



Remedy Optimization through Independent Design Reviews (IDRs)

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Office of Solid Waste and Emergency Response (OSWER)



- Develops standards and regulations for hazardous and non-hazardous waste (RCRA)
 - Promotes resource conservation and recovery (RCRA)
 - Cleans up contaminated property and prepares it for reuse (Brownfields, RCRA, Superfund, UST)
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- Helps to prevent, plan for, and respond to emergencies (Oil spills, chemical releases, decontamination)
 - Promotes innovative technologies to assess and clean up contaminated soil, sediment, and water at waste sites (Technology Innovation)

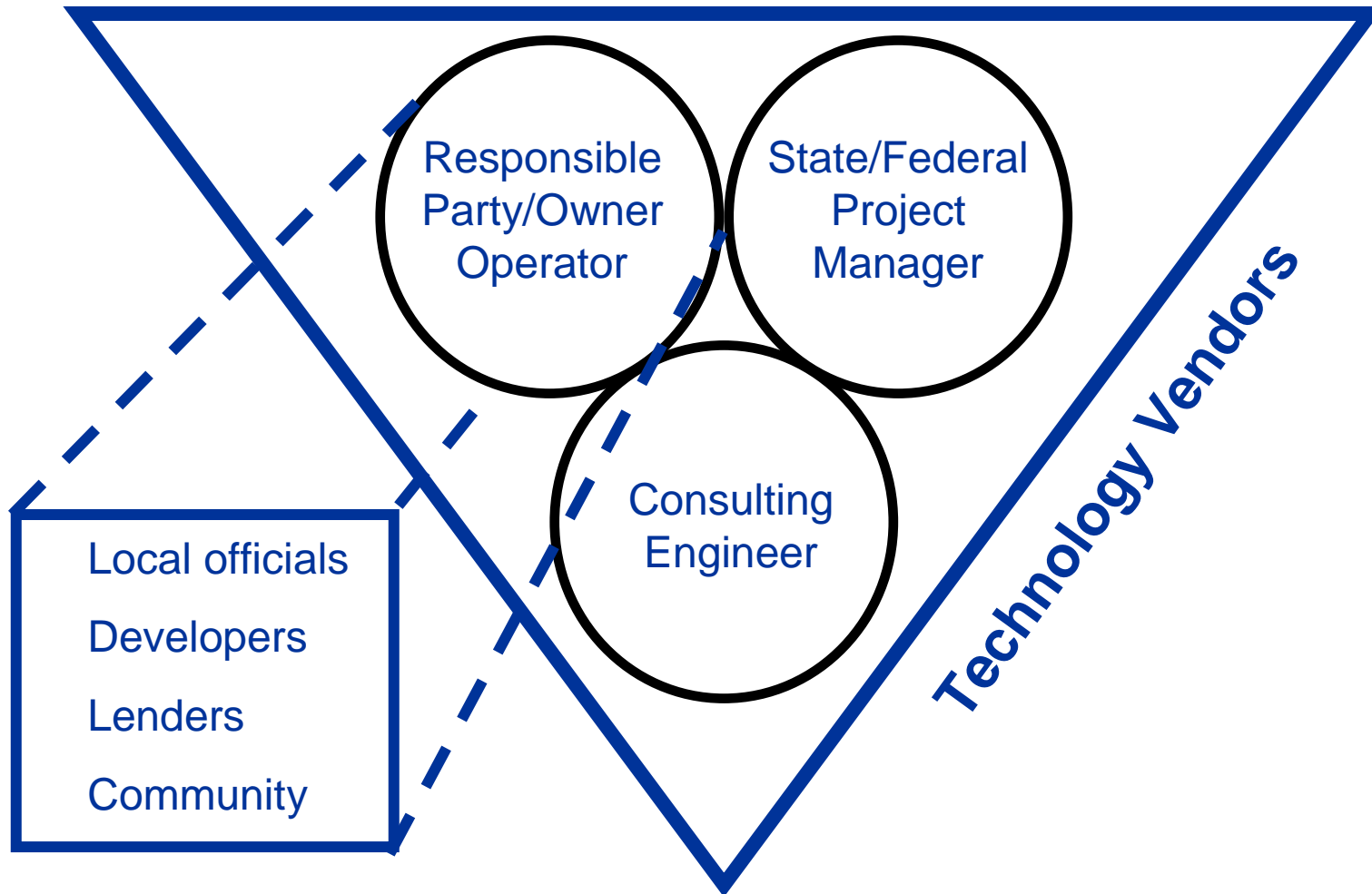


Office of Superfund Remediation and Technology Innovation (OSRTI)

Technology Innovation Field Services Division (TIFSD)

- OSRTI - implements and manages Superfund program
- TIFSD Core Mission:
 - Advancing best practices in site cleanup
 - Technology support to EPA Regional project managers, states, local governments, tribes
 - Informational support to cleanup community at large
- Primary activity areas to advance mission:
 - Evaluate and document innovative technologies
 - Transfer knowledge through publications, training, internet, etc.
 - Provide direct technical support at sites in Superfund, Brownfields, RCRA, and UST
 - Manage analytical services for the Superfund program

Target Audience





Presentation Overview

- Business Case for Remedy Optimization
- Optimization and IDR Basics
- IDR Case Studies
- Strategies, Tools, and Technologies
- EPA Optimization Update
- Questions

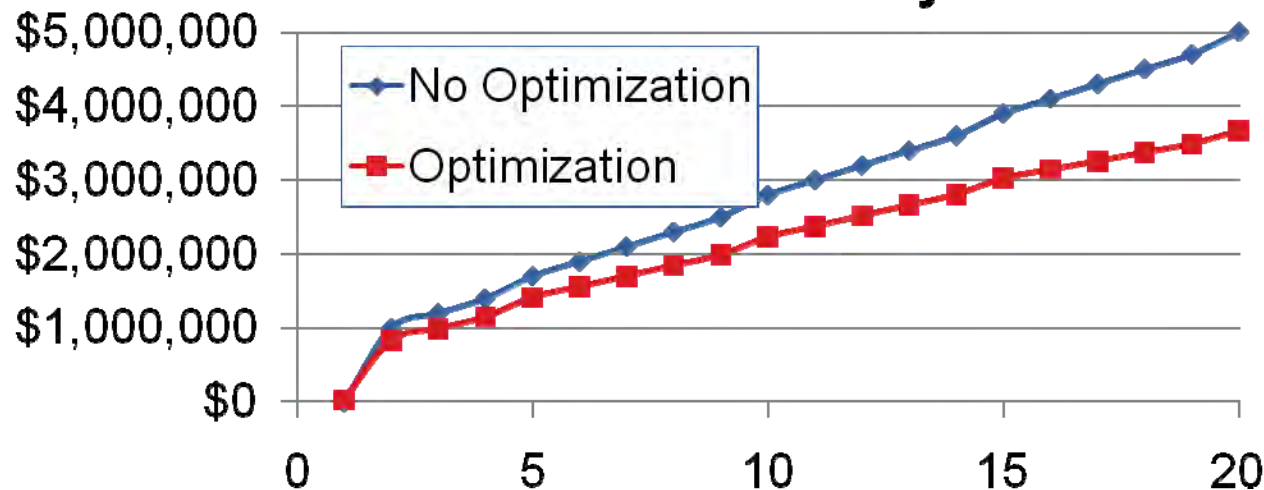


THE BUSINESS CASE FOR REMEDY OPTIMIZATION WITH IDRS

Business Case

- Optimization is low cost relative to cost of remedy
- Excellent return on investment
- Additional savings from continued optimization throughout remedy

