How Far Do You Go?
Cost/Benefit Considerations for Removal Actions

Dave Williams, OSC Region 7
Cost Benefit Simplified for Men

Cost

Benefit

Towne Square Jewelers
634 West Lincoln in Charleston
 Definitions

• **Cost/benefit analysis**—Any process for assessment of a project or proposal which offers an approach to making economic decisions.

• **Law of diminishing returns**—The tendency for a continuing effort toward a particular goal to decline in effectiveness after a certain amount of success has been achieved.
Central Question

How do you balance cleanup goals vs. analysis of diminishing returns?
Common Diminishing Return Experience

If I double my insulation thickness (R value), Will I cut my heating bill in half?
Adding Attic Insulation diminishing returns

Annual Cost To heat home

The effect of ceiling insulation on annual heating energy cost showing the diminishing benefit of additional insulation.

- Uninsulated roof: $3,900/yr
- Typical Solution: R-2.5 insulation saves $2,900/yr
- R-4.0 insulation: $850/yr (only $150 extra savings)
- R-5.0 insulation: $800/yr (only $50 extra savings)

Increased Insulation
Finite numbers

• **Buying a car:**
  • which saves more gas:
    – upgrading from 20 mpg to 30 mpg, or
    – from 30 mpg to 50 mpg?

• Assume 12,000 miles driven per year
Diminishing returns: upgrading vehicle mpg
Agenda

- Hurricane Ike-diminishing returns
- Cleanup goals
- Homer’s Solvent Site Example-
- Nebraska PCE in GW site
- Break-15 minutes
- Revisit Historical Dioxin Cleanups ?
- Armour Rd Arsenic site
Hurricane Ike Case Study

When do we reach diminishing returns?
Cost/Benefit & Diminishing Returns

• Hurricane Ike ravaged TX coast 2008
• EPA - ESF10 support for Stafford Act
  – State of TX has 25% cost share
  – EPA Mission-Recover “orphan” containers
    • Initial “target rich” setting
    • Many containers/day collected-low search time
    • Trend - to fewer collected/day & more search time
Cost/Benefit & Diminishing Returns

• TX Paying 25%--concerns
  – do we get our money’s worth?
  – Could TX use same $ for State staff to do job?

• Cost/ benefit analysis
  • When does TX “elect to stop” paying 25%?

• EPA provides cost/container info for each month on the job
Cost/Benefit & Diminishing Returns

Hurricane Ike ESF-10 example

- September: Cost per container
- October: Cost per container
- November: Cost per container
- December: Cost per container

The bar chart shows the cost per container for each month, with the highest cost in December.
CLEANUP GOALS
Risk management vs. Risk assessment

- Preliminary Remedial Goals
- Screening Levels
- Streamlined risk assessments
- Range of risk tolerance
  - $10^{-4}$ to $10^{-6}$

*What is proper balance of achieving cleanup goals vs. the analysis of diminishing returns?*
The Search for Balance

Cleanup goals

vs.

Diminishing Returns
Removal action:
What are you trying to achieve?

• NCP gives broad discretion regarding the “scope” of a removal action [300.415(b)(1)]
  - “… the lead agency may take any appropriate action to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or threat of release”

• OSCs must use their own discretion in determining the scope of a removal action
Factors to Consider When Determining Scope

- Appropriateness of using removal authority
- How clean?
- Use of science
- Cost
- The community
- Future uses
- Political climate
- Government partners
- PRPs
- Similar sites (wood treaters)
What is the Proper Balance?

How Clean?

Cost
Potential Sources for Site Cleanup Levels

• Preliminary Remediation Goals or Regional Screening Levels - EXIST
  – Carcinogens: Initially set at $10^{-6}$ carcinogenic risk level ("point of departure" for remedial program)
  – Non-carcinogens: Set at levels that do not exceed acceptable threshold levels based on standard exposure assumptions

• State tiered criteria - EXIST
  – Very similar to RSLs but may have criteria for soil to groundwater and groundwater to surface water

• Site-specific risk-based calculation - CREATED
  – Using site specific exposure assumptions
What Does the NCP Say About OSCs and Risk Assessment?

