make sure they have chosen the correct remedy

This document is NOT a 101 class for remediation! It assumes a basic CSM has been established and the hydrogeology is known

The Problem & Need for Optimization
Out of all the proposals received by state regulators for remediation projects, about 40% of regulators deemed the first submittal as incomplete.

Why?
- Proposed remedy was not fully supported by the CSM
- CSM was inadequate
- Inadequate amendment placement according to the CSM

Regulatory Linear Paradigm
- Main goal: clean up sites.
- Traditional approach to the remedial process was linear.

Interactive/Iterative Approach
- Evolution of environmental work has led to the realization that an iterative approach is required to efficiently clean up sites.
- Iterative: To state repeatedly, repetitious, repetitive
- Interactive: Acting one upon (or with) the other

ITRC Documents Support Interactive/Iterative Approach

Who is this Document written for?
- The remediation manager who has had a failure of some type:
  - Has pushed or moved the plume where they didn’t want it to go
  - Amendment is reacting with the geochemistry
  - Delivery method not compatible with hydrogeology
  - Have successfully cleaned up 50% of the mass and but stalled out for the rest
- The practitioner who is just about to start an in situ remediation project and wants to make sure they have chosen the correct remedy

This document is NOT a 101 class for remediation! It assumes a basic CSM has been established and the hydrogeology is known
Chapter 2: Remedial Design Characterization

When in situ remedies fail or produce less than optimal outcomes, it is often due to a lack of detailed data or an insufficiently developed CSM.

The success of in situ remedies is directly related to a thorough understanding of site and subsurface conditions.

Remedial design characterization (RDC) is the collection of additional data, above and beyond what are typically generated as part of generic site characterization studies, necessary to develop a sufficiently detailed CSM, which enables a design basis for an in situ remedy.

Tool: Common Issues Spreadsheet

<table>
<thead>
<tr>
<th>Common - Environmental Issues Associated with In-Situ Remediation</th>
<th>In-Situ and Beer Design - Chapter 2</th>
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RDC: Remedial Design Characterization

Objectives:

- Geology - stratigraphy, mineralogy, fractures, soil properties that define flow regimes
- Hydrogeology - heterogeneities, aquifer properties that influence flow and transport
- Geochemistry - identify electron acceptors, competitors, and metal mobilization risks
- Microbiology - assess degradation potential
Chapter 3: Amendment, Dose, Delivery Design

Another Comprehensive Tool for RDC

Amendment Selection Table

Delivery/Injection Screening Matrix (Table 3.5)

Amendment Dose & Delivery

- Background Dose Requirements
- Target Dose
- Volume Considerations
- Amendment Delivery Optimization
- Grid patterns, Injection & Drift, Recirculation
- Overcoming Delivery Problems
  - Fouling and well rehabilitation

Improve the CSM – Why do it?

Why spend more money on characterization, when you could be spending it on cleanup?

When in situ remedies fail, it is often due to a lack of detailed data or an insufficiently developed CSM.
Chapter 4: Implementation, Monitoring, Data Analysis

THE OPTIMIZATION STAIRCASE

- Implementation & Optimization Staircase
  - Results of pilot or bench test may lead to another pilot or bench test before going for full scale site implementation
  - Optimization not meant to create endless cycle of testing, but a cost effective, efficient remediation strategy

- Adaptive Implementation and Feedback Optimization
  - Data set for CSM and corresponding design (amendment, dose, delivery) will never be perfect or fully complete
  - Staircase always allows for feedback to a design step or the CSM

Chapter 4: Monitoring

- Process and Performance Monitoring

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<tr>
<th>Data Type</th>
<th>Potential Implications</th>
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<td>Water Levels</td>
<td>This type of result may indicate a connection or preferential pathway. Be aware of the potential for daylighting and for amendment distribution challenges.</td>
</tr>
<tr>
<td>Pressure Injection</td>
<td>High pressures may result in fracturing or daylighting. A preferential pathway, link to section 3.6.1 fracture, or utility corridor may have been intercepted or an injection pressure fracture may have been created.</td>
</tr>
<tr>
<td>Physical Parameters</td>
<td>Conductivity, temperature, turbidity, or other indicator parameter of amendment (e.g., TOC, or color) is observed at a nearby monitoring well (e.g., 10 ft) at a lower than planned injection volume. This type of result may indicate a connection or preferential pathway between wells. It may also indicate a higher K area of the site, resulting in a larger than anticipated fractured flow.</td>
</tr>
</tbody>
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Chapter 5: Regulatory Perspectives

Adaptive Regulatory Process

A Powerful Remediation Design Tool for 2020

Thank You!