



Remedy Optimization through Remediation System Evaluations (RSEs)

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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)



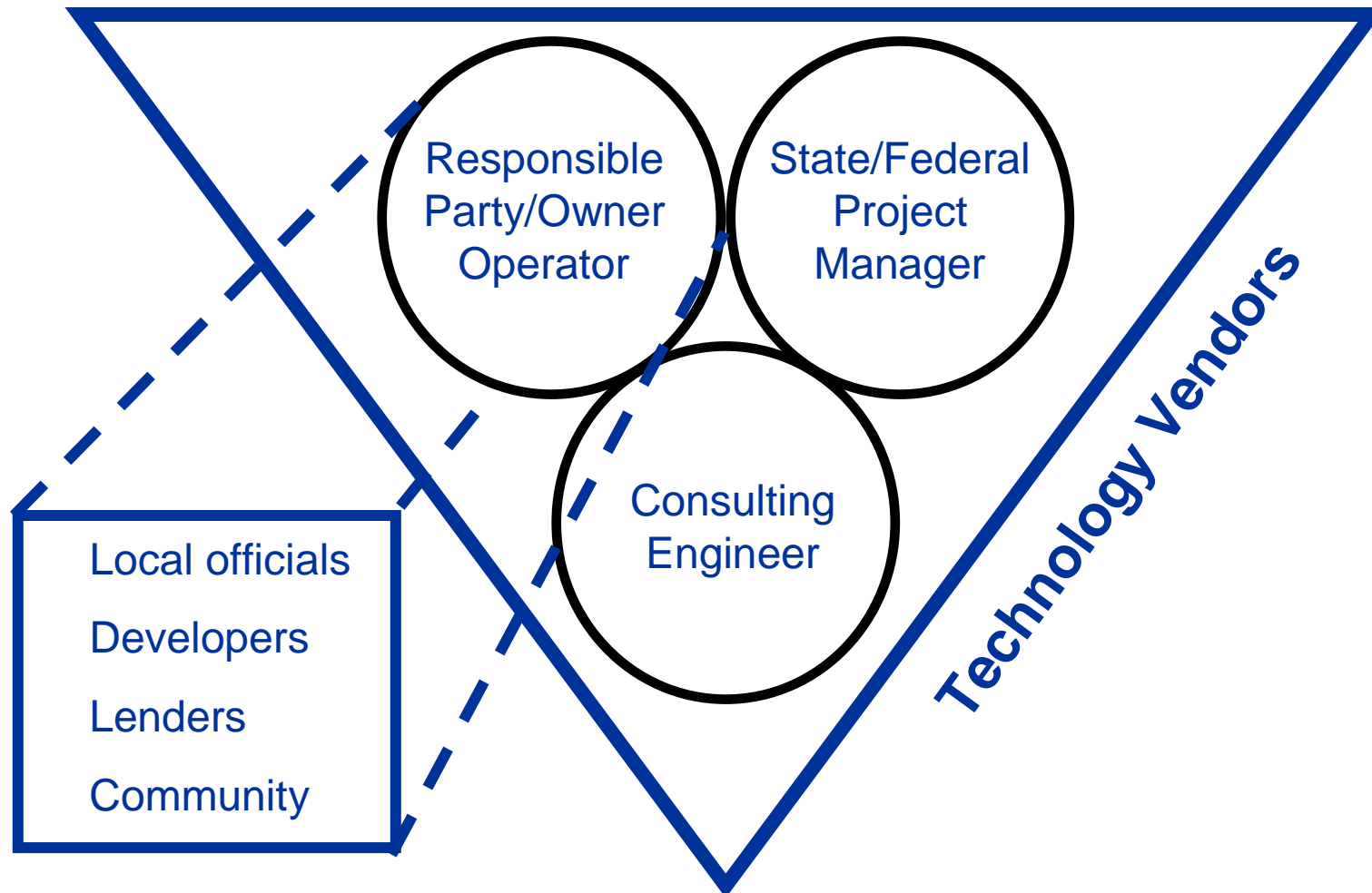
Office of Superfund Remediation and Technology Innovation (OSRTI)

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

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

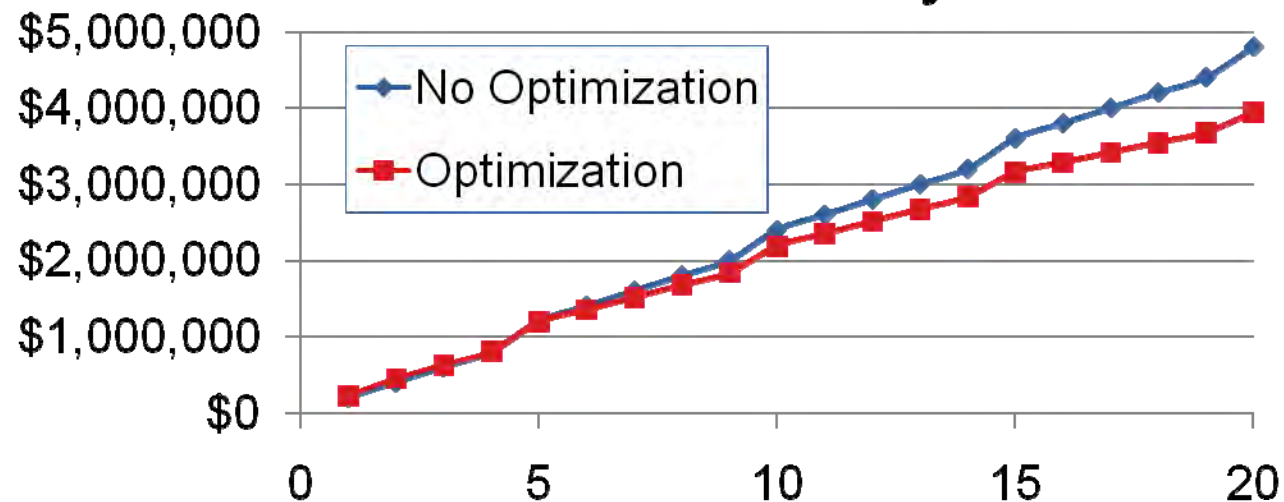


THE BUSINESS CASE FOR REMEDY OPTIMIZATION WITH RSES

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 once every 5 years, with each evaluation resulting in a 10% decrease in future O&M costs.