Cumulative Remedy Costs



Optimization conducted during design and once every 5 years. 20% decrease in life-cycle cost from design evaluation and 10% decrease in costs from each O&M optimization evaluation

\$100,000 investment
\$1,400,000 savings



Business Case

- Identifies potential liabilities
- Improves site conceptual model
- Site team and management provided with a valued third-party perspective
 - Provides confidence in path forward
 - Provides a structured strategy for moving forward
 - Weighs pros and cons of various options
 - Builds consensus among various stakeholders
 - Balances technical input from sole site contractor
- Cross-pollinates expertise among sites

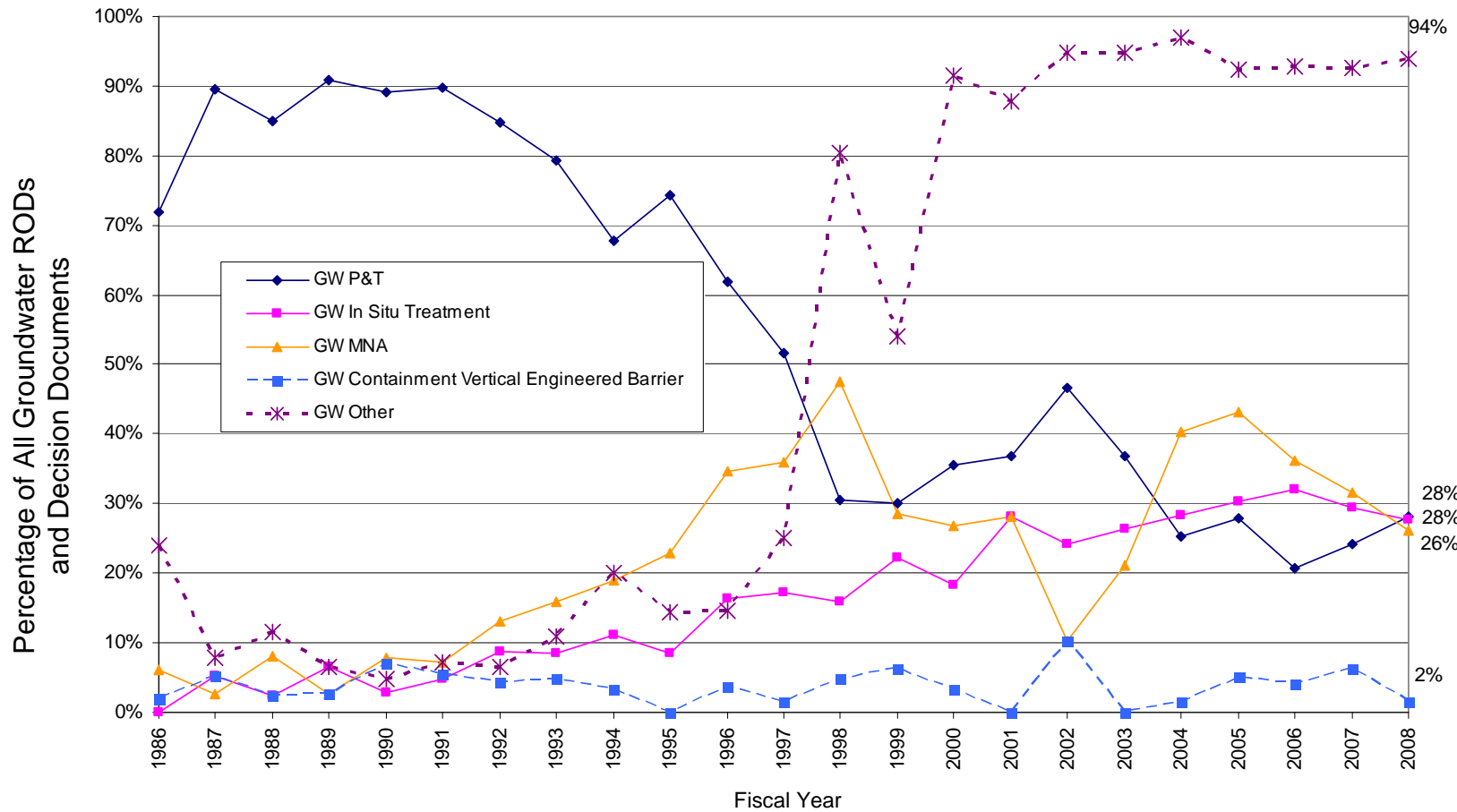


Remedy Optimization through IDRs



Business Case

Trends in RODs and Decision Documents Selecting Groundwater Remedies (FY 1986 - 2008)
Total Groundwater RODs and Decision Documents = 1,727



*Groundwater Other includes institutional controls and other remedies not classified as treatment, MNA, or containment.

*Note: Other remedies selected prior to 1998 may be under represented in figure.

*RODs and decision documents may be counted in more than one category.

*RODs from FY1986 - 2004 include RODs and ROD amendments.

*Decision documents from FY2005 - 2008 include RODs, ROD amendments, and select ESDs.



OPTIMIZATION AND IDR BASICS

EPA's Definition of Optimization

Comprehensive and systematic review of a site's past, current, and planned clean-up activities by a team of independent technical experts to identify protectiveness improvements, cost efficiencies, and opportunities for early site closure.



What are Your Objectives?

- Why are you interested in optimization?
 - Do you manage a single site?
 - Do you manage a portfolio of sites?
 - Are you the regulated party, the regulator, or both?
- Optimization of many sites yields lessons learned for optimizing a program
- An optimized remedy is in the eyes of the beholder

Remediation Strategies

Remediation Strategy Depends on Remedy Objectives and Institutional Drivers		
Party	Common Drivers	Common Remedial Strategies
Private Responsible Party (RP)	<ul style="list-style-type: none"> • Reduce liability • Reduce uncertainty • Control costs 	<ul style="list-style-type: none"> • Control/contain • Identify/eliminate liability • Avoid uncertainty • Avoid capital intensive projects*
Regulator	<ul style="list-style-type: none"> • Protect human health and the environment • Ensure cleanup... What if RP becomes insolvent? 	<ul style="list-style-type: none"> • Identify/eliminate liability • Intensive characterization • Aggressive remediation
Large Organizations	<ul style="list-style-type: none"> • Reduce liability • Control costs • Find a better way 	<ul style="list-style-type: none"> • Control/contain • Identify/eliminate liability • Invest in new technologies

