Triad Initiative

Tools for Defining Site Requirements

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Objectives

- Introduce Triad approach as a viable alternative investigation method
- Identify key differences of the Triad approach to conventional methods
- Discuss Triad investigation project objectives for Site ST-123
- Examine a field investigation method and data collected during the Triad investigation
- Integrate lessons learned

Complaints about Contaminated Sites and Cleanup Projects

- Site investigations and cleanups cost too much and take too long!
- Adequate site characterization is critical for success, but…
  - Multiple mobilizations have typically been required
  - Investigations are often phased, involving multiple work plans/ reports/reviews/approvals => more time and money
  - Contamination has often been missed, causing serious problems later during remediation or redevelopment
  - Characterization uncertainty impacts project management
    - Budget, exposure risk, and remediation
    - Reuse options, real estate transactions, and insurance
- Triad approach evolved to develop a shift in the approach to conventional characterization and site management

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Why Do We Need a Shift?

- Triad represents a multi-dimensional shift from conventional approaches to data quality, data objectives, data review, and project decision making because:
  - Experience shows that traditional notions of data quality and statistical confidence do not lead to efficient projects or reduced uncertainties
  - Conventional characterization can produce incomplete or inaccurate pictures of site contamination
  - Nature and extent of contamination are viewed differently by stakeholders

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Three Elements of the Triad Approach

- **Successful Strategies Condense into a Central Theme ("what") + 3 Elements ("how") of the Triad Approach**

Systematic Project Planning

Dynamic Work Strategies

Real-time Measurement Technologies

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Figure adapted from EPA Triad Guidance

Key Differences of the Triad Approach

- “Touchdown” planned before field work “comes to the line of scrimmage”
  - Systematic planning meetings are more intense and far-reaching than perceived
  - Stakeholders participate and decide what level of data uncertainty is acceptable
- An evolving conceptual site model (CSM) is used to:
  - Illustrate heterogeneity and physical reality
  - Distinguish different decision-driven populations
  - Manage decision uncertainty explicitly through data representativeness

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Key Differences of the Triad Approach

- "Data representativeness"
  - Develop multiple lines of evidence
  - Collaborate data sets
  - Demonstrate applicability of field and lab methods applicability
  - Understand that analytical quality ≠ Data quality

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Cost-Effective Data Quality for Heterogeneous Matrices

Cheaper, rapid (lab? field? std? non-std?) analytical methods

Targeted high-density sampling

Manages CSM & sampling uncertainty

Costlier rigorous (lab? field? std? non-std?) analytical methods

Low DL + analyte specificity

Manages analytical uncertainty

Collaborative Data Sets

Collaborative data sets complement each other so all sources of data uncertainty are managed. Using either alone will not produce reliable information.

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Adapted from EPA Triad Presentation

Triad Approach is Rarely Easy

- Triad projects are demonstrably "better, faster, and cheaper" than conventional methods…

Key Potential Stumbling Blocks

- <u>All</u> aspects of project management (including budgeting, contracting, etc.) must support a Triad effort
- Current institutional structures often pose barriers
- Contractual challenges are often significant in maintaining project direction
- Stakeholder up-front buy-in is key to success of the approach

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Hurlburt Field ERP Background

- RCRA permit regulated by FDEP, Tallahassee, and Region IV EPA, Atlanta
- Long established partnering with regulators since 1995
- Base is composed of approximately 6,600 acres (over 66 percent wetland)
- Extreme development pressure for redevelopment
- 25 ERP sites total
  - 9 sites closed with No Further Action (NFA) approved
  - 11 sites approved for Land Use Controls (LUCs)
  - 3 sites undergoing active remediation 123, 124, 125
  - 2 sites undergoing active investigation and study 215, 216
- One of three sites selected for FL Triad EPA/AF project

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Site ST-123 General Site History (Pre-Triad Investigation)

- Petroleum, oils, and lubricants (POL) fuel yard built in the 1940s to store jet fuel, waste fuel, and waste oil
- Site groundwater was impacted by petroleum constituents and chlorinated volatile organic compounds (CVOCs)
- Petroleum-contaminated soil (1,348 tons) was excavated from the shallow zone in April 2001
- HRC® was injected into the intermediate zone of the surficial aquifer and ORC® was injected into the groundwater beneath the excavated area to enhance benzene, toluene, ethylbenzene, and total xylenes (BTEX) degradation.