\$100,000 investment
\$1,000,000 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

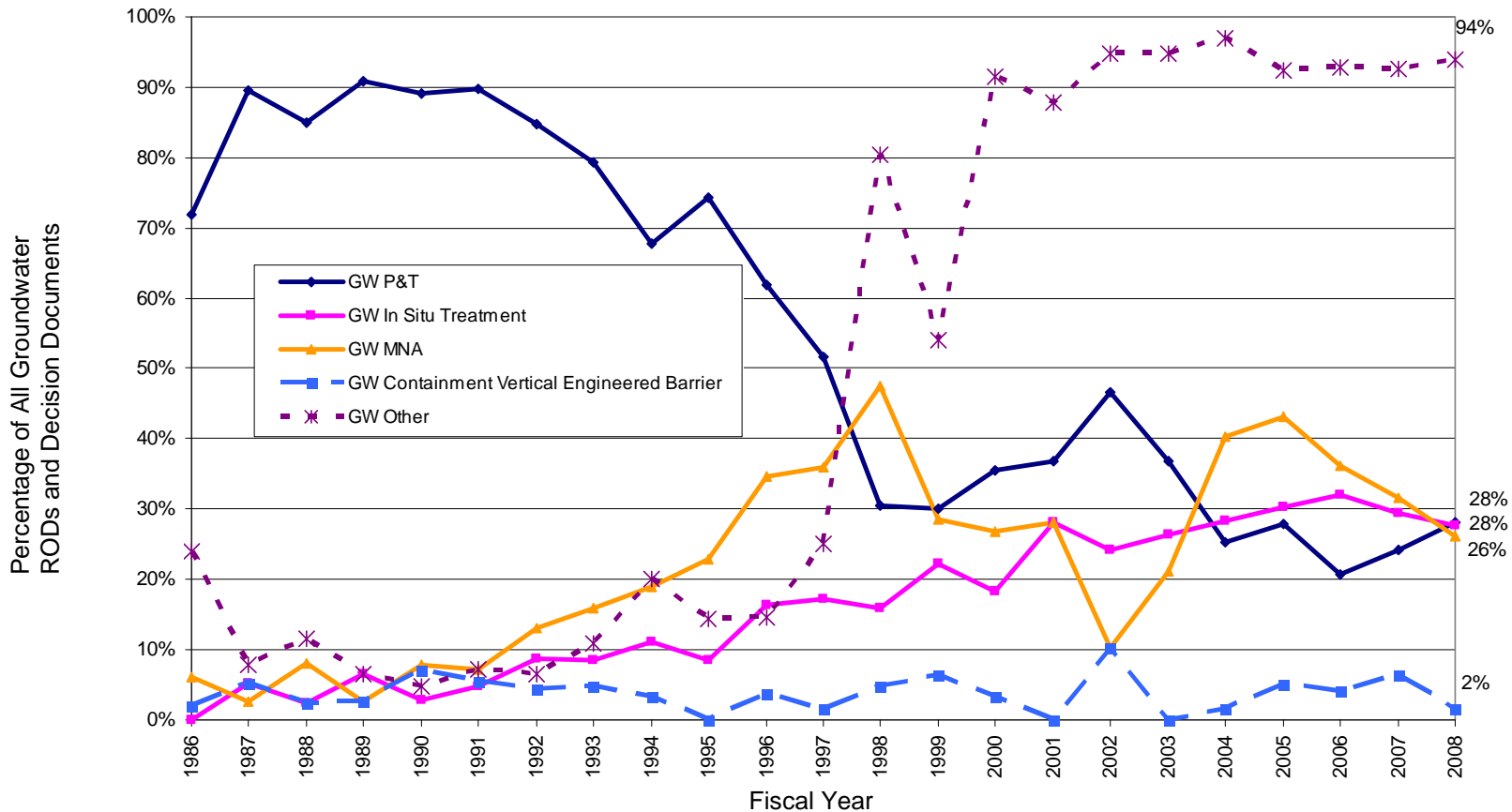


Remedy Optimization through RSEs



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 RSE 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 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

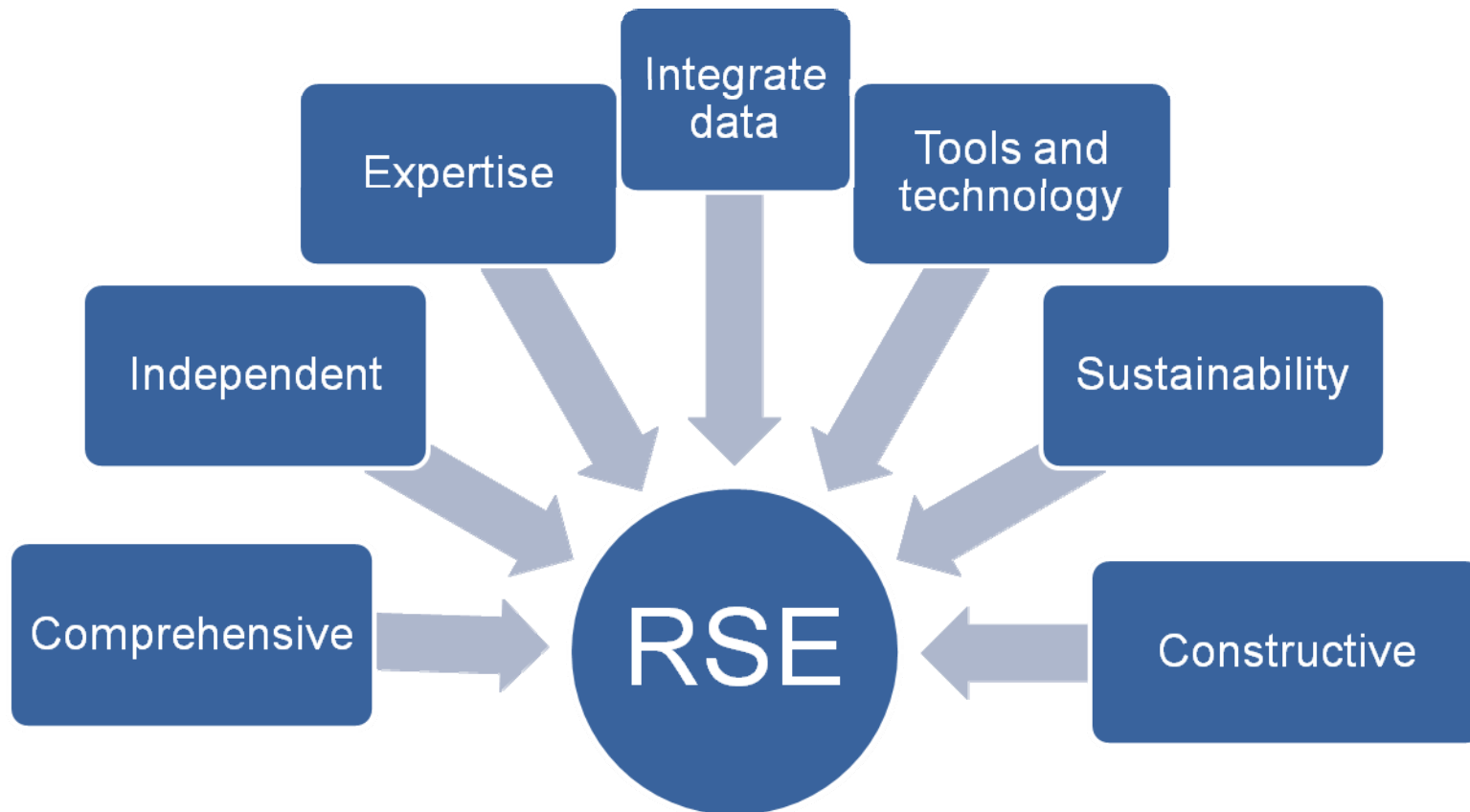
* *Especially if outcome is uncertain or not guaranteed*