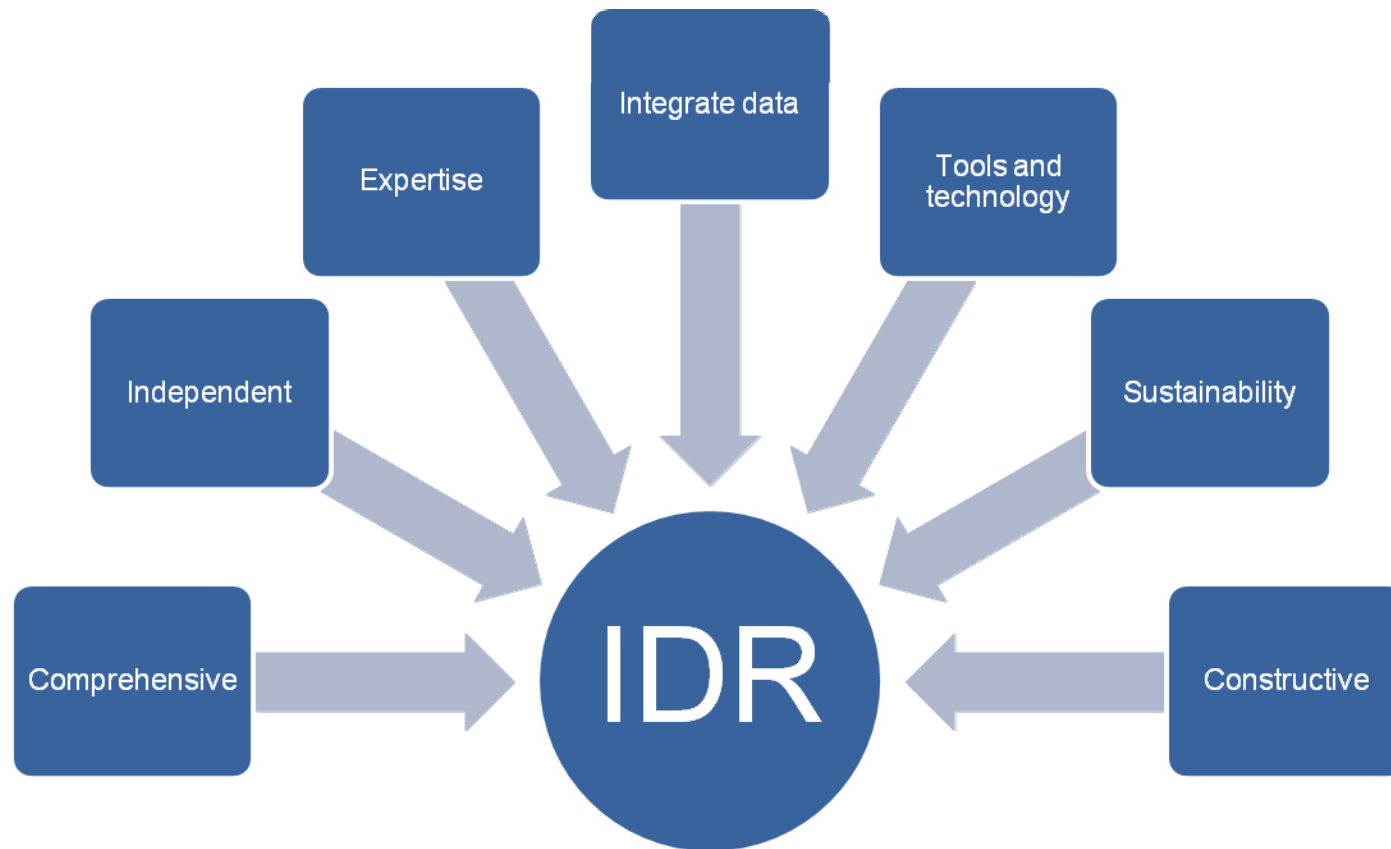
* *Especially if outcome is uncertain or not guaranteed*



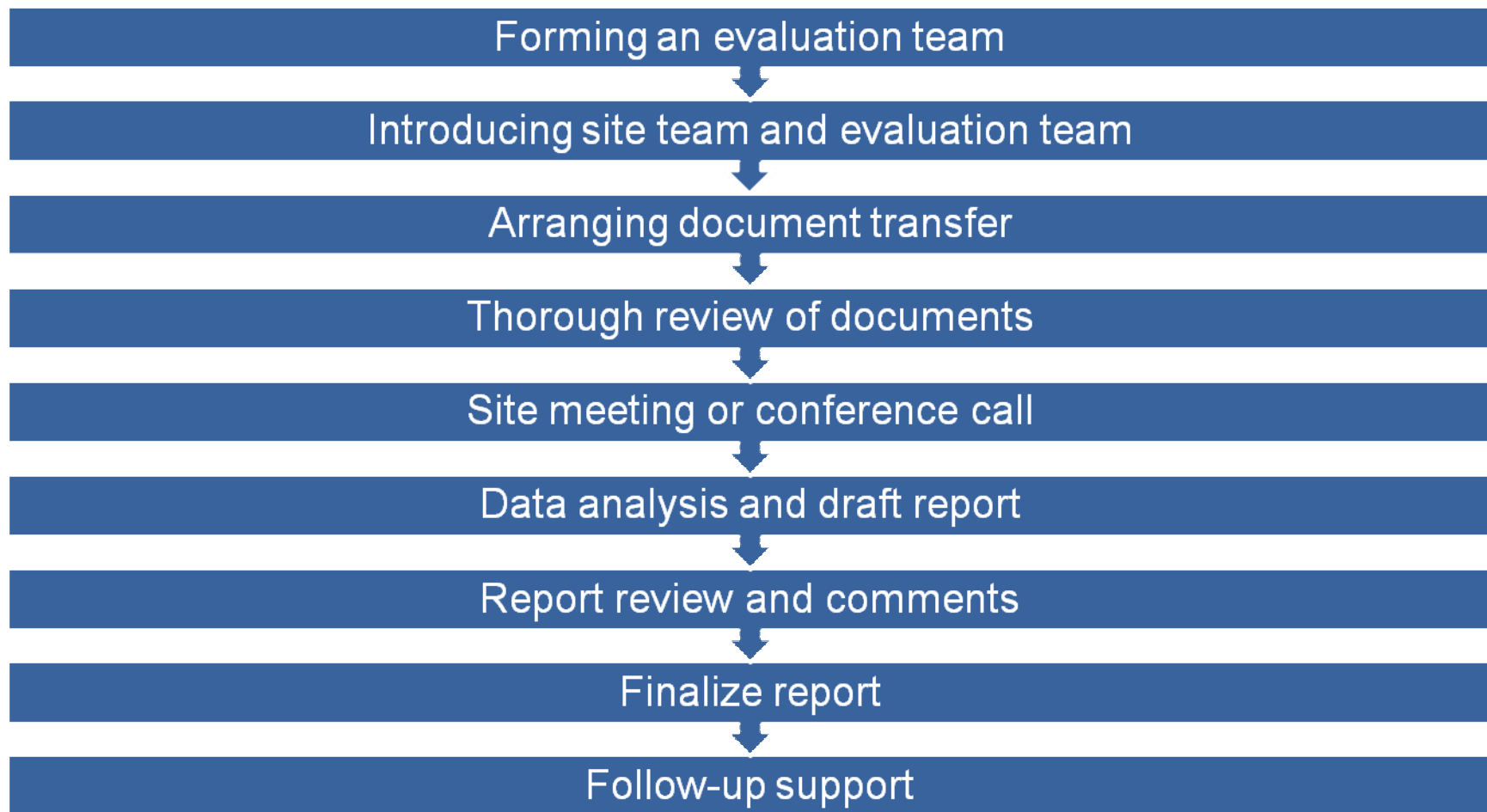
IDR Origins

- EPA developed the process in 2005 based on results from conducting optimization evaluations at operating remedies
- Optimize prior to remedy implementation and operation
- Goal of IDR is to
 - Ensure clear remedial objectives
 - Ensure sufficiently detailed site conceptual model for design
 - Ensure protectiveness
 - Control costs
 - Develop an exit strategy

IDR Principles



IDR Logistics



IDR Logistics

Participants

- Evaluation team
- Remedy owner/manager
- Consultant project manager
- Consultant technical leads
- Regulator(s)

IDR Logistics

Documents to review

- Remedial investigation report
- Feasibility report
- Record of Decision
- Pre-design work
 - Work plans for upcoming work
 - Treatability study results
 - Additional characterization results
 - Modeling studies
- Other design documents
- Cost estimates

IDR Logistics: Typical Report Sections

Background
Remedy objectives
Description of remedy

Convey that the evaluation team understands the site

Findings

- Update site conceptual model
- Identify site conceptual model data gaps
- Evaluate design parameters
- Evaluate cost estimates
- Set stage for recommendations
- Estimate environmental footprint of remedy

Considerations or recommendations with cost implications

- Remedial strategy
- Remedy implementation
- Next steps

- Protectiveness
- Cost-effectiveness
- Site closure
- Sustainability



Working an IDR into the Remedial Process

- Initiate IDR during...
 - Remedy selection
 - Remedy design
 - Remedy re-reselection or re-design
- IDR is a dynamic process...Use the same IDR evaluation team, and revisit remedy
 - Before finalizing each major submittal
 - During conceptual design
 - Pre-final design
 - During final design
- If limited remedy information is available, reduce initial scope of IDR to reserve resources for IDR when more information is available.

