Adaptations to Triad as a Basis for Exit Strategy Development

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Triad investigation value added:

- Exit strategy development
- Rigorous decision logic focused on remedial action
- Remediation data needs evaluation

Triad History

Overview

"Triad" was coined by the U.S. Environmental Protection Agency (EPA) to represent a new approach to managing decision uncertainty for hazardous waste sites. Practitioners have worked toward the most effective methods to investigate contaminated sites for the past 30 years. EPA's Technology Innovation Program studied "successful" versus "less successful" projects and identified common problems and strategies for solving them.

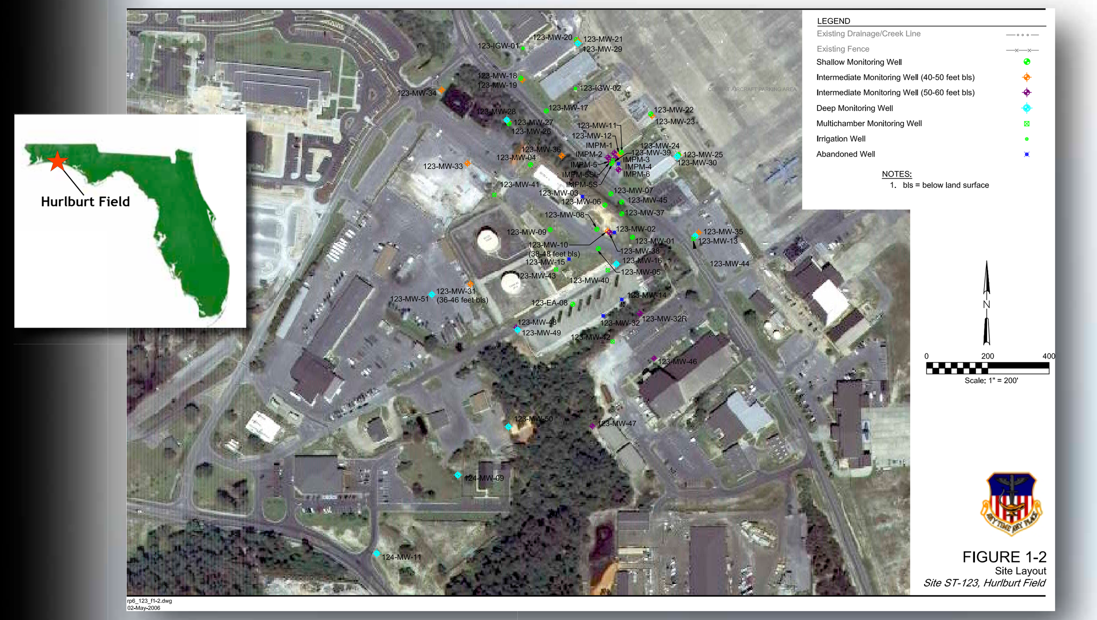
Triad is a synthesis of work strategies developed by practitioners from the U.S. Department of Energy, Tufts University, U.S. Army Corp of Engineers, EPA, other federal and state agencies, and the private sector. Systematic Planning, Dynamic Work Strategies, and Real-Time Measurements are the three primary components of the Triad approach.

U.S. Air Force Triad Initiative

- Air Staff selected the State of Florida to conduct three Triad pilot study projects because of the existing regulatory partnering process
- Each project had different contaminants and remediation requirements
- Site ST-123 at Hurlburt Field was selected as a pilot study area

Site ST-123 History

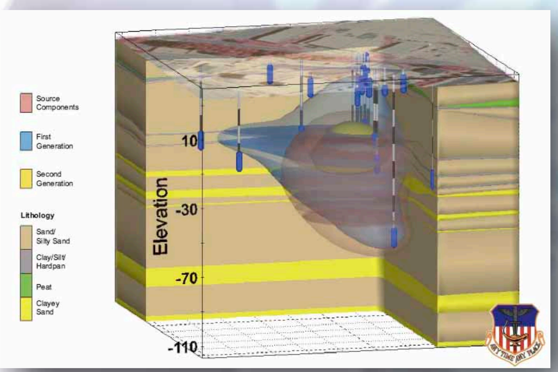
- Petroleum, oils, and lubricants (POL) fuel yard constructed in the 1940s to store jet fuel, waste fuel, and waste oil
- All above and underground storage tanks (ASTs and USTs) were removed prior to May 1994
- Site groundwater was impacted by petroleum constituents and chlorinated volatile organic compounds (CVOCs)
- Initial source area was associated with activities and operations within the POL fuel yard