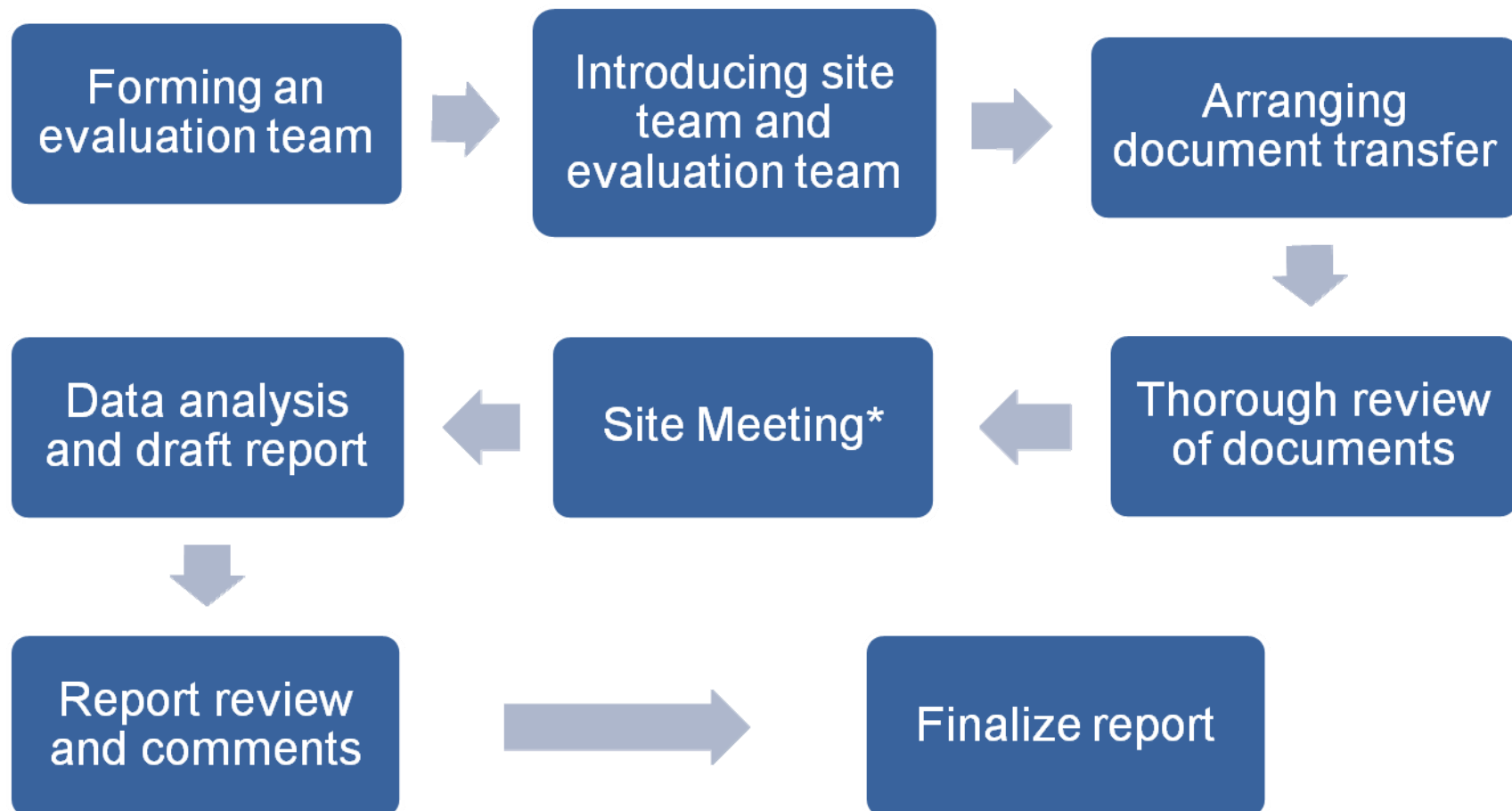
RSE Origins

- U.S. Army Corps of Engineers developed the process and a set of corresponding checklists in 2000 to...
 - Ensure clear remedial objectives
 - Evaluate protectiveness
 - Reduce costs
 - Ensure adequate maintenance of government-owned equipment
- www.environmental.usace.army.mil/rse.htm

RSE Principles



RSE Logistics



** 1 to 1.5 site meeting or conference call depending on remedy complexity*

RSE Logistics

Participants

- Evaluation team
- Remedy owner/manager
- Consultant project manager
- Consultant technical leads
- Operators or key technical staff
- Regulator(s)

RSE Logistics

Documents to review

- Remedial investigation report
- Feasibility report
- Record of Decision
- Design documents and O&M manual
- 1+ years of O&M reports
- 1+ years of annual summary reports
- Reports from other reviews
- Modeling studies
- Costs

RSE Logistics: Typical Report Sections

Background
Remedy Description
Remedy Objectives

Convey that the evaluation team understands the site

Findings

- Update site conceptual model
- Evaluate remedy & component performance
- Set stage for recommendations
- Breakdown of costs
- *Environmental footprint of remedy*

Protectiveness Statements

Recommendations with cost implications

- Improving protectiveness
- Reducing cost
- Technical improvement
- Site closure
- Sustainability



Working an RSE into the O&M Phase

- RSEs are...
 - Conducted during the O&M phase
 - Best suited for long-term remedies
 - Not direct observations of daily work practices
- When is the best time to conduct an RSE?
 - After operational data is available
 - In conjunction with other reviews or milestones
 - In advance of transferring remedy between parties
 - During budget updates
 - 5 years after previous review

Conducting an RSE: Typical Agenda

Introductions

Site conceptual model

- Contaminant sources
- Hydrogeology and geochemistry
- Previous and current remedies
- Remedy goals

Protectiveness

- Receptors, exposure pathways, & associated sampling
- Plume capture/control
- Performance monitoring & results
- Institutional controls

Conducting an RSE: Typical Agenda (continued)

Extraction/injection systems

- Performance relative to design
- Maintenance

Treatment system or other above-ground components

- Performance relative to design
- Actual relative to design conditions
- Downtime and recurring issues
- Operator responsibilities & level of effort
- Chemical, material, utilities usage
- Waste generation and disposal
- Process monitoring
- Treated water discharge
- Opportunities for system streamlining
- Exceedances and accidental releases