Date	HRC® Injection (pounds)	ORC® Injection (pounds)
January 1999	6,000	--
October 2000	540	--
August 2001	4,118	1,203

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Triad Investigation Project Objectives

Develop comprehensive CSM

- Delineate source area(s), identify target treatment areas, and determine if NFA is a feasible option at Site ST-123.
- Delineate vertical and horizontal extent of groundwater plume and determine if NFA is feasible.
- Obtain conceptual design data for potential remediation.
- Determine if monitored natural attenuation (MNA) is applicable to site.
- Evaluate protectiveness of human health and the environment.

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Triad Investigation
Project Objectives

Develop site closure strategy consistent with the base-wide ERP exit strategy

- Establish site clean up goals – maximum contaminant level (MCL) and alternative contaminant level (ACL - global risk-based corrective action [RBCA]) - that are:
  - Consistent with RCRA requirements
  - Protective to human health and the environment (risk based)
  - Practical
- Determine Hurlburt Field operational requirements

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Re-Defining the Source

What is the source of the CVOCs?

- **Source is unidentified; suspected source(s) include:**
  - **Avionics Building - large building that has gone through numerous renovations**
  - **Former underground storage tanks (USTs)**
  - **Washrack/oil-water separator**
  - **Unknown source or multiple sources**

How old is the release?

- **Release occurred prior to 1989 and is at least 15 years old**
- **Specific timeframe of the release is unknown**

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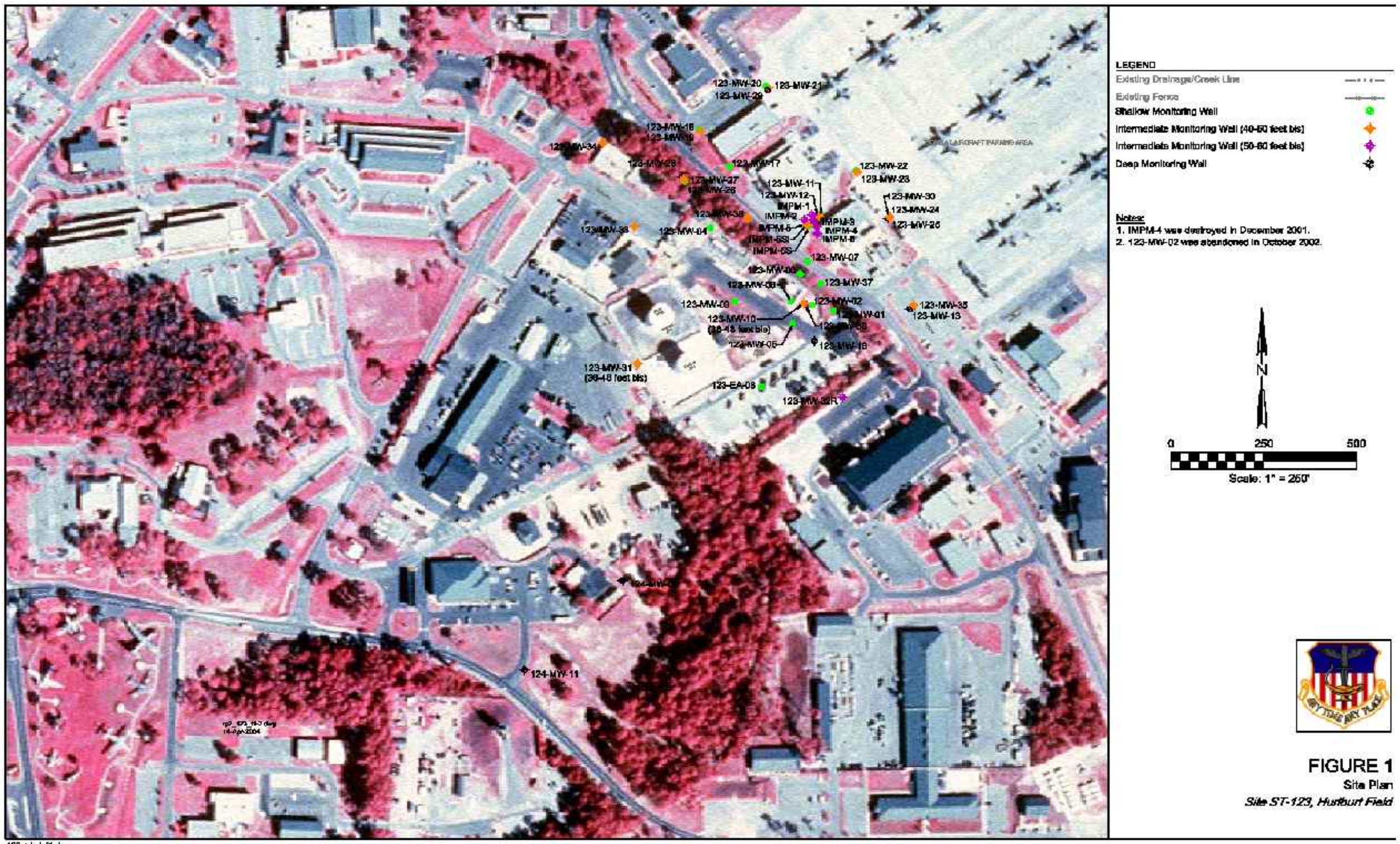
Site Plan



