New EPA Guidance on Cost-Effective Design of Pump and Treat Systems

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Accelerating Site Closeout, Improving Performance, and Reducing Costs through Optimization
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Presenters

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Presentation Objective

- Introduce the new EPA fact sheet titled

Cost-Effective Design of
Pump and Treat Systems

OSWER 9283.1-20FS, EPA 542-R-04-004
(Coming Soon!)
Presentation Objective

- Please note that there are three other new companion EPA fact sheets
  
  - *Elements for Effective Management of Operating Pump and Treat Systems*
    - OSWER 9355.4-27FS-A, EPA 542-R-02-009, December 2002
  
  - *O&M Report Template for Ground Water Remedies with Emphasis on P&T Systems*
    - OSWER 9283.1-22, EPA 542-R-04-003, Coming Soon!
  
  - *Effective Contracting Approaches for Operating Pump and Treat Systems*
    - OSWER 9283.1-21FS, EPA 542-R-04-005, Coming Soon!

*Look for all of the fact sheets at www.cluin.org/optimization*
Background

- All of these fact sheets were inspired by the results of a nationwide pilot to optimize operating Fund-lead P&T systems
  - 20 optimization evaluations (RSEs) were conducted
  - RSEs identified a number of useful practices
  - RSEs also identified over 200 opportunities for improvement
    - Over 60 related to improving or evaluating protectiveness
    - Over 60 related to cost reduction

Results suggested need for more specific guidance on P&T design and O&M
These fact sheets are intended to
- Demonstrate the need for active management during O&M
- Outline primary responsibilities during O&M
- Provide general information, tools, and “rules of thumb” for addressing those responsibilities

They are NOT intended to
- Replace hydrogeological or engineering expertise
- Replace the need for external or independent optimization evaluations
Cost-Effective Design of Pump and Treat Systems
Topics

- Remedy Goals and Performance Monitoring
- System Design Parameters
- The Extraction System
- Selecting the Appropriate Treatment Technology
- Discharge Options
- Controls/Redundancy/Failsafes
General Themes

- Use the appropriate design parameters
- Avoid redundant treatment components and treatment trains
- Avoid costly items (consider both capital and O&M costs) and plan for the long-term
- Weigh all of your options
  - Treatment components
  - Discharge options
  - Etc.
System Design Parameters

- **Flow rate**
  - Design extraction rate – base it on pumping data and perhaps modeling
  - Hydraulic capacity – design extraction rate × a factor of safety

- **Design concentration**
  - Determine for each constituent
  - Base it on samples collected during sustained pumping
  - Do NOT base it on maximum concentration from RI

- **Design mass removal rate**

- **NAPLs**
  - LNAPL, DNAPL, etc.
  - Is it recoverable?
Do NOT use the maximum RI concentration for design concentration!!!
System Design Parameters

- Perform and interpret process monitoring, for example...
  - Calculate mass loading/removal rate in influent water

\[
\text{influent concentration} \times \text{flow rate} \times \text{conversion factors} = \frac{\text{lbs}}{\text{day}}
\]

\[
\frac{1,000 \ \text{ug}}{\text{L}} \times \frac{250 \ \text{gal.}}{\text{min.}} \times \frac{3.785 \ \text{L}}{\text{gal.}} \times \frac{2.2 \ \text{lbs.}}{1 \times 10^9 \ \text{ug}} \times \frac{1,440 \ \text{min.}}{\text{day}} = \frac{3.0 \ \text{lbs.}}{\text{day}}
\]

- Compare results to design specifications for system and system components
## Treatment Technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Example Comments</th>
</tr>
</thead>
</table>
| For removing NAPL | ● Easy to maintain, do not remove emulsified product  
● Remove emulsified product, costly for large volumes  
● Removes neutral NAPL, costly to operate |
| Treating organic compounds | ● Good for most VOCs, low operator requirements  
● Good for many organics, low operator requirements  
● Effective for high concentrations, compound specific  
● Useful for ketones, requires more operator attention  
● Destroys most organics, high energy costs |
| Treating inorganic compounds | ● Low operator requirements, removal may not be sufficient  
● Effective and reliable, operator and material intensive  
● Low operator requirements, compound specific |