Conducting an RSE: Typical Agenda (continued)

Costs

- Confirmation/clarification of costs
- Actual costs vs. original cost estimates
- Primary cost drivers
- Project management, tech support, reporting
- Operator labor
- Utilities
- Materials chemicals
- Waste disposal and water discharge
- Laboratory analysis
- Routine maintenance
- Challenges to cost reductions

Conducting an RSE: Typical Agenda (continued)

Sustainability

- Electricity use & electrical components
- On-site fuel use & equipment
- Distances of personnel, vendors, and disposal facilities from site
- Materials and chemicals used
- Direct emissions from processes
- Water use (potable, groundwater, etc.)
- Sensitive habitats
- Potential uses for property
- Input from stakeholders

Conducting an RSE: Typical Agenda (continued)

Site closure

- Potential alternative remedies
- Evidence of remaining sources
- Exit strategy for system and individual components
- Appropriate milestones

Interview/meetings
debrief



Conducting an RSE: Typical Questions

- What is the conceptual model for the site?
 - How did we arrive at the current conditions?
 - Consider sources, hydrogeology, geochemistry, influence of remedies.
- What are existing data gaps in the site conceptual model?
- What specific evidence indicates that the remedy is performing as intended?
- Are current conditions the same as design conditions?
- What are the remedial objectives?
 - Are they still relevant and appropriate?



Conducting an RSE: Typical Questions

- What was the reasoning for each remedy component during design?
 - Are those reasons still appropriate given current conditions?
- At what point can each treatment component be discontinued?
- What aspect of the remedy creates the biggest headaches and consumes the most time?
- How is each sample result or data measurement used in evaluating remedy performance?

Conducting an RSE: Example Questioning

What non-required monitoring is conducted?

- Weekly off-site
- Every 2 hours on-site while staffed
- Autosampler hourly

How consistent are results?

- Very consistent

How do you operate plant?

- ORP and turbidity meters

How are on-site samples used?

- They are recorded

What is LOE for on-site analysis?

- 2-4 hours per day plus data management

What is cost of autosampler?

- Cost and repair frequency is increasing

RSE Follow Through

- The traditional RSE is complete after the final report is submitted.

How do you know...

- that the RSE recommendations are being interpreted correctly?
- that the RSE recommendations are being appropriately considered?
- which recommendations were implemented?
- what the site team does with the results?



RSE Follow Through

Answers...

- Follow-up with project owner and site team.
- Suggested time frames...
 - 3 months after final report is submitted
 - 1 year after final report is submitted
 - Additional follow-up as indicated by these calls
- Appropriate for the RSE team to continue providing technical support
 - Interpreting recommendations
 - Interpreting results from implementing recommendations



RSE Challenges

- It is natural for the site consultant to feel threatened
- There is often reluctance to abandon current practices
- Data quality and reporting varies from site to site, sometimes recommendations are constrained to collecting more data
- RSEs are “one-time” events. More influence from the RSE team is sometimes needed to overcome current site practices.



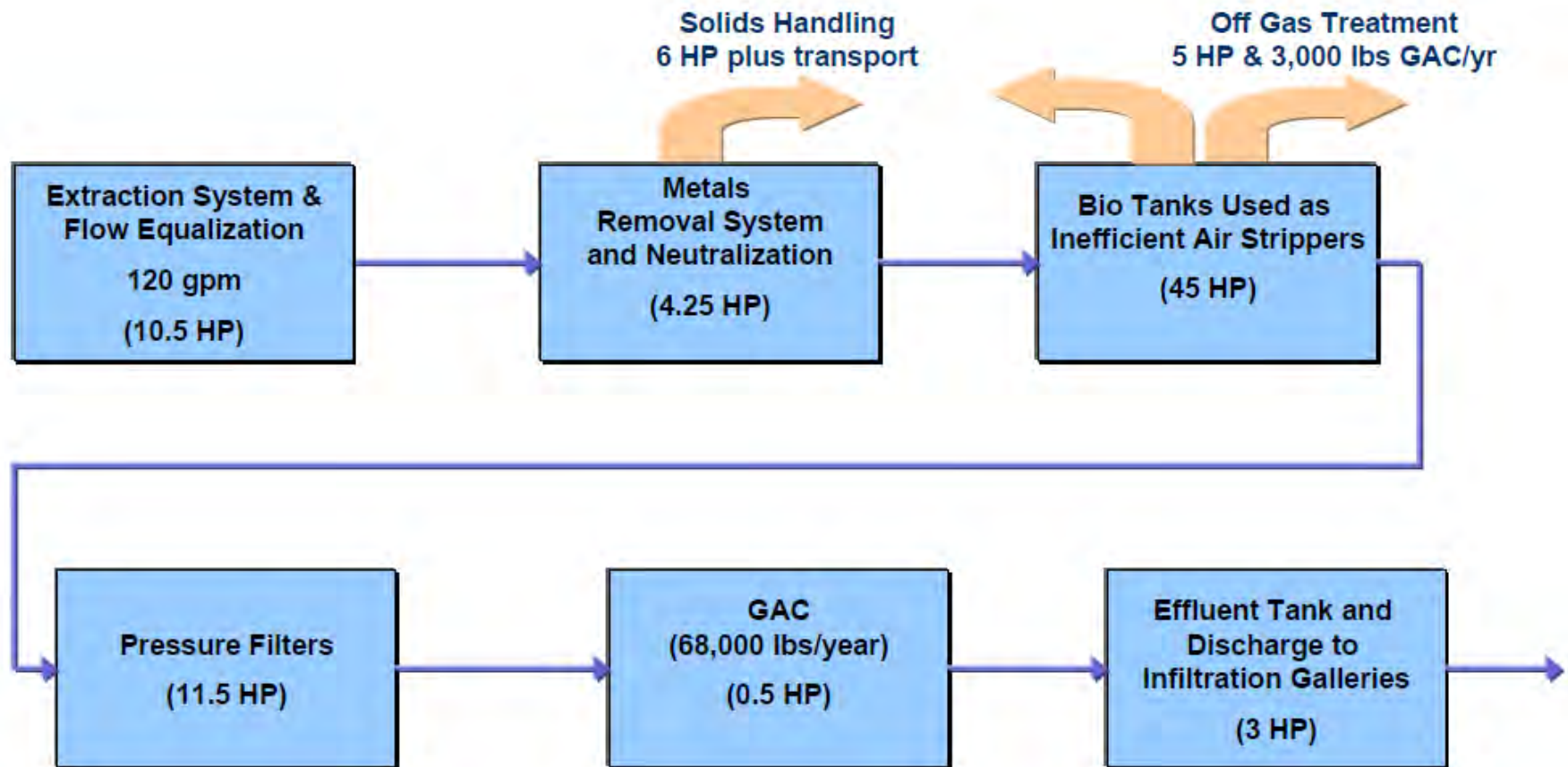
RSE CASE STUDIES

Case Study #1 – Baird & McGuire

- P&T System – RSE during year 6 of O&M
- Remedy protective but excessive cost (\$3.4 million per year)
 - Labor intensive on-site laboratory
 - 24-hour operation and 24-hour manned security
 - Inefficient treatment process for removing organic compounds
 - Significant oversight costs for limited effort