Conducting an IDR: Typical Agenda

Introductions

Site conceptual model

- Contaminant sources
- Hydrogeology and geochemistry
- Previous and current remedies
- Data gaps

Remedy objectives

- Source removal
- Source control
- Migration control
- Restoration
- Time frame

Conducting an IDR: Typical Agenda (continued)

Conceptual design

- Remedy physical, chemical, and biological processes
- Design criteria
- Design assumptions
- Remedy or remedy component alternatives
- Evaluating remedy performance
- Exit strategy

Design parameters

- Parameter values
- Uncertainty in values
- Data gaps
- *Performance metrics*

Cost estimates

- Labor
- Utilities
- Materials and waste
- Monitoring and evaluation

Conducting an RSE: Typical Agenda

Sustainability

- Electricity usage and electrical components
- On-site fuel usage and fuel-powered equipment
- Distances from site (personnel, vendors, disposal)
- Materials and chemicals used
- Direct emissions from processes
- Water (potable, groundwater, surface, etc.) used
- Sensitive habitats
- Potential uses for property
- Input from stakeholders on most critical environmental parameters/affects



Conducting an IDR: Typical Questions

- What is the conceptual model for the site?
 - How did we arrive at the current conditions?
 - Consider sources, hydrogeology, geochemistry
- What are existing data gaps in the site conceptual model?
- What are the remedial objectives? Are they still relevant and appropriate?
- What three aspects of the selected remedy and conceptual design cause the most concern about future performance?
- What are the likely points of failure?
- What is the level of certainty about each design parameter? How sensitive is remedy performance and cost to this parameter?



Conducting an IDR: Typical Questions

- How will specifically will remedy performance be evaluated?
 - How will you know it is being successful?
 - What parameters will be measured?
 - What values indicate adequate performance/progress?
- What function does this remedy component provide and what else can provide that function?
- What is the point of diminishing returns for this aspect/component of the remedy?
- What approach/component would be more appropriate at this point of diminishing returns?



IDR Follow Through

- The design process is dynamic and the IDR process is dynamic
- The IDR is best applied throughout the design process, with the level of effort increased or decreased as merited
- The IDR team will have detailed knowledge of the remedy, consider using its perspective during...
 - Remedy construction
 - Remedy commissioning
 - Remedy operation



IDR Challenges

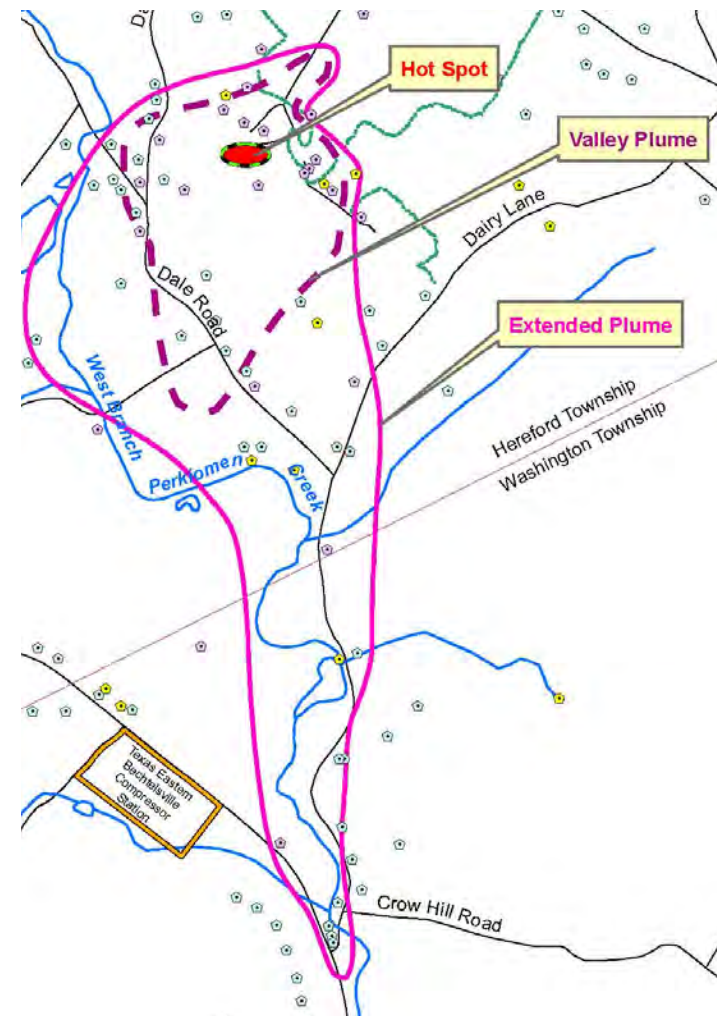
- Disagreement is possible. Each team member has different opinions, philosophies, and experiences.
- IDR team is unbiased (third-party) but does not have same level of responsibility as remedy designer.
- How does a project owner/manager interpret differing points of view?
- What if IDR identifies a better remedial alternative after official remedy selection?



IDR CASE STUDIES

Case Study #1 – Unnamed Site

- Evaluation conducted during early Remedial Design
- TCE DNAPL present at top of hill
- Dissolved plume migrating uncontrolled through bedrock aquifer
- Plume over 2 miles long through residential area





Case Study #1 – Unnamed Site (continued)

- Evaluation findings
 - Source area remedy focused on only addressing 100,000 ug/L contour for \$6 million
 - Significant contamination unaddressed
 - Requires another remedy to make consistent with NCP
 - Residences overlying a shallow TCE plume, vapor intrusion not yet considered
 - UV/Oxidation selected as treatment technology for extracted groundwater
 - Treated water discharged to subsurface near source



Case Study #1 – Unnamed Site (continued)

- Representative IDR recommendations
 - Capture of a larger portion of the plume
 - Can be implemented in a timely manner
 - Could be (but would not have to be) supplemented by additional source area remediation in the future
 - Evaluation team and site team agreed on 1,000 ug/L contour
 - Evaluate vapor intrusion
 - Change above-ground treatment process to more cost-effective air stripping with vapor phase GAC



Case Study #1 – Unnamed Site (continued)

- Additional follow-up
 - Site contractor developed cost of \$17.5 million for design/build
 - Third-party reviewed costs and assumptions
 - Final estimate of \$10 million for design/build plus potential for second phase, if necessary
 - Potential savings of \$7.5 million during RA from avoiding overdesign
 - Additional potential life-cycle savings from avoiding operation of an over-designed system