123_triad_H.dwg
22-Nov-2004

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Field Activities

Drilling Techniques

- Cone penetrometer testing (CPT) was used for lithology and hydraulic characterization
- Membrane interface probe (MIP) logging was used for vertical profiling using a flame ionization detector (FID), photo ionization detector (PID), and electron capture detector (ECD)
- DPT soil sampling
- Sonic drilling was used to install multichamber wells to collect groundwater data for vertical profiling at points beyond the physical limitations of the MIP

Field Activities - MIP/DPT/CPT

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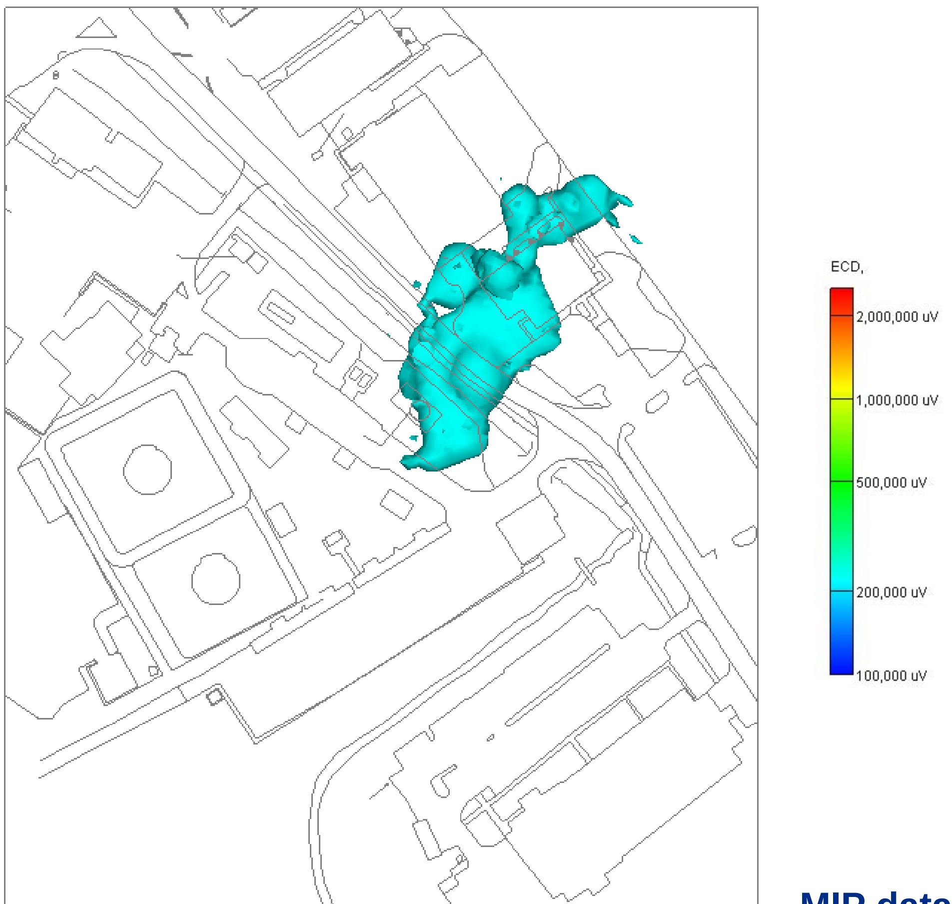
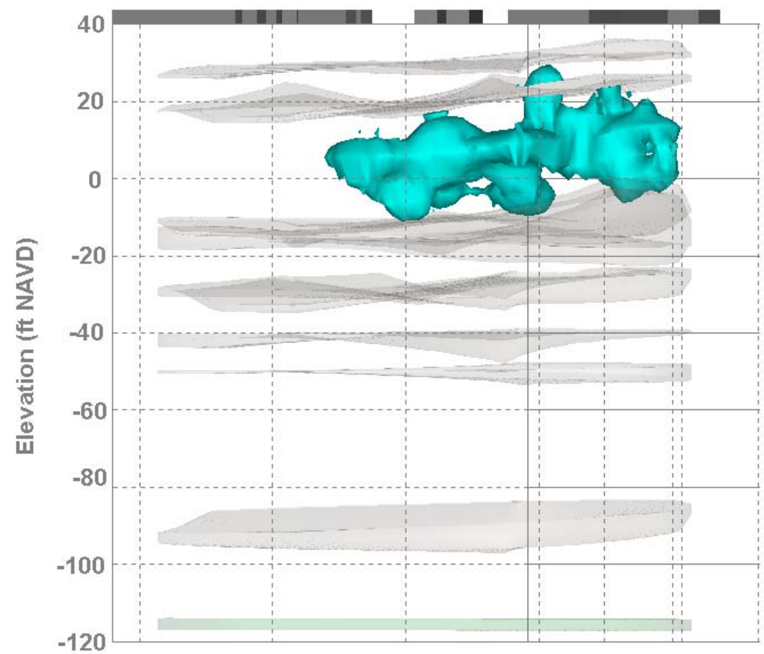
Field Activities – Sonic Bore