Case Study #1 – Baird & McGuire (continued)



Average motor horsepower indicated in parentheses



Case Study #1 – Baird & McGuire (continued)

- Representative recommendations
 - Eliminate on-site laboratory and send samples off-site
 - Automate plant to reduce on-site operator time
 - Modify security program
 - Modify inefficient treatment components
- Outcome
 - Plant automated
 - Most other major recommendations implemented
 - As of 2009, continuing to address inefficient treatment components
 - Annual costs cut to under \$1 million per year

Case Study #2 – GCL Tie & Treating

- Evaluation conducted early in LTRA (operating P&T system)
- Former wood-treating facility with existing soil remedy





Case Study #2 – GCL Tie & Treating (continued)

- Results of evaluation
 - Remedy generally protective but suggested vapor intrusion evaluation and a few additional monitoring wells
 - Costs for long-term monitoring were excessive
 - Pumping could be discontinued from the intermediate zone, allowing discontinuation of green sand filtration
 - GAC alone is more efficient than air stripping and GAC
 - Site owner paying for GAC that was not used because GAC was included in fixed-price bid

Case Study #2 – GCL Tie & Treating (continued)

- Representative recommendations
 - Re-bid groundwater monitoring
 - Adjust groundwater monitoring program
 - Stop pumping from intermediate zone
 - Bypass air stripper
 - Bid uncertain items as time and materials, not fixed-price
- Outcome
 - Above items implemented, but cost savings not yet quantified
 - Potential savings of close to \$200,000 per year are expected





Case Study #3 – SMS Instruments

- Evaluation conducted in year 9 before transfer to another party
- VOCs treated with air stripping
- Small plume that was mostly remediated except for lingering concentrations in one well
- Fairly simple treatment system
 - Operates for a relatively high cost (~\$378,000 per year)
 - Was able to operate for as little as \$260,000 during one year when funding was limited
- Data not thoroughly reviewed/evaluated

Case Study #3 – SMS Instruments (continued)

- Representative recommendations
 - Improve data analysis/reporting
 - Reduce operator labor and PM budget
 - Adjust monitoring program
 - Investigate and remediate potential residual source
- Outcome
 - Source area identified
 - Air sparging system implemented
 - P&T discontinued within 6 months
 - Air sparging O&M costs \$30,000 per year
 - Active remediation discontinued in 2007





Case Study #4 – Unnamed Site

- P&T system recovering chlorinated solvents
 - Extraction in source area within slurry wall and of diffuse plume outside of slurry wall
 - Air stripping with on-site regeneration of vapor GAC
 - Discharge of treated water to infiltration gallery
- Data and O&M reports not thoroughly reviewed

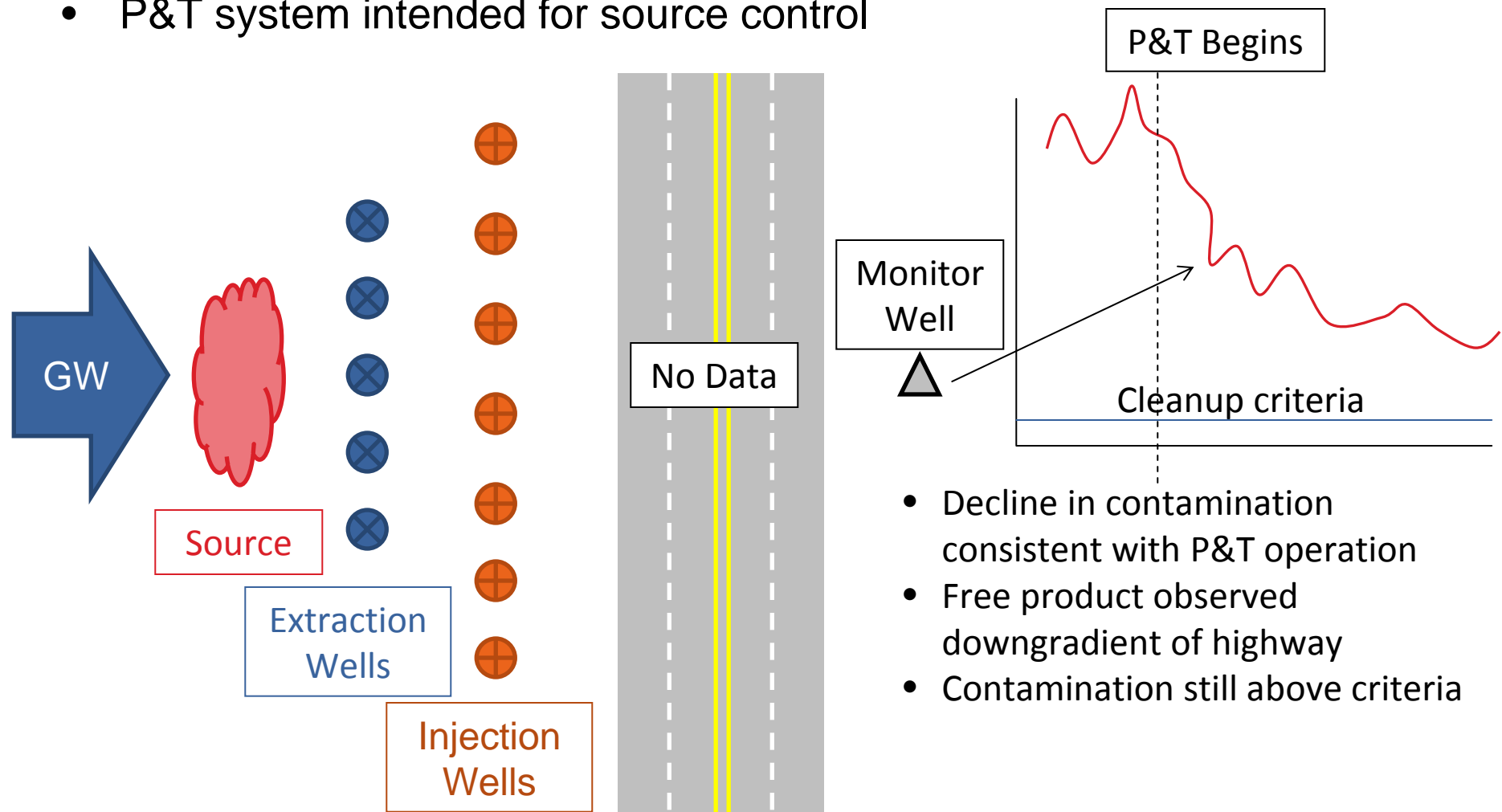


Case Study #4 – Unnamed Site (continued)