• The NCP does not require OSCs to conduct risk assessments

• Regional policies/SOPs?

• Special teams and other OSC resources are mentioned as having the capability to provide risk assessments and risk information to OSC/RPM
  • 300.145(b)(2) – ERT capabilities
  • 300.145(f) – Radiological Emergency Response Teams (RERT) capabilities
  • 300.175(b)(2) – EPA capabilities as part of NRT and RRTs
So . . . What is the Proper Balance?
Risk Reduction v. Scope of Action

• The “balance” is site-specific
  – What works for one site may not work for another
  • Factors other than “cleanup level” and “cost” may drive the site-specific balance
    – Use of science, community, future use, political climate, government partners, PRPs

• Sound too complicated?
  – If it were easy . . .

• Doing the most good with the funding available
  – Cost/benefit methodology
Cost/Benefit Methodology

• Moderately conservative
  – Cost of contaminant mass removed uses fewer assumptions
• Helps quantify the “bang for the buck”
• Only one piece of the puzzle
  – Requires understanding of the risk associated with whatever “cleanup level” is proposed using the cost/benefit methodology
• Should not be done in a “vacuum”
Homers Solvent Site
Homer’s Solvent Site Example

- You are OSC -soil TCE contamination
- Site assessment data--next slides
- Two areas “A” and “B” require analysis
- Risk assessor-36ppb TCE protects GW
- OSC must propose action for Homer site
- Handout
Homers Solvents-CSM sketch

- Area A
  - Avg TCE conc = 50 ppm

- Area B
  - 1000 cu yds
  - Avg TCE conc = 400 micrograms/kilogram (ppb)
OSC prepares Mgt Briefing

• Calculate the mass of TCE in Area A
• Calculate the mass of TCE in Area B
• What is the total TCE mass (A + B) ?
• What % of total TCE is in A?
• What % of total TCE is in B?
OSC Briefing

• What is cost of removal in each A & B?
  – assume unit cost of $100/ cu yd for removal, treatment and disposal

• What is cost per lb of TCE removed in each A & B?
OSC Prepares Briefing

• What do you recommend in your Action Memo?
• Why?
## Useful Briefing Table

<table>
<thead>
<tr>
<th></th>
<th>Volume</th>
<th>Mass</th>
<th>% Total Mass</th>
<th>Cost ($100/ cu yd)</th>
<th>Cost per Lb TCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td></td>
<td>NA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Calculations -10 min

• **Conversion factors & Useful info**
  • 1 cu yd = 27 cu ft
  • 1 cu ft soil = apx 100 lb
  • 1 cu yd soil = apx 2700 lb

• 1 ppm = 1 part/1,000,000 parts
• 1 microgram/kg = 1 ppb or
  1 part/1,000,000,000,000 parts
Review Homer Solvent Calculations

- Handout- solution sheets
- Discuss process & calculations
  - Flip chart
  - Discussion of units canceling
- Q /A on Homer Site
- What do you recommend in your action memo?
Homer Solvent Site: Incremental mass removal vs. Cost
Process summary

1. Make simplified 3-D sketch-CSM

2. Estimate total contaminant mass in the media you are cleaning up....each area separately.

3. Estimate costs for removal/cleanup of each area (eg $150/ton excavated).
   - Table-helpful for comparison & data display

4. Develop a management/action memo recommendation
Nebraska
PCE Site
Situation

- You are assigned OSC on NPL site
- PCE plume leaching to GW
- Source control soil excavation-good option
- Risk assessors -25 ppb PCE protects GW
  - Site info-next slides
“Tip Top” Dry Cleaner
SOIL DATA  1-4 ft interval
SOIL DATA  4-8 ft interval
Cleanup Option Evaluation

