Effective Management of Pump and Treat Systems: Lessons Learned from Evaluations of Systems Nationwide

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EPA-TIO Internet Training Seminar

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Today's Presenters

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Goals of this Seminar

- Answer the question: Why optimize P&T systems?
- Convey EPA's current effort to optimize Fund-lead P&T systems
- Describe the Remediation System Evaluation (RSE) process and other optimization tools
- Share lessons learned from RSEs conducted nationwide
- Encourage site managers to consider the RSE process at their sites

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Presentation Outline

- Why P&T optimization?
- EPA's current optimization focus
- What is an RSE?
- Technical Resources
- Example RSE
- Elements of effective system management
  - Contracting considerations
  - Investigation considerations
  - Design considerations
  - O&M considerations
- Conclusions

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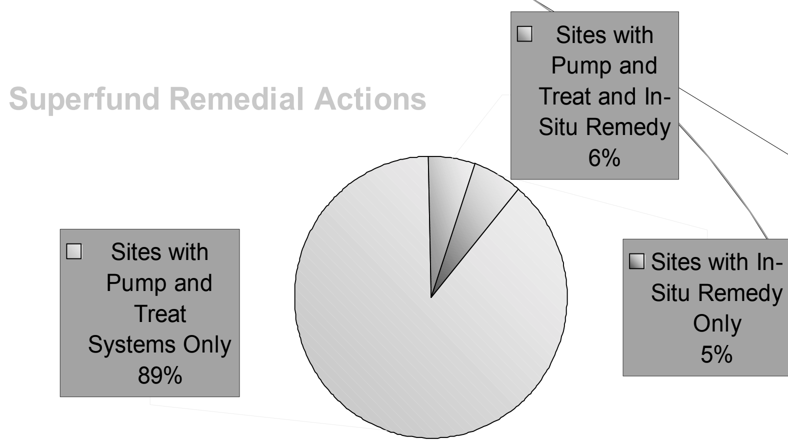
Why P&T Optimization?



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EPA's Current Optimization Focus

- Fund-lead P&T systems optimization
  - July 2000 Superfund Reform Strategy — commitment to evaluate Fund-lead P&T systems for improvement
  - Use 20 years of P&T O&M experience to improve
    - Effectiveness
    - Efficiency
  - Use a process developed by the USACE called a Remediation System Evaluation (RSE)

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EPA's Current Optimization Focus

- FY00 – pilot study of 4 RSEs in Regions 4 and 5 (all completed)
- FY01 – Nationwide optimization effort
  1 - identify Fund-lead P&T systems
  2 - collect cost and performance data on them
  3 - conduct 16 more RSEs (draft reports completed)
- FY02 – 1 - follow up on FY00 and FY01 RSE
  2 - conduct up to 15 additional RSEs
  3 - share lessons learned from conducting RSEs

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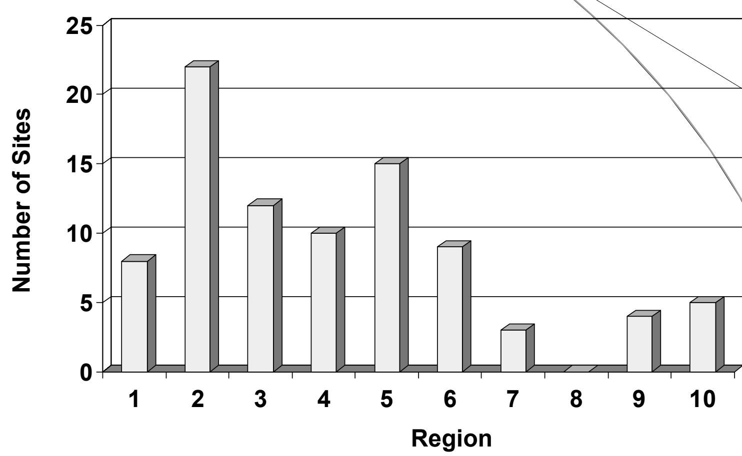
Fund-lead P&T Systems by EPA Region



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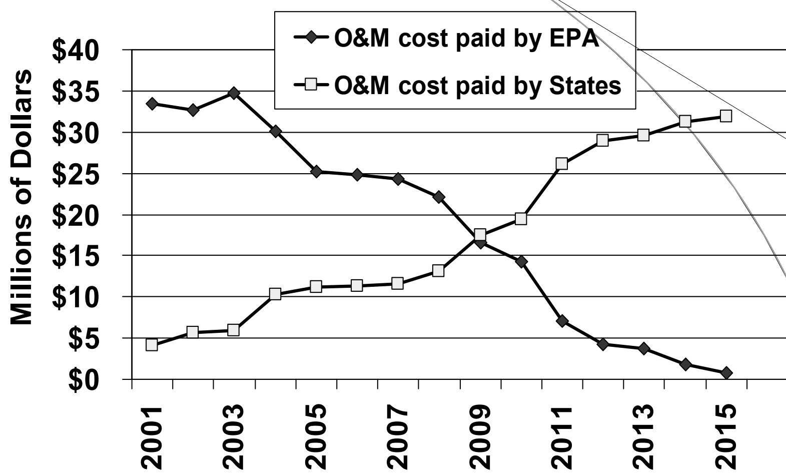
Trend of Annual O&M Costs for All Fund-lead P&T Sites