- RSE Finding
 - Occasional exceedances of discharge criteria that were not highlighted
 - Discussion with plant operator
 - Steam regeneration system would not shut down
 - Condensing steam would fill solvent storage tank
 - Operator would run liquid in solvent storage tank through air stripper to remove excess water before disposal
 - Air stripper not designed to treat that level of contamination

Case Study #5 – Unnamed Site

- P&T system intended for source control





Case Study #5 – Unnamed Site (continued)

- Productive aquifer and little soil organic carbon to adsorb contamination
- Concern about potential source under highway
- Extraction rates not known at each extraction well
- Treated water reinjected to flush presumed contamination beneath highway
- Why is monitor well still contaminated?
- Design documents did not adequately determine extraction rates needed for capture

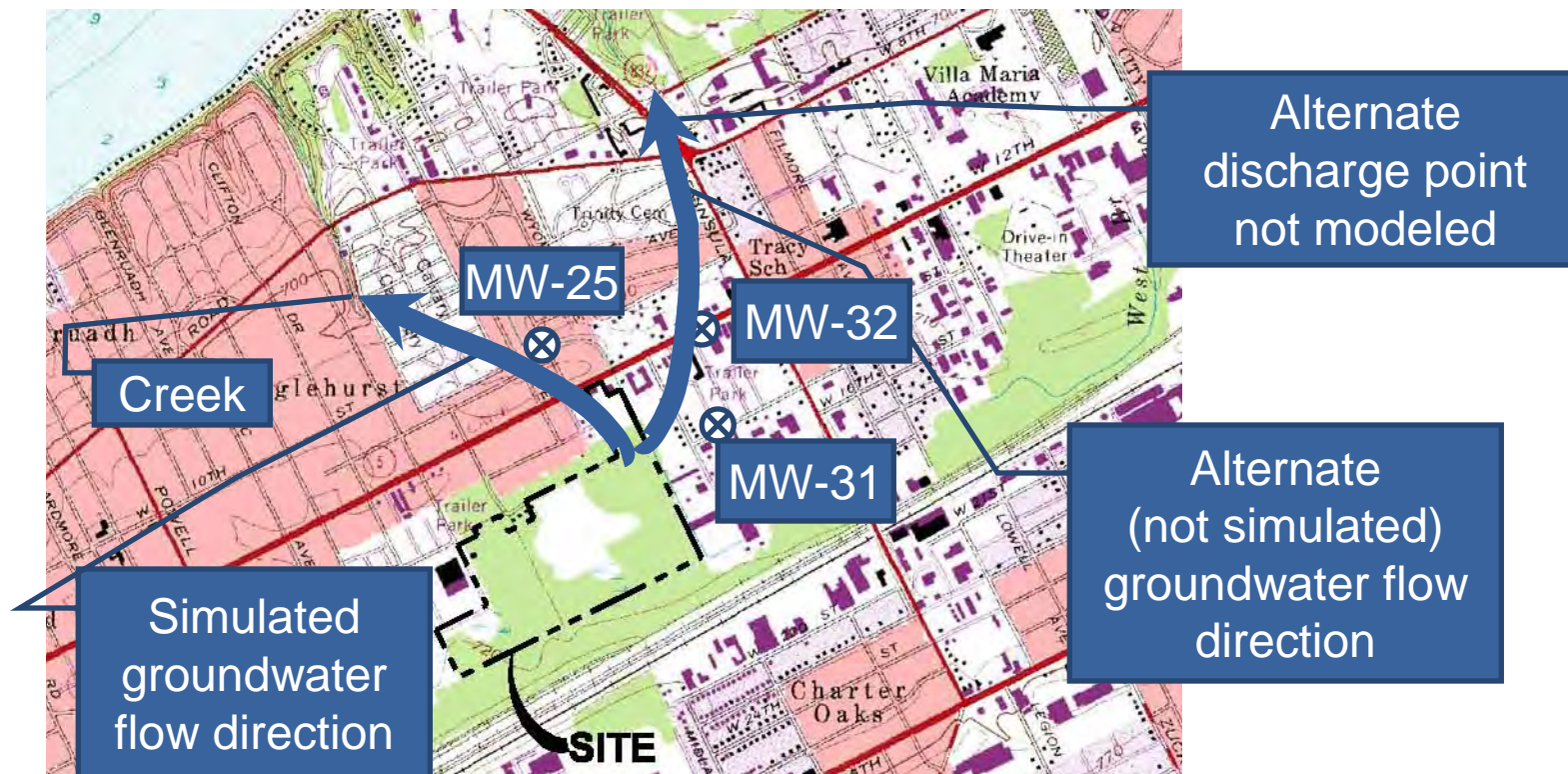


Case Study #5 – Unnamed Site (continued)