• Mgt seeks briefing on soil removal options
• Handout
• Use the 4-step process
• Prep mgt briefing
  – Use comparison table
• Select option you will propose in Action Memo
  – Support your recommendation
Divide -- Area A & B
Comparison of Options

<table>
<thead>
<tr>
<th>Volume</th>
<th>PCE Mass</th>
<th>% of Total PCE Mass</th>
<th>Total Cost</th>
<th>Cost per lb PCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>NA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Take 10 min for Calculations

• Handout has:
  – Site data/info
  – Drawings
  – Problem Statement
Review Nebraska PCE Calculations

- Handout/solution sheets
- Discuss process & calculations
- Resolution of cleanup goal vs. diminishing returns analysis
- What are your options if you recommend against achieving a set cleanup goal?
Revisit Historical Dioxin Cleanups?
30 Historical R7 Dioxin Sites

• Dioxin (2,3,7,8 TCDD) highly toxic
• Found in soils in ~30 sites in R7
• Historical cleanups
  – Largely residential
  – 1 ppb Cleanup Std
  – 120,000 tons disposed (aggregate)
• Proposed new PRG-0.072ppb TCDD
• Should EPA R7 revisit these 30 sites?
Dioxin Cleanup Question

• You have been asked to evaluate the cost/benefit of additional cleanup work to 0.072ppb TCDD at previously cleaned-up dioxin sites.

• Divide into 2 Areas
  – Historical Cleanups=Old
  – Cleanups Proposed=New
  – $1000/ton (Trans + Store + Dispose)
## Assumptions:

<table>
<thead>
<tr>
<th>Cleanup std</th>
<th>Waste Mass (tons)</th>
<th>Avg TCDD Conc in Waste</th>
<th>Cost per ton (total)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Old</strong></td>
<td>1ppb</td>
<td>120,000</td>
<td>20 ppb</td>
</tr>
<tr>
<td><strong>New</strong></td>
<td>0.072ppb</td>
<td>120,000</td>
<td>0.4 ppb</td>
</tr>
</tbody>
</table>
Dioxin Cleanup

- Handout
- Use the 4-step process to analyze
- Complete Table (next slide)
- Prepare a briefing for Sr Mgt
- What is your recommendation?
## Dioxin Briefing Information

<table>
<thead>
<tr>
<th></th>
<th>Waste Quantity</th>
<th>Contaminant Mass</th>
<th>% Total Contam Mass</th>
<th>Total Cost ($1000/cu yd)</th>
<th>Cost per Gram</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N A</td>
</tr>
</tbody>
</table>
Review Dioxin Site Calculations

- Handout-solution sheets
- Discuss process & calculations
- Recommendation?
- Q/A on Dioxin Site
A homeowners viewpoint?

Avg residential yard has 120 cu yd of soil in the top 3 inches to be removed to achieve 0.072ppb

Calculate mass & cost of TCDD removed from a residential yard.
Use table provided
## 2nd Residential Cleanup data & requested answers

<table>
<thead>
<tr>
<th>Cleanup Std</th>
<th>Waste Vol (cu yds)</th>
<th>Avg TCDD Conc in Waste</th>
<th>Contam Mass Removed</th>
<th>Total Cost ($1000 per ton)</th>
<th>Cost per gram removed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Per Home</strong></td>
<td>0.072ppb</td>
<td>120</td>
<td>0.4 ppb</td>
<td><strong>YIKES!</strong></td>
<td><strong>YIKES!</strong></td>
</tr>
</tbody>
</table>
Armour Rd Arsenic Site

MSMA

\[
\text{Na}^+ \cdot \text{O} \cdot \text{As} \cdot \text{OH} \quad \text{O} \cdot \text{CH}_3
\]
As Herbicide Formulator Facility

- Railroad use of product

- Operational spills & leaks
  - High conc As in soil – MSMA
  - Clear Source for GW contamination
  - Aquifer important area-wide
    - Protect GW essential
PRP Removal action