Triad Process

Systematic Planning

- Assemble project team and establish roles
- Team consensus on project objectives:
  - Eliminate significant uncertainties in the CSM that hinder selection of a full-scale corrective measure at the site
  - Minimize uncertainties in the CSM to ensure that all source areas are adequately delineated
  - Collect sufficient data to effectively support the development of a long-term site management strategy and exit strategy
- Develop preliminary conceptual site model (CSM)
- Define key decisions based on data gaps
- Develop logic and acceptable data quality levels to manage project decisions

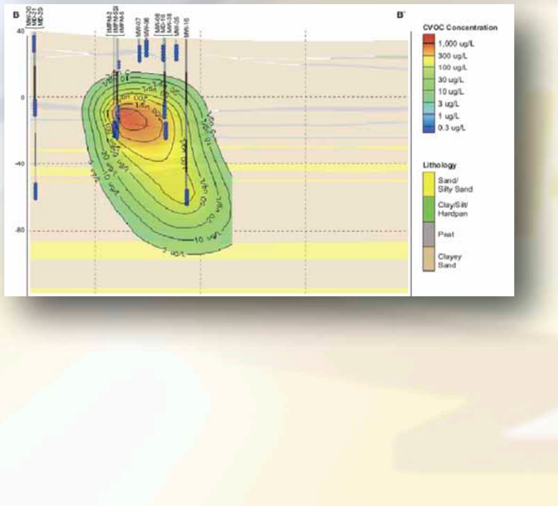


Preliminary CSM

Preliminary Suspected Source Areas

Pre-investigation source areas included:

- Building 90131 (Propulsion Building)
- Former UST area
- Oil-water separator (OWS)
- Stormwater drainage off the flightline
- Sewer/utility lines



Dynamic Work Strategies

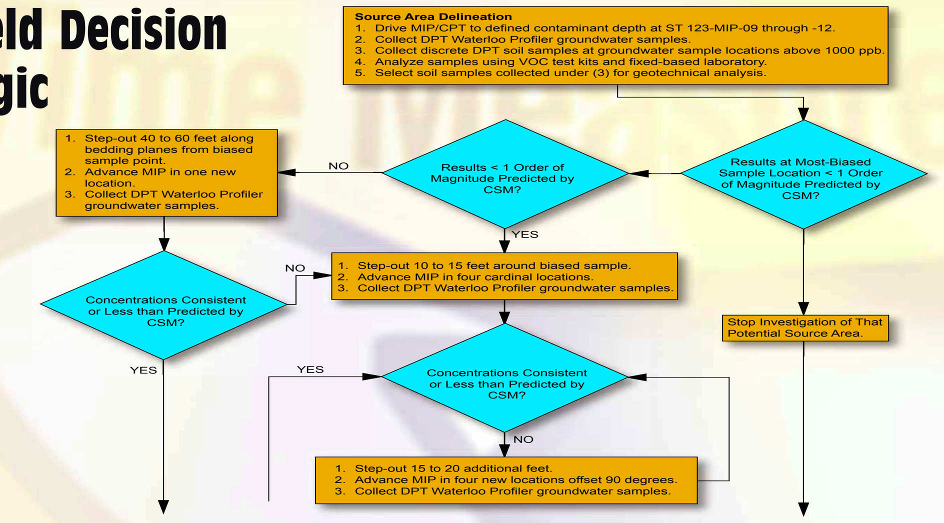
- Develop decision logic to address anticipated conflicts or developments in field
- Develop adaptive sampling and analysis strategy that could be used in the field based on decision logic
- Establish low-, medium-, and high-data priorities for each objective to facilitate future site decisions
- Define data management, quality assurance, and health and safety plans
- Reach team consensus

Future Remediation Efforts Consideration

- Identified source area uncertainty as a key data gap
- Established the following investigation objectives:
  - Identify target treatment areas
  - Determine feasibility of No Further Action (NFA) or aggressive site remedy for source areas

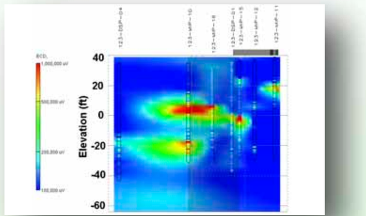
Item	Project Objective	Phase 1 Field Activities (High-Priority Needs)	Phase 2 Field Activities (Medium-Priority Needs)	Phase 3 Field Activities (Low-Priority Needs)
2	Delineate source area Identify target treatment areas Determine if NFA is a feasible option at Site ST-123	Characterize source materials in lower in termediate zone (50-80 feet bgs); Characterize source materials in deep zone (80-150 feet bgs); sample most biased locations first, stop if nothing there Develop non-parametric relationship between MIP and laboratory concentrations	Characterize source materials in shallow zone (7-40 feet bgs) Characterize source materials in upper intermediate zone (40-50 feet bgs) Delineate vadose zone contamination (0-7 feet bgs)	
3	Obtain conceptual design data for potential remediation	Delivery process information: soil type, density, grain-size distribution, conductivity, permeability, porosity	Obtain ISCO parameters (if applicable) Natural oxidant demand (NOD) tests Total organic carbon (TOC) data	Enhanced bioremediation microbial analysis Obtain ISCR parameters Determine reducing agent scavenger concentrations
6	Develop closure strategy acceptable to EPA, FDEP, and Air Force	Data for this objective will be obtained through other objectives		