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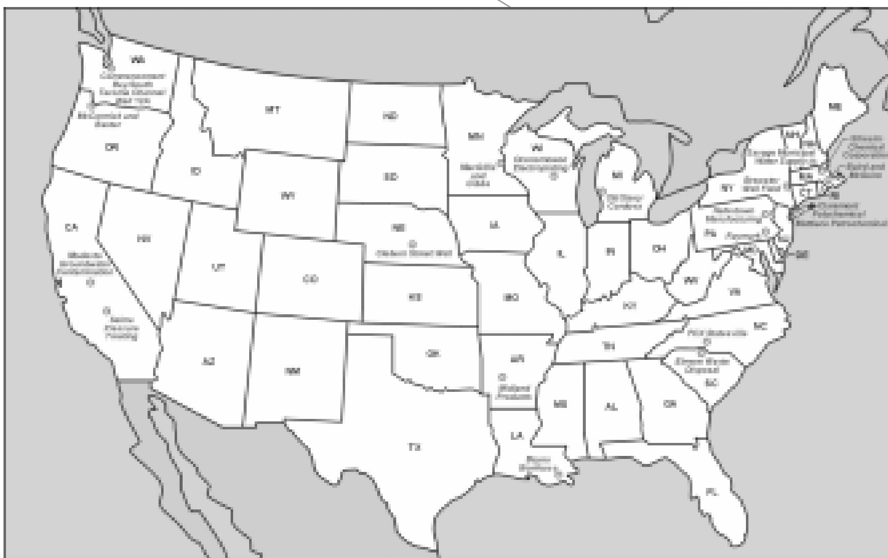
Locations of FY00-01 RSE Sites



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What is an RSE?

- RSE objectives:
  - Evaluate subsurface and treatment plant performance relative to remedial goals
  - Identify potential changes to the remedy to enhance effectiveness, reduce costs, and shorten time to closure
  - Verify site exit strategy

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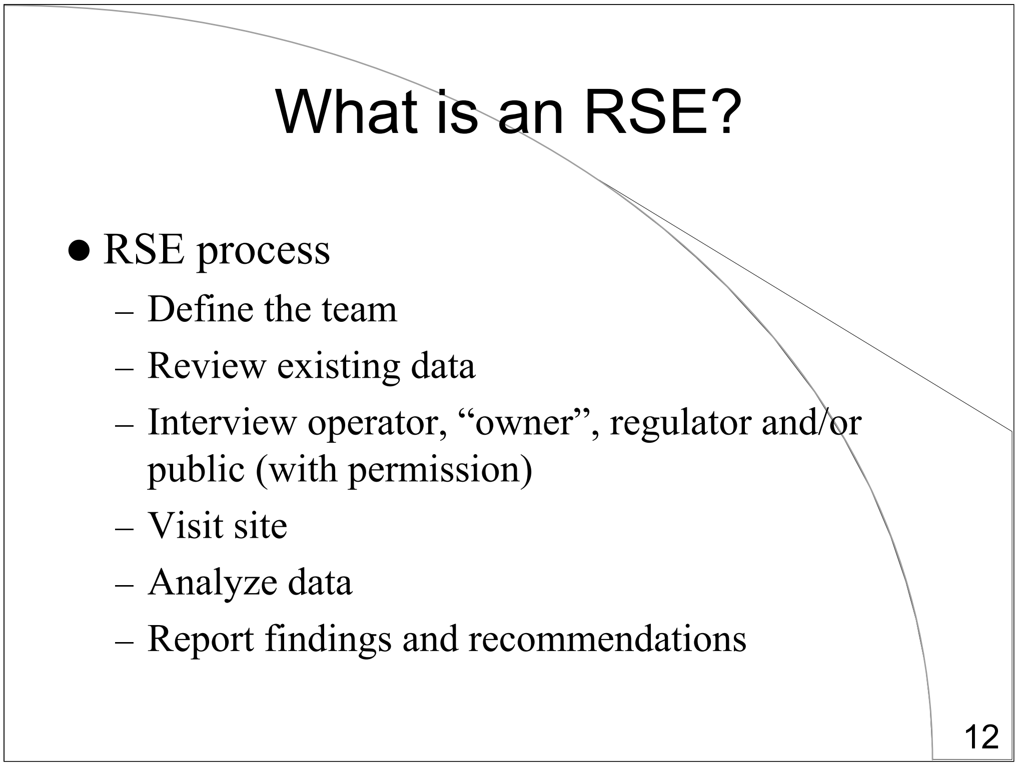
The focus of the RSE will be on the total project and even neighboring projects if they have contamination that crosses the fence. The below ground and above ground site activities are evaluated together.