• Source control - GW
  – Maximize mass As removed
• PRP Funds limited
• Space limited- Congested area
  – Structures, Railroads, Highways, Utilities
  – Excavation challenging
Congested Excavation Area - Rail spur between Habco bldg & former Payless bldg
Congested Excavation Area - in front of Habco building
Congested Excavation Area
Looking toward Habco building from RR tracks
Site characterization info

• Features & site info - next slides
• High Conc As in soil
  – 2000 ppm As avg for depth of 20 ft
• Boundaries of source area
  • Defined – irregular area
  • ~2 acres total
  • Excavate all inside boundary to 20 ft deep
  • CSM – excavation options evaluated
Site Features
Excavation Boundary
CSM- Excavation Options
Ideal & Actual

Ideal Excavation - Vertical Sides
- Sheet Piling - $\$
- Max. Volume Removed

Conceptual Site Model

Actual Excavation - High Wall Side Slopes
- Less Volume Removed
Actual Excavation Shape
note high walls & perimeter
## CSM Excavation Options Compared

<table>
<thead>
<tr>
<th></th>
<th>High wall</th>
<th>Vol &amp; Mass</th>
<th>Extras req’d</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Actual</strong></td>
<td>High slope</td>
<td>High</td>
<td></td>
<td>$100/yd</td>
</tr>
<tr>
<td><strong>Ideal</strong></td>
<td>vertical</td>
<td>max</td>
<td>Sheet piling</td>
<td>$100/yd + 1 million</td>
</tr>
</tbody>
</table>
CSM-High Wall (Wedge)
Slope & Volume

Conceptual Site Model - Volume of High Wall Side Slopes

Volume High Wall = \[ \frac{\text{Area } B \times \text{Perimeter Length}}{2} \]

Area B = \( \frac{1}{2} \times \text{Base} \times \text{Height} \)
= \( \frac{1}{2} \times 5' \times 20' \)
= 50 \, \text{ft}^2

Max High Wall Side Slope Recommended

1:1
20
20

1:2
20
40

Rise: Run
CSM-Actual Excavation Volume Calculations

Ideal Volume - Total High Wall Volume = Actual Volume

Ideal Vol = [Area inside excavation perimeter] x [20' depth]

Total High Wall Vol = [Length excavation perimeter] x [Area B]
Total Area Inside Irregular Exc Boundary Example Estimation Process
<table>
<thead>
<tr>
<th></th>
<th>Ideal</th>
<th>Actual</th>
<th>High Wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>As Mass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of total As mass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost ($100 per cu yd)</td>
<td>+ $1M -sheet pile</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost per lb As</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Armour Rd Site Calculations: Arsenic only

• Handouts-solution sheets

• Discuss process & calculations
But wait: What about dioxin, 2,4-T, 2,4,5-T, and pentachlorophenol

– F-listed wastes

– Are the non-arsenic contaminants significant, i.e., is the cost of treating them separately worth the benefit?
The F-list (non-specific source wastes)

- This list identifies wastes from common manufacturing & industrial processes, such as solvents, that have been used in cleaning or degreasing operations. Because the processes producing these wastes can occur in different sectors of industry, the F-listed wastes are known as wastes from non-specific sources. (See 40 CFR 261.31)
### “F-Listed” waste calculations

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Average concentration</th>
<th>Total soil volume</th>
<th>Total mass of contaminant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dioxin</td>
<td>1 ppt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pentachlorphenol</td>
<td>1 ppb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,4-D</td>
<td>3 ppb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,4,5-T</td>
<td>5 ppb</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
“Contained In” Policy

• If an F-listed waste contaminates soil, is the soil an F-listed waste?
Contained-in policy

- Add language from RCRA policy document
Armour Road Contained-in Determination by state of Missouri

- Include excerpt or handout of actual document
Armour Rd Site: Arsenic and other contaminants

• Recommended Action?

• Q/A on Armour Rd Site
Note Terraces
Steep high wall-max removal of As slump hazard
Mud problems
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Questions and Answers

Thanks for participating!