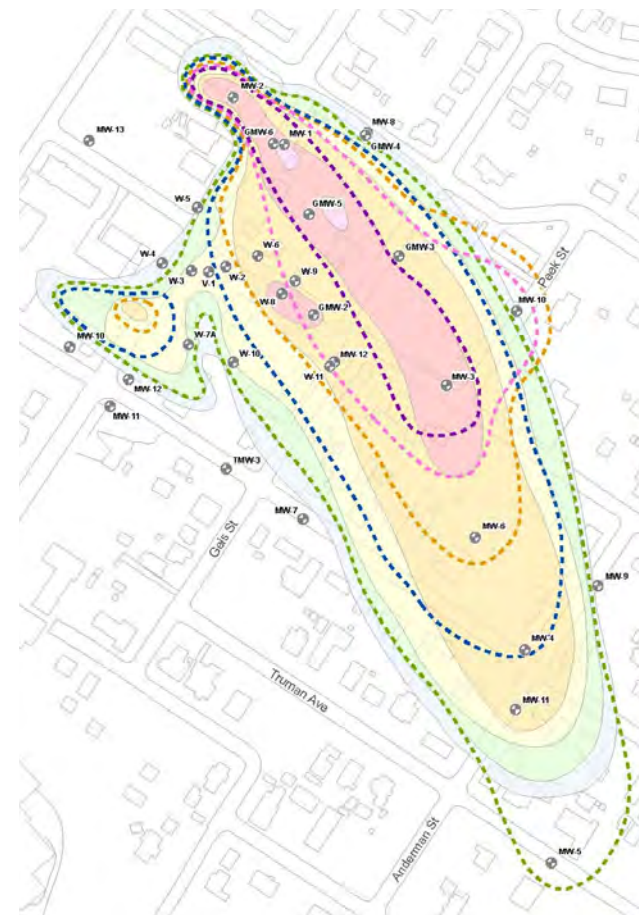


Case Study #1 – Unnamed Site (continued)

- Additional follow-up
 - Vapor intrusion was evaluated and vapor mitigation systems installed
 - Extraction well installation underway in Summer 2010
 - Remedy designed and implemented in phases
 - Phase 1: 10 wells at 700 to 1000 gpm
 - Potential to increase to 2,500 gpm
 - Treatment plant constructed for treatment of up to 2,500 gpm
 - Air stripping and vapor phase GAC used instead of UV/oxidation
 - Additional extraction and treatment from hot spot possible

Case Study #2 – Grants Chlorinated Solvents

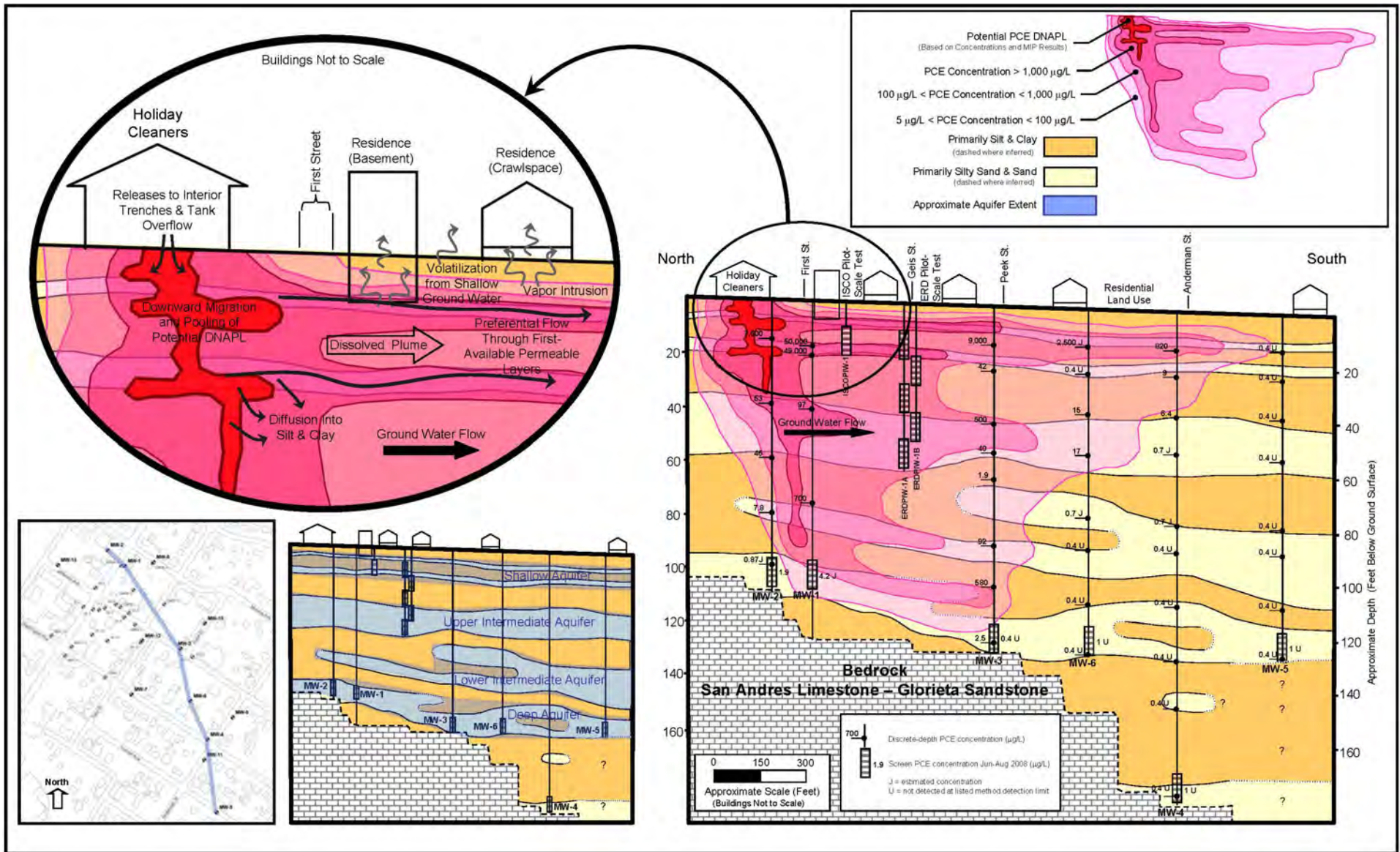
- Evaluation conducted during early design stage
- Large PCE plume from former dry cleaners
- ROD signed in June 2006
- Pre-design activities (with more investigation) underway during IDR
- Limited data available relative to other sites in design stage
- \$29 million ROD estimate for remediation





Case Study #2 – Grants Chlorinated Solvents (continued)

- IDR findings
 - Presence of contamination in thin lenses
 - Potential for substantial mass to have migrated from source area
 - Potentially less mass in subsurface than assumed in cost estimates
 - Need for additional information to help refine/confirm conceptual site model
 - Cost for remediation documented in ROD is likely overestimated





Case Study #2 – Grants Chlorinated Solvents (continued)

- Representative recommendations
 - Based on additional characterization
 - Reconsider thermal remediation for source area, or at least refine treatment volume and location
 - Reevaluate remedy approach for plume core and amounts of chemicals/nutrients for remediation
 - Reconsider remedial goals and time frames for comparing alternatives and determining progress
 - Monitoring well locations suggested



Case Study #2 – Grants Chlorinated Solvents (continued)

- Changes in remedy that have occurred
 - Completed additional source area characterization
 - Installed additional monitoring wells to delineated plume
 - Reduced and relocated area for thermal remediation
 - Considering MNA for a portion of the plume (reducing the area for active remediation)
 - Reevaluating chemical/nutrient amounts
 - Revised costs not yet developed but should reduce ROD estimate by millions of dollars