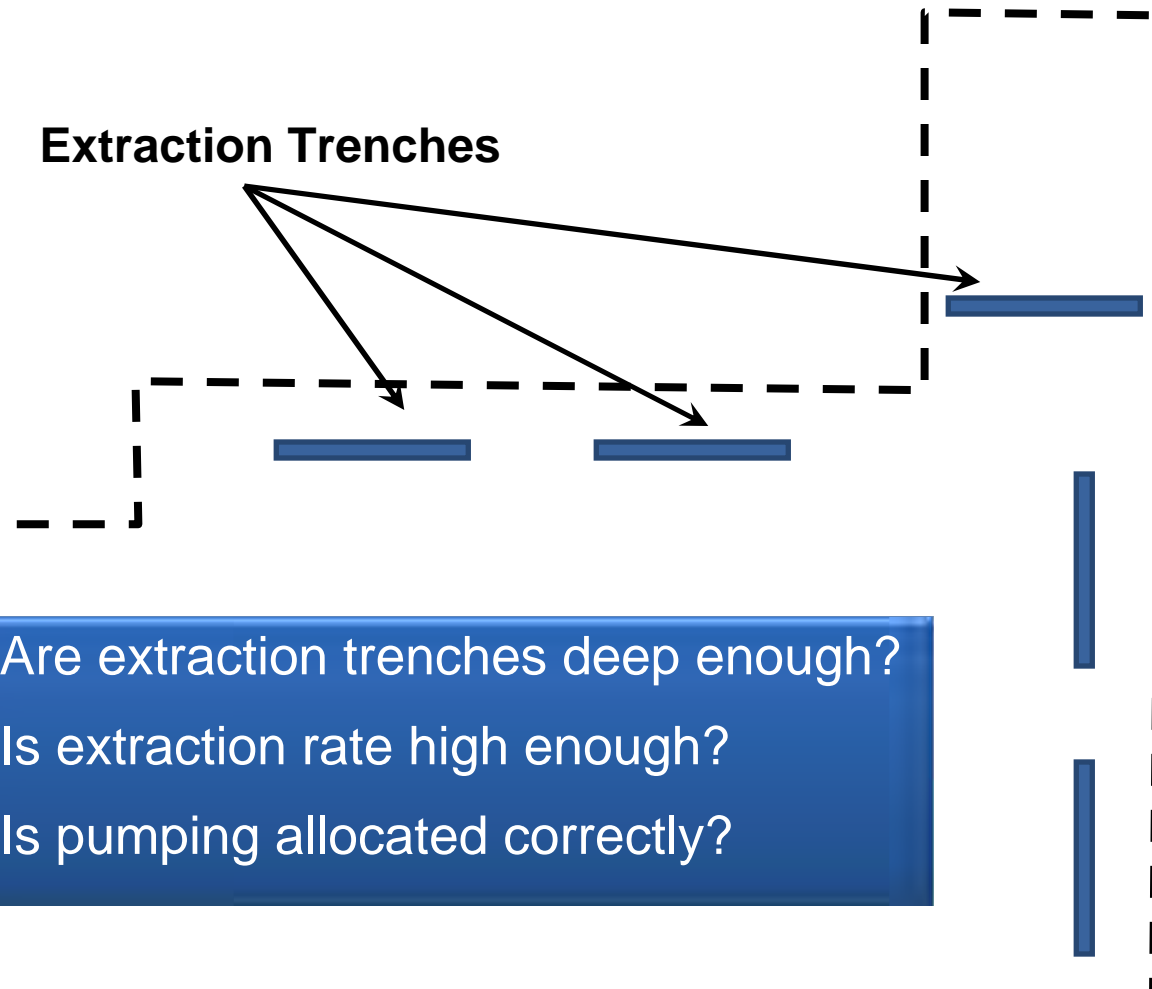
- RSE team reviewed all data and used MODFLOW to simulate extraction and injection with site parameters
 - RSE team concluded MW contamination likely because of incomplete capture
 - RSE team recommended adjustments to detect remaining MW contamination
- If remaining MW contamination caused by
 - Incomplete capture: source area can be easily removed and P&T system shut down
 - Source under highway: extraction system would likely need to be moved downgradient

Case Study #6 – Unnamed Site

- P&T system to contain VOC contamination from landfill, concern regarding plume capture



Case Study #6 – Unnamed Site (continued)



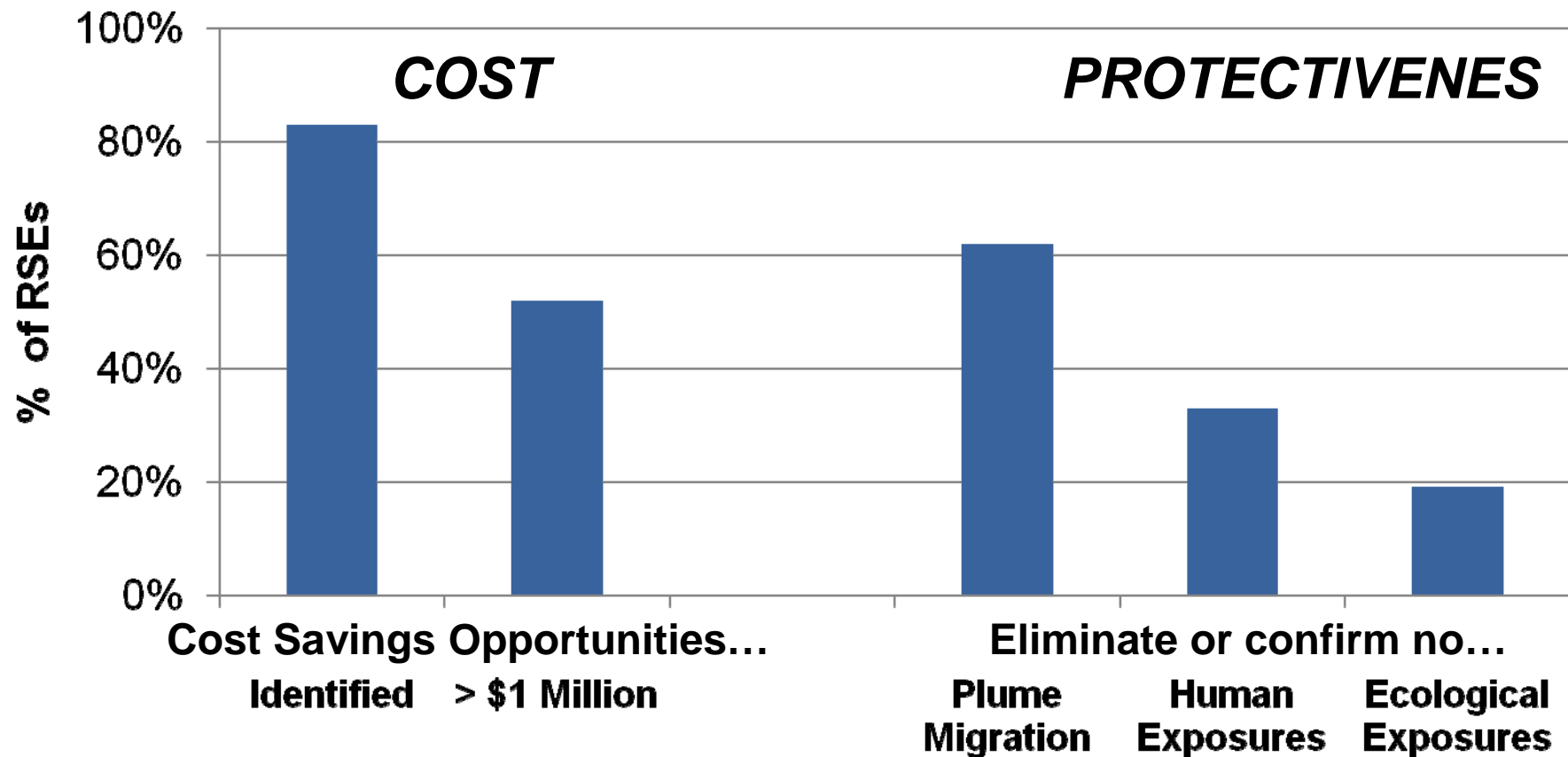
- Are extraction trenches deep enough?
- Is extraction rate high enough?
- Is pumping allocated correctly?