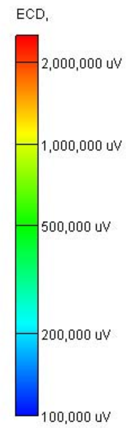
Shallow Zone
(ECD Response above 225,000 µV)

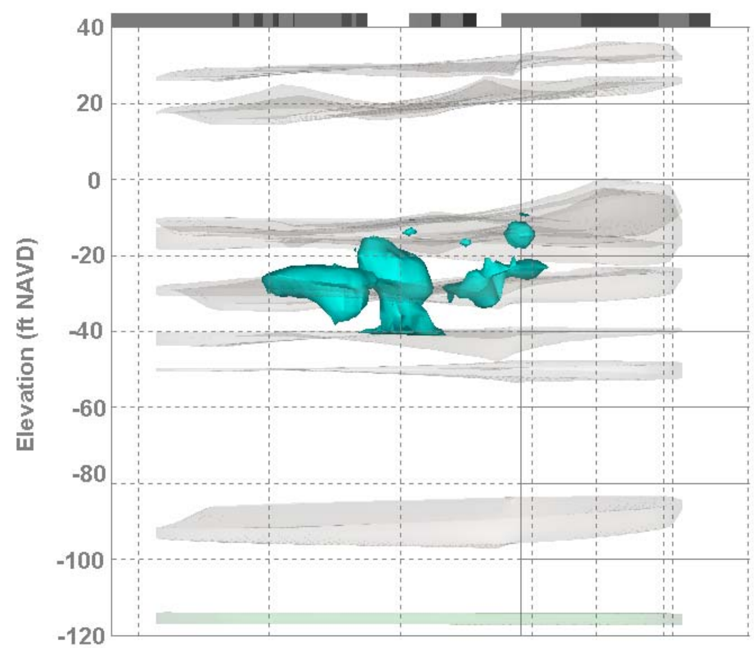




MIP data visualization of source area CVOC contamination identified (prior to this investigation was unknown).

Intermediate Zone
(ECD Response above 225,000 µV)





MIP data visualization of source area CVOC contamination identified (prior to this investigation through to be only between two buildings).