Case Study #3 – Woolfolk Chemical

- Evaluation conducted during “late RA” or “early LTRA”
- Former pesticide facility that operated between 1910 and 1999
- Remedy not declared operational and functional
 - Lack of plume delineation
 - P&T system does not adequately address plume
- Review focused on groundwater (OU1)





Case Study #3 – Woolfolk Chemical (continued)

- Representative IDR recommendations
 - Divide treatment into two separate treatment trains as to provide adequate capacity for expanded system
 - Delineate plume with suggested monitoring locations to distinguish between plume core and plume flank areas
 - Plume core – P&T
 - Plume flank – institutional controls
 - Eliminate SVOCs from future monitoring
 - Terminate extraction at some extraction wells
 - Consider adding new P&T piping during off-site excavation activities
 - Design recommendations for a streamlined P&T system

Case Study #3 – Woolfolk Chemical (continued)

- Changes in remedy that have occurred due to IDR
 - Plume delineation efforts substantially reduced by more appropriately locating new monitoring wells
 - Appropriate recognition of region-wide pesticide contamination (rather than all site related)
 - Site team proceeding with initial design, which would have taken significantly longer without IDR input



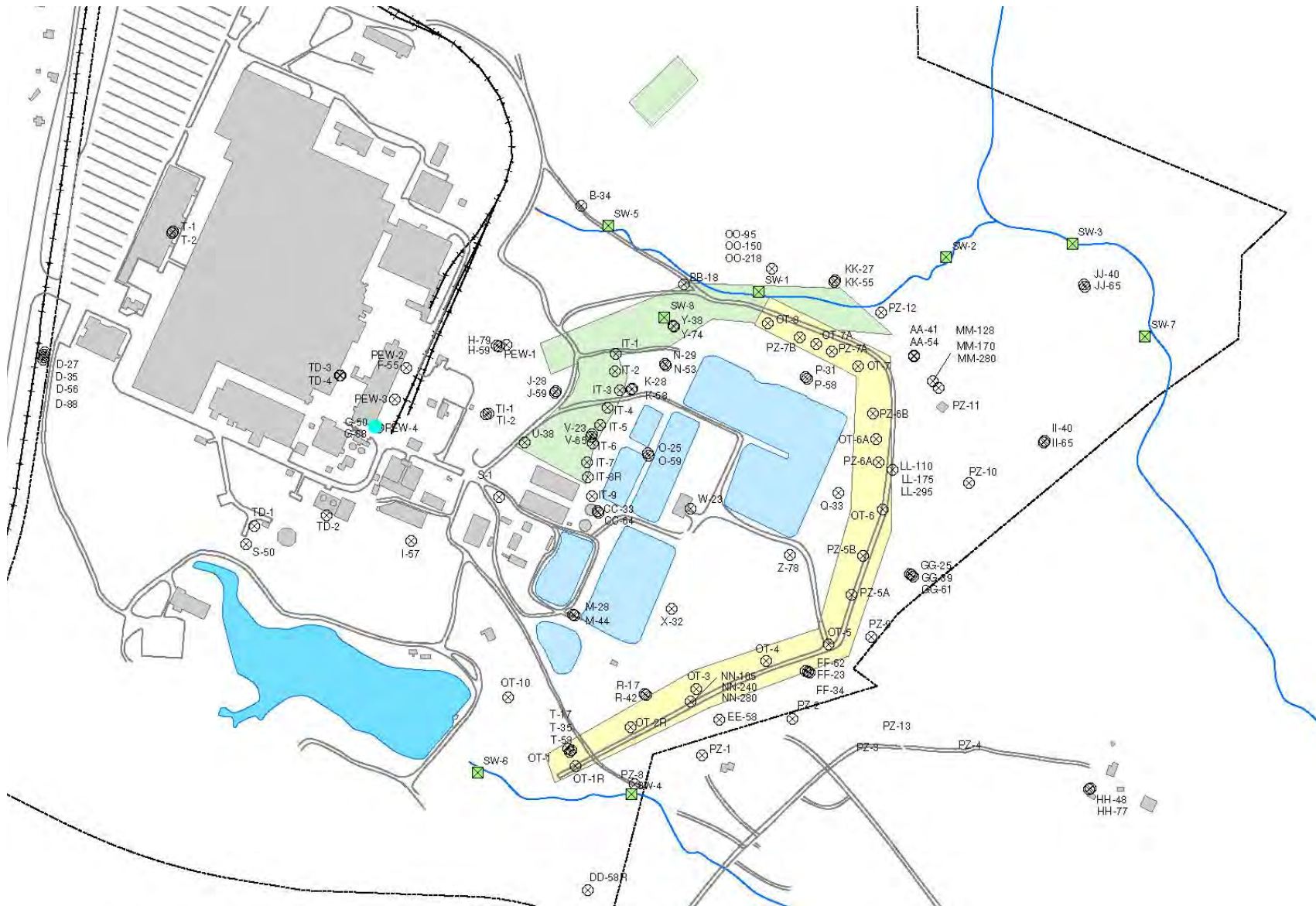


Case Study #4 - Celanese

- Large multi-constituent plume resulting from plastics manufacturing
- ROD signed in 1988
- P&T system with two tiers of extraction
 - Inner tier – shut down on trial basis in 2004
 - Outer tier – shut down in accordance with delisting in 1998 (before 1,4-dioxane was identified)
- By end of 2008, inner tier system was still off, with no technical evidence for either leaving it off or turning it back on



Remedy Optimization through IDRs





Case Study #4 – Celanese (continued)

- Region 4's concerns and motivation for conducting an IDR
 - Inner P&T system was shut down on a trial basis to evaluate MNA
 - Inner system has not been restarted
 - Should it be restarted?
 - If it should be restarted, should the system be modified?
 - Is another remedial approach more appropriate?
 - EPA hydrogeologist and PRP consultants do not agree on technical issues