Meeting the intent of the ROD is a key element of the review (as is an evaluation as to whether or not the ROD objectives can actually be achieved).



The key to an effective RSE is to have the most experienced team. The team should consist of different disciplines and backgrounds for maximum input.

Investigation, design, monitoring and operating data are reviewed to become familiar with the goals and function of each system component. These components include all aspects of the system from monitoring methods and frequency to particular unit operations to disposal of process wastes.

Once familiar with the system, the team makes a site visit. The intent is for maximum participation from the site manager, state site manager, operating contractor and others as necessary. This ensures that the team has a good grasp of site conditions and restraints. Site visits are usually one and a half to two days. The second day is reserved in case questions remain after reviewing the first day’s notes.

A full report is developed with 45 days. The report follows a standard format and is usually from 40 to 50 pages long including attachments. Input from the customer and operator are expected prior to finalizing the report and its recommendations.

RSE Process

- Define the team
  - Experienced senior staff independent from past/current P&T system team
  - Typically teams consist of environmental engineers and hydrogeologists but experts from other disciplines may be included

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The RSE team should be a group of experts in pump and treat systems.

It is strongly encouraged that the team contain members from diverse backgrounds to ensure that the project is reviewed from all angles.

Team members need to be highly sensitive to site managers and others involved. The expert team review is being done to identify issues that are much easier seen in hindsight than foresight. Many times designers and managers have more constraints than just technical issues when developing the system. Or the system may have been initiated years before anyone knew the difficulties in implementing and meeting cleanup goals using pump and treat systems.

RSE Process

- Review existing data
  - Obtain documents from customer
    - Remedial Investigation/FS/Record of Decision
    - Design documents/permit equivalents
    - As-built drawings
    - Long-term operating reports (month, quarter, annual)
    - Long-term monitoring data
  - Generate list of questions for site visit

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Team review and discussions prior to the site visit are crucial in focusing and making the most of the site visit. (Also dragging 200 pounds of documents to read on a flight is a bummer).

Team should review all documents to have a full understanding of the site and its needs.

Technical resources such as checklists and example reports are available; these will be discussed later.

RSE Process

- Visit site – typically lasts 1.5 days
  - Coordinate with operators and managers to ensure
    - maximize participation without inconvenience
    - allow time for document review prior to visit
  - Allow adequate time for follow up
  - Consult site managers and operators for follow up as needed

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Site manager and operators need to be present, ideally for both days.

RSE team needs adequate time to review documents prior to arrival at the site.

In preparation of the report, the RSE team may need to clarify issues or discussions with the site manager or operators.

RSE Background and Implementation Summary

- Analyze data and generate RSE Report

Findings	Recommendations
• system objectives • component performance • costs • effectiveness	• increase effectiveness • reduce cost • improve technical aspects • speed site closeout

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When to Apply an RSE?

- Consider RSEs a recurring event:
  - To fulfill "5-Year" Review requirements
  - Within 1-2 years of start-up
  - When significant change in subsurface or above-ground performance is noted that affects cost or compliance
  - For Fund-lead Superfund sites, prior to transition of the project to the State

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Technical Resources

www.frtr.gov/optimization

- USACE RSE Checklists
- Groundwater Cleanup: Overview of Operating Experience at 28 Sites; EPA 542-R-99-006, Sept. 1999
- Methods for Monitoring Pump-and-Treat Performance; EPA-600-R-94-123, June 1994
- EPA Ground Water Issue, Design Guidelines for Conventional Pump-and-Treat Systems EPA 540-S-97-504, September 1998

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There are many sources of information to draw upon to perform these reviews and optimization studies. The Federal Remediation Technologies Roundtable web site contains the best source for information regarding optimization:

www.frtr.gov/optimization.org

The Corps of Engineers has developed checklists for review and maintains an active web page with an RSE report:

http://www.environmental.usace.army.mil/library/guide/rsechk/rsechk.html

The Air Force has developed technical documents outlining the process and highlighting lessons learned, these can also be found through the FRTR web site.

Technical Resources

- AFCEE Remedial Process Optimization Handbook, Draft Final, December 1999
- Guide to Optimal Groundwater Monitoring; Navy LTM/RAO Working Group September 2000.
- MAROS - Monitoring And Remediation Optimization System AFCEE
- Cost-effective Sampling of Groundwater Monitoring Wells: A Data Review & Well Frequency Evaluation
- Long-Term Monitoring Optimization Guide, Final Version 1.1; AFCEE, October 1997

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Question and Answer Session

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When asking a question please state your name and the organization you represent.