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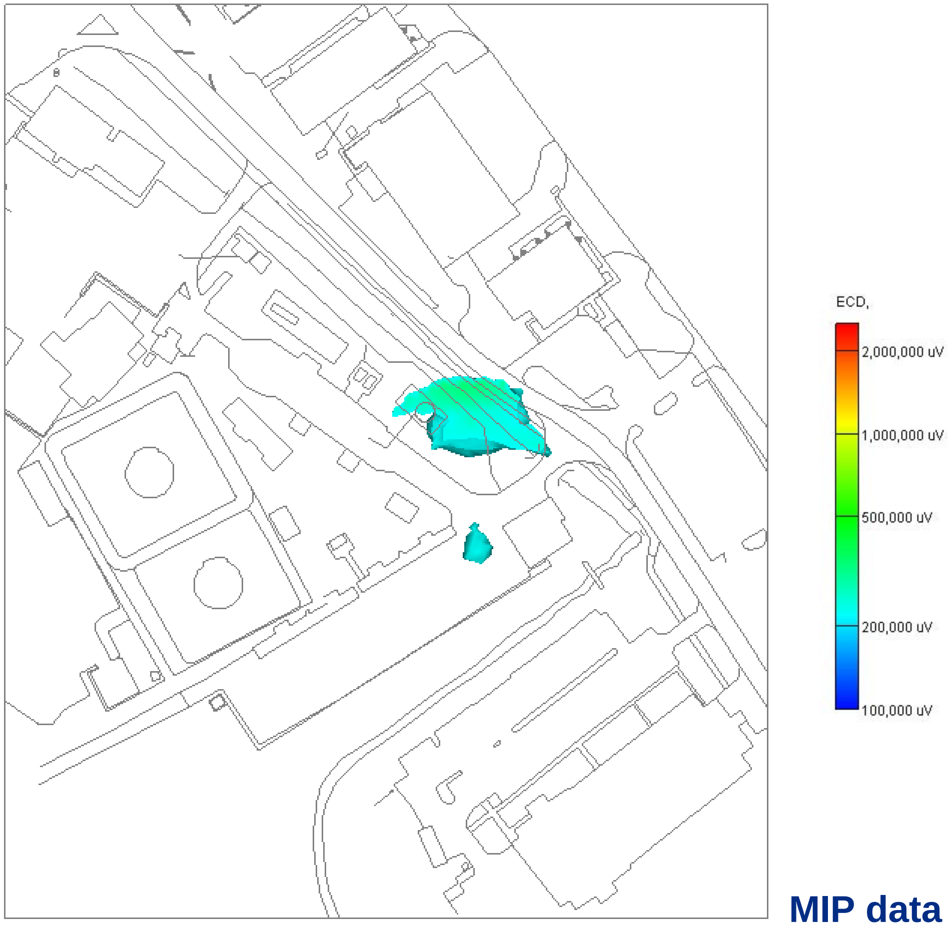
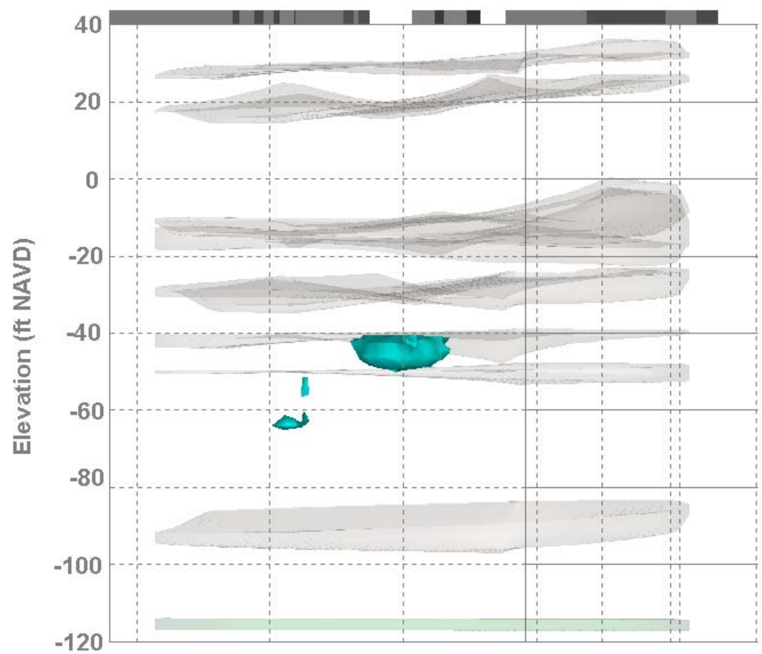
Deep Zone
(ECD Response above 225,000 µV)





MIP data visualization of downgradient CVOC contamination (prior to this investigation was thought to be more isolated).