Field Decision Logic



Real-Time Measurements

- Sample and analyze data quickly to support timely field decisions and close data gaps in the CSM
- Validate field screening methods to fulfill data quality objectives
- Refine CSM continually to guide investigation
- Adapt work plan as needed
- Communicate results to project team members



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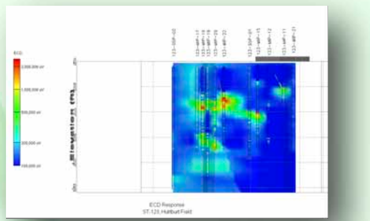

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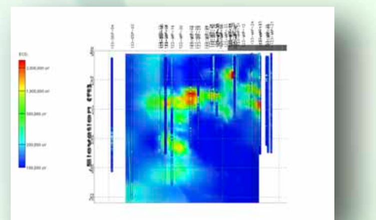
Field Adaptation of Source Area

- MIP measured the maximum electron capture detector (ECD) response at 123-MIP-30 (October 25, 2004), located adjacent to Building 90141 not originally suspected as source area
- Equipment was moved immediately and shallow soil samples were collected:
  - Soil total CVOCs > 700 mg/kg
  - Soil total organic carbon (TOC) > 55,000 mg/kg
- Work plan was modified to address high TOC concentrations
- Sample location plan was adapted to focus on the new unidentified source



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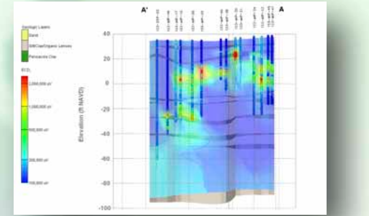

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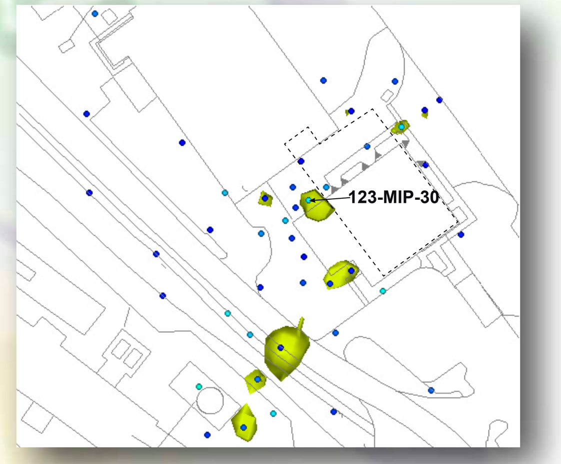
Post-Investigation Source Areas

Based on results during the investigation, three suspected source areas were identified:

- Flightline
- Former UST area
- Building 90141 (Aircraft Maintenance Building)/ Former Building 90129 (Radio and Radar Shop)



MIP ECD Response

Value Added

Exit Strategy Development Scoring

Feasibility Screening Sheets were developed to assist project stakeholders in deciding whether to proceed with an NFA remedy for a particular source area, addressing technical and administrative practicality factors.

NFA Remediation Decision - Feasibility Screening Matrix

Item	Criteria	Certainty (%)	Importance (%)
Technical Factors			
1	Is residual or mobile DNAPL suspected to be ABSENT in vadose or saturated zone soil samples?		100%
2	If residual or mobile DNAPL is present, is its architecture amenable to cost-effective remediation?		100%
3	Is the source geometry well characterized?		100%
4	Is the extent of the source material of reasonable size/depth for cost-effective remediation?		100%
5	Is delivery of in-situ amendments into the target treatment zone feasible?		100%
6	Is a cost-effective technology available and proven to remediate the source to the remedial action objectives?		100%
7	Are the numeric remedial action objectives realistic (i.e., not MCLs)?		100%
8	Is the lithology of the source area simple?		75%
9	Are the aquifer hydraulic conditions within the source area amenable to remediation?		75%
10	Are quantitative tools available and implementable to provide cost:benefit analysis and remediation progress monitoring?		75%
11	Is NA activity present which may support, with or without amendment, an MNA polishing step after source treatment?		50%
12	Have realistic remediation timeframe estimates been set based on site-specific conditions (using SourceDK model or similar)?		50%
Non-Technical (Intangible) Factors			
13	Are near-term site use goals (i.e., less than 30 years) strict enough to require source area remediation to NFA?		100%
14	Does current site infrastructure and use allow for relatively unimpeded site remediation activities?		100%
15	Is there a strong desire to reduce contaminant mass and thereby reduce the environmental burden of future generations?		100%
16	Are the project stakeholders willing to accept a relatively high level of risk in seeking, and possibly failing, to remediate to NFA?		75%
17	Is there a strong committment to test new technologies and advance the science of DNAPL remediation?		25%
TOTAL			

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.