Today's Outline

- EPA's current optimization focus
- What is an RSE?
- Technical resources
- RSE example
- Elements of effective system management
- Question and answer session

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Oconomowoc Electroplating Superfund Site

- Site history
  - Plating operations 1957 - 1991
  - Discharge to wetlands along Davy Creek
  - Added to NPL in 1983, ROD signed 1990
  - Soil, groundwater, surface water, and sediments contaminated with metals, solvents, and cyanide
  - Various removal actions - 1990's (sludge, soil, sediment)

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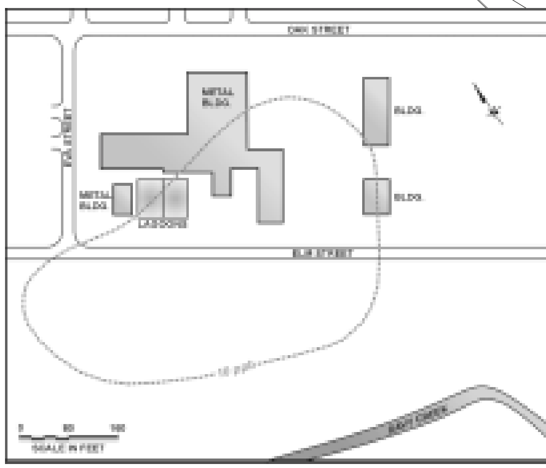
Oconomowoc Electroplating Superfund Site

Site layout



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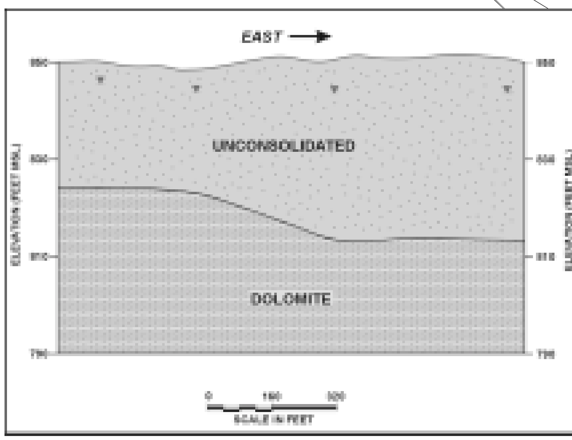
Oconomowoc Electroplating Superfund Site

Site geology



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Site characterization – geo cross-section

- Flat, slopes slightly south toward Davy Creek
- Sands to silty sands over dolomite bedrock
- Water table 1 - 8 feet below grade, slopes toward creek

Oconomowoc Electroplating Superfund Site

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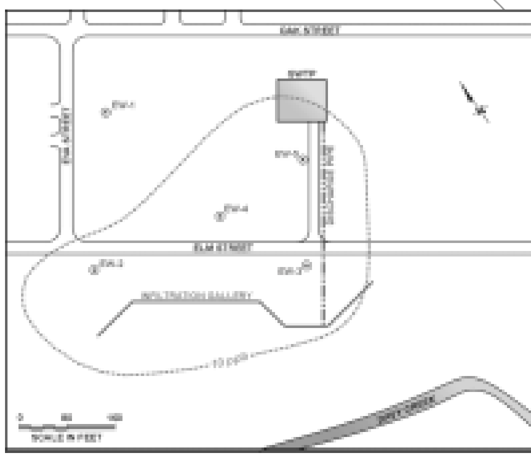
Oconomowoc Electroplating Superfund Site

Groundwater P&T system: Extraction System



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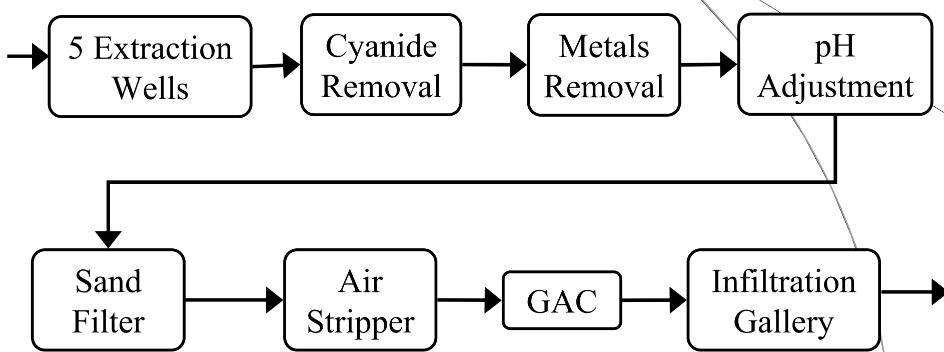
Oconomowoc Electroplating Superfund Site

Groundwater P&T system: Treatment System



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Oconomowoc Electroplating Superfund Site