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Site Direction Decision Logic

- Three components of the site direction decision logic are:
  - Source area(s) scoring
  - Team consensus building discussion process for uncertainty management
  - Application to define site direction (exit strategy/closure plan)
- CSM evaluation and assessment of the uncertainty and importance associated with the field decision logic
- Team member formulation of individual scores for each technical and administrative factors
- Consensus established site direction and lead to the site closure/exit strategy

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Sample scoring sheet completed by each Project Team member

NFA Remediation Decision - Feasibility Screening Matrix
Building 90141 Source
TRIAD Investigation Decision Logic
Site ST-123, Hurlburt Field, Florida

Purpose:
This tool is intended to assist project stakeholders in deciding whether to proceed with a No Further Action (NFA) site remediation strategy for a particular source area.
Due to likely significant variations in the geometry and mass of different sources, this screening matrix must be independently completed for each source.
It provides a comprehensive list of site-specific decision driving criteria (technical and non-technical) and allows the user to assign scoring values, certainty levels,
and weights to each criteria. The total weighted numeric score is calculated and then judged by the stakeholders to indicate the relative need and certainty
with which source area remediation can be performed to achieve site-specific NFA criteria. This tool was basically designed to form the basis for the decision of
whether to go with an aggressive remediation approach or some less aggressive approach such as containmeant and partial mass removal. It should
be noted that the process prescribed in this tool is dynamic and meant to be updated as necessary to keep current with technological advances in DNAPL remediation.

Procedure:
1. Cells highlighted in yellow or labeled with "user" are to be provided by the user.
2. Assign a "Value" of zero or 1 for each criteria; A "Value" of 1 indicates an affirmative answer to the criteria question and will be assigned a "Certainty" value.
A "Value" of zero indicates that the answer to the question is 100% certain in the negative.
3. Assign a percentage of "Certainty" with which the answer is provided. For example, if the weight-of-evidence unanimously indicates DNAPL presence, then 100% certainty should be entered.
4. Assign a relative degree of "Importance" to each criteria. These values should be assigned relative to each other. A 100% "Importance" is the highest level.

Assumptions:
1. Use of this spreadsheet is dependent upon the use of appropriate sampling and analytical procedures to derive the data upon which the criteria are scored.
2. This spreadsheet assumes that the source material is TCE and the history and nature of the release are relatively unknown.

References:
1. EPA, Sep 1993. Interim Final Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration. Directive 9234.2-25
2. EPA, Jan 1992. Estimating Potential for Occurrence of DNAPL at Superfund Sites. Publication 9355.4-07FS
3. EPA, Dec 2003. The DNAPL Remediation Challenge: Is There a Case for Source Depletion? EPA/600/R-03/143.