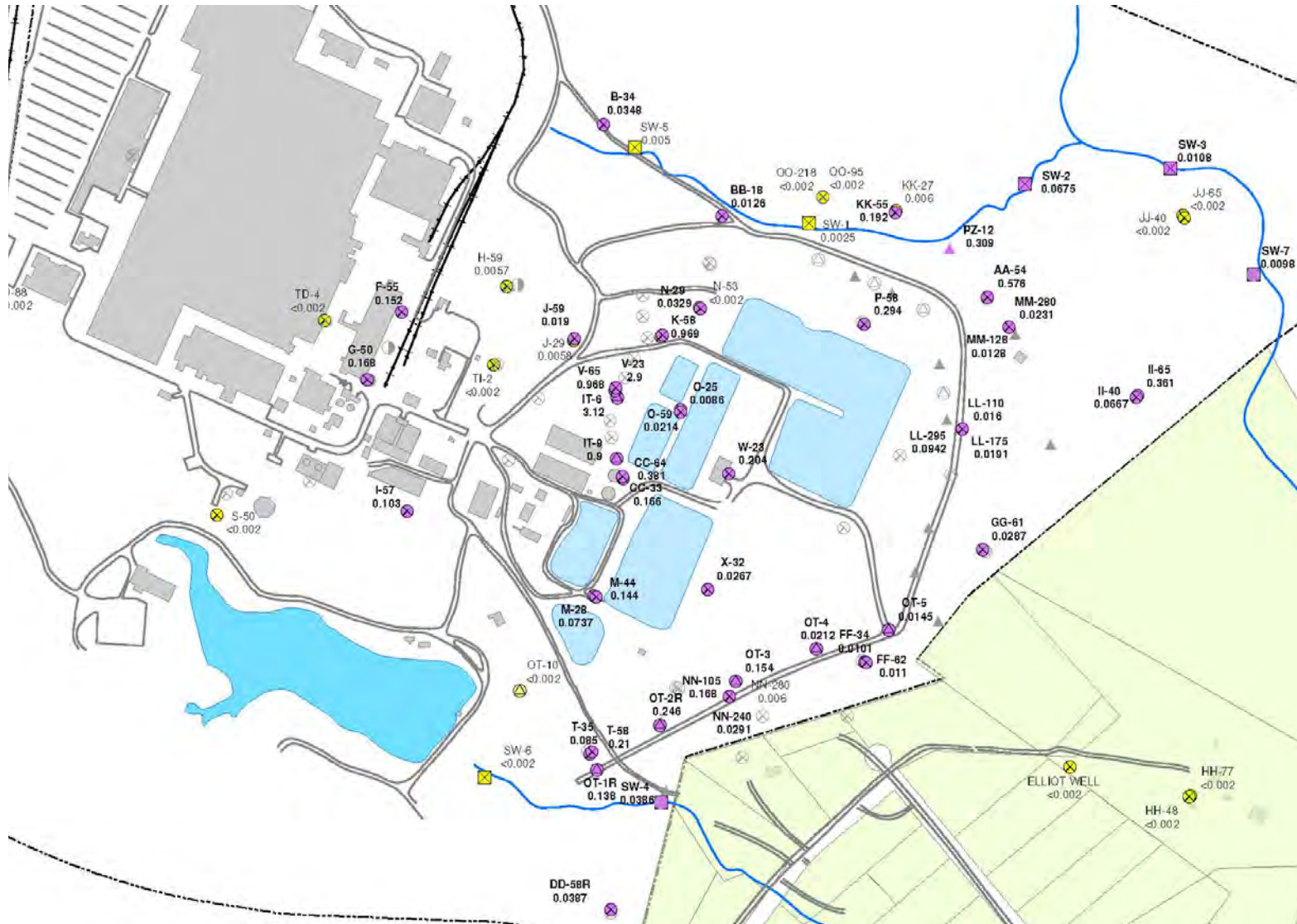


Case Study #4 - Celanese

- Initial IDR findings
 - Transition zone is a key feature for contaminant migration
 - Many wells have not been sampled for key constituents, leaving data gaps about plume migration
 - 1,4-dioxane (most extensive plume) is not delineated
 - 1,4-dioxane plume extends well beyond either former extraction system
 - TCE is detected at the source area and over 1,000 feet downgradient, but not in between
 - Several limitations and uncertainties to numerical groundwater flow model

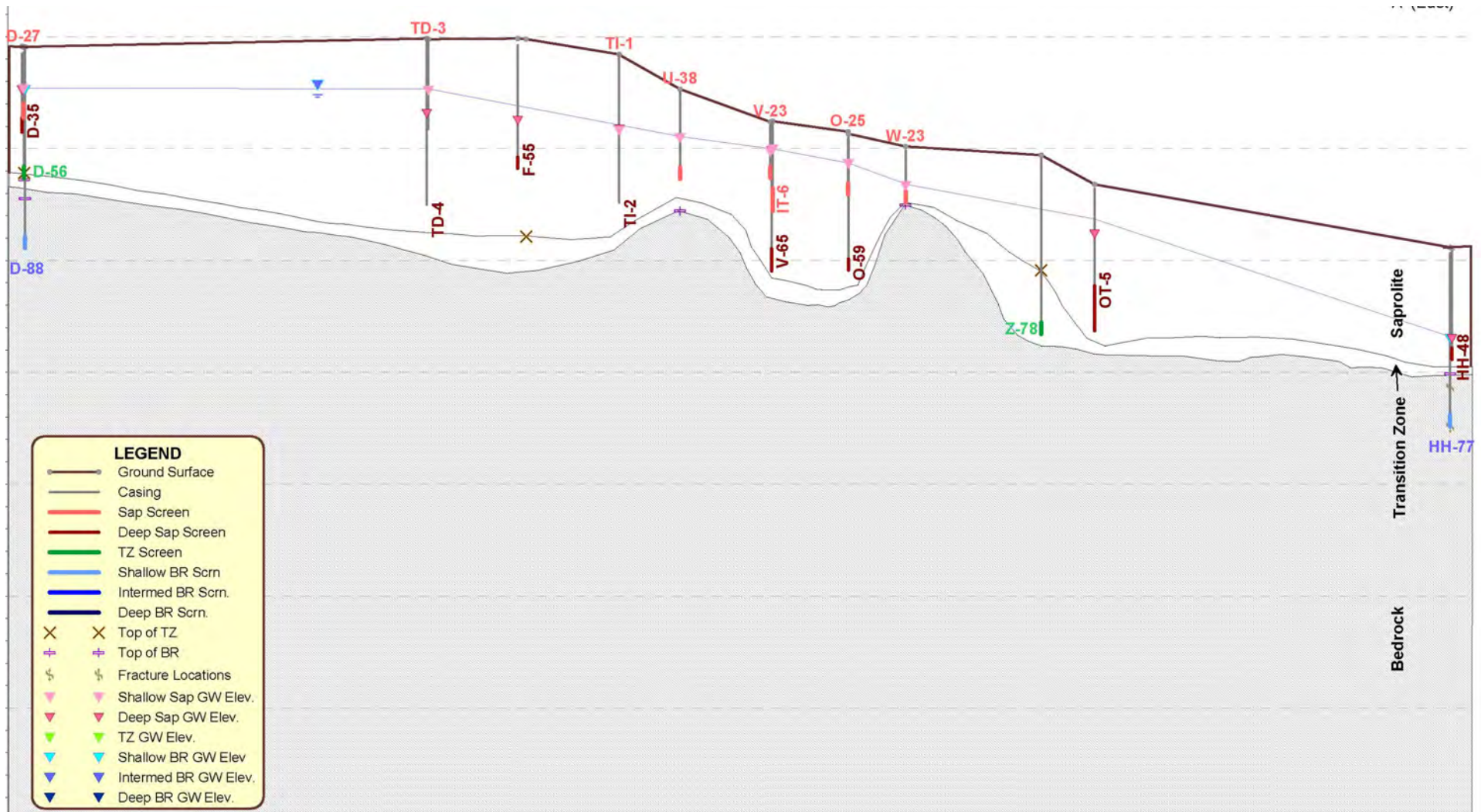


Remedy Optimization through IDRs





Remedy Optimization through IDRs





Case Study #4 – Celanese (continued)

- Representative recommendations after initial IDR and follow-up site meeting
 - Sample to determine link between the off-site/on-site TCE
 - Source area investigation for TCE
 - Delineate 1,4-dioxane using alternative approach
 - Help establish need for a 1,4-dioxane standard for surface water
 - Found common ground between EPA and PRP consultant
 - Presented suggested remedial strategy agreeable to both EPA and PRP
- Outcome
 - Evaluation completed in January 2009, PRP in the field in Spring 2010 implementing work



STRATEGIES, TOOLS, AND TECHNOLOGIES



Lessons Learned from Case Studies

- Most significant recommendations come from
 - Improving conceptual site model.
 - Asking “HOW?” and “WHY?” for each remedy component and considering technologies that can provide the same function.
- Additional information during remedy design can significantly change design, which can significantly affect
 - Remedy design
 - Remedy cost
 - Remedy performance



General Design Lessons Learned

- Most long-term remedies result from a continuing, residual source that was not addressed
- Remedy performance is uncertain until remedy has been implemented. Implement remedy in phases with evaluation at each phase.
 - Targeted pilot test
 - Expanded test
 - Area-wide remedy (in phases)
- Build flexibility into selected remedy and design, when possible.