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Oconomowoc Electroplating Superfund Site

- Extraction system findings
  - Chlorinated solvents plume extends outside of probable capture zone for system west of site
  - Solvents and metals present under wetlands
  - Extraction system drawing water from wetlands and infiltration gallery, but capture zone for one well still large relative to plume
  - Biofouling of wells and piping has reduced flow to 20 to 30 gpm rather than design of 35 gpm

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Oconomowoc Electroplating RSE

- Treatment system findings
  - Plant well maintained, operator looking to optimize
  - Influent cyanide concentration below Wisconsin PAL
  - Influent concentration of metals (except nickel) below PAL, but nickel is below enforcement standard
  - Low metals concentrations in sludge, but sludge is still listed waste
  - pH adjustment problems cause fouling of sand filters

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Oconomowoc Electroplating RSE

Annual Costs	
Utilities:	$18,000
Consumables:	$76,000
Labor:	$280,000
Analysis:	$ 70,000
Other items: (supplies, equipment, etc.)	$28,000
Approximate total annual O&M cost	$471,000

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Oconomowoc Electroplating RSE Recommendations

Effectiveness Recommendations	Capital Costs	Annual Costs
Delineate plume to west of site that is not currently being captured	$20K	$1K/yr
Perform capture zone analysis, optimization of the pumping system	$5K	
Surface water sampling in wetlands in areas of high groundwater contamination	< $1K	

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Oconomowoc Electroplating RSE Recommendations

Cost Reduction Recommendations	Capital Costs	Annual Savings
Eliminate cyanide removal system		$30K/yr
Replace metals removal system with simple oxidant addition	$4K	$10K/yr
Labor reduction with above changes	$3K	$117K/yr
Delisting sludge	$0K	$17K/yr

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Oconomowoc Electroplating RSE Recommendations

Technical Improvement Recommendations (Part 1)	Capital Costs	Annual Costs
Implement DQO process for monitoring program and assign responsibility for evaluating results against criteria		
Install additional monitoring points to better define plume, add existing monitoring points to water level and sampling program	$14.5K	$2.5K/yr

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Oconomowoc Electroplating RSE Recommendations

Technical Improvement Recommendations (Part 2)	Capital Costs	Annual Costs
Implement low-flow sampling (or take filtered samples)		
Improve well rehabilitation program reduce biofouling problem		
Manage monitoring/analytical data electronically		

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Oconomowoc Electroplating RSE Recommendations

- Recommendations for site closeout
  - Document discharge standards for treatment plant, establish firm closure criteria, and develop exit strategy
  - Additional source area definition for VOCs, implement source reduction technologies such as SVE

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Oconomowoc Electroplating RSE Recommendations

- Summary of cost savings

Potential Annual O&M Cost Savings	~$170K/yr
Total Life-cycle Cost Savings (20 yrs)	~$3.4 million

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Elements of Effective P&T System Management

- Contracting considerations
- Investigation considerations
- Design considerations
- O&M considerations

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Contracting Considerations

"Don't let contracting be an excuse"

- Require construction contractor to bring system to steady-state operation, then bid the O&M contract
  - typically 3 to 6 months to obtain steady-state operational data
  - liquidated damages should be used to enforce schedule

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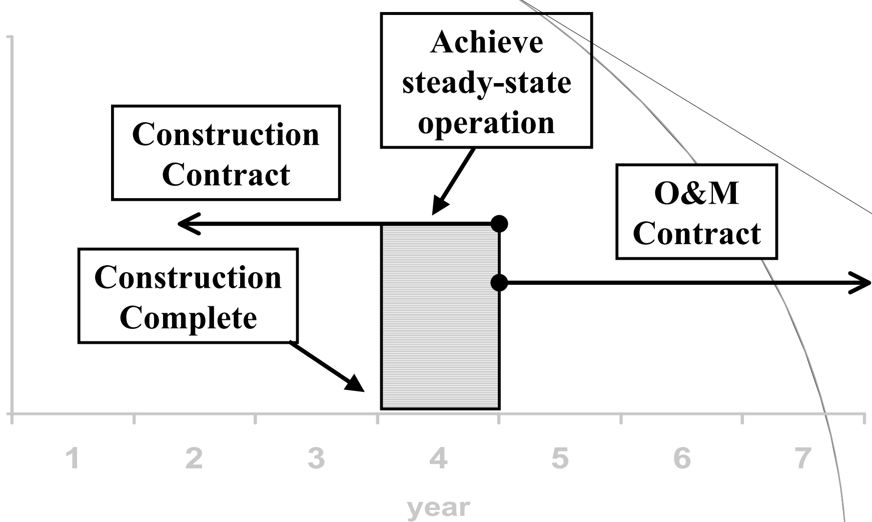
Contracting Example #1