Exit Strategy Screening of Sources

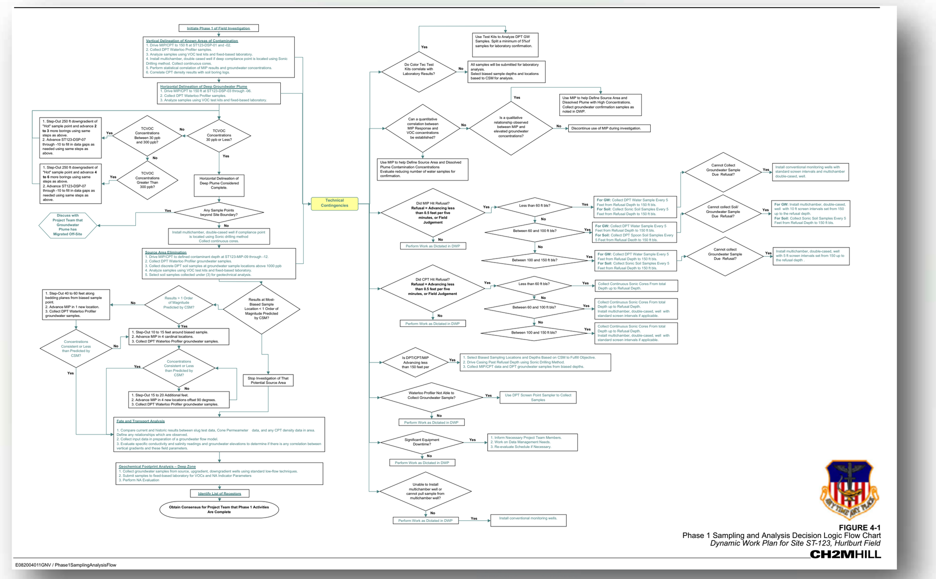
- Each team member "scored" each source area separately and an average was taken
- Average scores for each of the three identified sources indicated that less aggressive source remediation approaches, such as partial mass removal, may be the best site options

Triad Case Study Summary

- Four face-to-face meetings
- Three site visits
- Fifty days of field implementation

Site Direction Development

- Future site remediation strategy for Site ST-123 includes:
  - Land use controls (LUCs)
  - Source abatement
  - Long-term groundwater monitoring (LTM)
- Site remediation decision logic will be developed
- CSM will continue to evolve



Decision Logic Flowchart

Conclusions

- Developed a more comprehensive understanding of the site during the 5-month field investigation. In the long term, the Triad investigation will be the more cost-effective approach to site remediation.
- Expended 57 percent of the total dollars spent on the site since 1994 on investigation, remediation, and monitoring.
- Developed the framework for an exit strategy, which is consistent with regulatory protocol, Air Force long-term management goals, and technology constraints.
- Reduced decision uncertainty significantly; therefore, the future project scope can be narrowed and the long-term project costs reduced.
- Continue to adapt the dynamic Triad process in future investigations.

Lessons Learned for Future Adaptation

- Identify institutional structures that impact project requirements and contracting for Triad projects.
- Enlist a Triad mentor or establish meeting rules for the Systematic Planning phase.
- Team member awareness of the regulatory framework governing the site so data and reporting needs can be met.
- Incorporate prioritized data needs into the decision logic to manage scope.
- Consider field tools and site logistical issue coordination when writing sampling decision logic.
- Ensure subcontractors understand how a dynamic investigation is conducted so they can bid and plan accurately. Pauses, not re-mobilization, in field work to evaluate schedule, budget, and priorities can be beneficial.
- Empower field team to make decisions quickly and accurately by reaching consensus among project team members.

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Site ST-123 Timeline

Activities:

- Site Inspection
- Contamination Assessment/ Supplemental Contamination Assessment
- RCRA Facility Investigation/ Baseline Risk Assessment
- First HRC® Injection
- Corrective Measures Study
- Second HRC® Injection
- Soil Excavation
- ORC® Injection and Third HRC® Injection
- Lithology Characterization and Deep Soil Investigation
- Triad Investigation

1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006

Key Post-CMS Groundwater Sampling Dates (▲):