Case Study #6 – Unnamed Site (continued)

- RSE team recommendations:
 - Horizontal and vertical delineation with direct-push
 - Direct push to investigate other potential nearby sources
 - New piezometers for more water level measurements
 - Shut down test of extraction system
 - Model correction/redevelopment
- Site team developed sampling plan according to RSE recommendations
- RSE team has reviewed and worked with site team to optimize sampling plan

Brief Summary of RSE Results



Based on analysis of 52 RSEs



STRATEGIES, TOOLS, AND TECHNOLOGIES



Lessons Learned from Case Studies

- Some original designs prove to be appropriate, some do not
- Regardless of quality of original design
 - Site conditions change during operation
 - O&M yields data not available at the time of the design
- Common for site operators to “operate” remedy but not “evaluate” remedy
- Routine nature of O&M results in “business as usual”
- Good evaluation requires various areas of expertise
- Change or desire for change often comes from the top down
- Contractors/consultants are often resistant to change.... It affects revenue and jobs



Lessons Learned from Case Studies (continued)

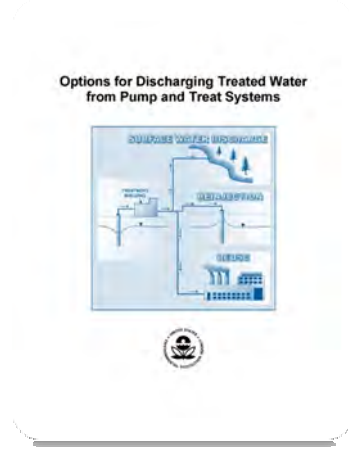
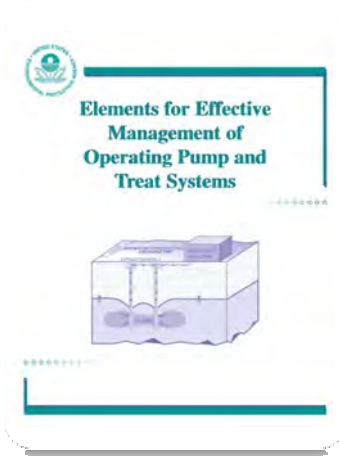
- Most significant recommendations come from the evaluation team asking itself a few basic questions
 - How does operational data change the site conceptual model?
 - Is the remedy performing as designed?
 - Are the designed and actual remedies appropriate for given site conditions?
 - What has changed since design?
 - Are there alternatives to this remedy?
 - Are there alternatives to this remedy component?
 - Is there a remaining source material? Can it be removed?



Lessons Learned from Case Studies (continued)

- A few more basic questions...
 - How is this particular data point used to evaluate the remedy?
 - Have I looked at all of the data?
 - For uncertain items, what do converging lines of evidence suggest?
 - What are the major cost drivers?
 - How does this site compare to similar sites?
 - What natural process are we fighting? Can they work to our advantage?
 - Are contract terms unfavorable or limiting to remedy owner?

Tools: Relevant EPA Documents





Tools: The RSE 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
- Use caution in initiating costly pilot tests
 - 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: RSE Team Skill Set

- Expertise with the following technologies:
 - Various treatment above-ground treatment components
 - Reagents for in-situ remedies
 - Delivery mechanisms for in-situ remedies
 - Methods for expedited additional characterization
- Expertise with the following topics:
 - Water treatment and remedial engineering
 - Hydrogeology
 - Geochemistry
 - Biochemistry
 - Cost
 - Other areas



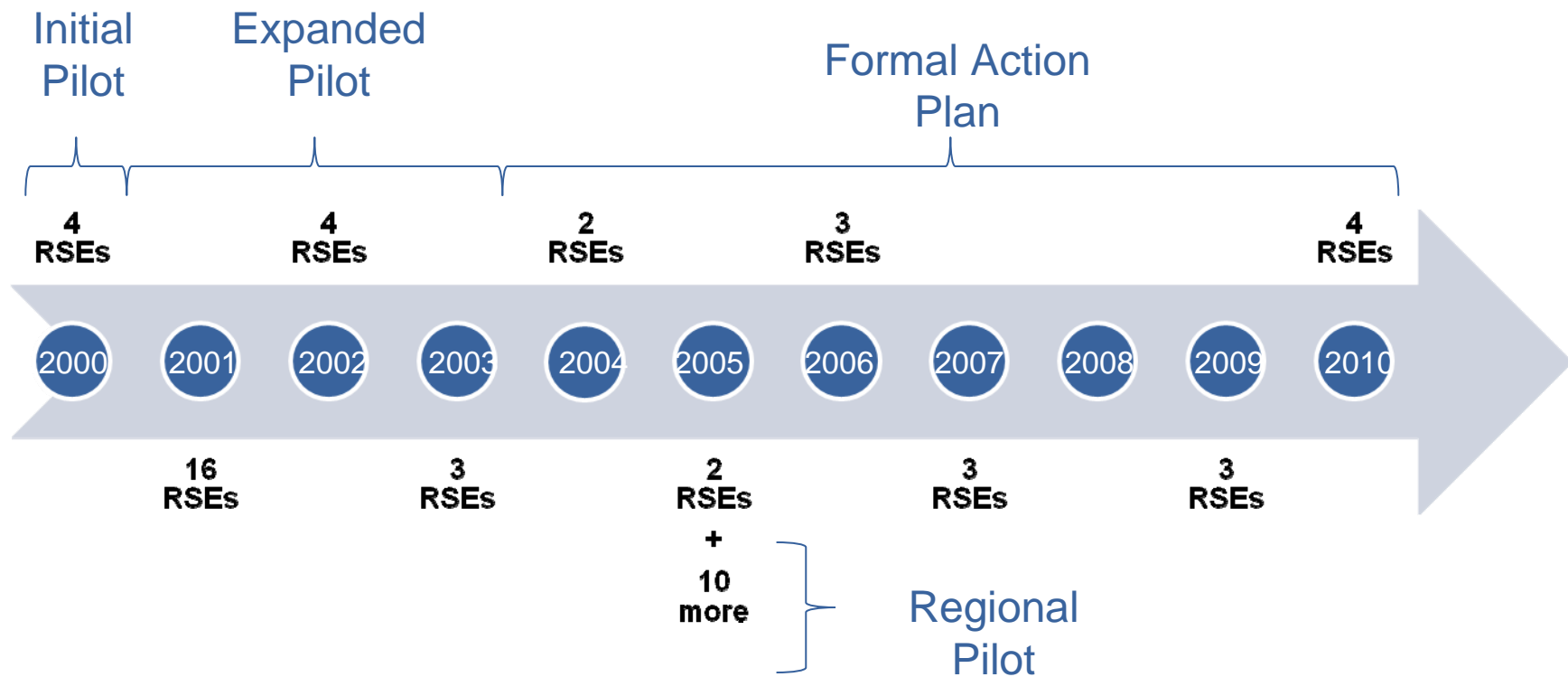
EPA OPTIMIZATION UPDATE



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

History of EPA Optimization (continued)





History of EPA Optimization (continued)

- Other forms of EPA optimization
 - Independent Design Review (IDR) process initiated in 2007 in response to RSE findings from previous years
 - Investigation Process Optimization (IPO) developed concurrently with RSE for optimization of investigation process
 - Long-term monitoring optimization, 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???