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Contracting Considerations

- Eliminate services no longer required after construction completion (e.g., trailers)
- Utilize technical assistance resources to scope work properly prior to O&M contract
- Each level of subcontracting costs money with no direct return
- Beware of O&M bids based on worst-case data from remedial investigation

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Contracting Considerations

- Remove contractor risk from contract
  - Bid based on cost per volume treated, or based on lump sum for monthly labor and equipment
  - Use cost-reimbursable terms for consumables, utilities, and system upgrades...otherwise all risks will be "lumped" into lump sum

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Contracting Example #2

• Project management • Sampling & analysis • O&M reporting • Basic O&M labor	Lump Sum
• Utilities • Materials • GAC change out • Plant upgrades	Cost reimbursable

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Contracting Considerations

- Avoid use of onsite labs or equipment for analysis except in very unusual circumstances
  - Require additional staff or time for calibration
  - Usually fulfill very short-term needs
  - Generally not certified
  - Usually cost-effective to send samples offsite

This consideration does not extend to inexpensive but accurate and easy-to-use field kits that may be appropriate and cost-effective for a site.

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Contracting Considerations

- Clearly define project management scope
  - Use 20% of annual O&M cost as a guideline
  - Require regular O&M reports (e.g., monthly or quarterly)
  - Require specific evaluations of O&M and groundwater data
  - Require an up-front summary detailing “what do the latest data mean with respect to system effectiveness and system objectives”

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Contracting Considerations

- Require cost-effective but comprehensive monitoring and analysis of that data
  - Water quality data for plume delineation and migration
  - Water levels for preliminary capture zone analysis via potentiometric surface maps superimposed on "target capture zone"
  - Extraction well performance to warn of fouling
  - Limit unnecessary process monitoring

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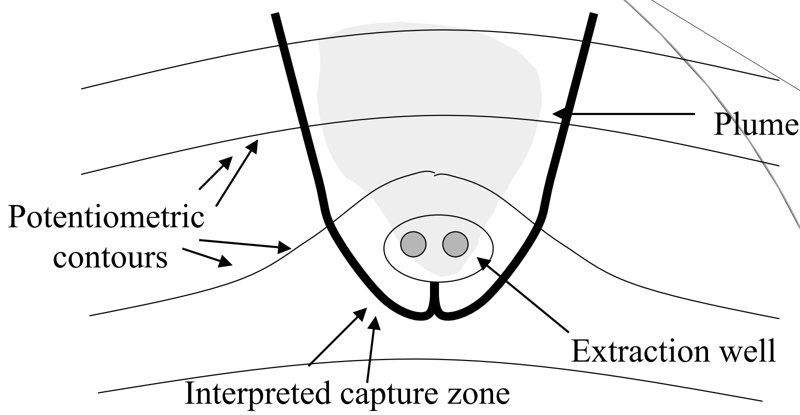
Contracting Example #3

Effective Capture Zone Analysis



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Contracting Considerations

- O&M necessities change with site conditions--contract should allow for reductions in scope of work accordingly
  - Reductions in labor
  - Reductions in process and gw monitoring
  - Elimination of unnecessary treatment processes
- Value engineering: limit awards to process improvements (and not scope reduction)

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Investigation Considerations

"Is additional investigation appropriate now?"

- Clearly delineate source areas
- Clearly delineate contaminant plumes
- Clearly identify all potential receptors

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Design Considerations

"Groundwater is not industrial wastewater"

- Base design concentrations on 24+ hour pumping test data at wells where extraction will occur
  - During pumping,VOC concentrations generally decline by over 90% from investigation MW values
  - Dilution and change in redox conditions often decrease metals concentration tremendously

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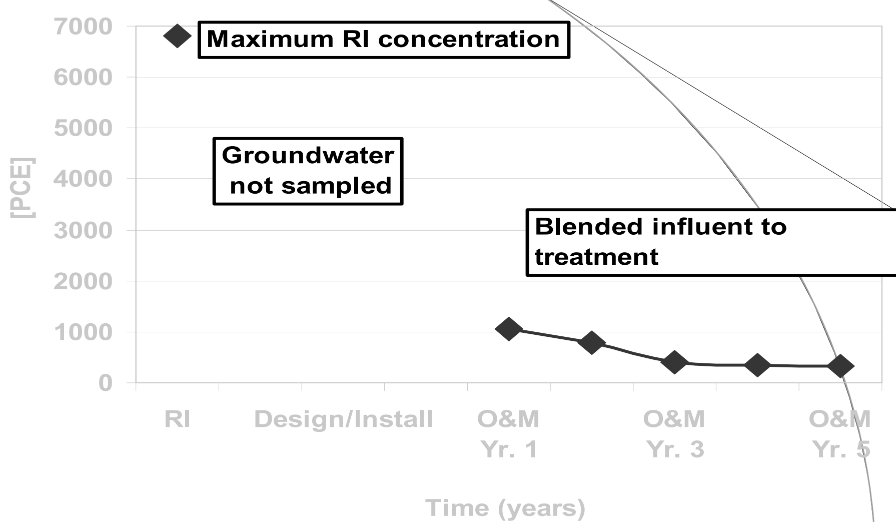
Design Example #1