Item	Criteria	Value (0 or 1)	Certainty (%)	Importance (%)	Score
Technical Factors					
1	Is the source on-going and continuing to add mass to the subsurface?	0	75%	100%	0.0
	If the facility is no longer in use, has it been properly abandoned?				-
	If facility is active, are leak tests performed with adequate detection limits to prove that the source is continuing?				-
	If the facility is active, do routine accidental spills have a pathway to the subsurface?				-
2	Is there a potential or real risk to human or ecological exposure from the contaminants of the source?	0	75%	100%	0.0
	Is the source within a residential area of high potential exposure (ingestion, dermal, inhalation)?				
	Has the indoor air pathway been considered and determined to be complete?				-
	Does the source appear to be leaching contaminants to groundwater at a rate faster than NA can attenuate it (expanding plume)?				-
	Is the contamination within the shallow subsurface (0-15 ft bgs) and accessible by workers?				-
3	Is residual or mobile DNAPL suspected to be <u>ABSENT</u> in vadose or saturated zone soil samples?	0	50%	100%	0.0
	No DNAPL accumulated in a monitoring well?				-
	No DNAPL been physically observed in a soil or water sample?				-
	Are dissolved-phase concentrations present at less than 1% of solubility?				-
	Have DNAPL indication tools (ribbon sampler, Sudan IV dye, etc.) detected its absence?				-
	Are soil concentrations less than that indicative of free-phase DNAPL? (use partitioning equations to estimate)				-
4	If residual or mobile DNAPL is present, is its architecture amenable to cost-effective remediation?	0	90%	100%	0.0
	Is DNAPL present as residual with relatively small mass?				
5	Is the source geometry well characterized?	1	75%	100%	0.8
	Has the lateral extent of source material been defined to within 20 feet?				-
	Has the vertical extent of source material been defined to within 20 feet?				-
	Are the source interconnections, if any, well characterized?				
6	Is the extent of the source material of reasonable size/depth for cost-effective remediation?	0	75%	100%	0.0
	Is the lateral footprint of source material less than 0.25 acre?				-
	Is the vertical extent of source material less than 100 feet below grade?				-
7	Is delivery of in-situ amendments into the target treatment zone feasible?	0	75%	100%	0.0
	Does source contain small thicknesses of soil containing less than 20% silt/clay?				-
	Is soil uncemented/less dense to allow access with standard DPT?				-
	Does the source exist at depths less than 100 feet below grade?				-
8	Is a cost-effective technology available and proven to remediate the source to the remedial action objectives?	1	25%	100%	0.3
	Are there case studies of remediation at similar sites that have shown success?				-
	Are chemical scavengers present at only low concentrations (i.e., low TOC for ISCO, low sulfate for ERD)?				
	Is the projected cost of the technology reasonable from a cost:benefit perspective and consistent with long-term site use goals?				-
9	Are the numeric remedial action objectives realistic (i.e., not MCLs)?	1	50%	100%	0.5
10	Is the lithology of the source area simple?	0	90%	75%	0.0
	Does the source area consist of a relatively homogeneous geologic unit?				-
	If the source consists of multiple geologic zones, is bedding planar?				
	Are lithologic lenses continuous?				-
11	Are the aquifer hydraulic conditions within the source area amenable to remediation?	0	60%	75%	0.0
	Is the hydraulic conductivity greater than 10 ft/day?				-
	Are there no significant temporal variations in groundwater flow patterns?				-
	Are there no significant vertical gradients?				-
12	Are quantitative tools available and implementable to provide cost:benefit analysis and remediation progress monitoring?	1	70%	75%	0.5
	Is a model available to estimate the benefits (i.e., reduction in remediation timeframe) of various degrees of mass removal?				-
	Are mass flux analysis tools available to use during remediation to estimate the pre- and post-remediation effects?				-
13	Is NA activity present which may support, with or without amendment, an MNA polishing step after source treatment?	1	75%	50%	0.4
	Is the aquifer sufficiently reduced to sustain complete reductive dechlorination?				-
	Is adequate organic carbon available to sustain long-term reductive dechlorination?				-
	Is the appropriate microbial population present to perform complete dechlorination to ethene?				-
14	Have realistic remediation timeframe estimates been set based on site-specific conditions (using SourceDK model or similar)?	0	75%	50%	0.0
Subtotal Technical Factors					***2.4***
Non-Technical (Intangible) Factors					
15	Are near-term site use goals (i.e., less than 30 years) strict enough to require source area remediation to NFA?	1	25%	100%	0.3
16	Does current site infrastructure and use allow for relatively unimpeded site remediation activities?	1	50%	100%	0.5
17	Is there a strong desire to reduce contaminant mass and thereby reduce the environmental burden of future generations?	1	50%	100%	0.5
18	Are the project stakeholders willing to accept a relatively high level of risk in seeking, and possibly failing, to remediate to NFA?	1	25%	75%	0.2
19	Is there a strong committment to test new technologies and advance the science of DNAPL remediation?	1	25%	25%	0.1
Subtotal Non-Technical Factors					***1.5***
TOTAL					**3.9**

TOTAL SCORE INTERPRETATION:

	If one or more GREEN cells appear, then the certainty score is irrelevant. MORE aggressive remediation techniques should be strongly considered.
	If multiple RED cells appear, then the certainty score is irrelevant. LESS aggressive remediation techniques should be strongly considered.
>14	- The site is extraordinarily well suited for aggressive source remediation.
9-14	- Indicators favor some degree of aggressive source remediation, less inherent risk of success with scores at the higher end of the range.
7-9	- Around the 50/50 mark, stakeholders will have to closely weigh the pros and cons of aggressive source remediation.
4-7	- Less aggressive source remediation approached are recommended. Stakeholders should consider alternative less aggressive or partial mass removal technologies
<4	- The project conditions are not amenable to source remediation and stakeholders should consider containment or long-term monitoring/land use control options.

If additional certainty is required by the project team, then additional data collection must be performed in order to close data gaps.
This scoring sheet can be revisited at the end of each data collection phase to assess the level of certainty and the need for additional data.

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Lessons Learned

- Team building is extremely important essential to project success?
- DPT/CPT/MIP and other field methods greatly improve resolution of field results
- Triad investigation will probably be cost effective and is definitely more time efficient than conventional methods
- Site ST-123 Triad investigation provided the data required to develop the RCRA Statement of Basis decision document with a clear exit strategy

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Discussion

Questions?

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