General Design Lessons Learned

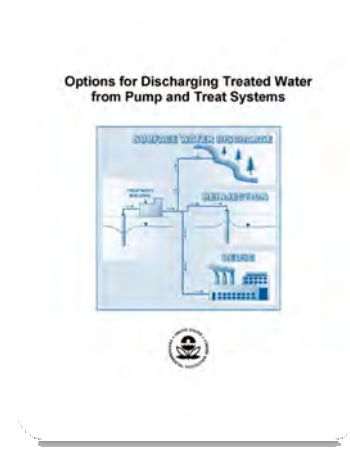
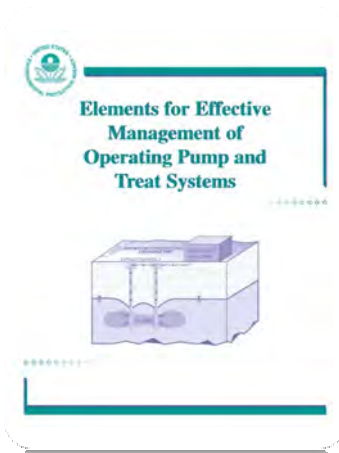
- Each remedial technology has a point of diminishing returns that is typically above cleanup criteria
 - P&T influent concentrations and mass removal decreases as remedy progresses
 - In-situ remedies often address areas of higher concentration better than areas of lower concentration
 - Because of natural oxidant demands or soil adsorptive capacities, in-situ remedies require the similar amount of reagent for dilute areas as for concentrated areas
 - Thermal remediation often removes substantial mass, but 99% removal of 10,000, ug/L of TCE still leaves areas with 100 ug/L



General Design Lessons Learned

- During design, determine the residual concentration or mass that will allow for a stable or decreasing plume.
- Determine an exit strategy from the primary active remedy to the polishing or passive remedy
 - Determined through modeling
 - Cannot confirm results until remedy is implemented, monitored, and evaluated
 - Requires flexibility in remedy selection and design documents
 - Requires continued performance monitoring and evaluation
 - Requires a backup plan

Tools: Relevant EPA Documents





Tools: The IDR Team Technical Skill Set

- ✓ Ability to use MODFLOW or similar software for conceptual modeling
- ✓ BIOSCREEN and BIOCHLOR for evaluating attenuation
- ✓ Johnson-Ettinger for screening vapor intrusion
- ✓ Excel for generating plots
- ✓ Contouring software for interpretation
- ✓ Long-term monitoring optimization software
- ✓ Sustainability footprint analysis spreadsheets
- ✓ Cost estimating software
- ✓ Vendor software



Technologies: Using Vendors Effectively

- New or different remedial options should be tested
- Bench scale testing is effective to see if technology is technically appropriate and if full-scale costs are reasonable
- Vetting technologies
 - Is there some certainty that full-scale costs are reasonable?
 - Will technology represent a clear improvement over status quo?
 - Is level of uncertainty in potential full-scale results acceptable?
 - Has technology been proven in bench scale tests or at similar sites?
 - Can you interview other sites where technology has been applied?
 - Will the vendor offer a performance guarantee?



Technologies: IDR Team Skill Set

- Expertise with the following technologies:
 - Various above-ground treatment components
 - Various soil vapor, water, and soil treatment technologies
 - Geochemistry, biochemistry, and reagent demand for in-situ remedies
 - Delivery mechanisms for in-situ remedies
 - Interpreting water quality results
 - Methods for expedited additional characterization
 - Cost estimating
- Detailed knowledge of emerging and innovative technologies



EPA OPTIMIZATION UPDATE

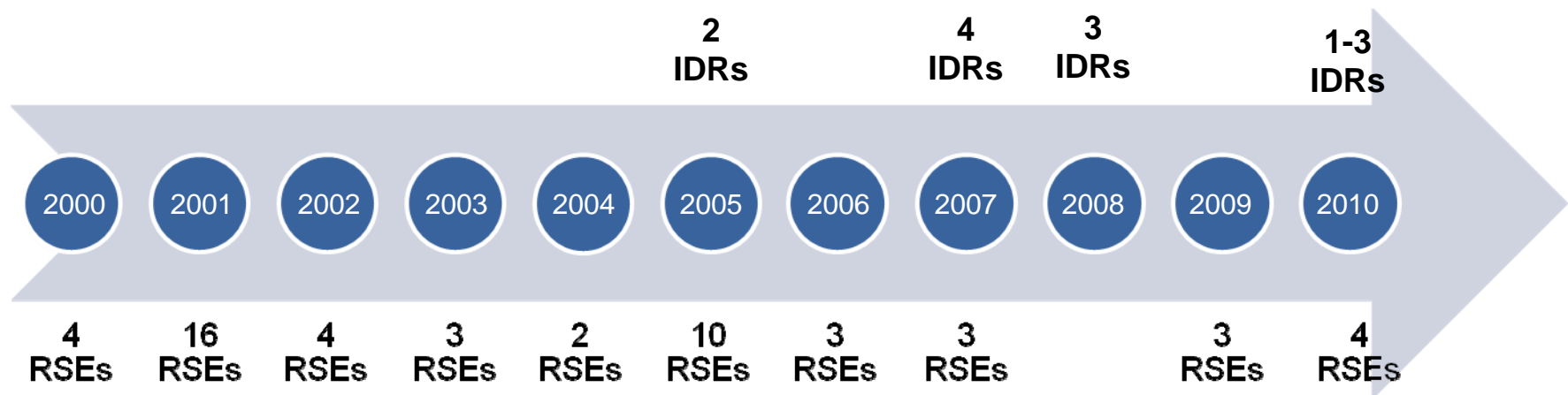


History of EPA Optimization

- Optimization at EPA
 - Began with application of optimization software to pumping scenarios for P&T systems
 - Review of data for software optimization highlighted larger issues
 - EPA adopted the use of the RSE from the U.S. Army Corps of Engineers
 - EPA develops the IDR process to evaluate remedies before O&M begins



History of EPA Optimization (continued)





History of EPA Optimization (continued)

- Other forms of EPA optimization
 - Remediation System Evaluation (RSE) process initiated in 2000
 - Investigation Process Optimization (IPO) developed concurrently with RSE for optimization of investigation process
 - Long-term monitoring optimization (LTMO), specifically aimed at optimizing long-term monitoring

Future EPA Optimization

To date less than 10% of the 1500+ Superfund sites have received optimization evaluations from EPA

- Benefits from existing optimization argue for widespread application
- EPA OSRTI does not have the resources to address all 1500 sites
- Education and technology transfer help but do not replace optimization



Need for a bolder strategy!!



Future EPA Optimization (continued)

- A National Optimization Strategy that...
 - Institutionalizes optimization across program
 - Expands optimization to more sites
 - Uses the optimization tools, lessons learned, & expertise of OSRTI
 - Leverages Regional and OSRTI resources
 - Expands pool of qualified optimization contractors
 - Develops Regional optimization programs
 - Involves OSRTI and Regional management
 - Has clear comprehensive, nationwide objectives
 - Tracks results for all sites
- One year of planning plus one addition year for ramp up



Information and Resources

- EPA's optimization clearinghouse

www.cluin.org/optimization

- U.S. Army Corps of Engineers RSE checklists

http://www.environmental.usace.army.mil/rse_checklist.htm



Contact Information

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QUESTIONS???