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Design Considerations

- Utilize technical assistance mechanisms
- Design treatment plants in a modular fashion
  - Groundwater flows slowly allowing time for adjustment
  - Use temporary holding tanks or leased equipment for potentially unnecessary treatment processes
  - Modify treatment plant based on changing site conditions

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Design Considerations

- Avoid redundancy
  - Parallel treatment trains require double the maintenance and equipment
  - Reserve parallel arrangements for high maintenance items such as pumps and filters
  - For many classes of contaminants a single treatment process should be sufficient
  - Many treatment technologies are proven and reliable when implemented as intended

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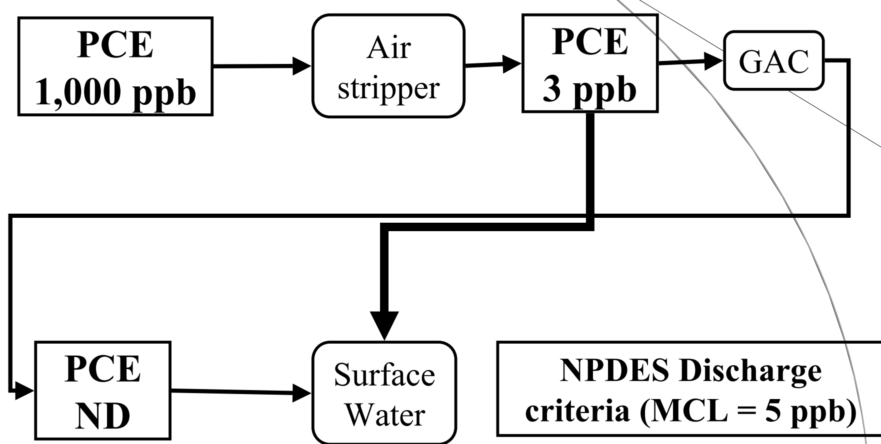
Design Example #2



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Design Considerations

- If possible, try to avoid costly items
  - Metals precipitation (labor)
  - Unnecessary thermal oxidizers (natural gas)
  - Throttled oversized pumps and blowers
  - Onsite analytical labs and equipment

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Design Considerations

- Consider alternate discharge points
- Maintain good relationships w/ local authorities
- Negotiate costs
  - Storm sewer systems --- typically only hookup fees
  - POTW --- fees based on volume

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Design Example #3

Pros		Cons
Often take ketones, may have relaxed limits (TTO)	**POTW**	**Cost, may have limit on flow rate**
Low cost, easy conduit to surface water	**Storm Sewer**	**May have strict limits, require extensive sampling**
Low cost, may allow high flow rates	**Surface Water**	**Distance from site, strict discharge criteria, aesthetics/public perception**
Resource conservation, plume control	**Reinjection**	**Maintenance (fouling), potential to spread plume**

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Design Considerations

- Correctly match process with contaminant
  - VOCs --- tray aerators or packed towers
  - SVOCs --- granular activated carbon
  - Acetone/ketones --- POTW or biotreatment
  - Metals --- metals precipitation

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Design Considerations

- In general (but not always), avoid
  - GAC without stripping --- for VOCs
  - GAC --- acetone/ketones
  - Activated sludge

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O&M Considerations

"The job has just begun"

- Hold contractor accountable:
  - Timely submittal of O&M and groundwater reports
  - Meeting discharge criteria and demonstrating it
  - Evaluating capture of contaminants
  - Comparing actual vs. design flow rates and chemical loading
- Regularly use technical assistance mechanisms and "third-party" reviews of system

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O&M Considerations

- Regularly compare influent concentrations with discharge criteria and criteria for alternate discharge locations
- Compare process monitoring with parameters necessary to run the treatment plant correctly
- Question any differences between design and actual parameters
- Monitor items that indicate well fouling and employ well maintenance program