*These and other provided comments are general “rules of thumb”.*
Treatment Technologies

- Preliminary design estimates for GAC
  - Determine influent concentration
  - Determine mass loading rate
  - Determine ratio (R) for pounds of contaminants to pounds of GAC

\[
R = \frac{1}{1,000} \times K \times C^{1/N}
\]

- Calculate GAC usage (mass loading rate / R) and associated cost per year
- Calculate vessel size based on usage and empty bed contact time

<table>
<thead>
<tr>
<th>Compound</th>
<th>PCE</th>
<th>TCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>K (mg/kg)(L/mg)^{1/N}</td>
<td>51</td>
<td>28</td>
</tr>
<tr>
<td>1/N</td>
<td>0.56</td>
<td>0.62</td>
</tr>
</tbody>
</table>
Consider ALL of your options before selecting a remedy, particularly if the presumptive remedy is known to be costly. Consider the following example decision tree for addressing metals in extracted groundwater:

1. Estimate influent metals concentrations by sampling during sustained pumping.
2. Are metals above discharge standards?
   - Yes: Are mass loading and groundwater quality favorable for ion exchange?
     - Yes: Ion exchange
     - No: Does filtration provide sufficient removal?
       - Yes: Filtration
       - No: Metals precipitation
Treatment Technologies
Continued

Are metals above discharge standards?

NO

Are concentrations high enough to affect other treatment components?

YES

Is frequent cleaning and use of filters more cost-effective than pre-treatment for metals?

NO

Filtration and cleaning

Yes

Metals precipitation

No specific action required for metals
# Discharge Options

## Pros

<table>
<thead>
<tr>
<th>POTW</th>
<th>Storm Sewer</th>
<th>Surface Water</th>
<th>Reinjection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Often take ketones, may have relaxed limits (TTO)</td>
<td>Low cost, easy conduit to surface water</td>
<td>Low cost, may allow high flow rates</td>
<td>Resource conservation, plume control</td>
</tr>
</tbody>
</table>

## Cons

<table>
<thead>
<tr>
<th>POTW</th>
<th>Storm Sewer</th>
<th>Surface Water</th>
<th>Reinjection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pay by volume, may have limit on flow rate</td>
<td>May have strict limits, require extensive sampling</td>
<td>Distance from site, strict discharge criteria, aesthetics/public perception</td>
<td>Capital cost, maintenance (fouling), potential to spread plume</td>
</tr>
</tbody>
</table>
## Controls, Failsafes, and Automation

- General guidelines for labor typically required at various types of treatment plants

<table>
<thead>
<tr>
<th>Treatment Train</th>
<th>Estimated Labor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air stripping</td>
<td>• Weekly checks by local operator (8-12 hrs/wk)</td>
</tr>
<tr>
<td>Vapor phase GAC for offgas treatment</td>
<td>• Quarterly checks by engineer</td>
</tr>
<tr>
<td>GAC</td>
<td>• Weekly checks by local operator (8-12 hrs/wk)</td>
</tr>
<tr>
<td></td>
<td>• Quarterly checks by engineer</td>
</tr>
<tr>
<td>Filtration</td>
<td>• Weekly or semi-weekly checks by local operator (8-16 hrs/wk)</td>
</tr>
<tr>
<td>UV/Oxidation</td>
<td>• Quarterly checks by engineer</td>
</tr>
<tr>
<td>GAC</td>
<td>• One operator full time with potential for part time assistance (40 - 60 hours/wk)</td>
</tr>
<tr>
<td>Metals removal</td>
<td></td>
</tr>
<tr>
<td>Filtration</td>
<td></td>
</tr>
<tr>
<td>(perhaps including air stripping, GAC, biotreatment, or UV/Oxidation)</td>
<td></td>
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</tbody>
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Discussion