2026 ITRC Project Team Proposal Form

Environmental Topic

Phytoremediation/Phytotechnology

Proposed Project Title

Advancing Nature-Based Remediation with Enhanced Phytotechnologies

Project Deliverables

1. Develop Information Sheet for Project Team
2. Update existing Phytotechnology Guidance Document (2009)
3. Prepare Tech Sheet on Endophyte-Assisted Phytoremediation
4. Develop digitized Decision Trees for existing remediation guidance tools or web-based tools for decision making
5. Develop and deliver webinars on various phytoremediation topics (as identified by project team throughout course of project)

This list is not exhaustive and may be expanded or adjusted pending input from project team.

Problem Statement

Nature-based solutions are becoming a growing priority for public agencies and private stakeholders as they seek to address environmental challenges in sustainable and cost-effective ways. Among these, phytotechnologies (including phytoremediation), are receiving renewed attention for their potential to remediate contaminated sites while delivering broader environmental and social benefits. While phytoremediation has been studied and applied for decades, its use is still limited by outdated perceptions and a lack of awareness of recent scientific and practical advancements.

Recent developments in the field, such as the use of endophyte-assisted degradation and enhanced rhizosphere activity, have significantly expanded the scope of what phytotechnologies can accomplish. These innovations allow for in-situ degradation of contaminants, treatment of deeper groundwater, and remediation of sites with higher contaminant concentrations than was previously feasible. Biologically enhanced approaches can also accelerate cleanup timelines and broaden the range of treatable contaminants. Despite this progress, many remediation decisions are still based on assumptions that no longer reflect the state of the science. As a result, phytotechnologies are often excluded from consideration during site evaluations, even when they could offer significant advantages.

Although current guidance documents—developed by ITRC, EPA, and other expert bodies—have played a valuable role in introducing phytotechnologies and describing their mechanisms, they do not fully capture the range of benefits these technologies now offer. In many cases, guidance documents have not kept pace with innovations or field-based evidence demonstrating expanded applications. This limits their utility for regulators, consultants, and responsible parties who are seeking modern, effective, and community-aligned remediation strategies.

The consequences of this gap are substantial. Communities, agencies, and site owners may be missing opportunities to implement solutions that not only address contamination but also contribute to air quality improvements, carbon sequestration, ecological restoration, and social uplift. These benefits are particularly relevant as environmental remediation increasingly intersects with sustainability, resilience, and community health goals.

This project team proposes to work with subject-matter experts to update the ITRC Phytotechnologies Guidance document. The goal is to reflect current capabilities, highlight case studies and practical applications, and address technical and regulatory barriers that stem from outdated perceptions. Some of the key challenges we intend to address include:

- Misunderstandings about cleanup timeframes
- Concerns about effectiveness for deep groundwater remediation
- Limited awareness of the full range of treatable contaminants
- Perceptions that high contaminant concentrations or large plumes prevent phytotechnology use
- Uncertainty about managing risks through endophyte enhanced tree and plant-based systems
- Questions about whether phytotechnologies can reliably meet regulatory cleanup goals
- A belief that immediate remediation is always necessary, even when there is no current exposure risk
- The assumption that phytotechnologies cannot be used as a primary remedial approach or as part of an integrated remedial approach

Through this effort, we aim to provide modern, science-based, and practical guidance that reflects the current and future role of phytotechnologies in environmental remediation.

Additional Information

Brief literature review:

Since the publication of the original ITRC Phytotechnologies Guidance document, the field has advanced significantly, warranting an updated framework that reflects cutting-edge science, expanded field applications, and emerging regulatory and stakeholder considerations. Recent literature demonstrates substantial progress in genetic engineering, microbiome enhancement, and the application of endophyte-assisted phytoremediation to address a broader range of contaminants under increasingly complex site conditions.

Notably, Sharon Doty and colleagues have contributed extensively to the development of transgenic and endophyte-assisted trees that dramatically improve contaminant uptake and degradation in real-world settings, including Superfund sites. These advancements have enhanced phytoremediation's efficiency, even for deep or recalcitrant pollutants, while expanding its geographic and climatic applicability. Complementing this, studies by Kang et al. (2012), Reichenauer and Germida (2008), and Yousaf et al. (2011) showcase the pivotal role of plant-associated microbial communities and engineered bacterial consortia in degrading hydrocarbons and boosting plant resilience.

Emerging research, such as that reviewed by Thijs et al. (2016) and Torres-Farradá et al. (2024), highlights the critical function of the plant microbiome and fungi in contaminant transformation, underscoring the need to integrate microbial synergy into future guidance. Additionally, advancements in biochar, compost amendments, and combined treatments (Hussain et al., 2018) point to a systems-based approach that exceeds the technical boundaries outlined in the existing guidance.

Beyond technical innovation, social acceptance and risk perception, explored by Weir & Doty (2016), illustrate the growing importance of stakeholder engagement and public trust in phytotechnologies. These dimensions, along with newer field applications and pilot studies (e.g., Landmeyer et al., 2021), reinforce the need for updated guidance that bridges scientific advances with practical implementation and regulatory clarity.

In summary, the recent literature confirms that phytotechnologies are evolving rapidly. To maintain relevance and utility, the ITRC guidance must be updated to incorporate biotechnological innovations, refined ecological understanding, expanded contaminant coverage, and contemporary implementation

challenges. This revision will empower regulators, practitioners, and site managers with state-of-the-art knowledge and tools to apply phytotechnologies more effectively across diverse environmental contexts.

The following publications illustrate these advancements and collectively underscore the need for an updated ITRC *Phytotechnologies Guidance* document.

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- Tournay, R.J. and Doty, S.L. (2022). Microbial Endophytes for Clean-up of Pollution. In Good Microbes in Medicine, Food Production, Biotechnology, Bioremediation, and Agriculture (eds F.J. de Bruijn, H. Smidt, L.S. Cocolin, M. Sauer, D. Dowling and L. Thomashow). https://doi.org/10.1002/9781119762621.ch29
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Identifying subject matter experts from states, federal government agencies, and the private sector that may be interested in joining this Project Team:

Proposal Supporters

- Kirby Gimson (Intrinsyx)
- Dr. Chris Cohu (Intrinsyx)
- Galen O'Toole (Intrinsyx)
- Dr. John Freeman (Intrinsyx)
- Joshua Reilly (Illinois EPA)
- James Fish (Alaska DEC)
- Dan Niles (CA Waterboards)

- Benjamin Stanphill (DTSC)
- David Tsao
- Kendra Waltermeyer (Jacobs)
- Doug Burge (Ramboll)

Similar work done by other organizations that could be leveraged:

Phytoremediation Advances Fact Sheet (NAVFAC)
Phytoremediation Resource Guide (USEPA)
Brownfields Technology Primer: Selecting and Using Phytoremediation for Site Cleanup (USEPA)
Citizen's Guide to Phytoremediation (USEPA)
Evaluation of Phytoremediation for Management of Chlorinated Solvents In Soil and Groundwater (USEPA)
Phytoremediation Monograph Final Report (IMPEL)