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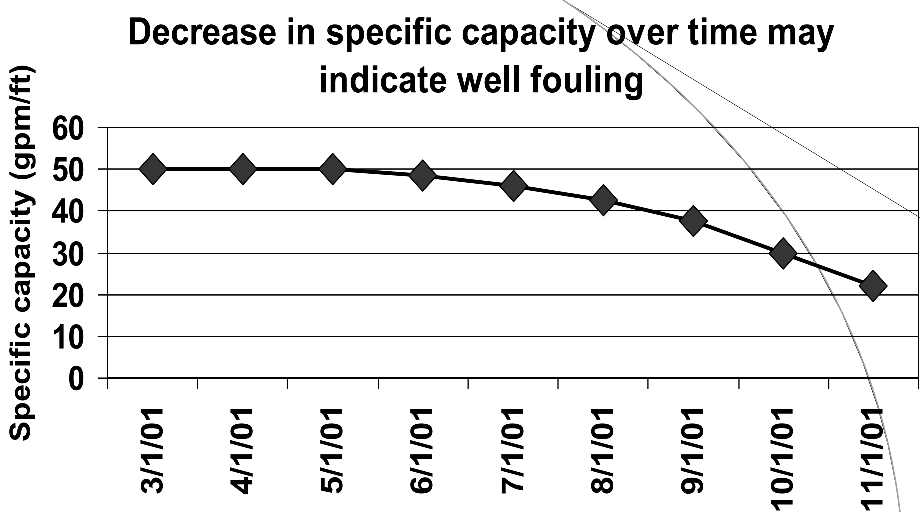
O&M Example #1



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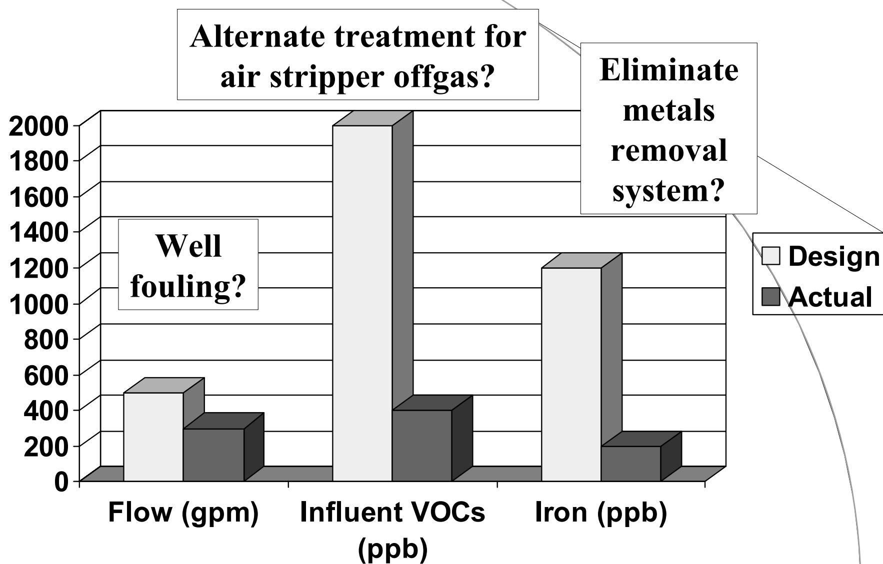
O&M Example #2



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O&M Considerations

- Regularly evaluate contaminant mass loading
  - Helps avoid replacing carbon due to fouling
  - Helps evaluate extent of treatment, for example:
    - no offgas treatment
    - VGAC
    - onsite regeneration of VGAC
    - thermal oxidizer

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O&M Example #3

- Calculate influent mass of TCE:
  - Influent concentration = 1000ug/l
  - Influent flow rate = 250 gpm

$$\frac{1000\text{ ug}}{\text{L}} \times \frac{250\text{ gal.}}{\text{min.}} \times \frac{3.785\text{ L}}{\text{gal.}} \times \frac{2.2\text{ lb}}{1\times 10^{9}\text{ ug}} \times \frac{1440\text{ min.}}{\text{day}} = \frac{3.0\text{ lbs}}{\text{day}}$$

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O&M Considerations

- Thoroughly review updates and reports to
  - measure progress,
  - evaluate plume capture, and
  - ensure effluent standards are met
- Present site description to vendors of various technologies for a free evaluation of that technology's applicability to the site (although helpful, consider vendors are selling a product)

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O&M Considerations

- Evaluate progress of remedy compared to goals --- exit strategy
  - Are endpoints established?
  - Are new cleanup criteria required?
  - Are there still additional sources of groundwater contamination?
  - Is more aggressive source removal necessary?
  - Is containment a more practicable approach?

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Conclusions

- Good contracting practices:
  - Effectively delegate responsibility to contractors
  - Hold contractors accountable
  - Promote cost-effective design and O&M
  - Ensure a protective remedy

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Conclusions

- Good system designs:
  - Address the appropriate problem
  - Are reviewed by a "third party"
  - Are built in a modular fashion for flexibility in addressing changing site conditions
  - Avoid redundancy
  - Have considered all options

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Conclusions

- Effective O&M managers:
  - Hold contractors accountable for quality and timely service
  - Continually evaluate the system as the site conditions change
  - Continually evaluate the remedy vs. its objectives
  - Develop an exit strategy

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Question and Answer Session

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When asking a question please state your name and the organization you represent.

Thank You

After viewing the links to additional resources, please complete our online feedback form.

Thank You

Links to Additional Resources

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