2018 ITRC Project Proposal

Optimizing *In Situ* Remediation Performance and Injection Strategies

Proposal Date
29 June 2017

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Proposal Summary
In situ reagent injection based remediation technologies have advanced to mainstream acceptance and offer a competitive advantage over many forms of *ex situ* treatment of soil and groundwater. However, detailed site specific injection based strategies are absolutely critical to the success of such *in situ* treatment remedies. Developing these strategies includes conducting site characterization using an integrated characterization strategy that will allow development of a detailed Conceptual Site Model that provides the critical subsurface information that will improve remediation outcomes.

This document will provide technical regulatory guidance on optimizing injection-based remediation technologies. As a first step, the team will collect case studies where injection-based remedies have been implemented. These case studies will be evaluated and serve as the basis for the guidance to provide insight on the following topics:

- overview of different injection techniques along with the strengths and limitations of each technique;
- review of drilling methods and their effects on injection efficiencies;
- summary of techniques to enhance and improve distribution in the sub-surface, such as hydraulic fracturing and augmentation with push-pull hydraulic systems; and
- minimum data required for evaluating in-situ alternatives including analytical techniques to determine radius of influence.

In addition, the guidance document will also discuss the risks and limitations of these injection-based technologies and how to address the risks and limitations in order to improve remedial success. Examples of issues to discuss include:

- ineffective treatment caused by a misunderstanding or incomplete understanding of the hydrogeology, geology, source area, and contaminant mass and distribution;
- ineffective treatment caused by a misapplication of a technology;
- the potential for contamination mobilization as a result of injection;
- inaccurate interpretation of remedy results due to inappropriate monitoring program design; and
- possible uncontrolled migration of injection materials to new exposure pathways.

In the interest of expedited and cost-effective solutions, many *in situ* projects have been executed based on an incomplete understanding of the hydrogeology, geology, and contaminant distribution and mass. Many sites have undergone multiple rounds of *in situ* injections and not advanced to closure. Better strategies and minimum design standards are required to decrease uncertainty and improve outcomes. A robust CSM and integrated high-resolution site characterization techniques necessary to develop adequate understanding of the hydrogeology, geology, and contaminant distribution and mass will be emphasized as critical to understanding the site and development of a successful *in situ* injection strategy. The integrated site characterization strategy detailed it the ITRC Integrated DNAPL Site Characterization Tech-Reg will be presented in this document and refined to focus a site characterization and development of a CSM for potential *in situ* remediation using injection techniques.

While *in situ* injection based remediation is accepted practice, the long track record of under-effective *in situ* applications, supported by slow progress in attaining site closures, as well as an industry-wide reliance upon sub-optimal designs and over-aggressive claims by injection reagent vendors has tarnished the image of *in situ* remediation. This team and its associated guidance document will provide regulators and other stakeholders with a solid platform to evaluate and improve outcomes of injection based remediation.

A draft outline of the document is as follows:

Typical site characteristics that lend themselves to injection-based remedies
Required site specific data necessary to design an injection-based remedy
Hydrogeology
Geology
Geochemistry
Groundwater hydraulics
Bench and Pilot testing
Best practices for developing an adequate and accurate CSM for injection-based remedies
Strategy for selecting appropriate injection-based technologies – include a matrix

Essential elements to understand if considering an injection-based remediation
- Appropriate Remedial Action Objectives (RAOs) (e.g., Can MCLs be reached?)
- Minimum design parameters
- Risk Management
- Injection selection and design – Direct push, permanent vs temporary
- Controlling short-circuiting
- How the formation will or will not accept recirculation
- Over-engineering versus intelligent engineering
- Radius of influence (ROI) – calculating, measuring, and augmenting
- Other hydraulic enhancement techniques

Safety considerations – Chemical and Physical Hazards

Sub-slab considerations

Assessment of remedy performance via monitoring and subsequent performance enhancement through optimization

Side effects – understanding, monitoring, controlling

Switching/coupling technologies

Regulatory Issues

This proposal answers the ITRC call for proposals to address:

- New technologies/tools, resources to address remediation of contaminated sites
- Remedy resiliency and remedy design considerations

This project will help ITRC meet its vision and mission statement in the 2016 Strategic Plan and provide technically sound innovative solutions to help break down barriers to the use of *in situ* remedial techniques.

Summary and Schedule of Deliverables (primary project product(s)

We anticipate that a web based interactive Technical Regulatory Guidance and associated Internet Based training will be developed.

This project is expected to take up to three years to prepare the guidance, respond to external review, finalize the web based guidance, and prepare the web based training.

General Project Schedule

1) Begin work at 2018 ITRC kick-off meeting.
2) Conduct monthly conference calls to begin to scope document outline and strategy.
3) Begin collecting and evaluating relevant case studies.
4) Meet with team in person at 2018 spring meeting to finalize strategy for developing the document and an initial outline of the document
5) Complete review extensive literature: July 2018.

6) Complete review and summation of in-situ injection technologies case studies where these technologies have been successfully demonstrated October 2018.
7) Complete outline of Tech Reg December 2018.
8) Complete a rough first draft to of In-Situ tech-reg doc discuss at 2019 spring meeting.
9) Revised Draft complete by August 2019.
10) Complete final draft Tech Reg and submit for External review by January 2020.
11) Finalize document July 2020
12) Final Web-based guidance and Training completed August 2020.
13) Implementation

Proposed Team Composition

- The following states have expressed interest in an ITRC Project addressing this issue: CA, CO, CT, DE, FL, KY, ME, MN, VA, VT.

  We expect other states will be very interested in this project

- Michael Smith and David Scheer are identified as possible team leaders.

- We have received significant interest in this proposal and participating in the project from the following IAP companies:

AECOM	Amec Foster Wheeler	Anchor QEA
Arcadis	Barr	Battelle
BP	Cascade-Env	CDM Smith
CH2M	ERM	Exxon Mobile
Geosyntec	Haley & Aldrich	InfraSUR
JRW Bioremediation	Kleinfelder	Langan
Pinyon Env.	Ramboll Environ	Woodard & Curran

  We also expect numerous other IAP members will be interested in participating in the project.

  Geoprobe has expressed serious interest in both the team and rejoining the IAP

- We have academic interest in this proposal from Boise State, Tufts University, University of Houston, University of New Mexico, and Yale University.

- The US EPA has expressed serious interest in this proposal as well as DOE and it is likely that DOD, will participate as well as they are also working with and using in-situ remedial technologies.

- We have approached NEWMOA and ASTWMO to determine if they are interested in partnering on this project if the proposal is approved. NEWMOA has expressed an

interest in partnering with training, not only for this project, but to include other training session we have done, both in person at the workshops they offer and possibly through webinars. ASTWMO is also interested but we have not yet worked how we could best partner.

Identification of Potential Funding Sources

We have approached a subset of the IAP companies who have expressed interest in the project for potential funding seed money for the team.

We have received positive responses from a number of companies who are considering the requests.

CH2M has stated that they will provide funding, the amount to be determined at the end of the year when they finalize next year's budget.

BP has stated they can commit to providing financial support, but can't give an amount at this time.

Another national company has asked what level of funding we need. While they have not yet committed, they are considering the request and I believe will be able to provide some funding.

We will also be approaching representatives from the specialist providers including chem-ox and bioremediation firms, problem holders wanting to use this technology, and Department of Defense/SERDP for possible funding.